# Ramara Creeks Subwatershed Plan

Lake Simcoe Region conservation authority

2015

# The Ramara Creeks Subwatershed Plan

# 2015

**This project has received funding support from the Government of Ontario. Such support does not indicate endorsement by the Government of Ontario of the contents of this material.**

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# *The Ramara Creeks Subwatershed Plan (2015)*
# *Executive Summary*

WHAT IS A SUBWATERSHED PLAN?


Subwatershed planning is a process whereby the components of the environmental system are characterized, the stresses and demands on that system are identified, and actions are recommended to guide the management of the subwatershed. These demands can be from urban and agricultural land uses and recreation and also include the ecological needs of the system. Social and economic factors are also considered through the subwatershed planning process.

A subwatershed plan will normally include recommendations around:

- Maintenance or enhancement of fish habitat;
- Protection of the integrity of both hydrological and hydrogeological functions;
- Improvement of water quality;
- Conservation of wetlands and woodlands;
- Stormwater management;
- Conservation and restoration of ecologically functional natural features and corridors; and
- Land-use planning.

Maintenance of the ecological processes of the subwatershed through the retention of key natural heritage features, sufficient supplies of ground and surface water, and the protection of water quality and aquatic habitat, while planning for urbanizing land uses and landscape restoration, are integral to the subwatershed planning process.

Subwatershed plans are often implemented through the incorporation of policies into municipal planning documents, including Official Plans; Secondary, District, or Community Plans; and subsequent development applications.

CONTEXT

This subwatershed plan looks at the tributaries that make up the Ramara Creeks subwatershed, located in the northeast of the Lake Simcoe watershed. The subwatershed falls entirely within the Township of Ramara, and includes the communities of Brechin, Bayshore Village, and the unique canal community of Lagoon City. It is 137 km$^2$ in size, and consists of a number of tributaries, many of which are primarily municipal drains flowing through agricultural areas. These include the Donnelly, Gettings, McNabb, Harrington, Murray, O'Connell, and Ross Drains, as well as a natural watercourse called

Wainman's Creek. The combined length of these watercourses is 217 km, which is approximately 7.4% of the combined watercourse length of all of the Lake Simcoe watershed's watercourses.

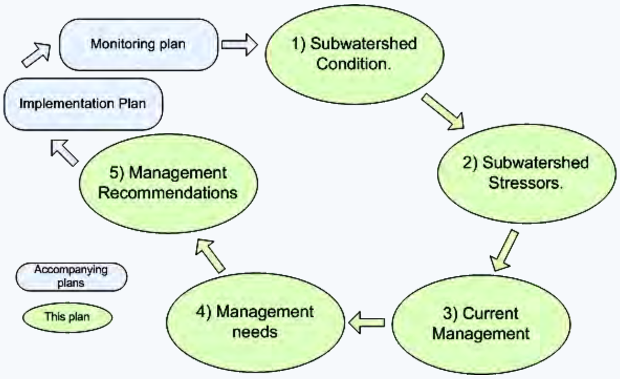
The dominant land use in the subwatershed is agriculture, which accounts for slightly more than half of the subwatershed area (51%). Natural heritage cover, including wetlands, forests, and grasslands, accounts for 41% of the subwatershed, while developed land uses account for approximately 5% of the land use. The remaining land is comprised of rural development, roads and railways, aggregate operations, and golf courses.

This subwatershed plan was prepared under the direction of the Lake Simcoe Protection Plan (LSPP), which was released by the province in 2009. The LSPP identifies the preparation of subwatershed evaluations/plans as a crucial stage in its implementation. The LSPP states that they "will be critical for prioritizing actions, developing focused action plans, monitoring and evaluating results…[and will] provide more detailed guidance for area-specific hydrologic and natural heritage resource planning and management."

It should be noted that the Lake Simcoe Region Conservation Authority's (LSRCA's) Integrated Watershed Management Plan (IWMP) (2008) also influenced the development of this subwatershed plan. The IWMP is considered to be a road map that outlines the future direction of the protection and rehabilitation of the entire Lake Simcoe watershed. Its broad-scale recommendations provide the basis for a number of this plan's recommended actions for the smaller scale Ramara Creeks subwatershed; these two reports are meant to complement each other.

APPROACH

The initial focus of this subwatershed planning exercise used an ecosystem approach. This approach takes into consideration all of the components of the environment to assess the overall health of the environment in the subwatershed, including consideration of the movement of water through the system, land use, climate, geology, and local species. Everything is intricately related; changes in any one area can have significant effects on others.




**State-pressure-response framework**

This subwatershed plan includes an analysis of water quality, water quantity, aquatic habitat, and terrestrial habitat (e.g. wetlands, forests, and grasslands). Each chapter follows an identical format loosely structured around a *state-pressure-response* framework. Each chapter begins with a description of the current condition (*state*), then describes the stressors likely leading to the current condition (*pressure*), and finally provides recommendations for improvement (*response)*.

Based on this analysis, a separate document, known as an "Implementation Plan", was developed to act upon the recommendations made in the subwatershed plan. The implementation plan was prepared by LSRCA staff, and reviewed by a subwatershed plan working group comprised of representatives from municipalities, provincial ministries, conservation authorities and community group representatives. The Implementation Plan will become the common work plan used in long term protection and rehabilitation efforts.

STATUS

*Water Quality* – There is one location that LSRCA staff visit regularly in the Ramara Creeks subwatershed, referred to as the Ramara Drain station, to collect water samples and test them for a number of substances, such as phosphorus and suspended sediments. Sampling at the Ramara Drain station began in 2009. In addition, a number of ‘spot-check’ samples were taken twice at seven locations around the study area in 2012 and twice again in 2013 to provide some indication of the spatial distribution of water quality.

The data from the Ramara Drain station shows relatively few exceedances of relevant guidelines, with phosphorus being the main parameter of concern. For example, 44% of the samples taken since 2009 have exceeded the phosphorus guidelines; this is the parameter with the highest number of exceedances. The only other parameter that showed exceedances at the Ramara Drain station was Total Suspended Solids; close to 9% of the samples exceeded relevant objectives for this parameter. With regard to the spot-check samples, phosphorus was again the main parameter of concern. Samples at all seven of these sites showed exceedances of phosphorus guidelines, with all of these exceedances seen in the samples taken during high flows. This indicates that rain events are likely causing the movement of phosphorus into the watercourses by causing soil to erode (particularly in areas that lack streamside vegetation), and washing fertilizers, manure and pet excrement, as well as other phosphorus-containing contaminants from lawns, fields, and streets and other hard surfaces into area streams. Chloride, the most common source of which is winter salt use for de-icing, has not been shown to be of concern at the Ramara Drain station; however, this may be due to the rural nature of the surrounding land uses in this area, as chloride concentrations are typically higher in urban areas. This may indicate that the one long-term station is not necessarily representative of the entire subwatershed, and that further study may be required to fully understand the variation of conditions across the area.

*Water Quantity* – Groundwater in the subwatershed generally flows from the topographic highs associated with the Mara County Forest towards the topographic lows associated with the major stream channels and Lake Simcoe, in a westward to south-westward direction. Research indicates that groundwater is a significant contributor to several of the headwater tributaries, but many of the middle and lower reaches are dependent on more localized recharge into the shallow groundwater system. This is the reason that many of the tributaries are prone to drying up in the summer months, as there is little precipitation to replenish their flow. There is, however, little monitoring data with respect to flow in the subwatershed; a better understanding of the flow characteristics will be gained through the collection of additional data; to this end, a project was recently undertaken to estimate ecological flows for a number of Lake Simcoe subwatersheds, for which two flow measurements were taken in the Ramara Creeks subwatershed.

Groundwater recharge is the process by which rain and melting snow percolate from the surface through the soil to replenish groundwater stores (which also ensures that there is a water source for streams and wetlands).  In order to protect this process, areas referred to as Significant Groundwater Recharge Areas have been identified for the study area.  This work has been further refined to identify Ecologically Significant Groundwater Recharge Areas, which are areas thought to contribute to ecologically important features such as streams and wetlands in the study area.

*Aquatic Habitat* – Fish communities in this subwatershed vary; of the eight sites that were surveyed, one site exhibited 'Good' conditions according to the Index of Biotic Integrity used to evaluate fish community health, two exhibited 'Fair' conditions, two exhibited 'Poor' conditions, and at the remaining three sites no fish were caught. Only warm water fish communities have been found within the subwatershed; some of the notable species caught at these sites include Northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieu*), and largemouth bass (*Micropterus salmoides*). The healthiest site was found on the watercourse referred to as Drain #1, which is found at the upstream end of a straightened municipal drain, downstream of a more natural area in the headwaters of the subwatershed. Communities of benthic invertebrates (organisms that live at the bottom of rivers and lakes) also vary within the subwatershed, though the results show the benthic invertebrate communities to be somewhat less healthy than the fish communities, with ratings ranging from 'Fairly Poor' to 'Very Poor'. The warm water, lack of flow and drying of stream channels, inputs of sediment and nutrients, and lack of riparian cover limit the aquatic communities that can be supported by the watercourses in this subwatershed. Conditions can be improved through stream rehabilitation, wetland protection, streambank planting, and treating stormwater run-off from both urban and agricultural areas.

*The Terrestrial Natural Environment* – These features include woodlands, wetlands, grasslands, and riparian (streambank) habitat, and account for approximately 41% of the land area in Ramara Creeks subwatershed. Woodlands cover 26% of the subwatershed, just below Environment Canada's guideline of 30%, as outlined in its '*How much habitat is enough*' document. The Environment Canada guidline is seen as a minimum forest cover threshold (considered to be a 'high risk' approach that will not support the healthiest systems). With respect to wetland cover, the subwatershed has very healthy levels, at 25%; this is well above Environment Canada's recommended wetland cover level of 10%. There are fairly low levels of natural cover along the watercourses of the subwatershed, with only 54% of this area being in natural cover. Environment Canada recommends that at least 75% of the 30 metre riparian buffer be in natural vegetation.  Shoreline cover is significantly lower, however, with only 22% natural cover. Agriculture, recreation, increases in urban area, and climate change are the concerns for the natural environment features in this subwatersheds.

## Recommendations

Recommendations based on analysis of the current conditions and stressors are provided in each chapter of this subwatershed plan. There are approximately 85 recommendations in total, with some pertaining to all of the partners involved in the development of the plan, including the LSRCA, municipalities, and the provincial ministries of Natural Resources and Forestry, Environment and Climate Change, and Agriculture, Food, and Rural Affairs. Through policies in the Lake Simcoe Protection Plan, it is expected that municipal Official Plans will be made consistent with these recommendations.

These recommendations include:

- Continuing to implement on-the-ground stewardship projects to improve aquatic habitat and water quality, promote infiltration of precipitation, and broaden the extent of natural features;
- Naturalizing swales and watercourses to preserve water quantity and maintain flow, particularly in the Lagoon City area;
- Adopting policies that protect the recharge of groundwater;
- Educating members of the public and targeted industries on topics including the dangers of using invasive species in horticulture, the importance of maintaining groundwater recharge areas, and good practices for the use of road salt to minimize environmental impacts;
- Studying the potential impacts of climate change and developing plans to limit its impacts;
- Researching and using new and innovative solutions, such as Low Impact Development practices, to address uncontrolled stormwater in urban areas;
- Evaluating monitoring activities, and adjusting programs as necessary to achieve program goals; and
- Working to make information about the health of the subwatershed readily available to all stakeholders.

## Next Steps

These recommendations form the basis of the Implementation Plan, which is the framework and process for acting on the recommendations. The Implementation Plan prioritizes the recommendations, identifying activities to be carried out to achieve each of the priority recommendations. It also identifies the milestones to be met, specific deliverables, and partners' responsibilities. The implementation process will also include regular tracking of activities to ensure that milestones are being met.

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# 1 Approach and Management Setting

## 1.1 Introduction

The Ramara Creeks subwatershed, located in the northeast section of the Lake Simcoe watershed, is comprised of a series of creeks and drains that flow directly into the lake. The subwatershed is 137 $km^2$ in area, comprising 5.4% of the Lake Simcoe watershed. The subwatershed falls entirely within Simcoe County, and the only lower tier municipality in the subwatershed is the Township of Ramara (Figure 1-1).

Agriculture is the dominant land use in the Ramara Creeks subwatershed, occupying 51.5% of its area. The majority if this is land used for hay and pasture, while the remainder is in crop land. Natural areas such as wetlands (24.8%) and upland forest (9.6%) also comprise a significant portion of the subwatershed's land area. Other land uses include urban areas (4.2%) and rural development (1.3%) of the subwatershed area. As mentioned above, the subwatershed consists of a series of creeks and drains that flow into the lake. These systems include the O'Connell Drain, Mahoney Drain, Gettings Drain, Ross Drain, Jackson Drain, Corrigan Drain, Harrington Drain, Murray Drain, Brechin Drain, Donnely Drain, McNabb Drain, Drain #1, Wainmance Creek, as well as a number of smaller, direct-to-lake creeks simply referred to as the Ramara Creeks. Most of these watercourses originate in agricultural areas, or in the wetland (treed swamp) areas in the extreme northern section of the subwatershed. Most of the subwatershed's urban areas fall near the Lake Simcoe shoreline, with the exception of the community of Brechin.

A large portion (111,031 m) of the subwatershed's watercourses are agricultural drains, constructed to help quickly drain water from agricultural lands. In general, agricultural drains are maintained regularly to ensure they continue to function as designed. As such, they may not provide the calibre of habitat to aquatic biota that a natural stream would. In addition, there may also be issues around water quality associated with agricultural drains, including high levels of sediment and nutrients, depending on the type of land that they drain.

In the Lake Simcoe watershed, the various land uses have had considerable impacts on water quality and quantity, and aquatic and terrestrial habitats. In order to mitigate the impacts of land use changes in each of the subwatersheds, and to prevent future impacts, subwatershed plans are developed. This plan provides a framework for the implementation of remedial activities and a focus for community action. More importantly, it helps to 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 Lake Simcoe Protection Plan (LSPP), subwatershed evaluations need to be developed and completed for priority subwatersheds within five years of the Plan coming into effect. Subwatershed plans for York Region (includes the East and West Holland Rivers, Maskinonge River and Black River subwatersheds) were completed in 2010 and Durham Region (includes the Beaver River and Pefferlaw Brook subwatersheds) in 2012. Subwatershed plans for the City of Barrie (includes Barrie Creeks, Lovers Creek and Hewitts Creek subwatersheds) and the Town of Innisfil (includes Innisfil Creek subwatershed) were completed in late 2012. A subwatershed plan for the Oro and Hawkestone Creeks subwatersheds was completed in 2013. The evaluation of the Ramara Creeks subwatershed will reflect the goals, objectives, and targets of the Lake Simcoe Protection Plan and will be tailored to the needs and local issues of the area.

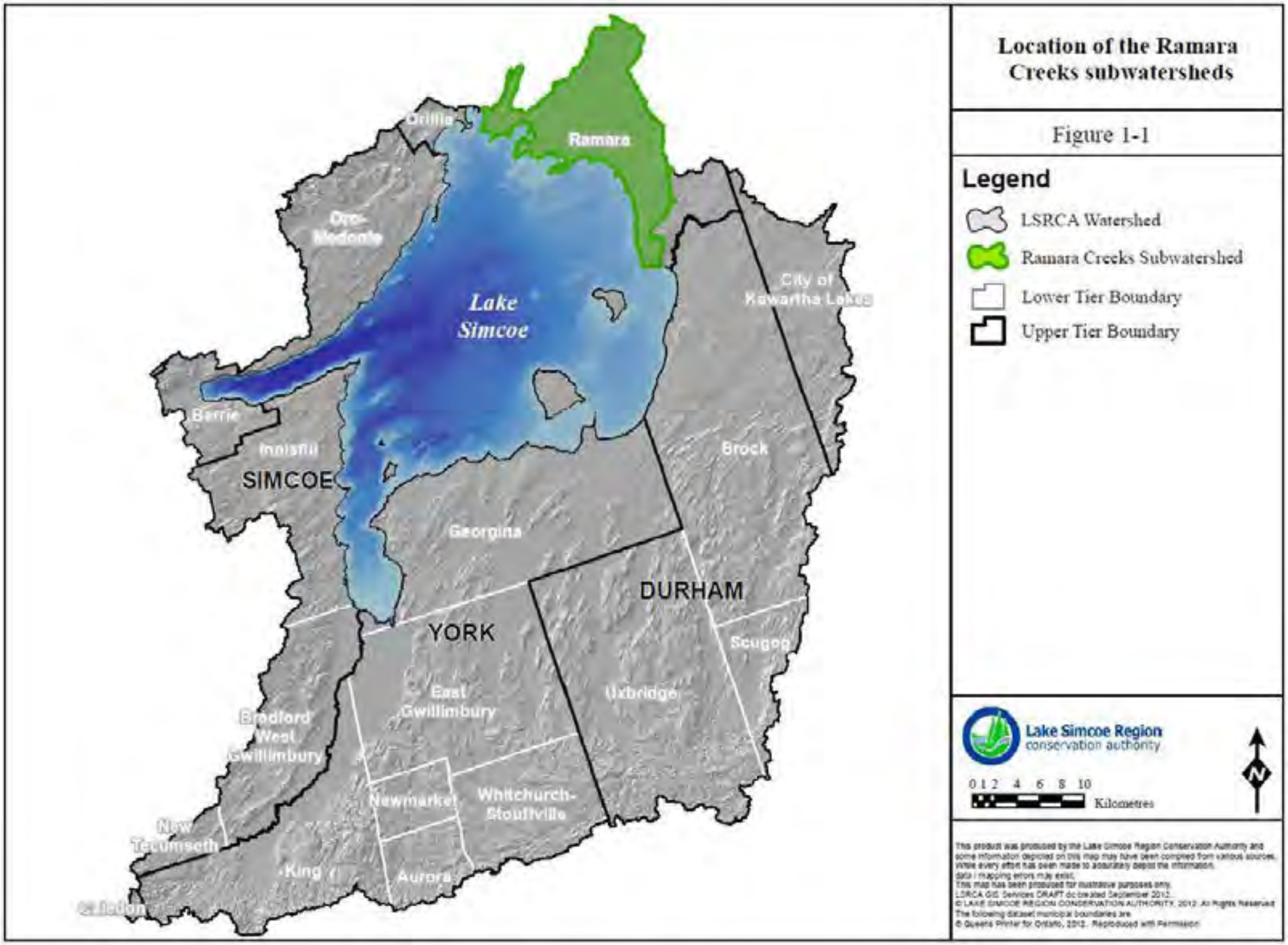
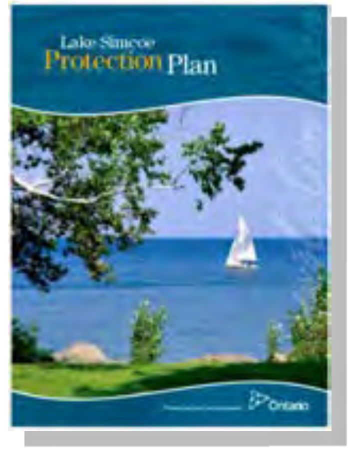



Figure 1-1: Location of the Ramara Creeks subwatershed

## 1.2 Subwatershed Evaluation Requirements within the Lake Simcoe Protection Plan




The Lake Simcoe Protection Plan (LSPP), released by the Province in 2009, aims to be a comprehensive plan to protect and restore the ecological health of the lake and its watershed. Its priorities include restoring the health of aquatic life, improving water quality, maintaining water quantity, and improving ecosystem health by protecting and rehabilitating important areas, as well as addressing the impacts of invasive species, climate change, and recreational activities.

Preparation of subwatershed evaluations/plans is identified as a crucial stage in implementation of the LSPP. The LSPP states that subwatershed plans "will be critical in prioritizing actions, developing focused action plans, monitoring and evaluating results… The plans will provide more detailed guidance for area-specific hydrologic and natural heritage resource planning and management"

Policies within the LSPP guiding the preparation of this subwatershed plan are:

**8.1-SA** Within one year of the date the Plan comes into effect, the MOE and LSRCA in collaboration with other ministries, the First Nations and Métis communities, watershed municipalities, the *Lake Simcoe Coordinating Committee* and the *Lake Simcoe Science Committee* will develop guidelines to provide direction on:

a. identifying sub-lake areas and subwatersheds of the *Lake Simcoe watershed* and determining which sub-lake areas and subwatersheds are of priority;

b. preparing subwatershed evaluations including, where appropriate, developing subwatershed-specific targets and recommending actions that need to be taken within subwatersheds in relation to:

    i. the phosphorus reduction strategy (Chapter 4),

    ii. stormwater management master plans, including consideration of the amount of impervious surfaces within subwatersheds (Chapter 4),

    iii. water budgets (Chapter 5),

    iv. instream flow regime targets (Chapter 5),

    *v.* preventing *invasive species* and mitigating the impacts of existing *invasive species* (Chapter 7),

    vi. natural heritage restoration and enhancement (Chapter 6),

    vii. increasing public access (Chapter 7), and

    viii. climate change impacts and adaptation (Chapter 7);

c. monitoring and reporting in relation to subwatershed targets that may be established; and

d. consultation to be undertaken during the preparation of the subwatershed evaluations.

**8.2-SA** In developing the guidance outlined in 8.1, the partners identified above will develop approaches to undertake the subwatershed evaluations in a way that builds upon and integrates with source protection plans required under the Clean Water Act, 2006, as well as relevant work of the LSRCA and watershed municipalities.

**8.3-SA** Within five years of the date the Plan comes into effect, the LSRCA in partnership with municipalities and in collaboration with the MOE, MNR, and MAFRA will develop and complete subwatershed evaluations for priority subwatersheds.

**8.4-DP** Municipal official plans shall be amended to ensure that they are consistent with the recommendations of the subwatershed evaluations.

This plan is being developed to meet requirements of policy 8.3-SA, while also following requirements of policies 8.1-SA and 8.2-SA. Ensuring municipal Official Plans are updated in accordance with policy 8.4-DP is identified as an activity within the associate implementation plan.

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.

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, human communities, 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.

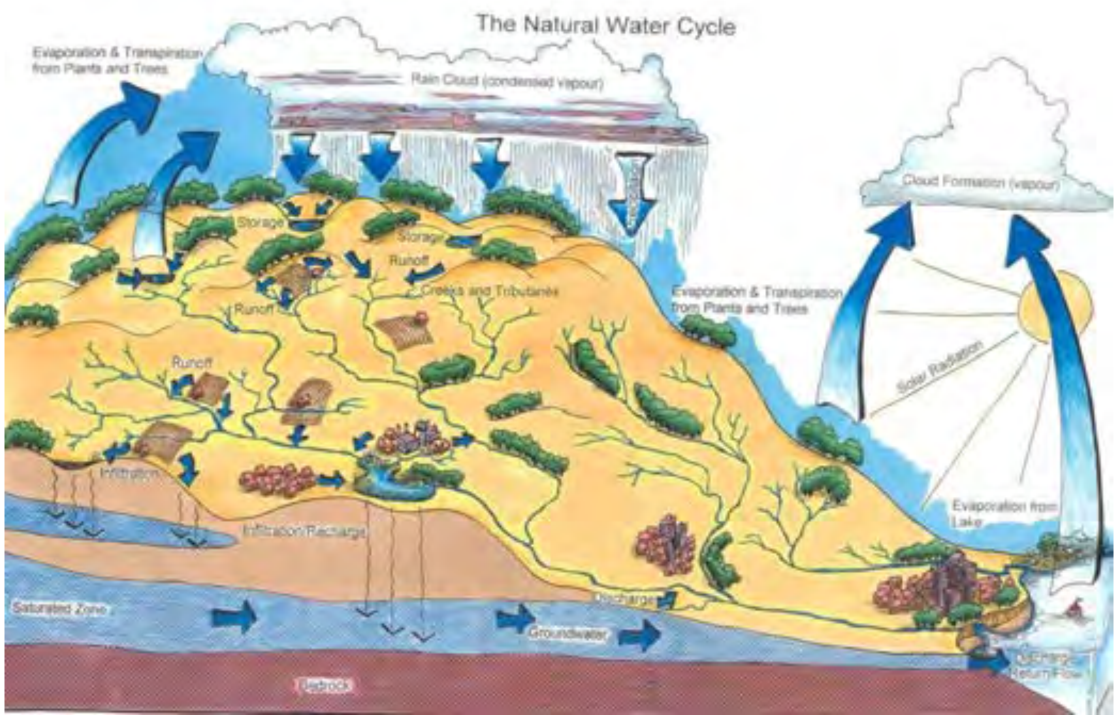



**Figure 1-2: The hydrological cycle (image courtesy of Conservation Ontario).**

### *1.2.1 Subwatershed Planning Context*

This subwatershed plan has been written firstly to comply with the requirements under the province's Lake Simcoe Protection Plan. 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 Lake Simcoe Phosphorus Reduction Strategy (2010) are the two main documents aside from the LSPP 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.

The Lake Simcoe Phosphorus Reduction Strategy, released by the Province in 2010, was a requirement of the Lake Simcoe Protection Plan. The Phosphorus Reduction Strategy is a long term, phased approach that focuses on a constant reduction of phosphorus in Lake Simcoe through shared responsibility. The actions that come out of the Strategy are providing a foundation and early planning tool for the reduction of phosphorus. As this is a living document, it will be reassessed and updated a minimum of every five years to ensure that it includes the most up to date information and is following the best approach to reduce phosphorus within the watershed.

Other technical documents that are being developed to meet the ‘strategic action’ policy requirements of the Lake Simcoe Protection Plan and their expected completion dates are shown in **Error! Reference source not found.**. As these documents are scheduled to be phased n over a number of years, they will be incorporated in the subwatershed plans as they become available. In cases where the documents are not available when a subwatershed plan is being written, they will be incorporated into the five year review and update of the subwatershed plan, as well as be addressed in the implementation plan where feasible.

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

### *1.2.2 Subwatershed Planning Process*

Preliminary Consultation

A start up meetings was held with the Township of Ramara to review over the intended direction and scope of the subwatershed plan, the projected timeline and how it would incorporate any new information coming from studies currently underway.

Characterization

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. Based on this important information, recommendations are developed to address the stressors as well as the gaps and limitations for each parameter. They are also intended to be consistent with the policies of the LSPP.

Subwatershed Working Group – Review Committee

The Subwatershed Working Group (SWG) consists of representative from the Township of Ramara, Simcoe County, Ministry of Environment and Climate Change, Ministry of Natural Resources and Forestry, Ministry of Agriculture, Food, and Rural Affairs, the Simcoe County Federation of Agriculture, Couchiching Conservancy, and the Lagoon City Parks and Waterways Commission. This is a voluntary committee that is essential to confirming that material presented in the subwatershed plans is tailored to the specific conditions within each municipality. The SWG met four times in 2014/early 2015 to discuss plan chapters, three times in 2014 (March, May, and September), and once in 2015 (January). Before each meeting, committee members are presented with characterization chapters and their associated recommendations. Comments received on the characterization material were documented and addressed, while comments received on recommendations were discussed, incorporated and re-distributed for further discussion/approval at the next meeting. This was done to ensure that all parties are fully aware of, and agree with, final recommendations that will be the basis of the Subwatershed Implementation Plans. The SWG, along with some additional representatives met a final time in March of 2015 to review and provide comment on the subwatershed implementation plan.

Public Consultation

Public consultation is expected to occur in the late spring of 2015 and is intended to educate residents within the subwatersheds about the area they live in, what the current conditions are in their subwatershed, what the immediate stressors are and how the recommendations will be carried out.

#### *1.2.3 Subwatershed Implementation Process*

Implementation Plan

Once the subwatershed plan is approved by the LSRCA Board of Directors and endorsed by the municipality, the recommendations are used to form the basis of the development of the Implementation Plan for the subwatersheds. The Implementation Plan is a framework and process for acting on the recommendations put forth in the Subwatershed Plans. It prioritizes the recommendations, identifying available options, the associated funding/ costing estimates, and partner's responsibilities.

Implementation Working Group

A significant part of the Implementation Plan involves the development of a long term work plan with the various partners. Through the initiation of the Implementation Working Group (IWG), efforts that are undertaken to implement the related recommendations will be documented and recognized. Project updates, integrating and linking the numerous efforts, and monitoring and reporting on success will be the ongoing business of the IWG.

It is recognized that many of these undertakings will be 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.

Implementation

To ensure that this subwatershed plan remains current and relevant, it has been developed using an adaptive management framework. As such, the subwatershed plan is scheduled to be updated every five years to ensure that it contains the best available science and monitoring data reflecting the health of the subwatershed. Between reviews, ongoing monitoring, assessing and evaluation of the subwatersheds as well as the extent and effectiveness of implementation of the recommendations of this subwatershed plan will be occurring, with new reports and studies being produced. Communications will need to be updated to coincide with these studies and implementation approaches will need to adapt to reflect the most current information available.

Figure 1-3 depicts the relationship between this subwatershed plan and the materials 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.

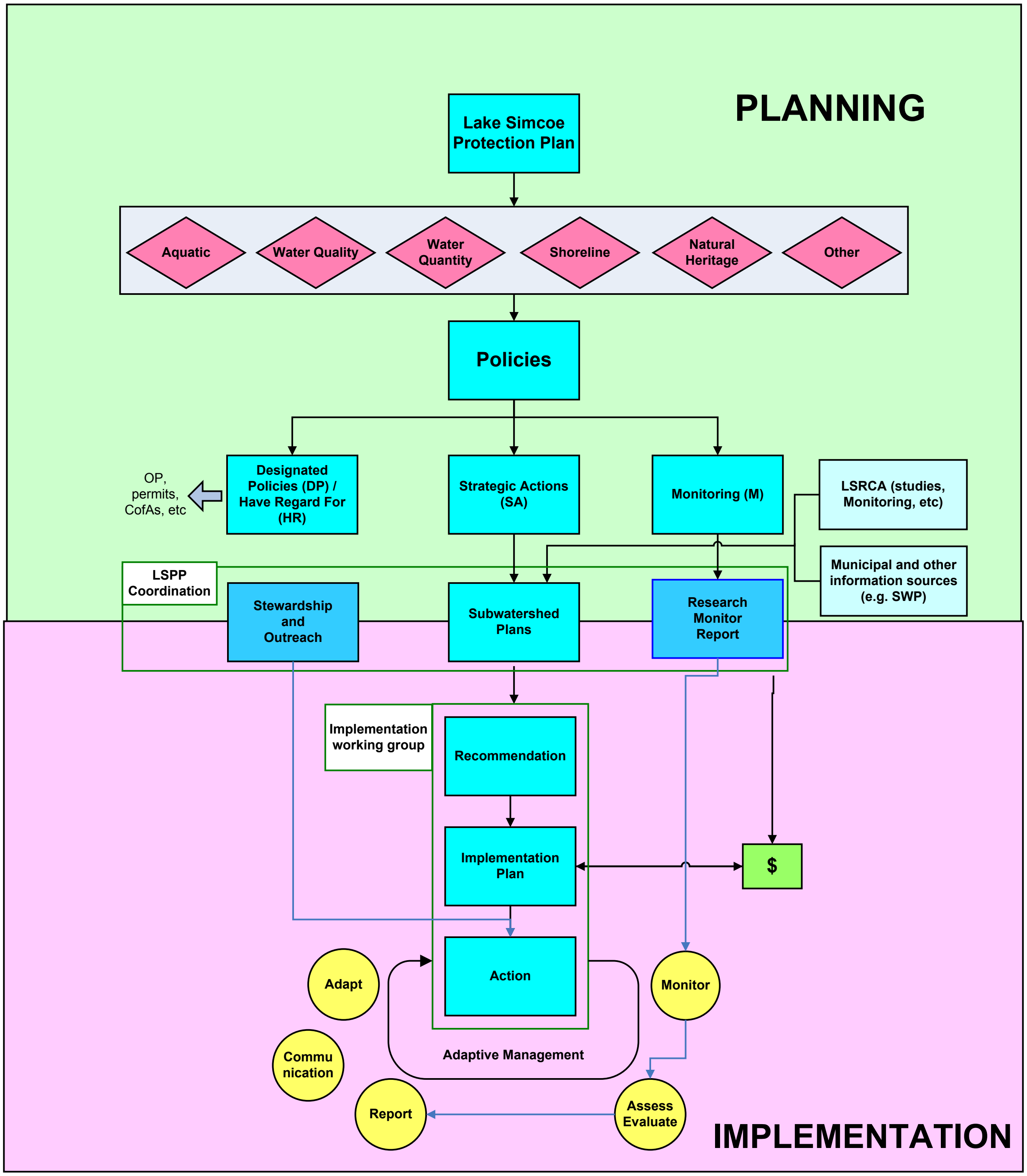



**Figure 1-3: Subwatershed planning context**

## 1.3 Current Management Framework

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There are a number of other technical documents that have been or are being developed to meet the 'strategic action' policy requirements of the Lake Simcoe Protection Plan; the documents completed to date have been incorporated into this plan. In cases where the documents are not available when a subwatershed plan is being written, they will be incorporated into the five year review and update of the subwatershed plan, as well as be addressed in the implementation plan where feasible.

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

## 1.4 Guiding Documents

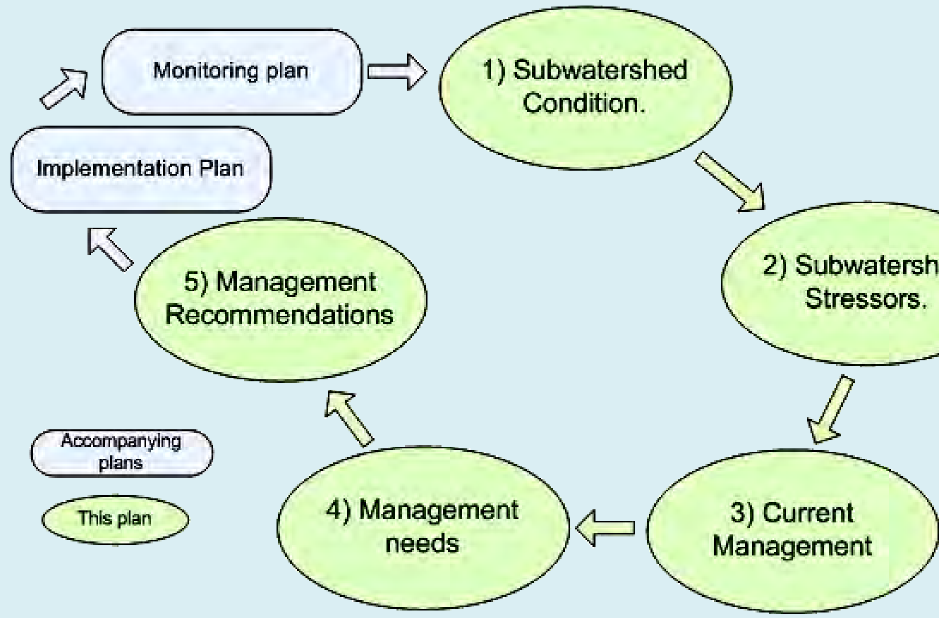
A number of documents and studies have been prepared with information and recommendations pertinent to the Ramara Creeks subwatershed and how to ensure its environmental health into the future. These documents cover a wide range of issues, and have influenced the formation of this subwatershed plan. They include:

- Natural Heritage System for the Lake Simcoe Watershed (Beacon Environmental and LSRCA, 2007)
- Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services (Wilson, 2007)
- Assimilative Capacity: Pollutant Target Load Study for the Lake Simcoe and Nottawasaga River Watersheds (Louis Berger Group, 2006)
- Estimation of the Phosphorus Loadings to Lake Simcoe (Louis Berger Group, 2010)

- Lake Simcoe Watershed Environmental Monitoring Report (LSRCA, 2013)
- South Georgian Bay-Lake Simcoe Watershed Preliminary Conceptual Water Budget Report (2007)
- Lake Simcoe Watershed Tier one Water Budget and Water Quantity Stress Assessment Report (LSRCA, 2009)
- Water Balance Analysis of the Lake Simcoe Basin using the Precipitation-Runoff Modelling System (PRMS) (Earthfx, 2010)
- Tier 2 Water Budget, Climate Change, and Ecologically Significant Groundwater Recharge Area Assessment for the Ramara Creeks, Whites Creek, and Talbot River Subawatersheds (Earthfx, 2014)
- Lake Simcoe Basin Wide Report (2008)
- Lake Simcoe Integrated Watershed Management Plan (2008)
- Lake Simcoe Protection Plan (2009)
- Lake Simcoe Phosphorus Reduction Strategy (2010)
- State of the Lake Simcoe Watershed (2003)
- Lake Simcoe Climate Change Adaptation Strategy (2011)

### *1.4.1 How this plan is organized*

This plan includes a chapter dedicated to each of the five subwatershed features identified previously, these being water quality, water quantity, aquatic natural heritage, 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 the following text box).




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: The Ramara Creeks subwatershed

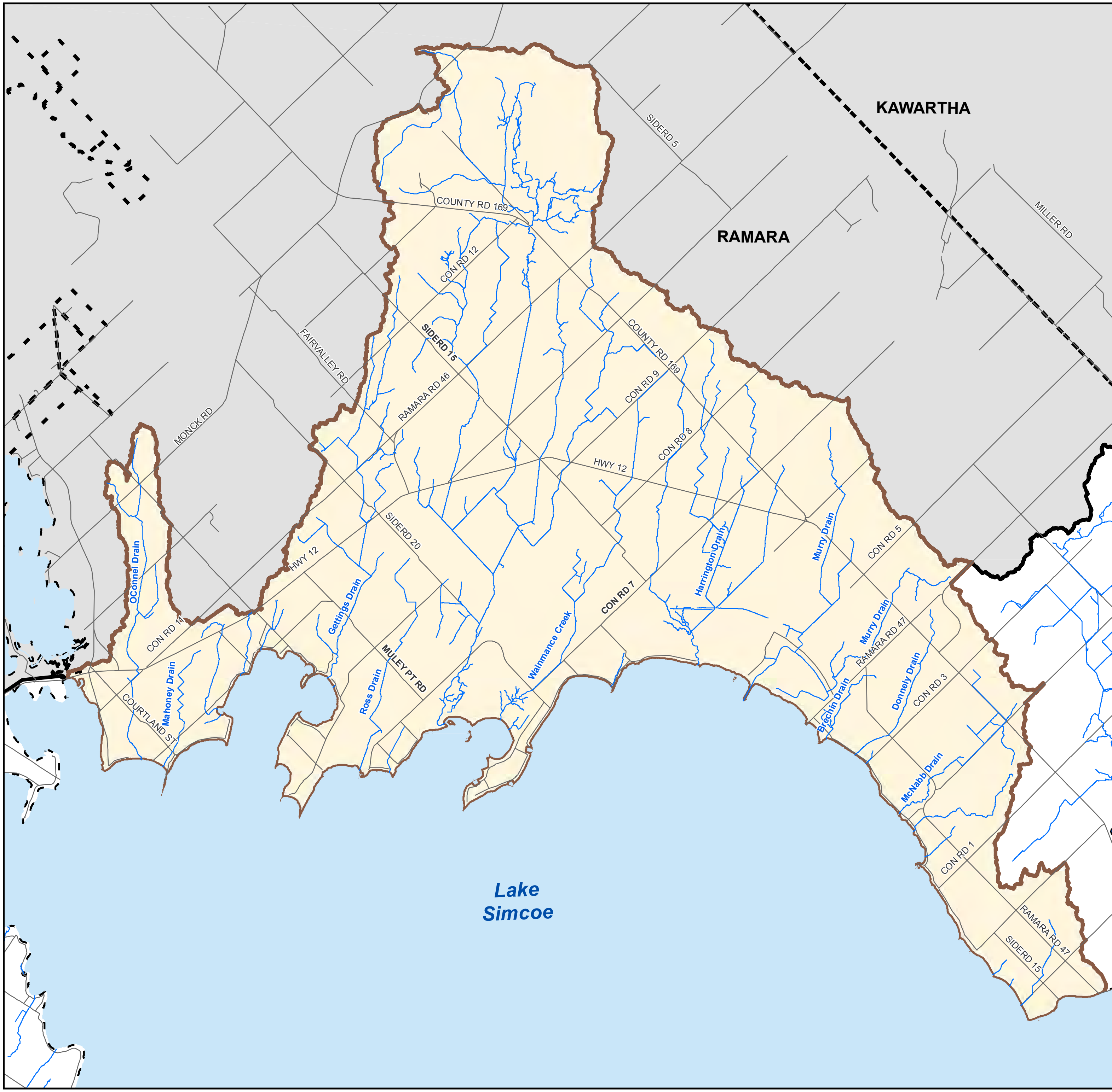
## 2.1 Location

All of the lands within the Lake Simcoe watershed ultimately drain into Lake Simcoe, via one of the tributary subwatersheds. The Ramara Creeks subwatershed is one of the 18 subwatersheds that make up the Lake Simcoe watershed; with the outlets of its many tributary catchments discharging into the northeast portion of Lake Simcoe (Figure 2-1).

The Ramara Creeks subwatershed falls entirely within the boundaries of the Township of Ramara, and includes the communities of Brechin, Bayshore Village, and the unique canal community of Lagoon City. This subwatershed consists of many tributaries draining directly into Lake Simcoe, a number of which are primarily municipal drains through agricultural areas. These include the Donnelly, Gettings, McNabb, Harrington, Murray, O'Connell and Ross Drains. The subwatershed covers an area of 137 $km^2$, and has a total watercourse length of 217 km, which is approximately 7.4% of the combined watercourse length of Lake Simcoe's watercourses.

# The Ramara Creeks subwatershed

Figure 2-1




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

## 2.2 Human Geography

### *2.2.1 Population and Municipal Boundaries*

As discussed earlier, the entire Ramara Creeks subwatershed falls within the boundaries of the Township of Ramara. The population of the Township of Ramara was estimated to be 9,275 in 2011. This is an decrease of 1.6% over the five year period since the 2006 census, where the population was 9,427. The national average growth rate is 5.9%; with the negative growth rate the Township is lagging behind in this regard, although some growth is anticipated in the coming years. The median age of Ramara residents in 2011 was 49.7, up from 45.9 in 2006. This is much higher than both the national and provincial median ages, 40.6 and 40.4, respectively. This higher median age could be reflective of the draw of a lakeside community as a retirement residence. Its distance from larger centres such as York Region and the City of Toronto may also prevent some people from settling here, as the commute would be well over an hour to travel to jobs in these areas, which could mean that younger families are settling in areas further south, such as northern York Region, Barrie or Innisfil. The median before-tax income for all census families in 2010 was $71,629, above the provincial median income of $66,358 (Statistics Canada, 2014). The projected population for the Township is 13,000, which represents an increase of 40% (Places to Grow Act, 2012).

The municipal population for the municipality and estimated population density for the subwatershed is presented below in Table 2-1.

**Table 2-1: Population and population density within the Ramara Creeks subwatershed (Data Source: Statistics Canada, 2011 Community Profiles)**

| | |
|---|---|
| **Subwatershed** | Ramara Creeks |
| **Subwatershed area (ha)** | 13,731 |
| **Municipality** | Township of Ramara |
| **Total Municipal Population** | 9,275 |
| **% Municipality in Subwatershed** | 31.7 |
| **Estimated Municipal Population (2011) within subwatershed** | 2,940 |
| **Estimated Population Density (persons/km$^2$)** | 21.4 |

The level of education attained by a person can influence both their career choice and income level. Table 2-2 lists the percentage of the Township of Ramara population, 15 years and over, and their educational attainment compared to provincial standings.

**Table 2-2: Educational attainment for the Township of Ramara (Statistics Canada, 2011).**

| Educational attainment | Township of Ramara | Province of Ontario |
|---|---|---|
| No certificate; diploma or degree | 20% | 19% |
| High school certificate or equivalent | 31% | 27% |
| Apprenticeship or trades certificate or diploma | 15% | 7% |
| College; CEGEP or other non-university certificate or diploma | 20% | 20% |
| University certificate or diploma below the bachelor level | 2% | 4% |
| University certificate; diploma or degree | 12% | 23% |

### *2.2.2 Land Use*

Land use within the Ramara Creeks subwatershed has been divided up into 11 classes including intensive and non-intensive agriculture, rural development, urban residential, and natural heritage features (Figure 2-2).

Intensive and non-intensive agriculture (51%) and natural heritage features (41%) make up the largest proportion of land in the Ramara Creeks subwatershed. Urban land use comprises only 4% of the land use, and the smallest land uses are industrial, commercial, and institutional (0.5% combined), aggregate (0.3%) and estate residential (0.03%).

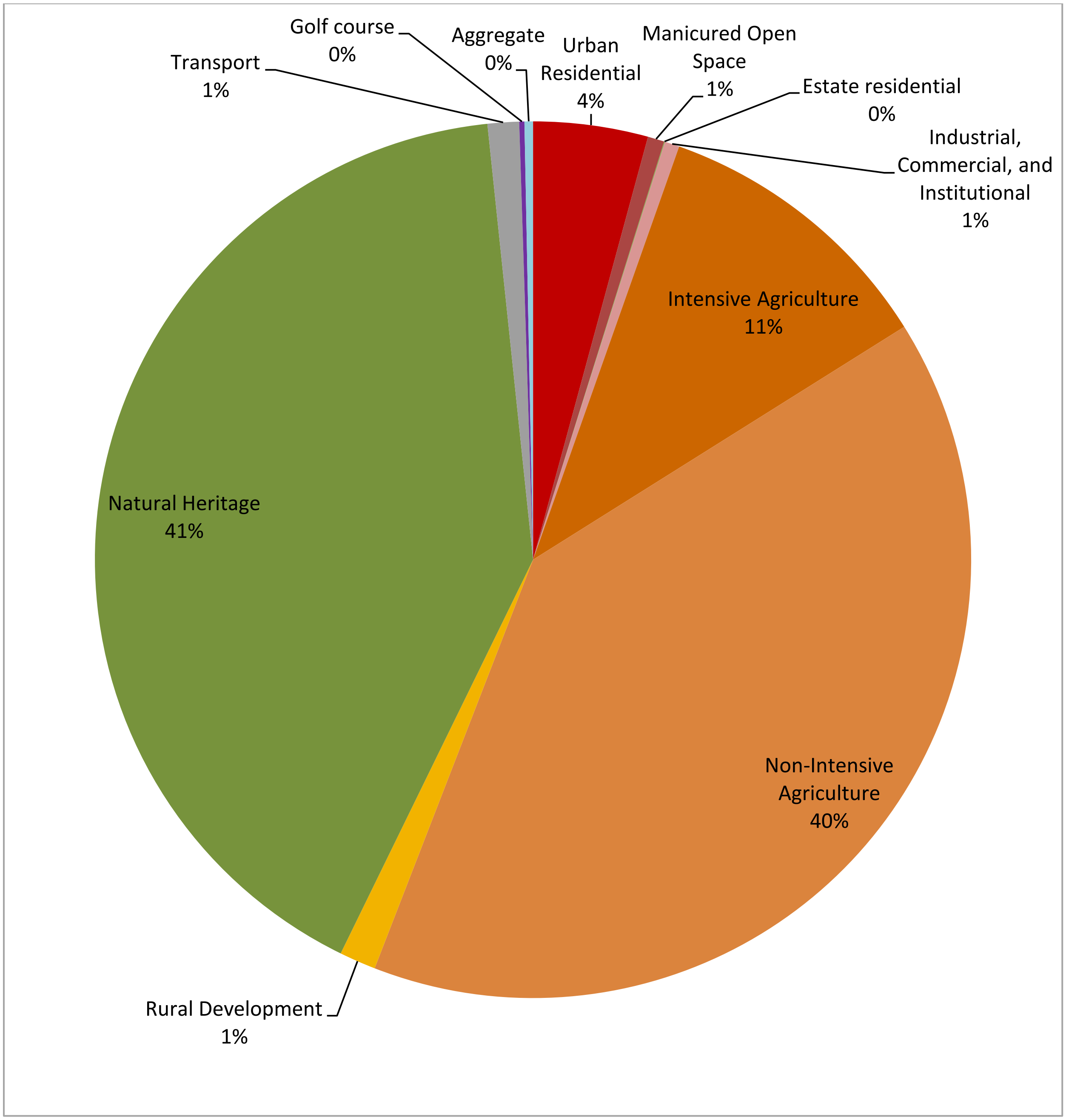
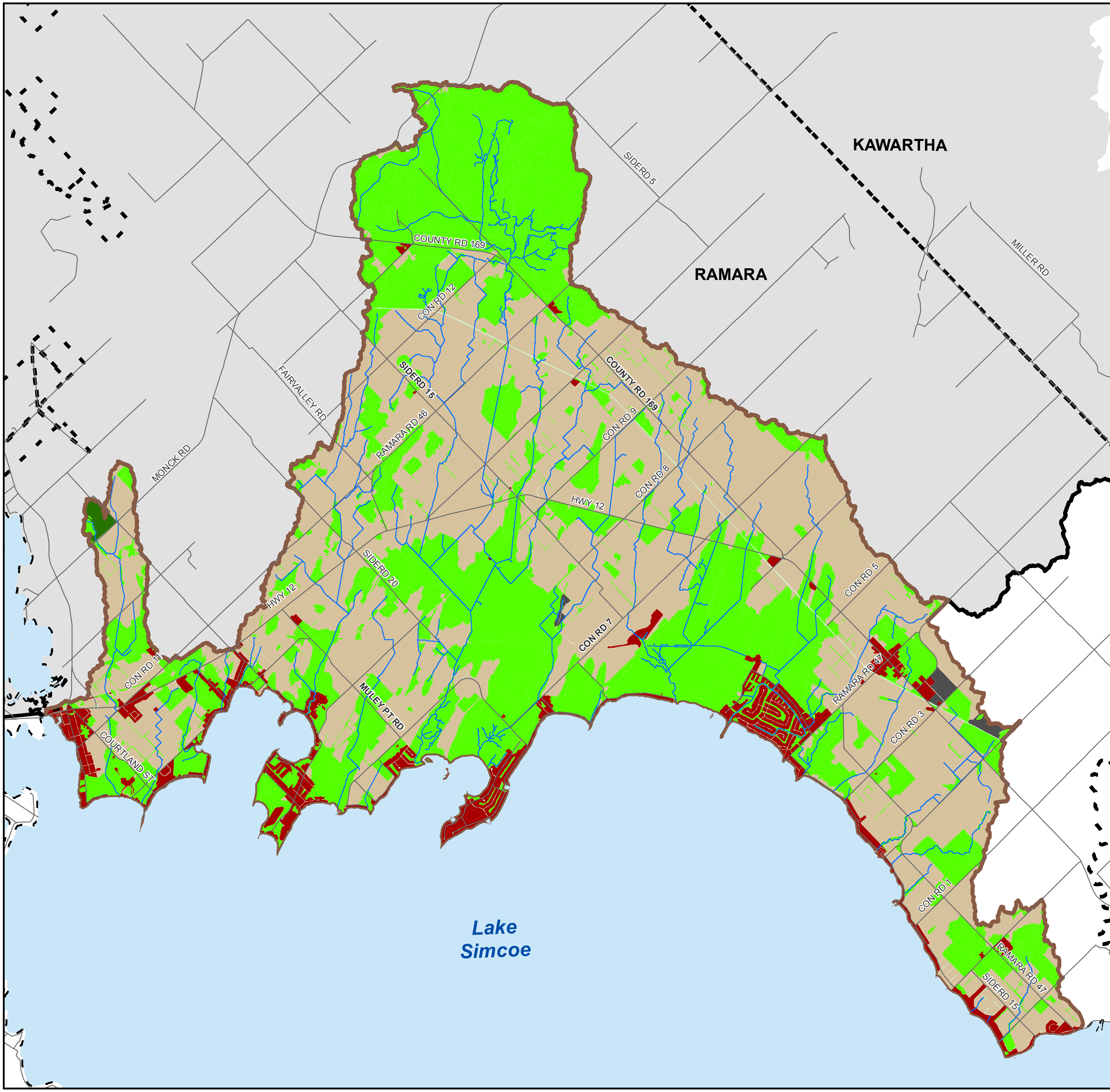



**Figure 2-2: Land use distribution within the Ramara Creeks subwatershed.**

The distribution of land uses within the subwatershed can be seen in Figure 2-3.

# Land uses in the Ramara Creeks subwatershed

Figure 2-3




## Legend

Road

Municipal Boundary

Watercourse

Subwatershed

Land Use

Urban

Rural

Natural Heritage

Golf Course

Aggregate

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

To see how this subwatershed compares to the other subwatersheds in the Lake Simcoe watershed Figure 2-4 to Figure 2-6 illustrate all 18 of the Lake Simcoe subwatersheds from the subwatershed with the highest percentage of urban, natural heritage, and rural land uses to the subwatershed with the lowest percentage. The Ramara Creeks subwatershed is outlined in black.

As can be seen in Figure 2-4, the Barrie Creeks has the highest percentage (62%) of urban land use, while the Whites Creek subwatershed in the eastern part of the watershed has the lowest (1%). The Ramara Creeks subwatershed has the ninth highest level of urban area, with 5.4%.

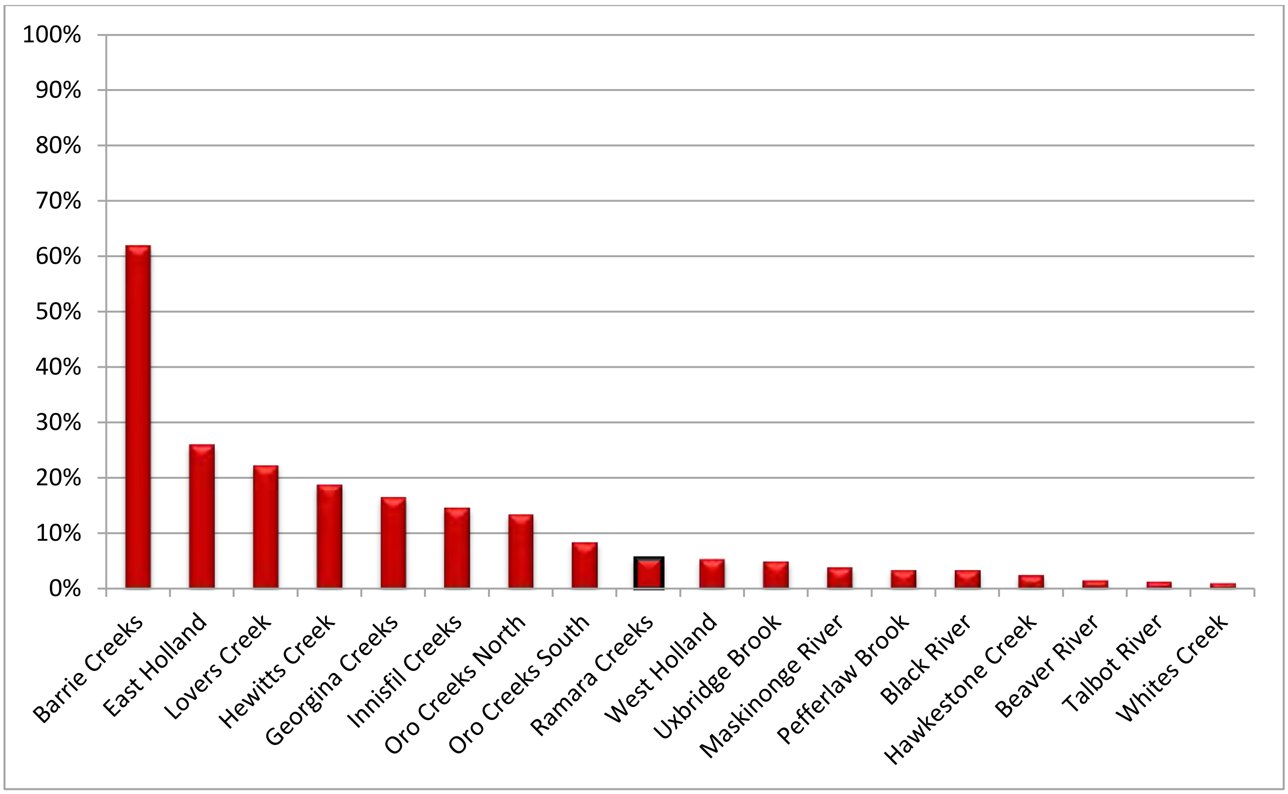



**Figure 2-4: Urban land use in the Lake Simcoe subwatersheds.**

The Ramara Creeks subwatershed has the eighth highest level natural heritage cover of the Lake Simcoe subwatersheds, at 41%. This is in stark contrast to the Barrie Creeks subwatershed, which has the lowest level of natural cover in the watershed, with only 17% (Figure 2-5).

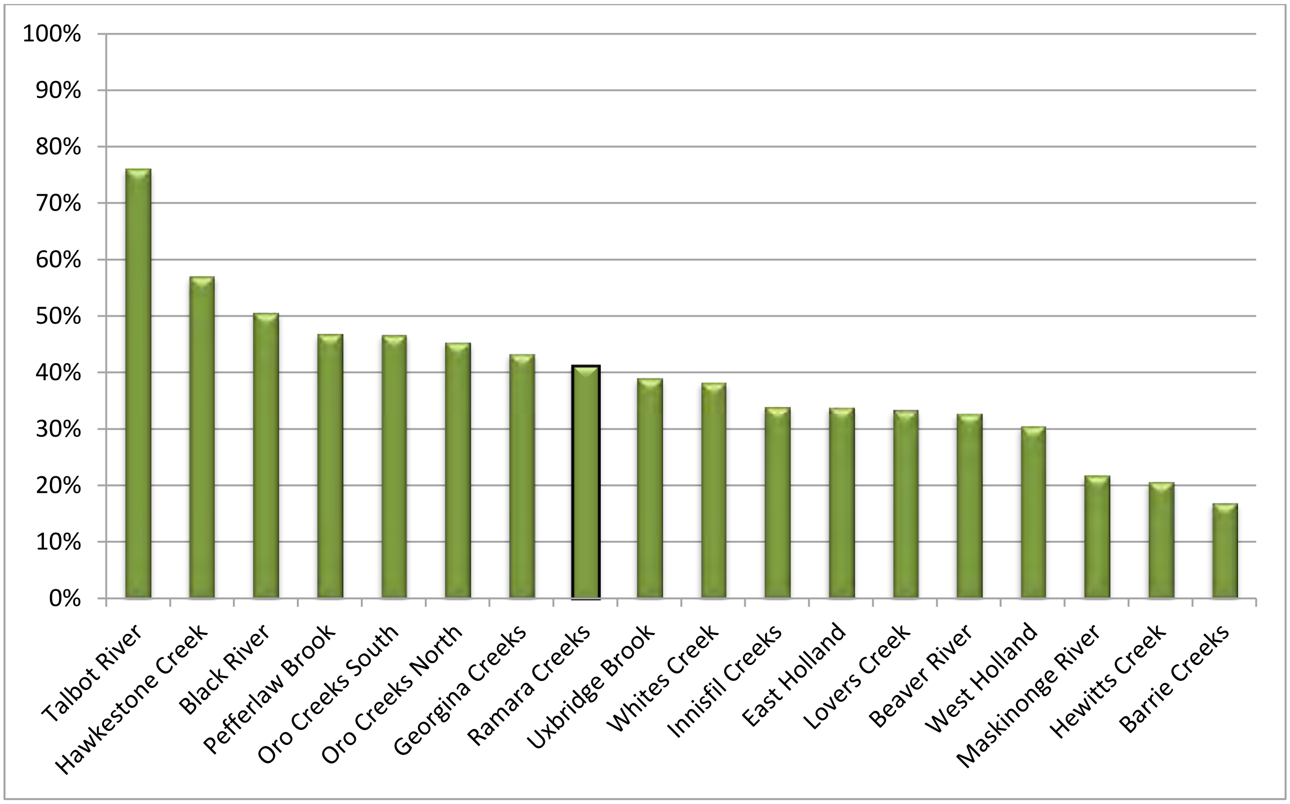



**Figure 2-5: Natural heritage land cover in the Lake Simcoe subwatersheds.**

Figure 2-6 illustrates the rural land use in the Lake Simcoe subwatersheds. The Maskinonge River subwatershed in the southern part of the watershed has the highest percentage with 73%, while the Barrie Creeks subwatershed has the lowest (5%). There is a large percentage gap between the two lowest (Barrie Creeks at 5% and Upper Talbot at 12%) and of the third lowest subwatershed (East Holland subwatershed) which has 34%. At 52%, the Ramara Creeks subwatershed has the eighth highest level of rural land use in the watershed; an indication that this land use is contributing to some of the issues being seen in the subatershed.

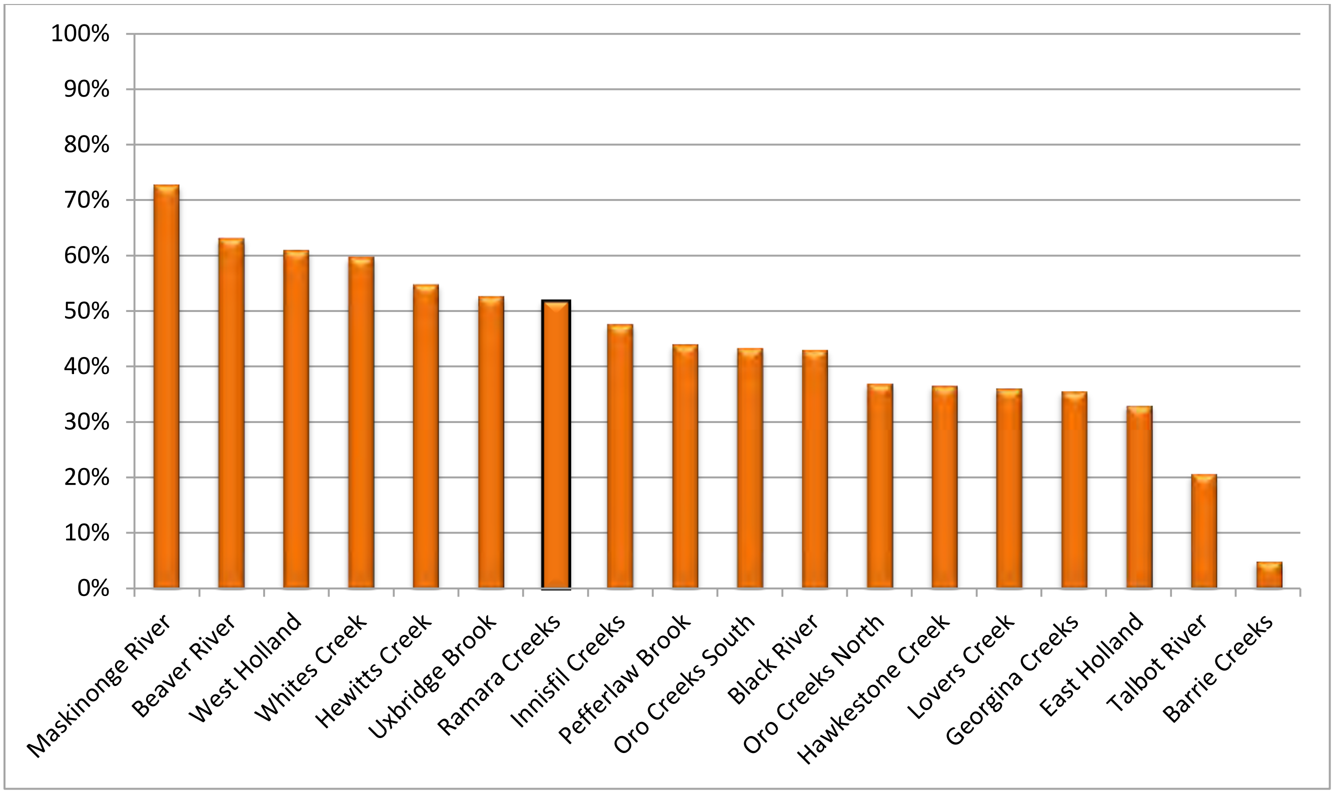



**Figure 2-6: Rural land use in the Lake Simcoe subwatersheds.**

#### 2.2.2.1 Impervious Surfaces

Impervious surfaces refer to hardened surfaces, such as roads, parking lots, and rooftops, which are made of (or covered in) a material impenetrable by water (i.e. asphalt, concrete, brick, rock, etc) [1]. As these surfaces reduce the amount of water infiltrating down into the groundwater supplies and increases surface runoff, the hydrologic properties or drainage characteristics of the area are significantly altered.

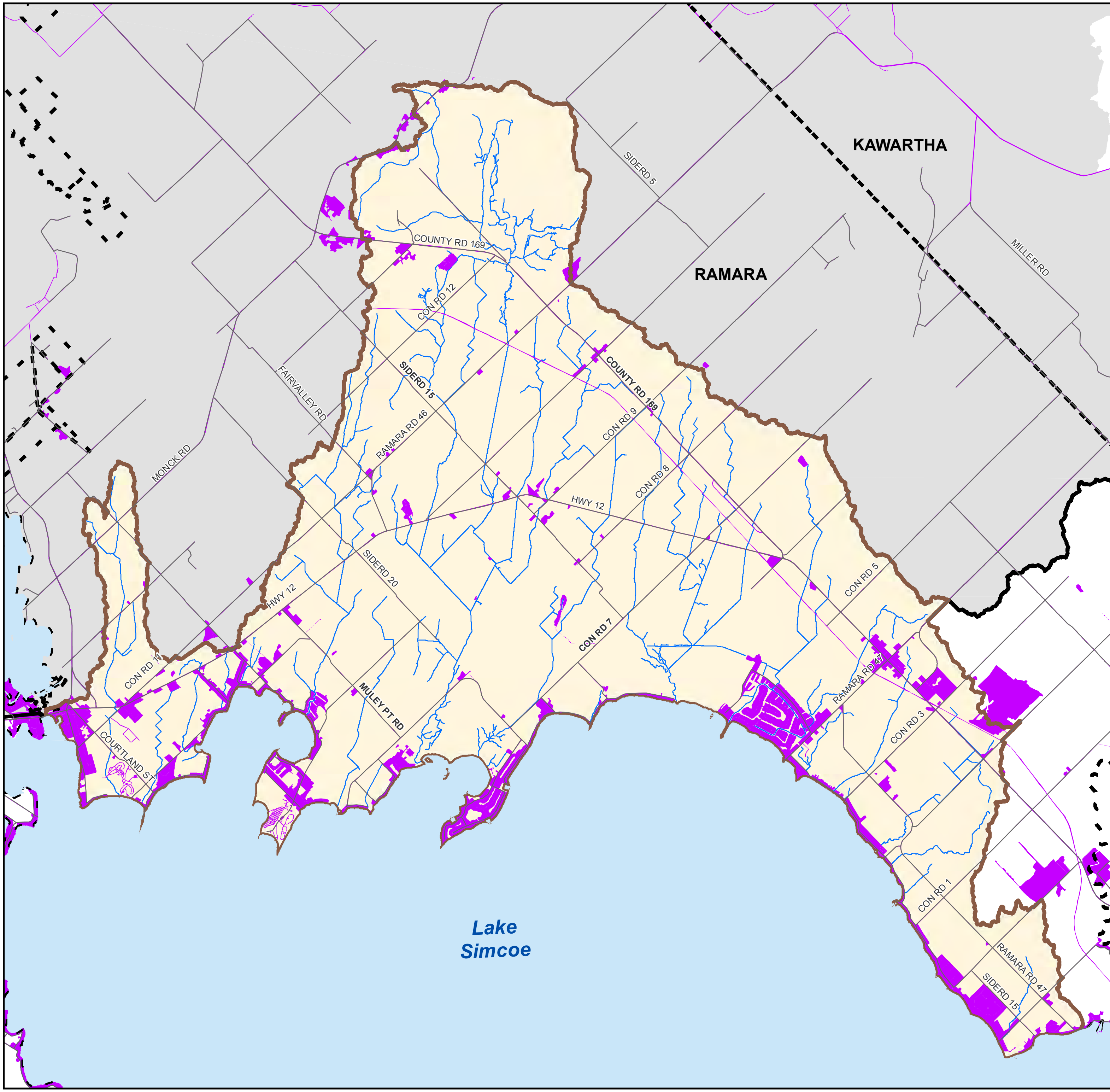
Increasing levels of impervious surfaces, generally associated with urban growth, can impact the surrounding environment in a number of ways. These impacts include decreases in evapotranspiration, as there is little vegetation and the permeable soil is paved over; decreases

[1] For the majority of this report, impervious surfaces do not include features such as wetlands. These are sometimes considered impervious in hydrogeological models, such as those presented in Chapter 4 – Water Quantity.

in groundwater recharge; increases in the volume and intensity of surface runoff, leading to an increase in flow velocities and energy (which can alter the morphology of the stream through channel widening, under cutting of banks, sedimentation, and braiding of the stream); thermal degradation of the watercourses; decreases in water quality as pollutants are washed off streets into storm drains or ditches which discharge to watercourses or the lake; and impairment of aquatic communities (which can be negatively affected by all impacts listed above).

Environment Canada's '*How Much Habitat is Enough?'* guidelines (2013), suggest a limit of 10% imperviousness for urbanized subwatersheds, where subwatersheds should still be able to maintain surface water quality and quantity, and preserve the density and biodiversity of aquatic species. These guidelines further recommend an upper limit of 25-30% impervious cover as a threshold for degraded systems that have already exceeded the 10% impervious guidelines.

The Ramara Creeks subwatershed falls below the 10% guideline, with just under 7% impervious area. This is in large part due to the prevalence of agricultural land uses in the subwatershed and relatively low level of developed areas. There is some increase in urban area projected for the subwatershed; it will be important to undertake measures to maintain this low level of imperviousness in order to preserve groundwater recharge and flow patterns. This is of particular importance in this subwatershed where low flows are an issue, as will be discussed in later chapters. Figure 2-7 illustrates the impervious cover within the subwatershed.




**Impervious cover in the Ramara Creeks subwatershed**

Figure 2-7

#### 2.2.2.2 Settlement Areas

The Township of Ramara is the only municipality within the boundaries of the study area. The Township's settlement areas falling within the Ramara Creeks subwatershed include Brechin, Lagoon City, Bayshore Village, and Udney. There are also a large number of residences found along the Lake Simcoe shoreline. Population growth in Ramara is not as significant as in areas further south, such as the City of Barrie, Town of Innisfil, and York Region, but some growth is identified in the province's Growth Plan for the Greater Golden Horseshoe, with the population expected to grow from the current level of 9,275 to 13,000 residents by 2031. The Township of Ramara experienced very slight growth in the number of private dwellings between the 2006 and 2011 census, with only 1.8% more private residences added in the period.

A large number of residents of the Township work outside their municipality, county, and even province and Canada. The majority of the residents of Ramara work outside of the municipality or have no fixed workplace address (~80%). Many of the people who work in large cities cannot afford to live within them, so they commute from smaller towns that have a more affordable cost of living. These small towns/communities are known as 'bedroom communities'. Typically bedroom communities are located in rural or semi-rural areas, surrounded by green space, and are in close proximity to a major highway that leads to the larger cities. The Township of Ramara is a good example of this, with only 11% of the total employed labour force working within the municipality (Table 2-3).

**Table 2-3: Place of work status in the Township of Ramara (Data Source: Statistics Canada, 2006).**

| Place of Work Status | Township of Ramara | |
|---|---|---|
| | Population | Pop. Percentage (%) |
| Worked at home | 415 | 9 |
| Worked outside Canada | 20 | <1 |
| No fixed workplace address | 725 | 16 |
| Worked in census (municipality) of residence | 530 | 11 |
| Worked in different census subdivision (municipality) within the census division (county) of residence | 2235 | 48 |
| Worked in different census division (county) | 690 | 15 |
| Worked in different province | 10 | <1 |
| **Total employed labour force** | **4,625** | **100** |

The Township of Ramara's economy is varied, with employment across a number of different sectors (Table 2-4). Construction (11%) and retail trade (10%) are the largest industries, while service jobs also constitute a large percentage of the employment, with close to 8% in educational services, 7% in professional, scientific, and technical services, and 6% in accommodation and food services. An additional 7% are employed in the arts, entertainment, and recreation industry.

**Table 2-4: Occupations in the Township of Ramara (Data Source: Statistics Canada, 2011 )**

| Industry | # employed | Industry | # employed |
|---|---|---|---|
| Agriculture, forestry, fishing and hunting | 140 | Mining, quarrying, and oil and gas extraction | 35 |
| Utilities | 55 | Real estate and rental and leasing | 170 |
| Construction | 490 | Professional, scientific, and technical services | 320 |
| Manufacturing | 285 | Administrative and support, waste management and remediation services | 170 |
| Wholesale trade | 215 | Educational services | 385 |
| Retail trade | 450 | Health care and social assistance | 255 |
| Transportation and warehousing | 240 | Arts, entertainment and recreation | 325 |
| Information and cultural industries | 55 | Accommodation and food services | 295 |
| Finance and insurance | 115 | Other services (except public administration) | 205 |
| Industry – not applicable | 125 | Public administration | 290 |
| **Total labour force** | **4625** | | |

## 2.3 Human Health and Well-being

One of the major reasons for understanding and managing watersheds and their function is to protect the health and well-being of watershed residents. Figure 2-8 illustrates the watershed governance prism (Parkes *et al.,* 2010) and the four different aspects of watershed governance including “watersheds”, “ecosystems”, “health and well-being”, and “social systems”. The combination of all of the aspects of watershed management gives a comprehensive view of the way watershed governance can link the determinants of health and well-being to watershed management.

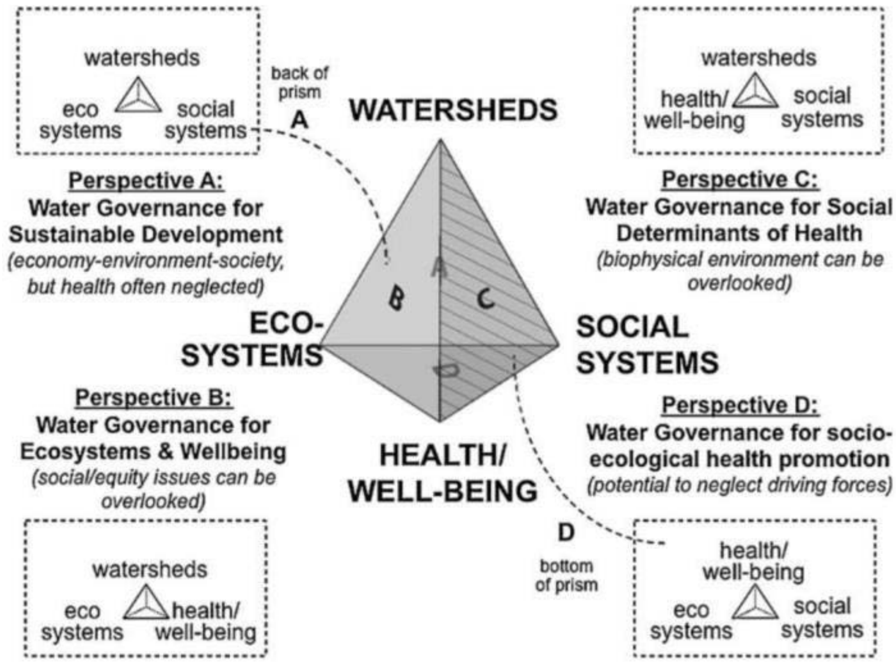



**Figure 2-8: Watershed Governance Prism (Parkes *et al*. 2010).**

The management of the Lake Simcoe watershed includes a number of these perspectives, incorporating issues related to human health and well-being, protection of wildlife habitats, and ensuring the preservation of water quality and water quantity.

### *2.3.1 Outdoor Recreation and Human Health*

Within an urban setting, green spaces (including parks, conservation areas, forests, wetlands, streams and lake shore) are at a premium. Even within a more rural setting, these features are sometimes taken for granted when, in fact, they are an essential part of a healthy community.

#### 2.3.1.1 <u>Physical</u>

Whether it’s an open soccer field, running/walking trails through forests or sandy beaches along the lake front, the green spaces within these subwatersheds provide a number of outdoor recreational opportunities for residents and visiting tourists. The different types of areas available offer a variety of physical activities that would not be available at a local gym and come at little to no cost. Parks and sports field provide areas for recreational or pick up games of soccer, football or frisbee. Trails are areas to walk, run, or bike. Parks and conservation areas with forest and wetlands provide a range of recreational and aesthetic opportunities and the nearby lake shore and waterways offer residents a place to swim, canoe, kayak and fish. It is these types of areas that encourage the physical stimulation of individuals and families, creating a healthier lifestyle for people of all ages.

By encouraging children to be active outdoors at a young age, a number of health-related issues can be minimized or avoided all together. These include:

- Childhood Obesity: In Canada, over 30% of children ages 2-17 are currently overweight or obese (Childhood Obesity Foundation). Obesity can also lead to a number of other diseases including Type-2 diabetes, hypertension, asthma and cardiovascular disease (National Environmental Education Foundation (NEEF)).
- Vitamin D Deficiency: Most common diseases resulting from a lack of Vitamin D include rickets (children) and osteoporosis later in life (NEEF).
- Myopia: One study found that 12 year olds who spent less time doing near-work activities (reading, drawing, etc.) and more time doing outdoor activities were two to three times less likely to develop myopia than those who spent the majority of their time doing near-work activities (Rose *et al.,* 2008).

The Township of Ramara contains a number of parks within the subwatershed. They list over 40 parks, which include a few with manicured open spaces and playgrounds, to natural treed areas, to lake-side parks with beach access, picnic tables, and public swim areas (pers.comm. Dyana Marks, November 28, 2014).

There are two Provincial Parks in the study area; Mara, and McRae Point. Both parks offer a number of activities with campsites (105 sites in Mara and 203 sites in McRae Point); hiking trails; swimming, boating, and fishing on Lake Simcoe; biking; and birding. Hunting is also permitted at McRae Point, in accordance with provincial regulations.

#### 2.3.1.2 Mental

In addition to physical health benefits, there are a number of mental health benefits associated with natural areas. These areas, free of technology and the "jolts per minute" of contemporary life, allow people to take in their surroundings, and benefit from the serene and calming environment. Those who like to explore natural areas are mentally engaged to interact with the surrounding flora and fauna and associate these visual 'pictures' with other senses, such as touch, smell, and sound. Studies have also shown the benefits of nature on the social interactions, emotional status, and cognitive growth of children. Many young children have grown up watching television and playing on computers or with video games, with very little 'play-time' (unstructured, spontaneous activity) in their daily routine. Burdette and Whitaker (2005) suggest that through playing outdoors, a child's social interactions, emotional status, and their cognitive growth are improved. In an unstructured, non-monotonous environment they will come across different situations that encourage them to problem solve, interact, and communicate with others and learn from the different experiences they are exposed to. Studies also show interactions with nature have positive impacts on those with attention-deficit/hyperactivity disorder (ADHD). Something as simple as a 20 minute walk through a park was found to increase concentration and elicit a positive emotional response (Faber and Kuo, 2008).

Recent studies have also linked walks in a natural environment with improvments in memory and mood in subjects suffereing from depression; and exercise is often touted as one of the 'natural cures' for depression and other mood disorders.

It should also be noted that many individuals also have an important spiritual connection to the environment.

#### 2.3.1.3 Community Engagement and Cohesiveness

The more people recognize the benefits that the green spaces in their city or town have on their well being, the more they will work to maintain and protect these areas. Green spaces can bring a community together to perform maintenance and restoration work, create fun and interactive environments, boost tourism (and in turn the local economy), and are places for community events, camps, or public forums. By putting effort into caring for the green spaces and enjoying the benefits they gain from them, people form an attachment to these areas, as well as their community as a whole.

#### 2.3.1.4 Economic Benefits

While the previous section highlighted the social and health benefits of urban natural areas, studies have also shown the monetary benefits of having tree-lined streets and urban natural areas.

For example, the presence of mature trees in residential areas can increase the sale prices of neighbouring properties by 2-15% (Wolf, 2007; Donovan and Butry, 2009), and decrease the amount of time such properties are on the market (Donovan and Butry, 2009). The presence of larger natural areas nearby can increase property values by up to 32% (Wolf, 2007). Even during the initial development process, retaining mature trees on residential lots can increase their sale value by up to 7% (Theriault *et al.*, 2002).

In addition to increasing property values, natural areas in or near residential neighbourhoods can act as a draw for white-collar workers working in high paying, creative jobs, who prefer to live in an urban setting that encourages their 'creativity', through a stimulating, diverse, cultural setting with easily accessible natural amenities for a healthy lifestyle. As a result, the preservation of urban green space can attract new businesses with highly paid staff, and strengthen the local economy (Florida, 2002). Commercial sectors can also benefit from an increase in urban tree cover. Studies have shown that shoppers tend to spend more time, and make more purchases, in downtown commercial and retail districts that have more trees, creating income both for the city and for store owners (Wolf, 2005).

### *2.3.2 Drinking Water Source Protection*

A threat to human health is the degradation and depletion of freshwater resources. Degradation of water quality can either be anthropogenic or natural in nature. Humans can impact their water through:

- Poor sanitation habits (crude solid waste disposal methods, improper filtration methods of waste water and drinking water);
- Removal of riparian buffers, allowing unfiltered run off from streets, lawns and agricultural fields to go directly into waterways;
- Improper storage of chemicals that can spill in to surface water or leach into the ground to reach the deeper groundwater resources;
- Warming of water temperatures (creates ideal temperatures for growth of bacteria) by connecting runoff systems to watercourses or creation of standing bodies of water that link to the watercourse.

Climate change can also impact water quality through changes in air temperature, precipitation and extreme events by:

- Releasing contaminants: extreme events and increases in precipitation may damage buildings/containers holding contaminants, cause the overflow of retention areas holding contaminants, and/or wash surface contaminants into watercourses;
- Transporting contaminants: extreme events can transport contaminants greater distances, potentially increasing the exposure to them;
- Creating warmer environments: surface waters become more hospitable to pathogens and other waterborne disease.

Poor water quality, either because of anthropogenic or natural conditions, can lead to an increase in water-borne diseases, loss of fisheries, contaminated food sources, and closures of beaches due to high levels of *Escherichia coli*. Residents can be directly impacted through sickness, increases in food costs (uncontaminated) or loss/decrease in income (loss of fisheries, farms with unusable, contaminated produce).

Depletion of available water is another major health concern. Low water quantity can result in water restrictions that lead to lower agricultural produce yields, increasing the cost of food. Less water available to residents also means that there is less water available to natural environments, leading to a loss of habitat through drying of wetlands and an increase in forest fires.

In 2006, the provincial government made a commitment to the citizens of Ontario by passing the *Clean Water Act* (CWA). The CWA introduced a new level of protection – Source Water Protection - for the Province's drinking water resources that will help communities across Ontario enjoy a safe and plentiful supply of clean drinking water for generations to come. Drinking Water Source Protection is the first step in a multi-barrier approach to protecting our sources of drinking water. It identifies possible threats to drinking water, assesses the risks of those threats, mitigates them and plans ahead to prevent contamination before it gets into the water supply. It is a responsible and effective way of ensuring safe, clean drinking water and avoiding serious health issues.

#### 2.3.2.1 Drinking Water Systems and their Vulnerable Areas

The South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region (SPR) is one of 19 in Ontario. It contains three Source Protection Areas (Lakes Simcoe and Couchiching-Black River, Nottawasaga Valley, and Severn Sound) that are composed of four watersheds: Lake Simcoe[2], Black-Severn River, Nottawasaga Valley, and Severn Sound.

One of the key documents of the Source Protection program that has been completed for each of the Source Protection Areas (and the watersheds within their borders) is the Assessment Report. The SGBLS Source Protection Committee released three updated Assessment Reports in July 2014 that provide the following information for each area (these were approved in January of 2015):

- Characterization of the Source Protection Area watershed: This includes descriptions of the natural and human geography;
- A conceptual water budget for the entire Source Protection Area and a Tier 1 water budget for each subwatershed: Those systems identified as having water quantity stress in the Tier 1 water budget progress to a more detailed Tier 2 water budget and Tier 3 if needed;
- Broad scale assessment of Regional Groundwater Vulnerability: This aspect of the Assessment Report requires that both Highly Vulnerable Aquifers (HVA) and Significant Groundwater Recharge Areas (SGRAs) be identified; and
- Drinking water system assessment: For each drinking water system within the Terms of Reference, the Vulnerability of the supply wells or surface water intakes is assessed and any potentially Significant Threats to the water quality are identified.

Within the whole SGBLS SPR there are 108 drinking water systems, with 31 in the Lake Simcoe watershed. There are four drinking water systems in the Ramara Creeks subwatershed; two of these are groundwater supply systems, and two are surface water intakes.

Each of the drinking water systems in the subwatershed have had their vulnerable areas delineated. These vulnerable areas that are directly associated with drinking water systems are referred to as Wellhead Protection Areas (WHPAs) for groundwater systems and Intake Protection Zones (IPZs) for surface water intakes:

- A WHPA is the area around a wellhead where land use activities have the greatest potential to affect the quality of water that flows into the well. Each WHPA is subdivided into four time-of-travel zones that estimate the amount of time it would take a contaminant to reach the municipal well
  - WHPA-A: 100 m radius.
  - WHPA-B: 2 year time of travel (tot) capture zone
  - WHPA-C: 5 year tot capture zone

[2] Information for the drinking water systems within the Ramara Creeks subwatersheds can be found in the Approved Lakes Simcoe and Couchiching-Black River Source Protection Area Assessment Report, Part 1: Lake Simcoe. Chapter 12 of this Assessment Report is specific to the Township of Ramara.

  - WHPA-C1: 10 year tot capture zone (for WHPAs delineated before April 2005).
  - WHPA-D: 25-year tot capture zone

- Similarly, an IPZ is the area around a surface water intake and includes three time-of-travel zones.
  - IPZ-1: 1000 m radius
  - IPZ-2: 2 hour time of travel
  - IPZ-3: Area within the surface water body through which contaminants released during an extreme event could be transported to the intake. For the intakes associated with this subwatershed, this includes the entire Lake Simcoe watershed, as well as the Lake Couchiching catchment area, as some flow back into Lake Simcoe has been noted.

Two additional vulnerable areas that were also delineated in the Assessment Reports are SGRAs and HVAs. These vulnerable areas do not pertain directly to any particular drinking water system, but instead are on a regional (landscape) scale:

- SGRAs are areas where water enters an aquifer (underground reservoirs from which we draw our water) through the ground. Recharge areas are significant when they supply more water to an aquifer than the land around it. SGRAs are important on the landscape for ensuring a sufficient amount of water enters an aquifer. For example, paving over an SGRA would prevent water from getting into the ground to recharge an aquifer, potentially decreasing the amount of water available.
- HVAs are those areas where an aquifer may be more prone to contamination. These areas have been identified where there is little or no protection from an overlying aquitard (a protective layer of low permeability materials). Generally, the faster water is able to flow through the ground to an aquifer, the more vulnerable the area is to contamination. For example, a fuel spill would get into an aquifer much more quickly where an HVA has been identified than where one has not.

Further information on these two regional scale Vulnerable Areas can be found in the South Georgian Bay Lake Simcoe Source Protection Region Assessment Reports.

The drinking water systems within this subwatershed are located within the Township of Ramara and are only four of the six systems servicing the township. The other two are located in the Severn Sound watershed. With two thirds of the systems within the Lake Simcoe watershed, and over 4000 people (combined) relying on these water supplies as a source of safe drinking water it stresses the importance of maintaining and/or improving the quality (and quantity) of these supplies. Restoration efforts along streams draining into Lake Simcoe, or on the lake itself, benefit not only the local wildlife and natural habitats, but also all those who depend on the watershed and lake as a source of safe drinking water.

For the Assessment Report, studies were undertaken to assess the vulnerability, issues, and threats for each of the Wellhead Protection Areas and Intake Protection Zones.

The Bayshore Village Well Supply consists of three water supply wells, located on Concession 6 in the Township of Ramara, servicing an estimated population of 750 residents in Bayshore Village. Two significant drinking water threats were identified in association with two land parcels. One of these threats is associated with individual sewage systems, and the other was related to the handling and storage of fuel (SGBLS-SPC, 2015).

The Val Harbour Subdivision Well Supply consists of two wells, and is located on Concession 7. The system services an estimated population of 148 in the Val Harbour subdivision. A total of 33 significant drinking water threats were identified in association with 25 land parcels. The majority of these threats were associated with individual sewage systems (23), with others related to the application (2) and storage (1) of agricultural source material; the handling and storage of commercial fertilizer (1); the application (2) and handling and storage (1) of pesticide; the handling and storage of fuel (2); and the use of land as livestock grazing or pasturing land (1) (SGBLS-SPC, 2015).

The Lagoon City Water Treatment Plant is located on the east shore of Lake Simcoe near the Harbour Canal in the community of Lagoon City, and serves the communities of Lagoon City, Brechin, and Concord Point, an estimated population of 2945 residents. There were 147 activities that are potentially significant drinking water threats identified on 55 land parcels within the IPZ-2. The most prevalent of these are the application of agricultural source material (54), and the application of pesticide to land (50). Other threats include the storage of agricultural source material (16), the use of land as livestock grazing or pasturing land (16), the application of non-agricultural source material(7), and individual sewage systems (4) (SGBLS-SPC, 2015).

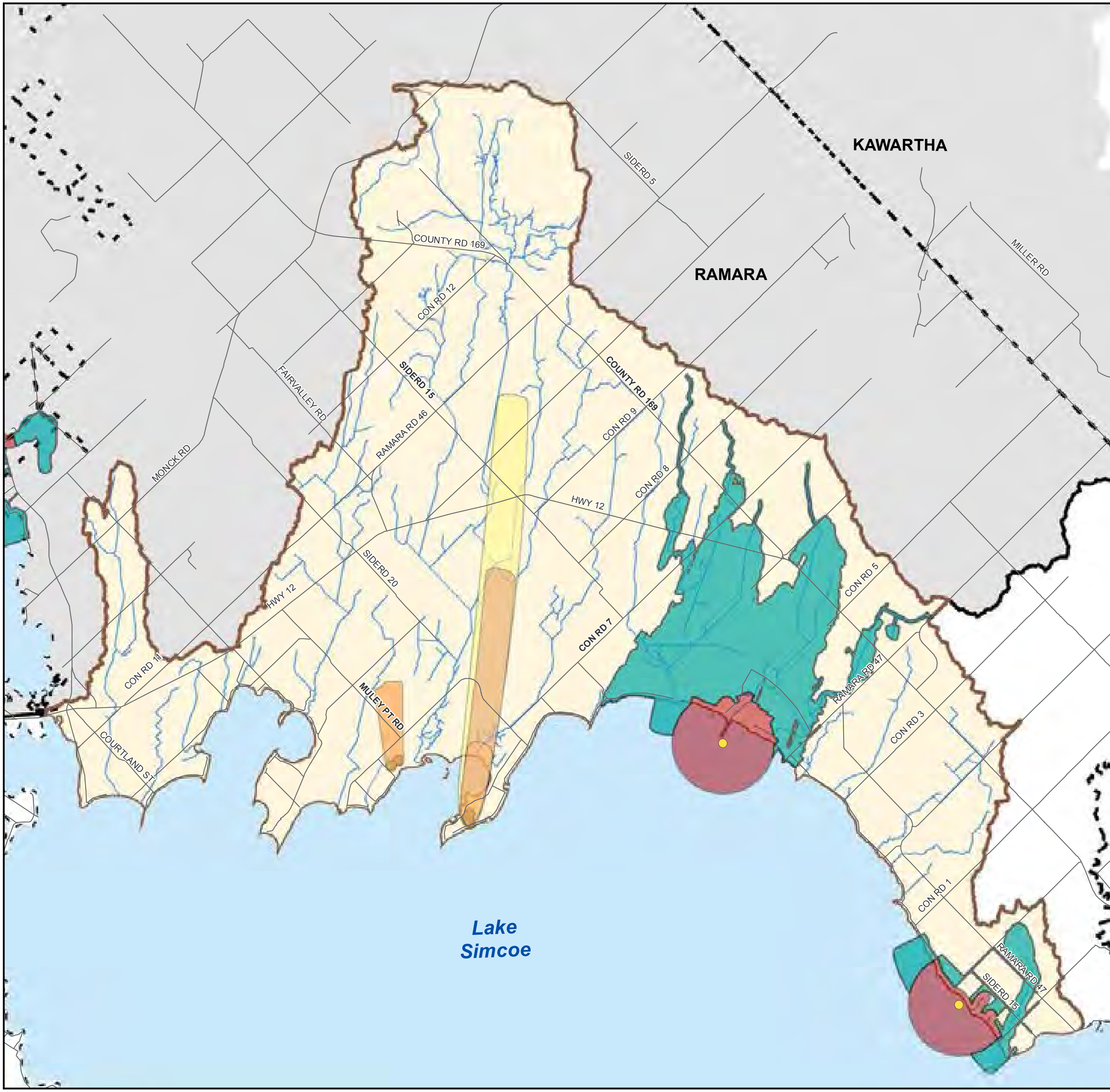
Lastly, the South Ramara Water Treatment Plant is located on the eastern shore ofLake Simcoe near the community of Heritage Farms. It serves the communities of Heritage Farms and Mara Shore Estates, with a population of approximately 221. In the IPZ-1 there were 74 threats identified associated with 69 parcels of land. The majority of these were individual sewage systems (69), with other threats including the application of agricultural source material (1), The handling and storage of fertilizer (1), the application of pesticide (1), the handling and storage of pesticide (1), and the handling and storage of fuel (1). There were 10 threats identified in the IPZ-2 associated with 6 parcels fo land, including the application of agricultural source material to land (6), the storage of agricultural source material (2), and the use of land as livestock grazing or pasturing land (2) (SGBLS-SPC, 2015).

The final document the Source Protection Committee (SPC) is responsible for is creating a Source Protection Plan that will be effective in mitigating all existing significant threats and preventing new ones from arising on the landscape. The process of creating this plan included the SPC developing policies to protect drinking water supplies. The revised proposed plan was submitted to the Minister in July, 2014 and was approved in 2015.

Full results of these studies, showing the vulnerability scores and the enumeration of threats to drinking water, can be found in the Approved Lakes Simcoe and Couchiching-Black River Assessment Report, Part 1: Lake Simcoe. The local vulnerable areas (Wellhead Protection Areas and Intake Protection Zones) for the drinking water systems located in the Ramara Creeks subwatershed are shown in Figure 2-9.

# Vulnerable areas (WHPA/IPZ) located within the Ramara Creeks subwatershed

Figure 2-9




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed
- IPZ-1 (1000m)
- IPZ-2 (2-hrs time of travel)
- WHPA-A (100m)
- WHPA-B (2-yrs tot)
- WHPA-C (5-yrs tot)
- WHPA-C1 (10-yrs tot)
- WHPA-D (25-yrs tot)

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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 dc created August 2014.

### *2.3.3 Ecological Goods and Services.*

In addition to the direct benefits to human health provided by publicly accessible natural areas and clean drinking water, the environment also provides a range of other, less tangible, benefits, often termed 'ecological goods and services'. These benefits include the storage of floodwaters by wetlands, water capture and filtration by forests, the absorption of air pollution by trees, and climate regulation.

The forests, wetlands, and rivers that make up watersheds are essentially giant utilities providing ecosystem services for local communities as well as the 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/eco-utility/benefits/overview).

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). 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 2008, the Lake Simcoe Region Conservation Authority partnered with the David Suzuki Foundation and the Greenbelt Foundation to determine the value (natural capital) of the ecosystem goods and services provided by the natural heritage features in the watershed in the report: *Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services* (Wilson, 2008). By identifying and quantifying ecosystem services within a watershed, environmental resources can be directed towards areas that are currently of high value or areas that have the potential to be of high value.

#### 2.3.3.1 Valuing Ecosystems

There have been several techniques developed to estimate economic values for non-market ecosystem services. The method used for the 2008 study uses avoided cost (i.e. damages avoided) and replacement cost (cost to replace that service) 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. Table 2-5 summarizes the value of the various ecosystem services by land cover type in the Ramara Creeks subwatershed, as well as for the whole Lake Simcoe watershed. All ecosystem service values have been updated to 2013 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 these values are likely non-linear in nature (i.e. the value of natural capital and its services will increase over time, as natural areas become more scarce, and demands for services such as clean water or mitigation of climate change become greater). It is also important to note that without the earth's ecosystems and resources, life would not be possible, so essentially the true value of nature is priceless. The valuations of ecosystem services, however, provide an opportunity to quantitatively assess the current benefits and the potential costs of human impact.

**Table 2-5: Summary of non-market ecosystem service values by land cover type (2013 values).**

| Land Cover Type | Total Ramara Creeks subwatershed value ($ million/yr) | Total Lake Simcoe basin value ($ million/yr) |
|---|---|---|
| Cropland | 2.59 | 57.8 |
| Forest | 6.45 | 236.20 |
| Forest/ Wetlands* | 41.50 | 640.01 |
| Wetlands | 15.59 | 253.57 |
| Grasslands | 0.99 | 37.27 |
| Hedgerows/ Cultural Woodland | 0.28 | 10.08 |
| Pasture | 4.74 | 43.47 |
| Urban Parks | 0.11 | 3.43 |
| Water** | 0.11 | 122.28 |
| **Total** | **72.35** | **1,404.12** |

* This includes treed swamps.
** This does not include the value of Lake Simcoe

As has been demonstrated, the natural systems of the Ramara Creeks subwatershed provide a number of goods and services. These so-called "free" ecosystem services have, in fact, significant value. The analysis in the 2008 report provided a first approximation of the value of the non-market services provided – totalling annually (in 2013 values) for the Lake Simcoe watershed $1.4 billion and at least $72.3.5 million for the Ramara Creeks subwatershed. The most highly valued natural assets are the forests and treed swamps. For the Lake Simcoe watershed these were calculated to be worth $236 and $640 million per year, respectively. These values for the Ramara Creeks subwatershed were calculated to be $6.5 million (forests) and $41.5 million (treed swamps).

The high value for forests reflects the many important services they provide, such as water filtration, carbon storage, habitat for pollinators, and recreation. Treed swamps and wetlands provide high value because of their importance for water filtration, flood control, waste treatment, recreation, and wildlife habitat.

It is important to note that while the value of Lake Simcoe is not included in the watershed total, it is of considerable value to all surrounding natural and human communities within the

Lake Simcoe watershed. It is the focal point of many waterfront communities (such as the Township of Ramara), provides a vast number of recreational opportunities for locals and tourists alike, is a source of drinking water for seven municipal surface water intakes, supports a substantial fishery and, as well as being a significant natural heritage feature, provides people with beautiful scenery. As such, the preservation of the lake and the rest of the natural heritage features within the watershed results in a significant cost savings in municipal infrastructure that would otherwise be needed to watershed residents and users.

## 2.4 Geology and Physical Geography

The geology, topography, and other physical features of a subwatershed provide the foundation for the subwatershed's hydrological and ecological processes, as they provide a strong influence on factors such as local climate patterns, types of land cover, land use practices, and surface water and groundwater flow paths.

### *2.4.1 Geology*

A number of studies have contributed to the geologic understanding in the study area. A generalized description of the bedrock geology, quaternary geology, and conceptual stratigraphic units within the Ramara Creeks subwatershed is provided. For more detailed information the reader is referred to Finamore and Bajc (1983,1984), Johnston *et al*. (1992), Armstrong (2000), and Easton (1992).

#### 2.4.1.1 <u>Bedrock Geology</u>

The Precambrian bedrock in the Ramara Creeks subwatershed forms the foundation to a sequence of younger Paleozoic sedimentary rocks. The Precambrian 'basement' rocks form part of the Central Gneiss Belt, which is a major subdivision of the Grenville Structural Province. The rocks of the Grenville Province constitute one of the main geological provinces of the Canadian Shield. In the study area, these Canadian Shield 'basement' rocks are characterized by metaplutonic and metasedimentary gneisses and migmatites of medium to high metamorphic rank.

A sequence of Middle Ordovician Paleozoic rocks overlay the Precambrian basement. These Paleozoic units predominantly consist of carbonate and clastic sedimentary deposits thought to have formed under marine conditions. East to west trending subcrop belts of progressively younger Ordovician units occur as one moves southward through the region. The Ordovician sequence in the study area consists of five formations that dip gently towards the south, from oldest to youngest. The five formations from oldest to youngest include: the Shadow Lake Formation, the Gull River Formation,the Bobcaygeon Formation, the Verulam Formation, and the Lindsay Formation.

**Shadow Lake Formation**

The Shadow Lake Formation is the oldest unit in the sequence and is found at the base of the Ordovician sequence. The composition of the unit consists mainly of sandstone, siltstone, and shale with minor dolostone. The rocks are predominantly clastic and thought to be the product of sedimentation in a supertidal environment (Johnson *et al*., 1992). The thickness of this formation varies between 1.63 to 9.15 m, and outcrops of the formation are limited in the study area. The shadow lake formation is represented by the darker pink colour in Figure 2-10.

**Gull River Formation**

The Gull River Formation overlies the Shadow Lake Formation and consists of micritic to fine grained limestones. The formation can be divided into a lower and upper unit , with an overall thickness of up to 25m (Armstrong, 2000). The lower member measures up to 14 m thick, while the upper member has a maximum thickness of about 10 m. At the top of the lower member, there is a distinctive horizon about 1.5 m thick of light green dolostone or dolomitic limestone, known informally as the 'green marker bed'. The Upper and Lower members are represented by the light purple and darker purple colour in Figure 2-10, respectively.

**Bobcaygeon Formation**

The Bobcaygeon Formation is the next unit in the sequence and is mainly composed of limestone that is generally more fossiliferous and coarser grained than the underlying Gull River Formation. It is divided into three members. The composition of the formation includes very fine to coarse-grained limestones in the lower and upper members, and interbedded shale and fine- to medium-grained limestones in the middle member. The composition of the upper member is characterized by limestones with shaly partings and a few thin shale beds. In terms of areal extent, this formation is the most significant Paleozoic unit subcropping in the study area. The Upper, Middle, and Lower Bobcaygeon formation is represented by the three shades of green in Figure 2-10.

**Verulam Formation**

Overlying the Bobcaygeon Formation is the Verulam Formation, which ranges between 45 to 60 m in thickness and is divided into two subgroups. The lower unit consists of interbedded calcareous shale and limestones that range from micritic mudstones to coarse-grained packstones and grainstones. The upper units consists of coarse-grained limestones and measures up to 10 m in thickness. The Verulam Formation forms a broad subcrop belt across the southern part of the study area. Due to its high shale content, the lower member of the Formation weathers easily and only the upper member forms good outcrops. The Verulam formation is represented by the colour grey in Figure 2-10.

**Lindsay Formation**

The Lindsay Formation is the youngest bedrock unit in the study area. The unnamed lower member consists of very fine grained to coarse grained , fossiliferous limestone with a distinctly nodular appearance (Johnson et al., 1992). The upper member of the formation in not present in the study area.

**Karst**

Karst topography refers to limestone regions with underground drainage and cavities caused by the dissolution of limestone rock. Karst landscapes are characterized by features such as sinkholes, caves, and solutionally enlarged joints in the bedrock called "grikes". Although Karst features are largely absent in the Ramara Creeks subwatershed, they are prominent across the

Carden Plain physiographic region located directly to the north and east of the subwatershed. Small portions of the Carden Plain traverse the northern boundary of the subwatershed.

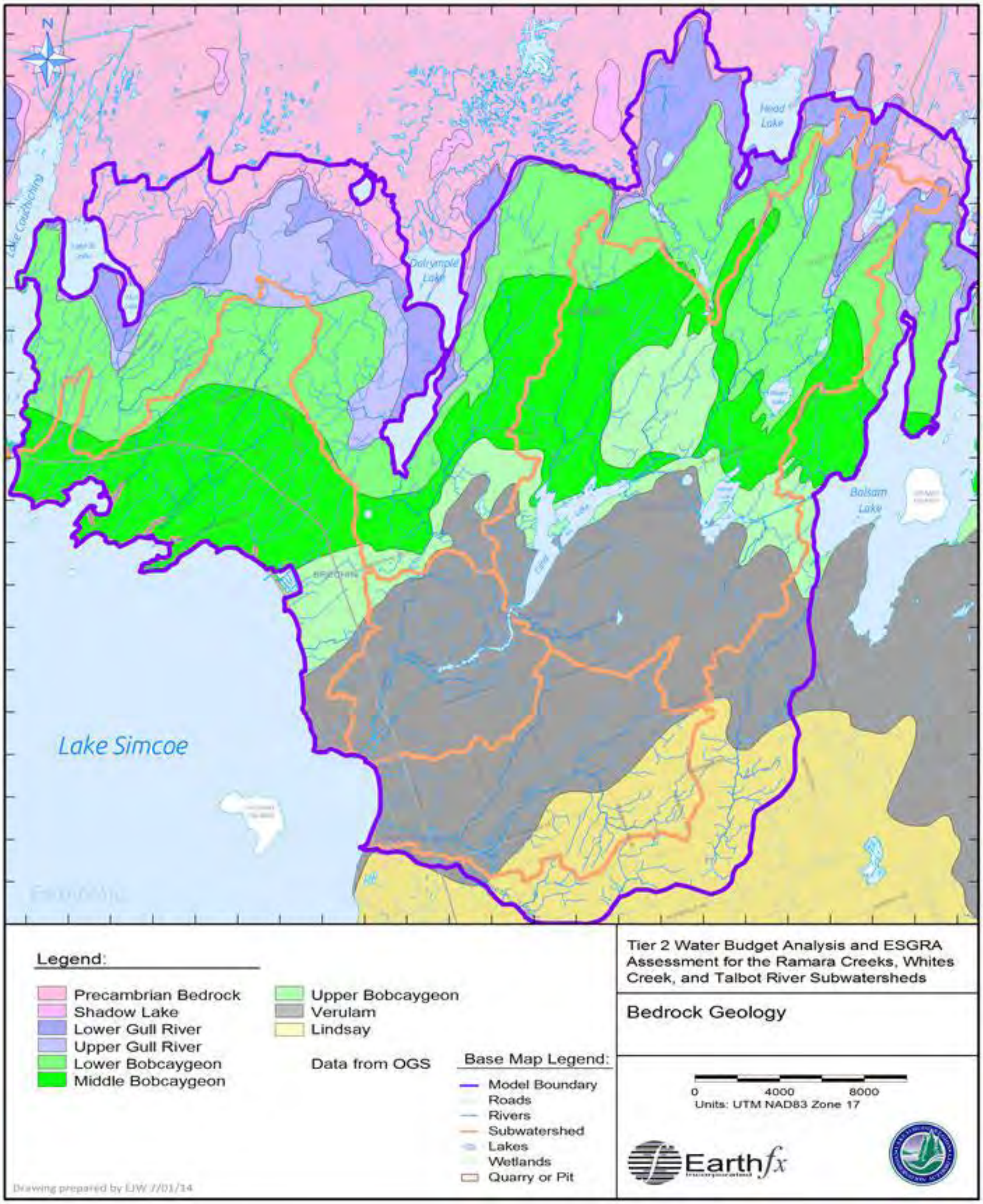
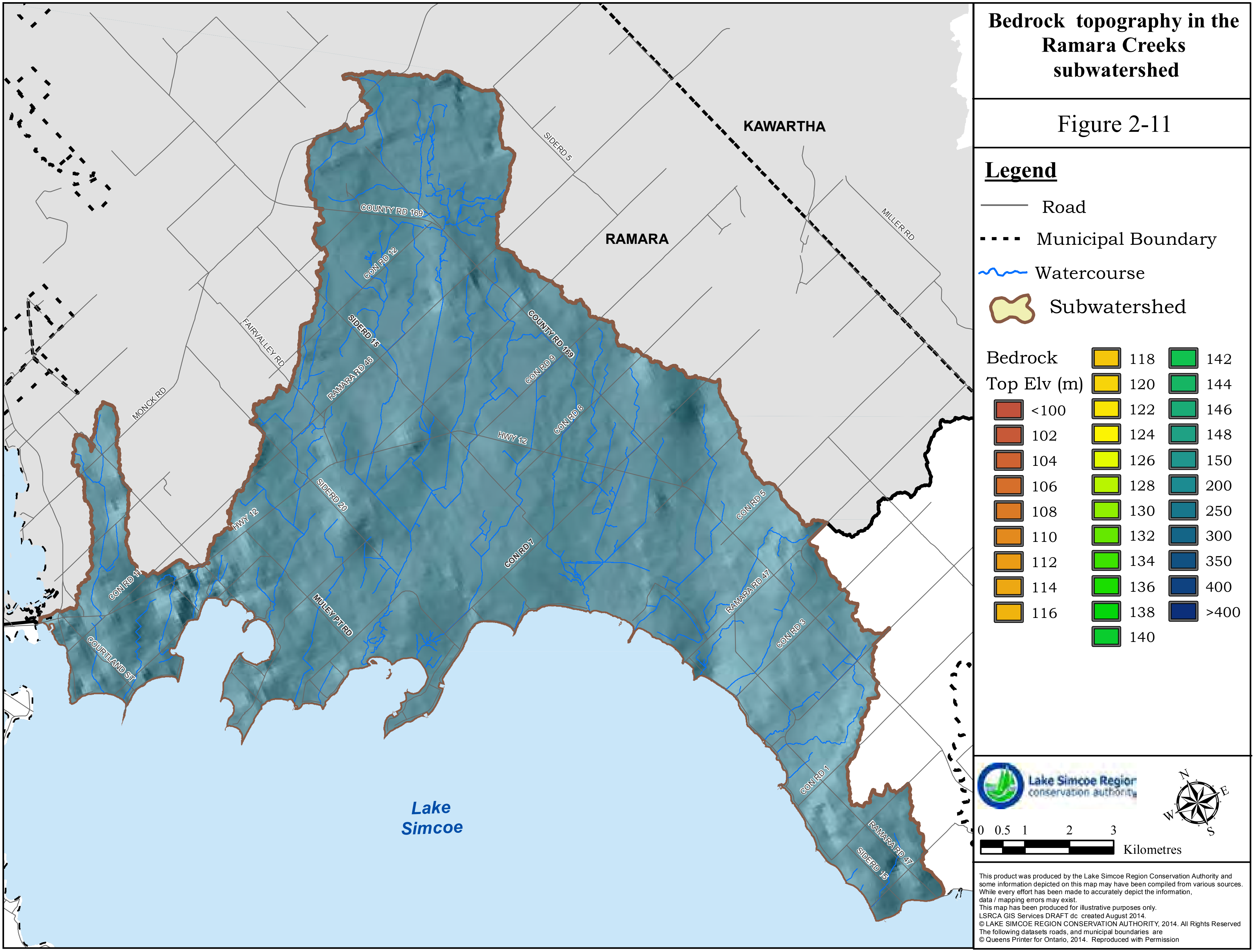



**Figure 2-10: Bedrock geology in the Ramara Creeks subwatershed.**

#### 2.4.1.2 Bedrock Topography

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. On a regional basis, the surface of this unit dips gently to the south-southwest (Armstrong, 2000). Based on Figure 2-11, the bedrock surface of the Ramara Creeks subwatershed has a general elevation range of 200 to 250 mASL. The highest elevation of the bedrock surface coincides with the northern portion of the Ramara Creeks subwatershed with gradually declining elevations towards the south western portion of the study area, along the shoreline of Lake Simcoe.



Bedrock topography in the Ramara Creeks subwatershed
Figure 2-11
Legend
Road
Municipal Boundary
Watercourse
Subwatershed
Bedrock Top Elv (m)
<100
102
104
106
108
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134
136
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142
144
146
148
150
200
250
300
350
400
>400
KAWARTHA
RAMARA
Lake Simcoe
COUNTY RD 169
CON RD 12
SIDERD 15
RAMARA RD 46
CON RD 9
CON RD 6
HWY 12
SIDERD 20
CON RD 7
MULEY PT RD
CON RD 11
COURTLAND ST
CON RD 5
RAMARA RD 47
CON RD 3
CON RD 1
SIDERD 5
MILLER RD
FAIRVALLEY RD
MONCK RD
Lake Simcoe Region conservation authority
N
E
W
S
0 0.5 1 2 3
Kilometres
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 dc created August 2014.
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### 2.4.1.3 Quaternary Geology

*Glacial History*

Like all of southern Ontario, the study area was repeatedly glaciated during the Pleistocene Epoch, although locally there is only clear evidence for glacial activity during the Wisconsinan, the final major glacial episode. Regionally, sediments of Quaternary age form a complex blanket of sediment deposits, on the bedrock surface. Most of these sediments were deposited either directly from glacier ice, in meltwater streams, or in ice-marginal or ice-dammed lakes. The Ramara Creeks subwatershed is thought to have been occupied by ice for most of the Late Wisconsinan period. Glacial ice movement in the area was out of the northeast.The pattern of glaciation in the Great Lakes region was typically lobate, with relatively thin glacier ice flowing from the north filling the lake basins and then spreading out radially as the ice mass became thicker. The extent of ice recession during the Erie phase following the glacial maximum is not well understood.

The bedrock within the Ramara Creeks subwatershed is overlain by unconsolidated sediments, known as the overburden, which were deposited during the Quaternary Period. The Quaternary period is the most recent time period of the Cenozoic Era on the geologic time scale. The Quaternary Period can be 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).

The quaternary deposits within the study area are shown on Figure 2-12. Much of the surfical geology described below is based on mapping and descriptions by the Ontario Geologic Survey Armstrong and Dodge (2007), and Armstrong (2000). As illustrated in the figure, the major surficial unit in the study area is the Newmarket Till sheet- a compact and fissile low conductivity till diamicton characterized by sandy silt to silty sand conditions. The other predominant unit is described as a well laminated, fine grained glaciolacustrine silt and clay unit thought to have been deposited in a post-glacial lake environment. As the Late Wisconsinan ice receded much of the area was inundated by the waters of Early Glacial Lake Algonquin, the first in a series of major post-glacial lakes in the region. The silt and clay deposits present across the Ramara subwatershed are thought to be the result of glacial sedimentation processes that occurred in these early post- glacial lakes. Together the Newmarket Till unit and glaciolacustrine sediments characterize the largest portion of the subwatershed.

As illustrated in Figure 2-12, several concentrated areas of sand deposits are also present across the study area, and particularly prominent in the northern upland portion of the subwatershed. These sandy to gravelly beach deposits developed where wave action reworked older sediments present on the shorelines of pre-existing post-glacial lakes. Unique ice contact deposits such as a southwest trending esker can also be observed across the study area. These stratified ice contact deposits developed in the waning stages of glaciation, when meltwater streams either on or within the glacier deposited bodies of sand and gravel. The southwest trending esker found in the subwatershed is an indication of this process. Other glacial recession features include a large number of southwest trending drumlins, found extensively across the central parts of the subwatershed.

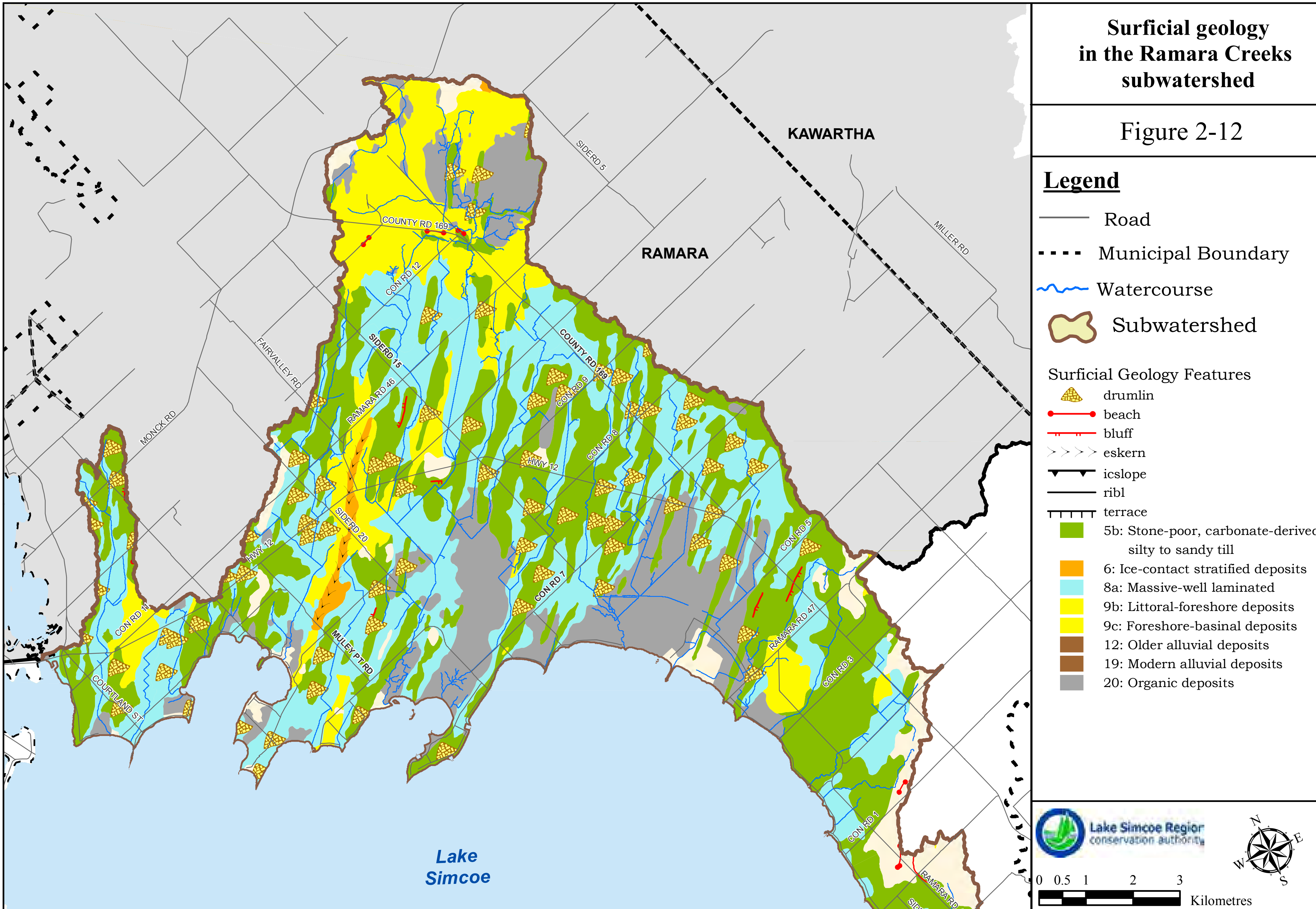
Sediments of recent age mainly in the form of organic deposits also occur in subwatershed, predominantly along the shoreline of Lake Simcoe . These recent sediments tend to overlie the glaciolacustrine till and clay deposits that are prominent across the subwatershed.

*Quaternary Sediment Thickness*

Within the subwatersheds, the Quaternary sediment thickness is the difference between the ground surface and the bedrock surface, as determined from borehole and water well information within the subwatershed. Figure 2-13 shows that the overburden thickness across the study area is relatively thin, ranging from 0 to 25 m. Overall, Quaternary sediment layers are thinner in areas of Newmarket Till, and slightly thicker across areas of organic and glaciolacustrine silt and clay deposits.

# Surficial geology in the Ramara Creeks subwatershed

## Figure 2-12



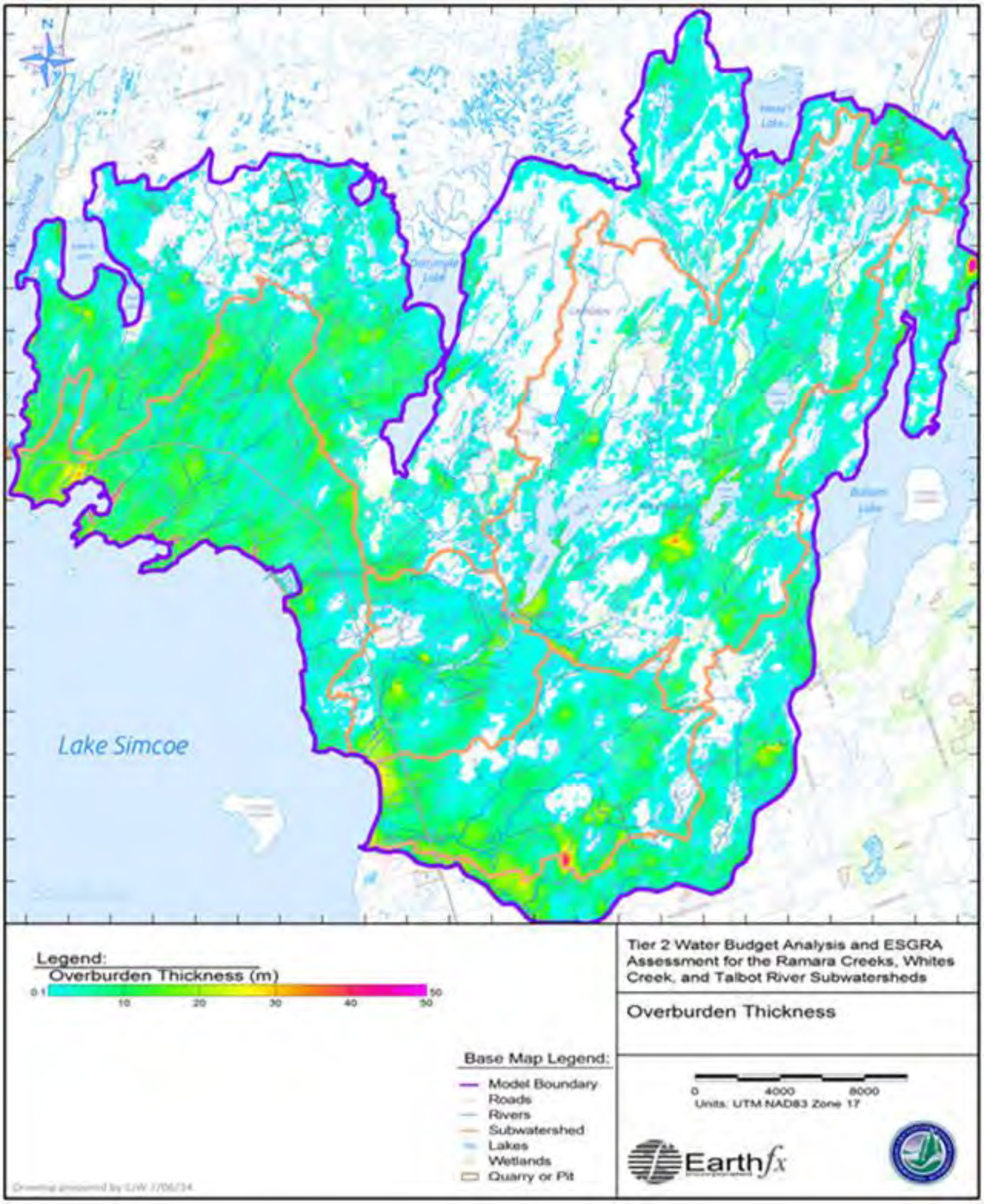



**Figure 2-13: Overburden thickness (in metres) (Earthfx, 2014).**

#### 2.4.1.4 Hydrostratigraphy

The geology of the subwatersheds significantly influences the local hydrogeology, which is how the groundwater moves within the soil and rocks. Hydrogeologists study the geologic formations to understand how much water infiltrates into the subsurface, where it flows, how quickly it flows, and where it re-enters the surface water system. Changes in groundwater quantity and quality have potential impacts on natural functions that could affect the surface water flow regime, aquatic ecosystems, and use of the resource as a viable water supply.

Hydrostratigraphy is the spatial mapping of geologic formations based on their water-bearing properties. The hydrostratigraphy of the surficial deposits within the subwatersheds is complex as a result of the glacial history. The hydrostratigraphic model for the Ramara Creeks subwatershed was derived using the stratigraphic mapping completed by the Ontario Geological Survey (Armstrong and Dodge, 2007), and (Armstrong, 2000).

Stratigraphic geology provides a framework for delineating the aquifer and aquitard layers for the study area. Figure 2-14 illustrates the generalized conceptual cross section that illustrates the stratigraphy for the Ramara Creeks subwatershed, while Figure 2-15 illustrates the location across which the cross section was developed. The conceptual hydrostratigraphic model developed by Earthfx (2014) is closely related to the stratigraphic model simply because stratigraphic units can generally be characterized as either aquifers or aquitards (Earthfx, 2014). An aquifer is an underground saturated permeable geological formation that is capable of transmitting water in sufficient quantities under ordinary hydraulic gradients to serve as a source of groundwater supply. Aquifers in the study area are generally associated with weathered and fractured bedrock and sandy channel sediment units while unweathered bedrock and silty sand till formations are generally associated with aquitards. A description of the interpreted hydrostratigraphic framework is provided below.

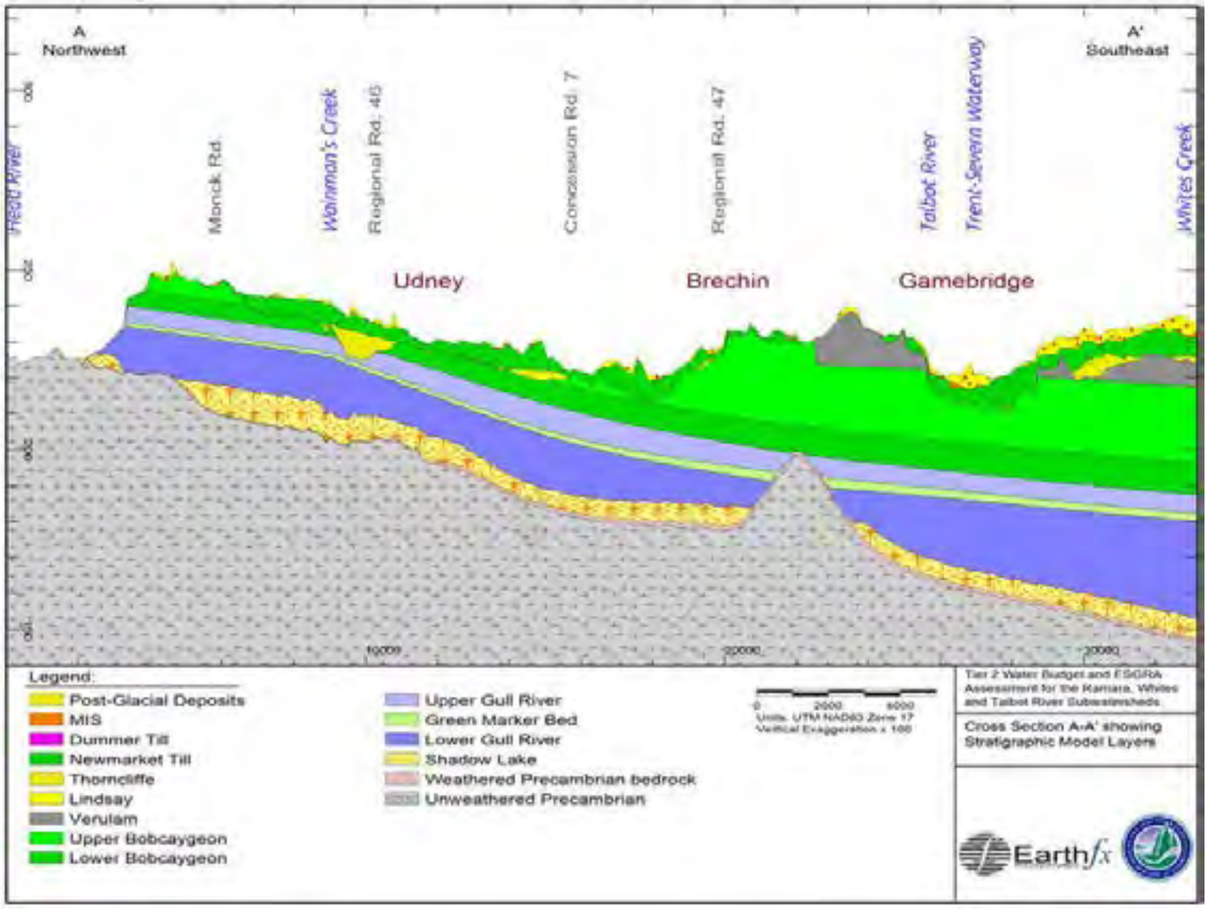



**Figure 2-14 Generalized conceptual stratigraphy of the Ramara Creeks subwatershed from the north-west to the south-east subwatershed boundary (cross section location A –A') (Earthfx, 2014).**

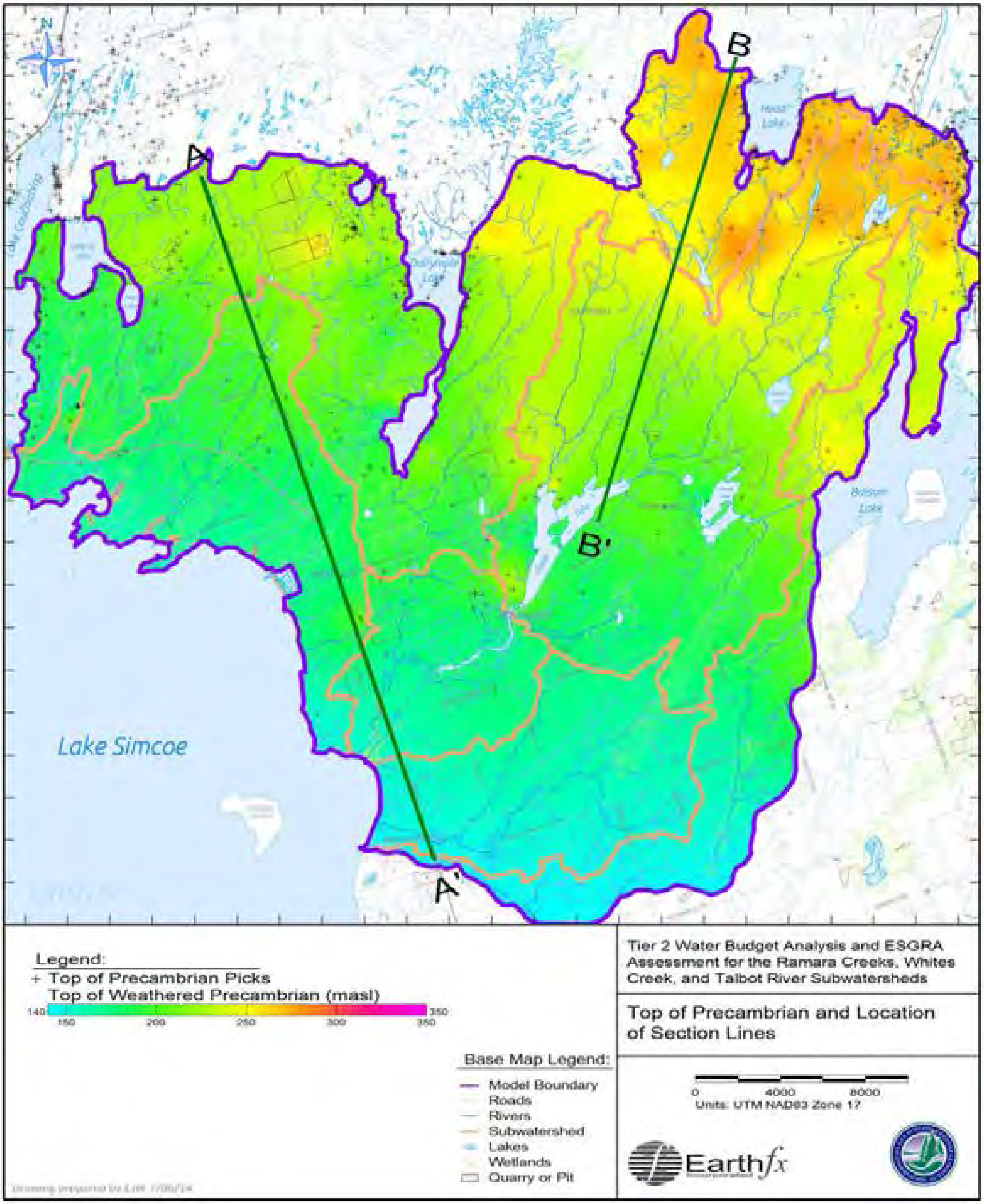



**Figure 2-15: Cross-section locations (Earthfx, 2014) *Note the cross section delineation B-B' is not covered in this subwatershed plan, as it is outside of the Ramara Creeks subwatershed boundary.**

The study area was subdivided into seven hydrostratigraphic conceptual model layers (from youngest to oldest), where each layer was occupied by one or more of the fourteen hydrostratigraphic units identified across the study area . The conceptual hydrostratigraphic model layers are:

1. Surficial Deposits – Mackinaw Interstadial Sediments
2. Surficial Deposits – Newmarket Till
3. Weathered Bedrock Interface Aquifer - Lindsay/Verulam bedrock and tunnel channel sands and gravels.
4. Upper Bedrock Aquitard - Interbedded Limestone and Shale of Verulam and Lindsay Formations / Unweathered limestone of Bobcaygeon Formation and Upper Gull River Formation
5. Green Marker Bed Aquifer
6. Lower Gull River Aquitard
7. Shadow Lake/ Fractured Precambrian Aquifer
8. Precambrian Bedrock (Model Base)

**Surficial Deposits - Mackinaw Interstadial Sediments**

The Mackinaw Interstadial Sediments are characterized by regionally variable glacio-lucustrine and glacio-fluvial overburden deposits found intermittently across the the study area. Generally the material associated with these depositis consists of glaciolacustrine desposits in the subsurface, and glaciofluvial sand and gravel at the surface. Post-glacial deposits such as fine-grained silts and clays interpreted to have originated from post-glacial lakes are also represented in this layer. Where present, the materials in this unit are the shallowest of the overburden units. These fine grained silts and clays are discontinuous across the study area and represent a poor aquitard.

**Surficial Deposits - Newmarket Till**

The Newmarket Till is continuous over the majority of the Ramara Creeks subwatershed and represents a regional aquitard that confines the underlying bedrock aquifers. The unit is characterized by a relatively low hydraulic conductivity that results from the unit's high density sandy silt to silt sand composition (Earthfx, 2014).

**Weathered Bedrock Interface Aquifer**

The composition of the weathered bedrock interface aquifer is dependent on location in the study area. In the southern part of the study area, the aquifer is characterized by weathered bedrock from the Lindsay and Verulam formations, and overburden sand and gravel sediments. The permeable composition of the unit serves as a regional shallow aquifer and is exploited by a number of private wells in the study area (Earthfx, 2014). The overlying sands and gravels of the unit are generally associated with tunnel channel features that formed as a result of high – energy sub-glacial drainage events that worked to erode earlier deposits. As flow waned, and the erosional processes subsided, these tunnel channels were infilled with the glacial sand and gravel sediments represented by Layer 3 in the model. In the northern end of the study area, the Lindsay and Verulam formations are absent and the Bobcaygeon and Gull River formations form the bedrock interface.

**Upper Bedrock Aquitard**

The Upper Bedock Aquitard is composed of the upper member of the Gull River Formation, as well as the overlying Bobcaygeon, Verulam and Lindsay Formations. These units are all considered to represent regional aquitards where they are intact and unweathered (Earthfx, 2014). Although the limestones and shales of the Verulam and Lindsay Formations are geologically distinct from the thickly bedded limestones of the underlying Bobcaygeon and upper Gull River Formations, these units all have similarily low hydraulic conductivity and are generally not exploited by water wells in the area (Earthfx, 2014).

**Green Marker Bed Aquifer**

The Green Marker Bed Aquifer characterizes the zone between the upper and lower members of the Gull River formation. This zone consists of fractured limestones of generally high hydraulic conductivity. The Formation is a productive aquifer for the domestic water supply, despite the Formation's limited thickness of less than 1.5 m.

**Lower Gull River Aquitard**

The composition of the Lower Gull River aquitard varies from fine grained dolostone to limestones high in clay content. The formation's fine grained composition is responsible for the unit's low hydraulic conductivity.

**Shadow Lake/ Fractured Precambrian Aquifer**

The Shadow Lake Formation and weathered Precambrian basement rocks form the final layer of the hydrostratigraphic model. The composition of the Shadow Lake Formation is highly variable but can generally be associated with coarse grained sandstones, while the weathered Precambrian basement rocks are representative of a zone of increased permeability at the Paleozoic- Precambrian contact. This final model overlies the Precambrian base of the model.

**Precambrian Bedrock (Model Base)**

The Precambrian model base is characterized by unweathered Precambrian age bedrock found extensively throughout the model area. This low permeability basement is not explicitly represented in the model.

### 2.4.2 Physiography, Topography and Soils

#### 2.4.2.1 Physiography

Physiography is the study of the physical structure of the surface of the land. A physiographic region is an area with similar geologic structure and climate, and which has a unified geomorphic history. The study of physiography is important from a water resource perspective as the knowledge gained from understanding the land composition aids hydrogeologists and hydrologists in understanding the groundwater and surface water flow systems. The physiography of an area is also important from a land use perspective as the sediments and landforms present at the surface influence the types of activities that are present in the study area, such as agriculture and aggregate extraction.

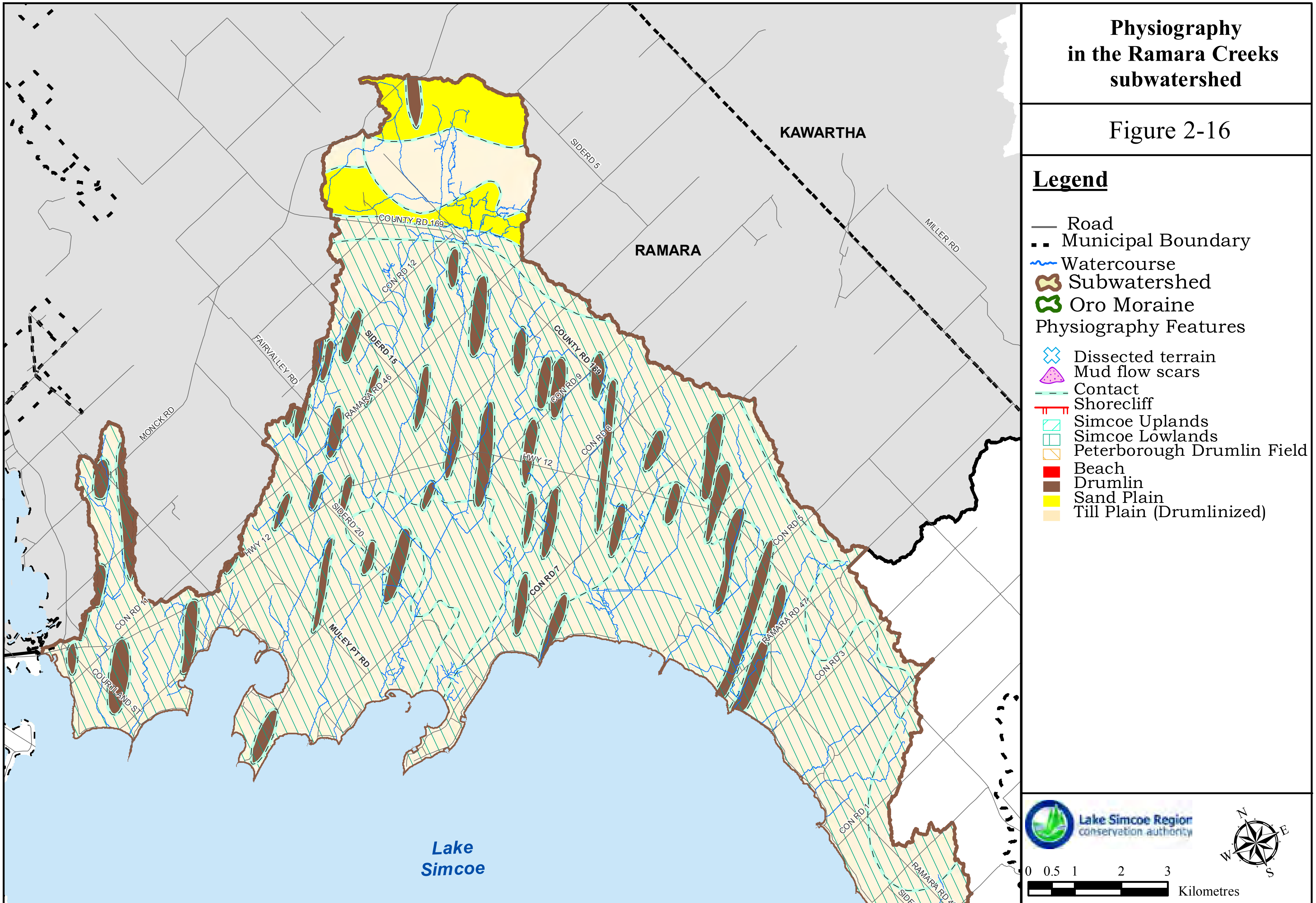
The physiographic regions within the Ramara Creeks subwatershed are a direct result of the deposition and erosion of the quaternary sediments (overburden) during glacial and post-glacial events, and closely correspond to the topography discussed in the following section. According to Chapman and Putnam (1984), the main physiographic region of the subwatershed is the Simcoe Lowlands. (Figure 2-16). The region is described as having lower elevations. The lowlands were flooded by glacial Lake Algonquin and are dominated by lake-deposited sediments, predominantly sand including silt and clay (Chapman and Putnam, 1984). There are also a number of abandoned beaches which developed along the shorelines of post-glacial lakes, in the low lying areas and on the flanks of the uplands (Earthfx, 2014). Tracts of organic deposits are present in the poorly drained areas of the subwatershed and a small moraine ridge known as the Simcoe Moraine strikes southeasterly across the western part of the study area (Earthfx, 2014).

#### 2.4.2.2 Topography

The topography of the subwatershed closely corresponds to its physiographic regions ( Figure 2-17). The topographic relief across the subwatershed is subdued. The lowest elevation is measured at 219 metres above sea level (masl) along the Lake Simcoe shoreline and a maximum elevation of 250 masl occurs around the northern upland portion of the subwatershed. The land rises gently from west to east.

#### 2.4.2.3 Soils

The soils present within a subwatershed influences the type and productivity of the vegetation communities commonly growing within it. Soils also influence the quality and quantity of water entering the ground and running along the surface. Traditionally, soils within the subwatersheds have been characterized based on the coarseness of their texture. Coarse-textured soils (gravel and sand) allow water to infiltrate better than finer-textured soils (clay, silty loam) do. The texture of the soil is important because it directly influences the landscape's ability to generate runoff. For example, during a heavy thunderstorm, rainfall that cannot infiltrate the ground will pool on the surface of an area with finer textured soils. Once enough water has collected it will start flowing overland as a result of gravity and in so doing can erode soil particles, washing them into ditches, streams, and lakes. OGS (2003) surficial geology maps were used to assign soil types found in the study area.  Figure 2-18 depicts the spatial distribution of the soil types present throughout the subwatersheds.

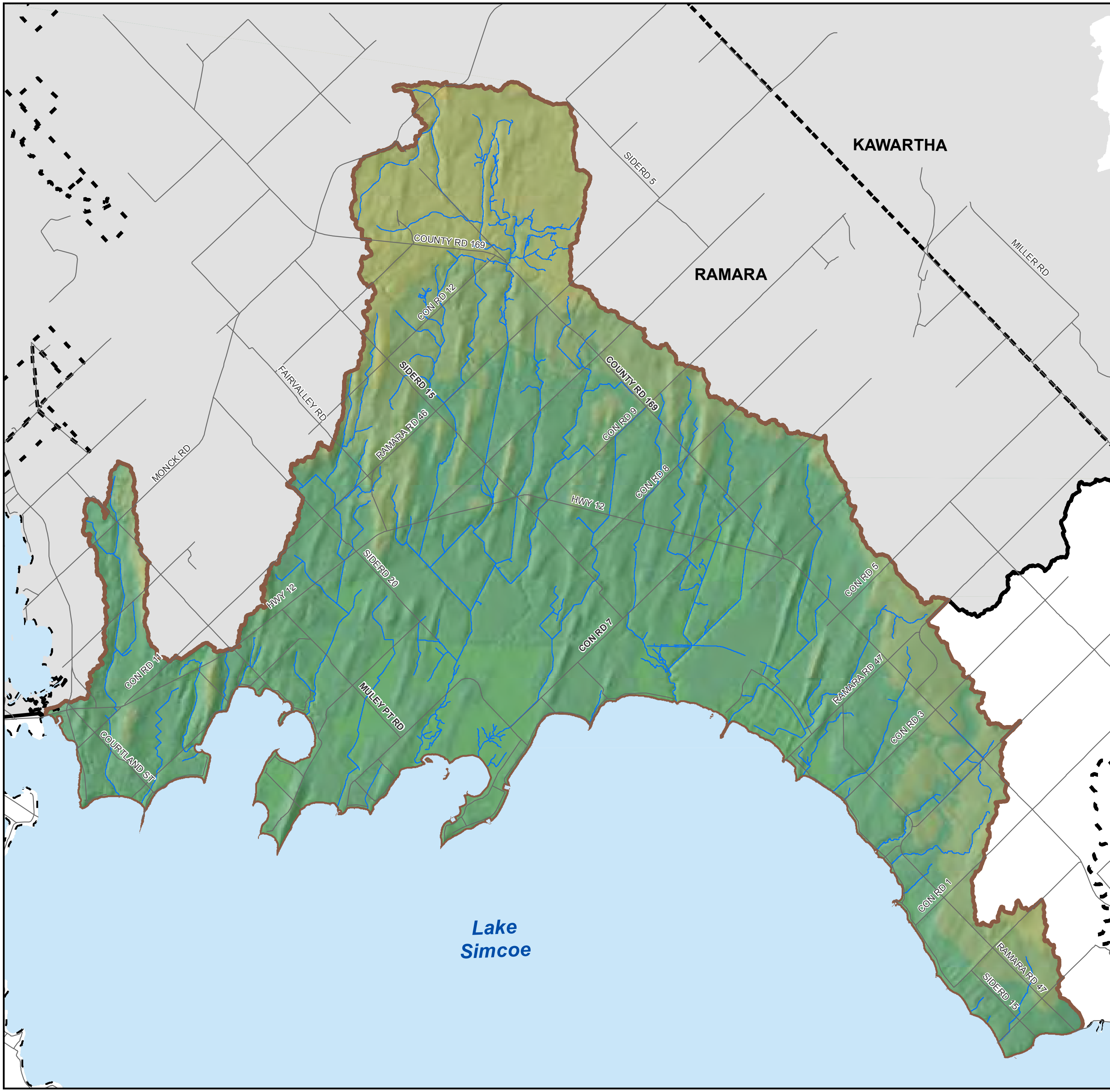



**Physiography in the Ramara Creeks subwatershed**

Figure 2-16

# Ground surface topography in the Ramara Creeks subwatershed

## Figure 2-17




### Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Ground Surface Elevation (m)

| | |
|---|---|
| 100 - 120 | 280 - 290 |
| 120 - 140 | 290 - 300 |
| 140 - 160 | 300 - 310 |
| 160 - 170 | 310 - 320 |
| 170 - 180 | 320 - 330 |
| 180 - 190 | 330 - 340 |
| 190 - 200 | 340 - 360 |
| 200 - 210 | 360 - 380 |
| 210 - 220 | 380 - 400 |
| 220 - 230 | 400 - 420 |
| 230 - 240 | 420 - 440 |
| 240 - 250 | 440 - 460 |
| 250 - 260 | 460 - 480 |
| 260 - 270 | 480 - 500 |
| 270 - 280 | 500 - 520 |
| | 520 - 540 |
| | 540 - 560 |

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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.
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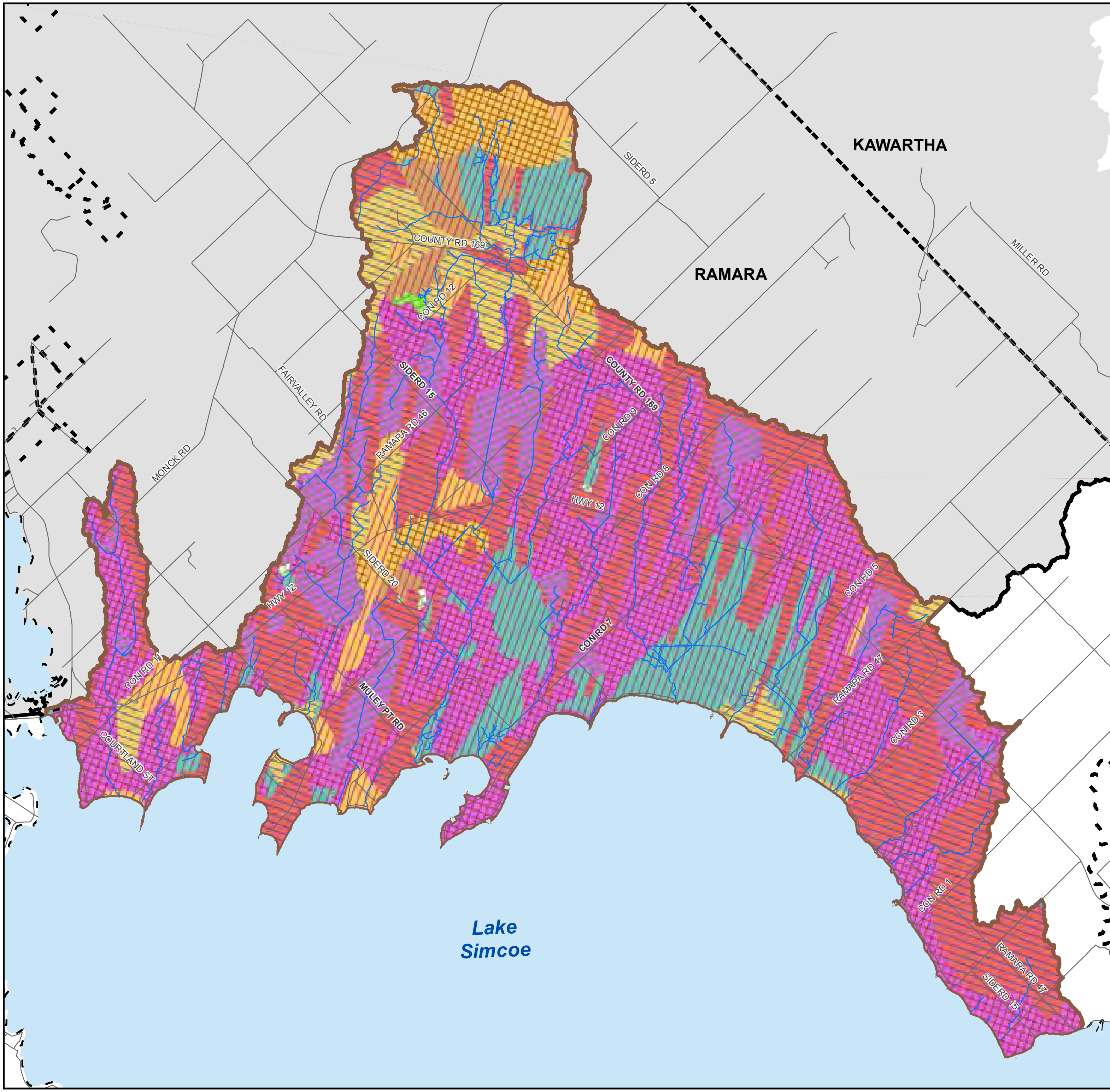
LSRCA GIS Services DRAFT dc created August 2014.

# Soil types in the Ramara Creeks subwatershed

Figure 2-18




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Soil Hydro Class

- A - high infiltration rates
- B - moderate infiltration rates
- C - slow infiltration rates
- D - very slow infiltration rates

Soil Texture Class

- GRAVELLY SANDY LOAM
- SAND
- SANDY LOAM
- LOAM
- LOAMY SAND
- SILTY CLAY LOAM
- CLAY LOAM
- ORGANIC

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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## 2.5 Fluvial Geomorphology

### *2.5.1 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 the 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.

### *2.5.2 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, which in turn are influenced by 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 eroded, 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 are adapted to and depend on the habitats provided by a system in dynamic equilibrium.

### *2.5.3 Current Status*

Specific fluvial geomorphology studies have not been completed for the Ramara Creeks subwatershed, but some relevant information was available through other studies. The information and data provided within this section has been collected by LSRCA staff completing studies on the condition of the fisheries in the subwatersheds. While a fisheries study is specific in nature, it also tends to provide a "snap-shot" of the biological, chemical and physical characteristics of the system. It should also be noted that some sections of the watercourses in the subwatershed have been moved, piped, channelized, eliminated or manipulated in some fashion to varying degrees. While specific data on the exact location and the degree to which a stream has been manipulated is not currently available, it is fair to say that the alteration of the watercourses has changed both the shape and functioning ability of them. Information on the impacts of manipulating watercourses is available in **Chapter 6, Aquatic Natural Heritage**.

#### 2.5.3.1 Strahler Stream Order

Stream order is a measure of the magnitude of a stream within a watershed and allows for the comparison of rivers of different sizes or importance within or between systems (Dunne and Leopold, 1978). A first-order stream is an unbranched tributary that typically drains the headwater portion of the watershed. When two or more first order streams converge, the downstream segment is classified as a second order stream. A third-order stream is the downstream segment of the confluence of two or more second order streams, and so on. As the order of a stream increases, the characteristics of the watercourse typically change. Larger order streams are generally characterized by lesser elevation gradients, slower velocities, and an increased stream area to accommodate the flow from additional tributaries. The stream order of a watershed is determined by the stream order of its outlet.

Table 2-6 below presents the stream order and the total length of the creek within the Ramara Creeks subwatershed.

**Table 2-6: Ramara Creeks subwatershed stream order and stream length.**

| Stream Order | Length of Creek per Order (m) | % of Creek per Order |
|---|---|---|
| $1^{st}$ | 109,633 | 50 |
| $2^{nd}$ | 63,225 | 29 |
| $3^{rd}$ | 31,835 | 15 |
| $4^{th}$ | 12,663 | 6 |
| ***TOTALS*** | 217,356 | ***100*** |

#### 2.5.3.2 Drainage Density

Drainage density is a measure of how well a watershed is drained by its streams and is calculated as the total length of all streams within a watershed divided by the total area of the watershed. Typically, watersheds with high drainage densities are characterized by greater peak flows, high suspended sediments and bed loads, and steep slopes (Dunne and Leopold, 1978). The drainage density of the Ramara Creeks subwatershed is 1.6, just slightly higher than the average for the Lake Simcoe watershed. This relatively low number is consistent with conditions in the subwatershed, which has low relief and characteristically low flows, and has also had flow patterns altered by municipal drains.

**Table 2-7: Ramara Creeks subwatershed stream length, subwatershed area, and drainage density.**

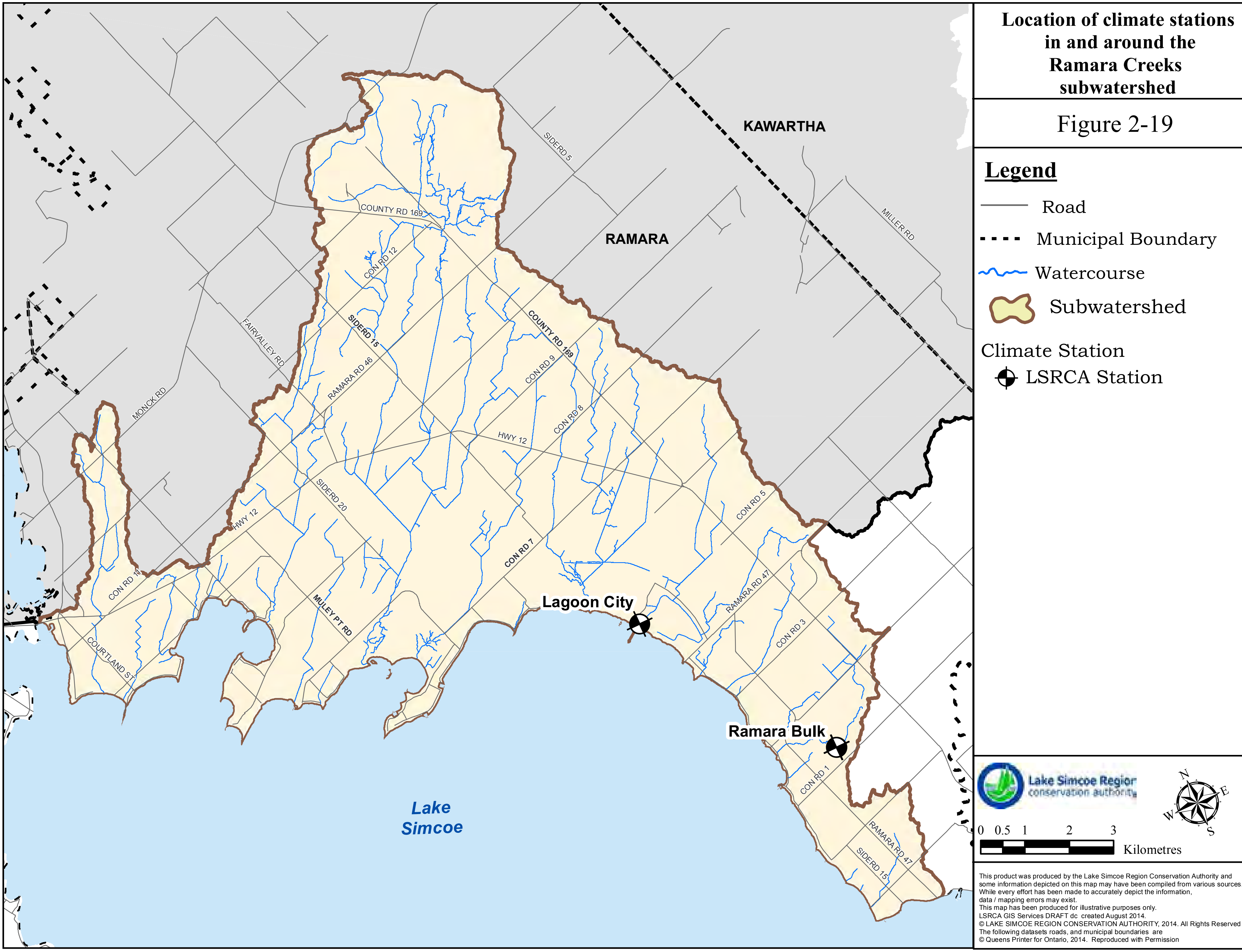
| Creek | Stream Length (km) | Watershed Area ($km^2$) | Drainage Density ($km/km^2$) |
|---|---|---|---|
| Ramara Creeks | 217.4 | 137.1 | 1.6 |
| *Lake Simcoe watershed average | 3672.3 | 2515.9 | 1.5 |

**The Lake Simcoe watershed average includes the subwatersheds of: Beaver River, Black River, East Holland River, Georgina Creeks, Georgina Island, Hawkestone Creek, Hewitts Creek, Innisfil Creeks, Lovers Creek, Maskinonge River, Oro Creeks North, Oro Creek South, Pefferlaw/Uxbridge Brook, Ramara Creeks, West Holland River, and Whites Creek.*

## 2.6 Climate and Climate Change

### *2.6.1 Current climate conditions and trends*

The Ramara Creeks subwatershed falls within the Simcoe and Kawartha Lakes climatic region as defined by Brown *et al*. (1980). The climate within the study area is characterized by moderate winters, warm summers, and long growing seasons with precipitation patterns that are usually reliable. Variations in topography, prevailing winds, and proximity to Lake Simcoe lead to local differences in climate across the study area.




**Location of climate stations in and around the Ramara Creeks subwatershed**

Figure 2-19

### 2.6.2 Temperature

To examine temperature trends for the past 60 years, the daily average air temperature was averaged for each year to produce Figure 2-20 to compare the average annual, average maximum annual, and average minimum annual air temperature. Figure 2-20 gives a general overview of the temperature trends at the Barrie WPCC meteorological monitoring station, illustrating how all appear to fluctuate in relatively the same manner over the years.

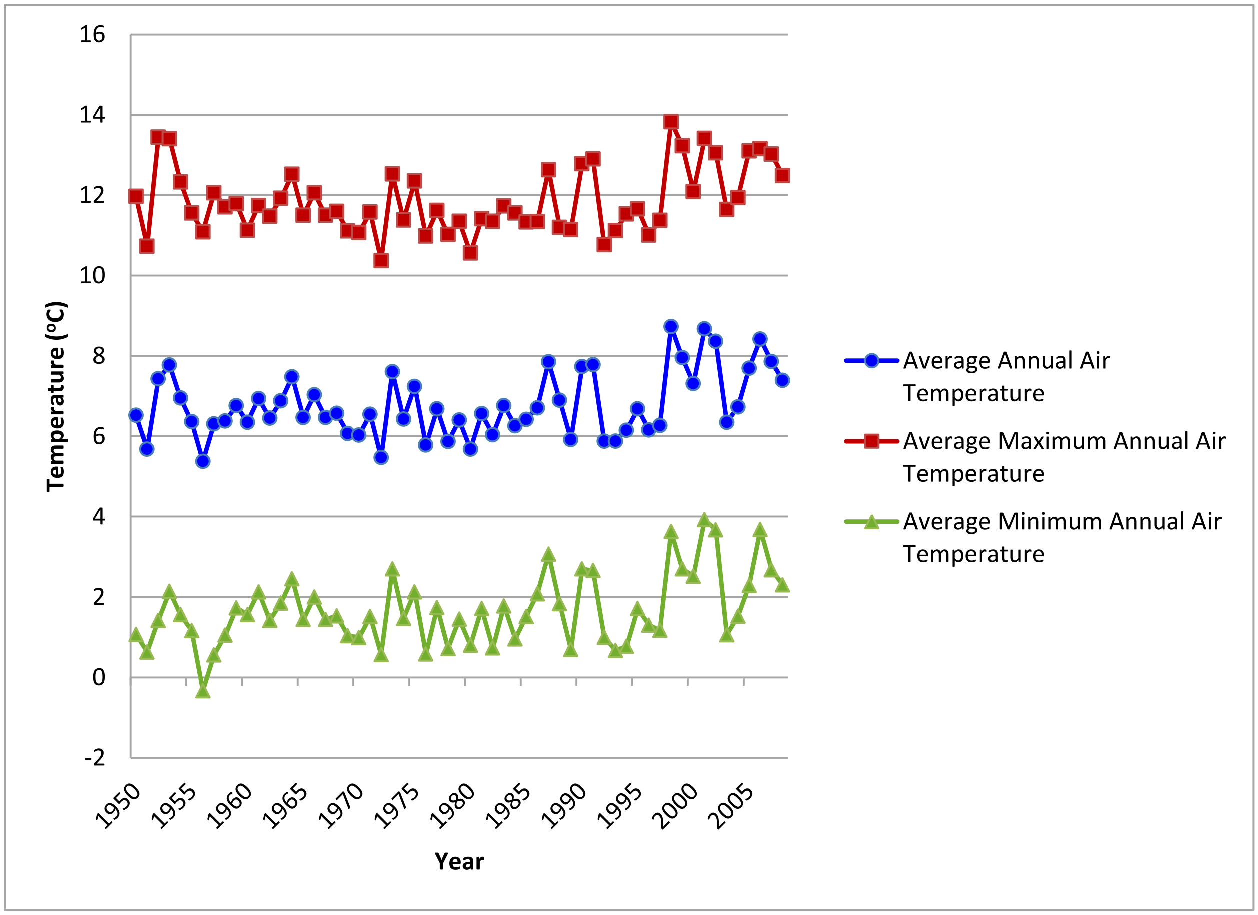



**Figure 2-20: Comparison of the average annual, maximum and minimum temperatures at the Barrie WPCC Meteorological Monitoring Station (1950-2008). Source: SGBLS, 2012.**

Figure 2-21 displays only the average annual temperature, giving a closer look at the trend for the period of record. From it we can see that there is a gradual increase over the entire period, with this trend becoming more pronounced after 1980. There is a slight decrease at the beginning of the period of record from 1950 through the 1960s, followed by a plateau for the next 20 years or so before starting to increase. Overall, there has been an increase of 0.87°C over the past 60 years.

It should be noted that this is only a broad assessment of temperature trends at the Barrie WPCC meteorological monitoring station.

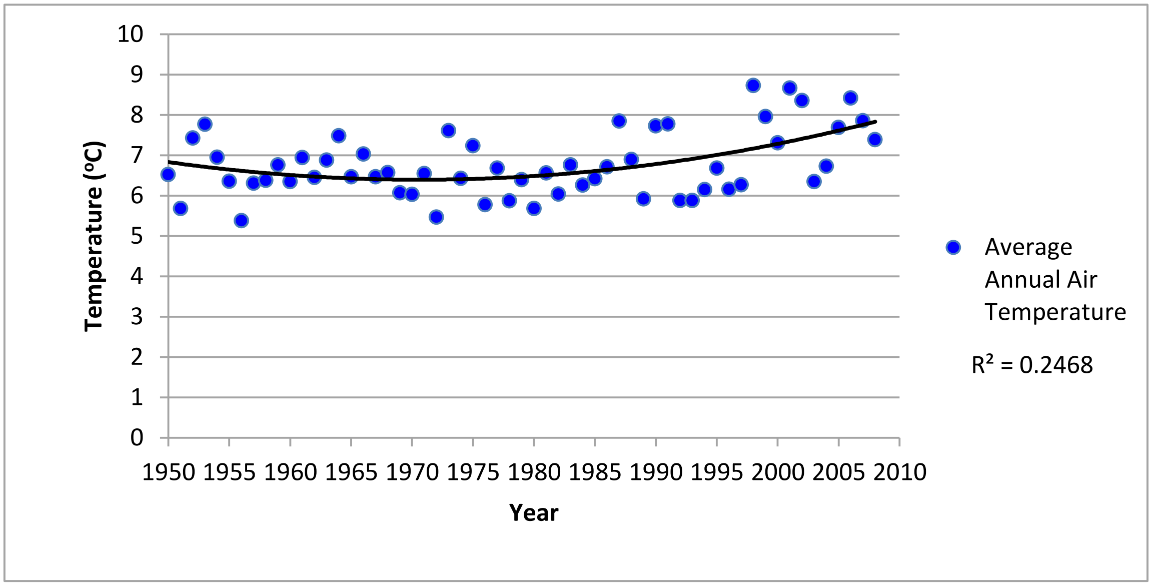



**Figure 2-21: Average annual temperature at the Barrie WPCC Meteorological Monitoring Station (1950-2008). Source: SGBLS, 2012.**

### 2.6.2.1 Precipitation

Precipitation is the driving force of the hydrological cycle, influencing aquatic and wetland habitats, as well as urban stormwater management needs.

Through the completion of water quantity modelling for this plan, Earthfx (2014) assessed data for 22 climate stations found in and around the Ramara Creeks subwatershed, looking at the 55-year period from 1955 to 2010, and found the median annual rainfall varied from 580 mm to 1130 mm (Figure 2-22), although there was a great deal of variation between stations. Seasonally, the winter months have slightly lower average median precipitation (either as rain or snow), with the range for average monthly median precipitation ranging from a low of 60 mm in the late winter, to a high of 80 mm in the late summer/fall (Figure 2-23) (Earthfx, 2014). This information is discussed further in section 4.2.7.

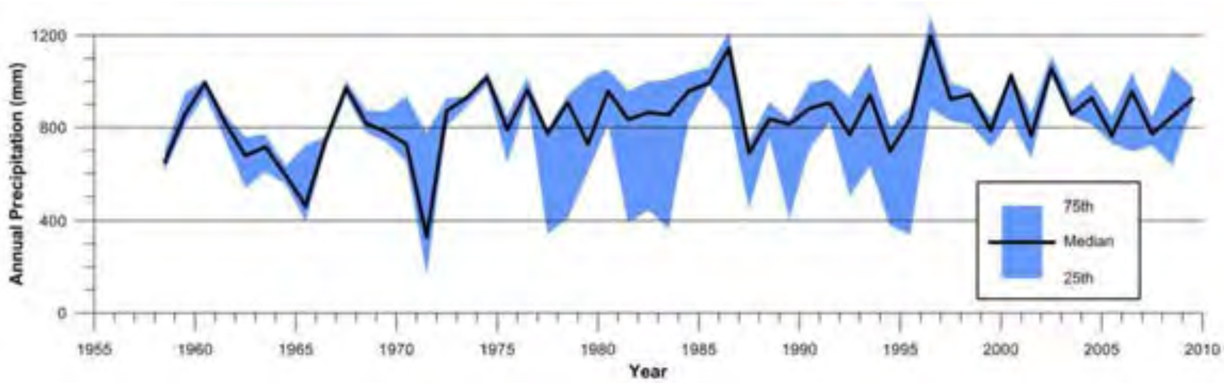



**Figure 2-22: Monthly precipitation quartiles for AES climate stations (1955-2010) (Earthfx, 2014)**

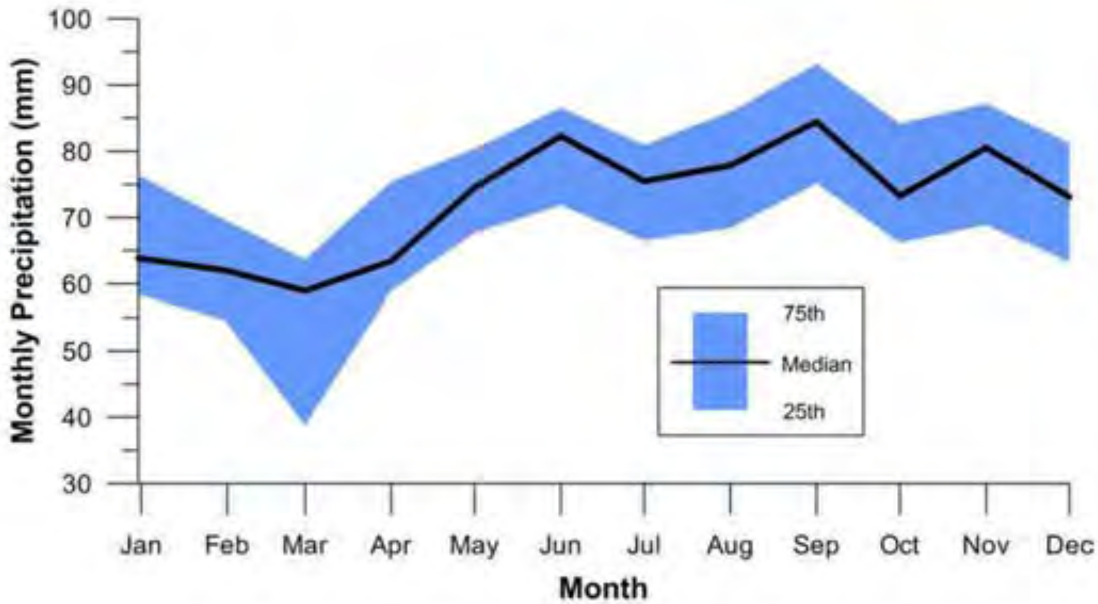



**Figure 2-23: Average monthly precipitation quartiles for AES climate stations (2000-2010) (Earthfx, 2014)**

### 2.6.2.2 Thermal Stability of Lake Simcoe

The thermal stability of the lake is important as it can have significant impacts on biological communities, which in turn can impact the lives of those who rely on the lake as a resource. The thermal stability of the lake refers to the amount of energy needed for a water column to mix completely, overcoming the vertical density differences of thermal stratification. In a system where there is low stability, the lake completely mixes, whereas in a system where there is high stability there is little to no mixing (remains stratified). In Lake Simcoe, which is a dimictic lake, the water column is thermally stratified during the ice-free season, and mixes in the spring and fall. Most winters, it completely freezes over.

To determine if the thermal stability of Lake Simcoe was changing in relation to mean air temperatures (collected at Environment Canada's weather station at Shanty Bay), Stainsby *et al.* (2011) compared the water column stability of the lake at three locations (main basin, Kempenfelt Bay, and Cook's Bay), and the timing of stratification in the spring and turnover in the fall occurred over an approximate 30 year time period (1980-2008). For the purpose of this subwatershed plan, the focus will be on Kempenfelt Bay (and to some extent the main basin) as this is the area most closely connected to the subwatersheds within the study area.

Out of the three sampling areas, Kempenfelt Bay generally has higher thermal stability due to its deeper depths (max 42 m; mean 26 m), whereas Cook's Bay tends to have lower thermal stability because of its shallower depths (max 21 m; mean 8 m) and consequently smaller volume of water that needs to mix or stratify (Stainsby *et al.*, 2011).

The first parameter studied was the temperature of Kempenfelt Bay during the ice-free period of the year. Figure 2-24 illustrates the temperature changes in Kempenfelt Bay from 1980 (a) and 2002 (b) as well as the stability of the lake. From it we can see that in comparison to the 1980 graph, in 2002 there is a high degree of red

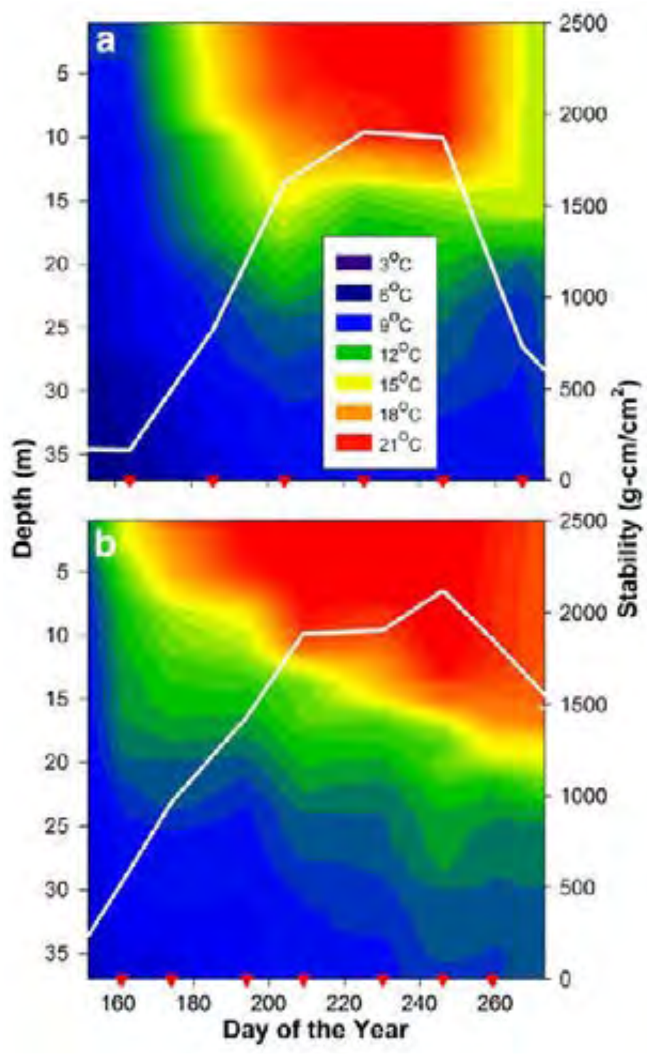



**Figure 2-24: Seasonal water column temperature contour in degrees Celsius) and stability (white line) in Kempenfelt Bay in 1980 (a) and 2002 (b). Red triangles show the sampling dates along the x-axis. Source: Stainsby *et al.*, 2011.**

(warmer temperatures during the ice-free season) and wider contours (the lake begins to stratify earlier in the year and mixes later in the fall, increasing the overall time the lake remains stratified), all of which correspond with the recorded higher lake stability (white line) (Stainsby *et al.*, 2011).

To further support these findings, Figure 2-25 illustrates the timing of the onset of stratification in Kempenfelt Bay (Figure 2-25a) and the main basin (Figure 2-25b). It can be seen from the data that the lake is stratifying earlier in the year. As of 2002, stratification is occurring approximately 20 days earlier in Kempenfelt Bay (Figure 2-25a) than it was in 1980. In the main basin, stratification is occurring approximately 13 days earlier (Figure 2-25b).

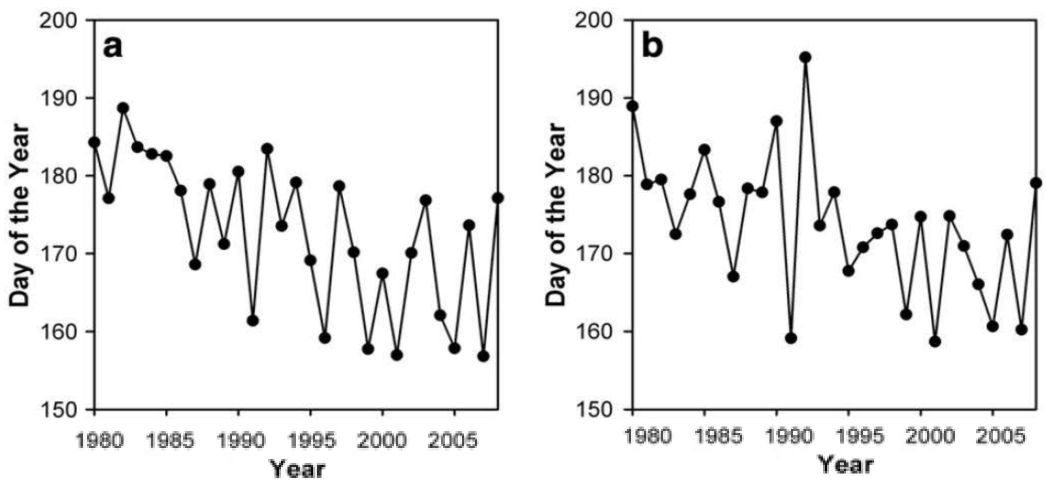



**Figure 2-25: The timing of the onset of stratification in (a) Kempenfelt Bay and (b) the main basin. Source: Stainsby *et al.*, 2011.**

When looking at the fall turnover, Figure 2-26 shows it to be occurring later and later each year. Between 1980 and 2002, mixing of the water column in the fall is occurring approximately 15 days later in Kempenfelt Bay (Figure 2-26a) and approximately 18 days later in the main basin (Figure 2-26b).

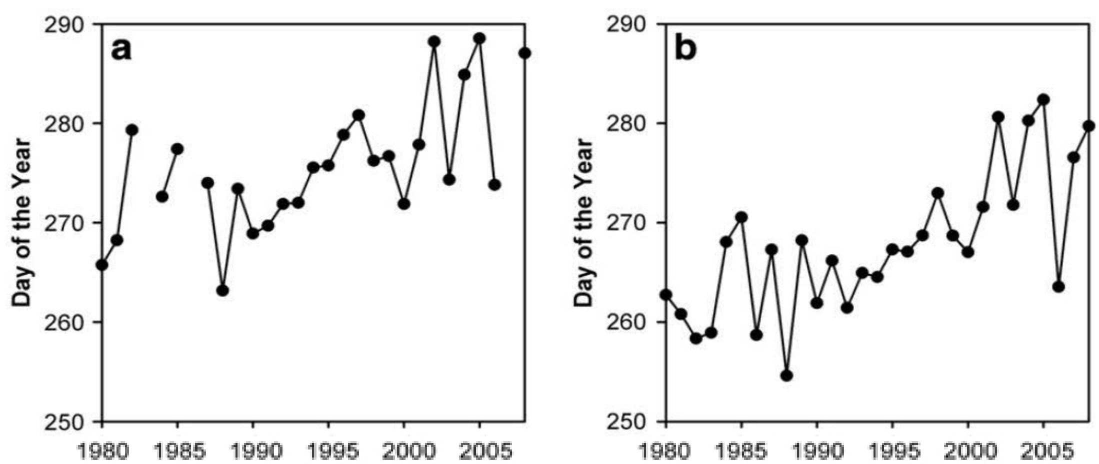



**Figure 2-26: The timing of fall turnover in (a) Kempenfelt Bay and (b) the main basin. Source: Stainsby *et al.*, 2011.**

Together this means that the lake remains stratified for a longer period of time. A longer stratified period can result in an increase in oxygen depletion in the hypolimnion, which in the deeper zones may create "dead zone" areas where conditions are anoxic. These conditions can also potentially increase the release of nutrients (such as phosphorus) and contaminants from sediments. The impacts of this can include large fish die-offs, changes in the fish communities, algal blooms (which, when dead and decomposing at the bottom further decrease oxygen levels) and can deteriorate drinking water (Kling *et al*., 2003). In Kempenfelt Bay and the main basin of Lake Simcoe, the water column remains stratified approximately 33 days longer in 2008 than in 1980 (Figure 2-27a and b).

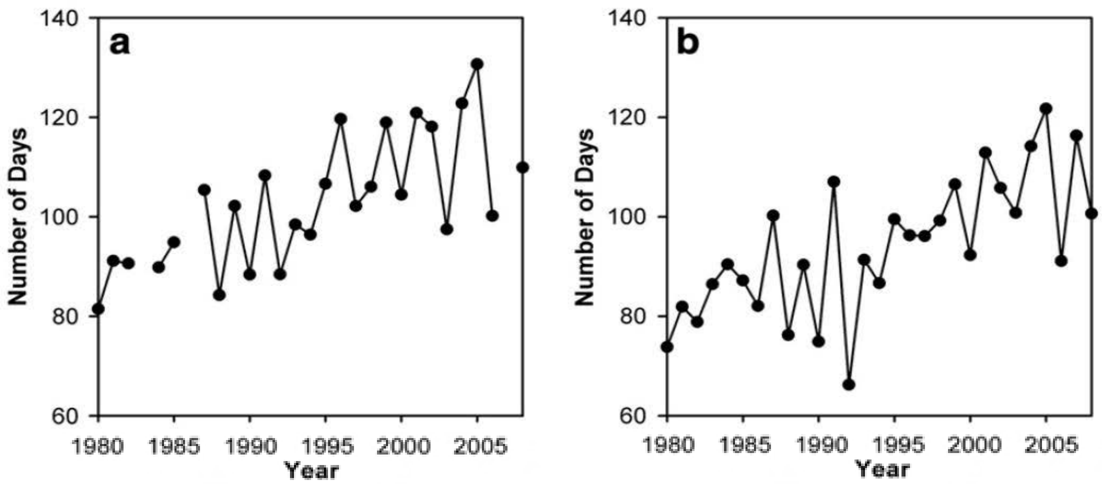



**Figure 2-27: The length of the stratified period in (a) Kempenfelt Bay and (b) the main basin. Source: Stainsby *et al.*, 2011.**

Many of the impacts already being observed in the Lake Simcoe watershed counteracts much of the work the LSRCA and partner municipalities have done to increase dissolved oxygen concentrations and decrease phosphorus levels in Lake Simcoe. To ensure that efforts are successful, despite the impacts of climate change, projects undertaken on tributaries, particularly those that are managed as coldwater, need to focus on reducing the temperature and the amount of phosphorus input. This can include an increase in riparian habitat, improved stormwater management, and improved practices in construction and agricultural activities. Additionally, municipalities are encouraged to include climate change adaptation policies in the Official Plans, to plan for the future and implement pre-emptive measures.

### *2.6.3 Climate change and predicted scenarios*

Climate change can have numerous impacts on ecological systems and those who depend on them. As mentioned in the previous section, an increase in air temperature can increase the thermal stability of the lake, extending the stratified period, as well as changing the composition of biological communities and creating ideal growing conditions for algae and bacteria. An increase in temperature can also cause an increase in evaporation and evapotranspiration, decreasing the amount of water infiltrating into the ground and recharging the groundwater system. Changes in precipitation patterns will also impact the hydrologic cycle, whether these changes show less or more precipitation. Where less precipitation is falling, habitats will experience drought, and be susceptible to fires (terrestrial) and reduction in area (watercourses and wetlands), and less water will be available to replenish aquifers. Where more precipitation falls, it is likely that flows will be altered (potentially changing the stream morphology), stormwater retention areas may overflow (releasing contaminants), and there is an increased risk of flooding and property damage. Further impacts of climate change can be found in the following chapters, where applicable, in the stressors section. An important part of addressing these stressors is to gain an understanding of what the changes will be in the future and act accordingly to minimize the impacts. Climate models, used worldwide, give us an estimate of what these possible changes are.

To obtain more accurate projections for parameters such as seasonal and annual temperature and precipitation, an ensemble of climate models are typically run together. The report "Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan" was released by the Expert Panel on Climate Change in November 2009 (EPCCA, 2009). The study included a review of climate change model projections for Ontario, completed by Environment Canada (CCCSN, 2009). The projections were based on a combination of 24 models and divides Ontario into 63 grid cells, one of which covers the Lake Simcoe watershed. Three scenarios were produced based on future amount of greenhouse gas (GHG) emissions (Low, Medium, and High).

Table 2-8 lists the projected change in average annual and seasonal temperatures, comparing 1961-1990 to the 2050s. From it we can see under high GHG emissions there is a projected increase in temperature of 3° for the area. All seasons are expected to see at least a 2.2° temperature increase; however the most significant increase is seen during the winter, where there is a projected increase of 2.5-3.4° based on Low to High GHG emissions.

**Table 2-8: Summary of projected change in average annual temperature (°C) in the 2050s compared with 1961-1990 (CCCSN, 2009).**

| | **Projected change in air temperature (°C)** | | |
|---|---|---|---|
| | GHG emmision scenario | | |
| **Season** | **Low** | **Medium** | **High** |
| Annual | 2.3 | 2.7 | 3.0 |
| Winter | 2.5 | 3.0 | 3.4 |
| Spring | 2.2 | 2.5 | 2.8 |
| Summer | 2.2 | 2.6 | 2.9 |
| Autumn | 2.3 | 2.6 | 2.8 |

Table 2-9 lists the projected change in average annual and seasonal temperatures, comparing 1961-1990 to the 2050s. Under the high GHG emission scenario, annual precipitation is projected to increase by 5.51%. All seasons are expected to increase by at least 3.06%, with the exception of summer precipitation. As the amount of GHG emissions increase, there is only a slight increase predicted for the Low and Medium emission scenarios, and a decrease in the amount of precipitation of -0.62% under the High GHG emission scenario.

**Table 2-9: Summary of projected change in precipitation (%) in 2050s compared with 1961-1990 (CCCSN, 2009).**

| | Projected change in precipitation (%) | | |
|---|---|---|---|
| | GHG emmision scenario | | |
| **Season** | **Low** | **Medium** | **High** |
| Annual | 5.15 | 5.45 | 5.51 |
| Winter | 9.38 | 10.19 | 10.76 |
| Spring | 8.58 | 9.1 | 9.65 |
| Summer | 0.92 | 0.11 | -0.62 |
| Autumn | 3.06 | 3.79 | 3.82 |

Despite the use of a combination of multiple models, it is important to note that there is still a very high level of uncertainty associated with the projections. As scientists continue to understand the smaller interactions (i.e. what role clouds play in climate change) and are able to integrate them into the models, this uncertainty will decrease.

# 3 Water Quality– Surface and Groundwater

## 3.1 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, including 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 limited 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.

The Lake Simcoe Protection Plan (LSPP) identifies a number of targets and indicators related to water quality in Lake Simcoe and its tributaries, which include:

- Reducing phosphorus loadings to achieve a target for *dissolved oxygen* of 7 mg/L in the lake (long-term goal currently estimated at 44 tonnes per year)
- Reducing pathogen loading to eliminate beach closures
- Reducing contaminants to levels that achieve Provincial Water Quality Objectives or better

For the most part, these targets are established to preserve the health of the Lake, rather than its tributaries. As such, the LSPP has also provided indicators to evaluate progress in achieving the water quality targets that can be evaluated in a subwatershed basis. These include:

- Total phosphorus
    - Concentration
    - Loading
- Pathogens
    - Beach closures
- Other water quality parameters, including:
    - Chlorides
    - Other nutrients (e.g. nitrogen)
    - Total suspended solids
    - Heavy metals
    - Organic chemicals

Where information is available, current conditions and trends are provided for the main water quality indicators, as identified by the LSPP.

## 3.2 Current Status

### *3.2.1 Measuring Groundwater Quality*

Groundwater quality sampling was conducted by LSRCA in 2004, and then annually since 2007 at all 14 Provincial Groundwater Monitoring Network (PGMN) wells located throughout the Lake Simcoe watershed. Each sample was analyzed for 41 chemical parameters including metals, nutrients, and general chemistry. One PGMN well is found in the Ramara Creeks subwatershed (Figure 3-1).

### *3.2.2 Measuring Surface Water Quality and Water Quality Standards*

Surface water quality is currently sampled at one station in the Ramara Creeks subwatershed under the Lake Simcoe Protection Plan (LSPP) (Figure 3-1). Preliminary sampling at this station (located in Ramara Drain #1) started in 2009, and became a regular part of the LSPP sampling program in 2011. Samples collected under the LSPP are analyzed for 12 parameters and are collected year round; every three weeks in the winter months (December to March) and every two weeks from April to November. Samples are analyzed in the Laboratory Services Branch of the Ministry of Environment and Climate Change, and are assessed using the Provincial Water Quality Objectives (PWQO) (Ministry of Environment, 1994). The station is located at a road crossing in a small treed patch, but much of the length of the watercourse upstream of the station is cropland. There is very little riparian vegetation along the watercourse in the vicinity of this station.

As stated by the Ministry of Environment and Climate Change, 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) are 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. Some of the water quality variables of greatest concern for the Ramara Creeks subwatershed are summarized in Table 3-1.

#### 3.2.2.1 <u>Spot check samples</u>

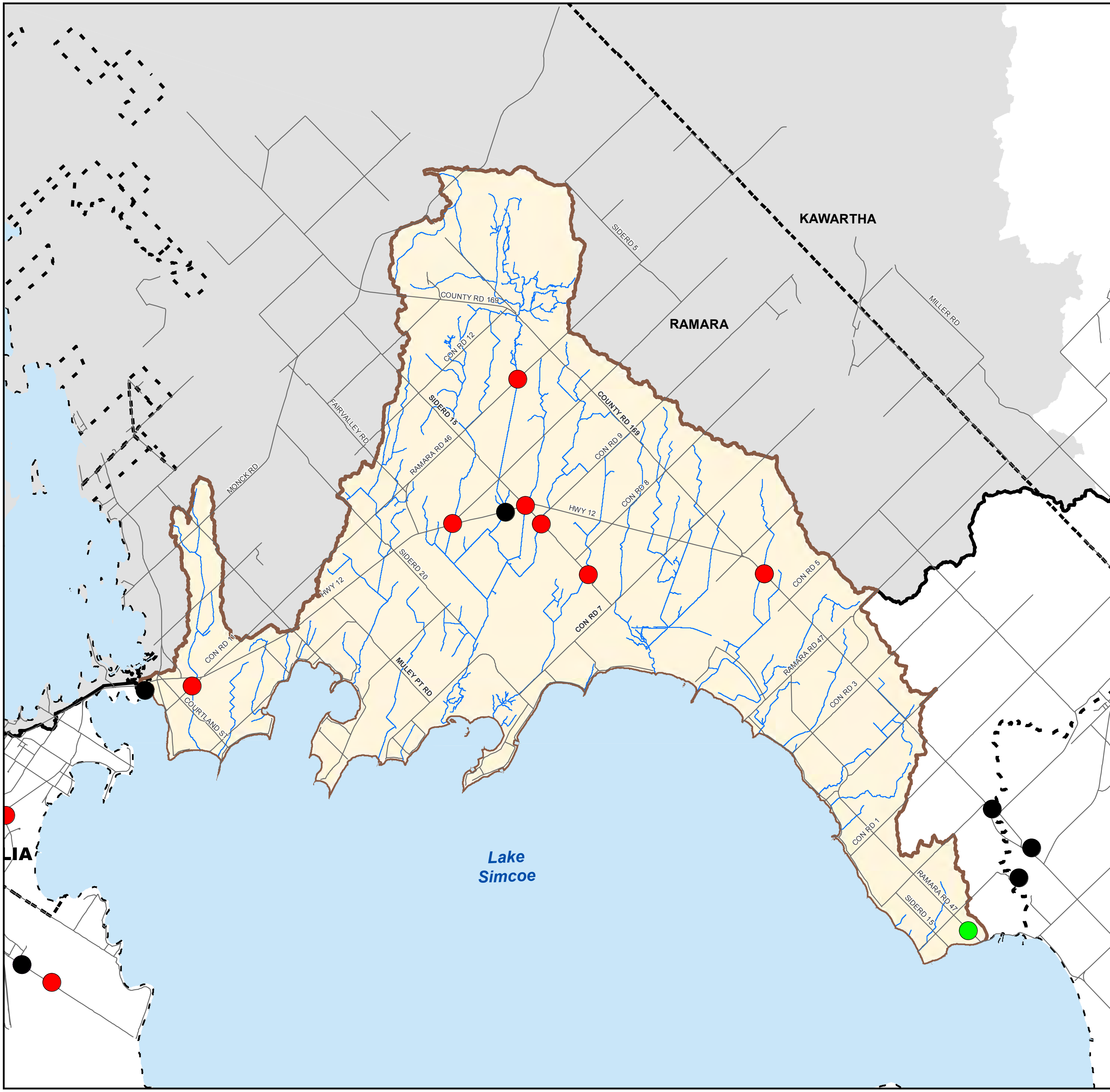
LSRCA also took a series of ‘spot check’ samples at a number of locations throughout the subwatershed to provide a snapshot of the water quality of the tributaries in the area (this was in addition to regularly completed sampling). This included sampling of five sites in 2012; nine sites were actually selected, but only five of the sites were useable. This is because three of the sites were not flowing, which is a regular occurrence in dry conditions in some of the watercourses in the Ramara Creeks subwatershed. Another site had apparent lake effect, with water moving upstream from the lake to the site. Sampling was repeated at the five useable 2012 sites in 2013, as well as an additional two sites (again, an additional two sites were selected in 2013, but there was apparent lake effect at these as well due to high lake levels). At each site two samples were collected, one on a day after a dry period of little to no rain, and another after a wet period of several rain events. These samples were analyzed at Maxxam Analytics, and evaluated against the same objectives as the LSPP samples.

**Table 3-1: A summary of surface water quality variables and their potential effects and sources**

| Variable | Effects | Sources | Objective/Guideline |
|---|---|---|---|
| Total Phosphorus | Phosphorus promotes eutrophication of surface waters by stimulating nuisance algal and aquatic plant growth, which results in restrictions on the recreational use of waterways, and the depletion of oxygen levels as they decompose, resulting in adverse impacts to aquatic fauna. | 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 of 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 originate from areas of soil disturbance, including construction sites and farm fields, lawns, gardens, eroding stream channels, and sand and grit accumulated on roads. | CWQG: 25 mg/L + background (approximately 5 mg/L) for short term (<25 hr) exposures.<br>→30 mg/L<br><br>EPA (1973) and European Inland Fisheries Advisory Commission (1965): no harmful effects on fisheries below 25 mg/L |
| 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 salt applications during the winter months. Other sources include waste water treatment, industry, and potash used for fertilizers. | CCME (draft June 2010): CWQG for protection of freshwater aquatic life is 120 mg/L for chronic (long-term) exposure and the benchmark concentration is 640 mg/L for acute (short-term) exposure. |
| 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:<br>Copper: 5 µg/L<br>Zinc: 20 µg/L<br>Lead: 5 µg/L<br>Iron: 300 µg/L |

## Water quality monitoring sites in the Ramara Creeks subwatershed

Figure 3-1




**Legend**

Road
Municipal Boundary
Watercourse
Subwatershed

Monitoring Stations

Ground Water (PGMN)
Water Quality Stations (PWQMN)
Spot check stations

Lake Simcoe Region conservation authority

0 0.75 1.5 3 4.5 Kilometres

N E S W

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 dc created July 2012.

#### 3.2.2.2 Temperature Collection

The MNRF/DFO protocol, "*A Simple Method to Determine the Thermal Stability of Southern Ontario Trout Streams*" (Stoneman, C.L. and M.L. Jones 1996), Figure 5-1 in **Chapter 5 - Aquatic Natural Heritage** suggests that trout streams are considered to be coldwater if they have an average maximum summer temperature of approximately 14°C. Cool water sites are considered to have average maximum summer temperatures of 18°C. Warm water sites have an average maximum daily water temperature of 23°C.

To monitor these temperatures, electronic data loggers are installed throughout the Lake Simcoe watershed during the hot summer months. They are installed in late May/early June and then retrieved in late September/early October each year. The loggers are used to monitor the daily fluctuations in water temperature of the watercourse over the summer. They are set to take a temperature reading every hour for the entire study period. Periodic checking of the loggers throughout the summer is necessary for quality control purposes. Once the loggers are retrieved in early fall, the data is downloaded and then compared to the air temperature data over the same period of time. Using an Excel spreadsheet, the maximum, minimum, and mean temperatures for each day are graphed. There is some emphasis placed on the daily high temperatures and average maximum temperatures, specifically in cold water stream conditions. The streams can then be classified as cold, cool, or warm (see **Chapter 5 - Aquatic Natural Heritage** for figure displaying temperature of creeks). Daily minimum stream temperatures are used to observe stream recovery from periods of extended warming and the influence of groundwater/baseflow in the individual system.

The LSRCA has been collecting temperature data since 2010 in the Ramara Creeks subwatershed (note: data has been collected to characterize the watercourses, so for some sites this means data has only been collected once, and there is one long-term site). While this has enabled us to classify these streams, 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.

#### 3.2.2.3 Beach Monitoring

Public beaches in the Township of Ramara are monitored every year, from June until the end of August, to ensure that the water is safe for swimmers (in terms of bacteria). Typically, there is a minimum of five sampling sites at each beach that are spread out to be representative of the whole beach area. Samples are normally taken once a week, but additional samples will be taken under certain conditions. Samples are sent to the Provincial Laboratory and analyzed for *E. coli* bacteria (a key indicator of fecal pollution). Other parameters are not tested for unless deemed necessary. Additional data that is recorded at the time of sampling include weather conditions, whether there was rain in the previous two days, wind direction, degree of wave action, number of bathers, number of waterfowl and/or animals in the area, and clarity of the water (Simcoe Muskoka Health Unit, 2011).

### 3.2.3 Groundwater Quality Status

Samples at the PGMN well in the Ramara Creeks subwatershed (Figure 3-1 shows the well location) generally fall within prescribed guidelines. For this analysis we look at two common parameters of concern; chloride and nitrite + nitrate. Concentrations of nitrite + nitrate fall well below guideline values in all samples. Chloride concentrations have been found to be below the Canadian Drinking Water Guideline. Table 3-2 shows a comparison of the average concentration found in the Ramara well with the applicable drinking water guidelines.

Because of the close connection of groundwater to surface water, chloride concentrations are also compared to the guidelines for surface water, which are 120 mg/L for chronic effects, and 640 mg/L for acute effects on aquatic organisms. When compared with these guidelines, 42% of the samples at the Ramara well have shown exceedances of the chronic guideline since sampling began in 2007. These increased chloride concentrations may be due the shallow nature of this monitoring well, combined with its proximity to developed areas and roadways. There does, however, appear to be a decreasing trend in concentrations. This decline could be due to a decrease in the amount of snow, resulting in a reduction in the amount of winter salt being applied. Further sampling is needed to understand the long-term trends and confirm the sources of chloride within the well.

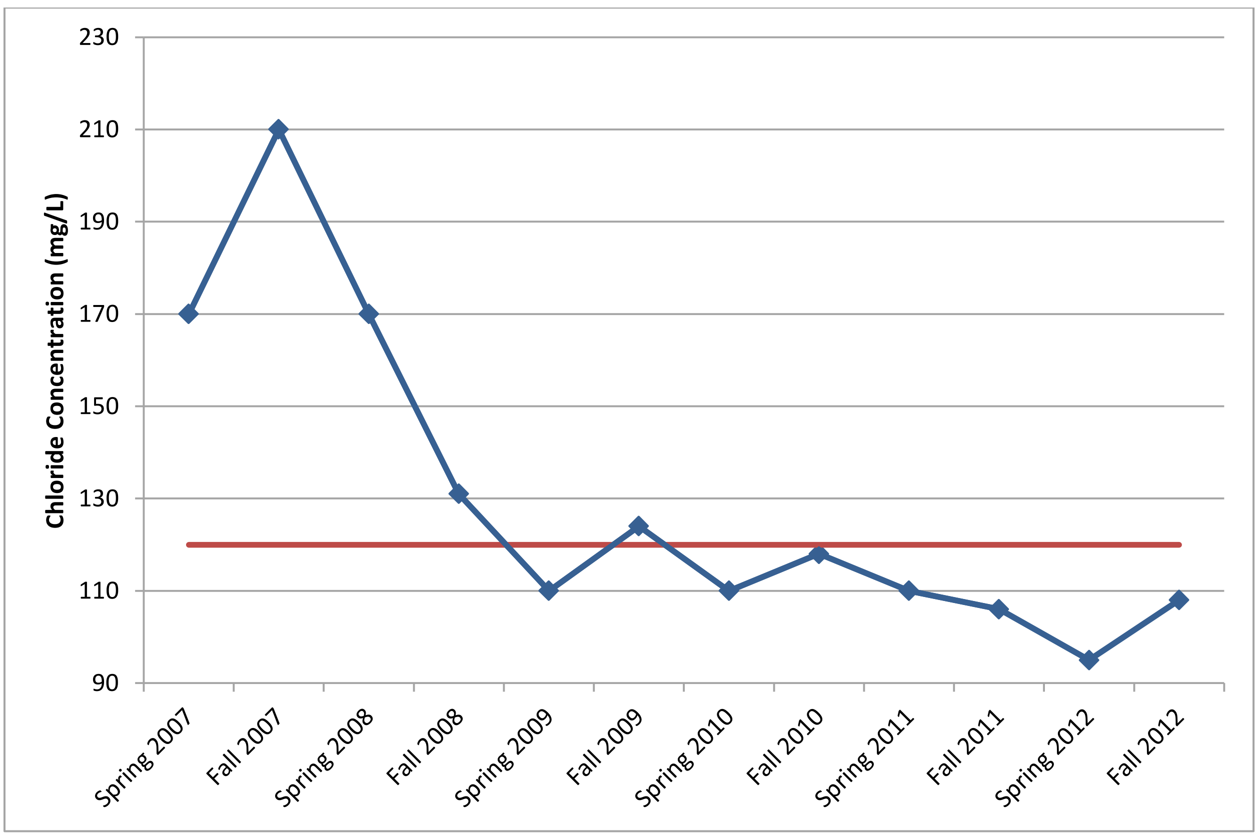



**Figure 3-2: Chloride concentrations at the Ramara PGMN well**

**Table 3-2: Comparison of measured concentrations of chloride and nitrite + nitrate with their respective guidelines at the Provincial Groundwater Monitoring Network station located in the Ramara Creeks subwatershed (2007-2012 data)**

| Parameter | Canadian Drinking Water Guideline (mg/L) | Ramara well (average concentration, mg/L) |
|---|---|---|
| Chloride | 250 | 130 |
| Nitrite + Nitrate | 10 | 0.08 |

Under studies completed for the Source Water Protection program, Wellhead Protection Areas (WHPAs) have been delineated for the Bayshore Village Subdivision and Val Harbour Subdivision Well Supplies. An assessment of potential significant threats was undertaken within each WHPA. For the Bayshore Village Subdivision Well Supply, potential significant drinking water threats are associated with individual sewage systems and the handling and storage of fuel, while the Val Harbour Subdivision Well Supply has potential significant drinking water threats associated with a variety of land uses, including fuel storage and individual sewage systems (SGBLS, 2011).

For more in-depth information on the drinking water systems in these subwatersheds, see the Approved Lake Simcoe and Couchiching – Black River Source Protection Area, Part 1: Lake Simcoe Watershed Assessment Report (SGBLS, 2015). Individual studies completed by consultants on the water quality of the drinking water sources are available in the Assessment Report Appendix R for the Township of Ramara.

### *3.2.4 Surface Water Quality Status*

Surface water quality sampling has only recently been initiated in the Ramara Creeks subwatershed. A new station was installed as part of monitoring works under the Lake Simcoe Protection Plan in 2009. As such, there are no long-term data for this area, and we are not able to examine for trends at this time. The data are, however, compared to water quality guidelines for a number of parameters.

While there is not yet a long period of record for water quality at the Ramara Drain station, water quality sampling has been undertaken throughout the Lake Simcoe watershed since the 1960s, in some subwatersheds. It is worthwhile to look at the data for these stations to understand conditions around the watershed, and how conditions at the Ramara Drain station compare to these. Analysis of Lake Simcoe stations have been completed for the long-term (entire period of record for all stations) and short-term (including data for the period from 2007-2011), and are shown in Table 3-3 and Table 3-4.

**Table 3-3: Historic surface water quality conditions for tributaries in the Lake Simcoe watershed.**

| Monitoring station (period of record) | Historic Conditions (Entire Station Record) Percentage of samples that meet objectives (PWQO or CWQG): Orange = median Concentration ≥objective Green = median Concentration <objective | | | | | | | Historical Trends Analysis (entire station record)+ Yellow = Increasing Grey = no significant trend Blue = Decreasing | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chloride | Phosphorus | Nitrate | TSS | Iron | Zinc | Copper | Chloride | Phosphorus | Nitrate | TSS |
| West Holland River (1965 – 2011) | 97 | 3 | 93 | 82 | 53 | 97 | 85 | Yellow | Blue | Grey | Blue |
| Tannery Creek (1965 – 2011) | 61 | 9 | 85 | 52 | 36 | 77 | 73 | Grey | Blue | Blue | N/D |
| Mt. Albert Creek (1971 – 2011) | 100 | 9 | 100 | 89 | 61 | 99 | 89 | Yellow | Grey | Yellow | N/D |
| Beaver River (1972-2011) | 100 | 63 | 99 | 94 | 91 | 98 | 86 | Yellow | Blue | Grey | Blue |
| Pefferlaw Brook++ (1973-2011) | 100 | 50 | 100 | 97 | 89 | 98 | 85 | Yellow | Blue | Yellow | Blue |
| Lovers Creek (1974-2011) | 87 | 76 | 100 | 90 | 83 | 96 | 83 | Yellow | Yellow | Grey | Grey |
| Schomberg River (1977-2011) | 100 | 7 | 97 | 67 | 38 | 97 | 76 | Yellow | Blue | Blue | Blue |
| Maskinonge River (1985-2011) | 93 | 14 | 100 | 93 | 33 | 93 | 91 | Yellow | Yellow | Yellow | Yellow |
| East Holland River (1993-2011) | 38 | 1 | 100 | 45 | 7 | 90 | 81 | Yellow | Blue | N/D | |
| Black River (1993-2011) | 99 | 39 | 100 | 100 | 69 | 99 | 99 | Yellow | Grey | N/D | |
| Hawkestone Creek (1993-2011) | 100 | 89 | 100 | 96 | 91 | 100 | 99 | Yellow | Grey | N/D | |
| Kettleby Creek (1993-2011) | 100 | 54 | 100 | 80 | N/D | | | Yellow | Blue | N/D | |
| North Schomberg River (1993-2011) | 32 | 25 | 51 | 79 | N/D | | | Grey | Blue | N/D | |
| Talbot River (1993-2011) | 100 | 84 | 100 | 98 | N/D | | | N/D | Blue | N/D | |
| Whites Creek (1994-2011) | 100 | 69 | 98 | 97 | N/D | | | Yellow | Grey | N/D | |
| Uxbridge Brook (2002-2011) | 100 | 29 | 99 | 93 | 76 | 99 | 99 | N/D | | | |
| Objective | 120 mg/L | 0.03 mg/L | 2.9 mg/L | 30 mg/L | 300 µg/L | 20 µg/L | 5 µg/L | | | | |

Note: Monitoring of zinc and copper generally started in the early 1980s. There were no data for metals where stations were monitored under the LSSP program but not PWQMN (Kettleby, North Schomberg, Talbot and Whites).

+Where trends were not listed for TSS or iron for stations with early monitoring (1960s or 1970s), either monitoring for those parameters started after 2000 or there were large gaps in the data (>10 years). For stations monitored starting in 1993, nitrate, TSS and metals were not monitored until after 2000.

++Chloride started in 1993 for Pefferlaw.

**Table 3-4: Current water quality conditions for tributaries in the Lake Simcoe watershed**

| Monitoring Station | Current Conditions (2007 – 2011) Percentage of samples that meet objective (PWQO or CWQG) Orange = median Concentration ≥objective Green = median Concentration < objective | | | | | | | Current Condition Trend Analysis (2002-2011) Yellow = Increasing Grey = no significant trend Blue = Decreasing | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chloride | Phosphorus | Nitrate | TSS | Iron | Zinc | Copper | Chloride | Phosphorus | Nitrate | TSS |
| West Holland River* | 92 | 6 | 96 | 89 | 75 | 100 | 92 | Grey | Grey | Grey | Grey |
| Tannery Creek | 50 | 8 | 100 | 63 | 26 | 95 | 87 | Blue | Yellow | Blue | Yellow |
| Mt. Albert Creek | 100 | 16 | 100 | 79 | 49 | 100 | 95 | Yellow | Yellow | Grey | Grey |
| Beaver River* | 100 | 71 | 99 | 94 | 87 | 97 | 100 | Grey | Grey | Grey | Grey |
| Pefferlaw River* | 100 | 50 | 100 | 96 | 84 | 100 | 97 | Yellow | Yellow | Grey | Grey |
| Lovers Creek* | 61 | 62 | 100 | 85 | 66 | 100 | 97 | Yellow | Yellow | Blue | Grey |
| Schomberg River | 99 | 19 | 99 | 78 | 32 | 100 | 95 | Yellow | Grey | Grey | Grey |
| Maskinonge River** | 91 | 5 | 100 | 92 | 9 | 97 | 82 | Grey | Grey | Grey | Grey |
| East Holland River* | 22 | 2 | 100 | 36 | 3 | 89 | 74 | Grey | Grey | Grey | Grey |
| Black River* | 99 | 34 | 100 | 99 | 66 | 100 | 100 | Yellow | Grey | Grey | Grey |
| Hawkestone Creek* | 100 | 84 | 100 | 96 | 87 | 100 | 97 | Grey | Yellow | Blue | Grey |
| Kettleby Creek[+] | 100 | 66 | 100 | 80 | N/D | | | Yellow | Grey | Grey | N/D |
| North Schomberg River[+] | 34 | 36 | 57 | 79 | N/D | | | Blue | Grey | Grey | N/D |
| Talbot River***[+] | 100 | 90 | 100 | 97 | N/D | | | Blue | Grey | Grey | N/D |
| Whites Creek[+] | 99 | 71 | 98 | 97 | N/D | | | Grey | Grey | Grey | N/D |
| Uxbridge Brook | 100 | 24 | 100 | 89 | 68 | 97 | 97 | Yellow | Yellow | Grey | Yellow |
| Objective | 120 mg/L | 0.03 mg/L | 2.9 mg/L | 30 mg/L | 300 µg/L | 20 µg/L | 5 µg/L | | | | |

* Chloride, phosphorus and nitrate trends for this station are 2000-2011
** All trends for this station are 2003-2011
*** All trends for this station are 2006-2011
+ TSS for this station is 2008-2011

As noted above, surface water quality data for the Ramara Creeks subwatershed has been collected since 2009. While this dataset is not yet long enough to examine for trends, it was compared with water quality guidelines for chloride, phosphorus, nitrate and TSS (Table 3-5). Compared with other recently initiated stations, conditions at the Ramara Drain station are fairly similar; in that phosphorus is the main parameter of concern, with the highest level of guideline exceedances. There are also some exceedances of Total Suspended Solids. The issues that are being seen with chloride concentrations at some stations are not being observed at the Ramara Drain station. These parameters are discussed in more detail in the subsequent sections.

**Table 3-5: Current surface water quality conditions for Ramara Creeks compared to other tributaries where monitoring has more recently started within the Lake Simcoe watershed (2008-2011)**

| Monitoring Station | Current Conditions (2008-2011). Percentage of samples that meet objectives (PWQO or CWQG) Orange = median concentration > objective Green = median concentration < objective | | | |
|---|---|---|---|---|
| | Chloride | Phosphorus | Nitrate | TSS |
| Bluffs Creek | 100 | 88 | 100 | 94 |
| Hawkestone Creek | 100 | 83 | 100 | 96 |
| Hewitts Creek | 90 | 52 | 80 | 87 |
| Hotchkiss Creek | 10 | 55 | 98 | 83 |
| Leonards Creek | 98 | 55 | 100 | 92 |
| Ramara Drain* | 100 | 36 | 100 | 91 |
| Objective | 120 mg/L | 0.03 mg/L | 2.9 mg/L | 30 mg/L |

* Data collection for Ramara Drain started in 2009

#### 3.2.4.1 Phosphorus

As with many Lake Simcoe subwatersheds, phosphorus is considered to be the main parameter of concern in Ramara Creeks. At 0.039 mg/L, the mean phosphorus concentration for the Ramara Drain station is above the PWQO, and close to half of the samples (44%) were in exceedance of the objective. The maximum concentration was 0.39 mg/L, more than 10x the objective. Given the rural location of this station, the most likely sources of this phosphorus are agriculture or faulty septic systems. Because the concentrations in this subwatershed are relatively low in comparison with many other Lake Simcoe subwatersheds, and because water flows are also relatively low, the subwatershed only makes up 2% of the phosphorus load going into Lake Simcoe each year (this is discussed further in the Stressors section of this chapter).

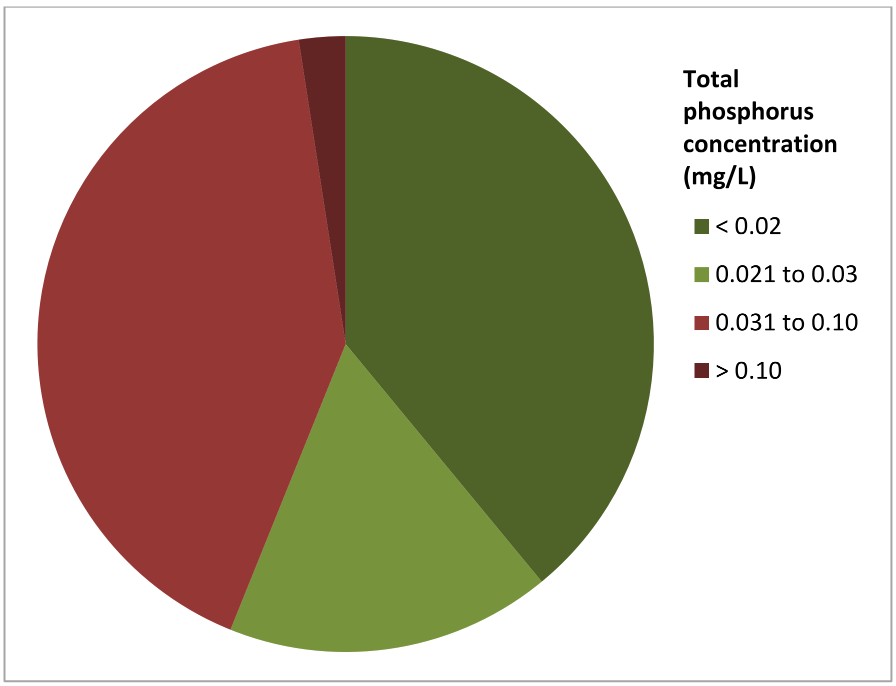



**Figure 3-3: Ramara drain station phosphorus concentrations (2009-2013).**

#### 3.2.4.2 Chloride

The *Canadian Environmental Protection Act* has defined road salts containing chloride as toxic (2001). This was based on research that found that the large amount of road salts being used can 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 and throughout Ontario, including waters that could be considered pristine northern rivers (LSRCA, 2007) as well as in Lake Simcoe itself (Eimers and Winter, 2005).

The concentrations at the Ramara Drain water quality monitoring station did not show any exceedances of guidelines for chloride in the period of record, with a mean value of 10.7 mg/L;

well below both the chronic toxicity (120 mg/L) and acute toxicity (640 mg/L) guidelines. It should be noted, however, that this monitoring station is in a fairly rural area, well shielded from most impacts of urban runoff, which typically has much higher chloride concentrations due to winter salt use. Concentrations at this station are therefore not likely representative of the whole subwatershed, particularly the more developed areas of Brechin and Lagoon City, and along major roadways such as Highway 12. Chloride concentrations in these areas are likely more in line with those seen in other, more urban areas; however additional monitoring needs to be undertaken to confirm this.

#### 3.2.4.3 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 in Table 3-1, TSS can act as a transport mechanism for a variety of other parameters, some in a benign form such as clay-bound aluminum, while others such as phosphorus can cause excessive nutrient loading downstream. Excessive amounts of TSS will also have negative impacts on fish and benthic organisms.

High TSS concentrations would be expected during and following rain events as soil from pervious areas and accumulated grit and dirt from impervious surfaces are washed into streams. Water quality sampling conducted during predominantly dry weather conditions will usually indicate a lower occurrence of TSS exceedances.

The Canadian Council of Ministers of the Environment (CCME) has set an interim guideline for TSS of 30 mg/L (CWQG, 1999). As Figure 3-4 shows, TSS has not been a significant issue at the Ramara Drain station, with an average concentration of 15.4 mg/L,although close to 9% of the samples exceed the guideline.

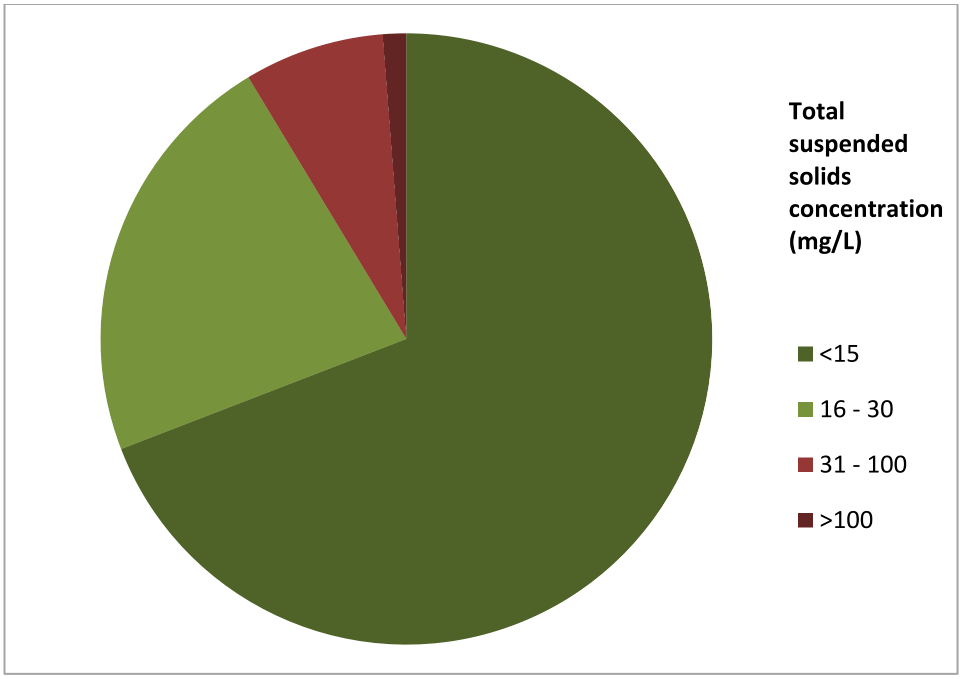



**Figure 3-4: Ramara Drain total suspended solids concentrations 2009-2013 (mg/L). The Canadian Water Quality Guideline is 30 mg/L.**

3.2.4.4 Spot Check Data

Ten samples were taken in 2012, one "wet condition" and one "dry condition" sample at each of the five stations. Of these ten samples, all but two exceeded the Provincial Water Quality Objective for phosphorus (these were at Ramara Sideroad and Concession 9 and at Highway 12 and Sideroad 15). For most stations, the wet condition concentrations were similar to those in dry conditions.

There were 14 samples taken in 2013. High flow phosphorus concentrations exceeded low flow at all stations, with the wet condition sample concentration varying from about two to six times higher than the dry condition sample. Phosphorus concentrations at all stations exceeded the PWQO in the high flow samples, while none exceeded it in the low flow samples. This demonstrates that rain events are likely causing the movement of phosphorus into the watercourses by causing soil to erode (a particular issue where natural riparian vegetation is lacking), and washing fertilizers, manure and pet excrement, and other phosphorus-containing contaminants from lawns, fields, streets and other hard surfaces into area streams.

Samples were also analyzed for chloride, nitrogen, metals, and dissolved organic carbon. The measurement of physical parameters including dissolved oxygen and pH showed normal summer levels. Iron was the only other chemical parameter that was above the PWQO. In 2012, there were five stations with exceedances of the PWQO, with exceedances in both the high and low flow condition at three stations. The station with the highest level was on Ramara Road 46 northwest of County Rd. 169; this was the only station with an exceedance in 2013. The source of this iron is not currently known.

These spot check samples provide a snapshot of the tributaries, but more samples are required to better understand the status of the water quality in the subwatershed.

### 3.2.4.5 Beach Postings

The Simcoe Muskoka Health Unit (SMU) collects samples at each of the beaches in the Township of Ramara to test for *E.coli* levels.

An advisory indicates that bacteria levels in the water are at a concentration that could potentially cause minor skin, eye, ear, nose, and throat infections and stomach disorders. Warning signs are posted at the beach and those who still choose to swim are advised to not put their head under water or swallow the water.

A closure, which rarely occurs, happens when there is a catastrophic event or an immediate risk to health present. Examples that could cause a beach closure include sewage spills or a toxic chemical release.

In the five year period between 2008 and 2012, there were no beach postings or advisories at any of the beaches within the Township of Ramara (SMDHU, 2013).

***Key points – Current Water Quality Status:***

- There are is one Provincial Groundwater Monitoring Well within this subwatershed, and one Provincial Water Quality Monitoring Network station for sampling surface water
- Of the two groundwater drinking systems within the Ramara Creeks subwatershed, the Bayshore Village Subdivision Well Supply have potential significant drinking water threats associated with individual sewage systems and the handling and storage of fuel, while the Val Harbour Subdivision Well Supply had potential significant drinking water threats associated with a variety of land uses.
- There are few issues with surface water quality; the majority of water quality samples collected at the Ramara Drain station meet the relevant water quality objectives.
- The main parameter of concern for surface water is the nutrient phosphorus. Forty-four percent of the samples at this station have exceeded the Provincial Water Quality Objective since sampling began in 2009. The highest concentration recorded at the station was 0.39 mg/L, 13 times the provincial objective.
- Approximately eight percent of the samples exceed the Canadian Water Quality Guidelines for Total Suspended Solids.
- The spot check samples collected in 2012 and 2013 found a number of exceedances of the PWQO for phosphorus. The only other parameter that exceeded relevant guidelines was iron; the source of this iron is not currently known.
- In the five year period between 2008 and 2012, there were no beach postings along the shoreline of the Ramara Creeks subwatershed.

## 3.3 Factors impacting status - stressors

There are numerous factors that can have an effect on the water quality of the ground and surface water within the Ramara Creeks subwatershed. These include:

- Phosphorus,
- Chloride,
- Sediment,
- Thermal degradation,
- Pesticides,
- Metals,
- Bacteria,
- Emerging contaminants,
- Uncontrolled stormwater and impervious surfaces,
- Recreation, and
- Climate change.

These factors, as well as issues associated with the unique area of Lagoon City, are discussed further in the following sections.

### *3.3.1 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, where a chemical reaction causes a chemical in solution to become a solid; and degradation, where a chemical breaks down 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 discharge 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, solvents, phosphorus, and other nutrients. Groundwater contamination becomes an issue where it is discharged to the surface and is used by animals or humans. As mentioned in Section 3.2.3, no contaminants were identified within the Bayshore Village Subdivision or Val Harbour Well Supplies; however possible Significant Threats (as defined in the Clean Water Act) were identified related to septic systems and the handling and storage of fuel, as well as the potential for the application of non-agricultural source material, fertilizer and/or pesticides, and activities related to livestock.

### *3.3.2 Surface Water*

#### 3.3.2.1 Phosphorus

One of the most significant causes of water quality degradation in Lake Simcoe and its tributaries is an excess of phosphorus. Phosphorus promotes the eutrophication of surface waters by stimulating excessive growth of plants and algae. This impairs both the aquatic communities (the decomposition of this extra plant material depletes dissolved oxygen levels, particularly in the deeper parts of the lake where there is critical coldwater species habitat) and recreational opportunities (restricts recreational use of waterways, washes up on beaches, creates a negative aesthetic view along the shoreline, etc.). In the Ramara Creeks subwatershed, these issues are particularly prevalent in communities along waterways, such as in Lagoon City, where the lack of flow tends to exacerbate these issues.

Phosphorus occurs naturally in the environment and is a vital nutrient needed by both plants and animals. However, current land uses have increased the phosphorus loading to Lake Simcoe from an estimated 32 T/yr (prior to settlement and land clearing in the 1800s) to an estimated average load of 86 T/yr for the most recent five-year period (MOE, 2010; O'Connor *et al.*, 2013). Rural and agricultural land uses make up 51.8% of the Ramara Creeks subwatershed. Runoff from pastures and crop land comprises a large proportion of the phosphorus from these areas; another source is the wind erosion of top soil. Urban land use makes up a small proportion (5.4%) of the subwatershed, but contributes to the phosphorus loading through stormwater runoff (discussed further in Section 3.3.2.7).

As discussed above, phosphorus loads have been calculated for the Lake Simcoe watershed by the LSRCA, in partnership with the Ministry of the Environment and Climate Change. This work takes into account water quality data from sampling stations throughout the watershed, flow data, climate information, and atmospheric sources of phosphorus as found through a number of other sampling stations located around the watershed. The sources estimated through this exercise are the tributaries (which measures sources from urban, agricultural, natural, and other areas within the lake's subwatersheds), sewage treatment plants, atmospheric, septic systems (within 100 metres of the Lake Simcoe shoreline), and the watershed's five vegetable polders. The phosphorus load for each subwatershed is displayed in Figure 3-5 below. The Ramara Creeks subwatershed had the eighth highest loading in the subwatershed, at an average of two tonnes per year (O'Connor *et al.*, 2013).

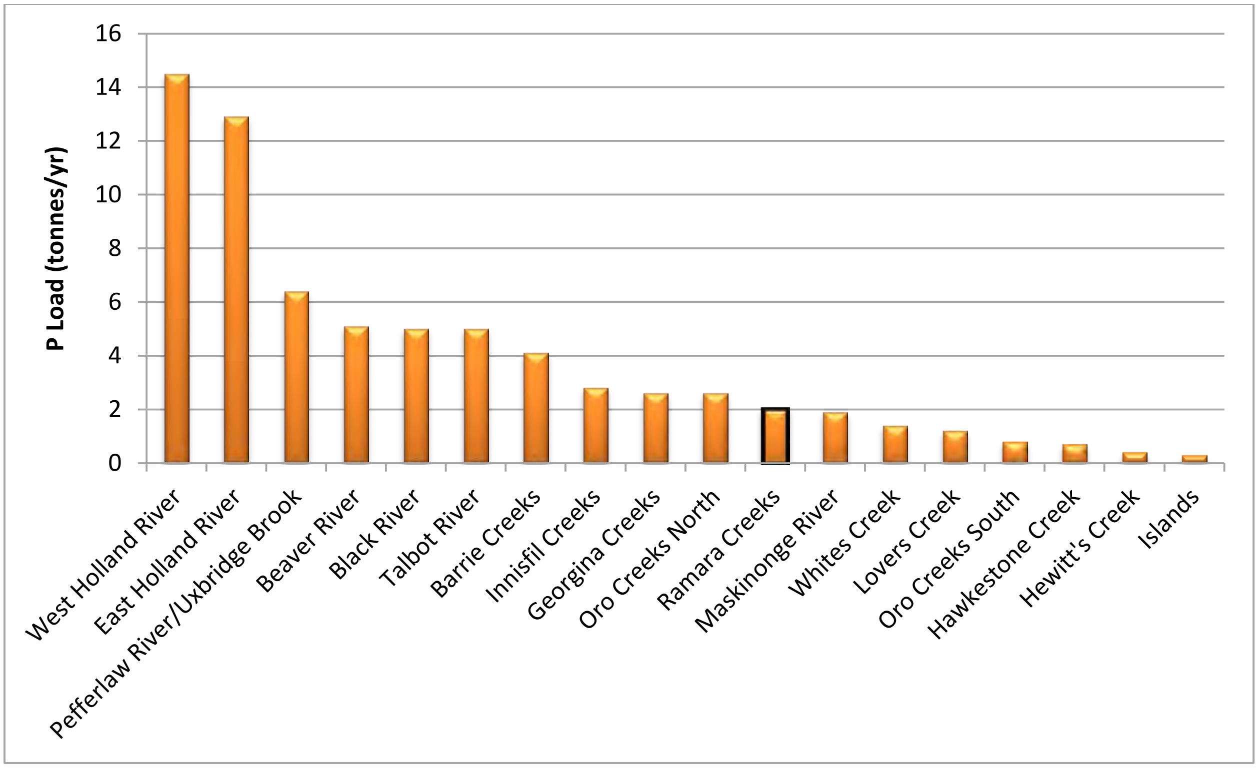



**Figure 3-5: Average phosphorus loads (tonnes/year) contributed by each Lake Simcoe watershed (data: LSRCA/MOECC, 2013)**

Similar work was undertaken using loading estimate models for the *Assimilative Capacity Studies (ACS), 2006*, but have since been updated by the original authors, the Louis Berger Group, in a report completed in September 2010, entitled '*Estimation of the Phosphorus Loadings to Lake Simcoe*'. A watershed model (CANWET) that estimates nutrient loads based on inputs such as land use, precipitation, and soil type was used for both the ACS and the updated study. This type of exercise is useful for anticipating how the phosphorus load in each subwatershed is influenced by land use, and how the loads will change as land use changes. The following table (Table 3-6) presents the average yearly phosphorus loads (as modeled through the 2010 Louis Berger Group report) derived from each source in the subwatershed under current conditions, the approved growth scenario, and the approved growth scenario with implementation of agricultural best management practices (BMPs). Urban BMPs are not considered in this particular study as the model used did not consider them, but the model is currently being updated and future versions of this subwatershed plan will consider the amount of phosphorus that can be reduced through urban BMPs, which, while they do not make up a significant portion of this subwatershed, could help to alleviate some of the water quality issues that have been noted in the canals and along the lakeshore.

According to the model, the primary source of phosphorus in the Ramara Creeks subwatershed under existing conditions is derived from septic systems (45%), shallow groundwater flow (19%), and tile drainage (15%). Under the approved growth scenario, there is a projected increase in total phosphorus loads of 16.5% without the implementation of agricultural BMPs (again, urban BMPs are not considered). The projected phosphorus load under the approved growth scenario can be reduced by 2.3% through the implementation of a number of agricultural BMPs (Table 3-6). Under existing conditions, the model ranks the Ramara Creeks subwatershed as the seventh lowest contributor of total phosphorus to Lake Simcoe (Figure 3-6), and is expected to remain the seventh lowest under the committed growth scenario (Figure 3-7) (Louis Berger Group Inc., 2010). It should be noted that upwards of 100 septic systems have been taken offline through a series upgrades undertaken by the Township; which would help to offset some of the load from this source.

**Table 3-6: Phosphorus loads by source for the Ramara Creeks subwatershed associated with agriculture BMP scenarios (Louis Berger Group Inc., 2010).**

| Source | Existing (kg/year) | Committed Growth Scenario (kg/year) | Difference (Existing to Growth) (%) | Committed Growth with Agricultural BMPs (kg/year) | Difference (Growth to Agricultural BMP) (%) |
|---|---|---|---|---|---|
| Hay/Pasture | 94 | 89 | -5.3% | 87 | -2.2% |
| Crop Land | 81 | 80 | -1.2% | 48 | -40% |
| Turf-Sod | 7 | 4 | -42.9% | 4 | 0 |
| Tile Drainage | 312 | 303 | -2.9% | 303 | 0 |
| Low intensity development | 4 | 4 | 0 | 4 | 0 |
| High intensity development | 75 | 317 | 322.7% | 317 | 0 |
| Septics | 936 | 936 | 0 | 936 | 0 |
| Polder | 0 | 0 | 0 | 0 | 0 |
| Quarry | 0 | 0 | 0 | 0 | 0 |
| Unpaved road | 8 | 8 | 0 | 8 | 0 |
| Transition | 5 | 4 | -20% | 4 | 0 |
| Forest | 7 | 6 | -14.3% | 6 | 0 |
| Wetland | 0 | 0 | 0 | 0 | 0 |
| Stream bank | 96 | 127 | 32.3% | 106 | -16.5% |
| Groundwater (shallow subsurface flow) | 400 | 405 | 1.2% | 405 | 0 |
| Point sources | 41 | 124 | 202.4% | 124 | 0 |
| **TOTAL** | **2,066** | **2,407** | **16.5%** | **2,352** | **-2.3%** |

*- Based on Strategic Direction #3 in the Phosphorus Reduction Strategy, future development should be moving to no net increase in phosphorus. Currently our understanding is that the province is working on a phosphorus reduction tool to ensure this.*

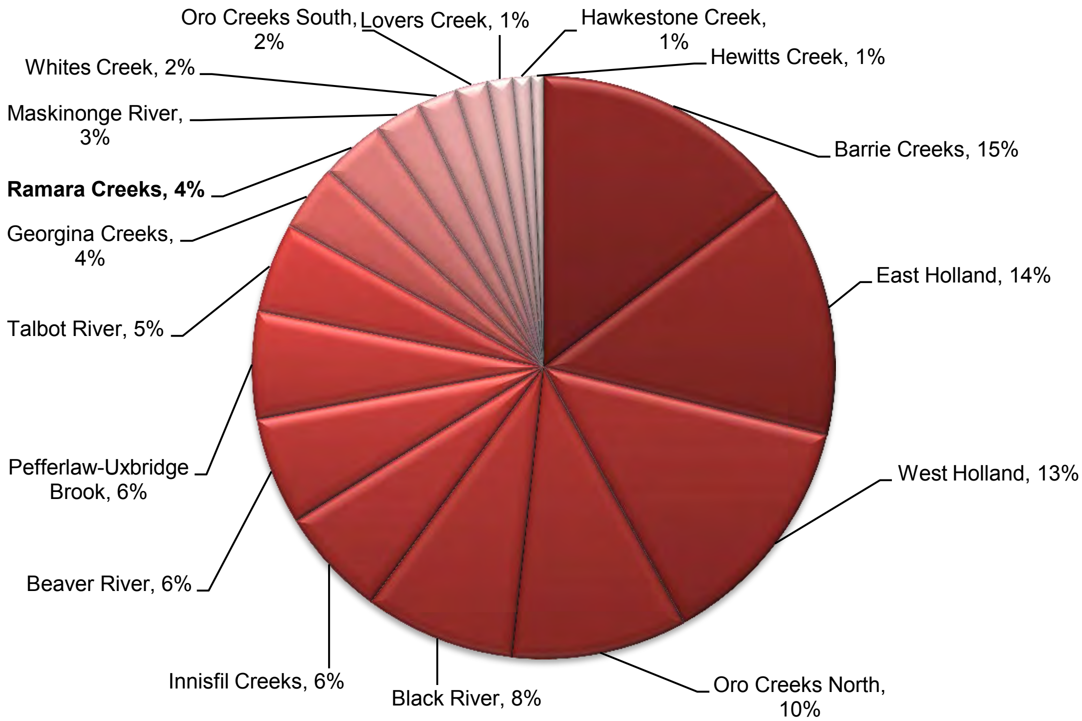



**Figure 3-6: Percent phosphorus loads (modelled) to Lake Simcoe per subwatershed under current conditions (data: Louis Berger Group, 2010).**

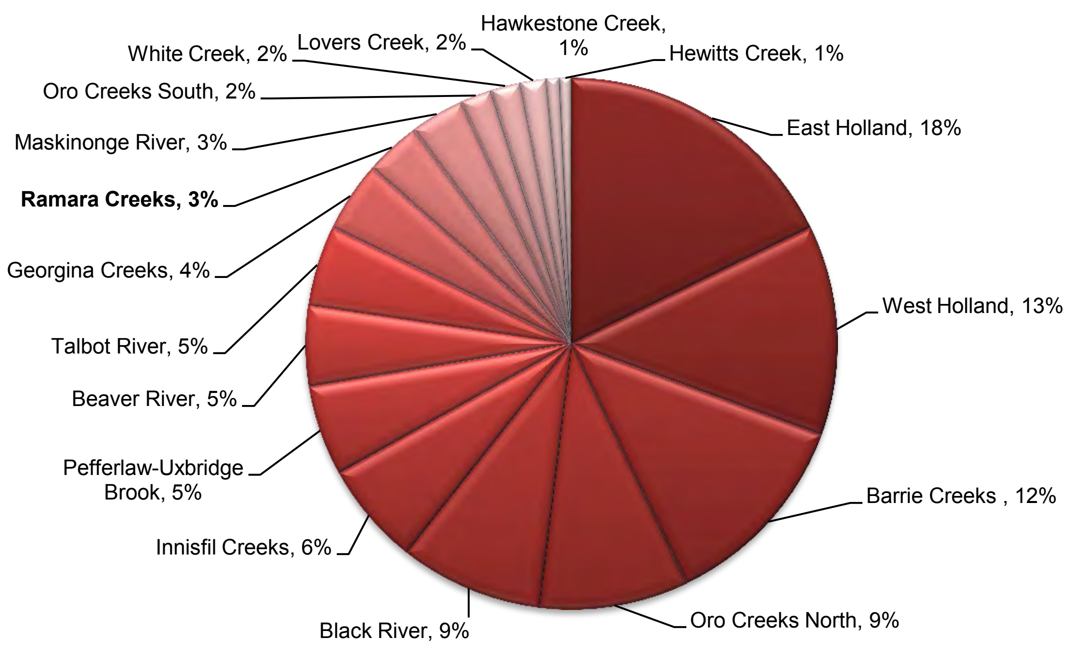



**Figure 3-7: Percent phosphorus loads (modelled) to Lake Simcoe per subwatershed under committed growth scenario (data: Louis Berger Group, 2010).**

Another way to look at the phosphorus loading of each subwatershed is the amount per year per hectare, or export rate. Figure 3-8 illustrates this, using the loads calculated by LSRCA and MOECC (O'Connor *et al.* 2013), showing that although the total phosphorus loads to Lake Simcoe from a number of other subwatersheds are much higher than that of Oro Creeks North (Figure 3-5), it contributes the fifth highest amount of phosphorus per hectare in the entire Lake Simcoe watershed. The Ramara Creeks subwatershed has the 6$^{th}$ lowest loading rate in the Lake Simcoe watershed.

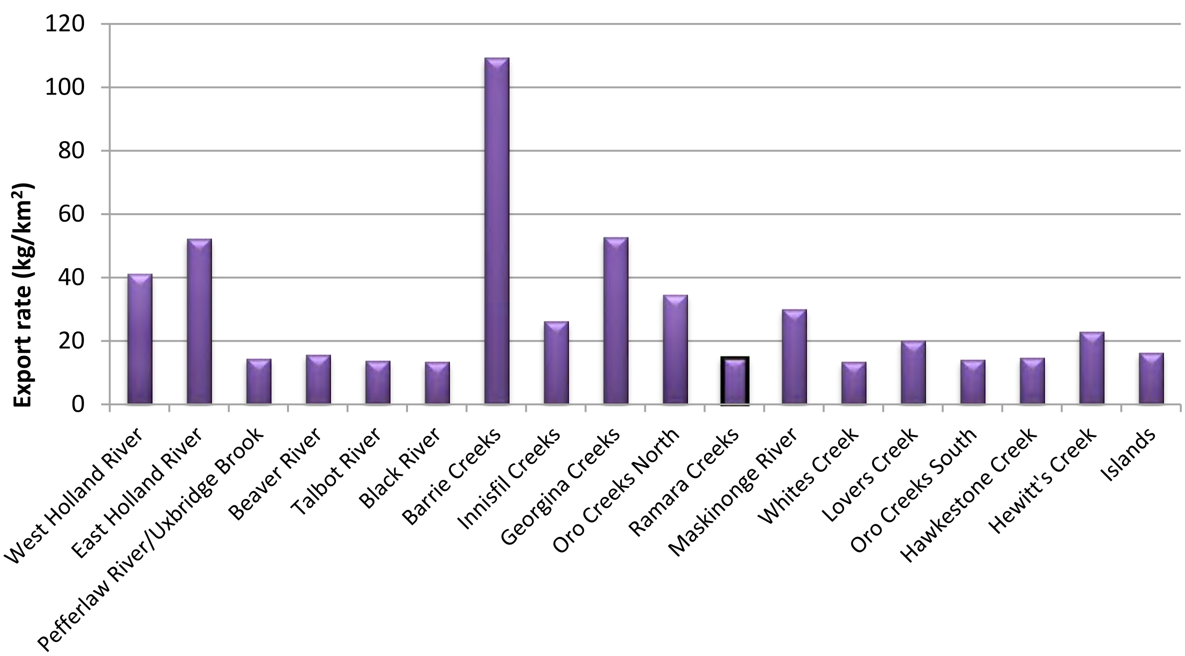



**Figure 3-8: Phosphorus loading (kg/yr) per hectare under current conditions for each Lake Simcoe subwatershed (data: LSRCA/MOECC, 2013).**

### Catchment Level Best Management Practices Analysis

An additional analysis undertaken for the 2010 report by the Louis Berger Group was to split the subwatersheds up further into catchments, each named by the tributaries they contain. The Ramara Creeks subwatershed has 12 catchments, ranging in size from 240.5 ha (Corrigan Drain) to 2,869.9 ha (Drain #1 [3]).

As already mentioned, an overall potential reduction of 2.3% can be achieved through the implementation of agricultural BMPs for the Ramara Creeks subwatershed. However, to achieve the basin wide total phosphorus target of 44 T/year, the CANWET watershed model also produced targets for individual subwatersheds. These were further narrowed down to catchment level targets to give a better idea of priority areas for phosphorus reduction. Figure 3-9 illustrates the total phosphorus loads per catchment, based on the agricultural BMP scenario, while Figure 3-10 illustrates the target total phosphorus loads for each catchment.

The difference between the two figures for the Ramara Creeks subwatershed is a further 74.2% reduction from the agricultural BMP scenario to the required (modelled) target loads.

To prioritize areas for phosphorus reduction, each catchment area was assessed based on the amount of phosphorus that needs to be reduced to reach the target, and the associated unit cost ($/kg). For instance, a catchment which contributes relatively high phosphorus loads, but can be reduced at a lower cost, is a higher priority than a catchment that contributes lower phosphorus loads or has a higher unit cost. The Louis Berger Group (2010) prioritized all the catchments in the Lake Simcoe watershed, splitting them into four Tiers (Tier 1 being the highest priority, Tier 4 the lowest) for each subwatershed. Table 3-7 lists each of the 12 catchments in the Ramara Creeks subwatershed based on this ranking system.

**Table 3-7: Classification of catchments in prioritization tiers (Louis Berger Group Inc., 2010).**

| Subwatersheds | Catchments* | | | |
|---|---|---|---|---|
| | **Tier 1 (highest priority)** | **Tier 2** | **Tier 3** | **Tier 4 (lowest priority)** |
| Ramara Creeks Subwatershed | | | Drain #1 (2) | Corrigan Drain |
| | | | Drain #1 (3) | Ramara Creeks 1 |
| | | | Gettings Drain | Ross/Jackson Drain, Drain #1 (1) |
| | | | Harrington Drain | |
| | | | Mahoney Drain | |
| | | | McNabb/Donnely/Brechin Drain | |
| | | | Murry Drain | |
| | | | O'Connel Drain | |
| | | | Wainmance/Bayshore Creek | |

** Catchments are illustrated in following figures*

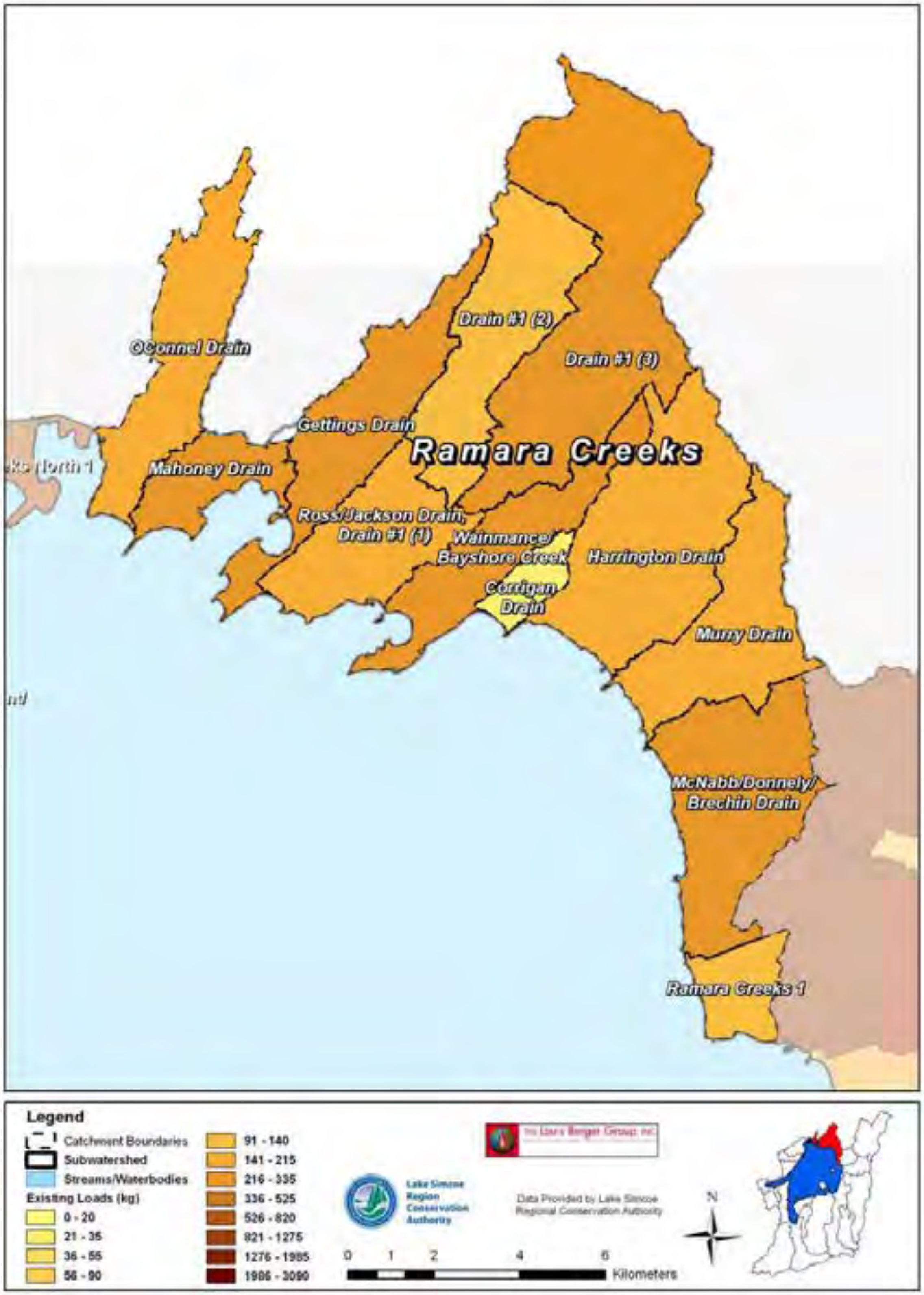



**Figure 3-9: Ramara Creeks subwatershed agricultural BMP scenario total phosphorus loads (Berger, 2010).**


**Figure 3-10: Ramara Creeks subwatershed target total phosphorus loads (Berger, 2010).**

#### 3.3.2.2 Chloride

The main source of chloride, in its various compounds, in the environment is from road salt (Environment Canada, 2001). 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.

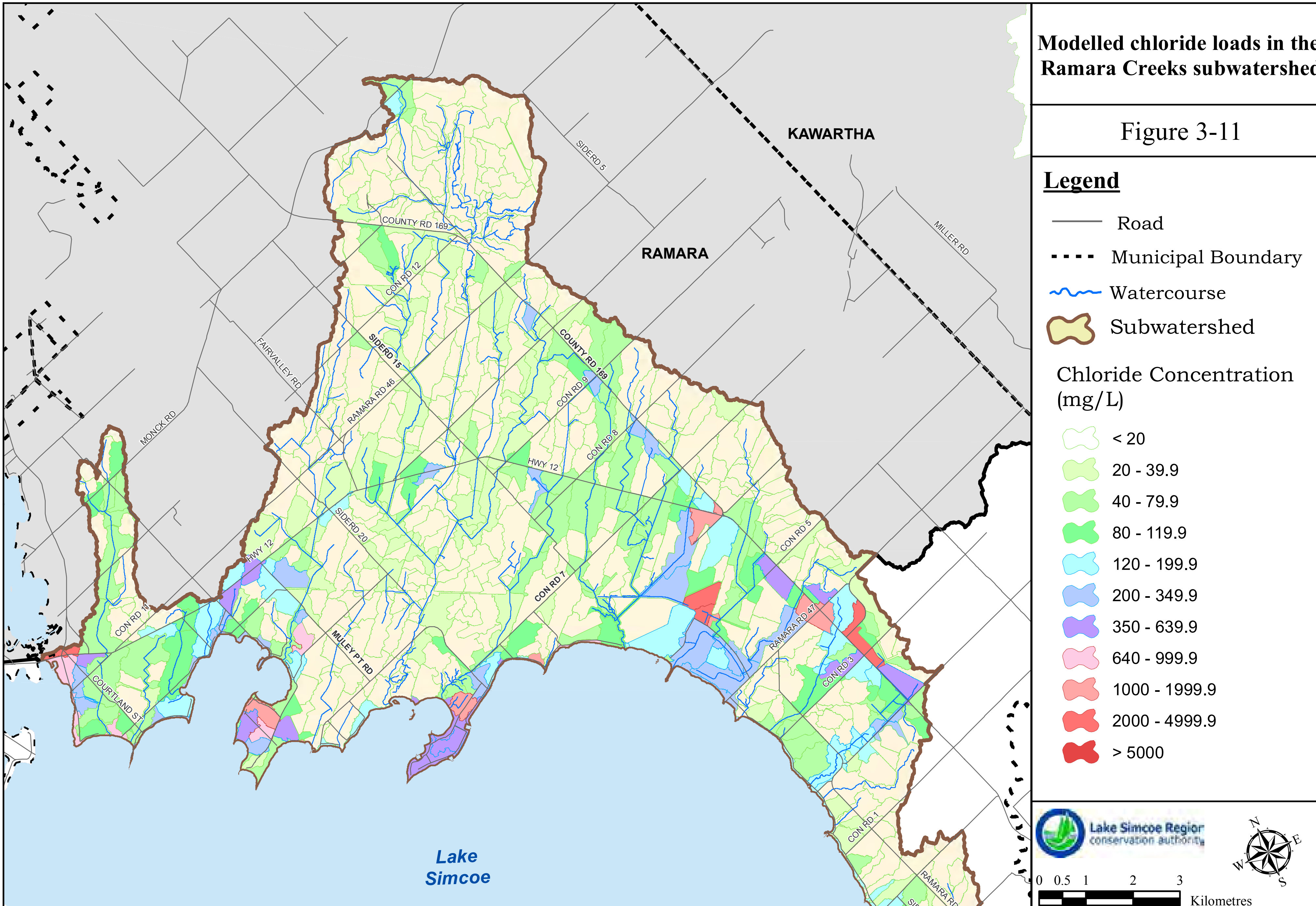
High levels of chloride, such as those found in runoff water draining from roads and salt storage yards, can damage the roots and leaves of aquatic and terrestrial plants, and can also have behavioural and toxicological impacts to animals. Continued exposure to high chloride levels can cause a shift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

As the Ramara Drain water quality station has such a short period of record, it is not yet possible to discern trends. Chloride concentrations fall well below the guideline values at the station, but as discussed earlier, concentrations at this station are not likely representative of the whole watershed, given its location. However; given the trends currently being seen across the Lake Simcoe watershed it is not unreasonable to think that areas of high chloride concentration might be present in the subwatershed. Given that there are some areas of growth planned for the subwatershed, it is likely that concentrations will increase over time unless practices are instituted to prevent chloride from reaching area watercourses and the lake.

Because there is only one monitoring station in the subwatershed, and because chloride concentrations found at that station are unlikely to represent conditions in other areas of the subwatershed, the LSRCA has undertaken a project to model chloride loads for catchments throughout the entire Lake Simcoe watershed, including a breakdown of catchments within the Ramara creeks subwatershed. These predicted annual average chloride concentrations are based on the land use characteristics in a catchment, and the typical salt application rates (information which has been provided by watershed municipalities). Once the chloride concentrations were modelled, it was possible to identify ‘Salt Vulnerable Areas’ (SVAs) throughout the watershed. SVAs are areas where chloride concentrations may be high enough to affect aquatic biota. The potential impacts are based on the results of previous studies testing the toxicity of chloride at various concentrations on a number of aquatic organisms, including invertebrates, amphibians, fish, and algae. These areas were ranked according to the number of species affected; and, not surprisingly, many of them were found in densely developed areas or along major highways and roads. Because it is still a relatively rural municipality, there aren’t many SVAs in the Township of Ramara; those that are present are located mainly within the denser lakeshore communities and along some of the major roads, such as County Road 169. Once SVAs have been identified, it is important that the road and property managers in the area seek to implement practices to limit the amount of salt reaching the watercourses within them.

**Modelled chloride loads in the Ramara Creeks subwatershed**

Figure 3-11

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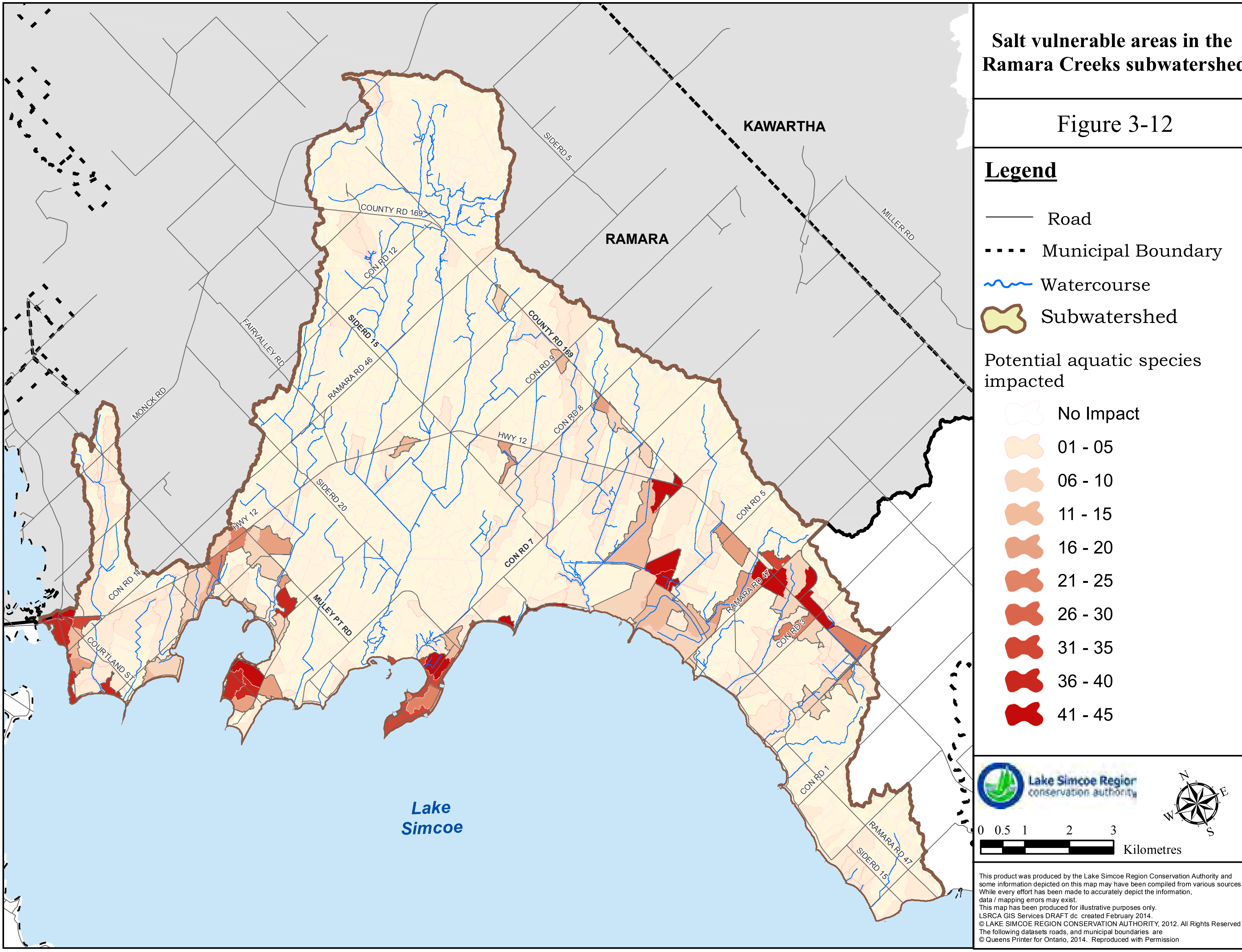
This map has been produced for illustrative purposes only.
LSRCA GIS Services DRAFT dc created February 2014.


Salt vulnerable areas in the Ramara Creeks subwatershed
Figure 3-12
Legend
Road
Municipal Boundary
Watercourse
Subwatershed
Potential aquatic species impacted
No Impact
01 - 05
06 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 - 35
36 - 40
41 - 45
0 0.5 1 2 3
Kilometres
N
E
S
W
KAWARTHA
RAMARA
Lake Simcoe
COUNTY RD 169
CON RD 12
SIDERD 15
RAMARA RD 46
FAIRVALLEY RD
MONCK RD
SIDERD 5
MILLER RD
CON RD 9
CON RD 8
HWY 12
SIDERD 20
CON RD 7
CON RD 5
RAMARA RD 47
CON RD 3
MULEY PT RD
CON RD 11
COURTLAND ST
CON RD 1
SIDERD 15
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#### 3.3.2.3 Sediment

While a certain amount of sediment input is normal in a natural system, in larger amounts it can 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 5 - Aquatic Natural Heritage**.

There are a number of sources of sediment in the Ramara Creeks 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, some farmers may also remove treed windbreaks and 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. Another issue is where livestock have access to streams; their trampling of the banks and stream bottoms can cause significant erosion and contribution of sediment. Restricting access and providing alternative water sources are relatively simple solutions to this issue. For more information on the extent of agriculture and riparian buffers in this subwatershed, see **Chapter 2 - Study Area** and **Chapter 6 - Terrestrial Natural Heritage**, respectively.

*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. For more information on the extent of urban area within this subwatershed, see **Chapter 2 - Study Area**.

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

#### 3.3.2.4 Thermal degradation

Surface water tends to warm when it is detained (e.g. in a pond or by a control structure) or flowing slowly through a watercourse, or when it flows over impervious surfaces. 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.

Similar conditions can occur in municipal drains and lagoons due to the reduced velocity of the flow. The use of practices such as planting vegetation along ponds and watercourses, and the installation of bottom-draw structures in ponds that ensure that the coolest water is being discharged, can help to reduce the heating effect, but ponds and slowly flowing watercourses will still have an impact on the thermal regime of a watercourse. Temperature monitoring in the subwatershed has indicated that the watercourses surveyed are all considered to be 'warmwater' with respect to aquatic habitat (this is discussed in detail in **Chapter 5 – Aquatic Natural Heritage**); however, continued warming without undertaking efforts to reduce temperature will render watercourses in the subwatershed unsuitable for even the most tolerant fish species. The implementation of some of the practices discussed above could improve thermal conditions in some of the subwatershed's streams such that they may be able to support more sensitive 'cool water' species. It will, however, be important to take measures to maintain at the very least the current level of health in this subwatershed.

#### 3.3.2.5 Pesticides

Given the large proportion of agricultural and urban land uses, pesticide use is a concern in the Ramara Creeks subwatershed. While pesticide use 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 surface waters of the subwatersheds. 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 and integrated pest management practices 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, hydrocarbons and heavy metals in the Ramara Creeks subwatershed (Drain #1) in 2004 with the Toxic Pollutant Screening Program. Only surface water samples were collected at Drain #1 (13 other stations around the watershed had sediment samples taken as well). None of the pollutants that were included in the analysis were detected, indicating that these substances, which represent some of the most widespread toxic contaminants found in natural waters, are not an issue in this area of the subwatershed.

#### 3.3.2.6 Metals

Metals are found almost everywhere and are persistent within the environment. While some are naturally occurring, elevated amounts in settled areas are typically associated with agricultural waste, industrial wastes (e.g. metal finishing, tanneries, plastic fabrication), residential sewage, and urban runoff (Adriano, 2001). These elevated levels of metals in the environment can have significant impacts on wildlife communities, as metals can bioaccumulate within organisms, cause chronic toxicity, and adversely affect organisms' behaviour, growth, metabolism, and reproduction (Wright and Welbourne, 2002).

In 2008, Landre *et al*. took sediment samples from Lake Simcoe, at the same 22 locations of an earlier study (Johnson and Nicolls, 1988). Sampling sites were located in the main basin, at the outlet to Lake Couchiching, and in Kempenfelt Bay and Cook's Bay. Each of the samples was tested for 17 metals: aluminum, arsenic, barium, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead, rubidium, antimony, strontium, vanadium, and zinc. This study found high concentrations of cadmium, chromium, copper, mercury, nickel, lead, and zinc near the shore in Kempenfelt Bay, with concentrations decreasing farther away from shore and into the main basin, and declining further still toward the outlet basin (offshore of the Ramara Creeks subwatershed). A similar pattern was seen in Cook's Bay, with sites closest to the shore having the highest metal concentrations (Landre et al., 2011).

Higher concentrations close to shorelines are not unexpected as these are the areas of the subwatersheds experiencing urban growth, both in the residential and commercial sectors, and is where streams running through agricultural and urban lands discharge loads into the lake. In addition, historically, metal pollution was not regulated from metal finishing facilities and tanneries that were operating in and around areas such as Kempenfelt Bay and in the East Holland River, in the past.

When comparing current results to the results of the earlier study (Johnson and Nicolls, 1988), metal concentrations had remained the same or decreased, with the exception of copper and zinc in Kempenfelt Bay. The concentrations of these two metals were on par with the peak levels seen in the 1950s, 60s, and 70s (both decreased slightly in 1980s). Additionally, cadmium, mercury, lead and antimony were found at concentrations that were three to seven times higher than pre-1900s conditions (Landre *et al*., 2011). Of all the metals studied, chromium was the greatest concern, as it exceeded the Ontario Sediment Quality Guidelines severe effect level at three sample sites. This makes it one of the metals of most concern to ecological systems.

Depending on the chemical form of chromium, the type of organism and the life stage of the organism, contamination that exceeds the guideline can impact the growth, activities, reproduction and survival, as well as causing changes to chromosomes and physical formation, due to its carcinogenic, mutagenic, and teratogenic properties (U.S Environmental Protection Agency, 2011).

Overall though, because of a decrease in industrial activity, better wastewater treatment and an increase in urban area, there has been a shift in the source of metals from industrial discharge to urban runoff (Landre et al., 2011). Hence, to manage the concentration of metal contaminants in Lake Simcoe, it is important to install and maintain sufficient stormwater treatment facilities and to decrease metal inputs into stormwater.

#### 3.3.2.7 Bacteria

The presence of bacteria in surface waters has become a significant concern in recent years. Municipal health units monitor the health of local beaches at regular intervals throughout the summer to ensure that they are safe for human contact. The Provincial Water Quality Objective (PWQO) for body-contact recreation has been defined by the Ministry of the Environment and Climate Change by using the relative numbers of *Escherichia coli* (*E. coli*) bacteria as an indicator to assess the risk to human health. When the *E. coli* population exceeds the PWQO, the beach is designated unsafe for bathing activities. *E. coli* is a fecal bacteria found in the intestines of mammals that can cause serious illness and even death.

The presence of high levels of *E. coli* in the lake's waters is an indication of contamination by human sewage or animal wastes. While there are other reasons for beach postings, including water turbidity, the presence of blue-green algae, or poor aesthetics, closures in Lake Simcoe are generally due to high levels of *E. coli*. The number of beach closures due to high concentrations of *E. coli* varies from year to year, as they are heavily influenced by precipitation levels. Storm water carries with it animal waste (e.g. from farms with livestock, as well as from pet and waterfowl waste), which can contaminate beaches when it reaches them either through direct runoff from adjacent areas, or being carried to tributaries and discharged when it reaches the lake.

There were no beach closures or advisory postings in the period from 2008-2012 (SMDHU [pers. comm.], 2013)

#### 3.3.2.8 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 with levels exceeding 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 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 and hormones (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 polychlorinated biphenyls (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.

**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 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 considered 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.

#### 3.3.2.9 Uncontrolled stormwater and impervious surfaces

Urban land use comprises approximately 8% of the subwatershed area in Ramara Creeks. 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. Generally, concentrations of pollutants such as bacteria (e.g. *Escherichia coli* and other fecal coliforms, *Pseudomonas aeruginosa* and fecal 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 (MOECC, 1994).

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 waterbodies. However, in many older urban areas stormwater typically still reaches watercourses untreated.

Paved surfaces increase the volume and velocity of surface runoff, which leads to streambank erosion, contributing more sediment to watercourses. Subwatersheds with less than 10% imperviousness[1] (hardened surfaces) should maintain surface water quality and quantity and preserve aquatic species density and biodiversity, as recommended in Environment Canada's Areas of Concern (AOC) Guidelines (2004). The AOC Guidelines further recommend an upper limit of 30% as a threshold for degraded systems that have already exceeded the 10% impervious guidelines. The impervious area in the Ramara Creeks subwatershed is currently 6.7%, below the AOC guidelines. It will be important to maintain this low level of imperviousness and to implement practices that will promote infiltration in paved areas as growth proceeds in the subwatershed into the future in order to avoid its associated impacts.

[1] Impervious surfaces refer to any hardened surface, but do not include features such as wetlands that are sometimes considered impervious in hydrogeological models

The increase in impervious surface area associated with urban growth and the resultant increases in stormwater runoff can have significant effects on water quality and quantity and aquatic habitat in a subwatershed. While it will obviously not be possible to eliminate impervious surfaces and their impacts, there are activities that can be undertaken to reduce these impacts.

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. 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. Another input of sediment and nutrients from urban areas is the wind erosion of soils stripped bare for development. These areas can be without vegetated cover for prolonged periods of time, and can be a significant source of windborne pollution.

Based on the Stormwater Practices Manual (MOECC, 1994, 2003), there are various levels of stormwater control established to ensure the protection of receiving waters (i.e. watercourse, ditch, lake). Four levels of protection were established focusing on the ability of stormwater management ponds to control and remove suspended solids. The four levels are:

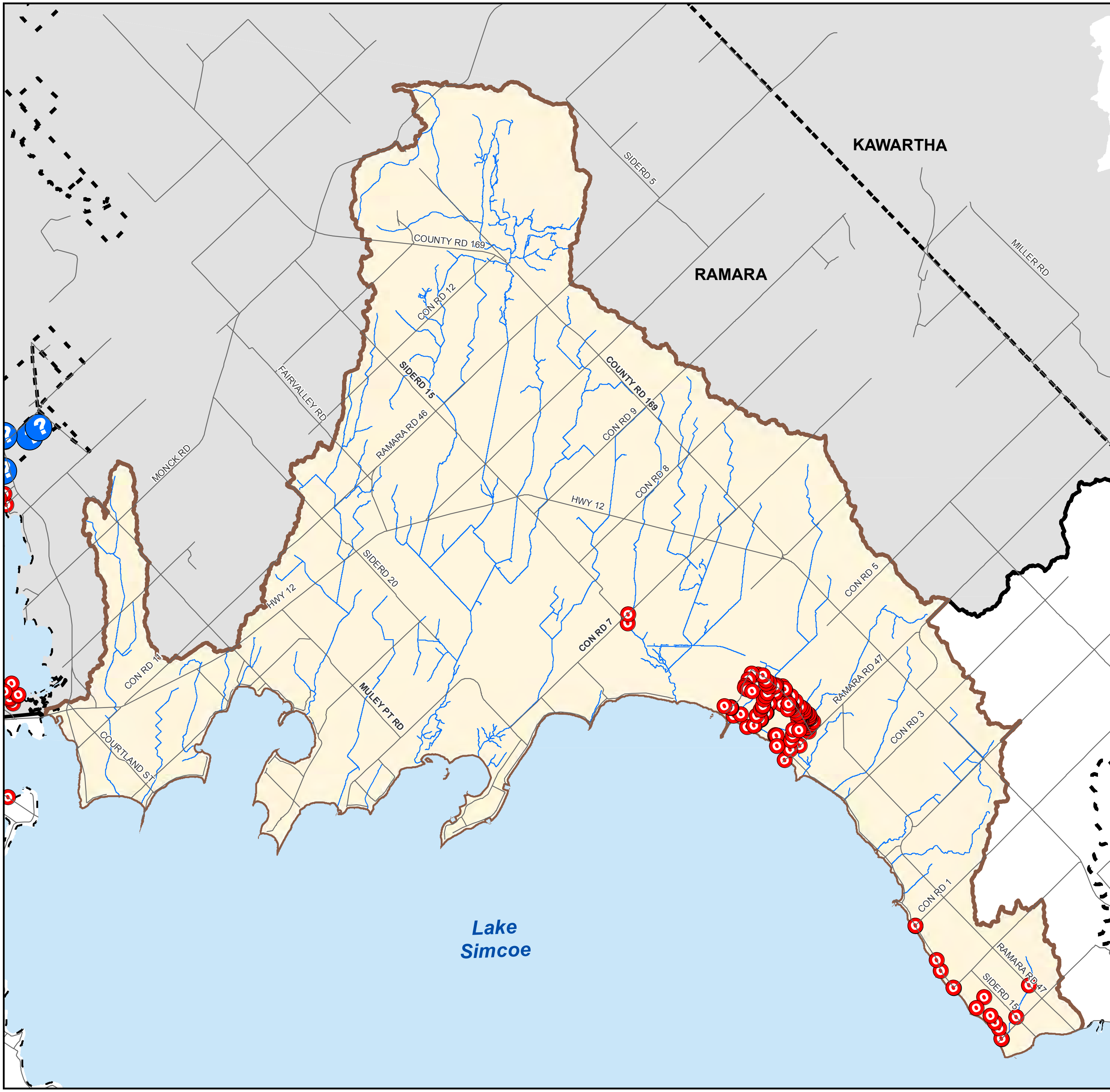
> **Level 1** is the most stringent level of protection designed to protect habitat which is essential to the fisheries productivity (such as spawning, rearing, and feeding areas) and requires 80% removal of suspended solids.
>
> **Level 2** protection calls for a 70% removal of suspended solids. In 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 considered for any new development, only for instances where uncontrolled urban areas can implement some stormwater management facilities to improve the environmental health.

Urban areas in the Ramara Creeks subwatershed include Lagoon City and Brechin. As indicated by the Draft Stormwater Management Master Plan being developed for the Township, there are no stormwater controls in Lagoon City, with most of the runoff discharging via grassed swales, ditches, and storm sewers into the existing canals or directly into Lake Simcoe. Brechin contains one dry pond for quantity control, at the Brechin Public School; a wet pond that provides quality and quantity control from existing and future development in the Ramara Industrial Park lands; as well as an oil/grit separator and two bioswales at the site of the Township of Ramara administrative building (CC Tatham & Associates, Draft 2014). Stormwater outlets for these areas are shown in Figure 3-13.

The Draft Stormwater Management Master Plan identifies a number of new stormwater pond locations, as well as retrofit opportunities for dealing with stormwater from new and existing developments. Where appropriate and feasible, the use of a number of different Low Impact Development practices is recommended to reduce the amount of stormwater directly reaching watercourses and the lake via storm drains and ditches. The use of these practices may be somewhat limited given high groundwater table throughout much of these areas; but practices that take in the site-specific qualities of these areas can and should be implemented in these areas to address the quality and quantity of this untreated stormwater reaching the streams, lagoons, and the lake itself.

# Stormwater outlets in the Ramara Creeks subwatershed

Figure 3-13




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed
- Stormwater Outlet

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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 dc created July 2012.

#### 3.3.2.10 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 negatively impact 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 may be increasing as a result of increasing population and diminishing natural heritage lands.

#### 3.3.2.11 Climate Change

While it is difficult to predict direct impacts of climate change to water quality within the Lake Simcoe watershed, it is likely that it will exacerbate the many of the previously mentioned water quality stressors, creating cumulative, long-term impacts.

Warmer temperatures will lead to further thermal degradation of watercourses and create ideal habitat for bacteria and pathogens. An increase in the frequency and intensity of weather events can also have an impact on contaminants, including:

- Causing the release of contaminants through damage to storage facilities, overflow of retention areas and mobilization of surface contaminants that are normally immobile;
- Transporting contaminants greater distances; and
- Increasing the quantity of contaminants (such as road salt) that are required to deal with weather events (such as snowfall).

Figure 3-14 shows two different climate scenarios (based on different models) and how they will impact the total phosphorus loads in the coming years. The climate change scenario outputs were initially reporting the base case phosphorus load (2004-2007). However, it was felt that using the 2004-2007 loads in light of the other longer term scenarios does not provide a meaningful comparison and could be misleading given the small snap-shot of time. The rationale behind this reasoning is that the climate change scenarios use a much greater modelling period of 30 years (1961-1990) to develop the climate change precipitation and temperature projections. Thus, to have a meaningful comparison, model runs were performed using the original precipitation and temperature data spanning the period 1961-1990, comparing existing loads and future climate change loads using the same modelling period of 30 years. Figure 3-14 illustrates the current ‘baseline’ value for Ramara Creeks. Both scenarios show phosphorus loads increasing, with a more pronounced increase after 2070.

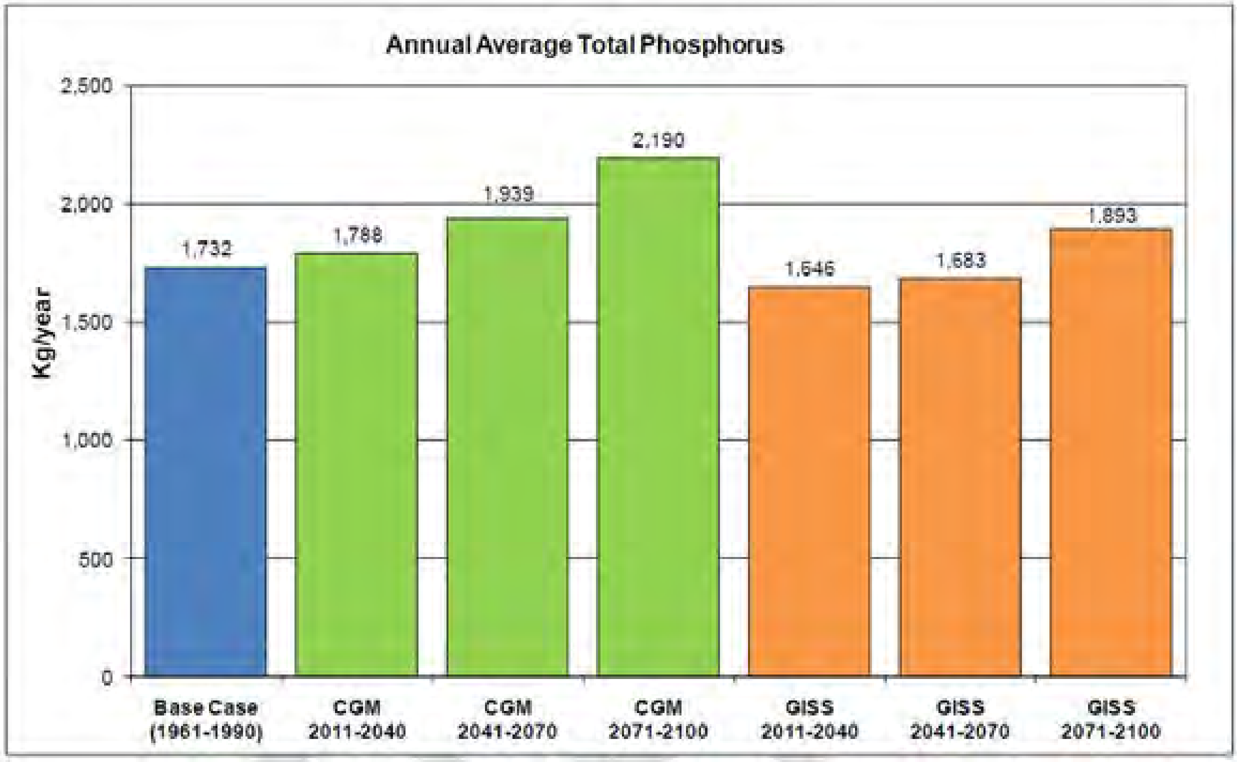



**Figure 3-14: Base case land use applied to climate change scenarios for total phosphorus loads in the Ramara Creeks subwatershed (Louis Berger Group Inc., 2011).**

Further information on how climate change will affect aquatic and terrestrial natural heritage can be found in **Chapter 5 – Aquatic Natural Heritage** and **Chapter 6 – Terrestrial Natural Heritage**, respectively.

3.3.2.12 Lagoon City

The watercourses of Lagoon City are artificially engineered, and do not necessary flow in the way a natural watercourse would. While a natural watercourse is typically continually being replenished by upstream water sources that flow through the system, the water in the lagoons tends to be somewhat stagnant; which can be associated with a number of water quality issues. These include high phosphorus concentrations, likely from runoff from adjacent roads and properties, which contribute to high rates of growth of aquatic plants and algae. This excessive growth, particularly the aquatic plants, can present an issue with respect to boat navigation, as well as the aesthetic issue of the accumulation of dead and decaying plant material and its associated smell. The Lagoon City Parks and Waterways Commission undertakes harvesting, and sprays an herbicide in areas of abundant plant growth.

As mentioned above, the growth of algal blooms is another of the issues commonly seen in Lagoon City. Factors contributing to this growth are the high levels of phosphorus, and warm, slow-moving waters found in the lagoons. These blooms are particularly prevalent in late summer, when temperatures are warmest and there is less rain water and flow to "flush" the lagoons. Of particular concern are blooms of *Cyanobacteria*, or blue-green algae. In addition to being a nuisance, some species of the bacteria comprising these blooms secrete toxins, which can have a number of effects, depending on the species of *Cyanobacteria*. These effects can include impacts to the liver or the nervous system, or skin irritation, depending on the species present. Exposure to the water by humans and pets, as well as the consumption of fish from affected areas, is best avoided during periods of algal bloom to prevent potential impacts due to exposure to these toxins.

The nearby access to water, and availability of food from manicured lawns and bird feeders, makes Lagoon City ideal habitat for Canada Geese and other waterfowl. The birds themselves can be a nuisance, and their droppings can also exacerbate water quality issues, due to the phosphorus and algae they contribute to the lagoons. The Lagoon City Parks and Waterways Commission suggests a number of ways for residents to deter geese from their properties, including the use of scare tape, the planting of ornamental grasses along the shorewall to prevent the easy access to water that attracts them (a practice which will also help to prevent phosphorus and other contaminants from reaching the lagoons by filtering runoff), and limiting food sources, such as bird seeds.

***Key points – Factors Impacting Water Quality - Stressors*:**

- No contaminants were identified as Drinking Water Issues or Conditions in the Bayshore Village Subdivision and Val Harbour Subdivision Well Supplies, or for the Lagoon City or South Ramara Water Treatment Plants.
- There are potential threats to drinking water associated with individual sewage systems, the handling and storage of fuel, as well as those associated with agricultural land uses.
- According to modelled load estimates, the primary source of total phosphorus in the Ramara Creeks subwatershed is septic systems (45%). Under the approved growth scenario in the modelling done for the Assimilative Capacity Studies, there is a projected increase in total phosphorus loads of 16.5% if agricultural BMPs are not implemented.
- When comparing the phosphorus loads (kg/yr) per hectare of the subwatersheds in the Lake Simcoe watershed, Ramara Creeks is the eighth lowest contributor per hectare.
- Sediment sources include agricultural areas, sites stripped for development, and sand used on roads in the winter. Sediment itself is a pollutant, and also acts as a vector for other pollutants, such as phosphorus.
- Increasing surface water temperatures can be attributed to overland flow across impervious surfaces and discharge from ponds. Stream temperature issues can be expected to increase in the coming years as the amount of impervious area increases.
- Chloride concentrations are well within guideline values at the water quality station; however, concentrations may be much higher in the subwatershed's urban areas, particularly around commercial and industrial areas. Given the trends across much of the Lake Simcoe watershed, it can be expected that concentrations will increase in the subwatershed as growth occurs.
- The emerging threat of climate change will interact with all of these stressors, creating additive long-term impacts that, based on climate change scenarios, will increase phosphorus in the Ramara Creeks subwatershed.

## 3.4 Current Management Framework

Various programs exist to protect and restore the water quality in the Lake Simcoe watershed, ranging from regulatory mechanisms, to funding and technical support provided to private landowners, to ongoing research and monitoring.

Many of these programs already address some of the stresses to water quality in the Ramara Creeks subwatershed, as outlined in the following sections.

### *3.4.1 Protection and Policy*

There are numerous acts, regulations, policies and plans aimed at maintaining or improving water quality. These include the Lake Simcoe Protection Plan, the Provincial Policy Statement, the *Clean Water Act* and municipal official plans. This management framework addresses many of the stresses identified in these subwatersheds. In Table 3-8 we categorize nine such stressors, recognizing that many of these overlap and that the list is by no mean complete. The legal effects of the various Acts, policies, and plans on the stressors are categorized as ‘existing policies in place’ (shown in green), or ‘no applicable policies’ (shown in red). The policies included in the table include those which have legal standing and must be conformed to, or policies (such as some of those under the Lake Simcoe Protection Plan) which call for the development of further management tools, research or education programs.

The intent of these regulations, policies and plans are summarized in **Chapter 1 - Introduction**. Readers interested in the details of these regulations, policies and plans are directed to read the original documents.

**Table 3-8: Summary of the current management framework as it relates to the protection and restoration of water quality.**

| Stressor affecting water quality | Lake Simcoe Protection Plan (2009) | 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 | LSRCA Watershed Development Policies (2008) | Comprehensive Stormwater Management Master Plan Guidelines (2011) | Simcoe County Official Plan (2007) | Township of Ramara Official Plan (2003) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Development and site alteration | Existing | Existing | Existing | None | None | None | None | Existing | Existing | Existing | Existing |
| Application of road salt | None | Existing | None | None | Existing 3 | None | None | None | None | None | None |
| Loss of natural heritage features | Existing | Existing | Existing | None | None | None | None | Existing | Existing | Existing | Existing |
| Uncontrolled Stormwater | Existing | Existing | Existing | None | Existing | None | None | Existing | Existing | Existing | Existing |
| Impervious surface | Existing | None | Existing | None | None | None | None | Existing | Existing | None 7 | Existing 8 |
| Discharge of material | None | None | None | Existing | Existing | Existing | Existing | None | Existing | None | Existing 9 |
| Agricultural runoff | Existing | None | None | Existing | None | None | None | None | None | Existing | None 10 |
| Septic systems | Existing | None | Existing 2 | None | Existing 4 | None | None | Existing 5 | None | None | None 11 |
| Climate change | Existing | None | None | None | None | None | None | None | Existing 6 | None | None |

Legend: **Existing Policies** (Existing) | **No applicable policies** (None)

[1] Gives specifics of what stormwater management plans are to include, but these are very general (e.g. 'protect water quality')

[2] PPS specifies where private septic systems would be allowed, does not give details around inspections/restrictions

[3] General policy regarding the discharge of any material that may impair the quality of water (not specific to road salt)

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

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

[6] Refers to the Climate Change Adaptation Strategy in the LSPP – Policy 7.11

[7] Targets for impervious cover provided for the Oak Ridges Moraine Conservation Plan areas, but not subject area

[8] In Shoreline Residential areas

[9] Within or adjacent to the Natural Areas features and functions identified in the Official Plan

[10] There are no policies in the OP; however, one of the Objectives is to 'encourage best farm management practices including opportunities for sound disposal of animals wastes on farmland'

[11] The preferred treatment for hamlets is identified as private or communal (not municipal). Municipal is preferred in Villages

Legislation and policy restrictions are the primary source of protection for water quality in the Lake Simcoe watershed, guided by the fundamental provincial planning policies as articulated in the Provincial Policy Statement (PPS) and Lake Simcoe Protection Plan (LSPP). However, some stressors are better suited to policy and regulation than others. For example, a water quality stressor such as climate change is hard to regulate; however, stressors associated with site alterations and stormwater are much easier to control and regulate.

Policy tools to deal with these stressors can be found in Provincial Policy (such as PPS or LSPP), municipal official plans and zoning bylaws, and Conservation Authority Regulations. Together these documents are intended to provide protection to features that are significant both locally and provincially, while providing clarity to private landowners, and accountability to the electorate.

Further to the guidelines provided by the PPS, the LSPP identifies additional targets to improve existing water quality in the Lake Simcoe watershed. These targets call for the reduction of phosphorus, pathogens (such as *E. coli*), and contaminants (i.e. heavy metals, organic chemicals, sediments, and chlorides). To assist in achieving these targets, policies established under the Lake Simcoe Protection Plan place firmer controls on sewage treatment plants (Policies 4.1-4.4), stormwater management (Policies 4.-5-4.12), septic systems (Policies 4.13-4.15), and construction activities (Policies 4.16-4.21), as well as promoting better management practices throughout the various communities in the watershed (LSPP, 2009).

Within the Lake Simcoe watershed and its tributaries, excessive phosphorus is considered the most significant cause of water quality impairment. Because of this, Policy 4.24-SA of the LSPP committed the Province, LSRCA, local stakeholders, municipalities and other partners to develop a comprehensive Phosphorus Reduction Strategy within the first year of the Plan. In June 2010, the Lake Simcoe Phosphorus Reduction Strategy (PRS) was completed. The PRS is an adaptive management tool that takes a watershed-based approach to managing the phosphorus levels in Lake Simcoe. By looking at the problems and researching solutions for the lake and its tributaries, the PRS provides direction to achieve proportional reductions from each major contributing source of phosphorus to reduce the current total load of 72 T/yr down to 44 T/yr in the future. The goal of 44 T/yr is the annual phosphorus load required to achieve the LSPP deep water dissolved oxygen target of 7 mg/L, that research proposes is needed to support a naturally reproducing and self-sustaining cold water fishery in Lake Simcoe.

The PRS is broken down into six key concepts, derived from the LSPP, to address the major sources or sectors contributing phosphorus to the Lake Simcoe watershed. These include:

- Adaptive Management;
- Watershed Approach;
- Stewardship and Community Action;
- Source-specific Actions;

- Monitoring and Compliance; and
- Research, Modelling and Innovation.

Each of these sections includes the ways in which that concept can address the stressors and how they contribute to the overall function of the PRS tool. Additionally, “strategic directions” have been incorporated into the PRS to set out actions to be taken to reach the goal of 44 T/yr. Many of the gaps, related mostly to insufficient information available, are addressed in the “strategic directions” to continue research efforts and link to the appropriate actions (such as stewardship efforts, work with aggregate and development industries, etc). Related policies from the LSPP have also been included in the source-specific actions to further the connection between the PRS and LSPP documents.

The watershed-based approach for protecting drinking water was first adopted in Ontario in 2006, with the *Clean Water Act* to protect drinking water at its source, as part of the Province’s overall commitment to safeguard human health and the environment, by using a multi-barrier approach. 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, 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. Participants in the Source Protection program include the Ministry of the Environment and Climate Change, Source Protection Authorities, Source Protection committees, municipalities, First Nations, consultants, and the public.

A key component of the Source Protection Program is the creation of a Source Protection Plan. A Source Protection Plan is a document that focuses on preventing the overuse and contamination of drinking water supplies across the Source Protection Region. The South Georgian Bay Lake Simcoe Source Protection Plan includes policies and strategies to protect drinking water by allowing municipalities to take a proactive approach in preventing, reducing or eliminating significant threats to water resources (for example: chloride from road salt).

Currently (2014) the Source Protection program is in Stage 3 of 4. In October 2012, the proposed Source Protection Plan was submitted to the Ministry of the Environment and Climate Change for review. A year later, the Ministry of the Environment and Climate Change completed their review of the proposed plan and provided recommendations to ensure the policies contained in the plan were implementable as written. The Source Protection Committee acknowledged the recommendations and worked to amend the proposed policies before re-consulting the public on the amendments through a series of open houses and consultations. On July 3$^{rd}$, 2014 the revised proposed Source Protection Plan was submitted to the Ministry of Environment and Climate Change for a second round of review and approval. Upon plan approval, municipalities in the South Georgian Bay Lake Simcoe Source Protection Region will implement and enforce the policies in order to protect local drinking water sources.

In addition to the PPS, the LSPP, the *Clean Water Act* and the other acts and policies in Table 3-8, municipal Official Plans are key to preserving and improving water quality within the subwatershed. The Township of Ramara’s Official Plan (OP) has goals and policies set around the protection of water quality in the Township’s watercourses and waterbodies. The OP addresses, at least to some extent, the majority of the stressors listed in Table 3-8, with the exception of agricultural runoff, septic systems, and climate change. The goal for 'Water' under the OP's Natural Resources section is to protect the quantity and quality of surface water and groundwater for their benefit as fishery habitat, and for domestic and agricultural uses. The objectives include carefully utilizing water resources for recreational purposes, and protecting surface and ground water resource areas from contamination. The objectives for 'Agriculture' under the Natural Resources heading includes encouraging best farm management practices, including opportunities for sound disposal of animal wastes on farmland. The Natural Areas and Physical Environment goal includes protecting, conserving, and enhancing natural areas, features, and functions, including good community planning and design to prevent contamination of air, water and land resources. Under its Natural Areas policies, the OP states that development or site alteration proposed in or adjacent to natural areas including watercourses, lakes, and discharge areas are required to demonstrate that the natural condition will be maintained; that unreasonable soil erosion will not cause increased siltation, and that waste materials or harmful or toxic substances will not be discharged into or impair surface water quality. In its policies around recharge areas, the OP notes that once these areas are defined, they should be protected from contaminants likely to move toward and reach a well or series of wells supplying water. In its Water Resources policies, the OP states that because groundwater aquifers are the primary source of water taking supplies for agricultural, industrial, and domestic uses, quality and quantity need to be protected. In looking at options for waste water servicing, potential impacts on groundwater and surface water quality resources are to be considered. The OP also requires stormwater controls for developments of greater than five residential lots, and in commercial and industrial designations.

Lastly, on a smaller scale than the LSPP, the Subwatershed Plans themselves are also an important vehicle for highlighting the current conditions of the water quality, what the stressors are, where the gaps are in current acts, regulations, policies, and plans, and to provide recommendations that count on the involvement of various partners, as well as encouraging the incorporation of applicable recommendations into municipal Official Plans.

### *3.4.2 Restoration and Remediation*

There is a range of programs operating in these subwatersheds to assist private landowners improve the environmental health of their land.

The Landowner Environmental Assistance Program (LEAP) is a partnership between the Lake Simcoe Region Conservation Authority, its member municipalities, and the York, Durham and Simcoe chapters of the Ontario Federation of Agriculture. This program provides technical and financial support to landowners in the Lake Simcoe watershed wanting to undertake stewardship projects on their land. Project types which have traditionally been funded by the LEAP program include managing manure and other agricultural wastes, decommissioning wells and septic systems, fencing and planting riparian areas, and increasing the amount of wildlife habitat in the watershed, among others. Between 2004 and 2013, the LSRCA, through the LEAP as well as through funding partnerships such as the federal Lake Simcoe Cleanup Fund and through Source Water Protection, supported a number of projects specifically aimed at improving water quality in the Ramara Creeks subwatershed, including 99 septic system upgrades, 10 well decommissionings, improvements to manure storage (3) and milk house waste (1), stream bank erosion projects (9), clean water diversion (2), and the installation of fencing to restrict livestock (6).

The Ontario Ministry of Agriculture, Food and Rural Affairs has also partnered with Agriculture and Agri-Food Canada and the Ontario Soil and Crop Improvement Association to provide the Environmental Farm Program to registered farm landowners throughout the province. This farmer-focused program provides funding to landowners who have successfully completed an Environmental Farm Plan for projects including management of riparian areas, wetlands, and woodlands. Through this program, close to 30 projects to improve water quality have been completed in the Township of Ramara; these include improved cropping systems, upland riparian area habitat management, manure storage and handling, and runoff control.

In 2008, 2009, and 2014, LSRCA field staff surveyed the majority of the watercourses in the subwatershed, documenting the range of potential stewardship projects that could be implemented to help improve water quality and fish habitat. This survey found almost 400 sites in this subwatershed where runoff was entering creeks, potentially impacting water quality.

### *3.4.3 Science and Research*

An ongoing commitment to applied science and research is necessary to improve our understanding of the water quality within the Lake Simcoe watershed. Ongoing monitoring programs led by the MOECC and the LSRCA, and periodic research studies conducted by academics, are contributing to our understanding of these values.

Since the 1980s, efforts have been made through the Lake Simcoe Environmental Management Strategy (LSEMS) to identify and measure sources of phosphorus in the watershed and recommend remedial measures. As set out in the Lake Simcoe Protection Act (passed December 2008), objectives of the LSPP include reduction of phosphorus loads. Estimates of total phosphorus (TP) loads to the tributaries and lake are used to evaluate the progress towards achieving the water quality-related objectives of LSEMS and the LSPP. Research projects aimed at understanding the links between phosphorus loading and biotic impairment also require estimates of phosphorus loading to the lake. Since the 1990s, annual TP loads have been estimated from atmospheric deposition, tributary discharge, urban runoff, water pollution control plants (WPCPs), septic systems, and vegetable polders. Total phosphorus loss from the lake through the outflow is also quantified. Quantitative hydrological data and lake water balances are evaluated and used for the calculation and validation of the loads.

The Ontario Ministry of the Environment and Climate Change, Environment Canada, Parks Canada, and LSRCA operate monitoring sites throughout the watershed and information from these programs is used for load estimations. Ongoing research and monitoring will aid in detecting changes in watershed conditions that affect phosphorus loads. As the effectiveness of management efforts and understanding of issues such as climate change and atmospheric deposition improves through research and monitoring, we will be better prepared to deal with future impacts.

In addition to these ongoing monitoring programs, numerous scientific and technical reports have been published based on research conducted in the Lake Simcoe watershed. As a result of this combined focus, Lake Simcoe is one of the most intensively studied bodies of water in Ontario. The results of this research have been summarized, in part, in LSEMS (2008) and Philpot *et al*. (2010), and have informed the development of this subwatershed plan.

The Lake Simcoe Protection Plan also commits the MOECC, MNRF, MAFRA, and LSRCA to research and monitoring related to water quality in Lake Simcoe and its tributaries. An enhanced scientific water quality monitoring program is proposed to continue and build upon routine monitoring of key parameters and of biological indicators linked to water quality, as well as monitoring and reporting upon the effectiveness of measures put forth to improve water quality (Policy 4.22). Additionally, scientific research projects that build on existing research and monitoring programs for identifying emerging issues are to be promoted (Policy 4.23).

## 3.5 Management Gaps and Recommendations

As described in the previous sections, many regulations and municipal requirements aimed at protecting water quality of the Ramara Creeks subwatershed already exist. Similarly these subwatersheds have been the focus of numerous restoration and remediation efforts, such as those coordinated through the Landowners Environmental Assistance Program (LEAP) and the Environmental Farm Plan. Despite this strong foundation, there are a number of gaps in the management framework that need to be considered. This section identifies some of the gaps in existing protection and restoration of the water quality in the Ramara Creeks subwatershed, and outlines recommendations to help fill these gaps.

It is recognized that many of the undertakings in the following set of recommendations 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 in the implementation phase

### *3.5.1 Groundwater (Hydrogeologic and Hydrologic)*

There is a need to maintain and, in some locations, enhance groundwater flow patterns in terms of volume and temperature in the tributaries that are dependent on baseflow contributions for the ecological requirements of those systems, within the Ramara Creeks subwatershed.

> **Recommendation 3-1** - That LSRCA, with the support of MOECC, provide a white paper to watershed municipalities describing the range of possible LID technologies to mitigate the impacts of development on surface and groundwater quality and quantity. Further, that LSRCA and watershed municipalities identify the barriers associated with the uptake of LID technology and, with the support of MOECC, develop recommendations for overcoming these barriers.
>
> **Recommendation 3-2** - That federal and provincial governments provide sufficient financial incentives, or otherwise address barriers identified in Recommendation #1, to ensure subwatershed municipalities adopt Low impact Development (LID) practices and promote the adoption of Smart Growth Urban Design Guidelines.
>
> **Recommendation 3-3** – That support for the implementation of innovative practices for tile drains, such as the installation of micro-wetlands at the outlets or tile drain control structures, will be offered to interested landowners, and that these projects be monitored to determine their benefits to both the receiving waterbody and the farmer.

### *3.5.2 Surface Water*

#### 3.5.2.1 Urban - improving stormwater

The majority of the urban areas in the Township of Ramara are lacking stormwater controls. While this can cause issues in any watercourse, as well as in the lake nearshore, these issues have become particularly acute in the canals of the Lagoon City area, where poor water quality and excessive growth of plants and algae are regular occurrences. This general lack of stormwater control within the subwatershed provides many opportunities for retrofits and/or more innovative Low Impact Design (LID) solutions. Significant reductions in phosphorus loads to Lake Simcoe, in addition to improvements to the tributaries, would result from improved stormwater control. New developments will present an opportunity to implement innovative solutions to stormwater control.

The LSPP already includes a number of polices related stormwater management, leading off with the requirement for municipalities to prepare and implement comprehensive stormwater management master plans. The following recommendations build on the LSPP stormwater management policies

> **Recommendation 3-4 -** That the Township of Ramara, in cooperation with LSRCA, promote the increased use of innovative solutions to address stormwater management and retrofits. This could include an assessment of potential retrofit opportunities, as well as the promotion of practices including 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; enhance urban tree cover; where conditions permit, the use of soakaway pits, infiltration galleries, permeable pavement and other LID solutions; 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.

> **Recommendation 3-5 -** That the Province of Ontario, through the implementation of the Lake Simcoe Phosphorus Reduction Strategy, provide significant incentive funding to the Township of Ramara and/or the LSRCA to maintain, construct and /or retrofit stormwater facilities and/or Low Impact Development practices as identified in the Township's Stormwater Management Master Plan.

> **Recommendation 3-6 -** That the Township of Ramara routinely monitor and maintain the design level of existing stormwater facilities. In addition to maintaining design level, criteria for maintenance should also include frequency and exposure to spills and other contaminant sources. Further, that the federal and provincial governments be requested to share in the cost of maintenance.

> **Recommendation 3-7 -** That the Township of Ramara finalize their draft Stormwater Management Master Plan as outlined in the LSPP 2011 Comprehensive Stormwater Management Master Plans Guidelines document with particular emphasis on maintenance of facilities, and the need for retrofit where appropriate.

> **Recommendation 3-8 -** That the LSRCA and its partners recognize that while the construction and/or retrofit of quality control facilities is extremely important, quantity control may be a consideration in some areas of the Ramara Creek subwatershed; therefore, quantity control facilities should be constructed in those areas where

geographical space is limited or other LID options are not feasible. In these situations, federal and provincial governments should provide financial incentives to allow the Township to complement quantity control storm water ponds with an enhanced street sweeping program.

**Recommendation 3-9-** That the Official Plan be amended to contain policies that would help minimize impervious surface cover in the Ramara Creeks subwatershed (recognizing that a similar policy exists for the Shoreline Residential designation), through requirements such as retrofitting low impact design solutions and limiting impervious surface areas on new development.

### 3.5.2.2 Urban – construction practices

While the rate is not as high as in some areas of the Lake Simcoe watershed, there is some growth projected for the Ramara Creeks subwatershed. Significant deterioration to tributary water quality can occur during construction phase as exposed soils are very susceptible to run-off and wind erosion if codes of practices are not followed. While site alteration by-laws, and policies in the LSPP (e.g. 4.20-DP) aim to minimize construction phase impacts, further improvements could be made through use of current BMP and improved enforcement.

**Recommendation 3-10 -** That the LSRCA and the Township of Ramara promote and encourage the adoption of best management practices to address sedimentation and erosion controls during construction and road development. This may include, but will not be limited to, more explicit wording in subdivision agreeements detailing what is required in this regard.

**Recommendation 3-11 –** That the Township of Ramara and LSRCA review and, where necessary, revise current monitoring, enforcement, and reporting on site alteration and tree cutting by: 1) undertaking a review of the current programs and actions, 2) encouraging the allocation of adequate resources for the improvements, and 3) monitoring and reporting on results.

### 3.5.2.3 Urban – reducing salt (chloride)

Chloride concentrations have been increasing across the Lake Simcoe watershed over the past number of years. While the Ramara Drain water quality station has not shown issues with respect to chloride, it is reasonable to assume that this is due to the rural nature of the station's location. Recently completed mapping shows a number of chloride 'hot spots', areas anticipated to have higher concentration, mainly located around county roads, this in spite of Salt Management Plans that are already in place. It is in these areas that impacts to the health of aquatic and riparian biota are anticipated, and where actions can be undertaken to minimize these impacts.

**Recommendation 3-12 -** That LSRCA, with the support of the municipalities, develop a program to determine relative contribution of chloride from road salt application, establish baseline indicators and examine the effectiveness of current protocols on salt storage, application, and disposal, as outlined in their respective Salt Management Plans, adapting them as necessary.

**Recommendation 3-13 -** The LSRCA has recently undertaken an exercise to identify areas in the Lake Simcoe watershed, including watercourses within the Ramara Creeks subwatershed, which are vulnerable to road salt (as outlined by Environment Canada). This assessment may be refined through further examination of relative salt tolerance of local biota. As outlined in Environment Canada's Code of Practice for the Environmental Management of Road Salt, municipalities should examine alternate methods of protecting public safety while reducing environmental impacts in these areas, once identified. These methods should be utilized in the salt vulnerable areas identified through the LSRCA exercise in addition to those areas identified in the Township's Salt Management Plan.

**Recommendation 3-14 -** That LSRCA, in coordination with the municipalities, develop and undertake a program to raise the awareness of property owners, property managers and snow removal contractors on salt application and its environmental impacts. Particular emphasis may be given to those who own or manage property in salt vulnerable areas. The program should reflect BMPs for salt storage and application, as well as appropriate snow disposal.

**Recommendation 3-15 -** Recognizing that increasing concentrations of chloride in watercourses is an emerging issue shared by all municipalities in the Lake Simcoe watershed, that watershed municipalities, academia, LSRCA, MOECC, MTO, and MNRF form a Salt Working Group, or utilize and existing group such as the Simcoe County Road Superintendents, as a mechanism to share information on best practices for salt application, methods of increasing public awareness of the environmental impacts of road salt, and the effectiveness of municipal Salt Management Plans.

**Recommendation 3-16** – That the Township of Ramara consult with the Ministry of Transportation to have street sweeping activities in the subwatershed undertaken earlier in the season to minimize the impact of winter salt and sand in areas lacking stormwater controls.

#### 3.5.2.4 Reducing blue-green algae outbreaks in Lagoon City

Lagoon City represents unique challenges for the Ramara Creeks subwatershed. This community is one of the areas of greatest population density in the municipality, and as it is built around a series of engineered watercourses, water quality management becomes particularly challenging.

The combination of high phosphorus loads in the lagoons, and relatively stagnant water, leads to high rates of growth of algae and aquatic plants, including an outbreak of potentially fatal blue-green algae in the summer of 2013.

**Recommendation 3-17 –** The Township of Ramara, through Lakehead University or other partners, undertake a study of the relative sources and fates of phosphorus in the

Lagoon City lagoons. Based on that study, that the Township develop a targeted approach to improving water quality in the lagoons, with the intent of reducing blue-green algae outbreaks.

### *3.5.3 Agriculture and rural areas*

Subwatershed modelling (that excludes atmospheric) indicates that over 20% of the phosphorus load can be attributed to agriculture in the Ramara Creeks subwatershed. Recent water quality monitoring (2009 to 2011) within these two creeks has shown that phosphorus concentrations regularly exceed the provincial standards. Considering the current concentrations of phosphorus in Ramara Creeks, and the high proportion that can be attributed to agricultural sources, actions leading to reduction in agricultural phosphorus loads to the subwatershed is a priority.

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

Although there are currently no requirements for farmers to undertake BMPs such as cover crops, conservation tillage, the planting of windrows, and leaving riparian buffers intact, there are a number of available programs to assist farmers to implement these programs. In particular, the Environmental Farm Plan program and LSRCA’s Landowner Environmental Assistance Program (LEAP) provides guidance and funding for a number of types of projects. Other gaps in current management include 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.

**Recommendation 3-18 -** That the watershed municipalities, through the LSRCA, create a roundtable made up of municipalities, OMAFRA, MOECC, OFA, BILD, NGOs and related landowner representatives, or through the expansion of existing frameworks such as the Lake Simcoe Stewardship Network, to determine co-operative ways of implementing phosphorus reduction measures in the Ramara Creeks subwatershed, and to develop an ‘action plan’ for their implementation within the agricultural and rural communities.

**Recommendation 3-19 -** That the recently developed spatially-explicit prioritization tool be used to properly allocate stewardship resources, so that funds are provided in locations where maximum phosphorus reduction can be achieved. These tools should be updated continually to reflect updated information and the completion of projects.

**Recommendation 3-20** - Given the anticipated challenge in using stormwater pond retrofits to offset phosphorus loading from projected growth areas in the Ramara Creeks, Talbot River, and Upper Talbot River subwatersheds, that the LSRCA assess the feasibility of expanding the Lake Simcoe Phosphorus Offsetting Program (LSPOP) to support phosphorus-reduction projects on agricultural land in these subwatersheds

Note that unrestricted livestock access and its related impacts were reported on and remedial actions are recommended as part of the implementation of agricultural BMPs in **Chapter 5 - Aquatic Natural Heritage**. Recommendation 5-7 is most relevant to the concern.

### *3.5.4 Water Temperature – thermal degradation*

Increases in stream temperature in the subwatersheds, whether they are due to impervious surfaces, lack of riparian vegetation, reduction of groundwater contributions, or climate change negatively affect the distribution and existence of a number of sensitive species. The watercourses in the Ramara Creeks subwatershed are all considered to be warm water, and therefore do not contain the most sensitive cold water species; however, they do support some cool water species. Measures should therefore be taken to ensure that conditions continue to support these species.

> **Recommendation 3-21**– As new or retrofit stormwater facilities are constructed, LSRCA will work with municipalities to reduce potential thermal impacts of those stormwater ponds and to recognize the importance of LID uptake in relation to maintaining stream temperature.
>
> **Recommendation 3-22** -That LSRCA work with its federal, provincial and municipal 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. Emphasis at this time should be placed on building ecological resilience in vulnerable subwatersheds through stream rehabilitation, streambank planting, barrier removal, and the implementation of other BMPs, in conjunction with the protection of current hydrologic functions.

Note that thermal issues associated with dams are also reported on and remedial actions are recommended as part of the implementation of BMPs in **Chapter 5 - Aquatic Natural Heritage**. Recommendation 5-7 and 5-9 assist in dealing with this specific concern.

### *3.5.5 Monitoring and Assessment*

Currently there is only one surface water quality station to represent the many watercourses in the Ramara Creeks subwatershed. To enhance our understanding of the conditions in the subwatershed, there is a need to provide improved and expanded information on temporal and spatial change in water quality. The existing monitoring networks are not comprehensive enough and a review of the expectations of the program is required. More extensive and frequent sampling will be required to meet future needs. In addition, potential issues related to new water quality contaminants such as pharmaceuticals will require further investigation.

> **Recommendation 3-23**- That the LSRCA enhance the existing monitoring network, through the comprehensive monitoring strategy, to address identified limitations and gaps of the current monitoring program. Review of potential enhancements should consider:

- Undertaking periodic monitoring of toxicants such as pesticides and pharmaceuticals
- Spatial coverage of monitoring stations relative to addressing key monitoring questions such as the relationship between changes in land use cover and changes in water quality and quantity
- Establishing new monitoring stations. A potential location is in the drain discharging into Lagoon City, however, the results of studies currently being undertaken in Lagoon City should be reviewed to ensure that the location a new sampling station is appropriate given the conditions in the system
- Monitoring additional parameters that are key indicators of ecosystem health and restoration progress

**Recommendation 3-24** –That the MNRF, LSRCA, and MOECC develop a framework to allow effective and efficient management and sharing of data before implementing the comprehensive monitoring program. This framework may include the designation of one agency as the curator of all monitoring data collected in the Lake Simcoe watershed.

**Recommendation 3-25** – That the LSRCA, MNRF, and MOECC analyse and report the results of the existing and proposed water quality, water quantity, and aquatic and terrestrial natural heritage monitoring programs regularly, and that the information be used to update the LSRCA Watershed Report Card. Further, stakeholders should be made aware when updates are available, and be provided access to the monitoring data collected via a web portal, to increase distribution and communication of this data.

**Recommendation 3-26** That the LSRCA, in collaboration with MNRF, MOECC, and MAFRA, develop a program for assessing efficacy of new stormwater facilities, stewardship best management practices, and restoration projects, to improve understanding of the effectiveness of stewardship efforts.

# 4 Water Quantity – Surface and Groundwater

## 4.1 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.

An assessment of surface water quantity looks at 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 assessments include 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 its lowest levels, when it can be the only source of water to streams.

Many natural systems rely on a consistent supply of groundwater. For instance, a large number of fish species are dependent on specific ratios of groundwater to total streamflow for their survival. Ponds and wetlands are also often maintained by groundwater flow during the dry summer months. In many areas of the subwatershed, humans are extremely dependent on a reliable supply of groundwater for a variety of purposes including irrigation of fields, potable water, industry, and recreation.

Targets set for water quantity under the Lake Simcoe Protection Plan include:

- Maintenance of instream flow regimes that are protective of aquatic ecosystem needs, and;
- Effective water conservation and efficiency plans.

The physical properties of a watershed, such as drainage area, slope, geology, and land use can influence the distribution of the water and the processes that function within it. This chapter quantifies the surface and groundwater components within the hydrologic cycle for the study area and also identifies how the rural and urban land uses in the Ramara Creeks subwatershed have altered the hydrologic cycle (Figure 4-1), including changes to the surface flow volumes, recharge, annual flow patterns, and the risk of flooding.

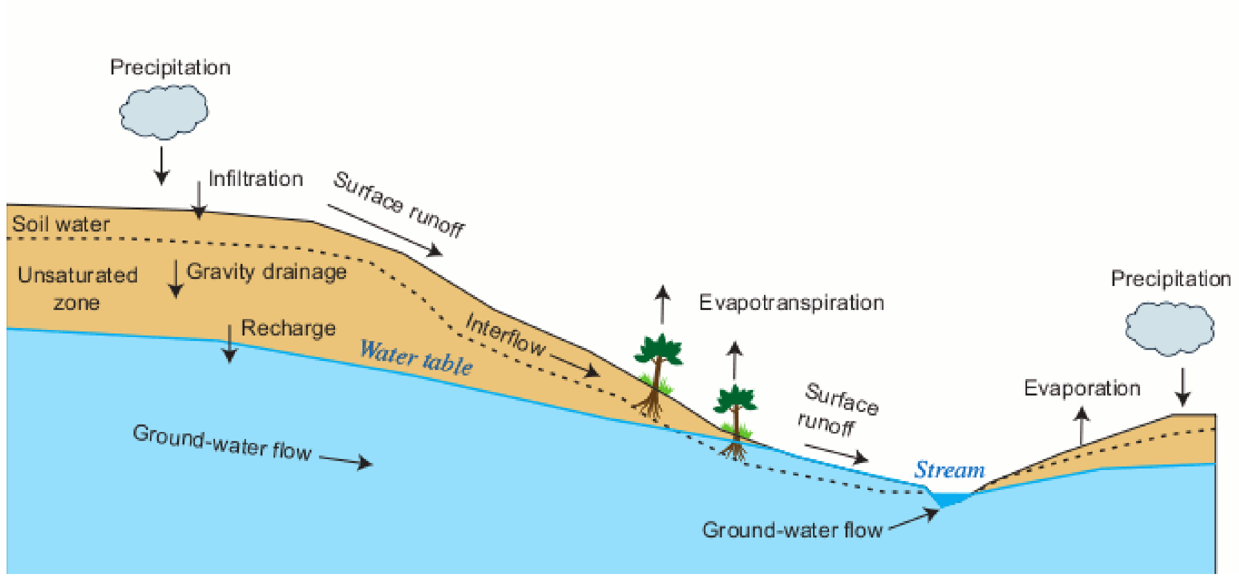



**Figure 4-1: Hydrologic Cycle (USGS, 2008).**

### *4.1.1 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.

<u>Climate</u>

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 run off. In Southern Ontario, relatively little precipitation runs over the land to watercourses, as a high percentage of the precipitation is either cycled back into the atmosphere through evapotranspiration or infiltrates into the soil. 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. This type of event is observed in March or April snowmelts or the onset of spring rains in April or May.

An assessment of the climate in the Ramara Creeks subwatershed was undertaken as part of a broader Tier 2 Water Budget study completed by Earthfx, 2014 for the Ramara Creeks, Whites Creek, and Talbot River subwatersheds. There are three climate stations, Lagoon City (6114295) and Orillia Brain (6115811) established by Environment Canada and LSRCA's Beaver River station that are active in and around the study area. In addition, there are six inactive stations with varied periods of record that have historic information in close proximity to the study area.

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 including 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 infiltrate 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 or hardened surfaces, 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 land types present in the subwatershed will influence how much water remains at the surface and how fast it will be flowing. A large number of land use categories are found across the Ramara Creeks, subwatershed as assessed as part of the Tier 2 Water Budget study and discussed within Chapter 2. Across the study area, natural heritage features (including forests and wetlands) cover approximately 41% of the subwatershed, while agricultural land uses cover about 51% of the area. Developed/settled areas (i.e. urban, rural residential, transportation, parks, industrial, and commercial land uses) cover only 4% of the study area, while pits and quarries make up approximately 0.3%. Some notable natural features in the Ramara Creeks subwatershed include a number of wetlands along the Lake Simcoe shoreline as well as the Mara County Forest wetland located on the northern boundary. The key upland groundwater recharge area located on the northern tip of the subwatershed is another important feature due to its role in sustaining groundwater recharge to ecologically significant features in the subwatershed.

As the population continues to grow, urbanized areas in the Ramara Creeks subwatershed may expand, resulting in an increase in impervious surfaces. These impervious surfaces lead to a decrease in the time it takes a watercourse to reach peak flow following a rain event, as the ability of the surrounding lands 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, the maximum height of peak flow can also increase as water cannot infiltrate into the ground, and therefore runs off into surface water bodies, increasing the risk of flooding, particularly during the spring freshet. At this time, the Ramara Creeks subwatershed currently has a low percentage of hardened surfaces, and few development pressures.

Water Use

In the Ramara Creeks subwatershed both surface and groundwater are used for a variety of purposes, including municipal water supply, agriculture, golf course irrigation, aggregate operations , private water supplies, and by the native plants and animals. 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 of 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 water withdrawals has been undertaken as part of the Source Water Protection initiatives required under the Clean Water Act, 2006 (discussed in Section 4.4.1).

### *4.1.2 Previous Studies*

Information from several groundwater and water budget studies were used to assess the hydrogeology of the Ramara Creeks subwatershed. The following are a list of key studies and reports that have influenced the information provided in this chapter:

Source Water Protection Water Budget Studies

A number of Source Water Protection water budget studies were completed for the Ramara Creeks subwatershed.

- South Georgian Bay-Lake Simcoe Watershed Preliminary Conceptual Water Budget Report (2007);
- Lake Simcoe Watershed Tier One Water Budget and Water Quantity Stress Assessment Report (LSRCA, 2009);
- Water Balance Analysis of the Lake Simcoe Basin using the Precipitation-Runoff Modelling System (PRMS) (Earthfx, 2010).

A complete summary of the Source Water Protection work in the study area is included in the "Approved Assessment Report: Lake Simcoe and Couchiching-Black River Source Protection Area, Part 1 Lake Simcoe Watershed" (South Georgian Bay-Lake Simcoe Source Protection Committee, 2015).

Lake Simcoe Protection Plan Studies

As required under the Lake Simcoe Protection Plan Policy 5.2-SA, a Tier 2 Water Budget & Water Quantity Stress Assessment was completed for the Ramara Creeks subwatershed, as part of a broader Tier 2 Water Budget study that also incorporated the Whites Creek, and Talbot River subwatersheds. The Tier 2 analysis undertaken for the three subwatersheds was completed by Earthfx (2014) by means of an integrated surface water and groundwater flow model that was used to quantify water budget elements by subwatershed and to undertake the stress assessment scenarios outlined by the Clean Water Act, 2006 Technical Rules (MOE, 2011).

In addition to the completion of a Tier 2 Water Budget study, the Lake Simcoe Protection Plan Policy 6.37-SA also requires that ecologically significant groundwater recharge areas be identified. Ecologically significant groundwater recharge areas within the Ramara Creeks subwatershed were also delineated as part of the broader Earthfx (2014) study. The results of ecologically significant groundwater recharge area assessment are further discussed in Section 4.2.6.

Lake Simcoe Region Conservation Authority Surface Water Monitoring Program

Information about water quantity is required by a wide audience, including research scientists, policy-makers, design engineers and the general public. Water level and flow data are used by decision makers to resolve issues related to sustainable use, infrastructure planning, and water apportionment. Hydrological models use the data to improve the forecasting of floods and water supplies, and to predict the impacts of changes to flow regimes on human and aquatic health and economic activity.

The Lake Simcoe Region Conservation Authority, in co-operation with Environment Canada and the Ministry of the Environment and Climate Change, operate and maintain 16 hydrometric stations on the major tributaries of Lake Simcoe. Data is collected, catalogued, and interpreted by the Lake Simcoe Region Conservation Authority using Kisters WISKI hydrologic software. This data is essential for flood-forecasting, planning, nutrient budget estimation for Lake Simcoe, and to support the water quantity information needs of our municipal partners. The Lake Simcoe Region Conservation Authority also manages an extensive field program to monitor the general health of streams and tributaries across the Lake Simcoe watershed. Lake Simcoe monitoring staff collect and analyze a variety of data through a number of monitoring programs including: precipitation data, continuous groundwater level and stream flow monitoring, surface water and groundwater quality monitoring, spot flow measurements, and snow surveys.

## 4.2 Current Status

### *4.2.1 Hydrogeologic Setting*

The hydrogeology of the Ramara Creeks subwatershed is shaped by the stratigraphic framework discussed in **Chapter 2 – Study Area and Physical Setting**. In order to understand the hydrogeological conditions across the subwatershed Earthfx (2014) conducted an investigation of the study area to characterize the hydrogeological setting. An investigation into hydrogeological setting was necessary to complete the modelling work used to characterize the groundwater flow system. An integrated groundwater and surface water model known as GSFLOW was developed for the study area using MODFLOW for groundwater and PRMS for surface water. The MODFLOW sub-model determined groundwater levels in the study area, provided estimates of the rates of groundwater discharge to streams and wetlands, and identified the exchange of water between shallow and deep aquifers and lateral groundwater inflow and outflow across catchment boundaries (Earthfx, 2014). The integrated model boundaries are shown in Figure 4-2. In addition to the Ramara Creeks subwatershed, the model area also incorporates the adjacent Whites Creek and Talbot River subwatersheds, as well as portions of catchments located to the north, east, and south of these three core subwatersheds. Although the model area covers additional subwatersheds, the focus of this chapter will be on the trends and patterns specifically observed within the Ramara Creeks region of the model area.

The conceptual model of stratigraphic units within the subwatershed was presented in Figure 2-14, **Chapter 2 – Study Area and Physical Setting**. The location of the aquifers and aquitard complexes in the model area can be observed from the diagram.

As a result of the model the cross sectional profile of the study area was created, and is representative of the hydrogeology across the Ramara Creeks, as well as the Whites Creeks, and Talbot River subwatersheds (Figure 2-14, **Chapter 2 – Study Area and Physical Setting**).The profile demonstrates how the thickness and depth of the aquifer complexes vary throughout the model area.

A critical first step in developing the groundwater flow model was the interpretation and creation of the hydrostratigraphic layers (i.e. the aquifer and aquitard layers). The hydrostratigraphic model layers in the overburden are a simplification of the conceptual geologic interpretation described in **Chapter 2 – Study Area and Physical Setting**. A listing of the final seven integrated hydrostratigraphic units represented in the Tier 2 Model is described in Table 4-1 below.

In the model unweathered bedrock and silty sand till formations are generally associated with aquitards, while weathered and fractured bedrock and sandy channel sediment units generally behave as aquifers. The top two layers in the model are assigned properties of overburden materials, while the remainder of the layers represent the aquifers and aquitards present in the bedrock units.

**Table 4-1: MODFLOW layer structure (Earthfx, 2014).**

| GEOLOGIC LAYERS (Earthfx, 2013) | | HYDROSTRATIGRAPHIC LAYERS Regional Conceptual Model | HYDROSTRATIGRAPHIC LAYERS Carden Plains (Alvar Conceptual Model) |
|---|---|---|---|
| OVERBURDEN | Post-Glacial Deposits | **Layer 1 and Layer 2** - Surficial Deposits | *(PRMS Soil Zone Representation)* |
| | Glaciofluvial Sediments | | |
| | Dummer till | | |
| | Newmarket Till | | |
| | Thorncliffe / Channel Sediments | **Layer 3** (aquifer) - Thorncliffe/Channel Sediments/Weathered Bedrock | |
| PALEOZOIC BEDROCK | Lindsay Formation | | *(Formations Not Present)* |
| | Verulam Formation | **Layer 4** (aquitard) - Interbedded Limestone and Shale of Verulam and Lindsay Formations/ Unweathered limestone of Bobcaygeon Formation and Upper Gull River | |
| | Bobcaygeon Formation | | **Layer 1 and Layer 2** - Alvar Fracture Network<br>**Layer 3** (aquifer) - Weathered Bedrock |
| | Upper Gull River | | **Layer 4** (aquitard) |
| | Green Marker Bed | **Layer 5** (aquifer) - Green Marker Bed | **Layer 5** (aquifer) - Green Marker Bed |
| | Lower Gull River | **Layer 6** (aquitard) | **Layer 6** (aquitard) |
| | Shadow Lake Formation | **Layer 7** (aquifer) - Shadow Lake/Fractured Precambrian | **Layer 7** (aquifer) - Shadow Lake/Fractured Precambrian |
| PRECAM BEDROCK | Precambrian | *(model base)* | *(model base)* |

The groundwater system within the study area is complex. The uppermost model layers in the model characterize the regionally variable surficial deposits found across the study area. Layer 1 is representative of the glacio-lacustrine and glacial-fluvial overburden deposits found intermittently across the model area. In the model, these surficial deposits are formally referred to as the Mackinaw Interstadial Sediments (MIS) and function as a regionally discontinuous aquifer (Earthfx, 2014). Generally the material associated with this unit consists of glaciolacustrine deposits in the subsurface, and glaciofluvial sand and gravel at the surface. Post-glacial deposits such as fine grained silts and clays interpreted to have originated from post-glacial lakes are also represented in the first layer of the model. Where present, the materials in this unit are the shallowest of the overburden units. These fine grained silts and clays are discontinuous across the study area and represent a poor aquitard.

Layer 2 of the model represents two till units formally known as the Newmarket Till and Dummer Till. Unlike the regionally extensive Newmarket Till, the stony Dummer Till is not found in the Ramara Creeks subwatershed, but does appear to the extreme east of the Tier 2 model boundary. The higher density sandy silt to silty sand materials that characterize the Newmarket Till form a protective barrier for the deeper aquifer and can be found expansively across the Ramara Creeks subwatershed.

Layer 3 of the model is representative of the interface between the bedrock and the permeable overburden materials present across the model area. This hydrostratigraphic unit incorporates both the weathered shale bedrock of the Lindsay formation and the permeable overlying glaciofluvial and gravel overburden materials. The permeable glaciofluvial sand and gravel materials are generally associated with channel tunnel features formed as a result of high – energy sub-glacial drainage events that worked to erode earlier deposits. As flow waned, and the erosional processes subsided, these tunnel channels were infilled with the glacial sand and gravel sediments represented by Layer 3 in the model. The interface between the shale beds of the Lindsay/Verulam formations and the permeable overlying tunnel channel sediments serve as a regional shallow aquifer used by a number of private wells in the model area.

Layer 4 of the model consists of the upper member of the Gull River Formation, as well as the overlying Bobcaygeon, Verulam and Lindsay Formations. These units are all considered to represent regional aquitards where they are intact and unweathered (Earthfx, 2014). Although the clay rich limestones and interbedded shales of the Verulam and Lindsay Formations are geologically distinct from the thickly bedded limestones of the underlying Bobcaygeon and upper Gull River Formations, these units all have similarily low hydraulic conductivity and are generally not exploited by water wells in the area (Earthfx, 2014). Together these low hydraulic conductivity units are referred to as the Upper Bedrock Aquitard and are assumed to form the bedrock surface across the model area.

The Green Marker Bed Formation is represented by layer 5 in the model and characterizes the zone between the upper and lower members of the Gull River formation. This zone consists of fractured argillaceous limestones (i.e limestone with a significant clay mineral component) of generally higher hydraulic conductivity. The Formation is a productive aquifer for the domestic water supply, despite the Formation's limited thickness of less than 1.5 m.

Layer 6 of the model is characterized by the Lower Gull River formation and serves as a regional aquitard. The composition of the unit varies from fine grained dolostone to argillaceous limestone with typically low hydraulic conductivity values. The hydrostratigraphic unit is formally referred to as the Lower Bedrock Aquitard.

The last hydrostratigraphic unit represented in the model consists of the Shadow Lake Formation and the weathered Precambrian basement rocks. The composition of the Shadow Lake Formation is highly variable but can generally be associated with coarse grained sandstones, while the weathered Precambrian basement rocks are representative of a zone of increased permeability at the Paleozoic-Precambrian contact. This final model layer serves as a regional aquifer and overlies the base of the model which is characterized by unweathered Precambrian age bedrock found extensively throughout the model area. This low permeability basement is not explicitly represented in the model.

#### *4.2.2 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.

Hydraulic conductivity is the primary variable that controls the calculated hydraulic head (also referred to as observed groundwater levels). Within the model, reasonable estimates of hydraulic conductivity were assigned to each material based on published literature (Freeze and Cherry, 1979), estimates from aquifer testing, and calibration values from previous modelling studies undertaken in the area. For a full list of the modelling studies that were consulted refer to the Earthfx (2014) report. Coarse grained materials (sands and gravels) were assigned a higher hydraulic conductivity than finer grained materials (silts and clay). Initial estimates of hydraulic conductivity of the aquifers and aquitards were made based on the typical values and reported ranges presented in Table 4-2. Estimates were then refined through model calibration.

**Table 4-2: Reported hydraulic conductivity values from previous studies (Earthfx, 2014).**

| Material | Geometric Mean Hydraulic Conductivity (m/s) | Range in Values (m/s) | Sources* |
|---|---|---|---|
| Overburden (undifferentiated) | $2x10^{-5}$ | $4x10^{-7}$ - $3x10^{-3}$ | 1,3,5 |
| Newmarket Till | $1x10^{-7}$ | $2x10^{-8}$ - $6x10^{-7}$ | 1 |
| Weathered Lindsay/Verulam | $5x10^{-6}$ | $4x10^{-7}$ - $5x10^{-5}$ | 1,3,4 |
| Weathered Bobcaygeon/Gull River | $6x10^{-6}$ | $6x10^{-8}$ - $4x10^{-4}$ | 1,4 |
| Verulam | $4x10^{-7}$ | $1x10^{-10}$ - $6x10^{-4}$ | 1,2,3 |
| Bobcaygeon (undifferentiated) | $4x10^{-7}$ | $1x10^{-9}$ - $2x10^{-4}$ | 1 |
| Upper Bobcaygeon | $1x10^{-7}$ | $5x10^{-10}$ - $6x10^{-3}$ | 1,2,3,7,8,9 |
| Lower Bobcaygeon | $1x10^{-8}$ | $1x10^{-11}$ - $1x10^{-5}$ | 1,3,6,7,8,9 |
| Gull River (undifferentiated) | $1x10^{-8}$ | $2x10^{-11}$ - $2x10^{-5}$ | 1,8,9 |
| Upper Gull River | $6x10^{-7}$ | $5x10^{-11}$ - $2x10^{-3}$ | 1,3,6,7,8 |
| Green Marker Bed | $7x10^{-6}$ | $4x10^{-9}$ - $2x10^{-3}$ | 1,3 |
| Lower Gull River | $6x10^{-7}$ | $2x10^{-11}$ - $1x10^{-4}$ | 1,3,6,7,8 |
| Shadow Lake / Precambrian Contact | $5x10^{-8}$ | $1x10^{-11}$ - $6x10^{-4}$ | 1,3,6,7,8,9 |
| Precambrian | $1x10^{-9}$ | $1x10^{-10}$ - $6x10^{-8}$ | 7 |

* Numbers refer to sources listed in the Tier 2 Water Budget, Climate Change, and Ecologically Significant Groundwater Recharge Area Assessment for the Ramara Creeks, Whites Creek, and Talbot River Subwatersheds (Earthfx, 2014).

Figure 4-3 to Figure 4-9 display the spatial distribution of hydraulic conductivities within each aquifer and aquitard in the subwatershed. The higher hydraulic conductivities assigned in Layer 1 within the study area correlate to the glacial overburden deposits whose permeable sand and gravel materials are associated with high recharge rates (Figure 4-3). Contrary to Layer 1, the extensive Newmarket Till aquitard unit (Layer 2) that overlies much of the study area exhibits lower hydraulic conductivity values typically associated with the silty sand units (Figure 4-4). The weathered Lindsay/ Verulam Bedrock interface and overlying permeable tunnel channel infill sediments (Layer 3) act as a regional shallow aquifer and are therefore characterized by higher hydraulic conductivity values (Figure 4-5), while the unweathered, thickly bedded limestones of Layer 4 (Upper Bedrock Aquitard) are characteristic of lower conductivities (Figure 4-6). The Green Marker Bed (Layer 5), an argillaceous limestone formation exhibits higher conductivities due to its increased fractures occurrences (Figure 4-7), while Layer 6 (the Lower Bed Aquitard) is characterized by low hydraulic conductivities due to its fine grained dolostone and argillaceous limestone composition (Figure 4-8). Finally, the Shadow Lake –

Precambrian Aquifer (Layer 7) exhibits higher conductivity rates due to its composition of basal coarse grained sandstones and weathered Precambrian bedrock (Figure 4-9), while the lowest hydraulic conductivity in the model layer sequence occurs at the model base, where the surface of the unweathered Precambrian Formation is found. Figure 4-10 provides a cross sectional profile that summarizes the hydraulic conductivity of the hydrostratigraphic units simulated by the groundwater model.

Specific storage and porosity are closely related hydraulic properties. Porosity refers to the volume of void space per unit volume of geologic materials, where specific storage refers to volume of water stored within the geologic materials. Storage in a confined aquifer is derived from two sources. Water is slightly compressible and will expand slightly as the pressures in the aquifer drop. The soil matrix is also slightly compressible and water can be squeezed from the pore space when pressures in the aquifer decrease. This occurs when the fluid pressure decreases, the inter-granular stresses increases to balance the constant overburden stress and the aquifer matrix is compressed. In an unconfined aquifer, the water yielded by gravity drainage as the water table declines is also considered to be a form of release of water from groundwater storage. The amount of water yielded from unconfined storage is generally orders of magnitude larger than that from compressive storage. The following section (4.2.3) will discuss how these properties influence groundwater flow.

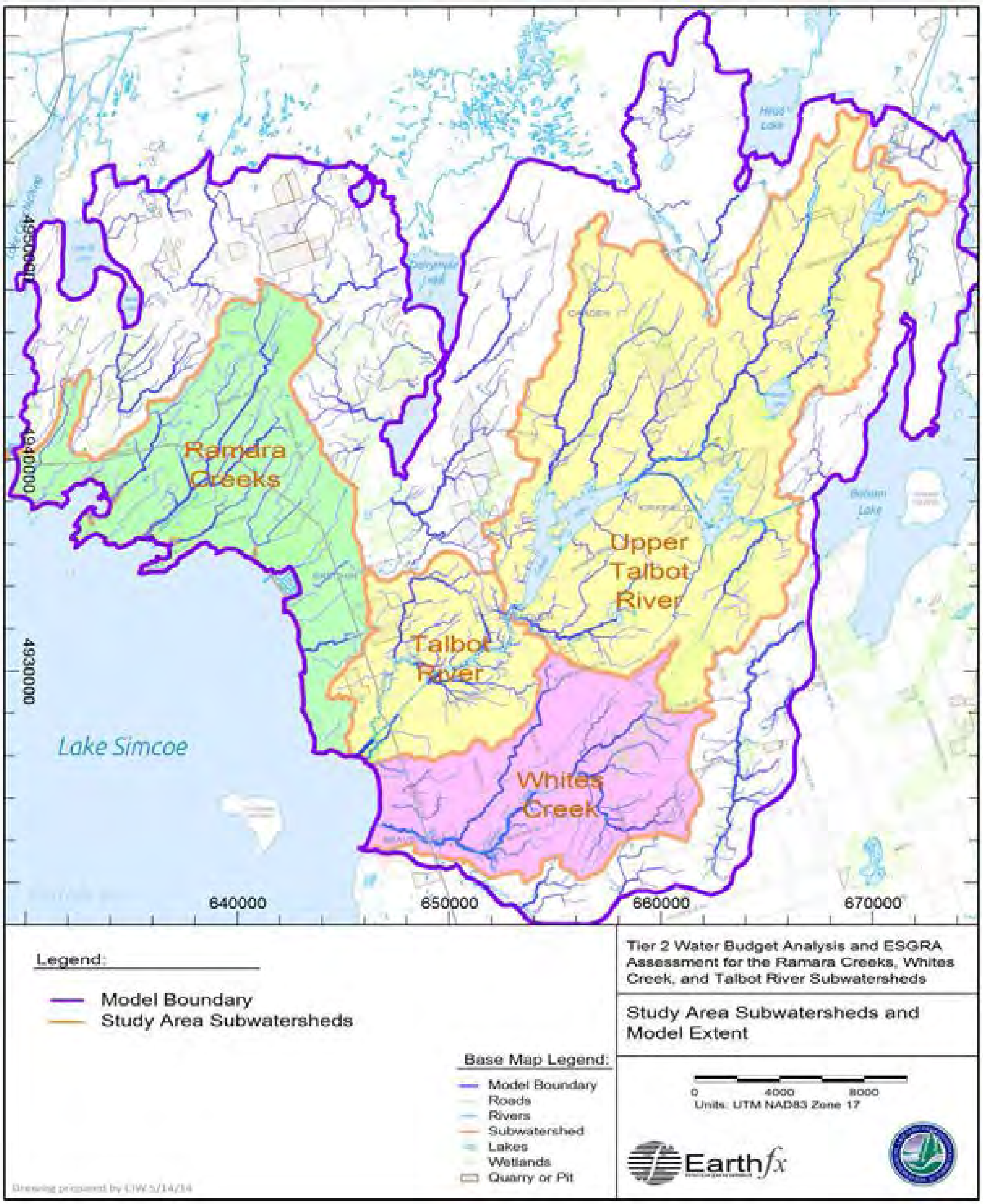



**Figure 4-2: Model area boundaries (Earthfx, 2014).**

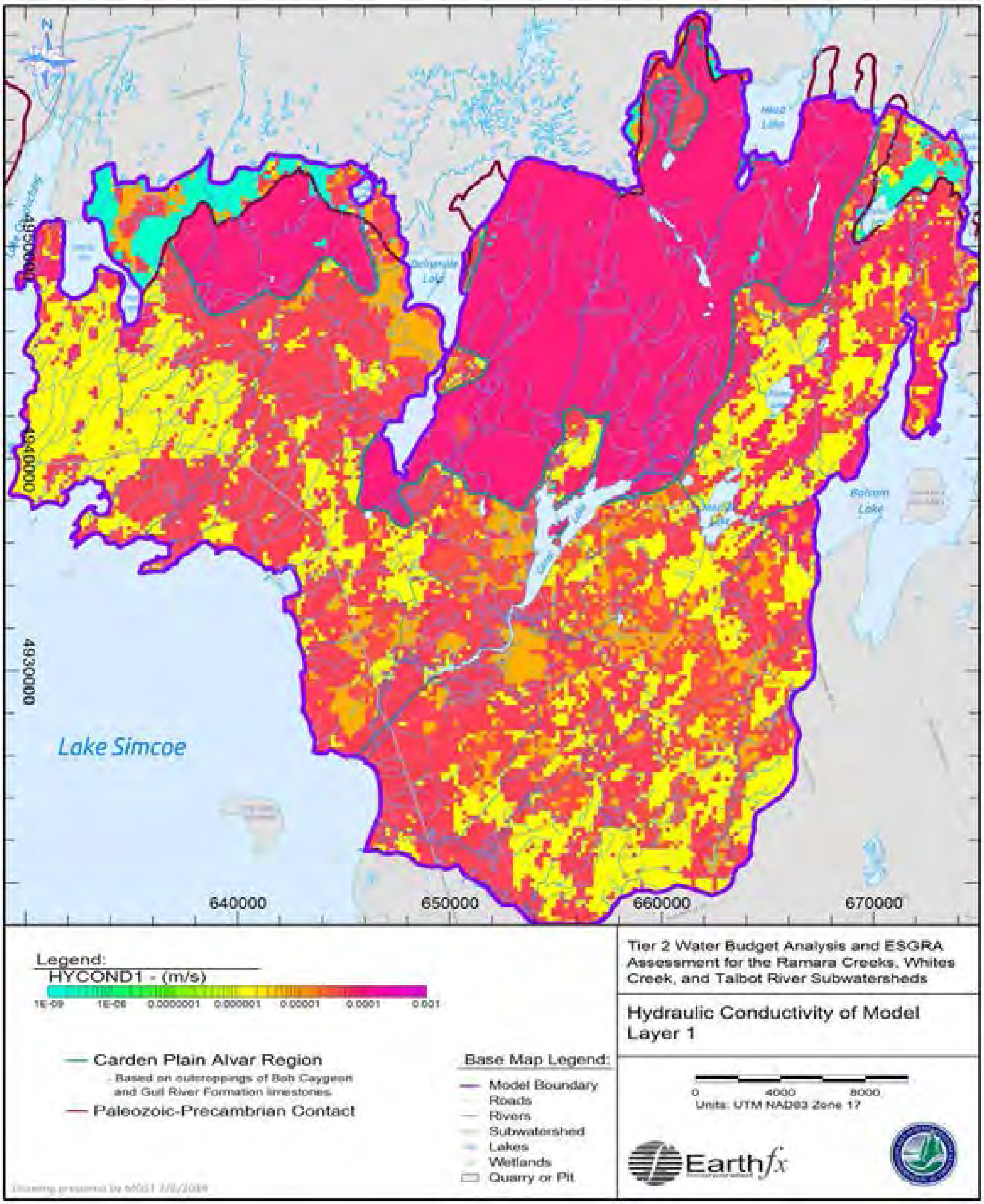



**Figure 4-3: Hydraulic conductivity, in m/s, for Layer 1 (surficial deposits/highly weathered alvar) (Earthfx, 2014).**

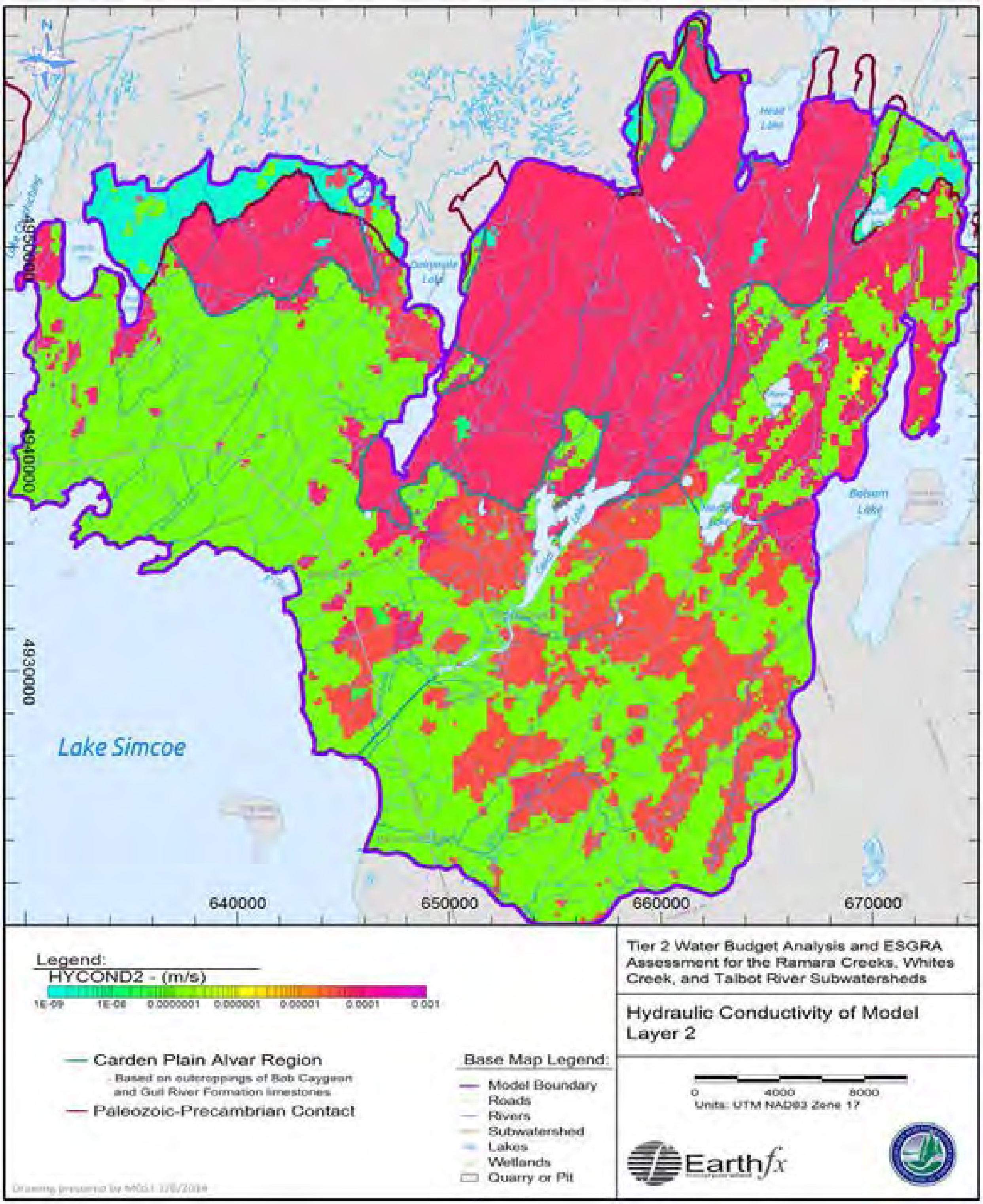



**Figure 4-4: Hydraulic conductivity, in m/s, for Layer 2 (Newmarket Till) (Earthfx, 2014).**

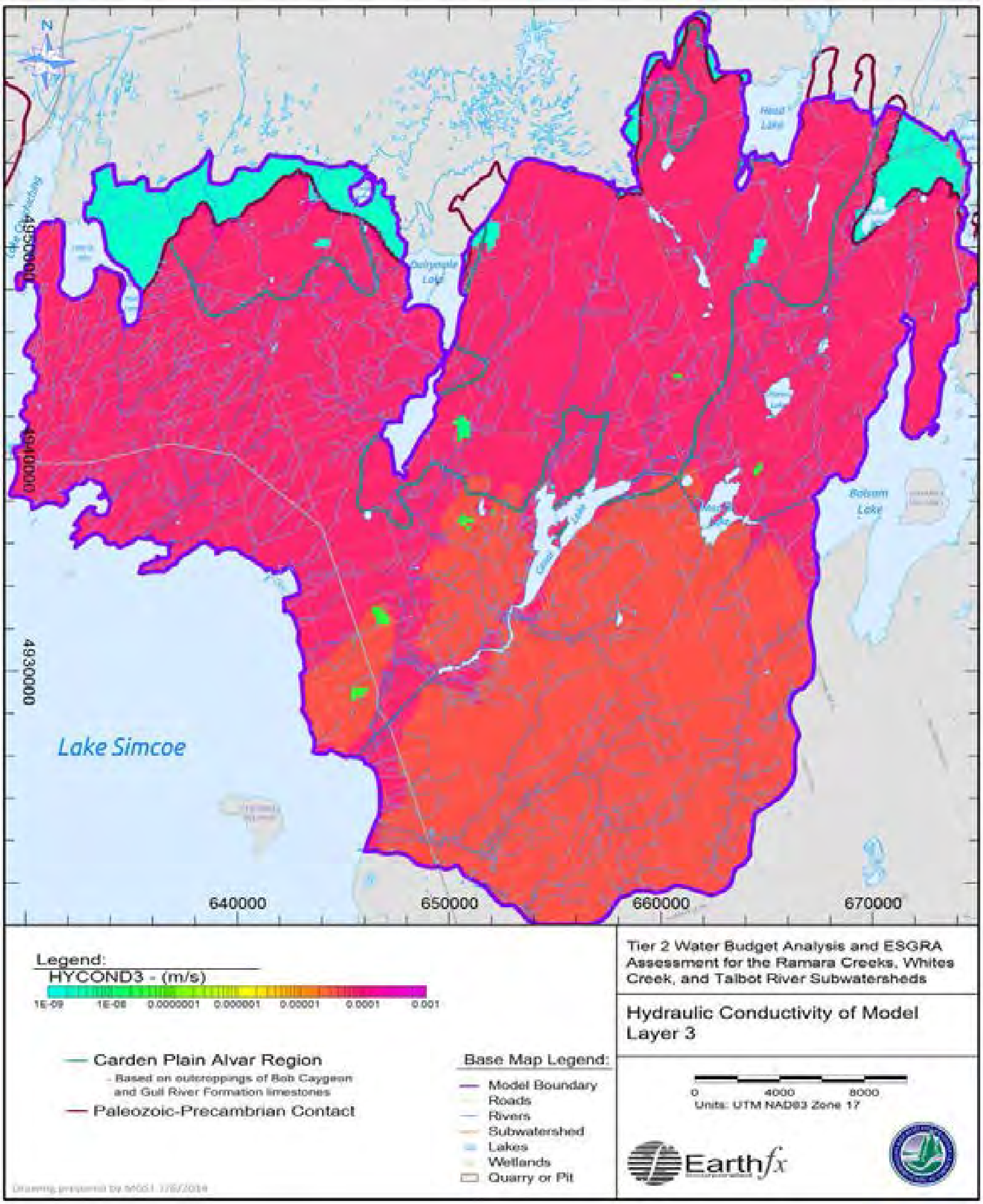



**Figure 4-5: Hydraulic conductivity, in m/s, for Layer 3 (weathered bedrock interface aquifer) (Earthfx, 2014).**

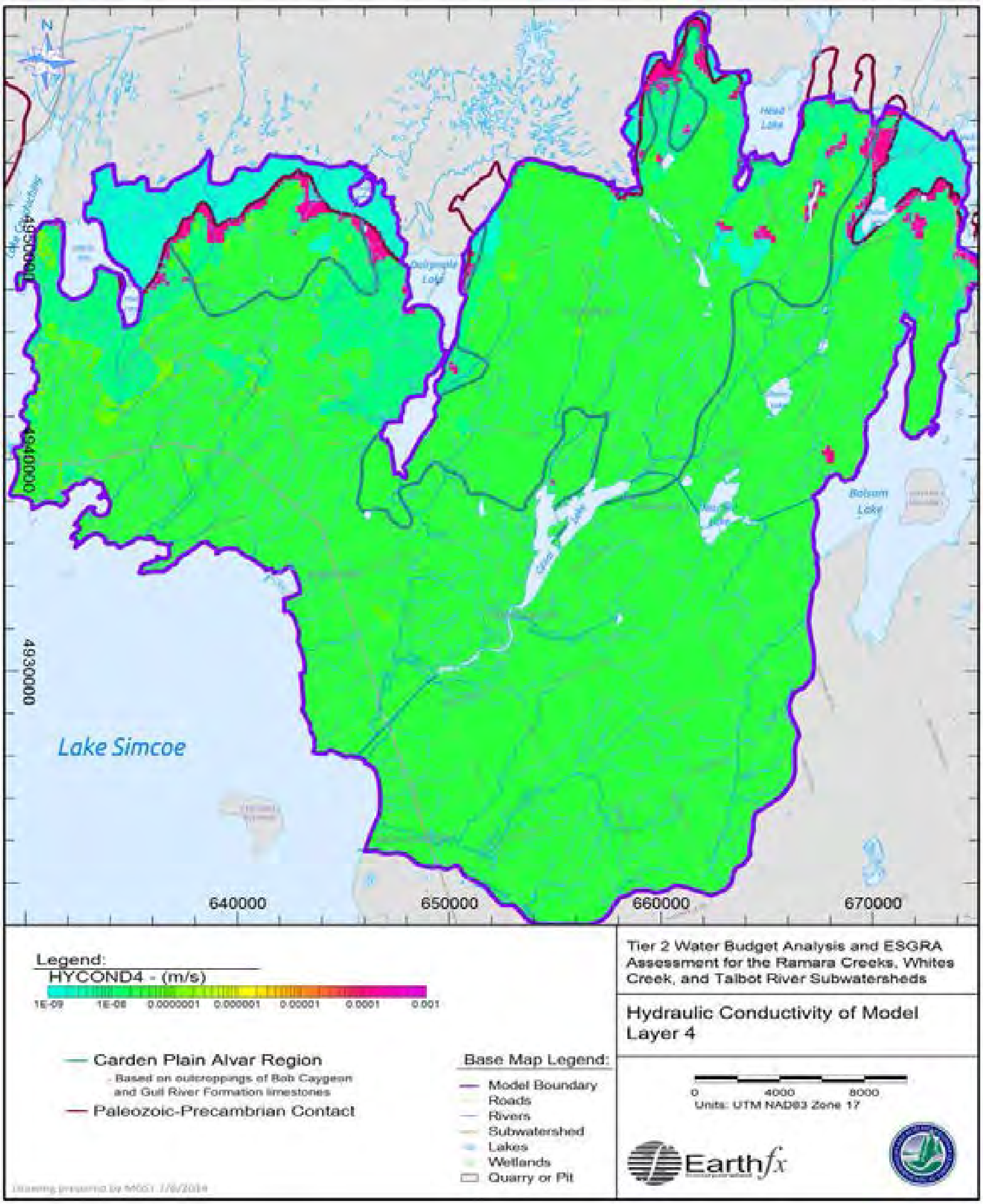



**Figure 4-6: Hydraulic conductivity, in m/s, for Layer 4 (upper bedrock aquifer) (Earthfx, 2014).**

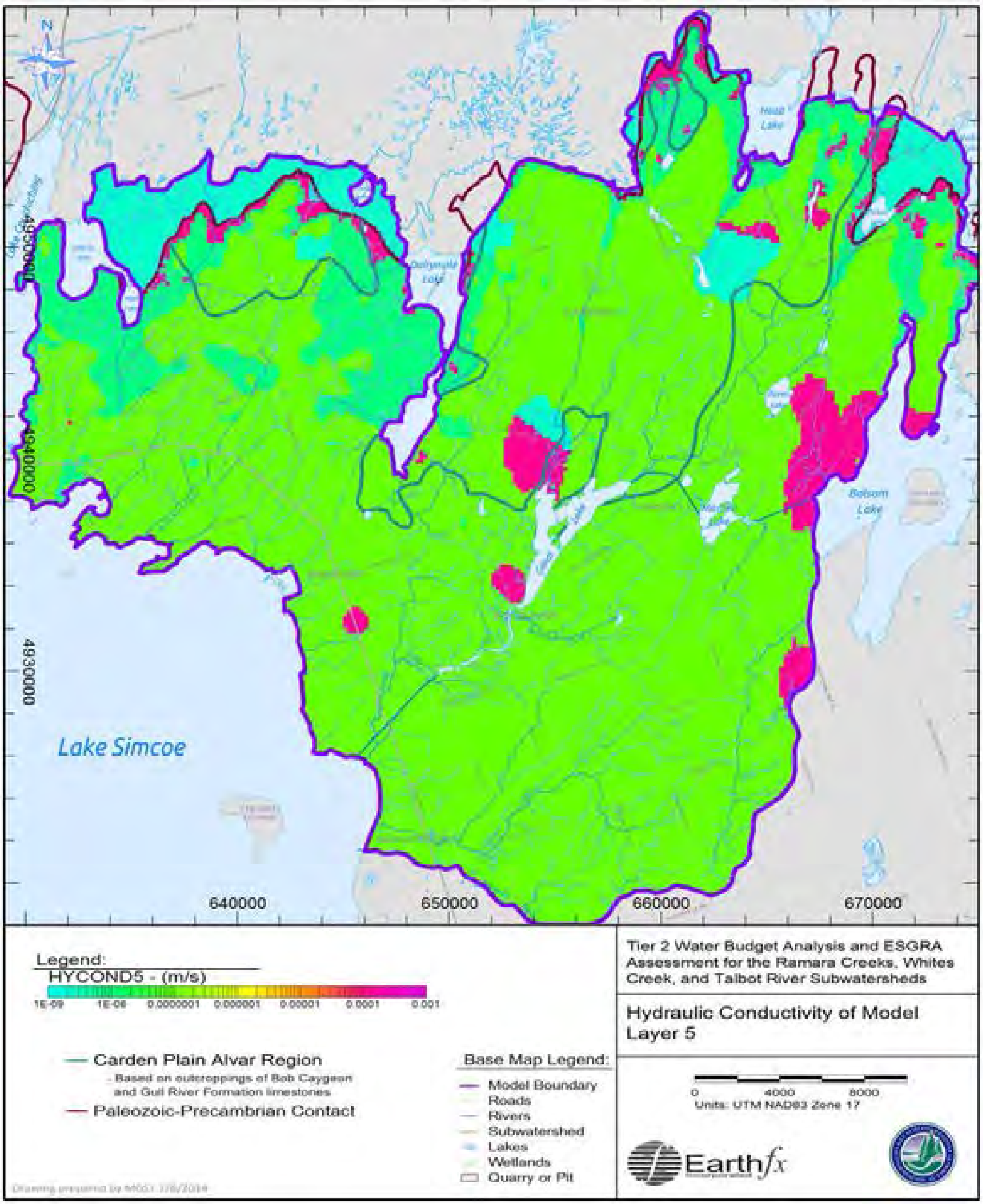



**Figure 4-7: Hydraulic conductivity, in m/s, for Layer 5 (Green Marker Bed) (Earthfx,2014).**

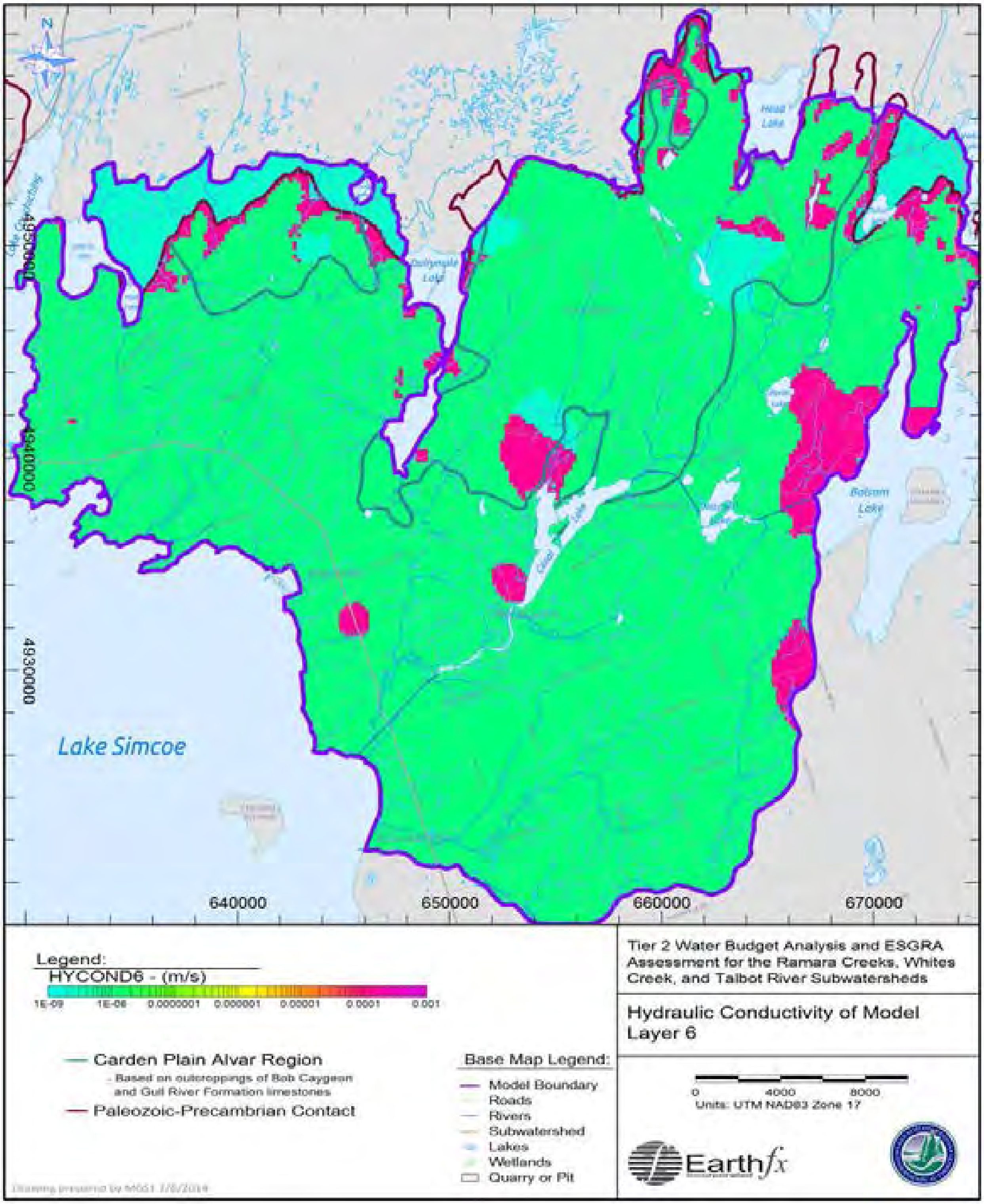



**Figure 4-8: Hydraulic conductivity, in m/s, for Layer 6 (Lower Bedrock Aquifer) (Earthfx, 2014).**

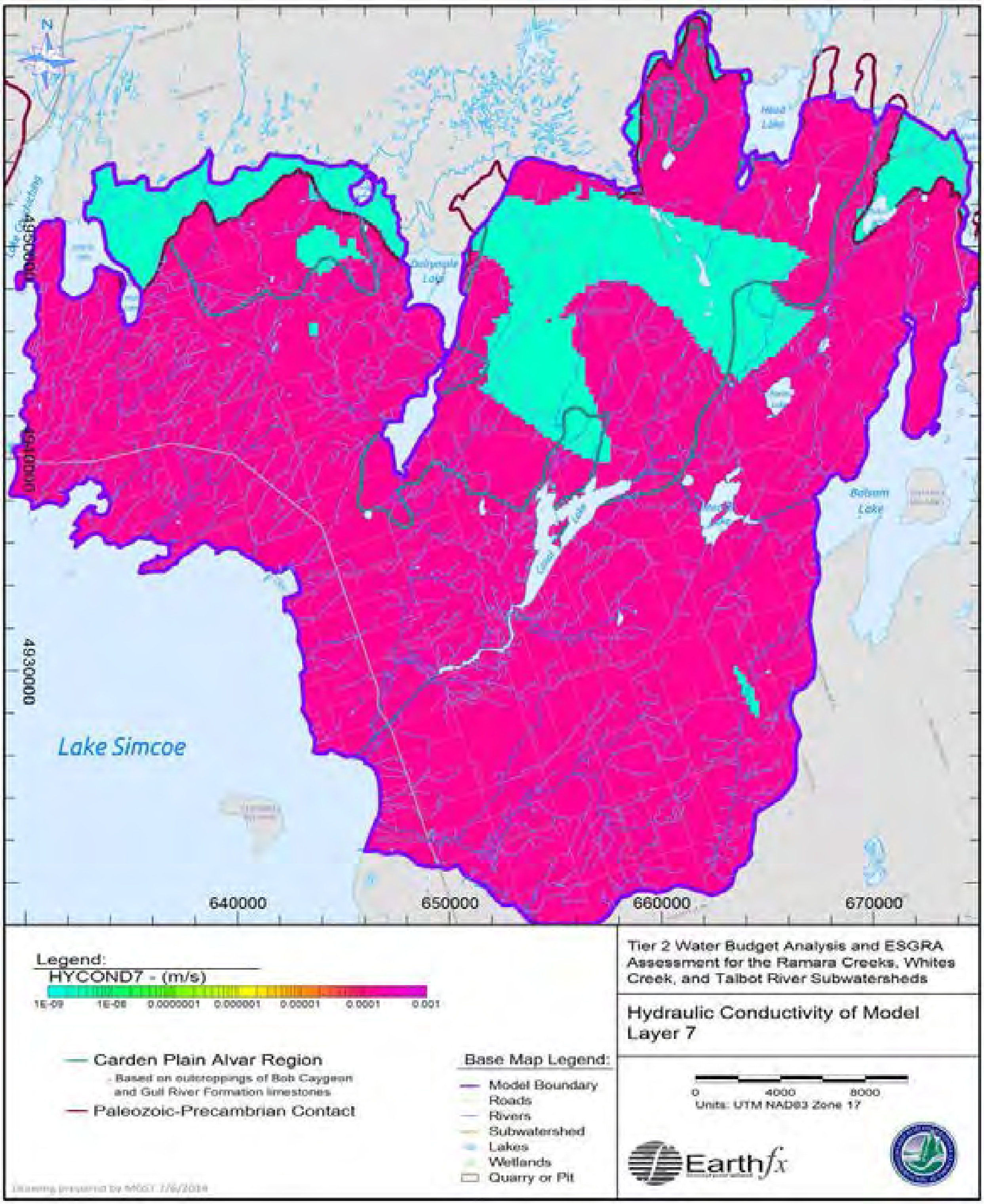



**Figure 4-9: Hydraulic conductivity, in m/s, for Layer 7 (Shadow Lake-Precambrian contact aquifer) (Earthfx, 2014).**

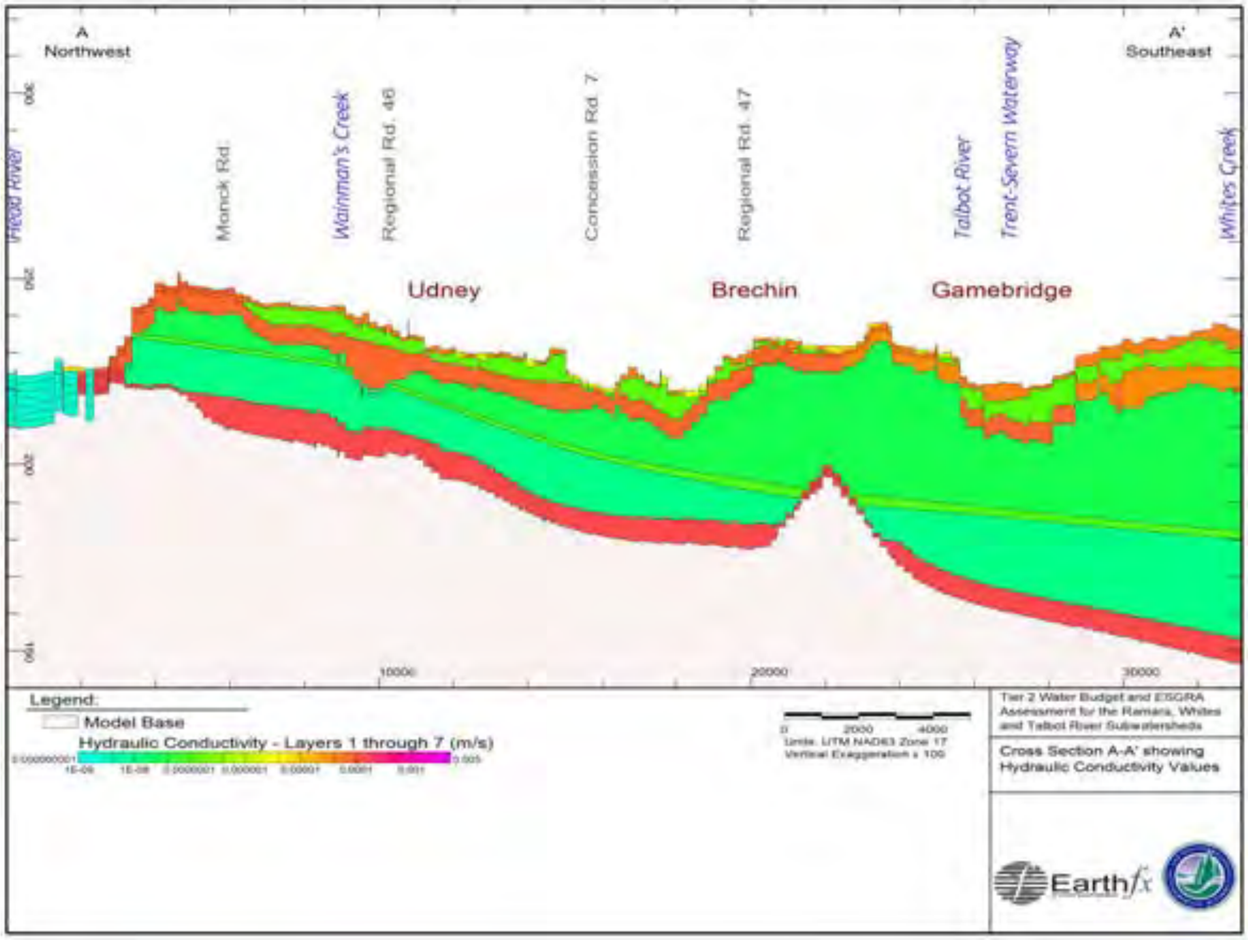



**Figure 4-10: Regional north-south section showing hydraulic conductivity distribution in numerical model layers**

### *4.2.3 Groundwater Flow*

Groundwater flow is controlled by the variation in aquifer transmissivity (i.e. hydraulic conductivity multiplied by aquifer thickness) taking into consideration hydraulic gradients. Groundwater moves continuously but at different rates based on the hydraulic properties of the formations mentioned in Section 4.2.2. Groundwater will flow down a hydraulic gradient from points of higher to lower hydraulic heads. The direction of movement at any point within the system is dependent on the distribution of hydraulic potential. Within each formation, groundwater can move in both the horizontal and vertical directions. Since the shallow water table commonly follows the ground surface topography, horizontal flow can be topographically mapped using water table data obtained from shallow wells.

Regional water level patterns in the Ramara Creeks subwatershed were interpreted using static water level data from wells documented in the MOE Water Well Information System (WWIS). The available static water level data were analysed, and measurements were assigned to one of the 14 hydrogeologic units identified in the study area based on the reported depth of the well screen for each well (Earthfx, 2014). Analysis of the water level data indicated that the majority of the well screens are located in the shallow overburden and weathered bedrock interface aquifer (Layer 3), while only a small number of the wells are screened in the deeper bedrock units (Earthfx, 2014).

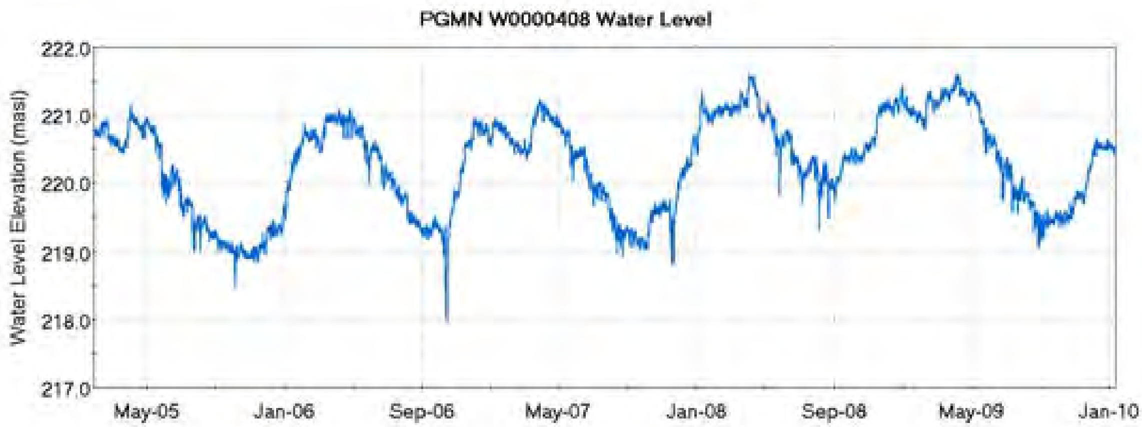
Due to the availability and spatial distribution of WWIS data, it was possible to reliably interpolate the water levels in the shallow groundwater system. Data for the deeper system was too sparse to interpolate, however individual measurements were still used during the calibration of the model. As illustrated in Figure 4-11, interpolated water levels (hydraulic heads) indicate that the shallow groundwater system tends to be a subdued replica of the land surface topography (Earthfx, 2014).

The interpolation of water levels also allows for the development of a reasonable representation of regional groundwater flow patterns across the study area. The direction of groundwater flow is interpreted as moving perpendicular to the contours delineated in Figure 4-11. In the Ramara Creek subwatershed, a westward to south-westward trend in regional groundwater flow toward the eastern shores of Lake Simcoe can be observed across the study area. Characteristically gentler flow gradients are interpreted as the shores of Lake Simcoe are approached, while the steeper flow gradients in the area correspond to the northern upland region of the subwatershed. Radial flow occurs from a large groundwater recharge mound located in the north end of the subwatershed, and major surface water bodies (Lake Simcoe and Dalrymple Lake) represent areas of groundwater discharge.

Figure 4-12 illustrates that groundwater in the Ramara Creeks subwatershed can generally be found less than 10 m below ground surface. Groundwater levels are at their highest elevation of 240 metres above sea level (masl) at the upland recharge area in the northern part of the subwatershed, while groundwater levels are at their lowest elevation of 220 masl along the eastern shores of Lake Simcoe. This corresponds well with the water level measurements taken at the single Provincial Groundwater Monitoring Network (PGMN) well located at the south end of the subwatershed.

The Provincial Groundwater Monitoring Network (PGMN) is a province-wide program that aims to gather long term baseline data for groundwater quality and quantity in key aquifers across Ontario. The Ministry of the Environment and Climate Change, in partnership with the Lake Simcoe Region Conservation Authority, manages a number of PGMN wells in the Lake Simcoe watershed, one of which is located in the Ramara Creeks subwatershed. The single PGMN well in the subwatershed is located near the outfall of the Trent- Severn Waterway into Lake Simcoe, and has been online since January of 2005. The well is completed to a depth of 13.7 metres below ground surface and screened in the overburden/weathered bedrock interface aquifer unit associated with layer 3 of the groundwater submodel. A review of the available long-term water level data from the PGMN well was conducted to quantify seasonal fluctuations in groundwater levels. Water levels in the PGMN well are presented in Table 4-3, and show a seasonal fluctuation of approximately 2 m (between 219 masl and 221 masl). Water levels generally increase in late winter/spring until they peak between April and May, after which they experience gradual declines into late fall/early winter(Earthfx, 2014). These fluctuations are slightly offset from the seasonal patterns at Lake Simcoe, where stage fluctuates approximately 0.5 m seasonally, with an increase from mid-March to April, a plateau until July, followed by a water level decline into the winter months (Earthfx, 2014). Due to the well's proximity to Lake Simcoe, measured water levels at the PGMN well were not considered a reflection of seasonal trends across the Ramara Creeks subwatershed.

**Table 4-3: Water levels at PGMN well W000408 (overburden/ weathered bedrock interface aquifer).**




Groundwater is exchanged between the different aquifers as leakage across the aquitards. The direction of vertical flow depends on the relative heads in the different aquifers. Leakage rates vary locally depending on the magnitude of the vertical gradients and on the thickness and hydraulic conductivity of the confining units. Gradients across the Ramara Creeks subwatershed are generally downward and steepest where the Newmarket Till is thickest.

Backward particle tracking analyses were carried out within the subwatershed. With backward tracking, particles are introduced in a dense distribution at the point of known groundwater discharge or around ecologically significant discharge features and traced back to the point of recharge. Based on reverse particle tracking completed for this area, the regional groundwater flow contribution supports numerous wetland and stream features in the Ramara Creeks subwatershed. In general, important features such as wetlands and streams are supported by the key recharge areas located within the topographic boundaries of the subwatershed. However, despite the relatively contained nature of groundwater flow in the subwatershed, backward particle tracking analysis indicated that some of the headwaters in the subwatershed are likely receiving groundwater inflow from recharge zones in the Carden Plain alvar located outside of the subwatershed boundary (Earthfx, 2014). The Carden Plain Alvar is a unique physiographic region characterized by Karst topography formed through the solutional weathering of limestone pavement. In the model area, the dissolution of alvar has resulted in formation of solutionally enlarged joints in the bedrock. These large fractured joints allow significant amounts of recharge to rapidly enter the groundwater system.

Backward particle tracking analysis also highlighted the connection between the groundwater system and specific surface water features. For example, both the wetlands and streams in the Ramara Creeks subwatershed are greatly reliant on the topographic high located between Dalrymple Lake and Lake St. John. As previously noted, this topographic high is interpreted to act as a significant recharge zone for the Ramara Creeks subwatershed.

**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.
- Under the Provincial Groundwater Monitoring Network (PGMN), the LSRCA, in partnership with the Ministry of Environment, currently operates one monitoring well within the Ramara Creeks subwatershed. Well W0000408 is completed to a depth of 13.7 m, and is screened in the overburden/weathered bedrock interface aquifer unit associated with Layer 3 of the groundwater submodel. The well is located near the outfall of the Trent Severn Waterway into Lake Simcoe. Water level measurements in the well show a seasonal fluctuation of approximately 2 m (between 219 masl and 221 masl).  Water levels in the well generally increase in late winter/spring until they peak between April and May, after which they experience gradual declines into late fall/early winter(Earthfx, 2014).

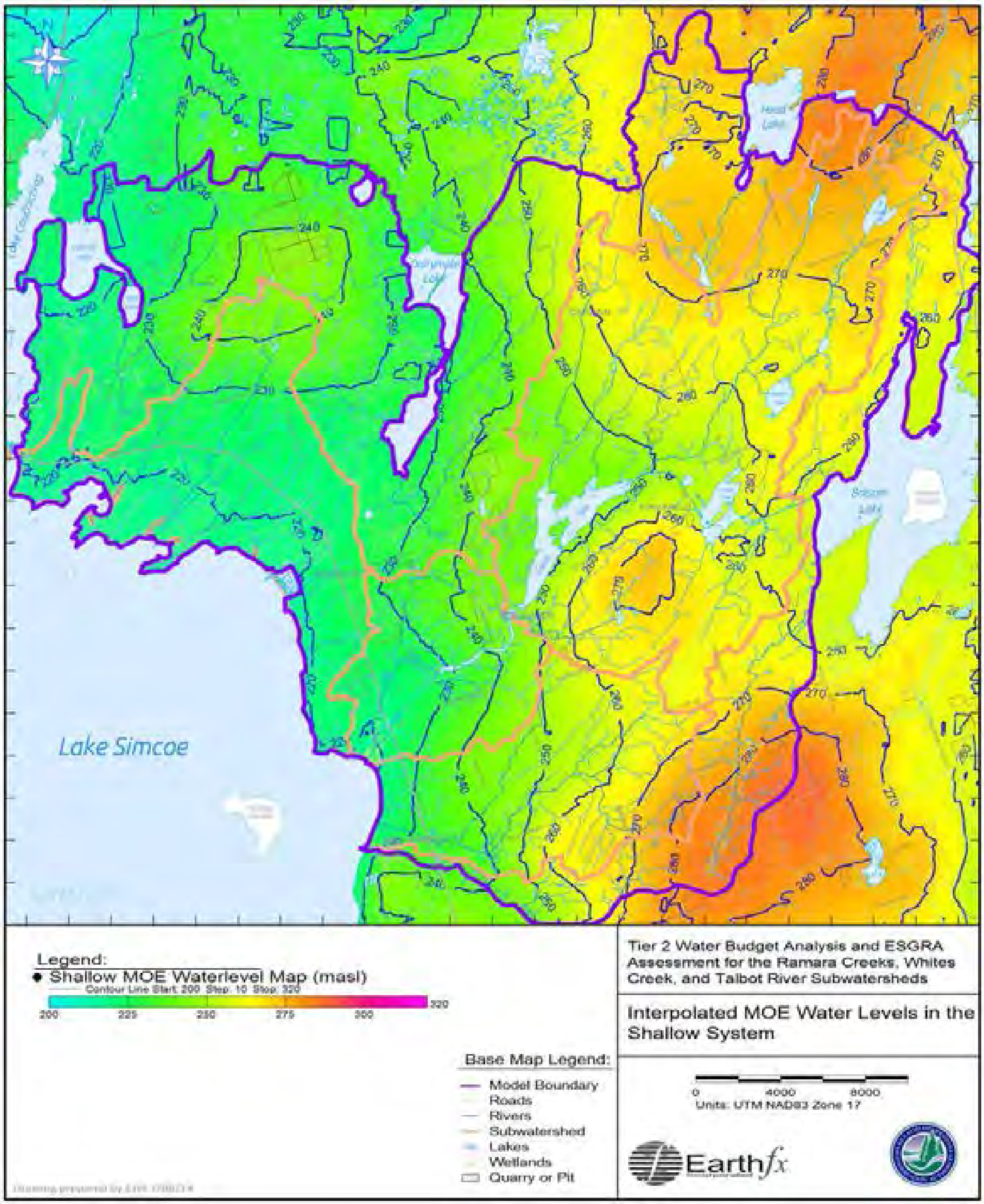



**Figure 4-11: Interpolated MOE water levels in the shallow groundwater system (Earthfx, 2014).**

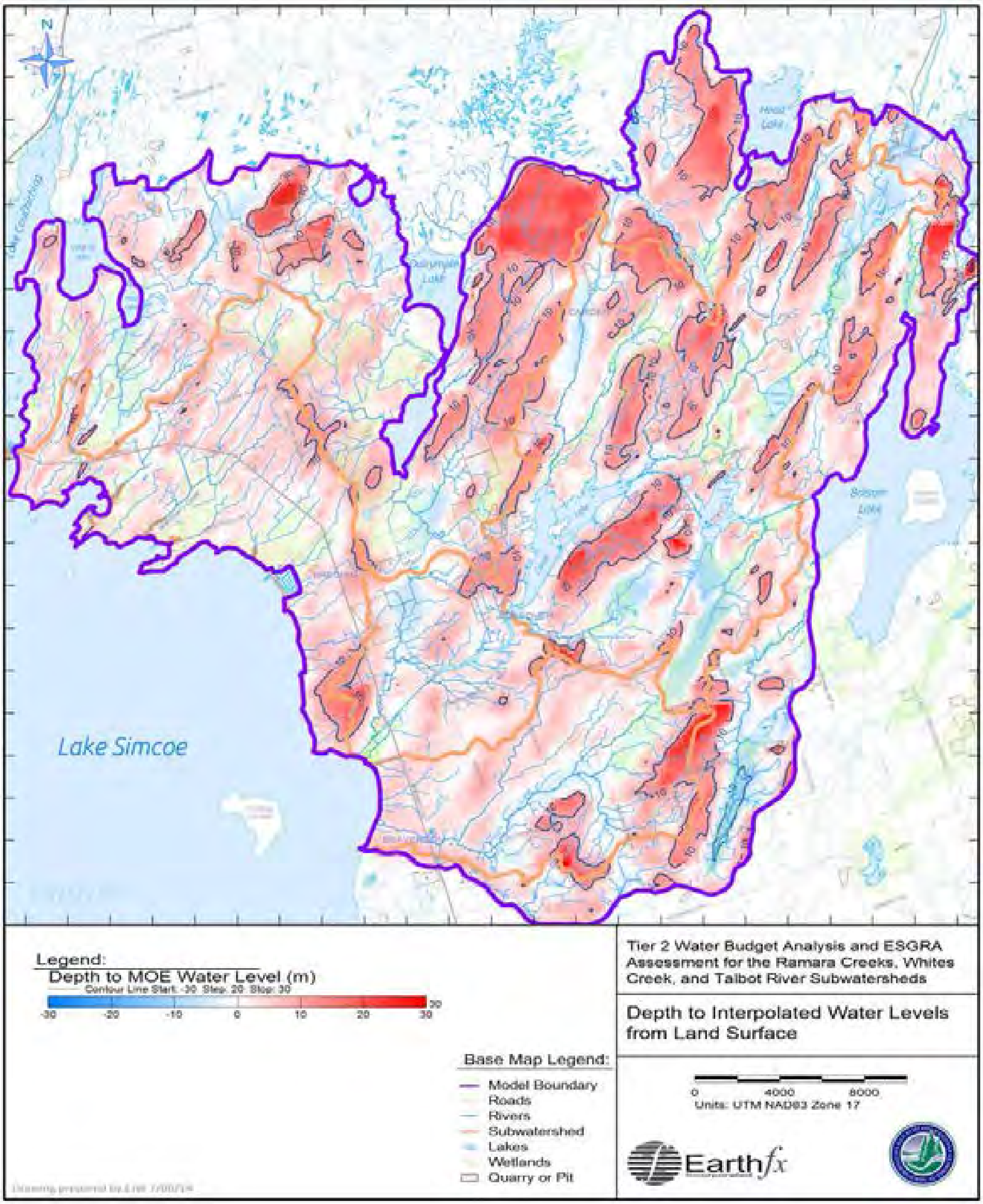



**Figure 4-12: Depth to interpolated water level from ground surface (Earthfx, 2014).**

### 4.2.4 Streamflow

The model developed for the Tier 2 Water Budget Assessment simulates streamflow in an area well beyond the boundaries of the Ramara Creeks subwatershed. The model incorporates the surrounding Talbot River and Whites Creek subwatersheds, as well as small additional areas to the north, south, and east of the three core subwatersheds. The streams, lakes, and wetlands that drain the study area are shown in Figure 4-13. The study area contains three major subwatersheds; the Talbot River, Whites Creek, and Ramara Creeks. These subwatersheds are bounded by the Beaver River to the south, the Head River to the immediate north and the 12,500 $km^2$ Trent River watershed to the east. Surface water data from several sources including streamflow measurements, previous modelling efforts, canal operations, and surface feature mapping were compiled. Streamflow monitoring locations are shown in Figure 4-14. As illustrated in Figure 4-14, there are no surface flow monitoring locations within the Ramara Creeks subwatershed. There is one active stream gauge located on the boundary between the Ramara Creeks and Talbot River subwatersheds, which has been operated by the LSRCA since 2005.

Streamflow at this gauge appears to be strongly influenced by the Trent-Severn Waterway Canal Operations. The Trent-Severn Waterway provides a 386 km navigable chain of interconnected rivers and lakes from Lake Ontario at Trenton to Port Severn in Georgian Bay. The canal serves thousands of recreational boaters during its May to October operating season. Water levels are maintained by a series of dams, and navigation is accomplished through locks which raise and lower boats between adjacent sections of the waterway. There are six such structures between Lake Simcoe and Balsam Lake, all of which run through the Talbot river subwatershed. Mean daily discharge (streamflow) on the Talbot River at the LSRCA gauge is presented in Figure 4-15. The large events recorded during January 2008 and December 2009 were the result of control operations by staff to divert water from the upper Trent watershed to Lake Simcoe. These operations are routinely undertaken to create additional winter storage in the central Trent-Severn to accommodate predicted spring freshet flow. The influence of the Trent-Severn Waterway controls can also be observed during the summer and fall months as gradual or sudden changes in discharge. Because flows at this gauge are influenced by the canal operations, and since the timing and volume of releases were not provided, they were not suitable for model calibration, and therefore not used.

Anecdotal information provided by LSRCA monitoring staff suggests that the majority of the streams in the Ramara Creeks subwatershed dry out during the summer months. These streams are suspected to be particularly sensitive to drought because of their dependence on localized, surface water driven recharge. Due to the inherent behaviour of locally recharged streams, streamflow in these reaches responds quickly to recharge events making them flashy in nature and prone to drying up during the dryer summer climate conditions.

Anecdotal information provided by monitoring staff also indicates that many of the streams have been converted to agricultural drainage channels to accommodate the agricultural irrigation activities occurring across much of the subwatershed. The conversion of stream reaches to agricultural drainage channels likely further exacerbates the impacts of drought on these already sensitive streams. The naturalization of streams and local surrounding recharge areas may help increase the resilience of these reaches to drought conditions and climate change. When flowing, many of the streams in the subwatershed are characterized by warm water conditions, with the exception of a few places around the subwatershed, such as the north-western and north-central regions of the subwatershed, where coolwater conditions have been recorded.

Baseflow

Baseflow is considered 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 coldwater habitat. This habitat can be affected by localized pumping as the aquifers are drawn down and less baseflow is released.

While flow gauges are a very effective tool for examining baseflow, no gauge is present in the Ramara Creeks subwatershed, which makes an accurate description of baseflow across the entire study area difficult. For this reason discrete baseflow measurements were conducted in the Ramara Creeks subwatershed. The results of the 2005 survey conducted by the LSRCA are illustrated in Figure 4-16.

The study included performing discharge measurements 72 hours after precipitation to ensure they were representative of baseflow. For the purpose of analysis each measure was compared to the closest upstream measure to determine if the reach between the measures was gaining or losing flow. Gaining reaches indicate groundwater contribution to the stream while losing reaches could indicate water taking, groundwater infiltration, or impoundments. Figure 4-16 indicates that discharge measurements for the majority of reaches in the Ramara Creeks could not be taken due to a number of possible reasons including that the reaches were either dry, standing, or too low to allow for discharge detection. Because of their dependence on localized, surface water driven recharge, many of the streams in the Ramara Creeks subwatershed are sensitive to drought, and flashy in nature as discussed above, making it difficult to obtain representative discharge measurements.

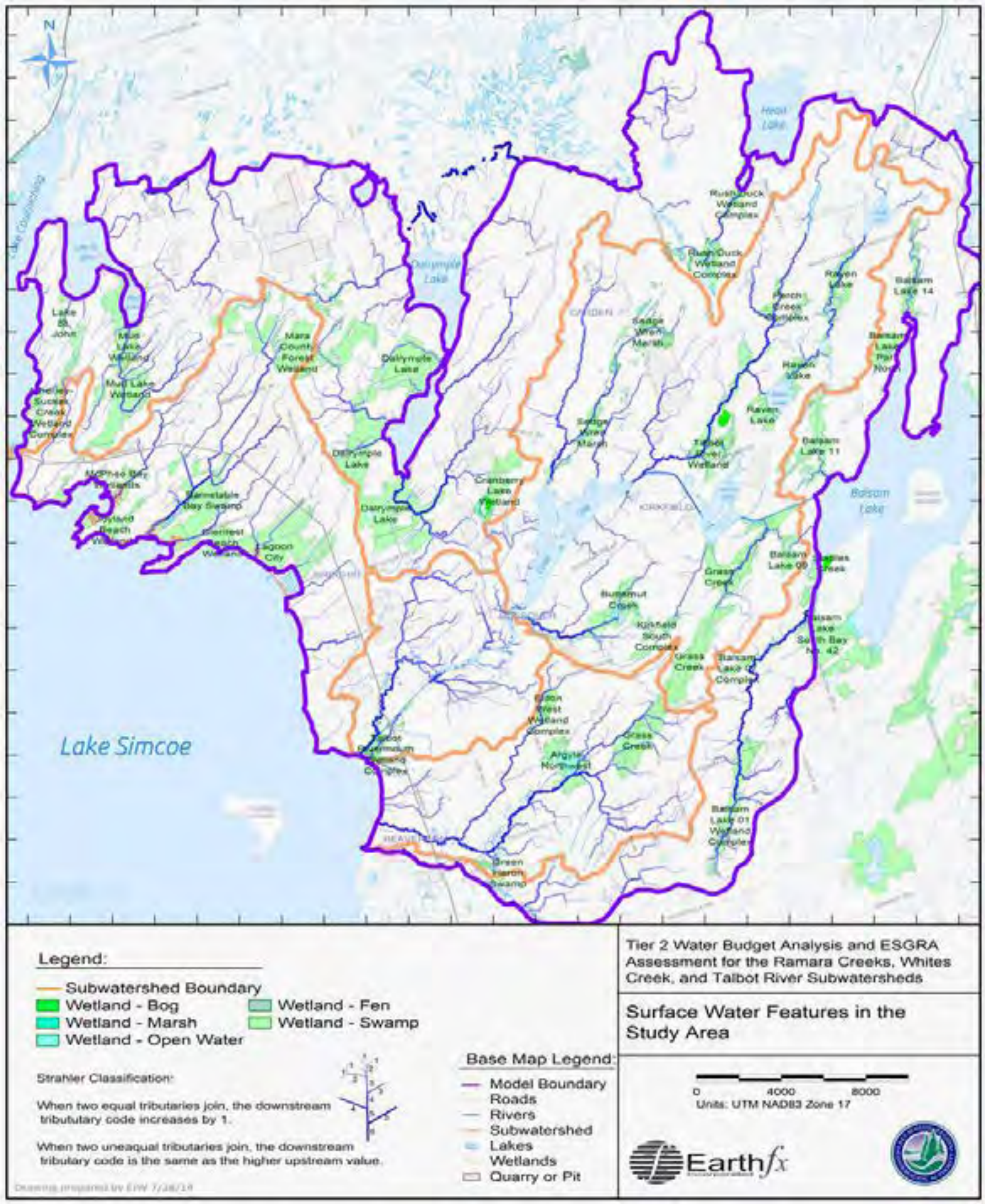



**Figure 4-13: Study area surface water features (Earthfx, 2014).**

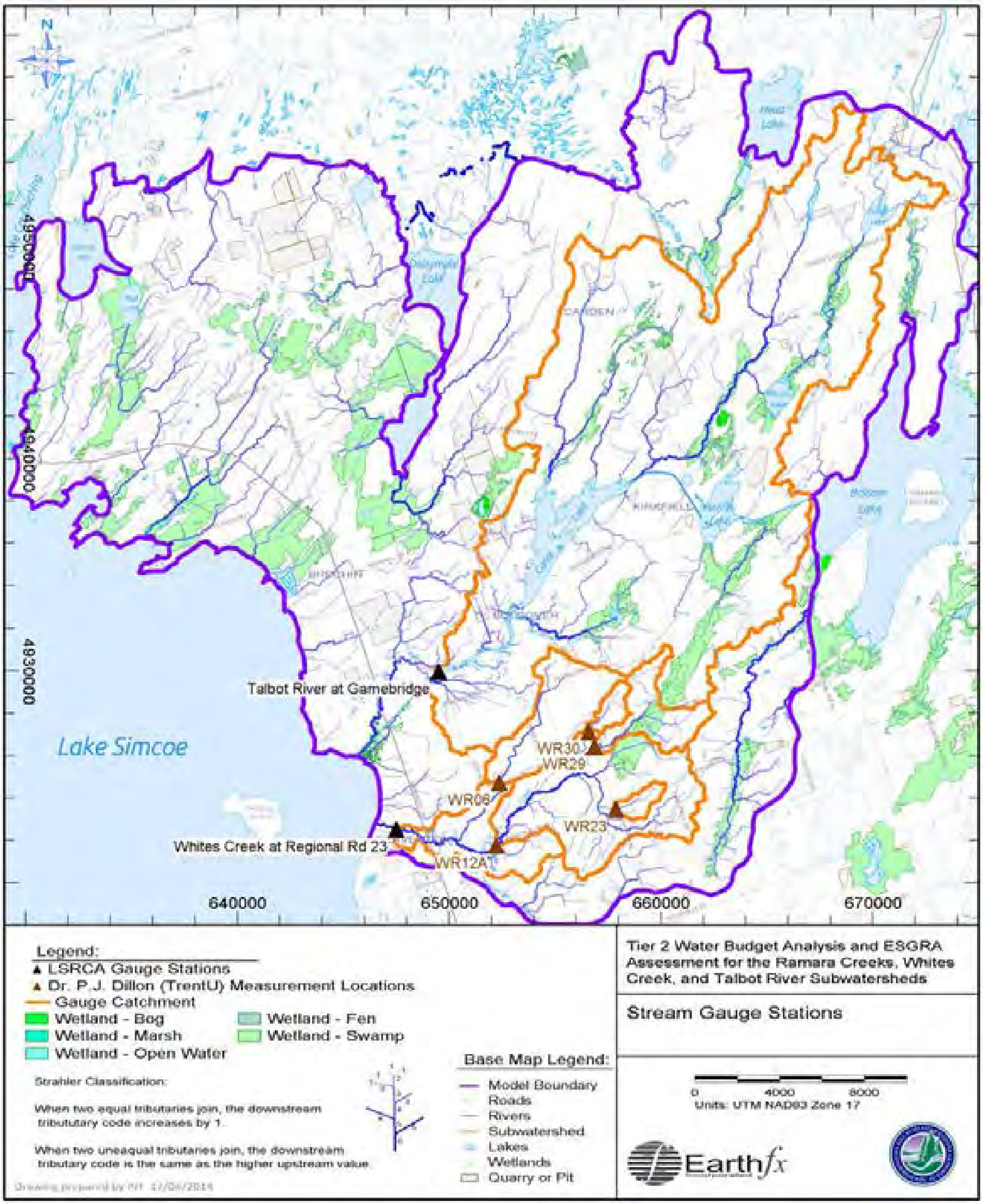



**Figure 4-14: Stream discharge measurement locations within the study area (Earthfx, 2014).**

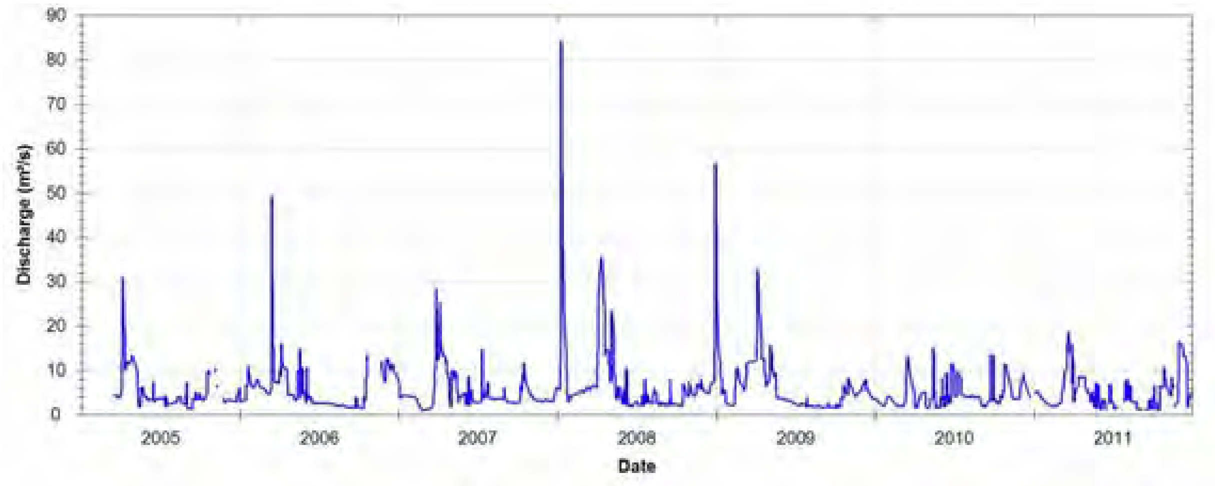
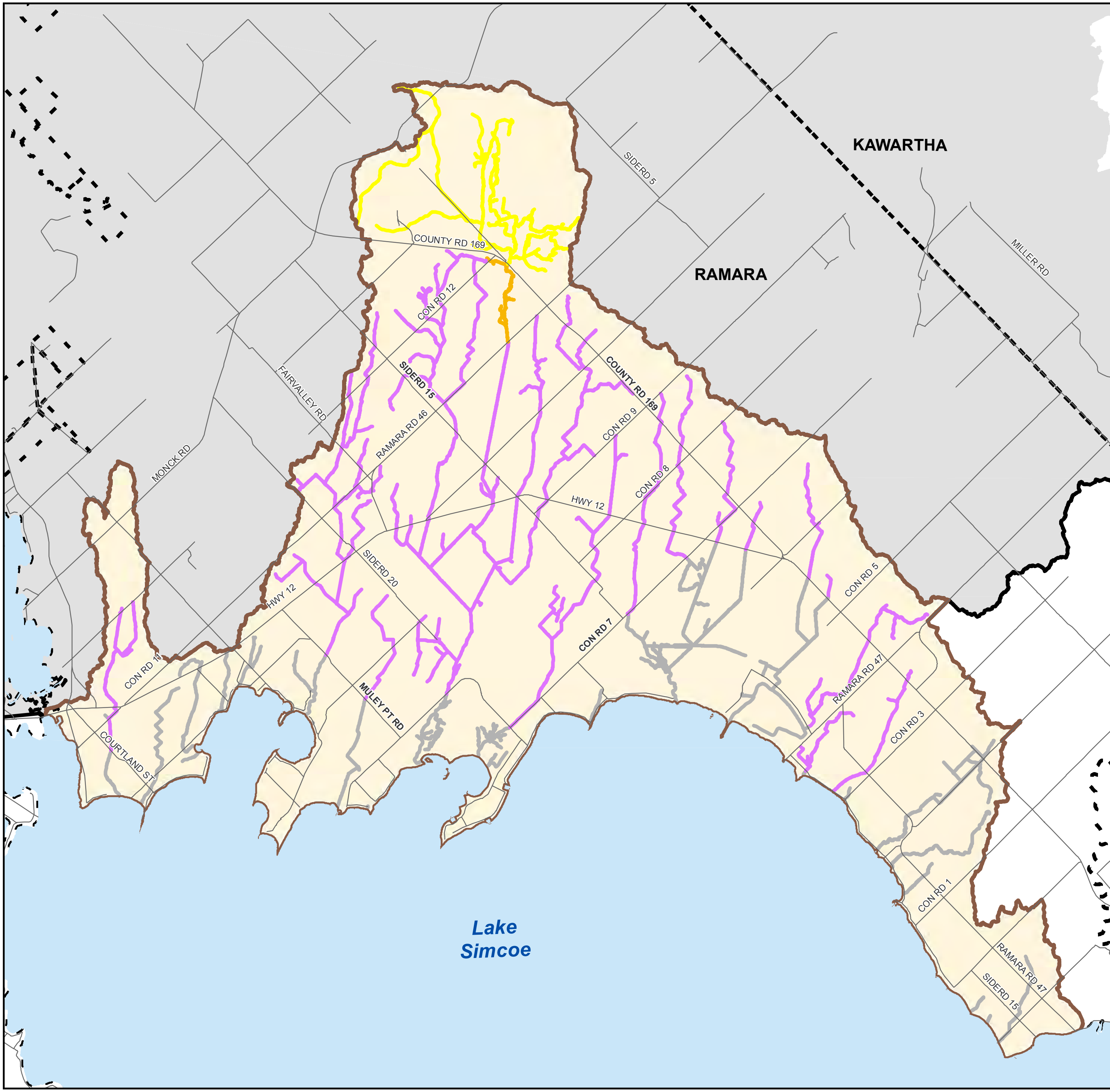



**Figure 4-15: Mean daily discharge observed at Talbot River near Gamebridge (LS0109) (Earthfx, 2014).**

## Gaining and losing reaches within the Ramara Creeks subwatershed

Figure 4-16




**Legend**

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Base Flow (L/s/km)

- <-20
- -10 to -20
- -5 to -10
- -0.01 to -5
- 0.01 to 5
- 5 to 10
- 10 to 20
- 20 to 30
- >30
- Dry, Standing or Too Low
- No Data

Lake Simcoe Region conservation authority

0 0.5 1 2 3 Kilometres

N E S W

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 dc created August 2014.

### *4.2.5 Groundwater Discharge*

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. As described in the previous section, baseflow is the portion of water that is contributed from groundwater; this 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 (as discussed in the previous section) 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, as discussed in Section 4.2.4 there are no stream gauges in the Ramara Creeks subwatershed, therefore hydrograph separation techniques could not be applied, and groundwater discharge to subwatershed streams could not be quantified in this manner. Instead, groundwater discharge patterns across the Ramara Creeks subwatershed were interpreted through the simulation of various scenarios using the integrated surface and groundwater model designed to evaluate water quantity and flow in the Ramara Creeks, Whites Creek, and Talbot River model area.

The calibration of the integrated groundwater/surface water model included the groundwater heads and flow patterns observed from wells in the MOE water well database (MOE WWIS database), in conjunction with streamflow data gathered from gauge stations present in the Talbot River and Whites Creek subwatersheds. The groundwater level data and the stream flow data served as the primary calibration targets for the integrated ground/ surface water model. The direct contribution of groundwater to streamflow in the Ramara Creeks subwatershed was assessed from the integrated model output. This value does not account for the total groundwater contribution to streamflow because it does not include groundwater discharge to wetlands and lakes and does not include discharge of groundwater in riparian areas (surface leakage) that subsequently reaches the stream as Dunnian runoff. Dunnian runoff is typical in humid regions characterized by a high groundwater table. Dunnian runoff is associated with excess saturation mechanism where near the bottom of a hillslope the soil water content is high and gradually decreases upstream of the hillslope. However, direct groundwater discharge to streams provided a good parameter to study the sensitivity of channel features to changes in the groundwater system.

As mentioned above, groundwater discharge values within the Ramara Creeks subwatershed were derived from outputs of the integrated ground/surface water model. Simulated groundwater discharge to streams is illustrated in Figure 4-17. Average groundwater discharge to the Ramara Creeks subwatershed under current conditions is estimated to be 10,112 $m^3$/day.

Groundwater discharge values were also used to evaluate the response of surface and groundwater systems under drought scenarios. The Earthfx (2014) study used the integrated surface/groundwater model to simulate the effects of two drought scenarios across the model area. The first analysis represented an extreme 2 year drought condition where recharge across the area was assumed to be zero over that time period. The second scenario was used to evaluate the response of the ground/surface water system to a historic 10 year period of low rainfall from 1957 to 1967. This analysis allowed for the examination of how groundwater discharge would be affected under a similar period of low rainfall. Details regarding the simulation and results of the drought scenarios are further discussed in section 4.4.4.

The monthly average groundwater discharge to the Ramara Creeks subwatershed at the beginning of the 10 year drought is illustrated in Figure 4-18, while stream discharge at the worst of the 10 year drought (November 1964) is illustrated in Figure 4-19. Simulated groundwater discharge to streams, as shown in these figures, represents the accumulated leakage into the streams across the stream bed (also referred to as hyporheic flow). The pronounced impact of the drought occurs at the headwater tributaries in the subwatershed. This is particularly noticeable around the headwater streams of Wainman's Creek, where a 100% decrease in flow was predicted Figure 4-20. The main tributaries in the subwatershed are generally affected to a lesser degree.

The yearly average total groundwater discharge to the Ramara Creeks subwatershed from 1957 to 1967 is illustrated in Figure 4-21. Groundwater seepage to streams is at its minimum in late-summer/early fall and reaches a maximum in the late spring. The most severe drop in groundwater discharge occurs in response to a dry period in April 1959. The rates of groundwater discharge are less affected by drought after 1960, when the groundwater system in the subwatershed seems to recover. Trends in yearly average groundwater discharge conditions (Figure 4-21) correspond well with the monthly average discharge trends illustrated (Figure 4-22), with both trend analyses showing a minimum average groundwater discharge occurring in 1959.

The change in groundwater discharge to major streams in the subwatershed from the beginning of the 10 year drought to the height of the 10 year drought was also evaluated as part of the drought analysis. A 37.7% reduction in groundwater discharge to Wainman's Creek was predicted between July of 1956 and November 1964 (the height of the drought period).

To better illustrate the connections between the groundwater system and specific surface features, groundwater seepage can be plotted on a reach-by-reach basis. Figure 4-23 delineates groundwater seepage along the entire main channel of Wainman's Creek in July 1956 and November 1964. Chainage starts at Lake Simcoe and ends at a first-order stream in the Mara County Forest Wetland. Chainage refers to a reach-by-reach distance measured from Lake Simcoe where groundwater seepage measurements were taken. The corresponding cross-section in Figure 4-23 is shown as if the reader is looking in the direction of increasing chainage from left to right. Higher rates of groundwater seepage are generally noted at the downstream ends of streams, particularly where the till layers are relatively thinner. Groundwater discharge is also noted in all wetland areas. Discharge rates are decreased significantly in November 1964 at the height of the 10 year drought (Earthfx, 2014).

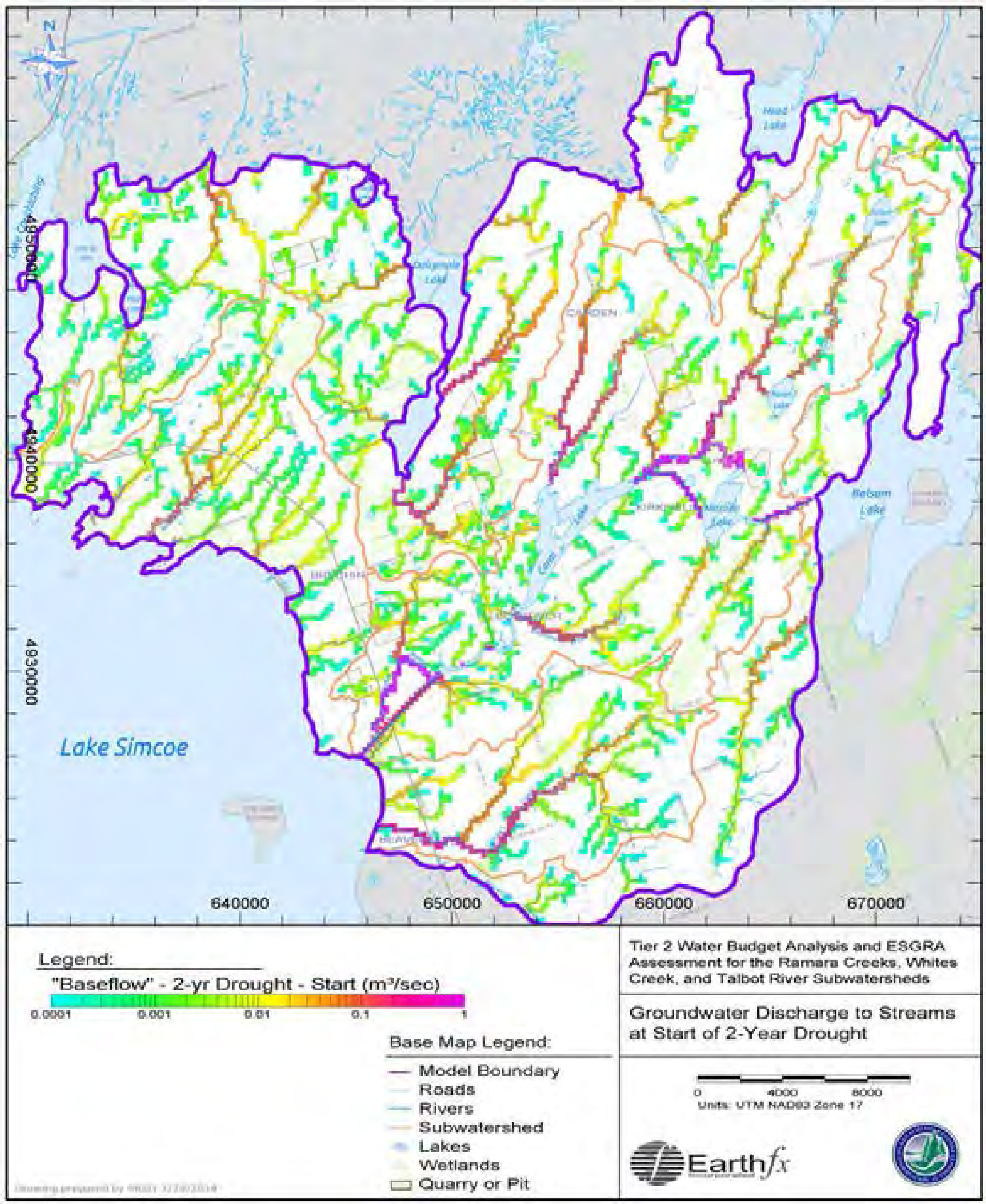



**Figure 4-17: Simulated groundwater discharge to streams (baseflow) under current conditions (Earthfx, 2014).**

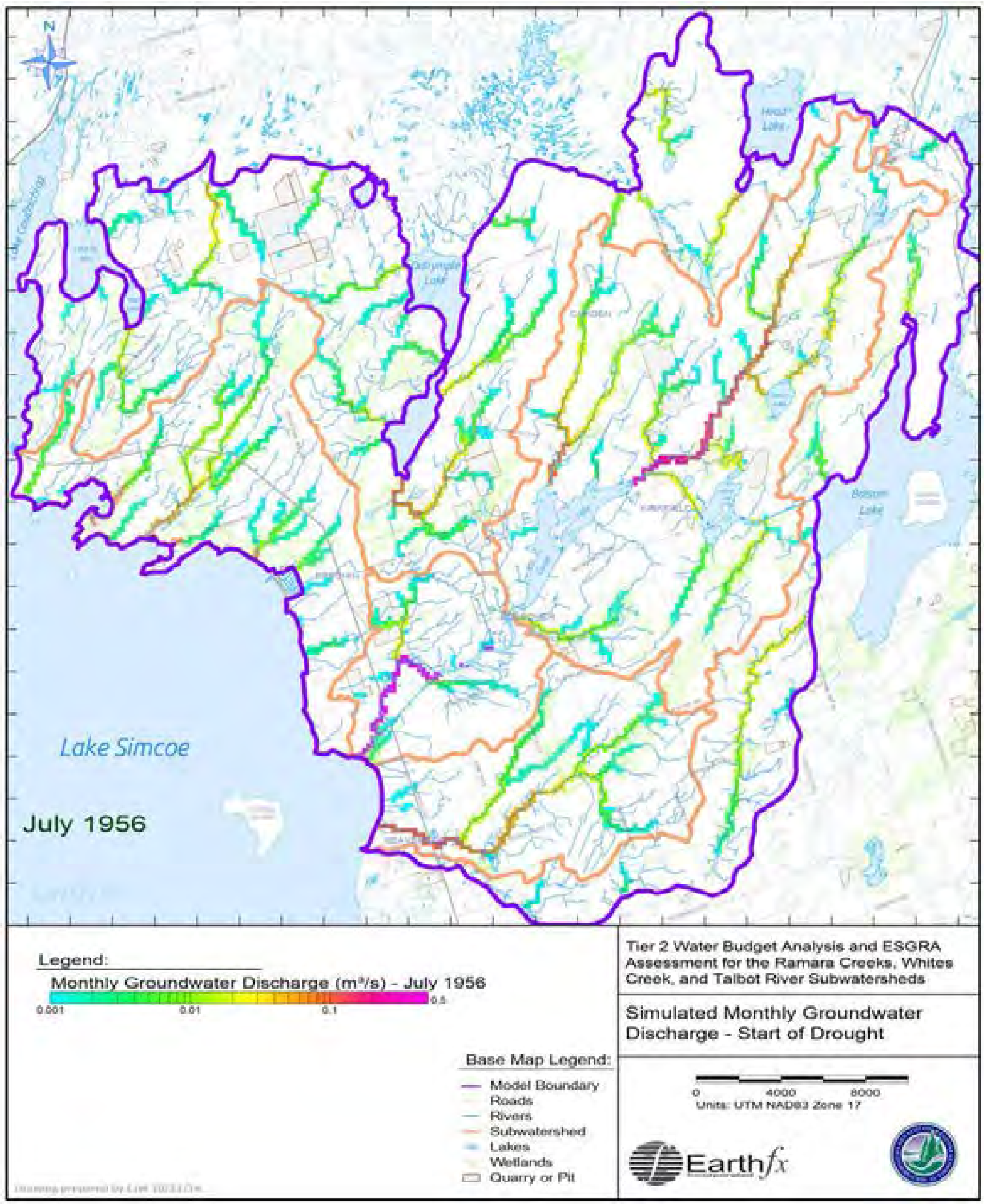



**Figure 4-18: Simulated groundwater discharge to streams in July 1956 at the start of the 10 year drought (Earthfx, 2014).**

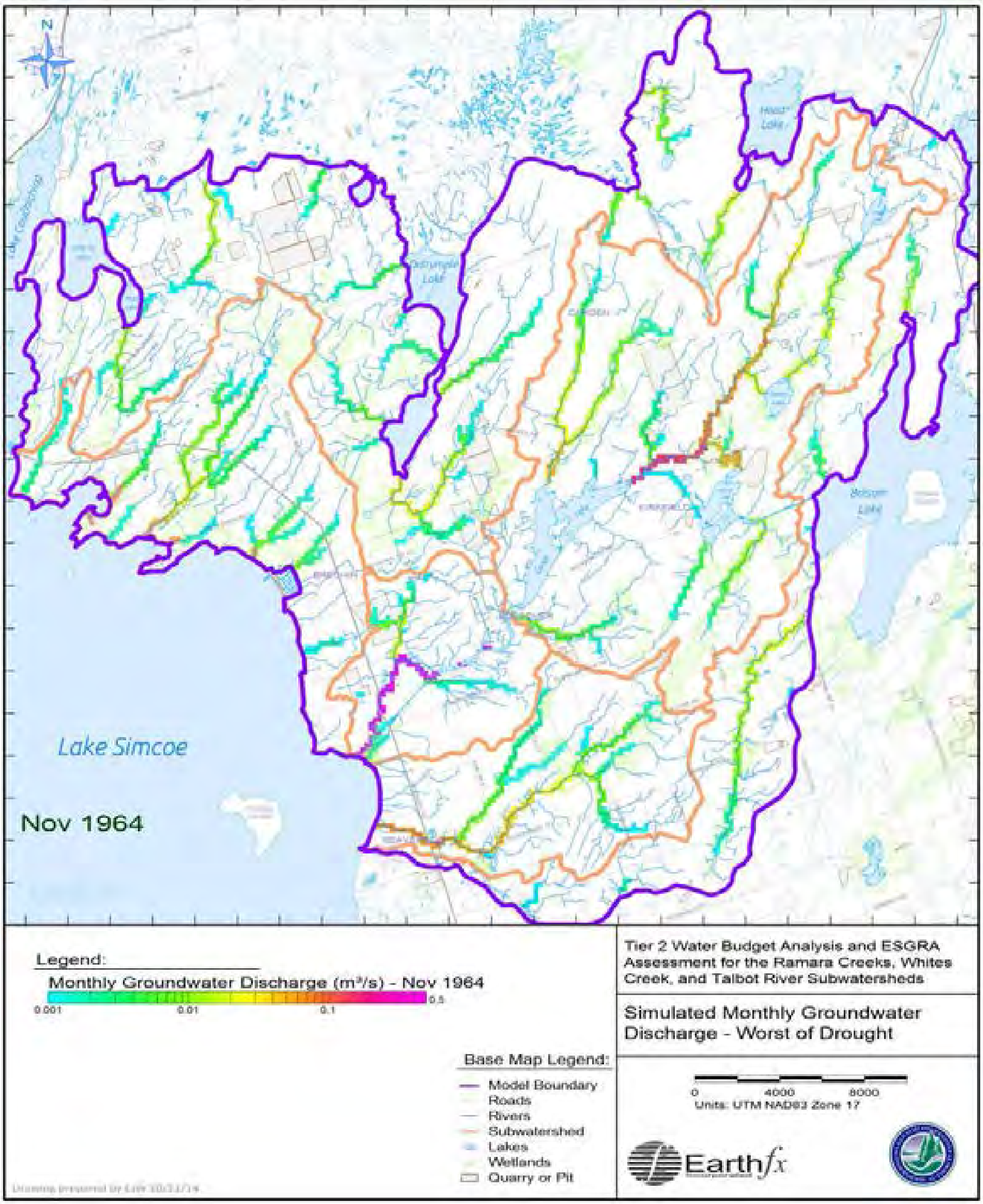



**Figure 4-19: Simulated groundwater discharge to streams in November 1964 at the worst of the 10 year drought (Earthfx, 2014).**

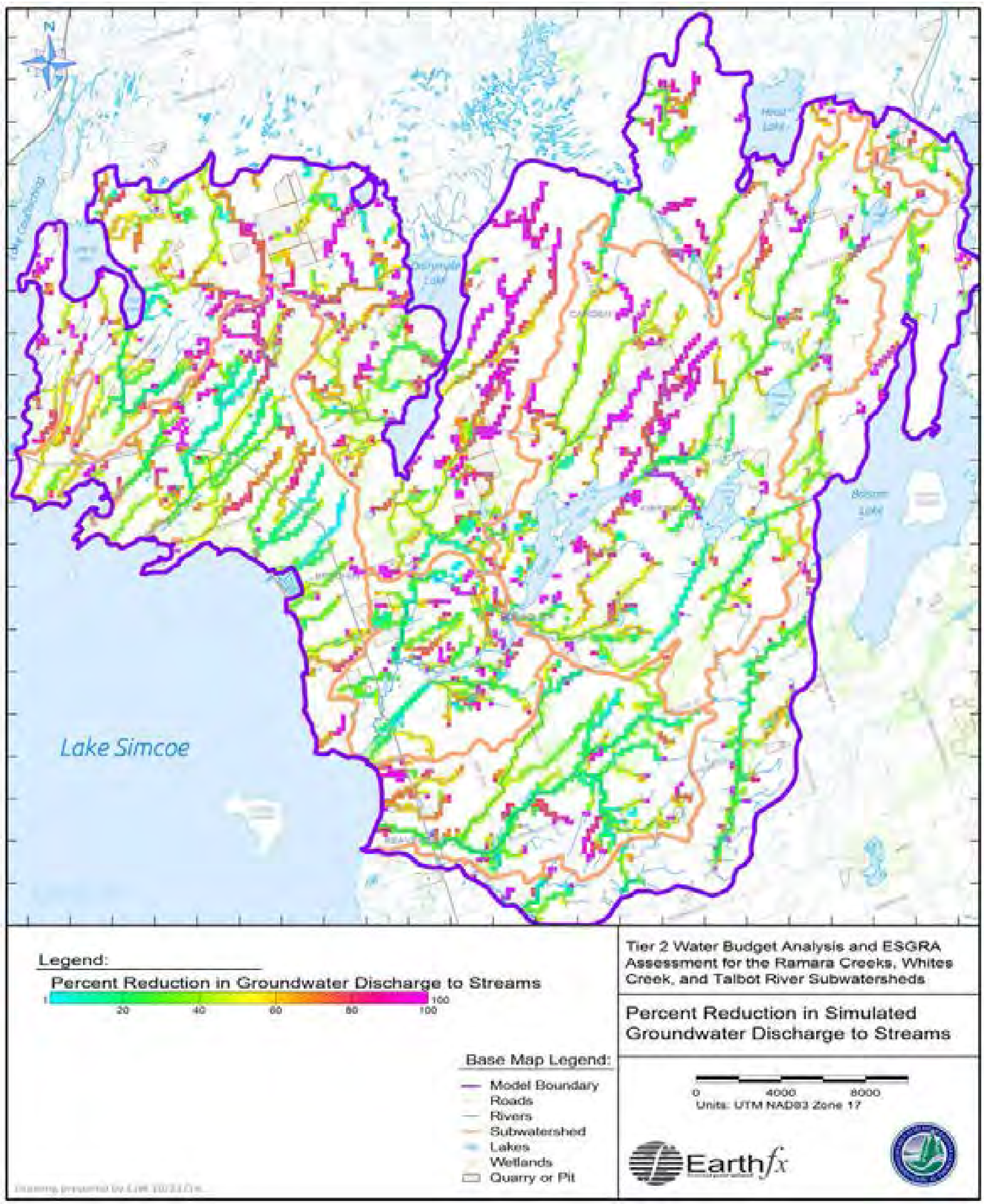



**Figure 4-20: Percent reduction in simulated groundwater discharge to streams (July 1976 versus November 1964) (Earthfx, 2014).**

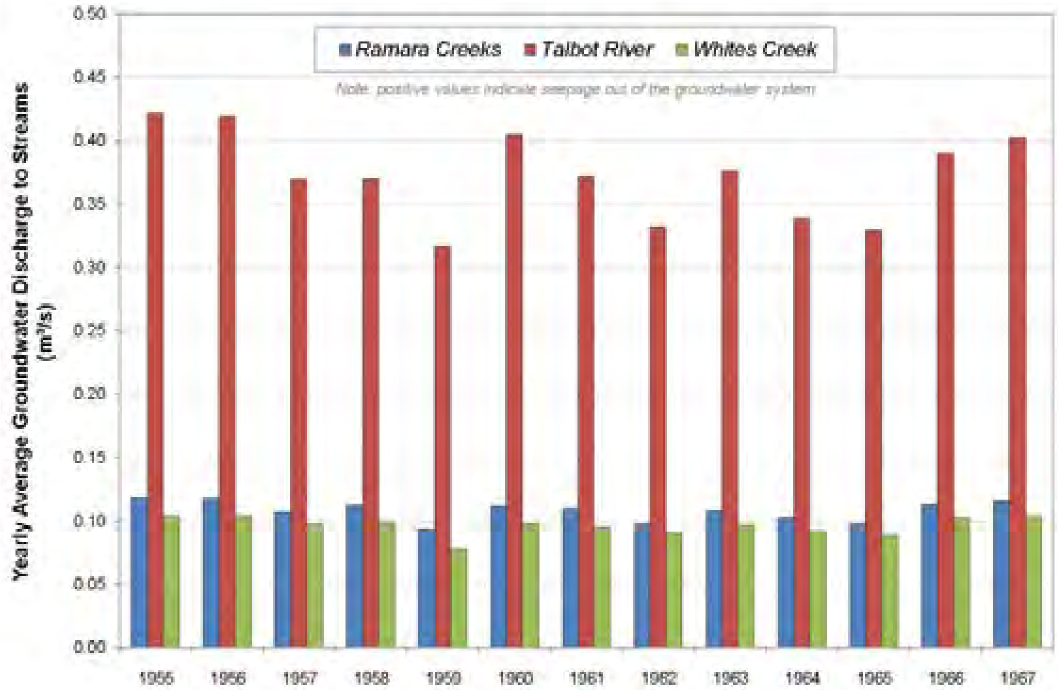



**Figure 4-21: Simulated annual average groundwater discharge to stream channels ($m^3/s$) in the study catchments (Earthfx, 2014)**

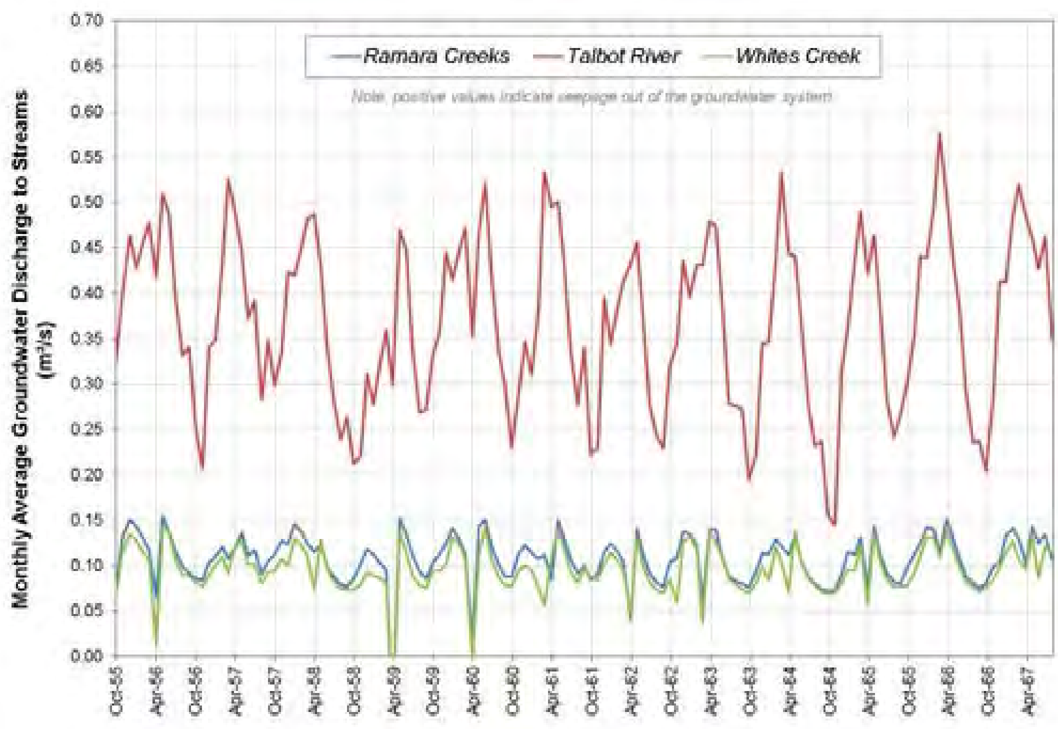



**Figure 4-22: Simulated monthly average groundwater discharge to stream channels ($m^3/s$) in the study catchments (Earthfx, 2014).**

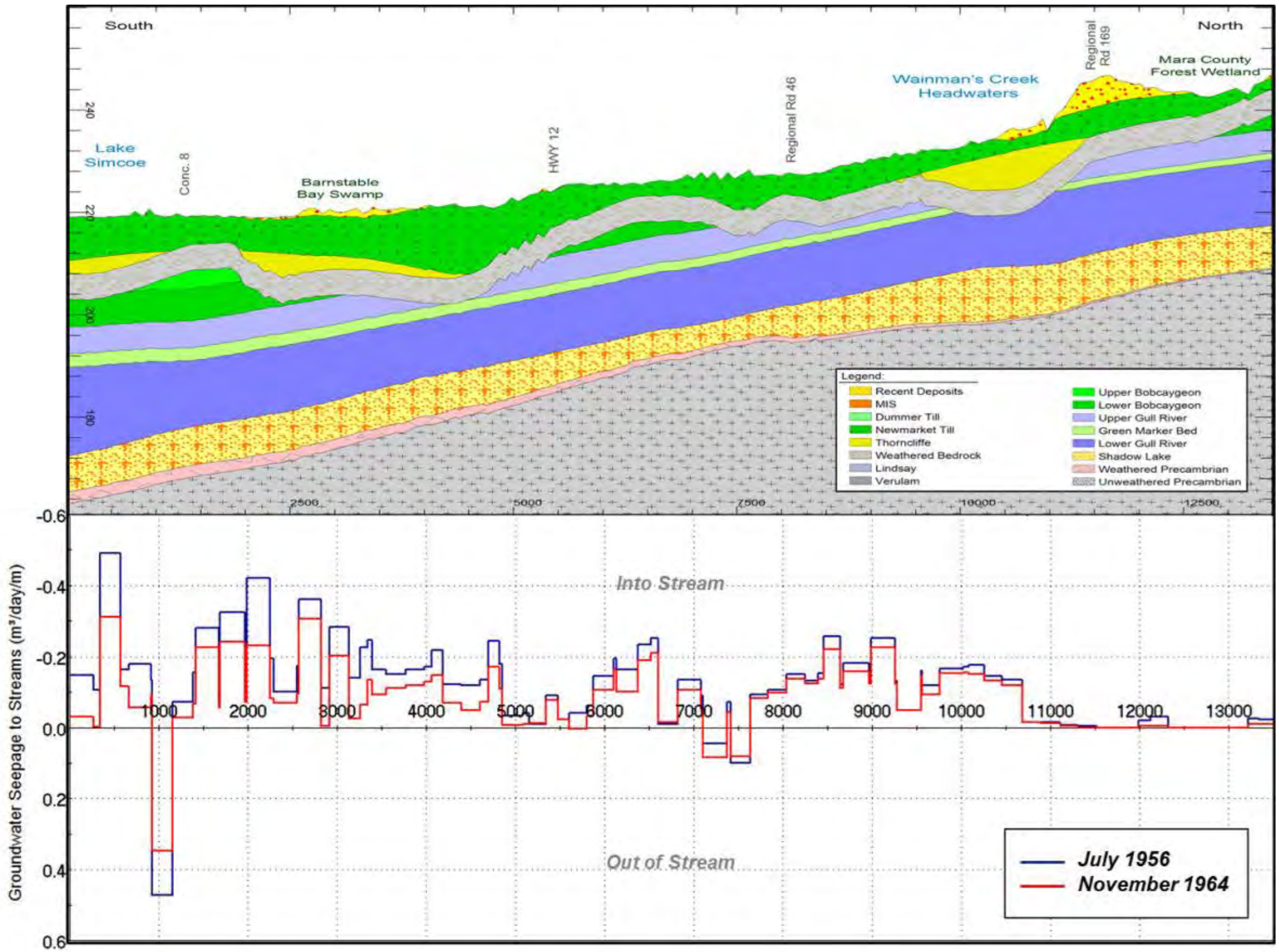



**Figure 4-23: Cross section along Wainman's Creek (Ramara Creeks subwatershed) showing simulated groundwater discharge to streams in July 1956 and November 1964 (Earthfx, 2014).**

### *4.2.6 Groundwater Recharge*

Groundwater is replenished as precipitation or snowmelt and infiltrates into the ground surface. Precipitation is the primary source of groundwater recharge (i.e., the amount of water that infiltrates through the unsaturated zone and ultimately reaches the water table). However, the rate and direction of groundwater movement is influenced by the distribution and thickness of surficial geology and associated soil properties, topography, vegetation, land cover, and land use. For example, water will move more readily through coarse loose material and bedrock fractures than through material such as clay or unfractured rock. In areas where there are impervious surfaces, such as within urban areas, the amount of infiltration is reduced, while in areas of sands and sandy loam, infiltration rates are increased.

Mapping of recharge zones and the policies that protect them are necessary to ensure the sustainability of groundwater supplies and a healthy subwatershed. The rate of groundwater recharge varies over the subwatershed area and is controlled by the factors listed above.

Rates of recharge within the Ramara Creeks subwatershed were originally predicted by the PRMS model completed by Earthfx (2010) for the whole Lake Simcoe basin in order to support basin wide Tier 2 water budget modelling work. However, through the completion of a more refined Tier 2 Water Budget study conducted specifically for the Ramara Creeks, Whites Creek, and Talbot River subwatersheds, a new, integrated groundwater and surface water model was developed. The new integrated GSFLOW model represents an amalgamation of the two widely-recognized USGS models: PRMS and MODFLOW (Earthfx, 2014). The PRMS submodel evaluates the impacts of various combinations of precipitation, climate, topography, soil type, and land use on streamflow and groundwater recharge, while the MODFLOW submodel simulates groundwater flow in multi-layered aquifer systems. The two models are coupled in GSFLOW through an integrated calibration exercise in which parameter values for both of the sub-models are adjusted. This stepwise process is necessary due to the complexity of the surface water and groundwater systems in region. The result of the integration is a detailed representation of surface and groundwater interactions in the study area.

Using the refined PRMS submodel, annual average groundwater recharge across the Ramara Creeks, Whites Creek, and Talbot River subwatersheds was estimated to be 151 mm/year, compared to the 164 mm/year predicted by the 2010 PRMS model. Figure 4-24 illustrates that the groundwater recharge rates for the Ramara Creeks subwatershed range from a low of near zero to 500mm/year. Overall, average recharge rates across the Ramara Creeks subwatershed tend to be less than the average recharge predicted across the whole model area. This is predominantly due to the clay and silt rich surficial geology that dominates the majority of the subwatershed. As discussed in **Chapter 2 (Section 2.4.1.3)**, a large portion of the Ramara Creeks subwatershed is overlain by fine grained glaciolacustrine silt and clay sediments deposited during glacial sedimentation. These fine grained deposits are generally associated with lower hydraulic conductivities and porosities and therefore contribute to the lower recharge rates predicted over the subwatershed. The Newmarket Till unit found across the subwatershed also contributes to the lower recharge rates due to its low conductivity sandy silt to silty sand composition.

As illustrated in Figure 4-24, small areas located along the southern, northern, and eastern boundaries of the subwatershed exhibit significantly higher than average groundwater recharge rates compared to the remainder of the Ramara Creeks subwatershed. These small, high recharge outcrop areas are characterized by the presence of highly fractured Paleozoic bedrock known as “alvar” - a bare to very thinly covered limestone unit predominantly present in the Upper Talbot subwatershed. Due to its carbonate composition, the alvar is susceptible to dissolution processes by aqueous solutions (i.e. rainwater dissolved with $CO^2$). The dissolution of alvar results in the formation of unique features across the landscape known as Karst. Noteable karst features found in the model area include solutionally enlarged joints called “grikes”. These large fractured joints allow significant amounts of recharge to rapidly enter the groundwater system resulting in rapid fluctuations in the water table, as well as the rapid lateral conveyance of groundwater through extensive fracture networks present across the alvar landscape. The presence of these fractures explains the considerably higher recharge rates predicted over these unique alvar areas. The distinct connections between geology and groundwater recharge indicate that groundwater recharge in the area is mostly dominated by surficial geology.

Significant Groundwater Recharge Areas

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.

Significant Groundwater Recharge Areas were developed for the entire Lake Simcoe watershed to meet the technical requirements under the Clean Water Act, 2006. The recharge areas were delineated by using the PRMS – surface water model developed through source water protection studies (Earthfx, 2010). Significant Groundwater Recharge Areas within the Lake Simcoe watershed represent areas where the recharge rate is 15% greater than the average recharge (164 mm/yr) across the watershed. The average recharge for the Ramara Creeks, Whites Creek, and Talbot River model area was predicted to be 164 mm/year by the 2010 PRMS surface water model. As a result, areas with an average recharge rate of 189 mm/year or greater were classified as significant groundwater recharge areas. The shaded areas within Figure 4-25 represent a recharge rate of 189 mm/year.

Both the Significant Groundwater Recharge Areas (Figure 4-25) delineated through Source Water Protection studies and the recharge mapping delineated through the Lake Simcoe Protection Plan Tier 2 study of the Ramara Creeks, Whites Creek, and Talbot River subwatersheds shows that the central portion of the Ramara Creeks subwatershed is characterized by an area of low recharge due to the silty clay glaciolacustrine overburden deposits and high density Newmarket till that overlies the subwatershed. The majority of the significant recharge areas are located in the northern part of the Ramara Creeks subwatershed and coincide with the key groundwater recharge mound located on the topographic high present in the area.

Ecologically Significant Groundwater Recharge Areas

Ecologically Significant Groundwater Recharge Areas (ESGRAs) are identified as areas of land that are responsible for supporting groundwater systems that sustain sensitive features like streams and wetlands. To establish the ecological significance of a recharge area, a linkage must be present between a recharge area and an ecologically significant feature (e.g. a reach of a stream, a wetland, or pond). The identification of an ESGRA is not related to the volume of recharge that may be occurring; rather they represent pathways in which recharge, if it occurred, would reach an ecologically significant feature.

ESGRAs were delineated for the Ramara Creeks subwatershed by Earthfx (2014) using a calibrated GSFLOW model that relies on particle tracking methodology to trace the flow of groundwater to ecologically significant locations within the watershed. The particle tracking methodology involves the release of virtual particles from specified discharge points within the subwatershed (i.e. streams and wetlands). The features from which the virtual particles were released are highlighted in Figure 4-26. After being released, particles are then tracked backwards until they reach a point where their path intersects the land surface (e.g. a recharge area). These intersection points are referred to as endpoints. Using this methodology, groundwater flow pathlines can be determined by connecting points along the particle path. Particle endpoints and flow paths help establish the parameters of the regional flow system, and outline the flow of groundwater to ecologically significant locations.

ESGRAs that support the ecologically significant features within the subwatershed were delineated by a statistical method that analyses the density of endpoints established through particle tracking methodologies. This analysis is done by performing a cluster analysis using a Normalized Bivariate Kernel Density Estimation function. The cluster analysis is then used to convert the distribution of endpoints into an ESGRA.

Figure 4-27 identifies the endpoints of reverse tracked particles released from ecologically significant features such as streams and wetlands found within the subwatershed while Figure 4-28 illustrates the flow pathlines outlined by reverse tracked particles. As illustrated in Figure 4-28, the number of pathlines leaving the study area is not large, and the pathlines generally do not extend far beyond subwatershed boundaries. Nevertheless, the pathlines do indicate that certain surface water features, in particular the headwaters of the Ramara Creeks subwatershed, are likely receiving significant quantities of lateral groundwater inflow from recharge zones within Carden Plains Alvar areas located along subwatershed boundaries. Figure 4-29 shows the final ESGRAs delineated for the model area. Approximately 26% of the Ramara Creeks subwatershed area can be classified as an ESGRA. The distribution of ESGRA coverage in the subwatershed reflects that the key upland recharge feature in the north of the subwatershed is also responsible for sustaining important ecologically significant surface water features within the subwatershed.

In addition to the backward particle tracking method, a validation exercise utilizing a forward particle tracking methodology was employed to verify the reverse particle tracking analysis to ensure that significant recharge areas contributing to ecologically sensitive features were not missed. As a verification exercise, forward tracking was conducted from the delineated ESGRAs and required the release and tracking of particles across all cells in the study area in the direction of flow. During the exercise a large number of particles are introduced to clearly show the discharge to ecologically significant locations. Forward tracking can be used to help define and visualize the regional flow system and identify linkages between the study area and those in adjacent subwatersheds. Analysis of forward particle tracks in the Ramara Creeks subwatershed indicated that particle endpoints generally fell within the topographic boundary of the subwatershed, which suggests that cross-boundary flow to surface features in other subwatersheds is minimal (Earthfx, 2014). Results of the exercise are presented in Figure 4-30. It can be observed that in general forward tracking of particles distributed across the study watersheds results in endpoints located along the headwater streams and wetlands of each of the catchments. Several of the wetlands in the Ramara Creeks subwatershed and a number of stream reaches along Lake Simcoe are seen to have sparse particle endpoint coverage. These wetlands and streams are situated in the low-lying till and glaciolacustrine sediments and are likely supplied primarily by runoff which collects and recharges the water table (Earthfx, 2014).

While Significant Groundwater Recharge Areas (SGRAs) represent high volume recharge areas, ESGRAs better represent areas of land that contribute significant recharge to sensitive features of ecological significance within the study subwatersheds. Areas of ESGRA and SGRA overlap provide significant volumes of recharge to ecologically sensitive features in the subwatershed – for example, the key upland recharge area found to the north of the subwatershed represents an area of significant recharge that maintains a number of ecologically significant features in the subwatershed (Figure 4-31). Areas where ESGRAs don't coincide with SGRAs, such as those in the central portion of the Ramara Creeks subwatershed, tend to represent lower volume, localized flow systems which provide flows needed to maintain ecologically significant features. In the Ramara Creeks subwatershed localized flows support the large wetland complex north of Lagoon City, along the shore of Lake Simcoe (Earthfx, 2014). Both SGRAs and ESGRAs for the study area are shown in (Figure 4-31).

***Key points – Current Hydrogeologic Status:***

- The physical properties of 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.
- Monitoring groundwater levels can characterize baseline conditions, and assess how groundwater is affected by climate change, seasonal fluctuations, and 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, and also measure the effectiveness of the programs and policies that are designed to protect these groundwater resources. Monitoring from the shallow Ramara PGMN well shows that the groundwater levels tend to peak in late April/early May resulting from the melting snow pack, with the water levels declining in the late fall/early winter months.
- An examination of water wells within the study area indicate that the groundwater levels within the Ramara Creeks subwatershed tend to be shallow and are found within 10 metres below the surface.
- The water level map for the Ramara Creeks subwatershed shows that on a regional scale, groundwater flow within the major aquifer systems is generally from the topographic highs associated with northern upland groundwater recharge area of the subwatershed towards the topographic lows associated with the major stream channels, wetlands and Lake Simcoe.
- Groundwater recharge areas 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 in at the topographic high points located in the north of the subwatershed.
- The groundwater model indicates that the wetlands and streams within the Ramara Creeks subwatershed are greatly reliant on the topographic highs between Dalrymple Lake and Lake St. John which act as a significant recharge zone
- Many of the surface water features in central Ramara rely on local recharge areas to maintain flows. This local recharge generally supports lower volume, nearby flow systems which provide flows needed to maintain ecologically significant features.
- Surface water flows are a function of overland runoff and groundwater discharge (baseflow) resulting from the localized groundwater flow system
- Groundwater discharge is the main component of streamflow during dry periods and as such maintains an environment that allows certain species to survive even during the dry summer months. The groundwater model indicates that groundwater seepage to streams increases in the spring and declines in the late summer/fall. Anecdotal data provided by LSRCA monitoring staff indicates that many of the streams in the subwatershed dry up during summer drought conditions.
- The groundwater model estimated that most of the groundwater discharge is occurring along the main tributaries of Wainman's Creek and the wetland features within the Ramara Creeks subwatershed. These areas have been identified as being the most tolerant to drought conditions across the subwatershed. The headwaters in the subwatershed are particularly sensitive, and have been identified as most susceptible to drought.

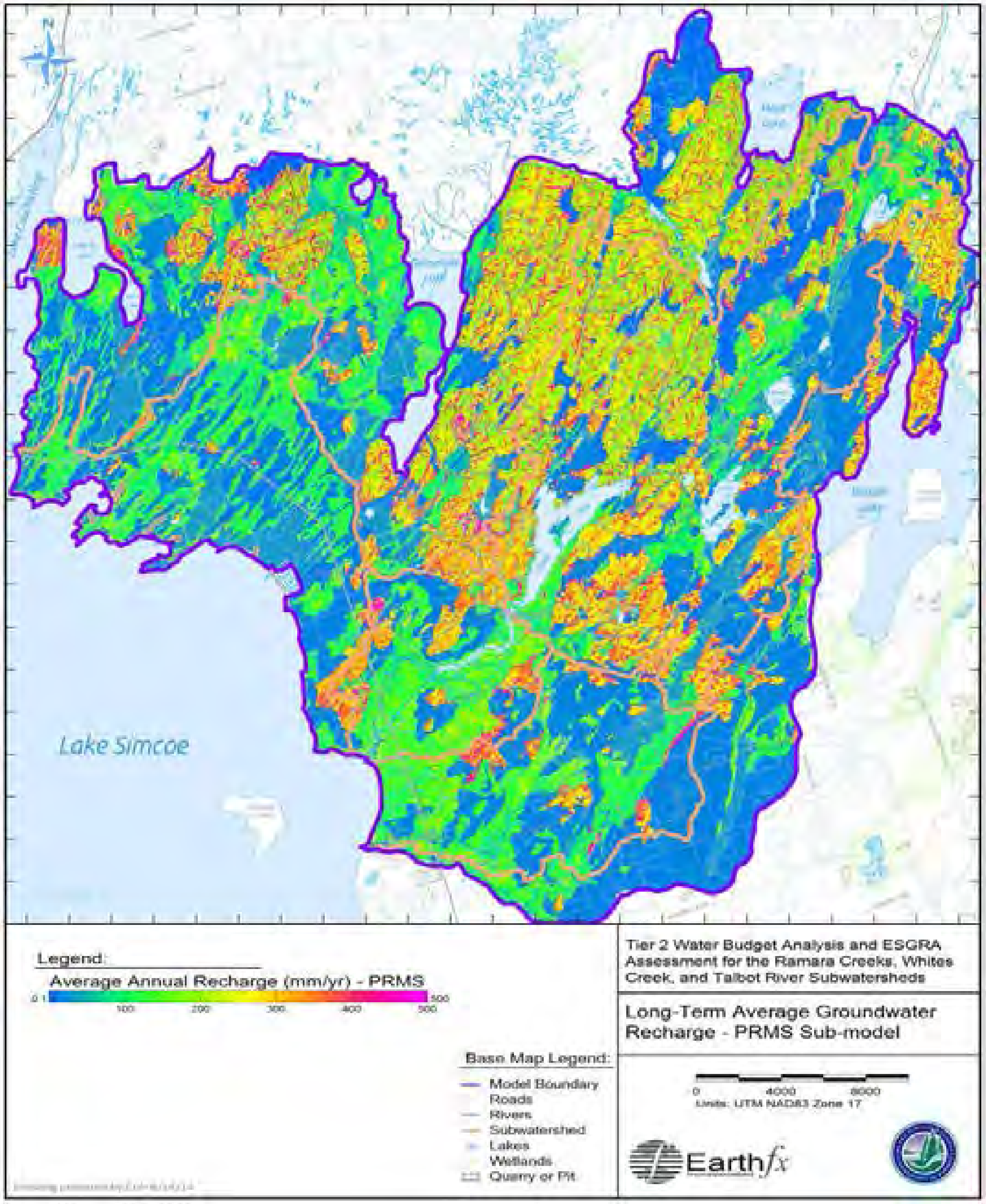



**Figure 4-24: Simulated long-term average distribution of groundwater recharge (Earthfx, 2014).**

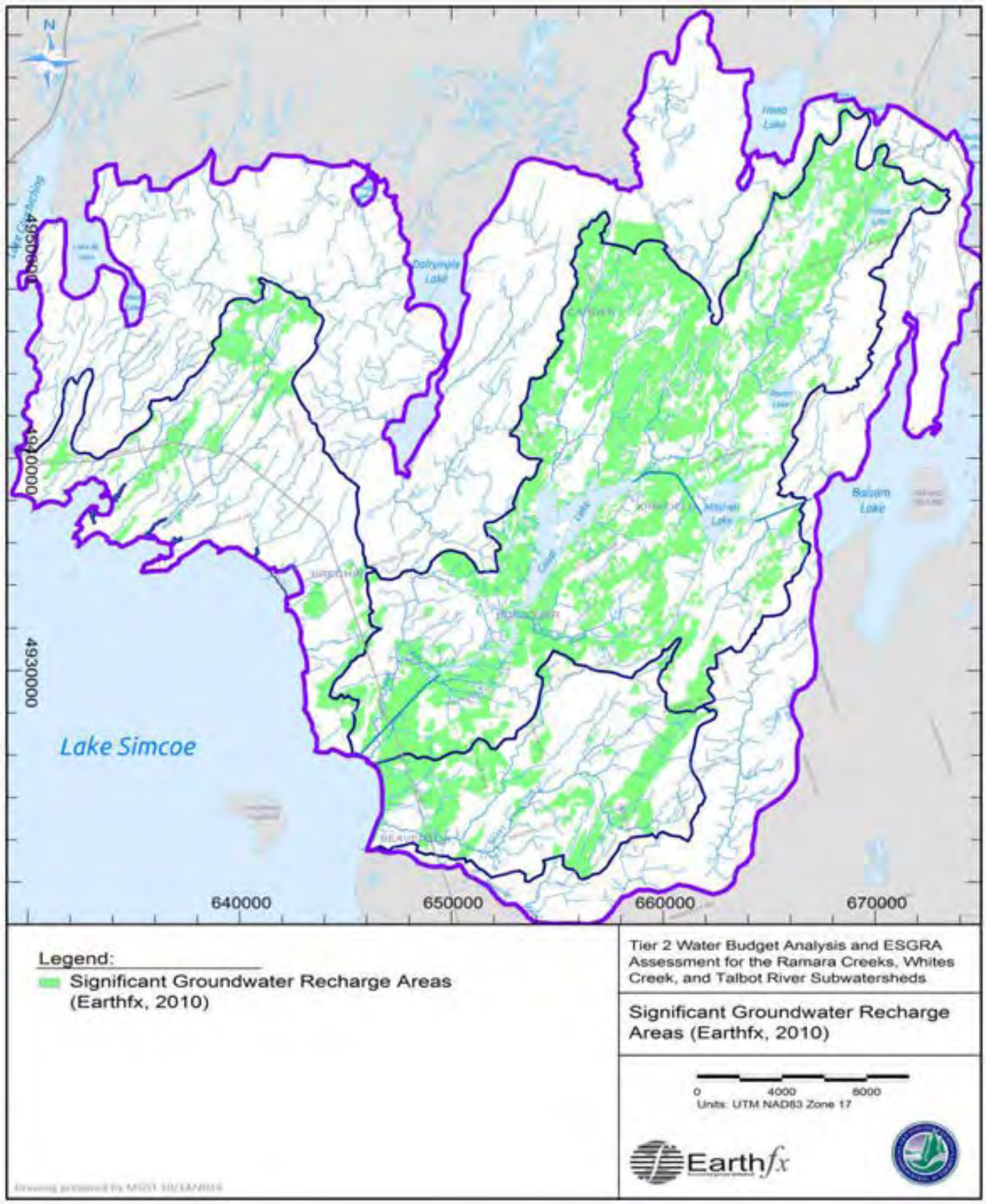



**Figure 4-25: Significant Groundwater Recharge Areas (Earthfx, 2014).**

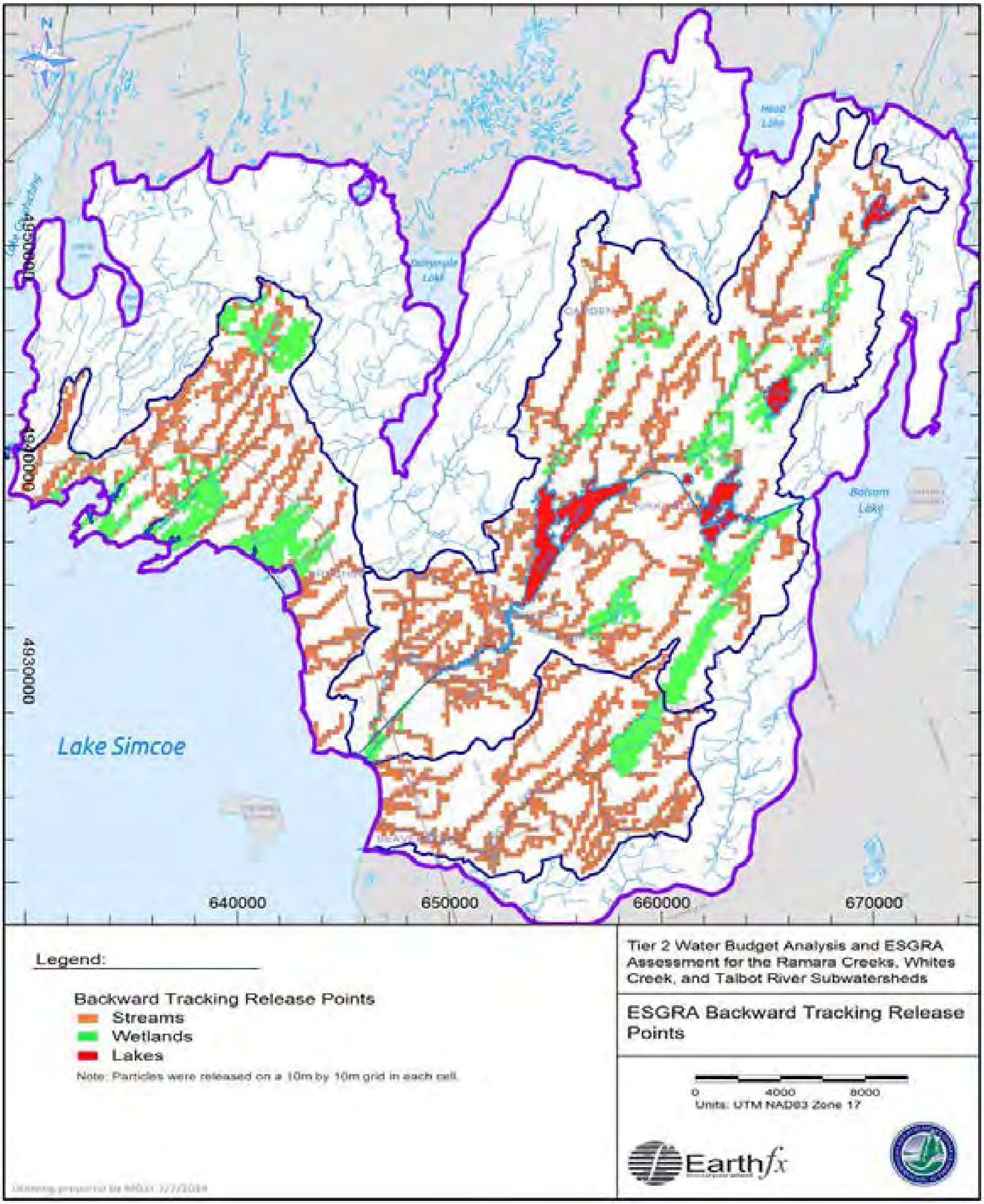



**Figure 4-26: ESGRA backward tracking release points (Earthfx, 2014).**

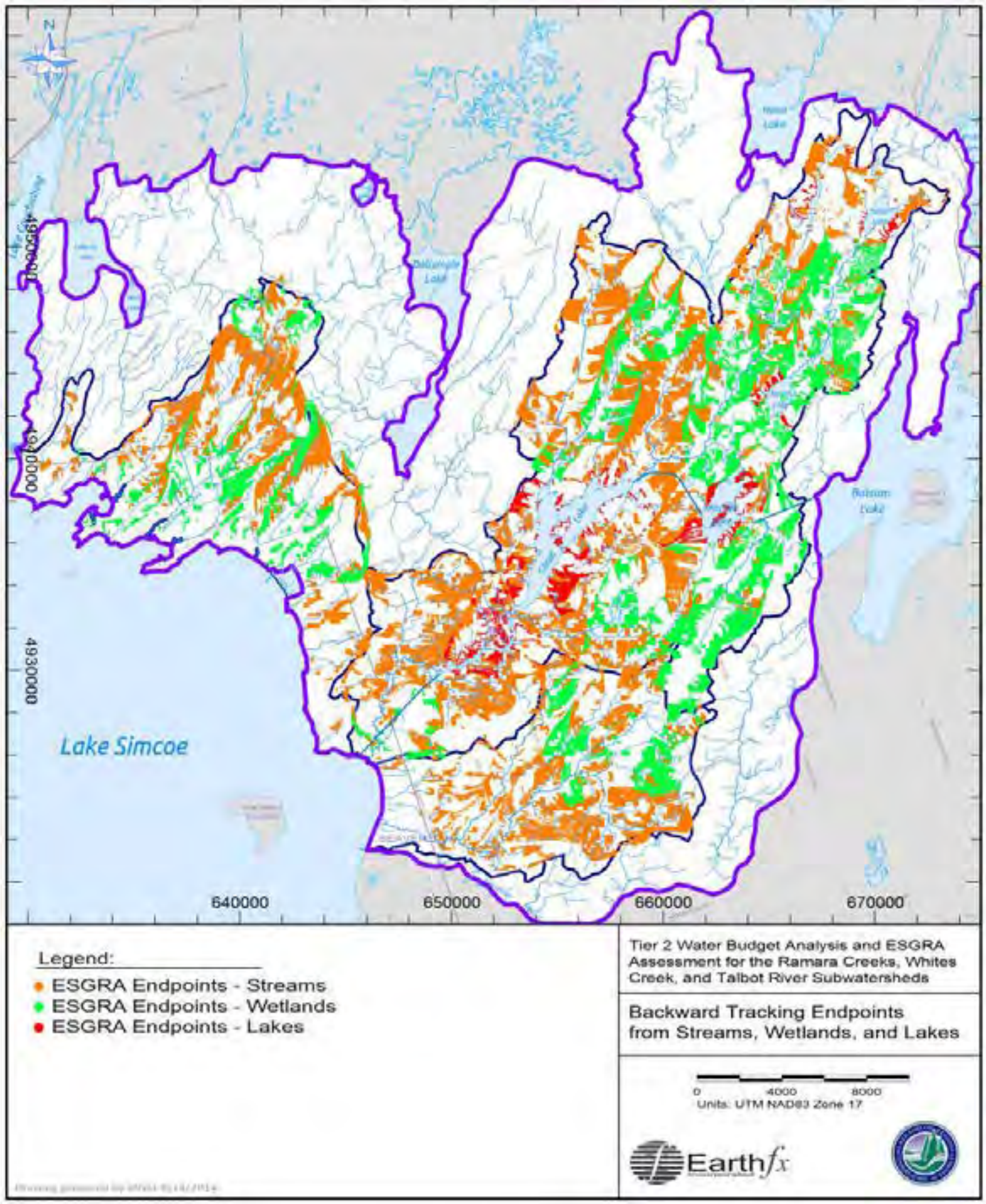



**Figure 4-27: ESGRA endpoints for backward tracking from streams, wetlands and lakes (Earthfx, 2014).**

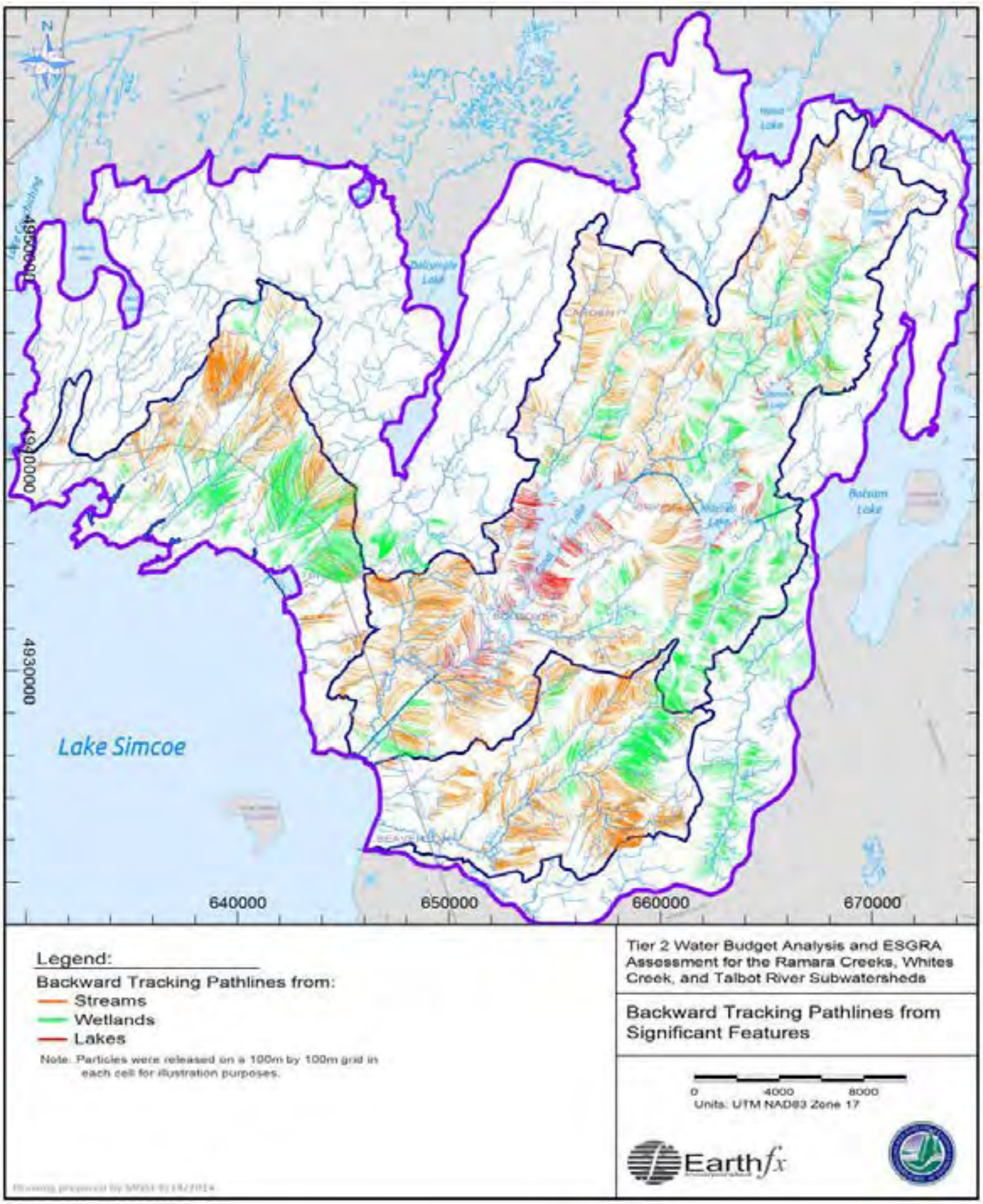



**Figure 4-28: Backward tracking pathlines from significant features (Earthfx, 2014).**

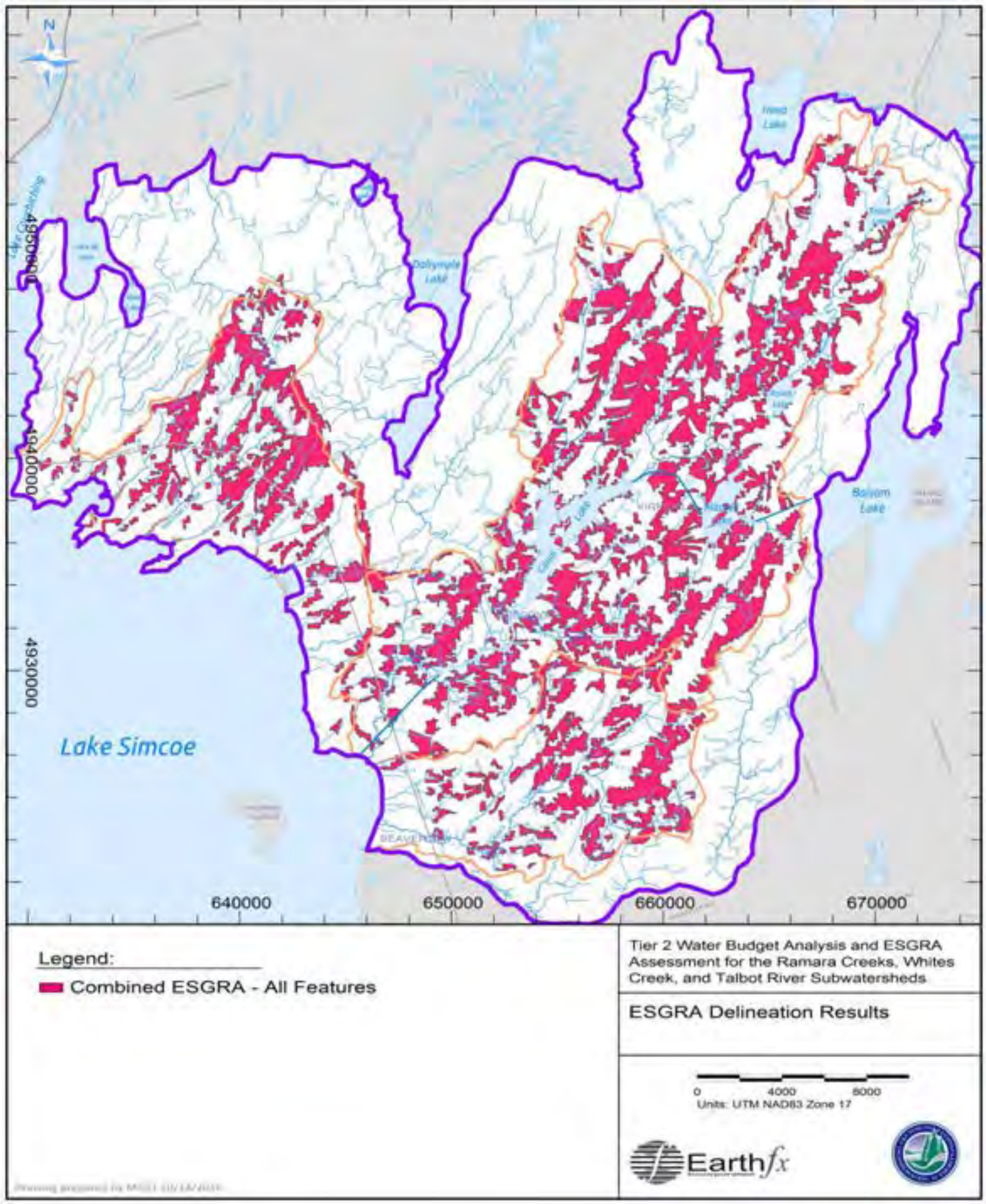



**Figure 4-29: Combined ESGRA delineation by backward tracking from all features (Earthfx, 2014).**

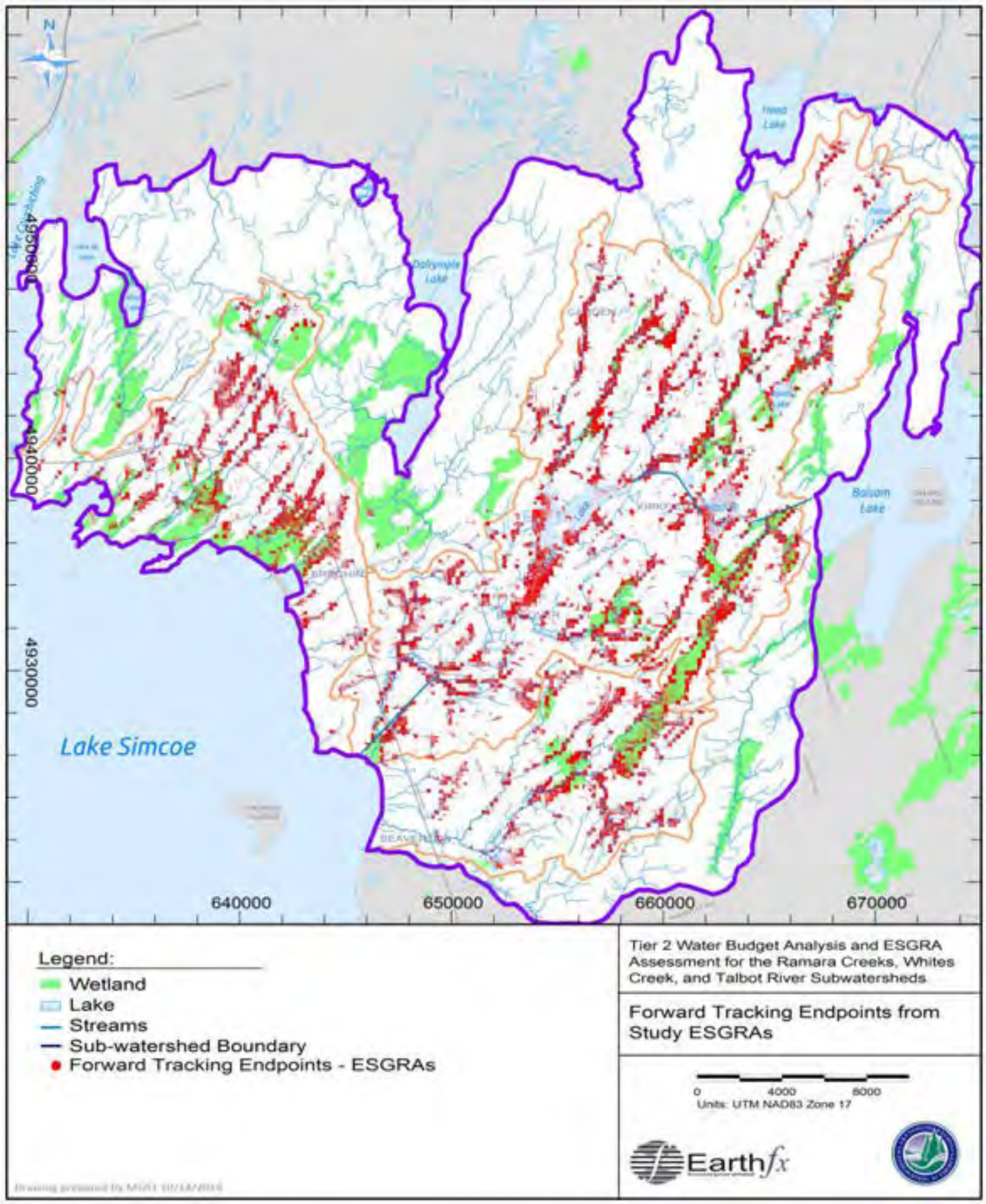



**Figure 4-30: Endpoints from forward tracking particles released in delineated ESGRAs (Earthfx, 2014).**

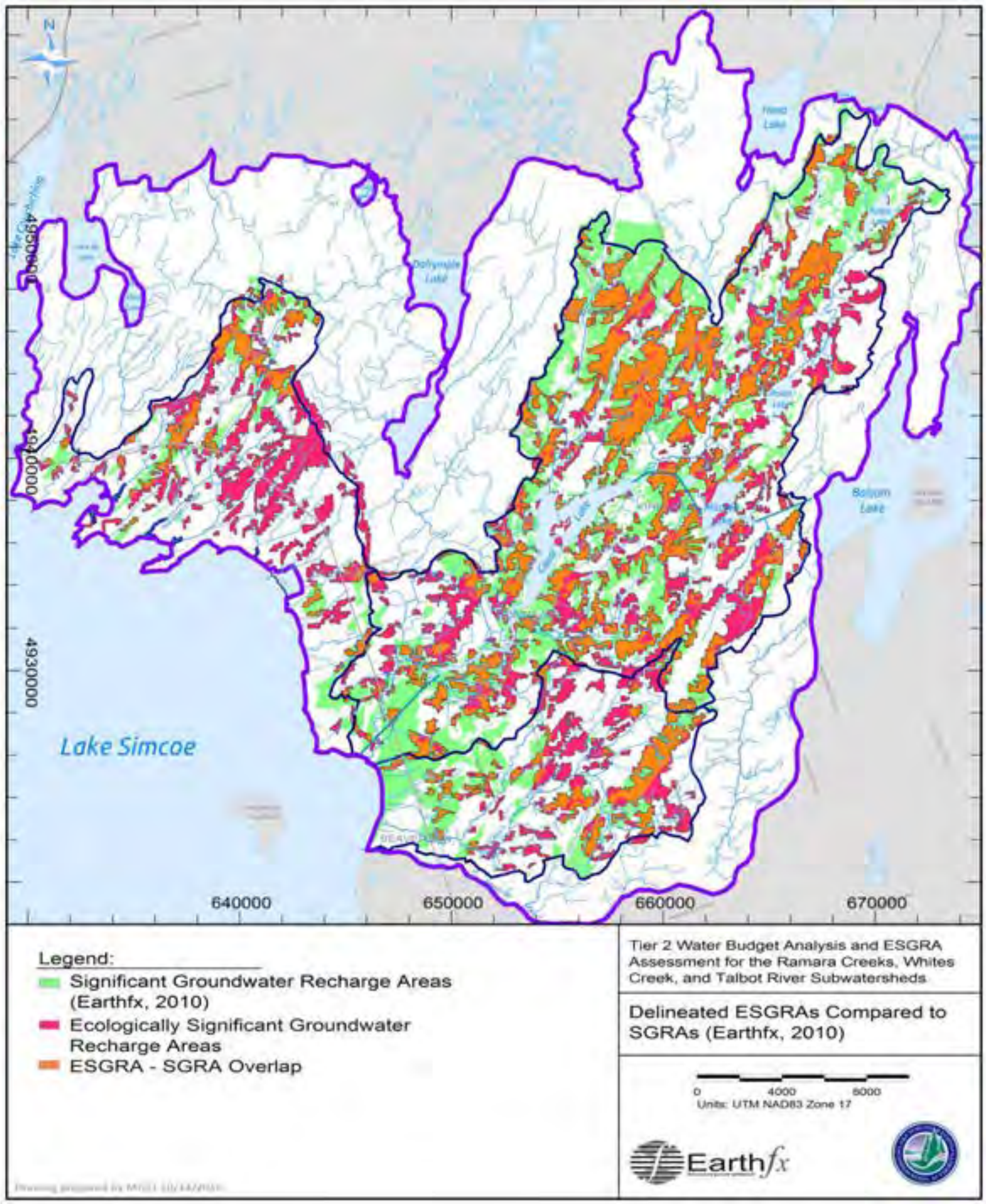



**Figure 4-31: Delineated ESGRAs compared to previously identified SGRAs.**

#### *4.2.7 Current Climatic Conditions*

Precipitation and Temperature

Precipitation in the form of rain or snow replenishes both the surface water and groundwater systems 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. Precipitation is an input value in the water balance calculation accounting for a portion of the available water supply.

An assessment of the climate in the Ramara Creeks subwatershed was undertaken as part of the Tier 2 Water Budget study completed by Earthfx (2014) for the Ramara Creeks, Whites Creek, and Talbot River subwatersheds. Due to the small number of climate stations located within the Tier 2 model area, data from additional stations outside of the study area were accessed to conduct the climate analysis. A total of 22 Environment Canada climate stations located both inside and out of the core study area were consulted for the climate assessment. The greatest distance from the study area to a station was approximately 28 km, while the average distance was about 10 km. Of the 28 stations consulted, seven were within the study area, while one (Lagoon City -6114295) was located within Ramara Creeks subwatershed. Periods of record for historic information varied among the available climate stations. Characterization of the climate of the study area began with the assessment of the data over a 55 year period spanning from 1955 to 2011. Over the 55 year period, median annual rainfall varied from 580 mm to 1130 mm across the study area as illustrated in Figure 4-32, however interstation variability was high. Monthly precipitation totals were also analysed for a period spanning from 2000 to 2010 (Figure 4-33). Over the 11 year period median monthly precipitation ranged from 20 to 175mm, however interstation variability remained high. The winter months were determined to have slightly lower average median precipitation (as either rain or snow). The average monthly median precipitation ranged from a late winter low of 60 mm to a summer/fall plateau of about 80 mm (Figure 4-34). The relative frequency of precipitation form (as snow, rain, or mixed event) is illustrated in Figure 4-35 for the full range of temperatures observed in the study area. For the selected climate stations used in the study, 68% of precipitation events are rain only, while 27% are snow only, and 5% are mixed (Earthfx, 2014).

Evapotranspiration

Evapotranspiration (ET) 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 characteristic of the water, soil, snow, and plant surface also affect the evapotranspiration process. Areas covered by plants will have more evapotranspiration occurring than developed areas with impervious surfaces. Unlike precipitation, evapotranspiration is accounted for as a loss to the system in the water budget calculation.

Actual evapotranspiration (AET) depends on several factors including potential evapotranspiration (PET), the amount of water in interception storage, the amount of water in depression storage, the soil type, and the amount of water in the soil zone. Potential evapotranspiration is the sum of evaporation and plant transpiration from the earth's land surface to the atmosphere. In the PRMS submodel, the soil zone is stratified into two layers, of which the capillary soil zone is susceptible to ET. Water is extracted from the gravity soil zone, if available, to replenish the capillary zone when it is not at capacity. The capillary zone has an evaporation extinction depth, below which only transpiration can occur (Earthfx, 2014).

Figure 4-36 illustrates that actual evapotranspiration in the Ramara, Whites, Talbot model area is sensitive to land use and land cover. Within the developed areas of the subwatersheds, reductions in pervious surfaces result in increased runoff, decreased infiltration, and a reduction in the soil moisture available for evapotranspiration. Areas of reduced perviousness also indicate a reduction in vegetative surfaces and soil zone water holding capacity. Lower evapotranspiration rates are particularly evident around the quarries in the model area, where the absence of vegetation results in minimal evapotranspiration. Moreover, since much of the runoff on quarry floors is routed directly to stream networks, there is often little to no soil moisture available for evapotranspiration.

The distribution of actual evapotranspiration, shown in Figure 4-36 also illustrates evidence of dendritic patterning. Dendritic patterning is indicative of the concept that downstream areas receiving more run-on from surrounding upslope areas will have more infiltration and therefore more soil water available for evapotranspiration. As a result, due to greater soil water availability, downstream areas in the subwatershed exhibit higher evapotranspiration rates than upslope areas.

Figure 4-36 also shows that the small areas of exposed alvar bedrock located along the northern and southern boundaries of the Ramara Creeks subwatershed also exhibit lower evapotranspiration rates. As previously mentioned, these areas are characterized by thin soils with low moisture storage capacities. The low storage capacity of these soils in turn limits the amount of soil water available for evapotranspiration, resulting in the low evapotranspiration rates presented in Figure 4-36.

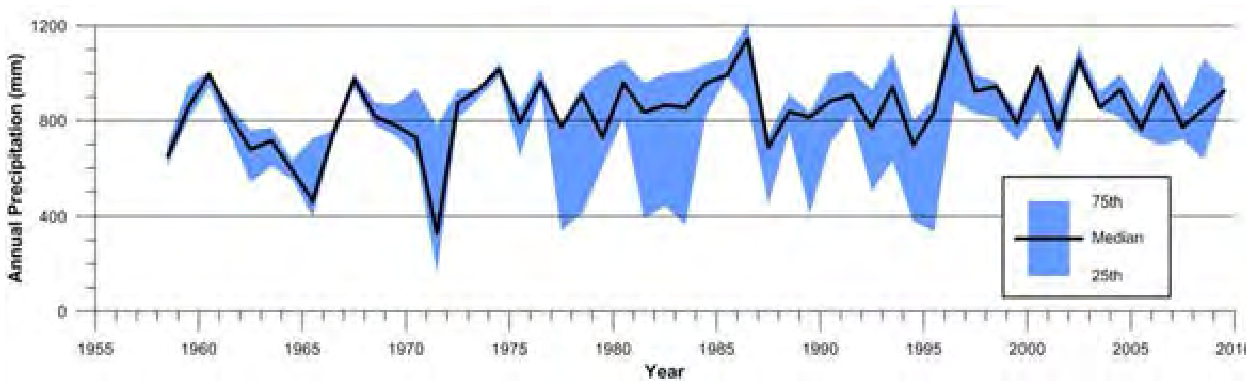



**Figure 4-32: Annual precipitation quartiles at AES climate stations (Earthfx, 2014).**

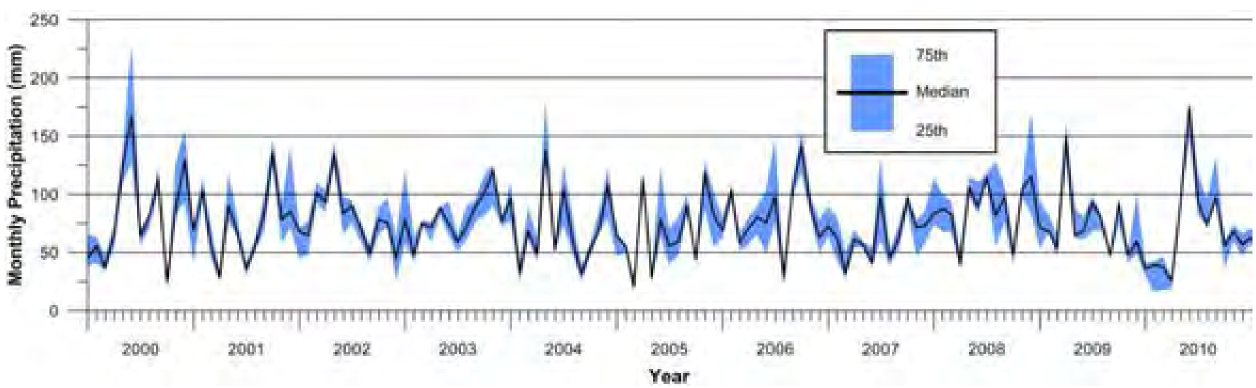



**Figure 4-33: Monthly precipitation quartiles at AES climate stations (2000 through 2010) (Earthfx, 2014).**

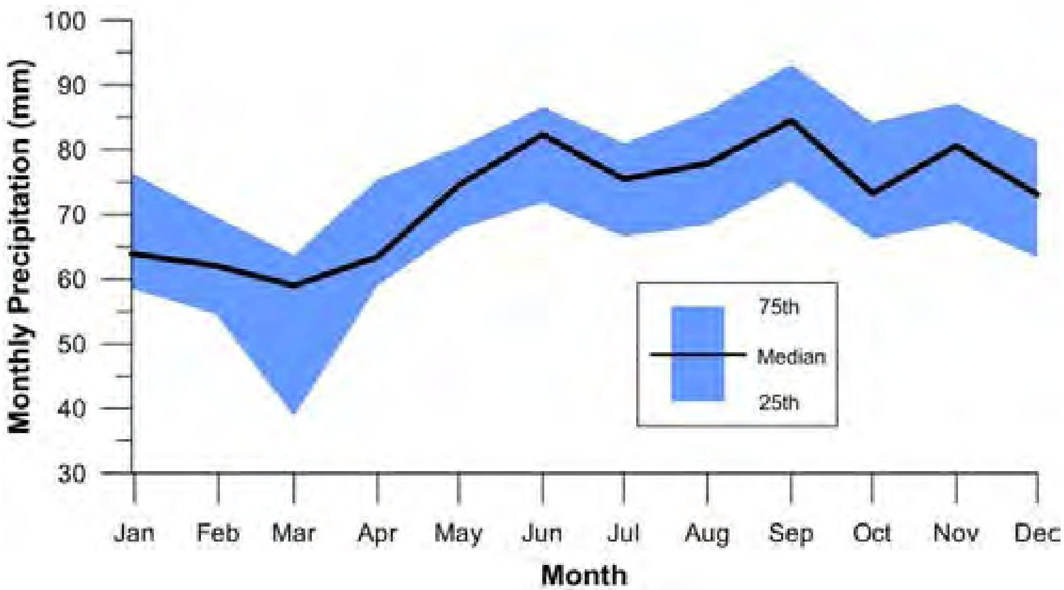



**Figure 4-34: Average monthly precipitation quartiles for AES climate stations (2000-2010) (Earthfx, 2014).**

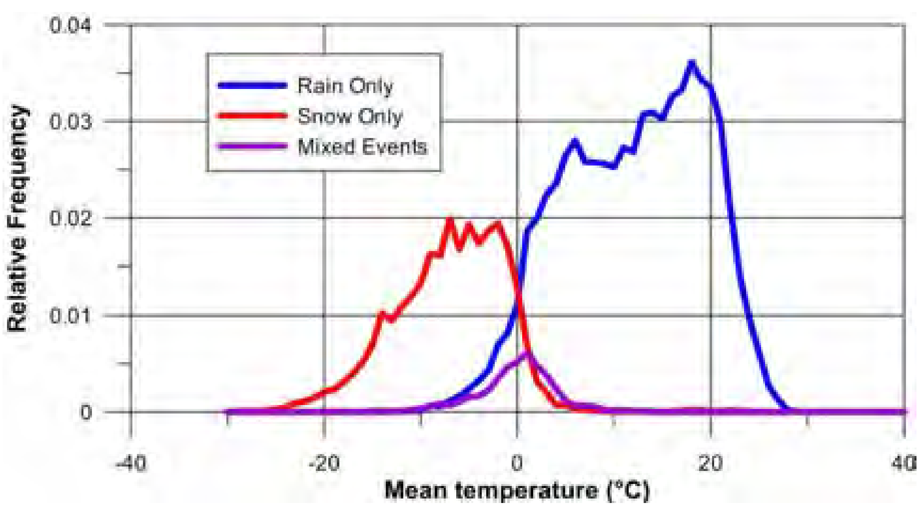



**Figure 4-35: Relative frequency and daily mean temperature of observed precipitation types at AES climate stations (1955 -2010) (Earthfx, 2014).**

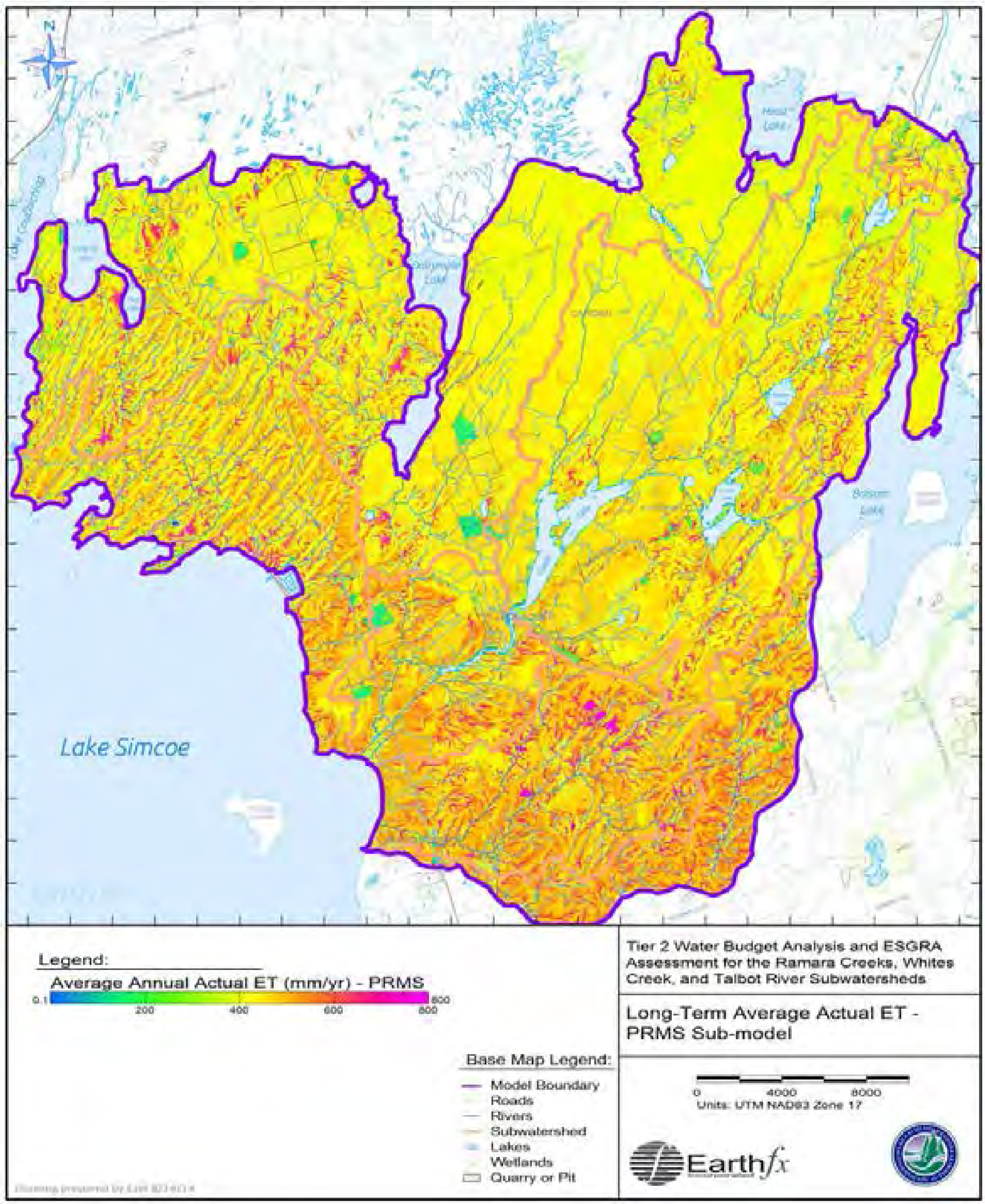



**Figure 4-36: Simulated long-term average distribution of actual evapotranspiration (Earthfx, 2014).**

## 4.3 Water Budget and Stress Assessment

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

The following section describes how the input and output values of the water budget equation were determined for the Ramara Creeks subwatershed. The findings of the water budget study are further discussed within Section 4.4. Earthfx (2014) completed the water budget study on behalf of the LSRCA. The study included water budget assessments for the Ramara Creeks, Whites Creek, and Talbot River subwatersheds in support of the water budget requirements under the Lake Simcoe Protection Plan, 2009.

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

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

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

The project objectives were to provide estimates of each component of the hydrologic cycle for the subwatershed based on various land and water use scenarios and to determine if the subwatersheds could be potentially under stress (i.e. water demand outweighs water supply). This required constructing a new model using the U.S. Geological Survey (USGS) fully-integrated GSFLOW model code.

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

- Current Conditions – current land use and groundwater use;
- Future Conditions – future land use and groundwater use;
- Planned Conditions
- Drought scenario
- Climate Change scenario

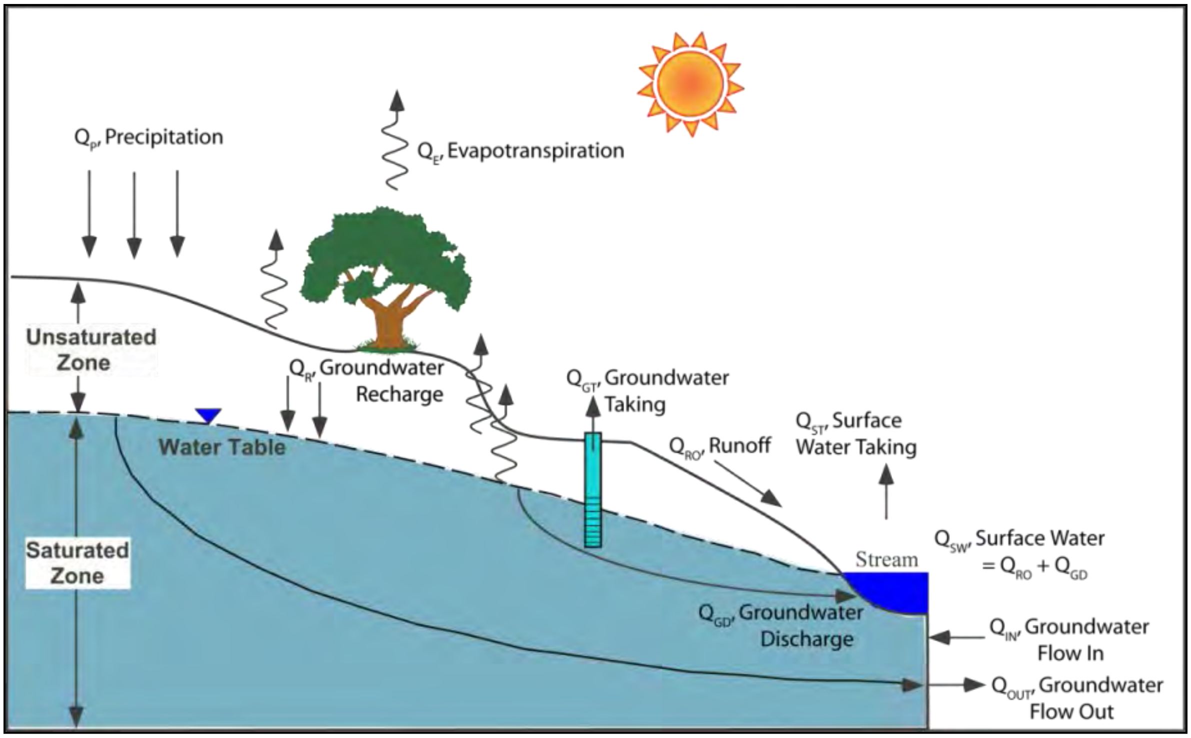



**Figure 4-37: Water budget components (Earthfx, and Gerber, 2008).**

### *4.3.1 Local Water Budget Initiatives*

The water budget methodology presented in this chapter includes an assessment of existing hydrologic conditions within the subwatershed using both a conceptual model and numerical modelling information developed through the Lake Simcoe Protection Plan initiatives (discussed in Section 4.1.2).

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, and use mathematical equations to approximate existing hydrogeologic conditions. While models can quantify the various components of the hydrologic cycle they can be also used 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 Ramara Creeks subwatershed is an integrated surface water/groundwater model developed by Earthfx (2014). In addition to the Ramara Creeks subwatershed, the model's boundaries were extended to include the Whites Creek and Talbot River subwatersheds, as well as small portions of adjacent catchments.

The modelling approach centred on constructing a new model using the U.S. Geological Survey (USGS) fully-integrated GSFLOW model. GSFLOW incorporates two submodels – the PRMS hydrologic model (surface water model) and the MODFLOW-NWT (groundwater model). The PRMS model was already applied to the Ramara Creeks subwatershed as part of a larger hydrological model development study for the entire Lake Simcoe basin (Earthfx, 2010a). For the 2014 Tier 2 water budget study, the PRMS model was refined and extended to cover adjacent catchments. The groundwater model built on the previously developed LSRCA Tier 2 numerical models and incorporated a more refined conceptual hydrostratigraphic model.

The model domain encompasses the entire Ramara Creeks, Whites Creek, and Talbot River subwatersheds and incorporates portions of neighbouring watersheds that could potentially contribute flows to the study area. Figure 4-2 in section 4.2 shows the model boundaries for the Tier 2 Water Budget study. Further information about the model can be obtained from the "Tier 2 Water Budget, Climate Change, and Ecologically Significant Groundwater Recharge Area Assessment for the Ramara Creeks, Whites Creek and Talbot River Subwatersheds" study completed by Earthfx (2014).

### *4.3.2 Water Supply Estimation*

Water supply is the amount of water available at any given instant for use as a water supply. In surface water resources, available supply is considered to be a proportion of streamflow, which is monitored at a number of stations across the Lake Simcoe basin. Surface water supply thus involves the interpolation of gauge data to the outlets of subwatersheds in gauged systems, and interpolation from similar subwatersheds for ungauged systems. Typically, surface water supply has been based on expected monthly flows (as determined through statistical analysis of observed flows or through surface water modelling). For groundwater, the available supply for a subwatershed is considered to be the sum of the recharge and subsurface inflows (lateral inflow or underflow in). The water supply component of the stress assessment was estimated using the integrated submodel discussed in the previous section. The groundwater recharge term was determined from the PRMS submodel.

In the Tier 2 study lateral inflows into the Ramara Creeks subwatershed were calculated by summing the predicted MODFLOW inter-cell flux across the subwatershed boundaries. A visual representation of the lateral flux can be seen by looking at the groundwater flow gradients. The total lateral inflow ($Q_{in}$), in all layers, was calculated. Per the guidance for the Tier 2 study the lateral *outflows* were not subtracted from the inflows for the Ramara Creeks subwatershed. The total current and future lateral inflow for the Ramara Creeks subwatershed is tabulated in Table 4-4 and Table 4-5 respectively (Earthfx, 2014).

Together the PRMS groundwater recharge and MODFLOW predicted lateral inflows from the water supply term in the Tier 2 calculation. Table 4-4 and Table 4-5 present the current and future water supply estimates used in the water budget calculation.

**Table 4-4: Current water budget estimates (Earthfx, 2014).**

| Inflows and Outflows (all values in $m^3/d$) | Ramara Creeks |
|---|---|
| Recharge in | 20,671 |
| Stream leakage in | 244 |
| Lake leakage in | 0 |
| Lateral inflow | 7,782 |
| **Total Groundwater Inflow:** | **28,697** |
| Lateral outflow | 10,662 |
| Net groundwater discharge to surface features | 14,439 |
| Net outflow in at constant head cells | 3,285 |
| Wells | 312 |
| **Total Groundwater Outflow:** | **28,698** |

***values subject to round off**

**Table 4-5: Future water budget estimates (Earthfx, 2014).**

| Inflows and Outflows (all values in $m^3/d$) | Ramara Creeks |
|---|---|
| Recharge in | 20,807 |
| Stream leakage in | 229 |
| Lake leakage in | 0 |
| Lateral inflow | 7,748 |
| **Total Groundwater Inflow:** | **28,784** |
| Lateral outflow | 10,484 |
| Net groundwater discharge to surface features | 14,606 |
| Net outflow in at constant head cells | 3,272 |
| Wells | 422 |
| **Total Groundwater Outflow:** | **28,784** |

***values subject to round off**

### *4.3.3 Water Demand Estimation*

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). The water demand for the Ramara Creeks subwatershed has been estimated from a number of information sources, including the Ministry of the Environment's

Permit to Take Water and Water Taking Reporting System (WTRS) databases, as well as population estimates, and water well records.

Demand from other non-permitted water use sectors was also estimated. Three types of non-permitted uses were estimated, including estimates of unserviced population consumption, agricultural irrigation, and agricultural livestock consumption. 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 subwatershed, will differ by the specific application).

For future scenarios, only the future demand on municipal supply wells and surface water intakes was considered; future demands of other permitted and non-permitted takings were not simulated (Earthfx, 2014).

<u>Permit To Take Water (PTTW)</u>

The most important source of consumptive demand information was the MOE Permit to Take Water (PTTW) database and actual municipal water use data obtained from the MOE Water Taking Reporting System. 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 through studies such as LSRCA Tier 1 Water Budget (2009), and the Ramara Creeks, Whites Creek, and Talbot River subwatersheds Tier 2 Water Budget and Stress Assessment (Earthfx, 2014).

Verifying and estimating actual consumption is difficult, but recent legislation (387/04) now requires that actual extraction rates be recorded through the Ministry of Environment's Water Taking Reporting System (WTRS), and over time the actual demand estimates will improve. The MOE Water Taking Reporting System (WTRS) database contains self-reported information on actual takings, as opposed to permitted takings. Water taking data contained within the database is generally complete for municipal takings. Non-municipal pumping information is not as complete due to changing permit numbers, incomplete records, backlogs in the transcription of paper records, and non-compliance with reporting requirements. A subset of WTRS data for 2005 to 2011 was used for the Tier 2 water budget analysis despite some noted data gaps, particularly in records prior to 2007. For takings where no historical reported rates could be found, it was assumed that pumping rates were at their maximum permitted daily value (Earthfx, 2014). Actual water use was received for most of the permitted water users in the Ramara Creeks subwatershed. The data was reviewed, corrected as needed, and incorporated into this study. A list of the most recent PTTW information is presented in Table 4-6 and Table 4-7. Best available location data for groundwater and surface water permits are shown in Figure 4-38 (Earthfx, 2014).

Two municipal and two non-municipal permits governing the use of eight wells (six municipal, two non-municipal) were identified within the Ramara Creeks subwatershed. Two additional permits for surface water takings were also identified; however, these systems take water directly from Lake Simcoe and therefore were not included in the water budget, as Lake Simcoe is not simulated within the model. Estimates for actual water use were available for all four of the groundwater permits in subwatershed. Table 4-6 summarizes the permitted municipal groundwater takings in the Ramara Creeks subwatershed, while Table 4-7 summarizes the non-municipal permitted groundwater takings.

**Table 4-6: Summary of operational limits and historical average pumping rates for municipal takings.**

| Permit Holder | MOE Permit Number | Source Name | Subwatershed | Maximum Permitted Taking ($m^3/d$) | Average Demand ($m^3/d$) |
|---|---|---|---|---|---|
| Val Harbour Subdivision Municipal Well | 7653-87TS7U (94-P-3026) | Well 1 | Ramara Creeks | 67.7 | 11.0 |
| | | Well 2 | Ramara Creeks | 139.7 | 24.0 |
| | | Well 3R | Ramara Creeks | 207.4 | 0.0 |
| Bayshore Village Municipal Well | 4512-66JSJZ | Well No. 3 | Ramara Creeks | 196.4 | 43.8 |
| | | Well No. 4 | Ramara Creeks | 807.4 | 162.2 |
| | | Well No. 5 | Ramara Creeks | 240.0 | 59.5 |

**Table 4-7: Summary of operational limits and historical average pumping rates for permitted groundwater takings (Earthfx, 2014).**

| Permit Holder | MOE Permit Number | Sub-watershed | Well Name | Purpose | Maximum Permitted Taking ($m^3/d$) | Average Demand ($m^3/d$) |
|---|---|---|---|---|---|---|
| Bayshore Village Golf Course | 92-P-3079 | Ramara Creeks | Well #1 | Agricultural - Golf Course | 81.8 | 14.0 |
| Mara Provincial Park | 5227-79UJ6E | Ramara Creeks | Campground Well | Campgrounds - Water Supply | 56.4 | 7.3 |

Municipal Water Supply

A total of six municipal wells are located within the Ramara Creeks subwatershed. Average municipal pumping was calculated from data provided in the MOE Water Taking Reporting System (WTRS) database. Where actual pumping data was not available, the average yearly demand was assumed equal to the maximum permitted rate. All municipal wells within the subwatershed have reported takings from WTRS. Table 4-6 summarizes the average pumping values determined for the municipal wells in the Ramara Creeks subwatershed (Earthfx, 2014).

Future pumping demand was estimated using projected population growth data. The Ramara Creeks subwatershed is anticipated to experience a population increase of 3,300 by 2031 from the 2011 population. It is further anticipated that 90% of the population growth will be within three designated settlement areas of Brechin, Lagoon City, and Atherley-Uptergrove. Brechin and Lagoon city are serviced by surface water takings from Lake Simcoe and are therefore not represented in the model. The Atherley-Uptergrove settlement area is serviced by private domestic wells, which was included within the estimates for unserviced private domestic water demand discussed further below. The 10% of the estimated growth not associated with these three designated settlement areas (an estimated 330 residents) are assumed to be serviced by the Val Harbour and Bayshore Village wellfields. The projections of future populations of the Val Harbour and Bayshore Village communities were used to estimate future demand on their respective wellfields (Earthfx, 2014). An estimated 36.5% and 36.8% increase in demand was assumed for the Val Harbour and Bayshore Village systems to represent the future growth in population. Estimated current and future pumping rates for the municipal wells within the subwatershed are presented in Table 4-8.

**Table 4-8: Current and future demand for municipal wellfields**

| Settlement | Well | Current Demand ($m^3/d$) | | Future Demand ($m^3/d$) | |
|---|---|---|---|---|---|
| Val Harbour (Ramara Creeks) | Well 1 | 35.0 | 11.0 | 47.8 | 15.0 |
| | Well 2 | | 24.0 | | 32.8 |
| | Well 3R | | 0.0 | | 0.0 |
| Bayshore Village (Ramara Creeks) | Well No. 3 | 265.5 | 43.8 | 363.2 | 59.9 |
| | Well No. 4 | | 162.2 | | 221.9 |
| | Well No. 5 | | 59.5 | | 81.4 |

Non-Permitted Water Use - Agricultural Consumption

Under the Ontario Water Resources Act (Revised Statutes of Ontario 1990, Chapter O.40), farmers using 50,000 litres or less per day, and farmers who are taking water for livestock watering but not storing the water, are exempt from obtaining a PTTW, and are therefore non-permitted agricultural consumers. To estimate this agricultural consumption, MOE Guidance Module 7 (MOE, 2007) has suggested using water use coefficients documented by deLoe (2001, 2005). The 2001 data compiled by deLoe has been allocated to subwatersheds using area weighting to estimate subwatershed water use as per the following process.

Agricultural demand was estimated for each study subwatershed in the Tier 1 Water Budget and Water Quantity Stress Assessment (LSRCA, 2009) using de Loe's methodology. Although this method provides an estimate of total water consumption, there is no method to differentiate what is taken from groundwater versus surface water. For the purpose of this study, non-permitted agricultural demand was treated as a groundwater taking. Table 4-9 below presents the agricultural demand estimated for the Ramara Creeks subwatershed. When de Loe's methodology is applied, the non-permitted agricultural demand is estimated to be 14,358 $m^3$/year.

Non-Permitted Water Use - Unserviced Domestic Water Use

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.

For the purposes of this report an assumption has been made that all households in the study area not serviced by municipal water are obtaining water from a private well. To derive an estimate of the average volume of groundwater used for domestic purposes, the 2006 Statistics Canada census data were used to determine the “un-serviced” population within each subwatershed relying on private wells. This un-serviced population was then multiplied by a per-capita usage of 335 L/day, based on the recommendation within Guidance Module 7 (MOE, 2007). A relatively low consumptive factor (0.2) has been used to calculate water consumption, as residences on private wells most often utilize a private septic system, which returns the majority of water used to the local subsurface. This variable of the water consumption calculation is a relatively small proportion of the overall subwatershed demand and therefore the variation of household use is not a factor that will change the outcome of the stress assessment significantly; therefore this somewhat simple method is suitable for this assessment.

Table 4-9 presents the current unserviced domestic demand within the Ramara Creeks subwatershed. When the value is corrected using the consumptive factor, the unserviced domestic demand is estimated at 82,095 $m^3$/year. These values were incorporated within the steady state model by decreasing the applied recharge over the subwatershed by the estimated unserviced demand.

**Table 4-9: Summary of unserviced domestic and non-permitted agricultural consumption.**

| Subwatershed | Unserviced Domestic Demand ($m^3$/yr) | Unserviced Domestic Consumption ($m^3$/yr) | Non-permitted Agricultural Demand ($m^3$/yr) | Non-permitted Agricultural Consumption ($m^3$/yr) |
|---|---|---|---|---|
| Ramara Creeks | 410,477 | 82,095 | 17,948 | 14,358 |

Quarry Takings

Surface and groundwater takings by quarry operations were also represented in the integrated surface/groundwater model and accounted for in the Tier 2 water budget. A total of 11 quarry related permits were identified and simulated within the Tier 2 model area for the Ramara Creeks, Whites Creek, and Talbot River subwatersheds. Of the 11 quarries identified, only one, located on the boundary between the Ramara Creeks and Talbot River subwatersheds, actually crosses into the Ramara Creeks subwatershed. The takings from this quarry were only accounted for in the Talbot River water budget calculations, since only a very small portion of the quarry is actually located within the Ramara Creeks subwatershed. Quarry-related permits to take water in the study area represent combined surface water and groundwater takings because surface water runoff and groundwater leakage are both collected and stored in sumps in the quarry floors. These sump ponds are dewatered to control local groundwater, and the water is used in processing (Earthfx, 2014). The quarry permits in and around the Ramara Creeks subwatershed are summarized in Table 4-10 .

**Table 4-10: Summary of operational limits and historical average pumping rates for permitted quarry takings.**

| Permit Holder | MOE Permit Number | Well Name | Purpose | Maximum Permitted Taking ($m^3/d$) | Average Demand ($m^3/d$) |
|---|---|---|---|---|---|
| James Dick South | 6536-7QJH9L | Sump Pond | Quarry Dewatering | 2,880.0 | 500.3 |
| **Lafarge Brechin Quarry** | **2446-98JKGW (4100-8T2R5R)** | **Quarry Sump (Brechin Quarry)** | **Quarry Dewatering** | **3,600.0** | **982.1** |
| Bot Aggregates Ltd. | 7614-8C6N8N | Quarry Sump | Quarry Dewatering | 1,226.9 | 18.0 |

***Bold** text indicates that the permit is partially located within the Ramara Creeks subwatershed.

<u>Consumption Correction Factor</u>

A number of corrections and adjustment factors were applied to the permitted and non-permitted consumptive demand estimates, as appropriate for a Tier 2 analysis.

The selected consumptive demand factors were applied to the PTTW permits based on the default values (Table 4-11) provided in the Water Budget & Water Quantity Risk Assessment Guide (MNR and MOE, 2011). A consumption factor for the unserviced population was estimated at 20% (i.e., 80% of the water is assumed to be returned to the shallow aquifer through the septic system). This value is consistent with water supply consumption values listed in the guidance document. The consumption factor for the un-permitted agricultural use (primarily livestock, including dairy operations) was estimated as 80%, close to the recommended factor of 78% suggested by de Loe (2001) (Earthfx, 2014).

As the municipal wells in the model area extract water from deep aquifer units these takings are treated as 100% consumptive.

**Table 4-11: Consumptive use factors (MOE, 2011).**

| Category | Specific Purpose | Consumptive Factor | Category | Specific Purpose | Consumptive Factor |
|---|---|---|---|---|---|
| Agricultural | Field and Pasture Crops | 0.80 | Institutional | Hospitals | 0.25 |
| Agricultural | Fruit Orchards | 0.80 | Institutional | Other - Institutional | 0.25 |
| Agricultural | Market Gardens / Flowers | 0.90 | Institutional | Schools | 0.25 |
| Agricultural | Nursery | 0.90 | Miscellaneous | Dams and Reservoirs | 0.10 |
| Agricultural | Other - Agricultural | 0.80 | Miscellaneous | Heat Pumps | 0.10 |
| Agricultural | Sod Farm | 0.90 | Miscellaneous | Other - Miscellaneous | 1.00 |
| Agricultural | Tender Fruit | 0.80 | Miscellaneous | Pumping Test | 0.10 |
| Agricultural | Tobacco | 0.90 | Miscellaneous | Wildlife Conservation | 0.10 |
| Commercial | Aquaculture | 0.10 | Recreational | Aesthetics | 0.25 |
| Commercial | Bottled Water | 1.00 | Industrial | Manufacturing | 0.25 |
| Commercial | Golf Course Irrigation | 0.70 | Industrial | Other - Industrial | 0.25 |
| Commercial | Mall / Business | 0.25 | Industrial | Pipeline Testing | 0.25 |
| Commercial | Other - Commercial | 1.00 | Industrial | Power Production | 0.10 |
| Commercial | Snowmaking | 0.50 | Recreational | Fish Ponds | 0.25 |
| Construction | Other - Construction | 0.75 | Recreational | Other - Recreational | 0.10 |
| Construction | Road Building | 0.75 | Recreational | Wetlands | 0.10 |
| Dewatering | Construction | 0.25 | Remediation | Groundwater | 0.50 |
| Dewatering | Other - Dewatering | 0.25 | Remediation | Other – Remediation | 0.25 |
| Dewatering | Pits and Quarries | 0.25 | Water Supply | Campgrounds | 0.20 |
| Industrial | Aggregate Washing* | 0.10 | Water Supply | Communal | 0.20 |
| Industrial | Brewing and Soft Drinks | 1.00 | Water Supply | Municipal | 0.20 |
| Industrial | Cooling Water | 0.25 | Water Supply | Other - Water Supply | 0.20 |
| Industrial | Food Processing | 1.00 | | | |

Monthly Correction Factor

Many water permit holders do not require the use of water at a constant rate throughout the year. For example, there are several golf course, campground, and aggregate washing permits in the subwatershed study area. Additionally, many of the permits in the study area are limited by time, only allowing pumping during a subset of the year. For permits without WTRS data, monthly allocation of takings was done based on restrictions listed in the individual permit to take water. If the permit did not have any restrictions, the monthly allocation was assigned based on the suggested monthly values for the usage classes and sub-classes listed in the Water Budget & Water Quantity Risk Assessment Guide (MNR and MOE, 2011). The time-limited permits were allocated to months based on an analysis of each permit. In some cases, only a portion of a month was allocated. In general, the monthly allocation was applied in a manner consistent with that in the Water Budget & Water Quantity Risk Assessment Guide (MNR, 2011). Overall, permitted water demand in the study subwatershed is higher in the summer due to these activities.

The agricultural demand estimates given by de Loe (2001) were reported on an annual basis. Although it is quite likely that agricultural demand for the summer season exceeds winter demands, there was no information available to allocate seasonal water taking using the data provided by de Loe (2001). Therefore, the given annual agricultural water demand estimates were assumed to be constant year-round (Earthfx, 2014).

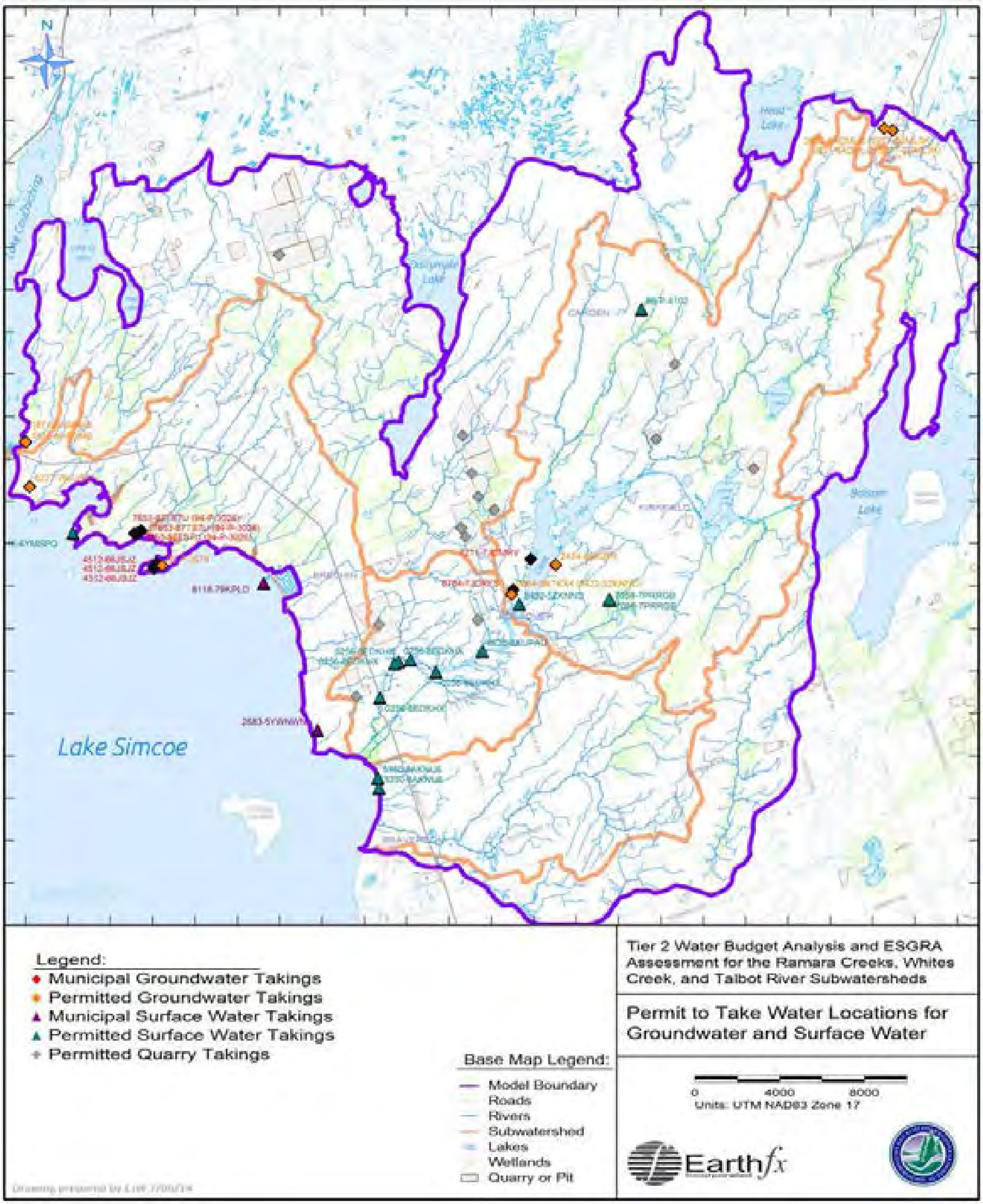



**Figure 4-38: Location of permitted groundwater takings within the Ramara Creeks, Whites Creek, and Talbot River subwatersheds (Earthfx, 2014).**

### 4.3.4 Water Reserve Estimation

The MOE Guidance Module (MOE, 2007) defines water reserve as that portion of water required to support other water uses within the watershed including both ecosystem requirements (instream flow needs) and human uses (aside from permitted uses). Examples of human uses could include dilution for sewage treatment plant discharge, hydroelectric power needs, recreation, and navigation needs. Ecological needs include sustaining groundwater discharge to sensitive coldwater fish habitat. The reserve quantity is subtracted from the total water source supply prior to evaluating the percent water demand.

The Guidance Module recognized that groundwater discharge to streams must be maintained to sustain baseflow throughout a watershed. Instream flow requirements are used to estimate the ecological component of the surface water reserve term for the Tier 2 stress assessment. As it is difficult to separate out the groundwater and surface water components of the instream requirements, Guidance Module 7 recommends a simplified estimation method whereby the reserve is estimated as at least 10% of the existing groundwater discharge (Earthfx, 2010).

There are several alternative methods for estimating groundwater discharge. Discharge can be determined either through (1) a groundwater flow model, if available; (2) baseflow separation applied to long-term flow gauge data, or (3) from spot flow measurements if no other data are available. The groundwater reserve was estimated as 10% of the MODFLOW simulated groundwater discharge to streams.

It is recognized that preserving 10% of baseflow is a simplified approach to preserving ecological requirements. Future work on determining instream flow needs will have to focus on identifying a flow regime that captures the range of seasonal high and seasonal low flows.

## 4.4 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.

### 4.4.1 Water Demand

Potential water quantity stress has been estimated on a subwatershed scale through the Source Water Protection and Lake Simcoe Protection Plan initiatives. Several water budget initiatives have been undertaken to identify potential water quantity stress within the subwatersheds. 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) and Earthfx (2014). Considerable effort was made in the Tier 1 (LSRCA, 2009) and Tier 2 (Earthfx, 2014) water budgets discussed in previous sections to document the various sources of water demand.

The results of the water demand analysis are presented as a series of summary tables. The overall total water demand includes the total of permitted usage, population, municipal, and agricultural demand, as shown in Table 4-12 and Table 4-13 for current and future scenarios. All values were corrected for consumption factors (i.e., locally returned flow is not included). The total groundwater demand from all sources in the Ramara Creeks subwatershed is 576 $m^3/d$.

**Table 4-12: Current groundwater consumption summary (Earthfx, 2014).**

| Current Groundwater Consumption ($m^3/yr$) | | | | | | |
|---|---|---|---|---|---|---|
| **Watershed Name** | **Municipal** | **Unserviced** | **PTTW** | **Quarry Dewatering** | **Agricultural** | **Total Consumption** |
| Ramara Creeks | 109,758 | 82,095 | 4,127 | 0 | 14,358 | 210,338 |
| **Current Groundwater Consumption ($m^3/d$)** | | | | | | |
| **Watershed Name** | **Municipal** | **Unserviced** | **PTTW** | **Quarry Dewatering** | **Agricultural** | **Total Consumption** |
| Ramara Creeks | 301 | 225 | 11 | 0 | 39 | 576 |

**Table 4-13: Future groundwater consumption summary (Earthfx, 2014).**

| Future Groundwater Consumption ($m^3/yr$) | | | | | | |
|---|---|---|---|---|---|---|
| **Watershed Name** | **Municipal** | **Unserviced** | **PTTW** | **Quarry Dewatering** | **Agricultural** | **Total Consumption** |
| Ramara Creeks | 150,118 | 82,095 | 4,127 | 0 | 14,358 | 250,698 |
| **Future Groundwater Consumption ($m^3/d$)** | | | | | | |
| **Watershed Name** | **Municipal** | **Unserviced** | **PTTW** | **Quarry Dewatering** | **Agricultural** | **Total Consumption** |
| Ramara Creeks | 411 | 225 | 11 | 0 | 39 | 686 |

The current total groundwater inflow is 28,697 $m^3$/day. Currently, permitted and municipal uses account for 2% and 52% of the consumptive groundwater demand within the Ramara Creeks subwatershed, respectively. Agriculture accounts for 6.8%, while the unserviced domestic supply accounts for 39% of consumptive groundwater use.

In the future, municipal demand is anticipated to see a slight increase. The Tier 2 future demand analysis considers only the increases in municipal groundwater demand, therefore increases in unserviced domestic consumption from the Atherley-Uptergrove system and municipal surface water demand from the Brechin and Lagoon City systems were not considered under the future Tier 2 water budget scenarios. The population-adjusted calculation for the future water demand scenario represents the anticipated future takings of municipal pumping wells for Val Harbour and Bayshore Village systems only. The population of the Ramara Creeks subwatershed is predicted to increase by 62% by 2031 from 2011 to 5,330, however only 10% of this growth is within the two municipal groundwater supply systems mentioned above (Table 4-14) . Therefore, the results of the future Tier 2 water budget scenario only account for 10% of the estimated population growth within the Ramara Creeks subwatershed (detailed in Section 4.4.4).

**Table 4-14: Estimated future demand for Val Harbour and Bayshore Village.**

| Settlement | Current Serviced Population | Future Growth | Future Serviced Population | Current Demand ($m^3$/d) | Future Demand ($m^3$/d) |
|---|---|---|---|---|---|
| Val Harbour | 148 | 54 (36.5%) | 202 | 35.0 | 47.8 |
| Bayshore Village | 749 | 276 (36.8%) | 1,025 | 265.5 | 363.2 |
| **Total** | **897** | **330 (36.8%)** | **1,227** | **302.9** | **414.3** |

Notes:

1) Total future growth estimate based on 10% of 2031 predicted growth estimate (3,300 people) assumed to be serviced entirely by Val Harbour and Bayshore Village.
2) Growth distributed between Bayshore Village and Val Harbour proportional to current populations.
3) Future demand assumed to increase proportionately to growth in serviced population (i.e., a population increase of 36.5% results in an estimated increase in demand of 36.5%).

Municipal Water Supplies

There are six municipal water supply wells that service the communities within the Ramara Creeks subwatershed. Municipal groundwater takings account for approximately 52% of the estimated total groundwater taking within the subwatershed. Municipal well locations are shown on Figure 4-38. The data presented in this report were analysed to estimate actual annual average pumping rates which are often less than the permitted rates. The numerical groundwater flow model, discussed in Section 4.3, incorporated average pumping rates where the data were available.

Agricultural

The total consumption for agricultural use in the Ramara Creek subwatershed is estimated to be 14,358 $m^3$/yr, which is approximately 6.8% of the total water taking within the subwatershed. However, this water for irrigation is consumed only through the growing season, from May through mid-October. Therefore, the average daily water consumption for the growing season can be much higher. This water is used mainly for irrigation and in some cases livestock watering. The agricultural water supply is derived from both ground and surface water resources. For the purpose of this study, there was no differentiation between groundwater and surface water takings, and the non-permitted agricultural demand was treated as a groundwater taking. Some of the water used for irrigation will return back to the groundwater system as an irrigation return flow, and some will be lost to the atmosphere due to evapotranspiration. Water extracted for irrigation generally leads to an overall water loss in a water budget.

Other Permitted Uses

Several aggregate pits and quarries within the Ramara Creeks, Whites Creek, and Talbot River model area have a Permit To Take Water. This water is used for dewatering or aggregate washing activities, or for dust suppression. There is only one quarry operation that crosses into the Ramara Creeks subwatershed; however, the takings from this quarry are only accounted for in the Talbot River water budget calculations, since only a very small portion of the quarry is actually located within the Ramara Creeks subwatershed.

In addition, there are a number of permits related to golf course irrigation and campground facilities with the Ramara Creek subwatershed. As with the agricultural irrigation, some of the water applied over the golf courses will infiltrate back into the shallow groundwater system, and some will be lost to the atmosphere through evapotranspiration. Campgrounds generally use the domestic supply, such as drinking water and restroom facilities, therefore most of the water will be returned via septic systems with some being lost.

#### *4.4.2 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 surface, such as roadways, parking lots, and building roofs, than natural or rural lands. Increased runoff rates 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.

Natural land cover and land use was simulated in the water budget using LSRCA Ecological Land Classification (ELC). Land use patterns were defined using the LSRCA ELC land use coverage which covered all of the immediate study area. SOLRIS data (MNR, 2008) and SIL data (Southern Ontario Interim Land Cover) (MNR, 2006) was used to infill the remaining areas.

A large number of land use types and categories are found across the Ramara Creeks, Whites Creek, and Talbot River subwatersheds assessed as part of the Tier 2 Water Budget study. For illustrative purposes only the five primary types of land uses types (forest, agricultural ,urban, water bodies, and wetlands) are shown in Figure 4-39.  Across the Ramara Creeks subwatershed specifically, natural areas, including forests and wetlands, cover approximately 41% of this relatively rural subwatershed, while agricultural land uses cover about 51% of the area. Developed/settled areas (i.e. urban, rural residential, transportation, parks, industrial, and commercial land uses) cover only 4% of the study area, while pits and quarries make up approximately 0.3% of the area. Some notable natural features in the subwatershed include a number of wetlands along the Lake Simcoe shoreline as well as the Mara County Forest wetland located to the north of the subwatershed. Key upland groundwater recharge areas located in the northern end of the subwatershed are another important feature due to their role in sustaining groundwater recharge to ecologically significant features.

It should be noted that the percentage of impervious surfaces used in the surface water model (PRMS) developed by Earthfx (2014) for the water budget exercise may differ from the percentage discussed in Chapter 2. The percent impervious cover reported in **Chapter 2** assumes specific landuses are 100% impervious, whereas the model assumes that each type of landuse varies in the percentage of impervious area. It should also be noted that although the most accurate available land use information was used, these numbers will continue to change as development occurs.

The following will discuss the various landuses within the Ramara Creeks subwatershed in the context of Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas. The subwatershed contains a low level of impervious (hardened) surfaces due to the lack of urban areas. Figure 4-40 illustrates the distribution of land uses for recharge areas within the subwatershed. Urban areas and industrial, commercial, and institutional landuses combined only comprise 1% of the land within the SGRAs and ESGRAs, while rural development comprises 1.4%.

Agriculture practices, like urban development, can influence the quantity of both surface and groundwater within a watershed. Agricultural land use leaves the ground in a more natural state, allowing for groundwater infiltration to occur. Agricultural land uses comprise the greatest portion of the Ramara Creeks SGRAs and ESGRAs. Intensive and non-intensive agricultural land uses account for close to 55% of the landuses within SGRAs and ESGRAs at 13% and 42%, respectively. When groundwater infiltration occurs in agricultural and rural areas the ground can become supersaturated following a prolonged precipitation event leading to the ponding of water at the surface. Before and after the 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 their root system.

As mentioned in Section 4.4.1 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 groundwater and 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.

Natural heritage features comprise the second largest landuse within the significant groundwater recharge areas at 41% cover (Figure 4-41). The natural heritage features leave the landscape in a natural state, promoting infiltration. There are currently no active aggregate operations being run within the SGRAs and ESGRAs. Future land development plans should focus on promoting land use activities that maintain and protect the recharge occurring within SGRAs and ESGRAs.

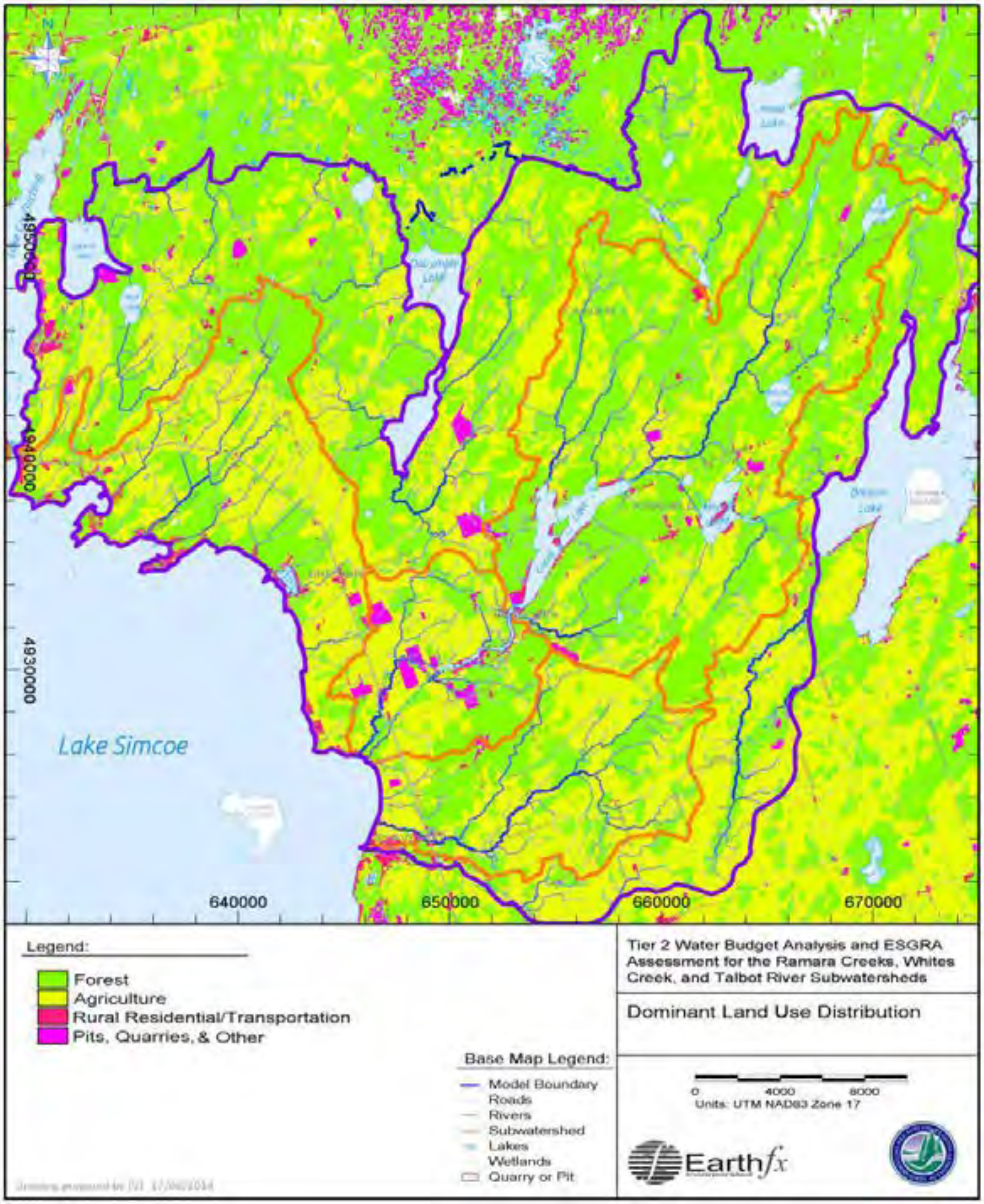



**Figure 4-39: Distribution of dominant land use types used in the integrated surface/groundwater model (Earthfx, 2014).**

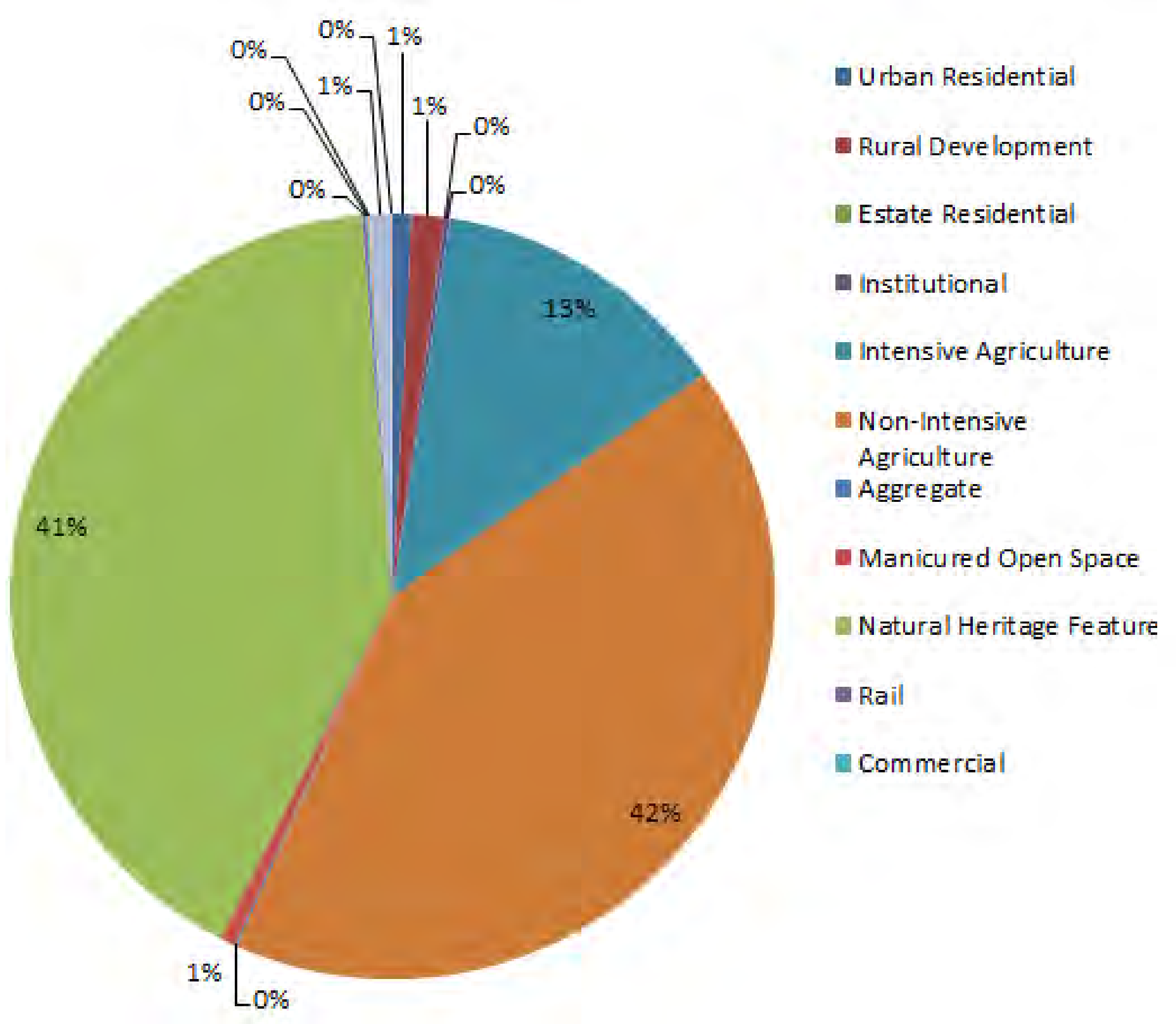
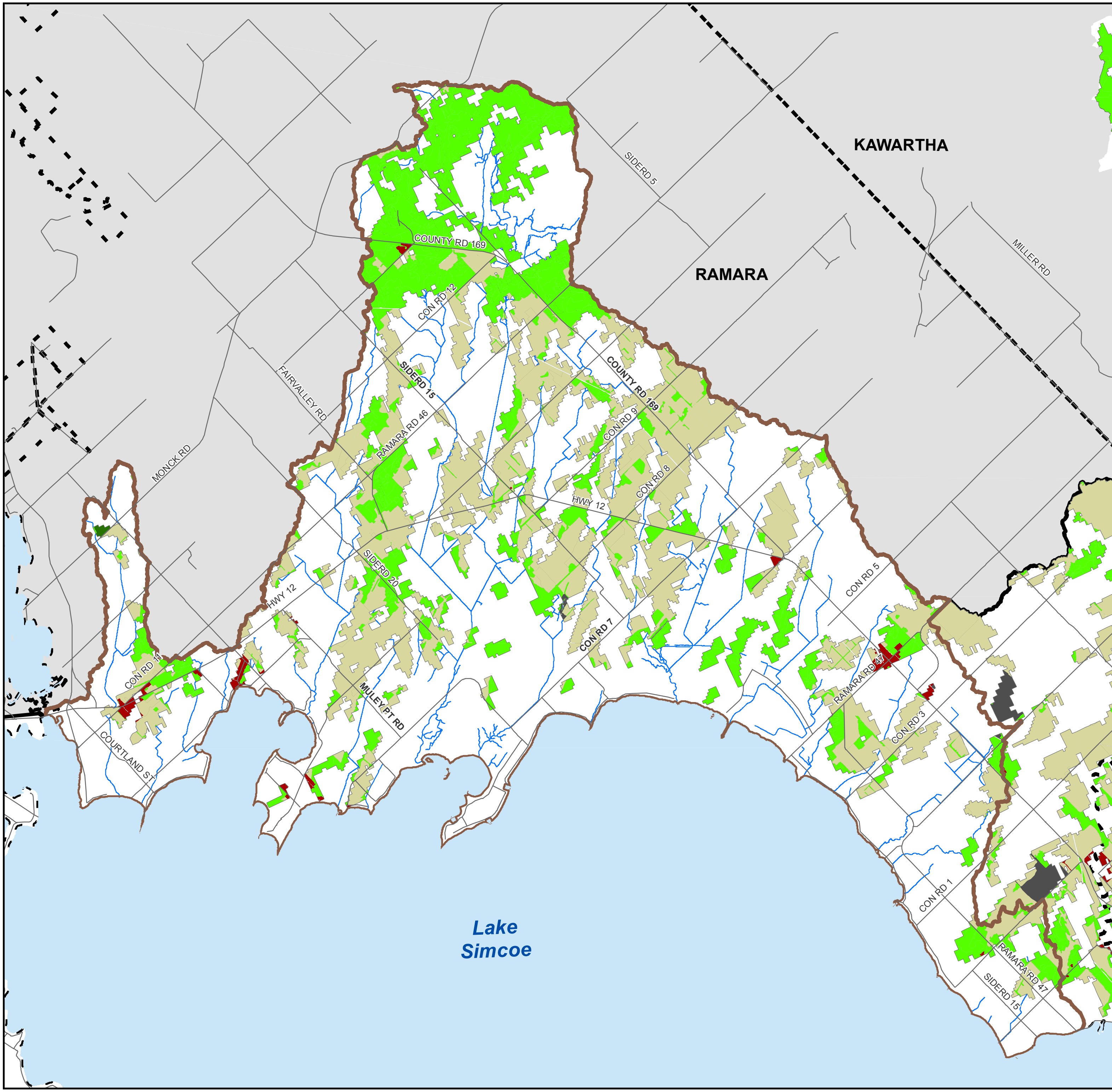



**Figure 4-40: Land use distribution within Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas for the Ramara Creeks subwatershed.**

**Spatial distribution of land use within SGRA and ESGRA in the Ramara Creeks subwatershed**

Figure 4-41




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Land Use

- Urban
- Rural
- Natural Cover
- Golf Course
- Aggregate

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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 dc created November 2014.

### 4.4.3 Water Budget Stress Assessments

Potential water quantity stress has been estimated on a subwatershed basis through the Source Water Protection and Lake Simcoe Protection Plan initiatives. Several water budget initiatives have been undertaken to identify potential water quantity stress within the Ramara Creeks subwatershed. The indicators of stress presented in this report are based on these studies and more information can be obtained from the following reports: LSRCA (2009), Earthfx (2014).

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

Tier 1 Water Budget Results

The Tier 1 Water Budget Study (LSRCA, 2009) conducted a comparison of current conditions and future demand for the Ramara Creeks subwatershed, on both an average annual and monthly basis. The completion of the analysis helps to determine whether stress on the groundwater and surface water resources can be anticipated under various scenarios. The stress assessment evaluates the ratio of the consumptive demand for permitted and non-permitted users to water supplies, minus water reserves, within each subwatershed (equation shown in blue text box above). The major components of the water budget have been estimated and tabulated as described in the preceding sections, including water supply, water demand, and water reserve.

Results of the current and future groundwater stress assessment, using annual average demand, are shown in Table 4-16 and Table 4-17. Under both the current and future conditions scenarios the Ramara Creeks subwatershed had a 1% water demand (i.e. water demand exceeded water supply by 1%) , and was therefore found not to be potentially stressed with regard to average annual water demand under current and future conditions.

Results of the current monthly groundwater stress assessments are shown in Table 4-17. As presented in the Table, the Ramara Creeks subwatershed was estimated to have a stress level of 1%, throughout all months of the year. The lack of seasonal changes in stress levels is a result of a fairly consistent groundwater and surface water supply and consistent water demand within the subwatershed.

Overall, the results provide a reasonable assessment of the annual groundwater and monthly surface and groundwater supply and demand conditions. As a result of the current and future average annual stress assessment the Ramara Creeks subwatershed didn't advance to a Tier 2 Water Budget Assessment per the Clean Water Act Technical Rules. However, the Lake Simcoe Protection Plan requires that a Tier 2 assessment be undertaken; this is discussed further below.

**Table 4-15: Tier One results - current annual groundwater stress assessment (LSRCA, 2009)**

| Subwatershed | Area | Precip | AET | Surplus Water | Annual Mean Flow | | Baseflow | | Available Supply | | | | Reserve | | | | Groundwater Consumption | | GW Stress |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | GW | | SW | | GW | | SW | | | | |
| | km² | mm/a | mm/a | mm/a | m³/s | mm/a | m³/s | mm/a | mm/a | m³/s | mm/a | m³/s | mm/a | m³/s | mm/a | m³/s | m³/a | mm/a | % |
| Ramara Creeks | 144 | 962 | 558 | 404 | 0.8 | 182 | 0.3 | 73 | 294 | 1.3 | 75 | 0.3 | 7 | 0.03 | 54 | 0.2 | 255,000 | 2 | 1% |

Note: Values rounded for presentation purposes

10 - 24% of available supply being taken
25% or more of available supply being taken

AET - Actual Evapotranspiration
GW - Groundwater
SW - Surface Water

**Table 4-16: Tier One results - future annual groundwater stress assessment (LSRCA, 2009).**

| Subwatershed | Area | Precip | AET | Surplus Water | Annual Mean Flow | | Baseflow | | Available Supply | | | | Reserve | | | | Groundwater Consumption | | GW Stress |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | GW | | SW | | GW | | SW | | | | |
| | km² | mm/a | mm/a | mm/a | m³/s | mm/a | m³/s | mm/a | mm/a | m³/s | mm/a | m³/s | mm/a | m³/s | mm/a | m³/s | m³/a | mm/a | % |
| Ramara Creeks | 144 | 962 | 558 | 404 | 0.8 | 182 | 0.3 | 73 | 294 | 1.3 | 75 | 0.3 | 7 | 0.03 | 54 | 0.2 | 288,000 | 2 | 1% |

Note: Values rounded for presentation purposes

10 - 24% of available supply being taken
25% or more of available supply being taken

AET - Actual Evapotranspiration
GW - Groundwater
SW - Surface Water

**Table 4-17: Tier One results - current monthly groundwater stress assessment (LSRCA, 2009).**

| Subwatershed | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ramara Creeks | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% |

Notes:

>50% of available supply being taken
>25% & <50% of available supply being taken

Tier 2 Water Budget Results

The objectives and approach of the Tier 2 Water Budget Assessment is similar to that of the Tier 1 in that the overall goal is to quantify water supply, reserve, and demand. Once these budget components are estimated, the "percent water demand" equation and stress level assessment screening thresholds are the same between tiers. The methods used to quantify the water budget components, however, are more robust in a Tier 2 study.

The Ramara Creeks, Whites Creek, and Talbot River subwatersheds Tier 2 Water Budget (Earthfx, 2014) conducted a comparison analysis of current and future conditions for average annual, monthly, and two-year drought conditions. The completion of the analysis helps to determine whether stress on the groundwater resources can be anticipated under various scenarios. The stress assessment evaluates the ratio of the consumptive demand for permitted and non-permitted users to water supplies, minus water reserves, within each subwatershed. The major components of the water budget for the Ramara Creeks subwatershed have been estimated and tabulated as described in the preceding sections, including water supply, water demand and water reserve.

The results of the stress assessment for annual average demand under current and future conditions are shown in Table 4-18 and Table 4-19. This assessment suggests that the Ramara Creeks subwatershed is estimated to have a potential stress level of 2% under current conditions, and a 2.4% stress level under future conditions, indicating that there is less than a 1% change in overall groundwater demand between current and future conditions. These values suggest that the Ramara Creeks subwatershed is not stressed from a groundwater perspective. Some differences exist between the consumptive demand values derived in the Tier 1 and the values derived under the Tier 2. Differences in methods for estimating recharge, discharge to streams, and cross-watershed flows result in additional variances in the values used in the water demand computations between the two studies.

**Table 4-18: Percent water demand stress assessment – current conditions (Earthfx, 2014).**

| Component | | Ramara Creeks |
|---|---|---|
| Groundwater Supply | Recharge In | 20,671 |
| | Stream Seepage | 244 |
| | Lake Seepage | 0 |
| | Lateral Inflow | 7,782 |
| | *Total:* | 28,697 |
| Groundwater Reserve | | 1,444 |
| Consumptive Demand | | 575 |
| **Percent Water Demand** | | **2.1%** |

**Table 4-19: Percent water demand stress assessment – future conditions (Earthfx, 2014)**

| Component | | Ramara Creeks |
|---|---|---|
| Groundwater Supply | Recharge In | 20,807 |
| | Stream Seepage | 229 |
| | Lake Seepage | 0 |
| | Lateral Inflow | 7,748 |
| | *Total:* | 28,784 |
| Groundwater Reserve | | 22.924 |
| Consumptive Demand | | 686 |
| **Percent Water Demand** | | **2.4%** |

*values subject to round off

Drought Scenarios

As part of the Tier 2 Water Budget Analysis for the Ramara Creeks, Whites Creek, and Talbot River subwatersheds (Earthfx, 2014), a stress assessment on current and future conditions was completed. Two drought scenarios were simulated for the study area. The first represents an extreme condition assuming that no recharge occurs in the groundwater system for a two-year period. The second scenario considers a historic 10-year period of low rainfall.

A Tier 2 level two-year drought assessment was completed by setting recharge to zero and running the transient groundwater model (MODFLOW only) for a two-year period. Under the extreme conditions, the water table is seen to decline and groundwater discharge to streams is reduced. Table 4-20 summarizes the change in groundwater discharge to surface features in the Ramara Creeks subwatershed under the two-year drought for both current and future conditions. Average groundwater discharge to the Ramara Creeks subwatershed under current conditions is estimated to be 10,112 $m^3$/day. At the end of the two-year drought, groundwater discharge in the subwatershed is reduced to 3,931 $m^3$/day, indicating a 61% reduction in groundwater discharge over the two-year drought scenario. Groundwater discharge to streams at the start and end of the two-year drought (under current conditions) are presented Figure 4-42 and Figure 4-43, respectively. The percent change in the surface discharge due to the drought is presented in Figure 4-44 for the current conditions scenario. The largest impacts due to drought are seen in the headwater tributaries across the model, which are sustained mainly by groundwater discharge that occurs where the streambed intersects the water table. These tributaries are therefore sensitive to small changes in groundwater levels (Earthfx, 2014).

**Table 4-20: Two-year drought impact on groundwater discharge to surface features.**

| Component | Ramara Creeks |
|---|---|
| **Current Conditions** | |
| Average groundwater discharge ($m^3/d$) | 10,112 |
| Groundwater discharge at end of 2-year drought ($m^3/d$) | 3,931 |
| **Percent Reduction** | **61%** |
| **Future Conditions** | |
| Average groundwater discharge ($m^3/d$) | 9,398 |
| Groundwater discharge at end of 2-year drought ($m^3/d$) | 3,736 |
| **Percent Reduction** | **60%** |

Figure 4-45 presents the change in groundwater levels in the weathered bedrock aquifer (layer 3) after the two-year drought. As illustrated in the figure, the largest declines in groundwater water levels occur around the topographic high points in the model, which typically represent areas of groundwater recharge. In the Ramara Creeks subwatershed, changes in water level were generally between 0.5 and 2.5 m, with the largest declines occurring at the upland recharge feature located at the northern tip of subwatershed boundary. Despite the drop in water levels, none of the municipal pumping wells went dry during the two-year drought simulation.

The 10-year drought scenario utilized the transient GSFLOW model. A model run spanning from October 1953 to October 1967 was executed using MNR in-filled hourly precipitation data. The areas most affected by the drought are similar to those in the two-year drought simulation. As expected, the drawdowns are not as severe as those predicted under the two-year drought scenario. The decrease in simulated monthly average water levels between July 1956 (the beginning of the drought period) and November 1964 (the most severe drought year) are shown in Figure 4-46. In the Ramara Creeks subwatershed, drawdown is generally predicted to be less than 1.5 m, rather than the less than 2.5 m predicted under the two-year drought scenario. In the central areas on the subwatershed, water levels appear unaffected, even during the most severe drought episodes. As with the previous scenario, no municipal pumping wells went dry during the 10-year drought assessment.

Despite minimal decreases in water levels within the Ramara Creeks subwatershed, the upland area located just north of the subwatershed boundary is simulated to exhibit more pronounced drawdowns. Although this area is located outside of watershed boundaries, it is predicted to contribute groundwater inflow that supports ecologically significant features in the Ramara Creeks subwatershed.

Table 4-21 summarizes the change in total streamflow and groundwater discharge to Wainman's Creek from the beginning of the 10-year drought to the most severe period of drought (November 1964). As presented in the Table, streamflow in Wainman's Creek is reduced by 70%, while monthly groundwater discharge to the stream is reduced by 38%. Figure 4-47 presents the percent reduction in simulated monthly average streamflow. As presented in the figure, the greatest decreases occur in the headwater tributaries, with many showing a near 100% decrease in flow. These decreases accumulate downstream and are added to the losses experienced in the downstream reaches. The main tributaries are generally affected to a lesser degree.

**Table 4-21: Ten-year drought impact on total streamflow and groundwater discharge to Wainman's Creek (Earthfx, 2014).**

| Component ($m^3/s$) | Wainman's Creek |
|---|---|
| Monthly average total streamflow – July 1956 | 0.191 |
| Monthly average total streamflow – November 1964 | 0.057 |
| **Percent Reduction** | **70%** |
| | |
| Monthly groundwater discharge to streams - July 1956 | 0.056 |
| Monthly groundwater discharge to streams - Nov. 1964 | 0.035 |
| **Percent Reduction** | **38%** |

Under both current and future conditions, the subwatershed was assessed at the low stress level.

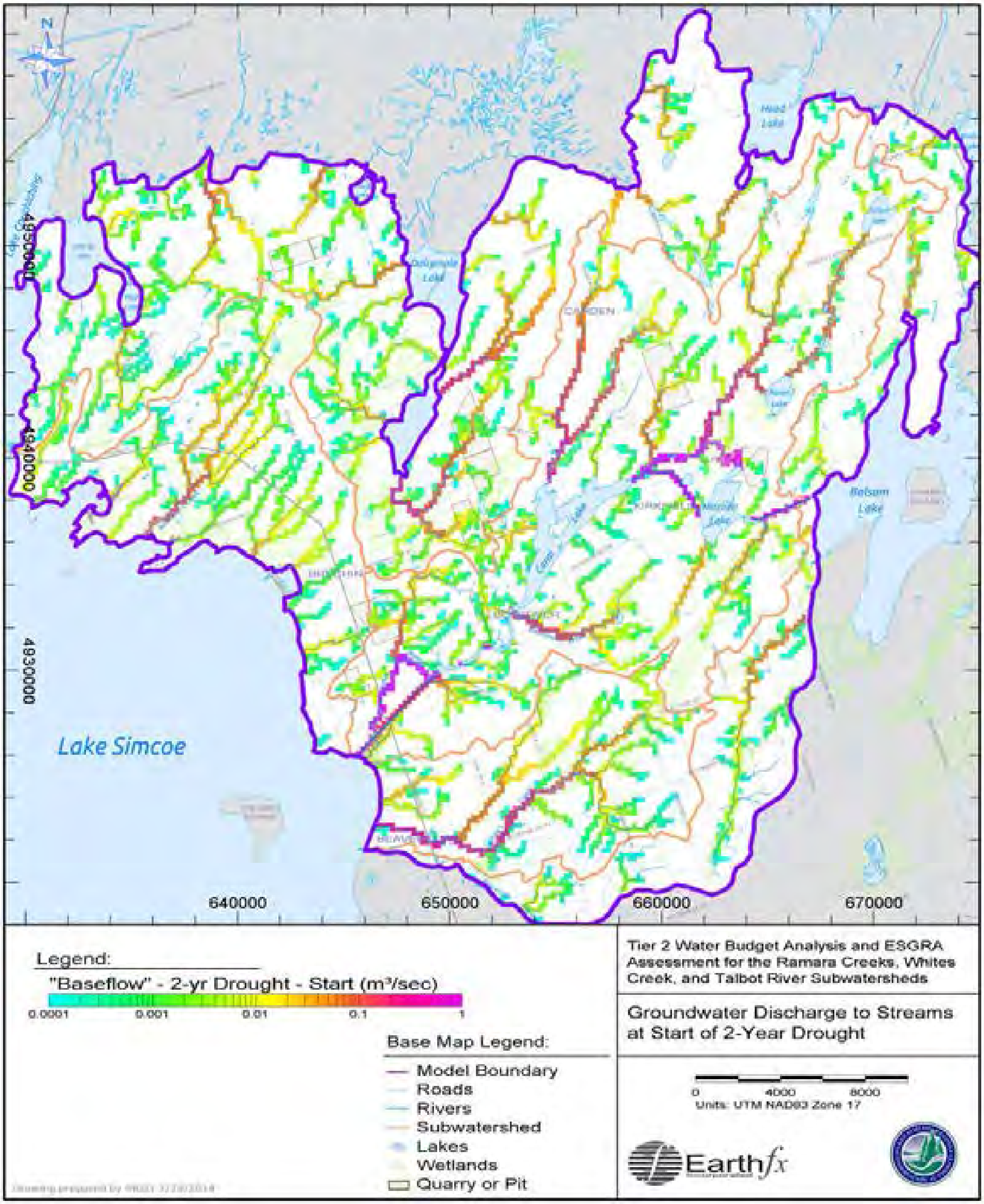



**Figure 4-42: Simulated groundwater discharge to streams (baseflow) at start of two-year drought (current conditions).**

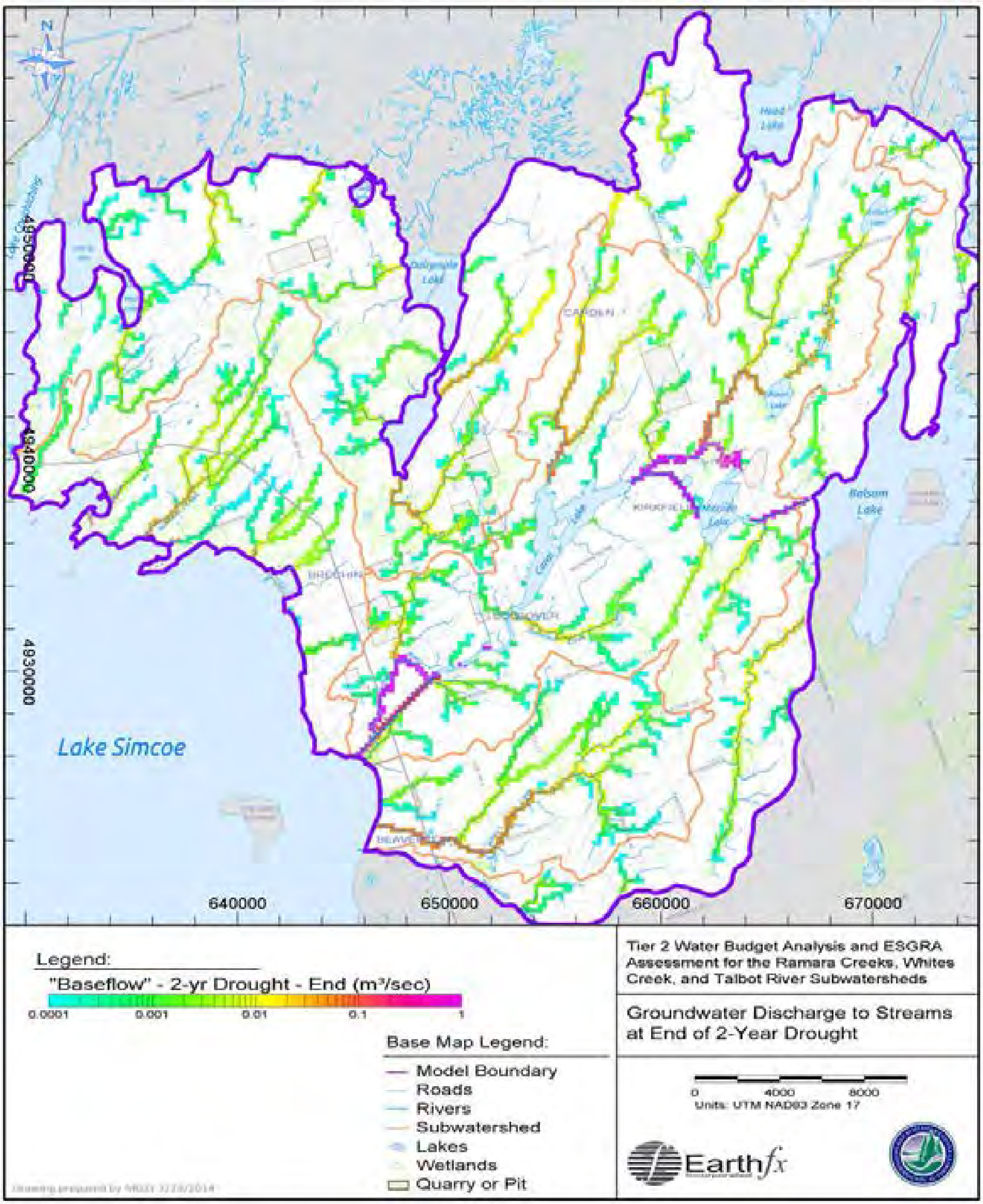



**Figure 4-43: Simulated groundwater discharge to streams (baseflow) at end of two-year drought (current conditions).**

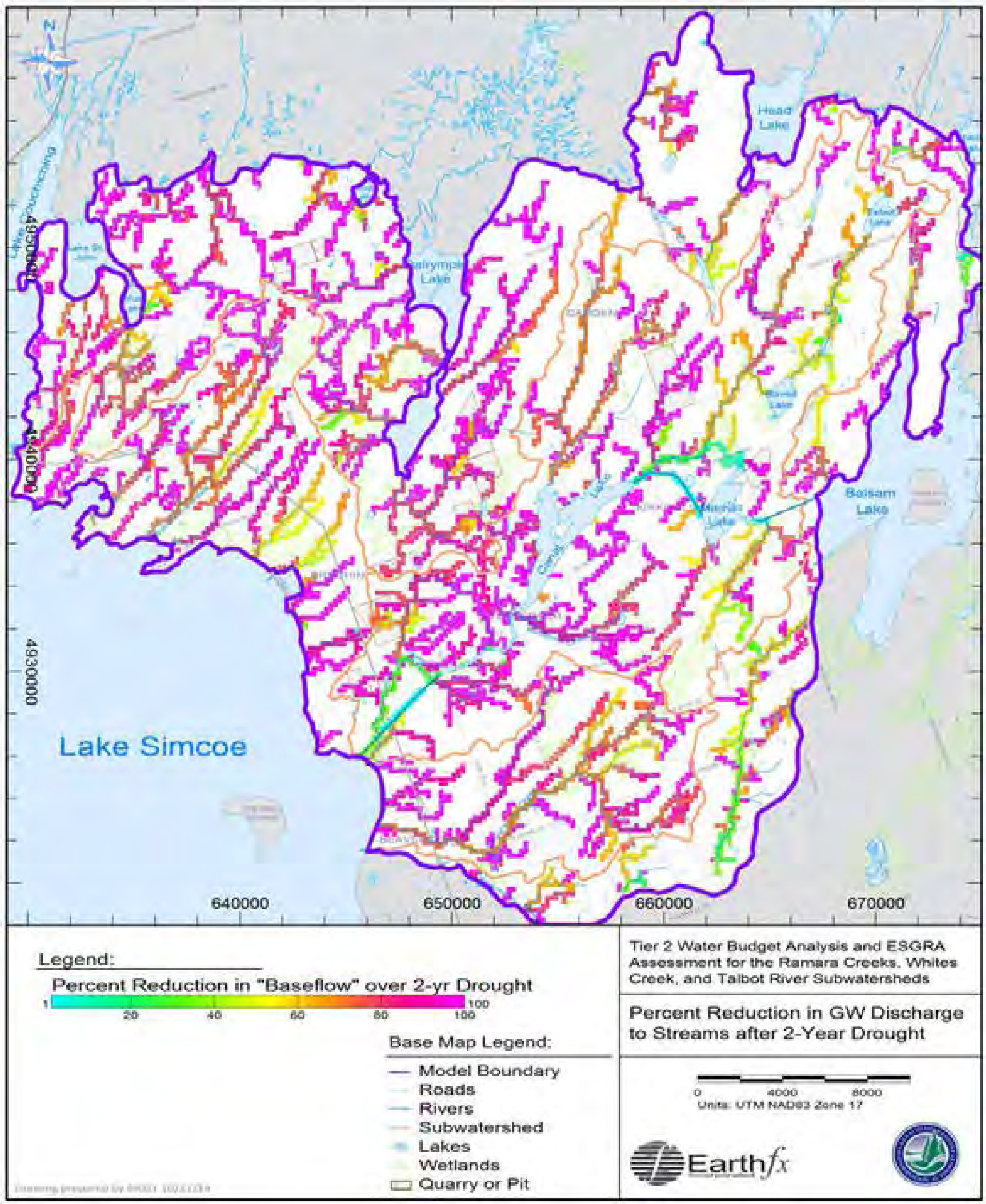



**Figure 4-44: Percent reduction in baseflow at the end of the two-year drought (current conditions).**

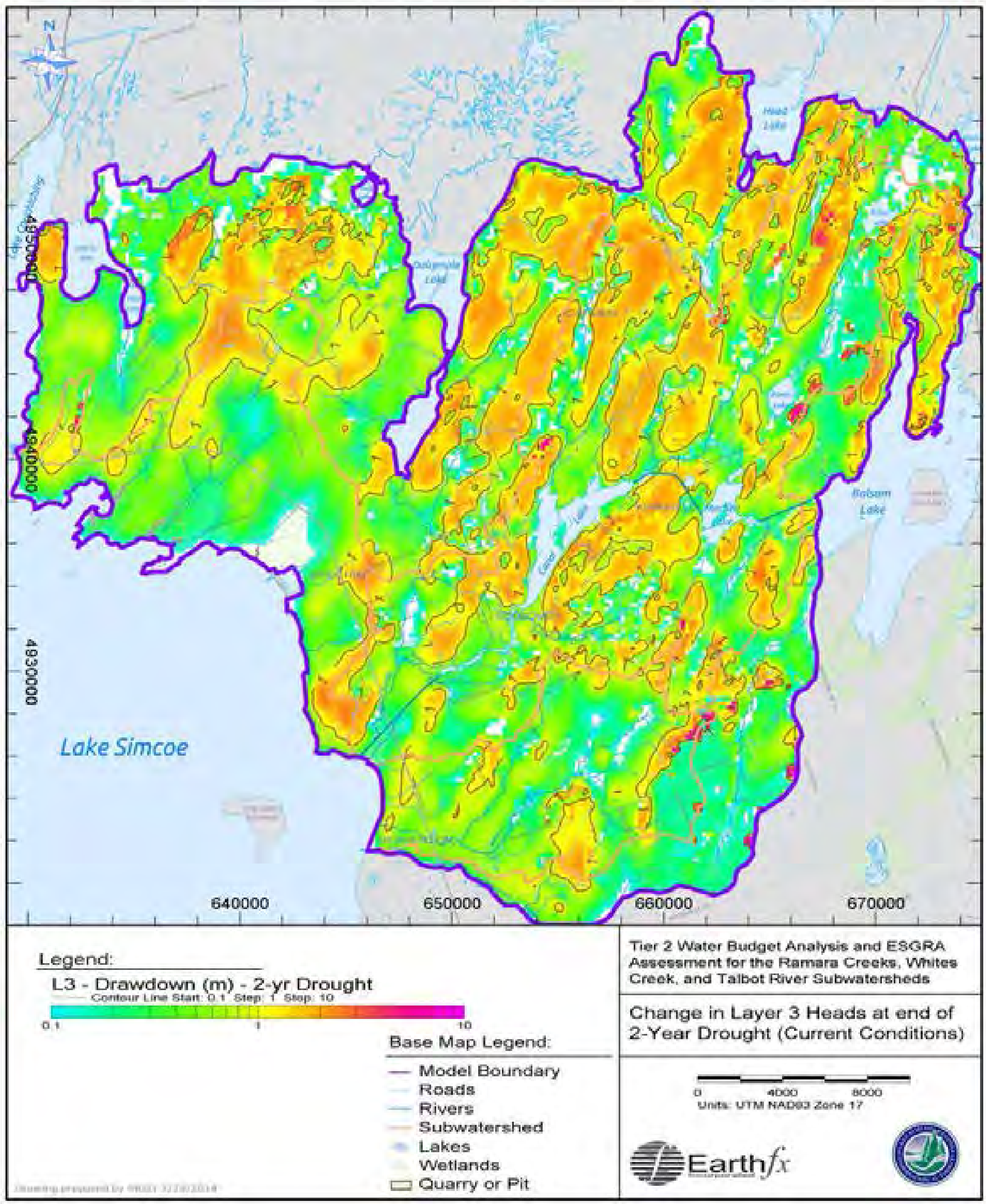



**Figure 4-45: Change in Layer 3 heads after a two-year drought with no groundwater recharge (current conditions).**

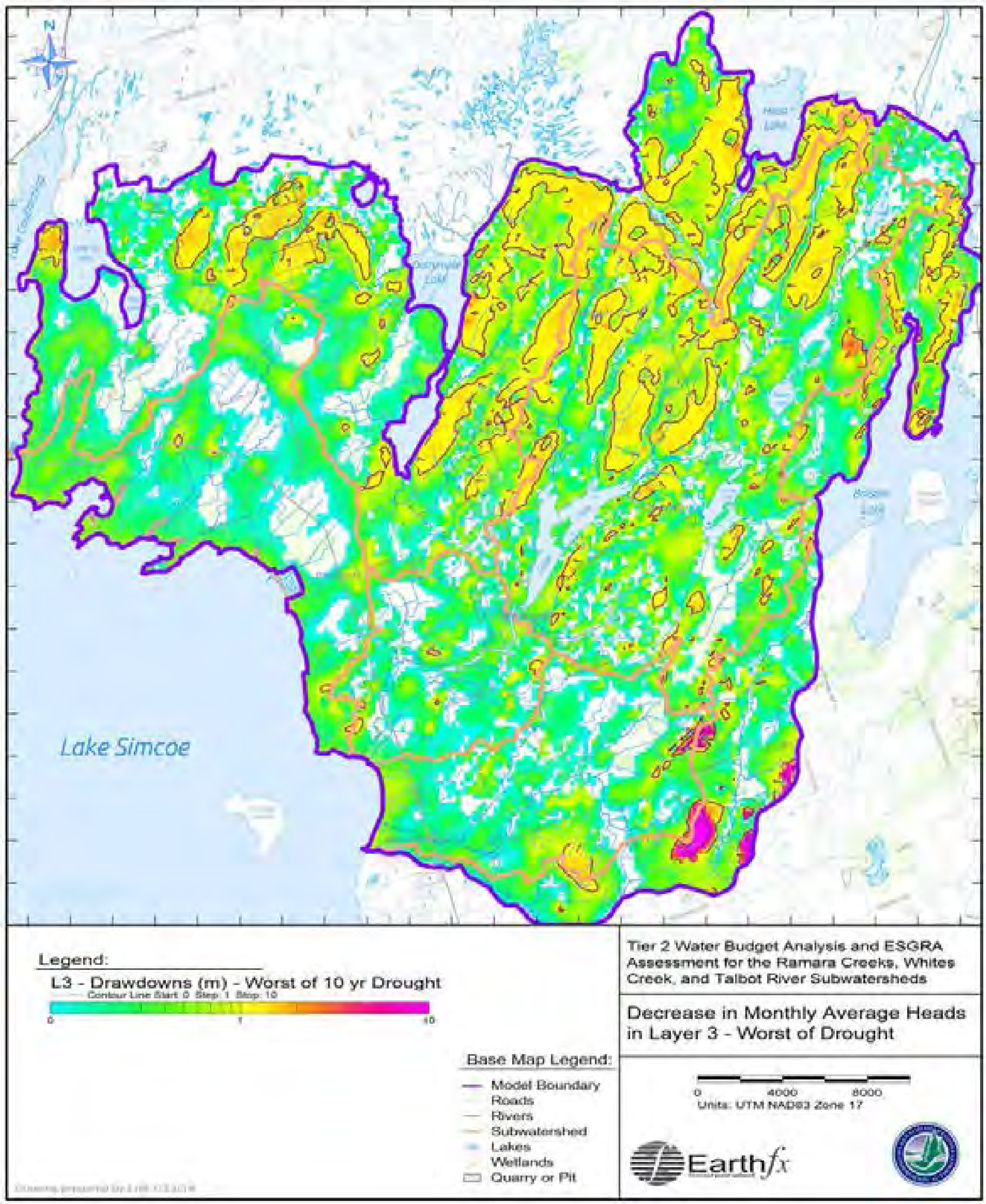



**Figure 4-46: Decrease in simulated monthly average heads in Layer 3 at worst of drought (November 1964).**

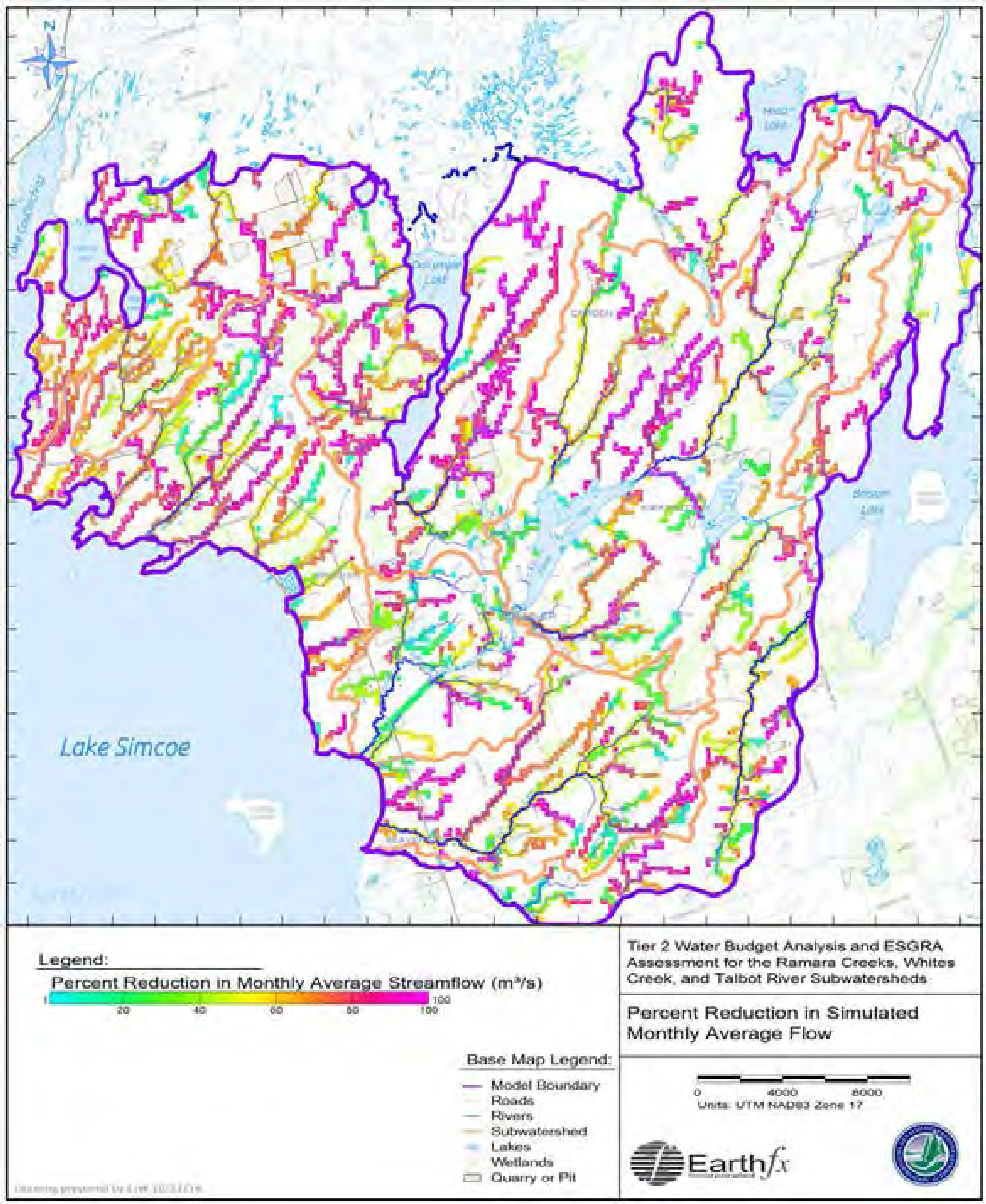



**Figure 4-47: Percent reduction in simulated monthly average flow (July 1976 versus November 1964).**

**Key Points – Water Budget:**

- The water demand estimates for the Ramara Creeks subwatershed suggests that water demand is relatively uniform over the year, with minor increases in the summer months due to some seasonal permitted uses.
- The total current groundwater demand from all sources in the Ramara Creeks subwatershed is 210,338 $m^3$/yr.
- Permitted and domestic wells account for approximately 91% of the current groundwater consumption within the Ramara Creeks subwatershed.
- The predominant land use types are natural heritage features and agricultural land uses, with settlement areas accounting for a very small percentage of the total area. The subwatershed contains a low level of impervious surfaces due to the lack of urban areas.
- The Tier 1 water budget for the Ramara Creeks subwatershed estimated the current groundwater consumption to be 255,000 $m^3$/annum, which represents 1% of the available groundwater supply. Future groundwater use is projected to be 288,000 $m^3$/annum, representing 1% of the available groundwater supply for the Ramara Creeks subwatershed. Overall, the Tier 1 indicated that the Ramara Creeks subwatershed was not stressed from a groundwater perspective.
- The Tier 2 water budget for the subwatershed estimated the current groundwater use to be 210,338 $m^3$/annum, which represents 2.0% of the available groundwater supply. Future groundwater use is projected to be 250,698 $m^3$/annum which represents 2.4% of the available groundwater supply for Ramara Creeks subwatershed. Overall, the Tier 2 Water Budget indicated that the subwatershed is not stressed from a groundwater perspective.

### *4.4.4 Climate Change*

The climate of the Ramara Creeks 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. In the hot summer months the water is flowing but an overall loss is occurring due to the high rates of evaporation.

Changes in climate trends have the potential to impact local water resources. An assessment of the effects of climate change on surface and groundwater resources in the Ramara Creeks, Whites Creek, and Talbot River subwatersheds was conducted using the integrated surface and groundwater model developed by Earthfx (2014). A detailed evaluation of the potential impacts of climate change on the hydrology and hydrogeology of the Ramara Creeks subwatershed is further discussed below.

Changes in climate have the potential to impact local surface water and groundwater systems and the interactions between them. Predictions of projected changes in Ontario climate based on over 30 global circulation models indicate that total annual temperature will likely increase by 2 to 6% , while precipitation may increase by 2 to 4% by the 2050s over the Great Lakes Basin (Bruce *et al*., 2003). Changes in extreme warm temperatures are expected to be greater than changes in the annual mean temperature (Kharin and Zwiers, 2005), and the number of days exceeding 30 degrees Celsius is projected to more than double by the 2050s in southern Ontario (Hengeveld and Whitewood, 2005), while heat waves and drought may become more frequent and longer lasting.

To evaluate the potential effects of climate change on groundwater and surface water systems on a subwatershed scale, Earthfx (2014) used the integrated surface and groundwater model in conjunction with transient global circulation model (GCM) datasets to simulate a number of climate change scenarios. In order to simulate the scenarios at a local scale, it was first necessary to downscale outputs from a selection of global circulation models. Outputs were downscaled using the Change Field Method – an approach recommended by Provincial Guidance, that involves the modification of baseline climate data by shifting the mean of observed climate data, and multiplying observed climate parameters by appropriate scale factors (e.g. a 2.5% increase in average daily temperature, and a 10% increase in total precipitation for January). The application of the Change Field Method yields a range of future climate data sets which can then be input into the local scale model to simulate future responses to climate change; these responses are then compared to baseline conditions for an overview of climate change impacts. For this study, a baseline period from 1971 -2000 and a future period representing 2041 – 2070 were utilized (Earthfx, 2014).

Before applying the change field method it was necessary to select the subset of global circulation models that would be downscaled and simulated for the climate change analysis, this was accomplished using the Percentile Method. In the percentile method, outputs of global circulation models, as sampled at a Ontario climate station, are ranked in ascending order, first based on their mean annual temperature change field, and then based on their precipitation change field – for this study the Orillia Brain climate station, located on the north shores of Lake Simcoe, was selected. A percentile is assigned to each climate scenario, and the $5^{th}$, $25^{th}$, $50^{th}$, $75^{th}$, and $95^{th}$ percentiles are selected for modelling temperature and precipitation change (Earthfx, 2014). For this study, a total of nine unique climate scenarios were selected and simulated using the integrated surface/groundwater model. The subset of climate data sets used for the study was obtained from the Ministry of Natural Resources. The subset of climate data obtained was then adjusted based on the change field for each of the nine unique scenarios.

Figure 4-48 shows the range in monthly change fields used to scale the precipitation data for the nine climate scenarios presented as box-whisker plots. The zero line in the plot represents the baseline scenario. As can be seen, monthly precipitation increases in the majority of the climate change scenarios except for June and July, resulting in generally wetter falls, winters, and springs and drier summers (Earthfx, 2014). Figure 4-49 shows the range in monthly change fields used to shift the temperature data for the nine climate change scenarios. All the scenarios show an increase in temperature of at least one degree Celsius in all months, with winter and late summer/fall (August and September) having the highest increase (Earthfx, 2014).

The integrated surface/groundwater model was run to simulate each of the nine climate change scenarios. Analysis of model runs indicated that all components of the water budget are affected by changes in precipitation and temperature under the future climate scenarios. The results discussed in this section are presented in terms of monthly and annual average values over the model area.

Figure 4-50 shows the percent change in annual average net groundwater recharge under the climate change scenarios. When averaged over the year, recharge rates appear largely unchanged in the Ramara Creeks subwatershed, with little to no increase occurring over the majority of the till covered landscape. However, as seen in Figure 4-51, median monthly groundwater recharge under climate change is predicted to increase significantly in the late fall and winter months and decrease during March and April. This indicates that although the net annual groundwater recharge may be largely unchanged over the study area, there is a noticeable change in the magnitude and timing of seasonal recharge patterns.

To evaluate local groundwater response in significant hydrogeologic features under climate change, two inspection points were selected for analysis. The first is located in the upland recharge area of the Ramara Creeks subwatershed, while the second is in a lowland discharge area of the subwatershed. Figure 4-52 and Figure 4-53 plot the average simulated monthly groundwater levels simulated for the two inspection points under each of the selected climate change scenarios. As illustrated in figures, groundwater levels experience an earlier and more prolonged response to the spring freshet, combined with a less dramatic decreases in water level over the winter months of January to March (Earthfx, 2014). This can be attributed to the wetter winters predicted by the global circulation models, which predict that a larger portion of winter precipitation will fall as rain rather than snow. Warmer temperatures predicted during the winter are also simulated to cause a reduction in average snowpack and ice coverage, which would otherwise serve to impede the movement of precipitation and runoff into the subsurface. The overall result of these climate change factors is an increase in groundwater recharge, which in turn is predicted to lead to higher groundwater levels throughout the winter months when compared to the baseline scenario (Earthfx, 2014).

Climate change impacts to streamflow were also evaluated at several locations within the model area. Figure 4-54 illustrates average simulated monthly streamflow in Wainman's Creek under baseline and climate change scenarios. As illustrated in the figure, significant changes in runoff timing are predicted during the winter and spring months. Warmer winter conditions with higher average precipitation are simulated to cause higher winter streamflows from

December through March. Due to the warmer winter temperatures, precipitation that would be stored in the snowpack under baseline conditions is instead predicted to run off as streamflow during mid-winter melt and rain-on-snow runoff events (Earthfx, 2014). For Wainman's Creek, these predicted increases in winter temperatures and streamflow result in a decrease in the magnitude of spring freshet peaks. In a number of areas throughout the model domain, this increase in winter temperatures and decrease in snowpack storage, leads to a shift in the timing of the freshet, causing more water to move off study catchments earlier. Shifts in freshet timing in turn result in a shift in the timing of spring recharge. Shifts in recharge from April to March produce a corresponding shift in the onset of low water periods. With longer summer low flow periods occurring earlier, the duration and severity of summer low flows increases. This is particularly true for stream catchments located in alvar areas, where the karstic nature of the landscape provides little recharge storage to support streamflow during the summer months (Earthfx, 2014). Overall, increasing temperatures, combined with a shift in the magnitude and timing of spring freshet and recharge events, are predicted to increase the stress placed on study area streams.

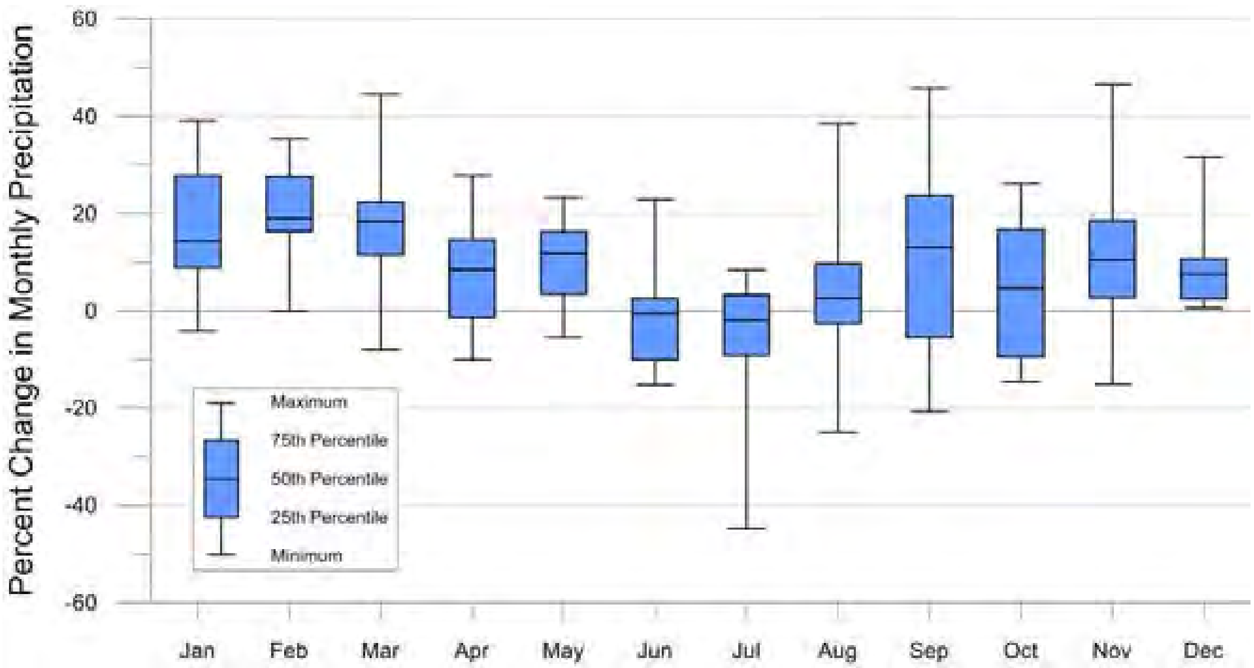



**Figure 4-48: Monthly precipitation change field statistics for the climate scenarios selected for this studies.**

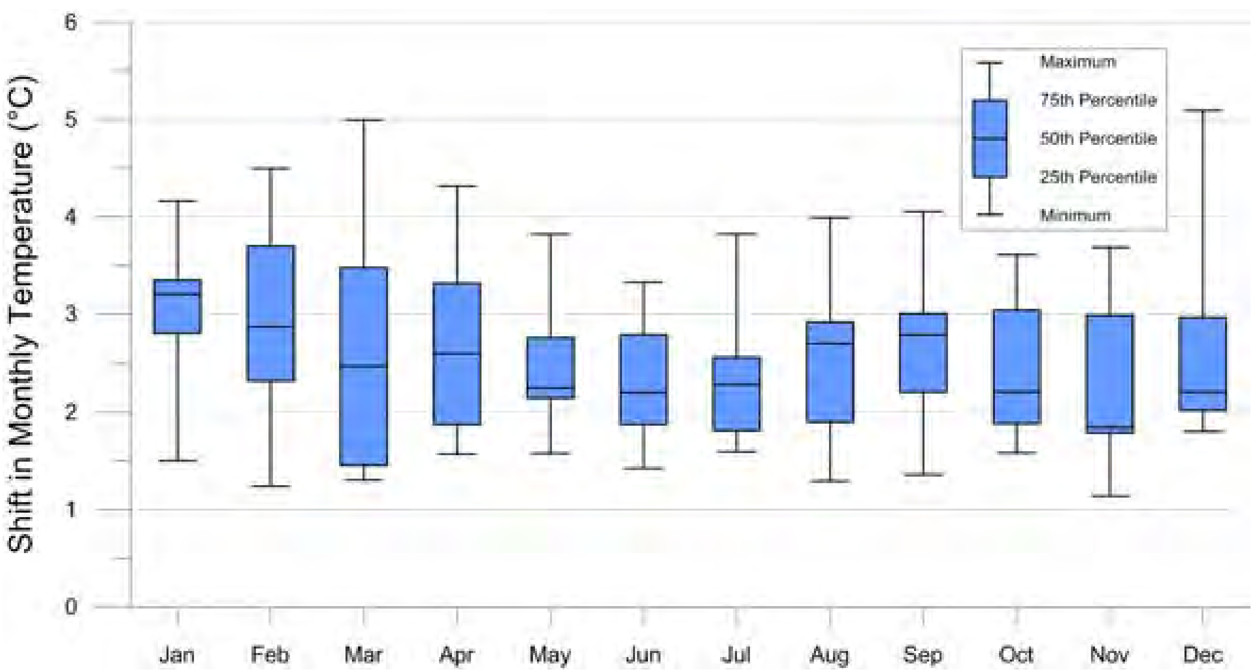



**Figure 4-49: Monthly temperature change field statistics.**

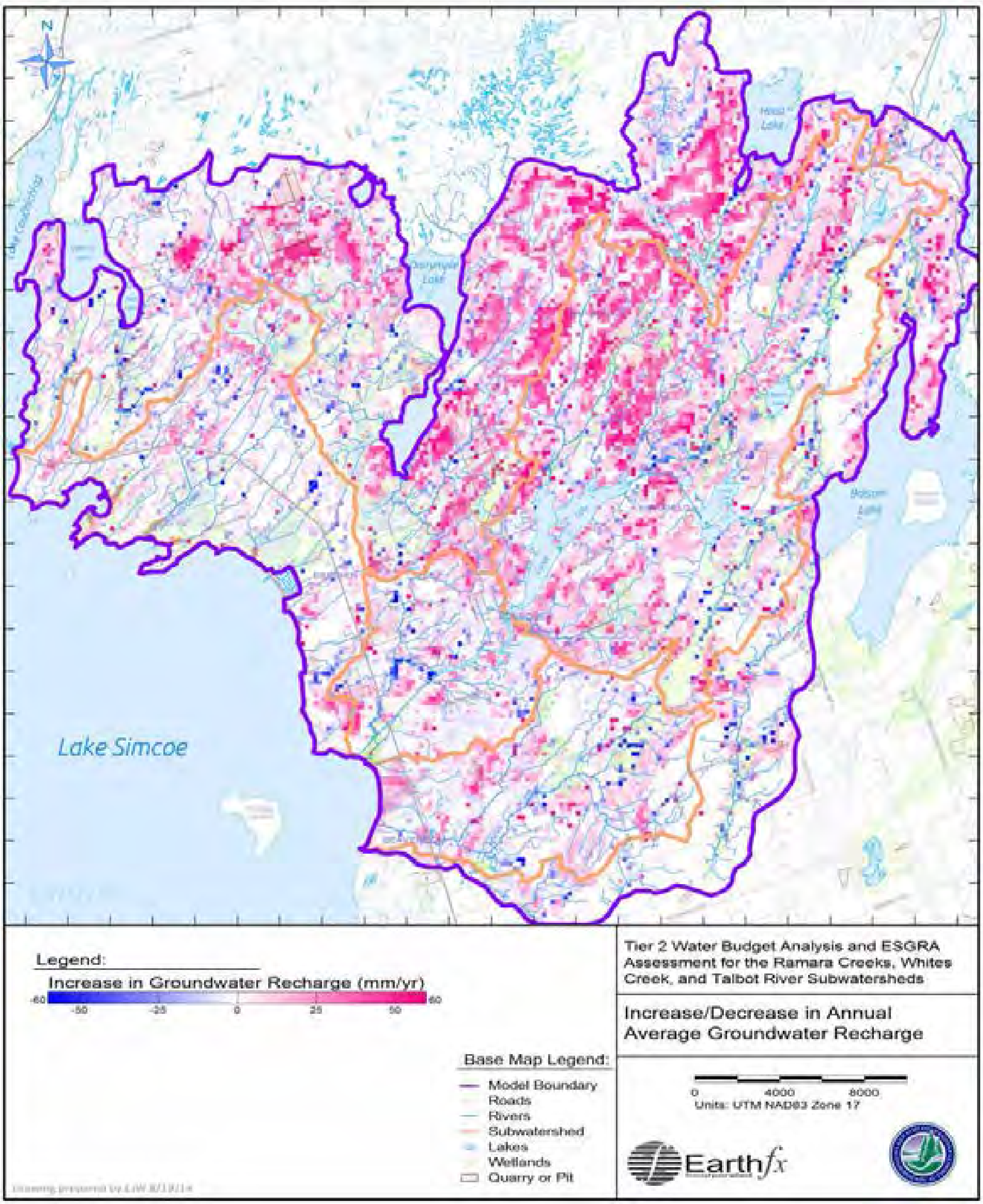



**Figure 4-50: Change in annual average net groundwater recharge.**

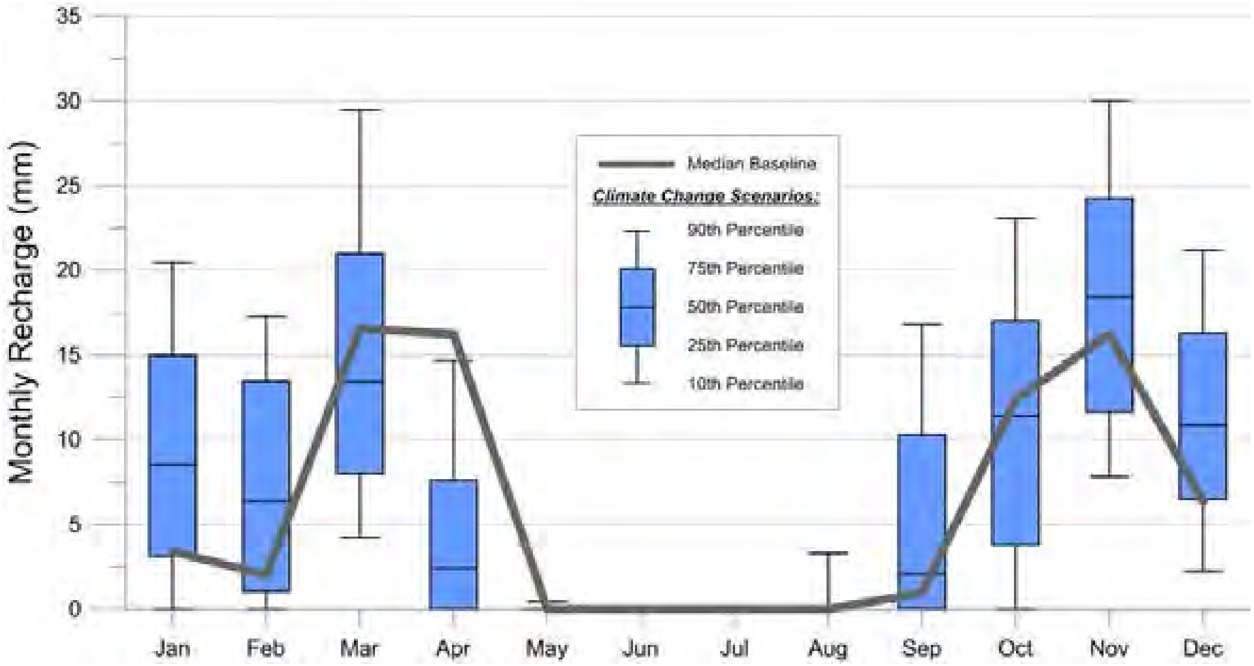



**Figure 4-51: Monthly average groundwater recharge statistics for the study area (Earthfx, 2014).**

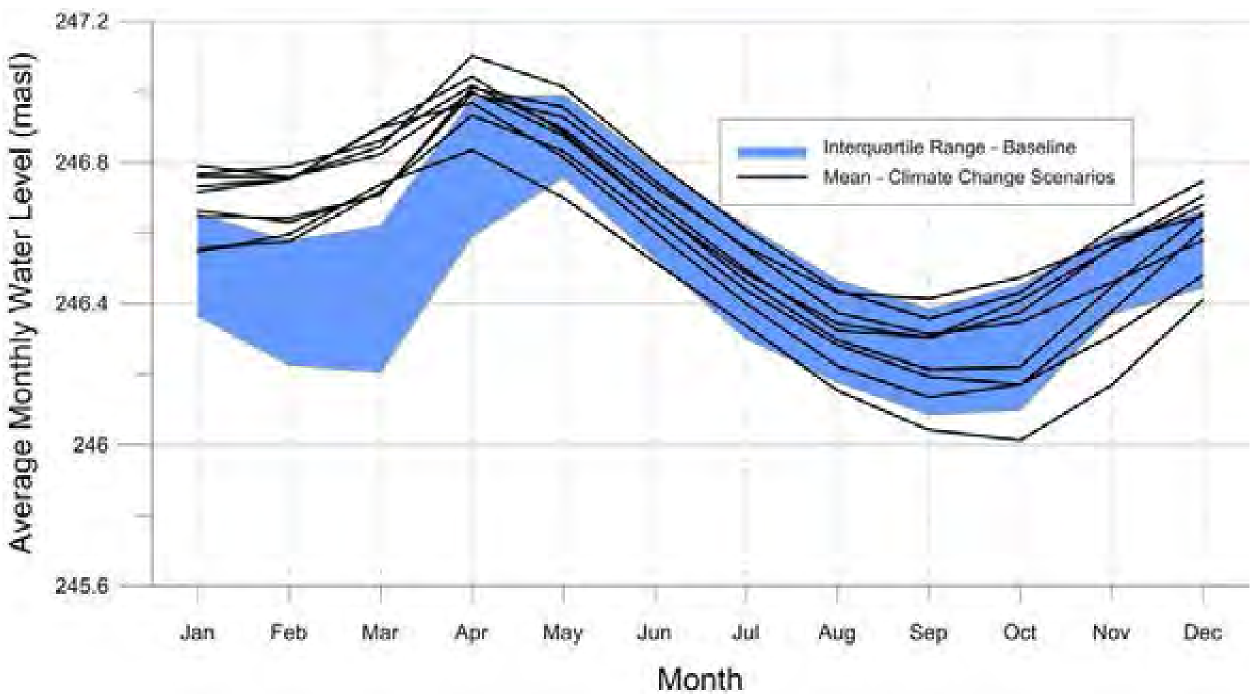



**Figure 4-52: Average simulated monthly groundwater levels at Location A –Upper Ramara (layer 3) (Earthfx, 2014).**

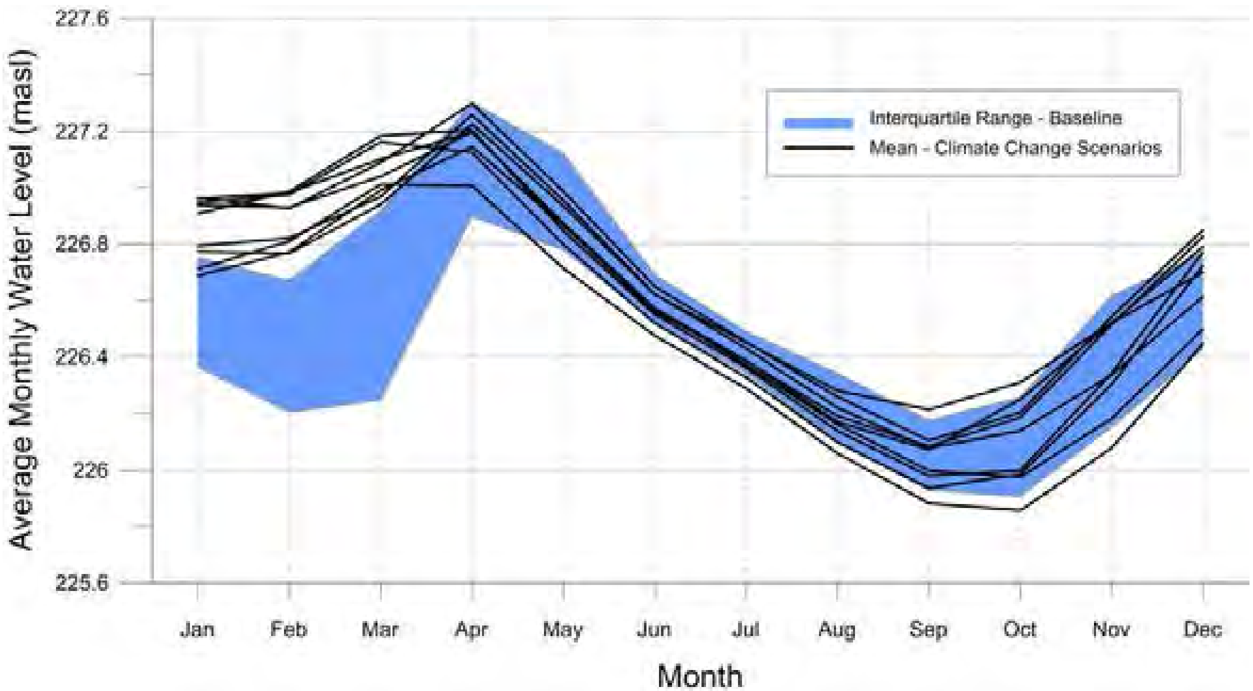



**Figure 4-53: Average simulated monthly groundwater levels at Location B (layer 3).**

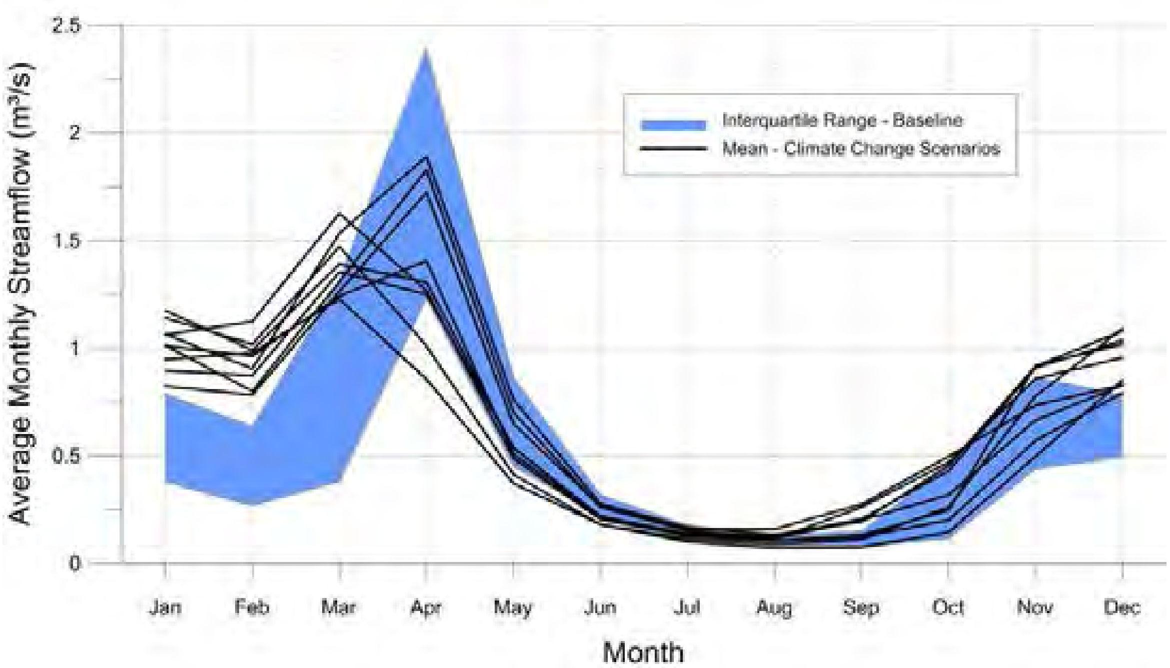



**Figure 4-54: Average simulated monthly streamflow in Wainman's Creek.**

**Key points –Climate Change:**

- A watershed scale integrated groundwater- surface water model was used in conjunction with nine unique Global Circulation Model datasets to simulate the effects of climate change scenarios in the study area.
- Analysis of the climate change scenario outputs indicated that temperature in the study areas will increase by at least one degree Celsius in all months, with winter and late summer/ fall having the highest increase. Monthly precipitation is also generally expected to increase, except during the summer months. This is predicted to result in a wetter fall and winter, and a drier warm season.
- Warmer winter temperatures, increased winter precipitation, and reduced snowpack and ice pack coverage are predicted to increase groundwater recharge during fall and winter, and lead to higher groundwater levels throughout the winter months.
- Warmer winter conditions and higher average precipitation are also simulated to cause higher winter streamflows from December through March; this in turn will shift the timing and decrease the magnitude of spring freshet peaks, causing more water to move off study area catchments earlier.
- Shifts in freshet timing and spring recharge are predicted to produce a corresponding shift in the onset of low water periods. The onset of earlier summer low flow periods will increase the duration and severity of summer low flows.
- Stream catchments located in alvar areas will be most affected by prolonged summer low flows; this is due to the karstic nature of the alvar landscape, which provides little recharge storage to support streamflow during the summer months (Earthfx, 2014).

## 4.5 Current Management Framework

### 4.5.1 Protection and policy

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 Growth Plan for the Greater Golden Horseshoe, 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. Table 4-22 categorizes four 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 the various Acts, policies, and plans on the stressors are categorized as 'existing policies in place', or 'no applicable policies'. The policies included in the table include those which which have legal standing and must be conformed to, or policies (such as some of those under the Lake Simcoe Protection Plan) which call for the development of further management tools, research or education programs.

The intent of these regulations, policies, and plans are summarized in **Section 1.3 – Current Management Framework**. Readers interested in the details of these regulations, policies and plans are directed to read the original documents.

**Table 4-22: Summary of current regulatory framework as it relates to the protection and restoration of water quantity**

| Stressor affecting water quantity | Lake Simcoe Protection Plan (2009) | Growth Plan for the Greater Golden Horseshoe (2006) | Provincial Policy Statement (2005) | Ontario Water Resources Act (1990) | Water Opportunities Act (2010) | Proposed South Georgian Bay Lake Simcoe Source Protection Plan (2012) | LSRCA Watershed Development Policies (2008) | Simcoe County Official Plan (2007) | Township of Ramara Official Plan (2003) |
|---|---|---|---|---|---|---|---|---|---|
| Impervious surfaces | | | | | | | | | 2 |
| Agricultural water demand | | | | | | | | | 3 |
| Commercial and residential water demand | | | | | | | | | 3 |
| Climate change | | | | | | 1 | | | |

| Restrictive policies in place | No applicable policies |
|---|---|

[1] No policies to prevent climate change, but policies include an assessment of possible impacts
[2] General policy to minimize impervious surfaces
3 General statement around sustainable use of water resources

As can be seen in Table 4-22, a number of Acts, plans, and policies already exist to protect surface and ground water quantity in the Ramara Creeks subwatershed. Most of these policy tools are directed towards protecting and enhancing groundwater recharge and discharge, or promoting water conservation.

Under the Provincial Policy Statement, municipalities are required to restrict development and site alteration in or near vulnerable headwaters, seepage areas, recharge/discharge areas, springs, and wetlands in order to protect, improve or restore their hydrologic function. Under the LSPP, the Conservation Authority has to identified areas of ecologically significant groundwater recharge (i.e. areas where groundwater which eventually support sensitive features such as wetlands or cold water streams, initially enters the system), and municipalities are to incorporate policies in their respective Official Plans to protect, improve, and restore the function of these, as well as significant groundwater recharge areas previously identified under the South Georgian Bay – Lake Simcoe Source Protection Plan.

The Township of Ramara's 2003 Official Plan contains many policies around protecting and maintaining both surface and groundwater quantity. These include their objective to protect, conserve, and enhance natural area features and functions and encouraging private land stewardship. The natural resources objectives include ensuring that surface and groundwater resources used for existing and future uses are sustainable. There are a number of policies around protecting areas of groundwater recharge and discharge, as well as the promotion of innovative development techniques that strengthen and support natural areas objectives. The OP's stormwater policies note that facilities shall be designed to maintain groundwater and watercourse baseflow, and protect aquatic species and natural area habitat, and that development proposals should minimize impervious surfaces and maximize natural areas to achieve minimal surface water volumes. These policies will all help to ensure that the quantity of water resources is maintained.

Under the Lake Simcoe Protection Plan, an application for any development larger than four units (or individual units larger than 500m$^2$) is required to be accompanied by a stormwater management plan that demonstrates consistency with the municipality's Stormwater Management Master Plan (as required under the LSPP), consistency with subwatershed plans and water budgets, an integrated treatment train approach to reduce reliance on end-of-pipe controls, and indication of how changes in the water balance (e.g. pre- vs. post-development) will be minimized, and how phosphorus loadings will be minimized.

Furthermore, the draft South Georgian Bay – Lake Simcoe Source Protection Plan prohibits an increase in impervious cover in vulnerable areas around municipal wells, unless it can be demonstrated pre-development recharge can be maintained, and also prohibits designating new land uses that result in recharge reduction that would create a 'significant threat', unless the proponent can demonstrate that post-development recharge will match pre-development recharge.

Water conservation is promoted through regulatory restrictions, education programs, and municipal water use efficiency plans.

For example, under the Ontario *Water Resources Act*, any use of water which exceeds 50,000 litres per day requires a Permit to Take Water from the Ministry of the Environment. Under the LSPP, results of Tier 2 water budgets may provide background information for decisions made by the MOE related to these Permits. The LSPP also directs the MOE and MNR to develop in-stream flow targets for water quantity stressed subwatersheds. When completed, these targets are to be used to inform future strategies related to water taking, which may include policies that identify how much water can be allocated among users in a subwatershed, including setting aside an allocation to support the natural functions of the ecosystem.

Results of these Tier 2 water budgets and instream flow targets are also intended to inform municipal water conservation plans, which the LSPP requires the Township of Ramara to prepare and implement. These plans are intended to establish targets for water conservation and efficiency, identify water conservation measures such as the use of flow-restricting devices and other hardware, and practices and technologies associated with water reuse and recycling, as well as methods for promoting water conservation including full-cost pricing for residents on municipal water supplies, and public education and awareness programs for rural residents not on municipal water systems.

Water conservation and stewardship is also to be promoted in the agricultural, recreational, commercial, and industrial sectors, through partnerships between government agencies and key private stakeholders.

### *4.5.2 Restoration and remediation*

Although neither the Provincial government (through the Lake Simcoe Community Stewardship Program) nor the LSRCA (through the Landowner Environmental Assistance Program) have funding for stewardship projects specific to issues related to water quantity, projects such as retrofitting on-line ponds and planting trees and shrubs which are supported to those programs will have benefits related to reducing evaporation, and increasing groundwater recharge. These projects are described in more detail in Chapters 3, 5 and 6.

The Environmental Farm Plan program, which is a partnership between the Ontario Ministry of Agriculture, Food and Rural Affairs, Agriculture and Agri-Food Canada, and the Ontario Soil and Crop Improvement Association does support projects specifically directed to managing water use on farms. Projects supported through the Environmental Farm Plan include infrastructure to support water use efficiency, including both in-barn and irrigation equipment, and support for establishing off-line irrigation ponds to reduce water taking demands on surface water features.

### *4.5.3 Science and research*

As a result of the tragedy in Walkerton in 2000, and the subsequent Clean Water Act and Source Protection Planning process, the amount of research conducted on water quantity and ground water movement in the Lake Simcoe watershed increased exponentially.

The development of the South Georgian Bay – Lake Simcoe Source Protection Plan was supported by the establishment of a subwatershed-scale water budget, which described the movement of water among hydrologic elements in the watershed (e.g. wetlands, soils, aquifers), and the extractions of this water for human use. These budgets, and associated stress assessments also formed a significant part of the data used in drafting this subwatershed plan.

Another important component of the Source Protection Plan was the identification of 'Significant Groundwater Recharge Areas'. These areas are locations where surficial geology and hydraulic gradient tend to support a relatively high volume of water recharging into aquifers. The Lake Simcoe Protection Plan has directed the MOECC, MNRF, and LSRCA to follow up on this study and identify 'Ecologically Significant Groundwater Recharge Areas.' This new class of recharge area is to be identified based on ecological interactions, rather than volume of water. To identify these areas, reverse particle tracking models will be developed based on groundwater models created as part of the Source Protection Planning process, to identify areas which contribute groundwater to sensitive surface features such as wetlands and coldwater streams.

In order to support water budgeting and other watershed-scale modeling, LSRCA manages a network of 12 climate stations (including precipitation gauges), and 15 surface water flow stations (in partnership with the Water Survey of Canada). These stations provide monthly stream flow data, which can be used to monitor mean, median, and baseflow conditions for many of Lake Simcoe's subwatersheds.

## 4.6 Management Gaps and Limitations

### *4.6.1 Water Demand*

The Source Water Protection initiative addresses many potential concerns around water quantity, although these policies 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 River subwatershed; 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.

### *4.6.2 Land Use*

There are few policies in the framework that deal specifically with the issue of impervious cover that accompanies 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, and, as mentioned above, does not 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.

#### *4.6.3 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 included 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. The modelling undertaken for the Ramara Creeks subwatershed includes an assessment of the risks of climate change impacts, however additional research is needed 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.

#### *4.6.4 Water Budget Estimates*

While the water budget determined water taking rates to be broadly sustainable; however where low water issues occur the OWRA does enable Ministry of the Environment staff to limit takings through the PTTW process. This, however, is rarely done. This may be addressed through the LSPP's policies around developing targets for environmental flows.

## 4.7 Management Gaps and Recommendations

As described in the previous sections, there are a number of regulations and municipal requirements aimed at protecting water quantity of the Ramara Creeks subwatersheds already exist. Despite this strong foundation, there are gaps in the management framework that need to be considered. This section identifies some of the gaps in the existing protection of the water quantity in the Ramara Creeks subwatershed, and outlines recommendations to help fill these gaps.

It is recognized that many of the undertakings in the following set of recommendations 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 in the implementation phase.

### *4.7.1 Water Demand*

**Recommendation 4-1 -** That the MOE continue to improve the Water Taking Reporting System by integrating the Permit to Take Water (PTTW) database with the Water Well Information System (WWIS) database, and connecting those takings to wells / aquifers to facilitate impact assessment (i.e. the PTTW database needs to be connected to the WWIS database).

**Recommendation 4-2** - That the MNRF and MOECC, in partnership with LSRCA, build on existing methodologies needed to determine ecological (instream) flow targets for the stressed Ramara Creeks subwatershed.

**Recommendation 4-3** – That the MOECC and MNRF require the LSPP Tier 2 integrated model (or another, comparable model, if deemed appropriate) be used to simulate proposed dewatering activities associated with aggregate operations near the Ramara Creeks subwatershed, and the impacts they would have on stream and wetland features in the subwatershed prior to issuing or renewing Permits to Take Water or aggregate permits. When reviewing aggregate applications, the MOECC is encouraged to collect the most up to date extraction, pumping, and groundwater level data, and use the data to update the integrated model.

### *4.7.2 Reducing Impact of Land Use – groundwater recharge and discharge*

**Recommendation 4-4** – That the Municipality, in the context of LSPP Policy 6.37-SA, adopt the 'Guidance for the protection and restoration of significant groundwater recharge areas in Lake Simcoe' document. Further, that the Municipality utilize this document to incorporate policies around significant groundwater recharge areas into their official plan, as per LSPP Policy 6.38-DP.

**Recommendation 4-5** – That the Municipality adopt the 'Guidance for the Stormwater Management Policy in Lake Simcoe' document, following its completion. Further, that the Municipality utilize this document to incorporate policies around stormwater management into its official plan, as per LSPP Policy 4.7-DP.

**Recommendation 4-6** – That the MOE amend the Environmental Compliance Approvals application form and Guide to recognize the importance of protecting Ecologically Significant Groundwater Recharge Areas and Significant Groundwater Recharge Areas.

**Recommendation 4-7 -** The Lake Simcoe Region Conservation Authority should create eligibility for infiltration projects under the LEAP, targeting funding to those in ecologically significant groundwater recharge areas in order to maintain existing groundwater recharge functions.

**Recommendation 4-8** – The Federal and Provincial governments should consider extending programs like Lake Simcoe Clean Up Fund and Showcasing Water Innovation to improve water quantity in these areas.

**Recommendation 4-9** - That the Township of Ramara, in partnership with LSRCA, should undertake works to naturalize swales within Lagoon City in order to achieve benefits to the system related to preserving water quantity and maintaining flow within the system.

### *4.7.3 Climate Change*

**Recommendation 4-10 –**That the LSRCA, in collaboration with the MNR and MOE, utilize the LSPP Tier 2 integrated model in the development of in-stream flow targets and the development of management strategies to address climate change impacts.

**Recommendation 4-11** –That the LSRCA expand the surface water monitoring network to the Ramara Creeks subwatershed, and that the data collected be input into the integrated model to improve the interpretation of surface and groundwater flows and interactions in the subwatershed.

**Recommendation 4-12** - That the LSRCA expand the environmental monitoring network to include a climate station in the Ramara Creeks subwatershed; reliable meteorological baseline data will improve climate change predictions and allow for the improved identification of vulnerable areas.

**Recommendation 4-13-** That the MOECC, in partnership with the LSRCA, expand the PGMN in the subwatershed to improve understanding of groundwater flows and levels in the deeper bedrock system; new wells should be screened in the deeper aquifer units and situated away from the influence of lakes, canals, and other pumping wells.

**Recommendation 4-14**- That the LSRCA, in partnership with the province and municipalities, develop management strategies to address the predicted impacts of climate change. Emphasis at this time should be placed on building ecological resilience in the Ramara Creeks subwatershed through promoting recharge by protecting existing natural cover, and increasing natural cover in the SGRAs/ESGRAs.

**Recommendation 4-15** - That LSRCA work with the municipalities, MAFRA, and landowners to examine innovative forms of municipal drain maintenance, or opportunities to create new drains using principles of natural channel design.

# 5 Aquatic Natural Heritage

## 5.1 Introduction

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, gravelly 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.

All habitat features are impacted by changes in the system, both natural and anthropogenic in nature. 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.

The following sections in this chapter highlight the current status (Section 5.2) of the Ramara Creeks subwatershed, as well as the stressors impacting them (Section 5.3), and the current management framework in place to protect and restore them (Section 5.4).

## 5.2 Current Status

To assess the environmental quality and the overall health of the aquatic system, the Lake Simcoe Protection Plan has provided indicators to determine how well the aquatic ecosystem is functioning. The indicators relevant to the Ramara Creeks subwatershed and its tributaries are:

- Natural reproduction and survival of native aquatic communities;
- Presence and abundance of key sensitive species, and;
- Shifts in fish community composition.

To address these indicators, a number of analyses have been done on the stream systems. The following sections summarize these results.

### 5.2.1 Overview of aquatic communities – Tributaries

#### 5.2.1.1 Fish Community

Studying the health of the fish community of the Ramara Creeks subwatershed provides an important window into the health of the aquatic system as a whole. Fish are sensitive to a great number of stresses including water quality, temperature, flow regimes, and the removal of in-stream habitat. While they are able to move quickly in response to a sudden change in conditions (e.g. a release of a chemical into the system) and are therefore not a good indicator of these types of issues, prolonged stresses will eventually cause a shift in the fish community from one that is sensitive and requires clean, cool water to survive to one that is more tolerant of degraded conditions. Long term monitoring will identify changes and trends occurring in the fish community, and will help to identify and guide restoration works.

A total of 24 species have been captured from the Ramara Creeks subwatershed since sampling began in 2003 (Table 5-1). Sampling has been completed by LSRCA, the Ministry of Natural Resources and Forestry, and Michalski-Neilson Associates, a private consulting firm which undertook some sampling in the Lagoon City area. The fish community in the Ramara Creeks subwatershed is characteristic of a warm and cool water system containing species such as largemouth bass (*Micropterus salmoides*), brown bullhead (*Ameiurus nebulosus),* northern pike (*Esox lucius*), and rock bass (*Ambloplites rupestris*).

The water temperature of a system can dictate the composition of the fish community, as well as determine the way systems are managed. Figure 5-1 below illustrates the combination of maximum air temperatures versus water temperature at 4pm (when water temperatures tend to reach their maximum) that makes a cold, cool, or warm water stream. Typically, the average maximum summer water temperatures for a cold water system is 14°C; this is generally due to inputs of cool groundwater, which ensure that air temperatures have little effect on the water temperature. Cool water is approximately 18°C and warm water systems have an average summer maximum daily water temperature of approximately 23°C (Stoneman and Jones, 1996). This temperature rating system has been used to classify the tributaries in the Lake Simcoe watershed.

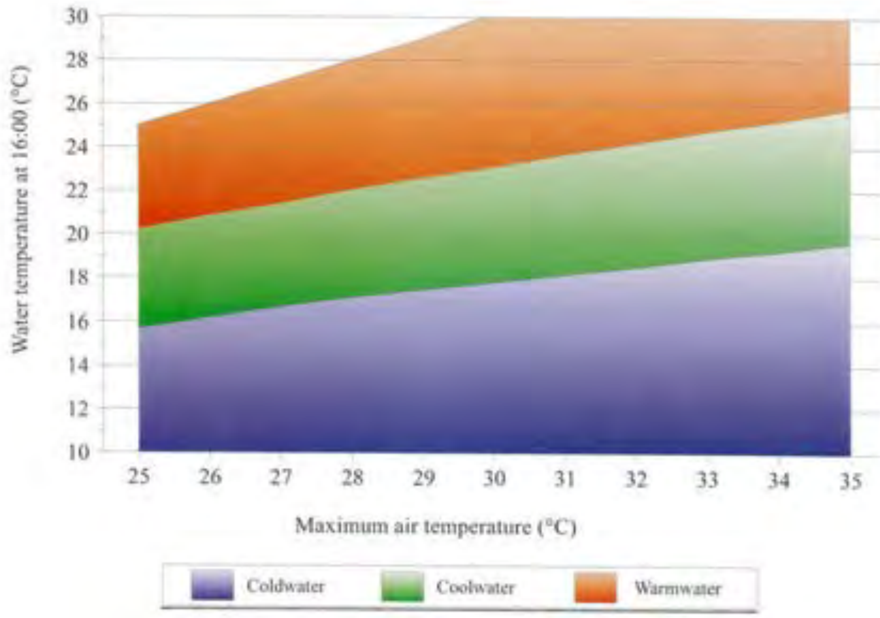



**Figure 5-1: Cold, cool and warm water trout stream temperature ranges (Stoneman and Jones, 1996).**

**Table 5-1: Fish species captured in the Ramara Creeks subwatershed from 2003-2013[+].**

| Common Name | Scientific Name |
|---|---|
| Northern Pike | *Esox lucius* |
| Central Mudminnow | *Umbra limi* |
| Common White Sucker | *Catostomus commersoni* |
| Northern Redbelly Dace | *Phoxinus eos* |
| Common Carp^* | *Cyprinus carpio* |
| Golden Shiner | *Notemigonus crysoleucas* |
| Emerald Shiner | *Notropis atherinoides* |
| Common Shiner | *Luxilus cornutus* |
| Rosyface Shiner | *Notropis rubellus* |
| Bluntnose Minnow | *Pimephales notatus* |
| Fathead Minnow | *Pimephales promelas* |
| Blacknose Dace | *Rhinichthys atratulus* |
| Creek Chub | *Semotilus atromaculatus* |
| Pearl Dace | *Margariseus margarita* |
| Brown Bullhead | *Ameiurus nebulosus* |
| Brook Stickleback | *Culaea inconstans* |
| Rock Bass | *Ambloplites rupestris* |
| Pumpkinseed | *Lepomis gibbosus* |
| Bluegill | *Lepomis macrochirus* |
| Smallmouth Bass | *Micropterus dolomieu* |
| Largemouth Bass | *Micropterus salmoides* |
| Black Crappie ^ | *Pomoxis nigromaculatus* |
| Yellow Perch | *Perca flavescens* |
| Johnny Darter | *Etheostoma nigrum* |

*^ = Not native to Lake Simcoe watershed*

** = Invasive species*

*+= Three sources of data were used for this table: 1) LSRCA data from 2002 to present and 2) MNRF data from 2010 3) Michalski-Neilson 2005-2006*

The first step in analyzing the condition of a subwatershed's aquatic community is to undertake a general overview of the current fish communities to see what type of fish are at a site (cold water species[1], warm water species[2], or no fish) and what the temperature of the creek is at the site (cold, cool, or warm water), as well locating any barriers to the movement of some or all fish species (Figure 5-3). This broad overview can show the general shifts in the fish communities; for example, as water temperatures rise, a coldwater fish community may shift to a warm water community, and where dams are present fish may eventually disappear from an area.

Figure 5-2 shows the variation in temperature among the watercourses. Due in part to the absence of cold water groundwater recharge areas, there are no cold water systems in the Ramara Creeks subwatershed. As such, cold water species such as brook trout and mottled sculpin are absent. Some cool water species are present in the watercourses, but all of the systems are considered warm water.

The temperatures of these warm water systems are compounded by the extensive municipal drainage system; municipal drains are a source of warm water in the system as they often have little to no riparian vegetation, leading to increasing water temperatures as a result of lack of shade. Please refer to section 5.3.7 – municipal drains for more details.

**LSRCA field crew - electrofishing**

An Index of Biotic Integrity (IBI) was used to assess the ecological integrity of the creeks through an analysis of the composition of fish communities within the system (Figure 5-3). Fish population and community composition surveys are valuable tools for examining the health and stability of streams and rivers. Over time, shifts in composition along with the presence or absence of key species not only provides an indication of system health but can be used to help identify what ecosystem stressors, such as climate change and urbanization, are influencing aquatic habitats.

With this method there are five rankings that can be assigned to a site:

- Very good: Excellent diversity, top predators, trout present and high fish abundance
- Good: Average diversity, top predators present, trout present, average abundance

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[1] Cold water species are indicators of cold water habitat. There are no coldwater species found in this subwatershed. All species listed in Table 5-1 are either cool or warm water species.

[2] Warm water species are considered to be generalist species that are not coldwater indicators and can exist in warm, cool and coldwater sections of a stream. Only warm and cool water fish species are found in the Ramara Creeks subwatershed.

- Fair: Low/average diversity, some top predators, no trout, low/average abundance of fish
- Poor: Low diversity, no top predators, no trout, low abundance of fish
- No Fish: No fish were captured at these sites

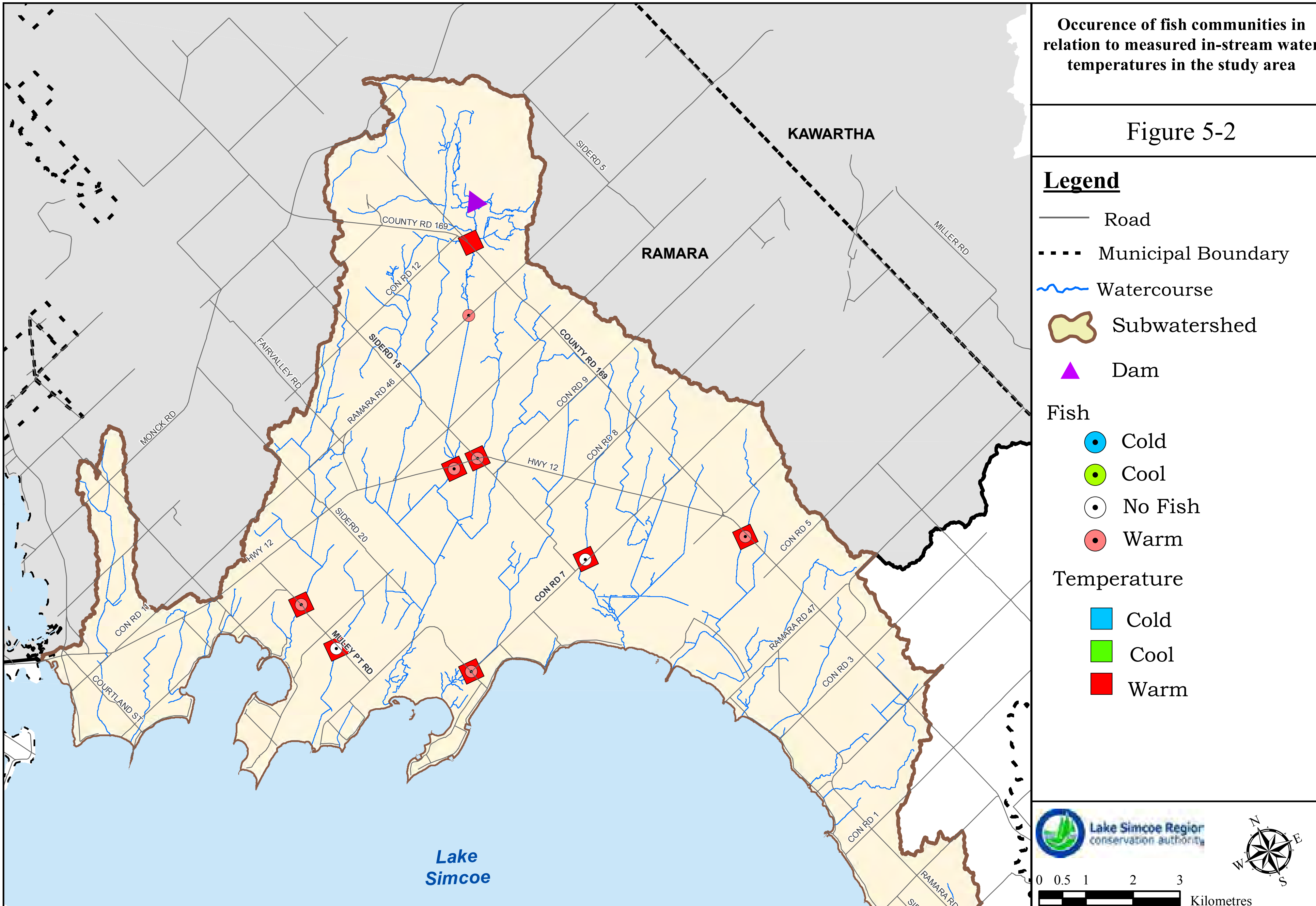
While the IBI is suitable for use in the Lake Simcoe watershed, there is potential for improvement by including a greater range of top predators into the IBI calculations. Currently only brook trout are weighed and measured individually. This may skew the results, particularly for the Ramara Creeks subwatershed, as warm water predators are not included in the IBI calculations.

Overall, Figure 5-3 shows that the ecological integrity of the systems varies spatially across the subwatershed, with the majority of the sites assessed as Fair or having No Fish. The extensive municipal drainage system, lack of flow in most of the watercourses during the summer months, and barriers to fish movement such as perched culverts and cement box culverts, play a significant role in affecting the health of the aquatic community.

In general, sampling sites near areas of natural heritage displayed Fair IBI scores, while those sites near agricultural areas were ranked Poor or did not contain any fish. Evidently, no fish were captured at most of the sites situated in segments of drains that are dry for more than two consecutive months of the summer. Although nearly all of the sites received low IBI scores, the upstream segment of Drain #1 received an IBI score of Good, even with the absence of trout from the watercourse. This upstream segment of Drain #1 is surrounded by significant areas of natural heritage and extensive riparian vegetation, elements that contribute to the highest IBI score in the subwatershed. Downstream of this sampling site, as the stream is straightened into a municipal drain, the site is ranked Fair. None of the sites in this subwatershed were rated Very Good according to the IBI due to a combination of the above factors, particularly the absence of a cold water fish community and low abundance of fish in those drains that are dry during the summer.

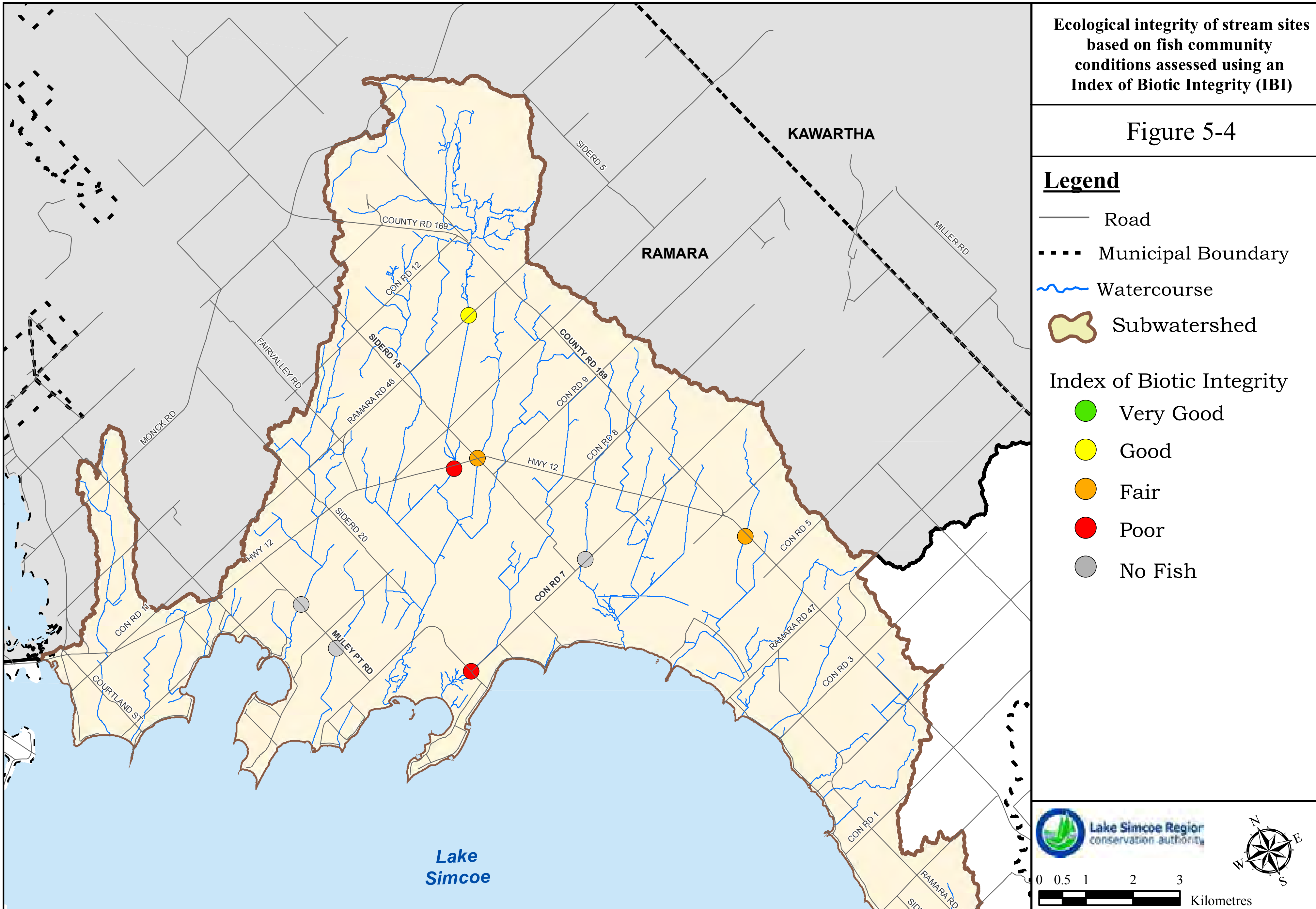
**Occurence of fish communities in relation to measured in-stream water temperatures in the study area**

Figure 5-2



**Ecological integrity of stream sites based on fish community conditions assessed using an Index of Biotic Integrity (IBI)**

Figure 5-4



### Significance of Mudpuppy in the Ramara Creeks subwatershed

The mudpuppy (*Necturus maculosus*), also known as the common mudpuppy or waterdog, is the largest salamander species in Canada, growing up to 50 centimetres in length, including the tail. It is also the only completely aquatic salamander in Canada, and can be found in lakes, ponds, rivers, and streams. Adults are grey to rusty brown on top with dark blue spots and a grey belly, and have red external gills characteristic of the mudpuppy.

**Mudpuppy (photo credit: Todd Pierson)**

As this bottom-dwelling species is primarily nocturnal, mudpuppies can be found hiding under rocks, debris and bank overhangs during the day. They forage year-round for worms, fish eggs, aquatic insects, crayfish and small fish.

Mudpuppies breed in May or June, laying 30 to 190 eggs. The eggs attach to the underside of submerged rocks or logs, which the female guards over the two-month incubation period. It takes four to six years for larvae to reach maturity.

The mudpuppy is the only known host species for the salamander mussel, previously known as the mudpuppy mussel. This is the only species of freshwater mussel that uses an amphibian host. The salamander mussel larvae are parasitic, using hooks to encyst in the host's tissue to complete their transformation into juveniles. Following this transformation, the juveniles detach and fall to the substrate to develop into free-living adults. Due to their host-parasite relationship, the salamander mussel's distribution is limited to the extent of the mudpuppy.

Mudpuppies can live for over 30 years, primarily due to the absence of natural enemies. However, poor water quality has been identified as a threat to this species and, further, mudpuppies may be adversely affected by dredging, commercial fishing nets, and boat propellers. Mudpuppies have also been caught by anglers ice-fishing for whitefish. Despite these threats, the mudpuppy is considered to be Not At Risk under both the federal *Species at Risk Act* and Ontario's *Endangered Species Act*. Confirmed as recently as 2010, the IUCN global status of mudpuppy is Least Concern.

In the summer of 2014, a mudpuppy was caught by LSRCA staff in the Ramara Creeks subwatershed. Although staff were not directly targeting mudpuppies, the individual was found in a lake-level marsh with little to no flow, and as indicated by its small size, was likely a juvenile.

This sighting by LSRCA staff is significant because according to Ontario Nature's Amphibian and Reptile atlas, there are no recent (1993 to present) or historical (before 1993) sightings of mudpuppy in the Ramara Creeks subwatershed. This does not necessarily indicate an absence of mudpuppy from this subwatershed, but only that it has not been recorded in the Ontario Nature Amphibian and Reptile Atlas or by LSRCA staff.

#### 5.2.1.2 Benthic community

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, the Hilsenhoff Biotic Index (HBI) was selected as it provides a full spectrum of the different levels of organic pollution within a watercourse, which enables watershed managers to document declining watershed conditions by comparing years of data; whereas other indices (such as BioMAP) only provide an 'impaired' or 'unimpaired' rating.

Figure 5-4 is an assessment of the ecological integrity of the creeks through the composition of the benthic invertebrate communities within the system. This composition is dependent on the quality of the water and the degree of organic pollution. With this method there are seven rankings that can be assigned to a site:

- Excellent: No apparent organic pollution
- Very good: Slight organic pollution
- Good: Some organic pollution
- Fair: Fairly significant organic pollution
- Fairly poor: Significant organic pollution
- Poor: Very significant organic pollution
- Very poor: Severe organic pollution

Figure 5-4 shows the ecological integrity of the watercourses, based on benthic analysis, across the subwatershed. The Ramara Creeks subwatershed is characterized by significant agricultural land use, which likely contributes to the low benthic invertebrate scores. The sites vary from Fairly Poor, Poor, to Very Poor, with the majority of sites assigned Fairly Poor.

Most of the sampling sites, which are all located downstream of agricultural lands, are in municipal drains that are intersected by barriers such as cement box culverts, culverts, and farm equipment crossings. For example, Harrington Drain, the only site ranked Very Poor in the subwatershed, is situated less than 100 m downstream of a roadway and cement box culvert, in addition to an area where farm equipment crosses directly through the stream.

Although most of the natural watercourses in the Ramara Creeks subwatershed have been converted into municipal drains, the upstream segment of Drain #1 demonstrates the importance of retaining the natural stream channel, extensive riparian vegetation, and surrounding areas of natural heritage. As the stream is straightened into a municipal drain and the dominant land use cover changes to agriculture, the benthic invertebrate scores decline, likely a result of altered flow, loss of riparian vegetation, and collection of runoff from agricultural areas. This is consistent with the fish index of biotic integrity (IBI) scores, as the upstream segment of Drain #1 received the highest IBI score in the subwatershed, ranked as Good. And, as in the benthic invertebrate scores, the IBI score declines as the stream is straightened into a municipal drain.

Where water flow varies across the length of the larger municipal drains, there is a notable difference in the benthic invertebrate scores. Segments of the drain with consistent year-round flow receive higher Hilsenhoff biotic index (HBI) scores than sections of the drain that are dry during the summer. This finding is also consistent with the fish IBI scores, where there are no fish in those parts of the drain that experience little to no flow.

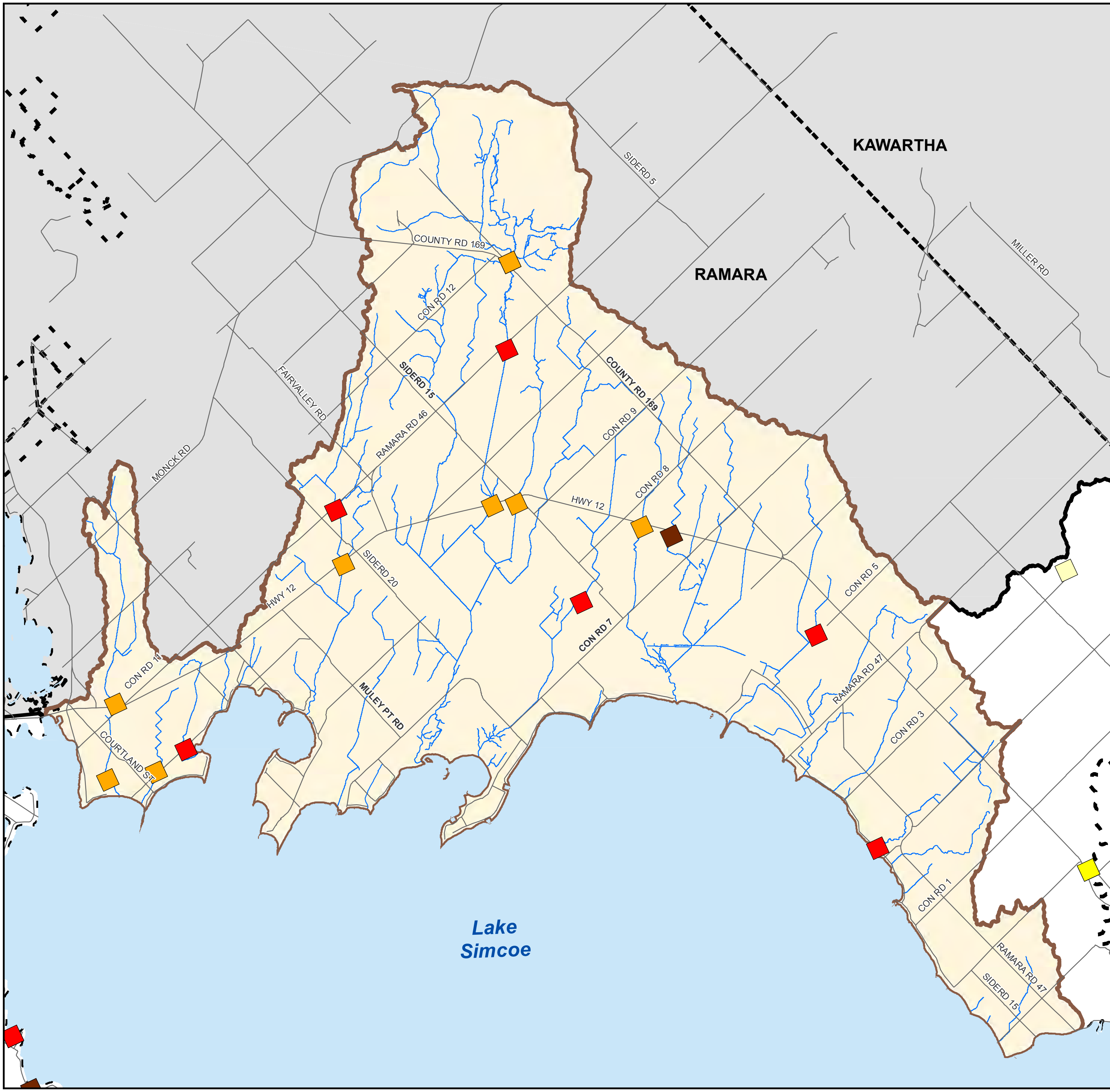
The dominant soil cover also plays a role in the benthic invertebrate scores. One of the subwatershed's few natural watercourses, Ramara Creek, is ranked Poor. Although water flows through significant areas of natural heritage before reaching the sampling site, it is also downstream of agricultural lands and small urban areas, which contribute to the poor benthic invertebrate scores. However, the location of the sampling site in a swamp is likely the most important contributing factor as mucky soils do not support the more sensitive benthic invertebrate species.

When using fish and benthic indices to evaluate the ecological integrity of a system, it is likely that there will be some discrepancies between the data. For example, there may be a poor rating of a site by the IBI and a good rating by the HBI. This may be explained by the absence of cold water indicator fish species in the Ramara Creeks subwatershed, which would result in a lower IBI score, while some highly sensitive insects are not affected by warmer water temperatures. There may also be the opposite scenario where the IBI gives a good rating and HBI a poor rating. A likely explanation for this is that fish are more mobile than benthic invertebrates, and in times where habitat conditions have deteriorated (low oxygen, low water levels, high temperatures, or poor water quality), benthic invertebrates are unable to move as quickly to better conditions and whole populations can be eliminated. If this occurs, benthic invertebrate communities will likely not return the following year, whereas fish will return if habitat conditions have improved. The last scenario is at sites where no fish have been caught. Conditions at a site could include low flow, high gradient, or have barriers to fish passage. While these conditions are not favourable to fish, benthic invertebrates can still have healthy populations at these sites, which will be reflected in a higher HBI rating. Although not common due to the consistently low HBI and IBI scores across the Ramara Creeks subwatershed, these types of occurrences happen at two of the sites, as follows:

- In Mahoney Drain, no fish were found; however, the benthic HBI gives a score of Fairly Poor.
- In Murray Drain, the benthic HBI score is rated Poor, whereas the IBI is rated Fair.

**Ecological integrity of stream sites based on benthic community conditions assessed using the Hilsenhoff Biotic Index (HBI)**

Figure 5-3




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Hilsenhof Biotic Index

- Excellent
- Very Good
- Good
- Fair
- Fairly Poor
- Poor
- Very Poor

Lake Simcoe Region conservation authority

0 0.5 1 2 3 Kilometres

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 dc created August 2014.

## 5.2.2 Overview of aquatic communities – Lake Nearshore

In addition to assessing the tributaries within the subwatershed, the nearshore lake communities were also analyzed, as the nearshore zones are critical areas that are linked to both the terrestrial riparian area and to the tributaries and the aquatic communities within them. The nearshore zone for Lake Simcoe is from the shoreline to when the depth reaches 15-20 m. This is an important fish feeding, migration, and nursery area; and is also an area that has undergone significant environmental change, including the introduction of a number of invasive species (including zebra and quagga mussels, plants, and zooplankton), changes in the aquatic plant communities, and the impacts of shoreline development and hardening. Part of the mandate of the LSRCA Lake Science Research and Monitoring Program is to assess the environmental status of Lake Simcoe and track any ecological changes; the collected data is being used to set public policy, advise lake managers, and verify environmental guidelines. Included in this mandate are three areas of interest: aquatic plants, sediment phosphorus, and invasive species.

In May 2008, LSRCA carried out a survey of aquatic plants across Lake Simcoe to set a baseline for future change. While previous studies focused on Cook's Bay, an area of high plant biomass, this new study covered the entire lake, and identified five other areas of high biomass, one of which is the Ramara shoreline, particularly at McPhee Bay, and also in Barnstable Bay, although densities are not quite as high in this area. Excess nutrient runoff into Lake Simcoe (the Ramara Creeks subwatershed contributes an estimated 2.0 tonnes of phosphorus per year [values are based on a three-year average from 2007-2009]), soft substrates, the sheltered nature of the bays, and the high light transparency of the water provide optimal conditions for plant growth. If the aquatic plant community changes in this area correspond to those in Cook's Bay, then the biomass of aquatic plants has increased three-fold since the 1980s as well. This is likely due to zebra mussels (*Dreissena polymorpha*) clearing the water and creating ideal habitat for plant growth.

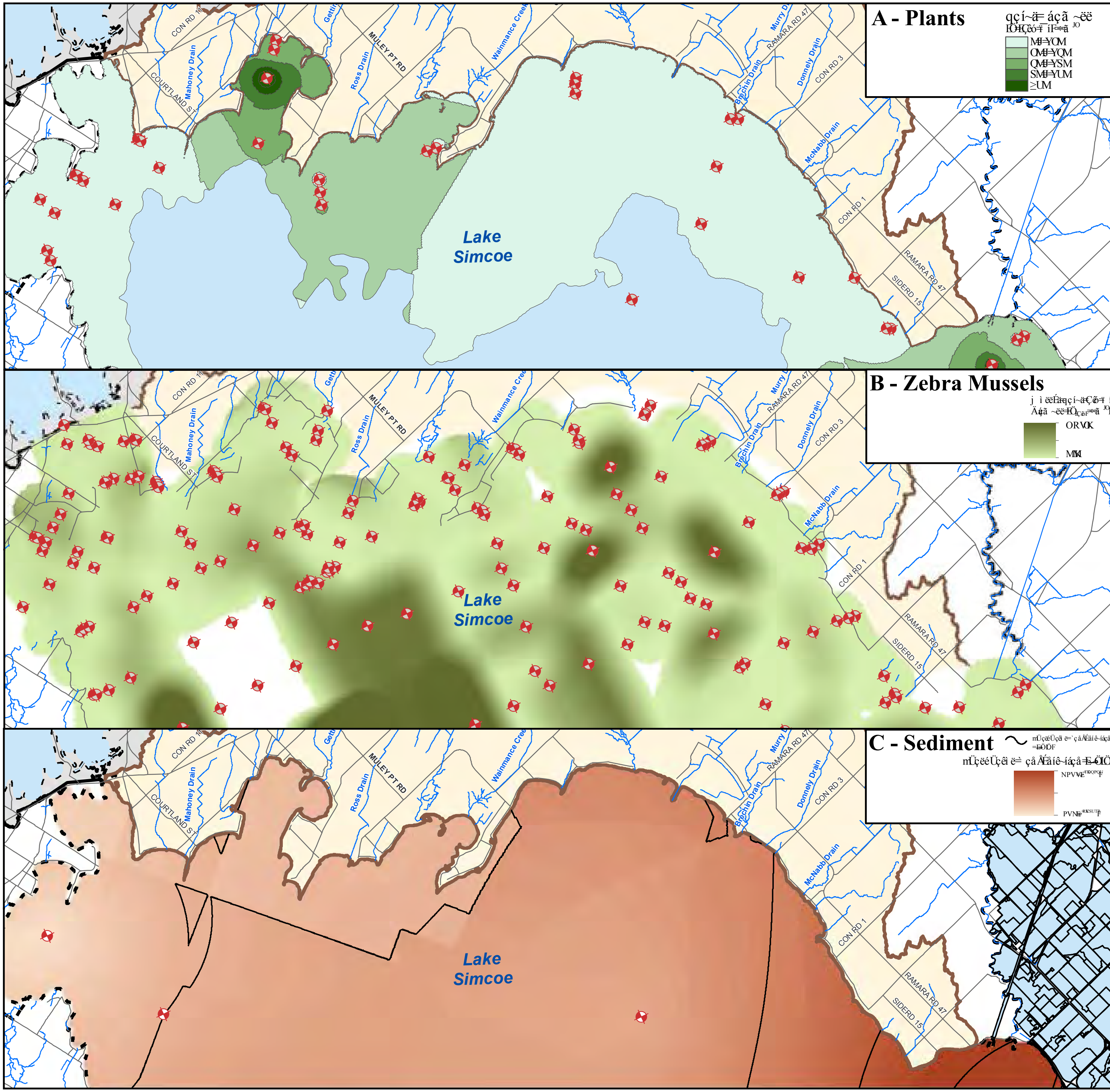
The second component being analyzed is the amount of phosphorus contained in lake sediments, which was poorly understood prior to the initiation of the LSRCA Lake Science Research and Monitoring Program. Monitoring of sediment phosphorus is undertaken because of the potential for phosphorus release under low dissolved oxygen concentrations in the water (less than 2 mg/L) and this is, thus far, an undetermined source of phosphorus loading. Along the Ramara shoreline, mean sediment nutrient concentrations are relatively high with total phosphorus (TP) ~0.8 mg/g, likely due to soft, muddy substrates which hold more nutrients than coarser grained sediments (Figure 5-5c). For comparison, concentrations range across the lake from TP ~0.35 mg/g in Cook's Bay to ~1.4 mg/g near Beaverton. (For details on the total phosphorus within the tributaries please refer to **Chapter 3 - Water Quality**).

The last component of the LSRCA Lake Science Research and Monitoring Program is monitoring invasive species with the goals of assessing the impact on native biological communities, tracking changes through time, and identifying new risks (a complete list of invasive species within the tributaries and within Lake Simcoe can be found in the Stressors section of this chapter). While some exotic species are studied under other projects (e.g. Eurasian milfoil and curly-leaf pondweed with aquatic plant monitoring, spiny waterflea with our zooplankton projects), a targeted survey was carried out in 2009-10 to supplement the annual benthic invertebrate monitoring and determine the extent of dreissenid mussel (zebra mussel, *Dreissena polymorpha*; quagga mussel, *Dreissena rostriformis bugensis*) impact on Lake Simcoe. Since their initial invasions in 1995 (zebra mussel) and 2004 (quagga mussel), these two species have colonized a large portion of the lake area and have caused significant ecological changes, in particular to native food webs, shifted energy flow from shallow to deep water, and increased the penetration of sunlight into the water column. The changes have resulted in a hardening of the substrate in shallow water due to mussel shells, a decline in native bivalve species (16 species were recorded in 1926-9, four species are recorded at present – the two invasive mussels and extremely low numbers of two native species which are on the threshold of extirpation in Lake Simcoe), an increase in plant biomass due to deeper light penetration into the water column and a larger area now available for plant colonization. In general, these mussels are limited to sandy or hard substrates in Lake Simcoe, and limited to depths shallower than 20 m.

Overall, the goal of the LSRCA Lake Science Research and Monitoring Program is to monitor for environmental changes in Lake Simcoe, fill existing data gaps, target emerging environmental issues, and understand linkages between current ecological stressors. In terms of the aspects highlighted within this section, the use of biological indicators highlights a holistic ecosystem approach to lake management. This approach, using diatoms as a rapid assessment tool, evaluates the nutrient runoff to Lake Simcoe from individual tributaries and allows management strategies to be specifically applied. Monitoring of benthic invertebrate and fish communities not only allows the evaluation of ecosystem health in these habitats, but also their development as biological indicators for oxygen levels, contaminants, and nutrients. Nutrient flux from the land to the tributaries to Lake Simcoe is reflected in both the plant biomass and sediment phosphorus levels (higher nutrient supply from tributaries equals more phosphorus in sediments and more plant biomass). In addition, the work with zebra and quagga mussels not only provides monitoring of these invasive species but suggests how they are impacting Lake Simcoe (high amounts of zebra mussels equals high filtering of particles from the water column, allowing greater light penetration and in turn more plant biomass and more offshore nutrients pulled to shallow water habitats).

In terms of rating the condition of the nearshore habitats, based on the three components above, the shoreline along the Ramara Creeks subwatershed is considered to be in fair condition.

# Lake nearshore habitat of the Ramara Creeks subwatershed




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed
- Sampling Location

Lake Simcoe Region conservation authority

N E S W

### 5.2.3 Rare and Endangered Species

There are no known aquatic Species at Risk in the Ramara Creeks subwatershed.

***Key Points - Current Aquatic Natural Heritage Status:***

- Unlike most of the subwatersheds in Lake Simcoe, there are no cold water fish communities in the Ramara Creeks subwatershed; the fish community is characteristic of a warm and cool water system containing species such as largemouth bass, rock bass, and northern pike.
- The ecological integrity of this system is poor, as indicated in the low fish IBI and benthic invertebrate HBI scores. IBI scores ranged from Fair to No Fish, with those sites that do not contain any fish located in municipal drains with little to no riparian cover. The HBI scores were also low, ranging from Fairly Poor to Very Poor. The sampling sites with better scores were often near areas of natural heritage. Drain #1 demonstrates the importance of retaining the natural stream channel, extensive riparian vegetation, and surrounding areas of natural heritage. The upstream segment of this drain received the highest IBI score in the subwatershed (Good), and one of the highest HBI scores (Fairly Poor), but these scores decline as the stream is straightened into a municipal drain.
- The lake nearshore community around the Ramara Creeks subwatershed is in relatively poor condition, being identified as an area with some of the highest plant biomass in Lake Simcoe. There are also some areas in the nearshore with high concentrations of zebra mussels, and sediment phosphorus concentrations are approximately 0.08 mg/g, with the highest concentrations being found along the southern portion of the subwatershed.
- The Ramara Creeks subwatershed contributes an estimated 2.0 tonnes of phosphorus per year to Lake Simcoe through excess nutrient runoff (values are based on a three-year average from 2007-2009).
- There are some invasive species in the subwatershed. Common carp and rusty crayfish have invaded the tributaries of the subwatershed, while zebra mussels have established in the lake nearshore habitat.
- There are 9 municipal drains in this subwatershed, comprising 51 % of the watercourses.
- The Lake Simcoe Basin Best Management Practice Inventory (LSRCA, 2014) looked at barriers to fish movement, which included dams, perched culverts, weirs, and other barriers, and sections of the bank that have been hardened or channelized. The BMP inventory covered the majority of the watercourses in the Ramara Creeks subwatershed, and identified 19 barriers to fish movement, 73 hardened and channelized sections of stream, and an additional 18 sites were identified to have been straightened.

## 5.3 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:

- Barriers,
- Bank hardening and channelization,
- Enclosures,
- Flow diversion,
- Uncontrolled stormwater and impervious surfaces,
- Municipal drains,
- Removal of riparian vegetation,
- Water quality and thermal degradation,
- Loss of wetlands,
- Invasive species, and
- Climate change.

These factors are discussed in detail in the following sections.

### 5.3.1 *Barriers*

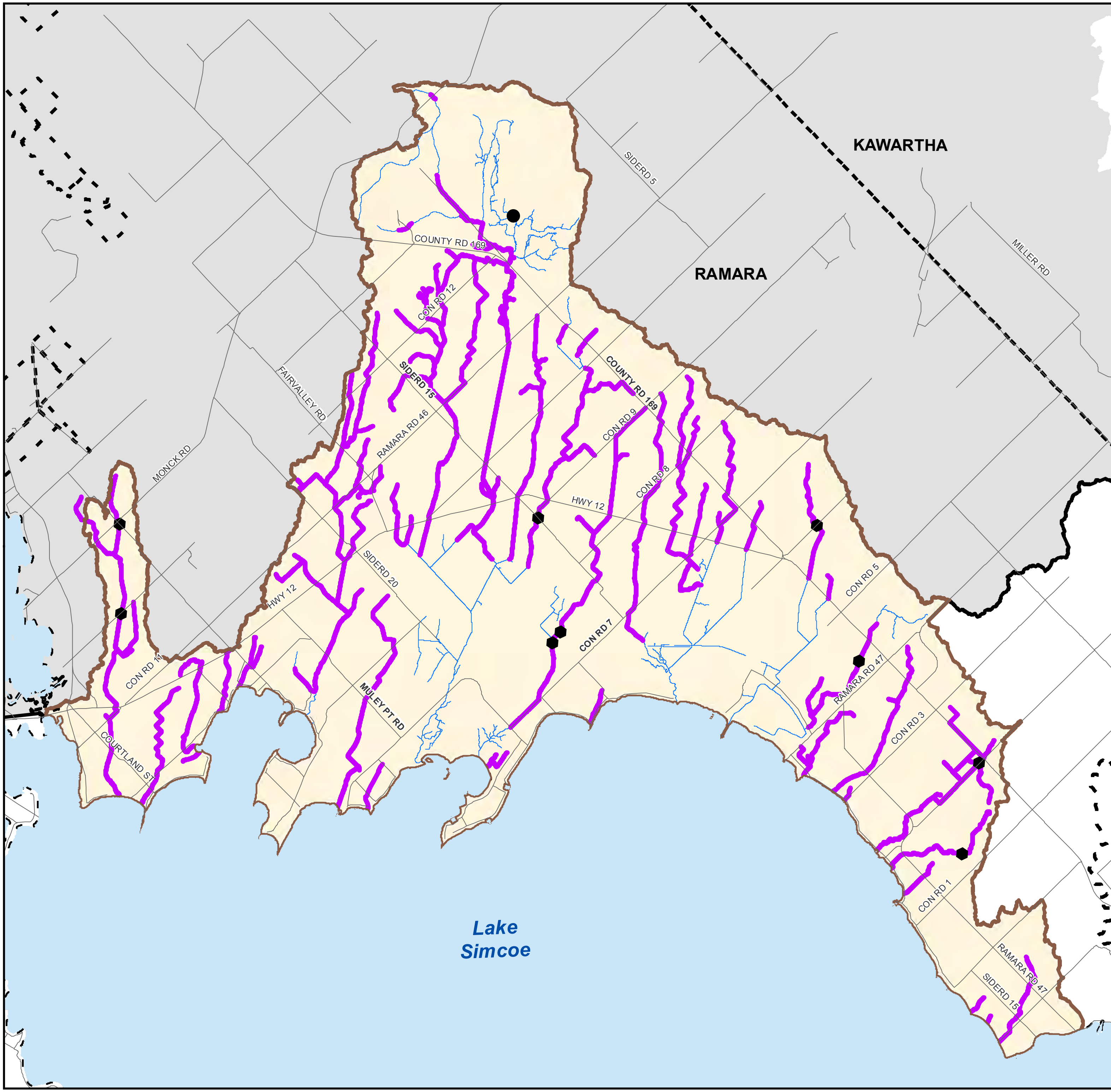
Barriers to fish movement in the form of dams, perched culverts, and enclosed watercourses serve to fragment the fish community by preventing fish from accessing important parts of their habitat. The impoundments created by dams serve to increase water temperatures, raise bacteria levels, and disrupt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

The Lake Simcoe Basin Best Management Practice Inventory (LSRCA, 2014) looked at barriers to fish movement, which included dams, perched culverts, weirs, and other barriers, and sections of the bank that have been hardened or channelized. The BMP inventory covered the majority of the watercourses in the Ramara Creeks subwatershed.

The BMP Inventory has identified 19 barriers to fish movement in the Ramara Creeks subwatershed (Figure 5-6).

# Barriers to fish movement in the Ramara Creeks subwatershed

Figure 5-6




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed
- BMP Watercourses Surveyed
- Barrier

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

### 5.3.2 *Bank hardening and channelization*

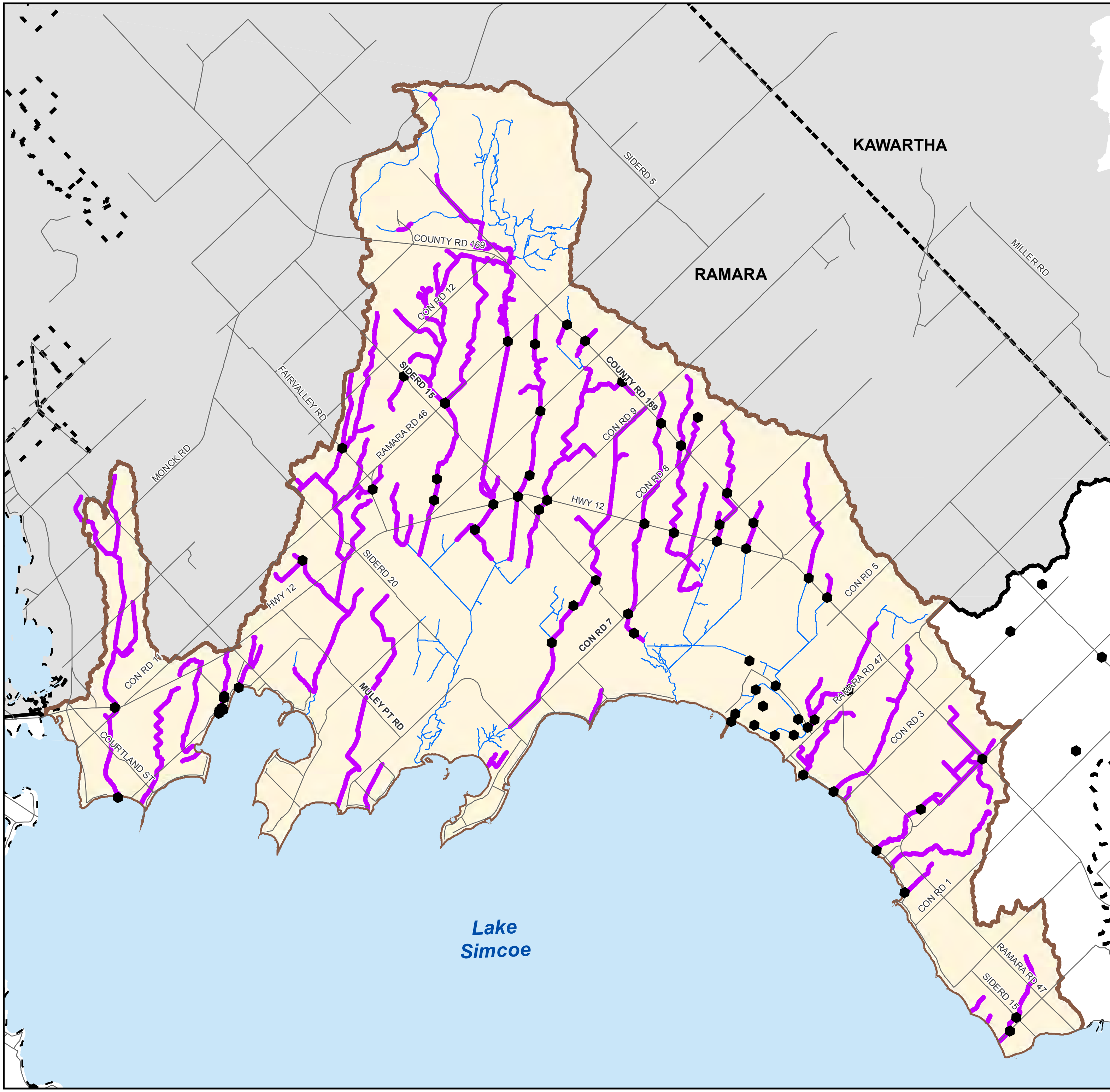
In the past it has been common practice to straighten watercourses to accommodate various land uses, and to harden banks as a way to prevent stream bank erosion and increase 'developable' area. While we now know that these practices are harmful to the environment and can cause more issues than they resolve, 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)
- Changes to the migration patterns of fish (and wildlife)
- Bank erosion downstream of the channelized section
- Sediment deprivation in 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 the 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.

There were 73 hardened and channelized sections of stream identified in the Ramara Creeks subwatershed through the BMP Inventory. An additional 18 sites were identified to have been straightened. These are depicted in Figure 5-77.




# Bank hardening and/or channelization in the Ramara Creeks subwatershed

Figure 5-7

## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed
- BMP Watercourses Surveyed
- Bank Hardening and or Channelization

0 0.5 1 2 3 Kilometres

**Figure 5-8: Examples of perched culverts, channelization, bank hardening, and barriers in the Ramara Creeks subwatershed.**

## 5.3.3 *Uncontrolled stormwater and impervious surfaces*

Urban stormwater runoff occurs as rain or melting snow washes off 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 these practices have changed and efforts are made to intercept and treat stormwater prior to its entering watercourses or waterbodies. However, in many older urban areas stormwater typically still reaches watercourses untreated.

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 surface is paved over; infiltration to groundwater is significantly reduced; and thus the runoff characteristics change. This results in increases in the frequency and magnitude of runoff events, a decrease in baseflow, and an increase in flow velocities and energy (further changes to the hydrologic regime are discussed in  greater detail in **Chapter 4 - Water Quantity**). These changes further affect the form of the morphology of the stream, including channel widening, undercutting, sedimentation, and channel braiding.

One of the most significant impacts of stormwater runoff though, is to water quality (discussed in more depth in **Chapter 3 – Water Quality**). Problems with degraded water quality directly affect the aquatic ecosystem. This occurs as pollutants are washed off of streets, parking lots, rooftops and roadways into storm drains or ditches which discharge to watercourses 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 associated impacts include increased water temperature and the collection of trash and debris.

All of these changes 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 (Figure 5-9).

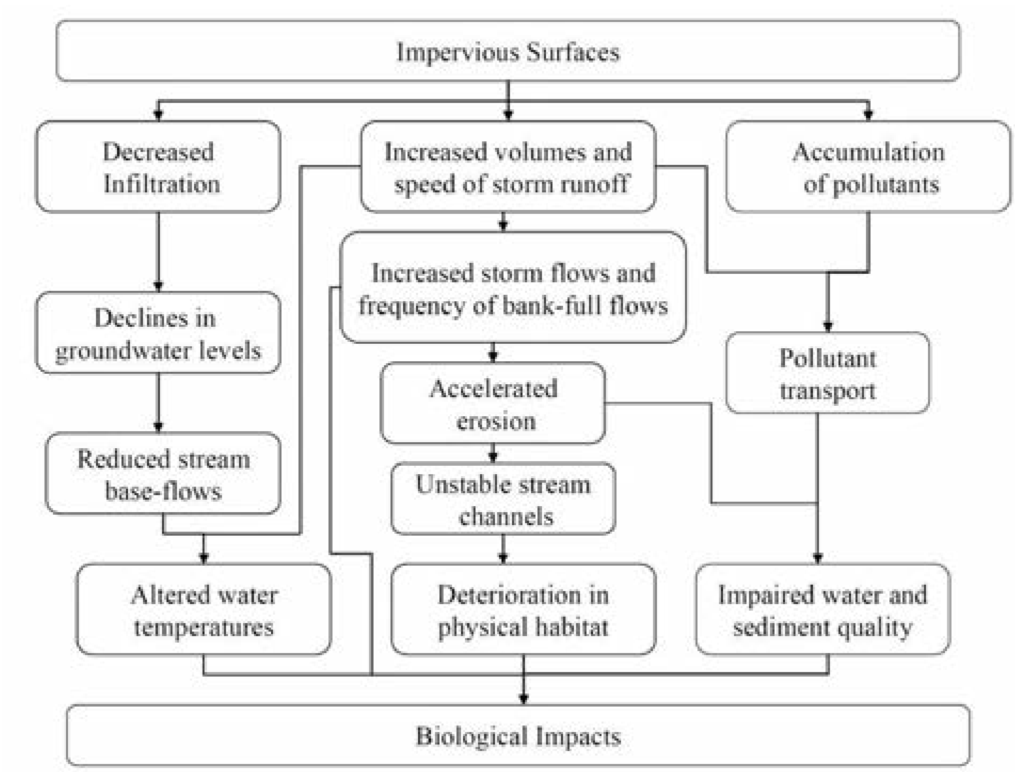



**Figure 5-9: Pathways by which impervious surfaces may impact aquatic biological communities (ORMCP Technical Paper Series, #13).**

## 5.3.4 *Municipal drains*

Municipal drains are generally located in rural agricultural areas and are intended to improve the drainage of the surrounding land. Typically they are ditches or closed systems (buried pipes or tiles) and can include structures such as buffer strips, grassed water ways, dykes, berms, stormwater detention ponds, bridges, culverts, and pumping stations. Currently, a number of creeks and small rivers have been designated as municipal drains (OMAFRA, 2001).

As these are direct links to watercourses, there are a number of impacts on the aquatic communities. The inputs into the drain consist of both overland flow and tile outlets and can carry contaminants, sediment, and debris into the drain. With little to no riparian vegetation, water temperature is increased and the drain therefore becomes a source of warm water in the watercourse system. Additionally, these drains come to be used as fish habitat. The issue with this is that municipal drains require maintenance to ensure they continue to work properly. While maintenance work is in progress, fish migration can be blocked and water quality can decline. The work itself may either negatively change or destroy fish habitat through altering or removal of the little riparian vegetation present, disrupting and changing bottom substrate composition and altering the width-to-depth ratio.

The construction and maintenance of municipal drains is regulated under the *Ontario Drainage Act,* while the protection of fish habitat is regulated under the federal *Fisheries Act*. To ensure that drains are properly maintained, while fish habitat is minimally impacted, Fisheries and Oceans Canada (DFO) developed a Class Authorization System. Drains are classified into six types (A, B, C, D, E, and F) based on the sensitivity of fish and fish habitat found in the drain and the type of work completed. Types A, B, and C are considered to contain fish and fish habitat more resilient to drain maintenance, while Types D and E have fish and habitat that are less resilient and maintenance work is determined on a case-by-case basis. Type F drains are intermittent and are usually dry for at least two consecutive months in the year. As fish habitat is not an issue here when dry, the only conditions for the maintenance work are that it be completed when dry and that soil is stabilized upon completion of work. Table 5-2 and Figure 5-10 illustrate the municipal drains that are found in the Ramara Creeks subwatershed, based on their drain type classification. While there is one Type B municipal drain and two Type C municipal drains in this subwatershed, the majority of drains are classified as Type E or Type F.

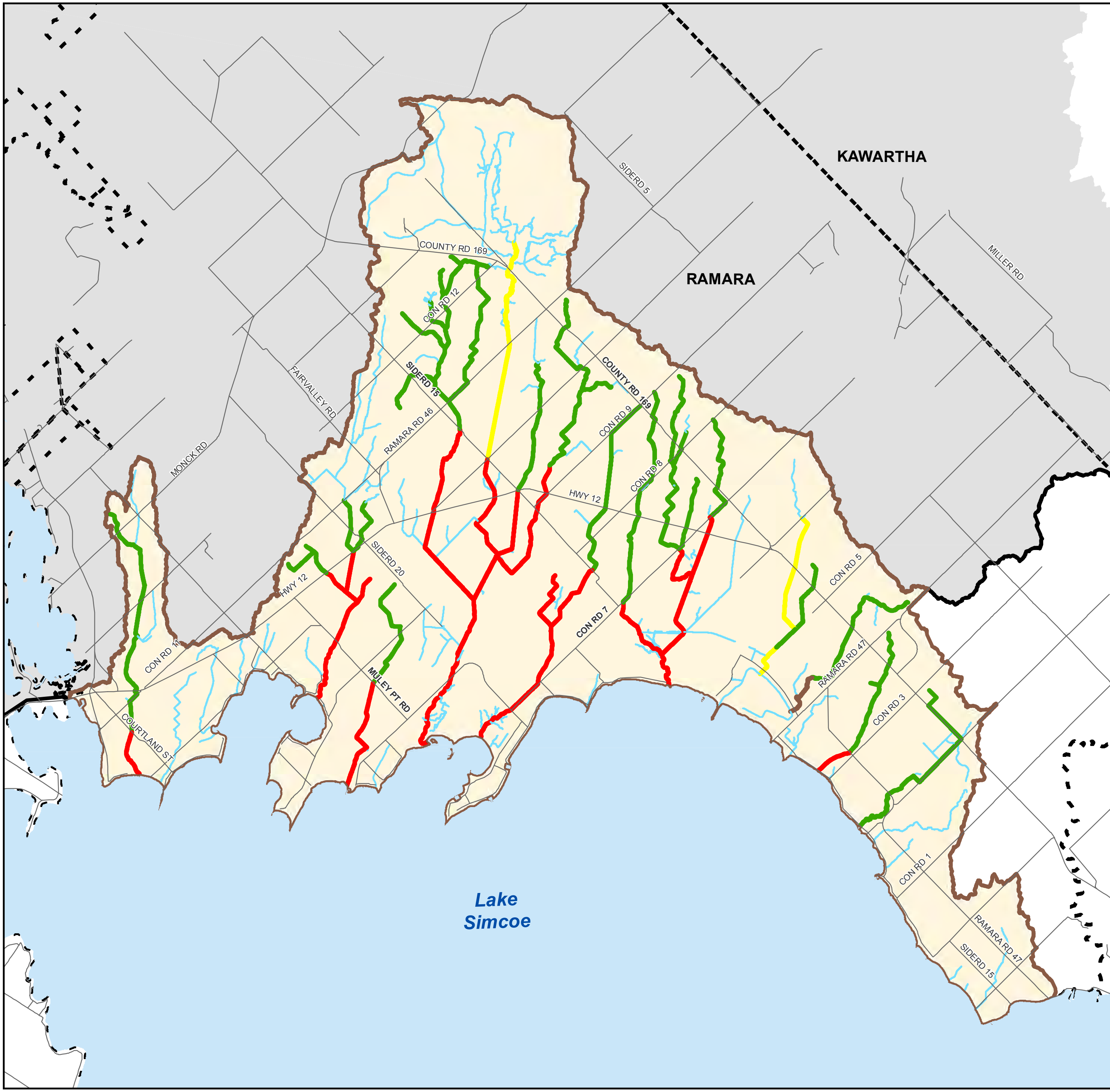
Interestingly, the upstream segments of nearly all the municipal drains are classified as Type F, in that they are subject to intermittent periods of flow and are usually dry for more than two consecutive months of the year; but, as permanent flow resumes downstream, these drains are then re-classified as Type E.

**Table 5-2: Municipal drains located in Ramara Creeks subwatershed**

| Watercourse | Drain Class | Length of drain (m) | % of watercourse |
|---|---|---|---|
| Donnely Drain | E | 801.1 | 21 |
| | F | 3014.8 | 79 |
| Drain #1 | C | 5409.7 | 6.2 |
| | E | 15754.4 | 18.1 |
| | F | 20449.3 | 23.4 |
| Gettings Drain | E | 4700.6 | 23.4 |
| | F | 3975 | 19.8 |
| Harrington Drain | E | 6847.7 | 21.9 |
| | F | 14122.3 | 45.1 |
| McNabb Drain | F | 4804.7 | 62.4 |
| Murry Drain | B | 1064.9 | 6.0 |
| | C | 3304.0 | 18.8 |
| | F | 5465.9 | 31.1 |
| O'Connell Drain | E | 1023.1 | 10.7 |
| | F | 5272.3 | 55.2 |
| Ross Drain | E | 2450.0 | 47.5 |
| | F | 2640.9 | 51.2 |
| Wainmance Creek | E | 5970.2 | 44.9 |
| | F | 3960.1 | 29.8 |

## Municipal drains in the Ramara Creeks subwatershed

Figure 5-10




**Legend**

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Drain Class

- A
- B
- C
- D
- E
- F

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

## 5.3.5 *Loss of riparian vegetation*

While many policies now afford some protection to the riparian areas adjacent to the 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 urban 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 suspended 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 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.

Only 50% of the area within 30 m of the watercourses in the Ramara Creeks subwatershed are in natural cover; this is among the lowest of Lake Simcoe's subwatersheds. This level of natural cover continues to decrease with increasing distance from the watercourses as the land use changes to agricultural. See section 6.2.4 – Riparian and Shoreline Habitat, for more information.

## 5.3.6 *Water quality and thermal degradation*

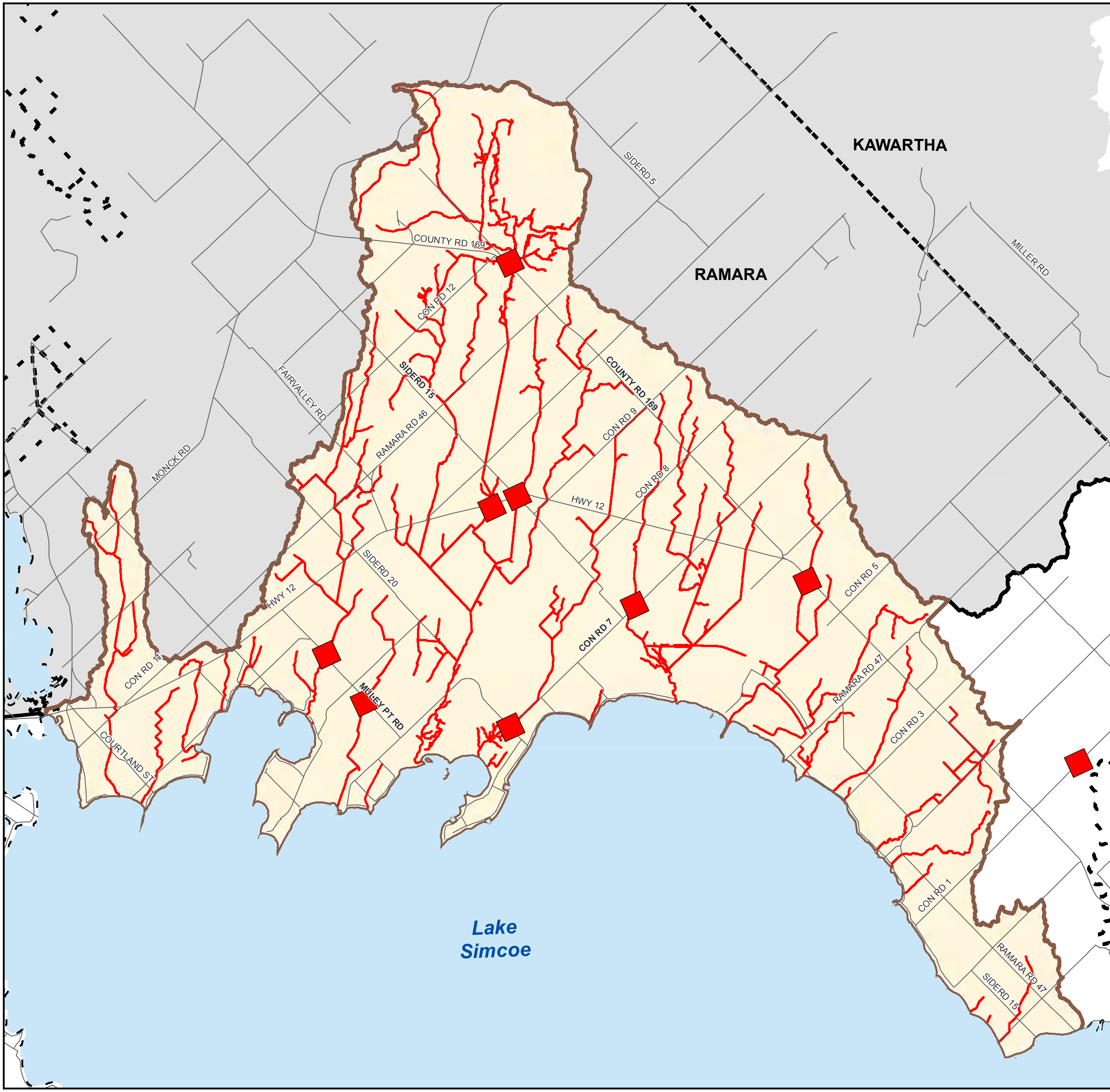
Inputs of contaminants, including high levels of chloride and suspended sediment, to watercourses can be harmful to many species of fish and benthic invertebrates, particularly the more sensitive species. It can force them to leave their habitats, inhibit their growth, or cause die-offs if concentrations of a contaminant get too high. Specific information on water quality issues pertaining to this subwatershed can be found in **Chapter 3 - Water Quality**.

Thermal degradation of a system can be caused by a number of factors. The first is the removal of riparian vegetation and the shade that it creates. If large portions of a watercourse are shaded, these areas may be key in maintaining cold or cool water temperatures or may be a refuge for cool or cold water aquatic species during the hot summer temperatures. Runoff can also cause thermal degradation in a system. As impervious surfaces (such as pavement) heat up from the sun they easily warm any water running over them, creating a warm water source as the water drains into a watercourse, possibly rendering the surrounding waters uninhabitable for coldwater species. Lastly, the detention of water in a pond creates a source of warm water into a system as it 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.

illustrates the OMNRF approved temperature designation of the creeks (and the temperature at which they are managed at based on timing restrictions for in-water works) with current temperature ratings. As there are no cold water inputs in the Ramara Creeks subwatershed, the watercourses are all managed as warm water. The watercourses are likely experiencing thermal degradation as a result of agricultural runoff and the loss of riparian cover. As such, the current stream temperatures should be maintained to ensure that the watercourses do not get any warmer. More information about the impacts of municipal drains on water temperature can be found in section 5.3.7 – Municipal Drains.

**Temperature designations and measured instream temperatures in the Ramara Creeks subwatershed**

Figure 5-11




**Legend**

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Timing Restrictions

- October 1 to June 1
- March 1 to June 30
- April 1 to June 30

Current Temperature

- Cold
- Cool
- Warm

0 0.5 1 2 3 Kilometres

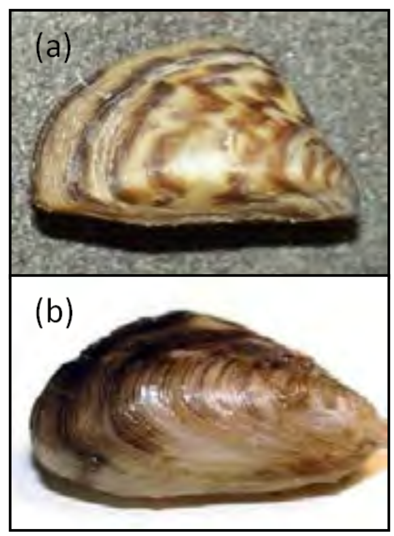
### 5.3.7 *Loss of wetlands*

While the current status and stressors to wetlands are covered are in detail in Chapter 6 - Terrestrial Natural Heritage, it is important to highlight the significant relationship they have with nearby aquatic systems. Wetlands are important to the aquatic natural heritage system as they store water and reduce flooding, prevent erosion along banks and are a source of groundwater recharge and discharge. They also improve the quality of water that filters through them into the creeks by removing sediments, pathogens, nutrients and pesticides. Prior to the establishment of Lagoon City on the shores of Lake Simcoe, this area was productive wetland, which was then drained and filled in to accommodate construction of the resort town. Consequently, Lagoon City is now experiencing water quality issues, as described in more detail in Chapter 3 – Water Quality.

As of 2012, 3465 ha of wetland remains in the Ramara Creeks subwatershed, according to data available from the MNRF and LSRCA. This accounts for 25% of the landscape and includes provincially significant wetlands.

### 5.3.8 *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 invasive species 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.




**Two invasive mussel species in Lake Simcoe: (a) zebra mussel; (b) quagga mussel.**

As of 2013 the only invasive fish species found in the Ramara Creeks subwatershed was the common carp (*Cyprinus carpio*). Carp have a number of characteristics that make them detrimental to areas they are introduced to: they are prolific breeders, so their numbers can quickly shift the balance from native species; they feed by disturbing bottom sediment, which uproots vegetation, prevents new vegetation from becoming established, disturbs fish and amphibian nests, and causes the water to become cloudy; and their diets include, among other things, the eggs of other fish, as well as the invertebrates and plants that native species may use as a food source. The only invasive benthic invertebrate species that has been caught is the rusty crayfish, a species native to the Ohio, Kentucky, and Tennessee regions. It is thought to have been introduced in the 1960s by non-resident fishermen who used it as bait. Rusty crayfish have a number of characteristics that are cause for concern: they feed heavily on aquatic plants and other benthic invertebrates, thus disturbing the dynamics of the ecosystem; they are competition for native crayfish as well as juvenile fish; they aggressively chase native species from the best daytime hiding spots, leaving the native crayfish more vulnerable to predation; and they are also more aggressive when under attack by fish and are thus less likely to be preyed upon. In addition, they are able to mate with native species of crayfish, a process that may hasten the local extinction of the native species.

There have also been a number of invasive species indentified in Lake Simcoe that can impact the nearshore environments and the tributaries in the Ramara Creeks subwatershed. These include:

- Eurasion watermilfoil (*Myriophyllum spicatum*),
- Curly-leaf pondweed (*Potomogeton crispus*,
- Common carp (*Cyprinus carpio*),
- Rainbow smelt (*Osmerus mordax*),
- Round goby (*Neogobius melanostomus*),
- Spiny waterflea (*Bythotrephes longimanus*),
- Rusty crayfish (*Orconectes rusticus*),
- Zebra mussel (*Dreissena polymorpha*),
- Quagga mussel (*Dreissena rostriformis bugensis*)

The LSPP includes a number of polices (7.1-SA to 7.10SA) to prevent the introduction of invasive species into the Lake Simcoe watershed. Of most importance is Policy 7.4-SA that requires that a “watch list” be developed and that response plans for those species on the list be prepared. These response plans will detail the actions that should be taken if the species are detected within the watershed. The following organisms are on the aquatic watch list:

- Fanwort (*Cabomba caroliniana):* A submersed freshwater perennial plant that is extremely persistent and competitive. Under suitable environmental conditions, it can form dense stands, crowding out previously well-established plants.
- European water chestnut *(Trapa natans):* Native to Europe, Asia, and Africa, *T. natans* is an invasive aquatic plant that can form dense mats of floating vegetation.
- Water soldier (*Stratiotes aloides):* An aquatic plant commonly sold in the aquarium and water garden industry. The plant is native to Europe and Central Asia, but has been identified in the Trent Severn Waterway near the hamlet of Trent River. Water soldier forms dense large masses of plants which crowd other aquatic plants.

- Asian carp: The term “Asian carp” refers to four invasive species (bighead, silver, grass, and black carp) that were brought to North America in the 1960s and 70s. Since then they have migrated north through U.S. waterways towards the Great Lakes, replacing native species in their path.
- Viral hemorrhagic septicaemia: A deadly infectious fish disease caused by the viral hemorrhagic septicemia virus. The virus can be spread from fish to fish through water transfer, as well as through contaminated eggs and bait fish from infected waters.

**Invasive plant species on aquatic ‘watch list’: (A) Fanwort, (B) European water chestnut, and (C) Water soldier. (Photo Credits: Ontario’s Invading Species Program)**

### 5.3.9 *Climate Change*

Recent work from an MOECC Vulnerability Report for Lake Simcoe watershed wetlands, streams and rivers (Chu, 2010) suggests that climate change over the next 90 years will increase stream temperatures 1.3°C above current conditions, and 89% of the wetlands within the watershed will be vulnerable to drying and shrinkage. This prediction essentially threatens most wetlands in the Ramara Creeks subwatershed.

In addition, as part of the Tier 2 Water Budget, Climate Change, and Ecologically Significant Groundwater Recharge Area Assessment for the Ramara Creeks, Whites Creek, and Talbot River Subwatersheds (2014), Earth*fx* Inc. conducted a 10-year drought scenario and climate change assessment for the Ramara Creeks subwatershed.

The drought analysis examined how the subwatershed would respond to conditions similar to a historic 10-year period of low rainfall. According to the model, the largest relative impact on streamflow occurs in the headwater streams; however, most of the areas within the subwatershed showed little response to the drought scenario, likely a result of a high groundwater storage capacity.

According to the climate change scenarios, median monthly groundwater recharge increases in the fall and winter and decreases during the spring freshet, but is little changed in other months. Warmer winters are expected to result in higher average precipitation and runoff moving into the subsurface, resulting in less accumulation of snowpack and ice coverage during the winter months. The changes to the timing of runoff, stream flows, and spring freshet will likely have an impact on aquatic natural heritage.

These studies highlight the importance of protecting and building more resilience to respond to climate change through the protection and maintenance of the current groundwater recharge-discharge system, as well as through activities such as instream rehabilitation, barrier removal, stream bank planting, the use of natural channel design during channel reconstruction, water quality protection in both urban and rural settings, and wetland protection. Long-term monitoring will be needed to assess the impacts of climate change to aquatic communities, where the key shifts are taking place and how they might be mitigated.

***Key Points – Factors Impacting Aquatic Natural Heritage – stressors:***

- There are several stressors to the aquatic natural heritage systems in the Ramara Creeks subwatershed, the cumulative impacts of which can be seen in the thermal degradation of the watercourses, and the poor habitat conditions and water quality as indicated by the benthic invertebrate data and the absence of fish in some of the watercourses.
- Some of the most significant stressors include physical changes such as bank hardening, channelization, the removal of riparian vegetation, and barriers such as perched culverts and cement box culverts.
- The extensive municipal drainage system, comprising 51% of the watercourses, plays a large role in the current condition of this subwatershed. Agricultural runoff collected in the municipal drains often contains pollutants, nutrients and sediments that may impair water quality.
- Habitat quality and quantity are also impacted by changes in flow regime resulting from land use changes, stream alterations, uncontrolled stormwater, and municipal drains. Increased flow degrades habitat through processes such as bank erosion, while decreased flow can lead to a temporary or permanent reduction in the amount of aquatic habitat present. A number of municipal drains in this subwatershed are dry for more than two consecutive months of the year, and do not support any fish communities.
- Zebra mussels have invaded the lake nearshore habitat of the Ramara Creeks subwatershed. In the tributaries of the subwatershed, there are populations of common carp and rusty crayfish. If populations of these invasive species increase, it is likely they will negatively affect native communities by occupying and/or destroying the habitat of native species and by out-competing them for resources.
- The introduction of zebra mussels and excess nutrient runoff have contributed to changes in the aquatic plant communities in the lake nearshore; some of the highest plant biomass in Lake Simcoe is found in the nearshore off of the Ramara Creeks subwatershed.
- The emerging threat of climate change will interact with all of these threats, creating additional long-term stresses on the aquatic systems. Although research in this area is still emerging, initial predictions suggest that over the next 90 years stream temperatures will increase by 1.3°C above current conditions, and 89% of the wetlands in the Lake Simcoe watershed will be vulnerable to drying and shrinkage. Further, climate change scenarios indicate that median monthly groundwater recharge will increase in the fall and winter and decrease during the spring freshet, impacting processes such as stream flow and runoff.

## 5.4 Current Management Framework

Various programs exist to protect and restore aquatic natural heritage values in the Lake Simcoe watershed, ranging from regulatory mechanisms, to funding and technical support provided to private landowners, to ongoing research and monitoring.

Many of these programs already address some of the stresses facing aquatic systems in the Ramara Creeks subwatershed, as outlined below.

### 5.4.1 Protection and policy

There are numerous acts, regulations, policies, and plans aimed at maintaining or improving aquatic habitat. These include the *Fisheries Act*, *Endangered Species Act*, the Lake Simcoe Protection Plan, and municipal official plans. This management framework addresses many of the stresses identified in this subwatershed. In Table 5-3 we categorize 12 such stressors, recognizing that many of these overlap and that the list is by no means complete. The legal effects of the various Acts, policies, and plans on the stressors is categorized as 'existing policies in place' (shown in green), or 'no applicable policies' (shown in red). The policies included in the table include those which have legal standing and must be conformed to, or policies (such as some of those under the Lake Simcoe Protection Plan) which call for the development of further management tools, research or education programs.

The intent of these regulations, policies and plans are summarized in **Section 1.3 – Current Management Framework**. Readers interested in the details of these regulations, policies and plans are directed to read the original documents.

**Table 5-3: Summary of the current management framework as it relates to the protection and restoration of aquatic natural heritage**

| Stressor affecting aquatic habitat | 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) | Lakes and Rivers Improvement Act (1990) | LSRCA Watershed Development Policies (2008) | Simcoe County Official Plan (2007) | Township of Ramara Official Plan (2003) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site alteration in wetlands | | | | 4 | | 5 | | | | | 13 |
| Loss of riparian areas / shoreline development | 1 | | | 4 | | | | 6 | | | 14 |
| Stream alteration (including enclosures and flow diversion) | 1 | | | | | | | | | 12 | 15 |
| Instream barriers | | | | | | | | | | 12 | |
| Bank hardening | 1 | | | | | | | 7 | 9 | 12 | |
| Impervious surfaces | | | | | | | | | | | 16 |
| Municipal drains | | | | | | | | | | | |
| Uncontrolled stormwater | | | | | | | | | 10 | | |
| Interference with groundwater recharge / discharge | | | | | | | | | 11 | | |
| Degradation of water quality (including thermal impacts) | 2 | | | | | | | 8 | | | 17 |
| Introduction of invasive species | 3 | | | | | | | | | | |
| Climate change | | | | | | | | | | | |
| Existing policies in place | | | | | | No applicable policies | | | | | |

[1] Regulations only apply to those areas outside designated Settlement Areas

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

[3] Discusses developing proposed regulations, conducting studies/risk assessments, developing response plans, education programs, but nothing banning use/etc

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

[5] Restrictions apply only to direct or indirect fish habitat

[6] Not directly stated, but applicants who are applying for approval under the *Lakes and Rivers Improvement Act* need to be aware of the rights of riparian owners, and take into account the effect that the proposed work will have on the rights of riparian owners.

[7] Refers to channelization, including revetments, embankments, and retaining walls in rivers

[8] Not directly stated, but most of the policies would indirectly cover this

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

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

[11] Within hydrologically defined Environmentally Significant Areas

[12] References Fisheries Act (1985)

[13] If not PSW, requires proponent to demonstrate no negative impact on the feature or its functions

[14] Policies mainly relate to planning/building code issues; however one requires a 20 m setback, to protect from flood risk; another requires completion of assessment report for DFO, Simcoe County regarding development in fish habitat in Barnstable Bay

[15] Development proposals are to demonstrate that the natural condition of a watercourse will be maintained (but does not specifically address stream alteration)

[16] Township adopt guidelines for stormwater measures including maximum impervious area on individual lots – only applies in Shoreline Residential Areas

[17] There are policies related to water quality, although none specifically mention thermal impacts

Legislation and policy restrictions are the primary source of protection for aquatic natural heritage features in the Lake Simcoe watershed. However, some stresses are better suited to policy and regulation than others. For example, stressors such as climate change and invasive species are hard to regulate; however, activities related to the loss of habitat, or capture and killing of fish are much easier to define and enforce.

The new Federal *Fisheries Act* manages threats to fish that are part of or support commercial, recreational or Aboriginal fisheries with the goal of ensuring their productivity and ongoing sustainability. Under the Act, the Fisheries Protection Policy Statement applies to proponents of existing or proposed works, undertakings or activities that are likely to result in impacts to fish or fish habitat that are part of or support commercial, recreational or Aboriginal fisheries, including projects that have the potential to affect the passage of fish or modify the flow of watercourses.

The *Fisheries Act* is complemented by the Lake Simcoe Protection Plan, which (outside designated settlement areas) establishes restrictions to development or site alteration within 100 m of the Lake Simcoe shoreline (30 m in already built-up areas, subject to a natural heritage evaluation) (policies 6.1 and 6.2), or within 30 m of wetlands and watercourses, with natural heritage evaluations necessary for development proposed within 120 m of the feature (policies 6.22 – 6.25). Exemptions to these policies are provided for existing uses, municipal infrastructure, and aggregate operations. These activities will be required to demonstrate that they maintain or improve fish habitat in the watercourse, wetland, or riparian area.

Aquatic habitat is also offered some protection by municipal official plans. In the Official Plan for the Township of Ramara, Policy 5.2.3.7 of the Natural Area Framework outlines a limited number of uses permitted on lands of provincial, regional and local significance identified as fish habitat. Some of these uses include passive recreation, permitted agricultural activities, facilities for preservation and conservation of natural areas, and water supply, wastewater treatment, storm water management, and road, railway and utility infrastructure approved under applicable provisions.

However, Policy 5.2.4.1 of the Township of Ramara's Official Plan states that, where it is demonstrated that there will be no negative impact on natural features and functions, development and/or site alteration may be permitted following consideration of an Environmental Impact Statement (EIS). Among other requirements, the EIS is to contain specified performance criteria, as outlined in the official plan. For example, with respect to fish habitat, development and/or site alteration proposed in areas within and/or adjacent to the features and functions of the natural areas shall satisfy, as a minimum standard, that the health of aquatic communities and fish habitat are not altered, disrupted or destroyed and there is no net loss of productive capacity.

Beyond the protection of aquatic habitat features themselves, processes related to groundwater flow (including both recharge and discharge) are also protected by a suite of policy mechanisms. The Lake Simcoe Protection Plan requires LSRCA (in partnership with MOECC and MNRF) to define and map Ecologically Significant Groundwater Recharge Areas (ESGRAs) throughout the watershed. ESGRAs are identified as areas of land that are responsible for supporting groundwater systems that sustain sensitive features like coldwater streams and wetlands. Once identified, municipalities are required to incorporate these features into their official plans together with policies to protect, improve or restore the function of the recharge areas.

Drainage works, such as those permitted under the Provincial *Drainage Act,* are exempt from many of the policy provisions provided under the Lake Simcoe Protection Plan and municipal official plans, but are not exempt from the requirements of the Federal *Fisheries Act* or the Provincial Regulation on development and interference with wetlands (O. Reg. 179/06). Maintenance of existing designated drains requires class authorization under the *Fisheries Act*.

For infrastructure or other works occurring in water, the Ontario Ministry of Natural Resources and Forestry is responsible for determining in-water work timing restrictions to ensure that fish and other aquatic life are permitted to carry out critical 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.

### 5.4.2 Restoration and remediation

There is a range of programs operating in the Ramara Creeks subwatershed to assist private landowners in improving the environmental health of its tributaries. Table 5-4 summarizes the stewardship projects completed between 2004-2014 with various sources of funding.

**Table 5-4: Summary of stewardship projects completed between 2004 and spring 2014 in the Ramara Creeks subwatershed with various sources of funding shown. Note: funding sources indicated may not have been used for every single project, but was applied to some within that category, in some years.**

| Project Type | Project Count | Tree Program Funding | Provincial Source Water Funding | LEAP Funding | Federal Lake Simcoe Clean-up Fund |
|---|---|---|---|---|---|
| Clean Water Diversion | 2 | | | | ✓ |
| Enhancing Wildlife Habitat | 4 | | | ✓ | ✓ |

| Project Type | Project Count | Tree Program Funding | Provincial Source Water Funding | LEAP Funding | Federal Lake Simcoe Clean-up Fund |
|---|---|---|---|---|---|
| Erosion (general) | 2 | ✓ | | | ✓ |
| Erosion (streambank) | 9 | ✓ | | ✓ | ✓ |
| Fencing | 6 | | | ✓ | |
| Manure Storage | 3 | | | ✓ | ✓ |
| Milkhouse Waste | 1 | | | | ✓ |
| Septic | 99 | | ✓ | ✓ | ✓ |
| Storing and Handling Fuel, Fertilizer and Chemical | 2 | | ✓ | | |
| Tree Planting | 12 | ✓ | | ✓ | ✓ |
| Grand Total | **140** | | | | |

The Landowner Environmental Assistance Program (LEAP) is a partnership between the Lake Simcoe Region Conservation Authority, its member municipalities, and the York, Durham and Simcoe chapters of the Ontario Federation of Agriculture. This program provides technical and financial support to landowners in the Lake Simcoe watershed wanting to undertake stewardship projects on their land. Project types which have traditionally been funded by the LEAP program include removing barriers from streams, adding bottom-draw structures to online ponds, and fencing and planting riparian areas, among others.

The Ontario Ministries of Natural Resources, Environment, and Agriculture, Food and Rural Affairs provide the Lake Simcoe Community Stewardship Program with financial and technical assistance for non-farm rural landowners in the Lake Simcoe watershed to implement projects such as shoreline stabilization, erosion control, and fish habitat improvements, among others. Thus far, no projects have been undertaken in the Ramara Creeks subwatershed with funding from the Lake Simcoe Community Stewardship Program.

The Ontario Ministry of Agriculture, Food and Rural Affairs has also partnered with Agriculture and Agri-Food Canada and the Ontario Soil and Crop Improvement Association to provide the Environmental Farm Program to registered farm landowners throughout the province. This farmer-focused program provides funding to landowners who have successfully completed an

Environmental Farm Plan for projects including management of riparian areas, streambank fencing, and nutrient management. A few projects have already been implemented through this program that would directly improve aquatic natural heritage in the Ramara Creeks subwatershed.

In 2014, LSRCA field staff surveyed the majority of the watercourses in the Ramara Creeks subwatershed, documenting the range of potential stewardship projects that could be implemented to help improve water quality and fish habitat. The Lake Simcoe Basin Best Management Practice Inventory (LSRCA, 2014) found over 191 additional places in this subwatershed where additional riparian planting could be introduced, over 19 barriers that should be removed to improve fish passage, several locations along creeks that require additional fencing, and 73 locations where the creek channel had been hardened and/or channelized, and an additional 18 sites were identified to have been straightened, which could be mitigated to improve fish habitat.

The forthcoming shoreline management strategy, and wetland and riparian area prioritization exercise, will identify and prioritize stewardship opportunities in this subwatershed, specific to the shoreline and inland riparian and headwater areas, respectively.

### 5.4.3 Science and research

An ongoing commitment to applied science and research is necessary to improve our understanding of the extent, character, and function of the fish and other aquatic natural heritage values within the Lake Simcoe watershed. Ongoing monitoring programs led by the MNRF and the LSRCA, and periodic research studies conducted by academics, are contributing to our understanding of these values.

The Ministry of Natural Resources and Forestry has been studying the structure and function of Lake Simcoe's ecosystem, including internal energy dynamics, food web interactions, and the impacts of invasive species and climate change since 1951 when the Lake Simcoe Fisheries Assessment Unit was created. This unit uses a series of research and monitoring programs, including creel surveys, index netting, angler diaries, spawning studies, and water level and temperature monitoring, among others, to meet the needs of fisheries resource managers (as outlined in Philpot *et al*, 2010).

The Lake Simcoe Region Conservation Authority monitors fish communities, benthic invertebrates, and temperature at a network of sites throughout the watershed. Some of these sites are visited only once, to describe the aquatic system, and some are visited annually to document changes in the health of the tributaries.

More recently, the LSRCA began a nearshore monitoring program in the Lake, to better understand the connection between watershed land use and the health of the Lake Simcoe ecosystem. This monitoring program includes a study of the aquatic plants, benthic invertebrates, and sediment chemistry in this nearshore zone, some results of which are shown in Figure 5-5.

In addition to these ongoing monitoring programs, numerous scientific and technical reports have been published based on research conducted in the Lake Simcoe watershed. As a result of this combined focus, Lake Simcoe is one of the most intensively studied bodies of water in Ontario. The results of this research have been summarized, in part, in LSEMS (2008) and Philpot *et al.* (2010), and have informed the development of this subwatershed plan.

The Lake Simcoe Protection Plan commits the MNRF, MOECC, LSRCA, and others to continue to invest in research and monitoring related to aquatic communities of Lake Simcoe and its tributaries. Ongoing research is proposed to examine the biological components of the ecosystem, their processes and linkages; to build on existing knowledge; or address knowledge gaps (policy 3.5). The proposed monitoring program is intended to build on the existing monitoring described above, to describe the fish communities, benthic communities, macrophytes, and/or fishing pressure in the lake, its tributaries, and other inland lakes within the watershed (policy 3.6).

## 5.5 Management Gaps and Recommendations

(Note: It is recognized that many of the undertakings in the following set of recommendations 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 in the implementation phase.)

### 5.5.1 Stewardship implementation – increasing uptake

In addition to protecting existing aquatic habitat, programs which support the stewardship, restoration, or enhancement of aquatic habitat will be critical to meet the targets and objectives of the Lake Simcoe Protection Plan. To that end, Lake Simcoe Stewardship Network has been established to provide a forum that helps identify priorities and coordinate efforts between the multiple organizations undertaking stewardship in the watershed. The Stewardship Network includes the Ministry of Natural Resources and Forestry, Ministry of Environment and Climate Change, Ministry of Agriculture, Food and Rural Affairs, Ontario Federation of Agriculture, Ontario Soil and Crop Improvement Association, Lake Simcoe Region Conservation Authority, South Simcoe Streams Network and watershed municipalities.

**Recommendation 5-1** – That MNRF, MOECC, OMAFRA, and LSRCA continue to implement stewardship projects in the Ramara Creeks subwatershed, and encourage other interested organizations in doing the same.

**Recommendation 5-2 –** Governmental and non-governmental organizations should continue to improve coordination of programs to: (1) avoid inefficiencies and unnecessary competition for projects, and: (2) make it easier for landowners to know which organization they should be contacting for a potential project, using tools such as existing networks (including Environmental Farm Plan coordinators), a simple web portal, or other, locally appropriate avenues.

**Recommendation 5-3 –** That MOECC, MNRF, LSRCA and other members of the Lake Simcoe Stewardship Network are encouraged to document completed stewardship projects in a common tracking system to allow efficient tracking, coordinating, and reporting of stewardship work accomplished. This could also involve engaging 'project champions' to promote the projects that the have been completed and encourage others to do the same.

**Recommendation 5-4 –** That the Federal, Provincial, and Municipal governments be encouraged to provide consistent and sustainable funding to ensure continued delivery of stewardship programs. Further, that partnerships with other organizations (e.g. Ducks Unlimited Canada, TD Friends of the Environment, Royal Bank of Canada, local businesses) be pursued.

**Recommendation 5-5 –** The MOECC, MNRF, MAFRA, LSRCA and other interested members of the Lake Simcoe Stewardship Network support research to determine barriers limiting uptake of stewardship programs in this subwatershed, and share these results with other members of the Lake Simcoe Stewardship Network, to enable agencies and stakeholders to modify their stewardship programming as relevant. This research should include a review of successful projects to determine what aspects led to their success, and how these may be emulated

**Recommendation 5-6 –** The MOECC, MNRF, MAFRA and LSRCA continue to investigate new and innovative ways of reaching target audiences in the local community and engage them in restoration programs and activities (e.g. local radio, Chamber of Commerce, 4H clubs, high school environmental clubs, through Facebook groups, hosting a Lake Simcoe Environment Conference for high schools/science community interaction, and/or including inserts in tax or utility bills). Results of these efforts should be shared with the Lake Simcoe Stewardship Network.

**Recommendation 5-7 –** That the LSRCA create and/or publicize link to a website that provides information and contact information on available funding programs for stewardship works, and ensure that this site is kept current.

### 5.5.2 Stewardship implementation – prioritize projects

Stewardship programs play an important role in meeting the goals and objectives of the subwatershed plans. However, in order to ensure that they are both effective and efficient, stewardship projects should be selected in the context of the priority needs of the Lake Simcoe watershed, and its subwatersheds. An analysis of aquatic habitat has identified bank hardening, barriers and insufficient riparian cover as some of the most important factors impacting instream habitat. Analogous to terrestrial natural heritage stewardship requirements, a tool has been developed to prioritize aquatic stewardship projects, taking into account: the most significant habitat stressors in the watershed; the use of best available datasets to identify potential restoration sites, such as the BMP inventory and riparian assessment; the expected improvements to aquatic habitat and therefore fish and benthic invertebrate condition, including improved water temperature, increased connectivity for movement within and between tributaries, enhanced riparian cover, and restored natural features within and along watercourses, including flow and channel design.

**Recommendation 5-8** – That priorized restoration areas identified through the recently developed tool be integrated into a stewardship plan that ensures prioritized restoration opportunities are undertaken as soon as feasible. This stewardship plan needs to incorporate the outcomes of recommendations to improve uptake identified in Recommendations 5-1 through 5-6.

### 5.5.3 Impacts to Hydrologic Regime

In addition to the stressors on aquatic habitat identified above (barriers, channelization etc), the condition of the fish and benthic communities in the subwatershed are also likely being impacted by stream hydrology, particularly from low flow condition. While water quantity and associated recommendations are discussed in detail within Chapter 4, the following recommendations are specific to aquatic habitat:

**Recommendation 5-9** –That LSRCA, with assistance from MNRF and MOECC, establish ecological flows (instream) targets for each main tributary. These instream flow targets should be based on the framework established for the Maskinonge River. Once these targets are established, a strategy should be established to achieve them. This strategy should also protect baseflow and location of upwellings in order to maintain thermal stability.

**Recommendation 5-10** –That LSRCA work with the municipalities, MAFRA, and landowners to examine innovative forms of municipal drain maintenance, or opportunities to create new drains using principles of natural channel design.

**Recommendation 5-11** – The LSRCA work with the municipality and MAFRA to determine which municipal drains are natural watercourses that have been straightened, and which are created watercourses, and catalog which of these is still in use. Those no longer in use that were historically natural watercourses should be priorities for rehabilitiation as described in Recommendation 5-9 above.

### 5.5.4 Water Quality and Water Temperature

Based on the generally fair to fairly poor benthic invertebrate community scores, water quality in the Ramara Creeks subwatershed is degraded in most areas. Similarly, the assessment of fish Index of Biotic Integrity and water temperature indicate that the thermal regime of the watercourses is being affected by factors such as loss of riparian cover, municipal drains, and barriers. Recommendations addressing water quality are presented in **Chapter 3 – Water Quality**, and recommendations pertaining to increased water temperature are described above, e.g. Recommendation 5-7.

### 5.3.10 *Monitoring and Assessment*

Long-term monitoring is required to identify changes and trends occurring in the aquatic community. These on-going annual surveys of fish, invertebrates, stream temperatures, water quality, baseflow and channel morphology are also intended to provide information that will direct future rehabilitation efforts. Additional environmental characteristics such as fish community surveys, field confirmation of groundwater inputs, algae/diatom sampling, lake/tributary interface assessment, as well as an expanded water quality and quantity network will need to be considered to provide the information to look at the system in an integrated and holistic way. A renewed need for regular reporting of the results and a systematic re-evaluation of the program is also required.

**Recommendation 5-12** – That LSRCA, with support from the Township and the Province, aim for improved spatial and temporal resolution in annual monitoring of aquatic habitat, including water quality, fish and benthic indicators.

**Recommendation 5-13 –** That LSRCA and its partners work to create a centralized location for reports and resources pertaining to Lake Simcoe and its watershed such that information can be accessed by all interested stakeholders.

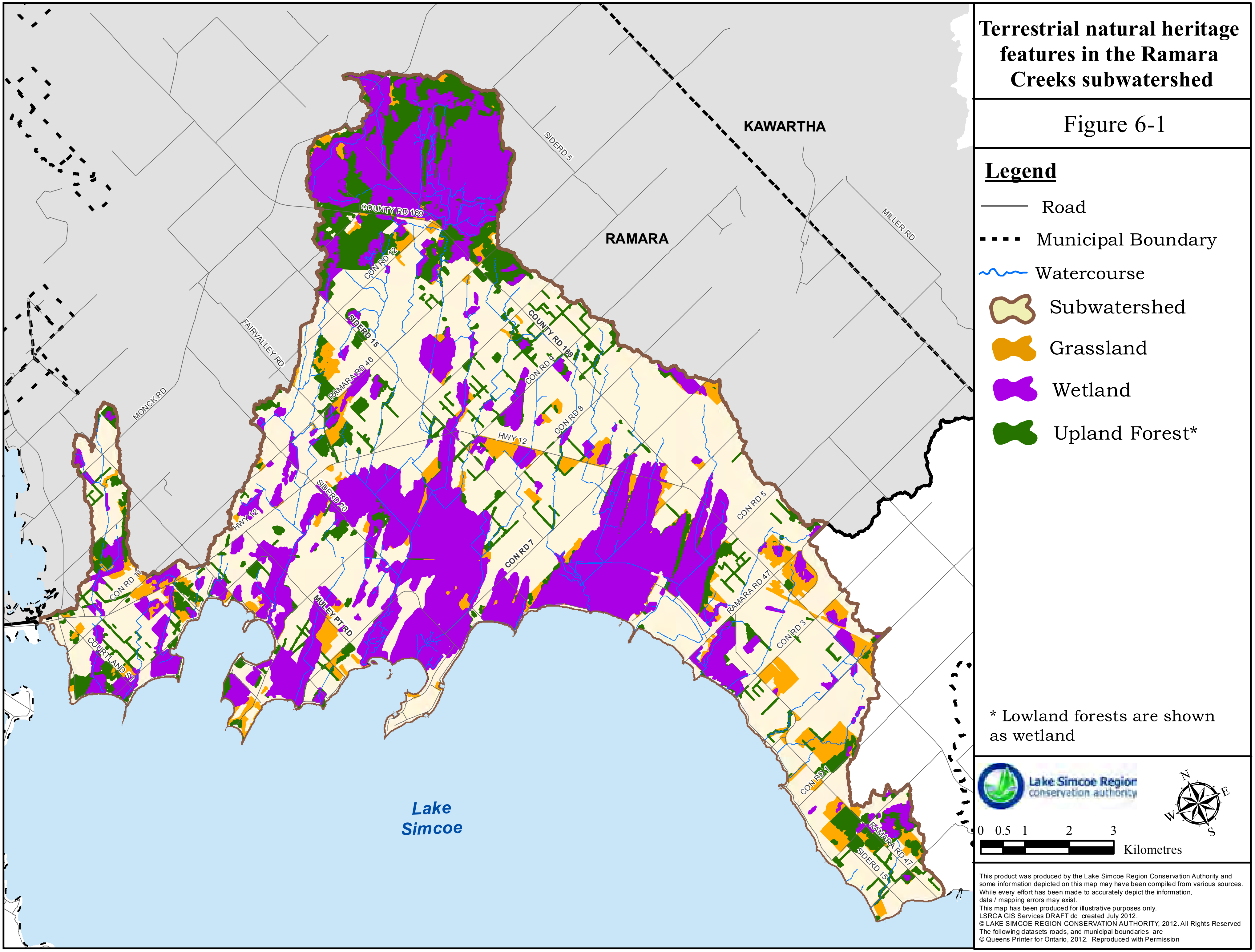
# 6 Terrestrial Natural Heritage

## 6.1 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 and water quality. 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 Ramara Creeks 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 the 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. Figure 6-1 details the distribution of natural features in the subwatershed.

Currently, natural heritage features account for 41.1% of the Ramara Creeks subwatershed (including 25.2% wetland, 9.6% upland forest, and 5.8% grassland).



Terrestrial natural heritage features in the Ramara Creeks subwatershed
Figure 6-1
Legend
Road
Municipal Boundary
Watercourse
Subwatershed
Grassland
Wetland
Upland Forest*
* Lowland forests are shown as wetland
Lake Simcoe Region conservation authority
N
E
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0 0.5 1 2 3
Kilometres
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KAWARTHA
RAMARA
Lake Simcoe
COUNTY RD 169
CON RD 12
SIDERD 15
RAMARA RD 46
FAIRVALLEY RD
MONCK RD
SIDERD 5
MILLER RD
CON RD 9
CON RD 8
HWY 12
SIDERD 20
CON RD 7
CON RD 5
CON RD 11
COURTLAND ST
MULEY PT RD
RAMARA RD 47
CON RD 3
CON RD 1
SIDERD 15

## 6.2 Current Status

Terrestrial natural heritage features, as described by the Provincial Policy Statement, include woodlands, wetlands, valleylands, Areas of Natural and Scientific Interest, habitat for endangered species, and wildlife habitat. The Provincial Policy Statement provides direction for the protection of *significant* natural heritage features throughout the Province.

The Lake Simcoe Protection Plan (LSPP) provides further targets for the Lake Simcoe watershed, to:

- Ensure no further loss of natural shorelines on Lake Simcoe;
- Achieve a greater proportion of natural vegetative cover in large high quality patches;
- Achieve a minimum 40 percent high quality natural vegetative cover in the watershed;
- Achieve protection of wetlands;
- Achieve naturalized riparian areas on Lake Simcoe and along streams;
- Restore natural areas or features, and;
- Achieve increased ecological health based on the status of indicator species and maintenance of natural biodiversity

The current state of natural heritage features in the Ramara Creeks subwatershed can be described, relative to these targets, where data permits.

At 41.1%, the total natural cover in the Ramara Creeks subwatershed is about average with respect to other Lake Simcoe subwatersheds, with about half of the subwatersheds having more natural cover and half having less. The subwatershed does exceed the target of 40% natural areas for the entire Lake Simcoe watershed set by the Lake Simcoe Protection Plan, although it has not yet been determined if all of these natural areas would be considered 'high quality' as is the goal of the LSPP. The subwatershed has a high level of agriculture, with 50% of the subwatershed area being occupied by this land use. Other, less prevalent land uses include urban, industrial, and institutional land uses, as well as rural development and aggregate extraction operations (Figure 2-2).

### *6.2.1 Woodlands*

The *Natural Heritage Reference Manual* (OMNR, 2010) 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
- **Ecological Values:** diversity of species, structural heterogeneity, nutrient and energy cycling.
- **Hydrological Values:** interception of precipitation, reduction of intensity of rainfall runoff, slower release of melt water from snowpack, shade to water courses

Woodlands include all treed communities, whether upland or wetland. The Ecological Land Classification (ELC) communities that were considered to represent woodlands are forest, swamp, plantation, and cultural woodland (the breakdown of these woodland types is displayed in Table 6-1 and Figure 6-2). Some woodlands in this section are also counted as wetlands later in the chapter (e.g. wooded swamp), as the two terms are not mutually exclusive.

The ecological function of woodlands tends to be influenced by 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).

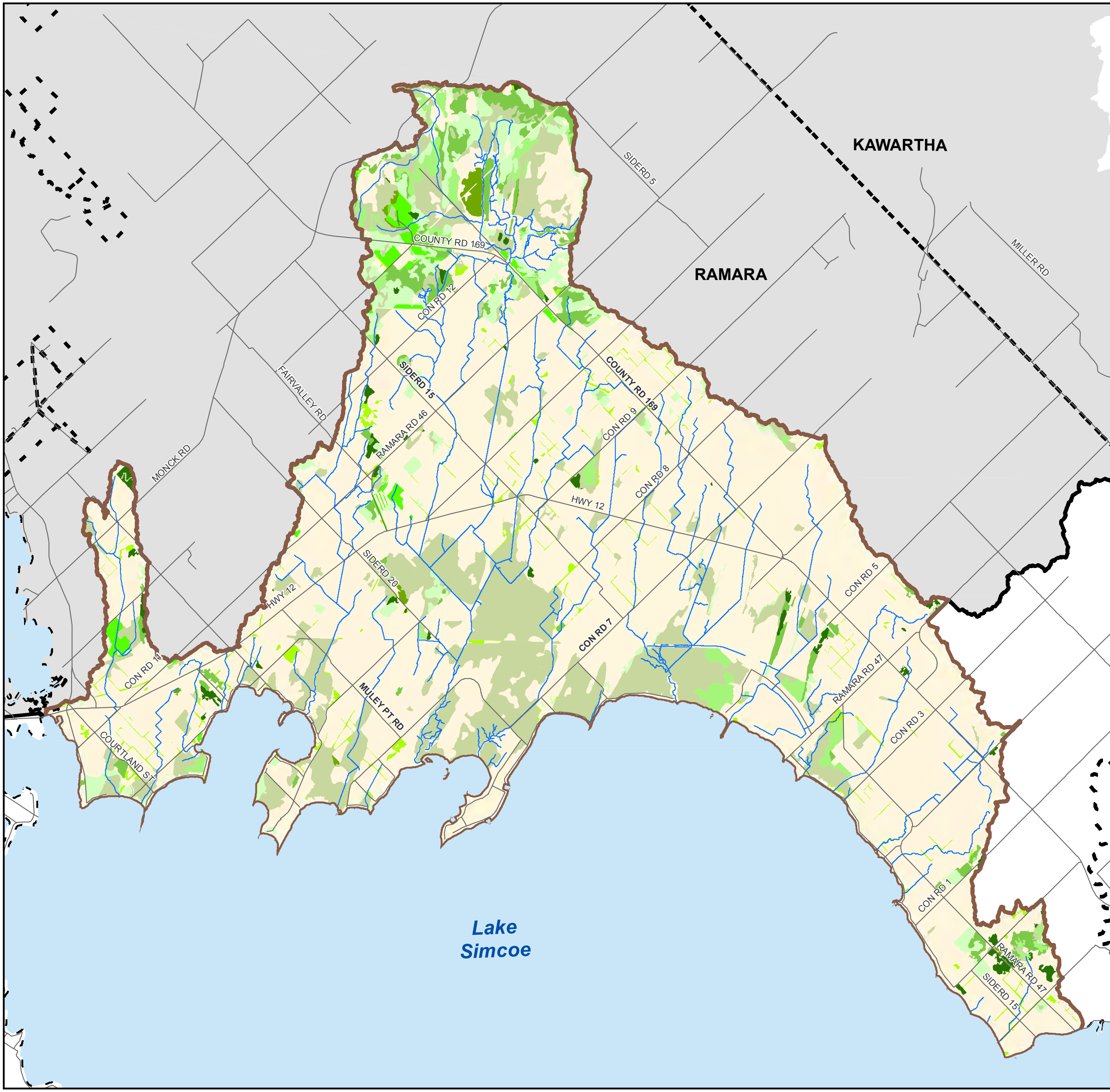
Of these factors, there is increasing scientific evidence to show that the total woodland cover of a landscape may exert the most important influence on biodiversity. Obviously, the loss of woodland cover results in a direct loss of habitat of that type. This reduction in habitat can result in proportionally 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 (Fahrig, 2003). Research that has examined the independent effects of habitat loss and 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).

Prior to European settlement the dominant land cover type of Southern Ontario was woodland. Total pre-settlement woodland cover in Simcoe County was estimated to be 83%. By 1955 this had decreased to 32.4%, and then had increased to 40.2% by 1978 across the county (Larson *et* *al*., 1999), with areas being cleared for agriculture and urban development. Woodland cover in the Ramara Creeks subwatershed is 25.7% (Table 6-1); well below the average for the County.

The Lake Simcoe Protection Plan sets a target of the retention of a minimum of 40% high quality natural vegetative cover in the entire Lake Simcoe watershed, which would include forest, native grassland, and non-forest wetland ecosystems. Clearly, this amount of natural cover cannot be achieved uniformly throughout the watershed, as development pressures are distributed unevenly throughout the watershed. At 41.1% natural cover, the Ramara Creeks subwatershed comes close to meeting this target, although it is unknown what proportion of this 41.1% is considered to be 'high quality', as this definition has yet to be finalized. LSRCA's Integrated Watershed Management Plan allows for uneven distribution of woodland cover, while still setting a target of a minimum of 25% forest cover within each of Lake Simcoe's subwatersheds. At 25.7%, existing forest cover within the Ramara Creeks subwatershed barely exceeds this minimum level.

# Woodland types in the Ramara Creeks subwatershed

Figure 6-2




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Woodland Type

- Coniferous Forest
- Coniferous Swamp
- Cultural Plantation
- Cultural Woodland
- Deciduous Forest
- Deciduous Swamp
- Mixed Forest
- Mixed Swamp

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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**Table 6-1 Woodland cover types in the Ramara Creeks subwatershed**

| Woodland Type | | Woodland Cover | |
|---|---|---|---|
| | | **Area (ha)** | **Area (%)** |
| Upland forest | Cultural Plantation (CUP) | 114.4 | 0.8 |
| | Cultural Woodland (CUW) | 163.0 | 1.2 |
| | Conifer Forest (FOC) | 106.2 | 0.8 |
| | Deciduous Forest (FOD) | 582.5 | 4.2 |
| | Mixed Forest (FOM) | 346.0 | 2.5 |
| Swamp forest | Conifer Swamp (SWC) | 45.2 | 0.3 |
| | Deciduous Swamp (SWD) | 1944.5 | 14.2 |
| | Mixed Swamp (SWM) | 231.2 | 1.7 |
| **Total upland forest** | | **1312.1** | **9.6** |
| **Total forest** | | **3533.0** | **25.7** |
| **Target (LSPP)[1]** | | **5492.4** | **40** |
| **Target (LSRCA IWMP)[2]** | | **3432.6** | **25** |

The most common forest types in the Ramara Creeks subwatershed are deciduous swamp, which is defined as a wetland community where tree cover is greater than 25%, and the deciduous content is greater than 25% coverage; and deciduous forest, which is defined as a natural community with greater than 60% canopy cover and greater than 75% deciduous composition (Table 6-1).

Relatively uncommon in this subwatershed are coniferous woodlands (including forests, swamps, and plantations), which account for only 7.5% of the total woodland. These relatively rare forest types provide habitat for unique wildlife communities, particularly those which prefer coniferous woodlands, such as pine warbler (*Dendroica pinus*), Cooper's hawk (*Accipiter cooperii*), and blue jay (*Cyanocitta cristata*) (Bird Studies Canada *et al.,* 2008).

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. 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

[1] The Lake Simcoe Protection Plan sets a target of 40% high quality natural vegetative cover (which includes, but is not restricted to, woodlands) for the entire Lake Simcoe watershed

[2] LSRCA's Integrated Watershed Management Plan recommends a target of 25% woodland cover per subwatershed

provide habitat for a wide range of flora and fauna. They form important building blocks of the natural heritage system.

The summary statistics reflecting the percentage of the watershed under forested cover cannot address these more detailed issues related to the diversity and ecological integrity of individual forest patches. These issues typically relate to factors such as forest size, forest age, proximity to other natural areas, topographic heterogeneity, and structural diversity within the forest. Policy 6.48 of the LSPP requires the MNRF (in collaboration with the LSRCA, First Nations, and Métis communities) to map and identify `high quality` natural areas in the Lake Simcoe watershed. When this policy has been developed and mapping complete, more could be said about the distribution of these site-specific quality measures in this study area.

Although the total extent of forest cover in a subwatershed is the primary driver for many forest-dependent ecological processes, some species are also sensitive to the size of remnant forest patches (Robbins *et al.,* 1989; Lee *et al.,* 2002), the amount of 'interior' forest habitat (Burke and Nol, 1998a; Burke and Nol, 2000), and the proximity or connectivity between remnant forest patches (Nupp and Swihart, 2000).

Contiguous woodland areas have been calculated and the distributions of woodland patch sizes are displayed in the graph below (Figure 6-3). While the total area of woodland represents the amount of forest completely within the subwatershed, the number of patches also includes any patches touching the subwatershed boundary. This methodology was used to avoid underestimating the number of large patches. If only patches within the subwatershed boundaries were considered, the number of large patches would be underestimated.

The study area contains a wide range of forest patch sizes, ranging from less than 0.5 hectares to close to 600 hectares. Approximately 25% of the subwatershed's forest patches are less than 0.5 hectares in size, although these patches account for less than 1% of the subwatershed's forest area. There are far fewer large forest patches, yet these account for a large proportion of the subwatershed's forest area; for example, over 30% of the forest area in the subwatershed is found in the two largest forest patches. Half of the subwatershed's forested area is found in patches 50 ha or larger.

Beyond issues of habitat size however, is the issue of amount of interior habitat available. Many species and ecological functions have been shown to be influenced by forest edges, a symptom known as 'edge effect'. These effects can extend up to 20 m into the woodland for climatic factors such as light, temperature, moisture levels and wind speed (Burke and Nol, 1998b), up to 40 m for the prevalence of non-forest plant species (Matlack, 1994), and 100 m or greater for the rate of predation on nesting birds (Burke and Nol, 2000). Although this research has typically been interpreted such that 100 m becomes the rule of thumb for differentiating between 'edge' and 'interior' forest habitats, more recent research (Falk *et al.,* 2010) suggests that the impacts of edge effect on predation rates and nest survival in forest-dwelling songbirds may extend over 300 m into woodlots.

As can be seen in Figure 6-3, there are a number of interior forest patches in the Ramara Creeks subwatershed. Over a third of these are less than 0.5 ha in size, but there are also a number of larger patches, with six patches over 50 ha in size; two of these falling in the 200-300 ha range.

These two largest patches account for over 40% of the interior forest in the subwatershed, and likely support a diverse array of sensitive forest species. In addition, "deep forest core" areas, which are those areas lying deeper than 200 metres from the forest edge, were analyzed for the subwatershed. Thirty such areas were identified; close to half of these are less than 0.5 ha in size. About 80% of the deep forest core area is found within three patches, ranging in size from 81 to 172 ha. These patches could potentially support some of the most sensitive forest dwelling species, with few edge effects being felt.

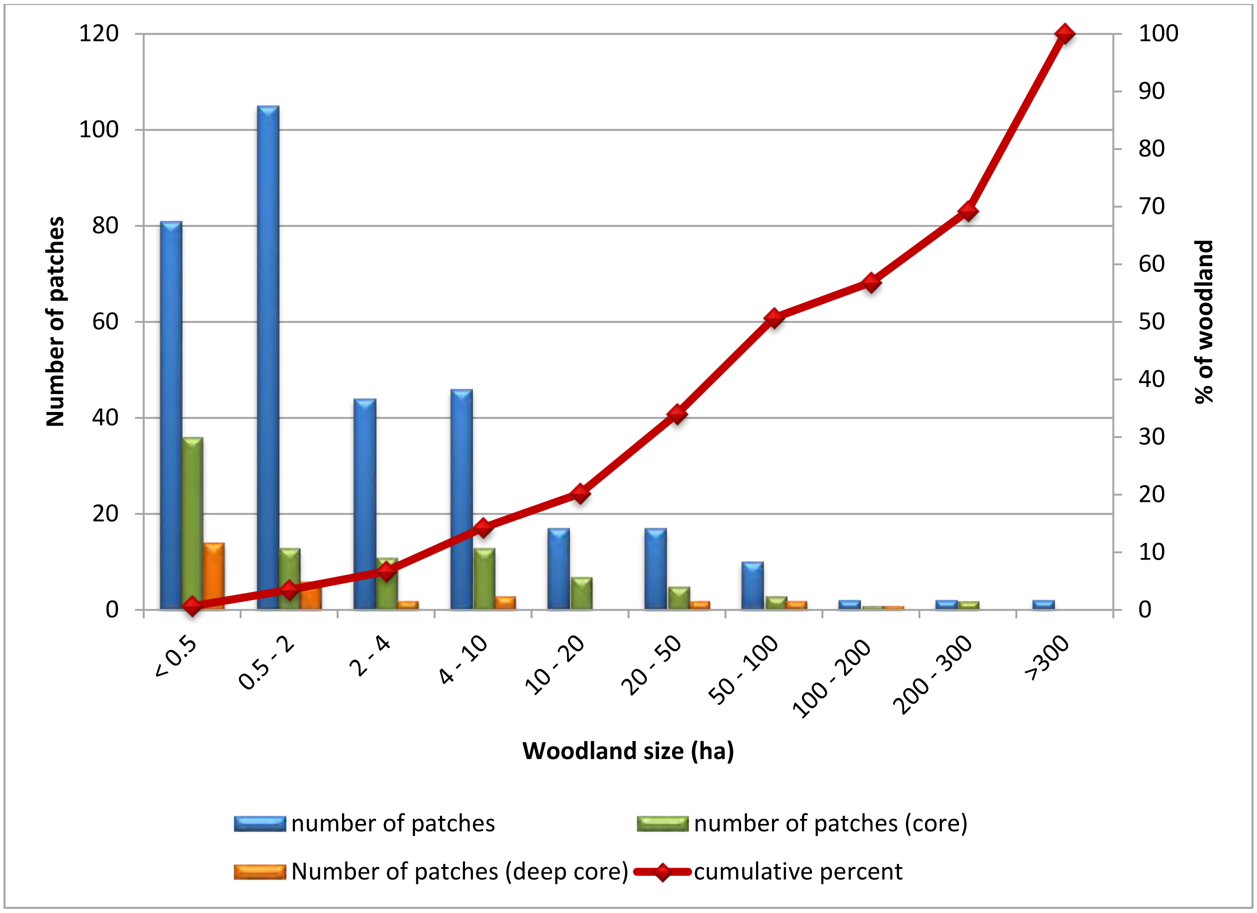



**Figure 6-3 Woodland patch size distribution in the Ramara Creeks subwatershed**

Despite the recent evidence of the importance of total forest area for the preservation of wildlife, the importance of maintaining physical connectivity between woodlands should not be overlooked. Some forest-dwelling species, particularly small mammals, amphibians, and plants, require contiguous forested habitat to allow them to move from one habitat patch to another. Species which are unable to disperse in this way are somewhat vulnerable to local extinction, caused by factors such as inbreeding depression, disease epidemic, or mere chance.

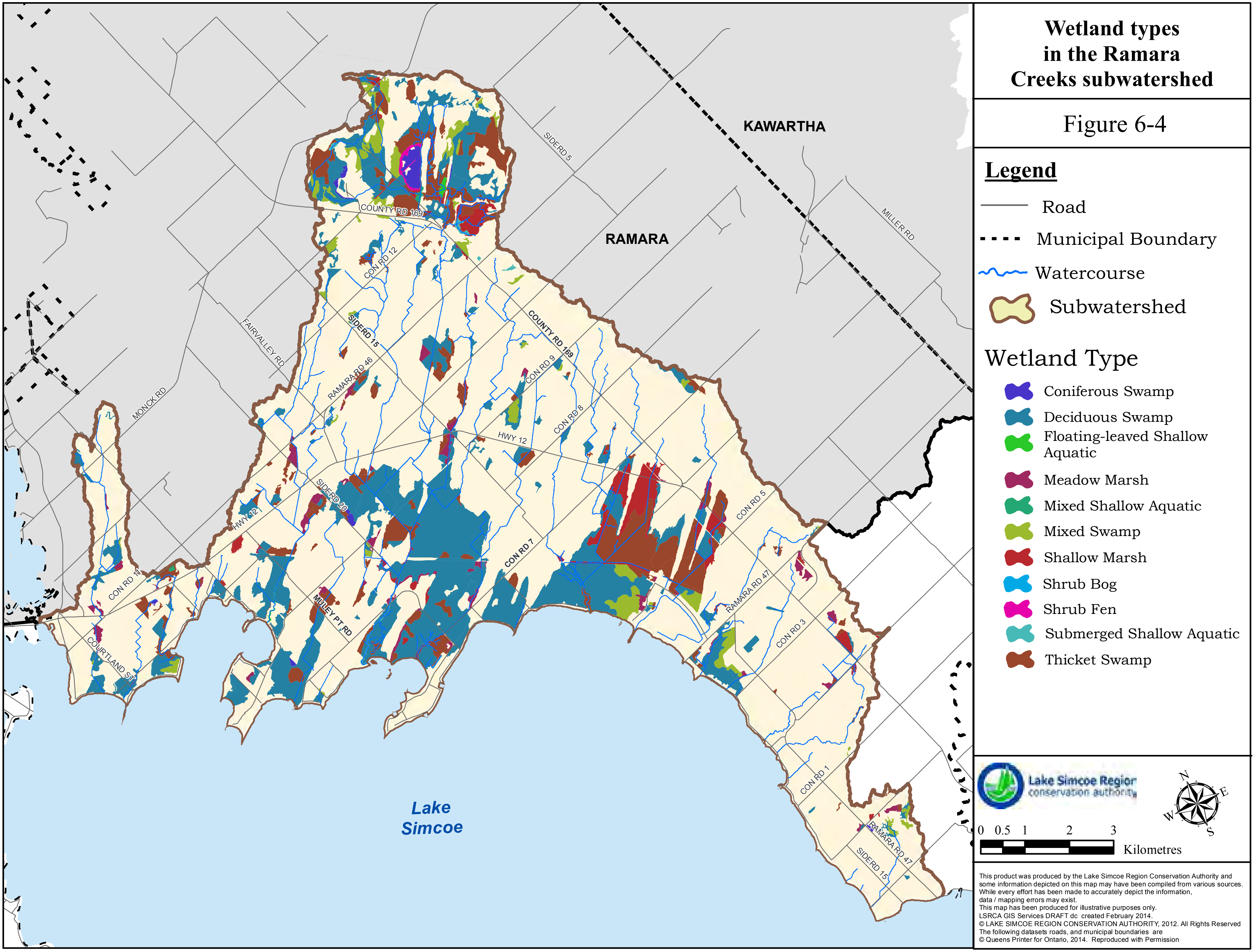
### 6.2.2 Wetlands

The Provincial Policy Statement defines wetlands as lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs, and fens. The Ramara Creeks subwatershed contains all of these wetland types.

Wetlands provide numerous functions for an ecosystem. These include (OMNR, 2010):

- **Natural water filtration:** by removing contaminants, suspended particles, and excessive nutrients, wetlands improve water quality and renew water supplies
- **Habitat:** wetlands provide nesting, feeding and staging ground for several species of waterfowl and other wildlife including reptiles and amphibians, as well as spawning habitat for fish
- **Natural shoreline protection:** these vegetated areas protect shorelines from erosion
- **Natural flood control:** by providing a reservoir, wetlands help to control and reduce flooding through water storage and retention
- **Contribution to natural cycles:** wetlands provide a source of oxygen and water vapour, thus playing a role in the natural atmospheric and climatic cycles
- **Opportunities for recreation:** these include hiking, birdwatching, fishing, and hunting

In its 'How Much Habitat Is Enough?' guidelines (2013), Environment Canada recommends that, at a minimum, the greater of 10% of a watershed, or 40% of the historic wetland coverage, should be protected and restored. Subwatersheds that meet these characteristics experience greatly reduced flood frequencies, and more stable base flow. The additional benefits of wetland cover, listed above, are also maintained. In addition, improvements to water quality have been found when wetlands occupy more than 18% of a given watershed, and amphibian and fish communities are more persistent when wetlands occupy more than 30% and 50% of the total watershed area respectively (Detenbeck *et al.,* 1993; Gibbs, 1998; Brazner *et al.,* 2004). Although the Lake Simcoe Protection Plan does not set a quantitative target for wetland cover within the watershed, it identifies the "protection of wetlands" as a target, implying no further loss of wetland beyond that in existence when the LSPP came into force.



Wetland types in the Ramara Creeks subwatershed
Figure 6-4
Legend
Road
Municipal Boundary
Watercourse
Subwatershed
Wetland Type
Coniferous Swamp
Deciduous Swamp
Floating-leaved Shallow Aquatic
Meadow Marsh
Mixed Shallow Aquatic
Mixed Swamp
Shallow Marsh
Shrub Bog
Shrub Fen
Submerged Shallow Aquatic
Thicket Swamp
KAWARTHA
RAMARA
Lake Simcoe
COUNTY RD 169
CON RD 12
SIDERD 5
MILLER RD
FAIRVALLEY RD
SIDERD 15
RAMARA RD 46
CON RD 9
CON RD 8
HWY 12
MONCK RD
SIDERD 20
CON RD 7
CON RD 5
RAMARA RD 47
CON RD 3
CON RD 1
CON RD 14
COURTLAND ST
MULEY PT RD
Lake Simcoe Region conservation authority
N E S W
0 0.5 1 2 3
Kilometres
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In a study undertaken by Ducks Unlimited Canada in 2010, it was estimated that, prior to European settlement, 34.9% of Mara Township (the portion of the Township of Ramara that occupies the Ramara Creeks subwatershed) was wetland (DUC, 2010). Wetlands were lost as settlement occurred, reducing their relative cover in Mara to 22.3% by 1967. Wetland levels have been fairly steady since 1967; a slight decrease was seen in the 1982 data, but this may have been due to improved mapping and analysis; and in the 2002 numbers, Mara has 22.6% wetland cover; consistent with the 1967 level (DUC, 2010). It should be noted that the Ducks Unlimited study derives its estimates of wetland distribution from soil maps, and likely underestimates the current extent of wetlands in this subwatershed. Thus, they may also underestimate the amount of wetland lost since the time of settlement (pre-settlement maps may provide a better estimate).

According to data available from the MNRF and LSRCA (current as of 2012), there are 3464 ha of wetland remaining in the Ramara Creeks subwatershed (Figure 6-4, Table 6-2).

**Table 6-2 Distribution of wetland types in the Ramara Creeks subwatershed**

| Wetland type | Wetland Cover | |
|---|---|---|
| | Area (ha) | Area (%) |
| Meadow marsh (MAM) | 131.7 | 0.9 |
| Shallow marsh (MAS) | 217.9 | 1.6 |
| Floating leaved shallow aquatic (SAF) | 10.0 | 0.07 |
| Mixed shallow aquatic (SAM) | 5.1 | 0.03 |
| Submerged shallow aquatic (SAS) | 19.9 | 0.15 |
| Coniferous swamp (SWC) | 45.2 | 0.33 |
| Deciduous swamp (SWD) | 1944.5 | 14.2 |
| Mixed swamp (SWM) | 231.2 | 1.7 |
| Thicket swamp (SWT) | 798.3 | 5.8 |
| Treed bog (BOT) | 48.8 | 0.36 |
| Shrub fen (FES) | 9.7 | 0.07 |
| Treed fen (FET) | 2.2 | 0.02 |
| **Total marsh** | **384.6** | **2.8** |
| **Total swamp** | **3019.2** | **22.0** |

| Wetland type | Wetland Cover | |
|---|---|---|
| | Area (ha) | Area (%) |
| Total bog | 48.8 | 0.36 |
| Total fen | 11.9 | 0.09 |
| TOTAL | 3464.5 | 25.2 |

As can be seen from Table 6-2, the Ramara Creeks subwatershed contains many wetland types. The dominant wetland type in the subwatershed is swamp, which is a wetland that is dominated by woody plants. Of particular note is that the subwatershed contains both fen and bog habitat. While these wetland types are common in northern Ontario, they are considered to be relatively rare in southern Ontario. Both habitat types are peatlands, with bogs being fed by rainwater and fens being fed by groundwater; and can be home to unique species including pitcher plants and sundews.

Like forests, wetland size and proximity to other natural areas has a significant influence on some wildlife species and ecological functions (e.g. Detenbeck *et al.,* 1993; Gibbs 1998; Guadagnin & Maltchik, 2006). Contiguous wetland areas have been calculated and the distribution of wetland patch sizes is displayed in the graph below. While the total area of wetland represents the amount of wetland completely within the subwatershed, the number of patches also includes any patches touching the subwatershed boundary. This methodology was used to avoid underestimating the number of large patches.

### 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. Wetlands which score 600 or more total points (or 200 points in the biological or special feature components) are classified as being 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."*

There are approximately 3465 ha of wetland in the Ramara Creeks subwatershed, which is approximately 25% of the landscape (Table 6-2). These wetlands can mainly be found in the headwaters of the watercourse known as Ramara Creeks "Drain #1" in the extreme northeast of the subwatershed, and in the lower reaches and in shallow marshes along the shoreline. These include the Provincially Significant Lagoon City wetland, Barnstable Bay

Swamp, Joyland Beach Wetlands, McPhee Bay Wetlands, and the Mara City County Forest wetland, as well as the Locally Significant Glenrest Beach Wetland. The remainder of the wetlands have been identified by LSRCA in their natural heritage system mapping, but have not been evaluated under the provincial system (Figure 6-4).

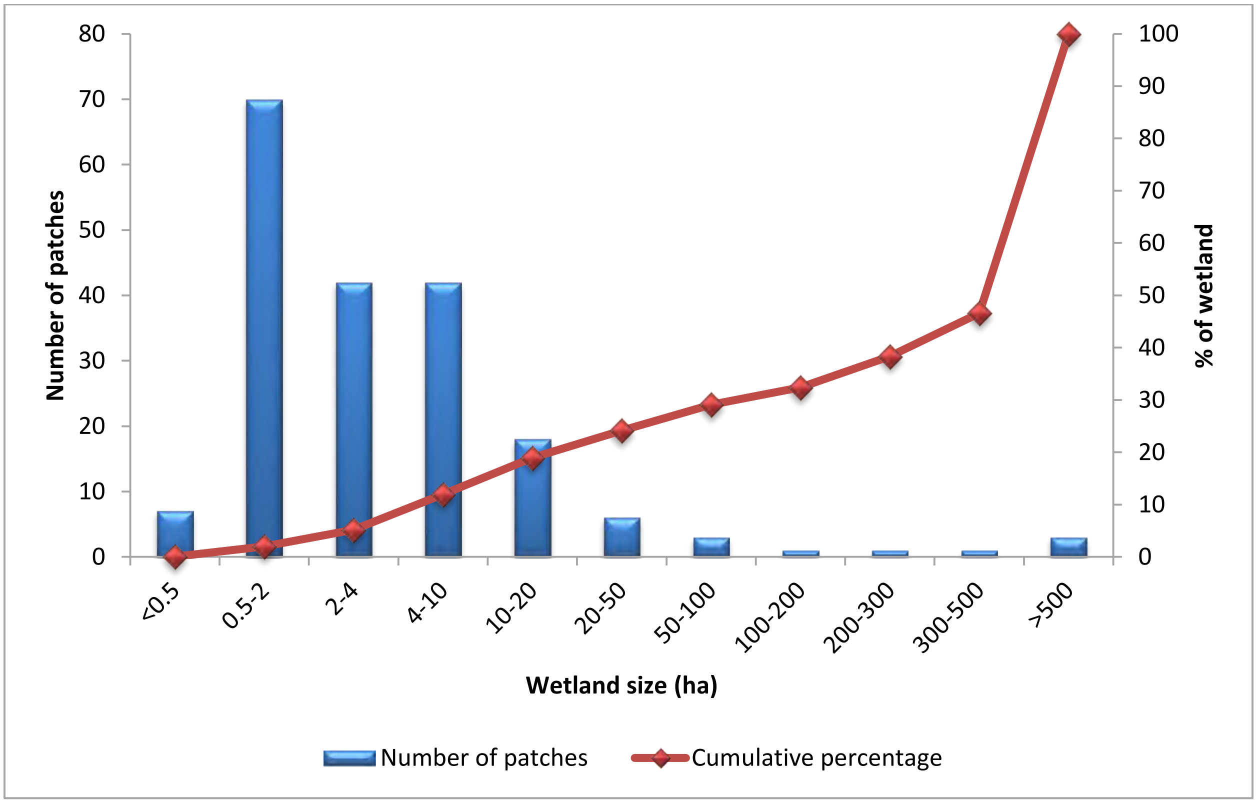



**Figure 6-5 Wetland patch size distribution in the Ramara Creeks subwatershed**

Again, like woodlands, the physical connections between individual wetland patches are extremely important for some species. In the case of wetlands specifically, many species of turtles, frogs, and salamanders require both upland and wetland habitat to meet the needs of their breeding cycle. Preserving these species in a rural-urban landscape like that of the Ramara Creeks subwatershed requires both habitat types, as well as physical connectivity between them, be protected.

### *6.2.3 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.

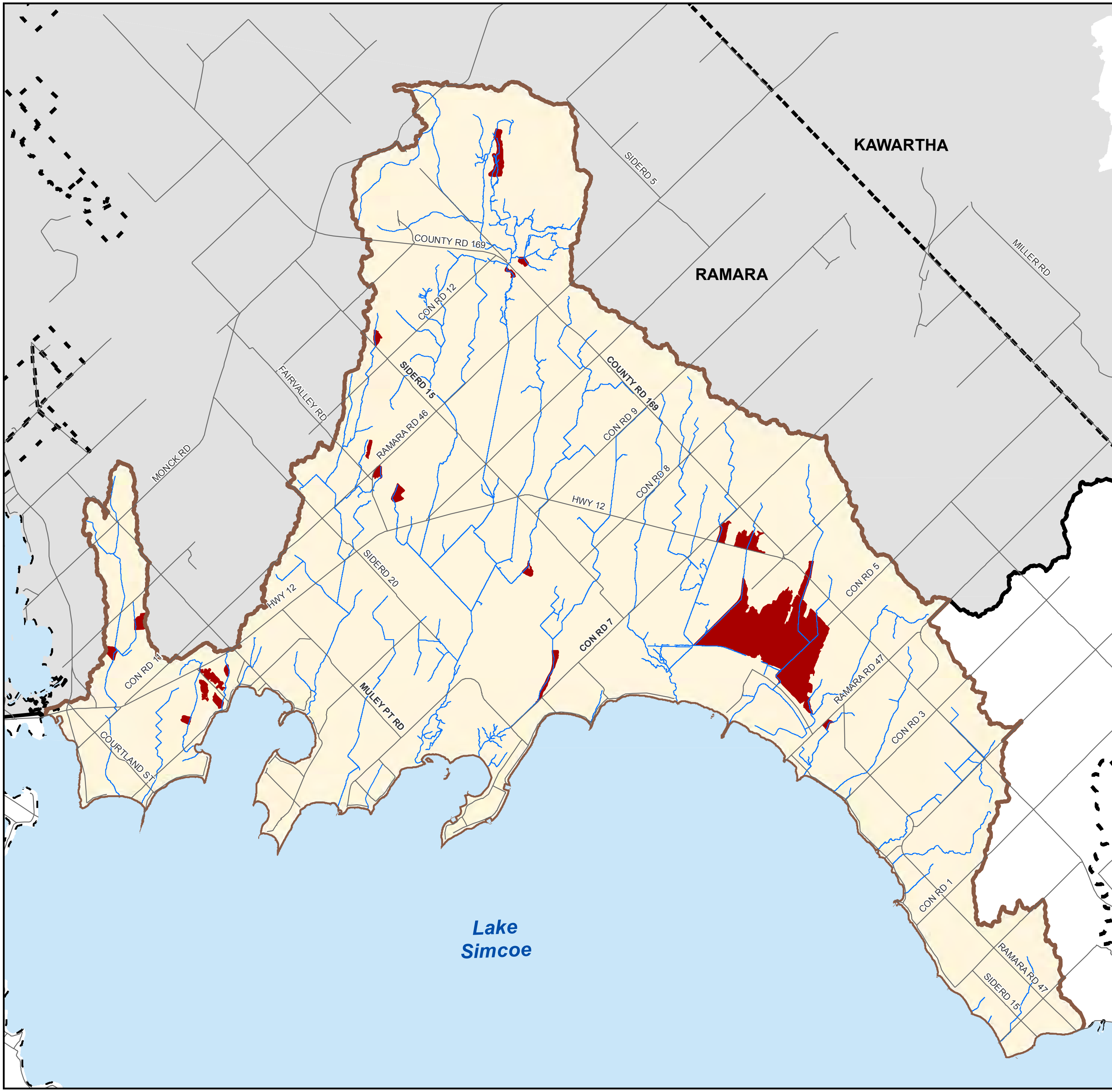
Valleylands provide numerous functions for an ecosystem. These include (OMNR, 2010):

- **Ecological Values:** dispersal and migration of wildlife, microclimate for plant communities
- **Hydrological Values:** movement of surface water, groundwater discharge areas, transport of sediment and nutrients, often associated with floodplains
- **Cultural values:** location of aboriginal travel routes, influence current development patterns

In the Ramara Creeks subwatershed, approximately 350 ha of the land area has been identified as valleyland. The largest patch of this is found in the mid-lower reaches along the Murray and Harrington drains, and there is a larger patch found in the headwaters in the Mara County forest. The remaining valleyland area consists of small patches spread throughout the subwatershed (Figure 6-6).

**Valleylands in the Ramara Creeks subwatershed**

Figure 6-7




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed
- Valleyland

Lake Simcoe Region conservation authority

0 0.5 1 2 3 Kilometres

### 6.2.4 Riparian and shoreline habitat

The term riparian refers to the area of land adjacent to a stream, river, or lake. These areas provide important fish and wildlife habitats, such as natural linkages among different habitat features that create critically important wildlife migration corridors (Environment Canada, 2013).

Riparian vegetation contributes to ecological function within a watershed in a number of ways:

- The flow of stormwater is slowed, causing sediment to be deposited on land rather than in the river or stream
- The slower moving stormwater has increased opportunity for infiltration into the groundwater, replenishing aquifers and helping to maintain baseflow
- The roots of the plants absorb some of the contaminants contained in stormwater, preventing them from reaching the waterway
- Erosion of the streambank is prevented, as the roots help to keep the soil in place
- Vegetation provides shade, helping to maintain cool stream temperatures
- Falling debris (branches, leaves) from the riparian vegetation provide food and shelter for benthic invertebrates and fish
- The linear nature of these features are extremely important to migrating birds and other terrestrial wildlife travelling throughout the watershed
- The seasonal flooding of most riparian areas provides habitat to specialized plant communities that may not be found elsewhere in the watershed

The Lake Simcoe Integrated Watershed Management Plan (LSRCA, 2008) aspires to have all streams within the watershed naturally vegetated, with a 30 metre buffer containing natural vegetation on either side of the watercourse. Although the Lake Simcoe Protection Plan does not specify a quantitative target, it sets a target of "naturalized riparian areas on Lake Simcoe and along streams," referring to a minimum to a 30 m width along watercourses and the Lake Simcoe shoreline. In its '*How Much Habitat is Enough'* (2013) document, Environment sets a guideline of 75% natural vegetation within a 30 metre buffer on either side of a watercourse.

The Ramara Creeks subwatershed has a relatively low level of natural cover within the 30 m riparian buffer along its watercourses, with 53.5% of this area occupied by natural heritage features (Table 6-3, Figure 6-8). This is followed by rural land uses, which occupy 43% of the land. At this distance, urban land uses occupy only 2% of the buffer. The level of natural cover decreases with increasing distance from the watercourses, and the level of agriculture increases. The proportion of agriculture cover begins to exceed that of natural heritage at a distance of 120 metres from the watercourse, and occupies close to 10% more of the riparian area than natural heritage features at a distance of 200 metres (Figure 6-7). Aggregate operations, golf courses, roads, and railways occupy a very small proportion of the riparian area; these are not shown in Figure 6-7.

It may be difficult to achieve a 30 metre vegetated buffer in some parts of the subwatershed, particularly in the agricultural areas. For some, it can mean taking large swaths of land out of production; causing a significant impact on the livelihood of the farmers managing the land. Maintaining a buffer of this size can also make it difficult to maneuver machinery around smaller pieces of property. It is important in these circumstances to recognize the importance of maintaining as wide a vegetated buffer as possible, on one or both sides of the watercourse, both for the health of the stream and to prevent the loss of farm land and soils through erosion. A balance between these competing demands should be sought wherever possible.

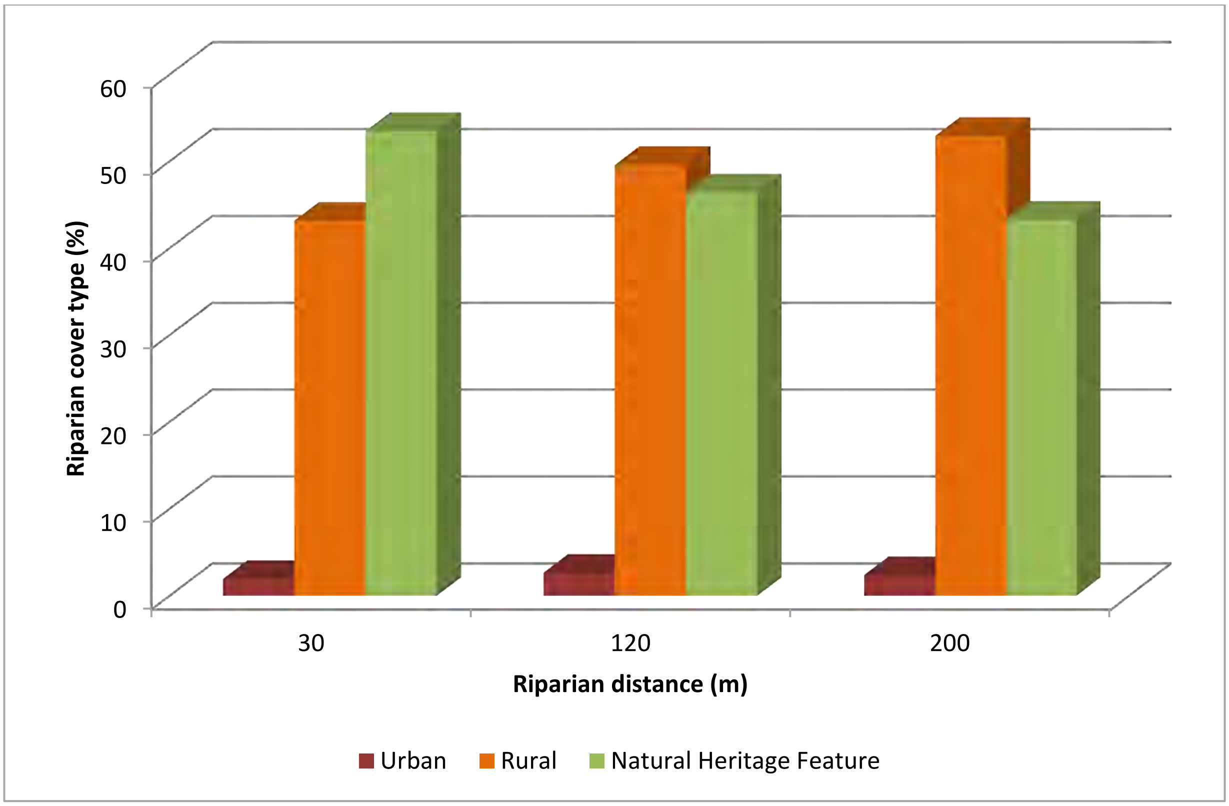
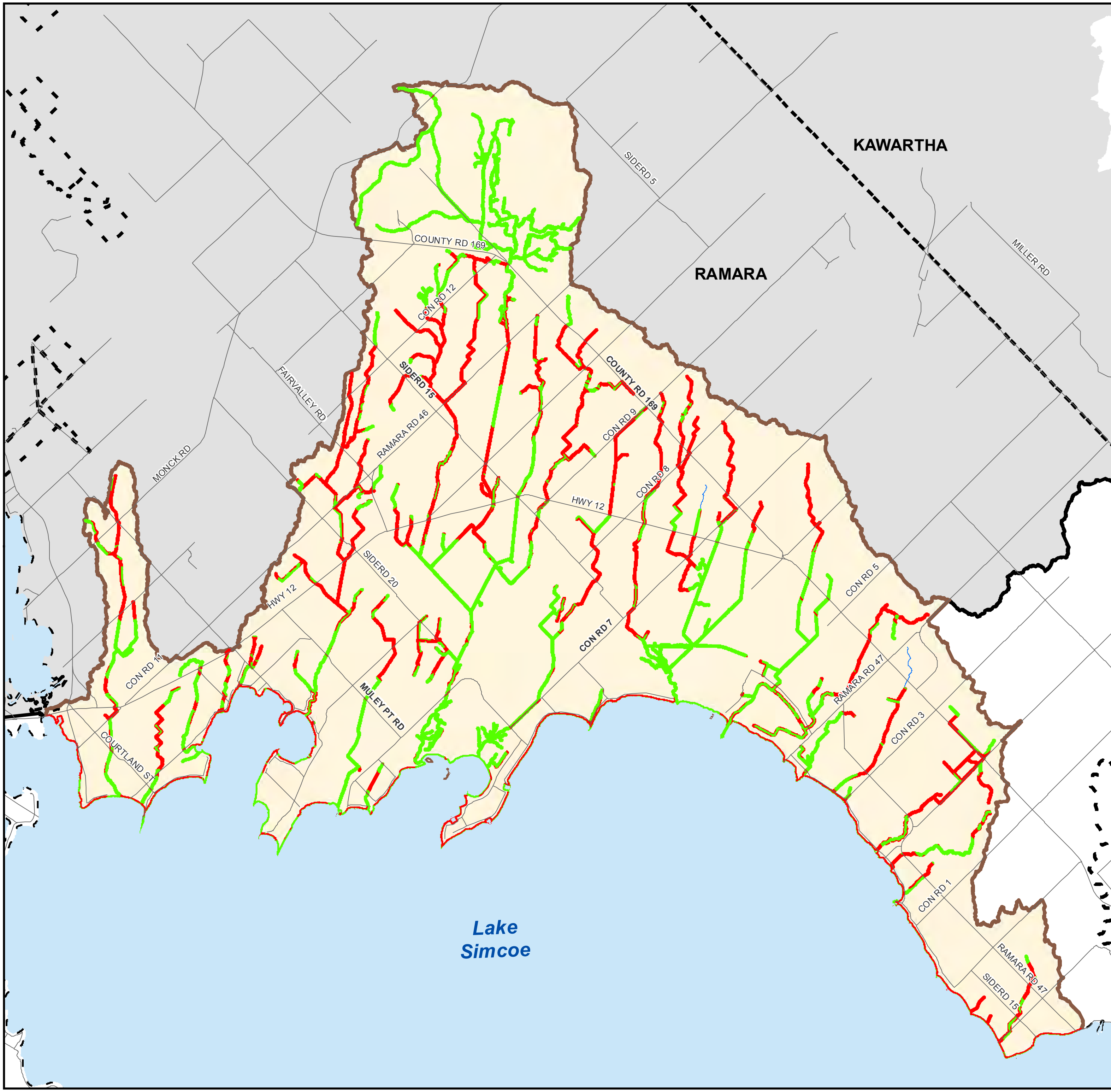



**Figure 6-7: Riparian cover percentage per buffer distance for Ramara Creeks**

# Riparian and shoreline habitat in the Ramara Creeks subwatershed

Figure 6-8




## Legend

- Road
- Municipal Boundary
- Watercourse
- Subwatershed

Riparian

- Meets riparian target
- Does not meet riparian target

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

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 dc created July 2012.

Although neither the Lake Simcoe Protection Plan nor the Lake Simcoe Integrated Watershed Management Plan identify a quantitative target for natural cover along the Lake Simcoe shoreline, the LSPP identifies "no further loss of natural shorelines" as a management target. The shoreline of the subwatershed has experienced heavy development pressures and shoreline manipulation; with only 21.5% of the shoreline in a naturally vegetated state.

**Table 6-3 Extent of natural vegetation along riparian areas in the Ramara Creeks subwatershed**

| | Natural vegetation in riparian zone (%) |
|---|---|
| Stream banks (30 m buffer) | 53.5 |
| Lake Simcoe shoreline | 21.5 |
| **Both** | 50.3 |

### *6.2.5 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 and Forestry 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 MNRF to define ANSIs are:

1. Representation;
2. Diversity;
3. Condition;
4. Ecological function; and
5. Special features.

Candidate sites of each of a list of landform types within each ecodistrict are evaluated and ranked using the criteria above. Those scoring the highest are deemed to be the 'best' example of that landform type in that ecodistrict, and are classified as a Provincially Significant ANSI, and are protected under the Provincial Policy Statement. Candidates with the second highest score are identified as a Regionally Significant ANSI, and are afforded protection in some parts of the province.

One ANSI falls within the boundaries of the Ramara Creeks subwatershed, the regionally significant McGinnis Point Life Science ANSI. This ANSI, which falls entirely within the Ramara Creeks subwatershed, has been described as a shoreline swamp with two creek outlets. Mainly silver-red maple swamp with cedar, yellow birch, cedar swamp, alder-willow dogwood thickets and cattail-bulrush marsh (Hanna, 1984). McGinnis Point is included in the Township of Ramara's Official Plan as Core/Corridor in the Natural Area framework, and it subject to fairly rigorous restrictions.  Policy 5.2.3.7 of the Official Plan states that development and/or site alteration within designated Core Areas and Corridors are not permitted except for uses such as passive recreation and permitted agricultural activities; infrastructure such as water supply, waste water treatment, stormwater management, roads, and railways; and facilities for the preservation and conservation of natural areas.

**Table 6-4 ANSIs found in the Ramara Creeks subwatershed**

| ANSI Name | Significance Level | Status | Life Science/ Earth Science | Total Area (ha) |
|---|---|---|---|---|
| McGinnis Point | Regional | Confirmed | Life | 280.7 |

### *6.2.6 Species of conservation concern*

The frequency of occurrence of all native species of plants, mammals, birds, amphibians, reptiles, and fish in Ontario have been documented by the Ministry of Natural Resources and Forestry using a series of S-ranks (or Sub-national ranks).  Those designated as being provincially rare (i.e. ranked S1-S3) are those which are typically considered as being of 'conservation concern.'  Other species may be further protected by designation as being Endangered, Threatened, or of Special Concern under the Federal *Species at Risk* Act or Provincial *Endangered Species Act*.

Species of conservation concern thought to be found in the Ramara Creeks subwatershed include:

- Blanding's Turtle (*Emydoidea blandingii*; S3; Threatened), which live in shallow water, usually in large wetlands;
- Snapping turtles (*Chelydra serpentina*; S3; Special Concern), which inhabit large wetlands;
- Black tern (*Chlidonias niger*; S3B, Special Concern), which build floating nests in loose colonies in shallow marshes;
- Bobolink (*Dolichonyx oryzivorus*, Threatened), which nest in hayfields and other grasslands;
- Golden-winged warbler (*Vermivora chrysoptera;* S4; Special Concern), which nest in areas with young shrubs surrounded by mature forest, or recently disturbed areas;
- Whip-poor-will (*Caprimulgus vociferus*; S4B; Threatened), usually found in areas with a mix of open and forested areas.
- Canada warbler (*Wilsonia canadensis*; Special Concern. Possible sighting noted in 2$^{nd}$ Breeding Bird Atlas). This species resides in moist thickets, nesting in riparian thickets or brushy ravines.

### 6.2.7 Grasslands

In addition to these rare and at-risk species, there are also rare ecosystems. There are a few documented remnants of pre-settlement tallgrass prairie ecosystems in the Lake Simcoe watershed. These small relict ecosystems are dominated by big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium*). Historic records provide a more detailed plant list of these remnants, including 17 plant species which are rare in the Lake Simcoe watershed (Reznicek, 1983).

Even grasslands dominated by non-native plants (i.e. hayfields or old-field ecosystems) can be home to a number of at-risk species including monarch butterflies, bobolinks, and eastern meadowlark (*Sturnella magna*; recommended by COSEWIC, not yet listed). In fact, grassland-dependent wildlife are experiencing significant population declines in Ontario (McCracken, 2005). There are scattered grasslands throughout the subwatershed, primarily on the margins of woodlands, swamps, and agricultural areas; these areas comprise close to 6% of the subwatershed area. Some of the largest patches can be found in the southern portion of the subwatershed, interspersed with agricultural areas (Figure 6-1,Table 6-5).

**Table 6-5 Distribution of grassland types in the Ramara Creeks subwatershed**

| Grassland type | Grassland Cover | |
|---|---|---|
| | Area (ha) | Area (%) |
| Cultural meadow (CUM) | 309.0 | 2.2 |
| Cultural thicket (CUT) | 493.5 | 3.6 |
| **Total** | **802.5** | **5.8** |

***Key Points - Current Terrestrial Natural Heritage Status:***

- The Ramara Creeks subwatershed contains 41.1% natural heritage cover, with 25.2% wetland, 9.6% upland forest, and 5.8% grassland. This subwatershed is somewhat lacking with respect to riparian buffers, with only 53.5% of the area within a 30m buffer along its watercourses consisting of natural heritage cover. Environment Canada recommends that 75% of this area be in natural cover (EC, 2013).
- There is a wide range of forest patch sizes, with a number of patches containing forest interior habitat, which supports a number of sensitive bird species. There are six of these patches that are over 50 ha in size. In addition, there are also several patches of deep forest interior, which is the core forest found greater than 200 m from the forest edge.
- There is also a wide range of wetland patch sizes. The majority of the patches are smaller than 20 ha in size. Seventy percent of the wetland area is contained within a six wetland patches that are over 100 ha in size.
- Several Species of Conservation Concern are also thought to be found in this subwatershed. There have been confirmed sightings of Blanding's turtle and snapping turtle, as well as probable sightings of black tern, bobolink, golden-winged warbler, and whip-poor-will.
- The natural heritage component of the assessments of the Ramara Creeks subwatershed is relatively data-poor, particularly as it relates to the distribution of flora and fauna throughout the subwatershed.
- The Lake Simcoe Protection Plan allows for uneven distribution of natural heritage features (associated with the uneven distribution of people) throughout the Lake Simcoe watershed, by setting natural heritage targets for the Lake Simcoe watershed as a whole.

## 6.3 Factors Impacting Natural Heritage Status – Stressors

There are numerous factors that can affect terrestrial natural heritage features. They range from natural factors such as floods, fires, and droughts; to human influences, such as land use conversion, 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 cannot regenerate after it has been urbanized, 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.

### *6.3.1 Land use change*

Prior to European settlement, the Ramara Creeks subwatershed was almost entirely covered by upland and wetland forest (Larson *et al.,* 1999; DUC, 2010). The loss of natural habitat and its conversion to agriculture and urban land use began almost immediately upon European settlement, and has been ongoing. This habitat conversion represents the most significant threat to terrestrial natural heritage features in this subwatershed.

While the loss of natural areas has not been as extensive in the study area as in other areas of the Lake Simcoe watershed, there has been a significant loss of natural features. Natural habitat remains just over 40% of the Ramara Creeks subwatershed, with the majority of the rest of the subwatershed being converted to agricultural and urban land uses (Figure 2-2).

Natural heritage features within settlement areas are those most susceptible to land use change, as these areas are experiencing the greatest relative growth pressure, and as these areas aren't subject to the higher level of protection provided by policies under the Lake Simcoe Protection Plan. Ecosystem types that are under this type of pressure include deciduous and mixed forests.

Notwithstanding the above, the greatest change expected in this subwatershed will be a shift from existing agricultural land uses to more intensive land uses including residential, commercial, and industrial. Thus, the greatest impacts to natural heritage features may be indirect in nature, through changes to the landscape matrix within which extant natural heritage features are situated.

Forests in urban settings are subject to stresses that forests in more rural or agricultural settings aren't, including an increase in predator pressure from house cats and racoons, increased noise levels, increased levels of ground level ozone, and an increased density of invasive non-native species. As a result, forest-dwelling songbirds and amphibians living in primarily urban landscapes tend to be much less common, and restricted from smaller forests, than those living in primarily rural landscapes (Austen *et al*., 2001; Homan *et al.,* 2004).

Similarly, wetland-dependent wildlife face additional challenges in primarily urban landscapes. As natural areas are converted to farmland, amphibians make increasing use of irrigation ponds as replacement breeding habitat for lost wetlands, making these critical wildlife habitat in some regions (Hecnar and M'Closkey, 1998). As landscapes convert to urban land uses, amphibians make similar shifts to stormwater ponds. However, stormwater ponds in many cases can be detrimental to amphibian populations, particularly if they are hypoxic, are surrounded by unsuitable upland habitat, are located near roads, or have high concentrations of petrochemicals. In those cases, stormwater ponds can act to suppress amphibian populations beyond the suppression caused by wetland habitat loss alone (Hamer and McDonnell, 2008).

Under the Provincial Growth Plan for the Greater Golden Horseshoe (OMPIR, 2006), the Township of Ramara is slated to have some additional growth, although it is not designated as a 'growth centre' under the plan. They have been designated to receive an increase in population of 3,725 people (40%) by 2031. The estimated urban growth area is approximately 764 ha (Louis Berger Group, 2010), which would result in an increase of the urban area to close to 11% of the subwatershed area. As this development proceeds, there will likely be stresses associated with the loss and fragmentation of natural habitat.

### *6.3.2 Habitat fragmentation*

The conversion of natural vegetation to other land uses is perhaps the most obvious stress related to land use change, but the perforation or fragmentation of extant natural vegetation can be a significant stress as well. One issue of particular concern in urban or suburban areas is the encroachment of estate residential development into forests, and the related decline in forest interior conditions. In some parts of North America, exurban development (also known as estate residential development, or non-farm rural land use) is becoming a significant proportion of all development. Many people prefer to locate their houses in or near natural heritage features for the aesthetic appeal, the privacy, and the access to outdoor recreational opportunities. As demonstrated in Figure 6-9, this type of development not only reduces the amount of habitat on the landscape, but can have disproportionate effects on interior forest habitat (i.e. that area more than 100 m from a forest edge).

Based upon studies of birds and mammals, it has been found that this type of development increases habitat that supports human-adapted species at the expense of more sensitive species (Odell and Knight, 2001). Findings by Friesen (1998) found that that the number of houses surrounding a forest undermined its suitability for Neotropical migrants. These species consistently decreased in diversity and abundance as the level of adjacent development increased. Similarly, non-native vegetation is much more common in woodlots near exurban development than in woodlots in more rural or forested landscapes (Hansen *et al.,* 2005).


**Figure 6-9 Example of loss of forest interior resulting from estate residential development**

In the Lake Simcoe watershed as a whole, this type of development has a significant impact on interior forest habitat, with an estimated loss of about 8% of this highly productive wildlife habitat to estate residential development (LSRCA, 2008). These impacts are much less pronounced in the Ramara Creeks though, with estate residential occupying only 0.3% of the subwatershed area.

#### *6.3.3 Shoreline development*

The Lake Simcoe shoreline has long been a draw for cottage and housing development, but this type of development has impacts on native species and habitats as well. The impacts of shoreline development on fish and aquatic habitats (as described in **Chapter 5 – Aquatic Natural Heritage**) is perhaps best documented, but the clearing of vegetation along shorelines has also been associated with a decline in native songbirds (Clark *et al.,* 1984; Henning and Remsburg 2009), amphibians (Henning and Remsburg 2009), and small mammals (Racey and Euler, 1982), and an increase in non-native species.

The lakeshore has been subject to significant urban development. Currently, only 21.5% of the shoreline in the Ramara Creeks subwatershed remains under natural cover. Much of the shoreline area that has been changed from natural cover is defined as urban, with small lakeshore communities such as Lagoon City, Bayshore Village, and Atherley, as well as a narrow band of houses being built along the lakeshore outside of these communities. There are also some areas of agriculture, rural development, and manicured parklands.

#### *6.3.4 Road development*

In addition to the loss and fragmentation of habitat associated with land use change, the development and use of roads can have impacts on natural heritage values as well. Roads can have significant impacts on wildlife communities and the ability of wildlife to move throughout their home ranges. Direct mortality of animals related to roads can be particularly significant for species such as frogs, turtles, and salamanders, which are relatively slow moving but need to travel from wetland to upland areas to fulfil the requirements of their breeding cycle (Fahrig and Rytwinski, 2009). Snapping turtles and associated issues with road mortality have been noted in the subwatershed (D. Stephen, pers. comm., May 22, 2014). Even more mobile animals such as mammals (Findlay and Houlahan, 1997) and birds (Kociolek *et al.,* 2011) can be subject to increased mortality along roads. In addition to the direct impacts associated with mortality, roads can decrease the value of adjacent natural areas as breeding habitat, by increasing noise levels and increasing illumination at night (Kociolek *et al.,* 2011), and by acting as a source of chloride or petrochemicals to amphibian breeding ponds (Fahrig and Rytwinski, 2009). Conversely of course, some scavenger species such as American crows and red-tailed hawks respond positively to the presence of roads, as roads provide a consistent food source for them.

Research in the United States and Europe suggests that this 'road effect zone' can extend for hundreds of metres from roads (Forman and Deblinger, 2000), suggesting that many of the natural heritage features in the study area may be exhibiting these types of impacts, although there are many large tracts of natural features that will not likely be showing impacts yet. If these effects are not considered, development in the subwatershed will increase the number of natural areas vulnerable to these effects.

### *6.3.5 Changes to hydrologic regime*

Although the current status of, and stressors on, surface water hydrology are dealt with more fully in **Chapter 4 – Water Quantity**, changes to the hydrological regime in the subwatershed can have impacts on the extent and quality of natural heritage features as well, particularly wetland and riparian ecosystems. These ecosystems 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 or changes in the condition of these ecosystem types. Factors leading to changes in hydrologic regime include loss of upland and wetland natural heritage features, and their conversion to impervious cover. This relationship is discussed more fully in Chapter 4.

Perhaps less obvious, but also important from a natural heritage standpoint, is the introduction of agricultural drains, particularly in remnant natural heritage features. When agricultural drains are introduced to swamps or mesic forests, the water table drops. This lowering of the water table changes the infiltration rate of surface water; in some cases, enough to change the hydroperiod of vernal pools. These small shallow and temporary water bodies are critical breeding habitat for a range of frog and salamander species, as well as stopover habitat for migratory waterfowl. In some areas, the lowering of the water table caused by agricultural drains causes the vernal pools to dry up more quickly, exposing the eggs and tadpoles.

As soil moisture is a major determining factor for the presence or absence of many plant species, lowering the water table can also have significant impacts on plant communities in remnant natural areas. Further, in areas of residential development, many of the plants which colonize rapidly changing areas such as this are non-natives.

There are a number of areas in the subwatershed where municipal drains pass through wetlands, including several provincially and locally significant wetlands near the lake shore, including the Lagoon City provincially significant wetland (PSW), the Barnstable Bay Swamp PSW, and the Joyland Beach PSW. The presence of the drains could potentially impact the health and quality of these and other wetland areas in this subwatershed.

### *6.3.6 Invasive species*

Non-native species can be a significant threat to biodiversity as well. Some species, when in the absence of predators or disease to check the growth of their populations, can become extremely abundant. This is particularly the case with species which aren't native to North America. Many of these species, when introduced as a garden plant or house pets, or inadvertently through international shipping, can become extremely aggressive invasives. The most aggressive of these can reduce biodiversity by outcompeting native species for resources such as food (e.g. red-eared slider), breeding habitat (e.g. house sparrow), sunlight (e.g. dog-strangling vine), or through direct consumption (e.g. emerald ash borer).

Little is known about which terrestrial invasive species are present in the Ramara Creeks subwatershed; however this is no doubt reflective more of a lack of documentation, than a lack of invasive species. The Lake Simcoe Protection Plan recommends the development and implementation of a monitoring program which will document the presence and extent of terrestrial invasive species in the Lake Simcoe watershed. This monitoring program has the potential to make significant contributions to filling this data gap.

The Lake Simcoe Protection Plan has also developed a 'watch list' of invasive species which are not yet in the Lake Simcoe watershed, but which, if they do appear here, are expected to have significant negative impacts on natural areas. Terrestrial species on that list are: kudzu (*Pueraria lobata*), emerald ash borer (*Agrilus planipennis*), Asian long-horned beetle (*Anoplophora glabripennis*), chronic wasting disease (which affects deer), oak wilt, and white nose syndrome (which affects bat populations).

Within five years of the release of the LSPP (i.e. 2014), the MNRF is to develop response plans to address invasive species in the watershed, and those on the watch list.

**Figure 6-10: Invasive species on Lake Simcoe Protection Plan 'watch list' – emerald ash borer (top left, photo: CFIA website, David Cappaert, Michigan State University); Asian long-horned beetle (centre-right, photo: David Copplefield, Ontario's Invading Species Awareness Program); Kudzu (bottom, photo: Sam Brinker, MNR)**

### *6.3.7 Trophic cascades*

Land use changes can not only affect wildlife populations directly through the loss or disturbance of habitat, they can also be affected indirectly as significant decreases or increases in populations of one species affect species elsewhere in the food web, through processes known as “trophic cascades.”

An example of such a trophic cascade is the decrease in songbirds that has been observed as top carnivore populations decrease (Crooks and Soulé, 1999). This trophic cascade occurred because the loss of top predators (in that case coyotes), allowed populations of mid-level predators such as housecats, skunks, and racoons to increase. Although these species aren’t at the top of the food chain, they are extremely effective predators, so an increase in their populations led to a significant decline in the populations of their prey (in that case, songbirds). Similar trophic cascades have been observed in wildflowers, nesting songbirds, butterflies, and other invertebrates, by high levels of selective grazing of woodland vegetation as populations of white-tailed deer increase (Cote *et al.,* 2004).

A similar trophic cascade that has recently come to light in Ontario is the decline of songbirds that feed on flying insects. This group, which includes species as diverse as swifts, swallows, nighthawks and flycatchers, has seen population declines of up to 70% in the past two decades. Although there are a lot of stresses facing these species, the only attribute they share that best explains their concurrent decline is their reliance on flying insects such as bees, wasps, butterflies, and moths as a food source. There are a number of factors contributing to the decline of these insects, including light pollution, loss of wetlands and other natural vegetation, declines in water quality, climate change, and increased use of insecticides in urban and rural settings (McCracken, 2008).

### *6.3.8 Recreation*

Despite the social values related to outdoor recreation, if not properly managed, recreation itself can become a stressor on natural heritage features. Impacts from recreational activities can include increased soil erosion (e.g. Marion and Cole, 1996), destruction of vegetation (Cole, 1995), introduction of invasive species (Potito and Beatty, 2005), and disturbance to resident wildlife (Miller *et al.,* 1998). These impacts can be largely mitigated with the appropriate design and location of trails and other recreational features, and the management of recreational users, to ensure that motorized vehicles and off-leash dogs are prohibited from sensitive sites.

While development in this subwatershed will be limited compared to other areas of the watershed, these types of impacts will no doubt increase, as the combination of larger populations in this and the surrounding areas and small lot sizes will tend to increase the numbers of people looking for opportunities for outdoor recreation. Further, as development proceeds, accessible upland natural areas may become even rarer, concentrating this pressure into increasingly rare remnant habitats. As a result, as development proceeds, the need to manage the impacts associated with outdoor recreation will only intensify.

### *6.3.9 Climate change*

Projections suggest that climate change will have significant impacts on terrestrial natural heritage features in the Lake Simcoe watershed. Recent modeling work was completed for the Lake Simcoe watershed, examining the response of tree species to climate change, as influenced through factors such as the current range of the species, its current local abundance, phenology, and seed production (Puric-Mladenovic *et al.,* 2011). As climates change, the model predicts that balsam fir (*Abies balsamea*), yellow birch (*Betula alleghaniensis*), paper birch (*Betula papyrifera*), American beech (*Fagus grandifolia*), and eastern hemlock (*Tsuga canadensis*) will all exhibit slight decreases in their occurrence in the forests of the Ramara Creeks subwatershed. In fact, the projected shifts in climate may cause some species which are currently relatively widely distributed to become more narrowly restricted to remaining habitat, including red maple becoming restricted to wetlands, as they shift to areas with moister soil, and yellow birch becoming restricted to ravines, as they shift to areas with cooler and moister microclimate. Other species, notably red oak (*Quercus rubra*), are anticipated to become more common as a result of the warming climate.

Modeling results suggest that forests in cooler microclimates in ravines and north facing slopes, which tend to have a relatively high dominance of eastern hemlock, yellow birch, and American beech, may be among the most sensitive ecosystem to the changing climate. Sadly though, the species which the model suggests are the most vulnerable to climate change are those which we think of as being prototypically Canadian. Both sugar maple (*Acer saccharum*) (Canada's national symbol), and white pine (*Pinus strobus*) (Ontario's provincial tree) are predicted to experience severe declines in the Ramara Creeks subwatershed (Puric-Mladenovic *et al.,* 2011).

A separate set of models, developed to assess the vulnerability of wetland ecosystems, suggest that a 'worst case' climate change scenario would have catastrophic impacts on wetlands in the Lake Simcoe watershed. The increases in average annual temperature and decreases in average annual precipitation projected to occur by the year 2100 is estimated to make 90% of the swamps and 84% of the marshes in the Lake Simcoe watershed vulnerable to drying. As drying occurs, it is expected that marshes would shift in composition to become swamp (or thicket swamp) type communities, and treed swamps would shift to become mesic forests. These same models suggest that the wetlands in the study area are quite vulnerable to these changes, due to the changes in groundwater discharge combined with changes in air temperature and precipitation (Chu, 2011).

In sum, these models suggest that there will be a shift in community composition in the natural areas in the Ramara Creeks subwatershed, and a net loss of tree species diversity; although the relatively high levels of natural cover in this subwatershed may to provide refugia for some species. Unfortunately, natural areas lacking in biodiversity tend to be more vulnerable to other threats such as insects, disease, and invasive species, suggesting that the impacts seen to terrestrial natural heritage features may become cumulative in nature.

This loss in native tree species diversity may be mitigated somewhat by the ability of species not currently found here to thrive in the expected new climate. Species found in southern Ontario (such as black maple [*Acer nigrum]*) or the southeastern US (such as black hickory

[*Carya texana*]) may become relatively common in forests in this subwatershed, further influencing the shift in plant community composition. However, the fragmented nature of the landscape that these species would need to cross will no doubt limit their ability to colonize forest remnants, without assisted migration (i.e. planting) (Puric-Mladenovic *et al.,* 2011).

Other, less desirable, species may also be able to respond positively to changing climates as well. Some invasive species are projected to experience a northward range expansion (e.g. Kudzu [*Pueraria lobata*], an extremely invasive vine), or experience increased growth rates and biomass (e.g. Eurasian water milfoil [*Myriophyllum spicatum*], a widespread invasive aquatic plant) (Sager and Hicks, 2011).

The predicted impacts of climate change on wildlife are less clear. Some authors (e.g. Walpole and Bowman, 2011) suggest that as average annual temperature increases, more species of both birds and mammals will be able to inhabit the Lake Simcoe watershed. Others caution that, for some species, the disadvantages of climate change may outweigh the advantages. For example, wetland-dependent species may suffer significant population declines as wetlands dry up (Chu, 2011). Similarly, although some migratory birds have been able to take advantage of warmer springs and are migrating earlier, other species appear less able to adapt their behaviour to changing temperature and are vulnerable to not being able to find sufficient food resources or suitable nesting sites later in the season (Burke *et al.,* 2011). These relationships may be even more complicated in this subwatershed however, as the interacting effects of climate change, landscape fragmentation, and urbanization may constrain the ability of wildlife to colonize habitat areas, and to persist within them.

***Key Points – Factors Impacting Terrestrial Natural Heritage - stressors***

- There are multiple stressors to natural heritage systems in the Ramara Creeks subwatershed, many of which interact.
- Over the short term, the greatest impact to natural heritage features is expected to be due to changes in land use. These impacts can only be expected to increase as the population in this subwatershed increases.
- In addition to the direct loss of natural areas, development is typically associated with an increase in roads (which can cause mortality in wildlife and disturbance to remaining nearby natural areas), an increase in impervious surfaces (which can affect the hydrology of remnant natural areas), and the loss of natural habitat along shoreline and other riparian areas (which tend to be disproportionately important to wildlife).
- Remnant natural areas in settled landscapes typically face more intense stresses as well, including an increase in the number and diversity of invasive species, increased pressure from recreational users, and trophic cascades caused by changes in food webs and other inter-species relationships.
- The emerging threat of climate change will interact with all of these threats, creating additive long-term stresses on natural areas and wildlife populations. Although research in this area is still emerging, initial predictions suggest a loss of wetlands and wetland-dependent species, and a loss of some of our most-loved species of native trees.

## 6.4 Current Management Framework

Various programs exist to protect and restore terrestrial natural heritage features in the Lake Simcoe watershed, ranging from regulatory mechanisms, to education programs, to funding and technical support provided to private landowners.

Many of these programs already address some of the stresses facing terrestrial natural heritage in the Ramara Creeks subwatershed, as outlined below.

### *6.4.1 Protection and policy*

#### 6.4.1.1 Land use planning and policy

Several acts, regulations, policies, and plans have shaped the identification and protection of the terrestrial natural heritage of the Ramara Creeks subwatershed. Those having most impact on natural heritage features are summarized in Table 6-6. This management framework relates to many different stressors that can potentially affect natural heritage, ranging from direct impacts associated with habitat loss and urban development, to stresses such as climate change and invasive species which are more global in nature.

Table 6-6 categorizes 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 the various Acts, policies, and plans on the stressors is categorized as ‘existing policies in place’, or ‘no applicable policies’. The policies included in the table include those which have legal standing and must be conformed to, or policies (such as some of those under the Lake Simcoe Protection Plan) which call for the development of further management tools, research or education programs.

The intent of these regulations, policies and plans are summarized in **Section 1.3 – Current Management Framework**. Readers interested in the details of these regulations, policies and plans are directed to read the original documents.

**Table 6-6 Summary of the current management framework as it relates to the protection of terrestrial natural heritage**

| Stressor affecting the protection and restoration of terrestrial natural heritage | 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) | Simcoe County Official Plan (2007) | Township of Ramara Official Plan (2003) |
|---|---|---|---|---|---|---|---|
| Site alteration in upland natural heritage features | Existing policies in place: 1,4 | No applicable policies | Existing policies in place | Existing policies in place: 6 | Existing policies in place | Existing policies in place: 2,4 | Existing policies in place: 4, 5 |
| Site alteration in wetlands | Existing policies in place: 1,4 | No applicable policies | Existing policies in place | Existing policies in place: 6 | Existing policies in place: 4 | Existing policies in place: 4 | Existing policies in place: 4 |
| Shoreline development | Existing policies in place: 4 | No applicable policies | Existing policies in place | Existing policies in place: 6 | Existing policies in place | Existing policies in place | Existing policies in place: 9 |
| Loss of connectivity between natural heritage features | Existing policies in place | No applicable policies | Existing policies in place | No applicable policies | No applicable policies | Existing policies in place | Existing policies in place: 10 |
| Impervious areas | Existing policies in place | No applicable policies | Existing policies in place | No applicable policies | Existing policies in place | No applicable policies: 7 | Existing policies in place: 11 |
| Climate change | Existing policies in place | No applicable policies | No applicable policies | No applicable policies | No applicable policies | No applicable policies | No applicable policies |
| Introduction of invasive species | Existing policies in place: 3 | No applicable policies | No applicable policies | No applicable policies | No applicable policies | No applicable policies | No applicable policies |
| Protection of species of conservation concern | Existing policies in place | No applicable policies | Existing policies in place: 8 | Existing policies in place: 6 | Existing policies in place: 8 | Existing policies in place: 6, 8 | Existing policies in place: 6,8 |

Legend: Existing policies in place (green) | No applicable policies (red)

[1] Regulations specific to those areas outside settlement areas
[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] Includes the feature plus a designated set back (or 'buffer' or 'adjacent lands')
[5] Where feature is included in Natural Area Framework
[6] Specific to Endangered and Threatened species
[7] Targets for impervious cover provided for the Oak Ridges Moraine Conservation Plan area, but not the subject area
[8] In the context of "Significant Wildlife Habitat"
[9] Contains policies related to required setbacks from shorelines, streambanks
[10] Contains policies around Corridors, but does not directly mention maintaining connectivity between natural heritage features
[11] Only policy is related to adopting guidelines for stormwater management that would include setting a maximum impervious area on individual lots, however only applies within Shoreline Residential areas

Legislation and policy restrictions are the primary source of protection for natural heritage features in the Lake Simcoe watershed, guided by the fundamental Provincial planning policies as articulated in the Provincial Policy Statement (PPS). However, some stresses are better suited to policy and regulation than others. For example, natural heritage stressors such as climate change and invasive species are hard to regulate; however, stresses associated with the loss of habitat and conversion to residential or industrial land uses are much easier to control and regulate.

Policy tools to deal with those stresses can be found in Provincial policy (such as the PPS or LSPP), municipal official plans and zoning bylaws, and Conservation Authority Regulations. Together, these documents are intended to provide protection to features that are significant both locally and provincially, while providing clarity to private landowners, and accountability to the electorate.

Further to the guidelines provided by the PPS, the LSPP identifies additional targets for the retention of natural heritage features in the Lake Simcoe watershed. Targets which would constrain development or other land use change include: ensuring no further loss of natural shorelines on Lake Simcoe, achieving protection of wetlands, and achieving naturalized riparian areas on Lake Simcoe and along streams.

Policies established under the Lake Simcoe Protection Plan will assist in achieving these targets by establishing restrictions to development or site alteration within 100 m of the Lake Simcoe shoreline (30m in already built-up areas, subject to a natural heritage evaluation), or within 30m of a key natural heritage feature (i.e. wetlands, significant woodlands, significant valleylands, or natural areas adjacent to Lake Simcoe), with natural heritage evaluations necessary for development proposed within 120 m of the feature.

Draft definitions of Key Natural Heritage Features protected by the LSPP include all areas that meet the definition of wetland provided by either the Ontario Wetland Evaluation System or the Ecological Land Classification manual, all woodlands larger than 10 ha in size (or larger than four ha in size if they contain late successional tree species more than 100 years old, or are near other Key Natural Heritage Features) and all valleylands that meet specific dimensional requirements.

The Township of Ramara Official Plan contains a number of Natural Area Policies, aimed at the preservation of the municipality's natural areas. In the Natural Area framework classifies significant natural features and functions into two levels:

- **Core Areas and Corridors**, which are natural areas of provincial, regional, and local significance, in which development is strongly discouraged aside from a few permitted activities. These areas include provincially significant wetlands, significant habitat of endangered and threatened species, significant woodland cores and corridors, and fish habitat
- **Supportive and Complementary Areas and Corridors**, which are natural areas of regional and local significance and other areas in County Greenlands, and are subject to a less stringent policy regime. These areas include significant valleylands, environmentally sensitive areas, significant wetlands, significant woodlands, significant

wildlife habitat, significant Areas of Natural and Scientific Interest, and regionally and locally significant natural areas features and functions (e.g. headwaters, recharge and discharge areas, watercourses)

Few uses are permitted in the Core Areas and Corridors, as well as in their adjacent areas. A number of uses are permitted in the Supportive and Complementary Areas and Corridors, but these are quite limited. Any development and/or site alteration proposed within any of these areas by an amendment to the plan or zoning by-law may be considered with the preparation of an Environmental Impact Statement, if it can be demonstrated that there will be no negative impact on the Natural Areas features and functions. In addition, the Official Plan contains policies to prevent development and/or site alteration in or near dynamic beaches on the lake as well as within floodplain areas, which should prevent the removal of riparian vegetation.

The LSRCA is assisting municipalities in identifying natural heritage systems for inclusion in Official Plans with their *Natural Heritage System for the Lake Simcoe Watershed* (Beacon and LSRCA, 2007). This planning tool interprets and applies the Provincial Policy Statement (PPS) to the Lake Simcoe watershed, which, when paired with the Natural Heritage Reference Manual (OMNR, 1999), provides comprehensive science-based criteria to identify significant natural heritage features. The *Natural Heritage System* applies these criteria to the Lake Simcoe watershed to provide specific recommendations to LSRCA staff to guide plan review, and recommendations to municipalities to assist with Official Plan development.

An additional layer of regulatory control is afforded to wetlands under Ontario Regulation 179/06 (Regulation of development, interference with wetlands and alterations to shorelines and watercourses). Watershed development policies established by LSRCA under that Regulation prohibit development in Provincially Significant wetlands, and restrict development in all other wetlands in the Lake Simcoe watershed.

#### 6.4.1.2 Acquisition of natural heritage features by public agencies

Several mechanisms exist for the acquisition of natural heritage features by the Lake Simcoe Region Conservation Authority and municipal governments.

The LSRCA has a land securement program which aims to acquire significant natural heritage features in the Lake Simcoe watershed, on a willing buyer – willing seller basis. LSRCA has developed a Natural Heritage System Land Securement Project, which focuses LSRCA's securement efforts by identifying nine land securement priority areas (LSRCA, 2010) which will be actively pursued. One of these priority areas falls within the Ramara Creeks subwatershed; this is identified as the Ramara Wetlands, and contains areas of up to four significant ecological features, include the Barnstable Bay Swamp wetland complex (PSW), the McGinnis Point Area of Natural and Scientific Interest, significant waterfowl habitat, interior forest, and a Wellhead Protection Area. The target area is approximately 3,000 ha in size, the PSW is 726 ha (composed of swamp and marsh), and the ANSI consists of 200 ha shoreline swamp along Barnstable Bay on Lake Simcoe, with two creek outlets flowing into it. In addition to this priority area, the LSRCA may also consider receiving donations of relatively large parcels of land, if they meet the criteria of the Conservation Land Tax Incentive Program.

Similarly, Simcoe County has a land acquisition program intended to increase the amount of County Forest holdings. Priority acquisition of land for the County Forest program is given to properties adjacent to existing county forests, and that contribute to both forestry and natural heritage purposes.

The Township Ramara also has parkland dedication targets in its Official Plan. These targets are intended to ensure that as the population grows, opportunities for outdoor recreation grow as well. Although parkland targets are primarily geared towards 'traditional' municipal parks (e.g. soccer fields, baseball diamonds, playgrounds, and other manicured greenspace), larger 'regional' parks sometimes include natural heritage features within them.

### *6.4.2 Restoration and remediation*

There are a range of programs operating in the subwatershed to help private landowners improve the environmental health of their land, and the Ministry of Natural Resources and Forestry has developed a report to help to prioritize restoration activities.

The Landowner Environmental Assistance Program (LEAP) is a partnership between the Lake Simcoe Region Conservation Authority, its member municipalities, and the York, Durham and Simcoe chapters of the Ontario Federation of Agriculture. This program provides technical and financial support to landowners in the Lake Simcoe watershed wanting to undertake stewardship projects on their land. Project types which have traditionally been funded by the LEAP program include managing manure and other agricultural wastes, decommissioning wells and septic systems, fencing and planting riparian areas, and increasing the amount of wildlife habitat in the watershed, among others. Between 2004 and 2013, 152 projects were completed under the LEAP in the Ramara Creeks subwatershed. The majority of these were focussed on protecting water quality, but they also included four projects to enhance wildlife habitat, 11 erosion projects, and 12 tree planting projects.

The Ontario Ministries of Natural Resources and Forestry, Environment and Climate Change, and Agriculture, Food and Rural Affairs provide the Lake Simcoe Community Stewardship Program for non-farm rural landowners in the Lake Simcoe watershed. This program is intended to provide non-farm rural residents with financial and technical assistance in implementing projects such as shoreline stabilization, septic system upgrades, wetland creation, and forest management, among others. The Lake Simcoe Community Stewardship Program has implemented 18 shoreline improvement projects in the Ramara Creeks subwatershed thus far.

The Ontario Ministry of Agriculture, Food and Rural Affairs has also partnered with Agriculture and Agri-Food Canada and the Ontario Soil and Crop Improvement Association to provide the Environmental Farm Program to registered farm landowners throughout the province. This farmer-focused program provides funding to landowners who have successfully completed an Environmental Farm Plan for projects including management of riparian areas, wetlands, and woodlands. Through this program, eight upland and riparian area management projects have been completed.

In 2009, LSRCA field staff surveyed 24.4% of the watercourses in the Ramara Creeks subwatershed through Phase 2 of the Best Management Practices Inventory Program, documenting the range of potential stewardship projects that could be implemented to help improve water quality and fish habitat. Among its findings, this survey found over 50 places in this subwatershed where additional riparian planting could be introduced.

The forthcoming shoreline management strategy, and wetland and riparian area prioritization exercise will identify and prioritize stewardship opportunities in this subwatershed, specific to the shoreline and inland riparian and headwater areas respectively.

These ongoing stewardship programs will soon be complemented by a forthcoming Voluntary Action Program. Initially, the Lake Simcoe Protection Plan proposed the development of a regulation to prohibit activities that would adversely affect the ecological health of the Lake Simcoe watershed (policy 6.16). Feedback during the initial rounds of consultation in development of this regulation raised concerns about its enforceability, and the need to educate the public on best management practices before taking a regulatory approach. As a result, the MOECC reframed the Shoreline Regulation as a Shoreline Voluntary Action Program.

The Shoreline Voluntary Action Program is intended to increase the extent of native vegetation along shorelines, and reduce the use of phosphate-containing fertilizer in the watershed, through a combination of surveys which are aimed at understanding the current range of public knowledge, attitudes, and practices, and outreach to summer camps, landowners, and garden centres.

This voluntary action program is being run as a two year pilot program, with ongoing monitoring to determine the rate of uptake, impacts on phosphorus levels, and impacts on native vegetation along the shoreline. After the pilot program is complete, these results will be reviewed to determine if a voluntary program is sufficient, or if a regulatory approach is necessary.

In addition, the Ministry of Natural Resources and Forestry has completed a report entitled 'Delineation of Priority Areas for Restoration in the Lake Simcoe Watershed' (MNR, 2011). The MNRF analyzed existing natural land cover as well as potential areas for restoration using a series of mapping resources and analysis techniques. Through this analysis, priority restoration areas were identified, their area measured, and mapped for all Lake Simcoe subwatersheds. The types of restoration opportunities are riparian areas, which looked at opportunities for all stream orders; wetlands; and linkages and corridors. This report will form an important basis for the identification of priority areas for restoration throughout the study area. The number of patches and area identified for the Ramara Creeks subwatershed for wetland and linkage/corridor restoration can be found in Table 6-7 below.

**Table 6-7 – Wetland and linkage/corridor areas identified in MNRF's draft 'Delineation of Priority Areas for Restoration in the Lake Simcoe Watershed' (MNR, 2011)**

| Subwatershed | Wetlands | | Linkages/Corridors | |
|---|---|---|---|---|
| | # of areas | Total area (ha) | # of areas | Total area (ha) |
| Ramara Creeks | 242 | 3237 | 6908 | 1709 |

### *6.4.3 Science and research*

An ongoing commitment to applied research and science is necessary to improve our understanding of the extent, character, and function of the terrestrial natural heritage features and wildlife within the Lake Simcoe watershed. Applied science and research can include formal scientific studies, citizen scientist-based monitoring programs, and Traditional Ecological Knowledge.

Comparatively less research is being done on terrestrial natural heritage systems, values, and features than is being done on water quality or aquatic habitats, however MNRF research scientists are undertaking studies related to characterizing the natural heritage features and ecological processes in the watershed. As with water quality and aquatic research, the Lake Simcoe Science Committee plays a role in reviewing this research and making recommendations to the Minister.

In addition to these specific research projects, the MNRF, LSRCA, and MOECC are developing a terrestrial natural heritage monitoring program which will track the condition of the Lake Simcoe watershed with respect to the targets and indicators set by the Lake Simcoe Protection Plan (and described in Section 6.2). When this data becomes available, and trends become evident, it will help to revise and refine this subwatershed plan at its five year review period.

Ontario, as a province, is fortunate in that much terrestrial natural heritage monitoring is undertaken by volunteer citizen scientists, which has the potential to complement these other studies. Programs such as the Marsh Monitoring Program, and Breeding Bird Survey coordinated by Bird Studies Canada provide information on long-term trends in wildlife populations throughout Ontario. At this point there are no Marsh Monitoring Program routes in the subwatershed, and there is one Breeding Bird Survey route that crosses through the subwatershed.

***Key Points – Current Management Framework Protecting Terrestrial Natural Heritage***

- The suite of natural heritage protection policies provided under the Lake Simcoe Protection Plan and municipal official plans provide relatively comprehensive protection for natural heritage features in the Ramara Creeks subwatershed. Exceptions include grasslands and some small isolated forests.
- Wetlands are effectively protected in the Ramara Creeks subwatershed, with the exception of development or site alteration associated with municipal infrastructure
- Existing natural vegetative cover along the shoreline and in the riparian zone of the tributaries is protected by policies provided under the Lake Simcoe Protection Plan and municipal official plans
- The Ministry of Natural Resources and Forestry and the Lake Simcoe Region Conservation Authority provide programs to assist private landowners in improving natural heritage features on their property. A major focus of these programs is in increasing natural vegetative cover along the shoreline and in the riparian zone of tributaries
- Despite the existence of these programs, uptake has been limited in this subwatershed. The forthcoming Shoreline Voluntary Action Program may help increase uptake, by increasing public awareness of the value of shoreline ecosystems, increasing public awareness of the existence of funding and technical assistance programs, and by conducting surveys to determine barriers to public uptake

## 6.5 Management Gaps and Recommendations

As can be seen in the previous sections, there are a number of programs in place to protect and enhance the natural heritage features in the Ramara Creeks subwatershed. Despite this strong foundation, there are a number of gaps and limitations in the current management framework that could be improved upon in the future of subwatershed management.

Listed below is an initial ‘long list’ of recommendations for improving the state of natural heritage values in the Ramara Creeks subwatershed, for discussion.

It is recognized that many of the undertakings in the following set of recommendations 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 in the implementation phase.

### *6.5.1 Official Plan conformity*

Under Policy 8.4 of the Lake Simcoe Protection Plan, municipalities must amend their official plans to ensure that they are consistent with the recommendations of this subwatershed plan, upon their five-year official plan review.

> **Recommendation 6-1** - That the LSRCA, and relevant provincial agencies assist Ramara Township in ensuring its official plan is consistent with the recommendations presented in the Ramara Creeks subwatershed plan, as approved by the LSRCA Board of Directors. This approval will be subsequent to consultation with the Township, the subwatershed plan working group, and the general public, as outlined in the *Guidelines for developing subwatershed plans for the Lake Simcoe watershed (May, 2011).*

### *6.5.2 Revisions in Key Natural Heritage protection policies*

Policy 6.50 of the LSPP requires the MNRF, MOECC, and LSRCA to establish a monitoring program in relation to the targets and indicators established by that plan for natural heritage and hydrologic features, which includes an indicator related to ‘habitat quality’. Although there is currently no site level definition for “high quality” natural vegetation, when this definition becomes available, it has the potential to complement existing natural heritage protection policies in provincial plans and municipal official plans to ensure that the most high quality natural areas in the Lake Simcoe watershed are protected from incompatible development and site alteration

> **Recommendation 6-2** – That the MNRF, MOECC, and LSRCA review the terrestrial natural heritage data provided by the comprehensive monitoring program, when it becomes available, to define site level characteristics or indicators of ‘high quality’ natural heritage features, and provide policy recommendations to subwatershed municipalities (as necessary) to ensure high quality natural heritage features are adequately protected from development and site alteration.

The existing suite of natural heritage protection policies provided by the LSPP, municipal Official Plan, and Provincial Regulations provide some level of protection from development for much of the natural vegetative cover in the study area. The incomplete coverage of this protection suggests that some marginal loss in natural heritage cover should be anticipated as development proceeds in this area. The LSPP however establishes a target of 40% native vegetation across the Lake Simcoe watershed, which represents an increase of approximately 5% from current conditions. The possibility of meeting this target would be greatly increased with the adoption of a policy of no net loss of natural heritage features.

> **Recommendation 6-3** - That LSRCA, in partnership with subwatershed municipalities and other interested stakeholders, develop policies for municipal Official Plans that would provide mitigation and restoration for development and site alteration within natural heritage features that are not defined as “key” by the Lake Simcoe Protection Plan or as “significant” under municipal official plans, to ensure no net loss in overall natural vegetative cover as a result of development.

### *6.5.3 Grassland protection*

Grassland habitats are an often overlooked natural heritage feature, and unprotected by natural heritage protection policies. For example, neither the LSPP nor the Provincial Policy Statement accounts for “grasslands” as a type of natural heritage feature. However, as outlined in section 6.2.6, they are disproportionately important for species of conservation concern. Native grasslands are recognized by the Natural Heritage Reference manual, and recommended for inclusion in natural heritage systems designated under municipal official plans as ‘rare vegetation communities’.

However, on their own, native grasslands will likely be insufficient to protect grassland dwelling wildlife. There are only five identified native grasslands (i.e. tallgrass prairies or alvars), , in the Lake Simcoe watershed. These features are each less than 25 ha in size, and together are less than 30ha in total size. Features this small will be insufficient for the long-term persistence of grassland birds and insects. The protection of non-native grasslands is difficult however, as many of these are abandoned lots or vacant or non-intensive agricultural land, and as such they are often temporary in nature.

The concern in this subwatershed related to the preservation of habitat for grassland-dependent wildlife is one that is widespread throughout the Province. In 2010, the bobolink was listed under the Provincial *Endangered Species Act* as being a Threatened species, triggering a protection to its habitat. Because of the conflict that creates with farm operations however, in 2011 the Provincial government instituted a three-year exemption for farmers while they study other options for protecting both grassland-dependent birds, and farm businesses

> **Recommendation 6-4 –** That the MNRF, MAFRA, LSRCA, Township of Ramara, and interested members of the agricultural community review the results of the studies being conducted on methods and policy tools to protect grassland dependent wildlife on active agricultural land as they become available, to determine if they provide

solutions for the conservation of grassland habitat which would be applicable for this subwatershed.

**Recommendation 6-5** – That the Township of Ramara, with the assistance of the MNRF and LSRCA, give consideration to including policies in its Official Plan to contribute to the protection of grassland habitats, as necessary, based on the results of Recommendation #6-4, and recognize the need for balance in the approach to development in urban areas.

### *6.5.4 Infrastructure as a Key Natural Heritage Feature gap*

Infrastructure projects, including roads, sewers, and municipal drains, aren't subject to the Planning Act, and as such are exempt from natural heritage protection policies developed under municipal Official Plans, and are also exempt from natural heritage protection policies under the Lake Simcoe Protection Plan. Protection for natural heritage features with respect to infrastructure projects is provided through the Environmental Assessment process.

**Recommendation 6-6** – That the proponents and reviewers of all Environmental Assessments recognize the intent and targets of the Lake Simcoe Protection Plan when developing and assessing alternatives to the proposed undertaking.

**Recommendation 6-7** – That reviewers of Environmental Assessments for municipal infrastructure in the Lake Simcoe watershed, including subwatershed municipalities, MTO, LSRCA and MOECC (when reviewing such documents), give due consideration to the preservation of barrier-free connectivity for wildlife between nearby wetland and upland habitats. This should include due consideration of alternate route configuration, the use of wildlife crossing structures, and/or the use of traffic calming measures (such as signage, including the use of electronic signs at peak migration times; road re-design; and speed bumps) in critical locations.

### *6.5.5 Land securement by public agencies*

The protection of a system of natural heritage features by public bodies plays an important role in ensuring the protection of significant and highly vulnerable sites, and in providing natural areas for public use and enjoyment. This includes the Ramara Wetlands, which were identified by the LSRCA as a priority area for securement.

**Recommendation 6-8** – That the LSRCA and subwatershed municipalities should continue to secure outstanding natural areas for environmental protection and public benefit, through tools such as land acquisition or conservation easements, and should support the work of Land Trusts doing similar work. Priority areas identified by LSRCA's Land Securement Strategy in the Ramara Creeks subwatershed are the Lagoon City, Barnstable Bay, and Joyland Provincially Significant wetlands.

**Recommendation 6-9** – That the LSRCA and subwatershed municipalities, with the assistance of the MNRF, continue to refine their land securement decision processes to ensure that they are securing natural areas that are critical to the health of the watershed (or securing and restoring areas which have the potential to become critical to the health of the watershed), but which are otherwise vulnerable to loss through incompatible land uses.

**Recommendation 6-10** – That the Federal, Provincial, and Municipal governments provide consistent and sustainable funding, and that the Township utilize its parkland dedication process, to support securement of notable natural areas.

### *6.5.6 Stewardship implementation – increasing uptake*

In addition to protecting existing natural heritage features, programs which support the stewardship, restoration, or enhancement of private lands will be critical to meet the targets and objectives of the Lake Simcoe Protection Plan. To that end, programs are provided through partnerships with the Ministry of Natural Resources and Forestry, Ministry of the Environment and Climate Change, Ministry of Agriculture, Food and Rural Affairs, Ontario Federation of Agriculture, Ontario Soil and Crop Improvement Association, Lake Simcoe Region Conservation Authority, South Simcoe Streams Network and watershed municipalities. Despite this range of players, the uptake of proffered stewardship programs is limited by the number of private landowners who voluntarily participate.

**Recommendation 6-11** – That the MNRF, MOECC, MAFRA, and LSRCA continue to implement stewardship projects in these subwatersheds, and work collaboratively with other interested organizations, through the Lake Simcoe Stewardship Network, to do the same.

**Recommendation 6-12** – That governmental and non-governmental organizations continue to improve coordination of programs to: (1) avoid inefficiencies and unnecessary competition for projects, and: (2) make it easier for landowners to know which organization they should be contacting for a potential project, using tools such as a simple web portal, or other, locally appropriate avenues.

**Recommendation 6-13** – That the Federal, Provincial, and Municipal governments be encouraged to provide consistent and sustainable funding to ensure continued delivery of stewardship programs. Further, that partnerships with other organizations (e.g. Ducks Unlimited Canada, TD Friends of the Environment, Royal Bank of Canada, local businesses) be pursued.

**Recommendation 6-14** – That the MOECC, MNRF, LSRCA and other members of the Lake Simcoe Stewardship Network are encouraged to document completed stewardship projects in a common tracking system to allow efficient tracking, coordinating, and reporting of stewardship work accomplished. This could also involve engaging ‘project champions’ to promote the projects that they have completed and encourage others to do the same.

**Recommendation 6-15** – That the MOECC, MNRF, MAFRA, LSRCA, and other interested members of the Lake Simcoe Stewardship Network support research to determine public motivations and barriers limiting uptake of stewardship programs in this subwatershed and share these results with other members of the Lake Simcoe Stewardship Network, to enable agencies and stakeholders to modify their stewardship programming as relevant. This research should include a review of successful projects to determine what aspects led to their success, and how these may be emulated.

**Recommendation 6-16** – The MOECC, MNRF, MAFRA and LSRCA continue to investigate new and innovative ways of reaching target audiences in the local community and engage them in restoration programs and activities (e.g. 4H clubs, high school environmental clubs, through Facebook groups, hosting a Lake Simcoe Environment Conference for high schools/science community interaction). Results of these efforts should be shared with the Lake Simcoe Stewardship Network.

### *6.5.7 Stewardship implementation – prioritize projects*

Stewardship programs play an important role in meeting the goals and objectives of the subwatershed plans. However, in order to ensure that they are both effective and efficient, stewardship projects should be selected in the context of the priority needs of the Lake Simcoe watershed, and its subwatersheds. An analysis of natural heritage and hydrological priorities, and an assessment of barriers to uptake as listed above, would allow improved targeting of programs to areas of relatively high need.

**Recommendation 6-17** – That the LSRCA and MNRF, with the assistance of the MOECC, use their draft 'Delineation of Priority Areas for Restoration' report to develop a spatially-explicit decision support tool to assist in targeting terrestrial stewardship projects in the Lake Simcoe watershed. In the context of the Ramara Creeks subwatershed, this decision tool should take into account factors including:

- The need to increase the extent of natural shoreline and riparian cover
- Protecting and restoring significant groundwater recharge areas and ecologically significant groundwater recharge areas, to help mitigate the expected impacts of climate change
- The need to protect and restore grassland habitat
- Opportunities to enhance resilience to climate change
- The need to balance the needs of wildlife corridors with protection of crops and livestock
- The need to reduce phosphorus loadings to the tributaries.

**Recommendation 6-18** – That the members of the Lake Simcoe Stewardship Network be encouraged to build into their projects relevant provisions for the anticipated impacts of climate change, such as the need to recommend native species which will be tolerant of future climate conditions, and the likelihood of an increase in invasive plants, pests, and diseases which may further limit the success of traditional stewardship approaches.

#### *6.5.8 Dealing with indirect impacts*

Despite the gaps in existing natural heritage protection policies as noted above, a large proportion of current natural heritage features in the Ramara Creeks subwatershed have some level of protection from development or site alteration. As such, the greatest impacts to natural heritage values in these subwatersheds in coming years may be indirect, rather than direct, in nature. Forests in urban areas are typically under more stress from invasive species, feral cats, unmanaged recreation, and indirect impacts associated with nearby roads.

**Recommendation 6-19** – That the County of Simcoe and Township of Ramara, with assistance of MNRF and LSRCA, conduct natural heritage inventories, and develop and implement management plans for publicly accessible natural areas that they own, to mitigate potential threats related to invasive species and increased recreation pressure.

**Recommendation 6-20** – That the MNRF and its partners provide outreach to garden centres, landscapers, and garden clubs regarding the danger of using invasive species in ornamental gardens.

**Recommendation 6-21** – That the Township of Ramara and the County of Simcoe, with support from LSRCA, make information available to residents on the impact of human activities on natural areas. Priority issues include the dangers of invasive species, the importance of keeping pets under control, and the importance of staying on trails while in natural areas.

**Recommendation 6-22** – That the Township of Ramara give preference to native species when selecting trees to be planted in boulevards, parks, and other municipal lands.

**Recommendation 6-23** – That the Ministry of Transportation, Township of Ramara and the County of Simcoe, in partnership with the Simcoe County Federation of Agriculture, LSRCA, and MNRF, promote and implement, where appropriate, the use of treed windbreaks and/or 'living snowfences' along roadsides to prevent impacts from wind and blowing snow. The creation of a 'living snowfence' involves selectively harvesting crops in order to leave a specified amount of plant material standing along a roadway to facilitate snow accumulation.

#### *6.5.9 Filling data gaps*

Our understanding of the status and pressures related to terrestrial natural heritage features and processes in the Lake Simcoe watershed is relatively limited. Policy 6.50 of the LSPP requires the MNRF, LSRCA, and MOECC to develop a monitoring program for natural heritage features and values in the Lake Simcoe watershed which should contribute significantly to addressing this data gap. This monitoring program could be complemented by the following recommendations to more fully fill data gaps.

**Recommendation 6-24** – That the MNRF, with the assistance of LSRCA and MOECC, complement the proposed monitoring strategy with standardized surveys of the distribution and abundance of terrestrial species at risk throughout the Lake Simcoe watershed.

**Recommendation 6-25** – That the MNRF, LSRCA, and MAFRA continue to maintain an up-to-date seamless land cover map for the watershed, as defined by the LSPP, with natural heritage features classified using Ecological Land Classification, managed in such a way as to allow change analysis.

**Recommendation 6-26** – That the MNRF and LSRCA take advantage of data that is already available, by developing a biodiversity database that can collate information reported in EIS and EA reports, information reported in natural area inventories, plot-based data collected in the watershed-wide Vegetation Survey Protocol that is underway, plot-based data collected by citizen-scientists for the Breeding Bird Atlas, and other data as may be available.

**Recommendation 6-27** – That the MNRF, with the assistance of the LSRCA, take advantage of this soon-to-be compiled data, and develop lists of watershed-rare taxa, and policies to support their protection.

### *6.5.10 Improving data management*

The forthcoming monitoring program identified by the LSPP has the potential to exponentially increase the amount of data on the extent and condition of natural heritage values and features in the Lake Simcoe watershed. However, the number of government agencies contributing to, and utilizing, this database will make data management a significant challenge.

**Recommendation 6-28** – That the MNRF, LSRCA, and MOECC develop a framework to allow effective and efficient management and sharing of data before implementing the comprehensive monitoring program. This framework may include the designation of one agency as the curator of all monitoring data collected in the Lake Simcoe watershed.

### *6.5.11 Terrestrial natural heritage research needs*

The Lake Simcoe watershed, including some areas in the Ramara Creeks subwatershed, is one of the most rapidly urbanizing watersheds in Ontario. Although there is a substantial suite of policies in place to protect existing natural heritage features from development and site alteration, the effects on those features resulting from intensified development in the surrounding landscape is less well understood.

**Recommendation 6-29** – That the Lake Simcoe Science Committee, other levels of government, and academia support research to better understand the stresses to wildlife and wildlife habitat associated with urban development, to allow management responses to be refined. Important questions of interest include: the use of stormwater ponds as amphibian breeding habitat, the importance of remnant natural areas to quality of life for local residents, the indirect impacts of roads on resident and migratory wildlife, and the impacts of high density and low density development on wildlife communities in natural areas.  This research may include literature reviews, analysis of data available through the monitoring program, or original, innovative, peer-reviewed research.

# 7 Integration and Implementation

## 7.1 Introduction

This subwatershed plan has been developed with technical chapters arranged thematically, to allow us to examine each theme in detail, and to allow this document to address the specific issues identified in the Lake Simcoe Protection Plan. This integration chapter, however, is intended to highlight the interactions between water quantity, water quality, terrestrial ecosystems, and aquatic ecosystems, and to describe some of the natural processes supporting biodiversity and watershed health in the Ramara Creeks subwatershed. An understanding of how these factors interact is important to gain a full understanding of the watershed ecosystem, and to design conservation programs which are both effective and cost-efficient. To help build this understanding, this chapter examines how some of the key points highlighted in Chapters 3 to 6 interact, through the use of conceptual diagrams. Conceptual diagrams are useful tools for synthesizing complex, detailed information in a form that is attractive and informative. Conceptual diagrams are 'thought drawings' that provide representations of ecosystems or watersheds, and highlight key attributes and interactions, in a form that is readily understandable by a wide range of audiences (Longstaff *et al*., 2010).

## 7.2 Groundwater interactions - land cover, groundwater, and aquatic habitats

The amount of precipitation that infiltrates through the soil to contribute to groundwater depends on the permeability of the soil. Groundwater recharge is most significant in areas with coarse, highly permeable soils such as sandy or gravelly sites on heights of land, and is often found in the headwaters of watersheds (Figure 7-1) (Earthfx, 2014). In the case of the the Ramara Creeks subwatershed, the regional groundwater flow contribution from within the subwatershed supports numerous wetland and stream features. Some of the headwater streams are likely reciving groundwater inflow from recharge zones in the Carden Plain alvar and other recharge areas located just outside of the subwatershed boundaries. Where these types of areas are forested, the amount of rainfall that infiltrates into groundwater tends to be greater. Forests promote infiltration by intercepting the rain and reducing the force at which it strikes the soil. They also increase soil porosity through the actions of root growth and decomposition, and the actions of small mammals and other burrowing wildlife.

Groundwater flow in this subwatershed generally follows surface water flow, from the higher topography in the headwaters to the northeast to the lows associated with major stream channels and Lake Simcoe. In their 2014 study of the area, Earthfx found while much of the stream flow in the subwatershed originates within the subwatershed boundaries, there are significant quantities of groundwater flow discharging to some significant features in the study area, including both streams and wetlands, that are originating from outside of the watershed through lateral groundwater inflow. One area in particular, the topographic high located between Lake Dalrymple and Lake St. John, acts as a recharge area for a groundwater system that is responsible for providing much of the groundwater contribution to these features.

This groundwater can be released to the surface where it becomes available for use in aquatic or wetland ecosystems, through the process of groundwater discharge (Figure 7-1) (Earthfx, 2013a). This discharge happens in areas with similarly coarse soil, but also in areas where the ground surface lies below the water table, often in depressional areas or in ravines, and can take the form of groundwater seepage or springs. Groundwater discharge to the headwater reaches represents a significant portion of the total baseflow in these areas; however the majority of the streams are dependent on localized, surface water driven recharge.

Based on modelling results, many of the subwatershed's streams and wetlands are fed by localized recharge, while some features, particularly those streams and wetlands in the headwaters are fed by groundwater originating from outside of the subwatershed, particularly in the areas of the Carden Plain and the area between Lake St. John and Lake Dalrymple mentioned above. Groundwater discharge to the headwater reaches represents a significant portion of the total baseflow. In such cases, the groundwater discharge makes an important contribution to creek ecosystems and to riparian wetlands.

This groundwater recharge – discharge relationship can happen over relatively large distances, and is easily overlooked as it happens below ground. This relationship however is one of the most significant links between upland and aquatic features in watersheds, and preserving this relationship is critical to preserving the functioning of surface water features such as watercourses and wetlands.

For some watercourses, particularly small ones, groundwater discharge can be a significant contributor to flow during times of limited rainfall. Evidence of the importance of this groundwater source is seen in many of the subwatershed's watercourses, particularly through the middle and lower reaches, that are not well connected to the deeper groundwater system, and these systems tend to dry up in the summer months when the shallow sub-surface flow is depleted. In cases where the watercourses supported by groundwater sources, such as in the headwaters, the addition of this water obviously plays a role in protecting fish habitat, but even in larger systems, the typically cold discharged groundwater can decrease the temperature of the creek, helping it to support healthier fish communities. As such, the preservation of groundwater recharge and discharge, even at relatively large distances from creeks, is critical to preserving the fish habitat that is present in this subwatershed.

In areas that have become urbanized, this groundwater relationship can be interrupted (Figure 7-1). Because urban areas constitute such a small portion of the study area, it is not likely that there have been significant impacts to infiltration. It was noted that future recharge inflow conditions within the Ramara Creeks subwatershed is expected to be reduced by less than one percent of the current conditions (Earthfx, 2014). The Earthfx report (2014) also noted that there are no planned water demand conditions and only assessed current and future water demand conditions within the study area. Under both current and future water demand conditions, the subwatershed was assessed at the low stress level. In addition, a 2-year and 10-year drought analysis was completed, which focused on the predicted response of water levels in the municipal wells, along with the response of groundwater levels, groundwater discharge to streams, and total streamflow within the subwatershed. The results of both analyses found some reduction in groundwater levels, but municipal pumping wells did not go dry. There were some impacts found with regard to streamflow, particularly in the headwater streams, which are dependent on groundwater discharge, with reductions in discharge of up to 61% being seen (Tables 4-20 and 4-21).

One important measure to protect this hydrological-ecological relationship is with the identification and protection of Ecologically Significant Groundwater Recharge Areas (Figure 4-29), which are those areas of groundwater recharge that support the flow of groundwater to ecologically sensitive features such as wetlands and creeks. Once identified, the Lake Simcoe Protection Plan directs municipalities to develop policies in their Official Plans to protect, improve, or restore these features.

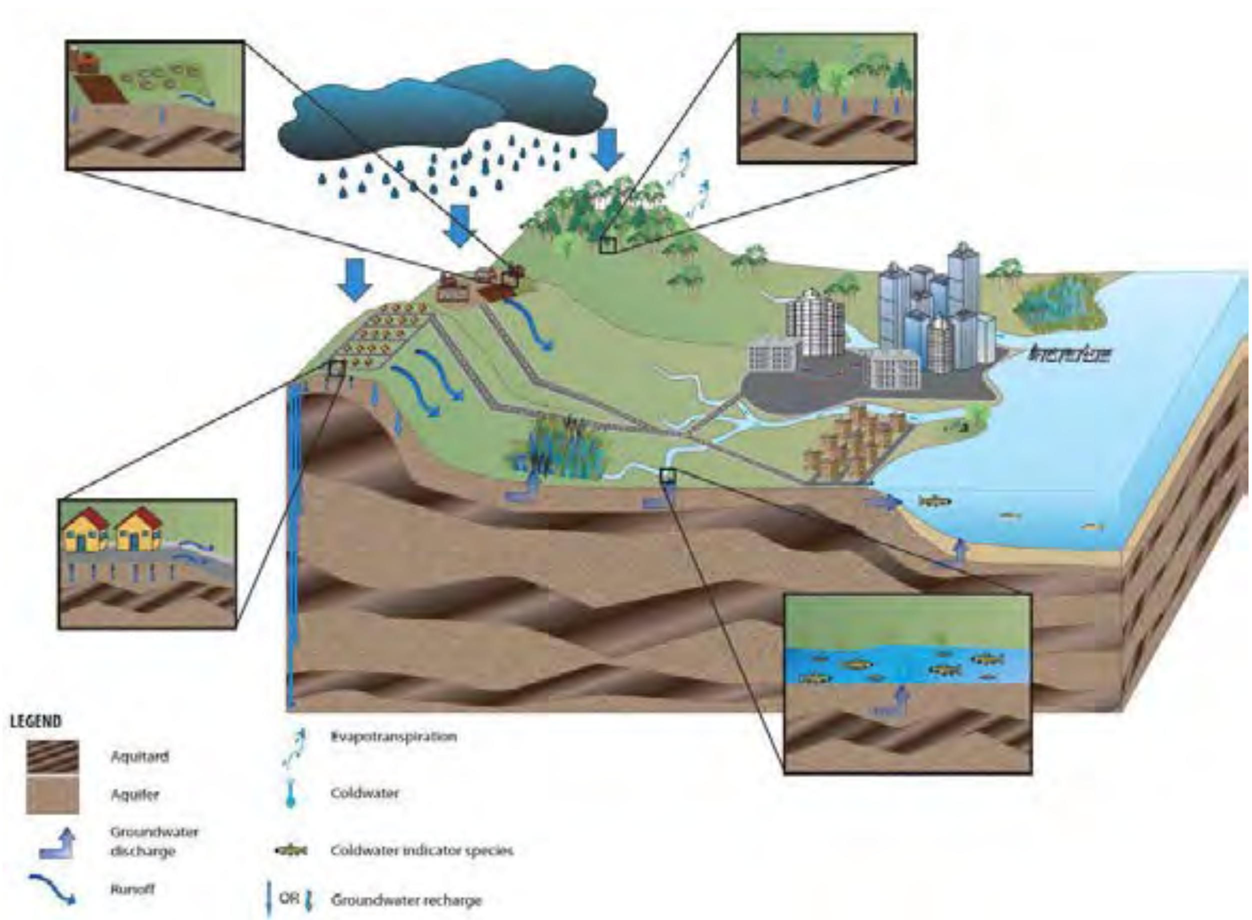



**Figure 7-1: Groundwater interactions in the Ramara Creeks subwatershed**

## 7.3 Rural and agricultural interactions - land use, streams, and aquatic wildlife

When rain falls and flows over soils on agricultural land, it can cause more erosion than in natural areas, due to a relative lack of vegetative cover, particularly in the spring when the fields are tilled and after harvest in the fall. Water quality can also be affected due to runoff picking up contaminants not present in natural areas. Soil particles eroded by stormwater in agricultural areas often have phosphorus adsorbed to them, particularly if the storm event happens relatively soon after a surface application of manure or fertilizer (Figure 7-2). As such, agricultural stormwater can contribute to both the sediment loads and phosphorus loads in receiving water bodies. In fact, historically, the conversion of much of the Lake Simcoe watershed to agricultural land in the mid-1800s caused a spike in phosphorus loadings to the lake (Wilson and Ryan, 1988). Agriculture remains a significant contributor of phosphorus to Lake Simcoe; it is the most prevalent land use in the study area, and modelling has estimated that it contributes close to one third of the phosphorus load in the Ramara Creeks subwatershed (Louis Berger Group, Inc., 2010). This includes contributions from crop land as well as the relatively high proportion of pasturing lands found in the subwatershed. In addition, septic systems, which are primarily found in rural and agricultural areas, are estimated to contribute 45% of the phosphorus load. Other contaminants, such as nitrates and metals, can also be washed off of agricultural lands and into nearby watercourses during runoff events.

The addition of contaminant-laden sediment to watercourses can have significant deleterious impacts to aquatic ecosystems. Suspended sediment in watercourses increases the amount of sunlight that is absorbed by the water, and thus can contribute to increasing water temperatures. At high levels, it can also clog or abrade fish gills, impeding their ability to breathe, and can also cloud the water, reducing the hunting efficiency of visual predators. As the sediment settles out of the water column, it can blanket the substrate, covering important spawning habitat. The addition of the phosphorus adsorbed to sediment contributes to the eutrophication cycle, which is of significant concern in the Lake Simcoe watershed. Phosphorus acts as a fertilizer in aquatic ecosystems, causing increased growth of aquatic plants and, most significantly in streams, algae. As the algae decompose, bacteria involved in the decomposition process remove dissolved oxygen from the water column. At high levels of algae, this respiration can cause the amount of dissolved oxygen in watercourses to decline to critical levels, making them less suitable as habitat for fish and other aquatic organisms (Figure 7-2).

An issue specific to the management of agricultural watersheds is agricultural drains, which constitute a large proportion of the watercourses in the Ramara Creeks subwatershed. These drains include both open ditches and tile drains, which are typically installed in areas with poor natural drainage, to improve agricultural productivity. Ditches, or open drains, are typically straightened to quickly remove water from the area and generally have limited amounts of riparian vegetation. To ensure that they continue to work properly, they require maintenance, which can involve the alteration or removal of remaining vegetation, and disruption and change to the substrate. In addition, their intended function of rapidly draining wet soil has the unintended consequences of changing the rate and timing of peak flows, and increasing the volume of phosphorus and sediment travelling from agricultural fields to Lake Simcoe. In cases where these drains bisect wetlands they can cause the water table to drop, decreasing the extent and hydroperiod of ephemeral wetland pools, which can lead to a loss of breeding habitat for frogs and salamanders and migratory habitat for waterfowl (Figure 7-2).

Another issue occurring in agricultural lands is the degradation of water quality and riparian areas where livestock have access to watercourses. The input of urine and manure directly into the water and onto low lying nearby fields, where it can be washed into the watercourse, affects water quality. The livestock can also trample streambanks, contributing to instability and erosion, as well as sedimentation in the stream; while livestock in the stream can destroy spawning habitat (Figure 7-2).

In addition to these issues from various farm practices, sewage from most of the 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 (Figure 7-2). As an example, inputs from malfunctioning septic systems near the lake were found to be the most significant contributor to phosphorus loads in the Ramara Creeks subwatershed under the modelling completed by Berger and Associates in their 2010 report (Table 3-6).

The presence of natural vegetation along many watercourses flowing through agricultural land in (such as those areas coloured green in Figure 6-8) can help to buffer watercourses from these impacts. Riparian buffers act as an important last line of defence between farm fields and watercourses. The vegetation that they contain reduces the velocity of stormwater runoff, allowing sediment to be deposited within the buffer rather than in the creek; absorbs nutrients such as phosphorus and nitrogen; and binds the soil on the banks of the river, slowing the rate of erosion caused by stormwater runoff (Figure 7-3). As was noted in Chapter 6: Terrestrial Natural Heritage, it is recommended that a minimum of 75% of the riparian area within 30 m of a watercourse be in natural cover. The watercourses of the Ramara Creeks subwatershed fall short of this, with just over half of the riparian area having natural cover. The higher levels of natural cover are mainly found in the swamp areas near the Lake Simcoe shoreline, and in the Simcoe County forest in the extreme northeast of the subwatershed. The remainder of the subwatershed's watercourses, particularly where they flow through agricultural areas, are lacking in natural cover (Figure 6-8). In these areas, impacts on watercourses from agricultural land uses can be most significant, and can be associated with a shift in tributary fish communities.

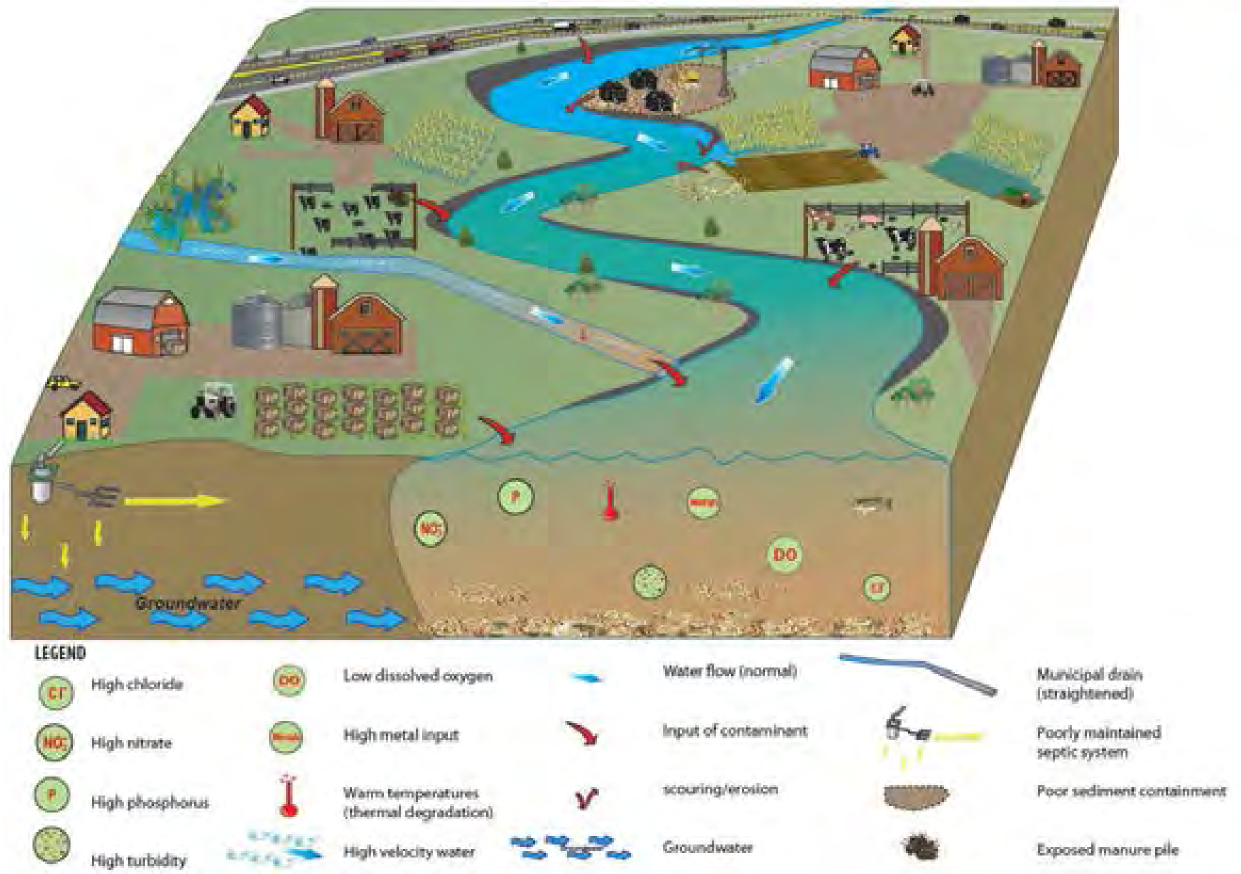



**Figure 7-2: Influences of rural and agricultural land use on subwatershed health.**

The release of sediment and phosphorus from farm fields can also be reduced through the use of cover crops, by minimizing and/or properly timing fertilizer application, by fencing streams to prevent livestock access, through enhancement of riparian buffers, and with the preservation of remnant wetlands and forests. The release of phosphorus and other contaminants from barn yards can be reduced through the proper storage and spreading of manure, and the proper storage and disposal of milkhouse waste (Figure 7-3).

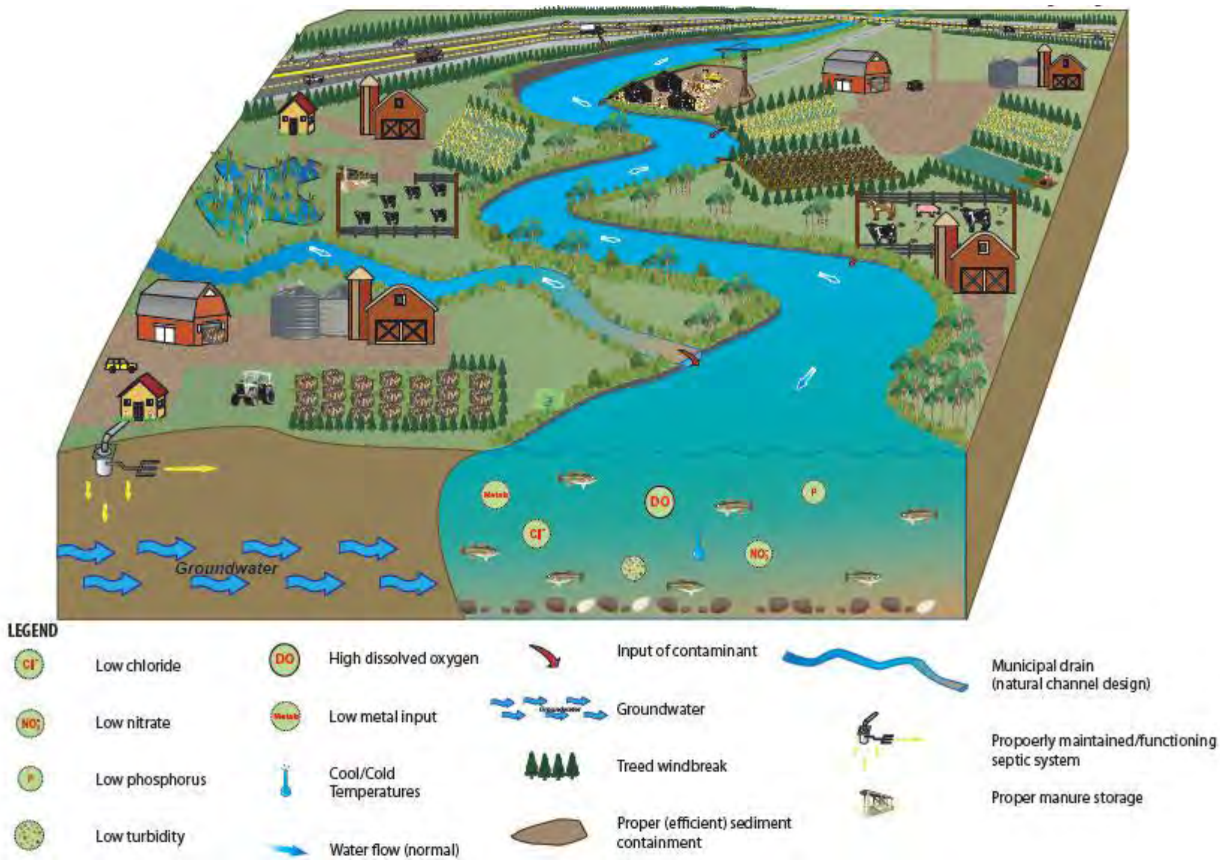



**Figure 7-3: An agricultural landscape with appropriate best management practices implemented to protect subwatershed health**

A number of stewardship programs have been provided by various government agencies, with the intent of engaging private landowners in undertaking these types of stewardship projects, through increasing awareness of the importance of these actions, and by providing technical and financial assistance to help these voluntary actions. Through such programs, the Lake Simcoe Region Conservation Authority, Ontario Soil and Crop Improvement Association, and their partners have implemented extensive projects in the agricultural areas of the Ramara Creeks subwatereshed, primarily related to stream bank fencing, establishment of riparian buffers and other tree planting projects, and improved management of manure and milkhouse waste (Figure 7-4). In addition to the projects shown here, there have also been close to 100 septic system repairs and/or upgrades completed in the subwatershed.

Despite this effort, many more opportunities to increase the amount of stream bank vegetation, reduce barnyard runoff, and restrict livestock access still remain in the Ramara Creeks subwatershed. In addition, there are likely many more septic systems that will require repairs or upgrades to prevent them from contributing phosphorus to ground and surface water as they age.

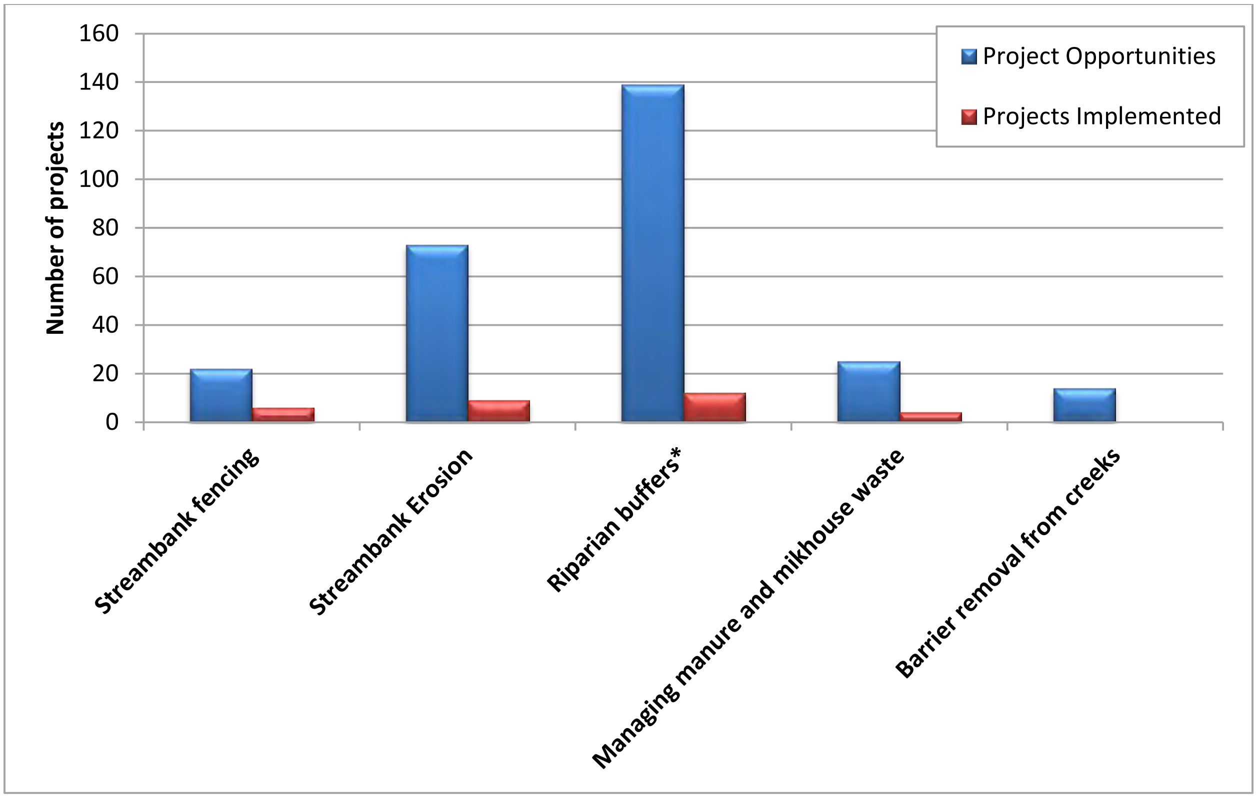
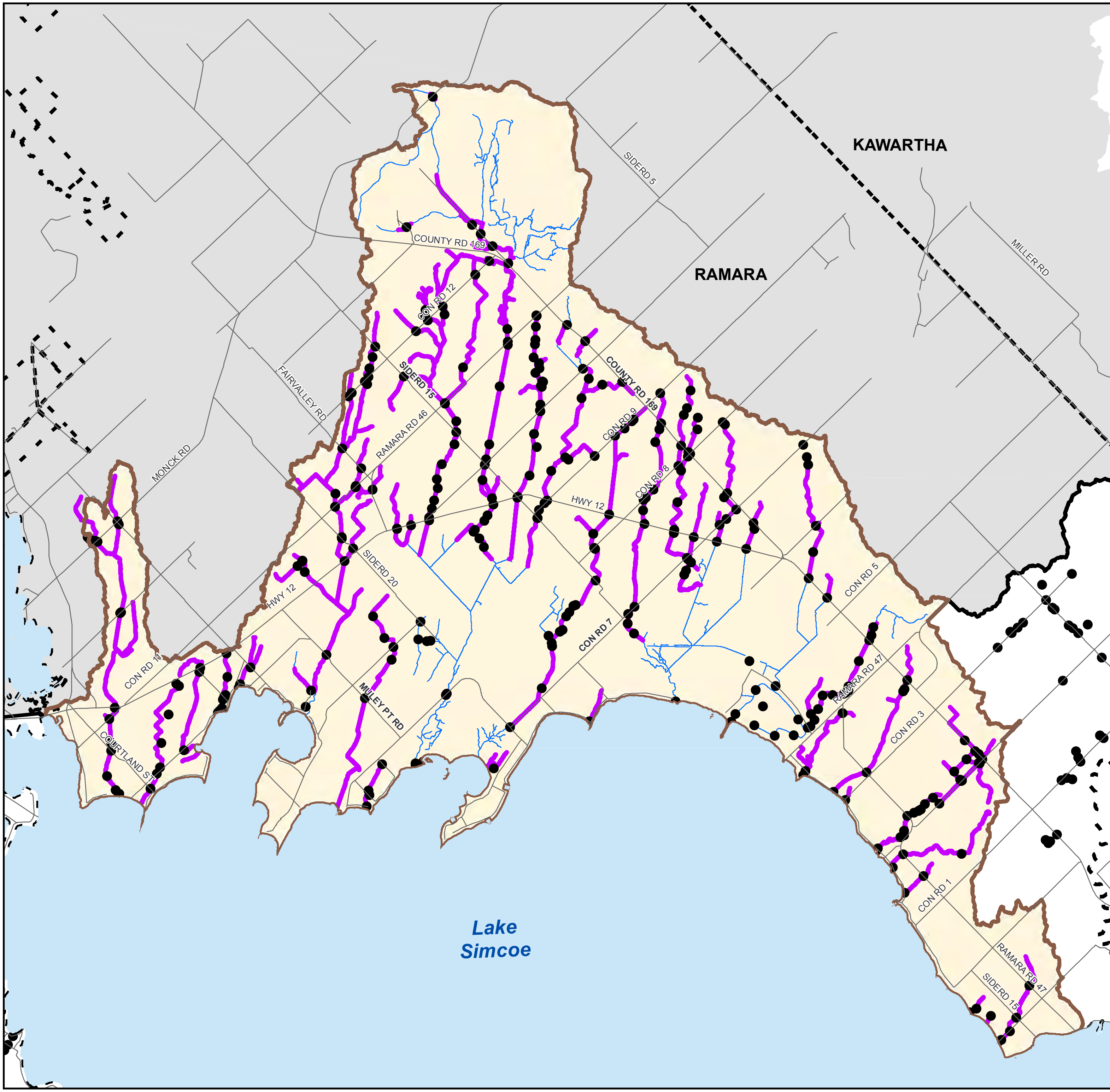



**Figure 7-4: Approximate number of stewardship projects (completed by the LSRCA) and stewardship opportunities in the Ramara Creeks subwatershed.** *Projects implemented in this category may include both riparian and upland tree plantings

**Best Management Practices project opportunities in the Ramara Creeks subwatershed**

Figure 7-5




## Legend

- BMP Opportunities
- Road
- Municipal Boundary
- Watercourse
- BMP Watercourse Surveyed
- Subwatershed

Lake Simcoe Region conservation authority

N E S W

0 0.5 1 2 3 Kilometres

## 7.4 Urban interactions - land use, streams, and aquatic wildlife

When stormwater flows over urban areas, it may pick up more contaminants than in other types of land use (Figure 7-6). Urban areas can generally be found in small pockets of development throughout the study area, with the largest area being the community of Brechin, and others including Lagoon City, Bayshore Village, and Udney. Urban areas, and the stormwater associated with them, have been found to be significant contributors to the phosphorus load in Lake Simcoe. While urban areas are not the most significant contributor to the phosphorus load in the Ramara Creeks subwatershed, they undoubtably contribute some phosphorus to the system, and cause particular issues in areas like Lagoon City. With some expansion of the urban area expected in this subwatershed, the proportion of the load attributed to this land use is expected to increase, if appropriate best management practices are not undertaken (Table 3-6).

While limited, there is some urban development expected in the Township of Ramara; many of the stresses associated with urban land use may also become more extensive, including a projected increase in loading of phosphorus and chloride in watercourses, and a further increase in water temperature. In addition to the impacts associated with built urban areas, there are also a number of issues associated with the building phase of new development. Development 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.

As in agricultural landscapes, the contribution of sediment and phosphorus can have deleterious impacts on species living in nearby streams by increasing water temperatures, decreasing levels of dissolved oxygen, and disturbing spawning sites. Other contaminants that occur in stormwater runoff from the urban parts of these subwatersheds, however, include phenolics, metals, and organic compounds (Figure 7-6). At high levels, these contaminants can interfere with enzyme activity in aquatic organisms, leading to changes in behaviour, movement, predator avoidance, feeding rates, reproduction, reduced growth rates or even death. At this point, effects due to the presence of these contaminants in the more urban areas of the subwatershed are unknown due to limited monitoring information in the area; however with the lack of stormwater controls it can be assumed that they are having some impact on subwatershed health.

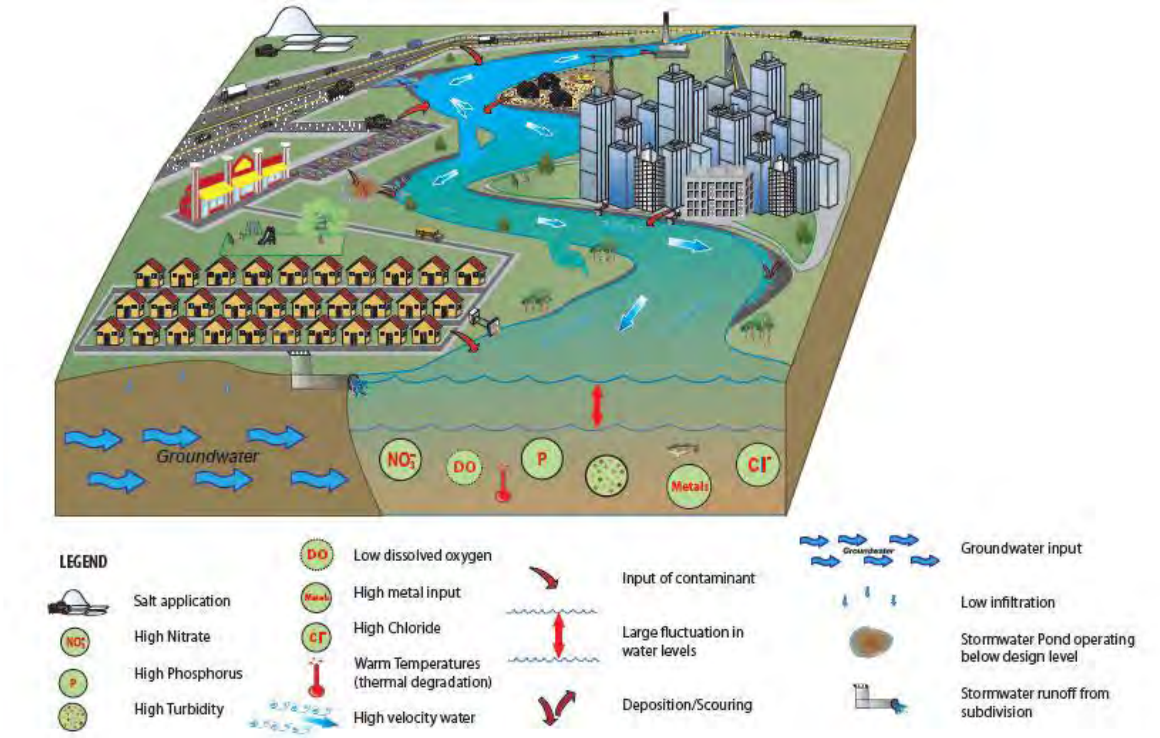



**Figure 7-6: Influences of urban land use on subwatershed health**

Complicating matters further is our management of snow. Where, historically, snow would accumulate in the forest, melt, and form a spring freshet, providing flooded areas along the banks of rivers which act as spawning sites for species such as northern pike or muskellunge, it is now diligently cleared from city streets, parking lots and sidewalks, and often relocated to designated disposal sites to improve mobility and decrease the risk of injury or car accidents. In many cases, salt is also applied to roads and parking lots to decrease the temperature at which ice freezes. The result of this snow removal, however, is a significant change to the timing, volume, location, and chemical composition of the spring freshet (Figure 7-6). Increasing concentrations of chloride in watercourses can decrease feeding and growth rates in fish and, if they reach acute chloride concentrations, can lead to widespread mortality in fish and other aquatic organisms. Chloride concentrations at the Ramara Drain site fall well below the guideline for chronic exposure. It is too early yet to determine trends for this station; however given that the majority of other Lake Simcoe water quality stations, and areas throughout the province and beyond, are displaying increasing trends in chloride concentrations, it is possible that these this station is not necessarily representative of the entire study area, due to its location. This station is located away from large roadways and urban areas, and may not be showing the influence of these types of land uses. Additional monitoring around the study area, in a wider varity of land use types, would give us a better understanding of chloride concentrations in the subwatershed, and could potentially identify chloride ‘hot spots’ that should be targeted for chloride reduction activities.

Other methods of reducing salt application on roads include carefully calibrating the application of salt to the temperature of the road, ensuring that snow meltwater does not drain directly into storm sewers, or using treatment measures other than chloride in areas that are particularly sensitive to contamination.

Additionally, as stormwater flows over urban areas, it tends to reach creeks more quickly than it would when flowing over natural areas. As a result, streams can exhibit both a decrease in baseflow levels and an increase in flow rate and volume during high flow events. Both of these stresses can make aquatic environments less suitable as habitat for resident fish, due to a loss of habitat during low flow periods, and an increase in the energy necessary to manoeuvre through the creek during high flow events. This increased velocity also can increase the rate of erosion of exposed soil or streambanks, increasing the amount of sediment that gets deposited in the creek, and can increase the transport of contaminants. The flow of stormwater over hardened urban surfaces such as roads, parking lots, sidewalks, and asphalt shingles also tends to increase its temperature. As such, urban stormwater can increase the temperatures in urban creeks, making them unsuitable habitat for more sensitive species (Figure 7-6). While Ramara remains a largely agricultural community, it is important to bear this in mind for the existing urban areas, as well as those that will be built into the future.

While it is difficult to identify a particular source of nutrient enrichment, the area of dense plant growth in McPhee Bay and Barnstable Bay and relatively high sediment phosphorus levels along the Ramara shoreline (Figure 5-5) may be a result of nutrient inputs from the urban areas along the lake shore in this area. This area is one of several areas around the lake which have one or more conditions that make them favourable for aquatic plant growth – these are generally sheltered bays with soft substrates and sufficient quantities of available nutrients to encourage the dense growth of plants. Further research in this area may help to further identify the sources of phosphorus that are contributing to this plant growth.

As in agricultural landscapes, the preservation of native vegetation along watercourses plays an important role in slowing the velocity of stormwater, collecting sediment, capturing phosphorus and nitrogen, and binding the soil on the banks of the river (Figure 7-7). The preservation of native vegetation along roadsides also plays an important role in protecting the health of urban watersheds, as windbreaks of this sort help reduce the accumulation of blowing snow on highways, thus reducing the need to apply sand or salt to roads (Figure 7-7). In addition, the presence of vegetation directly alongside waterways, such as in Lagoon City and along the lakeshore, will discourage the use of those areas by waterfowl, which contribute to water quality issues.

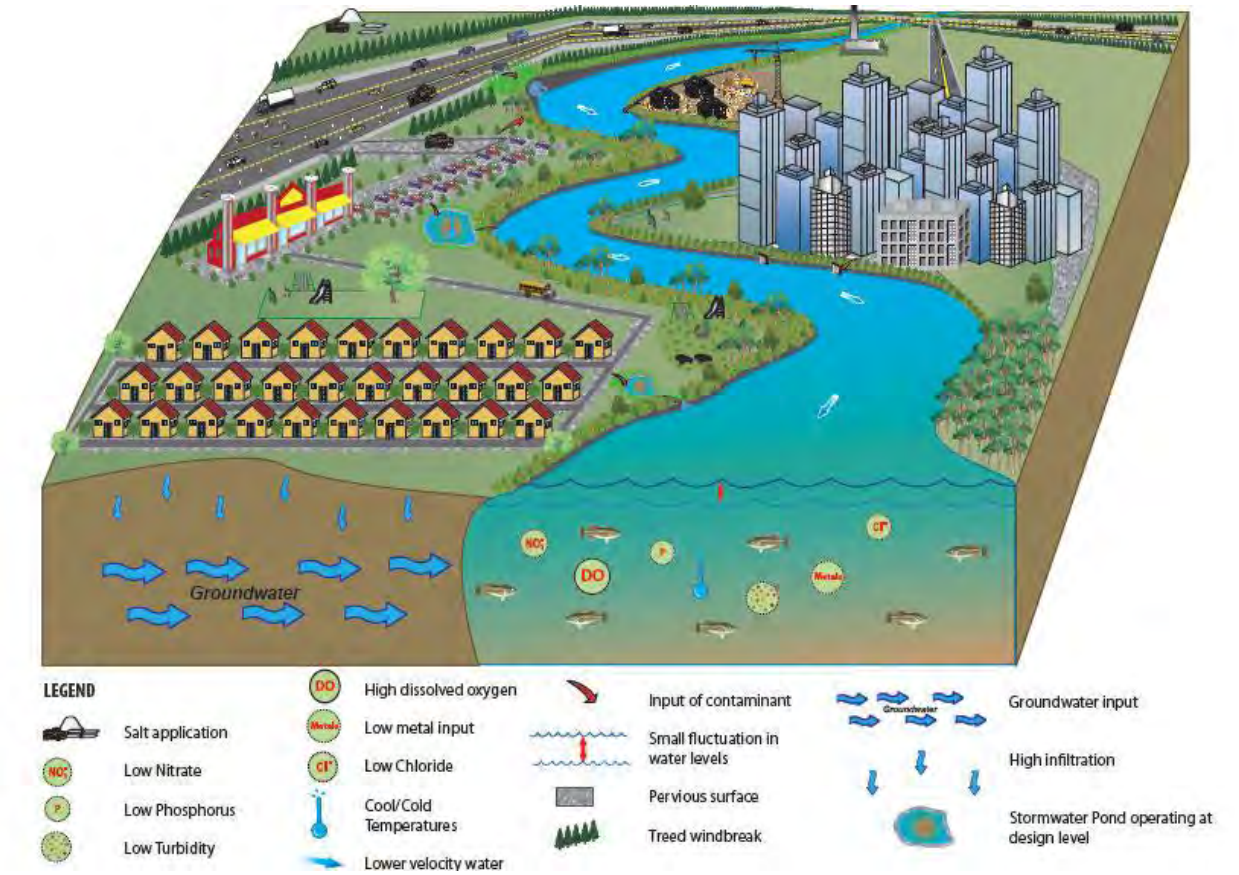



**Figure 7-7: An urban landscape with appropriate best practices implemented to protect subwatershed health**

One of the standard ways of addressing the concerns associated with urban stormwater runoff is the use of stormwater ponds. Stormwater ponds are designed to trap sediments to improve the quality of the stormwater, which is ultimately released back into the watershed. Without proper maintenance, however, stormwater ponds can operate below their designed efficiency, and can contain sediments which have high concentrations of phosphorus, chloride, heavy metals, and petrochemicals. In extreme cases, during high flow events, some un-maintained stormwater ponds can actually act as a source of contaminants to nearby watercourses. As well, the large surface area of stormwater ponds tends to contribute to an increase in water temperature. As such, stormwater ponds have the potential to negatively impact the thermal regime of nearby watercourses, decreasing habitat quality for sensitive fish species. Poorly maintained stormwater ponds can also be detrimental to bird and amphibian populations, which often utilize them as breeding habitat as wetlands are lost from urbanizing landscapes. However, if the stormwater ponds are hypoxic, surrounded by unsuitable habitat or roads, or have high concentrations of other contaminants, they can cause reductions in reproduction rates and overall survival for these species (Figure 7-6). There are few stormwater facilities in the Ramara Creeks subwatershed, and these issues are therefore limited in scope; however it is important to ensure that existing facilities are maintained so that they function as designed, and don't contribute to water quality issues in the subwatershed.

The best way to manage stormwater runoff in urban areas is to reduce the volume of run-off through the use of Low Impact Development. Low Impact Development (LID) is a term that refers to a suite of innovative design solutions that can be incorporated into new developments, with the goal of increasing the amount of stormwater that infiltrates into the ground and decreasing the amount that flows over land. Tools in the LID toolbox include green roofs, infiltration swales, permeable pavement, and a greater focus on retaining urban forest cover. Other, secondary treatments include proper site control during construction, ongoing maintenance of stormwater ponds, the upgrade of stormwater ponds built with earlier technology, and the establishment and preservation of riparian buffers (Figure 7-7). Despite the challenges to watershed health associated with the limited amounts of stormwater control in the study area, there remain significant opportunities both in existing areas, and with new development, for the implementation of innovative low impact development techniques, as well as to use innovative design for stormwater management ponds and retrofits.

Stewardship projects have generally been limited to agricultural areas in this subwatershed, but there are also a number of opportunities to improve conditions in the urban areas, such as increasing the extent of riparian buffers and upgrading and/or retrofitting stormwater ponds (Figure 7-4, Figure 7-5).

## 7.5 In-stream interactions - activities in and near creeks, water quality, and aquatic wildlife

In addition to actions being undertaken across the watershed as whole, actions in or near creeks can have even more direct impacts to hydrologic and ecologic systems. The riparian buffers along the edges of watercourses or the lake make important contributions to aquatic wildlife, as the plant debris that is dropped into the water body provides an important food source for aquatic invertebrates, which form the base of aquatic food webs. The shade provided by vegetation along the banks, particularly for small streams like many of the tributaries in this subwatershed, plays an important role in reducing water temperature in mid-summer, which is a particularly important factor in providing habitat for more sensitive species. Riparian vegetation also makes an important contribution to terrestrial wildlife, acting as a productive source of food for many species, and acting as a migration corridor through landscapes that are often otherwise lacking in native vegetation. In fact, given the fragmentation of habitat by roads, agriculture, and urban communities in parts of this subwatershed, riparian zones can provide some of the best opportunities to maintain and increase connectivity for wildlife.

When this vegetation is cleared, these benefits are lost. The impacts of lost riparian vegetation can be exacerbated by other more extreme interventions such as stream channelization, bank hardening, or converting free-flowing streams to underground pipes. These types of interventions remove habitat for aquatic species, and increase the velocity of water, causing an increase in erosion downstream of the hardened or enclosed site, or in areas where the hardening begins to fail, which in turn increases sedimentation and phosphorus inputs (Figure 7-8). In the case of agricultural drains, periodic maintenance intended to promote efficient draining prohibits the establishment of trees along one (or both) sides of the drain, and causes disturbance to fish habitat and water quality while maintenance is occurring.


**Figure 7-8: Influences of riparian land use on subwatershed health**

These impacts can also be worsened in ponds or reservoirs created by barriers on creeks. The ponds created by these barriers increase the amount of area exposed to the sun, and as such increase water temperature, potentially encouraging the enhanced growth of aquatic plants, algae, and bacteria, and a decrease in oxygen levels when these plants and algae decompose. Barriers erected on creeks also fragment fish habitat, impeding the seasonal travel of migrant spawners such as white sucker, and impeding the ability of other species to disperse through the drainage network. Over time, barriers can lead to a loss in fish biodiversity, as isolated stream reaches become more vulnerable to local extinctions (Figure 7-8). Septic systems, which support many of the rural residences in this subwatershed, can also be a source of phosphorus to nearby watercourses and can impact water quality, if they are not properly maintained.

Creek-based stewardship activities beyond the establishment of additional riparian vegetation can be difficult however, as projects related to channel restoration can be extremely expensive, and in agricultural or developed areas, options to establish a naturally meandering channel can be extremely constrained due to conflicting land uses. Despite that, the Lake Simcoe Region Conservation Authority and a number of community partners have been able to undertake a number of projects in the Ramara Creeks subwatershed in recent years to improve fish habitat, reduce temperatures, and reduce phosphorus loading. Many more opportunities to remove barriers from creeks and naturalize creeks which have been channelized remain in this subwatershed, where adjacent land uses permit (Figure 7-4, Figure 7-5).

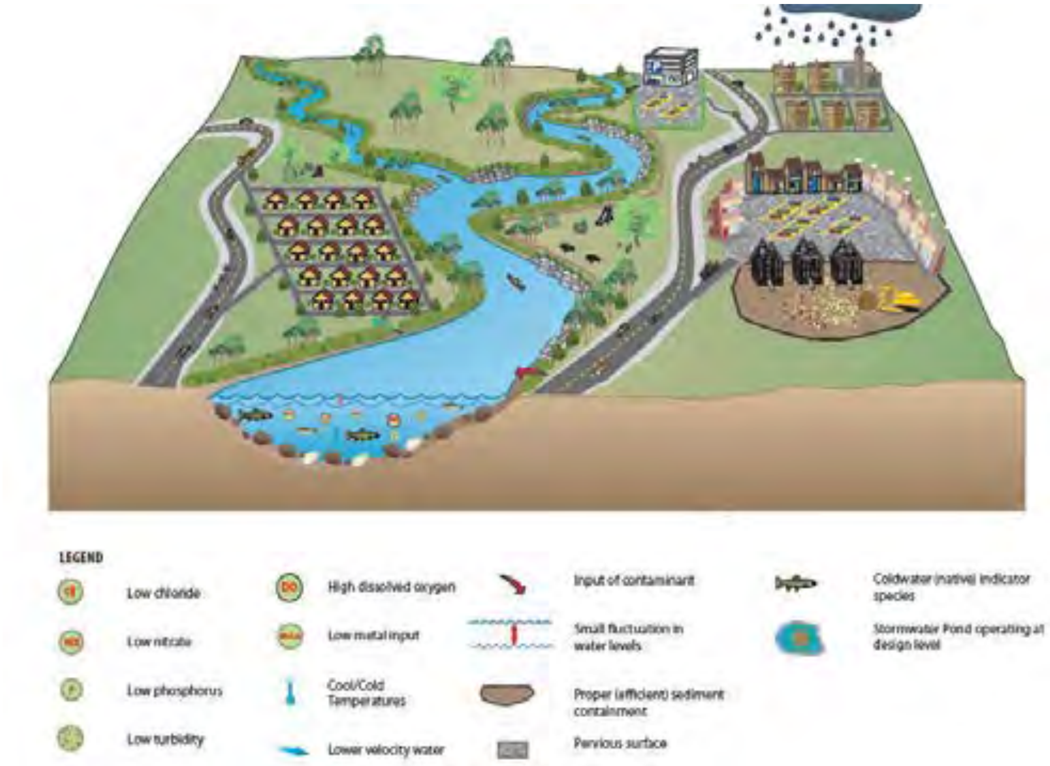



**Figure 7-9: Riparian area with appropriate best practices implemented to protect subwatershed health**

## 7.6 Shoreline interactions - activities in and near the lakeshore, water quality, and aquatic wildlife

Of particular importance to this subwatershed is the role played by the Lake Simcoe shoreline. The shoreline along the Township of Ramara has been the focus of development and public use for nearly a century, which has led to an increase in the extent of impervious surfaces and hardened banks, and increased population levels (Figure 7-10). A large proportion of the native vegetation has been removed from the shoreline in this subwatershed, and what is left is often mowed right to the water's edge.

The loss of shoreline vegetation has negative impacts on nearshore aquatic communities, through an increase in water temperature and sediment input, and a decrease in input of woody debris (which is an important component of habitat for many aquatic organisms). Unfortunately, the impacts of this loss of vegetation ares often exacerbated by other works along the shoreline, such as the installation of concrete, steel, or gabion baskets as retaining walls to prevent erosion or to make the shoreline more conducive for recreation. The loss of the natural shoreline and associated aquatic vegetation associated with this construction means a loss of spawning and feeding habitat for native fish (Figure 7-10). In the unique area of Lagoon City, although the watercourses are man-made, the intensity of the development, the presence of the concrete shore walls, the lack of flow in the canals, and the absence of stormwater controls have tended to intensify these effects, resulting in a number of issues. These include the growth of harmful blue-green algae blooms, and the prolific growth of aquatic plants, which requires mechanical harvesting for area residents to have use of the canals.

This type of shoreline development, in combination with an increase in impervious surfaces, also increases the amount of contaminants in runoff. Increased nutrients and an increase in temperature create an ideal growing situation for algae and aquatic plants, which can be a nuisance to swimmers and boaters, and can also create anoxic conditions for aquatic communities.  Shoreline areas are also disproportionately important for terrestrial wildlife as well, as the clearing of shoreline areas for cottages or homes leads to loss of habitat for songbirds, amphibians, turtles, and small mammals.

Although the development of individual shoreline properties may seem small in nature, the cumulative effect of all of these small developments can add up to significant impacts. The Ramara Creeks subwatershed's shoreline, which represents 18.5% of the total lakeshore, has already had close to 80% of its length developed in some way.

Stewardship options for shoreline properties are quite similar to those for riparian areas, and include septic system repairs, shoreline naturalization, erosion control projects, and tree planting (Figure 7-11).  Financial and technical support for these types of projects is provided by the MNR and LSRCA.

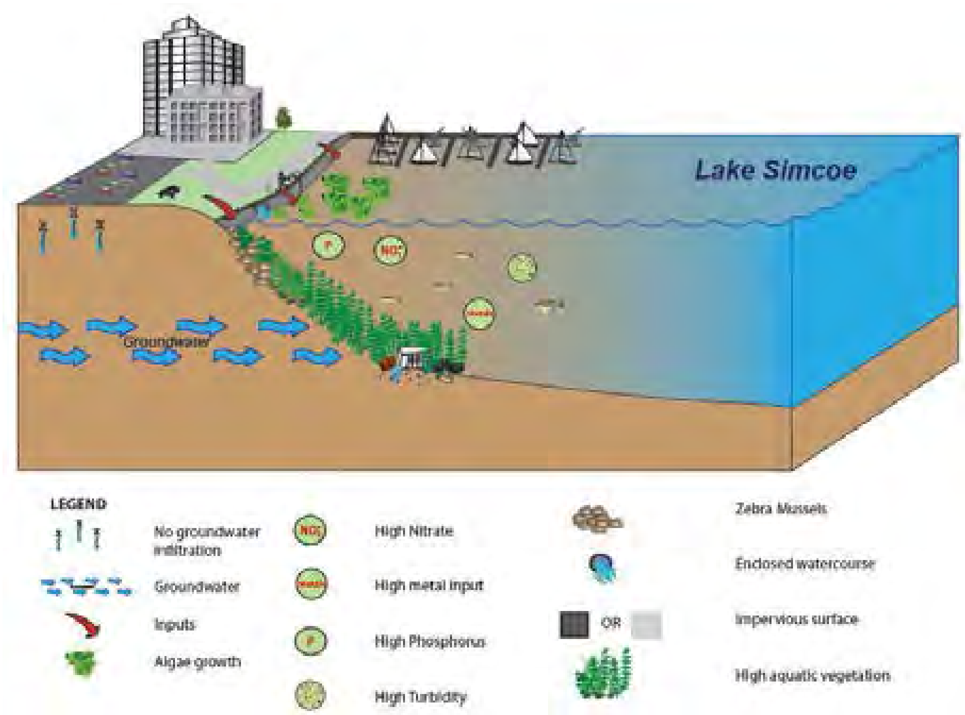



**Figure 7-10: Influences of shoreline land use on subwatershed health**

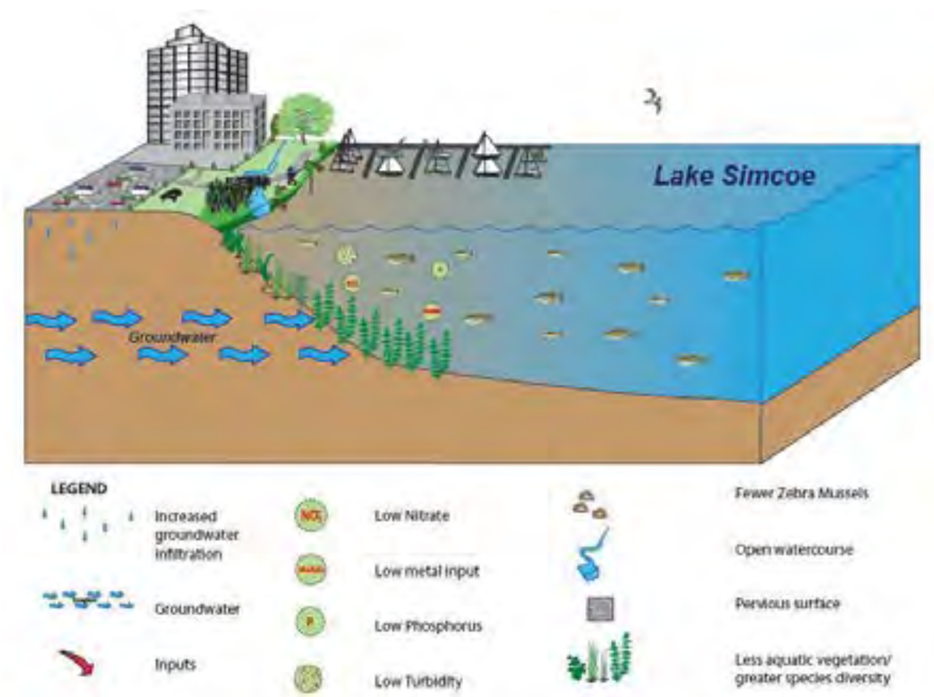



**Figure 7-11: Shoreline area with appropriate best practices implemented to protect subwatershed health**

## 7.7 Developing an implementation plan

The Ramara Creeks Subwatershed Plan includes an assessment of the current state of the environment in the subwatershed, the stressors upon its health, and the current management framework to address those stressors. As a result of that assessment, the subwatershed plan has developed a list of recommended actions which, if implemented, would provide additional guidance on the protection and restoration of that subwatershed.

Achieving these recommendations will require the coordinated response of multiple government agencies, and many individual landowners, working together in a multifaceted approach to protecting and improving subwatershed health. To ensure these actions are fostered and coordinated, this subwatershed plan will be complemented with a Subwatershed Implementation Plan, as well as a Subwatershed Implementation Working Group.

The Subwatershed Implementation Plan is a brief document, intended to provide the necessary support and direction to achieve a short list of priority recommendations within five years of the completion of this subwatershed plan. To meet that goal, the implementation plan is written with more specific detail on timelines, deliverables, and the specific steps necessary to achieve those priority recommendations.

This implementation plan will also form the basis of periodic meetings of the Subwatershed Implementation Working Group, a watershed-wide group comprised of upper and lower tier municipalities where subwatershed plans have been completed, provincial Ministries of the Environment and Climate Change, Natural Resources and Forestry, and Agriculture, Food, and Rural Affairs as well as the Lake Simcoe Region Conservation Authority, and other relevant stakeholders. These representatives, who are the primary lead agencies on the recommendations developed in this and other implementation plans, will meet periodically to coordinate and report on implementation of the priority recommendations. This group will also assist in periodic review and updates to this subwatershed plan.

# 8 Combined Recommendations

This chapter provides a compiled list of the recommendations identified in the detailed technical chapters of this subwatershed plan. These recommendations will be brought forward and prioritized in the development of an implementation plan for the Ramara Creeks subwatershed.

The recommendations in this chapter have been grouped into categories of similar issues. Thus, for example, recommendations derived from the terrestrial natural heritage chapter may be grouped with recommendations derived from the water quality chapter, in cases where they address shared issues. In such cases, the numbering system will allow the reader to trace the recommendation back to the chapter where it originated.

Recommendations in the following list are numbered as chapter number – recommendation number. In cases where a recommendation originated from more than one chapter, it is numbered based on its first occurrence, with all other occurrences listed in parentheses.

It is recognized that many of the undertakings in the following set of recommendations 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 more fully in the implementation phase.

## 8.1 Protection and Policy

### 8.1.1 Official Plan consistency

**Recommendation 6-1** - That the LSRCA, and relevant provincial agencies assist Ramara Township in ensuring its official plan is consistent with the recommendations presented in the Ramara Creeks subwatershed plan, as approved by the LSRCA Board of Directors. This approval will be subsequent to consultation with the Township, the subwatershed plan working group, and the general public, as outlined in the *Guidelines for developing subwatershed plans for the Lake Simcoe watershed (May, 2011).*

### 8.1.2 The adaptive watershed planning process

**Recommendation 8-1** – That the LSRCA and other relevant and interested stakeholders establish an implementation working group to assist in coordinating the implementation priority recommendations to address the most significant threats in these subwatersheds.

**Recommendation 8-2** – That the LSRCA, with the assistance of the other government agencies and stakeholder groups involved in implementing the recommendations of this subwatershed plan, report on the progress of this implementation annually.

**Recommendation 8-3** – Within five years of the completion of this subwatershed plan, that the LSRCA, in collaboration with MOECC, MNRF, subwatershed municipalities, and other interested and relevant stakeholders, review progress on achieving its recommendations and update the subwatershed plan accordingly.

### 8.1.3 Protecting Natural Heritage

**Recommendation 6-2** – That the MNRF, MOECC, and LSRCA review the terrestrial natural heritage data provided by the comprehensive monitoring program, when it becomes available, to define site level characteristics or indicators of 'high quality' natural heritage features, and provide policy recommendations to subwatershed municipalities (as necessary) to ensure high quality natural heritage features are adequately protected from development and site alteration.

**Recommendation 6-3** - That LSRCA, in partnership with subwatershed municipalities and other interested stakeholders, develop policies for municipal Official Plans that would provide mitigation and restoration for development and site alteration within natural heritage features that are not defined as "key" by the Lake Simcoe Protection Plan or as "significant" under municipal official plans, to ensure no net loss in overall natural vegetative cover as a result of development.

**Recommendation 6-4 –** That the MNRF, OMAFRA, LSRCA, Township of Ramara, and interested members of the agricultural community review the results of the studies being conducted on methods and policy tools to protect grassland dependent wildlife on active agricultural land as they become available, to determine if they provide solutions for the conservation of grassland habitat which would be applicable for this subwatershed.

**Recommendation 6-5** – That the Township of Ramara, with the assistance of the MNRF and LSRCA, give consideration to including policies in its Official Plan to contribute to the protection of grassland habitats, as necessary, based on the results of Recommendation #6-4, and recognize the need for balance in the approach to development in urban areas.

### *8.1.4 Reducing impact of land use – groundwater recharge and discharge*

**Recommendation 4-4** – That the Municipality, in the context of LSPP Policy 6.37-SA, adopt the 'Guidance for the protection and restoration of significant groundwater recharge area in Lake Simcoe' document. Further, that the Municipality utilize this document to incorporate policies around significant groundwater recharge areas into their official plans, as per LSPP Policy 6.38-DP.

**Recommendation 4-5** – That the Municipality adopt the 'Guidance for the Stormwater Management Policy in Lake Simcoe' document, following its completion. Further, that the Municipality utilize this document to incorporate policies around stormwater management into their official plans, as per LSPP Policy 4.7-DP.

**Recommendation 4-6** – That the MOECC amend the Environmental Compliance Approvals application form and Guide to recognize the importance of protecting Ecologically Significant Groundwater Recharge Areas and Significant Groundwater Recharge Areas.

**Recommendation 4-7 -** The Lake Simcoe Region Conservation Authority should create eligibility for infiltration projects under the LEAP, targeting funding to those in ecologically significant groundwater recharge areas in order to maintain existing groundwater recharge functions

### *8.1.5 Incorporating LSPP objectives in Environmental Assessments*

**Recommendation 6-6** – That the proponents and reviewers of all Environmental Assessments recognize the intent and targets of the Lake Simcoe Protection Plan when developing and assessing alternatives to the proposed undertaking.

**Recommendation 6-7** – That reviewers of Environmental Assessments for municipal infrastructure in the Lake Simcoe watershed, including subwatershed municipalities, MTO, LSRCA and MOECC (when reviewing such documents), give due consideration to the preservation of barrier-free connectivity for wildlife between nearby wetland and upland habitats. This should include due consideration of alternate route configuration, the use of wildlife crossing structures, and/or the use of traffic calming measures (such as signage, including the use of electronic signs at peak migration times; road re-design; and speed bumps) in critical locations.

### 8.1.6 Improving stormwater management

**Recommendation 3-7 -** That the Township of Ramara finalize their draft Stormwater Management Master Plan as outlined in the LSPP 2011 Comprehensive Stormwater Management Master Plans Guidelines document with particular emphasis on maintenance of facilities, and the need for retrofits where appropriate.

### 8.1.7 Promoting Low Impact Development

**Recommendation 3-**That LSRCA, with the support of MOECC, provide a white paper to watershed municipalities describing the range of possible LID technologies to mitigate the impacts of development on surface and groundwater quality and quantity. Further, that LSRCA and watershed municipalities identify the barriers associated with the uptake of LID technology and, with the support of MOECC, develop recommendations for overcoming these barriers.

**Recommendation 3-9-** That the Official Plan be amended to contain policies that would help minimize impervious surface cover in the Ramara Creeks subwatershed (recognizing that a similar policy exists for the Shoreline Residential designation), through requirements such as retrofitting low impact design solutions and limiting impervious surface areas on new development.

### 8.1.8 Improving construction practices

**Recommendation 3-10 -** That the LSRCA and the Township of Ramara promote and encourage the adoption of best management practices to address sedimentation and erosion controls during construction and road development. This may include, but will not be limited to, more explicit wording in subdivision agreeements detailing what is required in this regard.

**Recommendation 3-11 –** That the Township of Ramara and LSRCA review and, where necessary, revise current monitoring, enforcement, and reporting on site alteration and tree cutting by: 1) undertaking a review of the current programs and actions, 2) encouraging the allocation of adequate resources for the improvements, and 3) monitoring and reporting on results.

### 8.1.9 Land securement by public agencies

**Recommendation 6-8** – That the LSRCA and subwatershed municipalities should continue to secure outstanding natural areas for environmental protection and public benefit, through tools such as land acquisition or conservation easements, and should support the work of Land Trusts doing similar work.  Priority areas identified by LSRCA's Land Securement Strategy in the Ramara Creeks subwatershed  are the Lagoon City, Barnstable Bay, and Joyland Provincially Significant wetlands.

**Recommendation 6-9** – That the LSRCA and subwatershed municipalities, with the assistance of the MNRF, continue to refine their land securement decision processes to ensure that they are securing natural areas that are critical to the health of the watershed (or securing and restoring areas which have the potential to become critical to the health of the watershed), but which are otherwise vulnerable to loss through incompatible land uses.

**Recommendation 6-10** – That the Federal, Provincial, and Municipal governments provide consistent and sustainable funding, and that the Township utilize its parkland dedication process, to support securement of notable natural areas.

## 8.2 Restoration and remediation

### *8.2.1 Improving stormwater management*

**Recommendation 3-2 -** That federal and provincial governments provide sufficient financial incentives, or otherwise address barriers identified in Recommendation #1, to ensure subwatershed municipalities adopt Low impact Development (LID) practices and promote the adoption of Smart Growth Urban Design Guidelines.

**Recommendation 3-4 -** That the Township of Ramara, in cooperation with LSRCA, 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; enhance urban tree cover; where conditions permit, the use of soakaway pits, infiltration galleries, permeable pavement and other LID solutions; 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.

**Recommendation 3-5 -** That the Province of Ontario, through the implementation of the Lake Simcoe Phosphorus Reduction Strategy, provide significant incentive funding to the Township of Ramara and/or the LSRCA to maintain, construct and /or retrofit stormwater facilities and/or Low Impact Development practices as identified in the Township's Stormwater Management Master Plan.

**Recommendation 3-6 -** That the Township of Ramara routinely monitor and maintain the design level of existing stormwater facilities. In addition to maintaining design level, criteria for maintenance should also include frequency and exposure to spills and other contaminant sources. Further, that the federal and provincial governments be requested to share in the cost of maintenance.

**Recommendation 3-8 -** That the LSRCA and its partners recognize that while the construction and/or retrofit of quality control facilities is extremely important, quantity control may be a consideration in some areas of the Ramara Creek subwatershed; therefore, quantity control facilities should be constructed in those areas where geographical space is limited or other LID options are not feasible. In these situations, federal and provincial governments should provide financial incentives to allow the Township to complement quantity control storm water ponds with an enhanced street sweeping program.

**Recommendation 3-20** - Given the anticipated challenge in using stormwater pond retrofits to offset phosphorus loading from projected growth areas in the Ramara Creeks, Talbot River, and Upper Talbot River subwatersheds, that the LSRCA assess the feasibility of expanding the Lake Simcoe Phosphorus Offsetting Program (LSPOP) to support phosphorus-reduction projects on agricultural land in these subwatersheds

**Recommendation 3-21**– As new or retrofit stormwater facilities are constructed, LSRCA will work with municipalities to reduce potential thermal impacts of those stormwater ponds and to recognize the importance of LID uptake in relation to maintaining stream temperature.

**Recommendation 4-9 -** That the Township of Ramara, in partnership with LSRCA, should undertake works to naturalize swales within Lagoon City in order to achieve benefits to the system related to preserving water quantity and maintaining flow within the system.

### *8.2.2 Managing water demand*

**Recommendation 4-1 -** That the MOECC continue to improve the Water Taking Reporting System by integrating the Permit To Take Water (PTTW) database with the Water Well Information System (WWIS) database, and connecting those takings to wells / aquifers to facilitate impact assessment (i.e. the PTTW database needs to be connected to the WWIS database).

**Recommendation 4-3** – That the MOECC and MNRF require the LSPP Tier 2 integrated model (or another, comparable model, if deemed appropriate) be used to simulate proposed dewatering activities associated with aggregate operations near the Ramara Creeks subwatershed, and the impacts they would have on stream and wetland features in the subwatershed prior to issuing or renewing Permits to Take Water or aggregate permits. When reviewing aggregate applications, the MOECC is encouraged to collect the most up to date extraction, pumping, and groundwater level data, and use the data to update the integrated model.

**Recommendation 4-8** – The Federal and Provincial governments should consider extending programs like Lake Simcoe Clean Up Fund and Showcasing Water Innovation to improve water quantity in these areas.

### *8.2.3 Managing agricultural impacts*

**Recommendation 3-3** – That support for the implementation of innovative practices for tile drains, such as the installation of micro-wetlands at the outlets or tile drain control structures, will be offered to interested landowners, and that these projects be monitored to determine their benefits to both the receiving waterbody and the farmer.

**Recommendation 3-18 -** That the watershed municipalities, through the LSRCA, create a roundtable made up of municipalities, OMAFRA, MOECC, OFA, BILD, NGOs and related landowner representatives, or through the expansion of existing frameworks such as the Lake Simcoe Stewardship Network, to determine co-operative ways of implementing phosphorus reduction measures in the Ramara Creeks subwatershed, and to develop an ‘action plan’ for their implementation within the agricultural and rural communities.

**Recommendation 4-15 (5-10)** - That the LSRCA, in partnership with the province and the municipality, work with landowners to naturalize the agricultural drainage channels in the subwatershed to increase ecological resilience of the surface water system. To ensure the continued preservation of naturalization projects the LSRCA, in partnership with the municipality, should carry out an outreach program to educate landowners on the maintenance practices and benefits of naturalized channel design for agricultural drains.

**Recommendation 5-11** – The LSRCA work with the municipality and MAFRA to determine which municipal drains are natural watercourses that have been straightened, and which are created watercourses, and catalog which of these is still in use. Those no longer in use that were historically natural watercourses should be priorities for rehabilitiation as described in Recommendation 5-9 above.

### *8.2.4 Reducing blue-green algae outbreaks in Lagoon City*

**Recommendation 3-17 –** The Township of Ramara, through Lakehead University or other partners, undertake a study of the relative sources and fates of phosphorus in the Lagoon City lagoons. Based on that study, that the Township develop a targeted approach to improving water quality in the lagoons, with the intent of reducing blue-green algae outbreaks.

### *8.2.5 Dealing with indirect impacts to natural areas*

**Recommendation 6-19** – That the County of Simcoe and Township of Ramara, with assistance of MNRF and LSRCA, conduct natural heritage inventories, and develop and implement management plans for publicly accessible natural areas that they own, to mitigate potential threats related to invasive species and increased recreation pressure.

**Recommendation 6-20** – That the MNRF and its partners provide outreach to garden centres, landscapers, and garden clubs regarding the danger of using invasive species in ornamental gardens.

**Recommendation 6-21** – That the Township of Ramara and the County of Simcoe, with support from LSRCA, make information available to residents on the impact of human activities on natural areas. Priority issues include the dangers of invasive species, the importance of keeping pets under control, and the importance of staying on trails while in natural areas.

**Recommendation 6-22** – That the Township of Ramara give preference to native species when selecting trees to be planted in boulevards, parks, and other municipal lands.

### *8.2.6 Increasing uptake of stewardship programs*

**Recommendation 5-1 (6-11)** – That MNRF, MOECC, OMAFRA, and LSRCA continue to implement stewardship projects in the Ramara Creeks subwatershed, and encourage other interested organizations in doing the same.

**Recommendation 5-2 (6-12) –** Governmental and non-governmental organizations should continue to improve coordination of programs to: (1) avoid inefficiencies and unnecessary competition for projects, and: (2) make it easier for landowners to know which organization they should be contacting for a potential project, using tools such as existing networks (including Environmental Farm Plan coordinators), a simple web portal, or other, locally appropriate avenues.

**Recommendation 5-3 (6-14) –** That MOECC, MNRF, LSRCA and other members of the Lake Simcoe Stewardship Network are encouraged to document completed stewardship projects in a common tracking system to allow efficient tracking, coordinating, and reporting of stewardship work accomplished. This could also involve engaging 'project champions' to promote the projects that the have been completed and encourage others to do the same.

**Recommendation 5-4 (6-13) –** That the Federal, Provincial, and Municipal governments be encouraged to provide consistent and sustainable funding to ensure continued delivery of stewardship programs. Further, that partnerships with other organizations (e.g. Ducks Unlimited Canada, TD Friends of the Environment, Royal Bank of Canada, local businesses) be pursued.

**Recommendation 5-5 (6-15) –** The MOECC, MNRF, OMAFRA, LSRCA and other interested members of the Lake Simcoe Stewardship Network support research to determine barriers limiting uptake of stewardship programs in this subwatershed, and share these results with other members of the Lake Simcoe Stewardship Network, to enable agencies and stakeholders to modify their stewardship programming as relevant. This research should include a review of successful projects to determine what aspects led to their success, and how these may be emulated

**Recommendation 5-6 (6-16) –** The MOECC, MNRF, OMAFRA and LSRCA continue to investigate new and innovative ways of reaching target audiences in the local community and engage them in restoration programs and activities (e.g. local radio, Chamber of Commerce, 4H clubs, high school environmental clubs, through Facebook groups, hosting a Lake Simcoe Environment Conference for high schools/science community interaction, and/or including inserts in tax or utility bills). Results of these efforts should be shared with the Lake Simcoe Stewardship Network.

**Recommendation 5-7 –** That LSRCA create and/or publicize link to a website that provides information and contact information on available funding programs for stewardship works, and ensure that this site is kept current.

### *8.2.7 Prioritizing stewardship projects*

**Recommendation 5-8 (3-19)** – That priorized restoration areas identified through the recently developed tool be integrated into a stewardship plan that ensures prioritized restoration opportunities are undertaken as soon as feasible. This stewardship plan needs to incorporate the outcomes of recommendations to improve uptake identified in Recommendations 5-1 through 5-6.

**Recommendation 6-17** – That the LSRCA and MNRF, with the assistance of the MOECC, use their draft 'Delineation of Priority Areas for Restoration' report to develop a spatially-explicit decision support tool to assist in targeting terrestrial stewardship projects in the Lake Simcoe watershed. In the context of the Ramara Creeks subwatershed, this decision tool should take into account factors including:

- The need to increase the extent of natural shoreline and riparian cover
- Protecting and restoring significant groundwater recharge areas and ecologically significant groundwater recharge areas, to help mitigate the expected impacts of climate change
- The need to protect and restore grassland habitat
- Opportunities to enhance resilience to climate change
- The need to balance the needs of wildlife corridors with protection of crops and livestock
- The need to reduce phosphorus loadings to the tributaries.

### *8.2.8 Reducing salt use*

**Recommendation 3-12 -** That LSRCA, with the support of the municipalities, develop a program to determine relative contribution of chloride from road salt application, establish baseline indicators and examine the effectiveness of current protocols on salt storage, application, and disposal, as outlined in their respective Salt Management Plans, adapting them as necessary.

**Recommendation 3-13 -** The LSRCA has recently undertaken an exercise to identify areas in the Lake Simcoe watershed, including watercourses within the Ramara Creeks subwatershed, which are vulnerable to road salt (as outlined by Environment Canada). This assessment may be refined through further examination of relative salt tolerance of local biota. As outlined in Environment Canada's Code of Practice for the Environmental Management of Road Salt, municipalities should examine alternate methods of protecting public safety while reducing environmental impacts in these areas, once identified. These methods should be utilized in the salt vulnerable areas identified through the LSRCA exercise in addition to those areas identified in the Township's Salt Management Plan.

**Recommendation 3-14 -** That LSRCA, in coordination with the municipalities, develop and undertake a program to raise the awareness of property owners, property managers and snow removal contractors on salt application and its environmental impacts. Particular emphasis may be given to those who own or manage property in salt vulnerable areas. The program should reflect BMPs for salt storage and application, as well as appropriate snow disposal.

**Recommendation 3-15 -** Recognizing that increasing concentrations of chloride in watercourses is an emerging issue shared by all municipalities in the Lake Simcoe watershed, that watershed municipalities, academia, LSRCA, MOECC, MTO, and MNRF form a Salt Working Group, or utilize and existing group such as the Simcoe County Road Superintendents, as a mechanism to share information on best practices for salt application, methods of increasing public awareness of the environmental impacts of road salt, and the effectiveness of municipal Salt Management Plans.

**Recommendation 3-16** – That the Township of Ramara consult with the Ministry of Transportation to have street sweeping activities in the subwatershed undertaken earlier in the season to minimize the impact of winter salt and sand in areas lacking stormwater controls.

**Recommendation 6**-**23** – That the Ministry of Transportation, Township of Ramara and the County of Simcoe, in partnership with the Simcoe County Federation of Agriculture, LSRCA, and MNRF, promote and implement, where appropriate, the use of treed windbreaks and/or 'living snowfences' along roadsides to prevent impacts from wind and blowing snow. The creation of a 'living snowfence' involves selectively harvesting crops in order to leave a specified amount of plant material standing along a roadway to facilitate snow accumulation.

## 8.3 Applied science

### *8.3.1 Establishing instream flow targets*

**Recommendation 4-2 (5-9)** –That LSRCA, with assistance from MNRF and MOECC, establish ecological flows (instream) targets for each main tributary. These instream flow targets should be based on the framework established for the Maskinonge River. Once these targets are established, a strategy should be established to achieve them. This strategy should also protect baseflow and location of upwellings in order to maintain thermal stability.

**Recommendation 4-10 –**That the LSRCA, in collaboration with the MNRF and MOECC, utilize the LSPP Tier 2 integrated model in the development of in-stream flow targets and the development of management strategies to address climate change impacts

### *8.3.2 Increasing our understanding of climate change*

**Recommendation 3-22 (4-14)** -That LSRCA work with its federal, provincial and municipal 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. Emphasis at this time should be placed on building ecological resilience in vulnerable subwatersheds through stream rehabilitation, streambank planting, barrier removal, and the implementation of other BMPs, in conjunction with the protection of current hydrologic functions.

**Recommendation 6-18** – That the members of the Lake Simcoe Stewardship Network be encouraged to build into their projects relevant provisions for the anticipated impacts of climate change, such as the need to recommend native species which will be tolerant of future climate conditions, and the likelihood of an increase in invasive plants, pests, and diseases which may further limit the success of traditional stewardship approaches.

### *8.3.3 Monitoring and assessment*

**Recommendation 3-23 (5-12)** - That the LSRCA enhance the existing monitoring network, through the comprehensive monitoring strategy, to address identified limitations and gaps of the current monitoring program. Review of potential enhancements should consider:

- Undertaking periodic monitoring of toxicants such as pesticides and pharmaceuticals
- Spatial coverage of monitoring stations relative to addressing key monitoring questions such as the relationship between changes in land use cover and changes in water quality and quantity

- Establishing new- monitoring stations. A potential location is in the drain discharging into
- Lagoon City, however, the results of studies currently being undertaken in Lagoon City should be reviewed to ensure that the location a new sampling station is appropriate given the conditions in the system
- Monitoring additional parameters that are key indicators of ecosystem health and restoration progress

**Recommendation 4-11** –That the LSRCA expand the surface water monitoring network to the Ramara Creeks subwatershed, and that the data collected be input into the integrated model to improve the interpretation of surface and groundwater flows and interactions in the subwatershed.

**Recommendation 4-12** - That the LSRCA expand the environmental monitoring network to include a climate station in the Ramara Creeks subwatershed; reliable meteorological baseline data will improve climate change predictions and allow for the improved identification of vulnerable areas.

**Recommendation 4-13-** That the MOECC, in partnership with the LSRCA, expand the PGMN network in the subwatershed to improve understanding of groundwater flows and levels in the deeper bedrock system; new wells should be screened in the deeper aquifer units and situated away from the influence of lakes, canals, and other pumping wells.

**Recommendation 6-24** – That the MNRF, with the assistance of LSRCA and MOECC, complement the proposed monitoring strategy with standardized surveys of the distribution and abundance of terrestrial species at risk throughout the Lake Simcoe watershed.

**Recommendation 6-25** – That the MNRF, LSRCA, and OMAFRA continue to maintain an up-to-date seamless land cover map for the watershed, as defined by the LSPP, with natural heritage features classified using Ecological Land Classification, managed in such a way as to allow change analysis.

**Recommendation 3-26** That the LSRCA, in collaboration with MNRF, MOECC, and OMAFRA, develop a program for assessing efficacy of new stormwater facilities, stewardship best management practices, and restoration projects, to improve understanding of the effectiveness of stewardship efforts.

### *8.3.4 Improving data management*

**Recommendation 3-24 (6-28)** –That the MNRF, LSRCA, and MOECC develop a framework to allow effective and efficient management and sharing of data before implementing the comprehensive monitoring program. This framework may include the designation of one agency as the curator of all monitoring data collected in the Lake Simcoe watershed.

**Recommendation 3-25** – The the LSRCA, MNRF, and MOECC analyse and report the results of the existing and proposed water quality, water quantity, and aquatic and terrestrial nautral heritage monitoring programs regularly, and that the information be used to update the LSRCA Watershed Report Card. Further, stakeholders should be made aware when updates are available, and be provided access to the monitoring data collected via a web portal, to increase distribution and communication of this data.

**Recommendation 5-13 –** That LSRCA and its partners work to create a centralized location for reports and resources pertaining to Lake Simcoe and its watershed such that information can be accessed by all interested stakeholders.

**Recommendation 6-26** – That the MNRF and LSRCA take advantage of data that is already available, by developing a biodiversity database that can collate information reported in EIS and EA reports, information reported in natural area inventories, plot-based data collected in the watershed-wide Vegetation Survey Protocol that is underway, plot-based data collected by citizen-scientists for the Breeding Bird Atlas, and other data as may be available.

**Recommendation 6-27** – That the MNRF, with the assistance of the LSRCA, take advantage of this soon-to-be compiled data, and develop lists of watershed-rare taxa, and policies to support their protection.

### *8.3.5 Additional research needs*

**Recommendation 6-29** – That the Lake Simcoe Science Committee, other levels of government, and academia support research to better understand the stresses to wildlife and wildlife habitat associated with urban development, to allow management responses to be refined. Important questions of interest include: the use of stormwater ponds as amphibian breeding habitat, the importance of remnant natural areas to quality of life for local residents, the indirect impacts of roads on resident and migratory wildlife, and the impacts of high density and low density development on wildlife communities in natural areas. This research may include literature reviews, analysis of data available through the monitoring program, or original, innovative, peer-reviewed research.

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# APPENDIX 1

## Public Consultation Comments

**Ramara Creeks subwatershed plan – comments received during public consultation and review period**

| Commenter | Comment | Related Recommendation | LSRCA comments | Changes made |
|---|---|---|---|---|
| Comment at Public Consultation Session | Commenter wondered whether tile drainage increased or decreased phosphorus loading – noted that farmers typically require less fertilizer when fields have tile drains | N/A | - Discussions with OMAFRA and further research have demonstrated that the effects of tile drains on water quality are quite complicated, and dependent on a number of site-specific variables, such as soil type, crop type, what is applied, when it is applied, precipitation patterns, etc | - Recommendation 3-3 refined to reflect voluntary nature of implementing innovative projects and studying their potential benefits to both the farmer and the health of the system<br>- Item added to implementation plan – topics to be discussed through agricultural round table |
| Comment at Public Consultation Session | Suggested looking at installing dykes so that clean water can be released into the lake in the spring, rather than stagnant water in the fall | N/A | - This is beyond the scope of work that LSRCA would normally undertake and would not constitute an appropriate recommendation for this plan | None |
| Pamela Fulford | Please include the Lake Simcoe Islands in your studies, either as an add-on to each one i.e. Strawberry Island added to Ramara Creeks or all the islands done together in one study. This would also bring the First Nations people in at least for Georgina Island | N/A | - At this point, it will not be possible to include Strawberry Island in the subwatershed plan, as we would not have sufficient data to include it. It may be possible to look at its inclusion upon the five-year review of the plan.<br>- We are in the process of developing a subwatershed plan for the islands of | None |

| Commenter | Comment | Related Recommendation | LSRCA comments | Changes made |
|---|---|---|---|---|
| | | | the Georgina Island First Nation (Fox, Snake, and Georgina Islands), in partnership with the First Nation, the province, and the Ontario Centre for Climate Impacts and Adaptation Resources. | |
| OFA | Concern that Ramara Creeks only occupies 5.4% of Lake Simcoe watershed (with 51% of this being agricultural land use), but same principles being applied as in larger subwatersheds with respect to buffers. Also notes that many watercourses dry up and farmers are frustrated that proposed 30 metre buffer would apply in these as well | **Recommendation 6-17** – That the LSRCA and MNR, with the assistance of the MOECC, use their draft 'Delineation of Priority Areas for Restoration' report to develop a spatially-explicit decision support tool to assist in targeting terrestrial stewardship projects in the Lake Simcoe watershed. In the context of the Ramara Creeks subwatershed, this decision tool should take into account factors including:<br>- The need to increase the extent of natural shoreline and riparian cover<br>- … | - We need to be consistent with all Lake Simcoe subwatersheds, regardless of size – some will have more rural issues, while some will have more urban, but we rely on commonly used guidelines and norms to develop our recommendations, understanding that they may need to be treated on a case-by-case basis<br>- This recommendation was developed based on a comparison of measured values of riparian cover in the subwatershed with commonly used guidelines developed by Environment Canada, which is that 75% of a 30 metre buffer on either side of a watercourse be in natural vegetation. We are not proposing that all watercourses have this width of vegetated buffer, but, if there are opportunities to establish natural buffers, even those of less than 30 | None – these projects would only be undertaken with the support of willing landowners on appropriate sites. |

| Commenter | Comment | Related Recommendation | LSRCA comments | Changes made |
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| | | | metres, these would serve to improve the health of the subwatershed. | |
| OFA | Concerns with designation of agricultural drains as watercourses – drains are for farming, and need to be accessible for maintenance. Tree plantings could impair this ability, and tree roots could damage tiles or impede the movement of water. Suggests grassed buffer zones, perhaps 5-10 metres in width, based on findings in a Beacon Environmental study. Also suggests that Ramara Creeks would be an ideal location for researching ideal buffer widths | **Recommendation 3-3** – That the impact of tile drains in this subwatershed be further explored; where they are determined to be having an impact, options to mitigate these impacts, such as the installation of micro-wetlands at the outlets, or the removal of drains in land no longer in production, should be explored where opportunities arise. As is further outlined in Recommendation 5-10, municipal drains that are no longer required for agricultural purposes should be decommissioned and the natural flow of historical watercourses re-established wherever possible. | - Because many drains do contain fish, at least at certain times of year, they are considered fish habitat, as defined by the *Fisheries Act*. The drain classification will indicate whether the watercourse is intermittent, as well as the sensitivity of the fish species found in it, which would dictate any restrictions on the timing of maintenance<br>The goal of achieving the greatest amount of riparian buffer possible given site-specific conditions and the needs of the property owner is reflected elsewhere in the plan; a specific buffer width is not a requirement of the plan. With respect to conducting research on buffer widths, we recognize that a great deal of research has already been undertaken in many jurisdictions on optimal buffer width, so it is likely unnecessary to conduct further studies in this subwatershed. | See changes to Recommendation to 3-3 noted above |
| OFA | Cautions against decommissioning drains that are no longer required for agricultural purposes and re- | **Recommendation 5-10** –That LSRCA work with the municipalities, MAFRA, and | - Given that it is unlikely that many of the agricultural lands in the subwatershed will be used for | **Recommendation 5-10** –That LSRCA work with the municipalities, MAFRA, and |

| Commenter | Comment | Related Recommendation | LSRCA comments | Changes made |
|---|---|---|---|---|
| | establishing natural flow patterns – wondering what criteria would be used. Also concerns around decommissioning drains in agricultural areas due to anticipated effects of climate change. | landowners to examine innovative forms of municipal drain maintenance, or opportunities to create new drains using principles of natural channel design. The partners should also look for opportunities to decommission municipal drains when the land use changes and they are no longer required. | purposes other than agriculture, and due to the concerns raised by the OFA, the reference to decommissioning municipal drains when they are no longer required in Recommendation 5-10 has been removed. | landowners to examine innovative forms of municipal drain maintenance, or opportunities to create new drains using principles of natural channel design. |
| OFA | Regarding the use of treed windbreaks/living snow fences along road sides to prevent impacts from wind and blowing snow: believes it is important to include in the recommendation that farmers are to be fairly compensated for providing this service to the community for the loss of productive crop land if trees are planted and for loss of crop due to accumulation of snow if corn is used as a living snow fence. | **Recommendation 6-23** – That the Ministry of Transportation, Township of Ramara and the County of Simcoe, in partnership with the Simcoe County Federation of Agriculture, LSRCA, and MNRF, promote and implement, where appropriate, the use of treed windbreaks and/or ‘living snowfences’ along roadsides to prevent impacts from wind and blowing snow. The creation of a ‘living snowfence’ involves selectively harvesting crops in order to leave a specified amount of plant material standing along a roadway to facilitate snow accumulation. | At this juncture, funding is available for landowners for the trees that would be planted on their properties. As with the riparian buffer plantings, this program would be strictly voluntary. There are also benefits to landowners, including reduced soil loss from their properties. | None |

| Commenter | Comment | Related Recommendation | LSRCA comments | Changes made |
|---|---|---|---|---|
| OFA | Suggests that, in order to engage the agricultural community, a pilot project be undertaken demonstrating the benefits of tile drain control boxes for tile drainage systems, and offering grants for this type of project through the LSRCA Landowner Environmental Assistance Program | N/A | LSRCA staff has met with Simcoe OFA, and have indicated that they would consult with our OFA members at their June 23 meeting about a process to consider additional farm categories, including tile drain controls. | None – this suggestion is already being acted upon by LSRCA staff in consultation with its OFA partners. |