Submitted to:
City of Orillia

City of Orillia
Comprehensive Stormwater Management Master Plan

Final Report

Prepared by:
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12 February, 2016
Reference: 65538

Aquafor Beech Limited

12 February 2016

City of Orillia
50 Andrew Street South, Suite 300
Orillia, Ontario
L3V 7T5

Attention: **Mr. Kyle Mitchell, B. Sc. Env Mgmt, C.Tech, EPt**
Manager of Water Resources

Dear Mr. Mitchell:

Aquafor Beech Limited is pleased to submit the Final Report for the City of Orillia Comprehensive Stormwater Management Master Plan study. The study was undertaken in accordance with the Lake Simcoe Protection Plan (LSPP) and the Lake Simcoe Region Conservation Authority (LSRCA) Guidelines which aim to protect and revitalize the Lake Simcoe basin. Key objectives in meeting the goals of the LSPP are reduced loadings of phosphorus and other pollutants to Lake Simcoe and its tributaries. The study also follows the Master Planning approach under the Municipal Class Environmental Assessment Process.

The CSWM-MP seeks to reduce the stormwater impacts of urban development through the implementation of effective stormwater management controls and other measures. The recommended plan consists of a suite of five types of traditional and innovative stormwater management measures:

- Pollution control measures;
- Source control low impact development (LID) measures;
- Conveyance control LID measures;
- End-of-pipe controls; and
- Stream restoration works.

We understand that this document will be made available for public review and comment for the statutory 30-day review period required under the Municipal Class EA process.

It has been our pleasure working with the City on the study. Should you have any questions, please contact myself at (905) 790-3885, ext. 276, or Mr. Dave Maunder at extension 290.

Sincerely,
AQUAFOR BEECH LIMITED

LICENSED PROFESSIONAL ENGINEER
G. R. FREW
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APPENDICES

1 Introduction

The City of Orillia covers a geographic area of about 2,800 hectares northwest of Lake Simcoe near the intersection of Highway 11 and Highway 12. Growth forecasts indicate that the city is expected to experience considerable growth in the coming years, with its current estimated population of approximately 30,000, increasing to 41,000 people by the year 2031, according to the City's Official Plan (August, 2013).

Water quality and general environmental degradation due to stormwater runoff impacts from urbanization is a concern in many growing municipalities in Ontario. Urban development alters the natural hydrological cycle as a result of clearing of vegetation and paving of the ground surface (i.e. increasing impervious cover). The alteration is manifested by significant changes in the proportion of precipitation that infiltrates into the ground, evaporates back into the atmosphere and enters drainage features as surface runoff. Effects can include, but are not limited to, increased flooding and stream erosion, thermal impacts, loss of baseflow to local streams, aquatic and terrestrial habitat loss and degraded water quality.

There are four main watershed basins to which stormwater drainage from the City is discharged:

- The Lake Simcoe Drainage Basin.
- The Lake Couchiching Drainage Basin
- Bass Lake Watershed.
- Silver Creek Watershed.

Because the City of Orillia drains, in part, to the Lake Simcoe watershed, there is a requirement to prepare a Comprehensive Stormwater Management Master Plan (CSWM-MP). This requirement arises from the policies of the Lake Simcoe Protection Plan (effective June 2, 2009 through the provisions of the *Lake Simcoe Protection Act, 2008*, S.O. 2008, c. 23, as amended). Policy 4.5 of the Lake Simcoe Protection Plan states that

> *"within 5 years of the date the Plan comes into effect, municipalities, in collaboration with the LSRCA will prepare and implement comprehensive stormwater management master plans for each settlement area in the Lake Simcoe Watershed"*

1.1 Study Objectives

The development of a Comprehensive Stormwater Master Plan is an important step to meet the objectives of the Lake Simcoe Protection Plan (LSPP), specifically:

- Reducing loading of phosphorus and other nutrients of concern to Lake Simcoe and its tributaries
- Reducing discharge of pollutants to Lake Simcoe and its tributaries

Therefore, the overarching objective of this study is the development of a Comprehensive Stormwater Management Master Plan (CSWM-MP) for the City of Orillia in accordance with the:

1. Lake Simcoe Protection Plan (July 2009);
2. Lake Simcoe Region Conservation Authority (LSRCA) Guidelines for the Development and Implementation of Comprehensive Stormwater Management Master Plans in the Lake Simcoe Watershed (April, 2011);
3. Recommendations of the Oro Creeks and Hawkestone Creek Subwatershed Plan (LSRCA, 2013); and
4. The Municipal Class Environmental Assessment Master Planning process, as described by the Municipal Engineers Association (2000, as amended 2007) – Phases 1 and 2.

1.2 Study Process

The study process will follow the steps presented within the LSPP and (LSRCA) Guidelines for the Development and Implementation of CSWM-MP in the Lake Simcoe Watershed (April, 2011). General steps will include:

- Existing Conditions Characterization of the Study Area (subwatershed basis);
- Evaluate the Environmental Impact of Stormwater from Existing and Proposed Development;
- Determine the Effectiveness of Existing Stormwater Management Systems;
- Examination of identified SWM retrofit opportunities;
- Identification and Evaluation of SWM Retrofit Opportunities (new facilities or retrofit of existing);
- Identification of a Recommended Approach for Stormwater Management for the City of Orillia; and
- Development of an Implementation Plan.

1.3 The Class Environmental Assessment Process

The Environmental Assessment Act was legislated by the Province of Ontario in 1980 to ensure that an Environmental Assessment is conducted prior to the onset of development and development related (servicing) projects. Depending on the individual project or Master Plan to be completed, there are different processes that municipalities must follow in order to meet Ontario's Environmental Assessment requirements.

The Comprehensive Stormwater Management Master Plan study will be prepared following a Master Planning approach under the Municipal Class Environmental Assessment Process. The long range planning approach that is undertaken within the process will enable the City of Orillia to identify opportunities and be proactive in addressing issues before they become a problem. It will also allow the City to implement individual works which, over time, collectively become part of a larger management system.

Class Environmental Assessments (Class EA) are prepared for approval by the minister of the environment. A Class EA is an approved planning document that defines groups of projects and activities and the environmental assessment (EA) process which the proponent commits to for each project undertaking. Provided the process is followed, projects and activities included under the Class EA do not require formal review and approval under the EA Act. In this fashion the Class EA process expedites the environmental assessment of smaller recurring projects.

The Municipal Class Environmental Assessment Master Planning process to be followed in this study is illustrated in Figure 1.1, and may involve up to five phases of assessment. These phases include:

- **Phase 1**: Establish the Problem or Opportunity
- **Phase 2**: Identify and Assess Alternative Solutions to the Problem, and Select a Preferred Alternative
- **Phase 3**: Identify and Assess Alternative Design Concepts for the Preferred Solution, and Select a Preferred Design Concept.
- **Phase 4**: Prepare an Environmental Study Report
- **Phase 5**: Proceed with Design and Implementation.

Public and agency consultation is an important and necessary component of the five phases.

In partial fulfillment of Ontario’s Environmental Assessment requirements, a Master Plan must satisfy at least the first two phases of the Class Environmental Assessment process. Depending on the type of Master Plan to be completed, Phases 3 and 4 may also be required.

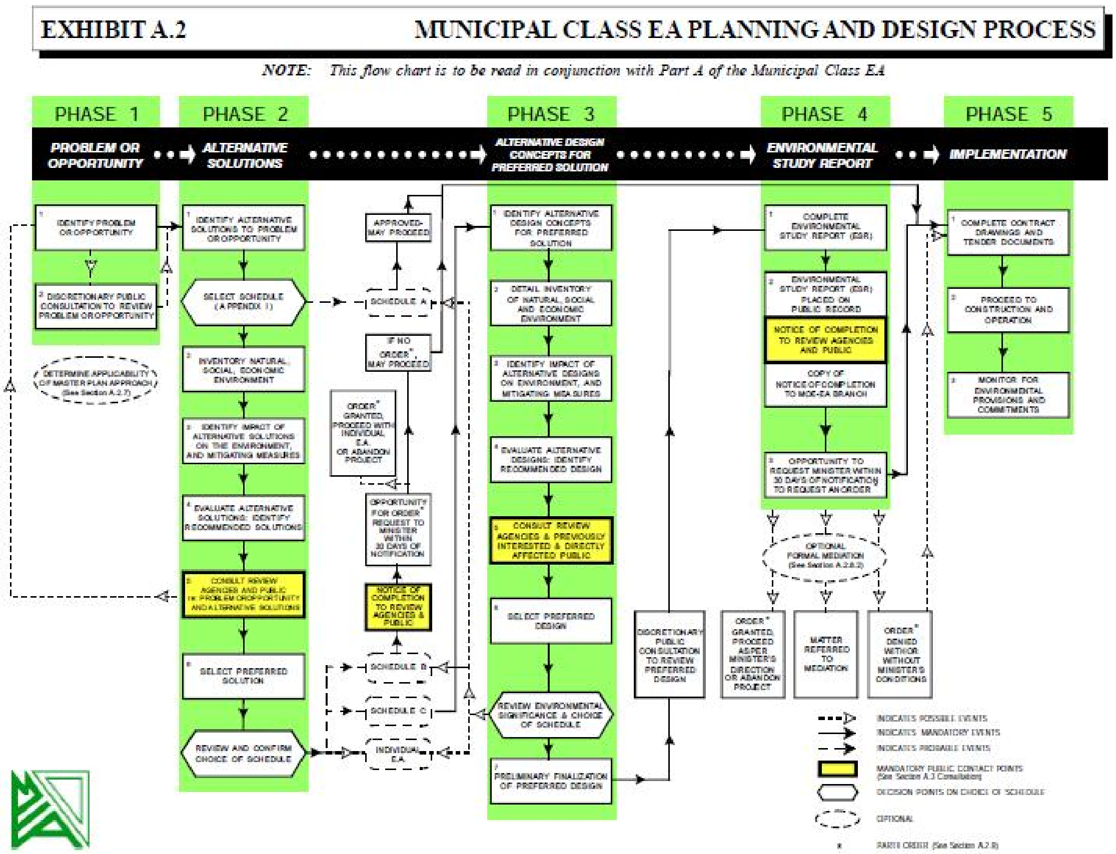


Figure 1.1: MEA Planning and Design Process

The Municipal Engineers Association’s Class EA document also classifies projects as Schedules A, A+, B or C depending on their level of environmental impact and public concern. Any project identified in this Master Plan must be classified as to their level of complexity and potential level of environmental impact, which will in turn decide which Schedule process needs to be followed.

- **Schedule ‘A’** projects are generally routine maintenance and upgrade projects; they do not have the potential for significant environmental impacts or need public input. Schedule ‘A’ projects are pre-approved without any further public consultation.
- **Schedule ‘A+’** Introduced in 2007 by the Municipal Engineers Association, these projects are pre-approved; however the public is to be advised prior to the project implementation. Per Appendix I –Project Schedules of the Municipal Class Environmental Assessment (2000, as amended in 2007), wastewater management projects that are intended to “modify, retrofit, or improve a retention/detention facility including outfall or infiltration systems for the purposes of stormwater quality control” including “biological treatment through the establishment of constructed wetlands” are pre-approved under Schedule A^{+} of the MEA.
- **Schedule ‘B’** projects have more environmental impact and do have public implications. Examples would be stormwater ponds, river crossings, expansion of water or sewage plants

beyond up to their rated capacity, new or expanded outfalls and intakes, and the like. Schedule ‘B’ projects require completion of Phases 1 and 2 of the Class EA process.

- **Schedule ‘C’** projects have the most major public and environmental impacts. Examples would be storage tanks and tunnels with disinfection, anything involving chemical treatment or expansion beyond a water or sewage plants rated capacity. Schedule ‘C’ projects require completion of Phases 1 through 4 of the Class EA process, before proceeding to Phase 5 implementation.

The Municipal Engineers Association’s Class EA document also identifies four different approaches to completing Master Plans corresponding to different levels of assessment. Regardless of the approach selected, all Master Plans must follow at least the first two phases of the Class Environmental Assessment process.

- **Approach 1**, the most common approach, is to follow Phases 1 and 2 as defined above, then use the Master Plan as a basis for future investigations of site specific Schedule ‘B’ and ‘C’ projects. Any Schedule ‘B’ and ‘C’ projects that need specific Phase 2 work and Phases 3 and 4 work, usually have this Phase 2, 3 and 4 deferred until the actual project is implemented.
- **Approach 2**, is to complete all of the work necessary for Schedule ‘B’ site-specific projects at the time they are identified. Using this approach, a municipality would identify everything it needed in the first five years and would complete all the site specific work required, including public consultation to meet Class EA requirements. The Master Plan in such cases has to be completed with enough detail so that the public can be reasonably informed, and so that the approving government Agencies (Conservation Authorities, Natural Resources, Federal Department of Fisheries and Oceans, Transportation Canada etc.) can be satisfied, in principal, that their concerns will be addressed before construction commences.
- **Approach 3**, is to complete the requirements of Schedule ‘B’ and Schedule ‘C’ at the Master Plan stage.
- **Approach 4**, is to integrate approvals under the EA and Planning Acts. For example, the preparation of new or amended Official Plans could be undertaken simultaneously with Master Plans for water, wastewater and transportation, and approval for both sought through the same process.

This study follows Approach 1. Accordingly, the Stormwater Management Master Plan would become the basis for, and be used in support of, future investigations for the specific Schedule “B” and “C” projects identified within it. Schedule “B” projects would require the filing of the Project file for public review, while Schedule “C” projects would have to fulfill Phases 3 and 4 prior to filing an Environmental Study Report (ESR) for public review.

1.4 Document Structure

Based on the Comprehensive Stormwater Management Master Plan Guidelines (LSRCA, 2011) and following an approach that is consistent with Problem/Opportunity identification as per the Class EA Master Plan process, this report includes the following Chapters:

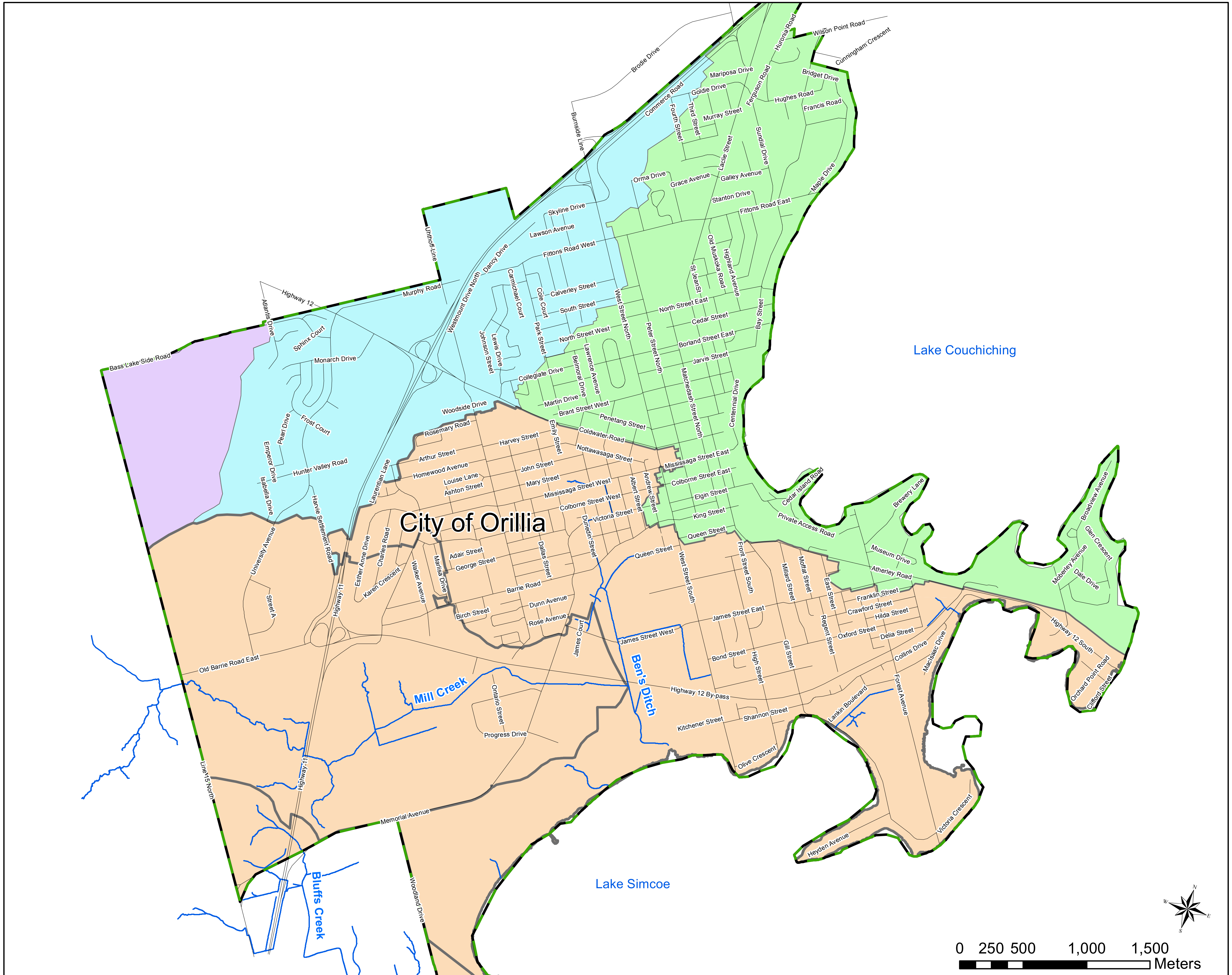
- **Chapter 1**: provides background to the undertaken project, study objectives, and the Class EA Master Plan process;
- **Chapter 2**: provides a brief overview of the study area, and includes a description of the general stormwater drainage patterns and from a watershed perspective (LSRCA Guidelines Steps 1 and 2);
- **Chapter 3**: discusses Federal, Provincial, and Municipal policy documents that were reviewed with special focus on policies and guidelines pertaining to Stormwater Management (Water Quality/Quantity);
- **Chapter 4**: provides a summary of the existing and future landuses, and presents the characterization of the study area in terms of environmental features and functions, including surficial geology, surface water system, groundwater system, and terrestrial and aquatic ecology. (LSRCA Guidelines Step 3). Stormwater management issues are discussed in the context of existing facilities and retrofit opportunities for managing the quantity and quality of stormwater within the City of Orillia;
- **Chapter 5**: identifies different management units within the City's study area (LSRCA Guidelines Step 4);
- **Chapter 6**: evaluates environmental impacts of urban development in terms of water balance, water quality, and water quantity (LSRCA Guidelines Step 5). The effectiveness of the existing SWM facilities is also summarized (LSRCA Guidelines Step 6);
- **Chapter 7**: discusses specific problems and opportunities according to Phase 1 of the Master Plan process. The study goals and objectives are articulated accordingly (LSRCA Guidelines Step 7);
- **Chapter 8**: proposes a long list of alternative solutions based on the findings of Chapters 4 through 6, and following the objectives of the study;
- **Chapter 9**: discusses the evaluation of alternative solutions using a set of evaluation criteria;
- **Chapter 10**: presents the Recommended Approach (LSRCA Guidelines Step 8);
- **Chapter 11**: reviews the environmental benefits of the Recommended Approach
- **Chapter 12**: presents an Implementation Plan for the Recommended Approach, including operation and maintenance considerations (LSRCA Guidelines Steps 9 and 10);
- **Chapter 13**: Summary and Conclusions.

2 Study Area

The City of Orillia is a community of approximately 30,000 residents located on the northwest shores of Lake Simcoe, near the intersection of Highway 11 and Highway 12. According to the City's Official Plan (August, 2013), the city's population is anticipated to grow to 41,000 people by the year 2031. This growth will include additional urban development and intensification, resulting in additional impervious surfaces generating stormwater runoff.

In a watershed context, Figure 2.1 illustrates the municipal boundary that comprises the study area, together with the primary drainage patterns. As shown, there are four main watershed basins to which stormwater drainage from the City is discharged:

- The Lake Simcoe Drainage Basin (1,571.6 ha, 55%). This includes portions of Mill Creek, Bluffs Creek, and other small drainage features which drain to Lake Simcoe. This basin is located within the Oro Creeks North Subwatershed in the Lake Simcoe Region Conservation Authority (LSRCA) jurisdiction. A significant portion of the older existing urban lands within the city are located in the eastern portion of this basin.
- The Lake Couchiching Drainage Basin (660.9 ha, 23%), which includes small drainage features draining directly to Lake Couchiching. A significant portion of the older existing urban lands, including the downtown area, are located in this basin.
- Bass Lake Watershed (126.9 ha, 5%). The northwest portion of the city drains via the Bass Lake Drain. Currently, the watershed is mostly undeveloped.
- Silver Creek Watershed (491.9 ha, 17%). The northern limits of the city drain to this basin. Urban development within the watershed includes most of the lands east of Highway 11, and portions of the lands to the west of Highway 11.



KEY MAP

Legend

StudyArea
Road
Stream

Subwatershed

Bass Lake Basin
Lake Couchiching Basin
Lake Simcoe Basin
Silver Creek Basin

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City Of Orillia Comprehensive Stormwater Management Master Plan

Study Area

Mapping Source: City of Orillia (2014)

FIGURE: 2.1

DATE: March 2014

3 Policy and Technical Direction

There are numerous acts, regulations, policies and plans aimed at maintaining or improving environmental features and functions federally, provincially and within the City of Orillia study area. In order to understand the function of each document, it is important to understand the scale of implementation and the key objectives behind the documents. This Chapter will touch on some of those pertaining to specific direction related to stormwater and environmental protection.

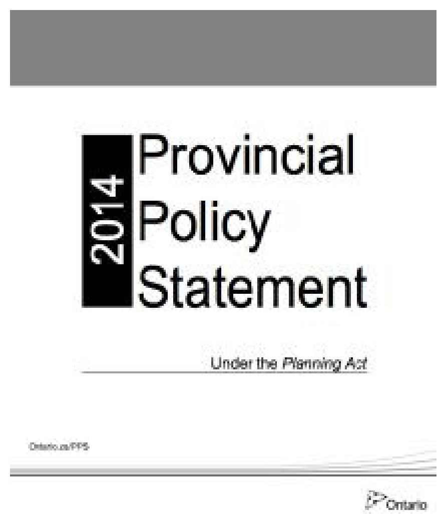
3.1 Policy framework

Federal, Provincial, and Municipal policy documents were reviewed with special focus on policies and guidelines pertaining to Stormwater Management (Water Quality/Quantity). These documents were categorized as follows:

- Provincial Plans;
- Provincial and Conservation Authority Guidelines;
- Official Plans;
- Watershed and Subwatershed Plans

3.1.1 Provincial Plans

<u>Provincial Policy Statement, MMAH (April 2014)</u>



The Provincial Policy Statement (PPS) provides direction for the long-term protection, restoration and improvement of the diversity and connectivity of natural features, the ecological function and biodiversity of natural systems, and the quality and quantity of water at a watershed scale. The PPS recognizes the efficient use and management of land and infrastructure, and the protection of ecological functions of sensitive recharge/discharge areas.

Stormwater-related items in the PPS include:

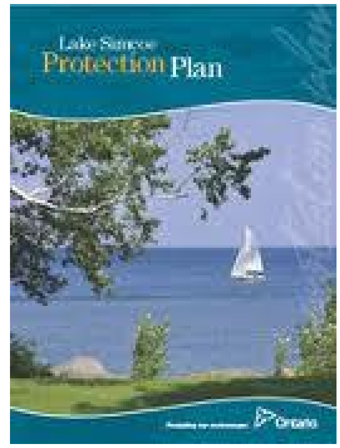
Policy 1.6.6.7 – Planning for stormwater management shall:

1. Minimize, or, where possible, prevent increases in contaminant loads;
2. Minimize changes in water balance and erosion;
3. Not increase risks to human health and safety and property damage;
4. Maximize the extent and function of vegetative and pervious surfaces; and
5. Promote stormwater management best practices, including stormwater attenuation and re-use, and low impact development.

Policy 2.2.1h – Ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces.

In addition, the PPS emphasizes the integration of climate change impacts to infrastructure planning in an "efficient and cost-effective manner that considers impacts from climate change while accommodating projected needs".

<u>Lake Simcoe Protection Plan (June 2009)</u>



The Lake Simcoe Protection Plan applies to the Lake Simcoe watershed. The plan is based on the Lake Simcoe Protection Act (2008) which intends to restore and protect the ecological health of the watershed. The act allows policies in relation to research and monitoring of activities that impact ecological health within the watershed. These policies include the following which are relevant to the impact of development on stormwater and measures to address stormwater management issues within the watershed:

Policy 4.5-SA **-** Within 5 years of the date the Plan comes into effect, municipalities in collaboration with the LSRCA will prepare and implement comprehensive stormwater management master plans for each settlement area in the Lake Simcoe Watershed.

Policy 4.6-SA **-** Municipalities are encouraged to implement a stormwater retrofit prior to the completion of a stormwater management master plan if a stormwater retrofit opportunity has been identified as a priority for a settlement area and is determined to be economically feasible.

Policy 4.7-DA **-** Municipalities shall incorporate into their official plans policies related to reducing stormwater runoff volume and pollutant loadings from major development and existing settlement areas.

Policy 4.8-DP **-** An application for major development shall be accompanied by a stormwater management plan.

Policy 4.9-DP **-** Stormwater management works that are established to serve new major development in the Lake Simcoe watershed shall not be permitted unless the works have been designed to satisfy the Enhanced Protection level specified in Chapter 3 of the MOE's "Stormwater Management Planning and Design Manual 2003", as amended from time to time.

Policy 4.10-DP **-** Every owner and operator of a new stormwater management works in the Lake Simcoe watershed shall be required to inspect and maintain the works on a periodic basis.

Policy 4.11-DP **-** Every owner and operator of a new priority stormwater management works in the Lake Simcoe watershed shall be required to monitor the operation of works, including monitoring the quality of the effluent from the works, on a periodic basis.

Policy 4.12-SA **-** The MOE will review the approvals issued under section 53 of the Ontario Water Resources Act in respect of existing priority stormwater management works within the Lake Simcoe watershed. If a review of an approval for an existing priority stormwater management works determines that the conditions in the approval are inadequate, having regard to the objectives of the Plan, including the conditions related to inspection, maintenance and monitoring, the approval will be referred to the Director for the purpose of determining whether an amendment to the approval is necessary to assist in meeting the objectives of the Plan.

***Policy 4.24* -** Implementation of phosphorus reduction measures including an assessment of sources or sectors that contribute to phosphorus loadings

***Policy 5.6-DP (f) and (g)* -** Other water conservation technologies (such as rainwater harvesting or reuse of stormwater) will be used to reduce water use; and stormwater treatment facilities are used to capture and treat runoff from areas with impervious surfaces.

***Policy 6.23-DP* -** Development or site alteration is not permitted within a key natural heritage feature, a key hydrologic feature and within a related vegetation protection zone referred to in policy 6.24, except in relation to Retrofits of existing stormwater management works.

The Growth Plan (2012)

The Growth Plan (2012) is a policy document that has been prepared under the Places to Grow Act (2005). The overarching objective of the document is to provide a framework for implementing the Government of Ontario's vision for "building stronger, prosperous communities by better managing growth in the Greater Golden Horseshoe".

Concerning stormwater management, ***Policy 3.2.5.8*** points out that municipalities are encouraged to implement and support innovative stormwater management actions as part of redevelopment and intensification.

The Clean Water Act (2006)

The intent of the Clean Water Act (2006) is to protect existing and future sources of drinking water, as part of an overall commitment to protecting and enhancing human health and the environment. The Act establishes a process to protect municipal residential drinking water sources and designated private drinking water sources. This process promotes the shared responsibility of all stakeholders to protect local sources of drinking water. Source protection represents the first barrier in the multi-barrier approach to providing a safe supply of water.

Within the City of Orillia, two stormwater outfalls (No. 24 and 11) to Lake Couchiching have been identified as significant drinking water threats to the water intake for the Orillia surface water supply.

3.1.2 Provincial and Conservation Authority Guidelines

Stormwater Management Planning and Design Manual (MOE 2003)

The Ministry of Environment Stormwater Management Planning and Design Manual (MOE, 2003) is a document which updates earlier stormwater management manuals released by the Ministry of Environment (MOE) in 1991 and 1994, with an overarching objective to provide guidance for the selection and design of appropriate stormwater management practices. The key components of the 2003 manual include the following:

- Providing direction for sizing of the stormwater quality control component of stormwater management facilities in order to achieve water quality objectives which provide protect fisheries habitat;
- Incorporating in-stream erosion control and water balance objectives in addition to flood and water quality objectives into the selection and design of Stormwater Management Practices (SWMPs);
- Providing information on SWMPs such as sand filters, bioretention filters, wet swales and hybrid wet pond/wetlands;
- Providing design examples for SWMPs;
- Providing an appendix which deals with integrated planning for stormwater management.

LSRCA Technical Guidelines for Stormwater Management Submissions (April 2013)

This document provides guidance regarding the stormwater management requirements of the Lake Simcoe Region Conservation Authority (LSRCA) in accordance with the LSRCA Watershed Development Policies and Lake Simcoe Protection Plan. The document provides direction and tools in the following areas:

- Stormwater quantity control
- Stormwater quality control
- Stream erosion control
- Water balance and groundwater recharge
- Hydrologic modeling and SWM pond design

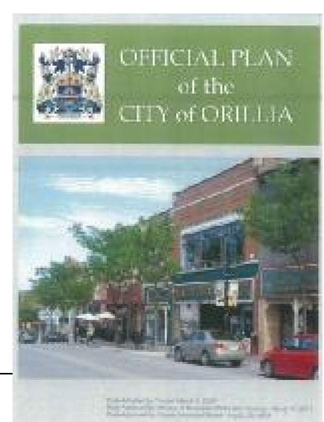
Draft Lake Simcoe Watershed Model By-law for Municipalities and **Draft Lake Simcoe Watershed LID SWM Guidelines for Municipalities (LSRCA April 2015)**

The intention of these draft documents is to provide a model framework for LID SWM requirements to be defined within the Municipal legislative framework. It is up to each Municipality to select some or all of the draft Model By-law and LID SWM Guidelines, as they so choose.

3.1.3 Official Plans

The City of Orillia Official Plan (August 2013)

The City's Official Plan provides the basis for managing change in the City to 2031 and includes a vision which guides future growth and development in a manner that promotes clean air, land and water. One of the main Principles identified in the Plan is to "ensure the sustainability and integrity of the Environment". Among the objectives of the Plan is to ensure that proposed changes in landuse have no negative impacts, with particular attention to the water quality of Lake Simcoe. Select policies include:



Policy 4.7a – development or site alteration within the Lake Simcoe Watershed shall, where applicable, seek to avoid, minimize and/or mitigate impacts associated with the quality and quantity of urban runoff into receiving streams, lakes and wetlands.

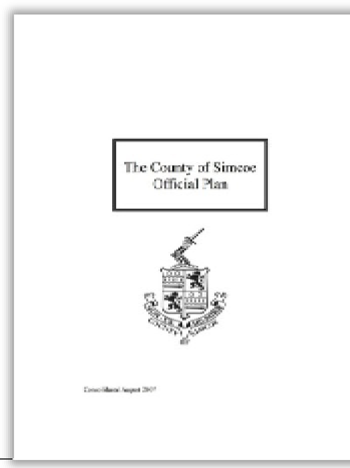
Policy 4.7v **–** an application for major development within the Lake Simcoe Watershed, shall be accompanied by a Stormwater Management Plan that:

- Incorporates an integrated treatment train approach to minimize stormwater management flows and reliance on end-of-pipe controls through measures including source controls, lot-level controls and conveyance techniques such as grassed swales, where appropriate;
- Identifies specific location of permanent end-of-pipe facilities, and offers specific direction on how they will be designed to satisfy, at a minimum, the enhanced protection level specified in the MOE Stormwater Management Planning and Design Manual;
- Evaluates changes in the water balance and phosphorus loadings between pre-development and post-development conditions, and evaluates how such changes will be minimized;

Policy 4.7w **–** Stormwater runoff volume and pollutant loadings from major development and within the city shall be reduced by:

- Encouraging a hierarchy of source, lot-level, conveyance, and end-of-pipe controls;
- Encouraging the implementation of innovative stormwater management measures;
- Allowing for flexibility in development standards to incorporate alternative stormwater techniques;
- Support implementation of source control programs which are targeted to existing areas that lack adequate stormwater controls;

Policy 4.7x – stormwater management works for major development shall not be permitted unless the works are designed to satisfy the Enhanced Protection Level specified in Chapter 3 of the MOE Planning and Design Manual 2003. This policy does not apply if the works are intended to serve infill development or re-development, if it is not feasible to comply with the specified design standard, and the person seeking to establish the works demonstrates that the works incorporated the most effective measures in the circumstances to control the quality and quantity of stormwater.



<u>The County of Simcoe Official Plan (2007)</u>

The County's Official Plan is designed to assist in growth management in a county expected to experience rapid growth in population and urban development. The Plan's environmental goal is to protect, conserve, and enhance the County's natural heritage. Select policies include:

Policy 3.3.16 – All plans of subdivision shall be accompanied by a Stormwater Management Report. A SWM Report will also be required for industrial, commercial and institutional development. The report shall be prepared in accordance with the MOE Stormwater Management

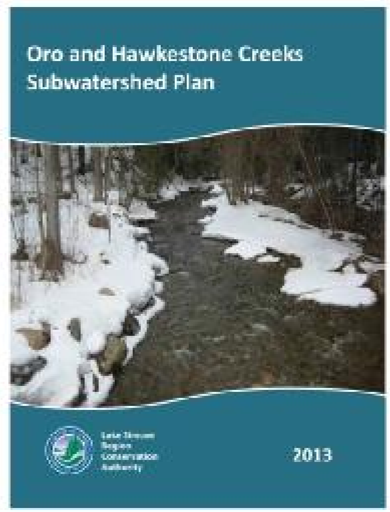
Planning and Design Manual. Stormwater Management Plans are to address the following:

- Maintain pre-development water quality and improve runoff quality where appropriate;
- Accommodate flows from the 100-year storm event, or accepted engineering standards for the local municipality;
- Maintain current flow rates beyond the property boundary;

Policy 4.5.2.5 – Stormwater management quality and quantity facilities shall be located outside of the floodplain except as provided in the flood fringe above the 100 year storm event level (under a two-zone concept or special policy area).

3.1.4 Watershed and Subwatershed Plans

Oro and Hawkstone Creeks Subwatershed Plan (LSRCA, 2013)

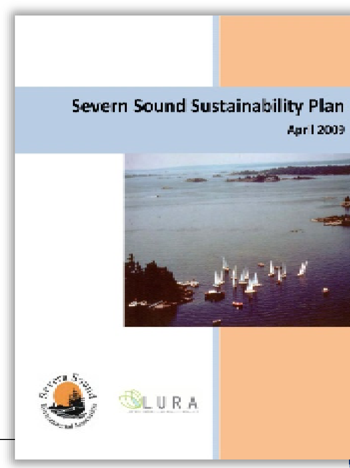


This subwatershed plan was prepared under the direction of the Lake Simcoe Protection Plan and looks at three subwatersheds in the northwestern portion of the Lake Simcoe watershed: Oro Creeks North, Hawkstone Creek, and Oro Creeks South. The Oro Creeks North subwatershed is 75km^2 in size, with just over 20% falling within the City of Orillia, including portions of the Mill Creek and Bluffs Creek catchments. The majority of the remainder of the watershed lies within the Township of Oro-Medonte.

The study includes a summary of the current state of the environmental features and functions within each of the component watersheds, together with a description of the environmental stresses, and recommendations for improvement. Important recommendations relative to this study include:

- Continued implementation of stewardship measures and projects to improve water quality and aquatic habitat, and promote infiltration of precipitation;
- Improved landuse planning practices to minimize impacts from development;
- Researching and implementing new innovative solutions, such as low impact development (LID) measures to address uncontrolled stormwater in urban areas such as the City of Orillia.

Severn Sound Sustainability Plan (Lura, 2009)



The headwaters of the Severn Sound watershed include the northwest portion of the City of Orillia which drain via the Bass Lake Drain and Silver Creek catchments. Goals and strategies identified in the plan include:

- Minimize contaminants to surface and groundwater from stormwater systems (EN.S.17). Recommended actions include application of Level 1 stormwater quality control, and retrofitting stormwater management facilities in older neighbourhoods;

- Reduction in stormwater discharges and total phosphorus loadings by 20% (SN.S.18);
- Reduced water consumption through conservation measures (EN4.2).

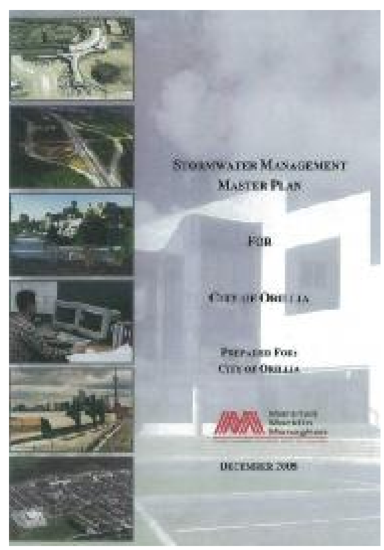
3.2 Technical Direction

Several background studies and reports that shed light on the existing and historical environmental conditions and stormwater systems within the study area were reviewed. The main objective of the background review is to set a framework for understanding of the motives behind this study and establish a foundation for the "Problem/Opportunity" component as this study is prepared as a Master Plan EA study.

Technical studies reviewed include the following:

- City of Orillia Stormwater Management Master Plan (MMM, 2005);
- The Assimilative Capacity Studies for the Lake Simcoe Watershed and Nottawasaga River (LSRCA and NVCA, 2006);
- Lake Simcoe Basin Stormwater Management and Retrofit Opportunities (LSRCA, 2007);
- City of Orillia Development Charges Background Study (Hemson, 2013).

City of Orillia Stormwater Management Master Plan (MMM, 2005)



This study builds upon earlier Master Drainage Plans (MDPs), and was undertaken to provide the City with guidance in controlling the quantity and quality of stormwater, and to identify recommended improvements to the storm drainage system to handle future needs as the city grows. The study provides an overview of the natural resources within the various watersheds which drain the city. It also provides a significant amount of background information and mapping to detail the existing storm drainage system within the city, including major/minor system drainage patterns and existing stormwater management facilities. Recommendations with respect to drainage improvements within each watershed are provided for:

- major/minor system drainage upgrades;
- stormwater quality retrofits within existing development areas;
- stormwater management requirements for future development areas.

Retrofit opportunities within existing development areas include:

- 6 outfalls from small developed urban drainage areas (less than 5 ha) were identified in the Lake Simcoe and Lake Couchiching basins where oil-grit separators are recommended;

- 15 outfalls from larger developed urban drainage areas (greater than 5 ha) and one very large area (outfall 103 from Ben's Ditch) were identified as sites for potential end-of-pipe stormwater pond retrofits within the Lake Simcoe and Lake Couchiching basins;
- An end-of-pipe retrofit opportunity within subbasin #8 of Mill Creek was also identified;
- Existing SWM pond F1 in the Silver Creek Subwatershed was identified for potential water quality improvements;
- Source and conveyance control retrofits are also recommended as part of future small re-development sites.

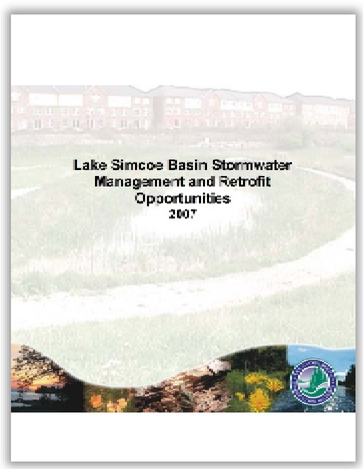
In terms of stormwater infrastructure for future urban development lands, the following was recommended:

- 2 end-of-pipe stormwater ponds with quantity and quality controls are recommended for future development in subbasin E of the Silver Creek watershed;
- 2 end-of-pipe stormwater ponds are recommended for future development in the Bass Lake Drain watershed;
- 4 end-of-pipe stormwater ponds with quantity and quality controls are recommended for future development in the Mill Creek watershed;
- On-site quantity and quality controls are also recommended for future infill/re-development sites.

<u>The Assimilative Capacity Studies for the Lake Simcoe Watershed and Nottawasaga River (LSRCA and NVCA, 2006)</u>

The study was initiated to determine how much development can be accommodated in the Lake Simcoe Watershed and the management tools and practices that can be undertaken to minimize future phosphorus loading in order to meet the Lake Simcoe Environmental Management Strategy (LSEMS) remedial targets for Lake Simcoe. The LSEMS target phosphorus load which was established by the study is 75 Tons/year. The study showed that implementing stormwater management measures (i.e. Best Management Practices) would help to offset the impact of future urban development by decreasing phosphorus loadings.

<u>Lake Simcoe Basin Stormwater Management and Retrofit Opportunities (LSRCA, 2007)</u>



The study synthesized information regarding urban catchments, outlets, and existing stormwater management facilities within the Lake Simcoe watershed. In addition, the study estimated the total phosphorus load coming from urban catchments and the level of treatment and reduction in load provided by existing facilities. Potential retrofit opportunities were also identified. Findings from the study relevant to the City of Orillia include the following:

- The city contributes an estimated 2,064 kg of phosphorus per year to Lake Simcoe;

- The city contributes an estimated 1,281 kg of phosphorus per year to Lake Couchiching;
- There are currently no stormwater management facilities providing water quality control within the city for drainage to either Lake Simcoe or Lake Couchiching;
- 5 retrofit opportunity sites were identified to provide water quality control for drainage to Lake Simcoe. These retrofits could reduce phosphorus loadings from the City by approximately 36%;
- 6 retrofit opportunity sites were identified to provide water quality control for drainage to Lake Couchiching. These retrofits could reduce phosphorus loadings from the City by approximately 20%;

City of Orillia Development Charges Background Study (Hemson, 2013)

The cost of providing stormwater management facilities and storm sewer systems to new subdivisions is considered to be a local cost and was not included in the Development Charges calculation. However, the DC does allow for the recovery of a negative reserve fund balance totaling approximately $906k.

4 Characterization of the Study Area

This chapter describes existing environmental conditions within the City of Orillia, with special focus on the environmental features and functions that are relevant to stormwater quantity and quality within the study area. The framework for characterizing the existing environmental conditions is based on the Comprehensive Stormwater Management Master Plan Guidelines (LSRCA, 2011). It starts by defining existing land use and potential land use changes within the study area, and subsequently moves to describe the existing environmental features and functions in order to identify management units, evaluate impacts, identify opportunities and constraints and establish recommended stormwater management strategy with an implementation plan.

4.1 Background

The City of Orillia is located within the County of Simcoe on the northern shores of Lake Simcoe. As was shown in **Figure 2.1**, stormwater drainage from the City is discharged to four main watershed basins, the largest of which is the Lake Simcoe basin, followed by Lake Couchiching, Silver Creek, and Bass Lake watersheds. The City has a population of approximately 30,000 and is expected to grow to 41,000 by the year 2031.

Previous technical studies have described some of the existing environmental features and functions within the study area, including characterization of the overland drainage system and issues (MMM, 2005) as well as water quality and environmental issues (LSRCA, 2013). Building on this existing background knowledge, together with available information provided by the City of Orillia and LSRCA, the study area was characterized based on the framework proposed by Comprehensive Stormwater Management Master Plan Guidelines (LSRCA, 2011). The existing conditions characterization provides a baseline against which alternative stormwater management strategies can be assessed.

4.2 Land Use

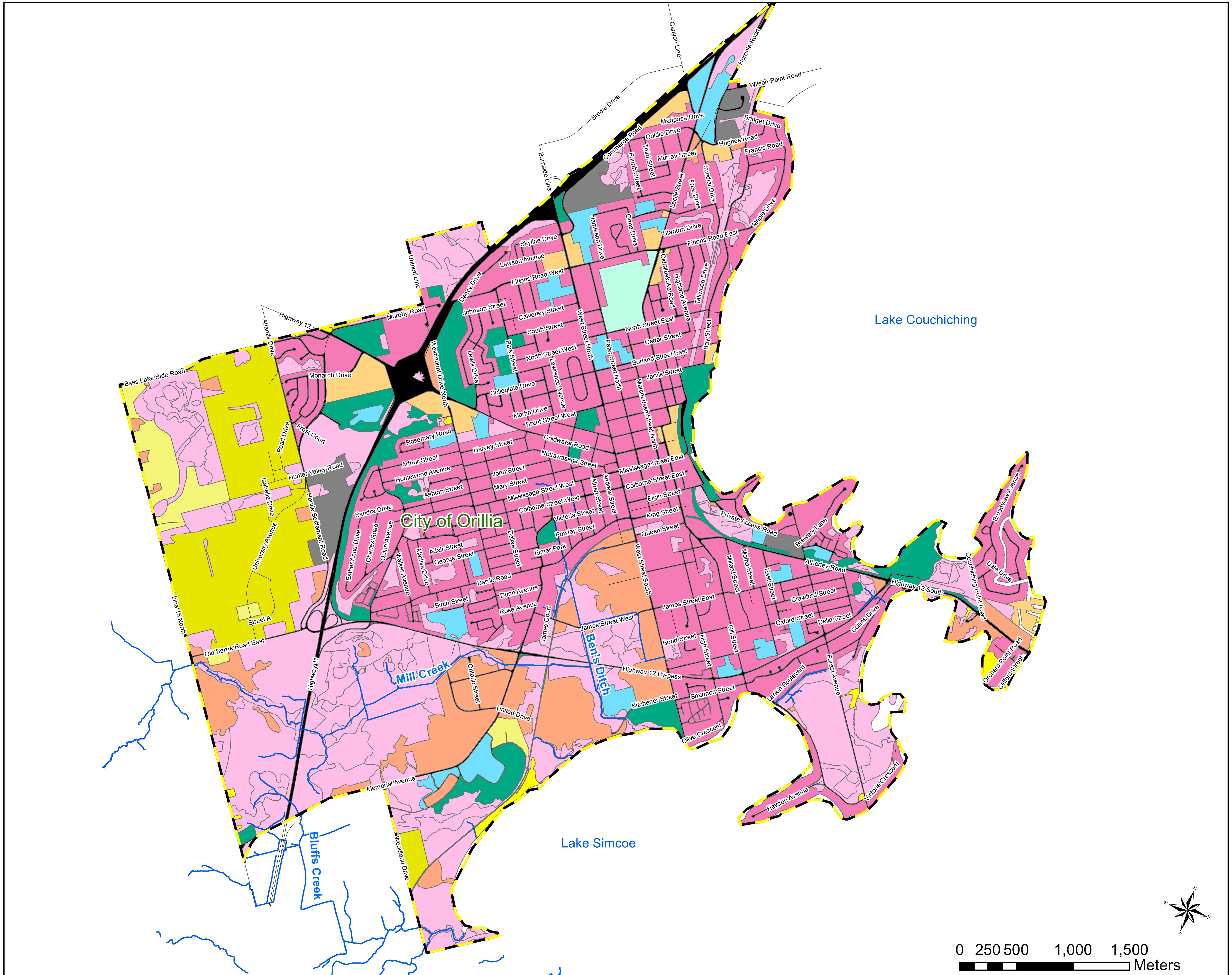
The City of Orillia covers a total area of approximately 29 km^2, constituting many land uses. Planning documents and schedules regulating landuse within the City of Orillia, including the Orillia Official Plan and the Simcoe County Official Plan were reviewed to characterize existing and future landuse designations within the study area.

4.2.1 Existing Landuses

A breakdown of the existing landuses within the City of Orillia, facilitated using GIS layers provided by the city, is summarized in Table 4.1 and illustrated Figure 4.1. As shown, the eastern portion of the study is comprised of predominantly urban landuses, with larger rural areas and natural features to the west of Highway 11 and south of Highway 12.

Table 4.1: Existing Landuses within the City of Orillia

Existing Land Use	Area (ha)	Percentage of Study Area (%)
Commercial	56.9	2.0%
Estate Residential	10.9	0.4%
Golf Course	22.5	0.8%
Industrial	50.1	1.8%
Institutional	91.5	3.2%
Intensive Agriculture	206.1	7.2%
Manicured Open Space	144.5	5.1%
Natural Heritage Feature	745.8	26.2%
Non-intensive Agriculture	49.1	1.7%
Road	206.6	7.2%
Rural Development	216.4	7.6%
Urban	1051.2	36.9%



Legend

- StudyArea
- Road
- Stream

Existing Land Use

- Commercial
- Estate Residential
- Golf Course
- Industrial
- Institutional
- Intensive Agriculture
- Manicured Open Space
- Natural Heritage Feature
- Non-intensive Agriculture
- Road
- Rural Development
- Urban

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City Of Orillia Comprehensive Stormwater Management Master Plan

Existing Land Use

Mapping Source: City of Orillia (2014)

FIGURE: 4.1

DATE: June 2014

4.2.2 Official Plan Landuses

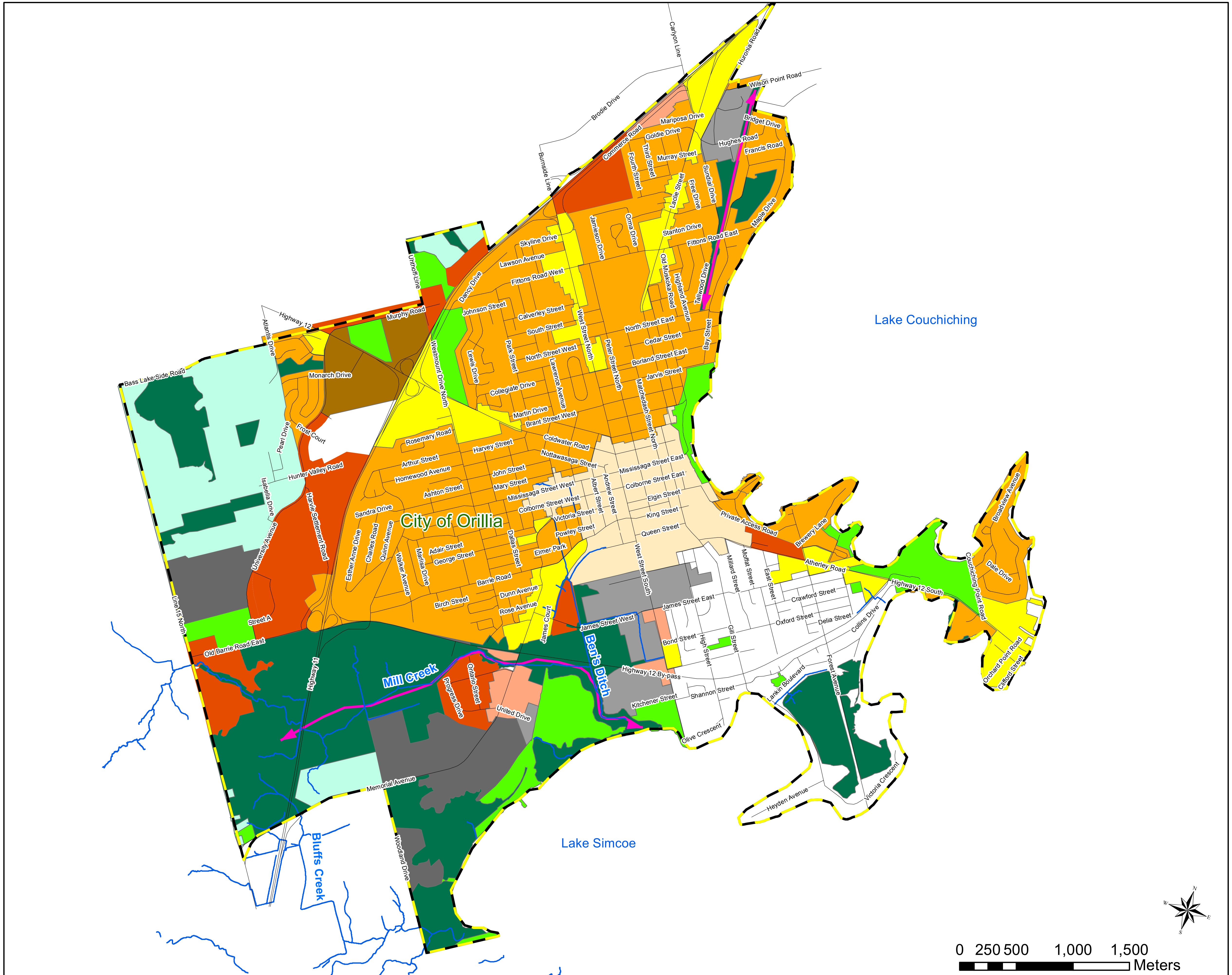
Future landuses, as per Schedule A of the City of Orillia Official Plan, are depicted in Figure 4.2. Comparison to existing landuses in Figure 4.1 indicates that future urban growth is expected to be concentrated within the western portion of the study area, including:

- Neighborhood Greenfield lands (northwest of University Avenue, northeast of Highway 11 and Memorial Avenue, and northeast of Highway 11 and Uhthoff Line;
- Business Park lands (southwest and northeast of Old Barrie Road and University Avenue);
- Major Institutional lands (west of University Avenue and east of Woodland Drive).

In addition to the above, the Official Plan identifies several areas within the existing urban areas of the City which will be subject to future urban intensification. The above future urban growth and intensification areas within the city are illustrated in Figure 4.3.

Table 4.2: Official Plan Landuses

Official Plan Land Use	Area (ha)	Percentage of Study Area (%)
Arterial Commercial	33.5	1.2%
Business Park	201.6	7.1%
Community Commercial	52.4	1.8%
Downtown Area	145.9	5.1%
Intensification Area	194.5	6.8%
Environmental Protection Area	456.1	16.0%
Stable Neighbourhood	1066.7	37.4%
Industrial	138.7	4.9%
Neighbourhood Greenfields	208.4	7.3%
Parklands	243.7	8.5%
Light Industrial	87.4	3.1%



KEY MAP

Legend

- StudyArea
- Road
- Stream
- OP Sch A - Artirial Commercial
- OP Sch A - Business Park
- OP Sch A - Community Commercial
- OP Sch A - Downtown Area
- OP Sch A - Environmental Protection Area
- OP Sch A - Intensification Area
- OP Sch A - Major Institutional
- OP Sch A - Neighbourhood Greenfields
- OP Sch A - Parklands
- OP Sch A - Potential Environmental Linkage
- OP Sch A - Stable Neighbourhood
- OP Sch A -Light Industrial

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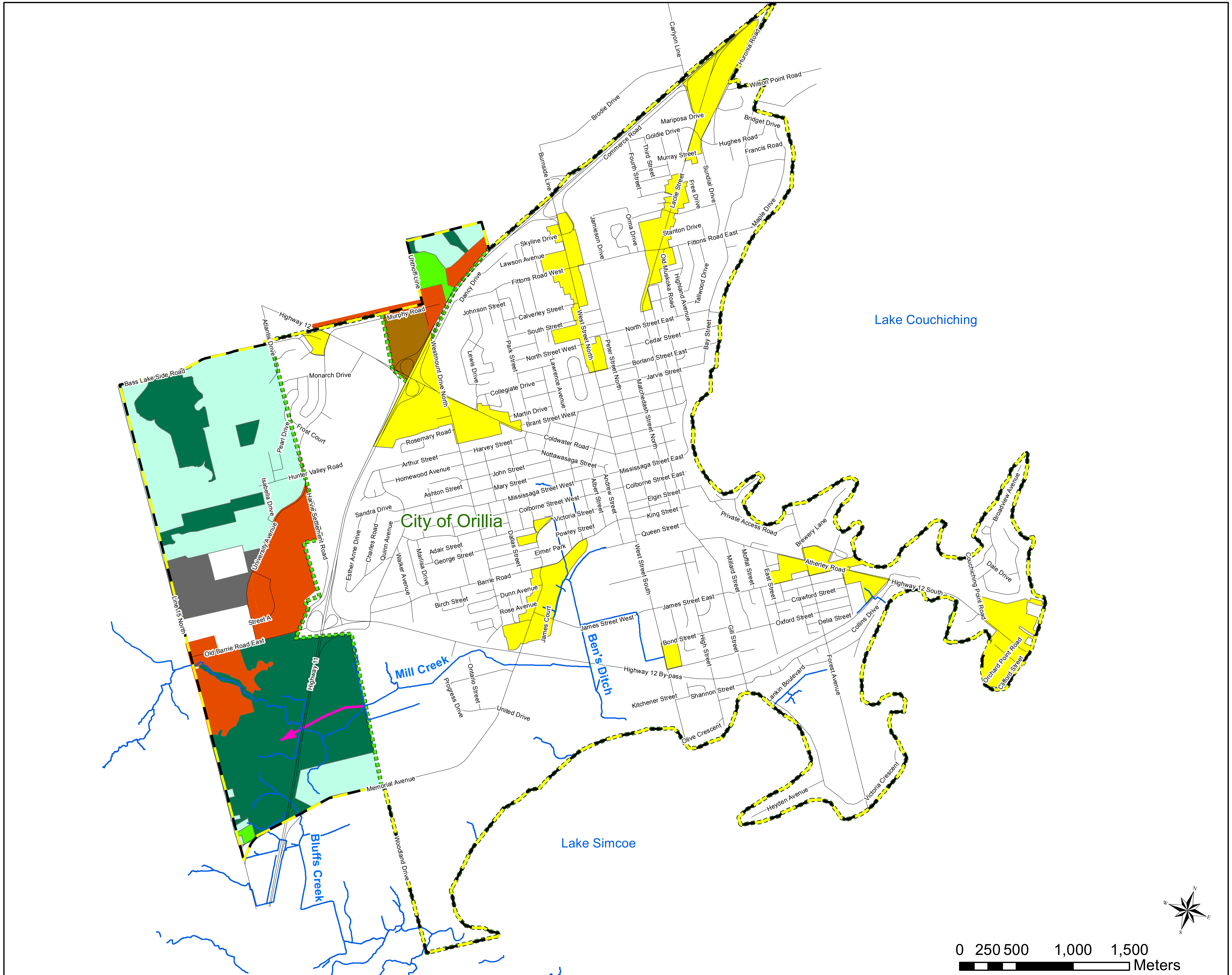
City Of Orillia Comprehensive Stormwater Management Master Plan

Official Plan Land Use

Mapping Source: City of Orillia (2014)

FIGURE: 4.2

DATE: June 2014



KEY MAP

Legend

- StudyArea
- Road
- Stream
- OP Sch A - Intensification Area
- Existing Development Area
- OP Sch A - Potential Environmental Linkage
- OP Sch A - Artirial Commercial
- OP Sch A - Business Park
- OP Sch A - Community Commercial
- OP Sch A - Downtown Area
- OP Sch A - Environmental Protection Area
- OP Sch A - Parklands
- OP Sch A - Stable Neighbourhood
- OP Sch A -Light Industrial
- OP Sch A - Major Institutioonal

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City Of Orillia Comprehensive Stormwater Management Master Plan

Future Urban Growth and Intensification Areas

Mapping Source: City of Orillia (2014)

FIGURE: 4.3

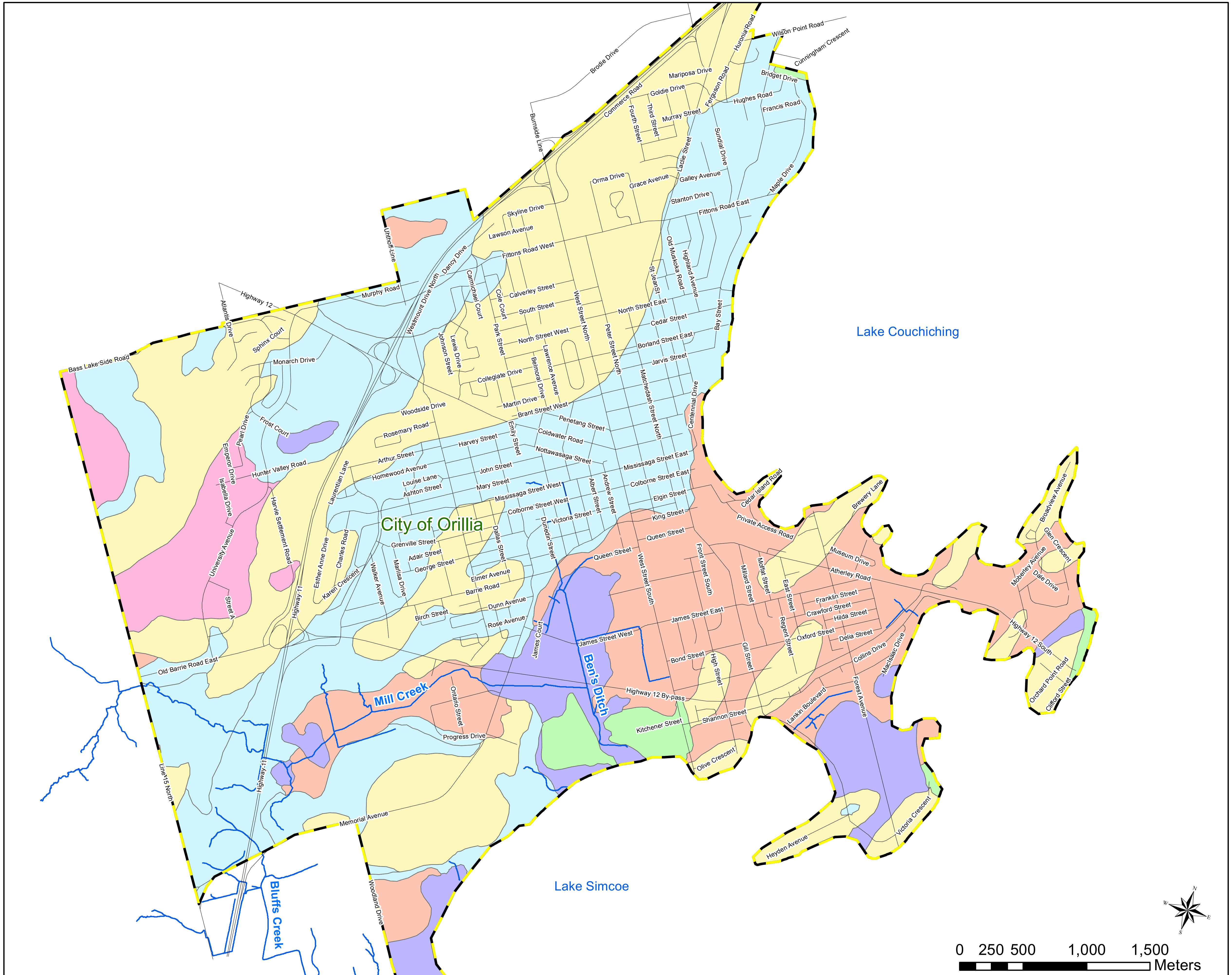
DATE: June 2014

4.3 Physiography and Soil

The physiography and soils present in the study area are important in that they influence the quality and quantity of water infiltrating into the ground and running along the surface. Corse-textured soils, such as sands and gravels, allow water to infiltrate, while fine-textured soils such as silts and clays, generate more surface runoff.

According to the Oro Creeks and Hawkestone Creek Subwatershed Plan (LSRCA, 2013), the bedrock within the City of Orillia Study area is overlain by mainly sandy sediments which were deposited by Glacial Lake Algonquin and its successor lakes following the last major period of glaciation (Figure 4.4). The western and central portions of the city are underlain by the Simcoe Lowlands physiographic region, while the western portion of the city is within the Simcoe Uplands.

Many of the soils within the city are classified as “A” or “B” soils with high to moderate infiltration rates and consist of gravels, sands, and loam textures. Silty clay loam “C” soils with slower infiltration rates are also present in parts of the southeast portion of the city and within the older downtown area.



KEY MAP

Legend

- StudyArea
- Road
- Stream

Surficial Geology

- Bog And Swamp Deposits
- Fill
- Glaciolacustrine Deep Water Deposits
- Glaciolacustrine Shallow Water Deposits
- Ice-contact Stratified Drift
- Till

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City Of Orillia Comprehensive Stormwater Management Master Plan

Physiography and Soil

Mapping Source: City of Orillia (2014)

FIGURE: 4.4

DATE: June 2014

4.4 Natural Heritage

4.4.1 Terrestrial Ecology

Terrestrial natural heritage features are among the most important parts of an ecosystem and are most likely to be impacted by human activities (LSRCA, 2013). Terrestrial resource coverage within the City of Orillia study area is illustrated in Figure 4.5. These areas include woodlands, wetlands, grasslands, and valleylands, many of which are designated as Environmental Protection Areas within the City's Official Plan (Figure 4.2). In addition to the important ecological functions that these features provide, they also offer significant hydrological benefits in terms of interception of precipitation, storage and reduction of stormwater runoff, and augmentation of baseflows.

Some specific terrestrial features within the city study area include (MMM, 2005):

Lake Simcoe Watershed Basin:

- Orillia Filtration Complex, Bluffs Creek East and Victoria Point Wetlands;
- Orillia Filtration Swamp Provincially Significant Wetland (PSW);
- Mill Creek valley corridor, including online ponds;
- Bluffs Creek East wetland at the mouth of Bluffs Creek;
- Four significant woodlot areas;

Lake Couchiching Watershed Basin:

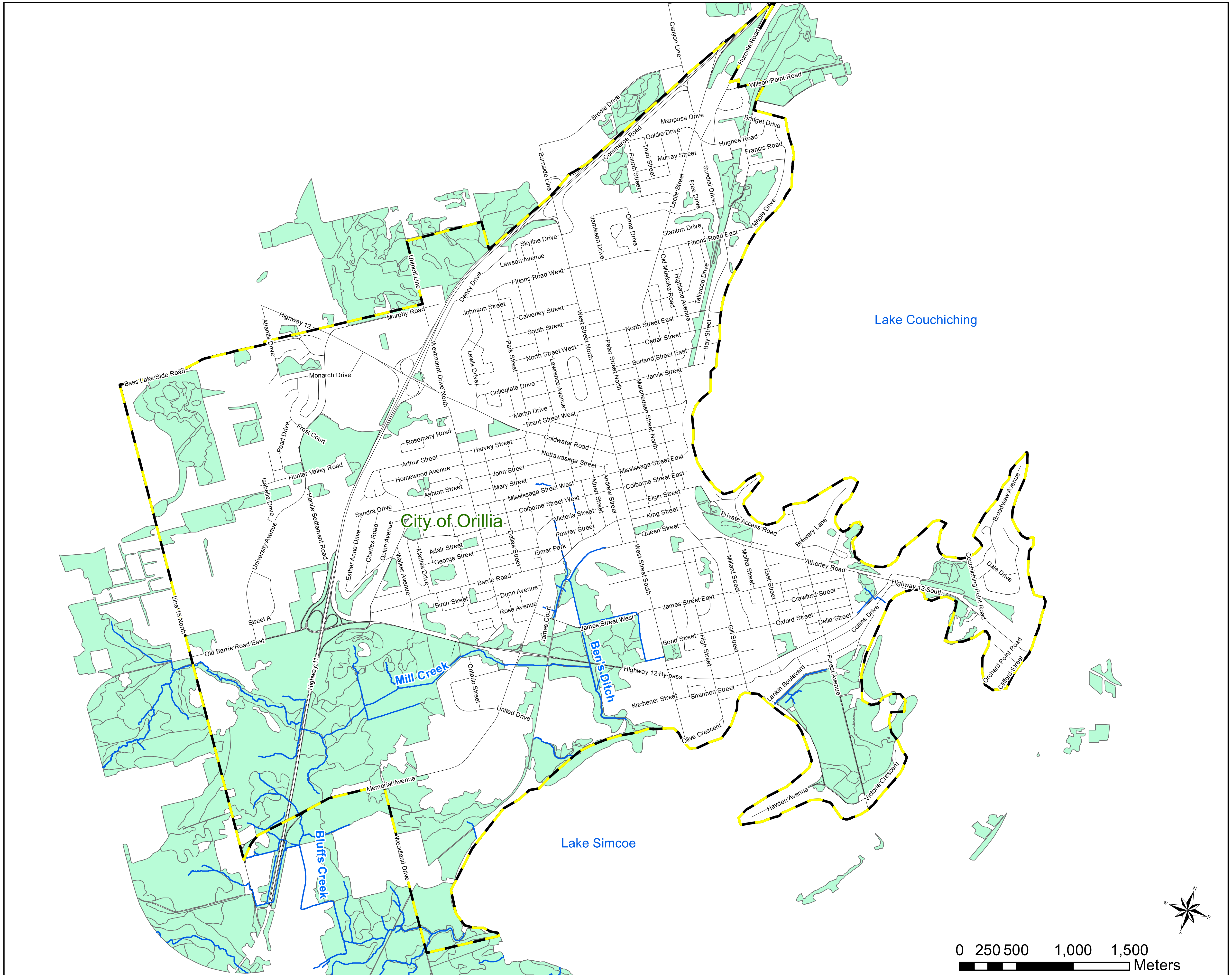
- Couchiching Conservancy Wetland;
- Atherley Narrows PSW

Silver Creek Watershed:

- Woodland habitat associated with the creek corridor;
- Silver Creek Swamp
- Marsh lands southwest of Highway 11 and Highway 12

Bass Lake Watershed:

- Wetland complex south of Bass Lake Sideroad;
- Portions of two significant woodlots.



KEY MAP

Legend

- StudyArea
- Road
- Stream

Land Use

- Natural Heritage Feature

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City Of Orillia Comprehensive Stormwater Management Master Plan

Terrestrial Resources

Mapping Source: City of Orillia (2014)

FIGURE: 4.5

DATE: June 2014

4.4.2 Aquatic Ecology

Aquatic habitat and fish communities can be impacted by changes to the system, including stresses caused by conversion of natural lands to urban landuses. The increase in impervious surfaces associated with these landuse changes can result in loss of natural storage, decreased infiltration and increased runoff. One of the most significant impacts of stormwater runoff is to water quality which directly affects the aquatic ecosystem (LSRCA, 2013). Pollutants are washed off streets, parking lots and rooftops into storm drains and ditches which discharge to the watercourses and lakes. Generally, stormwater contains elevated concentrations of pollutants such as bacteria (e.g. E coli), nutrients (e.g. phosphorus), metals, and organic compounds. Other impacts include increased water temperatures resulting from runoff from pavement and other urban surfaces.

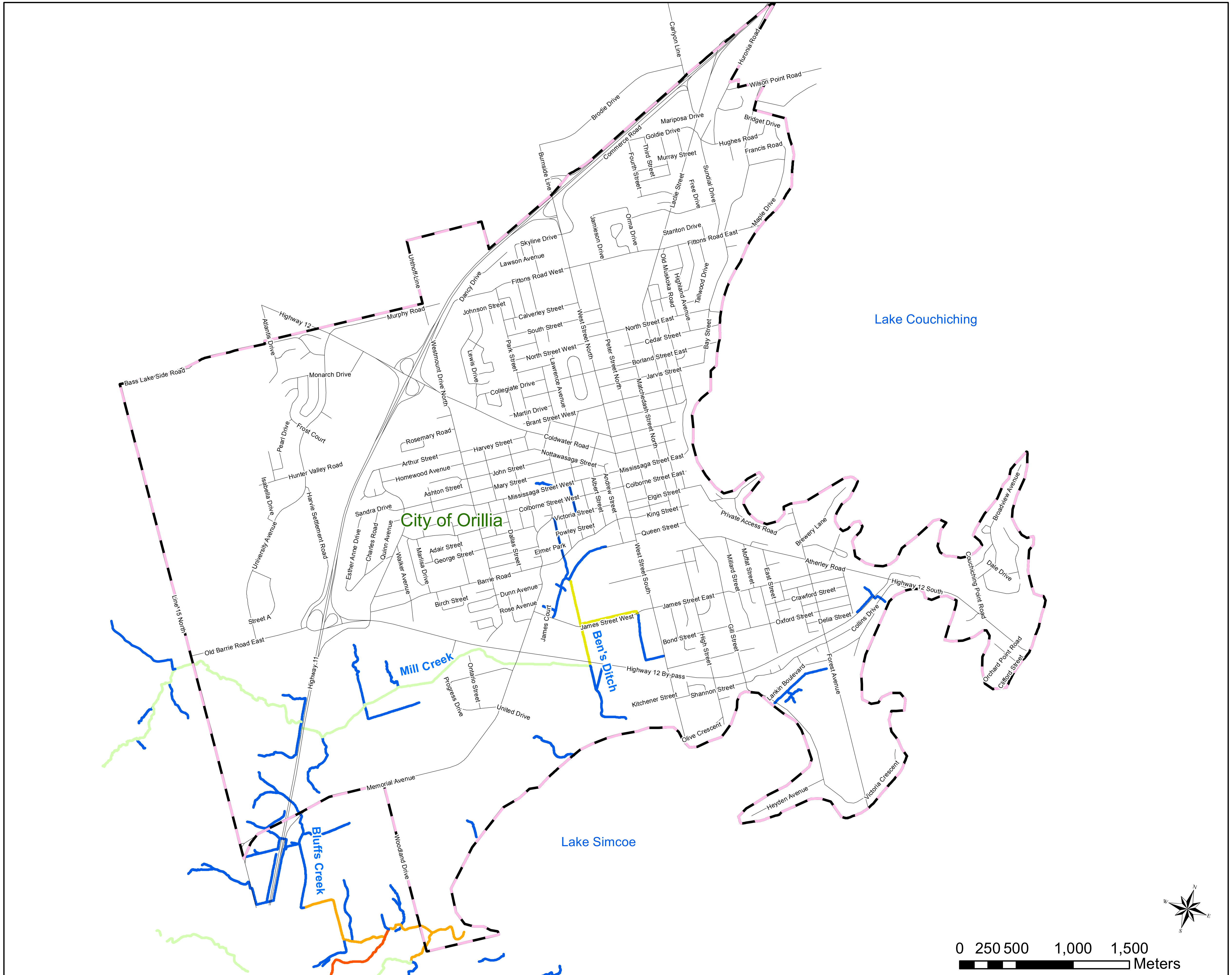
LSRCA mapping of aquatic resources within the City of Orillia streams is illustrated in Figure 4.6. Findings from the Oro Creeks and Hawkestone Creek Subwatershed Plan (LSRCA, 2013) include the following:

- healthy coldwater habitat is found at sites in both Bluffs Creek and Mill Creek, with sites in Bluffs Creek supporting populations of brook trout, indicating areas of extremely healthy habitat;
- barriers in the upper end of Mill Creek degrade habitat and block fish passage, preventing populations of sensitive species, such as brook trout, from utilizing these areas;
- the ecological integrity at stream sites on Mill Creek and Bluffs Creek, as measured using an Index of Biotic Integrity (IBI), was classified as “fair”;
- the ecological integrity at stream sites on Mill Creek, based on benthic analysis, was classified as “excellent” to “fair”;
- there are no known Species at Risk in the Oro Creeks North subwatershed, which includes the portion of the City of Orillia draining to Lake Simcoe.

Further background review indicates the following with respect to the aquatic resources within the city’s other watershed basins (MMM, 2005):

- Sundial Creek, draining to Lake Couchiching, is classified as coldwater habitat;
- Bass Lake is warmwater fish habitat and its tributaries are coldwater streams;
- Fish community investigations in Silver Creek resulted in the capture of coldwater and coolwater species of fish

In addition to the above, the shores of Lake Couchiching and Lake Simcoe support warmwater fish communities. Lake Simcoe also supports a coldwater fish community.



KEY MAP

Legend

- StudyArea
- Road
- Stream

Fish Habitat

- Not Classified
- A - Permanent flow; Cold/cool; No sensitive species and/or communities present
- C - Permanent flow; Warm; No sensitive species and/or communities present
- D - Permanent flow; Cold/cool; Sensitive species and/or communities present
- E - Permanent flow; Warm; Sensitive species and/or communities present

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City Of Orillia Comprehensive Stormwater Management Master Plan

Aquatic Resources

Mapping Source: City of Orillia (2014)

FIGURE: 4.6

DATE: June 2014

4.5 Groundwater Features and Functions

The groundwater resources of the study area are briefly reviewed below in terms of groundwater recharge and discharge characteristics. Further discussion regarding groundwater protection is also provided.

4.5.1 Groundwater Recharge

Groundwater is replenished as precipitation infiltrates through the unsaturated zone and reaches the water table. It is influenced by the surficial geology, soil properties, topography, landuse and vegetation. Protection of groundwater resources is necessary to ensure the sustainability of municipal groundwater supplies and healthy watersheds.

Areas defined as “Significant Groundwater Recharge Areas” include areas identified under the Clean Water Act (2006) and ecologically significant groundwater recharge areas (ESGRAs). ESGRAs are areas of land that are responsible for replenishing groundwater systems that directly support sensitive areas like coldwater streams and wetlands.

LSRCA mapping of significant recharge areas within the City of Orillia is illustrated in Figure 4.7. As shown, significant areas within the western and northern portions of the city are classified as having medium to high groundwater recharge potential. This is consistent with the coarse soils reported in these areas (Section 4.3). Comparison to Figure 4.3 indicates that many of the areas designated for future urban development fall within groundwater recharge zones.

4.5.2 Groundwater Discharge

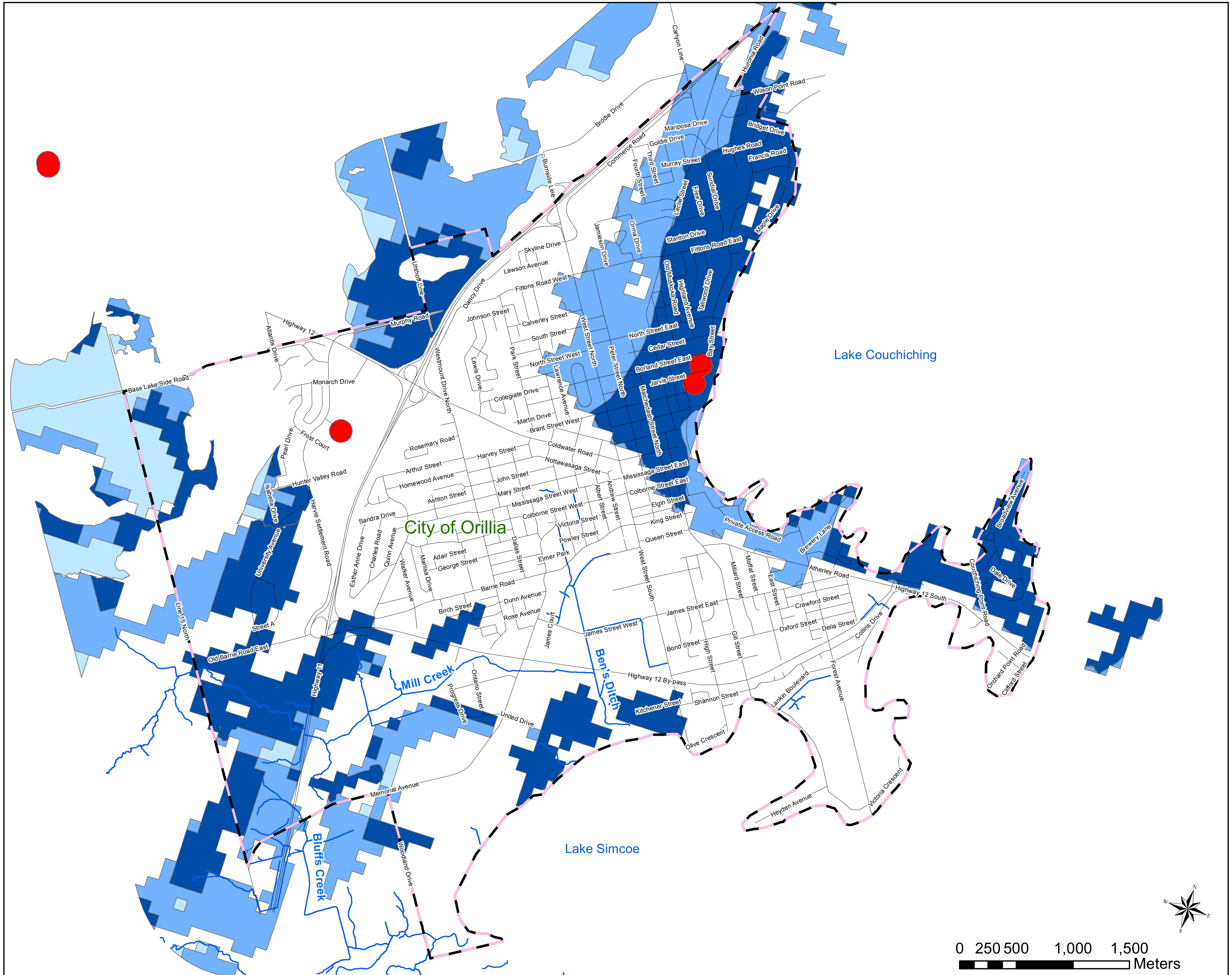
Groundwater discharge occurs where the groundwater table intersects the ground surface, often in low topographic areas and around watercourses in the form of springs and seeps, or as baseflow to streams. These discharges provide a supply of clean cool water to streams and wetlands.

Potential groundwater discharge volumes where estimated as part of the Oro and Hawkestone Creeks Subwatershed Plan (LSRCA, 2013). Within the City of Orillia, groundwater discharge to portions of Mill Creek and Bluffs Creek was estimated to exceed 100 m^3 per day. In the upper reaches of Silver Creek just north of Orillia, groundwater discharge of up to 300 m^3 per day was estimated.

4.5.3 Source Water Protection

Figure 4.8 shows Wellhead Protection Areas around the municipal wells located within the study area. A Wellhead Protection Area is the area around a wellhead where land use activities have the potential to affect the quality and quantity of water that flows into the well. The delineation of Wellhead Protection Areas is needed in order to identify and protect areas that replenish municipal wells. The establishment of Wellhead Protection Areas guards against sources of contamination and maintains a high-quality water supply. Special arrangements are generally suggested for infiltration practices within wellhead protection areas, and certain study requirements are needed accordingly.

In addition to the groundwater wells, the City has a municipal water intake in Lake Couchiching. Two stormwater outfalls (No. 24 and 11) to Lake Couchiching have been identified as significant drinking water threats within the intake protection zone to the water intake.



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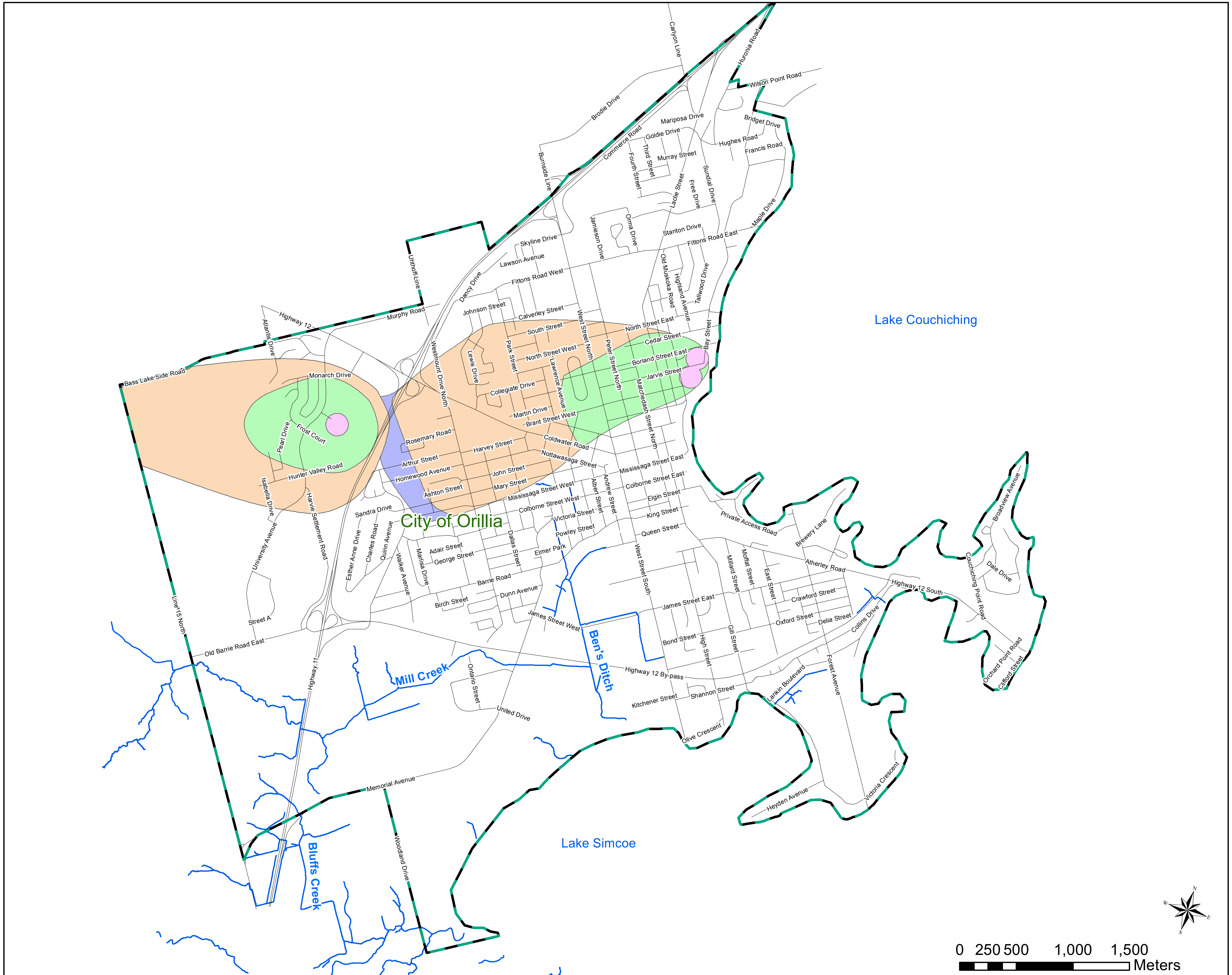
City Of Orillia Comprehensive Stormwater Management Master Plan

Significant Recharge Areas
& Municipal Wells

Mapping Source: City of Orillia (2014)

FIGURE: 4.7

DATE: June 2014



KEY MAP

Legend

Wellhead Protection Area

- WHPA-A (100m)
- WHPA-B (2-yrs time of travel)
- WHPA-C-1 (10-yrs time of travel)
- WHPA-D (25-yrs time of travel)
- StudyArea
- Road
- Stream

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City Of Orillia Comprehensive Stormwater Management Master Plan

Wellhead Protection Areas

Mapping Source: City of Orillia (2014)

FIGURE: 4.8

DATE: June 2014

4.6 Surface Water Features and Flooding

As was illustrated in Figure 2.1, the study area falls within four subwatersheds:

- The Lake Simcoe Drainage Basin (1,572.5 ha, 55%), including portions of Mill Creek, Bluffs Creek, and other small drainage features which drain to Lake Simcoe. This basin is located within the Oro Creeks North Subwatershed in the Lake Simcoe Region Conservation Authority (LSRCA) jurisdiction. A significant portion of the older existing urban lands within the city are located in the eastern portion of this basin.
- The Lake Couchiching Drainage Basin (674.9 ha, 24%), which includes small drainage features such as Sundial Creek, draining directly to Lake Couchiching. A significant portion of the older existing urban lands, including the downtown area, are located in this basin.
- Bass Lake Watershed (127.0 ha, 4%). The northwest portion of the city drains via the Bass Lake Drain. Currently, the watershed is mostly undeveloped.
- Silver Creek Watershed (497.5 ha, 17%). The northern limits of the city drain to this basin. Urban development within the watershed includes most of the lands east of Highway 11, and portions of the lands to the west of Highway 11.

4.6.1 Flow Monitoring

There are no known long-term streamflow gauges within the City of Orillia. However, a Water Survey of Canada streamflow gauge site (No. 02ED030) is located just north of the City of Orillia on Silver Creek at Burnside Line and Division Road West. Mean streamflow rates recorded at the gauge site since it was installed in 2006 is summarized in Table 4.3.

4.6.2 Flood Flow Modeling

Flood flow estimates at various locations throughout the City of Orillia were estimated through hydrologic modelling completed as part of the 1991 City of Orillia Master Drainage Plan (UMA, October 1991). Various design storm distributions were assessed using the OTTHYMO hydrologic model and the 6-hour Chicago Storm distribution was found to produce the highest runoff. Table 4.4 summarizes the flood flow estimates from the 1991 modeling, as reported by MMM in 2005. As shown, 2-year through 100-year flood flows have been estimated for Silver Creek, Bass Lake Drain, Mill Creek and Bluffs Creek. Flood flow estimates for the Regional Storm event, Hurricane Hazel, have also been estimated for Mill Creek.

It is important to note that these flood flow estimates are based on landuses at the time of the 1991 study, and do not reflect subsequent development. As such, the City should consider development of an updated model that also accounts for potential climate change impacts. LSRCA has just recently developed a VISUAL OTTHYMO model that covers parts of Orillia as part of a report entitled "Hydrologic Model for Orillia Creeks and Talbot River Watersheds" (July 2012). This modelling work may serve as a basis for any further analyses by the City.

4.6.3 Flood Hazard Mapping

Two types of flood hazard lands have been identified within the City of Orillia:

- all lands located at an elevation of 220.5m or less are considered flood-prone due to potential high water levels on Lake Simcoe and Lake Couchiching. This includes shoreline areas along both lakes, as well as the low-lying lands near the central portion of the city which are drained through a pumping station located along James Street and discharges via Ben's Ditch.
- the regulatory floodplain of Mill Creek. The floodplain is several hundred metres wide in some places through the southwest portion of the city. Near the creek outlet through Ben's Ditch, the floodplain overlaps the low-lying flood-prone lands noted above that would be inundated due to high water levels on Lake Simcoe.

Figure 4.9 illustrates the flood hazard lands.

4.6.4 Water Budget

The accounting of the quantity and distribution of water within a watershed is undertaken using a water budget. Inputs to the water budget include precipitation, and outputs include evaporation, transpiration, infiltration and surface runoff.

On a large-scale subwatershed basis, the Oro and Hawkestone Creeks Subwatershed Plan (LSRCA, 2013) estimates the following components of the water budget for Oro Creeks North:

- Annual precipitation, averaged over a series of local meteorologic gauge sites is 975 mm/year;
- Annual evapotranspiration varies significantly with different types of land cover, but averages 564 mm/year;
- Mean annual streamflow is estimated as 254 mm/year, of which 122 mm/year is from groundwater baseflow.

Based on the above, the estimated annual runoff volume is 132 mm/year (i.e. 254-122 mm/yr) and the estimated annual infiltration volume is 279 mm/year (i.e. 975-564-132 mm/yr). This relatively high infiltration to runoff ratio corresponds well to the coarse-textured soils over much of the Oro Creeks North subwatershed, as described in Section 4.3.

Table 4.3: Silver Creek Streamflow Data - Mean Monthly Flow Summary (m^3/s)*

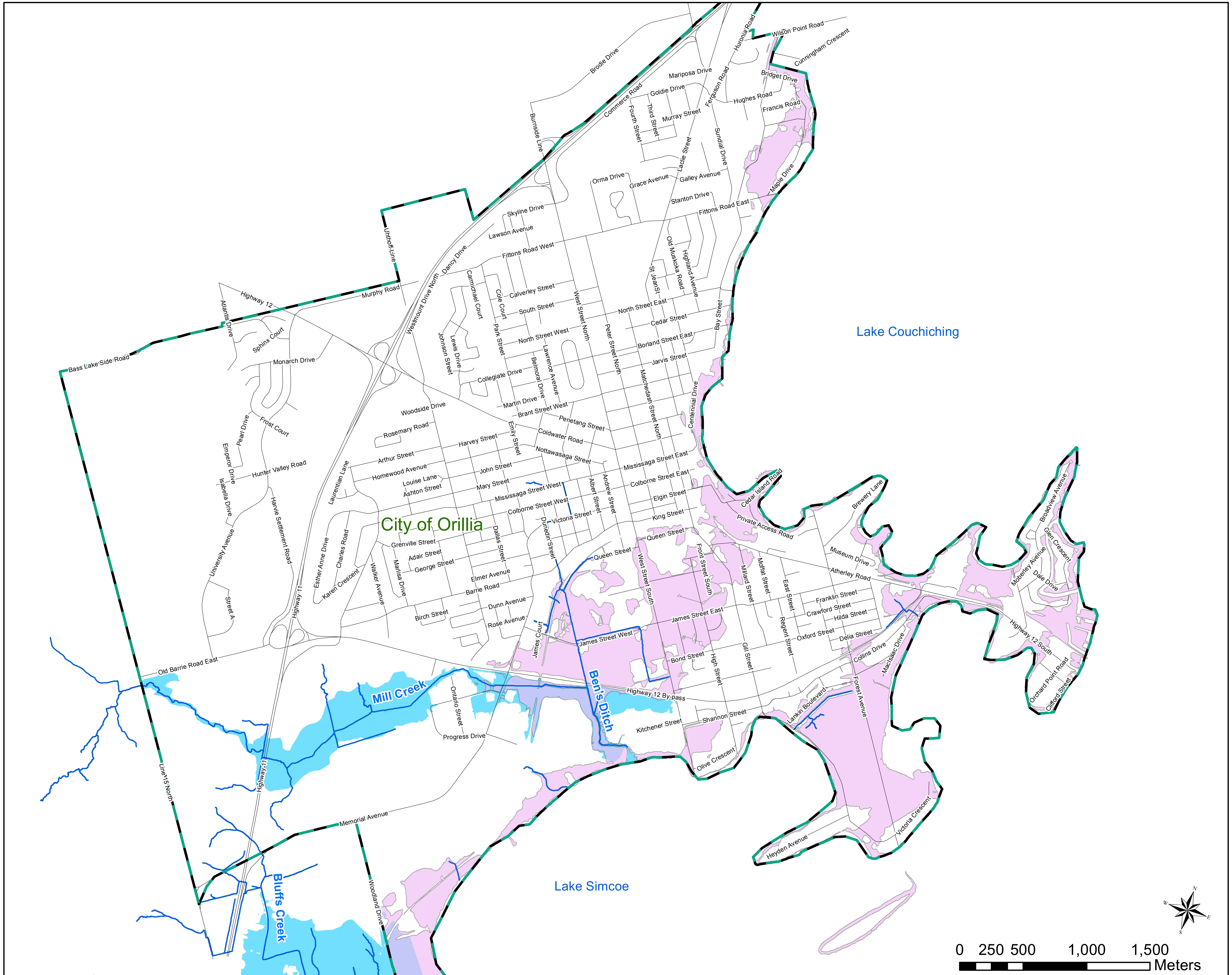
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2006	0.239	0.190	0.425	0.336	0.160	0.154	0.130	0.089	0.142	0.257	0.301	0.284	0.226
2007	0.205	0.118	0.350	0.282	0.153	0.117	0.147	0.101	0.130	0.198	0.148	0.172	0.177
2008	0.328	0.190	0.216	0.527	0.237	0.173	0.144	0.149	0.133	0.120	0.178	0.258	0.221
2009	0.157	0.218	0.317	0.304	0.211	0.171	0.187	0.217	0.151	0.209	0.189	0.181	0.209
2010	0.163	0.127	0.239	0.125	0.151	0.208	0.160	0.136	0.166	0.134	0.147	0.145	0.159
2011	0.138	0.132	0.333	0.302	0.191	0.172	0.167	0.217	0.099	0.206	0.194	0.221	0.198
2012	0.186	0.161	0.300	0.151	0.123	0.114	0.081	0.100	0.129	0.175	0.156	0.159	0.153
Mean	*0.202*	*0.162*	*0.311*	*0.290*	*0.175*	*0.158*	*0.145*	*0.144*	*0.136*	*0.185*	*0.188*	*0.203*	*0.192*
Max	*0.328*	*0.218*	*0.425*	*0.527*	*0.237*	*0.208*	*0.187*	*0.217**	*0.166*	*0.257*	*0.301*	*0.284*	*0.226*
Min	*0.138*	*0.118*	*0.216*	*0.125*	*0.123*	*0.114*	*0.081*	*0.089*	*0.099*	*0.120*	*0.147*	*0.145*	*0.153*

* Water Survey of Canada Data – Silver Creek at Orillia gauge site No. 02ED030 (Burnside Line & Division Road West)

Table 4.4: Flood Flow Estimates* - City of Orillia Streams

Location	Area (ha)	Flood Flow Estimates (m^3/s)*						
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
<u>Silver Creek</u>								
Highway 11	19	0.22	0.35	0.45	0.57	0.67	0.77	n/a
Uhthoff Line at Golf Course entrance	193	0.66	1.3	1.9	2.6	3.2	3.9	n/a
<u>Bass Lake Drain</u>								
Bass Lake Sideroad E.	145	0.48	1.1	1.4	1.9	2.3	3.0	n/a
<u>Mill Creek</u>								
Line 15 N.	481	0.92	1.4	1.7	2.3	2.8	3.3	29.5
Highway 11	728	1.1	2.2	2.9	4.1	5.1	6.1	47.9
Memorial Ave	1022	1.7	3.3	4.5	6.2	7.5	8.7	58.7
Outlet	1066	1.9	3.8	5.3	7.3	8.8	10.1	62.4
<u>Bluffs Creek Tributary</u>								
Memorial Ave - west branch	20	0.11	0.24	0.34	0.49	0.61	0.74	n/a
Memorial Ave - east branch	30	0.11	0.25	0.36	0.52	0.67	0.82	n/a
Outlet near Woodland Dr.	262	1.0	2.1	3.1	4.4	5.5	6.7	n/a

* Source: 1991 Master Drainage Plan, as reported in MMM, 2005



KEY MAP

Legend

StudyArea
Road
Stream
Regulatory Floodplain
Flood Prone Lands (below 220.5m)

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City Of Orillia Comprehensive Stormwater Management Master Plan

Flood Hazard Lands

Mapping Source: City of Orillia (2014)

FIGURE: 4.9

DATE: June 2014

4.7 Water Quality

Background studies and reports were reviewed to summarize available water quality information related to the city of Orillia's surface water resources.

4.7.1 Water Quality Monitoring

There is little water quality monitoring data available for watercourses within the City of Orillia. Sampling information reviewed in the Oro Creeks and Hawkestone Creek Subwatershed Plan (LSRCA, 2013) is limited to:

- "spot check" sampling conducted by LSRCA at a site on Mill Creek;
- data for a number of water quality parameters for some of the watercourses located near the Kitchener Street Waste Diversion Site;
- a Provincial Water Quality Monitoring Network (PWQMN) gauge site on Bluffs Creek just outside of the City of Orillia.

"Spot Check" Sampling

The "spot check" data included comparison of instream concentrations of phosphorus, chlorides, nitrogen, metals, and dissolved organic carbon to Provincial Water Quality Objectives (PWQO). Dissolved oxygen, pH and water temperature were also measured and found to be at normal summer levels. The "spot check" site on Mill Creek in the City of Orillia was found to exceed the PWQO for phosphorus and iron, however, nearby road construction may have contributed to these exceedances. Out of 14 samples taken in the spring and summer of 2012, four had phosphorus concentrations exceeding PWQO (0.030 mg/L). These exceedances occurred in dry conditions and ranged from 0.087 to 0.100 mg/L. Wet weather sample concentrations were found to be below PWQO levels.

Kitchener Street Sampling

Water quality sampling undertaken as part of the permit for the Kitchener Street Waste Diversion site indicates elevated levels of Phosphorus and Chlorides at a number of sites on Mill Creek and Ben's Ditch. Copper, Iron and Zinc concentrations also exceeded PWQOs at sites on Ben's Ditch north of Highway 12.

Bluffs Creek PWQO Monitoring

The Bluffs Creek water quality monitoring station just outside of the City of Orillia was initiated in 2008. Although the period of record is short, it has thus far shown healthy water quality conditions (LSRCA, 2013). The median phosphorus concentration measured at the site is less than half of the PWQO of 0.030mg/L. Chloride and total suspended solids (TSS) concentrations were also found to be well within water quality guidelines.

In addition to the above information, the 2005 Stormwater Management Master Plan (MMM, 2005) provides a very brief summary of limited historical information regarding water quality within some of the other watersheds:

- water quality at beaches on Lake Couchiching was characterized as very good with only rare exceedances of PWQO for fecal coliform;
- water temperatures in Silver Creek were found to be within 15°C – 19°C in the summer of 1982, and dissolved oxygen levels were found to be at saturation (9.4mg/L) in 1989;
- water quality of Bass Lake remained fairly constant according to data collected between 1968 and 1987

4.7.2 Phosphorus Loadings

One of the most significant causes of water quality degradation in Lake Simcoe and its tributaries is elevated levels of phosphorus which promotes eutrophication of surface water by stimulating algae growth. This, together with other pollutants can, in turn, impair both recreational activities and the health of aquatic communities. Urban landuses are a significant contributor to the phosphorus loadings in the City of Orillia through stormwater runoff (LSRCA, 2013).

The current estimated average annual loading of phosphorus to Lake Simcoe is 86 tons per year, of which approximately 2.6 tons per year is contributed through the Oro Creeks North subwatershed, which includes the southern end of the City of Orillia. Modelling undertaken as part of the Oro Creeks and Hawkestone Creek Subwatershed Study (LSRCA, 2013) indicates that, in order to meet the basin-wide total phosphorus loading target of 44 tons per year to Lake Simcoe, loadings from the Oro Creeks North subwatershed need to be reduced by roughly 67.8%. Within this subwatershed, the Mill Creek and Bluffs Creek catchments were ranked as Tier 2 and Tier 3 areas in terms of priority for phosphorus reductions. The study also makes management recommendations to promote stormwater management retrofits and encourage the use of low impact development (LID) measures to reduce phosphorus loadings.

4.8 Fluvial Geomorphology

Based on the background information available, there have been no specific fluvial geomorphologic studies completed for the City's watersheds. As such, a synoptic level geomorphic investigation was undertaken of representative creek segments to illustrate the variety of stream conditions within the City of Orillia. The investigation was intended to define aspects such as channel geometry, valley confinement, erosion controls and risks, dominant geomorphic processes, and insight into the overall stability of the channel following Rapid Geomorphic Assessment (RGA) protocol (MOE, 1999). The investigation was supplemented with comments based on review of aerial photography and topographic mapping.

Locations of the investigations were chosen for their accessibility, as well as the potential implications or risks with existing municipal infrastructure. The locations of the field investigations are identified in Figure 4.10 and include the following streams:

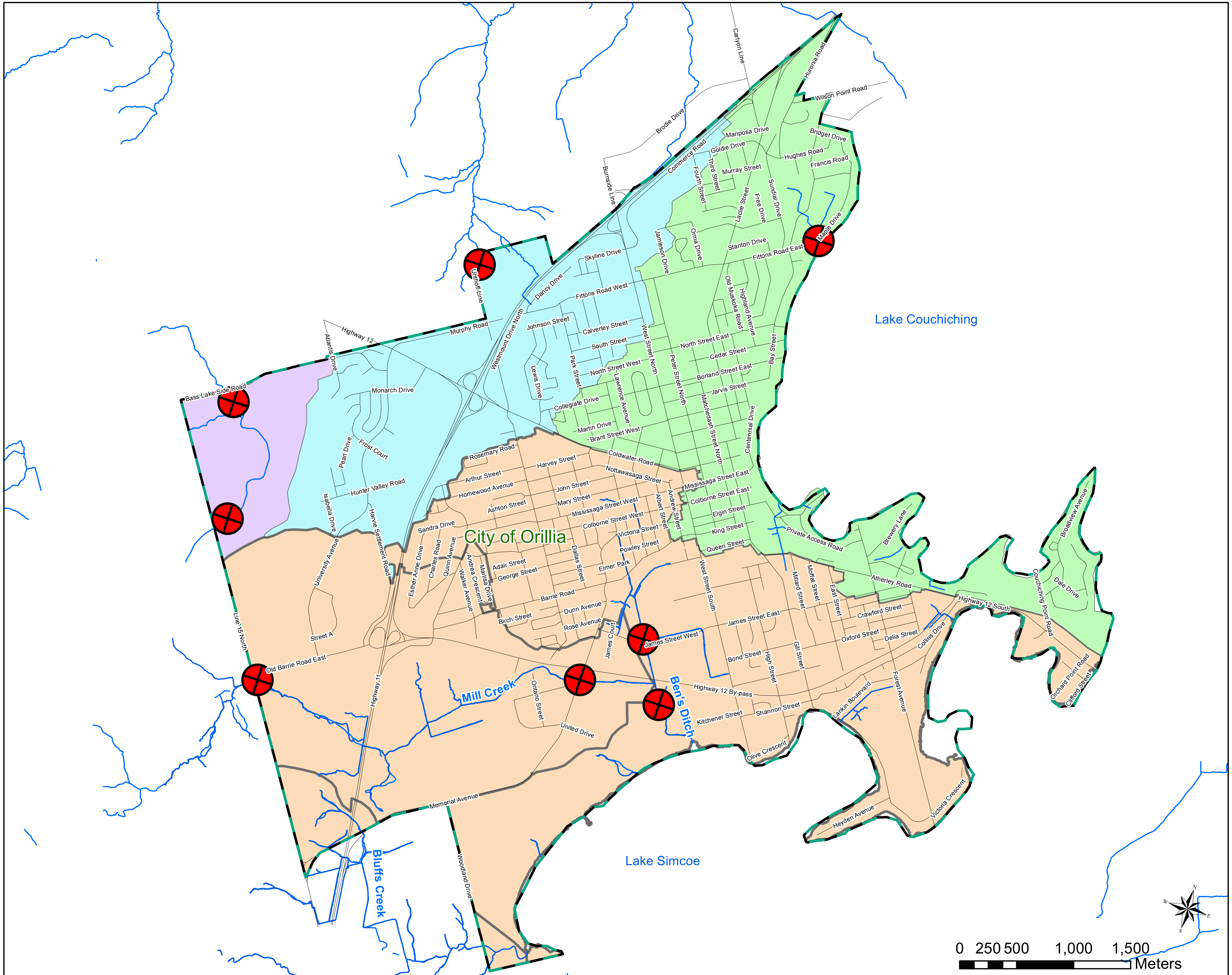
- Mill Creek / Ben's Ditch (Lake Simcoe Basin)
- Sundial Creek (Lake Couchiching Basin)

- Silver Creek
- Bass Lake

References regarding channel stability can be compared to Table 4.5 which is consistent with widely used RGA analysis.

Table 4.5: Rapid Geomorphic Assessment descriptions based on index value (MOE, 1999)

Stability Index Value	Stability Class	Description
0 – 0.25	Stable	Channel morphology is within the expected range of variance for stable channels of similar type. Channels are in good condition with minor adjustments that do not impact the function of the watercourse.
0.25 – 0.40	Transitional	Channel morphology is within the expected range of variance but with evidence of stress. Significant channel adjustments have occurred and additional adjustment may occur.
0.40 – 1.0	In Adjustment	Metrics are outside of the expected range of variance for channels of similar type. Significant channel adjustments have occurred and are expected to continue.



Legend

- StudyArea
- Road
- Stream

Subwatershed

- Bass Lake Basin
- Lake Couchiching Basin
- Lake Simcoe Basin
- Silver Creek Basin
- Geomorphic Investigation Location

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City Of Orillia Comprehensive Stormwater Management Master Plan

Fluvial Geomorphologic Investigations

Mapping Source: City of Orillia (2014)

FIGURE: 4.10

DATE: June 2014

4.8.1 Mill Creek & Ben's Ditch Characterization

4.8.1.1 Mill Creek at Line 15 North

Mill Creek converges from a wetland area into the City limits under Line 15 North south of Old Barrie Road, extending downstream through a densely vegetated corridor with industrial use lining the top of the corridor. Within this segment of Mill Creek, a low gradient channel naturally meanders through the corridor controlled primarily by bank and floodplain vegetation. Review of aerial photography suggests a private road crossing spans the corridor approximately 250m downstream of Line 15 North, and an inline dam exists another 250m further downstream. Photos of representative conditions are provided below.

Wetland Condition Upstream Line 15 North

Densely Vegetated Corridor Downstream Line 15 North.

4.8.1.2 Mill Creek Downstream Hwy 11

As Mill Creek continues downstream of Hwy 11, the stream system has been channelized (straightened) as the creek extends through agricultural and / or meadow lands devoid of trees and mature vegetation. Under low flow conditions the wetted area within the channel nearly tops the banks, suggesting that spilling into the floodplain is relatively frequent. The bed is covered with a thin layer of deposited fine sediments with a continuous low velocity, backwater condition prevalent. No significant risks were observed along where the creek was accessed (Hurtubise Drive and Memorial Ave), however, where Mill Creek is confined to a 30m wide corridor between Ontario St and Hwy 12 By-Pass, risks due to erosion of the road embankment exist. Further downstream, Mill Creek is intermittently confined by commercial properties extending to the edge of the corridor, with bank treatments in the form of riprap used to prevent erosion. Photos of Mill Creek Downstream Hwy 11 are provided below.

Straightened Creek South of Hwy 12 at Hurtubise Dr.

Manicured Lawns Where Mill Creek Extends Through Commercial Properties Upstream Memorial Ave.

4.8.1.3 Ben's Ditch

Ben's Ditch confluences with Mill Creek South Hwy of 12 By-Pass, draining the south portion of the downtown core. Similar to Mill Creek, Ben's Ditch has been historically altered to maintain a straightened planform, controlled along the banks by dense grasses and sparsely located trees. The creek maintains a wide, flat floodplan with the exception of areas where fill has been historically added to enable development beyond the banks of the channel (ie. north of James Street West crossing). Rapid geomorphic assessment (RGA) indicates the channel is stable, with dominant geomorphic process aggrading. This is consistent with the low velocity conditions and sediment deposits along the bed. Photos of Ben's ditch are provided below.

Ben's Ditch at James St.

Ben's Ditch confluence with Mill Creek south of Hwy. 12

4.8.2 Sundial Creek Characterization

The Sundial Creek system was investigated at the Fittons Road East crossing. The main drainage crossing was observed to drain Grants Wetland, under Fittons Road through a CSP culvert, and through a narrowly confined corridor between two residential properties. Within Grants wetland area, the channel was intermittently defined and controlled by vegetation as well as potentially backwater conditions from Lake Couchiching levels, with a corridor greater than 130m in width. On the downstream side of Fittons Road, the creek corridor tapers from a 130m width to a 3m width as the channel drains directly into Lake Couchiching between two adjacent driveways and houses. Photos of these conditions are provided below.

Sundial Creek Channelized & Confined Between Private Residences.

Sundial Creek Draining Through Grants Wetland.

Upstream of Grants wetland, a tributary of Sundial Creek drains under Fittons Road as well, away from the Lake in the westerly direction. Similar to the residential constraints described within the downstream most segment, this feature drains within close proximity to residential houses, some of which have undertaken significant realignment or erosion protection works. Photos of this upstream feature are provided below.

Sundial Creek Channelized & Confined Between Private Residences.

Sundial Creek Draining From Grants Wetland.

4.8.3 Silver Creek Characterization

The upper drainage area of the Silver Creek subwatershed is located within the northern section of the City limits, and recent development has altered the headwater features, condensing the local drainage into stormwater retention facilities, which then drain downstream beyond the City limits into Silver Creek. At the downstream extent of the large stormwater facility near the intersection of Murphy Road and Uhthoff Line, significant flows were observed exiting the pond outlet structure, onto a riprap protected slope and into a confined valley setting. At this outfall location, flows were observed to be 'lost' through the oversized riprap, and potential undermining of the slope may become an issue over time.

Silver Creek Stormwater Facility Collects Headwater Drainage.

Silver Creek Stormwater Outlet Protected by RipRap.

4.8.4 Bass Lake Characterization

The main Bass Lake drainage feature within the study extents crosses Line 15 North and is contained within a 10 – 20m wide corridor, with gradual slopes that drain towards the headwater feature which would be considered generally unconfined. The primary control on the channel is long grasses which are flanked by agricultural fields. As the creek extends further downstream, the gradual valley slopes rescind and the channel enters a lower gradient, heavily wooded area with large wetland and ponded areas. Within this wetland section flow velocities are negligible as they drain under Bass Lake Side Road towards Bass Lake Provincial Park. Representative photos of the feature are provided below.

Bass Lake Drainage Through Agricultural Lands.

Bass Lake Drainage Downstream of Bass Lake Side Road.

4.8.5 Summary of Geomorphic Conditions and Channel Characterization

The largest watercourse within the City limits is Mill Creek, which drains into Lake Simcoe via Ben's Ditch. At the outlet Mill Creek would be considered a 4th order watercourse, indicating a number of smaller drainage features combine throughout the City's largest basin within the study area to form the relatively sizable watercourse. Mill Creek is generally within an unconfined valley setting with widely accessible floodplains which span well beyond the channel, traversing low gradients with backwater conditions observed under relatively dry conditions. Overall, the dominant geomorphic process of the main Mill Creek channel and associated tributaries is defined as aggradational maintaining an overall stable RGA index.

The other watercourses observed within the City limits, such as Sundial, Silver, and Bass Creeks are more consistent with headwater features typically found within the upper reaches of a subwatershed. Although these creeks are lesser in size, headwater systems are important sources of food, sediment, water, nutrients, and organic matter for downstream reaches, and must be given due consideration when planning for development, as well as agricultural land use practices. Activities such as development which eliminate headwater features can have implications on groundwater recharge, water quantity, and the overall health of the downstream channel. Specifically, within Sundial Creek, headwater features have been incorporated directly into the residential development, channelizing, hardening, and landscaping segments of the channel. Within Silver Creek, many headwater features may have been removed to accommodate development, and remaining features should be protected where possible. Within Bass Lake, the channel is largely healthy and stable, with important perennial hydrological functions.

4.9 Stormwater Management

As discussed in Section 2 and shown in Figure 2.1 there are four main watershed basins to which stormwater drainage from the City is discharged:

- The Lake Simcoe Drainage Basin
- The Lake Couchiching Drainage Basin
- Bass Lake Watershed
- Silver Creek Watershed.

Stormwater runoff is conveyed to these receiving water bodies via the major and minor drainage systems. The minor system conveys runoff from the most frequent storm events and typically consists of the storm sewer network and roadside ditches in the urban areas, as well as roadside ditches and driveway culverts in the rural lands. Runoff from large storm events are conveyed by the major system which includes road rights-of-way in the existing urban areas, as well as main ditches, swales, watercourses and floodplains. The City also has a number of existing stormwater management facilities which provide water quality and quantity (flood) control for the drainage areas they service.

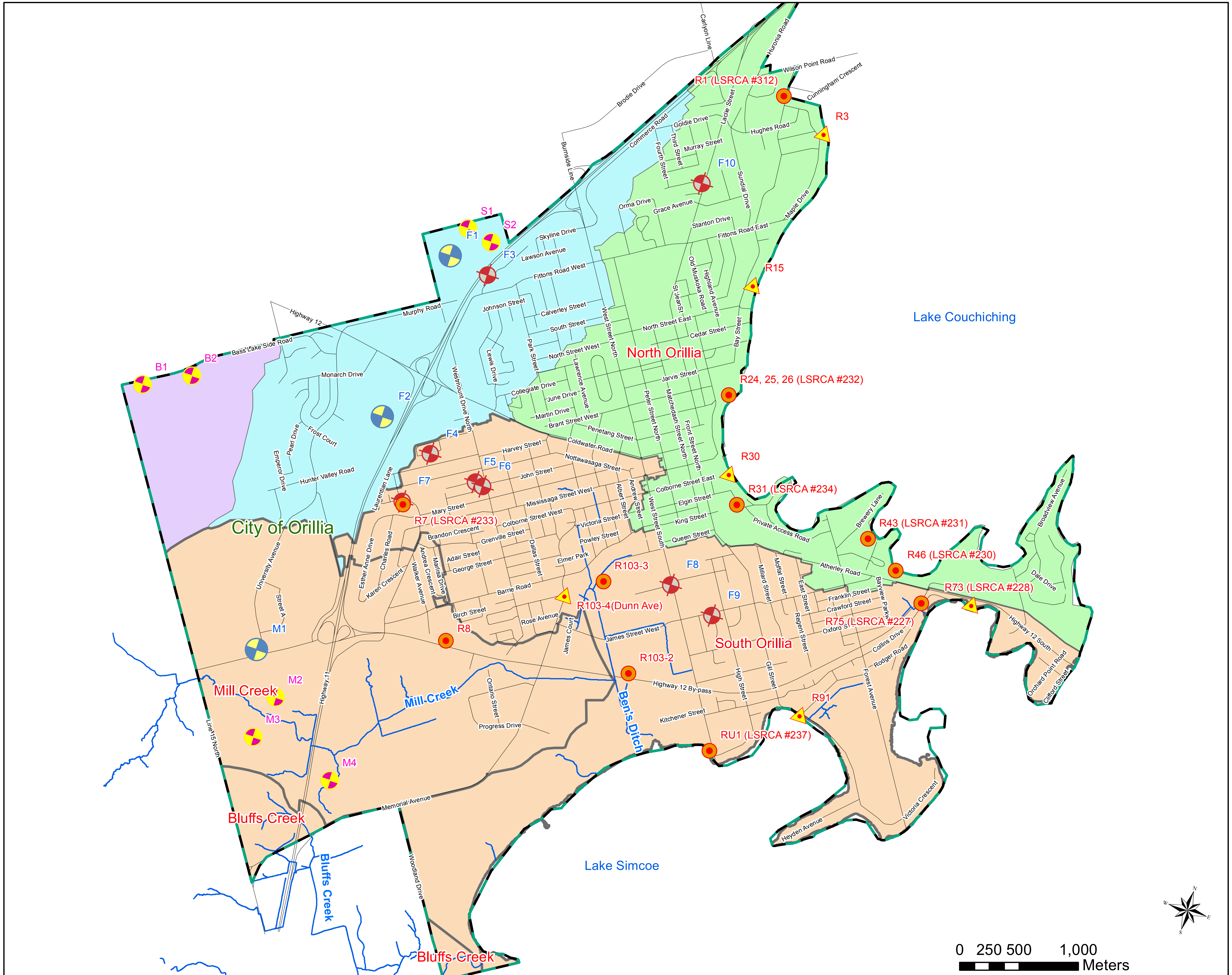
The following previous studies inventoried the City of Orillia storm drainage system, including existing and proposed future stormwater management facilities, as well as stormwater retrofit opportunities:

- 2005 Stormwater Management Master Plan Study (MMM);
- 2007 Lake Simcoe Basin Stormwater Management and Retrofit Opportunities Study (LSRCA).

Figure 4.11 illustrates the locations of the following types of stormwater management facilities which have been identified within the City of Orillia:

- Existing stormwater management facilities serving existing development;
- Proposed future stormwater management facilities to serve future development;
- Proposed stormwater quality retrofits within the existing development area.

Details with respect to each of these types of facilities are provided below.



KEY MAP

Legend

StudyArea

Road

Stream

Future Ponds

End-of-Pipe Retrofit Opportunities

SWM Facility Retrofit Opportunity

Oil and Grit Separator

Existing SWM Facility

Quality and Quantity

Quantity

Subwatershed

Bass Lake Basin

Lake Couchiching Basin

Lake Simcoe Basin

Silver Creek Basin

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City Of Orillia Comprehensive Stormwater Management Master Plan

Existing and Proposed Stormwater Management Facilities

Mapping Source: City of Orillia (2014) & Lake Simcoe Region Conservation Authority (2007)

FIGURE: 4.11

DATE: June 2014

4.9.1 Existing Stormwater Management Facilities

In Ontario, prior to the 1980's, stormwater runoff from urban development areas was typically discharged from storm sewers or ditches directly to the receiving stream or river. Much of the existing urban development within the City of Orillia took place prior to the implementation of modern stormwater management. As such, there are large areas within the city where uncontrolled and untreated stormwater runoff is discharged directly to the receiving water bodies such as Lake Simcoe and Lake Couchiching.

Table 4.6 summarizes the location and characteristics of the existing stormwater management facilities in the City of Orillia. As shown, there are seven existing stormwater facilities in the Lake Simcoe basin (i.e. M1, F4, F5, F6, F7, F8 and F9). Pond M1 is a wet detention pond providing water quality and quantity control to the University Avenue lands north of Old Barrie Road. Currently the drainage area to this pond is only partially developed, with further future urban development planned. The remaining facilities are in the form of either oversized storm sewer pipes or dry detention ponds. These types of facilities provide storage to control runoff rates (i.e. quantity control), but are generally not designed to remove pollutants. Therefore, the majority of lands within the Lake Simcoe Basin drain without water quality control. Only the drainage area to Pond M1, representing less than 9% of the area within the City draining to Lake Simcoe, receives water quality treatment.

Within the Lake Couchiching basin there is only one existing facility (F10). This facility provides quantity control only. As such, there are currently no water quality controls within the Lake Couchiching basin.

Within the Silver Creek watershed, there are two existing stormwater ponds (F1 and F2) which provide both water quality and quantity control for much of the newer urban development located to the west of Highway 11. There is also one dry pond (F3) which provides only quantity control for a small area east of Highway 11.

4.9.2 Proposed Future Stormwater Management Facilities

The 2005 Stormwater Management Master Plan Study (MMM) outlines a series of stormwater management facilities which will be required to service the future urban development lands within the City. The general locations of these future facilities are illustrated in Figure 4.11 and outlined in Table 4.7. It should be noted that the illustrated locations are conceptual in nature. The ultimate location and number of facilities will depend on the future development layout, road locations and grading, land ownership and timing of development.

It is anticipated that all of these facilities will take the form of end-of-pipe wet ponds which provide both quantity (flood) control and water quality control. In order to satisfy the requirements of LSRCA and the City's Official Plan policies, these future stormwater ponds will be designed to provide "Enhanced" or "Level 1" water quality control, as outlined the MOE Planning and Design Manual.

Table 4.6: Existing Stormwater Management Facilities within the City of Orillia

SWM Facility No.	Watershed	Type of Facility	Type of Control	Drainage Area	Notes / Surce of Info.
M1	Lake Simcoe / Mill Crk.	wet pond	water quality & quantity control	138.7	control of Mill Creek sub-basins 2&3 (partially developed)
F4	Lake Simcoe	pipe storage	quantity control only	6.2	catchment area estimated from City mapping
F5	Lake Simcoe	pipe storage	quantity control only	3.0	catchment area estimated from City mapping
F6	Lake Simcoe	pipe storage	quantity control only	5.0	catchment area estimated from City mapping
F7	Lake Simcoe	dry pond	quantity control only	5.3	this site also ID'd by LSRCA as retrofit opportunity (site 233)
F8	Lake Simcoe	pipe storage	quantity control only	3.9	catchment area estimated from City mapping
F9	Lake Simcoe	pipe storage	quantity control only	2.9	catchment area estimated from City mapping
F10	Lake Couchiching	pipe storage	quantity control only	11.5	catchment area estimated from City mapping
F1	Silver Creek	wet pond	water quality & quantity control	166.0	control for sub-basin 2 (MMM'05)
F2	Silver Creek	wet pond	water quality & quantity control	227.6	control for sub-basin 1 (MMM'05). Ultimately drains to F1
F3	Silver Creek	dry pond	quantity control only	6.3	area D in sub-basin 2. Ultimately drains to pond F1

Table 4.7: Proposed Future Stormwater Management Facilities

SWM Facility No.	Watershed	Type of Facility	Type of Control	Notes / Surce of Info.
M2	Lake Simcoe	wet pond	water quality & quantity control	per MMM'05, Section 6.5.3. Ponds to serve fut. bus. park
M3	Lake Simcoe	wet pond	water quality & quantity control	per MMM'05, Section 6.5.3. Ponds to serve fut. bus. park
M4	Lake Simcoe	wet pond	water quality & quantity control	per MMM'05, Section 6.5.3. Ponds to serve fut. res
S1	Silver Creek, basin E	wet pond	water quality & quantity control	per MMM'05, Section 6.3.3. Ponds to serve fut. res & comm. dev. W. of Hwy11
S2	Silver Creek, basin E	wet pond	water quality & quantity control	per MMM'05, Section 6.3.3. Ponds to serve fut. res & comm. dev. W. of Hwy11
B1	Bass Lake	wet pond	water quality & quantity control	per MMM'05, Section 6.4.3. Ponds to serve fut. res. dev.
B2	Bass Lake	wet pond	water quality & quantity control	per MMM'05, Section 6.4.3. Ponds to serve fut. res. dev.

4.9.3 Proposed Stormwater Quality Retrofits within Existing Development Areas

Previous studies have investigated opportunities to provide water quality treatment within existing development areas which currently discharge without control. The focus of these investigations was on identifying locations where there is sufficient space to construct new stormwater controls at existing storm sewer outfalls.

In 2007, LSRCA estimated the potential benefits of implementing 279 “end-of-pipe” water quality retrofits over the entire Lake Simcoe basin, including several in the City of Orillia. It concluded that phosphorus loadings to the lake could be reduced by approximately 32%. Within the City of Orillia, the identified water quality retrofit opportunities consist of:

- Small urban sewershed areas where there is potential to add oil-grit separator devices at the outfall location; and
- Larger drainage areas where there is space at the outfall to construct a stormwater management pond.

The 2005 Stormwater Management Master Plan Study (MMM) also identified a number of potential retrofit sites within the city. As part of this current CSWM-MP study, the feasibility of these sites was reviewed, together with others identified by City staff. The reviews consisted of:

- Cursory site assessments via mapping and air photo review;
- Follow-up site investigations to assess drainage conditions and available space; and
- Discussions with city staff;

Review and screening of the potential retrofit sites is summarized in Appendix A. Table 4.8 summarizes those “end-of-pipe” retrofit opportunities considered feasible. As shown, nine (9) retrofit opportunities were identified for drainage to Lake Simcoe. This includes two options to provide a facility on Ben’s Ditch to outfall 103. Initially, background studies had suggested a new stormwater pond at the outlet of Mill Creek to Lake Simcoe (i.e. at outfall 103). However, this site includes the City’s wastewater treatment plant as well as a landfill, leaving insufficient space at this location. Instead, two other alternative locations on city-owned lands were identified on Ben’s Ditch; between James Street and Highway 12 (site 103-2) or southwest of Queen St. W. and West St. S. (site 103-3). As shown in Table 4.8, the retrofit opportunities within the Lake Simcoe basin could provide some measure of water quality control for approximately 456ha of upstream urban drainage, representing roughly 29% of the total area within the city draining to the lake.

A further eight (8) retrofit opportunities were identified for drainage to Lake Couchiching. These opportunities would provide some measure of water quality control for approximately 312ha of upstream urban drainage, representing roughly 47% of the total area within the city draining to the lake. The majority of this control would be provided at a new end-of-pipe facility that could be located in Couchiching Beach Park to provide control to the combined drainage from outfalls 24, 25 and 26.

In addition to the end-of-pipe water quality retrofits discussed above, provincial agency and Official Plan policies also promote opportunities to implement new innovative stormwater management measures further upstream in the urban drainage system. Low impact development “LID” measures may be implemented on a lot-level basis, or within municipal rights-of-way to enhance pollutant removal efficiency and water balance. These opportunities are discussed further in Section 8.

Table 4.8: City of Orillia Water Quality Retrofit Opportunities

Site / Outfall No.		LSRCA Site No. *	Watershed / Basin	Retrofit Type	Drainage Area (ha)
dry SWM Pond #F7		233	Lake Simcoe, basin #16	add WQ function to dry pond	5.3
Mill Creek basin 8		--	Lake Simcoe/ Mill Crk. basin #8	new SWM pond or inline facility	48.3
outfall #103-2	optional site 1 on Ben's Ditch to outfall 103	236	Lake Simcoe / basin #14-17, 7	new SWM pond / SWM wetland	352
outfall #103-3	optional site 2 on Ben's Ditch to outfall 103	236	Lake Simcoe / basin #15, 16	new SWM pond	261
outfall #U1		237	Lake Simcoe, basin #13	new SWM pond or inf. gallery	23.4
outfall #91		--	Lake Simcoe, basin #9	OGS	4.3
outfall #75		227	Lake Simcoe, basin #2	new SWM pond	19.7
outfall #73		228	Lake Simcoe, basin #1	OGS	3.1
Memorial / Dunn (#103-4)		--	Lake Simcoe, basin #14	OGS and upstream bioswales	7.0
total area within Lake Simcoe Watershed served by potential end-of-pipe water quality retrofits (assuming Optoinal Site 1 selected for outfall 103):					456.1
outfall #46		230	Lake Couchiching, basin #21	new SWM pond	13.1
outfall #43		231	Lake Couchiching, basin #22	new SWM pond / bioswales	8.7
outfall #31		234	Lake Couchiching, basin #17	new SWM pond	51.9
outfall #30		--	Lake Couchiching, basin #14	OGS	3.2
outfalls #24, 25, 26	investigate potential to divert to new SWM facility in Couchiching Beach Park	232	Lake Couchiching, basin #9	new SWM pond	203.2
outfall #15		--	Lake Couchiching, basin #7	OGS	3.1
outfall #3		--	Lake Couchiching, basin #3	OGS	4.4
outfall #1		312	Lake Couchiching, basin #1	new SWM pond	24.4
total area within Lake Couchiching Watershed served by potential end-of-pipe water quality retrofits:					312.0

* Lake Simcoe Basin Stormwater Management and Retrofit Opportunities (LSRCA 2007).

4.10 Summary of Key Environmental Issues

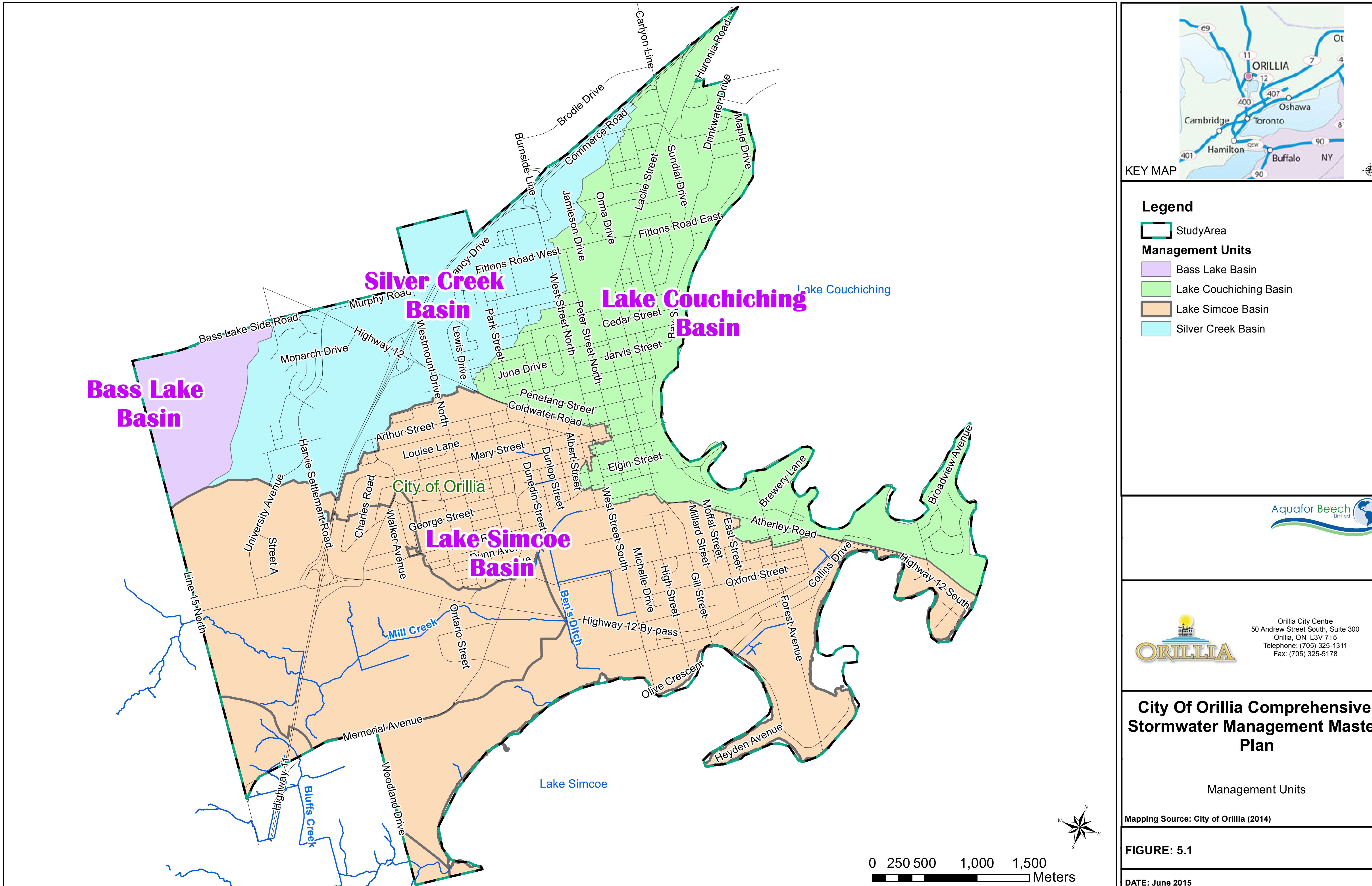
Key environmental findings from the review of background information and characterization of the study area are summarized below:

- Surface Water Quality: In-stream concentrations of phosphorus, chlorides, iron, copper and zinc were found to exceed Provincial Water Quality Objectives (PWQOs) at select locations on Mill Creek and Ben's Ditch within the older part of the city;
- Terrestrial Ecology: There are a number of terrestrial natural heritage features within the city that provide hydrological benefits in terms of interception of precipitation, storage and reduction of stormwater runoff , and augmentation of baseflows;
- Aquatic Ecology: The city's streams support a number of sensitive coldwater and coolwater fish communities that are directly impacted by hydrologic changes due to development. Without controls, these stormwater impacts can include increased runoff, decreased infiltration, increased water temperatures, and increased pollutant loadings;
- Groundwater Resources: Much of the city, including areas designated for future urban development, is underlain by coarse soils which provide an important groundwater recharge function. Protection of this function will be important as the groundwater, in turn, supplies municipal wells and also discharges as baseflow to study area streams, providing a source of cool, clean water to streams and wetlands.
- Surface Water and Flood Hazards: Designated flood hazard lands within the city include areas susceptible to high lake levels as well as the Regulatory floodplain of Mill Creek. Without stormwater controls, floodplain hazard lands can be impacted by increased flood flows due to higher levels of imperviousness and fragmented natural landscape cover which are typical of increased urbanization.
- Stormwater Management: Much of the existing urban development in the city of Orillia took place before the implementation of modern stormwater management. There are existing stormwater ponds within the Silver Creek watershed which provide water quality and quantity control over virtually the entire basin. However, within the older parts of the city, there is only one stormwater pond providing water quality control, and a limited number of quantity control facilities serving small drainage areas. As such, there are currently no stormwater quality control facilities for over 91% of the lands discharging to Lake Simcoe and 100% of the lands discharging to Lake Couchiching.
- Several opportunities within the older parts of the city have been identified to retrofit stormwater discharges to the lakes through the construction of new end-of-pipe water quality ponds or oil-grit separators. These opportunities could provide some level of water quality control to approximately 29% of the city lands draining to Lake Simcoe, and approximately 47% of the city lands draining to Lake Couchiching. Additional retrofit opportunities using source-control and conveyance-control LID measures are also suggested to enhance pollutant removal efficiency and water balance.

5 Management Units

The City's Study Area has been divided into four discrete Management Units based on the watershed drainage basins to which stormwater drainage from the City is discharged, as illustrated in Figure 5.1. The landuse and stormwater management characteristics within each of these units are summarized below:

- Lake Simcoe Basin (55% of city):
  - much of the basin has already been developed without stormwater management.
  - Only 9% of the basin receives water quality treatment via existing Pond M1.
  - Future development includes intensification and infill in existing urban areas, and greenfield development in the west end.
- Lake Couchiching Basin (23% of city):
  - the basin has already been developed without stormwater management.
  - Future development is limited to intensification and infill in the existing urban areas.
- Bass Lake Watershed (5% of city):
  - The basin is undeveloped.
  - All future development will be in the form of greenfield development.
- Silver Creek Watershed (17% of city):
  - Much of the basin has already been developed and receives water quality and quantity treatment via existing Ponds F1 and F2.
  - Future development includes intensification and infill in the existing urban areas, with limited future greenfield development in the north end.



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City Of Orillia Comprehensive Stormwater Management Master Plan

Management Units

Mapping Source: City of Orillia (2014)

FIGURE: 5.1

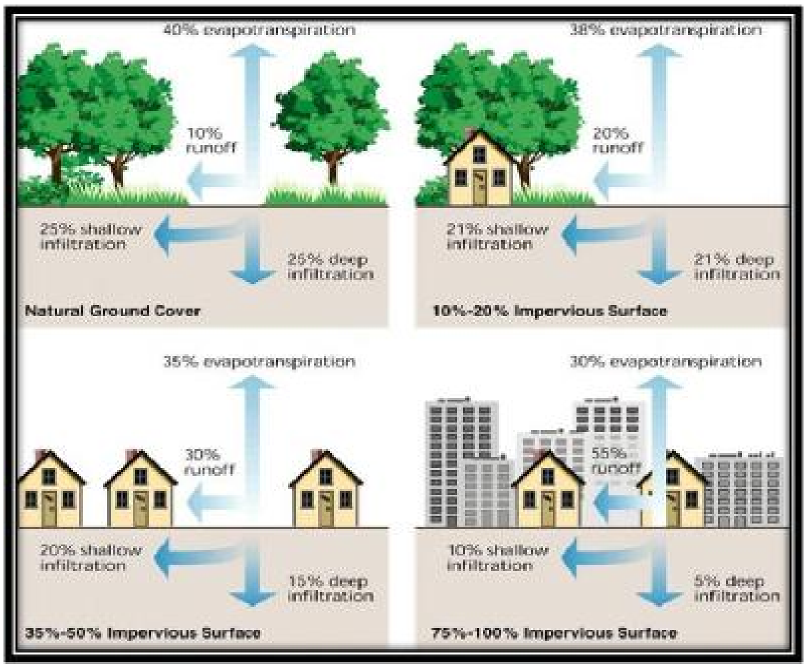
DATE: June 2015

6 Stormwater Impacts from Existing and New Development

6.1 Stormwater Impacts - General

As part of land use change and development, pervious land surfaces are converted to impervious surfaces. Runoff from impervious surfaces, including building rooftops, roadways, sidewalks, parking surfaces etc. reduce the volume of precipitation lost to the natural hydrologic pathways such as infiltration and evapotranspiration. As a result, runoff volumes and peak flows are increased during precipitation events, hydrologic response times to precipitation events are reduced, base flow conditions are impaired, ground water recharge is reduced, and the fluvial geomorphic processes of erosion and deposition are altered.

Watersheds with significant development are more prone to both erosion and flooding which can lead to degraded riparian habitat and infrastructure damage. The inset figure illustrates representative changes in the proportion of precipitation entering different flow pathways, when land use changes from native vegetation to an urban landscape. In general, for a given storm event, the total volume of stormwater runoff reaching a stream can increase 3 to 5 fold compared to rural or forested watersheds, accompanied with an increase in magnitude and duration of peak runoff and a significant decrease (greater than 50%) in infiltration.



Implications of these impacts include flooding issues, property and infrastructure damage, and modifications in stream morphology due to excessive erosion and/or sedimentation. Accordingly, areas of concern under future development scenarios include:

1. **Water Balance -** The reduction in the volume of precipitation lost to the natural hydrologic pathways such as infiltration and evapotranspiration are anticipated due to the reduction in permeable surfaces and the commensurate increase in impermeable surfaces within the developed lands. This, in turn, can lead to a reduction in baseflow contribution to nearby watercourses;
2. **Water Quality** – Stormwater runoff from urban sources typically contains elevated levels of contaminants such as sediment, nutrients, metals, and bacteria. Therefore, without controls, increased urban development can be expected to lead to degradation of instream water quality. This, in turn, has a the potential to impact:

- the health of existing fish communities within the city's streams and receiving water bodies such as Lake Simcoe and Lake Couchiching;
- the suitability of water for drinking and recreation.

3. **Water Quantity:** Larger runoff volumes have the potential to impact:
    - Flooding – increased peak flows can be anticipated as pervious land surfaces are converted to impervious surfaces.
    - Erosion – without mitigation, the fluvial geomorphic processes of erosion and deposition will be altered and increased rates of erosion can be anticipated.

6.2 Stormwater Impacts – City of Orillia

The following summarizes the estimated environmental impacts from stormwater associated with existing and future urban development within the City of Orillia. As noted in Section 0, much of the existing development in the Lake Simcoe and Lake Couchiching basins of the City of Orillia took place before stormwater management became common practice. With respect to future development, Figure 4.3 indicates that further urban growth is concentrated over the lands west of Highway No. 11 in the Mill Creek/Lake Simcoe basin, the Bass Lake basin, and the Silver Creek Basin. Further urban infill and intensification is also planned within the existing development areas, mainly in the Lake Simcoe and Lake Couchiching basins. The impacts of these planned landuse changes are assessed under the following three categories:

1. Water Balance;
2. Water Quality; and
3. Water Quantity

The impacts listed relate only to drainage and stormwater management and will serve as the basis for the development of evaluation criteria in the determination of the preferred stormwater management options in subsequent chapters.

6.2.1 Water Balance

As explained earlier, urban development can dramatically alter the natural hydrological cycle, with increased surface runoff and decreased infiltration to the ground due to increased levels of imperviousness and decreased natural cover.

The soils covering most of the city are relatively coarse, consisting of sands, gravel, and loam. These types of soils have moderate to high infiltration rates, and therefore function as a potential contributor of baseflow to study area streams. Without stormwater controls, the impervious surfaces associated with urban development will reduce the capacity of the land to infiltrate rainfall events into the groundwater system, creating an increase in the volume of surface water runoff instead. This alteration to the water budget can, in turn, contribute to increased rates of flooding, erosion, and pollutant loadings. The corresponding reduction in groundwater levels can also result in reduced supplies of clean, cool baseflows to area streams, thereby negatively impacting downstream fish communities.

For the City of Orillia study area, a water balance spreadsheet assessment was completed to estimate the potential impacts of future development on groundwater infiltration. Details are provided in Appendix B.

Pre-Development Groundwater Infiltration

The Oro and Hawkestone Creeks Subwatershed Plan (LSRCA, 2013) provides the following components of the pre-development annual water budget:

- Precipitation = 975mm/yr
- Evapotranspiration = 564 mm/yr
- Surplus water = 411 mm/yr
- Mean annual streamflow = 254mm/yr
- Baseflow = 122 mm/yr

Given the above, the estimated split between the annual runoff and annual infiltration is as follows:

- Runoff = 132 mm/yr,
- Infiltration = 279 mm/yr.

This annual infiltration estimate was checked against suggested water budget components from the MOE Stormwater Management Planning and Design Manual. Based on the general topography, soils, and vegetative cover, the MOE Manual would suggest an “infiltration factor” of 70% be applied to the water surplus, resulting in an estimated annual infiltration rate of 287 mm, which is consistent with the value estimated above.

Post-Development Impacts

For post-development conditions, the annual infiltration deficit was estimated based on the change in imperviousness for a range of landuses. Table 6.1 presents the results for five typical types of landuse changes. As shown, without stormwater controls that promote groundwater recharge, the volume of water that is naturally infiltrating under existing (pre-development) conditions is expected to decrease dramatically, with infiltration deficits exceeding 200mm per year for the highest intensity urban developments.

Table 6.1: Estimated Development Impacts to Annual Infiltration

Proposed Landuses	Imperviousness		Soil Type	Annual Infiltration (mm/yr)		Infiltration Deficit (mm/yr)
	Existing / Pre-Development	Post-Development		Existing/ Pre-Development	Post-Development	
Parkland	0%	25%	coarse A/B	279	209	70
Residential	0%	50%	coarse A/B	279	140	139
Institutional	0%	70%	coarse A/B	279	84	195
Business	0%	80%	coarse A/B	279	56	223
Intensification	40%	70%	coarse A/B	167	84	84

In order to estimate infiltration targets to overcome these potential deficits and maintain existing groundwater recharge rates, further water balance analysis was completed using a typical range of annual rainfall events. Details are provided in Appendix B and indicate that a stormwater infiltration target between 2 mm and 8 mm over the catchment area, depending on landuse, would be appropriate to maintain the existing groundwater recharge rates within the City. Within the context of new and infill development, the selection of a specific infiltration target within this range would depend on the types of proposed landuses (i.e. imperviousness). At a site scale, geotechnical studies and infiltration tests may also be needed to confirm the assumed rates.

6.2.2 Water Quality

The basis for undertaking this Stormwater Management Master Plan study lies in the requirements of the Lake Simcoe Protection Plan (2009). Therefore, the main focus of the study is intended to be on the stormwater quality impacts to Lake Simcoe, including phosphorus loadings in particular. However, as part of the analyses, impacts to the Lake Couchiching, Silver Creek and Bass Lake watershed basins were also investigated.

The Ontario Ministry of the Environment's "Lake Simcoe Phosphorus Loading Development Tool" (assessment tool) was utilized to quantify phosphorus loadings from the City study area. The model applies typical stormwater export coefficient values for phosphorus to various types of landuses. The model can also estimate phosphorus loadings reductions associated with a suite of stormwater management practices.Table 6.2 summarizes how the City of Orillia landuse categories were applied to the available landuses categories within the model, together with the corresponding phosphorus export coefficients. Because the City of Orillia is partially located within the Oro Creeks North subwatershed, the coefficient values from this basin were selected from the model for application. These same values were also assumed to apply in the assessments for the neighboring Lake Couchiching, Silver Creek, and Bass Lake watershed basins.

Table 6.2: Landuses and Associated Phosphorus Export Coefficients in the MOE Assessment Tool

MOE/LSRCA Model Landuse Category	City Landuse Categories		Phosphorus Export Coefficient (kg/ha/yr)
	Existing Landuses	Future OP Landuses	
crop land	Intensive Agriculture	n/a	0.36
hay / pasture	Non-intensive Agriculture	n/a	0.12
sod farm / golf course	Golf Course	Golf Course	0.24
	Manicured Open Space	Parklands	
forest	Natural Heritage Feature	Environmental Protection Area	0.10
low intensity development	Estate Residential	n/a	0.13
	Rural Development		
high intensity development (residential)	Urban	Intensification Area	1.32
		Neighbourhood Greenfields	
		Stable Neighbourhood	
high intensity development (comm./ind.)	Commercial	Artirial Commercial	1.82
	Industrial	Business Park	
	Institutional	Community Commercial	
	Road	Downtown Area	
		Industrial	
		Light Industrial	

In addition to water quality analysis for phosphorus loads, this study investigated the loadings of other common water quality pollutants, including:

- E.coli;
- Total Suspended Solids (TSS);
- Zinc; and
- Copper.

These four pollutants are generally found in urban environments and affect the overall surface water and groundwater quality and aquatic habitat integrity. A comprehensive water quality database developed by Aquafor Beech was used to define Event Mean Concentration (EMCs) as functions of pre-development and post-development land uses within the study area. Six land use categories were chosen to represent the local landscape within the study area. Table 6.3 shows Event Mean Concentrations applied for each land use.

Table 6.3: Landuses and Suggested Event Mean Concentrations for Select Water Quality Pollutants

Landuse	Total Suspended Solids TSS (mg/L)	Copper Cu (mg/L)	Zinc Zn (mg/L)	E.coli (count/100ml)
Comm./Ind./Instit./Roads	87	0.128	0.290	3,000
Residential	131	0.025	0.111	12,645
Open Space (parklands/golf)	216	0.025	0.123	4,100
Agricultural	100	0.008	0.018	51,532
Forest	55	0.006	0.025	100
Rural Development	71	0.002	0.004	83

The annual loadings for each pollutant were estimated using annual runoff estimates based on annual precipitation, typical runoff coefficients and EMC values for each landuse category.

Landuse polygons from the City`s mapping served to quantify the landuse categories within each of the four main management unit drainage basins for the water quality impact assessment. Existing and post-development (i.e. future / Official Plan) landuses were tabulated within each of the basins. Within the post-development scenario, the landuse areas were further broken down into categories according to the potential for treatment using end-of-pipe stormwater management facilities:

- Most of the existing urban development lands currently have no water quality stormwater controls and are assumed to remain uncontrolled in the future;
- Some existing urban development lands could potentially be retrofitted to provide water quality treatment where there currently is none. This would include end-of-pipe retrofit opportunity sites (Table 4.8) as well as other source and conveyance control opportunities discussed later in Section 8;
- Future development areas were also identified, including "greenfield" development areas and areas of urban intensification.

The results of the water quality assessment are summarized in Table 6.4. Summary output from the phosphorus loadings model tool and the pollutant loading model is provided in Appendix C and D. The initial assessment quantifies the pollutant loadings associated with existing urbanization and the effectiveness of the associated existing stormwater management facilities. This assessment is followed by an evaluation of the predicted impacts due to further future urbanization.

Table 6.4: Water Quality Impact Assessment for Existing and Future Landuses

Watershed Basin	Area (ha)	Existing Development without SWM	Existing Development & Existing SWM	Effectiveness of Existing SWM	Future - uncontrolled new urban, and no retrofits)	
Annual Phosphorus Pollutant Loadings *		Annual Loading (kg)	Annual Loading (kg)	-	Annual Loading (kg)	Change from Existing
Lake Simcoe	1571.6	1054	1017	-3%	1697	67%
Lake Couchiching	660.9	782	782	n/a - no SWM	799	2%
Silver Creek Basin	491.9	490	181	-63%	634	249%
Bass Lake Basin	126.9	23	23	n/a - no SWM	120	416%
** Estimated using MOE Lake Simcoe Phosphorus Loading Development Tool*						
Annual TSS Pollutant Loadings		Annual Loading (tonnes)	Annual Loading (tonnes)	-	Annual Loading (tonnes)	Change from Existing
Lake Simcoe	1571.6	581	553	-5%	812	47%
Lake Couchiching	660.9	390	390	n/a - no SWM	418	7%
Silver Creek Basin	491.9	242	48	-80%	142	194%
Bass Lake Basin	126.9	20	20	n/a - no SWM	64	221%
Annual Copper Pollutant Loadings		Annual Loading (kg)	Annual Loading (kg)	-	Annual Loading (tonnes)	Change from Existing
Lake Simcoe	1571.6	203	196	-3%	503	156%
Lake Couchiching	660.9	187	187	n/a - no SWM	165	-12%
Silver Creek Basin	491.9	157	81	-48%	95	17%
Bass Lake Basin	126.9	3	3	n/a - no SWM	12	343%
Annual Zinc Pollutant Loadings		Annual Loading (kg)	Annual Loading (kg)	-	Annual Loading (tonnes)	Change from Existing
Lake Simcoe	1571.6	623	603	-3%	1,348	124%
Lake Couchiching	660.9	544	544	n/a - no SWM	513	-6%
Silver Creek Basin	491.9	408	151	-63%	225	49%
Bass Lake Basin	126.9	7	7	n/a - no SWM	52	631%
Annual E.coli Pollutant Loadings		Annual Loading (trillions)	Annual Loading (trillions)	-	Annual Loading (trillions)	Change from Existing
Lake Simcoe	1571.6	501	452	-10%	533	18%
Lake Couchiching	660.9	289	289	n/a - no SWM	321	11%
Silver Creek Basin	491.9	189	89	-53%	155	75%
Bass Lake Basin	126.9	66	66	n/a - no SWM	58	-13%

Existing Pollutant Loadings and Effectiveness of Existing SWM Facilities

As noted in **Section 4.9.1**, there are three existing stormwater management ponds providing water quality treatment within the City of Orillia:

- Pond M1 in the Lake Simcoe Basin
- Ponds F1 & F2 in the Silver Creek Basin

For the purposes of the impact assessment, the following typical treatment efficiencies were applied for the end-of-pipe stormwater ponds:

- Phosphorus removal – 63% (P-Loading model)
- TSS removal – 80%
- Copper removal – 48%
- Zinc removal – 63%
- E.coli – 53%

As shown in Table 6.4, existing landuses are estimated to contribute just over 1000 kg of Phosphorus annually to Lake Simcoe. The treatment provided by the existing stormwater management pond M1 reduces the annual loading by roughly 3%. The effectiveness of the pond in reducing overall loadings of other pollutants is also summarized in Table 6.4.

The Lake Couchiching basin is effectively fully urbanized and has no water quality controls, resulting in elevated pollutant loadings.

Effectively all of the runoff from the Silver Creek basin receives treatment via stormwater ponds F1 and F2. As such, the loadings from this urbanized basin are much lower, on a per hectare basis, than those to Lake Simcoe and Lake Couchiching.

The Bass Lake basin is currently undeveloped and therefore pollutant loadings in this basin are typically much lower, on a per hectare basis, than to the other urban basins.

Impacts of Future Development

Ultimately, it is understood that the future development areas will need to implement modern stormwater management controls, and that some existing urban areas may be retrofitted to provide stormwater controls at some point in the future. However, for the purposes of this impact assessment, the phosphorus and other pollutant loadings under the existing landuse scenario were compared to loadings under a post-development scenario in which future urban development takes place without any stormwater management controls or retrofits.

Model results comparing existing and post-development phosphorus loads are provided in Table 6.4. As shown, without stormwater quality controls, future development within the Lake Simcoe basin is expected to increase phosphorus loadings to the lake by approximately 680 kg per year, an increase of

67%. This is attributed to the conversion of rural landuses with lower phosphorus exports to urban landuses with higher unit export values. Metals loadings within the Lake Simcoe basin could also increase dramatically. TSS loadings to the lake would also increase significantly, and E.coli loadings would also experience a moderate increase.

Given that much of the city lands draining to Lake Couchiching are already developed, the predicted changes to the phosphorus loadings to the lake are negligible (2%). Only small changes to the other pollutant loadings within the Lake Couchiching basin are also predicted.

In the Silver Creek watershed, if the new urban development were to occur without stormwater controls, phosphorus and other pollutant loadings are predicted to increase significantly.

In the Bass Lake Subwatershed, the conversion of mostly rural landuses to new urban landuses without stormwater controls would result in a large (>400%) increase in many pollutant loadings to this system. Only the loadings of E.coli would be expected to be reduced.

6.2.3 Water Quantity

Flood flow estimates at various locations throughout the City of Orillia were estimated through hydrologic modelling completed as part of the 1991 City of Orillia Master Drainage Plan. The previous work also estimated flood flow rates associated with future landuses at select locations. Table 6.5 compares these flood flow estimates for select locations in the Mill Creek and Bass Lake watersheds.

Table 6.5: Impact Assessment - Flood Flows

Location		Flood Flow Estimates (m^3/s)*						
	Landuse	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Regional
Bass Lake Drain								
Bass Lake Sideroad E.	Existing Future	0.48 1.3	1.1 1.8	1.4 2.2	1.9 3.4	2.3 4.7	3.0 6.1	n/a n/a
Mill Creek								
Line 15 N.	Existing Future	0.92 n/a	1.4 n/a	1.7 n/a	2.3 n/a	2.8 n/a	3.3 3.3	29.5 30.1
Highway 11	Existing Future	1.1 n/a	2.2 n/a	2.9 n/a	4.1 n/a	5.1 n/a	6.1 12.2	47.9 51.4
Memorial Ave	Existing Future	1.7 n/a	3.3 n/a	4.5 n/a	6.2 n/a	7.5 n/a	8.7 15.8	58.7 62.3
Outlet	Existing Future	1.9 n/a	3.8 n/a	5.3 n/a	7.3 n/a	8.8 n/a	10.1 13.4	62.4 66.2

* Source: 1991 Master Drainage Plan, as reported in MMM, 2005

As shown, without controls, flood flows were expected to increase significantly due to the increased runoff volumes and more rapid response associated with increased impervious cover in the future landuse scenario. This, in turn, can also lead to an increased frequency of flooding at flood-susceptible properties and road crossings. Increased runoff can also alter the fluvial geomorphic processes of erosion and deposition, and increased rates of erosion can be anticipated.

For the Silver Creek watershed, the previous modelling work assumed that flood flows are controlled by existing stormwater management ponds F1 and F2, and therefore no significant changes were expected. For the Lake Couchiching watershed, little impact to flood flows was expected, as the watershed is essentially fully developed, and future development would be in the form of re-development only.

As was noted earlier (Section 4.6.2), it is important to note that these flood flow estimates are based on landuse assumptions at the time of the 1991 study. As such, the City should consider development of an updated model based on current landuses and that also accounts for potential climate change impacts. LSRCA has just recently developed a VISUAL OTTHYMO model that covers parts of Orillia as part of a report entitled “Hydrologic Model for Orillia Creeks and Talbot River Watersheds” (July 2012). This modelling work may serve as a basis for any further analyses by the City.

7 Problem & Opportunity Identification

This study has the form of a Master Plan (Section 1.3), and has been initiated through the Environmental Assessment Process (Municipal Class EA) in order to assess, evaluate, prioritize, and select the preferred stormwater management alternatives for the City of Orillia. In light of the characterization of the study area carried out in Chapter 4, and the impact assessment in Chapter 6, this Chapter will establish the Problem or Opportunity as per the Phase I requirements of the Master Plan, and review the stormwater goals and objectives for water balance, water quality, and water quantity. The identification and assessment of alternative solutions to the Problem, and the selection of a Preferred Alternative will be discussed in Chapters 8 through Chapter 10.

7.1 Problem Identification

As demonstrated through the impact assessment in Chapter 6, urban development can result in significant negative impacts to the hydrologic characteristics of a watershed, including:

1. **Water Quality** – Without stormwater controls, large increases in pollutant loadings can be expected to the City's receiving lakes and streams. Phosphorus loadings from the City to Lake Simcoe were predicted to increase by roughly 67%, for example, due to future urban development.
2. **Water Balance** – Infiltration deficits ranging between 70mm/year to 223mm/year are predicted as landuse changes result in increased impervious cover over the coarse soils which underlay the City of Orillia. This, in turn, can lead to a reduction in baseflow contribution to nearby watercourses.
3. **Water Quantity:** Without stormwater controls, the increased impervious cover and urban drainage systems associated with development will increase runoff volumes and peak flood flow rates within the receiving streams. This, in turn can lead to increased frequency of flooding and rates of erosion.

Much of the existing urban development within the City of Orillia took place before the use of stormwater management measures became common practice. As such, the receiving streams and lakes have already been impacted by existing development, and, in the absence of stormwater controls, the above impacts can be expected to increase as further development and urban intensification continues.

7.2 Opportunities

The Comprehensive Stormwater Master Plan seeks to reduce the stormwater impacts of urban development through the implementation of effective stormwater management controls and other measures. This includes not only controls to mitigate impacts from new development lands, but also opportunities to retrofit the stormwater drainage systems within the existing development areas.

The need to address stormwater impacts has been reviewed as part of previous studies, including:

- general subwatershed management strategies (LSRCA, 2013);
- stormwater quality retrofit opportunities (LSRCA, 2007, and MMM, 2005);
- stormwater facilities for future development areas (MMM, 2005)

The identification and evaluation of stormwater management alternatives (Chapter 8 and 9) will take into consideration the findings and recommendations from the above studies, such as the previously-identified end-of-pipe retrofit opportunities, together with additional smaller-scale source and conveyance-type stormwater control opportunities. The recommendation of a Preferred Alternative (Chapter 10) will be consistent with the general Oro and Hawkestone Creek watershed-scale objectives and city-scale objectives in terms of water balance, water quality, and water quantity concerns.

7.3 Stormwater Management Objectives

Consistent with the overall approach of this study, the intent is to undertake the level of detail necessary to satisfy Phases 1 and 2 of the Class EA process as part of Approach 1 for Master plans. As discussed above, the identification of problems and opportunities within the city's study area have focused on the following key stormwater management issues:

- Water Quality;
- Water Balance; and
- Water Quantity

The next step of the study process is to establish a set of objectives that corresponds to a vision for the future state of the social, economic, and environmental conditions within the study area. Table 7.1 presents three groupings of objectives consisting water quality objectives, water balance objectives and water quantity objectives.

The objectives are tabulated in terms of their priority within the study area. Since the overarching objective of this study is to meet the vision and objectives of the Lake Simcoe Protection Plan (LSPP), water quality represents the top objective of this study, followed by water balance and water quantity (flooding and erosion). In that regard, it should be noted that preserving the water balance and water quantity has a positive feedback into water quality improvement since a decrease in surface runoff results in a decrease of pollutant loadings into the receiving water bodies, including Lake Simcoe. Regarding water quality targets, the federal and provincial water quality objectives (PWQOs) for the pollutants assessed in this study are listed in Table 7.2.

Table 7.1: Objectives and Targets of the Orillia Comprehensive Master Plan

Objectives		Target Criteria
Water Quality	Reduce phosphorus loadings to Lake Simcoe to 44 tonnes per year, in order to achieve a target for dissolved oxygen of 7 mg/L in the lake.	Lake Simcoe Protection Plan Targets; and PWQO Standards (**Table 7.2**)
	Reduce pathogen loading to eliminate beach closures	
	Reduce contaminants to levels that achieve Provincial Water Quality Objectives or better	
Water Balance	Preserve and re-establish the natural hydrologic cycle	prevent infiltration deficit (**Table 6.1**)
	Maintain groundwater levels and baseflows	
Water Quantity	Minimize risk of flooding	Flooding: control 2-yr to 100-yr outflows to pre-development rates
	Reduce stream erosion impacts	Erosion: capture of runoff from 4-hr 25mm event and release over 24 hours

Table 7.2: Water Quality Targets based on Provincial and Federal Standards

Parameter	Water quality objective or criteria used	Guidance Type	Reference
Total Phosphorus	0.030 mg/L 0.020-0.035 (mesoeutrophic), 0.035-0.100 (eutrophic)	PWQO Trophic “trigger” range	OMOE 1999 CCME 2004
E.coli	100 counts/100ml	PWQO	OMOE 1999
Copper	0.005	PWQO	OMOE 1999
Zinc	0.030	PWQO	OMOE 1999
Total Suspended Solids	25.0 mg/L	Review of observations of effects on fish	DFO 2000

The targets identified in Table 7.1 would help offset the impact of development on the overall environmental conditions within the City of Orillia. More specifically, following the LSPP targets and PWQO standards in addition to providing part or all of the infiltration volume lost due to development (Table 6.1) would result in avoiding cumulative environmental degradation.

The implementation of stormwater measures throughout the city (i.e. existing and new development) will provide benefits which extend beyond just improving water quality. Indirectly, in-stream erosion problems will be lessened, aquatic habitat and fisheries health will be improved and groundwater resources and watershed hydrologic functions will be enhanced.

In order to achieve the objectives in Table 7.1, the following scales should be taken into consideration:

- **New development**: new stormwater management opportunities to mitigate the impacts of future development;
- **Existing development**: stormwater retrofit opportunities to mitigate the impact of past uncontrolled development.

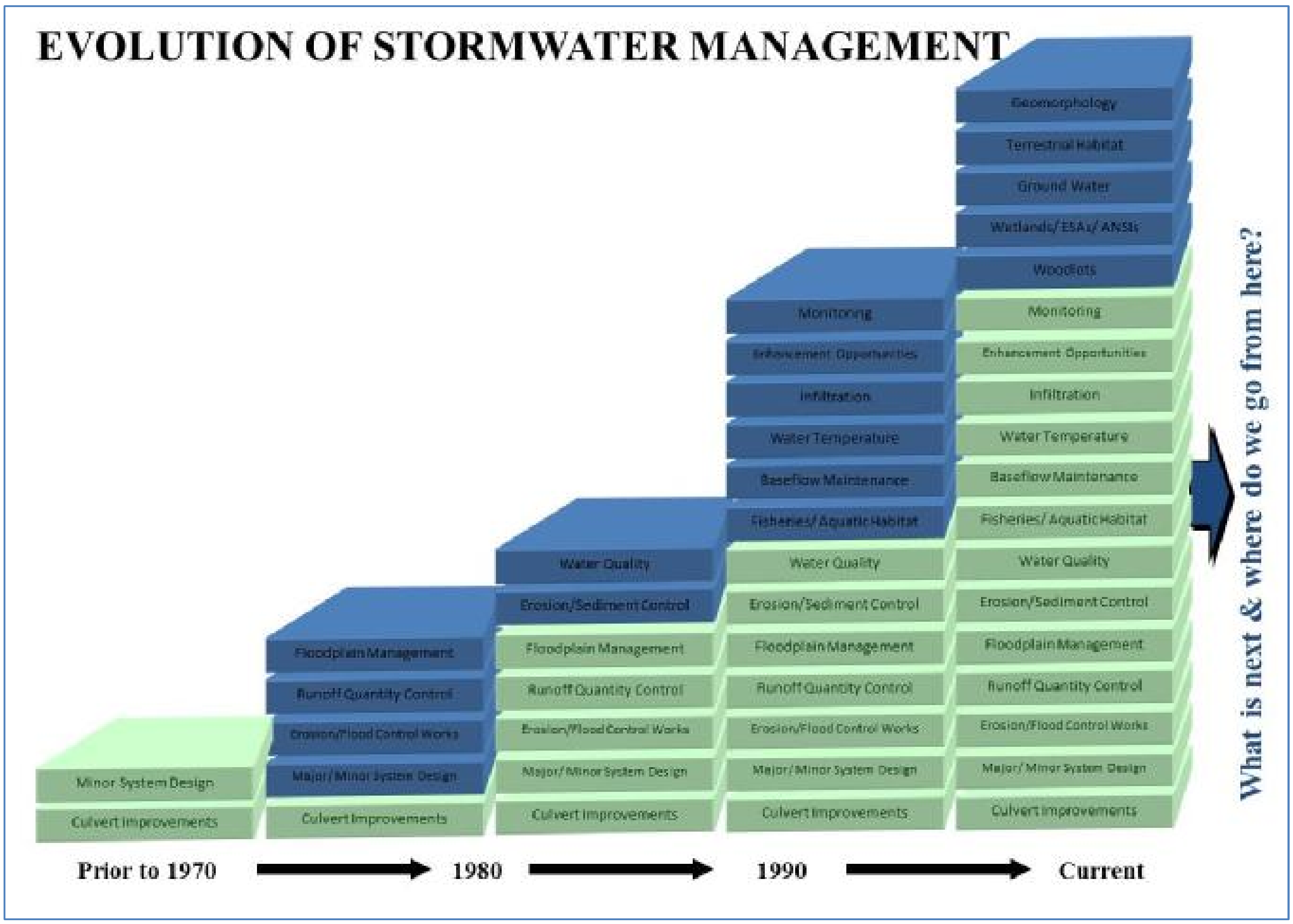
Chapter 8 will present a long list of alternative solutions that can be implemented to achieve the objectives. Chapter 9 will present an evaluation process to select a preferred alternative (i.e. recommended approach).

8 Identification of Alternative Solutions

Identification and assessment of alternative solutions (i.e. options) to the problems identified earlier, and selecting a preferred option constitute the second phase (Phase 2) of the Class EA process. In line with the findings of Chapter 4 (Characterization of the Study Area) and the conclusions of Chapter 6 (Evaluation of Environmental Impacts), alternative solutions are presented in this Chapter with focus on addressing water quality, water balance, and water quantity issues within the City of Orillia. Chapter 9 will then present an evaluation of these alternatives, and Chapter 10 will present the Recommended Approach.

8.1 Overview of Stormwater Management

During the past three decades, there has been an evolution in stormwater management in an effort to address downstream conditions resulting from urbanization (see inset figure below). In the early 1980s, stormwater management focused solely on controlling the quantity of runoff and providing flood protection through rapid conveyance measures. By the early 1990s, water quality and downstream erosion control were given additional focus. Today, with the systemic improvements in watershed management and our understanding of environmental features and functions at a watershed scale, stormwater



management now addresses a broad suite of issues including stream morphology, the protection of groundwater resources, fish habitat, and terrestrial habitat.

Stormwater runoff from urban areas may degrade the environment both during construction activities and post-development. Post construction pollutant loadings from urbanized areas are significant. Common pollutants include heavy metals from automobiles and air emissions, nutrients, fertilizers, chlorides from road deicers bacterial contamination from animal wastes, and toxic contamination from a variety of commercial and industrial sources. These pollutants, when conveyed to the receiving water bodies, impact the environment in many ways. The particulate (those that can be settled) and dissolved contaminants stress aquatic ecosystems by depleting oxygen, covering habitat or through the bioaccumulation or bio-concentration of contaminants in the tissues of various aquatic species. In addition, receiving waters can also be effected by thermal impacts resulting from an increase in ambient water temperatures.

Rigorous scientific research, evaluating the range of stormwater management treatment strategies, has produced an overwhelming amount of evidence that pipe and pond stormwater treatment strategies alone do not meet general water quality, water balance, and water quantity objectives, and are resulting in longer periods of elevated flow, thermal enrichment of surface water bodies and increased pollutant loadings. The Oro and Hawkestone Creeks Subwatershed Plan (LSRCA, 2013) recognized the shortcoming of using only conventional stormwater management facilities, and recommends "researching and using new and innovative solutions, such as Low Impact Development (LID) practices, to address uncontrolled stormwater in urban areas" such as the City of Orillia. Moreover, the City of Orillia Official Plan also recognizes the benefits of a "treatment train approach" to stormwater management, encouraging innovative measures in a hierarchy of source, lot-level, conveyance, and end-of-pipe controls to reduce stormwater runoff volume and pollutant loadings.

8.2 Long List of Alternatives

A "long list" of conventional and innovative stormwater management measures has been formulated. The list includes the following five (5) general stormwater management categories which have the potential to address the water balance, water quality, and water quantity issues within the City of Orillia:

1. Pollution Prevention Measures and Municipal Management/Operational Practices;
2. Source Controls;
3. Conveyance Controls;
4. End-of Pipe Controls; and
5. Stream Restoration.

In the following sections, these categories are discussed in detail in terms of form, function, and environmental advantages.

8.2.1 Pollution Prevention Measures and Municipal Management/Operational Practices:

These are methods that are intended to reduce pollution through the improved operation and maintenance of privately and publicly owned land, buildings, and infrastructure. Certain municipal programs such road as salt management, street sweeping and parks maintenance activities (e.g. application of herbicides and pesticides) are known to impact water quality. Application of such measures often includes changing behavior, current practices and educational programs. These measures and practices are not site-specific and can generally be applied over a watershed or municipal boundary to prevent sources of pollution from entering the drainage system.

Pollution prevention measures and practices are activities that are generally implemented to fulfill the following objectives:

- Minimize the potential for spills and contaminated run-off into the storm drainage network;
- Reduce chemical loading rates (e.g. road salt);
- Reduce the discharge of stormwater pollutants attributed to vehicle emissions;
- Promote the use of surface storage and drainage.

Typical municipal pollution prevention initiatives include:

- Storm drain flushing;
- Catch basin cleaning;
- Street sweeping;
- Leaf pick-up and removal;
- Alternatives to road salt;
- Vehicle use reduction (e.g. promotion of car-pooling, bicycles and biodiesel);
- Modified engineering standards.

8.2.2 Source Control Measures

Source control measures are small-scale stormwater management measure located at the beginning of a drainage system where stormwater is captured and treated on-site or close to where the rainfall lands. Due to the relatively small area treated by an individual measure, source controls must be well distributed to treat stormwater runoff effectively.

Source control measures are generally installed on private property and can be used within variety of land uses. They can be implemented in urbanizing areas and can also be used to retrofit existing areas. In residential areas, source control measures provide treatment for the stormwater generated by roof and driveway areas. In commercial areas, these measures may target roof, side-roads, and parking areas.

Source control measures remove pollutants from stormwater through a variety of mechanisms, including mechanical filtration, biological uptake, adsorption, and settling. These measures exhibit a wide variability in their ability to remove pollutants, generally ranging between 40% and 80% in efficiency depending on the particular measure and the type of pollutant being analyzed. In addition to pollutant removal, source control measures also reduce stormwater runoff volumes though infiltration and/or reuse.

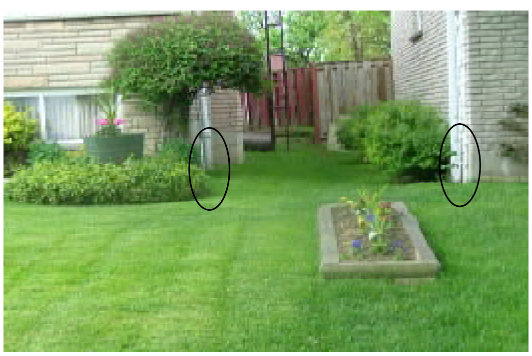
Despite the emphasis on source control in most recent stormwater policy and guidelines documents, systematic implementation of these measures throughout a municipality has not yet occurred in Canada. The implementation of a variety of source control measures has however become more common in the last decade. Acceptance and promotion of this approach to stormwater management offers considerable promise for protecting water resources.

Several representative source control measures are discussed below:

Downspout Disconnection:

Roof leaders (eavestroughs) connections from houses can vary within different areas of the City depending on when the home was constructed. In many municipalities, the roof leaders within older neighbourhoods, if connected, are typically directed into the municipal storm sewer system. These conditions, known as 'directly connected', promote a significant inflow of stormwater runoff directly into these systems during a rainfall event.

A relatively simple source control measure is to disconnect the roof leader from the municipal sewer so that the relatively clean rooftop drainage can be treated on a permeable ground surface and/or used as a resource for on-site purposes. The simplest forms of roof leader disconnection are to the lawn, to a depressed area in the lawn, or to a rain barrel. More advanced systems utilize naturalized gardens and bioretention techniques as discussed below.

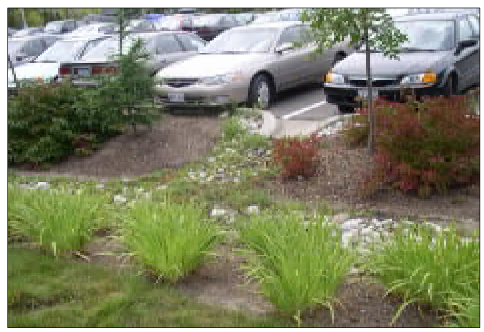


Enhanced Yard Vegetation and Rain Gardens:

In residential landuses rain garden areas can be placed in the front or backyard where they will capture 'disconnected' rooftop and yard drainage and in doing so will prevent relatively clean stormwater from entering the conventional stormwater infrastructure system and mixing with more contaminated stormwater.


Bioretention Areas:

Bioretention systems are landscaped areas which capture, temporarily store, and treat stormwater runoff by passing it through engineered soil filter media, thereby reducing runoff volumes and pollutants. The primary component of a bioretention cell is a filter bed with a mixture of sand, soil, and organic material as filtering medium. In commercial land uses, bioretention areas can be used at the base of buildings, in parking lot islands, or at the edge of a parking lot where stormwater is directed to. Bioretention areas are relatively inexpensive to build, easy to maintain, and can add aesthetic value to a site, without consuming large amounts of valuable land area.

Reduced Lot Grading:

Typical grading around buildings (≥ 2%) is reduced to encourage infiltration.

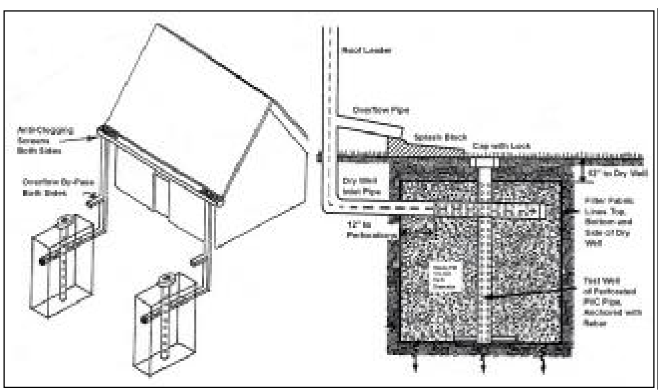
Permeable Pavement:

Permeable pavement systems are an alternative to traditional impervious pavements which allow stormwater to drain through into a stone reservoir where it is infiltrated into the native soil. They can be used for low traffic roads, parking lots, driveways and paths. These source controls can be used in new development areas, or as a retrofit to existing employment lands where the systems can be used to take advantage of the large impervious parking areas and where pervious landscaped areas are limited. These systems can also be used for residential driveways. This design can also direct drainage to grassed areas to help remove stormwater pollutants which would otherwise be directed to storm sewers and receiving watercourses.

<u>Soakaway Pits/Infiltration Trenches</u>:

Infiltration chambers and soakaway pits are stone-filled trenches or galleries that are constructed below grade. Pre-manufactured chambers are also available. Typically these stormwater control measures store and infiltrate runoff discharged from rooftop areas via a downspout or swale.

Larger open space areas within municipalities such as parks or sports fields represent retrofit opportunities using these techniques. Re-construction of existing parking lots also represents an opportunity to install underground infiltration chambers to capture, infiltrate and treat roof runoff. An example of an infiltration gallery constructed under a sports field in the City of Toronto is illustrated.



<u>Oil Grit Separators</u>:

Oil/grit separators are used to trap and retain oil and/or sediment in detention chambers. These unit are either located at the beginning of a storm sewer (pretreatment or source control) or at the end of a storm sewer (end-of-pipe control).

<u>Green Rooftop Technology</u>:

These systems are constructed on buildings with flat rooftops in order to reduce runoff volume (via increased evapotranspiration), improve water quality and reduce energy usage.

8.2.3 Conveyance Control Measures

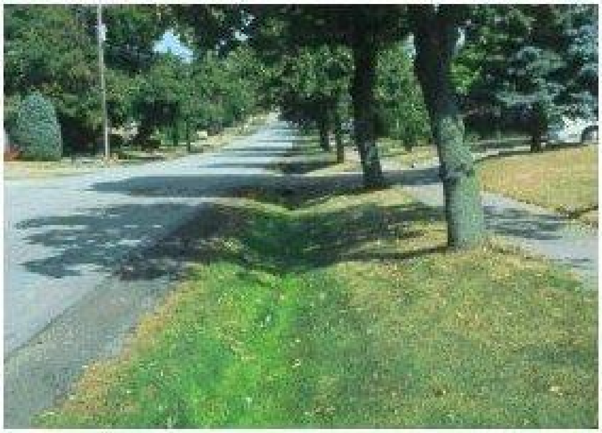
Conveyance control measures are designed to treat stormwater as it travels overland or through pipes en route to the downstream outlet. Traditional urban conveyance systems are comprised of curbs, gutters and buried concrete (or other) piping systems that carry stormwater away from a development area to a water body, generally along the road network. In appropriate applications, alternative conveyance control measures can be used to improve water quality conditions at lower cost to the municipality than traditional conveyance systems.

Like source controls, these systems remove a portion of the total stormwater volume from entering the storm sewer network, slow the erosive velocity of stormwater entering watercourses, and filter out pollutants from stormwater.

Conveyance control measures can often provide stormwater treatment for the collected drainage concentrated within the right-of-way of a municipal road. Because residential streets account for a significant share of a community's impervious surfaces, conveyance control measures present an important opportunity to improve downstream water quality conditions (e.g. sediment, nutrient, bacteria, oil/grit, thermal impact reduction, etc.), promote groundwater recharge and minimize watercourse erosion.

Various types of conveyance control measures are reviewed below:

<u>Grassed Swales</u>:



This straight-forward stormwater treatment measure consists of simple linear channels lined with grass and designed to promote shallow flow conditions. Grassed swales improve water quality through the trapping of sediment. Improvement in water quality is directly correlated to sediment trapping since contaminants typically adhere to or form part of the sediment. Dissolved contaminants, such as salt, are not treated by grassed swales.

Bioretention/ Bioswales:

Along municipal roads, bioretention areas can be placed at the edge of paved areas, either between the curb and sidewalk, or extending into the road in the approximate area of one parking spot. These 'low-tech' water quality treatment systems use plants and soil to trap and treat petroleum products, metals, nutrients, sediments and other pollutants that typically accumulate on asphalt surfaces.

Exfiltration Trench / Perforated Pipe System:

An exfiltration trench / perforated pipe system can be constructed adjacent to a road in the grassed area between the curb and the sidewalk. These systems promote infiltration of road drainage as it is conveyed along road right-of-ways. Road drainage is first directed to the grassed surface where pollutants such as sediment, oil, grease, or grit, are filtered prior to entering the trench. After water has percolated through the gravels and pollutants have been removed, the water can then either infiltrate into the native soils or if the volume and rate of incoming water exceeds the infiltrative capacity it is conveyed to a local stormwater drain system.

Pervious Catch Basins:

This technique involves a standard catch basin with a large sump which is physically connected to exfiltration storage media to make the walls or bottom of the catch basin pervious.

Permeable Pavements:

Permeable pavement techniques were discussed above under the source control measures category. The technique can also be classified as a conveyance control measure when applied in a linear form over a municipal roadway. These measures allow rain to pass through, collecting in the void space of the base course and ultimately draining away by natural infiltration.

Vegetated Filter Strip:

Filter strips are densely vegetated (planted) strips of land engineered and constructed to improve water quality by permitting sediment deposition during shallow flow conditions. Pollutant removal efficiency depends largely on the quantity of water, as channelized flow conditions do not provide treatment. The type of vegetation and the soil infiltration rate also dictate pollutant removal efficiency. Depending on the amount and type of vegetation planted and the need for replacement or amendment of soils, filter strips can be inexpensive to construct and maintain. When located adjacent to a stream or valley a vegetated filter strip is often referred to as stream or valley buffer strips.

8.2.4 End-of-Pipe Measures

End-of-pipe measures are the most commonly used stormwater management measure in most municipalities. These measures provide treatment for the collected drainage at the end of conveyance system prior to discharge of stormwater to a watercourse. End-of-pipe measures are typically implemented in urbanizing areas as a requirement of development. Typical end-of-pipe measures used to treat stormwater include stormwater ponds (dry or wet), wetlands, hybrid facilities and/or infiltration basins.

In many typical end-of-pipe measures, a permanent pool of water provides the water quality treatment. This permanent pool promotes the settling of sediments and pollutants to the bottom of the facility as stormwater travels through the facility. Provided the facility is functioning properly and is well maintained, sediments and pollutants will not be transported downstream of the facility. To optimize pollutant removal capacities, design engineers usually aim to maximize the distance that stormwater must travel through these facilities so that a larger percentage of the suspended solids will fall out of suspension.

The results of many monitoring programs indicate that most engineered wet ponds typically achieve 60-80% suspended solids (SS) removal and 40-50% total phosphorus (TP) removal. In general, a larger volume of water utilized for water quality storage will enhance performance; however, suspended solids removal performance becomes asymptotic with increasing design storage (there is a limit to storage beyond which there are negligible increases in suspended solids settling) (MOE, 2003).

Ideally, end-of-pipe measures are designed as large centralized facilities that treat the collected drainage from as much upstream development area as is realistically possible. This will reduce construction, operations and maintenance costs.

Wet Ponds:

These facilities comprise the most common form of end-of-pipe stormwater management facilities.

Wet ponds include a permanent pool of water for quality control treatment, and are also often designed with temporary extended detention storage for erosion and water quantity (flood) control.

Constructed Wetlands:

Constructed wetlands comprise one of the preferred end-of-pipe facilities for water quality enhancement. These facilities may be effective in reducing downstream erosion potential but their role in water quantity control is limited because of their limited storage volume and shallow water depth. Construction costs for wetlands systems tend to be higher other alternative end-of-pipe measures.

Hybrid Wet Ponds / Wetlands:

These systems are designed as a combination of wet ponds and constructed wetlands. Typically, the wet pond cell is constructed in series with a wetland cell. The total required permanent pool volume is shared, with approximately 50% within each element.

Dry Ponds:

Stormwater dry ponds do not have a permanent pool of water and therefore do not provide the same water quality function as we ponds. Instead, these types of facilities are designed primarily for erosion and flood control. Dry ponds facilities can be retrofitted so that a permanent pool of water is incorporated into the design to provide water quality treatment.

There are two existing dry ponds within the City of Orillia (Table 4.6). One of these dry ponds, located in the Lake Simcoe basin, was also identified as a water quality retrofit opportunity.

Infiltration Basins:

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater into the soil. Infiltration basins can have high pollutant removal efficiency and can help recharge the groundwater, thus restoring low flows to stream systems. Infiltration basins can be designed as above ground or below ground facilities.

Filters:

These systems utilize materials such as sand, peat moss or clear stone to filter out pollutants in stormwater runoff.

Oil & Grit Separators:

These mechanical devices are used for the capture of spills and removal of coarse sediment from stormwater. Oil/grit separators are intended to remove floatables (debris, gasoline, oil, grease, light petroleum products and other floating liquids) from stormwater runoff. These systems are used for small contributing drainage areas, often less than 2 hectares. Generally these devices are used for commercial and industrial land use but can also be used for redevelopment and infill areas where available space is constrained and traditional forms of water quality treatment cannot be implemented.

8.2.5 Stream Restoration

Stream restoration measures are designed to address erosion and flooding problems and restore stream functions and stability. They are generally applied on a stream reach basis and include stream rehabilitation using natural or engineered channel design principles and naturalization of stream riparian zones using native materials. They may also include individual structures, such as streambank re-grading, gradient controls and floodplain contouring to address specific erosion and flooding problems.

9 Evaluation of Alternative Solutions

This Chapter describes the evaluation criteria and evaluation process and prioritizes the works in fulfillment of the Class Environmental Assessment process (Class EA). The study was carried out using Approach 1 for Master Plans in conformity with the Municipal Engineers Association Class Environmental Assessment process (MEA 2000, as amended 2007). More specifically, the Master Planning approach as outlined in section A.2.7 of the Class Environmental Assessment document was followed. This Master Plan is intended to address Phases 1 and 2 of the Class EA process, as defined previously in Chapter 1.3 (Figure 1.1), and is to be used as a basis for future investigations of specific Schedule B and C projects identified within. Schedule B projects would require the filing of the Project file for public review while Schedule C projects would have to fulfill Phases 3 and 4 prior to filing an Environmental Study Report (ESR) for public review.

The Master Planning approach is followed for studies where it is expected that a series of measures will be distributed geographically throughout the study area and will be implemented over an extended period of time. This approach explicitly recognizes that there are real benefits in terms of better planning when long range holistic studies are undertaken over logical planning units, such as a subwatershed. This long range planning approach would enable the City to identify opportunities and be proactive in addressing issues before they become a problem. Moreover, it would allow the City to implement individual works, which collectively become part of a larger management system. Figure 9.1 shows the evaluation process that was applied.

The Master Planning approach also forms the basis for future investigations of specific projects. Projects undertaken by municipalities are assigned to various EA project schedules according to their anticipated level of environmental impact:

- **Schedule A** projects are limited in scale and have minimal adverse environmental effects. These projects are pre-approved and include a number of municipal maintenance and operational activities.
- **Schedule A+** projects are pre-approved, however, the public is to be advised prior to project implementation.
- **Schedule B** projects have the potential for some adverse environmental effects and require public consultation. These projects generally include improvements and minor expansions to existing facilities.
- **Schedule C** projects have the potential for significant environmental effects and require public consultation. These projects generally include the construction of new facilities and major expansions to existing facilities.

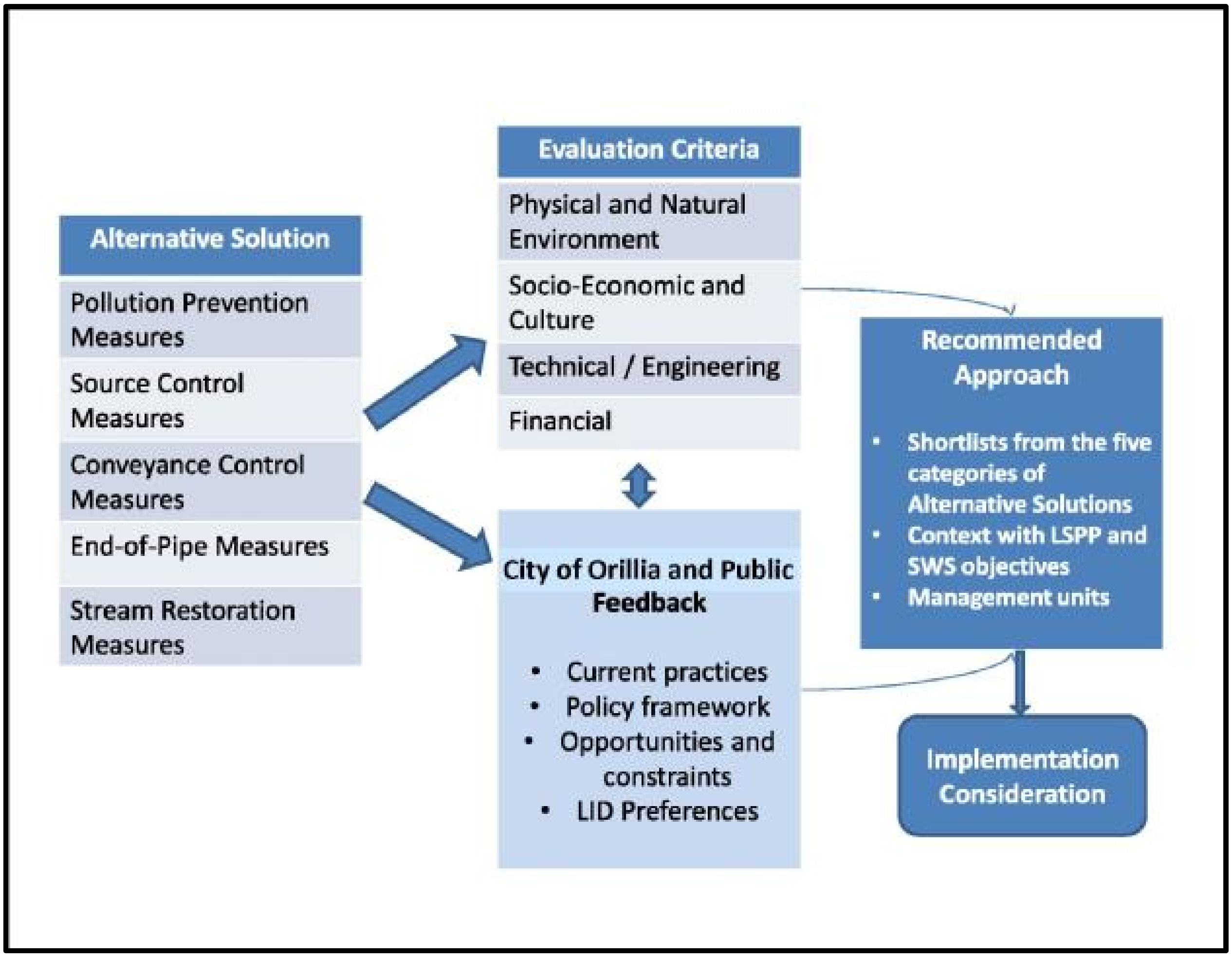
The following EA schedules are typically applied to the various classes of stormwater management alternatives which are considered in this study (Chapter 8):

- Pollution prevention measures are classified as Schedule A projects.
- Source control measures are classified as Schedule A projects.

- Conveyance control measures are typically undertaken as part of roads improvement works and are therefore classified according to the EA Schedule for the roads project.
- End-of-pipe controls are classified as Schedule A+ or B projects.
- Stream restoration works are classified as Schedule A+ or B projects.

Schedule B projects would require the filing of the Project file for public review while Schedule C projects would have to fulfill Phases 3 and 4 of the Class EA process prior to filing an Environmental Study Report (ESR) for public review.

Figure 9.1: The Process Applied to Evaluating Stormwater Management Alternatives



9.1 Evaluation Criteria

In order to develop a Recommended Approach, discussions were undertaken between the Study Team and City of Orillia staff with respect to the City's preferences and the feasibility of implementing various stormwater control measures. The objective of the discussions was to screen the "longlist" of alternatives from Chapter 8 to generate a "shortlist" of stormwater management measures that constitute the "Recommended Approach". Through these discussions, the stormwater alternatives were assessed in a general sense in terms of the following set of evaluation criteria:

1. **Impacts/Benefits to the Physical and Natural Environment** – this includes the ability to meet various stormwater control targets set out through the Lake Simcoe Protection Plan, LSRCA and city policies. The impacts to terrestrial and aquatic habitat, and groundwater resources is also considered.
2. **Socio-Economic and Cultural** – this includes potential impacts to existing and future landuses, general aesthetics, public acceptance, and policy/By-law requirements.
3. **Technical and Engineering** – this includes general feasibility/constructability, level of proven effectiveness, regulatory acceptance, and impacts to existing infrastructure.
4. **Financial considerations -** this includes capital costs, operation and maintenance costs, as well as benefits in terms of avoidance of other costs.

Further description of the above evaluation criteria that were considered through discussions with the City of Orillia are provided in Table 9.1 through Table 9.4.

Table 9.1: Description of the Physical and Natural Environment Criteria

Criteria	Description of Criteria
Ability to meet targets for Water quality	• Reduce phosphorus loadings and other nutrients of concern **(LSPP)** • Reduce pathogen loading to eliminate beach closures **(LSPP)** • Reduce contaminants to levels that achieve Provincial Water Quality Objectives or better **(LSPP)** • Ability of the SWM alternative to meet water quality criteria as per the 2003 MOE Stormwater Management Manual. • Ability to improve water quality conditions for identified contaminants of concern.
Ability to meet water budget targets	• Ability of the SWM alternative to mitigate undesired impacts to the pre-development water balance and prevent adverse changes to site hydrology (surface drainage, groundwater, and soils). • Maintain existing recharge and discharge areas • Maintain hydrological and hydrogeological functions within the landscape including wetlands and woodlots • Maintain in-stream flow regimes **(LSPP)** • Effective water conservation **(LSPP)** • Maintain pre-development infiltration.
Ability to meet targets for Flooding	• Ability of the SWM alternative to meet flood control criteria by maintaining peak post development runoff rates to pre-development rates for the 2 year through 100 year events • Cannot increase flooding risks to infrastructure and private property. • Address climate change issues and incorporate adaptations **(LSPP)**
Ability to meet targets for Erosion	• Ability of the SWM alternative to control water course erosion in accordance with the 2003 MOE Stormwater Management Manual. • Prevent down cutting of streambeds. • Potential to reduce sediment sources.
Impact on terrestrial habitat (Connectivity, Diversity and Sustainability)	• Potential for the SWM alternative to mitigate impacts to terrestrial habitat • Ability for the SWM alternative to provide opportunities for connectivity, diversity and sustainability for terrestrial habitats.
Impact on aquatic habitat (Connectivity, Diversity and Sustainability)	• Potential to restore a self-sustaining coldwater community (**LSPP**) • Potential for the SWM alternative to maintain and improve 'habitat classification i.e. Cool Water and Dissolved Oxygen (**LSPP**) • Mitigate impacts to aquatic habitat (including flow, erosion, water quality) • Preservation of the function of first order streams through the promotion of recharge and the maintenance of baseflow
Source Water Protection	• Ability of the SWM alternative to protect drinking water sources and minimize the potential for groundwater contamination (including from de-icing salt), especially within identified WHPA where threats have been identified (**Figure 4.8**). • Maintain and where feasible enhance infiltrated water quantity and quality • Ability to recharge groundwater aquifers

Table 9.2: Description of the Socio-Economic and Cultural Criteria

Criteria	Description of Criteria
Impact on existing land uses (including agricultural, commercial and residential)	• Potential for the SWM alternative to be integrated with the existing agricultural, residential and commercial / industrial land uses within the study area.
Aesthetic value	• Potential for the SWM alternative to provide an aesthetic benefit to the existing community and proposed development
Potential benefit to community and public acceptance	• Potential benefit to the community with respect to integration into public areas (passive use areas, pedestrian and bike trails) as well as general public acceptance of the SWM alternatives.

Table 9.3: Description of the Technical/ Engineering Criteria

Criteria	Description of Criteria
Level of service- proven effectiveness	• Degree to which the SWM alternative has been proven effective through scientific literature, implementation and/or monitoring.
Regulatory agency acceptance	• General level of acceptance of the SWM alternative by the various regulatory agencies (Municipal, Provincial, and CA) with respect to water quality, erosion, water balance preservation, flood control and the preservation of natural features
Policy and by-law requirements	• Degree to which the SWM alternative will be impacted by or contradict existing City of Orillia SWM policy including alteration to existing or development of new by-law requirements.
Impact on existing infrastructure	• Potential impacts to existing stormwater infrastructure • Potential impacts to other forms of existing infrastructure (services, roads, etc)
Constructability	• Degree of difficulty in constructing the SWM alternative given the existing site conditions and constraints.

Table 9.4: Description of the Financial Criteria

Criteria	Description of Criteria
Capital costs	• The relative cost of constructing the SWM alternative.
Operations and Maintenance Costs	• The relative cost of operating and maintaining the SWM alternative
Cost avoidance	• Potential for the proposed SWM alternative to reduce the costs associated with upgrades to existing SWM infrastructure and services including existing drainage networks and end-of-pipe facilities

9.2 Assessment and Screening of Alternatives

In light of the evaluation criteria tabulated above (Table 9.1 through Table 9.4) and the long list of alternatives discussed in Chapter 8, the following discussion presents the assessment of alternative solutions. The process used for the assessment is based on the interdependence between evaluation criteria and feedback from the City of Orillia and the public, as shown in Figure 9.1.

9.2.1 Pollution Prevention and Municipal Management/Operational Practices

Pollution Prevention Measures and Municipal Management/Operational Practices are methods which are not site specific and can generally be applied over a watershed or municipal boundary to prevent sources of pollution from entering the drainage system. These measures often include changing behavior, current practices and educational programs. Many of the Pollution Prevention Measures and Municipal Management/Operational Practices listed in Chapter 8 are currently being undertaken by the City. These measures and practices include:

- Reduced road salt – the City uses a sand-salt mixture on municipal roads that has a lower salt content (5%-7%) than is typically applied by other municipalities.
- Modifying Engineering Standards – through its development review process, the City promotes the use of reduced lot grading to promote infiltration and reduced runoff rates.
- Street Sweeping.
- Catch Basin Cleaning – annual cleaning following the spring melt.
- Storm Drain Flushing – the City has a limited CCTV and flushing program.
- OGS Cleaning – annual cleaning of oil-grit separators within municipal property.
- Storm Outfall Cleaning – annual dredging of accumulated sediment at storm outfalls to Lake Simcoe and Lake Couchiching.
- City By-law 1047 which governs sewage discharge. For example, de-chlorination of swimming pool drainage is requiring before discharging to the storm sewer system.
- Reduced stormwater pollutants attributed to vehicle emissions – the City has a 3-minute idling By-law.

In addition to the list above practices, additional measures of particular interest to the City include:

- Further reduction of salt loadings to the surface water and groundwater systems. This could be achieved if the salt content applied to County and MTO roads throughout the City was also reduced.
- Additional reductions to vehicle use through promotion of carpooling.
- Expansion of the storm drain flushing program. The use of additional sand to offset the reduction in road salt has resulted in increased rates of accumulation within the City’s storm drain system.
- Promoting additional public and business education / awareness through programs such as the “Yellow Fish Road”, for example.

In terms of the evaluation criteria discussed above, the implementation of these additional measures would provide the following benefits:

Criteria	Anticipated Benefits
Physical and Natural Environment	• reduced loadings of phosphorus and other pollutants; • benefit to downstream aquatic habitat • protection of drinking water sources and reduced groundwater contamination
Socio-Economic and Cultural	• aesthetic improvements • public support
Technical / Engineering	• maintains existing infrastructure • regulatory agency acceptance
Financial	• Avoiding cost resulting from any deterioration of SWM infrastructure due to lack of operation and maintenance practices

9.2.2 Source Control Measures

Source control measures are small-scale stormwater treatment systems that are located at the beginning of a drainage system, that is they capture and treat stormwater on-site or close to where the rainfall lands. These measures, as detailed in Chapter 8 are generally installed on private property within residential, commercial, industrial and institutional land uses. A cursory review of current drainage practices within the city as well as discussions with City staff indicate that the following source control measures are already being applied:

- Downspout disconnection – for the most part, roof runoff from residential properties is not connected directly to the municipal storm drainage system. In most cases, roof runoff is instead directed overland, thus providing an opportunity for infiltration and reduced runoff volumes (see Lawrence Ave. example – inset).
- Rain barrels - The city's Waste Management Department offers rain barrels to City residents at a discounted price. The program reduces storm runoff and conserves water for irrigation.
- Oil-grit separators – The city requires these devices on all new industrial development sites within the Lake Simcoe basin. Consideration should be given to expanding this practice city-wide.
- Reduced lot grading – Through its development review process, the City promotes the use of reduced lot grading to promote infiltration and reduced runoff rates. Typical municipal standards

required that the grading around buildings be equal to or above 2%. The City of Orillia promotes the use of grades as low as 1%, where feasible, within landscaped areas.

In addition to the above forms of source control measures, the City is in favour of applying a full range of other source control practices, including:

- Enhanced yard vegetation and rain gardens.
- Downspout disconnection for existing sites where it is not already in practice (see example inset)
- Bioretention areas
- Permeable pavement
- Soakaway pits / infiltration chambers
- Green roof technology

Implementing a social marketing strategy is key to promoting many source control measures, where public input is surveyed and assessed in terms of acceptance, awareness of environmental benefits, and aesthetic preferences.

In terms of the evaluation criteria discussed above, the implementation of these additional measures would provide the following benefits:

Criteria	Anticipated Benefits
Physical and Natural Environment	• reduced loadings of phosphorus and other pollutants; • benefit to downstream aquatic habitat • maintain the existing water budget • maintain instream flow regime through augmented baseflows and reduced flood flows • protection of drinking water sources through aquifer recharge
Socio-Economic and Cultural	• aesthetic improvements • public support
Technical / Engineering	• proven effectiveness • regulatory agency acceptance
Financial	• Avoiding cost associated with upgrading existing SWM infrastructure including the downstream storm network and end-of-pipe SWM facilities

9.2.3 Conveyance Control Measures

Conveyance control measures are measures that are designed to treat stormwater as is travels overland or through pipes on route to the downstream outlet. Traditional conveyance systems comprise curbs, gutters, ditches and buried concrete storm sewer systems that move water away from a development area generally via the road network. The most cost-effective means of implementing new stormwater conveyance controls into existing municipal roadways is to complete the construction concurrent with municipal road works projects.

Capital roads projects that are planned within the City may range from simple re-surfacing, to complete re-construction. Re-surfacing projects can generally be classified under General Operation and Maintenance of Linear Paved Facilities and Related Facilities of Appendix 1 of the MEA document and will generally be considered as Schedule A or A+ and are pre-approved projects. All re-surfacing projects, both urban and rural cross-sections, are considered as Schedule A or A+ projects.

Road re-constructions can generally be classified under Construction or Re-construction of Linear Paved Facilities and Related Facilities Appendix 1 of the MEA document. Such road projects, by their nature, may be relatively large in terms of their total costs, and are subject to the predetermined cost ranges which determine whether the projects are A, A+, B or C.

Discussions with the City staff were carried out in order to solicit feedback as to existing drainage systems, constraints and opportunities, preferences (if any), and potential areas for implementation. One form of conveyance control measure that is already widely used over a significant portion of the City's roads is grassed swales (see example inset). Unlike typical urban curb-and-gutter systems, grassed swales provide an opportunity to improve water quality by trapping sediment and reducing pollutant runoff.

In addition to further application of grassed swales, the City is in favour of applying a full range of other conveyance control stormwater practices, including:

- Bioretention – this class of LID conveyance control offers the highest opportunity for overall water quality treatment and reduced runoff volumes. Special soil media mixtures are also available to enhance the removal of phosphorus. These types of stormwater measures can be constructed in a variety of forms, depending on the surrounding landuses, and available space.
- Pervious pipe / exfiltration – this class of LID does not offer the same level of biological treatment as bioretention systems, however, significant water quality and water balance benefits are provided through storage and infiltration of stormwater runoff. Depending on available space, these systems can be located beneath the boulevard and sidewalk, or beneath the road itself.
- Permeable pavement – this class of LID is best suited for driveways and parking areas. Municipal parking lots as well as on-street parking zones are good candidates.

In terms of the evaluation criteria discussed above, the implementation of these conveyance control measures would provide the following benefits:

Criteria	Anticipated Benefits
Physical and Natural Environment	• reduced loadings of phosphorus and other pollutants; • benefit to downstream aquatic habitat • maintain the existing water budget • maintain instream flow regime through augmented baseflows and reduced flood flows • reduced downstream erosion • protection of drinking water sources through aquifer recharge
Socio-Economic and Cultural	• aesthetic improvements
Technical / Engineering	• proven effectiveness • regulatory agency acceptance
Financial	• Avoiding cost associated with upgrading existing SWM infrastructure including downstream end-of-pipe SWM facilities

9.2.4 End-of-Pipe Control Measures

End-of-pipe controls are the most commonly used stormwater management measure in most municipalities. These measures as detailed in Chapter 8.2.4 provide treatment for the collected drainage at the end of conveyance system prior to discharge of stormwater to a watercourse. End-of-pipe measures are typically implemented in urbanizing areas as a requirement of development. Typical end of pipe measures which are used to treat stormwater include stormwater ponds (dry or wet), wetlands, hybrid facilities and/or infiltration basins.

End-of-pipe controls fall within the Municipal Class EA process in general because they are retained in the ownership of the municipality and designated as stormwater infrastructure. Projects undertaken by municipalities vary in their environmental impacts. Consequently, projects are classified according to Class EA Schedules ranging from A and A+ to B and C project schedules in accordance with Part C - Municipal Water and Wastewater Projects. Proposed stormwater facilities can generally be classified under two (2) Class EA Schedules according to the project nature i.e. either Retrofit or New Construction. The construction of new end-of-pipe controls are generally classified as Schedule B, whereas end-of-pipe control retrofits can be classified as either Schedule A+ or Schedule B according to the following criteria:

Schedule A+

- Introduced in 2007 by the Municipal Engineers Association, these projects are pre-approved; however the public is to be advised prior to the project implementation. Per Appendix I –Project Schedules of the Municipal Class Environmental Assessment (2000, as amended in 2007), wastewater management projects that are intended to **“modify, retrofit, or improve a retention/detention facility including outfall or infiltration systems for the purposes of stormwater quality control” including “biological treatment through the establishment of constructed wetlands”** are pre-approved under Schedule A^+ of the MEA.

- Schedule A+ does not allow for the expansion of the existing facility, therefore the alteration/upgrade or retrofit must be confined to the existing facility footprint or stormwater management block limits.

Schedule B

- Generally includes improvements and minor expansion to existing facilities beyond the existing facility footprint or stormwater management block limits. With these types of activities there is potential for some adverse environmental impacts and therefore the proponent is required to proceed through a screening process including consultation with those who may be affected.

The use of end-of-pipe facilities within existing and future urban development areas of the City is outlined in Section 0. As discussed, the use of end-of-pipe ponds is very limited within the Lake Simcoe and Couchiching basins. The feasibility of retrofitting existing facilities and constructing new end-of-pipe facilities within the existing developed areas of these watersheds was also assessed as part of this current CSWM-MP study. The reviews consisted of:

- Inventory of potential sites identified in background studies, including the Lake Simcoe Basin Stormwater Management and Retrofit Opportunities document (LSRCA, 2007), and the2005 Stormwater Management Master Plan Study (MMM)
- Cursory site assessments via mapping and air photo review;
- Follow-up site investigations to assess drainage conditions and available space; and
- Discussions with city staff;

Review and screening of the potential retrofit sites is summarized in Appendix A. A series of (8) retrofit opportunities were identified for drainage to Lake Simcoe, and a further eight (8) retrofit opportunities were identified for drainage to Lake Couchiching (see Table 4.8). The recommendations consist of stormwater ponds, or oil-grit separator devices for small drainage areas. These retrofits could provide some measure of water quality control for areas that currently discharge untreated stormwater.

In terms of the evaluation criteria discussed above, the implementation of these end-of-pipe measures would provide the following benefits:

Criteria	Anticipated Benefits
Physical and Natural Environment	• reduced loadings of phosphorus and other pollutants; • benefit to downstream aquatic habitat • maintain instream flow regime through augmented baseflows and control of flood flows to pre-development levels • control of downstream erosion
Socio-Economic and Cultural	• potential benefit to the community when integrated into public areas
Technical / Engineering	• proven effectiveness • regulatory agency acceptance

Financial	• Avoiding cost associated with downstream flood and erosion risks

9.2.5 Stream Restoration

Stream restoration measures enhance the ability of the natural environment to improve water quality and prevent watercourse erosion from further degrading infrastructure, public and private property. Existing natural areas provide valuable ecological functions, such as quality and quantity treatment of stormwater at no cost. If an existing natural area is degraded, it may be possible to restore the area and regain lost ecological functions.

Section 4.9 of this study presented a cursory geomorphic assessment of representative stream segments within the City of Orillia. Since this document reviews stream restoration as a diagnostic exercise, stream erosion or problem site restoration measures are recommended to be addressed as part of a future City-wide Stream Restoration Master Plan. The objective would be to undertake a comprehensive program which follows Approach 2 of the Master Plan process and would result in a prioritized plan for undertaking future stream works.

9.3 Public Input

A public information center (PIC) was held on May 13, 1015 at City Hall to provide an overview of the study, including the study process, alternative stormwater measures considered, and the preliminary recommendations. A key objective of the process was to obtain feedback from interested parties to expand or revise the preliminary recommendations. The information and feedback that was gathered could then be used to further develop and finalize a recommended plan.

Poster board materials that were presented at the PIC are provided in Appendix E. In general, there was support for the proposed stormwater measures, particularly from a stormwater volume and flood reduction perspective. General design concepts for various soils conditions and roadway configurations were also discussed with the public and city staff.

10 The Recommended Approach

A key component of a Master Plan is to define and describe the Recommended Approach and the proposed alternative solutions (Figure 9.1), and provide physical context for the implementation of these measures. This chapter summarizes the components of the Recommended Approach that were developed through the evaluation and consultation process outlined in Chapter 9. Implementation considerations are discussed in Chapter 12.

10.1 SWM Control Targets

Lake Simcoe Region Conservation Authority is in the process of updating its Stormwater Management Policy. The most recent version of this draft policy (Sep, 2014), outlines the following general criteria:

1. *The following general criteria shall be incorporated in site design for stormwater runoff to protect surface and ground water and other natural resources:*

   i. Reduce impacts on water

   ii. Decrease runoff volume

   iii. Decrease flow frequency, duration, and peak runoff rates

   iv. Increase infiltration (groundwater recharge)

   v. Reduce time to peak flows by increasing the time of concentration to and through storm sewers

   vi. Store stormwater runoff on-site

   vii. Maintain existing flow patterns

   viii. Avoid natural channel and steep slope erosion as well as protect in stream habitats and channels.

   ix. Preserve vegetation

   x. Decrease erosion and sedimentation

   xi. Preserve and replace existing topsoil in an uncompacted manner

In terms of management units (Figure 5.1), although the LSRCA stormwater management criteria technically apply only to those parts of the City of Orillia which drain to the Lake Simcoe basin, the same water quality, erosion, flooding, and water balance objectives can effectively be applied to the other lands draining to the Lake Couchiching, Silver Creek and Bass Lake basins. All of these lands share similar soils and rainfall-runoff characteristics. The key difference between these management units lies mainly in the proportion of existing urban development versus future urban development areas.

Table 10.1 summarizes the general water quality, water balance, and water quantity targets for the recommended measures that are discussed in the following sections. It is assumed that combinations of source control, conveyance control, and end-of-pipe control measures will meet the overall objectives of the Lake Simcoe Protection Plan (LSRCA, 2009).

In the following Sections, five (5) categories of traditional and innovative stormwater management measures are described in the context of management units and other considerations.

Table 10.1: Summary of Stormwater Management Measures and Targets[1] under the Recommended Approach

Management Units	State of Development/Location		Water Balance	Water Quality	Water Quantity / Erosion
Lake Simcoe Basin; Lake Couchiching Basin; Silver Creek Basin; Bass Lake Basin	Greenfield Development	Targets[1]:	- Maintain pre-development infiltration volume (no increase in runoff volume)	- Level 1 / Enhanced pollutant removal per MOE (2003) Stormwater Management Planning and Design Manual - Capture and treatment of 25mm of runoff from new impervious surfaces, per draft LSRCA LID SWM Guidelines (April 2015)	- quantity control: 2-year to 100-year control of peak flows to pre-development levels - erosion control: capture runoff from 4-hr 25mm event and release over 24 hours - no increase to downstream flood risk
		Recommended measures:	<u>LID source controls (see Section 10.3):</u> - downspouts directed to pervious areas, rain barrels, soakaway pits or equivalent practice - reduced lot grading, enhanced yard vegetation, rain gardens, bioretention areas, grassed swales - green roof technology, permeable pavement, OGS for ICI properties - <u>LID conveyance controls - Municipal ROW (see Section 10.4):</u> - as part of capital road works and recommended ditch retrofits – bioretention systems, pervious pipe/exfiltration systems, or grassed swales - other site-specific options - permeable pavement, bioretention planters, enhanced OGSs - consider designing for seasonal operation in WHPAs		
				<u>Traditional end-of-pipe SWM detention ponds</u> - wet SWM ponds, SWM wetlands - dry SWM ponds may be considered if upstream source and conveyance LIDs are sized to provide Enhanced water quality treatment	
	Re-development / intensification / infill in existing urban areas (redevelopment of existing properties within an urbanized area)	Targets[1]:	- Maintain existing infiltration volume (no increase in runoff volume)	- Level 1 / Enhanced pollutant removal per MOE (2003) Stormwater Management Planning and Design Manual - Capture and treatment of 25mm of runoff from new impervious surfaces, per draft LSRCA LID SWM Guidelines (April 2015)	- No increase in peak outflows (make best efforts to reduce peak outflows to predevelopment conditions) - erosion control: capture runoff from 4-hr 25mm event and release over 24 hours - no increase to downstream flood risk
		Recommended measures:	<u>LID source controls (see Section 10.3):</u> - downspouts directed to pervious areas, rain barrels, soakaway pits or equivalent practice - reduced lot grading, enhanced yard vegetation, rain gardens, bioretention areas, grassed swales - underground infiltration/storage chambers, green roof technology, permeable pavement, OGS for ICI properties <u>LID conveyance controls – Private Sites (see Section 10.4) :</u> - grassed swales, infiltration trenches, perforated pipe systems - permeable pavement		
	Existing urban Areas	Targets[1]:	- Maintain existing infiltration volume (no increase in runoff volume)	- Level 1 / Enhanced pollutant removal per MOE (2003) Stormwater Management Planning and Design Manual - Capture and treatment of 25mm of runoff from impervious surfaces (private site target), or 12.5mm of runoff for reconstructed road surfaces (road reconstruction target) per draft LSRCA LID SWM Guidelines (April 2015),	- No increase in peak outflows (make best efforts to reduce peak outflows to predevelopment conditions) - erosion control: best efforts to capture runoff from 4-hr 25mm event and release over 24 hours
		Recommended measures:		- Pollution control measures (see Section 10.2)	
			<u>LID source control retrofits (see Section 10.3)::</u> - downspouts directed to pervious areas, rain barrels, soakaway pits or equivalent practice - reduced lot grading, enhanced yard vegetation, rain gardens, bioretention areas, grassed swales - underground infiltration/storage chambers, green roof technology, permeable pavement, OGS for ICI properties - <u>LID conveyance control retrofits – Municipal ROW (see Section 10.4):</u> - as part of capital road works and recommended ditch retrofits – bioretention systems, pervious pipe/exfiltration systems, or grassed swales - other site-specific options - permeable pavement, bioretention planters, enhanced OGSs - consider designing for seasonal operation in WHPAs		
				<u>End-of-Pipe stormwater retrofits (see Section 10.5):</u> Lake Simcoe Basin: - retrofit of Pond F7 from quantity-only (dry) to include water quality treatment - construction of 4 new end-of-pipe SWM facilities at existing uncontrolled outfalls - addition of 3 OGS's at existing small uncontrolled lake outfalls Lake Couchiching Basin: - construction of 5 new end-of-pipe SWM facilities at existing uncontrolled outfalls - addition of 3 OGS's at existing small uncontrolled lake outfalls	
	Stream corridors	Targets[1]:	- stable natural channel design over full range of flood events to repair erosion damage and associated water quality degradation.		
		Recommended measures:	- stream restoration works prioritized through future Stream Restoration Master Plan study (see Section 10.6)		

1 – These targets may be superseded by the more stringent of site-specific studies and/or agency policies.

10.2 Proposed Pollution Control Measures

The City of Orillia already has in practice a variety of works and measures which control and/or reduce pollutants and their potential transfer to the environment. As discussed in Section 9.2.1, these measures and practices include:

- Reduced road salt – the City uses a sand-salt mixture on municipal roads that has a lower salt content (5%-7%) than is typically applied by other municipalities.
- Modifying Engineering Standards – through its development review process, the City promotes the use of reduced lot grading to promote infiltration and reduced runoff rates.
- Street Sweeping
- Catch Basin Cleaning – annual cleaning following the spring melt.
- Storm Drain Flushing – the City has a limited CCTV and flushing program.
- OGS Cleaning – annual cleaning of oil-grit separators within municipal property.
- Storm Outfall Cleaning – annual dredging of accumulated sediment at storm outfalls to Lake Simcoe and Lake Couchiching.
- City By-law 1047 which governs sewage discharge. For example, de-chlorination of swimming pool drainage is requiring before discharging to the storm sewer system.
- Reduced stormwater pollutants attributed to vehicle emissions – the City has a 3-minute idling By-law.

In addition to the current pollution prevention and control measures practiced within the City of Orillia, a number of additional measures and/or expansion of the above practices are recommended:

- Additional reductions to vehicle use through promotion of carpooling.
- Expansion of the storm drain flushing program. Currently, the City's CCTV and storm sewer flushing program is undertaken mainly on an "as-needed" basis. However, the use of additional sand to offset the reduction in road salt has resulted in increased rates of accumulation within the City's storm drain system. As such, the City should consider expansion of the current program to include regularly scheduled CCTV and storm sewer flushing.
- Promoting additional public and business education / awareness through programs such as the "Yellow Fish Road", for example.
- Promotion of safer alternative products.
- Practicing safe materials storage controls.
- Erosion and sediment control enforcement.

In addition to current practice of applying reduced quantities of road salt to municipal roads, it is recommended that the City pursue further reductions through the use of:

- salt alternatives,
- snow disposal practices; and
- discussions with other agencies to reduce the use of salt on Regional and MTO roads through the city, particularly within the city`s well head protection zones (Figure 4.8).

Historically, stormwater management measures have been concerned principally with heavy metals, nutrients, hydrocarbons, pathogens, and sediment that run over impervious surfaces (e.g. road surfaces) into stormwater runoff and eventually contaminate groundwater and surface-water supplies. Recently, the application of road salt (NaCl) and its environmental consequences have come under scrutiny due to growing concern over habitat degradation, and water-quality issues.

Environment Canada has conducted a comprehensive assessment of road-salt application to determine whether conventional deicers should be considered toxic substances under the Canadian Environmental Protection Act. Environment Canada's "Code of Practice for the Environmental Management of Road Salt" helps municipalities better manage salt use to reduce negative environmental impacts of chloride. In that regard, cities within watersheds in Southern Ontario have been investigating management tools to alleviate the use of road salt and/or turn to alternative road deicers to prevent sodium contamination of residential drinking wells. The case studies from these watersheds would provide some guidance into salt management and monitoring within the City of Orillia.

Salt management case studies from Ontario

- The City of Mississauga Salt Study - developed between 2008 and 2010 examined the difference between using salt-sand mixtures and salt treated with magnesium chloride. The study found that there is a reduction of Total Suspended Solids (TSS) and Total Phosphorus (TP) with the use of the salt treated with magnesium chloride. The study also found that chloride reduction is attainable using both compounds. One of the key recommendations of the study is that the City of Mississauga needs to optimize salt use and reduce salt loadings especially in primary roads where the impact of road salt loadings is more pronounced that in secondary roads.
- Research done by the University of Waterloo and the National Water Research Institute within the Region of Waterloo (UW and NWRI, 2010) showed that the reduction in total road salt application of 25% in urban road network resulted in approximately 50% reduction in chloride levels in the vadose zone (i.e. unsaturated zone). The research also showed that hybrid stormwater management ponds were more effective at reducing chloride discharge at the outflow. In addition, this report highlights the impacts of parking lot surfaces on chloride transfers into the environment, particularly within vulnerable groundwater zones and presents management options.

10.3 Proposed Source Control Measures

Cursory filed investigations and discussions with city staff indicate that a number of source control drainage measures are already in practice. As discussed in Section 9.2.2, these current measures and practices include:

- Downspout disconnection – for the most part, roof runoff from residential properties is directed overland, thus providing an opportunity for infiltration and reduced runoff.
- Rain barrels - The City's Waste Management Department offers rain barrels to City residents at a discounted price to promote water conservation and reduced runoff volumes.
- Reduced lot grading – Through its development review process, the City promotes the use of reduced lot grading to enhance infiltration and reduced runoff rates.
- Oil-grit separators – The city requires these devices on all new industrial development sites within the Lake Simcoe basin.

With respect to the last point, it is recommended that the city expand the requirements for oil-grit separators city-wide, for industrial sites that discharge to the storm drainage system.

Other source control recommendations are discussed below in terms of their use in existing urban development areas (i.e. retrofits) and within future developments. As noted in Section 9.2.2, the City is in favour of applying a full range of other source control practices, including:

- Enhanced yard vegetation and rain gardens.
- Downspout disconnection for existing sites where it is not already in practice
- Bioretention areas
- Permeable pavement
- Soakaway pits / infiltration chambers / french drains
- Green roof technology

10.3.1 Existing Urban Areas - Residential Land Use Retrofits

Cursory field reconnaissance surveys showed several source control opportunities within existing residential areas in the City of Orillia. Figure 10.1 illustrates representative examples of residential properties where opportunities exist for source control retrofits including downspout disconnection to a rain garden, naturalized landscapes, permeable pavement, and infiltration galleries.

Figure 10.1: Representative Source Control Retrofit Opportunities - Existing Residential Landuses

Downspout disconnection to Bioretention /Rain Gardens - Existing (Left), Example Opportunity (Right)

Naturalized Landscaping and Tree Planting - Crawford St. (Left), Example Opportunity (Right)

Permeable Pavement - Shannon St. (Left), Example Opportunity (Right)

Infiltration Gallery / French Drain – Lawrence Ave. (Left), Example Opportunity (Centre, Right)

Since these measures are generally implemented within private properties, the City has limited role in leading the implementation of these measures. However, the City could provide a supportive role through the following:

1. Social marketing strategy and raising awareness within community;
2. Working with representative landowners on pilot projects and demonstration sites; and
3. Refine, update or change by-laws related to implementing these measures.

Municipalities within Ontario are carrying out Social Marketing programs to improve the uptake rate of source control retrofits on residential properties. There are many strategies that are being used. Four types of social marketing programs are identified below.

LSRCA RainScaping and Landowners Environmental Assistance Program

LSRCA's RainScaping program encourages LID practices such as source controls on residential properties to be implemented on new and existing development. Through the program, LSRCA offers guidance documents, training and workshop. These are geared towards landscape contractors, developers, consultant engineers, and municipal planners. Municipal staff from municipalities within the LSRCA jurisdiction are encouraged to attend events and review guidance documents to facilitate knowledge transfer within the Lake Simcoe watershed.

LSRCA's Landowners Environmental Assistance Program (LEAP) provides landowners with technical assistance and funding opportunities. LEAP is administered by the LSRCA and covers BMPs on both rural and urban properties. Rain gardens can be funded up to $10,000 at a cost-share rate of 75%. Properties eligible for rain garden LEAP funding must be within an urban area.

LEAP strives to use successes on residential lots as demonstration sites. These sites provide in-ground, aesthetically beautiful examples of rain gardens that can be duplicated by homeowners. Demonstration sites must show source control at its very best; eye catching dynamic designs that are well maintained and sited in high traffic locations.

TRCA's Greening Your Grounds (A Homeowners Guide to Stormwater Landscaping Projects)

TRCA's Greening Your Grounds is a 55 page step-by-step guide to help homeowners with implementing source controls on their properties. The guide covers the following source controls:

- Naturalization;
- Downspout Disconnection;
- Rain Barrels;
- Rain Gardens;
- Soakaways; and

- Permeable Pavement.

The guide takes homeowners from site assessment to selecting, installing and maintaining a source control that is appropriate for their property. To promote the implementation of source controls across the province, the TRCA offers the guide for $12 a copy. For quantities of 100 or more, the municipal logo can be added to the cover.

Special Events

Directly engaging property owners through special events is an effective means of building interest in source controls within a community. In the Alton Village (within the Town of Caledon), an "Ask a Designer Night" was held by Credit Valley Conservation to allow home owners to connect with landscape designers. Done well, special events can successfully launch the residential LID program, showcase the beauty of LID landscapes, secure the participation of homeowners, and provide a promotional opportunity for program partners. These events should avoid technical presentation atmospheres and allow for more interaction between landscape designers and the public.

Intensive Social Marketing

Social marketing program can be rolled out on a large level or can be tailored to specific neighbourhoods within a municipality. The Region of Peel has conducted an intensive social marketing campaign for the source level controls. Key aspects in the Region's program included:

- Determining priority areas and approaches;
- Establishing a community advisory group with resident and stakeholder representatives;
- Securing a representative sample of homeowners in the priority areas and conducting primary market research with those homeowners;
- Identifying and securing interviews with service and product suppliers and other key stakeholders;
- Developing a marketing strategy and implementation plan and executing the strategy; and
- Monitoring uptake and market transformation.

Market research conducted for the Region of Peel and other similar studies has shown that it is important to determine what will motivate residents to implement stormwater source controls on their properties. The most effective way to homeowner motivation is to conduct market research with a demographically representative sample. Market research allows a municipality to better understand residents' perspectives, intrinsic motivations and understanding, and identifies barriers to their uptake of LID measures. Through market research for the Region of Peel and other municipalities, the following have been found to be key components of a successful marketing strategy:

- **Visually Based Campaign** – Home owners respond best to simple messages and images. Words and phrases that reflect the emotional connection residents have with their home and its landscape should be used.
- **Demonstration Sites** – Successful strategies often include a demonstration initiative in a high profile, leading residential community. Signage in these areas should promote the program and provide contact information to interested homeowners.
- **Landscape Advisory Service** – A municipal or municipally supported service can be established to assist homeowners in their transition from more traditional landscapes to the marketed landscape. This service provides design ideas and answers to frequently asked questions about promoted source controls.

In addition to the marketing strategy components noted above, the following two tasks were completed for the Region of Peel study:

- **Strategic Partnerships –** Partnerships with key stakeholders in the Region were important as they are in the best position to communicate directly, face-to-face with homeowners. Partnerships can be formed with neighbourhood associations, gardening clubs, environmental organizations, landscape suppliers and landscape contractors.
- **Products and "How-to" resources –** Information packages, guides and web resources should be developed in parallel with the roll-out of the marketing program to support the increased uptake.

10.3.2 Existing Urban Areas - Public Landuse Retrofits

Proposed source control measures within public lands may include retrofits in public open spaces, public schools, and libraries. Pilot projects are suggested within these areas to define variables such as landowners' awareness of the impacts from stormwater, their willingness to implement, the importance of public funding, and the adoption rates for each of the proposed measures. Areas which are frequented by the broader community are ideal sites for innovative pilot projects as they provide a visible 'high profile' location to showcase the project, allow for a greater opportunity for education, community involvement and support. When implementing novel SWM techniques, providing a forum for community interaction and involvement is critical if broader, community wide adoption is desired.

Prime opportunities to introduce source control retrofits into municipal lands would include the City's community parks. Figure 10.2 illustrates representative examples of parking lots within municipal properties where opportunities exist for source control retrofits. Some of the most effective source controls that can be implemented to provide both quality and quantity control to municipal parking lots include permeable pavement, bioretention, as well as other proprietary treatment systems. Municipal and private parking lots in Ontario have been successfully retrofitted with one or a combination of these source controls.

Figure 10.2: Representative Source Control Retrofit Opportunities - Existing Public Landuses

Traditional Parking Lots - Dunedin St. Park (Left) and Couchiching Beach Park (Right)

Examples of parking lot source controls that could be implemented within municipal lots. An inlet to a Jellyfish proprietary water quality device to reduce the loading of phosphorus and other pollutants (left). Permeable pavement used to reduce runoff and pollutant loading to receiving waterbodies (right).

10.3.3 New Development Areas

Source control measures should be applied to new developments as part of a treatment train approach to stormwater management, whereby stormwater Best Management Practices (BMP) are applied in succession along the stormwater flow path. In general, the application of innovative LID source and conveyance controls and end-of-pipe facilities within new developments should be done in accordance with the Recommended Approach and relevant guidelines that include the Ontario Ministry of the Environment's 2003 Stormwater Management Planning and Design Manual and LID Manuals proposed by Conservation Authorities within Ontario including TRCA and CVC LID Manuals.

Locally, the LSRCA has released a draft document titled L**ake Simcoe Watershed LID SWM Guidelines for Municipalities** (Draft April 2015). This document specifies that:

"For new, nonlinear developments that create more than 0.5 hectares of new impervious surface on sites without restrictions, stormwater runoff volumes will be controlled and the post-construction runoff volume shall be retained on site from runoff of the first 25 mm of rainfall from all impervious surfaces on the site."

To achieve this target, the proponent of new development must design infiltration or filtration systems that that provide a water quality volume (calculated as an instantaneous volume) of 25 mm of runoff (or 25 mm minus the volume of stormwater treated by another system on the site) from the new impervious surfaces created by the project.

10.4 Proposed Conveyance Control Measures

Stormwater conveyance control options differ depending on the streetscape (right-of-way) type and available space. In general, the best opportunities to implement stormwater treatment measures in the municipal right-of-way are in the grassed area located between the curb and the sidewalk (the boulevard) as well as the road surface immediately adjacent to the curb. Different streetscapes in the City of Orillia were reviewed, and the way to manage stormwater conveyance along these streetscapes was examined through:

- Review of the general types of treatment measures;
- Cursory "windshield" investigations in representative areas within the City; and
- Desktop analysis for aspects of implementation.

Although the discussions below focus on opportunities to implement conveyance controls into existing roadways (i.e. retrofits), it is understood that these measures will also be required within new developments as part of a treatment train approach to stormwater management, whereby stormwater Best Management Practices (BMP) are applied in succession along the stormwater flow path.

Through discussions with City staff, two primary opportunities to retrofit existing roadways using new stormwater conveyance controls were identified:

- Road re-surfacing and re-construction works; and
- Retrofit of existing paved ditches.

The location of these conveyance control retrofit opportunities are illustrated in Figure 10.3 and discussed in further detail below.

10.4.1 Road Re-Construction / Re-Surfacing

The most cost-effective means of implementing new stormwater conveyance controls into existing municipal roadways is to complete the construction concurrent with municipal road works projects. The opportunity to incorporate the conveyance controls may come as a result of development pressures which require replacement of the infrastructure (e.g. road widenings), or as a result of deteriorating conditions and general age of the infrastructure.

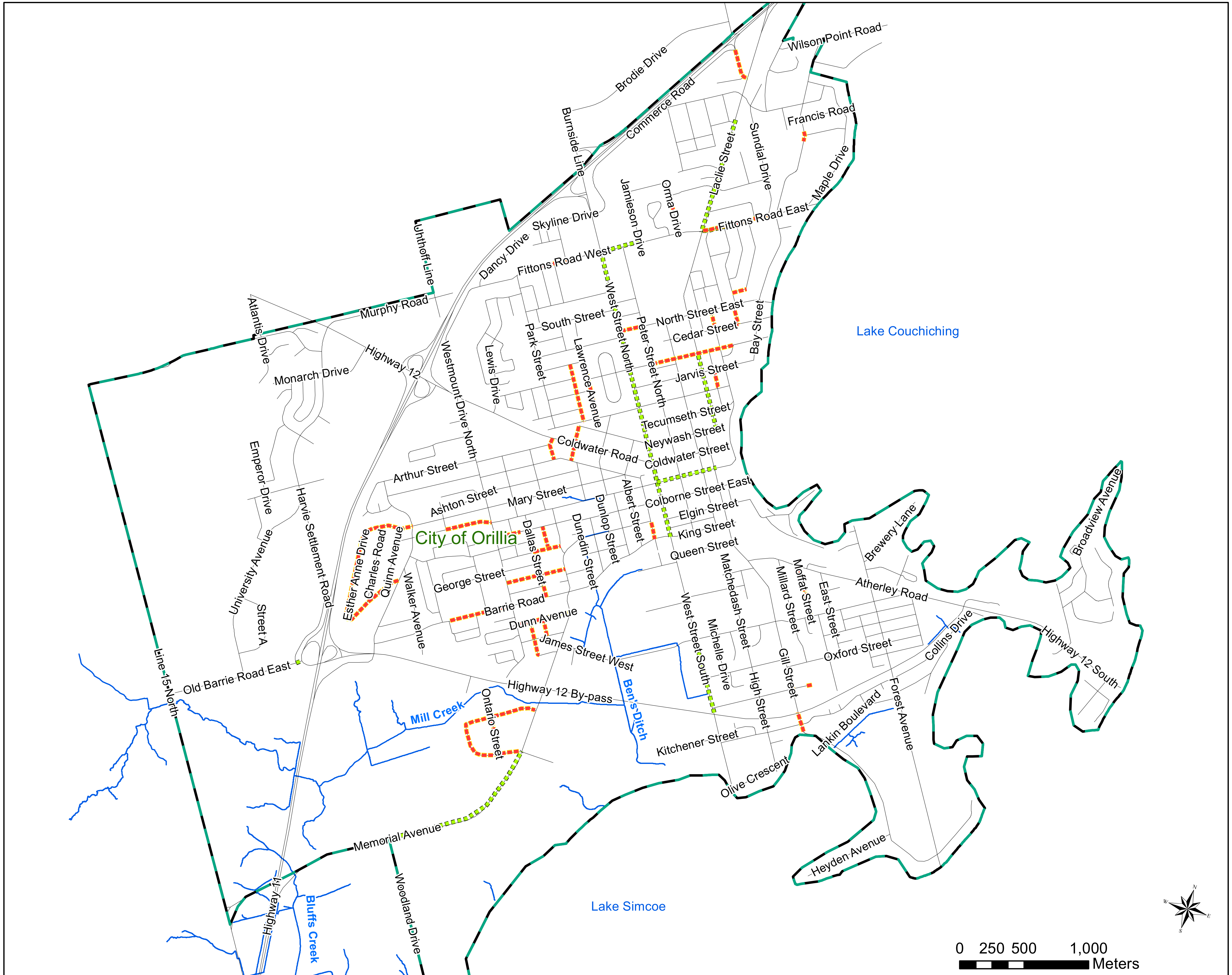
A list of the City's scheduled road works is summarized in Table 10.2. As shown, approximately 6km of roadway is scheduled for works between 2015 and 2023. This program, therefore, represents a significant opportunity to implement stormwater retrofits over considerable length of currently untreated roadways.

The LSRCA's **Lake Simcoe Watershed LID SWM Guidelines for Municipalities** (Draft April 2015 classifies road reconstruction as "Linear Development". In Section 1.2.3 of the LSRCA Draft Guidelines the following volume control requirements are stated for linear development:

"Linear projects on sites without restrictions that create 0.5 or greater hectares of new and/or fully reconstructed impervious surfaces, shall capture and retain the larger of the following:

i. The first 12.5 mm of runoff from the new and fully reconstructed impervious surfaces on the site *ii. The first 25 mm of runoff from the net increase in impervious area on the site"*

The LSRCA Draft Guidelines state that mill and overlay and other resurfacing activities are not considered full reconstruction projects.



KEY MAP

Legend

StudyArea

Conveyance Control LID Opportunities

Road Reconstuction

Roadside Ditch Design

Aquafor Beech Limited

Orillia City Centre
50 Andrew Street South, Suite 300
Orillia, ON L3V 7T5
Telephone: (705) 325-1311
Fax: (705) 325-5178

City Of Orillia Comprehensive Stormwater Management Master Plan

Roadside Ditch Improvement Opportunities

Mapping Source: City of Orillia (2014)

FIGURE: 10.3

DATE: June 2015

Table 10.2: City of Orillia Capital Roads Re-Construction Works

Road	from	to	length	comments	year
West St.	Coldwater Rd.	King St.	600	underground services	2016
Fittons Rd.	Jamieson Dr.	West St.	300	DC Sewer upgrade	2017
Laclie St.	Neywash St.	Borland St.	600	widening	2018
Laclie St.	Borland St.	Fittons Rd.	900	widening	2019
Memorial Ave.	United Dr.	Woodland Dr.	1300	widening	2020
West St.	James St.	Highway #12	600	widening	2021
Laclie St.	Fittons Rd.	Murry St.	900	widening	2022
Mississauga St.	Front St.	Albert St.	700	streetscaping	2023

10.4.2 Ditch Retrofits

As noted earlier, a significant number of roads within the city have a rural cross-section which conveys stormwater runoff via grassed swales / ditches. Unlike typical urban curb-and-gutter systems, the grassed swales in a rural configuration provide an opportunity to improve water quality by trapping sediment and reducing pollutant runoff.

However, within several of these rural road cross-sections, the roadside ditches have been paved (see example – Dallas St. and Argyle Ave, inset), and therefore currently offer no stormwater treatment or runoff reduction benefits. Sites such as these have been compiled and identified as prime candidates for future stormwater conveyance control retrofits. A list of the identified roadside ditch retrofit opportunities is provided in Table 10.3.

In addition to this list, the Progress Drive industrial subdivision was also identified as a significant stormwater retrofit opportunity. Currently, the subdivision drains via basic grassed ditches to Mill Creek. However, there is ample room available to retrofit these ditches using LID conveyance measures such as bioswales, for example.

The location of the identified ditch retrofit opportunities is illustrated in Figure 10.3.

Table 10.3: Identified Roadside Ditch Retrofit Opportunities

Road	from	to	ditch
Progress Drive business park subdivision			all
Parkview Ave.	Jarvis St.	Brant St. E.	east
Borland St.	Peter St. N.	Lavallee Cres	both
North St. E.	West St. N.	Peter St. N.	north
Canice St.	North St. E.	Cedar St.	both
Cedar St.	Canice St.	Cowan St.	north
Cowan St.	North St. E.	Cedar St.	both
Tallwood Dr.	Highland Ave.	No. 341	west
Fittons Rd. E.	Laclie St.	Sundial Dr.	both
Orma Dr.	No. 31	top of hill	both
Sundial Dr. N.	Commerce Rd.	Laclie St.	both
Drinkwater Dr.	Bay St. extension		both
Belmoral Ave.			
Lawrence Ave.			
Emily St.	Coldwater St.	Nottawasaga St.	both
Cameron St.	Penetang St.	Coldwater St.	west
Cameron St.	Coldwater St.	Nottawasaga St.	west
Dallas St.	Colborne St. W.	Barrie Rd.	both
Albany Ave.	Westmount Dr.	Memorial Ave.	both
Andrew St.	City Hall parking	Barrie Rd.	east
Mississauga St. W.	Allen St.	Westmount Dr.	north
Barrie Rd.	Westmount Dr.	Jamieson Dr.	south
Karen Cres.			
Sandra Cres.			
Ester Anne Dr.			
Carlton St.			
Clinton St.			
Dunn Ave.			
Colbourne St. W.	Hammond Ave		both
Bleeker St.	Colborne St. W.	McKinnel St.	both
McKinnel St.			both
Fittons Rd. W.	Alexander	Derby St.	both
Simcoe St.	dead-end	school	south
Gill St.	Simcoe St.		4 corners
Gill St.	Hwy #12	Victoria Cres	both
Oxford St.	Regent St.		north
East St.	Clayborne Pl #312	#316 East St.	east
Moffat St.	top of hill	Atherley Rd.	east

10.4.3 Conveyance Retrofit Recommendations

When considering which form of conveyance control measures to implement as part of the road re-construction works or ditch retrofits, a variety of conveyance control systems are available. The recommended measures are listed below, prioritized in terms of preference, from highest to lowest, based on the anticipated water quality treatment levels:

1. **bioretention systems** – this class of LID measure offers the highest opportunity for overall water quality treatment and reduced runoff volumes. Special soil media mixtures are also available to enhance the removal of phosphorus within these systems.
2. **pervious pipe / exfiltration systems** – these systems do not offer the same level of biological treatment as bioretention systems, however, significant water quality and water balance benefits are provided through storage and infiltration of stormwater runoff.
3. **grassed swales** - if bioretention or pervious pipe systems are not feasible due to space and/or utility conflicts, then a grassed swale configuration should be considered.
4. **permeable pavement** - opportunities to include permeable pavement in the design may also be considered in specific areas.
5. **oil-grit separators** - where none of the above LID measures are feasible, consideration should be given to including an oil-grit separator with enhanced removal capacity into the conveyance system.

The recommended measures are discussed below in terms of their applicability to urban and rural road cross-sections. Alternative configurations of these measures are also discusses according to their applicability to different landuses, streetscapes, and available space.

<u>Rural Cross-Sections (Roads with Ditches)</u>

Where space is available within the boulevard, the preferred retrofit configuration would include bioretention LID measures. For residential landuses, or areas with numerous closely-spaced driveways, these types of stormwater measures can be constructed as a series of individual bioretention cells located between the driveways. For industrial or business frontages with longer uninterrupted boulevards, linear bioretention swales can be applied.

These systems can be constructed using different covers, depending on resident preferences. In high-profile prestigious areas, aesthetic planted garden bioretention systems would be used. In lower-profile areas, low-maintenance systems with basic turf cover would be used. Example concepts are illustrated in Figure 10.4.

Where bioretention systems are not feasible, due to limited surface space or utility conflicts, underground perforated pipe systems would be an alternative LID recommendation.

Where none of the above LID systems is feasible due to cost or other constraints, the rural/ditched cross-section using enhanced grassed swales should remain. This configuration is preferable to an urban cross-section as it provides better opportunities for water quality treatment and runoff reduction.

Roadside Ditch Retrofit Improvements

Turf Bioswale

Planted Garden Bioretention

Figure 10.4: Roadside Ditch Improvement Opportunities

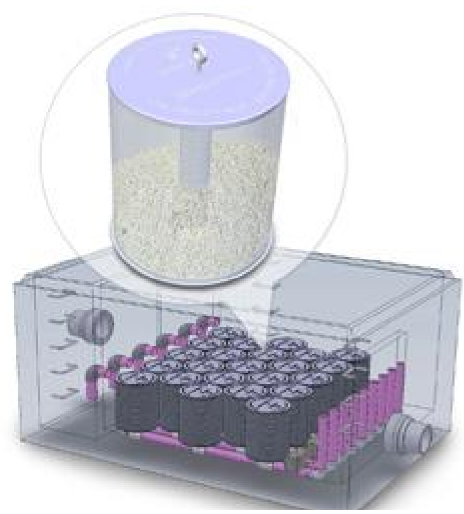
Urban Cross-Sections (Roads with Curb-and-Gutter)

Where space is available, the preferred retrofit configuration would include bioretention LID measures. These systems can be constructed in a variety of forms in an urban setting:

- For residential landuses, or areas with numerous closely-spaced driveways, these types of stormwater measures can be constructed as a series of individual bioretention cells located between the driveways in the boulevard. Runoff would be directed to the units via curb cuts. Depending on residents' preferences, the units can be constructed using either planted gardens or simple turf cover. Example concepts are illustrated in Figure 10.5.
- For industrial or business frontages with longer uninterrupted boulevards, linear bioretention swales can be constructed and fed via curb cuts. In most cases, the bioswales would be constructed using low-maintenance turf cover, however planted gardens could also be used for high-profile prestige areas.
- For roads through high-density downtown core areas, there may not be sufficient space for boulevard bioretention/bioswale systems. In these settings, smaller, compact bioretention planter units may be used instead. Alternatively, "bumpout" units may be constructed adjacent to the curb within the roadway. Consideration should also be given to including permeable pavement for on-street parking zones within the downtown setting. Example concepts are illustrated in Figure 10.5.

Where bioretention systems are not feasible, due to limited surface space or utility conflicts, underground perforated pipe systems would be an alternative LID recommendation, either beneath the boulevard/sidewalk or beneath the road surface itself (Figure 10.5.).

Where none of the above LID measures are feasible within the road right-of-way, consideration should be given to adding an oil-grit separator with enhanced removal capacity into the road design. As noted by LSRCA Technical Guidelines for Stormwater Management Submissions, these devices should ideally be placed within a treatment train mechanism, where they complement other upstream source and conveyance stormwater measures in terms of removal efficiency for phosphorus or other pollutants of concern. The Lake Simcoe Protection Plan (LSPP) recommends stormwater treatment measures that have optimal phosphorus removal. Recent advances in OGS technology have revealed that high levels of phosphorus removal are possible by using a combination of filtration and sorption mechanisms within an OGS device. Enhanced OGS devices have been used by many municipalities to remove sediment-bound and dissolved phosphorus, Total Suspended Sediments (TSS), and hydrocarbons, with a Total Phosphorus (TP) removal efficiency of around 77%, and sediment removal efficiency of around 89%.



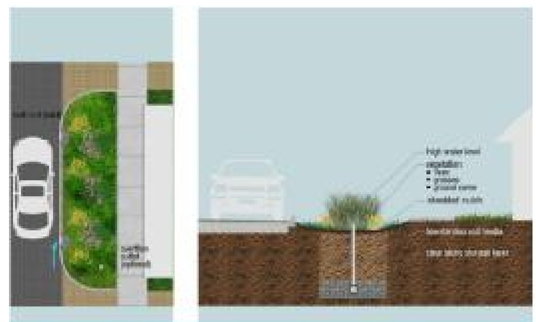
Enhanced Oil-Grit Separator Device

Downtown Streetscape Example:

Biorettention Planters:

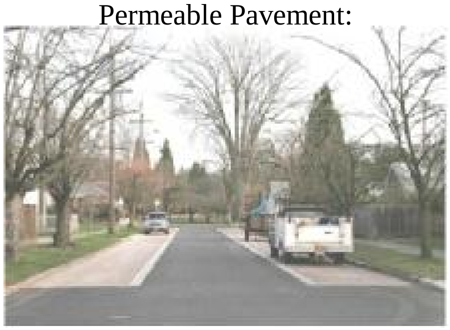
Residential Streetscape Example:

Boulevard Bioretention:



Perforated Pipe:

Permeable Pavement:



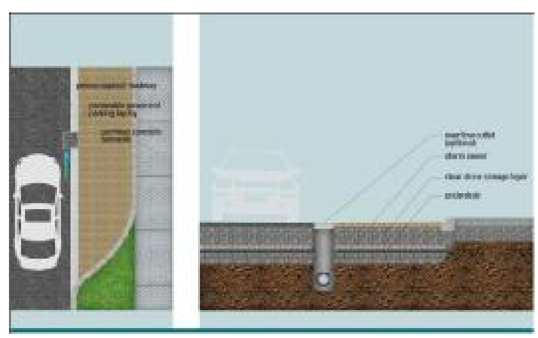


Figure 10.5: Urban Road LID Opportunities

10.4.4 Conveyance Retrofits in Well Head Protection Areas

Although it is technically feasible to implement the recommended LID conveyance control retrofits as part of any of the identified roads or ditch improvements projects, these systems represent a potential pathway for dissolved pollutants such as chlorides from road salt application to enter the groundwater system. Therefore, some municipalities limit or restrict the use of infiltration-based LID's as part of road designs within well head protection areas (WHPAs) in order to avoid contamination of the municipal drinking water supply.

City of Orillia staff have discussed this issue with LSRCA. As noted earlier, the City already applies a sand-salt mixture that has a lower salt content (5%-7%) than is typically applied by other municipalities. For this reason, complete restriction on the use of LID measures within WHPAs (Figure 4.8) is not anticipated. Rather, consideration may be given to designing any LID systems within the WHPAs for seasonal operation. For example, curb-cuts that are used to direct runoff to boulevard bioretention areas may be fitted with slotted gate plates that can be closed during the winter season, so that stormwater runoff bypasses the LID and the roadway functions as a traditional curb and gutter system. Further reductions, restrictions, or alternatives to the use of road salt in the WHPAs may also be considered.

10.5 Proposed End-of-Pipe Retrofits

Within the City of Orillia, future urban development is expected to include a complete range of modern stormwater management measures which meet current LSRCA and MOE targets. However, as noted earlier, stormwater treatment for water quality control is very limited in some of the older parts of the City that were constructed before modern stormwater management practices. Therefore, the recommended approach focusses on implementing new stormwater controls within the existing uncontrolled urban areas of the City, as these areas represent the greatest overall opportunity for improving stormwater water quality, and phosphorus reductions in particular. The following end-of-pipe retrofit opportunities were identified:

Lake Simcoe Basin

- Retrofit of the existing quantity-only (dry) pond F7 to include a quality treatment function;
- Construction of 4 new end-of-pipe stormwater facilities at existing uncontrolled storm sewer outfalls. Five potential sites were identified including two options to treat drainage from a large upstream area via new facilities on Ben's Ditch (i.e. site 103-2 or 103-3). The other three end-of-pipe retrofit sites include site 8 (Mill Creek), and Lake Simcoe outfalls U1 and 75.
- Addition of 3 oil-grit-separators (OGSs) at outfalls to Lake Simcoe from small catchments.

Lake Couchiching

- Construction of 5 new end-of-pipe stormwater facilities at existing uncontrolled storm sewer outfalls. The identified sites include Couchiching Beach Park where there is an opportunity to treat drainage from a large upstream area via potential stormwater diversion from outlets 24, 25, and 26.
- Addition of 3 oil-grit-separators (OGSs) at outfalls to Lake Couchiching from small catchments.

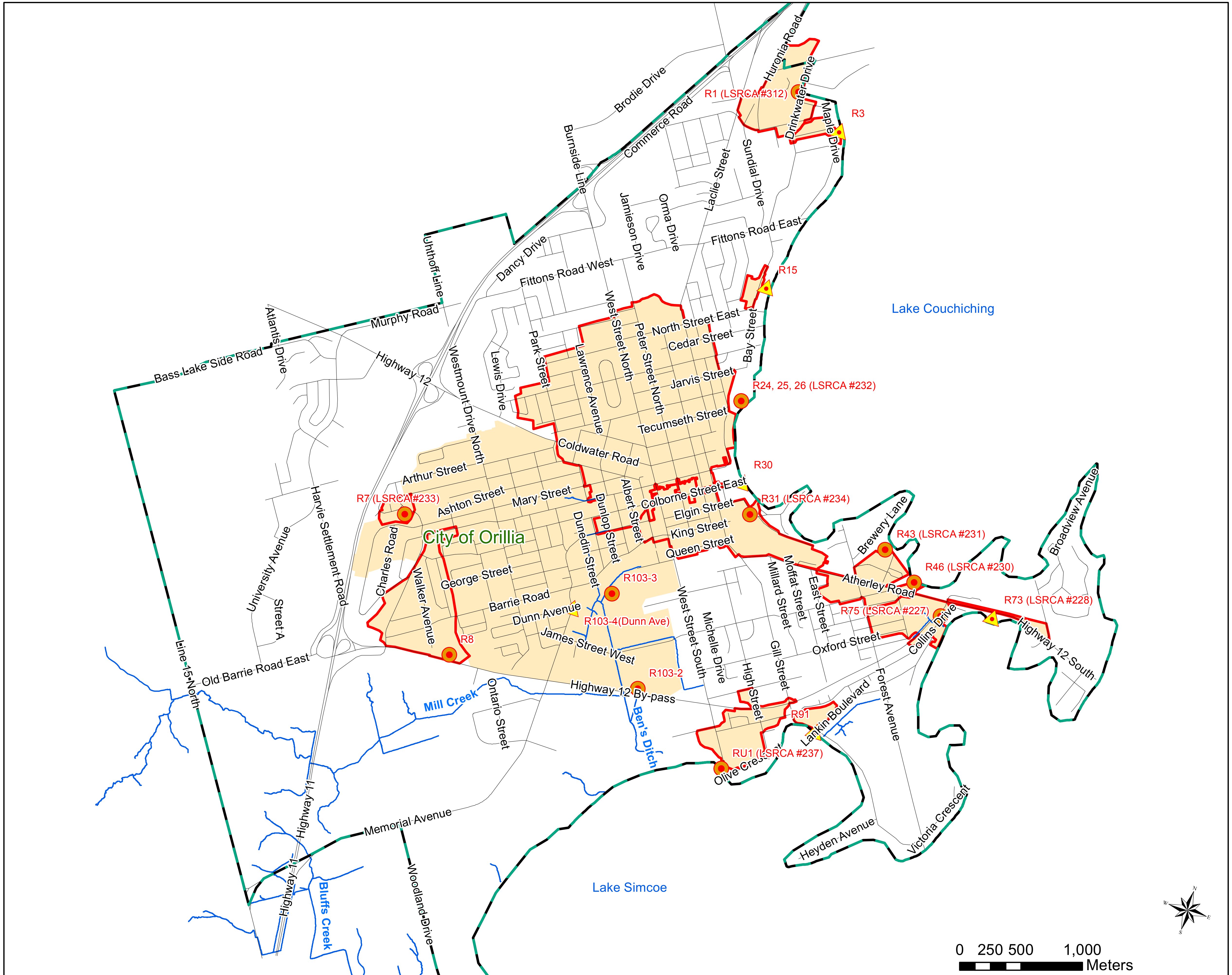
In total, 17 sites are identified for end-of-pipe water quality control retrofits. These sites are summarized in Table 10.4, and Figure 10.6 illustrates the location of the sites throughout the study area. As noted earlier, only 9% of the city's existing lands draining to Lake Simcoe currently receive water quality treatment, while all of the drainage to Lake Couchiching is untreated. The construction of the 16 end-of-pipe stormwater retrofits could potentially increase the portion of City lands receiving some measure of water quality treatment to 29% and 47% for the Lake Simcoe and Lake Couchiching basins, respectively.

Conceptual examples and photos of various end-of-pipe stormwater retrofits types are illustrated in Figure 10.7 to Figure 10.9. As shown, end-of-pipe treatment options include stormwater detention ponds, infiltration galleries, and oil-grit-separators with enhanced removal capacity.

Table 10.4: City of Orillia Water Quality Retrofit Opportunities

Site / Outfall No.		LSRCA Site No. *	Watershed / Basin	Retrofit Type	Drainage Area (ha)
dry SWM Pond #F7		233	Lake Simcoe, basin #16	add WQ function to dry pond	5.3
Mill Creek basin 8		--	Lake Simcoe/ Mill Crk. basin #8	new SWM pond or inline facility	48.3
outfall #103-2	optional site 1 on Ben's Ditch to outfall 103	236	Lake Simcoe / basin #14-17, 7	new SWM pond / SWM wetland	352
outfall #103-3	optional site 2 on Ben's Ditch to outfall 103	236	Lake Simcoe / basin #15, 16	new SWM pond	261
outfall #U1		237	Lake Simcoe, basin #13	new SWM pond or inf. gallery	23.4
outfall #91		--	Lake Simcoe, basin #9	OGS	4.3
outfall #75		227	Lake Simcoe, basin #2	new SWM pond	19.7
outfall #73		228	Lake Simcoe, basin #1	OGS	3.1
Memorial / Dunn (#103-4)		--	Lake Simcoe, basin #14	OGS and upstream bioswales	7.0
total area within Lake Simcoe Watershed served by potential end-of-pipe water quality retrofits (assuming Optoinal Site 1 selected for outfall 103):					456.1
outfall #46		230	Lake Couchiching, basin #21	new SWM pond	13.1
outfall #43		231	Lake Couchiching, basin #22	new SWM pond / bioswales	8.7
outfall #31		234	Lake Couchiching, basin #17	new SWM pond	51.9
outfall #30		--	Lake Couchiching, basin #14	OGS	3.2
outfalls #24, 25, 26	investigate potential to divert to new SWM facility in Couchiching Beach Park	232	Lake Couchiching, basin #9	new SWM pond	203.2
outfall #15		--	Lake Couchiching, basin #7	OGS	3.1
outfall #3		--	Lake Couchiching, basin #3	OGS	4.4
outfall #1		312	Lake Couchiching, basin #1	new SWM pond	24.4
total area within Lake Couchiching Watershed served by potential end-of-pipe water quality retrofits:					312.0

* Lake Simcoe Basin Stormwater Management and Retrofit Opportunities (LSRCA 2007).



Legend

StudyArea

End-of-Pipe Retrofit Opportunities

SWM Facility Retrofit Opportunity

Oil and Grit Separator

Drainage Area

Aquafor Beech Limited

ORILLIA

Orillia City Centre
50 Andrew Street South, Suite 300
Orillia, ON L3V 7T5
Telephone: (705) 325-1311
Fax: (705) 325-5178

City Of Orillia Comprehensive Stormwater Management Master Plan

End of Pipe Stormwater Retrofit Opportunities

Mapping Source: City of Orillia (2014)

FIGURE: 10.6

DATE: June 2015

Figure 10.7: Dry Pond Retrofit Example

The formerly quantity-only dry pond (Left) was retrofitted to provide additional water quality control.

Figure 10.8: Public Open Space Retrofit Opportunity Example

A previously under-utilized park area that was retrofitted to include a stormwater pond and underground infiltration gallery beneath a sports park.

Figure 10.9: Uncontrolled Storm Sewer Outfall – OGS Retrofit Opportunity Example

10.6 Stream Restoration Measures

Section 4.8 of this study presented a cursory review of the geomorphologic characteristics of the City of Orillia streams. Stream erosion and problem site restoration measures are recommended to be addressed as part of a future City-wide Stream Restoration Master Plan that follows Approach 2 of the Master Plan process and would result in a prioritized plan for undertaking future stream works. The purpose of the study would be to:

- To complete a comprehensive stream inventory of erosion sites;
- develop a restoration plan to address the erosion sites.

The goals of the study would be to:

- To gain insight into the controls and modifying influences on the City's watercourses
- To develop a long term plan for restoring the streams in a cost effective manner (considering both capital and maintenance costs).
- To develop an approach for selecting, screening, and recommending alternatives to stabilize and/or restore watercourses.
- To develop an implementation plan which costs, categorizes, and prioritizes the preferred rehabilitation alternatives.

11 Environmental Benefits of the Recommended Approach

This chapter summarizes the environmental benefits of the key stormwater measures which comprise the Recommended Approach (Chapter 10). Consistent with the goals of the Lake Simcoe Protection Plan, the focus of the assessment is on water quality, particularly phosphorus loadings, however, it is understood that the recommended measures can also be applied to reduce runoff volumes and flow rates, and to achieve a hydrologic water balance.

To quantify the water quality benefits of the recommended measures, pollutant loadings reductions have been estimated for each of the three key stormwater control categories:

- Source control measures;
- Conveyance control measures;
- End-of-pipe control measures.

The loadings reductions are summarized on both a unit basis for smaller-scale source and conveyance measures which are expected to be applied on a broad basis throughout the city, and individually for site-specific end-of-pipe measures.

Although estimates of the environmental benefits are provided for each of the recommended source, conveyance, and end-of-pipe control measures, it should be emphasized that the environmental benefits of the three stormwater control categories should be considered holistically, as part of a treatment train approach, where each of the three types complements the other.

11.1 Source Control Retrofits

The following analysis of source control benefits is based on estimating phosphorus and TSS removal from a one hectare drainage area within typical residential and industrial/commercial neighborhoods in the City of Orillia. The effectiveness of the source control measures depends on the participation, or willingness of landowners to implement these types of measures throughout the city. Landowner participation, referred to as an “uptake rate”, is expressed in percentage. Five (5) different control scenarios and two control measures (soakaways/infiltration trenches and sand/ media filters to represent bioretention) were investigated:

1. Existing Conditions (i.e. no source control retrofit);
2. 10% Uptake Rate;
3. 20% Uptake Rate;
4. 30% Uptake Rate; and
5. 40% Uptake Rate

For phosphorus, the MOE water quality assessment tool was used for input on the loadings rates and for the removal efficiencies of the soakaways and sand/media filters. For TSS loadings and removal rates, literature-based values were used. The results are provided in Table 11.1 and Table 11.2 and summarized below:

- The phosphorus load reduction is expected to range from:
  - 6% to 24%, for a 10% to 40% Uptake Rate, respectively, where soakaway/infiltration trenches are implemented;
  - 4.5% to 18% for a 10% to 40% Uptake Rate, respectively, where sand or media filters such as bioretention units are implemented.
- The TSS load reduction is expected to range from:
  - 7.5% to 30%, for a 10% to 40% Uptake Rate, respectively, where soakaway/infiltration trenches are implemented;
  - 8.5% to 34% for a 10% to 40% Uptake Rate, respectively, where sand or media filters such as bioretention units are implemented.

11.2 Conveyance Control Retrofits

As noted in **Chapter 10.4**, the identified capital roads projects and ditch retrofits represent a significant opportunity to implement stormwater retrofits over considerable length of currently untreated roadways.

The following analysis demonstrates the estimated phosphorus and TSS removal achieved through the implementation of various LID conveyance control measures within the roadways of a typical one hectare drainage area catchment. Four different LID retrofit control alternatives were investigated:

- Existing Conditions (i.e. no conveyance control retrofit);
- Perforated pipe / exfiltration systems;
- Sorptive media interceptors (i.e. enhanced OGS); and
- Sand or media filters (i.e. bioretention units)

For phosphorus, the MOE water quality assessment tool was used for input on the loadings rates and removal efficiencies of the conveyance control measures. For TSS loadings and removal rates, literature-based values were used. The results are provided in Table 11.3 and summarized below:

- The phosphorus load reduction is expected to range from 45% to 87%, depending on the LID control that is implemented. This corresponds to a significant reduction in annual phosphorus loadings of up to 1.2 to 1.6 kg per hectare, depending on landuse, for the most efficient LID's;
- The TSS load reduction is expected to range from 75% to 85%, depending on the LID control that is implemented. This corresponds to a large reduction in annual TSS loadings of over 380 to 570 kg per hectare, depending on landuse, for the most efficient LID's.

Table 11.1: Phosphorus Removal per hectare using Source Control Retrofits

Landuse	Source Control Measure	Source Control Removal Efficiency (%)	TSS Treatment	Existing Conditions (No Retrofit)	Uptake Rate			
					10%	20%	30%	40%
Residential	Soakaways / Infiltration Trenches	60%	Phosphorus Loading (kg/ha/year)	1.32	1.24	1.16	1.08	1.00
			Phosphorus Removal (%)	0.0%	6.0%	12.0%	18.0%	24.0%
	Sand or Media Filters (i.e. Bioretention)	45%	Phosphorus Loading (kg/ha/year)	1.32	1.26	1.20	1.14	1.08
			Phosphorus Removal (%)	0.0%	4.5%	9.0%	13.5%	18.0%
Industrial / Commercial	Soakaways / Infiltration Trenches	60%	Phosphorus Loading (kg/ha/year)	1.82	1.71	1.60	1.49	1.38
			Phosphorus Removal (%)	0.0%	6.0%	12.0%	18.0%	24.0%
	Sand or Media Filters (i.e. Bioretention)	45%	Phosphorus Loading (kg/ha/year)	1.82	1.74	1.66	1.57	1.49
			Phosphorus Removal (%)	0.0%	4.5%	9.0%	13.5%	18.0%

Table 11.2: TSS Removal per hectare using Source Control Retrofits

Landuse	Source Control Measure	Source Control Removal Efficiency (%)	TSS Treatment	Existing Conditions (No Retrofit)	Uptake Rate			
					10%	20%	30%	40%
Residential	Soakaways-Infiltration Trenches	75%	TSS Loading (kg/ha/year)	677.3	626.5	575.7	524.9	474.1
			TSS Removal (%)	0.0%	7.5%	15.0%	22.5%	30.0%
	Sand or Media Filters (i.e. Bioretention)	85%	TSS Loading (kg/ha/year)	677.3	619.7	562.1	504.6	447.0
			TSS Removal (%)	0%	8.5%	17.0%	25.5%	34.0%
Industrial / Commercial	Soakaways / Infiltration Trenches	75%	Phosphorus Loading (kg/ha/year)	449.8	416.1	382.3	348.6	314.9
			Phosphorus Removal (%)	0.0%	7.5%	15.0%	22.5%	30.0%
	Sand or Media Filters (i.e. Bioretention)	85%	Phosphorus Loading (kg/ha/year)	449.8	411.6	373.3	335.1	296.9
			Phosphorus Removal (%)	0.0%	8.5%	17.0%	25.5%	34.0%

Table 11.3: Pollutant Loadings and Removal per unit hectare Using Conveyance Control Retrofits

	Existing Conditions (No Retrofit)		Retrofit Using Perforated Pipe/Exfiltration			Retrofit Using Sorbtive Media (OGS)			Retrofit with Sand/Media Filters (Bioretention)		
	Loadings (kg/ha/yr)		Removal %	Loadings (kg/ha/yr)		Removal %	Loadings (kg/ha/yr)		Removal %	Loadings (kg/ha/yr)	
	Residential	Industrial/ Comm.		Residential	Industrial/ Comm.		Residential	Industrial/ Comm.		Residential	Industrial/ Comm.
Phosphorus	1.32	1.82	87%	0.17	0.24	79%	0.28	0.38	45%	0.73	1.00
TSS	677.3	449.8	75%	169.3	112.4	80%	135.5	90.0	85%	101.6	67.5

11.3 End of Pipe Retrofits

In total, 16 sites have been identified for end-of-pipe water quality control retrofits, including 8 sites in each of the Lake Simcoe and Lake Couchiching basins. For the purposes of estimating treatment efficiencies, the retrofits were assumed to be constructed as either wet detention ponds or enhanced OGS devices. In all cases, it was assumed that sufficient space is available to construct facilities with enough storage to meet the MOE “enhanced” level of water quality treatment. The environmental benefits of these proposed retrofits, in terms of phosphorus and TSS removal, is summarized in Table 11.4. For phosphorus, the MOE water quality assessment tool was used for input on the unit loadings and the removal efficiencies of the proposed end-of-pipe retrofits. For TSS loadings and removal rates, literature-based values were used.

In terms of phosphorus, the loadings reductions are expected to range from 63% to 79%, depending on the type of end-of-pipe stormwater measure that is implemented. As shown in Table 11.4, if all of the recommended end-of-pipe retrofits are constructed, annual phosphorus loadings to Lake Simcoe and Lake Couchiching could be reduced by approximately 446kg and 314kg, respectively.

In terms of TSS, the loadings reductions are expected to be approximately 80% for both stormwater detention ponds or enhanced OGS’s. As shown in Table 11.4, if all of the recommended end-of-pipe retrofits are constructed, annual TSS loadings to Lake Simcoe and Lake Couchiching could be reduced by approximately 218 tonnes and 139 tonnes, respectively.

It should be noted that two sites in particular account for a large portion of the anticipated loadings reductions. The proposed construction of a large stormwater facility on Ben`s Ditch (site 103-2) would serve a very large upstream area and therefore accounts for much of the potential pollutant reductions to Lake Simcoe. Similarly, the proposed construction of a large stormwater facility in Couchiching Beach Park to treat runoff from outfalls No. 24, 25 and 26 would also serve a very large upstream area and therefore accounts for much of the potential pollutant reductions to Lake Couchiching.

Table 11.4: Pollutant Loadings and Removals for Recommended End-of-Pipe Stormwater Retrofit Sites

					Phosphorus			TSS		
					Existing Conditions (no Retrofit)	Following Construction of Retrofit Works		Existing Conditions (no Retrofit)	Following Construction of Retrofit Works	
Site / Outfall No.*	BMP assumed	Drainage Area	Landuses	Estimated % impervious	Annual Loadings (kg/yr)	Removal %	Annual Loadings (kg/yr)	Annual Loadings (Tons/yr)	Removal %	Annual Loadings (Tons/yr)
dry SWM Pond #F7	SWM pond	5.3	residential	45%	7.0	63%	2.6	3.6	80%	0.7
Mill Creek basin 8	SWM pond	48.3	residential	45%	63.8	63%	23.6	32.7	80%	6.5
outfall #103-2	SWM pond	352.0	mixed	65%	552.6	63%	204.5	198.4	80%	39.7
outfall #U1	SWM pond	23.4	residential	45%	30.9	63%	11.4	15.8	80%	3.2
outfall #91	OGS	4.3	residential	45%	5.7	79%	1.2	2.9	80%	0.6
outfall #75	SWM pond	19.7	residential	45%	26.0	63%	9.6	13.3	80%	2.7
outfall #73	OGS	3.1	road ROW	85%	5.6	79%	1.2	1.4	80%	0.3
Memorial / Dunn (#103-4)	OGS	7.0	mixed	65%	11.0	79%	2.3	3.9	80%	0.8
				Subtotal - Lake Simcoe basin:	702.6		256.4	272.1		54.4
* assumes that optional site #1 (i.e. retrofit site R103-2) is constructed (and not R103-3)										
outfall #46	SWM pond	13.1	mixed	65%	20.6	63%	7.6	7.4	80%	1.5
outfall #43	SWM pond	8.7	res-hi	65%	13.7	63%	5.1	4.9	80%	1.0
outfall #31	SWM pond	51.9	mixed	65%	81.5	63%	30.1	29.2	80%	5.8
outfall #30	OGS	3.2	commercial	85%	5.8	79%	1.2	1.4	80%	0.3
outfalls #24, 25, 26	SWM pond	203.2	mixed	65%	319.0	63%	118.0	114.5	80%	22.9
outfall #15	OGS	3.1	residential	45%	4.1	79%	0.9	2.1	80%	0.4
outfall #3	OGS	4.4	residential	45%	5.8	79%	1.2	3.0	80%	0.6
outfall #1	SWM pond	24.4	industrial	85%	44.4	63%	16.4	11.0	80%	2.2
				Subtotal - Lake Couchiching basin:	494.9		180.6	173.5		34.7

11.4 City Wide Benefits of Combined Retrofits

In addition to the above site-specific and unit-area estimates, The MOE Phosphorus Loadings Tool was also used to estimate long-term aggregate benefits of implementing a comprehensive set of source, conveyance and end-of-pipe stormwater retrofits throughout the city. As was demonstrated in Chapter 6.2.2, without stormwater quality controls, future development is expected to result in significant increases to pollutant loadings to the City`s receiving lakes and streams.

Three combinations of future landuses and stormwater control scenarios were investigated:

1. Traditional end-of-pipe storm ponds within the future development/intensification lands. This scenario includes no retrofit works in the existing urban areas.
2. Traditional end-of-pipe storm ponds within the future development/intensification lands ***and*** construction of the identified end-of-pipe retrofits within the existing urban lands. This scenario does not include any source or conveyance control retrofits.
3. Traditional end-of-pipe storm ponds within the future development/intensification lands ***and*** construction of a complete set of source, conveyance, and end-of-pipe retrofits within the existing urban lands.

The following assumptions were made in developing the loadings model assessments:

- for application of source control retrofits, an uptake rate of 10% over the existing urban lands was assumed.
- for application of conveyance control retrofits, drainage areas were set assuming a right-of-way width of 20m plus 40m on either side, for a total catchment width of 100m.
- A phosphorus removal rate of 87%, representing perforated pipe/exfiltration, was used for the source and conveyance control retrofit areas.
- The larger of the two alternative end-of-pipe retrofit sites on Ben’s Ditch was assumed (i.e. site 103-2).
- Although a treatment train approach is to be implemented, for the purposes of modelling, it was assumed that the pollutant loadings reductions were not cumulative. For example, some of the identified conveyance control retrofit opportunities are located within the drainage areas of the end-of-pipe retrofits. In this case, only the end-of-pipe reductions were applied, making the results somewhat conservative.

The results of the loadings assessments are summarized in Table 11.5. As shown, if traditional stormwater ponds were implemented within only the future development lands (i.e. scenario 1), phosphorus and other pollutant loadings to Lake Simcoe could be expected to increase over the current-day levels. If, however, all of the recommended end-of-pipe retrofits were also implemented city-wide (i.e. scenario 2), the future increases of many pollutants (phosphorus, TSS, bacteria) would be offset and further reductions below current-day levels would result. For example, a reduction in annual phosphorus loadings to Lake Simcoe and Lake Couchiching of approximately 114kg (-11%) and 287kg (-37%), respectively, below current-day levels, is predicted. It should be noted that the total city-wide reductions under this landuse/retrofit scenario differ from the sum reductions from the individual end-of-pipe sites (Table 11.4) due to the fact that the retrofits offset some of the increases that would otherwise occur due to the future urban development.

If, in addition to the identified end-of-pipe retrofits, further source and conveyance controls were also implemented throughout the city, additional significant reductions in most pollutant loadings would be expected, particularly for phosphorus, TSS and bacteria. For example, under this comprehensive retrofit scenario, a reduction in annual phosphorus loadings to Lake Simcoe and Lake Couchiching of approximately 281kg (-28%) and 409kg (-52%), respectively, below current-day levels, is predicted.

Further reductions in pollutant loadings would be expected for each incremental site application of source and conveyance LID retrofit beyond the rates assumed in this analysis. For example, grants programs such as LSRCA's upcoming ICI Grants Program may be used to kick-start the application and uptake of source control LID retrofits. Application of a typical soakaway or infiltration LID retrofit (potential to reduce phosphorus loadings by 60%) to a 0.5 hectare industrial/commercial site (base P loading of 1.82 kg/ha/year) would result in a 0.55kg per year reduction in phosphorus loadings. Continued application and uptake of these practices over existing urban lands would provide a significant long-term cumulative benefit.

Review of Table 11.4 also indicates that annual loadings of metals such as copper and zinc to Lake Simcoe would be expected to increase significantly under the future landuse scenario. Further, even with a complete strategy of controls for future urban lands combined with additional source, conveyance and end-of-pipe stormwater retrofits in the existing urban lands, copper loadings to Lake Simcoe would still exceed existing levels. This is due to the fact that the reductions expected from the stormwater practices for copper are in the range of only 48%-60%, which, when applied to the recommended retrofits throughout the city, is still not enough to offset the large unit increase in loadings when rural lands are converted to urban landuses.

Options to reduce copper and other pollutant loadings further would require a more aggressive application and uptake of source controls LID retrofits than the 10% that was assumed for this assessment, as well as continued long-term application of conveyance control LID retrofits as the City completes capital roads projects beyond the 6km of roads through the 2023 timeframe that was assumed for this assessment.

Table 11.5: Comparison of Pollutant Loadings for a Range of Landuses and Stormwater Management Scenarios

Watershed Basin	Area (ha)	Existing Development without SWM	Existing Development & Existing SWM	Effectiveness of Existing SWM	Future - uncontrolled new urban, and no retrofits)		Future with traditional End of Pipe Controls		Future with EOP Controls + EOP retrofits in Existing		Future with EOP Controls + EOP & conveyance & source retrofits in Existing	
Annual Phosporus Pollutant Loadings *		Annual Loading (kg)	Annual Loading (kg)		Annual Loading (kg)	Change from Existing	Annual Loading (kg)	Change from Existing	Annual Loading (kg)	Change from Existing	Annual Loading (kg)	Change from Existing
Lake Simcoe	1571.6	1054	1017	-3%	1697	67%	1237	22%	903	-11%	736	-28%
Lake Couchiching	660.9	782	782	n/a - no SWM	799	2%	748	-4%	495	-37%	373	-52%
Silver Creek Basin	491.9	490	181	-63%	634	249%	234	29%	n/a - no EOP retrofits identified		224	23%
Bass Lake Basin	126.9	23	23	n/a - no SWM	120	416%	47	101%	n/a - no EOP retrofits identified		n/a - no ex. lands to retrofit	
** Estimated using MOE Lake Simcoe Phosphorus Loading Development Tool*												
Annual TSS Pollutant Loadings		Annual Loading (tonnes)	Annual Loading (tonnes)		Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing
Lake Simcoe	1571.6	581	553	-5%	812	47%	561	2%	348	-37%	281	-49%
Lake Couchiching	660.9	390	390	n/a - no SWM	418	7%	374	-4%	217	-44%	165	-58%
Silver Creek Basin	491.9	242	48	-80%	142	194%	63	30%	n/a - no EOP retrofits identified		63	30%
Bass Lake Basin	126.9	20	20	n/a - no SWM	64	221%	16	-20%	n/a - no EOP retrofits identified		n/a - no ex. lands to retrofit	
Annual Copper Pollutant Loadings		Annual Loading (kg)	Annual Loading (kg)		Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing
Lake Simcoe	1571.6	203	196	-3%	503	156%	357	82%	312	59%	265	35%
Lake Couchiching	660.9	187	187	n/a - no SWM	165	-12%	161	-14%	116	-38%	90	-52%
Silver Creek Basin	491.9	157	81	-48%	95	17%	86	6%	n/a - no EOP retrofits identified		81	0%
Bass Lake Basin	126.9	3	3	n/a - no SWM	12	343%	6	138%	n/a - no EOP retrofits identified		n/a - no ex. lands to retrofit	
Annual Zinc Pollutant Loadings		Annual Loading (kg)	Annual Loading (kg)		Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing	Annual Loading (tonnes)	Change from Existing
Lake Simcoe	1571.6	623	603	-3%	1,348	124%	883	46%	689	14%	567	-6%
Lake Couchiching	660.9	544	544	n/a - no SWM	513	-6%	487	-11%	314	-42%	239	-56%
Silver Creek Basin	491.9	408	151	-63%	225	49%	173	14%	n/a - no EOP retrofits identified		166	10%
Bass Lake Basin	126.9	7	7	n/a - no SWM	52	631%	21	186%	n/a - no EOP retrofits identified		n/a - no ex. lands to retrofit	
Annual E.coli Pollutant Loadings		Annual Loading (trillions)	Annual Loading (trillions)		Annual Loading (trillions)	Change from Existing	Annual Loading (trillions)	Change from Existing	Annual Loading (trillions)	Change from Existing	Annual Loading (trillions)	Change from Existing
Lake Simcoe	1571.6	501	452	-10%	533	18%	448	-1%	330	-27%	280	-38%
Lake Couchiching	660.9	289	289	n/a - no SWM	321	11%	300	4%	220	-24%	177	-39%
Silver Creek Basin	491.9	189	89	-53%	155	75%	106	19%	n/a - no EOP retrofits identified		102	15%
Bass Lake Basin	126.9	66	66	n/a - no SWM	58	-13%	27	-59%	n/a - no EOP retrofits identified		n/a - no ex. lands to retrofit	

12 Implementation

12.1 Overview

This Chapter provides recommendations on how to implement the City of Orillia Comprehensive Stormwater Management Master Plan. In preparing the Implementation Plan, the following points were considered:

- The Implementation Plan should be consistent with other Municipal programs, policies and standards, and it should recognize existing and proposed land uses;
- The success associated with implementing various steps will not only be dependent upon the development community, municipality and agencies, but will also be somewhat dependent upon the support of residents within the watershed; and
- The Implementation Plan, as presented, is a starting point. Several key studies will have to be undertaken in order to implement certain components. Furthermore, various policies and standards will have to be assessed and delegation of roles and responsibilities will have to be defined.

The successful implementation of this strategy will:

- Ensure that maximum benefit is achieved from existing and proposed stormwater management infrastructure over the short and long term;
- Establish a framework for retrofitting existing infrastructure and undertaking measures within existing urban areas which will improve water quality and quantity within the streams and rivers within the City of Orillia;
- Fulfill the requirements of the Lake Simcoe Protection Plan (LSPP) in terms of water quality improvements of urban stormwater discharging to streams, rivers and Lake Simcoe.
- Provide additional environmental benefits including :
    - Enhancement of groundwater resources and watershed hydrologic functions;
    - Reduced urban stormwater runoff volumes;
    - Reduction of in-stream erosion problems; and
    - Improvement of aquatic habitat and fisheries.

12.2 Implementation Considerations

Table 12.1 presents implementation considerations for each component of the Recommended Approach described in Chapter 10. In general, the activities that will need to be considered for each component, in order to successfully implement the Plan include:

- **Key Next Steps**: The key steps that need to be undertaken in order to continue the existing measure or to kick start a new program;
- **Future Study Requirements:** required in order to implement each type of measure which constitutes the recommended strategy;

- **Policy/Standards:** Existing or proposed policies and/or standards that need to be reviewed or updated;
- **Facilitator** & **Contributor**s: The agency or group that will coordinate efforts to implement the measure and/or the agency or groups that will assist in implementing the measure by providing support in any number of ways, e.g., funding, labour, materials, technical expertise;
- **Operations & Maintenance Considerations:** Operation and maintenance activities and costs associated with the implementation of the proposed measures;
- **Integration with Other Documents:** How the Recommended Approach integrates with existing and future documents and studies;
- **Cost:** Total cost of the program and/or unit cost to implement recommend works;
- **Timing / Scheduling:** The general timing (short vs. long term) over which the works are recommended to be implemented
- **Funding Considerations:** General funding alternatives that were considered.

In addition to the above, implementation recommendations related to new and re-development sites are also provided. Further discussion is also provided regarding climate change considerations for stormwater management.

Table 12.1: Implementation Considerations - Summary

Recommended Approach	Description of Recommended Approach	Key Next Steps	Future Study Requirements	Policy/ Standards	Facilitator & Contributors	Costs	Funding Considerations	Timing/ Schedule	O&M	Integration with Other Documents
Pollution Prevention Measures and Municipal Management/ Operational Practices	• Continue ongoing practices • Expansion of storm drain flushing program • Co-operation with the region and MTO to reduce road salt • Promote practices in relation to materials storage, drainage, and public education	• Develop and fund a regular storm drain flushing program • Discussions with MTO and region regarding road salt alternatives and application rates	n/a	n/a	Municipal departments, City staff , LSRCA, MTO and Region	Integrated within existing programs expansion of existing program budget for storm drain flushing – estimated annual cost: $60k	Allocation of City funds to ensure current level of service is maintained. Additional funding for regular storm drain flushing program. Current source: Municipal tax-based funding. Alternatives: Stormwater Utility, Perpetual Maintenance Fee (for new development areas)	Short-term (1-2 years) implementation of annual program	n/a	Municipal operational policies and standards
Source Control Stormwater Measures	Utilize multi-layered marketing strategy/program to drive uptake in residential land-use, followed by commercial/ industrial land-uses Strategy should include: 1. Visually based marketing campaign; 2. Community demonstration sites; and 3. Community Visioning Sessions	• Develop tailored City of Orillia resources • Continued strategic partnership with the LSRCA (Rain Scaping Program), and the RAIN SWM Program • Establish tracking system to document the implementation of source control measures • Undertake Public Lands Pilot project	• Undertake a public lands retrofit project. To include all necessary EA studies, site specific assessments, detailed design, construction and monitoring • Pilot project – need for feasibility assessment and in-situ soils test and geotechnical investigations	Review existing By-laws to ensure compliance with recommended source control retrofits.	Lead: City Support: LSRCA	• Social Marketing Strategy: $0.2M • Pilot projects / demonstration sites: $0.2M • Individual sites on private property: costs vary widely depending on site conditions and LID measures • Use of existing materials can reduce implementation costs i.e. TRCA's Homeowners Guide to Stormwater Landscaping: $12/guide.	City (marketing and pilot projects - current source: • General municipal tax-based funding Alternatives: • Stormwater Utility • Grants (public and private) • Combined Approach Private sites: • Funded on voluntary basis by landowners	City (marketing and pilot projects ($0.4M) – Short-term (1-3 years) Private sites – long-term conversion on voluntary basis	O&M will be the responsibility of the landowner Municipal Requirement: develop & distribute maintenance program guidance, & establish tracking system	Conforms with source control recommendations of LSPP and Oro and Hawkestone Creeks Subwatershed Study Low Impact Development Stormwater Planning and Design Guide (TRCA/CVC, 2010) Grey to Green Residential Retrofits: Engaging Residents to adopt Low Impact Development on their Properties

Recommended Approach	Description of Recommended Approach	Key Next Steps	Future Study Requirements	Policy/ Standards	Facilitator & Contributors	Costs	Funding Considerations	Timing/ Schedule	O&M	Integration with Other Documents
Conveyance Control Stormwater Measures	Implement conveyance control stormwater LID's as part of: • Road re-surfacing and re-construction works • Roadside ditch retrofits Recommended LID measures: • Bioretention; • Pervious pipe/exfiltration; • Grassed swales; • Permeable pavement (select locations); • OGS's with enhanced phosphorus removal	• Design and implement pilot project(s) • Incorporate conveyance control retrofit works into Capital Road program • Develop municipal standards for design • Develop O&M program	• Municipal Class EA's (consult MEA document for Schedule) • Geotechnical investigations • in-situ soils tests for infiltration	City departments to review roadway design standards and policies as part of first road retrofit pilot project	Lead: City Support: LSRCA	• Conveyance retrofits as part of identified Capital Roads Projects: $0 - $2.8M (replacement cost above a conventional storm sewer system). • Roadside ditch retrofits: $3.4M to $14.8M See Table 12.2 cost summary for unit Costs See additional operation and maintenance costs in Section 12.6.9.	Current source: • General municipal tax-based funding via capital road works Alternatives: • Stormwater Utility • Development Charges (for those road improvements required to support future growth)	• SWM as part of identified Capital Roads Projects: up to $7.8M (LID bioswale system) to 2023 per scheduled road works • Roadside ditch retrofits: Up to 14.8M (LID bioswale system) over 20 years	See Section 12.6.9 and Table 12.4 for O&M considerations	Conforms with conveyance control recommendations of LSPP and Oro and Hawkestone Creeks Subwatershed Study Low Impact Development Stormwater Planning and Design Guide (TRCA/CVC, 2010) Grey to Green Residential Retrofits: Engaging Residents to adopt Low Impact Development on their Properties
End-of-Pipe Stormwater Control Measures	• 8 end-of-pipe stormwater retrofits in the Lake Simcoe Basin (1 existing "dry" pond, 4 new SWM ponds at untreated outfalls, and 3 OGS's at untreated outfalls) • 8 end-of-pipe stormwater retrofits in the Lake Couchiching Basin (5 new SWM ponds at untreated outfalls, and 3 OGS's at untreated outfalls)	• Complete Class EA's • Preliminary and detailed design • land acquisitions • approvals/permits	• Confirm Schedule & complete Class EA including public consultation, as necessary • Surveys • Geotechnical investigations • Preliminary & Detailed Design • Approvals/permits	• City Standards • 2003 MOE Stormwater Management Planning and Design Manual	Lead: City Support: LSRCA	• Sites in Lake Simcoe basin: $16.68M • Lake Couchiching basin: $11.97M • Total (all sites): $28.65M	Current source: • General municipal tax-based funding Alternatives: • Stormwater Utility • Fee-in-lieu	Construction of all sites over 20 years ($1.43M per year)	Integrate within existing end-of-pipe O&M programs. Typical activities: • cleanout/dredge • regular inspection and maintenance • minor repairs	Conforms with recommendations of LSPP, LSRCA Stormwater Management and Retrofit Opportunities Study, and Oro and Hawkestone Creeks Subwatershed Study
Stream Restoration	City-wide Stream Restoration Master Plan Study	• Inventories to characterize existing conditions • Develop and prioritize restoration alternatives • Implementation	n/a	n/a	Lead - Town Support – LSRCA	Study cost: $100,000 (cost of individual works to be determined through study)	Current source: • General municipal tax-based funding Alternatives: • Stormwater Utility	Short-term ($0.1M) (1-3 years)	n/a	Oro and Hawkestone Creeks Subwatershed Study and this CSWM-MP

12.3 Funding Considerations - General

Many municipalities have experienced a significant gap between the required spending to maintain their assets in a state of good repair and funding available.

A municipality`s Capital Budget outlines the capital infrastructure required and the costs for the identified works. Typically, municipalities prepare an annual capital budget and forecast that covers a five or ten year period. While municipal Councils often formally adopt only the current year`s budget, the remaining forecast is also approved and provides firm direction for the municipality. Spending for stormwater infrastructure is just one category of capital works that is included in a Capital Budget.

Projects listed in the Capital Budget may be funded through a variety of sources. The general types of funding alternatives that are considered for stormwater works in most municipalities in Ontario are summarized below. Further information on each of the alternatives is also provided:

- Property Taxes;
- Stormwater Utility Charge;
- Development Charges;
- Perpetual Maintenance Fees;
- Stormwater Fee-In-Lieu Policy;
- Infrastructure Renewal Surcharge; and
- Grants and Private Sector Funding.

1. Property Taxes

Traditionally, most municipalities funded the works identified in their Capital Budget through basic property taxes, including most stormwater management works. However, in recent years, several municipalities have considered alternative approaches to funding stormwater works, often due to a predicted shortfall in consistent annual funding. The City of Orillia currently funds most of its stormwater projects through general property tax levies.

2. Stormwater User Rate Utility Fee

Under this system, a stormwater user rate utility fee is collected from all properties within the municipal boundary to cover the cost of providing stormwater management. The establishment of a utility fee provides an alternative method for partially or completely funding stormwater capital infrastructure and/or operating and maintenance costs. This is allowed for under Part XII of the Municipal Act. It is noted that the language in Section XII, specifically s.391 (d), refers to "…capital costs payable for…sewage and water…", but in s.1, "sewage includes storm water and other drainage from land". This is the legislative authority municipalities use to implement water and wastewater rates to cover the cost of those services.

With the imposition of all utility fees and charges, a by-law must be passed by the municipality to allow collection. There are a number of criteria that must be met to ensure that the fee or charge imposed is not a tax. One of the key criteria is that a clear "nexus" must exist between the fee and the benefit to be received by the entity paying the charge. Additionally, the amount of the charge may not exceed the cost of providing the service. Again, however, these criteria are the same as those that would apply to water and wastewater rates.

Many municipalities in Ontario and throughout Canada and the United States impose stormwater utility fees to pay for the costs of their stormwater systems. The City of Kitchener, City of Waterloo, City of Hamilton, City of Mississauga, City of London, City of St. Thomas, Town of Richmond Hill, Town of Markham and the Town of Aurora have stormwater utility fees. A number of other municipalities are in the process of either evaluating stormwater funding alternatives or in the process of introducing a stormwater utility. The Lake Simcoe Region Conservation Authority supports the implementation of stormwater utility fees as a funding vehicle to facilitate SWM maintenance, retrofits and improvements.

The following lists some of the methods used to assess the stormwater utility fee:

- flat rate;
- tiered flat rate;
- property area;
- zoning;
- assessed value;
- % impervious; and
- fee models listed above combined with credits for source control.

The calculation of the charges often recognizes the varying levels of imperviousness of different types of land use. Various jurisdictions also provide for credits if qualifying customers can demonstrate that they contribute significantly less stormwater discharge than the average for the particular property class in which they are categorized. The role of credits is critical in motivating residents and businesses to implement private property source controls and can include discounts for items such as:

- downspouts discharging to pervious area, infiltration trench or rain garden;
- sump pump discharging to pervious area, infiltration trench or rain garden;
- pervious pavement driveways; and
- various low impact development features and stormwater controls for industrial, commercial and institutional (ICI) properties.

Examples of stormwater rates applied in other municipalities are as follows:

- Aurora – Residential $4.78/month, ICI $62.96/month

- Hamilton – Residential $9.00/month, ICI $449.40/month
- London – Residential $10.87-$120.57/month, ICI $14.49-$120.57/month
- St. Thomas – Residential $5.54/month, ICI $917/ha/year
- City of Kitchener – Residential $6.28-$20.98/month, ICI $20.05-$2,133.07/month
- City of Mississauga - Residential $4.17-$14.17/month, ICI $3,000/ha/year (80% impervious)
- City of Waterloo - Residential $4.49-$14.89/month, ICI $17.30-$659.59/year
- City of Markham – Residential $3.92/month

3 Development Charges

Development charges (DCs) are fees collected from new development to cover costs for new infrastructure to ensure that growth pays for growth and the cost of growth related infrastructure doesn't result in higher property taxes for existing residents. This is a common funding tool used across the province. For stormwater capital projects including conveyance improvements as part of roads works, pond retrofits, road crossings and stream rehabilitation that are not part of a site plan or development application, the City can offset a portion of the capital cost with DCs.

4 Perpetual Maintenance Fee

A Perpetual Maintenance Fee (PMF) is a fee charged to developers to cover the cost of operating and maintaining an asset. In this case, it would be the stormwater management system constructed as part of new development and assumed by the city. The fee is used to partially or entirely offset the future maintenance and cleanout costs associated with stormwater management ponds, storm sewers and roadside swales. Examples of municipalities which have a PMF include the Town of Halton Hills and City of Brampton. The City of Brampton charges a PMF for SWM facilities at a rate of $570/ha for residential lands and $1,140/ha for industrial lands.

5 Stormwater Fee-in-Lieu Policy

A stormwater fee-in-lieu policy is a fee collected from a developer that is unable to implement stormwater management on his/her development site due to site constraints. The fee can be calculated using different methods, but is typically established based on the theoretical cost to implement a SWM system to service the development site. The collected fees are then used to complete pond retrofits or other stormwater infrastructure projects that benefit the watershed. A fee-in-lieu policy is common for many GTA municipalities. The City of Brampton collects a fee of $33,220 per hectare (residential site, 55% imperviousness) where SWM cannot be implemented. This amount is typical of other municipalities with fee-in-lieu policies.

6 Infrastructure Renewal Levy

Many municipalities have increased their focus on the funding of asset renewal needs by implementing enhanced infrastructure funding strategies and mechanisms, such as dedicated tax levies to be used only for the rehabilitation of infrastructure. The City of Barrie, for example, has established an Infrastructure Renewal Fund through the addition of a 1% dedicated tax levy.

7 Grants and Private Sector Funding

A variety of environmental grants and/or private sector funding may be a potential source of funds for community-based projects. Smaller-scale source control demonstration projects may represent opportunities for this type of funding via local businesses.

Examples of potential grants funding opportunities include the following:

- **Land Owners Environmental Assistance Program (LEAP)** – This LSRCA program provides landowners with technical assistance and funding opportunities to implement BMPs on both rural and urban properties. For example, rain gardens can be funded up to $10,000 at a cost-share rate of 75%. Demonstration sites are intended to show source control LID retrofits at their very best; eye catching dynamic designs that are well maintained and sited in high traffic locations. These sites provide in-ground, aesthetically beautiful examples of rain gardens that can be duplicated by homeowners.
- **Lake Simcoe Georgian Bay Cleanup Fund (LSCUF) -** this program is administered by Environment Canada and is intended to:
  - improve environmental monitoring, assessment and scientific information required to measure the effectiveness of control strategies, and identify and assess alternative approaches to reducing phosphorous discharges;
  - conserve critical aquatic habitat and associated species through targeted aquatic habitat protection, restoration and creation projects;
  - reduce rural and urban non-point sources of phosphorous / nutrients, including implementation of BMPs for the management of soil, crops, livestock, and water use, septic systems and creating and rehabilitating wetlands and naturalizing watercourses to attenuate phosphorous discharges;
  - reduce discharge of phosphorous from point sources including sewage, combined sewer overflows and urban stormwater systems including support to development and testing of innovative approaches to manage urban stormwater and wastewater.

  The fund has a target contribution of 1/3 to 2/3 of the cost of a project
- **LSRCA's ICI Grant Program –** this program is scheduled to begin in 2016 to promote stormwater LID retrofits for industrial, commercial and institutional (ICI) sites.
- **RBC Blue Water Project -** this project, launched in 2007, is a 10-year charitable commitment of $50 million to help provide access to drinkable, swimmable, fishable water.
- **TD Friends of the Environment Foundation** – this initiative supports a wide range of environmental initiatives, with a primary focus on environmental education, urban greening and enhancing biodiversity, and energy conservation.

12.4 Pollution Prevention and Municipal Management / Operational Practices

Pollution Prevention Measures and Municipal Management/Operational Practices are methods which are not site specific and can generally be applied over a watershed or municipal boundary to prevent sources of pollution from entering the drainage system. Key recommendations include:

- Continuation of current practices, including reduced road salt application, street sweeping, storm outfall cleaning, and promotion of reduced runoff through lower lot grades;
- Expansion of the existing storm drain flushing program such that it is recognized as a regular City maintenance item, as opposed to completing works on an “as-needed” basis;
- Co-operation with the Region and MTO to explore opportunities for reduce road salt application on their roads;
- Promote practices in relation to materials storage, drainage, and public education.

To move forward with the above recommendations, the key next step would include development of a regular storm drain flushing program so that an annual budget allocation for this practice can be established. The program would include regular maintenance in areas where sediment accumulation has historically been an issue. In doing so, the city would pro-actively deal with the sites before they become a problem, thereby maintaining the existing capacity of the system and reducing the opportunity for pollutant transfer to the receiving streams and lakes. The estimated cost for a regular storm drain flushing program is $60,000 per year. It is anticipated that such a program would be implemented in the short-term, within the next 2 years.

The current limited program is funded via general tax levies, however, the future adoption of a stormwater utility would represent an alternative stable source of funding. The City may also consider supplementing the funding for these types of works via a perpetual maintenance fee for future development areas.

Continued discussions with the Region and MTO with respect to road salt alternatives and general opportunities to reduce the level of salt applied to these roads through the City are also recommended, particularly within the City`s wellhead protection areas.

12.5 Source Controls

12.5.1 Description of Recommended Approach for Source Controls

<u>Residential Land Use Retrofits</u>

Since these measures are generally implemented within private properties, the City has limited role in leading the implementation of these measures. However, the City could provide a supportive role through the following:

1. Social marketing strategy and raising awareness within community. The City should refer to the **Grey to Green Residential Retrofits:** Engaging Residents to adopt Low Impact Development on their Properties (CVC, pending) which describes the step-by-step process to developing a residential marketing strategy.
2. Refine, update or change by-laws related to implementing these measures;
3. Strategic partnerships with local agencies and public outreach programs, including the LSRCA's RainScaping Program, the Windfall Ecological Centre (www.windfallcentre.ca) and the RAIN Stormwater Management Program.

4. Distribution of existing guidance materials for residential property owners including the "Greening Your Grounds: A Homeowners Guide to Stormwater Landscaping Projects" created by the Toronto and Region Conservation Authority (TRCA) and others.
5. Residential Workshops to educate and inform City of Orillia residents

Most relevant to the recommended residential land use retrofits proposed as part of the City of Orillia's Comprehensive Stormwater Management Master Plan, is the RAIN program. The RAIN Stormwater Management Program motivates homeowners to take action in reducing non-point source pollution entering local lakes and rivers via storm sewers. It promotes a collective strategy whereby small retrofits add up to a much larger net benefit. Residential strategies encouraged through RAIN include:

- Rain Barrels installation
- Rain Garden construction
- Use of permeable pavements
- Tree planting

The City should demonstrate their commitment to LID retrofits on private property, by undertaking pilot project(s) within a selected, high-visibility, public lands sites (municipally owned). The pilot project(s) should be combined with media releases, educational programs/ campaigns as well as high visibility education signage. By undertaking public land pilot projects, the City is taking a 'leading by example' approach which has been shown to improve private land retrofit uptake rates. Additional detail is provided below.

Public Land Use Retrofits

Proposed source control measures within public lands may include retrofits in public open spaces, public schools, and libraries. Pilot projects are suggested within these areas to define variables such as landowners' awareness of the impacts from stormwater, their willingness to implement, the importance of public funding, and the adoption rates for each of the proposed measures.

Potential public land retrofit site(s) should have high community appeal and be a community 'hub' which experiences high volumes of visitors, this can include but is not limited to:

- Schools,
- Parks,
- Community centers

12.5.2 Key Next Steps

The City should initiate a marketing study and campaign for the promotion of alternative residential landscapes that address lot-level storm water management issues related to water quality. This would generally involve:

1. **Marketing Campaign**
    a. **Visually-Based Advertising Campaign** – May include outdoor signage, point-of-purchase displays, direct mail initiatives and supporting marketing resources that are to be determined, but likely a full-colour, photo-based brochure promoting alternative landscapes would be the primary print resource. This creates desire and a vision of what their landscape could look like;

    b. **Web-based tools and Resources -** Modifications to the City of Orillia web site providing supporting tools and information for residents.

    c. **Joint ventures with Key Stakeholders -** Garden centres, box stores, landscape design and landscape maintenance firms should be engaged through joint promotional initiatives. Garden centres and nurseries can play a key role, as they are a trusted source of advice on plants, trees and shrubs and the layout of the landscape.

    d. **Landscape Consultation Service -** A landscape consultation service targeting residents in the study area and providing them with a how-to approach to implementing the alternative landscape will help residents make the transition. The consultation service will be linked to the retail stakeholders through promotional discounts at participating retailers and added support in design and plant selection provided by retail personnel.

    e. **Workshops -** In co-operation with participating retailers, workshops to motivate, promote and assist residents with design ideas and how-to information should be part of the overall alternative landscape program, but would be implemented in later years of the program. TRCA's Healthy Yards workshops or others should be considered (http://www.trca.on.ca/yards/#sthash.U9LXyz4b.dpbs)

2. **Coordinate with LSRCA** on establishing a technical framework from available LID information that would help the marketing strategy; and
3. **Establish tracking system** to document the implementation of source control measures (location, type, size, drainage area, etc.) for use in future asset management scenarios.

12.5.3 Future Study Requirements

In general, future study requirements for source controls are minimal. Source control measures fall outside of the Municipal Class EA process, since they are to be constructed on private property, often by the individual land owner as a retrofit or during development/ redevelopment.

Should residents wish to implement less common - more aggressive LID source control techniques such as full infiltration designs without secondary flow paths (i.e. overflows or underdrains), or source control techniques which include a structural component (i.e. permeable pavements or green roofs), the City could require the homeowner to undertake additional studies. Additional studies may include:

- In-Situ Hydraulic Conductivity Testing (per Appendix C of the Low Impact Development Stormwater Planning and Design Guide, TRCA/CVC, 2010); and/or
- Geotechnical investigations and recommendations from geotechnical engineer. For permeable pavements, manufacturer specifications and testing requirements should be followed.

It is suggested that the City encourage homeowners to undertake the above (as necessary) based on advice of design professionals.

12.5.4 Policy/ Standards Considerations

It is recommended that the City review its current by-laws to ensure barriers do not exist on the implementation of source control measures including limitations on the naturalized landscape approach, temporarily ponded water (up to 48hrs), uniform grading requirements etc.

The draft Lake Simcoe Watershed Model By-law and LID SWM Guidelines for Municipalities document by LSRCA provides a model framework that the City of Orillia may consider adopting, in whole or in part, to facilitate the use of source control LIDs.

12.5.5 Facilitators and Contributors

To aid in the successful implementation of the Recommended Approach for source controls, key facilitators and contributors would include:

- Lake Simcoe Region Conservation (LSRCA) - RainScaping Program & Toronto and Region Conservation Authority (TRCA) - Greening Your Grounds: A Homeowners Guide to Stormwater Landscaping Projects and the Healthy Yards Workshops

Additional facilitators and contributors would include:

- The Environmental Advisory Committee (EAC); and
- Naturalists clubs and local environmental organizations
- The Windfall Ecological Centre (www.windfallcentre.ca) and the RAIN Stormwater Management Program.

12.5.6 Costs

Provided below are costs estimates for the implementation of the Recommended Approach for Source Controls including the development of a City of Orillia Social Marketing Strategy and the implementation of Public Lands Pilot Projects.

Social Marketing Strategy

The estimated cost to implement a Social Marketing Strategy is approximately $200,000. This includes costs for a marketing campaign and production of materials. Through the use of strategic partnerships with groups listed previously, and distribution of existing resources, the costs have the potential to be significantly reduced.

Public Lands Pilot Project(s)

It is suggested that 2 to 3 public lands pilot projects be undertaken by the City of Orillia. The costs to implement a pilot project(s) within a selected, high-visibility, public lands site (municipally owned) including media releases, educational programs/ campaigns as well as high visibility education signage is estimated to cost $70,000.

Private Lands

The cost of implementation LID measures on private lands would be the responsibility of the landowner. Costs for such works can vary considerably based on site-specific conditions, the scale of the works, and the particular LID methods used.

12.5.7 Timing

In order to kick-start the source control works, it is recommended that the City begin to implement its components of the program (i.e. marketing and pilot projects) over the near-term. The gradual voluntary implementation of LID measures on private lands would then follow on a long-term basis.

12.5.8 Funding Considerations

Consistent with current practices, the recommended pilot projects and associated marketing strategy for source controls would be funded through the Capital Budget using general tax levies. The future adoption of a stormwater utility rate to fund stormwater works would be another option for the City. This model would be particularly useful in encouraging the adoption of source control stormwater works on private lands. The stormwater rate is typically levied as a function of lot size and/or imperviousness to reflect the amount of stormwater runoff that is generated. Credits are then provided to participating landowners.

A variety of environmental grants and granting agencies (both private and public) are also available and may be a potential source of funds for community-based pilot projects, education programs and training expenses. Examples include LEAP, LSCUF, RBC Blue-Water, TD Green Funds etc. Municipalities are not eligible for some grants, and as such, private land-owners must lead the application. This does not limit the involvement, financial and or technical support by the City.

12.5.9 Operation and Maintenance Considerations

Operation and maintenance activities and costs associated with the voluntarily implementation of Source Control measures on private property will be the responsibility of the private property owner. Generally, maintenance requirements for most source control technologies have little difference from most turf, landscaped, or natural areas and do not typically require new or specialized equipment. Typical homeowner activities will include:

- General inspection;
- Litter removal;
- Weed control;
- Grass Cutting; and
- General landscape upkeep i.e. pruning, mulching and seasonal clean-up activities.

Municipal guidance could be provided to property owners through the development of operation and maintenance guides/ resources that incorporates source control measures. Typical municipal requirements/ steps include:

- Develop/ adopt operation and maintenance program documents;
- Distribute materials through homeowner outreach; and
- Establish tracking system to document source control measure location, type, size etc. for use in future management scenarios

12.5.10 Integration with Other Document and Studies

The implementation of source control measures within the City of Orillia is consistent with a number of background documents. These documents, together with others which may be considered in the design and implementation of the works include the following:

- Lake Simcoe Protection Plan (2009), which indicates the need to prescribe source control measures for existing development areas where stormwater controls are lacking or insufficient;

- Subwatershed Studies, including the Oro and Hawkestone Creeks Subwatershed Plan especially material related to soil cover, wellhead protection areas, water quality analysis, and groundwater-surface water interactions;
- Evaluation of Low Impact Development Stormwater Technologies for the Uncontrolled Urban Areas in the Lake Simcoe Region (Ryerson University, 2010)
- Low Impact Development Stormwater Planning and Design Guide (TRCA/CVC, 2010)
- Greening Your Grounds: A Homeowners Guide to Stormwater Landscaping Projects (2012) http://www.trca.on.ca/get-involved/stewardship/healthy-yards-program/greening-your-grounds.dot
- Grey to Green Residential Retrofits: Engaging Residents to adopt Low Impact Development on their Properties http://www.creditvalleyca.ca/low-impact-development/low-impact-development-support/stormwater-management-lid-guidance-documents/

12.6 Conveyance Controls

12.6.1 Description of Recommended Approach for Conveyance Controls

Two primary opportunities to retrofit existing roadways using new stormwater conveyance controls were identified:

- Road re-surfacing and re-construction works identified in the City's Capital Roads Projects (Table 10.2); and
- Retrofit of existing roadside ditches, particularly those that are currently paved (Table 10.3).

The recommended measures are discussed below in terms of their applicability to urban and rural road cross-sections. Alternative configurations of these measures are also discusses according to their applicability to different landuses, streetscapes, and available space

Various forms of conveyance control retrofit measures were reviewed in terms of their applicability to urban and rural road cross-sections, streetscapes, adjacent landuses, and available space. The recommended stormwater retrofit measures are listed below, prioritized in terms of preference, from highest to lowest, based on the anticipated water quality treatment levels:

1. bioretention systems
2. pervious pipe / exfiltration systems
3. grassed swales
4. permeable pavement (select locations)
5. oil-grit separators with enhanced phosphorus removal

The following section details the key next steps, future study requirements, policy and standards considerations, potential facilitators and contributors, estimated costs, funding and operations and maintenance considerations, and integration of the recommended approach for conveyance control with existing and future documents and studies.

12.6.2 Key Next Steps

Key next steps related to the implementation of conveyance control measures include:

1. Undertaking pilot projects: The City's planned Capital Roads Projects listed in Table **10.2** represent an opportunity to implement conveyance control measures since it would be feasible and most cost effective to undertake the installation of these types of measures during road reconstruction. Existing guidance on road retrofits using conveyance control LIDs is provided in the Grey to Green Road Retrofits: Optimizing your Infrastructure Assets through Low Impact Development (2013- Draft).
2. Incorporating the recommended conveyance retrofit works into the Capital Program for road resurfacing and reconstruction, including the required funding allocation.
3. Developing Municipal standards for design, construction and operation and maintenance based on collected data from the pilot projects; and
4. Developing operation and maintenance tracking protocols for staff, effort, equipment etc. to better forecast O&M requirements and costs.

12.6.3 Future Study Requirements

In general, Conveyance control measures fall within the Municipal Class EA process, specifically Part B - Municipal Road Projects. The specific Class EA Schedule of individual projects must be determined in relation to the specifics of the road reconstruction process per Part B of the Municipal Engineers Association Class Environmental Assessment document (MEA 2000, as amended 2007), and should be reviewed in conjunction with the project schedules in Appendix I of the aforementioned document.

Additional study requirements for the implementation of conveyance control measures may include, but are not limited to, the following:

- Geotechnical Investigations – These studies would be focused on the local soils information gathered through subsurface geotechnical investigations and undertaken for the purposes of structural design of stormwater management facilities and in the design of LID infiltration techniques. Geotechnical investigations should be coordinated with those normally undertaken as part of road resurfacing and reconstruction projects (existing asphalt thickness, sub-grade thickness etc) and include boreholes within the ROW to determine soil stratigraphy, composition, grain-size and seasonally high groundwater table elevation.

- In-Situ Hydraulic Conductivity Testing - designs using LID infiltration techniques will require on-site soil testing using the Guelph Permeameter test (as specified in the Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0

(TRCA/CVC - 2010) or approved equivalent to confirm site specific design infiltration rates, design specification and costs.

12.6.4 Policy/ Standards Considerations

Consultations and discussions amongst municipal staff and departments may be required to confirm what, if any, changes may be necessary to City of Orillia roads standards such that the proposed LID conveyance measures may be accommodated. Issues to review might include:

- fire safety;
- winter snow plowing;
- access;
- utility locations
- seasonal operations and maintenance requirements;
- public entity requirements (school boards etc).

A strategic review of these issues and standards is suggested as part of the City's first pilot retrofit project.

The draft Lake Simcoe Watershed Model By-law and LID SWM Guidelines for Municipalities document by LSRCA provides a model framework that the City of Orillia may consider adopting, in whole or in part, to facilitate the use of conveyance control LIDs.

12.6.5 Facilitators and Contributors

The City of Orillia would lead the implementation of conveyance control retrofits within the municipal rights-of-way. To aid in the successful implementation, LSRCA would be expected to contribute design advice and recommendations through experience with similar systems in other municipalities.

12.6.6 Costs

The estimated costs to implement the recommended stormwater conveyance retrofits into the identified City of Orillia road rights-of-way are summarized in Table 12.2. Additional operation and maintenance costs are reviewed below in Section 12.6.8.

As discussed, the identified opportunities to implement stormwater LID's into the road rights-of-way include:

- scheduled road re-construction works,
- roadside ditch retrofits

Scheduled Road Re-construction Works

The most cost effective means of implementing conveyance control LID measures into existing municipal rights-of-way is to complete the construction concurrent with scheduled road works projects. For the purpose of this cost comparison, road re-construction is defined replacement of the existing roadway surface including replacement/installation of storm sewers, complete aggregate base replacement, concrete curb replacement, sub drains under curbs, catch basin replacement and the replacement off all subsurface infrastructure associated with the segment of road.

A typical "base" unit cost for road re-construction without a stormwater conveyance system is approximately $1,806/m. Typical unit costs to implement various forms of stormwater conveyance measures into the design of a roadway are listed below. These estimates are based on recent experience in the greater Toronto area, and assume a road width of 8.4m.

- grassed swale - $300/m
- conventional storm sewer pipe - $924/m
- perforated pipe/exfiltration system - $903/m
- boulevard bioswale - $1,323

As shown, implementation of a perforated pipe system as part of municipal road works projects has been estimated to be marginally lower or neutral to the cost of including a traditional storm sewer system into the design. In general, where added costs are to be incurred in the implementation conveyance controls (i.e. bioswales etc.) these costs can generally be attributed to a greater level of water quality control treatment provided.

As shown in Table 12.2, approximately 5.9km of road works have been identified in the City`s capital roads program to 2023, including 2.35km in the Lake Simcoe basin and 3.55km in the Lake Couchiching basin. The estimated cost for the stormwater component of these roads projects varies from roughly $5.45M for a conventional storm sewer system, to approximately $7.81M for a LID bioswale design. As demonstrated, the financial impact of replacing a conventional storm sewer system within the road designs with various forms of stormwater LID`s ranges from a savings of approximately $0.12M for a perforated pipe system, to an additional cost of approximately $2.35M for a boulevard bioswale design.

Roadside Ditch Retrofits

As shown in Table 12.2, approximately 11km of roadside ditch retrofit opportunities have been identified within the City, including 7.4km in the Lake Simcoe basin and 3.8km in the Lake Couchiching basin.

These retrofit opportunities are not within the roadways identified on the City`s capital roads project list. As such, the cost to implement the retrofits independent of a broader roads project, would be considered a "standalone" cost since it would not necessarily be in place of a stormwater system that was otherwise due for replacement as part of a complete road re-construction project.

As demonstrated Table 12.2, the cost to implement these retrofits ranges from approximately $3.3M for an enhanced grassed swale design, to $14.55M for a boulevard LID bioswale design. As demonstrated above, these costs would be considerably less if they were to be implemented as part of future long-term scheduled re-construction works.

12.6.7 Timing

The conveyance control retrofits to be implemented as part of up-coming capital roads projects would be implemented as per the scheduled road works between 2016 and 2023. (**Table 10.2**).

The additional roadside ditch retrofits would be implemented on a project-by-project basis as funding becomes available over the long term. Assuming roughly 550m of retrofits per year, a 20 year timeframe is recommended to implement the works over all of the identified roads (Table 10.3). Depending on the type of LID measure to be used, approximately $0.17M to $0.73M per year is required over the 20-year timeframe. A proposed schedule to implement the recommended stormwater works is provided in Section 12.9.

Table 12.2: Conveyance Control Retrofit Cost Estimates

As part of road re-construction:						Lake Simcoe Basin:			Lake Couchiching Basin:			Both Basins:	
				length of road works =		2,350 m			3,550 m			5,900 m	
	"base" road reconstruction cost before stormwater	additional stormwater cost	total unit cost			SWM Cost ($M)	Total Cost ($M)	Cost above conventional stm. Sewer	SWM Cost ($M)	Total Cost ($M)	Cost above conventional stm. Sewer	SWM Cost ($M)	Total Cost ($M)	Cost above conventional stm. Sewer
using a conventional stm. sewer system	$1,806 /m	$924 /m	$2,730 /m			$2.17	$6.42	-	$3.28	$9.69	-	$5.45	$16.11	-
using a perforated pipe system	$1,806 /m	$903 /m	$2,709 /m			$2.12	$6.37	-$0.05	$3.21	$9.62	-$0.07	$5.33	$15.98	-$0.12
using boulevard bioswale design	$1,806 /m	$1,323 /m	$3,129 /m			$3.11	$7.35	$0.94	$4.70	$11.11	$1.42	$7.81	$18.46	$2.35

Roadside Ditch Retrofits:				Lake Simcoe Basin:	Lake Couchiching Basin:	Both Basins:
			length of road works =	7,400 m	3,800 m	11,200 m
	"base" road reconstruction cost before stormwater	additional stormwater cost	total unit cost	Total Cost ($M)	Total Cost ($M)	Total Cost ($M)
using an enhanced grassed swale design	n/a	$300 /m	$300 /m	$2.22	$1.14	$3.36
using a perforated pipe system	n/a	$903 /m	$903 /m	$6.68	$3.43	$10.11
using boulevard bioswale design	n/a	$1,323 /m	$1,323 /m	$9.79	$5.03	$14.82

12.6.8 Funding Considerations

Under current City practices, the recommended costs to implement stormwater management works such as conveyance control LID measures would be funded through the Capital Budget using general tax levies. The future adoption of a stormwater utility rate to fund these stormwater works would be another option for the City which could provide a stable source of annual funding to complete the recommended projects over the 20-year timeframe. The City may also collect a portion of the necessary funding from Development Charges for those road improvement projects that are required to facilitate urban growth.

12.6.9 Operation and Maintenance Considerations

The purpose of this section is to outline the maintenance requirements for conveyance control practices proposed for the City of Orillia municipal road right-of-ways (i.e. exfiltration trench/perforated pipe systems and bioretention).

Maintenance requirements for most LID technologies including source and conveyance control practices have little difference from most turf, landscaped, or natural areas and do not typically require new or specialized equipment (EPA, 2007). However, LID techniques are green 'infrastructure' and do therefore provide a necessary function in communities. The relative importance of this function requires that maintenance personnel and inspectors are well versed in the design, intended function and maintenance requirements of each system. Just as contractor education is critical to ensure proper post-construction function, the education and training of the individuals servicing LID facilities is vital to their long continued operation. Table 12.3 provides a summary of the maintenance requirements for perforated pipe systems and bioretention/ bioswale practices. Additional information is provided in subsequent sections.

Table 12.3: Summary of Maintenance Requirements for Conveyance Controls

LID Technique	Maintenance Requirements	Notes:
Perforated pipe	Regular Maintenance • Clean debris and litter • Inspect perforated pipe for clogging • Lawn maintenance Annual • Vacuum debris from inlets/catch basins • Inspection of stone drainage area Long-tern (as required) • Perforated pipe clean	Ensure that perforated piping, grating, catch basins are not clogged with sediment or debris. Clean debris from grating, catch basins, and perforated pipe using high pressure sprayers or vacuum
Bioretention/ bioswales	Post Installation (1st 6 months) • Inspection after each storm >10mm or min. of twice • Irrigate until established (weekly for 1st yr and bi-weekly for 2nd year; as needed based on rainfall) Annual • Inspect each spring and events >60mm • Replace mulch as required • Reinforce planting as required Regular • Integration into existing landscape maintenance program (additional training required)	Lost plants should be re-planted to maintain desired plant density Core aerating or deep tilling may be required to alleviate clogging due to fines accumulation

Perforated Pipe Maintenance

With appropriate pre-treatment, perforated pipe systems do not require additional maintenance beyond that of a conventional storm sewer. These routine maintenance items include:

- Vacuum debris and litter from catch basins
- Replace damaged or missing grates
- Lawn maintenance (if planted under turf)

Perforated pipes have been installed in several Ontario communities with high levels of success. Conveyance systems consisting of grassed swales and underlying perforated pipes were installed in Ottawa during the 1980s and 1990s. After more than twenty years of performance, these systems were found to function without issue.

Inspections

Inspection and maintenance efforts occur following public complaints. Subsequent inspection efforts generally involve scoping pipes to located obstructions and debris. Observation ports extending from the surface to perforated pipes or stone galleries should be included in the design to allow for easy subsurface inspections.

Maintenance

If an issue has been identified through inspections obstructions can be removed or dislodged using vacuums or high pressure water sprayers. If inspections identify problems such as broken pipes, defects or other pipe structure problems full repairs may be necessary.

Bioretention / Bioswales Maintenance

Maintenance of bioretention, and bioswales, generally involves maintenance of the vegetative cover. Two or three growing seasons may be required to establish vegetation to the desired level. As such, contract documents often specify that the contractor be responsible for undertaking a minimum of two years maintenance. This ensures that the contractor is responsible for the health of the plant material before, during and after installation.

Inspections

Inspections are important to confirm that the LID practice is functioning and to identify maintenance or rehabilitation issues. Regular inspections should be conducted in order to schedule routine maintenance operations such as sediment removal, spot re-vegetation, and inlet stabilization. For the first six months following construction, the site should be inspected after each storm event greater than 10 mm, or a minimum of two visits. If staffing and budget allow, consider scheduling two inspections per year, one of which should occur after snow is melted and ground is thawed. At the minimum schedule annual inspections conducted in the spring of each year. Inspections should also occur after all major rainfall events in excess of 60 mm.

Ponded Water - If during inspections ponded water is identified as an issue, (ponding for more than 48 hours after a storm) adjustments to the grading may be needed or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment

Irrigation

The irrigation of plants is necessary for the first two years or until plants are established. Watering requirements may differ with selected plants but is typically required on a weekly basis during this period. The season between May and August is a critical period for the survival of then plants. During this hot dry season watering should be increased to occur twice a week. When planning watering operations, consider how much precipitation has fallen. During overly wet periods, watering schedules can be modified.

Removal of Litter and Debris

Trash and large debris tends to collect around pretreatment devices and at the inlets of LID practices. Trash may also become stuck in outlet areas affecting the hydraulic function of the facility. The removal of trash and debris should occur at least twice a year but will be heavily dependent on accumulation rates.

Sediment Removal

Pretreatment devices are designed to provide a buffer area where sedimentation occurs before it can reach the bioretention, or bioswale. These should be cleaned out before they lose their functionality. Sediment removal techniques will differ by pretreatment practices but may involve hand tools, or high-pressure washer and vacuum trucks. The frequency of sediment removal will also vary depending on pre-treatment practice and catchment conditions.

Surface Cover/Filter Bed - The surface of filter beds may become clogged with fine sediment over time. Core aeration or deep tilling of non-vegetated areas may relieve the problem. The surface cover layer (e.g., mulch) will need to be removed and replaced every 3-5 years in areas where vegetation has not yet colonized. The inlets and pretreatment measures may also need frequent inspections to ensure they are working properly and to remove deposited sediments.

Weeding and Pruning

Bioretention or bioswales which have perennial vegetation will require weeding and pruning. Pruning is typically required only once per year, while weeding may be more frequent dependent on local conditions.

Additional First Year Maintenance

Bioretention and bioswale, are most prone to failure during the first year of establishment. During the first year additional maintenance practices will be required, these typically include:

- Adding reinforcement planting to maintain desired vegetation density.
- Checking inflow and overflow points for clogging and remove any sediment
- Inspecting grass filter strips for erosion or gullies and reseeding as necessary

- Examining the drainage area for bare soil. These areas should be stabilized immediately. Silt fence or other measures may be needed until the area is reseeded
- Identifying plant material stressed due to salt contamination following the spring melt period and replacing dead vegetation as necessary. (Note: reduce salt loadings from de-icing practices if possible)
- Inspecting overflows to ensure that snow blockages are prevented

Typical O&M Costs for LID Source and Conveyance Controls

Table 12.4 and Table 12.5 provides typical maintenance costs by individual maintenance activities and generalized life cycle costs for perforated pipe and bioretention/ bioswales LID practices, respectively. Table 12.6 provides typical service and inspection costs, annualized costs and unit costs per drainage area for OGS unit with enhanced phosphorus removal capabilities.

Table 12.4: Typical Maintenance Costs by Activity for LID Measures

Activity	Applicable to:		Maintenance Interval (years)	Unit	Cost Per unit
	Perf. Pipe	Bioretnetion/ Bioswales			
Litter Removal	√	√	½	ha	$ 1,000 – 2,000
LID Litter Removal	√	√	½	m^2	$ 0.20
Weed Control		√	1	ha	$ 1,000
LID Weed Control		√	1	m^2	$ 0.20
Grass Cutting	√	√	*	ha	$ 250
Landscape Restoration (Terrestrial Vegetation)		√	10	ha	$ 1,000
LID Landscape Restoration		√	½	m^2	$ 0.20
Sediment Removal and Disposal (Heavy machinery)		√	10	m^3	$ 300-350
Sediment Removal and Disposal (Vacuum Truck)	√	√	½	m^3	$120-250
LID Sediment Removal (manual)	√	√	½	m^3	$ 50-100
Soil sampling and infiltration testing		√	10	L.S.	$ 1,000-1,200
Inspection of Inlet/Outlet	√	√	1	L.S	$ 150
Pervious pipe/ underdrain cleanout (8-10m/hr)	√	√	**	hr	$ 850
Infiltration media restoration (tilling and re-vegetation)		√	**	m^2	$ 150
Shrub Replacement		√	**	each	$ 20-40
* Routine maintenance **when necessary (repair item) (Source: MOE, 2003; Halton Hills, 2009)					

Generalized Life Cycle Costs

The following life cycle costs were developed as Life Cycle Assessment of Low Impact Development Practices through the STEP program (TRCA). The project evaluated the capital and life cycle costs of Low Impact Development (LID) practices over a 50 year time horizon based on a detailed assessment of local input costs, maintenance requirements, rehabilitation costs and design scenarios relevant to Canadian climates. The following life cycle costs for average annual maintenance costs and rehabilitation costs to a 50 year present value have been summarized in Table 12.6 below:

Table 12.5: Annual Maintenance Costs and Rehabilitation

	Avg. Annual Maintenance Cost	Rehabilitation Cost at 25 years
Perforated Pipes (road drainage) – per m^2 of facility	$ 12.77/m^2	n/a
Bioretention/ Bioswales (full infiltration) – per m^2 of facility	$ 7.26//m^2	$ 57/ m^2
Bioretention/ Bioswales (partial infiltration) – per m^2 of facility	$7.33/ m^2	$ 57/ m^2

Table 12.6: Typical Maintenance Costs for OGS with Enhance Phosphorus Removal

Drainage Area (ha)	Service Interval	Service Cost	Inspection Cost	Annualized Cost	Cost/ha/yr
0.6	5 yrs	2,200	1,750	$ 790/yr	$ 1,300
1	5 yrs	3,750	1,750	$ 1,120/yr	$ 1,120
1.5	5 yrs	5,200	1,750	$ 1,390/yr	$ 925

12.6.10 Integration with Other Documents/Studies

The implementation of conveyance control stormwater measures within the City of Orillia is consistent with a number of background documents. These documents, together with others which may be considered in the design and implementation of the works include the following:

- Lake Simcoe Protection Plan (2009), the recommended approach for conveyance controls aligns with the recommendations of the Lake Simcoe Protection Plan which indicates the need to prescribe conveyance control measures for existing development areas where stormwater controls are lacking or insufficient;
- Oro and Hawkestone Creeks Subwatershed Study, particularly material related to soil cover, wellhead protection areas, water quality analysis, and groundwater-surface water interactions; and
- Evaluation of Low Impact Development Stormwater Technologies for the Uncontrolled Urban Areas in the Lake Simcoe Region (Ryerson University, 2010)
- Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0 (TRCA/CVC - 2010)
- Grey to Green Road Retrofits: Optimizing your Infrastructure Assets Through Low Impact Development (2013- Draft). http://www.creditvalleyca.ca/wp-content/uploads/2013/09/SWI-ROWDraft-Complete1.pdf

12.7 End-of-Pipe Controls

12.7.1 Description of the Recommended Approach:

The recommended approach focusses on implementing new stormwater controls within the existing uncontrolled urban areas of the City, as these areas represent the greatest overall opportunity for improving stormwater water quality, and phosphorus reductions in particular. In total, 16 sites are identified for end-of-pipe water quality control retrofits, including:

- 8 sites in the Lake Simcoe basin - construction of 4 new end-of-pipe stormwater facilities at existing uncontrolled storm sewer outfalls, retrofit of an existing dry pond (F7), and addition of 3 OGS's at outfalls to Lake Simcoe.
- 8 sites in the Lake Couchiching basin - construction of 5 new end-of-pipe stormwater facilities at existing uncontrolled storm sewer outfalls, and addition of 3 OGSs at outfalls to Lake Couchiching.

As noted earlier, only 9% of the city's existing lands draining to Lake Simcoe currently receive water quality treatment, while all of the drainage to Lake Couchiching is untreated. The construction of the 16 end-of-pipe stormwater retrofits could potentially increase the portion of City lands receiving some measure of water quality treatment to 29% and 47% for the Lake Simcoe and Lake Couchiching basins, respectively.

12.7.2 Key Next Steps

Key next steps in regard to the implementation of the end-of-pipe ponds indicated above include:

- Complete Class Environmental Assessments for the proposed stormwater retrofit sites per the required class EA schedule.
- Preliminary and detailed design of the recommended stormwater retrofits.
- Undertake any required land acquisitions for the proposed end-of-pipe facilities within privately owned lands or lands held by other City of Orillia departments.
- Obtain the necessary approvals and permits from MOE and LSRCA.
- Tender development and construction of the stormwater facilities.

12.7.3 Future Study Requirements

Future study tasks associated with the implementation of the recommended end-of pipe stormwater management facilities would include, but are not limited to:

- Competition of Class EA studies, per the appropriate EA Schedule as detailed in Section 9.2.4;
- Public Information Center (Schedule B – required; optional under Schedule A+, but recommended);
- Examination of background material included as part of this document;
- Completion of site inventory and topographic surveys,

- Geotechnical Investigations (physical and chemical);
- Preparation of preliminary designs;
- Development of detailed designs;
- Approvals – MOE Environmental Compliance Approval (ECA) and necessary construction permits as required (LSRCA), including approvals for any end-of-pipe facilities proposed within the regulatory floodplain;
- Preparation of detailed design drawing packages, tender and specification; and
- Construction, construction administration and construction supervision services.

12.7.4 Policy/ Standards Considerations

In general, the proposed end-of-pipe stormwater facilities recommended as part of this study will be designed to comply with City of Orillia design standards as well as the criteria of the Ministry of Environment Stormwater Management Planning and Design Manual (MOE, 2003). Additional policy requirements include any facilities that would be located within regulatory floodplains and/or any facilities which may impact regulated species at risk habitat.

12.7.5 Facilitators and Contributors

The City of Orillia would lead the implementation of the recommended end-of-pipe stormwater controls. To aid in the successful implementation, LSRCA would be expected to collaborate on projects to provide guidance with respect to targets and objectives as well as approvals requirements.

12.7.6 Costs

Concept-level cost estimates were developed for the proposed end-of-pipe facilities:

- For proposed stormwater ponds, the costs are based on the estimated storage requirements to provide an "enhanced" level of water quality control (i.e. "level 1" control). Based on recent experience with other retrofit projects, a unit cost of $175/m^3$ of storage was applied to complete the estimate.
- For the proposed OGS sites, a unit cost of $45,000 per hectare of treated drainage area was applied.

Table 12.7 presents the cost estimates for the proposed end-of-pipe stormwater facilities. As shown, the total estimated cost of the recommended works is $28.65M, including $16.68M for the sites in the Lake Simcoe basin, and $11.97M for the sites in the Lake Couchiching basin. It should be noted that the majority of the total costs are attributed to just two of the sites which are much larger in scale than the remaining sites (i.e. outfall 103-2 and outfall 24/25/26).

Based on the estimated phosphorus loadings reductions presented earlier (Table 11.4), the estimated unit removal cost for the proposed retrofits is roughly $38,000 per kg per year.

Table 12.7: Cost Estimates for End-of-Pipe Stormwater Facilities

Site / Outfall No.*	BMP assumed	Drainage Area	landuses	% imp	SWM Pond Storage Estimates: Assume Level 1 Control (m3/ha)	(m3)	Unit Cost ($/m3)	($/ha)	Cost Est. ($M)	Phosphorus Reduction (kg/yr)	Est. cost per kg of P removal ($/kg)
dry SWM Pond #F7	SWM pond	5.3	res	45%	165	876	$175		$0.15	4.4	$34,722
Mill Creek basin 8	SWM pond	48.3	res	45%	165	7,970	$175		$1.39	40.2	$34,722
outfall #103-2	SWM pond	352.0	mixed	65%	215	75,680	$175		$13.24	348.2	$38,040
outfall #U1	SWM pond	23.4	res	45%	165	3,861	$175		$0.68	19.5	$34,722
outfall #91	OGS	4.3	res	45%	n/a - assume OGS			$45,000	$0.19	4.5	$43,153
outfall #75	SWM pond	19.7	res	45%	165	3,251	$175		$0.57	16.4	$34,722
outfall #73	OGS	3.1	road ROW	85%	n/a - assume OGS			$45,000	$0.14	4.5	$31,298
Memorial / Dunn (#103-4)	OGS	7.0	mixed	65%	n/a - assume OGS			$45,000	$0.32	8.7	$36,282
								Subtotal - Lake Simcoe basin:	$16.68	446.2	$37,392
* assumes that optional site #1 (i.e. retrofit site R103-2) is constructed (and not R103-3)											
outfall #46	SWM pond	13.1	mixed	65%	215	2,817	$175		$0.49	13.0	$38,040
outfall #43	SWM pond	8.7	res-hi	65%	215	1,871	$175		$0.33	8.6	$38,040
outfall #31	SWM pond	51.9	mixed	65%	215	11,159	$175		$1.95	51.3	$38,040
outfall #30	OGS	3.2	comm.	85%	n/a - assume OGS			$45,000	$0.14	4.6	$31,298
outfalls #24, 25, 26	SWM pond	203.2	mixed	65%	215	43,688	$175		$7.65	201.0	$38,040
outfall #15	OGS	3.1	res	45%	n/a - assume OGS			$45,000	$0.14	3.2	$43,153
outfall #3	OGS	4.4	res	45%	n/a - assume OGS			$45,000	$0.20	4.6	$43,153
outfall #1	SWM pond	24.4	ind.	85%	250	6,100	$175		$1.07	28.0	$38,156
								Subtotal - Lake Couchiching basin:	$11.97	314.3	$38,079
								TOTAL - Both Basins:	$28.65		

12.7.7 Timing

Given the number and scale of the recommended end-of-pipe stormwater retrofits, a 20 year timeframe is recommended to implement the works. A proposed schedule to implement the recommended end-of-pipe stormwater retrofits is provided in Section 12.9.

12.7.8 Funding Considerations

Under current City practices, the recommended costs to implement stormwater management works such as end-of-pipe retrofit measures would be funded through the Capital Budget using general tax levies. The future adoption of a stormwater utility rate to fund these stormwater works would be another option for the City which could provide a stable source of annual funding to complete the recommended projects over the 20-year timeframe.

As noted in Section 12.3, some municipalities derive partial funding for retrofit projects via a fee-in-lieu policy for development sites where traditional stormwater ponds are not practical. Given the limited number of re-development and infill sites in the City of Orillia, this would not be expected to be a significant source of funding.

12.7.9 Operation and Maintenance Considerations

Operation and maintenance is required to ensure the effective operation, longevity, and aesthetic functioning of a stormwater management facility. Typical activities that are required to properly operate and maintain stormwater management end-of-pipe facilities include the following:

- Regular inspection of the control structure, manholes and orifices (as applicable);
- Regular maintenance such as grass cutting, week control, and vegetation management;
- Debris removal, unclogging of outlets, and any other nuisance issues;
- Occasional repair works (as required) to structural elements such as pipes, baffle blocks, pipe grates and fences;
- Monitoring of the hydraulic performance;
- Sediment removal / dredging;

Additional operation and maintenance guidance is provided in Chapter 6 of the 2003, MOE Stormwater Management Planning and Design Manual.

12.7.10 Integration with Other Documents/Studies

The implementation of end-of-pipe stormwater measures within the City of Orillia is consistent with a number of background documents. These documents, together with others which may be considered in the design and implementation of the works include the following:

- Lake Simcoe Protection Plan (2009);

- Lake Simcoe Basin Stormwater Management and Retrofit Opportunities (LSRCA, 2007);
- The Oro and Hawkestone Creeks Subwatershed Study (LSRCA, 2013);
- MOE Stormwater Management Planning and Design Manual (2003)

12.8 Stream Restoration

Stream erosion and problem site restoration measures are recommended to be addressed as part of a future City-wide Stream Restoration Master Plan that follows Approach 2 of the Master Plan process and would result in a prioritized plan for undertaking future stream works. As noted earlier, the goals of the study would be to:

- gain insight into the controls and modifying influences on the City's watercourses
- develop a long term plan for restoring the streams in a cost effective manner (considering both capital and maintenance costs).
- develop an approach for selecting, screening, and recommending alternatives to stabilize and/or restore watercourses.
- develop an implementation plan which costs, categorizes, and prioritizes the preferred rehabilitation alternatives.

It is recommended that the study be undertaken using the following key steps:

1. Establishment of Existing Conditions
    a. Problem identification
    b. Study area delineation
    c. Physical inventory of erosion sites
    d. Erosion conditions assessment
2. Erosion Prioritization and Rehabilitation
    a. Prioritization
    b. Public consultation
    c. Establishment of rehabilitation alternatives
3. Development of an Implementation Plan

The City would initiate the project based on the cursory investigations that were undertaken as part of this CSWM-MP (Section 4.8). Additional support and background information may be available through LSRCA.

The cost to undertake a city-wide Stream Restoration Master Plan is estimated to cost approximately $100,000 and should be undertaken over the short-term (next 1-3 years). The costs of the individual restoration works that are recommended through the study would then be scheduled over the longer term (10-20 years).

12.9 Proposed Budget and Scheduling of Stormwater Management Measures

Based on the proceeding discussion, Table 12.8 provides a cursory Budget Schedule for the City to implement the recommended stormwater management measures. For the purposes of this Budget Schedule, it has been assumed that a steady level of annual funding will be available, beginning in 2017. As noted above, under current City practices, most works are funded through the Capital Budget using general tax levies. However, it is understood that the City is also exploring the option of adopting a stormwater utility rate, similar to many other municipalities, in order to provide the necessary level of stable, consistent annual funding.

As shown in Table 12.8, beginning in 2017, annual funding of $3.25M is required to fund the stormwater management works identified in this study. The following was considered in the development of the schedule:

- The recommended works are implemented over a 20 year timeframe, to 2036.
- Considerable time will be required to accumulate funds for the two large-scale end-of-pipe retrofit projects in the Lake Simcoe basin (retrofit 103-2) and in the Lake Couchiching basin (outfalls 24, 25, 26). Of these two, priority has been given to the Lake Couchiching outfall (24, 25, 26), as it has been identified as a significant threat in the Source Water Protection Plan due to its proximity to the City`s water supply intake. The remaining small-scale end-of-pipe retrofits have been scheduled in priority based on their anticipated cost per kilogram of phosphorus removal, while funds continue to accumulate over time to complete the other large-scale retrofit on Ben`s Ditch (103-2).
- Opportunities may exist to offset some of the required funding via other sources:
    - Development Charges may partially fund some of the capital roads projects that are attributed to improvements for future urban growth.
    - Perpetual Maintenance Fees may be collected from urban developments to fund future maintenance activities on stormwater infrastructure assumed by the City.
    - Private grants / sponsorship may be available to help with funding for source control LID demonstration projects.
- The use of LID bioswale systems ($1,323/m) was assumed for stormwater conveyance systems
- The City's capital roads projects were used to identify stormwater conveyance costs through 2023. Beyond 2023, an allowance of $1M per year has been assumed for the stormwater component of future roads projects that have not yet been scheduled. Based on the assumed unit cost for an LID bioswale system design, this provides funding for an average of 750m of roadway per year beyond 2023.
- Roadside ditch retrofits will be undertaken at an average rate of 550m per year over 20 years.

It should also be noted that the recommended works identified in this study have focused on the goals of water quality improvement for Lake Simcoe. Additional instream works will require further funding, including any future bridge/culvert capacity improvement works, and any stream restoration/erosion control works that may be recommended through the future Stream Restoration Master Plan study.

Table 12.8: Budget Schedule – Recommended Stormwater Management Works

Year	SWM Type / Measures	Scheduled Retrofit Projects			End-of-Pipe Retrofit Unit Cost per kg of P removal (Table 12.7)	length	unit cost	Cost of Projects ($M)	Annual Funding Amt. ($M)***	Funds Available - start of year ($M)	Funds Remaining - end of yr ($M)	Notes / Rationale
		SWM Works	Basin	Type								
2016	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Source Control SWM	Source Control LID marketing & pilot projects	Simcoe			assume $100k startup		$0.10				
	Conveyance Control SWM	SWM component of West St. capital works	200m-Simcoe, 400m-Couchiching	SWM component of Capital Road Project includes LID*		600	$1,323	$0.79				
	End-of-Pipe SWM	-	-	-	-	-	-	-				
						Total SWM works - 2016:		$0.95	$0.95	$0.95	$0.00	
2017	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Source Control SWM	Source Control LID marketing & pilot projects	Simcoe			assume $150k pilot & promo.		$0.15				
	Conveyance Control SWM	SWM component of Fittons Rd. capital works	Couchiching	SWM component of Capital Road Project includes LID*		300	$1,323	$0.40				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	-	-	-	-	-	-	-				
	Stream Restoration	Stream Restoration Master Plan Study	all			assume $100k for study		$0.10				
						Total SWM works - 2017:		$1.43	$3.25	$3.25	$1.81	assume SWM utility funding begins
2018	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Source Control SWM	Source Control LID marketing & pilot projects	Simcoe			complete pilot & promo. $150k		$0.15				
	Conveyance Control SWM	SWM component of Laclie St. capital works	Couchiching	SWM component of Capital Road Project includes LID*		600	$1,323	$0.79				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	-	-	-	-	-	-	-				accumulate funds for large-scale retrofit 24,25,26
						Total SWM works - 2018:		$1.73	$3.25	$5.06	$3.33	
2019	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of Laclie St. capital works	Couchiching	SWM component of Capital Road Project includes LID*		900	$1,323	$1.19				
	Conveyance Control SWM	roadside ditch retrofits**	Couchiching	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	-	-	-	-	-	-	-				accumulate funds for large-scale retrofit 24,25,26
						Total SWM works - 2019:		$1.98	$3.25	$6.58	$4.60	
2020	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of Memorial Ave. capital works	Simcoe	SWM component of Capital Road Project includes LID*		1300	$1,323	$1.72				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	-	-	-	-	-	-	-				accumulate funds for large-scale retrofit 24,25,26
						Total SWM works - 2020:		$2.51	$3.25	$7.85	$5.34	
2021	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of West St. capital works	Simcoe	SWM component of Capital Road Project includes LID*		600	$1,323	$0.79				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	-	-	-	-	-	-	-				
						Total SWM works - 2021:		$1.58	$3.25	$8.59	$7.01	accumulate funds for large-scale retrofit 24,25,26
2022	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of Laclie St. capital works	Couchiching	SWM component of Capital Road Project includes LID*		900	$1,323	$1.19				
	Conveyance Control SWM	roadside ditch retrofits**	Couchiching	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 24,25,26	Couchiching	SWM pond	$38,040			$7.65				priority retrofit to L. Couchiching Source Water Protection Threat
						Total SWM works - 2022:		$9.63	$3.25	$10.26	$0.63	
2023	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of Mississauga St. capital works	250m-Simcoe, 450m-Couchiching	SWM component of Capital Road Project includes LID*		700	$1,323	$0.93				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 73	Simcoe	OGS	$31,298			$0.14				
	End-of-Pipe SWM	Retrofit site 30	Couchiching	OGS	$31,298			$0.14				
						Total SWM works - 2023:		$1.99	$3.25	$3.88	$1.89	
2024	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				assume approx. $1M for SWM component of future Capital Roads Projects (equal to the cost of including LID bioswales for 750m of roadway)
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site U1	Simcoe	SWM pond	$34,722			$0.68				
	End-of-Pipe SWM	Retrofit site 75	Simcoe	SWM pond	$34,722			$0.57				
						Total SWM works - 2024:		$3.04	$3.25	$5.14	$2.10	
2025	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Couchiching	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site F7	Simcoe	SWM pond	$34,722			$0.15				
	End-of-Pipe SWM	Retrofit site F8	Simcoe	SWM pond	$34,722			$1.39				
						Total SWM works - 2025:		$3.33	$3.25	$5.35	$2.03	
2026	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 103-4 (Memorial/Dunn)	Simcoe	OGS	$36,282			$0.32				
	End-of-Pipe SWM	Retrofit site 31	Couchiching	SWM pond	$38,040			$1.95				
						Total SWM works - 2026:		$4.06	$3.25	$5.28	$1.22	

Year	SWM Type / Measures	Scheduled Retrofit Projects: SWM Works	Basin	Type	End-of-Pipe Retrofit Unit Cost per kg of P removal (Table 12.7)	length	unit cost	Cost of Projects ($M)	Annual Funding Amt. ($M)***	Funds Available - start of year ($M)	Funds Remaining - end of yr ($M)	Notes / Rationale
2027	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 46	Couchiching	SWM pond	$38,040			$0.49				
						Total SWM works - 2027:		$2.28	$3.25	$4.47	$2.19	
2028	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Couchiching	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 43	Couchiching	SWM pond	$38,040			$0.33				
						Total SWM works - 2028:		$2.12	$3.25	$5.44	$3.32	
2029	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 1	Couchiching	SWM pond	$38,156			$1.07				
						Total SWM works - 2029:		$2.86	$3.25	$6.57	$3.71	
2030	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 3	Couchiching	OGS	$43,153			$0.20				
						Total SWM works - 2030:		$1.99	$3.25	$6.96	$4.98	
2031	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Couchiching	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 15	Couchiching	OGS	$43,153			$0.14				
						Total SWM works - 2031:		$1.93	$3.25	$8.23	$6.30	
2032	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 91	Simcoe	OGS	$34,722			$0.19				
						Total SWM works - 2032:		$1.98	$3.25	$9.55	$7.57	
2033	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				accumulate funds for large-scale retrofit on Ben's Ditch (site 103-2)
	End-of-Pipe SWM	-	-	-		-	-	-				
						Total SWM works - 2033:		$1.79	$3.25	$10.82	$9.03	
2034	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Couchiching	replace asphalt ditch with LID		550	$1,323	$0.73				accumulate funds for large-scale retrofit on Ben's Ditch (site 103-2)
	End-of-Pipe SWM	-	-	-		-	-	-				
						Total SWM works - 2034:		$1.79	$3.25	$12.28	$10.50	
2035	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				accumulate funds for large-scale retrofit on Ben's Ditch (site 103-2)
	End-of-Pipe SWM	-	-	-		-	-	-				
						Total SWM works - 20305:		$1.79	$3.25	$13.75	$11.96	
2036	Pollution Control	annual sewer flushing	all			assume $60k annually		$0.06				
	Conveyance Control SWM	SWM component of future capital road works	-	SWM component of Capital Road Project includes LID*		-	-	$1.00				
	Conveyance Control SWM	roadside ditch retrofits**	Simcoe	replace asphalt ditch with LID		550	$1,323	$0.73				
	End-of-Pipe SWM	Retrofit site 103-2 (Ben's Ditch)	Simcoe	SWM pond	$38,040			$13.24				
						Total SWM works - 20305:		$15.03	$3.25	$15.21	$0.18	

* SWM component of capital road projects may vary from approx. $924/m for traditional storm sewer system, to $1,323 for LID bioswale system. Cost estimates assume use of LID bioswale.
Beyond 2023, allocation of $1M/year is assumed for SWM component of future capital roads projects, sufficient for use of LID bioswales over approx. 750m of roadway.
** assume average of 550m of ditch retrofits per year over 20 years (includes 1700m for Progress Drive ditch retrofits)
*** Assume annual funding of $3.25M starting in 2017

12.10 Measures for New Development & Redevelopment

To achieve the greatest water quantity and quality benefits throughout the City, the Recommended Approach of implementing source, conveyance and end-of-pipe controls should also be applied as part of new development/re-development within the City of Orillia. This is consistent with the agency requirements for modern stormwater management.

New-Development and SWM

Source, conveyance and end-of-pipe controls should be applied to new developments as part of a treatment train approach to stormwater management, whereby stormwater Best Management Practices (BMP) are applied in succession along the stormwater flow path.

Only with greater adoption and implementation of LID techniques in new developments that transcend stormwater management into areas such as energy efficiency, water conservation and re-use, green space maximization, tree conservation and better site design, will the additional water quality and broader environmental benefits be fully realized.

In general, the application of innovative LID source and conveyance controls and end-of-pipe facilities within new developments should be done in accordance with the Recommended Approach and relevant guidelines that include the Ontario Ministry of the Environment's 2003 Stormwater Management Planning and Design Manual and LID Manuals proposed by Conservation Authorities within Ontario including TRCA and CVC LID Manuals.

Redevelopment and SWM

The urban intensification associated with the future re-development pressures has the potential to add additional demands to the existing stormwater conveyance and treatment systems. Redevelopment projects can range in size from a single lot to the complete redevelopment of significantly larger areas. Many forms of redevelopment can be more intensive than previous uses and have higher levels of imperviousness (e.g., more pavement), runoff rates, and contaminant loading per unit of area. These effects are exacerbated when the proposed redevelopment sites are located in older development areas built before the need for stormwater controls was recognized.

Re-development projects generally present the most complex challenges with respect to integrating solutions for stormwater management. This is often due to a number of factors including:

- sites are typically constrained with respect to the extent of potential open space available;
- land cost often limit stormwater management options;
- there is typically limited flexibility to manipulate topography since grades around the perimeter of the site are fixed;
- service infrastructure around the site, including stormwater conveyance systems are typically fixed in terms of location, depth and capacity; and
- the presence of other service infrastructure beneath and around the site may limit potential excavation depths and opportunities for infiltration.

As a result, the exploration of stormwater management solutions for redevelopment sites requires a high level of imagination, ingenuity and creativity and can generally benefit from the application of LID source and conveyance controls as noted in the Lake Simcoe Protection Plan (LSRCA, 2009) and the Oro and Hawkestone Creeks Subwatershed Study.

12.11 Climate Change Considerations

The term *climate change* refers to a statistical variation in the climate of a specific location, region, or of the planet persisting for an extended period of time. Climate change may be caused by a variety of factors including natural processes; however, the current period of climate change has been shown by an overwhelming majority of scientific evidence to be caused by human factors, as proclaimed by the International Panel on Climate Change (IPCC).

The following sections illustrate two key relevant considerations related to climate change:

1. **Key findings and potential climate change impacts to water resources; and**
2. **Climate change adaptation strategies for stormwater infrastructure management**

In preparing this summary on Climate Change issues relating to the City of Orillia CSWM-MP, the following documents were reviewed and summaries of relevant information is provided in the subsequent sections:

- Guide for Assessment of Hydrologic Effects of Climate Change in Ontario (EBNFLO and AquaResource, 2010) ; and
- Technical Guide- Development, interpretation and use of rainfall intensity-duration frequency (IDF) information: Guidelines for Canadian water resources practitioners (CSA PLUS 4013-10, June 2010).

12.11.1 Key Findings and Potential Climate Changes Impacts to Water Resources

Most recent studies on climate change observations and predictions indicate the following:

- Total annual precipitation increased 5-35% since 1900, with southern Canada increasing 12% from 1900-1998 or by 5% from 1950-1998;
- Heavier, more frequent and intense rainfall events have been detected in the Great Lakes Basin since the 1970s
- The maximum intensity for one-day, 60-minute, and 30-minute duration rainfall events increased on average by 3-5% per decade from 1970 to 1998;
- Total annual precipitation could increase by 2 to 6% by the 2050s, 4.5-5.8% annually
- Summer and fall precipitation amounts may decrease up to 10% in Southern Ontario
- Increase in frequency / severity of extreme precipitation events
- Winter precipitation may increase as much as 10% in the south and 40% in the north

These findings have many important implications and impacts on the stormwater quality and quantity within the Lake Simcoe Watershed in general and within the City of Orillia in particular. These may include:

- More extreme thermal impacts on the natural environment (i.e. water temperatures thresholds for aquatic species);
- Increased seasonal evapotranspiration rates from open water sources, potentially leading to reduced water quality as a result of lower water levels;
- Earlier spring runoff events;
- Increased flows to stormwater systems – need for retrofit and/or Low Impact development;
- Uncertainty in hydrologic predictions/ models
- Possibility for more extreme high contaminant concentrations, and
- Increased demand on surface water causing increased stress on water supply and treatment, algae blooms affecting water quality.

12.11.2 Climate Change Adaptation Strategies for Stormwater Infrastructure Management

As a result of climate change, it is possible that stormwater infrastructure may be subject to loadings which exceed original design capacity. While in some cases the effect of a changing climate may be offset by the effect of other conservative engineering assumptions used at the time of design (e.g., rounding up pipe sizes, etc.), in other instances this may not be the case. For example, an ongoing infrastructure deficit may result in assets being used much longer than originally intended, perhaps leading to unanticipated surcharging and increasingly uneconomic operational and maintenance costs (i.e., sewer rehabilitation).

Existing Infrastructure and Climate Change Adaptation

Flood flow estimates and the associated bridge/culvert structure capacities had been documented at various locations throughout the city as part of the 1991 City of Orillia Stormwater Master Plan study and were reviewed again as part of the 2005 Stormwater Master Plan (MMM) (see Table 4.4 and Table 6.5). It is important to note that these estimates were based on landuse assumptions at the time of the 1991 study. As such, the City should consider development of an updated model based on current landuses. As part of the modelling update, the city should consider additional impacts beyond the landuse updates to also include potential climate change impacts. LSRCA has just recently developed a VISUAL OTTHYMO model that covers parts of Orillia as part of a report entitled "Hydrologic Model for Orillia Creeks and Talbot River Watersheds" (July 2012). This modelling work may serve as a basis for any further analyses by the City, such as re-evaluation of the levels of service / flood frequency at major bridge/culvert crossing structures.

In the case of existing infrastructure which is expected to be adversely affected (i.e., with a risk of exceeding original design capacity) by climate change, it may be possible to extend the lifespan by:

- removing or diverting loading from the storm sewer system (e.g., through implementation of Low Impact Development or green infrastructure strategies, integrated resource management techniques, rehabilitating sewers to reduce inflow and infiltration, etc.);
- expanding or rerouting major flow path (i.e., the solution may not always be in the piped system); and

- re-evaluating appropriate levels of service under future climate scenarios (e.g., is the originally anticipated level of service still going to be practical and economic?).

New Infrastructure and Climate Change Adaptation

Design of new infrastructure should consider the effects of anticipated climate change. Although there will normally be considerable uncertainty relating to the effects of projected climate change, especially at shorter storm durations, it may be possible in the particular location of interest to develop reasonable bounding estimates for consideration during design. Even if a defensible design estimate cannot be established, it will generally be possible at the early stages of infrastructure planning to design infrastructure that is resilient to a wide range of possible future climates.

Some general considerations for designing new infrastructure in the face of uncertain climate change include:

- Capitalize on local knowledge and data;
- Carefully consider the anticipated service life of infrastructure;
- Do not count on beneficial aspects of climate change;
- Consider upgraded design standards or an adaptation design increment to account for climate change impacts when investing in larger, long-lived infrastructure;
- Allow for flexible designs that can accommodate future infrastructure upgrades (increase) where possible;
- Arrange for possible expansion of major flow path; and
- Consider green infrastructure and low impact development.

13 Summary and Conclusion

The City of Orillia has undertaken the development of a comprehensive storm water management master plan (CSWM-MP) in accordance with the Lake Simcoe Protection Plan (LSPP) and the Lake Simcoe Region Conservation Authority (LSRCA) Guidelines which aim to protect and revitalize the Lake Simcoe basin. Key objectives in meeting the goals of the LSPP are reduced loadings of phosphorus and other pollutants to Lake Simcoe and its tributaries. The study also follows the Master Planning approach under the Municipal Class Environmental Assessment Process.

The existing environmental conditions of the study area, including existing stormwater management systems were reviewed through a suite of background documents, mapping and field investigations. The City drains via four main watershed basins, with varying degrees of urban development and stormwater treatment:

- Lake Simcoe Basin (1,571.6 ha, 55% of city) – most of the stormwater runoff to Lake Simcoe drains without any treatment. Only 9% of the basin receives water quality treatment via an existing stormwater pond (M1). Future development in this basin includes urban intensification and infilling, as well as "greenfield" development in the west end.
- Lake Couchiching Basin (660.9 ha, 23%) – this basin is fully developed without any stormwater management. Future development is limited to intensification and infilling in the existing urban areas.
- Silver Creek Watershed (491.9 ha, 17%) – much of this basin has been developed and receives water quality and quantity treatment via existing SWM ponds F1 and F2.
- Bass Lake Watershed (126.9 ha, 5%) – this basin is undeveloped, with future greenfield development planned.

As noted, much of the existing urban development within the City took place before the use of stormwater management measures became common practice. As such, the receiving streams and lakes have been impacted by existing development, and, in the absence of stormwater controls, these impacts can be expected to increase as further development and urban intensification continues. Impacts include:

- Water quality impacts – increased pollutant loadings, including phosphorus and other pollutants, to the City's receiving lakes and streams;
- Water balance – loss of natural infiltration as increased impervious cover replaces the coarse soils which underlay the City; and
- Water quantity – increased runoff volumes and peak flood flow rates which in turn lead to increased frequency of flooding and erosion.

The CSWM-MP seeks to reduce the stormwater impacts of urban development through the implementation of effective stormwater management controls and other measures. This includes not only controls to mitigate impacts from new development lands, but also opportunities to retrofit the stormwater drainage systems within the existing development areas.

A "long list" of alternative stormwater management measures was developed, screened and evaluated to address the stormwater impacts. Ultimately, it is understood that the future urban development will need to implement modern stormwater management controls, including source, conveyance and end-of-pipe control measures. The focus of the study recommendations was therefore on stormwater retrofit opportunities within the currently uncontrolled existing urban lands. The recommended measures include five categories of traditional and innovative stormwater management measures:

1. **Pollution Control Measures** – In addition to the current pollution prevention and control measures practiced within the City of Orillia, a number of additional measures and/or expansion current practices are recommended:

   - Expansion of the existing storm drain maintenance program to include regularly scheduled CCTV and storm sewer flushing.
   - Promoting additional public and business education / awareness through programs such as the "Yellow Fish Road", for example.
   - Promotion of safer alternative products.
   - Practicing safe materials storage controls.
   - Erosion and sediment control enforcement.
   - Additional reductions to vehicle use through promotion of carpooling.
   - Further reduction in road salt use through the salt alternatives and discussions with other agencies to reduce the application rates on Regional and MTO roads through the city, particularly within the city`s well head protection zones

2. **Source Control LID Measures** – a full range of source control low impact development (LID) stormwater measures is recommended. Current City practices include:

   - Downspout disconnection;
   - Rain barrels;
   - Reduced lot grading;
   - Oil-grit separators (OGS) on industrial sites

Additional recommendations focus on implementing other source control retrofits in existing urban areas, including:

- Enhanced vegetation and rain gardens;
- Bioretention areas;
- Permeable pavement;
- Soakaway pits / infiltration chambers / french drains
- Green roofs

Efforts should focus on promoting private landowners to implement these measures through marketing and high-profile demonstration sites on public lands.

3. **Conveyance Control LID Measures -** Two primary opportunities to retrofit existing roadways using new stormwater conveyance controls were identified:

- Road re-surfacing and re-construction works identified in the City's Capital Roads Projects (Table 10.2); and
- Retrofit of existing roadside ditches, particularly those that are currently paved (Table 10.3).

The recommended stormwater retrofit measures are listed below, prioritized in terms of preference, from highest to lowest, based on the anticipated water quality treatment levels:

- bioretention systems
- pervious pipe / exfiltration systems
- grassed swales
- permeable pavement (select locations)
- oil-grit separators with enhanced phosphorus removal

The forms of conveyance control retrofit measures that should be implemented will depend on the type of road (urban vs. rural cross-sections), streetscapes, adjacent landuses, and available space, and the location with respect to well-head protection areas (WHPAs).

4. **End of Pipe Controls -** the recommended approach focusses on implementing new stormwater controls within the existing uncontrolled urban areas of the City, as these areas represent the greatest overall opportunity for improving stormwater water quality, and phosphorus reductions in particular. In total, 16 sites are identified for end-of-pipe water quality control retrofits, including:

- 8 sites in the Lake Simcoe basin - construction of 4 new end-of-pipe stormwater facilities at existing uncontrolled storm sewer outfalls, retrofit of an existing dry pond (F7), and addition of 3 OGS's at outfalls to Lake Simcoe.
- 8 sites in the Lake Couchiching basin - construction of 5 new end-of-pipe stormwater facilities at existing uncontrolled storm sewer outfalls, and addition of 3 OGSs at outfalls to Lake Couchiching.

Only 9% of the city's existing lands draining to Lake Simcoe currently receive water quality treatment, while all of the drainage to Lake Couchiching is untreated. The construction of the 16 end-of-pipe stormwater retrofits could potentially increase the portion of City lands receiving some measure of water quality treatment to 29% and 47% for the Lake Simcoe and Lake Couchiching basins, respectively.

5. **Stream Restoration** – Stream erosion and problem site restoration measures are recommended to be addressed as part of a future City-wide Stream Restoration Master Plan that follows Approach 2 of the Master Plan process. The study would:

- Complete a comprehensive stream inventory of erosion sites;
- Develop a prioritized restoration plan to address the erosion sites.

The long-term aggregate benefits of implementing a comprehensive set of source, conveyance and end-of-pipe stormwater retrofits throughout the city was estimated using the MOE Phosphorus Loadings Tool. As noted, without stormwater quality controls, future development is expected to result in significant increases to pollutant loadings to the City`s receiving lakes and streams. The results of the loadings assessments are summarized in Table 11.5. As shown, under the recommended comprehensive approach, significant reductions in most pollutant loadings would be expected, particularly for phosphorus, TSS and bacteria.

A set of recommendations was also provided as to how to implementation the measures which comprise the City`s CSWM-MP. Key next steps, future study requirements, policies, facilitators, operations and maintenance, cost estimates and funding considerations for each of the recommended stormwater measures are summarized in Table 12.1. Preliminary scheduling and budgeting for the recommended works was also presented. The budget scheduling for the specific end-of-pipe stormwater measures and LID conveyance retrofits are summarized in Table 13.1and Table 13.2 below.

Table 13.1: Summary Budget Schedule
End-of-Pipe Stormwater Measures

Year	Location	Type	Cost ($M)
2022	Retrofit at Outlet 24, 25, 26	SWM Pond	$7.65
2023	Outlet 73	OGS	$0.14
	Outlet 30	OGS	$0.14
2024	Outlet U1	SWM Pond	$0.68
	Outlet 75	SWM Pond	$0.57
2025	Retrofit F7	SWM Pond	$0.15
	Retrofit F8	SWM Pond	$1.39
2026	Retrofit 103-4	OGS	$0.32
	Outlet 31	SWM Pond	$1.95
2027	Outlet 46	SWM Pond	$0.49
2028	Outlet 43	SWM Pond	$0.33
2029	Outlet 1	SWM Pond	$1.07
2030	Outlet 3	OGS	$0.20
2031	Outlet 15	OGS	$0.14
2032	Outlet 31	OGS	$0.19
2036	Retrofit 103-2	SWM Pond	$13.24

Table 13.2: Summary Budget Schedule
LID Stormwater Conveyance Controls for Identified Capital Road Works*

Year	Road	from	to	Cost ($M)*
2016	West St.	Coldwater Rd.	King St.	$0.79
2017	Fittons Rd.	Jamieson Dr.	West St.	$0.40
2018	Laclie St.	Neywash St.	Borland St.	$0.79
2019	Laclie St.	Borland St.	Fittons Rd.	$1.19
2020	Memorial Ave.	United Dr.	Woodland Dr.	$1.72
2021	West St.	James St.	Highway #12	$0.79
2022	Laclie St.	Fittons Rd.	Murry St.	$1.19
2023	Mississauga St.	Front St.	Albert St.	$0.93

* stormwater component of capital road works

Further detail regarding the budget scheduling for the above works, together with other anticipated stormwater management funding requirements was summarized in Table 12.8. An annual value of $3.25M was estimated to fund the stormwater management works identified in this study. Additional considerations with respect to climate change were also summarized, including a recommendation that the City update previous hydrologic modelling to reflect current landuses and the impacts of future urban development and potential climate change.

APPENDIX A:

Stormwater Management Retrofit Opportunities Screening

Site Ref. No.: R7 (Existing Dry Pond F7)

Location: Woodside Dr. & Laurentian Lane

Drainage Area: 5.3 ha

Proposed Retrofit: add water quality control through conversion of dry pond to a wet pond or infiltration gallery

Notes:

- limited benefit due to small drainage area
- addition of permanent pool may present a safety issue due to sideslopes, nearby park, etc.
- limited space available
- estimated base is approx. 15 x 30m = 450m^2. Therefore, 1m deep permanent pool would provide approx. 85m^3/ha of storage which is enough for MOE Level 2 water quality control.

Recommendation:

- Retrofit considered feasible, but low priority due to limited benefit

Existing Dry Pond F7

F7 - Overflow to Woodside Drive

F7 - Street view of Overflow

Site Ref. No.: R103 (Stormwater Outfall 103 – Ben’s Ditch)

Location:

- Option 1 - Outfall from combined Ben’s Ditch & Mil Creek near outlet to Lake Simcoe
- Option 2 – Municipally-owned block of land on north side of Highway 12 (Ben’s Ditch only)
- Option 3 – Municipally-owned block of land southwest of Queen St. W and West St. S. (Ben’s Ditch only)

Drainage Area:

- Option 1 – approx.. 984 ha (combined Ben’s Ditch & Mil Creek)
- Option 2 – approx. 352 ha (Ben’s Ditch only)
- Option 3 – approx. 261 ha (Ben’s Ditch only)

Proposed Retrofit:

- new on-line SWM pond or SWM wetland facility to treat upstream storm runoff

Notes:

- Option 1 is not considered feasible due to the large area required and the lack of space due to the location of the Orillia Landfill to the west of the channel and the Wastewater Treatment Plant to the east of the channel.
- Option 2 has approx. 9.4 ha of municipally-owned lands available, representing approx. 2.5% of the upstream drainage area. Buried municipal infrastructure (forcemain) at this location may reduce the available land. Construction of a SWM pond and/or SWM wetland facility may also require removal/loss of existing trees at this location.
- Option 3 has approx. 13 ha of municipally-owned lands available, representing approx. 5% of the upstream drainage area. A SWM pond facility could be incorporated into a future recreation centre which is planned for this site. Site is known to be contaminated, and any work would be subject to site remediation.

Recommendation:

- Option 2 or 3 should be carried forward for further future consideration. Even if only portions of the lands are available, partial water quality control (i.e. MOE Level 2 or Level 3) may still be feasible and would represent a significant opportunity to treat runoff from a large upstream urban area which currently discharges without any water quality control.

Street view from West St. S., of open lands located S. of Queen St. W.

Ben’s Ditch looking downstream from James St. toward Highway 12

Site Ref. No.: R8 (Mill Creek Basin 8)

Location: south end of Walker Ave and/or south of Lexington Ave school, N. of Hwy 12

Drainage Area: 48.3 ha

Proposed Retrofit: construct new SWM pond

Notes:

- Limited space available

Recommendation:

- SWM pond may not be feasible due to lack of space. However, inline facility may be considered along north side of Highway 12, before discharge via culvert under the road to Mill Creek. This may also provide opportunity to treat road runoff from Highway 12.

South end of Walker Ave.

Ditch on N. side of Highway 12, south of Walker Ave.

Outlet of Basin 8 on south side of Highway No. 12

Site Ref. No.: R-U1 (Stormwater Outfall U1)

Location: West St. S. at Kitchener Park – municipally-owned

Drainage Area: 23.4 ha

Proposed Retrofit: construct new SWM pond or infiltration gallery

Notes:

- Facility may be located under parking lot or sports field
- Site is a former landfill, although the proposed retrofit site is not believed to be within the deposition area.

Recommendation:

- Retrofit considered feasible for future SWM facility, subject to site remediation if necessary

Outfall from West St. S. into Kitchener Park

Potential facility location – parking lot and sports field

Site Ref. No: R93 (Stormwater Outfall 93)

Location: end of Gill St.

Drainage Area: 6.0 ha

Proposed Retrofit: construct new SWM pond or infiltration gallery

Notes:

- Outfall located on private property
- Insufficient space available for SWM pond

Recommendation:

- Retrofit not considered feasible due to lack of land at outfall
- Consideration should be given to LID conveyance control retrofit of the upstream paved ditches on Gill St.

Outfall 93 from ditch at end of Gill St.

Outfall through front yard on Gill St.

Site Ref. No: R91 (Stormwater Outfall 91)

Location: end of Lankin Blvd.

Drainage Area: 4.3 ha

Proposed Retrofit: add OGS

Notes:

- No public land available for above-ground facility

Recommendation:

- OGS feasible.
- Consider adding OGS at adjacent outfall No. 110 to the west on Victoria Cres. also

End of Lankin Blvd.

Site Ref. No: R78 (Stormwater Outfall 78)

Location: Forest Ave. S.

Drainage Area: 31.6 ha

Proposed Retrofit: construct SWM pond

Notes:

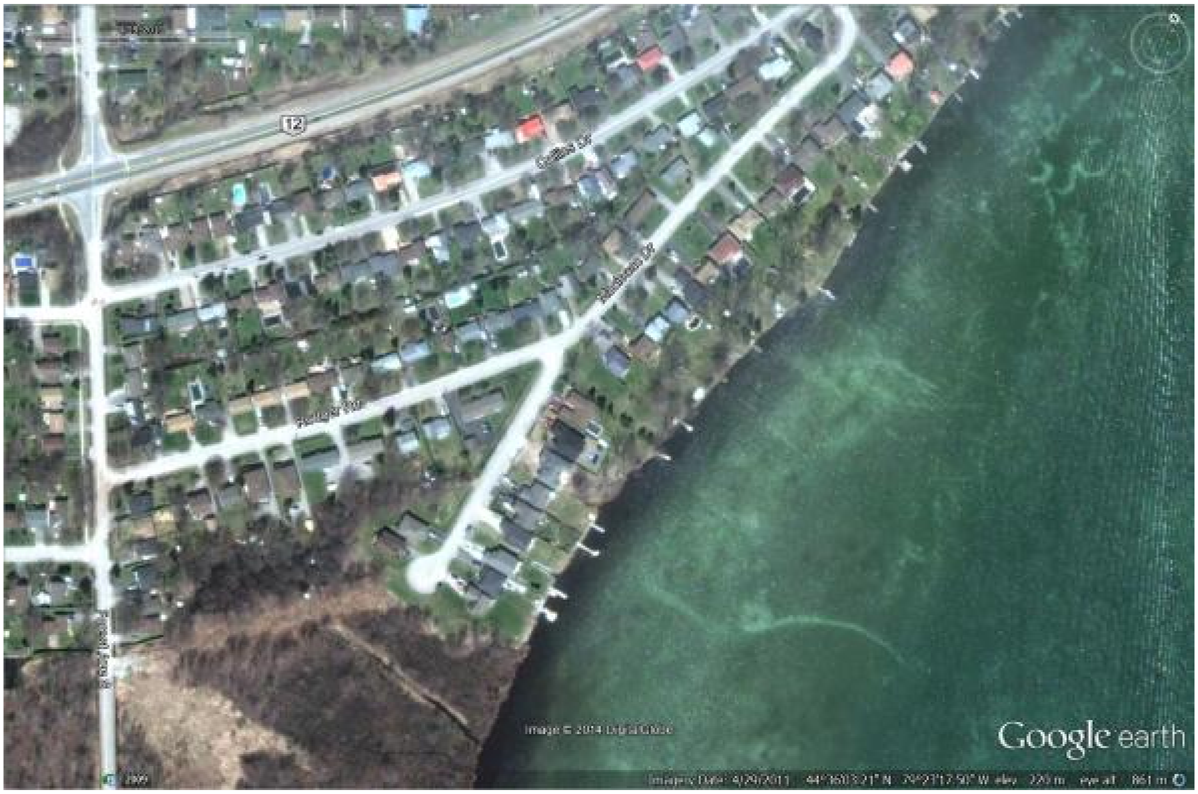
- upstream drainage area consists primarily of wetland;

Recommendation:

- site ruled out for SWM pond retrofit due to minimal benefit.

Outfall No. 78 to Lake Simcoe

Site Ref. No: R77 (Stormwater Outfall 77)



Location: McIsaac Dr.

Drainage Area: 2.0 ha

Proposed Retrofit: add OGS

Notes:

- small upstream area drains via roadside ditch;
- outlet is via pipe between homes

Recommendation:

- site ruled out due to minimal benefit.

Outfall No. 77 between homes on McIsaac Dr.

Site Ref. No: R75 (Stormwater Outfall 75)

Location: Collins Dr.

Drainage Area: 19.7 ha

Proposed Retrofit: construct new SWM pond

Notes:

- outlet is via channel between homes on east side of Collins Dr;
- municipally owned block of land on u/s (west) side of Collins Dr. (i.e. between Highway 12 and Collins Dr.) is candidate site;
- municipally owned block of land on north side of Highway 12 behind Bayview Pkwy is another candidate site.

Recommendation:

- Site is considered feasible for future SWM pond retrofit.

Candidate SWM Pond site on west side of Collins Dr.

Outfall No. 75 on east side of Collins Dr.

Site Ref. No: R73 (Stormwater Outfall 73)

Location: Atherly Road

Drainage Area: 3.1 ha

Proposed Retrofit: add OGS to outfall

Notes:

- collects road runoff via ditch on N. side of road;

Recommendation:

- OGS considered feasible;
- conveyance control LIDs should also be considered

Site Ref. No: Memorial & Dunn (outfall to Ben's Ditch)

Location: Memorial Ave. & Dunn Ave.

Drainage Area: 7 ha

Proposed Retrofit:

- add OGS to sewer

Notes:

- site has a history of sediment accumulation near outlet that can also cause surcharging and flooding

Recommendation:

- OGS considered feasible;
- may also retrofit upstream roadside ditches using bioswales

Site Ref. No: Progress Drive Subdivision (outfall to Mill Creek)

Location: Progress Drive and Ontario Street

Drainage Area: 28.1 ha

Proposed Retrofit:

- retrofit roadside ditches and outfall channels using LID bioswales

Notes:

- site represents good opportunity to provide water quality control within a high-density development

Recommendation:

- retrofit considered feasible;

Roadside Ditches within Progress Drive Industrial Subdivision

Site Ref. No: R48 (Stormwater Outfall 48)

Location: Park, west of Couchiching Point Road

Drainage Area: 16.9 ha

Proposed Retrofit: construct new SWM pond

Notes:

- upstream drainage area consists primarily of wetland;

Recommendation:

- site ruled out for SWM pond retrofit due to minimal benefit.

Site Ref. No: R46 (Stormwater Outfall 46)

Location: outfall channel adjacent to path, north of Atherley Road

Drainage Area: 13.1 ha

Proposed Retrofit: construct new SWM pond

Notes:

- upstream drainage area includes runoff from Atherley Road corridor;
- outfall channel and adjacent woodlot are municipally-owned

Recommendation:

- site considered feasible, subject to loss of a portion of woodlot adjacent to path.

Outfall No. 46 adjacent to path north of Atherley Rd.

Site Ref. No: R43 (Stormwater Outfall 43)

Location: outfall channel adjacent to path, between Brewery Lane and Leacock Lane

Drainage Area: 8.7 ha

Proposed Retrofit: construct new SWM pond

Notes:

- outfall channel and adjacent woodlot are municipally-owned
- upstream drainage area includes townhouse subdivision which drains via terrafix-block ditch to outfall channel;

Recommendation:

- site considered feasible, subject to loss of a portion of woodlot adjacent to path
- retrofitting of existing block ditch using LID conveyance techniques may also be feasible

Culverts to outfall channel No. 43 adjacent to path

Upstream terrafix-block lined ditch draining to Outfall No. 43

Site Ref. No: R-U5 (Stormwater Outfall U5)

Location: outfall from Brewery Lane

Drainage Area: 8.5 ha

Proposed Retrofit: construct new SWM pond

Notes:

- outfall on private land

Recommendation:

- retrofit not feasible

Site Ref. No: R-31 (Stormwater Outfall 31)

Location: outfall north of Cedar Island Road, west of Lakeview Cres.

Drainage Area: 51.9 ha

Proposed Retrofit: construct new SWM pond

Notes:

- small block of municipally-owned land between Cedar Island Road and path to east may represent a retrofit opportunity.
- open land on upstream (west) side of Cedar Island Road represents a retrofit opportunity, but is privately-owned.
- underground and above-ground utilities may reduce land available

Recommendation:

- retrofit may be feasible, subject to available land

Municipally owned-land adjacent to Outfall channel No. 31, between Cedar Island Road (left) and path (right)

Channel to Outfall No. 31 at Cedar Island Road: Left = downstream, Right = upstream

Site Ref. No: R-30 (Stormwater Outfall 30)

Location: outfall at end of Colborne St.

Drainage Area: 3.2 ha

Proposed Retrofit: add OGS to outfall

Notes:

- drains high-density urban lands via storm sewer;

Recommendation:

- OGS considered feasible

Site Ref. No: R-24, 35, 36 (Stormwater Outfalls 24, 25, 26)

Location: storm outfalls at end of Coldwater St. (26), Neywash St. (25) and Tecumseth St. (24)

Drainage Area: 203.2 ha (combined)

Proposed Retrofit: construct SWM facility along parking lot / laneway west of Centennial Dr.

Notes:

- outfall No. 24 identified as a source water protection threat due large drainage area and proximity to municipal water intake
- drains high-density urban lands via storm sewer;
- parking lot/lane known to have buried underground services

Recommendation:

- proposed location under parking lot/lane not considered feasible due to existing underground services
- consideration should be given to constructing a SWM facility in Couchiching Beach Park to the north instead

Parking Lot / Lane to west of Centennial Dr.

Couchiching Beach Park at end of Tecumseth St.

Site Ref. No: R-20A/B (Stormwater Outfalls 20A, 20B)

Location: storm outfalls at end of Borland St.

Drainage Area: 27.6 ha (combined)

Proposed Retrofit: construct new SWM facility

Notes:

- 20A collects storm drainage via ditch from Bay St.
- 20B collects storm drainage via storm sewer from Bay St.
- 20B includes existing OGS
- Private lands

Recommendation:

- Retrofit not considered feasible due to lack of land

Outfall 20 A/B on Borland St. looking downstream to outlet

Outfall 20 A/B on Borland St. looking upstream

Site Ref. No: R15 (Stormwater Outfall 15)

Location: Bay St., north of North St.

Drainage Area: 3.1 ha

Proposed Retrofit: add OGS

Notes:

- small upstream area drains via roadside ditch;
- outlet is via pipe between homes

Recommendation:

- OGS considered feasible.

Location of Outfall pipe No. 15 between homes on Bay St.

Site Ref. No: R6 (Stormwater Outfall 6)

Location: Maple Dr. at end of Bay St.

Drainage Area: 11.7 ha

Proposed Retrofit: construct new SWM pond

Notes:

- upstream area drains via roadside ditch;
- outlet is via pipe between homes

Recommendation:

- retrofit not considered feasible due to lack of land.

Roadside ditch drainage on Maple St. to Outfall No. 6

Site Ref. No: R3 (Stormwater Outfall 3)

Location: Maple Dr. at end of Francis Rd.

Drainage Area: 4.4 ha

Proposed Retrofit: add OGS

Notes:

- upstream area from Francis Rd. and west side of Maple Dr. drains via roadside ditch;
- outlet is via storm pipe between homes

Recommendation:

- OGS considered feasible

Site Ref. No: R1 (Stormwater Outfall 1)

Location: Drinkwater Dr. behind Brammer Dr.

Drainage Area: 24.4 ha

Proposed Retrofit: construct new SWM pond

Notes:

- Municipally-owned land on upstream (west) side of Drinkwater Dr.
- Drainage area includes upstream industrial/employment lands on Brammer Dr.

Recommendation:

- new facility may be feasible on municipally-owned lands

Candidate SWM Pond site on west side of Drinkwater Dr., behind Brammer Dr.

Outfall No. 1 on downstream (east) side of Drinkwater Dr.

APPENDIX B:

Water Budget Estimates:

Infiltration Deficits & Recharge Targets

Table A.1: Water Budget
Potential Infiltration Deficit Estimates

Soil / Landuse Scenario	Catchment Area (ha)	Pre-development Condition Area (ha)	Landuse	Soil Types	Infiltration depth (mm/yr)	Infiltration volume (m3/yr)	Post-development Condition Area (ha)	Landuse	Soil Types	Infiltration depth (mm/yr)	Infiltration volume (m3/yr)	Infiltration Deficit (m3/yr)	Infiltration Deficit (mm/yr)
coarse soils with proposed neighbourhood development (50% imp.)	10.00	10.0	Greenfield / Rural	sandy A/B	279	27,900	5.0	Lawns / open	sandy A/B	279	13,950		
		0.0	Impervious Surface	sandy A/B	0	0	5.0	Impervious Surface	sandy A/B	0	0		
					Total	**27,900**				**Total**	**13,950**	**13,950**	139.5
coarse soils with proposed major institutional development (70% imp.)	10.00	10.0	Greenfield / Rural	sandy A/B	279	27,900	3.0	Lawns / open	sandy A/B	279	8,370		
		0.0	Impervious Surface	sandy A/B	0	0	7.0	Impervious Surface	sandy A/B	0	0		
					Total	**27,900**				**Total**	**8,370**	**19,530**	195.3
coarse soils with proposed urban parkland (25% imp.)	10.00	10.0	Greenfield / Rural	sandy A/B	279	27,900	7.5	Lawns / open	sandy A/B	279	20,925		
		0.0	Impervious Surface	sandy A/B	0	0	2.5	Impervious Surface	sandy A/B	0	0		
					Total	**27,900**				**Total**	**20,925**	**6,975**	69.8
coarse soils with proposed business park development (80% imp.)	10.00	10.0	Greenfield / Rural	sandy A/B	279	27,900	2.0	Lawns / open	sandy A/B	279	5,580		
		0.0	Impervious Surface	sandy A/B	0	0	8.0	Impervious Surface	sandy A/B	0	0		
					Total	**27,900**				**Total**	**5,580**	**22,320**	223.2
coarse soils with proposed urban intesification (70% imp.). Note - assumes existing landuses = low density / residential	10.00	6.0	Lawns / open	sandy A/B	279	16,740	3.0	Lawns / open	sandy A/B	279	8,370		
		4.0	Impervious Surface	sandy A/B	0	0	7.0	Impervious Surface	sandy A/B	0	0		
			(assume low desity / res.)		**Total**	**16,740**				**Total**	**8,370**	**8,370**	83.7

Table A.2: Water Budget
Determination of Infiltration Targets for Future Development

Soil / Landuse Scenario	Catchment Area (ha)	Potential Infiltration Deficit (mm/yr)	Portion(s) Contributing to Infiltration: Component(s)	Area (ha)	Target Infiltration Depth (mm)	Rainfall Distribution and Infiltration Volumes: rainfall range:	1-4mm	4-8mm	8-12mm	12-16mm	16-20mm	20-24mm	24-28mm	>28mm	Resulting Annual Infiltration (m3/yr)	(mm/yr over catchment)	meets or exceeds deficit target?
						avg of range:	2	6	10	14	18	22	26	33			
						No. of events/yr:	18.4	10.9	5.1	2.9	2	1.8	1.2	2.7			
coarse soils with proposed neighbourhood development (50% imp.)	10.0	139.5	whole catchment:	10.0	4.0	Infiltration Volume (m3/event):	200	400	400	400	400	400	400	400			
						Annual Infiltration volume (m3/yr):	3680	4360	2040	1160	800	720	480	1080	14,320.00	143.2	YES
coarse soils with proposed major institutional development (70% imp.)	10.0	195.3	whole catchment:	10.0	6.0	Infiltration Volume (m3/event):	200	600	600	600	600	600	600	600			
						Annual Infiltration volume (m3/yr):	3680	6540	3060	1740	1200	1080	720	1620	19,640.00	196.4	YES
coarse soils with proposed urban parkland (25% imp.)	10.0	69.8	whole catchment:	10.0	1.5	Infiltration Volume (m3/event):	200	150	150	150	150	150	150	150			
						Annual Infiltration volume (m3/yr):	3680	1635	765	435	300	270	180	405	7,670.00	76.7	YES
coarse soils with proposed business park development (80% imp.)	10.0	223.2	whole catchment:	10.0	8.0	Infiltration Volume (m3/event):	200	600	800	800	800	800	800	800			
						Annual Infiltration volume (m3/yr):	3680	6540	4080	2320	1600	1440	960	2160	22,780.00	227.8	YES
coarse soils with proposed urban intesification (70% imp.). Note - assumes existing landuses = low density / residential	10.0	83.7	whole catchment:	10.0	2.0	Infiltration Volume (m3/event):	200	200	200	200	200	200	200	200			
						Annual Infiltration volume (m3/yr):	3680	2180	1020	580	400	360	240	540	9,000.00	90	YES

APPENDIX C:

MOE Phosphorus Loadings Model

MOE P-Budget Assessment:

Existing Landuses with & without existing SWM Ponds

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Project DEVELOPMENT Summary

DEVELOPMENT: **City of Orillia - Lake Simcoe Basin**
Subwatershed: **Oro Creeks North**

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	120.5	0.36	43.38
Forest	535.4	0.10	53.54
Hay-Pasture	11.2	0.12	1.34
High Intensity - Comm/Industria	128.6	1.82	234.05
High Intensity - Residential	517	1.32	682.44
Low Intensity Development	212.5	0.13	27.63
Sod Farm / Golf Course	46.4	0.24	11.14

DEVELOPMENT: City of Orillia - Lake Simcoe Basin
Subwatershed: Oro Creeks North

Total Pre-Developed Area (ha): **1571.60**   Total Pre-Developed Phosphorus Load (kg/yr): **1053.52**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Cropland	30.7	0.36	NONE	0%	11.05
			existing uncontrolled development		
Cropland	89.8	0.36	Wet Detention Ponds	63%	11.96
			portion of existing landuses to existing SWM pond M1		
Forest	517.7	0.10	NONE	0%	51.77
			existing uncontrolled development		
Forest	17.6	0.10	Wet Detention Ponds	63%	0.65
			portion of existing landuses to existing SWM pond M1		
Hay-Pasture	10.1	0.12	NONE	0%	1.21
			existing uncontrolled development		
Hay-Pasture	1.1	0.12	Wet Detention Ponds	63%	0.05
			portion of existing landuses to existing SWM pond M1		
High Intensity - Comm/Industria	118	1.82	NONE	0%	214.76
			existing uncontrolled development		
High Intensity - Comm/Industria	10.7	1.82	Wet Detention Ponds	63%	7.21
			portion of existing landuses to existing SWM pond M1		
High Intensity - Residential	517	1.32	NONE	0%	682.44
			existing uncontrolled development		
High Intensity - Residential	0	1.32	Wet Detention Ponds	63%	0.00
			portion of existing landuses to existing SWM pond M1		
Low Intensity Development	208.7	0.13	NONE	0%	27.13
			existing uncontrolled development		
Low Intensity Development	3.8	0.13	Wet Detention Ponds	63%	0.18
			portion of existing landuses to existing SWM pond M1		
Sod Farm / Golf Course	30.7	0.24	NONE	0%	7.37
			existing uncontrolled development (parklands / open space included in this landuse classification)		
Sod Farm / Golf Course	15.7	0.24	Wet Detention Ponds	63%	1.39
			portion of existing landuses to existing SWM pond M1 (parklands / open space included in this landuse classification)		

PostDeveloped Area Altered:	**1571.60**	Pre-Developed Phosphorus EXPORT:	**1053.52**
Total PreDeveloped Area:	**1571.60**	Post-Developed EXPORT (without BMP):	**1053.69**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**1017.18**
		Total Phosphorus Reduction Potential:	**36.3**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Lake Simcoe Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**1054**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**1017**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Lake Couchiching Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Forest	72.6	0.10	7.26
High Intensity - Comm/Industria	138.4	1.82	251.89
High Intensity - Residential	384.5	1.32	507.54
Low Intensity Development	4.3	0.13	0.56
Sod Farm / Golf Course	61.1	0.24	14.66

Total Pre-Developed Area (ha): **660.9**   Total Pre-Developed Phosphorus Load (kg/yr): **781.91**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	20	0.10	NONE	0%	2.00
High Intensity - Comm/Industria	106.3	1.82	NONE	0%	193.47
existing uncontrolled development					
High Intensity - Residential	384.5	1.32	NONE	0%	507.54
existing uncontrolled development					
High Intensity - Residential	55.3	1.32	Wet Detention Ponds	63%	27.01
future development to be receive quality and quanity control via future SWM ponds					
Sod Farm / Golf Course	61.1	0.24	NONE	0%	14.66
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	33.7	0.24	Wet Detention Ponds	63%	2.99
future development to be receive quality and quanity control via future SWM ponds					

PostDeveloped Area Altered:	**660.90**	Pre-Developed Phosphorus EXPORT:	**781.91**
Total PreDeveloped Area:	**660.90**	Post-Developed EXPORT (without BMP):	**798.75**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**747.67**
		Total Phosphorus Reduction Potential:	**34.2**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Lake Couchiching Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**782**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**748**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: **City of Orillia - Silver Creek Basin**
Subwatershed: **Oro Creeks North**

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	55.6	0.36	20.02
Forest	84.2	0.10	8.42
Hay-Pasture	0.1	0.12	0.01
High Intensity - Comm/Industria	137	1.82	249.34
High Intensity - Residential	149.7	1.32	197.60
Low Intensity Development	6	0.13	0.78
Sod Farm / Golf Course	59.3	0.24	14.23

DEVELOPMENT: **City of Orillia - Silver Creek Basin**
Subwatershed: **Oro Creeks North**

Total Pre-Developed Area (ha): **491.9** Total Pre-Developed Phosphorus Load (kg/yr): **490.40**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Cropland	55.6	0.36	Wet Detention Ponds	63%	7.41
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		
Forest	84.2	0.10	Wet Detention Ponds	63%	3.12
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		
Hay-Pasture	0.1	0.12	Wet Detention Ponds	63%	0.00
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Comm/Industria	137	1.82	Wet Detention Ponds	63%	92.26
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Residential	149.7	1.32	Wet Detention Ponds	63%	73.11
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		
Low Intensity Development	6	0.13	Wet Detention Ponds	63%	0.29
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		
Sod Farm / Golf Course	59.3	0.24	Wet Detention Ponds	63%	5.27
			assume all existing landuses in entire basin drain via SWM Ponds F1 & F2		

PostDeveloped Area Altered:	**491.90**	Pre-Developed Phosphorus EXPORT:	**490.40**
Total PreDeveloped Area:	**491.90**	Post-Developed EXPORT (without BMP):	**490.40**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**181.45**
		Total Phosphorus Reduction Potential:	**309.0**
			(kg/year)

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**490**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**181**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Bass Lake Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	30	0.36	10.80
Forest	53.7	0.10	5.37
Hay-Pasture	37.7	0.12	4.52
High Intensity - Comm/Industria	1.1	1.82	2.00
Low Intensity Development	4.4	0.13	0.57

Total Pre-Developed Area (ha): **126.900**
Total Pre-Developed Phosphorus Load (kg/yr): **23.27**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	38.3	0.10	NONE	0%	3.83
High Intensity - Residential	87.9	1.32	Wet Detention Ponds	63%	42.93
Sod Farm / Golf Course	0.7	0.24	Wet Detention Ponds	63%	0.06

future development to be receive quality and quanity control via future SWM ponds (High Intensity - Residential)

ɔpment to be receive quality and quanity control via future SWM ponds (parkland included in this landuse classification) (Sod Farm / Golf Course)

PostDeveloped Area Altered: **126.90**
Total PreDeveloped Area: **126.90**
Unaffected Area: **0**

Pre-Developed Phosphorus EXPORT: **23.27**
Post-Developed EXPORT (without BMP): **120.03**
Post-Developed EXPORT (with BMP): **46.82**
Total Phosphorus Reduction Potential: **-23.6**
(kg/year)

DEVELOPMENT:	**City of Orillia - Bass Lake Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**23**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**47**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

MOE P-Budget Assessment:

Future Landuses with:

- traditional SWM Ponds for future development lands

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Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Lake Simcoe Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	120.5	0.36	43.38
Forest	535.4	0.10	53.54
Hay-Pasture	11.2	0.12	1.34
High Intensity - Comm/Industria	128.6	1.82	234.05
High Intensity - Residential	517	1.32	682.44
Low Intensity Development	212.5	0.13	27.63
Sod Farm / Golf Course	46.4	0.24	11.14

DEVELOPMENT: City of Orillia - Lake Simcoe Basin
Subwatershed: Oro Creeks North

Total Pre-Developed Area (ha): **1571.60** Total Pre-Developed Phosphorus Load (kg/yr): **1053.52**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	391.4	0.10	NONE	0%	39.14
High Intensity - Comm/Industria	128.6	1.82	NONE	0%	234.05
existing uncontrolled development					
High Intensity - Comm/Industria	295.9	1.82	Wet Detention Ponds	63%	199.26
future development to receive quality and quanity control via future SWM ponds					
High Intensity - Residential	517	1.32	NONE	0%	682.44
existing uncontrolled development					
High Intensity - Residential	135	1.32	Wet Detention Ponds	63%	65.93
future development to receive quality and quanity control via future SWM ponds					
Sod Farm / Golf Course	46.4	0.24	NONE	0%	11.14
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	57.3	0.24	Wet Detention Ponds	63%	5.09
future development to receive quality and quanity control via future SWM ponds					

PostDeveloped Area Altered:	**1571.60**	Pre-Developed Phosphorus EXPORT:	**1053.52**
Total PreDeveloped Area:	**1571.60**	Post-Developed EXPORT (without BMP):	**1697.26**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**1237.05**
		Total Phosphorus Reduction Potential:	**-183.5**
			(kg/year)

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**1054**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**1237**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

Ontario
MINISTRY OF THE ENVIRONMENT

Database Version:
Update Date:

Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Lake Couchiching Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Forest	72.6	0.10	7.26
High Intensity - Comm/Industria	138.4	1.82	251.89
High Intensity - Residential	384.5	1.32	507.54
Low Intensity Development	4.3	0.13	0.56
Sod Farm / Golf Course	61.1	0.24	14.66

Total Pre-Developed Area (ha): **660.9** Total Pre-Developed Phosphorus Load (kg/yr): **781.91**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	20	0.10	NONE	0%	2.00
High Intensity - Comm/Industria	106.3	1.82	NONE	0%	193.47
existing uncontrolled development					
High Intensity - Residential	384.5	1.32	NONE	0%	507.54
existing uncontrolled development					
High Intensity - Residential	55.3	1.32	Wet Detention Ponds	63%	27.01
future development to be receive quality and quanity control via future SWM ponds					
Sod Farm / Golf Course	61.1	0.24	NONE	0%	14.66
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	33.7	0.24	Wet Detention Ponds	63%	2.99
future development to be receive quality and quanity control via future SWM ponds					

PostDeveloped Area Altered: **660.90**
Total PreDeveloped Area: **660.90**
Unaffected Area: **0**

Pre-Developed Phosphorus EXPORT: **781.91**
Post-Developed EXPORT (without BMP): **798.75**
Post-Developed EXPORT (with BMP): **747.67**
Total Phosphorus Reduction Potential: **34.2**
(kg/year)

DEVELOPMENT:	**City of Orillia - Lake Couchiching Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**782**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**748**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

Database Version:
Update Date:

Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Silver Creek Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	55.6	0.36	20.02
Forest	84.2	0.10	8.42
Hay-Pasture	0.1	0.12	0.01
High Intensity - Comm/Industria	137	1.82	249.34
High Intensity - Residential	149.7	1.32	197.60
Low Intensity Development	6	0.13	0.78
Sod Farm / Golf Course	59.3	0.24	14.23

Total Pre-Developed Area (ha): **491.9** Total Pre-Developed Phosphorus Load (kg/yr): **490.40**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	6.5	0.10	Wet Detention Ponds	63%	0.24
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Comm/Industria	128.6	1.82	Wet Detention Ponds	63%	86.60
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Residential	289.9	1.32	Wet Detention Ponds	63%	141.59
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
Sod Farm / Golf Course	66.9	0.24	Wet Detention Ponds	63%	5.94
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		

PostDeveloped Area Altered:	**491.90**	Pre-Developed Phosphorus EXPORT:	**490.40**
Total PreDeveloped Area:	**491.90**	Post-Developed EXPORT (without BMP):	**633.43**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**234.37**
		Total Phosphorus Reduction Potential:	**256.0**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Silver Creek Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**490**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**234**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

Ontario
MINISTRY OF THE ENVIRONMENT

Database Version:
Update Date:

Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Bass Lake Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	30	0.36	10.80
Forest	53.7	0.10	5.37
Hay-Pasture	37.7	0.12	4.52
High Intensity - Comm/Industria	1.1	1.82	2.00
Low Intensity Development	4.4	0.13	0.57

Total Pre-Developed Area (ha): **126.900** Total Pre-Developed Phosphorus Load (kg/yr): **23.27**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	38.3	0.10	NONE	0%	3.83
High Intensity - Residential	87.9	1.32	Wet Detention Ponds	63%	42.93
future development to be receive quality and quanity control via future SWM ponds					
Sod Farm / Golf Course	0.7	0.24	Wet Detention Ponds	63%	0.06
ɔpment to be receive quality and quanity control via future SWM ponds (parkland included in this landuse classification)					

PostDeveloped Area Altered:	**126.90**	Pre-Developed Phosphorus EXPORT:	**23.27**
Total PreDeveloped Area:	**126.90**	Post-Developed EXPORT (without BMP):	**120.03**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**46.82**
		Total Phosphorus Reduction Potential:	**-23.6**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Bass Lake Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**23**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**47**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

MOE P-Budget Assessment:

Future Landuses with:

- traditional SWM Ponds for future development lands
- identified end-of-pipe retrofits in existing urban lands

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Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Lake Simcoe Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	120.5	0.36	43.38
Forest	535.4	0.10	53.54
Hay-Pasture	11.2	0.12	1.34
High Intensity - Comm/Industria	128.6	1.82	234.05
High Intensity - Residential	517	1.32	682.44
Low Intensity Development	212.5	0.13	27.63
Sod Farm / Golf Course	46.4	0.24	11.14

DEVELOPMENT:	**City of Orillia - Lake Simcoe Basin**
Subwatershed:	**Oro Creeks North**

Total Pre-Developed Area (ha): **1571.60** Total Pre-Developed Phosphorus Load (kg/yr): **1053.52**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	72	0.10	Wet Detention Ponds	63%	2.66
existing lands that could be serviced by EOP retrofit opportunities					
Forest	319.4	0.10	NONE	0%	31.94
existing uncontrolled development					
High Intensity - Comm/Industria	349	1.82	Wet Detention Ponds	63%	235.02
ıt could be serviced by EOP retrofit opportunities AND future development lands to be controlled via future SWM ponds					
High Intensity - Comm/Industria	75.5	1.82	NONE	0%	137.41
existing uncontrolled development					
High Intensity - Residential	455.2	1.32	Wet Detention Ponds	63%	222.32
ıt could be serviced by EOP retrofit opportunities AND future development lands to be controlled via future SWM ponds					
High Intensity - Residential	196.8	1.32	NONE	0%	259.78
existing uncontrolled development					
Sod Farm / Golf Course	32.4	0.24	NONE	0%	7.78
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	71.3	0.24	Wet Detention Ponds	63%	6.33
evelopment lands to be controlled via future SWM ponds (parklands / open space included in this landuse classification					

PostDeveloped Area Altered:	**1571.60**	Pre-Developed Phosphorus EXPORT:	**1053.52**
Total PreDeveloped Area:	**1571.60**	Post-Developed EXPORT (without BMP):	**1697.26**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**903.23**
		Total Phosphorus Reduction Potential:	**150.3**
			(kg/year)

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**1054**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**903**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: **City of Orillia - Lake Couchiching Basin**
Subwatershed: **Oro Creeks North**

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Forest	72.6	0.10	7.26
High Intensity - Comm/Industria	138.4	1.82	251.89
High Intensity - Residential	384.5	1.32	507.54
Low Intensity Development	4.3	0.13	0.56
Sod Farm / Golf Course	61.1	0.24	14.66

DEVELOPMENT: City of Orillia - Lake Couchiching Basin
Subwatershed: Oro Creeks North

Total Pre-Developed Area (ha): **660.9** Total Pre-Developed Phosphorus Load (kg/yr): **781.91**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	17	0.10	Wet Detention Ponds	63%	0.63
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					
Forest	3	0.10	NONE	0%	0.30
existing uncontrolled lands					
High Intensity - Comm/Industria	68.5	1.82	Wet Detention Ponds	63%	46.13
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					
High Intensity - Comm/Industria	37.9	1.82	NONE	0%	68.98
existing uncontrolled development					
High Intensity - Residential	180.4	1.32	NONE	0%	238.13
existing uncontrolled development					
High Intensity - Residential	259.3	1.32	Wet Detention Ponds	63%	126.64
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					
Sod Farm / Golf Course	38.4	0.24	NONE	0%	9.22
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	56.4	0.24	Wet Detention Ponds	63%	5.01
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					

PostDeveloped Area Altered:	**660.90**	Pre-Developed Phosphorus EXPORT:	**781.91**
Total PreDeveloped Area:	**660.90**	Post-Developed EXPORT (without BMP):	**798.80**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**495.03**
		Total Phosphorus Reduction Potential:	**286.9**
			(kg/year)

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**782**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**495**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Database Version:
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Project DEVELOPMENT Summary

DEVELOPMENT: **City of Orillia - Silver Creek Basin**
Subwatershed: **Oro Creeks North**

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	55.6	0.36	20.02
Forest	84.2	0.10	8.42
Hay-Pasture	0.1	0.12	0.01
High Intensity - Comm/Industria	137	1.82	249.34
High Intensity - Residential	149.7	1.32	197.60
Low Intensity Development	6	0.13	0.78
Sod Farm / Golf Course	59.3	0.24	14.23

Total Pre-Developed Area (ha): **491.9** Total Pre-Developed Phosphorus Load (kg/yr): **490.40**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	6.5	0.10	Wet Detention Ponds	63%	0.24
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Comm/Industria	128.6	1.82	Wet Detention Ponds	63%	86.60
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Residential	289.9	1.32	Wet Detention Ponds	63%	141.59
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
Sod Farm / Golf Course	66.9	0.24	Wet Detention Ponds	63%	5.94
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		

PostDeveloped Area Altered:	**491.90**	Pre-Developed Phosphorus EXPORT:	**490.40**
Total PreDeveloped Area:	**491.90**	Post-Developed EXPORT (without BMP):	**633.43**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**234.37**
		Total Phosphorus Reduction Potential:	**256.0**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Silver Creek Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**490**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**234**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Database Version:
Update Date:

Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Bass Lake Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	30	0.36	10.80
Forest	53.7	0.10	5.37
Hay-Pasture	37.7	0.12	4.52
High Intensity - Comm/Industria	1.1	1.82	2.00
Low Intensity Development	4.4	0.13	0.57

Total Pre-Developed Area (ha): **126.900**
Total Pre-Developed Phosphorus Load (kg/yr): **23.27**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	38.3	0.10	NONE	0%	3.83
High Intensity - Residential	87.9	1.32	Wet Detention Ponds	63%	42.93
future development to be receive quality and quanity control via future SWM ponds					
Sod Farm / Golf Course	0.7	0.24	Wet Detention Ponds	63%	0.06
ɔpment to be receive quality and quanity control via future SWM ponds (parkland included in this landuse classification)					

PostDeveloped Area Altered: **126.90**
Total PreDeveloped Area: **126.90**
Unaffected Area: **0**

Pre-Developed Phosphorus EXPORT: **23.27**
Post-Developed EXPORT (without BMP): **120.03**
Post-Developed EXPORT (with BMP): **46.82**
Total Phosphorus Reduction Potential: **-23.6**
(kg/year)

DEVELOPMENT: City of Orillia - Bass Lake Basin
Subwatershed: Oro Creeks North

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**23**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**47**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

MOE P-Budget Assessment:

Future Landuses with:

- traditional SWM Ponds for future development lands
- identified end-of-pipe retrofits in existing urban lands
- source & conveyance LID retrofits in existing urban lands

Database Version:
Update Date:

Project DEVELOPMENT Summary

DEVELOPMENT: **City of Orillia - Lake Simcoe Basin**
Subwatershed: **Oro Creeks North**

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	120.5	0.36	43.38
Forest	535.4	0.10	53.54
Hay-Pasture	11.2	0.12	1.34
High Intensity - Comm/Industria	128.6	1.82	234.05
High Intensity - Residential	517	1.32	682.44
Low Intensity Development	212.5	0.13	27.63
Sod Farm / Golf Course	46.4	0.24	11.14

DEVELOPMENT: **City of Orillia - Lake Simcoe Basin**
Subwatershed: **Oro Creeks North**

Total Pre-Developed Area (ha): **1571.60** Total Pre-Developed Phosphorus Load (kg/yr): **1053.52**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	72	0.10	Wet Detention Ponds	63%	2.66
existing lands that could be serviced by EOP retrofit opportunities					
Forest	319.3	0.10	NONE	0%	31.93
existing uncontrolled development					
High Intensity - Comm/Industria	25.6	1.82	NONE	0%	46.59
existing uncontrolled development					
High Intensity - Comm/Industria	349	1.82	Wet Detention Ponds	63%	235.02
ıt could be serviced by EOP retrofit opportunities AND future development lands to be controlled via future SWM ponds					
High Intensity - Comm/Industria	49.9	1.82	Perforated Pipe Infiltration/Exfiltration Systems	87%	11.81
existing lands that could be retrofit using source and conveyance LID`s					
High Intensity - Residential	120.2	1.32	NONE	0%	158.66
existing uncontrolled development					
High Intensity - Residential	76.7	1.32	Perforated Pipe Infiltration/Exfiltration Systems	87%	13.16
existing lands that could be retrofit using source and conveyance LID`s					
High Intensity - Residential	455.2	1.32	Wet Detention Ponds	63%	222.32
ıt could be serviced by EOP retrofit opportunities AND future development lands to be controlled via future SWM ponds					
Sod Farm / Golf Course	32.4	0.24	NONE	0%	7.78
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	71.3	0.24	Wet Detention Ponds	63%	6.33
evelopment lands to be controlled via future SWM ponds (parklands / open space included in this landuse classification					

PostDeveloped Area Altered:	**1571.60**	Pre-Developed Phosphorus EXPORT:	**1053.52**
Total PreDeveloped Area:	**1571.60**	Post-Developed EXPORT (without BMP):	**1697.38**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**736.26**
		Total Phosphorus Reduction Potential:	**317.3**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Lake Simcoe Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**1054**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**736**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Lake Couchiching Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Forest	72.6	0.10	7.26
High Intensity - Comm/Industria	138.4	1.82	251.89
High Intensity - Residential	384.5	1.32	507.54
Low Intensity Development	4.3	0.13	0.56
Sod Farm / Golf Course	61.1	0.24	14.66

DEVELOPMENT:	**City of Orillia - Lake Couchiching Basin**
Subwatershed:	**Oro Creeks North**

Total Pre-Developed Area (ha): **660.9**   Total Pre-Developed Phosphorus Load (kg/yr): **781.91**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	17	0.10	Wet Detention Ponds	63%	0.63
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					
Forest	3	0.10	NONE	0%	0.30
existing uncontrolled lands					
High Intensity - Comm/Industria	14.3	1.82	NONE	0%	26.03
existing uncontrolled development					
High Intensity - Comm/Industria	68.5	1.82	Wet Detention Ponds	63%	46.13
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					
High Intensity - Comm/Industria	23.6	1.82	Perforated Pipe Infiltration/Exfiltration Systems	87%	5.58
existing lands which could be serviced by source and conveyance LID retrofits					
High Intensity - Residential	106.4	1.32	NONE	0%	140.45
existing uncontrolled development					
High Intensity - Residential	259.3	1.32	Wet Detention Ponds	63%	126.64
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					
High Intensity - Residential	74	1.32	Perforated Pipe Infiltration/Exfiltration Systems	87%	12.70
existing lands which could be serviced by source and conveyance LID retrofits					
Sod Farm / Golf Course	38.4	0.24	NONE	0%	9.22
existing uncontrolled development (parklands / open space included in this landuse classification)					
Sod Farm / Golf Course	56.4	0.24	Wet Detention Ponds	63%	5.01
existing lands which could be serviced by EOP retrofits AND future landuses to be controlled via SWM Ponds					

PostDeveloped Area Altered:	**660.90**	Pre-Developed Phosphorus EXPORT:	**781.91**
Total PreDeveloped Area:	**660.90**	Post-Developed EXPORT (without BMP):	**798.80**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**372.68**
		Total Phosphorus Reduction Potential:	**409.2**
			(kg/year)

DEVELOPMENT:	**City of Orillia - Lake Couchiching Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**782**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**373**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: **City of Orillia - Silver Creek Basin**
Subwatershed: **Oro Creeks North**

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	55.6	0.36	20.02
Forest	84.2	0.10	8.42
Hay-Pasture	0.1	0.12	0.01
High Intensity - Comm/Industria	137	1.82	249.34
High Intensity - Residential	149.7	1.32	197.60
Low Intensity Development	6	0.13	0.78
Sod Farm / Golf Course	59.3	0.24	14.23

DEVELOPMENT: **City of Orillia - Silver Creek Basin**
Subwatershed: **Oro Creeks North**

Total Pre-Developed Area (ha): **491.9** Total Pre-Developed Phosphorus Load (kg/yr): **490.40**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	6.4	0.10	Wet Detention Ponds	63%	0.24
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Comm/Industria	115.8	1.82	Wet Detention Ponds	63%	77.98
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Comm/Industria	12.9	1.82	Perforated Pipe Infiltration/Exfiltration Systems	87%	3.05
			existing lands which could be serviced by source & conveyance LID retrofits		
High Intensity - Residential	274.9	1.32	Wet Detention Ponds	63%	134.26
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		
High Intensity - Residential	15	1.32	Perforated Pipe Infiltration/Exfiltration Systems	87%	2.57
			existing lands which could be serviced by source & conveyance LID retrofits		
Sod Farm / Golf Course	66.9	0.24	Wet Detention Ponds	63%	5.94
			assume all existing and future landuses in entire basin drain via SWM Ponds F1 & F2		

PostDeveloped Area Altered:	**491.90**	Pre-Developed Phosphorus EXPORT:	**490.40**
Total PreDeveloped Area:	**491.90**	Post-Developed EXPORT (without BMP):	**633.60**
Unaffected Area:	**0**	Post-Developed EXPORT (with BMP):	**224.04**
		Total Phosphorus Reduction Potential:	**266.4**
			(kg/year)

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**490**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**224**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

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Project DEVELOPMENT Summary

DEVELOPMENT: City of Orillia - Bass Lake Basin
Subwatershed: Oro Creeks North

Pre-Development Landuse	Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Cropland	30	0.36	10.80
Forest	53.7	0.10	5.37
Hay-Pasture	37.7	0.12	4.52
High Intensity - Comm/Industria	1.1	1.82	2.00
Low Intensity Development	4.4	0.13	0.57

Total Pre-Developed Area (ha): **126.900**   Total Pre-Developed Phosphorus Load (kg/yr): **23.27**

POST-DEVELOPMENT EXPORT

Post-Development Landuse	Area (ha)	P coeff (kg/ha)	Best Management Practice applied with Reduction Potential		Pload (kg/yr)
Forest	38.3	0.10	NONE	0%	3.83
High Intensity - Residential	87.9	1.32	Wet Detention Ponds	63%	42.93
		future development to be receive quality and quanity control via future SWM ponds			
Sod Farm / Golf Course	0.7	0.24	Wet Detention Ponds	63%	0.06
		ɔpment to be receive quality and quanity control via future SWM ponds (parkland included in this landuse classification)			

PostDeveloped Area Altered: **126.90**
Total PreDeveloped Area: **126.90**
Unaffected Area: **0**

Pre-Developed Phosphorus EXPORT: **23.27**
Post-Developed EXPORT (without BMP): **120.03**
Post-Developed EXPORT (with BMP): **46.82**
Total Phosphorus Reduction Potential: **-23.6**
(kg/year)

DEVELOPMENT:	**City of Orillia - Bass Lake Basin**
Subwatershed:	**Oro Creeks North**

CONSTRUCTION EXPORT

Total Pre-Developed Phosphorus Load (kg/yr):	**23**
Construction Phase Total Load (kg) :	to be determined
Construction Phase Ammortized Annual Load Over 8 years (kg/yr) :	to be determined
Post Development Total Load (kg/yr) :	**47**
Total Load (kg/yr): Post Development + Construction	
Conclusion:	**Net Reduction in Load**

APPENDIX D:

Pollutant Loadings Estimates

Estimated Pollutant Loadings - Existing Landuses

Annual Precipitation (m) = 0.940 m/yr

Subwatershed / Basin	Landuse	SWM Controls	Area ha	%area	Runoff coefficient	Total Suspended Solids (TSS)				Copper (Cu)				Zinc (Zn)				E.coli			
						TSS EMC (mg/l)	EMC (kg/m3)	SWM Removal %	TSS Loading (Kg/year)	Cu EMC (mg/l)	EMC (kg/m3)	SWM Removal %	Cu Loading (Kg/year)	Zn EMC (mg/l)	EMC (kg/m3)	SWM Removal %	Zn Loading (Kg/year)	E.coli EMC (#/100ml)	EMC (#/m3) (millions)	SWM Removal %	E.coli. Loading (#/year) (trillions)
Lake Simcoe	Comm./Ind./Instit./Roads	no ex. water quality control	118.0	7.5%	0.8	87	0.087	0%	77,170	0.128	0.000128	0%	114	0.290	0.000290	0%	257	3,000	30.00	0%	26.61
		ex. area to Pond M1	10.7	0.7%	0.8	87	0.087	80%	1,395	0.128	0.000128	48%	5	0.290	0.000290	63%	9	3,000	30.00	53%	1.13
	Residential	no ex. water quality control	517.0	32.9%	0.55	131	0.131	0%	350,144	0.025	0.000025	0%	67	0.111	0.000111	0%	297	12,645	126.45	0%	337.98
		ex. area to Pond M1	0.0	0.0%	0.55	131	0.131	80%	0	0.025	0.000025	48%	0	0.111	0.000111	63%	0	12,645	126.45	53%	0.00
	Open Space (parklands/golf)	no ex. water quality control	30.7	2.0%	0.25	216	0.216	0%	15,594	0.025	0.000025	0%	2	0.123	0.000123	0%	9	4,100	41.00	0%	2.96
		ex. area to Pond M1	15.7	1.0%	0.25	216	0.216	80%	1,590	0.025	0.000025	48%	0	0.123	0.000123	63%	2	4,100	41.00	53%	0.71
	Agricultural	no ex. water quality control	40.8	2.6%	0.2	100	0.100	0%	7,667	0.008	0.000008	0%	1	0.018	0.000018	0%	1	51,532	515.32	0%	39.51
		ex. area to Pond M1	91.0	5.8%	0.2	100	0.100	80%	3,420	0.008	0.000008	48%	1	0.018	0.000018	63%	1	51,532	515.32	53%	41.41
	Forest	no ex. water quality control	517.8	32.9%	0.2	55	0.055	0%	53,536	0.006	0.000006	0%	6	0.025	0.000025	0%	24	100	1.00	0%	0.97
		ex. area to Pond M1	17.6	1.1%	0.2	55	0.055	80%	364	0.006	0.000006	48%	0	0.025	0.000025	63%	0	100	1.00	53%	0.02
	Rural Development	no ex. water quality control	208.7	13.3%	0.3	71	0.071	0%	41,791	0.002	0.000002	0%	1	0.004	0.000004	0%	2	83	0.83	0%	0.49
		ex. area to Pond M1	3.8	0.2%	0.3	71	0.071	80%	151	0.002	0.000002	48%	0	0.004	0.000004	63%	0	83	0.83	53%	0.00
		total:	1571.6						552,822				196				603				452
Lake Couchiching	Comm./Ind./Instit./Roads	no ex. water quality control	138.4	20.9%	0.8	87	0.087	0%	90,567	0.128	0.000128	0%	133	0.290	0.000290	0%	302	3,000	30.00	0%	31.23
	Residential	no ex. water quality control	384.5	58.2%	0.55	131	0.131	0%	260,418	0.025	0.000025	0%	50	0.111	0.000111	0%	221	12,645	126.45	0%	251.37
	Open Space (parklands/golf)	no ex. water quality control	61.1	9.2%	0.25	216	0.216	0%	31,018	0.025	0.000025	0%	4	0.123	0.000123	0%	18	4,100	41.00	0%	5.89
	Agricultural	no ex. water quality control	0.0	0.0%	0.2	100	0.100	0%	0	0.008	0.000008	0%	0	0.018	0.000018	0%	0	51,532	515.32	0%	0.00
	Forest	no ex. water quality control	72.5	11.0%	0.2	55	0.055	0%	7,495	0.006	0.000006	0%	1	0.025	0.000025	0%	3	100	1.00	0%	0.14
	Rural Development	no ex. water quality control	4.3	0.7%	0.3	71	0.071	0%	866	0.002	0.000002	0%	0	0.004	0.000004	0%	0	83	0.83	0%	0.01
		total:	660.9						390,363				187				544				289
Silver Creek Subwatershed	Comm./Ind./Instit./Roads	no ex. water quality control	0.0	0.0%	0.8	87	0.087	0%	0	0.128	0.000128	0%	0	0.290	0.000290	0%	0	3,000	30.00	0%	0.00
		all ex. dev'mt controlled by F1 & F2	137.0	27.9%	0.8	87	0.087	80%	17,931	0.128	0.000128	48%	69	0.290	0.000290	63%	111	3,000	30.00	53%	14.53
	Residential	no ex. water quality control	0.0	0.0%	0.55	131	0.131	0%	0	0.025	0.000025	0%	0	0.111	0.000111	0%	0	12,645	126.45	0%	0.00
		all ex. dev'mt controlled by F1 & F2	149.7	30.4%	0.55	131	0.131	80%	20,273	0.025	0.000025	48%	10	0.111	0.000111	63%	32	12,645	126.45	53%	45.99
	Open Space (parklands/golf)	no ex. water quality control	0.0	0.0%	0.25	216	0.216	0%	0	0.025	0.000025	0%	0	0.123	0.000123	0%	0	4,100	41.00	0%	0.00
		all ex. dev'mt controlled by F1 & F2	59.3	12.1%	0.25	216	0.216	80%	6,023	0.025	0.000025	48%	2	0.123	0.000123	63%	6	4,100	41.00	53%	2.69
	Agricultural	no ex. water quality control	0.0	0.0%	0.2	100	0.100	0%	0	0.008	0.000008	0%	0	0.018	0.000018	0%	0	51,532	515.32	0%	0.00
		all ex. dev'mt controlled by F1 & F2	55.7	11.3%	0.2	100	0.100	80%	2,096	0.008	0.000008	48%	0	0.018	0.000018	63%	1	51,532	515.32	53%	25.38
	Forest	no ex. water quality control	0.0	0.0%	0.2	55	0.055	0%	0	0.006	0.000006	0%	0	0.025	0.000025	0%	0	100	1.00	0%	0.00
		all ex. dev'mt controlled by F1 & F2	84.2	17.1%	0.2	55	0.055	80%	1,741	0.006	0.000006	48%	0	0.025	0.000025	63%	1	100	1.00	53%	0.07
	Rural Development	no ex. water quality control	0.0	0.0%	0.3	71	0.071	0%	0	0.002	0.000002	0%	0	0.004	0.000004	0%	0	83	0.83	0%	0.00
		all ex. dev'mt controlled by F1 & F2	6.0	1.2%	0.3	71	0.071	80%	240	0.002	0.000002	48%	0	0.004	0.000004	63%	0	83	0.83	53%	0.01
		total:	491.9						48,304				81				151				89
Bass Lake Subwatershed	Comm./Ind./Instit./Roads	no ex. water quality control	1.1	0.8%	0.8	87	0.087	0%	693	0.128	0.000128	0%	1	0.290	0.000290	0%	2	3,000	30.00	0%	0.24
	Residential	no ex. water quality control	0.0	0.0%	0.55	131	0.131	0%	0	0.025	0.000025	0%	0	0.111	0.000111	0%	0	12,645	126.45	0%	0.00
	Open Space (parklands/golf)	no ex. water quality control	0.0	0.0%	0.25	216	0.216	0%	0	0.025	0.000025	0%	0	0.123	0.000123	0%	0	4,100	41.00	0%	0.00
	Agricultural	no ex. water quality control	67.7	53.3%	0.2	100	0.100	0%	12,727	0.008	0.000008	0%	1	0.018	0.000018	0%	2	51,532	515.32	0%	65.58
	Forest	no ex. water quality control	53.7	42.3%	0.2	55	0.055	0%	5,558	0.006	0.000006	0%	1	0.025	0.000025	0%	3	100	1.00	0%	0.10
	Rural Development	no ex. water quality control	4.4	3.5%	0.3	71	0.071	0%	887	0.002	0.000002	0%	0	0.004	0.000004	0%	0	83	0.83	0%	0.01
		total:	126.9						19,865				3				7				66

Estimated Pollutant Loadings - Future Landuses with No SWM

Annual Precipitation (m) = 0.940 m/yr

						Total Suspended Solids (TSS)				Copper (Cu)				Zinc (Zn)				E.coli			
Subwatershed / Basin	Landuse	SWM Controls	Area ha	%area	Runoff coefficient	TSS EMC (mg/l)	EMC (kg/m3)	SWM Removal %	TSS Loading (Kg/year)	Cu EMC (mg/l)	EMC (kg/m3)	SWM Removal %	Cu Loading (Kg/year)	Zn EMC (mg/l)	EMC (kg/m3)	SWM Removal %	Zn Loading (Kg/year)	E.coli EMC (#/100ml)	EMC (#/m3) (millions)	SWM Removal %	E.coli. Loading (#/year) (trillions)
Lake Simcoe	Comm./Ind./Instit./Roads	uncontrolled	424.5	27.0%	0.8	87	0.087	0%	277,720	0.128	0.000128	0%	409	0.290	0.000290	0%	926	3,000	30.00	0%	95.77
	Residential	uncontrolled	652.0	41.5%	0.55	131	0.131	0%	441,560	0.025	0.000025	0%	84	0.111	0.000111	0%	374	12,645	126.45	0%	426.22
	Open Space (parkland/golf)	uncontrolled	103.7	6.6%	0.25	216	0.216	0%	52,631	0.025	0.000025	0%	6	0.123	0.000123	0%	30	4,100	41.00	0%	9.99
	Forest	uncontrolled	391.4	24.9%	0.2	55	0.055	0%	40,474	0.006	0.000006	0%	4	0.025	0.000025	0%	18	100	1.00	0%	0.74
	total:		1571.6						812,385				503				1,348				533
Lake Couchiching	Comm./Ind./Instit./Roads	uncontrolled	106.3	16.1%	0.8	87	0.087	0%	69,569	0.128	0.000128	0%	102	0.290	0.000290	0%	232	3,000	30.00	0%	23.99
	Residential	uncontrolled	439.8	66.5%	0.55	131	0.131	0%	297,876	0.025	0.000025	0%	57	0.111	0.000111	0%	252	12,645	126.45	0%	287.53
	Open Space (parkland/golf)	uncontrolled	94.8	14.3%	0.25	216	0.216	0%	48,123	0.025	0.000025	0%	6	0.123	0.000123	0%	27	4,100	41.00	0%	9.13
	Forest	uncontrolled	20.0	3.0%	0.2	55	0.055	0%	2,064	0.006	0.000006	0%	0	0.025	0.000025	0%	1	100	1.00	0%	0.04
	total:		660.9						417,633				165				513				321
Silver Creek Subwatershed	Comm./Ind./Instit./Roads - existing (to remain)	all ex. dev'mt controlled by F1 & F2	128.6	26.2%	0.8	87	0.087	80%	16,833	0.128	0.000128	48%	64	0.290	0.000290	63%	104	3,000	30.00	53%	13.64
	Comm./Ind./Instit./Roads - future (new)	uncontrolled	0.0	0.0%	0.8	87	0.087	0%	0	0.128	0.000128	0%	0	0.290	0.000290	0%	0	3,000	30.00	0%	0.00
	Comm./Ind./Instit./Roads - total		*128.6*																		
	Residential - existing (to remain)	all ex. dev'mt controlled by F1 & F2	149.7	30.4%	0.55	131	0.131	80%	20,273	0.025	0.000025	48%	10	0.111	0.000111	63%	32	12,645	126.45	53%	45.99
	Residential - future (new)	uncontrolled	140.3	28.5%	0.55	131	0.131	0%	94,995	0.025	0.000025	0%	18	0.111	0.000111	0%	80	12,645	126.45	0%	91.70
	Residential - total		*289.9*																		
	Open Space - existing (to remain)	all ex. dev'mt controlled by F1 & F2	59.3	12.1%	0.25	216	0.216	80%	6,023	0.025	0.000025	48%	2	0.123	0.000123	63%	6	4,100	41.00	53%	2.69
	Open Space - future (new)	uncontrolled	7.6	1.5%	0.25	216	0.216	0%	3,839	0.025	0.000025	0%	0	0.123	0.000123	0%	2	4,100	41.00	0%	0.73
	Open Space - total		*66.9*																		
	Forest - existing (to remain)	all ex. dev'mt controlled by F1 & F2	6.4	1.3%	0.2	55	0.055	80%	133	0.006	0.000006	48%	0	0.025	0.000025	63%	0	100	1.00	53%	0.01
	Forest - future (new)	uncontrolled	0.0	0.0%	0.2	55	0.055	0%	0	0.006	0.000006	0%	0	0.025	0.000025	0%	0	100	1.00	0%	0.00
	Forest - total		*6.4*																		
	total:		491.9						142,097				95				225				155
Bass Lake Subwatershed	Comm./Ind./Instit./Roads	uncontrolled	0.0	0.0%	0.8	87	0.087	0%	0	0.128	0.000128	0%	0	0.290	0.000290	0%	0	3,000	30.00	0%	0.00
	Residential	uncontrolled	87.9	69.3%	0.55	131	0.131	0%	59,512	0.025	0.000025	0%	11	0.111	0.000111	0%	50	12,645	126.45	0%	57.45
	Open Space (parkland/golf)	uncontrolled	0.7	0.6%	0.25	216	0.216	0%	377	0.025	0.000025	0%	0	0.123	0.000123	0%	0	4,100	41.00	0%	0.07
	Forest	uncontrolled	38.2	30.1%	0.2	55	0.055	0%	3,955	0.006	0.000006	0%	0	0.025	0.000025	0%	2	100	1.00	0%	0.07
	total:		126.9						63,845				12				52				58

Estimated Pollutant Loadings - Future Landuses with SWM in future development lands AND water quality retrofits in existing development lands

Retrofit Scenario:	include End of Pipe retrofits (Y/N) ?	y		
	include Conveyance retrofits (Y/N) ?	y		
	include Source Control retrofits (Y/N) ?	y	if yes, what % uptake rate?	10%
	Annual Precipitation (m) =	0.940	m/yr	

Lake Simcoe:

Subwatershed / Basin	Landuse	SWM Controls	Component Area or Uptake Rate	Total Potential Area (ha)	Include in SWM Scenario ?	Area to apply in SWM Scenario (ha)	%area	"Base" Runoff coefficient	Runoff coefficient adjusted if LID applied	Total Suspended Solids (TSS): TSS EMC (mg/l)	TSS: SWM Removal %	TSS: TSS Loading (Kg/year)	Copper (Cu): Cu EMC (mg/l)	Cu: SWM Removal %	Cu: Cu Loading (Kg/year)	Zinc (Zn): Zn EMC (mg/l)	Zn: SWM Removal %	Zn: Zn Loading (Kg/year)	E.coli: E.coli EMC (#/100ml)	E.coli: SWM Removal %	E.coli: E.coli. Loading (#/year) (trillions)
	Comm./Ind./Instit./Roads - total existing			128.6		128.6															
Lake Simcoe	Comm./Ind./Instit./Roads - existing	End of Pipe Retrofits	per identified retrofit sites	50.0	y	50.0	3.2%	0.8	0.8	87	80%	6,541	0.128	48%	25	0.290	63%	40	3,000	53%	5.30
	Comm./Ind./Instit./Roads - existing	Conveyance Retrofits	estimated from City plans	47.1	y	47.1	3.0%	0.8	0.4	87	60%	6,163	0.128	60%	9	0.290	60%	21	3,000	60%	2.13
	Comm./Ind./Instit./Roads - existing	Source Control Retrofits	10%	3.2	y	3.2	0.2%	0.8	0.4	87	60%	413	0.128	60%	1	0.290	60%	1	3,000	60%	0.14
	Comm./Ind./Instit./Roads - existing	none (remains uncontrolled)		28.4		28.4	1.8%	0.8	0.8	87	0%	18,565	0.128	0%	27	0.290	0%	62	3,000	0%	6.40
	Comm./Ind./Instit./Roads - future (new development)	future SWM / ponds	all future development lands	295.9		295.9	18.8%	0.8	0.8	87	80%	38,715	0.128	48%	148	0.290	63%	239	3,000	53%	31.37
	Comm./Ind./Instit./Roads - Total			424.5		424.5						70,395.9			210.1			362.9			45.3
	Residential - total existing			517.0		517.0															
	Residential - existing	End of Pipe Retrofits	per identified retrofit sites	320.2	y	320.2	20.4%	0.55	0.55	131	80%	43,370	0.025	48%	22	0.111	63%	68	12,645	53%	98.38
	Residential - existing	Conveyance Retrofits	estimated from City plans	63.3	y	63.3	4.0%	0.55	0.275	131	60%	8,571	0.025	60%	2	0.111	60%	7	12,645	60%	8.27
	Residential - existing	Source Control Retrofits	10%	13.4	y	13.4	0.8%	0.55	0.275	131	60%	1,809	0.025	60%	0	0.111	60%	2	12,645	60%	1.75
	Residential - existing	none (remains uncontrolled)		120.2		120.2	7.6%	0.55	0.55	131	0%	81,396	0.025	0%	16	0.111	0%	69	12,645	0%	78.57
	Residential - future (new)	future SWM / ponds	all future development lands	135.0		135.0	8.6%	0.55	0.55	131	80%	18,283	0.025	48%	9	0.111	63%	29	12,645	53%	41.47
	Residential - total			652.0		652.0						153,429.1			48.1			174.4			228.4
	Open Space - total existing			46.4		46.4															
	Open Space - existing	End of Pipe Retrofits	per identified retrofit sites	14.0	y	14.0	0.9%	0.25	0.25	216	80%	1,418	0.025	48%	0	0.123	63%	1	4,100	53%	0.63
	Open Space - existing	Conveyance Retrofits	n/a	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	none (remains uncontrolled)	n/a	32.4		32.4	2.1%	0.25	0.25	216	0%	16,454	0.025	0%	2	0.123	0%	9	4,100	0%	3.12
	Open Space - future (new)	future SWM / ponds	all future development lands	57.3		57.3	3.6%	0.25	0.25	216	80%	5,817	0.025	48%	2	0.123	63%	6	4,100	53%	2.59
	Open Space - total			103.7		103.7						23,689.1			4.1			17.0			6.4
	Forest - total existing			391.4		391.4															
	Forest - existing	End of Pipe Retrofits	per identified retrofit sites	72.0	y	72.0	4.6%	0.2	0.2	55	80%	1,489	0.006	48%	0	0.025	63%	1	100	53%	0.06
	Forest - existing	Conveyance Retrofits	n/a	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	none (remains uncontrolled)	n/a	319.4		319.4	20.3%	0.2	0.2	55	0%	33,027	0.006	0%	4	0.025	0%	15	100	0%	0.60
	Forest - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.2	0.2	55	80%	0	0.006	48%	0	0.025	63%	0	100	53%	0.00
	Forest - total			391.4		391.4						34,516.5			4.0			16.3			0.7

Totals:	Total Potential Area (ha)	Area to apply in SWM Scenario (ha)
end-of-pipe retrofit areas =	456.2	456.2
conveyance control retrofit areas =	110.4	110.4
source contol retrofit areas =	16.5	16.5
uncontrolled areas =	500.4	500.4
future development areas with SWM =	488.2	488.2
Total Area to Subwatershed / Basin:	1571.6	1571.6

	TSS Totals:	Cu Totals:	Zn Totals:	E.coli Totals:
loadings from end-of-pipe retrofit areas =	52,818.3	47.4	111.1	104.4
loadings from conveyance control retrofit areas =	14,734.0	10.7	27.8	10.4
loadings from source contol retrofit areas =	2,221.4	1.0	2.9	1.9
loadings fom uncontrolled areas =	149,442.0	48.4	155.2	88.7
loadings from future development areas with SWM =	62,815.0	158.9	273.5	75.4
Total Loadings to Subwatershed / Basin:	282,030.7	266.3	570.5	280.8
Comparison to Future Uncontrolled Loadings:	812,385.2	503.4	1,348.2	532.7
change:	-65%	-47%	-58%	-47%
Comparison to Existing Loadings:	552,822.3	196.4	602.6	451.8
change:	-49%	36%	-5%	-38%

.ake Couchiching:

Subwatershed / Basin	Landuse	SWM Controls	Component Area or Uptake Rate	Total Potential Area (ha)	Include in SWM Scenario ?	Area to apply in SWM Scenario (ha)	%area	"Base" Runoff coefficient	Runoff coefficient adjusted if LID applied	Total Suspended Solids (TSS) TSS EMC (mg/l)	SWM Removal %	TSS Loading (Kg/year)	Copper (Cu) Cu EMC (mg/l)	SWM Removal %	Cu Loading (Kg/year)	Zinc (Zn) Zn EMC (mg/l)	SWM Removal %	Zn Loading (Kg/year)	E.coli E.coli EMC (#/100ml)	SWM Removal %	E.coli. Loading (#/year) (trillions)
	Comm./Ind./Instit./Roads - total existing			106.3		106.3															
Lake Couchiching	Comm./Ind./Instit./Roads - existing	End of Pipe Retrofits	per identified retrofit sites	68.5	y	68.5	10.4%	0.8	0.8	87	80%	8,957	0.128	48%	34	0.290	63%	55	3,000	53%	7.26
	Comm./Ind./Instit./Roads - existing	Conveyance Retrofits	estimated from City plans	22.0	y	22.0	3.3%	0.8	0.4	87	60%	2,879	0.128	60%	4	0.290	60%	10	3,000	60%	0.99
	Comm./Ind./Instit./Roads - existing	Source Control Retrofits	10%	1.6	y	1.6	0.2%	0.8	0.4	87	60%	208	0.128	60%	0	0.290	60%	1	3,000	60%	0.07
	Comm./Ind./Instit./Roads - existing	none (remains uncontrolled)		14.3		14.3	2.2%	0.8	0.8	87	0%	9,352	0.128	0%	14	0.290	0%	31	3,000	0%	3.22
	Comm./Ind./Instit./Roads - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.8	0.8	87	80%	0	0.128	48%	0	0.290	63%	0	3,000	53%	0.00
	Comm./Ind./Instit./Roads - Total			106.3		106.3						21,395.5			52.6			96.7			11.5
	Residential - total existing			384.5		384.5															
	Residential - existing	End of Pipe Retrofits	per identified retrofit sites	204.0	y	204.0	30.9%	0.55	0.55	131	80%	27,638	0.025	48%	14	0.111	63%	43	12,645	53%	62.69
	Residential - existing	Conveyance Retrofits	estimated from City plans	62.2	y	62.2	9.4%	0.55	0.275	131	60%	8,430	0.025	60%	2	0.111	60%	7	12,645	60%	8.14
	Residential - existing	Source Control Retrofits	10%	11.8	y	11.8	1.8%	0.55	0.275	131	60%	1,602	0.025	60%	0	0.111	60%	1	12,645	60%	1.55
	Residential - existing	none (remains uncontrolled)		106.4		106.4	16.1%	0.55	0.55	131	0%	72,069	0.025	0%	14	0.111	0%	61	12,645	0%	69.57
	Residential - future (new)	future SWM / ponds	all future development lands	55.3		55.3	8.4%	0.55	0.55	131	80%	7,492	0.025	48%	4	0.111	63%	12	12,645	53%	16.99
	Residential - total			439.8		439.8						117,230.7			33.1			124.6			158.9
	Open Space - total existing			61.1		61.1															
	Open Space - existing	End of Pipe Retrofits	per identified retrofit sites	22.7	y	22.7	3.4%	0.25	0.25	216	80%	2,301	0.025	48%	1	0.123	63%	2	4,100	53%	1.03
	Open Space - existing	Conveyance Retrofits	n/a	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	none (remains uncontrolled)	n/a	38.4		38.4	5.8%	0.25	0.25	216	0%	19,513	0.025	0%	2	0.123	0%	11	4,100	0%	3.70
	Open Space - future (new)	future SWM / ponds	all future development lands	33.7		33.7	5.1%	0.25	0.25	216	80%	3,421	0.025	48%	1	0.123	63%	4	4,100	53%	1.53
	Open Space - total			94.8		94.8						25,235.4			4.0			17.1			6.3
	Forest - total existing			20.0		20.0															
	Forest - existing	End of Pipe Retrofits	per identified retrofit sites	17.0	y	17.0	2.6%	0.2	0.2	55	80%	351	0.006	48%	0	0.025	63%	0	100	53%	0.01
	Forest - existing	Conveyance Retrofits	n/a	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	none (remains uncontrolled)	n/a	3.0		3.0	0.5%	0.2	0.2	55	0%	311	0.006	0%	0	0.025	0%	0	100	0%	0.01
	Forest - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.2	0.2	55	80%	0	0.006	48%	0	0.025	63%	0	100	53%	0.00
	Forest - total			20.0		20.0						662.0			0.1			0.4			0.02

Totals:			Totals:		Totals:	Totals:	Totals:
end-of-pipe retrofit areas =	312.1	312.1	loadings from end-of-pipe retrofit areas =	39,246.2	48.8	101.3	71.0
conveyance control retrofit areas =	84.2	84.2	loadings from conveyance control retrofit areas =	11,309.0	5.8	16.7	9.1
source contol retrofit areas =	13.4	13.4	loadings from source contol retrofit areas =	1,809.4	0.6	2.0	1.6
uncontrolled areas =	162.2	162.2	loadings fom uncontrolled areas =	101,246.0	29.8	103.5	76.5
future development areas with SWM =	89.0	89.0	loadings from future development areas with SWM =	10,912.9	4.7	15.3	18.5
Total Area to Subwatershed / Basin:	660.9	660.9	Total Loadings to Subwatershed / Basin:	164,523.5	89.8	238.9	176.8
			Comparison to Future Uncontrolled Loadings:	417,633.3	165.0	512.6	320.7
			change:	-61%	-46%	-53%	-45%
			Comparison to Existing Loadings:	390,363.1	187.4	543.7	288.6
			change:	-58%	-52%	-56%	-39%

Silver Creek:

Subwatershed / Basin	Landuse	SWM Controls	Component Area or Uptake Rate	Total Potential Area (ha)	Include in SWM Scenario ?	Area to apply in SWM Scenario (ha)	%area	"Base" Runoff coefficient	Runoff coefficient adjusted if LID applied	Total Suspended Solids (TSS): TSS EMC (mg/l)	SWM Removal %	TSS Loading (Kg/year)	Copper (Cu): Cu EMC (mg/l)	SWM Removal %	Cu Loading (Kg/year)	Zinc (Zn): Zn EMC (mg/l)	SWM Removal %	Zn Loading (Kg/year)	E.coli: E.coli EMC (#/100ml)	SWM Removal %	E.coli. Loading (#/year) (trillions)
	Comm./Ind./Instit./Roads - total existing			128.6		128.6															
Silver Creek	Comm./Ind./Instit./Roads - existing	End of Pipe Retrofits	none identified	0.0	y	0.0	0.0%	0.8	0.8	87	80%	0	0.128	48%	0	0.290	63%	0	3,000	53%	0.00
	Comm./Ind./Instit./Roads - existing	Conveyance Retrofits	none identified	0.0	y	0.0	0.0%	0.8	0.4	87	60%	0	0.128	60%	0	0.290	60%	0	3,000	60%	0.00
	Comm./Ind./Instit./Roads - existing	Source Control Retrofits	10%	12.9	y	12.9	2.6%	0.8	0.4	87	60%	1,683	0.128	60%	2	0.290	60%	6	3,000	60%	0.58
	Comm./Ind./Instit./Roads - existing	SWM Ponds F1 & F2	all other areas without s. or c.control	115.8		115.8	23.5%	0.8	0.8	87	80%	15,150	0.128	48%	58	0.290	63%	93	3,000	53%	12.28
	Comm./Ind./Instit./Roads - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.8	0.8	87	80%	0	0.128	48%	0	0.290	63%	0	3,000	53%	0.00
	Comm./Ind./Instit./Roads - Total			128.6		128.6						16,833.4			60.4			99.0			12.9
	Residential - total existing			149.7		149.7															
	Residential - existing	End of Pipe Retrofits	none identified	0.0	y	0.0	0.0%	0.55	0.55	131	80%	0	0.025	48%	0	0.111	63%	0	12,645	53%	0.00
	Residential - existing	Conveyance Retrofits	none identified	0.0	y	0.0	0.0%	0.55	0.275	131	60%	0	0.025	60%	0	0.111	60%	0	12,645	60%	0.00
	Residential - existing	Source Control Retrofits	10%	15.0	y	15.0	3.0%	0.55	0.275	131	60%	2,027	0.025	60%	0	0.111	60%	2	12,645	60%	1.96
	Residential - existing	SWM Ponds F1 & F2	all other areas without s. or c.control	134.7		134.7	27.4%	0.55	0.55	131	80%	18,246	0.025	48%	9	0.111	63%	29	12,645	53%	41.39
	Residential - future (new)	future SWM / ponds	all future development lands	140.3		140.3	28.5%	0.55	0.55	131	80%	18,999	0.025	48%	9	0.111	63%	30	12,645	53%	43.10
	Residential - total			289.9		289.9						39,272.3			18.9			60.1			86.4
	Open Space - total existing			59.3		59.3															
	Open Space - existing	End of Pipe Retrofits	none identified	0.0		0.0	0.0%	0.25	0.25	216	80%	0	0.025	48%	0	0.123	63%	0	4,100	53%	0.00
	Open Space - existing	Conveyance Retrofits	none identified	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	SWM Ponds F1 & F2	all other areas without s. or c.control	59.3		59.3	12.1%	0.25	0.25	216	80%	6,023	0.025	48%	2	0.123	63%	6	4,100	53%	2.69
	Open Space - future (new)	future SWM / ponds	all future development lands	7.6		7.6	1.5%	0.25	0.25	216	80%	768	0.025	48%	0	0.123	63%	1	4,100	53%	0.34
	Open Space - total			66.9		66.9						6,791.3			2.0			7.2			3.0
	Forest - total existing			6.4		6.4															
	Forest - existing	End of Pipe Retrofits	none identified	0.0		0.0	0.0%	0.2	0.2	55	80%	0	0.006	48%	0	0.025	63%	0	100	53%	0.00
	Forest - existing	Conveyance Retrofits	none identified	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	SWM Ponds F1 & F2	all other areas without s. or c.control	6.4		6.4	1.3%	0.2	0.2	55	80%	133	0.006	48%	0	0.025	63%	0	100	53%	0.01
	Forest - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.2	0.2	55	80%	0	0.006	48%	0	0.025	63%	0	100	53%	0.00
	Forest - total			6.4		6.4						133.0			0.0			0.1			0.01

Totals:	Total Potential Area (ha)	Area to apply in SWM Scenario (ha)
end-of-pipe retrofit areas =	0.0	0.0
conveyance control retrofit areas =	0.0	0.0
source contol retrofit areas =	27.8	27.8
ex. development lands controlled via SWM Ponds F1 & F2 =	316.3	316.3
future development areas with SWM =	147.8	147.8
Total Area to Subwatershed / Basin:	491.9	491.9

Totals:	TSS	Cu	Zn	E.coli
loadings from end-of-pipe retrofit areas =	0.0	0.0	0.0	0.0
loadings from conveyance control retrofit areas =	0.0	0.0	0.0	0.0
loadings from source contol retrofit areas =	3,710.7	2.9	7.3	2.5
loadings fom ex development land areas =	39,552.5	68.9	128.5	56.4
loadings from future development areas with SWM =	19,766.8	9.7	30.6	43.4
Total Loadings to Subwatershed / Basin:	63,030.0	81.4	166.4	102.3
Comparison to Future Uncontrolled Loadings:	142,097.4	94.9	224.7	154.7
change:	-56%	-14%	-26%	-34%
Comparison to Existing Loadings:	48,304.1	81.4	150.9	88.7
change:	30%	0%	10%	15%

Bass Lake:

Subwatershed / Basin	Landuse	SWM Controls	Component Area or Uptake Rate	Total Potential Area (ha)	Include in SWM Scenario ?	Area to apply in SWM Scenario (ha)	%area	"Base" Runoff coefficient	Runoff coefficient adjusted if LID applied	Total Suspended Solids (TSS) TSS EMC (mg/l)	TSS SWM Removal %	TSS Loading (Kg/year)	Copper (Cu) Cu EMC (mg/l)	Cu SWM Removal %	Cu Loading (Kg/year)	Zinc (Zn) Zn EMC (mg/l)	Zn SWM Removal %	Zn Loading (Kg/year)	E.coli E.coli EMC (#/100ml)	E.coli SWM Removal %	E.coli. Loading (#/year) (trillions)
	Comm./Ind./Instit./Roads - total existing			0.0		0.0															
Bass Lake	Comm./Ind./Instit./Roads - existing	End of Pipe Retrofits	none identified	0.0	y	0.0	0.0%	0.8	0.8	87	80%	0	0.128	48%	0	0.290	63%	0	3,000	53%	0.00
	Comm./Ind./Instit./Roads - existing	Conveyance Retrofits	none identified	0.0	y	0.0	0.0%	0.8	0.4	87	60%	0	0.128	60%	0	0.290	60%	0	3,000	60%	0.00
	Comm./Ind./Instit./Roads - existing	Source Control Retrofits	10%	0.0	y	0.0	0.0%	0.8	0.4	87	60%	0	0.128	60%	0	0.290	60%	0	3,000	60%	0.00
	Comm./Ind./Instit./Roads - existing	none	all other areas without s. or c.control	0.0		0.0	0.0%	0.8	0.8	87	0%	0	0.128	0%	0	0.290	0%	0	3,000	0%	0.00
	Comm./Ind./Instit./Roads - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.8	0.8	87	80%	0	0.128	48%	0	0.290	63%	0	3,000	53%	0.00
	Comm./Ind./Instit./Roads - Total			0.0		0.0						0.0			0.0			0.0			0.0
	Residential - total existing			0.0		0.0															
	Residential - existing	End of Pipe Retrofits	none identified	0.0	y	0.0	0.0%	0.55	0.55	131	80%	0	0.025	48%	0	0.111	63%	0	12,645	53%	0.00
	Residential - existing	Conveyance Retrofits	none identified	0.0	y	0.0	0.0%	0.55	0.275	131	60%	0	0.025	60%	0	0.111	60%	0	12,645	60%	0.00
	Residential - existing	Source Control Retrofits	10%	0.0	y	0.0	0.0%	0.55	0.275	131	60%	0	0.025	60%	0	0.111	60%	0	12,645	60%	0.00
	Residential - existing	none	all other areas without s. or c.control	0.0		0.0	0.0%	0.55	0.55	131	0%	0	0.025	0%	0	0.111	0%	0	12,645	0%	0.00
	Residential - future (new)	future SWM / ponds	all future development lands	87.9		87.9	69.3%	0.55	0.55	131	80%	11,902	0.025	48%	6	0.111	63%	19	12,645	53%	27.00
	Residential - total			87.9		87.9						11,902.5			5.9			18.7			27.0
	Open Space - total existing			0.0		0.0															
	Open Space - existing	End of Pipe Retrofits	none identified	0.0		0.0	0.0%	0.25	0.25	216	80%	0	0.025	48%	0	0.123	63%	0	4,100	53%	0.00
	Open Space - existing	Conveyance Retrofits	none identified	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.25	0.25	216	60%	0	0.025	60%	0	0.123	60%	0	4,100	60%	0.00
	Open Space - existing	none	all other areas without s. or c.control	0.0		0.0	0.0%	0.25	0.25	216	0%	0	0.025	0%	0	0.123	0%	0	4,100	0%	0.00
	Open Space - future (new)	future SWM / ponds	all future development lands	0.7		0.7	0.6%	0.25	0.25	216	80%	75	0.025	48%	0	0.123	63%	0	4,100	53%	0.03
	Open Space - total			0.7		0.7						75.5			0.0			0.1			0.0
	Forest - total existing			38.2		38.2															
	Forest - existing	End of Pipe Retrofits	none identified	0.0		0.0	0.0%	0.2	0.2	55	80%	0	0.006	48%	0	0.025	63%	0	100	53%	0.00
	Forest - existing	Conveyance Retrofits	none identified	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	Source Control Retrofits	n/a	0.0		0.0	0.0%	0.2	0.2	55	60%	0	0.006	60%	0	0.025	60%	0	100	60%	0.00
	Forest - existing	none	all other areas without s. or c.control	38.2		38.2	30.1%	0.2	0.2	55	0%	3,955	0.006	0%	0	0.025	0%	2	100	0%	0.07
	Forest - future (new)	future SWM / ponds	all future development lands	0.0		0.0	0.0%	0.2	0.2	55	80%	0	0.006	48%	0	0.025	63%	0	100	53%	0.00
	Forest - total			38.2		38.2						3,954.9			0.4			1.8			0.07

Totals:	Total Potential Area (ha)	Area to apply in SWM Scenario (ha)	Totals:	TSS	Cu	Zn	E.coli
end-of-pipe retrofit areas =	0.0	0.0	loadings from end-of-pipe retrofit areas =	0.0	0.0	0.0	0.0
conveyance control retrofit areas =	0.0	0.0	loadings from conveyance control retrofit areas =	0.0	0.0	0.0	0.0
source contol retrofit areas =	0.0	0.0	loadings from source contol retrofit areas =	0.0	0.0	0.0	0.0
uncontrolled areas =	38.2	38.2	loadings fom uncontrolled areas =	3,954.9	0.4	1.8	0.1
future development areas with SWM =	88.6	88.6	loadings from future development areas with SWM =	11,977.9	5.9	18.7	27.0
Total Area to Subwatershed / Basin:	126.9	126.9	Total Loadings to Subwatershed / Basin:	15,932.8	6.4	20.5	27.1
			Comparison to Future Uncontrolled Loadings:	63,844.5	11.8	52.4	57.6
			change:	-75%	-46%	-61%	-53%
			Comparison to Existing Loadings:	19,864.6	2.7	7.2	65.9
			change:	-20%	138%	186%	-59%

APPENDIX E:

Public Information Centre (PIC) Material

CITY OF ORILLIA

CLASS ENVIRONMENTAL ASSESSMENT
COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

PUBLIC INFORMATION CENTRE
Tudhope Boardroom, City Hall
50 Andrew Street, South
Wednesday, May 13, 2015, 4:00 P.M. – 8:00 P.M.

The City of Orillia (City) has initiated the development of a comprehensive storm water management master plan (CSWM-MP) in accordance with the Lake Simcoe Protection Plan, the Lake Simcoe Region Conservation Authority (LSRCA) Guidelines and the **Municipal Class Environmental Assessment Process**.

As of June 2, 2009 the policies of the Lake Simcoe Protection Plan came into legal effect. Policy 4.5 of the “Lake Simcoe Protection Plan” states that “municipalities, in collaboration with the LSRCA will prepare and implement comprehensive stormwater management master plans for each settlement area in the Lake Simcoe Watershed”. The city of Orillia is a settlement area within the Lake Simcoe Watershed and therefore needs to prepare a comprehensive stormwater management plan.

The City has retained Aquafor Beech Ltd. to develop the Stormwater Management Master Plan. This Class Environmental Assessment (EA) Master Plan is intended to improve the management of stormwater for both existing and planned development. The Comprehensive Stormwater Management Master Plan study will be prepared following a Master Planning approach under the Municipal Class Environmental Assessment Process in compliance with the Municipal Engineers Association document "Municipal Class Environmental Assessment," (October 2000, as amended in 2007 and 2011). The long range planning approach that is undertaken within the process will enable the City of Orillia to identify opportunities and be proactive in addressing issues before they become a problem. It will also allow the City to implement individual works which, over time, collectively become part of a larger management system.

A key component of the study is consultation with interested stakeholders (public, landowners and regulatory agencies). Public consultation will involve one (1) Public Information Centre (PIC). This PIC will be designed to obtain input from the public to assist in the decision making process. We are interested in hearing any comments or input that you may have about this study. There are no formal presentations scheduled. City staff and their consultant will be available to discuss the proposed works.

Your comments will be maintained for reference throughout the project and will become part of the public record. Under the *Freedom of Information and Protection of Privacy Act* and the *Environmental Assessment Act*, unless otherwise stated in the submission, any personal information such as name, address, telephone number and property location included in a submission will become part of the public record files for this matter and will be released, if requested, to any person.

Subject to comments received and the receipt of necessary approvals, the City of Orillia intends to proceed with the finalization of this project in June 2015.

For further information please contact:

Kyle Mitchell
Manager of Water Resources
City of Orillia
(705) 325-3224
Email: KMitchell@orillia.ca

Greg Frew
Project Coordinator
Aquafor Beech Ltd.
(905) 629-0099 , Ext. 276
Email: frew.g@aquaforbeech.com

Comprehensive Stormwater Management Master Plan
Comment Form

Input from members of the community is important at this stage of the study in order to:

- Confirm the work completed and findings to date;
- Provide comments on the evaluation criteria and alternatives as presented; and
- Provide feedback on the selection of the preferred alternatives.

We would appreciate if you could take a few minutes to complete the following questionnaire.

Name: ____________________

Address: ____________________

Telephone no.: ____________________

Email: ____________________

The objective of this project is to develop a Comprehensive Stormwater Management Master Plan to meet the objectives of the Lake Simcoe Protection Plan (LSPP), specifically to reduce the discharge of pollutants and the loading of phosphorus and other nutrients of concern to Lake Simcoe and its tributaries. As part of this environmental assessment study, we would like your thoughts and suggestions on the following:

1. Were the PIC boards clear and easy to understand? Was the project team helpful in answering your questions and keeping you informed?

____

____

____

____

____

Comprehensive Stormwater Management Master Plan Comment Form

2. Do you agree with the selection process and criteria used to select the Preferred Alternatives? Are there additional considerations that you would like to highlight? Please answer below:

____
____
____
____

3. What are your environmental interests or concerns regarding the environmental quality of the streams and rivers located within the City of Orillia and within Lake Simcoe itself?

____
____
____
____

Having viewed the preferred alternatives, you will see that a combination of approaches have been proposed which include retrofits with existing urban areas both within the municipal road right-of-way, public lands, within existing ponds etc.

4. Would you support municipal road right-of-way retrofits with 'green' stormwater features as depicted on the PIC boards that improved water quality, better protect local waterways and Lake Simcoe while also enhancing the street aesthetic? What are your comments with respect to implementing these measures within the public right-of-way?

____
____
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____
____

Comprehensive Stormwater Management Master Plan Comment Form

5. If retrofits were proposed on your street and you and your neighbors were involved in the design process with the City, would you be willing to contribute to this environmental effort?

   Yes   or   No   (please circle one)

   If yes, would you be willing to help the City in maintaining these green features in your neighborhood? Please indicate the level of maintenance you would be willing to undertake.

Level of Maintenance (select one)	
0 hrs per month	
1-2 hrs per month	
2-4 hrs per month	
Greater than 5 hrs per month	

6. Source controls, may in the future form a considerable part of the overall solution for the City and its residents to better protect the local environment. To help the City better plan for the future, provided below is a list of measures that could be implemented by homeowners (on private property)

Please indicate which of the measures you would be willing to implement on your property.

Private Property	**Willingness to Implement**	
Roof Downspout Disconnection	☐ Yes	☐ No
Rain Barrel	☐ Yes	☐ No
Soakaway Pit/ French Drain	☐ Yes	☐ No
Permeable Driveway	☐ Yes	☐ No
Landscaping/Rain Garden	☐ Yes	☐ No
Tree Planting	☐ Yes	☐ No
Naturalized Front Yard	☐ Yes	☐ No

Comprehensive Stormwater Management Master Plan

Comment Form

7. For any of the homeowner source control measures you would **NOT** be willing to implement, please check off one or more reasons why:

Homeowner Source Control Measure	Lack of Time	Lack of Space	Lack of Information	Lack of Help	Potential Negative Effects	Money	Other
Roof Downspout Disconnection	☐	☐	☐	☐	☐	☐	☐
Rain Barrel	☐	☐	☐	☐	☐	☐	☐
Soakaway Pit	☐	☐	☐	☐	☐	☐	☐
Pervious Driveway	☐	☐	☐	☐	☐	☐	☐
Landscaping/ Bioretention	☐	☐	☐	☐	☐	☐	☐
Tree Planting	☐	☐	☐	☐	☐	☐	☐
Naturalized Front Yard	☐	☐	☐	☐	☐	☐	☐

8. Do you have any additional comments that you would like to make?

____

____

____

____

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____

____

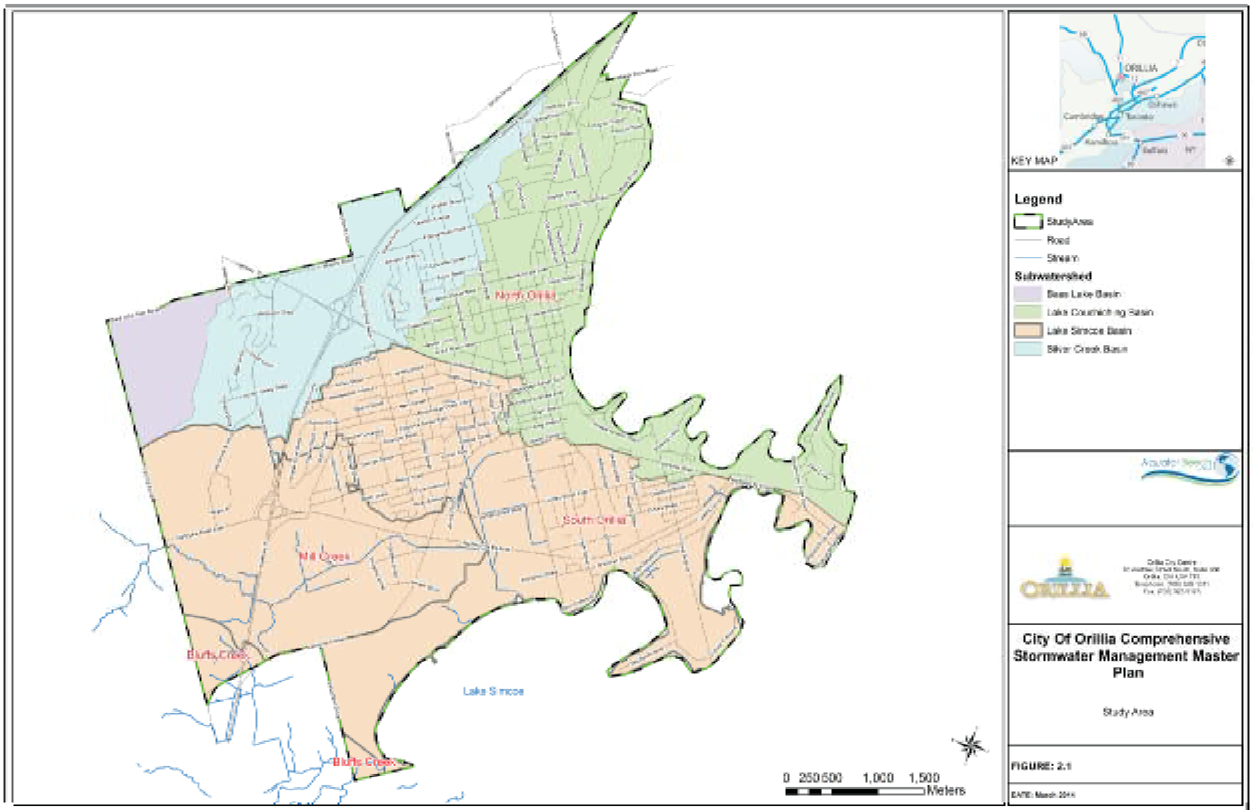
Comprehensive Stormwater Management Master Plan Comment Form

Please complete the questionnaire and leave it with one of the Project team or mail your responses and comments to City Staff by May 31, 2015 to:

Kyle Mitchell
Manager of Water Resources, City of Orillia
50 Andrew Street South, Suite 300
Orillia, ON L3V 7T5
(705) 325-3224
Email: KMitchell@orillia.ca

Thank you for participating in this consultation.

WELCOME TO THE PUBLIC OPEN HOUSE
for
City of Orillia Comprehensive Stormwater Management Master Plan

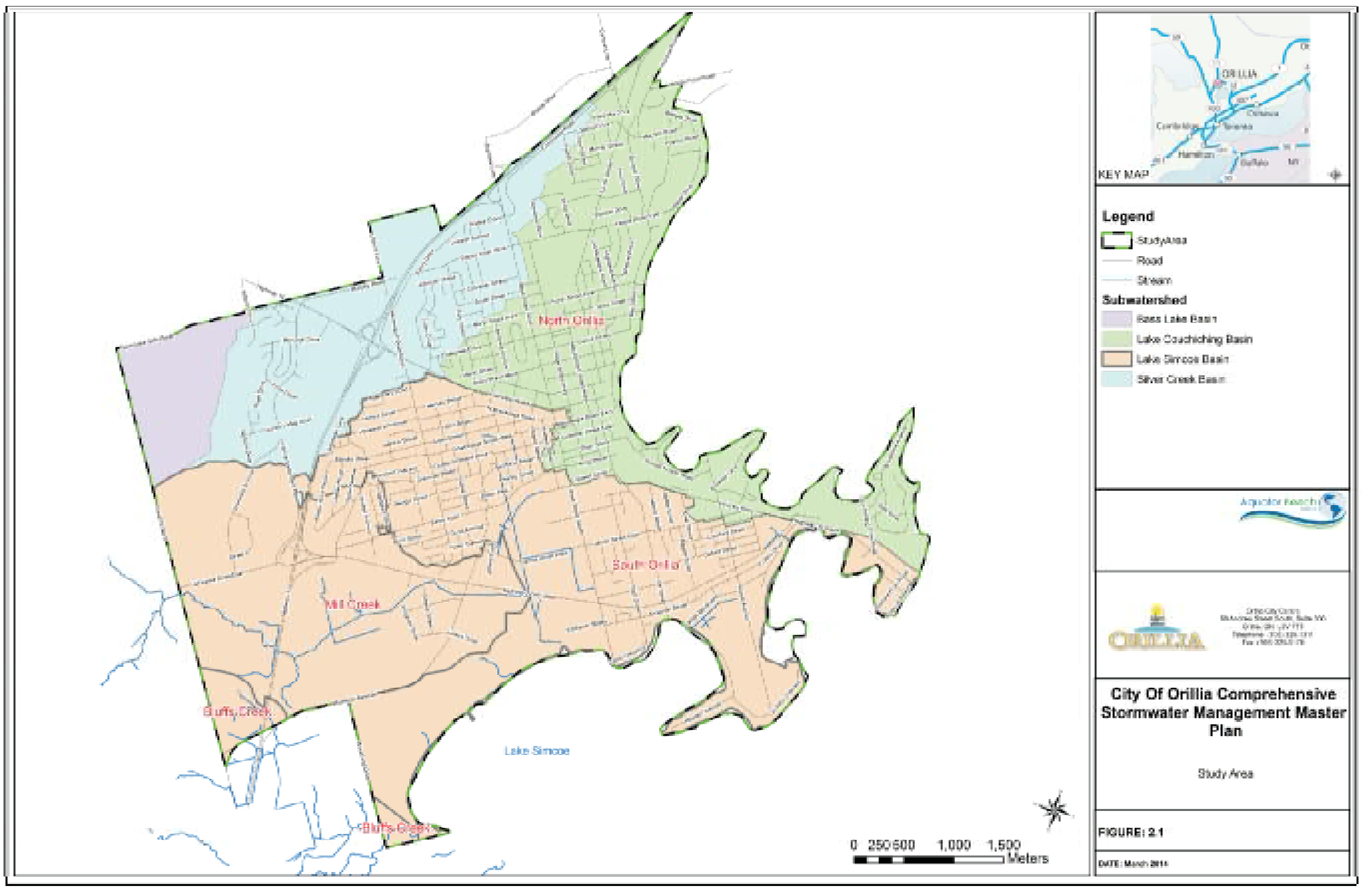


Public Open House
Wednesday May 13, 2015
Tudhope Boardroom
Orillia City Hall
50 Andrew Street South
4:00pm to 8:00pm

WELCOME TO THE PUBLIC OPEN HOUSE
for
City of Orillia Comprehensive Stormwater Management Master Plan

The City of Orillia has initiated the development of a Comprehensive Stormwater Management Master Plan (CSWM-MP) in accordance with the Lake Simcoe Protection Plan, Lake Simcoe Region Conservation Authority (LSRCA) Guidelines, and the Municipal Class Environmental Assessment Process for Master plans.

The long range planning approach that is undertaken within the process will enable the City of Orillia to identify opportunities and be proactive in addressing stormwater issues before they become a problem. It will also allow the Town to implement individual works which, over time, collectively become part of a larger management system.



<u>*Purpose of Tonight's Meeting*</u>

Tonight's Open House will provide an opportunity for the public to review the current level of environmental protection and provide input on the alternatives, criteria for evaluation and the selection process for the preferred alternatives for this project. The staff of the City of Orillia and the members of the Project Team are available to answer any questions that you may have about the overall study and how the project may impact you. The input from this Open House will then be used to refine the recommendations of the City of Orillia Comprehensive Stormwater Management Master Plan.

Public Open House
Wednesday May 13, 2015
Tudhope Boardroom
Orillia City Hall
50 Andrew Street South
4:00pm to 8:00pm

City of Orillia Comprehensive Stormwater Management Master Plan

- Study Objective & Process -

Objective		Target
Water Quality	Reduce phosphorus loadings to Lake Simcoe to 44 tonnes per year, in order to achieve a target for dissolved oxygen of 7 mg/L in the lake.	Lake Simcoe Protection Plan Targets and PWQO Standards
	Reduce pathogen loading to eliminate beach closures	
	Reduce contaminants to levels that achieve Provincial Water Quality Objectives or better	
Water Balance	Preserve and re-establish natural hydrologic cycle	prevent Infiltration deficit
	Maintain groundwater levels and baseflows	
Water Quantity	Minimize risk of flooding	control 2-yr to 100-yr outflows to pre-development rates
	Reduce stream erosion impacts	

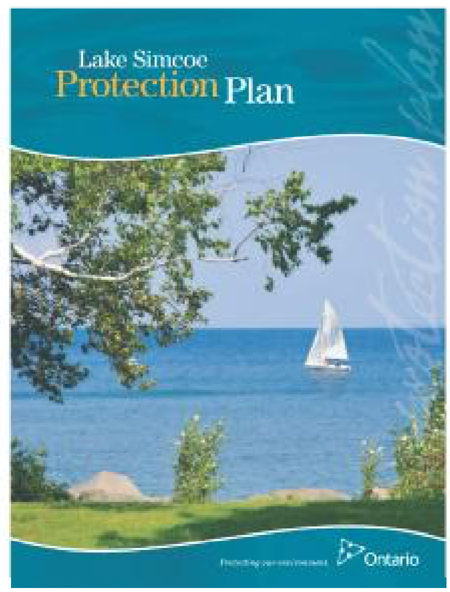
Study Objective:

As per the polices of the Lake Simcoe Protection Plan, which aim to protect and revitalize the Lake Simcoe basin, municipalities are required to prepare and implement comprehensive stormwater management master plans for each settlement area in the Lake Simcoe Watershed.

The City of Orillia is a settlement area located on the northwest shores of the Lake Simcoe watershed, and as such is required to prepare a Comprehensive Stormwater Management Master Plan (CSWM-MP).

The development of a Comprehensive Stormwater Master Plan for the City of Orillia is an important step to meet the objectives of the Lake Simcoe Protection Plan (LSPP), specifically:

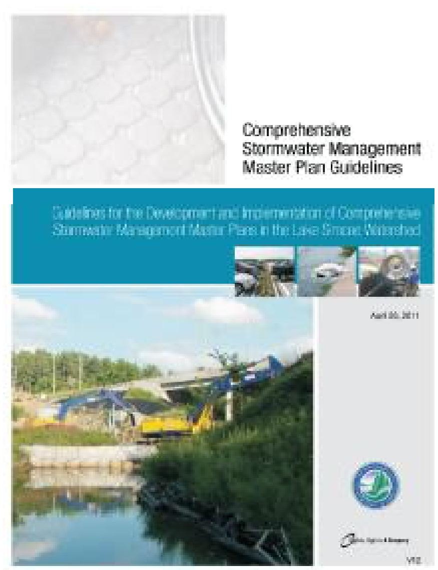
- Reducing loading of phosphorus and other nutrients of concern to Lake Simcoe and its tributaries
- Reducing discharge of pollutants to Lake Simcoe and its tributaries



Study Process:

The study process followed the ten (10) steps presented within the LSPP and (LSRCA) Guidelines for the Development and Implementation of CSWM-MP in the Lake Simcoe Watershed.

1. Scoping
2. Determine Study Area
3. Characterization of the Study Area
4. Divide into Management Units
5. Evaluate Environmental Impacts
6. Determine Effectiveness of SWM Systems
7. Identify and Evaluate SWM Opportunities
8. Establish Recommended Approach
9. Develop Implementation Plan
10. Develop Inspection and Maintenance Programs



Public Open House
May 13, 2015

City of Orillia Comprehensive Stormwater Management Master Plan

- Stormwater Background -

What is Stormwater?

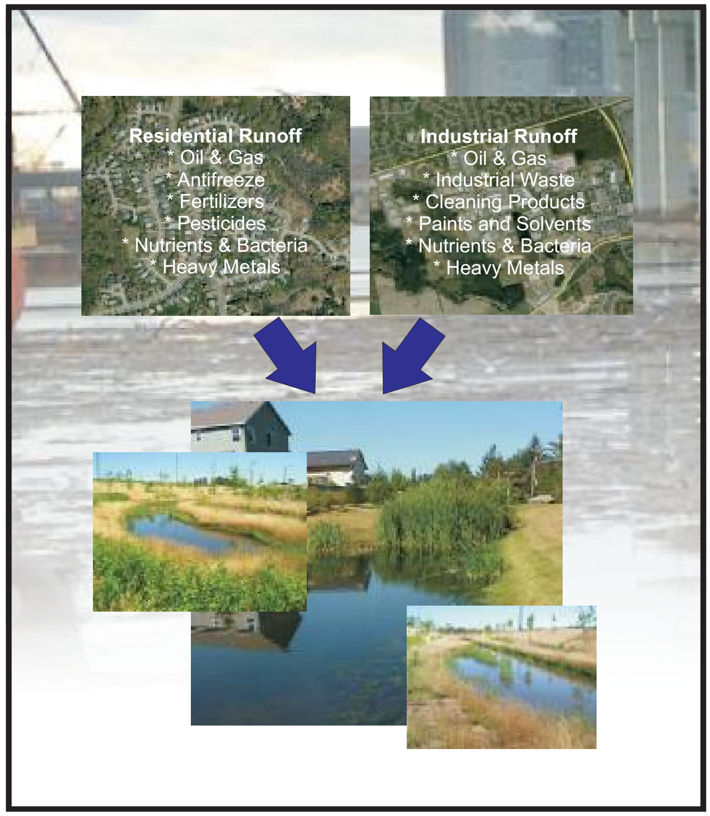
Stormwater is water that flows across the land surfaces and is routed into drainage systems which ends up in our natural areas such as creeks, lakes, and wetlands.

Stormwater in Urban Areas

As towns and cities expand over our undeveloped, natural areas, the amount of "permeable" or "porous" areas are reduced and replaced by hard surfaces which do not absorb stormwater. With less "porous" areas available, risks of flooding and erosion may increase.

How does this effect Water Quality?

Untreated runoff carries oils and grease, pesticides, fertilizers, and other chemicals off roads, lawns, and buildings which go directly into our natural areas, such as creeks, lakes, and wetlands.



City of Orillia Comprehensive Stormwater Management Master Plan

- Characterization & Key Findings -

Characterization & Key Findings:

In order to develop a recommended stormwater management strategy and implementation plan for the City of Orillia, the existing environmental conditions of the study area were characterized. Special focus was given to the environmental features and functions that are relevant to stormwater quantity and quality and the effectiveness of existing stormwater infrastructure.

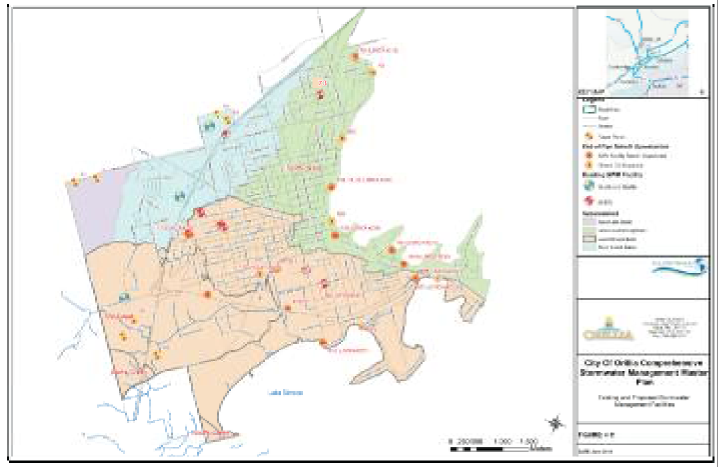
Stormwater Drainage in Orillia

Lake Simcoe Basin (55% of city):
- much of the basin has already been developed without stormwater management.
- Only 9% of the basin receives water quality treatment via existing Pond M1.
- Future development includes intensification and infill in existing urban areas, and greenfield development in the west end

Lake Couchiching Basin (23% of city):
- the basin has already been developed without stormwater management.
- Future development is limited to intensification and infill in the existing urban areas.

Bass Lake Watershed (5% of city):
- The basin is undeveloped.
- All future development will be in the form of greenfield development.

Silver Creek Watershed (17% of city):
- Much of the basin has already been developed and receives water quality and quantity treatment via existing Pond F1 and F2.
- Future development includes intensification and infill in the existing urban areas, with limited future greenfield development in the north end.



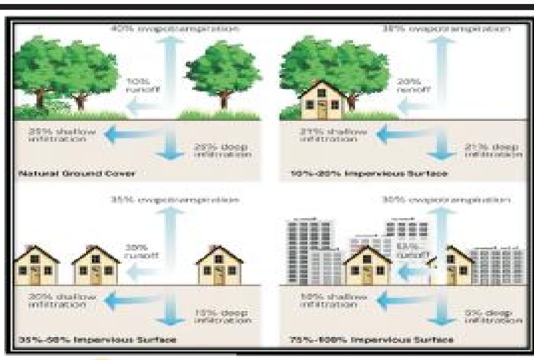
Characterization of Existing Conditions:

Water Quality:
- Surface water: Concentrations of Phosphorus, Chlorides, Total Suspended Solids, Iron, Copper and Zinc are above the Provincial Water Quality Objectives (PWQOs);

Groundwater:
- Much of the City is underlain by coarse soils which provide an important function in infiltrating and storing water for municipal supply.

Surface Water and Flood Hazards:
- portions of the city are susceptible to flooding and could be impacted by changes to stormwater runoff

Aquatic Ecology: Stress due to:
- City's streams support a variety of sensitive coldwater and coolwater fish.



Annual Phosphorous Pollutant Loadings:

Watershed Basin	Catchment Area (ha)	Existing development without SWM	Existing development & Existing SWM	Effectiveness of Existing	Future - uncontrolled new urban, and no retrofits	
		Annual Loading (kg)	Annual Loading (kg)		Annual Loading (kg)	Change from Existing
Lake Simcoe	1571.6	1054	1017	-3%	1697	67%
Lake Couchiching	660.9	782	782	n/a - no SWM	799	2%
Silver Creek Basin	491.9	490	181	-63%	634	249%
Bass Lake Basin	126.9	23	23	n/a - no SWM	120	416%

*Estimated using MOE Lake Simcoe Phosphorous Loading Development Tool

Water Quantity & Balance:

Proposed Landuse	Imperviousness		Soil Type	Annual Infiltration (mm/yr)		Infiltration Deficit (mm/ yr)
	Existing / Pre-Development	Post-Development		Existing / Pre-Development	Post-Development	
Parkland	0%	25%	coarse A/B	279	209	70
Residential	0%	50%	coarse A/B	279	140	139
Institutional	0%	70%	coarse A/B	279	84	195
Business	0%	80%	coarse A/B	279	56	223
Intensification	40%	70%	coarse A/B	167	84	84

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Public Open House
May 13, 2015

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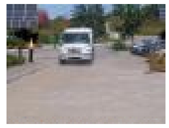
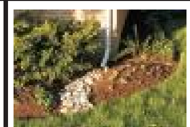
City of Orillia Comprehensive Stormwater Management Master Plan

- Alternatives & Evaluation Process -

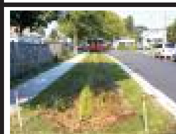
Pollution Prevention Measures
These are methods that have the intent to improve operation and maintenance of privately and publicly owned land, buildings, and infrastructure that will reduce pollution generation. Certain municipal programs such as road salt management, street sweeping and storm sewer cleaning can affect water quality.



Source Control Measures
Source controls are physical measures that encourage the infiltration of water into the ground and reduce stormwater runoff and can included LID techniques such as green roofs, permeable pavement, soakaway pits, bioretention, rainwater harvesting and downspout disconnection etc.



Conveyance Control Measures
Conveyance controls are linear stormwater transport systems that are generally located within the road right-of-way and encourage infiltration of water into ground, improve water quality and reduce runoff. They can include traditional curb and gutter systems and low impact development (LID) techniques such as, bio-swales, grassed channels and subsurface perforated pipe systems.



End-of-Pipe Measures
This option involves addressing SWM using conventional stormwater facilities at the end of the flow conveyance system. These facilities are utilized for erosion, water quantity and quality control applications. They include stormwater ponds, wetlands, and subsurface storage tanks and superpipes.

Stream Restoration Measures
The replanting of floodplain and creek buffers improves stream corridor functions and water quality, slowing runoff, moderating stream temperatures, reducing erosion and improving aquatic and terrestrial habitat conditions.

The overarching objective of the evaluation criteria was to generate a "shortlist" of stormwater management measures that constitute the "Recommended Approach". The evaluation criteria stems from the Lake Simcoe Protection Plan (LSPP) as a guiding document in recognition of the key findings of the study area characterization. The evaluation criteria consists of four (4) general categories. The evaluation criteria set is as follows:

Physical and Natural Environment (7)
- Ability to meet water quality control targets (LSPP and PWQO);
- Ability to meet water budget targets (LSPP and Infiltration Deficit);
- Ability to meet flood control targets (LSPP);
- Ability to meet erosion control targets (LSPP);
- Impacts on terrestrial habitat (connectivity, diversity and sustainability) (LSPP);
- Impacts on aquatic habitat (connectivity, diversity and sustainability) (LSPP);
- Ability to protect groundwater resources (Source Water Protection) (LSPP)

Socio-Economic and Cultural (4)
- Impacts on existing and future land uses;
- Aesthetic Value;
- Potential benefit to the community and public acceptance;
- Policy and By-law requirements;

Technical and Engineering (4)
- Level of service/ proven effectiveness;
- Regulatory agency acceptance;
- Impact on existing infrastructure
- Constructability;

Financial (3)
- Capital cost of the recommended stormwater measures;
- Operation and Maintenance cost of the recommended stormwater measures;
- Cost avoidance

Alternative Solution
1. Pollution Prevention
2. Source Control Measures
3. Conveyance Control Measures
4. End-of-Pipe Measures
5. Stream Restoration Measures

Evaluation Criteria
1. Physical & Natural Environment
2. Social-Economic & Culture
3. Technical/Egineering
4. Financial

City of Orillia
- Current Practices
- Policy Framework
- Opportunities & Constraints
- LID Preferences
- Multi-department

Recommended Approach
- Shortlists from the five categories of Alternative Solutions
- Context with LSPP and SWS objectives
- Management Units

Public Consultation
WE ARE HERE

Finalization of Recommended Approach

Implementation Consideration

Public Open House
May 13, 2015

City of Orillia Comprehensive Stormwater Management Master Plan

- Preferred Alternatives -

Pollution Prevention

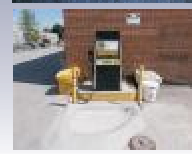
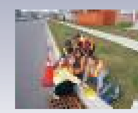
Current City Practices included:

- Reduced road salt application
- Reduced lot grading
- Catch basin and storm sewer cleaning
- Storm outfall maintenance
- Pool Drainage Standards

Additional measures which are proposed to augment current City practices may include:

- Expansion of the storm drain flushing program
- Further salt reductions on Region and MTO roads
- Public Education, and business awareness (Yellowfish Road Program)

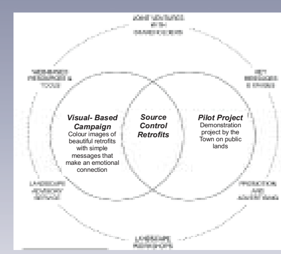


Source Controls

Proposed source controls measures are designated as retrofit measures within residential and public land use areas. Proposed source control measures include:

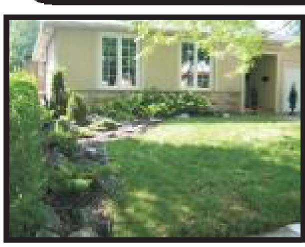
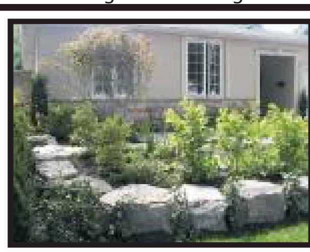
- enhanced yard vegetation / rain gardens
- downspout disconnection
- permeable pavement
- soakaway pits/french drains/infiltration chambers
- green roof technology



Since source control measures are generally implemented within private properties, the City has a limited role in leading the implementation of these measures. However, the City could provide a supportive role through the following:

- Social marketing strategy and raising awareness within community;
- Refine, update or change by-laws related to implementing these measures.
- Continued promotion of the existing rain barrel program
- Continue to require such measures through its review process for new development

This recommendation is considered a long-term strategic initiative for the City of Orillia

Adsorptive Landscaping Retrofit - Before and After (L to R)


Soakaway Pit/ French Drain Retrofit - During and After (L to R)




L to R: Rain Garden, Rain Barrels, Permeable Pavement and Downspout Disconnection,

GreenRoof

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City of Orillia Comprehensive Stormwater Management Master Plan

- Preferred Alternatives -

Conveyance Controls Measures

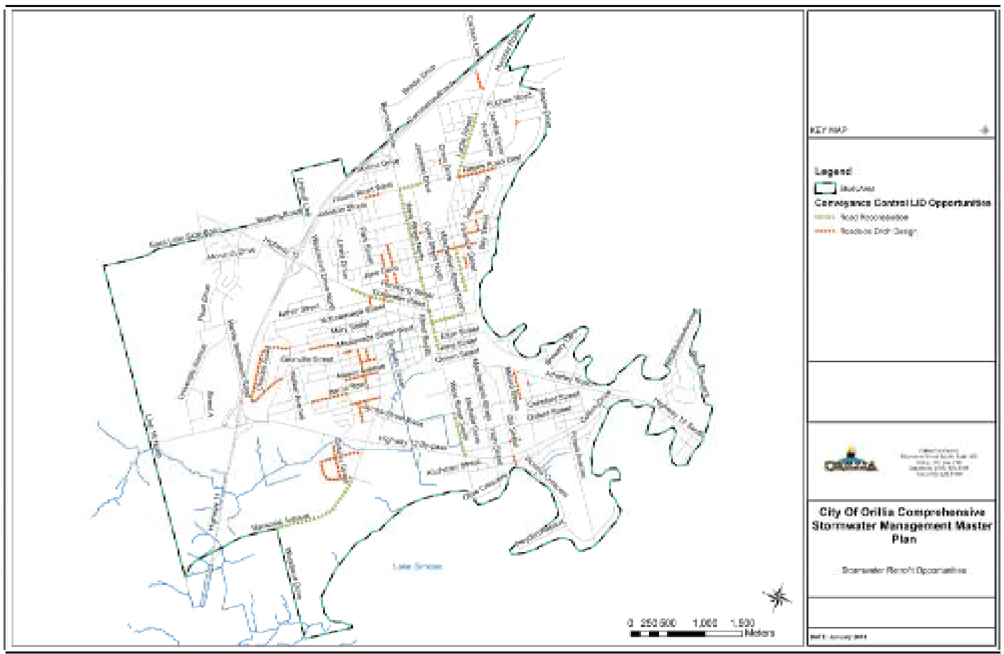
Conveyance control measures are measures that are designed to treat stormwater as it travels overland or through pipes on route to the downstream outlet. Conveyance Control Measures include:

- Bioretention / bioswales
- Exfiltration Trenches / Perforated Pipe Systems
- Grasses Swales
- Premabale pavement

The Lake Simcoe Protection Plan and the Oro Creeks Subwatershed Plan recommend that "The City of Orillia make stormwater retrofits and the use of LID solutions a priority, due to their significant potential to reduce phosphorus loading"

In accordance with these recommendations. The City plans to promote new technology in new development areas, and within existing development areas (Retrofits)

Opportunities to add new technology include:
- As part of road re-surfaceing/re-construction
- Roadside ditch improvements



Examples / Concepts

Roadside Ditch Retrofit Improvements

Turf Bioswale

Planted Garden Bioretention

Public Open House
May 13, 2015

City of Orillia Comprehensive Stormwater Management Master Plan

- Preferred Alternatives -

Conveyance Control Measures - Examples / Concepts

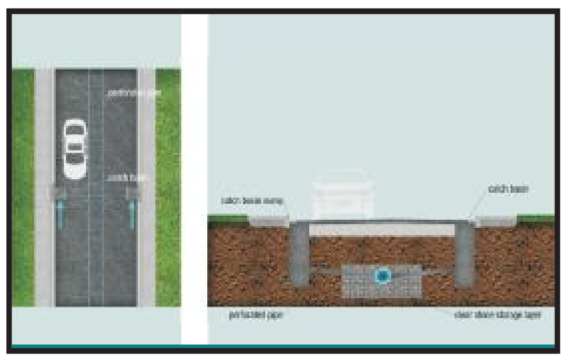
Downtown Streetscape Example:

Bioretentention Planters

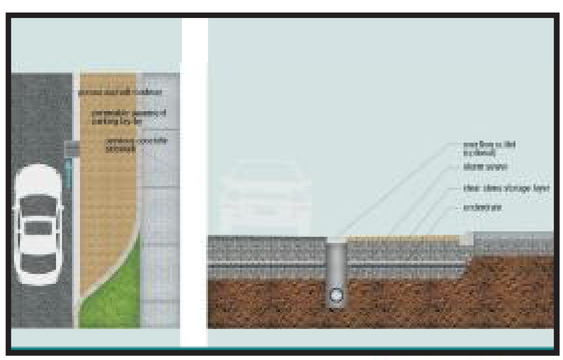
Residential Street scape Example:

Boulevard Bioretention

Perforated Pipe



Permeable Pavement



City of Orillia Comprehensive Stormwater Management Master Plan

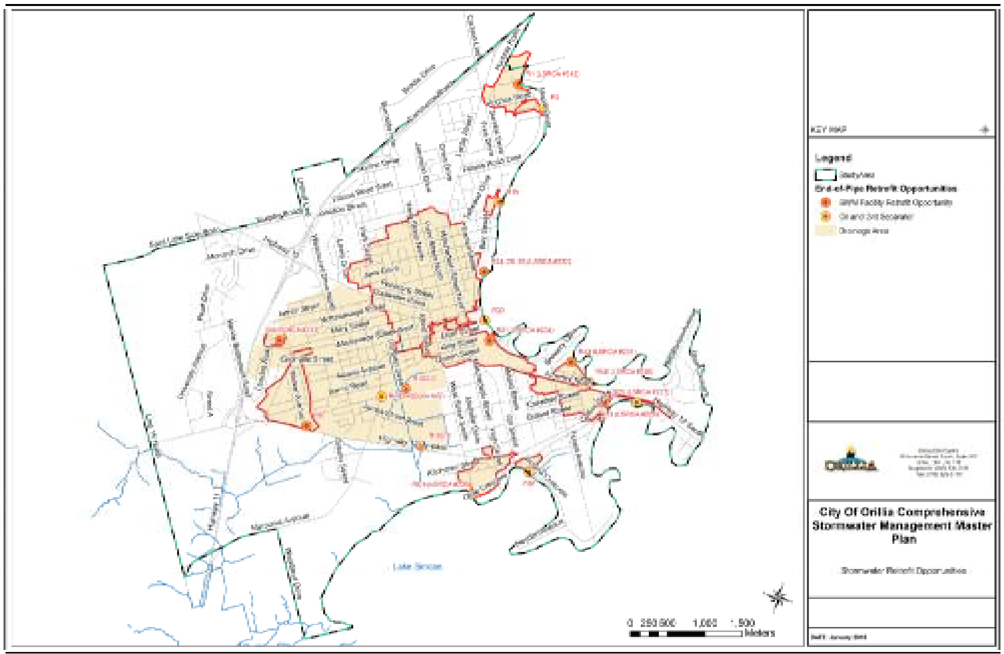
- Preferred Alternatives -

End-of-Pipe Controls Measures

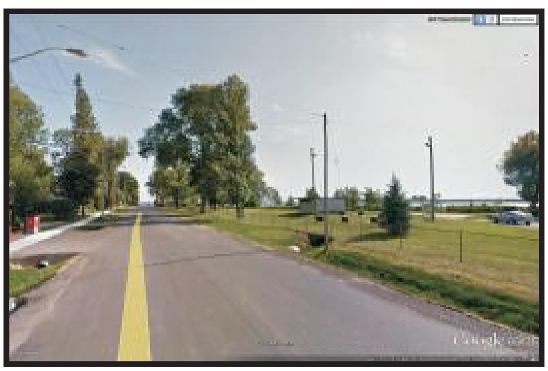
Feasible of retrofitting existing SWM facilities and constructing new facilities within existing development areas was assessed.

Identified Sites
- 8 opportunities in Lake Simcoe
- 8 opportunities in Lake Couchiching

Future Stormwater facilities will also be require in new development area to provide water quality, erosion and flood control.



Examples / Concepts



Stream Restoration Measures

A preliminary geomorphic/erosion assessment was completed as part of this study. Stream erosion and problem site restoration measures are recommended to be addressed through the completion of a future City Wide Stream Restoration Master Plan. The city-wide study would be undertaken following Approach 2 of the Municipal Class EA process and would result in a prioritized plan for undertaking future stream works.

Future City Wide Stream Restoration Master Plan.

Public Open House
May 13, 2015

City of Orillia Comprehensive Stormwater Management Master Plan

- Nest Steps & Contact Information -

Next Steps

The following next steps will be undertaken to complete the City of Orillia Comprehensive Stormwater Management Master Plan:

- Review Public Consultation Feedback and Comments
- Refinement of Study Recommendations
- Develop an Implementation Plan
- Final Report and Project File followed by 30 days Public Review Period in accordance with the MEA Process

Mr. Kyle Mitchell
Manager of Water Resources
City of Orillia
Telephone: (705) 325-3224
Email: KMitchell@orillia.ca

Mr. Greg Frew, P.Eng
Project Engineer
Aquafor Beech Limited
Telephone: (905) 629-0099, Extension 276
Email: frew.g@aquaforbeech.com

Thank You for Participating

Public Open House
May 13, 2015