Conservation Report 2018

The First 50 Years and Beyond

LOWER TRENT
CONSERVATION

Acknowledgements

For the love of the watershed, this report was written by Anne Anderson, Ewa Bednarczuk, and Glenda Rodgers with much input and assistance from other Lower Trent Conservation staff, most notably: Marilyn Bucholtz, Gage Comeau, Robert Elliot, Anna Morgan, Shan Mugalingam, and Janet Noyes. The beautiful maps were prepared by Jeffrey Meyer.

Note to the Reader

This report provides an overview of the Lower Trent watershed region and the programs and priorities of Lower Trent Conservation. It also takes the reader back in time, to the early days of conservation in the region.

While the report is not intended to be a technical document, some technical terms have been used. For the benefit of the reader, the italicized words are defined in the glossary.

We hope that this report helps the reader develop a better appreciation of the natural aspects of the local watersheds under the care of Lower Trent Conservation.

The full citation of this document is: Lower Trent Conservation. 2018. Conservation Report 2018: The First 50 Years and Beyond

Table of Contents

List of Figures

List of Tables

List of Maps

Appendices

The native wildflower garden at the Lower Trent Administration Office, in the City of Quinte West, just south of Wooler

1. Introduction

50 Years of Conservation

Lower Trent Conservation (LTC), officially known as the Lower Trent Region Conservation Authority, was formed by the Province in 1968 under the *Conservation Authorities Act*, at the request of the local municipalities. The Conservation Authority was given a mandate to develop and implement a program for managing the renewable natural resources of the *watershed* region.

Locally, the realization that natural resources were not inexhaustible unless managed and protected began to take hold in the late 1950's and early 1960's. Led by the Royal Canadian Legion, Branch 110 of Trenton, a conservation committee began the job of establishing a Conservation Authority to deal with concerns with industrial and sewage waste, weed control, and garbage dumping along the Trent River.

It took almost 10 years of hard work and dedication by a local group of conservation-minded individuals to make progress. Finally, on April 30, 1968 with over one hundred people in attendance, the majority of the municipalities voted in favour of the establishment of the Lower Trent Region Conservation Authority. The Order-in-Council from the Province of Ontario for the formation of the Conservation Authority was received on May 16, 1968.

Members of the Board of Directors - 1969

What's in a name?

***Lower Trent Conservation* (LTC) refers to the Lower Trent Region Conservation Authority which was established under the *Conservation Authorities Act* in 1968.**

The logo, introduced around 1968, was modified over the years and a new one introduced in 2000. It was refreshed in 2018.

circa 1970

2000

2018

Strategic Outlook

Lower Trent Conservation's Strategic Plan (2018) sets out our vision (the ideal conditions of the *watershed*), our mission (what we do), and program goals and priorities on how we intend to achieve our vision and carry out our business.

Our Vision (2018):

Healthy Watersheds for Healthy Communities

Our Mission (2018):

To protect land, water and living things by working with and inspiring others.

In 1973, a portion of the former Sidney Township (now City of Quinte West) along the Bay of Quinte, was added to the *watershed* jurisdiction. Later, in 2018, a small area in the former Seymour Township (now Municipality of Trent Hills) was added, increasing the jurisdiction to the current day area of 2,070 km^2 (a more accurate calculation through GIS than the often cited 2,121 km^2). Fifty years after its formation, in 2018, the Conservation Authority still thrives under the same mandate – protecting the local environment in the *watershed* region.

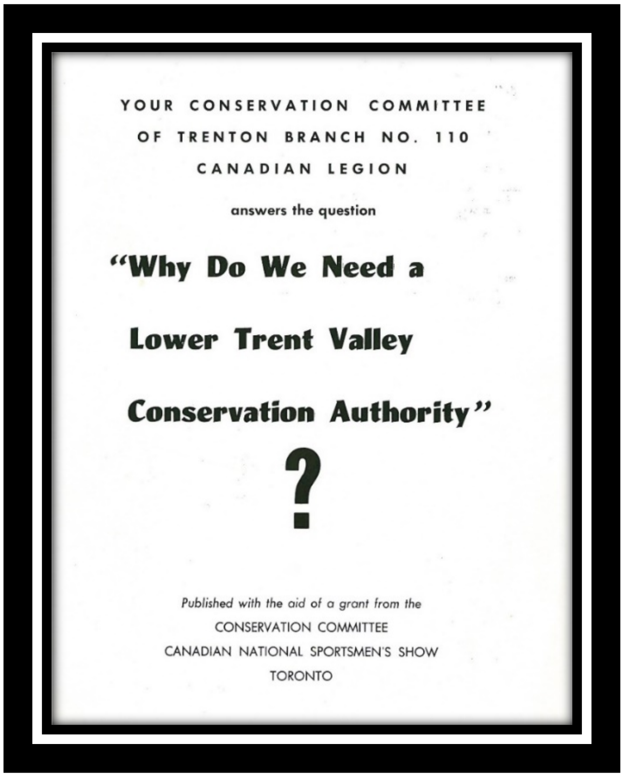
Looking back…

In 1970, The Lower Trent Region Conservation Report was released, which provided a detailed description of the *watershed* region, current conditions, issues, and provided recommendations for the newly formed Conservation Authority to address the environmental issues. The 1970 Report served as a guide for the development of the Conservation Authority's program during its early years. Subsequent reports and updates, including our Conservation Strategy (Lower Trent Region Conservation Authority 1993, Lower Trent Conservation, 2008), have provided guidance to the Conservation Authority in developing its program and delivering its services.

Purpose

The purpose of this Conservation Report is to provide an understanding of the current state of the Lower Trent *watershed* region and the issues we are facing today. It updates the 1970 Conservation Report (Department of Energy and Resources Management, 1970 a, b, c) and provides background information about our *watersheds*, our current programs and services, and identifies data/information gaps and *watershed* issues. It also sets out goals and priorities for the next 10 years, as identified in the complementary document, Lower Trent Conservation's 2018 Strategic Plan.

The Report will help guide the Conservation Authority's program planning and priorities. It also looks back on the past 50 years of conservation efforts in the *watershed* region - an opportunity to reflect on our accomplishments and how far we have come. Some of the issues identified in the early days have been addressed, others remain, and still other issues have emerged.


YOUR CONSERVATION COMMITTEE
OF TRENTON BRANCH NO. 110
CANADIAN LEGION

answers the question

"Why Do We Need a Lower Trent Valley Conservation Authority"

?

Published with the aid of a grant from the
CONSERVATION COMMITTEE
CANADIAN NATIONAL SPORTSMEN'S SHOW
TORONTO

The Cause Is Conservation

C. G. MacDonald, last night re-elected chairman of Lower Trent Valley Conservation Authority, talks common problems with vice-chairman Arthur Workman. In background is secretary William Lawson.

View of Percy Reach on the Trent River

2. Overview of the Lower Trent Watershed Region

What is a Watershed?

A *watershed* is the area of land drained by a river or creek and its tributaries; each *watershed* is a complete system. Since decisions and actions made in one location can affect upstream and downstream areas, *watersheds* are ideal units for protecting and managing the local environment.

Within Lower Trent Conservation's *watershed* region there are several *watersheds*. Some form part of the Trent River drainage basin, the remainder flow directly into Lake Ontario or the Bay of Quinte.

The *watershed* region is also part of the Great Lakes basin. Lower Trent Conservation's jurisdiction includes over 100 km of Lake Ontario and Bay of Quinte shoreline.

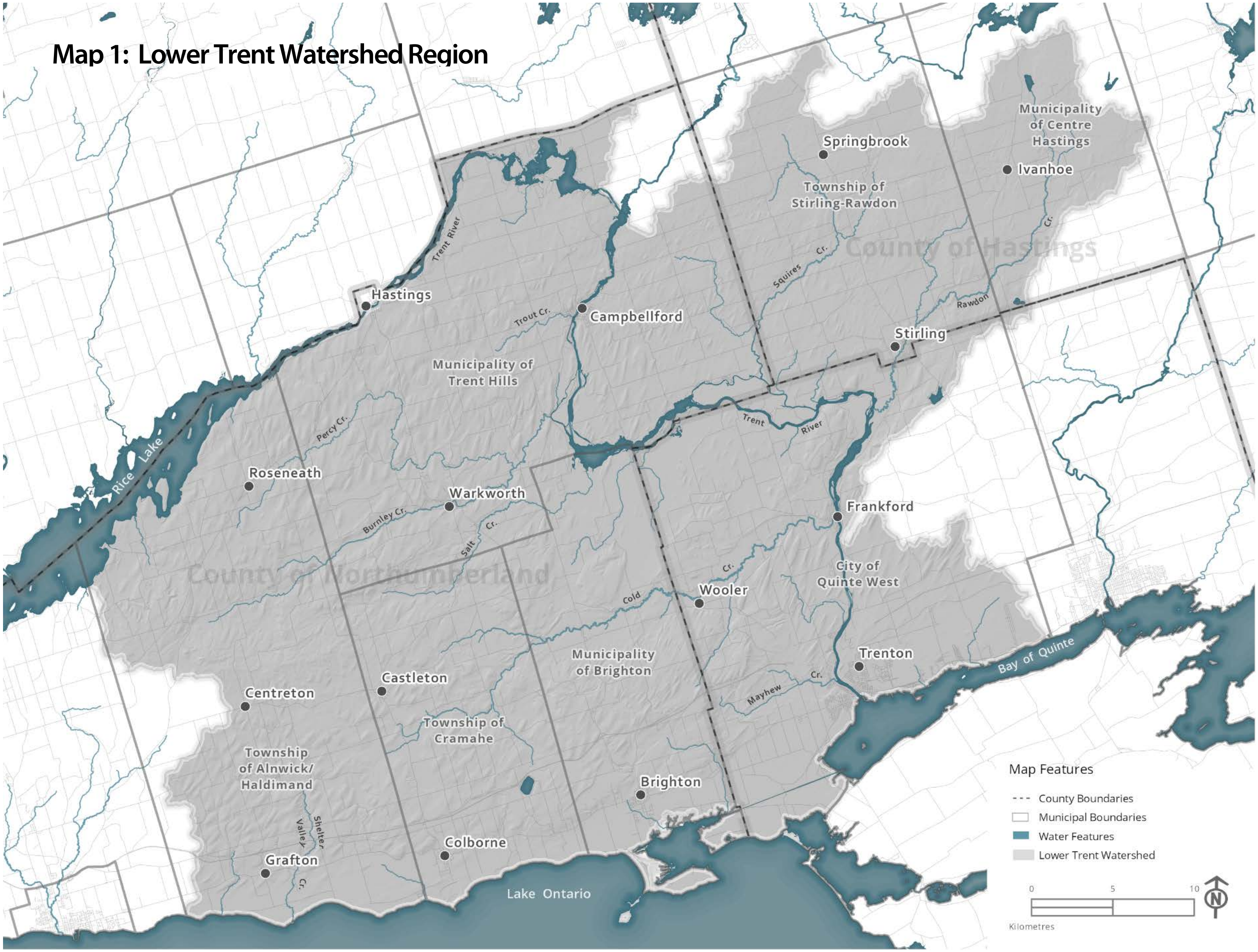
The Watershed in a Nutshell

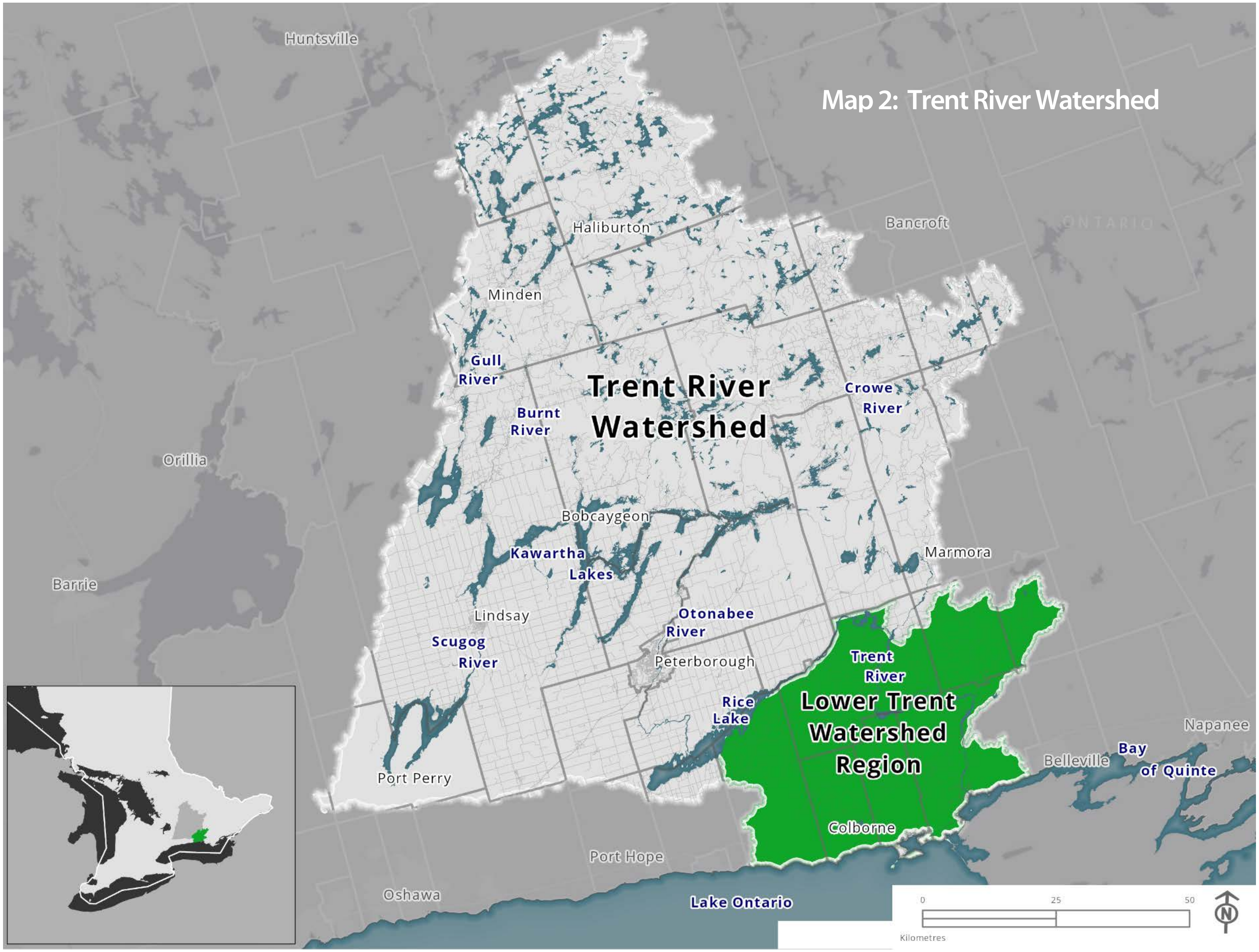
The Lower Trent *watershed* region covers approximately 2,070 km^2, stretching from Rice Lake to Lake Ontario and the Bay of Quinte, and from just west of Grafton to Quinte West. The Trent River flows through the *watershed* region from Rice Lake, emptying into the Bay of Quinte at Trenton. The *watershed* region is comprised of several *watersheds*: some that flow into the Trent River, and others that flow directly into Lake Ontario and the Bay of Quinte (Map 1).

The Lower Trent *watershed* region encompasses the downstream portion of the expansive Trent River *watershed* (Map 2). With its headwaters in the southern fringe of Algonquin Park, water from over 200 lakes in the Haliburton Highlands flows through the Kawartha Lakes, down the Otonabee River and into Rice Lake in Lower Trent Conservation's *watershed* region. From there, the Trent River makes its way to the Bay of Quinte. The Trent River system drains more than 12,000 km^2 of central Ontario (Parks Canada, 2017).

The landscape of the *watershed* region is a mosaic of agricultural land use, urbanized areas, forests, *wetlands*, and old fields crisscrossed by river/stream systems and transportation and utility corridors. A large proportion of the population lives in rural areas. Urban areas are located in proximity to historical transportation routes and are mostly confined to the shore of Lake Ontario, the Bay of Quinte, and the Trent River. Trenton, within the City of Quinte West, is the largest urban centre with a population of approximately 20,000.

Map 1: Lower Trent Watershed Region




Map 2: Trent River Watershed
Huntsville
Haliburton
Bancroft
ONTARIO
Minden
Gull River
Trent River Watershed
Crowe River
Burnt River
Orillia
Bobcaygeon
Kawartha Lakes
Marmora
Barrie
Lindsay
Otonabee River
Scugog River
Peterborough
Trent River
Rice Lake
Lower Trent Watershed Region
Napanee
Belleville
Bay of Quinte
Port Perry
Colborne
Port Hope
Oshawa
Lake Ontario
0
25
50
Kilometres
N

Rolling landscape typical of the Lower Trent Watershed Region

There are seven municipalities located fully or partially in the Lower Trent watershed region:

- Township of Alnwick/Haldimand
- Municipality of Brighton
- Municipality of Centre Hastings
- Township of Cramahe
- City of Quinte West
- Township of Stirling-Rawdon
- Municipality of Trent Hills

The majestic Trent River

Looking back…

In 1968, when the Lower Trent Region Conservation Authority was formed, there were 17 participating municipalities:

- Township of Alnwick
- Village of Brighton
- Township of Brighton
- Town of Campbellford
- Village of Colborne
- Township of Cramahe
- Village of Frankford
- Township of Haldimand
- Village of Hastings
- Township of Huntington
- Township of Murray
- Township of Percy
- Township of Rawdon
- Township of Seymour
- Township of Sidney
- Village of Stirling
- Town of Trenton

"Green Socks" is a magnificent 450+ year old white oak growing at Peter's Woods Provincial Nature Reserve north of Centreton

3. Human History of the Watershed

Travelling through Time

Archaeological data indicate that this area of southern Ontario was home to Indigenous people for thousands of years. Samuel de Champlain travelled with and met Indigenous people in his exploration of the area over 400 years ago. Alderville, located in the northwest portion of the Lower Trent watershed region, has been home to the Mississauga Anishinabeg of the Ojibway Nation since the mid-1830's. Before that time, the people lived in their traditional lands around the Bay of Quinte (Grape Island). With the influx of refugee settlement after the American Revolution (United Empire Loyalists), their existence found itself under increased pressure. The Mississauga were directly involved in early "land surrenders" along the St. Lawrence River and the Bay, resulting in their relocation to Alderville (Alderville Black Oak Savanna, 2018a). The Ojibway people know the Alderville area as 'Pemadashcoutayang' or 'Lake of the Burning Plains'. This name reflects the important role that fire played on these lands. Fire was used in a multitude of different ways, the most common was to clear land for both agriculture and hunting. Wildlife was attracted to the new green growth of the grasses that came after a spring burn (Alderville Black Oak Savanna, 2018b).

Before first contact between Indigenous peoples and Europeans near the turn of the 17th century, much of southern Ontario was shaped by the land practices of Indigenous people who cleared land for agriculture to grow crops, like corn, and burned forests to create more open areas preferred for hunting (Riley, 2013). Even though some 80% of southern Ontario lands around the Great Lakes are estimated to have been forested at that time, there are records of extensive areas with an open country character with scattered trees and meadows, as a result of Indigenous land care practices (Riley, 2013). Diseases introduced by Europeans and warfare between Indigenous nations and European colonizers devastated Indigenous populations and disrupted their land care practices. Following contact, a 150 year period of rewilding of the landscape took place. Once European settlers began arriving in southern Ontario in larger numbers in the late 1700s and early 1800s, they found a reforested landscape that was over 90% forested (Riley, 2013). Over the next 100 years, much of that forest cover was cleared.

Champlain travelled down the Trent River in 1615 and was impressed by the apparent richness of the land, with vines and walnut trees, and with plentiful fish and game (Department of Energy and Resources Management, 1970c). He also noted that in the eastern end of Lake Ontario there were *prairies* with "much game and fine woods, with many chestnuts" (Riley, 2013). Fur traders used this route extensively. For many years after the Trent River area was settled, water remained the chief avenue of transportation, and as early as 1785, interest in the *Trent-Severn Waterway* as a possible canal route began to grow. The process of constructing the waterway was a lengthy one, with construction beginning in 1833 and the first boat navigating the entire route in 1920 (Lower Trent Region Conservation Authority, 1982). The *Trent-Severn Waterway* remains an important transportation corridor with a focus on tourism and recreational boating. Over 120,000 vessels used the *Trent-Severn Waterway* in 2016, and there were over 1,000,000 land visitors that same year (Trent Severn, 2017).

The first permanent European settlers in this region were *United Empire Loyalists*, who arrived at the mouth of the Trent River in 1790 (Department of Energy and Resources Management, 1970a). The shores of Lake Ontario, the Bay of Quinte, and the Trent River were the first areas settled. At this time, large expanses of oak and white pine forests grew throughout the *watershed* region. The settlers viewed the forests as an obstacle to agriculture and the work of clearing the land began. The ashes of hardwoods were in commercial demand as early as the 1780s for the manufacture of *potash* used as crop fertilizer. For the first quarter of the nineteenth century, the best timber was reserved for the British navy. The Trent River valley became the second most important lumber producing area in Ontario. In a space of 50 years (1840-1890), most of the marketable pine of this region was removed and the lumber industry came to a virtual standstill (Lower Trent Region Conservation Authority, 1982).

From the time of the *United Empire Loyalists*, agriculture has been an important economic and cultural facet of the Lower Trent *watershed* region and continues to be a dominant land use. The nature and distribution of agricultural enterprises in the region is constantly changing based on market demands and social pressures.

The development of industry in the urban centres diversified the economy and culture of the area. Industries in Trenton have included: lumber processing, *creosote* preserving and the manufacture of paper, structural steel, machinery, clothing, and flour. Colborne and Brighton have been food processing and canning centres. Industries in Frankford have included a concrete pipe factory, a cannery, a cheese factory, paper mills, and a hydro plant. Carpets and woolen goods, aircraft seats, and furniture have been manufactured in Campbellford. Stirling has been predominately a dairy products centre.

Construction at 8 Wing/Canadian Forces Base (CFB) Trenton began in the early 1930's, with further expansion during the Second World War. 8 Wing/CFB Trenton is at the forefront of Canadian military airlift with its fleets of tactical and strategic transport and Search and Rescue aircraft. The base is highly responsive to international events and daily flights to the four corners of the globe are routine. As the hub of air transport operations, 8 Wing is involved in virtually every Canadian Forces operation. Most personnel and equipment deployed to any destination within Canada or around the world pass through Trenton at some point. Currently, there are approximately 3,200 regular force, 600 reserve force, and 500 civilian members who make-up the workforce at 8 Wing/CFB Trenton (Royal Canadian Air Force, 2018). Living in many of the communities located in the Quinte Region, members and their families comprise many of the approximately 20,000 Trenton residents and 50,000 residents of the City of Belleville. 8 Wing is the largest employer in the *watershed* region with an annual payroll of more than $110 million, creating a significant economic impact on the local economy (Royal Canadian Air Force, 2018).

One of North America's largest glacial erratic rocks is located at the Bleasdell Boulder Conservation Area

Molded by Ice

In four successive cold periods of the *Pleistocene epoch* (2.6 million years ago to 11,000 years ago) vast masses of ice moved across the Province of Ontario. The last glaciation period, the Wisconsinan Episode, occurred 85,000 to 11,000 years ago (Chapman and Putnam, 1984). The ice advanced and receded multiple times during this time. The diverse landforms we see today in the Lower Trent *watershed* region are a result of the scouring, scraping, melting, depositing, and molding actions of these massive ice sheets, which were approximately 2 km thick.

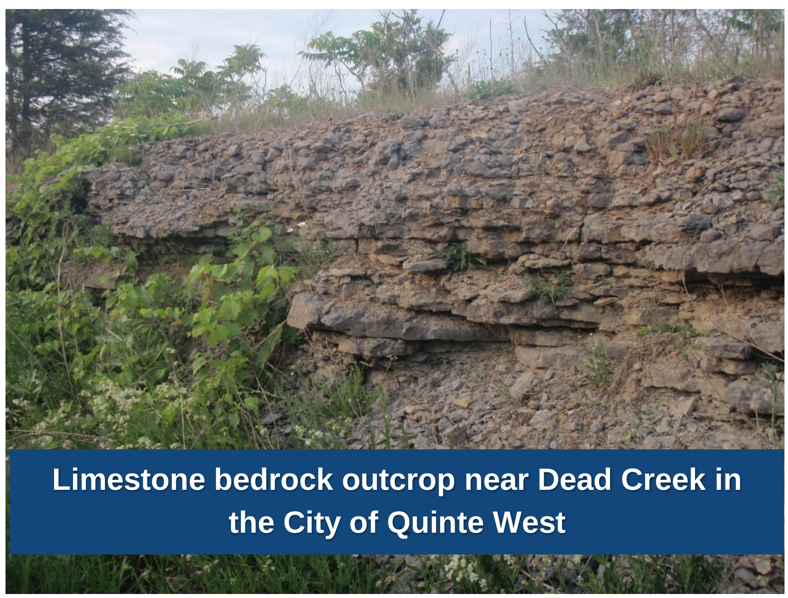
4. Physical Geography

The Dirt on the Rocks

Bedrock Geology

Precambrian rocks, in excess of one billion years old, form the foundation of the Lower Trent *watershed* region. Approximately 600 million years ago, the *Precambrian* land surface was slowly inundated by *Paleozoic* seas, and sediments were deposited, buried, and compressed to become the sedimentary rocks that cover about one third of southern Ontario. During the *Middle Ordovician* period, carbonates of the Trenton Group were deposited. These *Paleozoic* rocks form the uppermost bedrock formation in the region. Only a small area at the northern part of the *watershed* region is directly underlain by *Precambrian* bedrock (Morrison, 2004).

Both *Paleozoic* and *Precambrian* bedrock *outcrops* occur in the northern portion of the *watershed* region with some *Paleozoic outcrops* in the valley of the Trent River, and near the shoreline of Lake Ontario. Where the *overburden* is thin, the bedrock is shaped by running water. There is some evidence of *karst* topography in the northeast portion of the region.



Limestone bedrock outcrop near Dead Creek in the City of Quinte West

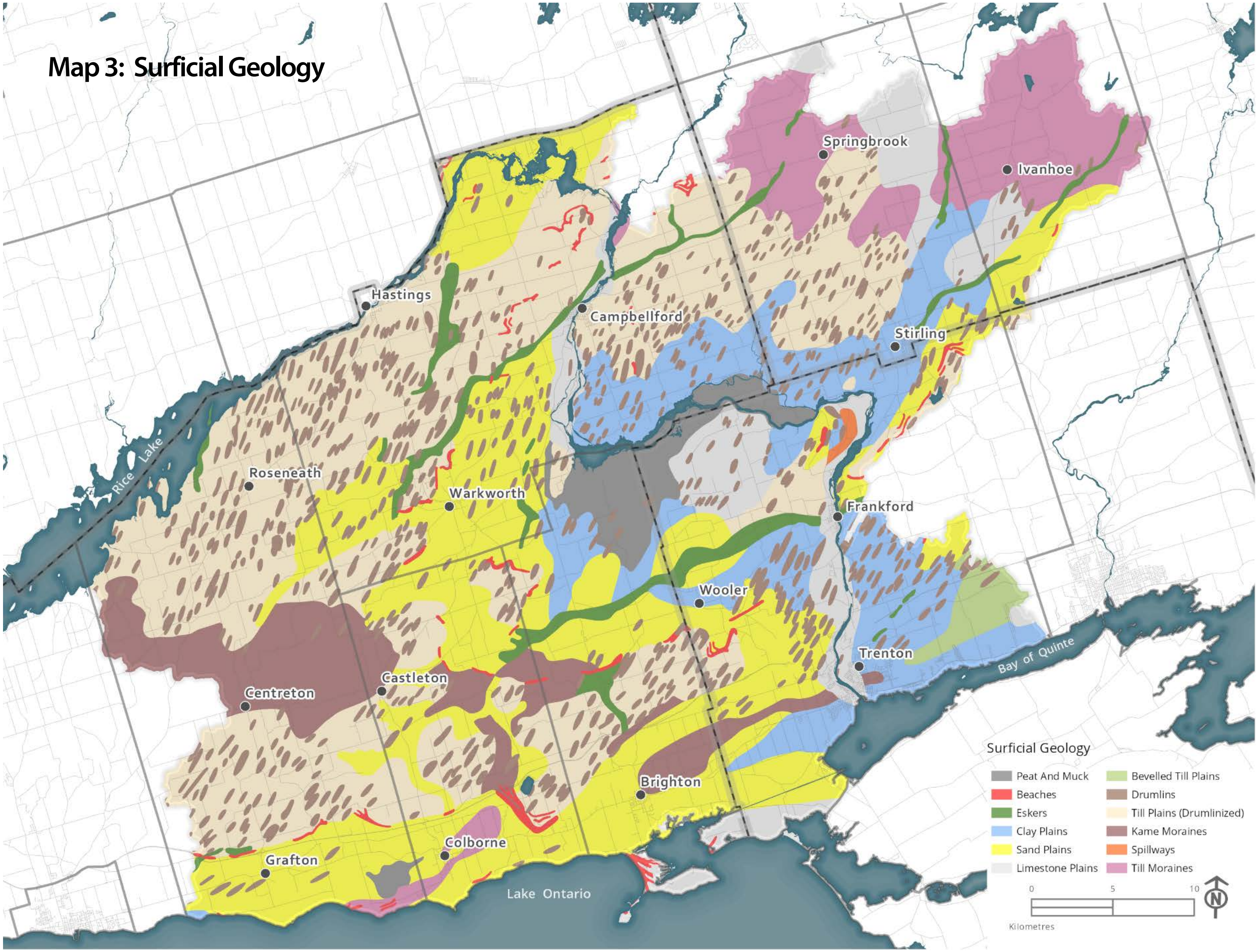
On a regional scale, the bedrock surface slopes gently towards Lake Ontario. Bedrock is inferred to be relatively flat with a few local highs in the southern part of the region. The *bedding planes* dip at about 4 m/km to the southwest (Morrison, 2004).

Surficial Geology

Surficial geology describes the types and distribution of sediments that overlay the bedrock across the landscape including sand, gravel, and clay. The Lower Trent *watershed* region is covered with deep, well-drained *overburden*, composed of a variety of unconsolidated materials ranging in grain size from clay to gravel to boulders. Glacial ice advanced and melted on many occasions during the *Pleistocene* period resulting in a predominance of glacial deposits (Morrison, 2004). A significant portion the region was inundated by glacial Lake Iroquois, the much larger predecessor of Lake Ontario, which greatly influenced the landscape we see today. The consequences of this glacial and fluvio-glacial activity took the form of *till* plains, *kame moraine*s, *till moraines*, sand plains, and clay plains. In addition to this already complex physiography, several extensive *eskers* and *drumlins* were created (Department of Energy and Resource Management, 1970a). Across the southern and central parts of the region, numerous beaches, bars, spits, and terrace *escarpments* can be found - remnant shoreline features of former Lake Iroquois. The *surficial geology* of the Lower Trent *watershed* region is displayed on Map 3.


A drumlin near Sager Conservation Area

Map 3: Surficial Geology



Peterborough Drumlin Field

A *drumlin* is a tear drop, whale back, or half-buried egg shaped hill formed by glacial ice. *Drumlins* are aligned on the landscape in the direction of the ice sheet movement.

Three to four thousand *drumlins* occur in the 5,000 km^2 Peterborough Drumlin Field, averaging two to three per square kilometre.

Landforms

Physiography, also called geomorphology, refers to land surface features. Chapman and Putnam (1984) describe five major physiographic features within the Lower Trent *watershed* region: Oak Ridges Moraine, Dummer Moraine, Peterborough Drumlin Field, South Slope, and Iroquois Lake Plain (Map 4). The following is a description of these regions as described in the Lower Trent Region Conservation Authority Watershed Inventory (1982) and Chapman and Putnam (1984).

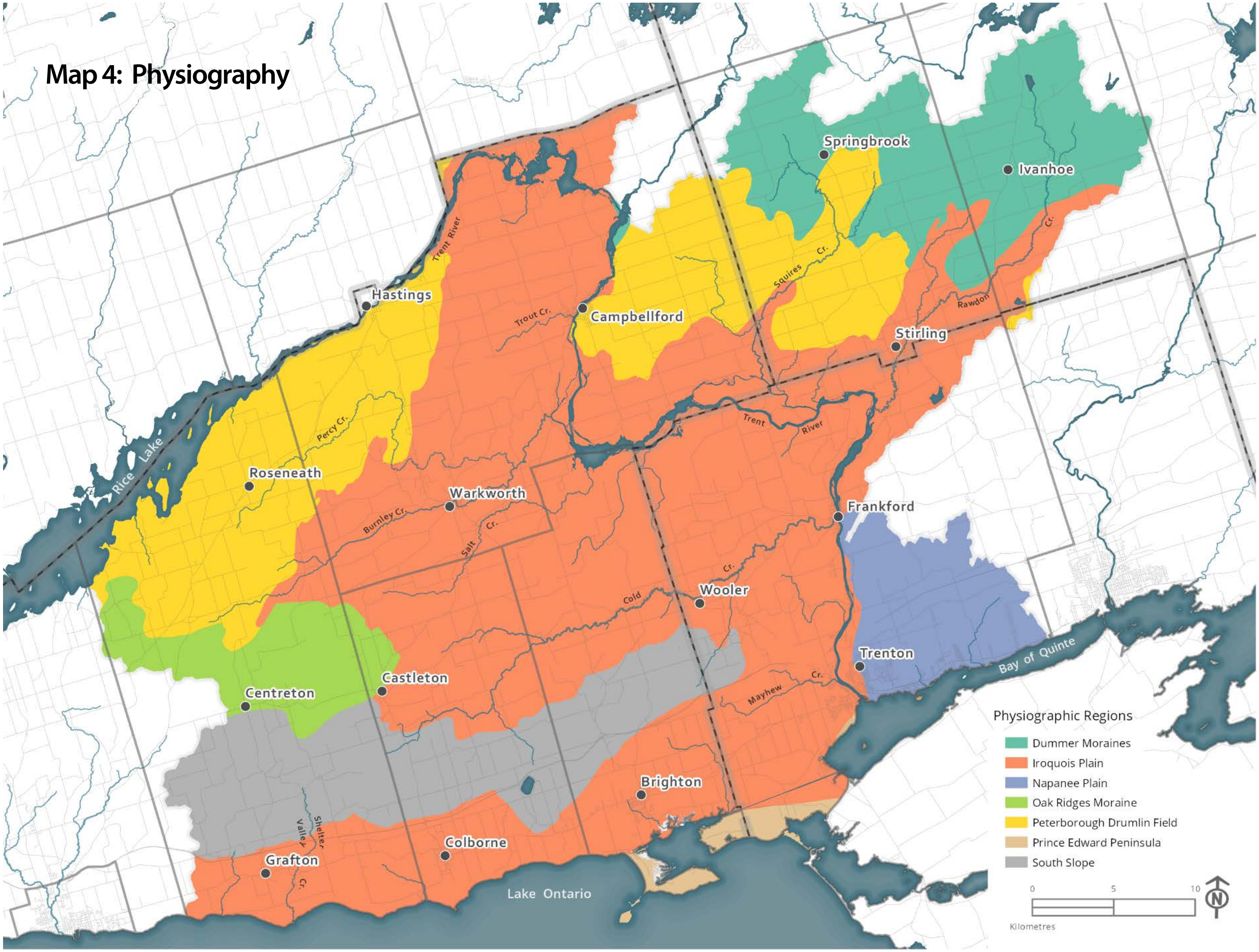
The Oak Ridges Moraine is the most distinctive landform produced by glacial activity in the region. This landform, which occupies the west central portion of the *watershed* region, has been interpreted to be an *interlobate moraine* formed at the interface of the Lake Ontario and Simcoe ice lobes. The Moraine's high relief and *hummocky* terrain is a product of the large amounts of unsorted *tills* and partially sorted outwash sands and gravels deposited by the advancing and ablating ice fronts. The sand and gravel deposits of the Moraine perform an important *groundwater recharge* function.

This upland area is a water source for many streams which flow through the adjacent *till* plains. On much of the Moraine itself, streams are virtually absent. The water drains almost vertically through the sand and gravel, moving laterally only when it reaches less permeable material to reappear as springs along the slope of the Moraine.

Within the Lower Trent *watershed* region, the Dummer Moraine lies along the northeastern fringe in the geographic townships of Rawdon and Huntingdon. The *till moraines* of this area are characterized by angular fragments and blocks of limestone, along with many *Precambrian* rocks. The surface is extremely rough even though most of the morainic ridges are quite low. Among the *moraines* are areas of shallow drift consisting of sand and gravel, and even areas of bare limestone, some of which exhibit *karst* features. The area is well suited for forest cover, which is the predominant land cover in the area.

The Peterborough Drumlin Field occupies the north-central portion of the Lower Trent *watershed* region, lying between the Oak Ridges Moraine and Rice Lake, and extending east across the region. Typical *drumlins* are elongated, low lying hills, less than 1.5 km in length, 400 m or less in width, and approximately 25 m in height (Gillespie and Acton, 1981). They are composed of highly calcareous glacial *till* consisting of sand and gravel. The general orientation is from northeast to southwest, aligned with the direction of the ice movement. Between the *drumlins* in the north central part of the region are fine textured lake deposits from meltwater; between the *drumlins* in the western and southern parts are sands and gravels.

Map 4: Physiography



The South Slope lies between the Oak Ridges Moraine and the Lake Iroquois Plain. It is a heavily drumlinized *till* plain that is thought to have been formed during a re-advancement of the Simcoe ice lobe. As a result of the steepness of this region, streamflow is rapid, cutting sharp valleys in the *till*. Numerous gullies have been cut by intermittent drainage and *erosion* resulting in bare, eroding slopes being common.

The Lake Iroquois Plain is located along Lake Ontario and extends along the Trent River through the central portion of the *watershed* region *(Trent Embayment)*. Aside from a few wave uprush uplands, much of the lake plain topography is gently rolling to flat, with *lacustrine* deposits composed of sand, fine sand, and silt. Old cliffs, bars, beaches, and boulder pavements mark the old shoreline of the glacial lake. The shore cliffs, which extend on average approximately eight kilometres inland of the present shore of Lake Ontario, are most prominent between Brighton and Colborne where they attain heights of up to twenty metres. The *Trent Embayment* is a large and complex bay of glacial Lake Iroquois covering much of the central and eastern portion of the Lower Trent *watershed* region. The wave action and deep water currents of the embayment played a major role in the inundated area by eroding and reworking much of the *till* deposited under active ice conditions. Many *drumlins* of the heavily drumlinized Peterborough field stood as islands in this great bay. Consequently, wave-cut beaches and shorelines commonly truncate these exposed islands. The Oak Hills are the most dramatic examples of this occurrence. In the eastern portion of the *watershed* region, where bay waters were deeper and less turbulent, extensive clay plains were deposited.

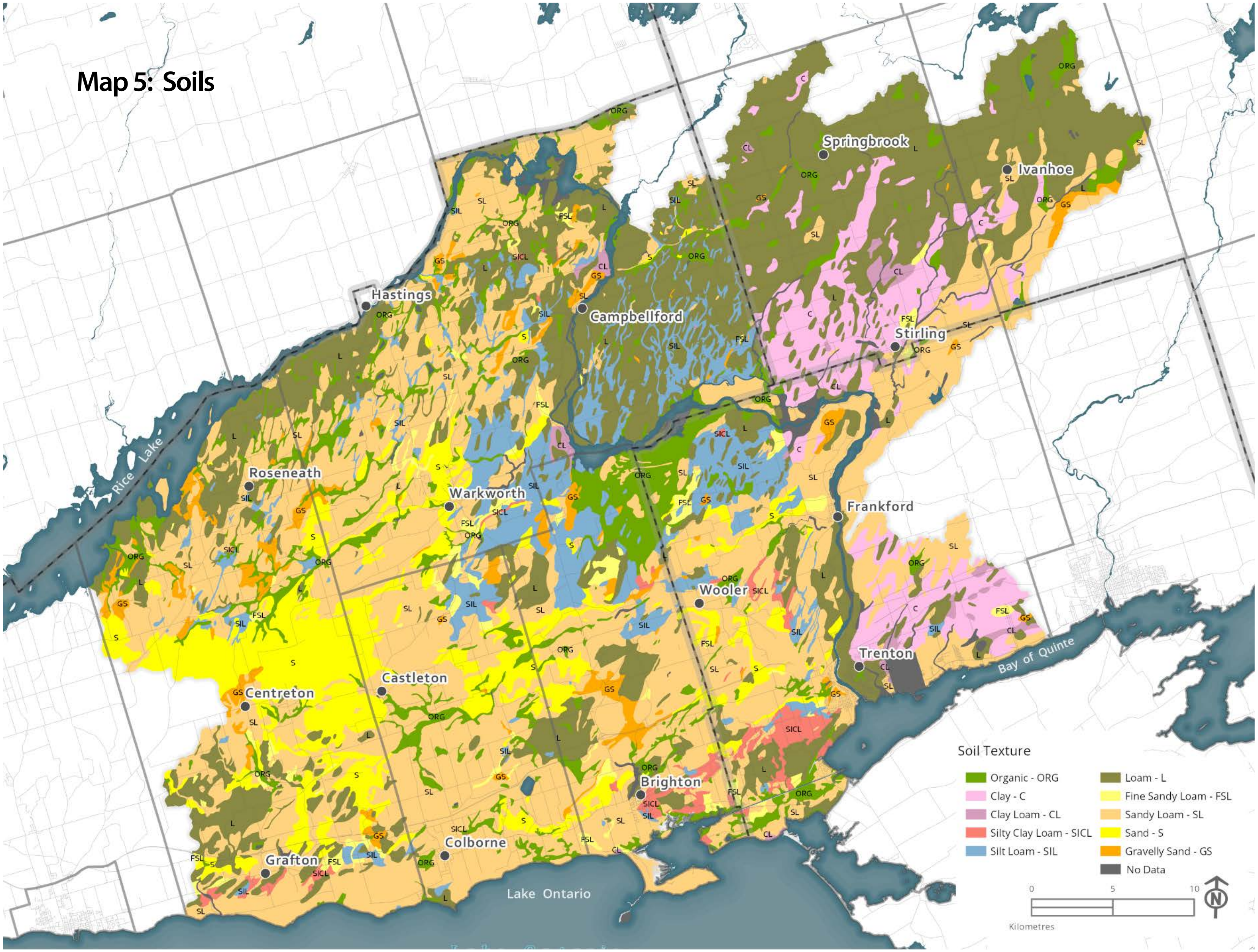
Soils

The Canadian System of Soil Classification classifies soils into different categories such as Orders, Great Groups, Subgroups, Families, and Series based on soil properties and uses. Examining soil composition allows for an understanding of the impact of surface water, drainage, and how the composition influences land use activities like agriculture. The structure of soil types affects the movement of water into the ground. Sandy soils generally allow for more rapid *infiltration*, whereas loams possess fair to good water retention, and clays retard the *infiltration* of water altogether (Lower Trent Region Conservation Authority, 1982).

Soils within the Lower Trent *watershed* region primarily belong to either one of the following Great Groups: the Gray Brown Podzolic Group or the Brown Forest Group (Department of Energy and Resources Management, 1970a). A complex array of soil types have evolved in response to the diverse geological fabric of this highly glaciated region (Map 5). Soils differ greatly in composition, depth, and texture depending on their parent materials, whether it be glacial *till*, *glacial-fluvial* outwash or lacustrine deposits. Sandy-loam and sand type soils are generally found in the western and southern half of the region. The loams are related mainly to those *till* plain areas in the northeastern and the northern half of the region. The clay type soils are associated with the clay plain that skirts the northern fringe area of Percy Reach (on the Trent River south of Campbellford) (Lower Trent Region Conservation Authority, 1982).

Soil types and their corresponding characteristics strongly influence land uses. Sandy soils with low fertility do not suit agricultural uses; many of these areas have been reforested (i.e., Northumberland County Forest). Clay soils tend to be limited for agriculture due to drainage problems. The most productive soils with the most agricultural use are the sandy loams.

Map 5: Soils


Springbrook
Ivanhoe
Hastings
Campbellford
Stirling
Roseneath
Warkworth
Frankford
Wooler
Trenton
Castleton
Centreton
Brighton
Colborne
Grafton
Rice Lake
Bay of Quinte
Lake Ontario
Soil Texture
Organic - ORG
Clay - C
Clay Loam - CL
Silty Clay Loam - SICL
Silt Loam - SIL
Loam - L
Fine Sandy Loam - FSL
Sandy Loam - SL
Sand - S
Gravelly Sand - GS
No Data
0
5
10
Kilometres

Topography

Topography or "the lay of land" refers to the characteristics of land in terms of elevation, slope, and orientation. The diversification of the topographical features evident in the Lower Trent *watershed* region is primarily due to the glacial and interglacial periods that occurred during the *Pleistocene* era, especially during the last ice age. Map 6 shows the elevation variation in the region.

The southern portion of the *watershed* region is composed of sand plain or *kame* morainic features, which were altered by extensive wave washing during the Lake Iroquois stage. As a result, there are rolling and steeply sloped hills, and beach terraces descending to Lake Ontario. However, the areas along the lake are quite flat. The western portion of the *watershed* has variable topography due to the morainic deposits. The central portion of the region draining into the Trent River displays a complex topography due to river and lake meltwater types of deposition. Areas to the north and east of the Trent River display a flat to gentle rolling topography.

Erosion

Soil *erosion* is a naturally occurring process that affects all landforms and occurs throughout the *watershed* region. *Erosion*, whether it is by water, wind, ice or gravity, involves three distinct actions – soil detachment, movement, and deposition. Soil *erosion* can be a slow process that continues relatively unnoticed or can occur at an alarming rate, causing serious loss of topsoil.

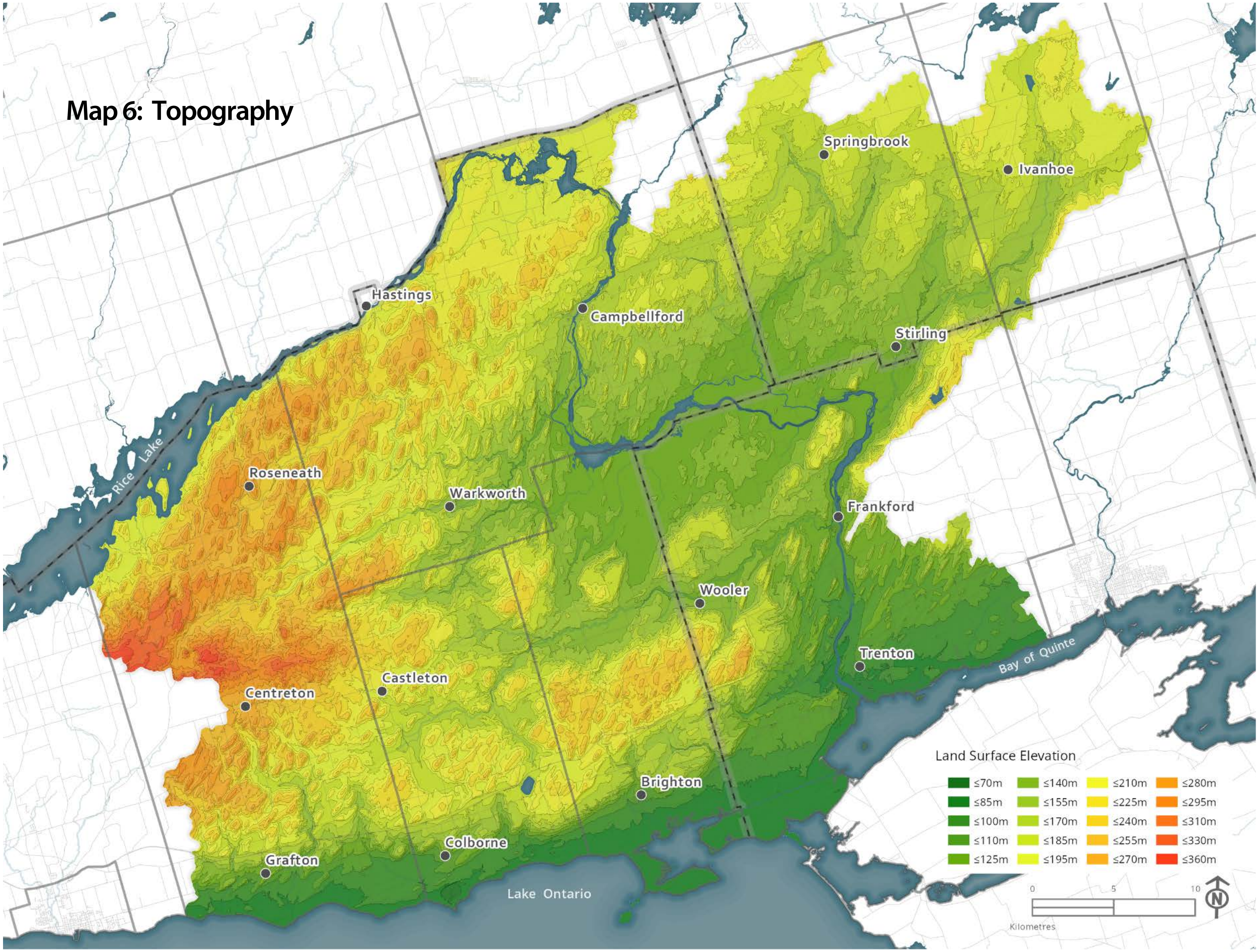
The rate of *erosion* is sometimes accelerated as a result of flooding, and by increased runoff associated with changing land uses. *Erosion* or slope failure also occurs in valley slopes outside of the river or stream. Such *erosion* is influenced by development activities, which results in interference with the drainage of slopes weakening their stability. Slopes (or valley lands) are then more susceptible to dramatic slope failure, such as slumping of the entire slope.

Erosion can also be caused by wave action and sediment transport along the Lake Ontario shoreline. Continual shoreline *erosion* and sediment deposition is constantly changing the shape of the shoreline. Changes to these *littoral* processes can have significant impacts to *erosion* rates.

Erosion and slope failure can be catastrophic, resulting in damage to property, injury to humans, and even loss of life. *Erosion* hazards within the Lower Trent *watershed* region are generally associated with steep slopes that are the result of glacial and lake deposits, steeply eroded riverine valleys, and the shoreline of Lake Ontario and the Bay of Quinte.

Erosion of Lake Ontario shoreline at Hortop Public Safety Lands

Map 6: Topography



A storm brewing over High Bluff Island
southwest of Presqu'ile Provincial Park on Lake Ontario

5. Climate

Wacky Weather

Past & Current Trends

Warm summers and cool winters are characteristic of the temperature regime of southern Ontario. Topography exerts a significant influence on local temperature and precipitation. The year-round open water of Lake Ontario has a pronounced effect in moderating the climate of the southern portion of the *watershed* region from the more extreme conditions, which might normally be expected to prevail. Trenton Airport and Peterborough Airport stations provide the best continuous records for the area and, together, give a thorough picture of the climate. The Trenton station reflects the climate of areas adjacent to the Bay of Quinte and Lake Ontario, while the Peterborough station reflects conditions for inland areas.

Drought conditions in a local wetland

Table 1 shows the long-term (1981-2010) mean monthly precipitation and temperature for the area. Historical records from the Peterborough Airport climate station show that inland areas receive a mean monthly precipitation of 71.3 mm/month and an annual mean of 855.4 mm/year (Government of Canada, 2018a). There is less precipitation in January through March compared with the rest of the year. November was the wettest month in this period, with 86.4 mm of precipitation, and February the driest month with 51.5 mm. The mean temperature for the period was 6.2°C. January was the coldest month with a mean temperature of -8.5°C, and July the warmest month with a mean temperature of 19.6°C (Government of Canada, 2018a).

Records from the Trenton Airport climate station show that areas adjacent to Lake Ontario and the Bay of Quinte receive more precipitation, resulting in a mean monthly amount of 75.9 mm and annual mean of 911.3 mm/year (Government of Canada, 2018b). November was the wettest month with 95.5 mm, and February the driest month with 56.5 mm. It was also warmer near the lake for the period, with a mean annual temperature of 7.3°C. January was the coldest month with a mean temperature of -6.8°C, and July the warmest month with a mean temperature of 20.7°C (Government of Canada, 2018b).

The monthly temperatures and precipitation for both stations are shown in ***Figure 1*** and ***Figure 2***.

Table 1. Precipitation and Temperature (1981 – 2010)

Month	Peterborough Airport		Trenton Airport	
	Precipitation (mm)	Temperature (EC)	Precipitation (mm)	Temperature (EC)
January	57.4	-8.5	68.1	-6.8
February	51.5	-7	56.5	-5.7
March	56.1	-1.8	62.3	-0.7
April	68.6	5.9	77.3	6.6
May	81.5	12.1	79.4	12.7
June	79.9	17	78.3	18
July	70.6	19.6	69	20.7
August	77	18.3	72.2	19.7
September	85.3	13.9	90.1	15.3
October	76.9	7.5	83.6	8.6
November	86.4	1.9	95.5	3
December	64.2	-4.4	79	-3.3
AVG MONTHLY MEAN	**71.3**	**6.2**	**75.9**	**7.3**
ANNUAL MEAN	**855.4**		**911.3**	

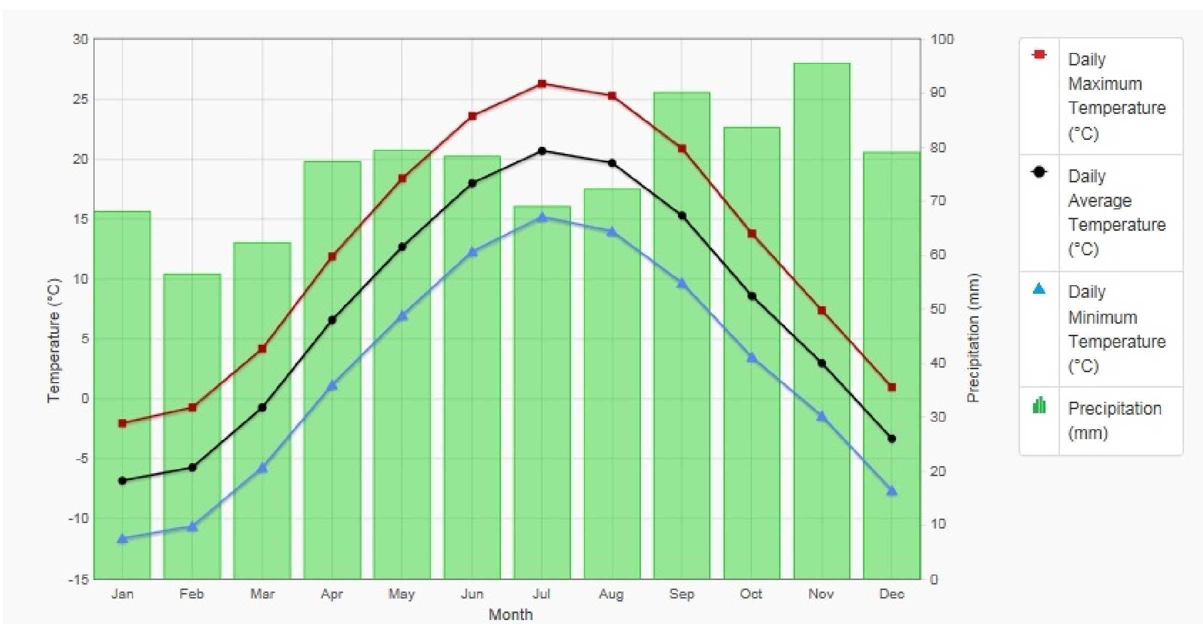


Figure 1. Temperature and precipitation graph for 1981 to 2010 Canadian Climate Normals, Peterborough Airport (Government of Canada, 2018a)

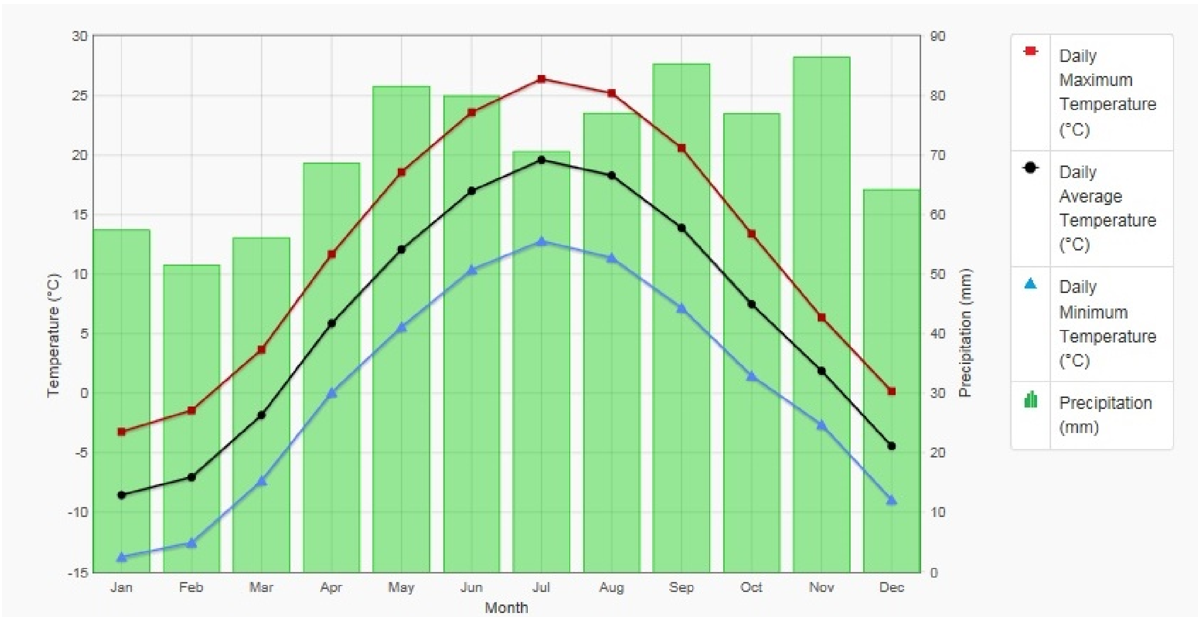


Figure 2. Temperature and precipitation graph for 1981 to 2010 Canadian Climate Normals, Trenton Airport (Government of Canada, 2018b).

Impact of Climate Change

There is scientific evidence that a warming world will be accompanied by changes in intensity, duration, frequency, and geographic extent of weather and climate extremes. Within a changing climate system, some of what are now considered to be extreme events will occur more frequently (e.g., heat waves, extreme precipitation events, heavy downpours), and some less frequently (e.g., cold snaps, frosts). Some examples of projected weather and climate extremes regionally (Canada and the northern United States) and their associated impacts are:

- Abnormally hot days and nights; heat waves are likely to become more frequent. Cold days and cold nights are very likely to become much less frequent. The number of days with frost is very likely to decrease.
- Sea ice extent is expected to continue to decrease, and may even disappear entirely in the Arctic Ocean in summer in the coming decades. This increases exposure of coastlines to strong wave action.
- On average, precipitation is likely to be less frequent, but more intense, and precipitation extremes are very likely to increase.
- Changes in evaporation and *evapotranspiration* are likely because of increasing temperatures.
- Decreased soil moisture may occur due to increasing *evapotranspiration.*
- A suite of climate simulations show that North America may experience increased annual runoff in the eastern regions.
- There is a trend towards reduced *snowpack* and earlier snowmelt runoff peaks (spring *freshet*) (Climate Change Science Program, 2008).

A Changing Climate

There is no doubt – *climate change* is real. In 2015, NASA (National Aeronautics and Space Administration) proclaimed 2014 as the warmest year on record.

In 2016, they said 2015 was the warmest year on record.

In 2017, they said 2016 was the warmest year on record.

Of the 17 hottest years ever recorded, 16 have occurred since 2000.

Climate change will affect the hydrological regime and natural heritage of the Lower Trent *watershed* region. An understanding of how climate will change locally is needed, and then mitigation and adaption strategies must be developed. While mitigation is important, the most direct actions that Lower Trent Conservation can take are in the area of adaptation.

There is uncertainty with respect to the extent and time frame of *climate change*, and the types of impacts that will occur. Scientists have been working with over 20 Coupled Atmosphere – Ocean General Circulation Models that have been endorsed by the Inter-Governmental Panel on Climate Change. Subject to modelling uncertainty, these models can predict the future climate parameters based on selected emission scenarios. Taking 1990 levels of greenhouse gases and then increasing these at varying rates, the models have been used to produce ensemble *climate change* projections at the global scale, at the hemisphere scale, for the country as a whole, and at the provincial scale.

At the global scale, the data indicates that there has been a 0.6°C increase in the 20th century and that the 20th century likely was the warmest century of the past 1,000 years (CCSP, 2008). The 2009 State of the Climate report (National Oceanic and Atmospheric

Administration, 2017), which draws on data for 10 key climate indicators, presents unmistakable scientific evidence that the world is warming. More than 300 scientists from 160 research groups in 48 countries contributed to the report which confirms that the past decade (2000 – 2009) was the warmest on record, and that the Earth has been growing warmer over the last 50 years (National Oceanic and Atmospheric Administration, 2018.) Earth's 2016 surface temperatures were the warmest since modern recordkeeping began in 1880, according to independent analyses by NASA and the National Oceanic and Atmospheric Administration. Also, 2016 was the third year in a row to set a new record for global average surface temperatures.

Canada, on average, has warmed by more than 1.4ºC since 1948 (Lemmen et al., 2008). The greatest temperature increases have been observed in the Yukon and Northwest Territories. On a seasonal basis, temperature increases have been greater during the winter and spring months; summer warming has been more modest. Canada, on average, has become wetter during the past half century, with mean precipitation across the country increasing by about 12%. Annually averaged, the largest percentage increase in precipitation occurred in the Arctic, while southern Canada has seen little change (Lemmen et al., 2008).

While there are some cooler and drier years, on average, Ontario has been getting warmer and wetter. Since 1948, average annual temperatures have increased by as much as 1.4ºC (Chiotti and Lavender, 2008). During the period between 1950 and 2003, the north sub-region of the Province has shown both the largest increase in the number of warm days as well as a significant decrease in the number of cold days. In southern Ontario (and the Great Lakes Basin), temperature increases have been greater during the winter and spring months, whereas summer warming has been more modest. The impact of warming is felt more at night than during the day.

Local Climate Change Projections

Based on what has occurred over the past decades, the following projections have been made by climate scientists, and may apply to the Lower Trent *watershed* region:

- average annual temperatures will increase, with the most pronounced temperature increases occurring in winter and at night
- seasonal projections of temperature scenarios indicate that maximum warming will occur locally in winter (i.e., winter weather will become less cold, more so in the north sub-region of Ontario)
- the number of days exceeding 30ºC in the south sub-region of the province is projected to be more than double by 2050
- although annual precipitation totals are likely to increase, summer and fall decreases of up to 10% are projected for the south sub-region of the province by 2050
- winter projections show increases in precipitation, increasing from south to north (of the Province) and ranging from 10% to more than 40%
- changes in the extreme daily precipitation amounts in Ontario are expected to be greater than the changes projected in the annual mean amounts, meaning that these types of events will become more frequent and intense
- it is likely that *lake-effect* snow will increase, in the short to medium term, as lake temperatures rise and winter air temperatures are still cool enough to produce snow
- by the end of the 21st century, snowfall may decrease and may possibly be replaced by heavy *lake-effect* rainfall events
- an increase in yearly-average surface air temperature between 1.5 to 2.0°C is anticipated for the Great Lakes Region of Canada between 1990 and 2030
- an increase in yearly-average total annual precipitation between 1 and 10% is anticipated for the Great Lakes Region of Canada between 1990 and 2030

It should be noted that there is greater variation in projections of precipitation than of temperature, with the greatest precipitation increases projected for the north sub-region of Ontario (CCSP, 2008).

Climate Change is likely to impact the *hydrologic cycle* (water quantity) and ambient water quality within the Lower Trent *watershed* region. The following is anticipated:

- a more active hydrological cycle with more frequent and intense precipitation events
- decreased snow pack and earlier spring *freshet* and, possibly, multiple *freshet* events
- a decrease in peak stream flow during spring *freshet*
- an increase in summer and fall peak stream flow due to increases in frequency and intensity of storm events which, in turn, will result in increased *erosion* (notably agricultural lands) and more spills due to back-ups in storm sewers and sanitary sewers (within urban catchments)

- increased frequencies of sanitary sewer overflows and effluent "by-pass" events from sewage treatment plants
- persistence of low flow conditions
- increased median stream flow in the fall and winter; decreased median stream flow in the spring and summer
- increased frequency of severe events (dramatic increases or decreases in temperature in winter) could result in *"frazil ice"* conditions and ice jams
- changes in flora and fauna due to a changing ecological regime (i.e., would become more temperate)
- possible increase in the blooms of *cladophora* and *cyanobacteria* in waterbodies due to increases in temperature, atmospheric carbon dioxide levels, and decreases in stratification resulting in enhanced mixing of water bringing nutrients to the euphotic zone
- any increase in likelihood of *cyanobacteria* blooms will result in an increased risk of *cyanobacteria* based toxin (e.g. *microcystin*-LR) production in the affected waterbodies; increases in temperature can potentially induce the harmful variety of *cyanobacteria* to secrete the toxins into the water column; the current treatment processes employed in the water treatment plants are unlikely to remove the *hydrophilic* toxins from water
- possible changes in pH (acidity/alkalinity) and pE (redox potential) of water, resulting in changes in chemical behavior in water (aquatic chemistry), due to changes in atmospheric carbon dioxide and temperature

.

Cold Creek

6. Water Resources

Water, Water, Everywhere

Surface Water

The Lower Trent *watershed* region is comprised of the downstream portion of the Trent River *watershed* and smaller streams and their *watersheds*, which drain directly to Lake Ontario and the Bay of Quinte. The Trent River itself has eight main tributaries. Map 7 shows the *watersheds* of the region.

Aside from Lake Ontario, the Bay of Quinte and Rice Lake, there are no large inland lakes in the *watershed* region. The largest are Little (Biddy) Lake and Oak Lake, which have surface areas of 65 ha and 48 ha, respectively. The remaining lakes are smaller still and often associated with *wetlands* or created through the construction of dams. Some of the smaller lakes include: Dartford Pond (44 ha), White Lake (35 ha), Stevenson Lake (30 ha), Lamey Lake (17 ha), Barry Lake (17 ha), Ross Lake (17 ha) and Killoran Lake (11 ha), as well as Matson Lake, Moreland Lake, McLeary Lake, Tremur Lake, O'melia Lake, Snake Lake and Cranberry Lake, all less than 11 ha (Lower Trent Region Conservation, 1982).

Our Largest Little Lakes

Oak Lake

Situated within the *watershed* of the Trent River, but without a surface water connection, is a little jewel: Oak Lake. It is approximately 48 ha in size with a maximum depth of 10 m. Oak Lake is a remnant of glacial Lake Iroquois. When the levels of the glacial lake receded, water was trapped by massive barrier bars along the north side, forming the current day lake (OMNR, 1974). The lake is enjoyed by year round residents and cottagers. However, because of intense shoreline development and nearby agricultural activity, water quality, water levels, and shoreline *erosion* are ongoing concerns.

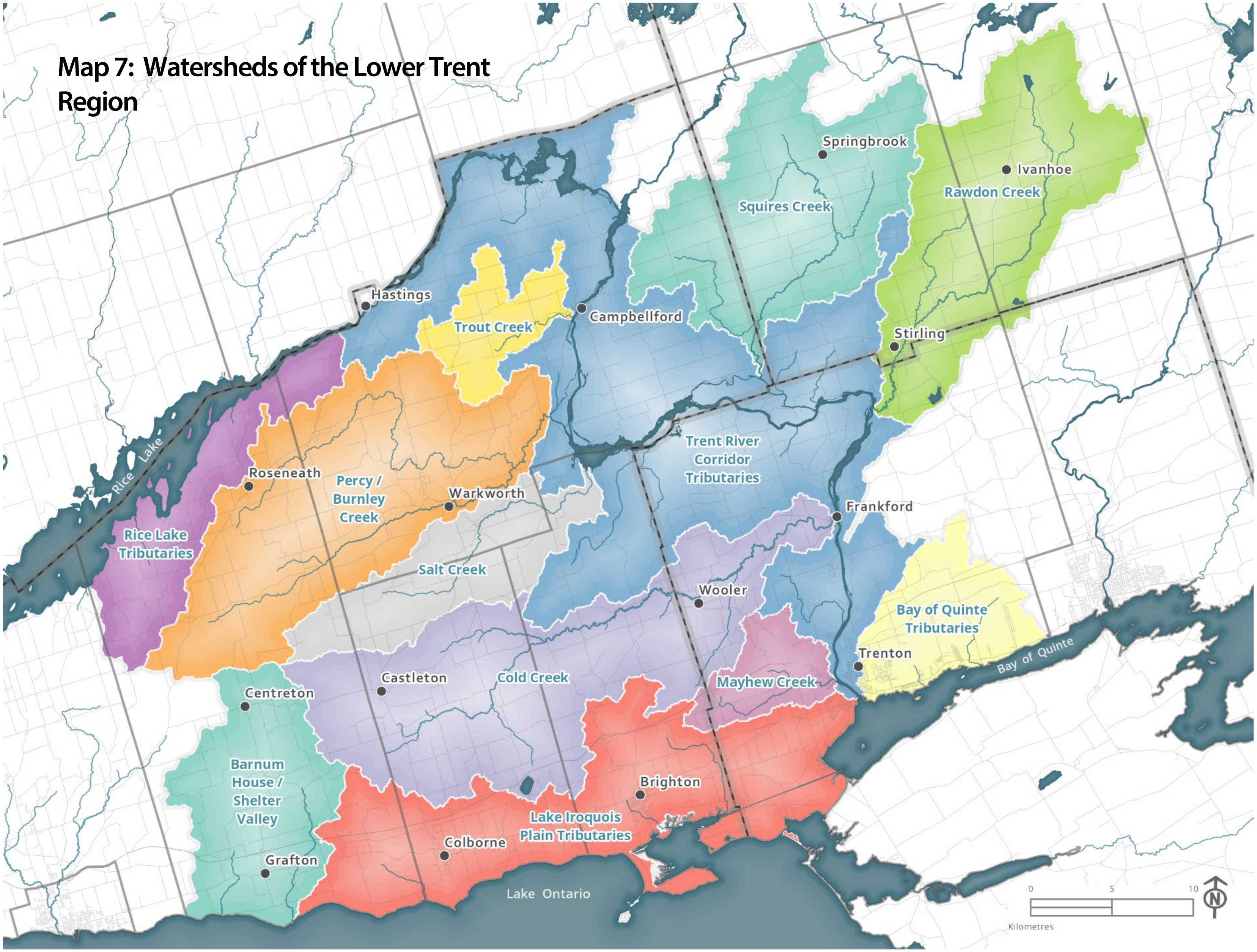
Little (Biddy) Lake

Little Lake (aka Biddy Lake) is located in the Cold Creek *watershed*. It is encircled with permanent and seasonal residences. Just 65 ha in size, it has a maximum depth of 8.5 m. Little Lake is fed by four inlets (springs and seasonal watercourses) and has one outlet on the north side which becomes a tributary of Cold Creek. During the summer month, water levels drop, hampering motor boat traffic on both the north and south shores (LTRCA, 1982).

Lake Ontario & the Bay of Quinte

The Lower Trent *watershed* region abuts Lake Ontario and the Bay of Quinte.

Lake Ontario has an average depth of 86 m, with a circumference of 1,146 km (Great Lakes Environmental Research Laboratory, 2018a). Because of the lake's depth, Lake Ontario doesn't normally freeze over during the winter months. A partial ice sheet forms, its size varying with the severity of the winter. The lake typically freezes just around the edges, closing its harbors during the winter months. The 1992-2016 long-term average surface water temperature for Lake Ontario is 10.05°C (mean) with the average maximum temperature of 22.23°C, and the average minimum temperature of 1.75°C (Great Lakes Environmental Research Laboratory, 2018b). Summer stratification occurs in Lake Ontario with the *thermocline* forming at a depth of approximately 17 m from surface (Thomann et al., 1977).



Map 7: Watersheds of the Lower Trent Region
Springbrook
Ivanhoe
Rawdon Creek
Squires Creek
Hastings
Campbellford
Trout Creek
Stirling
Trent River Corridor Tributaries
Rice Lake
Roseneath
Percy / Burnley Creek
Warkworth
Frankford
Rice Lake Tributaries
Salt Creek
Wooler
Bay of Quinte Tributaries
Trenton
Castleton
Cold Creek
Mayhew Creek
Bay of Quinte
Centreton
Barnum House / Shelter Valley
Brighton
Lake Iroquois Plain Tributaries
Colborne
Grafton
Lake Ontario
0
5
10
Kilometres
N

The Bay of Quinte is much shallower and warms up a lot more in the summer. In the winter, it freezes over. The average surface temperature (1972 – 2008) is 19.5°C, with the average maximum 28.2°C and the average minimum 5.5°C. The average, average maximum, and average minimum temperatures for the bottom of the Bay of Quinte are 9.7°C, 19.1°C, and 0.2°C, respectively (Minns et al., 2011).

The Bay of Quinte is divided into upper, middle, and lower bays due to *bathymetry* and *hydrodynamic* characteristics, with the upper bay being in Lower Trent Conservation's jurisdiction. Complete mixing occurs in the shallow upper bay, whereas thermal stratification occurs in the deeper middle and lower bays. Surface temperatures rose almost 1°C between 1972 and 2008. The surface warming has lengthened and strengthened stratification in deeper areas but, as of 2011, no changes in *thermocline* depth or bottom temperatures were evident (Minns et al., 2011).

The *watershed* region includes over 100 km of Lake Ontario shoreline, including Presqu'ile Bay, Wellers Bay, and the Bay of Quinte. Presqu'ile Bay and the Bay of Quinte are connected by the Murray Canal (approximately 8 km in length), which was constructed between1882-1889. Approximately 40% of the region's shoreline is vegetated (e.g., *wetland*, trees, and shrubs). The remaining 60% is urban, rural residential, cottages, trailer parks, and agriculture, with little natural vegetation along the shore. The shoreline is influenced by fluctuations in water levels and wave action, resulting in *inundation*, *erosion*, and *accretion*.

Lower Trent Conservation's Lake Ontario shoreline is characterized by low bluffs and plains, with some *wetlands* and beach deposits. The highest bluffs are located in the western portion of the region, reaching 10 m in height. These bluffs and the lower bluffs to the east (from Alnwick/Haldimand to the Barcovan Beach area of Quinte West) are actively eroding. In some areas, landowners have attempted to protect their properties with various types of shoreline protection, ranging from naturalized planted shorelines to hardened shorelines comprised of gabion netting and baskets, wood crib walls, cement seawalls, and armour stone and boulder revetments. Some of this protection work is failing due to the erosive forces of wind, wave, and ice activity. In 2017, record high lake levels, which exceeded the 100 year static water level, resulted in extensive *erosion* damage to the natural shoreline and existing shore protection works.

Cobble and pebble beaches occur in Alnwick/Haldimand, Cramahe, and Brighton. Some of these are dynamic beaches - unstable accumulations of shoreline sediments. Over 20 dynamic beaches have been identified. An extensive sand beach deposit with dunes is found at Presqu'ile Provincial Park. This 2.5 km beach is accreting (undergoing constant widening).

To the east, Presqu'ile Bay, Wellers Bay, and the Bay of Quinte are more protected shorelines with low banks and large coastal *wetlands*. Areas with low banks and beaches are more susceptible to flooding hazards.

In the early 1990s, detailed mapping delineating the static 100 year flood line (at a scale of 1:2,000) was prepared for the Lake Ontario shoreline under the Canada – Ontario Flood Damage Reduction Program.

Lake Ontario Tributaries

Draining directly to Lake Ontario are the *watersheds* of those streams which originate in the Oak Ridges Moraine and South Slope. For reporting, Lower Trent Conservation has divided the watercourses that empty into the lake into two groups:

The Group of Twelve

Lower Trent Conservation divides its region into 12 *watershed* groups for reporting purposes:

Rice Lake Tributaries
Trent River Corridor Tributaries
Trout Creek
Percy/Burnley (Mill) Creek
Salt Creek
Squires (Hoards) Creek
Rawdon Creek
Cold Creek
Mayhew Creek
Barnum House/Shelter Valley Creeks
Lake Iroquois Plain Tributaries
Bay of Quinte Tributaries

Barnum House/Shelter Valley Creeks (with *headwaters* on the Oak Ridges Moraine)

- Barnum House Creek
- Shelter Valley Creek

Lake Iroquois Plain Tributaries (with *headwaters* in the South Slope)

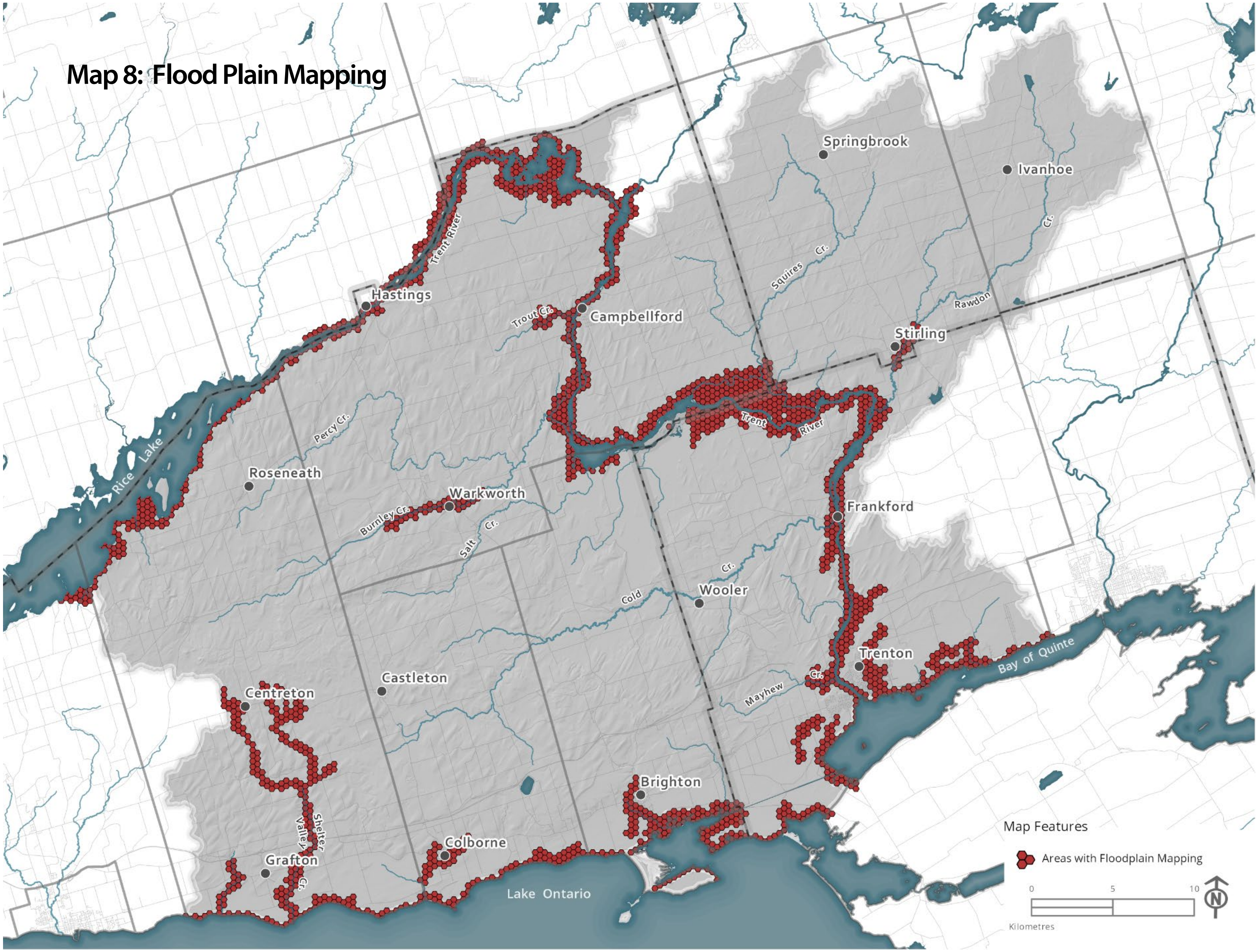
- Lakeport Creek
- Colborne Creek
- Salem Creek
- Butler (Proctor) Creek
- Smithfield Creek

In addition to these watercourses, there are some small streams, *wetlands*, and coastal areas that drain directly into the lake.

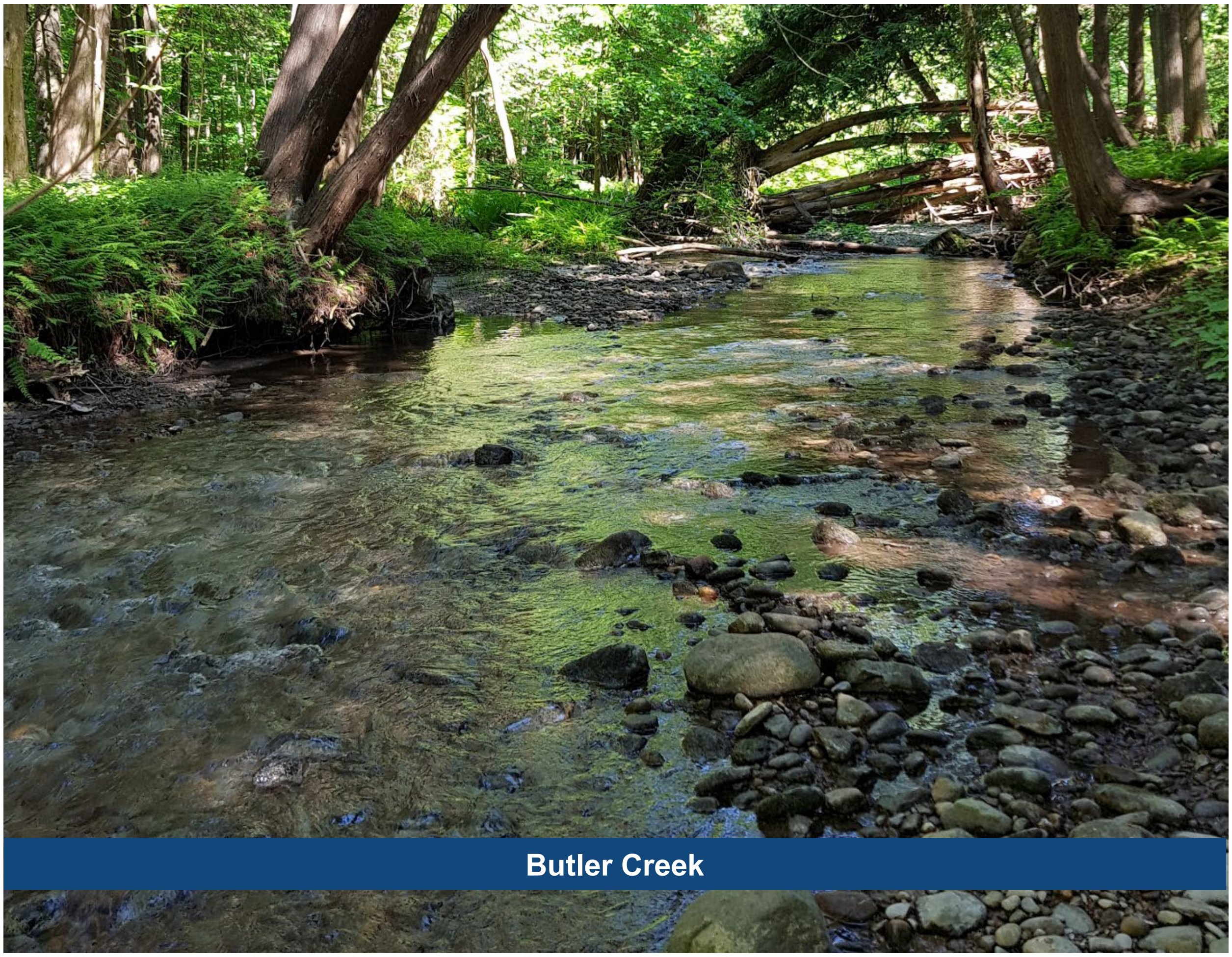
The Oak Ridges Moraine acts as both a major *drainage divide* and recharge area for groundwater, which provides *baseflow* for streams flowing to the north and south. Precipitation, for the most part, drains vertically until it reaches beds of lower permeability where it then migrates laterally. There is a conspicuous lack of streams on the higher elevations of the Moraine. *Groundwater discharge*, in the form of seeps and springs, occurs along the topographic break between the Moraine and the surrounding drumlinized *till* plains, along the incised stream valleys within the Moraine, and in the inter-*drumlin* swales. These seeps and springs are a major source of water to the streams. Stream gradients in the northern segments of these basins are steep. In their descent from the South Slope to the Lake Iroquois sand plain, stream gradients steepen to flow through deep ravines in the Lake Iroquois shoreline cliffs. After following passages through shoreline valleys, stream gradients become considerably less steep as they flow onto the Lake Iroquois plain. The streams meander through broad flood plains and low banks, which are frequently over-topped and constantly changing, during their journey to Lake Ontario (Lower Trent Region Conservation Authority, 1982).

Flood plain mapping was completed for sections of Barnum House and Shelter Valley Creeks (in 1978), Colborne Creek (in 1982), and Butler Creek (in 1978 and updated in 1988). Map 8 shows the areas of the *watershed* region where *flood plain* mapping has been completed.

Map 8: Flood Plain Mapping



Many watercourses originating on the Moraine and the South Slope are cold to *cool water* streams (e.g., Barnum House Creek, Butler Creek). However, runoff from surrounding land uses, like agriculture and development, may increase water temperatures downstream.



Butler Creek

Bay of Quinte Tributaries

The Bay of Quinte Tributaries drain the southeastern portion of the Lower Trent *watershed* region, emptying into the Bay of Quinte. These *watersheds* consist largely of a thin mantle of clay and clay loam soils over a limestone base. The creeks are intermittent and portions have been channelized, piped, and/or diverted.

In addition to several unnamed watercourses, there are a few named ones:

- Massey Creek
- Meyers Creek
- DND (Department of National Defence) Creek
- Dead Creek
- York Creek
- Hutchinson Creek

Watershed Plans

Two *watershed* plans were completed by Lower Trent Conservation, both with funding through the Bay of Quinte Remedial Action Plan:

- **South Sidney Subwatershed Plan (Totten Sims Hubicki Associates, 1995)**
- **Dead & York Creek Subwatershed Plan (Lower Trent Conservation, 1998).**

A State of the Watershed Report was completed for Mayhew Creek in 2000, as the first step in developing a *watershed* plan, also with support through the Bay of Quinte Remedial Action Plan. It identified the issues to be addressed in a *watershed* plan. Unfortunately, funding did not materialize and the *watershed* plan was never completed.

Flood plain mapping was completed for reaches of Massey Creek, Meyers Creek, and an unnamed creek as part of the South Sidney Watershed Plan in 1995 and for a length of Dead Creek and York Creek in 1998 as part of the Dead & York Creek Subwatershed Plan (Lower Trent Conservation, 1998). The DND Creek Flood Plain mapping study was completed in 1978, with updates in 2002 and 2012 (Map 8).

These streams are *warm water* streams with negligible flow in the summer. They are low gradient streams, draining predominantly agricultural lands. DND Creek, which runs through the Trenton Air Base, has been significantly altered and includes channelized reaches.

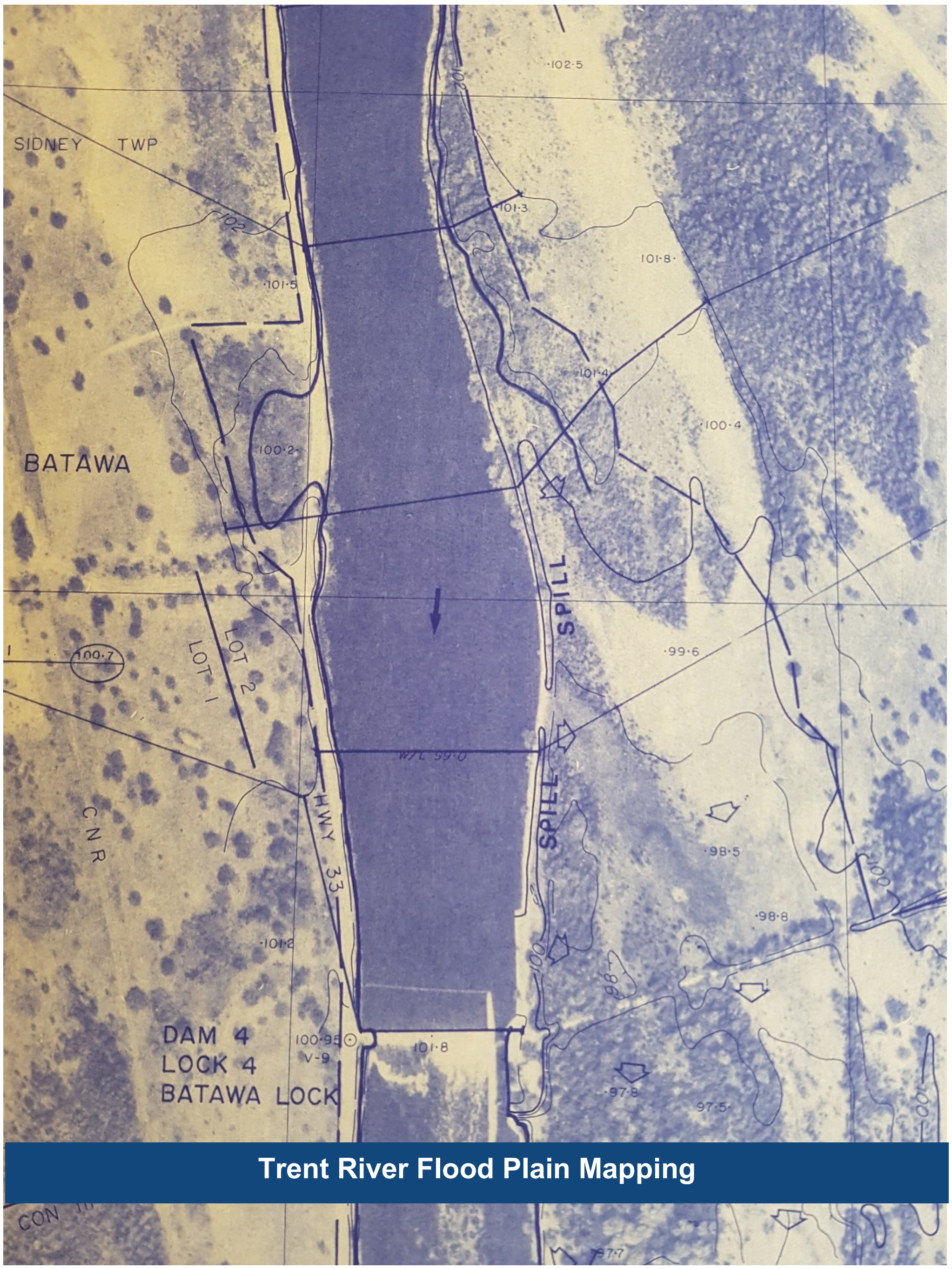
The Trent River and Rice Lake

The backbone of the Lower Trent *watershed* region is the Trent River, stretching from Rice Lake to the Bay of Quinte. It is the southernmost section of the *Trent-Severn Waterway*.

The Trent River *watershed* includes all of the land drained by the Trent River and is the largest *watershed* located entirely in southern Ontario. With its *headwaters* beginning in the southern fringes of Algonquin Provincial Park, the enormous Trent River system drains over 12,000 km^2. Water from over 200 lakes in the Haliburton Highlands flows through the Kawartha Lakes, down the Otonabee River, and into Rice Lake. The Crowe River, the largest tributary of the Trent, empties into the Trent River at Crowe Bay, below Healey Falls.

The Trent River *watershed* is under the jurisdiction of five Conservation Authorities: Kawartha Region, Otonabee Region, Ganaraska Region, Crowe Valley, and the Lower Trent Region. The upper portion of the *watershed* is outside of Conservation Authority jurisdiction. Lower Trent Conservation protects and manages the southern portion of the mighty Trent River *watershed*. The Trent River forms the northern boundary of the Lower Trent *watershed* before taking its southerly course to the Bay of Quinte. From Rice Lake, southwest of Hastings, the river descends approximately 110 m and travels 92 km to the Bay of Quinte (Lower Trent Region Conservation Authority, 1982), where it discharges approximately 4 billion m^3 of water annually (based on Water Survey of Canada data). *Flood plain* mapping was prepared for the Trenton section of the Trent River in 1975. In 1983, the *flood plain* mapping study for the entire Trent River and south shore of Rice Lake was completed, with more detailed mapping for Hastings, Campbellford, Percy Boom, and Frankford in 1988. Map 8 shows the location of the mapping along the Trent River and other watercourses in the *watershed* region.

The temperature profiles of the Trent River show that the water column is unstratified. The average temperature is 12.5°C, the average maximum is 24°C, and the average minimum is 1°C (Manning and Gracey, 1991).



Trent River Flood Plain Mapping

The Trent-Severn Waterway

The *Trent-Severn Waterway*, founded in 1833, is an interconnected series of lakes, improved river channels, and man-made canals stretching for 386 km through the heart of Ontario, from Georgian Bay to the Bay of Quinte. The system also includes a linkage to Presqu'ile Bay and Lake Ontario via the 8 km long Murray Canal.

The water in the system comes from two major *watersheds*, the Trent and Severn. The Trent River basin drains more than 12,000 km^2 of Central Ontario. The neighbouring Severn River *watershed* drains an area just over 6,000 km^2.

The Waterway, including its tributary lakes and rivers, is an important economic, environmental, and recreational resource used by thousands of boaters, shoreline residents, businesses, and vacationers every year. It also provides water for power generation, municipal water supplies, and agriculture, and supports a tremendous variety of fish and wildlife.

Water levels and flows throughout the Trent and Severn drainage basins are managed by Parks Canada, an agency of Environment Canada.

Trent River Tributaries

There are several tributaries that drain into the Trent River in our *watershed* region:

- Rice Lake Tributaries
- Trent River Corridor
- Trout Creek
- Percy/Burnley (Mill) Creek
- Salt Creek
- Squires (Hoards) Creek
- Rawdon Creek
- Cold Creek
- Mayhew Creek

Cold, Salt, Percy/Burnley (Mill), Trout, and Mayhew Creeks drain into the Trent River from the west. Percy/Burnley Creek, Salt Creek, and Cold Creek *watersheds* originate in the sandy soils of the Oak Ridges Moraine which provides augmentation of stream flows during drier summer months. Of the local streams, Cold Creek has the largest drainage basin in the Lower Trent *watershed* region. These *watersheds* are generally characterized by the rough to hilly relief of the Peterborough Drumlin Field and the South Slope where slopes are numerous and steep. Much of the area, however, has been modified by the effects of the *Trent Embayment* towards the end of the last ice age. The shallow, turbulent, near shore waters of the *Trent Embayment* have reworked the rugged terrain, producing gently to moderately sloping areas of sandier soils. The good natural drainage of the deep, predominantly sandy and loamy *tills* of this area, and the relatively mild stream gradients, help to dissipate the magnitude of peak flows and supply fairly good year round baseflow (Lower Trent Region Conservation Authority, 1982).

The Rice Lake tributaries include the small tributaries that drain into the southeast portion of the Lake.

Squires (Hoards) Creek and Rawdon Creek drain the northeastern portion of the *watershed* region, flowing into the Trent River. The *headwaters* of Squires and Rawdon Creeks arise in the stony *till* of the Dummer Moraine. The topography of many of these basins is the result of the combination of two processes: glacial deposition of the Peterborough

Drumlin Field and subsequent *inundation* by the *Trent Embayment*. Creeks in this area experience very low summer flows as a result of the lack of groundwater storage and low baseflow supplies. In contrast to the steep valleys and well defined flood plains of the creeks to the west, the flood plains of Squires and Rawdon Creeks are broad, flat, and ill-defined (Department of Energy and Resources Management, 1970a).

In addition to the *watersheds* listed above, small tributaries, *riparian wetlands*, and small areas drain directly into the Trent River and comprise the Trent River Corridor *watershed* grouping. Murray Marsh is located in the heart of the *watershed* region and flows northward into the Trent River. The small *watersheds* along the river generally have a low gradient and are often located in the *flood plain*.

Murray Marsh

A *flood plain* mapping study was completed for Mayhew and Rawdon Creeks in 1975, and Cold Creek (in conjunction with Butler Creek) in 1978. These were updated in the 1980s and, in that same decade, studies were completed for Killoran, Trout, Burnley (Mill), and Glen Miller Creeks (Map 8).

The larger streams flowing into the Trent River have a tendency to be *cold water* streams in the upper reaches, particularly those originating on the Oak Ridges Moraine and the South Slope. Water temperatures warm as they pass through agricultural, residential, and urban areas on their journey to the River and, as such, they are generally classified as cool or *warm water* streams in the mid and lower reaches. The streams entering the Trent River from the north and east do not benefit from the recharge of *cold water* from the Oak Ridges Moraine. These streams are generally *warm water*, but there are portions of the *headwaters* of Rawdon Creek and Squires Creek that are considered cool to cold.

Record Flooding on Lake Ontario - 2017

2017 was the year of the flood along Lake Ontario.

Lower Trent Conservation first issued a Flood Outlook Statement on April 27, 2017 for Lake Ontario and a Flood Warning was in effect for May through August. Water levels as recorded at Cobourg reached a record setting daily average of 75.88 masl (metres above sea level) at the end of May, surpassing (by 11 cm) the highest water level recorded since 1918, when measurements first began.

High Water & Erosion

Flooding is a natural occurrence along the Trent River, local watercourses, and along Lake Ontario and the Bay of Quinte. During a flood, water levels rise resulting in the *inundation* of areas not ordinarily covered by water. Such areas are known as *flood plains*. Floods can occur at any time of the year and are caused by heavy rainfall, rapid melting of a thick snow pack or ice jams, and, in the case of Lake Ontario, winds and wave action. During flooding events and periods of high water, the rate of streambank and shoreline *erosion* can be accelerated. While flooding and *erosion* are natural processes in all rivers, streams, and coastal shorelines of the Great Lakes, they can have a detrimental effect on life and property. The extent of flooding is generally determined by the drainage basin or *watershed* characteristics, the shoreline morphology, and surrounding land uses. Sometimes floods occur because of a reduction in the natural channel capacity due to ice and debris jams. Ice and debris "block" the ability of water to move and, as a result, the water spills over the banks of the watercourse.

For Lower Trent Conservation's local (inland) watercourses, the most significant flooding is usually experienced in the spring, as a result of snowmelt. The spring *freshet* on local streams generally occurs in March or early April, but sudden thaws, heavy rainfalls, and ice jams can cause flooding earlier in the year. Because of the vast size of the Trent River basin (with *headwaters* as far north as Algonquin Provincial Park) and the fact that water flow is regulated by the *Trent-Severn Waterway*, the spring *freshet* on the Trent River occurs later (mid-April to May) and is prolonged, often lasting for several weeks.

In addition to the spring *freshet*, *frazil ice* formation also increases the risk for flooding on the Trent River. This can occur throughout the winter in turbulent water, when flows are high and temperatures are cold. Despite the regular occurrence of flooding in the spring, with some years more severe than others, it is important to remember that flooding can occur at any time as a result of heavy rainstorms.

Flooding also occurs along Lake Ontario and the Bay of Quinte. While static water levels peak in June, flooding can occur at any time of year as a result of high water levels, combined with wind and waves. In 2017, a prolonged period of flooding occurred on Lake Ontario, with water levels exceeding the 100 year static flood level for several weeks.

Drought 2016

2016 was a particularly dry year.

A Level 1 *Low Water Condition* was declared by Lower Trent Conservation on June 3rd due to lack of rainfall and low flows in local creeks and streams, upgraded to Level 2 on July 4th, and to Level 3 for Stirling-Rawdon and Centre Hastings in the northeastern portion of the *watershed* region on September 1st. Several rural landowners reported dry wells and the Stirling municipal drinking water system was stressed.

The 7 month drought advisory was lifted by Lower Trent Conservation on February 10, 2017.

Low Water

Water supports almost all aspects of human activity including health, industrial development, agriculture, and recreation. Historically, periods of dry weather and low water levels, or drought, were relatively uncommon in Ontario occurring once every 10-15 years. However, recent studies indicate that low water levels may become more common, as the Province's demand for water steadily increases and *climate change* impacts weather patterns and water availability. The most severe drought in recent history occurred in 2016. The Lower Trent *watershed* region experienced a 7 month drought lasting from June 2016 into February of 2017. Drought conditions were declared based on the Provincial Low Water Response Program criteria for precipitation and stream flow.

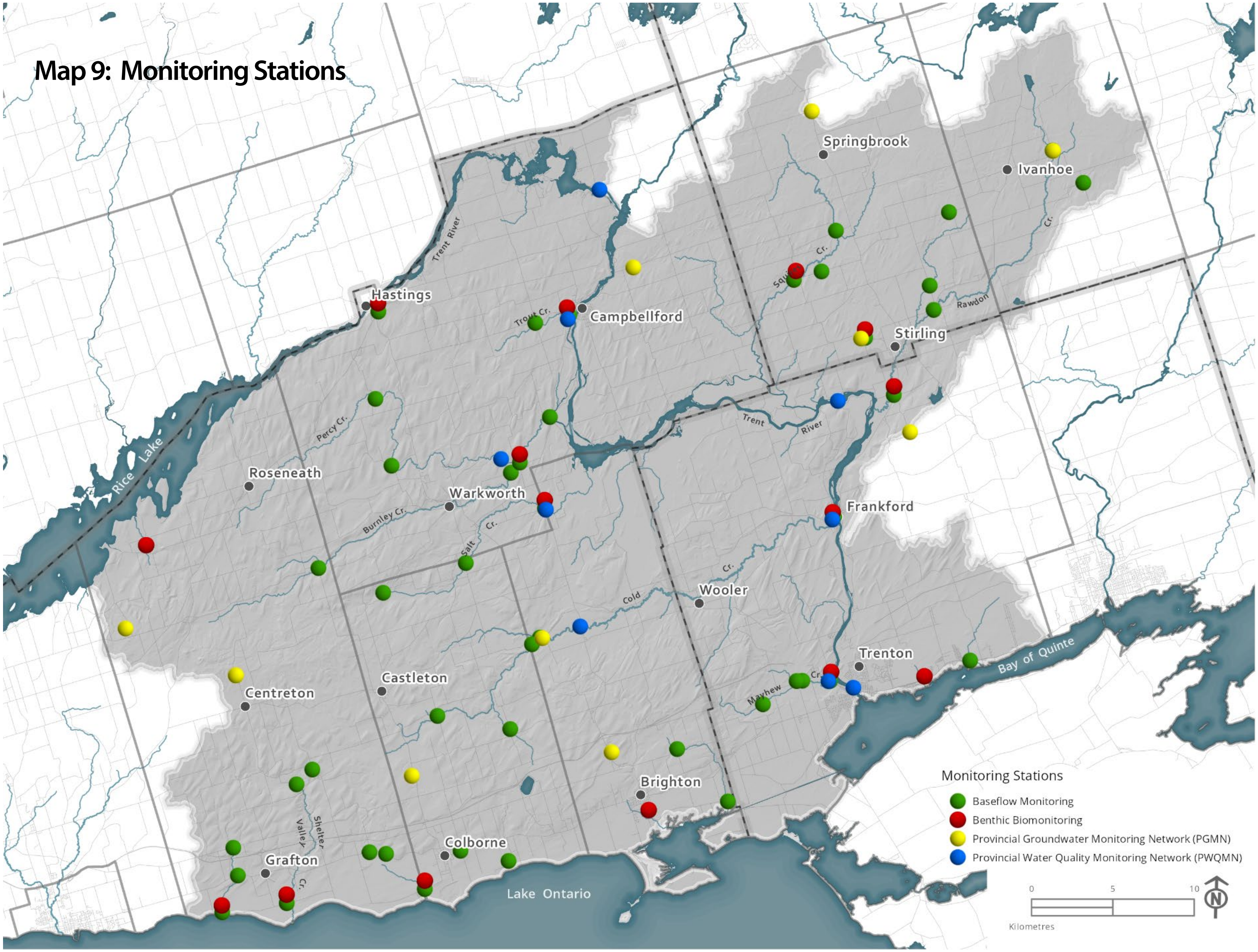
Lack of precipitation affects the quantity of stream flow and groundwater, resulting in water shortages for human use. In addition to impacting human activities, ecological impacts are also felt, as *wetlands* and streams dry up and vegetation dies off. Low water in streams also results in deteriorated water quality, as there is less dilution. The lowest amount of precipitation and stream flows generally occur in August or September, but January and February can also be dry months.

Lower Trent Conservation monitors precipitation and stream flow as part of the Ontario Low Water Response Program. The program does not currently include groundwater indicators, but anecdotal information about local wells is taken into consideration. In average years, there are some brief localized water shortages for rural wells but, overall, there are no widespread water quantity concerns in the *watershed* region.

Locally, the Oak Ridges Moraine, in the northwest part of the region, helps to maintain stream flow and groundwater levels through the drier summer months. The areas to the east of the Trent River are more susceptible to drought due to the shallow soils, resulting in limited groundwater storage.

Baseflow has been measured in the Lower Trent *watershed* region on an annual basis since 2002 in order to characterize the streams under a variety of conditions (e.g., wet vs. dry years) and to track any changes that occur. Map 9 shows the current location of the baseflow sites.

Map 9: Monitoring Stations



The baseflow of a stream is a measure of the *groundwater recharge* contributing to the overall flow. During the summer months, it is baseflow that sustains a stream and prevents it from drying up. The constant supply of groundwater is also typically cold and clean which contributes to a steady thermal regime and overall ecosystem health.

A typical trend found through such monitoring is that development near a watercourse will decrease the relative contribution of baseflow vs. surface water runoff, increase the flashiness of the stream (the time it takes to respond to rainfall events), decrease water quality, and increase temperature fluctuations/variability within the stream.

Low Water – Squires (Hoards) Creek

A Lock Monster!

There are 42 locks on the *Trent-Severn Waterway.* These locks raise and lower watercraft between stretches of water at different levels along the Waterway to ease navigation. Locks 1 to 18 are in the Lower Trent *watershed* region.

Water Control Structures

Dams are built to store water to create ponds, compensate for fluctuations in river flow, and meet demands for water and energy.

The largest dam that affects the Lower Trent *watershed* region is the Moses-Saunders Power Dam on the St. Lawrence River, straddling the border between the United States and Canada. It is located between Massena, New York and Cornwall, Ontario and was built between 1954 and 1958. The dam's operation impacts water levels on Lake Ontario and the Bay of Quinte; however, the main factor in determining water levels and outflows are the naturally occurring water supplies into Lake Ontario from Lake Erie, *watershed* runoff via rivers and streams, and precipitation and evaporation. Plan 2014, the current plan prepared by the International Joint Commission to guide operation of the dam, specifies weekly outflows based on the water level of Lake Ontario, the water supplies to the lake, and conditions upstream and downstream on the St. Lawrence River. The plan is designed to protect various interests that may be affected by extreme flows or levels including protection against flooding, hydropower production, minimum depths for municipal water intakes, and navigation (International Joint Commission, 2018).

The *Trent-Severn Waterway* system has 125 dams of various sizes and types (Parks Canada, 2000). These dams were constructed to manage water levels for recreational navigation on the Trent and Severn Rivers. In the Lower Trent *watershed* region, there are 15 dams on the Trent River between Rice Lake and the Bay of Quinte. Fourteen of these dams are operated by the *Trent-Severn Waterway.* While the main purpose of these dams is to control water levels for navigation, they are also operated by *Trent-Severn Waterway* staff to help minimize flooding. However, they were not designed for flood control and their capacity to control flooding, particularly for large events, is limited. Eight of the dams are being used by Ontario Power Generation, and two by Innergex Renewable Energy Inc., for power generation.

There are several small dams, some associated with historic mills, on local watercourses. Some of these dams have fallen into a state of disrepair. Those remaining are maintained mostly for aesthetic or recreational purposes. Lower Trent Conservation owns one dam, the Warkworth Dam. Located on Burnley (Mill) Creek in the village of Warkworth, it is operated twice a year (in the fall and spring) to alleviate potential flooding. There is also a flow regulation weir on Barnum House Creek in the Barnum

House Creek Natural Habitat Area. The weir was constructed by the Ministry of Natural Resources in 1977, in an effort to maintain flow in an eastern and western channel to address landowner concerns regarding *riparian* rights. Lower Trent Conservation's Flood Control Structures also include two weirs on Mayhew Creek: a two-stage weir on the main channel and a broad-crested weir on the overflow channel. There is also a weir dam on Rawdon Creek in the Village of Stirling in between the floodwalls.

Beaver dams are abundant across the *watershed* region and often cause concerns for local residents. In developed areas, beaver dams can result in flooding of agricultural lands, roadways, and nearby properties.

Flood & Erosion Control

Historically, many of the urban centres within the Lower Trent *watershed* region were settled along river valleys and in close proximity to watercourses. While there were many benefits to locating in these places, there were also risks from flooding and *erosion*.

Following the flood of 1980, Lower Trent Conservation constructed flood and *erosion* control projects at ten locations in various municipalities throughout the region to protect existing homes and businesses against these natural hazards. Grants were provided by the Province of Ontario to construct these structures, with the remaining funds coming from the individual municipalities that directly benefited from the project. They include:

- Mayhew Creek (Barry Heights - Trenton) Flood Control: channel improvement
- Mayhew Creek (Trenton) Flood Control: by-pass channel, weirs & berm
- DND Creek (Trenton) Flood Control: gabion channel
- Glen Miller Creek (Trenton) Flood Control: berm & channel improvements
- Trent River (Trenton) Flood Control: berm
- Cold Creek (Frankford) Flood & Erosion Control: berm & channel improvements
- Rawdon Creek (Stirling) Flood & Erosion Control: flood wall, weir & gabion channel
- Burnley/Mill Creek (Warkworth) Flood Control: dam & flood wall
- Trout Creek (Campbellford) Flood Control: flood wall & channel improvements
- Killoran Creek (Hastings) Flood Control: flood wall & channel improvements.

As these structures were constructed over 30 years ago, a maintenance program and regular inspections are required to ensure that they are in good condition and continue to function as designed.

In addition to the flood and *erosion* control structures built and maintained by Lower Trent Conservation, the Conservation Authority also maintains ownership of Hortop Public Safety Lands, a narrow strip of land approximately 976 m in length, in the Township of Alnwick/Haldimand. This property was deeded to Lower Trent Conservation in 1981, as part of a shoreline development, and was meant to serve as a buffer zone to protect homeowners from shoreline *erosion* up to the 100 year *erosion* line. The shoreline, as anticipated, has receded over the past four decades; eventually, the property will erode away and the aging homes will be subject to shoreline *erosion*.

Groundwater Tech Talk

***Infiltration* is the component of the water cycle that penetrates the ground surface**

Infiltration* = recharge + interflow + *baseflow

Recharge is the component of *infiltration* that replenishes the shallow and deep *aquifer*/groundwater, increasing the groundwater storage, which results in increases in groundwater levels

Interflow is the component of *infiltration* that moves laterally within the unsaturated (vadose) zone and returns to the surface or streams

***Baseflow* is the component of *infiltration* that replenishes the stream flow, originating from shallow or deep groundwater**

Groundwater

Groundwater does not mirror surface water drainage patterns, but extends beyond *watershed* boundaries. It is not confined to only a few channels or depressions in the same way that surface water is concentrated in streams and lakes. Sometimes it is thought that water flows through underground rivers, or that it collects in underground lakes. Rather, it exists almost everywhere underground. It is found in the spaces between particles of rock and soil, or in crevices and cracks in the bedrock.

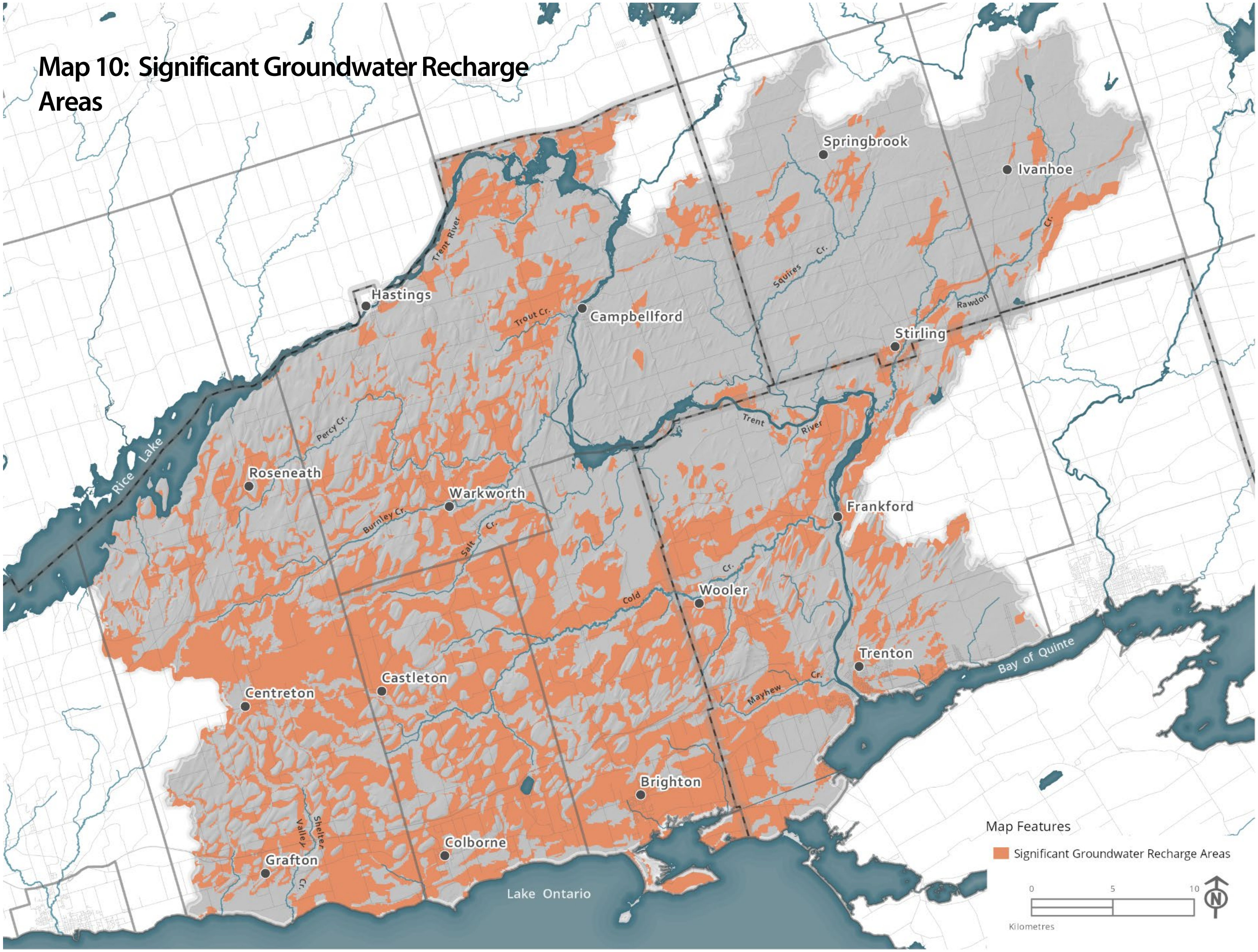
Groundwater flows slowly through water-bearing formations *(aquifers)* at different rates. In some places, where groundwater has dissolved limestone to form caverns and large openings, its rate of flow can be relatively fast, but this is an exception.

The level below which all the spaces are filled with water is called the *water table (unconfined aquifer*) or *potentiometric surface (confined aquifer).* Above the *water table* lies the unsaturated zone. Here, the spaces in the rock and soil contain both air and water. Water in this zone is called soil moisture. The entire region below the *water table* is called the saturated zone, and water in this saturated zone is called groundwater.

Groundwater recharge is a hydrologic process by which *aquifers* are replenished by the downward movement of water. The amount of *groundwater recharge* that occurs in a particular area depends on the climate and *surficial geology* of that area. Significant *groundwater recharge* areas are locations where the geological conditions favour *groundwater recharge*. The significant *groundwater recharge* areas in the Lower Trent *watershed* region (Map 10) were identified as areas where greater than 55% of the water surplus (precipitation – *evapotranspiration*) can be infiltrated into the subsurface layers. Significant *groundwater recharge* areas are important features for the maintenance of groundwater quantity and quality.

In the Lower Trent *watershed* region, recharge areas are generally associated with deep, well-drained glacial *overburden* such as *moraines* and drumlinized *till* plains, where a high *infiltration* rate contributes to groundwater storage, providing for domestic and municipal water consumption and *baseflow* to creeks.

Map 10: Significant Groundwater Recharge Areas



The Big Rain Barrel

The Oak Ridges Moraine is like a giant rain barrel – its groundwater reserves feed several of the watercourses in the western portion of the *watershed* region.

In the Oak Ridges Moraine, in the western portion of the region, data suggests a mix of upward gradients (areas of *groundwater discharge*) near lakes and rivers, and predominantly downward gradients (areas of *groundwater recharge*) away from the water bodies. This is mainly a function of the ground surface topography. The deep recharge on the Moraine feeds the *headwaters* of the *cold water* streams flowing into Lake Ontario and the Trent River.

The rugged topography, combined with rapid changes in the *surficial geology* associated with the *drumlin* field which covers much of the *watershed* region, results in recharge and discharge occurring over relatively short distances. In the glacial melt water lake areas between Campbellford and Stirling, and in areas of thin *overburden* over bedrock, the *infiltration* is low (Morrison, 2004). Potential discharge areas in the region are highly correlated with *wetlands*, watercourse valleys, and springs (Lower Trent Conservation, 2005).

Water budgets prepared for the Trent Source Protection Assessment Report demonstrate that there is low water quantity stress for the Lower Trent *watershed* region. These water budgets were assessed on a fairly large scale and would not have identified specific, localized water shortages.

Lower Trent Conservation maintains 10 well sites, with 12 wells and level loggers, in partnership with the Ministry of the Environment and Climate Change as part of the Provincial Groundwater Monitoring Network. Some wells are located on Conservation Authority owned lands while others are located on private property. The location of the wells is shown on Map 9. Groundwater quality is also monitored at some of these sites.

Surface Water Quality

The physical landscape, the condition of the vegetation cover, and the type and intensity of land use all impact the quality of surface water. Lower Trent Conservation monitors several surface water parameters. While sampling occurs at a number of sites across the *watershed* region (Map 9), at some sites – referred to as Supersites – the following monitoring programs are undertaken: sampling and identification of benthic *macroinvertebrates* to family level, temperature, and baseflow. Supersites were chosen based on an in-depth site review taking into account a variety of factors (e.g., safe access, the occurrence of monitoring programs at the site).

Water Quality Monitoring

Lower Trent Conservation maintains nine Provincial Water Quality Monitoring Network stations in partnership with the Ministry of the Environment and Climate Change. During the ice-free season, monthly water samples are collected from each station and are submitted to the Ministry of the Environment and Climate Change where they are analysed for 39 chemical parameters. These parameters are typically grouped according to their management implications of nutrients (nitrogen and phosphorus compounds), metals, and general chemistry (i.e., suspended sediment, chloride).

There are 3 sites which have been sampled on an ongoing basis since the early 1970s. Two of the sites are on the Trent River and the other at the confluence of Cold Creek and the Trent River. Figure 3, Figure 4, and Figure 5 show the average annual total phosphorus concentrations for those sites. Phosphorus has been a contaminant of concern for many years in the Lower Trent *watershed* region and was identified as an issue when the Bay of Quinte was listed as an Area of Concern in 1985. Overall, there has been a general downward trend in total phosphorus concentration and less variability between years. The spikes shown in Figure 4 and Figure 5 could be a result of data anomalies or years with significant runoff events and stream bank *erosion*.

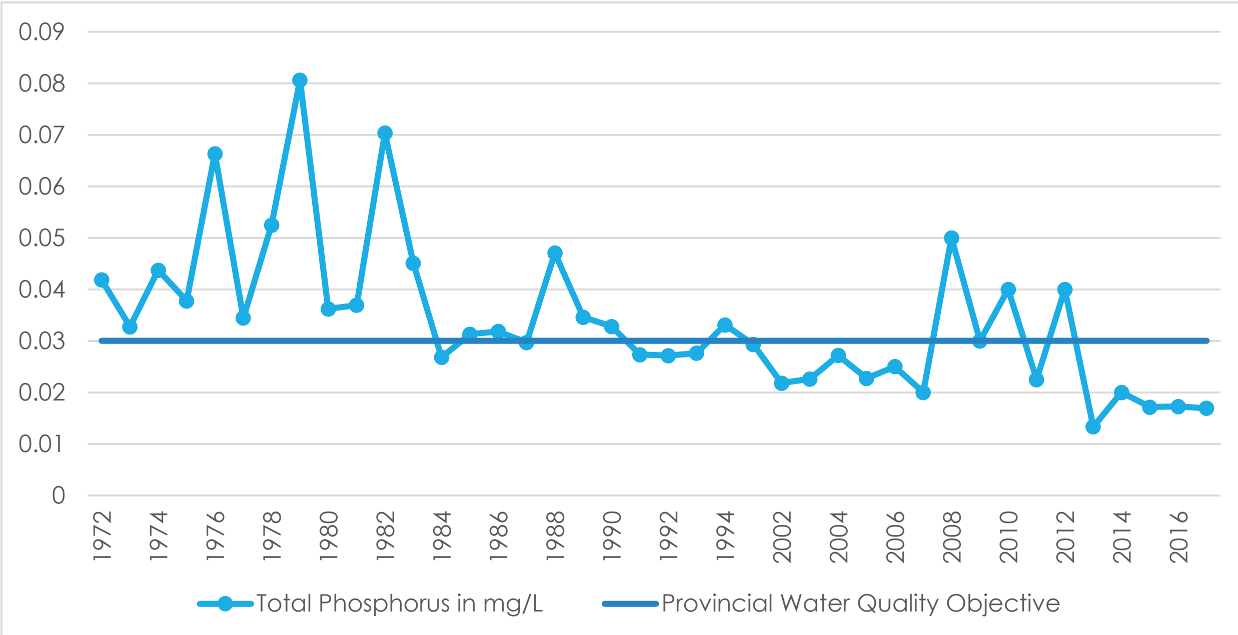


Figure 3. Average total phosphorus concentrations – Trent River @ Dixon Drive Trenton

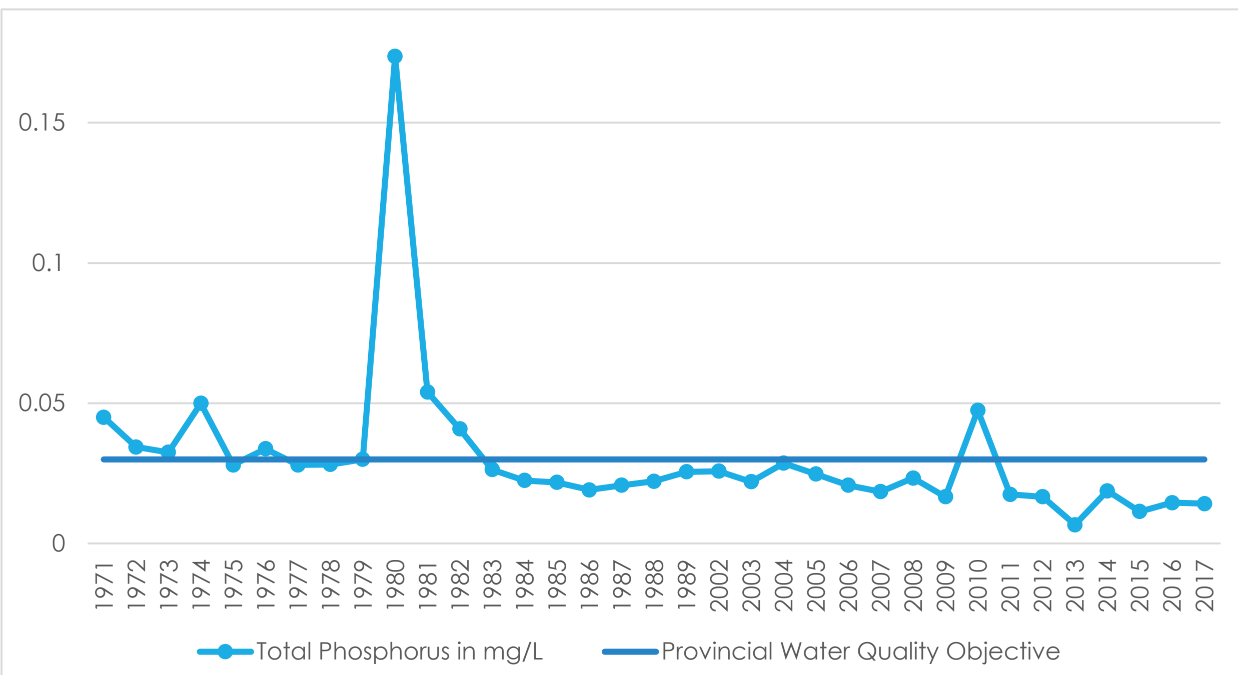


Figure 4. Average total phosphorus concentrations – Trent River @ Healey Falls

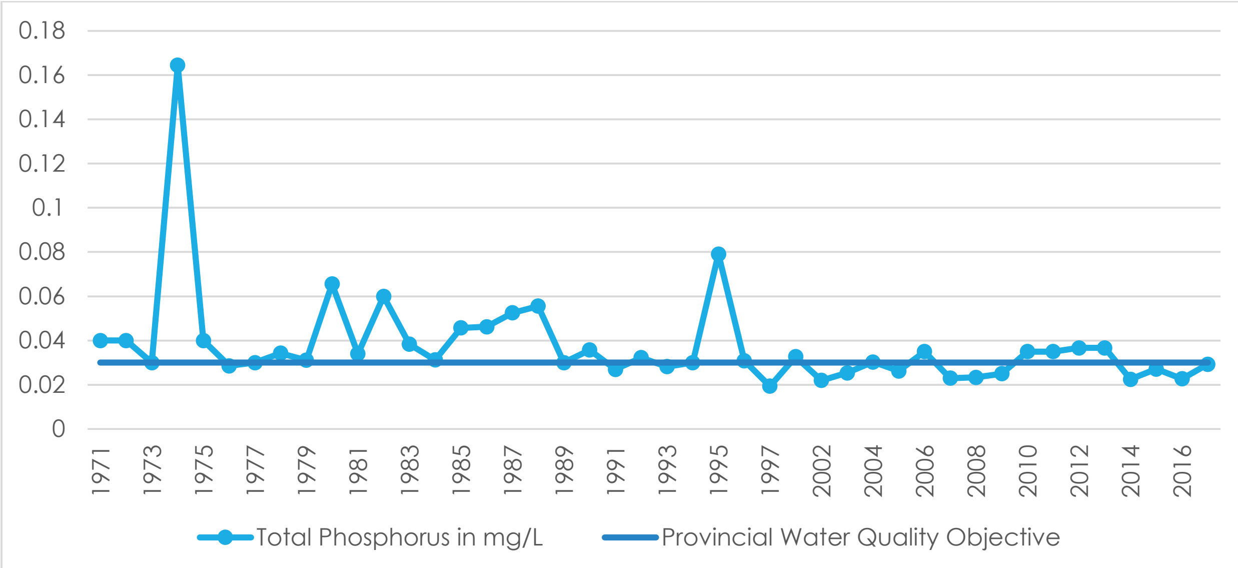


Figure 5. Average total phosphorus concentrations – Cold Creek @ Frankford

A small group of parameters is often used to provide a representative overview of water quality in an area of interest. Seven parameters have been selected to represent the water quality in the Lower Trent *watershed* region based on the potential human sources of the parameter and effects on aquatic life and/or human health (Appendix 1). These parameters can be compared to Provincial Water Quality Objectives and/or Canadian Water Quality Guidelines to determine if they are of concern.

Appendix 2 shows the number of samples collected over three time periods at each location, as well as the number of those samples which had results that were higher than the Provincial Water Quality Objectives and/or Canadian Water Quality Guidelines (exceedances). The locations of the sampling sites are shown on Map 9.

Lower Trent Conservation does not have a Provincial Water Quality Monitoring Network station in each of its *watersheds* (see Map 9) resulting in a significant gap in our understanding of water quality in the entire Lower Trent *watershed* region. Additionally, some of the water quality monitoring stations under the program have been discontinued or moved, impacting the continuity of data.

In general, five out of the seven parameters monitored exceeded the Provincial Water Quality Objectives and/or Canadian Water Quality Guidelines at some point during the period from 2002-2016 (Appendix 2). The most common exceedances included lead, total phosphorous, and total suspended solids, with copper and zinc having occasional exceedances. No obvious trends through time can be discerned. While the long-term data for phosphorus concentrations illustrated in Figure 3, Figure 4, and Figure 5 show a downward trend on the Trent River, with annual averages below the provincial water quality objectives, there still are occasional exceedances at every site (Appendix 2), indicating an ongoing issue with phosphorous loading. Exceedances in total suspended solids are likely from bank *erosion*, and urban and agricultural runoff. Lead is naturally occurring in the environment; variations in lead concentrations in the *watershed* region are not well understood. Potential sources are mining, fossil fuels, waste dumps, and industrial plants, as well as natural sources.

Benthic Macroinvertebrates

Aquatic *macroinvertebrates*, commonly referred to as benthic *macroinvertebrates*, are the organisms that live in the bottom of watercourses. They serve many functions in the aquatic ecosystem including acting as both decomposers and as food for larger *macroinvertebrates*, birds, and fish. They are excellent indicators of aquatic health and can be used to assess long-term water quality.

Lower Trent Conservation collects and analyzes benthic macroinvertebrate samples at sites distributed throughout the *watershed* region using the Hilsenhoff Biotic Index (see Table 2). The Hilsenhoff Biotic Index estimates the overall tolerance of the community in a sampled area, weighted by the relative abundance of each taxonomic group (Table 3).

There are many benefits of using benthos as an assessment tool for water quality; they are prime *bioindicator* species of aquatic health since they have limited movement within their preferred habitat, and they are sensitive to pollutants and habitat modifications. Overall, benthic analysis is a useful tool for detecting and tracking changes in water quality throughout the *watershed* region over time. As our monitoring program matures, the information that is gained about the health of our *watersheds* through the collection of benthos will help in making decisions and guiding restoration programs and stewardship initiatives.

The benthic samples are collected from the monitoring sites in the late spring of each year and specimens are identified to “Order”, with selected samples identified to the family level. Map 9 shows the location of the benthic sampling sites.

Benthic Macroinvertebrate Sampling

Table 2. Benthic Macroinvertebrate Results

Watershed Grouping	Stream Code ID	New Site ID	Hilsenhoff Biotic Index					Avg
			2012	2013	2014	2015	2016*	
Barnum House/Shelter Valley	**Barnum House Creek**							5.42
	BHC01	**1BHSV01**	5.68	5.38	4.93	5.15		
	BHC02	**BH01**	5.96	5.17	5.44	7.23	6.43	
	BHC03	**BH02**	5.74	5.29	4.98	4.93		
	Shelter Valley Creek							
	SVC01	**SVC01**					5.74	
	SVC05	**SVC03**	5.29	5.09	5.77	5.66		
	SVC06		5.18	5.38	6.03	4.88		
	SVC07		5.49	3.91	4.85	5.29		
Bay of Quinte Tributaries	**Massey Creek**							5.50
	MSC01	**MSC01**	5.93	4.48	6.00	4.25		
	MSC03	**MSC02**	6.18	5.33	5.50	5.42		
	Meyers Creek							
	MYC01	**MYC01**		5.12	5.78	5.91	5.68	
		1BQ01					5.91	
Cold Creek	**Cold Creek**							4.94
	CC01	**CC01**		4.10	5.28	4.68	6.03	
	CC05		5	5.04	5.13	4.77		
	CC10		5.97	3.74	4.65			
	CC20		5.21	4.61				
Lake Iroquois Plain Tributaries	**Colborne-Lakeport Creek**							5.52
	CLC01	**CLC01**	6.08	5.68	6.40	4.24	6.08	
	CLC07		6.69	5.71	6.07	6.05		
	CLC08	**CLC02**	5.22	5.53	5.12	4.79		
	Proctor Creek							
	PRC01	**BC01**	6.35	5.20	5.77	4.93		
	PRC02	**BC02**	5.31	5.19	5.64	4.93	6.64	
	Salem Creek							
	SC01	**SC01**	5.83	4.75	5.73	4.68		
	Smithfield Creek							
	SMC04		5.07	4.85				
Mayhew Creek	**Mayhew Creek**							5.37
	MAC01	**MAC01**	5.69	5.02	3.92	4.07	5.74	
	MAC04		5.75	5.78	6.18	6.19		
Percy/Burnley Creek	**Burnley-Mill Creek**							4.98
	BMC05	**BMO2**	4.95	5.04	5.90	4.85		
	BMC06		5	5.29	5.6			
	BMC07	**BM07**	5.4	5.21	6.08			
		1PB02					6.30	

	Percy Creek							
	PC01		4.46	4.55	5.66	4.73		
	PC02	**PC01**					5.13	
	PC03		4.82	4.18	4.32	4.06		
	PC04	**PC02**	4.75	3.39	5.01			
Rawdon Creek	**Rawdon Creek**							5.14
		RC01					5.26	
	RC08	**RC02**	4.84	4.67	4.73	4.89		
	RC12	**RC04**	5.62	5.79	4.59	4.70		
		1RC01					6.34	
Rice Lake Tributaries	**Rice Lake Tributary**							5.22
	RLT01		5.82	4.02	6.34	4.79		
	RLTORM1	**RLT01**					5.15	
Salt Creek	**Salt Creek**							5.55
	02HK015	**SAC01**					6.05	
		1SAC01					5.97	
	SAC05		5.45	6.06	5.46	4.66		
	SAC06		5.18					
Squires-Hoards Creek	**Squires-Hoards Creek**							5.27
	SH05	**SH01**	5.55	4.69	5.22	5.34		
	SH08	**SH02**	4.97	5.01	4.81	4.52	5.89	
		1SH02					6.65	
Trent River Corridor Tributaries	**Trent River**							5.90
		1TRC02					6.74	
	Killoran Creek							
	KC01		5.97	5.16			5.49	
	Marsh Creek							
		MC01					6.15	
Trout Creek	**Trout Creek**							5.29
	TC01	**TC01**	5.75	3.86	4.70	5.39	6.18	
	TC02	**TC02**	5.68	4.75	5.41	5.21		
	TC03		5.3		6.03	5.26		

*Fewer sites were sampled in 2016 as a new random survey design was implemented for the benthic monitoring program. This new program introduced the concept of "Super Sites", and randomly sampled sites, which are primarily based on stream order.

Table 3. Interpretation of Hilsenhoff Index Results

Degree of Organic Pollution	Water Quality	Index
Organic Pollution Unlikely	Excellent	0.00-3.75
Possible Slight Organic Pollution	Very Good	3.76-4.25
Some Organic Pollution Probable	Good	4.26-5.00
Fairly Substantial Organic Pollution Likely	Fair	5.01-5.75
Substantial Organic Pollution Likely	Fairly Poor	5.76-6.50
Very Substantial Organic Pollution Likely	Poor	6.51-7.25
Severe Organic Pollution Likely	Very Poor	7.26-10.00

Table 2 shows the results of the benthic macroinvertebrate analysis. An average Hilsenhoff Biotic Index was calculated for each site and averaged over five years, then all sites within each *watershed* were averaged. Table 3 is used to evaluate the results and give an indication of water quality within the *watershed*. Based on this analysis, the majority of *watersheds* have “Fair” water quality, with one *watershed* having “Fairly Poor” and two having “Good” water quality.

Stream Temperature

The temperature of a stream has a considerable influence on the health of aquatic organisms, and is often a deterministic factor in the presence of a species. The collection of temperature data allows staff to observe changes in thermal regimes over time, and assist in assessing the health of local watercourses in conjunction with other Lower Trent Conservation monitoring programs. Although Lower Trent Conservation does not have a fish monitoring program, measuring temperature changes over time can help assess the health of a watercourse and the presence of specific freshwater fish.

Generally, the thermal regimes in the upper reaches of the watercourses flowing out the Oak Ridges Moraine are cold/cool, with water temperature increasing downstream (Table 4). On the other hand, the watercourses originating and flowing through the clay plains into the Bay of Quinte have a *warm water* thermal regime.

Table 4. Analysis of Stream Temperature Data

Site Code	Watercourse	2012	2013	2014	2015	2016	2017
BH02	Barnum House Creek	Cold-cool	Cold-cool	Cold-cool	Cold-cool	Cold-cool	
BH01		Cool-warm	Cool	Cool	Cool	Cool-warm	Cool
BM02	Burnley-Mill Creek	Cool-warm	Cool-warm	Cool-warm	Cool-warm	Cool-warm	Cool-warm
BM03					Cool	Cool	Cold-Cool
PC01	Burnley-Percy Creek	Warm	Warm	Warm	Warm	Warm	Warm
PC02						Cool-warm	Cool
CLC03	Colborne-Lakeport Creek	Cool-warm	Cool	Cool	Cool	Cool-warm	Cool
CLC01		Cool-warm	Cool-warm	Cool-warm	Cool-warm	Cool-warm	Cool-warm
-		Cold	Cold-cool	Cold	Cold		
CLC02						Cold-cool	Cold-cool
-	Cold Creek	Cool-warm	Cool-warm	Cool-warm			
CC01					Warm		Warm
CC02							
CC04		Cool-warm	Cool-warm	Cool-warm	Warm	Cool-warm	Cool-warm
MC01	Marsh Creek					Cool-warm	
MAC01	Mayhew Creek	Warm	Warm	Warm	Warm	Warm	
-		Warm	Warm	Warm	Warm		
MAC05			Warm	Warm	Warm	Warm	
MAC04		Cool-warm	Cool-warm	Cool	Cool-warm	Dry	Cool
-	Proctors Creek	Cool	Cool-warm	Cool-warm			
BC02		Cool	Cool-warm	Cool	Cool-warm	Cool-warm	Cool
BC01		Cool	Cold-cool		Cool	Cool	
RC01	Rawdon Creek	Warm	Cool-warm	Cool-warm	Cool-warm	Cool-warm	Cool-warm
RC04		Warm	Cool-warm	Cool	Cool-warm		Cool
RC02		Cold-cool	Cool	Cool	Cool	Cold-cool	Cool
-		Cool-warm	Cool-warm		Cool-warm		
SC01	Salem Creek	Cool-warm	Cool	Cool		Cool-warm	Cool
-	Salt Creek	Cool	Cool	Cool			
-		Cool	Cool	Cool			

SVC03	Shelter Valley Creek				Cool	Cool-warm	Cool
SVC01		Cool-warm	Cool-warm	Cool	Cool-warm	Cool-warm	
SH01	Squires-Hoards Creek	Cool-warm	Warm	Warm		Cool-warm	Cool
TC01	Trout Creek	Warm	Warm		Warm		Cool-warm
RLT01	Rice Lake Tributary				Cold-cool	Cold-cool	Cold-cool
KC01	Killoran Creek				Cool-warm	Cool-warm	Cool-warm
SMC01	Smithfield Creek				Cool-warm	Cool-warm	Cool-warm
MYC01	Meyers Creek				Warm	Warm	Warm

Thermal Regimes: Cold, cold-cool : Cool, cool-warm : Warm

Bay of Quinte

The Bay of Quinte was identified as an Area of Concern in 1985 resulting in the implementation of a Remedial Action Plan to address the issues. One of the main environmental issues with the Bay of Quinte has always been the amount of nutrients entering it, particularly phosphorus. Excess phosphorus resulted in excess algae and *eutrophication*. Regular sampling for phosphorus, among other water quality parameters, has occurred since the early 1970s through Project Quinte, a multiagency research project which began in 1972 to study the Bay of Quinte before and after phosphorus reduction, and various Bay of Quinte Remedial Action Plan projects. Although there have been significant reductions in the amount of phosphorus entering the Bay from multiple rural and urban sources, such as sewage treatment plants, *stormwater*, and agriculture, phosphorus levels and undesirable algae blooms are an ongoing issue. While the *biomass* of algae appears to be declining in the Bay of Quinte in recent years, the relative composition of blue-green algae (or *cyanobacteria*) that can potentially produce toxins is increasing.

Lake Ontario

The Great Lakes contain one-fifth of the world's fresh surface water and one of the most diverse ecosystems on earth. They provide drinking water to tens of millions of Canadians and Americans, and are important to the economies of both countries. The Great Lakes Water Quality Agreement, signed by Canada and the United States in 1972, commits both countries to cooperatively restore and protect the water quality and aquatic ecosystem health of the Great Lakes (Environmental Protection Agency and Government of Canada, 2017).

Some toxic chemicals in the Great Lakes have declined substantially over the past 40 years. While significant progress has been made, the Great Lakes are still experiencing concentrations of some toxic chemicals, such as PCBs, which pose a threat to human health and the environment. Lake Ontario's ecosystem is in fair condition and the trend is unchanging. Contaminants in fish, such as PCBs, have steadily decreased, leading to less restrictive consumption advisories (Environmental Protection Agency and Government of Canada, 2017).

At the request of local residents, the Ministry of the Environment and Climate Change conducted a water sampling program on Presqu'ile Bay. The 2013 report indicated that the Bay is *mesotrophic* and does not seem to be at risk for algal blooms because of frequent water exchange with Lake Ontario and the Murray Canal. Total phosphorus concentrations generally fall below the Provincial water quality objective of 20 µg/L. The survey showed limited indication of fecal bacteria contamination beyond natural conditions. A second monitoring survey was conducted in 2015; the report has not yet been released. (Ontario Ministry of the Environment and Climate Change, 2016).

Chemicals of Emerging Concern

Chemicals of emerging concern are chemicals that have just gained entry into the environment (new to commerce or a new formulation, nanomaterials, or other chemicals), are newly characterized as a result of increases in their concentrations, or are just now being discovered because of improvements in instrumentation and analytical abilities to detect these chemicals in air, water, sediment, or biota (International Joint Commission, 2011). Common examples that have been gaining increased attention include microplastics, personal care products, and pharmaceuticals.

Studies have documented the occurrence of plastic debris, including plastic bags, bottles, boxes, fibers, microbeads, and cigarette butts, in marine and fresh waters including the Great Lakes. Larger plastic debris can degrade into smaller microplastics, and it is these smaller particles that are of particular concern. Microplastics generally refer to particles 5 mm or less in size and encompass a range of categories including: microbeads from personal care products, fibres from synthetic clothing, preproduction pellets and powders, and fragments degraded from larger plastic products (International Joint Commission, 2017).

Pharmaceuticals and Personal Care Products refer, in general, to any products used by individuals for personal health or cosmetic reasons, or used by agribusiness to enhance growth or health of livestock. Pharmaceuticals and Personal Care Products comprise a diverse collection of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, and cosmetics. The main routes of entry of Pharmaceuticals and Personal Care Products to the environment are: municipal waste water treatment plants and septic fields; disposal via municipal refuse in landfills that leach to groundwater; and *stormwater* overflow from residential sources (Environment and Climate Change Canada, 2018).

Groundwater Quality

Currently, six of the 12 Provincial Groundwater Monitoring Network wells in the *watershed* region are monitored annually for water chemistry (Map 9). The water quality is analyzed by the Ministry of the Environment and Climate Change for general chemistry and metals. Appendix 3 lists parameters of interest due to potential anthropogenic causes of elevated levels. Table 5 shows the number of exceedances of the Ontario Drinking Water Objectives for the period of sampling (2002-2016). Due to a lack of long-term consistent data, we are unable to determine firm conclusions or trends with water quality at our monitoring wells. The data that is available does indicate that well W121-1 (located in a shallow *aquifer* and near a road) consistently shows levels of both chloride and sodium above the Ontario Drinking Water Objectives. Another shallow well, located in an agricultural field (well 172-1), often shows nitrate+nitrite levels above the Ontario Drinking Water Standards.

Table 5. Nitrite + Nitrate and Chloride Exceedances

Parameter	Ontario Drinking Water Standard/ Objective	2002-2006		2007-2011		2012-2016	
		N	Exceedances	N	Exceedances	N	Exceedances
W121-1 (Township of Stirling-Rawdon)							
Chloride	250 mg/L*	3	2	6	3	4	2
Sodium	20 mg/L**	3	3	7	7	4	4
Sodium	200 mg/L*	3	0	7	1	4	2
Nitrate- Nitrite	10 mg/L***	3	0	7	0	2	0
W122-1 (Township of Cramahe)							
Chloride	250 mg/L*	4	0	3	0	6	0
Sodium	20 mg/L**	4	0	4	0	6	0
Sodium	200 mg/L*	4	0	4	0	6	0
Nitrate- Nitrite	10 mg/L***	3	0	4	0	3	0
W123-1 (Township of Alnwick/Haldimand)							
Chloride	250 mg/L*	4	0	3	0	4	0
Sodium	20 mg/L**	4	0	4	0	4	0
Sodium	200 mg/L*	4	0	4	0	4	0
Nitrate- Nitrite	10 mg/L***	3	0	4	0	2	0
W172-1 (Township of Stirling-Rawdon)							
Chloride	250 mg/L*	1	1	4	0	2	0
Sodium	20 mg/L**	1	1	5	1	2	2
Sodium	200 mg/L*	1	0	5	0	2	0
Nitrate- Nitrite	10 mg/L***	1	1	5	5	1	0
W173-1 (Municipality of Trent Hills)							
Chloride	250 mg/L*	4	1	7	0	6	0
Sodium	20 mg/L**	4	2	8	6	6	0
Sodium	200 mg/L*	4	1	8	0	6	0
Nitrate- Nitrite	10 mg/L***	3	0	8	0	3	0
W174-1 (Municipality of Brighton)							
Chloride	250 mg/L*	4	0	7	0	4	0
Sodium	20 mg/L**	4	0	8	0	4	0
Sodium	200 mg/L*	4	0	8	0	4	0
Nitrate- Nitrite	10 mg/L***	3	0	8	0	2	0
W212-1 (Municipality of Centre Hastings)							
Chloride	250 mg/L*	3	0	4	0	8	0
Sodium	20 mg/L**	3	0	5	0	8	0
Sodium	200 mg/L*	3	0	5	0	8	0
Nitrate- Nitrite	10 mg/L***	3	0	5	0	4	0

Parameter	Ontario Drinking Water Standard/ Objective	2002-2006		2007-2011		2012-2016	
		N	Exceedances	N	Exceedances	N	Exceedances
W213-1 (City of Quinte West)							
Chloride	250 mg/L*	3	0	2	0	6	0
Sodium	20 mg/L**	4	0	4	0	6	2
Sodium	200 mg/L*	4	0	4	0	6	0
Nitrate- Nitrite	10 mg/L***	3	0	4	0	3	0
W214-1 (Municipality of Brighton)							
Chloride	250 mg/L*	3	0	7	0	6	0
Sodium	20 mg/L**	3	1	8	8	6	2
Sodium	200 mg/L*	3	0	8	0	6	0
Nitrate- Nitrite	10 mg/L***	2	0	7	0	3	0
W411-2 (Township of Alnwick/Haldimand)							
Chloride	250 mg/L*	3	0	8	0	8	0
Sodium	20 mg/L**	3	1	8	0	8	0
Sodium	200 mg/L*	3	0	8	0	8	0
Nitrate- Nitrite	10 mg/L***	3	0	8	0	4	0
W411-3 (Township of Alnwick/Haldimand)							
Chloride	250 mg/L*	0	0	8	0	2	0
Sodium	20 mg/L**	0	0	8	8	2	0
Sodium	200 mg/L*	0	0	8	0	2	0
Nitrate- Nitrite	10 mg/L***	0	0	8	0	1	0

*Drinking Water Aesthetic Objective

**The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets

***Drinking Water Standard

View of Trenton and the Trent River from Mount Pelion

8. Land Use

The Human Footprint

Population Distribution and Density

According to the 2016 census, the population of the municipalities in the Lower Trent *watershed* region is 91,201 (total municipal population including areas outside the *watershed* region). The population strictly within Lower Trent's jurisdiction is approximately 75,000. (Note: The population has been estimated using the 2016 census data for the member municipalities and calculating the percent within the *watershed* region using the apportionment data provided by the Province to the Conservation Authority for levy allocation.) Quinte West has the largest population at 43,577. Between the 1996 and 2016 censuses, the overall population of the municipalities in the region increased by approximately 3%. Alnwick/Haldimand and Brighton had by far the greatest population increase. The population distribution according to Statistics Canada census data, by municipality, is shown in Table 9.

Looking back…

How many people lived here when Lower Trent Conservation was formed?
48,000

Alnwick/Haldimand: 3,300
Brighton: 5,200
Centre Hastings: 700
Cramahe: 3,600
Quinte West: 23,800
Stirling-Rawdon: 2,900
Trent Hills: 8,500

Source: Conservation Report, 1970

Table 9. Municipal populations 1996 to 2016

Municipality	1996 Population	2006 Population	2016 Population	1996 -2016 Population Change	% Population Change 1996-2016
Alnwick/Haldimand	5,528	6,435	6,869	1,341	24%
Brighton	9,022	10,253	11,844	2,822	31%
Centre Hastings	4,103	4,386	4,774	671	16%
Cramahe	5,474	5,950	6,355	881	16%
Quinte West	41,676	42,697	43,577	1,901	4%
Stirling-Rawdon	4,905	4,906	4,882	-23	-0.5%
Trent Hills	12,437	12,247	12,900	463	4%
TOTAL	**83,145**	**86,874**	**91,201**	**8,056**	

Source: Statistics Canada

Population Projections

Ontario's population is projected to grow by 30.3 percent, or more than 4.2 million, over the next 25 years, from an estimated 14.0 million on July 1, 2016 to more than 18.2 million by July 1, 2041. The number of seniors aged 65 and over is projected to almost double from 2.3 million, or 16.4 percent of population in 2016, to 4.6 million, or 25.0 percent by 2041. The growth in the share and number of seniors will accelerate over the 2016–2031 period as *baby boomers* turn age 65. After 2031, the growth in the number of seniors is projected to slow significantly (Ministry of Finance, 2018).

The Ontario Ministry of Finance has developed population projections at the County level. The Lower Trent *watershed* region includes portions of both Northumberland County and Hastings County. The population of Northumberland County is projected to grow by 19% between 2016 and 2041 while the population of Hastings County is projected to grow by 3.3% in the same time period (Ministry of Finance, 2018).

Some municipalities have conducted growth studies for *official plans* and other purposes. These studies offer population projections at a more local level. The Northumberland County Official Plan (2016) projects the following population increases from 2011 to 2041 for the lower tier municipalities: Brighton 1,734 (15%), Trent Hills 2,173 (17%), Cramahe 1,013 (16%), and Alnwick/Haldimand 1,232 (18%). Quinte West projects a population increase to as much as 51,717 residents by 2030 in their 2013 *Official Plan*.

Settlement Patterns

Settlement Areas

Settlement areas are urban areas and rural settlement areas, and include cities, towns, villages and hamlets (Provincial Policy Statement 2014). Settlement areas are to be the focus of growth and development, the promotion of their vitality and regeneration is encouraged.

Approximately 5.5% of the land base of the Lower Trent *watershed* region is designated for settlement (urban, settlements, future development, and Oak Ridges Moraine settlement areas) (Map 13). Trenton, Batawa, Frankford, Bayside, Campbellford, Hastings, Warkworth, Stirling, Brighton, Colborne, and Grafton are the main settlement areas in the region and are serviced by water and/or sewer. There are also a number of small villages and hamlets found throughout the region including: Castleton, Roseneath, Centreton, Wooler, Springbrook, and Ivanhoe. These communities are not serviced by municipal water and wastewater treatment.

In addition to traditional settlement areas, 8 Wing/Canadian Forces Base (CFB) Trenton is located in Quinte West, immediately adjacent to the east side of Trenton. Canadian Forces Base Trenton is one of the largest and busiest air force bases in Canada. The *watershed* region is also home to the Alderville First Nation community.

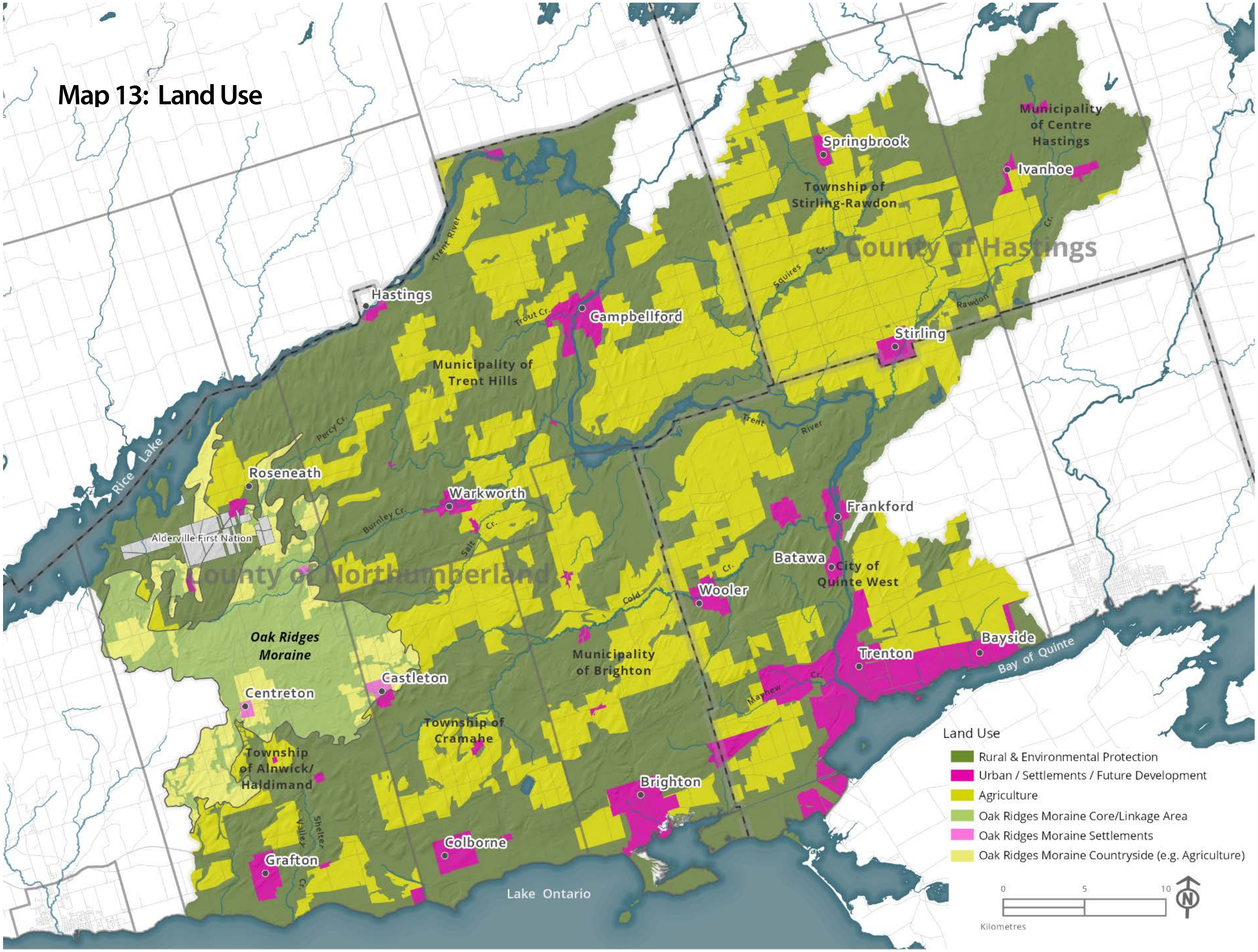
Rural Areas

According to the Provincial Policy Statement 2014, rural areas are a system of lands that may include rural settlement areas, rural lands, prime agricultural areas, natural heritage features and areas, and other resource areas.

Over a third of the *watershed* region is used for agricultural purposes. Map 13 shows the area designated as agriculture. The map also shows the rural areas within the region which includes woodlands, *wetlands*, rural residential, seasonal residential, and other rural lands excluding municipally designated agricultural land. The Oak Ridges Moraine countryside designation on Map 13 includes both rural and agricultural lands.

There are a number of rural residential areas scattered throughout the *watershed* region which are not serviced by municipal water and wastewater treatment.

Map 13: Land Use



In much of Ontario, cottage and trailer park development occurs adjacent to waterbodies. In the case of the Lower Trent *watershed* region, this includes Rice Lake, Trent River, Lake Ontario, Wellers Bay, the Bay of Quinte, and smaller inland lakes. Most of this development occurred historically; currently, there is not any significant new cottage and camp development occurring in the region. The current trend is the conversion of seasonal residences to permanent residences. This could result in negative impacts on water quality with increased septic system loading year round.

Infrastructure

Transportation

Provincial highways, county roads, and local roads within the Lower Trent *watershed* region are shown on Map 14. The CPR and CNR rail lines run in east-west corridors along the south half of the region. The similarities with all of these corridors are the use and transportation of potentially harmful or toxic substances (i.e., salts, herbicides) and possible spills of material. They also fragment habitat and pose a risk to wildlife through vehicle collisions and other negative road effects such as noise, light, and pollutants. Paved roads can contribute significantly to the amount of *impervious surface* in a *watershed*.

Highway 401 and County Road 2 are the major east-west transportation roads. Major routes in the north-south direction include:

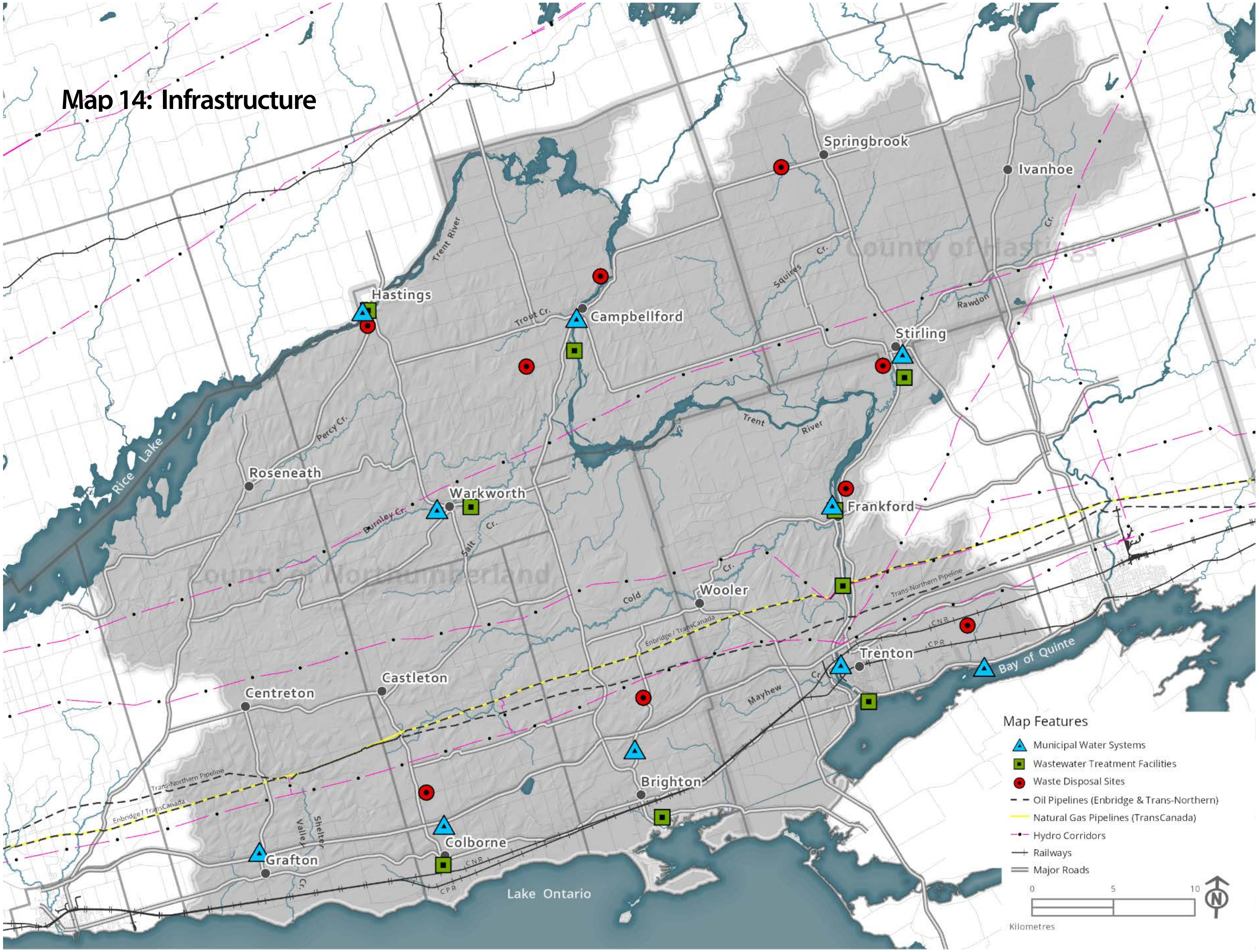
- Highway 33 from Trenton to Frankford and Stirling
- County Road 30 from Brighton to Campbellford
- County Road 25 from Colborne through Castleton, Warkworth, and Hastings
- County Road 45 from Cobourg to Hastings, and
- Highway 62, which crosses the northeast portion of the *watershed* region.

There is also a network of municipal roads throughout the *watershed* region, many of which are laid out on a grid parallel with Lake Ontario.

Canadian Forces Base Trenton contains a military airport with daily military flight travel over the region. In addition to CFB Trenton, there is a small airport located near Stirling which is home to the Oak Hills Flying Club.

The *Trent-Severn Waterway* is an important transportation corridor for recreational boating. It provides a navigable route from Lake Ontario to Georgian Bay via the Trent and Severn Rivers, their many lakes, and a series of locks and canals. The Murray Canal, which is the most southern portion of the *Trent-Severn Waterway*, connects the Bay of Quinte to Lake Ontario. Lake Ontario itself is part of the Great Lakes St. Lawrence Seaway System, an international shipping route. Docking facilities are located south of Colborne at Ogden Point.

Map 14: Infrastructure



Landfills

There are currently three active landfills within the *watershed* region located in Brighton, Frankford and Rawdon, and four waste transfer facilities in Trenton, Seymour, Stirling, and Colborne (Map 14).

A search of available databases for a study completed by Lower Trent Conservation for the Bay of Quinte Remedial Action Plan identified 24 closed/historic landfills in the *watershed* region (Lower Trent Conservation, 2004). Waste decomposition in landfills can produce methane gas and small amounts of other potentially harmful gases such as carbon dioxide. Soluble volatile organic compounds such as benzene and toluene are associated with *leachate* and may lead to groundwater contamination at landfill sites, although these compounds can also occur naturally in the shale oil of local limestone formations. Heavy metals can also be associated with *leachate* from landfill sites. Since garbage has a very long decomposition process, the production of landfill toxins continues long after a landfill has closed (Lower Trent Conservation, 2004).

There are several waste diversion programs in place in the *watershed* region to reduce the pressure on landfills and to ensure proper disposal of hazardous materials. Since 1990, Quinte Waste Solutions provides curbside recycling, commercial recycling, household hazardous waste collection, and waste electronics collection for the nine municipal partners that make up the Centre and South Hastings Waste Services Board. In the Lower Trent *watershed* region, this includes: Quinte West, Stirling-Rawdon, and Centre Hastings. Northumberland County provides curbside recycling and hazardous waste depots for the municipalities of Brighton, Cramahe, Alnwick/Haldimand, and Trent Hills. A curbside organics collection program has been in effect since August 2013 in the City of Quinte West.

Drinking Water Source Protection

In 2006, the Ontario government passed the *Clean Water Act* to protect drinking water at the source through the production of locally developed, science based assessment reports and source protection plans.

The Assessment Report identifies vulnerable areas near municipal water supplies - Wellhead Protection Areas for municipal wells or Intake Protection Zones for surface water intakes (Map 15).

The Source Protection Plan establishes policies to ensure that activities in the vulnerable areas do not become a threat to drinking water supplies. Policies include: education & outreach, amendments to municipal land use planning policies and provincial instruments, risk management plans, restricted land use, and prohibition.

The Trent Source Protection Plan came into effect on January 1, 2015.

Water and Wastewater

Most of the Lower Trent *watershed* region's urban settlement areas are serviced by water and wastewater systems (Map 14). Grafton is only serviced by municipal water as are many residents in Bayside. Wastewater treatment is through septic systems. Water treatment plants treat and provide the residents with a reliable source of potable water for domestic, industrial, and commercial uses, as well as for fire protection purposes. Sources of municipal water are protected through the Trent Source Protection Plan. Policies in the plan ensure that activities in the vulnerable areas adjacent to municipal wells (Wellhead Protection Areas) or surface water intakes (Intake Protection Zones) do not pose a threat to drinking water (Map 15). The sewage treatment plants receive and treat sewage and wastewater. *Biosolids* are removed, managed, and treated.

Within the *watershed* region, there are many rural areas dependent on private wells and septic systems. A complete inventory of septic systems and private wells is not available. However, based on the population of the *watershed* region and the population serviced by municipal systems, there are approximately 26,600 residents on private water and 41,000 on private septic systems. Table 10 identifies the population serviced by the municipal drinking water systems and Table 11 identifies population services by municipal wastewater treatment plants.

Map 15: Municipal Drinking Water Vulnerable Areas

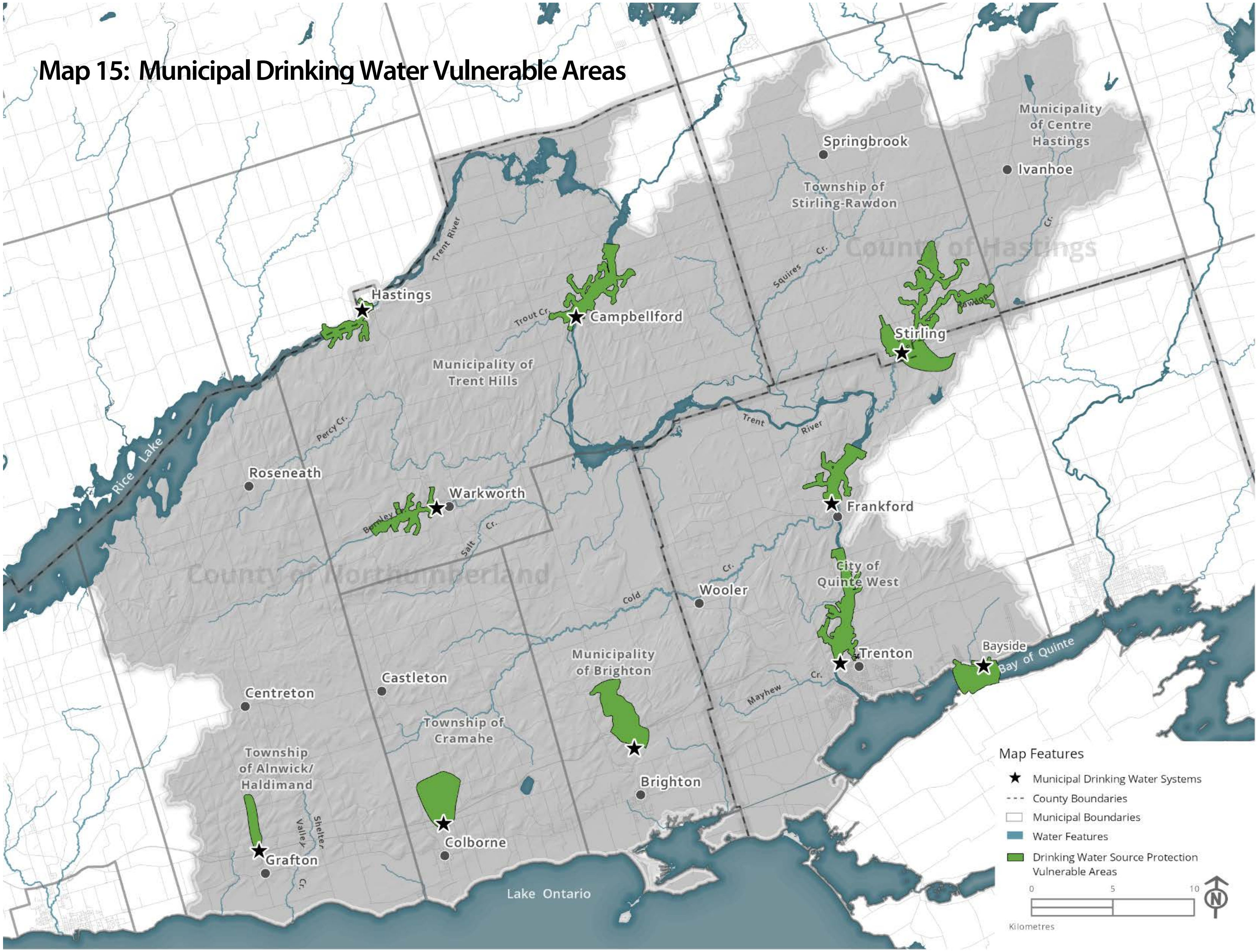


Table 10. Municipal Water Supplies in the Lower Trent Watershed Region

Site Name	Municipality	Source	Population Serviced
Bayside	City of Quinte West	Bay of Quinte	4,800
Brighton	Municipality of Brighton	Groundwater	6,900
Campbellford	Municipality of Trent Hills	Trent River	4,400
Colborne	Township of Cramahe	Groundwater	2,000
Frankford/Batawa	City of Quinte West	Trent River	3,500
Grafton	Township of Alnwick/Haldimand	Groundwater	1,000
Hastings	Municipality of Trent Hills	Trent River	1,100
Stirling	Township of Stirling-Rawdon	Groundwater	1,900
Trenton	City of Quinte West	Trent River	22,000
Warkworth	Municipality of Trent Hills	Burnley (Mill) Creek	800
		TOTAL	**48,400**

Table 11. Municipal Wastewater Servicing

Location	Discharge Body	Population Serviced	Design Capacity (m^3/day)	Annual Average Daily Flow (m^3/day)	Treatment Type
Batawa WPCP	Trent River	300	783	462	Secondary
Brighton Lagoon	Lake Ontario – Presqu'ile Bay	6,500	4,600	2,732	Lagoon
Campbellford WPCP	Trent River	3,100	6,600	4,695	Secondary
Colborne WPCP	Colborne Creek	1,800	1,375	1,300	Secondary
Frankford WPCP	Trent River	3,500	2,800	2,074	Secondary
Hastings WPCP	Trent River	1,276	1,060	843	Secondary
Trenton WPCP	Bay of Quinte	17,000	15,900	11,768	Secondary
Warkworth Lagoon	Burnley (Mill) Creek	501	390	204	Lagoon
	TOTAL SERVICED	**33,977**			

Impervious Surfaces

Impervious surfaces such as rooftops, sidewalks, paved roadways, driveways, and parking lots are surfaces that do not permit the *infiltration* of water. They decrease the amount of water that infiltrates into the ground, increase the volumes of *stormwater* runoff, and speed the delivery of runoff to streams resulting in a variety of environmental impacts. Less than 10% imperviousness in a *watershed* should maintain water quality and quantity, and preserve aquatic species density and biodiversity (Environment Canada, 2013). An upper limit of 30% is a threshold for degraded systems. Only one of the Lower Trent Conservation's *watershed* groupings (Bay of Quinte Tributaries) has over 10% *impervious surfaces* of its total land area (Table 12).

Table 12. Percent of Area Covered with Impervious Surfaces

Watershed Grouping	% Imperviousness
Squires Creek	2.02
Rawdon Creek	2.49
Trout Creek	3.51
Trent River Tributaries	4.39
Rice Lake Tributaries	4.97
Percy/Burnley Creek	3.09
Salt Creek	2.71
Cold Creek	3.54
Barnum House / Shelter Valley Creeks	4.62
Lake Iroquois Plain Tributaries	6.41
Mayhew Creek	9.00
Bay of Quinte Tributaries	11.53

Pipelines

There are three pipelines that run parallel to Highway 401 through the Lower Trent *watershed* region. The Trans-Northern pipeline carries refined oil, the Enbridge pipeline, crude oil, and the TransCanada pipeline, natural gas. These pipelines pass through the Township of Alnwick/Haldimand, Township of Cramahe, Municipality of Brighton, and the City of Quinte West.

What ever happened to the hole in the ozone?

Ozone is a gas that protects the Earth from harmful ultraviolet radiation. The ozone hole was first documented in 1987 over Antarctica in the southern hemisphere. It was caused by ozone depleting chemicals like chlorofluorocarbons making their way into the atmosphere. In the 1980s and 90s, the world pulled together to phase out the use of chemicals used in refrigerators, air conditioners, and aerosol cans. This global effort reversed the growth of the hole. The ozone hole is still present and large, about 2.5 times the size of the USA, but it is shrinking and could recover more in the future.

Regional Economy

Industrial and Commercial Sectors

All of the municipalities in the *watershed* region have lands designated for industrial and commercial use. Most of the major industrial facilities in the region are located in Trenton and include paper packaging production and food processing. Smaller industrial facilities are located in urban areas such as Brighton, Colborne, Campbellford, Hastings, and Warkworth. In addition, commercial activities are found in most of the settlement areas.

What happened to acid rain?

Acid rain forms when carbon dioxide, nitrogen dioxide, and sulphur dioxide, either naturally occurring or released by burning fossil fuels, dissolve in water vapour and rain droplets causing rain pH to fall below 5.5. Acid rain can make lakes more acidic impacting aquatic life including plankton, fish, and clams. Not all lakes become acidified. Lakes with a limestone bed, like those that occur in the Lower Trent region, are better able to neutralize acid. In areas further to the north, where rock is mostly granite, the lakes cannot neutralize acid. In the 1980s and 90s, acid rain was damaging to both aquatic and terrestrial ecosystems. To combat the problem, the United States and Canada imposed limits on the amount of sulphur dioxide and nitrogen dioxide industry could release into the atmosphere. As a result, emission levels decreased significantly, as did acid rain. Many badly impacted places have shown great recovery over time. However, many impacted lakes have not recovered as fast as expected and the delicate food chains have been negatively impacted, potentially irreversibly.

Mining and Aggregate Extraction

The glaciofluvial deposits in the various landforms have created ready sources for granular material. There are numerous small gravel pits, some abandoned and others still in operation.

Good quality limestone can be found in the limestone plains in the northeastern portion of the *watershed* region. The most prominent gravel and sand bearing landforms in the region are the numerous *eskers* that transect it. The quality of sand and gravel in these *eskers* also varies, depending on the source rocks and landforms over which the glacial meltwaters flowed. Extensive sand and gravel beaches were formed by the wave activity along the shores of glacial Lake Iroquois and the *Trent Embayment* and on the numerous *drumlins*, *till* ridges, and other formations which stood as islands in these waterbodies. These beach deposits contain the highest quality aggregates as they are well sorted and require little treatment to remove oversized or silt and clay-sized particles. (LTRCA, 1982).

The Oak Ridges Moraine is the most prominent *kame* deposit occurring within the *watershed* region. Sand and gravel deposits in this massive landform are often irregular and of unpredictable depth and quality. The Oak Ridges Moraine is dotted with small sand and gravel pits (LTRCA, 1982). Today, there are restrictions on pit and quarry operations set out in the Oak Ridges Moraine Conservation Plan.

Forestry

Much of the land in the Lower Trent *watershed* region possesses significant potential for forestry. The *Canada Land Inventory* rates approximately 80% of the land base as having only slight to moderate limitation for the potential growth of commercial forest. The soils in areas adjacent to Murray Marsh, Wilson Island (aka Anderson Island), and a few small sections of land in the northeast corner of the region are either too wet or too shallow, or a combination of both, to allow proper rooting, resulting in less capability for commercial forest production (Lower Trent Region Conservation Authority, 1982).

Large scale human influences on local forest cover began shortly after the American Revolution, when settlers began clearing land for agriculture. Not all the cleared land was suitable for agriculture resulting in the abandonment of marginal agricultural lands. Reinvasion by various shrub cover species is becoming a major influence, with lands returning naturally to forest cover. Reforestation, particularly of morainic lands, has also represented a major landscape influence in the region, beginning with the establishment of the Northumberland County Forest in 1924 (Lower Trent Region Conservation Authority, 1982).

Currently, there are no large forestry operations within the Lower Trent *watershed* region. Most forestry activity today is limited to woodlots on private land and small sawmills. Small timbers, polewood, posts, and pulpwood are the main wood material produced from these local woodlots. Northumberland County harvests timber in the Northumberland County Forest. Forestry activities within the Northumberland County Forest are guided through a Five Year Silviculture Operations Plan and meet Forest Stewardship Council standards. Between 2010 and 2015, 23,860 cubic metres of timber were harvested over 578 hectares of the County Forest.

Looking back…

Forest land was first cleared for agriculture, with settlers using the forest products directly for building, fuel, fencing, household utensils, and implements. Cutting of the finest white pine also occurred for the masting requirements of the British Royal Navy. Later, the square timber trade grew, followed by early lumber production by pit-saw mills, then waterpower mills, and finally motor-powered mills. Local rail developments increased this production after 1854 (LTRCA 1982).

Agriculture

Following the earlier Indigenous agricultural practices, a new wave of more intense agricultural activity began in the 19th century with the arrival of Loyalist settlers. Agriculture continues to be an important economic and cultural facet within the *watershed* region. Approximately 57.4% of the land in the *watershed* region is *Canada Land Inventory* class 1-3 and considered prime agricultural land. Currently, approximately 35% of our *watershed* region is designated agricultural in municipal *official plans* (including Oak Ridges Moraine countryside), representing the best quality agricultural lands in the region; in addition, some rural lands are used for agricultural purposes.

The following data has been provided by the Ontario Ministry of Agriculture, Food and Rural Affairs. The data is described by County and provides an overview of agricultural activity across the region. Table 13 shows that the number of farms declined between 2006 and 2016, as well as the number of total hectares being farmed. The percentage of agricultural land in pasture has declined and the percentage of cultivated land has increased. Of the cultivated land, there is little change in the distribution between field crops, fruit crops, and vegetable crops in Northumberland County, where there has been an increase in both field crops and vegetable crops in Hastings County (Table 14). Both Northumberland County and Hastings County experienced declines in most livestock species between 2006 and 2016 (Table 15).

Table 13. Number of Farms

Number of Farms	Northumberland 2006	Northumberland 2016	Hastings 2006	Hastings 2016
Total Number of Farms	1,031	954	1,146	974
Farms Total Area (ha)	97,594	94,3567	121,886	102,774
% Pasture	17.3	12.7	24.8	22.2
% Cultivated	62.9	66.7	46.8	48.9
Other (includes woodlots, wetlands, summerfallow, or other land not being used)	19.8	20.6	28.4	28.9

Note: Table provides a summary of total land base of farms by county and the percentage of land under pasture and cultivation (2006, 2016 Census Agriculture Data).

Table 14. Area Under Various Crop Productions

Crops	Northumberland 2006	Northumberland 2016	Hastings 2006	Hastings 2016
Field Crops (ha)	59,125	59,305	42,783	49,081
Fruit Crops (ha)	977	901	162	58*
Vegetable Crops (ha)	390	384	129	407

Note: Table provides a summary of area of crop types by county (2006, 2016 Census Agriculture Data).
*some data suppressed for protection of privacy

Table 15. Livestock Production

Livestock**	Northumberland 2006	Northumberland 2016	Hastings 2006	Hastings 2016
Dairy Cows	5,875	4,877	6,324	3,875
Beef Cows	9,702	6,225	10,849	8,013
Steers	2,496	1,367	2,263	3,935
Total Cattle and Calves	34,147	24,058	39,087	29,412
Pigs	14,415	5,226	6,649	8,566
Sheep and Lambs	8,108	8,906	4,539	7,176
Hens and Chickens	496,844	417,057	276,058	168,876
Turkeys	*	*	669	166

** number of animals

Farms: fewer but bigger

While there are fewer agricultural operations in Canada than there were in 1871, the average farm size has risen consistently—from 40 ha in 1871 to 332 ha in 2016. Canada reported 14 times as much wheat acreage in 2016 than was reported on the first Census of Agriculture in 1871. There were also 10 times as many pigs and 5 times as many head of cattle than reported in 1871.

Trends in Agriculture

The agricultural sector continues to see tremendous shifts or trends. As with the rest of Ontario and the country, one of most significant long-term trends is movement towards fewer and larger operations in all sectors of the agriculture industry. Both Northumberland County and Hastings County have seen a decline in the number of farms between the 2006 and 2016 censuses, with an increase in size. Individual fields are becoming larger, with the removal of treed fencerows.

Tobacco, once an important crop grown in the sandy soils in the western portion of the *watershed* region, is now non-existent. Livestock numbers have declined since 2006 while the percentage of agricultural land that is cultivated has increased. In addition, some smaller parcels of farmland and farms with *Canada Land Inventory* ratings of 4 -7 have been allowed to sit idle for a number of years with trees and shrubs beginning to return. In recent years, field crop production, particularly rotations of corn and soybeans, has increased.

Farmland bordering Murray Marsh

Tourism and Outdoor Recreation

Tourism in the Lower Trent *watershed* region is connected to opportunities in the rural landscape and outdoor recreation. Recreational areas within the region include a number of marinas, beaches, and a range of private campgrounds that allow both seasonal trailer use and tenting. There are also prime fishing and boating locations, at least nine public golf courses, and a ski hill at Batawa. There is also an extensive network of trails. While local Conservation Areas and two Provincial Parks

only permit non-motorized activities on their trails, such as biking, hiking, cross-country-skiing, and snowshoeing, there are many kilometres of motorized trails for ATVs and snowmobiles on both public (e.g., Northumberland County Forest, Crown Land) and private lands. The Waterfront Trail and the Trans Canada Trail also cross the *watershed* region. The Lower Trent Trail follows the west side of the Trent River from Trenton to Glen Ross, while the Trans Canada Trail is in the northern portion of the region.

Land Use Planning Framework

Land-based activities affect the natural environment in various ways. Land use planning addresses how land may be used and the organization of supporting services. The Provincial Policy Statement is issued under the authority of Section 3 of the *Planning Act*. The Provincial Policy Statement provides direction to municipalities with respect to provincial interests related to land use planning and development.

In addition to the *Planning Act* and the Provincial Policy Statement, the Province has put in place legislation and plans to accommodate growth while protecting farmland, water resources, and natural heritage in the Greater Golden Horseshoe. In the Lower Trent *watershed* region, the Growth Plan (2017) applies to Northumberland County, while the Oak Ridges Moraine Conservation Plan and the Greenbelt Plan (2017) apply to the northern portions of the Township of Alnwick/Haldimand, the Township of Cramahe, and to a small area in the Municipality of Trent Hills. The Greenbelt Plan only applies to the area covered by the Oak Ridges Moraine Conservation Plan. These plans were first introduced by the Province in 2006, 2002, and 2005, respectively.

The Oak Ridges Moraine is one of Ontario's most significant landforms stretching from the Niagara Escarpment eastward to the Lower Trent *watershed* region. The Oak Ridges Moraine is a significant headwater area for most of the stream systems west of the Trent River within the region: tributaries of Rice Lake, Burnley Creek, Percy Creek, Salt Creek, Cold Creek, Shelter Valley Creek, and Barnum House Creek. The unique concentration of environmental, geological, and hydrological features of the Oak Ridges Moraine makes its ecosystem vital to south-central Ontario. The Oak Ridges Moraine Conservation Plan was implemented by the Province to provide land use and resource management planning direction to provincial ministries and agencies, municipalities, municipal planning authorities, landowners, and other stakeholders on how to protect the Moraine's ecological and hydrological features and functions.

The Greenbelt Plan and the Growth Plan were designed to provide a regional approach to growth management and environmental protection for municipalities within and surrounding the Greater Golden Horseshoe. The purpose of the Growth Plan is to reduce urban sprawl by setting targets for intensification of housing and employment opportunities.

At the local level, municipal *Official Plans* provide guidance by establishing goals, objectives, and policies to manage and direct development and its effects on the social, economic, and natural environment of the municipality. Zoning By-laws implement *official plan* policies and set out specific land use permissions and controls. *Official Plans* and Zoning By-laws must conform to the Provincial Policy Statement.

Significant Woodlands

Candidate *significant woodlands* have been identified for the municipalities of Trent Hills and Quinte West (Lower Trent Conservation, 2001). This work was updated for the City of Quinte West through a project of the Bay of Quinte Remedial Action Plan in 2015 (Lower Trent Conservation, 2015).

Five criteria were used to identify *significant woodlands* in the 2001 report including: size, presence of interior habitat, proximity to other significant natural features, hydrologic values, and age (Lower Trent Conservation, 2001). The Municipality of Trent Hills recognizes the *significant woodlands* in their *Official Plan* as part of their Greenlands System. In Trent Hills, Environmental Impact Studies may be required by the municipality to demonstrate that there will be no negative impacts to *the significant woodlands* or their ecological functions. The 2015 report considered woodland size, presence of *forest interior*, proximity to other natural features, and proximity to watercourses (Lower Trent Conservation, 2015).

Provincially Significant Wetlands

Provincially Significant Wetlands have been evaluated by the Ministry of Natural Resources using the Ontario Wetland Evaluation System and are recognized as having ecological significance. The status of a *wetland* may change as a result of the evaluation process. The Ontario Wetland Evaluation System generates a numerical ranking of *wetland* values or functions, which are grouped into four main categories:

- Biological – productivity and biological diversity
- Social – direct human use of *wetlands* including economically valuable products, recreation, and education
- Hydrological – water related values including reduction of flood peaks, contributions to *groundwater recharge*, and water quality improvements
- Special features – addresses the geographic rarity of the *wetland*, occurrence of rare species, ecosystem age, and habitat quality for wildlife

The Provincial Policy Statement (2014) states that development and site alteration shall not be permitted in significant *wetlands*. Currently, there are 47 *Provincially Significant Wetlands* identified in the Lower Trent *watershed* region (Map 16 and Table 16). The Ministry of Natural Resources and Forestry continues to conduct evaluations, adjusting boundaries and identifying new *Provincially Significant Wetlands.*

Map 16: Significant Natural Areas

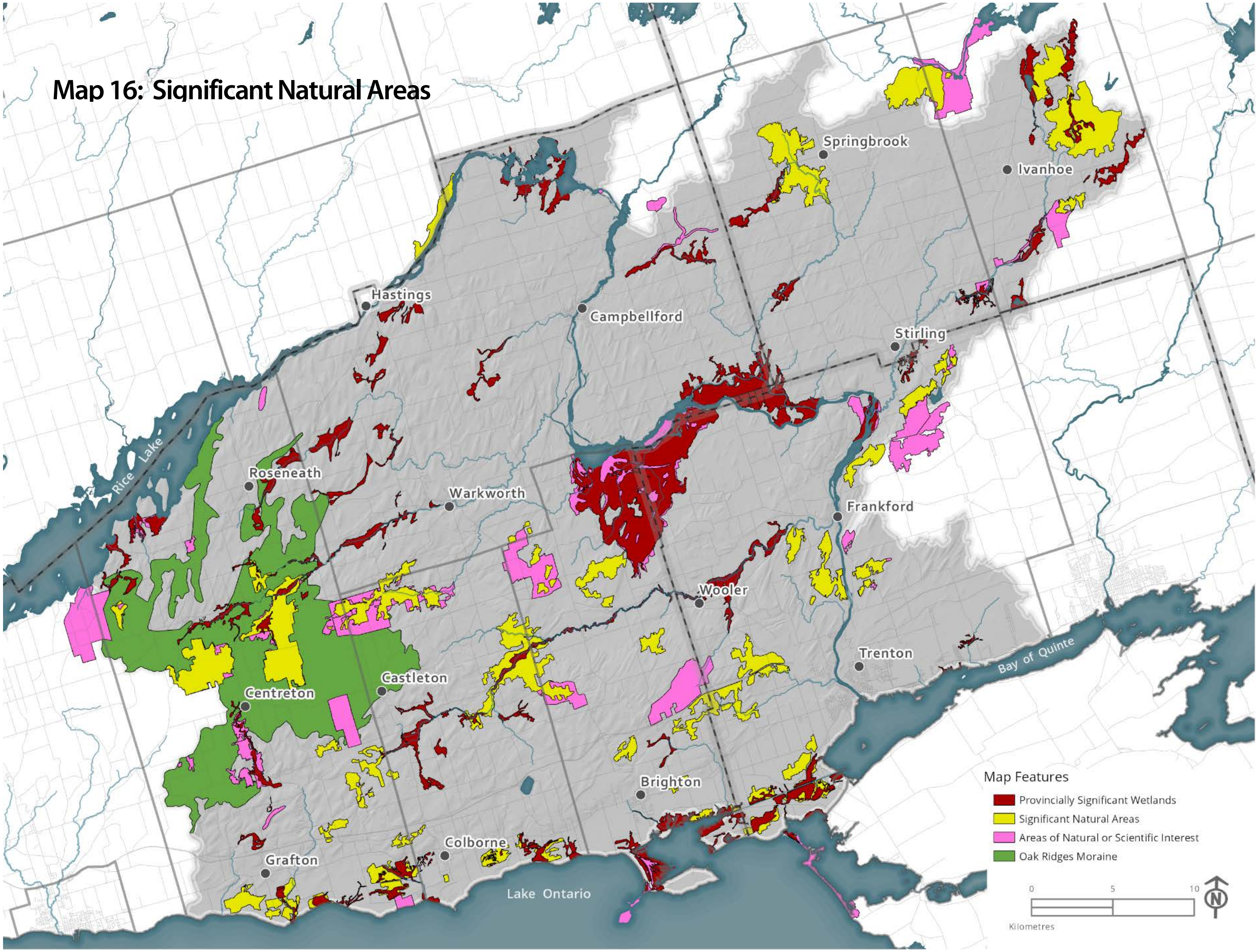


Table 16. Provincially Significant Wetlands

Provincially Significant Wetlands	Area (Ha)
Alnwick/Haldimand	**1,394**
Burnley Creek Headwaters Wetland Complex	152
Burnley Creek Midriver Wetland	195
Burnley (Mill) Creek Wetland	2
Colborne Creek	7
Cold Creek Wetland Complex	5
Cranberry (Little) Lake Wetland	55
Curtis Point	79
Dunnette Landing	93
Grafton Swamp	57
Lakeport	115
McGlennon Wetland	65
Percy Creek Wetland	208
Shelter Valley Complex	136
Stoney Creek Complex	145
Wicklow Bay Wetland	48
Wicklow Gravel Pit	32
Brighton	**2,590**
Boat Harbour Wetland	22
Cold Creek Shiloh to Wooler Wetland	120
Matson Lake	46
Murray Marsh	1,811
Presqu'ile Bay Marsh	591
Centre Hastings	**877**
Crookston Fen	153
Crookston Marsh	28
Fuller Creek	177
Moreland Lake	103
Rawdon Creek Swamp	129
Rawdon Creek Wetland Complex	5
Ross Lake Wetland	60
White-Snake Lakes	222
Cramahe	**717**
Colborne Creek	18
Cold Creek Shiloh to Wooler Wetland	140
Cold Creek Wetland Complex	327
Hunt and Beach Road-Popham Bay Wetland	49
Lakeport	20
Lone Pine Marsh	36
Salem Woods Wetland	23
Spencer Point	104
Quinte West	**2,730**
Bayside East Wetland Complex	25
Bayside Wetland	14
Carrying Place	30
Cold Creek Shiloh to Wooler Wetland	420
Dead Creek Marsh Complex	385
Murray Marsh	1,296

Presqu'ile Bay Marsh	8
Stirling Wetland	58
Trent River Final Bend Swamp	130
Wellers Bay Complex	28
Wilson Island East Wetland	336
Stirling-Rawdon	**411**
Hoards Creek Flats Wetland	100
Rawdon Creek Wetland Complex	97
Rylstone Wetland	159
Stirling Wetland	16
Wilson Island East Wetland	39
Trent Hills	**2,548**
Barry Lake Complex	116
Burnley (Mill) Creek Wetland Complex	200
Dartford Pond - O'Reilly Lake	170
Hoards Creek Tributary	183
Killoran Lake	67
Nappan Island Complex	521
O'Melia Lamey Lake Wetland	60
Percy (Halfway) Creek Wetland	203
Trout Creek	124
Wilson Island East Wetland	904
TOTAL	**11,267**

ANSIs

ANSIs (Areas of Natural and Scientific Interest) were first identified as 254 potential provincial parks or nature reserves in 1981. However, public resistance to their establishment resulted in the areas being identified as ANSIs. Property tax break incentives were implemented to encourage landowners to protect these special places.

Areas of Natural and Scientific Interest

Areas of Natural and Scientific Interest (ANSIs) contain natural landscapes that are important for natural heritage protection, appreciation, scientific study, or education. They have been designated by the Ministry of Natural Resources and Forestry as locally, regionally, or provincially significant. ANSIs are classified as either life science or earth science and include forests, valleys, *prairies*, *savannahs*, *alvars,* and *wetlands.*

Provincially significant ANSIs are representative of the best examples of the natural heritage features in the province. More than 500 ANSIs have been identified across Ontario and 39 are found in the Lower Trent *watershed* region (Map 16 and Table 17).

Murray Marsh Life Science Provincially Significant ANSI

Table 17. Areas of Natural and Scientific Interest (ANSI)

Name	Type of ANSI	Size (ha)	Municipality
Alderville First Nations Black Oak Savannah	Candidate Life Science	40	Alderville First Nation
Barry Lake	Life Science	<1	Trent Hills
Batawa	Life Science	365	Quinte West
Batawa Savannah	Life Science	<1	Quinte West
Bend Bay Valley	Life Science	1047	Centre Hastings, Stirling-Rawdon
Brighton Bluff	Earth Science	679	Brighton, Quinte West
Burnley Creek	Candidate Life Science	1213	Alnwick/Haldimand
Carmel Esker and Gravel Bedforms	Candidate Earth Science	348	Alnwick/Haldimand
Centreton Kettles	Candidate Life Science	30	Alnwick/Haldimand
Cramahe Hill Beaches	Earth Science	696	Brighton, Trent Hills
Dunnette Landing Marsh	Life Science	209	Alnwick/Haldimand
Eddystone Drumlin	Earth Science	41	Alnwick/Haldimand
Frankford East Drumlins	Candidate Life Science	62	Quinte West
Harwood	Candidate Earth Science	870	Alnwick/Haldimand, Hamilton
Harwood Plains	Candidate Life Science	79	Alnwick/Haldimand
Healey Falls	Earth Science	6	Trent Hills
Hilton Proposed Boundary	Earth Science	327	Brighton, Cramahe
Johnston Drumlin Forest	Life Science	<1	Quinte West
Johnston Drumlins	Life Science	182	Quinte West
Lakeport	Life Science	<1	Alnwick/Haldimand
Lakeport	Earth Science	82	Alnwick/Haldimand
Morrow Bay Woods	Life Science	47	Alnwick/Haldimand
Murray Marsh	Life Science	3760	Quinte West, Brighton, Trent Hills
Nappan Island	Life Science	<1	Trent Hills

Northumberland County Forest	Candidate Life Science	785	Alnwick/Haldimand
Oak Heights - Salt Creek	Candidate Earth Science	785	Alnwick/Haldimand, Cramahe
Oak Lake Island Beaches	Earth Science	72	Quinte West
Oak Lake Island Shorelines	Candidate Earth Science	274	Quinte West
Oak Lake Slope	Life Science	269	Quinte West
O'Melia Lake	Life Science	<1	Trent Hills
Pancake Hill Proposed Boundary	Earth Science	350	Centre Hastings, Stirling-Rawdon
Pancake Hill Slope Forest	Life Science	<1	Quinte West
Petherick Corners Esker	Earth Science	94	Trent Hills
Petherick Island Beaches	Earth Science	66	Trent Hills
Presqu'ile Tombolo and Coastal Islands	Candidate Life Science	420	Brighton
Sager Sand Barrens and Forest Complex	Life Science	609	Quinte West
Salt Creek	Candidate Life Science	944	Trent Hills, Alnwick/Haldimand, Cramahe
Shelter Valley	Life Science	432	Alnwick/Haldimand
Stirling Slope Complex	Life Science	199	Quinte West
Stockdale Drumlins	Candidate Life Science	134	Quinte West
Trent River Final Bend Swamp	Life Science	257	Quinte West
Wellers Bay Sandbar	Life Science	234	Quinte West/Prince Edward County
Wilson Island	Life Science	<1	Trent Hills

The Provincial Policy Statement (2014) states that development and site alteration shall not be permitted in significant ANSIs unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.

Natural Heritage System

To better protect natural features, areas, and linkages, and support ecological function, the Provincial Policy Statement (2014) also requires that *natural heritage systems* be identified by municipalities. Currently, no *natural heritage systems* have been adopted in the Lower Trent *watershed* region. A system has been proposed for the City of Quinte West (Lower Trent Conservation, 2015), developed through the Bay of Quinte Remedial Action Plan. However, the proposed *natural heritage system* has not yet been adopted into the City's *official plan*. Northumberland County is developing a county wide *natural heritage system*, which will include the Township of Alnwick/Haldimand, Township of Cramahe, Municipality of Brighton, and Municipality of Trent Hills, over half of the *watershed* region. As part of the Coordinated Land Use Planning Review (2017), the Province has committed to identifying and mapping a region-wide *natural heritage system*, which would include Northumberland County.

Legislation & Regulations

Through Section 28 of the *Conservation Authorities Act*, Conservation Authorities are empowered to regulate development and activities in or adjacent to river or stream valleys, Great Lakes and inland lakes shorelines, watercourses, *hazardous lands,* and *wetlands*. The Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation ensures consistency between conservation authorities and complements municipal implementation of provincial policies (e.g., *hazardous lands*, *wetlands*) under the *Planning Act*. Development taking place in a regulated area requires permission from the Conservation Authority to confirm that the control of flooding, *erosion*, dynamic beaches, pollution, or the conservation of land is not affected.

Below are other key provincial and federal legislation that impacts land use and land activity:

The *Clean Water Act*, introduced in 2006, is aimed at protecting drinking water at the source as part of the Province's overall commitment to the protection of human health and the environment. A key focus of the legislation is the production of locally developed, science based assessment reports and source protection plans.

The *Lakes and Rivers Improvement Act* was introduced in 1990 to protect the Province's surface water resources. The *Act* regulates the public and private use of Ontario's lakes and rivers, including the construction, repair, and use of dams. The *Act* provides for the requirement of Water Management plans from waterpower facilities to ensure environmental, social, and economic concerns are addressed. The *Act* also prohibits the deposit of refuse, matter, or substances into lakes and rivers that may impair water quality and/or quantity.

The *Ontario Water Resources Act* focuses on both groundwater and surface water throughout the Province. The *Water Resources Act* regulates sewage disposal and "sewage works", and prohibits the discharge of polluting materials that may impair water quality. Permits to take more than 50,000 litres of water per day from ground or surface water sources are also regulated under the *Water Resources Act*. The *Water Resources Act* regulates well construction, operation, and abandonment in addition to the approval, construction, and operation of "water works".

The *Federal Fisheries Act* contains two key provisions on conservation and protection of fish habitat essential to sustaining freshwater and marine fish species. The Department of Fisheries and Oceans administers section 35, the key habitat protection provision, prohibiting any work or undertaking that would cause the harmful alteration, disruption, or destruction of fish habitat. Environment and Climate

Change Canada administers section 36, the key pollution prevention provision, prohibiting the deposit of deleterious substances into waters frequented by fish.

The *Public Lands Act* outlines the use, management, sale, and disposition of public lands and forests. The *Act* guides Ontario's public land use planning and development, regulating public and private roads on public lands. The *Public Lands Act* also empowers the Province to construct and operate dams on waterways throughout the Province.

The *Species at Risk Act* (SARA) is a key federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of their biological diversity on federal lands.

The *Invasive Species Act* aims to prevent new species from arriving and to control – and where possible, eradicate – those that are already here. It allows the Province to regulate pathways of invasion such as firewood, recreational boating, purchase and trade, and guard against species coming from one part of the large and ecologically diverse province to another.

Both the Federal and Provincial governments have an *Environmental Protection Act,* which are the primary pollution control legislation with a focus on preventing the discharge of substances that can impact human health or the environment.

The *Aggregate Resources Act* provides the mechanism for the Province to regulate the management and use of aggregate resources including the issuing of permits and licenses, inspection, enforcement, and rehabilitation of sites. Aggregates are usually sand, gravel, clay, earth, and bedrock. They are used to make roads, subway tunnels, homes, and other structures.

Protected Areas

Within the Lower Trent *watershed* region, there are a number of areas that are protected for their natural values through ownership and conservation easements by government (federal, provincial, municipal), the Conservation Authority, and non-governmental organizations. They include Conservation Areas, Natural Habitat Areas, County Forests, Land Trust properties, Provincial Parks, and others (Map 17 and Table 18). Most of these are accessible to the public.

Conservation Areas and Natural Habitat Areas

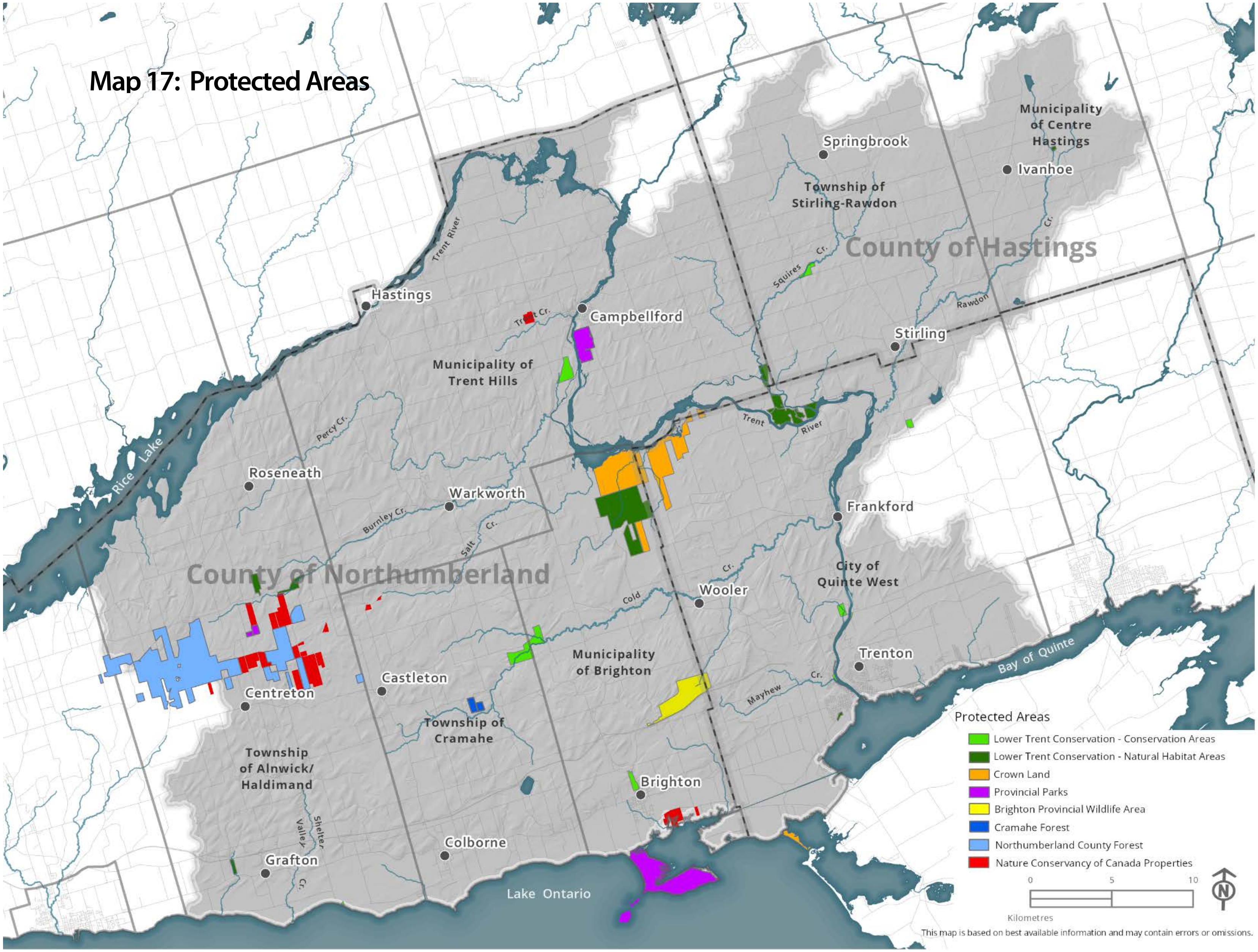
Lower Trent Conservation owns over 1500 hectares of conservation lands, which are classified into ten Conservation Areas and seven Natural Habitat Areas. Conservation Areas provide natural habitat protection and *erosion*/flood protection, while providing access and facilities for the public. Natural Habitat Areas are generally large tracts of land that remain in a natural state. They have no maintained trails or facilities, but are open to the public. More information on these lands is provided in Lower Trent Conservation's Conservation Lands Strategy (2017).

County Forests

The 2195 ha Northumberland County Forest lies primarily within the Lower Trent *watershed* region. It is owned and maintained by Northumberland County. Although forest harvest and recreation occur in the County Forest, the main objective is the maintenance of the *ecological integrity* of the forest.

The Cramahe Township Forest is approximately 130 ha and is owned by Cramahe Township. It was managed by the Ministry of Natural Resources until 2000. In 2000, the Northumberland Stewardship

Map 17: Protected Areas



Council provided management services until it was disbanded in 2016. From 2016 to the present time (2018), the Northumberland Tree Planters have provided management services. Early tree plantings were done in 1927, 1951, 1964, and 1965 by the Ministry of Natural Resources. The Stewardship Council and Northumberland Tree Planters have planted every year since 2005. Timber harvesting operations have taken place in the conifer plantations as part of the ongoing management (Glenn McLeod, personal communication).

Land Trusts

Land Trusts are non-profit, charitable organizations which have, as one of their core activities, the acquisition of land or interests in land (like conservation easements) for the purpose of conservation. The Nature Conservancy of Canada, the Northumberland Land Trust, and the Lone Pine Land Trust own and manage properties within the *watershed* region, which are protected for their ecological and cultural significance. The Ontario Farmland Trust protects and preserves Ontario farmlands and associated agricultural, natural, and cultural features of the countryside. As of 2017, there are no farms protected through this program in the Lower Trent region. The Hastings Prince Edward Land Trust also operates within the eastern portion of the *watershed* region; however, it does not own any properties within the region.

Provincial Parks

There are three provincial parks in the *watershed* region: Presqu'ile, Ferris, and Peter's Woods. Presqu'ile is a natural environment class park; the objectives of natural environment class parks are to protect outstanding recreational landscapes, representative ecosystems, and provincially significant elements of Ontario's natural and cultural heritage, and to provide high quality recreational and educational experiences. Ferris is a recreation class park; the objective of recreation class parks is to provide a wide variety of compatible outdoor recreation opportunities in attractive natural surroundings. Peter's Woods is a nature reserve class park. Policies for nature reserve class parks provide for the greatest level of protection of all classes of parks. The objectives of nature reserve class parks are to protect representative ecosystems and provincially significant elements of Ontario's natural heritage, including distinctive natural habitats and landforms, for their intrinsic value, to support scientific research, and to maintain biodiversity. Camping is permitted at Presqu'ile and Ferris Provincial Parks, but not at Peter's Woods.

A Spotted sandpiper feeding along the beach at Presqu'ile Provincial Park

Federal Lands

The *Trent-Severn Waterway* is made up of 386 km of interconnected lakes and rivers. It is a national historic site of Canada, which includes a series of locks and dams allowing boaters to travel from Lake Ontario to Georgian Bay on Lake Huron. Parks Canada also owns several strips of land along the Trent River that are accessible by the public.

One of the many canals on the Trent-Severn Waterway

Wellers Bay Coastal Sand Spit is a long, narrow baymouth barrier beach that extends 7 km across the mouth of Wellers Bay, separating it from Lake Ontario. It is a provincially designated Area of Natural and Scientific Interest and part of the Wellers Bay Wetland Complex Provincially Significant Wetland. The barrier beach extends from the City of Quinte West into Prince Edward County. The Quinte West portion is accessible to the public, whereas the Prince Edward County portion is a National Wildlife Area, off limits to the public. Public access is also prohibited in the Prince Edward County portion due to the presence of unexploded explosive ordnances from times when the Department of National Defense used the sandbar as an Air Weapons Range during World War II (Environment Canada, 2016).

Table 18. Areas Secured for Protection

Name	Location	Size (ha)
Conservation Areas		
Bleasdell Boulder	Quinte West	36
Goodrich-Loomis	Brighton / Cramahe	178
Glen Miller	Quinte West	4
Haldimand	Alnwick/Haldimand	2
King's Mill	Stirling-Rawdon	31
Proctor Park	Brighton	34
Sager	Quinte West	19
Seymour	Trent Hills	81
Trenton Greenbelt	Quinte West	13
Warkworth	Trent Hills	3
Natural Habitat Areas		
Alderville Woods	Alnwick/Haldimand	46
Barnum House Creek	Alnwick/Haldimand	19
Burnley Creek	Alnwick/Haldimand	43
Douglas Spring	Centre Hastings	7
Keating-Hoards	Quinte West/Trent Hills	311
Murray Marsh	Brighton	668
Trenton Escarpment	Quinte West	8
Provincial Parks		
Presqu'ile Provincial Park	Brighton	937
Ferris Provincial Park	Trent Hills	198
Peter's Woods	Alnwick/Haldimand	33
Other Protected Areas		
Northumberland County Forest	Alnwick/Haldimand	2100
Cramahe Forest	Cramahe	58
Brighton Provincial Wildlife Area	Brighton	809
Other Crown Land	Various	1,538
Nature Conservancy of Canada	Various	1,459
Northumberland Land Trust	Brighton, Cramahe, Alnwick/Haldimand	192
Lone Pine Land Trust	Brighton	179
Alderville Black Oak Savannah	Alnwick/Haldimand	60
Red Cloud Pioneer Cemetery	Cramahe	<1
Trent-Severn Waterway	Various	977
Wellers Bay barrier beach	Quinte West	36

Appreciating the view from Pott's Island in the Murray Marsh

9. Watershed Programs

Caring for the Watershed

Lower Trent Conservation's 2018 Strategic Plan describes "what we do" through our mission statement: To protect land, water and living things by working with and inspiring others.

To carry this out, we have established programs that have grown and evolved over the past 50 years. The current programs (2018) are outlined below.

Watershed Monitoring

Lower Trent Conservation's monitoring program is focussed on aquatic resources monitoring including participating in the Provincial Groundwater Monitoring Network (PGMN) and the Provincial Water Quality Monitoring Network (PWQMN), as well as monitoring benthic *macroinvertebrates*, temperature, and stream flow. Lower Trent Conservation collects and manages the *watershed* data and contributes to provincial databases. The data is useful in developing long-term water quality trends. A Watershed Report Card is produced every 5 years in conjunction with a Conservation Ontario initiative for Province wide reporting on *watershed* health, including surface water quality, groundwater quality, forest conditions, and *wetland* cover.

Environmental Planning

Lower Trent Conservation provides advice to our member municipalities and *watershed* residents, both through the formal commenting process under the *Planning Act*, and on an informal basis through general inquiries and pre-consultation meetings. Conservation Authorities have been delegated responsibility for provincial interests related to the natural hazards component of the Provincial Policy Statement. Plan Review Service Agreements have been established with our municipalities to provide advice on other environmental components (e.g., natural heritage, water) of the Provincial Policy Statement.

Hazard Lands & Wetland Regulations

Lower Trent Conservation regulates development and activities in or adjacent to river and stream valleys, watercourses, the Lake Ontario and Bay of Quinte shorelines, steep slopes and unstable soils, and *wetlands* in accordance with Ontario Regulation 163/06 – the Development, Interference with Wetlands & Alterations to Shorelines and Watercourses Regulation. By reviewing applications for activities near these areas, Lower Trent Conservation can ensure that development will not be impacted by flooding or *erosion* and that new development does not aggravate flooding upstream or downstream. It is a preventative approach. Environmental impacts are also taken into consideration before issuing a permit.

Flood & Erosion Control Projects

Lower Trent Conservation has completed flood and *erosion* control projects at 10 locations throughout the Lower Trent *watershed* region. These structures protect existing development within flood susceptible areas of the region from impacts resulting from a flood. The structures were constructed with the aid of the Province of Ontario and the local municipality on a cost sharing basis. Staff conduct regular inspections and maintenance, as required, in cooperation with the applicable municipality. Lower Trent Conservation operates one dam, located in Warkworth. The operations, geared towards flood protection for the village, consist of removal of logs in the fall to prepare for winter and spring runoff, and replacement of the logs in the spring to replenish the Mill Pond at Warkworth Conservation Area.

Stewardship Initiatives

Private landowners play a key part in making sure our natural resources are protected into the future. Lower Trent Conservation works with *watershed* landowners providing site visits, technical resources, advice, and financial assistance through our Healthy Lands – Clean Water program. The Conservation Authority also delivers specially funded stewardship programs as opportunities arise (e.g., Bay of Quinte Habitat Enhancement Program, Ontario Drinking Water Stewardship Program) and connects landowners to stewardship programs delivered by other organizations. We offer native tree and shrub seedlings for purchase through our Tree Seedling Program. In addition to services for private landowners, we carry out restoration projects for sensitive habitats on public lands.

Flood Forecasting & Warning

Lower Trent Conservation maintains a flood forecasting and warning system to provide early warning of possible risks to people and property from flooding. Because of our diverse *watershed*, there are three distinct forecast areas: the Trent River, local streams, and Lake Ontario and the Bay of Quinte. We provide local municipalities, other agencies and the public with advance notice, information, and advice so that they can respond to potential flooding and flood-related emergencies.

We use stream gauges, weather stations, *snowpack* measurements, weather forecasts, and computer models to determine the potential for flooding. When spring melt or severe storms are anticipated, Lower Trent Conservation estimates the severity, location, and timing of possible flooding.

Low Water Response

The Province established the Ontario Low Water Response Program to respond to drought-like conditions. Low rainfall and hot weather can result in low stream flows and groundwater levels. This can affect the amount of water available for drinking water, agriculture, and industry, as well as the health of the ecosystem. Lower Trent Conservation’s role in the program is to establish and coordinate a *watershed* based Water Response Team for the Lower Trent *watershed* region should low water become an issue. This Team may consist of municipal, agriculture, industry, business, recreation, and government representatives from the *watershed* region. The Team assesses current precipitation and streamflow conditions in the region and responds in various ways to conserve our water resources. The response could range from issuing communications that advocate water conservation practices and water use reductions, to making recommendations to the Province concerning water allocations.

Watershed Strategies & Studies

Watershed strategies are broad, long-term plans that help to ensure that our *watershed* management program fulfills our vision of healthy *watersheds* for healthy communities. This includes *watershed* plans, natural heritage strategies, and shoreline plans and surveys. While these types of studies are important for proactively identifying *watershed* opportunities and constraints, and to focus program priorities, they are only completed when special funding is allocated through the municipalities, Province, or federal government.

Community Outreach

Engaging residents in environmentally sustainable behaviours and drawing attention to conservation issues are important parts of our business. Outreach activities are a component of each of our program areas and are meant to encourage people to take environmental action. Lower Trent Conservation hosts hikes and other events to engage the public in outdoor environmental activities. We also attend community events (e.g., Bay of Quinte Home Show, Hastings County Plowing Match, and Trenton Woodlot Conference) and make presentations to local clubs and group meetings.

Lower Trent Conservation's "Volunteers for Conservation Program" offers opportunities for individuals to get involved with local environmental projects. These dedicated groups and individuals devote time and energy to various local conservation projects. Volunteers may assist with various aspects of Lower Trent Conservation's programs including *watershed* restoration, conservation lands, special events, environmental education, or administration.

Youth Education

Lower Trent Conservation recognizes that the students of today are the environmental stewards of tomorrow. As a result, we have a youth education program - Connecting Kids with Nature - with three main categories: Tri-County Children's Water Festival, Caring For Our Watersheds, and Environmental Programming providing presentations and workshops in schools, at children's day camps, and to youth-based community groups.

Conservation Lands

Lower Trent Conservation owns approximately 1,500 hectares of land with 17 properties in total that range in size from small parkettes to large natural areas (our largest is over 650 hectares):

Conservation Areas:

Bleasdell Boulder
Goodrich-Loomis
Glen Miller
Haldimand
King's Mill
Proctor Park
Sager
Seymour
Trenton Greenbelt
Warkworth

Natural Habitat Areas:

Alderville Woods
Barnum House Creek
Burnley Creek
Douglas Spring
Keating-Hoards
Murray Marsh
Trenton Escarpment

Our Conservation Lands are special places in the *watershed* where the natural world comes first. They provide a number of important benefits: protection of natural ecosystems, outdoor recreation, and tourism opportunities. Our Conservation Lands program focusses on maintaining these properties, repairing and improving facilities and infrastructure, and improving user experiences. Efforts to improve habitat are made possible through funding from special grant applications. Currently, there are no entrance fees for our Conservation Lands; however, fees are charged for some uses of our properties and facilities (e.g., special events, agriculture, hunting, and other activities). Donation boxes have been place at some our Conservation Areas to help support ongoing maintenance.

Descriptions of our properties and our Conservation Lands priorities are outlined in our Conservation Lands Strategy (2017).

Drinking Water Source Protection Program

Lower Trent Conservation was designated by the Ministry of the Environment and Climate Change as the lead Conservation Authority for the Trent Conservation Coalition Drinking Water Source Protection Region, encompassing the *watersheds* of the five Conservation Authorities in the Trent River *watershed* (Kawartha Conservation, Otonabee Conservation, Crowe Valley Conservation, Ganaraska Conservation, and Lower Trent Conservation) as well as areas outside of Conservation Authority jurisdiction. Regionally, Lower Trent Conservation is responsible for administering the Source Protection Committee and coordinating technical studies, public consultation, the preparation of source protection plans, and reporting on implementation activities.

Locally, Lower Trent Conservation disseminates information and provides advice to local municipalities to facilitate implementation and to identify local priorities for future updates to the source protection plan. We also have been delegated responsibility to deliver risk management services, and develop and deliver source protection education and outreach, on behalf of most of our local municipalities.

Bay of Quinte Remedial Action Plan

Lower Trent Conservation administers the Bay of Quinte Remedial Action Plan and provides communications and technical support aimed at the clean-up of the Bay. Lower Trent Conservation also co-chairs the Bay of Quinte Restoration Council. The Restoration Council includes agencies from all levels of government as well as local representatives who have come together to implement the Remedial Action Plan. The Restoration Council is working to remove the “Area of Concern” designation established by the International Joint Commission in 1985. *Eutrophication* and undesirable algae is the most challenging of the remaining *beneficial use impairments.*

Program Support

Corporate Services is an important part of day-to-day operations and provides support to all Lower Trent Conservation programs. These include financial and human resources management, administrative and information technology (hardware, software, and telecommunications) coordination and support, program planning and development, customer relations, partnership building, information management, geographic information systems (mapping), and marketing and communications.

Geographic Information Systems

Geographic Information System (GIS) is a computerized system of organizing, storing, analyzing, editing, and displaying spatial data. We use GIS to assist with making decisions about land use planning, managing our own lands, and stewardship programs. In addition, we provide GIS services to other organizations for environmental mapping on a fee-for-service basis.

Information Management

Information management includes ensuring that data is securely stored, organized, up to date, and accessible, with mechanisms in place for sharing it with others to assist with collaborative *watershed* management and protection.

Marketing and Communications

Corporate marketing and communications activities include media relations and production of annual reports, displays, brochures, and other communications products. In addition to traditional media, we use our website and social media (e.g., Facebook, Twitter, YouTube) to keep our municipal partners, *watershed* residents and other stakeholders, as well as staff and the Board of Directors, up to date with our programs and events.

Fundraising

Fundraising results in a significant amount of revenue for the Conservation Authority, and is critical to the continued delivery of our youth education programs and maintaining viable stewardship and outreach programs. Fundraising efforts range from grant applications to direct solicitation of funds.

Administration

Administration includes management of our finances, human resources, and other assets, as well as program planning and development, customer relations, partnership building, and communications.

Lower Trent Conservation has established policies and procedures for administration, purchasing, personnel management, health and safety, and accessibility to provide guidance to staff for program implementation. These documents need to be reviewed and updated regularly to ensure they are relevant and compliant with legislation.

Looking back…

Recommendations from 1970 – 2018 – A Comparison

Lower Trent Conservation produced its first Conservation Report in 1970. It outlined a Conservation Plan consisting of some 60 recommendations to address priorities regarding water, fish and wildlife, recreation, land use and forestry development, as well as various programs and projects. Nearly 50 years later, the vast majority of those recommendations have been fulfilled. For instance, numerous conservation lands have been acquired to provide both recreation opportunities and protection of sensitive habitats and natural features. Regulations controlling development in *flood plains* and *wetlands* have been put in place. Other issues require ongoing work (e.g., stewardship programs promoting sound land use practices, financial assistance to reduce erosion and siltation in stream channels, water quality monitoring using regular water sampling). Only 11 recommendations were not carried out as they are no longer deemed relevant or feasible. Undoubtedly, had action to resolve the varied environmental issues not been taken, the wellbeing of the *watershed* region and its residents would be worse off. However, with time, new issues arise and fresh approaches are needed to protect the health of our *watersheds*.

A Monarch caterpillar munches on some common milkweed

10. Watershed Challenges

What's Bugging Us?

As the human footprint gets larger and larger, so too does the number of environmental impacts. Below, we have identified the challenges that matter the most in the Lower Trent *watershed* region at this particular time. The first few are causes (e.g., human activities) and the remainder are the effects (e.g., habitat loss). There has been no attempt to list these in order of significance.

Increased Development Pressure

Growth pressures from the Greater Toronto Area can be felt in parts of our *watershed* region. The push for growth and development in local municipalities puts more pressure on land and water resources. As the amount of available land decreases, development pressures adjacent to sensitive areas increases.

Bird's eye view of Brighton

Septic Systems

While we do not have sufficient data to document the impacts of septic systems on our water resources, approximately half of the homes in our *watershed* region rely on septic systems to treat wastewater. Some are located close to waterways and many are older and not properly maintained. Malfunctioning septic systems are known contributors of nutrients and pathogens to groundwater and surface water.

Agricultural Runoff

Agriculture is a major industry in our *watershed* region and occupies a substantial percentage of the land base. While many farmers have implemented best management practices to minimize soil and nutrient loss, there are still farms that could benefit from practices such as planting vegetated buffers, installing fencing along watercourses, conservation tillage, and improved manure storage and handling.

Climate Change

Climate change is the most significant environmental challenge we are facing today. It will have a dramatic effect on natural environments, resulting in increased flooding and drought, affecting plant and animal habitats, and leading to acceleration in biodiversity loss in some areas.

Forest Coverage

The cutting down of trees to make way for more homes and industries results in a gradual decline in forest cover. Forest coverage in our *watershed* region (approximately 35%) is marginally above the threshold established by Environment Canada to protect species diversity and aquatic ecosystems. However, in terms of interior forest, our region falls below the guideline of 10%. The tools for protecting woodland coverage are weak, and there continues to be small losses in coverage to allow for development.

Invasive Species

Increasing numbers of *invasive* species are being introduced to our region. These species compete with, and displace, native species. *Invasive* species can negatively impact our wellbeing and the local economy.

The emerald ash borer is an invasive insect that infests ash trees across Ontario

Species at Risk

The list of endangered, threatened, and special concern animals and plants in Ontario grows each year. Our *watershed* region is not spared from this decline in biodiversity. Maintaining biodiversity is important to all of us for several reasons including: clean air and water, healthy soils, raw materials, food, human health, and ecosystem resilience.

Shoreline Vegetation

Vegetated shorelines are essential components of a healthy *watershed* – slowing runoff and erosion, reducing sediment and nutrient input to waterways, providing habitat for a variety of species, and providing shade to maintain cooler water temperatures for fish. Many of our urban, residential, agricultural, and recreational properties are lacking in shoreline vegetation as they have been cleared to maximize use of the property and increase access and views of the water.

Habitat Loss

The loss of forest cover, shoreline vegetation, and the increasing numbers of *invasive* species all result in habitat loss and declining biodiversity. Human activity continues to encroach on natural environments, thereby deteriorating and destroying the habitats of countless species.

Water Quality

No obvious trends in water quality are apparent in our *watersheds*, based on the available data. However, the data suggests that phosphorus concentrations occasionally exceed the Provincial Water Quality Objectives and it has long been a concern in the Bay of Quinte. With a push for more development in our *watershed* region, we could start to see deterioration in water quality. Chloride from road salt is becoming a bigger issue in urban areas.

With a warming climate, the likelihood of blue-green algae blooms in shallow, slow moving water bodies like the Bay of Quinte and Rice Lake is likely to increase. While the *biomass* of algae appears to be declining in the Bay of Quinte in recent years, the relative composition of blue-green algae (or *cyanobacteria*) in the Bay is increasing. Even more worrisome is that the relative composition of the genus of *cyanobacteria* that can potentially produce toxins is increasing. This is a concern for human health, with the Bay being a source of drinking water.

Other emerging water quality issues include microplastics and pharmaceuticals.

Algal bloom

Bay of Quinte

The Bay of Quinte was identified as one of 43 areas of concern around the Great Lakes by the International Joint Commission in 1985. Eleven *beneficial use impairments* were identified, and a Remedial Action Plan was put in place to address these impairments. Today, most of the *beneficial use impairments* have met the delisting criteria set out in the Plan, but *eutrophication* and undesirable algae remains a challenge.

Barred owl

11. Knowledge Gaps

Unsolved Mysteries

Lower Trent Conservation's programming is determined by mandate, resources, and priorities. The mandate, as set out in Section 20 of the *Conservation Authorities Act* (2017) is: to provide, in the area over which it has jurisdiction, programs and services designed to further the conservation, restoration, development and management of natural resources, other than gas, oil, coal and minerals. This broad mandate is enabling and places very little restrictions on the type of conservation work conservation authorities can undertake. Resources, however, are limiting. Without grants for special projects, it is difficult to take on more work with only marginal increases in our annual budget. Through our strategic plan and annual business plan, and with input from local municipalities, priorities are identified which enable us to focus our attention and resources toward moving the conservation yardstick forward.

The following is a list of knowledge and information gaps identified by Lower Trent Conservation staff. The information, policies, and programs outlined below would help the Conservation Authority better understand and respond to the challenges identified above, and achieve our *watershed* vision: Healthy Watersheds for Healthy Communities. The list is in no particular order, but has been used to inform the development of 2018 Strategic Plan.

Watershed Monitoring

A more robust monitoring program is needed with more strategically placed sampling locations and expansion to include terrestrial environments. The data derived from the sampling program needs to be analyzed and utilized to inform our program priorities. The surface water quality monitoring program currently focuses mainly on the Trent River. More monitoring stations across the *watershed* region would provide better indicators of *watershed* health. More data on phosphorus, chloride, and E. coli would be the highest priority.

- Erosion monitoring stations along the Lake Ontario shoreline are lacking in the City of Quinte West and the Municipality of Brighton. Where there are stations (Townships of Alnwick/Haldimand and Cramahe), they are not surveyed on a regular basis. Improved data would help establish erosion rates and inform implementation of our planning and regulations programs.
- There is a lack of data on fish habitat and fish species presence in the *watershed* region. This data is a significant indicator for healthy *watersheds*.

Better Mapping & Data

- Additional *watershed* geographic information system base data is needed (e.g., accurate parcel fabric mapping, accurate water features mapping, high resolution DEM, LiDAR data, and frequent orthophotography coverage). With good quality base data, analytical tools can be used to enhance our understanding of our *watersheds* and guide our programs.
- There is limited high quality vegetation community mapping for the *watershed* region. While *Ecological Land Classification* mapping has been completed for some municipalities, it has not been field verified. A seamless layer for the *watershed* region would assist in natural heritage planning, municipal plan input and review, and with our stewardship program.

- Little information has been collected on vegetation communities on our Conservation Lands. Better information would help to inform management practices on our Conservation Lands.
- Information on *invasive* species and *species at risk* is sporadic for our *watershed* region. As a minimum, inventories to identify *invasive* species and habitat for *species at risk* for our own properties would lead to more conservation-minded management practices on our Conservation Lands.
- There is a lack of data on *impervious surfaces* for our region. This type of data would help inform the planning and *stormwater* review programs, as well as stewardship.

Technical Studies

- The anticipated impacts of *Climate Change* are not well understood for our *watershed* region. A better understanding of changing weather patterns will help us adjust our programs to protect our communities – both human and natural.
- The *flood plain* mapping for the Trent River and smaller streams is very dated. Updated modelling and mapping would help to ensure that new development is located safely outside of the *flood plain*.

Policies, Plans & Programs

Long-term Planning

- Only two *watershed* plans have been developed for our region: Dead Creek and South Sidney. *Watershed* plans would help guide development and protect natural areas and water resources. They, especially, should be completed in developing areas of the *watershed* region.
- While the *Planning Act* calls for a natural heritage systems approach to municipal planning, a Natural Heritage System has not been mapped out for the Lower Trent *watershed* region. Both a Natural Heritage System, and Strategy for protecting it, are needed to maintain *watershed* ecosystem health.
- 2017 saw extreme high water levels on Lake Ontario. A new and expanded Lake Ontario shoreline management plan would provide a better understanding of risks and recommendations for setbacks and shore protection.
- A Phosphorus Management Strategy is needed for the Bay of Quinte to make sure water quality does not return to conditions that required a Remedial Action Plan in the first place.
- As the Bay of Quinte gets closer to being removed from the Areas of Concern list, a plan is needed for the long-term monitoring and protection of the Bay. Over 40 years of research and monitoring by federal, provincial, and local agencies has taken place for the Bay.
- Natural habitats, such as forests, need to be inventoried and mapped, and plans put in place to protect them.

Policy Development

- Reviewing *stormwater* management plans is an important component of Lower Trent Conservation's plan review program. A *stormwater* management policy would clarify our policies for municipalities and developers, and help ensure that we are providing consistent comments.

- While the Trent Source Protection Plan sets out policies to protect municipal sources of drinking water, approximately half of the residents of the *watershed* region rely on private wells. Development of a program to protect private sources of drinking water would help ensure safe drinking water for all *watershed* residents.

- *Wetland* coverage in our *watershed* region meets the federal guidelines established for *wetland* coverage to maintain healthy *watersheds*. However, development sometimes infringes upon these areas. A policy should be established to ensure no net loss of *wetlands.*

Stewardship

- Areas that score low in terms of *watershed* health on our Watershed Report Card would benefit from a targeted stewardship program. These areas should be identified through regular *watershed* monitoring and reporting.

Education & Outreach

- There is a need to continue to educate *watershed* residents, business operators, and municipal politicians and staff to promote the importance of conservation work. Youth environmental education is critical to foster the next generation of environmental champions.

Conservation Lands

- None of the trails or facilities on our Conservation Lands are identified as “accessible.” An inventory and assessment of our trails and facilities is needed to identify potential candidates for accessibility upgrades and classification.

- Our Conservation Lands could be further utilized to demonstrate best management practices, encouraging environmental stewardship on private lands and partnerships with other environmental groups.

Connecting kids with nature

12. Recommendations

Back to the Future

We hope that the information provided in this document provides a sound background on the Lower Trent *watershed* region, from a physical, ecological and social perspective, as well as an understanding of the role Lower Trent Conservation plays in protecting the local *watersheds.*

Lower Trent Conservation has accomplished much in its first 50 years, but there is much more to do. Current issues and data gaps have been identified which the Conservation Authority needs to focus on in its future Conservation Programs. To that end, a Strategic Plan released in 2018 sets out a path forward for the next 10 years. The Plan sets out goals and actions to improve Lower Trent Conservation's environmental programs and the health of the *watershed* region. Lower Trent Conservation also develops a Business Plan annually; the issues and data gaps identified in this report, and the goals and priority actions set out in the Strategic Plan, will need to remain foremost in our minds as we develop annual business plans and budgets.

Looking back…

Key Accomplishments in 50 Years of Conservation

- 17 properties, totaling 1,500 ha, acquired and managed for environmental protection and outdoor recreation
- *Flood plain* mapping prepared for Lake Ontario, Bay of Quinte, Trent River, and 14 tributaries
- Flood forecasting and low water advisory programs developed
- Environmental plan review services provided to local municipalities
- Hazard land and *wetland* regulations implemented to protect people and property
- 10 flood and erosion control structures built and maintained
- Environmental monitoring programs developed and *watershed* report cards produced
- Outreach to thousands of people through events and publications
- Youth education programs developed and delivered
- Land stewardship programs implemented and tree seedlings sold and planted
- Coordination of a regional drinking water source protection program and local delivery
- Local administration of the Bay of Quinte Remedial Action Plan

The goals and priority actions set out in the 10 year Strategic Plan are listed below:

Advance Watershed Knowledge

- Invest in monitoring programs to track and report on changes in our environment to support adaptive resource management
- Acquire additional *watershed* data and increase use of analytical tools to facilitate a greater understanding of our *watersheds*, enhance data analyses, and guide program development
- Identify and fill information gaps on vegetation communities and create seamless *Ecological Land Classification* mapping for the *watershed* region
- Undertake inventories of our Conservation Lands, including identification of *invasive* species and habitat for *species at risk*
- Develop understanding of the anticipated impacts of *climate change* locally
- Encourage data sharing with our partners and improve accessibility to our information to advance *watershed* knowledge in our communities

Protect Land & Water Resources

- Incorporate measures into our programs to adapt to *climate change* and mitigate its effect on the *watershed* region
- Protect water resources through preparation of a *stormwater* management policy
- Develop programs to maintain the long-term health of the Bay of Quinte following delisting as an Area of Concern
- Develop and support implementation of a Natural Heritage Strategy for the *watershed* region, incorporating *Ecological Land Classification* communities and mapping developed by individual municipalities and the Province
- Develop a stewardship restoration plan to prioritize target areas and projects
- Establish policies to ensure a no net loss of *wetlands* and protect other natural habitats

Support Sustainable, Healthy Communities

- Work with our municipalities to complete *watershed* plans, on a priority basis, in areas facing development pressures
- Collaborate with our municipalities to help them understand and meet the environmental requirements of new provincial land use plans, policies, and regulations
- Work with our municipalities and communities to ensure that sources of drinking water are adequately protected
- Create guidelines and communication tools that clarify the requirements for landowners and business operators to comply with our regulations and programs

- Update and expand the Lake Ontario shoreline management plan to include all our Lake Ontario shoreline municipalities
- Collaborate with our municipalities and others to update flood plain mapping and other tools to support the planning, regulations, and flood protection programs
- Connect people with nature by encouraging increased use of our Conservation Lands and other natural areas
- Promote the connection between environmental health and human wellness
- Identify and implement opportunities to improve accessibility on our Conservation Lands

Inspire Others to Take Action

- Enhance our community outreach program to further engage the public and provide opportunities for experiential learning
- Further develop our volunteer program to engage more people in conservation work and citizen science
- Incorporate best management and stewardship practices on our Conservation Lands, utilizing them as learning sites for municipalities and community members to incorporate on their property
- Recognize conservation efforts of the community through awards and other recognition tools
- Expand and implement the land stewardship program and capitalize on opportunities to deliver other stewardship programs
- Sustain robust youth environmental education programming, providing in-school and experiential learning to connect kids with nature and foster the next generation of environmental champions
- Seize opportunities to lead by example, through practices on our Conservation Lands, program delivery, and business operations

This Conservation Report is a snapshot in time. While some of the information – geology, *physiography*, soils – remain constant, other areas like land use, climate, and current issues undergo change. The Report should be updated at least every 5 years to keep pace with changes in the state of the environment, funding, and political, development, and social pressures.

Since the Strategic Plan and this Report were developed and released concurrently, this Report does not include additional recommendations. During the 5-year review, progress on the recommendations set out in our strategic plan should be assessed, and additional recommendations set out to complement our strategic plan and address any emerging concerns and opportunities.

Snapping turtles emerging from their nest

Why Woodlands?

Woodlands enhance the natural beauty of our rural and urban landscapes, and provide a wide range of *ecological goods and services* – things that are essential to our survival like clean water, fresh air, food, and raw materials. Woodlands provide wildlife habitat and contribute significantly to biodiversity. Many crops, including tomatoes, apples, strawberries, and squash, are pollinated by insects that live in woodlands. Woodlands filter water, especially reducing non-point sources of water pollution. They reduce runoff, helping water soak directly into the ground, thereby lessening demands on stormwater infrastructure and reducing flooding and *erosion*. They filter air by removing dust and pollutants, and produce oxygen. They store carbon, helping to mitigate *climate change*. The shade cools water, buildings, and streets, and they act as windbreaks and provide privacy. They provide lumber for construction, firewood, and raw materials for the pulp and paper industry. They provide recreational areas for camping, hiking, and hunting. We could not invent anything more hard working than trees.

7. Natural Heritage

Living Things

Communities of living things, including plants and animals, both shape and are shaped by their physical environments - the soil, water, and climate.

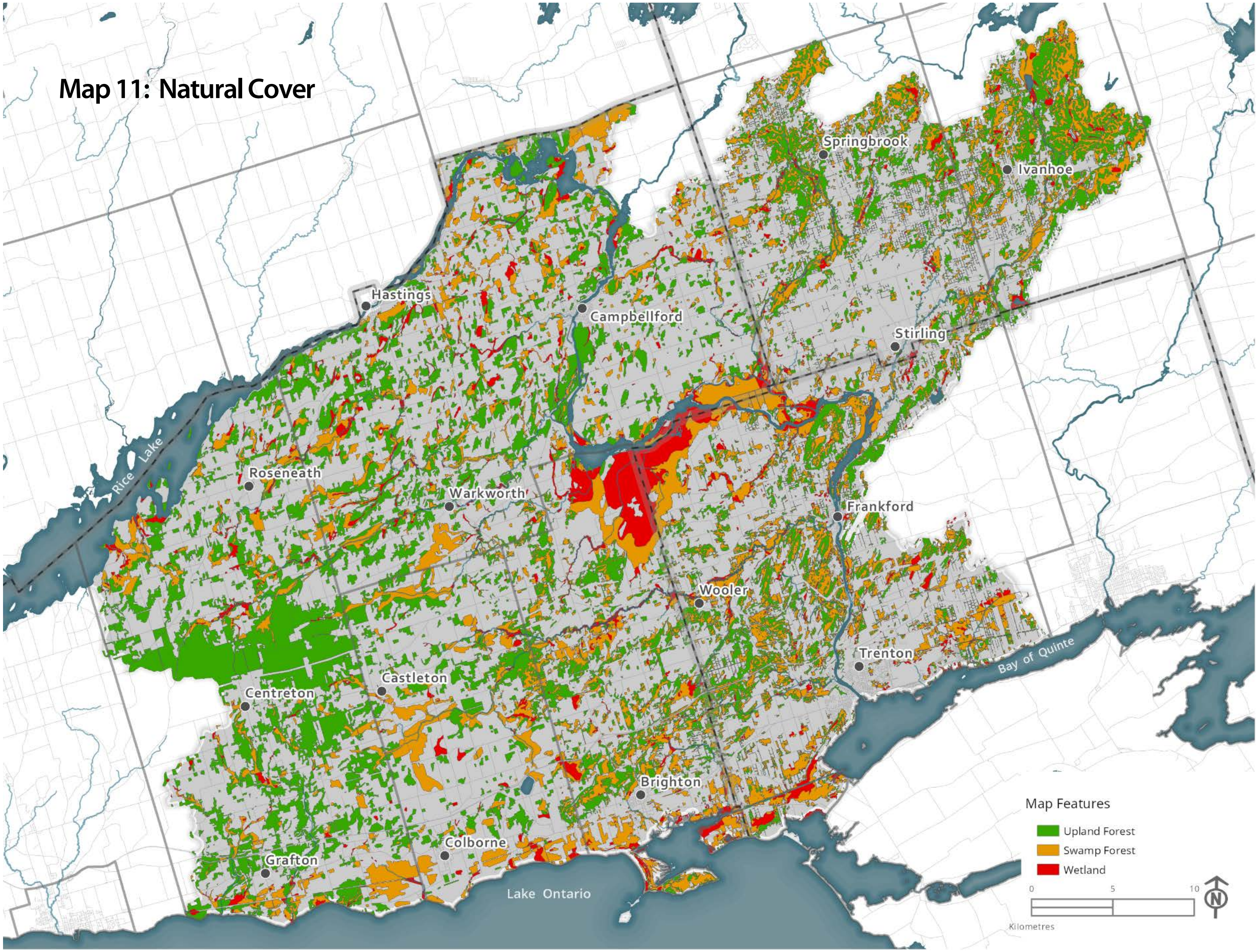
Forests and Forest Interior

The Lower Trent *watershed* region is characterized as the deciduous forest of the Great Lakes-St. Lawrence Forest Region. The dominant tree cover in the forest region consists of deciduous hardwood species such as sugar maple, red maple, beech, basswood, red oak, white oak, white ash, and white elm. More southerly species such as shagbark hickory, bitternut hickory, black walnut, and butternut, can also be found sporadically due to the moderating influence of Lake Ontario. The Great Lakes-St. Lawrence Forest Region is also characterized by conifers such as white pine, hemlock, white cedar, and balsam fir, which are prominent either in coniferous stands or sharing dominance with deciduous species in mixed stands.

The present extent of natural forest cover reflects historic and current settlement patterns, with agricultural activities having the greatest influence throughout the majority of the Lower Trent *watershed* region. Across southern Ontario, the average forest cover has declined from about 80% from pre-European settlement to about 17% today (Butt et al., 2005). However, in eastern Ontario, as a result of the retirement of marginal agricultural lands and stewardship reforestation efforts over the past 100 years, forest cover has increased from 20-30% in the 1880s to about 38% (Landowner Resource Centre, 1997).

Today's forest cover is greatly reduced from pre-settlement times and is highly fragmented (Map 11). The majority of forests are second or third growth; extremely few being old-growth (over 120 years old). Harvesting the largest trees, fire suppression, tree diseases, *invasive* insect infestations, *invasive* plants, and excessive browsing by white-tailed deer have all had negative effects on existing forest cover (Ecosystem Status and Trends Secretariat, 2016). Forests are a critical component of terrestrial ecosystems. In addition, they

Map 11: Natural Cover



are important for good water quality and stream hydrology, and for reducing soil *erosion*, producing oxygen, storing carbon, mitigating *climate change*, and providing many other *ecological goods and services*. A great diversity of wildlife depend on forests for food, water, and shelter. The total forest cover in a *watershed* is a strong predictor of the persistence and size of bird populations, and likely of other flora and fauna groups (Environment Canada, 2013).

Within a *watershed*, the "How much habitat is enough?" guidelines state that 30% forest cover is regarded as dangerously low for maintaining biodiversity (Environment Canada, 2013). Having at least 50% forest cover is considered a less risky approach to protecting species diversity and healthy aquatic ecosystems (Environment Canada, 2013). Currently, about 35% of the Lower Trent *watershed* region is forested (Table 6). Of that, only 7% is *forest interior* habitat, which is found deep within the forest, sheltered from edges and needed by many sensitive species (Table 6). *Forest interior* habitat should make up at least 10% of the *watershed* region (Environment Canada, 2013).

Climate models are predicting a northern shift of climatic conditions of *ecoregion* 6E (within which the *watershed* region is located) to north of Sudbury around 2041-2070 (Ontario Ministry of Natural Resources and Canadian Forest Service, 2010). It is uncertain how forest communities will respond to these climatic shifts. The Forest Gene Conservation Association is recommending the practice of assisted migration, whereby native trees from more southerly seed zones are planted in the northern limits of their range to provide genetic variability and potential *climate change* adaptability. However, overall, increasing forest cover and species diversity in Ontario is considered the best approach for improving forest resiliency and adaptation to *climate change*.

Riparian Forests

Riparian forest is the forested area found along a stream, river, or lake. Maintaining natural vegetation in *riparian* areas is important to maintaining water quality as *riparian* vegetation slows runoff, reduces sediment and nutrient input to rivers and streams, and provides shade to maintain lower water temperature (important for *cold water* fish species). In the Lower Trent *watershed* region, only 43% of the total *riparian* area is forested. That is below the recommended minimum target of 50% for healthy watercourses (Conservation Ontario, 2011). Only five out of 12 *watershed* groupings meet the recommended target (Table 6).

Wetlands

Wetlands are lands inundated with water resulting in the formation of waterlogged *(hydric)* soils and the presence of water-loving or water-tolerant plants. They occur in areas with a high *water table*, in low-lying areas, or along lakes and rivers. Many *wetlands* are always flooded, while others flood periodically in the spring or fall. Others may seem dry with no pooling of water; however, the *water table* can be high and close to the surface (Ontario Ministry of Natural Resources and Forestry, 2017).

Wetland types in the region include swamps, marshes, fens, and bogs. Swamps are the most common type of *wetland* found in the Lower Trent *watershed* region. Swamps are dominated by trees and shrubs. Marshes are the most recognized type of *wetland*, but are less common in the region. Marshes are dominated by cattails and water-lilies, with shallow areas of open water. Fens are rare in the *watershed* region occurring in only a few areas. They are characterized by Sphagnum moss, sedges, grasses, and reeds; they are acidic and low in nutrients. Bogs are even rarer. A single kettle bog has been confirmed in the Lower Trent *watershed* region; it is found in the Cold Creek Significant Natural Area. Bogs are dominated by peat and collect rain and snow as the major water source. They are low in nutrients and strongly acidic.

Why Wetlands?

***Wetlands* are critical to the ecological and hydrological function of a *watershed* and provide *watershed* residents with a variety of *ecological goods and services* including: water quality improvement, flood attenuation, and fish and wildlife habitat.**

Coastal *wetlands* are any *wetland* types which occur in close proximity to the Lake Ontario shoreline (OMNRF, 2017).

Prior to 1800, there were some 2.38 million hectares of *wetlands* in southern Ontario. By 1982, this coverage dropped to 0.93 million hectares – a 60% reduction (Environment Canada, 2013). *Wetland* loss within the Lower Trent *watershed* region contributes to this pattern of decline.

Today, *wetlands* in the Lower Trent *watershed* region slightly exceed the minimum target of 10% for healthy *wetland* habitat recommended by Environment Canada (2013) (Map 11) (Table 6). On a smaller scale, based on available data, the recommended *wetland* target of 6%, is met by all of the local *watershed* groupings (Table 6). However, the protection of existing *wetlands* and the enhancement and restoration of degraded *wetlands* are critical to meeting this recommendation. Protection of isolated *wetlands* in both rural and urban areas is also important to improving and maintaining water quality. Ensuring no net loss of *wetland* area, as well as maintaining and restoring *wetland* function in *headwaters*, floodplains, and coastal areas, is vital to the health of our *watersheds.* A Wetland Conservation Strategy for Ontario has been developed which outlines policies to encourage no net loss of *wetlands* (OMNRF, 2017).

Table 6. Current Forest and Wetland Conditions

Watershed Grouping	Area (ha)	% Forest Cover	% Forest Interior	% Riparian Forest	% Wetland Cover*
Target for watershed grouping		**>40%**	**>10%**	**>50%*** **	**>6%**
Barnum House / Shelter Valley Creek	11798	39	5	61	9
Bay of Quinte Tributaries	7092	24	3	31	18
Cold Creek	25896	37	7	50	19
Lake Iroquois Plain Tributaries	22788	32	5	38	25
Mayhew Creek	3829	51	12	54	25
Percy / Burnley Creek	24147	41	7	52	12
Rawdon Creek	19687	46	16	51	22
Rice Lake Tributaries	10782	27	3	40	8
Salt Creek	9033	37	10	49	16
Squires Creek	18597	40	10	46	18
Trent River Corridor Tributaries	46925	29	5	29	22
Trout Creek	4425	26	2	40	13
Target for entire watershed region		**>50%**	**>10%**	**>50%*****	**>10**
TOTAL	**204999**	**35**	**7**	**43**	**18**

Results based on 2018 Watershed Report Card

Grey cells indicate watershed groupings that failed to meet minimum water quality and habitat targets, which were based on Watershed Report Card guidelines (Conservation Ontario, 2011).

Rare Habitats

***Prairies* and *savannahs* are so rare and imperilled some say they are more threatened than rainforests.**

Prairies and Savannahs

Savannahs are characterized by open habitats with scattered trees like oaks, pines, and maples. *Prairies* are characterized by tall, warm-season grasses, wildflowers, and shrubs. Both of these communities are tolerant of dry, nutrient poor, sandy soils, and historically were maintained by droughts as well as fires set by lightning strikes and indigenous peoples (Walters, 2016).

Some 1,000 km^2 of southern Ontario was once covered by *prairie* and *savannah* habitats. Today, most of the remnants of tall grass *prairie* and oak *savannah*s occurring in the Lower Trent *watershed* region are found in the *Rice Lake Plains* area located between Rice Lake and Lake Ontario (Map 12). In addition, small pockets of *savannah* found along the Trent River are representative of once much larger and continuous areas. Up to 300 km^2 of the *Rice Lake Plains* area is estimated to have been covered by tallgrass *prairie* and oak *savannah* (Bakowsky and Riley, 1994). The black oak *savannah* and tall grass *prairie* remnants that occur in the *Rice Lake Plains* area are considered to be among the most significant ecological communities in North America, and are globally rare.

These habitats have been lost to agriculture, urbanization, and fire suppression. The protection of these remaining rare and unique ecosystems within the Lower Trent *watershed* region is important. These remnant natural heritage gems showcase the tremendous diversity of habitats that once occurred here on a much larger scale (Walters, 2016).

Other Habitats

Other unique and fascinating habitats can also be found in the Lower Trent *watershed* region including: *alvar* on limestone bedrock with shallow soils, limestone cliff *escarpment* along ancient glacial Lake Iroquois shoreline, small bluffs along Lake Ontario, and sand dunes with their accompanying panne wetlands in Presqu'ile Provincial Park.

Significant Natural Areas

An extensive evaluation of the Lower Trent *watershed* region was completed in the mid-1990s. In 1993, the Waterfront Natural Areas report (Brownell, 1993) evaluated areas along the Lake Ontario shoreline from Burlington to Trenton, including 37 in the *watershed* region. Based on natural areas and *wetlands* identified by Reid and Grand (1994), an additional 41 sites were investigated in the field by Lower Trent Conservation (Brownell and Blaney 1995a, 1995b, 1996a, 1996b) resulting in the identification of 38 Significant Natural Areas (Table 7). These areas were selected based on a combination of attributes including size, biological representation, ecological sensitivity, condition, contribution to ecosystem health, and special habitats. The majority of these areas are located on private lands and are afforded no special protection.

Map 12: Rice Lake Plains

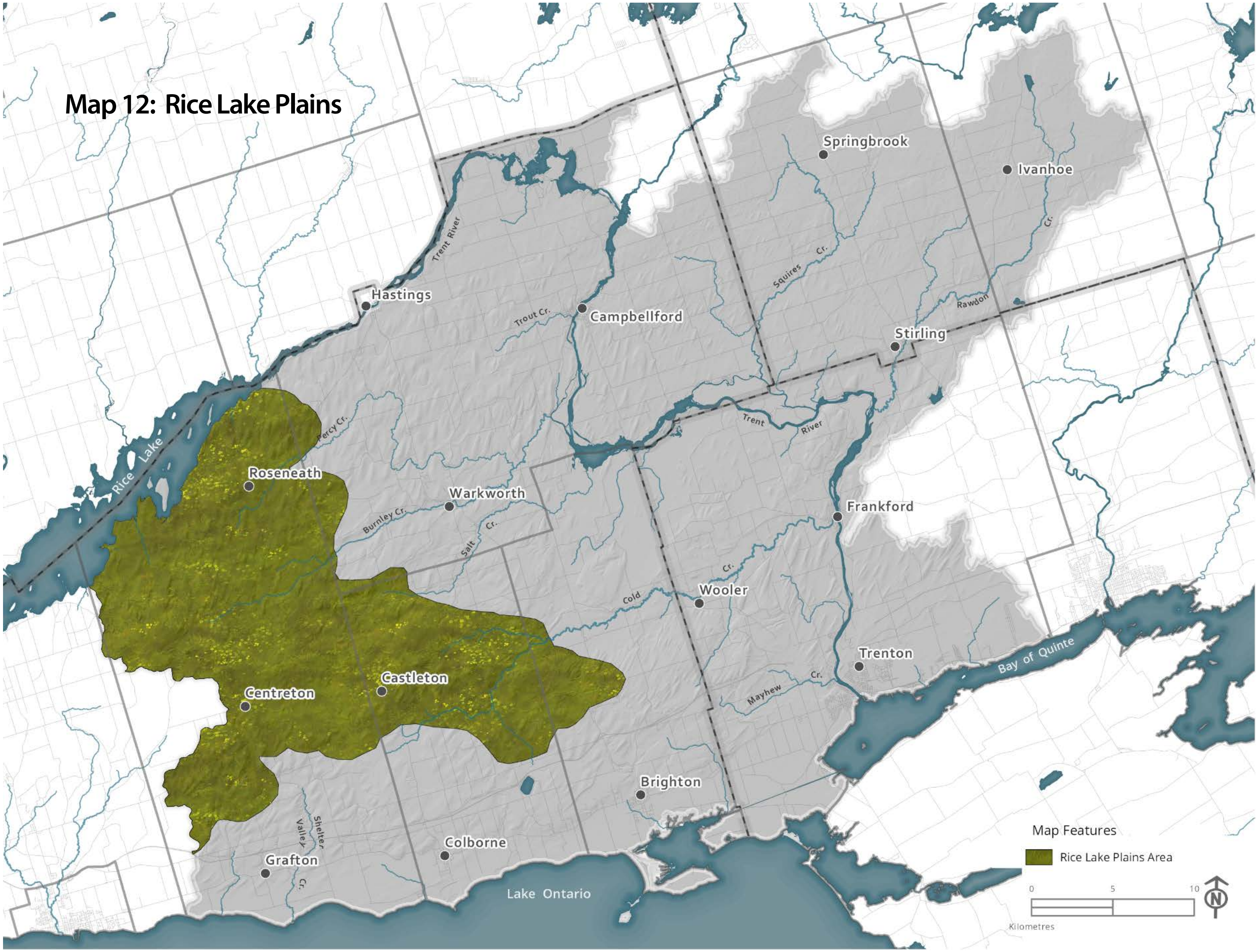


Table 7. Significant Natural Areas

Significant Natural Area (SNA)	Municipality
Alderville Woods	Alnwick/Haldimand
Barcovan Swamp	Quinte West
Batawa	Quinte West
Big Apple Headwater	Alnwick/Haldimand, Cramahe
Brighton Woods	Brighton
Burnley - Carmel Headwater	Alnwick/Haldimand
Carman Headwater	Brighton
Carrying Place Woods	Quinte West
Chubb Point Lowland Woods	Alnwick/Haldimand
Codrington East Ravine	Brighton
Colborne Woodlot	Cramahe
Cold Creek Complex	Brighton, Cramahe
Cramahe Hill Complex	Trent Hills, Brighton, Cramahe
Crookston Forest	Centre Hastings
Dead Creek Escarpment Woods and Alvar	Quinte West
Dead Creek Marsh	Quinte West
Grafton Undulating Woods	Alnwick/Haldimand
Harwood Plains	Alnwick/Haldimand
Hunt and Beach Road Wetland	Cramahe
Johnstown Drumlins	Quinte West
Lakeport Creek Headwater	Alnwick/Haldimand
Lakeport Wetland	Alnwick/Haldimand
Lovett Swamp	Quinte West
Lower Shelter Valley Creek	Alnwick/Haldimand
Mayhew Creek Headwater	Quinte West, Brighton
McGlennon Point Wetland	Alnwick/Haldimand
Moreland Lake Complex	Centre Hastings
Murray Hills Headwater	Quinte West
Nappan Island	Trent Hills
Northumberland County Forest	Alnwick/Haldimand
Oak Lake	Quinte West
Pancake Hill	Centre Hastings
Rawdon Wetland and Alvar Complex	Centre Hastings, Stirling-Rawdon
Salem Corners Swamp	Cramahe
Salem Creek Woods	Cramahe
Salt Creek Valley	Trent Hills, Cramahe, Alnwick/Haldimand
Spencer Point Creek Wetland and Woodlot	Cramahe
Spring Valley Headwater	Brighton
Squire Creek Headwater	Stirling-Rawdon
Stewart Road-Willow Point (Carley Point) Woods	Brighton
Stirling Slope Complex	Quinte West
Stockdale Drumlins	Quinte West
Swing Bridge Woods	Quinte West, Brighton
Tubbs Corners Headwater	Alnwick/Haldimand, Cramahe
Vernonville Creek Headwater	Alnwick/Haldimand
Wicklow Beach Wetland	Alnwick/Haldimand
Wicklow Creek	Alnwick/Haldimand
Wooler Road Woods	Quinte West

Over 40 sites were field investigated in the Lower Trent watershed region by Vivian Brownell and Sean Blaney (1995a and 1996a). Of these, 38 were recommended for recognition as Significant Natural Areas.

What Lives Here?

Mammals

> **Looking back…**
>
> Samuel de Champlain, believed to have paddled down the Trent River in 1615, wrote about the plentiful bear and moose at the mouth of the river.

The diversity of habitats of the Lower Trent *watershed* region sustains a diverse assemblage of mammals. Occasionally, moose will wonder down for a visit from northern Ontario and black bears are not uncommon in the countryside. Elk, once common but locally extirpated, were reintroduced in the Bancroft area and are also very occasionally spotted in the region. On the other hand, white-tailed deer are very common, enjoying abundant human created edge habitats. Cougars have been spotted more rarely still, however, reports of sightings continue to accumulate. Coyotes and red foxes are common, whereas wolves are extremely rare and possibly extirpated from the *watershed* region. Beaver have made a comeback following declines in trapping interest. Muskrat, river otter, fisher, striped skunk, mink, and other weasel family members are regularly reported. The elusive nocturnal southern flying squirrels, as well as red and grey squirrel, are also at home in the forests of the *watershed* region. Other small mammals include mouse, vole, shrew, and lemming. Several species of once common bats, including the little brown bat, have experienced sharp population declines across Ontario and eastern North America due to a fungal disease called White Nose Syndrome.

Relative newcomers like the marsupial opossum are able to survive in this northern extent of their range more and more as *climate change* produces milder winters.

Reports of *invasive* European wild boar or feral hogs are increasing around the Kingston and Ottawa areas, threatening to spread to other areas. The house mouse and Norway rat, originating from Europe, are already common around human settlements. Feral and domestic cats, also introduced by people, pose serious threats to birds.

Black-Legged Tick (Deer Tick)

While several species of ticks can be found in southern Ontario, populations of the Black-Legged Tick (*Ixodes scapularis*) are relatively new arrivals. Ideal breeding grounds for these ticks – deciduous forests and lots of hosts, like small mammals and deer to feed on – are widespread in our *watershed* region. Our changing climate is likely to blame for making our area more conducive to tick survival. Ticks have a complicated life cycle, but they're able to survive longer in warmer temperatures, like those we have seen in recent years.

These ticks are very small, and are more than just a harmless nuisance. Some carry Lyme disease which they can transmit to humans and pets. If left untreated, Lyme disease symptoms can progress to cardiac symptoms such as heart palpitations, arthritic symptoms, extreme fatigue and general weakness, and central and peripheral nervous system disorders. Preventative measures include long sleeved clothing, long pants, and insect repellant, along with prompt removal of any embedded ticks.

Insects

A rich community of insects calls the *watershed* region home. However, a few species are suffering. Monarch, Karner blue, and mottled duskywing butterflies, for instance, are sharply declining. Efforts to protect and restore habitat with host plants are few. Additionally, many bees and other insects are negatively affected by neonicotinoid pesticides.


Black-legged tick

Birds

A few hundred resident and migratory bird species occur in the *watershed* region. Resident birds breed here in the spring and spend the winter here or further south. On the other hand, migrant species may breed in this area, or pass through on their way to breeding sites, returning to over-wintering habitats in the southern United States as well as the Caribbean and Central or South America. The Carolina parakeet and the passenger pigeon, once found in the region, are now extinct across their range. Many species like grassland birds and other songbirds are experiencing serious population declines whereby once common birds like barn swallows and bobolinks are now at risk. Conversely, the bald eagle and the osprey have both made successful recoveries following DDT induced declines in the 1960s. Wild turkeys were successfully reintroduced across southern Ontario, including the *watershed* region, in the 1980s and have once again become common. Mourning doves continue to expand their range northwards as *climate change* results in milder winters. *Invasive* birds common throughout the *watershed* region include European starling, house sparrow, and mute swan.

Herptiles

All but one of Ontario's eight turtle species are considered at risk of decline. Five turtle species occur in the *watershed* region including: painted, snapping, northern map, Blanding's, and musk turtles. Roads fragmenting aquatic and terrestrial nesting habitats are a great cause of mortality when turtles seeking nesting sites along and across roads are struck and killed by cars.

Snakes are also in danger of population declines. Of the 17 Ontario species, seven snake species have been recently observed in the *watershed* region: eastern garter, Dekay's Brownsnake, eastern hog-nosed, milksnake, northern watersnake, red-bellied, and smooth greensnake. The eastern ribbonsnake has not been sighted since 1997. Rattlesnakes likely occurred in the *watershed* region until they were exterminated by European settlers.

Most of the 14 Ontario species of frogs and toads occur in the *watershed* region, as do several salamanders. Community monitoring programs through the Bay of Quinte Remedial Action Plan help to inform amphibian species distribution.

Fish and Fish Habitat

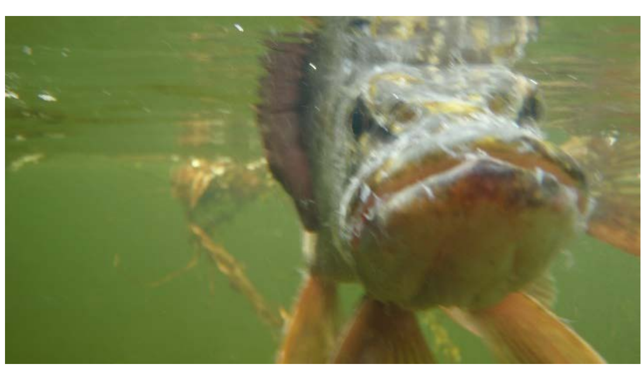
American eel and lake sturgeon were once very plentiful in the Trent River and the Bay of Quinte. Today, they are both in danger of becoming extinct as they are unable to navigate hydroelectric turbines and dams. Mussels are only now being studied and many are considered at risk.

Some of the fish of interest occurring near the mouth of the Trent River include: Atlantic, Coho, chinook and pink salmon, brown and rainbow trout, black crappie, cisco (lake herring), large and small mouth bass, northern pike, muskellunge, and yellow perch.

The Bay of Quinte is a popular sport fishing destination and is an important draw for tourists. It supports a world renowned walleye (pickerel) fishery.

Several species of Asian carp are likely to invade the regional waterways in the near future; a few sterile individuals have already been found in the Bay of Quinte in recent years.

Fish communities and their habitats, such as spawning grounds, nurseries, rearing, food supply and migration areas, are shaped by stream and *watershed* characteristics. Fish habitat in the Lower Trent *watershed* region includes the Trent River, Rice Lake, Bay of Quinte, Lake Ontario, and their tributaries, as well as *wetlands*. The region supports a diverse fish community with headwater, mid-stream, large river, and open lake habitat. However, numerous dams on the Trent River and other watercourses, as well as perched culverts, act as barriers to fish movement through the system.



Streams support cold, cool, and warm fish habitats. The Oak Ridges Moraine is the source of most *cold water* streams flowing south into Lake Ontario and east into the Trent River. *Cold water* streams are generally groundwater fed, fast flowing, and well shaded by vegetation. There are a number of *cold water* streams in the region including Cold Creek, Mill Creek, and Percy Creek. *Cold water* species are more sensitive to habitat changes than fish found in warmer waters. Brook trout are the most sensitive to water quality conditions. They have a low temperature change tolerance and spawn exclusively in areas of groundwater seepage. *Cold water* streams also support fisheries for migratory trout and salmon from Lake Ontario.

Cold Creek Fish Habitat

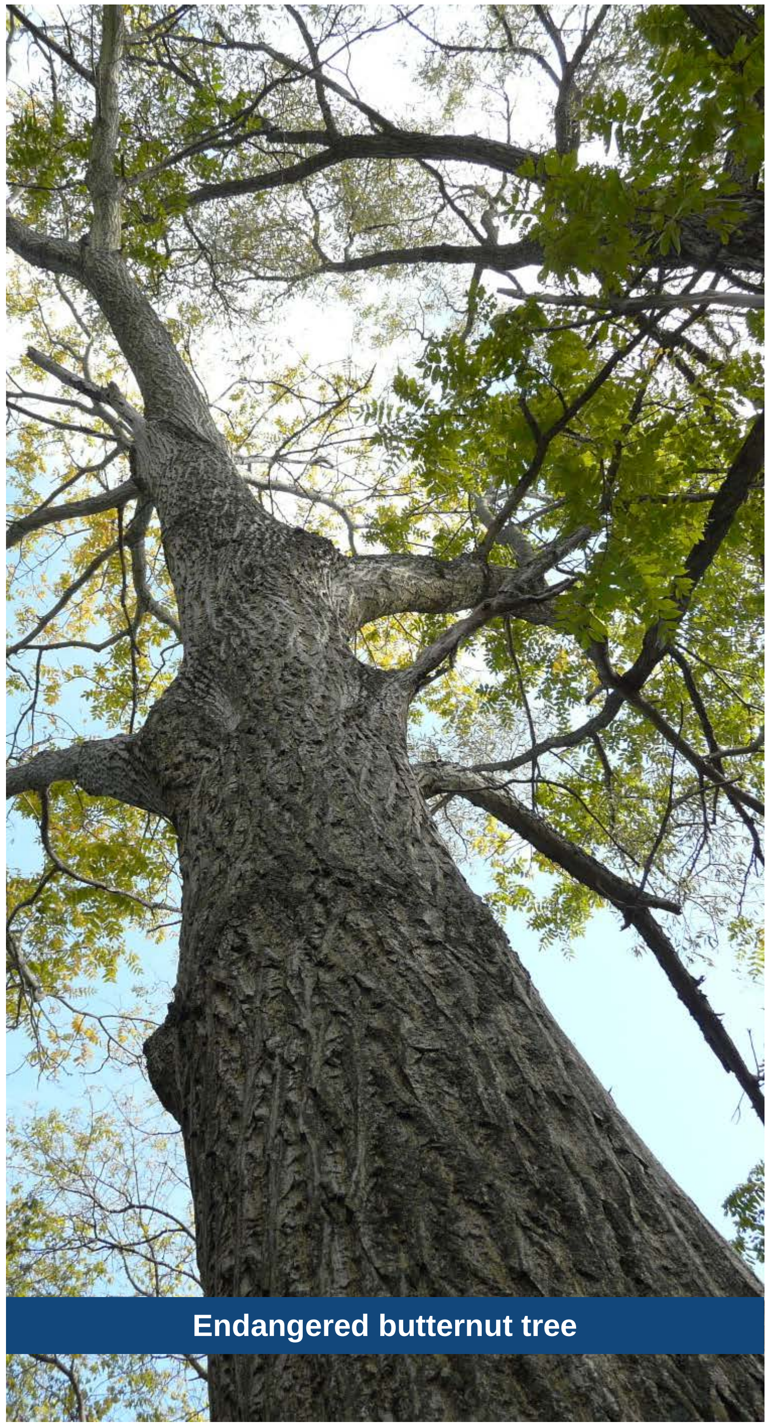
Warm streams generally occur in wide, shallow, slow moving waterways. Each water temperature classification of a stream will support its own assemblage of common fish species such as: bluegill, pumpkinseed, small and largemouth bass, and white perch. Fish communities are impacted by the loss of forests and *wetlands* to agriculture and development which contributes to the influx of excess nutrients and sediments into waterbodies and warmer water temperatures. In addition, water level regulation on Lake Ontario, infilling of coastal *wetlands*, loss of shoreline habitat, fragmentation of habitat, *invasive* exotic species, and *climate change* also impact fish communities (Johanson and McNevin, 2007). A large proportion of *impervious surfaces* such as buildings, roads, and parking lots, within a *watershed*, is also detrimental to fish habitats. When *watershed* imperviousness surpasses 10%, there is a rapid decline in fish habitat and channel stability of *riparian* zones (Environment Canada, 2013).

Poisonous Plants!

Poison ivy, giant hogweed, wild parsnip - it is wise to familiarize oneself with these residents of the *watershed* region. Skin contact with these plants can result in uncomfortable itchy rashes and blisters. Contact with giant hogweed and wild parsnip can result in burns following exposure to direct sunlight.

Flora

The flora of the *watershed* region is very diverse. In the central region of Ontario, which encompasses Northumberland County, nearly half of the plant species are native and the other half are introduced (Riley, 1989). Many have already been extirpated and many more are rare. This is not surprising given the scale of land conversion and habitat loss that has taken place since early European settlement.



Endangered butternut tree

Pests & Diseases

Many introduced pests and diseases have devastated several tree species in the *watershed* region - Chestnut blight, Dutch elm disease, beech bark disease, butternut canker, and now emerald ash borer and oak wilt. They are changing the forest make up by attacking and killing American chestnut (functionally extinct in Ontario), elm, beech, butternut, ash and oak, respectively. In addition, introduced *invasive* species like common buckthorn, dog strangling vine, and garlic mustard are supressing seedlings and regeneration of native trees, thus perpetuating their own species throughout the region. The forest will no doubt look very different in the next 50 years. Chestnut blight arrived in Ontario in the 1920s and within 50 years had almost eliminated American chestnut (Elliott, 1998).

Once common trees, like American chestnut, are extirpated. American beech, American elm, butternut, and all species of ash are in danger of population declines due to introduced pests and diseases. Other species more common in Carolinian Canada, such as Chinquapin oak and dwarf hackberry, occur in the *watershed* region in the northern limits of their range.

Some of the known oldest and largest trees in the region can be found in Peter's Woods Nature Reserve, where a white oak has been estimated to be over 450 years old. Large bur oaks, once representative of an extensive *savannah* community, are scattered throughout the *watershed* region and a few large examples occur at the Glen Miller Conservation Area on the shores of the Trent River.

Species at Risk

The Ontario *Endangered Species Act* (2007) and the federal *Species at Risk Act* (2002) identify and protect *Species at Risk*. Under the *Endangered Species Act*, species are designated by the Committee on the Status of Species at Risk in Ontario (COSSARO), whereas, under the *Species at Risk Act,* species are designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Species at risk in Ontario identified in the Lower Trent *watershed* region as of 2017 are listed in Table 8. More data is required on *Species at Risk* and their habitats in the region. Sadly, this list will likely grow with time as more species will be added. Updated lists of *species at risk* can be found on the Ministry of Natural Resources and Forestry website.

Eastern hog-nosed snake

Table 8. Known Species at Risk in the Lower Trent Watershed Region

Scientific Name	Common Name	Provincial Status *	National Status*
Plants			
Celtis tenuifolia	Dwarf hackberry	Threatened	Threatened
Juglans cinerea	Butternut	Endangered	Endangered
Birds			
Ammodramus henslowii	Henslow's sparrow	Endangered	Endangered
Charadrius melodus	Piping plover	Endangered	Endangered
Chlidonias niger	Black tern	Special Concern	NA
Haliaeetus leucocephalus	Bald eagle	Endangered	NA
Ixobrychus exilis	Least bittern	Threatened	Threatened
Rallus elegans	King rail	Endangered	Endangered
Seiurus motacilla	Louisiana waterthrush	Special Concern	Threatened
Vermivora chrysoptera	Golden-winged warbler	Special Concern	Threatened
Hirundo rustica	Barn swallow	Threatened	Threatened
Riparia riparia	Bank swallow	Threatened	Threatened
Dolichonyx oryzivorus	Bobolink	Threatened	Threatened
Sturnella magna	Eastern meadowlark	Threatened	Threatened
Antrostomus vociferus	Eastern whip-poor-will	Threatened	Threatened
Chaetura pelagica	Chimney swift	Threatened	Threatened
Chordeiles minor	Common nighthawk	Special Concern	Threatened
Hylocichla mustelina	Wood thrush	Special Concern	Threatened
Melanerpes erythrocephalus	Red-headed woodpecker	Special Concern	Threatened
Fish			
Acipenser fulvescens	Lake sturgeon	Special Concern	NA
Anguilla rostrata	American eel	Endangered	NA
Moxostoma carinatum	River redhorse	Special Concern	Special Concern
Percina copelandi	Channel darter	Threatened	Threatened

Scientific Name	Common Name	Provincial Status *	National Status*
Mussels			
Ligumia nasuta	Eastern pondmussel	Endangered	Endangered
Villosa iris	Rainbow	Special Concern	Endangered
Reptiles and Amphibians			
Emydoidea blandigii	Blanding's turtle	Threatened	Threatened
Graptemys geographica	Northern map turtle	Special Concern	Special Concern
Heterodon platirhinos	Eastern hog-nosed snake	Threatened	Threatened
Lampropeltis triangulum	Milksnake	Special Concern	Special Concern
Sternotherus odoratus	Stinkpot or Musk turtle	Threatened	Threatened
Chelydra serpentina	Snapping turtle	Special Concern	Special Concern
*Chysemys picta**	Midland Painted Turtle	NA	Special Concern
Insects			
Danas plexippus	Monarch	Special Concern	Special Concern
Lycaeides melissa samuelis	Karner blue	Extirpated	Extirpated
Erynnis martialis	Mottled dusky wing	Endangered	NA

***Species At Risk Status Classification**

Extirpated: Lives somewhere in the world, and at one time lived in the wild in Ontario, but no longer.
Endangered: Lives in the wild in Ontario but is facing imminent extinction or extirpation.
Threatened: Lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening it.
Special concern: Lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats.

Source: Kate Pitt, Biologist at Ministry of Natural Resources & Forestry, November 2015.
*Designated Special Concern in 2018

Invasive Species

Invasive species are species of plants, animals, and micro-organisms, which are introduced to an area outside of their native range, and are able to outcompete native species in their new surroundings. *Invasive* species introduction and spread threaten the environment, the economy, and society, including human health. Undisturbed healthy ecosystems, such as large forests with minimal edges and abundant interior habitat, may be more resilient to invasion by non-native species. As with *Species at Risk*, a thorough inventory of *invasive* species in the Lower Trent *watershed* region does not yet exist. Observations of *invasive* species can be reported to the Invading Species Hotline (1-800-563-7711) or by using Early Detection & Distribution Mapping System (EDDMapS). *Invasive* species are governed under the Ontario *Invasive Species Act* (2015).

For a sample of *invasive* species known to occur in the Lower Trent *watershed* region, see Appendix 4. A short list of emerging species of public concern found in the *watershed* region includes: water soldier, Phragmites, dog-strangling vine, giant hogweed, wild parsnip, and emerald ash borer.

Water soldier, an invasive plant, in the Trent River

References

Alderville Black Oak Savanna. 2018a. How we started. Retrieved from URL: http://alderville.ca/alderville-first-nation/history/

Alderville Black Oak Savanna. 2018b. How we started. Retrieved from URL: http://ww2.alderville.ca/who-we-are/how-we-started/

Bakowsky, W. and J.L. Riley. 1994. A survey of the prairies and savannas of southern Ontario. In R. Wickett, P. Dolan Lewis, A. Woodliffe and P. Pratt, eds. Proceedings of the Thirteenth North American Prairie Conference: Spirit of the Land, Our Prairie Legacy. August 6-9, 1992. Windsor: Corporation of the City of Windsor. pp. 7-16.

Brownell, V. 1993. Waterfront Natural Areas – Part 2: A biological inventory and evaluation of 28 natural areas along the Lake Ontario waterfront from Newcastle to Trenton. pp. 188.

Brownell, V. and S. Blaney. 1995a. Lower Trent Natural Areas – Volume 1: A biological inventory and evaluation of 20 natural areas in the Lower Trent region, 1994. Lower Trent Conservation. pp 165.

Brownell, V. and S. Blaney. 1995b. Lower Trent Natural Areas – Volume 2: A biological inventory and evaluation of 20 natural areas in the Lower Trent region, 1994. Lower Trent Conservation.

Brownell, V. and S. Blaney. 1996a. Lower Trent Natural Areas – Volume 3: A biological inventory and evaluation of 23 natural areas in the Lower Trent region, 1995. Lower Trent Conservation. pp 148.

Brownell, V. and S. Blaney. 1996b. Lower Trent Natural Areas – Volume 4: Wetlands - A biological inventory and evaluation of 20 natural areas in the Lower Trent region, 1995. Lower Trent Conservation. pp 165.

Butt, S., Ramprasad, P., Fenech, A. 2005. Changes in the landscape of southern Ontario, Canada since 1750: impacts of European colonization. In Integrated mapping assessment. Edited by A. Fenech, D. MacIver, H. Aulg, and R. Hansell. Environment Canada, Toronto, Ontario, Canada. pp. 83–92.

CCSP, 2008. Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [T. R. Karl, G. A. Meehl, C. D. Miller, S. J. Hassol, A. M. Waple, and W. L. Murray (Eds.). Department of Commerce, NOAA's National Climatic Data Center, Washington, D.C., USA, 164 pp.

Chiotti, Q. and Lavender, B. 2008. Chapter 6, Ontario; in From Impacts to Adaptation: Canada in a Changing Climate, edited by D.S. Lemmen, F. J. Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, pp. 227-274.

Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario, 3rd Edition. Ontario Geological Survey, Special Volume 2.

Conservation Ontario. 2011. Guide to developing Conservation Authority watershed report cards. pp. 90.

Department of Energy and Resources Management. 1970a. Lower Trent Region Conservation Report 1970, vol. 1, Report and plan. pp 155.

Department of Energy and Resources Management. 1970b. Lower Trent Region Conservation Report 1970, vol. 2, Appendix. pp. 44.

Department of Energy and Resources Management. 1970c. Lower Trent Region Conservation Report 1970, vol. 3, History. pp. 37.

Elliott, K. A. 1998. The forests of southern Ontario. The Forestry Chronicle. November/December. 74(6).

Ecosystem Status and Trends Secretariat. 2016. Mixedwood Plains Ecozone evidence for key finding summary. Canadian biodiversity: ecosystem status and trends 2010, Evidence for Key Findings Summary Report No. 7. Canadian Councils of Resource Ministers.

Environment Canada. 2013. How much habitat is enough? Third edition. Environment Canada. Toronto, Ontario. pp. 127.

Environment and Climate Change Canada. 2016. Wellers Bay National Wildlife Area Management Plan, Environment and Climate Change Canada, Canadian Wildlife Service, Ontario Region, 50 pp.

Environment and Climate Change Canada. 2017. Retrieved from URL: https://ec.gc.ca/scitech/default.asp?lang=en&n=FDFE3DAA-1

Environmental Protection Agency and Government of Canada. 2017. State of the Great Lakes 2017. https://binational.net/wp-content/uploads/2017/06/Summary-Highlights-Report-EN.pdf

Gillespie, J. E. and C.J. Acton. 1981. Ontario Institute of Pedology. Soils of Peterborough County. Report number 45. Agriculture Canada Research Branch.

Government of Canada. 2018a. Canadian Climate Normals 1981-2010, Peterborough Airport. Retrieved from URL: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=5186&autofwd=1

Government of Canada. 2018b. Canadian Climate Normals 1981-2010, Trenton Airport. Retrieved from URL: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=5126&autofwd=1.)

Great Lakes Environmental Research Laboratory. 2018a. About Our Great Lakes: Lake by Lake Profiles. Retrieved from: https://www.glerl.noaa.gov/education/ourlakes/lakes.html

Great Lakes Environmental Research Laboratory. 2018b. Great Lakes Statistics. Retrieved from: https://coastwatch.glerl.noaa.gov/statistic/

International Joint Commission. 2011. 15th Biennial Report on Great Lakes Water Quality. http://www.ijc.org/files/publications/C265.pdf

International Joint Commission (2017). International Joint Commission Recommendations on Microplastics in the Great Lakes. http://ijc.org/files/tinymce/uploaded/Publications/IJC_Microplastics_GL.pdf

International Joint Commission. 2018. Retrieved from URL: http://ijc.org/en_/islrbc/Regulating_Lake_Ontario-St._Lawrence_River.

Johanson, P. and B. McNevin, 2007. A Fish Habitat Management Plan for the Bay of Quinte. Bay of Quinte Remedial Action Plan.

Lemmen, D.S., Warren, F.J., Lacroix, J., and Bush, E., editors (2008): From Impacts to Adaptation: Canada in a Changing Climate, 2007; Government of Canada, Ottawa, ON, 448 pp.

Landowner Resource Centre. 1997. Queen's Printer for Ontario Printed in Ontario Canada.

Lower Trent Region Conservation Authority. 1982. The Watershed Inventory.

Lower Trent Region Conservation Authority. 1993. Conservation Strategy: vision for the future. pp. 15

Lower Trent Conservation. 2001. Natural Heritage Report: Campbellford/Seymour/Percy/Hastings, Quinte West and Belleville. pp. 32+

Lower Trent Conservation. 2004. Potential sources of contamination in the Bay of Quinte watershed. pp. 36+

Lower Trent Conservation. 2005. Wetland-groundwater linkage study for the Lower Trent Conservation watershed. June 6, 2005. pp. 28+

Lower Trent Conservation. 2008. Conservation Strategy. pp. 16

Lower Trent Conservation. 2015. Proposed natural heritage strategy: for consideration by the municipalities and First Nation territory of the Bay of Quinte Region. pp. 69

Lower Trent Conservation. 2017. Conservation Lands Strategy.

Lower Trent Conservation. 2018. Strategic Plan.

Lower Trent Conservation. 1998. Dead & York Creek Subwatershed Plan. pp. 122.

Manning, P. and Gracey, K. 1991. Form and Availability of Inorganic Phosphorus in Suspended Particulates of Trent-Severn Waterway, Ontario. Canadian Mineralogist. Vol. 29, pp. 575-585.

Minns, C. K., Moore, J. E., Doka, S. E., St. John, M.A. 2011. Temporal trends and spatial patterns in the temperature and oxygen regimes in the Bay of Quinte, Lake Ontario, 1972–2008. Aquatic Ecosystem Health Management. 14 (1), 9–20.

Morrison Environmental Limited. 2004. Municipal Groundwater Study for the Trent Conservation Coalition. Trenton (ON): Trent Conservation Coalition.

Ministry of Finance. 2018. Retrieved from URL: https://www.fin.gov.on.ca/en/economy/demographics/projections/table4.html

National Oceanic and Atmospheric Administration. (Publication date unknown). Retrieved from URL: https://www.ncdc.noaa.gov/sotc/global/200913

Ontario Ministry of the Environment and Climate Change. 2016. Presqu'ile Bay Water Quality Monitoring Study 2013. 108 pp.

Ontario Ministry of Natural Resources. 1974. Tweed District Special and Sensitive Areas Report.

Ontario Ministry of Natural Resources and Canadian Forest Service. February, 2010. Queen's Printer for Ontario. Applied Research and Development Branch. The Provincial Geomatics Service Centre, PGSC Project ID: #8411. Projection: Lambert Conformal Conic. Datum: North American Datum 1983.

Ontario Ministry of Natural Resources and Forestry. 2017. A Wetland Conservation Strategy for Ontario 2017–2030. Queen's Printer for Ontario. Toronto, ON. 52 pp.

Parks Canada. 2000. Trent-Severn Waterway National Historic Site of Canada Management Plan. 115 p.

Parks Canada. 2017. Trent-Severn Waterway National Historic Site. Retrieved from URL: https://www.pc.gc.ca/en/lhn-nhs/on/trentsevern/info/infonet

Reid, R. and J. Grand. 1994. Lower Trent Region Conservation Authority Natural Areas – Wetlands evaluation, landscape analysis and project outline. 133 pp.

Riley, J. L. 1989. Distribution and status of the vascular plants of central region, Ontario Ministry of Natural Resources, Parks and Recreational Areas Section. Central Region. Richmond Hill. pp. 110.

Riley. J. L. 2013. The once and future Great Lakes country: an ecological history. McGill-Queen's University Press. Montreal & Kingston.

Royal Canadian Air Force. 2018. Retrieved from URL: http://www.rcaf-arc.forces.gc.ca/en/8-wing/index.page

Thomann, R. V., R. P. Winfield, and D. S. Szumski. 1977. Estimated response of Lake Ontario Phytoplankton to Varying Nutrient Levels. Journal of Great Lakes Research. 3(1-2): 123-131.

Totten Sims Hubicki Associates. 1995. Township of Sidney, Lower Trent Region Conservation Authority - South Sidney Watershed Plan. pp. 127+

Trent Severn - your waterway resource since 1997. 2017. Lock Statistics. Retrieved from https://www.trentsevern.com/index.php/waterway-index/locks-index/lock-statistics

Walters, B. 2016. Northumberland County Forest 5-Year Silvicultural Operations Plan (2016-2020).

Glossary

Accretion - the process of growth or increase, typically by the gradual accumulation of additional layers or matter.

Alvar - limestone plains with thin *overburden* and specially adapted, often rare, vegetation communities.

Aquifer - a body of permeable rock that can contain or transmit groundwater.

Area of Natural and Scientific Interest - area identified by the provincial government for its special life science or earth science natural features or functions.

Baby boomer - a descriptive term for a person who was born between 1946 and 1964. The baby boomer generation makes up a substantial portion of the world's population, especially in developed nations.

Base flow - the portion of stream flow that is not runoff and results from seepage of water from the ground into a channel slowly over time. The primary source of running water in a stream during dry weather.

Bathymetry - the measurement of depth of water in lakes.

Bedding plane - the surface that separates one stratum, layer, or bed of stratified rock from another.

Beneficial use impairments - specific problems in the Bay of Quinte that result in limited use of the area and are caused by unfavourable changes to the chemical, biological, or physical makeup of the water.

Bioindicator - an organism whose status in an ecosystem is analyzed as an indication of the ecosystem's heath.

Biomass - the total mass of organisms in a given area or volume.

Biosolid - organic matter recycled from sewage, especially for use in agriculture.

Canada Land Inventory - a comprehensive multi-disciplinary land inventory of rural Canada, covering over 2.5 million square kilometres of land and water. Land capability for agriculture, forestry, wildlife, recreation, wildlife (ungulates and waterfowl) was mapped.

Cladophora - a genus of green algae (family *Cladophoraceae*) found growing attached to rocks or timbers submerged in shallow lakes and streams; there are some marine species. Several species, including *Cladophora glomerata*, are considered a nuisance in recreational bodies of water.

Climate change - a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Cool water - watercourse thermal regimes across four seasons are between 19-25°C.

Cold water - watercourse thermal regimes across four seasons are below 19°C.

Confined aquifer - a water-bearing stratum that is confined or overlain by a rock layer that does not transmit water in any appreciable amount or that is impermeable.

Creosote - a dark brown oil distilled from coal tar and used as a wood preservative. It contains a number of phenols, cresols, and other organic compounds.

Cyanobacteria - microscopic bacteria found in lakes, streams, and oceans.

Drainage divide - *watershed* boundary, usually on a ridge or high elevation.

Drumlin - an egg-shaped hill, largely composed of glacial drift, formed beneath a glacier or ice sheet and aligned in the direction of ice flow.

Ecological goods and services - the direct economic and cultural benefits provided to humans by ecosystems such as wetlands and forests, and includes water filtration, flood protection, and wildlife habitat.

Ecological integrity - refers to the ability of an ecosystem to support and maintain ecological processes and a diverse community of organisms.

Ecological Land Classification - a cartographical delineation or regionalisation of distinct ecological areas, identified by their geology, topography, soils, vegetation, climate conditions, living species, habitats, water resources, and sometimes, anthropic factors.

Ecoregion - a unique area of land and water defined by a characteristic range and pattern in climatic variables, including temperature, precipitation, and humidity. The climate within an ecoregion has a profound influence on the vegetation types, substrate formation, and other ecosystem processes, and associated biota that live there.

Erosion - the process of eroding or being eroded by wind, water, or other natural agents.

Esker - a long ridge of gravel and other sediment, typically having a winding course, deposited by meltwater from a retreating glacier or ice sheet.

Escarpment - a long, steep slope, especially one at the edge of a plateau or separating areas of land at different heights.

Evapotranspiration - the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

Eutrophication - excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.

Flood plain - an area of low-lying land adjacent to a watercourse, which is subject to flooding.

Forest interior - area in a forest that is at least 100 m away from the edge.

Frazil ice - soft or amorphous ice formed by the accumulation of ice crystals in water that is too turbulent to freeze solid.

Freshet - a sudden rise in the level of a stream, or a flood, caused by heavy rains or the rapid melting of snow and ice.

Glacial-fluvial - glacial meltwater sediments in a *flood plain* environment.

Groundwater discharge - the movement of groundwater from the subsurface to the surface.

Groundwater recharge - a hydrologic process where water moves downward from surface water to groundwater. Recharge is the primary method through which water enters an *aquifer.*

Hazardous lands - property or lands that could be unsafe for development due to naturally occurring processes.

Headwaters - a tributary stream of a river close to or forming part of its source.

Hydric - containing plenty of moisture; very wet.

Hydrodynamic - pertaining to forces in, or motions of, liquids.

Hydrologic cycle - the continuous movement of water on, above, and below the surface of the Earth. Water leaves the atmosphere and falls to earth as precipitation where it enters surface water or percolates into the water table and groundwater, and eventually is taken back into the atmosphere by transpiration and evaporation to begin the cycle again.

Hydrophilic - having a tendency to mix with, dissolve in, or be wetted by, water.

Hummocky - A hummock is a small knoll or mound above ground. They are typically less than 15 m in height and tend to appear in groups or fields. It is difficult to make generalizations about hummocks because of the diversity in their morphology and sedimentology. An extremely irregular surface may be called hummocky.

Impervious surface - land surfaces such as roads, parking lots, and building roofs that repel rainwater and do not permit it to soak into the ground.

Infiltration - the process by which water on the ground surface enters the soil.

Inundation - flooding.

Interlobate - occurring between two glacial ice sheets or lobes.

Invasive - (especially of plants or a disease) tending to spread prolifically and undesirably or harmfully.

Kame - a steep-sided mound of sand and gravel deposited by a melting ice sheet.

Karst - a distinctive topography in which the landscape is largely shaped by the dissolving action of water on carbonate bedrock (usually limestone, dolomite, or marble).

Lacustrine - relating to or associated with lakes.

Lake-effect - a meteorological phenomenon in which warm moist air rising from a body of water mixes with cold dry air overhead resulting in precipitation especially downwind.

Leachate - water that has percolated through a solid and leached out some of the constituents.

Littoral - relating to or situated on the shore of the sea or a lake.

Low water condition - Ontario's Low Water Response Program identifies three levels of low water conditions:

Level 1 - the first indication of a potential water supply problem, managed through water conservation

Level 2 - a potentially serious problem, managed through water conservation and restrictions on non-essential water use

Level 3 - water supply fails to meet demand, managed through water conservation, restrictions, and regulation of water use.

Macroinvertebrates - organisms that live underwater in streams and rivers, lack a backbone, and can be seen by the naked eye.

Mesotrophic – water bodies that contain moderate quantities of nutrients and are moderately productive in terms of aquatic animal and plant life.

Microcystin - a class of toxins produced by certain freshwater cyanobacteria; primarily *Microcystis aeruginosa*, but also other Microcystis, as well as members of the Planktothrix, Anabaena, Oscillatoria, and *Nostoc* genera.

Middle Ordovician - relating to or denoting the second period of the *Paleozoic* era, between the Cambrian and Silurian periods.

Moraine - a mass of rocks and sediment carried and deposited by a glacier, typically as ridges at its edges or extremity.

Natural heritage system - defined by the Province of Ontario as a system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue.

Official plan - describes upper, lower, or single-tier municipal council's policies on how land in the community should be used. It is prepared with input from the community and helps to ensure that future planning and development will meet the specific needs of the community.

Outcrop - a rock formation that is visible on the surface.

Overburden - rock or soil overlying a mineral deposit, archaeological site, or other underground feature.

Paleozoic - relating to or denoting the era between the Precambrian eon and the Mesozoic era.

Percolation - the process of a liquid slowly passing through a filter.

Physiography - another term for physical geography.

Pleistocene - relating to or denoting the first epoch of the Quaternary period, between the Pliocene and Holocene epochs.

Potash - any of various mined and manufactured salts that contain potassium in water-soluble form. The name is derived from pot ash, which refers to plant ashes soaked in water in a pot, the primary means of manufacturing the product before the industrial era.

Potentiometric surface - a synonym of "piezometric surface" which is an imaginary surface that defines the level to which water in a confined aquifer would rise were it completely pierced with wells.

Prairie - a large open area of grassland dominated by species such as big bluestem, little bluestem, and Indian grass.

Precambrian - relating to or denoting the earliest eon, preceding the Cambrian period and the Phanerozoic eon.

Provincially significant wetland - wetlands identified by the Province as being the most valuable. They are determined by a science-based ranking system known as the Ontario Wetland Evaluation System.

Rice Lake Plains - an area of roughly 100,000 acres (40,470 hectares) located at the eastern end of the Oak Ridges Moraine, southeast of Peterborough. Historically, the Rice Lake Plains were covered with tall grass prairies and oak savannah, dominated by massive black and white oak, and grasses like big bluestem, Indian grass, and switchgrass.

Riparian - relating to or situated on the banks of a river.

Savannah - a grassy plain with few trees.

Significant woodland - defined by the Province of Ontario as an area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history. These are to be identified using criteria established by the Ontario Ministry of Natural Resources.

Snowpack - seasonal accumulation of snow.

Species at risk - endangered, threatened, special concern, and extirpated animals and plants.

Stemflow - the flow of intercepted water down the trunk or stem of a plant.

Stormwater - water that originates during precipitation events and snow/ice melt. Stormwater can soak into the soil (infiltrate), be held on the surface and evaporate, or runoff and end up in nearby streams, rivers, or other waterbodies (surface water).

Surficial geology - unconsolidated geologic materials lying on top of the bedrock.

Thermocline - a steep temperature gradient in a body of water such as a lake, marked by a layer above and below which the water is at different temperatures.

Till - sediment consisting of particles of various sizes and deposited by melting glaciers or ice sheets.

Trent Embayment - inundated bay of the glacial Lake Iroquois with many islands.

Trent-Severn Waterway - a 386 km long canal route connecting Lake Ontario at Trenton to Lake Huron at Port Severn.

Unconfined aquifer - an aquifer where the water table is the upper boundary and with no confining layer between the water table and the ground surface. Unconfined aquifers are generally more susceptible to contamination than *confined aquifers*.

United Empire Loyalists - American Loyalists who resettled in British North America during or after the American Revolution.

Warm water - watercourse thermal regimes across four seasons are above 25°C.

Watershed - the area of land drained by a river or creek and its tributaries.

Water table - the level below which the ground is saturated with water.

Wetland - permanently or seasonally saturated land consisting of marshes, swamps, fens, or bogs.

Appendices

Appendix 1

Seven parameters selected to represent the water quality in the Lower Trent watershed region.

PARAMETER	SOURCE	EFFECTS
Chloride (Cl-)	Naturally occurring salts, sodium chloride (road salts), calcium chloride (industry and wastewater treatment, road salts), potassium chloride (fertilizers and road salts) and magnesium chloride (de-icing agent) (Mayer et al., 1999).	Toxic (acute and chronic) to aquatic organisms (depending on concentration)
Copper (Cu)	Urban areas and landfills that contain household materials, auto parts, and construction materials.	Attached to soil particles, copper can be relatively immobile, yet is toxic to aquatic organisms at high concentrations (Ministry of the Environment and Climate Change, 1991).
Lead (Pb)	Inputs of lead into the environment increased during the industrial revolution because of the combustion of fossil fuels. In the 1970s, lead was removed as a gasoline additive, decreasing its environmental inputs (Wetzel, 2001).	Toxic at relatively low concentrations, affecting the central nervous system of organisms.
Zinc (Zn)	Anthropogenic sources are associated with urbanized and industrial areas.	An important micronutrient for cell function (Wetzel, 2001), but at high concentrations can be toxic to aquatic organisms.
Total Phosphorus (P)	Incidental input or physical methods (e.g., erosion) (Sharpley et al., 1996). Sources include fertilizers (organic and synthetic) and septic systems.	Essential to life processes but, in excess, can cause increased aquatic vegetative growth, including toxic cyanobacteria, and can cause anoxic conditions when vegetation decomposes. As a result, phosphorous can be indirectly toxic to humans and aquatic organisms (Carpenter et al., 1998).
Nitrate (NO_3^-)	Wastewater, septic systems, agricultural land use, and atmospheric deposition.	The most stable and usable form of nitrogen, but can be toxic in high concentrations and cause rapid growth of aquatic vegetation.
Total Suspended Solids (TSS)	Includes all particles suspended in water which will not pass through a filter. Present in sanitary wastewater and many types of industrial wastewater. There are also nonpoint sources of suspended solids, such as soil erosion from agricultural and construction sites.	Excessive suspended sediments can decrease fish survival rates and benthic macroinvertebrate production. It can also interfere with disinfection processes at water treatment plants.

Appendix 2

The number of samples collected over three periods at each location as well as the number of those samples which had results that were higher than the Provincial Water Quality Objectives and/or Canadian Water Quality Guidelines (exceedances).

Parameter	PWQO	2002-2006		2007-2011		2012-2016	
		N	Exceedances	N	Exceedances	N	Exceedances
Trent River (Dixon Drive)							
Chloride	250 mg/L*	24	0	23	0	32	0
Copper	5µg/L	24	0	23	0	32	0
Lead	5µg/L	24	2	23	1	32	1
Zinc	30µg/L	24	0	23	0	32	0
Total Phosphorus	0.03 mg/L	24	3	23	4	32	2
Nitrate	2.9 mg/L*	24	0	23	0	32	0
Total Suspended Solids	25 mg/L*	24	0	23	0	32	0
Cold Creek (Frankford)							
Chloride	250 mg/L*	24	0	24	0	33	0
Copper	5µg/L	24	0	24	0	33	0
Lead	5µg/L	24	1	24	2	33	1
Zinc	30µg/L	24	0	24	0	33	0
Total Phosphorus	0.03 mg/L	24	7	24	6	33	9
Nitrate	2.9 mg/L*	24	0	24	0	33	0
Total Suspended Solids	25 mg/L*	24	0	24	0	33	1
Trent River (Healey Falls)							
Chloride	250 mg/L*	24	0	23	0	33	0
Copper	5µg/L	24	0	23	0	33	0
Lead	5µg/L	24	3	23	2	33	0
Zinc	30µg/L	24	0	23	0	33	0
Total Phosphorus	0.03 mg/L	24	2	23	3	33	1
Nitrate	2.9 mg/L*	24	0	23	0	33	0
Total Suspended Solids	25 mg/L*	24	0	23	0	33	0

Parameter	PWQO	2002-2006		2007-2011		2012-2016	
		N	Exceedances	N	Exceedances	N	Exceedances
Trent River (Glen Ross)							
Chloride	250 mg/L*	24	0	23	0	33	0
Copper	5µg/L	24	1	23	0	33	0
Lead	5µg/L	24	2	23	2	33	0
Zinc	30µg/L	24	0	23	0	33	1
Total Phosphorus	0.03 mg/L	24	1	23	4	33	1
Nitrate	2.9 mg/L*	24	0	23	0	33	0
Total Suspended Solids	25 mg/L*	24	0	23	0	33	0
Mill Creek (Banta Rd) Inactive since 2010							
Chloride	250 mg/L*	24	0	15	0		*No Data*
Copper	5µg/L	24	0	15	1		*No Data*
Lead	5µg/L	24	2	15	3		*No Data*
Zinc	30µg/L	24	0	15	0		*No Data*
Total Phosphorus	0.03 mg/L	24	9	15	5		*No Data*
Nitrate	2.9 mg/L*	24	0	15	0		*No Data*
Total Suspended Solids	25 mg/L*	24	0	15	0		*No Data*
Mill Creek (County Rd 29) Inactive since 2010							
Chloride	250 mg/L*	24	0	15	0		*No Data*
Copper	5µg/L	24	0	15	1		*No Data*
Lead	5µg/L	24	1	15	4		*No Data*
Zinc	30µg/L	24	0	15	0		*No Data*
Total Phosphorus	0.03 mg/L	24	6	15	5		*No Data*
Nitrate	2.9 mg/L*	24	0	15	0		*No Data*
Total Suspended Solids	25 mg/L*	24	0	15	0		*No Data*
Cold Creek (County Rd 30)							
Chloride	250 mg/L*	24	0	23	0	32	0
Copper	5µg/L	24	0	23	1	32	0
Lead	5µg/L	24	0	23	4	32	0

Parameter	PWQO	2002-2006		2007-2011		2012-2016	
		N	Exceedances	N	Exceedances	N	Exceedances
Cold Creek (County Rd 30) cont.							
Zinc	30µg/L	24	0	23	0	32	0
Total Phosphorus	0.03 mg/L	24	8	23	3	32	5
Nitrate	2.9 mg/L*	24	0	23	0	32	0
Total Suspended Solids	25 mg/L*	24	1	23	0	32	3
Mayhew Creek (Fraser Rd.) Inactive since 2010							
Chloride	250 mg/L*	24	0	15	0		*No Data*
Copper	5µg/L	24	0	15	1		*No Data*
Lead	5µg/L	24	2	15	2		*No Data*
Zinc	30µg/L	24	0	15	0		*No Data*
Total Phosphorus	0.03 mg/L	24	7	15	3		*No Data*
Nitrate	2.9 mg/L*	24	0	15	0		*No Data*
Total Suspended Solids	25 mg/L*	24	0	15	0		*No Data*
Mayhew Creek (Front St.)							
Chloride	250 mg/L*	24	0	23	0	33	0
Copper	5µg/L	24	0	23	0	33	0
Lead	5µg/L	24	0	23	3	33	2
Zinc	30µg/L	24	0	23	0	33	0
Total Phosphorus	0.03 mg/L	24	7	23	11	33	9
Nitrate	2.9 mg/L*	24	0	23	0	33	0
Total Suspended Solids	25 mg/L*	24	0	23	0	33	2
Trout Creek (Campbellford) Started in 2011							
Chloride	250 mg/L*		*No Data*	8	0	33	0
Copper	5µg/L		*No Data*	8	0	33	0
Lead	5µg/L		*No Data*	8	0	33	0
Zinc	30µg/L		*No Data*	8	0	33	1
Total Phosphorus	0.03 mg/L		*No Data*	8	6	33	18
Nitrate	2.9 mg/L*		*No Data*	8	0	33	0

Parameter	PWQO	2002-2006		2007-2011		2012-2016	
		N	Exceedances	N	Exceedances	N	Exceedances
Trout Creek (Campbellford) Started in 2011 cont.							
Total Suspended Solids	25 mg/L*		*No Data*	8	0	33	3
Salt Creek (Evans Rd) Active from 2011-2015							
Chloride	250 mg/L*		*No Data*	8	0	27	0
Copper	5µg/L		*No Data*	8	0	27	0
Lead	5µg/L		*No Data*	8	0	27	0
Zinc	30µg/L		*No Data*	8	0	27	0
Total Phosphorus	0.03 mg/L		*No Data*	8	4	27	11
Nitrate	2.9 mg/L*		*No Data*	8	0	27	0
Total Suspended Solids	25 mg/L*		*No Data*	8	0	27	4
Salt Creek (Highway 30) Active from 2011-2016							
Chloride	250 mg/L*		*No Data*	8	0	33	0
Copper	5µg/L		*No Data*	8	1	33	0
Lead	5µg/L		*No Data*	8	0	33	0
Zinc	30µg/L		*No Data*	8	1	33	0
Total Phosphorus	0.03 mg/L		*No Data*	8	4	33	12
Nitrate	2.9 mg/L*		*No Data*	8	0	33	0
Total Suspended Solids	25 mg/L*		*No Data*	8	0	33	2

*no PWQO – Canadian Water Quality Guideline

Appendix 3

Three parameters selected to represent groundwater water quality in the Lower Trent *watershed* region.

Parameter	Source(s)	Ontario Drinking Water Objective	Effects
Chloride (Cl^-)	Chloride is common in nature, generally as sodium chloride ($NaCl$), potassium chloride (KCl), and magnesium chloride. Sources include rocks, road salting, agricultural runoff, industrial wastewater, and wastewater treatment plants.	250 mg/L	Chloride is not usually harmful to humans. At concentrations above the Ontario Drinking Water Objective of 250 mg/L, chloride and sodium chloride impart undesirable tastes to water and may cause corrosion in water distribution systems.
Sodium	Sodium is the most abundant of the alkali elements and constitutes 2.6% of the Earth's crust. Compounds of sodium are widely distributed in nature. Weathering of salt deposits and contact of water with igneous rock provide natural sources of sodium in groundwater regimes.	200 mg/L 20 mg/L	The taste of drinking water is generally considered offensive at sodium concentrations above the Ontario Drinking Water Objective of 200 mg/L. To maintain a total daily sodium intake of 500 mg, as is widely prescribed for persons on a sodium restricted diet, a sodium concentration in drinking water no higher than 20 mg/L is required.
Nitrate and Nitrite	The most common contaminant identified in groundwater is dissolved nitrogen in the form of nitrate (NO_3^-). Nitrate is the main form in which nitrogen occurs in groundwater. Nitrogen can enter groundwater through municipal and industrial wastewater effluent, septic leachate, animal waste, and runoff from fertilized agricultural fields and lawns. Elevated concentrations of nitrate, particularly those greater than 3 mg/L, are usually the result of human activity.	10 mg/L	Dissolved nitrogen in the form of nitrate is becoming increasingly widespread because of agricultural activities and disposal of sewage on or beneath the land surface. Nitrites can react with hemoglobin in the blood of warm-blooded animals to produce methemoglobin; this destroys the ability of red blood cells to transport oxygen. This condition is serious in babies under three months, causing methemoglobinemia or "blue baby" syndrome. Nitrates can also cause digestive problems. High concentrations of nitrate can be toxic to fish and other organisms.

Appendix 4

The following is a list of some invasive species known to occur in the Lower Trent watershed region during the time of writing of this report. Undoubtedly, this list will grow. For a current list, consult the Ontario Invasive Species Centre.

Aquatic Invasive Species	
Aquatic Plants: Found in and around water bodies. They spread by shipping vessels, recreational and commercial boating, and the aquarium and water garden trade. Aquatic plants impact wetlands and waterways. They affect recreational activities, displace native vegetation, slow down water, and alter oxygen levels. The plants reduce biodiversity by competing aggressively with native plants.	
Water Soldier (*Stratiotes aloides*)	• Prohibited under the *Invasive Species Act* • Perennial plant native to Eurasia • Cold tolerant, grows in standing or slow flowing water bodies in water depths up to 5 metres • First known wild population in North America was discovered in 2008 in the Trent River near the hamlet of Trent River • Possibly introduced to the Trent River through aquarium or water garden releases
Water Hyacinth (*Eichhornia crassipes*)	• Free-floating plant native to South America and introduced to North America in 1884 to New Orleans • Found in isolated locations of Essex County, Ontario; however, an observation was made in Warkworth Mill Pond in the summer of 2016. It is not expected to over-winter, but the location is being monitored • Grows very rapidly over large areas, displacing native plants and forming dense mats 2m thick
Eurasian Water-Milfoil (*Myriophyllum spicatum*)	• Perennial that grows under the water's surface and is native to Europe, Asia, and northern Africa; introduced to North America in the 19th century • Water-Milfoil prefers shallow water one to three metres deep, but can root in up to ten metres of water. • Can interbreed with native milfoils, creating an aggressive hybrid
European Frog-bit (*Hydrocharis morsus-ranae*)	• Native to Europe and parts of Asia and Africa, it spread from the Rideau Canal and is now in the Trent River • Grows very rapidly and forms dense floating mats • The plant is round to heart-shaped and roughly the size of a Canadian Loonie, it resembles a small lily pad
Curly-Leaved Pond Weed (*Potamogeton crispus*)	• Perennial, submerged plant that is native to Eurasia • Can grow in all types of water • Translucent leaves that have curly margins
Flowering Rush (*Butomus umbellatus*)	• Perennial plant that looks similar to bulrushes • It has umbel shaped flowers that are pink and at the top of the stock • Flowers between May and September, and is hard to identify until flowering
Narrow-Leaved Cattail (*Typha angustifolia*)	• Very similar to the native cattail, but has very narrow long upright leaves and a distinguishing gap between the male and female portions of the flower • Native to northern Africa, Asia, and Eurasia

Hybrid Cattail (*Typha x glauca*)	• Hard to distinguish from the parent cattails, common cattail and narrow-leaved cattail • Leaves are slightly smaller than common cattail and slightly larger than narrow-leaved cattail • Spread by rhizomes and by seeds dispersing in the wind
Yellow Iris (*Iris pseudacorus*)	• Native to Europe, western Asia, and northern Africa, the Yellow Iris spread through the water garden industry • It can grow in treed and open wetlands, along river and lake edges, and in flood plains • It is poisonous to both humans and animals if eaten, and the sap can cause dermatitis • It was often planted in wastewater ponds as it is able to absorb heavy metals
Invertebrates: Invasive invertebrates impact aquatic ecosystems by competing with native species for food and habitat, and can destroy native fish spawning habitats. They spread through boating, ballast water from ships, aquarium and water garden trade, live fish food, and bait bucket release.	
Rusty Crayfish (*Orconectes rusticus*)	• Large, aggressive crayfish native to the Ohio River Basin in the USA. Likely introduced by anglers. • Commonly found in fresh water bodies with clay, silt, and gravel bottoms containing logs or debris. • Competes with native crayfish for food and resources causing their decline. Eats large amounts of aquatic plants reducing fish spawning and nursery habitat.
Zebra & Quagga Mussels (*Dreissena polymorpha & D. bugensis*)	• Freshwater bivalves native to the Black Sea region of Eurasia and introduced by ballast water in the late 1980's. • Zebra mussels are found throughout the Great Lakes, Lake St. Clair, and the Mississippi River watershed. Quagga mussels are limited to the St. Lawrence River and southern Great Lakes: Ontario, Michigan, Huron, and Erie. • Both species filter water to the point where food sources such as plankton are removed, altering food webs. This also causes clearer water, allowing sunlight to penetrate deeper, increasing growth of aquatic vegetation.
Chinese Mysterysnail (*Bellamya chinensis*)	• Found in slow flowing streams, thriving in disturbed watersheds with silt, sand, and mud substrates. • May prey on fish eggs • Clog water intake pipes • 6.5cm or less with a brown to green shell
Banded Mysterysnail (*Viviparous georgianus*)	• Similar to the Chinese mysterysnail • 3.5cm or less • Yellow to greenish brown with 3-4 dark brown spiral bands
Fish: Impact the aquatic ecosystem by competing with native fish for food and habitat, altering food webs, and preying on sport fish eggs and larvae populations.	
Asian Carps	• 4 species of Asian carps (Silver carp, Bighead carp, Grass carp, and Black carp) brought from Asia to North America in the 1960s and 70s to remove excess or undesirable plankton, thus improve water quality in sewage treatment plants and aquaculture facilities. • Asian Carps have not yet reached Ontario, or the Great Lakes, and are considered prohibited under the *Invasive Species Act*.

Asian Carps cont.	• The black carp feeds on native mussels and snails, some of which can be already endangered. Grass carp can alter the food webs of a new environment by altering the communities of plants, invertebrates, and fish. Bighead and Silver carp consume the plankton necessary for larval fish and native mussels, and are the two species that spread the most aggressively.
Sea Lamprey (*Petromyzon marinus*)	• A parasitic, jawless fish characterized by a toothed, funnel-like sucking mouth that is adapted to both fresh and salt water. • Native to the northern Atlantic Ocean and the Baltic, western Mediterranean and Adriatic Seas, sea lampreys invaded the Great Lakes in the early 20th century through shipping canals. • The sea lamprey uses its sucker mouth, sharp teeth and rasping tongue to attach itself to the body of a fish and suck the fish's blood. Fish that survive the attack are left with a large open wound that can become infected and often leads to death.
Round Goby (*Neogobius melanostomus*)	• Small bottom dwelling invasive fish • They prefer water with rocky and sandy bottoms. The fish feed aggressively on insects and other small organisms. • The Round Goby is able to reproduce quickly, spawning up to several times each season. • Recognizable from the native Goby by its fused scallop-shaped pelvic fin.
Terrestrial Invasive Species	
Forest Pathogens: There is an increase in forest pathogens due to a rise in international trade and exchange of plant material. They are caused by different organisms that affect the whole tree, causing defoliation, root decay, and stem cankers that reduce the distribution of nutrients in the tree.	
Beech bark disease (*Neonectria faginata*)	• In Ontario, only American Beech *Fagus grandifolia* are hosts. • The disease results when the beech scale insect *Cryptococcus fagisuga* attacks the bark, creating a wound. Later, two different fungi (*Neonectria faginata* and *Neonectria ditissima*) can invade the tree through the wound, causing a canker to form. In subsequent years, new cankers will continue to form, ultimately leading to the death of the tree.
Butternut canker (*Sirococcus clavigignenti-juglandacearum*)	• The most obvious symptoms of this disease are the elongated, sunken cankers, which commonly originate at leaf scars, buds, or wounds of Butternut (*Juglans cinerea*) trees. In spring, an inky-black fluid exudes from cracks in the canker; in summer, the cankers appear as sooty black patches, often with a whitish margin. • Butternut trees of all ages and sizes and on all sites can be infected by this disease. Cankers spread around branches and trunks, eventually girdling and killing the tree.
Dutch Elm Disease (*Opithostoma ulmi*)	• The disease is spread by native elm bark beetles and European bark beetles; the beetles create galleries through the bark of the trees allowing the fungus to grow. • Can also be transported by the tree's root system or movement of firewood. • The fungal disease attacks and blocks the water system in the trees.
Terrestrial plants: Can be a tree, shrub, or herbaceous plant. The plants can be introduced and spread by infested packaging material, seed dispersal by the environment and human sources, or from garden and horticultural industries. They reproduce quickly and crowd out native species, impacting forest regeneration.	
Wild Parsnip (*Pastinaca sativa*)	• A member of the carrot family, wild parsnip is native to Europe and Asia and likely introduced to North America by European settlers for its edible roots.

Wild Parsnip (*Pastinaca sativa*) cont.	• Wild parsnip roots are edible, but **the sap of the plant can cause severe burns**. Collecting the plant from the wild should only be done with extreme care. • The plant can form dense stands and spreads quickly in disturbed areas such as abandoned yards, waste dumps, meadows, open fields, roadsides, and railway embankments. Its seeds are easily dispersed by wind and water, and on mowing or other equipment.
Bird vetch (*Vicia cracca*)	• Perennial vine that can grow up to 2m long • Purplish-blue flowers that are densely packed on one side • Native to Europe and Asia, it is now widespread throughout Ontario
Common periwinkle (*Vinca minor*)	• Vine-like herb with showy pinwheel-shaped blue or purple flowers • Widespread in Ontario due to ornamental gardens, commonly used as a groundcover plant • Forms dense and extensive mats on the forest floor
European Black Alder (*Alnus glutinosa*)	• Deciduous tree that can reach 20m tall • Leathery oval leaves with a blunt tip and double-toothed margins • Lives in moist and wet soils around wetlands • Escaped from cultivation in the United States, seeds having spread by wind and water
Dog-Strangling Vine (*Cynanchum rossicum*)	• A perennial plant native to Eurasia and was introduced to the USA in the 1800s as garden ornamentals. • Reproduces by spreading its seeds through wind dispersal and through vegetative production. • Has very flexible requirements for light and soil, and grows best in dense vegetation where it can climb other plants and shade them out. Dense mats can choke out small trees and take over rapidly. • Threatens the monarch butterfly, as the butterfly lays its eggs on the plant mistaking it for the native milkweed.
European Buckthorn (*Rhamnus cathartica*)	• A small shrub/tree native to Eurasia and introduced to North America in the 1880s in ornamental plantings and fencerows. • Buckthorn thrives in a variety of habitats and forms dense thickets that crowd and shade out native plants. • Alters nitrogen levels in the soil, creating better conditions for its own growth and discouraging the growth of native species. • It produces large numbers of seeds that germinate quickly and prevent the natural growth of native trees and shrubs.
Garlic Mustard (*Alliaria petiolate*)	• Release a strong garlic odour when crushed • Brought to North America to be used as an edible herb, spread by seeds • Kidney shaped leaves with scalloped edges • 4 small, white petal flowers
Giant Hogweed (*Heracleum mantegazzianum*)	• Giant hogweed is a garden ornamental plant in Southeast Asia that has spread to Ontario. • There are many native plants that look similar such as Cow parsnip, Angelica, and Queen Anne's-Lace. • It is distinguishable by its thick hollow stem with stiff hairs and its lobed leaves.

Giant Hogweed (*Heracleum mantegazzianum*) cont.	• Seeds may take several years to germinate and are viable in soils for up to 15 years. • The clear watery sap produced contains toxins that can cause severe burns if exposed to sunlight, and potential blindness if contact with eyes occurs.
Goutweed (*Aegopodium podagraria*)	• Introduced to North America, through horticultural industry, as ornamental plants. • No more than 1 metre tall • Leaves are alternate, have serrated edges, and can be multicolored or solid green.
Japanese Knotweed (*Reynoutria japonica*)	• Aggressive perennial plant that is native to eastern Asia, it was introduced to North America as a form of erosion control. • It is often mistaken for bamboo due to it semi-woody appearance and height of 1-3m • It has a vigorous root system that can spread 10m from the parent stem and grow through concrete.
Multiflora Rose (*Rosa multiflora*)	• Spread through the horticulture industry, it was also used for erosion control, natural barriers, and to attract wildlife. • Climbing and rambling plant that can grow 3-5m. • It has white flowers and prickled stems. • It grows rapidly and produces a large number of fruits.
Purple Loosestrife (*Lythrum salicaria*)	• Wetland plant that is native to Europe and Asia and likely brought to North America in ballasts of ships. • Each plant can grow up to 30 flowering heads and can produce up to 2.7 million seeds per year. • In 1992, it was approved to release two European leaf eating beetles (*Galerucella calmariensis and G. pusilla*), which are natural enemies of the plant and feed on it. • The release of the beetles (including releases in the Lower Trent watershed region) cut back Purple Loosestrife populations by up to 90 percent.
Himalayan Balsam (*Impatiens glandulifera*)	• An annual herb native to the western Himalayas. In the early 1800s, it was introduced to many parts of Europe, New Zealand, and North America as a garden ornamental. • Can completely cover an area and crowd out native vegetation. Mature seed capsules explode when touched and can eject seeds as much as 5m from the parent plant. • Can aggressively replace native perennial plants along river banks, leading to soil erosion.
Reed Canary grass (*Phalaris arundinacea*)	• Tenacious, rapidly growing, perennial species that escaped cultivation in Eurasia. • Stems are smooth, and usually hollow. They grow 1-2 metres in height and have leaves with an open sheath. • It prefers moist to wet soil and is most often found in wetlands, along river banks, or in ditches. • It looks similar to the native Reed canary grass, but it has large green seed heads as opposed to smaller purple-tinted heads of the native species.
Roundpod St. Johnswort	• Perennial herb that grows 0.8 metres tall and is native to Eurasia and North Africa.

(*Hypericum cistifolium*)	• It has showy yellow flowers that are grouped at the top of the plant. • Prefers dry, sandy soils and full sun; growing on roadsides, grasslands, meadows, and open pastures. • Leaf glands contain a toxin that can cause skin irritation and burns when it comes into contact with the plant. Animals that eat the plant may become sensitive to sunlight and develop red blistering skin.
White sweetclover (*Meliltus albus*)	• Biennial plant that is native to Europe and Asia, typically used as a forage crop. • It is a threat to endangered grassland and prairie habitats in Ontario. • Each plant can produce up to 350,000 seeds that can remain viable in the soil for up to 80 years. • It has small white flowers that grow in multiple racemes.
European Common Reed (*Phragmites australis subsp. Australis*)	• A perennial grass native to Eurasia that has rapidly spread across southern Ontario. It crowds out native vegetation, thus resulting in decreased plant biodiversity. • Generally provides poor habitat and food supplies for wildlife, including several Species at Risk. • Grows very quickly, thereby causing lower water levels as water is transpired faster than it would be with native vegetation.
Wild Chervil (*Anthriscus sylvestris*)	• Native to Europe, it was brought to North America as a wildflower seed mix used for planting in meadows. • Short-lived species only producing flowers and seeds in its second year. • Host to the disease yellow fleck virus, which can impact plants in the carrot and parsnip family.
Forest Pests: Associated with the import and export of wood, shipping containers, and the movement of firewood. They degrade the quality of wood, which eliminates wildlife habitat. Trees are unable to defend themselves against introduced pests, resulting in widespread tree mortality.	
Emerald Ash Borer (*Argrilus planipennis*)	• Forest pest native to Asia that has killed millions of Ash trees in Ontario. • Moving Ash from one area to another is discouraged. • The Emerald Ash Borer attacks both healthy and stressed Ash trees. Its larvae tunnel through the tree's vascular system, which delivers water, nutrients, and sugars throughout the tree, essentially strangling the tree.
Wildlife Diseases & Diseases Spread by Wildlife to Humans	
Lyme disease	• An infection caused by the bacteria *Borrelia burgdorferi*. In Ontario, these bacteria are spread by the bite of blacklegged ticks, *Ixodes scapularis*. The blacklegged tick can be found sporadically throughout the province. • Established blacklegged tick populations infected with Lyme disease can be found along the north shores of Lake Erie, Lake Ontario, and the St. Lawrence River. • Lyme disease can cause acute and/or chronic symptoms such as fever, headache, muscle and joint pains, fatigue, and a skin rash.

LOWER TRENT
CONSERVATION

Tel: 613 394 4829 Fax: 613 384 5226 Website: www.ltc.on.ca Email: information@ltc.on.ca