Environment

Municipality of Clarington

Robinson Creek and Tooley Creek Watershed Management Plan

Prepared by:

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Project Number:

60119359-112956

Date:

December, 2011

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December 1, 2011

Ms. Faye Langmaid
Manager of Special Projects
Municipality of Clarington
40 Temperance Street
Bowmanville, ON L1C 3A6

Dear Ms. Langmaid:

Project No: 60119359-112956

Regarding: Robinson Creek and Tooley Creek Watershed Management Plan

We are pleased to provide you with the Final Robinson Creek and Tooley Creek Watershed Management Plan.

Please let me know if you have any questions, concerns or comments.

Sincerely,
AECOM Canada Ltd.

Jason Cole
Hydrogeologist

Robin Frizzell, M.Sc., P.Geo
Senior Hydrogeologist

JC:mm
Encl.

Distribution List

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2	Yes	Municipality of Clarington
2	Yes	AECOM Canada Ltd.
1	Yes	Central Lake Ontario Conservation Authority

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	Clarington	March 2011	Working Draft Version. General edits. Consistency with municipal policies.
2	Clarington	April 2011	Final Draft. Review from Clarington.
3	Clarington	May 2011	Revised Final Draft. Review from Clarington focusing on Section 6.
4	Clarington/ CLOCA	July 2011	Final review from Clarington. Comments from CLOCA.
5	CLOCA/MNR/Local Stakeholders	Nov 2011	Final comments from CLOCA. Comments from MNR. Comments and input from local stakeholders.
6	Clarington	Dec 2011	Final – issued.

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1. Introduction

The Municipality of Clarington retained AECOM to conduct an Existing Conditions Study and prepare a Watershed Management Plan for the Robinson Creek and Tooley Creek Watersheds. The Robinson Creek and Tooley Creek Watersheds are under the jurisdiction of the Central Lake Ontario Conservation Authority (CLOCA) who were consulted on and involved with completion of this project. This Watershed Study will be the basis for a Courtice Employment Lands Secondary Plan, which is one of the special studies to be undertaken as part of the Clarington Official Plan review, which is currently being conducted.

Section 4.3.1 of the Clarington Official Plan identifies the mandate to "undertake multi-stakeholder watershed planning studies in order to protect the integrity of ecological and hydrological functions and to establish priorities for the preparation of watershed plans". The Existing Conditions Study for the Robinson Creek and Tooley Creek Watersheds was completed in August 2010 and provides a detailed assessment of the current state of the watersheds by examining policy and land use, hydrology and hydraulics, groundwater quantity and quality, aquatic species and habitat, surface water quantity and quality, and terrestrial natural heritage. The Existing Conditions Report documents the existing or baseline conditions of the Robinson Creek and Tooley Creek Watersheds and provides the scientific basis for preparing a Watershed Management Plan.

Section 20.2.3 of the Clarington Official Plan requires that a subwatershed plan (or in this case, a watershed plan) be prepared prior to municipal approval of a draft plan of a subdivision. This report, the Watershed Management Plan, is intended to form the basis for any Environmental Impact Study (EIS) undertaken in support of development in either the Robinson Creek or Tooley Creek Watershed. Additionally, the objectives and recommendations in this Watershed Management Plan will be incorporated into the Clarington Official Plan.

The Robinson Creek and Tooley Creek Watersheds are located entirely within the Municipality of Clarington, in the Regional Municipality of Durham (**Figure 1.1**). The headwaters for both watersheds fall within an area known as the Iroquois Plain physiographic region, which is located to the south of the Oak Ridges Moraine physiographic region and the Oak Ridges Moraine Conservation Planning Boundary. As such, watershed management and planning within the Robinson Creek and Tooley Creek Watersheds are not bound by the policies and regulations set forth in the Oak Ridges Moraine Conservation Act (O. Reg 140/02). It is recognized, that many of the policies and regulations outlined in the Oak Ridges Moraine Conservation Act would benefit these watersheds and have been adopted where applicable.

Both the Robinson Creek and the Tooley Creek Watersheds are considered urban watersheds. As shown on **Figure 1.2**, with the exception of the northeast corner of the Tooley Creek Watershed, which falls within land designated as Greenbelt (the reader is referred to Section 3 for a description of the Greenbelt Plan), the majority land area of these watersheds has been identified in the *Places to Grow Act* and the *Growing Durham Study*, to be converted from their existing land use of primarily agriculture to future employment and living areas by 2031. Bloor Street and Courtice Road have been designated as Higher Order Growth Corridors. Also of consequence to future growth and development in the Robinson Creek and Tooley Creek Watersheds, is the Regional Amendment to the Official Plan 128 (ROPA 128), which was adopted by Durham Regional Council on June 3, 2009 and was submitted to the Ministry of Municipal Affairs and Housing (MMAH) for approval in July 2009. A draft decision on ROPA 128 dated March 2010 provided by MMAH recommended the removal of the Courtice Employment Area from the future land use forecasts. This area encompasses the land on the east side of Courtice Road, north of Baseline Road, south of Highway 2 and west of the Future 407 East Durham Link. At the time this report was completed, the ROPA 128 lands were under appeal. Therefore, to conservatively assess the impact of future growth scenarios on the natural environmental, the Watershed Management Planning recommendations provided in this report have assumed that the Courtice Employment Lands will be part of future development in the watersheds.

1.1 About Watershed Management

A watershed study and associated watershed management plan provide the background information needed for integration of watershed information into the Official Planning or Secondary Planning process. The planning boundary considered within a watershed management plan is the entire extent of a given watershed. According to Water Management on a Watershed Basis: Implementing an Ecosystem Approach (MOEE, 1993), "the boundaries of a watershed provide the natural limits for managing these interactions and the subsequent state of the environment and the resources within." A watershed is defined by topographical land boundaries, where all water that falls on the land surface will drain to a particular point, such as a river, stream, or lake. The health of the natural resources within a watershed is influenced by the health of the lands that water flows through. Interactions between human activities on the land are reflected in this process and in the present day conditions observed in the water and the natural environment.

A comprehensive watershed plan balances ecological protection with land development opportunities; with the goal to protect, and maintain a healthy ecosystem, both in human terms, and in terms of the natural environment, as well as encourage development. It should also provide an implementation framework for establishing planning targets and objectives, and setting forth a plan to see the targets and objectives established. Finally, a watershed plan should include a monitoring program to ensure that targets defined in the watershed management plan are met.

The goal of this study is to develop a Watershed Management Plan for the Robinson Creek and Tooley Creek Watersheds and provide detailed technical recommendations that promote sustainable use of the watersheds that can be implemented and adopted into the official plan in support of future development.

1.2 Vision for the Robinson Creek and Tooley Creek Watersheds

The Robinson Creek and Tooley Creek Watershed Management Plan provides a 'vision' for how the watersheds should look in order to manage future growth scenarios, and sustain and/or improve the natural environment. This watershed management plan will define what areas are appropriate for preservation, protection, enhancement, or rehabilitation, to satisfy our vision for the watersheds.

Our vision for the Robinson Creek and Tooley Creek Watersheds is:

> *"To maintain and enhance the health and quality of the Robinson Creek and Tooley Creek Watersheds and their ecosystems, by developing a strategy to minimize and mitigate impacts associated with future growth in the watersheds"*

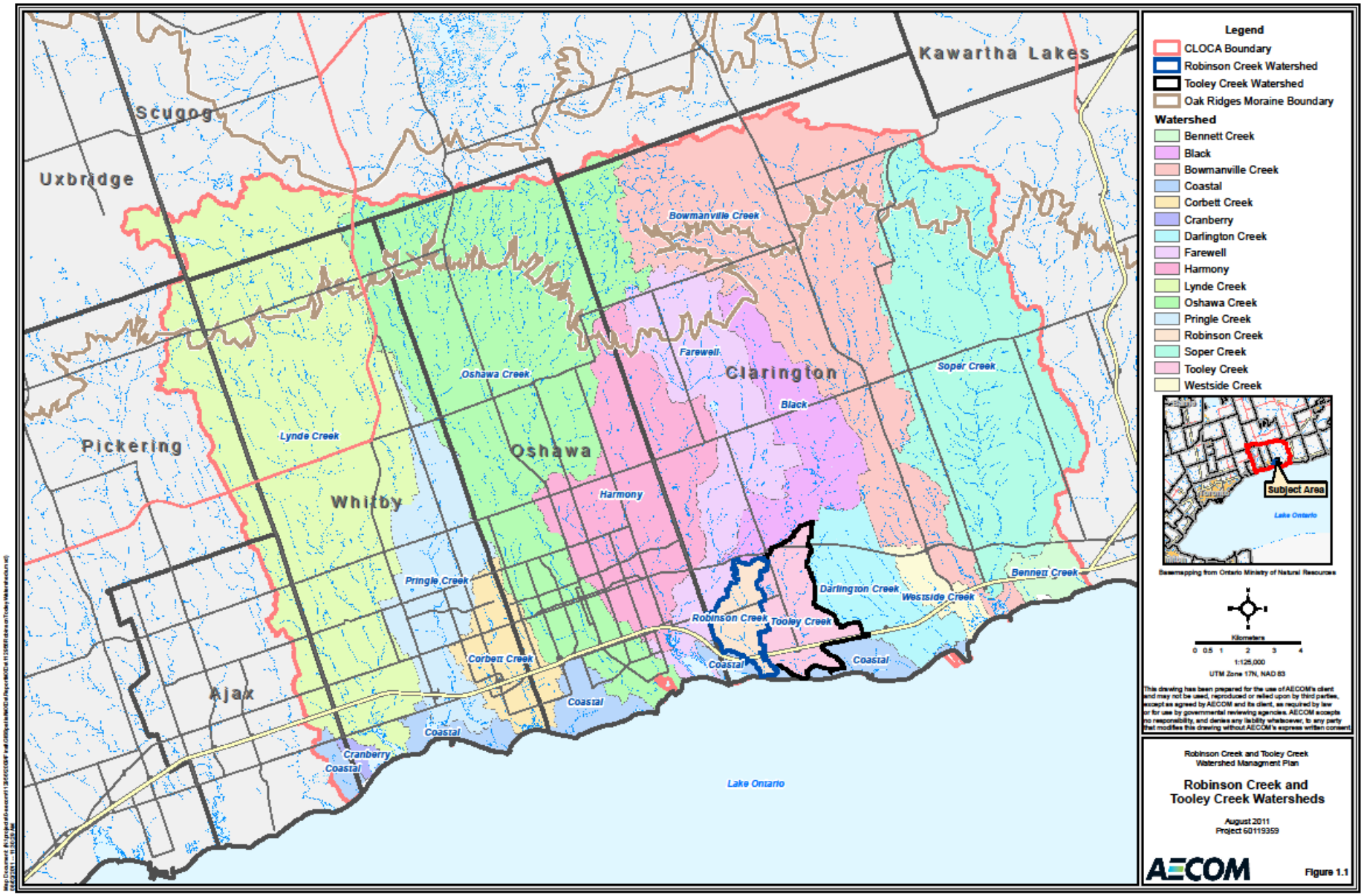


Figure 1.1 Robinson Creek and Tooley Creek Watersheds

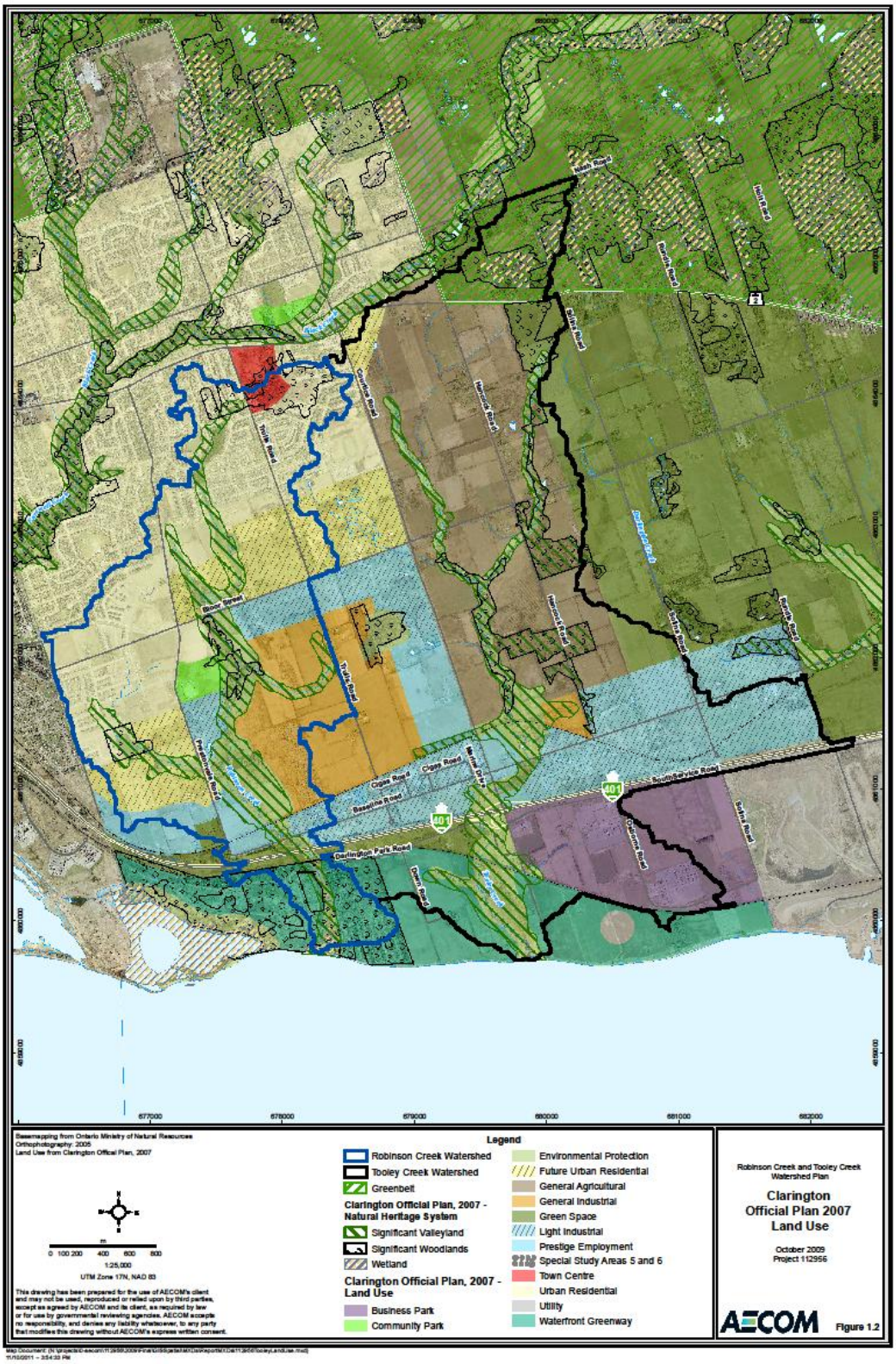


Figure 1.2 Clarington Official Plan 2007 Land use

2. Watershed Management

2.1 The Watershed Planning Process

Watershed based management was first introduced in Ontario in June 1993 in the document, *Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach* (MOEE and MNR, 1993). Since then, a number of technical documents have been produced that provide technical guidance on the completion of watershed management planning, including, but certainly not limited to:

- *Watershed Management in Ontario: Lessons Learned and Best Practices*, by Conservation Ontario, 2003;
- *Watershed Planning from Recommendations to Municipal Policies: A Guidance Document*. Interim Version. Prepared for the York, Peel, Durham, Toronto Groundwater Study Conservation Authorities Moraine Coalition (YPDT CAMC), by Ogilvie, Ogilvie and Company and Anthony Usher Planning Consultant, 2005; and
- *A Work Plan to Fulfill the Watershed Planning Requirements of the Oak Ridges Moraine Conservation Plan Regulation*, by Toronto and Region Conservation Authority, Lake Simcoe Region Conservation Authority, and the Region of York, 2003.

Each of these documents was relied upon for the preparation of the Robinson Creek and Tooley Creek Watershed Management Plan.

The rationale behind the watershed scale approach was to use the hydrologic cycle as the system that integrates physical, chemical, and biological processes of the ecosystem. The watershed provides a convenient boundary that can be understood by the public and can easily be incorporated into regional and municipal planning documents.

As shown in **Figure 2.1**, Conservation Ontario (2003) outlines four distinct phases of watershed management planning:

1. **Plan:**
   Identify issues and objectives for the watershed, outline targets and goals for the watershed, evaluate existing information and alternatives and make specific recommendations in the form of Watershed or Sub-Watershed Management Plan.
2. **Implement:**
   Use policy, programs, projects, and actions to put in place the recommendations made during the planning phase.
3. **Monitor and Report:**
   Establish monitoring to measure the progress of reaching the goals, objectives, and targets set for the watershed or sub-watershed, and communicate the progress to decision makers and to the public.
4. **Review, Evaluate and Update:**
   Regularly review the watershed management plan, evaluate the success/ failure of recommendations, and update the plan if changes are needed to address deficiencies or future scenarios.

The ‘Plan’ phase of watershed planning can be further described according to eight specific steps that AECOM, the Municipality of Clarington and CLOCA undertook to create this Watershed Management Plan (**Figure 2.2**).

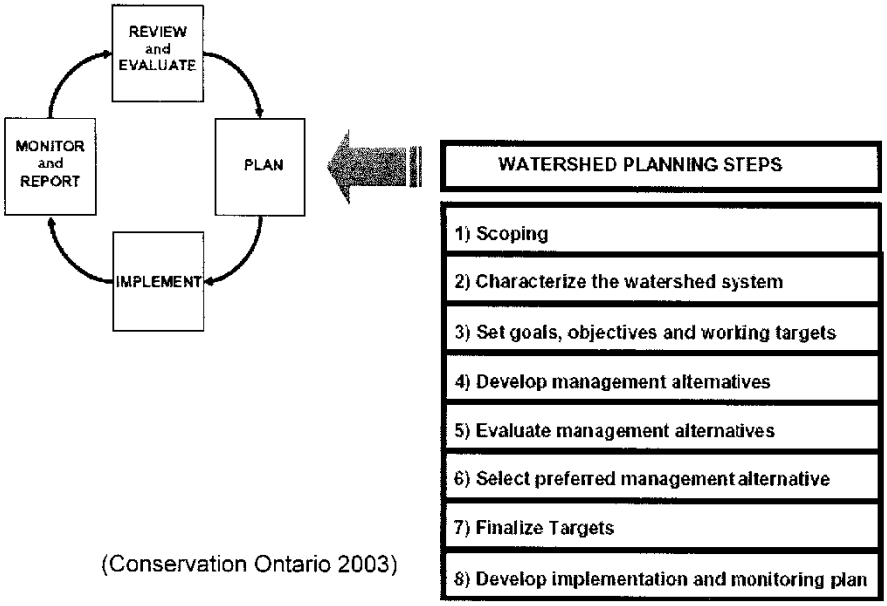


Figure 2.1 Watershed Management Phases and Planning Steps

It is important to recognize the importance of community involvement at critical stages of the watershed planning process.

As described in *A Work Plan to Fulfill the Watershed Planning Requirements of the Oak Ridges Moraine Conservation Plan Regulation* (2003), completion of the '*Plan*' phase of a watershed management plan should be completed in three stages:

1. **Characterize** the watershed (i.e., establish existing conditions);
2. **Analyze and Evaluate** alternative land use scenarios for land use and water management; and
3. **Develop** a watershed management plan.

Characterize the Watershed

Characterization of the watershed requires technical input from a variety of specialized environmental, ecological, and engineering disciplines to establish baseline conditions of the following:

- Groundwater quality and quantity;
- Water budget;
- Hydrology and hydraulics;
- Surface water quality and quantity;
- Aquatic species and habitat;
- Terrestrial Natural Heritage; and
- Land use planning.

The characterization stage for the Robinson and Tooley Creek Watersheds was completed between 2009 and 2010 by AECOM. *The Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report* (AECOM, 2010), describes in detail the existing conditions of the Robinson Creek and Tooley Creek Watersheds and forms the basis for making scientifically sound management recommendations and decisions for the watersheds. A summary of the existing conditions for the Robinson Creek and Tooley Creek Watersheds is presented in **Section 4**.

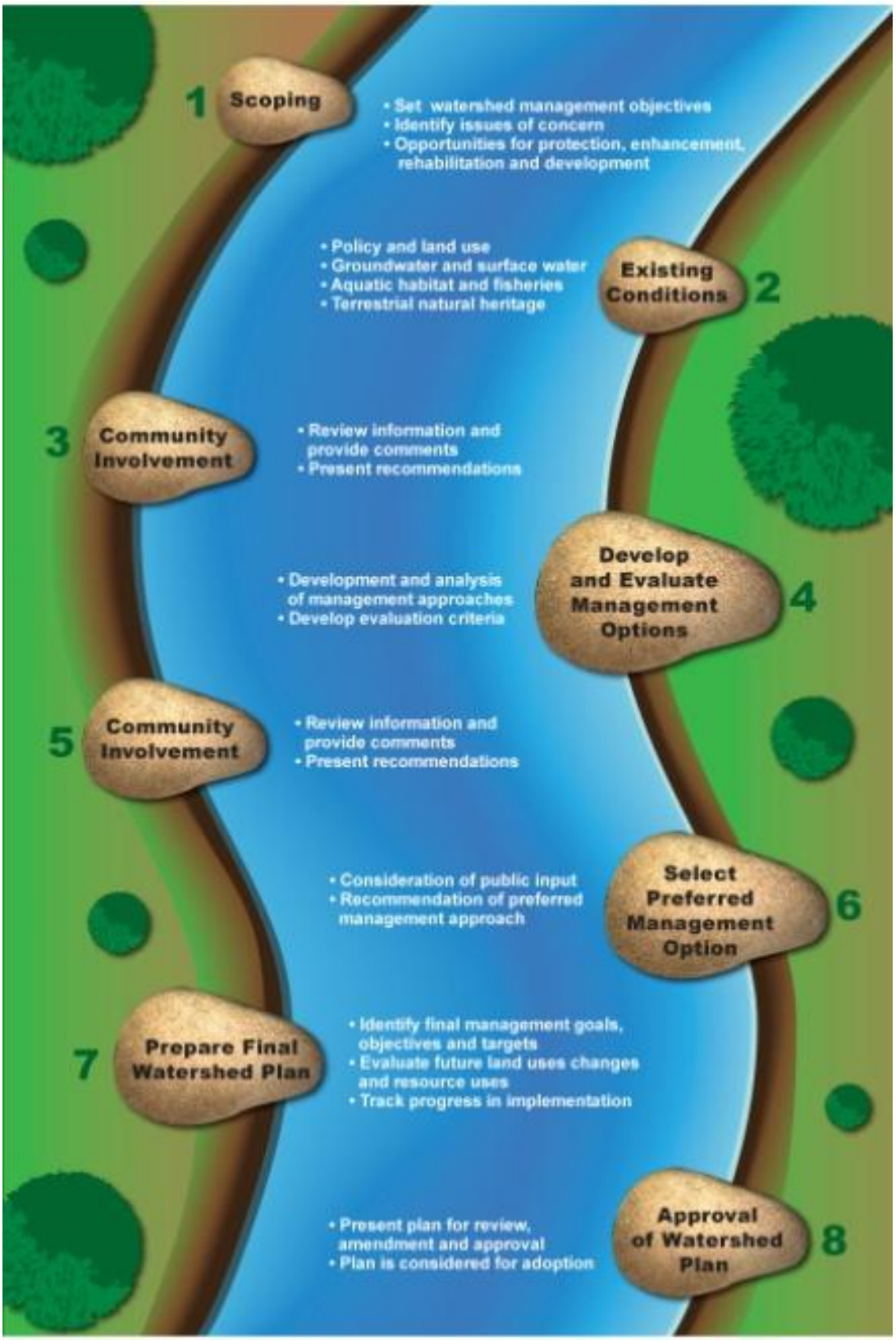


Figure 2.2 Watershed Management Planning steps for the Robinson and Tooley Creek Watersheds

Analyze and Evaluate Alternative Scenarios

Analysis and evaluation of alternative land use scenarios for water and land management were undertaken as part of this report based upon the existing conditions and included current and future land use scenarios, as outlined in the Clarington Official Plan. These features were assessed, and management scenarios and approaches were established that include the following:

- A Targeted Natural Heritage System (TNHS);
- A Water Budget and the identification of High Volume Recharge Areas (HVRA);
- Current and Future levels of Imperviousness; and
- Existing and Future Hydrologic and Hydraulic Modelling and Hazard Analysis.

A technically preferred management scenario was selected from the analysis and evaluation of the above scenarios. Management recommendations through policy implementation actions are addressed at this stage. This work is presented and described in detail in **Section 5**.

Development of a Watershed Management Plan

The final stage, *development of a watershed management plan*, is completed once the watershed has been characterized and the preferred management scenario has been selected. The watershed management plan builds upon the current and future plans for the watershed and presents specific watershed planning recommendations that are designed to guide development and conservation within the watershed boundaries. Due to the complexity of making watershed management recommendations, this work is further described, in detail, in **Section 2.2**.

2.2 Development of a Watershed Management Plan

Recommendations made in a Watershed Management Plan, need to be made based upon sound technical information and to be effective, must be implemented and adopted into official plans. These are the specific recommendations that are designed to be consistent with the overall vision for the watershed.,

It is recognized that all municipalities need to be flexible to the different situations that occur in different parts of their jurisdiction. Management Recommendations made in this Report are specifically tailored to best fit the needs of the Robinson Creek and Tooley Creek Watersheds. Some recommendations will only be appropriate or justifiable for these specific watersheds and the Municipality of Clarington may wish to limit their application appropriately. However, in circumstances where policies are applicable outside of the Robinson Creek and Tooley Creek Watersheds, the Municipality is encouraged to find ways to adopt those recommendations in general.

Management Recommendations are made based on the watershed components identified in the Existing Conditions Report and the Evaluation of Management Alternatives, and include the following:

- Groundwater Quantity
- Groundwater Quality
- Surface Water Quantity
- Surface Water Quality
- Fisheries and Aquatic Habitat
- Terrestrial Natural Heritage

Using the watershed components listed above, *issues and opportunities for improvement* within the watersheds were identified. Based upon the identified issues and opportunities, *goals, objectives, and management actions*, were developed, evaluated, and specific recommendations were made to maintain or enhance the Robinson Creek and Tooley Creek Watersheds. The following describes this process.

Identify Issues and Opportunities for Improvement

Issues and opportunities for improvement were identified based upon the results of the *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM, 2010)*, input from the Municipality of Clarington, CLOCA, and the public. Issues and opportunities for improvement were determined for each of the watershed components (i.e., groundwater quantity, surface water quality, etc.) and can be defined as general or specific functions or actions that need to be maintained or enhanced to promote the future health and quality of the Robinson Creek and Tooley Creek Watersheds.

The identification of issues and opportunities at the early stage of this study was important to explore opportunities for maintaining and enhancing the natural features, functions, processes and linkages within the watersheds. Management 'targets' within the Province of Ontario have been defined by the Ministry of Natural Resources and Environment Canada (Environment Canada, 2005), which provide objectives such as:

- Maintenance and enhancement of riparian corridors and linkages to improve surface water quality, aquatic conveyance and wildlife movement;
- Identification of Core Natural Areas and Linkages;
- Protection of significant aquatic and terrestrial habitat;
- Protection of important groundwater recharge and discharge areas;
- Identification of and mitigation of point-source and non-point source pollutants;
- Specific stormwater management criteria and levels of water quality/ quantity treatment; and
- Flood hazard analysis and prevention.

All natural environment features are interconnected within the watershed. This means that some issues and opportunities for improvement will overlap between the different disciplines. For example, maintaining groundwater quality will not only improve the health of aquifers and water resources, but will also help maintain surface water quality because the two systems are inherently interconnected, through groundwater discharge to surface features such as streams and wetlands.

Set Management Goals

Management Goals are designed to address the issues and opportunities for improvement that have been identified within a watershed. A Management Goal begins as a goal statement (i.e., Protect Aquatic Habitat and Species), that is used to identify a management outcome that would maintain or enhance the natural environment and can be implemented through a watershed management plan. Each watershed component (i.e., surface water quality or groundwater quantity) will have a unique set of management goals.

Set Objectives

Objectives are designed to specifically address the Management Goals for each of the watershed components and are designed to achieve the desired management outcome. For example, if the Management Goal is to 'protect and enhance groundwater quantity', an Objective may be to 'maintain or enhance groundwater recharge within the watershed.' Objectives are set so that targets (such as groundwater recharge rates) can be established to measure the success of the management goals.

Recommended Management Actions

Recommended Management Actions integrate science into action though municipal regulations and planning, and community involvement. For each of the Goals and Objectives, a set of Management Actions are presented to address policy, regulation, community based strategies, monitoring and procedures for implementation. By putting in place each of the recommended Management Actions presented, the watershed management goals and objective should be fulfilled, and the overall *vision* for the watershed should be achieved.

The following management actions are used to determine the overall management strategy for the watersheds:

Regulation and Policy Initiatives

These Management Actions involve the use of legislation and regulations to achieve the intended watershed goals, objectives and targets. For the Robinson Creek and Tooley Creek Watersheds, these actions would be carried out through official plans and secondary plans from the Municipality of Clarington or by regulations, policy and programs implemented by CLOCA.

Community Education and Stewardship

These Management Actions are volunteer based and are generally completed in conjunction with an established agency. Educational and stewardship programs can provide both technical and financial assistance and/or incentives to a land owner or community group to manage the land in a more environmentally sustainable manor. There are many agencies based federally, provincially, regionally, and locally that are working to improve the health of the Robinson Creek and Tooley Creek Watersheds. It should be understood that programs and funding sources evolve overtime to meet need and economic constraints. Just a few of these agencies and programs are listed below:

- Central Lake Ontario Conservation Authority (CLOCA)
  - Land Stewardship Program (http://www.cloca.com/stewardship/Stewardship%20Brochure.pdf);
  - Clean Water Stewardship Program (http://www.cloca.com/stewardship/stew_cwp.php);
- Source Water Protection and the Ontario Drinking Water Stewardship Program (http://www.sourcewaterprotection.on.ca/grants_stewardship.html)
- Ontario Federation of Anglers and Hunters (OFAH)
  - Community Stream Steward Program (http://www.ofah.org/streamsteward/);
- Durham Land Stewardship Council;
- Conservation Ontario;
- Trout Unlimited Canada;
- Ontario Wildlife Foundation; and
- Environmental Farm Plan (EFP).

Land Acquisition and Dedication

Although policies can be put in place by various levels of government and conservation authorities to protect natural features and landowners can be assisted and educated on the importance of protecting valued features, land acquisition and/or dedication provides the best long term protection and management options for some areas. Various levels of government and conservation authorities already participate in land acquisition and dedication to achieve protection and restoration targets, and provide opportunities for public open space.

Monitoring and Reporting

In order to assess the benefits of each management action, regular monitoring is required both before and after the management action has been put in place. The Municipality, the public, and stakeholder groups should know if the management efforts are functioning as planned. If they are not, further action may need to be taken to determine possible explanations and improvements. The results of the monitoring must be communicated to local decision makers and the community, whether the management actions were successful or unsuccessful.

2.3 Participation

A key element in watershed planning and watershed management involves partnerships between regions, municipalities, conservation authorities, public agencies, local communities, stakeholders and the public, to share in the responsibility for maintaining and improving the health of the watershed. The list of stakeholders asked to provide comment on draft versions of the existing conditions report and the watershed management plan include CLOCA, MOE, MNR, Darlington Provincial Park, and the Region of Durham.

AECOM, in co-operation with the Municipality of Clarington and CLOCA, completed two Public Information Centre (PIC) meetings in 2010 and 2011 as part of the Robinson Creek and Tooley Creek Watershed Management Plan project.

PIC #1 PIC #1 was held on June 25, 2010 at the South Courtice Area at 1595 Prestonvale Road in Courtice. The results of the existing conditions field investigations were presented at this meeting and the community was given an opportunity review the information and provide comments. Recommendations for moving forward with developing and evaluating management options were presented and feedback from the community obtained prior to moving forward with the next steps.

PIC#2 PIC#2 was held on February 24, 2010, at the Courtice Community Complex at 2950 Courtice Road in Courtice. The focus of this PIC was to present the technically preferred management scenarios related to the targeted natural heritage system, the water balance, imperviousness, and future hazard analysis.
Members of the public, community groups and other stakeholders provided feedback and suggestions on the preferred management scenarios and how they will affect the overall watershed management strategy.

3. Applicable Planning Initiatives

An effective watershed management plan is able to integrate the ideas, concerns, and priorities of federal, provincial, and municipal government, conservation authorities and other stakeholders. The Management Plan must be able to fit within the current policy framework and provide the basis for making future management decisions. This section provides a detailed summary of applicable planning initiatives, starting with the most general and far reaching, and ending with local policy initiatives. The recommendations provided in this plan are consistent with the following listed planning initiatives.

Climate Change

The consideration of climate change at the local, regional and global scale has been extensively studied (Millennium Ecosystem Assessment, 2005) and must be considered when undertaking planning processes such as a watershed management plan. Climate change, as defined by McCarthy *et al. (*2006) is considered to be any change in climate over time whether due to natural variability or anthropogenic activity.

Within Canada, the effects of climate change are already being observed. In many provinces, including Ontario, phenomena such as rising atmospheric temperatures, loss of biodiversity and changing water levels are being observed (Fischlin et al. 2007). By preserving and enhancing the existing habitat and functions of the natural environment in the Robinson and Tooley Creek Watersheds, these ecosystems will be better equipped to adapt to predicted and unforeseen stressors as a result of climate change. With the potential stressors in mind, appropriate considerations and potential scenarios must be considered throughout the watershed management planning process for Robinson and Tooley Creek.

Clean Water Act

The Clean Water Act provides for the protection of drinking water at its source. The legislation sets the basic framework for communities to follow in developing an approach to protect their water resources by identifying and assessing risks, developing source protection plans, and implementing these plans. Its intention is to protect water at the source, using science based assessment report and protection plans.

The Central Lake Ontario Conservation Authority (CLOCA) has recently released a *Proposed Assessment Report* (July, 2010) on the Central Lake Ontario Source Protection Area, which includes the areas covered by the Robinson Creek and Tooley Creek Watersheds. This report includes an assessment of the threats, conditions and issues for municipal water intake zones, wellhead protection areas, significant groundwater recharge and discharge areas, and highly vulnerable aquifers.

If the results of this assessment show that an activity poses a significant risk to a drinking water source, the approved protection plan may restrict or limit certain activities in that area through regulatory requirements or approvals, zoning by-laws, official plan amendments, education or voluntary initiatives.

Great Lakes Water Quality Agreement

The Great Lake Water Quality Agreement (GLWQA), was instated in 1972, and renewed in 1978, between Canada and the United States. This agreement makes specific commitments for both Canada and the United States to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem and includes a number of objectives and guidelines to achieve these goals. In 1987, a Protocol was signed to amend the 1978 Agreement. The goal of these new protocols was to strengthen the commitments outlined in 1978 and to increase the accountability of the two countries.

With respect to this study, the most significant portion of the GLWQA is Annex 13, "Pollution from Non-Point Sources". Annex 13 outlines programs and measures for the abatement and reduction on non-point sources of pollution from land use activities.

> *"The Parties (Canada and the United States), in conjunction with State and Provincial Governments, shall:*
>
> *a) Identify land-based activities contribution to water quality problems described in Remedial Action Plans for Areas of Concern, or in Lakewide Management Plans including, but not limited to, phosphorus and Critical Pollutants; and*
>
> *b) Develop and implement watershed management plans, consistent with the objectives and schedules for individual Remedial Action Plans or Lakewide Management Plans, on priority hydrologic units to reduce non-point source inputs. Such watershed plans shall include a description of priority areas, intergovernmental agreements, implementation schedules, and programs and other measures to fulfill the purpose of this Annex and the General and Specific Objectives of this Agreement. Such measures shall include provisions for regulation of non-point sources of pollution."*

In June 2009, the Governments of Canada and the United States announced that they would be updating the GLWQA to strengthen the watershed management language.

Provincial Policy Statement

The Provincial Policy Statement (PPS) issued under the authority of Section 3 of the Planning Act and came into effect on March 1, 2005. The PPS has a strong focus on the long-term prosperity and environmental health of Ontario. It states that natural features and areas shall be protected for the long-term. This policy prescribes the extent to which natural features are protected when development is proposed. The PPS includes social and economic components and should be read in its entirety. Although the PPS is provincial legislation, it is implemented by the Municipality of Clarington through their Official Plan.

The PPS supports improved land use planning and management, which contributes to a more effective and efficient land use planning system. Section 1.2.1 of the PPS states:

> *"A co-ordinated, integrated and comprehensive approach should be used when dealing with planning matters within municipalities, or which cross lower, single and/or upper-tier municipal boundaries, including:*
>
> *a. Managing and/or promoting growth and development;*
> *b. Managing natural heritage, water, agricultural, mineral, and cultural heritage and archaeological resources;*
> *c. Infrastructure, public service facilities and waste management systems;*
> *d. Ecosystem, shoreline and watershed related issues;*
> *e. Natural and human-made hazards; and*
> *f. Population, housing and employment projections, based on regional market areas."*

The PPS provides direction on the protection of the Natural Heritage System by not permitting development and site alteration in a number of circumstances:

> *"2.1.3 Development and site alteration shall not be permitted in:*
>
> *a. significant habitat of endangered species and threatened species;*
> *b. significant wetlands in Ecoregions 5E, 6E and 7E; and*
> *c. significant coastal wetlands.*

2.1.4 Development and site alteration shall not be permitted in:

a. significant wetlands in the Canadian Shield north of Ecoregions 5E, 6E and 7E;
b. significant woodlands south and east of the Canadian Shield;
c. significant valleylands south and east of the Canadian Shield;
d. significant wildlife habitat; and
e. significant areas of natural and scientific interest

unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.

2.1.5 Development and site alteration shall not be permitted in fish habitat except in accordance with provincial and federal requirements.

2.1.6 Development and site alteration shall not be permitted on adjacent lands to the natural heritage features and areas identified in policies 2.1.3, 2.1.4 and 2.1.5 unless the ecological function of the adjacent lands has been evaluated and it has been demonstrated that there will be no negative impacts on the natural features or on their ecological functions."

The PPS also provides direction on protection and enhancement of water and water resources. Section 2.2 Water, subsection 2.2.1 states that:

"Planning authorities shall protect, improve or restore the quality and quantity of water by:

a. using the watershed as the ecologically meaningful scale for planning;
b. minimizing potential negative impacts, including cross-jurisdictional and cross-watershed impacts;
c. identifying surface water features, groundwater features, hydrologic functions and natural heritage features and areas which are necessary for the ecological and hydrological integrity of the watershed;
d. implementing necessary restrictions on development and site alteration to:
    1. protect all municipal drinking water supplies and designated vulnerable areas; and
    2. protect, improve or restore vulnerable surface and groundwater, sensitive surface water features and sensitive groundwater features, and their hydrologic functions.
e. Maintaining linkages and related functions among surface water features, groundwater features, hydrologic functions and natural heritage features and areas;
f. Promoting efficient and sustainable use of water resources, including practices for water conservation and sustaining water quality; and
g. Ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces."

Section 3.1 Natural Hazards of the PPS addresses the importance of flooding and erosion impacts on public safety, property, and environmental protection. This section of the PPS supports management actions and recommendations which reference the applicability of O.Reg 42/06 "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses". Section 3.1.1 of the PPS states that:

"Development shall generally be directed to areas outside of:

a. hazardous lands adjacent to the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes which are impacted by flooding hazards, erosion hazards and/or dynamic beach hazards;
b. hazardous lands adjacent to river, stream and small inland lake systems which are impacted by flooding hazards and/or erosion hazards; and
c. hazardous sites."

Oak Ridges Moraine Conservation Plan

The Robinson Creek and Tooley Creek Watersheds do not originate within the Oak Ridges Moraine (ORM) and are not included within the ORM planning boundary, and therefore the mandates set out in the Oak Ridges Moraine Conservation Plan (ORMCP) do not apply to these watersheds. However, this document provides a detailed framework for completing and implementing land use and resource management planning initiatives that can be applicable even outside of their intended area.

Section 24 (3) of the ORMCP speaks to watershed planning and states that:

(3) A watershed plan shall include, as a minimum,

a. A water budget and conservation plan as set out in section 25;

b. Land and water use and management strategies;

c. A framework for implementation, which may include more detailed implementation plans for smaller geographic areas, such as subwatershed plans, or for specific subject matter, such as environmental management plans;

d. And environmental monitoring plan;

e. Provisions requiring the use of environmental management practices and programs, such as programs to prevent pollution, reduce the use of pesticides and manage the use of road salt; and

f. Criteria for evaluating the protection of water quantity and quality, hydrological features, and hydrogeological functions.

The Greenbelt Plan

Ontario's Greenbelt is 1.8 million acres of provincially protected green space, farmland, communities, forests, wetlands, and watersheds. The Greenbelt covers lands south of the Oak Ridges Moraine, surrounding Clarington's urban boundaries. The Greenbelt Plan contains policies for providing permanent agricultural and environmental protection as well as providing for a wide range of recreation, tourism and cultural opportunities in the area. The Greenbelt Plan encompasses lands within the Niagara Escarpment Plan (NEP) and the Oak Ridges Moraine Conservation Plan, while building upon the foundation of ecological protection provided by these two Plans. The Protected Countryside is comprised of an Agricultural System and a Natural System, together with a number of settlement areas and is intended to improve linkages among these areas and surrounding systems.

The Natural System identifies lands that support both natural heritage and hydrologic features and functions. The Natural System policies protect areas of natural heritage, hydrologic and/or *landform* features, which are often functionally inter-related and which collectively support biodiversity and overall ecological integrity. This Natural System comprises a Natural Heritage System and a Water Resource System that often coincides given ecological linkages between terrestrial and water based functions. The Natural Heritage System includes areas of the Protected Countryside with the highest concentration of the most sensitive and/or *significant* natural features and functions. The Water Resource System is made up of both ground and surface water features and their associated functions, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption.

Roughly 38.2 ha of the Tooley Creek Watershed area is within the Greenbelt (3.3% of the watershed). The area of Greenbelt within the Tooley Creek Watershed extends from Highway 2 to the northern limit of the watershed, within which there are Greenbelt designations of *Protected Countryside* and *Natural Heritage System.* The Greenbelt does not extent into the Robinson Creek Watershed.

Lake Ontario Shoreline

A Lake Ontario shoreline management plan was completed in 1990 by Sandwell Swan Wooster Incorporated for CLOCA, Ganaraska Region Conservation Authority (GRCA) and Lower Trent Region Conservation Authority (LRCA). This report provided development objectives in relation to land use, hazards, erosion limit setbacks, and management.

Durham Region Official Plan

Durham Region's Official Plan (Office Consolidation 2008) is the overarching policy document guiding land use within the Region. These policies implement provincial legislation and provide planning context to lower tier municipalities.

It should be noted that portions of the two watershed areas are within the Urban System and Rural System of the Regional Official Plan. Within the Urban Systems, sections 8.1.5 and 8.1.6 state:

> *To protect key natural heritage or hydrologic features and functions located within or outside of Urban Areas from the impacts of urbanization."* AND *"To integrate nature into the urban fabric of the Region."*

The Regional Official Plan defines a Greenlands System for which it prescribes goals and general policies (Section 10 of the Official Plan). Section 10.2.3 states:

"The Greenlands System includes areas with the highest concentration of sensitive and/or significant natural features and functions. These areas are to be managed as a connected and integrated natural heritage system recognizing the functional inter-relationships between them. The main features of the Greenlands System, particularly the Oak Ridges Moraine, valley systems and the Waterfronts, shall be protected for their special natural and scenic features, their roles as predominant landscape elements in the Region and the recreational opportunities they facilitate. Further, linking the waterfronts with the Oak Ridges Moraine through the connecting valley systems shall be a primary objective of the continuous Greenlands System, as is linking of the valley systems themselves. The Greenlands System also contains agricultural and agricultural-related and secondary uses which shall be protected as integral components of the System."

Growing Durham

In July 2007, Durham Region initiated a "Growing Durham Study," which built on the Region's Official Plan review work and provides comprehensive analysis of the implications of growth in the Region, including a review and evaluation of alternate growth scenarios. The recently completed Study addresses Growth Plan population and employment forecasts to 2031.

Regional Official Plan Amendment 128

Regional Official Plan Amendment (ROPA) 128 was adopted by the Durham Regional Council on June 3, 2009. This adopted amendment contains many policies that will help the Region achieve its targeted growth plan looking towards the year 2031. This amendment includes guidance on policies and targets for urban densities and corridors, residential and employment lands, infrastructure and transit, and will promote intensification.

On March 12, 2010, the Ministry of Municipal Affairs and Housing (MMAH) issued a statement regarding the Growing Durham Study and ROPA 128 that outlines key concerns about the amendment. The primary concern is that the land budget overestimates the amount of land needed to accommodate the growth forecast for the Region. MMAH proposed draft modifications to ROPA 128 that effectively removed the employment lands in the Tooley Creek Watershed.

On October 27, 2010 MMAH issued its Final Decision on ROPA 128. The decision includes a refusal to expand the Courtice Urban boundary and the redesignation of lands from Prime Agricultural Area to Employment Area in the Tooley Creek Watershed. The primary concern from MMAH is that the Region's land budget calculations overestimates the amount of land needed to accommodate the growth forecast for the Region. The Municipality of Clarington has appealed this aspect of MMAH's decision to the Ontario Municipal Board in November 2011. Other aspects of ROPA 128 have been appealed by other parties.

Municipality of Clarington Official Plan

The Municipality of Clarington's Official Plan includes land use planning policies to address conformity with both provincial and regional policies. Policies within municipal official plans are typically more detailed to better reflect local conditions and growth patterns.

Section 4 of the Official Plan describes Clarington's Natural Environmental and Resource Management Policies. The goals and objectives of this section are outlined in Sections 4.1 and 4.2, and state that:

"4.1 Goals

4.1.1 To enhance the natural heritage system and its ecological integrity.

4.1.2 To promote responsible stewardship of the natural heritage system and wise use of the natural resources in order to provide long term and sustainable environmental, economic, and social benefits.

4.2 Objectives

4.2.1 To achieve in the public interest, an appropriate balance between the protection of the Municipality's natural heritage system and the management of its natural resources.

4.2.2 To protect natural heritage features and functions from incompatible development.

4.2.3 To enhance ecological processes, biodiversity and connections within the natural heritage system.

4.2.4 To protect residents from natural and man-made hazards.

4.2.5 To recognize and protect the Oak Ridges Moraine for its unique landform characteristics, its significant function of groundwater recharge and discharge, its significant natural heritage features and their ecological functions, and its significant aggregate resources.

4.2.6 To recognize and protect the Lake Iroquois Beach for its significant function of groundwater recharge and discharge, its significant natural heritage features and their ecological functions, and its aggregate resources.

4.2.7 To recognize the Lake Ontario Waterfront as a dynamic and distinctive element of the Municipality's environment.

4.2.8 To protect and enhance the Ganaraska Forest and the Long Sault Forest and to provide for an appropriate natural corridor between them.

4.2.9 To minimize light pollution from existing and new development."

Section 4.4 of the Official Plan, defines and describes Clarington's Natural Heritage System. The Municipality's Natural Heritage System is comprised of natural heritage features together with their ecological functions.

Secondary Plans

This Watershed Study will be the basis for a Courtice Employment Lands Secondary Plan. This study is one of the special studies to be undertaken as part of the Clarington Official Plan review. Within the Robinson Creek and

Tooley Creek Watersheds, the Municipality of Clarington has two Secondary Plans that provide specific details and clarifications on applicable policies for those areas. The two Secondary Plans are:

1. The Southwest Courtice Secondary Plan; and
2. The Clarington Energy Business Park Secondary Plan.

The Southwest Courtice Secondary Plan covers an area in the western portion of the Robinson Creek Watershed to the west of Prestonvale Road. This area has been designated as urban residential and is required as part of the 20 year supply of land.

The Clarington Energy Business Park Secondary Plan covers an area south of Highway 401 and north of the CN rail corridor, between Courtice Road and Solina Road. This area has been identified for prestige employment uses and the overall goal of the Secondary Plan is to guide growth and development in this area. Approximately half of the area covered by this Secondary Plan is within the Tooley Creek Watershed.

Darlington Provincial Park

Management of Darlington Provincial Park is legislated under the Provincial Parks and Conservation Reserves Act, 2006. The purpose of this Act is to:

> *"Permanently protect a system of provincial parks and conservation reserves that includes ecosystems that are representative of all of Ontario's natural regions, protects provincially significant elements of Ontario's natural and cultural heritage, maintains biodiversity and provides opportunities for compatible, ecologically sustainable recreation."*

All provincial parks in Ontario were established with the following objectives in mind:

1. *"To permanently protect representative ecosystems, biodiversity and provincially significant elements of Ontario's natural and cultural heritage and to manage these areas to ensure that ecological integrity is maintained;*
2. *To provide opportunities for ecologically sustainable outdoor recreation opportunities and encourage associated economic benefits;*
3. *To provide opportunities for residents of Ontario and visitors to increase their knowledge and appreciation of Ontario's natural and cultural heritage; and*
4. *To facilitate scientific research and to provide points of reference to support monitoring of ecological change on the broader landscape."*

Darlington Provincial Park is considered a "recreational class park", where the objective of the park is to provide a wide variety of outdoor recreation opportunities in natural surroundings.

407 East Environmental Assessment

The proposed extension of Highway 407 through Durham Region was incorporated into regional and municipal Official Plans in the 1990s. Since then, planning decisions related to land use and transportation in the Greater Golden Horseshoe have included the 407 corridor as part of future existing conditions.

The Ontario Ministry of Transportation (MTO) in consultation with Durham Region, its constituents and surrounding municipalities, undertook an individual Environmental Assessment (EA) study to address the long-term transportation needs in the Region of Durham and surrounding area. The EA was initiated in January 2005, after approval of the Terms of Reference by the Minister of the Environment.

The proposed 407 East corridor, identified through the EA process includes a transportation corridor, consisting of a highway and a transitway, and the associated support facilities. The transportation corridor includes:

- Mainline section from Brock Road to Highway 35/115;
- Two north-south freeway links connecting the proposed 407 extension to Highway 401, one in Whitby (West Durham Link) and the other in Clarington (East Durham Link);
- Protection of a dedicated transitway corridor.

The 407 East Durham Link crosses through the eastern portion of the Tooley Creek Watershed from north of Highway 2 to Highway 401, between Hancock and Solina Roads.

The 407 East Environment Assessment was submitted in August, 2009 to the Ontario Minister of the Environment and was approved in June 2010. The Canadian Environmental Assessment Agency Report for 407 East was approved in July 2011 by the Honourable Peter Kent, Minister of the Environment.

Based on an announcements in 2011 by the Ontario Government, the 407 East will be built in two phases. This first phase will run from Brock Road in the west to Harmony Road in the east, and include the West Durham Link. The targeted date for the completion of this phase is 2015. The second phase will bring the 407 East into the Municipality of Clarington. The second phase, which may include sub-phases will run from Harmony Road in the west to Highway 35/115 in the east and include the East Durham Link. The targeted date for the completion of this phase is 2020.

4. Robinson Creek and Tooley Creek Watersheds: Existing Conditions

The following is a summary of the Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report completed by AECOM in September 2010. The reader is referred to the Existing Conditions Report (AECOM, 2010) for complete documentation on the state of the watersheds.

It is important to note that recent hydrologic and hydraulic modelling completed by CLOCA has shown that the watershed boundaries for both the Robinson Creek and Tooley Creek Watersheds differ from the previously accepted watershed boundaries used in the Existing Conditions Report (AECOM, 2010). To account for these changes and to present the most up-to-date state of the watersheds, figures originally presented in the Existing Conditions Report, have been modified and included in the Watershed Management Plan Report. In a few cases, the changes to the watershed boundaries have resulted in changes to the conclusions presented in the Existing Conditions Report. For example, the water budget results and the percentage of natural and naturalized cover have required recalculation due to the changes in the surface area and land use of the watersheds. A revised water budget is presented in **Section 5.3** for both watersheds.

Where the results presented herein differ from results previously presented in the Existing Conditions Report, data contained in this Watershed Management Plan shall supersede the data in the Existing Conditions Report.

4.1 Robinson Creek Watershed: Existing Conditions

4.1.1 Study Area

The Robinson Creek Watershed is located in the Regional Municipality of Durham, entirely within the local Municipality of Clarington, and is under the jurisdiction of CLOCA (**Figure 4.1).** It is one of the smallest watersheds within the jurisdiction of the Municipality of Clarington, measuring approximately 594 ha in size.

The headwaters of Robinson Creek originate to the north of Bloor Street. A defined stream channel for Robinson Creek is first observed beginning near Trulls Road, just north of Sandringham Drive in the community of Courtice. Robinson Creek drains into Lake Ontario through a portion of the Provincially Significant McLaughlin Bay Wetland Complex and Darlington Provincial Park. Land use throughout the Robinson Creek Watershed is dominated by agricultural and urban residential land use, with relatively small proportions of natural and naturalized cover. The watershed is quickly becoming more urbanized with areas associated with the community of Courtice, dominating the landscape along the northern and western limits of the watershed. Development along the Highway 401 corridor is also expected in increase in the future.

4.1.2 Climate

Climate and precipitation normals between 1971 and 2000 were obtained from Environment Canada's Bowmanville Mostert Meteorological Station, which is considered the most representative climate station for the Robinson Creek Watershed with available long-term historical data (**Table 4.1**).

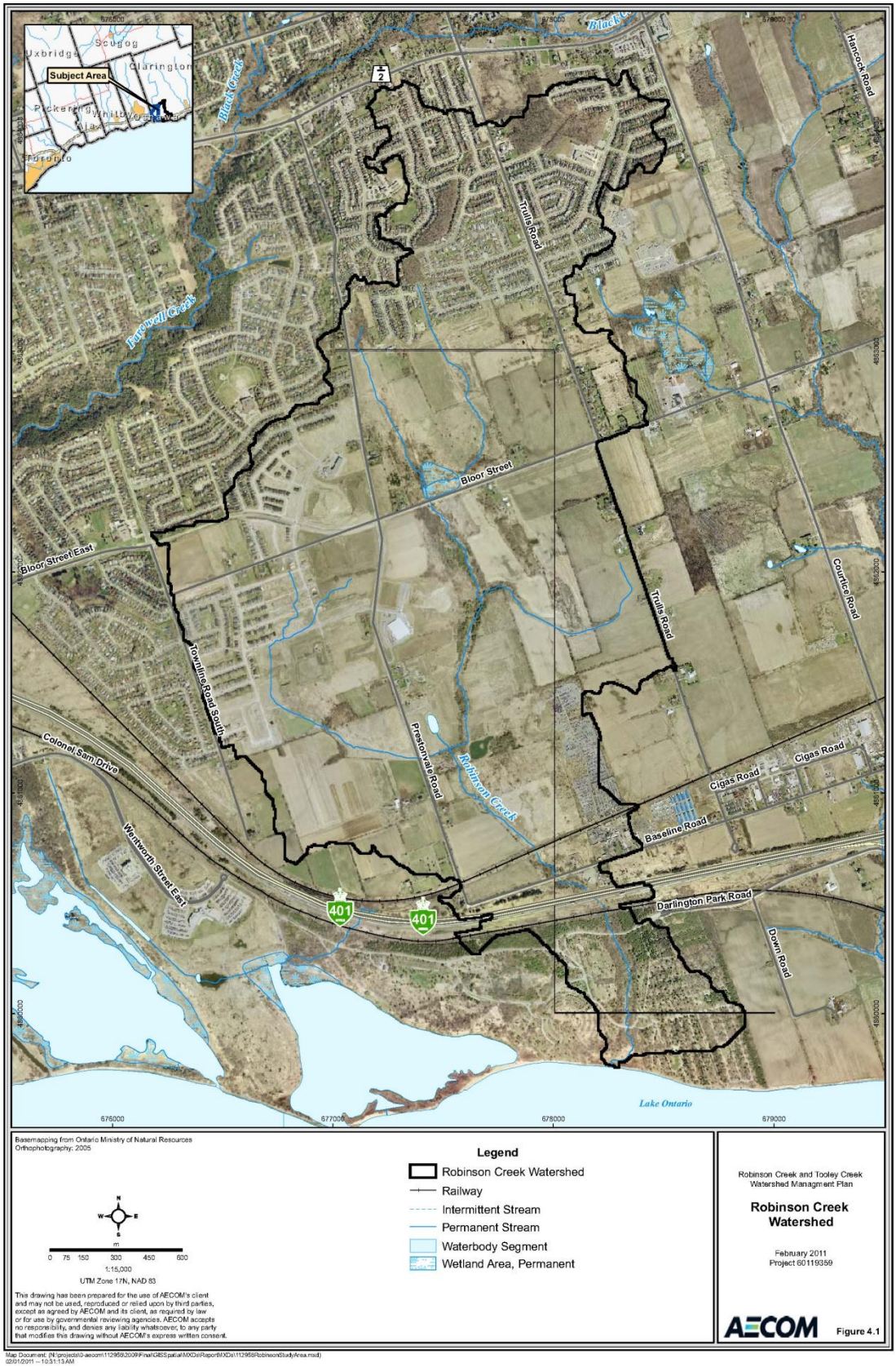


Figure 4.1 Robinson Creek Watershed

Table 4.1 Comparison of Precipitation Climate Normals to Observed Conditions

Air Temperature Climate Normals (1971 – 2000)[1]				Precipitation Climate Normals (1971 – 2000)[1]			
Date	*Maximum*	*Minimum*	*Mean*	*Date*	*Rain*	*Snow*[2]	*Total*
January	-1.9	-10.7	-6.3	**January**	33.1	30.0	63.1
February	-0.9	-9.7	-5.3	**February**	30.8	16.4	46.3
March	4.0	-4.9	-0.5	**March**	46.3	13.5	60.7
April	10.9	1.1	6.0	**April**	70.0	2.9	72.9
May	17.8	6.6	12.2	**May**	73.7	0.0	73.7
June	22.8	11.3	17.1	**June**	81.5	0.0	81.5
July	25.5	14.0	19.8	**July**	63.7	0.0	63.7
August	24.5	13.2	18.9	**August**	81.0	0.0	81.0
September	20.2	9.2	14.7	**September**	90.5	0.0	90.5
October	13.4	3.4	8.4	**October**	67.8	0.1	67.9
November	6.9	-0.7	3.1	**November**	77.9	6.1	84.0
December	1.2	-6.6	-2.7	**December**	47.4	24.2	71.6
Total	-	-	-	**Total**	**764.6**	**93.2**	**857.9**

Notes: 1. Source: www.climate.weatheroffice.ec.gc.ca/climatenormals
2. 1 cm of snow equals 1 mm of precipitation

4.1.3 Physiography and Geology

The Robinson Creek Watershed is located within the Iroquois Plain physiographic region (**Figure 4.2**), which is a gently sloping lowland area extending from the edge of the till plain of the South Slope region (located to the north of the study area) down to Lake Ontario (Chapman and Putnam, 1984).

The geology of the Robinson Creek Watershed consists of Quaternary sediments that overlie Ordovician bedrock of the Blue Mountain Formation, locally referred to as the Whitby Formation (**Figures 4.3 and 4.4**). The primary soil within the watershed is a stony, sandy, silty till known as the Newmarket Till (the upper soil layer on the photograph to the left is Newmarket Till). This unit is very dense and restricts groundwater flow and infiltration. The remaining surficial soils in the watershed are part of the Iroquois Plain, which consists of shallow lake deposits of fine sand, silt and clay. These glaciolacustrine deposits were formed by glacial melt water discharging into glacial Lake Iroquois during the last glacial period. The shoreline of Lake Iroquois is characterized by raised sand and gravel beach deposits and is considered a significant natural feature. The Lake Iroquois Shoreline is not present within the Robinson Creek Watershed, although it can be found to the north and east of the watershed. Within the watershed, fine sand deposits were deposited close to the former shoreline, with subsequent deposits of silts and clays being deposited farther south (closer to present day Lake Ontario as show in the lower soil layer on the photograph to the left). Fine sand deposits can be found in the northern portion of the watershed near Trulls Road, where a defined stream channel for Robinson Creek is first observed. Newmarket Till soils dominate remaining surface area of the watershed, with portions of Robinson Creek valley containing glaciolacustrine silts and clays.

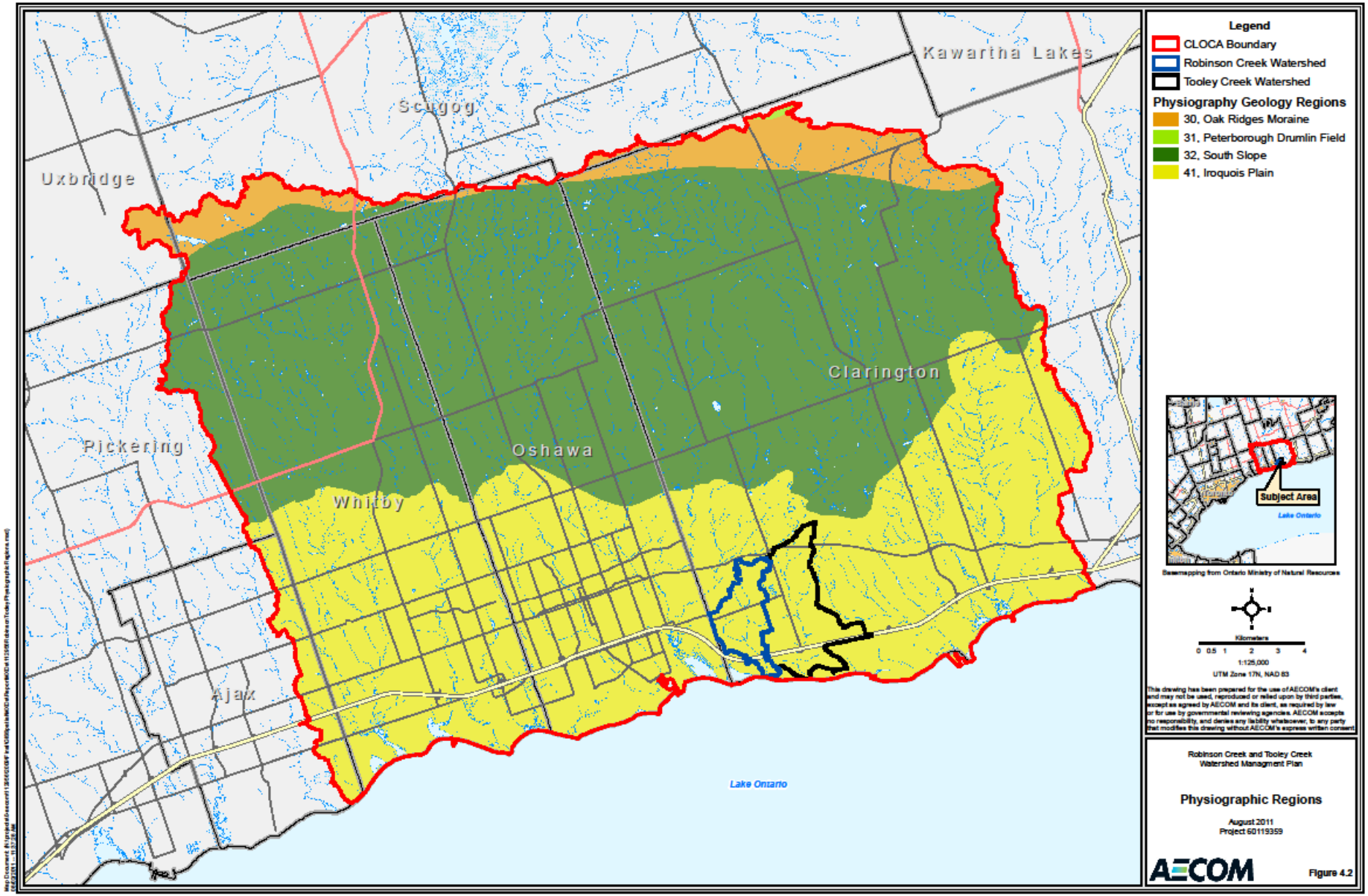


Figure 4.2 Physiographic Regions

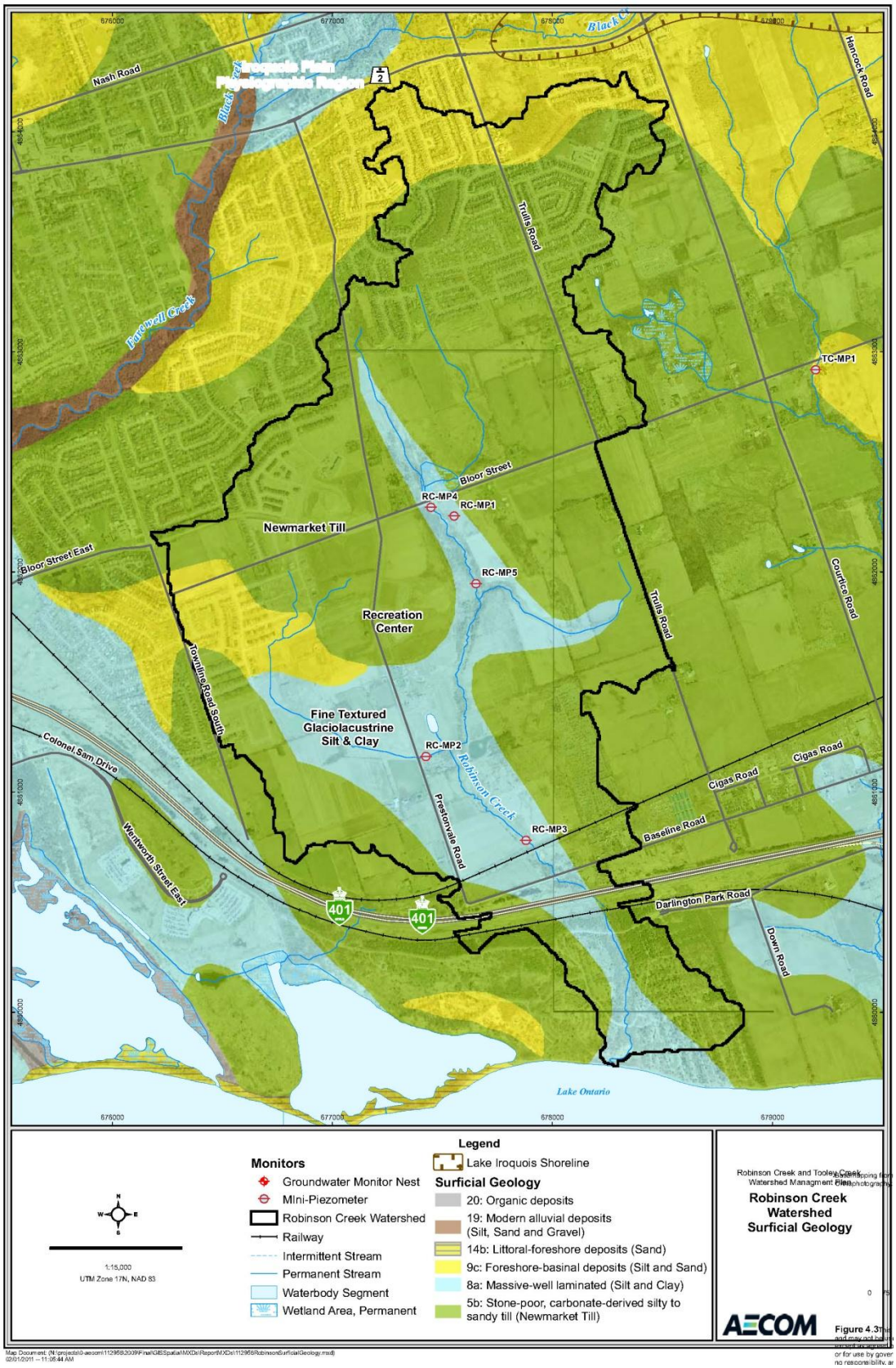


Figure 4.3 Robinson Creek Watershed Surficial Geology

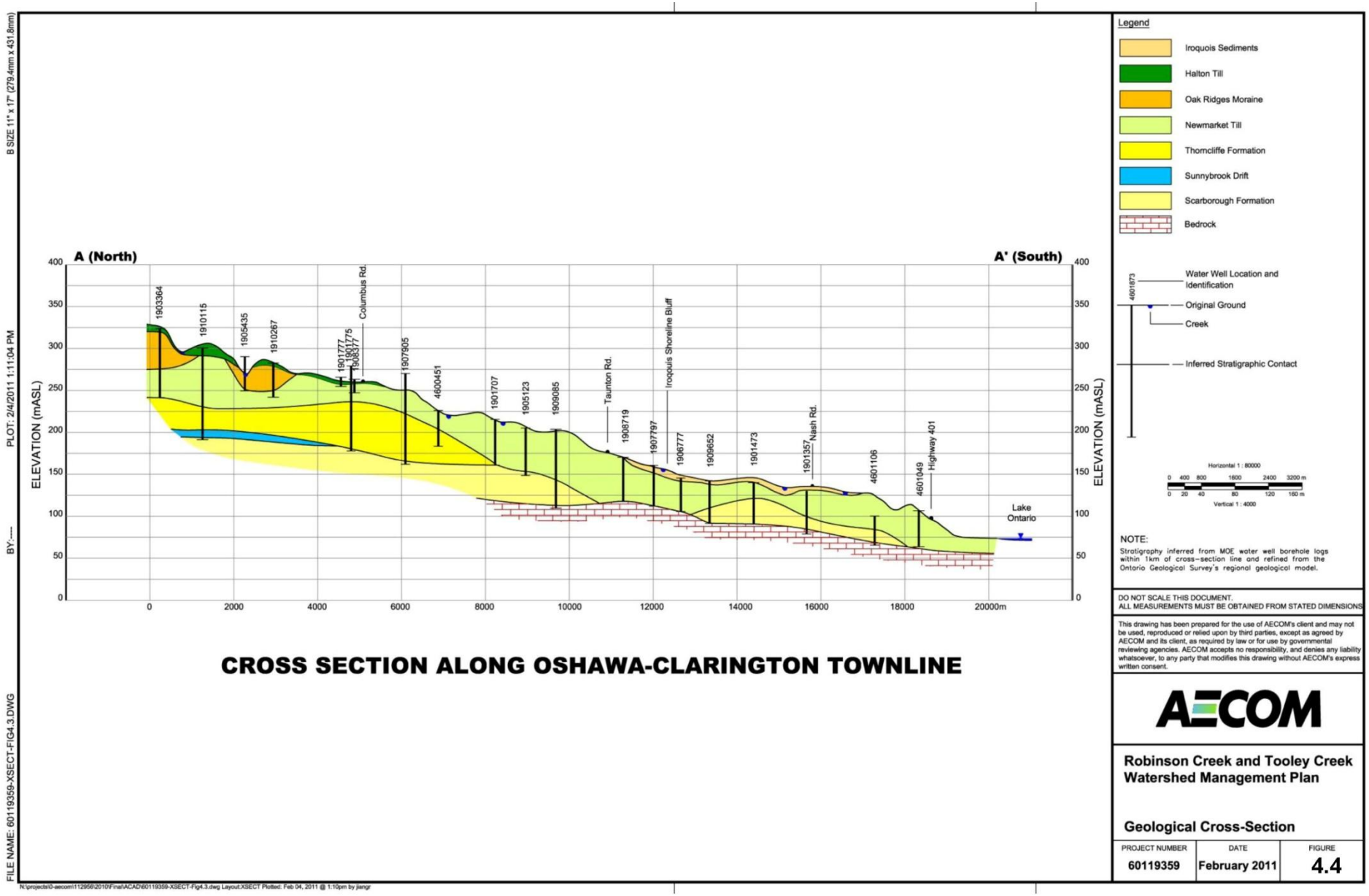


Figure 4.4 Geological Cross-Section

4.1.4 Groundwater

Groundwater flow in the Robinson Creek Watershed is controlled by the thick deposits of the Newmarket Till Aquitard present within the watershed (**Figure 4.3**). This unit is very dense and restricts groundwater flow and infiltration. Groundwater flow in the watershed generally follows surface topography and flows from north to south, with minor components bending towards discharge areas in the Robinson Creek valley (**Figure 4.5**).

A small portion of the Iroquois Plain Shallow Aquifer is present in the northern portion of the watershed. The high permeability of the sandy near shore deposits of the Iroquois Plain Shallow Aquifer provides a pathway for local groundwater recharge and discharge. The water table is typically near surface because the low permeability of the underlying Newmarket Till Aquitard restricts drainage of groundwater to depth. Areas covered by these sandy soils provide a potentially important groundwater recharge and discharge function that contributes to stream flow in Robinson Creek. These potentially important groundwater recharge areas are presented on **Figure 4.6**, and generally coincide with the area covered by the Iroquois Plain Shallow Aquifer. A quantitative analysis of groundwater recharge areas is presented in Section 5.4.2.

The Robinson Creek Watershed does not contain any confined aquifers that are part of the Oak Ridges Moraine. The southern extent of the major regional aquifer units from the Oak Ridges Moraine, such as the Thorncliffe Aquifer and the Oak Ridges Moraine Aquifer, pinch out to the north of the Robinson Creek Watershed (YPDT-CAMC Technical Report #01-06) (**Figure 4.4**). These aquifer units do not contribute to groundwater flow or groundwater discharge in the watershed. It is therefore likely that any groundwater discharge occurring in Robinson Creek and its tributaries is derived locally, rather than from deep regional groundwater flow. Important groundwater discharge areas were delineated through visual observations of seeps and are presented on **Figure 4.7**. These important groundwater features generally coincide with wetlands, watercourses and observed groundwater springs and seeps.

There are no municipal supply wells or other large watertakings located in the Robinson Creek Watershed. Based upon a search of the Ministry of the Environment's Permit To Take Water Database, there are no significant groundwater or surface water users in the watershed. Domestic water users have traditionally utilized groundwater for potable water use, obtaining water from lenses within the Newmarket Till or from bedrock aquifers. With increasing urban development in the watershed, current domestic well users could obtain water from municipal systems that derive water from Lake Ontario.

4.1.5 Fisheries and Aquatic Habitat

Specific indicators of aquatic habitat condition and health were documented for the Robinson Creek Watershed in relation to the local environment including: Strahler stream order, instream barriers to fish migration that contribute to isolation of habitats or populations, riparian vegetation, thermal regimes and land use/cover. In addition to these environmental indicators and conditions, fish species, fish locations, and benthic invertebrate composition and distribution was also documented.

Robinson Creek flows for approximately 6.7 km (north to south) before out letting into Lake Ontario at the south end of Darlington Provincial Park. **Figure 4.8** shows stream order classifications within the Robinson Creek Watershed. Stream order provides a method of grouping streams of a similar size, depth and flow, as well as suggesting a level of sensitivity a watercourse may have to disturbance or development. In general, as stream order increases, so does watercourse depth and width.

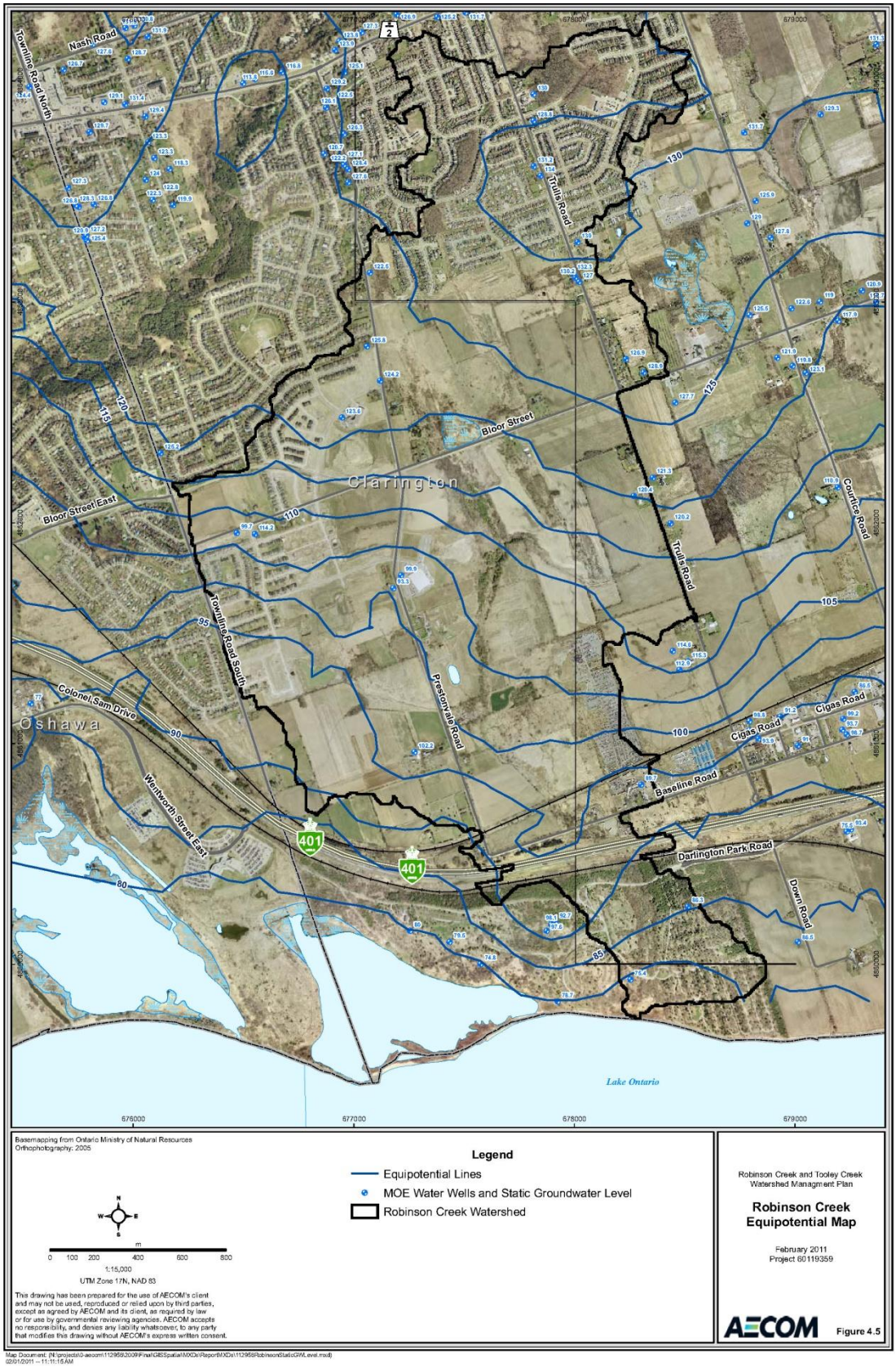


Figure 4.5 Robinson Creek Equipotential Map

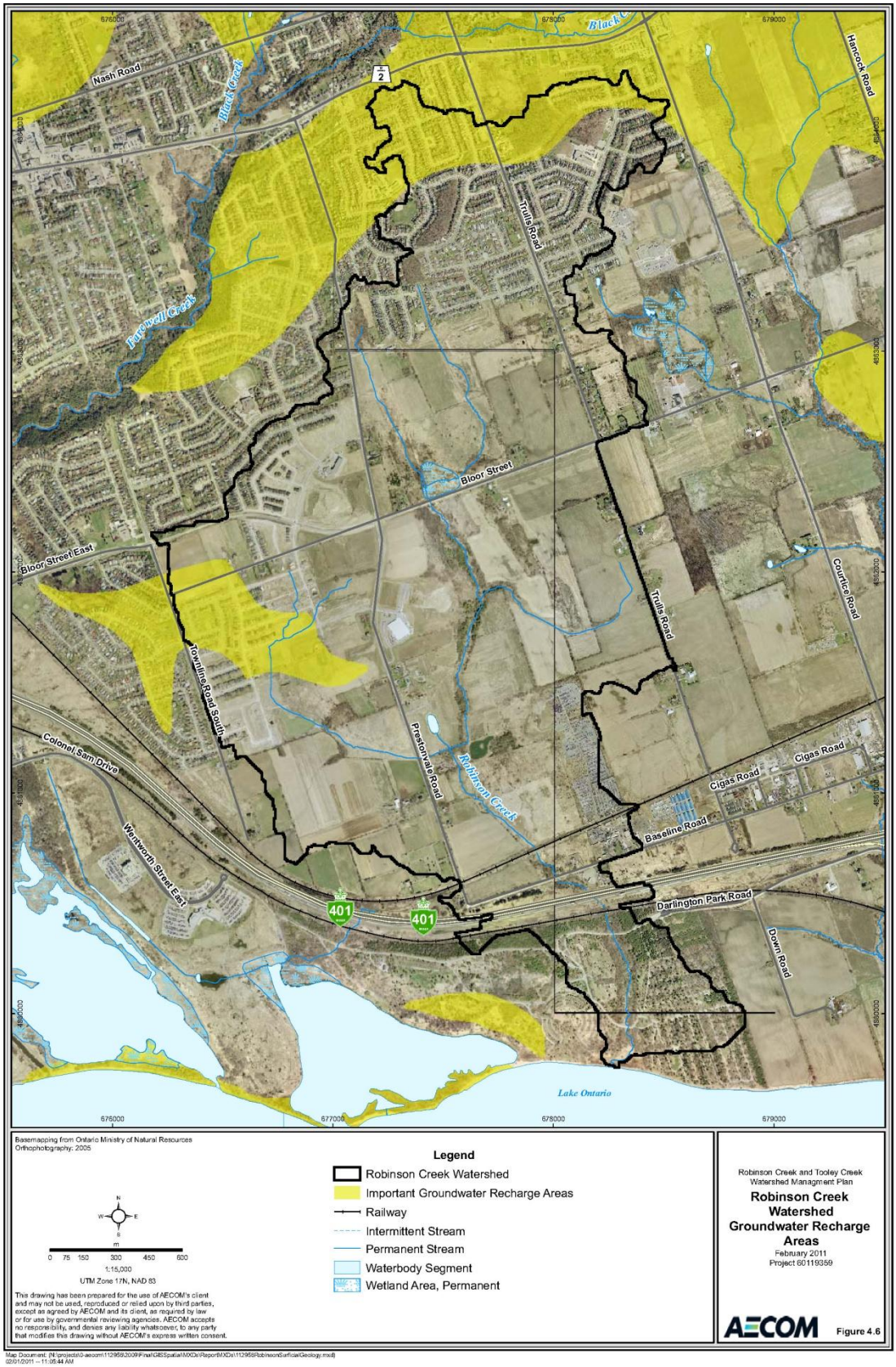


Figure 4.6 Robinson Creek Watershed Groundwater Recharge Areas

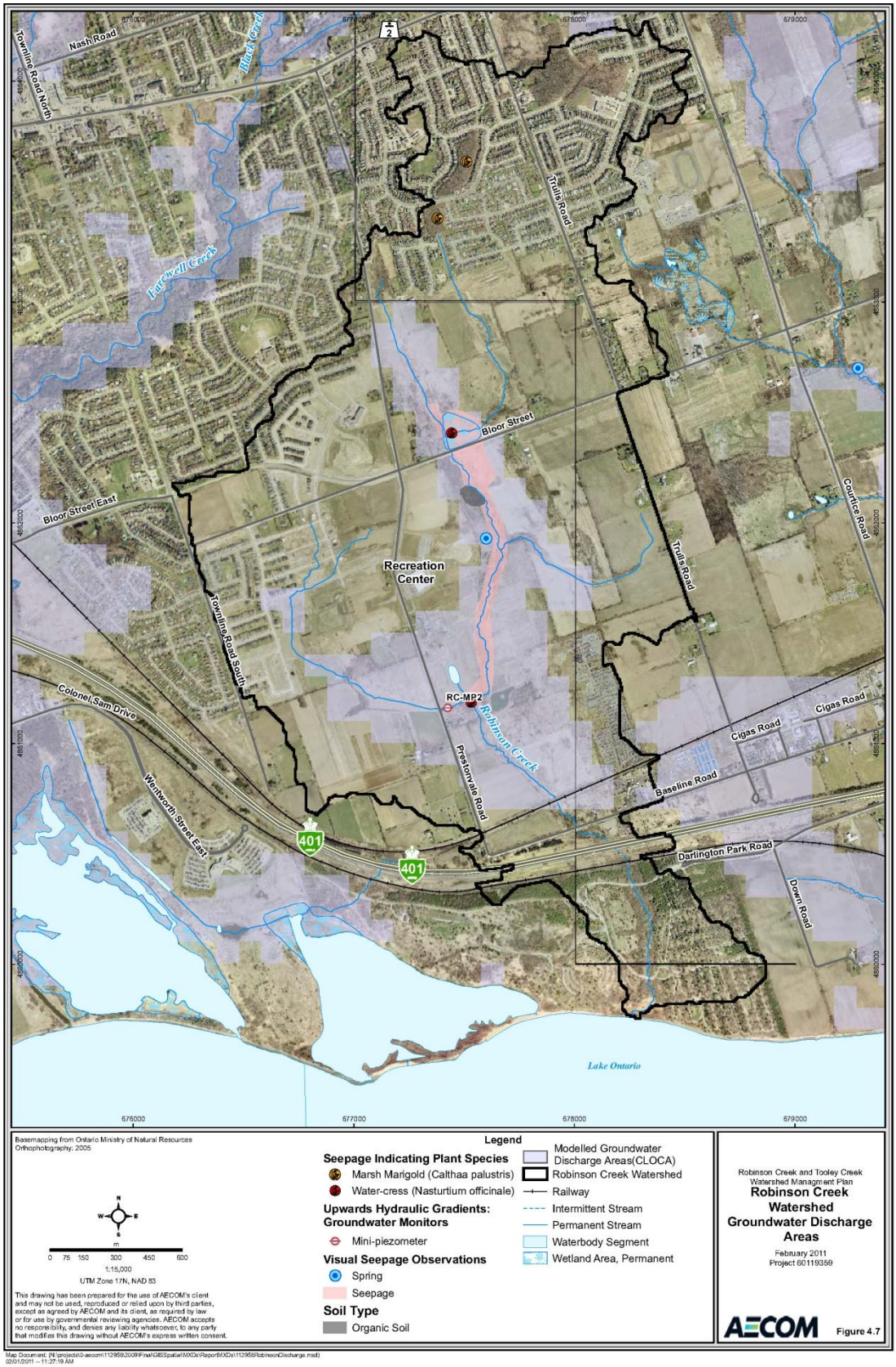


Figure 4.7 Robinson Creek Watershed Groundwater Discharge Areas

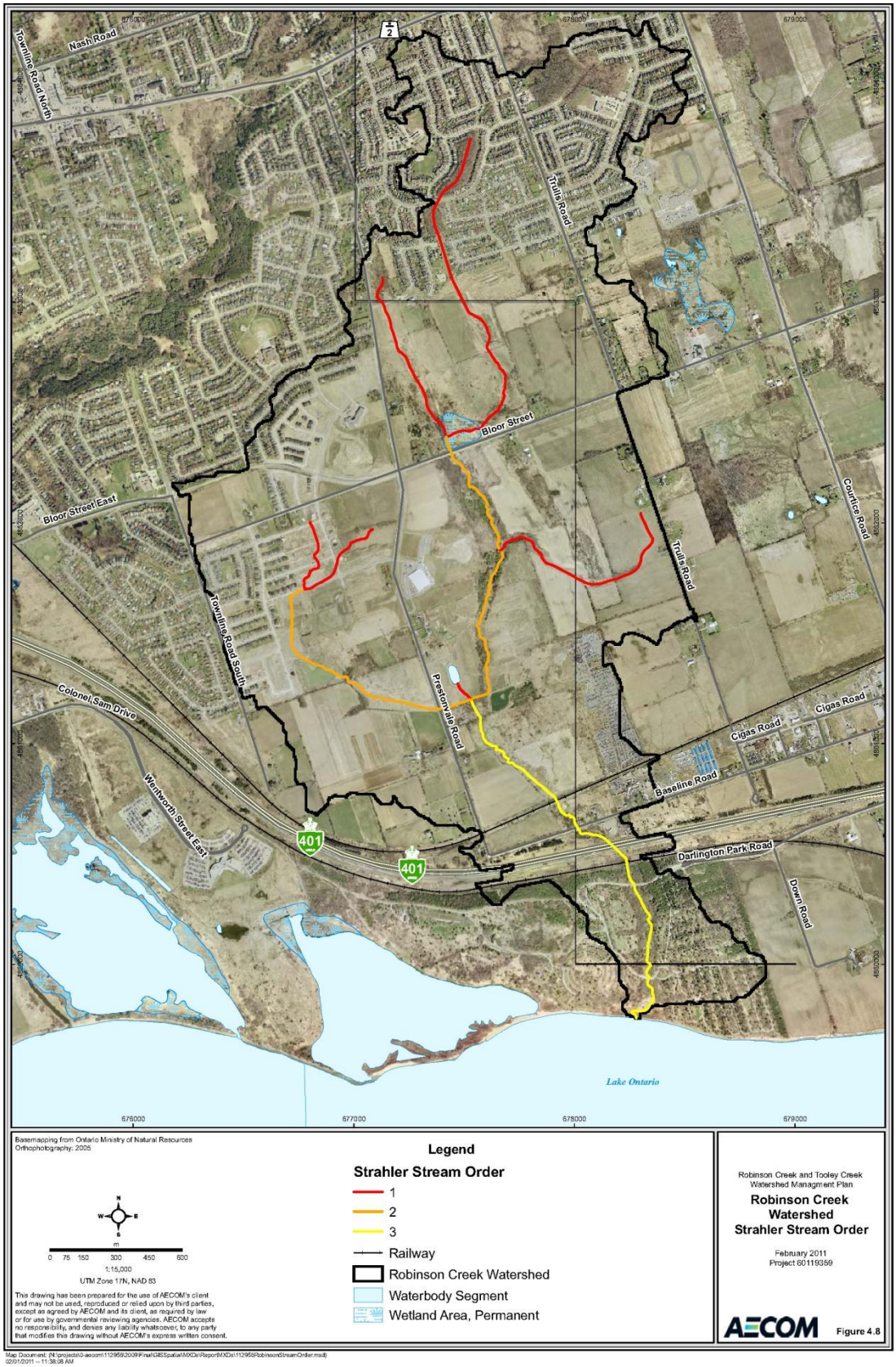


Figure 4.8 Robinson Creek Watershed Strahler Stream Order

Riparian vegetation cover varies greatly between each of the stream orders along Robinson Creek. Maintaining adequate riparian cover around a watercourse will improve surface water quality by reducing sedimentation. Riparian vegetation also functions to provide allochthonous inputs into streams such as leaf and woody debris, which creates habitat cover and provides shade cover over streams contributing to the buffering of water temperatures. Environment Canada guidelines state that 75% of a stream length should be buffered by 30 m of riparian cover to maintain a healthy state (EC, 2004). Within the Robinson Creek Watershed approximately 72% of first order streams lack sufficient riparian vegetation. The majority of second order stream reaches within the Robinson Creek Watershed are surrounded by large naturalized riparian buffers that are relatively undisturbed from development or local agriculture. In total approximately 70% of second order streams maintain adequate riparian buffer vegetation. The majority of the third order stream reaches within the Robinson Creek Watershed also maintain adequate riparian vegetation with roughly 79% of the main branch containing good riparian cover.

Two barriers to fish passage were identified along the length of Robinson Creek. The first impediment to fish migration is located at the railway crossing of Robinson Creek upstream of Baseline Road (**Figure 4.9**). The second barrier to fish movement is located on the south side of Bloor Street and is associated with a perched culvert.

Fish community sampling for Robinson Creek was completed in June and August/September 2009 as part of the Existing Conditions Report. Eleven (11) known species, representing seven families were identified (**Table 4.2**). Of the 11 fish species caught, Blacknose Dace (*Rhinichthys atratulus*), Creek Chub (*Semotilus atromaculauts*) and Fathead Minnow (*Pimephales promelas*), where the most common species captured, and were all captured in similar proportions within Robinson Creek. These fish species represent a warm to coolwater community and are each widespread in their southern Ontario distribution.

AECOM captured young-of-the-year Rainbow Trout (*Oncorhynchus mykiss*), which is a coldwater species, at station R2, suggesting that the railway crossing north of Baseline Road is not a significant barrier to rainbow trout migration (**Figure 4.11**). Although Rainbow Trout where captured in September 2009, they represented less than 1% of all fish captured. These data are consistent with CLOCA reports confirming young-of-the-year rainbow trout in Robinson Creek in 2003, however, it should also be noted that CLOCA was not able to capture migratory species from the same areas in 2008 and 2009. The confirmed occurrence of rainbow trout, both in 2009 (AECOM) and 2003 (CLOCA) suggests that limited runs of migratory rainbow trout exist in the watershed, and furthermore, the middle reaches of the watershed provide tolerable, cool to cold water conditions for coldwater fish species, such as a rainbow trout.

Table 4.2 Known Fish Community Composition – Robinson Creek Watershed

Family	Common Name	Scientific Name	Abundance (% of total captured)	Thermal Class	COSEWIC Status	COSSARO Status
Catostomidae	White Sucker	*Catostomus commersoni*	<1%	Cool	NAR	NAR
Centrarchidae	Pumpkinseed	*Lepomis gibbosus*	3%	Warm	NAR	NAR
Cyprinidae	Fathead Minnow	*Pimephales notatus*	36%	Warm	NAR	NAR
	Creek Chub	*Semotilus atromaculauts*	25%	Cool	NAR	NAR
	Blacknose Dace	*Rhinichthys atratulus*	30%	Cool	NAR	NAR
	Longnose Dace	*Rhinichthys cataractae*	<1%	Cool	NAR	NAR
	Northern Redbelly Dace	*Phoximus eos*	3%	Cool/Warm	NAR	NAR
Gasterosteidae	Brook Stickleback	*Culaea inconstans*	2%	Cool	NAR	NAR
Percidae	Johnny Darter	*Etheostoma nigrum*	<1%	Cool	NAR	NAR
Salmonidae	Rainbow Trout	*Oncorhynchus mykiss*	<1%	Cold	NAR	NAR
Cyprinodontidae	Banded Killifish	*Fundulus diaphanus*	<1%	Cool	NAR	NAR

Figure 4.9 Robinson Creek Watershed Instream Barriers

The presence of cool and coldwater species within the watershed also speaks to the thermal regime of the watershed as displayed in **Table 4.3**. Stream temperatures collected between July and August 2009 (temperature locations shown on **Figure 4.10**) indicate that the thermal regime is generally coolwater rather than warmwater (as shown in the Ministry of Natural Resources database), and supports a coolwater thermal classification for Robinson Creek. AECOM's conclusion is consistent with CLOCA's thermal data collected between 2005 and 2009, and generally matches the thermal class of the fish community, with the exception of the presence of rainbow trout; which are most often associated with coldwater systems.

Table 4.3 Stream Temperature Monitoring within Robinson Creek

Temperature Logger Location	Period of Record	Days within Mean Daily Temperature Range				Min Temp (°C)	Max Temp (°C)	Classification
		Cold (<19°C)	*Cool (19 – 25°C)*	*Warm (>25°C)*	*Lethal Limit for Rainbow Trout (>26°C)*			
RC-WT2 (MP2)	July 12 – August 31, 2009	8	42	1	0	16.2	25.1	Coolwater
RC-WT3 (MP3)	July 12 – August 31, 2009	21	30	0	0	15.7	23.8	Coolwater

Currently, and historically, the fish community within the Robinson Creek Watershed contains a range of warm to cold water fish species that are typical of an urban fish community. With the exception of rainbow trout, the fish community of Robinson Creek is typical of a coolwater system with the distribution of species primarily dependant on flow regime within the watershed and less on water temperatures. To this end, flow regime within Robinson Creek is a primary factor of fish species distribution and habitat potential. Seasonal fish habitat within intermittent reaches of Robinson Creek does exist within some of the first and second order stream reaches but the majority of permanent fish habitat exists within the second and third order stream reaches.

The surface water quality in Robinson Creek is reflective of an urbanized watershed. Field parameters and chemical results are presented in **Table 4.4**. Concentrations of total phosphorus that exceed Provincial Water Quality Objective (PWQO) standards were found at each monitoring station during all monitoring events in the summer of 2009 (sampling locations shown on **Figure 4.10**). Chloride, total ammonia, and total suspended solids (TSS) concentrations were generally elevated. These results suggest that some non-point source contaminants such as road salt, agricultural fertilizers and septic systems have impacted the water quality in Robinson Creek.

Table 4.4 Robinson Creek Surface Water Quality

Parameters	Units	PWQO	June 24 – 25/09			August 24/09			September 3/09	
			R1	***R2***	***R3***	***R1****	***R2****	***R3****	***R4***	***R5***
Water Temperature	°C	-	21.1	23.4	19.6	14	16.7	16.8	17.7	20.1
pH	-	6.5 - 8.5	7.77	7.85	7.56	8.25	7.95	8.21	8.04	8.04
Conductivity	µS/cm	-	637	610	664	625	586	736	894	600
Total Ammonia	mg/L	-	0.08	0.22	0.07	0.06	0.06	0.07	0.09	0.07
Un-ionized Ammonia	mg/L	0.02	0.002	0.005	0.008	NA	NA	NA	NA	0.003
Total Phosphorus	mg/L	0.03	**0.076**	**0.064**	**0.037**	**0.050**	**0.058**	**0.11**	**0.048**	**0.067**
TSS	mg/L	-	34	27	17	17	21	61	23	61
Chloride	mg/L	150**	88	84	74	95	88	54	**180**	130
BOD	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND

*Notes: *water temperature, pH and conductivity collected on September 4, 2009*
*** Currently there is no PWQO for chloride, however, 150 mg/L is used as a protection of freshwater biota criteria by the Toronto Region Conservation Authority, Ontario MOE - Environmental Monitoring and Reporting Branch and the BC Ministry of the Environment*
ND = Not Detectable
NA = Not Available, due to missing data required for calculation
***Bold numbers** are above their respective PWQO*

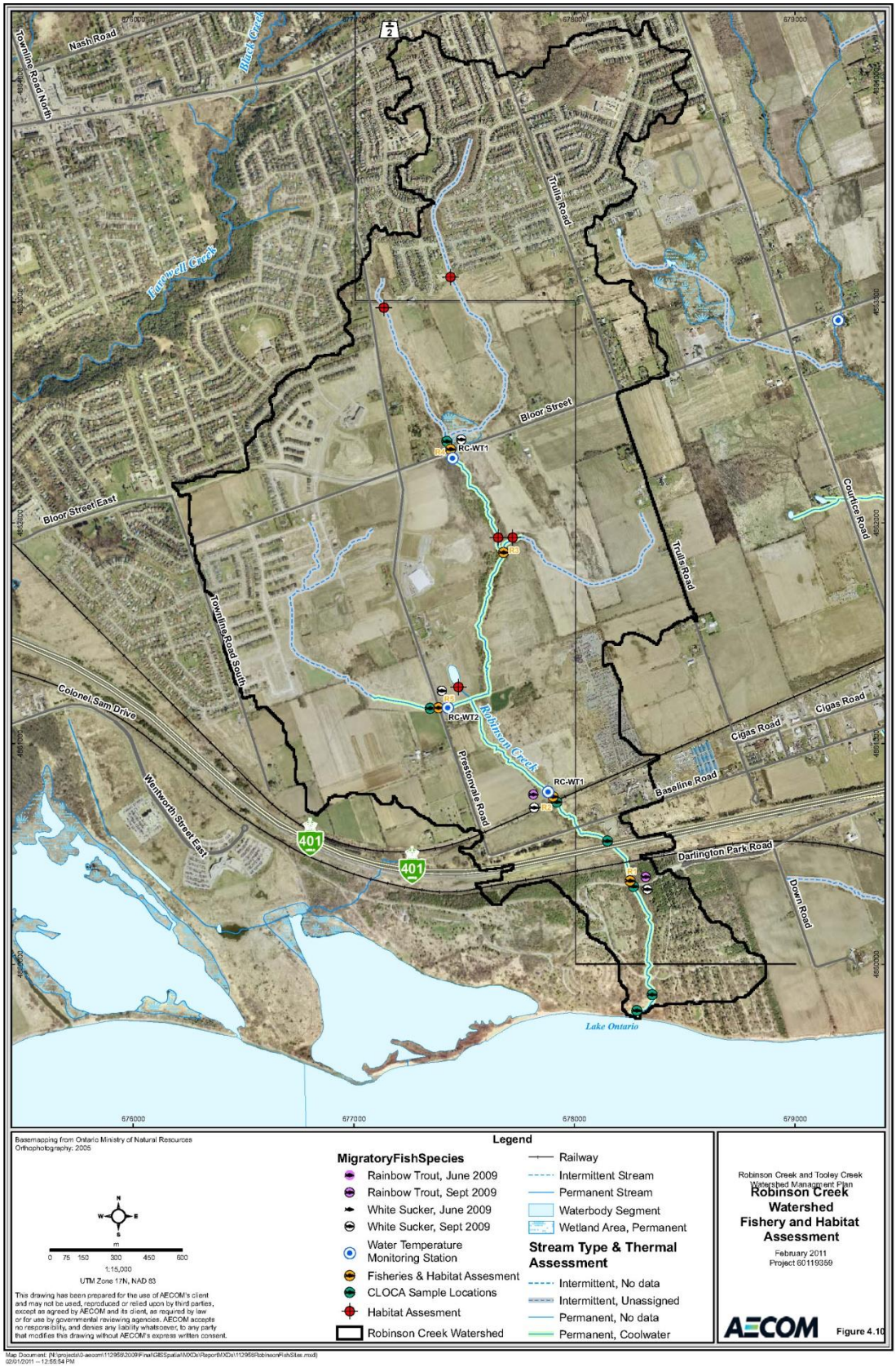


Figure 4.10 Robinson Creek Watershed Fishery and Habitat Assessment

4.1.6 Terrestrial Natural Heritage

The Robinson Creek watershed is located along the north shore of Lake Ontario within Ontario Ministry of Natural Resources Site District 6-13. The site district is further divided by Chapman and Putnam (1984) into the Iroquois Plain and the Oak Ridges Moraine South Slope physiographic regions. The watershed occurs below the South Slope and historic Lake Iroquois shoreline, and is entirely located within the Lake Iroquois Plain physiographic region. The Iroquois Plain is an east-west trending feature that consists of sandy to silty deposits.

Ontario Ministry of Natural Resources (OMNR) (1984) found approximately five to ten percent of Site District 6-13 to be in relatively natural and undisturbed state. The most common remnant natural features include shoreline bluffs and beaches, rivermouth marshes, stream valleys and riparian corridors, and isolated upland forests. Urban residential development has been approved in the watershed, particularly in the northwest (i.e., west of Prestonvale Road and north of Bloor). Findings presented in the Watershed Plan Existing Conditions Report (AECOM 2010) indicate that that 19.6% of the watershed supports natural and naturalized cover (**Figure 4.13**), including all or parts of the following designated natural areas:

- McLaughlin Bay Wetland Provincially Significant Wetland (located in part in the Robinson watershed at the mouth of the Robinson Creek);
- Darlington Provincial Park (along the shore of Lake Ontario, partly within the Robinson watershed); and
- The Robinson Creek Valley Environmentally Sensitive Area (occurs entirely with the Robinson watershed).

Young deciduous forest and thicket communities are the most common vegetation community types, with Green Ash (*Fraxinus pennsylvanica*) abundant throughout (**Figure 4.11**). Common associates include, American Elm (*Ulmus americana*) and Manitoba Maple (*Acer negundo*); the latter is particularly common in lowlands and floodplains. Mid-age and mature forest cover is rare in the watershed. Where these communities do occur, Sugar Maple (*Acer saccharum*) forms associations with White Ash (*Fraxinus americana*), Red Oak (*Quercus rubra*), American Beech (*Fagus grandifolia*), and/or Eastern Hemlock (*Tsuga canadensis*). Coniferous and mixed forests comprise a relatively small component of forest cover, with White Pine (*Pinus strobus*), Red Pine (*Pinus resinosa*) and White Spruce (*Picea glauca*) occurring in upland situations (commonly as remnant plantations), and Eastern White Cedar (*Thuja occidentalis*) occurring in the floodplains. Upland meadows occur throughout the watershed, particularly as abandoned agriculture fields. These meadows are typically dominated by varying degrees of cool-season grasses, Canada Goldenrod (*Solidago canadensis*), Heath Aster (*Aster ericoides*) and New England Aster (*Aster novae-angliae*).

Deciduous swamp communities are the most common wetland types, with Green Ash and Swamp Maple (*Acer freemanii*) abundant throughout treed types, and Red-osier Dogwood (*Cornus stolonifera*) and Willow species (*Salix sp.)* dominating the thicket swamps. Marsh communities are present in smaller portions, with Reed-canary Grass (*Phalarus aurundinacea*) and forb meadow marshes the most common types, followed by shallow Cattail (*Typha sp.*) marshes. Seepage wetlands are rare, and are generally associated with areas where stream valleys have exposed shallow localized groundwater flow, predominately along the main branches of the Robinson Creek valley.

193 species of vascular plants are known to occur within the Robinson Creek Watershed (AECOM 2010). Forty-six of the species indentified are non-native occurrences, representing approximately 24% of all species recorded. The high proportion of non-native species is largely attributed to the fragmented nature of the vegetation throughout the watershed, which is typical of southern Ontario. Eleven species are considered regionally significant (uncommon to rare in Durham Region according to Varga et al., 2000).

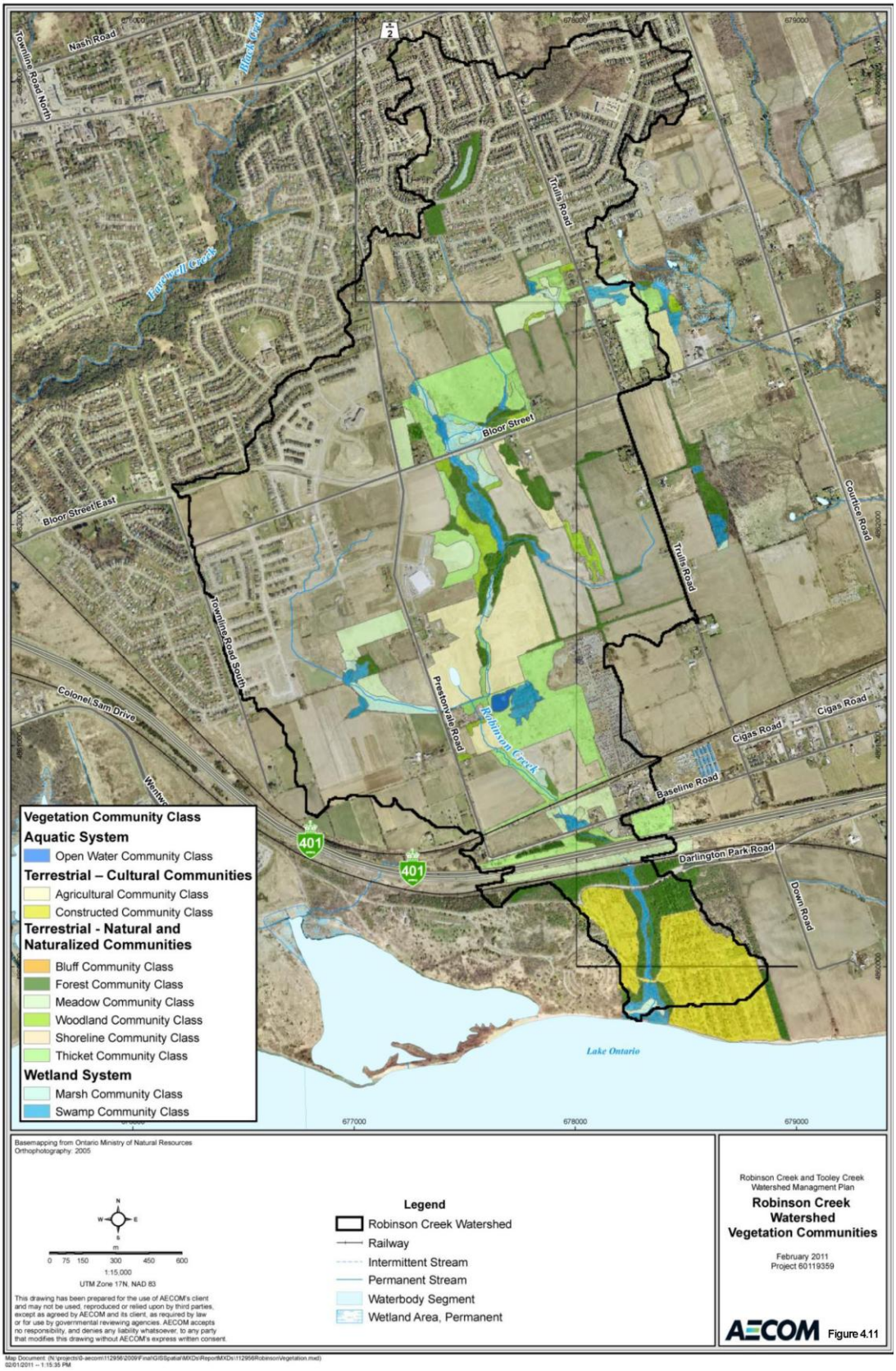


Figure 4.11 Robinson Creek Watershed Vegetation Communities

Fifty-five breeding bird species were recorded in the Robinson Creek Watershed as part of the Existing Conditions study (**Figure 4.12**). This number is relatively low given the size of the watershed; however, it reflects the low quality of habitat available. The most frequently observed bird species are those that are common in southern Ontario typical of edges, shrub habitats and disturbed areas. The most abundant species recorded include: Blue Jay (*Cyanocitta cristata*), House Wren (*Troglodytes aedon*), Gray Catbird (*Dumetella carolinensis*), Yellow Warbler (*Dendroica petechia*), Northern Cardinal (*Cardinalis cardinalis*), Song Sparrow (*Melospiza melodia*), Red-winged Blackbird (*Agelaius phoeniceus*), and American Goldfinch (*Cardeulis tristis*). Negligible numbers of area-sensitive forest bird species were recorded; i.e., five individuals of three forest area-sensitive species were recorded: White-breasted Nuthatch (*Sitta carolinensis*), Black-throated Green Warbler (*Dendroica virens*) and Blue-gray Gnatcatcher (*Polioptila caerulea*). A few grassland or open land area-sensitive species were recorded in the watershed; however, only Savannah Sparrow (*Passerculus sandwichensis*) was recorded in any significant numbers.

Darlington Provincial Park is a very important migrant stop-over location for songbirds in particular, but also for shorebirds and waterfowl. The Darlington Provincial Park Checklist of Birds (T. Hoar 1997) lists the 264 bird species which have occurred in the park. (Note that only half the park is within the watershed.) The majority of these would have been observed during migration seasons, including some species that have probably only been observed once or twice.

Species at Risk are those species with status under the Federal Species at Risk Act (SARA) and/or the Provincial Endangered Species Act. Species at Risk are identified federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and provincially by the Committee on the Status of Species at Risk in Ontario (COSSARO). Five Species at Risk are known to occur with the Robinson watershed (AECOM 2010):

- Piping Plover (*Charadrius melodus*);
- Blanding's Turtle (*Emydoidea blandingii*);
- Snapping Turtle (*Chelydra serpentine*);
- Milksnake (*Lampropeltis triangulum triangulum*); and
- Butternut (*Juglans cinerea*).

4.1.7 Land Cover

Land use and land cover in the Robinson Creek Watershed has changed significantly over the past few decades. The focus of the land use has changed from agriculture to urban residential. **Figure 4.13** presents an overview of the land use found within the watershed based upon the results of the Existing Conditions Study conducted in 2009/2010 and is based upon municipal land use designations and ELC polygon mapping. All land uses have been simplified into broad land use categories to focus on the various aspects of the natural heritage system. Although the full break down of land use is not presented, they have been grouped into the same classes used for hydrologic modelling of the watershed:

- **Development**
  Urban Residential, Rural Residential, Industrial and Commercial, Town Centre and Transportation and Utility;
- **Natural Heritage**
  Woodlots and Forest, Lakes and Wetlands, Meadows and Grasslands, Savannah and Thicket, and Darlington Provincial Park;
- **Agriculture**
  Agricultural Facility, Crop Field, and Pasture; and
- **Greenspace**
  Community Parks, Stormwater Management Facilities, and Waterfront Greenway.

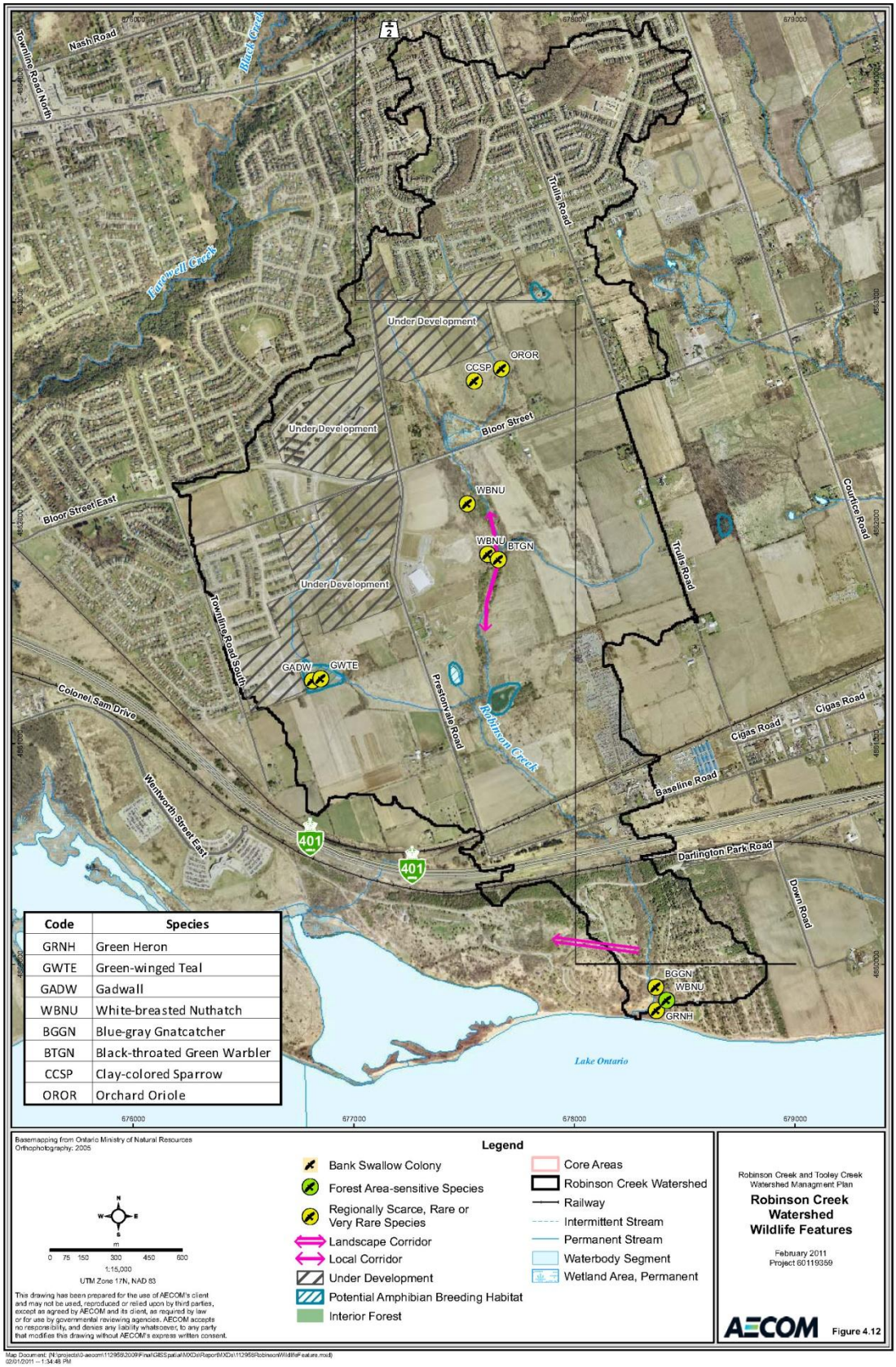


Figure 4.12 Robinson Creek Watershed Wildlife Features

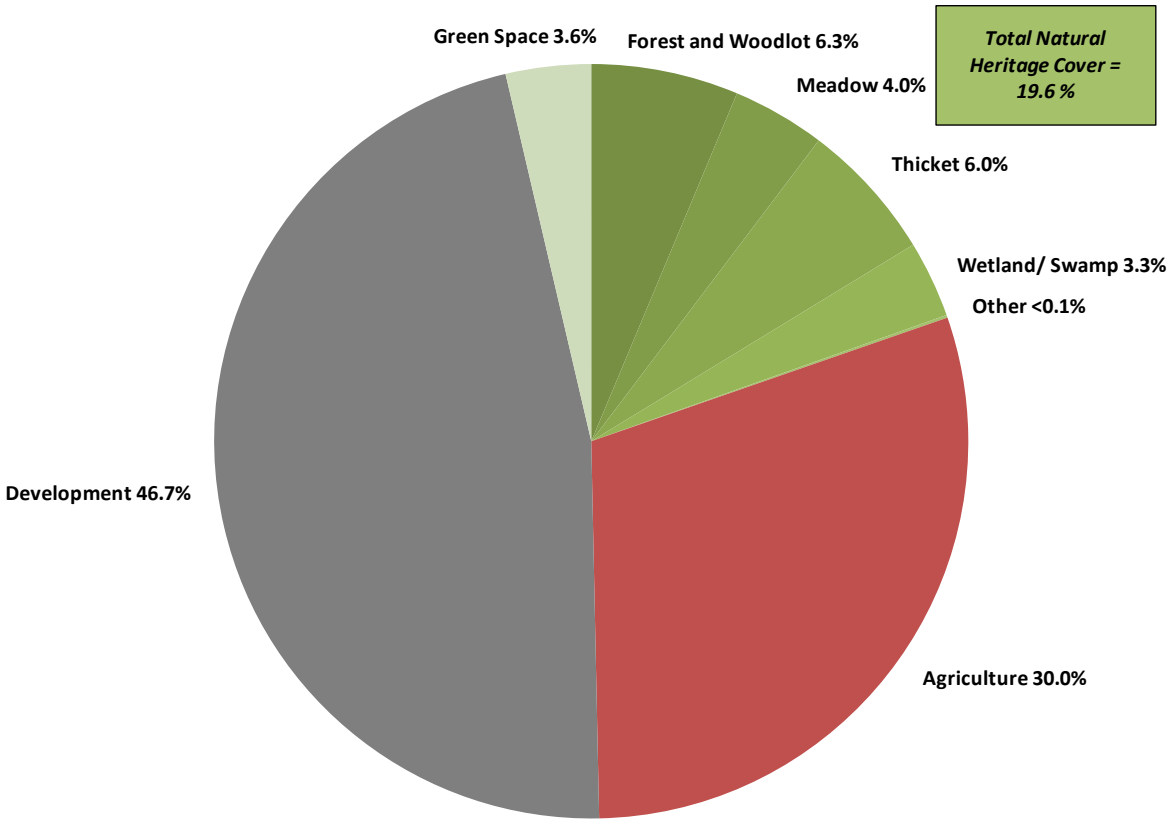


Figure 4.13 Robinson Creek Watershed – Existing Land Cover

The total natural heritage cover for the watershed, including natural and naturalized cover, but not including manmade green space such as stormwater management facilities, is 19.6%. This falls short of the 30% target that is recommended for a healthy watershed (EC, 2005). Lands classified as wetland and swamp habitat make up 3.3% of land use in the watershed, which again falls short of the recommended 10% guideline (EC, 2005). The Robinson Creek Watershed does not currently contain any interior forest habitat or core areas (**Figure 4.12**). The majority of the higher quality forest habitat is found within the Robinson Creek valley lands and within Darlington Provincial Park.

4.1.8 Summary of Positive Attributes and Opportunities for Improvement

As part of watershed management planning, it is important to recognize both the positive and negative attributes of a watershed. Although the Robinson Creek Watershed is mostly an urban watershed, some very positive results on the health of the watershed were documented in the Existing Conditions Study. Conversely, the same study highlighted a number of areas that could be improved to help create a healthier watershed and build a resiliency into the natural heritage system to protect against future stresses such as climate change.

The Robinson Creek Watershed has many positive attributes including:

- Groundwater discharge is sufficient to sustain baseflow in all but the driest years and thermally buffer stream temperatures;
- The rate of groundwater use in the watershed is low and it expected to decline in the future;
- Robinson Creek hosts a variety of healthy warm to cold water fish communities;
- The thermal regime and stream flow in Robinson Creek is sufficient to sustain a population of rainbow trout, which is a cold water species, and provides rainbow trout habitat;

- Valley lands throughout the watershed are moderately well vegetated and provide a local north-south wildlife corridor;
- The majority of 2nd and 3rd order reaches of Robinson Creek have adequate riparian cover;
- A portion of the McLaughlin Bay Provincially Significant Wetland is found in the watershed; and
- Darlington Provincial Park and the Lake Ontario Shoreline provide an important stop-over for migrant song birds, as well as shorebirds and waterfowl.

However, several areas of concern were identified in the watershed where opportunities for improvement exist, including:

- Natural and naturalized cover in the watershed make up 19.6% of the land cover, which is below target guidelines;
- Wetland communities only make up 3.3 % of the watershed, which is below target guidelines;
- A poorly developed forest bird and marsh breeding bird community;
- A lack of interior forest habitat;
- Wildlife connectivity in the watershed is limited and poorly developed;
- Water quality indicators in Robinson Creek show that water quality is poor and reflects the urban nature of the watershed;
- Imperviousness is expected to increase in the watershed with increasing urban development;
- A potential reduction in groundwater recharge due to increased imperviousness; and
- A flooding spill over hazard land occurs over Highway 401 for the 100-year uncontrolled storm event.

It is the purpose of this watershed management plan to maintain what is good about the watershed and provide opportunities to improve some of the negative attributes that have been identified. By understanding the positive and negative attributes of the Robinson Creek Watershed, specific management recommendations can be made to improve the health of the watershed.

4.2 Tooley Creek Watershed: Existing Conditions

4.2.1 Study Area

The Tooley Creek Watershed is located in the Regional Municipality of Durham, entirely within the local Municipality of Clarington, and is under the jurisdiction of CLOCA (**Figure 4.14)**. Along with the Robinson Creek Watershed, it is one of the smallest watersheds within the jurisdiction of the Municipality of Clarington, measuring approximately 1,157 ha in size.

The Tooley Creek Watershed originates near the Lake Iroquois Shoreline at Nash Road, and outlets into Lake Ontario through the Tooley Creek Coastal Marsh. Erodible, high bluffs are found along the Lake Ontario shoreline, between the mouths of Robinson Creek and Tooley Creek. A portion of the Tooley Creek Watershed north of Highway 2 falls within the Greenbelt (refer to **Section 3** for a description of the Greenbelt Plan) and contains a portion of the Provincially Significant Maple Grove Wetland Complex. Existing land use within the Tooley Creek Watershed is predominately agricultural with some rural residential use. The community of Courtice lies at the northwestern edge of the watershed and is the primary source of development pressure. Land use throughout the Tooley Creek Watershed is dominated by agricultural land use, with relatively small proportions of other land uses.

4.2.2 Climate

Climate and precipitation normals between 1971 and 2000 were obtained from Environment Canada's Bowmanville Mostert Meteorological Station, which is considered the most representative climate station for the Tooley Creek Watershed with available long-term historical data (**Table 4.1**).

4.2.3 Physiography and Geology

The Tooley Creek Watershed is located within Iroquois Plain physiographic region (**Figure 4.1**), which is a gently sloping lowland area extending from the edge of the till plain of the South Slope region (located to the north of the study area) down to Lake Ontario (Chapman and Putnam, 1984). It is important to note that this feature is an extensive east to west feature extending from Burlington to Trenton, and hosts many interesting natural heritage features that rely on shallow groundwater conditions. Much of it has been developed and the remnants provide pathways for wildlife movement. The Tooley Creek Watershed hosts an undeveloped portion of this unique geologic feature, something the Robinson Creek Watershed does not.

The geology of the Tooley Creek Watershed consists of Quaternary sediments that overlie Palaeozoic aged limestone and shale of the Blue Mountain and Lindsay formations (**Figures 4.3 and 4.15**). The primary quaternary soil within the watershed is a stony, sandy, silty till known as the Newmarket Till. This unit is very dense and restricts groundwater flow and infiltration. The remaining surficial soils in the watershed are part of the Iroquois Plain, which consists of shallow lake deposits of fine sand, silt and clay. These glaciolacustrine deposits were formed by glacial melt water discharging into Glacial Lake Iroquois during the last glacial period. The shoreline of Lake Iroquois is characterized by raised sand and gravel beach deposits and can be found in the northern portion of the watershed (**Figure 4.15**), although the effect on the landscape and topography are minor relative to other parts in the region where the shoreline is strongly pronounced. Within the watershed, fine sand deposits were deposited close to the former shoreline, with subsequent deposits of silts and clays being deposited farther south (closer to present day Lake Ontario). Newmarket Till is the dominant surficial material within the watershed, with deposits of fine sand of the Iroquois Plain are present at the headwaters of Tooley Creek Watershed near Highway 2.

Figure 4.14 Tooley Creek Watershed

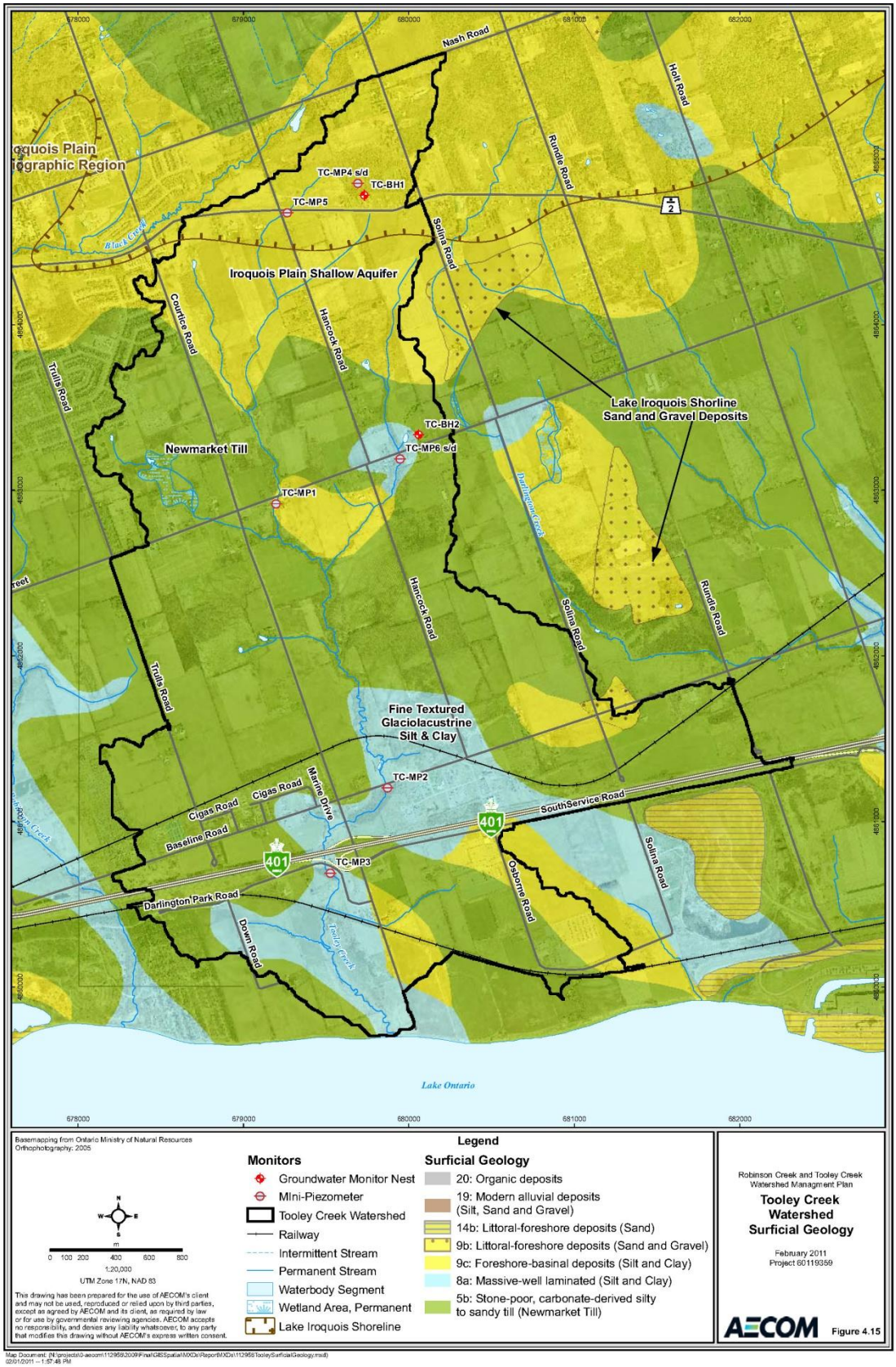


Figure 4.15 Tooley Creek Watershed Surficial Geology

4.2.4 Groundwater

Similarly to the Robinson Creek Watershed, groundwater flow in the Tooley Creek Watershed is controlled by the thick deposits of Newmarket Till present at surface (**Figure 4.15**). This unit is very dense and restricts groundwater flow and infiltration. Groundwater flow in the watershed generally follows surface topography and flows from north to south, with minor components bending towards discharge areas in Tooley Creek (**Figure 4.16**).

The northern portion of the watershed hosts a portion of the Iroquois Plain Shallow Aquifer. The high permeability of the sandy near shore deposits of the Iroquois Plain Shallow Aquifer provides a pathway for local groundwater recharge and discharge. Areas covered by these sandy soils provide a potentially important groundwater recharge and discharge function that contributes to stream flow and temperature buffering in Tooley Creek. These potentially important groundwater recharge areas are presented on **Figure 4.17**, and coincide with the area covered by the Iroquois Plain Shallow Aquifer. A quantitative analysis of groundwater recharge areas is presented in Section 5.4.2.

The Tooley Creek Watershed does not contain any confined aquifers that are part of the Oak Ridges Moraine. The southern extent of the major regional aquifer units from the Oak Ridges Moraine, such as the Thorncliffe Aquifer and the Oak Ridges Moraine Aquifer, pinch out to the north of the Tooley Creek Watershed (YPDT-CAMC Technical Report #01-06) (**Figure 4.3**). These aquifer units do not contribute to groundwater flow or groundwater discharge in the watershed. It is therefore likely that any groundwater discharge occurring in Tooley Creek and its tributaries is derived locally, rather than from deep regional groundwater flow. Significant groundwater discharge areas were delineated through visual observations of seeps and are presented on **Figure 4.18**. These important groundwater features generally coincide with wetlands, watercourses and observed groundwater springs and seeps.

Groundwater quality in the Tooley Creek Watershed can be described as hard with high concentrations of anions and cations such as calcium, magnesium, sodium, and bicarbonate, which is typical for southern Ontario groundwater. Concentrations of nitrate and sodium are elevated in the groundwater of the unconfined Lake Iroquois Shallow Aquifer, but are still at levels below Ontario Drinking Water Standards (ODWS). These elevated concentrations reflect the unconfined nature of the aquifer and the use of road salt and fertilizers in the area.

There are no municipal supply wells or other large water takings located in the Tooley Creek Watershed. Based upon a search of the Ministry of the Environment's Permit To Take Water Database, there are no significant groundwater or surface water users in the watershed. Domestic water users have traditionally utilized groundwater for potable water use, obtaining water from the Iroquois Plain Shallow Aquifer, lenses within the Newmarket Till or from bedrock aquifers. With increasing urban development in the watershed, current domestic well users could obtain water from municipal systems that derive water from Lake Ontario.

4.2.5 Fisheries and Aquatic Habitat

Specific indicators of aquatic habitat condition and health where documented for the Tooley Creek Watershed in relation to the local environment including: Strahler stream order, instream barriers to fish migration that contribute to isolation of habitats or populations, riparian vegetation, thermal regimes and land use/cover. In addition to these environmental indicators and conditions, fish species, fish locations, and benthic invertebrate composition and distribution was also documented.

Tooley Creek flows for approximately 15.7 km (north to southeast) before out letting into Lake Ontario. **Figure 4.19** shows stream order classifications within the Tooley Creek Watershed. Stream order provides a method of grouping streams of a similar size, depth and flow, as well as suggesting a level of sensitivity a watercourse may have to disturbance or development. In general, as stream order increases, so does watercourse depth and width.

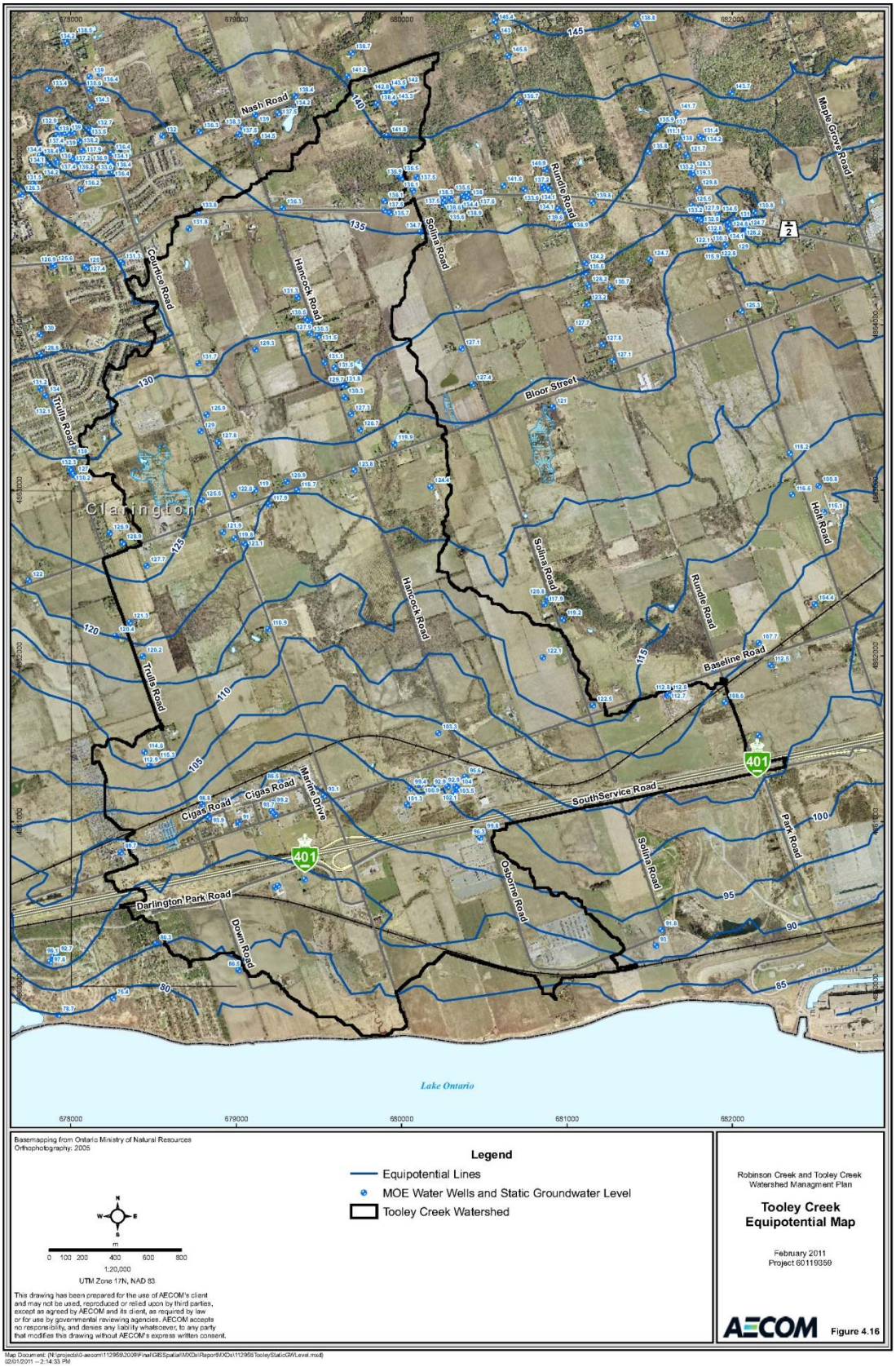


Figure 4.16 Tooley Creek Equipotential Map

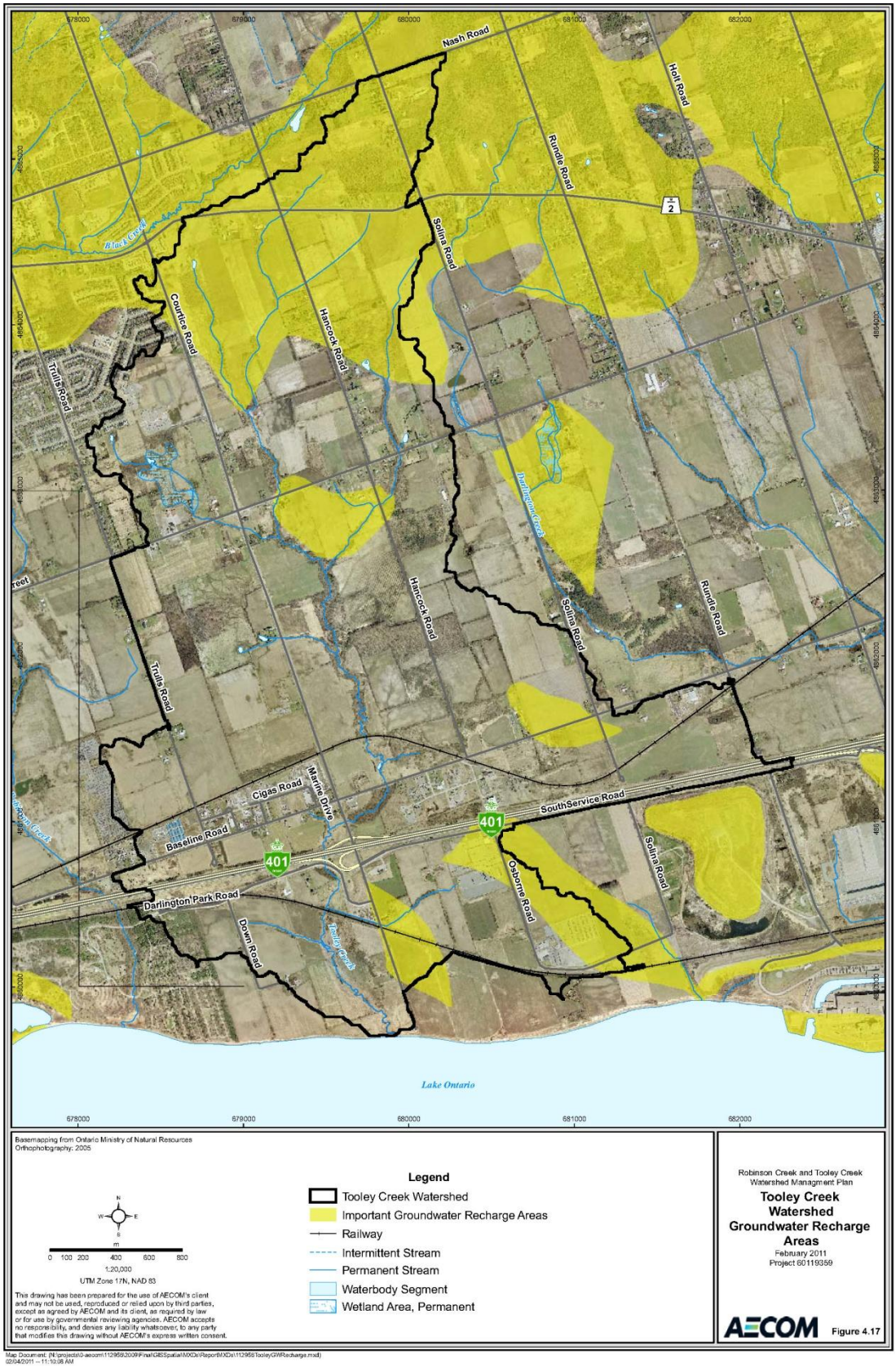


Figure 4.17 Tooley Creek Watershed Groundwater Recharge Areas

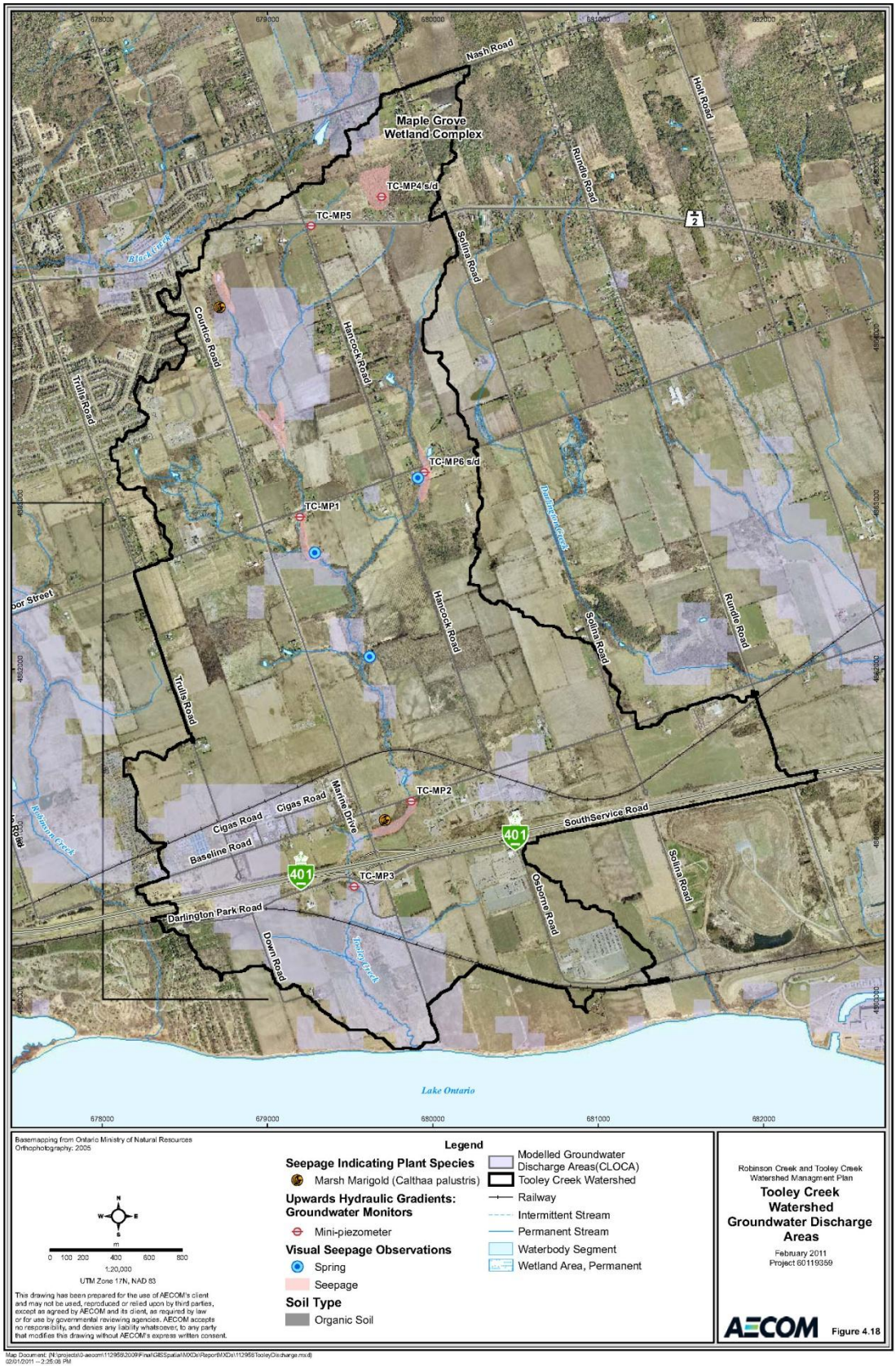


Figure 4.18 Tooley Creek Watershed Groundwater Discharge Areas

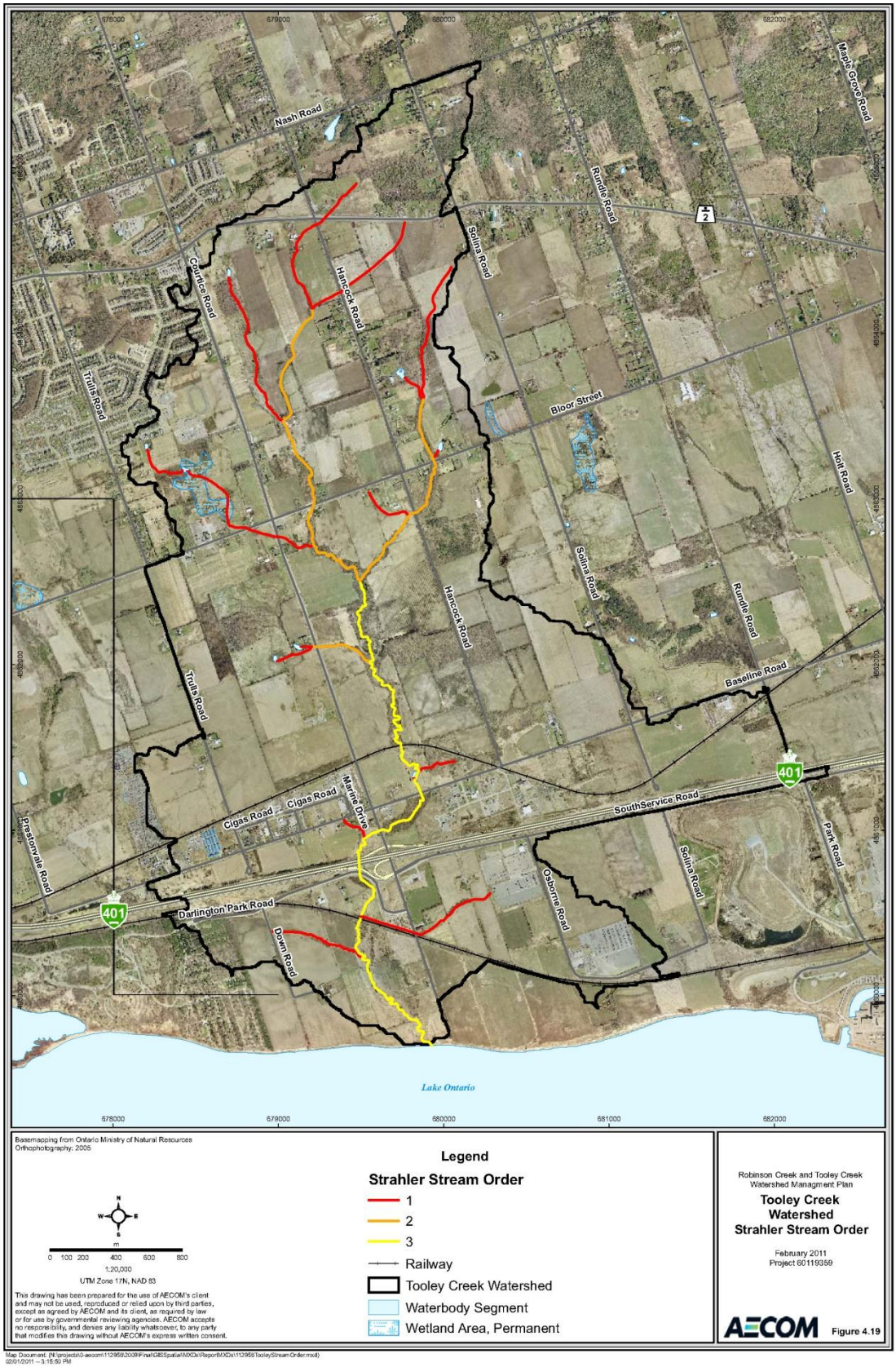


Figure 4.19 Tooley Creek Watershed Strahler Stream Order

Riparian vegetation cover varies greatly between each of the stream orders along Tooley Creek. Maintaining adequate riparian cover around a watercourse will improve surface water quality by reducing sedimentation. Riparian vegetation also functions to provide allochthonous inputs into streams such as leaf and woody debris, which creates habitat cover and provides shade cover over streams contributing to the buffering of water temperatures. Environment Canada guidelines state that 75% of a stream length should be buffered by 30 m of riparian cover to maintain a healthy state (EC, 2004). Within the Tooley Creek Watershed the majority of the first order streams maintain riparian vegetated areas composed of forested cover or at a minimum naturalised scrublands. In total approximately 65% of first order streams maintain some/adequate riparian vegetation. The majority of second order stream reaches within the Tooley Creek Watershed are also surrounded by large naturalised riparian buffers that are relatively undisturbed from development or local agriculture. In total approximately 84% of second order streams maintain some/adequate riparian vegetation. Although many upstream portions of the third order reaches (main branch) of Tooley Creek maintain adequate riparian vegetation, far less of the lower section of the watershed (near Lake Ontario) contains adequate riparian cover. In these areas Tooley Creek flows through pasture fields where riparian cover has been depleted by unrestricted cattle access to the creek. From the confluence of the two primary second order tributaries to the outlet into Lake Ontario Tooley Creek maintains intact riparian cover for about half of its length, with remaining areas possessing degraded riparian habitat or lacking such features altogether.

Three barriers to fish passage were identified along the length of Tooley Creek (**Figure 4.20**). The first impediment to fish migration is located at the first railway crossing of Tooley Creek is located south of Highway 401. The second barrier to fish movement is located at the second railway crossing located north of Baseline Road, east of Courtice Road. The third and primary impediment to fish migration is a closed bottom box culvert located at the downstream end of the Highway 401 underpass, which is a box culvert that is perched by approximately 0.45 m.

Fish community sampling for the Tooley Creek Watershed was completed in June and August/September 2009 as part of the Existing Conditions Report (**Figure 4.21**). Thirteen (13) known species, representing six families were identified (**Table 4.5**). Of the 13 fish species caught, Blacknose Dace (*Rhinichthys atratulus*) was by far the most common, consisting of 61% of all fish captured. Blacknose Dace is a warmwater fish species that is highly tolerant to environmental change and perturbation and is widespread in their southern Ontario distribution. The other most common fish species were Brook Stickleback (*Culaea inconstans*), Creek Chub (*Semotilus atromaculauts*) and Fathead Minnow (*Pimephales promelas*), all of which represent a warm to coolwater community and are widespread in their southern Ontario distribution.

Table 4.5 Known Fish Community Composition – Tooley Creek Watershed

Family	Common Name	Scientific Name	Abundance *(% of total captured)*	Thermal Class	COSEWIC Status	COSSARO Status
Catostomidae	White Sucker	*Catostomus commersoni*	1%	Cool	NAR	NAR
Centrarchidae	Pumpkinseed	*Lepomis gibbosus*	<1%	Warm	NAR	NAR
Cyprinidae	Fathead Minnow	*Pimephales promelas*	8%	Warm	NAR	NAR
	Creek Chub	*Semotilus atromaculauts*	13%	Cool	NAR	NAR
	Blacknose Dace	*Rhinichthys atratulus*	61%	Cool	NAR	NAR
	Northern Redbelly Dace	*Phoximus eos*	<1%	Cool/Warm	NAR	NAR
	Bluntnose Minnow	*Pimephales notatus*	<1%	Warm	NAR	NAR
	Longnose Dace	*Rhinichthys cataractae*	<1%	Cool	NAR	NAR
	Common Shiner	*Luxilus cornutus*	<1%	Warm	NAR	NAR
Gasterosteidae	Brook Stickleback	*Culaea inconstans*	14%	Cool	NAR	NAR
	Threespine Stickleback	*Gasterosteus aculeatus*	<1%	Cool	NAR	NAR
Percidae	Johnny Darter	*Etheostoma nigrum*	<1%	Cool	NAR	NAR
Salmonidae	Rainbow Trout	*Oncorhynchus mykiss*	1%	Cold	NAR	NAR

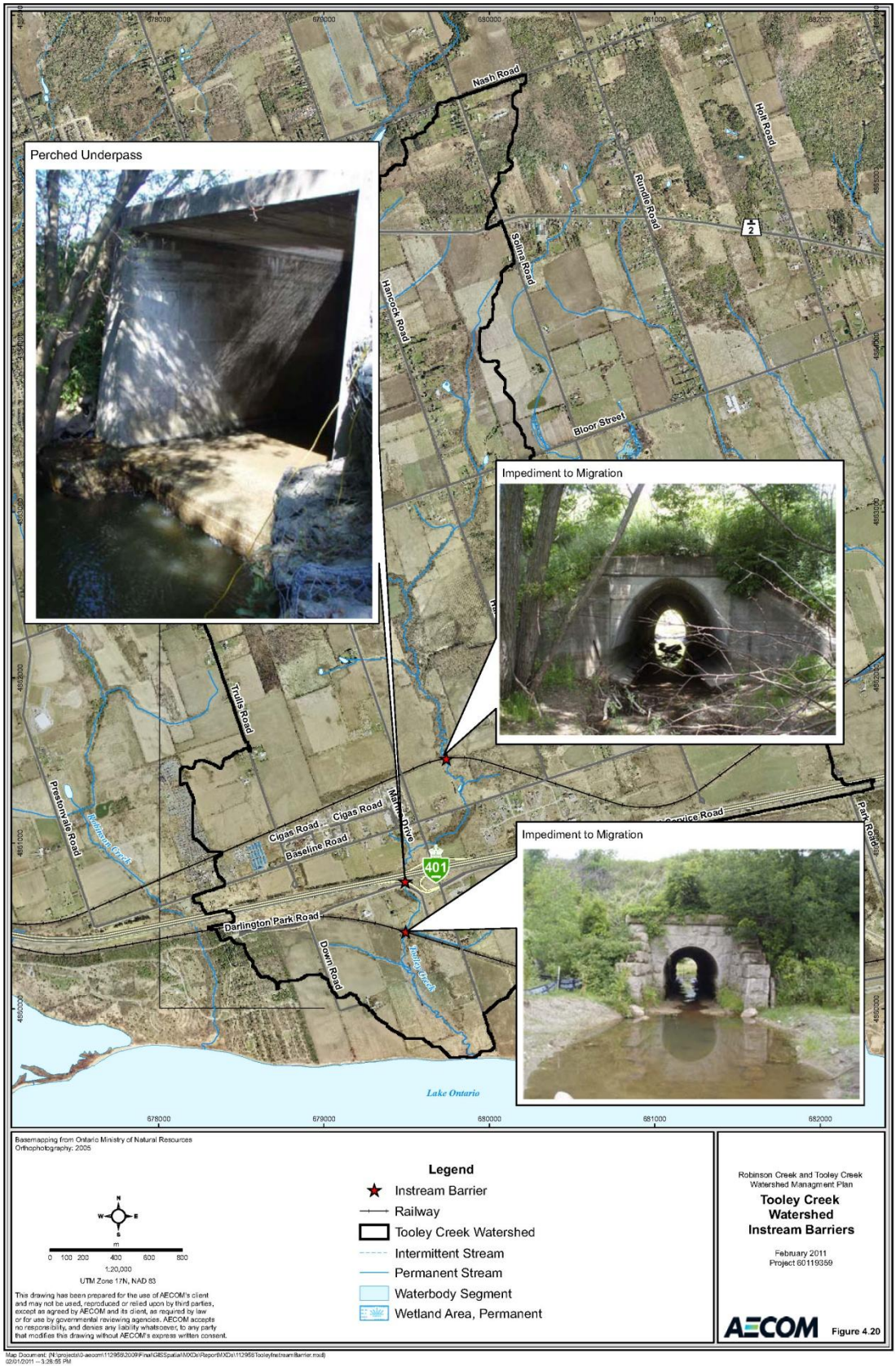


Figure 4.20 Tooley Creek Watershed Instream Barriers

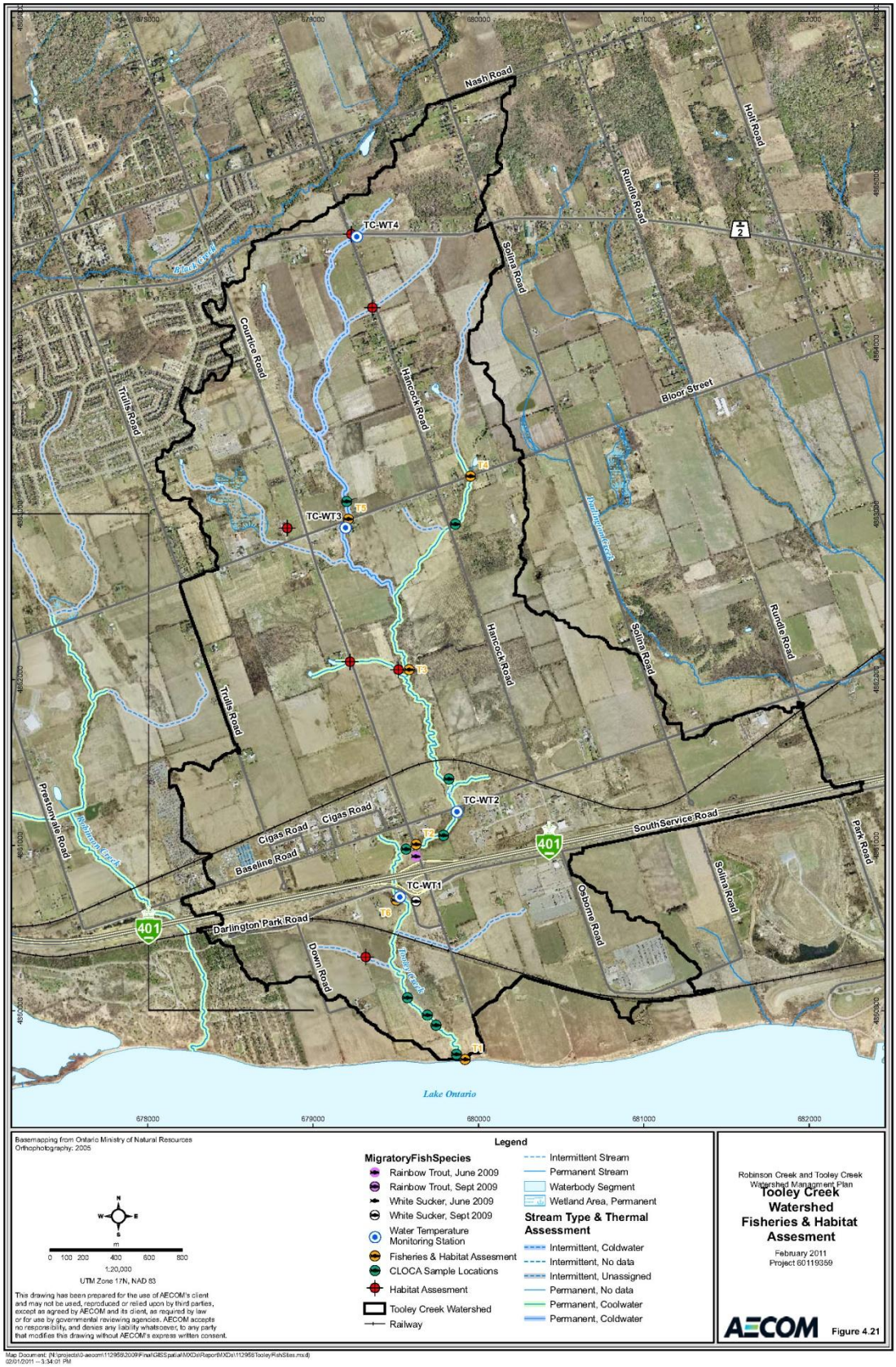


Figure 4.21 Tooley Creek Watershed Fisheries & Habitat Assessment

Rainbow Trout (*Oncorhynchus mykiss*), which is a coldwater species, represented only 1% of all fish captured, and was only captured in the lower reaches of Tooley Creek, south of the railway crossing barrier north of Baseline Road. The presence of rainbow trout within the lower reaches of the watershed demonstrates tolerable, coolwater conditions in this section of the creek, even though it lacks adequate riparian cover. However, more importantly, the occurrence of rainbow trout, in 2009, 2003, and 1997 indicates that limited runs of migratory rainbow trout have occurred throughout the watershed.

Stream temperature data collected between July and August 2009 indicates that the thermal regime can be classified as coolwater (**Table 4.6**). This result is consistent with CLOCA's thermal data collected between 2005 and 2009, and generally matches the thermal class of the fish community, with the exception of rainbow trout. The upper reaches of Tooley Creek were deemed to be a coldwater system due to significant groundwater inputs from the Iroquois Plain Shallow Aquifer and the Maple Grove Wetland Complex. The upper reaches have not been thermally characterized previously and therefore, a multi-year sampling approach is needed to gain an accurate picture of this system on a year-to-year basis.

Table 4.6 Stream Temperature Monitoring within Tooley Creek

Temperature Logger Location	Period of Record	Days within Mean Daily Temperature Range				Min Temp (°C)	Max Temp (°C)	Classification
		Cold (<19°C)	*Cool (19 – 25°C)*	*Warm (>25°C)*	*Lethal Limit for Rainbow Trout (>26°C)*			
TC-WT3 (MP1)	July 10 – August 31, 2009	52	1	0	0	12.8	19.9	**Coldwater**
TC-WT2 (MP2)	July 10 – August 31, 2009	41	12	0	0	14.7	21.2	Coolwater
TC-WT1 (MP3)	July 10 – August 31, 2009	43	10	0	0	14.3	20.9	Coolwater
TC-WT4 (MP5)	July 10 – August 31, 2009	51	2	0	0	13.8	19.2	**Coldwater**

In general, the species assemblage in Tooley Creek is typical of a warm to cold water urban fish community. The fish community present is primarily composed of generalist species that are not highly dependent on specific habitat requirements for spawning or life history processes. With the exception of rainbow trout, which are moderately sensitive to increased water temperatures for habitat suitability, the fish community is typical of warm/cool water conditions, the distribution of which is primarily dependant on flow regime within the watershed and to a lesser extent water temperatures.

The surface water quality in Tooley Creek is reflective of an urbanized watershed. Field parameters and chemical results are presented in **Table 4.7**. Concentrations of total phosphorus that exceed PWQO standards were found at each monitoring station during monitoring events in the summer of 2009, with the exception of Station T1 in June 2009 (**Figure 4.21**). Chloride, concentrations are elevated at Station T1, but are generally low at the other sampling locations. These results suggest that agricultural non-point source contaminants are impacting the surface water quality in Tooley Creek.

Table 4.7 Tooley Creek Surface Water Quality

Parameters	Units	PWQO	June 25/09			August 24/09		
			T1	T2	T5	T1*	T2*	T5*
Water Temperature	°C	-	25.5	19	14.9	20.6	15.1	11.5
pH	-	6.5 - 8.5	7.52	7.83	7.56	7.85	7.92	7.92
Conductivity	µS/cm	-	697	577	472	662	610	292
Total Ammonia	mg/L	-	0.09	0.21	0.16	0.07	0.11	0.05
Un-ionized Ammonia	mg/L	0.02	0.002	0.003	0.002	NA	NA	NA
Total Phosphorus	mg/L	0.03	0.027	**0.038**	**0.31**	**0.036**	**0.068**	**0.051**
TSS	mg/L	-	4	2	80	4	2	5
Chloride	mg/L	150**	120	50	45	120	33	53
BOD	mg/L	-	ND	ND	ND	ND	ND	ND

*Notes: *water temperature, pH and conductivity collected on September 4, 2009*
***Currently there is no PWQO for chloride, however, 150 mg/L is used as a protection of freshwater biota criteria by the Toronto Region Conservation Authority, Ontario MOE - Environmental Monitoring and Reporting Branch and the BC Ministry of the Environment*
ND = Not Detectable NA = Not Available, due to missing data required for calculation ***Bold numbers*** *are above their respective PWQO*

4.2.6 Terrestrial Natural Heritage

The Tooley Creek watershed is located along the north shore of Lake Ontario within Ontario Ministry of Natural Resources Site District 6-13. The site district is further divided by Chapman and Putnam (1984) into the Iroquois Plain and the Oak Ridges Moraine South Slope physiographic regions. The watershed occurs below the South Slope and historic Lake Iroquois shoreline, and is entirely located within the Lake Iroquois Plain physiographic region. The Iroquois Plain is an east-west trending feature that consists of sandy to silty deposits.

OMNR (1984) found approximately five to ten percent of Site District 6-13 to be in relatively natural and undisturbed state. The most common remnant natural features include shoreline bluffs and beaches, rivermouth marshes, stream valleys and riparian corridors, and isolated upland forests. Urban residential development has encroached on the watershed, particularly from the northwest (i.e., west of the Bloor Street – Courtice Road intersection). Findings presented in the Watershed Plan Existing Conditions Report (AECOM 2010) indicate that that 17% of the watershed supports natural and naturalized cover (**Figure 4.23**), including all or parts of the following designated natural areas:

- Maple Grove Provincially Significant Wetland (the western portion occurs within the headwaters of the Tooley Creek watershed);
- Tooley Creek Coastal Wetland (located at the mouth of Tooley Creek);
- Darlington Provincial Park (a small portion occurs in the Tooley watershed, south of Highway 401 and west of Down Road); and
- The Tooley Creek Valley Environmentally Sensitive Area (occurs entirely with the Tooley watershed).

Young deciduous forest and thicket communities are the most common vegetation community types, with Green Ash (*Fraxinus pennsylvanica*) abundant throughout (**Figure 4.22**). Common associates include, American Elm (*Ulmus americana*) and Manitoba Maple (*Acer negundo*); the latter is particularly common in lowlands and floodplains. Mid-age and mature forest cover is rare in the watershed. Where these communities do occur, Sugar Maple (*Acer saccharum*) forms associations with White Ash (*Fraxinus americana*), Red Oak (*Quercus rubra*), American Beech (*Fagus grandifolia*), and/or Eastern Hemlock (*Tsuga canadensis*). Coniferous and mixed forests comprise a relatively small component of forest cover, with White Pine (*Pinus strobus*), Red Pine (*Pinus resinosa*) and White Spruce (*Picea glauca*) occurring in upland situations (commonly as remnant plantations), and Eastern White Cedar (*Thuja occidentalis*) occurring in the floodplains. Upland meadows occur throughout the watershed, particularly as abandoned agriculture fields. These meadows are typically dominated by varying degrees of cool-season grasses, Canada Goldenrod (*Solidago canadensis*), Heath Aster (*Aster ericoides*) and New England Aster (*Aster novae-angliae*).

Deciduous swamp communities are the most common wetland types, with Green Ash and Swamp Maple (*Acer freemanii*) abundant throughout treed types, and Red-osier Dogwood (*Cornus stolonifera*) and Willow species (*Salix sp.)* dominating the thicket swamps. Marsh communities are present in smaller portions, with Reed-canary Grass (*Phalarus aurundinacea*) and forb meadow marshes the most common types, followed by shallow Cattail (*Typha sp.*) marshes. Seepage wetlands are rare, and are generally associated with areas where stream valleys have exposed shallow localized groundwater flow, predominately along the main branches of the Tooley Creek valley.

212 species of vascular plants are known to occur within the Tooley Creek Watershed (AECOM 2010). Forty-eight of the species indentified are non-native occurrences, representing approximately 23% of all species recorded. The high proportion of non-native species is largely attributed to the fragmented nature of the vegetation throughout the watershed, which is typical of southern Ontario. Seventeen species are considered regionally significant (uncommon to rare in Durham Region according to Varga et al., 2000).

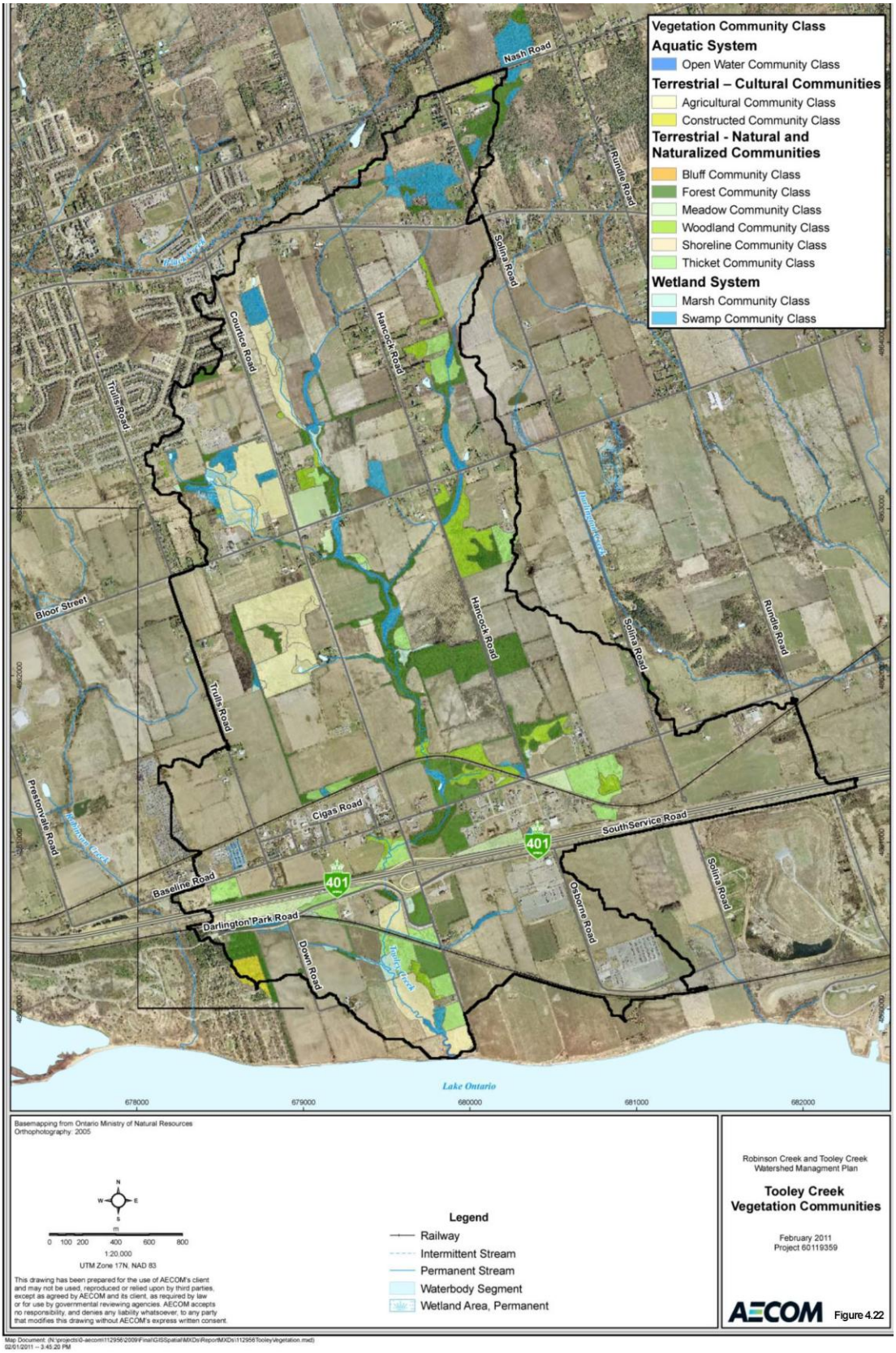


Figure 4.22 Tooley Creek Vegetation Communities

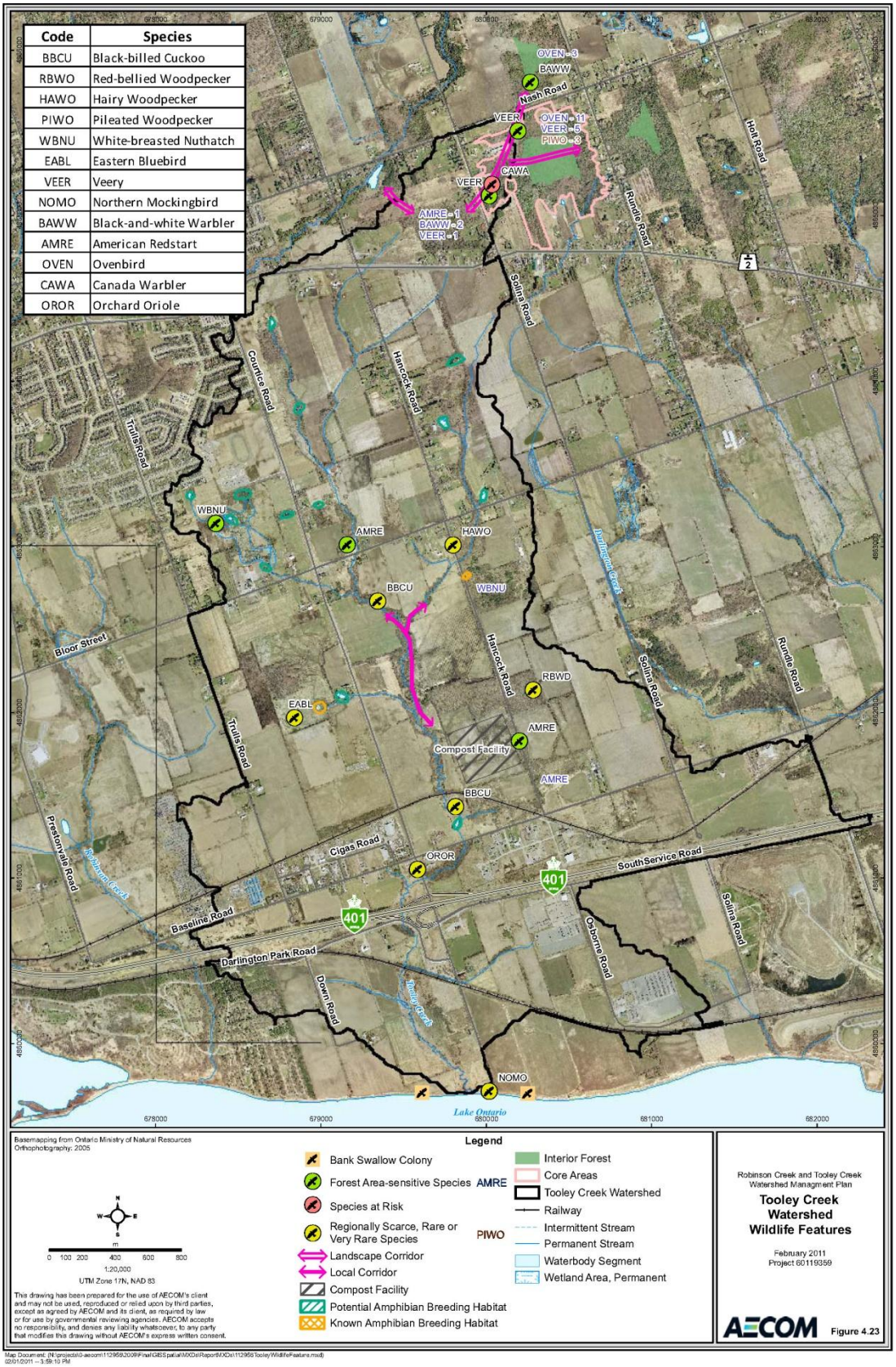


Figure 4.23 Tooley Creek Watershed Wildlife Features

Seventy-two breeding bird species were recorded in the Tooley Creek Watershed as part of the Existing Conditions study (**Figure 4.23**). The most frequently observed bird species are those that are common in southern Ontario typical of edges, shrub habitats and disturbed areas. The most abundant species recorded included: Blue Jay (*Cyanocitta cristata*), House Wren (*Troglodytes aedon*), Gray Catbird (*Dumetella carolinensis*), Yellow Warbler (*Dendroica petechia*), Northern Cardinal (*Cardinalis cardinalis*), Song Sparrow (*Melospiza melodia*), Red-winged Blackbird (*Agelaius phoeniceus*), and American Goldfinch (*Cardeulis tristis*).

The forest bird community is poorly developed in the Tooley Creek Watershed due to the very small and patchy amount of forest remaining, with notable exceptions including the northeast portion of the watershed (north of Highway 2 and east of Hancock Road), and in the forest north of the compost facility on Hancock Road. Numerous area-sensitive forest bird species were recorded in the northeast portion of the watershed (manly Warblers and Veery species), including three species that are considered regionally rare. A few grassland or open land area-sensitive species were recorded in the watershed; however, only Savannah Sparrow (*Passerculus sandwichensis*) was recorded in any significant numbers.

Species at Risk are those species with status under the Federal Species at Risk Act (SARA) and/or the Provincial Endangered Species Act. Species at Risk are identified federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and provincially by the Committee on the Status of Species at Risk in Ontario (COSSARO). Three Species at Risk are known to occur with the Robinson watershed (AECOM 2010):

- Red-headed Woodpecker (*Melanerpes erythrocephalus*);
- Canada Warbler (*Wilsonia canadensis*); and
- Butternut (*Juglans cinerea*).

4.2.7 Land Cover

Similar to the Robinson Creek Watershed, land use and land cover in the Tooley Creek Watershed has changed significantly over the past few decades. The focus of the land use is still agricultural with increasing mixed development. **Figure 4.24** presents an overview of the land use found within the watershed based upon the results of the Existing Conditions Study conducted in 2009/2010 and is based upon municipal land use designations and ELC polygon mapping. All land uses have been simplified into broad land use categories to focus on the various aspects of the natural heritage system. Although the full break down of land use is not presented, they have been grouped into the same classes as where used for hydrologic modelling of the watershed:

- **Development**
  Urban Residential, Rural Residential, Industrial and Commercial (including the compost facility off Hancock Road), and Transportation and Utility;
- **Natural Heritage**
  Woodlots and Forest, Lakes and Wetlands, Meadows and Grasslands, Savannah and Thicket, and Darlington Provincial Park;
- **Agriculture**
  Agricultural Facility, Crop Field, and Pasture; and
- **Greenspace**
  Community Parks, Greenbelt Lands and Waterfront Greenway.

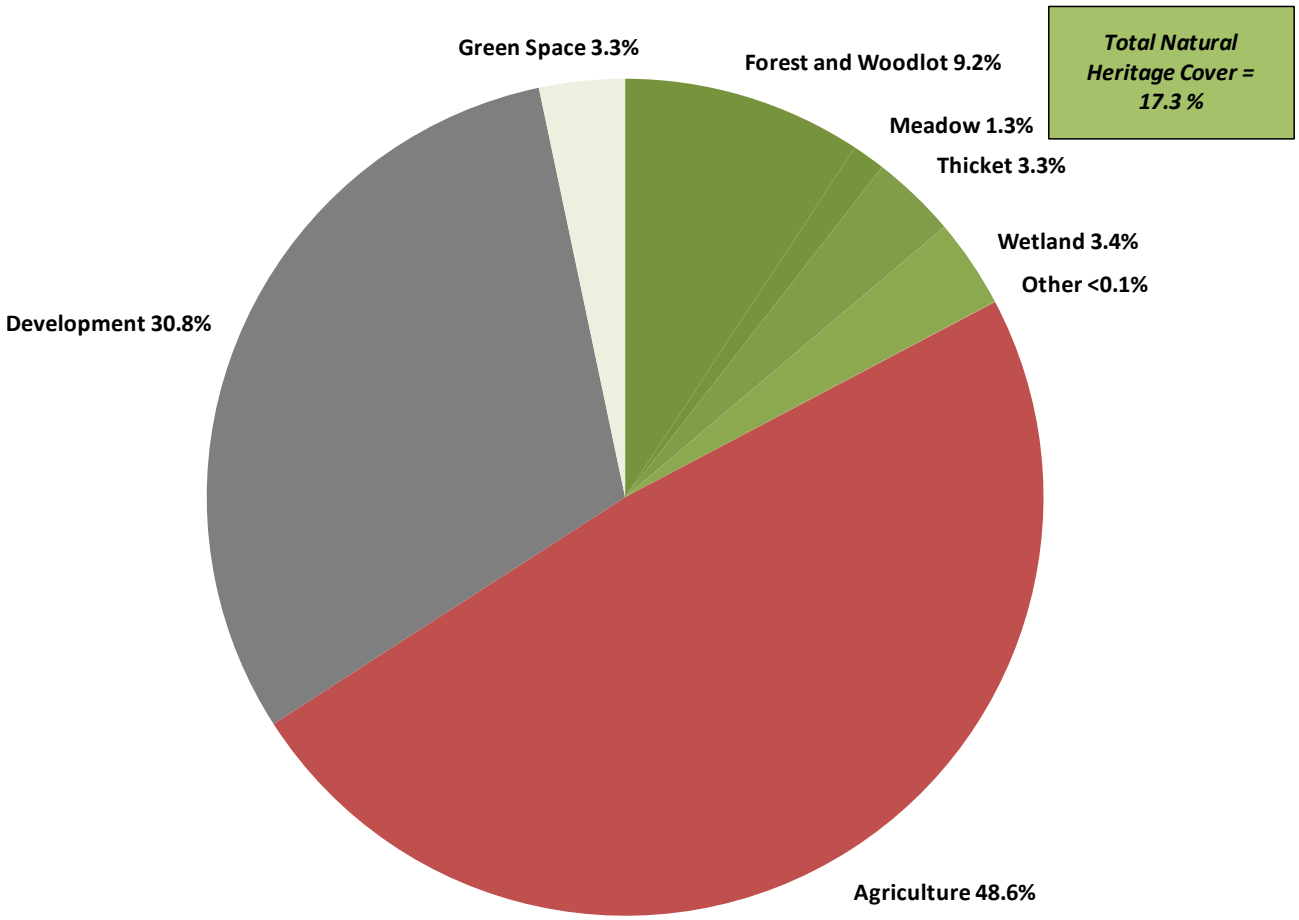


Figure 4.24 Tooley Creek Watershed – Existing Land Cover

The total natural heritage cover for the watershed, including natural and naturalized cover is 17.3%. Forest cover within the watershed is 9.3%, which falls short of the 30% target that is recommended for a healthy watershed (EC, 2005). Lands classified as wetland and swamp habitat make up 3.4% of land use in the watershed, which again falls short of the recommended 10% guideline (EC, 2005). The Tooley Creek Watershed contains some areas of interior forest habitat and core areas in the extreme northern portion of the watershed in the Maple Grove Wetland Complex (**Figure 4.23**). This Provincially Significant Wetland is mainly located outside of the Tooley Creek Watershed boundaries, but still contributes an important habitat and connectivity function for the watershed. A forested area located on both the east and west side of Hancock Road, north of Baseline Road exhibits many properties of a core area, but is slightly too small to be classified as such.

4.2.8 Summary of Positive Attributes and Opportunities for Improvement

As part of watershed management planning, it is important to recognize both the positive and negative attributes of a watershed. Although the Tooley Creek Watershed is currently dominated by agriculture and development, some very positive results on the health of the watershed were documented in the Existing Conditions Study. Conversely, the same study highlighted a number of areas that could be improved to help create a healthier watershed and build a resiliency into the natural heritage system to protect against future stresses such as climate change.

The Tooley Creek Watershed has many positive attributes including:

- The Lake Iroquois Shoreline and the Iroquois Plain Shallow Aquifer are present in the northern portion of the watershed and are important sources of groundwater recharge;
- The Provincially Significant Maple Grove Wetland Complex is located in the northern portion of the watershed and positively contributes to the overall health of the watershed;
- Groundwater discharge is sufficient to sustain baseflow and thermally buffer stream temperatures;
- The rate of groundwater use in the watershed is low and is expected to decline in the future;
- Tooley Creek hosts a variety of healthy warm to cold water fish communities;
- The thermal regime and stream flow in Tooley Creek is sufficient to sustain a population of rainbow trout, which is a cold water species, and provides rainbow trout habitat;
- Many of the 1st order streams originate on the Iroquois Plain and are classified as coldwater;
- Valley lands through the middle portion of the watershed are moderately well vegetated and provide a local north-south wildlife corridor;
- Much of Tooley Creek has adequate riparian cover; and
- Darlington Provincial Park and the Lake Ontario Shoreline provide an important stop-over for migrant song birds, as well as shorebirds and waterfowl.

However, several areas of concern were identified in the watershed where opportunities for improvement exist, including:

- Natural and naturalized cover in the watershed make up 17.3% of the land cover, which is below target guidelines;
- Wetland communities only make up 3.4 % of the watershed, which is below target guidelines;
- Forest cover only makes up 9.3 % of the watershed, which is below target guidelines;
- A poorly developed forest bird and marsh breeding bird community;
- Only minor areas of interior forest habitat is present in the watershed;
- Wildlife connectivity in the watershed is limited and poorly developed;
- Significant barriers to fish passage exist that limit runs of migratory fish species;
- Riparian cover along Tooley Creek south of Highway 401 is marginal;
- Water quality indicators in Tooley Creek show that water quality is poor and reflects the urban nature of the watershed;
- Imperviousness is expected to increase in the watershed with increasing urban development; and
- A potential reduction in groundwater recharge due to increased imperviousness.

It is the intent of this watershed management plan to maintain what is good about the watershed and provide opportunities to improve some of the negative attributes that were identified. By understanding the positive and negative attributes of the Tooley Creek Watershed, specific management recommendations can be made to improve the health of the watershed.

5. Analysis and Evaluation of Management Scenario

Based upon our understanding of the watershed functions and attributes, analysis and evaluation of management targets, integrating management with natural heritage scenarios, were completed. These features were assessed, and management scenarios and approaches were established that include the following:

- A Targeted Natural Heritage System (TNHS);
- A Water Budget and the identification of High Volume Recharge Areas (HVRA);
- Current and Future Levels of Imperviousness; and
- Existing and Future Hydrologic and Hydraulic Modelling and Hazard Analysis.

A technically preferred management scenario was selected from analysis and evaluation of the above management approaches and is presented in **Section 5.7**.

5.1 Watershed Constraints

Referencing the existing conditions, areas of constraint due to physical, geographical, and ecological parameters were identified so that watershed management targets and scenarios could be targeted to protect the key features of the watershed in order to build a natural resiliency to the ecosystem. Constraints specifically refer to features of the watersheds that will affect the long-term management of the watersheds and those features that limit the effectiveness of particular management actions or targets. Constraints have been defined and quantified where feasible. These constraints to the Robinson Creek and Tooley Creek Watersheds will serve as important considerations in establishing goals, objectives, management actions and watershed targets.

The primary constraints to watershed management within the Robinson Creek and Tooley Creek Watersheds include:

- The small size of the watersheds will limit the extent of ecological restoration that is practical within the watersheds;
- Limits on groundwater recharge rates caused by the predominance of low permeability till soils found at surface;
- Limits on baseflow and cold groundwater inputs due to small groundwater recharge areas;
- The urban nature of the watersheds limits wildlife connectivity and ecological diversity in the watersheds;
- Limits on the biotic diversity and vulnerability due to the limited extent of natural areas and extensive human development;
- Future land use needs in the watersheds; however, many potential impacts caused by development can be mitigated;
- The presence of Highway 401 in the south and the future 407 East Link to the East; and
- The uncertainty of climate change.

It was identified in the Existing Conditions Report that no significant regional aquifers provide a source of groundwater discharge to Robinson or Tooley Creek and that all groundwater found in the watersheds most likely was derived from within the watersheds (i.e., no groundwater flow between watersheds). With the exception of the small area covered by the Iroquois Plain Shallow Aquifer in the northern portion of the Tooley Creek Watershed, there does not appear to be much stream flow derived from groundwater discharge due to the presence of low permeability soils. This limits the practicality of trying to artificially increase groundwater recharge in most areas of the watersheds.

Due to the low amount of groundwater recharge, baseflow conditions in the creeks are low. This means that neither Robinson Creek nor Tooley Creek can be nominated for a complete restoration of a coldwater fishery, however opportunity exists to improve fish habitat and enhance riparian cover, protecting headwater areas, and controlling stormwater flows.

The low proportion of natural areas (including minimal core habitat/interior forest habitat) throughout both watersheds limits the resiliency of the existing natural system. Functionality of the system is further constrained by poorly established corridors between the existing natural areas. The watershed planning processes presents the opportunity to identify the existing (or functional) natural heritage system, and identify priority areas for enhancement to improve the functions and resiliency of the natural areas.

5.2 Setting Targets

With the above opportunities and constraints in mind, the document, *How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Area of Concern*, produced by Environment Canada in 2005 (herein referred to as *AOC Guidelines*), was the key reference document used for setting watershed management targets for the Robinson Creek and Tooley Creek Watersheds. The targets outlined in this document are based upon the best scientific information available and are meant to guide watershed management decisions, but are not meant to dictate what must be done. The *AOC Guidelines* are meant to be adaptable for all watersheds regardless of their size, current habitat quality, future stresses or other constraints. The targets that are set for the Robinson Creek and Tooley Creek Watersheds will be specifically applicable to these watersheds. Only targets that are reasonably or practically achievable will be recommended, as it is the intention of this Watershed Management Plan to be implemented in its entirety.

Using the *AOC Guidelines* as a starting point for habitat restoration and imperviousness targets for development, and taking into consideration the small, urbanized nature of the Robinson Creek and Tooley Creek Watersheds, the following watershed management targets are recommended (**Table 5.1**).

Table 5.1 Watershed Management Targets for the Robinson Creek and Tooley Creek Watersheds

Management Target Type	Parameter	Existing Condition	Proposed Future Management Target
Wetland Habitat	**Percentage of Watershed Comprised of Wetlands**	• Robinson Creek – 3.3% • Tooley Creek – 3.4%	• Robinson Creek - >6% wetland habitat • Tooley Creek - >6% wetland habitat
	Wetland Type	• Both the Robinson Creek Watershed and the Tooley Creek Watershed only have swamp and marsh habitat	• Rehabilitation activities should focus on rehabilitation of swamp and marsh habitats
	Wetland Location	• Robinson Creek – wetland communities are generally found within the Robison Creek Valley and north of Bloor St. A small portion of the McLaughlin Bay Wetland Complex is found near the outlet to Lake Ontario • Tooley Creek – wetland communities are predominantly found in the Maple Grove Wetland Complex. Small, isolated wetland habitat can be found along some of the 1st order streams and within the Tooley Creek Valley	• Robison Creek – historic and remnant marsh and swamp wetland habitats should be enhanced throughout within the Robinson Creek Watershed, particularly within the Targeted Natural Heritage System • Tooley Creek – historic and remnant marsh and swamp wetland habitats should be enhanced throughout the Tooley Creek Watershed, particularly within the Targeted Natural Heritage System

Table 5.1 Watershed Management Targets for the Robinson Creek and Tooley Creek Watersheds

Management Target Type	Parameter	Existing Condition	Proposed Future Management Target
	Size and Shape	• Robinson Creek – most wetlands are small and irregularly shaped, although there is a high density of wetland community types in the Robison Creek Valley, north and south of Bloor St. • Tooley Creek – most wetlands found within the Maple Grove Wetland Complex are large and well shaped. Wetland communities found outside this area are generally small and irregularly shaped	• Rehabilitation activities should focus on creating large, regularly shaped wetland habitat where appropriate. Ultimately wetland shape is dictated by soil moisture and site hydrology; however feature shape can be enhanced by restoring protected zones
Riparian Habitat	**Percentage of Stream Length Naturally Vegetated**	• Robinson Creek – 53% of the stream length maintains adequate riparian cover on either side of the wetted width and is composed of forested cover or naturalized scrublands • Tooley Creek – 65% of the stream length maintains adequate riparian cover on either side of the wetted width and is composed of forested cover or naturalized scrublands	• Robinson Creek – at least 75% of stream length should have a 30 m wide vegetated buffer on either side of the wetted width of the tributary • Tooley Creek – at least 75% of stream length should have a 30 m wide vegetated buffer on either side of the wetted width of the tributary
Surface Water	**Total Suspended Sediments (TSS)**	• Robinson Creek – TSS is often found above 25 mg/L (existing conditions range – 17 – 61 mg/L) • Tooley Creek – TSS is generally found below 25 mg/L (existing conditions range – 2 – 80 mg/L)	• TSS concentrations should be maintained below 25 mg/L during most times of the year for both Robinson Creek and Tooley Creek (*AOC Guidelines*)
	Surface Water Quality	• Robinson Creek – Surface water quality generally meets PWQO standards with the exception of phosphorus • Tooley Creek – Surface water quality generally meets PWQO standards with the exception of phosphorus	• Surface water quality for both Robinson Creek and Tooley Creek should meet PWQO standards during most times of the year
Imperviousness	**Impervious Surfaces**	• Robinson Creek – Current imperviousness in the watershed is 21% • Tooley Creek – Current imperviousness in the watershed is 13%	• Impervious surfaces should be kept to a minimum and all opportunities to increase infiltration should be explored. Natural vegetation should be maintained, and where possible improved or restored • Shall endeavour to keep imperviousness below 30% for each watershed
Natural Heritage System	**Natural and Naturalized Cover**	• Robinson Creek – 19.6% of the watershed contains natural or naturalized cover • Tooley Creek – 17.3% of the watershed contains natural or naturalized cover	• Robinson Creek – 30% of the watershed should contain natural or naturalized cover as part of the Natural Heritage System • Tooley Creek – 30% of the watershed should contain natural or naturalized cover as part of the Natural Heritage System
	Percent Forest Cover	• Robinson Creek – 6.3% of the watershed is currently under forest cover • Tooley Creek – 9.3% of the watershed is currently under forest cover	• Robinson Creek – minimum 100% increase in forest cover • Tooley Creek – minimum 100% increase in forest cover
	Core Areas and Interior Forest	• Robinson Creek – no core areas or interior forest habitat • Tooley Creek - <1% of the watershed are core areas. No interior forest habitat in the watershed	• Robinson Creek - at least one forest patch that contains interior forest habitat that is 100 m from the edge. At least one forest patch that is >25 ha in size • Tooley Creek - at least one forest patch that contains interior forest habitat that is 100 m from the edge. At least one forest patch that is >25 ha in size

Table 5.1 Watershed Management Targets for the Robinson Creek and Tooley Creek Watersheds

Management Target Type	Parameter	Existing Condition	Proposed Future Management Target
	Size and Shape of Forest Patches	• Robinson Creek – forest shapes tend to be linear following the creek valley • Tooley Creek – forest shapes tend to be linear following the creek valley. Some significant square shaped forest habitat is present near Hancock Rd. and north of Bloor St.	• Rehabilitation activities should focus on creating large, square or circular shaped forest habitats and connecting large, disconnected forest patches.
	Corridors	• Robinson Creek – the watershed is poorly connected. Limited N-S connectivity along the creek valley and E-W connectivity in Darlington Provincial Park • Tooley Creek – the watershed is poorly connected. Limited N-S connectivity along the creek valley and E-W connectivity in the Maple Grove Wetland Complex	• Robinson Creek – create a continuous N-S corridor between Highway 401 and Bloor St. Corridors should be designed to facilitate species movement and should be at least 60 m wide. Create opportunities for an E-W corridor connection to the Tooley Creek Watershed • Tooley Creek - create a continuous N-S corridor between Highway 401 and Highway 2. Corridors should be designed to facilitate species movement and should be at least 60 m wide. Create opportunities for an E-W corridor connection to the Robinson Creek Watershed • Lake Ontario Shore – create a continuous E-W corridor along the shoreline to create wildlife and habitat corridor.
	Watershed Cover Type and Forest Diversity	• Robinson Creek – young deciduous forest cover and thicket communities dominate in the watershed. Middle-aged and mature forest communities are rare • Tooley Creek – young deciduous forest cover and thicket communities dominate in the watershed. Middle-aged and mature forest communities are rare	• Rehabilitation activities should be representative of the forest cover type typical of the Great Lakes– St. Lawrence Forest Region and diversity of species found within this ecoregion

5.2.1 Discussion on Setting Targets

The following is a brief discussion on the rationale behind setting the target criteria for the Management of the Robinson Creek and Tooley Creek Watersheds, especially for targets that differ from the *AOC Guidelines*. Constrains identified in **Section 5.1** are the critical factor that limit the use of the AOC Guidelines, which in some cases may not be applicable to the Robinson Creek and Tooley Creek Watersheds.

It is important to realize that land use change through development and urbanization will have the greatest impact on the future health of the watershed. Currently, the Robinson Creek Watershed has 19.6% natural or naturalized cover and the Tooley Creek Watershed has 17.3% natural or naturalized cover. The AOC Guidelines recommend that 30% forest cover is needed to maintain a healthy watershed. It is recognized that both the Robinson and Tooley Creek Watersheds are small, predominantly urban watersheds, and that reaching a 30% forest cover target through land use policy planning is likely to be unachievable. It will also take away valuable land for other restoration activities such as rehabilitation of wetlands. For these reasons, the goal of future policy and planning initiatives related to the natural environment will be focused on increasing natural cover, not just forest cover, and building a resilient natural heritage system that can be sustained and thrive through future pressures such as development and climate change. This will be achieved by maintaining the current natural conditions and completing targeted enhancements to specific areas that will have the greatest overall benefit for the watersheds. Certainly opportunities for Clarington to meet and exceed AOC targets exist elsewhere in their jurisdiction, particularly within ORM and Greenbelt planning areas.

Similarly, AOC Guideline targets of 'at least one 200 ha forest patch which is a minimum of 500 m wide' cannot be reasonably achieved in either the Robinson Creek or Tooley Creek Watershed. The area of the Robinson Creek and Tooley Creek Watersheds are 592 ha and 1157 ha, respectively. Therefore, one 200 ha patch would take up 34% of the land area in the Robinson Creek Watershed and 17% of the land area in the Tooley Creek Watershed. Dedicating a space this large in either watershed is not consistent with the need to have 6% of the land area wetland habitat, have a diversity of habitat types (i.e., meadows and thickets), and achieve future development targets for the region as outlined in the Places to Grow Act. The same rationale applies to other AOC Guidelines such as 'greater than 10% of the watershed having forest cover 100 m from the edge and 5% of the watershed having forest cover 200 m from the edge'. Targets set as part of this management plan to create at least one forest patch that is a minimum 25 ha in size (i.e., a 500 m by 500 m patch) and has interior forest habitat with forest cover 100 m from the edge, is considered reasonable and achievable. This improvement will greatly improve forest habitat for birds and wildlife, and increase species diversity within both watersheds.

Wetland habitat loss and degradation has been significant in southern Ontario and within the Robinson Creek and Tooley Creek Watersheds. Wetlands provide important habitat, help improve surface water quality, help maintain baseflow and reduce storm flows. The AOC Guidelines suggest 10% wetland cover for a watershed and 6% wetland cover for a sub-watershed, to maintain watershed or sub-watershed health. Currently, the Robinson Creek and Tooley Creek Watersheds have 3.4% and 3.3% wetland habitat, respectively, which is below the AOC Guidelines for a watershed or sub-watershed. Given the small size of both the Robinson Creek and Tooley Creek Watersheds, the criteria for wetland cover target for a sub-watershed areas (of 6%) was considered more reasonable and achievable than the 10% watershed target.

Increasing riparian vegetation, especially on 1st order streams in both watersheds is expected to have a number of benefits such as cooler water temperatures, reduced nutrients and suspended solids, and will help support fish communities and maintain good water quality. The entire length of both Robinson Creek and Tooley Creek should be buffered by a 30 m vegetated area on both sides of the creek.

AOC Guidelines suggest that less than 10% of an urbanized watershed should be impervious. Achieving this target in the Robinson Creek or the Tooley Creek Watershed is not possible, as the current level of imperviousness in both watersheds exceeds this amount. The primary goal in these urban or future urban watersheds is to avoid peak flows, enhance riparian vegetation, and to minimize imperviousness surfaces through the use of such measures as permeable pavements and disconnecting roof downspouts.

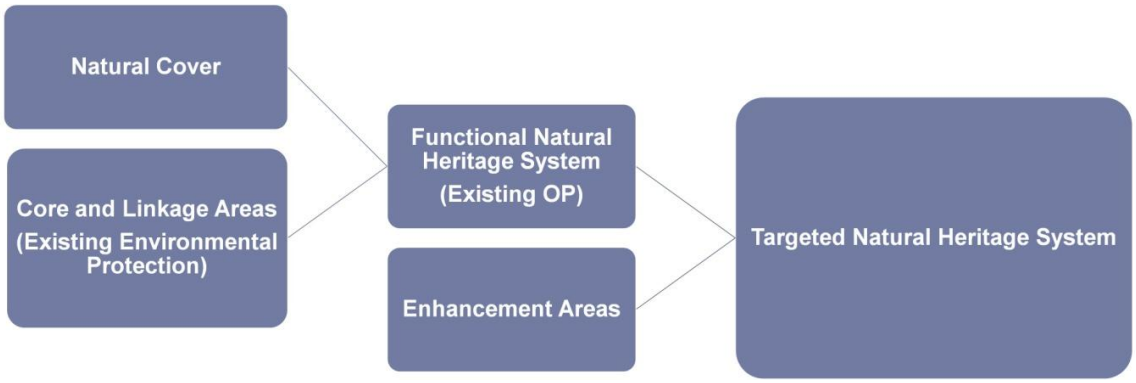
5.3 Natural Heritage System

Natural heritage system (NHS) is an ecologically based delineation of natural heritage components, including features, functions and linkages (OMNR 2009). The natural heritage components are delineated or connected as a system to provide long term ecological functions, as described by Provincial Policy Statement (PPS; MMAH 2005; Section 6.0):

> *"Natural Heritage System…means a system made up of natural heritage features and areas, linked by natural corridors which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. These systems can include lands that have been restored and areas with the potential to be restored to a natural state."*

The NHS was developed for the Robinson Creek and Tooley Creek Watersheds in two parts, an approach that is consistent with methodologies established in other watersheds within CLOCA jurisdiction (CLOCA 2009) and is supported by other Municipalities (e.g., Oshawa) and Conservation Authorities (Ganaraska Region Conservation Authority) in the region. The first part of the NHS is referred to as the *Functional Natural Heritage System (FNHS)* and includes a number of core and linkage components, based primarily on the existing natural heritage mapping produced for Watershed Plan Existing Conditions Report (AECOM 2010). The second part of the NHS indentifies the *Targeted Natural Heritage System (TNHS)*, by establishing protection and restoration opportunities required to

support and enhance the existing natural heritage components. A diagrammatic summary is presented below of the process for determining a Targeted Natural Heritage System.



5.3.1 Functional Natural Heritage System

The FNHS is the first part of the NHS and was established from Ecological Land Classification (ELC) mapping as a series of valued shape files (i.e., GIS polygons) using ESRI ArcGIS 9.3. The core and linkage components were derived primarily from ELC mapping produced for all natural and naturalized areas of the watersheds as part of the Watershed Plan study (AECOM 2010). Ecological Land Classification is the provincial standard for classifying vegetation communities in Ontario. Investigations classified vegetation communities to the Vegetation Type where possible according to the ELC protocols (Lee *et al.* 1998), using the draft 2nd updated hierarchy community descriptions (OMNR, 2008).

Other sources of data include the following list of secondary source information:

- Ministry of Natural Resources Natural Heritage Information Centre (NHIC) – Natural Area Records;
- Ministry of Natural Resources Natural Heritage Information Centre (NHIC) – Sensitive Species Records;
- MNR Wetland Evaluations;
- MNR Life Science Areas of Natural and Scientific Interest (ANSI) in Site District 6-13 report;
- Durham Region Coastal Wetlands Study;
- CLOCA's Environmental Sensitivity Mapping Project;
- CLOCA's baseline Ecological Land Classification mapping;
- Documentation prepared in support of the 407 East Environmental Assessment (EA);
- Ministry of Natural Resources (MNR) Natural Resource Values Systems (NRVIS) mapping;
- Biological Inventories of Darlington Provincial Park; and
- Digital Orthoimagery.

Criteria used to establish the core and linkage areas are provided below.

5.3.1.1 Identification of Core and Linkage Areas

Core areas are the building blocks of natural heritage systems, and generally include large areas of natural habitat and/or hydrological function. In areas where natural cover is not contiguous, core areas support higher percentage density of natural cover than other parts of the landscape, and should be capable of providing and sustaining ecological functions (OMNR 2009).

The linkage components (or linkage corridors) of natural heritage systems serve to connect core areas. Landscape theory identifies a number of benefits resulting from corridor functions, including increased local species richness and biodiversity, greater immigration and movement opportunities for individuals, and greater likelihood of seed dispersal and exchange of other genetic material between populations. Areas of natural cover best serve this purpose; however, agricultural lands or parklands can provide some linkage functions. Orientation and configuration

of a linkage should be designed to lead wildlife to suitable habitats so that wildlife is not funnelled to inhospitable areas (e.g., highways, urban areas) (OMNR 2009).

Linkages operate at varying scales, and are generally classified into three types as follows (CLOCA 2011):

- **Regional Linkage**
  Major movement corridors that connect a number of watersheds at a large landscape scale, such as the Oak Ridges Moraine and the provincial Greenbelt planning area.
- **Landscape Linkage**
  Major movement routes within the watersheds that connect core areas and are at least 100 m in width.
- **Local Linkage**
  Minor movement routes within the watershed that are at least 60 m in width.

Criteria used in the selection of core and linkage areas were based on guidance provided by the OMNR (2009) and CLOCA (2011). The following features are identified as core areas:

- **Natural heritage features and areas as defined by the PPS (MMAH 2005).**
  These features include significant wetlands, significant coastal wetlands, fish habitat, significant woodlands, significant valleylands, significant habitat of endangered species and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest.
- **Wetlands and Woodlands 0.5 ha in area or greater.**
  Consistent with the CLOCA (2011) approach, all wetlands and woodlands meeting the minimum mappable unit (at a scale of 1:10,000) recommended by Lee *et al.* (2001) are identified as core areas. This includes all natural and naturalized classifications (as per OMNR 2008), except Meadow (ME) Community Classes (ME communities were treated separately as described below).
- **High Quality Meadow (ME) Communities 0.5 ha in area of greater**.
  ME communities are generally not included because they can be replicated using relatively simple restoration measures (compared to other advanced community types such as thickets and woodlands). However, ME units were reviewed individually and included as core area if they were valued by the Landscape Analysis Model (LAM; as described in the next Section) and professional knowledge of the site (i.e., the ME unit was interspersed with other community types and/or supported relatively high native biodiversity). If the LAM determined the NHS was better served by reallocating an ME unit to a higher priority area, the ME was not retained as a core area.
- **Important hydrological features.**
  According to the PPS (MMAH 2005), core areas include remnant wetland features 0.5 ha or greater that do not fall within natural and naturalized ELC classifications (as per OMNR 2008), including potential wetlands in Agriculture (AG) Community Classes.
- **Riparian Corridors.**
  A 30 m buffer is applied to the wetted edge of each side of all watercourses, as recommended by the Central Lake Ontario Fisheries Management Plan (McNeice, J., and N. Meade, 2007).

Additionally, if lands that would otherwise meet the criteria for core areas were found to be highly disturbed, generally through human activity, professional judgement was used to assess the degree of perturbation and determine if the area should be included or excluded from the core areas.

The FNHS for the Robinson and Tooley Watersheds is identified in **Figure 5.1**.

5.3.2 Targeted Natural Heritage System

The TNHS is the second part of the NHS and is defined from the PPS definition for natural heritage system which includes areas with the potential to be restored or enhanced. These parts are often referred to as “enhancement areas”. Such lands may be agricultural, semi-natural or less intensively managed areas that contribute to the long-term ecological functions, or areas that are ideally located for purposes of restoring or improving habitats and natural connections (OMNR 2009). These types of areas were added to the NHS using a GIS model (i.e., the Landscape Analysis Model) based on the CLOCA (2011; section 2.1) approach to identify the TNHS. This is accomplished through a multi-step process as follows:

- Evaluate current habitat patch characteristics using landscape metrics (i.e., the Landscape Analysis Model);
- Determine target condition of natural cover;
- Produce a target system design model to achieve the target;
- Test the target system using the Landscape Analysis Model; and
- Complete professional edits to supplement model output TNHS.

Environment Canada (2004) recommends that at least 30% of each watershed should be in forest cover. Given a number of factors, including existing natural cover, planning objectives identified for the watersheds, and opportunities to improve targets in Greenbelt and ORM planning areas elsewhere in the Municipality of Clarington, the 30% forest cover target was deemed unrealistic. Rather, a 30% cover of natural vegetation (all community types in the terrestrial and wetland system as described by ELC) was established as the target. This represents an approximate increase in natural cover of approximately 12.0%, as detailed in **Table 5.2** below. The TNHS for the Robinson Creek and Tooley Creek Watersheds is identified in **Figure 5.2**.

Table 5.2 Natural Cover Calculations for FNHS and TNHS Scenarios

	Total Area	Existing Natural Cover		FNHS (ha)		TNHS (ha)	
	ha	ha	%	ha	%	ha	%
Robinson Creek Watershed	593.6	116.5	19.6	125.8	21.2	183.0	30.8
Tooley Creek Watershed	1157.0	199.6	17.3	254.4	22.0	343.4	29.7
Total	**1750.6**	**316.1**	**18.1**	**380.2**	**19.6**	**526.4**	**30.1**

AECOM completed a number of professional edits (sometimes referred to as manual edits) to refine the model output using intimate knowledge of the analysis areas, including a review of Ecosite and Vegetative Type ELC data collected by AECOM staff as part of the Existing Conditions studies (AECOM 2010). This processes included meetings with the Municipality of Clarington (October 6, November 26, December 9, 2010) and CLOCA (October 6, 2010). Considerations at this stage included a number of natural attributes, including those identified in **Table 5.3** below (adapted in part from Tables 3 and 4 of OMNR 2009).

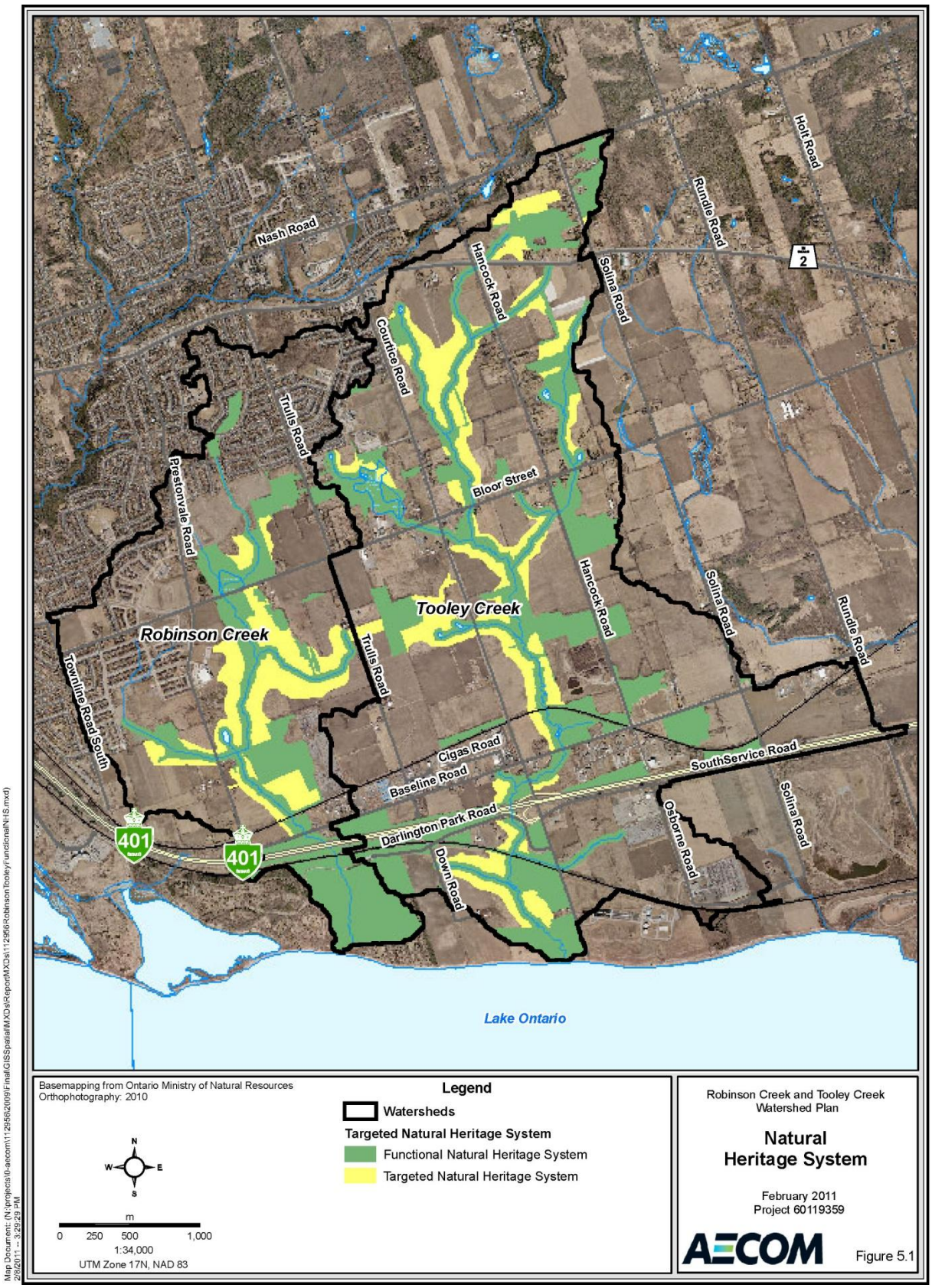


Figure 5.1 Natural Heritage System

Table 5.3 NHS Attributes Considered During Professional Edits

	Attribute
Core Areas	• Size, Shape and Bulk • Interior Habitat • Rare Habitats and species • Sensitive and rare natural communities • Potential for connectivity • Existing Protection and/or Significance established • Potential to persist as a self-sustaining unit • Level of perturbation
Linkage Areas	• Connectivity between two or more core areas, or two or more areas of potential restoration • Scale of corridor; proximity to corridor dead-end • Ecological function; redundancy of function • Potential of corridor to persist as self-sustaining unit • Existing and potential stressors • Suitability of the path, i.e., likelihood of potential passage

The professional edits identified a landscape scale corridor (100 m wide) to provide a connection between the Tooley and Robinson Watersheds, between Bloor Street and Baseline Road. The watershed boundary at this location corresponds with Trulls Road (**Figure 5.1**). Enhanced function of the connection could be achieved through road improvements (for example, implementation of wildlife crossing structures) and naturalization of the enhancement areas. Maintenance and enhancement of the corridor should be considered during design of future Trulls road improvement projects at this location, and at the site planning stage for development applications in the immediate area.

5.4 Water Budget and High Volume Recharge Areas

For both the Robinson Creek and Tooley Creek Watersheds, the water budget completed as part of the Existing Conditions Report has been revised due to recent adjustments in the hydrological boundaries of the Watersheds. Additionally, the groundwater recharge rates and runoff volumes have been further characterized using a Geographic Information Systems (GIS) based analytical model, rather than the more simplified method developed by Bernard (1932) and accepted by the MOE (1995), that was used in the Existing Conditions Report. This GIS-based model was developed to be consistent with provincial direction provided by the Ministry of the Environment (MOE) in the draft Assessment Report: Guidance Module 7, Water Budget and Water Quantity Risk Assessment (MOE, 2006b) prepared for the provincial Source Water Protection program under the *Clean Water Act*.

It is noted that the delineated boundaries are based on Ministry of Environment well records and geologic maps, and have not been confirmed by field data (e.g. boreholes and test pits). The values for groundwater recharge and surface runoff presented in this Report replace the values reported in the Existing Conditions Report due to changes in the boundaries for the Robinson and Tooley Creek Watersheds. The values for groundwater recharge and surface runoff may be updated by additional hydrogeologic studies and at the five year review of this Plan.

5.4.1 Water Budget

A *water budget* is used to describe the movement of water in a watershed. The total *precipitation* accounts for the water that falls both as rainfall and as snow, and constitutes the total amount of water available in a watershed. A large portion of the precipitation (often up to 60%) is returned to the atmosphere by *evaporation* or plant *transpiration*. The combined process of evaporation and transpiration is called *evapotranspiration (ET)*. The remaining water (~40%) comprises what is known as the *water surplus*. This is the water that is available to *runoff* to the stream system or *infiltrate* to the groundwater.
The proportion of the water surplus that is infiltrated depends upon the characteristics of the soils in the watershed, the topography, the land use and the vegetative cover that is present. This concept is based upon the fact that

water will infiltrate more easily though flat lying, high permeability soils than it will through steep slopes or low permeability soils. Naturally vegetated cover accepts infiltration more readily than urban developments. Water that infiltrates into the ground recharges the water table. This water may continue to flow downwards towards deep aquifers or it may flow laterally towards river valleys and contribute cold water to the stream, (i.e., groundwater discharge). The travel time through the soil creates a long time lag (often ranging from weeks to many years) between when the water infiltrated and when it is exposed at surface again.

Surface runoff generally coincides with rainfall events. As the surficial soil layers become saturated by rainfall, water may runoff to low lying areas. The amount of runoff depends on a large number of factors such as soils type, slope gradients, vegetative cover and the soil moisture prior to the rainfall. Runoff contributes water to stream flow at a much faster rate than groundwater will, and often at a much greater volume. The runoff water will have a temperature that mimics the air temperature and can be identified from groundwater in stream flow by a difference in temperature.

Long term meteorological data from 1971 – 2000 average was obtained from Environment Canada for the Bowmanville Mostert Meteorological Station (Environment Canada, 2011; **Table 4.1**), to be used to calculate the total precipitation and ET. The mean annual water surplus was calculated using the method described in Thornthwaite and Mather (1957), using a monthly time step and assuming a soil moisture of 150 mm. The soil moisture was estimated according to Thornthwaite and Mather, through analysis of soil type and vegetation in the watershed. The overall water surplus (the difference between the mean annual precipitation and ET) was then calculated and consists of the water available for runoff and infiltration.

A summary of the monthly mean precipitation rate, average daily air temperature, actual evapotranspiration and the generated water balance surplus is presented in **Table 5.4**. The long term average annual mean precipitation at the Bowmanville Mostert Meteorological Station was 857.8 mm/yr. The mean annual evapotranspiration is calculated to be 547.4 mm/yr. The mean annual water surplus is therefore calculated to be the difference, which is 310.4.mm.

Table 5.4 Water Budget Summary

Month	Mean Monthly Temperature (°C)[1]	Total Monthly Precipitation (mm) [1]	Actual Evapotranspiration[2] (mm)	Water Balance – Surplus (mm)
January	-6.3	63.1	0.0	63.1
February	-5.3	46.3	0.0	46.3
March	-0.5	60.7	0.0	60.7
April	6.0	72.9	32.2	40.7
May	12.2	73.7	76.7	-3.0
June	17.1	81.5	107.5	-26.0
July	19.8	63.7	108.7	-45.0
August	18.9	81.0	96.0	-15.0
September	14.7	90.5	76.4	14.1
October	8.4	67.9	38.5	29.4
November	3.1	84.0	11.4	72.6
December	-2.7	71.6	0.0	71.6
Year (mm/yr)		**857.8**	**547.4**	**310.4**

Notes: 1. Data obtained from the 1971 – 2000 average at the Bowmanville Mostert Meteorological Station.
2. Evapotranspiration calculated using the Thornthwaite and Mather (1957) method.

Based upon the mean annual water surplus calculated by the Thornthwaite and Mather (1957) method, groundwater recharge and surface water runoff rates were quantitatively calculated using a GIS-based analytical model. This model assumes that volumes for domestic and municipal groundwater takings are negligible, and that groundwater and/ or surface water inflow from outside the watershed are also negligible. The model integrates watershed characteristics such as slope, aspect, elevation, soils, land use, and land cover over a 20 x 20 m grid to determine groundwater recharge rates and runoff volumes for the watershed.

Figures 5.2 and **5.3** present the modelled groundwater recharge rates and runoff for the Robinson Creek Watershed.

Figures 5.4 and **5.5** present the modelled groundwater recharge rates and runoff for the Tooley Creek Watershed.

5.4.2 High Volume Recharge Areas

The identification and delineation of areas that contribute 'significantly' to groundwater recharge within a watershed is important for the protection and management of water resources. It is important to maintain groundwater recharge rates in significant groundwater recharge areas to ensure that groundwater levels are maintained, groundwater discharge rates to streams are maintained, and that sufficient groundwater supply is available for human uses.

Based upon the results of the water balance modelling, High Volume Recharge Areas (HVRAs), within both the Robinson Creek and Tooley Creek Watersheds have been identified. HVRAs have been quantitatively shown to be significant groundwater recharge areas within the watersheds, and will be treated as such in future land use scenarios. HVRAs were delineated based upon the methodology outlined by for the provincial Source Water Protection program under the Clean Water Act, Technical Bulletin: Delineation of Significant Groundwater Recharge Areas (2009), and are used by CLOCA in other local watersheds. HVRAs can be defined as the following:

1. An area where the predicted groundwater recharge rate is greater than the mean groundwater recharge rate for the watershed by a factor of 1.15 or more; or
2. An area where the volume of groundwater recharge is 55% or more of the volume determined by subtracting the annual evapotranspiration for the watershed from the annual precipitation for the watershed.
3. A HVRA must also have a hydrological connection to a surface water body or an aquifer that is a source of drinking water for a drinking water system.

HVRAs have been delineated for the Robinson Creek and Tooley Creek Watersheds, based upon the above listed methodology, and are presented in **Figures 5.6** and **5.7**. Maintaining infiltration in these areas is critical to maintaining the overall health of the watersheds. Specific regulation and planning recommendations will be made to maintain the functionality of these significant areas.

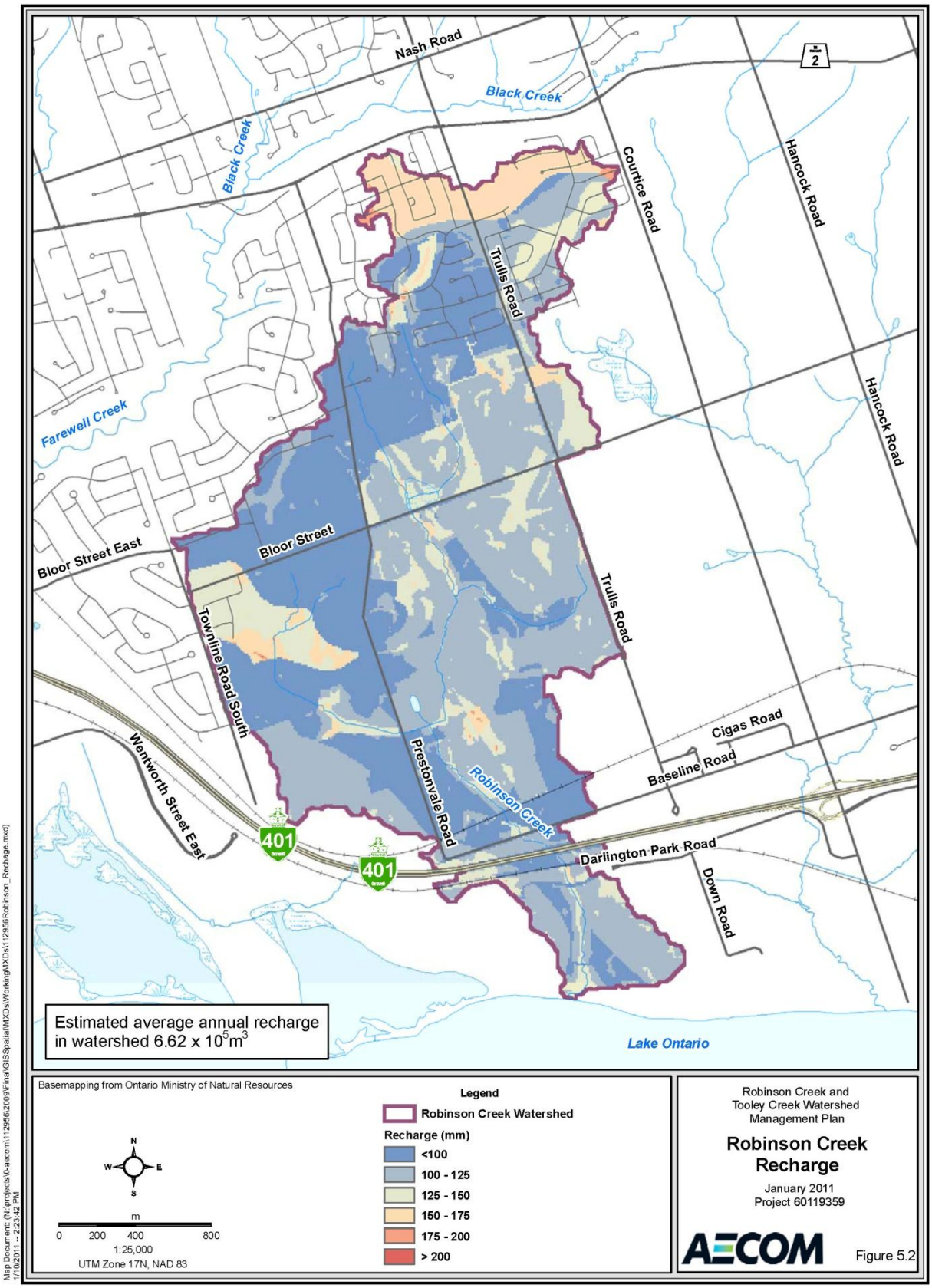


Figure 5.2 Robinson Creek Recharge

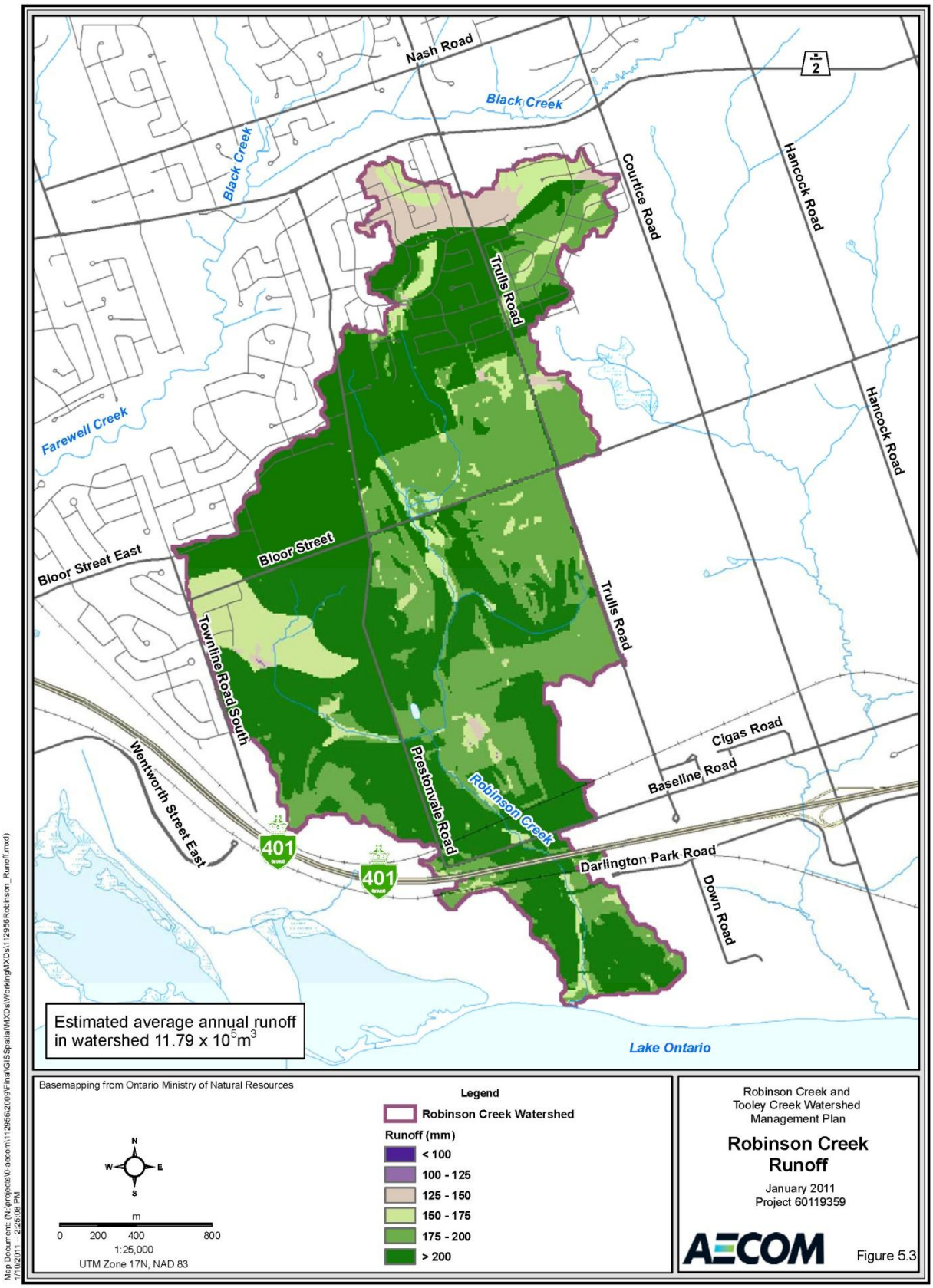


Figure 5.3 Robinson Creek Runoff

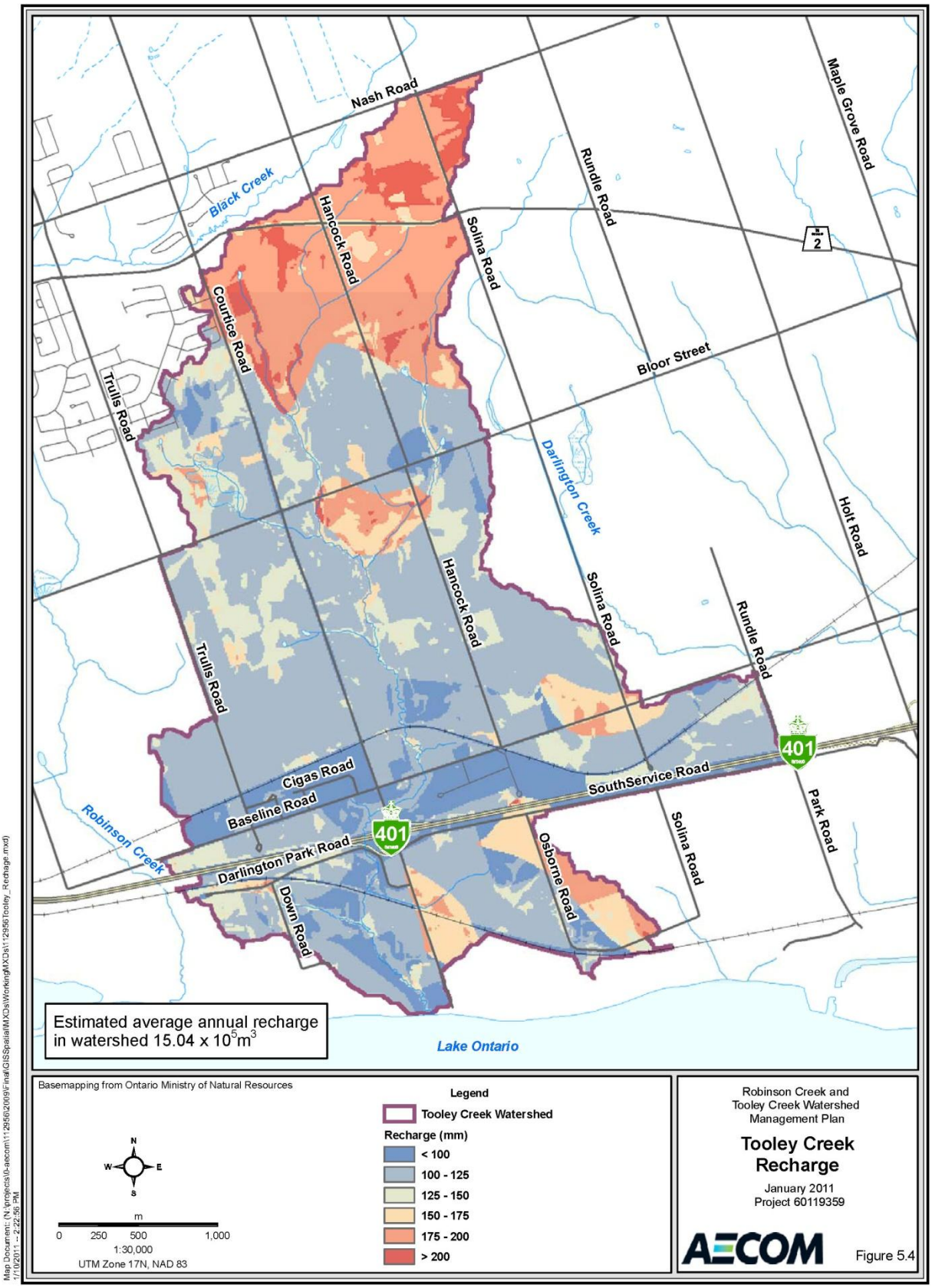


Figure 5.4 Tooley Creek Recharge

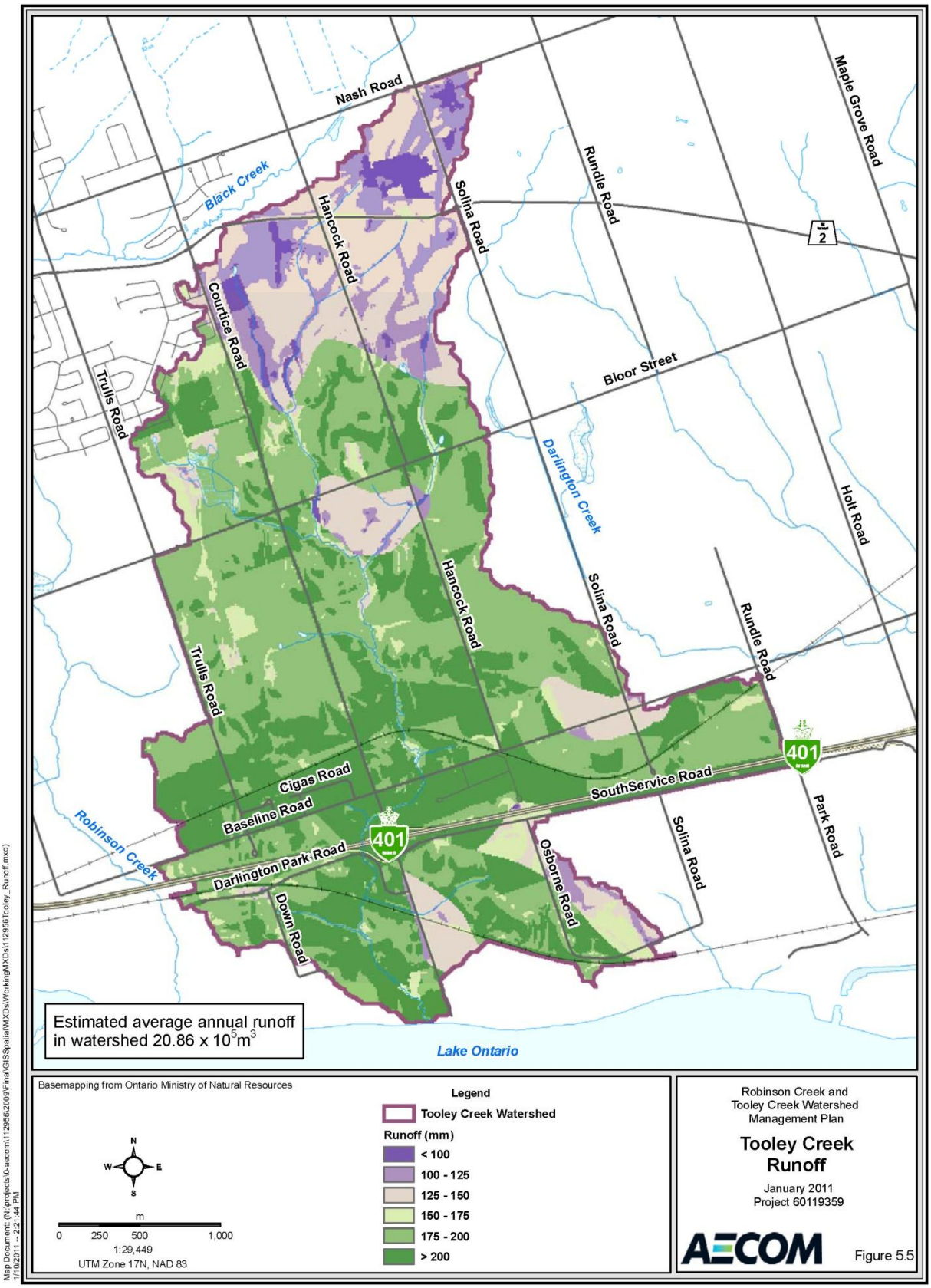


Figure 5.5 Tooley Creek Runoff

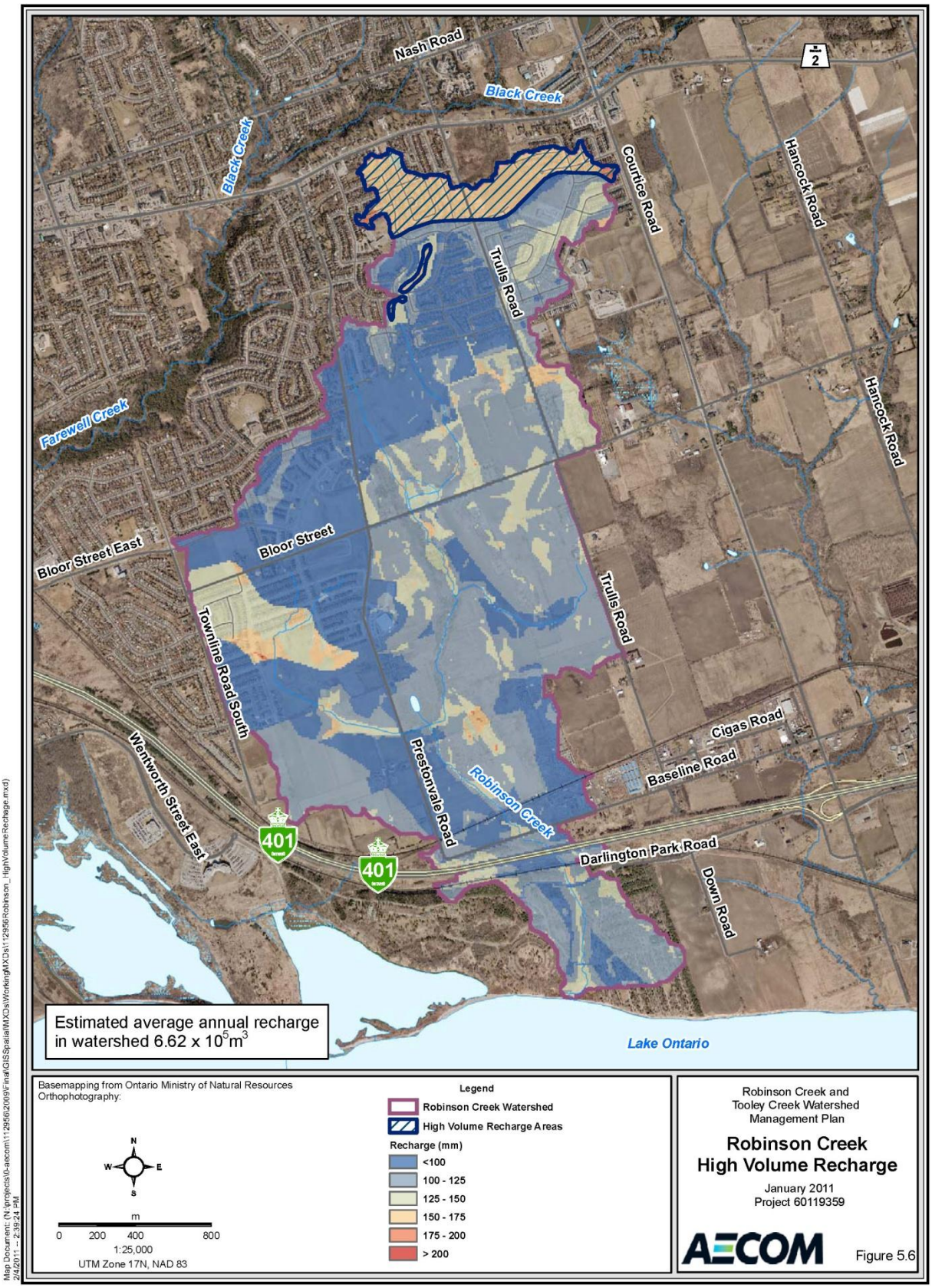


Figure 5.6 Robinson Creek High Volume Recharge

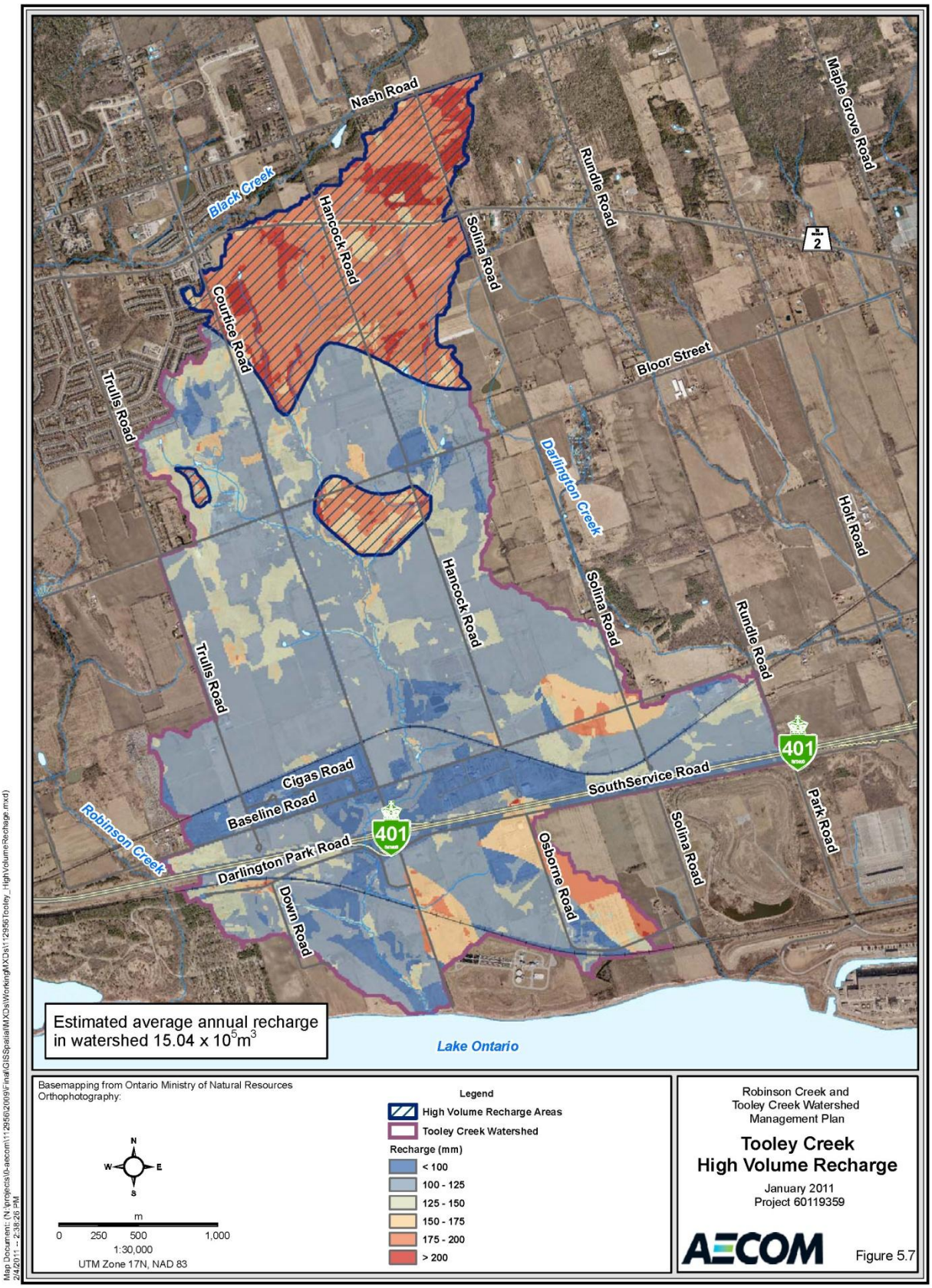


Figure 5.7 Tooley Creek High Volume Recharge

5.5 Imperviousness

The Robinson Creek and Tooley Creek Watersheds are projected to experience a rapid increase in population, employment and infrastructure, between 2011 and 2031, in order to accommodate the regional growth centre of Clarington. Future infrastructure and growth projects such as the Highway 407 East Extension and the recent Regional Official Plan Amendment 128 (ROPA 128)[1], will further add to the urbanization of these watersheds. With this rapid change from primarily agricultural land use to urban land use, there will also be a significant increase in imperviousness. This change in imperviousness must be managed wisely or impacts such as increased runoff, channel erosion, downstream flooding, stream water quality impairment, reduced infiltration and loss of fish and wildlife habitat may occur.

As part of this Watershed Management Plan, AECOM developed an analytical and GIS based model to determine the past, present and future amount of imperviousness in both the Robinson Creek and Tooley Creek Watersheds, based upon a number of future land use scenarios. This model is consistent with CLOCA's "Methodology of Imperviousness Analysis Modelling" (CLOCA, 2010), in that it uses the same land cover classifications, impervious values, and subwatershed land areas.

Four land use scenarios were considered for the Imperviousness Analysis:

- Past land use scenario, based on 1980 and 2005 land use for Robinson Creek and Tooley Creek, respectively;
- Current land use scenario, based on December 2010 *actual* land use conditions (**Figures 5.8** and **5.10**);
- Future scenario one, based on the Official Plan (2007 Consolidation) land use designations to 2031; and
- Future scenario two, based on the Official Plan (2007 Consolidation) land use designation to 2031, including Highway 407 East Link and ROPA 128 lands, and with the addition of the Natural Heritage System (**Figures 5.9** and **5.11**).

Table 5.5 presents the average level of imperviousness for the Robinson Creek and Tooley Creek Watersheds based on the above listed four scenarios.

Table 5.5 Imperviousness Scenarios for the Robinson Creek and Tooley Creek Watersheds

Land Use Scenario	Percent Imperviousness	
	Robinson Creek Watershed	Tooley Creek Watershed
Past Land Use (1980 – Robinson Creek; 2005 – Tooley Creek)	4%	12%
Current Land Use (2011)	21%	13%
Future Scenario #1 (2007 OP)	40%	13%
Future Scenario #2 (2007 OP + Hwy 407 + ROPA 128 + NHS)	36%	42%

The increase in imperviousness over time reflects the increasing urbanization of the watersheds and highlights the need to manage the effects urbanization. The addition of a designated Natural Heritage System will reduce the overall imperviousness of the watersheds and will protect key hydrological areas, which is expected to help minimize the downstream effects of increased runoff, improve water quality and maintain infiltration.

1. *At the time this report was completed, the ROPA 128 lands are under appeal from the Region of Durham and the Municipality of Clarington. Therefore, to conservatively assess the impact of future growth scenarios the Watershed Management Planning recommendations provided in this report have assumed that the Courtice Employment Lands (i.e., the ROPA 128 lands) will be part of future development in the watersheds.*

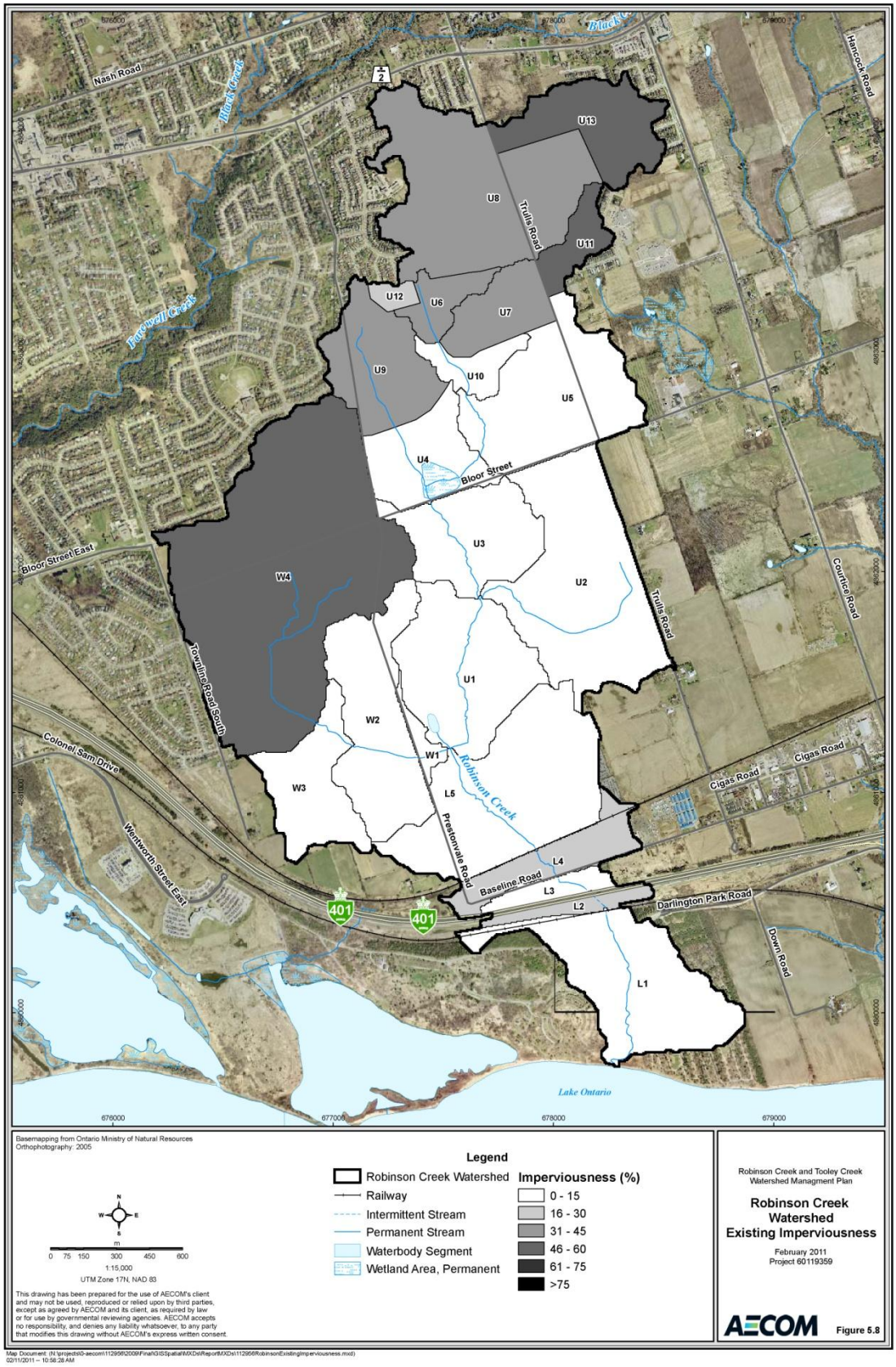


Figure 5.8 Robinson Creek Watershed Existing Imperviousness

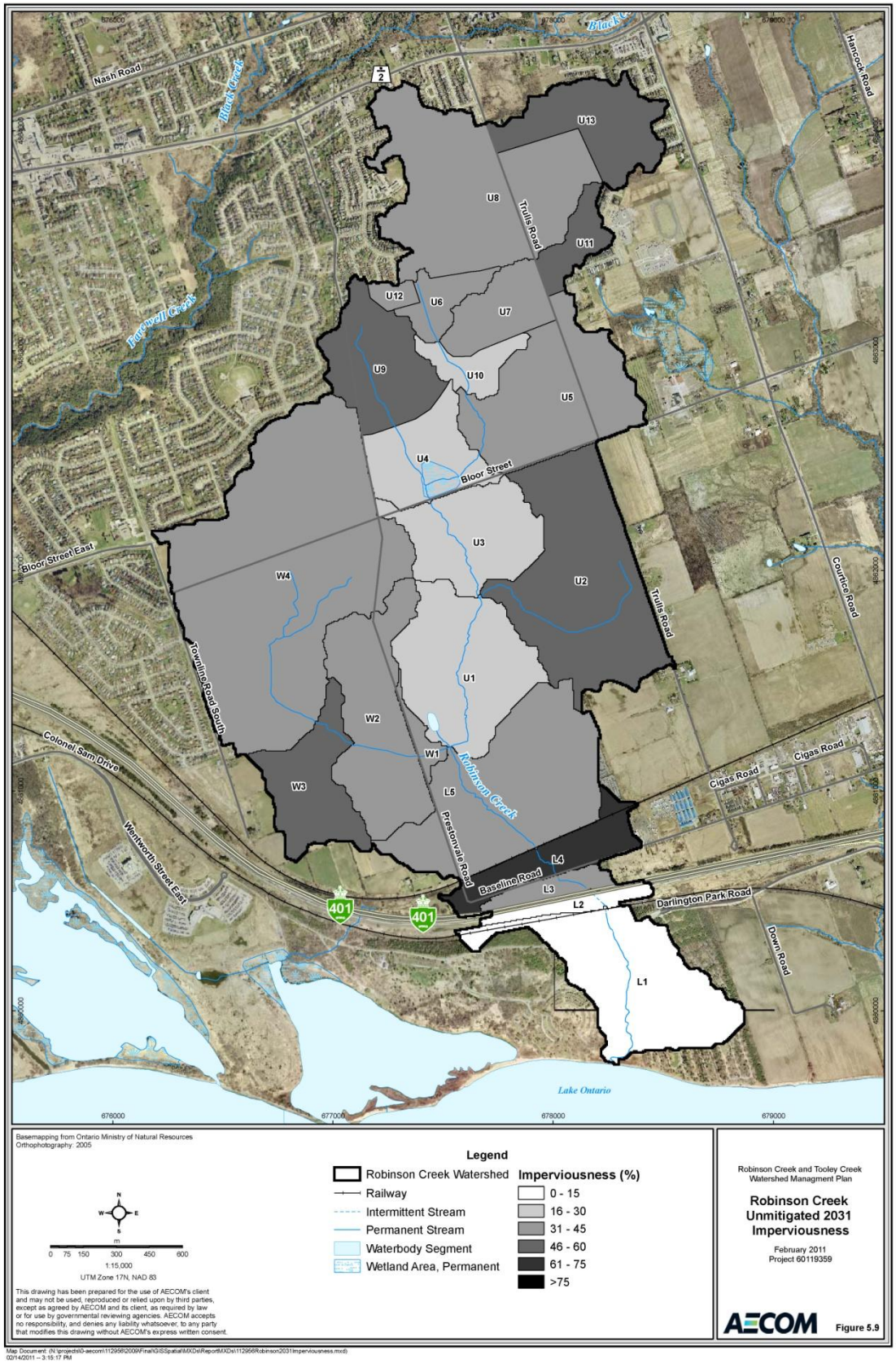


Figure 5.9 Robinson Creek Watershed Future Imperviousness

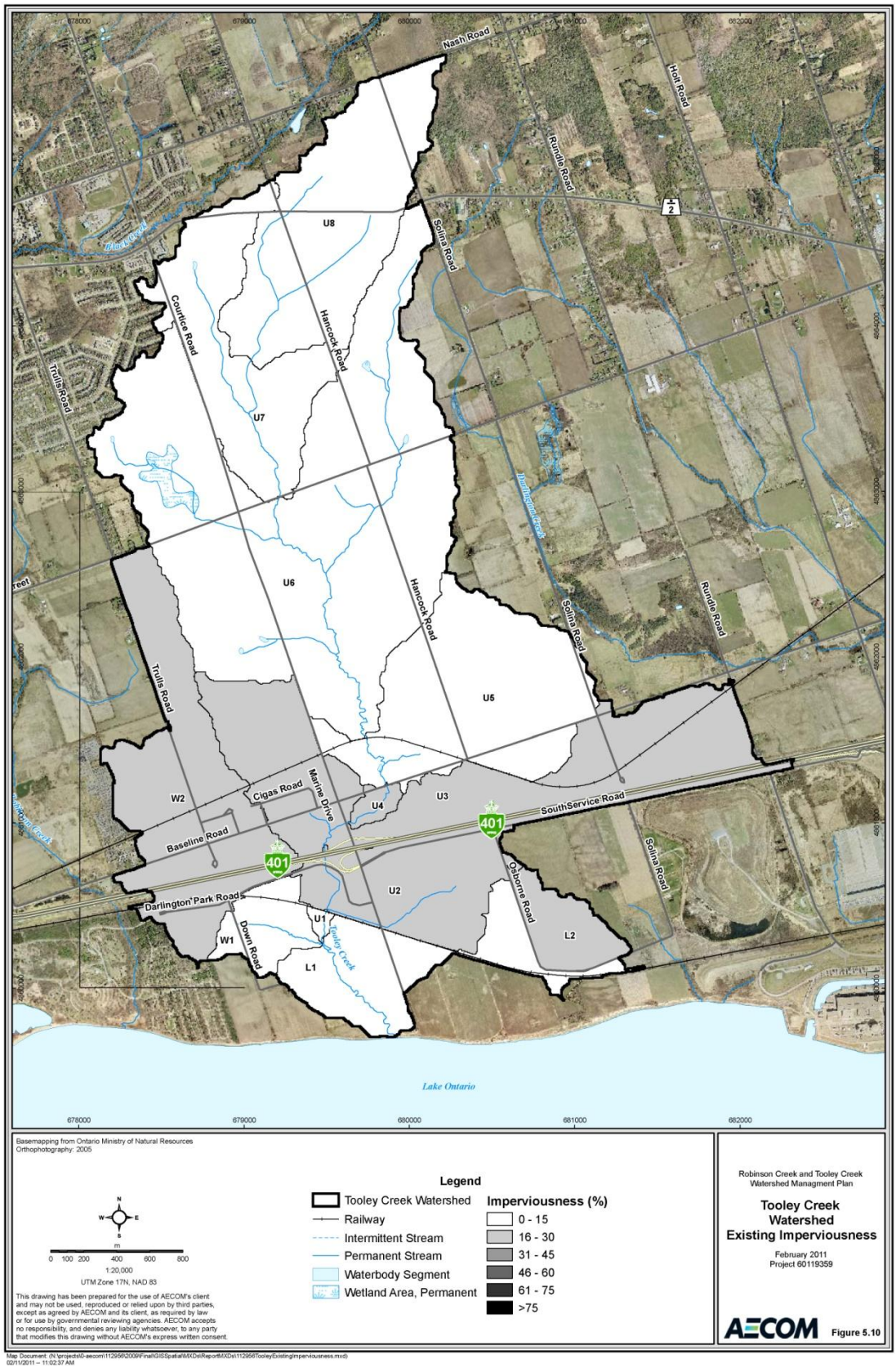


Figure 5.10 Tooley Creek Watershed Existing Imperviousness

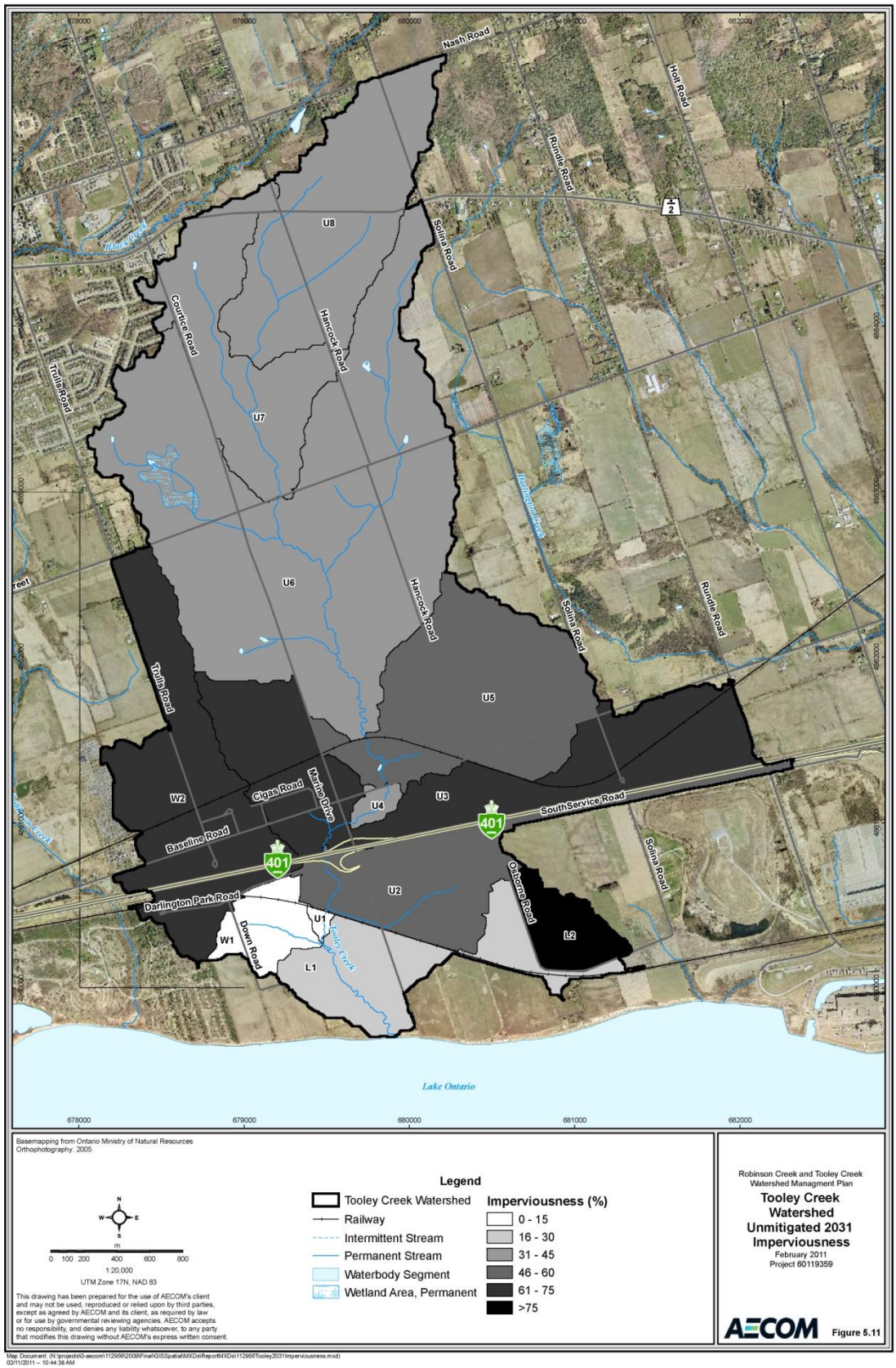


Figure 5.11 Tooley Creek Watershed Future Imperviousness

Regulation and policy initiatives are considered to be the most effective method for managing imperviousness, minimizing the impact of development and protecting the natural environment. Specific regulation and policy recommendations are presented in **Sections 6.3** and **6.4**, and include recommendations such as:

- The use of Low Impact Development (LID) technologies and methods;
- Enhanced level stormwater management;
- The use of technologies such as permeable pavements, soakaway pits, infiltration galleries, grassed swales or other technologies;
- Maintaining groundwater recharge rates to pre-development levels in High Volume Recharge Areas; and
- Maintaining and/or enhancing natural vegetation.

5.6 Surface Water Analysis

As described in the *Robinson Creek and Tooley Creek Watershed Plan - Existing Conditions Report (AECOM 2010)* both watersheds will be undergoing significant land use changes in the next 20 years as development proceeds. A recent hydrotechnical analysis (hydrology and hydraulics) was completed by CLOCA for both watersheds as part of their mandate to identify the Regulatory Floodplain. These analyses are contained in the following reports that were provided as Appendix A and Appendix B of the abovementioned *Existing Conditions Report*:

- *Hydrologic and Hydraulic Modelling for Tooley Creek – CLOCA 2008*
- *Hydrologic and Hydraulic Modelling for Robinson Creek – CLOCA 2010*

Both CLOCA reports relied on the Clarington OP (2007 Consolidation) to identify future land use but did not capture the following additional changes that are currently being considered, including:

- ROPA 128 lands (residential and employment) – Tooley Creek Watershed;
- The Highway 407 East Extension and the East Durham Link to the 401 – Tooley Creek Watershed;
- A Town Centre and increased Urban Residential lands – Robinson Creek Watershed; and
- Natural Heritage System lands: composed of increased Significant Valley and Environmental Protection lands - Tooley Creek and Robinson Creek Watersheds.

These changes are considered to be significant enough to warrant a reassessment of the hydrology and hydraulics of the Watersheds to identify potential negative or positive impacts of changing land use, and to determine mitigation strategies where needed.

An updated Surface Water Analysis report is contained in **Appendix A** of this Watershed Management Plan, and is intended to provide the basis for determining watershed management recommendations. A brief summary of the Surface Water Analysis Report is presented herein. The reader is referred to **Appendix A** for additional details.

5.6.1 Robinson Creek – Surface Water Analysis Summary

In general, the preservation and enhancement of the Natural Heritage System will maintain or improve the effects of storm flows in the watershed to at or below the levels predicted by CLOCA (CLOCA, 2010). As described in **Appendix A**, development of a Town Centre in the most northern part of the watershed, is expected to increase the likelihood of flooding to existing residential areas between Bushford Road and Sandringham Road for both minor and major flow events, including the Regulatory. The flooding hazard (floodplain) is defined in the MNR's Technical Guide – River and Stream Systems: as the greater of the flood resulting from Hurricane Hazel or the (uncontrolled) one hundred year flood. The Guideline also states that "stormwater management facilities may not be used to provide any reduction in flood flows. Mitigation of existing and future flooding though measures that may include structure controls, Low Impact Development and other source control strategies is recommended. While LID's and/or increasing or maintaining existing rates of infiltration help to mitigate impacts of increased stormwater volumes resulting from development, these measures will not provide relief for the Regulatory Event. Additionally, the Town Centre Lands are within an area identified as a High Volume Recharge Area (**Figure 5.6**). It was previously recommended that development in these lands should maintain pre-development groundwater infiltration

rates, post-development. Maintaining groundwater recharge in this area is expected to maintain or improve the results of the modelling presented in **Appendix A**. This area south of Highway #2 and East of Trulls Road (catchment U13) should be designated a Special Study Area and further investigation of planned development and mitigative measures, to promote recharge and reduce flooding, must be undertaken.

Several crossings were identified as areas that should be considered for upgrading, due to their impact on the Regulatory Floodplain under both existing and future landuse conditions. These crossings include:

- Highway 401 culverts;
- CNR railway culvert south of Highway 401.

Consideration should be given to upgrading these culverts during redevelopment or regular maintenance, but only after due consideration of downstream flood effects and impacts.

5.6.2 Tooley Creek – Surface Water Analysis Summary

In general, the change from agricultural land use to employment land use increases the Regulatory Floodline in all reaches of Tooley Creek to levels greater than those shown in CLOCA, 2008. As described in **Appendix A**, the most significant flooding increase is behind the Highway 401 culvert crossing back towards Baseline Road. Upgrading of the Highway 401 culvert crossing should be considered during the construction of the Highway 407 East Link in the area.

Model simulation results show that to control peak steam flows non-structural options should be considered for the watershed, including maintaining groundwater recharge rates at pre-development levels in High Volume Recharge Areas, Low Impact Development methods, and the use of end-of-pipe mitigation for downstream effects of peak surface water flows.

A number of crossings were identified as areas that should be considered for upgrading, due to their impact to the Regulatory Floodplain under both existing and future landuse conditions. These crossings include:

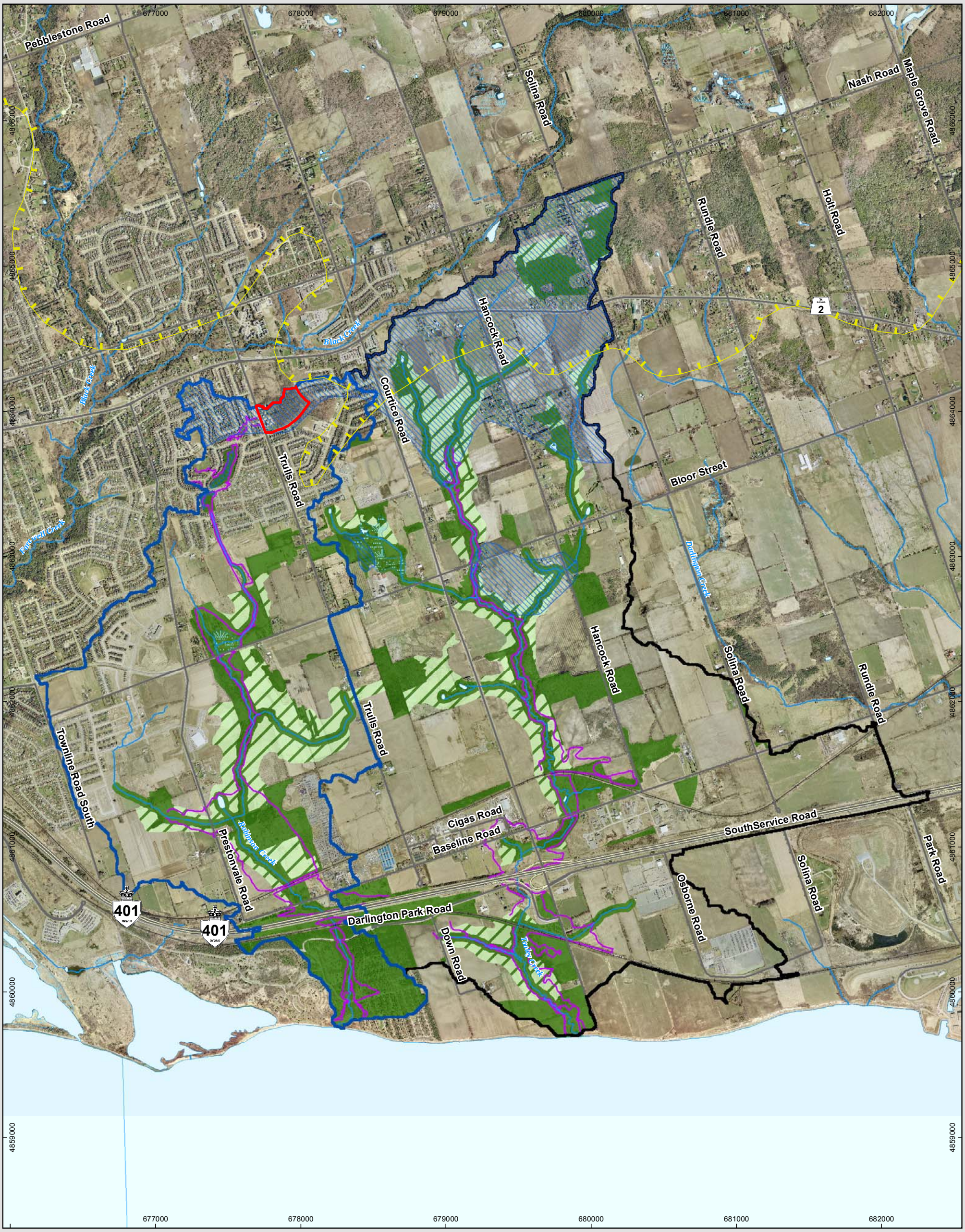
- Highway 401 culverts;
- CP railway culvert north of Baseline Road; and
- CNR railway culvert south of Highway 401.

Consideration should be given to upgrading these culverts during redevelopment or regular maintenance, but only after due consideration of downstream flood effects and impacts.

5.7 Environmental Constraints

As previously stated, the goal of this study is to develop a Watershed Management Plan for the Robinson Creek and Tooley Creek Watersheds that promotes sustainable use of the watersheds and can be implemented and adopted into the Clarington Official Plan in support of future development. This goal includes defining how the watersheds should look in order to manage future growth scenarios, and sustain and/or improve the natural environment. Defining which areas are appropriate for preservation, protection, enhancement, or rehabilitation is a key element of this goal.

Based upon the Opportunities and Constraints of the watersheds, the watershed targets, and the analysis and delineation of a Natural Heritage System, High Volume Recharge Areas, current and future levels of Imperviousness and Surface Water Analysis, an Environmental Constraints Map was developed (**Figure 5.12**). It is recommended that this figure be included in the Clarington Official Plan land use Schedule C to help guide development and environmental protection in the Robinson Creek and Tooley Creek Watersheds. This land use scenario must be used in conjunction with the other recommendations made in this report to minimize the effects of development in the watersheds.



Basemapping from Ontario Ministry of Natural Resources
Orthophotography: 2005

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UTM Zone 17N, NAD 83

Legend

- Tooley Creek Watershed
- Robinson Creek Watershed
- Special Study Area
- Railway
- Regional Floodline (CLOCA)
- Intermittent Stream
- Permanent Stream
- Waterbody Segment
- Wetland Area, Permanent

Natural Heritage System

- Functional Natural Heritage System
- Targeted Natural Heritage System
- High Volume Recharge Areas
- Lake Iroquois Beach

Robinson Creek and Tooley Creek
Watershed Managment Plan

Environmental Constraints

October 2011
Project 60119359

AECOM

Figure 5.12

Map Document: (N:\projects\0-aecom\112956\2009\Final\GISSpatial\MXDs\ReportMXDs\112956EnvironmentalConstraints.mxd)
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6. Robinson Creek and Tooley Creek Watershed Management Recommendations

Owing to the similarities between the Robinson Creek and Tooley Creek Watersheds, management recommendations will generally be made for both watersheds to avoid repetition. However, where differences exist between the two watersheds, watershed specific recommendations will be made. The majority of policy recommendations made in the management section will be implemented through

6.1 Groundwater Quantity

Groundwater within the Robinson Creek and Tooley Creek Watersheds supports vegetation, animals, and humans. People living in the rural areas obtain their drinking water from wells, and numerous businesses rely on groundwater for commercial and industrial use. Aquatic habitat, in both streams and wetlands, is dependent on specific groundwater conditions. Certain fish species require a consistent thermal regime, which is influenced by groundwater upwelling, and wetland vegetation can be highly sensitive to changes to the groundwater table. For these reasons an understanding of the groundwater system is fundamentally important to the overall health of a watershed.

Both the Robinson Creek Watershed and the Tooley Creek Watersheds contain groundwater recharge areas as well as discharge areas commonly associated with wetlands and streams that are important on the watershed scale. Hydrogeologically sensitive areas are identified on the basis of surficial geology, groundwater recharge and discharge areas, watercourse characteristics, and the locations of wetlands and water wells.

6.1.1 Groundwater Quantity – Issues and Opportunities for Improvement

The *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM 2010)*, documents the existing state of groundwater quantity in the Watersheds, and provides the necessary background information to identify potential issues and opportunities for improvement. A summary of the issues and opportunities related to groundwater quantity is outlined below.

Issues and Opportunities for Improvement	Rationale
Groundwater Recharge	Recharge is the term used to describe downward flowing groundwater, that is, from the ground surface towards the water table. Of all precipitation that reaches the ground surface, some is lost to evapotranspiration and some runs off the surface directly into streams. The remainder infiltrates into the ground. Recharge areas are important because they replenish the groundwater. Proper management of groundwater recharge areas within a watershed will ensure that sufficient water is available for human use and to sustain baseflow to aquatic resources. Groundwater recharge can be preserved by protecting key recharge areas and by maintaining pre-development groundwater infiltration rates throughout the watershed.
Groundwater Discharge	Groundwater discharge is where groundwater is “discharged” to surface, and is generally found where the water table intersects the ground surface or stream channel. Groundwater discharge is important for a variety of reasons. First, it sustains a minimum flow (baseflow) in streams, especially during the dry months of summer. Without groundwater contributions, streams in the watershed would dry up periodically throughout the year. Second, it moderates stream temperatures, particularly during hot summer days, and dampens stream temperature fluctuations. This helps support a variety of fish species that are sensitive to changes in water temperature. Maintaining groundwater discharge within a watershed through management will ensure that volumes and rates of groundwater inputs to streams and wetlands are maintained or enhanced. This will provide a direct benefit to aquatic species and habitat, as well as the terrestrial natural environment.
Aquifers and Aquitards	An aquifer is described as a rock or soil formation which is saturated and sufficiently permeable to transmit water readily. Examples of aquifer materials include sands and gravels. In contrast to an aquifer, an aquitard is a rock or soil formation that restricts groundwater movement. Examples of aquitard materials include silt, clay and till. Aquitards protect the integrity of the groundwater by restricting the movement of surficial contaminates. An aquifer that is protected by an aquitard is called a “confined aquifer”. An aquifer that is not protected by an aquitard is called an “unconfined aquifer”. Aquifers provide a source of potable water for many rural residences and transmit water to surface water bodies through groundwater discharge. Protection of these natural features will ensure that sufficient water is available to support human and natural functions.
Permits To Take Water (PTTW)	Permits to Take Water (PTTW) are issued by the Ministry of the Environment for any water taking that exceeds 50,000 L/day. It is recognised that no high volume water takings are currently active in the watershed, nor are

Issues and Opportunities for Improvement	Rationale
	any future large volume water takings likely. However, where water takings for construction dewatering or new industry are anticipated to exceed 50,000 L/day a permit must be obtained to ensure that water resources within the watershed are not stressed.
Groundwater Wells	Although the Robinson Creek and the Tooley Creek Watersheds are becoming increasingly urban and municipal water supply derived from Lake Ontario will become readily available, some residences may wish to maintain their reliance on well water. The groundwater system within the watershed should be managed to ensure that domestic water supply wells are not impacted by development and that they continue to function as a source of potable water. Additionally, groundwater wells that are no longer in use must be properly decommissioned as per Reg. 903. Improperly decommissioned wells can create a direct path for surficial contaminates to enter deep aquifers that otherwise would have been considered protected by an overlying aquitard.

6.1.2 Groundwater Quantity - Management Recommendations

Based upon the methodology outlined in Section 5, and the issues and opportunities listed above, the following Section presents the goals, objectives, and management alternatives that were developed and evaluated for the Robinson Creek Watershed relating to groundwater quantity. Specific management recommendations have been made that are designed to maintain and enhance groundwater quantity within the Robinson Creek and Tooley Creek Watersheds.

GOAL – Protect and Enhance Groundwater Quantity

Objective 1a. Maintain and Enhance Groundwater Recharge and Discharge Areas within the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Protect important groundwater features.*
- *Maintain or enhance groundwater recharge in High Volume Recharge Areas.*
- *Maintain or enhance groundwater discharge.*
- *Maintain or enhance the current water balance.*

Objective 1b. Minimize Changes to Groundwater Flow Patterns within the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Maintain current groundwater flow regime including groundwater table elevation.*
- *Maintain or enhance groundwater discharge to surface water features.*

Objective 1c. Promote Sustainable Rates of Groundwater Use Within the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Maintain sustainable groundwater use as it relates to hydrological, ecological and human functions.*

Objective 1d. Protect the Landscape Quality and the Important Groundwater Function of the Lake Iroquois Beach (Shoreline) Deposits

Working Targets

- *Maintain or enhance groundwater recharge along the Lake Iroquois Beach deposits.*
- *Maintain the character of the Lake Iroquois Shoreline landscape.*

Management Alternatives to Achieve Groundwater Quantity Objectives

Regulation and Policy

Management Action 1.1

Restrict development and site alteration within and adjacent to important groundwater features.

- Important groundwater features include, but are not limited to: seepage areas, springs, and groundwater fed streams.
- Development and site alteration within important groundwater features is prohibited.
- Development and site alteration adjacent to important groundwater features must maintain an undeveloped 30 m buffer to protect groundwater quantity.

Fulfills Objective 1a

Management Action 1.2

Restrict development and site alteration within and adjacent to High Volume Recharge Areas (HVRAs) to maintain groundwater recharge rates within these significant areas (see Figures 5.6 and 5.7).

- Groundwater recharge rates should be maintained at pre-development rates in HVRAs.
- Development and site alteration within a HVRA and within 120 m of a HVRA is restricted unless a water budget and hydrogeological evaluation is undertaken that demonstrates that:
  - Groundwater recharge rates and volumes will be maintained or enhanced post development through on-site mitigation efforts;
  - Groundwater discharge features or the groundwater flow regime that supports those features will not be affected; and
  - Best management practices related to groundwater recharge and stormwater management in urban areas are utilized, including the use of Low Impact Development (LID).

Fulfills Objectives 1a, 1b, and 1c

Management Action 1.3

Encourage development to implement practices to manage rainfall 'on-site' before it enters a storm sewer.

- Implement a hierarchy of practices to maintain or enhance groundwater recharge, starting with 'on-site', then 'conveyance', and lastly 'end of pipe' solutions, with priority given to on-site solutions.
- The use of LID stormwater techniques is recommended.

Fulfills Objective 1a

Management Action 1.4

Map the location of important groundwater features and HVRAs, and include in municipal planning documents.

Fulfills Objectives 1a, 1b, and 1c

Management Action 1.5

Minimize alterations of groundwater flow patterns for subsurface development and site alteration.

- Development and site alteration within HVRAs areas may be permitted only if:
  - Development and site alteration will not take place at a depth greater than 1 m above the seasonal high water table elevation, or
  - A hydrogeological evaluation is undertaken to the satisfaction of the municipality that demonstrates that groundwater flow alterations will be minimized and water table elevations will be maintained post development, or
  - Applicable approval requirements are fulfilled under the Aggregate Resources Act, Environmental Assessment Act, and/or Ontario Water Resources Act.

Fulfills Objective 1b

Management Action 1.6

Continue to restrict development within areas that are not serviced by municipal sewage and water services.

- In accordance with Clarington Official Plan Policy 11.8.1, all Employment Areas shall be developed on municipal water, sewer and roads designed to urban standards. Prior to the introduction of full municipal services, limited development on private services is permissible provided:
  - The use does not require water consumption in the production, manufacturing, refining or assembling process;
  - The applicant submits an engineering or hydrogeological report demonstrating that private services can be supported on site without impacting groundwater and soil conditions;
  - The applicant enters into a development agreement with the Municipality which includes, among other matters, the requirement to connect to future sanitary sewer and water supply services and the payment for the owner's share of installation and connection when such services are available.

Fulfills Objective 1c

Management Action 1.7

Restrict development and site alteration on and adjacent to the Lake Iroquois Beach (Shoreline) within the Tooley Creek Watershed.

- Development and site alteration on and within 120 m of the Lake Iroquois Beach shall endeavour to maintain the character of the landscape, minimize modifications to the natural contours and maintain groundwater recharge rates post development.
- Development and site alteration on and within 120 m of the Lake Iroquois Beach is restricted unless a water budget and hydrogeological evaluation is completed that demonstrates:
  - Groundwater recharge rates and volumes will be maintained or enhanced post development;
  - Groundwater discharge features or the groundwater flow regime that supports those features will not be affected; and
  - Best management practices related to groundwater recharge in urban areas are utilized, such as special house and infrastructure design requirements, and construction.

Fulfills Objective 1d

Management Action 1.8

Once approved, implement policies recommended in the Central Lake Ontario Source Protection Area Report created through the policies outlined in the Clean Water Act, 2006.

Fulfills Objectives 1a, 1b, 1c and 1d

Education and Stewardship

Management Action 1.9

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watersheds, to encourage landowners to preserve, conserve, and enhance groundwater quality on their property, and provide financial and technical assistance in support of these programs.

Fulfills Objectives 1a, 1b, 1c and 1d

Management Action 1.10

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watersheds, to educate landowners regarding the natural history and benefits of preserving the character of the Lake Iroquois Beach deposits.

Fulfills Objective 1d

Management Action 1.11

In partnership with CLOCA and other community groups, provide education and awareness to residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds through workshops, environmental education programs, and community events that convey the importance of protecting and enhancing groundwater resources within the watershed, including:

- Continue to support groundwater orientated educational events such as the Durham Children's Groundwater Festival.
- Provide easy access to information that local residents and landowners can use to make informed decisions about protecting and enhancing groundwater quantity within the watersheds.
- Providing easy access to information that local residents and landowners can use to make informed decisions about protecting, maintaining and using their well and septic system.
- Provide education and awareness of the importance of protecting the Lake Iroquois Beach deposits.

Fulfills Objectives 1a, 1b, 1c and 1d

Management Action 1.12

Continue to support education, stewardship and community programs that:

- Enhance the quality and quantity of surface water and groundwater and increase groundwater recharge capacity.
- Promote the creation of a continuous natural heritage system within the Watershed that takes into account the importance of hydrogeological functions.
- Provide technical assistance and guidance for the Permit To Take Water application process.
- Provide technical assistance and guidance for development of a water conservation program.
- Promote sustainable use and preservation of groundwater resources.

Fulfills Objectives 1a, 1b, 1c and 1d

Land Acquisition and Dedication

Management Action 1.13

Protect lands within HVRAs and groundwater discharge areas through land acquisition and/or dedication.

- Land within HVRAs and groundwater discharge areas should be considered for acquisition by or dedication to a public authority to actively protect and enhance the natural environment.
- Land along the Lake Iroquois Beach Shoreline should be considered for acquisition by or dedication to a public authority to actively protect and enhance this natural feature and to create recreational opportunities for the community.

Fulfills Objectives 1a, 1b, 1c and 1d

Management Action 1.14

Acquisition or dedication of valley lands as a condition of development approval

- The Municipality of Clarington should continue to implement the practice of acquiring valley lands as a condition of development approval. This policy will continue to support active management of significant natural features and will help maintain and enhance groundwater discharge to surface water features.

Fulfills Objectives 1a, 1b, and 1c

6.1.3 Groundwater Quantity – Monitoring

A groundwater quantity monitoring program should be implemented in the Robinson Creek and Tooley Creek Watersheds. This groundwater monitoring program should be implemented in association with the other natural environment disciplines (i.e., ecology) to integrate the scientific data.

Monitoring initiatives should focus on:

- The maintenance of baseline recharge rates in HVRA;
- The effectiveness of on-site stormwater management in maintaining groundwater recharge;
- Interactions between surface water and groundwater, especially in wetlands and groundwater fed portions of Robinson and Tooley Creeks;
- Baseflow monitoring of Robinson Creek and Tooley Creek; and
- Groundwater level monitoring.

It is recommended that consideration be given to integrating groundwater monitoring wells installed as part of site development activities, that are no longer in use, into the groundwater monitoring program and potentially into the Provincial Groundwater Monitoring Network. Permission from the well owner(s) will be needed to fulfill this recommendation.

CLOCA is encouraged to lead the groundwater quantity monitoring program.

6.2 Groundwater Quality

Groundwater quality within the Robinson Creek and Tooley Creek Watersheds is influenced by what we do on the surface and by the properties of the soils. As rainfall or snow melt moves over the land-surface or infiltrates into the ground, its chemistry (or quality) is changed by dissolving minerals from rocks or soil or from reacting with organic

matter. The resulting groundwater then flows towards streams, wetlands, and aquifers, where it is needed to support aquatic organisms and relied upon as a source of drinking water. Human influences can negatively alter or contaminate the groundwater through point source contamination (e.g., spills or septic systems) or non-point source contamination (e.g., road salt or nutrient spreading). Protecting the quality of the groundwater in the Robinson Creek and Tooley Creek Watersheds is paramount to the overall health of the watershed.

Presently, the groundwater quality in the Robinson Creek and Tooley Creek Watersheds is good. The groundwater quality can generally be described as hard, with high concentrations of anions and cations, such as calcium, magnesium, sodium and bicarbonate, typical of southern Ontario groundwater. However, shallow groundwater samples tend to contain concentrations of nitrate and sodium, likely derived from fertilizer spreading and road salt applications, respectively, at slightly elevated concentrations.

6.2.1 Groundwater Quality – Issues and Opportunities for Improvement

The *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM 2010)*, further documents the existing state of groundwater quality in the Watersheds, and provides the necessary background information to identify potential issues and opportunities for improvement. A summary of the issues and opportunities related to groundwater quality is outlined below.

Issues and Opportunities for Improvement	Rationale
Groundwater Recharge Areas	A groundwater recharge area is an area that is known to contain soils that allow infiltration more readily than within other areas within a watershed. These areas are important because recharge helps replenish that water table and groundwater aquifers that are used for both ecological and human functions. If the groundwater quality in a groundwater recharge areas becomes impaired, this may affect groundwater quality in aquifers elsewhere in the watershed. Proper management of groundwater recharge areas will maintain and/or improve the groundwater quality within the watersheds.
Improperly Installed or Abandoned Wells	O.Reg 903 describes in detail how water wells should be constructed, documented, operated, and abandoned, and who is qualified to perform these actions. Improperly installed or abandoned wells provide a direct connection between the land surface and deeper aquifers that otherwise would be protected by an overlying aquitard. The number of improperly installed wells and abandoned wells within the Robinson Creek and Tooley Creek Watersheds is unknown. All improperly installed, poorly maintained, or abandoned wells should be upgraded or decommissioned to protect groundwater quality within the watershed.
Improperly Maintained, Installed or Abandoned Septic Systems	Septic systems pose a risk to groundwater quality as they are a source of pollutants such as chloride, nitrate, and bacteria. Improperly maintained, installed, or abandoned septic systems pose a greater risk to groundwater quality because they may contaminate private wells or aquifers. The number of improperly maintained, installed, or abandoned septic systems within the Robinson Creek and Tooley Creek Watersheds is unknown. The proper management and operation of septic systems will help maintain or enhance the groundwater quality within the watersheds.
Non-Point Source Pollution	The spreading of nutrients (chemical fertilizer or manure including biosolids) on the land-surface and the use of road salt can lead to groundwater contamination. Because the use of nutrients and road salt is essential, proper management of these applications is needed to protect groundwater quality within the Robinson Creek and Tooley Creek Watersheds.
Groundwater Wells	Although the Robinson Creek and the Tooley Creek Watersheds is becoming increasingly urban and municipal water supply derived from Lake Ontario will become readily available, some residences may wish to maintain their reliance on well water. The groundwater system within the watershed should be managed to ensure that domestic water supply wells are not impacted by development and that they continue to function as a source of potable water.

6.2.2 Groundwater Quality – Management Recommendations

Based upon the methodology outlined in Section 5, and the issues and opportunities listed above, the following Section presents the goals, objectives, and management alternatives that were developed and evaluated for the Robinson Creek and Tooley Creek Watersheds relating to groundwater quality. Specific management recommendations have been made that are designed to maintain and enhance groundwater quality within the Robinson Creek and Tooley Creek Watersheds.

GOAL – Protect and Enhance Groundwater Quality

Objective 2a. Maintain and Enhance Groundwater Quality within the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Protect important groundwater features and HVRAs*
- *Decommission abandoned wells and boreholes*
- *Rehabilitate improperly installed wells*
- *Require water and sewage services*

Objective 2b. Encourage the Implementation of Best Management Practices to Manage the Groundwater Quality within the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Adopt best management practices within the watersheds*

Management Alternatives to Achieve Groundwater Quality Objectives

Management Action 2.1

Restrict development and site alteration within and adjacent to HVRAs.

- Development and site alteration within a HVRA and within 120 m of a HVRA is restricted unless a hydrogeological evaluation is undertaken that demonstrates that:
  - Groundwater quality will be maintained or enhanced post development; and
  - Best management practices related to groundwater recharge and stormwater management in urban areas are utilized, including LID.
- The following uses as outlined in Section 4.5.9 of the Clarington Official Plan are prohibited in HVRAs to protect groundwater quality:
  - Generation and storage of hazardous waste or liquid industrial waste;
  - Waste disposal sites and facilities, organic soil conditioning sites, and snow storage and disposal facilities;
  - Underground and above-ground storage tanks that are not equipped with an approved secondary containment devise; and
  - Storage of contaminants listed in Schedule 3 to O. Reg 347 (1990).

Fulfills Objectives 2a and 2b

Management Action 2.2

Ensure that wells or boreholes are properly abandoned as a condition of development approval.

- Development may be permitted only if the applicant demonstrates that all inactive wells or boreholes will or have been be decommissioned in accordance with the *Ontario Water Resources Act* (*O.Reg 903).*

Fulfills Objective 2a

Management Action 2.3

Continue to restrict development within areas that are not serviced by municipal sewage and water services.

- In accordance with Clarington Official Plan Policy 11.8.1, all Employment Areas shall be developed on municipal water, sewer and roads designed to urban standards. Prior to the introduction of full municipal services, limited development on private services is permissible provided:
  - The use does not require water consumption in the production, manufacturing, refining or assembling process;
  - The applicant submits an engineering or hydrogeological report demonstrating that private services can be supported on site without impacting groundwater and soil conditions;
  - The applicant enters into a development agreement with the Municipality which includes, among other matters, the requirement to connect to future sanitary sewer and water supply services and the payment for the owner's share of installation and connection when such services are available.

Fulfills Objective 2a

Management Action 2.4

Require private sewage system upgrading during property redevelopment

- On a property that includes an individual on-site sewage service, such as a leaching bed, development that alters the leaching bed or the plumbing or the potential treatment volume, may be permitted only if the applicant demonstrates that the sewage system meets or will be upgraded to meet the Ontario Building Code.

Fulfills Objective 2a

Management Action 2.5

Continue to apply best management practices for road salt spreading within the watersheds.

- Continue to implement policies and regulations that regulate the spreading of road salt through current best management practices.
- The current road salt management plan should be re-evaluated to further regulate road salt spreading in HVRAs.

Fulfills Objective 2b

Management Action 2.6

Once approved, implement policies recommended in the Central Lake Ontario Source Protection Area Report created through the policies outlined in the Clean Water Act, 2006.

Fulfills Objectives 2a and 2b

Education and Stewardship

Management Action 2.7

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watersheds, to encourage landowners to preserve, conserve, and enhance the groundwater quality on their property, and provide financial and technical assistance in support of these programs.

Fulfills Objectives 2a and 2b

Management Action 2.8

In partnership with CLOCA and other community groups, provide education and awareness to residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds through workshops, environmental education programs, and community events that convey the importance of protecting and enhancing groundwater resources within the watershed, including:

- Protecting and enhancing groundwater resources within the watershed.
- Protecting groundwater quality and having clean drinking water.
- Continuing to support groundwater orientated educational events such as the Durham Children's Groundwater Festival.
- Providing easy access to information that local residents and landowners can use to make informed decisions about protecting, maintaining and using their well and septic system.
- Promoting private water well testing in partnership with the Durham Regional Health Unit.

Fulfills Objectives 2a and 2b

Management Action 2.9

Continue to support education, stewardship and community programs that:

- Enhance the quality and quantity of surface water and groundwater and increase the quality and quantity of groundwater recharge.
- Educate the public on the need for clean drinking water.
- Upgrade existing wells or decommission abandoned wells.
- Educate the public on the risks to groundwater quality from improperly functioning septic systems.
- Inspect, upgrade or repair septic systems.

Fulfills Objectives 2a and 2b

Land Acquisition and Dedication

Management Action 2.10

Land within HVRAs should be considered for acquisition by or dedication to a public authority to actively protect and enhance the natural environment.

Fulfills Objectives 2a and 2b

6.2.3 Groundwater Quality – Monitoring

A groundwater quality monitoring program should be implemented in the Robinson Creek and Tooley Creek Watersheds. This groundwater monitoring program should be implemented in association with the other natural environment disciplines (i.e., surface water quality) to integrate the scientific data.

Monitoring initiatives should focus on:

- Groundwater quality monitoring, especially in HVRAs and along major transportation corridors;
- Surface water quality monitoring;
- Documenting the number and type of private water wells in the watersheds;
- Monitoring the usage of road salt and implementation of BMPs related to road salt spreading; and
- Monitoring the usage of agricultural fertilizers and the effect on groundwater and surface water quality.

It is recommended that consideration be given to integrating groundwater monitoring wells as part of site development activities, that are no longer in use, be incorporated into the groundwater monitoring program and potentially become part of the Provincial Groundwater Monitoring Network (permission from the well owners will be needed to fulfill this recommendation).

CLOCA is encouraged to lead the groundwater quality monitoring program.

6.3 Surface Water Quantity

Robinson Creek and Tooley Creek are two of the shortest watercourses within CLOCA's jurisdiction. Both watersheds are considered urban watersheds, with the Robinson Creek Watershed being more developed than the Tooley Creek Watershed. The headwaters of both creeks originate in the Iroquois Plain physiographic region and do not extend far enough northwards to be fed by the Oak Ridges Moraine.

Robinson Creek is a third order stream with an overall length of approximately 6.7 km and drains an area of 578 ha. The level of imperviousness in the headwaters area is high owing to urban development in the area. As Robinson Creek flows southwards, the level of imperviousness decreases, and leads to a current overall imperviousness of 21% for the watershed. Tooley Creek is also a third order stream with an overall length of approximately 15.7 km and drains an area of 1,040 ha. The headwaters of Tooley Creek originate in the Maple Grove Wetland Complex, which has a low level of imperviousness. Urban development in the Tooley Creek Watershed is small compared to the Robinson Creek Watershed which is reflected in the overall level of imperviousness, which is currently at 13%.

Surface water was analyzed from both a natural environment perspective (i.e., fisheries) and from a natural hazard perspective (i.e., flooding). Surface water flow provides fish habitat and spawning grounds, water for vegetation and animals and recreational opportunities. Hydrologic and hydraulic modelling provides information in creek flow patterns and how the watercourse will respond to the flow generated by a storm event. This analysis allows for natural hazard flood lines to be defined, which helps protect infrastructure, and public health and safety.

6.3.1 Surface Water Quantity and Control – Issues and Opportunities for Improvement

The *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM 2010)*, documents the existing state of the surface water quantity in the Watersheds from a natural environment perspective. CLOCA produced the hydrologic and hydraulic modelling reports for the Watersheds, which are entitled, *Hydrologic and Hydraulic Modelling for the Robinson Creek Watershed (CLOCA 2010)* and *Hydrologic and Hydraulic Modelling for the Tooley Creek Watershed (CLOCA 2007, revised 2008)*.

As part of this watershed management plan, the modelling completed by CLOCA was updated to account for various land use scenarios and future conditions, and is included in **Appendix A**. This report provides the necessary background information to identify potential issues and opportunities for improvement or surface water quantity. A summary of the issues and opportunities related to surface water quantity are outlined below.

Issues and Opportunities for Improvement	Rationale
Natural Hazards	The protection of people and property is paramount. Floodplains need to be defined based upon current and future land use scenarios to restrict new development within the floodplain. Current developments within the floodplain need to be identified and protected to avoid flood impacts. Barriers to flow (and by extension fish movement) need to be identified and redesigned to reduce the effects of flooding. CLOCA plays a key role in the protection of people and property in the Robinson Creek and Tooley Creek Watersheds through the enforcement of O. Reg 42/06 - Development, Interference with Wetlands and Alterations to Shorelines and Watercourses.
Stormwater Management	Management of stormwater flows is important to minimize extreme peak flows which can cause flooding. Especially in urban developments, where the level of imperviousness is high, stormwater needs to be controlled, from both a water quantity and water quality perspective. This will help protect stream channel geomorphology and maintain habitat of fish species. Local infiltration of stormwater is generally preferred over end-of-pipe solutions in areas were the soils are favourable for infiltration. This will help maintain groundwater recharge rates and help the overall water budget for the watersheds.
Maintaining Baseflow	Fish require minimum stream flows for passage, habitat and other life-cycle processes. Maintaining baseflow in Robinson Creek and Tooley Creek is imperative to protect and preserve sensitive fish species such as rainbow trout that were identified in both watercourses. Other aquatic, terrestrial and benthic organisms also rely on a minimum baseflow that needs to be maintained.
Imperviousness	Impervious land cover reduces infiltration, promotes runoff and increases storm and peak surface water flows. Each of these can lead to flooding hazards which risks public safety and property. Imperviousness also needs to be minimized in headwater areas from a stream response and baseflow perspective.
Wetlands	Wetland areas provide both quantity and quality control of surface water through water storage and retention. They work to naturally reduce peak flows. Existing wetland areas need to be protected and enhanced to help reduce flood risks and to help maintain the overall surface water health.

6.3.2 Surface Water Quantity – Management Recommendations

Based upon the methodology outlined in Section 5, and the issues and opportunities listed above, the following Section presents the goals, objectives, and management alternatives that were developed and evaluated for the Robinson Creek and Tooley Creek Watersheds relating to surface water quantity. Specific management recommendations have been made that are designed to maintain and enhance surface water quantity within the Robinson Creek and Tooley Creek Watersheds.

GOAL – Protect and Maintain Surface Water Quantity

Objective 3a. Maintain and Enhance the Water Balance and Baseflow in Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Minimize impervious surfaces in the Robinson Creek and Tooley Creek Watersheds.*
- *Maintain or enhance baseflow volumes.*
- *Maintain or enhance groundwater recharge rates.*

Objective 3b Maintain and Control the Level of Surface Water Flow, Storm-event Flows and Flood Hazard Protection for Future Development

Working Targets

- *Minimize imperviousness in the Robinson Creek and Tooley Creek Watersheds.*
- *Apply stormwater management best management practises.*
- *Control peak flows.*
- *Maintain channel form and minimize erosion.*

Management Alternatives to Achieve Surface Water Quantity Objectives

Regulation and Policy

Management Action 3.1

Maintain development setbacks from Robinson Creek and Tooley Creek.

- New development and site alteration within the Robinson Creek and Tooley Creek Watersheds will be setback on both sides of the watercourse as defined by the larger of:
  - The Functional Natural Heritage System;
  - The top-of-bank based on a stable slope;
  - The Regulatory Flood Line;
  - 30 m on both sides of the wetted width of the tributary;
  - Meander belt allowance for unconfined systems; and
  - Hazard limit as defined by the MNR Natural Hazards Training Manual.

Fulfills Objective 3a

Management Action 3.2

Restrict development and site alteration within and adjacent to features that contribute to surface water flow.

- Important features that contribute to surface water flow include, but are not limited to: seepage areas, springs, headwater areas, significant valley lands, and groundwater discharge areas.
- Development and site alteration within features that contribute to surface water flow is prohibited.
- Development and site alteration adjacent to important features that contribute to surface water flow must maintain an undeveloped 30 m buffer to protect natural stream flows.

Fulfills Objective 3a

Management Action 3.3

Minimize cumulative growth of impervious surfaces within the Robinson Creek and Tooley Creek Watersheds

- Impervious surfaces should be kept to a minimum and opportunities to increase infiltration should be explored prior to development approval.
- Natural vegetation should be maintained during development, and where possible improved or restored.
- Development may be permitted only if the development:
  - Minimizes impervious surfaces and where conditions permit, explores opportunities to increase infiltration, such as the use of: permeable pavements, soakaway pits, grassed swales or other technologies.
  - Maintains natural vegetation and where possible improves or restores vegetated areas.
- The Municipality shall endeavour to keep imperviousness at or below the current levels for both the Robinson Creek and Tooley Creek Watersheds. During development review every effort to reduce the level of impervious surfaces will be explored.

Fulfills Objectives 3a and 3b

Management Action 3.4

Compensate off-site for hard surface effects

- In developed portions and those areas of new development where planning policies encourage or mandate medium to high density urbanization, where it is not possible to maintain or enhance infiltration, off-site compensation that is satisfactory to the municipality may be utilized that includes, but is not limited to:
  - Target achievement through adjacent or abutting lots; and
  - Installation of downstream or downgradient surface water conveyance systems, such as ditching or exfiltration pipes.

Fulfills Objectives 3a and 3b

Management Action 3.5

Urban stormwater best management practices will continue to be required for new developments

- All development will meet or exceed stormwater development standards set-out by the municipality and by CLOCA (see *Technical Guidelines for Stormwater Management Submissions, CLOCA 2010*).
- The use of stormwater best management practices must be implemented for all new developments.
- The use of Low Impact Development (LID) technologies is recommended for all new developments.
- Alternative stormwater management designs and practices related to stormwater management should be explored for all new developments to minimize and attenuate runoff volumes and peak flow rates to pre-development levels.
- Developments with a proposed imperviousness land area of 0.25 ha or more will only be permitted if quality treatment of stormwater is conducted.
  - For smaller developments, stormwater management facilities may not be practical, but source control, conveyance treatment or end-of-pipe solutions should still be examined to the satisfaction of the municipality and CLOCA.
- All new developments must provide stormwater control to maintain post-development flows to pre-development levels for the 1:2 through 1:100 year rainfall events.
- Discharge of stormwater to a receiving watercourse must be outletted in a manner that does not adversely impact channel morphology or stream bank erosion. A geomorphological investigation should be conducted of the receiving branch of Robinson Creek or Tooley Creek to stormwater discharge to ensure that stream bank erosion is minimized.

Fulfills Objectives 3a and 3b

Management Action 3.6

Encourage development to implement practices to manage rainfall 'on-site' before it enters a storm sewer.

- Implement a hierarchy of practices to maintain or enhance groundwater recharge, starting with 'on-site', then 'conveyance', and lastly 'end of pipe' solutions, with priority given to on-site solutions.

Fulfills Objectives 3a and 3b

Management Action 3.7

Encourage public bodies or private landowners to upgrade perched or undersized culverts during redevelopment or regular maintenance.

- In the Robinson Creek watershed, the following culverts should be upgraded or enlarged during redevelopment or maintenance to reduce potential flooding impacts and/or improve fish passage:
  - Highway 401 culverts.
  - CP railway culvert north of Baseline Road.
  - CNR railway culvert south of Highway 401.
  - Perched CSP culvert on the south side of Bloor Street.
- In the Tooley Creek watershed, the following culverts should be upgraded or enlarged during redevelopment or maintenance to reduce potential flooding impacts and/or improve fish passage:
  - Highway 401 culverts.
  - CP railway culvert north of Baseline Road.
  - CNR railway culvert south of Highway 401.
  - Perched box culvert at the downstream end of the Highway 401 underpass.
  - Crushed CSP culvert where the eastern branch of Tooley Creek crosses Hancock Road.
- Notify the owner(s) of the above listed crossings of the need to upgrade or enlarge during redevelopment or maintenance

Fulfills Objective 3b

Management Action 3.8

The use of online stormwater management ponds is not permitted in either the Robinson Creek or Tooley Creek Watersheds.

Fulfills Objective 3b

Management Action 3.9

Continue to enforce O. Reg 42/06 – Development, Interference with Wetlands and Alterations to Shorelines and Watercourses

- CLOCA should continue to enforce the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulations in the Robinson Creek and Tooley Creek Watersheds for new developments and redevelopments.
- The Municipality should continue to incorporate the requirements of O.Reg 42/06 - Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, into development plans.
- CLOCA and Municipal staff should continue to review development applications and plans to ensure that stormwater management controls are appropriate, peak flows will be minimized and erosion and sedimentation controls will be effective.

Fulfills Objectives 3a and 3b

Management Action 3.10

Restrict development and site alteration within and adjacent to HVRAs.

- Development and site alteration within HVRAs and within 120 m of a HVRA is restricted unless a water budget and hydrogeological evaluation is undertaken that demonstrates that:
  - Groundwater quantity will be maintained or enhanced post development through the use of on-site mitigation measures; and
  - Best management practices related to groundwater recharge and stormwater management in urban areas are utilized, including LID.

Fulfills Objectives 3a and 3b

Education and Stewardship

Management Action 3.11

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watersheds, to encourage landowners to preserve, conserve, and enhance surface water quantity and quality on their property, and provide financial and technical assistance in support of these programs.

Fulfills Objectives 3a and 3b

Management Action 3.12

In partnership with CLOCA and other community groups, provide education and awareness to residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds through workshops, environmental education programs, and community events that convey the importance of protecting and enhancing surface water resources within the watershed, including:

- Provide easy access to information that local residents and landowners can use to make informed decisions about protecting surface water in the watersheds.
- Provide an environmental awareness program to better educate the public on the importance of stormwater management and associated best management practices.

Fulfills Objectives 3a and 3b

Management Action 3.13

Continue to support education, stewardship, and community programs that:

- Help reforest or revegetate the lands within the 30 m watercourse setback.
- Enhance the quantity of surface water runoff and help control erosion.
- Encourage stream bank restoration, particularly on private lands, that are currently devoid of adequate riparian cover.
- Help to promote infiltration and reduce impervious surfaces.
- Help increase riparian cover.
- Encourage the implementation of best management practices related to stormwater management and control.
- Help to manage or control storm flow events.

Fulfills Objectives 3a and 3b

Land Acquisition and Dedication

Management Action 3.14

Acquisition or dedication of valley lands as a condition of development approval

- The Municipality of Clarington should continue to implement the practice of acquiring valley lands as a condition of development approval. This policy will continue to support active management of significant natural features and will help maintain and enhance surface water quantity within the watersheds.

Fulfills Objectives 3a and 3b

6.3.3 Surface Water Quantity and Control – Monitoring

A surface water quantity monitoring program should be implemented in the Robinson Creek and Tooley Creek Watersheds. This surface water monitoring program should be implemented in association with the other natural environment disciplines (i.e., groundwater quantity) to integrate the scientific data.

Monitoring initiatives should focus on:

- Stream flow monitoring and bank erosion assessments should continue in the Robinson Creek and Tooley Creek Watersheds to further characterize the surface water system;
- Regular precipitation and stream flow monitoring to more accurately calibrate the potential flood hazard and define the floodplain in the watersheds;
- Interactions between surface water and groundwater, especially in wetlands and groundwater fed portions of Robinson and Tooley Creeks;
- Baseflow monitoring; and
- Channel morphology and evolution.

Consideration should be given to focusing more monitoring efforts on urban watersheds, such as Robinson Creek and Tooley Creek as they are under more immediate pressures from urbanization and development.

CLOCA is encouraged to lead the surface water quantity monitoring program.

6.4 Surface Water Quality

Land use and land cover have the largest effect on surface water quality. Areas where runoff and stormwater are controlled, non-point source contaminates (e.g., road salt and fertilizer) are limited and adequate riparian cover exists, generally have high surface water quality. In areas where one or more of these things are missing, the potential exists for reduced water quality. Contaminates such as sediment, phosphorus, chloride and bacteria, can affect aquatic species and habitat, and degrade the overall quality of the water resource.

The surface water quality of Robinson and Tooley creeks also affects the water quality in Lake Ontario, which is the receiving water body for these creeks. Much of the Region's drinking water supply is derived from Lake Ontario, so maintaining its health and integrity is paramount.

Surface water in the Robinson Creek and Tooley Creek Watersheds supports a variety of fish communities. The current land use in the watersheds is dominated by agriculture, which is generally responsible for non-point source contaminates such as nitrogen, phosphorus and bacteria. However, increasing urban development in the watersheds has the potential to increase concentrations of urban pollutants such as chloride and sediment in surface water bodies. Currently, the surface water quality in both the Robinson and Tooley Creek Watersheds is generally good (i.e., meets Provincial Water Quality Objectives), but contaminates such as chloride and phosphate were found to be above background levels.

6.4.1 Surface Water Quality – Issues and Opportunities for Improvement

The *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM 2010)*, documents the existing state of surface water quality in the Watersheds, and provides the necessary background information to identify potential issues and opportunities for improvement. A summary of the issues and opportunities related to surface water quality is outlined below.

Issues and Opportunities for Improvement	Rationale
Stormwater Management	Land development projects have the potential to degrade surface water quality by increasing non-point source pollutants, such as sediment. The impacts of post-development stormwater runoff quality can adversely affect drinking water supplies, recreation, fish and other aquatic life, property values and other uses of lands and waters. These adverse impacts can be controlled and minimized through the use of stormwater management and through the regulation of stormwater runoff quality.
Adequate Riparian Cover	The presence of riparian buffers around watercourses not only provides important terrestrial habitat, but also helps to control surface runoff and improve surface water quality by slowing the flow of runoff and filtering out sediment. Specific sections of Robinson Creek and Tooley Creek that were identified in the Existing Conditions Report, lack adequate riparian cover to protect surface water quality. Integrating riparian cover into the overall watershed management plan by enforcing development setbacks can return these lands to their natural state and function.
Non-Point Source Pollution	The spreading of nutrients (chemical fertilizer or manure including biosolids) on the land-surface and the use of road salt on roadways can adversely impact surface water quality. These non-point source pollutants include bacteria, including E. coli, chloride, nitrate, heavy metals and sediment. Because the use of nutrients and road salt is essential, proper management of these applications is needed to protect surface water quality within the Robinson Creek and Tooley Creek Watersheds.

6.4.2 Surface Water Quality – Management Recommendations

Based upon the methodology outlined in Section 5, and the issues and opportunities listed above, the following Section presents the goals, objectives, and management alternatives that were developed and evaluated for the Robinson Creek and Tooley Creek Watersheds relating to surface water quality. Specific management recommendations have been made that are designed to maintain and enhance surface water quality within the Robinson Creek and Tooley Creek Watersheds.

GOAL – Protect and Maintain Surface Water Quality

Objective 4a. Maintain and Enhance Surface Water Quality in the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Maintain surface water quality through the use of effective stormwater management.*
- *Maintain surface water quality parameters below the Provincial Water Quality Objective (PWQO) concentrations.*
- *Adopt best management practices for road salt spreading.*
- *Maintain surface water quality through the use of effective erosion and sedimentation control measures.*

Management Alternatives to Achieve Surface Water Quality Objectives

Regulation and Policy

Management Action 4.1

Continue to require enhanced level urban stormwater management new developments.

- Enhanced level urban stormwater management controls will continue to be required for all new developments.
- All development shall meet or exceed stormwater development standards set-out by the municipality and by CLOCA (see *Technical Guidelines for Stormwater Management Submissions, CLOCA 2010*).
- The use of LID stormwater techniques is recommended for all new developments.
- Alternative stormwater management designs and practices related to stormwater management should be explored for all new developments.
- The removal of vegetation during construction shall be kept to a minimum.
- All sediment that is eroded during construction shall be contained on site by the use of erosion and sedimentation control measures set-out by the municipality and by CLOCA.
- For the purposes of stormwater management, a target of 80% of suspended solids, as a long-term average, shall be removed from stormwater prior to discharge to a receiving waterbody.
- Where appropriate, the use of oil/ grit separators shall be considered to enhance the effectiveness of stormwater management facilities as part of the treatment train.
- Sub-surface stormwater cooling techniques should be explored for new developments to reduce the thermal impact of heated urban water on coolwater streams and coldwater fish habitat.
- Discharge of stormwater to the receiving watercourse must be outletted in a manner that does not adversely impact channel morphology or stream bank erosion. A geomorphological investigation should

be conducted of the receiving branch of Robinson Creek or Tooley Creek to stormwater discharge to ensure that stream bank erosion is minimized.

Fulfills Objective 4a

Management Action 4.2

Protect and restore vegetative setbacks along Robinson Creek and Tooley Creek.

- New development and site alteration within the Robinson Creek and Tooley Creek Watersheds will be setback from both sides of the watercourse as defined by the larger of:
  - The Functional Natural Heritage System;
  - The top-of-bank based on a stable slope;
  - The Regional Flood Line;
  - 30 m on both sides of the wetted width of the tributary;
  - Meander belt allowance for unconfined systems; and
  - Hazard limit as defined by the MNR Natural Hazards Training Manual.

Fulfills Objective 4a

Management Action 4.3

Implement policies recommended in the Central Lake Ontario Source Protection Area Report created through the policies outlined in the Clean Water Act, 2006.

- At the time this Watershed Management Plan was created, the Central Lake Ontario Source Protection Area Report was completed in draft and had not been approved by CLOCA's Board of Directors.
- A small portion of the southwestern Robinson Creek Watershed falls within the Intake Protection Zone (IPZ-2) for the Oshawa Water Treatment Plant (*see Figure 5.3 of the Central Lake Ontario Source Protection Area report*). When the Source Water Protection Report is approved, this area must be managed within the framework set out in the report and in the Clean Water Act.

Fulfills Objective 4a

Management Action 4.4

Continue to apply best management practices for road salt spreading in the Robinson Creek and Tooley Creek Watersheds.

- Continue to implement policies and regulations that regulate the spreading of road salt through current best management practices by all road authorities (local, regional and provincial).

Fulfills Objective 4a

Education and Stewardship

Management Action 4.5

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watersheds, to encourage landowners to preserve, conserve, and enhance surface water quality, and provide financial and technical assistance in support of these programs.

Fulfills Objective 4a

Management Action 4.6

In partnership with CLOCA and other community groups, provide education and awareness to residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds through workshops, environmental

education programs, and community events that convey the importance of protecting and enhancing surface water resources within the watershed, including:

- Continue to provide services and funding to the Community Stream Steward Program, initiated by the Ontario Federation or Anglers and Hunters.
- Provide easy access to information that local residents and landowners can use to make informed decisions about protecting surface water in the watersheds.
- Provide an environmental awareness program to better educate the public on the important of best management practices in protecting surface water quality.

Fulfills Objective 4a

Management Action 4.7

Continue to support education, stewardship, and community programs that:

- Assist with habitat restoration, reforestation, and buffer strip planting.
- Help implement agricultural best management practices and farm land conservation.
- Help to manage or control steam bank erosion.
- Help increase riparian cover.

Fulfills Objective 4a

Land Acquisition and Dedication

Management Action 4.8

Acquisition or dedication of valley lands as a condition of development approval

- The Municipality of Clarington should continue to implement the practice of acquiring valley lands as a condition of development approval. This policy will continue to support active management of significant natural features and will help maintain and enhance surface water quality within the watersheds.

Fulfills Objective 4a

6.4.3 Surface Water Quality – Monitoring

An integrated surface water quality monitoring program should be implemented to test the effectiveness of stormwater management practices, best management practises related to road salt spreading and nutrient applications, and surface water quality, within the Robinson Creek and Tooley Creek Watersheds. This surface water monitoring program should be implemented in association with the other natural environment disciplines (i.e., fisheries and aquatic habitat) to integrate the scientific data.

Monitoring initiatives should focus on:

- Monitoring the effectiveness and efficiency of the stormwater management ponds and other facilities;
- Surface water quality sampling, especially along major transportation corridors and development areas;
- Monitoring the usage of road salt and implementation of BMPs related to road salt spreading; and
- Monitoring the usage of agricultural fertilizers and the effectiveness of agricultural BMPs.

Consideration should be given to focusing more monitoring efforts on urban watersheds, such as Robinson Creek and Tooley Creek as they are under more immediate pressures from urbanization and development.

It is recommended that a stormwater management infrastructure monitoring program be developed and implemented in the Robinson Creek and Tooley Creek Watersheds.

CLOCA is encouraged to lead the surface water quality monitoring program.

6.5 Fisheries and Aquatic Habitat

Both the Robinson Creek and Tooley Creek watersheds have similar fisheries and aquatic habitat characteristics in that they generally support warm/cool water fish communities that are typical of surface water dominated streams. Common species include Blacknose Dace (*Rhinichthys atratulus*), Creek Chub (*Semotilus atromaculauts*) and Fathead Minnow (*Pimephales promelas*). Both creeks have some groundwater contribution within their headwaters which is considered critical to the annual base flow regimes of the stream systems. These groundwater contributions create habitat that can support cold water fish species such as Rainbow Trout (*Oncorhynchus mykiss*), which were found in small numbers in both creeks. Both Robinson Creek and Tooley Creek can be thermally classified as coolwater streams, where flow is dominated by surface water inputs, although some of the upper 1st order stream lengths in Tooley Creek are considered coldwater due to groundwater discharge.

Biological water quality assessments show that water quality in both watersheds is impaired based upon the diversity of macro-invertebrate species and surface water quality chemical samples. In general, the fish species existing within Robinson Creek and Tooley Creek are generalists in their habitat requirements and are widespread in their southern Ontario distribution.

However, the presence of rainbow trout in both Robinson Creek and Tooley Creek indicate that they are capable of supporting a coldwater fish community, and therefore, should be managed as such. Watershed management priorities related to fish and aquatic habitat should focus on maintaining base flow, improving water quality and promoting measures to reduce stream temperatures.

6.5.1 Fisheries and Aquatic Habitat – Issues and Opportunities for Improvement

The *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM 2010)*, documents the existing state of fisheries and aquatic habitat in the Watersheds, and provides the necessary background information to identify potential issues and opportunities for improvement. A summary of the issues and opportunities related to fisheries and aquatic habitat is outlined below.

Issues and Opportunities for Improvement	Rationale
Barriers to Fish Passage	Instream barriers can affect water quality and habitat conditions within a watershed. In stream barriers can arise from a variety of causes including man-made devices such as water control structures (i.e., dams, weirs and culverts) or natural obstacles such as log jams or debris weirs that prevent/deter/obstruct fish movement. The presence of barriers in watercourses can cause localized stress to fish throughout the year, but are particularly detrimental during spawning migrations or (in the case of the Robinson and Tooley Creek watersheds) during periods of low flow condition when migration upstream and downstream for fish is critical to finding adequate refuge habitat.
Invasive Species	No common invasive species were caught in either Robinson Creek or Tooley Creek during AECOM's 2009 fish sampling event. However, that does not preclude the fact that invasive species such as Round Goby or Zebra Mussels may be present in the watersheds due to their connection with Lake Ontario.
Maintaining Baseflow	Fish require minimum stream flows for passage, habitat and other life-cycle processes. Maintaining baseflow in Robinson Creek and Tooley Creek is imperative to protect and preserve sensitive fish species such as rainbow trout that were identified in both watercourses. Other aquatic, terrestrial and benthic organisms also rely on a minimum baseflow that needs to be maintained.

Issues and Opportunities for Improvement	Rationale
Adequate Riparian Cover	Riparian vegetation serves as natural filtration for overland surface water flow and aids in minimizing sedimentation within streams. Riparian vegetation also functions to provide carbon and nutrient inputs into streams such as leaf and woody debris, which creates habitat cover and provides shade cover over streams contributing to the buffering of water temperatures. Specific sections of Robinson Creek and Tooley Creek that were identified in the Existing Conditions Report, lack adequate riparian cover to protect fish habitat. By integrating riparian cover into the overall watershed management plan by enforcing development setbacks, these lands can return to their natural state and function.
Stream Temperature	Currently, both Robinson Creek and Tooley Creek have a thermal regime capable of supporting warm to cold water fish communities. Maintaining suitable cold water conditions for cold water fish species such as rainbow trout will be critical to maintaining a healthy stream system. Promoting groundwater discharge, increasing riparian cover and providing thermal buffering from stormwater inputs are important mechanisms to reduce stream temperature fluctuations.
Water Quality	Water quality in both Robinson Creek and Tooley Creek is currently classified as impaired. Concentrations of non-point source pollutants such as phosphorus and chloride regularly exceed PWQO standards. Biological water quality indicators show that water quality in these watercourses is typical of urban watersheds. Studies have shown that elevated Total Suspended Solids above 25 mg/L can adversely affect aquatic habitat for invertebrates by filling in interstices of course stream substrate.
Headwater Areas	Headwater areas are typically sustained by groundwater inputs and provide a critical function in maintaining base flow. These reaches are generally colder than 3rd or 4th order stream lengths due to consistent groundwater inputs. Both Robinson Creek and Tooley Creek have headwater areas on the Iroquois Plain Shallow Aquifer, which is a significant groundwater recharge and discharge area. Maintaining the interactions between surface water and groundwater in headwater areas will contribute to cooling surface water temperatures and create a constant base flow regime.
Urbanization	The biggest threat to fish species and aquatic habitat is urbanization of the watersheds. Without proper management, urbanization can lead to increased surface water temperatures, lower water quality, higher peak flows, reduced base flow, and channelization/ alteration of habitat. Management recommendations designed to mitigate the effects of urbanization are key to maintaining a healthy watershed.

6.5.2 Fisheries and Aquatic Habitat – Management Recommendations

Based upon the methodology outlined in Section 2, and the issues and opportunities listed above, the following Section presents the goals, objectives, and management alternatives that were developed and evaluated for the Robinson Creek and Tooley Creek Watersheds relating to fisheries and aquatic habitat. Specific management recommendations have been made that are designed to maintain and enhance the quality and diversity of fish species and aquatic habitat within the Robinson Creek and Tooley Creek Watersheds.

GOAL – Protect Fisheries and Aquatic Habitat

Objective 5a. Protect and Enhance Existing Fish Habitat and Resident Fish Communities in Robinson Creek and Tooley Creek

Working Targets

- *Protect headwater areas and baseflow.*
- *Maintain or decrease surface water temperatures.*
- *Maintain or improve surface water quality.*
- *Improve riparian vegetative cover.*

Objective 5b. Protect and Enhance Aquatic Habitat and Function

Working Targets

- *Protect headwater areas and baseflow*
- *Maintain or decrease surface water temperatures*
- *Maintain or improve surface water quality*
- *Improve riparian vegetative cover*
- *Protect existing feeding, breeding and rearing areas*

Management Alternatives to Achieve Fish and Aquatic Habitat Objectives

Regulation and Policy

Management Action 5.1

Protect and restore vegetative setbacks along Robinson Creek and Tooley Creek.

- New development and site alteration within the Robinson Creek and Tooley Creek Watersheds will be setback from both sides of the watercourse as defined by the larger of:
  - The Functional Natural Heritage System.
  - The top-of-bank based on a stable slope.
  - The Regional Flood Line.
  - 30 m on either side of the wetted width of the tributary.

Fulfills Objectives 5a and 5b

Management Action 5.2

Continue to apply best management practices for road salt spreading in the Robinson Creek and Tooley Creek Watersheds.

- Implement policies and regulations that regulate the spreading of road salt through current best management practices by all road authorities (local, regional, provincial).

Fulfills Objective 5b

Management Action 5.3

Restrict development and site alteration within and adjacent to aquatic habitat.

- Development within aquatic habitat is prohibited except development and site alteration permitted in accordance with Section 35 of the Federal Fisheries Act .
- Development and site alteration adjacent to aquatic habitat must maintain an undeveloped 30 m buffer on both sides of the wetted width of the tributary to protect fish and aquatic habitat.

Fulfills Objectives 5a and 5b

Management Action 5.4

Identify watercourse improvement projects to reduce bank erosion and sediment loading in Robinson and Tooley Creeks.

- Identify areas of Robinson Creek and Tooley Creek where erosion stabilization would assist in reducing bank erosion and sediment loading.
  - Erosion improvement works should consider the fundamentals of natural channel design and biotechnical methods.

Fulfills Objective 5b

Management Action 5.5

Encourage public bodies or private landowners to upgrade perched or undersized culverts during redevelopment or regular maintenance.

- In the Robinson Creek watershed, the following culverts should be upgraded or enlarged during redevelopment or maintenance to reduce potential flooding impacts and/or improve fish passage:
  - Highway 401 culverts.
  - CP railway culvert north of Baseline Road.
  - CNR railway culvert south of Highway 401.
  - Perched CSP culvert on the south side of Bloor Street.
- In the Tooley Creek watershed, the following culverts should be upgraded or enlarged during redevelopment or maintenance to reduce potential flooding impacts and/or improve fish passage:
  - Highway 401 culverts.
  - CP railway culvert north of Baseline Road.
  - CNR railway culvert south of Highway 401.
  - Perched box culvert at the downstream end of the Highway 401 underpass.
  - Crushed CSP culvert where the eastern branch of Tooley Creek crosses Hancock Road.

Fulfills Objectives 5a and 5b

Education and Stewardship

Management Action 5.6

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watershed, to encourage landowners to preserve, conserve, and enhance fish and aquatic habitat on their property, and provide financial and technical assistance in support of these programs.

Fulfills Objectives 5a and 5b

Management Action 5.7

In partnership with CLOCA and other community groups, provide education and awareness to residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds through workshops, environmental education programs, and community events that convey the importance of protecting and enhancing fish communities and habitat within the watershed.

- Work with residents adjacent to either Robinson Creek or Tooley Creek to encourage:
  - Planting native riparian species along exposed sections of the creeks; and
  - Maintain buffers between mown lawns and the creek.
- Work with the agricultural community to encourage erecting cattle fencing along the creeks to keep livestock away from the watercourse, especially south of Highway 401 in the Tooley Creek Watershed. This action is consistent with agricultural best management practices and the Nutrient Management Act. Encourage the planting of riparian vegetation between the cattle fencing and the creeks.

Fulfills Objectives 5a and 5b

Management Action 5.8

Continue to support education, stewardship and community programs that:

- Promote the creation of a continuous natural heritage system within the Watersheds.
- Increase riparian vegetation along Robinson and Tooley Creeks.
- Work to reduce bank erosion and sediment loading to Robinson and Tooley Creeks.

Fulfills Objectives 5a and 5b

Management Action 5.9

Reforestation/ revegetation of continuous riparian vegetation buffer zone along watercourses.

- Reforestation/ revegetation of a 30 m riparian vegetation buffer along watercourses should be encouraged as part of community stewardship activities.
  - This will help to improve wildlife travel and fish habitat and is consistent with the targets set out in the Natural Heritage System.

Fulfills Objectives 5a and 5b

Land Acquisition and Dedication

Management Action 5.10

Acquisition or dedication of valley lands as a condition of development approval

- The Municipality of Clarington should continue to implement the practice of acquiring valley lands as a condition of development approval. This policy will continue to support active management of significant natural features and will help maintain and enhance fish and aquatic habitat within the watersheds.

Fulfills Objectives 5a and 5b

6.5.3 Fish and Aquatic Habitat – Monitoring

Fisheries and aquatic habitat monitoring should continue to be conducted by CLOCA in the Robinson Creek and Tooley Creek Watersheds. More frequent monitoring may be necessary to assess the impacts of future development and the effectiveness of the Management Actions proposed in this report. This fish and aquatic habitat monitoring program should be implemented in association with the other natural environment disciplines (i.e., terrestrial natural heritage) to integrate the scientific data.

Monitoring initiatives should focus on:

- Species inventories and movement, especially of sensitive or migratory species, such as rainbow trout;
- Spawning habitat surveys;
- Monitoring of invasive species;
- Riparian cover habitat assessments;
- Stream flow and stream temperature monitoring; and
- Surface water quality monitoring.

It is recommended that permanent fish monitoring stations be designated in both Robinson Creek and Tooley Creek.

CLOCA is encouraged to continue to lead the fish and aquatic habitat monitoring program.

6.6 Terrestrial Natural Heritage

Land use throughout the Robinson and Tooley Creek watersheds is dominated by urbanization and agricultural use, with relatively small proportions of natural and naturalized cover. The most common remnant natural features include shoreline bluffs and beaches, rivermouth marshes, stream valleys and riparian corridors, and isolated upland forests. It was found that 19.6% of the Robinson Creek Watershed and 17.3% of the Tooley Creek Watershed currently have natural or naturalized cover. Forest cover in the watersheds stands at 6.3 % and 9.3 % for Robinson Creek and Tooley Creek, respectively. The forest bird community, as a result, is poorly developed in both the Robinson Creek and Tooley Creek watersheds due to the very small and patchy amount of remaining forest. The most frequently observed bird species are those that are common in southern Ontario typical of edges, shrub habitats and disturbed areas. Wetlands and amphibian breeding habitat in both watersheds have also been impacted by human disturbance.

Species at risk were identified in both the Robinson Creek and Tooley Creek Watersheds. Species at risk identified in the Robinson Creek Watershed include: Piping Plover (*Charadrius melodus*), Blanding's Turtle (*Emydoidea blandingii*), Milksnake (*Lampropeltis triangulum triangulum*), and Butternut *(Juglans cinerea*). Species at risk identified in the Tooley Creek Watershed include: Red-headed Woodpecker (*Melanerpes erythrocephalus*), Canada Warbler (*Wilsonia canadensis*), and Butternut *(Juglans cinerea*).

Presently, neither watershed has an appreciable amount of core habitat or interior forest habitat which limits the functionality of the natural heritage system as well as species diversity. It is important that a functional natural heritage system is protected to build a resiliency into the natural system to mitigate future impacts from development and climate change.

As previously described in **Section 5.3** and presented on **Figure 5.1**, the Natural Heritage System (NHS) for the Robinson Creek and Tooley Creek Watersheds is made up of two components: the Function Natural Heritage System (FNHS) and the Targeted Natural Heritage System (TNHS). The FNHS is made up of Core Areas, that generally include existing areas of natural and/or hydrological function, and Linkage Areas, that serve to connect the Core Areas. These are the key building blocks of the NHS. The TNHS includes areas that have the potential to be restored to high functioning ecological habitats. These areas were defined using CLOCA's Landscape Analysis Model and the approach outlined in "Developing CLOCA's Ultimate Natural Heritage System: A Methodology" (CLOCA, 2011).

6.6.1 Terrestrial Natural Heritage – Issues and Opportunities for Improvement

The *Robinson Creek and Tooley Creek – Watershed Plan Existing Conditions Report (AECOM 2010)*, documents the existing state of the Terrestrial Natural Heritage System in the Watersheds, and provides the necessary background information to identify potential issues and opportunities for improvement. A summary of the issues and opportunities related to Terrestrial Natural Heritage is outlined below.

Issues and Opportunities for Improvement	Rationale
Core Areas and Interior Forest Habitat	The amount of forest cover, size of the forest patches, and the linkages to other forest patches will determine their ability to support wildlife species such as mammals and forest interior birds. Presently, both the Robinson Creek and Tooley Creek Watersheds lack forest habitat that exhibit the functionality of a core area and the size for interior forest habitat. A priority for restoration of the natural heritage system in the watersheds is creating core and interior habitat, which will improve species diversity and improve the overall health and functionality of the natural heritage system.
Connectivity and Fragmentation	Movement corridors serve to increase local species richness and biodiversity, provide more immigration and movement opportunities for individuals among core natural areas, and provide greater likelihood of seed dispersal and exchange of other genetic material between populations. Presently, both the Robinson Creek Watershed and the Tooley Creek Watershed have poorly connected habitat. Major barriers include, Highway 401 and Lake Ontario to the south and urban development to the north and west. Local corridors exist within valley lands, but need to be larger in size to achieve their full potential.
Invasive Species	Several aggressive and problematic non-native invasive species occur throughout both watersheds including: White Swallow-wort (also known as Dog-Strangling Vine) (*Cynanchum rossicum*), Tartarian Honeysuckle (*Lonicera tatarica*), Glossy Buckthorn (*Rhamnus frangula*), European Buckthron *(R. cathartica*), Garlic Mustard (*Alliaria petiolata*), Flowering Rush (*Butomus umbellatus*), and Giant Hogweed (*Heracleum mantegazzianum)*. Such species threaten the biodiversity of natural spaces by outcompeting and replacing native flora representation, and compromising habitat value to wildlife. Management efforts should give invasive flora species due consideration to provide control where appropriate and protect relatively un-invaded habitats.
Species and Habitat Diversity	Due to the limited amount of forest cover and extensive urbanization in the watersheds, the forest mammal and bird communities are poorly developed. Wetlands and amphibian breeding habitat in both watersheds have also been impacted by human disturbance. Young deciduous forest and thicket communities are the most common vegetation community types in both watersheds, with Green Ash (*Fraxinus pennsylvanica*) abundant throughout. Forest cover and interior habitat should be enhanced. Protection should be given to upland forest habitats due to their rarity in the watersheds. Management actions such as defining and protecting a natural heritage system will help to increase species and habitat diversity.
Species at Risk	Species at risk were identified in both watersheds. Their locations, numbers, and habitat requirements should be taken into consideration when targeting areas for protection or restoration.
Wetlands	Wetland habitat loss and degradation has been significant in southern Ontario. Wetlands provide essential habitat and also perform many water quality and quantity improvement functions. The Robinson Creek Watershed hosts a portion of the McLaughlin Bay Provincially Significant Wetland, and the Tooley Creek Watershed hosts a portion of the Maple Grove Provincially Significant Wetland Complex. Existing wetlands must be protected and made key targets for restoration. Opportunities to restore remnant wetlands should also be explored.
Urbanization and Development	The biggest threat to terrestrial habitat in the watersheds is development. Unmanaged development can result in a loss of habitat, fragmentation of forest patches and barriers to wildlife movement. By defining a natural heritage system within the watersheds, development and urbanization can be managed so as to protect significant terrestrial habitat. Management recommendations designed to mitigate the effects of urbanization are key to maintaining a healthy watershed.

6.6.2 Terrestrial Natural Heritage – Management Recommendations

Based upon the methodology outlined in Section 2, and the issues and opportunities listed above, the following Section presents the goals, objectives, and management alternatives that were developed and evaluated for the Robinson Creek and Tooley Creek Watersheds relating to Terrestrial Natural Heritage. Specific management recommendations have been made that are designed to maintain and enhance the quality and diversity of plant and wildlife species and habitat within the Robinson Creek and Tooley Creek Watersheds.

GOAL – Maintain and Enhance the Health, Quality, and Functionality of the Robinson Creek and Tooley Creek Ecosystems

Objective 6a. Protect and Enhance the Natural Heritage System in the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Protection of a dedicated Natural Heritage System.*
- *Improvements to habitat size, shape, and functionality.*
- *Improved connectivity between habitat patches.*
- *The addition of core habitat and interior forest habitat.*

Objective 6b. Maintain and Enhance Native Vegetation Communities and Animal Species Diversity within the Robinson Creek and Tooley Creek Watersheds

Working Targets

- *Improvements to habitat quality and functionality.*
- *Increase habitat type and distribution.*
- *An increase in rare, sensitive, or at risk species.*
- *A reduction in the distribution of invasive species.*

Objective 6c. Manage the Potential Impact of Future Urban Development

Working Targets

- *Protection of a Natural Heritage System.*
- *Encourage sustainable land use practises.*

Management Alternatives to Achieve Terrestrial Natural Heritage Objectives

Regulation and Policy

Management Action 6.1

Define and protect a Natural Heritage System (NHS) for the Robinson Creek and Tooley Creek Watersheds as shown in Figure 5.1.

- The NHS will consist of:
  - A Functional Natural Heritage System (FNHS) that defines the location of the existing natural features and watercourse buffers, and
  - A Targeted Natural Heritage System (TNHS) that defines key areas for "Enhancement", restoration or protection to improve the overall function of the system.
  - Together they form the Natural Heritage System (NHS).
- A schedule representing the NHS should be incorporated into the Clarington Official Plan.
- The Majority of the lands identified in the NHS (**Figure 5.1**) are already subject to one or more Official Plan designations that protect natural heritage features, including significant valleylands, woodlots and

wetlands, and other lands identified as environmentally sensitive through the Provincial Policy Statement.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.2

Create Natural Heritage System Policies for the Robinson Creek and Tooley Creek Watersheds.

- Natural Heritage System policies should be developed to manage and protect the lands identified in **Figure 5.1** as NHS.
- The NHS policies should provide specific guidance and policies to direct environmental protection and urban development within the watersheds.
- The NHS policies should balance urban land use needs with environmental protection and enhancement.
- The Municipality of Clarington should work with CLOCA to develop Natural Heritage System policies for the Watersheds.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.3

Minimize the impact of development and site alteration on the Natural Heritage System and significant natural features.

- Existing policies in the Clarington Official Plan shall continue to guide development activities within and adjacent to the NHS in the Robinson Creek and Tooley Creek Watersheds.
- Development and site alteration within the FNHS portion of the NHS is prohibited to protect its ecological function.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.4

Net gains within the Natural Heritage System

- Development and site alteration should not create a net loss of terrestrial habitat or land area defined as NHS (both FNHS and TNHS) within the Robinson Creek and Tooley Creek Watersheds.
- All negotiations for alterations to the NHS shall only be contemplated during the applicable Secondary Planning Stage that encompasses the subject property within the Municipality of Clarington.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.5

Support CLOCA's Invasive Species Management Strategy (2010) within the Robinson Creek and Tooley Creek Watersheds.

- The goals and objectives from CLOCA's Invasive Species Management Strategy (2010) should be implemented to prevent, detect early, identify and remove invasive species within the watersheds, and to promote growth of native species.
- This strategy will provide direction to local governments and community groups.

Fulfills Objective 6b

Education and Stewardship

Management Action 6.6

Continue to implement and support the CLOCA Land Stewardship Program, throughout the Robinson Creek and Tooley Creek Watershed, to encourage landowners to preserve, conserve, and enhance the natural environment on their property, and provide financial and technical assistance in support of these programs.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.7

In partnership with CLOCA and other community groups, provide education and awareness to residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds through workshops, environmental education programs, and community events that increase awareness for terrestrial functions and features, including:

- Increases awareness of the impacts of urban development on the natural environment.
- Educate residents, landowners, and developers within the Robinson Creek and Tooley Creek Watersheds on the benefits of sustainable land use practices.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.8

Continue to support education, stewardship and community programs that:

- Increase natural or naturalized cover in the watersheds.
- Increase forest cover in the watersheds.
- Increase riparian vegetation in the watersheds.
- Encourage habitat diversity in the watersheds.
- Plant native vegetation within the watersheds.
- Prevent invasive species migration within the watersheds.
- Encourage sustainable land use practices.

Fulfills Objectives 6a, 6b, and 6c

Land Acquisition and Dedication

Management Action 6.9

Acquisition of lands within the Natural Heritage System.

- Lands within the NHS should be a priority for acquisition by the municipal government or conservation authority, for protection, revegetation / reforestation, and management.
- This policy will support active management within the NHS and will help maintain and enhance important natural features.

- Assess potential land acquisitions along the Highway 407 East Link as a potential compensation for natural heritage system losses resulting from the development of the 407 East Durham Link.
- Target remnant parcels along Highway 407 East Link for inclusion into the Natural Heritage System.

Fulfills Objectives 6a, 6b, and 6c

Management Action 6.10

Acquisition or dedication of valley lands as a condition of development approval

- The Municipality of Clarington should continue to implement the practice of acquiring natural heritage system lands as a condition of development. This policy will support active management of significant natural features and will help maintain and enhance groundwater discharge to surface water features.

Fulfills Objectives 6a, 6b, and 6c

6.6.3 Terrestrial Natural Heritage – Monitoring

A terrestrial natural heritage monitoring program should be implemented in the Robinson Creek and Tooley Creek Watersheds. This monitoring program should be implemented in association with the other natural environment disciplines (i.e., fish and aquatic habitat) to integrate the scientific data.

Monitoring initiatives should focus on:

- Monitoring the occurrences and distribution of species within the watersheds;
  - Bird and amphibian communities.
  - Species at risk.
  - Invasive species.
- The effectiveness of reforestation/ revegetation initiatives;
- The effectiveness of introducing an east-west wildlife corridor between the Robinson Creek Watershed and the Tooley Creek Watershed;
- The health of known butternut tree locations;
- The size, distribution, and growth of riparian cover and wetland habitat;
- Groundwater/ surface water interactions within wetland and headwater areas; and
- Monitoring of vegetation community conditions and changes.

CLOCA is encouraged to lead the terrestrial natural heritage monitoring program.

7. Watershed Management Plan Implementation

The goal of this study is to develop a Watershed Management Plan for the Robinson Creek and Tooley Creek Watersheds that provides detailed technical recommendations to ensure sustainable use of the watersheds that can also be easily implemented and adopted into the Clarington and if applicable Durham Region Official Plans. It should be understood that where restrictions overlap the most restrictive policy typically applies.

Consistent with the methodology for watershed management planning, outlined in **Section 2.2**, the W*atershed Components*, such as groundwater quality and terrestrial natural heritage, were documented, and *Issues and Opportunities for Improvement* for each watershed component were identified. Based upon the issues and opportunities for improvement, watershed management *Goals* and *Objectives* were identified, that were consistent with the *vision* for the Robinson Creek and Tooley Creek Watersheds. A series of *Management Actions* related to *Regulation and Policy Initiatives*, *Community Education and Stewardship*, *Land Acquisition and Dedication*, and *Monitoring and Implementation*, were recommended. It is these Management Actions that are the key to integrating science into action, to protect and restore the natural environment within the Watersheds, while encouraging future development.

It is the intention, that each of the recommended Management Actions is implemented within the Robinson Creek and Tooley Creek Watersheds. Implementation of the Watershed Management Plan must be undertaken by local governments, conservation authorities, organizations and members of the community. To ensure that the Management Actions are being met, the following Implementation Actions are recommended:

1. **Incorporate "Regulation and Policy Initiatives" into the Official Plan.**
   The lead agency for each Regulation and Policy Initiative varies from component to component, but it is always either the Municipality of Clarington or the Central Lake Ontario Conservation Authority. Community groups, other stakeholders, or individuals may wish to assist in the implementation of some Initiatives as appropriate. Some Regulation and Policy Initiatives may also be applicable for implementation by the Regional Municipality of Durham. The Municipality of Clarington is presently conducting an Official Plan review, so the timing of completion of this Watershed Management Plan could not be better. This Official Plan review will identify Secondary Planning Areas for the Robinson Creek and Tooley Creek Watersheds which will further guide future development. It is recommended that Regulation and Policy Initiatives presented in this report, be implemented into the Official Plan of the Municipality of Clarington and used to create the Secondary Plans within the Watersheds. In addition, it is also recommended that the Central Lake Ontario Conservation Authority update its policies in accordance with the recommendations made in this Watershed Management Plan.

2. **Secure Funding for Stewardship, Education and Land Acquisition and Dedication Management Actions.**
   Both financial and in-kind funding is required to implement many stewardship, educational, and land acquisition and dedication actions. Funding responsibilities rest predominantly with either the Municipality of Clarington, CLOCA, or the development proponent. In some cases funding may be the responsibility of community groups or individual land owners. The Municipality of Clarington currently has a land acquisition strategy that may require updating in response to this study. In addition to the policies and procedures established in the Land Acquisition and Dedication Sections a list of some potential non-profit funders is listed in Section 2.2.

3. **Monitor the Effects of Implementing the Plan.**
   Monitoring is needed to ensure that the watershed management plan is achieving the goals and objectives related to each watershed component and that positive changes are being realized. Monitoring efforts are needed to determine the long-term effectiveness of each of the Management Actions implemented as part of this plan. CLOCA should continue be the primary agency responsible for environmental monitoring with the Watersheds. Potential exists to enlist the support of members of the local academic community (i.e., Durham College or Sir Sanford Fleming College) or private firms. It is recommended that monitoring focus on the

watershed components studied for this management plan (groundwater quantity and quality, surface water quantity and quality, fisheries and aquatic habitat, and terrestrial natural heritage).

4. **Timing for Implementation and Watershed Plan Review.**
The present time frame for implementation of the Management Actions outlined in the Watershed Management Plan coincides with the official plan review for Durham Region and the Municipality of Clarington. By incorporating the regulations and policy initiatives into the Official Plan, the Management Actions will be implemented on an ongoing basis. It is suggested that the recommended policies, educational and stewardship actions be implemented over the next five years. It is however understood that the effects of many Management Actions may take many years or decades to be realized (e.g., increase in forest cover through reforestation). Additionally, other political or social changes may occur in the coming years that may affect the policies outlined in this Plan. For these reasons, it is recommended that the Robinson Creek and Tooley Creek Watershed Management Plan be reviewed within a ten year timeframe.

5. **Communication of Results and Reporting.** It is important to communicate how the Plan has been implemented, the results of monitoring, and the benefits that were (or were not) achieved. Reporting of results should be made to members of the public, community groups, municipalities, and other stakeholders through community presentations, reports (research papers, watershed report cards, discipline specific reports), newsletters and other print materials.

8. Closure

The Robinson Creek and Tooley Creek watersheds are small in size and will continue to be, under significant development pressure in the future. The creation the Robinson Creek and Tooley Creek Watershed Management Plan provides a solid foundation for making planning decisions that can support growth while maintaining and enhancing the watershed's health and integrity.

It is the intention of this Watershed Management Plan to be implemented in its entirety. Watershed Goals, Objectives, Management Actions and Targets have been designed based upon the current and future needs of the Robinson Creek and Tooley Creek Watersheds and the constraints that were identified. Protection of the existing natural features and functions is the first priority for the watersheds and should be undertaken before any of the other management actions.

The Robinson Creek and Tooley Creek Watersheds offer special challenges for watershed management. However, by integrating good science into community action and municipal policy, the watersheds have the potential to support a functional and diverse ecosystem, while meeting the development goals in the area.

AECOM is grateful for the assistance and advice provided by the Central Lake Ontario Conservation Authority. Without their technical assistance and co-operation, completing many aspects of this study would not have been possible.

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10. Glossary of Terms

Acquisition	Any form of conveyance of title or interest in land.
Agricultural Land uses	As defined in the Provincial Policy Statement.
Anthropogenic Disturbance	Disturbance caused by human activity
Anticipated Effect	An effect that is deemed possible to result from the implementation of a particular alternative.
Area of Natural and Scientific Interest (ANSI)	Areas of land and water containing natural landscapes or features which have been identified as having values related to natural heritage protection, scientific study, or education. Depending on the features of particular areas, they may be referred to as life science or earth science sites. These areas vary in their level of significance and their vulnerability to environmental impacts. (NEC, 2003)
Baseflow	Streamflow that results from groundwater discharge seeping into a stream. Baseflow represents the stream flow comprised entirely of groundwater inputs (i.e., no surface water inputs).
Best Management Practices (BMP)	A technique or methodology that, through experience or research, has been proven to reliably lead to a desired result. After researching all known management methods, the selection and adaptation of the most suitable practices for achieving the desired outcome.
Canker	In relation to Butternut, canker is the reason for Butternut decline and current Endangered status. Butternut canker is widespread, hyper-virulent, and fatal. Canker vectors are rain, wind and insects. Typical symptoms are crown dieback, long linear fissure/cracks often with black discharge, epicormic branching, and loose/sunken areas of bark
CLOCA	Central Lake Ontario Conservation Authority
Cold water species/ habitat	Aquatic species with a narrow thermal tolerance levels that are usually restricted to cold, highly oxygenated water. The water temperature range for these species is generally 10°C to 18°C.
Conservation Authority	A community-based environmental organization dedicated to restoring, developing and managing natural resources using the watershed as a management unit (Conservation Ontario, 2005)
Core Area	The building blocks of a natural heritage system; essential land units that support high habit and/or hydrological functions relative to other units in the analysis area; core areas meet criteria established in the Natural Heritage System methodologies.
Corridor	The naturally vegetated or potential revegetated areas that link or border natural areas and provide ecological functions such as habitat, passage, hydrological flow, connection or buffering from adjacent impacts
COSEWIC status	Status assigned by the Committee on the Status of Endangered Wildlife in Canada: • *Extinct* – A species that no longer exists. • *Extirpated* – A species no longer existing in the wild in Canada, but occurring elsewhere. • Endangered – A species facing imminent extirpation or extinction. • *Threatened* – A species likely to become endangered if limiting factors are not reversed. • Special Concern (formerly vulnerable) – A species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats. • *Not At Risk* – A species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Cultural Communities	In terms of vegetation, a vegetation community originating from, or maintained by, anthropogenic (human modified) influences and culturally based disturbances; often containing a large proportion of non-native species (Ecological Land Classification for Southern Ontario [MNR, 1998]).
Development	For the purposes of this plan, development is the creation of a new lot, change in land use, the construction of large buildings or structures, and/ or site alteration.

Edge Habitat	The interface between a habitat patch and its surroundings - particularly forest. Edge habitats tend to be inhabited by both generalist species that can use many kinds of habitat and species that specialize in edges.
Environmental Assessment	The purpose of environmental assessment (EA) is to ensure that the environmental effects of a project receive due consideration before the proponent and responsible authorities take actions in connection with the project. It is a planning process that predicts, interprets and evaluates environmental effects, and identifies mitigation and environmental protection measures to reduce, eliminate or compensate for the environmental effects associated with a proposed undertaking.
Ecological Land Classification (ELC)	The system for the consistent description, identification, classification and mapping of ecological land units in Southern Ontario.
Environmental Management Plan (EMP)	An Environmental Management Plan (EMP) can be defined as “an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented; and that the positive benefits of the projects are enhanced”. EMPs are tools for ensuring that the management actions arising from Environmental Impact Assessment (EIA) processes are clearly defined and implemented through all phases of the project life-cycle.
Environmental Reference for Highway Design (ERD)	A Ministry of MTO document provides guidance to managing environmental impacts of transportation projects in transportation project design. Full citation: Environmental Reference for Highway Design, Section 1: Introduction, October 2006. Ministry of Transportation Ontario.
Environmentally Significant/Sensitive Area (ESA)	An Environmentally Significant/Sensitive Area is a natural area identified by a municipality or Conservation Authority as fulfilling certain criteria for ecological significance or sensitivity.
Ephemeral Flow	A stream that flows for short periods of time in the spring or in response to runoff events, and usually or insufficient duration to create a defined channel (e.g., field swale or gully)
Fish Habitat	“Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.” *(Fisheries Act,* sec. 34(l)).
Fish	“includes (a) parts of fish: (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals: and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.” *(Fisheries Act,* Sec. 2).
Forest area-sensitive	Area-sensitive breeding birds that require a relatively extensive forest habitat patch in which to successfully reproduce, or occur in higher densities in such patches.
Floodplain	The area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards.
Generalist species	With reference to birds, “generalist” bird species occur in many different habitats, while habitat specialists will occur in only one or a few habitats.
GRCA	Ganaraska Region Conservation Authority
Groundwater	Subsurface water, or water stored in the pores, cracks, and crevices in the ground below the water table; water passing through, or standing in, soil and underlying strata and free to move by gravity.
Groundwater Discharge	Discharge areas are the opposite of recharge areas. They are the locations at which groundwater leaves the aquifer and flows to the surface. Groundwater discharge occurs where the water table or potentiometric surface intersects the land surface. Where this happens, springs or seeps are found. Springs and seeps may flow into fresh water bodies, such as lakes or streams, or they may flow into saltwater bodies
Groundwater Recharge	Recharge is the process by which groundwater is replenished. A recharge area is where water from precipitation is transmitted downward to an aquifer
HADD	Harmful Alteration, Disruption or Destruction of fish habitat.

Habitat Quality Categories

Qualitative habitat quality categories were assigned as follows, based on the factors described above and professional judgement. All ratings were applied relative to others features within the Study Area:

- *Very High:* exceptional quality; highly diverse habitat and species composition; many rare and/or sensitive habitats and species; large size; relatively undisturbed / less disturbed;
- *High:* good species and habitat diversity; moderate to high numbers of rare species; typically low levels of anthropogenic disturbance; may have uncommon and /or specialized habitat elements.
- *Moderate:* lower relative habitat and species diversity; lower relative numbers of rare species; typically smaller, more disturbed woodlands and / or cultural mosaics;
- *Low:* common / tolerant habitats with limited species diversity and few or no rare / specialized species; small, isolated, highly disturbed features.

Headwaters

The origins of streams or rivers.

Impact

A change brought about by a cause or agent and reflects a change in fish and/or fish habitat that has the potential to influence the productive capacity of fish habitat (see “effect” in *RMF Guide*).

Impervious Surface

A human-made surface that does not permit the infiltration of water, such as a rooftop, or a paved, non-permeable sidewalk, roadway, driveway or parking lot.

Intermittent Flow

A stream that flows for less than 9 consecutive months per year under average annual precipitation conditions, and are normally dry in May/June. It has a poorly defined channel.

Interior Forest Habitat

The habitat found deep within woodlands, away from the influence of edge effects. The interior sections of forest, generally 100 m or more in from the forest edge, are darker, cooler and moister, and less prone to disturbances from outside of the forest (both human and environmental).

Lake Iroquois Shoreline

The Glacial Lake Iroquois Shoreline Sediments are characterized by gravelly beach sediments along the former shoreline of the glacial lake. Nearshore glaciolacustrine deposits of sand and gravel overly the Newmarket Till and grade to the south into laminated silts and clays. The high permeability of the sandy Iroquois Shoreline deposits provides a pathway for local groundwater discharge that coincides with numerous wetlands and lowland stream headwaters.

Landscape Connectivity

The degree to which the landscape facilitates or impedes movement [of species, individuals and genetic material] among habitat patches. (Taylor et al. 1993). The degree to which key natural heritage features are connected to one another by links such as plant and animal movement corridors, hydrological and nutrient cycling, genetic transfer, and energy flows through food webs.” (ORMCP, 2002)

Low Impact Development (LID)

Land engineering design approach to managing stormwater runoff through conservation and use of on-site natural features to protect water quality. This approach implements engineered small-scale hydrologic controls to replicate the pre-development hydrologic regime of watersheds through infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.

Mitigation Measure

Action(s) that remove or alleviate to some degree the negative effects associated with the implementation of an alternative.

Monitoring

To keep track of systematically, usually for the purpose of collecting information; or to test or sample according to a schedule, typically using a system including measuring devices and standard observations.

Net Gain

An increase in the productive capacity of habitats for selected fisheries brought about by determined government and public efforts to conserve, restore and develop habitats.

No Net Loss

A working principle by which Fisheries and Oceans Canada strives to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada’s fisheries resources due to habitat loss or damage may be prevented.

Non-native

A species, subspecies, or lower taxon introduced outside its normal past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that

	might survive and subsequently reproduce
Oak Ridges Moraine	The Oak Ridges Moraine is an irregular ridge of sandy hills stretching 160 km from the Trent River in the east to the Niagara Escarpment in the west and it generally found to the north of the proposed 407 Transportation Corridor.
Openness Ratio	A measure of the “tunnel effect” or “see- throughness” of a wildlife structure that may influence use by some species. OR is the cross-sectional area of the structure opening divided by the travel distance through (or under) the structure.
Operation and Maintenance	Refers to the operation and maintenance of the Transportation Corridor.
Provincially Significant Wetlands	These are wetlands evaluated as provincially significant using the Ontario Wetlands Evaluation system (OWES).
Riparian	Relating to, living, or located on the bank of a natural watercourse (such as a river) or sometimes of a lake or a tidewater. In the ELC, refers to aquatic communities adjacent to, or associated with, a river or stream as opposed to a lake or pond (cf. lacustrine)
Riparian Vegetation	Plant communities along the river margins characterized by hydrophilic plants
Riparian Zone/Area	The interface between land and a stream.
Residual effect	The remaining negative or positive effect of an alternative after the application of avoidance/ mitigation/ compensation/ enhancement measures.
Road Ecology Group	Championed by the Toronto Zoo, the ONTARIO ROAD ECOLOGY GROUP is comprised of government and non-government scientists, educators, and transportation planners. The Group’s goal is to raise awareness about the threat of roads to biodiversity in Ontario, and to research and apply solutions.
Site Alteration	Means activities, such as grading, excavation and the placement of fill that would change the landform and natural vegetative characteristics of a site.
Specialized and Sensitive Wildlife Habitat (SSWH)	The identification of areas of Specialized and Sensitive Wildlife Habitat (SSWH) was based on a qualitative assessment based on the consideration of a number of factors including: breeding bird species richness/diversity, area-sensitive species, habitat diversity, species of conservation concern, amphibian breeding habitat and habitat continuity.
Species at Risk	Means an extirpated, endangered or threatened species or a species of special concern (Species at Risk Act (2002) / Species at Risk Act Registry Glossary (2003).
Species Diversity	Refers to the number of different species within an assemblage, ecological community, area or sample; also known as species richness.
Species Richness	Is the number of different species in a given area.
Stormwater Management	Stormwater management is the management of stormwater runoff, often using water retention facilities, to provide controlled release into receiving streams.
Tableland	A relatively flat upland area outside of valley land.
Terrestrial	Refers to an environment that is of, or on the ground, or to animals and plants living or growing on the ground (land). Specifically referring to habitats where the water table is rarely or briefly above the substrate surface and hydric soils have not developed.
TRCA	Toronto and Region Conservation Authority

Upland	A general term for an area that is higher in elevation than the surrounding landscape (Ecological Land Classification for Southern Ontario (Ecological Land Classification for Southern Ontario [MNR, 1998]).
Valleylands	A natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year (Provincial Policy Statement [MMAH, 2005]).
Vernal Pool	A shallow natural or man-made depression in level ground where no permanent above ground outlet is present. These pools hold water seasonally and serve as nurseries for species such as frogs and salamanders.
Warm water species/ habitat	Aquatic warm water habitat is classified as waters with temperatures above 25°C. Warm water species are tolerant to these conditions.
Water Budget	A summation of all water inputs and outputs from a given area over a period of time. Inputs and outputs include: groundwater flow, surface water flow, evaporation, transpiration, trans boundary flow, storage, interception, and infiltration.
Watercourse	A stream, river or channel in which a flow of water occurs, either continuously or intermittently, with some degree of regularity (Glossary of Drainage Terms [MTO, 1999]).
Watercourse Crossing	A culvert or bridge structure used to cross a water body (MTO/DFO/OMNR Protocol for Protecting Fish and Fish Habitat on Provincial Transportation Undertakings [2006]).
Wetlands	Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens. Periodically soaked or wet lands being used for agricultural purposes which no longer exhibit wetland characteristics are not considered to be wetlands for the purposes of this definition (Provincial Policy Statement [MMAH, 2005]).