West Holland River Subwatershed Management Plan

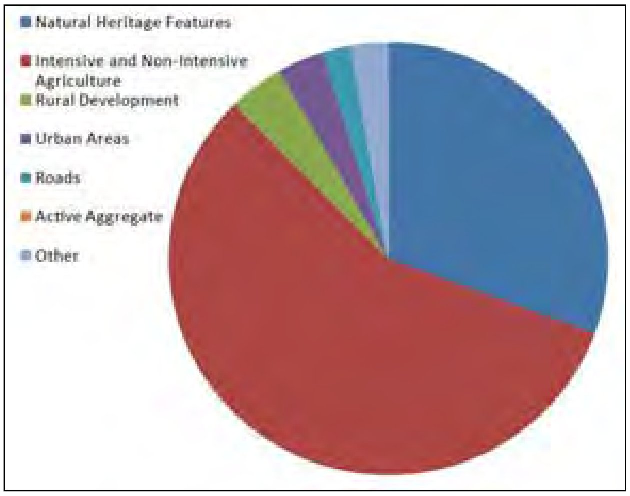
Lake Simcoe
Region
Conservation
Authority

2010

Executive Summary

Aerial view of the Holland Marsh polder

The West Holland River occupies 354 km^2 of lands immediately to the southwest of the tip of Lake Simcoe's Cook's Bay. Originating on the Oak Ridges Moraine, the headwaters of the subwatershed flow through mainly forested and agricultural areas before entering the Holland Marsh. The system then flows past the Town of Bradford, and then past forested and agricultural areas before discharging into the lake. The subwatershed supports some of Ontario's most productive vegetable farming operations. Many of these are found in the Holland Marsh polder, a former wetland area that has been drained, with water levels that are carefully controlled by a series of canals and pumping stations. The subwatershed jurisdiction is shared by York Region and Simcoe County. The municipalities that fall within its boundaries are King (including the communities of Schomberg, Lloydtown, Kettleby, and Snowball), Caledon, New Tecumseth, Bradford West Gwillimbury, and Newmarket.



Land use breakdown for the West Holland subwatershed

The land within the West Holland River subwatershed provides a number of benefits to the river, to Lake Simcoe, and to its residents and visitors. A breakdown of land use is shown to the left. Thirty-one percent of the subwatershed area is occupied by natural areas which absorb rain and snow melt, maintain groundwater levels and baseflow, help to prevent flooding and erosion, and improve water quality. These areas also provide habitat for a wide variety of species, as well as numerous nature-based recreation opportunities. In addition, the West Holland's agricultural areas, which occupy 57% of the subwatershed, provide a close-to-market supply of fresh vegetables, as well as opportunities for infiltration. The West Holland's natural features and greenspaces provide its urban residents with the connection with nature that many of them value. In a study undertaken to estimate the value of the services provided by the subwatershed's ecosystem, it was found that it would cost over $90 million to replace these natural services with man-made solutions. Given the immense intrinsic and monetary value of the subwatershed's features, the completion of this subwatershed plan is an important step in ensuring that these services continue to be performed economically, while balancing the other demands on the subwatershed such as urban growth, agriculture, industrial, and recreational uses in a truly integrated fashion.

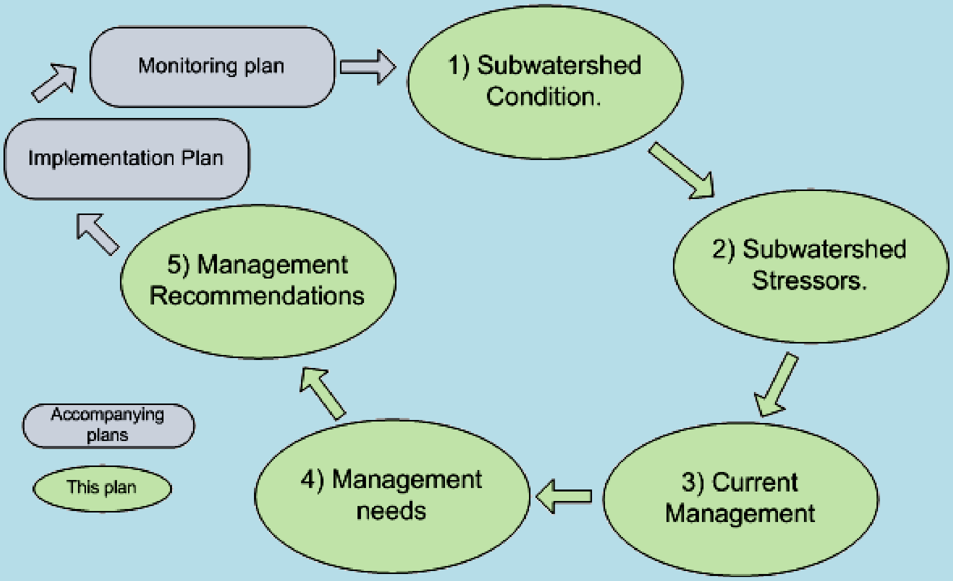
In spite of the benefits provided by its natural areas, the West Holland River is showing signs of stress from some of its land uses. For example, in both the 2008 Watershed Report Card and 2009 Report Card Update, the West Holland River received a 'D' for phosphorus concentration, with the highest average concentration in the Lake Simcoe watershed, of those systems where monitoring occurs. The amount of forest cover, interior habitat and riparian buffers are also less than what would be expected in a healthy system, and the fish and benthic invertebrate communities are also showing signs of stress. Much of this state can be attributed to the very large extent of agricultural land use in the subwatershed, as well as several urban areas located within the system. Impacts from the agricultural areas include the removal of riparian vegetation; the input of sediment-laden sediment which impacts both water quality and the habitat of fish and benthic invertebrates; the use of large volumes of water for irrigation, and the changes to the hydrology of the system by the artificially maintained polder system; channelization; and the rapid conveyance of stormwater directly to area watercourses by tile drainage. In the West Holland's urban areas, impacts from the high level of impervious surfaces include decreased infiltration of rain and melt water, which can result in low groundwater levels and reduced baseflow in area watercourses; impacts to water quality as contaminants are carried with stormwater runoff; instability and erosion of streambanks; effects on stream habitat such as sediment deposition or disruption of natural riffle-pool sequences, resulting in changes to the composition of aquatic communities; and impacts on biodiversity. These impacts can be particularly detrimental in those areas of the subwatershed that lack stormwater controls. In addition, there are issues associated with other activities in the subwatershed such as recreation and industrial uses, including water consumption, the introduction of invasive species, and the input of nutrients and other contaminants into area watercourses. The cumulative effects of these activities have caused the West Holland to become one of the most stressed subwatersheds in the Lake Simcoe watershed, and one of the largest contributors to Lake Simcoe's phosphorus loads.

Before (top) and after (bottom) a riparian planting project in the Holland Marsh

There have been numerous successes in improving the conditions in the West Holland River subwatershed. Initiatives such as the completion of streambank erosion control projects, tree plantings, establishment of riparian vegetation (see photos at left), and other BMPs will help to improve conditions with respect to bank stability, water quality and quantity, and aquatic and terrestrial natural heritage in the subwatershed.

The West Holland subwatershed is scheduled to experience some growth in the coming years. The Provincial Places to Grow Plan identifies that population and employment growth will occur in the Lake Simcoe watershed. Provincial growth forecasts have been allocated to all municipalities in York Region, as well as to a number of municipalities in Simcoe County. According to the Town of Bradford West Gwillimbury Official Plan (2002 consolidation) the population is expected to increased from 24,000 residents (2006 census) to close to 48,000 by 2026. The population of King Township is also expected to grow by approximately 15,000 residents (York Region draft Official Plan, 2009). Along with the housing that will have to be built to accommodate these new subwatershed residents, new employment lands, shopping centres, and schools will also be required to meet their needs. In addition to the above, in order to service these increases in population and employment, critical municipal infrastructure projects, including roads, municipal sewers and treatment facilities and water supply systems will also need to be built, maintained, and expanded in the subwatershed. This will result in increased levels of impervious surfaces and its associated impacts, combined with a reduction in the natural features that help to mitigate these impacts. These changes, as well as the unknown impacts that climate change may bring to the subwatershed, will have a significant effect on the health of the subwatershed if measures are not taken to mitigate them.

To build on the successes of the projects initiated so far, and to mitigate impacts of the changes that are to come, a comprehensive, integrated subwatershed plan is needed for the West Holland River subwatershed. The plan that follows is intended to provide the blueprint for the conservation authority, the municipalities, and subwatershed stakeholders to move forward and continue the important work that has been completed in order to mitigate the impacts of land use changes and improve conditions in the subwatershed. It includes chapters dedicated to each of five subwatershed parameters, these being water quality, water quantity, aquatic habitat, fluvial geomorphology and terrestrial natural heritage, although it is acknowledged that all of these parameters are related and certainly interact with each other. Each chapter is loosely structured around a state-pressure- response framework, in that each chapter firstly describes the current condition (state), secondly describes the stressors likely leading to the current condition(pressure), and finally recommends management responses in the context of the current management framework (response) (See text box below).



Plan section:

1) ***Subwatershed Condition:*** Describes and analyzes the current state or condition of the subwatershed feature based on the best available data and information. This assessment is based on monitoring data, model output, surveys etc.
2) ***Subwatershed Stressors:*** Uses the best available information to identify and quantify the factors affecting the current condition of the watershed. For example, describing phosphorus loads from different land use activities.
3) ***Current Management:*** Establishes the relationship of the subwatershed plan to other legislation and planning documents;
4) ***Management needs:*** Identifies areas within the current management framework where improvements within this plan may be able to have greatest impact i.e. gaps or opportunities for the subwatershed plan to act upon.
5) ***Management recommendations:*** outlines resource management goals and objectives; as well as options for protection, rehabilitation, and enhancement of conditions in the subwatershed.

The management responses (high level recommendations) fall into eight broad categories, these being:

A. Planning and Policy
B. Use of Better Management Practices
C. Changing the Way Things Are Done ‘On the Ground’
D. Applied Research and Science
E. Monitoring (Surveillance, Compliance, and Reporting)
F. Management, Rehabilitation, and Restoration
G. Adaptive Response (Climate, Social, Political)
H. Communications

From these recommendations fall a number of detailed recommendations, the implementation of which will help to meet the plan's goals and objectives. These detailed recommendations will form the implementation plan, a document which will assign responsibilities, develop timelines, estimate costs, and set priorities for undertaking the actions that will need to be taken in the West Holland subwatershed. Input from the subwatershed municipalities, conservation authority staff, stakeholders and members of the public will be incorporated through the process of developing the implementation plan. Implementing the recommended actions of this plan is a huge undertaking with respect to both the funding and human resources that will be needed, and will require assistance from all of these subwatershed partners.

Undertaking the actions outlined in the implementation plan will help to protect the existing natural resources, facilitate informed planning decisions, and improve the efficiency of the development review process. An over-arching concept to keep in mind throughout the subwatershed planning process is that it is far more beneficial, both financially and ecologically, to protect resources from degradation than to rehabilitate them once they have been damaged. These plans support this concept, and provide alternatives for instances where it may not be possible to maintain the West Holland's resources in their natural state.

The implementation plan will identify actions to be undertaken in both the short and the long term. However, the subwatershed plan will be reviewed on a regular basis as part of the adaptive management framework to ensure the effectiveness of the actions being undertaken. Depending on the state of the subwatershed, the subwatershed and implementation plan may be updated at that point in order to incorporate the most up to date information on the subwatershed state and to incorporate any new tools, technologies, and practices that may be used. By undertaking these regular evaluations and updates, the partners can ensure that all of the necessary steps are being taken in order to achieve the goal of a healthy West Holland River subwatershed.

Participation from subwatershed stakeholders will be important for developing the implementation plan

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1 Approach and Management Setting

1.1 Introduction

The West Holland River subwatershed, which occupies 35,409 ha of lands immediately to the southwest of the tip of Lake Simcoe's Cook's Bay, supports a wide variety of land uses, including some of southern Ontario's most productive vegetable farming operations, which are contained on the Holland Marsh. The subwatershed is shared by the Regional Municipality of York and Simcoe County, with a very small portion of Peel Region in the southwest. The Townships of King, Caledon, New Tecumseth, Bradford West Gwillimbury, and part of the Town of Newmarket lie within the subwatershed.

The headwaters of the West Holland River originate on the Oak Ridges Moraine, flowing through mainly forested and agricultural lands. The agricultural area of the Holland Marsh is in the centre of the subwatershed, just upstream of the West Holland's major urban area, the Town of Bradford. As it flows toward the confluence with the East Holland River and ultimately the mouth of the Holland River in Cook's Bay, there is more natural cover, with forests and wetlands, as well as some agriculture.

The land uses in the subwatershed have had considerable impacts. Water quality and quantity have deteriorated due to the inputs of harmful substances from both urban and rural areas and because of the increasing amount of impervious area in this rapidly urbanizing watershed.

In order to mitigate the impacts of land use changes in a subwatershed, and to prevent future impacts, subwatershed plans are developed. These plans provide a framework for the implementation of remedial activities and a focus for community action. More importantly, they prevent further serious degradation to the existing environment and can reduce the need for expensive rehabilitation efforts. Subwatershed plans provide a framework within which sustainable development can occur.

As part of the requirements through the Oak Ridges Moraine Conservation Act and Conservation Plan Regulation (ORMCP, O.Reg. 140/02), all municipalities with subwatersheds originating on the Oak Ridges Moraine (ORM) are required to develop a subwatershed plan for each. York Region has commissioned the Lake Simcoe Region Conservation Authority to complete these plans for their subwatersheds. The four York Region subwatersheds that originate on the ORM are the West and East Holland Rivers, Maskinonge River, and the Black River. The watershed planning requirements of the Act and Conservation Plan Regulation represent an opportunity to strengthen a long established watershed management partnership between the Regional Municipality of York and its two conservation authorities. York Region has gone beyond their requirements under the ORMCP with the development of these subwatershed plans for the entire subwatershed area, not just the portion that lies on the Oak Ridges Moraine.

1.2 West Holland River Subwatershed Planning Process

1.2.1 Oak Ridges Moraine Conservation Plan

The Oak Ridges Moraine Conservation Plan was developed in 2001, and is an ecologically based plan that provides land use and resource management direction for the 190,000 hectares of land and water that fall on the Oak Ridges Moraine (ORM), 11,363 ha of which falls within the West Holland River subwatershed. The ORM is one of Ontario's most significant landforms. It stretches from the Trent River in the east to the Niagara Escarpment in the west and divides the subwatersheds draining south into Lake Ontario from the subwatersheds draining north to Lake

Simcoe. It has a unique concentration of environmental, geological, and hydrological features that make its ecosystem vital to south-central Ontario, including:

- Clean and abundant water sources
- Healthy and diverse plant and animal habitat
- An attractive and distinct landscape
- Prime agricultural areas
- Sand and gravel resources close to market (MMAH, 2002).

Because of its location across the Greater Toronto Area, the ORM is under increasing pressure for new residential, commercial, industrial, and recreational uses which compete with the present natural environment. The Oak Ridges Moraine Conservation Plan provides land use and resource management planning direction to provincial ministers, ministries, and agencies, municipalities, municipal planning authorities, landowners and other stakeholders on how to protect the Moraine's ecological and hydrological features and functions.

1.2.2 Subwatershed Planning Context

This subwatershed plan has been written firstly to comply with the requirements under the ORMCP. However there are other documents that have influenced and fed into the development of this plan and its recommendations. The LSRCA’s Integrated Watershed Management Plan (2008) and the Province’s Lake Simcoe Protection Plan (2009) are the two main documents aside from the ORMCP that have guided this plan’s development.

The Integrated Watershed Management Plan, released by the Lake Simcoe Region Conservation Authority in 2008, was intended to be a roadmap to provide future direction for the protection and rehabilitation of the Lake Simcoe watershed ecosystem. Its broad-scale recommendations for the Lake Simcoe watershed provided the basis for a number of this plan’s recommended actions for the smaller scale West Holland River subwatershed; these two reports are meant to complement each other.

The Lake Simcoe Protection Plan, released by the Province in 2009, aims to be a comprehensive plan to protect and restore the ecological health of the lake and its subwatershed. Its priorities include restoring the health of aquatic life, improving water quality, maintaining water quantity, improving ecosystem health by protecting and rehabilitating important areas, and addressing the impacts of invasive species, climate change, and recreational activities. This subwatershed plan aims to be consistent with the themes and policies of the Lake Simcoe Protection Plan to ensure a consistent approach is being taken by all of the partners toward improving watershed health.

This subwatershed plan also aims to complement and be supportive of the policies of the applicable upper tier municipal official plans and the related municipal programs that strive to achieve similar outcomes related to subwatershed health.

Figure 1-1 depicts the relationship between this subwatershed plan and the documents that have guided and contributed to its development. It also depicts the implementation plan, which will provide details of a plan to undertake the recommended actions.

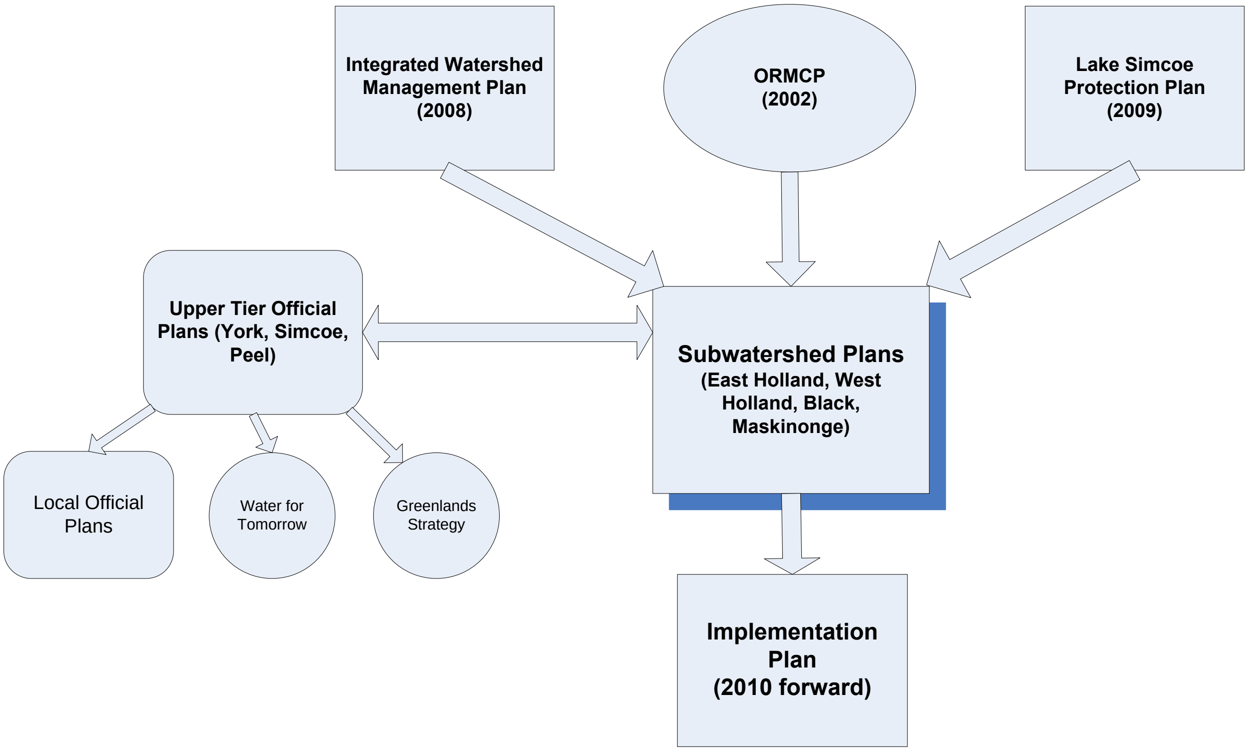


Figure 1-1 **Subwatershed planning context**

1.2.3 Subwatershed Planning Process

The Lake Simcoe Region Conservation Authority (LSRCA) has adopted a holistic approach to completing subwatershed plans to ensure compliance with ORMCP instead of managing one subwatershed at a time. This method ensures the completion of a comprehensive and consistent ORMCP watershed plan while maximizing efficiencies and funding. It also provides a one window approach for broader public consultation and the future development or policies and land use designations.

The initial focus of the subwatershed planning exercise has involved the completion and summarization of subwatershed characterization work. It also involved the development of water quality, quantity, aquatic, and terrestrial habitat models to assess the environmental impacts associated with potential changes in the landscape. This important information is then incorporated into the process of formulating management options and recommendations for the subwatershed plans.

The ecosystem approach to environmental management takes into consideration all of the components of the environment. These components include the movement of water through the system, the land use, climate, geology, and all of the species that comprise the community living in the system. These ecosystem components are all intricately related, and changes in any can have significant effects on the others.

To manage natural resources using an ecosystem approach it is essential to establish biophysical boundaries. In the Lake Simcoe watershed, the subwatersheds or river systems that drain into the lake have been identified as the best “fit” for the implementation of an ecosystem study because they are virtually self-contained water-based ecosystems (OMOE and OMNR, 1993). Watersheds are defined as the area of land drained by a watercourse and, subsequently, the land draining to a tributary of the main watercourse (Lake Simcoe is the “main watercourse” in this case) is called a subwatershed. Watershed processes are controlled by the hydrologic cycle (Figure 1-2). The movement of water influences topography, climate, and life cycles. It is due to this connectivity that any change within the watershed will impact other parts of the subwatershed.

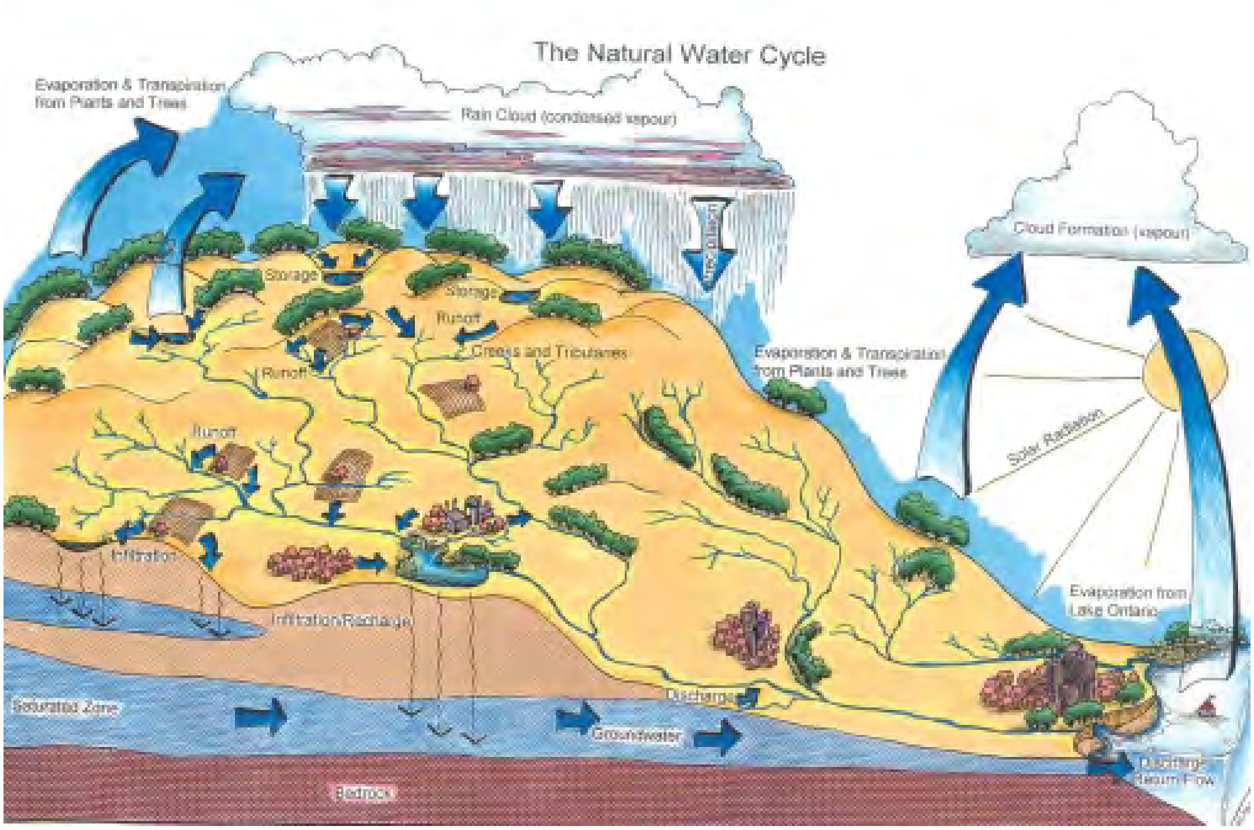


Figure 1-2 **The hydrologic cycle (image courtesy: Conservation Ontario)**

1.3 Current Management Framework

In addition to meeting the requirements of the ORMCP, the goals and management recommendations offered in this plan have been developed in context of the other existing legislation and their associated plans and policies. There are many regulations related to the protection and restoration of Lake Simcoe and its subwatersheds, and obviously each of these acts and associated plans differ, although in some cases policies do overlap. The manner in which regulations differ include: (1) the number and types of watershed activity they have authority over. For example some regulations have a very broad mandate, regulating many activities (e.g. the Greenbelt Plan) while others are very specific (e.g. The Endangered Species Act); (2) the legal effect of policies they contain–policies fall into two broad categories, those legally requiring conformity, and those with no legal requirement but stating the need to “have regard for”; (3) the geographic area they represent–most cover the entire Lake Simcoe basin, however the Greenbelt Act and the ORMCP have defined geographic boundaries which do not follow subwatershed boundaries; and (4) the degree of implementation–many aspects of more recent legislation such as the Lake Simcoe Protection Plan still need to be acted upon. Each chapter of this subwatershed plan provides a more detailed assessment of the legislation and associated polices related to that particular subwatershed feature (e.g. water quantity or aquatic habitat).

The key pieces of legislation, regulations and plans that form the planning framework in the subwatershed are described below. This is not a comprehensive list of all of the pieces that apply in the subwatershed, but rather those that are most influential of environmental conditions in the area.

1.3.1 Oak Ridges Moraine Conservation Plan

The province of Ontario developed the Oak Ridges Moraine Conservation Plan (ORMCP) in 2002, after recognizing the vital importance of this feature to southern Ontario and the intense pressure that was being placed on it. The authority to establish the ORMCP comes from the Oak Ridges Moraine Conservation Act (2001), which established objectives for the plan.

The ORMCP is an ecologically-based plan that was established to provide land use and resource management direction for the land and water within the Moraine. The government's vision for the Oak Ridges Moraine is that of "a continuous band of green, rolling hills that provides form and structure to south-central Ontario, while protecting the ecological and hydrological features and functions that support the health and well-being of the region's residents and ecosystems". To achieve this vision, the ORMCP sets out a number of objectives:

a) protecting the ecological and hydrological integrity of the Oak Ridges Moraine Area;

b) ensuring that only land and resource uses that maintain, improve or restore the ecological and hydrological functions of the Oak Ridges Moraine Area are permitted;

c) maintaining, improving or restoring all the elements that contribute to the ecological and hydrological functions of the Oak Ridges Moraine Area, including the quality and quantity of its water and its other resources;

d) ensuring that the Oak Ridges Moraine Area is maintained as a continuous natural landform and environment for the benefit of present and future generations;

e) providing for land and resource uses and development that are compatible with the other objectives of the plan;

f) providing for continued development within existing urban settlement areas and recognizing existing rural settlements;

g) providing for a continuous recreational trail through the Oak Ridges Moraine Area that is accessible to all including persons with disabilities;

h) providing for other public recreational access to the Oak Ridges Moraine Area; and

i) any other prescribed objectives.

The ORMCP contains four land use designations: Natural Core Areas, Natural Linkage Areas, Countryside Areas, and Settlement Areas.

Natural Core Areas – the protection of these lands, which contain the greatest concentrations of key natural heritage features, is vital to maintaining the integrity of the Moraine. Aside from existing uses, the only uses that will be permitted in these areas are resource management, agriculture, low intensity recreation, home businesses, transportation and utilities.

Natural Linkage Areas – these protect natural and open space linkages between the Natural Core Areas and along rivers and streams. The uses permitted in the Natural Core Areas are also permitted in Natural Linkage Areas, as are some aggregate resource operations.

Countryside Areas – these areas are intended to provide an agricultural and rural transition and buffer between the Natural Core and Linkage Areas and Settlement Areas. Prime agricultural areas and natural features are protected.

Settlement Areas – these include existing communities; urban uses and development as set out in municipal official plans are allowed.

The policies of the ORMCP provide protection for key natural heritage features and hydrologically sensitive features throughout the plan area

The *Oak Ridges Moraine Conservation Act, 2001* directs municipalities to bring their Official Plans into conformity with the ORMCP and to ensure that the planning decisions they make conform to the Plan. The policies include:

- Strict limitations on the activities that can be undertaken in Natural Core and Natural Linkage Areas
- Protecting key natural heritage features and hydrologically sensitive features by setting out minimum vegetation protection zones and minimum areas of influence around the features. Most activities are not permitted in minimum vegetation protection zones, and applicants are required to demonstrate that activities within the minimum area of influence will have no negative impact on the feature
- Requiring planning, design and construction practices that will maintain, improve, or restore the health, diversity, size, and connectivity of features on the moraine for developments adjacent to these features
- Municipalities are required to develop subwatershed plans (i.e. this plan) for river systems originating on the Moraine, including a water budget and conservation plan, land and water use and management strategies
- The protection of water quality and quantity
- Protection for landform conservation areas (such as steep slopes, kames, kettles, ravines, and ridges)

This subwatershed plan will satisfy the requirements of the ORMCP for both watershed planning (Section 24) and water budgets and conservation plans (Section 25).

1.3.2 Greenbelt Plan

Faced with intense growth pressures on the Greater Golden Horseshoe and its potential impacts to this area's rural and environmental resources, the Province created the Greenbelt Act in 2005. This Act authorizes the Lieutenant Governor in Council, by Regulation, to designate an area of land as the Greenbelt Area, and to establish a Greenbelt Plan for all or part of the Greenbelt Area. The Plan describes the Greenbelt as a broad band of permanently protected land which:

- Protects against the loss and fragmentation of the agricultural land base and supports agriculture as the predominant land use
- Gives permanent protection to the natural heritage and water resource systems that sustain ecological and human health and that form the environmental framework around which major urbanization in south-central Ontario will be organized; and
- Provides for a diverse range of economic and social activities associated with rural communities, agriculture, tourism, recreation and resource uses.

The Greenbelt includes lands within, and builds upon the ecological protection provided by, the Oak Ridges Moraine Conservation Plan.

The Plan identifies goals for the Protected Countryside area of the Greenbelt around Agricultural Protection; Environmental Protection; Culture, Recreation and Tourism; Settlement Areas; and Infrastructure and Natural Resources. The Environmental Protection goals are the most applicable to this subwatershed plan, and include:

- Protection, maintenance and enhancement of natural heritage, hydrologic and landform features and functions, including protection of habitat for flora and fauna and particularly species at risk;
- Protection and restoration of natural and open space connections between the Oak Ridges Moraine, the Niagara Escarpment, Lake Ontario, Lake Simcoe and the major river valley lands, while also maintaining connections to the broader natural systems of southern Ontario beyond the Greater Golden Horseshoe;
- Protection, improvement or restoration of the quality and quantity of groundwater and surface water and the hydrological integrity of watersheds; and
- Provision of long-term guidance for the management of natural heritage and water resources when contemplating matters including development and private or public stewardship programs

The Greenbelt Plan delineates a number of policy areas within the Protected Countryside, these are an agricultural system, which is comprised of specialty crop areas, prime agricultural areas, and rural areas; the Natural System, which contains the Natural Heritage System, Water Resource System, and key natural heritage features and key hydrologic features; and Settlement Areas, which are comprised of Towns/Villages and Hamlets.

Policies for the Natural System protect areas of natural heritage, hydrologic and/or landform features, which are often functionally inter-related and which collectively support biodiversity and overall ecological integrity of the system. These policies:

- Restrict the land uses that can be undertaken within key natural heritage and hydrologic features
- Protect important features from the impacts of development and site alteration and encourage improvement or restoration of features wherever possible
- Promote connectivity between features
- Protect, improve or restore the quality and quantity of water

1.3.3 Lake Simcoe Protection Plan

As part of the Ontario government’s overall strategy to protect and restore the ecological health of the Lake Simcoe watershed, the Lake Simcoe Protection Act was introduced and passed by the legislature in 2008, receiving Royal Assent in December of that year. This Act provides authority for the establishment of and amendments to a Lake Simcoe Protection Plan. The Lake Simcoe Protection Plan, which was released in June 2009, contains a wide variety of objectives to achieve their vision of a healthy lake with healthy communities and people as well as a healthy economy. These objectives, as set out in the Lake Simcoe Protection Act, include:

- protecting, improving or restore the elements that contribute to the ecological health of the watershed, including water quality, hydrology, key natural heritage features and their functions, and key hydrologic features and their functions;
- restoring a self-sustaining coldwater community in the lake;

- reducing loads of phosphorus and other nutrients of concern and reducing the discharge of pollutants;
- responding to the effects of invasive species and, wherever possible, preventing their introduction into the watershed;
- providing for ongoing research and monitoring in the watershed;
- improving conditions for environmentally sustainable recreation activities, and promoting these activities; and
- building on the protections offered by existing legislation in the watershed.

The Plan contains policies related to a number of critical issues: restoring the health of aquatic life in the watershed; improving water quality, maintaining water quantity; improving the health of the ecosystem by protecting and rehabilitating important areas such as shorelines and natural heritage; and addressing the impacts of invasive species, climate change, and recreational activities. The Plan takes a subwatershed approach to the activities that will need to be undertaken to improve conditions in the watershed. This approach will help to determine priorities in different areas of the watershed, depending on the conditions and issues in each subwatershed.

In addition to prescribing the development of the Lake Simcoe Protection Plan, the Lake Simcoe Protection Act established two advisory committees, the Lake Simcoe Science Committee and the Lake Simcoe Coordinating Committee, to facilitate the development and implementation of the Lake Simcoe Protection Plan.

The Lake Simcoe Science Committee, which is composed of scientific experts in watershed protection issues, is responsible for reviewing the environmental conditions of the watershed and to advise on the ecological health of the Lake Simcoe watershed and the current and potential threats to the ecological health, as well as to identify the scientific research that should be undertaken to support the implementation of the Plan. This committee may also be asked to advise on the design and implementation of monitoring programs to track whether the Plan is meeting its objects; proposed amendments to the Plan; and proposed regulations made under the Lake Simcoe Protection Act.

The functions of the Lake Simcoe Coordinating Committee will include:

- Providing advice to the Minister on Plan implementation and any issues or problems related to Plan implementation
- Providing advice to the Minister on the types of measures that could be taken to deal with threats to the ecological health of the watershed
- Assisting in monitoring progress on Plan implementation.

This committee will be comprised of representatives from across the watershed, including representatives from municipalities, Aboriginal communities, the LSRCA, the Province, the agricultural, commercial and industrial sectors, interest groups, environmental organizations, and the public.

1.3.4 Provincial Policy Statement

The Provincial Policy Statement (PPS), issued under the authority of Section 3 of the Planning Act (1990), provides direction on matters of provincial interest related to land use planning and development, and promotes the provincial “policy-led” planning system. The PPS recognizes the complex inter-relationships among economic, environmental and social factors in planning and embodies good planning principles. It includes policies on key issues including the efficient use and management of land and infrastructure; protection of the environment and resources; and ensuring appropriate opportunities for employment and residential development, including support for a mix of uses.

The PPS was updated in 2005, with the intent of providing strong, clear policy direction on land-use planning to promote strong communities, a clean and healthy environment, and a strong economy.

1.3.5 Nutrient Management Act

The Nutrient Management Act (NMA), approved by the Ontario legislature in 2002, was developed by the Ministries of the Environment and Agriculture and Food and Rural Affairs as part of the provincial government's Clean Water Program. Its intent is to provide for the management of materials containing nutrients in ways that will enhance the protection of the natural environment and provide a sustainable future for agricultural operations and rural development. The NMA specifies requirements for the development of Nutrient Management Plans or Strategies for farms that generate and/or store over 300 'nutrient units' of manure. These plans include information on how and where the manure is stored, how it is applied, as well as contingency plans for issues that may arise, such as inclement weather preventing the spreading of manure on fields. The implementation of these plans will help to protect water quality from contamination from nutrients, particularly phosphorus, as well as bacteria such as *E. coli*.

1.3.6 Environmental Protection Act

The purpose of the Environmental Protection Act (EPA), approved by the Ontario legislature in 1990, is to provide for the protection and conservation of the natural environment. The EPA contains policies and restrictions around the discharge of contaminants and pollution, and the management of waste and litter. It gives the Ministry of the Environment a number of powers, such as requiring an operation to have in place equipment and/or controls in order to prevent the release of contaminants or minimize the impacts from such a release, and issuing control orders in the case of a release of a contaminant in levels above that specified by the regulations.

1.3.7 Ontario Water Resources Act

The purpose of this Act is to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, in order to promote Ontario's long-term environmental, social and economic well-being. This is accomplished through policies around activities including the construction of wells, stormwater and sewage works, preventing the impairment of water quality, water takings, and water transfers. It is through this Act that the Ministry of the Environment issues Permits to Take Water for non-domestic water takings over 50,000 L/day and Certificates of Approval for stormwater management facilities and sewage treatment plants.

1.3.8 Growth Plan for the Greater Golden Horseshoe

The Growth Plan for the Greater Golden Horseshoe was prepared under the Places to Grow Act (2005). The Growth Plan provides a framework for implementing the government of Ontario's vision for building stronger, prosperous communities by better managing growth in the Greater Golden Horseshoe to 2031. The Growth Plan is aimed at avoiding the negative aspects of growth, such as deteriorating air and water quality and the disappearance of agricultural lands and natural resources. The plan provides improvements in the ways in which our urban areas will grow over the long term, and guides decisions on a wide range of issues such as transportation and infrastructure planning, land-use planning, urban form, and natural heritage and resource protection, all in the interest of promoting economic prosperity.

The Growth Plan builds on the Greenbelt Plan, Planning Act reform and the PPS. It works within the existing planning framework to provide growth management policy direction for the area.

This plan seeks to address the challenges of urban sprawl through policy directions that:

- direct growth to built-up areas;
- promote transit supportive densities and community infrastructure to support growth;
- ensuring sustainable water and wastewater services are available to support future growth;
- identify natural systems and prime agricultural areas, and enhance the conservation of these resources; and
- supports the protection and conservation of water, energy, air, and cultural heritage, as well as integrated approaches to waste management.

The Guiding Principles of the Growth Plan are to:

- Build compact, vibrant and complete communities
- Plan and manage growth to support a strong and competitive economy
- Protect, conserve, enhance and wisely use the valuable natural resources of land, air and water for current and future generations
- Optimize the use of existing and new infrastructure to support growth in a compact, efficient form
- Provide for different approaches to managing growth that recognize the diversity of communities in the GGH
- Promote collaboration among all sectors – government, private and non-profit –and residents to achieve the vision.

1.3.9 Clean Water Act

The Clean Water Act (CWA), approved by the Ontario legislature in 2006, was developed to protect drinking water at its source, as part of the Province’s overall commitment to safeguard human health and the environment. It was established to implement the recommendations of the Walkerton Inquiry, in which Justice Dennis O’Connor set out the concept of a multi-barrier approach to safe drinking water. The protection of sources of drinking water in the lakes, rivers and underground aquifers of Ontario comprises the first barrier. Source protection complements the other components of the multi-barrier approach, which include effective water treatment, secure distribution systems, monitoring programs, and responses to adverse test results, by reducing the risk that water is contaminated in the first place.

This Act is being implemented on a watershed scale, with most areas using existing conservation authority boundaries. The LSRCA is leading the initiative for the South Georgian Bay Lake Simcoe Source Protection planning region. The Source Protection process involves four stages:

- Stage 1: establishing source protection authorities and committees, and negotiating a terms of reference

- Stage 2: conducting an identification and assessment of the threats to drinking water in the source protection region and preparing an assessment report
- Stage 3: the preparation of a source protection plan, which will include policies to address significant threats to drinking water
- Stage 4: implementation of the source protection plans, including inspection and enforcement of the plan's policies, monitoring and reporting on progress, and reviewing the plan

It is expected that the process will be completed in 2012.

1.3.10 Endangered Species Act

The Endangered Species Act was approved by the Ontario legislature in 2007 and came into effect in 2008. This Act provides protection to Ontario's species at risk – those identified on the Species at Risk in Ontario list as extirpated, endangered, threatened or special concern. The Act recognizes the ecological, social, economic, cultural and intrinsic value of biodiversity, and that it is often human activities that put these species at risk. The Act provides protection to the species and their habitats, and also requires the development of recovery strategies once a species has been identified as being at risk. The implementation of these recovery strategies will help to protect the important habitats of these species, and enhance biodiversity in the subwatershed.

1.3.11 Fisheries Act

The *Fisheries Act* is a piece of federal legislation that dates back to confederation; it was established to manage and protect Canada's fisheries resources. The Act applies to all inland waters, and supersedes any provincial legislation.

The *Fisheries Act* contains a number of policies related to the protection and preservation of fish habitat, the most important of these being Section 35, a general prohibition of the harmful alteration, disruption or destruction of fish habitat, unless an authorization is issued. Under a Level III agreement between the LSRCA and Fisheries and Oceans Canada, LSRCA is responsible for reviewing applications and administering authorizations within the Lake Simcoe basin.

Under the Act, fish habitat includes "spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly to carry out their life processes." In order to protect fish habitat there is a hierarchy of management options including (in order of preference) relocation of the project, redesign, mitigation of the impact, and finally habitat compensation. Applicants must pursue location and design options which will avoid impacts to fish habitat before authorizations will be considered.

1.3.12 Conservation Authorities Act and the Role of the LSRCA

Delegated Responsibility to Represent Provincial Interest in Natural Hazards

Conservation Authorities (CAs) have delegated responsibilities to represent provincial interests regarding natural hazards encompassed by Section 3.1 of the Provincial Policy Statement, 2005 (PPS, 2005). These delegated responsibilities require CAs to review and provide comments on policy documents (Official Plans and comprehensive zoning by-laws) and applications submitted pursuant to the Planning Act as part of the Provincial One-Window Plan Review Service. In 2001, Conservation Ontario, the organization representing Ontario's 36 Conservation Authorities, signed a Memorandum of Understanding with the Ministry of Natural Resources and the Ministry of Municipal Affairs and Housing that defined the roles of and responsibilities of each agency with respect to delegated responsibilities for natural hazards.

Watershed Based Resource Management Agency

Conservation Authorities, as ‘public bodies’ pursuant to the Planning Act, are to be notified of policy documents and planning and development applications as prescribed under the Act. CAs may comment as per their mandate to the municipality/planning approval authority on these documents and applications. In this role, the CA is responsible to represent its program and policy interests as a watershed based resource management agency. In this regard, CAs operating under the authority of the CA Act, and in conjunction with municipalities, develop business plans, watershed plans and natural resource management plans within their jurisdictions (watersheds). These plans may recommend specific approaches to land use and resource planning and management that should be incorporated into municipal planning documents and related development applications in order to be implemented.

Planning Advisory Service to Municipalities

CAs may perform a technical advisory role to municipalities, as determined under the terms of a service agreement with participating municipalities which may include, but is not limited to, matters related to the assessment or analysis of environmental impacts associated with activities near or in the vicinity of sensitive natural features such as wetlands, river and stream valleys, fish habitat or significant woodlands; hydrogeology and storm water studies; and, in some cases, septic system reviews. By providing planning advisory services for the review of Planning Act applications, Conservation Authorities and municipalities can ensure the implementation of a comprehensive resource management program on a watershed basis.

The planning advisory service agreements allow the Conservation Authority the opportunity to provide advice to the municipality on the interpretation of the Provincial Policy Statement (PPS). With the exception of natural hazards for which Conservation Authorities have delegated responsibility to represent the provincial interest, this advice is not represented as a “provincial position”.

Regulatory Responsibilities

CA Act Regulations: In participating in the review of development applications under the Planning Act, Conservation Authorities will (i) ensure that the applicant and municipal planning authority are aware of the Section 28 regulations and requirements under the CA Act, and, (ii) assist in the coordination of applications under the Planning Act and the CA Act to eliminate unnecessary delay or duplication in the process.

LSRCA Watershed Development Policies

In order to protect the environmental integrity of the Lake Simcoe watershed to the extent of its jurisdictional capabilities, which are granted through the provincial Conservation Authorities Act, the LSRCA applies a number of Watershed Development Policies in reviewing applications for development and site alteration. These policies include directing development away from areas such as floodplains, wetlands, significant forests and valleylands, fish habitat, and a number of other sensitive or hazardous features; requirements for reports/studies including environmental impact studies, servicing plans, erosion and sediment control plans; buffer requirements for fish habitat; requiring Enhanced “Level 1” stormwater treatment for all new developments; as well as a number of others. The consistent application of these policies will ensure that important environmental features are protected, and enable the conservation authority to strive for minimal disturbance to the environment from development.

Watershed Regulations

In May of 2006, the Province of Ontario approved Ontario Regulation 179/06 which was entitled "Lake Simcoe Region Conservation Authority: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses". The format of this regulation was established by the Province in the Generic Regulation which was approved in May of 2004. All Conservation Authorities in Ontario were given two years (May 2004 to May 2006) to produce regulations and associated mapping which would conform to the Generic Regulation. This process involved extensive remapping of the entire Lake Simcoe watershed using 2002 air photos and digital elevation models, development of a Draft Regulation and a series of five public open houses throughout the watershed. The regulated areas for the West Holland River subwatershed can be seen in Figure 1-2.

The intent of this regulation is twofold. Firstly, it is to protect features in the natural environment such as wetlands (and associated buffer areas), watercourses and valley systems. Secondly, to steer development away from hazard lands such as unstable slopes, flood plain, dynamic beaches, meander belts and erosion prone areas.

The preservation or enhancement of natural features such as wetlands and watercourses is important for the overall health of the watershed and significantly affects the quantity and quality of storm water runoff. Wetlands act as giant sponges, absorbing precipitation and releasing it over long periods of time, which helps to preserve base flow in creeks during periods of drought. The natural water storage in wetlands also serves to reduce peak creek flows in downstream areas. Natural watercourses with their vegetated flood plains and meandering channels help to slow the rate of water flow and provide storage and thus dampening water flows and velocities in the creek.

Hazardous lands such as unstable slopes, flood plain, dynamic beaches, meander belts, and erosion prone areas are not suitable areas for new development. Many slopes in the watershed are relatively unstable and triggers such as vegetation removal, concentrated surface drainage or the construction of a house near the top of the slope is enough to cause slope failure. Flood plains can be dangerous areas. A number of significant flood events occur in our watershed on a yearly basis and the Regulation serves to tightly control the location and type of development in or around flood plains. Dynamic beaches are currently not a large issue in the Lake Simcoe watershed but if any are discovered in the future the Regulation serves to restrict development in these areas. Meander belts and erosion prone areas are naturally hazardous areas adjacent to watercourses and lakes that can also impact on land and structures. The Regulation controls development within these areas and the Authority, through its Development Policies, ensures that the necessary studies are completed to ensure that the development occurs in a safe location.

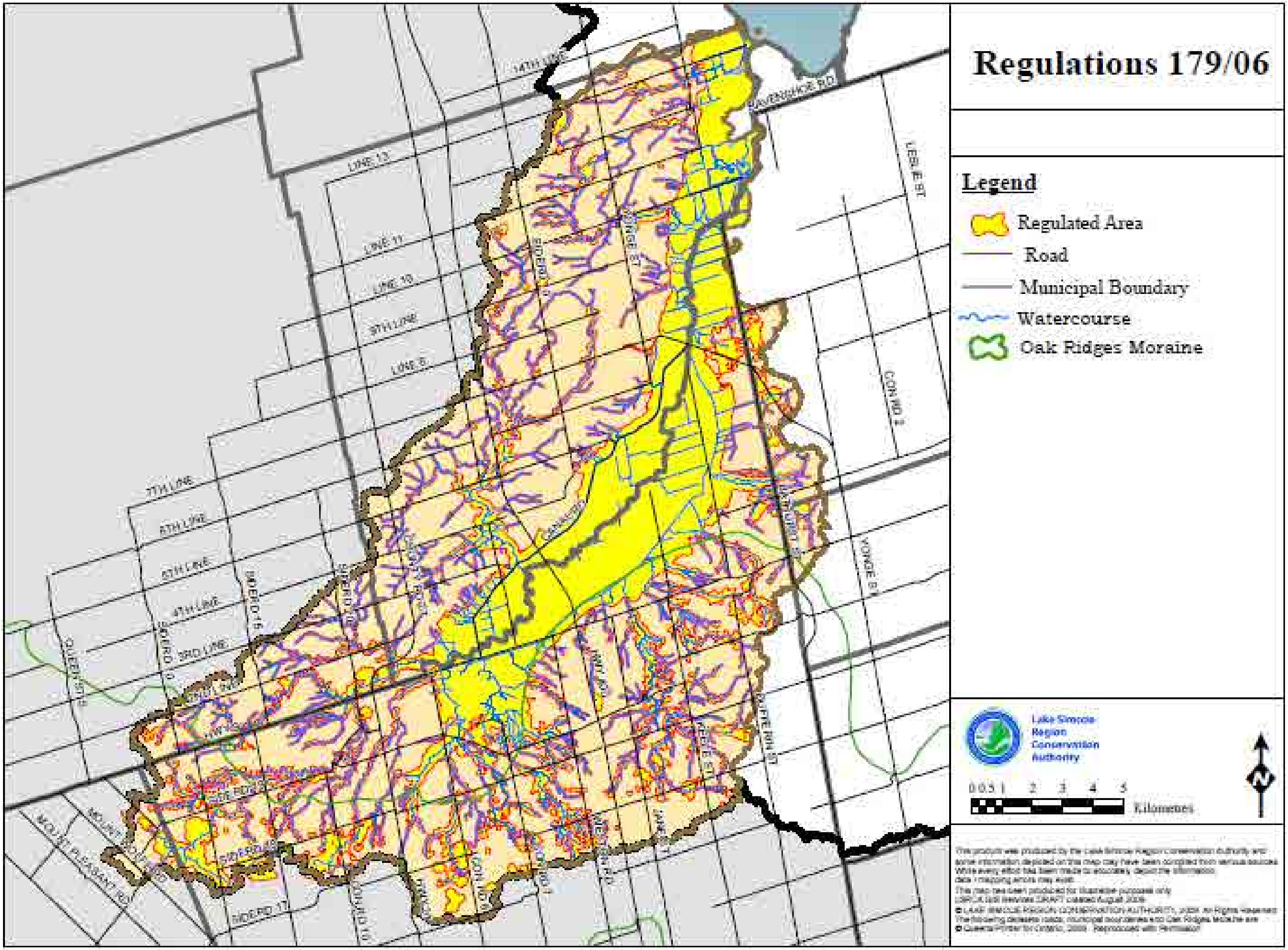


Figure 1-2 Areas regulated under O. Reg. 179/06

Flood Forecasting and Warning

The Flood Warning and Forecasting Program is a key component of the Authority's Watershed Management program. It works in concert with the Authority's regulations/planning program to achieve the Provincial goal of reducing the loss of life and property damage caused through flooding. The program is made up of two components; forecasting and warning.

Conservation authority staff utilize a number of parameters, including weather forecasts, stream flow gauges, weather stations, surveys of snow conditions, and computer models to predict whether a flood is likely to occur.

The warning component of the program follows the forecasting of stream flows and denotes the procedures required to ensure that a forecast of potential flooding or expected flooding is properly passed on to our flood clients to allow for appropriate response. The flood client base for the Authority consists of the Municipalities and School Boards within our jurisdiction as well as the media and police. There are three types of bulletins that a conservation authority will issue:

Flood Safety Bulletin/Advisory - Informs the public and municipalities that the conservation authority is assessing the flood potential.

Flood Advisory/Alert - Indicates the potential for flooding within specific watercourses or municipalities.

Flood Warning - Warns that flooding is imminent or is occurring in specific watercourses or municipalities.

1.3.13 York Region Official Plan

The York Region Official Plan is a document intended to provide guidance on growth and development for the region as a whole, with high level policies pertaining to building a sustainable region, under the broad headings of '*A Sustainable Natural Environment*', *'Healthy Communities'*, and '*Economic Vitality;'* and also around growth management, with policies pertaining to '*Building Cities and Complete Communities', 'Agriculture and Rural Areas,'* and '*Servicing [York Region's] Population*.' The plan's policies are meant to guide decisions related to these areas and manage growth within the region. They help to co-ordinate and set the stage for more detailed planning by local municipalities.

With respect to the policies around a sustainable natural environment, the plan provides direction on enhancing a linked Regional Greenlands System and the treatment of the components that comprise the system, including key natural heritage features and key hydrologic features, Oak Ridges Moraine and Greenbelt features, habitat of endangered, threatened and special concern species, wetlands, significant woodlands, and landform conservation features. The plan also provides policy direction on maintaining and enhancing water system health in order to ensure water quality and quantity, and to maintain the natural hydrologic function of water systems.

1.3.14 Simcoe County Official Plan

The Simcoe County OP is a broad policy document that is to be implemented through the Official Plans of the 16 local municipalities that lie within the County boundaries. The goals identified in the OP that relate to the subwatershed plan include:

- Protecting, conserving, and enhancing the County's natural and cultural heritage
- The wise management and use of resources

- Growth management to achieve lifestyle quality and efficient and cost effective municipal servicing, development and land use.

The OP's strategy is based on four themes: the direction of most non resource related growth and development to settlements; enabling and managing resource-based development; the protection and enhancement of the County's natural and cultural heritage, including water resources; and the development of communities with diversified economic functions and opportunities. The policies contained within the OP are meant to provide direction on matters of growth and development and the protection of a county-wide Greenlands system to the local municipalities.

There are a number of policies in the OP related to the protection of natural features and functions. They provide definitive guidelines for development in and around wetlands, fish habitat, and other sensitive and/or significant areas; directing local municipalities to map and provide policies for the protection of natural heritage features or areas that may be of local significance or that contribute to the County Greenland system; requiring stormwater reports for most developments; encouraging the maintenance and restoration of natural heritage areas within rural and agricultural lands; promoting development practices aimed at reducing the impacts of development; and the protection of water resources.

1.3.15 Peel Region Official Plan (2008)

The Peel Region Official Plan takes a holistic approach to planning through an overarching sustainable development framework that integrates environmental, social, economic, and cultural imperatives. It provides regional council with long term regional strategic policy framework for guiding growth and development in Peel while having regard for protecting the environment, managing resources and outlining the regulatory structure that manages this growth in the most effective and efficient manner. The OP's environment "theme" describes protecting, enhancing and fostering self sustaining regional, native biodiversity while reducing and measuring the impact of development on the ecosystem based on an integrated systems approach. In addition, under the environment "theme," the OP aims to ensure that water quantity and quality is protected or enhanced to meet ecosystem needs and for human uses. Further, the region seeks to reduce greenhouse gas emissions and other pollutants while promoting best practices in sustainable development.

The general goals of the OP include:

- Recognizing, respecting, preserving, restoring and enhancing the importance of ecosystem features, functions and linkages and enhancing environmental well being of air, water and land resources and living organisms
- Supporting growth and development which takes place in a sustainable manner and which integrates the environmental, social, economical and cultural responsibilities of the region and the province

The plan includes a number of policies to support these themes and goals, including the description of a regional Greenlands system, and a number of policies to protect water quantity and quality and to prevent land uses that would contribute to erosion and other impacts. The OP is also in conformity with the ORMCP and the Greenbelt Plan, and therefore contains policies that are consistent with these plans for the areas that fall within their geographic jurisdiction.

1.4 Recommended Actions for the West Holland River Subwatershed Plan

The following recommended actions were developed through the subwatershed planning process, and are based on the analysis of subwatershed conditions, stressors, and management gaps that were identified through the process. These recommendations are supported by a number of other, more detailed, recommended actions, which can be found in Chapter 10 of this document. These detailed recommendations will form the basis of the implementation plan, which will be developed following the completion of this plan.

The recommendations have been grouped into a number of categories in order to facilitate clarity and consistency. These categories are:

A. Planning and Policy

B. Use of Better Management Practices

C. Changing the Way Things Are Done 'On the Ground'

D. Applied Research and Science

E. Monitoring (Surveillance, Compliance, and Reporting)

F. Management, Rehabilitation, and Restoration

G. Adaptive Response (Climate, Social, Political)

H. Communications

Planning & Policy

1) That the municipal partners and the LSRCA strive to reduce the impacts of stormwater through a number of methods including the implementation of policies and guidelines and enabling the use of new and innovative technologies, retrofitting of existing development.
2) That the partner municipalities act to improve water quality by implementing measures to prevent and/or mitigate impacts from septic systems, development, and other activities that may cause impairment.
3) That the Province develop binding criteria for specific contaminants within the Lake Simcoe watershed, as well as criteria for addressing emerging substances of concern
4) That the municipal partners and the LSRCA strive to maintain natural hydrologic conditions on development sites
5) That the federal, provincial, and municipal governments, as well as the LSRCA, continue to evaluate and implement planning initiatives and practices aimed at reducing the impact of development on the condition of the West Holland subwatershed
6) That the value of the ecological goods and services (EGS) provided by ecological features be considered in decision making around growth and development
7) That the rural/agricultural community be engaged in developing solutions for minimizing the impacts of practices on their lands
8) That the municipal partners, the LSRCA, and the Province support a common framework and develop and endorse policies and programs for the protection and enhancement of the West Holland subwatershed's natural heritage system and its functions
9) That the partners, including the municipalities, LSRCA, and the Province, seek to gain an improved understanding of the natural heritage features of the West Holland subwatershed
10) That the Province, the municipal partners, and the LSRCA seek to gain an improved understanding of the impacts of climate change in the West Holland River subwatershed, incorporating this information into decision making scenarios and developing strategies to mitigate and adapt to its impacts.

Use of Better Management Practices

11) That the LSRCA and its municipal partners continue working to mitigate the impacts of stormwater to water quality and quantity through tracking its sources, completing stormwater retrofits, promoting methods of minimizing stormwater volume, and continuing to research new and innovative solutions to stormwater control and implementing these solutions where appropriate.

12) That support for programs offered to assist rural landowners in implementing BMPs on their properties, such as LSRCA's LEAP program, be continued and/or expanded as resources permit

13) That sectors that have the potential to have significant impacts on conditions in the West Holland River subwatershed be expected to undertake BMPs and other activities to mitigate their impacts, as required under the LSPP

14) That the LSRCA and the partner municipalities encourage the use of natural channel designs and 'soft solutions' wherever possible for preventing or mitigating streambank erosion and accommodating channel realignments; and that technical and financial resources be made available for retrofitting where appropriate to undertake these activities.

15) That the LSRCA assist partner municipalities in reducing the risk of flooding in the West Holland subwatershed

Changing the way things are done 'on the ground'

16) That the LSRCA and its partner municipalities strive to maximize the infiltration of stormwater where appropriate through development approvals and the use of practices and technologies

17) That the partner municipalities, the LSRCA, and the related stakeholders work to reduce the impacts of construction practices on the West Holland subwatershed's water quality

18) That the partner municipalities continue to work to prevent the pollution of local watercourses due to road maintenance activities (e.g. chloride levels, sediment, phosphorus)

Applied Research and Science

19) That the Province, LSRCA and the municipal partners continue to work to identify sources of phosphorus within the subwatershed in order to set targets and develop strategies and solutions for reducing loads within the West Holland subwatershed

20) That all partners study the requirements for environmental flows within the West Holland subwatershed, explore innovative solutions, and undertake works and practices where possible in order to ensure adequate baseflow to support ecological function

21) That all partners continue to research techniques that may be undertaken in the subwatershed for improving water quality

22) That the partners explore the subwatershed to determine where reductions in groundwater discharge, excessive water takings and other impacts to aquatic habitat have occurred and undertake activities to mitigate these impacts

23) That measures be taken at site level to reduce demands on water resources

24) That the partners (LSRCA, MNR, NRCAN, etc) undertake studies to enhance understanding of natural heritage resources within the West Holland subwatershed in support of management strategies related to unique and/or significant features

25) That LSRCA and its partner municipalities assess the feasibility of increasing and/or enhancing natural cover, and develop strategies to prioritize these undertakings in order to achieve the greatest benefit to the subwatershed

26) That all partners cooperate to determine the presence and extent of invasive species in the subwatershed, and work to prevent their establishment and spread

Monitoring

27) That the water quality monitoring program undertaken by the LSRCA be continued into the future, with regular reviews to ensure that program goals are being met, and expanded as resources permit to undertake special projects or enhance the understanding of conditions in the subwatershed; with results to be reported on annually

28) That the LSRCA continue to undertake the aquatic monitoring program, with expansions to the program in order to further understand conditions in the subwatershed; and cooperate with partner agencies on additional initiatives as required

29) That the LSRCA, partner municipalities, and developers undertake efforts to minimize the impacts of construction through the use of on-site practices aimed at protecting water quality; and by conducting monitoring to ensure the effectiveness of these practices.

30) That the LSRCA assess the impacts of land use change on fluvial geomorphology in the subwatershed.

31) That the amount of impervious area in the subwatershed be assessed on a regular basis by the LSRCA and its partner municipalities.

32) That the LSRCA undertake regular updates to its Natural Heritage and Land Use mapping to ensure the most up-to-date information is being used.

Management, Rehabilitation and Restoration

33) That the MNR, with the support of LSRCA and the partner municipalities, undertake initiatives aimed at maintaining the health of the subwatershed's fish community. These may include the development of fish community goals and objectives, fisheries management plans, or other plans aimed at protecting the habitat of species at risk in applicable catchments.

34) That the LSRCA and its partners continue monitoring the aquatic community and habitat in the West Holland subwatershed, assessing the monitoring program on a regular basis and undertaking targeted monitoring where appropriate to fill data gaps.

35) That the LSRCA, in conjunction with the town of Bradford West Gwillimbury, undertake a study and prepare a report to gain a better understanding of the Holland Marsh and find opportunities for reducing its impact.

36) That that LSRCA, in cooperation with its partner municipalities, prioritize and undertake activities to improve and restore aquatic ecological functions within the subwatershed, including barrier removal, natural channel design, restoring floodplain functions, and wetland creation. This could include undertaking pilot/demonstration projects to assess the feasibility of such works.

37) That the LSRCA continue to utilize buffer requirements and timing guidelines as tools to protect aquatic resources, and that other activities such as stormwater retrofits, tree planting, and habitat enhancement be undertaken to enhance aquatic habitat

38) That the LSRCA and the partner municipalities assess the feasibility of increasing natural cover (e.g. woodland, streambank vegetation, interior forest, grassland) in the subwatershed

and set priorities and develop plans to undertake this enhancement, based on overall benefit to the subwatershed.

39) That the LSRCA identify opportunities for land securement of priority sites.

40) That the partner municipalities, in cooperation with the LSRCA, look to enhance existing woodland areas through replacing plantation species with appropriate native species through succession in order to provide higher quality habitat while maintaining the functions that plantation areas perform. These include maintaining water quality, providing shelter, encouraging infiltration and stabilizing soils.

41) That the LSRCA support the work of MNR and OFAH with respect to invasive species and encourage the distribution of promotional materials.

42) That the partner municipalities adopt policies to encourage the use of native species, particularly those drought tolerant species, through development approvals and property management programs.

43) That the LSRCA continue to undertake stewardship initiatives, priority areas for which may be identified through Phase II of LSRCA's Natural Heritage System.

44) That the LSRCA request the Ministry of Natural Resources to undertake the development of watershed rare lists and protection policies for species at risk in the subwatershed.

45) That LSRCA and its municipal partners investigate initiatives to improve the long term benefit and environmental sustainability of public properties and facilities.

46) That the LSRCA, the partner municipalities, and developers work to identify opportunities for undertaking restoration works on development sites, and incorporate these into proposals, where appropriate

Adaptive Response

47) That the LSRCA and partner municipalities work to reduce their carbon footprint and to increase ecological resilience in the watershed

48) That the LSRCA and the partner municipalities support water conservation initiatives, such as York Region's "Water for Tomorrow" program.

49) That the LSRCA in conjunction with the MNR and MOE undertake initiatives to understand the environmental flow needs within the West Holland subwatershed, and develop programs and policies to ensure that these needs are met, including the continuation of the Low Water Response Program, setting environmental flow targets, and ensuring that water taking activities do not exceed the available supply.

50) That the LSRCA and its partners work to ensure that flood mapping is up to date; that the data needed for assessing flood risk is sufficient and that new monitoring equipment is added to the monitoring network as required; and that there be available programs to assist landowners in flood proofing their homes.

Communications

51) That the LSRCA use its website and other internet tools (e.g. Facebook groups) to communicate information about the subwatershed and the implementation of subwatershed plan recommendations

52) That outreach activities be conducted that: provide information to stakeholders about subwatershed plans and issues, encourage participation in the development of

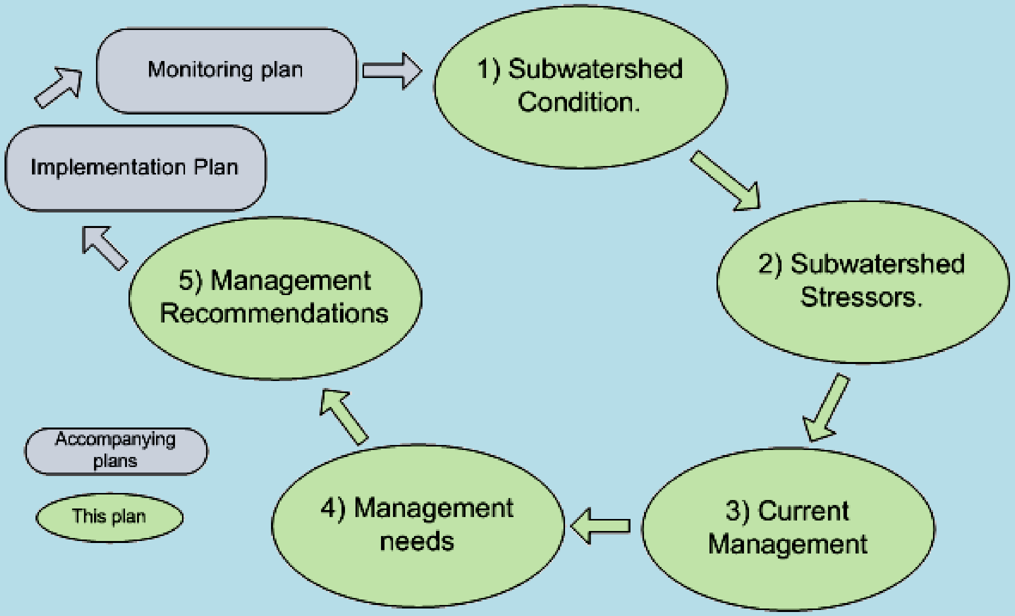
implementation plans and other subwatershed activities, and facilitate the undertaking of BMPs to improve subwatershed health

53) That the LSRCA promote enhanced relationships between sectors to work towards the goal of more sustainable development

54) That the LSRCA promote its programs (such as the LEAP), workshops, and seminars by a variety of methods in order to reach a broader audience and inform and educate subwatershed stakeholders about key issues and how they can be resolved

1.5 How this plan is organized

This plan includes a chapter dedicated to each of the five subwatershed features identified above, these being water quality, water quantity, aquatic habitat, fluvial geomorphology and terrestrial natural heritage. Each of these chapters follows an identical format, loosely structured around a pressure-state-response framework, in that each chapter firstly describes the current condition (state), secondly describes the stressors likely leading to the current condition (pressure), and finally recommends management responses in the context of the current management framework (response) (See text box below).



Plan section:

1) ***Subwatershed Condition:*** Describes and analyzes the current state or condition of the subwatershed feature based on the best available data and information. This assessment is based on monitoring data, model output, surveys etc.
2) ***Subwatershed Stressors:*** Uses the best available information to identify and quantify the factors affecting the current condition of the watershed. For example, describing phosphorus loads from different land use activities.
3) ***Current Management:*** Establishes the relationship of the subwatershed plan to other legislation and planning documents;
4) ***Management needs:*** Identifies areas within the current management framework where improvements within this plan may be able to have greatest impact i.e. gaps or opportunities for the subwatershed plan to act upon.
5) ***Management recommendations:*** outlines resource management goals and objectives; as well as options for protection, rehabilitation, and enhancement of conditions in the subwatershed.

The resulting plan will protect the existing natural resources, facilitate informed planning decisions, and improve the efficiency of the development review process. An over-arching concept to keep in mind throughout the subwatershed planning process is that it is far more beneficial, both financially and ecologically, to protect resources from degradation than to rehabilitate them once they have been damaged.

2 Study Area and Physical Setting

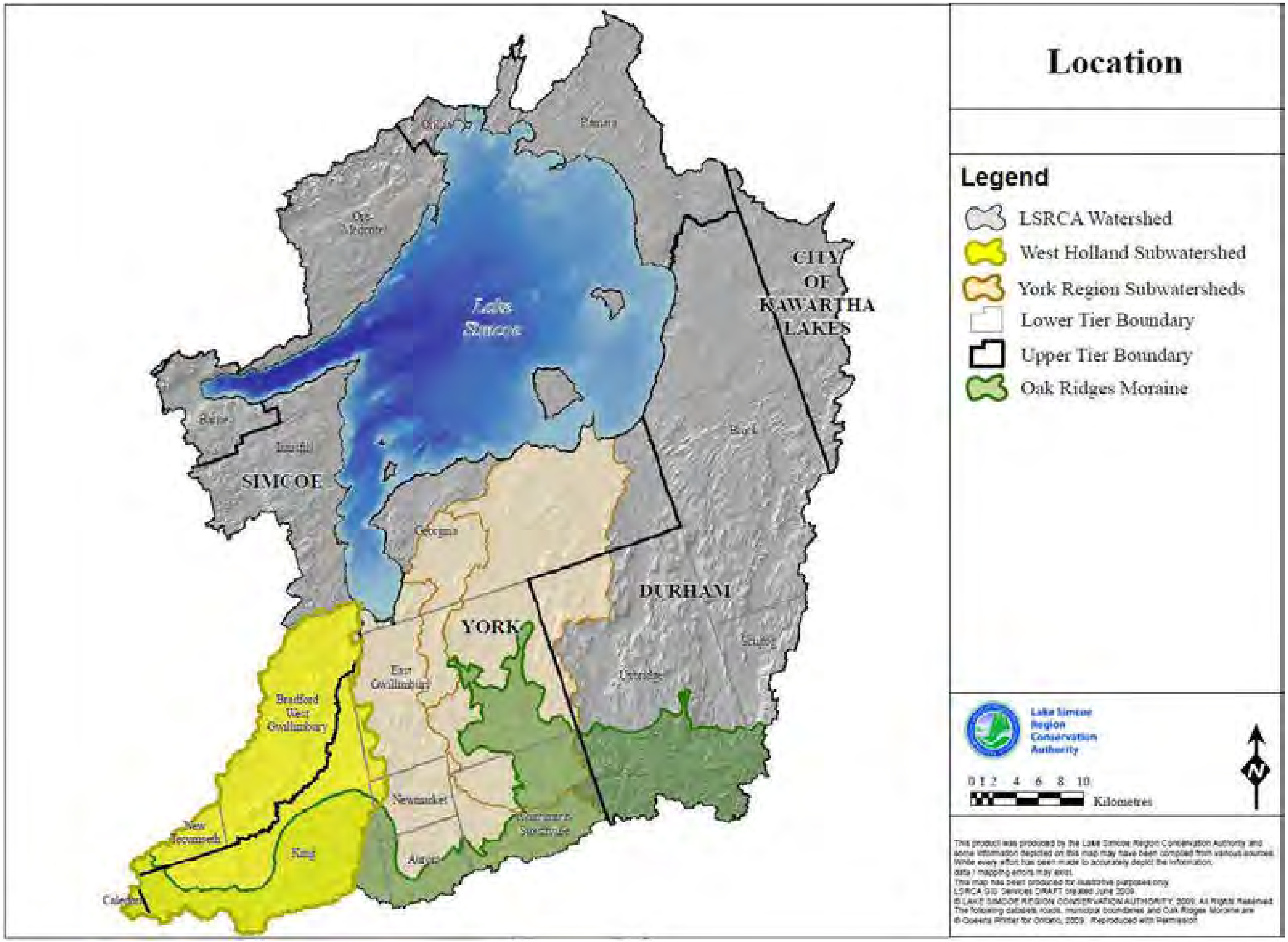
2.1 Location

The West Holland subwatershed is located west of the southern tip of Lake Simcoe's Cook's Bay (Figure 2-1). Municipally, the subwatershed is shared by Simcoe County (47%) in the west and York Region (53%) in the east, and includes the Townships of King, Caledon, New Tecumseth, Bradford West Gwillimbury, and part of the Town of Newmarket. The subwatershed covers an area of 354 km^2. The subwatershed has a length of approximately 30 km in a northeast, southwest direction. Neighbouring subwatersheds include the East Holland River and Black River to the east, the Maskinonge River to the northeast, and the Innisfil Creeks to the north.

Land use in the subwatershed is primarily agricultural, occupying 57% of the subwatershed area. Natural areas occupy approximately 31%. While 3% is occupied by urban areas, though this is expanding. Agricultural areas are found throughout the subwatershed, with natural areas interspersed throughout. The Holland Marsh is a significant feature, running northeast from Highway 9 to Cook's Bay. The largest urban area is the Town of Bradford, located near the centre of the subwatershed. Land use details are shown in Table 2-1 and Figure 2-2.

Table 2-1 Land use distribution in the West Holland River subwatershed (WHS)

Land Use	Area of the WHS (ha)	Percentage of the WHS (%)
Natural Heritage Features	10,778	31
Intensive and Non-Intensive Agriculture	20,074	57
Rural Development	1,435	4
Urban Areas	1,193	3
Roads	733	2
Active Aggregate Extraction	6	0
Other	973	3
Total	**35,192**	**100**



This product was produced by the Lake Simcoe Region Conservation Authority and some information depicted on this map may have been compiled from various sources. While every effort has been made to accurately depict the information, data / mapping errors may exist.
This map has been produced for illustrative purposes only.
LSRCA GIS Services DRAFT created June 2009
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The following datasets roads, municipal boundaries and Oak Ridges Moraine are © Queens Printer for Ontario, 2009. Reproduced with Permission.

Figure 2-1 The location of the West Holland subwatershed in the Lake Simcoe basin

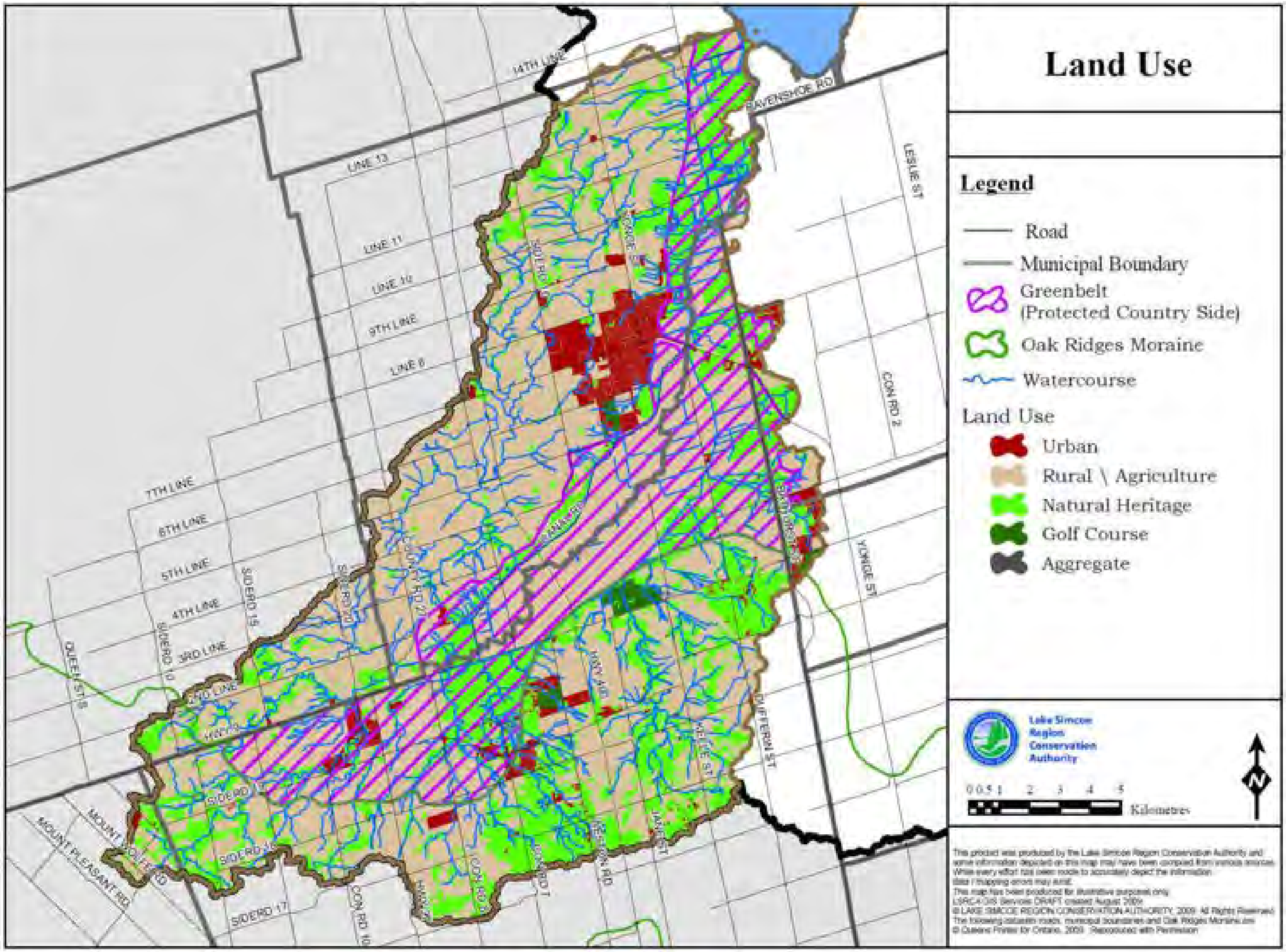

Figure 2-2 Land use in the West Holland subwatershed

2.2 Drainage

All of the lands within the Lake Simcoe watershed ultimately drain into Lake Simcoe, via one of the tributary rivers. The West Holland subwatershed is one of 18 subwatersheds that drain into Lake Simcoe. It is also one of five major tributaries that account for 60 percent of the total drainage to Lake Simcoe.

The subwatershed is drained by the West Holland River, which flows generally in a north-easterly direction and drains into Cook's Bay. The headwaters originate from discharge springs and seepages along the northern flanks of the Oak Ridges Moraine.

The main tributaries of the West Holland River include: Ansnorveldt Creek*1, flowing westward towards the main branch; Glenville Creek, flowing westward; East Kettleby Creek*, flowing westward; Kettleby Creek, flowing north; 400 Creek*, flowing northward; Pottageville Creek, flowing northwest, South Schomberg River*, flowing northward; North Schomberg River*, flowing north east; Fraser Creek, flowing northeast; Scanlon Creek, flowing northeast; William Neeley Creek, flowing northward; Coulson's Creek, flowing northeast into Cook's Bay.

2.3 Topography and Physiography

2.3.1 Topography

The topographic features of the West Holland subwatershed are related to its geological history, including significant glacial events. The ground surface topography within the West Holland subwatershed ranges from 370 metres above mean sea level (mASL), at the Oak Ridges Moraine (ORM), to 215 mASL at Lake Simcoe Figure 2-4.

There are three topographic areas that have been identified within the subwatershed: the northern extent of the ORM, a rolling clay plain, and a flat plain that is now part of the Holland Marsh extending from Holland Landing to Cook's Bay.

The ORM is located along the southern portion of the subwatershed. It is characterized by hummocky terrain that ranges from approximately 275 to 390 mASL. The area that has elevations ranging between 275 to 225 mASL represents the rolling clay plain that is characterized by numerous valleys, which make its relief very uneven. This is true for the area between Schomberg and Bradford, where considerable dissection has taken place giving rise to rough topography (Chapman and Putnam, 1984).The third topographic area is a flat plain ranging in elevation from 220 to 225 mASL. This plain is fairly widespread, extending from the Township of King in the south to Cook's Bay in the north. From east to west, it extends the abandoned shoreline of Lake Algonquin to the valley of the Holland River.

The Holland Marsh occupies an area of approximately 24 km2 within the flat plain of the West Holland River subwatershed. A polder is an agricultural area which at one point was a wetland, but has been drained so that the rich soils can be used for growing vegetables (Figure 2-3). The Holland Marsh, several polders in the Lake Simcoe watershed, and the largest of the five polders within the subwatershed, was once a shallow extension of Lake Simcoe, and was first drained in 1927 in order to grow agricultural crops. The peat soils of the Holland Marsh support one of the most important agricultural areas in Ontario exporting to markets throughout the province and internationally (CH2MHill, 2004).

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[1] A * indicates that the name is used internally by LSRCA, they have not been officially sanctioned.

The water levels in the marsh are maintained through a series of inner and outer canals and the Art Janse Pumping Station located at the north end of the Marsh near Highway 11. The pumping station is used to remove excess water from the inner canal of the cultivated marsh area during spring runoff or during significant storm events. This excess water is conveyed to the lake via a pumping station. During drier periods, irrigation water is drawn from the outer canal and the lower Holland River for crop irrigation. The 18 km inner canal system is only allowed to fluctuate by 125 mm during spring runoff or storm events (CH2MHill, 2004).

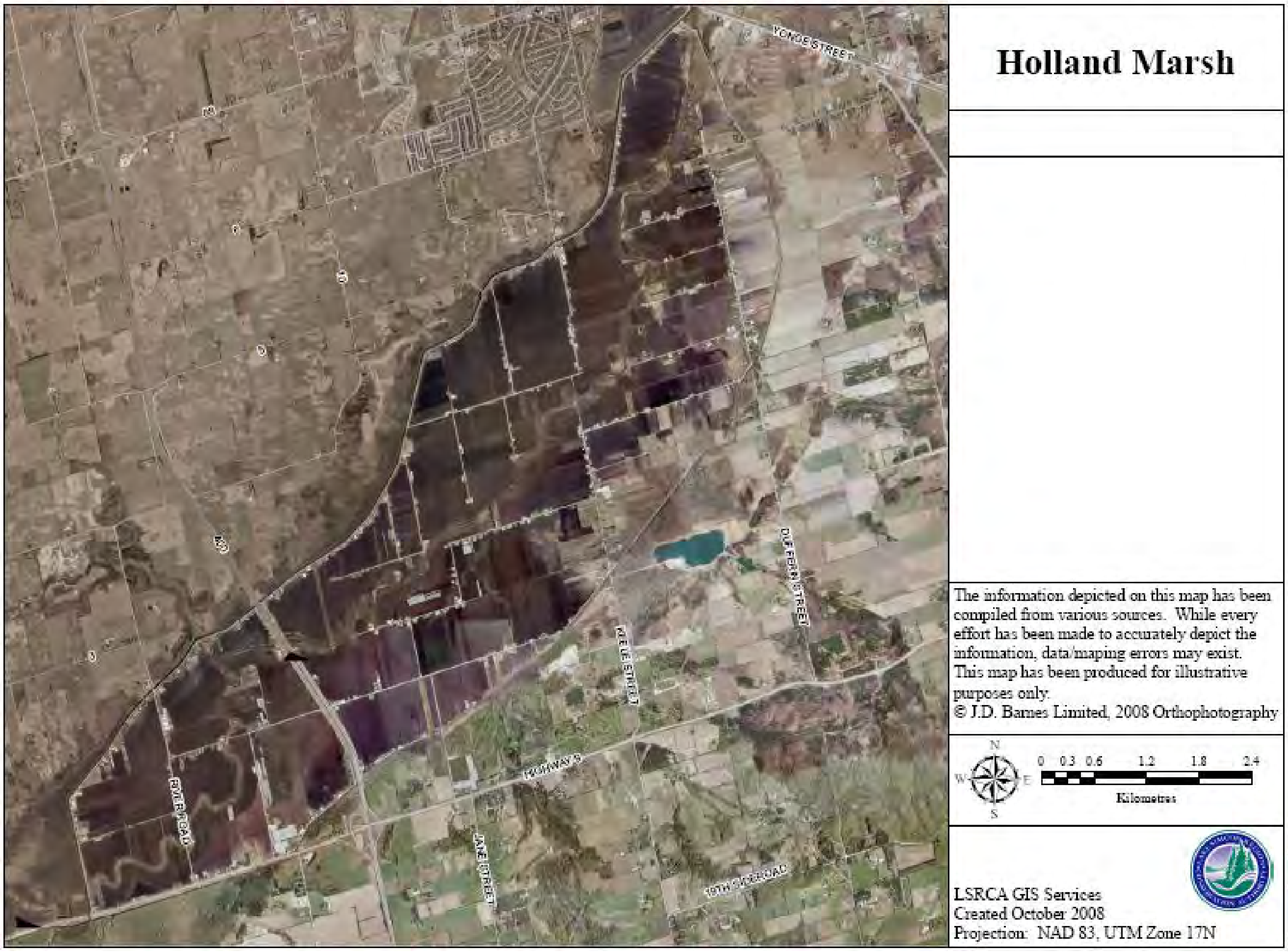

Figure 2-3 Holland Marsh polder

As is mentioned above, the West Holland River is also home to a number of other, smaller polder systems. These include the Colbar Marshes (308 ha), the Deerhurst Polder (85 ha), and the North Bradford Marsh (64 ha).

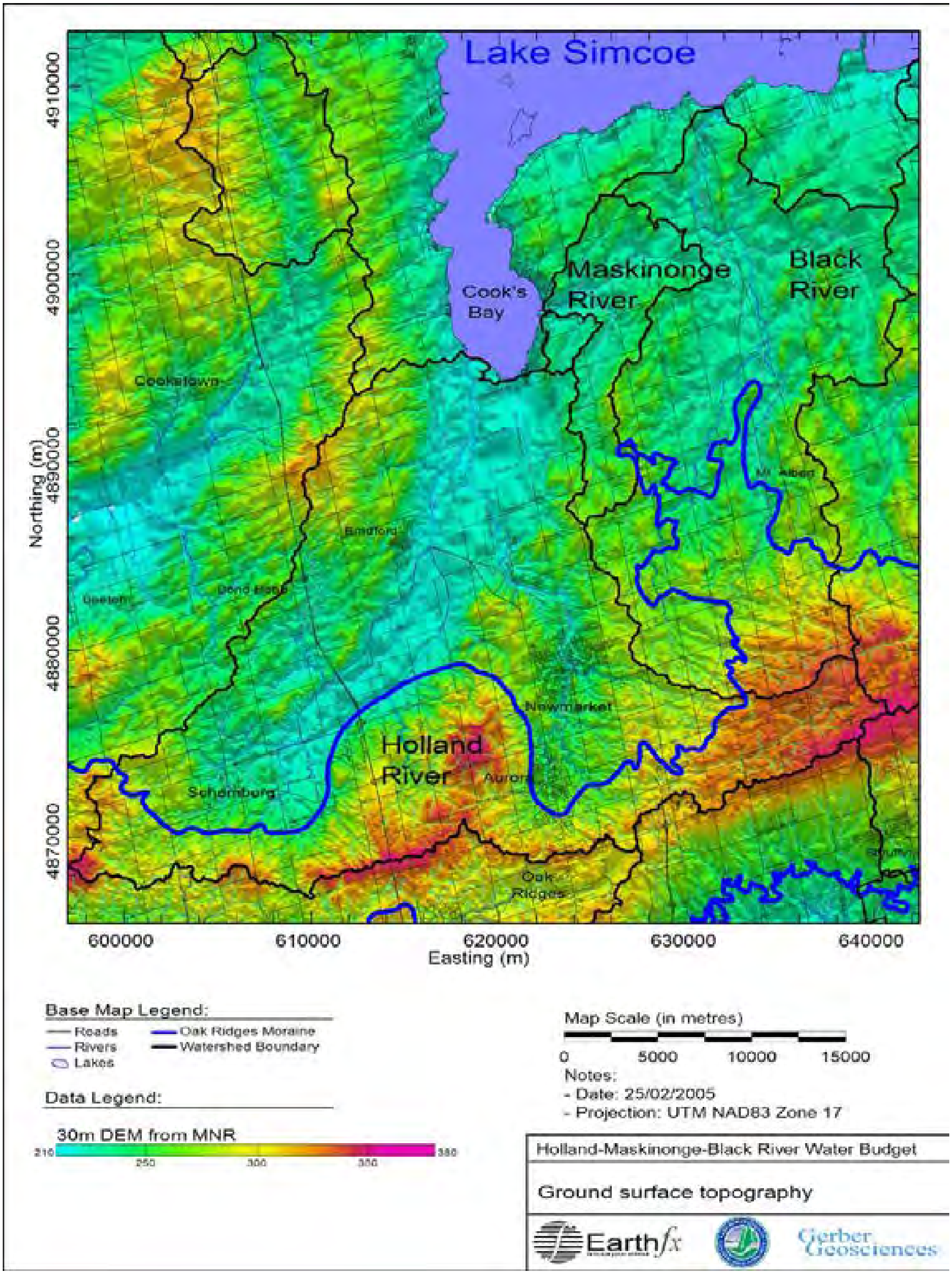

Figure 2-4 Ground surface topography (Earthfx and Gerber Geosciences, 2008)

2.3.2 Physiography

The physiographic regions within the West Holland subwatershed are a direct result of the deposition and erosion during glacial and post-glacial events, and closely correspond to the topography discussed above. According to Chapman and Putnam (1984), four physiographic regions are found within the subwatershed: the Oak Ridges Moraine (ORM), the Simcoe Lowlands, the Schomberg Clay Plain, and the Peterborough Drumlin Field (Figure 2-5). The ORM generally makes up the topographic highs, while the Simcoe Lowlands and the Schomberg Clay Plain make up the low areas within the subwatershed.

Oak Ridges Moraine

The headwaters of the streams flowing into Lake Simcoe from the south are located on the most widely recognized feature in the watershed, the Oak Ridges Moraine. The Oak Ridges Moraine is a significant physiographic feature that lies between the Trent River and the Niagara Escarpment. It is approximately 160 km in length, and has topographic elevations ranging from 305 to 395 mASL (Davies et al, 2008). The peak of the moraine forms the surface water divide separating flow towards Lake Simcoe from flow towards Lake Ontario.

The Oak Ridges Moraine is comprised of rolling sandy hills, hummocky topography and closed depressions that form the source of the headwaters to major streams that drain off the moraine. The moraine within the subwatershed consists primarily of surficial sand and gravel deposits, which can have a thickness of as much as 90m. Along the topographic divide within the moraine these deposits are covered with silt to clay silt till (Halton Till). Also, a sand to sandy silt till (Newmarket Till) abuts the northern edge of the moraine area, and is believed to extend under the sand and gravel cap of the moraine.

A unique feature of the Oak Ridges Moraine is the lack of surface drainage. Precipitation in this area either infiltrates to replenish the groundwater system or returns back to the atmosphere via evapotranspiration. It is at the northern and southern flanks of the moraine where the groundwater emerges as springs or seepages, creating the headwaters of the subwatersheds originating on the moraine, including the West Holland. The high infiltration capacity of the moraine makes it one of the most important recharge zones in southern Ontario, and within the West Holland subwatershed.

Simcoe Lowlands

The Simcoe Lowlands is the physiographic region that comprises the majority of the West Holland subwatershed. The region extends from the ORM northward to Lake Simcoe, and is described as having lower elevations, with flat-floored valley features that generally correspond to current river systems (Sharpe *et al.,* 1999). The lowlands were flooded by glacial Lake Algonquin and as a result are floored by sand, silt and clay (Chapman and Putnam, 1984).

There are two units that have been identified within the Simcoe Lowlands. The first unit is covered by organic deposits and occurs immediately below Cook's Bay, and is part of a large broad valley that extends southwest outside the study area. The floor of this valley is now a marsh in which the Holland River meanders toward Lake Simcoe. This valley is known as the Holland Marsh.

The second unit is covered by glaciolacustrine sand and silt, which extends to the east of the Holland Marsh and consists of a level plain covered by deep sand and silt deposits formed when glacial Lake Algonquin flooded this area.

Schomberg Clay Plain

The Schomberg Clay Plain is not a continuous feature like the Oak Ridges Moraine outlined above. It occurs in several low lying regions around the Schomberg, Newmarket, and Lake Scugog areas. Within this subwatershed, the clay plain has an approximate elevation range of 225 and 275 mASL, and extends from Schomberg to Bradford. The Schomberg Clay Plain is characterized as having rolling relief that reflects the underlying till plain. The Schomberg Clay Plain areas are characterized by thick deposits of fine-grained sediments that are draped over an irregular till plain and are typically 15 m in thickness (Chapman & Putnam, 1984).

Peterborough Drumlin Field

The Peterborough Drumlin Field extends north of the ORM to east of Lake Simcoe into the Nottawasaga basin. A portion of the Peterborough drumlin field regime occurs south of Kempenfelt Bay (west of Cooks Bay), and within the south-central and eastern portions of the Lake Simcoe watershed. Within the West Holland subwatershed, this regime is extensive in the north-western portion of the subwatershed. The till plains are covered by the clayey Kettleby Till, and the sand to sand silt Newmarket Till. It is defined by a rolling drumlinized till plain. One area is located west of Aurora and Newmarket along the western topographic divide and the second is located to the northeast of Holland Landing.

This physiograpic region is typically characterized by numerous drumlins that occupy the area between the Oak Ridges moraine and Cook’s Bay are on average oriented 60° west of south or 240°azimuth. On average, drumlins are 20-75 m in width and 100-450 m in length. Internally, drumlins are composed of a stone-rich, slightly silty to silty fine to medium grained sand till. Texturally, the percentage of silt increases in a southerly direction, more specifically drumlins immediately south of Cook’s Bay are composed of a stone-rich, slightly silty, fine to medium grained till. Whereas those immediately north of the Oak Ridges moraine are composed of a stone-rich, fine to medium grained sandy, silt till (SGBWLS, 2007).

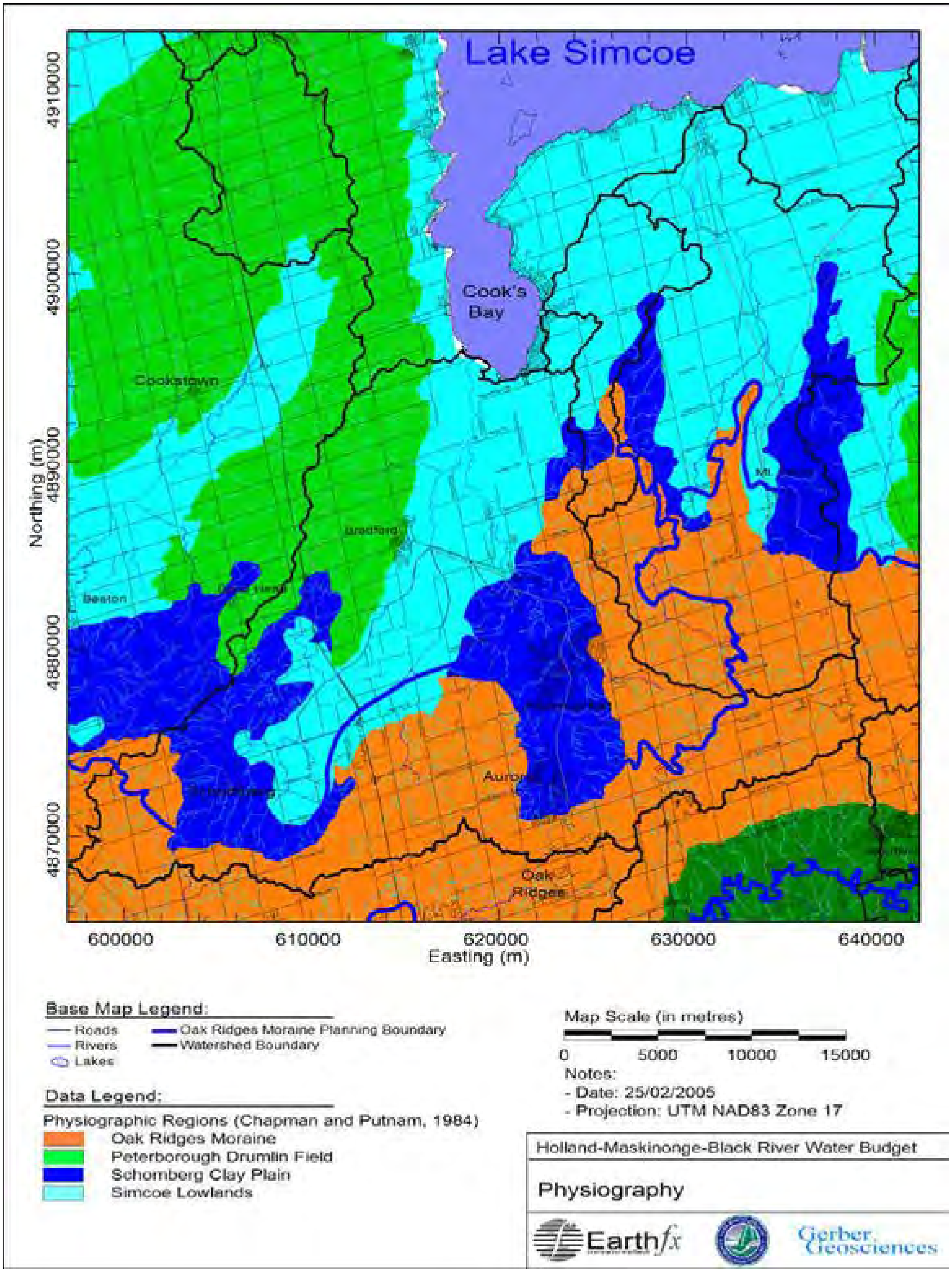

Figure 2-5 **Physiographic regions within the study area (Gerber & Earthfx, 2008).**

2.4 Geology

There have been a number of studies that have lead to the geologic understanding in the area. A generalized description of the bedrock geology, Quaternary geology, and conceptual stratigraphic units within the West Holland subwatershed is provided below. For more detailed information the reader is referred to Liberty (1969), Karrow (1989), Johnson et al. (1992) and Barnett (1992).

The geology of the West Holland subwatershed is complex and has been influenced by a number of glacial events. Bedrock topography, which has a significant influence on the nature and extent of deeper aquifer units, has been mapped using data obtained from the MOE's digital water well records. Overburden thickness has also been estimated as the difference between bedrock and ground surface elevation. Areas of thicker overburden generally correspond to moraine or 'hummocky topography' features

2.4.1 Bedrock Geology

The bedrock can be characterized as being from the Paleozoic Era, consisting primarily of limestone of the Middle Ordovician Simcoe Group in the north, and shale of the Upper Ordovician Blue Mountain in the south (Johnson *et al*., 1992). The bedrock has been overlain by a sequence of sediments that have been deposited over the last 135,000 years by glacial, fluvial and lacustrine environments (Figure 2-6).

The Middle Ordovician deposits make up the Simcoe Group, which consists of five formations. However, only the Verulam and Lindsay Formations are found within the subwatershed. The younger, Upper Ordovician deposits found within the subwatershed consist of the Georgian Bay-Blue Mountain Formation.

Verulam Formation

The oldest Paleozoic rocks underlying within the subwatershed are those of the Verulam Formation. The formation only occurs in a small area to the south of Cook's Bay. The formation is a member of the Simcoe Group, which is represented as (5) on Figure 2-6, and is of Middle Ordovician age (approximately 450 million years ago). Within the subwatershed the formation ranges in thickness from 32 to 65 m and consists of fossiliferous limestone with inter-beds of calcareous shale. The depositional environment of the Verulam Formation was open marine shelf (Thurston et al., 1992).

Lindsay Formation

The Lindsay Formation overlays the Verulam Formation and extends from the northeastern boundaries of the subwatershed toward its southern and southwestern boundaries. The formation is also of Middle Ordovician age and is a member of the Simcoe Group (which is represented as (5) on Figure 2-6. Within the subwatershed the Lindsay Formation has a thickness of 67 m and is richly fossiliferous, which indicates that the depositional environment was a shallow to deep marine environment (Thurston et al., 1992).

Blue Mountain Formation

The Blue Mountain Formation (formerly the Whitby Formations) overlies the Lindsay Formation. This formation is often referred to as part of the Georgian Bay formation (6) on Figure 2-6.The formation is Upper Ordovician in age (approximately 420 million years ago) and is present as a band running southeast to northwest in the southern portion of the subwatershed. The formation consists of a blue-grey, poorly fossiliferous, non-calcareous shale up to 60 m thick (Thurston *et al.,* 1992).

Georgian Bay Formation

The Georgian Bay formation (formally the Whitby Formations) overlies the Blue Mountain formation. The formation is Upper Ordovician in age and is present in the southern most portion of the subwatershed. The formation consists of carbonate rich, blue-grey shale. The depositional environment of the Georgian Bay formation was shallow carbonate sedimentation (GRIPS DRAFT, 2008). This formation is represented as (6) on Figure 2-6.

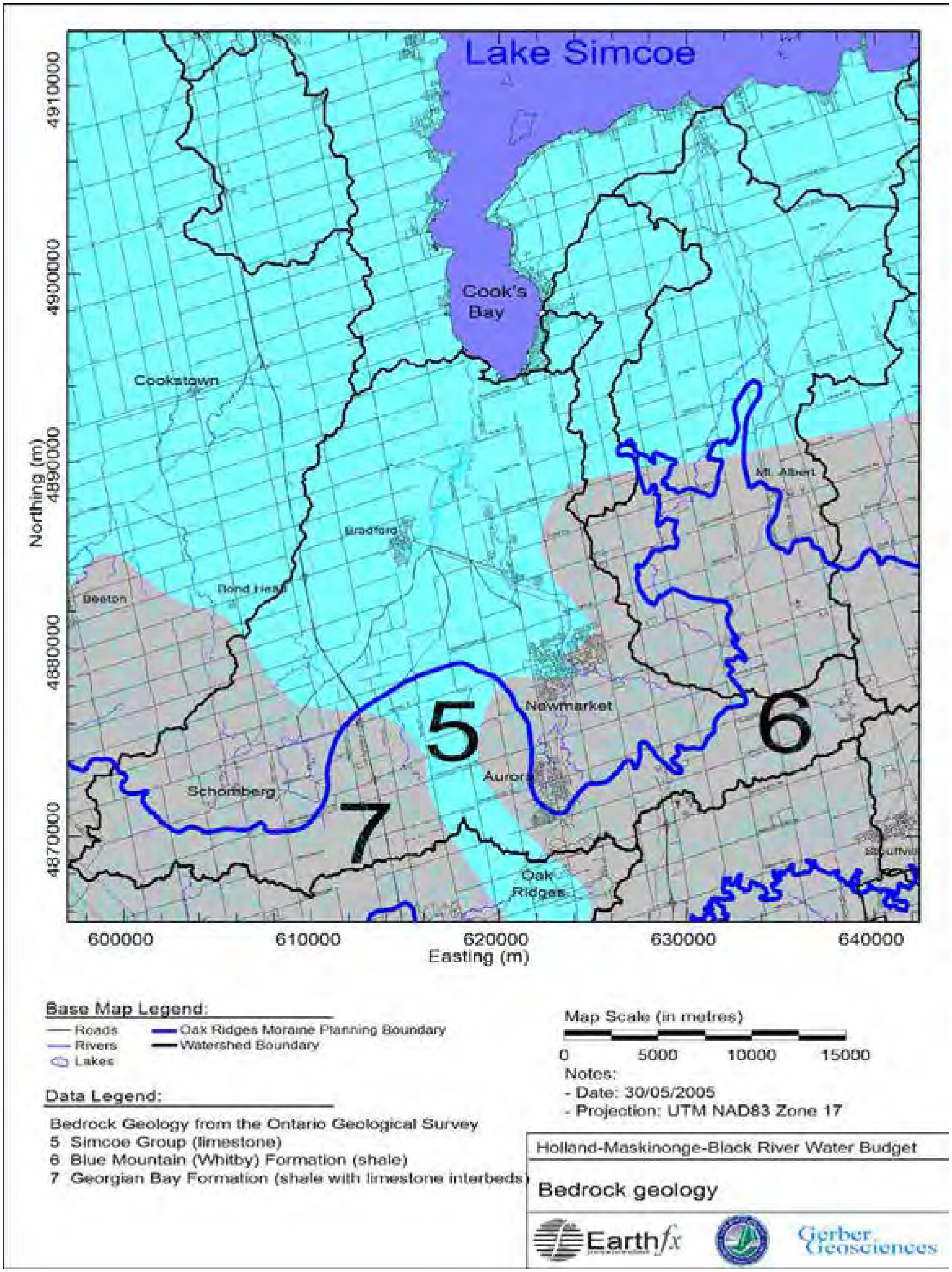

Figure 2-6 **Bedrock geology within the study area (Gerber & Earthfx, 2008).**

2.4.2 Bedrock Topography

The bedrock surface of the West Holland subwatershed has a general elevation range of 100 to 175 mASL, Figure 2-7. The bedrock surface is thought to have been the result of a long period of non-deposition and/or erosion activity that occurred between the deposition of the sedimentary bedrock and the overlying sediments.

The topographic lows are associated with significant valleys that have been eroded into the bedrock surface. These valleys are believed to be a result of fluvial activity prior to glaciation, approximately 440 to 2 million years ago with additional modification by glacial processes over the last 2 million years (Earthfx & Gerber, 2008).

A major bedrock valley known as the Laurentian bedrock channel traverses through the south western portion of the Lake Simcoe watershed. Recent interest has been generated over the Laurentian Channel (also referred to as the Laurentian Valley), a proposed Tertiary-aged river network that extended from Georgian Bay to Lake Ontario (Brennand *et al.,* 1998; Sharpe *et al.,* 2004).This interest has been driven primarily through the attempt to locate additional sources of potable water as increasing population continues to place additional stress on existing groundwater supplies. This valley identifies an ancient drainage system that extended from Georgian Bay to Toronto. Tributary valleys to the main Laurentian valley are interpreted to occur beneath the subwatershed extending from Mount Albert through Newmarket and Aurora to join the main valley south of the study area (Earthfx & Gerber, 2008).

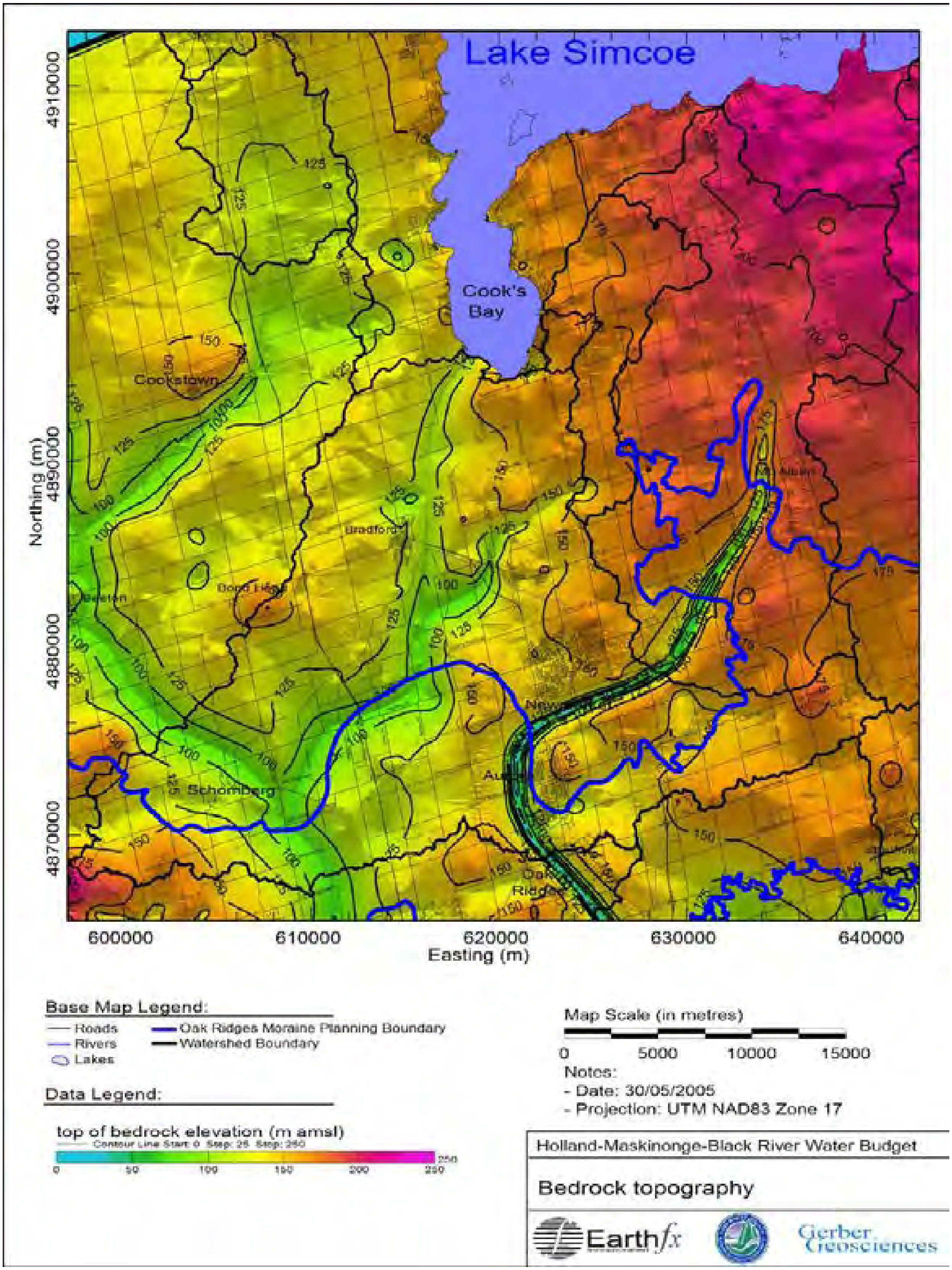

Figure 2-7 Bedrock elevation within the study area (Earthfx & Gerber, 2008).

2.4.3 Quaternary Geology

Glacial History

The bedrock within the West Holland subwatershed is overlain by unconsolidated sediments, known as the overburden, which was deposited during the Quaternary Period. The Quaternary Period can be further divided into the Pleistocene (Great Ice Age) and the Holocene (Recent) Epochs. During the Pleistocene, at least four major continental-scale glaciations occurred, which include, from youngest to oldest, the Wisconsinan, Illinoian, Kansan and Nebraskan Stages (Dreimanis and Karrow, 1972). All of the surficial deposits within the subwatershed, and within most of southern Ontario are interpreted to have been deposited by the Laurentide Ice Sheet during the Wisconsinan glaciation. The Laurentide Ice Sheet is the glacier that occupied most of Canada during the Late Wisconsinan period, approximately 20,000 years ago (Barnett, 1992).

Sediments deposited during the Late Wisconsinan substage are extensive in southern Ontario, and are thought to represent all of the surficial deposits in the West Holland subwatershed. All of the deposits which outcrop at surface within the subwatershed were likely laid down within the last 15,000 years during and after the Port Bruce Stade. Deep boreholes indicated that older Wiconsinan deposits do occur at depth; however, it is not always possible to date them (Dreimanis and Karrow, 1972).

The stratigraphy of the surficial deposits within the subwatershed is extremely complex, particularly in the ORM area where the deposits are very thick and are a direct result of the complex glacial history over the last 115,000 years.

Quaternary Sediment Thickness

Within the subwatershed the Quaternary sediment thickness is the difference between the ground surface and the interpolated bedrock surface. The thickness of the Quaternary sediments has been determined from borehole and water well information within the subwatershed. Figure 2-8 shows the thickness ranges from approximately 56 m to 240 m. The Paleozoic bedrock topography appears to strongly influence the overlying Quaternary sediment thickness and distribution. The thicker Quaternary sediments occur in bedrock topographical lows (i.e. within bedrock valleys and beneath the ORM), while the thinnest areas of Quaternary deposits occur at the north end of the subwatershed, south of Cook’s Bay. In addition, areas of thicker overburden can generally correspond to moraine and ‘hummocky topography’ features, as shown in Figure 2-8.

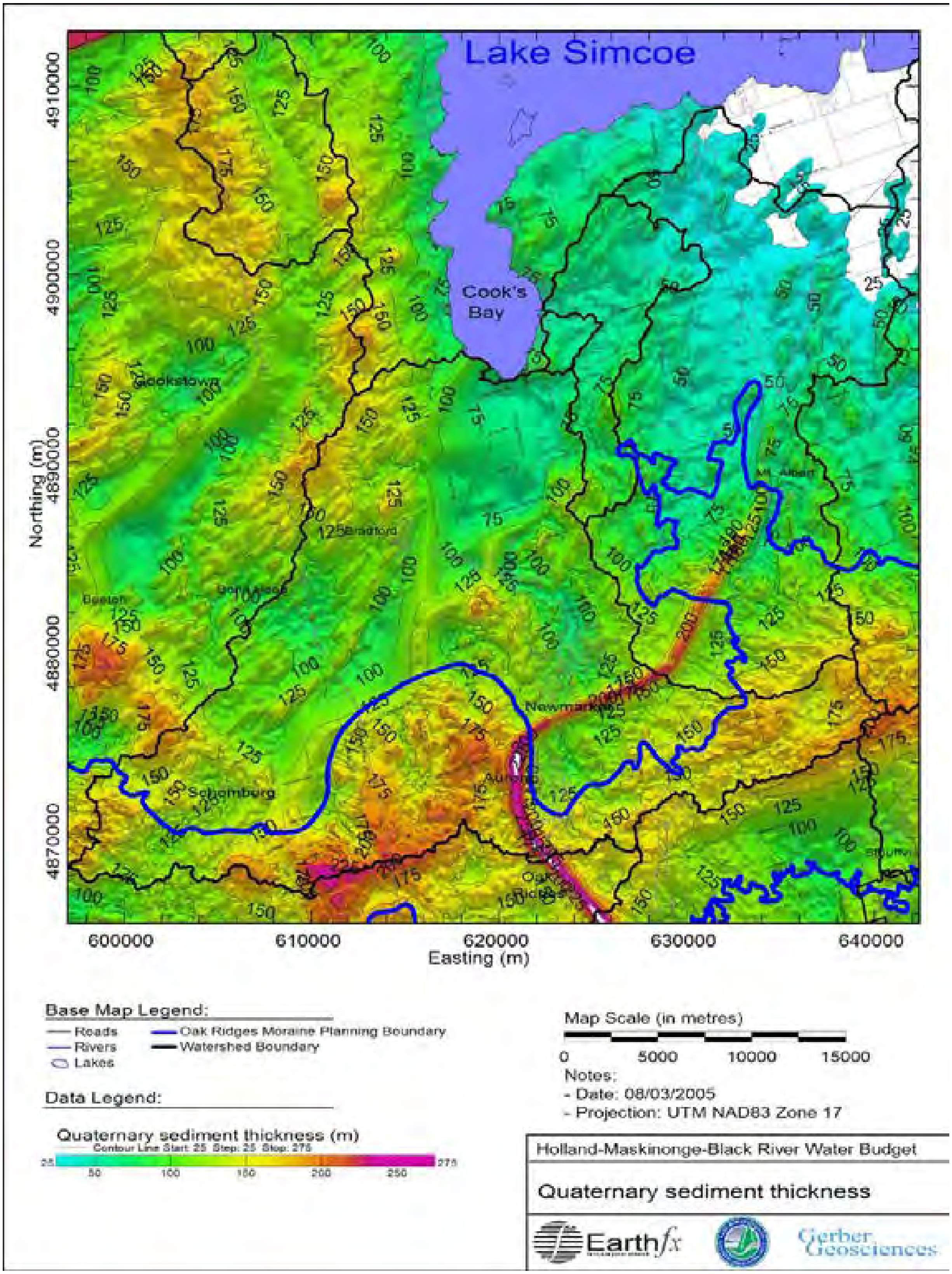

Figure 2-8 **Quaternary sediment thickness within the study area (Earthfx & Gerber, 2008)**

2.4.4 Stratigraphy

The stratigraphy of the surficial deposits within the West Holland subwatershed is complex as a result of the glacial history. There are a number of ongoing initiatives to understand the local stratigraphy. The following subsections provide a brief overview of relevant and previously completed stratigraphic studies.

The stratigraphic framework of Quaternary glacial and non-glacial sediments, as shown in Figure 2-9, was completed using exposed sediment along the Lake Ontario bluffs and in the Don Valley brickyard (Eyles, 2002). In addition, a conceptual understanding of the stratigraphic framework was completed for the ORM area by the Geological Survey of Canada (GSC) and later refined by the Conservation Authorities Moraine Coalition York-Peel-Durham-Toronto Groundwater Study (CAMC-YPDT). The GSC constructed a five-layer geologic model of the moraine based in part by the stratigraphy of the Scarborough Bluffs. The CAMC-YPDT group combined the two stratigraphic models presented above to produce and eight-layer geologic model, shown in Figure 2-10. Further information can be obtained from Earthfx *et al.* (2006).

The eight conceptual model layers (from youngest to oldest) are:

1. Surficial deposits and/or weathered Halton Till
2. Halton Till or Kettleby Till
3. Oak Ridges Aquifer complex and/or Mackinaw Interstadial deposits
4. Newmarket Till
5. Thorncliffe Formation deposits
6. Sunny Brook Drift
7. Scarborough Formation deposits
8. Weathered bedrock

<u>Don Formation and York Till</u>

The Don Formation and underlying York Till have not been mapped within the subwatershed due to lack of deep borehole information that would be necessary to delineate these deposits since they are only within lows on the bedrock surface.

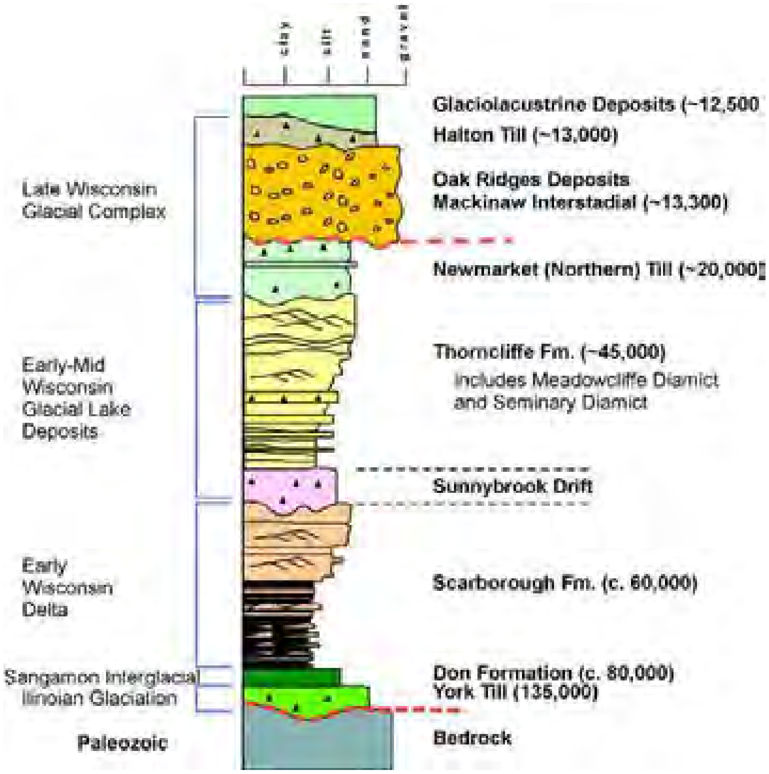

Figure 2-9 Quaternary deposits found within the Toronto area (Figure from Eyles, 2002).

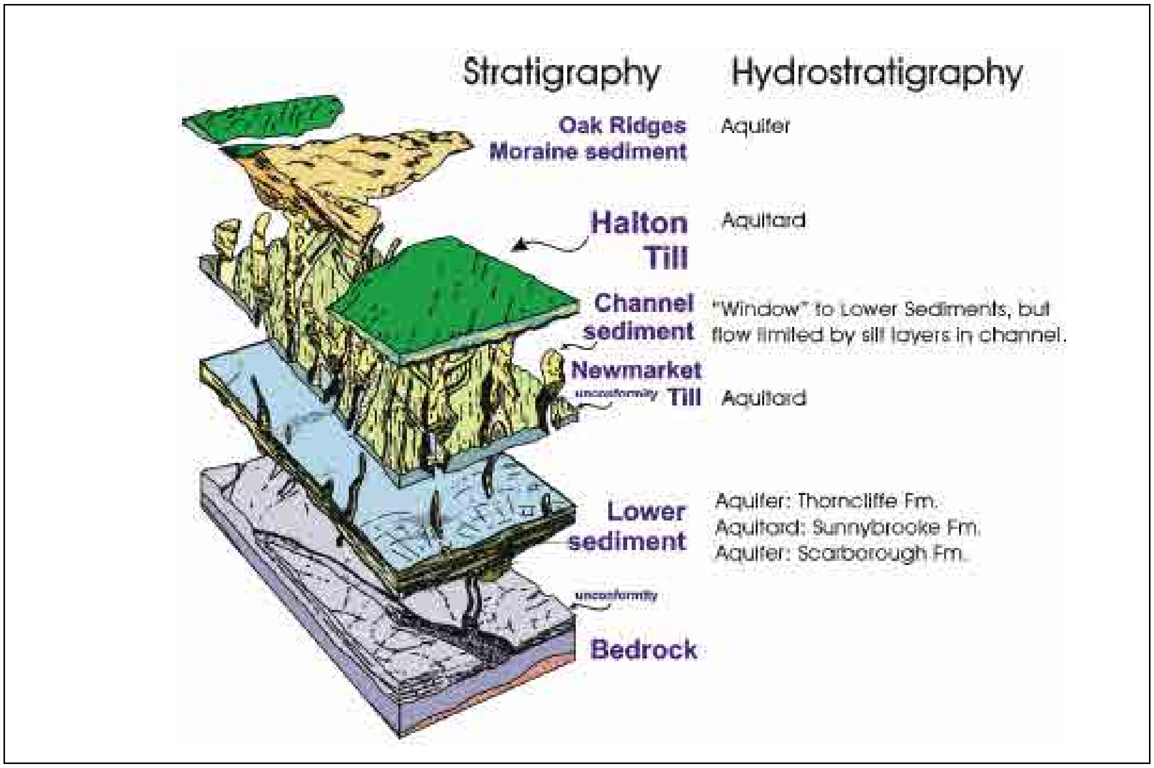

Figure 2-10 GSC stratigraphic framework of the ORM region (Sharpe et al., 1999)

Scarborough Formation

The oldest Quaternary deposit of significant (mappable) thickness present within the subwatershed is the Scarborough Formation or equivalent to the Scarborough Formation as mapped in outcrop in areas to the south. The Scarborough Formation marks the start of the Wisconsinan glaciation, approximately 100,000 years ago.

The Scarborough Formation (or equivalent) was formed by fluvio-deltaic processes leading to deposition of a lower clay layer overlain by sands showing varieties of cross-beddings. However, within the West Holland subwatershed these deposits are mostly sand. This unit is mainly found within bedrock valleys and thins laterally away from the valleys (Earthfx & Gerber, 2008).

Sunnybrook Drift

The Sunnybrook Drift (or equivalent) overlies the Scarborough Formation and consists of clast-poor silt and clay deposited by glacial and lacustrine processes. This formation was deposited in close proximity to an ice sheet as it finally reached the subwatershed about 45,000 years ago (Earthfx & Gerber, 2008).

Thorncliffe Formation

The Thorncliffe Formation (or equivalent) represents glaciofluvial deposition of sand and silty sand generally within lows in the underlying stratigraphy. South of the study area, this unit largely consists of glaciolacustrine deposits of sand, silt and clay. The Thorncliffe Formation was deposited approximatedly 45,000 years ago and consists of sedimentary deposits of silt-clay rythmites and cross-laminated and cross-bedded sands (Earthfx & Gerber, 2008).

Newmarket Till

The Newmarket Till overlies the lower sedimentary sequences described above. The Newmarket Till is a dense diamict unit deposited when the Laurentide ice sheet was at its maximum extent, approximately 18-20,000 years ago. This unit can be up to 100 m thick but is generally 20-30 m thick. The Newmarket Till is an important formation as it hydraulically separates the upper and lower aquifers and serves as a protective barrier to the deeper groundwater resources in the area (Earthfx & Gerber, 2008).

Channel Sediments

Following its deposition, the Newmarket Till was subject to erosional processes by glacial meltwater that modified the upper surface of the till. In some locations, the processes fully or partially eroded entirely through the till (Figure 2-11). These features have been termed tunnel channels by the GSC, who believe these erosional events occurred beneath glacial ice (Sharpe *et al*., 2004). The location of the major Newmarket Till tunnel channel erosion features as interpreted in the CAMC-YPDT study are shown on Figure 2-12. These channels cover much of the study area, as major erosional channels occur beneath the Holland Marsh extending from Lake Simcoe through Schomberg, and within the Aurora and Newmarket area. These erosional channels were largely infilled with sand and silt deposits as meltwater energy waned. Extensive work was carried out to identify these channels and map the upper silt layer that frequently occurs within them. The nature of the infill material is important for understanding the groundwater flow system as it determines the degree of hydraulic communication between the shallow and deeper aquifer systems.

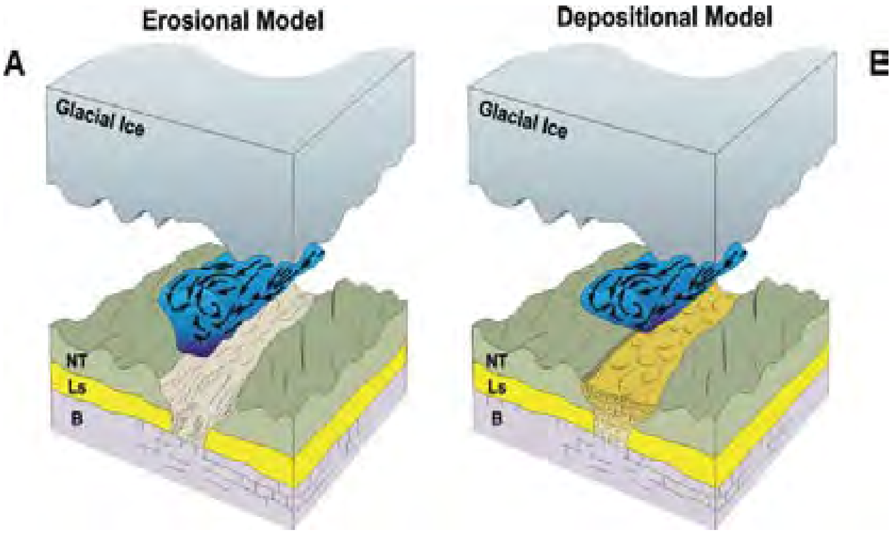

Figure 2-11 Interpreted erosional and depositional process in the tunnel channels (GSC)

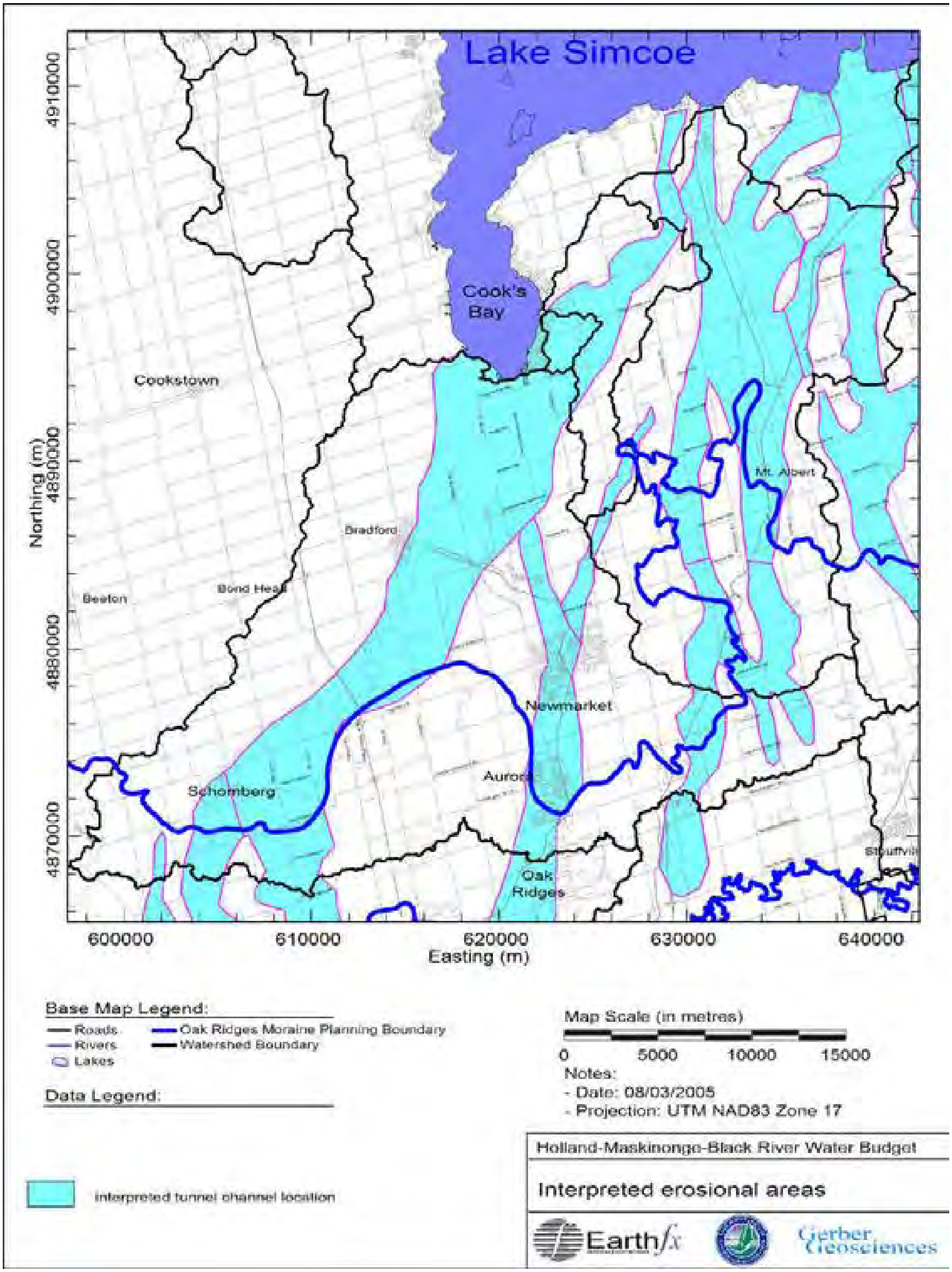

Figure 2-12 Interpreted subsurface erosional channel or tunnel locations where Newmarket Till and older deposits are either partially or completely eroded.

Oak Ridges aquifer complex and/or Mackinaw Interstadial deposits

Oak Ridges aquifer complex occurs above the Newmarket Till and is the most prominent geologic feature in the subwatershed. The Oak Ridges aquifer complex is an interlobate glacial deposit that largely consists of sand and gravel layers that can be up to 150 m thick. To the north and south of the ORM, sand units overlying the Newmarket Till have been categorized as belonging to the Mackinaw Interstadial deposits. Mackinaw Interstadial sediments generally only occur locally within areas of low topography upon the surface of the underlying Newmarket Till (Earthfx & Gerber, 2008).

Surficial deposits and/or weathered Halton Till

The last glacial advance in the area, approximately 13,000 years ago, led to deposition of the Halton and Kettleby Tills which generally have a silt to clayey-silt matrix. These till deposits overlie the ORM and Mackinaw Interstadial units. The uppermost units, which form an intermittent surficial veneer over the underlying till deposits consist of glaciolacustrine sand, silt, and clay associated with local ponding of glacial meltwater, and with Glacial Lake Schomberg and subsequently Glacial Lake Algonquin (Earthfx & Gerber, 2008).

Figure 2-14 and Figure 2-15 show typical cross sections through the study area depicting the key features of the geologic and hydrogeologic system. Figure 2-13 shows the area the cross section depicts. Figure 2-14 shows a west-east cross section along Aurora Road, whereas Figure 2-15 shows a north-south cross section along Yonge Street. Key components of the geologic system include (1) thick deposits associated with the ORM; (2) erosional breaches (tunnel channels) through the Newmarket Till; and (3) thickening of the Scarborough Formation sand deposits within the bedrock valleys. The geologic formation names used in this study are from the Scarborough bluffs area situated along the shore of Lake Ontario (Karrow, 1967) and are also used by subsequent researchers (see, for example, Barnett *et al*., 1998). The term “or equivalent” is used to denote similar deposits situated to the north of the moraine that are interpreted to represent the approximate time or position in the sequence, as determined to the south of the Moraine.

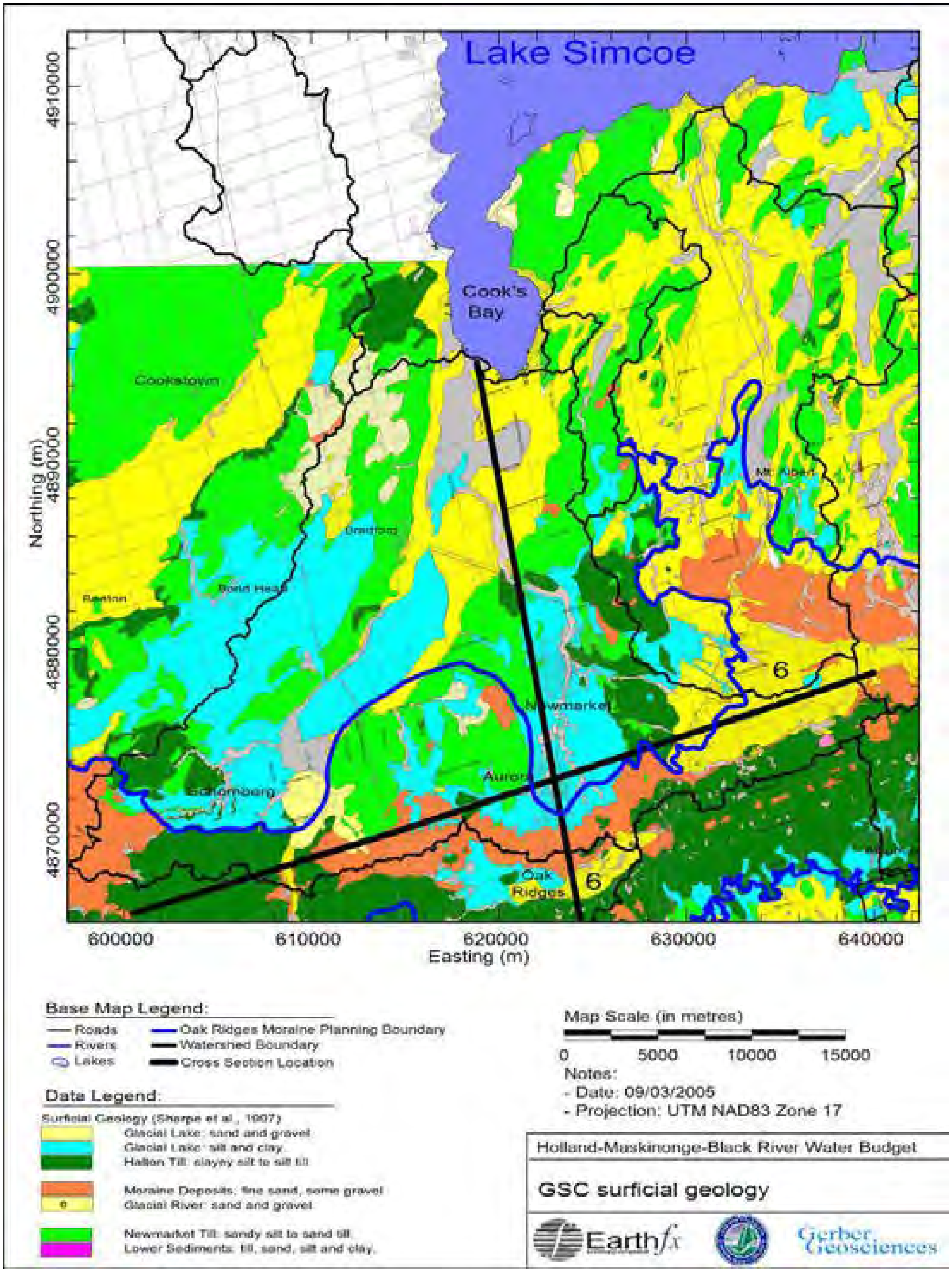

Figure 2-13 Surficial geology and north-south & east- west cross section lines (from Sharpe et al., 1997)

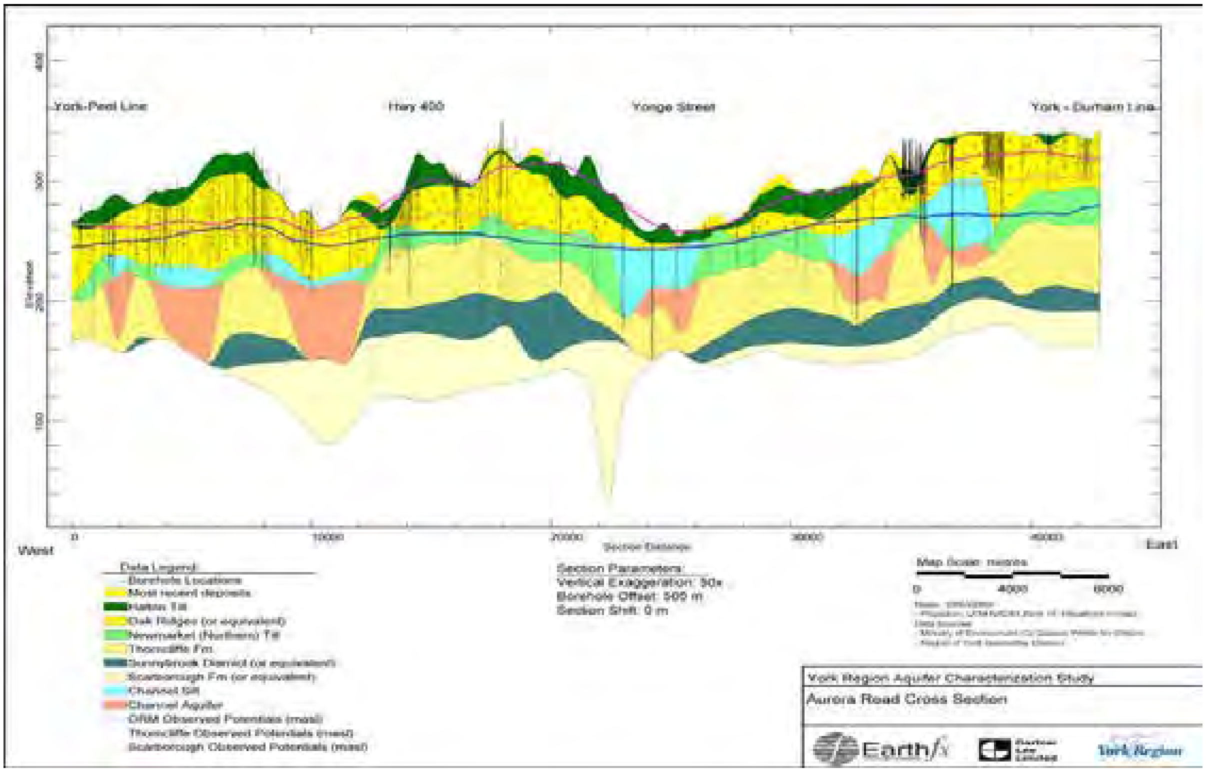

Figure 2-14 West-east cross section (Earthfx & Gerber, 2008)

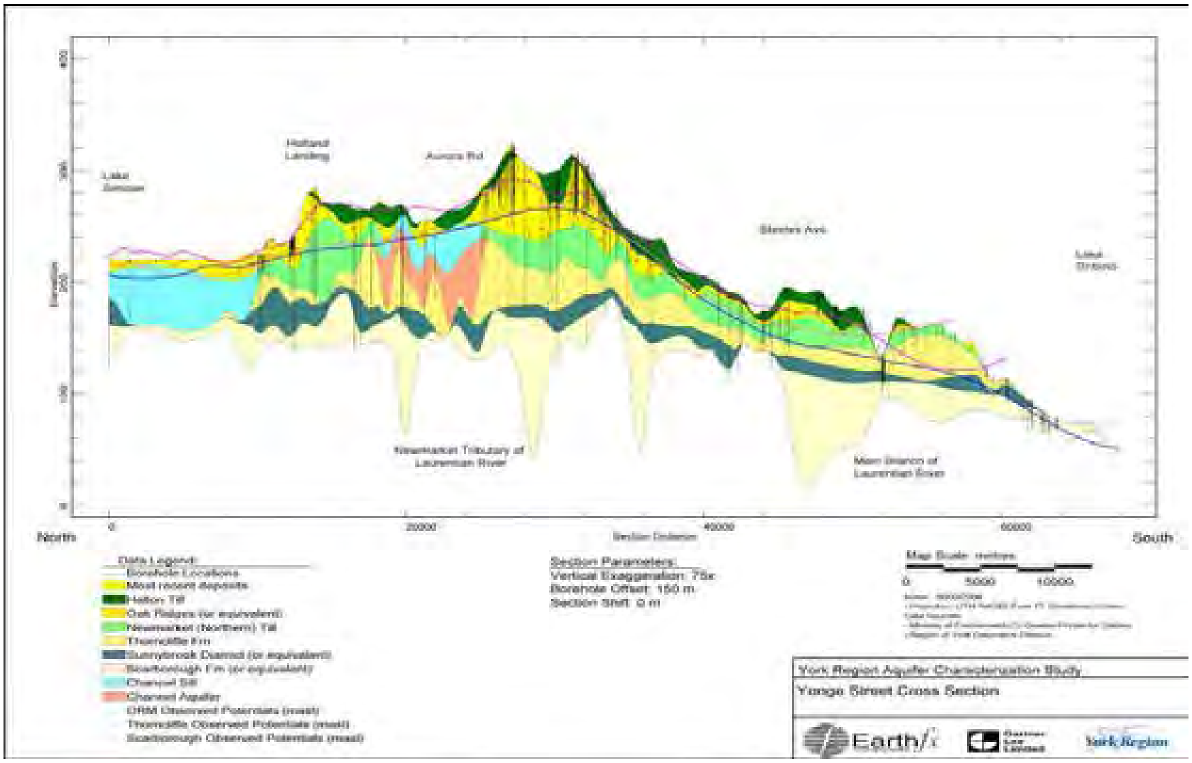

Figure 2-15 North-south cross section (Earthfx and Gerber, 2008)

3 Best Management Practices for the West Holland River Subwatershed

3.1 Introduction

The remaining chapters of this plan characterize current condition of the five main subwatershed features (water quality, water quantity, stream geomorphology, aquatic habitat and terrestrial natural heritage), and identifies some of the stressors leading to their current condition. For each of these features, objectives have been recommended along with specific targets to achieve them. While the actions required to meet these targets may include prohibition or restriction of specific activities, especially in environmentally sensitive areas, it will also require expanded use of best management practices (BMPs). Best management practices can be defined as those measures intended to provide an on-the-ground practical solution to pollution and other environmental impacts from all sources and sectors. BMP refers to operational activities, physical controls or educational measures that are applied to reduce the discharge of pollutants or impacts (US EPA, 2004).

In this chapter we provide an overview of current urban and rural/agricultural BMPs. The chapter concludes by highlighting BMP opportunities within the West Holland subwatershed, resulting from two recent studies by the LSRCA – the Lake Simcoe Basin Best Management Practice Inventory (2009) and the Lake Simcoe Basin Stormwater Management and Retrofit Opportunities (2008).

3.2 Urban Environments – Stormwater BMPs

3.2.1 Background

Urban stormwater runoff occurs as rain or melting snow washes streets, parking lots, and rooftops of dirt and debris, minor spills, and landscaping chemicals and fertilizers. In the past it was common practice to route stormwater directly to streams, rivers, or lakes in the most efficient manner possible. This practice typically has negative impacts on the receiving watercourse. Over the last two decades this has changed and efforts are made to intercept and treat stormwater prior to its entering watercourses or water bodies. However, in many older urban areas stormwater typically still reaches watercourses untreated.

Urban stormwater runoff is also greatly affected by land use type. Commercial and industrial areas usually have more impervious area (e.g. paved parking lots, sidewalks, roof tops) than any other type of land use and consequently generate more urban runoff and pollution. In sharp contrast are open areas that have little, if any, paved surface area. In these areas, the natural hydrologic cycle occurs whereby water can infiltrate down into the ground to be filtered by the soil before entering local streams and watercourses or continue deeper to recharge the ground water aquifer.

The impact of stormwater runoff on stream ecosystems has been well documented and in almost every instance is detrimental to the health of local rivers and streams. Impacts to watercourses have been categorized as follows (Scheuler, 1992):

- changes to stream hydrology (flow),
- changes to stream form (channel morphology),
- degraded water quality, and
- aquatic habitat,

As the amount of impervious area increases, the natural water balance is disrupted. Evapotranspiration is decreased as there is little vegetation and the permeable soil surfaces are paved over; infiltration to groundwater is significantly reduced; and thus the runoff characteristics change. This change results in increases in the frequency and magnitude of runoff events, a decrease in baseflow, and an increase in flow velocities and energy. These changes further affect the form or morphology of the stream, including channel widening, down cutting, sedimentation, and channel braiding. These changes occur due to the increase in the erosive force associated with the increase in stream flow. As the velocity of a stream increases, the erosive force is transferred to the streambanks, and they may begin to erode. If the banks are well vegetated or armoured, the erosive force can be transferred to the stream bottom and down cutting of the streambed can occur. The results of this erosion will be additional sediment and bedload being introduced into the stream system causing a further imbalance. When deposited along the inside bend of a river, this additional sediment may transfer even more force along the outside bend. Further deposition can occur where the river gradient flattens out and results in the creation of a braided channel. All of these changes can have significant impacts on the biological community in the watercourses (Figure 3-1).

Subwatersheds with less than 10% imperviousness should maintain surface water quality and quantity and preserve aquatic species density and biodiversity, as recommended in the Environment Canada’s Areas of Concern (AOC) Guidelines (2005). The AOC Guidelines further recommend an upper limit of 30% as a threshold for degraded systems that have already exceeded the 10% impervious guideline.

In the West Holland River subwatershed, approximately 2,500 ha (7%) is impervious. While the West Holland River subwatershed currently has a relatively low level of imperviousness, it should be noted that research has shown that as impervious cover increases to eight to nine percent, there is a significant decline in wetland aquatic macroinvertebrate health (Hicks and Larson, 1997 *in* AOC Guidelines, 2005). As the Holland Marsh wetland is a major ecosystem not just in the WHS, but also in the Lake Simcoe watershed, maintaining or improving wetland aquatic health is critical.

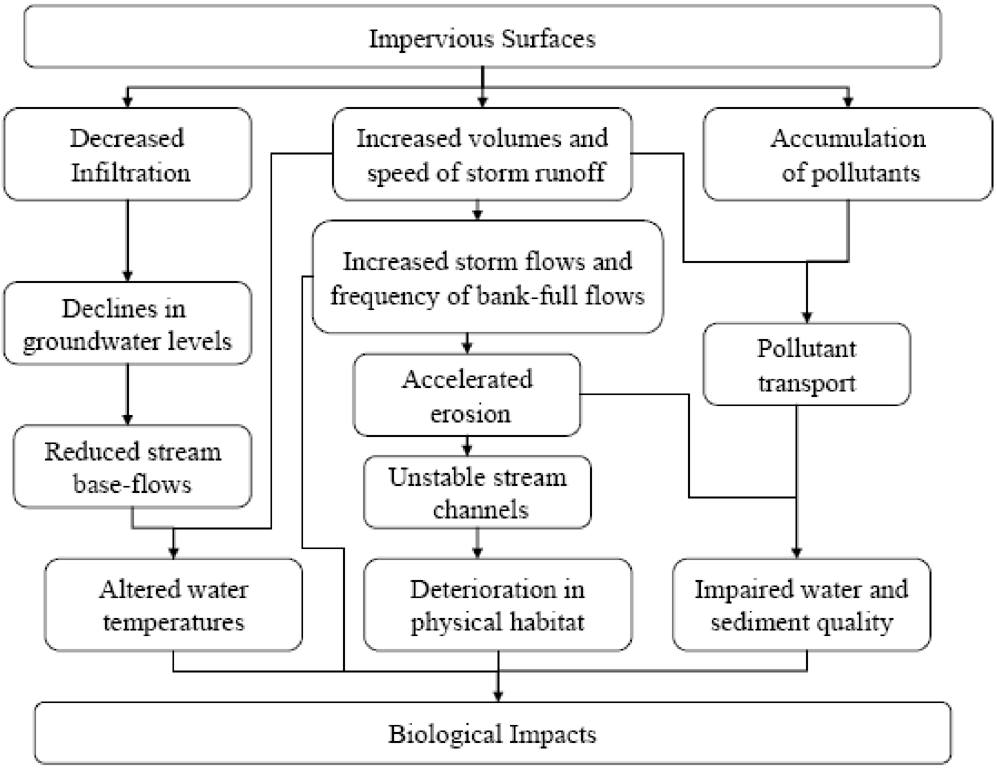

Figure 3-1 Pathways by which impervious surfaces may impact aquatic biological communities (ORM Technical Paper #13)

One of the most significant environmental impacts of stormwater runoff is to water quality. Problems with degraded water quality directly affect the aquatic ecosystem, recreational opportunities and aesthetics. This occurs as pollutants are washed off of streets, parking lots, rooftops, and roadways into storm drains or ditches which discharge to rivers, streams and lakes. Generally, concentrations of pollutants such as bacteria (e.g. *Escherichia coli*, faecal coliform, *Pseudomonas aeruginosa* and faecal streptococci), nutrients (e.g. phosphorus, nitrogen), phenolics, metals and organic compounds are higher in urban stormwater runoff than the acceptable limits established in the PWQO (MOE, 1994). Other harmful impacts include increased water temperature and the collection of trash and debris.

It is a combination of all the previously mentioned changes (hydrology, channel morphology, and water quality) that influence stream ecology and health. Impacts on the aquatic community range from the outright destruction of habitat to reductions in stream productivity and species diversity. The destruction of habitat can occur as spawning beds, nursery areas and structure are covered with sediment. Another way in which habitat can be destroyed is through thermal degradation. Cold water streams are defined as having stable water temperatures that generally do not exceed 20°C, even in the warm summer months. Stormwater runoff can reach temperatures exceeding 30°C because it is draining off of warm pavement. These inputs of warm water can significantly impact the temperature regime within cold water systems. The reduced infiltration of precipitation due to the impervious surfaces can also result in lower groundwater levels, and a potential reduction in the amount available to be discharged as baseflow. Streams that once flowed permanently may become intermittent, and flow can disappear altogether.

3.2.2 Stormwater Control

There are various methods of controlling stormwater runoff, from small-scale single lot controls to larger scale end-of-pipe stormwater management facilities (SWMF). The most common types of SWMF include wet ponds, dry ponds, and artificial wetlands.

Based on the Stormwater Practices Manual (MOE, 1994, 2003), there are various levels of stormwater control established to ensure the protection of receiving waters (e.g. watercourse, ditch, lake). These guidelines were produced by the Ministry of Environment taking into consideration concerns from the Ministry of Natural Resources (MNR) (Fish Habitat Protection Guidelines for Developing Areas, 1994). Four levels of protection were established focusing on the ability of SWM pond to control and remove suspended solids.

Level 1 is the most stringent level of protection designed to protect habitat which is essential to the fisheries productivity (e.g. spawning, rearing and feeding areas) and requires 80% removal of suspended solids.

Level 2 protection calls for a 70% removal of suspended solids. In this instance the receiving water can sustain the increased loading without a decrease in fisheries productivity.

Level 3 controls are relaxed further requiring a 60% sediment removal rate again reflecting the lower quality of the receiving water for fish production.

Level 4 controls exclusively address retrofit situations where, due to site constraints the other levels of control cannot be achieved. Level 4 protection is not to be considered for any new development, only for instances where uncontrolled urban areas can implement some SWMF to improve environmental health.

It is important to realize that, while these guidelines are specific to suspended solids, other pollutants such as bacteria, metals, and nutrients (e.g. phosphorus) are reduced by the same controls. Due to severe water quality problems in Lake Simcoe, and the potential destruction of the cold water fishery (e.g. lake trout *Salvelinus namaycush*), the entire watershed has been deemed a special policy area. As a result, all new development in the watershed since 1996 has been required to construct SWMF that meet the most stringent criteria or Level 1 protection. This special policy designation was a result of a recommendation contained in the Lake Simcoe Environmental Management Strategy (LSEMS) “Our Waters, Our Heritage, 1995” report, which deals exclusively with efforts to reduce phosphorus inputs to Lake Simcoe.

Dry ponds, also referred to as quantity control facilities, provide negligible water quality improvement benefits, instead acting to control and slowly release stormwater runoff to receiving water bodies. These facilities reduce the risk of flooding and mitigate hydrologic and channel morphology impacts associated with stormwater runoff.

3.2.3 Urban Environments – Employing Other Urban Best Management Practices and Stormwater Control Measures

There are some sections of existing urban areas where stormwater pond retrofits are not possible. These are largely the old sections of towns including the downtown core, commercial and industrial areas developed long before stormwater management practices were developed. To ensure that these areas are addressed, existing control measures should be undertaken along with newer, innovative, and unconventional BMPs are being recommended.

Rainwater Harvesting

Canadians could be considered one of the more wasteful societies in the world with regard to water. For example, the use of potable water for flushing toilets and irrigating lawns and cropland is a waste of a valuable resource. One method of reducing this wasteful use of water is rainwater harvesting, which involves the collection and storage of rainwater, usually from rooftops and other hard impermeable surfaces. The water can then be stored in tanks and used for non-potable uses such as washing cars, irrigating lawns, and flushing toilets. The storage tanks can range from a barrel at the bottom of a home's downspout to a large industrial-size facility with multiple tanks, pipes, pumps, and controls.

In addition to the conservation of potable water, the benefits of rainwater harvesting include reducing pollution from stormwater runoff and flood control. Collecting and storing stormwater decreases the volume and rate of runoff, which reduces the potential for the runoff to pick up pollution, as well as reducing the risk of flooding.

Under their Water for Tomorrow program, designed to promote water conservation, York Region offers rain barrels at a reduced price. While the widespread use of this practice, combined with downspout disconnection and other water conservation measures, will reduce the demand for water at peak times and reduce the potential for stormwater related issues, a more aggressive and targeted approach is recommended to achieve significant improvements for the purpose of stormwater management. For example, in the City of Portland, water harvesting for the purpose of stormwater management is encouraged through reduced development fees if the stormwater runoff is retained on site. This has led many commercial, industrial, and institutional landowners to undertake water harvesting projects based on the reduced fee and savings associated with a decrease in water use.

There are some concerns with large scale water harvesting, particularly with cost, maintenance, and public acceptance. Another concern is the potential harmful impact of these large-scale takings on baseflow and maintaining environmental flows to surface waters. These concerns can be mitigated by conducting a proper water balance for the affected site to ensure that there is adequate water to support baseflow.

Ditches/Grassed Swales

In the past, subdivisions were not built with curb and gutters which connected to storm sewers, but simple ditches to convey water away from roads and homes. Ditches have a number of benefits over curb and gutter systems. They are much less expensive to construct, reduce the size required for stormwater management facilities, allow water to infiltrate into the ground, and provide some snow storage during the winter months. The main drawbacks of ditches are that they use more space and are not as easy to maintain as curb and gutters.

The use of ditches and grassed swales is now making a comeback as resource managers and planners have realized the environmental benefits. Ditches and grassed swales have been estimated to remove 30% of the phosphorus, 70% of the suspended solids, and greater than 50% of certain metals and hydrocarbons contained in urban runoff (Low Impact Development Center, 2003 http://www.lowimpactdevelopment.org/).

When grassed swales and ditches are combined with bioretention facilities or infiltration galleries, there can be a greater benefit to water quality and quantity. These areas require more routine maintenance than do curb and gutter systems, and are therefore more costly, but the planting of native grasses, shrubs, and trees can also be undertaken to add aesthetic value and can significantly improve the public's acceptance of these features.

Roof Top Storage/Green Roofs

Providing roof top storage to retain rainfall is a common practice currently employed within the GTA and the Lake Simcoe watershed. The concept is to reduce the amount of runoff and subsequent pollution resulting from a building/structure. Roof top runoff is also controlled using a combination of other BMPs such as infiltration galleries, soakaway pits, and bioretention facilities. Infiltration galleries and soakaway pits can be constructed underneath existing infrastructure such as parking lots and boulevards and therefore don't constrain the developable area. Treating the runoff in a bioretention facility is probably the most effective method, but it requires land to construct and is therefore less attractive.

Green roofs were developed as an alternative to the above mentioned practices for treating roof top runoff. Green roofs have been described as the creation of a contained green space on a roof for the purpose of improving water quantity and quality control. Green roofs are constructed by first placing an impermeable membrane on the roof top followed by a drainage medium and soil. The roofs are then planted with a variety of ground covers. Research conducted into green roofs has documented that there are additional benefits associated with their construction. These include reduced energy consumption and cost, improved air quality, and a reduction in the urban heat island effect.

Soakaway Pits, Infiltration Galleries, Bioretention, and Permeable Pavement

These BMPs, while different, have a common objective – to reduce surface water runoff by infiltrating water back into the ground. They are more useful for quantity control, reducing peak runoff and flooding, and maintaining the water balance. There is also a benefit to water quality, by reducing the volume of runoff, they minimize water contamination.

Soakaway Pits

Soakaway pits are the smallest and least expensive of these BMPs. They are designed to control roof top runoff from smaller buildings. They should be located well away from building foundation drains, and require well-drained soils. They are sized according to the amount of roof runoff they will receive – a typical soakaway pit is 4-5 ft square, 3-4 ft deep, and can be covered in grass or stone. This is one of the few BMPs that a homeowner can install, with instructions for their construction easily accessible on the internet.

Infiltration Galleries

Infiltration galleries can include trenches, chambers, and large basins. They are generally designed to control larger volumes of runoff and are often twinned with some form of sediment control when involved with treating parking lot runoff. This ensures that they do not become plugged and increases their operational lifetime.

Bioretention

Bioretention is a BMP that is designed to control water quantity and improve water quantity using the chemical, biological, and physical properties of plants, microbes, and soils to removal pollutants from stormwater runoff and facilitate its infiltration. They are generally used in parking lots, road medians, and in conjunction with grassed swales, and can be significantly less expensive than traditional stormwater BMPs. While the design may vary, they generally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. They are designed such that runoff (usually as sheet flow from a parking area, though they can be adapted to receive flow from a curb and gutter system) first reaches the grass buffer, where the flow of water is slowed and some particulates are filtered out. It then flows into a sand bed, which further slows the flow, and spreads the runoff along the length of the ponding area. The ponding area is designed for the water to pond to a depth of approximately 15 cm, where it is stored and may undergo a number of natural processes; it then infiltrates into the soil within approximately four days (US EPA, 1999). The processes that can take place in a bioretention facility include (Prince George's County, 2007):

- Sedimentation
- Adsorption of pollutants to soil particles
- Filtration
- Volatilization of hydrocarbons and other pollutants
- Plant uptake
- Cooling of runoff water
- Decomposition
- Phytoremediation
- Bioremediation
- Storage capacity

These facilities are not appropriate for some areas, such as those where the water table is within 1.8 m of the ground surface. There have been some concerns with their use in cold climates as the soil may freeze, preventing runoff from infiltrating into the soil during the winter months, though a recent study by the Toronto and Region Conservation Authority's Sustainable Technologies Evaluation Program (TRCA, 2008) found that the bioretention area was an effective means for draining melt water, so long as it is designed to prevent freezing at the inlet of the area. Temperatures generally remained above freezing in the bioretention area due to microbial activity in the soil and an insulating layer of snow. Other considerations include the salt tolerance of the plants used in the area, the phosphorus content of the soil (if this is high, the bioretention area may actually contribute to phosphorus loading), and the annual inspection and maintenance requirements.

Permeable Pavement

Permeable pavement is another option for reducing runoff through infiltration, particularly from parking lots, which can generate large volumes of runoff. Forms of permeable pavement include porous pavement, cement pavers, and other turf grass pavers. While there are obvious benefits to reduce runoff and prevent flooding and erosion problems, there can be concern over potential groundwater contamination from the oils, metals, and other contaminants that accumulate on pavement.

Oil Grit/Hydrodynamic Separators

A typical oil/grit separator (OGS) operates by settling sediments and large debris out of stormwater runoff, and ultimately separating oils from the water. The units generally consist of 3-4 chambers, each designed for a specific function. The first chamber, referred to as the Grit Chamber, settles coarse sediment and large debris by slowing the flow of the water and screening larger debris with a trash rack. From there, the stormwater moves to the second chamber, the oil chamber, which traps and separates surface oils and grease from the stormwater runoff. This separation occurs because oil is lighter than water and floats on the surface. The discharge pipe is located near the bottom of the chamber, allowing the oil to pool on the surface and be contained. The third chamber houses the stormwater outlet pipe that discharges the overflow to the storm drain system.

These systems are effective at removing oil and sediment, but their capacity for phosphorus removal is low. Therefore, they should be used in combination with other stormwater practices. Another important consideration is maintenance – their efficiency is dependent upon regular maintenance. This involves cleaning them out at least twice per year and as necessary after major storm events. The maintenance costs can be high because they can contain hazardous materials which need to be safely disposed of.

Some manufacturers have tried to increase the effectiveness of OGS for removing particulate and oil as well as additional contaminants such as phosphorus. An example of this is Imbrium Systems Incorporated's Jellyfish System. Systems such as this should be explored through pilot projects in the urban and industrial areas of the subwatershed.

Road Salt

Road salt has become an increasingly important issue as the urban areas of the Lake Simcoe watershed expand. The Canadian Environmental Protection Act defined road salt containing chloride salts as toxic under the Act (Environment Canada, 2001). Analysis of surface water quality throughout the Lake Simcoe watershed shows an increasing trend in chloride concentrations (see water quality section). The use, storage and application of road salt as well as disposal of snow should be conducted in accordance with the *Code of Practice for the Environmental Management of Road Salts* (Environment Canada, 2004). York Region does have a Salt Management Plan, aimed at ensuring the proper timing and amount of road salt in order to reduce the amount needed and the impacts to the environment from its use. Local municipalities should adopt similar plans and/or the *Code of Practice.* To reduce the area of roads requiring salt during the winter, and also to limit the amount of impervious area, municipalities should also explore the feasibility of varying road widths – narrower streets could be used on less travelled routes to reduce impervious area, rather than simply using a standard width.

3.3 Rural/Agricultural Best Management Practices and Controls - Phosphorus Reduction Opportunities

There are a number of Best Management practices that can be implemented in a rural setting to help improve water quality and quantity. These include manure storage and management, private septic system repair or replacement, construction of bypass channels or bottom draws for online ponds, streambank erosion control, cover cropping, tree and shrub planting, installation of cropland erosion control structures, clean water diversion, livestock access restriction, and the completion of nutrient management plans. Funding and professional assistance is available through the LSRCA's Landowner Environmental Assistance Program (LEAP) for a number of these activities. Each of these BMPs is discussed below and more detail can be found at http://www.lsrca.on.ca/leap/index.html.

The implementation of agricultural BMPs, particularly those targeted at controlling erosion, is especially important in the Holland Marsh area because of some of its unique characteristics. The organic soils contained within the polder area are very light, and are thus susceptible to wind and water erosion. Most of the soils have a very high nutrient content, which means that soil erosion can have a significant impact on loading to the West Holland River and to Lake Simcoe. Finally, because the Holland Marsh is so close to Cook's Bay, erosion of soils either by wind or water has the potential to have a significant impact on the lake.

3.3.1 Streambank Erosion Control

Vegetation is often removed from streambanks in order to accommodate various activities (e.g. farming, urban development, etc.). This leaves the streambank vulnerable to erosion, which can affect the aquatic ecosystem and can be a source of phosphorus. Depending on the soil type, stormwater runoff and high flows in the watercourse can result in bank slumping and the loss of valuable land. The planting of trees and shrubs along a stream bank will prevent erosion by helping to bind the soil in place and slowing the flow of storm water.

3.3.2 Cropland Erosion Control Structures

These BMP projects are undertaken to reduce soil erosion, and to protect watercourses and waterbodies. Not only will they reduce the loss of valuable topsoil, but will reduce the deposition of soil particles containing phosphorus and other contaminants onto the lake and watershed. They can include grass waterways to slow the flow of water and cause sediment to settle; water and sediment control basins; terraces, which are built on a steep slope to enhance water retention and reduce erosion; and drop structures.

3.3.3 Cover Cropping

Cover cropping is a practice whereby plants are grown on agricultural lands where the fields would normally be left bare in between crops. Cover cropping can be used as a tool to manage soil fertility, soil quality, weeds, pests, and diseases.

Soil fertility can be improved through cover cropping – the cover crop takes up nutrients in the soil and maintains them in an inorganic form which is less likely to wash away during snow melt or precipitation events. These nutrients are then re-incorporated into the soil as the cover crop is decomposed, and made available to the newly planted crop, which is seeded over the residue of the cover crop. When used for cover crops, certain species (e.g. legumes) can be a significant source of nitrogen to the soil, as they have the capability to fix nitrogen. This can reduce, or in some cases negate, the need for chemical fertilization.

Soil quality is also improved through the use of cover crops as there are increases in organic matter; water holding capacity, as it reduces the rate and quantity of water that drains off the field; and nutrient holding and buffering capacity. As an added benefit it can also lead to increased soil carbon sequestration. Soil erosion is also reduced, as the roots help to create large soil aggregates and also hold the soil in place, and the plant material covers the soil surface when the cover crop dies off. Again, this helps to reduce the amount of soil and its associated contaminants reaching surface water through wind and water erosion.

3.3.4 Conservation Tillage

The traditional tillage method for agricultural operations generally involves tilling the soil in the fall after the completion of the harvest, and again in the spring to prepare for planting. This can result in high levels of soil erosion and nutrient loss, as large soil aggregations are broken up and left vulnerable to erosion, and the plant material which would normally aid in holding the soil in place is ploughed under during tillage. Conservation tillage is a practice where less or no tillage is undertaken, and a higher percentage of the plant residue is left on the field. This has several benefits: it requires less work and fuel, the stubble of the previous year’s crop helps to hold the soil in place, increases moisture retention and infiltration, and increases the organic matter content of the soil.

There are some challenges associated with conservation tillage. These include soil compaction, increased need for pesticides to reduce the amount of weeds (which would normally be tilled under), carryover of diseases, and a possible increase in saturated or flooded soils, which can delay planting.

3.3.5 Livestock Access Restriction

Livestock that have access to watercourses can impact the water quality and affect the riparian area. The input of urine and manure directly into the water and onto low lying areas in the riparian area where it can be washed into the watercourse affect water quality. The livestock can trample streambanks, which contributes to instability, erosion, and sedimentation in the stream; while livestock in the stream can destroy spawning habitat. These issues can be avoided with the installation of fencing along watercourses to exclude livestock; cattle crossings; and alternate water sources, such as nose pumps.

3.3.6 Clean Water Diversion

These systems direct clean melt water and/or precipitation away from potential sources of contamination including manure storage and exercise yards. These consist of systems such as eavestroughs, ditches, or trenches; rainwater collection systems; or any other permanent technique for preventing rain and snow from becoming contaminated.

3.3.7 Milkhouse Waste Management

Milkhouse waste water includes excess milk, the soap and acids used to clean equipment and kill bacteria, manure, and, dirt. This waste water, when released to surface waters, can have significant impacts to water quality. There are methods, such as adding the washwater into manure storage, and installing treatment trenches and milkhouse wastewater treatment systems in combination with management practices. A common management practice is to save the first flush of milk washwater and use it as a diluted feed back to calves. These methods will prevent waste water from being discharged to surface waters.

3.3.8 Manure Storage and Management

Manure from beef and dairy operations is very high in nutrients, such as phosphorus, and bacteria. If left on the field, it can easily seep into ground and surface water sources with snow melt and/or precipitation. This can have considerable environmental and health impacts. Manure is stored in order to allow its application at the most beneficial time for crops, and to apply the manure at an appropriate time to minimize potential environmental impacts. The type of manure storage facility depends on what is being stored. Storage facilities can consist of open storage structures with runoff containment or roofed structures for solid manure; concrete or steel storage tanks for liquid manure; earthen manure storage and runoff storage; and the containment of runoff from exercise yards.

3.3.9 Private Septic Systems

Waste from the majority of residences in rural areas is treated by private septic systems. As they age, these systems can malfunction and fail, and can be a considerable source of nutrient and bacteria contamination to surface and groundwater. Malfunctions and failures of septic systems will be detected through regular inspections – if a problem is detected it should be resolved in a timely manner to minimize environmental impacts. LSWQIP provides funding for septic system repair or replacement for those systems within 100 metres of the lake or a watercourse in the watershed, as this is the zone where malfunctions can have the greatest impact.

3.3.10 Wellhead Protection and Well Decommissioning

Wellhead protection is undertaken in order to reduce the risk of contamination of well water by implementing proper construction and maintenance practices and safeguards for existing wells. Wellhead projects that can be undertaken include grading and permanently seeding the soil surface around the well, sealing the space around the well, upgrading or replacing a dilapidated well casing and/or extending a well casing 16 inches above the finished ground level, installing proper well caps, and earth moving to ensure that water is directed away from the well head.

Wells left unused or abandoned without being properly decommissioned leave the groundwater supply vulnerable to contamination. Wellhead decommissioning is undertaken in order to prevent groundwater contamination via improperly abandoned or unused wells. This is completed by properly plugging unused wells by a licensed well contractor.

3.3.11 Bypass Channels and Bottom Draw Structures for Online Ponds

Online ponds, created by damming a watercourse, can cause a host of issues on the watercourse. They can increase water temperatures, raise bacteria levels, and disrupt the natural movement of fish, invertebrates, sediment, and nutrients. The natural movement of each is imperative for a healthy aquatic system. It is possible to reduce or negate the environmental impacts caused by an online pond, without the complete removal of the pond (which is important if the pond is used for irrigation). This can be accomplished either through the construction of a bypass channel around the pond or a bottom draw structure in the pond. A bypass channel is essentially a redirection of the watercourse around the pond, where the majority of the flow is diverted away from the pond, but enough flow if left going into the pond to maintain it. A bottom draw structure can be constructed where it would not be possible to put a bypass channel. These structures draw water from the cooler bottom waters of the pond, and this is discharged downstream to the watercourse, rather than the warm top waters from the pond flowing over the dam. While this does not negate the issues caused by the pond, it does improve conditions in the waters downstream of the pond.

3.4 Opportunities for BMP is the West Holland subwatershed

3.4.1 Urban BMP opportunities

The *Lake Simcoe Basin Stormwater Management and Retrofit Opportunities* report (LSRCA, 2008) identified and evaluated opportunities to control phosphorus from existing urban areas. In these urban areas, stormwater runoff should be addressed through stormwater pond retrofits. These include creating facilities in uncontrolled catchments or upgrading existing facilities or quantity only facilities to a higher level of control (i.e. Level 1). The report identified a total of 20 retrofit opportunities in the five urban areas in the West Holland River subwatershed. These have the potential to reduce over 600 kg/year of phosphorus entering the river, and ultimately the lake (Table 3-1). More details on stormwater retrofit opportunities in the West Holland subwatershed can be found in the LSRCA report *Lake Simcoe Basin Stormwater Management and Retrofit Opportunities*, published in 2007.

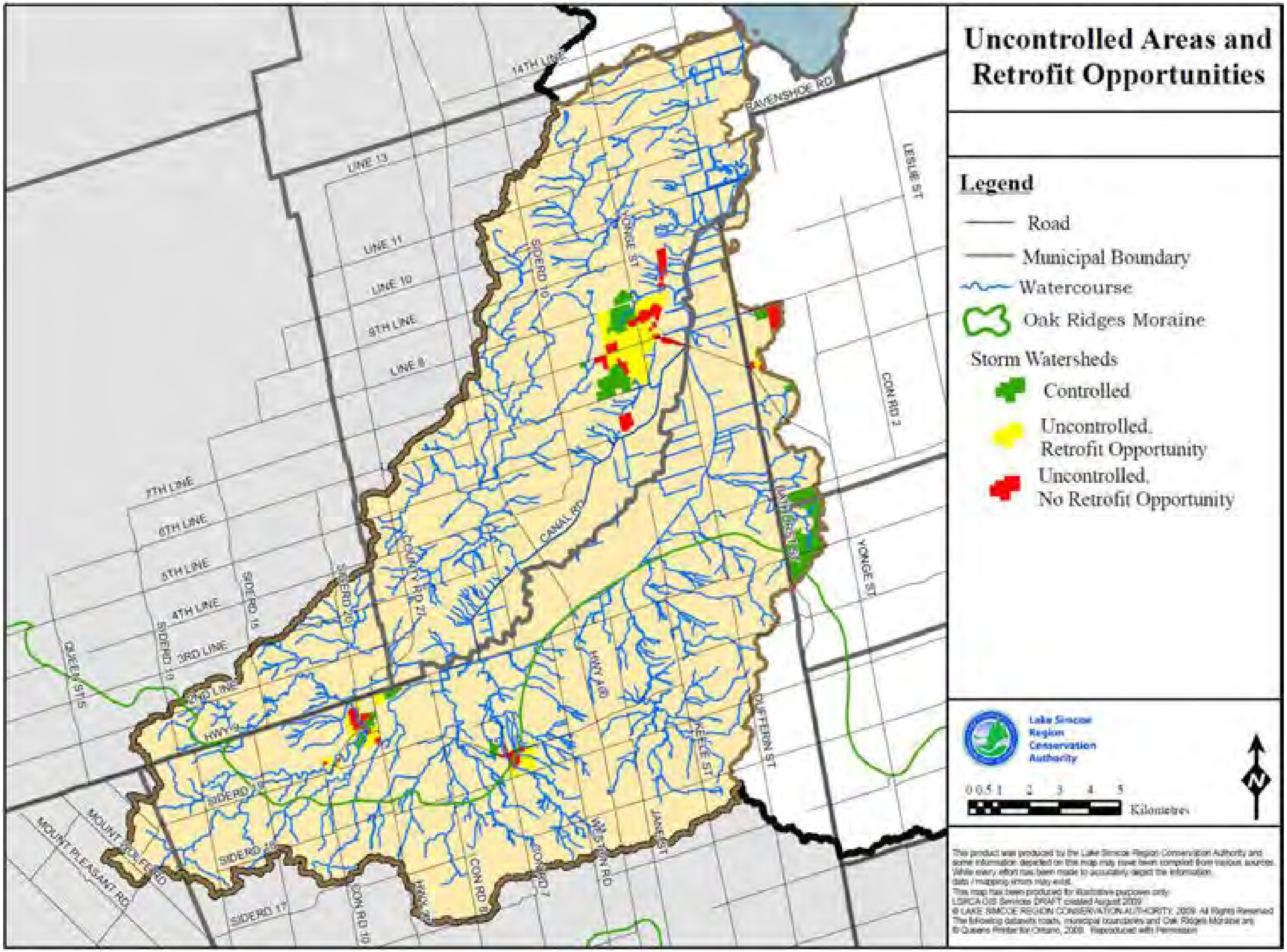

Figure 3-2   Stormwater retrofit opportunities in the West Holland subwatershed

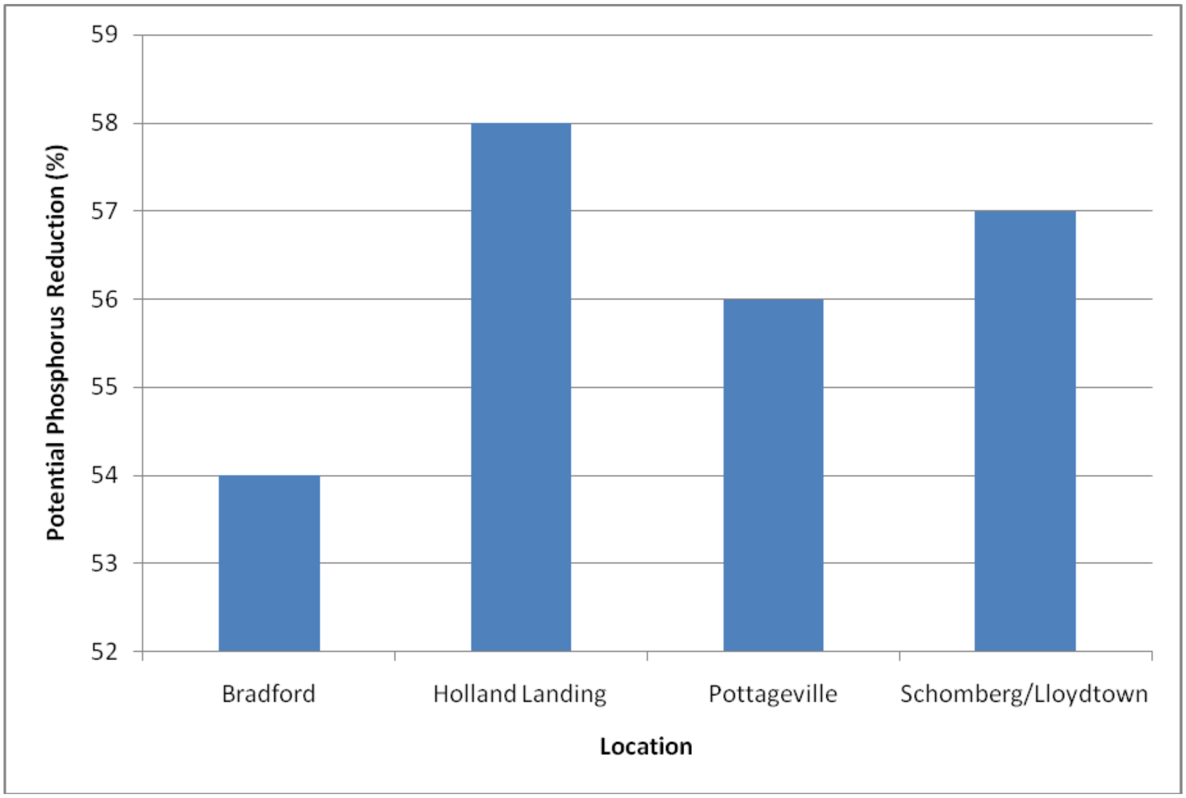

Figure 3-3 **Estimated reduction in phosphorus loading as a result of completing the 20 stormwater retrofit opportunities identified in urban areas of the West Holland subwatershed**

3.4.2 Stream Corridor BMP Opportunities

The Lake Simcoe Region Conservation Authority (LSRCA) conducted a Best Management Practices (BMP) Inventory, spanning 12 sections of the 18 subwatersheds within the Lake Simcoe basin in 2008 (LSRCA, 2009). The purpose of the BMP Inventory was to identify opportunities for the reduction of nutrients or improvements to fish habitat within the Lake Simcoe basin. Three priority areas were identified to focus the scope of the Inventory. These three areas are agriculture, tributary, and urban. Agriculture areas include any farming and agricultural operations; tributary areas include tributaries of all orders with a variety of land use, excluding urban and agriculture; and urban areas include any section of watercourse within an urban environment, including drains, stormwater outfalls, and any other sources of nutrients that could require the implementation of BMPs to improve conditions. The BMP Inventory identified 2,420 waypoints containing 8,656 BMP opportunities throughout the entire Lake Simcoe watershed. Just over four percent of the West Holland subwatershed was surveyed, in Phase 1 of the inventory (Figure 3-4), covering reaches in Schomberg and in the Scanlon Creek catchment**.** A total of 169 BMP opportunities were located in the survey area, with the largest proportion of BMP opportunities being related to bank erosion (18%), insufficient riparian cover (17%) and impervious surface runoff (9%) – see Figure 3-5.

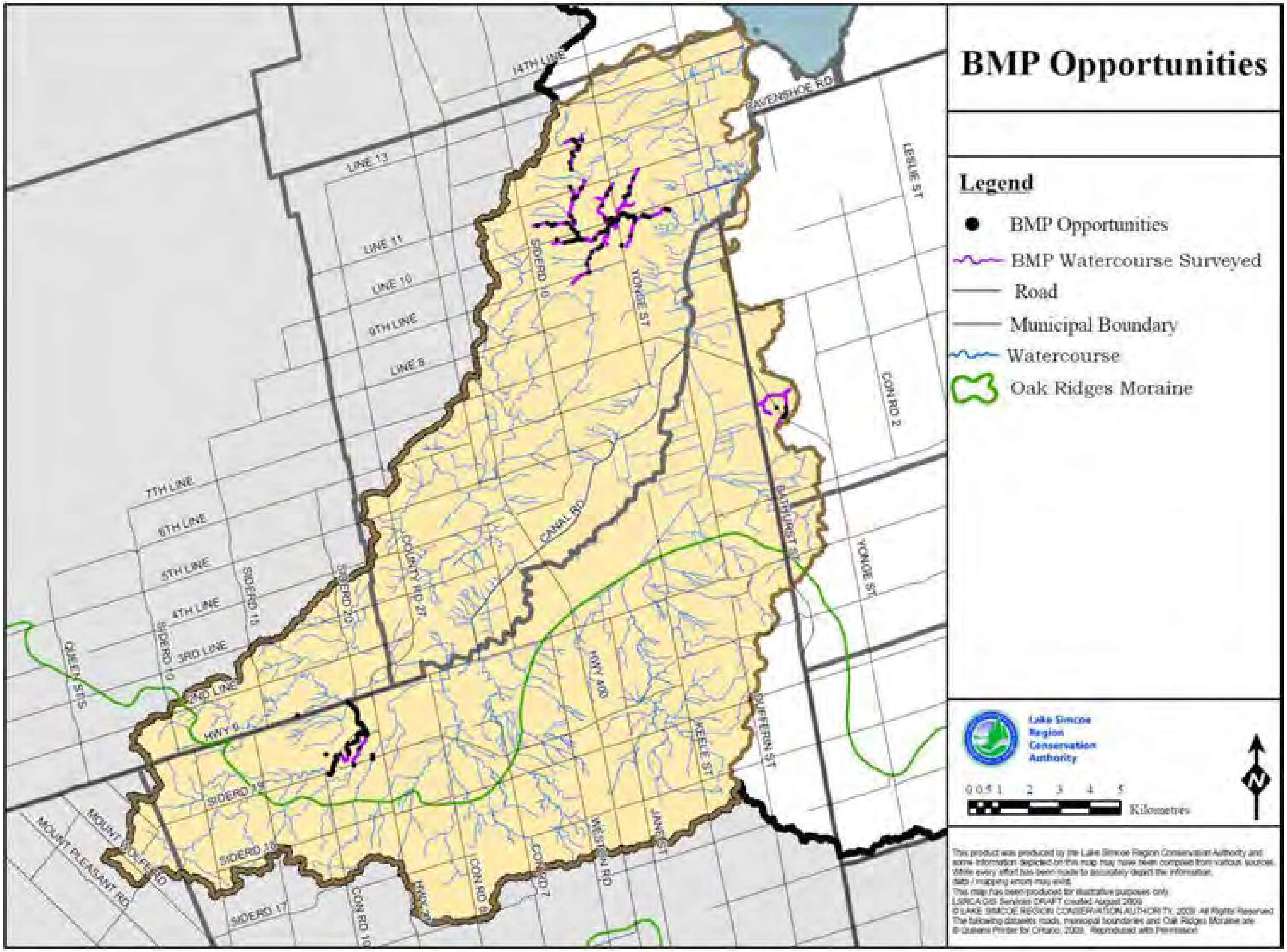

Figure 3-4 **Areas of the West Holland River surveyed for stream corridor BMP opportunities**

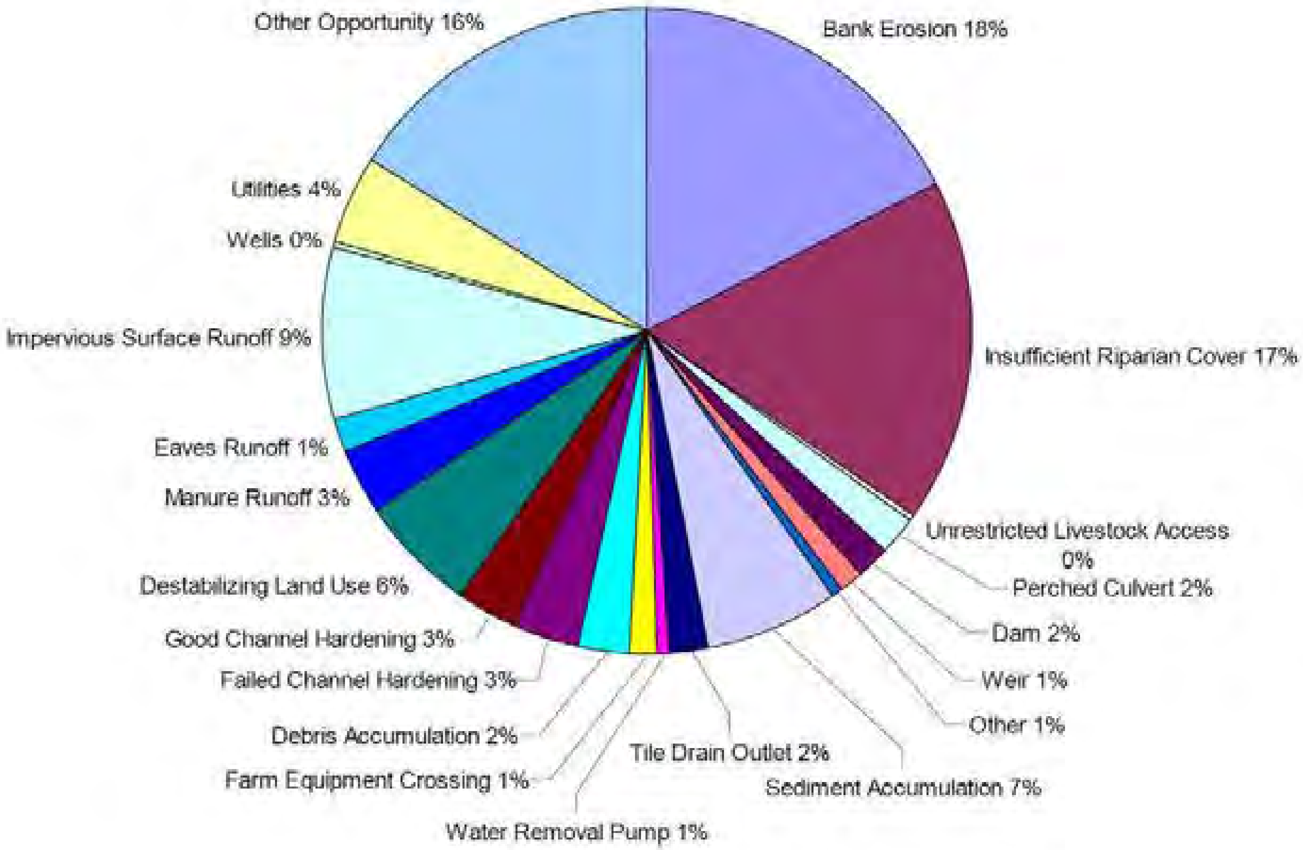

Figure 3-5 **Types and relative proportion of stream corridor BMP opportunities identified in the West Holland subwatershed**

4 Water Quality (surface and groundwater)

4.1 Introduction and background

The chemical, physical and microbiological characteristics of natural water make up an integrated index we define as “water quality”. Water quality is a function of both natural processes and anthropogenic impacts. For example, natural processes such as weathering of minerals and various kinds of erosion are two actions that can affect the quality of groundwater and surface water. There are also several types of anthropogenic influences such as point source and non-point sources of pollution. Point sources of pollution are direct inputs of contaminants to the surface water or groundwater system and include municipal and industrial wastewater discharges, ruptured underground storage tanks, and landfills. Non-point sources include, but are not exclusive to, agricultural drainage, urban runoff, land clearing, construction activity and land application of waste that typically travel to waterways through surface runoff and infiltration. Contaminants delivered by point and non-point sources can travel in suspension and/or solution and are characterized by routine sampling of surface waters in the Lake Simcoe watershed. Surface water quality results are compared to guidelines relating to the protection of the aquatic ecosystem.

4.2 Current Status

4.2.1 Measuring Groundwater Quality

The LSRCA does not currently conduct any groundwater quality monitoring in the West Holland River subwatershed.

4.2.2 Measuring Surface Water Quality and Water Quality Standards

Within the Lake Simcoe watershed there are 12 PWQMN stations, two of which are located in the West Holland River subwatershed. Samples are collected eight times a year on a monthly basis during the ice-free period. Each sample, analyzed for 32 chemical parameters in the Laboratory Services Branch of the Ministry of Environment, is assessed using the Provincial Water Quality Objectives (PWQO) (Ministry of Environment, 1994).

As stated by the Ministry of Environment, the goal of the PWQO is to protect and preserve aquatic life and to protect the recreational potential of surface waters within the province of Ontario. Meeting the PWQO is generally a minimum requirement, as one has to take into account the effects of multiple guideline exceedances, overall ecosystem health, and the protection of site-specific uses. In instances where a chemical parameter is not included in the PWQO, the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG) is applied (Environment Canada, 2003). The CWQG were developed by the Environmental Quality Branch of Environment Canada to protect aquatic species by establishing acceptable levels for substances that affect water quality and are based on toxicity data for the most sensitive species found in streams and lakes of Canada.

Table 4-1 A summary of surface water quality variables and their potential effects and sources

Variable	Effects	Sources	Objective/Guideline
Chloride	Control of excess chloride levels is important to protect the aesthetics and taste of drinking water. High levels may also have an impact on aquatic life. Background concentrations in natural surface waters are typically below 10 mg/L.	The largest source of chloride is from road salt applications during the winter months. Other sources include waste water treatment, industry, potash used for fertilizers	➢ Env. Canada (2001): approx 210 mg/L for the protection of aquatic life.
Total Phosphorus	Phosphorus promotes eutrophication of surface waters by stimulating nuisance algal and aquatic plant growth, which deplete oxygen levels as they decompose resulting in adverse impacts to aquatic fauna and restrictions on recreational use of waterways.	Sources include lawn and garden fertilizers, animal wastes, eroded soil particles and sanitary sewage.	➢ Interim PWQO: 0.03 mg/L to prevent excessive plant growth in rivers and streams.
Total Suspended Solids (TSS)	Elevated concentrations reduce water clarity which can inhibit the ability of aquatic organisms to find food. Suspended particles may cause abrasion on fish gills and influence the frequency and method of dredging activities in harbours and reservoirs. As solids settle, coarse rock and gravel spawning and nursery areas become coated with fine particles, limiting the ecological function of these important areas. Many pollutants are readily adsorbed and transported by suspended solids, and may become available to benthic fauna.	TSS originates from areas of soil disturbance, including construction sites and farm fields, lawns, gardens, eroding stream channels, and grit accumulated on roads	CWQG: 25 mg/L + background (approx 5 mg/L) for short term (<25 hr) exposures. EPA (1973(and EIFAC (1965): no harmful effects on fisheries below 25 mg/L
Metals	Heavy metals generally have a strong affinity to sediments and can accumulate in benthic organisms, phytoplankton, and fish. Several heavy metals are toxic to human health, fish and other aquatic organisms at low concentrations.	Most metals in surface runoff are associated with automobile use, wind-blown dusts, roof runoff and road surface materials	PWQOs: • Copper: 5 μg/L • Zinc: 20 μg/L • Lead: 5 μg/L • Iron: 300 μg/L • Cadmium: 0.5 μg/L • Chromium: 8.9 μg/L • Aluminium: 75 μg/L for clay free soils; 100 μg/L (CWQG)

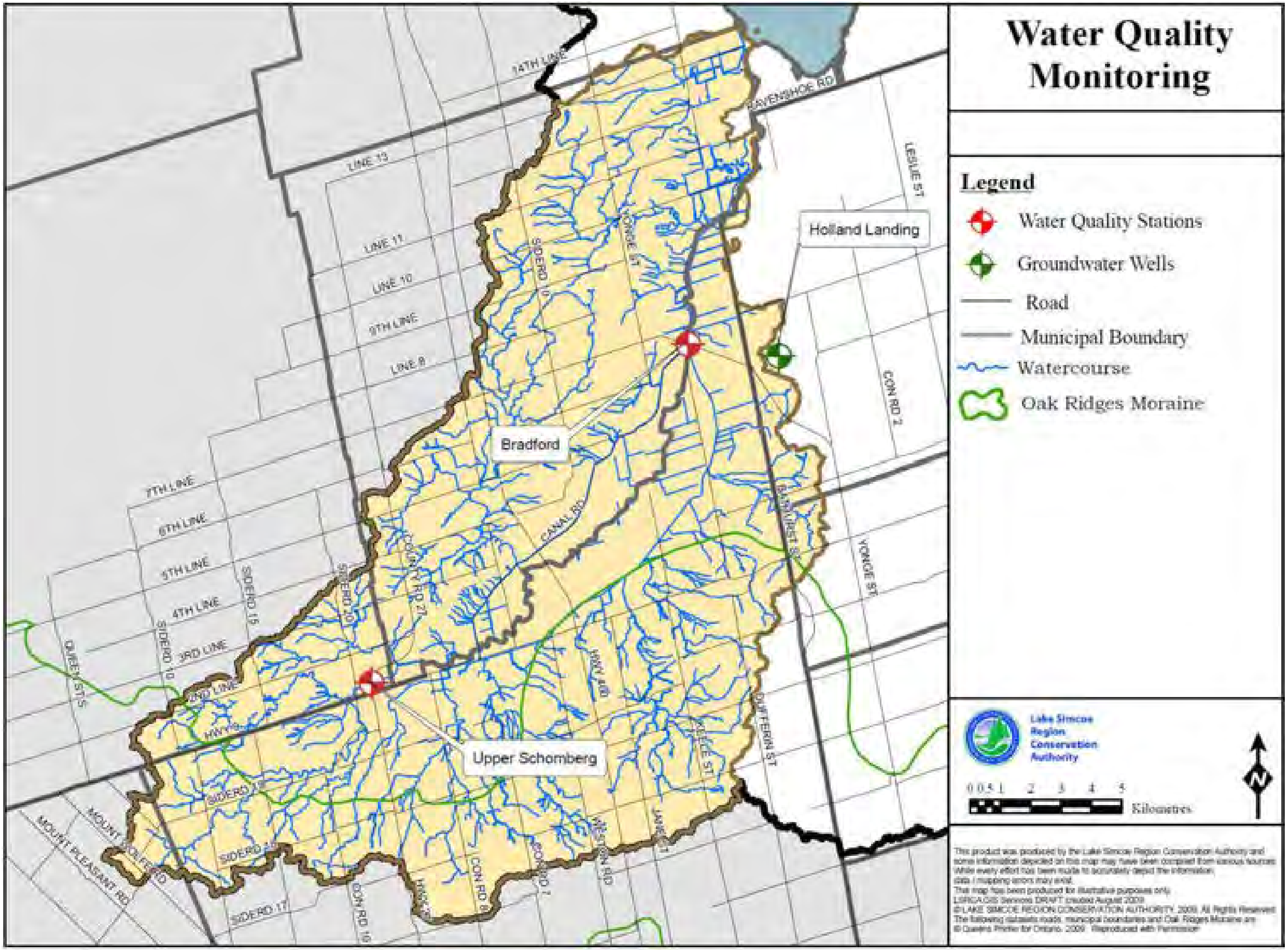

Figure 4-1 Water quality monitoring sites in the West Holland River subwatershed

Groundwater Quality Status

The LSRCA does not currently conduct any groundwater quality monitoring in the West Holland River subwatershed.

Surface Water Quality Status

Examination of the water quality data collected between 2002 and 2008 highlights phosphorus as the main parameter impacting water quality in the West Holland River. Table 4-2 details the number of samples from this data set meeting the guideline from this sampling period for both the West Holland River station and the Schomberg station, as well as other stations around the Lake Simcoe watershed. From this table other notable parameters can be seen, these include total aluminum, iron, Total Suspended Solids (TSS) and cadmium. It is also worth discussing chloride concentrations – although these currently meet the applicable objectives, chloride loads have been increasing in the subwatershed over the past several years.

Table 4-2 **A comparison of West Holland River surface water quality to other tributaries within the Lake Simcoe watershed**

Monitoring Station	Current Conditions (2002 – 2008) Percentage of samples meet objectives Orange = median Concentration >objective Green = median Concentration < objective								Trends Analysis (1965-2008) Orange = Increasing/ Blank = no significant trend/ Green = Decreasing								
	Chloride	Phosphorus	Nitrate	TSS	Iron	Zinc	Cadmium	Copper	Chloride	Phosphorus	Nitrate	TSS	Iron	Zinc	Aluminium	Cadmium	Copper
West Holland River	100	0	94	89	69	98	65	98	🟧	🟩	🟧		*Historical data n/a*	🟩	*Historical data n/a*	*Historical data n/a*	🟩
Tannery Creek	94	10	100	77	51	94	69	92	🟩 *	🟩	🟩	🟩		🟩			🟩
Mt. Albert Creek	100	10	100	88	61	100	61	100	🟧	🟩	🟧			🟩			🟩
Beaver River	100	73	98	92	88	98	65	100	🟧	🟩	🟧	🟩		🟩			🟩
Pefferlaw	100	43	98	96	90	98	78	100	🟧	🟩	🟧	🟩		🟩			🟩
Lovers Creek	100	54	98	92	75	100	73	100	🟧	🟧	🟧			🟩			🟩
Schomberg	100	2	100	78	38	98	80	100	🟧	🟩	🟩	n/a		🟩			🟩
Maskinonge River	100	0	100	95	46	98	64	100		🟧	🟧	🟧		🟩			🟩
East Holland	88	0	100	37	8	82	69	82	*Historical data n/a*								
Black River	100	20	100	96	76	98	65	98	*Historical data n/a*								
Hawkestone Creek	100	76	100	98	92	100	72	100	*Historical data n/a*								
Uxbridge Brook	100	29	98	98	78	98	67	98	*Historical data n/a*								
Objective	**210 mg/L**	**0.03 mg/L**	**2.9 mg/L**	**30 mg/L**	**300 µg/L**	**20 µg/L**	**0.5 µg/L**	**5 µg/L**									

Chloride

The Canadian Environmental Protection Act has defined road salts containing chloride as toxic under the Act (2001). This was based on research that found that the large amount of road salts being used could negatively impact ground and surface water, vegetation, and wildlife. While elevated chloride levels are primarily found around urban centres, chloride levels have been found to be steadily increasing across the Lake Simcoe watershed (LSRCA, 2007) (Figure 4-2) as well as in Lake Simcoe itself (Eimers and Winter, 2005). While concentrations recorded at Schomberg and Hwy 11 are well below the Canadian Water Quality Guidelines value of 210 mg/L, an increasing trend in chloride is obvious at both stations. Figure 4-2 shows the increasing trend in chloride concentrations in the West Holland River.

Reading & Interpreting Box Plots

A box plot presents a data set in graphical form. The shaded portion of the box represents the middle 50% of the data set showing where the majority of the values fall and the spread of the data. The line in the box is the median (50th percentile) of the data set. The whiskers show the lower and upper quartiles of the data set. The points above and below the whiskers represent outliers in the data set at the 5th and 95th percentile. A red line has also been included to highlight the applicable guideline for the parameter.

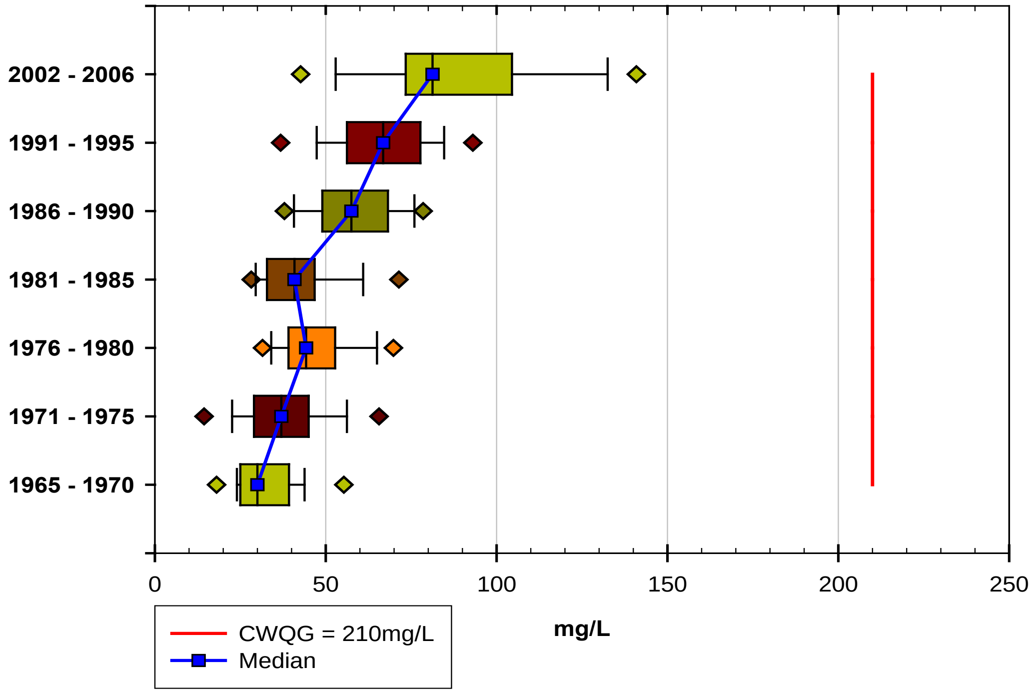

Figure 4-2 West Holland River chloride concentrations 1965 – 1995, 2002 - 2006 (mg/L)

Aluminum and Iron

The Provincial Water Quality Objective (PWQO) for aluminum requires that a sample be filtered so that it is clay free. This removes natural background aluminum associated with clay or bound up with suspended solids in the water column. The aluminum left after filtering is the portion that is bioavailable and therefore the portion that could affect the aquatic ecosystem. Samples analyzed under the PWQMN are not filtered, necessitating the use of guidelines less applicable to the Lake Simcoe watershed.

However, analysis of total aluminum and iron with TSS show good correlation (LSRCA, 2006) indicating that the majority of aluminum and iron is associated with clay or suspended solids. Enhanced sampling by LSRCA through 2007 collected filtered samples at the Schomberg station. None of the samples returned dissolved aluminum results above the PWQO, even though high total aluminum concentrations were recorded. Therefore, measures to control TSS will also have the benefit of controlling total aluminum and iron concentrations as well.

Cadmium

Compared to other Lake Simcoe stations, the West Holland station (at Hwy 11) is among the stations with the most exceedances of the PWQO for cadmium, although this is still only 35% of the samples in the 2002 – 2008 data set. Historic data for this station (1994 – 1995) recorded only trace levels of cadmium. It is likely that a change in sampling methodologies (wet weather sampling) associated with the current data set is the reason that higher cadmium levels are being detected as opposed to a new source of cadmium. The most likely source of cadmium for the West Holland River is associated with fertilizers and pesticides.

Total Suspended Solids

Total Suspended Solids (TSS) is a measure of the material in suspension in the water column. This is an important measure because, as outlined above, TSS can act as a transport mechanism for a variety of other parameters; some in a benign form such as clay bound aluminum, others such as phosphorus which can cause excessive nutrient loading downstream. Excessive amounts of TSS will also have negative impacts on fish and benthic organisms.

The Canadian Council of Ministers of the Environment (CCME) has recently set an interim guideline for TSS of 30 mg/L (CWQG, 1999). Applying this guideline to historic and current data, Schomberg appears as the only station with significant TSS exceedances. Gaps in the TSS data set at all stations make it difficult to determine any trend in concentrations. Compared with other Lake Simcoe stations Schomberg has among the highest concentrations, second only to the two East Holland River stations.

Phosphorus

Total phosphorus is a measure of all forms of phosphorus (dissolved and particulate) in a water sample, including phosphates, which are the most reactive (biologically accessible) form. Phosphorus is a nutrient essential to plant and animal life and is part of the natural cycle of decomposition and photosynthesis. Phosphorus binds to soil and is easily transported to streams with eroding soil where it can be utilized by aquatic plants and algae. Excessive levels of phosphorus cause an overabundance of plants and algae, which can impair the aesthetic and recreational opportunities of the lake. As the plant material dies off the resulting decomposition can lead to oxygen depletion (eutrophication) in surface waters. Eutrophication is one of the leading concerns regarding the health of Lake Simcoe (Scott *et al.*, 2006).

In both the historic and current data sets, phosphorus emerges as the most problematic water quality parameter at all West Holland River stations. The PWQO for phosphorus in streams and rivers is 0.03mg/L. In the historic data set for the six monitoring stations, this guideline is exceeded at the low end in 80% of samples taken at the south end of the Holland Marsh, to 99% of samples taken in the Marsh (83% at Canal and Hwy 9, 92% in North Canal, 97% at Schomberg, and 97% at Hwy 11).

In the current monitoring data the phosphorus PWQO is exceeded in 97% of samples at Schomberg and 100% of samples at Hwy 11. However, in spite of these exceedances, it can be seen in Figure 4-3 and Figure 4-4 there has been a decrease in concentrations at both stations when compared to historical data. The only exception is the 2002-2006 data set, which appears to display a slight increase. However, this is likely not due to a reversal of the long term trend, but to a change in sampling methodology. Sampling was formerly conducted on a set interval (i.e. every second Wednesday), but storm events are now being targeted. This methodology is preferred as it better characterizes the range of flows and concentrations that can occur within the subwatershed, but it has the potential to cause a bias in the data when compared with data collected under the former methodology. This is because there are more high flow samples in the data set under the new methodology. This may appear to be an increasing trend in the data, but is simply more accurate data. Further monitoring will clarify this trend.

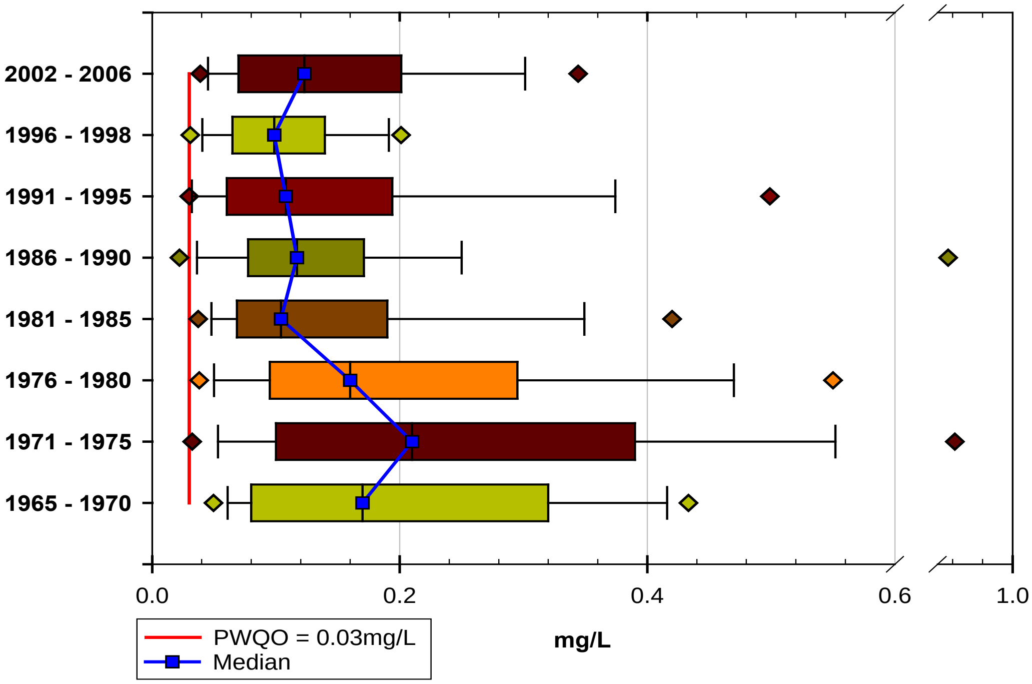

Figure 4-3 **West Holland at Hwy 11 – phosphorus concentrations 1965 – 1998, 2002 – 2006 (mg/L)**

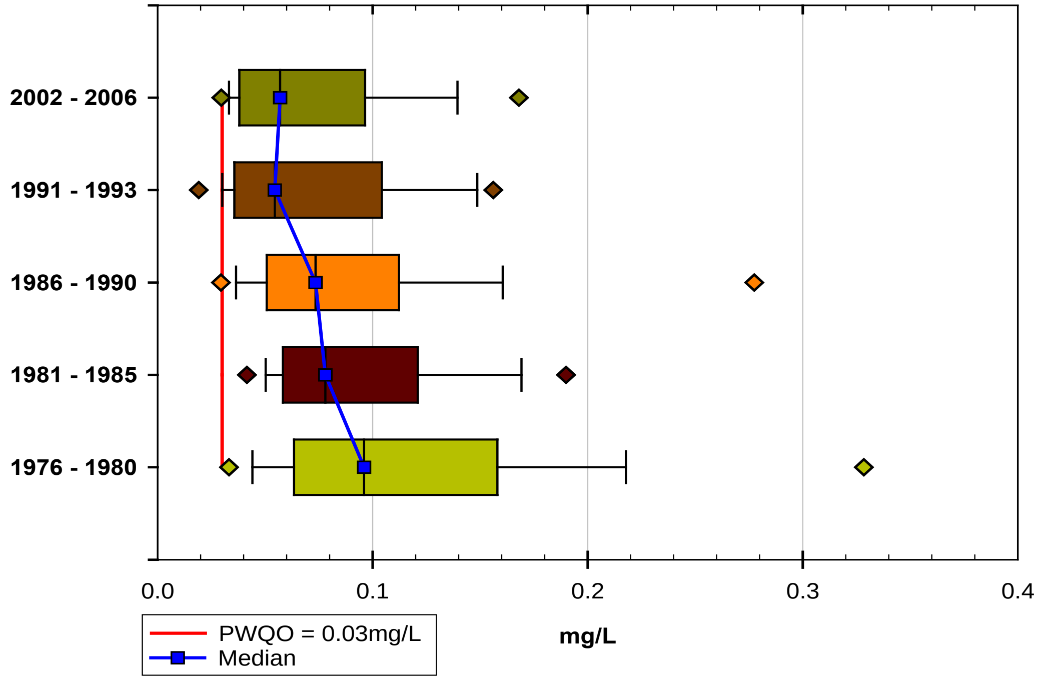

Figure 4-4 **Schomberg River – phosphorus concentrations 1976 – 1993, 2002 – 2006 (mg/L)**

Water Temperature

Although it is not a substance that can be measured through water quality sampling, water temperature is another important water quality parameter. Increasing water temperatures, due mainly to impervious surfaces and ponds, can cause a number of issues. These include decreased dissolved oxygen concentrations, stress to sensitive fish and benthic invertebrate species, and the increased growth of algae. Water temperatures in the West Holland River are monitored using in-stream data loggers, which record the temperature at regular intervals throughout the summer.

The LSRCA has been collecting temperature data for approximately five years. While this has been sufficient for increasing our understanding of where coldwater systems are found in the subwatershed (see Chapter 6, Aquatic Habitat for more detail), it is difficult at this point to see any trends or patterns in the data. There are factors influencing water temperature in addition to upstream and surrounding land use, including air temperature and the amount of precipitation, which make it difficult to analyze trends in water temperature.

Key points - Current Water Quality Status:

- Presently there is no monitoring for groundwater quality undertaken within the West Holland subwatershed and any possible exceedances of guidelines are not known. Increased efforts and development of monitoring and surveillance wells to monitor groundwater quality should be/are being considered
- Several of the surface water quality parameters within the West Holland River continue to fail to meet the established objectives or guidelines, particularly for phosphorus and TSS
- Median total phosphorus concentration in surface water are well above the PWQO, but there has been a decrease since the since the high levels recorded in the 1970s.
- While chloride levels are well below the Canadian Water Quality guidelines, there has been an increasing trend in chloride concentrations at both monitoring stations within the West Holland River, particularly in the past 20 years
- Schomberg appears to be the only station in the West Holland River with significant TSS exceedances and is among the highest concentrations, with the exception of the two East Holland River stations. Due to gaps within the TSS data set, a trend currently cannot be determined

4.3 Factors impacting status – stressors

4.3.1 Groundwater

Because groundwater moves more slowly and is subject to natural filtering as it moves through the soil, the quality of groundwater is most often better than that of surface water. As the water moves through the soil, contaminants are subject to the processes of adsorption, where they are bound to soil particles; precipitation; and degradation over time. These processes serve to improve the quality of the water.

There are some substances that can easily move through the groundwater system without attenuation by any of the aforementioned processes. The most notable of these is chloride from road salt. Further, if a contaminant source is located near a groundwater recharge area, there may not be sufficient time and distance for natural filtering to occur. There are also some parameters, including iron and chloride, which are naturally found within some groundwater aquifers.

Groundwater quality can also be impacted by anthropogenic factors. In rural areas, levels of contaminants including bacteria, phosphorus, nitrates, and road salt can become elevated where the groundwater is beyond the capacity of the natural filtration capability of the soils. Sources of contaminants in these areas are fertilizers, improperly functioning septic systems, manure storage facilities, and road salt application. In urban areas, groundwater can be subject to contamination by road salt, hydrocarbons, metals, phosphorus, and other nutrients. Groundwater contamination becomes an issue where it is discharged to the surface and is used by animals or humans.

Source Water Protection Authorities are currently determining the vulnerability of aquifers in the region to water quality stressors and identifying potential threats drinking water supply.

4.3.2 Surface Water

Natural Influences

Natural features in the environment generally serve to maintain water quality conditions. Naturally vegetated areas including grasslands, meadows, and woodland areas tend to improve the quality of water as it flows over land. The stems and roots of the vegetation slow the flow of water, enabling soil particles and other contaminants to be deposited, and increasing the amount of runoff that is infiltrated into the soil. Water is filtered as it flows through the soil to the groundwater. Wetlands slow the flow of water, provide storage and can absorb some contaminants, including nutrients such as phosphorus; and thus have a natural filtering ability. The inputs of clean cool groundwater into lakes and streams also serve to improve water quality, by diluting the concentration of any pollutants in the portion of the flow coming from surface water.

Rural and Urban Influences

A high percentage of the land within the West Holland River subwatershed, 57%, is agricultural. There are a number of water quality issues that are associated with agriculture. Runoff from pasture and cropland can contain high levels of nutrients, sediment, and bacteria; and wind can erode topsoil with its associated contaminants. All of these substances can end up in local watercourses if the appropriate Best Management Practices (BMPs) are not implemented. These BMPs can include conservation tillage, cover cropping, maintaining vegetated riparian buffers, cattle fencing, and the appropriate use of fertilizers and pesticides.

Runoff in urban areas, particularly those built prior to the requirement for stormwater management, can carry a host of pollutants to local watercourses. These pollutants build up on roads, driveways and parking lots, and even lawns, and are washed to watercourses during precipitation events. The pollutants that can be carried by urban stormwater runoff include nutrients and pesticides from lawns, parks, and golf courses; road salts; tire residue; oil and gas; sediment; and nutrients and bacteria from pet and wild animal faeces.

Paved surfaces increase the volume and velocity of surface runoff, which causes streambank erosion, contributing further more sediment to watercourses. The requirement for stormwater management facilities in all new developments will help to mitigate these issues in urban areas, however, the ongoing maintenance of these facilities is crucial to ensuring that they continue to reduce sediment and nutrient loads as designed, otherwise these new developments would be contributing additional phosphorus to the system. Additional best management practices should also be implemented in conjunction with stormwater management wherever possible to reduce the amount of these pollutants, as even a stormwater facility with the highest level of control does not achieve 100 % removal. A further input of sediment and nutrients from urban areas is the wind erosion of soils stripped bare for development. These areas can be without vegetation for prolonged periods of time, and can be a significant source of windborne pollution.

Urban areas in the West Holland River subwatershed include the small villages of Schomberg and Pottageville, the Town of Bradford West Gwillimbury, and a small portion of Newmarket and Holland Landing (Figure 4-5). These areas represent approximately 3% (1086.34 ha) of the entire West Holland subwatershed. Of this urban area approximately 57% is without stormwater controls, 16% has quantity control only, and the remaining 27% is controlled by Level 1 stormwater facilities (Table 4-3, Figure 4-5, Figure 4-6). This area represents a modeled phosphorus load of approximately 1570.49 kg/yr to the West Holland River, of which approximately 325.85 kg/yr (21%) has been reduced through existing controls (LSRCA, 2007)

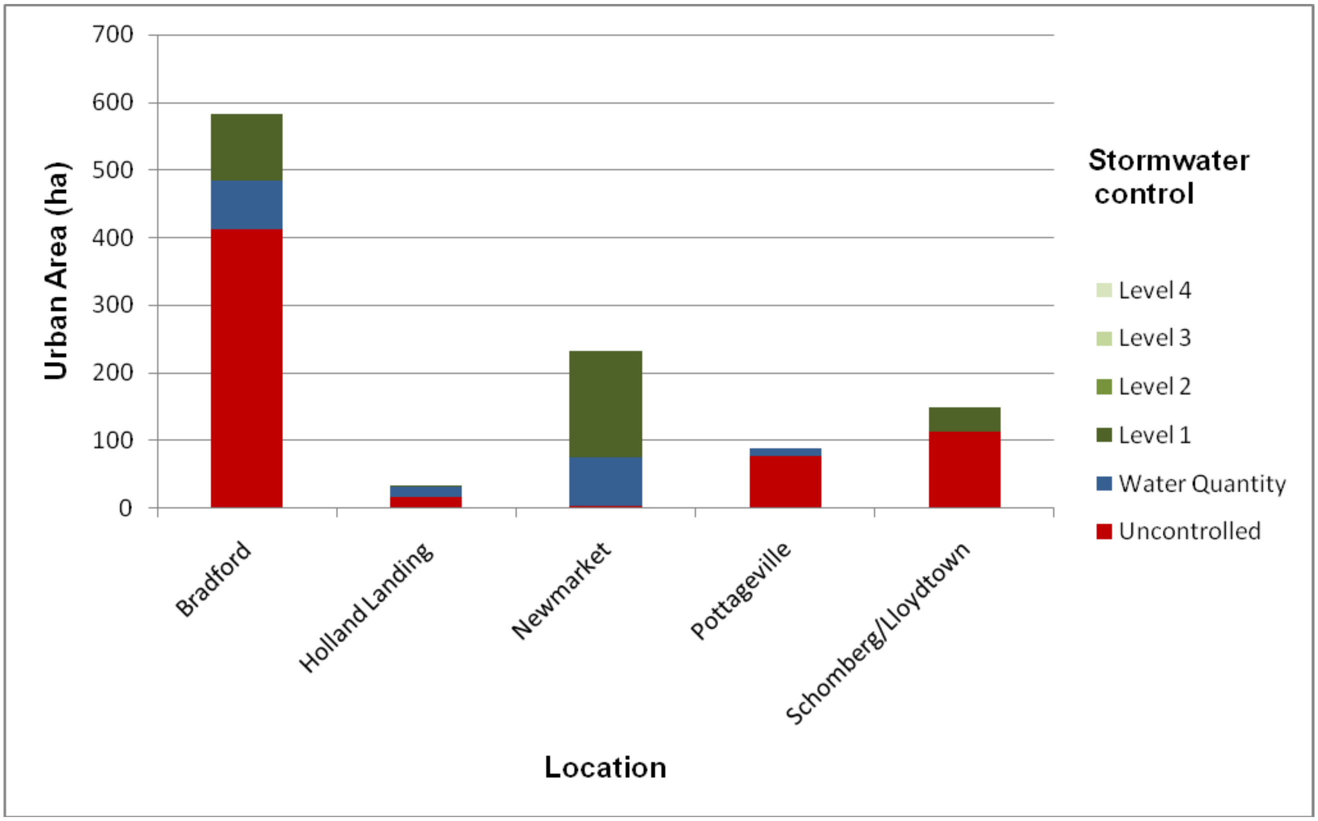

Figure 4-5 Area of stormwater control in urban regions of the West Holland subwatershed

Table 4-3 Controlled vs. uncontrolled stormwater catchments in the West Holland River subwatershed

Location	Total Number of Catch-ments	Total Urban Area (ha) Used	Uncontrolled			Quantity			Level 1			Level 2			Level 3			Level 4			Controlled (Total of Levels 1 to 4)		
			#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)
Bradford	38	581.82	32	413.29	71	3	71.88	12	3	96.65	17	0	0	0	0	0	0	0	0	0	3	96.65	17
Holland Landing	6	34.82	4	17.72	51	1	15.87	46	1	1.23	3	0	0	0	0	0	0	0	0	0	1	1.23	3
Newmarket	7	232.04	1	3.05	1	1	71.99	31	5	157.00	68	0	0	0	0	0	0	0	0	0	5	156.99	68
Pottageville	13	88.26	12	76.88	87	1	11.38	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schomberg /Lloydtown	27	149.40	23	113.43	76	0	0	0	4	35.97	24	0	0	0	0	0	0	0	0	0	4	35.97	24
Totals	**91**	**1086.34**	**72**	**624.37**	**57**	**6**	**171.12**	**16**	**13**	**290.85**	**27**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**290.85**	**27**

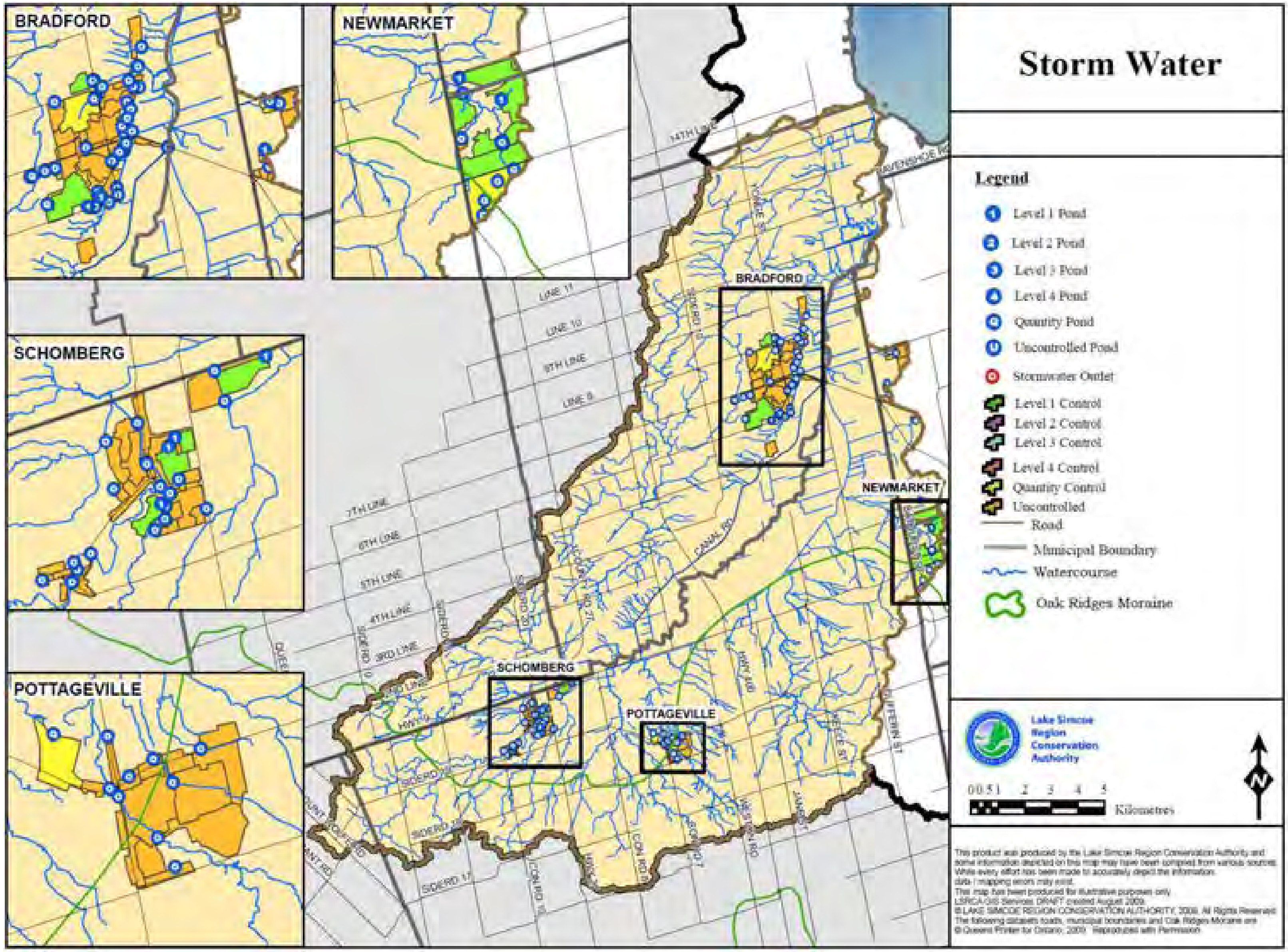

Figure 4-6 Stormwater control in the urban areas of the West Holland River subwatershed

Phosphorus

Phosphorus load estimates are those calculated during the Assimilative Capacity Study (see text box for more information). The assimilative capacity study used a watershed model (CANWET) that estimates nutrient loads based inputs such as land use, precipitation and soil type. The following table (Table 4-4) presents the average yearly phosphorus load derived from each source in the subwatershed under current conditions, the approved growth scenario, and the approved growth scenario with implementation of BMPs. The primary source of phosphorus in the West Holland subwatershed under existing conditions is derived from cropland (63%) and high density urban land use (15%). Under the approved growth scenario, there is a projected increase in total phosphorus loads of 29% without the implementation of BMPs. The projected phosphorus load under the approved growth scenario can be reduced by approximately 46% through the implementation of BMPs. Taken together, this suggests that total phosphorus loads could be decreased by 30% relative to current conditions in this subwatershed under an approved growth scenario assuming BMPs were implemented.

Table 4-4 Phosphorus loads by source in the West Holland River subwatershed

Source	Existing (kg/year)	Committed Growth Scenario (kg/year)	Change (Existing Condition to Committed Growth)	Committed Growth (with BMPs) (kg/year)	BMP Reduction Potential	Difference between Existing and Committed Growth w/BMPs	Phosphorus Load Allocation (kg/year)
Hay/Pasture	359	335	-23	291	-13%	68	291
Crop Land	2,686	2,484	-202	893	-64%	1,793	893
Other	122	133	12	100	-25%	22	100
Low Intensity Development	46	37	-10	37	0%	10	37
High Intensity Development	628	2,115	1,488	1,308	-38%	-680	1,308
Stream Bank Erosion	14	20	6	20	-2%	-6	20
Groundwater	342	303	-40	267	-12%	75	267
Point Source	20	20	0	20	0%	0	
Septic System	46	46	0	46	-1%	0	46
TOTAL	**4,263**	**5,495**	**1,231**	**2,982**	**46%**	**1,281**	**2,962**

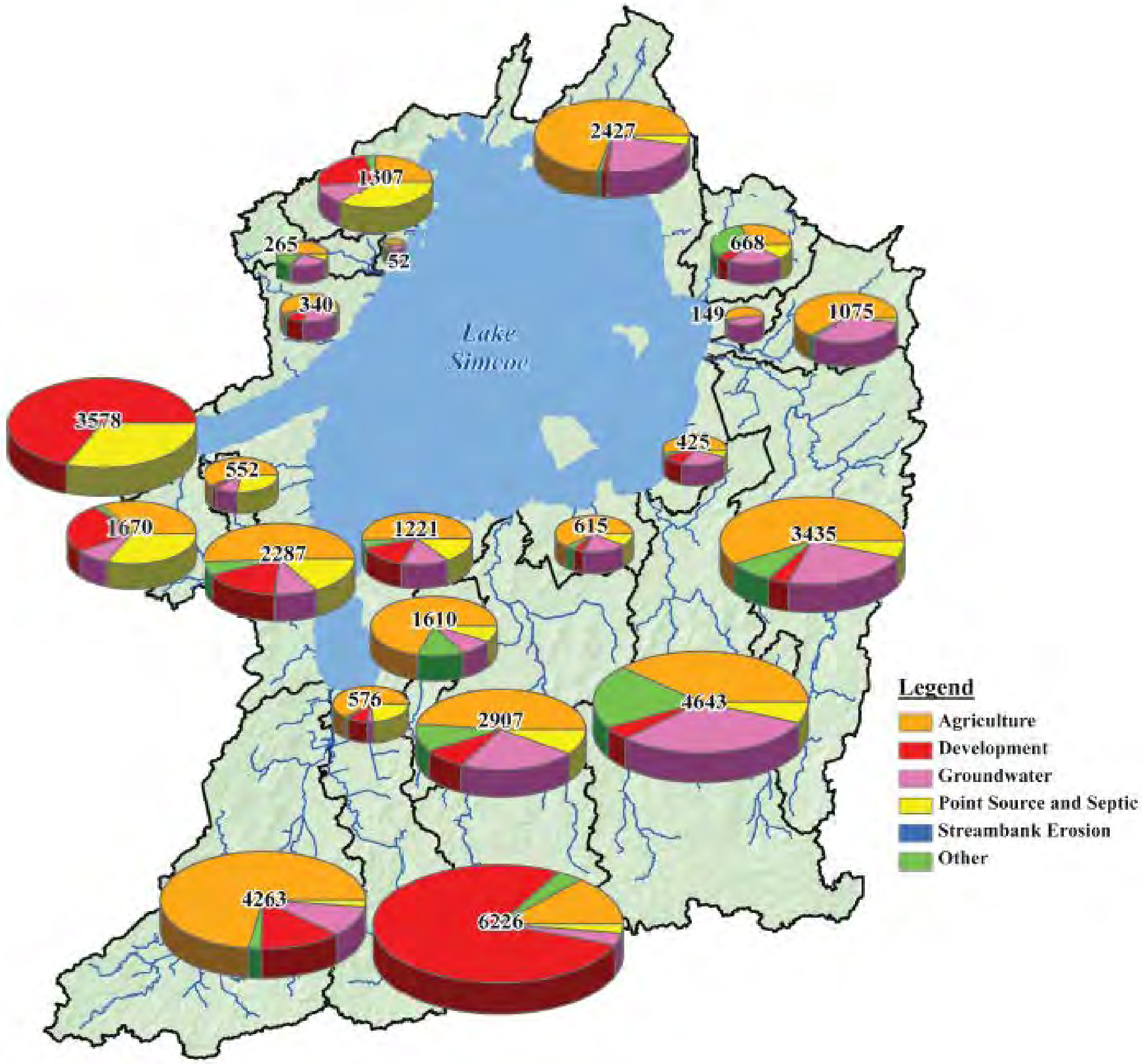

Figure 4-7 **Phosphorus load estimates for all subwatersheds in the Lake Simcoe Basin, with relative contributions from various sources**

Chloride

The main source of chloride, in its various compounds, in the environment is from road salt. It enters the environment through runoff from roadways as well as through losses from salt storage and snow disposal sites. Due to its high solubility, chloride very easily contaminates both surface and groundwater.

High levels of chloride, such as those found in runoff water draining from roads and salt storage yards, can damage the roots and leaves of aquatic and terrestrial plants, and can also have behavioural and toxicological impacts to animals. Continued exposure to high chloride levels can cause a shift from sensitive communities to those more tolerant of degraded conditions (including a number of invasive species that are able to thrive).

Sediment

While a certain amount of sediment input is normal in a natural system, in larger amounts it begins to cause a number of problems. Many contaminants, including phosphorus, bind themselves to soil particles, and eroding soil acts as a vector for introducing these particles to an aquatic system. There are also impacts to aquatic biota, which are discussed in greater detail in Chapter 6, Aquatic Habitat.

There are a number of sources of sediment in the West Holland River subwatershed:

Agricultural areas: fields are particularly vulnerable to erosion whenever they are bare (e.g. after tilling and in the spring prior to the establishment of crops). The flow of melt waters and precipitation over the fields during these periods can result in a huge influx of sediment. In addition, many farmers also remove treed windbreaks and much of the riparian vegetation along watercourses flowing through their properties in order to maximize the cultivable land, both of which help to prevent soil erosion. Practices such as conservation tillage and the use of cover crops, as well as the implementation of appropriate BMPs will help to reduce soil loss and its associated impacts on watercourses.

Development sites: these sites are often stripped of vegetation well in advance of development in an effort to reduce costs as the development is built in phases. These bare soils are then subject to erosion by both wind and water. The proper installation of erosion controls can prevent some of the soil from reaching watercourses, but need to be inspected and maintained regularly.

Urban areas: The use of sand as well as salt for maintaining safe road conditions during the winter is commonplace. However, large quantities of sand remain on the roadsides after all of the snow has melted in the spring, and if it is not removed (e.g. by street sweeping) in a timely manner, much of it will be washed away by surface runoff during rain events. This is of particular concern in areas without stormwater controls, as the sand will be transported directly to local watercourses.

Recreation

Natural areas such as streams and rivers are a popular location for recreational activities such as hiking, boating and snowmobiling. These activities if not managed correctly and undertaken in a responsible manner, can reduce ecological condition of the surface water quality in the area. Impacts from recreational activities can include increased bank erosion and instability, loss of riparian area resulting in an increase in input of total suspended solids (TSS) and pollution. Stresses on these sensitive areas are increasing as a result of increasing population and diminishing natural heritage lands.

Water temperature – thermal degradation

The warming of surface water can generally be attributed to one of two factors: flow over impervious surfaces, and/or the detention of water in a pond. During the summer, impervious surfaces such as parking lots and rooftops can become extremely warm. As water flows over these surfaces before discharging to a watercourse, its temperature increases as well. The detention of water in a pond increases the surface area of the water that is exposed to sunlight, and keeps it there for a prolonged period of time, leading to warming. Although online ponds are the greatest concern due to their direct impact on the watercourse, offline ponds (including stormwater ponds and detention ponds for irrigation) that discharge to watercourses are also a concern. While the planting of vegetation around a pond and along its outflow, and the installation of structures such as bottom-draws to ensure that the coolest water is being discharged can help to reduce the heating effect, ponds will still have an impact on the thermal regime of a watercourse. This issue will likely worsen as the amount of impervious area in the subwatershed increases in the coming years.

Pesticides

Given the large proportion of the subwatershed with agricultural and urban land uses, pesticide use is a concern in the subwatershed. While pesticide for cosmetic purposes has been banned by the Province of Ontario, which is a very positive step, there are a number of exceptions to this law that allows for the use of pesticides for public health or safety (including the protection of public works structures), golf courses, specialty turf, specified sports fields, arboriculture and to protect natural resources, if certain conditions are met. There are also exceptions for agriculture, forestry, research and scientific purposes, and uses of pesticides for structural exterminations (e.g., in and around homes to control insects) and uses of pesticides required by other legislation. Due to the number of uses still allowed for pesticides, there is still the potential for these substances to end up in the subwatershed's surface waters. There can be a number of impacts to both terrestrial and aquatic systems due to pesticide contamination, including:

- Cancers, tumours and/or lesions on fish and animals;
- Reproductive inhibition/failure – reduced egg suppression and hatching, sterility;
- Nest and brood abandonment;
- Immune system suppression;
- Endocrine disruption;
- Weight loss;
- Loss of attention; and
- Loss of predator avoidance (Ongley, E., 1996, Helfrich *et al*., 2009).

The use of best management practices for the storage and use of pesticides can limit the amount of pesticide required in a given area, and will also reduce the movement of the pesticides from target areas. These practices should be promoted throughout the subwatershed.

The LSRCA initiated sampling for pesticides in the West Holland River subwatershed in 2004 with the Toxic Pollutant Screening Program; the current program which was initiated in 2007 involves taking three samples each year in the subwatershed. As this is a relatively new program, there are few samples from which to draw information; it is therefore difficult to determine the state of this subwatershed with respect to pesticide levels. Continuation and enhancement of this program will enhance our understanding of the extent and fate of pesticides in this subwatershed, and may lead to the development of programs to prevent pesticides from reaching area watercourses.

Key points – Factors Impacting Water Quality - Stressors:

- The primary source of total phosphorus in the West Holland subwatershed is from croplands (63%) and high density urban land use (15%). Under the approved growth scenario modelled under ACS, there is a projected increase in the total phosphorus loads of 29% if BMPs are not implemented
- Most of the chloride in the subwatershed comes from the use of road salt, with the estimated annual loads increasing in recent years with the growing urban area in the subwatershed. It is expected that this load will increase into the future as the urban area continues to expand.
- Sediment sources include agricultural areas, sites stripped for development, and sand used on roads in the winter
- Increasing surface water temperatures can be attributed to overland flow across impervious surfaces and discharge from ponds. This is a trend that can be expected to increase in the coming years as the amount of impervious area increases.

Tools to Improve Water Quality: The Assimilative Capacity Study

The purpose behind the Assimilative Capacity Study (ACS) was to help the Lake Simcoe Environment Management Strategy (LSEMS) partners to determine how much development can be accommodated in the Lake Simcoe watershed and the management practices necessary to minimize future phosphorus loading from the watershed or to reduce current loadings, to meet the LSEMS remedial target for Lake Simcoe.

Study components

- The estimation of the assimilative capacity of the Lake Simcoe watershed required the completion of several steps. These included:
- Estimating the current contribution of phosphorus entering Lake Simcoe from all existing point and non-point sources
- Evaluating the potential reduction in phosphorus loading resulting from the implementation of BMPs throughout the watershed on the current load
- Estimating the impact of the future Official Plan designated population and urban area growth on phosphorus loading within the watershed with and without the implementation of BMPs
- Establishing phosphorus targets in the form of Total Maximum Monthly Loads (TMMLs) for individual subwatersheds within the basin which are in turn linked to the LSEMS lake phosphorus target load of 75 T/y
- Assessing whether the TMMLs can be achieved and maintained under the future growth scenario
- Recommending options for future growth based on the results.

These tasks were completed through the development of two water quality models, CANWET, a watershed water quality model; and MIKE3\ECO Lab, a hydrodynamic lake water quality model. These are discussed in further detail in the ACS reports, which can be found on the LSRCA website.

Phosphorus Targets: Developing Total Maximum Monthly Loads (TMMLs)

The practice of developing total maximum loads was first initiated by the United States Environmental Protection Agency (USEPA) to regulate and protect degraded water resources. Once a water quality indicator is identified, in this case total phosphorus, a target value for that indicator is determined that will allow for the attainment of water quality objectives. This target condition is established to provide measurable environmental management goals and a clear linkage to attaining water quality objectives (i.e. PWQOs). The development of TMMLs in the Lake Simcoe watershed represents the first time this method has been proposed for use in protecting water resources in Canada.

Two water quality objectives were necessary in the development of a Lake Simcoe TMML phosphorus target setting strategy. The first objective considered was the existing LSEMS lake target of 75 (T/y). The second was the PWQO for total phosphorus concentration guideline for the streams and rivers flowing into the lake (0.03 mg/L). It is important to understand that PWQO are not standards that must be met but rather objectives that are recommended to ensure healthy aquatic ecosystems

Summary of the Assimilative Capacity Study Results

Current Conditions

Sixteen out of 23 subwatersheds in the Lake Simcoe watershed, including the West Holland River, exceed a PWQO-based load target. The West Holland River subwatershed's modelled phosphorus loads exceeded the PWQO based target in every month. The loads in this subwatershed are highest in March during the spring freshet, and again later in June. The concentration of total phosphorus is generally highest during the months of lowest flow, from August to January. The primary sources of phosphorus in the West Holland River subwatershed were found to be cropland and high-intensity developed land. The measured phosphorus load for the period 2004-2007 was found to be 7,659 kg. The overall target load for the West Holland River is 2,982 kg/year.

Committed Growth without Implementation of BMPs

Committed growth is the scenario involving population and urban expansion based on the municipal Official Plan designations into the future. It does not include implementation of enhanced BMPs to offset the impact of growth and is therefore the worst-case scenario option. Not surprisingly, phosphorus loads delivered to West Holland River increase under this scenario by approximately 29%. The majority of this increase is based on assumed increased stormwater runoff from approved development proposed for the subwatershed.

Committed Growth with Full Implementation of BMPs

The last scenario modelled involves the population and urban expansion along with a full implementation of BMPs to offset the impacts associated with development. The results of this scenario indicate that an estimated total reduction of up to 28% (from 41.5 to 37.2 T/y) could be achieved for the Lake Simcoe watershed. This result suggests that the continued growth within the watershed could occur without impacting negatively on water quality.

Modelling results suggest that with BMP implementation, the West Holland River subwatershed would observe a 46% decrease in its estimated total phosphorus load. The estimated cost of implementation of the BMPs in the West Holland River is $21.9 million. Approximately 94% of this cost is derived from the implementation of urban BMPs, such as the installation or upgrades of stormwater management facilities. Approximately 6% would be derived from agricultural BMPs, such as nutrient management, cover cropping, and contour farming. Very little of this cost (<1%) would be associated with stream protection BMPs, which include fencing, buffer protection, and streambank stabilization.

4.4 Current management framework

There are numerous acts, regulations, policies and plans aimed at maintaining or improving water quality. These include the Provincial Policy Statement, the Ontario Water Resources Act, the Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, the Oak Ridges Moraine Conservation Plan, the Lake Simcoe Protection Plan, and the Nutrient Management Act.

This management framework relates to many different stressors that can potentially affect water quality, ranging from the discharge of material to urban development. In Table 4-5we categorize 12 such stressors, recognizing that many of these activities overlap and that the list is by no means inclusive of all activities. The legal effects of this management framework broadly fall into one of two categories. The first broad category we define as those having little or no legal standing and are referred to as General or Have Regard to Statements in Table 4-5 and are shown in blue. The second category includes those that have legal standing and must be conformed to; these are referred to as Regulated / Existing Targets in Table 4-5 and are shown in green. In many cases an act, regulation, policy, or plan does not relate to the activity specified, these are shown in red.

Table 4-5 Summary of current regulatory framework as it relates to the protection and restoration of water quality

Stressor affecting water quality	Oak Ridges Moraine Conservation Plan (2002)	Greenbelt Plan (2005)	Lake Simcoe Protection Plan (2008)	Growth Plan for the Greater Golden Horseshoe (2006)	Provincial Policy Statement (2005)	Nutrient management Act (2002)	Ontario Water Resources Act (1990)	Environmental Protection Act (1990)	Clean Water Act (2006) – Source Water Protection[7]	LSRCA Watershed Development Policies (2008)	York Region Official Plan (2008)	Simcoe County Official Plan (2007)	Peel Region Official Plan (2008)
Growth, development and site alteration	🟩	🟩	🟩	🟦	🟦	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩
Application of road salt	🟦	🟦	🟥	🟦	🟥	🟥	🟦 2	🟥	🟥	🟥	🟥	🟥	🟥
Loss of natural heritage features	🟩	🟩	🟩	🟦	🟦	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩
Stormwater	🟩	🟦	🟩	🟦	🟦	🟥	🟩	🟥	🟥	🟩	🟩 5	🟩	🟩
Impervious surface	🟩	🟩	🟦	🟥	🟦	🟥	🟥	🟥	🟥	🟦	🟩 6	🟩 6	🟩 6
Discharge of material	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟥	🟦	🟥	🟦
Agriculture	🟥	🟦	🟦	🟦	🟦	🟩	🟥	🟥	🟥	🟥	🟦	🟦	🟦
Restoration	🟦	🟦	🟦	🟥	🟦	🟥	🟥	🟥	🟩	🟩	🟦	🟦	🟦
Septic systems	🟩	🟥	🟩	🟥	🟦 1	🟥	🟩 3	🟥	🟥	🟩 4	🟩	🟩	🟦
Climate change	🟥	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟦

🟦 General/Have regard to statement 🟩 Regulated/Existing targets 🟥 No applicable policies

[1] PPS only specifies where private septics would be allowed, but doesn't give details around inspections/restrictions

[2] Just general policy (not specific to road salt): 'Every person that discharges or causes or permits the discharge of any material of any kind into or in any waters or on any shore or bank thereof or into or in any place that may impair the quality of the water of any waters is guilty of an offence'

[3] Septic systems >10,000 L/day are regulated under OWRA (smaller systems under building code)

[4] One policy regarding replacement of septic systems that are in wetlands

[5] Specific policies within ORM planning area, otherwise this is a 'have regard to'

[6] Within ORM planning area

[7] It is possible that many of these activities may be the addressed through policies developed under Source Protection Plans, but this is dependent on the threats and stressors identified through the Threats Assessment

In this section we provide a summary the various acts, regulations, policies and plans as they pertain to activities affecting water quality. This summary is to give context to *future management considerations* and the *opportunities and recommendations to improve water quality*. This summary is not intended to be comprehensive in terms of all the legislative pieces that relate to water quality, or of the acts, regulations, policies and plans that are discussed below – the reader is directed to each act, regulation, policy, or plan for a full assessment of how it relates to water quality.

4.4.1 Oak Ridges Moraine Conservation Plan (2002)

Among the objectives of the Oak Ridges Moraine Conservation Plan is to maintain, improve, or restore all of the elements that contribute to the ecological and hydrological functions of the ORM area, including the **quality** and quantity of its water and its other resources.

With respect to water quality this plan:

- Requires a natural heritage evaluation to demonstrate that the development or site alteration will have no adverse effects on key natural heritage features or their ecological functions, and to specify a minimum vegetation protection zone to ensure that the features are protected.
- Prohibits development and site alteration in hydrologically sensitive features such as streams, wetlands, kettle lakes, and seepage areas, and associated vegetative protection zone.
- Prohibits development and site alteration outside of Settlement Areas if it would cause the total percentage of the area of the subwatershed with impervious cover to exceed 10 per cent. Approval authorities should strive to maintain at least 30 per cent of the area outside of Settlement Areas in self-sustaining vegetation.
- Requires applications for major development include a sewage and water system plan that demonstrates that the quantity and quality of ground and surface water will be maintained, and that the project will comply with the applicable watershed plan.

The plan also includes specific requirements for Stormwater Management such as:

- Applications for development are required to demonstrate that planning, design and construction practices that protect water resources will be used, including; minimizing the removal of vegetation, grading, and soil compaction; keeping all sediment that is eroded during construction within the site.
- Stormwater Management Plans are to provide for an integrated treatment train approach that uses a planned sequence of methods of controlling stormwater and minimizing its impact by techniques that include lot level controls, conveyance controls, and end-of-pipe controls.
- Municipal development standards shall incorporate planning, design and construction practices that will reduce the portions of lots and sites that have impervious surfaces; and provide the flexibility to use alternative stormwater management techniques such as directing roof discharge to rear yard ponding areas and using grassed swales.
- The minimum standard for water quality is that 80 per cent of suspended solids shall be removed from stormwater runoff as a long-term average.
- Disposal of stormwater into a kettle lake is prohibited and new stormwater management ponds are prohibited within key natural heritage features and hydrologically sensitive features.

4.4.2 The Greenbelt Plan (2005)

One of the stated goals of the Greenbelt Plan is the ‘protection, improvement or restoration of the quality and quantity of ground and surface water and the hydrological integrity of watersheds.’ This goal is supported by a number of policies in the plan that relates to the Protected Country side areas of the Greenbelt.

The Water Resource System Policies requires:

- Planning authorities to provide for a comprehensive, integrated and long-term approach for the protection, improvement or restoration of the quality and quantity of water,
- Municipalities are required to protect vulnerable surface and ground water areas, such as wellhead protection areas, from development that may adversely affect the quality and quantity of ground and surface waters.
- Policies specifically related to Stormwater Management Infrastructure include:
- Stormwater management ponds are prohibited in key natural heritage features or key hydrologic features or their vegetation protection zones.
- Applications for development and site alteration shall be accompanied by a stormwater management plan which demonstrates that:
    - Planning, design and construction practices will minimize vegetation removal, grading and soil compaction, sediment erosion and impervious surfaces
    - Where appropriate, and integrated treatment approach shall be used to minimize stormwater management flows and structures through such measures as lot level controls and conveyance techniques such as grass swales
    - The objectives of a stormwater management plan are to avoid, minimize and/or mitigate stormwater volume, contaminant loads and impacts to receiving water courses in order to protect water quality, minimize the disruption of pre-existing (natural) drainage patterns and prevent increases in stream channel erosion.

The plan also contains policies specifically related to natural heritage features which would also have an influence on water quality. See Chapters 6 and 8 for more information.

4.4.3 Lake Simcoe Protection Plan (2009)

The Lake Simcoe Protection Plan (LSPP) sets out very ambitious targets for improving water quality in the lake and its tributary rivers and streams, and a number of policies for achieving these targets.

The water quality targets in the Lake Simcoe Protection Plan are:

- To achieve 7 mg/L dissolved oxygen in Lake Simcoe (which equates to a phosphorus load to the lake from all sources of approximately 44 tonnes/year).
- Reduce pathogen loading to eliminate beach closures
- Reduce contaminants to levels that achieve Provincial Water Quality Objectives or better

The policies to achieve these targets include those around stormwater, septic systems, construction and aggregate extraction activities, and the development of a phosphorus reduction strategy. These are outlined in further detail below.

In regards to Stormwater the LSPP requires:

- Preparation and implement comprehensive stormwater management master plans for each settlement area in the Lake Simcoe watershed.
- Municipalities are to incorporate policies related to reducing stormwater runoff volume and pollutant loadings from major development and existing settlement areas into their official plans.
- Applications for major development must be accompanied by a stormwater management plan that demonstrates, among other requirements:

  - That an integrated treatment train approach will be used
  - How changes between the pre- and post-development water balance will be minimized
  - How phosphorus loadings will be minimized
- Every owner and operator of a new stormwater management works to inspect and maintain the works on a periodic basis.

In regards to *Septic Systems,* the LSPP requires development of a proposal for a regulation under the Ontario Building Code act to:

- Designate the lands within 100 metres of the Lake Simcoe shoreline, other lakes and any permanent stream of the watershed, as a prescribed area for required septic system maintenance and re-inspections.
- Investigate new standards for septic systems.
- Place limitations on when and where new septic systems can be built within this 100 metre buffer around the lake and its streams and rivers.

The LSPP contains policies to minimize the impacts from exposed soils at construction and mineral aggregate sites. These policies requires municipalities to ensure that the following measures are incorporated into subdivision and site plan agreements:

- the removal of vegetation, grading, and soil compaction; and stipulating that the removal of vegetation is not to occur more than 30 days prior to grading or construction
- structures to control and convey runoff are in place and exposed soils are seeded once construction is complete
- sediment and erosion controls are implemented effectively

Phosphorus Reduction Strategy

The LSPP has set ambitious targets for reducing the phosphorus load to the lake which will require a reduction from all sources in the watershed. To help accomplish this goal, the LSPP contains policies for the development of a phosphorus reduction strategy, which will support a phased, coordinated and adaptive management approach to reducing excess phosphorus loadings. The policies also consider the need for innovative solutions to reducing phosphorus.

The phosphorus reduction strategy will include the development of subwatershed phosphorus loading targets, an assessment of the sources of phosphorus loadings in the watershed (including tributary sources and stormwater runoff) and an identification of practical and effective actions that should be taken to address each source.

Additional Policies

The LSPP also contains a number of other policies which, while not directly related to water quality but, will help to protect and enhance water quality in the West Holland subwatershed when they are implemented. These include:

- Water conservation and efficiency initiatives, which will reduce surface runoff and improve the efficiency of sewage treatment plants and septic systems
- Natural heritage targets around shorelines, the amount of high quality vegetative cover and riparian cover, the protection of wetlands and other important features, restoration of natural areas or features, and overall ecological health

- Consideration of climate change and its potential effects throughout the Lake Simcoe watershed
- The coordination of stewardship efforts throughout the watershed in order to capitalize on the strengths of the various partners; increase effectiveness in cost-sharing, communication and co-marketing; enhance stewardship opportunities; and champion key new initiatives, technologies, and BMPs

4.4.4 Places to Grow Act – Growth Plan for the Greater Golden Horseshoe (2006)

Policies within this plan will help to maintain and/or improve water quality by directing development to built-up areas and those areas that already have municipal water and wastewater systems. Perhaps most important with regard to surface water quality are the Growth Plan's policies around Water and Wastewater. These include the following:

- The construction of new, or expansion of existing, municipal or private communal water and waste water systems should only be considered where the following conditions are met:
    - Strategies for water conservation and other water demand management initiatives are being implemented in the existing area
    - Plans for expansion or for new services are to serve growth in a manner that supports achievement of the intensification target and density target
- Municipalities that share an inland water source and/or receiving water body, should coordinate their planning for potable water, stormwater, and wastewater systems to ensure that water quality and quantity is maintained or improved
- Municipalities are encouraged to implement and support innovative stormwater management actions as part of redevelopment and intensification

The Growth Plan also supports and builds on the protection offered to natural features in plans such as the Greenbelt and ORMCP. Municipalities are encouraged to identify and develop policies to protect natural features, the linkages between, and areas that complement them.

4.4.5 Provincial Policy Statement (2005)

Policies that are directly related to maintaining and/or improving water quality in the Provincial Policy Statement *(*PPS) include:

- Planning authorities shall protect, improve, or restore the quality of water by implementing necessary restrictions on development and site alteration to:
    - Protect municipal drinking water supplies
    - Protect, improve or restore vulnerable surface water and groundwater, sensitive surface water features and sensitive groundwater features, and their hydrologic functions, including:
        - Promoting the efficient and sustainable use of water resources
        - Ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious sites
- Growth should be directed to promote the use of existing sewage and water services, ensuring that these services can be provided in a manner that can be sustained by the

water resources on which they rely, and that protects human health and the natural environment.

- Growth is to be focused in settlement areas which, if implemented, should limit the amount of natural area removed, thus maintaining their functions. Development and site alteration are not permitted in features such as significant wetlands, woodlands and ANSIs, or the lands adjacent to them, unless it can be demonstrated that there will be no negative impacts on the natural features or their functions.

4.4.6 Nutrient Management Act (2002)

The goal of the Act is to set standards for nutrient management on farms that create nutrients (such as manure, biosolids, and fertilizers) and for farms that use these materials. The Act and its regulations are currently limited to farms that create over 300 nutrient units (one nutrient unit is equivalent to the amount of nutrient that is created by approximately one cow), or those smaller farms that are expanding and will be generating over 300 nutrient units.

Farms that generate manure are required to complete a Nutrient Management Strategy – a document that shows how much manure and/or other materials prescribed by the regulation are produced, how they will be stored, and where they will be used. Farms that use or store manure or other prescribed substances on their land, but do not generate manure for removal are required to complete a Nutrient Management Plan. These plans include many similar components to the Nutrient Management Strategies, but must also include contingency plans for situations such as weather preventing the application of the material on the field or if storage becomes too full.

This Act gives current best management practices the force of law, and creating comprehensive, enforceable, province-wide standards to regulate the management of all land-applied materials containing nutrients. Specific regulations of this Act include:

- Restrictions on how and where farmers can apply nutrients to their land.
- Setbacks from sensitive features such as wells and streams are required for new barns that will be storing manure.

4.4.7 Ontario Water Resources Act (1990)

With respect to water quality, the Ontario Water Resource Act (OWRA):

- Requires that construction of new water works (including sewage treatment works and stormwater management facilities) or alterations to existing works may proceed only after a Certificate of Approval under Section 53 of the Act has been issued by the MOE. This enables MOE to track the amount of pollutant being discharged into the water, and ensures that project designs meet the proper specifications.
- Prohibits the discharge of material of any kind into waters (or on the shore or bank of a water body) that may impair the quality of water
- States that every person that discharges or causes or permits the discharge of any material of any kind into or in any waters or on any shore or bank thereof or into or in any place that may impair the quality of the water of any waters is guilty of an offence.

The OWRA also enabled the development of water quality of objectives to provide the basis upon which the limits of the uses of water resources can be established in order to protect water quality. The Provincial Water Quality Objectives (PWQO) established under this directive, provide a series of goals, policies and guidelines are intended to assist those making decisions under or related to the OWRA and the Environmental Protection Act (See EPA below). For example, they give directions that assist in defining site specific effluent limits, which may then be incorporated into Certificates of Approval or control orders. ***The policies and guidelines do not have any formal legal status.***

The PWQOs are numerical and narrative criteria which serve as chemical and physical indicators representing a satisfactory level for surface waters and groundwater (where it discharges to the surface). PWQOs are set at a level of water quality which is protective of all forms of aquatic life and all aspects of the aquatic life cycle during indefinite exposure to the water. PWQOs are intended to provide guidance in making water quality management decision such as the designation of surface waters which should not be further degraded. They are used to assess ambient water conditions, infer use impairment, assist in assessing spills, and in monitoring the effectiveness of remedial actions. The publication states that meeting the PWQO is a minimum requirement, and that considerations such as ecosystem health, the additive effects of more than one chemical, or the protection of other uses may lead to more stringent requirements.

4.4.8 Environmental Protection Act (1990)

The main policy of the Environmental Protection Act (EPA) that will help to protect water quality is that '…a person shall not discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment, if the discharge causes or may cause an adverse effect.' This does not apply to discharges that are authorized under this Act or the OWRA if the discharge does not cause and is not likely to cause an adverse effect. It also does not apply to a discharge of a contaminant that arises when animal wastes are disposed of in accordance with normal farming practices, when the only adverse effect that is caused or may be caused is the impairment of the quality of the natural environment for any use that can be made of it.

The EPA enables a Director of the MOE to:

- order someone who causes or allows the discharge of a contaminant that results in injury, damage, or endangerment to land, water, property, animal or plant life, or human health or safety to prevent or repair the injury or damage or (if water supplies are threatened) provide temporary or permanent water supplies.
- require a person who owns a property or has management of an undertaking to put in place equipment and/or precautionary measures to be in place to prevent the discharge of a contaminant or to minimize its impact if it is released into the environment.
- issues stop orders or control orders where a contaminant has been released in a concentration or level that exceeds that prescribed by the regulations.

4.4.9 Clean Water Act (2006) – Source Water Protection

While its aim is to protect sources of drinking water, a number of the initiatives included the Clean Water Act will help to improve water quality throughout the subwatershed. The goals of the Act are to identify threats to drinking water, and then implement changes to reduce or remove those threats. A Source Protection Plan will be prepared for each Source Protection Area. This plan may set out significant threat policies to which planning decisions must conform – they will affect future activities and land use planning around wellheads and water intakes. The plan may also provide for the prohibition of certain activities and the use of risk management plans to impose conditions on certain activities, and may include policies for which municipalities must have regard in other vulnerable source water areas such as moraines, aquifers, headwaters and recharge areas. Implementation of Source Protection Plans will include the incorporation of the Plan's policies into municipal Official Plans, changes to zoning by-laws, and inspections and enforcement.

4.4.10 LSRCA Watershed Development Policies

Although not extensive, the LSRCA Watershed Development Policies do address the protection of water quality. Policies include:

- Requiring Enhanced Level 1 stormwater quality protection for all new developments in the watershed
- Requiring erosion and sediment control plans for plans of subdivision
- Protecting environmentally significant areas, wetlands and floodplains (as permitted under its mandate) and their functions, which will maintain water quality

4.4.11 York Region Official Plan (2009)

York Region's Official Plan (OP) includes a number of policies related to the protection of the quality of both ground and surface water. The policies within the OP related to water quality include:

- The preparation of a comprehensive regional water strategy for both piped services and surface and groundwater sources that will include long-term protection strategies, enhancement guidelines and monitoring requirements;
- That the natural quality and hydrological characteristics of watercourses and lakes (including water quality and temperature) will be maintained, and that development be designed with the goal of maintaining water balance
- Directing development away from sensitive surface water and groundwater features
- Continuing to partner with other regions and conservation authorities to study, analyze, and monitor ground and surface water resources to ensure a unified approach to protecting and enhancing water quality and quantity
- Monitoring the quantity and quality of surface and ground water systems in York Region, in co-operation with local municipalities and conservation authorities) by:
    - Assessing the sustainability of current activities and land uses
    - Identifying areas that are susceptible to, or currently experiencing, water quality and quantity problems
- Requiring local municipalities to establish policies and programs to protect, enhance, and monitor water systems
- Encouraging agricultural land management practices that minimize the application of pesticides and nutrients
- Working with partners in the implementation of stormwater management initiatives
- Requiring the preparation of comprehensive stormwater management plans as a component of secondary plans
- Requiring that development have an integrated and innovative approach to water management, be water efficient, and maximize stormwater quality, quantity, and infiltration through an integrated treatment approach
- Encouraging innovative approaches to stormwater within secondary plans
- Requiring owners and operators of stormwater management works to inspect, maintain, and monitor effluent quality on a periodic basis

- Working with local municipalities and LSRCA in the preparation and implementation of comprehensive stormwater master plans for each settlement area within the Lake Simcoe watershed by 2014
- Working in partnership with local municipalities, conservation authorities, adjacent municipalities and other agencies to co-ordinate watershed planning initiatives and implement watershed plan objectives; and supporting the goals and objectives of watershed plans

In addition to these policies, York Region's protection of the regional Greenlands System will help to ensure that the functions of the Region's natural features, such as the filtering effect of wetlands, will continue to protect and enhance water quality.

4.4.12 Simcoe County Official Plan (2007)

This plan does contain some policies related to the protection and enhancement of water quality. These include:

- Policies related to development in and around wetlands, significant forests, and other natural heritage features, the protection of which will help to maintain water quality
- Requiring a Stormwater Management Report for all plans of subdivision or the creation of more than five lots; as well as industrial, commercial, or institutional developments with more than 1000 m^3 of impervious area.
- Encouraging the maintenance and restoration of natural heritage areas within rural and agricultural areas; and the protection of the areas designated Greenlands, one of the objectives of which is to protect, improve, and restore the quality and quantity of surface and ground water.
- Encouraging good farm and land stewardship practices and stewardship and education programs
- Stating that land use planning and development decisions shall contribute to the protection, maintenance, and enhancement of water and related resources and aquatic ecosystems
- Ensuring that new development is sufficiently set back from rivers and streams in order to develop vegetative corridors along watercourses

4.4.13 Peel Region Official Plan (2008)

Policies in the Official Plan around the protection and enhancement of water quality include:

- Protecting, maintaining and enhancing the quality and quantity of water resources, including surface and groundwater system, and related natural systems, jointly with local municipalities, conservation authorities, and other related agencies; and directing area municipalities to establish policies and programs to protect, maintain, and enhance water resources
- Preparing green development standards, and encouraging area municipalities to do the same
- Adopting policies and establishing programs for the restoration of the natural environment in Peel, working jointly with local municipalities, the conservation authority and other partners

- Encouraging area municipalities, in consultation with conservation authorities, to promote and enforce soil conservation measures on developing land
- Promoting and participating in the development of watershed plans
- Protecting, maintaining and enhancing the integrity of ecosystems through the proper planning and managing of groundwater resources and related natural systems in Peel
- Working with partners to protect, maintain, and enhance groundwater resources
- Directing area municipalities to include, in their official plans, objectives and policies for the management of stormwater quantity and quality that would avoid, minimize and/or mitigate stormwater volume, contaminant loads, and impacts to receiving watercourses
- Supporting programs of partner organizations which encourage farmers to develop and follow conservation measures and sustainable farming practices
- Supporting the initiatives of partners which encourage sound agricultural land management and soil conservation practices and other measure that minimize or eliminate the amount of pesticide, nutrients, silt and other contaminants which have the potential to enter ground and surface water systems
- Preparing, in consultation with area municipalities, conservation authorities, and other partners, a climate change strategy to address mitigation and adaptation
- Protecting and/or enhancing the features and functions of the regional Greenlands system, which will help to maintain or improve water quality

4.5 Management gaps and limitations

Clearly there are already numerous legislations, regulations and municipal requirements aimed at protecting West Holland River water quality. Despite this strong foundation, there are a number of gaps and limitations in the management framework that need to be considered, including a number of emerging issues such as the effects of climate change and the potential for new water quality contaminants such as pharmaceuticals. This section provides an overview of factors that need to be considered in the future management of the subwatershed.

4.5.1 Growth, Development and Site Alteration

These activities are strongly regulated in areas such as key natural heritage features, key hydrologic features, and shorelines through the ORMCP, Greenbelt Plan, Lake Simcoe Protection Plan, York Region's and Simcoe County Official Plans, and LSRCA Watershed Development Policies. The protection of these features and functions serves to prevent further deterioration of the West Holland's water quality. There are, however, limitations with these policies:

- For many natural heritage features (other than wetlands) it is only those considered significant that are protected, and in general only those considered provincially significant are protected. Although they are not considered to be significant, these features still perform important functions in the watershed, and the development of these areas and loss of these functions will have impacts to watershed health. Wetlands are now well protected through the Generic Regulation (179/06);
- The policies that apply to hydrologic features are not consistent across the subwatershed – the definition of a key hydrologic feature is different for the ORMCP area, the Greenbelt Plan area, and the LSPP area which covers the remainder of the subwatershed. Features such as seepage areas, springs, aquifers and recharge areas

are protected in the ORMCP area, but not the LSPP area, and the Greenbelt Plan includes seepage areas and springs but not aquifers and recharge areas. These discrepancies can leave some of these features unprotected.

- Some plans specify a minimum vegetation protection zone (e.g. the ORMCP and Greenbelt Plan), and also identify a further ‘area of influence’ (as it is referred to in the ORMCP) outside of the minimum vegetation protection zone. Within this area of influence, a proposal for development or site alteration triggers the requirement for a natural heritage and/or hydrologic evaluation. This evaluation is meant to describe the existing conditions, assess the potential impacts from proposed development/site alteration and determine if the minimum vegetation protection zone provides sufficient protection. If the minimum vegetation protection zone is not found to be sufficient, the evaluation should specify the dimensions of the required minimum vegetation protection zone. While the goal of these policies is undoubtedly to protect the features, in reality the required evaluations rarely specify anything greater than the minimum; in essence the minimum becomes the maximum distance. There is therefore little further protection gained through this process for these features and their functions by way of a buffer distance.

4.5.2 Road Salt

There is no legislation that specifically regulates the application of road salt. The ORMCP, Greenbelt Plan, Growth Plan for the GGH, and the OWRA address it either through broad ‘have regard for’ policies, or general water quality statements.

These are very general policies that in no way require the management of road salt and its impacts to water quality and aquatic biota. Urban areas have been expanding in the subwatershed, and thus the increasing chloride concentrations are not unexpected. However, while safety must obviously continue to be the priority for road salt use, municipalities should continue to explore the most environmentally friendly options for maintaining safe roads in order to protect the subwatershed’s water quality and the aquatic communities residing within its watercourses. These options include ensuring the proper timing and amount of road salt application, as well as exploring the use of alternative de-icing substances. York Region has adopted a Salt Management Plan for this purpose. Local municipalities within the subwatershed should adopt similar plans and/or the *Code of Practice for the Environmental Management of Road Salts* (Environment Canada, 2004).

4.5.3 Stormwater

The ORMCP, PPS, Greenbelt Plan, Growth Plan, LSPP, Official Plans, and LSRCA Development Policies all contain some form of policy recommendation around requirements for stormwater management. Although some of these are ‘have regard for’ statements, there is policy support to require that all applications for development within the Lake Simcoe watershed are required to have Enhanced Level 1 stormwater control or better. The LSPP has gone a step further and contains several policies around reducing the impacts of stormwater. These are highlighted in the above section. While these policies are an important step in reducing the impacts of stormwater, there are some limitations:

- There are no required timelines for the implementation of the recommendations of stormwater master plans required through the LSPP
- There is no mention of funding support for the implementation of such activities as stormwater retrofits in the LSPP

- While municipalities are required to incorporate policies around stormwater including encouraging a hierarchy of treatment, the implementation of innovative stormwater management measures, allowing for flexibility in development standards around alternative community design and stormwater techniques, this does not necessarily mean that developers will adopt these standards. Municipalities should *require* some or all of these practices rather than encouraging their use in order to create a level playing field for all developers undertaking works in the watershed, otherwise there is little incentive to change standard practices.

4.5.4 Impervious Surfaces

The ORMCP, Greenbelt Plan and Regional Official Plans contain policies around that aim to limit impervious area to a certain level, while the PPS, LSPP and LSRCA Watershed Development Policies contain more general statements about striving to limit impervious area. These policies are limited in scope, and there are gaps in the geographic area covered. The issues with these policies include:

- The ORMCP and Greenbelt Plan do set a limit of 10 per cent, but these limits apply only outside of Settlement Areas in the ORMCP, and only in the Natural Heritage System of the Greenbelt. Thus there is no defined limit areas within the ORMCP and Greenbelt Plan areas not covered by these policies, as well as areas outside of the ORMCP and Greenbelt boundaries, and the subwatershed's impervious area could easily exceed 10 per cent
- York Region's policies around impervious surfaces only apply in the ORMCP area
- There is no agency ensuring that subwatershed impervious areas do not exceed the defined limit
- Approval agencies should be striving for either a reduction in impervious areas on development sites or the mandatory use of practices that increase infiltration in order to reduce the impacts of impervious area within the subwatershed

4.5.5 Discharge of Material

The OWRA, EPA, Nutrient Management Act, Clean Water Act, and Official Plans all contain policies related to the discharge of materials that would impact water quality. Some are related to specific activities and/or contaminants; for example the Nutrient Management Act is mainly related to the phosphorus and bacterial contaminants from agricultural activities, whereas the Clean Water Act is concerned with the protection of drinking water. Others regulate the discharge of substances that have the potential to impair water quality. The limitations with these policies include:

- Much of the regulation is related to point sources of pollutant (e.g. WWTPs, industrial activities, stormwater ponds) and do not generally address non-point sources of pollutant
- Cumulative impacts are generally not considered – the Province has developed Provincial Water Quality Objectives under the EPA and OWRA, but the objectives and their related policies have no legal standing, and are generally seen as merely guidelines, not as limits to be strictly adhered to. There is no enforcement related to exceedances of these objectives. This has led to ever deteriorating water quality conditions in the subwatershed which will require a significant investment to rehabilitate

- The LSPP identifies a target of achieving the PWQO or better in its watersheds, but while it does include a number of policies aimed at improving water quality, there are none that specifically identify how the PWQO target will be reached
- The Nutrient Management Act only applies to farms of a certain size or that store and/or utilize a minimum amount of manure

4.5.6 Agriculture

The Nutrient Management Act contains the most stringent of the policies related to agriculture, as it requires plans for the management of contaminants created and/or stored on farms. Other policies relate to the protection of agricultural resources, but few relate to the management of contaminants from agricultural areas, with only ‘have regard to’ statements encouraging the use of agricultural BMPs.

- There are no policies that regulate or require the use of BMPs such as cover crops, conservation tillage/no tillage, wind breaks or other practices that would protect water quality
- Also lacking are policies requiring livestock to be fenced and kept out of watercourses, an activity that causes numerous water quality issues as well as causing bank instability
- There is nothing that requires farmers to test soils to ensure that the use of fertilizer is actually required – many farmers simply fertilize at certain times every year, without testing the soil to ensure that it is actually necessary, which may be resulting in unnecessary inputs of nutrients into the subwatershed.

4.5.7 Restoration

Most of the policies related to restoration are quite general in nature, and do not contain specific requirements. Some require applications for development in site alteration in key hydrologic features and key natural heritage features to be accompanied a natural heritage or hydrologic evaluation, which in some cases requires the applicant to include planning, design, or construction practices that will maintain and, where feasible, improve or restore the health, size and diversity of the feature.

4.5.8 Septic Systems

Policies relating to septic systems are included in the PPS, ORMCP, OWRA, LSPP, and the York Region Official Plan. These policies range from outlining the types of developments where septic systems may be constructed (as is the case in the PPS) to those policies in the ORMCP and LSPP which do not allow for the construction of any new septic systems, on the ORM and within 100 metres of Lake Simcoe or any of its permanent streams, respectively. The issues around the policy framework include:

- The ORM policy is the only one that will help to protect the quality of groundwater from malfunctioning septic systems, policies such as those in the Lake Simcoe Protection Plan will mainly serve to protect surface water
- These policies do not require the regular inspection of existing systems, leaving both surface and groundwater vulnerable to contamination. The LSPP’s proposed regulation under the Ontario Building Code for required septic system maintenance re-inspections for systems within 100 metres of Lake Simcoe or any of the watershed’s permanent streams is a good step. However the appropriate agency should ensure that funding is available to residents within these areas to undertake required system maintenance and/or repairs identified through this program

4.5.9 Climate Change

Climate change is generally not well addressed in the current management framework. The LSPP contains the most comprehensive policies related to this issue which, although it is still difficult to predict its impacts, may exacerbate water quality issues in this subwatershed. The adaptation strategy that will be developed through the LSPP is a significant first step in addressing this issue, and some of the Official Plan policies are beginning to consider climate change as well. While it may not be appropriate for some of the existing legislation to address climate change issues, it will be important to incorporate climate change considerations wherever possible in making management decisions for the subwatershed, and implement policies requiring, at the very least, the implementation of so called “no regrets” options should be incorporated into development and site alteration wherever possible.

Emerging Contaminants

As anthropogenic activities increasingly impact our natural areas, the potential for introduction of harmful substances becomes more of a concern. It is for this reason that a Toxic Pollutant Screening Program was initiated by the Lake Simcoe Region Conservation Authority in 2004. The goal of this project was to develop a better understanding of the location and prevalence of certain elements, chemicals, and chemical compounds that have the potential to negatively impact either human or aquatic life in the watershed. Sampling through this program revealed that there are currently some substances whose levels exceed regulatory guidelines in some Lake Simcoe tributaries. In addition, there were some substances, such as pharmaceutical products, that were not included in this monitoring work. Many of these substances have the potential to impact humans and affect aquatic life.

Endocrine Disrupting Chemicals

Endocrine disrupting chemicals (EDCs) are chemicals which adversely affect the endocrine system, which is a set of glands and the hormones they produce which guide development, growth, reproduction, and behaviour. Harmful effects have been observed on wildlife and humans including reproductive disorders, impacts on growth and development, as well as the incidence of some cancers. EDCs can come from both natural and man-made sources including pesticides; hormones, including both natural and synthetic which are used in oral contraceptives and in livestock farming; and can be the product of industrial processes such as incineration. In nature, EDCs including PCBs and other man-made chemicals have caused, among other issues, severe reproductive problems in fish and birds, swelling of the thyroid glands in numerous animal species, reduction in frog populations, and, in birds, the thinning of eggshells. The Lake Simcoe Region Conservation Authority's Toxic Pollutant Screening Program included monitoring for organochlorine pesticides, which are EDCs. These substances were not detected in any of the samples taken in the East Holland River subwatershed.

Pharmaceuticals and Personal Care Products

The presence of pharmaceuticals and personal care products (PPCPs) in the natural environment has been a growing concern over the past two decades, and will become more prevalent with the growing population and increasing use of these products. While the effects of pharmaceuticals on humans during the course of treatment are very well studied; the impacts of their by-products after use is not. Although some of the products and their by-products can be broken down incidentally at Waste Pollution Control Plants, the plants are generally not equipped to remove PPCPs from waste water. Studies have shown hormones, antibiotics, anti-inflammatory drugs, fragrances, antiseptics, sunscreen agents and a host of other PPCPs in varying amounts in the environment, though they are mostly seen within 100 metres of a waste water treatment plant discharge. In general, the levels in the environment are quite low; however, the effects of prolonged exposure to low levels are not well known. Some studies have shown that PPCPs have the potential to alter physiology, behaviour, and reproductive capacity. Concerns in the environment related to PPCPs include endocrine disruption in aquatic life and antibiotic resistance. Further understanding of these and other concerns is required in order to determine potential steps.

Polybrominated Diphenyl Ethers

Polybrominated Diphenyl Ethers (PBDEs) are emerging as a chemical of concern to both human and environmental health due to their persistence and ability to bioaccumulate in the environment. PBDEs are a group of chemicals used as flame retardants in a number of manufactured products, particularly in plastics. They are found in most homes and businesses in products such as electronics, TVs, textiles, cars, aircrafts, construction products, adhesives, sealants, and rubber products. They have become an increasingly common pollutant and have been found in samples taken in air, water, and land. PBDEs have been also been detected in a number of species (including humans) worldwide and studies are finding that levels of PBDEs have been increasing steadily and substantially over time. In the Canadian environment the greatest potential risk from PBDEs is secondary contamination in wildlife from the consumption of prey with elevated PBDE levels as well as effects on benthic organisms through exposure to PBDEs in sediments.

Due to the environmental persistence and bioaccumulation of PBDEs they are defined as toxic to the environment as defined under the Canadian Environmental Protection Act (CEPA. Currently Canada is proposing a ban on the import and manufacture of a number of forms of PBDEs. This ban however does not include the decaBDE form, the most commonly used form. Efforts to control the release of decaBDE would involve working with industry and stakeholders to minimize the impact of PBDEs in the environment. Through the federal government, environmental objectives are also being proposed for virtual elimination of a number of forms of PBDEs detectable in the environment.

4.5.10 Agriculture

Although there are currently no requirements for farmers to undertake BMPs such as cover crops, conservation tillage, the planting of wind rows, and leaving riparian buffers intact, there are a number of available programs to assist farmers to implement these programs. In particular, the LSRCA's Landowner Environmental Assistance Program (LEAP) provides guidance and funding for a number of types of projects; and there are a number of policies in the Lake Simcoe Protection Plan related to agricultural stewardship.

4.5.11 Atmospheric deposition

The municipalities have requirements for sediment and erosion control from ongoing developments; and the LSPP is also proposing the use of best practices to minimize the amount of dust erosion from sites. There are few, if any, policies around preventing erosion from agricultural lands, although there are a number of funding programs for the implementation of BMPs.

Although there are some policies and/or by-laws in place, it will be important to ensure that there are sufficient resources for their enforcement in order to prevent inputs from this source.

4.6 Recommended Actions to Improve Water Quality

The following recommended actions were developed to improve water quality in the West Holland River subwatershed. The main parameter of concern identified through the development of the subwatershed plan was phosphorus, which has exceeded the Provincial Water Quality Objective in every water quality sample in the main branch over the past number of years, as well as chloride. Much of the impact on water quality can be attributed to the large area of the subwatershed in agriculture, which includes the Holland Marsh, and also the urban areas of Bradford, Schomberg, and Kettleby. Inputs of stormwater runoff from agricultural areas as well as from uncontrolled urban areas are extremely high in phosphorus, and high levels of chloride have been observed, particularly around Highway 400. The implementation of the actions outlined below will help to mitigate the impacts of the existing urban and rural land uses, as well as the growth that is to come in the Town of Bradford, on the water quality in this subwatershed.

These recommendations, which are grouped and numbered as described in Section 1.4, were developed to address the water quality issues and stressors that were identified throughout this chapter. In addition, they consider, and are consistent with applicable policies and recommendations in the province's Lake Simcoe Protection Plan, and the LSRCA's Integrated Watershed Management Plan. Each recommendation below also identifies the applicable 'detailed recommendations' as outlined in Chapter 10. These detailed actions will form the basis of the Implementation Plan for York Region's ORM subwatersheds, to be developed following the completion of this plan.

4.6.1 Planning and Policy

1) That the municipal partners and the LSRCA strive to reduce the impacts of stormwater through a number of methods including the implementation of policies and guidelines and enabling the use of new and innovative technologies, retrofitting of existing developments.

   Detailed recommendations: A.1.1 – A.1.3

2) That the partner municipalities act to improve water quality by implementing measures to prevent and/or mitigate impacts from septic systems, development, and other activities that may cause impairment.

Detailed recommendations: A.2.1 – A.2.4

3) That the Province develop binding criteria for specific contaminants within the Lake Simcoe watershed, as well as criteria for addressing emerging substances of concern

   Detailed recommendations: A.2.5 – A.2.8

4) That the municipal partners and the LSRCA strive to maintain natural hydrologic conditions on development sites

   Detailed recommendations: A.3.1 – A.3.2

5) That the federal, provincial, and municipal governments, as well as the LSRCA, continue to evaluate and implement planning initiatives and practices aimed at reducing the impact of development on the condition of the West Holland subwatershed

   Detailed recommendations: A.3.3 – A.3.5, C.1.2

6) That the value of the ecological goods and services (EGS) provided by ecological features be considered in decision making around growth and development

   Detailed recommendation: A.3.6

7) That the rural/agricultural community be engaged in developing solutions for minimizing the impacts of practices on their lands

   Detailed recommendation: A.4.1

10) That the Province, the municipal partners, and the LSRCA seek to gain an improved understanding of the impacts of climate change in the West Holland subwatershed, incorporating this information into decision making scenarios and developing strategies to mitigate and adapt to its impacts.

    Detailed recommendations: A.6.1 – A.6.2, G.1.1 – G.1.3

4.6.2 Use of Better Management Practices

11) That the LSRCA and its municipal partners continue working to mitigate the impacts of stormwater to water quality and quantity through tracking its sources, completing stormwater retrofits, promoting methods of minimizing stormwater volume, and continuing to research new and innovative solutions to stormwater control and implementing these solutions where appropriate.

    Detailed recommendations: B.1.1 – B.1.5

12) That support for programs offered to assist rural landowners in implementing BMPs on their properties, such as LSRCA's LEAP program, be continued and/or expanded as resources permit

    Detailed recommendations: B.2.1 – B.2.3

13) That sectors that have the potential to have significant impacts on conditions in the West Holland subwatershed be expected to undertake BMPs and other activities to mitigate their impacts, as required under the LSPP

    Detailed recommendations: B.2.4 – B.2.5

4.6.3 Changing the Way things are done ‘on the ground’

16) That the LSRCA and its partner municipalities strive to maximize the infiltration of stormwater where appropriate through development approvals and the use of practices and technologies

    Detailed recommendations: C.1.1, C.2.1 – C.2.2

17) That the partner municipalities, the LSRCA, and the related stakeholders work to reduce the impacts of construction practices on the West Holland subwatershed’s water quality

    Detailed recommendations: C.3.1 – C.3.2

18) That the partner municipalities continue to work to minimize the environmental impacts of road maintenance activities (e.g. chloride levels, sediment, phosphorus) on local watercourses

    Detailed recommendations: C.4.1 – C.4.6

4.6.4 Applied Research and Science

19) That the Province, LSRCA and the municipal partners continue to work to identify sources of phosphorus within the subwatershed in order to set targets and develop strategies and solutions for reducing loads within the West Holland subwatershed

    Detailed recommendations: D.1.1 – D.1.4, D.1.8 – D.1.13

21) That all partners continue to research techniques that may be undertaken in the subwatershed for improving water quality

    Detailed recommendations: D.1.6 – D.1.7

4.6.5 Monitoring

29) That the LSRCA, partner municipalities, and developers undertake efforts to minimize the impacts of construction through the use of on-site practices aimed at protecting water quality; and by conducting monitoring to ensure the effectiveness of these practices.

    Detailed recommendations E.3.1 – E.3.2

4.6.6 Management, Rehabilitation and Restoration

37) That the LSRCA continue to utilize buffer requirements and timing guidelines as tools to protect aquatic resources, and that other activities such as stormwater retrofits, tree planting, and habitat enhancement be undertaken to enhance aquatic habitat

    Detailed recommendation: F.1.17

38) That the LSRCA and the partner municipalities assess the feasibility of increasing natural cover (e.g. woodland, streambank vegetation, interior forest, grassland) in the subwatershed and set priorities and develop plans to undertake this enhancement, based on overall benefit to the subwatershed.

    Detailed recommendations: A.5.3, F.2.1 – F.2.5

4.6.7 Adaptive Response

47) That the LSRCA and partner municipalities work to reduce their carbon footprint and to increase ecological resilience in the watershed

    Detailed recommendations: G.1.1 – G.1.3

5 Water Quantity (surface and groundwater)

5.1 Introduction and Background

The effective management of water resources requires the accounting of the total quantity of water and its distribution within a watershed, known as a water budget. The input into the budget is the total amount of precipitation within a watershed and the outputs include evaporation, transpiration, infiltration (movement of water into the subsurface), and runoff (or overland flow) into rivers and streams, which all make up components of the hydrologic cycle.

Surface water quantity deals with components of the hydrologic cycle that move overland and are within lakes, streams and wetlands. Surface flow is comprised of groundwater discharge into rivers and streams, overland flow from rain, snow melt and precipitation that falls directly into lakes, rivers, streams and wetlands.

Groundwater quantity deals with components of the hydrologic cycle that are present below the earth's surface, in the spaces between rocks and soil particles. The discharge of groundwater to lakes and streams remains relatively constant from season to season; it therefore forms an important part of the surface water flow system, and is particularly important when surface runoff is at is lowest levels, when it can be the only source of water.

Many natural systems rely on a consistent supply of groundwater. Fish species that depend on coldwater conditions for their survival require a very high ratio of cold, clean groundwater to total stream flow. Many ponds and wetlands are maintained by groundwater flow during the dry summer months. In many areas throughout the subwatershed, humans are extremely dependent on a reliable supply of groundwater for many purposes including irrigation of fields, potable water, industry, and recreation.

The physical properties within a watershed such as drainage area, slope, geology and land use can influence the distribution of the water and the processes that function within a watershed. This chapter quantifies the surface and groundwater components within the hydrologic cycle for the subwatershed and also identifies how the rural and urban land uses in the West Holland subwatershed have altered the hydrologic cycle (Figure 5-1), including changes to the surface flow volumes, annual flow patterns and the risk of flooding.

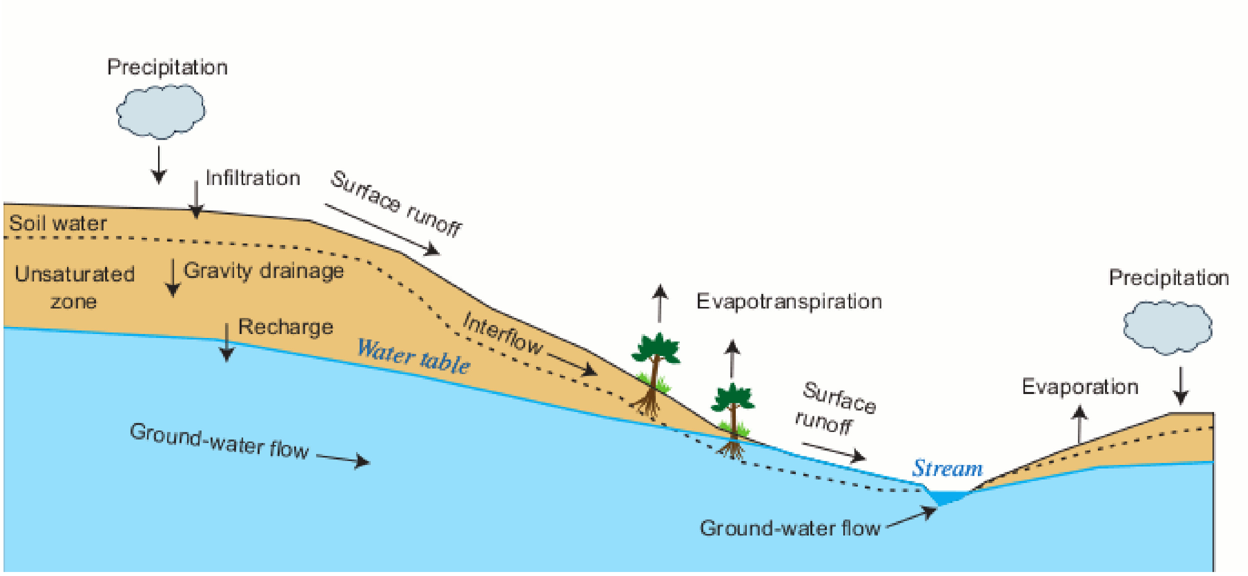

Figure 5-1 Hydrologic cycle (USGS, 2008)

5.1.1 Understanding the Factors that Affect Water Quantity

There are several factors that influence the quantity of surface and groundwater available within a subwatershed. They are climate, geology, land use and water use.

Climate

Both surface and groundwater quantity can be influenced by a number of climatic factors, including precipitation, evaporation, and evapotranspiration. Precipitation is the main climate variable that has a direct influence on the quantity of water available, since it is the main input into the system. The amount of precipitation that falls, particularly in one event, will have a significant influence on how much infiltrates into the soil, and how much will runoff. An intense storm event, where a large quantity of precipitation falls over a short time will direct most of the precipitation overland, as will a significant snowmelt event. The West Holland subwatershed lies within the Simcoe and Kawartha Lakes Climatic Region (Brown *et al*.,1980), which is characterized by having relatively predictable precipitation patterns, with the mean annual precipitation for the subwatershed being approximately 815mm/year (Earthfx & Gerber, 2008). However, it should be noted that precipitation patterns have become less predicable in recent years, perhaps due to climate change. For example, in the last four years within the Lake Simcoe basin alone there have been three 100 year storm events.

There are other variables associated with climate that will influence water quantity. In particular, evapotranspiration is strongly influenced by climate and unlike precipitation it is considered an output or loss to the system. Evapotranspiration is the water lost to the atmosphere by two processes, evaporation and transpiration. Evaporation is the loss from open bodies of water, such as lakes and reservoirs, wetlands, bare soil, and snow cover; transpiration is the loss from living-plant surfaces. Several factors other than the physical characteristics of water, soil, snow and plant surfaces also affect the evapotranspiration process. The important factors include net solar radiation, surface area of open bodies of water, wind speed, density and type of vegetative cover, availability of soil moisture, root depth, reflective land-surface characteristics, and season.

Geology

Geology also has a significant influence on groundwater quantity. The underlying geology and the type of soil present at the surface will determine how much water will be infiltrated during a precipitation event. For example, coarse-grained and loosely packed soils, such as sands and gravels will promote groundwater recharge, whereas fine-grained or hard packed soils, such as clay will allow less water to infiltrate to recharge the groundwater system. The surficial geology is an important factor in determining the amount of water that flows to and within a watercourse.

Land Use and Land Cover

Land cover is an important factor that can strongly influence both surface and groundwater quantity because it will affect several aspects of the water budget including; surface water runoff, evaporation and infiltration. Developed land will often have a higher proportion of impervious surface, such as roadways, parking lots, and buildings roofs. Increased runoff rates result in erosion and reduced infiltration to recharge groundwater reserves. In addition, groundwater pathways may also be affected because of development, which can result in decreased discharge to wetlands and streams.

The surface water in this watershed flows from the topographic high in the Oak Ridges Moraine northeast to Lake Simcoe. The land types present in the subwatershed will influence how much water remains at the surface and how fast it will be flowing. The land types present in the subwatershed include the Oak Ridges Moraine, wetlands, woodlands, and valley lands. The wetlands are found in areas of topographic lows, where the groundwater often intersects the surface in these areas. The intersection of the surface with the ground water table allows for a constant flow of surface water throughout these areas. Since the wetlands are in areas of topographic lows water flow in the areas will be relatively slow compared to the slopes of the Oak Ridges Moraine.

As the population continues to grow, urbanized areas are expanding, resulting in expanding areas of impervious surfaces. Impervious surfaces present in the subwatershed include parking lots, roads, and rooftops. One major impervious surface present in the subwatershed is Highway 400, which stretches the entire length of the subwatershed. Impervious surfaces lead to a decrease in time to peak flow following a rain event, as the ability to store and slowly release water has been eliminated. Watercourses in the undeveloped areas of the subwatershed exist under natural conditions making them less vulnerable to extreme changes in climatic events; for example time to peak flow will not occur as rapidly. As impervious surfaces increase in area, peak flow volume can also increase as water cannot infiltrate into the ground, and therefore runs off into surface water bodies, which can increase the risk of flooding particularly during the spring freshet.

Water Use

In the West Holland subwatershed both surface and groundwater is used for a variety of purposes, including municipal water supply, agriculture, industrial use, golf course irrigation and private water supplies. Many of these users withdraw large amounts of water and could potentially be putting stress on the system. Therefore, it is important to be able to identify the large water users by location, source water (surface or groundwater), type of water use, and amount of water takings to ensure the water within the subwatershed is managed in a sustainable manner. An effort to quantify these required water withdrawals has been undertaken as part of the Source Water Protection initiatives required under the Clean Water Act (discussed in Section 5.5.6)

5.1.2 Previous Studies

Information from several groundwater and water budget studies were used to assess the hydrogeology of the West Holland subwatershed. To date no studies have been conducted to assess the surface hydrology of the West Holland subwatershed. The following are a list of key studies and reports that have influenced the information provided in this chapter:

York Peel Durham Toronto/Conservation Authorities Moraine Coalition (YPDT/CAMC) Groundwater Study

In 2000, the nine conservation authorities having jurisdiction on the ORM (Credit Valley, Nottawasaga Valley, Toronto and Region, Lake Simcoe Region, Central Lake Ontario, Kawartha, Ganaraska Region, Otonabee and Lower Trent) formed a coalition to investigate common issues pertaining to the groundwater flow systems associated with the ORM. The coalition is referred to as the Conservation Authorities Moraine Coalition (CAMC).

Around the same time, the Regional municipalities of York, Peel, Durham and the City of Toronto (YPDT), through a planning led process, were also looking at the common issues they faced with respect to development issues on the ORM. The need for more environmental protection on the moraine and greater access to groundwater related information was highlighted.

In 2001, the two groups came together to look at groundwater issues in a broad regional context. The project is referred to as the YPDT/CAMC Groundwater management program. The overall goal of this study is to provide a hydrogeological analysis of the system that will support water resource management of the subwatersheds that drain off the ORM. The three main technical components that form the foundation of analysis system consist of:

1. A database of all water related information;
2. A geologic and hydrogeologic interpretation of the subsurface stratigraphy including development and refinement of a conceptual model; and
3. A numerical groundwater flow model. To date, four numerical models have been created. These four models, termed: i) the Core Model; ii) the Regional Model, iii) the Durham Model, and iv) the West extension Model, have different geographical extents and different resolutions (additional details regarding the numerical models are provided in Appendix A). Three of the models cover the southern and eastern parts of the Lake Simcoe Watershed.

This modelling work is documented in the report completed by Earthfx (2006) and was used extensively throughout this report and forms the basis for much of the water budget work that was completed for the West Holland Subwatershed ORMCP and Source Water Protection Studies.

Holland River, Maskinonge River, and Black River Watershed and Water Budget Study

This study was completed to address the water budget component required under the Oak Ridges Moraine Conservation Plan and is based on the previous modelling work by the YPDT-CAMC groundwater study (described above). The study details the movement of water through the East Holland, West Holland, Maskinonge and Black River subwatersheds, under five different groundwater and land use scenarios (Earthfx & Gerber, 2008).

Source Water Protection Studies

Much of the information presented throughout this chapter has been extracted from and is consistent with preliminary information, data and modeling results developed and reported through several Source Water Protection (SWP) water budget studies:

- Draft Preliminary Conceptual water budget (SGBLS, 2007)
- Draft Tier 1 Water Budget and Water Quantity Risk Assessment (LSRCA, 2009)
- Draft Tier 2 Water Budget Assessment of the Holland and Maskinonge River Watersheds (Earthfx, 2009)

These draft reports were developed consistent with provincial direction provided by the Ministry of the Environment (MOE) in the Technical Rules (MOE, 2009) prepared for the provincial SWP program under the Clean Water Act. Due to the overlapping information, every effort has been made to maintain a consistent interpretation of information reported in this chapter with that reported under the draft documents (above).

5.2 Current Conditions

5.2.1 Hydrogeologic Setting

The hydrogeology of the West Holland subwatershed is shaped by the stratigraphic framework discussed in Chapter 2. In order to characterize the hydrogeological conditions across the ORM the CAMC-YPDT (Conservation Authorities Moraine Coalition- York, Peel, Durham, Toronto) study group constructed a database, containing streamflow, climate, borehole, and water well information. The database was used in the development of a hydrostratigraphic framework used in the numerical model development mentioned above.

For numerical modeling purposes, the hydrostratigraphy of the ORM complex was divided into the following eight layers: (1) surficial deposits and/or weathered Halton Till; (2) Halton Till or Kettleby Till; (3) Oak Ridges Aquifer Complex; (4) Newmarket Till; (5) Thorncliffe Aquifer Complex; (6) Sunnybrook Drift; (7) Scarborough Aquifer Complex; and (8) Weathered Bedrock. The regional stratigraphic framework and the local hydrostratigraphic units are summarized in Table 5-1.

Table 5-1 Hydrostratigraphic framework

Layer	Name	Function	Description
1	Recent glaciolacustrine deposits	Aquitard	Thin deposits of sands, silts and clays; generally of low permeability and only used locally for minor water supply to private homes
2	Halton Till or Kettleby Till	Aquitard	Sandy silt to clayey silt till, typically 3 to 6 m thick but can range up to 30 m, low permeability
3	Oak Ridges Aquifer Complex	Aquifer	Mainly granular sediments interlayed with finer materials, up to 100 m thick, generally medium to high permeability, forms important local and regional aquifers
4	Newmarket Till	Aquitard	Dense, sandy silt to clayey silt till, up to 50 m thick, of low permeability. In lateral tunnel areas the infill material is primarily low permeability silts.
5	Thorncliffe Aquifer Complex	Aquifer	Sands and silt, up to 60 m thick in some areas, generally high permeability, forms important regional aquifers
6	Sunnybrook Drift	Aquitard	Silts and clays, generally less than 20 m thick, low permeability
7	Scarborough Aquifer Complex	Aquifer	Sands, silts and clays, up to 60 m thick, variable permeability, forms important aquifers in localized areas
8	Weathered Bedrock	Aquifer	Limestone and shale; limestone in northern part of Region act as an aquifer for private supplies

The groundwater system within the subwatershed consists of three principal aquifers: 1) the upper aquifer system or *Oak Ridges aquifer complex* occurs within deposits of the ORM and 2) the Mackinaw Interstadial Unit, 3) the intermediate aquifer or *Thorncliffe aquifer complex* occurs within the Thorncliffe formation; and the deep aquifer system or *Scarborough aquifer complex* occurs within the deposits of the Scarborough formation (Figure 2-9 and Figure 2-10).

The Thorncliffe and Scarborough aquifers are separated from the Oak Ridges aquifer by the Newmarket till. The Newmarket till effectively forms a protective barrier for the deeper aquifers. However, within this subwatershed this aquitard has been breached by erosive processes, resulting in Channel Aquifers, also referred to as tunnel channels. These tunnel channels were infilled with sand and silt deposits as melt water energy waned. The nature of the infill material is important for understanding the groundwater flow system as it determines the amount of transfer between the shallow and deeper aquifer systems. It has been estimated that the rate at which water can move through these channels is an order of magnitude greater than that of the Newmarket Till aquitard. Refer to Figure 2-10 and Figure 2-11 for a hydrogeologic profile of the West Holland River. From the diagram the location of the three aquifer complexes can be observed. The interpreted location of the tunnel channels within the subwatershed are shown in Figure 2-11.

The conceptual model of ground water flow within the subwatershed was presented above in Figure 2-9 and Figure 2-10. As a result of the model the cross sectional profile of the West Holland River was created (Figure 2-14 and Figure 2-15). The profile demonstrates how the thickness and depth of the aquifer complexes varies throughout the subwatershed.

5.2.2 Hydraulic Properties

Hydraulic properties such as hydraulic conductivity, specific storage (S_s), specific yield (S_y) hydraulic gradients, and porosity characterize the amount, rate and direction of groundwater flow through soil and rock. This numerical value below is referred to as hydraulic conductivity. Both the vertical and horizontal hydraulic conductivities for the West Holland subwatershed have been calculated in metres per second (m/s). Ansiotropy is a ratio of the vertical conductivity to the horizontal conductivity. It is useful in characterizing the properties of (k), of a unit layer which vary according to the direction of flow. Table 5-2 is a summary of the hydraulic conductivity estimates through all of the hydrogeologic layers derived from the CORE model, described in the water budget section below (i.e. Section 5.3).

Table 5-2 Summary of hydraulic conductivity (K) estimates used in the Core Model (Earthfx & Gerber, 2008)

Unit	Model Layer	Horizontal K_h (m/s)	Vertical K_v (m/s)	Anisotropy (K_v/K_h)
Recent Deposits	1			1.0
Weathered Halton Till	1	5.0×10^{-6}	1.5×10^{-6}	1.0
Halton Till	2	5.0×10^{-7}	1.5×10^{-7}	0.3
Oak Ridges Moraine	3	5×10^{-7} to 2.4×10^{-4}	variable	0.5
Weathered Newmarket Till	3	5.0×10^{-6}	5.0×10^{-6}	1.0
Newmarket Till	4	5.0×10^{-8}	1.0×10^{-8}	0.2
Newmarket Till under ORM	4	5.0×10^{-8}	1.25×10^{-9}	0.03
Tunnel Channel Silt	4	5.0×10^{-7}	1.0×10^{-7}	0.2
Tunnel Channel Sand	5	1×10^{-4}	1×10^{-4}	1.0
Thorncliffe Fm.	5	1×10^{-5} to 1×10^{-3}	variable	0.5
Sunnybrook Drift	6	5.0×10^{-8}	5.0×10^{-9}	0.1
Scarborough Fm.	7	1×10^{-5} to 3×10^{-4}	variable	1.0
Weathered bedrock	8	7.0×10^{-6}	7.0×10^{-6}	1.0

5.2.3 Groundwater Flow

Groundwater flows from areas of high to low hydraulic head. The direction of movement at any point within the system is dependent on the distribution of hydraulic potential (Funk, 1977). Groundwater moves continuously but at different rates based on the hydraulic properties of the formations mentioned above. Within each formation, groundwater can move in both the horizontal and vertical directions. Since the water table commonly follows the ground surface topography, horizontal flow can be topographically mapped using water table data obtained from shallow wells.

Groundwater flow within the three major aquifer systems is generally from the topographic highs associated with the ORM towards the topographic lows associated with the major stream channels and Lake Simcoe (Figure 5-2). In the shallow groundwater flow system, groundwater flow patterns are influenced by ground surface topography, but are more significantly influenced by the stream network. Local deflections in flow direction toward tributary streams and their associated valleys occur in all three aquifers (Earthfx & Gerber, 2008).

A geologic profile in the general north-south direction from the Oak Ridges Moraine to Lake Simcoe (Figure 5-6) shows the various components of the hydrogeologic system in this subwatershed. This is a simplified graphical presentation showing groundwater recharge, movement and discharge in the different lithologic layers underlying the subwatershed.

Groundwater flow within the deep groundwater flow system comprised of the Thorncliffe (Figure 5-3) and Scarborough (Figure 5-4) aquifer complexes exhibit a similar, but more subdued, pattern to the shallow flow system with flow converging on the lower reaches of the major streams, particularly the Holland Marsh. The southern boundary of the study area (Holland Watershed divide) along the ORM appears to approximate a groundwater flow divide for all three aquifers. This divide is less pronounced between Schomberg and Oak Ridges, perhaps because of the influence of the bedrock valley system and the presence of tunnel channel in this area (Figure 5-4). It should be noted that the potentiometric surface for the Scarborough aquifer complex is the least certain as it is based on fewer data points than the two overlying aquifers, which may explain the lack of clear channel flow dominated system in the observed data. Note that in the report water levels in wells are herein referred to as potentials. Observed potentials will refer to measured water levels in wells and simulated potential will refer to Core Model (discussed in Section 5.3) estimated water levels (Earthfx & Gerber, 2008).

The relative rates of vertical groundwater flow between the shallow and deep aquifer systems, as simulated by the numerical groundwater flow model, is displayed on Figure 5-5. This flow (referred to as vertical leakage) occurs through the Newmarket Till aquitard, or the aquitard material formed by the silt infill following tunnel channel erosion through the Newmarket Till. Vertical hydraulic gradients are mainly downward between the shallow and deep aquifers under the ORM and till highlands and upward in the vicinity of river valleys associated with topographic lows, particularly the Holland Marsh area. The vertical gradients in all aquifers are also locally enhanced by municipal groundwater pumping. The major area within the subwatershed that has upward groundwater flow from the deep aquifer complexes to the shallow groundwater flow system occurs along the Holland Marsh area (Earthfx & Gerber, 2008).

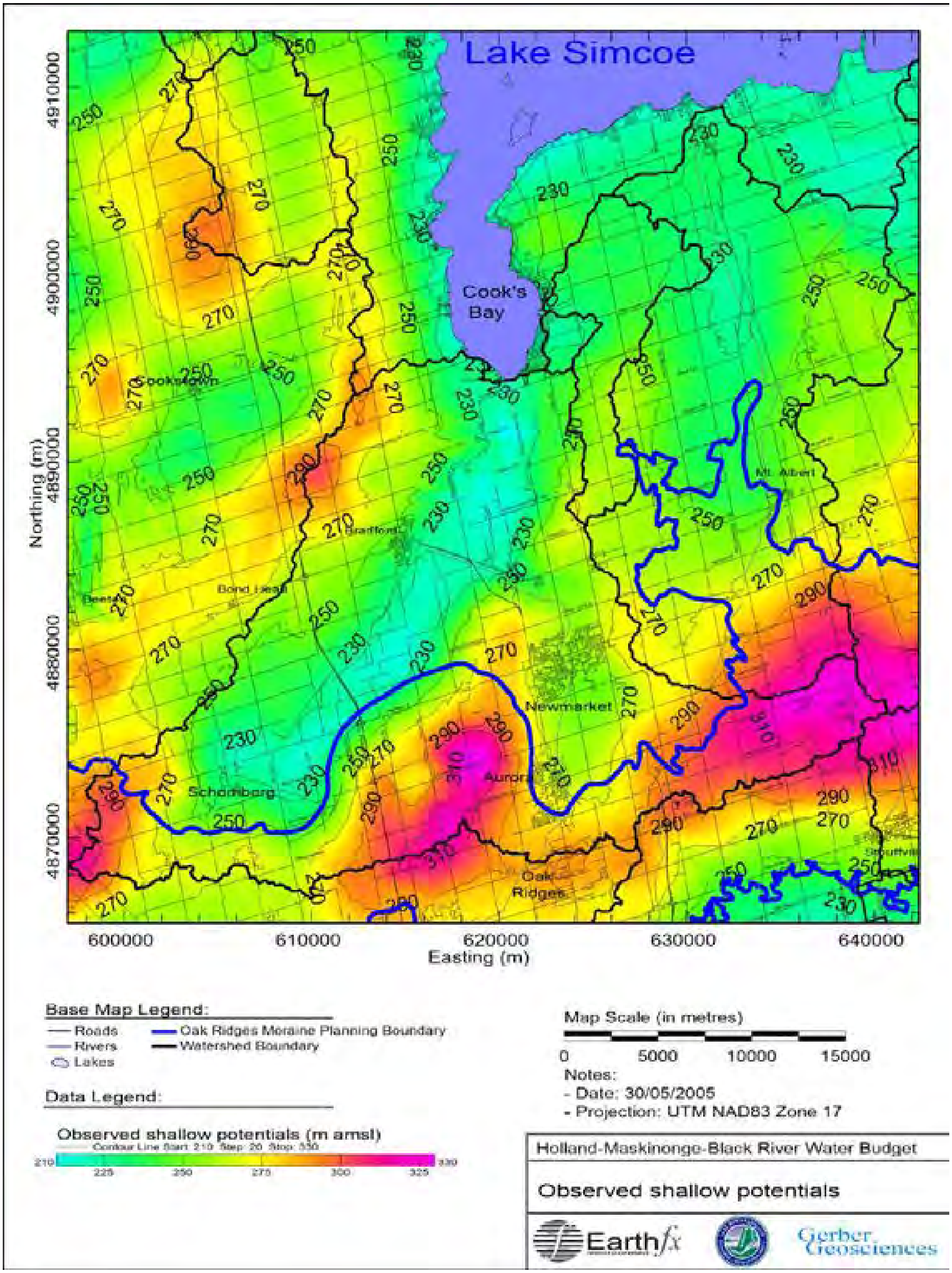

Figure 5-2 Observed potential within the shallow groundwater flow system. Water levels in wells are referred to as potentials (Earthfx & Gerber, 2008)

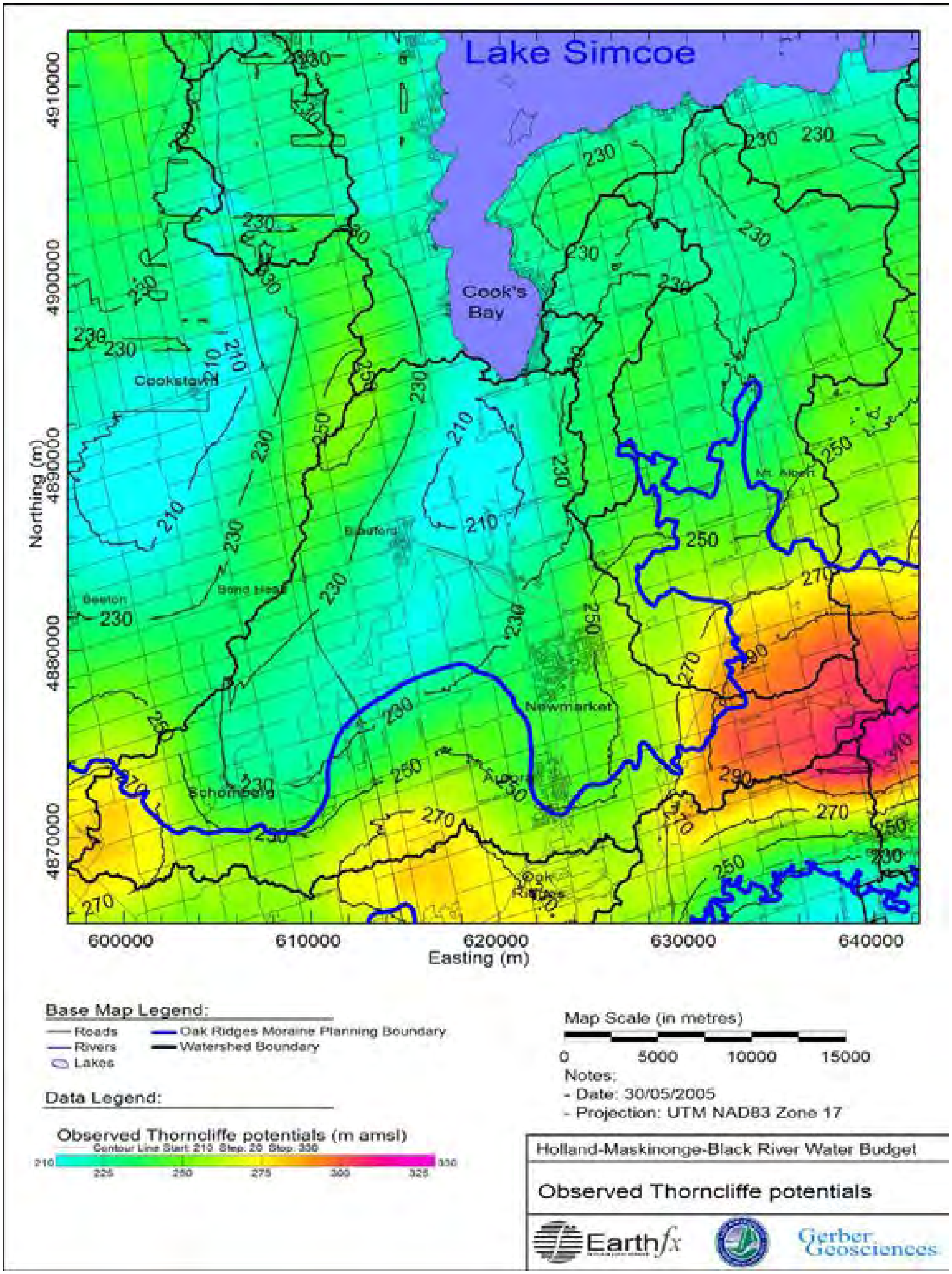

Figure 5-3 **Observed potentials within the Thorncliffe aquifer complex (Earthfx & Gerber, 2008).**

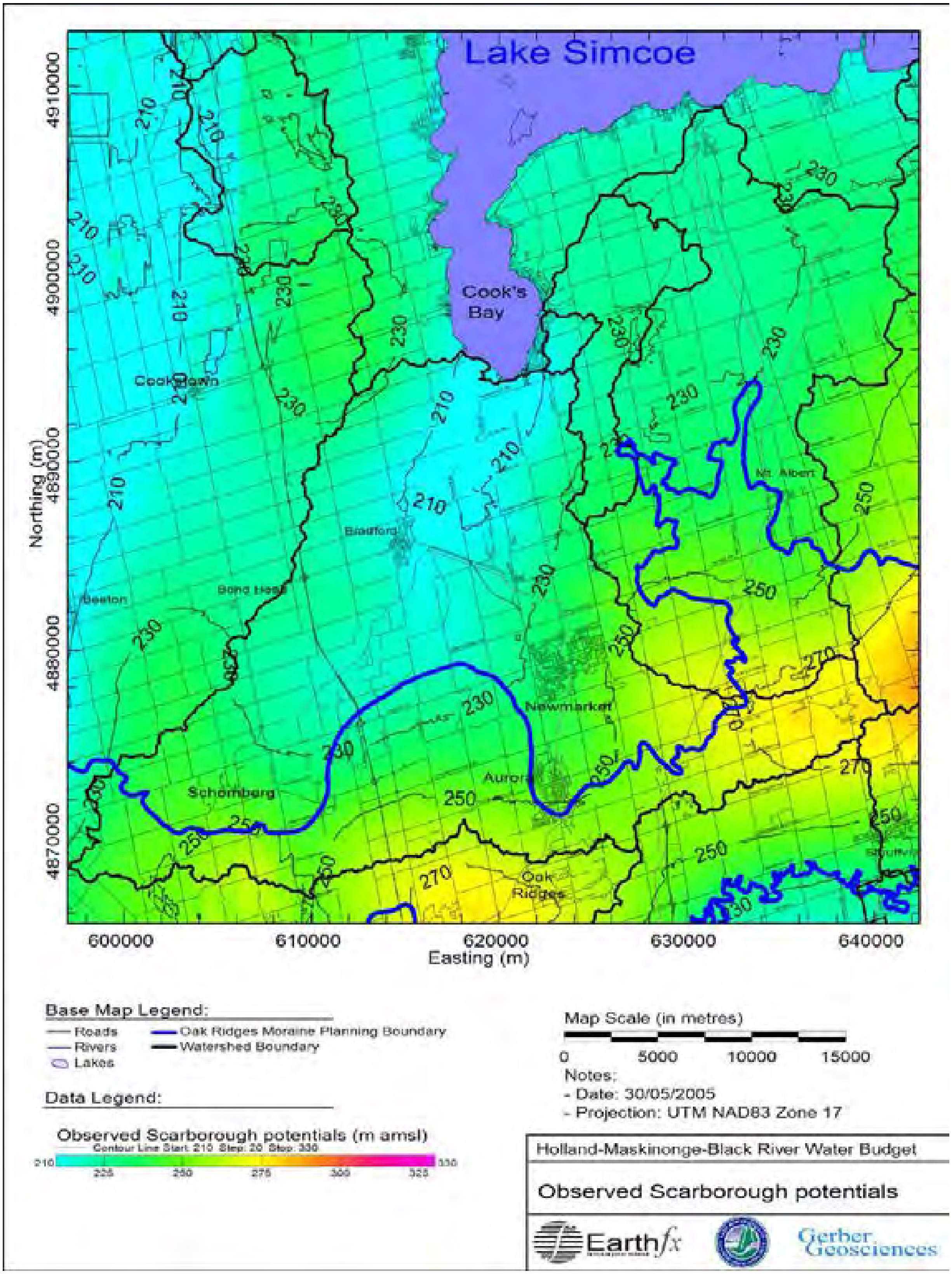

Figure 5-4 Observed potential within the Scarborough aquifer complex (Earthfx & Gerber, 2008)

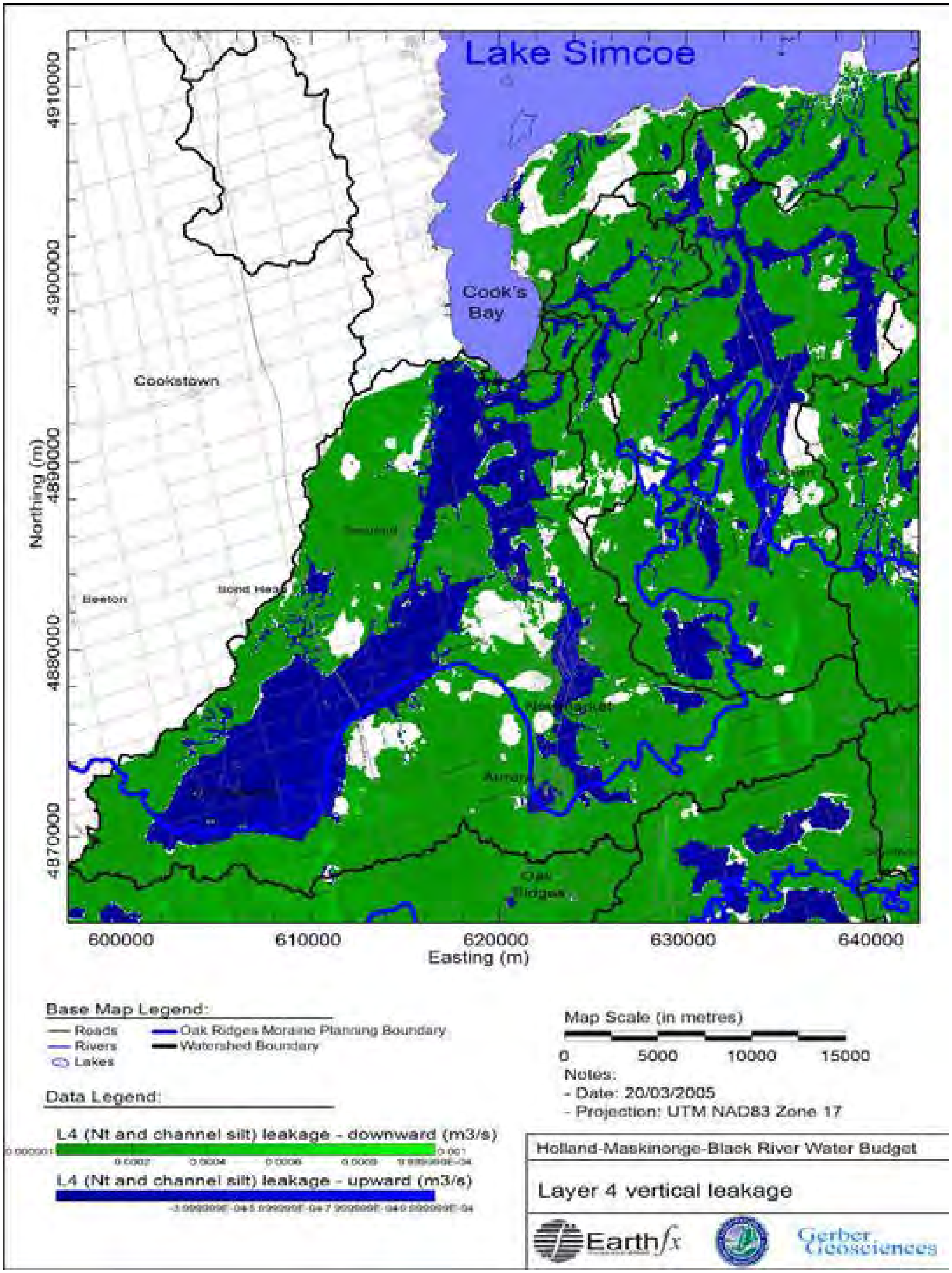

Figure 5-5 MODFLOW calculated vertical groundwater flow between the shallow and deep groundwater flow system through the Newmarket Till (N_t) and Channel Silt deposits (White zones= no leakage) (Earthfx & Gerber, 2008)

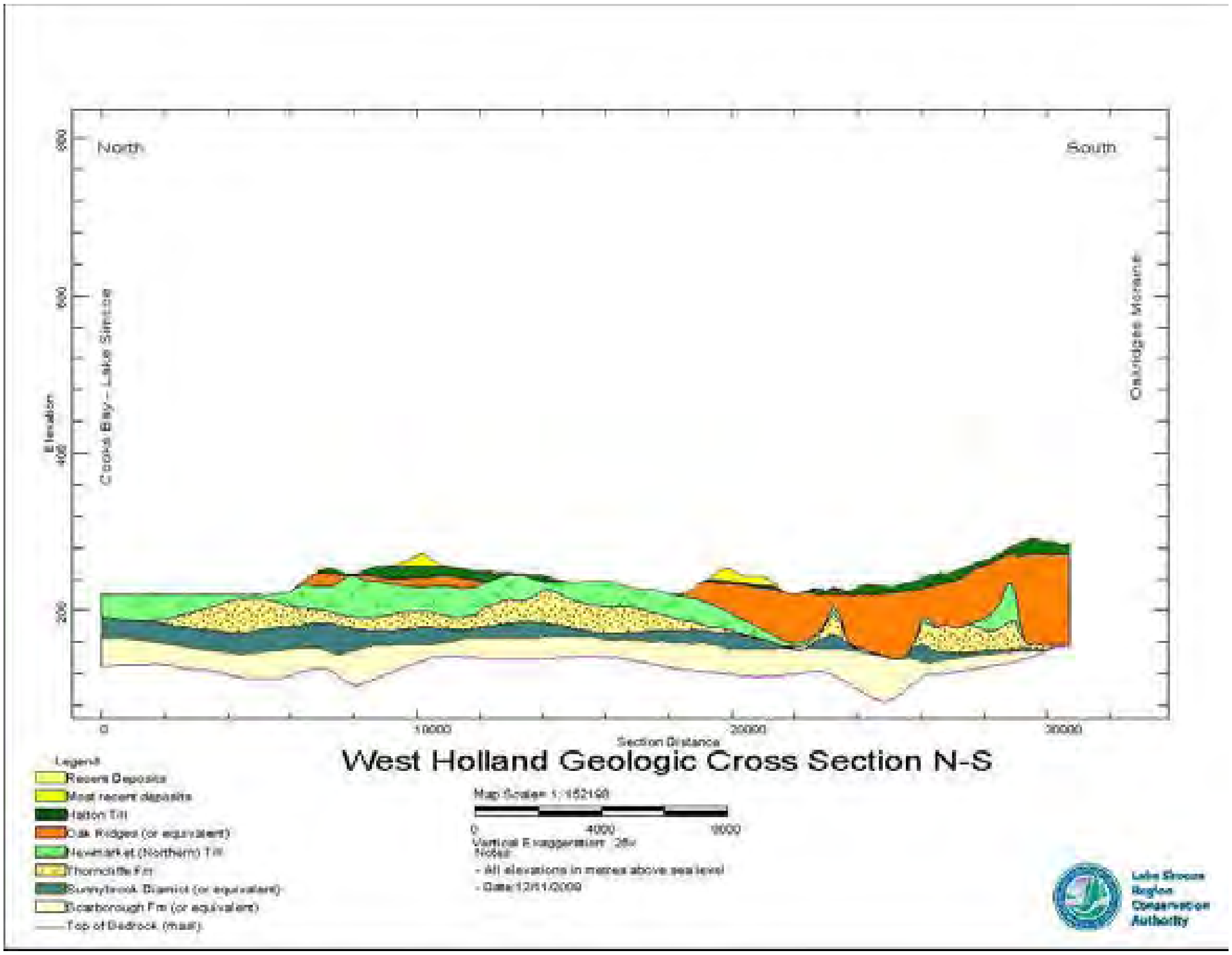

Figure 5-6 **West Holland River profile (Earthfx and Gerber, 2008)**

5.2.4 Stream Flow

There are several streamflow gauging stations within the West Holland; however Upper Schomberg (02EC010) is the only HYDAT streamflow gauging station with long term continuous streamflow measurements within the West Holland subwatershed (Earthfx & Gerber, 2008). Figure 5-10 summarizes the observed streamflow data from the Holland Landing station. Historically flow stations have operated on the North Schomberg River (1982-2000), Pottageville Creek (1982-1991) and Kettleby (1982-2004) and have been reactivated as of 2006.

The 1966 to 2007 data set for the Upper Schomberg River shows no statistically significant trend in either an increase or decrease in mean annual flows. Both Kettleby and North Schomberg also lack a significant trend. The precipitation data also do not display a significant trend suggesting that the lack of a trend in flow data is not due a masking effect of the climatic data. The period of record at Pottageville is too short for any meaningful trends to be examined.

Total streamflow measured at the Upper Schomberg station is equivalent to approximately 200mm/year when averaged over the drainage area. The range of average annual stream flow over the past 40 years is approximately 120mm/year to 330mm/year (Earthfx, 2008).

Runoff/Impervious Surfaces

A change in the amount of impervious surface in a catchment may show up as a change in the seasonal flow volumes through a river system. Frozen ground during winter acts as an impervious surface limiting infiltration. Evapotranspiration effects will be minimal due to dormant or absent vegetative cover. In a watershed with minimal impervious surfaces streamflow through winter will make up the majority of the yearly flow volume, while summer will contribute the least volume due to the affect of infiltration and evapotranspiration. As a watershed becomes more urbanized it can therefore be expected that this seasonal variation will lessen as more of the area becomes impervious.

Land use and Stream Flow

Changes in land use and water taking (both surface and groundwater takings) can dramatically alter flow characteristics and morphology of a stream. The land use changes associated with urbanization can have a significant impact on surface flows. This is due in large part to the increase in impervious surfaces, which include roads, parking lots, and rooftops. The increase in impervious surfaces leads to a significant reduction in evapotranspiration and infiltration of water into the soil, as there is little vegetation and the paved surfaces do not provide opportunities for the water to reach the soil, thereby disrupting the natural hydrologic balance. This disruption creates conditions for a higher volume of precipitation to be converted to surface water runoff, which flows at a faster velocity to receiving watercourses than it naturally would. The reduced infiltration of precipitation due to impervious surfaces can also result in lower groundwater levels and a reduction in the volume of water that is discharged as baseflow. Streams that once flowed permanently may become intermittent, or flow can disappear altogether for periods of time.

In the West Holland we can see that land use plays an important role in the volume and rate of flow, time to peak flow, and the amount of runoff following a precipitation event. Approximately 70 percent of the lands within the West Holland River subwatershed have been changed significantly to accommodate various land uses, the most prevalent of which is agriculture. The canal system associated with the Holland Marsh agricultural area has virtually eliminated natural flow through this section of the subwatershed. Impacts can also be seen in the upstream and downstream areas which make it difficult to accurately study flow patterns. Tile drains also alter the drainage characteristics at the site due to the efficiency at which they remove water from the field. The main hydrologic impact of tile drained fields is on peak flows and time to peak flows, but not the total quantity of stream flow (Maidment, 1992). This can mean higher peak storm flows and shorter response time to storm events which can lead to similar issues as impervious surfaces. Factors such as soil moisture and type, precipitation amount and intensity, amount of area tile drained and the size of the subwatershed will influence whether the influence of tile drains on water quantity will be seen at the subwatershed scale.

The Town of Schomberg upstream of the Upper Schomberg flow station has seen growth over the last decade. To investigate if this change in impervious surface has had any effect on the hydrology of stream seasonal flow volumes from 1966-1975 and 2002-2007 were compared (Figure 5-7). A very slight increase can be seen between the two time periods (less than 1% in summer and 2.7% in fall). While it is difficult to determine if the increase is significant, it will be worth monitoring over the coming years to see if the hydrology is shifting due to upstream land use changes.

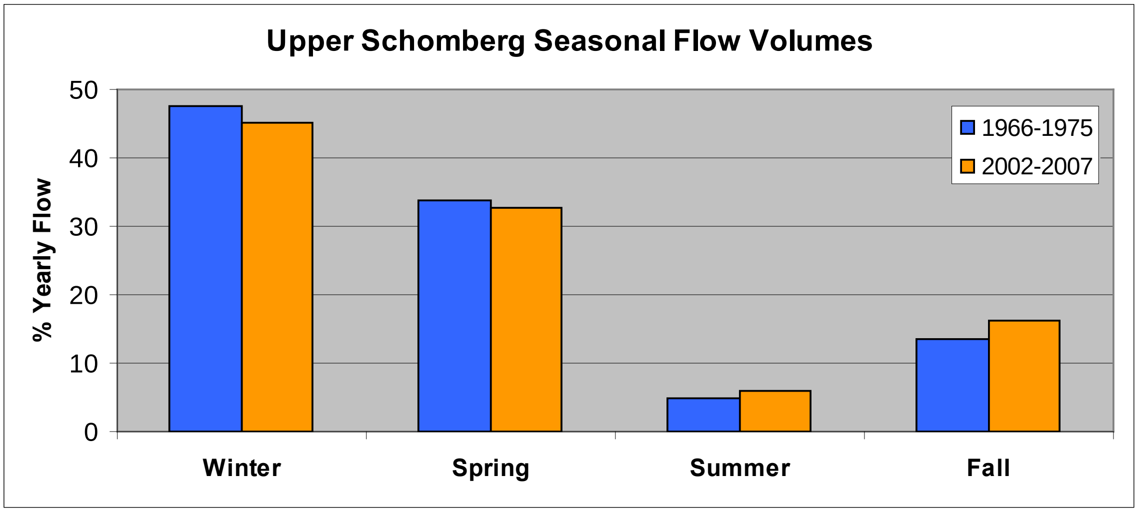

Figure 5-7 **Seasonal flow volumes at the Upper Schomberg flow station**

5.2.5 Baseflow

Baseflow is the portion of stream flow that is derived from groundwater discharge, from sources such as springs and seepages that release the cool groundwater. The baseflow component within streams is vital for fish populations that require cold water habitat. This habitat can be affected by localized pumping as the aquifers are drawn down and less baseflow is released.

The component of streamflow that can be attributed to groundwater discharge was estimated by applying a technique called "baseflow separation" to the long-term daily flow record. The technique used in the water budget study is one of many possible methods, and is described in Clarifica (2002). It calculates the daily value of groundwater discharge as the minimum daily mean flow. An example of the hydrograph separation results using this methodology is shown on Figure 5-11. Groundwater discharge for the West and East Holland River was estimated as being equivalent to approximately 100mm/year over the drainage area, or nearly half of the total streamflow (Earthfx & Gerber, 2008).

While flow gauges are a very effective tool for examining baseflow there are too few to accurately describe baseflow across the entire subwatershed. For this reason spot baseflow discharge measurements were conducted on the West Holland River in July of 2004. Low flow stream surveys have also been conducted by Golder Associates in 2004 for the South Simcoe Groundwater Study, the Geological Survery of Canada (GSC), and Conestoga Rovers and Associates (CRA, 2003) for the CAMC- YPDT ORM Study. Due to the nature of the Holland Marsh it was not possible to conduct discharge measurements in or downstream of the Marsh. Therefore all baseflow data discussed pertains to the upper tributaries of the West Holland River.

There were relatively few tributaries that were found to be dry. The majority of the tributaries were found to be low gaining reaches, four reaches were found to be significant losing reaches and there was one short but significant gaining reach. The losing reaches could be attributed to geology (infiltration) or water taking. The gaining reach on Kettleby Creek is likely a product of geology as the reach sits on the Oak Ridges Moraine. Kettleby Creek is also home to a number of coldwater fish species. Cold water river conditions are indicative of groundwater discharge.

The site locations of the 2004 survey conducted by the LSRCA are illustrated in Figure 5-8 and the results are depicted in Figure 5-9.

Low flow stream flow surveys measure the discharge at various points along a river reach during a period without influence from storm events. All or most of the flow in the stream during this period of time is assumed to represent groundwater discharge. The objective of these surveys was to identify those reaches receiving significant groundwater discharge and to determine relative rates of groundwater discharge to the various ungauged tributaries and stream reaches.

These relative rates were used as guides in the calibration of the groundwater flow model discussed in section 5.3.4. While it was recognized that the measured flows tend to underestimate annual average groundwater discharge, the observations provided calibration targets for the spatial distribution of groundwater discharge and minimum groundwater discharge quantities to streams.

The position of the Schomberg River stream flow gauging station within the flow system is shown on the river profile included as (Figure 2-14). From the geologic section it can be seen that most of the groundwater discharge at the streamflow gauging station is from the upper aquifer unit. However, not all groundwater recharge that occurs within the station drainage areas is realized as groundwater discharge at the stream flow gauging stations. A portion of the recharge likely moves to the deep aquifers and ultimately discharges to the stream downstream of the gauge (note: surface water catchments do not always align with groundwatersheds).

The ability of a river system to withstand drought depends largely on the baseflow volume the system can generate. With baseflow volume declining in the West Holland River it is more susceptible to drought. This is exemplified by the extremely dry conditions of 2007. For the West Holland River, August 2007 became one of the lowest recorded flows in the 20 year period of record (Figure 5-12). While neighbouring rivers like the Black and Pefferlaw experienced low water levels neither system recorded record low flow levels. Examination of the Baseflow Index for both the Black and Pefferlaw show a stable trend in baseflow over the period of record explaining their ability to better withstand the dry conditions of 2007.

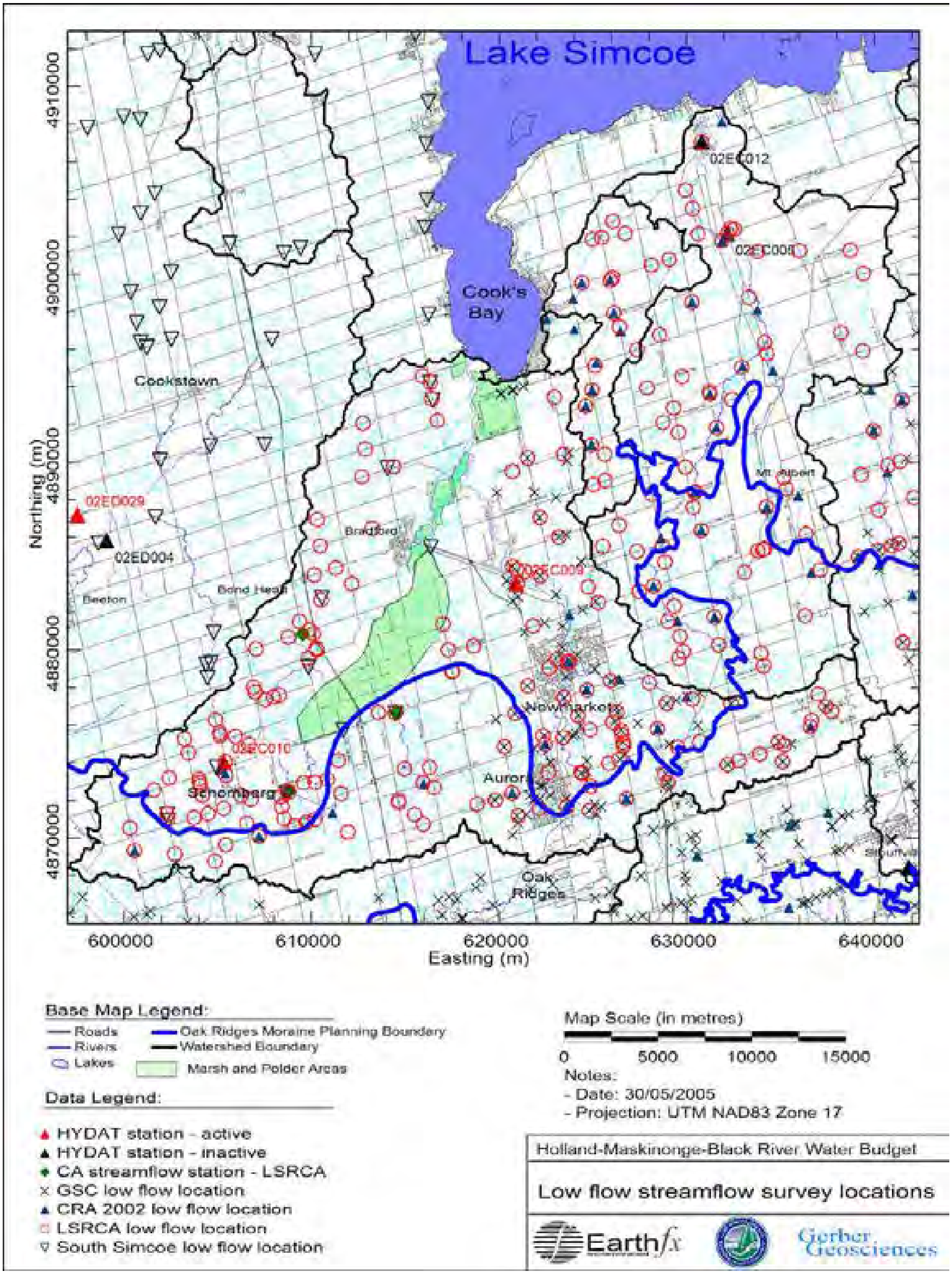

Figure 5-8 Low flow streamflow survey locations in the West Holland subwatershed and surrounding area (Earthfx & Gerber, 2008).

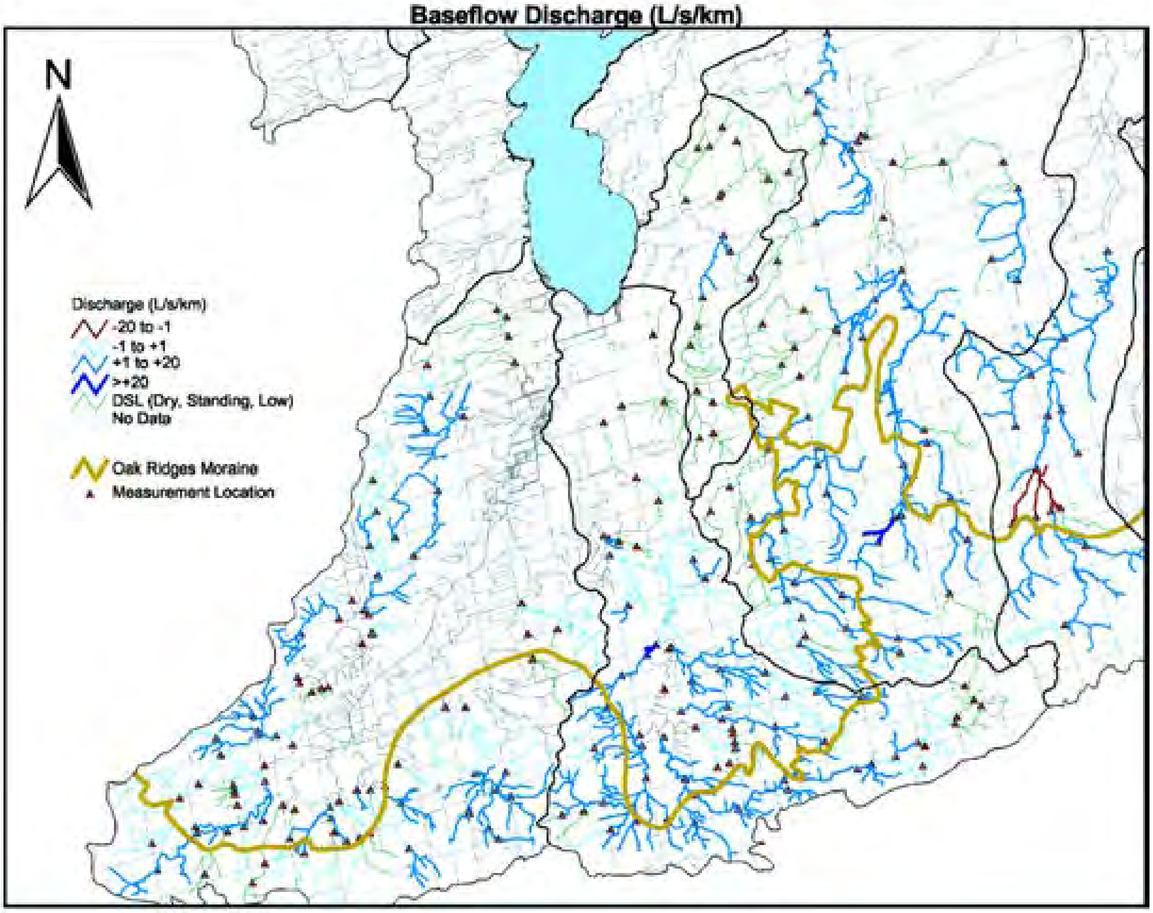

Figure 5-9 Low flow stream survey results for 2004. Figure provided by LSRCA.

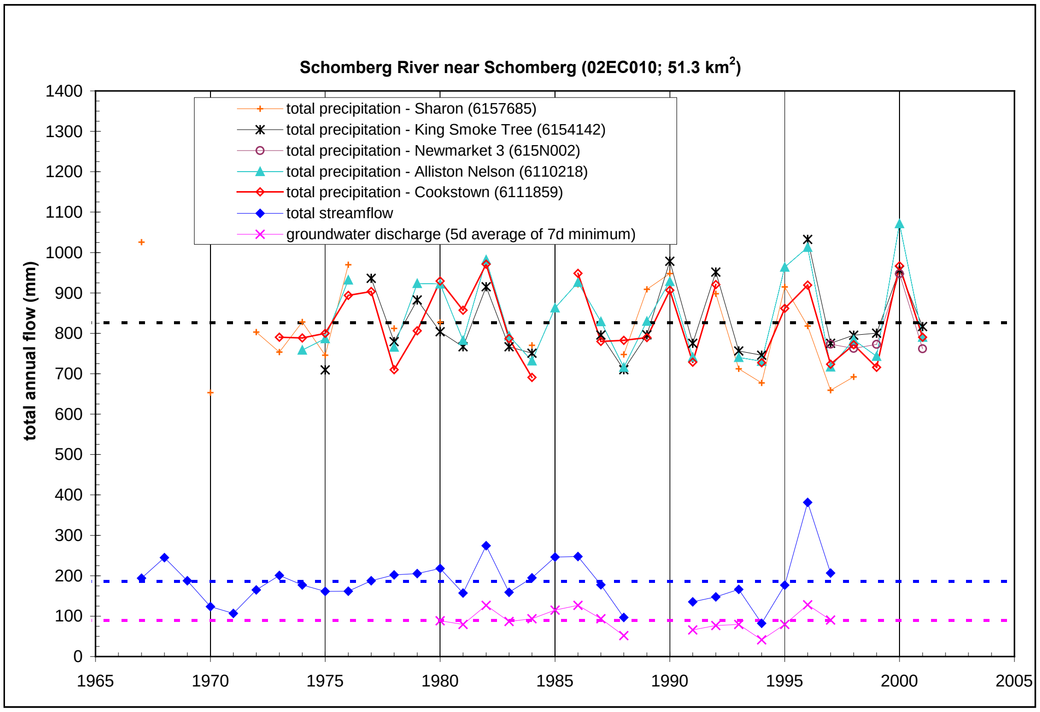

Figure 5-10 Observed stream flow and estimated groundwater discharge at Schomberg River near Schomberg (02EC010). Drainage area is 51.3 km^2. Groundwater discharge estimates from Gerber and Howard (1997) obtained using a computer program now known as HYSEP (Sloto and Crouse, 1996) (figure from Earthfx & Gerber, 2008).

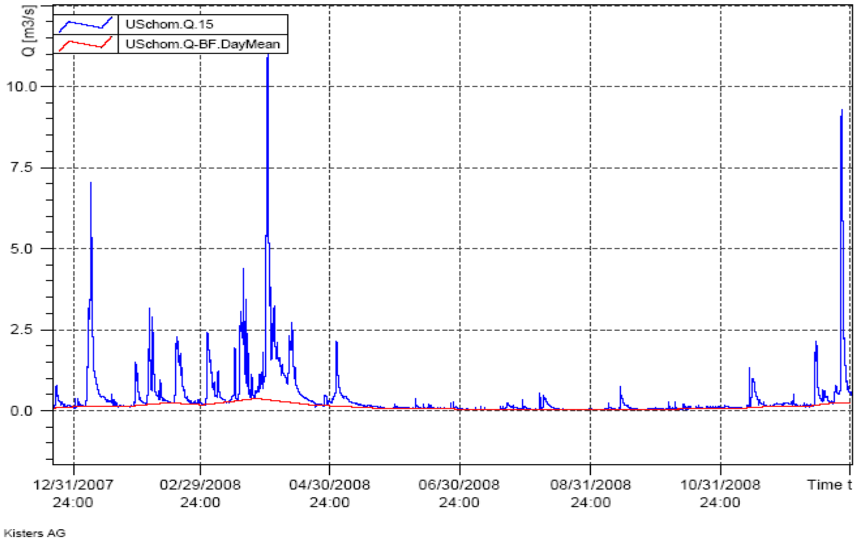

Figure 5-11 Example of stream flow hydrograph separation results for Schomberg River (2008)

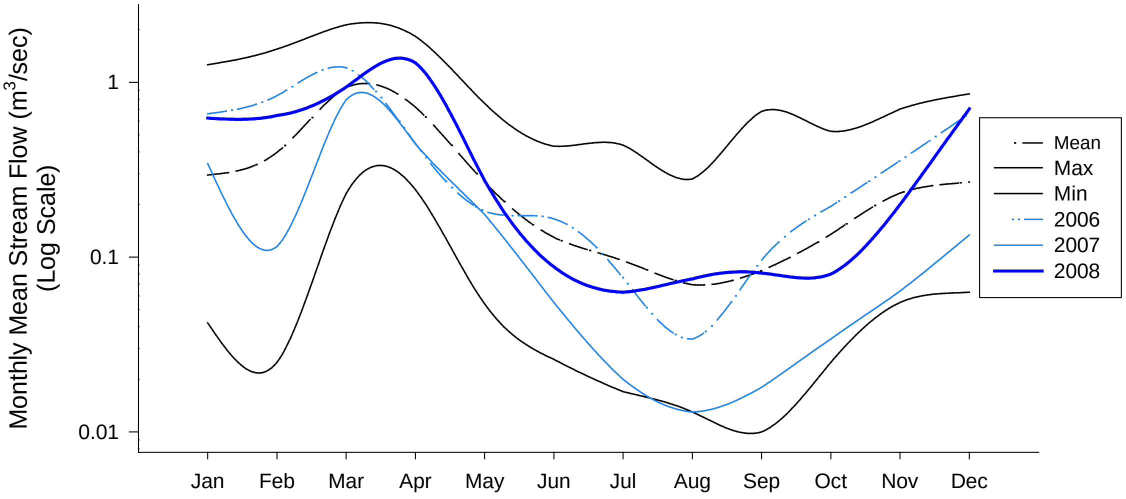

Figure 5-12 Streamflow at Schomberg River (1987-2008)

5.2.6 *Groundwater Discharge Areas*

In areas where the static water table intersects the ground surface there is potential for discharge to occur. Groundwater discharge areas are often in low topographic areas and can be observed in and around watercourses in the form of springs and seeps, or as baseflow to streams. These areas are characterized by upward vertical hydraulic gradients. The portion of water that is contributed from groundwater is referred to as baseflow and provides clean cool water to streams and wetlands.

Groundwater discharge rates vary throughout the year due to seasonal and longer-term changes in recharge and groundwater potentials. Hydrograph separation techniques applied to long term surface water flow records are the best methods for quantifying the portion of streamflow derived from groundwater discharge to streams. However, there are few long-term gauges within the study area and not all significant stream tributaries are monitored.

A discharge map (Figure 5-13) was created using the potentiometric surface produced from shallow wells in the MOE water well database in conjunction with the topographic mapping. Potential discharge zones are where the water levels are within two metres of the surface (topographic mapping).

Groundwater discharge zones are associated with the north flank of the ORM along the break in slope and further downstream in the Holland River Valley. Numerical models have been used to predict the location and rates of groundwater discharge throughout the subwatershed.

5.2.7 *Groundwater Recharge Areas*

Groundwater is replenished as precipitation or snowmelt infiltrates into the ground surface. The rate and direction of groundwater movement is dependent upon several factors, such as soil permeability, surface topography, land use, and vegetation cover. For example, water will move more readily through coarse loose material and bedrock fractures than through material such as clay or unfractured rock.

The mappings of these recharge zones and the policies that protect them are necessary to ensure the sustainability of groundwater supplies and a healthy subwatershed. In the version of the Core Model described in Earthfx (2004), groundwater recharge to the Core Model was initially estimated considering land use, climate and soil properties, and published values from previous modelling studies. These estimates were adjusted during model calibration. The spatial distribution of applied recharge within the study area is provided in Figure 5-14 (Earthfx & Gerber, 2008). This map was based on preliminary efforts to characterize recharge across the subwatershed.

The most significant areas for groundwater recharge within the West Holland subwatershed are located on the Oak Ridges Moraine. As demonstrated on Figure 5-14, the southern end of the subwatershed on the Oak Ridges Moraine, specifically the northern flank, provides the highest recharge rates and is capable of infiltrating approximately 360 millimetres of water per year due to the sandy soils and hummocky topography (Earthfx, 2006).

Significant groundwater recharge can be described as areas that can effectively move water from the surface through the unsaturated soil zone to replenish available groundwater resources. The mapping of these recharge zones is necessary to ensure the sustainability of groundwater supplies. In turn, land development plans should consider the protection of these areas in order to maintain the quantity and quality of groundwater required by a healthy subwatershed.

Methods to determine significant recharge areas have been developed based on geology and topography, and continue to be refined to better understand and protect groundwater.

Groundwater Monitoring

The static water levels measured in monitoring wells characterize the amount of water stored in an aquifer, aquifer complex or saturated portion of the subsurface system. Groundwater levels can fluctuate due to precipitation, barometric pressure, temperature, and water withdrawal.

Monitoring these ambient groundwater levels can help understand baseline conditions and assess how groundwater is affected by climate change, seasonal fluctuation, land and water use. Monitoring helps to identify trends and emerging issues, and provides a basis for making informed resource management decisions. The data can also be used to measure the effectiveness of the programs and policies that are designed to manage and protect groundwater resources.

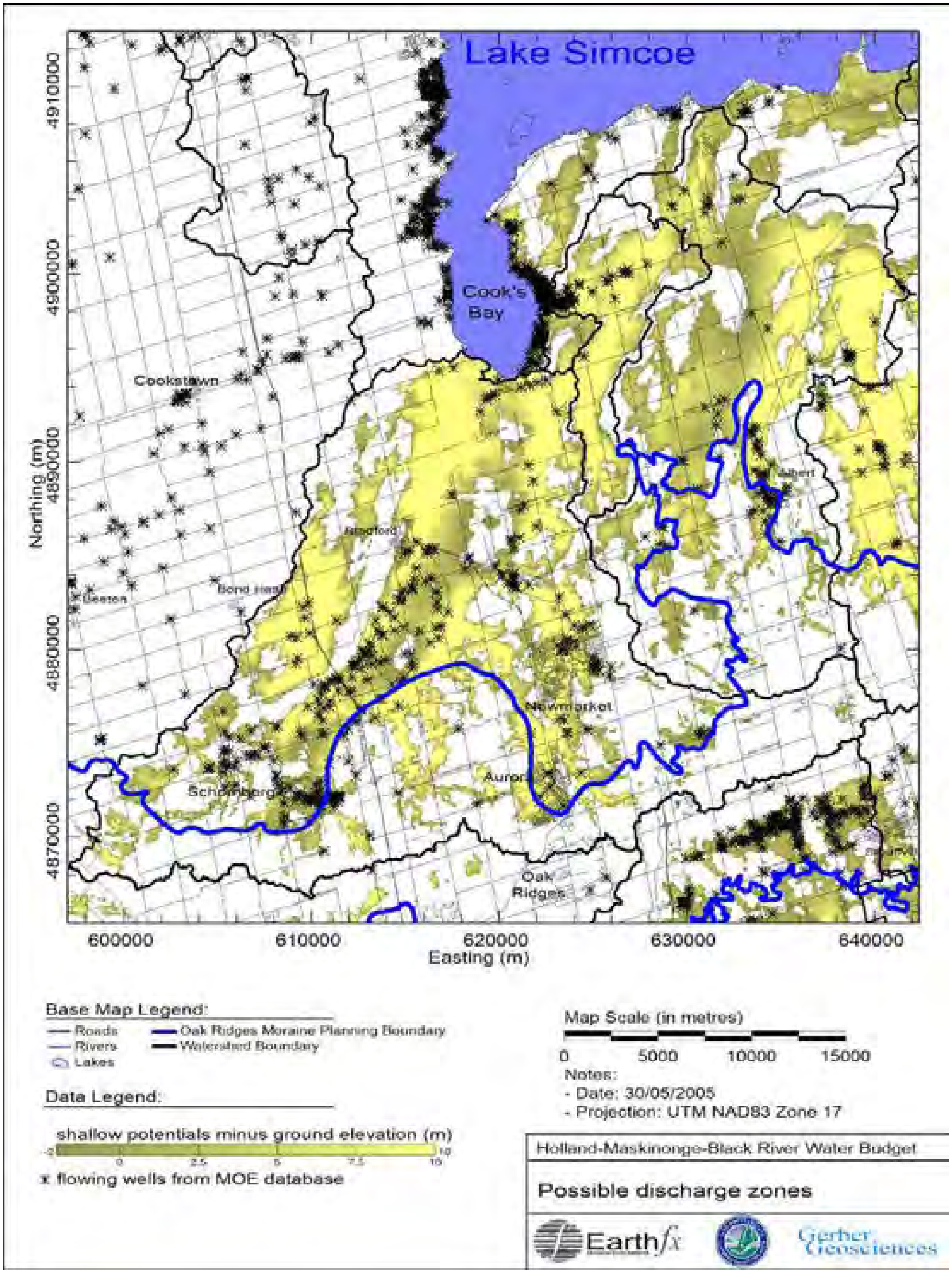

Figure 5-13 Shallow groundwater flow system potentials minus ground surface elevation illustrating possible groundwater discharge zones. Discharge verified by location of flowing wells from MOE database (Earthfx & Gerber, 2008).

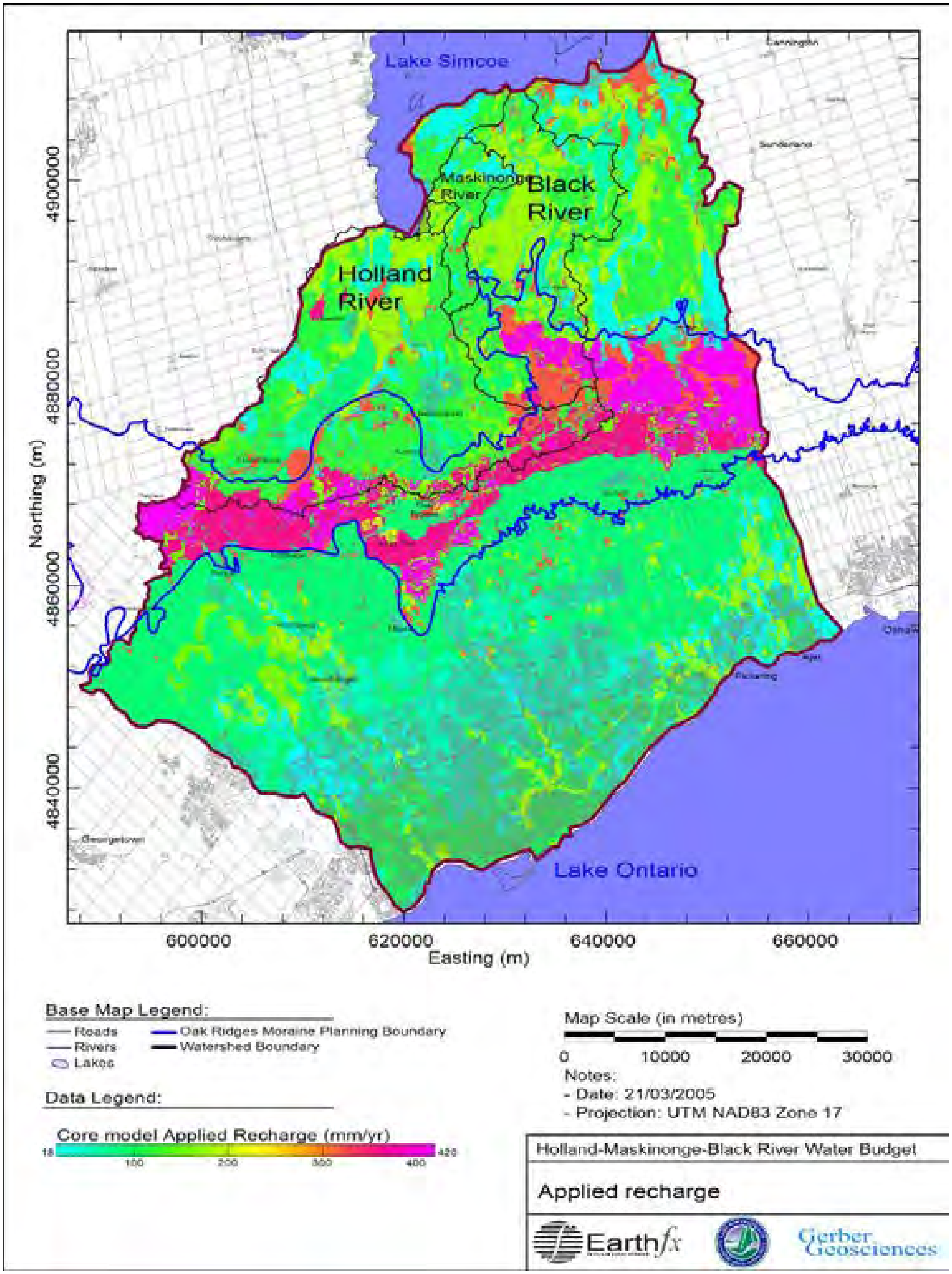

Figure 5-14 Applied recharge in the Core Model (from Earthfx, 2004)

Key points – Current Hydrogeologic Conditions:

- The physical properties within a watershed, such as drainage area, slope, geology and land use can influence the distribution of the water and the processes that function within a watershed.
- Groundwater discharge is the main component to streams during dry periods and as such maintains an environment that allows cold water fish to survive even during the dry summer months.
- The water table map for the West Holland shows that on a regional scale groundwater flow within the major aquifer systems is generally from the topographic highs associated with the ORM towards the topographic lows associated with the major stream channels and Lake Simcoe
- Surface water flows are a function of overland runoff and groundwater discharge (baseflow). As impervious surfaces are increased within an urban area the quantity of runoff increases as does the rate of overland flow (i.e. peak flow). This also causes a decrease in groundwater infiltration or recharge and less groundwater is available to sustain the streams during the dry summer months.
- The canal system associated with the Holland Marsh has virtually eliminated natural flow through this section of the subwatershed. Impacts from the canal can also be seen upstream and downstream, making it difficult to accurately understand flow patterns.
- Groundwater recharge can be described as areas that can effectively move water from the surface through the unsaturated soil zone to replenish available groundwater resources. The mapping of these recharge zones show that the most significant recharge within the subwatershed occurs on the ORM.
- Monitoring groundwater levels can characterize baseline conditions, and assess how groundwater is affected by climate change, seasonal fluctuation, land and water use. Monitoring groundwater levels can help identify trends and emerging issues, and can provide a basis for making informed resource management decisions, measure the effectiveness of the programs and policies that are designed to protect these groundwater resources.

5.3 Water Budget

A water budget characterizes the hydrologic conditions within a subwatershed by quantifying the various elements of the hydrologic cycle, including precipitation, interception, and evapotranspration. Therefore, the water budget can be used to identify areas where a water supply could be under stress, now or in the future, and help protect the ecological and hydrological integrity of an area by establishing water supply sustainability targets and strategies.

The following section provides information regarding the water budget study that was completed for the West Holland subwatershed. York Region enlisted the assistance from LSRCA to complete the water budget studies for the watersheds that originate in the ORM. Earthfx & Gerber (2008) completed the water budget study on behalf of the LSRCA, which included the East and West Holland River, Maskinonge River and the Black River subwatersheds. The water budget addresses the requirements set out in the Oak Ridges Moraine Conservation Plan and those requirements specifically related to the Yonge Street area.

The general water budget may be expressed as an equation with water Inputs = Outputs + Change in Storage; or

$$P + SW_{in} + GW_{in} + ANTH_{in} = ET + SW_{out} + GW_{out} + ANTH_{out} + \Delta S$$

Where:
P = Precipitation
**SWin = **surface water flow into the watershed
GWin = groundwater flow into the watershed
ANTHin = anthropogenic or human inputs such as waste discharges
ET = evapotranspiration
SWout = surface water flow out (includes runoff)
GWout = groundwater flow out
ANTHout = discharge to wells (i.e. drinking water supplies)
∆S = change in storage (surface water, soil moisture)

Source: (OMOE, 2005b)

The project objectives were to provide estimates of each component of the hydrologic cycle from the subwatershed based on various land and water use scenarios. Estimates were completed using a water budget analysis program (VL-WABAS) and a three-dimensional numerical groundwater flow model (MODFLOW).

The five groundwater and land use scenarios analysed within this study include:

- 2002 land use and groundwater use (current conditions);
- estimated 1950 land use and groundwater use conditions;
- estimated 2002 drought conditions;
- estimated 2026 land use and groundwater use conditions; and,
- estimated 2026 drought conditions (with future pumping levels).

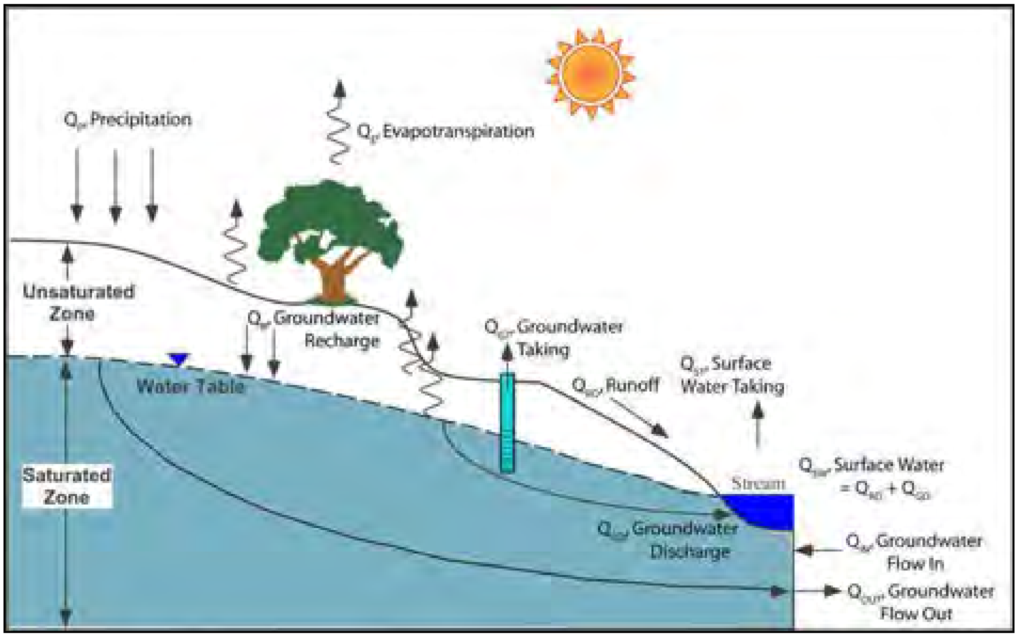

Figure 5-15 Water budget components (Earthfx and Gerber, 2008)

5.3.1 Local Water Budget Initiatives

The water budget methodology presented in this chapter includes an assessment of existing hydrologic conditions within the subwatershed using both conceptual modelling and numerical modelling information developed through the Source Water Protection program and the CAMC-YPDT Groundwater study (discussed in Section 5.1.2)

Water budgets are generally developed using an approach that estimates the amount and location of water conceptually; however they can be refined by using surface and groundwater models. These models are referred to as numerical models that use mathematical equations to approximate existing hydrogeologic conditions. While models can quantify the various components of the hydrologic cycle they can be use to estimate the direction of groundwater or surface water flow within a subwatershed and therefore aid in the identification of potentially stressed areas. Numerical model outputs are intended to provide estimates of possible conditions that may exist within the subwatershed; these estimates or predictions may point to possible areas of concern and may also be considered when providing solutions to identified problems.

The numerical model used to assess the West Holland subwatershed was developed through the CAMC-YPDT study group. A major part of this investigation included the construction of two three-dimensional numerical groundwater flow models (Figure 5-16) (Earthfx, 2006). The initial five-layer Regional Model covers the entire ORM, while the more recent model has been expanded to an eight-layer Core Model that covers much of the western portion of the ORM.

Both the Regional and Core Models include portions of the Lake Simcoe Region Conservation Authority (LSRCA) subwatersheds situated within York Region (Figure 5-17). The Core Model was the tool used in the study completed by Earthfx and Gerber (2008) to quantify the water budget components within the West Holland subwatershed. The Core Model was created using the United States Geological Survey (USGS) MODFLOW code to solve the equations for groundwater flow (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996). The model was created using geologic data supplied by the Ontario Geologic Survey, and the Geologic Survey of Canada. The MODFLOW groundwater Core Model is unable to predict the surface water components necessary to complete a detailed water budget analysis, so a WABAS surface water model was used.

The WABAS model was used to quantify the surface water components necessary to complete the water budget. A VL-WABAS model was used to estimate the following parameters (Earthfx & Gerber, 2008).

- actual evapotranspiration (ET);
- snowmelt;
- surface runoff (RO);
- infiltration (GWI); and
- storage within each water reservoir (pervious and impervious interception storage, surficial soil storage, and snowpack storage).

Further information about the model and its limitations can be obtained from Earthfx & Gerber, (2008) and Earthfx (2006).

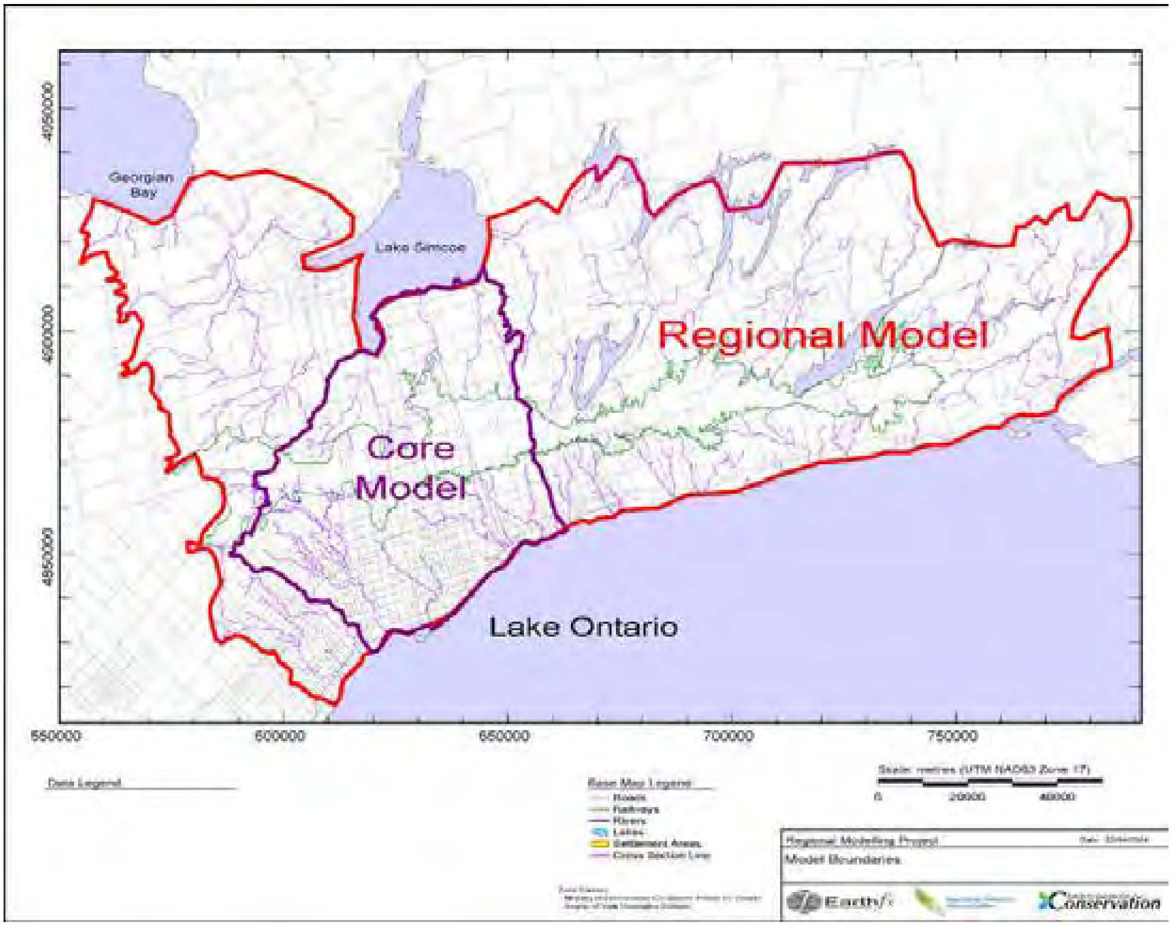

Figure 5-16 Regional ORM Model and Core Model boundaries (figure from Earthfx, 2006).

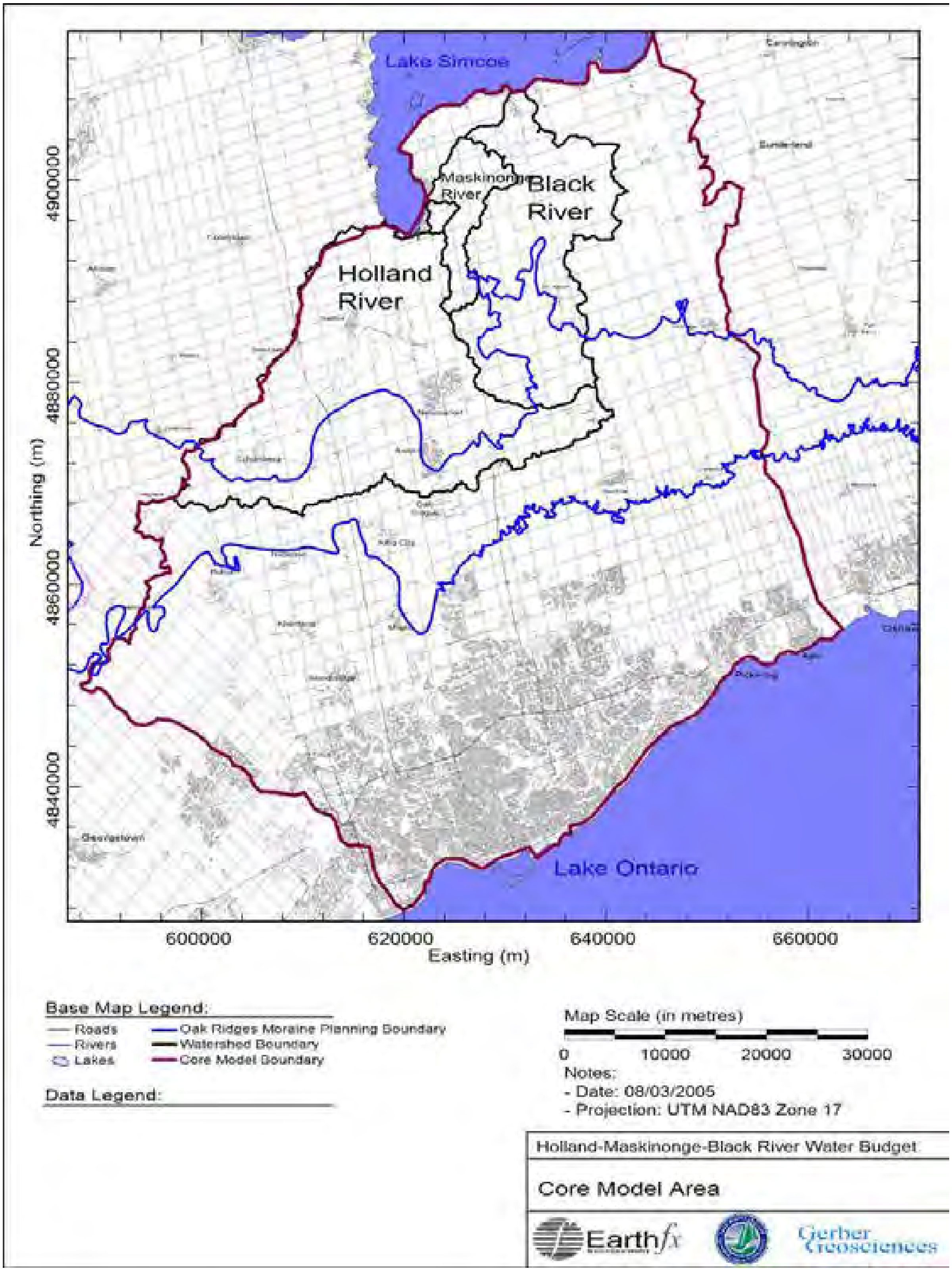

Figure 5-17 The West Holland subwatershed location within the Core Model area (Figure from Earthfx and Gerber, 2008)

5.3.2 Precipitation and Evapotranspiration

Precipitation in the form of rain or snow is the source of all water within a subwatershed. Typically, precipitation will vary seasonally and from year to year due to climatic factors. Precipitation is often measured at one or more meteorological stations within a subwatershed using precipitation gauges.

There are nine active Environment Canada climate stations situated near or within the West Holland subwatershed. However, only six of these stations have a period of record greater than 20 years. The total annual precipitation for these six stations ranges from 785 to 837 mm/year. Two stations situated near the West Holland subwatershed, Sharon and King Smoke Tree, have average total precipitation of 814 and 826 mm/year, respectively. Data from inactive stations within or near the subwatershed were used to supplement the active station data in the detailed water budget analyses (Earthfx & Gerber, 2008).

The average annual precipitation and evapotranspiration is shown in Figure 5-18, and Figure 5-19 respectively. Table 5-3 show water budget estimates for different scenarios calculated under steady state conditions (Earthfx & Gerber, 2008). The table also shows the annual precipitation and evapotranspiration for the West Holland subwatershed.

A comparison of the current 2002 average conditions to the estimated 2002 drought conditions reveals a 6.5% decrease in total precipitation, a 9.3% decrease in evapotranspiration (AET), an increase in runoff of 10.1% and a decrease in recharge of approximately 7.3%. The reduction in recharge and increase in pumping again leads to a reduction in groundwater discharge to streams (Earthfx & Gerber, 2008).

Table 5-3 Water budget estimates for different scenarios. (Note: All estimates were calculated under steady state conditions Earthfx & Gerber, 2008)

Condition	Precipitation	ET	RO	GWI
Current	794	536	99	164
1950	794	540	93	166
2002 Drought	742	486	109	152
2026 Predicted “current”	794	530	105	163
2026 Predicated “drought”	742	482	114	151
All units in mm/annum ET= Evapotranspiration RO= Runoff GWI= Groundwater Infiltration				

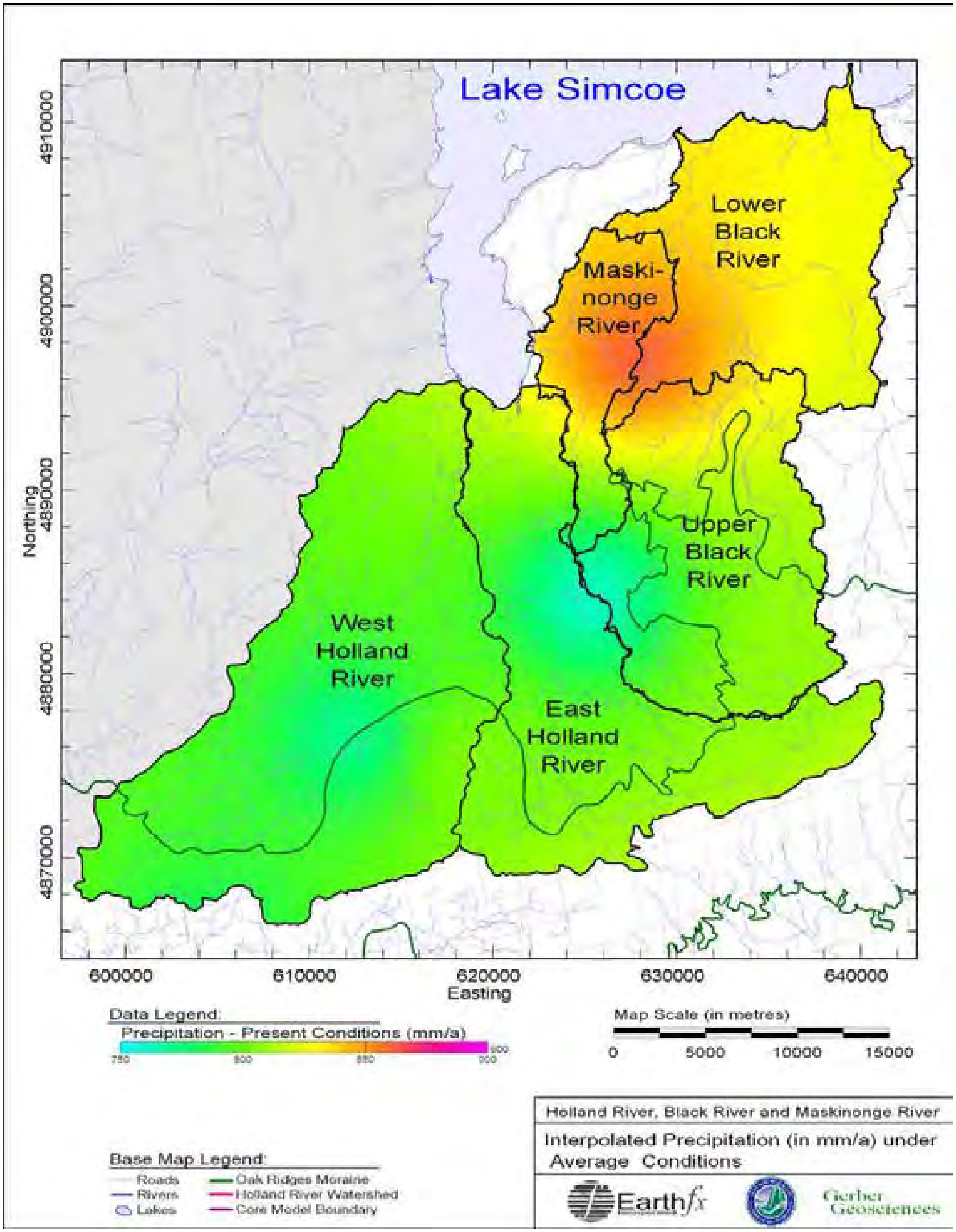

Figure 5-18 Average annual precipitation over a 20- year period (1980-1999) in mm/a (Earthfx & Gerber, 2008)

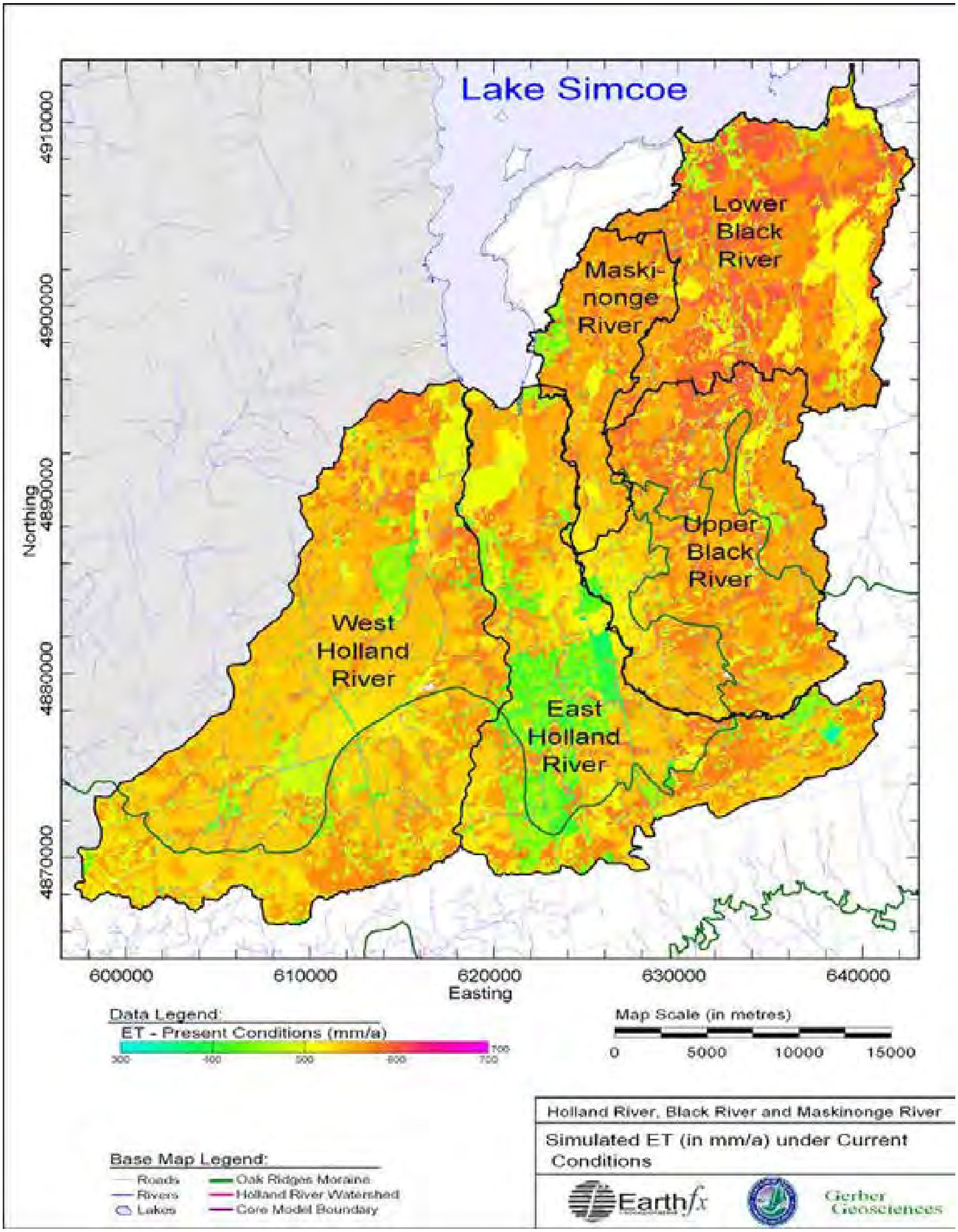

Figure 5-19 Simulated (VL-WABAS) annual average evapotranspiration in mm/a with 2002 land use (Earthfx & Gerber, 2008).

5.3.3 Infiltration

Groundwater infiltration (GWI) is influenced by the distribution and thickness of surficial deposits and associated soil properties, topography, land cover and use. In areas where there is imperviousness, such as within urban areas, the amount of infiltration is reduced, while infiltration rates are increased in areas of sands and sandy loams, particularly within the ORM.

The groundwater recharge input file for the Core Model was modified by replacing the original recharge estimates with the GWI rates (Table 5-3) calculated by VL-WABAS within the study area. The groundwater model was then run with the modified recharge file to simulate groundwater flow under 2002 land use conditions (Earthfx & Gerber, 2008).

The groundwater flow model is a steady-state model and uses estimates of annual average net recharge (GWI) as input to the model (Figure 5-21).The recharge is initially applied to model Layer 1 which represents the weathered Halton/Kettleby Till and surficial sands. If this layer is missing in a particular area, or if the model cells go dry in that layer during the simulation (i.e. the simulated water-table drops below the base of the layer), the recharge is passed on to the next layer down. This allocation of recharge to the different layers is shown in Figure 5-20 and was determined from the final distribution of recharge in the Core Model/VL-WABAS results (Earthfx & Gerber, 2008).

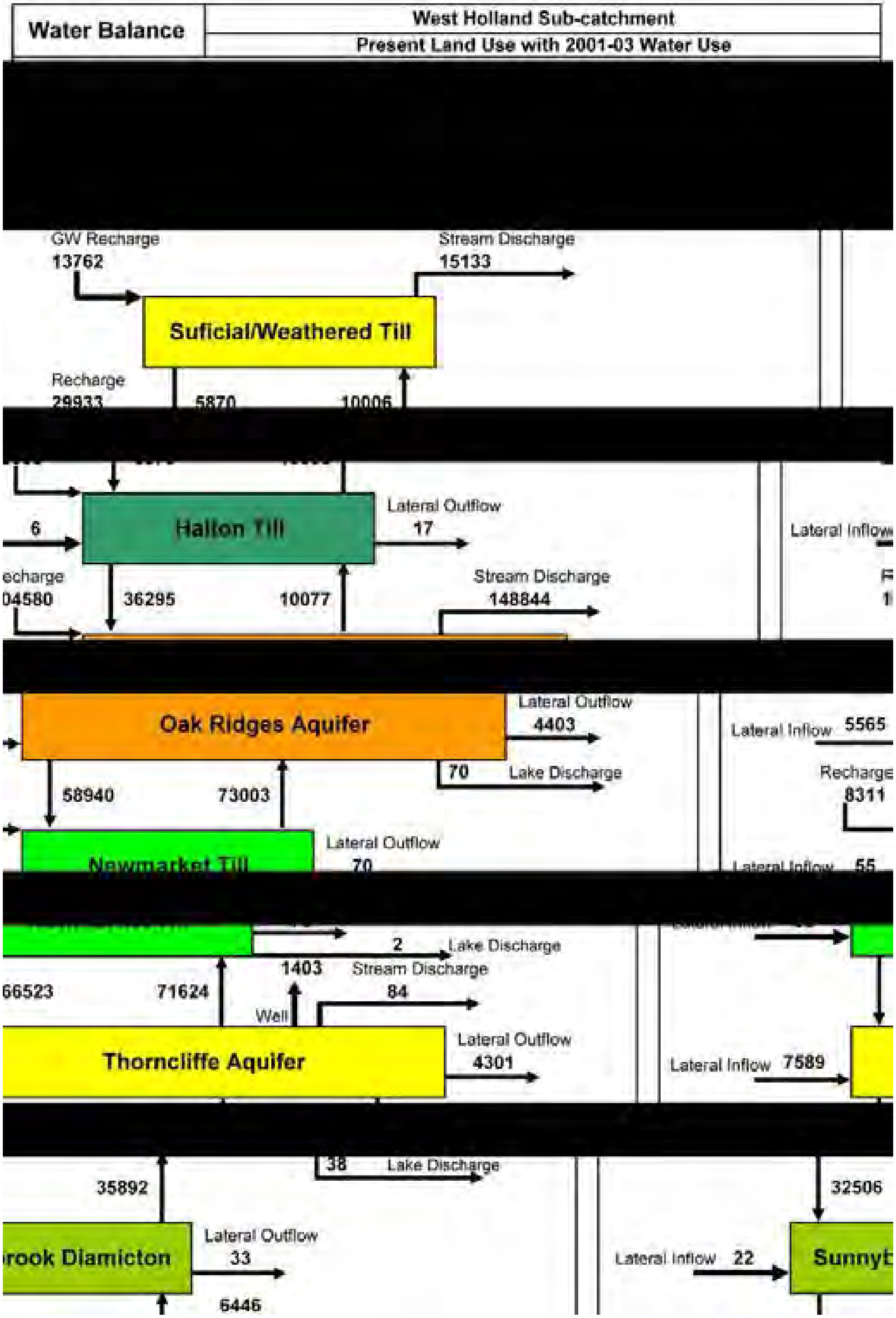

Figure 5-20 Detailed water budget for the West Holland River subwatershed-2002 conditions. (Earthfx & Gerber, 2008)

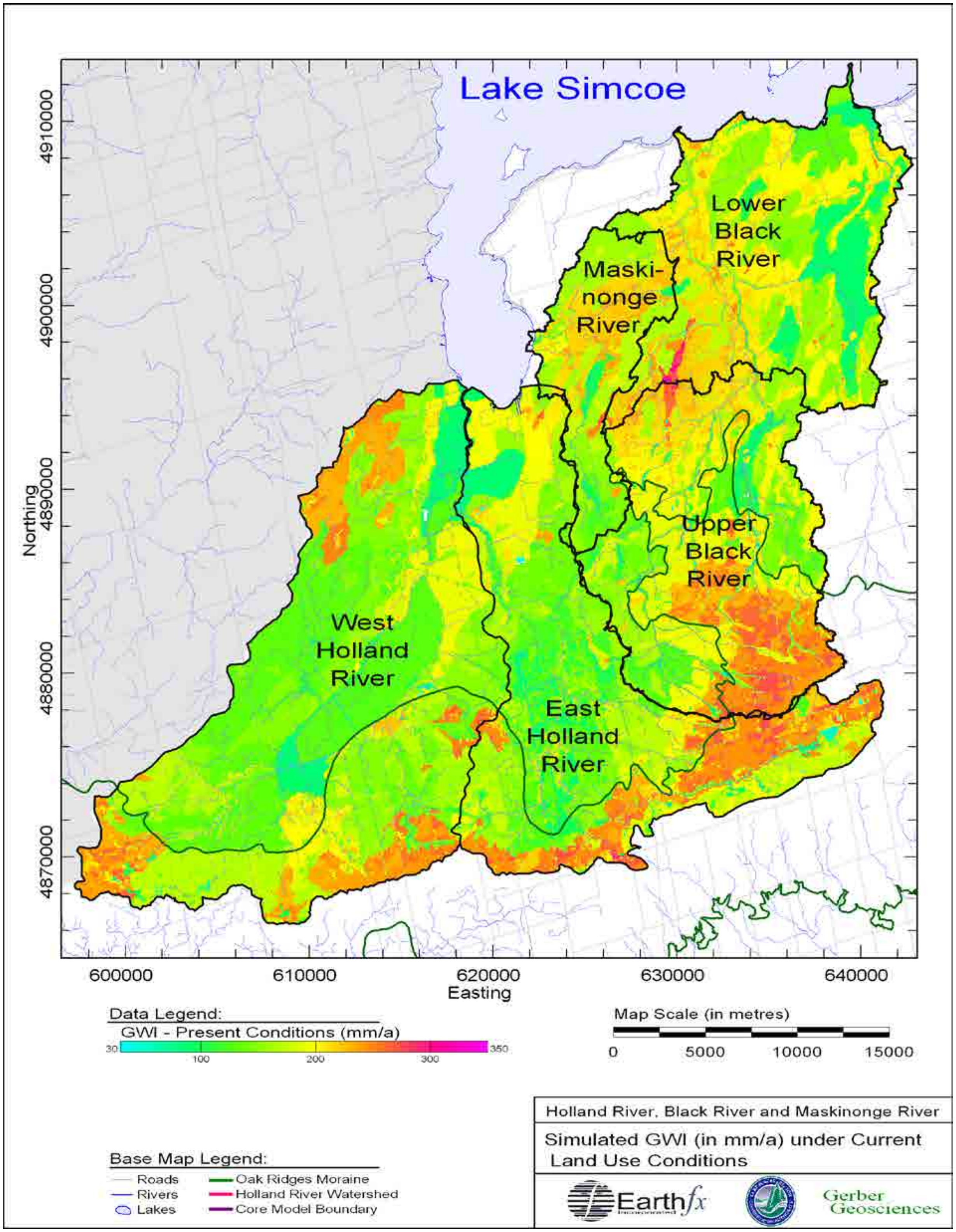

Figure 5-21 Simulated (VL-WABAS) annual average groundwater infiltration (GWI) in mm/annum with 2002 land use (Earthfx & Gerber, 2008)

5.3.4 *Discharge*

Simulated discharge to streams (Figure 5-22) was generated from the groundwater model in cubic metres per second (m^3/s). Discharge to streams includes discharge to drains (smaller creeks) and discharge to rivers (larger tributaries) where the creek may be either gaining groundwater discharge or losing streamflow to the groundwater system depending on the depth to groundwater. Groundwater discharge to drain segments (which were used to represent the smaller, but more numerous, tributaries) was about 42% of the total discharge. The remaining 58% was to river segments which represented the larger tributaries and main stream reaches. Recharge from the river to the aquifer was neglible at less than 2% of the total stream/aquifer water exchange[2]. A qualitative comparison of model results to LSRCA baseflow estimates indicates that there is a good correlation between model-predicted discharge locations and field measured discharge, particularly in the upper reaches of the watersheds. In particular, the model matches the very high discharge along the northern flank of the ORM within the West Holland subwatershed, which make up the headwaters to the West Holland River.

Figure 5-13 shows the potential discharge zones within the West Holland subwatershed overlain with flowing wells. These zones are areas where the water table is at or near the ground surface.

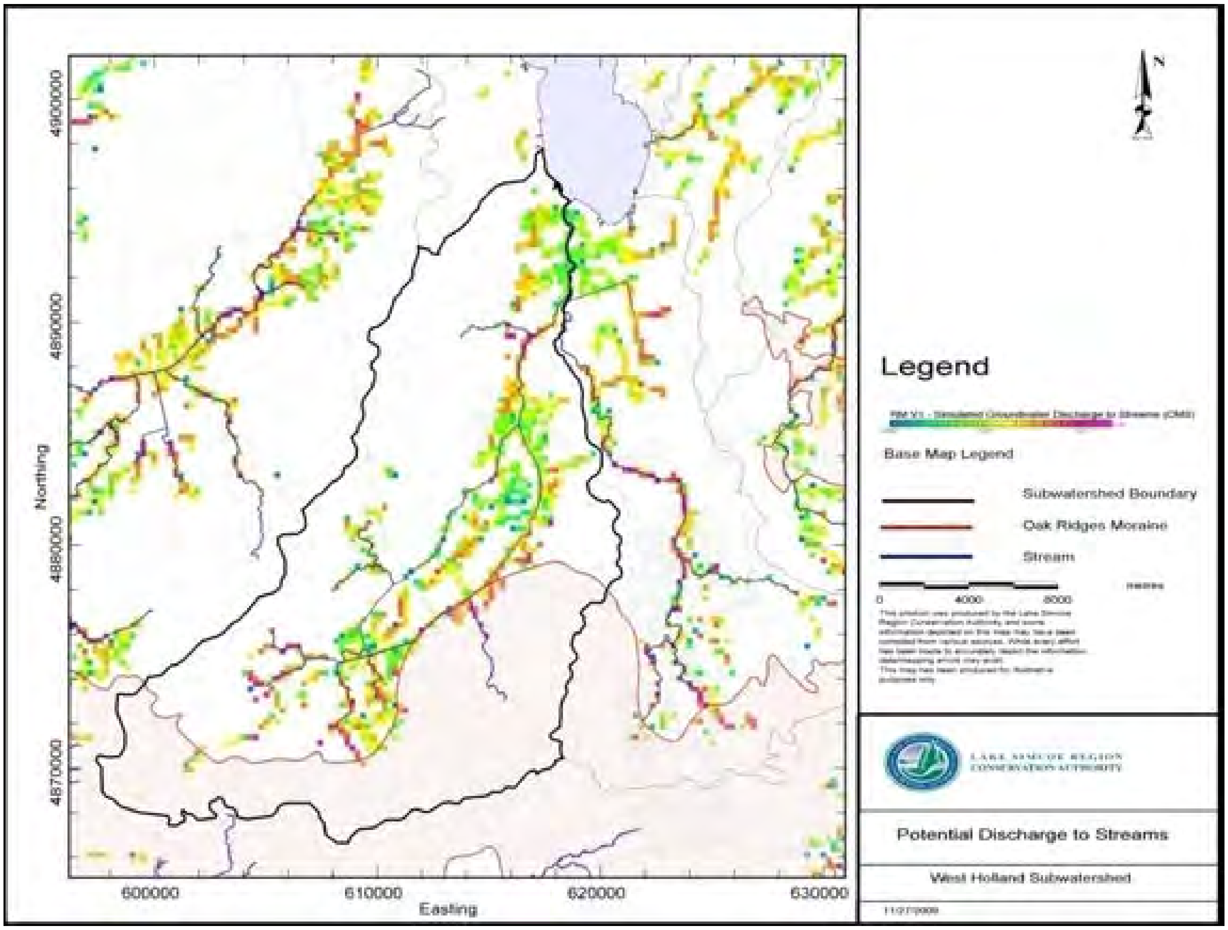

Figure 5-22 Potential discharge to streams within the West Holland subwatershed (LSRCA, 2009)

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[2] Model simulated conditions over the entire East and West Holland River, Maskinonge River and Black River study area.

5.3.5 *Water Takings- Groundwater and Surface Water Consumption*

Municipal water supply services are typically not available within rural areas and therefore residents and businesses rely solely on private water wells or surface water to meet their water needs. Any person/business taking more than 50,000 litres of water per day (L/day) are required by law to obtain a permit to take water (PTTW) from the Ministry of the Environment (MOE).

Municipal and other water supplies are obtained from both surface water (lakes and rivers) and groundwater. Section 34 of the Ontario Water Resources Act (OWRA) requires that any person or business taking more than 50,000 litres of surface or groundwater per day (L/day) are required by law to obtain a Permit To Take Water (PTTW) from the Ministry of the Environment (MOE). Permits are not required to take water for domestic purposes, livestock watering, or firefighting. Significant efforts have been made to quantify the amount of water takings within the subwatershed and York Region through studies such as Marshall Macklin Monaghan and Golder Associates (2003), LSRCA Tier 1 Water Budget (2009), and Earthfx & Gerber (2008).

Along with municipal supply groundwater is extracted from aquifers and surface water within the study area for a number of uses including agricultural use, industrial/commercial use, golf course irrigation, and private domestic supply. The groundwater model simulated only the large water users such as municipal, golf courses, industrial and agricultural irrigation. Domestic wells and other small users were not represented (Earthfx & Gerber, 2008.)

Municipal Water Supply

There are 12 municipal water supply wells that service the communities within the study area. Data on average daily water takings from most of the municipal wells within the subwatershed were obtained and used to estimate actual annual average pumping rates. Actual pumping rates are often less than the permitted rates. The numerical groundwater flow model, discussed previously, incorporated average pumping rates where the data were available (Earthfx & Gerber, 2008).

Permit to Take Water (PTTW)

There are a number of large groundwater and surface water takings within the subwatershed that require a Permit to Take Water for uses such as industrial and golf course irrigation. Some of the water pumped for these uses is lost to evapotranspiration while some may infiltrate back to the subsurface as irrigation return flow (actual consumption, i.e. water removed from the watershed, will differ by the specific application). The rates used in the model for simulating consumptive use from these wells were obtained from Marshall Macklin Monaghan and Golder Associates (2003) (Earthfx & Gerber, 2008).

Key points – Current Water Quantity Status

- Water budget drought scenarios indicated an increase in RO (runoff) and a decrease in GWI (recharge) when compared to the current conditions.
- Within the model severe drought conditions affected simulated groundwater potentials and groundwater discharge to streams over a broad area but mostly along the crest of the Oak Ridges Moraine.
- The estimated future land use changes (modelled scenario) indicated a decrease in evaporation, an increase in runoff and a negligible change in recharge. Therefore having a minor impact on the regional groundwater balance.
- The Town of Schomberg has seen growth over the last decade. A comparison of the seasonal flow volumes from (1966-1975) to (2002-2007) was done to see if impervious surfaces were having an effect on the stream hydrology. A very slight increase of <1% in the summer and 2.7% in the fall was found. While it is difficult to see the increase as significant, it will be worth monitoring over the coming years.

5.4 Factors Impacting Status- Stressors

Land use change, increased water use, short-term summer droughts and long-term climate change can all result in stress on the quantity of water within a watershed. Potential impacts of these stressors include reduced groundwater recharge or discharge, increased surface water runoff, well interferences and changes to groundwater flow patterns and groundwater-surface water interaction.

The purpose of completing a water budget and water quantity risk assessment is to determine if the watershed can support current or future water takings without exhibiting a continued long-term decline in groundwater levels or surface water flow. The most basic definition of stress is whether a watershed can support the current levels of pumping without exhibiting a continued long term decline in water levels.

5.4.1 Water Demand

Potential water quantity stress is being estimated on a subwatershed scale through the Source Protection Planning process. Several water budget initiatives have been undertaken to identify potential water quantity stress within the subwatershed. The indicators of stress presented in this report are based on these studies and more information can be obtained from the following reports; SGBLS (2009), Earthfx (2009), and Earthfx and Gerber (2008).

The water demand component of the water budget refers to water taken as a result of an anthropogenic activity (e.g., municipal drinking water takings, private water well takings, as well as other permitted takers). Water demand can be estimated from a number of information sources, including the Permit To Take Water applications, municipal pumping records, water well records, population estimates, and agricultural censuses.

The percentage of quantity demand can be expressed as in the following equation:

$$\%WaterDemand = \frac{Q_{DEMAND}}{Q_{SUPPLY} - Q_{RESERVE}}$$

where:

Q_{Demand} = amount of water consumed (pumped);

Q_{Supply} = recharge plus lateral groundwater inflow into the subwatershed (Qr + Qin); and

$Q_{Reserve}$ = the portion of available surface water or groundwater reserved for other needs such as navigation, assimilative capacity, and ecosystem health. This is estimated as 10% of the model predicted baseflow discharge to the streams in the subwatershed

Considerable effort was made in the Tier 1 (SGBLS, 2009) and Tier 2 (Earthfx, 2009) water budgets indicated above to document the various sources of water demand. Marshall Macklin Monaghan and Golder Associates (2003) analyzed the PTTW data to estimate water use in York Region. .

Table 5-4 summarizes the groundwater takings in the West Holland subwatershed. Surface and groundwater takings within the West Holland subwatershed include the following uses:

- Municipal supply;
- Agricultural use;
- Private domestic supply; and
- Other permitted takings (e.g. industrial use, golf course irrigation).

Table 5-4 Estimates of annual current & future consumptive groundwater use (Earthfx, 2009)

Scenario	**Municipal (m^3/a)**	**Domestic (m^3/a)**	**Permits (m^3/a)**	**Agriculture (m^3/a)**	**Total (m^3/a)**	**Total (m^3/s)**
Current Consumptive Use	3,043,000	163,000	139,000	728,000	4073000	0.129
Future Consumptive Use	3,387,000	229,000	139,000	728,000	4483000	0.142

Municipal Water Supplies

There are 12 municipal water supply wells that service the communities of Bradford, Bondhead, Asnorveldt and Schomberg within the West Holland subwatershed. The municipal water takings account for approximately three-quarters of the estimated total groundwater withdrawal in the East and West Holland River, Maskinonge River and Black River study area. Municipal well locations are shown on (Figure 5-23). Some of the wells listed are used primarily as backup wells. For example, York Region often installs two wells in close proximity such that if one is off-line for repairs, the other well can be used. The data presented in this report were analyzed to estimate actual annual average pumping rates which are often less than the permitted rates. The numerical groundwater flow model, discussed in Section 5.3, incorporated average pumping rates where the data were available.

Agricultural

Agricultural practices also place a huge demand on the water supply for livestock watering and irrigation. The water used for irrigation is often supplied by surface water where available. To obtain a surface water supply many farms construct on-line ponds. On-line ponds are built in an existing watercourse and allow water to flow in and out. The volume of water in the pond is controlled by a berm or other form of control structure. On-line ponds restrict the natural streamflow as a large volume of water becomes contained in the pond. When surface water is unavailable large volumes of water are pumped from the ground. Some of the water used for irrigation infiltrates back into the groundwater system.

Other Permitted Uses

The rolling hills of the Oak Ridges Moraine have made the southern end of the subwatershed an ideal setting for golf courses. Irrigation water for these golf courses is predominantly supplied by surface water from the West Holland River. As with the agricultural irrigation some of the water applied over the golf course will infiltrate back into the groundwater system, and some will be lost to the atmosphere through evapotranspiration.

Some of the water pumped for industrial, agriculture and golf course irrigation is lost to the atmosphere via evapotranspiration. While some may infiltrate back to the subsurface as irrigation return flow (actual consumption, i.e. water removed from the watershed will differ by the specific application). Water consumption rates from these wells are shown in Table 5-4 and were obtained from Marshall Macklin Monaghan and Golder Associates (2003).

An extensive marsh network occupies a broad valley emanating from Cook’s Bay and trends southwest towards Schomberg. Since 1925, large tracts of the marsh area have been dyked and drained for agricultural purposes (Ontario Department of Energy and Resources Management, 1966). These areas are known as polders (Figure 5-24).

The West Holland or Schomberg River divides at Highway 9 into two canals that channel flow around the Holland Marsh polder. These canals also collect drainage from streams emanating from the surrounding upland areas. The area within the polder is drained by a series of canals and ditches to the perimeter canal. Water levels within the polder area have historically been controlled by two pumping stations that pump water from the external canal back to the Holland River downstream from Bradford. The Springdale pumping station was situated on the north canal west of Highway 400, and the Bradford pumping station was situated at the north end of the Holland Marsh south of Highway 11 in Bradford. During drought conditions, water can be pumped from the external drainage canal back into the polder. Presently, only the north pumping station is in operation and is now known as the Art Janse Pumping Station. The two drainage canals join near Bradford at Highway 11 where the Holland River flows north to Cook’s Bay. A number of smaller polders also occur along this part of the stream reach which is subject to backwater flow and flooding conditions from Lake Simcoe (Frank *et al*., 1985).

The amount of actual water use within the Holland Marsh area is unknown. For the 1977 irrigation season, approximately 45,500 m^3/d was authorized for withdrawal for market gardening by over 80 irrigators (Vallery *et al*., 1982). Much of this water is believed to be extracted from surface water sources, mainly the Holland River and the two marsh drainage canals. The LSRCA initiated a long-term program in 2004 to track water uses within the watershed. This program consists of verification of the information contained within the PTTW database, augmented with survey information. For comparison purposes, pumping from the canal to the Holland River at the Bradford pump house at the north end of the marsh at Highway 11 (station #03-0077-303-02) for flood control averages 5.5 million m^3/d for the seven-year period from 1991 to 1997.

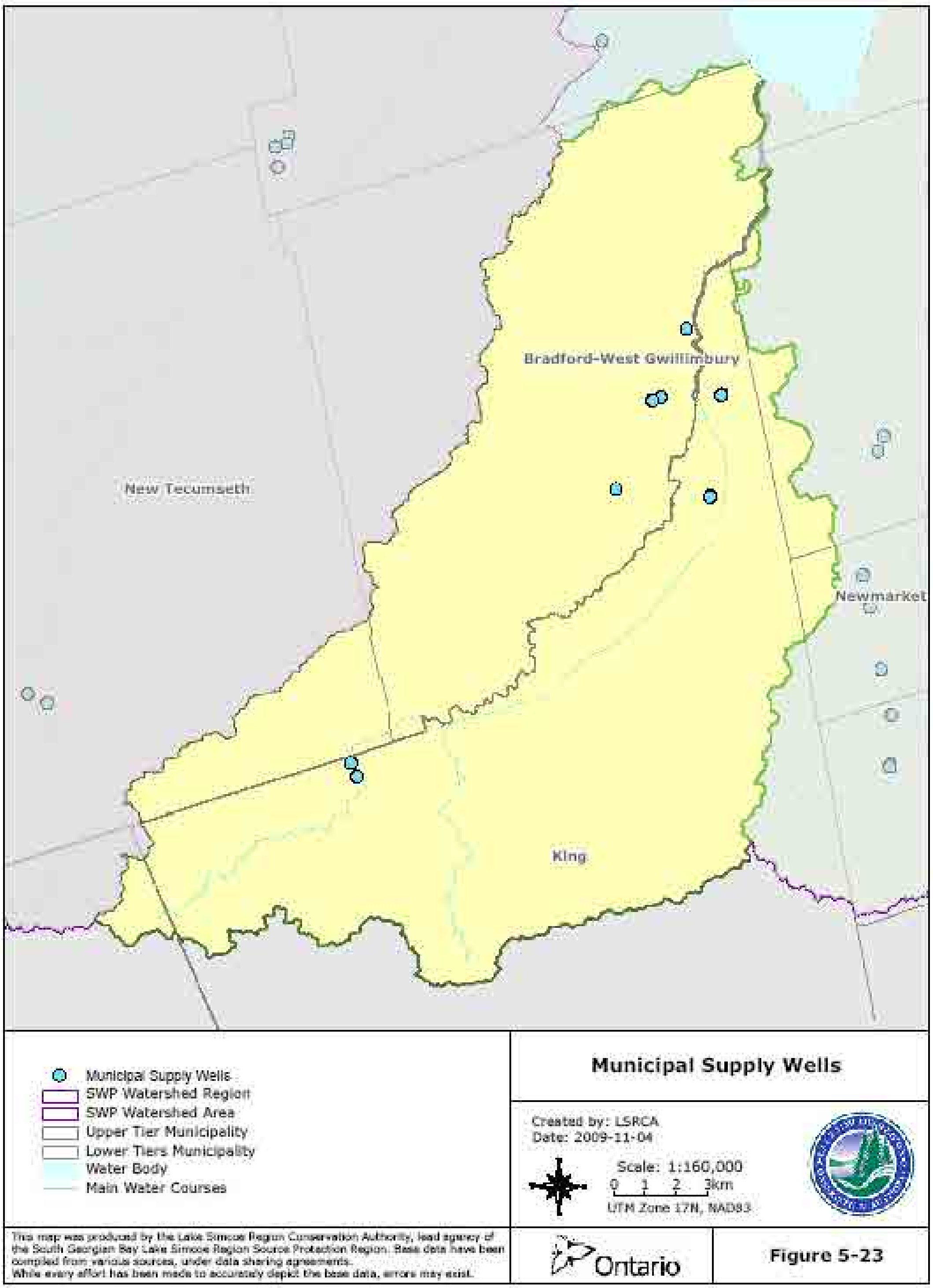

Figure 5-23 Municipal well locations in the West Holland subwatershed (LSRCA, 2009)

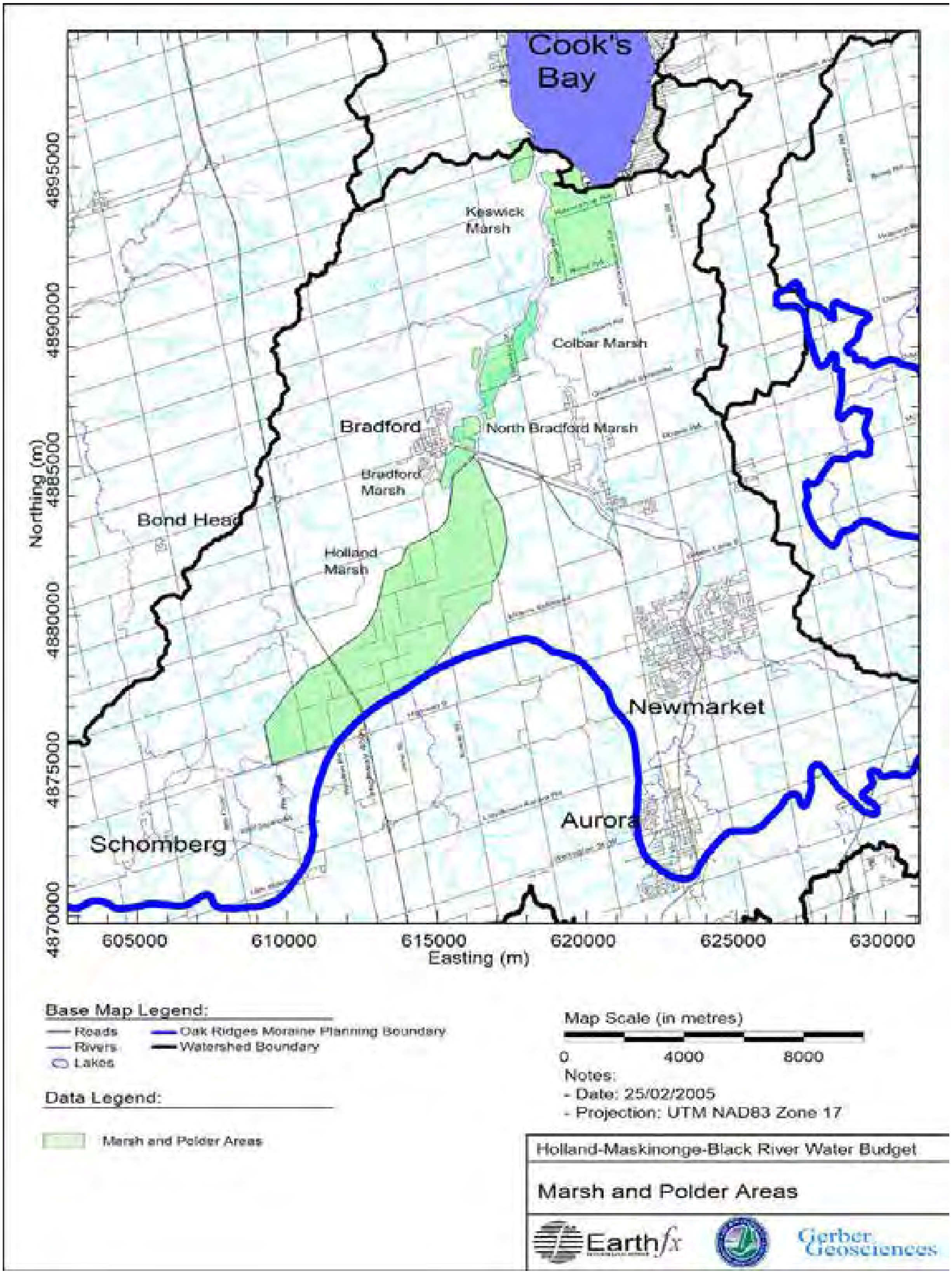

Figure 5-24 **Marsh and polder areas (Earthfx & Gerber, 2008)**

5.4.2 Land Use

It is important to consider land cover within a water budget study because it affects several aspects of the water budget including surface water runoff, evaporation, and infiltration. Developed land will often have a higher proportion of impervious surfaces, such as roadways, parking lots, and building roofs. Increased runoff rates are a result of impervious surfaces and result in erosion and reduced infiltration to recharge groundwater reserves. The potential for the introduction of contaminants to both groundwater and surface water must be a consideration when a new land use is being proposed. Each type of land use can affect the quantity of both ground and surface water in the subwatershed.

Impervious Land Cover

Impervious areas were estimated based on the land use data for the Lake Simcoe basin as well as for the West Holland River subwatershed. Table 5-6 below illustrates the percentage of impervious land cover within the basin (the surface of the lake was not included for the purpose of this analysis) and within the West Holland subwatershed. It should be noted that although the most accurate available land use information was used, these numbers will continue to change as development occurs.

Table 5-5 Comparison of impervious land cover within the Lake Simcoe watershed and the West Holland River subwatershed

	Area (km^2)	Impervious (km^2)	Impervious (%)
Lake Simcoe watershed	2,601*	238	9.2
West Holland River	352	27	7.7

* Area does not include the surface of Lake Simcoe

The following sections describe urban and agricultural land uses within West Holland subwatershed. Details concerning the location and extent of impervious and pervious land cover in the subwatershed and how specific land cover effects surface water runoff is also provided.

Urban Development

Urban development is not widespread throughout the subwatershed. The Town of Bradford represents the largest urban development. Even though urban development is not wide spread the impervious surfaces associated with an urban landscape can be found throughout the subwatershed. Impervious surfaces consist of roads, parking lots, sidewalks, rooftops, and hardened channels. Impervious surfaces affect the quantity of both ground and surface water in the watershed. When a precipitation event occurs impervious surfaces do not allow water to penetrate the ground, this causes the water to remain at the surface. The elimination of water penetrating the soils in these urban areas has a ripple effect on the distribution of water within the subwatershed. Groundwater recharge has been significantly reduced in the urban centres. The absence of groundwater recharge in these urban areas can have an impact on the baseflow of the West Holland River and its tributaries. Baseflow in the river can be particularly important in drought years.

Impervious surfaces also decrease the time to peak surface flow following a precipitation/snow melt event. Since the water is unable to infiltrate the ground it must remain at the surface, increasing the overall quantity of water at the surface. The water from the precipitation travels to the streams and river quickly through overland run off and through a series of storm water drains. The rapid increase in surface water can lead to localized flooding if the system becomes overburdened. As the water moves downstream, the wetlands in the lower reaches of the subwatershed will exhibit flooding.

Urban centres have placed demand on the available water within the subwatershed for domestic purposes. The water supply for these centres mainly comes from a series of municipal wells and waste water is sent to sewage treatment plants. After treatment the water is released back into the surface water system.

While the subwatershed imperviousness, at 7.7%, is still relatively low, imperviousness within the built boundaries of Bradford, the subwatershed's major urban area, is a very high 61.5%. At this level, the urban areas are almost certainly having impacts on aquatic biota, as well as on the hydrologic regime in the area.

Agricultural Areas

Like urban development, agriculture can influence the quantity of both surface and groundwater within a subwatershed. Agricultural land use leaves the ground in a more natural state than urban areas, allowing for groundwater infiltration to occur. Because groundwater infiltration is occurring in rural areas the ground can become supersaturated following a prolonged precipitation event leading to the ponding of water at the surface. In the pre and post growing season the land is left open allowing for increased erosion and runoff following a precipitation event. During the growing season a large volume of water will be lost to the atmosphere through evapotranspiration. The water lost through evapotranspiration is removed from the ground as the plants draw the water up through the root system. As mentioned in section 5.4.1 agricultural practices including livestock watering and irrigation also place a huge demand on the water supply.

5.4.3 Climate

The climate of the West Holland River subwatershed directly determines the quantity of surface and groundwater present in the system. When the spring melt occurs, a large volume of water is released. This water will first infiltrate the ground. When the soil becomes supersaturated the remaining water will flow overland until it reaches the tributaries and main branch of the river.

The temperature in the subwatershed can directly affect the quantity of water present in the system. In the cold winter months the water is frozen at the surface so the quantity of available water is reduced. While in the hot summer months the water is flowing but an overall loss is occurring due to the high rates of evaporation.

5.4.4 Water Budget Estimates

The Holland River, Maskinonge River and Black River Watersheds Water Budget Study 2008 conducted a comparison analysis of past, current average, drought, and future average and drought conditions. The completion of the analysis helps to determine whether stress on the groundwater resources can be anticipated under various scenarios. The VL- WABAS model a water budget analysis program was used to simulate the water budget estimates. The simulated VL- WABAS estimates for the West Holland water budget under different conditions is summarized in Table 5-3 (Earthfx & Gerber, 2008).

In general, the modelled scenarios analyzed indicated that increased groundwater takings had the most significant, but localized impact on aquifer potentials (levels). Modelled simulations of severe drought conditions showed an increase in runoff, and a decrease in infiltration and evapotranspiration. The simulated drought conditions affected groundwater potentials (levels) and groundwater discharge to streams over a broad area but mostly along the crest of the Oak Ridges Moraine. The estimated future land use changes (modelled scenario) indicated a decrease in evaporation, an increase in runoff and no change in recharge, which indicates a minor impact to the regional groundwater balance (Earthfx & Gerber, 2008). However, this could have implications to stream flow. Increased runoff can lead to a decrease in time to peak flow, increasing the risk for flooding.

The results of the model simulation can be compared to any available historical observations (e.g. fisheries and stream headwater mapping) to assess the accuracy of the simulations and the suitability of the existing monitoring network, particularly streamflow measurements, to detect change in the flow system. This analysis conducted over time will allow more confidence to be placed in estimates of future change to the hydrologic cycle (Earthfx & Gerber, 2008).

***Key points – Factors Impacting Water Quantity status - stressors*:**

The use of large amounts of groundwater and surface water for municipal use and agricultural irrigation throughout the West Holland subwatershed can cause reduced flow in streams, lowering the water table and aquifer levels and reduces the total inflow of water to the lake.

- With the increasing urban growth and impervious surfaces the amount of water available for infiltration to the groundwater system decreases, while the increase of flow in streams during storm events increases.
- The Tier 1 water budget estimated the current GW use within the West Holland is 4,073,000m^3/annum, which represents 12 % of the total available GW supply. Future GW use is projected to be 4,483,000m^3/annum which represents 13% of the available GW supply.
- The Tier 1 water budget estimated the current SW use within the West Holland is 4,408,000m^3/annum, which represents 12% of the available SW supply. Future SW use is projected to be 4,417,279m^3/annum which represents 12% of the available SW supply.

5.5 Current Management Framework

There are numerous acts, regulations, policies and plans aimed at maintaining or improving water quantity. These include the Provincial Policy Statement, the Ontario Water Resources Act, the Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, the Oak Ridges Moraine Conservation Plan, the Lake Simcoe Protection Plan, and the Clean Water Act.

This management framework relates to many different stressors that can potentially affect water quantity, ranging from the urban development to the demand for water resources. In There are numerous acts, regulations, policies and plans aimed at maintaining or improving water quality. These include the Provincial Policy Statement, the Ontario Water Resources Act, the Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, the Oak Ridges Moraine Conservation Plan, the Lake Simcoe Protection Plan, and the Nutrient Management Act.

This management framework relates to many different stressors that can potentially affect water quality, ranging from the discharge of material to urban development. In Table 4-5we categorize 12 such stressors, recognizing that many of these activities overlap and that the list is by no means inclusive of all activities. The legal effects of this management framework broadly fall into one of two categories. The first broad category we define as those having little or no legal standing and are referred to as General or Have Regard to Statements in Table 4-5 and are shown in blue. The second category includes those that have legal standing and must be conformed to; these are referred to as Regulated / Existing Targets in Table 4-5 and are shown in green. In many cases an act, regulation, policy, or plan does not relate to the activity specified, these are shown in red.

Table 4-57 we categorize six such stressors, recognizing that many of these activities overlap and that the list is by no means inclusive of all activities. The legal effects of this management framework broadly fall into one of two categories. The first broad category we define as those having little or no legal standing and are referred to as General or Have Regard to Statements in There are numerous acts, regulations, policies and plans aimed at maintaining or improving water quality. These include the Provincial Policy Statement, the Ontario Water Resources Act, the Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, the Oak Ridges Moraine Conservation Plan, the Lake Simcoe Protection Plan, and the Nutrient Management Act.

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Table 5-7 Summary of current regulatory framework as it relates to the protection and restoration of water quantity

Stressor affecting water quantity	Oak Ridges Moraine Conservation Plan (2002)	Greenbelt Plan (2005)	Lake Simcoe Protection Plan (2009)	Growth Plan for the Greater Golden Horseshoe (2006)	Provincial Policy Statement (2005)	Ontario Water Resources Act (1990)	Clean Water Act (2006) – Source Water Protection[2]	LSRCA Watershed Development Policies (2008)	York Region Official Plan (2008)	Simcoe County Official Plan (2007)	Peel Region Official Plan (2008)
Growth, development and site alteration	🟩	🟩	🟩	🟦	🟦	🟥	🟥 2	🟩	🟩	🟩	🟩
Loss of natural heritage features	🟩	🟩	🟩	🟦	🟦	🟥	🟥 2	🟩	🟩	🟩	🟩
Impervious surface	🟩	🟩	🟦	🟥	🟦	🟥	🟥 2	🟦	🟩 1	🟩 1	🟩 1
Agricultural use	🟥	🟦	🟦	🟥	🟥	🟦	🟥 2	🟥	🟥	🟦	🟦
Water demand	🟩	🟦	🟩	🟩	🟦	🟦	🟦	🟥	🟩	🟩 3	🟦
Climate change	🟥	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟦

🟦 General/Have regard to statement
🟩 Regulated/Existing targets
🟥 No applicable policies

[1] Applies within ORM planning area
[2] May be addressed through the development of Source Protection Plans
[3] Included as part of water budgets for ORM subwatershed plan

In this section we provide a summary the various acts, regulations, policies and plans as they pertain to activities affecting water quantity. This summary is to give context to *future management considerations* and the *opportunities and recommendations to maintain and improve water quantity*. This summary is not intended to be comprehensive in terms of all the legislative pieces that relate to water quantity, or of the acts, regulations, policies and plans that are discussed below – the reader is directed to each act, regulation, policy, or plan for a full assessment of how it relates to water quantity.

5.5.1 Oak Ridges Moraine Conservation Plan

The objectives of the Oak Ridges Moraine Conservation Plan include maintaining, improving or restoring all of the elements that contribute to the ecological and hydrological functions of the ORM area, including the quality and quantity of its water and other resources.

The policies of this Plan that will protect the quantity of water resources include:

- Municipalities are required to complete water budgets and conservation plans which include:
    - Quantification of components of the water balance equation
    - Characterization of the groundwater and surface water flow systems
    - Identification of targets to meet the water needs of the affected ecosystems; the availability, quantity and quality of water sources; and goals for public education and for water conservation
    - Development of a water-use profile and forecast
    - Identification and evaluation of various water conservation measures

    - Requirement for the use of specified water conservation measures and incentives
    - Plans for implementation and monitoring
- Development and site alteration is prohibited in hydrologically sensitive features and their related minimum vegetation protection zones, including streams, wetlands, kettle lakes, and seepage areas and springs, with exceptions for activities such as fish and wildlife management, conservation projects, transportation and infrastructure, and low-intensity recreational uses.
- Except with respect to land in Settlement Areas, development and site alteration with respect to land in a subwatershed are prohibited if they would cause the total percentage of impervious area in the subwatershed to exceed 10 per cent. Planning authorities are also to consider the desirability of having at least 30 per cent of the area of a subwatershed in natural self sustaining vegetation. Within Settlement areas, planning authorities should consider the importance of ensuring that natural vegetation is maintained, and improved or restored wherever possible, and should attempt to keep impervious surfaces to a minimum.

The ORMCP also contains policies for the protection of key natural heritage features and their functions, similar to those for hydrologically sensitive features. By protecting the ecosystem holistically, the implementation of the ORMCP will help to conserve water resources and ensure that there is enough available to sustain the needs of the ecosystem as well as those who reside within it.

5.5.2 Greenbelt Act and Plan (2005)

One of the Greenbelt Plan's Environmental goals is the 'protection, improvement or restoration of the quality and quantity of ground and surface water and the hydrological integrity of watersheds.' This goal is supported by a number of policies that relate to the Protected Countryside areas of the Greenbelt.

The following policies related to water quantity apply for lands within the Natural Heritage System of the Protected Countryside:

- New development or site alteration shall demonstrate that:
    - There will be no negative effects on…key hydrologic features
    - The removal of other natural features…should be avoided
    - The disturbed area of any site does not exceed 25%, and impervious surfaces do not exceed 10% of the developable area
- Where non-agricultural uses are contemplated, applicants shall demonstrate that:
    - At least 30% of the total developable area will remain or be returned to natural self-sustaining vegetation (this will encourage infiltration and slow runoff), and that buildings and structures are to occupy less than 25% of the total developable area of the site

Policies of the Water Resources system (within the Protected Countryside) that relate to water quantity include:

- Planning authorities shall provide for a comprehensive, integrated and long-term approach for the protection, improvement or restoration of the quality and quantity of water
- Cross-jurisdictional and/or cross-watershed impacts should be considered, and should be integrated with ORM subwatershed plans
- Municipalities shall protect vulnerable surface and groundwater areas

The Greenbelt Plan also limits development in Key Natural Heritage Features and Key Hydrologic Features, which will protect the important watershed functions that they perform:

- Development and site alteration are not permitted within these features, including any associated vegetation protection zone (with some exceptions, such as conservation and flood control works)

5.5.3 Lake Simcoe Protection Plan

The Water Quantity policies of the Lake Simcoe Protection Plan (LSPP) focus on ensuring sufficient water supply to maintain healthy aquatic ecosystems and promoting the conservation and efficient use of water.

They include:

- The MOE and MNR will be developing in-stream flow targets for water quantity stressed watersheds in the Lake Simcoe basin, which includes the West Holland River. This includes the development of targets for in-stream flow regimes and water extraction limits, and will build on watershed information and assessments developed through the Drinking Water Source Protection Program.
- The MAFRA, in cooperation with key stakeholders, will assist and encourage water conservation and efficiency efforts in the agricultural community through stewardship programs aimed at promoting the adoption of BMPs
- The MOE will work with other water use sectors (including recreational, commercial, and industrial users) to encourage the development and implementation of water conservation and efficient use practices.

LSPP policies around stormwater management will also help to protect water quantity. Applications for major development will be required to include a stormwater management plan, which demonstrates, among other things, consistency with water budgets; an integrated treatment train approach to minimize stormwater management flows and reliance on end-of-pipe controls through measures such as source and lot-level controls and conveyance techniques; and how anticipated changes in water balance will be minimized.

The LSPP also provides protection to key natural heritage and hydrologic features which will, in turn, protect their functions related to water quantity.

5.5.4 Growth Plan for the Greater Golden Horseshoe (2006)

Under its policies for managing growth, the Growth Plan specifies that population and employment growth will be accommodated by directing growth to built-up areas through intensification – this may help to limit the spread of impervious area, reducing its impacts on stream flow and infiltration to groundwater. Specific policies within this plan related to water quantity include:

- That the construction of new, or the expansion of existing, municipal or private communal water and wastewater systems should only be considered where the following conditions are met:
    - Strategies for water conservation and other water demand management initiatives are being implemented in the existing area
    - Plans for the expansion or for new services are to serve growth in a manner that support the achievement of the intensification target and density target

- Municipalities that share an inland water source and/or receiving water body should coordinate their planning for potable water, stormwater and wastewater systems to ensure that water quality and quantity is maintained or improved.
- Municipalities are encouraged to implement and support innovative stormwater management actions as part of redevelopment and intensification
- Municipalities will develop and implement official plan policies and other strategies in support of the following conservation objectives:
    - Water conservation, including water demand management for the efficient use of water; and water recycling, to maximize the reuse and recycling of water

5.5.5 Provincial Policy Statement (2005)

Policies that are directly related to the management of water quantity in the PPS include:

- Implementing necessary restrictions on development and site alteration to
    - Protect municipal drinking water supplies (i.e. quantity)
    - Protect, improve or restore vulnerable surface and groundwater, sensitive surface water features and sensitive groundwater features and their hydrologic functions
    - Maintaining linkages and related functions among surface water features, groundwater features, hydrologic functions and natural heritage features and areas
    - Promoting efficient and sustainable use of water resources, including practices for water conservation and sustaining water quality
- Directing growth to promote the use of existing sewage and water services, ensuring that these services can be provided in a manner that can be sustained by the water resources on which they rely, and that protects human health and the natural environment
- Focusing growth in settlement areas, a policy which, if implemented, should limit the amount of natural area removed, thus maintaining the natural functions of these areas. Development and site alteration are not permitted in features such as significant woodlands and ANSIs, or the lands adjacent to them, unless it can be demonstrated that there will be no negative impacts on the natural features or their functions
- Ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or improve the extent of vegetative and pervious surfaces

5.5.6 Clean Water Act (2007)

The recently enacted Clean Water Act (CWA) ensures the safety of drinking water by identifying potential risks to local water sources. A key focus of the CWA is to identify where long-term municipal water supplies could be threatened, identify the causes of concern and possible management strategies that will ultimately aid in the development of the source protection plans.

The Ministry of Environment (2009) indicates that this legislation is designed to promote voluntary initiatives but does require mandatory action where needed. The legislation sets out a basic framework for communities to follow in developing an approach to protecting their water supplies that works for them:

Identify and assess risks to the quality and quantity of drinking water sources and decide which risks are significant and need immediate action, which need monitoring to ensure they do not become significant, or which pose a low or negligible risk.

Develop a source protection plan that sets out how the risks will be addressed. Broad consultation will involve municipalities, conservation authorities, property owners, farmers, industry, businesses, community groups, public health officials, First Nations and the public in coming up with workable, effective solutions.

Carry out the plan through existing land use planning and regulatory requirements or approvals, or voluntary initiatives. Activities that pose a significant risk to drinking water sources may be prohibited or may require a site specific risk management plan. This plan will set out the measures that a property owner will take to ensure the activity is no longer a threat.

Stay vigilant through ongoing monitoring and reporting to measure the effectiveness of the actions taken to protect drinking water sources and ensure they are protected in the future.

5.5.7 Ontario Water Resources Act (1990)

Section 34 of the Ontario Water Resources Act (OWRA) deals with the issue of water taking. The OWRA stipulates that a person shall not take more than 50,000 litres of water on any day by any means except in accordance with a permit issued by the Director (the permit is issued under Section 34 (1) of the OWRA. This policy applies to all uses except for domestic or farm purposes, which includes ordinary household purposes or the watering of livestock, poultry, home gardens, or lawns; or to use for firefighting. The irrigation of crops grown for sale is not included under 'domestic and farm purposes.' A permit is however required for takings for domestic and farm purposes if the amount of water taken exceeds 379,000 litres per day.

A Director has discretion to issue, refuse to issue, or cancel a permit, and can impose a number of terms and conditions in issuing a permit as he or she considers proper, and can also alter the terms and conditions of a permit after it has been issued.

The following are some of the terms and conditions that a Director may include in a permit:

- Limiting the amount and rate of water taking
- Governing the manner in which water may be taken
- Governing the return, after use, of water taken under the permit
- Governing the monitoring and reporting of the amount, rate, use, and effects of water taking (including effects on water quantity and quality)
- Governing the use and conservation of water taken, including requiring the implementation of specified measures to promote the efficient use of water or reduce the loss of water through consumptive use or to prepare a water conservation plan
    - Requiring the holder to implement specified measures to prevent the water taking from causing interference with other water takings and/or to remedy any interference with other water takings that is caused by the water taking under the permit

Section 34 (4) of the OWRA states that where the taking of water for any purpose, other than for domestic or farm use or for firefighting, interferes, in the opinion of a Director, with any public or private interest in any water, the Director may…prohibit the person from so taking water without a permit issued by the Director.

5.5.8 LSRCA Watershed Development Policies (2008)

LSRCA's Watershed Development Policies address issues of water quantity in a number of ways:

- Requiring Enhanced Level 1 stormwater controls of all new developments

- Noting that stormwater management plans accompanying development proposals must make all feasible efforts to maintain pre-development infiltration and evapotranspiration rates to the receiving watershed
- Stipulating that peak discharges are to be controlled to a minimum of pre-development levels
- Requiring a minimum 24-hour detention of runoff from a 25 mm storm for erosion protection and baseflow maintenance
- Protecting natural features, thus promoting infiltration for the slow release of water after storm events and the maintenance of aquifer levels

5.5.9 York Region Official Plan (2009)

York Region's Official Plan (OP) includes a number of policies related to the protection of the quality of both ground and surface water. The policies within the OP related to water quality include:

- The preparation of a comprehensive regional water strategy for both piped services and surface and groundwater sources that will include long-term protection strategies, enhancement guidelines and monitoring requirements;
- That the natural quality and hydrological characteristics of watercourses and lakes (including water quality and temperature) will be maintained, and that development be designed with the goal of maintaining water balance
- To direct development away from sensitive surface water and groundwater features
- To continue to partner with other regions and conservation authorities to study, analyze, and monitor ground and surface water resources to ensure a unified approach to protecting and enhancing water quality and quantity
- To monitor the quantity and quality of surface and ground water systems in York Region, in co-operation with local municipalities and conservation authorities) by:
    - Assessing the sustainability of current activities and land uses
    - Identifying areas that are susceptible to, or currently experiencing, water quality and quantity problems
- Requiring local municipalities to establish policies and programs to protect, enhance, and monitor water systems
- To work with the province, local municipalities, conservation authorities and other in establishing procedures for water taking permits that protect and enhance water resources
- To require the preparation of comprehensive master environmental servicing plans as part of secondary plans to protect and enhance the natural hydrologic function of water systems. These plans will emphasize water reuse and incorporate innovative technologies with the goal that the water balance and hydrologic functions will be maintained
- Working with partners in the implementation of stormwater management initiatives
- Requiring the preparation of comprehensive stormwater management plans as a component of secondary plans, and encouraging innovative approaches to stormwater management within secondary plans

- That development have an integrated and innovative approach to water management, be water efficient, and maximize stormwater quality, quantity, and infiltration through an integrated treatment approach
- Work with local municipalities and LSRCA in the preparation and implementation of comprehensive stormwater master plans for each settlement area within the Lake Simcoe watershed by 2014
- Requiring all new buildings to achieve 10% greater water efficiency than the Ontario Building Code, and encouraging all new buildings to achieve 20% greater efficiency
- To restrict the use of potable water for lawn watering
- Requiring the installation of rainwater harvesting and re-circulation/reuse systems on all new residential buildings for outdoor irrigation and outdoor water use
- Encouraging the use of water efficient, drought resistant landscaping by:
    - providing a minimum 6” of topsoil
    - installing drought resistant sod
    - providing landscape features that minimize the demand for water and chemicals by utilizing native and drought resistant species
    - installing permeable driveway surfaces
- Encouraging all developments to incorporate green roofs into building design
- Supporting the goals and objectives of subwatershed plans

In addition to these policies, York Region’s protection of the regional Greenlands System will help to ensure that the functions of the Region’s natural features, such as the water retention and infiltration capacity of natural features such as wetlands and forests, will continue to protect and enhance water quantity within the subwatershed.

5.5.10 Simcoe County Official Plan (2007)

The policies contained within Simcoe County’s Official Plan around water quantity include:

This plan does contain some policies related to the protection and enhancement of water quality. These include:

- Policies related to development in and around sensitive groundwater features and their related hydrologic functions, wetlands, significant forests, and other natural heritage features, the protection of which will help to promote infiltration and maintain water quantity
- Requiring a Stormwater Management Report for all plans of subdivision or the creation of more than five lots; as well as industrial, commercial, or institutional developments with more than 1000 m^3 of impervious area.
- Encouraging the maintenance and restoration of natural heritage areas within rural and agricultural areas; and the protection of the areas designated Greenlands, one of the objectives of which is to protect, improve, and restore the quality and quantity of surface and ground water.
- Only approving development where it is demonstrated that there is minimal risk to groundwater contamination

- Working with municipalities and conservation authorities to develop subwatershed plans, including water budgets and water conservation plans to meet the requirements of the Oak Ridges Moraine Conservation Plan
- Stating that land use planning and development decisions shall contribute to the protection, maintenance, and enhancement of water and related resources and aquatic ecosystems

5.5.11 Peel Region Official Plan (2008)

The Peel Region Official Plan contains a number of policies that relate to the protection of surface and groundwater quantity. These policies include:

- Protecting, maintaining and enhancing the quality and quantity of water resources, including surface and groundwater system, and related natural systems, jointly with local municipalities, conservation authorities, and other related agencies; and directing area municipalities to establish policies and programs to protect, maintain, and enhance water resources
- Preparing green development standards, and encouraging area municipalities to do the same
- Adopting policies and establishing programs for the restoration of the natural environment in Peel, working jointly with local municipalities, the conservation authority and other partners
- Promoting and participating in the development of watershed plans
- Protecting, maintaining and enhancing the integrity of ecosystems through the proper planning and managing of groundwater resources and related natural systems in peel
- Working with partners to protect, maintain, and enhance groundwater resources
- Directing area municipalities to include, in their official plans, objectives and policies for the management of stormwater quantity and quality that would avoid, minimize and/or mitigate stormwater volume, contaminant loads, and impacts to receiving watercourses
- Supporting programs of partner organizations which encourage farmers to develop and follow conservation measures and sustainable farming practices
- Pursuing, with local municipalities, the public, and business, water conservation strategies; and pursuing a water efficiency strategy with a goal to decrease per capita consumption by 10-15% over the next 20 years
- Preparing, in consultation with area municipalities, conservation authorities, and other partners, a climate change strategy to address mitigation and adaptation
- Protecting and/or enhancing the features and functions of the regional Greenlands system, which will help to maintain or improve water quantity

5.6 Management Gaps and Limitations

5.6.1 Water Demand

The Source Water Protection initiative will address potential concerns around water quantity, although these policies will pertain to drinking water resources, and not the flows that are required to sustain healthy aquatic ecosystems within the subwatershed. The Lake Simcoe Protection Plan also contains a policy around maintaining adequate flows, with the development of in-stream flow targets for water quantity stressed subwatersheds. It does not, however, stipulate timelines for any subwatershed other than the Maskinonge, it is therefore not clear when this work and any associated limitations on water takings would be in place, or how they would be enforced and by whom. Another limitation in managing water demand is the Permit to Take Water process. These permits are only required when a user is taking more than 50,000 L/day, and are not required for most domestic and agricultural uses. This makes it difficult to track the cumulative use for a subwatershed, leading to the potential for stress at certain times of the year.

5.6.2 Land Use

There are few policies in the framework that deal specifically with the issue of impervious cover that accompanies development. The ORMCP sets a limit of 10% impervious cover, but this only applies outside of Settlement Areas, and it stresses minimizing impervious surfaces and their impact on water quantity within Settlement Areas, but does not set actual targets. The Greenbelt Plan limits impervious area to 10% for development and site alteration, but only within its Natural Heritage System; and in the Protected Countryside requires a stormwater management plan which demonstrates how impervious surfaces will be minimized in a development. The policies within the current planning framework around impervious cover generally do not require any concerted effort on the part of developers to move beyond traditional designs for developments and measurably reduce impervious surfaces, nor do they require the use of techniques aside from stormwater controls to increase infiltration.

With respect to water demand, the policies being developed through Source Water Protection will be most protective of the quantity of water resources within the subwatershed, although these policies will only pertain to drinking water resources. Currently, the Ontario Water Resources Act is the main policy piece that considers water quantity. However, it only requires a permit for users taking greater than 50,000 L/day, and is not required for most domestic and agricultural uses. There is the potential for significant stress on a system due to the cumulative takings of both permitted and un-permitted users in a subwatershed, and these cumulative uses are generally not considered as part of the permitting process. This issue may be addressed through policies in the LSPP requiring the development of in-stream flow targets for water quantity stressed subwatersheds, which may lead to policies that require the development of targets for in-stream flow regimes, and set out how much water can be allocated among users in a subwatershed, including an allocation to support the natural functions of the ecosystem. The LSPP, however, does not define what constitutes a water quantity stressed subwatershed, nor does it specify timelines for the completion of this work with the exception of the Maskinonge River subwatershed. The LSPP also contains policies around reducing water demand by new and expanded major recreational uses, such as golf courses, through limiting grassed, watered and manicured areas; requiring the use of grass mixtures that require less water (where applicable); the use of water conserving technologies; and water recycling. As well, the LSPP contains policies aimed at undertaking stewardship activities with the agricultural community and other water use sectors, such as recreational, to encourage the implementation of best management practices to conserve water.

5.6.3 Climate

While it would be extremely difficult to account for variations in climate and their effects on water quantity within the policy framework, Source Water Protection and the LSPP have begun to consider the potential impacts of climate change on this important resource. Modelling undertaken for Source Protection has including drought scenarios, and the LSPP includes a section on climate change, including a policy to develop a climate change adaptation strategy for the Lake Simcoe watershed. This will include an assessment of the risks of climate change impacts, additional research to better understand the impacts of climate change, the development of an integrated climate change monitoring program to inform decision making, and finally to develop adaptation plans. These are important first steps in what should now become a routine consideration for all activities.

5.6.4 Water Budget Estimates

While the water budget determined water taking rates to be broadly sustainable, they also indicated potential impacts to stream flow due to these takings. The OWRA does enable Ministry of the Environment staff to limit takings through the PTTW process; however, this is rarely done. This may be addressed through the LSPP's policies around developing targets for environmental flows.

5.7 Recommended Actions to Improve Water Quantity

The following recommended actions were developed to improve water quantity in the West Holland River subwatershed. The main issues with respect to water quantity in the West Holland River subwatershed are water demand, due to the large agricultural areas, and reduced infiltration due to the impervious surfaces associated with the subwatershed's urban areas. The Holland Marsh and its canal system also impact the natural hydrology of the subwatershed. Given that the urban area in the subwatershed, mainly around the town of Bradford, is planned to increase and with it the impervious area of the subwatershed, as is the demand for locally grown produce, water quantity issues may increase in the coming years. The implementation of the following recommended actions will help to mitigate the issues associated with new and existing landuses, on the quantity of water in this subwatershed.

These recommendations, which are grouped and numbered as described in Section 1.4, were developed to address the water quality issues and stressors that were identified throughout this chapter. In addition, they consider, and are consistent with applicable policies and recommendations in the province's Lake Simcoe Protection Plan, and the LSRCA's Integrated Watershed Management Plan. Each recommendation below also identifies the applicable 'detailed recommendations' as outlined in Chapter 10. These detailed actions will form the basis of the Implementation Plan for York Region's ORM subwatersheds, to be developed following the completion of this plan.

5.7.1 Planning and Policy

1) That the municipal partners and the LSRCA strive to reduce the impacts of stormwater through a number of methods including the implementation of policies and guidelines and enabling the use of new and innovative technologies, retrofitting of existing developments.

   Detailed recommendations: A.1.1 – A.1.3

4) That the municipal partners and the LSRCA strive to maintain natural hydrologic conditions on development sites

   Detailed recommendations: A.3.1 – A.3.2

5) That the federal, provincial, and municipal governments, as well as the LSRCA, continue to evaluate and implement planning initiatives and practices aimed at reducing the impact of development on the condition of the West Holland subwatershed

   Detailed recommendations: A.3.3, A.3.5, C.1.1

6) That the value of the ecological goods and services provided by ecological features be considered in decision making around growth and development

Detailed recommendation: A.3.6

7) That the rural/agricultural community be engaged in developing solutions for minimizing the impacts of practices on their lands

Detailed recommendation: A.4.1

10) That the Province, the municipal partners, and the LSRCA seek to gain an improved understanding of the impacts of climate change in the West Holland River subwatershed, incorporating this information into decision making scenarios and developing strategies to mitigate and adapt to its impacts.

Detailed recommendations: A.6.1 – A.6.2, G.1.1 – G.1.2

5.7.2 Use of Better Management Practices

11) That the LSRCA and its municipal partners continue working to mitigate the impacts of stormwater to water quality and quantity through tracking its sources, completing stormwater retrofits, promoting methods of minimizing stormwater volume, and continuing to research new and innovative solutions to stormwater control and implementing these solutions where appropriate.

Detailed recommendations: B.1.1 – B.1.5

12) That support for programs offered to assist rural landowners in implementing BMPs on their properties, such as LSRCA's LEAP program, be continued and/or expanded as resources permit

Detailed recommendations: B.2.1 – B.2.3

13) That sectors that have the potential to have significant impacts on conditions in the West Holland subwatershed be expected to undertake BMPs and other activities to mitigate their impacts, as required under the LSPP

Detailed recommendations: B.2.4 – B.2.5

5.7.3 Changing the way things are done 'on the ground'

16) That the LSRCA and its partner municipalities strive to maximize the infiltration of stormwater where appropriate through development approvals and the use of practices and technologies

Detailed recommendations: C.1.1, C.2.1 – C.2.2

5.7.4 Applied Research and Science

20) That all partners study the requirements for environmental flows within the West Holland subwatershed, explore innovative solutions, and undertake works and practices where possible in order to ensure adequate baseflow to support ecological function

Detailed recommendations: D.1.5, D.1.7, D.1.14 – D.1.15, D.2.2

22) That the partners explore the subwatershed to determine where reductions in groundwater discharge, excessive water takings and other impacts to aquatic habitat have occurred and undertake activities to mitigate these impacts

Detailed recommendations: D.2.1

23) That measures be taken at site level to reduce demands on water resources

Detailed recommendation: D.2.3

5.7.5 Monitoring

31) That the amount of impervious area in the subwatershed be assessed on a regular basis by the LSRCA and its partner municipalities.

    Detailed recommendation: E.3.3

5.7.6 Management, Rehabilitation and Restoration

38) That the LSRCA and the partner municipalities assess the feasibility of increasing natural cover (e.g. woodland, streambank vegetation, interior forest, grassland) in the subwatershed and set priorities and develop plans to undertake this enhancement, based on overall benefit to the subwatershed.

    Detailed recommendations: A.5.3, F.2.1 – F.2.5

42) That the partner municipalities adopt policies to encourage the use of native species, particularly those drought tolerant species, through development approvals and property management programs.

    Detailed recommendation: F.3.2

5.7.7 Adaptive Response

47) That the LSRCA and partner municipalities work to reduce their carbon footprint and to increase ecological resilience in the watershed

    Detailed recommendations: G.1.1 – G.1.3

48) That the LSRCA and the partner municipalities promote and support water conservation initiatives, such as York Region’s the ‘Water for Tomorrow’ program.

    Detailed recommendation: G.2.1

49) That the LSRCA in conjunction with the MNR and MOE undertake initiatives to understand the environmental flow needs within the West Holland subwatershed, and develop programs and policies to ensure that these needs are met, including the continuation of the Low Water Response Program, setting environmental flow targets, and ensuring that water taking activities do not exceed the available supply.

    Detailed recommendations: G.2.2 – G.2.4

50) That the LSRCA and its partners work to ensure that flood mapping is up to date; that the data needed for assessing flood risk is sufficient and that new monitoring equipment is added to the monitoring network as required; and that there be available programs to assist landowners in flood proofing their homes.

    Detailed recommendations: G.2.5 – G.2.7

6 Aquatic Habitat

6.1 Introduction and background

Habitat can be described as a place where an animal or plant normally lives, often characterized by a dominant plant form or physical characteristic. All living things have a number of basic requirements in their habitats including space, shelter, food, and reproduction. In an aquatic system, good water quality is an additional requirement. In a river system, water affects all of these habitat factors; its movement and quantity affects the usability of the space in the channels, it can provide shelter and refuge by creating an area of calm in a deep pool, it carries small organisms, organic debris and sediments downstream which can provide food for many organisms and its currents incorporate air into the water column which provides oxygen for both living creatures and chemical processes in the water and sediments. Habitat features also frequently affect and are affected by other features and functions in a system. For instance, the materials comprising a channel bed can affect the amount of erosion that will take place over time; this in turn affects the channel shape and the flow dynamics of the water. The coarseness of the channel's bed load can also affect the suitability for fish habitat – some species require coarse, gravel deposits for spawning substrates, while finer sediments in the shallow fringes of slow moving watercourses often support wetland plants that are required by other species.

The West Holland River is one of the largest subwatersheds in the Lake Simcoe basin. Tributaries are numerous and vary in their habitat characteristics. They include Ansnorveldt Creek, Glenville Creek, East Kettleby Creek, Kettleby Creek, 400 Creek, Pottageville Creek, Schomberg River, Fraser Creek, Scanlon Creek, and William Neely Creek. The subwatershed also features the Holland Marsh and its extensive canal and Municipal Drain system. It should be noted that tributaries to the West Holland River that do not originate on the Oak Ridges Moraine, Fraser Creek for example, have some different characteristics such as temperature regime and substrate, and may not display the same aquatic communities as would be expected for a tributary stream.

Table 6-1 A summary of aquatic environments found in the West Holland subwatershed and their habitat features

Aquatic Environment	Habitat Features	Examples in the West Holland River Subwatershed
Rivers and streams	• Vegetation • Food sources – algae, benthic invertebrates, fish • Flow • Cover • Spawning/nursery habitat • Vegetation • Water quality • Temperature refugia	Main branch of the West Holland River and tributaries
Lakes and ponds	• Temperature refugia • Shelter • Spawning/nursery habitat	Numerous unnamed ponds and lakes throughout the subwatershed
Wetlands	• Spawning/nursery habitat	• Holland Marsh • Ansnorveldt PSW • Pottageville Wetland Complex

There are numerous causes of stress in an aquatic environment. Any type of land use change from the natural condition will place a strain on the system, and can cause significant changes to the aquatic community. The conversion of natural lands such as woodland and wetland to agriculture or urban uses eliminates the functions that these features perform, such as improvement of water quality, water storage, and increasing the amount of infiltration to groundwater. This can result in impacts to water quality and a reduction in baseflow, resulting in watercourses that are unable to support healthy communities of native biota.

6.2 Current status

To assess the impact of the aforementioned stresses on the biological community, monitoring of the fish and benthic invertebrate communities is undertaken at sites throughout the subwatershed. The results of these studies are discussed in the following sections.

6.2.1 Fish Community

The West Holland River and its tributaries have been subject to fisheries studies and there are 156 known fisheries data collection points within the system. These sites have not only been explored by the Ministry of Natural Resources (OMNR) and LSRCA but also by private industry in support of various development proposals and academia due to the presence of threatened fish species. Sampling by the LSRCA is completed using backpack Electrofishers following procedures outlined in the Stream Assessment Protocol for Southern Ontario Version 7 (Stanfield, 2005).

There have been 34 species of fish captured in the West Holland River subwatershed since 1930 (Table 6-2). The West Holland ranges from cold headwater communities featuring such species as brook trout (*Salvelinus fontinalis*) and mottled sculpin (*Cottus bairdii*) to diverse warm large order systems displaying such species as largemouth bass (*Micropterus salmoides*) and brown bullhead (*Ameiurus nebulosus*). Generally, the West Holland River displays cold to coolwater tributaries feeding a warmwater Main Branch. The white sucker (*Catostomus* *commersoni*) is a migratory species found throughout most of the watershed where barriers do not impede migration. Figure 6-1 displays the presence of coldwater fish communities and habitat suitability at sites sampled between 2005 and 2007.

Table 6-2 Fish species captured in the West Holland subwatershed 1930 - 2008

Common Name	***Scientific Name***
Bowfin	*Amia calva*
Brook Trout	*Salvelinus fontinalis*
Northern Pike	*Esox lucius*
Central Mudminnow	*Umbra limi*
Common White Sucker	*Catostomus commersoni*
Goldfish*	*Carassius auratus*
Northern Redbelly Dace	*Phoxinus eos*
Redside Dace~	*Clinostomus elongatus*
Common Carp*	*Cyprinis carpio*
Brassy Minnow	*Hybognathus hankinsoni*
Golden Shiner	*Notemigonus crysoleucas*
Emerald Shiner	*Notropias atherinoides*
Common Shiner	*Luxilus cornutus*
Spottail Shiner	*Notropis hudsonius*
Bluntnose Minnow	*Pimephales notatus*
Fathead Minnow	*Pimephales promelas*
Blacknose Dace	*Rhinichthys atratulus*
Longnose Dace	*Rhinichthys cataractae*
Creek Chub	*Semotilus atromaculatus*
Pearl Dace	*Margariscus margarita*
Yellow Bullhead	*Ameiurus natalis*
Brown Bullhead	*Ameiurus nebulosus*
Brook Stickleback	*Culaea inconstans*
Rock Bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Largemouth Bass	*Micropterus salmoides*
Black Crappie^	*Pomoxis nigromaculatus*
Yellow Perch	*Perca flavescens*
Greenside Darter	*Etheostoma blennioides*
Rainbow Darter	*Etheostoma caeruleum*
Iowa Darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
Mottled Sculpin	*Cottus bairdi*
Slimy Sculpin	*Cottus cognatus*

*** = non-native invasive species**

~ = endangered species

^ = non-native species

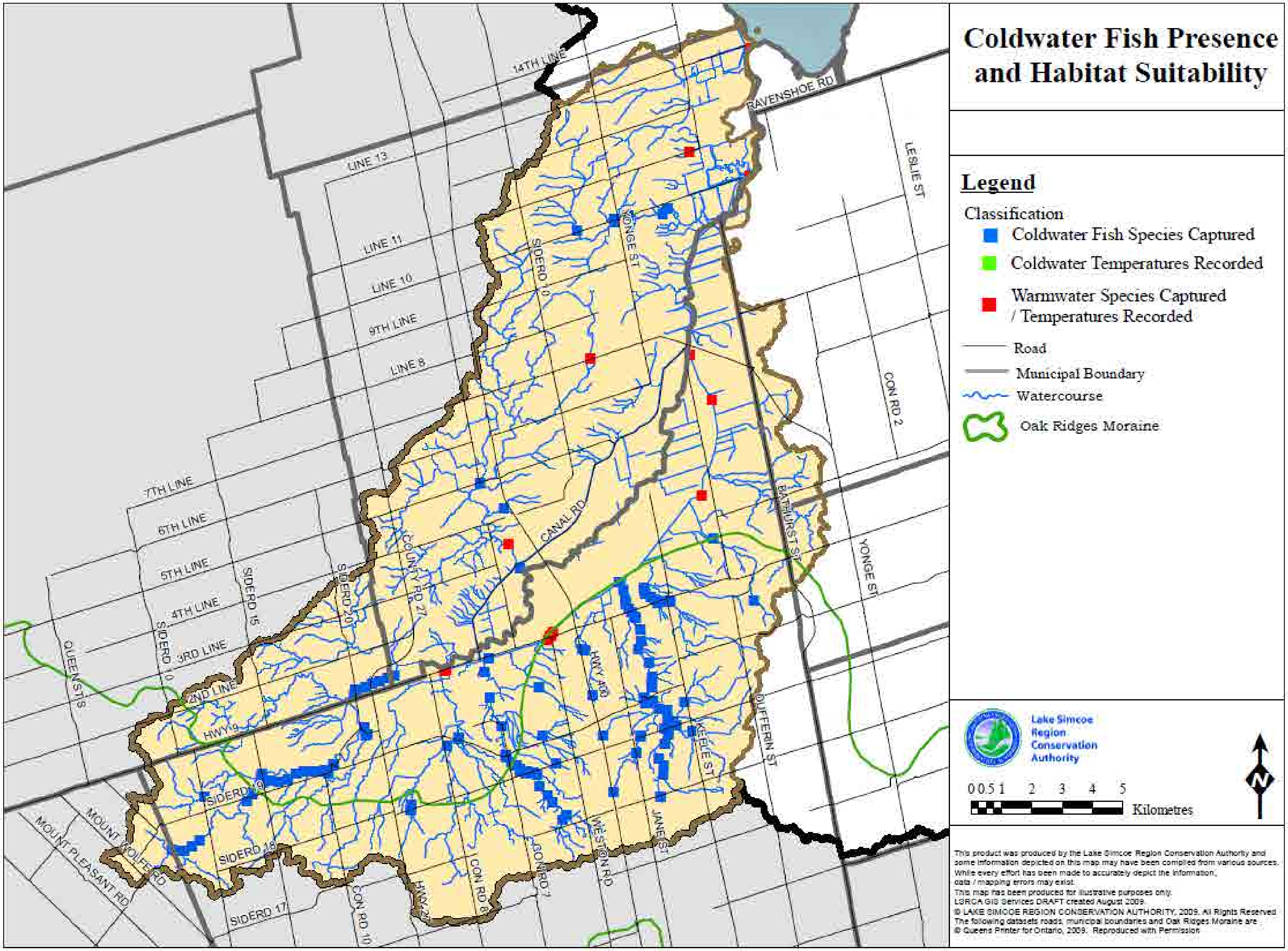

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Figure 6-1 **Coldwater fish presence and habitat suitability in the West Holland subwatershed**

Figure 6-2 The provincially “Endangered” Redside Dace captured from Kettleby Creek in 2006

6.2.2 Benthic Invertebrates

Aquatic insects, or benthic invertebrates, are an ideal indicator of water quality as different species have different tolerances to factors such as nutrient enrichment, dissolved solids, oxygen and temperature. The presence or absence of certain species is used to determine water quality at a given site. Of the indices developed to assess water quality in relation to benthic invertebrate communities, BioMAP was selected as it provides a means to locate pollution sources without the large investment of time and resources required by some other indices.

Benthic invertebrates have been collected from the West Holland River subwatershed since 2004 employing a consistent and standard collection method (Ministry of the Environment and Conservation Ontario, 2003). Figure 6-3 is a compilation, standardization and summary of this data with the results reported as “Impaired”, “Unimpaired” or “Inconclusive”. It is difficult to draw conclusions from this small data set, thus benthic reference site collection is expected to continue. As would be expected, reference sites within agricultural areas of the Schomberg River and Fraser Creek are impaired where forested sites in Kettleby and Pottageville Creeks appear unimpaired.

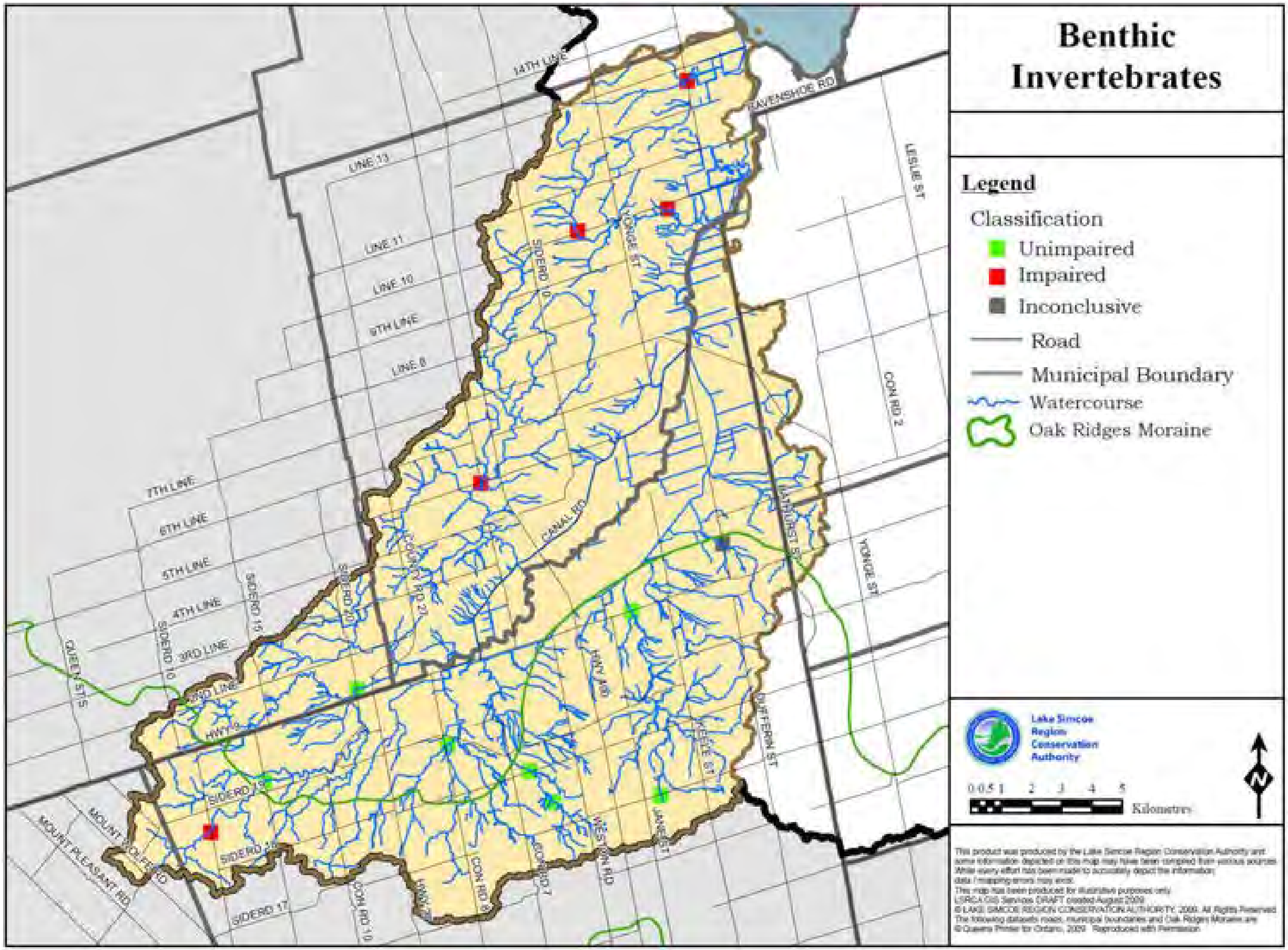


Figure 6-3 Benthic invertebrate sampling sites within the West Holland subwatershed (2004-2007)

Rare and Endangered Species

The only rare or endangered fish species known to reside in the West Holland River subwatershed is the Redside Dace (*Clinostomus elongatus*) (Figure 6-2). The Redside Dace is considered Endangered both provincially and federally. Captures of Redside Dace have been noted in both Kettleby Creek and the 400 Creek (Andersen, 2004). The Recovery Strategy for Redside Dace (2008) was prepared by the Redside Dace recovery team with the long term goal of restoring viable populations of Redside Dace in a significant portion of their historic range in Ontario by:

i) protecting existing healthy, self-sustaining populations and their habitats;

ii) restoring degraded populations and habitats; and

iii) re-introducing Redside Dace to sites of former distribution where feasible.

In addition, several species of potentially “Threatened” or “Endangered” mollusc species have been identified as present in the subwatershed by Fisheries and Oceans Canada. However, none are currently listed under the *Species at Risk Act* and, therefore, have no special status as of this publication.

Key Points – Current Aquatic Habitat Status:

- The limited benthic and fish community data indicates that West Holland River aquatic habitat varies between locations, with some areas recording good habitat quality and other areas exhibiting poor habitat quality.
- Fish communities range from cold and cool headwater communities to diverse warm large order communities (mainly the main branch). Tributaries that don’t originate on the ORM display different characteristics than those that do.
- Generally, the West Holland River displays cold to coolwater tributaries feeding a warm water main branch
- Redside Dace is the only Species at Risk present in the subwatershed.
- There appears to be a trend in the benthic invertebrate data that reference sites within the agricultural areas of the Schomberg River and Fraser Creek are impaired, where forested sites in Kettleby and Pottageville Creeks appear unimpaired.

6.3 Factors impacting status - stressors

There are a number of land uses, activities and other factors that can have an effect on the health of the aquatic community in the subwatershed. These include:

- Changes to instream habitat and habitat fragmentation
- Removal of riparian vegetation
- The introduction of invasive species
- Impacts to the hydrologic regime
- Water quality and thermal degradation

These factors are discussed in detail below:

6.3.1 *Changes to Instream Habitat and Habitat Fragmentation*

Barriers

Barriers to fish movement in the form of dams, perched culverts, and enclosed watercourses serve to fragment a fishery by preventing fish from accessing important parts of their habitat. The impoundments created by dams serve to warm water temperatures, raise bacteria levels, and disrupt the natural movement of fish, invertebrates, sediment, and nutrients. The natural movement of each is imperative for a healthy aquatic system.

Ninety eight such barriers to fish movement have been identified in the West Holland River subwatershed thus far, however, it is anticipated that this number will grow incrementally upon study of individual systems. These barriers take many forms ranging from concrete structures associated with dams to perched culverts (Figure 6-4 and Figure 6-5). Some structures represent on-line, or in-river, stormwater management. Watercourse enclosures are mainly noted within the Town of Bradford West Gwillimbury and are associated with older residential and industrial developments.

Figure 6-4 The Camp Kettleby Dam – An example of an on-line structure within the West Holland River subwatershed

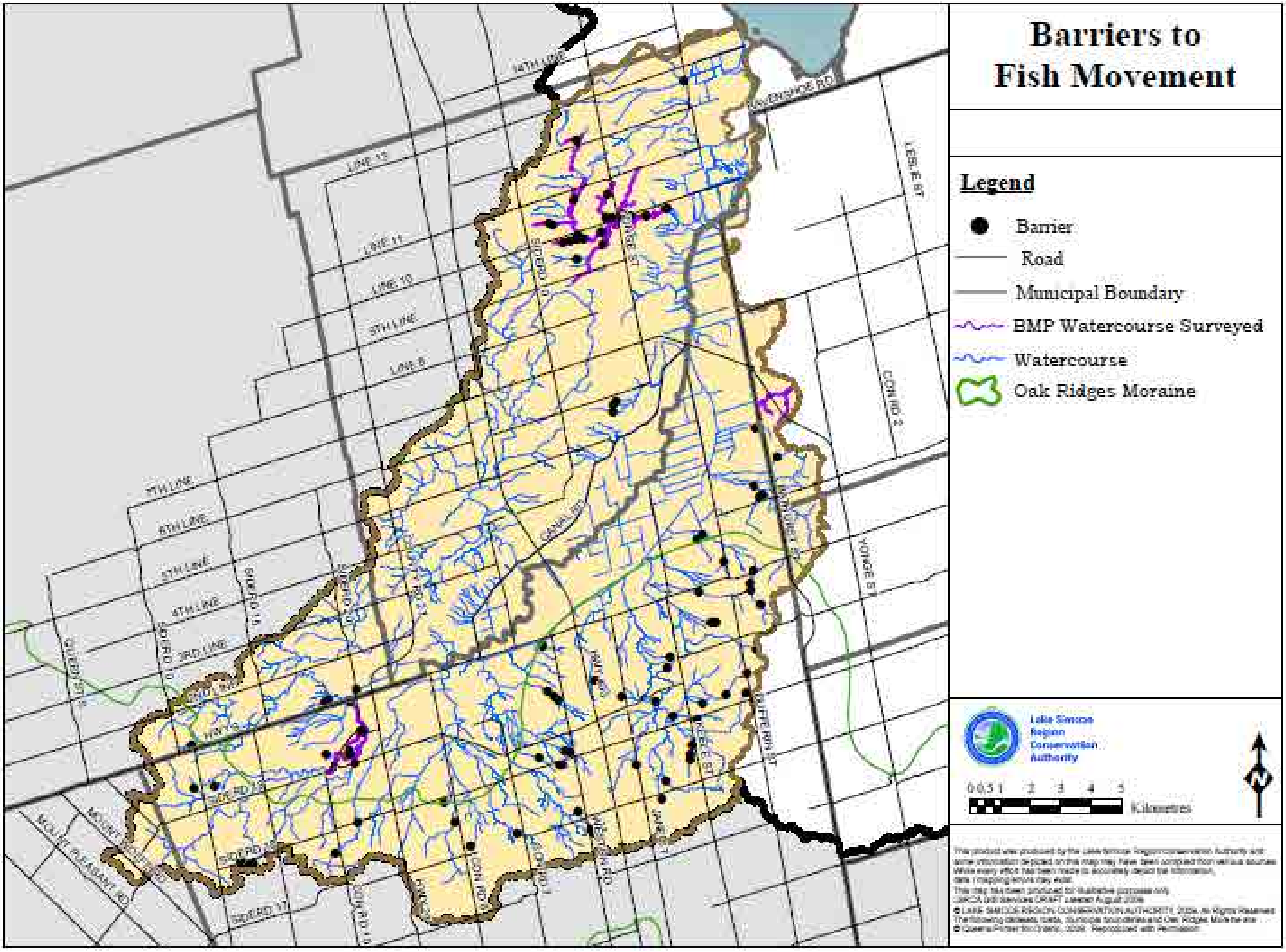


Figure 6-5 Locations of known barriers in the West Holland River subwatershed

Bank Hardening and Channelization

In the past, it has been common practice to straighten watercourses to accommodate various landuses, and to harden banks with a view to preventing streambank erosion. While we now know that these practices are harmful to the environment and can cause more issues than they resolve, there are several areas in the subwatershed where these practices have been utilized.

Water generally flows more quickly through a channelized section of stream, particularly during high flow events. This increase in flow can have several effects:

- Unstable banks in the channelized section (if they are not hardened)
- Flooding downstream of the channelized section (water is confined to the channel, which results in larger volumes of water flowing more rapidly than under natural conditions being conveyed to downstream sections)
- Bank erosion downstream of the channelized section
- Sedimentation downstream of the channelized section where the flow of water slows

These effects result in the degradation of aquatic habitat. The riffle/pool sequences that occur in natural channels are lost in the channelized section as well as downstream. Much of the natural cover in the watercourse can be lost. Fluctuating flow levels can place stress on aquatic biota, and in many cases can cause a shift from a more sensitive community to one that is better able to tolerate adverse conditions. Finally, the deposition of sediment as the water slows coming out of the channelized section can blanket the substrate, interfering with spawning activities and affecting the benthic invertebrate community.

In the West Holland River, many watercourses have been channelized to accommodate agricultural development, especially in the Fraser Creek and direct tributaries of the Holland Marsh. Some of these systems are recognized Municipal drains. There were 33 hardened and/or channelized sites identified through the BMP inventory (Figure 6-6).

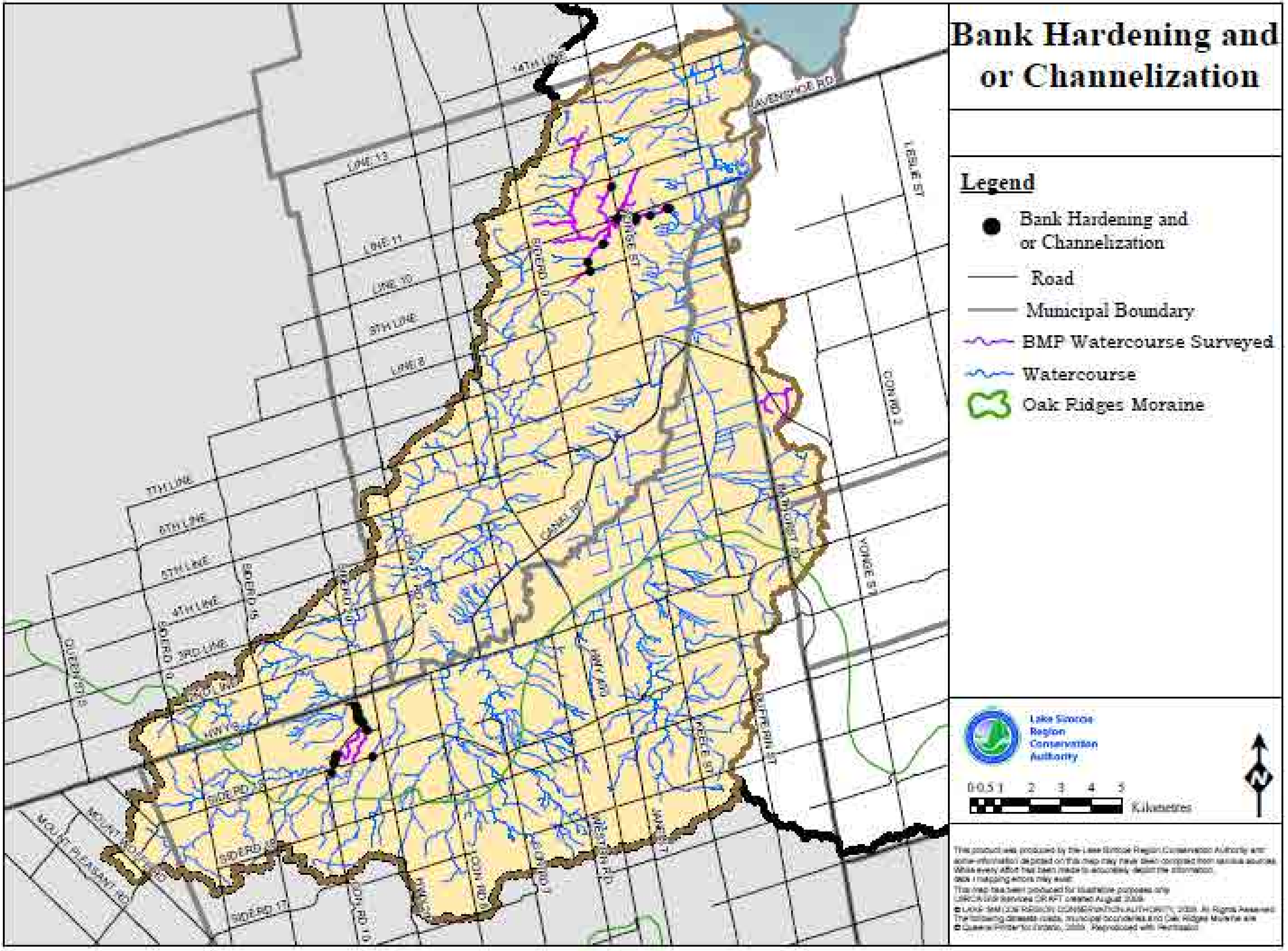


Figure 6-6 **Areas of bank hardening and channelization in the West Holland subwatershed**

Removal of Riparian Vegetation

While the LSRCA’s policies currently afford some protection to the riparian areas adjacent to watercourses, this has not always been the case. In many instances, vegetation in the riparian areas of the subwatershed’s watercourses has been removed to accommodate development and agricultural activities, leaving the bank vulnerable to erosion due to the removal of the stabilizing influence of the roots of the vegetation. This can result in inputs of sediment into the watercourse, which can settle and smother the substrate, thus eliminating important habitat used by fish for spawning and inhabited by benthic invertebrates. Sediment in suspension in the water can also interfere with the feeding of those fish species that are visual feeders.

Riparian vegetation is also an important source of allochthonous material such as leaves and branches that serve as a food source for benthic invertebrates, and can also provide cover for fish.

In addition, riparian vegetation serves to enhance water quality – it filters the water flowing overland, causing sediment and other contaminants to settle out or be taken up prior to their reaching the watercourses; and also helps to moderate water temperatures through the shade it provides. Removal of this vegetation can have an influence on the type of aquatic community able to inhabit the watercourse – a reach that may have been able to support a healthy coldwater community may no longer be able to do so, and the community may shift to a cool or warm water community containing less sensitive species. There were 93 sites in the subwatershed that were identified in the BMP Inventory as having insufficient riparian cover; these are identified in Figure 6-7. The subwatershed fares poorly in terms of natural cover in the riparian area. In Lake Simcoe’s Watershed Report Card – 2009 Update, the West Holland River received a grade of ‘D,’ as just over half of the area within a 30 metre buffer on either side of its watercourses is comprised of natural cover.

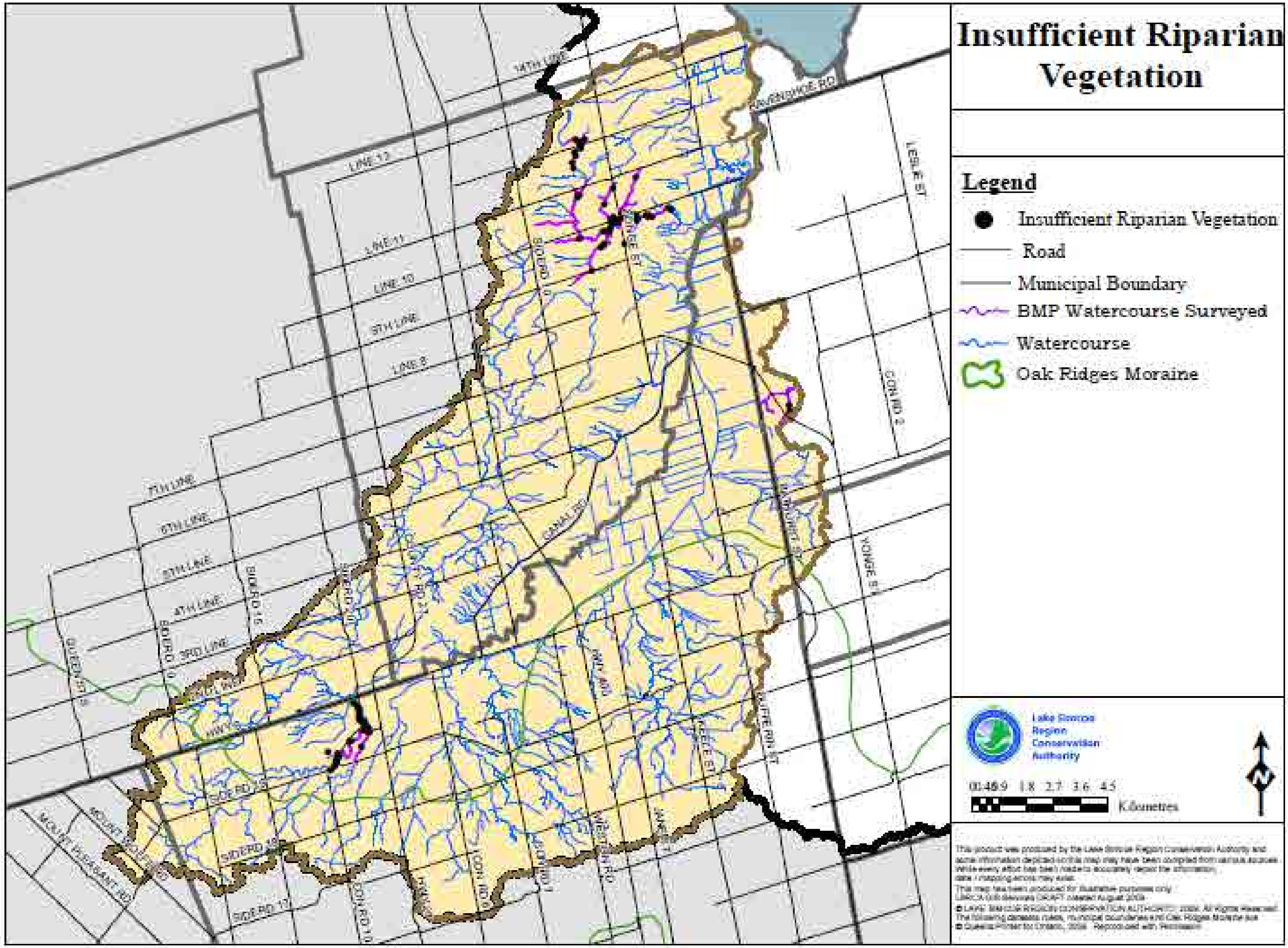


Figure 6-7 Sites identified in the West Holland River subwatershed as having insufficient riparian vegetation

Invasive Species

The traits possessed by non-native invasive species, including aggressive feeding, rapid growth, prolific reproduction, and the ability to tolerate and adapt to a wide range of habitat conditions enable them to outcompete native species for food, water, sunlight, nutrients, and space. This may result in the eventual reduction in the number and abundance of native species. The replacement of native species with introduced affects the balance of the ecosystem, as species that relied on the native species for food, shelter and other functions now either have to move to another area with these species, or must utilize another source that is perhaps less desirable. This cycle reverberates throughout the ecosystem, and can be exacerbated by the introduction of additional invasive species. Ecosystems that are already under stress are particularly vulnerable to invasion by non-native species, as the existing ecosystem is not robust enough to maintain viable populations of native species as the invasive species become established. The process may happen more quickly in already disturbed systems than it would in a healthy community.

Known invasive fish species within the West Holland River subwatershed include carp (*Cyprinis carpio*) and goldfish (*Carassius auratus*). Carp were stocked into Ontario waters as early as the late 1800s and were subsequently released into public waters through a dam break in 1896 (Scott and Crossman, 1973). The carp now flourishes in most warmwater systems in southern Ontario and disrupts native fish through their violent spawning activities which tend to uproot vegetation and cause increased turbidity in the water column. Goldfish are usually released into natural systems by well-intentioned pet owners. Competition by goldfish and other aquarium species with native species for space, cover, food, and spawning habitat is well documented.

Impacts to the hydrologic regime

Changing hydrologic conditions, including reduced baseflow and the higher peak flows brought about by increasing levels of impervious surfaces as well as water takings, can cause considerable stress to aquatic biota, and can cause a shift from a community containing more sensitive species to one containing species more tolerant of degraded conditions. Changes to the hydrologic regime are discussed in greater detail in Chapter 5, Surface Water Quantity.

Water quality and thermal degradation

Through contemporary studies and recent changes to development law, much of the system has been identified as cold or coolwater habitat. However, despite this designation, many of the coldwater systems are currently under stress. Land uses in the subwatershed have resulted in a reduction in cold groundwater inputs to watercourses, removal of riparian vegetation which helps to maintain stream temperature, the covering of stream substrate with silt, and the input of sediment and nutrients that degrade habitat quality. These changes have made many of the cold headwater reaches of the system unsuitable for mottled sculpin and other sensitive species, although they can still be found in some reaches where suitable conditions remain. The protection and enhancement of the subwatershed’s coldwater habitats will enhance the health of the whole West Holland River ecosystem. Specific information on water quality issues can be found in Chapter 4.

Key Points - Factors impacting Aquatic Habitat – stressors:

- Physical changes such as artificial barriers, on-line ponds, channelization and removal of riparian vegetation are some of the main stressors on the West Holland Rivers aquatic habitats – e.g. there are 98 known barriers; 33 hardened and channelized sections, especially within the Fraser Creek and direct tributaries of the Holland Marsh to accommodate agricultural development; and 93 sites with insufficient riparian cover
- Habitat quality and quantity is also impacted by changes in flow regime resulting from land use changes and water taking, particularly due to the channels within the Holland Marsh. Increased flow degrades habitat through processes such as bank erosion. Decreased flow can lead to a temporary or permanent reduction in the amount of aquatic habitat present.
- A water quality concern within the West Holland River is the thermal degradation occurring due to land use changes (online ponds, marsh channels, impervious areas). These changes have made many of the cold headwater reaches of the system unsuitable for mottled sculpin and other sensitive species. These issues are discussed in more detail within Chapter 4, Water Quality.
- Invasive fish species are negatively affecting native communities by occupying and/or destroying the habitat of native species, consuming their eggs and young, and by outcompeting them for resources
- Tile drainage is also likely having an impact on water quantity in the subwatershed

6.4 Current Management Framework

There are numerous acts, regulations, policies, and plans aimed at maintaining or improving aquatic habitat. These include the Fisheries Act, Endangered Species Act, the Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, the Oak Ridges Moraine Conservation Plan, and the Lake Simcoe Protection Plan. This management framework relates to many different stressors that can potentially affect aquatic habitat, with activities ranging from the loss of riparian areas to urban development. In Table 6-3 we categorize 11 such stressors, recognizing that many of these overlap and that the list is by no means inclusive of all stressors. The legal effects of this management framework broadly fall into one of two categories. The first broad category we define as those having little or no legal standing and are referred to as General or Have Regard to Statements in Table 6-3 and are shown in blue. The second category includes those that have legal standing and must be conformed to; these are referred to as Regulated / Existing Targets in Table 6-3 and are shown in green. In many cases an act, regulation, policy or plan does not have policies of either category that relate to the activity specified, these are shown in red.

Table 6-3 **Summary of current management framework as it relates to the protection and restoration of aquatic habitat**

Stressor affecting aquatic habitat	Oak Ridges Moraine Conservation Plan (2002)	Greenbelt Plan (2005)	Lake Simcoe Protection Plan (2009)	Growth Plan for the Greater Golden Horseshoe (2006)	Provincial Policy Statement (2005)	Endangered Species Act (2008)	Ontario Water Resources Act (1990)	Fisheries Act (1985)	Ontario Fisheries Regulations (1989)	LSRCA Watershed Development Policies (2008)	York Region Official Plan (2008)	Simcoe County Official Plan (2007)	Peel Region Official Plan (2008)
Growth, development and site alteration	🟩	🟩	🟩	🟦	🟦	🟦	🟥	🟥	🟥	🟩	🟩	🟩	🟩
Introduction of invasive species	🟥	🟥	🟦 3	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟥	🟥	🟦
Loss of natural heritage features	🟩	🟩	🟩	🟦	🟦	🟩 7	🟥	🟩 9	🟥	🟩	🟩	🟩	🟩
Loss of riparian areas	🟩 1	🟩 1	🟩 4	🟥	🟦	🟩 7	🟥	🟩	🟥	🟩	🟩	🟩	🟦
Stream alteration	🟩 2	🟩 2	🟩 4	🟥	🟥	🟥	🟥	🟩	🟥	🟩	🟦	🟦	🟦
Instream barriers	🟩 2	🟩 2	🟩 4	🟥	🟥	🟥	🟥	🟩	🟥	🟩	🟦	🟥	🟥
Bank hardening	🟩 2	🟩 2	🟩 4	🟥	🟥	🟥	🟥	🟩	🟥	🟩 10	🟦	🟥	🟥
Changing hydrologic conditions	🟦	🟦	🟩 5	🟦	🟦	🟥	🟩	🟥	🟥	🟩 11	🟦	🟦	🟦
Degradation of water quality (including thermal impacts)	🟦	🟦	🟩 6	🟦	🟦	🟥	🟥	🟥	🟥	🟦	🟦	🟦	🟦
Restoration	🟦	🟦	🟦	🟥	🟦	🟦 8	🟦	🟦	🟦	🟩 12	🟦	🟦	🟦
Climate change	🟥	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟦

🟦 General/Have regard to statement 🟩 Regulated/Existing targets 🟥 No applicable policies

[1] Protected through required buffers around streams/waterbodies

[2] Development/site alteration restricted within 30 metres of streams, presumably would prohibit channelization, other in-stream and riparian activities

[3] Discusses developing proposed regulations (to be considered by federal government under fisheries act), conducting studies/risk assessments, developing response plans, education programs, but nothing banning use/etc

[4] Implied under buffer restrictions

[5] Instream flow targets and water conservation, but nothing around impervious areas/higher peak flows

[6] Only contains specific policies and targets about phosphorus reduction, none about other contaminants

[7] Related to those features that are part of SARO listed species' habitat

[8] Person holding a permit to conduct an activity may be required to rehabilitate habitat damaged/destroyed in undertaking the activity; is also mentioned in policy pertaining to Species at Risk in Ontario Stewardship Program

[9] would only apply to those areas that can be classified as fish habitat

[10] Not directly stated, but stream alteration policies would cover this

[11] stormwater controls required, application must demonstrate every effort made to achieve pre-development hydrologic conditions

[12] Required for valleyland applications, may be required in other cases

In this section we provide a summary the various acts, regulations, policies and plans as they pertain to activities affecting aquatic habitat. This summary is to give context to *future management considerations* and the *opportunities and recommendations*. This summary is not intended to be comprehensive in terms of all the pieces of the management framework that relate to aquatic habitat, or of the acts, regulations, policies and plans that are discussed below – the reader is directed to each act, regulation, policy, or plan for a full assessment of how it relates to aquatic habitat.

6.4.1 Oak Ridges Moraine Conservation Plan (2002)

This plan designates Natural Core and Natural Linkage Areas for the purpose of maintaining and improving the ecological integrity of the plan area. Of the 11,363 ha of the West Holland River subwatershed that falls within the Oak Ridges Moraine planning area, approximately 3,900 ha (or 17% of the subwatershed) is designated ORMCP Natural Core and Linkage areas. The policies that apply in the Natural Core and Linkage Areas include:

- Every application for development or site alteration shall identify planning, design and construction practices that ensure that buildings or site alterations do not impede the movement of plants and animals among key natural heritage features (a designation which includes fish habitat), hydrologically sensitive features and adjacent land.
- A minimum area of influence and minimum vegetation protection zone, which are 30 metres and 120 metres, respectively. An application for development or site alteration within the minimum area of influence that relates to a key natural heritage feature, but is outside of that feature and the minimum vegetation protection zone, are to be accompanied by a natural heritage evaluation. A natural heritage evaluation shall:
    - Demonstrate that the development or site alteration will have no adverse affects on the key natural heritage feature or the related ecological functions
    - Identify planning, design and construction practices that will maintain and, where possible, improve or restore the health, diversity and size of the key natural heritage feature and its connectivity with other key natural heritage features
    - Demonstrate how connectivity within and between key natural heritage features will be maintained and, where possible, improved or restored before, during and after construction
    - Determine if the dimensions of the minimum vegetation protection zone as specified in the ORMCP are sufficient, and specify the dimensions necessary to provide for the maintenance and, where possible, improvement or restoration of natural self-sustaining vegetation within it

Policies related to water conservation and the protection of water quality and quantity will have the added benefit of helping to maintain a great number of important natural heritage features, such as wetlands (see chapter 4 and 5).

The ORMCP also details a number of requirements for those uses that are permitted within Natural Core and Linkage Areas, such as gravel pits, agricultural uses, and low-intensity recreational uses to ensure that they have minimal impact on these important areas.

6.4.2 Greenbelt Plan (2005)

One of the stated goals of the Greenbelt Plan is the protection, maintenance and enhancement of natural heritage, hydrologic and landform features and functions, including the protection of habitat for flora and fauna, as well as protecting and restoring natural and open space connections.

Wetlands, seepage areas and springs, fish habitat, permanent and intermittent streams, lakes, and significant woodlands, are all considered to be key natural heritage or key hydrologic features. Under the policies for the Natural Heritage System areas, the Plan states that:

- The minimum vegetation protection zone shall be a minimum of 30 metres wide measured from the outside boundary of these key natural heritage feature or key hydrologic features. Thus, areas within the Greenbelt boundaries within the West Holland River require a minimum 30 metre buffer.
- For development or site alteration within these features, as permitted by the Plan's policies, the application shall demonstrate that there will be no negative effects on Key Natural Heritage or Key Hydrologic Features, and that connectivity shall be maintained or enhanced wherever possible.
- The amount of disturbed and impervious area of sites where development and site alteration is permitted is limited; stating that they should not exceed 25 and 10 per cent of the site's developable area, respectively.
- Applicants are to demonstrate, where non-agricultural uses are contemplated, that
    - At least 30 per cent of the total developable area will remain in or be returned to natural, self-sustaining vegetation
    - Connectivity along the system and between key natural heritage and hydrologic features located within 240 metres of each other is maintained or enhanced
    - Buildings and structures are not to occupy more than 25 per cent of the total developable area

There are also a number of policies under the Water Resource System area of the Natural System that relate to the protection and enhancement of fish habitat. These are discussed in greater detail in Chapters 4 and 5. The external connections policies in the Water Resource System section includes encouraging planning approaches that increase or improve fish habitat and to avoid, minimize or mitigate the impacts associated with urban runoff, and the integration of watershed planning and management approaches for lands both within and beyond the Greenbelt.

6.4.3 Lake Simcoe Protection Plan (2009)

The Lake Simcoe Protection Plan (LSPP) includes numerous designated polices that will help protect aquatic habitat: Those related to the protection of permanent and intermittent streams include:

- Restrictions to structures along or within streams if it impedes flow or harmfully alters fish habitat.
- Requires any shoreline alteration required for drainage or stabilization only be completed if remediation will maintain natural stream contours and a vegetated riparian area will be established (with the exception of agricultural activities that are not required to establish riparian areas).

- Any development and site alteration within 120m of a stream should integrate with stewardship and remediation activities.

The policies in the plan that will support healthy aquatic communities in Lake Simcoe's tributaries (such as those in the West Holland subwatershed) include:

- The development of fish community objectives, to be used by public bodies to inform decisions relating to the management of land, water and natural resources, increase the resilience of the aquatic communities to future impacts of invasive species and climate change, and ensure sustainable resource use and social benefit
- The completion of baseline mapping of aquatic habitat will be completed, building on existing monitoring programs and established databases
- The development and implementation of an annual aquatic community monitoring program, which will build upon existing monitoring programs in order to support an adaptive management approach

The LSPP also deals explicitly with issues around invasive species, with a target of preventing the introduction of new invasive species in the watershed. The policies aimed at meeting this target include:

- The delivery of annual information and education programs for the general public and key stakeholders on how to prevent the spread of, and how to detect, invasive species
- The development of a community based social marketing project to identify effective methods to engage stakeholders for the purpose of modifying their behaviour to reduce the introduction and spread of invasive species
- The development of a regulatory proposal that would require anglers who are fishing with live bait in the Lake Simcoe watershed to only use live bait caught in the watershed
- The completion of a study to evaluate the potential risk of movement of invasive species through the Trent-Severn Waterway resulting from natural dispersal and boat traffic
- A mobile boat wash/education program will be developed and implemented

LSPP policies described in other chapters of this plan, particularly around the protection of natural heritage features and water quality and quantity, as described in their respective chapters, will also support healthy aquatic environments throughout the watershed.

6.4.4 Places to Grow Act – Growth Plan for the Greater Golden Horseshoe (2006)

The Growth Plan does not contain any policies related to aquatic habitat, except that the population density target calculation will exclude such areas as fish habitat and other natural heritage and hydrologic features that are otherwise protected through measures such as the Provincial Policy Statement or applicable Official Plans.

6.4.5 Provincial Policy Statement (2005)

By focusing growth within settlement areas and away from significant or sensitive resources, the implementation of the Provincial Policy Statement (PPS) will help to protect aquatic habitat within the West Holland subwatershed. The policies that support this in the PPS include:

- Directing growth to settlement areas and requiring planning authorities to identify and promote opportunities for intensification and redevelopment

- Supporting a coordinated, integrated and comprehensive approach between municipalities when dealing with managing natural heritage and water resources, and ecosystem, shoreline and watershed related issues.

Under its ‘Wise Use and Management of Resources’ policies, the PPS specifies that:

- Natural heritage features and areas (which includes fish habitat, among other features) shall be protected for the long term
- The diversity and connectivity of natural features in an area, and the long-term ecological functions and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing the linkages between and among natural heritage features and areas, and surface and groundwater features
- Development and site alteration shall not be permitted in fish habitat except in accordance with provincial and federal requirements.

Policies around the protection of water resources will also protect quality aquatic habitat for biota. See chapter 4 for PPS policies related to protecting water quality and chapter 5 for water quantity.

6.4.6 Endangered Species Act (2008)

The purposes of the Endangered Species Act (ESA) are to protect species that are at risk and their habitats, as well as promoting the recovery of those species. Through the implementation of the policies of the ESA, protection will be afforded to the aquatic habitats of the West Holland subwatershed’s rarest species, such as the Redside Dace, thus helping to preserve the subwatershed’s biodiversity. These policies state that no person shall:

- Kill, harm, harass, capture or take a living member of a species that is listed on the Species at Risk Ontario (SARO) list as an extirpated, endangered, or threatened species
- Possess, transport, collect, buy, sell, lease, trade or offer to do the same with any specimen (living or dead) or part of a species that is listed on the SARO list as an extirpated, endangered, or threatened species
- damage or destroy the habitat of a species listed as endangered, threatened, or extirpated

The policies of the ESA also require that a recovery strategy be prepared for each of the species on the SARO list as an endangered or threatened species. These strategies are to include an identification of the habitat needs of the species, a description of the threats to the survival and recovery of the species. The ESA includes a policy that states that the precautionary principle should be used in the development of recovery plans – where there is a threat of significant reduction or loss of biological diversity, a lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.

6.4.7 Ontario Water Resources Act (OWRA) – Permit to Take Water

The issuance of Permits to Take Water occurs under the *Ontario Water Resources Act (OWRA)*. In relation to aquatic habitat, the *OWRA* states (see section 34 (1)) that when issuing permits, a MOE Director should consider the following:

i. The impact or potential impact of the water taking on
    a. the natural variability of water flow or water levels
    b. minimum stream flow

    c. Habitat that depends on water flow or water levels, and

ii. Groundwater and surface water and their interrelationships that affect or are affected by…the water taking or proposed water taking, including its impact or potential impact on water quantity or quality.

As discussed in Chapter 5, Surface Water Quantity, the issuance of permits to take water is the responsibility of the Ministry of the Environment. It is only necessary to obtain a permit for water takings exceeding 50,000 L/day, and permits are not required for takings for household use or for watering livestock and poultry. While this legislation specifically addresses the quantity of water, as well as the quality with respect to certain activities, the management of water resources can have a significant influence on the health of aquatic habitat. This is discussed in greater detail in Chapter 4, Water Quantity.

6.4.8 Fisheries Act (1985)

The *Fisheries Act* is federal legislation that deals with the management of Canada's fisheries resources and the conservation and protection of fish and fish habitat. Section 35 of the *Act* states that no one may carry on any work or undertaking that results in the harmful alteration, disruption or destruction (known as a HADD) of fish habitat, unless authorized to do so by the Minister of Fisheries and Oceans Canada. It is among the oldest and strongest environmental legislation in the country. The enforcement of this Act limits the work that can be done in and around a watercourse, including channelizing and hardening activities, relocation of stream channels, and the creation of barriers, thus ensuring that habitat quality is protected and that aquatic systems do not become fragmented.

Ontario Fisheries Regulation (1989) (created under the federal Fisheries Act)

These regulations set out the rules around fishing (both recreational and commercial) and possessing fish in the province of Ontario. Aside from rules around fishing licenses, fishing quotas and acceptable methods, the regulations most applicable to this subwatershed plan mainly focus on preventing the introduction of invasive species and protection of endangered species, and include:

- Regulation 6 (1) states that no person shall possess a live invasive fish without a license.
- Regulation 28 states that it is illegal for anyone to deposit live fish into a body of water other than the body of water from which they were caught. There is also a specific regulation regarding bait fish – it is illegal to release baitfish into any waters, or within 30 metres of any waters.
- Regulation 29 stipulates that it is against the regulations for any person to use as bait or even possess for use as bait, an invasive species.
- Regulation 7 (1) states that no person shall fish for or possess a specially protected fish without a licence.

The enforcement of these regulations, though difficult, is an important tool for preventing the introduction and spread of invasive species and the protection of endangered species in the subwatershed.

6.4.9 Timing Restrictions for In-Water Works

The Ontario Ministry of Natural Resources (OMNR) is responsible for determining in-water works restrictions such that fish and other aquatic life are permitted to carry out their life processes undisturbed. These restrictions are based on the presence of warm and cold water thermal fish communities as determined by contemporary thermal regime and fisheries studies (Figure 6-8).

The Main Branch of the West Holland River from the mouth to the Town of Aurora border is considered warmwater habitat wherein in-water works are not permitted between April 1st and June 30th of any given year. This restriction also applies to Eastern, Western and Holland Landing Creeks and municipal and agricultural drainage systems. Coldwater timing restrictions, wherein in-water works are permitted only between May 31st and September 15th of any given year apply to the rest of the Main Branch and the Sharon Creek, Bogart Creek, Tannery Creek, Weslie Creek, and Marsh Creek tributaries. These restrictions are mandated by the Aurora District of the Ministry of Natural Resources. In-water restrictions are currently being reviewed by OMNR and may lead to revised timing and location of restrictions – contact OMNR for latest information.

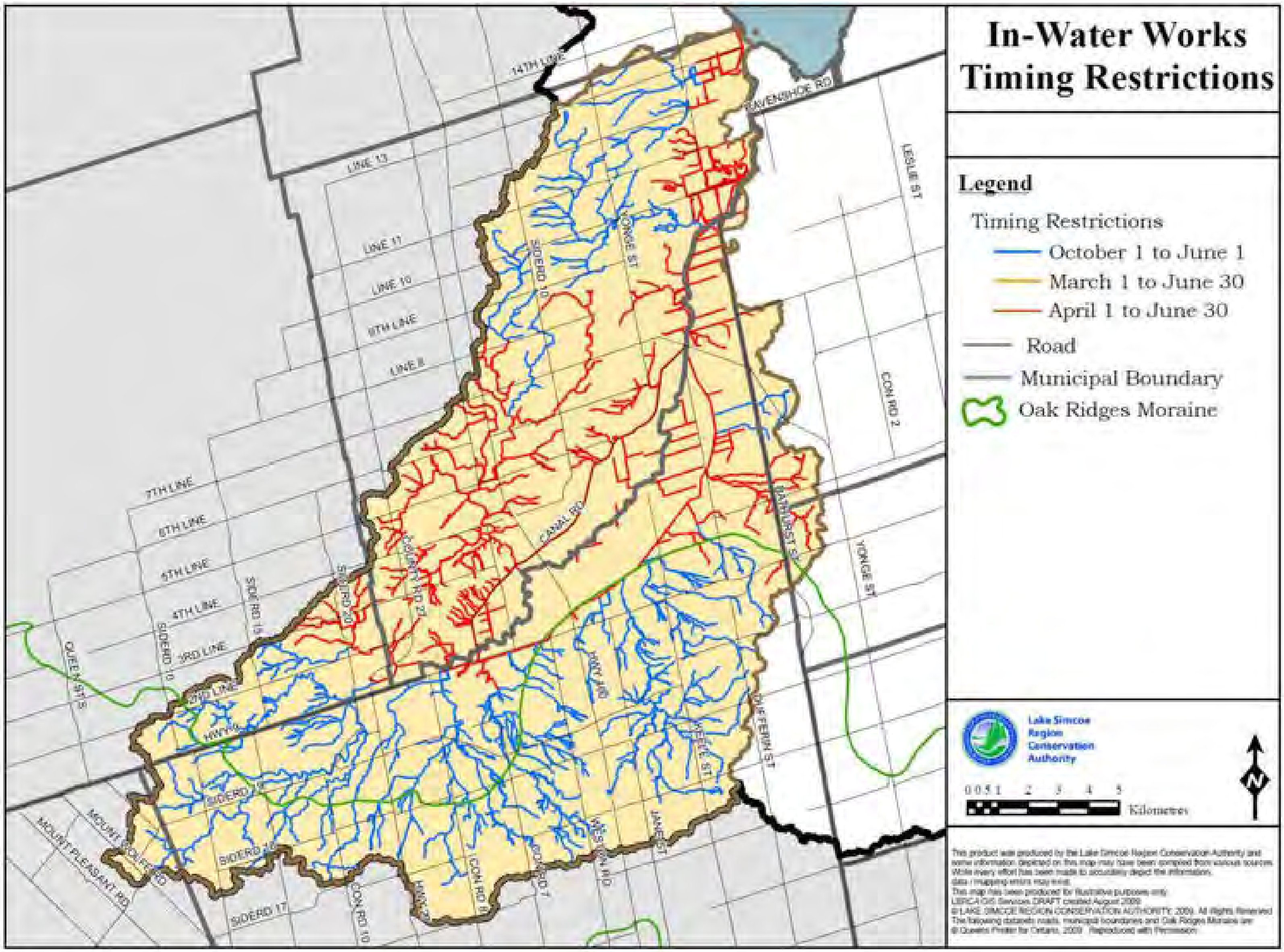


Figure 6-8 Timing restrictions for in-water works in the West Holland River subwatershed

6.4.10 LSRCA Watershed Development Policies

The Authority requires an undisturbed vegetative buffer strip running consistently along both sides of all watercourses. The buffer is to be measured perpendicularly outwards from the edge of the annual average high water mark as follows: a) a minimum 15 metre buffer for all watercourses, b) a minimum 30 metre buffer for all coldwater or marginally coldwater (coolwater) watercourses. Where watercourses have not been studied as to thermal regimes or fish population, the 30 metre buffer will be required*.* In the West Holland, only those areas within the "white belt" (the designated urbanizing areas that do not fall within the Oak Ridges Moraine) are afforded the minimum buffer of 15 metres. Note that this policy has largely been superseded by LSPP which requires a minimum 30m vegetative protective zone for <u>all</u> key natural heritage and hydrological features (see below).

6.4.11 York Region Official Plan (2009)

There are a number of policies in York Region's Official Plan that pertain to the protection of fish and aquatic habitat. These policies include:

- The protection and enhancement of the Regional Greenlands System and its functions and to direct new development and site alteration away from the Greenlands System. The Greenlands System contains many of the East Holland's watercourses
- Requiring local municipalities to develop local Greenlands Systems that identify enhancement areas and linkage opportunities and include policies, initiatives and mapping that protect and complement the regional system
- Prohibiting development and site alteration within key natural heritage features (which includes fish habitat) and adjacent lands, unless it is demonstrated that the activity will not result in a negative impact to the feature or its functions
- Prohibiting the removal of key natural heritage features
- Being consistent with federal and provincial regulations regarding fish habitat
- Cooperating with conservation authorities, the province, and local municipalities to further define and better understand key natural heritage features and their functions and to promote improved stewardship and protection strategies
- Encouraging private and public landowners with lands containing key natural heritage features to manage their lands in a manner that conserves and enhances features in accordance with the policies of the OP
- Protecting and enhancing aquatic habitats, including fish and wildlife habitats, in co-operation with the province and conservation authority through the implementation of fisheries management plans, watershed plans, and other resource management plans
- Supporting the goals and objectives of subwatershed plans

Policies related to the protection of water resources will also help to protect aquatic habitat, by ensuring that there is enough water of sufficient quality to support healthy aquatic ecosystems.

6.4.12 Simcoe County Official Plan (2007)

This plan does contain some policies related to the protection and enhancement of aquatic habitat. These include:

- Policies related to development in and around fish habitat, wetlands, significant forests, and other natural heritage features

- Requiring a Stormwater Management Report for all plans of subdivision or the creation of more than five lots; as well as industrial, commercial, or institutional developments with more than 1000 m^3 of impervious area; implementation of these plans will prevent the input of sediment, nutrients and other contaminants as well as mitigating the flow of stormwater, which can impact aquatic habitat
- Encouraging good farm and land stewardship practices and stewardship and education programs
- Stating that land use planning and development decisions shall contribute to the protection, maintenance, and enhancement of water and related resources and aquatic ecosystems
- Ensuring that new development is sufficiently set back from rivers and streams in order to develop vegetative corridors along watercourses
- Stating that development shall maintain the principle of no negative impacts on fish habitat, in accordance with the Fisheries Act

6.4.13 Peel Region Official Plan (2008)

- Ensuring, jointly with area municipalities, and conservation authorities, in consultation with the Department of Fisheries and Oceans, no negative impacts occur to fish habitat as a result of development or site alteration
- Protecting, maintaining, and enhancing the quality and integrity of ecosystems, jointly with area municipalities, conservation authorities, and other partners
- Adopting policies and establishing programs for the restoration of the natural environment in Peel, working jointly with local municipalities, the conservation authority and other partners
- Supporting and encouraging area municipalities, in consultation with the conservation authorities, the development of programs to manage and eliminate invasive species; also encouraging the use of native species
- Preparing green development standards, and encouraging area municipalities to do the same
- Promoting and participating in the development of watershed plans
- Directing area municipalities to include, in their official plans, objectives and policies for the management of stormwater quantity and quality that would avoid, minimize and/or mitigate stormwater volume, contaminant loads, and impacts to receiving watercourses
- Supporting programs of partner organizations which encourage farmers to develop and follow conservation measures and sustainable farming practices
- Preparing, in consultation with area municipalities, conservation authorities, and other partners, a climate change strategy to address mitigation and adaptation
- Protecting and/or enhancing the features and functions of the regional Greenlands system, which will help to maintain or enhance aquatic habitat

6.4.14 Additional legislation and policies that address aquatic habitat issues

The policies discussed in the water quantity, water quality, and natural heritage chapters, if implemented, will all serve to protect and enhance the quality and quantity of aquatic habitat in the West Holland River. Readers should refer to these chapters for specific information around the policies that protect the quality and quantity of water that the aquatic community depends on, as well as the protection of the amount and quality of natural heritage features and their functions.

6.5 Management gaps and limitations

As can be seen in the above section, there are a number of pieces of legislation, regulations and municipal requirements aimed at protecting the aquatic habitat of the West Holland River. Despite this strong foundation, there are a number of gaps and limitations in the management framework that need to be considered, such as the effects of climate change. This section provides an overview of factors that need to be considered in the future management of the subwatershed.

6.5.1 Growth, Development and Site Alteration

These activities are strongly regulated in areas such as key natural heritage features, key hydrologic features, and shorelines through the ORMCP, Greenbelt Plan, Lake Simcoe Protection Plan, York Region and Simcoe County Official Plans, and LSRCA Watershed Development Policies. Fish habitat is often considered a key natural heritage feature within this framework, in addition to the other features that will help to protect and enhance fish habitat. There are, however, limitations with these policies:

- For many natural heritage features (other than wetlands) it is only those considered significant that are protected, and in general only those considered provincially significant are protected. Although they are not considered to be significant, these features still perform important functions in the watershed, and the development of these areas and loss of these functions will have impacts to watershed health. Wetlands are now well protected through the Generic Regulation (179/06);

- The policies that apply to hydrologic features are not consistent across the subwatershed – the definition of a key hydrologic feature is different for the ORMCP area, the Greenbelt Plan area, and the LSPP area which covers the remainder of the subwatershed. Features such as seepage areas, springs, aquifers and recharge areas are protected in the ORMCP area, but not the LSPP area, and the Greenbelt Plan includes seepage areas and springs but not aquifers and recharge areas. These discrepancies can leave some of these features unprotected, which could have impacts to aquatic habitat.

- Some plans specify a minimum vegetation protection zone around key natural heritage and key hydrologic features (e.g. the ORMCP and Greenbelt Plan), and also identify a further ‘area of influence’ (as it is referred to in the ORMCP) outside of the minimum vegetation protection zone. Within this area of influence, a proposal for development or site alteration triggers the requirement for a natural heritage and/or hydrologic evaluation. This evaluation is meant to describe the existing conditions, assess the potential impacts from proposed development/site alteration and determine if the minimum vegetation protection zone provides sufficient protection. If the minimum vegetation protection zone is not found to be sufficient, the evaluation should specify the dimensions of the required minimum vegetation protection zone. While the goal of these policies is undoubtedly to protect the features, in reality the required evaluations rarely specify anything greater than the minimum; in essence the minimum becomes the maximum distance. There is therefore little further protection gained through this process for these features and their functions by way of a buffer distance.

6.5.2 Introduction of Invasive Species

Only the Lake Simcoe Protection Plan and Ontario Fisheries Regulations under the Fisheries Act contain policies around the introduction of invasive species. The following are some of the gaps and limitations with the policies as they currently stand:

- The Ontario Fisheries Regulations do set strict rules around the possession, transport, and release of invasive species. However, the list of invasive species on the list included with the regulations is very limited – it does not include common carp, for example. This list also only contains invasive fish species, which means that there are no rules around species such as rusty crayfish, for example.
- It is very difficult and expensive to enforce these regulations.
- The LSPP notes the importance of identifying funding sources for the implementation of invasive species response plans, but there is currently not a guaranteed fund for undertaking these activities.

6.5.3 Loss of Natural Heritage Features

A number of the natural features that contribute to healthy aquatic habitat in the subwatershed are protected through the existing management framework. The loss of those features not protected because they are not of significance or don't fall within certain geographic regions as identified by the various pieces of legislation could contribute to the degradation of aquatic habitat.

6.5.4 Loss of Riparian Areas

With the release of the Lake Simcoe Protection Plan, which builds upon the protection already existing through the ORMCP and Greenbelt Plans, development within 30 metres of a permanent or intermittent stream is not permitted anywhere in the Lake Simcoe watershed, with the exception of a few activities, most of which would have little impact. However, one of the permitted activities, if the need for the project has been demonstrated, is infrastructure. The undertaking of an infrastructure project could result in a significant loss of riparian area.

6.5.5 Stream Alteration, Instream Barriers, and Bank Hardening

As any of these activities would be considered to be a harmful alteration, disruption or destruction of fish habitat, they would be strictly regulated under the Fisheries Act. These activities would also be regulated under the policies of the ORMCP, Greenbelt Plan, and LSPP.

6.5.6 Changing Hydrologic Conditions

The policies related to changing hydrologic conditions are generally 'have regard to' statements. The LSRCA Watershed Development Policies require applicants to make every effort to limit impervious surface and maintain pre-development hydrologic conditions, and the LSPP will set Instream flow targets and does include requirements for water conservation plans. However, there are limitations:

- The total amount of impervious surface is generally not accounted for through a subwatershed
- All development will have a certain amount of impervious surfaces, regardless of efforts to limit it. None of the policies applicable in the watershed *require* the use of innovative BMPs to encourage infiltration (such as soakaway pits) and water conservation practices (such as dual-flush toilets, rainwater harvesting, and water recycling). These are the

types of activities will be needed to ensure consistent hydrologic conditions that will maintain aquatic habitat.

6.5.7 Degradation of Water Quality

As is discussed in Chapter 4, a number of the Acts, regulations and policies that apply in the watershed are aimed at preventing the degradation of water quality. There are, however, some significant gaps, which has resulted in declining water quality in the subwatershed. This, combined with a number of other factors, has had an impact on the subwatershed’s aquatic community. These gaps and limitations include:

- Aside from requiring Level 1 stormwater control for all new developments, there are no policies around non-point source inputs of pollutants.
- Point source discharges are well regulated, requiring permits to be issued, but the cumulative impacts of these discharges to the receiving watercourse and their aquatic habitat may not be thoroughly considered.
- There is no policy support or related enforcement for the Provincial Water Quality Objectives – the degradation of water quality due to the input of contaminants as well as thermal degradation has continued despite the objectives that have been set. The LSPP sets a target of achieving the PWQOs or better in the watershed, but generally does not include policies to meet this target.

6.5.8 Restoration

Most of the policies related to restoration are quite general in nature, and do not contain specific requirements. Some require applications for development or site alteration in key hydrologic features or key natural heritage features to be accompanied by a natural heritage or hydrologic evaluation, which in some cases requires the applicant to include planning, design or construction practices that will maintain and, where feasible, improve or restore the health, size, and diversity of the feature. The limitations to this approach include:

- Resources are needed to ensure that the specified design practices are being undertaken during and after construction
- It may be difficult to measure whether the health, size and diversity of a feature has been maintain or restored – this would require a significant input of resources, and impacts may not be seen for some time after the construction has been completed.

6.5.9 Climate Change

Climate change is generally not well addressed in the current management framework. The LSPP contains the most comprehensive policies related to this issue which, although it is still difficult to predict its impacts, may cause considerable stress to the aquatic communities in this subwatershed. The adaptation strategy that will be developed through the LSPP is a significant first step in addressing this issue, and some of the Official Plan policies are beginning to consider climate change as well. While it may not be appropriate for some of the existing legislation to address climate change issues, it will be important to incorporate climate change considerations wherever possible in making management decisions for the subwatershed, and implement policies requiring, at the very least, the implementation of so called “no regrets” options should be incorporated into development and site alteration wherever possible.

6.6 Recommended Actions to Improve Aquatic Habitat

The following recommended actions were developed to improve habitat for aquatic biota in the West Holland River subwatershed. While there are pockets of healthy fish and benthic invertebrate communities in the subwatershed, mainly in the headwaters draining off of the ORM, the aquatic communities are showing signs of stress in others. For the most part, this can be attributed to anthropogenic activities. The aquatic communities in and around the agricultural areas of the subwatershed, and urban areas and highways are undergoing stress from online ponds and other barriers, removal of riparian vegetation, channelization and bank hardening, changing flow regimes because of increasing impervious area, water extraction, and the input of harmful chemicals and sediment. These stresses can be expected to increase with the increasing urban area in the town of Bradford and the demand for locally grown produce, unless measures are undertaken to prevent them. The implementation of the actions below will help to mitigate the impacts of this growth, as well as that of the existing urban and rural land uses, on the quality of aquatic habitat in this subwatershed.

These recommendations, which are grouped and numbered as described in Section 1.4, were developed to address the water quality issues and stressors that were identified throughout this chapter. In addition, they consider, and are consistent with applicable policies and recommendations in the province's Lake Simcoe Protection Plan, and the LSRCA's Integrated Watershed Management Plan. Each recommendation below also identifies the applicable 'detailed recommendations' as outlined in Chapter 10. These detailed actions will form the basis of the Implementation Plan for York Region's ORM subwatersheds, to be developed following the completion of this plan.

6.6.1 Planning and Policy

1) That the municipal partners and the LSRCA strive to reduce the impacts of stormwater through a number of methods including the implementation of policies and guidelines and enabling the use of new and innovative technologies, retrofitting of existing developments.

   Detailed recommendations: A.1.1 – A.1.3

4) That the municipal partners and the LSRCA strive to maintain natural hydrologic conditions on development sites

   Detailed recommendations: A.3.1 – A.3.2

5) That the federal, provincial, and municipal governments, as well as the LSRCA, continue to evaluate and implement planning initiatives and practices aimed at reducing the impact of development on the condition of the West Holland River subwatershed

   Detailed recommendations: A.3.3, A.3.5, C.1.1

6) That the value of the ecological goods and services (EGS) provided by ecological features be considered in decision making around growth and development

   Detailed recommendation: A.3.6

7) That the rural/agricultural community be engaged in developing solutions for minimizing the impacts of practices on their lands

   Detailed recommendation: A.4.1

10) That the Province, the municipal partners, and the LSRCA seek to gain an improved understanding of the impacts of climate change in the West Holland subwatershed, incorporating this information into decision making scenarios and developing strategies to mitigate and adapt to its impacts.

Detailed recommendations: A.6.1 – A.6.2, G.1.1 – G.1.3

6.6.2 Use of Better Management Practices

11) That the LSRCA and its municipal partners continue working to mitigate the impacts of stormwater to water quality and quantity through tracking its sources, completing stormwater retrofits, promoting methods of minimizing stormwater volume, and continuing to research new and innovative solutions to stormwater control and implementing these solutions where appropriate.

    Detailed recommendations: B.1.1 – B.1.5

12) That support for programs offered to assist rural landowners in implementing BMPs on their properties, such as LSRCA's LEAP program, be continued and/or expanded as resources permit

    Detailed recommendations: B.2.1 – B.2.3

13) That sectors that have the potential to have significant impacts on conditions in the West Holland subwatershed be expected to undertake BMPs and other activities to mitigate their impacts, as required under the LSPP

    Detailed recommendations: B.2.4 – B.2.5

14) That the LSRCA and the partner municipalities encourage the use of natural channel designs and 'soft solutions' wherever possible for preventing or mitigating streambank erosion and accommodating channel realignments; and that technical and financial resources be made available for retrofitting where appropriate to undertake these activities.

    Detailed recommendations: B.3.1 – B.3.3

6.6.3 Changing the way things are done 'on the ground'

17) That the partner municipalities, the LSRCA, and the related stakeholders work to reduce the impacts of construction practices on the West Holland subwatershed's water quality

    Detailed recommendations: C.3.1 – C.3.2

6.6.4 Applied Research and Science

20) That all partners study the requirements for environmental flows within the West Holland subwatershed, explore innovative solutions, and undertake works and practices where possible in order to ensure adequate baseflow to support ecological function

    Detailed recommendations: D.1.5, D.1.7, D.1.14 – D.1.15, D.2.2

22) That the partners explore the subwatershed to determine where reductions in groundwater discharge, excessive water takings and other impacts to aquatic habitat have occurred and undertake activities to mitigate these impacts

    Detailed recommendations: D.2.1

26) That all partners cooperate to determine the presence and extent of invasive species in the subwatershed, and work to prevent their establishment and spread

    Detailed recommendations: D.3.7 – D.3.8

6.6.5 Monitoring

28) That the LSRCA continue to undertake the aquatic monitoring program, with expansions to the program in order to further understand conditions in the subwatershed; and cooperate with partner agencies on additional initiatives as required

    Detailed recommendations E.2.1 – E.2.2

6.6.6 Management, Rehabilitation and Restoration

33) That the MNR, with the support of LSRCA and the partner municipalities, undertake initiatives aimed at maintaining the health of the subwatershed's fish community. These may include the development of fish community goals and objectives, fisheries management plans, or other plans aimed at protecting the habitat of species at risk in applicable catchments.

    Detailed recommendations: F.1.1 – F.1.4, F.1.7

34) That the LSRCA and its partners continue monitoring the aquatic community and habitat in the West Holland subwatershed, assessing the monitoring program on a regular basis and undertaking targeted monitoring where appropriate to fill data gaps.

    Detailed recommendations: F.1.5 – F.1.6

36) That that LSRCA, in cooperation with its partner municipalities, prioritize and undertake activities to improve and restore aquatic ecological functions within the subwatershed, including barrier removal, natural channel design, restoring floodplain functions, and wetland creation. This could include undertaking pilot/demonstration projects to assess the feasibility of such works.

    Detailed recommendations: F.1.8 – F.1.10, F.1.12 – F.1.15, F.1.17

38) That the LSRCA continue to utilize buffer requirements and timing guidelines as tools to protect aquatic resources, and that other activities such as stormwater retrofits, tree planting, and habitat enhancement be undertaken to enhance aquatic habitat

    Detailed recommendation: F.1.17

38) That the LSRCA and the partner municipalities assess the feasibility of increasing natural cover (e.g. woodland, streambank vegetation, interior forest, grassland) in the subwatershed and set priorities and develop plans to undertake this enhancement, based on overall benefit to the subwatershed.

    Detailed recommendations: A.5.3, F.2.1 – F.2.5

41) That the LSRCA support the work of MNR and OFAH with respect to invasive species and encourage the distribution of promotional materials.

    Detailed recommendation: F.3.1

44) That the LSRCA request the Ministry of Natural Resources to undertake the development of watershed rare lists and protection policies for species at risk in the subwatershed.

    Detailed recommendation: F.4.3

6.6.7 Adaptive Response

47) That the LSRCA and partner municipalities work to reduce their carbon footprint and to increase ecological resilience in the watershed

    Detailed recommendations: G.1.1 – G.1.3

7 Fluvial Geomorphology

7.1 Introduction and background

Fluvial geomorphology is the study of the processes that influence the shape and form of streams and rivers. It describes the processes whereby sediment and water are transported from the headwaters of a watershed to its mouth. These processes govern and constantly change the form of river and stream channels, and determine how stable the channels are. Fluvial geomorphology provides a means of identifying and studying these processes, which are dependent on climate, land use, topography, geology, vegetation, and other natural and human influenced changes.

An extensive understanding of geomorphic processes and their influences is required in order to protect, enhance, and restore stream form in a watershed. Changes in land use, and urbanization in particular, can significantly impact the movement of both water and sediment, and can thus cause considerable changes to the geomorphic processes in the watershed. Changes to the morphology of stream channels, such as accelerated erosion, can impact the aquatic community, which has adapted to the natural conditions, and can also threaten human lives, property, and infrastructure.

The watercourses of the West Holland River are generally fairly stable. The main impacts to stability in this subwatershed have been the removal of vegetation to accommodate agriculture, the channelization of some reaches, and small pockets of urban areas. These changes have led to some impacts including channel widening and aggradation, and one section of planform change. The land use changes that are anticipated for this subwatershed could have an impact on the stability of the system; it will be important to undertake all possible measures to limit these impacts and preserve stream form and function into the future.

7.1.1 Geomorphic Processes

All streams and river systems are constantly in a state of transition, influenced by the flow of water and the amount of sediment entering into the system. The amount of water in a natural watercourse is influenced by both climate and geology. The amount of water delivered to the surface of a watercourse, as well as how and when it arrives is influenced by climate. Typical patterns are high flow events during the spring freshet, and low flow conditions during the winter and summer months.

The surficial geology of an area influences the path of water once it reaches the ground surface. The underlying geology establishes the volume and proportion of groundwater and surface water available to flow through a watershed through its effect on infiltration. Geology also shapes the amount and type of sediment that enters a watercourse, and the strength and erodibility of the surficial material through which the watercourse flows. A complex underlying geology and topography can result in considerable variation in channel character, as well as sensitivity to potential impacts, within the same drainage system.

Natural watercourses respond to continually changing conditions in flow and sediment supply with adjustments in shape and channel position. These changes take place through the processes of erosion and deposition. This ability to continually change is an inherent characteristic of natural systems that allows the morphology of the channels to remain relatively constant. The state in which flow and sediment supply are balanced to achieve this stable channel form is referred to as “dynamic equilibrium.” While in a state of dynamic equilibrium, channel morphology is stable but not static, since it makes gradual changes as sediment is deposited and moved throughout the watercourse. For example, many natural watercourses can be seen to “migrate” within their floodplain over time. This is due to the erosion of the outsides of channel bends, but with corresponding deposition of material on the insides of bends. This process maintains the balance between flow and sediment supply in the system. Riparian and aquatic biota is adapted to and depend on the habitats provided by a system in dynamic equilibrium.

7.2 Current status

PARISH Geomorphic Ltd. was retained to compile spatial information on the West Holland River subwatershed. This assessment involved two components: desktop analysis and field reconnaissance. The desktop analysis involved classifying the streams into stream order, valley segmentation, reach breaks for 3rd and higher order streams, belt width corridor delineation, and historic analysis using aerial photography (2002) and other digital datasets such watercourses, contour lines (5 m interval), quaternary geology, soils, roads, land-use, and watershed boundaries (Table 7-1). Desktop analysis also involved assessing historical changes in the planform. In this case three sets of aerial photographs, spanning 43 years were used. The field reconnaissance component of the assessment built upon the desktop analysis by field truthing random reaches to confirm the results of the desktop work and identify areas of unusual channel conditions such as excessive erosion or deposition.

Table 7-1 A summary of geomorphologic features investigated

River Feature	Description	Method
Planform	The shape of a watercourse as viewed from above	Assessment of historical aerial photos
Stream Order	A measure of the degree of stream branching within a watershed	Assessment of aerial photos
Valley Segments	Relatively homogenous sections of watercourses that exhibit distinct and similar physical elements	Assessment of aerial photos
Reach Break Determination	Reaches are lengths of channel that display similarity with respect to valley setting, planform, floodplain materials, and land use or land cover.	Assessment of aerial photos
Meander Belt Width	The stream corridor that the river channel potentially has had in the past and, more importantly, could occupy in the future	Assessment of aerial photos
Rapid Geomorphic Assessment (RGA)	Assesses the geomorphic condition of the reach by evaluating the occurrence of four geomorphic processes: aggradation, degradation, widening, and planform adjustment	Field survey
Rapid Stream Assessment Technique (RSAT)	Assesses the overall stability of the reach from both a geomorphic and ecological perspective by evaluating channel dimensions	Field survey

7.2.1 Planform

An analysis of historical aerial photographs was used to identify changes in channel planform (Parish Geomorphic Ltd 2001). Aerial photographs from three sets of coverages, 1959/61, 1976, and 2002, spanning 43 years were used. Migration rates are usually calculated to determine rates of change along a river (PARISH Geomorphic Ltd, 2001). However, as this study was a high-level survey of the watershed, the air photo resolution was insufficient to accurately calculate migration rates. Planform was examined for all three study years. There was one area of channel planform change identified in the West Holland River subwatershed.

Channel planform remained largely unchanged on the main branch of the West Holland River over the 43 year study period. The main branch was fairly sinuous, particularly in the area of the Holland Marsh. Downstream of this area to the confluence with the East Holland River, the river planform remains largely unchanged and mildly sinuous. River planform was carefully examined for all three years of available aerial photographs.

This subwatershed is considered very stable; however, it did appear to have a slightly altered planform between all three study years. This reach flows through a forested area immediately upstream of the Holland Marsh. Overall, this subwatershed does not appear to have exhibited much change in landuse, nor have the watercourses undergone significant adjustment overall.

7.2.2 Stream Order

Stream order is a measure of the degree of stream branching within a watershed; a first-order stream is an unbranched tributary, a second-order stream is a tributary formed by the connection of two or more first-order streams, a third-order stream is a tributary formed by the connection of two or more second-order streams, and so on. Stream orders for the West Holland River subwatershed were calculated manually as part of the desktop exercise.

Bifurcation ratio is the rate at which a stream divides, which influences the pattern of sediment delivery and the shape of the hydrograph. Bifurcation ratio values between three and five are typical for areas in southern and eastern Ontario with glacial deposits (Chorley, 1969). The West Holland River subwatershed falls within these typical ratio values, with a bifurcation ratio of 3.19. Stream order and average bifurcation ratio for the subwatershed can be seen in Table 7-2 below.

Table 7-2 Summary of stream order and bifurcation ratio for the West Holland River

Orders	***West Holland River***
1	614
2	151
3	41
4	11
5	5
6	2
7	1
Average Bifurcation Ratio	**3.19**

7.2.3 Valley Segments

Valley segments are defined as relatively homogenous sections of watercourses that exhibit distinct and similar physical elements. As such, valley segment boundaries are determined by primary features of the watersheds such as topography, geology, climate, and hydrography/drainage networks (Kilgour and Stanfield, 2000). Climate is considered to have only minor influence on local scales and was not considered as part of the valley segment assessment.

The attributes that were used to identify valley segment breaks were defined by the differences in stream slope, catchment size, and surficial geology. These properties were categorized using

GIS software, and subsequently overlaid to determine the locations of valley segment breaks, although some adjustments to correct errors due to GIS issues were necessary.

Valley segments were delineated using a hierarchy of rules as outlined by Kilgour and Stanfield (2000), whereby segments were first partitioned based on the drainage network/hydrography. Segment boundaries were identified where two tributaries merged, resulting in an increase based on the Horton System (1945). Digital mapping was used to determine and allocate stream order. All third-order (and larger) streams were considered in this subwatershed due to the large catchment size. Additional segment boundaries were also placed where watercourses crossed a boundary that separated two distinct geological units of differing porosity (e.g. sandy material to clayey material), provided the boundaries were not in conjunction with an existing hydrological junction. Finally, segments were also identified where gradients changed dramatically within one of the previously identified segments. This typically occurred where a channel dramatically changed confinement, such as where it passed onto a large floodplain.

The West Holland River drains through large areas of glacial outwash and lake bed materials. Adjacent surficial geology type was considered to be a better characteristic for delineating river segments, as it would pick up local sources or sinks of baseflow. Therefore additional segment boundaries were placed where watercourses crossed a boundary that separated two distinct geological units of differing porosity (e.g. sandy material to clayey material), provided the boundaries were not in conjunction with an existing hydrological junction. For this analysis, digital surficial geology maps (Ontario Geological Society) were used.

A total of 149 valley segments were identified within the West Holland River, ranging in length from as short as 56 metres (segment 1) to as long as 5,400 metres (segment 110) (See Parish Geomorphic Ltd, 2006 for location of valley segments).

7.2.4 Reach Break Determination

Reaches are lengths of channel (typically ranging between 200 m and 2 km in length) that display similarity with respect to valley setting, planform, floodplain materials, and land use or land cover. Reach length will vary in scale given that the morphology of low-order watercourses traverse a smaller distance compared to higher-order watercourses. The delineation of reaches along a drainage network is beneficial, as it enables grouping and the identification of general reach characteristics. It is also an ideal starting point from which the effect of subwatershed changes can be assessed.

At the reach scale, characteristics of the river corridor (i.e. valley setting, vegetation, etc.) exert a direct influence on channel form, function, and processes (PARISH Geomorphic Ltd., 2001). At this scale, the watercourse strives to obtain a form that is in quasi-equilibrium with the physical properties of its local setting and the hydrologic and sediment regimes. For example, a comparison of two reaches situated immediately up and downstream of each other but in different physical settings (i.e. scrubland versus forest) may exhibit considerable variation in channel form.

Location of reach breaks are presented in Figure 7-1.

7.2.5 Meander Belt Width

The meander belt width represents the stream corridor that the river channel potentially has had in the past and, more importantly, could occupy in the future. This is determined by identifying the spatial extent of the meander pattern within a reach. Widths are measured at right angles to the trend of the valley. Additional factors, such as remnant channel (ox-bow lakes) and meander scars also assist in identifying the maximum extent the channel may occupy within its floodplain.

As part of best management practices, it is imperative to establish maximum allowable setbacks as a means to preserve stream margin habitats, including floodplains and wetland environments. Encouraging setbacks such as vegetation buffer strips in zoning regulations and controlling urban and agricultural development in the stream corridor will minimize potential property damage while enhancing and protecting overall natural habitat.

The meander belt width analysis was undertaken using digital mapping and recent aerial photography. The information developed as part of the meander belt width process can be used to revise the Authority’s Generic Regulation mapping and increase accuracy.

Meander belt widths were greatest (161 to 310 metres) downstream of the Holland Marsh Canal and Yonge Street to the confluence with the East Holland River. Narrowest meander belt widths (0 to 30 metres) tended to occur in the headwater areas of the subwatershed, such as the headwaters of Fraser Creek and the North and South Schomberg Rivers.

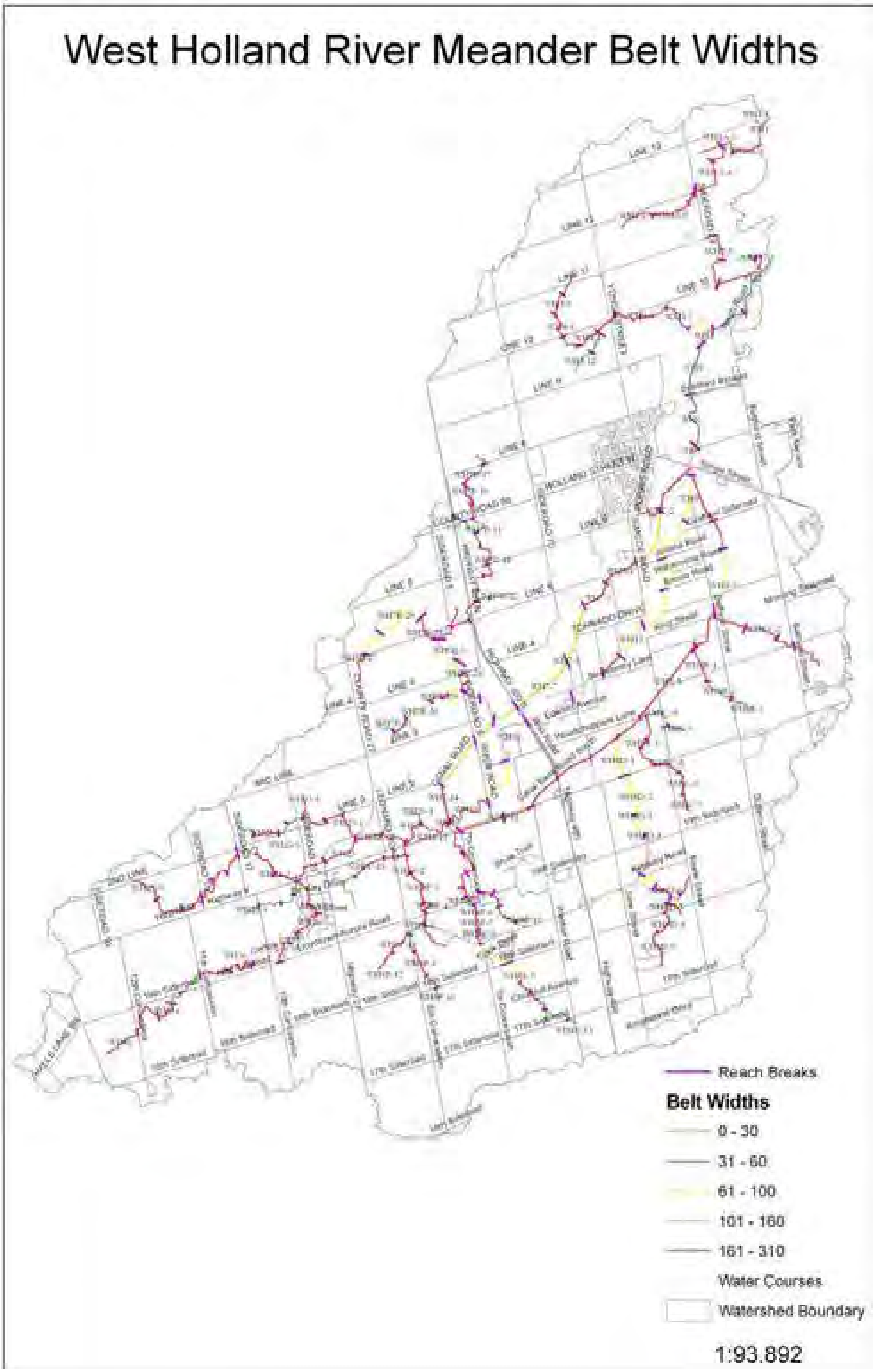


Figure 7-1 **West Holland River reach break and meander belt width.**

7.2.6 Field Reconnaissance

Because of the large area and high number of reaches in the West Holland River subwatershed, walking all of the reaches was not feasible. A variety of methods were used to determine the reaches that would be walked. Rapid stream assessments were carried out to verify features observed in aerial photographs (such as changes in landuse and planform). A matrix was constructed to identify representative reaches to be walked based on catchment area and stream gradient, both of which have a significant influence on reach characteristics.

Sites were selected to ensure there was representation from combinations of small, medium, and large catchment areas and low, moderate, and high channel gradient. Within each category, reaches exhibiting planform change in the historic analysis were selected for rapid assessments. As there was a minimal amount of planform change observed in the subwatershed, additional reaches were selected randomly. The rapid assessments of the selected reaches were used to assess the overall health and condition of each of them.

A Rapid Geomorphic Assessment (RGA) assesses the geomorphic condition of the reach by evaluating the occurrence of four geomorphic processes: aggradation, degradation, widening, and planform adjustment. A score is determined for each process and the four scores are averaged to yield an RGA score (Table 7-3).

Table 7-3 RGA scores and their definitions

RGA Score	State description	geomorphic condition
0 - 0.20	in regime	Reach is in good condition, in a state of dynamic equilibrium
0.21 – 0.4	transitional	Showing signs of stress and that it may undergo an adjustment
>0.4	adjustment	Geomorphology is adjusting or changing to new conditions

A Rapid Stream Assessment Technique (RSAT) assesses the overall stability of the reach from both a geomorphic and ecological perspective by evaluating channel dimensions, substrate composition of riffles and pools, and evaluating the quality of available habitat in the reach based on physical, chemical, and biological criteria. Each category is given a rating of excellent, good, fair, or poor with an associated numerical value. These values are summed to give an RSAT score (Table 7-4)

Table 7-4 RSAT scores and their definitions

RSAT Score	Stability rating
<20	low stability rating
20-35	a moderate level of stability
>35	a high stability rating

In some cases, the RGA and RSAT scores may appear to be contradictory as some reaches yield good RGA scores and poor RSAT scores. However, RGA scores rate the stream purely from a geomorphic perspective whereas RSAT scores rate the stream from an ecological perspective. Therefore streams that flow through agricultural areas will often receive scores indicating that they are fairly stable as they are often highly vegetated but will score poorly on the RSAT due to poor water quality and low scores on the biological criteria, which will lower the overall score.

Thirty-one reaches were evaluated for the West Holland River subwatershed between summer 2005 and fall 2006. Only one reach received an RGA score of ‘in adjustment,’ 13 reaches were determined to be ‘transitional,’ and 17 were determined to be ‘in regime.’ The RSAT assessment determined all reaches to be moderately stable, which indicates that the subwatershed was in reasonable condition with good habitat conditions. Channel widening was the dominant channel process observed throughout the majority of the subwatershed. This was evidenced by many leaning and fallen trees, exposed tree roots, and the occurrence of large organic debris.

Aggradation was also frequently observed, particularly in the downstream sections of the subwatershed. This was evidenced by siltation in pools, poor longitudinal sorting of bed material, and the presence of medial bars. Substrate throughout the subwatershed was primarily composed of silts and sands with some coarser substrate occasionally observed in riffles (pebbles, gravels, cobbles). Riffle sediments were slightly coarser in the upstream reaches; however, pools remained primarily composed of sand and silt for the entire subwatershed. There was some erosion observed in most reaches, although it was fairly minor. Several reaches did, however, experience high levels of erosion. Of the reaches observed there was one reach in particular, south of Lloydtown-Aurora Road (WH8 F-5), that displayed major erosion, undercutting, and bank slumping. However, this problem is not widespread throughout the subwatershed. Sediment size was evaluated in each reach and was determined to be predominantly composed of sand and silt throughout the subwatershed.

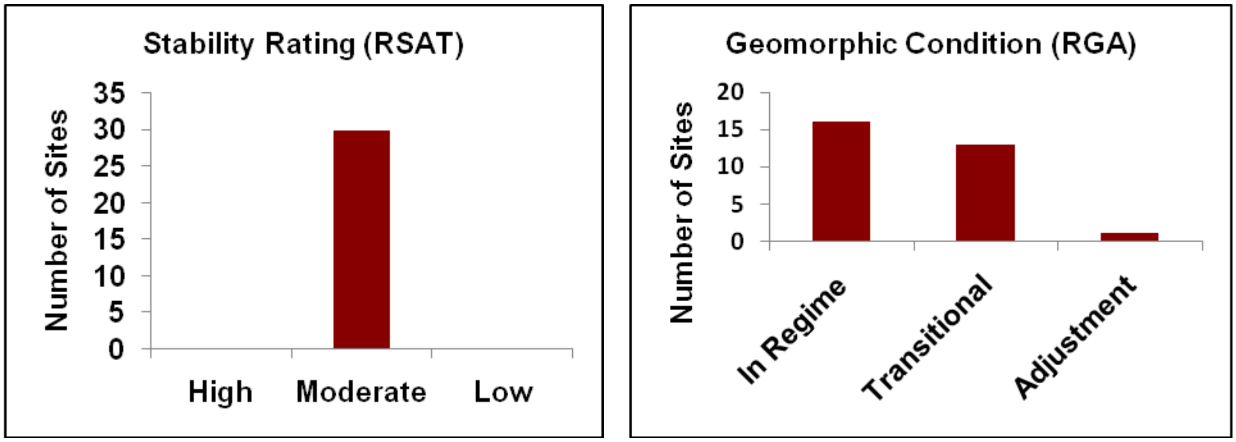


Figure 7-2 **Summary of field survey results**

Several sections of the West Holland River have been channelized, in particular some of the smaller tributaries near the mouth and the two canals that flow parallel to the main branch through the Holland Marsh. As observed in the historic aerial photographs, the majority of the subwatershed is used for agricultural purposes with some upstream sections in more forested areas. The Town of Bradford is the only major urban centre in the subwatershed, located west of the main branch of the West Holland. Several reaches in the system had been channelized and were dominated by silty substrate and in-stream vegetation. Beaver activity and debris jams were also observed in some reaches throughout the subwatershed. Detailed descriptions of conditions at each of the reaches surveyed can be seen in Table 7-5. Figure 7-3 to Figure 7-6 highlight some of the conditions in the subwatershed.

Table 7-5 **Fluvial geomorphology assessment: field observations in the West Holland River subwatershed**

Reach Name	Location	RSAT	RGA	Length (m)	Riffle Substrate	Pool Substrate	Erosion	Notes
WH1A-2	Runs adjacent to North Road between the end of Bathurst St and Line 10	24.0	0.07	580.05	NA	Silt/sand	Bank slumping, large erosion on right bank before reach flows 90 degrees to south	Large ditch with slow moving water. Bank stable except at 90 degree turn
WH1A-3	Between Line 13 and Line 12	24.0	0.12	688.52	NA	Silt/sand		Ditch with minimal erosion. Dominated by tall grasses. Slow moving stagnant water, very silty and turbid
WH1A-5	South of Line 12	21.0	0.28	560.6	Sand/pebble/gravel	Silt/sand	Bank slumping evident	Channel relatively narrow and entrenched. Flows through grassy fields with some trees. No indication of any depositional features
WH1A-7	Between Yonge St and 20th Sideroad	22.0	0.21	1182.78	Gravel/cobble/boulder	Silt/sand	Bank erosion common with undercuts	Large boulders throughout channel. Gradient seems high. Large debris jams. Very straight and ditch-like at times.
WH1A-6	Between Line 11 and 12 east of Yonge Street	22.0	0.43	1416.52	Pebble/gravel/small cobble/boulder	Silt/sand	Many eroded banks, undercuts, scour	Very active channel through cedar thicket/ very large meanders. Many depostional features such as bars and islands. Major woody debris jam in channel.
WH2-2	North of Line 10	22.0	0.08	813.52	NA	Silt/sand		Straight ditch to canal. Slow moving, heavy siltation. Dominated by tall wetland grasses. Bank stability is relatively good.
WH2-3	Runs parallel to Line 10	22.0	0.08	1320.98	NA	Silt/sand		Straight ditch to canal. Slow moving, heavy siltation. Dominated by tall wetland grasses. Bank stability is relatively good.
WH2-4	North of Line 10	22.0	0.08	953.1	NA	Silt/sand		Straight ditch to canal. Slow moving, heavy siltation. Dominated by tall wetland grasses. Bank stability is relatively good.
WH2-5	South of Line 11	21.0	0.14	1118.96	NA	Silt/sand	Some erosion, scour and exposed roots	Grassy, slow and narrow moving ditch.
WH4-2	South of Line 10 east of Yonge St	23.0	0.21	1079.35	NA	Silt/sand		Reach enters forest swamp/wetland and fans out with multiple channels and ponded water common. Bank definition is minimal. Grassy banks with large fallen woody debris and major jams
WH4-3	South of Line 10 east of Yonge St	22.0	0.33	893.25	Pebble/gravel/cobble/boulder	Silt/sand	Erosion on most banks with undercutting	Some valley wall contact. Reach flows through cedar thicket mostliy inside scanton creek. Good riffle-pool sequence. Major woody debris at tiems. Minimal depositional features
Wh4-4	South of Line 10 east of Yonge St	22.0	0.23	1205.87	Pebble/gravel/cobble	Silt/sand	Many eroded banks, undercut. Slumping on banks	Good riffle-pool sequence.
WH4-5	South west of Yonge St and Line 10	23.5	0.26	839.4	Sand/pebble/gravel/cobbles	Silt/sand	Major slumping at downstream end	Multiple beaver dams at us end of reach. Good pool-riffle sequences
WH4-6	South west of Yonge St and Line 10	24.5	0.28	872.51	Pebble/gravel/cobble	Silt/sand	Minor amounts of erosion	2 large beaver dams and a large weir at reach end causing backwater. Gradients very high from dams.
WH4-7	South of Line 10	21.0	0.36	690.39	Pebble/gravel/small cobble	Silt/sand	Banks with major erosion	Large woody debris jams, exposed clay in bed. Good riffles-pools, bar formations, islands.

Reach Name	Location	RSAT	RGA	Length (m)	Riffle Substrate	Pool Substrate	Erosion	Notes
Wh4-8	North of Line 10	21.5	0.36	947.19	Coarse sand/very coarse sand/pebble/gravel/cobble	Silt/sand	Major erosion on most meander bends/banks	Good riffle-pool sequence. Valley wall contact. Bar formations and islands present. Riffles large and very coarse.
Wh4-9	Between Line 10 and Line 11	24.5	0.29	845.5	P/gr/cobble	Silt/sand		Several driveways with culverts intersect channel. Long riffles
WH4-10	Crossing Line 11 west of Yonge St	26.0	0.26	670.55	Cs/vcs/p/gr/small cobble	Silt/sand	Moderate to high erosion. Exposed tree roots. Exposed clay downstream	Very naturalized channel. Few riffles. Large fallen trees
WH4-11	South west of Yonge St and Line 10	22.5	0.39	778.83	pebble/gravel/cobble	Silt/sand	Slumping on banks and minor erosion through site	Few riffles. Channel braids several times. Some valley wall contact. Exposed clay bed/bank at times. Clay knick point
WH4-12	Between Line 9 and Line 10	24.0	0.14	781.05	NA	Silt/sand	Minimal erosion/slumping	Channel dominated by scrubland grasses and shrubs.
WH7-4	Along Line 5 west of Simcoe Road	21.0	0.19	1088.82	NA	Silt/sand/ muck	Erosion and basal scour through reach. Exposed tree roots	Frozen. Some fallen trees on banks
WH7-6	Between Line 4 and Tornado Drive	23.5	0.16	1655.75	Pebble/gravel/cobble	Silt/sand	Major slumping ds of bridge bank scour and erosion evident at some areas	Some leaning trees with exposed roots
WH7B-2	East of River Road	23.5	0.19	633.9	NA	Silt/sand	Lots of fallen trees	Wetland riparian zone. 2 culverts at road. Both banks wetland area.
WH8A-1	East of Dufferin St	25.0	0.18	1282.64	Gravel/cobble	Silt/sand	Minimal erosion and slumping	Very wooded, good riparian
WH8C-2	South of Woodchoppers Lane	23.0	0.18	810.44	NA	Silt/sand/muck		Small trib into major channel reach
WH8D-1	North of Hwy 9	21.0	0.17	1411.2	NA	Silt/sand/muck	Eroded banks. Fallen trees	Typical channel design. Small drainage pipe in left bank
Wh8E-7	North of Lloydtown-Aurora Road	22.5	0.25	538.9	Gravel/cobble/sand	Sand/pebble/ gravel	Undercut erosion on right bank	Major woody debris.
WH8F-5	South of Lloydtown-Aurora Road	22.0	0.18	498.99	Pebble/gravel	Silt/sand	Large eroded banks on meanders. Major erosion at confluence	Channel frozen and snow covered. Wetlands floodplain. Large fallen trees on bank and in channel
WH8F-11	West of 8th Concession	24.0	0.18	958.11	Cobble/sand/pebble	Sand/silt/pebble/gravel	Exposed roots and undercutting on right bank. Cedars leaning and slumping	Riffles are large coarse materials. Roadside drain joins the reach at 8th concession.
WH18	Between River Road and Canal Road	20.0	0.11	2019.4	NA	Silt/sand		Very sinuous. Very poor riparian vegetation.

Figure 7-3 A channelized portion of the West Holland River (Reach WH 1A-2)

Figure 7-4 An example of a debris jam (Reach WH 4-7)

Figure 7-5 Undercutting of the bank (Reach WH 4-8)

Figure 7-6 Channel hardening (Reach WH 18)

Key Points – Current Fluvial Geomorphology Status:

- The West Holland River subwatershed is a fairly stable system, with all of the sites surveyed having a moderate stability score
- An assessment of geomorphic condition (RGA) shows that the majority of the sites (53%) were in good condition (a state of dynamic equilibrium), while approximately 43% were in a state of transition and only 0.03% were adjusting
- There are, however, several impacted sections within the subwatershed, existing and planned urbanized areas in the subwatershed will likely continue to stress the system, as well as continuing agricultural practices

7.3 Factors impacting status - stressors

The changes exerted by humans on natural landscapes can significantly alter the geomorphic processes in watercourses. Land use changes result in a shift in the balance of runoff, evapotranspiration, and infiltration of precipitation. The removal of trees and other natural cover for agriculture will result in a reduction in evapotranspiration; while the paving of natural surfaces for urbanization will reduce the amount of surface water infiltrating into the ground and an increase in runoff. As discussed in Chapter 5 urban areas, such as Bradford, in the West Holland River subwatershed are having a variety of effects on hydrology such as a decrease in time to peak flow following a rain event, a lessening of seasonal variation in flow rates, and a decrease in baseflow rates. Each of these effects can lead to changes in stream geomorphology as they all influence erosion and deposition processes.

Land use changes will also alter the sediment regime in the watercourse, which will contribute to unnatural shifts in the geomorphology of stream and river systems, resulting in changes far beyond those experienced in a system in dynamic equilibrium. The changes also tend to occur much more quickly than they would in a natural system, and can result in impacts to the biotic communities living in and around the watercourse, public safety issues, and damage to property.

The effects of land use changes on instream function and the ability to self regulate can be exacerbated by additional activities directly adjacent to or within watercourses. In urban areas, the common practice of straightening and realigning stream channels in order to accommodate development eliminates natural habitat and enhances channel instability, because the new channel form lacks the natural adjustment mechanisms that would maintain stability. In agricultural areas, channels are often realigned and channelized to maximize the area available for crops, riparian vegetation is often removed, and land is tilled up to the edge of the bank. The results of these practices are unstable banks, the loss of natural channel form and correction ability, and the loss of habitat. The extent to which West Holland River streams have been channelized is discussed in more detail in Chapter 6 (Aquatic Habitat).

While the land use changes that have been and continue to be undertaken in the Lake Simcoe watershed have caused channel instability and erosion; the traditional methods to manage these issues have themselves caused problems. The use of engineered solutions to protect banks and stream channels such as hardening the river bed and/or banks with concrete, riprap, gabion baskets or armourstone; and weirs and other structures to control flows often fail, as the structures are undermined by the watercourse as it moves to adjust to changing conditions. These structures also reduce the quality and quantity of riparian and aquatic habitat. The hardening of the watercourse increases the velocity of flows, and reduces the potential for natural attenuation of flows along the length of the watercourse. This serves to exacerbate the impacts of urban land uses, resulting in failure of the structures and ongoing degradation of the stream, resulting in the continual need for repair of existing structures, and damage elsewhere in the system that also requires repair.

Traditional stormwater management practices also interfere with natural processes. The goal has commonly been to remove stormwater as quickly and efficiently as possible and convey it to a watercourse. To accomplish this, many watercourses have been hardened and channelized. This has resulted in increase flow velocities and volumes, and most often causes erosion in downstream areas that do not have the natural ability to accommodate these flows. Issues with stormwater are further discussed in Chapter 3.

7.3.1 Recreation

Natural areas such as streams and rivers are a popular location for recreational activities such as hiking, boating and snowmobiling. If not managed correctly and undertaken in a responsible manner, these activities can impair ecological condition of the area. Impacts from recreational activities can include increased bank erosion and instability, loss of riparian area resulting in an increase in input of total suspended solids (TSS) and pollution and an increase in runoff as the banks are pounded down from man-made trails. Stresses on these sensitive areas are increasing as a result of increasing population and diminishing natural heritage lands.

7.3.2 Mitigating Issues Associated with Land Use Changes

It has become increasingly understood that, in many cases, engineered structures may not be the best solution for mitigating streambank erosion. There has been an increasing consideration of the natural geomorphic processes that shape watercourses, as well as consideration for ecological conditions and potential impacts on those areas that lie upstream and downstream in the design and construction of erosion protection works. It is now common practice to re-route watercourses that have been straightened and/or hardened, through a practice called “Natural Channel Design.” Through this practice, channels are designed to mimic natural conditions, taking into account what is understood of the physical conditions in the watercourse. This creates habitat, and will also help to prevent further impacts in the downstream sections of the watercourse. Figure 7-6 below displays a site where natural channel design was implemented.

Figure 7-6 **An example of natural channel design**

Stormwater management has become a requirement in the Lake Simcoe watershed, in an attempt to mitigate some of the impacts of an urbanizing environment. The most commonly used type of stormwater management is end-of-pipe stormwater ponds, which serve to detain the excess runoff from urban areas and release it slowly to a receiving watercourse. This is thought to help prevent the erosion that results from the high flows received by watercourses in areas without stormwater management. However, there are issues associated with these facilities, including the increase in water temperature and the required maintenance to ensure that the pond continues to function as designed. Minimizing land use change, particularly in the vicinity of watercourses, is the best way to prevent impacts to stream form.

Key Points – Factors Impacting Fluvial Geomorphology - stressors:

- In agricultural areas, channels are realigned and channelized to maximize the area available for crops, riparian vegetation is removed, and land is tilled up to the edge of the bank. The results of these practices are unstable banks, the loss of natural channel form and correction ability, and the loss of habitat.
- Urbanization within the watershed is leading to increased flow velocities and volumes, which can cause erosion in downstream areas that do not have the natural ability to accommodate these flows. The removal of riparian vegetation also creates issues of bank stability.
- Straightening and realigning stream channels in order to accommodate development is eliminating natural habitat and enhancing channel instability.

7.4 Current management framework

While the majority of the policies in the relevant acts, regulations, policies, and plans relate to water quality and quantity and natural heritage, the implementation of a number of these policies will have the added benefit of protecting riparian areas and other natural features that help to maintain stable watercourses, or by helping to reduce some of the stresses that cause channel movement and bank instability, such as large volumes of storm water. This management framework includes the Fisheries Act, Endangered Species Act, the Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, the Oak Ridges Moraine Conservation Plan, and the Lake Simcoe Protection Plan. This management framework relates to many different stressors that can potentially affect stream geomorphology, including stream alteration, urban development, and site alteration. In Table 7-6 we categorize 8 such stressors, recognizing that many of these stressors overlap and that the list is by no means inclusive. The legal effect of this management framework broadly falls into one of two categories. The first broad category we define as having little or no legal standing and are referred to as General or Have regard to Statements in Table 7-6 and are shown in blue. The second category includes those that have legal standing and must be conformed to; these are referred to as Regulated / Existing Targets in Table 7-6 and are shown in green. In many cases an act, regulation, policy, or plan does not relate to the activity specified, these are shown in red.

Table 7-6 Summary of the current management framework as it relates to the protection and restoration of stream geomorphology

Stressor affecting stream geomorphology	Oak Ridges Moraine Conservation Plan (2002)	Greenbelt Plan (2005)	Lake Simcoe Protection Plan (2009)	Growth Plan for the Greater Golden Horseshoe (2006)	Provincial Policy Statement (2005)	Fisheries Act (1985)	Ontario Water Resources Act (1990)	LSRCA Watershed Development Policies (2008)	York Region Official Plan (2008)	Simcoe County Official Plan (2007)	Peel Region Official Plan (2008)
Development and site alteration	🟩	🟩	🟩	🟦	🟦	🟩	🟥	🟩	🟩	🟩	🟩
Impervious surfaces	🟩	🟩	🟦	🟥	🟥	🟩	🟥	🟦	🟩 [4]	🟩 [4]	🟩 [4]
Removal of riparian vegetation	🟩	🟩	🟩	🟥	🟦	🟩	🟥	🟩	🟩	🟦	🟦
Stormwater controls	🟩	🟦	🟩	🟦	🟦	🟥	🟩	🟩	🟩 [5]	🟩	🟩
Channelization/stream alteration	🟩	🟩	🟩	🟥	🟥	🟩	🟥	🟩 [1]	🟦	🟦	🟦
Bank hardening	🟩	🟩	🟩	🟥	🟥	🟩	🟥	🟩 [2]	🟦	🟦	🟦
Restoration	🟦	🟦	🟦	🟥	🟦	🟦	🟥	🟩 [3]	🟦	🟩	🟩
Climate change	🟥	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩

🟦 General/Have regard to statement 🟩 Regulated/existing targets 🟥 No applicable policies

[1] would be considered in some cases, but generally discouraged
[2] not a policy directly addressing bank hardening, but follows from policies regarding stream alteration
[3] required for valleyland applications, may be required in other cases (case-by-case basis)

[4] within ORM planning area
[5] specific policies within ORM planning area, otherwise this is a 'have regard to'
[6] within Major Open Space Areas and Greenbelt Natural Heritage System

In this section we provide a summary the various acts, regulations, policies and plans as they pertain to activities affecting stream geomorphology. This summary is to give context to *future management considerations* and the *opportunities and recommendations to improve stream geomorphology and stability*. This summary is not intended to be comprehensive in terms of all the legislative pieces that relate to stream geomorphology, or of the acts, regulations, policies and plans that are discussed below – the reader is directed to each act, regulation, policy, or plan for a full assessment of how it relates to stream geomorphology.

7.4.1 Oak Ridges Moraine Conservation Plan (2002)

This plan designates Natural Core and Natural Linkage Areas for the purpose of maintaining and improving the ecological integrity of the plan area. Of the 11,363 ha of the subwatershed that lies within the Oak Ridges Moraine planning area, approximately 3,900 ha (or 17% of the subwatershed) is designated ORMCP Natural Core and Linkage areas. The policies that apply in the Natural Core and Linkage Areas include:

- Development and site alteration are prohibited if they would cause the impervious area of the subwatershed, outside of designated settlement areas, to exceed 10%.
- A minimum area of influence and minimum vegetation protection zone around key natural heritage features (such as wetlands or fish habitat) and hydrologically sensitive features (such as a stream), which are 30 metres and 120 metres, respectively. An application for development or site alteration within the minimum area of influence that relates to a key natural heritage feature, but is outside of that feature and the minimum vegetation protection zone, are to be accompanied by a natural heritage and/or hydrological evaluation. These evaluations are required to:
    - Demonstrate that the development or site alteration will have no adverse affects on the feature or the related functions
    - Identify planning, design and construction practices that will maintain and, where possible, improve or restore the health, diversity and size of the feature and its connectivity with other key natural heritage features
    - Determine if the dimensions of the minimum vegetation protection zone as specified in the ORMCP are sufficient, and specify the dimensions necessary to provide for the maintenance and, where possible, improvement or restoration of natural self-sustaining vegetation within it

The ORMCP requires applications for major development to demonstrate how the removal of vegetation will be kept to a minimum, which will help to promote infiltration; and also to minimize the amount of impervious area on the site.

The ORMCP also details a number of requirements for those uses that are permitted within Natural Core and Linkage Areas, such as gravel pits, agricultural uses, and low-intensity recreational uses to ensure that they have minimal impact on these important areas.

7.4.2 The Greenbelt Plan (2005)

Among the goals stated for the Environmental Protection area of the Greenbelt is the protection, maintenance and enhancement of natural heritage, hydrologic and landform features and functions. Although this does not state the protection of the stability of watercourses, that will be one of the outcomes of achieving this goal. Applications for development under Greenbelt Plan Policies are required to demonstrate that:

- There will be no negative effects on key natural heritage or hydrologic features
- Connectivity is maintained or enhanced wherever possible
- Removal of other natural features…should be avoided
- The disturbed area of any site does not exceed 25% and the impervious surface does not exceed 10% of the total developable area

Though these policies do not apply in the Greenbelt's identified Settlement Areas, they will help to limit impacts outside of settlement areas.

The Greenbelt Plan also limits development and site alteration within key natural heritage features and key hydrologic features, and identifies a minimum vegetative protection zone around them to afford further protection.

The Plan also encourages municipalities to support planning approaches that establish or increase the extent of vegetation protection zones in natural, self sustaining vegetation; increase or improve fish habitat; and avoid or minimize the impacts associated with urban runoff.

7.4.3 Lake Simcoe Protection Plan (2009)

The implementation of a number of the policies in the Lake Simcoe Protection Plan will benefit conditions in the subwatershed with respect to fluvial geomorphology.

The Stormwater Management policies will likely have the greatest benefit. Among these that relate to fluvial geomorphology are:

- Municipalities are to prepare and implement comprehensive stormwater management master plans for each settlement area. These are to include:
    - An evaluation of the cumulative environmental impact of stormwater from existing and planned development
    - A determination of the effectiveness of existing stormwater management works at reducing the negative impacts of stormwater on the environment
    - An examination of stormwater retrofit opportunities
- Municipalities are to incorporate into their official plans policies related to reducing stormwater runoff volume, including:
    - Encouraging the implementation of a hierarchy of source, lot-level conveyance and end-of-pipe controls
    - Encouraging the implementation of innovative stormwater management measures
    - Allowing for flexibility in development standards to incorporate alternative community design and stormwater techniques
    - Support implementation of source control programs, which are targeted to exiting areas that lack adequate stormwater controls
- Stormwater management works that are established to serve new major development shall not be permitted unless the works have been designed to satisfy the *Enhanced Protection Level* specified by MOE

- Owners of stormwater control structures are required to inspect and maintain the works to ensure they are functioning properly

The LSPP also contains policies around water conservation and efficiency. This includes requiring municipalities to identify and evaluate methods for promoting water conservation such as water reuse and recycling, which will reduce the volume and velocity of stormwater runoff.

There are also policies which place limitations and restrictions around placing structures and altering the shore of watercourses within the Lake Simcoe watershed. Where works are allowed, the proposal must enhance ecological features; and minimize erosion, sedimentation, and the introduction of excessive nutrients or other pollutants and utilize planning and design practices that maintain and improve water quality.

The MNR and LSRCA are required to delineate priority areas for riparian area restoration. The implementation of these restoration works will help to provide stability to the West Holland's watercourses.

7.4.4 Places to Grow – Growth Plan for the Greater Golden Horseshoe (2006)

While the Growth Plan does not deal directly with issues of fluvial geomorphology, there are policies within it that, when implemented, will help to prevent these issues. Most notable among these:

- Municipalities are encouraged to implement and support innovative stormwater management actions as part of their redevelopment and intensification activities.
- The identification of natural systems for the Greater Golden Horseshoe and the potential development of additional policies for their protection. The protection of these natural systems and their associated functions will help to mitigate storm flows and maintain stable watercourses.
- Water conservation measures, including water recycling, are encouraged. The widespread adoption of these practices will reduce the volume of stormwater flowing to watercourses, helping to prevent issues such as instability and erosion.

7.4.5 Provincial Policy Statement (2005)

By encouraging development patterns that protect resources and the quality of the natural environment, such as directing growth within settlement areas and away from significant or sensitive resources, the policies of the PPS can help to protect the stability of the subwatershed's watercourses. Relevant policies include:
Settlement areas are to be the focus of growth.

- Natural heritage features and areas shall be protected for the long term
- The diversity and connectivity of natural features in an area, and the long term ecological function and biodiversity of natural heritage systems should be maintained, restored or, where possible, improved, recognizing the linkages between and among natural heritage features and areas, surface water features and groundwater features.
- Restrictions on development in features such as natural heritage features such as significant woodlands and valleylands, significant wildlife habitat, and fish habitat, or lands adjacent to these features.
- Planning authorities are to protect, improve, or restore the quality and quantity of water by (not all listed):

  - Implementing necessary restrictions on development to protect, improve or restore vulnerable surface and groundwater features, sensitive surface water features and their hydrological functions
  - Maintaining linkages and relative functions among surface water features, groundwater features, hydrologic functions, and natural heritage features and areas
  - Ensuring stormwater management practices minimize stormwater volumes…and maintain or increase the extent of pervious surfaces
- Development shall generally be directed away from hazardous land adjacent to river, stream and small inland lake systems which are impacted by flooding and/or erosion hazards.

7.4.6 Ontario Water Resources Act (1990)

The Ontario Water Resources Act deals with the approval of stormwater management works under Section 53. Under this Act, the MOE reviews applications for stormwater works, and provides a Certificate of Approval if the application and associated studies are deemed to be sufficient.

7.4.7 Fisheries Act

The *Fisheries Act* is federal legislation that deals with the management of Canada's fisheries resources and the conservation and protection of fish and fish habitat. Section 35 of the *Act* states that no one may carry on any work or undertaking that results in the harmful alteration, disruption or destruction (known as a HADD) of fish habitat, unless authorized to do so by the Minister of Fisheries and Oceans Canada. It is among the oldest and strongest environmental legislation in the country. The enforcement of this Act limits the work that can be done in and around a watercourse, including channelizing and hardening activities, relocation of stream channels, and the creation of barriers, thus ensuring that habitat quality is protected and that aquatic systems do not become fragmented.

Through an agreement with the Department of Fisheries and Oceans (DFO), the LSRCA administers the *Fisheries Act* through its permitting process. LSRCA staff, acting on behalf of DFO, review applications for proposed works occurring in and around water and provide guidance and ensure that the works adhere to the requirements of the *Act*. Where in-water works are permitted, LSRCA staff work closely with the proponent to ensure that there is no loss of fish habitat due to the works, and that the works have minimal impact during the time that the site is disturbed

7.4.8 LSRCA Watershed Development Policies

The Authority requires an undisturbed vegetative buffer strip running consistently along both sides of all watercourses. The buffer is to be measured perpendicularly outwards from the edge of the annual average high water mark as follows: a) a minimum 15 metre buffer for all watercourses, b) a minimum 30 metre buffer for all coldwater or marginally coldwater (coolwater) watercourses. Where watercourses have not been studied as to thermal regimes or fish population, the 30 metre buffer will be required. Note that this policy has largely been superseded by LSPP which requires a minimum 30m vegetative protective zone for all key natural heritage and hydrological features (see below).

These required buffers will help to maintain the integrity of streambanks, thus protecting their form and function.

7.4.9 York Region Official Plan (2009)

The implementation of a number of the policies in this plan will help to ensure the stability of streams within York Region. These include:

- Numerous policies around the protection and enhancement of the features and functions of the Regional Greenlands System will help to maintain the stability of the watercourses in the subwatershed by enhancing infiltration, thus reducing the velocity and volume of overland flows, and by providing stability to streambanks
- Provisions providing for the protection of significant woodlands and wetlands identified in the OP
- Maintaining the natural quality and hydrological characteristics of watercourses and lakes…and that development will be designed with the goal of maintaining water balance
- Maintaining linkages and related functions among surface water features, groundwater features, hydrologic function, and natural heritage features
- Requiring the preparation of comprehensive Master Environmental Servicing Plans as a component of secondary plans and major development and redevelopment to minimize stormwater volume and contaminant loads, and maximize infiltration through an integrated treatment approach
- Requiring owners and operators of stormwater management works to inspect, maintain, and monitor effluent quality on a periodic basis
- Requiring that development have an integrated and innovative approach to water management, be water efficient, and minimize stormwater and contaminant loads and maximize infiltration through an integrated treatment approach

7.4.10 Simcoe County Official Plan (2007)

With respect to policies that will contribute to the stability of watercourses, the Simcoe County Official Plan:

- Contains policies related to development in and around fish habitat, wetlands, significant forests, and other natural heritage features. These will serve to maintain the features and their functions, thus helping to maintain the stability of watercourses
- Requiring a Stormwater Management Report for all plans of subdivision or the creation of more than five lots; as well as industrial, commercial, or institutional developments with more than 1000 m^3 of impervious area; implementation of these plans will mitigate the flow of stormwater, which will prevent high flows and streambank erosion
- Encouraging good farm and land stewardship practices and stewardship and education programs
- Stating that land use planning and development decisions shall contribute to the protection, maintenance, and enhancement of water and related resources and aquatic ecosystems
- Ensuring that new development is sufficiently set back from rivers and streams in order to develop vegetative corridors along watercourses

7.4.11 Peel Region Official Plan (2008)

The implementation of a number of the policies contained within Peel Region's Official Plan will serve to maintain or enhance the stability of watercourses in the West Holland River subwatershed. Applicable policies include:

- Protecting, maintaining, and enhancing the quality and integrity of ecosystems, jointly with area municipalities, conservation authorities, and other partners
- Adopting policies and establishing programs for the restoration of the natural environment in Peel, working jointly with local municipalities, the conservation authority and other partners
- Preparing green development standards, and encouraging area municipalities to do the same
- Promoting and participating in the development of watershed plans
- Directing area municipalities to include, in their official plans, objectives and policies for the management of stormwater quantity and quality that would avoid, minimize and/or mitigate stormwater volume, contaminant loads, and impacts to receiving watercourses
- Supporting programs of partner organizations which encourage farmers to develop and follow conservation measures and sustainable farming practices
- Preparing, in consultation with area municipalities, conservation authorities, and other partners, a climate change strategy to address mitigation and adaptation
- Protecting and/or enhancing the features and functions of the regional Greenlands system

7.5 Management gaps and limitations

As can be seen in the above section, there are a number of pieces of legislation, regulations and municipal requirements aimed at maintaining stream stability in the West Holland River. Despite this strong foundation, there are a number of gaps and limitations in the management framework that need to be considered, such as the effects of climate change. This section provides an overview of factors that need to be considered in the future management of the subwatershed.

7.5.1 Growth, Development and Site Alteration

These activities are strongly regulated in areas such as key natural heritage features, key hydrologic features, and shorelines through the ORMCP, Greenbelt Plan, Lake Simcoe Protection Plan, York Region and Simcoe County Official Plans, and LSRCA Watershed Development Policies. The protection and potential enhancement of these features will help to prevent the damaging flows that lead to instability in the system. There are, however, limitations with these policies:

- For many natural heritage features (other than wetlands) it is only those considered significant that are protected, and in general only those considered provincially significant are protected. Although they are not considered to be significant, these features still perform important functions in the watershed, and the development of these areas and loss of these functions will have impacts to watershed health. Wetlands are now well protected through the Generic Regulation (179/06);

- The policies that apply to hydrologic features are not consistent across the subwatershed – the definition of a key hydrologic feature is different for the ORMCP area, the Greenbelt Plan area, and the LSPP area which covers the remainder of the subwatershed. Features such as seepage areas, springs, aquifers and recharge areas are protected in the ORMCP area, but not the LSPP area, and the Greenbelt Plan includes seepage areas and springs but not aquifers and recharge areas. These discrepancies can leave some of these features unprotected.
- Some plans specify a minimum vegetation protection zone around key natural heritage and key hydrologic features (e.g. the ORMCP and Greenbelt Plan), and also identify a further 'area of influence' (as it is referred to in the ORMCP) outside of the minimum vegetation protection zone. Within this area of influence, a proposal for development or site alteration triggers the requirement for a natural heritage and/or hydrologic evaluation. This evaluation is meant to describe the existing conditions, assess the potential impacts from proposed development/site alteration and determine if the minimum vegetation protection zone provides sufficient protection. If the minimum vegetation protection zone is not found to be sufficient, the evaluation should specify the dimensions of the required minimum vegetation protection zone. While the goal of these policies is undoubtedly to protect the features, in reality the required evaluations rarely specify anything greater than the minimum; in essence the minimum becomes the maximum distance. There is therefore little further protection gained through this process for these features and their functions by way of a buffer distance.

7.5.2 Impervious Surfaces

The ORMCP, Greenbelt Plan and Regional Official Plans contain policies around that aim to limit impervious area to a certain level, while the PPS, LSPP and LSRCA Watershed Development Policies contain more general statements about striving to limit impervious area. Since all new developments – and hence new impervious areas – are required to have Level 1 stormwater control that will collect and mitigate flows, storm flows from these areas should not have a significant impact on stream stability. Issues from overland storm flows mainly stem from the existing, uncontrolled, urban areas. However, increases in impervious area affect baseflow, which can also have impacts on stream form, so it is therefore still important to limit impervious areas to the extent feasible. The policies around limiting impervious surfaces are limited in scope, and there are gaps in the geographic area covered. The gaps and limitations with these policies include:

- The ORMCP and Greenbelt Plan do set a limit of 10 per cent, but these limits apply only outside of Settlement Areas in the ORMCP, and only in the Natural Heritage System of the Greenbelt. Thus there is no defined limit areas within the ORMCP and Greenbelt Plan areas not covered by these policies, as well as areas outside of the ORMCP and Greenbelt boundaries, and the subwatershed's impervious area could easily exceed 10 per cent (and already has in the West Holland subwatershed)
- York Region's policies around impervious surfaces only apply in the ORMCP area
- There is no agency ensuring that subwatershed impervious areas do not exceed the defined limit
- Approval agencies should be striving for either a reduction in impervious areas on development sites or the mandatory use of practices that increase infiltration in order to reduce the impacts of impervious area within the subwatershed

7.5.3 Removal of Riparian Vegetation

With the release of the Lake Simcoe Protection Plan, which builds upon the protection already existing through the ORMCP and Greenbelt Plans, development within 30 metres of a permanent or intermittent stream is not permitted anywhere in the Lake Simcoe watershed, with the exception of a few activities, most of which would have little impact. However, infrastructure is one of the permitted activities, if the need for the project has been demonstrated and there are no viable alternatives. The undertaking of an infrastructure project could result in a significant loss of riparian area.

7.5.4 Stormwater Controls

The ORMCP, PPS, Greenbelt Plan, Growth Plan, LSPP, Official Plans, and LSRCA Development Policies all contain some form of policy recommendation around requirements for stormwater management. Although some of these are 'have regard for' statements, there is policy support to require that all applications for development within the Lake Simcoe watershed are required to have Enhanced Level 1 stormwater control or better. The LSPP has gone a step further and contains several policies around reducing the impacts of stormwater. These are highlighted in the above section. While these policies are essential for reducing further damaging impacts of stormwater on stream form, there are some limitations:

- There are no required timelines for the implementation of the recommendations of stormwater master plans required through the LSPP
- There is no mention of funding support for the implementation of such activities as stormwater retrofits in the LSPP
- While municipalities are required to incorporate policies around stormwater including encouraging a hierarchy of treatment, the implementation of innovative stormwater management measures, allowing for flexibility in development standards around alternative community design and stormwater techniques, this does not necessarily mean that developers will adopt these standards. Municipalities should *require* some or all of these practices rather than encouraging their use in order to create a level playing field for all developers undertaking works in the watershed, otherwise there is little incentive to change standard practices.

7.5.5 Channelization/Stream Alteration/Bank Hardening

As these activities would be considered to be a harmful alteration, disruption or destruction of fish habitat, they would be strictly regulated under the Fisheries Act. They would also be regulated under the policies of the ORMCP, Greenbelt Plan, and LSPP.

7.5.6 Restoration

Most of the policies related to restoration are quite general in nature, and do not contain specific requirements. Some require applications for development or site alteration in key hydrologic features or key natural heritage features to be accompanied by a natural heritage or hydrologic evaluation, which in some cases requires the applicant to include planning, design or construction practices that will maintain and, where feasible, improve or restore the health, size, and diversity of the feature.

7.5.7 Climate Change

Climate change is generally not well addressed in the current management framework. The LSPP contains the most comprehensive policies related to this issue which, although it is still difficult to predict its impacts, some of the predicted changes, such as intense storm events, may exacerbate issues of channel stability in this subwatershed. The adaptation strategy that will be developed through the LSPP is a significant first step in addressing this issue, and some of the Official Plan policies are beginning to consider climate change as well. While it may not be appropriate for some of the existing legislation to address climate change issues, it will be important to incorporate climate change considerations wherever possible in making management decisions for the subwatershed, and implement policies requiring, at the very least, the implementation of so called “no regrets” options should be incorporated into development and site alteration wherever possible.

7.6 Recommended Actions to Improve Fluvial Geomorphology

The following recommended actions were developed to improve fluvial geomorphology in the West Holland River subwatershed. There are a number of reaches within the subwatershed experiencing issues with respect to fluvial geomorphology. These issues include channelization, the absence of riparian vegetation, bank hardening, streambank erosion, channel downcutting, and aggradation. Much of this condition can be attributed to agricultural and urban land uses. In an agricultural setting, riparian vegetation is often removed, resulting in bank instability and erosion, cattle in some areas are allowed to access stream channels, and the erosion of sediment from fields can cause an imbalance in the watercourse. The increasing impervious area in urban catchments contributes significantly to streambank erosion due to increasing peak flows. Channels are often straightened and/or hardened in an attempt to mitigate these issues, which can cause problems in other areas of the watercourse. The implementation of the actions below will help to mitigate the impacts of the growth that is scheduled for this subwatershed, as well as that of the existing rural and urban land uses, on the stability of watercourses in this subwatershed.

These recommendations, which are grouped and numbered as described in Section 1.4, were developed to address the water quality issues and stressors that were identified throughout this chapter. In addition, they consider, and are consistent with applicable policies and recommendations in the province’s Lake Simcoe Protection Plan, and the LSRCA’s Integrated Watershed Management Plan. Each recommendation below also identifies the applicable ‘detailed recommendations’ as outlined in Chapter 10. These detailed actions will form the basis of the Implementation Plan for York Region’s ORM subwatersheds, to be developed following the completion of this plan.

7.6.1 Planning and Policy

1) That the municipal partners and the LSRCA strive to reduce the impacts of stormwater through a number of methods including the implementation of policies and guidelines and enabling the use of new and innovative technologies, retrofitting of existing developments.

   Detailed recommendations: A.1.1 – A.1.3

4) That the municipal partners and the LSRCA strive to maintain natural hydrologic conditions on development sites

   Detailed recommendations: A.3.1 – A.3.2

5) That the federal, provincial, and municipal governments, as well as the LSRCA, continue to evaluate and implement planning initiatives and practices aimed at reducing the impact of development on the condition of the West Holland subwatershed

   Detailed recommendations: A.3.3, A.3.5, C.1.1

6) That the value of the ecological goods and services provided by ecological features be considered in decision making around growth and development

Detailed recommendation: A.3.6

7) That the rural/agricultural community be engaged in developing solutions for minimizing the impacts of practices on their lands

Detailed recommendation: A.4.1

10) That the Province, the municipal partners, and the LSRCA seek to gain an improved understanding of the impacts of climate change in the West Holland subwatershed, incorporating this information into decision making scenarios and developing strategies to mitigate and adapt to its impacts.

Detailed recommendations: A.6.1 – A.6.2, G.1.1 – G.1.3

7.6.2 Use of Better Management Practices

11) That the LSRCA and its municipal partners continue working to mitigate the impacts of stormwater to water quality and quantity through tracking its sources, completing stormwater retrofits, promoting methods of minimizing stormwater volume, and continuing to research new and innovative solutions to stormwater control and implementing these solutions where appropriate.

Detailed recommendations: B.1.1 – B.1.5

12) That support for programs offered to assist rural landowners in implementing BMPs on their properties, such as LSRCA's LEAP program, be continued and/or expanded as resources permit

Detailed recommendations: B.2.1 – B.2.3

13) That sectors that have the potential to have significant impacts on conditions in the West Holland subwatershed be expected to undertake BMPs and other activities to mitigate their impacts, as required under the LSPP

Detailed recommendations: B.2.4 – B.2.5

14) That the LSRCA and the partner municipalities encourage the use of natural channel designs and 'soft solutions' wherever possible for preventing or mitigating streambank erosion and accommodating channel realignments; and that technical and financial resources be made available for retrofitting where appropriate to undertake these activities.

Detailed recommendations: B.3.1 – B.3.3

15) That the LSRCA assist partner municipalities in reducing the risk of flooding in the West Holland subwatershed

Detailed recommendations: B.3.3 – B.3.4

7.6.3 Changing the way things are done 'on the ground'

16) That the LSRCA and its partner municipalities strive to maximize the infiltration of stormwater where appropriate through development approvals and the use of practices and technologies

Detailed recommendations: C.3.1 – C.3.2

7.6.4 Monitoring

30) That the LSRCA assess the impacts of land use change on fluvial geomorphology in the subwatershed.

Detailed recommendation: E.3.2

7.6.5 Management, Rehabilitation and Restoration

36) That that LSRCA, in cooperation with its partner municipalities, prioritize and undertake activities to improve and restore aquatic ecological functions within the subwatershed, including barrier removal, natural channel design, restoring floodplain functions, and wetland creation. This could include undertaking pilot/demonstration projects to assess the feasibility of such works.

    Detailed recommendations: F.1.8 – F.1.10, F.1.12 – F.1.14, F.1.17

37) That the LSRCA continue to utilize buffer requirements and timing guidelines as tools to protect aquatic resources, and that other activities such as stormwater retrofits, tree planting, and habitat enhancement be undertaken to enhance aquatic habitat

    Detailed recommendation: F.1.17

38) That the LSRCA and the partner municipalities assess the feasibility of increasing natural cover (e.g. woodland, streambank vegetation, interior forest, grassland) in the subwatershed and set priorities and develop plans to undertake this enhancement, based on overall benefit to the subwatershed.

    Detailed recommendations: A.5.3, F.2.1 – F.2.5

7.6.6 Adaptive Response

47) That the LSRCA and partner municipalities work to reduce their carbon footprint and to increase ecological resilience in the watershed

    Detailed recommendation G.1.1 – G.1.3

50) That the LSRCA and its partners work to ensure that flood mapping is up to date; that the data needed for assessing flood risk is sufficient and that new monitoring equipment is added to the monitoring network as required; and that there be available programs to assist landowners in flood proofing their homes.

    Detailed recommendations: G.2.5 – G.2.7

8 Terrestrial Natural Heritage System

8.1 Introduction

Terrestrial natural heritage features are extremely important components of subwatershed health, as they not only provide habitat for many of the species residing in the subwatershed, but also influence subwatershed hydrology. They are among the most important parts of the ecosystem, and are the most likely to be directly impacted by human activities.

A terrestrial natural heritage system is composed of natural cover (features), natural processes (functions), and the linkages between them. The matrix of agricultural, rural, urban, and natural areas within the West Holland River subwatershed's terrestrial system interacts with other hydrological and human systems, and serves as habitat for flora and fauna throughout the subwatershed. The system includes not only large tracts of natural features, but also small features that can be found within urban and agricultural areas. Measuring the quantity, quality and distribution of natural heritage features within the subwatershed can tell us a great deal about its health. This chapter describes the natural heritage features of the West Holland River subwatershed, detailing the current conditions; and also describes the Natural Heritage System (NHS) that has been developed by the LSRCA and Beacon Environmental to protect the integrity of the natural heritage features throughout the Lake Simcoe watershed. The NHS is described in detail in Section 8.4.7.

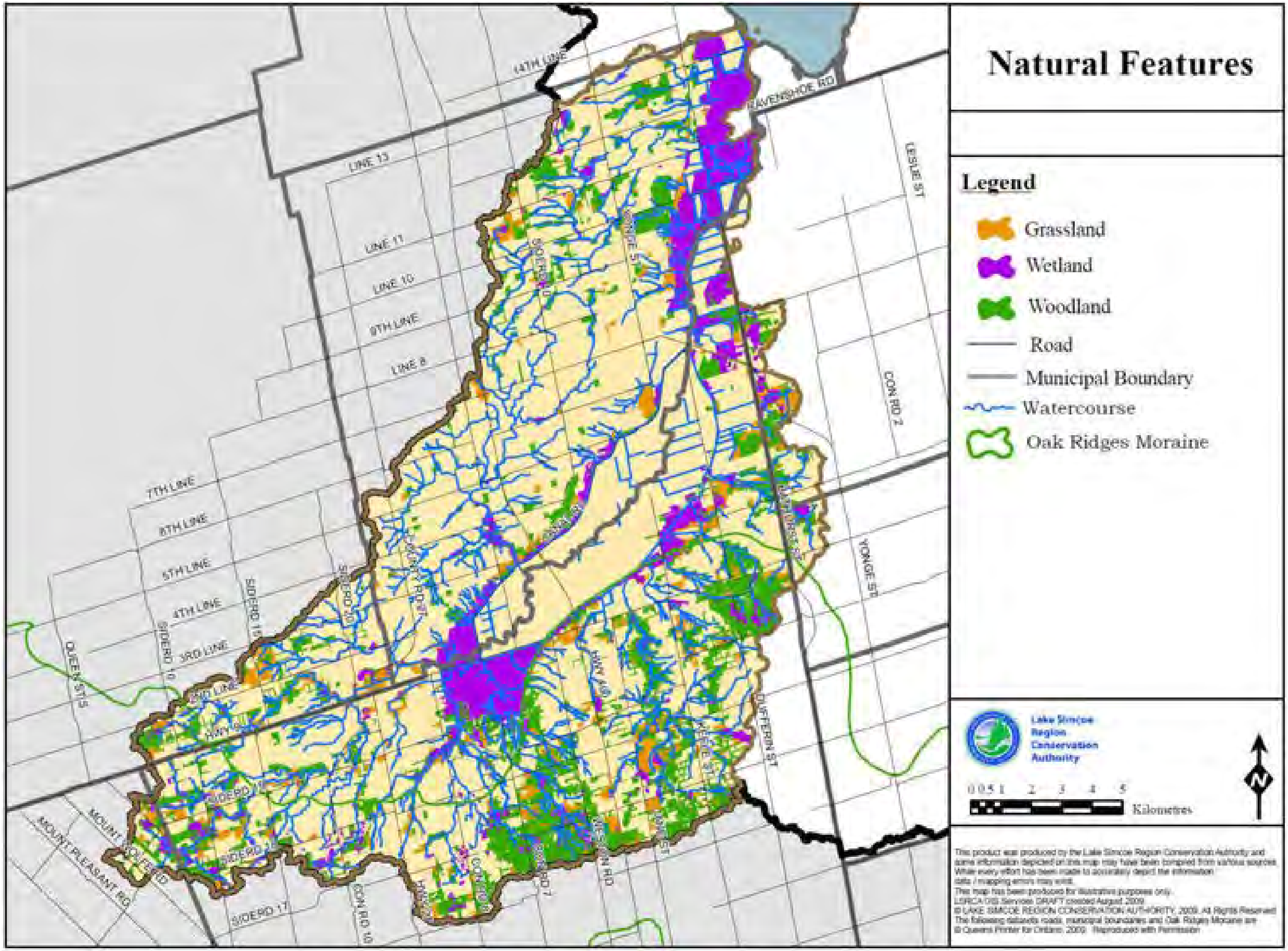


Figure 8-1 Natural features of the West Holland subwatershed

8.2 Current Status

The natural heritage contribution to watershed health can be described using the Provincial Policy Statement components of the natural environment. Those related to terrestrial natural heritage are Habitat for Species at Risk, Wetlands, Woodlands, Valleylands, Wildlife Habitat, Areas of Natural and Scientific Interest, and Linkages. Also included is a discussion on imperviousness.

The following paragraphs provide a summary of each of these components.

8.2.1 Species at Risk

There is general support for the notion that special efforts should be made to protect species that are at a risk of becoming lost from a region or province. This is in part related to objectives of maintaining or enhancing biodiversity at regional, provincial and national levels. Information regarding Species at Risk is housed with the Ministry of Natural Resources' (MNR) Natural Heritage Information Centre (NHIC).

The following table presents species have been identified within the West Holland River subwatershed within the last 20 years.

Species at Risk – MNR Status

- **Extirpated** - a native species that no longer exists in the wild in Ontario, but still exists elsewhere
- **Endangered** - a native species facing extinction or extirpation
- **Threatened** - a native species at risk of becoming endangered in Ontario
- **Special Concern** - a native species that is sensitive to human activities or natural events which may cause it to become endangered or threatened

Table 8-1 NHIC Endangered and Threatened element occurrences for the West Holland River subwatershed (WHS)

Common Name	Species	MNR Status	Occurrences in the Lake Simcoe Watershed	Occurrences in the WHS	Habitat
Jefferson's Salamander	*Ambystoma jeffersonianum*	THR	1	1	Vernal pools for breeding and mature woodlands for summering
Redside Dace	*Clinostomus elongatus*	THR	4	3	Cold water streams
Least Bittern	*Ixobrychus exilis*	THR	6	2	Large marshes
Purple Twayblade	*Liparis liliifolia*	END-NR	2	2	Woodlands
King Rail	*Rallus elegans*	END-R	3	2	Large marshes
Total			**16**	**10**	

While other Species at Risk occur in the Lake Simcoe watershed, of the species that occur in the West Holland River subwatershed, it has a high proportion of those occurrences. For example, it holds the only record for Jefferson's salamander and both occurrences of Purple Twayblade known in the watershed. It is also home to two of three records for King Rail and three of four Redside Dace records. These habitats are therefore important not just to the West Holland River subwatershed, but to the larger Lake Simcoe watershed.

The majority of the reported occurrences of Species at Risk are from areas that have been studied, such as evaluated wetland and Areas of Natural and Scientific Interest. It is likely that more occurrences will be forthcoming when increased efforts are made to document the natural history elements of the area. For example, the endangered tree, Butternut, is known to be relatively widespread in the area.

8.2.2 Wetlands

Many of Ontario's fish, fauna and flora species use wetlands during all or part of their life cycles. A high proportion of designated "Species at Risk" are wetland-associated species. This is not surprising given that wetland loss within the Great Lakes basin is estimated at 68% south of the pre-Cambrian shield (Snell, 1987 as cited in Detenbeck *et al.*, 1999). Wildlife functions include critical fish nursery and spawning areas, habitat for relatively specialized species, and habitat for a wide range of attributes such as area-sensitive forest breeding birds, winter deer yards and amphibian breeding pools.

Today, there are approximately 3,620 ha of wetlands in the West Holland River subwatershed, which is approximately 10.3% of the landscape. Of these, approximately 34.5% have not been evaluated using the Ontario Wetland Evaluation System (Table 8-2).

What is a Provincially Significant Wetland?

The Ontario Wetland Evaluation System was developed by the Ontario Ministry of Natural Resources (1993). It was implemented in a response to an increasing concern for the need to conserve wetland habitats in Ontario. The wetland evaluation system aims to evaluate the value or importance of a wetland based on a scoring system where four principal components each worth 250 points make a total of 1000 possible points.

The four principal components that are considered in a wetland evaluation are the biological, social, hydrological, and special features. Based on scoring a wetland can fall into one of two classes, Provincially Significant or Locally Significant. It takes 600 total points or full points (200) in any one component for a wetland to be classed as Provincially Significant. The Province of Ontario, under the Provincial Policy Statement (PPS) protects wetlands that rank as Provincially Significant. The PPS states that *"Development and site alteration shall not be permitted in significant wetlands."*

Table 8-2 Wetlands in the West Holland River subwatershed

Status	Area (ha)	Percentage of WHS
Provincially Significant Wetlands (PSWs)	2,368	6.7%
Evaluated Non-Provincially Significant Wetlands	2	<1%
Additional wetlands identified using Ecological Land Classification System	1,250	3.6%
Total	**3,620**	**10.3%**

A majority of the West Holland River subwatershed wetlands are of provincial significance, which account for a tenth of the Lake Simcoe watershed's PSWs. However, less than 1% of the watershed's evaluated non-PSWs are situated within the West Holland River subwatershed, likely due to the efforts of the MNR to update wetland evaluations in York Region, which has resulted in many becoming provincially significant.

There are three types of wetlands found within the West Holland subwatershed – Swamp, Marsh and Fen. The majority is Swamp (70.3%), while just over 5% is Fen. The distribution of wetlands in the West Holland River subwatershed is outlined in Table 8-3.

Table 8-3 Wetland distribution in the West Holland River subwatershed

Wetland Type	**Area (ha)**	**Percentage of Wetlands**	**Characteristics** (source: Environment Canada)
Fen	189.4	5.2%	A high water table with slow internal drainage. Fens are not as low in nutrients as bogs and as a result are more productive. Although fens are dominated by sedges they may also contain shrubs and trees.
Marsh	804.4	22.2%	Periodically or permanently covered by standing or slowly moving water. Marshes are rich in nutrients and are characterized by an emergent vegetation of reeds, rushes, cattails and sedges.
Swamp	2,543.6	70.3%	Swamps are dominated by shrubs or trees. They may be flooded seasonally or for long periods of time. Swamps are both nutrient rich and productive.
*Other	83.4	2.3%	*These are wetlands that have been identified through interpretation of aerial photography, but have not been interpreted to the community level.

The West Holland River subwatershed has a relatively low proportion of the Lake Simcoe watershed's swamp (7%), but does have a higher amount of marsh, owed largely to the Holland Marsh PSW. Of note is that it contains 43% of the Lake Simcoe watershed's rare fen communities.

According to the various sources and as quoted in the Areas of Concern (AOC) Guidelines developed by Environment Canada (Environment Canada, 2004) a subwatershed (in this case, the West Holland River subwatershed) with over 10% wetland cover is in relatively fair shape from a hydrological and biological perspective although there are other factors, such as the distribution of wetlands within the subwatershed, which are also important. However, the 10% target must also be tempered with the historical cover of wetlands in a given subwatershed. Historically, it is likely that the West Holland River subwatershed had double the amount of current wetland cover. This particular subwatershed would have likely have contributed a higher percentage of wetland to the overall total of wetlands within the Lake Simcoe basin.

The 10.3% of the West Holland River subwatershed that is currently wetland is substantially concentrated in two general areas, the Holland Marsh at the northern tip of the subwatershed in between the western canal and the West Holland River (which includes high quality marshes and rare fen communities), and the Pottageville Wetland Complex, which is comprised predominantly of swamp, where the West Holland River has retained its natural meander. There are also areas of wetland concentrations, just south of Ansnorveldt along the eastern canal, that comprise the Ansnorveldt PSW. The Dufferin Marsh is a smaller wetland located in the community of Schomberg, just off of the ORM. On the Oak Ridges Moraine in the West Holland River subwatershed, there are scattered wetlands surrounding some, but not all, headwater areas. What is particularly notable is the lack of wetlands in the headwater areas on the west side of the West Holland River and canals.

8.2.3 Woodlands

Prior to European settlement the dominant land cover type of Southern Ontario was woodland. Estimates of total cover were in the 80% range. In 1978, woodland cover in York Region was estimated at 18.5% (Larson *et al*., 1999). The current distribution of woodlands in the West Holland River subwatershed is depicted in Table 8-4.

Woodland Composition

Woodlands include all treed communities, whether upland or wetland swamp. The ELC communities that were considered to represent woodlands are forest, swamp, plantation, and cultural woodland (the breakdown of these types is shown in Table 8-4). Some woodlands that were counted as wetlands in the previous section may also be counted as woodlands, as the two terms are not mutually exclusive.

Total woodland cover comprises approximately 7,400 ha, or 21%, of the total area of the West Holland River subwatershed. Of this area, approximately 1,100 ha (i.e., 15% of woodland cover) could be considered to be of lower ecological quality (i.e., plantations, which can be considered standing crops) or are cultural woodlands (which are woodlands that have broken canopies). While these areas may not be as beneficial ecologically, they still have high intrinsic value as they are part of a functioning landscape. They also present opportunities for future restoration projects.

Table 8-4 Woodland cover by type

Woodland Type	**Woodland Cover**			
	Area in Subwatershed (ha)	**Cover within Subwatershed (%)**	**Cover By Woodland Type (%)**	**Percentage of LSRCA Woodland Type**
Cultural Plantation (CUP)	559	1.6%	7.6%	9.6%
Cultural Woodland (CUW)*	545	1.5%	7.4%	13.9%
Conifer Forest (FOC)	206	0.6%	2.8%	4.5%
Deciduous Forest (FOD)	2,641	7.5%	35.7%	13.5%
Mixed Forest (FOM)	1,579	4.5%	21.4%	10.5%
Conifer Swamp (SWC)	203	0.6%	2.7%	6.6%
Deciduous Swamp (SWD)	1,214	3.4%	16.4%	10.9%
Mixed Swamp (SWM)	441	1.2%	6.0%	5.2%
Total	**7,388**	**20.9%**		**10.3%**

**This category includes substantial hedgerows that are continuous with other natural features (ca. 103 ha).*

The most prevalent forest type within the West Holland River subwatershed is deciduous forest (7.5%), followed by mixed forest (4.5%) and deciduous swamp (3.4%). It is expected that deciduous communities would dominate this subwatershed as it lies within the ORM and southern extent of the Lake Simcoe watershed. That it contains nearly a tenth of the watersheds plantation is likely due to the high concentration of plantation associated with the ORM.

Woodlands have many important functions

The *Natural Heritage Reference Manual* (OMNR, 1999) lists a variety of important functions associated with woodlands and Larson *et al*. (1999) summarize the importance of woodlots. These important functions can generally be described as follows:

Economic Services and Values

Oxygen production, carbon sequestration, climate moderation, water quality and quantity improvements, woodland products, economic activity associated with cultural values;

Cultural/Social Values

Education, recreation, tourism, research, spiritual and aesthetic worth; and

Ecological Values

Diversity of species, structural heterogeneity, energy (photosynthesis), nutrient and energy cycling.

Structural diversity of habitat is a key driver of biodiversity. In woodlands, habitat niches can range from microhabitats such as the surfaces of fissured trunks, leaves and rotting logs to macrohabitat features such as the horizontal layers within the woodland (e.g., supercanopy, canopy, subcanopy). In addition, woodlands are present in a wide variety of topographic settings and soil and moisture regimes. These can range from talus slopes to heavy clay soils; from saturated organics to very dry sandy soils. For all of these reasons it is not surprising that many woodland species are obligates (i.e., they are only found in woodlands), or that woodlands provide habitat for a wide range of flora and fauna. They form important building blocks of the natural heritage system.

In an overview of the science regarding the function of woodlands the LSRCA NHS document discusses in detail factors relating to fragmentation (the splitting of larger woodlands into ever smaller pieces), patch size (the requirement of woodland pieces to be of a certain area for the maintenance of some functions), woodland quality (such as shape, interior habitat, age, composition, structure and the presence of invasive species), and total woodland cover (i.e., the woodland area within a jurisdiction or watershed).

Of these factors there is increasing scientific evidence that the total woodland cover of a landscape may exert the most important influence on biodiversity. Obviously the loss of woodland cover results in a direct loss of habitat of that type. This reduction in habitat can result in proportionally smaller population sizes, and animals in habitat remnants may experience altered dispersal rates, decreased rates of survival, decreased productivity, altered foraging behaviours and decreased mating opportunities (Brooker and Brooker, 2002). Research that has examined the independent effects of habitat loss *versus* habitat fragmentation suggests that habitat loss has a greater effect than habitat fragmentation on the distribution and abundance of birds (Fahrig, 2002) and there is now substantive evidence that total woodland cover is a critical metric (e.g., Austen *et al.* 2001; Golet 2001; Fahrig 2002; Lindenmayer *et al.* 2002; Trzcinski *et al.* 1999; Friesen *et al.* 1998, 1999; Rosenburg *et al.* 1999; Radford *et al*. 2005).

Woodland Patch Size Analysis

A woodland patch is defined as the total area of a contiguous patch of wooded habitat, as mapped by the LSRCA Natural Heritage and Land Use mapping project. This analysis does not incorporate other parameters of “quality” that generally can only be established with detailed field work.

Contiguous woodland areas have been calculated and the distribution of woodland patch sizes is displayed in the graph below. While the total area of woodland represents the amount of forest completely within the subwatershed, the number of patches includes any patches touching the subwatershed rather than those that are entirely within the subwatershed. This methodology was used because it is important to properly capture the number of large forest patches and if only patches within the subwatershed boundaries were considered, the number of large patches would be underestimated.

This analysis does not in any way incorporate the benefits of adjacent or nearby natural areas, nor does it discount woodland patches that have exurban development envelopes within them. The results of this analysis are provided in Figure 8-2.

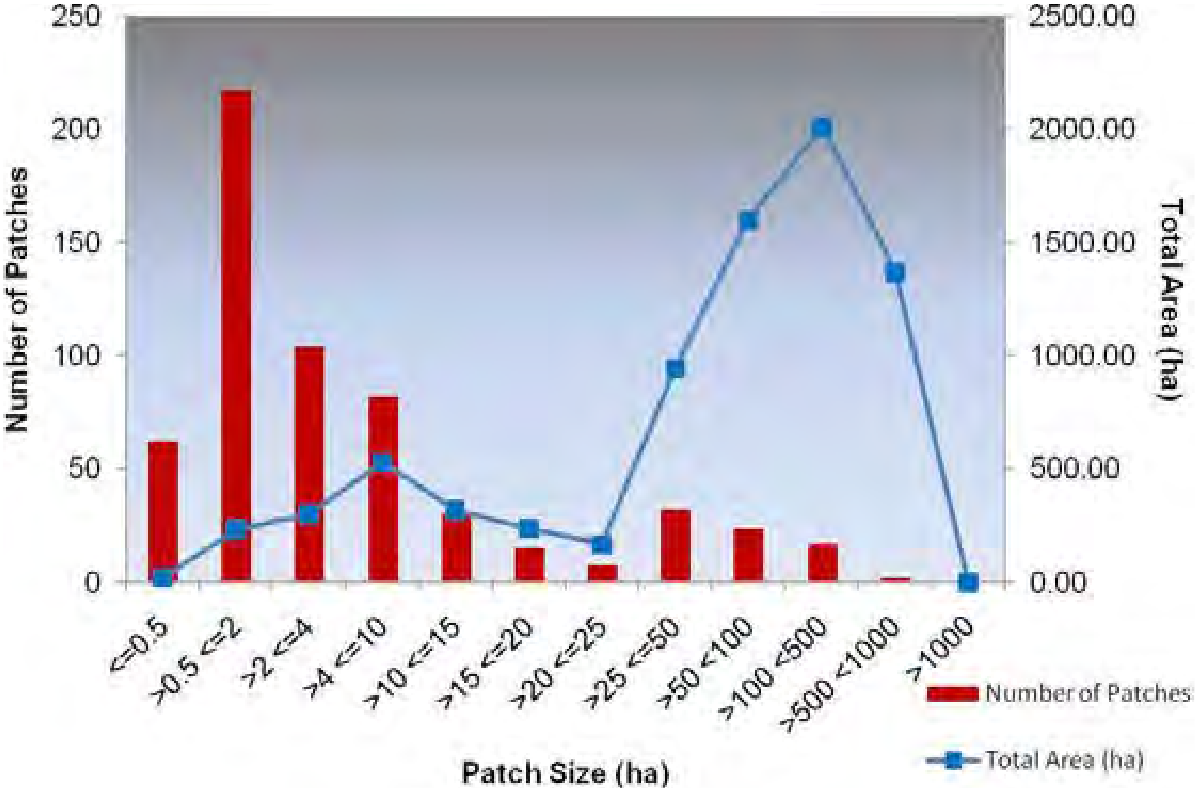


Figure 8-2 Woodland patch size analysis – West Holland

In Figure 8-2 the red bars represent the number of woodland patches and the blue line represents the total area of woodland (right hand axis and provided in ha). This analysis demonstrates that for the entire subwatershed, approximately 5,925.24 ha of woodlands in patches of 25 ha or greater are distributed among just 75 patches. This represents 76.6% of the forest cover of the subwatershed. The loss of these patches would result in the loss of three-quarters of the forest cover in the West Holland River subwatershed.

There are two woodland patches that are 500 ha or greater in area within and straddling the West Holland River subwatershed (for a total area of 1,743 ha). Aggregations of woodland patches and/or the presence of extensive woodland patches, such as these two 500 ha patches, may be critically important for the productivity of forest associated flora and fauna. Extensive areas of woodland cover provide much of the core woodland function in this watershed, such as productive breeding grounds for area-sensitive woodland bird species and other wildlife requiring large woodlands. These areas could be a focus for restoration efforts in the future. Together and with adjacent forest patches, these two woodland patches comprise the "West Holland Area," which is approximately 1,855 ha in size and extends southward onto the Moraine (Beacon and LSRCA, 2007).

Big woods are important natural areas within the subwatershed that should be protected. They have two components. The first are the large, dense woodland areas that offer the kind of nesting, shelter and foraging opportunities that are not available in smaller woods, and are needed by species including the red-shouldered hawk and southern flying squirrel. The second are the smaller patches of woodland that can contribute to big woods habitat if they are dense enough and close enough to a large wooded area.

The analysis also indicates that approximately 1,083 ha (14% of the total woodland) is accounted for in patches up to 10 ha, (i.e., the first four columns of Figure 9-1). The (unlikely) total loss of this woodland cover (and without the "recruitment" of new patches) would reduce the percent of the subwatershed that is wooded from the current 20.9% to 17.9%.

Forest Interior Habitat

Forest interior habitat is the part of a wooded area that is deeper than 100 metres from the perimeter of the woodland. Areas within the first 100 metres from the perimeter of a forest are considered to be 'edge' habitat and not suitable for species that require deeper forests. Many of these species are declining as their interior habitat disappears. Certain bird species such as the Northern Parula, Black and White Warbler, and Blackburnian Warbler for example, avoid small fragmented forests when breeding. In smaller forests they are subject to predators, parasites, harsh winds, lack of food, and a higher susceptibility to fire and human interference.

Through its AOC guidelines, Environment Canada recommends that interior forest occupies more than 10% of the area of a subwatershed, which would ensure that sufficient habitat is available for more sensitive species that require this habitat. The interior forest cover of the West Holland River subwatershed is currently 4.7%, well below the Environment Canada target.

Overall, the literature indicates the total woodland cover threshold for maintaining woodland dependent biodiversity is probably somewhere in the 30 to 40 percent cover range. The Lake Simcoe watershed presently has 27.4% forest cover, which indicates that woodland cover is at a critical minimum level.

This analysis also indicates the importance of the larger woodlands of the West Holland River subwatershed, especially those over 25 ha. However in terms of total forest cover, at 21% the subwatershed is substantially below both the suggested minimum threshold and the cover level in the basin. The subwatershed would benefit from an increase in forest cover and this in turn would support the forest levels within the entire basin.

The socio-economic value of woodlands is also important. Ecological values are often incompatible with human use. Separation of woodlands that are specifically identified for their social values can be important. The West Holland River subwatershed presently hosts 103 ha of "urban woodlands". Even very small woodlands in an urban area can be important in a social sense.

8.2.4 Valleylands

A valleyland is a natural depression in the landscape that is often, but not always, associated with a river or stream. Valleylands are an important part of the framework of a watershed as the landscape is generally a mosaic of valleylands and tablelands.

The *Natural Heritage Reference Manual* (OMNR, 1999) refers to valleylands as the “backbone” of a watershed because of the many important ecological functions they perform, such as channeling water and wildlife, providing a connection between natural heritage features, providing important migration corridors, providing microclimates, transporting sediment and nutrients, acting as natural drainage areas, maintaining water levels by acting as floodplains and seepage areas, and maintaining water quality through riparian vegetation communities.

The LSRCA NHS has identified approximately 1,400 ha of significant valleylands within the watershed, making up approximately 4% of the landscape. These valleylands are generally found in the headwater tributaries along both the east and west sides of the West Holland River.

The West Holland River subwatershed includes the Holland River valley, a prominent feature through which the West Holland River meanders. This feature is visible from Hwy. 400, with its two treed ridges running along the east and west sides, approximately 2.4 m apart on either side of the valley floor. The valley extends north from the Oak Ridges Moraine and is currently one of the most productive vegetable production areas of southern Ontario.

The Happy Valley Candidate ANSI is also in the West Holland River subwatershed, and is an area of rugged topography on the Oak Ridges Moraine. Serving as the headwaters of the Schomberg River, several small, clear, sand-bottomed streams originate in these hills and pass northwards into the Pottageville Swamp. Sugar Maple (*Acer saccharum*), American Beech (*Fagus grandifolia*), and Eastern Hemlock (*Tsuga canadensis*) contribute to the dominant forest cover of these hills (Ecologistics, 1982).

8.2.5 Wildlife Habitat

Significant Wildlife Habitat (SWH) is an area that is considered to be an important habitat of a particular species or group of species. Examples of SWH include unique habitats such as bat hibernacula or important winter habitat for White-tailed Deer. The importance of SWH is based on the premise that some habitat types are no longer plentiful and it also encompasses areas where species concentrate to breed or to hibernate, as well as unique habitat.

The driving force for the designation of SWH is the protection of biodiversity. The provision of habitat is one of the main functions of natural heritage features (OMNR, 1999). There are five principal types of SWH suggested by the *Natural Heritage Reference Manual* (OMNR, 1999) and the *Significant Wildlife Habitat Technical Guide* (OMNR, 2000). These are seasonal concentrations of animals, rare vegetation communities, specialized habitats for wildlife, habitats of species of conservation concern, and wildlife movement corridors. However, as most of these require comparative analysis, wildlife habitat is difficult to evaluate.

The Lake Simcoe NHS uses four criteria, based on available sources of information to identify SWH, which are Winter Deer Yards, Colonial Waterbird Nesting Sites, Rare ELC communities (bog, fen, prairie and alvar), and Grasslands. The West Holland River subwatershed has some representation of each of these.

Because White-tailed Deer (*Odocoileus virginianus*) do not move well in deep snow, they sometimes remain in sheltered areas during the winter, which typically consist of a core area of coniferous forest (over 60% canopy cover), surrounded by mixed or deciduous forest. Yards can persist over many years and can be critical to the survival of White-tailed Deer in some parts of the Province (OMNR, 2000). A Deer Yard (Stratum 1) is often referred to as the core of a deer yard. Deer use this area when mobility is most restricted under severe winter conditions (when snow reaches depths greater than 46 centimetres). A Deer Wintering Area (Stratum 2) is the area occupied by deer in early winter or occasionally all winter during mild winters. A mild winter occurs when the snow cover in the area is light and fluffy, and less than 30 centimetres. There are approximately 225 ha of core deer yard (Stratum 1) area within the West Holland River subwatershed, as identified by the MNR. This represents just over 8% of the Lake Simcoe watershed's Stratum 1 and Stratum 2 areas. LSRCA's Natural Heritage System, discussed later in this chapter, recommends that Stratum 1 areas are Level 2 features, however, Stratum 2 areas are not afforded protection unless identified in official plans.

Colonially-nesting waterbirds concentrate in relatively small areas for nesting purposes. These species include cormorants, herons, terns, and gulls. Individual colonies may support the entire breeding population for a given species across a relatively large area. Because colonial waterbirds typically nest in relatively confined areas, they can be particularly susceptible to disturbance, disease, or habitat destruction. There are two occurrences of each of the following colonial waterbird nesting sites known from this watershed, Black Tern (*Chlidonias niger)* and Great Blue Heron (*Ardea herodias*).

Table 8-5 Seasonal concentrations of animals in the West Holland River subwatershed

Habitat Type	Area in WHS (ha)	Percentage of WHS	Percentage of LSRCA Habitat Type
Deer Yard (Stratum 1)	225	0.6%	8.3%
Deer Wintering Area (Stratum 2)	1,687	4.8%	8.3%
Colonial Waterbird Nesting Sites (BSC)	Two occurrences – Black Tern Two occurrences – Great Blue Heron		

There is one rare ELC community known to occur within the West Holland River subwatershed, the fen within the Holland Marsh PSW. At 189 ha in size, it represents just over 40% of the watershed's known fen communities. Fens are relatively rare in southern Ontario and are host to a range of plants and wildlife that require the unique parameters found only in fens.

Grassland communities (which in this case refers to upland ELC communities of Cultural Meadows and Cultural Thickets) in the Lake Simcoe watershed are generally dominated by non-native cool season grasses, native and non-native forbs, and a variety of native and non-native shrubs. Shrub cover may vary from 0 to 100%. Grasslands generally do not include pasture lands, which, to the extent possible, are mapped separately within the Lake Simcoe watershed as an agricultural use (i.e., they are actively grazed by livestock) (Beacon and LSRCA, 2007).

However, despite the fact that grasslands are often dominated by non-native vegetation species, many native flora and fauna species use them. Indeed, many of these species (e.g., Bobolink [*Dolichonyx oryzivorus*] and Eastern Meadowlark [*Sturnella magna*]) are not found in any other habitat types and are therefore considered habitat specialists. Presumably, in pre-settlement times these species were confined to habitats such as burns, previously flooded areas, prairie habitats and then, today, in human-altered environments (Beacon and LSRCA, 2007).

Table 8-6 Specialized habitats for wildlife: grasslands

Habitat Type	Area in WHS (ha)	Percentage of WHS	Percentage of LSRCA Habitat Type
Cultural Meadow	1,581	4.5%	17.8%
Cultural Thicket	583	1.6%	8.4%

With just over 2,000 ha of meadow and thicket, the West Holland River subwatershed accounts for about a quarter of the watershed's grassland community. It also contains one of the larger meadow patches, making this an important component of the natural heritage system of the West Holland River subwatershed.

There are likely additional occurrences of significant wildlife habitat in the West Holland subwatershed; these will be identified through further exploration of the subwatershed's natural heritage features.

8.2.6 Areas of Natural and Scientific Interest

To encourage the protection of unique natural heritage features and landscapes in southern Ontario, the Ontario Ministry of Natural Resources developed the provincial Areas of Natural and Scientific Interest (ANSI) program.

There are two types of ANSIs, life science and earth science. Life science ANSIs are based on biological and ecological characteristics. Earth science ANSIs are based on geological landform characteristics.

The selection criteria used by the MNR to define ANSIs are:

1. Representation;
2. Diversity;
3. Condition;
4. Ecological function; and
5. Special features.

ANSIs can be designated within one of two levels of significance, regional or provincial. These levels are based on ecoregions and ecodistricts. Provincial significance relates to the whole province, while regional significance is assigned at the ecoregional level.

The West Holland River subwatershed presently has two approved provincially significant Life Science ANSIs, and two provincially significant Earth Science ANSIs, as shown in the table below. Some ANSIs are also Provincially Significant Wetlands (e.g. Holland River Marsh and Pottageville Swamp). Several are located within the ORM.

The Holland River Marsh ANSI is a nature reserve because of its extensive size, a historical remnant of one of the largest marshes in southern Ontario. In addition, it has two regionally significant features, 1) significant breeding and migratory waterfowl habitat, 2) contains a shrub fen, an uncommon vegetation type (Hanna, 1984).

Pottageville Swamp ANSI is located just north of the village of Pottageville, south of Highway 9. It is a source area for many small tributaries that flow northward into the Holland River. Originally Pottageville was part of the Holland Marsh wetland systems, but drainage projects carried out north of the swamp have isolated it from most of the remaining wetland complexes. The Pottageville Swamp is composed mainly of organic soils and hosts mature vegetation such as Silver Maple (*Acer saccharinum*), Eastern White Cedar (*Thuja occidentalis*), Tamarack (*Larix laricina*), Trembling Aspen (*Populus tremuloides*), and White Ash (*Fraxinus americana*) (Ecologistics, 1984).

Table 8-7 ANSIs in the West Holland River subwatershed

ANSI	Life Science/ Earth Science	Significance Level	Status	Total Area (ha)	Area in WHS (ha)	%of WHS
Pottageville Swamp	Life	Provincial	Approved	925.6	925.6	2.6
Pottageville Swamp	Life	Provincial	Candidate	169.2	169.2	2.4
Holland River Marsh	Life	Provincial	Approved	2,300.8	651.9	1.9
Happy Valley	Life	Provincial	Candidate	858.4	858.4	1.1
Glenville Hills	Life	Provincial	Candidate	524.3	377.6	0.9
Hall-Thompson Lake Kettles	Life	Provincial	Candidate	323.4	323.4	0.5
Linton-Kelly Lake Channels	Earth	Provinical	Approved	288.5	288.5	0.8
Palgrave Moraine topography	Earth	Regional	Approved	76.9	76.9	0.2
Glenville Hills Kames	Earth	Provincial	Candidate	86.4	58.6	0.2
Mount Wolfe	Earth	Provincial	Candidate	35.8	35.8	0.1
Kettleby Till	Earth	Provincial	Candidate	10.2	10.2	0.02
				5,599.4	**3,776.0**	**10.7**

8.2.7 Landscape Connectivity

Landscape connectivity refers to the inter-connectivity of the natural heritage features on the landscape. Landscapes having greater connectivity (where more features are better connected) are likely to have higher functioning ecosystem processes. While greater connectivity is generally strived for, restoration in landscapes that are not currently ‘connected’ should be undertaken in a deliberate manner to ensure that connecting features does not result in deleterious ecological effects.

A detailed landscape connectivity assessment has not been undertaken in the subwatershed to date. A preliminary analysis indicates that one of the major areas of connectivity in the West Holland River subwatershed is the Oak Ridges Moraine in the southeast and its connection to the West Holland River. The West Holland River Valley is generally well connected to Cook’s Bay through mixed forest and wetland; however, there are opportunities to improve connectivity within the West Holland River subwatershed.

Key Points - Current Terrestrial Natural Heritage Status:

- Wetlands occupy approximately 10.3% of the subwatershed area with the majority (65%) being provincially significant, while 34.5% of wetlands have not been evaluated using OWES. Of the noted wetlands, the majority are Swamps (70.3%), while 22.2% are Marsh and only 5.2% are Fens
- Woodland cover in the West Holland subwatershed is 21%, but approximately 15% of this can be considered to be of lower ecological quality (e.g. plantations or cultural woodland). Excluding these lower quality forest types, woodland cover is approximately 17.4%, far less than the 30% generally recommended
- Forest interior habitat is currently 4.7%, well below the 10% recommended by Environment Canada
- There are five known Species at Risk that have been identified in the subwatershed in the past 20 years: Jefferson's Salamander, redside dace, Least bittern, Purple Twayblade and King Rail. There are likely more, but these occurances have not yet been verified
- The subwatershed contains three significant types of wildlife habitat: deer wintering areas (4.8% of the subwatershed), colonial waterbird nesting sites (two known sites), and grassland communities that support specialized bird species (26.2% of the subwatershed area).
- There are several Areas of Natural and Scientific Interest (ANSIs) in the subwatershed – two are approved (the Holland River Marsh and the Pottageville), and there are three candidate sites.
- Approximately 7% of the subwatershed is impervious (below Environment Canada's 10% recommendation)

8.3 Factors impacting status - stressors

There are numerous factors that can affect natural heritage features. They range from natural factors such as floods, fires, and droughts; and human influences, such as outright destruction, water use, the introduction of invasive species, and climate change. Natural factors are generally localized and short in duration, and a natural system is generally able to recover within a relatively short period. Some degree of natural disturbance is often a part of the life cycle of natural systems. Conversely, human influences are generally much more permanent – a forest can not regenerate after it has been paved over, natural communities have a great deal of difficulty recovering from the introduction of an invasive species, and wetlands may be unable to survive when their water source has been drawn down. The Natural Heritage System for the Lake Simcoe Watershed (Beacon and LSRCA, 2007) provides an important tool for reducing the impact of human influences by ensuring that the functions of natural systems can be preserved and/or restored.

8.3.1 Land use changes and habitat fragmentation

Land use in the subwatershed is primarily agricultural, occupying 58% of the subwatershed area. Natural areas occupy approximately 31%, and 2.6% is occupied by urban areas, though this is expanding (Figure 8-3). Agricultural areas are found throughout the subwatershed, with natural areas interspersed throughout. The Holland Marsh is a significant feature, running northeast from Highway 9 to Cook's Bay. The largest urban area is the Town of Bradford, and is located near the centre of the subwatershed.

Historic analyses were conducted by Parish Geomorphic Ltd. using aerial photographs from three sets of coverages (1959/61, 1976, and 2002) for the purposes of analyzing the subwatershed's geomorphology. Aerial photography was used to identify natural changes and human alterations in channel planform to analyze conditions with respect to fluvial geomorphology, and also changes in land use. This analysis found that the West Holland River subwatershed has experienced some change, particularly with respect to agricultural lands. Between the 1959/61 photographs and the 1976 photographs, the amount of land used for agriculture increased, particularly between the East and West Branches, north of Hochreiter Road. The Town of Bradford also expanded significantly.

This increase in agricultural activities has caused natural heritage areas to decline in quality and integrity. Results of this include an increase in fragmentation, a decline in species richness, increased predation and an increase in edge effects. As farms continue to grow to accommodate the economy's demands, there is an increase in the amount of contaminants, such as phosphorus, going into the surrounding habitats, further deteriorating what natural space is left. As such, many of the areas categorized as natural heritage have degraded ecological condition and habitat functionality.

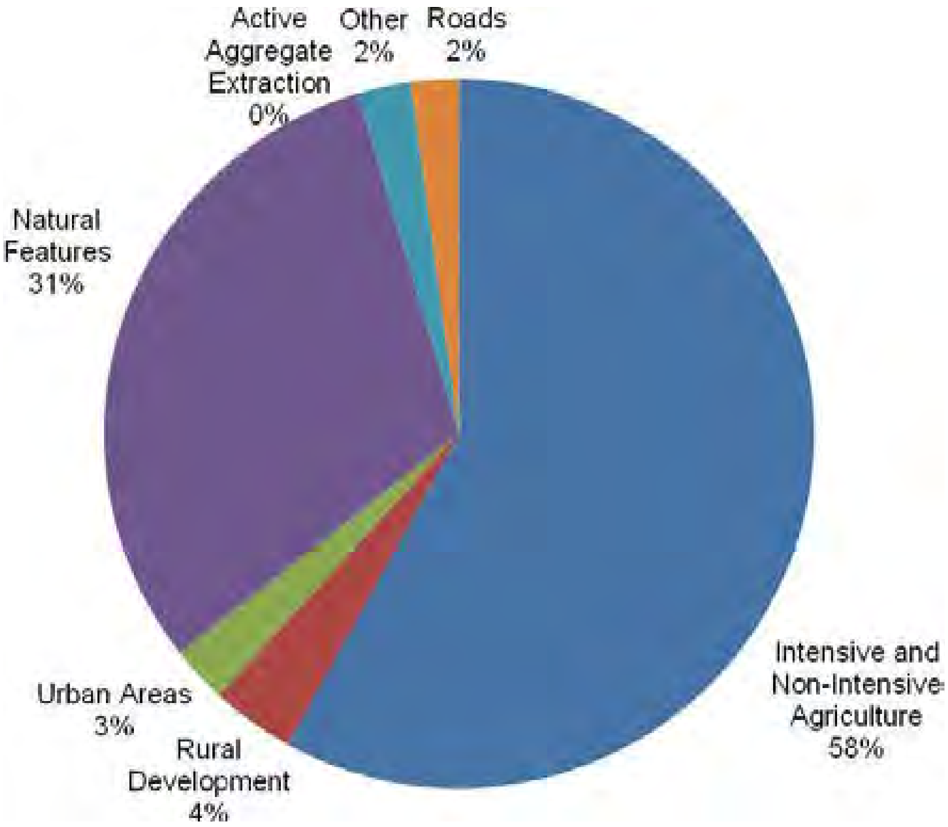


Figure 8-3 Land use distribution in the West Holland subwatershed

Based on future land use projections, urban areas are anticipated to expand by roughly 4% (an additional 1,557 ha) with the majority of this increase attributable to high intensity development

Forested and transitional lands (such as meadows) are projected to decrease by approximately 450 ha and wetlands by 27 ha (Louis Berger Group, 2006).

Highways 400, 11, 27, and 9 are the major roads to run through the West Holland Subwatershed. Highways 400, 11, and 27 follow a north/south path, with Highway 11 passing through Bradford. Highway 9 runs east/west across the southern portion of the subwatershed. Average road density in this subwatershed is approximately 0.95 km/km^2 and the total length of highways and local roads is 542 km.

The land use of the West Holland River subwatershed can also be expressed in terms of imperviousness (the inability for water/moisture to permeate the surface). Subwatersheds with less than 10% imperviousness in an urbanizing watershed should maintain surface water quality and quantity and preserve aquatic species density and biodiversity, as recommended by the Environment Canada's Areas of Concern (AOC) Guidelines (2005).

In the West Holland River subwatershed, approximately 2,500 ha (7%) is impervious. While the West Holland River subwatershed currently has a relatively low level of imperviousness, it should be noted that research has shown that as impervious cover increases to eight to nine percent, there is a significant decline in wetland aquatic macroinvertebrate health (Hicks and Larson, 1997 *in* AOC Guidelines [2005]). In addition, the impervious areas within the subwatershed's urban areas are high (e.g. the Town of Bradford has 61.5% imperviousness). As urban areas in this subwatershed are anticipated to expand, it will be important to minimize the amount of impervious area to avoid the aforementioned impacts. The impacts of impervious surfaces are discussed further in Chapter 3.

8.3.2 Changes to hydrologic regime

Of all the natural heritage types identified above, changes to hydrologic regime will have the greatest impact on wetlands. Wetland types (e.g. fen, marsh, swamp) and their associated vegetation are dependent upon natural variations in hydrologic conditions such as baseflow rates, seasonal flooding and drainage. Any alteration to the hydrologic regime can lead to loss of wetlands and/or changes in wetland condition. Factors leading to changes in hydrology include extraction of water from rivers and streams, increased impervious surface, and deforestation. Processes leading to changes in surface and ground water quantity are discussed in more detail within Chapter 5 – Water Quantity.

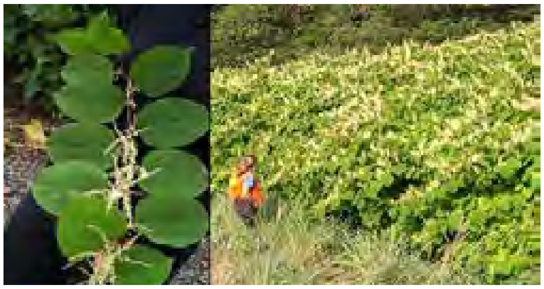
8.3.3 Invasive species

Invasive non-native species are a threat to biodiversity. While each species plays a specific role within their native ecosystems, once out of that setting and into a new ecosystem, these species can grow into enormous populations, if unchecked by the evolved predatory/prey relationships of their native systems. Invasive species can dominate a habitat niche, preventing other species from surviving, thereby reducing biodiversity. The presence of invasive species can be an indicator of disturbance in an ecosystem as there are generally very few if any non-native species present in less disturbed features. Invasive species are usually highly effective at transporting themselves. For example, plants can disperse their seeds through such tactics as hitching a ride with an unsuspecting dog or person, through wind dispersal or by a tenacious root system. Therefore, woodlands and wetlands that have been visited by very few people often have few to no invasive species and therefore, higher biodiversity.

While there is very little information related to terrestrial invasive species in the West Holland River specifically, the following are a few notable species within the Lake Simcoe watershed:

A threatening upland species that has shown rapid increase recently is dog-strangling vine (*Vincetoxicum rossicum*). Its strong vine-like structure creates a thicket blanket on the ground and can grow over small shrubs and trees leading to their death. This species is highly effective at crowding out other species; it is difficult even to walk through and blocks light from penetrating the ground.

Japanese knotweed (*Polygonum cuspidatum*) is a highly invasive perennial that has escaped from gardens. This species will inhabit any type of habitat from roadsides, building sites and abandoned lands to meadows and woodland edges. It grows very aggressively, out-competing other species. It spreads rapidly by way of its thick and vigorous underground rhizomes, making it difficult to remove (OFAH 2006).



Japanese Knotweed (photo: Kentucky Division of Forestry)

Capable of growing in a range of habitats, the Common Buckthorn (*Rhamnus cathartica*) has a rapid growth rate that allows it to create a thick cover, blocking shrubs and plants in the lower canopy and groundcover from sunlight. It has ‘allelopathic’ properties that inhibit the growth of nearby native plants, further allowing its own species to take over. Buckthorn is also a concern for the agricultural community as it is a host over the winter for soybean aphids and is an alternate host of oat rust.

Garlic Mustard (photo: Kentucky Division of Forestry)

In the past Garlic Mustard (*Allaria petioloata*) was used for medicinal purposes and as an herb in food. Now it is a persistent invasive species that threatens native groundcover in large areas and the species that depend on them. Garlic mustard has several properties that allow it to successfully replace large amounts of native groundcover in an area including: the ability to self-pollinate, production of over 100 seeds per plant and production of phytotoxic chemicals that inhibit the growth of nearby vegetation. Because of the sticky nature of its seeds, it is easily transported by human activity and the passing wildlife. This plant prefers shady sites with fertile, low pH soils such as savannahs, upland and floodplain forests, and along roadsides.

Giant Hogweed (*Heradeum mantegazzianum*) is an ornamental plant found in many gardens. As an individual plant can produce over 100,000 seeds that can stay viable up to seven years in the seed bank, it can easily spread over an area and replace the native species. While similar looking to the native Angelica and Cow parsnip, it is much larger, growing up to five metres in height. It also presents a health hazard to individuals that touch its clear sap. The sap contains toxins that cause photodermatitis and temporary or permanent blindness if it comes in contact with eyes (Pridham, 2009).

8.3.4 Recreation

Natural areas such as woodlands are a popular location for recreational activities such as hiking, cycling and snowmobiling. These activities if not managed correctly and undertaken in a responsible manner, can reduce ecological condition of the natural heritage features. Impacts from recreational activities can include increased soil erosion, loss of habitat area (especially for species sensitive to human presence), introduction of invasive species and pollution. Stresses on these sensitive areas are increasing as a result of increasing population and diminishing natural heritage lands. Within the West Holland River watershed areas that are stressed by recreational activities include Scanlon Creek, the Joker's Hill Trails at Thornton Bales, and the Oak Ridges Trail.

Key Points – Factors impacting Terrestrial Natural Heritage - stressors

- While there are multiple stressors to natural heritage systems, the greatest impact has been due to agricultural activities. Only 31% of the West Holland River subwatershed area is now classified as being a natural feature.
- Invasive species can have a significant impact of natural heritage systems by out competing and displacing native species. The extent and impact of terrestrial invasive species in watershed is poorly defined.
- Recreational activities, such as hiking, boating and snowmobile use, in natural heritage areas can lead to impacts such as erosion, species exclusion and invasive species introduction.
- Changes in hydrologic regimes due to factors such as water extraction for municipal and agricultural use and increased impervious surfaces is may be stressing wetlands in the subwatershed

8.4 Current Management Framework

Several acts, regulations, policies, and plans have shaped the identification and protection of the terrestrial natural heritage in the West Holland River subwatershed. Those having most impact on natural heritage features are summarized in Table 8-8. This management framework relates to many different stressors that can potentially affect natural heritage, ranging from the discharge of material to urban development. In Table 8-8 we categorize eight such stressors, recognizing that many of these activities overlap and that the list is by no means inclusive of all activities. The legal effects of this management framework broadly fall into one of two categories. The first broad category we define as those having little or no legal standing and are referred to as General or Have regard to Statements in Table 8-8 and are shown in blue. The second category includes those that have legal standing and must be conformed to; these are referred to as Regulated / Existing Targets in Table 8-8 and are shown in green. In many cases an act, regulation, policy, or plan does not relate to the activity specified, these are shown in red.

Table 8-8 Summary of current legislation and acts that relate to the protection and restoration of terrestrial natural heritage

	Oak Ridges Moraine Plan (2002)	Greenbelt Plan (2005)	Lake Simcoe Protection Plan (2009)	Growth Plan for the Greater Golden Horseshoe (2006)	Provincial Policy Statement (2005)	Endangered Species Act (2008)	LSRCA Watershed Development Policies (2008)	York Region Official Plan (2008)	Simcoe County Official Plan (2007)	Peel Region OP (2008)
Growth/development/site alteration	🟩	🟩	🟩	🟦	🟦	🟦	🟩	🟩	🟩	🟩
Habitat fragmentation	🟥	🟩 1	🟩 2	🟥	🟥	🟩	🟥	🟦	🟥	🟦 8
Connectivity	🟩	🟩	🟩	🟥	🟦	🟥	🟥	🟦	🟦 8	🟦
Impervious areas	🟩	🟩	🟦	🟥	🟥	🟥	🟦	🟩 8	🟩 8	🟩 8
Introduction of invasive species	🟥	🟥	🟦 3	🟥	🟥	🟥	🟥	🟥	🟥	🟦
Impacts from recreation	🟩	🟥	🟦	🟥	🟥	🟦 4	🟩 6	🟥	🟥	🟦
Restoration	🟦	🟦	🟦	🟥	🟦	🟦 5	🟩 7	🟦	🟦	🟦
Climate change	🟥	🟥	🟦	🟥	🟥	🟥	🟥	🟥	🟥	🟦

🟦 General/Have regard to statement 🟩 Regulated/Existing targets 🟥 No applicable policies

[1] The only policy relates to lot creation within the Protected Countryside
[2] Development not permitted in wetlands, *significant* forests*, significant* valleylands (e.g. other than wetlands, features not considered significant are not afforded the same protection)
[3] Discusses developing proposed regulations (to be considered by federal government under fisheries act), conducting studies/risk assessments, developing response plans, education programs, but nothing banning use/etc
[4] States that no person may damage or destroy the habitat of a species at risk, but does not specifically list any potential activities that may be permitted within habitat
[5] Person holding a permit to conduct an activity may be required to rehabilitate habitat damaged/destroyed in undertaking the activity; is also mentioned in policy pertaining to Species at Risk in Ontario Stewardship Program
[6] Along watercourses
[7] Required for valleyland applications, may be required in other cases (case-by-case basis)
[8] Within Oak Ridges Moraine planning area (as specified in the ORMCP)

In this section we provide a summary of the acts, regulations, policies, and plans as they pertain to the protection and restoration of terrestrial natural heritage. This summary is to give context to *future management considerations* and the *opportunities and recommendations to protect and improve natural heritage features in the subwatershed*. This summary is not intended to be comprehensive in terms of all the acts related to natural heritage, or the polices within these acts – the reader is directed to each piece of legislation for a full assessment of the legislation as it relates to natural heritage.

8.4.1 Oak Ridges Moraine Conservation Plan (ORMCP)

This plan designates Natural Core and Natural Linkage Areas for the purpose of maintaining and improving the ecological integrity. Approximately 3,900 ha (or 17%) of the subwatershed is designated ORMCP Natural Core and Linkage areas. The policies that apply in the Natural Core and Linkage Areas include:

- Every application for development or site alteration shall identify planning, design and construction practices that ensure that buildings or site alterations do not impede the movement of plants and animals among key natural heritage features, hydrologically sensitive features and adjacent land.
- A minimum area of influence and minimum vegetation protection zone. An application for development or site alteration within the minimum area of influence that relates to a key natural heritage feature, but is outside of that feature and the minimum vegetation protection zone, are to be accompanied by a natural heritage evaluation. Factors natural heritage evaluation shall include:
    - Demonstrate that the development or site alteration will have no adverse affects on the key natural heritage feature or the related ecological functions
    - Identify planning, design and construction practices that will maintain and, where possible, improve or restore the health, diversity and size of the key natural heritage feature and its connectivity with other key natural heritage features
    - Demonstrate how connectivity within and between key natural heritage features will be maintained and, where possible, improved or restored before, during and after construction
    - Determine if the dimensions of the minimum vegetation protection zone as specified in the ORMCP are sufficient, and specify the dimensions necessary to provide for the maintenance and, where possible, improvement or restoration of natural self-sustaining vegetation within it

ORMCP Key Natural Heritage Features

- Wetlands
- Significant portions of the habitat of endangered, rare and threatened species
- Fish habitat
- ANSIs (Life Science)
- Significant valleylands
- Significant woodlands
- Significant wildlife habitat
- Sand barrens, savannahs, and tallgrass prairies

Policies related to water conservation and the protection of water quantity and quality will have the added benefit of helping to maintain a great number of important natural heritage features, such as wetlands.

The West Holland River subwatershed also contains Landform Conservation Areas (both Categories 1 and 2), for which there are a number of policies:

- Applications for development or site alteration with respect to land in a landform conservation area shall identify planning, design and construction practices that will keep disturbance to landform character to a minimum, including
    - Maintaining significant landform features such as steep slopes, kames, kettles, ravines and ridges in their natural undisturbed form
    - Limits on the portion of the developable area of the site that is disturbed and the area of the site that has impervious surfaces

- Applications for development in landform conservation areas are to be accompanied by a landform conservation plan, that details (through maps) elevation contours; analysis of the site by slope type; significant landform features such as kames, kettles, ravines and ridges; and all water bodies including intermittent streams and ponds.
- Landform conservation plans should also include a development strategy that identifies appropriate planning, design and construction practices to minimize disruption to landform character

The ORMCP also details a number of requirements for those uses that are permitted within Natural Core and Linkage Areas, such as gravel pits, agricultural uses, and low-intensity recreational uses to ensure that they have minimal impact on these important areas.

8.4.2 Greenbelt Act (2005)

Sixty-three percent (just over 15,000 ha) of the West Holland River subwatershed lies within the Greenbelt Act Area. The Greenbelt Act area also includes the ORMCP areas (see below), but does not include designated urbanizing areas (known as the “White Belt”) that are not within the ORM. Within the Greenbelt Plan’s Natural System areas of the Protected Countryside (which includes towns, hamlets and villages), there are a subset of lands that are identified as the Natural Heritage System. This Natural Heritage System includes the areas of the Protected Countryside with the highest concentration of the most sensitive and/or significant natural heritage features and functions. The Greenbelt Plan identifies a number of policies related to the protection of the features within this system. These include:

Greenbelt Plan: Key Natural Heritage Features

- Significant habitat of endangered species, threatened species, and special concern species
- Fish habitat
- Wetlands
- Life Science Areas of Natural and Scientific Interest
- Significant valleylands
- Significant woodlands
- Significant wildlife habitat
- Sand barrens, savannahs and tallgrass prairies
- Alvars

- New development or site alteration (as permitted by the policies of the Greenbelt Plan) are required to demonstrate that
    - There will be no negative effects on key natural heritage features or key hydrologic features
    - Connectivity is maintained or enhanced wherever possible
    - The removal of other natural features should be avoided
    - The disturbed area of any site does not exceed 25%, and the impervious surface does not exceed 10% of the total developable area of the site
- Where non-agricultural uses are contemplated, the applicants must demonstrate that
    - At least 30% of the total developable area will remain in or be returned to natural self sustaining vegetation
    - Connectivity along the system and between key natural heritage features and key hydrologic features located within 240 metres of each other is maintained or enhanced
    - Buildings or structures will occupy less than 25% of the total developable area

- Development of lands within wetlands, seepage areas and springs, fish habitat, permanent and intermittent streams, lakes, and significant woodlands is not permitted (there are several activities which are allowed within these areas, such as conservation activities, fish and wildlife management, etc), including any associated vegetation protection zone.
- A proposal for development or site alteration within 120 metres of a key natural heritage feature within the Natural Heritage System requires a natural heritage evaluation which will identify a vegetation protection zone which is sufficient to protect the feature from the impacts of the proposed change (including before, during, and after construction), and restore or enhance the feature and/or its function wherever possible.

8.4.3 Lake Simcoe Protection Plan

The LSPP contains a number of policies aimed at protecting the natural features of the watershed. The Plan's natural heritage targets include:

- Achieving a greater proportion of natural vegetative cover in high quality patches
- Achieving a minimum 40 percent high quality natural vegetative cover in the watershed
- Protecting wetlands
- Naturalized riparian areas
- Restoration of natural areas or features
- Increased ecological health based on the status of indicator species and maintenance of natural biodiversity

The following are the policies set out by the plan that will help to meet these targets:

- Restricting the activities that can be undertaken in shoreline and riparian areas, and encouraging the re-naturalization of these areas
- The possible development of a shoreline regulation(s), which could address such issues as fertilizer use, activities contributing to the spread of invasive species, peat extraction, the filling and draining of existing wetlands, and vegetation removal
- The protection of key natural heritage and key hydrologic features (including wetlands, significant woodlands, significant valleylands and natural areas abutting Lake Simcoe) by prohibiting development and site alteration within these features and delineating a vegetation protection zone for each. A very limited number of land uses are permitted within this vegetation protection zone, these include forest, fish, and wildlife management; stewardship, conservation, restoration and remediation; flood or erosion control projects; stormwater retrofits; and low intensity recreational uses.
- The minimum vegetation protection zone is the area within 30 metres of the key natural heritage or hydrologic feature, but this may be larger if determined appropriate through a natural heritage evaluation, which is required of all applications for development or site alteration within 120 metres of a key natural heritage feature or hydrologic feature.
- Within identified settlement areas, an application for development shall, where applicable:
    - Increase or improve fish habitat in streams, lakes and wetlands, and any adjacent riparian areas

- Include landscaping and habitat restoration that increase the ability of native plants and animals to use valleylands or riparian areas as wildlife habitat and movement corridors
- Seek to avoid, minimize and/or mitigate impacts associated with the quality and quantity of urban run-off into receiving streams, lakes, and wetlands

8.4.4 Places to Grow Act – Growth Plan for the Greater Golden Horseshoe (2006)

The policies of this plan are meant to direct growth in such a manner as to protect natural heritage features and other significant areas from the issues associated with urban sprawl. This plan builds on the natural systems of the Greenbelt Plan, with policies that strive for a healthy natural environment with clean air, land, and water.

There are several Natural Systems policies in the Growth Plan that will support the protection of the subwatershed's natural areas. These include:

- The Ministry of Public Infrastructure Renewal will work with municipalities to identify natural systems for the Greater Golden Horseshoe, and where appropriate will develop additional policies for their protection
- The Greenbelt Policies apply throughout the natural system
- Planning authorities are encouraged to identify natural heritage features and areas that complement, link or enhance natural systems

8.4.5 Provincial Policy Statement (PPS) 2005

By focusing growth within settlement areas and away from significant or sensitive resources, the implementation of this piece of legislation will help to protect terrestrial natural heritage features within the West Holland River subwatershed. The policies that support this can be found under Section 2.0 of the PPS and include:

- Policies stating that natural heritage features and areas shall be protected for the long term, and that the diversity and connectivity of natural features in an area, and the long term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved.
- Policy 2.1.3 provides direction to regional and local municipalities regarding planning policies for the protection and management of natural heritage features and resources. The PPS defines seven natural heritage features (listed below) providing planning policies for each.
    - significant habitat of Species at Risk;
    - significant wetlands;
    - significant woodlands;
    - significant valleylands;
    - significant wildlife habitat;
    - Areas of Natural and Scientific Interest (ANSIs); and
    - fish habitat.
- The habitat of Species at Risk as well as provincially significant wetlands are designated and delineated by the Ontario Ministry of Natural Resources. These features and

habitats are afforded provincial protection and are precluded from development under the *Planning Act*. Proposed development in non-provincially significant features, such as wetlands and woodlands, are subject to the demonstration of no negative impact on the ecological function.

Municipal and local planning authorities are responsible for the identification and designation of these features within their Official Plans (with the exception of provincially significant wetlands and the significant habitat of Species at Risk).

The Greenbelt Plan and Oak Ridges Moraine Conservation Plan (ORMCP) are provincially legislated areas that take precedence over the PPS.

8.4.6 Endangered Species Act

The purposes of the Endangered Species Act (ESA) are to protect species that are at risk and their habitats, as well as promoting the recovery of those species. Through the implementation of the policies of the ESA, protection will be afforded to the habitats of the West Holland River subwatershed's rarest species, thus helping to preserve the subwatershed's biodiversity. These policies state that no person shall:

- Kill, harm, harass, capture or take a living member of a species that is listed on the Species at Risk Ontario (SARO) list as an extirpated, endangered, or threatened species
- Possess, transport, collect, buy, sell, lease, trade or offer to do the same with any specimen (living or dead) or part of a species that is listed on the SARO list as an extirpated, endangered, or threatened species
- damage or destroy the habitat of a species listed as endangered, threatened, or extirpated

The policies of the ESA also require that a recovery strategy be prepared for each of the species on the SARO list as an endangered or threatened species. These strategies are to include an identification of the habitat needs of the species, a description of the threats to the survival and recovery of the species. The ESA includes a policy that states that the precautionary principle should be used in the development of recovery plans – where there is a threat of significant reduction or loss of biological diversity, a lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.

8.4.7 The Role of the LSRCA

LSRCA Watershed Development Policies (2008)

The LSRCA has a number of policies aimed at protecting natural heritage features. Wherever possible, the LSRCA directs development away from features such as Environmentally Significant Areas, ANSIs, wetlands, significant valleylands, significant woodlands, sensitive or significant wildlife habitat, and the habitat of Species at Risk.

Depending on the location and scope of a plan of subdivision, the LSRCA may require the submission of a number of materials be included in the application, such as planting or vegetation plans, vegetation preservation plans, and environmental impact studies. The completion of these studies will help to protect features or minimize the impact of the development on the important features and functions within the subwatershed.

There are policies that deal specifically with maintaining valleylands by minimizing site alteration. Through these policies, the LSRCA may require a number of studies (such as

Vegetation Plans, Tree Preservation Plans) and can place additional restrictions on development proposals within or in proximity to valleylands.

The Authority endeavours through its policies to encourage municipalities to identify ESAs and to work with them to develop appropriate environmental protection policies to incorporate into their Official Plans. The LSRCA does not support development in Group 1 biological ESAs, unless it can be shown (through an environmental impact study) that there will be no negative impacts on the ESA. The LSRCA has other requirements for Group 2 and 3 ESAs that seek to minimize impacts of development.

Floodplains are also well protected through these policies, although development in this area may be permitted under some circumstances. However, the policies stipulate that within this area, cutting and filling will generally not be permitted in ESAs, wetlands, ANSIs, significant woodlands and valleylands, sensitive wildlife habitats, habitats of Species at Risk, and on steep slopes.

With respect to wetlands, the LSRCA's policy statement is that new development and/or interference in any way shall be prohibited within all PSWs, and that such activities will be prohibited within all other wetlands except under several circumstances. These include demonstrating the need to develop within the wetland, the absence of an alternate location for the proposed development, the design of the proposed development minimizes disturbance to the site, drainage patterns are maintained, and the completion of an appropriate EIS demonstrating that there will not be an effect on the control of flooding, or pollution or the conservation of land due to the development.

The policies also stipulate that some infrastructure projects may be permitted within wetlands. Where development is permitted, the LSRCA may also require wetland creation at a 3:1 ratio.

The LSRCA requires a 120 metre setback from all PSWs and a 30 metre setback from all other wetlands, unless it can be demonstrated through submission of hydrological studies that there will be no negative impacts to the wetland.

Lake Simcoe Natural Heritage System

LSRCA has recently developed a Natural Heritage System for the Lake Simcoe watershed. The *Natural Heritage System for the Lake Simcoe Watershed Phase 1: Components and Policy Templates* is used by LSRCA staff to guide plan review, though the main intent is for adoption through municipal Official Plans. The foundation of the NHS is the *Provincial Policy Statement 2005* (PPS), the principal tool designed by the Province to incorporate natural heritage planning across the watershed. Science is the support structure of the NHS and supporting documentation (Beacon and LSRCA, 2007) provides comprehensive criteria based on recent scientific concepts in order to identify lands of ecological value within the watershed.

A four-tiered policy approach was developed to direct the protection of the natural features of the Natural Heritage System (Table 8-9). The first two levels of this policy approach are assigned a "provincially significant" designation and are considered to be those features that would be identified if following the guidelines and intent of the PPS. Level 3 of this approach represents significance at the watershed level, while Level 4-supporting features are those that are considered to be supporting the natural heritage system of the watershed. Finally, Big Woods Policy Areas are target areas for replacement, restoration and stewardship priorities (Beacon and LSRCA, 2007).

Table 8-9 **Policy guidelines of the LSRCA Natural Heritage System Phase 1**

Significance	Policy Level	Guideline
Provincial	Level 1	Provincially significant, retention and protection
	Level 2	Provincially significant, retain and demonstrate no negative impact
Watershed	Level 3	Watershed significant, retain and avoid; demonstrate no net negative impact, replacement may be acceptable
Supporting	Level 4	Not necessarily a constraint to development but replacement encouraged
Big Woods Policy Areas	BWPA	Retain, no net loss of woodland

Approximately 7,900 ha (33%) of the West Holland River subwatershed is within the four-tier LSRCA NHS, the breakdown is as follows (Table 8-10 and Figure 8-4):

Table 8-10 **LSRCA Natural Heritage System Policy Levels in the West Holland subwatershed**

Policy Level	Area in the EHS (ha)	Percentage of the EHS
Level 1	5,785	24.2
Level 2	600	2.5
Level 3	869	3.6
Level 4 - supporting	669	2.8
Total	7,923	33.1

While the Natural Heritage System of the West Holland River subwatershed is comprised mostly of Level 1 features, Level 1 and Level 2 features accounts for approximately 80%.

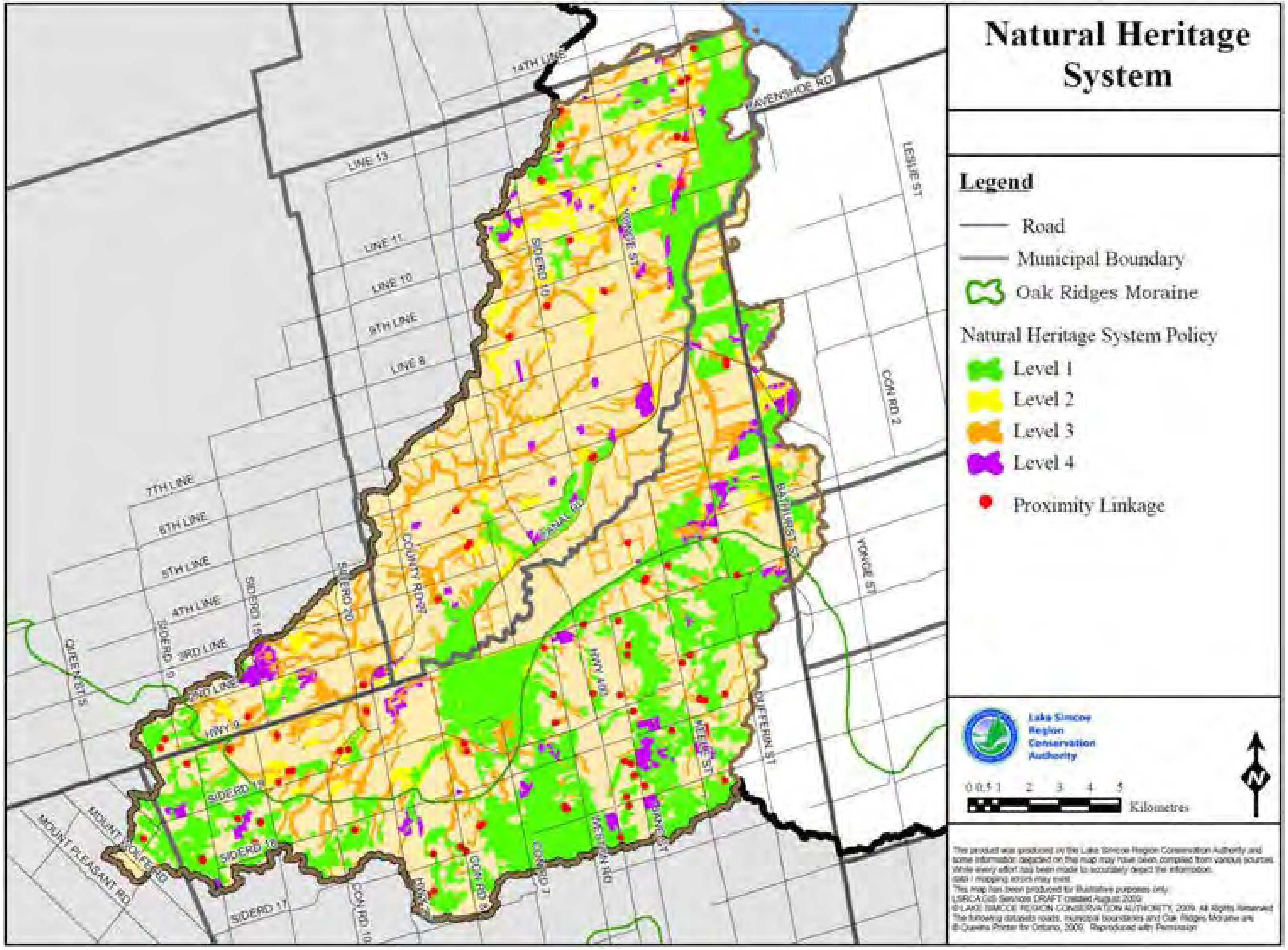


Figure 8-4 LSRCA Natural Heritage System in the West Holland subwatershed

8.4.8 York Region Official Plan (2009)

Just over half of the West Holland River subwatershed (53%) is located within the Regional Municipality of York. The York Region Official Plan protects the natural heritage features of the landscape through a set of policies that apply to an identified Regional Greenlands System as well as to identified Environmental Policy Areas (EPAs), Wetland Areas, Forest Resource Areas, and Landform Conservation Areas.

Of the lands of the West Holland River subwatershed that are in York Region, 5.5% (approximately 1,040 ha) form part of the Greenlands System and 13.8% (approximately 2,612 ha) are included as “Significant Forested Areas”. These two designations are not mutually exclusive.

The plan’s policies related to the protection of natural heritage features and functions include:

- Directing new development and site alteration away from the Greenlands System
- The Greenlands System is to be enhanced through greening initiatives, partnerships, infrastructure projects and urban development to achieve ecological gains for the system
- Development applications within 120 metres of the Greenlands System must be accompanied by an Environmental Impact Study, and include details of enhancement opportunities and mitigative measures
- Requiring that the Regional Greenlands Strategy be identified more specifically for Urban Towns and Villages, in local OPs and secondary plans, and integrated into community design. These plans are to contain policies and detail initiatives that encourage system remedial works and enhancement opportunities
- Encouraging links and enhancements in local OPs for new community areas
- Requiring infrastructure projects that are permitted within the Greenlands Sytem to be designed and constructed to be sensitive to the features and functions of the system, and include context sensitive design and innovative technologies to minimize impacts and enhance the Greenlands System
- Prohibiting development and site alteration within key natural heritage features and key hydrologic features and adjacent lands, unless it can be demonstrated that the activity will not result in a negative impact on the feature or its functions.
- Co-operating with conservation authorities, the Province, and local municipalities to further define and better understand key natural heritage features and key hydrologic features and their functions and to promote improved stewardship and protection strategies
- Prohibiting development and site alteration within the wetlands identified in the OP mapping and to require a minimum vegetation protection zone of 30 metres; and placing restrictions on development within 120 metres of these wetlands. Under certain circumstances, development will be permitted (e.g. no loss of wetland function, or contiguous wetland area).
- Increasing woodland cover in York Region to 25% of the land area
- Prohibiting development and site alteration within significant woodlands and their associated vegetation protection zone (with some conditions). In circumstances where these activities are permitted, a woodland compensation plan must be completed

- Managing York Region forests sustainably in a manner that enhances ecological, educational, and recreational functions to ensure their health in perpetuity
- Supporting the goals and objectives of subwatershed plans

8.4.9 Simcoe County Official Plan (2007)

The policies within the Simcoe County Official Plan related to the protection of terrestrial natural heritage features and functions include:

- The identification and protection of a country Greenlands System; and encouraging the rehabilitation of the Greenlands System toward a natural heritage state
- Restricting development and site alteration within a number of environmental features, including wetlands, habitat of endangered and threatened species, fish habitat, significant woodlands and valleylands, significant ANSIs; and requiring an environmental impact statement for proposals that fall within a certain distance of a feature (the width depends on the type of feature). The environmental impact statement is required to demonstrate that there will be no negative impact on the feature or its functions
- Encouraging the maintenance and restoration of natural heritage areas where appropriate in rural and agricultural areas
- Encouraging good farm and land stewardship practices and stewardship and education programs

8.4.10 Peel Region Official Plan (2008)

- Protecting and/or enhancing the features and functions of a regional Greenlands system, which consists of Core Areas, Natural Areas and Corridors, and Potential Natural Areas and Corridors. Features included in the Greenlands System include ANSIs, Environmentally Significant Areas, fish and wildlife habitat, habitats of threatened and endangered species, wetlands, woodlands, valley and stream corridors, shorelines, natural lakes, natural corridors, and groundwater recharge and discharge areas
- Preparing green development standards, and encouraging area municipalities to do the same
- Adopting policies and establishing programs for the restoration of the natural environment in Peel, working jointly with local municipalities, the conservation authority and other partners
- Promoting and participating in the development of watershed plans
- Protecting, maintaining and enhancing the integrity of ecosystems jointly with area municipalities, conservation authorities and other partners
- Studying, recognizing, and protecting the overall integrity of Peel's ecosystems which are part of connected biotic and abiotic systems providing local and large scale natural functions
- Supporting programs of partner organizations which encourage farmers to develop and follow conservation measures and sustainable farming practices
- Preparing, in consultation with area municipalities, conservation authorities, and other partners, a climate change strategy to address mitigation and adaptation

8.5 Management gaps and limitations

As can be seen in the above section, there are a number of pieces of legislation, regulations and municipal requirements aimed at protecting and enhancing the natural heritage features in the West Holland River. Despite this strong foundation, there are a number of gaps and limitations in the management framework that need to be considered, such as the effects of climate change. This section provides an overview of the factors that need to be considered in the future management of the subwatershed.

8.5.1 Growth, Development and Site Alteration

These activities are strongly regulated in areas such as key natural heritage features, key hydrologic features, and shorelines through the ORMCP, Greenbelt Plan, Lake Simcoe Protection Plan, York Region and Simcoe County Official Plans, and LSRCA Watershed Development Policies. The protection and potential enhancement of these features will be extremely important in maintaining all aspects of ecosystem health in the subwatershed. There are, however, limitations with these policies:

- For many natural heritage features (other than wetlands) it is only those considered significant that are protected, and in general only those considered provincially significant are protected. Although they are not considered to be significant, these features still perform important functions in the watershed, and the development of these areas and loss of these functions will have impacts to watershed health. Wetlands are now well protected through the Generic Regulation (179/06);
- The policies that apply to hydrologic features are not consistent across the subwatershed – the definition of a key hydrologic feature is different for the ORMCP area, the Greenbelt Plan area, and the LSPP area which covers the remainder of the subwatershed. Features such as seepage areas, springs, aquifers and recharge areas are protected in the ORMCP area, but not the LSPP area, and the Greenbelt Plan includes seepage areas and springs but not aquifers and recharge areas. These discrepancies can leave some of these features unprotected.
- Some plans specify a minimum vegetation protection zone around key natural heritage and key hydrologic features (e.g. the ORMCP and Greenbelt Plan), and also identify a further ‘area of influence’ (as it is referred to in the ORMCP) outside of the minimum vegetation protection zone. Within this area of influence, a proposal for development or site alteration triggers the requirement for a natural heritage and/or hydrologic evaluation. This evaluation is meant to describe the existing conditions, assess the potential impacts from proposed development/site alteration and determine if the minimum vegetation protection zone provides sufficient protection. If the minimum vegetation protection zone is not found to be sufficient, the evaluation should specify the dimensions of the required minimum vegetation protection zone. While the goal of these policies is undoubtedly to protect the features, in reality the required evaluations rarely specify anything greater than the minimum; in essence the minimum becomes the maximum distance. There is therefore little further protection gained through this process for these features and their functions by way of a buffer distance.

8.5.2 Habitat Fragmentation

A number of the policies of the ORMCP, Greenbelt, LSPP and York Region’s Greenlands System protect key natural heritage features, which will aid in preventing the fragmentation of terrestrial habitat within the West Holland River subwatershed. However, the main limitation of this framework is that:

- Those features not subject to the application of these policies (such as regionally or locally significant forests) are vulnerable to being lost to development pressures. The loss of these features, although they are not considered to be significant under the regulatory framework, could cause considerable fragmentation of the natural landscape of the subwatershed, which could subsequently impact in the subwatershed.

8.5.3 Connectivity

The ORMCP, Greenbelt, and LSPP all contain policies requiring the completion of natural heritage evaluations for proposals within the minimum vegetation protection zone of key natural heritage features. These policies generally state that a natural heritage should identify planning, design and construction practices that will maintain and, where possible, improve or restore the health, diversity and size of the key natural heritage feature and its connectivity with other natural heritage features. The ORMCP also includes a policy stating that applications outside of Settlement Areas are to ensure that no buildings or other site alterations impede the movement of plants and animals among key natural heritage features, hydrologically sensitive features and adjacent land within Natural Core and Linkage Areas. Again, the limitation to these policies is that they only apply to those features identified as key natural heritage features and the linkages between, leaving many natural areas unprotected. There are additional general statements regarding protecting connectivity in the plans, but none containing specific policies that would protect features other than those identified as key natural heritage features.

8.5.4 Impervious Areas

The ORMCP, Greenbelt Plan and Regional Official Plans contain policies around that aim to limit impervious area (and hence its impacts on the natural features of the subwatershed) to a certain level, while the PPS, LSPP and LSRCA Watershed Development Policies contain more general statements about striving to limit impervious area. These policies are limited in scope, and there are gaps in the geographic area covered. The issues with these policies include:

- The ORMCP and Greenbelt Plan do set a limit of 10 per cent, but these limits apply only outside of Settlement Areas in the ORMCP, and only in the Natural Heritage System of the Greenbelt. Thus there is no defined limit within the ORMCP and Greenbelt Plan areas not covered by these policies, as well as areas outside of the ORMCP and Greenbelt boundaries, and the subwatershed’s impervious area could easily exceed 10 per cent (and already has in the West Holland subwatershed)
- York Region’s policies around impervious surfaces only apply in the ORMCP area
- There is no agency ensuring that subwatershed impervious areas do not exceed the defined limit
- Approval agencies should be striving for either a reduction in impervious areas on development sites or the mandatory use of practices that increase infiltration in order to reduce the impacts of impervious area within the subwatershed

8.5.5 Introduction of Invasive Species

There are few policies related to the introduction of invasive species in the current management framework, and only the Lake Simcoe Protection Plan contains policies related to terrestrial invasive species. The limitations of the policies contained in this plan are as follows:

- Most of the policies are related to aquatic invasive species.
- The policies around terrestrial invasive species are focused on monitoring to determine the extent of invasive species and developing a watch list and associated response plan

for species expected to be introduced into the watershed, but not on preventing the introduction of these species. The policies around aquatic invasive species are more comprehensive.

- The LSPP notes the importance of identifying funding mechanisms for the implementation of invasive species response plans, but there is currently not a guaranteed fund for undertaking these activities.

8.5.6 Impacts from Recreation

A number of the plans allow for low impact recreation within key natural heritage features. The issues with these policies include:

- Although these policies are aimed at protecting these features from the impacts of other types of recreation, there are still potential issues that may arise from allowing activities such as non-motorized trails within these features, such as erosion from the trails themselves, introduction and spread of invasive species.
- These policies apply only in key natural heritage features, leaving other features more susceptible to damage from recreation activities

8.5.7 Restoration

Most of the policies related to restoration are quite general in nature, and do not contain specific requirements. Some require applications for development or site alteration in key natural heritage features to be accompanied by a natural heritage, which in most cases requires the applicant to include planning, design or construction practices that will maintain and, where feasible, improve or restore the health, size, and diversity of the feature. The limitations to this approach include:

- Resources are needed to ensure that the specified design practices are being undertaken during and after construction
- It may be difficult to measure whether the health, size and diversity of a feature has been maintain or restored – this would require a significant input of resources, and impacts may not be seen for some time after the construction has been completed.

8.5.8 Climate Change

Climate change is generally not well addressed in the current management framework. The LSPP contains the most comprehensive policies related to this issue which could potentially cause shifts in the vegetative communities in the subwatershed, impact the hydrologic regimes that sustain wetlands, and make the subwatershed ecosystem more susceptible to stresses such as disease and insect infestation. The adaptation strategy that will be developed through the LSPP is a significant first step in addressing this issue, and some of the Official Plan policies are beginning to consider climate change as well. While it may not be appropriate for some of the existing legislation to address climate change issues, it will be important to incorporate climate change considerations wherever possible in making management decisions for the subwatershed, and implement policies requiring, at the very least, the implementation of so called “no regrets” options should be incorporated into development and site alteration wherever possible.

8.6 Recommended Actions to Improve Terrestrial Natural Heritage

The following recommended actions were developed to improve terrestrial natural heritage in the West Holland River subwatershed. The subwatershed now contains just under 30% natural cover, and the existing land uses have caused considerable stress to the natural heritage features of the subwatershed. In addition to the natural heritage features that are removed to accommodate uses such as urban and agriculture, other issues include the resultant changes to hydrologic regime, which can affect features such as wetlands; the fragmentation of natural heritage features; the introduction of invasive species; and stresses from the increasing population utilizing natural heritage features for recreational opportunities. Given that the urban area and population in this subwatershed are expected to increase in the coming years, and the agricultural areas are, for the most part, likely to remain, measures must be undertaken to mitigate these impacts. The implementation of the actions below will help to mitigate these impacts on the natural heritage features of the West Holland River subwatershed.

These recommendations, which are grouped and numbered as described in Section 1.4, were developed to address the water quality issues and stressors that were identified throughout this chapter. In addition, they consider, and are consistent with applicable policies and recommendations in the province's Lake Simcoe Protection Plan, and the LSRCA's Integrated Watershed Management Plan. Each recommendation below also identifies the applicable 'detailed recommendations' as outlined in Chapter 10. These detailed actions will form the basis of the Implementation Plan for York Region's ORM subwatersheds, to be developed following the completion of this plan.

8.6.1 Planning and Policy

6) That the value of the ecological goods and services (EGS) provided by ecological features be considered in decision making around growth and development

   Detailed recommendation: A.3.6

7) That the rural/agricultural community be engaged in developing solutions for minimizing the impacts of practices on their lands

   Detailed recommendation: A.4.1

8) That the municipal partners, the LSRCA, and the Province support a common framework and develop and endorse policies and programs for the protection and enhancement of the West Holland subwatershed's natural heritage system and its functions

   Detailed recommendations: A.5.1 – A.5.2, A.5.6 – A.5.7

9) That the partners, including the municipalities, LSRCA, and the Province, seek to gain an improved understanding of the natural heritage features of the West Holland subwatershed

   Detailed recommendations: A.5.4 – A.5.5

10) That the Province, the municipal partners, and the LSRCA seek to gain an improved understanding of the impacts of climate change in the West Holland subwatershed, incorporating this information into decision making scenarios and developing strategies to mitigate and adapt to its impacts.

    Detailed recommendations: A.6.1 – A.6.2, G.1.1 – G.1.3

8.6.2 Use of Better Management Practices

12) That support for programs offered to assist rural landowners in implementing BMPs on their properties, such as LSRCA's LEAP program, be continued and/or expanded as resources permit

    Detailed recommendations: B.2.1 – B.2.3

13) That sectors that have the potential to have significant impacts on conditions in the West Holland subwatershed be expected to undertake BMPs and other activities to mitigate their impacts, as required under the LSPP

Detailed recommendations: B.2.4 – B.2.5

8.6.3 Applied Research and Science

24) That the partners (LSRCA, MNR, NRCAN, etc) undertake studies to enhance understanding of natural heritage resources within the West Holland subwatershed in support of management strategies related to unique and/or significant features

Detailed recommendations: D.3.1, D.3.3 – D.3.4, D.3.6 – D.3.7

25) That LSRCA and its partner municipalities assess the feasibility of increasing and/or enhancing natural cover, and develop strategies to prioritize these undertakings in order to achieve the greatest benefit to the subwatershed

Detailed recommendations: D.3.2, D.3.5

26) That all partners cooperate to determine the presence and extent of invasive species in the subwatershed, and work to prevent their establishment and spread

Detailed recommendations: D.3.7 – D.3.8

8.6.4 Monitoring

32) That the LSRCA undertake regular updates to its Natural Heritage and Land Use mapping to ensure the most up-to-date information is being used.

Detailed recommendation: E.4.1

8.6.5 Management, Rehabilitation and Restoration

38) That the LSRCA and the partner municipalities assess the feasibility of increasing natural cover (e.g. woodland, streambank vegetation, interior forest, grassland) in the subwatershed and set priorities and develop plans to undertake this enhancement, based on overall benefit to the subwatershed.

Detailed recommendations: A.5.3, F.2.1 – F.2.5

39) That the LSRCA identify opportunities for land securement of priority sites.

Detailed recommendation: F.2.3, F.4.1

40) That the partner municipalities, in cooperation with the LSRCA, look to enhance existing woodland areas through replacing plantation species with appropriate native species through succession in order to provide higher quality habitat while maintaining the functions that plantation areas perform. These include maintaining water quality, providing shelter, encouraging infiltration and stabilizing soils.

Detailed recommendation: F.2.4

41) That the LSRCA support the work of MNR and OFAH with respect to invasive species and encourage the distribution of promotional materials.

Detailed recommendation: F.3.1

42) That the partner municipalities adopt policies to encourage the use of native species, particularly those drought tolerant species, through development approvals and property management programs.

Detailed recommendation: F.3.2

43) That the LSRCA continue to undertake stewardship initiatives, priority areas for which may be identified through Phase II of LSRCA's Natural Heritage System.

Detailed recommendation: F.4.2

44) That the LSRCA request the Ministry of Natural Resources to undertake the development of watershed rare lists and protection policies for species at risk in the subwatershed.

Detailed recommendation: F.4.3

45) That LSRCA and its municipal partners investigate initiatives to improve the long term benefit and environmental sustainability of public properties and facilities.

Detailed recommendation: F.4.4

8.6.6 Adaptive Response

47) That the LSRCA and partner municipalities work to reduce their carbon footprint and to increase ecological resilience in the watershed

Detailed recommendations: G.1.1 – G.1.3

9 West Holland River Subwatershed's Natural Capital: The Value of the Subwatershed's Ecosystem Services

9.1 Introduction

In 2008, the Lake Simcoe Region Conservation Authority partnered with the David Suzuki Foundation and the Greenbelt Foundation to determine the value of the ecosystem goods and services provided by the features in the watershed in a report entitled 'Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services'. The value of the services provided by the entire Lake Simcoe watershed was estimated to be a minimum of $975 million dollars each year. As part of the subwatershed planning exercise, the Conservation Authority has completed a more specific analysis of the value of the services provided by the ecosystems of the West Holland River subwatershed.

9.2 What is Natural Capital?

Natural capital refers to our natural assets, and the ecosystem goods and services that those assets provide. Natural assets and ecosystem services are the foundations of life – including human life. The benefits provided by natural capital include the storage of floodwaters by wetlands, water capture and filtration by forests, the absorption of air pollution by trees, and climate regulation.

Forests, wetlands, and rivers that make up watersheds are essentially giant utilities providing ecosystem services for local communities as well as regional and global processes that we all benefit from. Ecosystems provide many services including carbon storage and sequestration, water storage, rainfall generation, climate buffering, biodiversity, soil stabilization, and more (Global Canopy Programme. http://www.globalcanopy.org/main.php?m=3 in Wilson, 2008). The goods and services provided by the West Holland River subwatershed are estimated to be worth over $90 million annually.

The most highly valued natural assets are the forests and wetlands, worth $319 and $435 million per year, respectively for the Lake Simcoe basin and approximately $33 and $39.5 million, respectively, for the West Holland River subwatershed. The high value for wetlands reflects the many important services they provide, such as water regulation, water filtration, flood control, waste treatment, recreation, and wildlife habitat. Forests provide high value because of their importance for water filtration, carbon storage, habitat for pollinators, and recreation.

As the subwatershed plan is developed for the West Holland River, this study reinforces the importance of ensuring meaningful protection of natural features, including through the implementation of the Natural Heritage System and policies through local official plans. The ecosystem values in this report can also be a useful tool for other regions to determine the hidden wealth of their respective ecological systems and plan more strategically for healthy and sustainable communities. By measuring or quantifying the value to communities of ecosystem services, we can more accurately account for land use changes which thereby help to inform land use and other decisions related to altering the landscape.

9.3 Valuing Ecosystems

Ecosystem goods and services are the benefits derived from ecosystems. These benefits are dependent on ecosystem functions, which are the processes or attributes that maintain the ecosystems and the species that live within them. Humans are reliant on the capacity of natural processes and systems to provide for human and wildlife needs (De Groot, 2002 in Wilson, 2008). These include products received from ecosystems (e.g. food, fibre, clean air, and water), benefits derived from processes (e.g. nutrient cycling, water purification, climate regulation), and non-material benefits (e.g. recreation and aesthetic benefits) (Millennium Ecosystem Assessment, 2003 in Wilson, 2008).

Several techniques have been developed to determine economic values for non-market ecosystem services. The method used for this study uses avoided cost and replacement cost for ecosystem service valuation, as well as contingent valuations or willingness-to-pay studies for cultural values. Some of the values were derived using direct analysis and some values were adapted from other studies. All ecosystem service values are reported in 2005 Canadian dollars.

The estimated values provided are likely a conservative estimate because our knowledge of *all* the benefits provided by nature is incomplete, and because without the earth's ecosystems and resources, life would not be possible, so essentially the value of nature is priceless. It is also important to note that the value of natural capital and its services will increase over time, as services such as water supply become increasingly scarce due to population growth and the anticipated effects of climate change, for example. The valuations of ecosystem services, however, provide an opportunity to rigorously assess the current benefits and the potential costs of human impact.

9.3.1 West Holland River Subwatershed's Ecosystem Values

1. Water Quality, Supply, and Regulation

Forests and wetlands can reduce non-point source water pollution because they filter, store, and absorb pollutants, such as nitrogen and phosphorus. Studies by the U.S. Environmental Protection Agency show that forests in rural areas improve water quality because trees divert rainwater into the soil where bacteria and microorganisms filter out pollutants. This filtering significantly reduces the sediment, pollutants, and organic matter that reach streams.

i. Water Filtration Services

Natural cover in watersheds is vital for a clean and regular supply of safe drinking water. While there are no drinking water intakes in the West Holland River, the water does drain to the lake, where eight communities draw their drinking water supply – cleaner water from the rivers will result in reduced treatment requirements. Studies have shown that treatment costs increase as forest and wetland cover decreases in watersheds.

The value of the current forest/wetland cover for water filtration services, based on the estimated daily residential water use in the Lake Simcoe watershed, is $209.86 per hectare.

ii. Water Regulation and Flood Control

Forests and wetlands also regulate the flow of water, providing protection against flooding and erosion. The loss of forest affects stream flows leading to instability in drainage systems, reduced infiltration of water into soils, and increased peak flows. Wetlands act as natural retention reservoirs for water, slowing its release. Changes in stream flow due to forest and wetland loss results in lower water levels in dry seasons, higher than normal water levels in wet seasons or storms, greater amounts of sediment entering rivers, and increased water temperatures (Ribaudo, 1986 in Wilson, 2008).

The value of water regulation by forests is calculated as a replacement value, which represents the construction costs for water runoff control if the current forest cover was removed and converted to urban land use. The forest cover provides savings because it provides green infrastructure for the region. The total annual savings are $1,886 per hectare. For each five per cent of forest cover converted to urban land use, the incremental cost is an estimated $458 per hectare per year.

The annual value of flood control by wetlands is based on an average ($4,039 per hectare), a value which was derived from the review of four different studies.

iii. Waste Treatment

Wetlands are effective waste treatment systems – constructed wetlands are often used to treat human and agriculture wastes. Depending on the type, size, plants, and soils, wetlands can regulate, filter, and absorb a significant amount of nitrogen, phosphorus, and other contaminants. In the absence of wetlands, these nutrients would otherwise need to be removed by treatment plants. The combined annual total for waste treatment of nitrogen and phosphorus by wetlands is estimated at $2,148 per hectare (based on a range of $1,061 to $3,235/ha/year).

2. Clean Air

Trees are essential because they produce oxygen for our air. On average, one tree produces nearly 260 pounds of oxygen each year. Forests and trees also provide improvements in air quality. Trees remove air pollution such as carbon monoxide and sulphur dioxide by adsorption through their leaves and they also intercept airborne particles by retaining them on their leaves. These pollutants can have significant economic impacts in terms of health damage costs, economic losses due to agricultural crop damages, visibility reduction, and soil damage.

The amount of air pollutants removed by the tree canopy cover was calculated for the report using CITYgreen software. This software calculates the value of air cleansing by trees using average removal rates of various pollutants by trees. The annual value of the service of pollutant removal by tree canopy cover is estimated at $377 per hectare.

3. Carbon Services

Globally, forests and wetlands function as large terrestrial banks of carbon, preventing increases in the level of greenhouse gases in the atmosphere. Forests and wetlands play an integral role in the global carbon cycle by pulling carbon from the atmosphere. As a result, large amounts of carbon are stored in trees, plants, roots, and soils.

i. Forests

Carbon storage and annual carbon sequestration by forests are often misunderstood. Forest carbon storage refers to the total amount of carbon contained in an ecosystem at a given time. Carbon sequestration refers to the annual amount of carbon uptake by an ecosystem after subtracting the carbon released to the atmosphere due to respiration, disturbance, and decomposition.

The economic value of the carbon stored by forests was calculated using the avoided cost (i.e. the damages avoided by the carbon stored). The Intergovernmental Panel on Climate Change reported that the average cost of global damages due to the level of carbon dioxide in the atmosphere in 2005 was $52 per tonne of carbon (IPCC, 2007 in Wilson, 2008). Lake Simcoe's forests store 220 tonnes of carbon per hectare. Therefore, the annual value of the carbon stored was worth an estimated $919 per hectare) in 2005.

The annual uptake of carbon (i.e. net carbon sequestration) was calculated using CITYgreen software. The average annual value of the carbon sequestered (approximately 0.75 tonnes of carbon per hectare) is $39 per hectare based on the average cost of carbon emissions ($52 per tonne of carbon).

ii. Wetlands

Carbon storage by wetlands was determined using Canada's Soil Organic Carbon Database (Tarnocai and Lacelle, 1996 in Wilson, 2008). Using data extracted from this database, the annual value of the carbon stored based on the average damage cost of carbon emissions ($52/tonne of carbon) was determined. The value per hectare ranges from $524 to $1,302 per year depending on the type of wetland, and the soil carbon ranges from 125 to 312 tonnes per hectare.

Based on average global carbon sequestration rates for wetlands of 0.25 tonnes per hectare per year (http://www.aswm.org/science/carbon/quebec/sym43.html in Wilson, 2008), the rate of carbon uptake in the Lake Simcoe watershed was estimated to be worth $13 per hectare. This is most likely a very conservative estimate because other studies have found higher rates of carbon uptake (Fluxnet Canada, http://www.trentu.ca/academic/bluelab/research_merbleue.html, in Wilson, 2008).

iii. Agricultural Land and Grasslands

Organic carbon stored in the agricultural soils of the Lake Simcoe watershed was extracted from the Canadian Soil Organic Carbon Database (Tarnocai and Lacell, 1996 in Wilson, 2008). The average annual value of the carbon stored by agricultural soils was calculated to be $547 per hectare. The average soil carbon content is 131 tonnes of carbon per hectare, ranging from 125 tonnes to 252 tonnes of carbon per hectare depending on the type of agricultural land cover.

Grasslands, a classification which in this report includes cultural meadow, alvar meadow, and tallgrass prairie land covers, store an average of 100 tonnes of carbon per hectare. The annualized value of carbon storage is worth an estimated $438 per hectare per year.

4. Biodiversity

i. Habitat

Wetlands are well known for the important habitat they provide for many species, especially birds, amphibians, and reptiles. The Lake Simcoe watershed is home to at least 32 of the 175 species at risk in southern Ontario.

The annual value for wetland habitat services is $5,830 per hectare based on the average annualized wetland habitat restoration costs for a group of relevant Great Lakes Sustainability Fund projects (IJC Study Board, 2006 in Wilson, 2008). The annualized value of restoring habitat represents the value of wetland habitat in terms of the avoided cost of damages to habitat.

The avoided cost of the loss or degradation of wetland habitat is also significant because of the importance of wetlands for many species, especially species at risk. In Canada, more than 200 bird species (including 45 species of waterfowl) and over 50 species of mammals depend on wetlands for food and habitat; many of these are species at risk.

ii. Pollination

Pollination is the transfer of pollen from one flower to another, which is critical for fruit and seed production in most plants. Approximately 80 per cent of all flowering plant species are specialized for pollination by animals, mainly insects. Without this service, many interconnected species and ecosystems functioning within an ecosystem would collapse (Commission on Genetic Resources for Food and Agriculture, 2007, in Wilson, 2008). Insect pollination is necessary for most fruits and vegetables including many annual crops grown in the watershed.

Several studies have documented the significance of the proximity of natural habitat to cropland for optimum yield and increased farm production. A Canadian study found that canola yield is correlated to the proximity of uncultivated areas. The researchers found that optimum yield and profit would be attained if 30 per cent of the field areas were set aside for wild pollinator habitat (Morandin and Winston, 2006 in Wilson, 2008).

The annual value of pollination services for the subwatershed was estimated based on 30 per cent of farm crop value (global average of crop production dependent on pollination). Given the significance of natural cover for pollinator biodiversity, nesting habitat, food, and nectar, the total value of pollination services was allocated proportionally to idle agricultural lands, grazing lands, hedgerows/cultural woodland, forest lands, and grasslands with an average annual value per hectare of $951.

5. Recreation and Tourism

The most important industries associated with Lake Simcoe are tourism and recreation. Approximately $200 million is spent annually on tourism and recreation on the watershed. The many recreation activities undertaken in and around Lake Simcoe depend largely on the health of the watershed and the lake itself. Based on the annual value of tourism, the natural cover (forests/wetland/grassland) in the subwatershed is worth $1,231 per hectare. This value assumes that without natural areas, tourism and recreation would not be viable in the region.

6. Other Ecosystem Services

There are a number of other ecosystem services provided by the subwatershed. These are listed below:

- Mitigation of air pollution by grasslands and urban recreational areas
- Water regulation services by grasslands and urban recreational areas
- Erosion control and sediment retention by grasslands, pasture lands, hedgerows, and cultural woodlands
- Soil formation by grasslands, forests, and soil building by earthworms for cropland, pasture, and hedgerows
- Seed dispersal (i.e. the natural regeneration by trees)
- Nutrient cycling by pasture land and hedgerows
- Recreation values for pervious urban recreational areas (estimated at 50 per cent of the value for natural cover)

A summary of the value of the various ecosystem services by land cover type in the West Holland River as well as for the whole Lake Simcoe watershed is provided in Table 9-1 below.

Table 9-1 Summary of non-market ecosystem service values by land cover type

Land Cover Type	Value per hectare ($/ha/yr)	Area (ha) in subwatershed	Total subwatershed value (million$/yr)	Area (ha) in Lake Simcoe basin	Total basin value (million$/yr)
Forests	4,798	6,849*	32.9	66,835*	320.7
Grasslands	2,727	1,356	3.7	7,576	20.7
Wetlands	11,172	3,537*	39.5	41,472*	463.3
Water	1,428	224	0.3	994	1.4
Cropland	529	17,770	9.4	94,986	50.2
Hedgerows/Cultural Woodland	1453	622	0.9	3,995	5.8
Pasture	1,479	2,304	3.4	25,989	38.4
Urban Parks	824	393	0.3	3,543	2.9
Total		**30,780**	**90.4**	**218,421**	**903.50****

* Swamps were included in the calculations for both forest and wetland

** Does not include the value of Lake Simcoe

9.4 Conclusions

As has been demonstrated, the natural systems of the West Holland River subwatershed provide a number of goods and services. These so-called “free” ecosystem services have, in fact, significant value. The analysis in this report provided a first approximation of the value of the non-market services provided – totalling at least $90 million each year. This results in a significant cost savings to the watershed residents and users.

It is critical that the true value and the costs of potentially damaging these ecosystem services be taken more directly into account in decision making by the municipal and provincial government, and also by the business community. We also have the opportunity to build on existing ecosystem services by enhancing the natural capital of the subwatershed through the restoration of woodlands, wetlands, and other forms of natural cover, as well as through stewardship activities.

The ecosystem values presented in this report can be a useful tool for determining the potential changes in ecosystem services due to policy and land use decisions. For example, land use planning at the subwatershed scale can utilize the physical supply of services (e.g. tonnes of carbon stored or nutrients absorbed) and the service values (e.g. dollars per hectare) to assess the loss of services and the cost due to changes in the natural cover of the watershed to an alternate use. It is important to note that ecosystem values should not be relied on solely, but considered in conjunction with other sources of information, such as biophysical and non-monetary ecological information

Measuring the value of and monitoring natural capital and the ecosystem services that it provides will become even more important as the climate changes. The IPCC’s latest report states that human pressures on natural ecosystems need to be reduced in order for our ecological systems to cope with the changing climate. Landscape scale protection of land and ecosystems will provide the additional benefit of our greater ability to cope and adapt in the face of climate change.

10 Detailed Recommendations for the West Holland River Subwatershed

This chapter includes the detailed recommendations discussed in the previous chapters of this subwatershed plan. These are the recommendations that will be brought forward in the development of the implementation plan for the four subwatersheds originating on the ORM within York Region, these being the West Holland, East Holland, Maskinonge, and Black Rivers. All subwatershed partners, including the LSRCA, applicable provincial ministries, the municipalities, community groups, citizens, and other stakeholders will be involved in the development of this implementation plan, through which the details regarding these recommendations will be defined. These details may include, but are not limited to, estimating timelines and costs, prioritizing activities, and identifying the partners that will be involved in the implementation of the various activities. When completed, this implementation plan will provide a road map for all partners to follow in order to improve conditions in the West Holland River subwatershed over the coming years.

As in previous chapters, the recommendations have been grouped into eight categories in order to facilitate clarity and consistency. In addition, the separate sections will help focus the development of a comprehensive Implementation Plan in the near future.

The recommendations have been placed into the following categories:

A Planning and Policy

B Use of Better Management Practices

C Changing the Way Things Are Done ‘On the Ground’

D Applied Research and Science

E Monitoring (Reporting and Compliance)

F Management, Rehabilitation and Restoration

G Adaptive Response (Climate, Social, Political)

H Communications

It is recognized that many of these undertakings are dependent on funding from all levels of government. Should there be financial constraints, it may affect the ability of the partners to achieve these recommendations. These constraints will be addressed through the development of the implementation plan.

10.1 West Holland Subwatershed Plan Recommendations

A PLANNING AND POLICY

A.1 Stormwater Management

A.1.1 That the applicable partner municipalities, in conjunction with the LSRCA, develop stormwater master plans that include maintenance schedules and funding requirements, as per the requirements set out by the LSPP

A.1.2 That the Province of Ontario, through the implementation of the Lake Simcoe Phosphorus Reduction Strategy, provide significant incentive funding to the related municipalities and/or the LSRCA to maintain, construct and /or retrofit stormwater facilities as identified by the LSRCA Stormwater Rehabilitation program

A.1.3 That the partner municipalities, in conjunction with LSRCA, re-evaluate stormwater management techniques and practices to determine whether a standard better than Level 1 can be achieved (e.g. through the implementation of new and innovative technologies)

A.2 Water Quality

A.2.1 That the partner municipalities, through the LSRCA, create a roundtable (or multiple groups, as appropriate) made up of municipalities, OMAFRA, MOE, OFA, BILD and related landowner representatives and other stakeholders, or through existing frameworks such as the Lake Simcoe Phosphorus Reduction Strategy, to determine co-operative ways of implementing phosphorus reduction measures in York Region's subwatersheds within the Lake Simcoe basin (or at another scale that is deemed appropriate) and to develop an 'action plan' for their implementation within the subwatershed's urban and rural areas

A.2.2 That the Province of Ontario and the partner municipalities support the maintenance and/or repairs required for septic systems within 100m of Lake Simcoe and its watercourses as part of the SWP Program implementation plan. LSRCA, through its stewardship program, will provide technical assistance and funding support as appropriate to complete upgrades and replacement of systems as required.

A.2.3 If required by the Lake Simcoe Protection Plan, the partner municipalities will provide staff in support of conducting mandatory inspections for septic systems within 100 metres of Lake Simcoe and any of its watercourses

A.2.4 That the Province, through the Ministry of the Ministry of the Environment and the Lake Simcoe Phosphorus Reduction Strategy, develop a Cumulative Effects Strategy for the Lake Simcoe basin.

A.2.5 That the MOE move forward a position statement regarding the Provincial Water Quality Objectives that supports their incorporation as legal requirements under the Lake Simcoe Phosphorus Reduction Strategy or provides phosphorus targets that must be adhered to. Given that the PWQO for phosphorus is an interim target, individual targets should be developed on a catchment basis as part of the Lake Simcoe Phosphorus Reduction Strategy

A.2.6 That the MOE move forward a position statement regarding the Provincial Water Quality Objectives that supports the inclusion of phosphorus, chloride, other than that used for winter road maintenance purposes, total suspended solids targets as values that must be adhered to throughout the Lake Simcoe basin

A.2.7 That the Province of Ontario, through the Lake Simcoe Phosphorus Reduction Strategy, incorporate mandatory criteria that reflect the PWQO targets as part of the effort to address the water quality targets for Lake Simcoe, as outlined in the Lake Simcoe Protection Plan

A.2.8 That the partner municipalities request that the Province of Ontario develop criteria for identifying concerns related to newly emerging contaminants, and further that guidelines be developed as appropriate to address these contaminants as they emerge

A.3 Planning and Policy Development

A.3.1 That the partner municipalities recognize that the objective of maintaining water recharge and minimizing the impact of impervious surfaces. This can be achieved by maintaining the water balance on a development site or improving site conditions. However, this will require the development industry to use innovative solutions for future growth to meet this recommendation. In addition, the municipality, in conjunction with LSRCA, will continue to research methods of maintaining pre- and post-development water balance in the subwatersheds

A.3.2 That where appropriate partner municipalities will ensure that the amount of impervious cover in new developments in the West Holland subwatershed is kept to a minimum through the required use of new technologies

A.3.3 That the partner municipalities adopt Low Impact Development (LID) practices for new developments throughout the Lake Simcoe watershed to further mitigate the impacts of urban development

A.3.4 That the LSRCA work with federal, provincial, municipal government, and granting agencies to investigate and implement LIDs aggressively within the Lake Simcoe watershed

A.3.5 That the public agencies promote the Adoption of Smart Growth Urban Design Guidelines and/or LID practices within the watershed

A.3.6 With respect to the value of ecosystem goods and services, the municipalities should: include a system of values of ecosystem goods with respect to policy development; integrate the value of ‘ecosystem goods’ into their growth strategy development, land use planning and decision-making; and create an integrated ‘natural capital’ account as a means of establishing a baseline from which planning and development decisions can be compared (i.e. the value of the loss of ecosystem goods)

A.3.7 That, where resources permit, LSRCA undertake enhanced enforcement of existing laws within the subwatershed and simplify review and approval procedures for municipal and private sector development proponents

A.4 Agriculture

A.4.1 That the partner municipalities, through the LSRCA, create a roundtable made up of municipalities, OMAFRA, MOE, OFA, BILD, and related landowner representatives, or through existing frameworks such as the Lake Simcoe Phosphorus Reduction Strategy, to determine co-operative ways of implementing phosphorus reduction measures in York Region’s subwatersheds within the Lake Simcoe basin and to develop an ‘action plan’ for their implementation within the agricultural and rural communities

A.5 Natural Heritage

A.5.1 That a concerted effort be made to identify opportunities to reconnect the natural features of the Oak Ridges Moraine (ORM) to Lake Simcoe, through a 'Natural Heritage System for Lake Simcoe'

A.5.2 That the applicable partner municipalities will encourage the use of a standard framework for the protection of Natural Heritage cover and functions in the Lake Simcoe basin such as the 'Lake Simcoe Natural Heritage System' (LSRCA, 2007) and its related policies, and reflect its guidance in their OPs and other appropriate instruments (EIS guidelines etc) as part of their routine planning process

A.5.3 That the partner municipalities, in conjunction with the LSRCA develop plans to increase the % of natural features on the landscape from 31% to 35%, or a lower percentage as determined through a feasibility study

A.5.4 That the partner municipalities and LSRCA request the Ministry of Natural Resources to undertake targeted wetland evaluations and wetland evaluation updates

A.5.5 That the partner municipalities and LSRCA request the Ministry of Natural Resources to undertake Species at Risk surveys, habitat mapping and monitoring

A.5.6 That the LSRCA utilize its authority through the [Generic Regulation (179/06)] under the Conservation Authorities Act to prevent the conversion of wetlands into other land uses, such as agriculture

A.5.7 As part of the Lake Simcoe Protection Plan (LSPP), that the Province of Ontario develop regulations for shoreline development and a Shoreline Management Plan for Lake Simcoe, in conjunction with the stakeholders

A.6 Climate Change

A.6.1 That the Province of Ontario, in consultation with the partner municipalities and the LSRCA, develop a climate change mitigation and adaptation strategy to deal with future change and to build resilience in the municipal system. This strategy should include targets and a funding strategy to address the required actions.

A.6.2 That the LSRCA, the partner municipalities and the province develop and incorporate climate change scenarios into long-range strategies

B USE OF BETTER MANAGEMENT PRACTICES

B.1 Stormwater Management

B.1.1 That the LSRCA continue to undertake the completion of stormwater retrofit projects in partnership with municipalities, subject to budget allocations. Further that the federal and provincial governments throughout the watershed be requested to share in the cost of undertaking these projects

B.1.2 That the LSRCA and its partners recognize that while the construction and/or retrofit of quality control facilities is extremely important, quantity control is also an important consideration in some areas of the subwatershed; therefore, quantity control facilities should be constructed in those areas where it is deemed appropriate but it is not possible to construct a full quantity/quality control facility.

B.1.3 That the municipalities of the subwatershed are encouraged to work with the LSRCA to promote the increased use of innovative solutions to address stormwater management and retrofits such as requiring enhanced street sweeping and catch basin maintenance, particularly in those areas currently lacking stormwater controls; improving or restoring vegetation in riparian areas; rainwater harvesting; construction of rooftop storage and/or green roofs; the use of bioretention areas and vegetated ditches along roadways; where conditions permit, the use of soakaway pits, infiltration galleries, and permeable pavement; the on-going inventory, installation and proper maintenance of oil grit/hydrodynamic separators combined with the use of technologies to enhance their effectiveness where this is appropriate; and where practical and feasible, enhance measures to control TSS

B.1.4 That the partner municipalities establish a database of oil/grit separators in the subwatershed in order to track the number and location of these structures and to ensure that regular maintenance is being undertaken as per the design specifications of the structures

B.1.5 That LSRCA initiate and monitor a pilot project to evaluate the effectiveness of reducing flooding and improving water quality by creating natural linear wetland facilities and/or reconnecting river floodplains. Should it be found to be effective, that further opportunities for undertaking these practices be explored and be implemented based on a cost/benefit analysis

B.2 Rural Water Quality

B.2.1 That the LSRCA continue to implement programs to address rural non-point sources of pollution by providing landowners with financial and technical assistance from the federal, provincial, municipal governments and the Lake Simcoe Conservation Foundation, to implement best management practices on their lands. Further that a review of the current level of financial incentives and eligible projects be reviewed in partnership with the agricultural and rural communities

B.2.2 That the LSRCA ‘Landowner Environmental Assistance Program’ (LEAP) which offers technical advice and financial assistance to the residents of the Lake Simcoe watershed, continue to be supported by the municipalities and various local committees for the West Holland R. subwatershed

B.2.3 That the LSRCA work with federal, provincial, municipal governments, the Lake Simcoe Conservation Foundation and granting agencies to investigate and implement BMPs aggressively within the Lake Simcoe watershed

B.2.4 That aggregate and major recreational uses, particularly in rural areas, be encouraged to utilize BMPs to ensure no runoff and dust control as part of the Lake Simcoe Phosphorus Reduction Strategy

B.2.5 That the LSRCA assist in the creation of water reservoirs on agricultural properties in order to capture water when it is most available and decrease the strain on water resources due to the requirements for irrigation

B.3 In-Channel

B.3.1 That all channel alterations and realignments will undertake natural channel design and stream restoration where possible, to mimic to the extent possible, natural conditions, in accordance with the Ontario Regulation 179/06 under the Conservation Authorities Act and LSRCA’s Watershed Development policies

B.3.2 That LSRCA encourage the use of natural solutions and work with proponents to develop a balance between engineered solutions and natural solutions with the goal of minimizing erosion potential when structures require replacement

B.3.3 That LSRCA will assist partner municipalities where technically feasible, to reduce the risk in flood-prone areas throughout the implementation of Natural Channel Design and other BMPs

B.3.4 That LSRCA develop programs to provide technical and financial assistance to implement BMPs to reduce flooding

C CHANGING THE WAY THINGS ARE DONE ‘ON THE GROUND’

C.1 Land Use Change

C.1.1 That the partner municipalities adopt Low Impact Development (LID) practices for new developments throughout the watershed

C.2 Increased Infiltration

C.2.1 That the LSRCA and the partner municipalities, as part of the implementation of the Lake Simcoe Phosphorus Reduction Strategy, ensure that the development industry maximizes the infiltration of stormwater where conditions permit, through the use of but not limited to the following: construction of rooftop storage and/or green roofs; the use of cisterns to store water; the use of bioretention areas and vegetated ditches along roadways; the use of soakaway pits, infiltration galleries, and permeable pavement

C.2.2 That member municipalities in consultation with LSRCA review the practice of roadside ‘ditch cleanouts’ which leave existing vegetation in place to increase water infiltration, reduce ditch maintenance costs and reduce nutrient inputs into Lake Simcoe against the increases in road maintenance costs associated with imperfectly draining road beds and other liabilities; further to develop a strategy to reach a balance between environment and roads maintenance, and construction costs and public liability on adjacent lands

C.3 Construction Practices

C.3.1 That the LSRCA and partner municipalities promote the adoption of sustainable site alteration and construction practices in the Lake Simcoe watershed, potentially through the use of grading permits

C.3.2 That the partner municipalities work with the LSRCA, the development industry, and contractors to prepare a construction practices code, including a database that will deal with but not be limited to: the phased stripping of land; the use of dust suppressants; the control of runoff and sediment movement across the site; the design and use of temporary sediment basins; the on-site protection of existing natural features; the storage of topsoil and overburden materials; acceptable de-watering techniques; the populating of the database; and enforcement of these activities. In addition, this system should be monitored at selected sites to ensure its effectiveness

C.4 Operations

C.4.1 That the partner municipalities and the Province should continue to explore the most environmentally friendly options for maintaining safe winter roads in order to protect the subwatershed’s water quality and the aquatic communities residing within its watercourses. These options include ensuring the proper timing and amount of road salt application, as well as exploring the use of alternative de-icing substances, piloting and field testing options and effective salt management plans

C.4.2 That the partner municipalities in the West Holland River subwatershed adopt the Code of Practice for the Environmental Management of Road Salts (Environment Canada, 2004) as a way of dealing with increasing chloride concentrations in the West Holland River

C.4.3 That the partner municipalities, where feasible, consider secondary treatment (eg constructed wetlands) for runoff from snow dumps; and monitor the effectiveness of any such facilities

C.4.4 That the partner municipalities consider options for addressing the application of de-icing agents to private parking lots of a certain size (e.g. shopping malls)

C.4.5 That the federal and provincial governments provide financial incentives to allow municipalities to implement an enhanced street sweeping program targeted to uncontrolled urban areas

C.4.6 That the LSRCA work with its member municipalities to enhance efforts to reduce the input of sediments and contaminants into Lake Simcoe and its tributaries through activities including stormwater management, and the protection and enhancement of riparian buffers

D APPLIED RESEARCH AND SCIENCE

D.1 Rehabilitation Opportunities Identification (P reduction / Nutrient Offsetting)

D.1.1 That in order to deal with the predicted 29% increase in P loading, the LSRCA and its partners need to research innovative methods of P reductions and/or trading

D.1.2 That the LSRCA, Province of Ontario and member municipalities implement policies and actions developed from the results of the Assimilative Capacity Studies (Total Maximum Monthly Loads)

D.1.3 That the LSRCA, its partner municipalities and the Province of Ontario encourage the implementation of the Lake Simcoe Phosphorus Reduction Strategy

D.1.4 That the LSRCA undertake a more detailed catchment level analysis of phosphorus loading as well as that of BMP opportunities

D.1.5 That the LSRCA with support of the partner municipalities, develop a framework for the development of environmental flow targets in the West Holland subwatershed

D.1.6 That while the current techniques used to improve water quality will remain important tools to try to meet water quality objectives, all partners (municipalities, Ministry of the Environment and LSRCA) must explore new and innovative practices being used around the world that can be used in conjunction with current practices, or perhaps where these practices are not feasible or practical to enhance water quality. These new techniques should be thoroughly researched to ensure that they are appropriate for use in the subwatersheds and achieve their stated purpose. Once this is verified, new practices should be used wherever it is appropriate and cost effective in order to achieve improvements in water quality

D.1.7 That the partner municipalities involved in service delivery and the LSRCA, in partnership with the Ministry of the Environment, undertake a study to assess the feasibility of water reuse (e.g. the reuse of STP effluent) within the Lake Simcoe basin

D.1.8 That the results from this BMP inventory should be prioritized and fed into the development of a stewardship plan for the subwatershed in order to focus the efforts of the LSRCA and its partners and ensure the greatest possible phosphorus reduction.

D.1.9 That the LSRCA combine the findings of Phases I and II of the Best Management Practices Inventory with the GIS exercise that was undertaken to determine the amount of natural cover within 30 metres of the watercourses in the subwatershed to develop an implementation plan to restore naturally vegetated buffers within the subwatershed

D.1.10 That the LSRCA continue to inventory priority subwatersheds for maximum nutrient reduction opportunities in both urban and rural areas

D.1.11 That the LSRCA, MOE, and watershed municipalities work with the agricultural, development, and aggregate sectors to develop a wind erosion\dust control strategy to reduce phosphorus contributions from atmospheric deposition. Further that additional scientific monitoring and research be conducted to better qualify and quantify potential sources of atmospheric deposition

D.1.12 That the LSRCA undertake work to further evaluate the control options to address the pump-off water from the Holland Marsh with the Ministry of the Environment and the Ministry of Agriculture, Food and Rural Affairs. Further that the current Environmental Study Report be revised, based on the outcome of further study and that the Environmental Assessment process be followed to select a preferred alternative for future implementation

D.1.13 That the LSRCA undertake work to further evaluate the control options to address the pump-off water from polders other than the Holland Marsh with the Ministry of the Environment and the Ministry of Agriculture, Food and Rural Affairs

D.1.14 That a strategy be developed by MOE in conjunction with LSRCA and the municipalities to enhance infiltration to supplement baseflow in watersheds where baseflow is insufficient to maintain stream health (quantity stressed). Technical and financial assistance should be provided to landowners wishing to implement BMPs, and further consideration should be given to requiring development in areas adjacent to these quantity stressed areas to maintain or improve the water balance in these priority areas

D.1.15 That a strategy be developed by MOE, in conjunction with LSRCA and the municipalities, to protect hydrologic function in gaining reaches of stressed watersheds and enhance infiltration wherever possible to protect baseflow, locations of upwelling in order to maintain thermal stability

D.2 Aquatic

D.2.1 That the LSRCA and its partners identify/review sites where reduction of discharge to streams has occurred and look for opportunities, through development, to potentially re-use, restore/retrofit a source of water for that specific part of the system

D.2.2 That guidelines and policies to complement the Permit To Take Water (PTTW) regulation should be developed by MOE in conjunction with LSRCA, to restrict surface water (stream) takings from losing stream reaches to protect ecological integrity in those streams

D.2.3 That LSRCA, in cooperation with the partner municipalities would support the use of rain water harvesting devices, such as cisterns, as a stormwater management option to be undertaken, and that an incentive program be created for landowners within the watershed willing to construct water harvesting devices

D.3 Terrestrial – Natural Heritage System

D.3.1 That a field-based monitoring program be developed and undertaken by watershed partners (eg. LSRCA, MNR, Natural Resources Canada) to improve the analysis of natural heritage values across the Lake Simcoe watershed

D.3.2 That the LSRCA and the partner municipalities investigate innovative ways and appropriate locations to increase the size of woodland patches in the West Holland R. watershed

D.3.3 That the Ministry of Natural Resources ensure that rare/unique Natural Heritage features be managed and protected through the development of Rare Communities Management Plans

D.3.4 That the Ministry of Natural Resources undertake a study to update the status (presence and extent) of the Species at Risk in the subwatershed to be completed, the results of which would lead to some level of recognition in the municipal Official Plans and the incorporation of their habitat into the future Natural Heritage System

D.3.5 That the LSRCA complete and implement its Natural Heritage System Phase 2: Restoration, Enhancement and Securement Strategy

D.3.6 That a detailed landscape connectivity assessment be undertaken by LSRCA and the partner municipalities, as part of Phase II of the Natural Heritage System

D.3.7 In conformance with the LSPP, that the LSRCA participate in further research to determine the extent and prevalence of invasive species within the Lake Simcoe watershed

D.3.8 In conformance with the LSPP, that the LSRCA cooperate with partners and universities to research methods for preventing the establishment and spread of invasive species

E MONITORING (Reporting and Compliance)

E.1 Water Quality

E.1.1 That the LSRCA continue to maintain and / or enhance the existing monitoring network. This sampling should be continued into the future to assess the state of water quality in the subwatershed, and determine/monitor any trends (including seasonal trends), emerging contaminants, or new substances of concern that may arise

E.1.2 That expansion of the PWQMN be considered in the Lake Simcoe watershed to capture proposed land use changes that could impact water quality

E.1.3 That the current LSRCA monitoring network be reviewed annually to ensure it meets the surveillance/compliance goals of the monitoring strategy and as required, allow for special projects to be undertaken to address emerging trends

E.1.4 That the LSRCA expand the sampling programs for toxic substances within the watershed in cooperation with the Ministry of the Environment, the municipalities, and other partners for the purpose of evaluating the potential human health threats and reporting on the results to all watershed stakeholders and the public

E.1.5 That LSRCA expand the water sampling program for pesticides and herbicides within the watershed, in cooperation with the Ministry of the Environment, and other partners

E.1.6 That water quality results are analyzed and reported annually and that the information be used to update the LSRCA Watershed Report Card. Further, that stakeholders be provided access to the water quality data collected via the world wide web to increase distribution

E.2 Aquatic

E.2.1 That the LSRCA develop and support a monitoring plan to expand the benthic sampling network throughout the Lake Simcoe watershed, including the West Holland River subwatershed

E.2.2 That the LSRCA participate on recovery teams and implement local projects to enhance and protect Species and Risk within the Lake Simcoe watershed, as required at the request of the Ministry of Natural Resources

E.3 Development related

E.3.1 That the LSRCA and its partner municipalities develop a protocol for the monitoring and compliance of current and existing facilities and future development sites pre, during and post construction to ensure continued maintenance and operational optimization. Monitoring would include phosphorus, sediment, and dust.

E.3.2 That the LSRCA identify and assess representative fluvial geomorphic sites, and use them for long-term monitoring and assessment of change in stream /channel stability, channel form, sediment delivery, etc as a result of development in the Lake Simcoe watershed and specifically the West Holland River catchment

E.3.3 That the LSRCA, in conjunction with the member municipalities, maintain a role in monitoring and reporting on the status of % impervious area, reporting in 5 year cycles as part of the update of the West Holland River Subwatershed Plan

E.4 Terrestrial

E.4.1 That LSRCA, in conjunction with the partner municipalities, undertake refinements, field verifications and updates of Natural Heritage and Land Use mapping

F Management, Rehabilitation and Restoration

F.1 Aquatic

F.1.1 In conformance with the LSPP, that the Ministry of Natural Resources lead the development of fish community goals and objectives for Lake Simcoe and its tributaries, in conjunction with the LSRCA and partner municipalities

F.1.2 In conformance with the LSPP, that the Ministry of Natural Resources investigate the fish community use of the lake-river interface to determine the importance of the lower Holland River ‘estuary’

F.1.3 That the LSRCA, in conjunction with the Ministry of Natural Resources, develop the fish community goals and objectives for coldwater and warmwater fish communities in the West Holland River and identify enhancement opportunities for each

F.1.4 That the LSRCA, in conjunction with the Ministry of Natural Resources co-ordinate the development of a publicly supported, scientifically defensible Fisheries Management Plan for the Lake Simcoe watershed

F.1.5 That LSRCA and the Ministry of Natural Resources continue current co-operative fish community monitoring, assess information gaps and determine activities necessary to fill them

F.1.6 That the Ministry of Natural Resources, the LSRCA, and the partner municipalities strive to protect the habitat of Species at Risk in the subwatershed

F.1.7 That the Ministry of Natural Resources and LSRCA work together to quantify and assess the quality of critical fish habitats in the lake and its tributaries

F.1.8 That the LSRCA evaluate and prioritize specific restoration/enhancement projects within the watershed to improve fish community and aquatic habitats within Lake Simcoe and its tributaries

F.1.9 That the LSRCA, in conjunction with the Ministry of Natural Resources and local partners, investigate opportunities to rehabilitate / restore estuary functions at the mouths of tributaries to Lake Simcoe

F.1.10 That the LSRCA initiate a study to investigate the feasibility of improving the hydrologic structure and restoring floodplain functions to the system of the lower West Holland River

F.1.11 That the LSRCA in conjunction with the municipality, prepare a report on the current water management system (pumping, flooding, re-routing) being used in the West Holland River / Holland Marsh canals to gain a better understanding of its operational requirements, and to look for opportunities to optimize the management of this system for water quality and natural heritage benefits

F.1.12 That LSRCA work with municipal partners to improve in-stream habitat and connectivity through a priority setting exercise specific to barrier/dam removal or retrofitting. Further, that the LSRCA use the LEAP stewardship program to provide technical and financial support to willing participants. Targets for this ‘reconnection’ program may include (as examples): reducing the number of online ponds by 20% by 2015; and, where appropriate and consistent with municipal culvert reconstruction priorities and budgets, fix/replace documented perched culverts as opportunities arise

F.1.13 That as part of the current LSRCA BMP Inventory project, in locations where channel stability is already considered to be ‘low’, assess those sites, develop priorities, assess the possibility of using ‘new’/innovative solutions and then repair

F.1.14 That the LSRCA continue to work with owners of recently documented channelized reaches of stream to develop priority list and implement solutions, such as Natural Channel Design

F.1.15 That LSRCA and its relevant partners support as a Pilot Demonstration Project, the rehabilitation of a municipal drain using Natural Channel Design eg Bradford West Gwillimbury Twp

F.1.16 That LSRCA and its relevant partners support as a Pilot Project, the creation of wetland using tile drainage as the supply of water

F.1.17 That the LSRCA continue to utilize buffer requirements and timing guidelines as part of its protection of coldwater resources and that the LSRCA undertake other programs including stormwater management upgrades and retrofits, riparian tree planting programs, and stewardship in the form of in-stream fish habitat works. These programs should be continued and enhanced into the future, with financial assistance and technical support provided by the LSRCA LEAP Program

F.2 Terrestrial

F.2.1 That the LSRCA look for opportunities through development proposals and stewardship initiatives to increase streambank vegetation in the West Holland R. catchment

F.2.2 That the lack of woodland cover in the West Holland River subwatershed be addressed by establishing a goal of increasing woodland cover from 21% to at least 25% (as is identified as York Region’s target in the official plan) in the subwatershed with an optimal woodland cover of 30% as identified as ideal by Environment Canada, over the next 25-30 years (2040), or to the highest percentage deemed feasible through an analysis of potential reforestation locations, recognizing that cover may vary between municipalities

F.2.3 That the LSRCA identify opportunities for restoration, enhancement and securement of priority sites to support the needs of the Natural Heritage System for Lake Simcoe as it relates to the West Holland River subwatershed; specific to the catchment, woodlands restoration efforts should focus on enhancing the 'Big Woods' area to enhance its function

F.2.4 That the partner municipalities, in conjunction with the LSRCA, develops a plan to replace plantation patches with preferred native species through succession, in order to maintain the water quality, provide habitat, encourage infiltration and soil stability functions of the plantations. Plan implementation will take advantage of both stewardship and private land development opportunities

F.2.5 That the LSRCA and the partner municipalities develop a plan to increase forest interior habitat. A legitimate goal of this plan should be to increase forest interior from 4.7% to 5% in the West Holland River subwatershed by 2020, or to the highest percentage deemed feasible through an analysis of potential reforestation locations

F.3 Invasive Species

F.3.1 That LSRCA support the work of MNR and the OFAH with respect to Invasive Species and encourage the promotion and distribution of information regarding the status of and management options for their control

F.3.2 That the partner municipalities adopt policies to promote and encourage the planting of native species (particularly drought tolerant species) through development approvals and property management programs.

F.4 Water and Land Management

F.4.1 That the LSRCA continue to undertake Land Securement activities in order to protect target areas. The LSRCA will use a criteria screening tool to determine those lands that are currently not protected and where purchase is the most appropriate protection action. In addition, alternatives to purchase should be considered, eg. Alternative Land Use Services (ALUS) as another means of long term protection

F.4.2 That the LSRCA continue to undertake stewardship initiatives throughout the Lake Simcoe watershed. Priority areas for undertaking stewardship activities maybe identified through Phase 2 of LSRCA's Natural Heritage System

F.4.3 That LSRCA request the Ministry of Natural Resources to undertake the development of watershed rare lists and protection policies for all floral and faunal groups

F.4.4 That the LSRCA work with its municipal partners to investigate efforts that could be made to improve public properties for long term environmental benefit and sustainability

F.4.5 That the LSRCA, the partner municipalities, and developers work to identify opportunities for undertaking restoration works as part of development applications (e.g. re-establishing riparian buffers, naturalizing farmed areas)

G ADAPTIVE RESPONSE (climate, social, political)

G.1 Climate Change

G.1.1 That LSRCA and partners develop mitigation and adaptation strategies for various sectors that incorporate the research of scientists, resource managers and other stakeholders to enhance the ability of our systems to adapt to the changing conditions and increase the resilience of the system

G.1.2 That LSRCA work with university partners to refine the anticipated impacts of climate change in the Lake Simcoe watershed. This information can then be used to develop management strategies to address these impacts

G.1.3 That the LSRCA and the partner municipalities will work with watershed partners to reduce their carbon footprint and to increase the ecological resilience of the Lake Simcoe watershed

G.2 Water Studies

G.2.1 That the LSRCA and the partner municipalities promote and support water conservation initiatives, such as York Region's 'Water for Tomorrow' program

G.2.2 That the LSRCA in conjunction with the province (MNR, MOE) undertake the development of environmental flow targets where the East Holland, West Holland, and the Maskinonge River are the priorities

G.2.3 That the Low Water Response program be continued to ensure that water supply and ecosystem integrity can be protected and maintained in low water conditions; further that the Provincial / LSRCA Low Water Response system and municipal lawn watering bans and advisories be better integrated to provide consistent messaging and better adoption of water restrictions during dry or drought periods. Also that municipal partners consider the utility of enacting a water conservation by-law

G.2.4 That interim targets for water takings should be established by the Ministry of the Environment based on environmental flows

G.2.5 That the LSRCA undertake and update flood control studies within the Lake Simcoe watershed to identify opportunities to reduce the potential for flooding by reducing peak flows, as scheduled in the LSRCA business plan

G.2.6 That the Province of Ontario reinvest in flood warning and flood plain mapping programs within the watershed. Further that the current flood warning network be expanded throughout the watershed including the addition of at least two full meteorological stations

G.2.7 That the LSRCA develop a program to provide technical and financial assistance to landowners wishing to flood-proof their homes in floodplain and prone areas

H COMMUNICATIONS

H.1 Web-based

H.1.1 That the LSRCA will update its website with findings and recommendations of the West Holland River Subwatershed Plan

H.1.2 That the LSRCA investigate the feasibility of using 'Facebook' and other non-conventional means of web-based communication to improve uptake and understanding of the subwatershed plans and their future implementation

H.2 Community / Partnership Outreach

H.2.1 That the LSRCA, the partner municipalities will engage the community of the West Holland River watershed through public information sessions and invite/encourage their participation in developing the future implementation plans

H.2.2 That LSRCA investigate new and innovative ways of reaching target audiences in the local community and engage/involve them in restoration programs and activities e.g.

high school environmental clubs, through Facebook groups, hosting a Lake Simcoe Environment Conference for high schools/science community interaction

H.2.3 That the LSRCA continue to ensure transparency and reasonable access to data, reports, and decisions of the LSRCA related to the subwatershed plans and their implementation

H.2.4 That co-ordinated, widespread education and outreach should be implemented; focused on using best management practices to prevent the spread of invasive species and the destruction of aquatic habitat in order to protect the integrity of the Lake Simcoe watershed. These programs should be targeted to their audiences, from school groups to residents and recreational users to ensure that they are effective

H.2.5 That the LSRCA work with partner agencies (e.g. OFAH, MNR) to enhance communications to prevent the introduction and spread of invasive species in the watershed

H.2.6 That the LSRCA promote the programs educating residents to return their pet fish to a pet store to prevent the introduction of non-native species to the subwatershed

H.3 Promotion

H.3.1 That the LSRCA promote enhanced relationships between all sectors to work towards the goal of more sustainable development

H.3.2 That LSRCA undertake more widespread promotion of the LEAP and other programs that it undertakes

H.3.3 That LSRCA hold workshops/seminars to educate landowners about key issues and inform them of the programs available to resolve these issues

H.4 Print/Air/TV

H.4.1 That LSRCA expand its media network to enhance the promotion of its stewardship programs and research to a wider audience

References

Andersen, J. J. 2004. A Report on a 2004 Effort to Find Redside Dace in the East and West Holland River Watersheds. Unpublished. Lake Simcoe Region Conservation Authority, Newmarket, Ontario.

Association of State Wetland Managers. Carbon balance of peatlands. http://www.aswm.org/science/carbon/quebec/sym43.html

Austen, M.J.W., C.M. Francis, M.S.W. Bradstreet and D.M. Burke. 2001. Landscape context and fragmentation effects on forest birds in Southern Ontario. *Condor* 103:701-714.

Beacon Environmental and the Lake Simcoe Region Conservation Authority 2007. Natural Heritage System for the Lake Simcoe Watershed. Prepared for the Lake Simcoe Region Conservation Authority and the Lake Simcoe Environmental Management Strategy. 142 pp. plus appendices.

Brennand, T. A., Moore, A., Logan, C., Kenny, F. M., Russell, H. A. J., Sharpe, D. R., and Barnett, P.J., 1998. Bedrock Topography of the Greater Toronto and Oak Ridges Moraine areas, southern Ontario: Geological Survey of Canada, scale 1: 200 000, Open File 3419.

Brooker, L and M. Brooker. 2002. Dispersal and population dynamics of the blue-breasted fairy wren, *Malurus pulcherrimus*, in fragmented habitat in the Western Australian wheatbelt. *Wildlife Research* 29: 225-233.

Brown, D.M., McKay, G.A and Chapman, L.J. 1980. The Climate of Southern Ontario. Environmental Canada, Climatological Studies number 5, 67p.

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Water Quality Guidelines (CWQG).

Champan, L. J. and D. F. Putman. 1973. The Physiography of Southern Ontario. Second Edition. Ontario Research Foundation, Canada.

Chapman, J.L. and Putman, D.F., 1984. The Physiography of Southern Ontario; Ontario Geological Survey, Special Volume 2, Ontario.

Chorley, R. 1969. Introduction to Physical Hydrology. Harper and Roe Publishers, Inc. Great Britain.

Clarifica Inc. 2002. Water Budget in Urbanizing Watersheds: Duffins Creek Watershed. Prepared for the Toronto and Region Conservation Authority, May 21, 2002.

Commission on Genetic Resources for Food and Agriculture. Pollinators: Neglected Biodiversity of Importance to Food and Agriculture. Food and Agriculture Organization of the United Nations (FAO). Rome (June 11-15, 2007).

Conestoga-Rover & Associates. 2003. York Peel Durham Groundwater Management Strategy Study, Aquifer Characterization Study, Stream Baseflow Assessment Program, Section

001, Oak Ridges Moraine. Prepared for Conservation Authorities Moraine Coalition. May.

Detenbeck, N.E., S.M. Galatowitsch, J. Atkinson and H. Ball. 1999. Evaluating perturbations and developing restoration strategies for inland wetlands in the Great Lakes Basin. *Wetlands* 19: 789-820

Dreimanis, A. and Karrow, P.F. 1972. Glacial history in the Great Lakes, St. Lawrence region, the classification of the Wisconsinan stage, and its correlatives; Proceedings of the 24th International Geologica Congress, Quaternary Geolgoy, Section 12, p. 5-15.

Earthfx Incorporated. 2004. Groundwater Modelling of the Oak Ridges Moraine and Toronto and Region Conservation Authority (TRCA) Watersheds. Draft report prepared for the York Peel Durham Toronto Groundwater Management Strategy Study. December.

Earthfx Incorporated. 2006. Groundwater Modelling of the Oak Ridges Moraine Area. CAMC-YPDT Technical Report #01-06

Earthfx and Gerber, 2008. Holland River, Maskinonge River and Black River Watersheds Water Budget Study; Prepared for LSRCA Final report

Earthfx Incorporated. 2009. Tier 2 Water Budget Assessment of the Holland and Maskinonge River Watersheds. Draft report prepared for the South Georgian Bay Lake Simcoe Source Protection Region. July.

Ecologistics Limited. 1982. Environmentally Significant Areas Study. South Lake Simcoe Conservation Authority, Newmarket, Ontario. v + 314 pp.

Ecologistics Limited. 1982. Environmentally Significant Areas Study. South Lake Simcoe Conservation Authority, Newmarket, Ontario. v + 314 pp.

Eimers, M.C., J.G. Winter. 2005. Lake Simcoe Water Quality Update 2000 – 2003. Lake Simcoe Environmental Management Strategy Implementation Phase III Technical Report Imp. B.20.

Environment Canada. 2001. Canadian Environmental Protection Act, 1999, Priority Substances List Assessment Report: Road Salts.

Environment Canada. 2004. Canadian Environmental Protection Act, 1999, Code of Practice for the Environmental Management of Road Salts. http://gazette.gc.ca/archives/p1/2004/2004-04-03/html/notice-avis-eng.html

Environment Canada, Canadian Wildlife Service. 2004. How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern (Second Edition). Minister of Public Works and Government Services Canada. 80 pp.

Eyles, N., 2002. Ontario Rocks: three billion years of environmental change: Fitzhenry & Whiteside Limited.

Fahrig, L. 2002. Effect of habitat fragmentation on the extinction threshold: a synthesis. *Ecological Applications* 12: 346-353.

Fluxnet Canada. Peatland Carbon Study. Mer Bleu Eastern Peatland. http://www.trentu.ca/academic/bluelab/research_merbleue.html

Friesen, L.E., M. D. Cadman and R. J. MacKay. 1998. Nesting success of neotropical migrant songbirds in a highly fragmented landscape. *Conservation Biology* 13: 338-346.

Gerber, R.E. and K.W.F. Howard. 1997. Ground-water recharge to the Oak Ridges Moraine. In Environmental Geology of Urban Areas, edited by N.Eyles, Geological Association of Canada Geotext 3, 173-192.

Gerber Geoscience Inc. and Earth FX Inc., 2008. Holland River, Maskinonge River, and Black River Watersheds, Water Budget Study.

Golder Associates Limited and Waterloo Hydrogeological Inc. 2004. South Simcoe Municipal Groundwater Study. August.

Golet, F.H., Y. Wang, J.D. Merrow and W.R. DeRagon. 2001. Relationship between habitat and landscape features and the avian community of red maple swamps in southern Rhode Island. *Wilson Bulletin* 113: 217-227.

Government of Ontario. Oak Ridges Moraine Conservation Plan Technical Paper Series. 13 – Subwatersheds – Impervious Surfaces.

Hanna, R. 1984. Life Science Areas of Natural and Scientific Interest in Site District 6-8: A Review and Assessment of Significant Natural Areas in Site District 6-8. OMNR, Central Region, Richmond Hill. SR OFER 8411. vii + 67 pp.

Harbaugh, A.W. and M.G. McDonald. 1996. User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-differen ground-water flow model. U.S. Geological Survey Open-File Report 96-485, 56p.

Horton, R.E. 1945. Erosional development of streams and their drainage basins: hydrophysical approach to quantitative morphology. Geological Society of America Bulletin 56:275-370.

Intergovernmental Panel on Climate Change. 2007. Summary for Policymakers. In: Climate Changes 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge University Press, Cambridge, UK, 7-22.

International Joint Committee Study Board. 2006. Valuating Wetland Benefits compared with Economic Benefits and Losses. International Lake Ontario-St. Lawrence River Study. http.//www.losl.org/PDF/Wetland-Value-Paper-April-27-2006-e.pdf

Johnson, M.D., Armstrong, D.K., Sanford, B.V., Telford, P.G. and Rutka, M.A., 1992. Paleozoic and Mesozoic geology of Ontario; *in* Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2, p.907-1008.

Karrow, P.F. and S. Occhietti, Quaternary geology of the St. Lawrence lowlands of Canada, *in*, R.J. Fulton (ed.), Quaternary Geology of Canada and Greenland, GSA Geology of North Aerica series v. K-1, 321-389, 1989.

Kassenaar, J.D.C. and Wexler, E.J. 2006 Groundwater Modelling of the Oak Ridges Moraine Area. CAMC-YPDT Technical Report #01-06.

Kilgour, B., and L.W. Stanfield. 2000. Development of a landscape-based protocol for predicting fisheries potential in Ontario. Draft document submitted to Regional Municipality of Ottawa-Carleton (unpublished).

Lake Simcoe Environmental Management Strategy (LSEMS). 1995. Our Waters, Our Heritage. Lake Simcoe Environmental Management Strategy Implementation Program: Summary of Phase I Progress and Recommendations for Phase II

Lake Simcoe Region Conservation Authority. 2007. Lake Simcoe Basin Stormwater Management and Retrofit Opportunities.

Lake Simcoe Region Conservation Authority. 2009. Lake Simcoe Basin Best Management Practices Inventory.

Larson, B.M., J. Riley, E. A. Snell and H. G. Godschalk. 1999. The Woodland Heritage of Southern Ontario. Federation of Ontario Naturalists. Don Mills, Ontario. 262 pp.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray, 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources. SCSS Field Guide FG-02. 225 pp.

Liberty, B.A. 1969. Palaeozoic geology of the Lake Simcoe Area, Ontario. Geological Survey of Canada Memoirs (355)1-201

Lindenmayer, D.B., R.B. Cunningham, C.F. Donnelly, H. Nix and B.D. Lindenmayer. 2002. Effects of forest fragmentation on bird assemblages in a novel landscape context. *Ecological Applications* 72: 1-18.

Louis Berger Group, Inc. 2006. Assimilative Capacity: Pollutant Target Load Study for the Lake Simcoe and Nottawasaga River Watersheds.

Markstrom, S.L., Niswonger, R.G., Regan, R.S., Prudic, D.E., and Barlow, P.M., 2008, GSFLOW—Coupled ground-water and surface-water flow model based on the integration of the Precipitation-Runoff Modeling System (PRMS) and the Modular Ground-Water Flow Model (MODFLOW-2005): U.S. Geological Survey Techniques and Methods 6-D1, 240 p.

Marshall Macklin Monaghan Limited and Golder Associates. 2003. Draft York Region Water Use Assessment. Prepared for York Region, May 2003.

McDonald, M.G. and A.W. Harbaugh. 1988. A modular three-dimensional finite-difference groundwater flow model. U.S. Geological Survey Techiniques in Water Resources Investigations, Book 6, Chapter A1, 586p.

Ministry of Environment. 1994. Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy.

Ministry of the Environment. 1994. Stormwater Management Practices Planning and Design Manual.

Ministry of the Environment. 2003. Stormwater Management Planning and Design Manual.

Ministry of the Environment and Conservation Ontario. 2003. Water Sampling and Data Analysis Manual. Conservation Ontario, Newmarket, Ontario.

Ministry of the Environment. 2009. Ontario's New Clean Water Act: Why We Need It, How It Will Work. http://www.ene.gov.on.ca/en/news/2006/101801mb.php

Ministry of Municipal Housing and Affairs, 2002. O*ak Ridges Moraine Conservation Plan 2002*. Ministry of Municipal Housing and Affairs. Queen's Printer for Ontario. Toronto. 73 pp.

Ministry of Natural Resources (MNR). 1994. Fish Habitat Protection Guidelines for Developing Areas.

Morandin, L.A., and M.L. Winston. 2006. Pollinators provide economic incentive to preserve natural land in agro-ecosystems. Agriculture, Ecosystems and Environment. 116:289-292

North-South Environmental Inc. 2005. York Region Significant Woodlands Study. Prepared for the Regional Municipality of York

Ontario Department of Energy and Resources Management. 1966. Holland Valley Conservation Report – Water. Conservation Authorities Branch, Toronto.

Ontario Ministry of Environment and Energy & Ontario Ministry of Natural Resources. 1993c.

Ontario Ministry of Municipal Affairs and Housing. 2005. Provincial Policy Statement 2005. Queen`s printer. Toronto. Ontario.

Ontario Ministry of Municipal Housing and Affairs. 2005. The Greenbelt Plan 2005. Queen`s Printer. Toronto. Ontario.

Ontario Ministry of Natural Resources. 1993. Water Management on a Watershed Basis: Implementing an Ecosystem Approach. Queen's Printer for Ontario, Toronto, Ontario.

Ontario Ministry of Natural Resources. 1999. Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement. Ontario Ministry of Natural Resources. Peterborough. 127 pp.

Ontario Ministry of Natural Resources. 2000. Significant Wildlife Habitat Technical Guide. Ontario Ministry of Natural Resources. 151 pp.

Ontario Ministry of Natural Resources. 2004. Significant Wildlife Habitat Technical Paper for the Oak Ridges Moraine. MNR Technical Paper-2.

Ontario Ministry of Natural Resources. 2007. Natural Heritage Information Center. Accessed online on October 15th, 2007.

PARISH Geomorphic Ltd., 2001. Geomorphological protocols for subwatershed studies. Submitted to: Regional Municipality of Ottawa-Carleton.

PARISH Geomorphic Ltd. 2007. Basin Scale Fluvial Geomorphology Assessment for the York Region Watersheds. Prepared for the Lake Simcoe Conservation Authority. 20 pp. plus appendices.

Prince George's County, Maryland. 2007. The Bioretention Manual. http://www.princegeorgescountymd.gov/Government/AgencyIndex/DER/ESG/Bioretention/pdf/Bioretention%20Manual_2009%20Version.pdf. Accessed Jan. 21, 2010.

Province of Ontario. 1990. *Ontario Water Resources Act*. Queen's Printer for Ontario.

Radford, J.-Q, Bennett, A.F. and G.J. Cheers. 2005. Landscape-level thresholds of habitat cover for woodland-dependent birds. *Biological Conservation*. 124: 317-337.

Redside Dace Recovery Team. 2008. Recovery Strategy for Redside Dace (*Clinostomus elongatus*) in Ontario.

Regional Geological Mapping of Oak Ridges Moraine, Greater Toronto Area, Southern Ontario; in Current Research, 1999E; Geological Survey of Canada.

Regional Municipality of York. 2004. York Region Official Plan

Ribaudo, M.O. 1986. Regional estimate of off-site damages from soils erosion. In: The off-site costs of soil erosion. (ed.) T.E. Waddell. (Proceedings of a symposium held May 1985).

Rochfort, Q., K. Exall, J. Marsalek, J. P'ng, V. Shi, V. Stevanovic-Briatico, and S. Kok. Effectiveness of Street Sweeping in Stormwater Pollution Source Control; A Summary of the 2004, 2005 & 2006 Field Seasons, Markham Road, Toronto. Water Science and Technology Directorate, Environment Canada 867 Lakeshore Rd., Burlington, ON. L7R 4A6

Rosenburg, K. V., R. W. Rohrbaugh, Jr., S. E. Barker, J. D. Lowe, R. S. Hames and A. A. Dhondt. 1999. A land manager's guide to improving habitat for Scarlet Tanagers and other forest-interior birds. The Cornell Lab of Ornithology.

Schueler, T.R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Washington Metropolitan Water Resources Planning Board, Washington, D.C.

Scott W. B and E. J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada – Bulletin 184, Ottawa, Ontario.

Scott, L.D., J.G. Winter, and R.E. Girard. 2005. Annual water balances, total phosphorus budgets, and total nitrogen and chloride loads for Lake Simcoe (1998 – 2004). Lake Simcoe Environmental Management Strategy Implementation Phase III Technical Report Imp. A.6.

Sharpe, D.R., Barmett. P.J., Brennand, T.A., Finley, D., Gorell, G., Russell, H.A.J, 1997. Glacial geology of the Greater Toronto and Oak Ridges Moraine areas compilation map sheet. Geological Survey of Canada Open File 3062, scale 1:200,000.

Sharpe, D. R, Pugin, A., Pullan, S.E. and J. Shaw, 2004. Regional unconformities and the sedimentary architecture of the Oak Ridges Moraine Area, southern Ontario; Canadian Journal of Earth Sciences, 41: 183-198.

Sharpe, D.R., Barmett. P.J., Russell, H.A.J, Brennand, T.A., Gorell, G., 1999. Regional Geological Mapping of Oak Ridges Moraine, Greater Toronto Area, Southern Ontario; in Current Research, 1999E; Geological Survey of Canada.

Simcoe County. 2007. Simcoe County Official Plan.

Sloto, R.A. and M.Y. Crouse. 1996. HYSEP: A computer program for streamflow hydrograph separation and analysis. U.S. Geological Survey Water-Resources Investigations Report 96-4040, 46p.

South Georgian Bay Lake Simcoe Source Protection Region. 2007. Lake Simcoe Conceptual Water Budget.

South Georgian Bay Lake Simcoe Source Protection Region, 2009. Lake Simcoe Tier 1 Water Budget and Stress Assessment Summary

Stanfield, L. 2005. Ontario Stream Assessment Protocol. Ministry of Natural Resources.

Stoneman C. L. and M. L. Jones. 1996. A Simple Method to Evaluate the Thermal Stability of Trout Streams. N. Amer. J. Fish Management, Bethesda, Maryland.

Tarnocai, C. and B. Lacelle. 1996. Soil Organic Carbon Database of Eastern Canada. Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Ontario.

Thurston, P.C., Williams, H.R., Sutcliffe, H.R. and Stott, G.M., 1992. Geology of Ontario, Special Volume 4, Part 2. Ontario Geological Survey, Ministry of Northern Developments and Mines, Ontario.

Toronto and Region Conservation. 2008. Performance Evaluation of Permeable Pavement and a Bioretention Swale – Seneca College, King City, Ontario. Prepared under the Sustainable Technologies Evaluation Program.

Trzcinski, M. K., L. Fahrig and G. Merriam. 1999. Independent effects of forest cover and fragmentation on the distribution of forest breeding birds. *Ecological Applications* 9: 586-593.

United States Environmental Protection Agency. 1999. Stormwater Technology Fact Sheet – Bioretention. EPA 832-F-99-012.

United States Environmental Protection Agency. 2004. The Use of Best Management Practices (BMPs) in Urban Watersheds, EPA/600/R-04/184

United States Environmental Protection Agency. 2006. National Recommended Water Quality Criteria.

Wilson, S. J. 2008. Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services. Friends of the Greenbelt Foundation Occasional Paper Series, June 2008. Submitted to the David Suzuki Foundation, the Friends of the Greenbelt Foundation, and the Lake Simcoe Region Conservation Authority.

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Region
Conservation
Authority