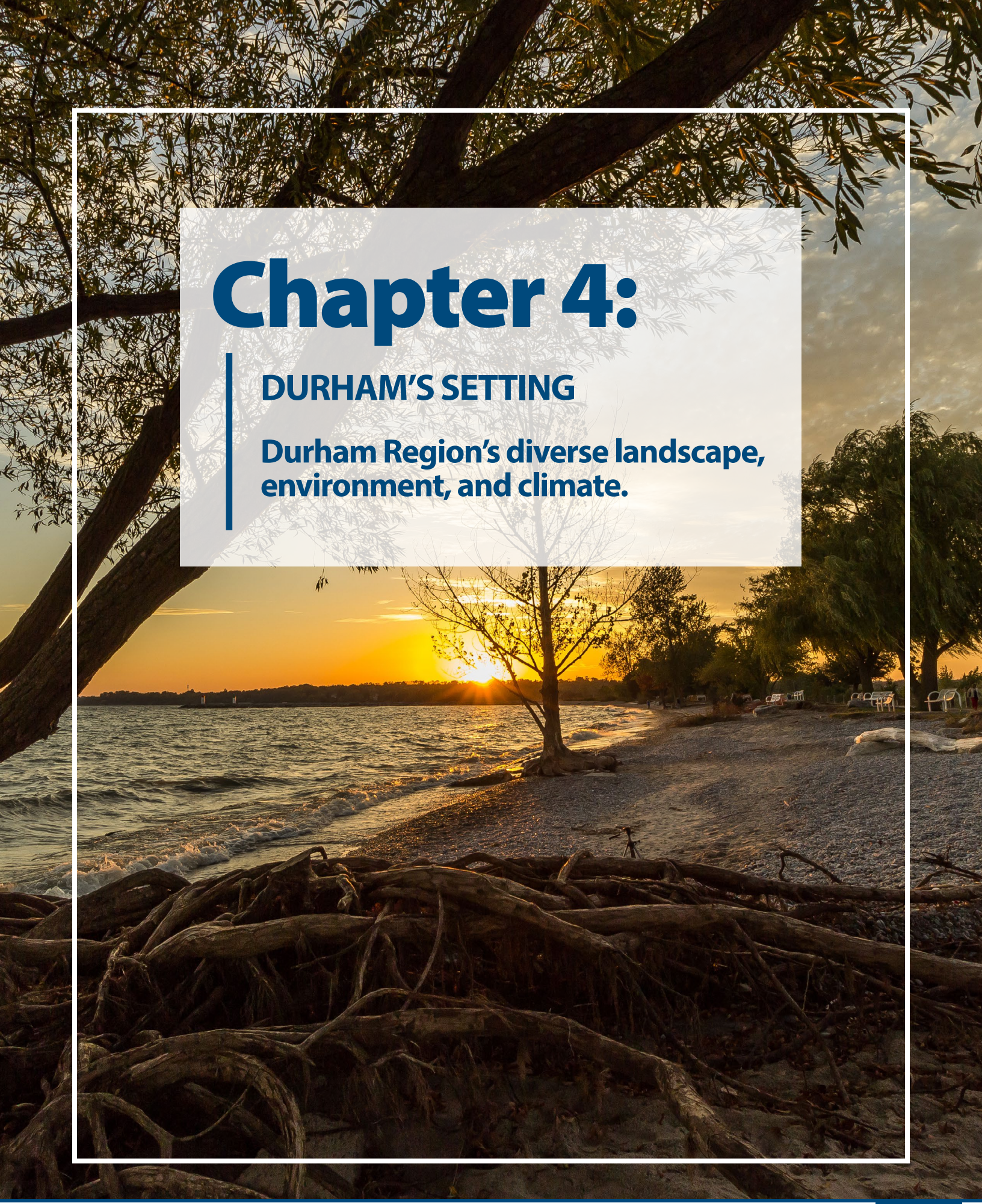


Chapter 4:

DURHAM'S SETTING

Durham Region's diverse landscape, environment, and climate.

Key Messages

- **Most of Durham Region is within Ontario's ecologically sensitive and agriculturally productive Greenbelt which includes the Oak Ridges Moraine.**
- **Durham Region depends on these natural features for clean air, water, a sustainable local food supply and protection from climate hazards such as flooding, water contamination and extreme heat.**
- **Durham Region's Greenbelt is also critical to the health of the Great Lakes system that holds most of North America's surface fresh water.**
- **Numerous factors threaten the ecological sustainability of Durham Region including land use changes, invasive species, and climate change.**

Acronyms

ANSIs	Areas of natural and scientific interest
˚C	Degree(s) Celsius
CCHVA	Climate change and health vulnerability assessment
CTC SPR	Credit Valley – Toronto and Region – Central Lake Ontario Source Protection Region
DRHD	Durham Region Health Department
DWS	Drinking water supply system
EDOH	Ecological determinants of health
GHGs	Greenhouse gases
GTA	Greater Toronto Area
NA-CORDEX	North American Coordinated Regional Climate Downscaling Experiment
NCP	Nature's contributions to people
OCC	Ontario Climate Consortium
ORMCP	Oak Ridges Moraine Conservation Plan
RCPs	Representative Concentration Pathways
SDII	Single Day Intensity Index
SPA	Source Protection Area
SPP	Source Protection Plan
SPR	Source Protection Region
URVs	Urban River Valleys

Terms & Definitions

Aquifer

A zone located beneath the ground's surface that can retain and release groundwater. Large quantities of groundwater may be stored in an aquifer. There are two main types of aquifers: confined and unconfined.

- Confined aquifers have a layer of impenetrable rock or clay above them, trapping the groundwater within the boundary.
- Unconfined aquifers lie below a permeable layer of soil that groundwater can easily pass through.

Areas of Natural And Scientific Interest (ANSIS)

These are areas of land and water containing natural landscapes or features that have been identified as having life science (biological) or earth science (geological) values of special significance depending on the features present.

Baseline

The baseline or reference is the starting level that change is measured against. It can be a "current baseline" which represents measurable present-day conditions, or a "historical baseline" which represents conditions from the past.

Clean Water Act, 2006

The Clean Water Act, 2006, is legislation passed by the Province of Ontario in 2006 designed to help communities protect the source of their drinking water. The Act requires municipalities, businesses, and residents to work together to create local SPPs.

Climate

Climate refers to the average or expected weather and related atmospheric, land and ocean conditions for a particular location over a long period of time. [6, 164] The simplest way to describe climate is to look at average conditions like temperature and precipitation over time. Other useful factors to describe climate include the type and timing of precipitation, amount of sunshine, average windspeeds and directions, number of days above freezing and/or weather extremes. [3]

Climate Change

Refers to a change in the state of the climate that can be identified by changes in statistical measures like the average (mean) and/or variability in weather and atmospheric conditions that persists for an extended period, typically decades or longer. [1, 2, 3]

Climate Change Scenario

This is a description of a possible future climate based on how Earth's climate operates, future world population levels, economic activity, and greenhouse gas emissions. [3] There are currently four main climate scenarios called Representative Concentration Pathways (RCPs): RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5.

Climate Drivers

These are natural or artificial factors that have a strong enough impact on Earth's climate to force it toward warmer or cooler temperatures, causing climate to change. Examples of climate drivers include GHGs, volcanic eruptions and changes in solar output from the sun.

Climate drivers are sometimes referred to as climate forcing agents.

Climate Model

A mathematical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes and accounting for some of its known properties.

Climate Projection

The term projection is often used in two ways in climate change literature.

1. A projection is a description of a possible future and the pathway which led to it.
2. Model-generated estimates of future climates. [1]

Ecological Determinants of Health (EDOH)

Also referred to as ecosystem services, or nature's contributions to people. These are all the life supporting systems provided by nature including air, food, water, fuels, raw materials, nutrient cycling, a stable climate, and waste decomposition. It also includes settings to promote physical and mental wellbeing.

Ecozone

A very large area of land and water characterized by a distinctive bedrock zone that differs in origin and chemical makeup from the bedrock zone that is beside it. The characteristics of this bedrock zone in addition to long-term continental climatic patterns, has a major influence on the ecosystem processes occurring there. This area is generally resilient to short-term and medium-term change and responds to global or continental cycles and processes operating over thousands to millions of years. [4]

Ecoregion

A unique area of land and water nested within an ecozone that is defined by a characteristic range and pattern in climatic variable, including, temperature, precipitation, and humidity. The climate within an ecoregion has a profound influence on the vegetation types, ecosystem processes, and associated organisms (e.g., plants, animals) that live there. [4]

Extreme Weather Event

An event that is rate at a particular place and time of year.

Grasslands

A large open area covered with a variety of grasses and other plants, in which the varieties vary from location to location, but shrubs and trees are always absent in this biome habitat.

Greenbelt

Ontario's Greenbelt was created in 2005 and covers two million acres of protected land in the heart of the Greater Golden Horseshoe.

The purpose of creating the area was to:

1. Prevent further loss of farmland and natural heritage.
2. Restrict urban sprawl.
3. Work with the Growth Plan to develop vibrant communities where people can live, work, and play.

The Greenbelt's natural systems support ecological and human health. It safeguards the vital resources that clean our air and water, reduces flood risks, provides a home for wildlife, and ensures our communities have greenspace to explore. Its protection is essential for climate resilient communities and a thriving local economy. [5]

Greenhouse Gasses (GHGs)

These are heat trapping gases which are an important part of the atmosphere's makeup and help warm the planet through the greenhouse effect. Although these gases are generated from natural processes, they can be influenced by human activities as well.

There are five main types of GHGs:

- Carbon dioxide
- Methane
- Nitrous oxide
- Water vapour
- Halocarbons

Halocarbons are the only GHG that are not generated from natural processes and instead are exclusively made and released by human activities and products.

Ground Water

Groundwater is water that has filtered down into the ground to fill the spaces between sediments and cracks in rock. Groundwater fills in the empty spaces underground, in what is called the saturated zone, until it reaches an impenetrable layer of rock.

Groundwater is contained and flows through bodies of rock and sediment called aquifers. It can be discharged through springs, lakes, rivers, streams, or human made wells. It is recharged by precipitation, snowmelt, or water seepage from other sources, including irrigation and leaks from water supply systems.

Growing Season End Date

The first day after five days of consecutive maximum temperatures below 5˚C are reached.

Growing Season Start Date

The first day after five days of consecutive minimum temperatures above 5˚C are reached.

Halocarbons

A term for the group of partially halogenated organic species, which includes the chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), halons, methyl chloride and methyl bromide. Many halocarbons have large Global Warming Potentials. The chlorine and bromine-containing halocarbons are also involved in the depletion of the ozone layer.

Highly Vulnerable Aquifers

Areas that are more susceptible to contamination moving from the surface into the groundwater

Hot Days

The total number of days each year where the daily maximum temperature exceeds 30˚C.

Intake Protection Zones

These are areas around municipal surface water intakes. The size of each zone is determined by how quickly water flows to the intake in hours. These are primarily drawn and discussed for emergency response purposes.

Native Species

Native species refer to plants and animals that are naturally found in a particular region and normally thrives in that ecosystem. Native species can be:

- Endemic (found only within that area)
- Indigenous (found within that location as well as elsewhere)

When referring to "native" plants, this means plants that were growing in an area before European settlement.

Nature's Contributions to People (NCP)

These are all the contributions, both positive and negative, of living nature to people's quality of life. These are also referred to as the EDOH; beneficial contributions include things like providing food and clean water. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services identifies 18 categories of NCP that can be organized into three general functions [6]:

- Material contributions are substances, objects or other material elements from nature that directly sustain people's physical existence and material assets.
- Non-material contributions are nature's effects on subjective or physiological aspects underpinning people's quality of life, both individually and collectively.
- Regulating contributions are functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people, and/or regulate the generation of material and non-material contributions.

Natural Heritage Area

These are areas in our environment that have important natural heritage features that support key ecological processes within a watershed. Natural heritage features include:

- Woodlands
- Grasslands
- Savannahs
- Lakeshores
- Lakes
- Watercourses, valleylands and wetlands
- Stormwater management features, ponds, and other water bodies
- Groundwater
- Glacial features
- Areas of natural and scientific interest
- Agricultural lands
- Wildlife

Negative Radiative Forcing

This refers to an effect of a climate driver on our climate. Negative radiative forcing occurs when more energy leaves the climate system than what enters it, leading to a cooler climate.

Oak Ridges Moraine

The Oak Ridges Moraine is one of Ontario's most important ecological features. It has a unique concentration of environmental, geological, and hydrological features that make its ecosystem vital to south-central Ontario, including clean and abundant water resources, healthy and diverse plant and animal habitat, and an attractive and distinct landscape. [7]

Positive Radiative Forcing

This refers to an effect of a climate driver on our climate. Positive radiative forcing occurs when more energy is being kept within the climate system than what is leaving it, leading to a warmer climate.

Radiative Forcing

Radiative forcing is used to measure how much effect climate drivers have on the Earth's energy balance. It is defined as the net change in the energy balance of Earth's system due to an external disruption, measured in watts per square meter (Wm^2).

Representative Concentration Pathways (RCPs)

RCPs provide time-dependent estimates of GHG concentrations from a starting period until 2100 based on assumptions about economic activity, energy sources, population growth, and other socio-economic factors. [8] Each RCP plots a different emissions trajectory or pathway and cumulative emission concentration in 2100 based on relevant available data.

Since RCPs are standardized, they allow different groups of scientists to estimate future climate projections in a consistent way. This allows for comparisons to be made. They provide a basis for assessing the risk of crossing preidentified emissions thresholds in terms of both physical change in the environment and impacts on biological, ecological, and human systems. There are currently four main RCPs used for climate change assessment: RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5.

RCP 8.5

The highest emission scenario, where rising radiative forcing pathway leading to 8.5 W/m2 in 2100 and GHG emissions are up to seven times higher than preindustrial levels. [8]

Savannahs

This biome habitat is characterized by grassy plains scattered with tall trees and little to no underlying vegetation.

Significant Groundwater Recharage Area

This is an area where large amounts of water go into the ground instead of flowing directly into creeks, rivers, or lakes.

Simple Daily Intensity Index (SDII)

Average intensity (mm/day) over a given period, calculated as total wet day precipitation divided by the total number of wet days. This measure is related to heavy rainfall events.

Source Water Protection

Source water protection means to protect the raw water from contamination and overuse that we take from lakes, rivers, or underground aquifers to supply people with drinking water. In Ontario, this is based on the Clean Water Act, 2006.

Source Water Protection Area

Is an area that shows the area that needs to be protected based on where the public water system draws its drinking water supplies. It is usually described using a topographic map connecting the highest points uphill of the drinking water intake from which overland flow drains to the intake.

Surface Water

Surface water is any body of water found on Earth's surface and includes both the saltwater in the ocean and the freshwater in rivers, lakes, and streams.

Urbanization

The increase in the proportion of a population living in urban areas; the process by which many people become permanently concentrated in relatively small areas, forming cities.

Watershed

A watershed is an area of land that drains rainfall and snowmelt into streams and rivers. Everybody of water has a watershed. Smaller bodies of water flow into larger ones, including lakes, bays, and oceans. Watersheds can vary substantially in size, ranging from a few square meters to millions of square kilometers.

Watershed Management

This term describes the use of land, forest, and water resources in ways that do not harm the plants and animals living there. Watershed management may include goals and processes to protect and conserve the watershed and its associated ecosystems.

Water Table

This is the boundary between water-saturated ground and unsaturated ground. Below the water table, rocks and soil are full of water. An area's water table can fluctuate as water seeps downward from the surface.

Wellhead Protection Areas

Areas where water travels through the ground to a municipal well.

Chapter 4

DURHAM'S SETTING

Durham Region's landscape, environment, and climate.

This chapter provides a geographic overview of the Regional Municipality of Durham. It serves as a comprehensive reference guide on the key ecological characteristics of the region that influence both its resilience and vulnerabilities to climate change.

Durham Region is located east of the City of Toronto and is the largest geographical jurisdiction within the Greater Toronto Area (GTA). It is within the Golden Horseshoe of Ontario, a highly developed and populated economic centre of the province (**Figure 4.1**)

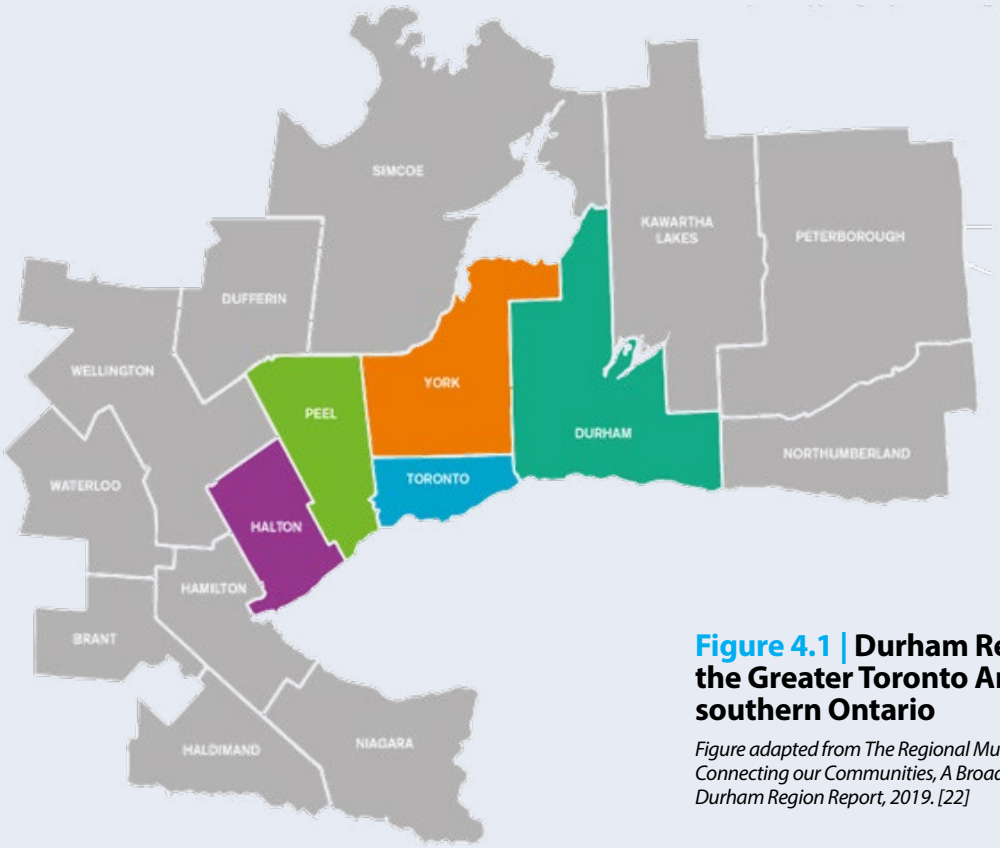


Figure 4.1 | Durham Region within the Greater Toronto Area (GTA) and southern Ontario

Figure adapted from The Regional Municipality of Durham Connecting our Communities, A Broadband Strategy for Durham Region Report, 2019. [22]

Durham Region is a dual-tier municipality and is comprised of eight lower-tier municipalities: City of Pickering, Town of Ajax, Town of Whitby, City of Oshawa, Municipality of Clarington, Township of Uxbridge, Township of Scugog, and Township of Brock. The Mississaugas of Scugog Island First Nation (MSIFN) is located within the geographic boundaries of the Regional Municipality of Durham. The ancestral and treaty territory of the Mississauga Nation encompasses the entirety of the Regional Municipality of Durham. The Williams Treaties include traditional territories of seven First Nations, including the Chippewas of Beausoleil, Georgina Island and Rama and the Mississaugas of Alderville, Curve Lake, Hiawatha, and Scugog Island.

The Region covers 2,590 square kilometers and consists of a diverse mix of urban, suburban, and rural areas **(Figure 4.2)**. The southern lakeshore communities of Pickering, Ajax, Whitby and Oshawa are large urban centres. Clarington, and the northern townships of Scugog, Uxbridge and Brock are predominantly rural areas, with a thriving agricultural sector.

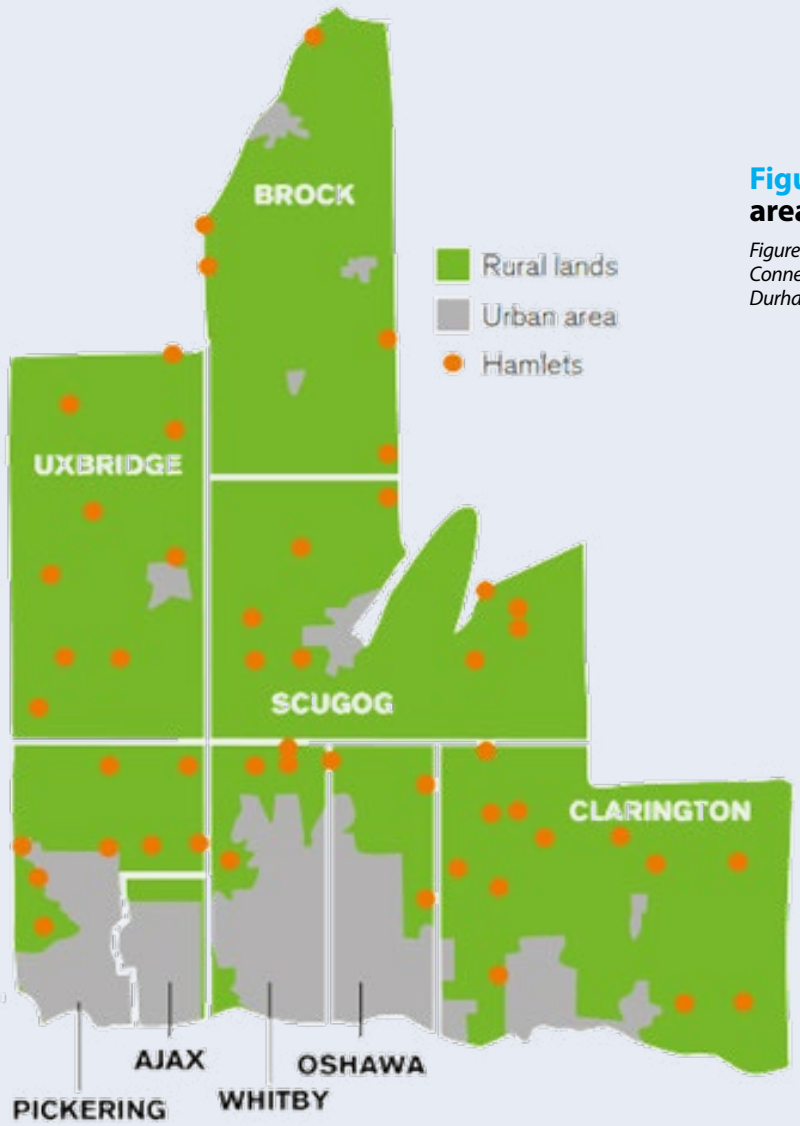


Figure 4.2 | Durham Region's local area municipalities.

Figure adapted from The Regional Municipality of Durham Connecting our Communities, A Broadband Strategy for Durham Region Report, 2019. [22]

4.1 Geography & Environment

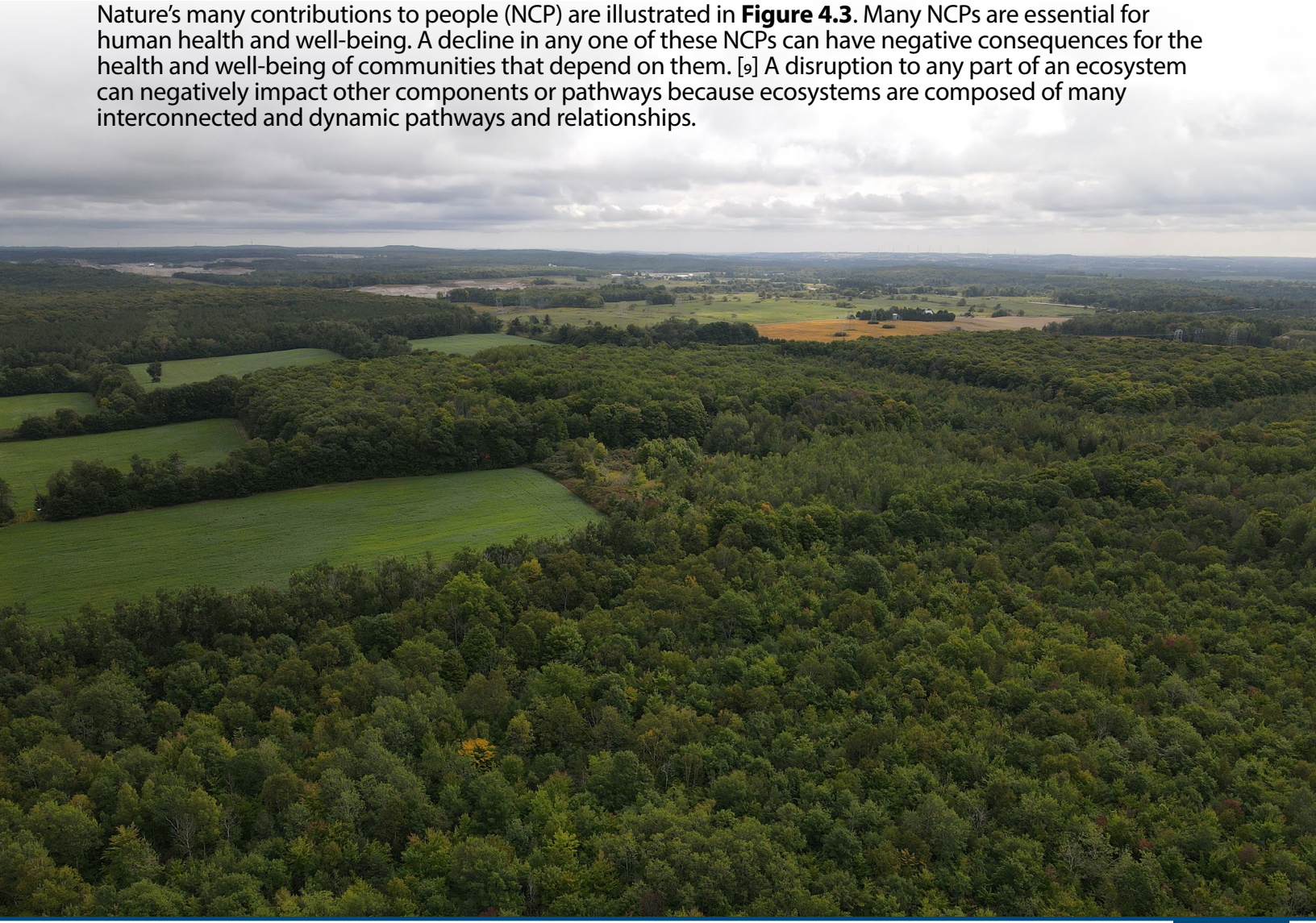
Most of Durham Region is within Ontario's environmentally sensitive and agriculturally productive Greenbelt, providing clean air and water, a sustainable local food supply and protection from climate hazards like flooding and extreme heat.

Durham Region is in the Lake Simcoe-Rideau Ecoregion which extends from Lake Huron in the west to the Ottawa River in the east and includes most of the Lake Ontario shoreline. Over 80 per cent of Durham Region lies within the provincially designated Greenbelt, which also contains the environmentally significant Oak Ridges Moraine. Historical glacial activities in the area have substantially impacted Durham Region's current landscape and geology.

4.1.1 Ecosystems of Significance

We are fortunate that Durham Region's natural environment provides us with essential ecosystem services, also known as the ecological determinants of health (EDOH).

Nature's many contributions to people (NCP) are illustrated in **Figure 4.3**. Many NCPs are essential for human health and well-being. A decline in any one of these NCPs can have negative consequences for the health and well-being of communities that depend on them. [9] A disruption to any part of an ecosystem can negatively impact other components or pathways because ecosystems are composed of many interconnected and dynamic pathways and relationships.



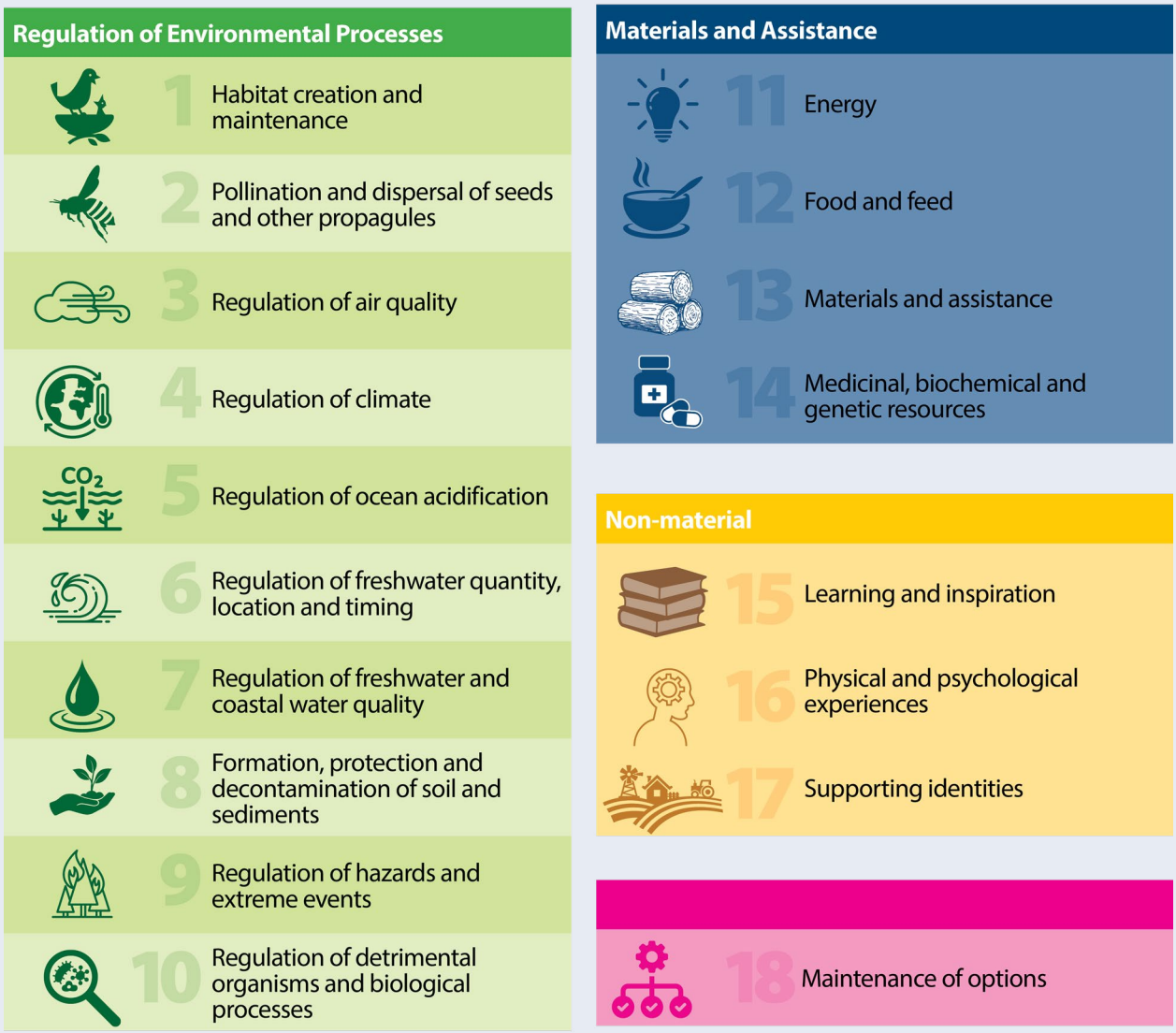


Figure 4.3 | The EDOH and nature's contribution to people.

Figure Source: Adapted from the 2019 IPBES Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Figure SPM 1. [6]

The municipalities within south-central Ontario are fortunate to have an array of natural features, referred to as natural heritage areas, that provide these key natural contributions to the community. These areas provide opportunities for recreation and the appreciation of nature, and play a key role in retaining rainwater, erosion management, filtering pollutants and providing a wide diversity of habitats for local fish and wildlife. The natural heritage areas and greenlands systems in south-central Ontario are formed by the Niagara Escarpment, the Oak Ridges Moraine, and the Greenbelt (**Figure 4.4**). [5]

Natural Heritage Areas

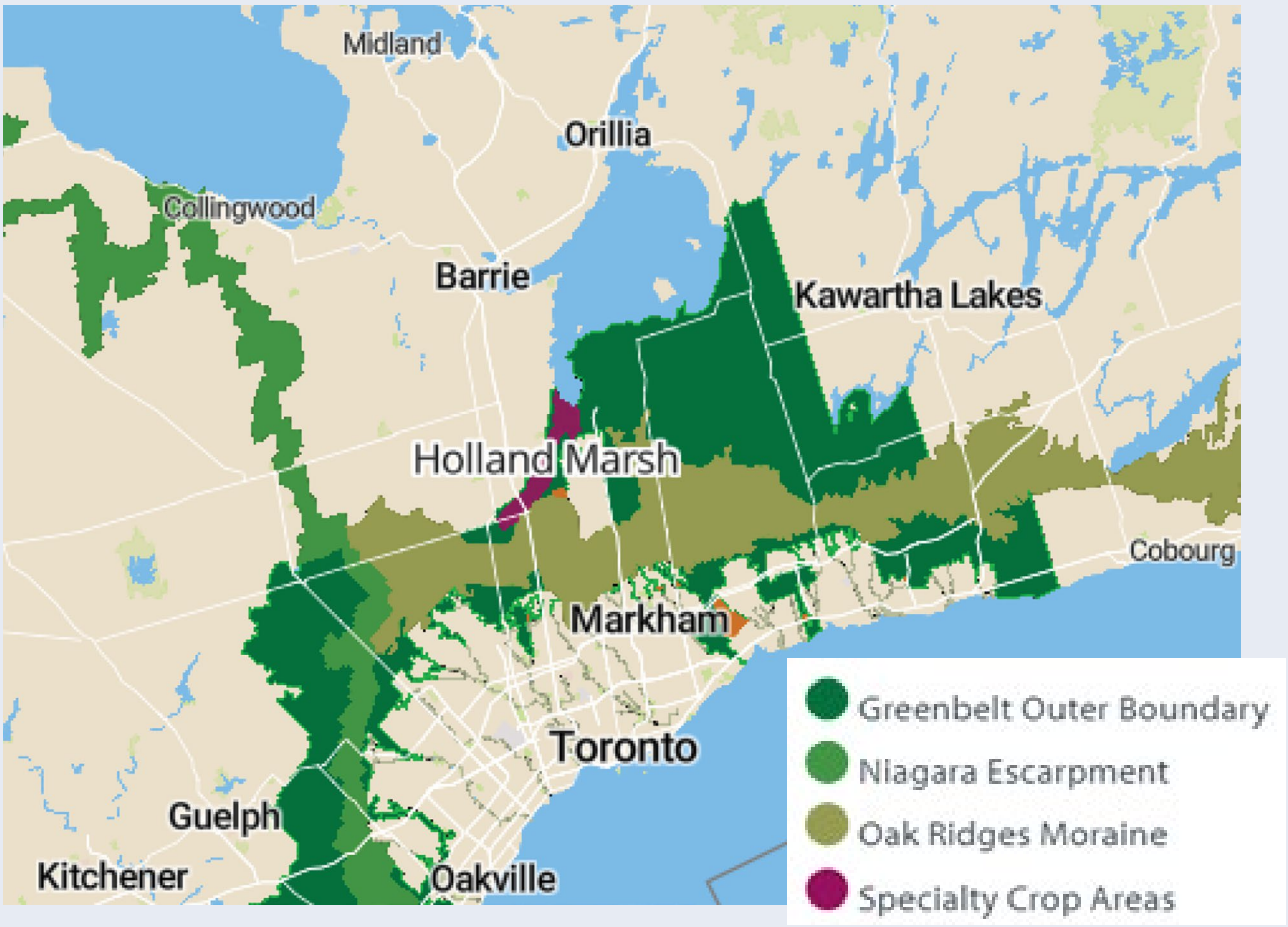


Figure 4.4 | Location of key natural heritage areas in south-central Ontario.

Natural heritage areas include the Greenbelt, Niagara Escarpment, and the Oak Ridges Moraine.

Figure Source: Adapted from the Greenbelt Foundation. [5]

Figure 4.5 illustrates the substantial contribution of the Oak Ridges Moraine to Durham's greenlands system.

Durham's Greenlands System

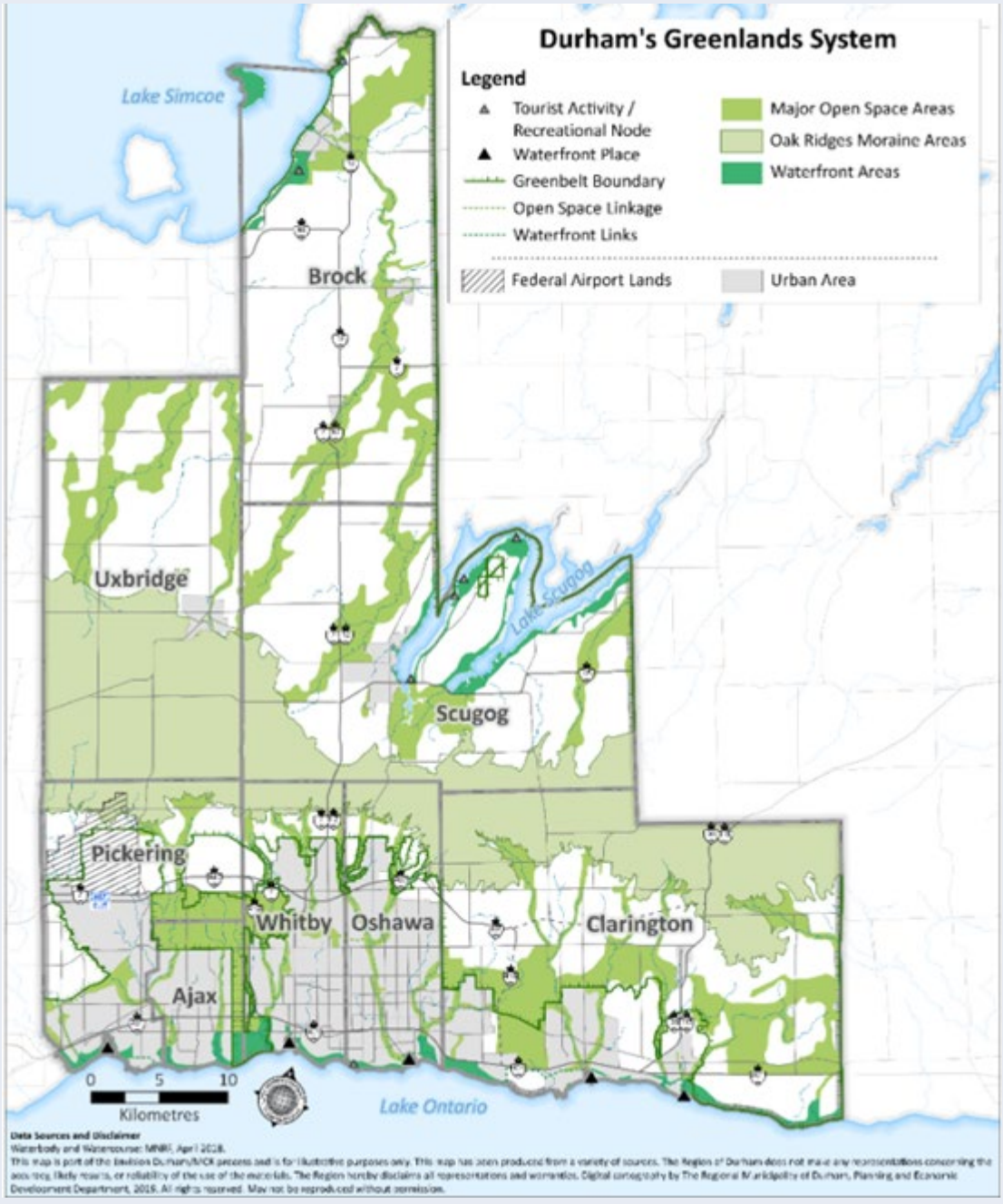


Figure 4.5 | Durham Region's greenlands system including the Greenbelt boundary, open space areas, waterfront areas and the Oak Ridges Moraine

Figure Source: The Regional Municipality of Durham, Planning and Economic Development Department, 2019.

4.1.1.1 The Greenbelt

Ontario's Greenbelt's natural systems support ecological and human health by safeguarding the vital resources that clean our air and water, reduces flood risks, provides a home for wildlife, and ensure our communities have greenspace to explore.

Ontario's Greenbelt was created in 2005 and covers two-million acres of protected land in the heart of the Greater Golden Horseshoe. The Greenbelt includes a diverse range of landscapes such as forests, wetlands, rivers, lakes, and prime agricultural areas. It provides numerous ecological benefits including wildlife habitat, clean air and water, opportunities for outdoor recreation and flood prevention for Durham Region communities. [10] The Greenbelt serves as a green space buffer helping to prevent urban sprawl and maintain the ecological health of the region. Farmlands within the Greenbelt contribute to local food production and help to ensure a sustainable food supply for the GTA. The Greenbelt provides an estimated $3.2 billion dollars in ecosystem services each year, including $224 million per year in flood protection for private property and $52 million per year in carbon sequestration. [5] The Greenbelt also provides home to and protects 78 at risk or endangered species. Therefore, its protection is essential for climate resilient communities and a thriving local economy. [5]

The purpose of creating the Greenbelt in 2005 was three-fold:

1. Prevent further loss of farmland and natural heritage areas.
2. Restrict urban sprawl.
3. Work with the Growth Plan to develop vibrant communities where people can live, work and play.

The Greenbelt's natural systems support ecological and human health. It is one of the most biologically rich areas in all of Canada. The Greenbelt absorbs rainwater, manages stormwater during severe weather events, and helps prevent flooding. In times of drought, this healthy, connected system provides a buffer against disease and other stresses.

In a warming climate, the tree cover and vegetation of the Greenbelt keeps ambient air temperatures down due to the cooling effect of the region's river valleys. The forests, wetlands and soils also slow down the impact of climate change by absorbing or sequestering carbon dioxide from the atmosphere.

The Greenbelt also plays an essential role in driving the local economy through agriculture. Farmland makes up 40 per cent of the Greenbelt, including rare specialty crop areas. Based on 2023 estimates, 4,782 farms are protected by the greenbelt, totalling 750,000 acres, and these farms earn an estimated 68 per cent more revenue per acre than the average Ontario farm. [5] Local food, craft beer and cider, award-winning wines, farmers' markets, agri-food and culinary tourism experiences all help to keep rural economies thriving. With farmland disappearing at an alarming rate in southern Ontario, the permanently protected Greenbelt is essential to sustain a reliable source of food close to home.

Urban River Valleys (URVS) And Coastal Wetlands

In 2017 the Greenbelt was expanded to include 21 URVs and seven coastal wetlands connecting its suburban and rural lands to Lake Ontario.

These URVs and coastal wetlands are shown in **Figure 4.6.** Of the 21 URVs added to the Greenbelt, nine are located within Durham Region, including:

- Duffin's Creek
- Carruther's Creek
- Lynde Creek
- Oshawa Creek
- Farewell Creek/Harmony Creek
- Bowmanville Creek
- Soper Creek
- Wilmont Creek
- Graham Creek

The addition of these waterways to the Greenbelt is an important recognition of the important role the Greenbelt plays in protecting the hydrological features we rely on for clean drinking water, food protection, and healthy ecosystems. [11]

Protecting urban river valleys is the first step to ensure these systems remain healthy for generations to come. However, urban development is currently the greatest threat to the health and vitality of our URVs. [11] Water-resistant surfaces and loss of forest cover in the watershed creates challenges for the rivers including: [10]

- Decreasing ground river recharge
- Increasing water temperatures
- Increasing pollution
- Increasing riverbank erosion

Greenbelt Urban River Valleys

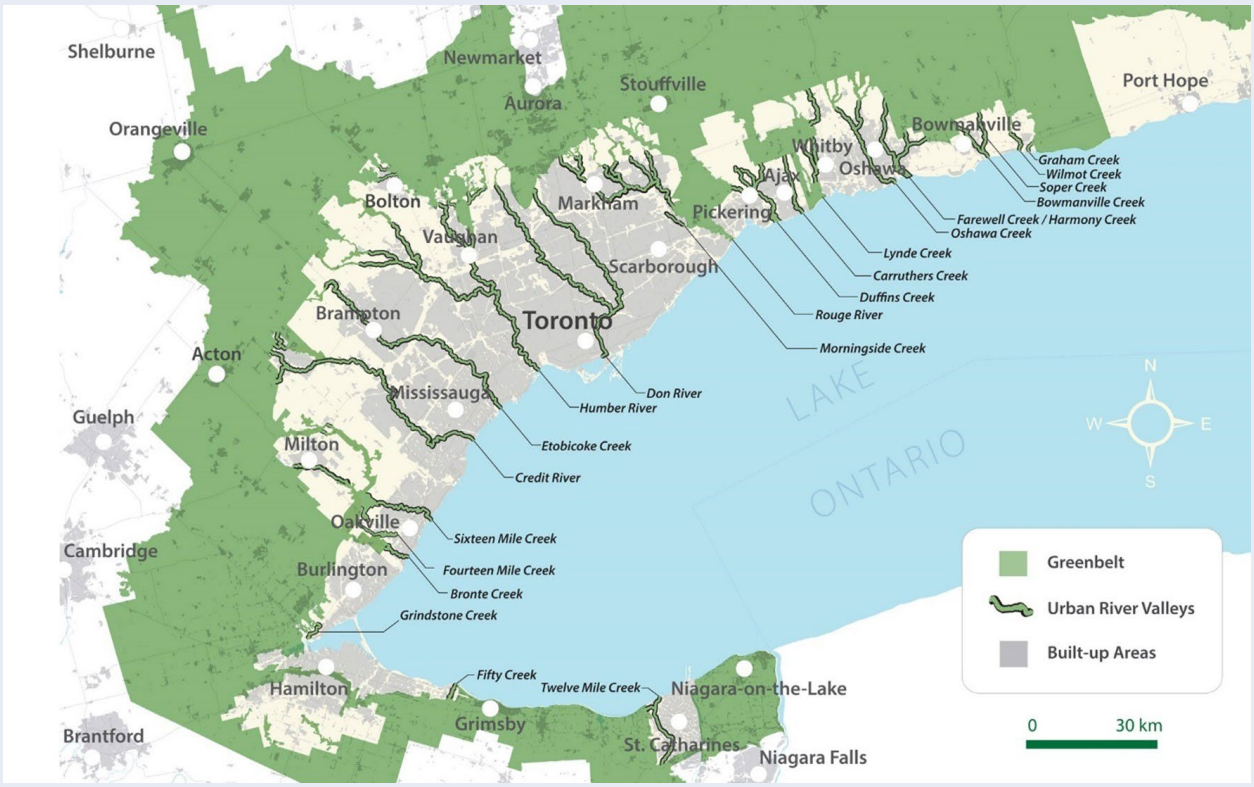


Figure 4.6 | Urban River Valleys added to the Greenbelt area in 2017

Source: Greenbelt Foundation, Greenbelt protected urban river valleys. February 2020, Available at: Greenbelt Protected Urban River Valleys - Greenbelt Foundation.

4.1.1.2 The Oak Ridges Moraine

The Oak Ridges Moraine is one of Ontario's most significant landforms and has a unique concentration of environmental, geological, and hydrological features that make its ecosystem necessary to the region. [12, 13]

The Moraine is a prominent ridge of land stretching approximately 160 kilometres in length from the Niagara Escarpment in the west to Rice Lake in the east, bisecting Durham Region. The Moraine covers over 190,000 hectares of land and water.

The Moraine was formed by glacial sediments, including gravel, sand, and glacial till. Due to the high permeability of these substrates, the Moraine creates the important divide between the watersheds draining south into western Lake Ontario from those draining north into Georgian Bay, Lake Simcoe, and the Trent River system. The Moraine is the headwaters which filters and replenishes groundwater and feeds into many smaller creeks. The sand deposits store and then discharge cool water into the creeks. The Moraine is also characterized by a high-water table which makes this area a significant groundwater resource.

The Moraine shapes the present and future form and structure of the GTA, and its ecological functions are critical to the region's continuing health. It has a unique concentration of environmental, geological, and hydrological features that make it essential to south-central Ontario, including:

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

Due to its environmental importance, the Ontario government created the Oak Ridges Moraine Conservation Plan, which has strict land use polices designed to protect this feature. The Moraine is also subject to the Greenbelt Plan. Together these two plans identify where urbanization should not occur to provide permanent protection to the agricultural land base and the ecological and hydrological features, areas and functions occurring on this landscape and found within the Oak Ridges Moraine. See **Appendix 4.1** for a detailed description of the Oak Ridges Moraine Conservation Plan.

4.1.2 Fresh Water Resources

The Great Lakes are globally rare, comprising the largest group of freshwater lakes by total area in the world.

They hold approximately 84 per cent of North America's surface fresh water and about 21 per cent of the world's surface freshwater. [14] Despite their paramount importance, numerous factors threaten the sustainability of this freshwater system.

4.1.2.1 The Great Lakes – St. Lawrence River Basin

The Great Lakes make Ontario a great place to live and support an ecosystem that is unique in the world.

The Great Lakes provides enormous resources including drinking water, energy, food, and recreational opportunities. They support a rich array of plants, animals, and ecosystems, contributing to environmental and human health and well-being. The Lakes also provide numerous economic advantages.

For ages, First Nations peoples have lived in the Great Lakes Basin, fishing, hunting, farming, and trading and maintaining a spiritual and cultural relationship with the Great Lakes. Indigenous Peoples recognize, honour and respect water as a sacred gift that sustains all life. Many Indigenous women have a traditional role and responsibility to protect the waters. Cultural identities, traditional and sacred laws and customs govern First Nations People's perspectives and influence their relationship and stewardship responsibilities with water and the natural environment. As such, First Nations communities living in the Great Lakes area have expressed a shared responsibility to protect these waters.

Why The Great Lakes Matter

Water quality & quantity

The Great Lakes hold one-fifth of all the fresh surface water on the planet. The Lakes and their related ecosystems recycle and purify our drinking water giving us enough clean water to drink. Our tap water is some of the highest-quality drinking water in the world. More than 80 per cent of Ontarians get their drinking water from Lakes Superior, Huron, Erie, and Ontario. [15]

The waters within the Lakes are slow moving and replenish at a rate of less than one per cent per year. It takes 300 years for a drop of water to travel from Lake Superior through the other lakes and the St. Lawrence River, eventually to the ocean.

Ecological diversity

The Great Lakes region is one of the most ecologically diverse regions in North America and is home to over 4,000 species of plants, fish, and wildlife. Variations in the Lakes' depth, climate, and geology help sustain the rich diversity within these ecosystems. Some of the species found within the Great Lakes region are found nowhere else on Earth.

Climate

The Great Lakes, as well as smaller lakes, such as Lake Simcoe within the Water Basin, play an important role in local weather patterns and climate processes, due to their vast sizes and depths. [3] In other words, they play a key role in moderating our climate and contribute to climate resiliency.

Economic advantages

The Great Lakes provide numerous economic advantages which has drawn people from all over the world to the growing communities along Ontario's Great Lakes shores. The Lakes stimulate Ontario's economy and give us a competitive edge making, the regional economy the third largest in the world. [15]

Approximately 95 per cent of Ontario's agricultural lands depend on the Great Lakes – St. Lawrence River basin. [15] For example, Lake Erie supports one of the world's most valuable freshwater commercial fisheries, as well as a popular sport fishery.

Manufacturing and other industries rely on the cool, clean Great Lakes water. These waters help to generate approximately 83 per cent of Ontario's electricity, including hydroelectricity and cooling water for power plants. [15] Great Lakes shipping routes also help move goods and products, stimulating over $15 billion in annual economic activity in Ontario and Quebec. [15]

The Great Lakes and St. Lawrence River also contribute to the province's tourism sector. They are icons that help make Ontario a natural tourist destination for both local and international visitors. Ontario's many provincial parks, including 30 operating along the Great Lakes, attract 10 million visits every year. [15] In 2010, Ontario welcomed over 73 million tourist visits in the Great Lakes Region with estimated spending of $12.3 billion. [15]

Physical, spiritual, and social wellbeing

The Great Lakes help us enjoy healthy active lifestyles. The Lakes and their wetlands, marinas and waterfronts offer many different recreational opportunities like bird watching, swimming, fishing, boating and cottaging. Great Lakes coastal trails allow for walking, hiking, and cycling. The Lakes form a natural environment for waterfront festivals and heritage attractions that strengthen communities and present opportunities for families to enjoy the outdoors close to home.

The natural beauty of the Great Lakes and their diverse ecosystems allows us to appreciate our natural world. To many Ontarians, the Great Lakes' nature holds spiritual significance as well.

Although the Great Lakes are of paramount importance for the many regions listed above, their well-being is currently under threat from many diverse factors. Some of the challenges facing the Great Lakes today include: [15]

- **Population growth and urbanization:** Ontario's future population growth is expected to be concentrated around the Great Lakes with a projected annual growth rate of six per cent. Population growth can put stress on the ecosystem including growing water demand and increased runoff of unwanted phosphorous and chemical contaminants into the Great Lakes. Growth that is not properly managed can lead to the loss of important habitats like wetlands.
- **Natural heritage loss:** Loss of fish and wildlife habitats, like wetlands, are affecting ecosystem health and negatively impacting natural and cultural heritage. The populations of some Great Lakes species have declined to the point where they are now at risk in Ontario and are protected under the Endangered Species Act, 2007.
- **Invasive species:** Invasive species are causing significant ecosystem disruption and some populations of native fish species have declined dramatically as a result.
- **Climate change:** Impacts like less ice coverage, more evaporation and bigger storms, fluctuating water levels, and high summer temperatures pose risks for Great Lakes' communities and the ecosystem.
- **Chemical contaminants:** There are increasing concerns about newer chemicals, such as flame retardants and pharmaceuticals from urban, industrial, and agricultural sources. Sewage treatment facilities were not designed to remove some chemicals making prevention more effective than removal for keeping these chemicals out of Great Lakes waters.

- **Water levels:** Fluctuating water levels in the Great Lakes are having social, economic, and environmental impacts. These include access to water for lakefront property, recreational boating and commercial shipping, and reduced habitat for aquatic species. Additionally, artificial controls on the waters in Lake Ontario and the upper St. Lawrence River place stress on the surrounding wetlands, which rely on periodic high and low waters.
- **Algae:** More algae are growing in Great Lakes' waters including nuisance algae and toxic blue-green algae.
- **Beaches:** Some of Ontario's Great Lakes' beaches are not only affected by aesthetic issues from excess algae, but also by excessive bacterial levels that make the waters less safe to swim. Bacteria in beach water can come from many sources like sewage and septic systems, waterfowl, and runoff from rural and urban areas with higher impacts seen following heavy rain events.

In response to the threats facing the Great Lakes and their importance to Ontarian's health and well-being, the Ontario government established The Great Lakes Protection Act in 2017. [16] See **Appendix 4.2** for more information on The Great Lakes Protection Act and Ontario Great Lakes Strategy.

4.1.2.2 Our Lakes and Lakeshores

Durham Region is fortunate to be home to many lakes of different sizes that provide important ecological functions, safe drinking water and opportunities for recreation for residents and visitors to use and enjoy.

The largest lakes present within the region include Ontario, Scugog and Simcoe. Some of the smaller lakes include Samac, Brown, Brookdale, Staley, Lazy, Long, Island and Windsor.

An interesting feature in Durham Region is the presence of a single kettle lake – Chalk Lake. A kettle lake is a shallow spring fed, sediment-filled body of water formed by retreating glaciers.

Ecological Functions

Lakes are complex ecosystems. They provide a home for various types of plants and freshwater animals and microorganisms. The area along the lake also provides some of the most productive and valuable fish and wildlife habitat in the ecosystem. This is a nutrient rich area in which almost all aquatic life begins.

Shoreline plants play an important role in maintaining the natural functions of the shoreline, they increase bank stability and reduce the potential for erosion. They can also help reduce pollution from runoff sediment, nutrients, and toxic chemicals by absorbing them through their root systems. Plants of various sizes provide shade, nesting sites, food, and habitat for mammals, fish, and birds.

A healthy lake is one where human activity has not impaired the natural functions of the lake or significantly altered the natural composition of plants, animals, and microbes. Conversely, an unhealthy lake is one in which the nutrients are out of balance, giving rise to overgrowth of certain species, like blue green algae blooms. Lakes have been seriously degraded in the past through various human activities such as poor stormwater management, leaky septic systems, oil and gas discharges from boat motors, and shoreline alteration. Retaining walls along shorelines can lead to erosion by altering currents and removing important and necessary near-shore habitats for fish, amphibians, and invertebrates.

Over several decades various organizations and citizen groups have made progress in stopping further degradation of aquatic ecosystems to reverse the effects of historical damage.

Contributions to people

Lakes and lakeshores make many important contributions to Durham Region residents, our communities, and visitors. Most area residents get their drinking water from lakes. For example, the community of Beaverton takes their drinking water from Lake Simcoe.

Lakes also provide opportunities for recreation including fishing, boating and bird-watching, and aquatic and ice sports. There are 14 public beaches within the region located in seven of Durham Region's eight municipalities. Examples include Paradise Beach (Ajax), Beaverton South Beach (Brock), and Kinsmen Beach (Scugog). Throughout the summer, DRHD tests the water at these beaches as part of its beach monitoring program to let beach visitors know which beaches are safe for swimming.

4.1.2.3 Our Watercourses, Valleylands, Wetlands and Other Water Bodies

Watercourses and their associated valley-lands, wetlands and other bodies of water are significant assets within the Durham Region community.

In Durham Region, water generally flows south from the Oak Ridges Moraine or Lake Iroquois Shoreline to Lake Ontario, or flow north from the Oak Ridges Moraine to Lake Scugog or Lake Simcoe.

Watercourses, URVs And Wetlands

Watercourses and their surrounding vegetation provide habitat, food and shelter for fish, aquatic, and terrestrial wildlife.

These areas form important natural linkages between different habitat features. These permit wildlife movement and increase wildlife diversity in the area. Trees and shrubs in the area help prevent erosion. In urbanized areas, watercourses, and URVs are important areas which provide communities with greenspace to explore, clean and filter our water and air, reduce our flood risks, and provide homes to wildlife.

Wetlands are complex ecosystems that provide a productive and diverse habitat for a variety of plants and animals. Humans also benefit from wetlands, as wetlands control flood conditions, water quality and quantity, as well as air quality. There are four kinds of wetlands:

1. **Swamps:** wooded wetlands where standing to gently flowing nutrient rich, mineral waters occur seasonally or persist for long periods on the surface.
2. **Marshes:** Wetlands which are periodically inundated with standing or slowly moving water that fluctuates seasonally.
3. **Bogs:** peat-covered areas with a high-water table for most of the year and a surface carpet of mosses.
4. **Fens:** peatlands characterized by layers of poorly, to well-decomposed peat.

Both fens and bogs are rare in Durham Region.

Human-Made Water Bodies

Although not naturally occurring, naturalized human-made aquatic features like private ponds and sloughs, temporal ponds, and seepage areas from artesian wells have become an integral part of the landscape in many parts of Durham Region. [12]

Private ponds and sloughs are created for many different reasons, some of which include recreation, fish culture, personal relaxation, livestock, watering, and irrigation. Regardless of the reason they were created, they quickly become an important part of the landscape and wildlife use them to feed, breed and live. [12] For example, temporary ponds are critical to the survival of amphibian species.

4.1.2.3 Drinking Water

Drinking water in the region comes from two types of sources: surface water and ground water. Durham Region operates the municipal drinking water supply system (DWS) which consists of 12 drinking water systems that operate in the eight area municipalities across the region comprising both surface and ground water sources (**Figure 4.7**).

Durham Region is fortunate to have some of the highest-quality drinking water in the world.

Drinking Water Supply

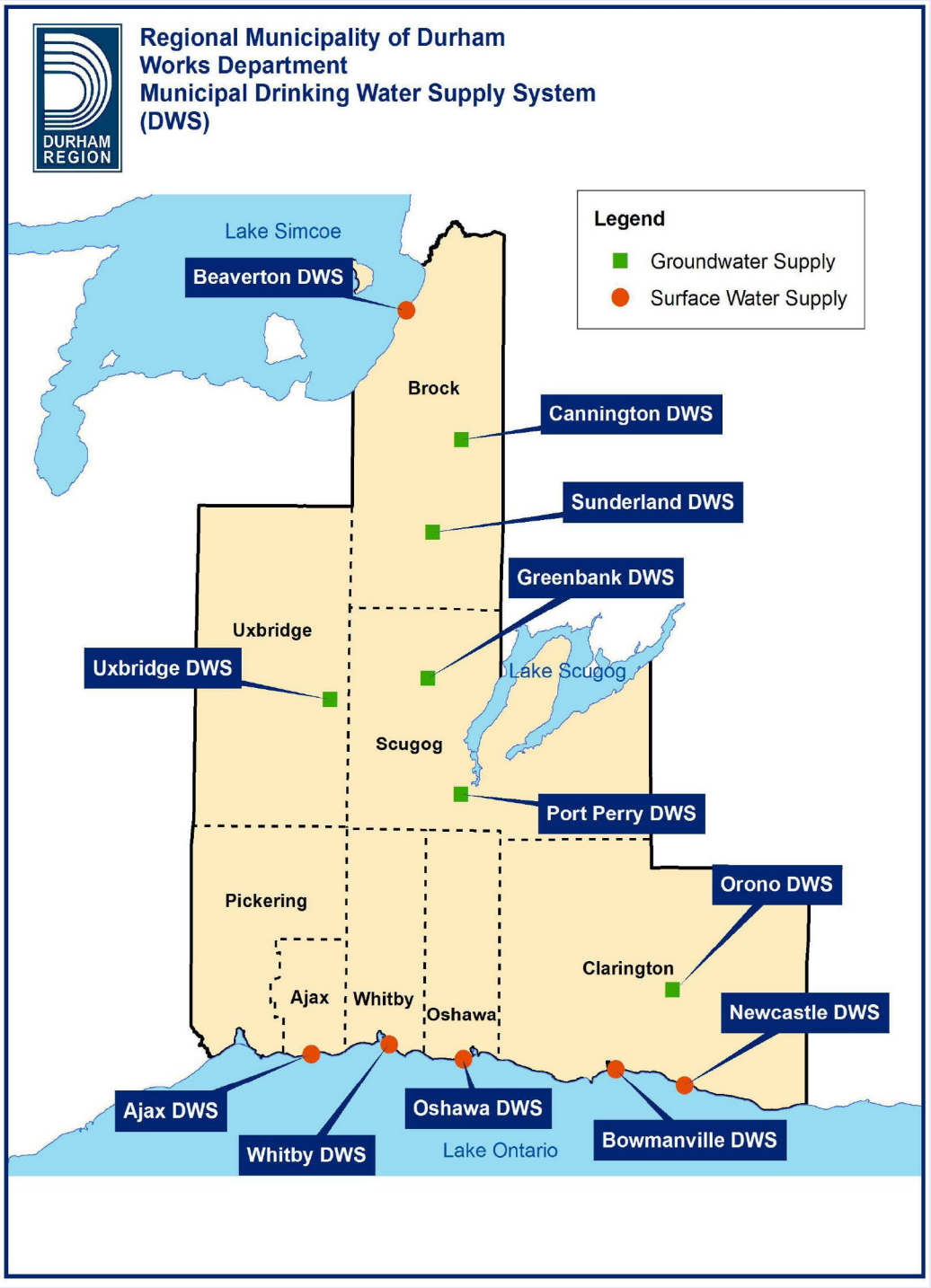


Figure 4.7 | Locations of Municipal DWS groundwater and surface water supply sources across Durham Region.

Data Source: Regional Municipality of Durham Works Department.

Surface Water

Surface water systems take water from open water sources like rivers and lakes.

There are two sources of surface water in Durham Region, Lake Simcoe (with a water supply plant located in Beaverton) and Lake Ontario (which has water supply plants in Ajax, Whitby, Oshawa, Bowmanville, and Newcastle) (**Figure 4.7**).

Surface water undergoes chemical and physical treatment which removes any biological, organic, or inorganic material from the water prior to being released as drinking water.

Groundwater

Groundwater systems take water from underground sources like wells.

There are 22 municipally operated groundwater wells in Durham Region located in Blackstock, Cannington, Greenbank, Orono, Port Perry, Sunderland, Uxbridge, and Uxville (**Figure 4.7**). Since the ground acts like a natural filter for the water, drinking water from groundwater sources requires much less treatment than water from surface water sources, and only needs a small amount of chemicals to control minerals and maintain disinfection in the drinking water distribution system.

In addition to the DWS operated by the Durham Region, there are also privately owned wells across the region where some residents get their water. There are two types of private wells used in the region - drilled wells and dug wells. Generally, private wells do not receive the same treatment processes that DWS wells or groundwater intake systems do. Instead, well owners are responsible for protecting their drinking water.

To do so, well owners must be aware of their well's potential for contamination and it is recommended individuals test drinking water from private wells for the presence of harmful bacteria at least three times per year. Private wells can be contaminated by both naturally occurring sources and by human activities. For example, water run-off from rainfall or snowmelt can contaminate private wells by washing microorganisms into the well system or seeping underground. Private well water samples are accepted by DRHD and submitted to the Public Health Ontario Laboratory for testing.

4.1.2.4 Storm and Wastewater Management

Water management systems provide critical support to human and ecosystem health.

Stormwater Management

Stormwater management refers to the process of controlling the movement and release of water from rainfall or melting snow, and is important for maintaining the health of our aquatic environments, safety of our drinking water and flood prevention.

The goal of stormwater management is to maintain the health of our aquatic environments (e.g., streams, lakes, aquatic life) and the natural water cycle. Effective stormwater management is important for reducing the amount of runoff and runoff pollution by slowing the movement of the runoff and allowing the water to soak into the ground. When stormwater stays close to where it fell (i.e., as rain, snow, or ice) less soil erosion occurs, fewer pollutants are carried to surface water bodies and risks of downstream flooding is prevented.

Durham Region operates a regional storm drainage system separate from the sanitary sewer and drinking water supply systems. The region maintains ditches, catch basins, maintenance holes, culverts, and underground storm sewer pipes. This extensive system is used to collect stormwater runoff from rainfall or from melting snow and ice on regional roads. The method used to collect stormwater runoff varies across urban and rural parts of the region.

- **Urban areas:** Where there are curbs and gutters along the road, stormwater is usually collected in catch basins. The catch basins take the water to the outfall through an underground storm sewer system.
- **Rural areas:** Open ditches and culverts collect and carry stormwater to the outfall.

Collected runoff water is then carried to discharge points called outfalls. Stormwater quantity and quality controls are used to reduce stormwater outfall impacts on the rivers, creeks, and lakes within Durham Region.

Wastewater Treatment

Durham Region provides wastewater collection and treatment which is a service essential to the economy, our community's health and for the protection of our environment.

The wastewater collection system in the region uses a system of underground pipes and pumping stations to bring wastewater to one of 11 water pollution control plants across the region (see **Appendix 4.3** for a list of treatment facilities in Durham). The wastewater is then treated, tested to ensure quality meets the high standards set by the Ontario Ministry of the Environment, Conservation and Parks, and releases the effluent into certain bodies of water.

Although not naturally occurring, stormwater management features and sewage lagoons have become an integral part of the landscape in many parts of Durham Region. [12] Both have quickly become naturalized with wildlife using them to breed, feed and live. [12] Temporary ponds are critical to the survival of amphibians. Sewage lagoons, such as the ones at Beaverton, Sunderland, Cannington, and Port Petty, provide essential habitats for many bird, mammal, insect, reptile, and amphibian species.

As natural wetlands are degraded or removed, these features become increasingly important to wildlife and the environment. Thousands of birds and other wildlife may be attracted to these feeding and resting areas. These human-made water bodies, in addition to the naturally occurring water bodies present throughout the region, comprise the significant water features needed to ensure a healthy environment and sustainable wildlife populations. [12]

4.1.3 Natural Heritage Features

Residents of Durham Region are fortunate to have a rich tapestry of natural heritage areas comprised of a diverse group of natural heritage features.

In addition to the Greenbelt and Oak Ridges Moraine, Durham Region is home to other significant natural heritage areas including the shorelines of Lake Ontario, Scugog and Simcoe, the Lake Iroquois shoreline, Second Marsh in the City of Oshawa, the Rouge River Valley in the City of Pickering, and the Wilfrid Bog in the Township of Brock, among many others. [12]

Natural heritage areas in Durham Region are made up of a diverse group of natural heritage features, including:

- Agricultural lands
- Areas of natural and scientific interest
- Glacial features and groundwater
- Lakes and lakeshores
- Watercourses, valley-lands and wetlands
- Stormwater management features, ponds, and other bodies of water
- Woodlands, grasslands, and savannahs
- Wildlife

Figure 4.8 is a descriptive map of some of the natural heritage areas and features within Durham and its surrounding regions.

Natural Heritage Features

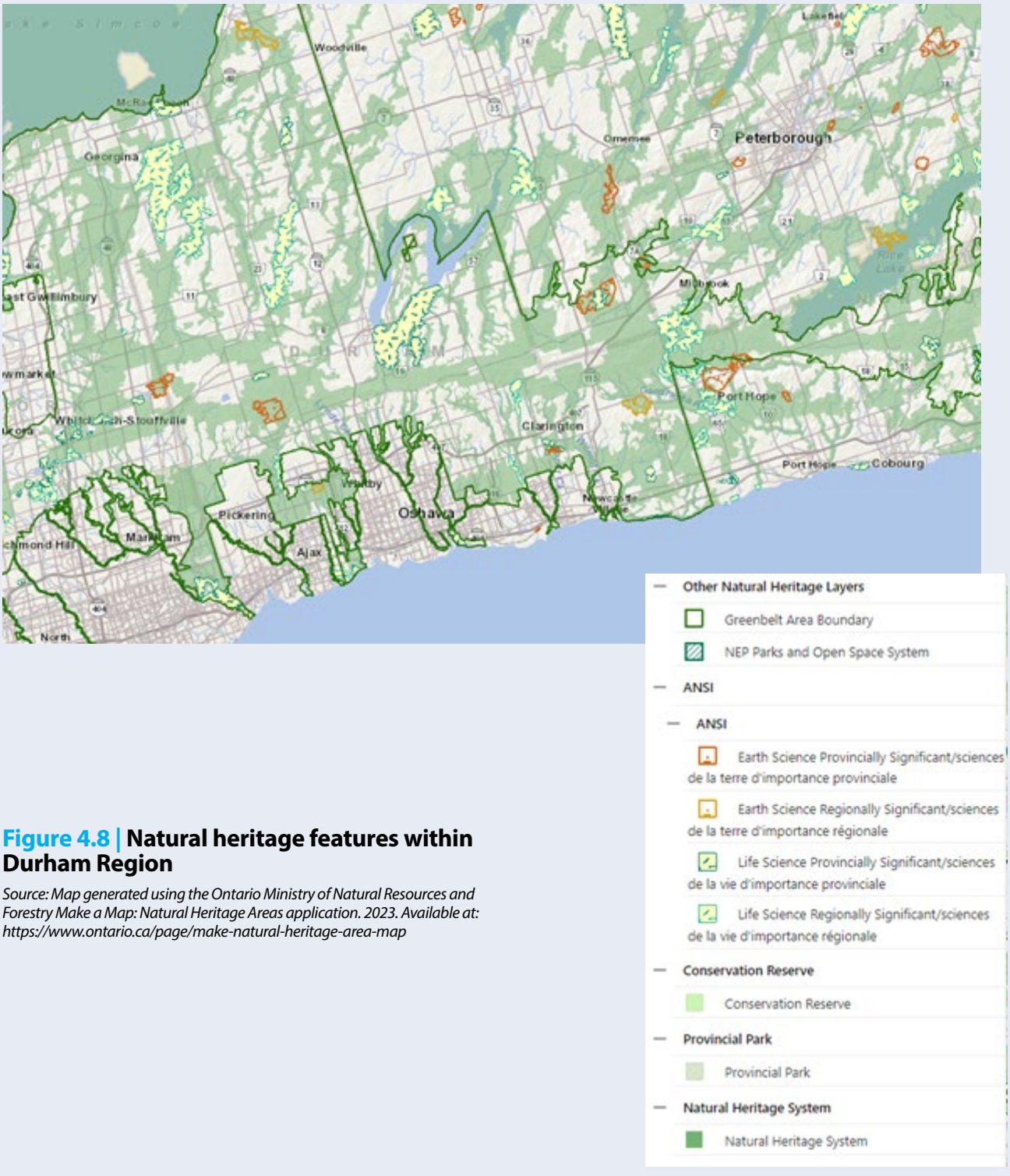


Figure 4.8 | Natural heritage features within Durham Region

Source: Map generated using the Ontario Ministry of Natural Resources and Forestry Make a Map: Natural Heritage Areas application. 2023. Available at: https://www.ontario.ca/page/make-natural-heritage-area-map

Agricultural Lands

Durham Region is a leading agricultural producer with the largest Gross Domestic Product from agriculture of the GTA municipalities. [17]

In 2017, Durham Region contributed $321.7 million to Ontario's total farm production. Durham Region is home to more than 1,300 farms, with a total farmland area of more than 118,497 hectares. Agriculture in the region is diverse and the key agricultural sectors in the region are (**Figure 4.9**) [17]:

- Oilseed and grain farming with corn, soybeans and hay being the most dominant crops in the region
- Cattle ranching and farming, including both beef and dairy
- Greenhouse, nursery, and floriculture production
- Fruit and vegetable
- Equine industry

Farmers are stewards of the land and play a critical role in climate resiliency through the implementation of best management practices. Through water and land conservation projects and a focus on sustainability, farmers and agricultural operators help ensure the land we depend on for sustenance persists in a healthy state for future generations. Sustainable and environmentally friendly management techniques play an enormous role in maintaining the environment and support the production of agricultural goods. [12]

Across the region, farmers and agricultural operators are already using and adopting best management practices and the latest technology to reduce environmental impacts and ensure continued viability of their land and agricultural operations. Based on results of the 2018 Local Food Business Retention and Expansion survey, many local farmers indicated they have already begun taking steps such as: diversification of crops and crop varieties, erosion management, using frost fans, and adjusting planting and harvesting schedules. [17]

Number of Farms in Durham Region by Industry Group, 2013

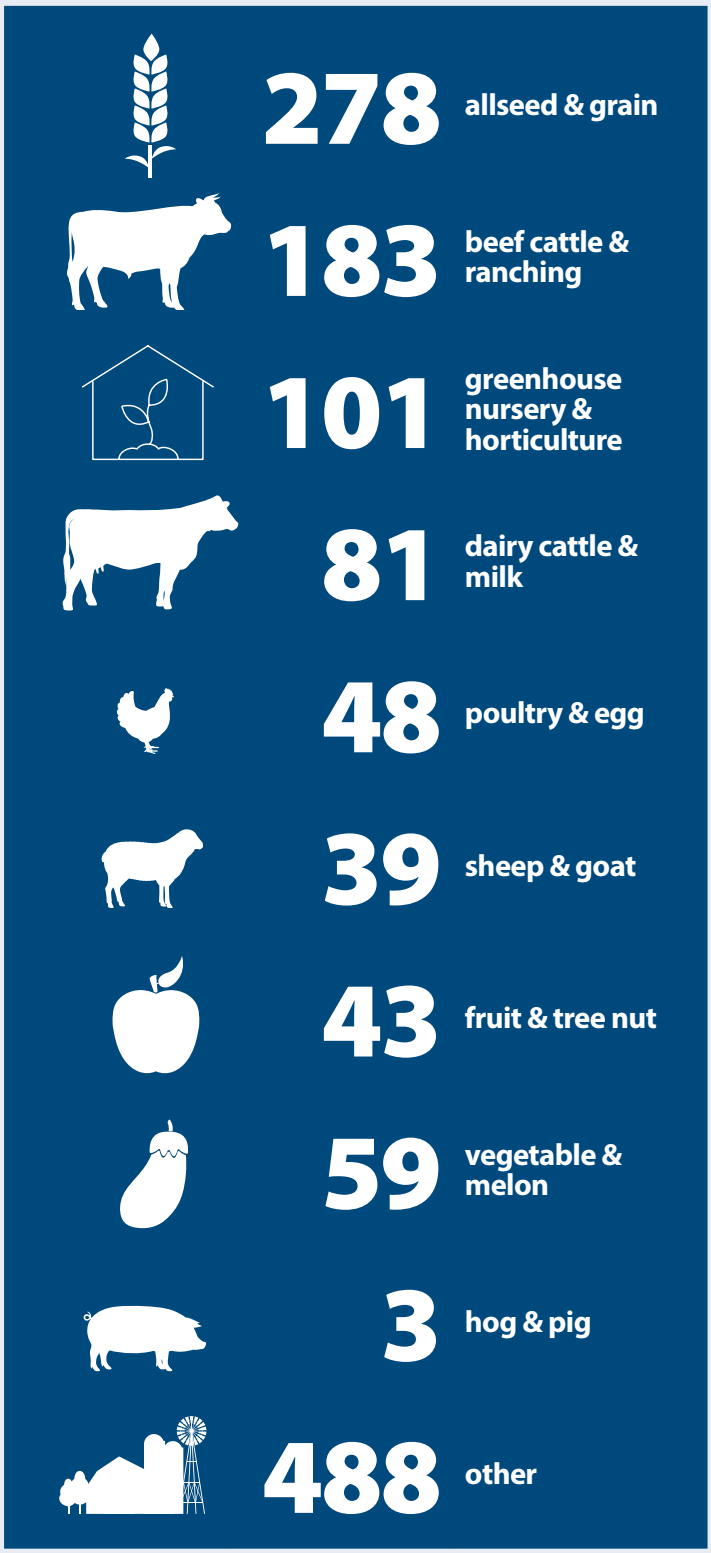


Figure 4.9 | Number of farms in Durham Region by industry group, 2016

Figured adapted from: Durham Region's Agriculture sector climate adaptation strategy – 2019. [17]

Areas of Natural and Scientific Interest (ANSIs)

ANSIs are areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values of special significance. [12]

ANSIs are designated as earth science (geological) or life science (biological) depending on the features present. These areas are selected by the Ontario Ministry of Natural Resources and Forestry to include areas that represent the best examples of Ontario's natural diversity. These sites are worthy of protection or scientific study.

Examples in Durham Region include Second Marsh in Oshawa, the Rouge River Valley in Pickering, and the Wilfrid Bog in Brock.

Glacial Features

Durham Region was the site of significant glacial activity tens of thousands of years ago, which has had a large impact on the region's landscape as well as key ecological functions.

Remnants of the presence and passing of these important geological events can be witnessed across the land surface of the region which is gently undulating to rolling terrain of ice-laid materials deeply covering the bedrock. These areas are characterized by eskers (lateral ridges which run north to south) and moraines (ridges that run east to west) present across much of the northeast parts of the region.

Eskers are formed when glacial ice movement is slow and sluggish. Streams within and beneath the glacier carve out ice tunnels which slowly fill with sediment as the glacier retreats. Moraines form as the ice mass retreats and leaves the debris it was carrying in ridges.

Deep ground materials predominate with numerous areas showing well developed drumlins and moraine features. Mineral materials comprise more than 95 per cent of the substrates in these deposits, which provide a high capacity to buffer the acidity of atmospheric depositions before it reaches the region's many surface water bodies. [18]

The two most ecologically and geologically significant glacial features within Durham Region include the Oak Ridges Moraine and the Lake Iroquois Shoreline. The Shoreline is an ancient geological landform that was formed by post-glacial Lake Iroquois. Distinctive features include its extensive sand and gravel deposits.

Groundwater recharge areas

Glacial features have important implications for groundwater in the region, which can be found at varying depths underground and is commonly found in aquifers.

The rate and volume of precipitation, which moves through the ground, generally depends on the characteristics of the subsoil. Coarse-grained soil such as sand and gravel, like what is found within the Oak Ridges Moraine and Lake Iroquois Shoreline, are highly permeable and these areas function as groundwater recharge areas.

The Oak Ridges Moraine and Lake Iroquois Shoreline provide critical baseflow (slow release of groundwater) to many streams in the region, especially during dry summer months. Surface water bodies are also highly dependent on recharge from groundwater flow for their maintenance.

Woodlands, Grasslands and Savannahs

Woodlands, grasslands, and savannahs provide numerous benefits to both ecosystems and human health including fresh water supply and temperature regulation.

Woodlands

Woodlands help regulate the water systems within the region. They soak up rain and snowmelt and slow the release of water into creeks which helps reduce the potential for damaging floods downstream and prevent soil loss. They help protect groundwater recharge areas which supply drinking water to many area residents. Trees also provide shade which helps moderate summer water temperatures, which benefits fish and other aquatic life that live in Durham Region's watercourses.

Woodlands provide habitat and food for a variety of wildlife. Trees also help improve air quality and help conserve energy by providing a windbreak in the winter and shade in the summer.

Woodlands also provide lots of recreational opportunities for residents and visitors to enjoy, and support an extensive trail network. Examples of public areas that offer trails in the region include Greenwood Conservation Area (Ajax), Purple Woods Conservation Area (Scugog), and Durham Regional Forest (Uxbridge).

Grasslands

Grasslands provide open habitat and high perches which offer opportunities for wildlife to both hunt or forage and spot potential danger. This makes this habitat ideal for deer, woodpeckers, and several sparrow species. [12] Grasslands across the region are also important to several native bird species that are on the Threatened Species list such as the Eastern Meadowlark and Bobolink. Their populations are in steep decline due to the lack of available grassland habitat. [12] Grasslands are at the highest risk for conversion to agricultural lands. As development spreads across the region and province, the risk to these key habitats is growing.

Savannahs

Although savannahs are relatively uncommon in Durham Region, there are patches of it within parts of the Oak Ridges Moraine, as well as eastern areas of the region. [12]

Plants and Wildlife

The change to natural habitats through urbanization, climate change and invasive species threatens native wildlife populations.

Native species

Native species refer to plants and animals that are naturally found in a particular region and normally thrives in that ecosystem or habitat, in this case, Durham Region.

"Native" plants refer to plants that were growing in Durham Region prior to European settlement. As a direct result of European settlement, there are many plants that now grow and thrive in the region that did not originally grow in Ontario. [12] Durham Region, especially in the areas within the Greenbelt, is home to many native tree (e.g., White Pine, Sugar Maple, Oak, and spruce species) and wildflower (e.g., Trillium, Jack-in-the-Pulpit, Wild Columbine, common Blue Violet) species. [12]

Durham Region's watercourses are home to a large diversity of native fish species including Lake Trout, Salmon, and Carp in Lake Ontario and Large and Small-Mouth Bass, Northern Pike, and others in Lake Scugog. Muskellunge can also be found in some smaller area lakes.

Durham Region is home to a healthy deer population and an occasional moose or black bear can call heavily wooded areas home. Durham Region's cities are populated by many racoons, squirrels, and rabbits. Additionally, coyotes and foxes are well established in many residential areas, especially those adjacent to green spaces, such as farmland, conservation areas and parks.

In recent years, there has been an increase in reported residential incidents with coyotes. However, the majority of these are a result of wildlife feedings. To prevent incidents, residents are urged to not feed coyotes, and if coyotes are seen, keep away a safe distance, and make sure dogs are always leashed. Mating season, from January to mid-March, is the most active and highest risk for incidents as coyotes are more mobile and can become territorial towards one another. As urban expansion has encroached on some coyote habitats, they have moved into metropolitan areas to find dens to raise their pups and keep safe. Urban compost or human food, shelter, and lack of fences, attract urban coyotes to backyards. [19]

Endangered species

There are many animal and plant species that are currently considered at risk or endangered under The Endangered Species Act and the Ontario Species at Risk Act. Durham Region is home to 10 bird, one fish, one snake, and four turtle species that are currently considered endangered. As urbanization continues to change the natural habitats of these species and increase pressures on them, the risk of losing these native endangered species increases. [12]

Invasive species

Non-native invasive species are plants, animals, fungi, diseases that are not indigenous to an ecosystem, but have become established in that ecosystem and threaten the well-being and survival of native species. The introduction and spread of invasive species are caused by both accidental or intentional introduction though global trade and travel, habitat modification, and climate change.

After habitat loss, invasive species are the second biggest threat to biodiversity. [12] They also result in economic, ecological, and social damages. However, since everything in nature is interconnected, the implications of invasive species are likely beyond what we currently understand.

Economically, invasive species directly or indirectly impact a wide range of industries and activities. Some examples include agriculture, forestry, recreation, and water treatment.

Ecologically, invasive species often out-compete native species, preying on them or causing other ecological imbalances. Some invasive species can hybridize with native species reducing genetic integrity. Whereas other invasive species directly kill native species resulting in permanent loss of native species from the ecosystem.

Socially, some invasive species, like the Giant Hogweed, threaten human health and safety. Other invasive species can decrease the quality of outdoor recreation and impact appreciation of our natural landscapes. For example, Garlic Mustard has escaped gardens and is outcompeting our native flora so that hardwood forests that once supported trilliums in the spring have been replaced with these non-native species. Garlic Mustard has also bwween shown to reduce the growth of hardwood trees, so the impact of this invasive species is wide reaching.

4.1.4 Conservation Authorities

Durham Region works in partnership with local conservation authorities to protect and enhance our natural environment.

Conservation authorities are unique to Ontario and are governed by the Conservation Authorities Act, which is administered by the Ministry of Natural Resources and Forestry. There are 36 conservation authorities operating across Ontario and their jurisdiction is organized based on watersheds. Conservation authorities are local watershed management agencies that deliver services and programs to protect and manage impacts on water and other natural resources in partnership with all levels of government, landowners and other organizations and interested parties. They promote an integrated watershed management approach balancing human, environmental and economic needs.

Conservation authorities' work is based on the following objectives:

1. Develop and maintain programs that will protect life and property from natural hazards such as flooding and erosion.
2. Develop and maintain programs that will conserve natural resources:
    - Ensure Ontario's water resources are properly safeguarded, managed, and restored.
    - Protect, manage, and restore Ontario's woodlands, wetlands, and natural habitat.
    - Connect people to the natural environment.

Conservation authorities have signaled that Ontario's water and land resources are at risk from climate change. Consequently, conservation authorities have identified and are responding to local impacts such as:

- Threats to water quality and quantity
- Rising temperatures and changing precipitation patterns reduce river flows and warm surface waters, create more drought conditions and more frequent severe weather
- More extreme rainfall is being experienced leading to increased flood and erosion problems
- Reduced wetlands
- Degraded biodiversity

Conservation authorities also support development of Ontario's Low Carbon Economy and are transitioning to a greener economy by supporting more renewable sources of energy, practicing water conservation, reducing emissions, planning, and implementing climate change adaptation, and building increased resiliency in watershed through watershed management programs.

Conservation Authorities In Durham Region

Durham Region has 17 different quaternary watersheds that intersects its municipalities.

Consequently, Durham Region's water protection, restoration and management services are delivered by five different conservation authorities including:

- Toronto and Region Conservation Authority
- Lake Simcoe Region Conservation Authority
- Central Lake Ontario Conservation Authority
- Ganaraska Region Conservation Authority
- Kawartha Conservation Authority

The distribution of these conservation authorities is shown in Figure **4.10**.

Since the region is the primary funder of conservation authorities within the area, it also enables the implementation of projects and initiatives that support environmental improvement and protection. With a quickly growing population and future impacts of climate change affecting the Region's natural heritage areas, water quantity and quality in the future is of paramount importance for the region to continue to plan for these major changes across all sectors, in collaboration with all eight municipalities and the five corresponding conservation authorities [3], as well as local First Nations and other partners.

Conservation Authorities

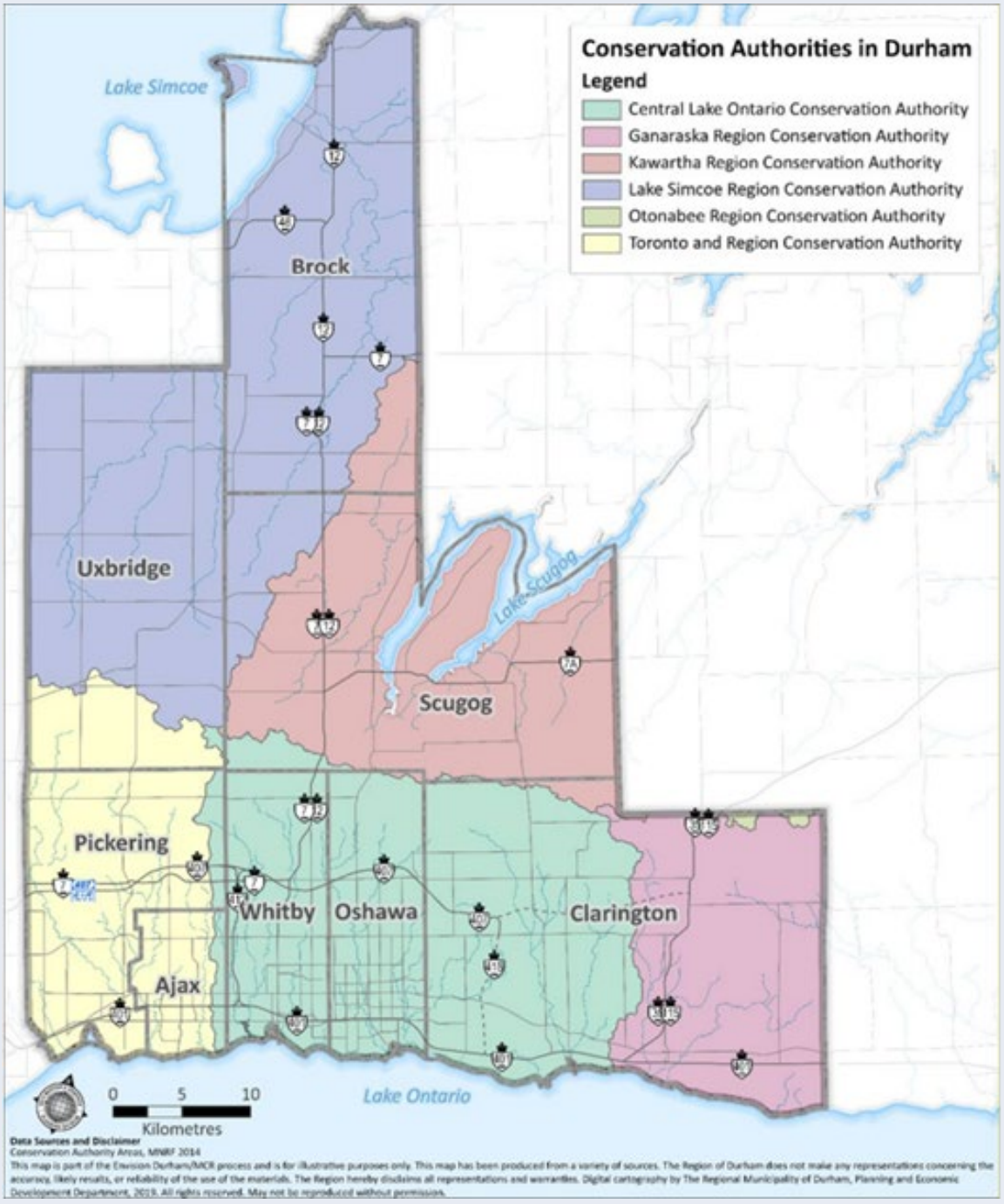


Figure 4.10 | Conservation Authorities in Durham Region.

Source: The Regional Municipality of Durham, Planning and Economic Development Department, 2019.

4.1.4.1 Sourcewater Protection

Durham Region is home to some of the best drinking water in the world and it is important to protect the surface and ground waters that supply the region's municipal drinking water systems. This is called source water protection.

In 2006, the province of Ontario passed the Clean Water Act, 2006 which was legislation designed to help communities protect the sources of their drinking water. The Act requires municipalities, businesses, and residents to work together to create local Source Protection Plans (SPP). The goal of a local SPP is to manage or eliminate existing activities that are or could become significant threats to municipal drinking water sources.

A SPP sets polices to:

- Safeguard human health.
- Ensure adequate safe, clean water is available.
- Protect current and future sources of municipal drinking water from significant threats.

Each drinking water SPP is based on an understanding of water quantity, quality, processes, threats, and possible solutions for the watersheds in a region. The 15 possible threats to water quality and quantity were also identified under the act. Some examples include:

- Waste disposal sites
- Sewage systems
- Management, application, handling, and storage of agricultural and non-agricultural source materials
- An activity that takes water and does not return it to the same source

The Clean Water Act, 2006 established source protection areas (SPAs) across Ontario based on the watershed boundaries of the provinces 36 conservation authorities. Watersheds are areas where water flows to a common collection point, like a stream or lake. Using the watershed approach encourages holistic decision-making for resource management and is the best way to protect source water since water flows across traditional municipal boundaries. In many cases, SPAs are grouped to make one Source Protection Region (SPR). There are 10 SPRs and nine SPAs working independently to implement the Drinking Water Source Protection Program in Ontario.

In Durham Region, there are five SPAs, belonging to three different SPRs. These are listed below in **Table 4.1** and their geographic boundaries are illustrated in **Figure 4.11**. There is existing legislation under the Lake Simcoe Protection Act. The purpose of this Act is to protect and restore the ecological health of the Lake Simcoe watershed. This includes but is not limited to reducing the discharge of pollutants to Lake Simcoe and its tributaries. This includes work conducted by the DRHD and its sewage system re-inspection program in north Durham.

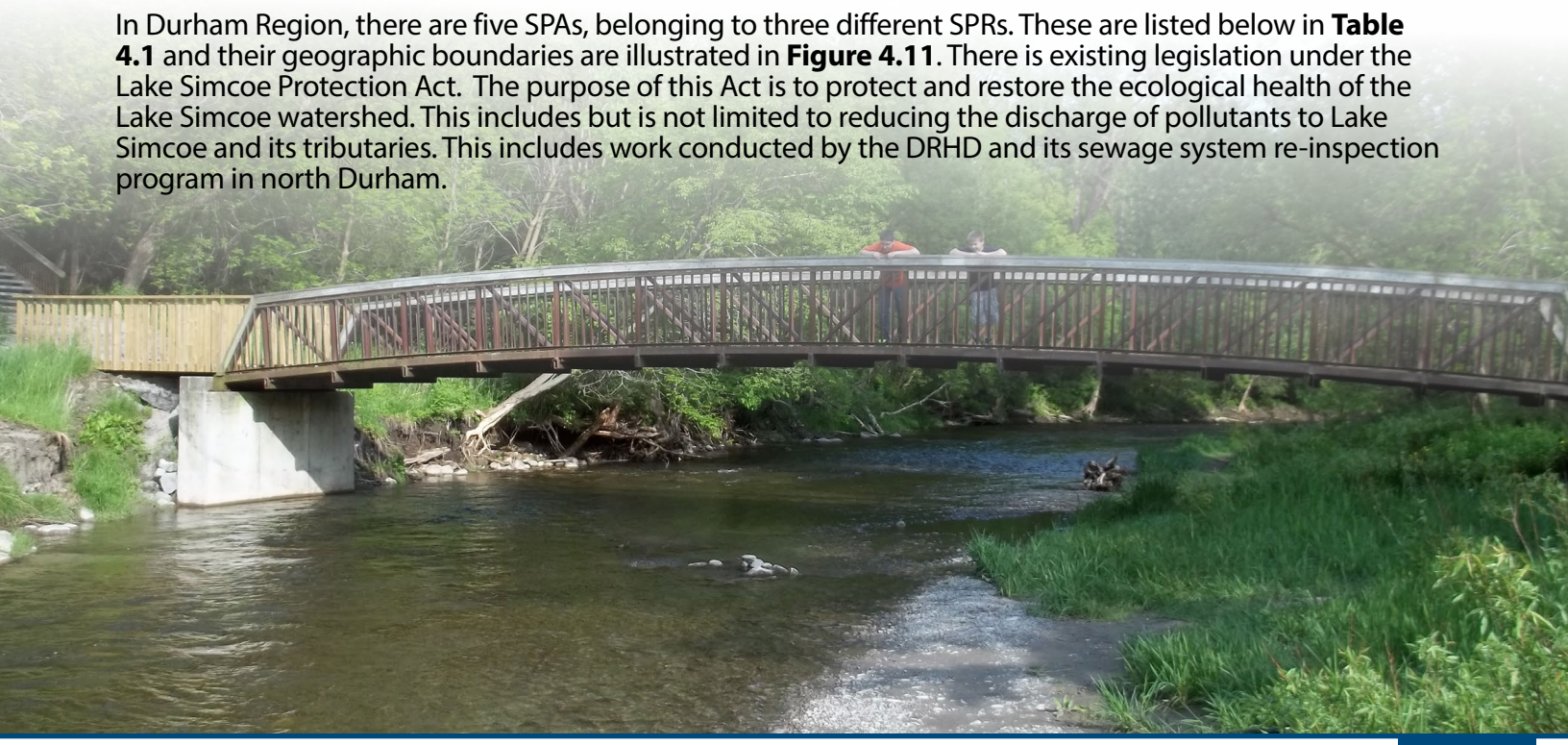


Table 4.1 | Source Protection Regions (SPRs) and Source Protection Areas (SPAs) within Durham Region responsible for implementing the Drinking Water Source Protection Program in Ontario.

Source Protection Regions	Source Protection Areas within Durham Region included in the SPR
Credit Valley – Toronto and Region – Central Lake Ontario (CTC) SPR	• Toronto SPA • Central Lake Ontario SPA
South Georgian Bay Lake Simcoe Region SPR	• Lake Simcoe and Couching/ Black River SPA
Trent conservation coalition SPR	• Kawartha Haliburton SPA • Ganaraska Region SPA

Adapted from: South Georgian Bay Lake Simcoe Source Protection Plan, 2022 [24]; Protecting our Drinking Water Sources Report, CTC Source Protection Region, 2019 [20]; Ganaraska Source Protection Plan, Updated 2021 [23].

Source Protection Regions Within Durham Region

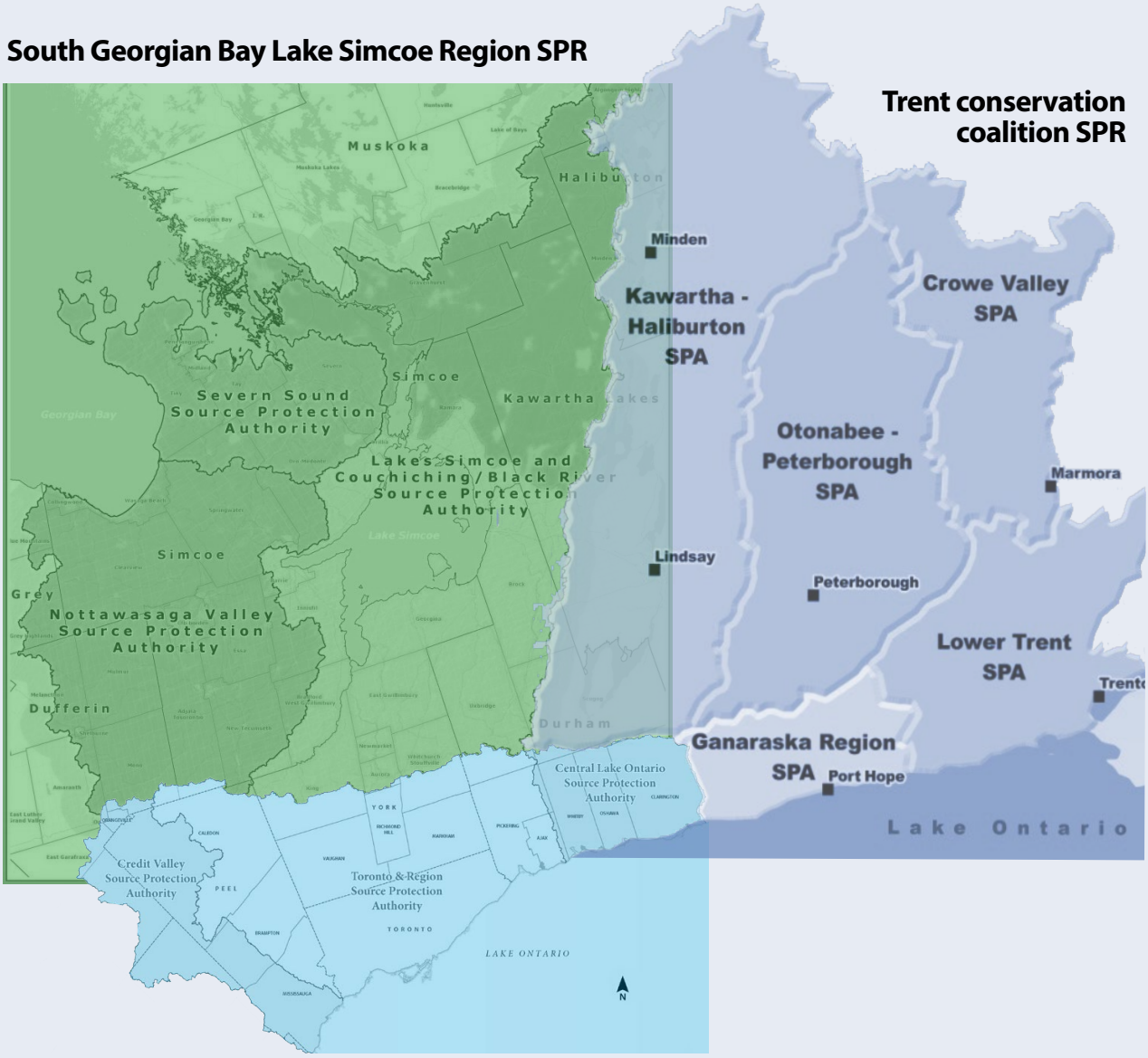


Figure 4.11 | Water Source Protection Regions (SPRs) within Durham Region

Figures adapted from: South Georgian Bay Lake Simcoe Source Protection Plan, 2022 [24]; Protecting our Drinking Water Sources Report, CTC Source Protection Region, 2019 [20]; Ganaraska Source Protection Plan, Updated 2021 [23].

Threats to Water Quality

Addressing potential threats to municipal sources of drinking water includes identification of vulnerable ground and surface water areas and identify potential threats to those areas.

In this context, vulnerability describes how easily a drinking water source can become polluted. In Durham Region, both ground water and surface water are used as sources of municipal drinking water, so it is important to identify and assess vulnerabilities and threats to both. [20]

Groundwater is extracted through wells which draw water from underground areas called aquifers, where water fills cracks in bedrock or spaces between grains of sand, gravel, or dirt. Aquifers are replenished when water from rain and melting snow soaks into the ground. Sometimes this water can carry pollutants. It can take years or even decades for water to reach a well and the speed depends on the characteristics of the soil and bedrock in the area.

- **Wellhead Protection Areas:** Areas where water travels through the ground to a municipal well.
- **Highly Vulnerable Aquifers:** Areas that are more susceptible to contamination moving from the surface into the groundwater.
- **Significant Groundwater Recharge Areas:** Areas where larger amounts of water go into the ground instead of flowing directly into creeks, rivers, or lakes.

River and lake intakes can be contaminated when pollutants are spilled into the water or on nearby land and make their way to the intake, therefore, impacting surface water vulnerability.

- **Intake Protection Zones:** Areas around municipal surface water intakes. The size of each zone is determined by how quickly water flows to the intake, in hours. These are primarily drawn for emergency response purposes.

Threats to drinking water in vulnerable areas are generally comprise of two different types, chemicals, and pathogens. Chemical threats include products like fuels, fertilizers, pesticides, and similar products. Pathogens are bacteria, virus or other organisms that can cause ill health to humans, and these can be found in human and animal waste. Human pathogens can be found in septic systems and animal pathogens can be found in manure.

Threats to water quality in Durham Region

In Durham Region there are four issues with associated drinking water threat activities:

1. **Chloride:** storage of snow, application, handling and storage of road salt.
2. **Sodium:** storage of snow, application, handling and storage of road salt.
3. **Nitrate:** sewage systems, application, storage, and handling of agricultural source material.
4. **Pathogens:** sewage systems, application, storage, and handling of agricultural source material.

Threats to Water Quantity

SPPs are not only about water quality - they also help determine if there is sufficient water to supply the drinking water system now and into the future.

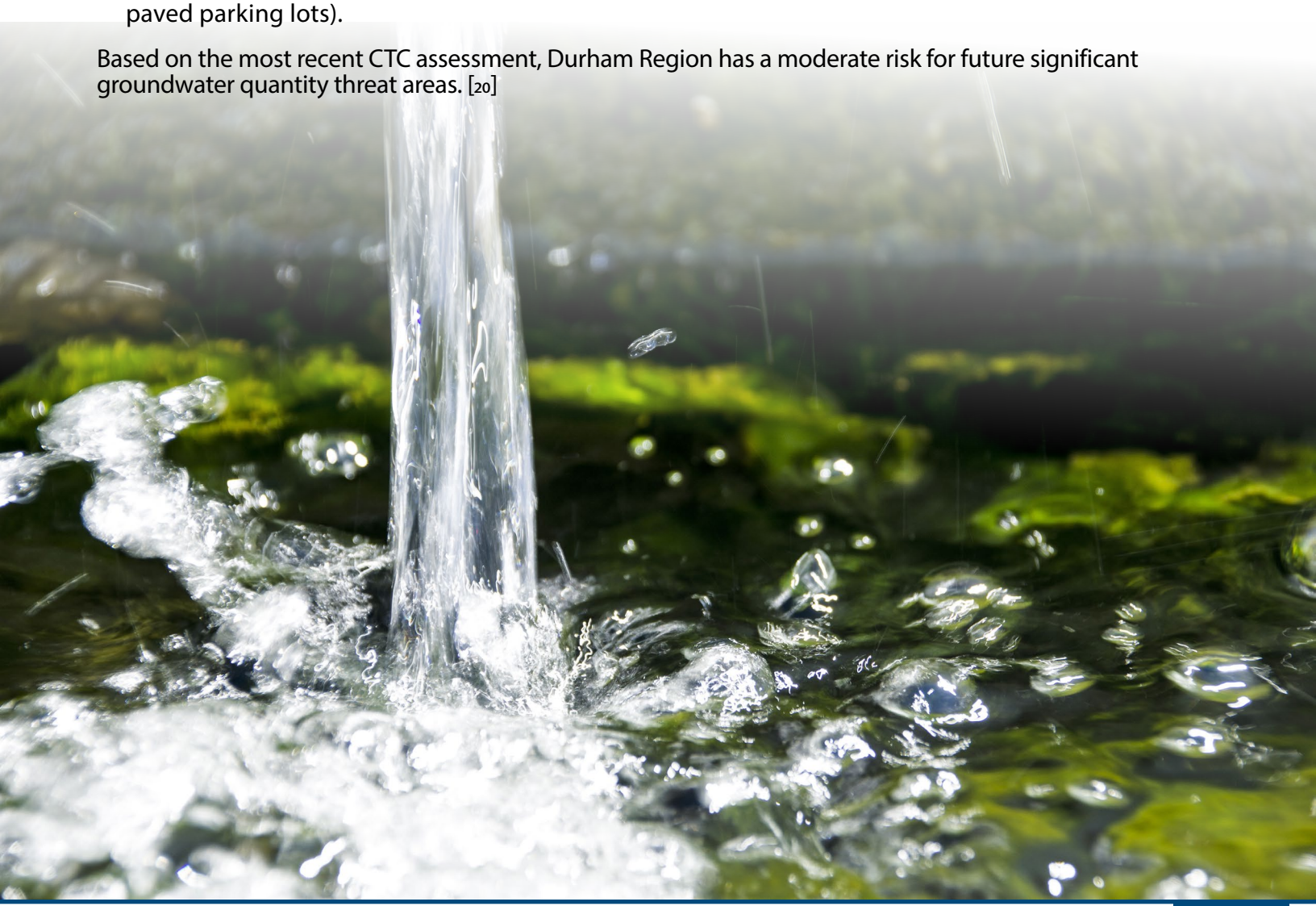
This is estimated through water budget studies which measure the amount of water that enters, is stored within, and leaves a watershed. A water budget examines the following factors to understand the supply of water and the impacts of taking water from within that watershed:

- The flow of surface and groundwater systems.
- How water enters and leaves a watershed.
- How much water is stored within the watershed?
- How much water is available for human consumption?
- How much water is required for natural heritage systems (i.e., aquatic life and wetlands)?

There are two main threats to water quantity as described by the MECP:

1. **An activity that takes water from an aquifer or surface water body without returning it to the same body.** For example, municipal and private wells and withdrawals from agriculture, businesses, and aggregate operations.
2. **An activity that reduces the recharge of an aquifer.** Examples include land use developments, such as subdivisions, employment areas, or land converted into impervious surfaces (e.g., roads or paved parking lots).

Based on the most recent CTC assessment, Durham Region has a moderate risk for future significant groundwater quantity threat areas. [20]



4.2 Climate

Durham Region falls within the Lake Simcoe-Rideau Ecoregion which is characterized by a mild and moist climate and large annual fluctuations in temperatures. [4]

Temperature and Extreme Heat And Cold

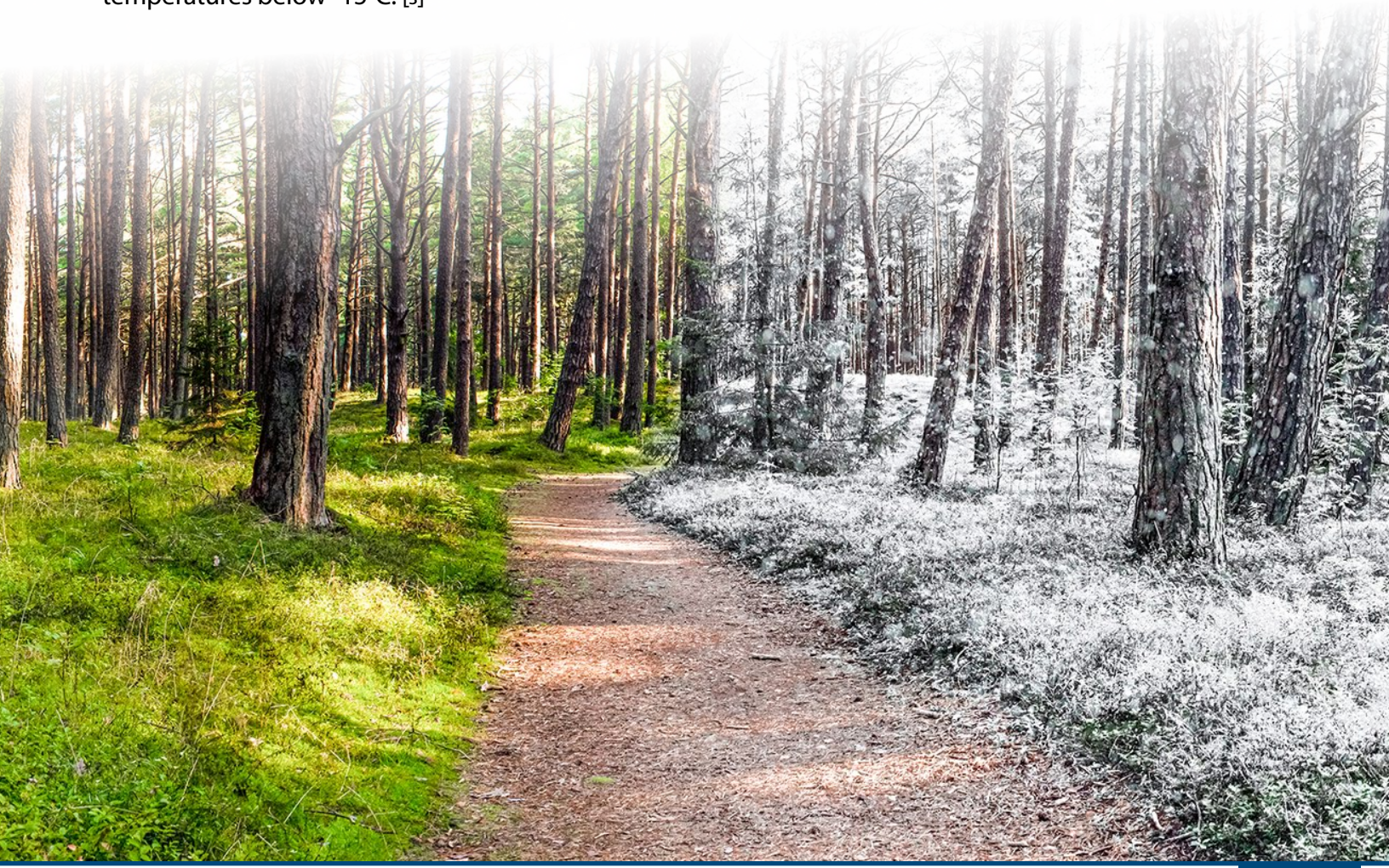
Durham Region experiences four distinct seasons with large annual fluctuations in temperatures.

Based on historical data from 1971 to 2000, the average annual mean temperature experienced in the region is around 7.1 ˚C. [3]

Durham Region experiences four distinct seasons with large annual fluctuations in temperatures. The region experiences cold winters, moderate spring and fall seasons, and warm summers. On average, July is the warmest month and January is the coldest month (**Figure 4.12**).

Historically, on average Durham Region experiences 146.8 freezing days (days with the minimum temperature below 0˚C) and 42 summer days (days where the maximum temperature is above 25˚C) per year. [3]

In terms of extreme temperatures, on average Durham Region experiences approximately eight extreme heat days, with temperatures exceeding 30˚C, and approximately nine extreme cold days, with temperatures below -15˚C. [3]



Average Monthly Temperatures

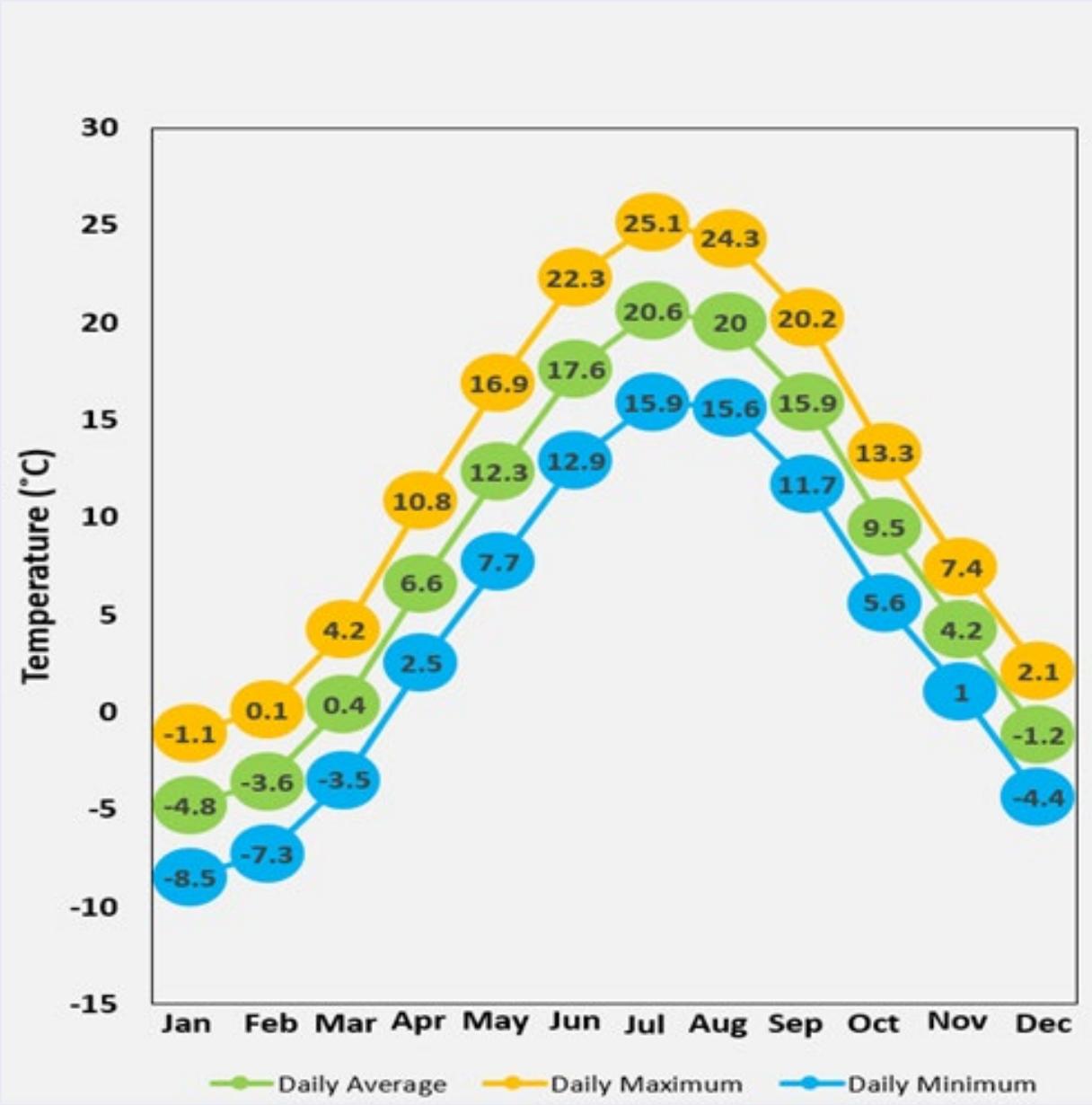


Figure 4.12 | Historical average monthly temperature range (˚C) in Durham Region, 1981 to 2010.

Statistics were calculated using data measured at the Oshawa Water Pollution Control Plant.

Data Source: Environment Canada, Canadian Climate Normals 1981-2010 Station Data, Oshawa WPCP. 2021.

Precipitation

Durham Region generally experiences a moist climate.

Historically, the region experiences a total average annual precipitation of 952.4mm. [3]

Seasonal variation is observed for both average total precipitation amounts and average Simple Daily Intensity Index (SDII) (**Figure 4.13**). [3] Fall tends to be the wettest season in terms of both total precipitation, as well as more frequent extreme precipitation events.

SEASONAL PRECIPITATION

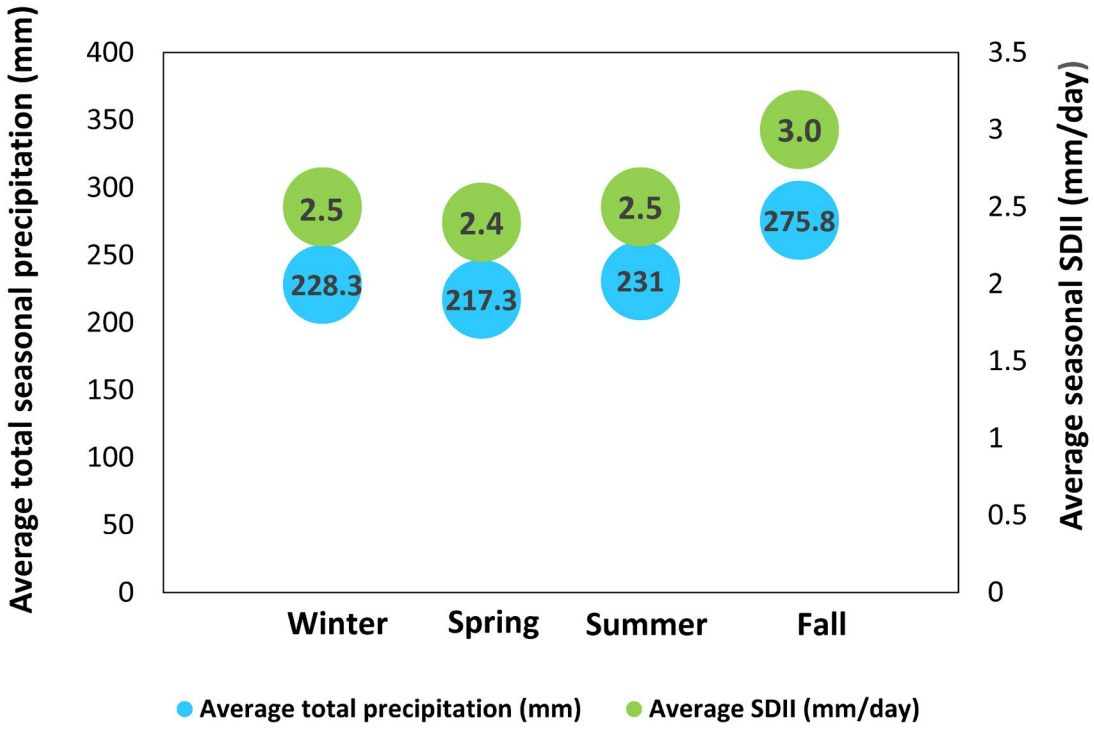


Figure 4.13 | Historical average seasonal total precipitation and Simple Daily Intensity Index (SDII) in Durham Region, 1971 to 2000.

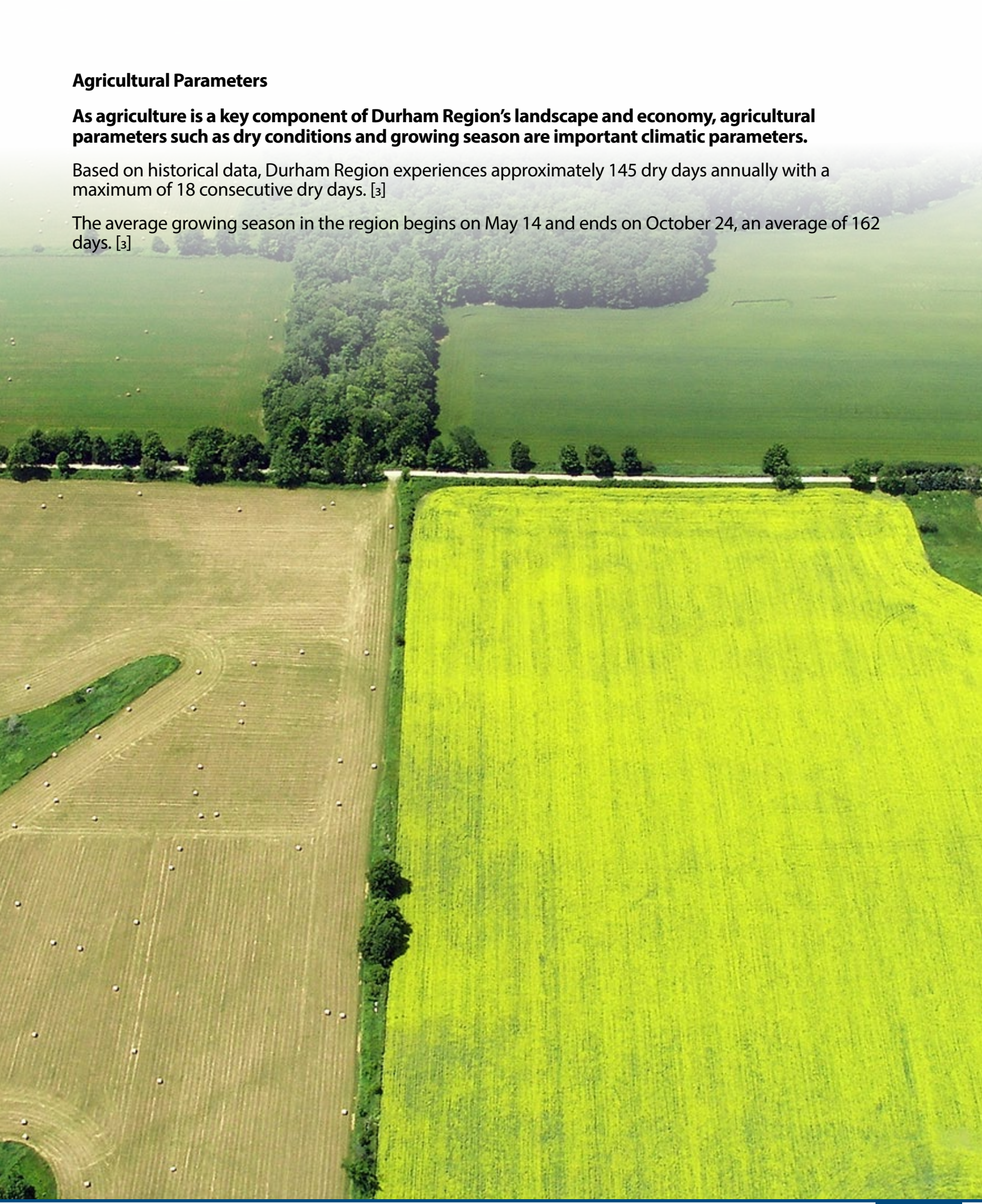
Data Source: OCC Report, 2020. [3]

Agricultural Parameters

As agriculture is a key component of Durham Region's landscape and economy, agricultural parameters such as dry conditions and growing season are important climatic parameters.

Based on historical data, Durham Region experiences approximately 145 dry days annually with a maximum of 18 consecutive dry days. [3]

The average growing season in the region begins on May 14 and ends on October 24, an average of 162 days. [3]



4.2.1 Future Climate Projections

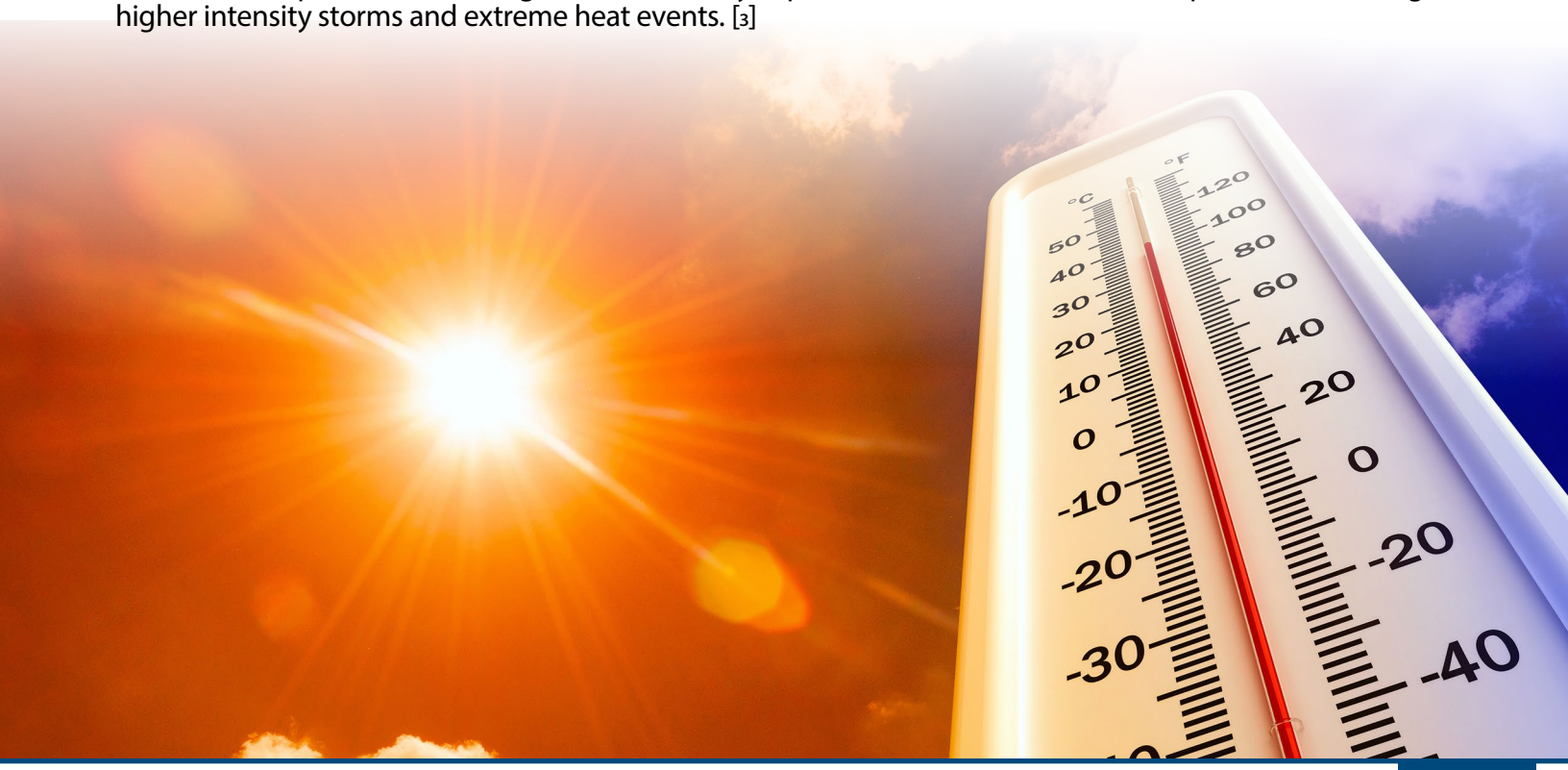
Based on current projections, Durham Region is expected to experience a warmer, wetter climate in coming years along with more variable weather patterns, including higher intensity storms and extreme heat events. [3]

This section focuses on future climate projections for Durham Region, specifically. Please refer to **Chapter 1, Section 1.4.2** for a description of projected changes for Canada as a whole.

In 2018, Durham Region hired the Ontario Climate Consortium (OCC) to develop a report exploring how climate change concerns were being integrated into environmental policies and plans. A key finding of this report was identifying the need for the region to undertake a climate modeling exercise to update current climate projections. Through funding received through the Greenbelt Foundation, the OCC developed the 2019 Durham Climate Modeling Project and carried out climate modeling analysis and produced bias-corrected climate projections for 52 climate parameters for RCP 8.5 (business-as-usual or high emissions) and RCP 4.5 (stabilizing) scenarios for the short (2011-2040), mid (2041-2070), and long (2071-2100) term. A full description of these methods, as well as RCP 4.5 scenario projections can be found in the OCC's Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region. [3] Additionally, **Chapter 1, Appendix 1.1** provides an overview how scientists use climate models to project future climate change and a description of the four emissions scenarios (i.e., RCP8.5, RCP6.0, RCP4.5 and RCP2.6) commonly used in this work.

All climate projections described in this report, as well as subsequent topic-specific climate change and health vulnerability assessments, are based on the RCP 8.5 emissions scenarios based on locally downscaled projections produced by the OCC using bias-corrected climate data specific to Durham Region. The RCP 8.5 emissions scenario was chosen because global GHG emissions are still trending upwards in alignment with this scenario. Additionally, this scenario is currently the most frequently used by climate modelers and scientists. [3]

Figure 4.14 and **Table 4.2** provides a summary of key climate projections for Durham Region based on the RCP 8.5 scenario for all climate periods up until 2100. Projections for each municipality can be found in **Appendix 4.4**. More detailed projections will be outlined in the relevant specific climate change and health vulnerability assessments. Overall, Durham Region is expected to experience a warmer, wetter climate across all time periods. [3] The Region will also likely experience more variable weather patterns, including higher intensity storms and extreme heat events. [3]



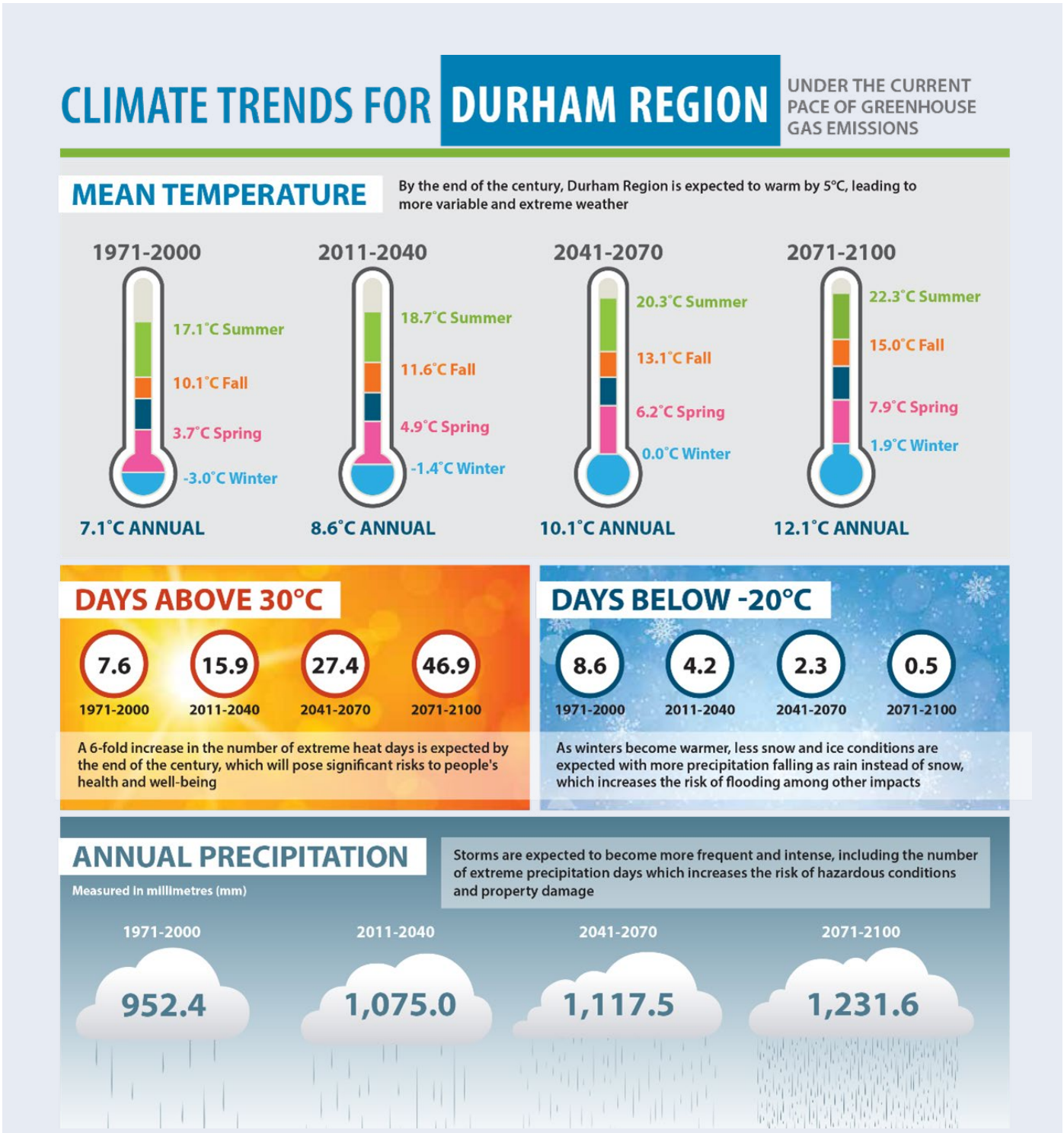


Figure 4.14 | Summary of projected climate trends for Durham Region under the current pact of greenhouse gas emissions.

Data Source: Flood Ready Durham. [10]

Table 4.2 | A summary of the top climate change parameters for Durham region based on the highest emissions scenario (RCP 8.5) for all climate periods up until 2100.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.1	8.6	10.1	12.1	Increasing
Annual average number of days above 35˚C	0.2	1.2	4.0	10.8	Increasing
Annual average number of days above 30˚C	7.6	15.9	27.4	46.9	Increasing
Annual average number of days below -15˚C	22.7	13.1	7.9	2.6	Decreasing
Annual average number of days below -10˚C	49.0	34.3	23.5	11.3	Decreasing
Precipitation					
Total average annual precipitation (mm)	952.4	1075.0	1117.5	1241.6	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	35.4	40.4	44.0	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	58.0	61.7	67.7	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.8	2.9	3.2	Increasing
Agricultural parameters					
Average growing season length for climate period	162 days	183 days	193 days	213 days	Increasing

Note: Historical (1971 to 2000); short term (20011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs.

Data source: Adapted from Delaney et al 2020. [3]

Helpful Resources

Want to learn more?

This section provides a summary of key resources to help understand Durham Region's diverse geography and highlight climate changes which may impact Durham's communities in the years to come. While this list provides an overview of existing literature, it is not a complete list. Instead, it is intended as a starting point for learning and perhaps inspiring discussion and collaboration.

CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY (CLOCA)

CLOCA is responsible for managing and protecting the natural resources and watershed area within its jurisdiction. It works to preserve and enhance water quality manage flood risks, conserve natural habitats, and promote environmental education.

FLOOD READY DURHAM

The Flood Ready Durham provides information and resources about flood risk and resilience including Region-wide floodplain mapping, which allows residents to access and identify their exposure to river flooding.

GANARASKA REGION CONSERVATION AUTHORITY (GRCA)

The GRCA's mandate includes flood control, water quality, conservation of natural areas, and environmental education. They work collaboratively with various stakeholders to promote sustainable land and water management practices in their region.

GREENBELT FOUNDATION

The Greenbelt foundation is a nonprofit organization in Ontario created to support and promote the protection and enhancement of Ontario's Greenbelt. The Foundation works to ensure the long term health and sustainability of the Greenbelt by investing in projects and initiatives that support agriculture, local food, natural heritage, rural health, and outdoor recreation and tourism.

GROWING RESILIENCE: DURHAM REGION AGRICULTURE SECTOR CLIMATE ADAPTATION STRATEGY 2019 [17]

The Regional Municipality of Durham

2019

This strategy identifies anticipated risks to Durham's local agriculture sector resulting from warmer weather and extreme weather due to climate change

GUIDE TO CONDUCTING A CLIMATE CHANGE ANALYSIS AT THE LOCAL SCALE: LESSONS LEARNED FROM DURHAM REGION [3]

Ontario Climate Consortium (OCC)

2020

This document guides Ontario municipalities, conservation authorities, and the broader community on how to develop local climate projections in 2020.

In a Durham Region context, is also provides climate projections for the region as a whole, regional conservation authorities and local municipalities under both the RCP 8.5 and RCP 4.5 emission scenarios.

KAWARTHA CONSERVATION AUTHORITY

The Kawartha Conservation Authority works to protect and enhance water quality, manage flood risks, conserve natural habitats and promote environmental education and awareness in the region.

LAKE SIMCOE REGION CONSERVATION AUTHORITY (LSRCA)

The LSRCA's primary focus is the health and sustainability of the Lake Simcoe watershed which includes the lake itself as well as the surrounding land and water bodies.

NATURAL AREAS AS NEIGHBOURS

Durham Environmental Advisory Committee (DEAC) [12]

2017

This report is an information guide for Durham residents and visitors to understand, appreciate and care for the natural heritage areas in Durham Region. The guide also highlights nature's value and the ecosystem services nature provides for our well being. Importantly the guide also lists many things people can do to help the environment and to explore natural heritage areas safely and respectfully near them.

OAK RIDGES MORAINE CONSERVATION PLAN 2017 [13]

Government of Ontario

2017

The Oak Ridges Moraine Conservation Plan is a land use planning document and policy framework implemented by the Ontario government in 2002. Its purpose is to protect and manage the ecological and hydrological features of the Oak Ridges Moraine, an ecologically significant landform of southern Ontario. The plan is implemented and enforced by various local municipalities, conservation authorities, and provincial government agencies responsible for land use planning in the area.

ONTARIO'S GREAT LAKES STRATEGY [15]

Ontario Ministry of the Environment, Conservation and Parks

2017

This document is the roadmap that sets a vision, goals, and priorities to help restore, protect, and conserve the Great Lakes.

PROTECTING OUR DRINKING WATER SOURCES [20]

CTC Source Protection Region

2019

Provides an overview of the Source Protection Plans and the scientific information used to develop them.

PROTECTING THE GREAT LAKES [16]

Ontario Ministry of the Environment, Conservation and Parks

2023

Provides an overview of Ontario's plan to protect and restore the health of the Great Lakes – St. Lawrence River basin, the importance of the Great Lakes in an Ontario context, and how the plan aims to create more opportunities for individuals and communities to get involved in local protection and restoration efforts.

TORONTO AND REGION CONSERVATION AUTHORITY (TRCA)

The TRCA's mandate focuses on watershed management, flood risk management, conservation and restoration, education, and engagement, and planning and development. The TRCA works with intersectoral stakeholders to protect the environmental health, resilience, and quality of life within the Toronto region and surrounding areas

TOWARDS RESILIENCE: DURHAM COMMUNITY CLIMATE ADAPTATION PLAN (DCCAP) 2016 [21]

The Regional Municipality of Durham

2016

This document outlines Durham's Community Climate Adaptation Plan, including 18 proposed programs approved in principle by Durham Regional Council on behalf of the Durham community.

References

[1] IPCC, Managing the risks of extreme events and disasters to advance climate change adapation, C. Field, V. Barros, T. Stocker, D. Qin, D. Dokken, K. Ebi, M. Mastrandrea and K. e. a. Mach, Eds., Cambridge: IPCC, 2012.

[2] Intergovernmental Panel on Climate Change (IPCC), Climate Change 2007: Synthesis Report, A. Allali, R. Bojariu, S. Diaz and e. al., Eds., IPCC, 2007, p. 73.

[3] F. Delaney, P. Ng, K. Dokoska, G. Milner, K. Potter and M. Notaro, "Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region," Ontario Climate Consortium, Toronto, 2020.

[4] W. Crins, P. Gray, P. Uhlig and M. Wester, The ecosystems of Ontario, Part 1: Ecozones and ecoregions, Peterborough, ON: Ontario Ministry of Natural Resources, Inventory, Monitoring and Assessment, 2009.

[5] Greenbelt Foundation, "Greenbelt: Learn," 2023. [Online]. Available: https://www.greenbelt.ca/learn.

[6] IPBES, Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, E. Brondízio, J. Settele, S. Díaz and H. Ngo, Eds., Bonn, Germany: IPBES secretariat, 2019, p. p1144.

[7] Ministry of Municipal Affairs, "Oak Ridges Moraine conservation plan (2017)," Queen's Printer for Ontario, Toronto, ON, 2017.

[8] IPCC, "Summary for policymakers," in Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fith assessment report of the intergovernmenal panel on climate change, Cambridge, UK and New York USA, Cambridge University Press, 2014.

[9] CPHA, "Global change and public health: Addressing the ecological determinants of health," Canadian Public Health Association (CPHA), Ottawa, ON, 2015.

[10] The Regional Municipality of Durham, "Flood Ready Durham," [Online]. Available: https://www.durham.ca/en/flood-ready-durham/flood-factors.aspx.

[11] Greenbelt Foundation, "The importance of urban river valleys," August 2018. [Online]. Available: https://www.greenbelt.ca/urban_river_valley_importance. [Accessed 2 June 2023].

[12] Durham Environmental Advisory Committee (DEAC), "Natural areas as neighbours," The Regional Municipality of Durham, Whitby, ON, 2017.

[13] Ontario Ministry of Municipal Affairs, "The Oak Ridges Moraine conservation plan, 2017," Queen's Printer for Ontario, 2017.

[14] GLISA, "Sustained assessment of the Great Lakes," GLISA, Michigan, 2023.

[15] Ontario Ministry of the Environment, Conservation and Parks, "Ontario's great lakes strategy," October 2021. [Online]. Available: https://www.ontario.ca/page/ontarios-great-lakes-strategy. [Accessed 19 June 2023].

[16] Ontario Ministry of the Environment, Conservation and Parks, "Protecting the Great Lakes," Ontario Ministry of the Environment, Conservation and Parks, 2023.

[17] Durham Region, "Growing Resilience: Durham Region agriculture sector climate adaptation strategy - 2019," The Regional Municipality of Durham , Whitby, 2019.

[18] Environment Canada, "The potential of soils and bedrock to reduce the acidity of atmospheric deposition in Canada. Environmental fact sheet 88-1," Inland Waters and Lands Directorate, Environment Canada, Ottawa, 1988.

[19] M. Murray and C. St. Clair, "Predictable features attract urban coyotes to residential yards," The Journal of Wildlife Management, vol. 81, no. 4, pp. 593-600, 2017.

[20] CTC Source Protection Region, "Protecting our drinking water sources," CTC Source Protection Region, Toronto, 2019.

[21] The Regional Municipality of Durham, "Towards resilience: Durham community climate adaptation plan 2016," The Regional Municipality of Durham, Whitby, 2016.

[22] The Regional Municipality of Durham, "Connecting our communities: A broadband strategy for Durham Region," The Regional Municipality of Durham, Whitby, 2019.

[23] Ganaraska Region Source Protection Area, "Ganaraska source protection plan - updated December 2021," 2021.

[24] South Georgian Bay Lake Simcoe Source Protection Region, "Approved South Georgian Bay Lake Simcoe source protection plan," 2022.

APPENDIX 4.1

A Description of The Oak Ridges Moraine Conservation Plan (ORMCP)

The ORMCP is a land use planning initiative to protect the ecological integrity and water resources in the region.

The ORMCP was developed by the Government of Ontario in 2017, based on the Oak Ridges Moraine Conservation Act, 2001. [1] The Conservation Plan is an ecologically and hydrologically based plan. Its purpose is to provide land use and resource management planning direction to provincial ministers, ministries, agencies, municipalities, landowners, and other partners on how to protect the Moraine's ecological and hydrological features and functions.

To achieve this purpose, the Plan outlines the following objectives, based on the Oak Ridges Conservation Act, 2001: [1]

1. Protecting the ecological and hydrological integrity of the Oak Ridges Moraine Area.
2. Ensuring only land and resource uses that maintain, improve, or restore the ecological and hydrological functions of the Moraine Area are permitted.
3. Maintaining, improving, or restoring all the elements that contribute to the ecological and hydrological functions of the Moraine Area, including the quality and quantity of its water and other resources.
4. Ensuring the Moraine Area is maintained as a continuous natural landform and environment for the benefit of present and future generations.
5. Providing for land and resource uses and development that are compatible with the other objectives outlined in the Plan.
6. Providing for continued development within existing urban settlement areas and recognizing existing rural settlements.
7. Providing for a continuous recreational trail through the Moraine Area that is accessible to all including persons with disabilities.
8. Providing for other public recreational access to the Moraine Area.

LAND USE DESIGNATION

The cornerstone land use policy of the Conservation Plan is environmental protection to ensure the integrity of the Moraine.

To facilitate this policy, the plan divides the Moraine into 4 land use designations: [1]

1. Natural Core Areas (38%)
2. Natural Linkage Areas (24%)
3. Countryside Areas (30%)
4. Settlement Areas (8%)

Figure A4.1.1 presents a map of the distribution of these land use designations within Durham Region and **Table A4.1.1** lists the definitions of these as well as the acceptable use within each of these areas.

Oakridges Moraine Land Use Designations

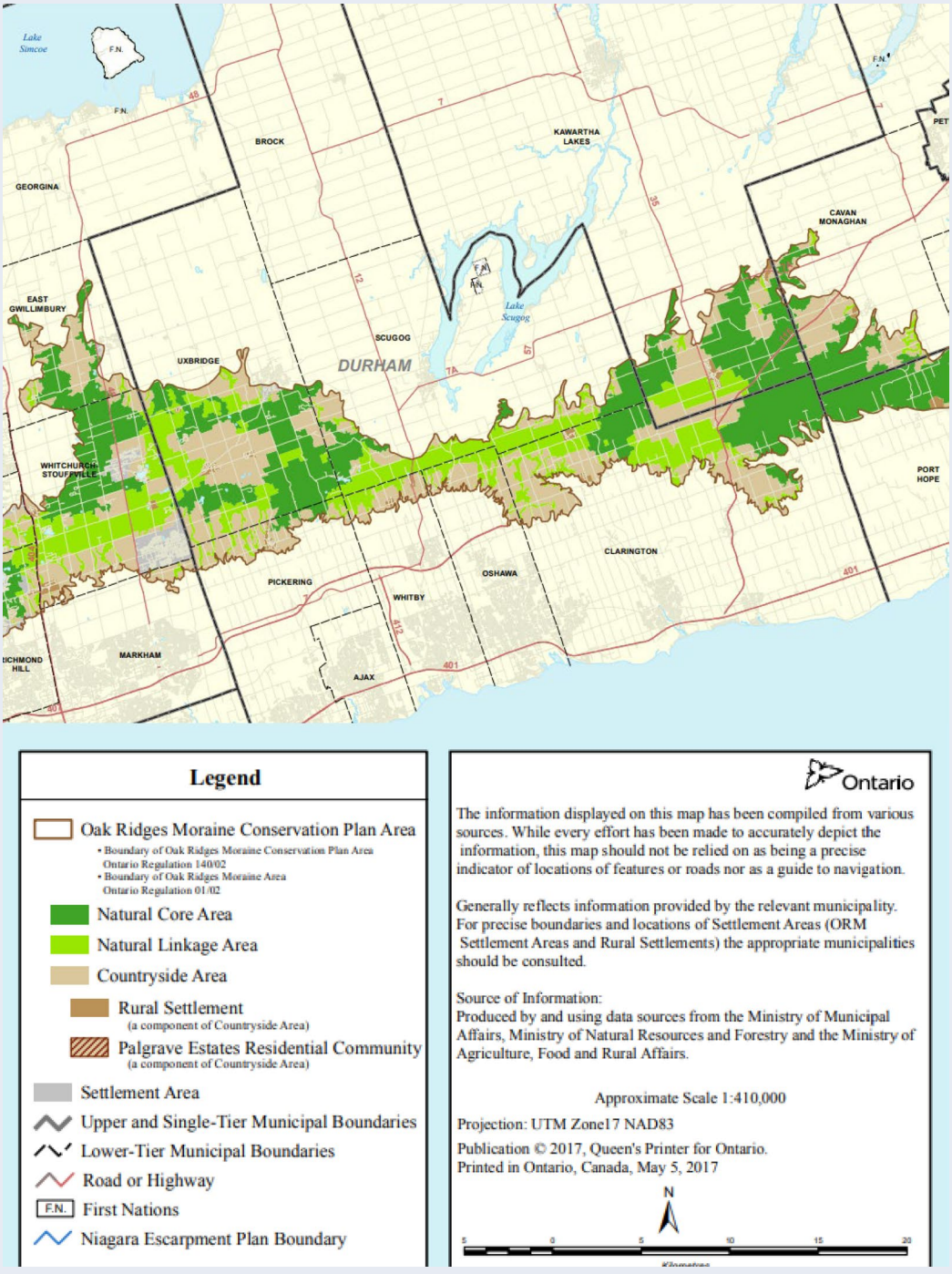


Figure A4.1.1 | Oak Ridges Moraine Conservation Plan Area land use designations within Durham Region. Note, Rural Settlements are a sub-category of Countryside Areas.

Figure Adapted From: The Oakridges Moraine Conservation Plan 2017. [1] The original figure was produced by and used data sources from the Ontario Ministry of Municipal Affairs, Ministry of Natural Resources and Forestry and the Ministry of Agriculture, Food, and Rural Affairs.

Table A4.1.1 The Oak Ridges Moraine Conservation Plan land use designation category definitions and allowed use.

Land Use Designation	Definition	Acceptable Use
Natural Core Areas	These areas have the greatest concentrations of key natural heritage features which are critical to maintaining the integrity of the Moraine as a whole.	• Currently existing uses • Agricultural uses • Very restricted new resource management • Low intensity recreational, home business and infrastructure use
Natural Linkage Areas	Critical natural and open space linkages between the Natural Core Areas and along rivers and streams.	Uses allowed in Natural Core Areas, plus: • Some aggregate resource operations
Countryside Areas	These areas provide an agricultural and rural transition and buffer between the Natural Core Areas and Natural Linkage Areas with the urbanized Settlement Areas. Includes prime agricultural areas identified in the Agricultural System referred t in the Growth plan in the Greenbelt Plan. Rural Settlements are included which are existing hamlets or similar mall generally long-established communities that are identified in official plans.	• Typical agricultural and rural uses are allowed to support agriculture and the rural economy • Existing public service facilities should be maintained and adapted to meet the needs of the community, where feasible
Settlement Areas	These areas reflect a range of existing communities.	• Urban use and development as set out in municipal official plans

Data source: Adapted from the 2017 Oak Ridges Moraine Conservation Plan. [1]

The Plan's Natural Core Area and Natural Linkage Area designations are considered the natural heritage system for the Moraine. These areas have the highest concentration of natural heritage features and provide a continuous east-west ecological connection across the entire Plan Area. Over 85 per cent of the key natural heritage features (such as wetlands and woodlands) and key hydrological features (such as kettle lakes and springs) fall within the Natural Core Areas or Natural Linkage Areas. This system links with the natural heritage systems of the Greenbelt Plan and the Niagara Escarpment Plan which extend into the Greater Golden Horseshoe and beyond.

Generally, the policies on creating and developing new urban developments in Natural Core Areas, Natural Linkage Areas and Countryside Areas are very restrictive with exceptions permitted in the Moraine's Rural Settlement areas. Development near these key natural heritage features and key hydrologic features is only allowed if it will not adversely affect these features. Development in wellhead protection areas and areas highly vulnerable to groundwater contamination is limited. Limitations are also set on impervious surfaces in areas outside Settlement Areas.

Municipal Implementation

The Oak Ridges Moraine Conservation Act 2001 requires that all decisions on planning applications shall conform with the Oak Ridges Moraine Conservation Plan and directs municipalities to bring their official plans into conformity with the plan. [1]

The Conservation Plan provides policies to protect water quality and quantity across the Moraine and requires municipalities to prepare watershed plans, water budges and water conservation plans to incorporate into their official plans within specified time periods.

Municipalities are encouraged to develop additional policies for the Moraine that support, complement, or exceed the policies of this Plan or where it conflicts with this Plan or other provincial plans. The Plan also promotes engagement with the public, First Nations, Métis, and Inuit (FNMI) communities, and other partners in local efforts to implement the Plan and to provide the necessary information to ensure the informed involvement of local citizens. Planning authorities and municipalities are encouraged to coordinate planning matters and build constructive, cooperative relationships with FNMI communities and to facilitate knowledge sharing in growth management and land use planning processes.

Additional Resources

OAK RIDGES MORAINE CONSERVATION PLAN 2017 [1]

Government of Ontario

2017

The Oak Ridges Moraine Conservation Plan is a land use planning document and policy framework implemented by the Ontario government in 2002. Its purpose is to protect and manage the ecological and hydrological features of the Oak Ridges Moraine, an ecologically significant landform of southern Ontario. The plan is implemented and enforced by various local municipalities, conservation authorities, and provincial government agencies responsible for land use planning in the area.

References

[1] Ontario Ministry of Municipal Affairs, "The Oak Ridges Moraine conservation plan, 2017," Queen's Printer for Ontario, 2017.

APPENDIX 4.2

A Description of the Great Lakes Protection Act, 2017

In response to threats facing the Great Lakes and their importance to Ontarian's health and wellbeing, the Ontario government established The Great Lakes Protection Act in 2017 [1], which:

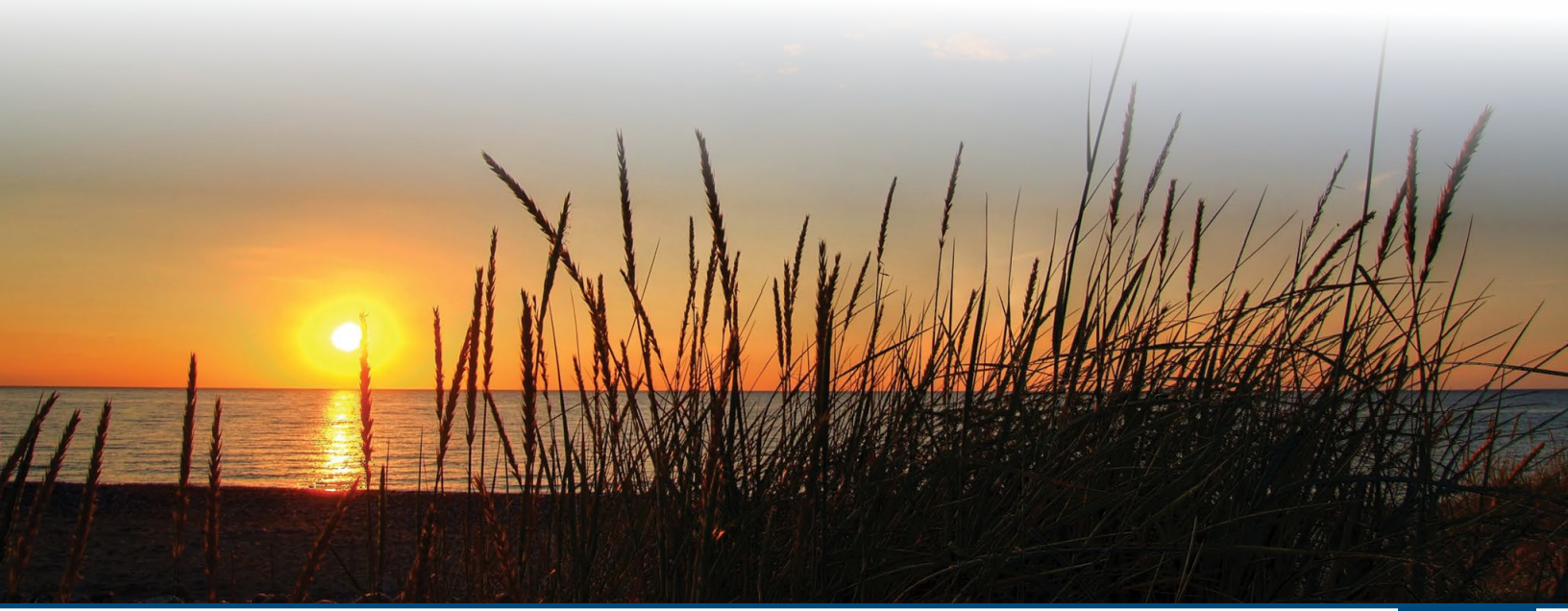
1. Ensures we establish and maintain monitoring and reporting programs to strengthen protection of the Lakes by improving the ability to set clear targets for local and lake-wide areas.
2. Commits to establishing at least one target to reduce algal blooms.
3. Allows the Minister of Natural Resources and Forestry to establish targets to prevent the loss of wetlands.
4. Improves consultation and engagement requirements and requires consideration of traditional ecological knowledge and engagement with FNMI communities.
5. Enables geographically focused activities as a tool for developing and implementing policies to address priority issues within a specific location.
6. Creates more opportunities for Ontarians to become involved in the protection and restoration of the ecological health of the Great Lakes – St. Lawrence River Basin.
7. Improves the capacity of the Great Lakes – St. Lawrence River Basin so it can be resilient to the impacts of climate change.

ONTARIO'S GREAT LAKES STRATEGY

Creation of Ontario's Great Lakes Strategy was a major outcome of The Great Lakes Protection Act, 2017 and is required to be reviewed every six years. [1, 2]

The Strategy focuses on empowering action by all partners on the Great Lakes and on restoring Great Lakes water, beaches, and coastal areas. It aims to conserve biodiversity and deal with invasive species and addresses the need for climate change adaption. The Strategy highlights the importance of scientific information to guide decision making and monitor progress yet recognizes that there is no "one-size-fits-all" solution as there are different Great Lakes issues and opportunities across the province.

The Strategy is designed to focus provincial resources across ministries and to enhance collaboration with other government and the Great Lakes community. It includes Ontario's portion of the geography of Lakes Superior, Huron, Erie and Ontario, their connecting rivers, the St. Lawrence River, the Ottawa River and surrounding watersheds and groundwater.



CURRENT GREAT LAKES GOALS

The most recent Strategy includes the following Great Lakes Goals: [2]

1. **Engaging and empowering communities:** To create opportunities for individuals and communities to become involved in the protection and restoration of the ecological health of the Great Lakes – St. Lawrence River Basin.
2. **Protecting water for human and ecological health:** To protect human health and wellbeing through the protection and restoration of the ecological health of the Great Lakes – St. Lawrence River Basin.
3. **Improving wetlands, beaches, and coastal areas:** To protect and restore wetlands, beaches, shorelines, and other coastal areas of the Great Lakes – St. Lawrence River Basin.
4. **Protecting habitats and species:** To protect and restore the natural habitats and biodiversity of the Great Lakes – St. Lawrence River Basin.
5. **Enhancing understanding and adaptation:** To advance science relating to existing and emerging stressors, such as climate change, that improves understanding and management of the Great Lakes – St. Lawrence River Basin.
6. **Ensuring environmentally sustainable economic opportunities and innovation:** To enrich the quality of life in communities in the Great Lakes – St. Lawrence River Basin through support of environmentally sustainable economic opportunities and innovation and through environmentally sustainable use of natural resources.

These goals are guided by the following key principles:

- **Ecosystem approach:** Recognize the intrinsic value of the Great Lakes and the interdependence of land, air, water and living organisms, including humans. This approach applies the best available science, considers cumulative impacts, encourages conservation of resources, and promotes watershed and sub-watershed approaches.
- **Precautionary approach:** Caution will be exercised to protect the environment when there is uncertainty about environmental risks.
- **Accountability:** Promote increased transparency by setting clear goals, reporting regularly on progress, and sharing information.
- **Adaptive management:** Continuously improve and adapt policies and management approaches by monitoring impacts, assessing effectiveness, and adjusting actions while considering new science, Traditional Ecological Knowledge and innovative design practices and technologies, and the need to adapt to a changing climate.
- **Collaboration and engagement:** Provide the community, including First Nations, Métis, and Inuit (FNMI) communities, municipalities, conservation authorities, environmental organizations, the scientific community, and the industrial, agricultural, recreational and tourism sectors and the public, with opportunities to discuss, advise and participate directly in Great Lakes activities.
- **Recognition of FNMI communities:** Indigenous communities within the Great Lakes Basin maintain a spiritual and cultural relationship with water. Their identity, cultures, interests, knowledge, and traditional practices are considered.

Additional Resources

ONTARIO'S GREAT LAKES STRATEGY [2]

Ontario Ministry of the Environment, Conservation and Parks, 2017

This document is the roadmap that sets a vision, goals, and priorities to help restore, protect, and conserve the Great Lakes.

PROTECTING THE GREAT LAKES [1]

Ontario Ministry of the Environment, Conservation and Parks, 2023

Provides an overview of Ontario's plan to protect and restore the health of the Great Lakes – St. Lawrence River basin, the importance of the Great Lakes in an Ontario context, and how the plan aims to create more opportunities for individuals and communities to get involved in local protection and restoration efforts.

References

[1] Ontario Ministry of the Environment, Conservation and Parks, "Protecting the Great Lakes," Ontario Ministry of the Environment, Conservation and Parks, 2023.

[2] Ontario Ministry of the Environment, Conservation and Parks, "Ontario's great lakes strategy," October 2021. [Online]. Available: https://www.ontario.ca/page/ontarios-great-lakes-strategy. [Accessed 19 June 2023].

APPENDIX 4.3

Wastewater Treatment Facilities in Durham Region

Durham Region provides wastewater collection and treatment which is a service essential to the economy, our community's health and for the protection of our environment.

The wastewater collection system in the region uses a system of underground pipes and pumping stations and brings it to one of 11 water pollution control plants across the region. Durham Region owns and operates the following water pollution control plants:

- Cannington Lagoons
- Corbett Creek Water Pollution Control Plant
- Courtice Water Pollution Control Plant
- Duffin Creek Water Pollution Control Plant
- Harmony Creek Water Pollution Control Plant
- Lake Simcoe Water Pollution Control Plant
- Newcastle Water Pollution Control Plant
- Nonquon River Water Pollution Control Plant
- Port Darlington Water Pollution Control Plant
- Sunderland Lagoon
- Uxbridge Brook Water Pollution Control Plant

Figure A4.3.1 below illustrates how wastewater is cleaned in Durham Region.

An Integrated Management System (IMS) helps the Region meet the Standard of Care requirements for drinking and wastewaters. An IMS demonstrates that management controls over the Region's municipal drinking water and wastewater treatment systems exist. This system was initially put in place in 2003 for the Region's municipal drinking water systems. It was then later expanded to include wastewater when the Duffin Creek Water Pollution Control Plant was added in the Region.

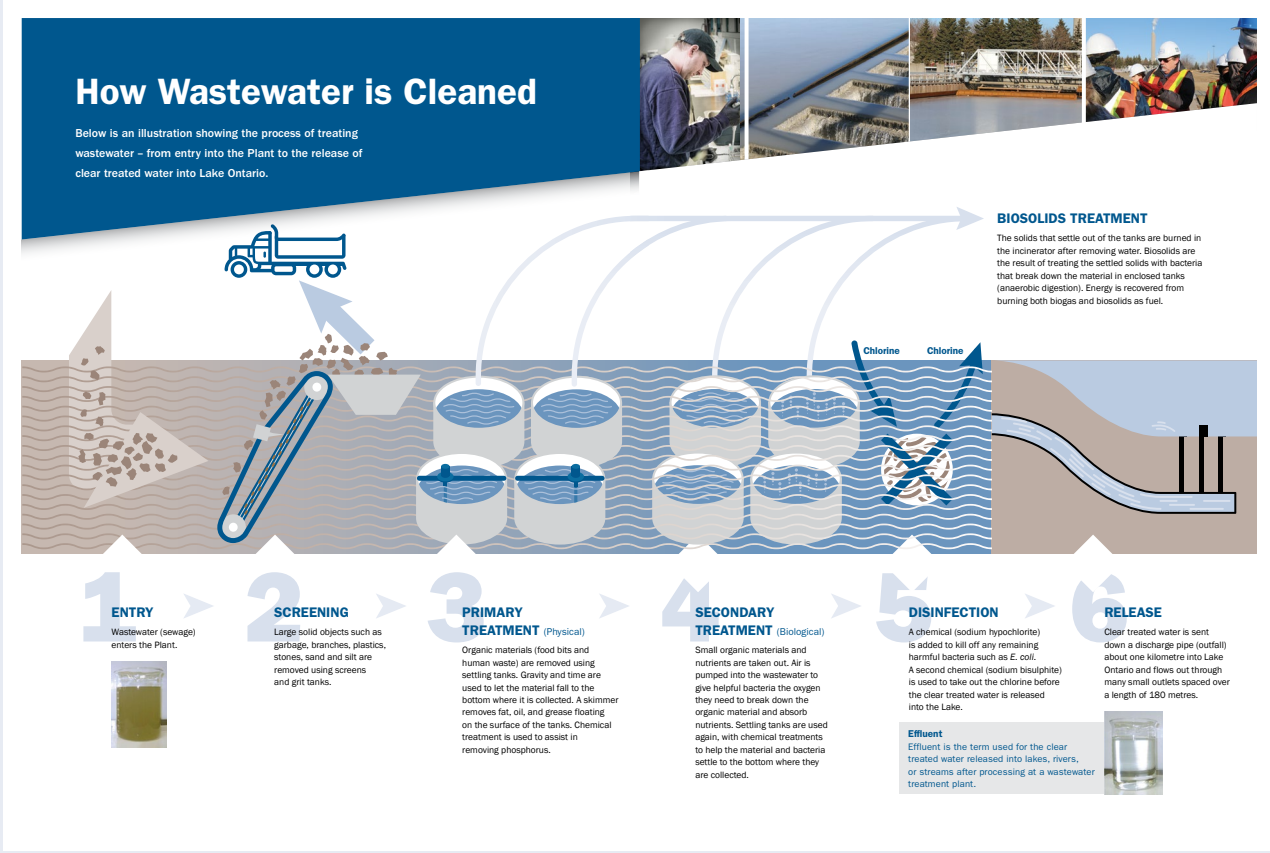


Figure A4.3.1 | An illustration of how wastewater is cleaned in Durham Region.

Source: The Regional Municipality of Durham, Works Department.

Additional Resources

WASTEWATER AND SEWERS

Durham Region Works Department

durham.ca/wastewater

Provides links to videos and illustrations on how wastewater is treated in Durham Region before it is returned to the environment. This landing page also contains information on wastewater collection and treatment processes, by-laws and the Master Plan.

APPENDIX 4.4

Climate Projections for Durham Region's Local Municipalities

The climate conditions across Durham Region varies by municipality and the future projections are no different.

Based on observed historical conditions, it is apparent climate varies notably across the Durham Region because of the unique geography and local features of each local municipality. Climate projections for Durham Regions 8 local municipalities based on the high emissions RCP 8.5 scenario are provided below, as well as a "ranking" based on which municipality is likely to experience the greatest temperature and precipitation changes by the end of the century (2100). These projections were calculated by the Ontario Climate Consortium (OCC) based on methods described in **Chapter 4, Section 4.2.1**. [1]

Municipal Comparisons

As we move towards 2100 projected changes in average and extreme temperatures are anticipated to vary substantially across Durham's local municipalities.

Changes in Temperature

Table A4.4.1 summarizes projected changes expected for each of Durham's local municipalities in terms of average annual and extreme temperatures based on the RCP 8.5 emissions. Municipalities are ranked from largest to smallest amount of anticipated change based on comparing the long-term projections (1971 to 2100) to the historical baseline (1971 to 2000).

Table A4.4.1 | Projected changes in average and extreme temperatures in each of Durham Region's local municipalities by 2100, ranked from most to least projected change.

Ranking	Projected changes		
	Mean air temperature	Extreme heat days*	Extreme cold days**
1: most change	Oshawa (+5.8˚C)	Scugog (+16.6 days)	Oshawa (-37.4 days)
2	Brock (+5.3˚C)	Uxbridge (+16.5 days)	Pickering (-37.4 days)
3	Scugog (+5.2˚C)	Brock (+16.0 days)	Ajax (-37.1 days)
4	Clarington (+5.2 ˚C)	Whitby (+13 days)	Clarington (-36.8 days)
5	Pickering (+5.2˚C)	Pickering (+8.3 days)	Whitby (-35.0 days)
6	Ajax (+5.1˚C)	Ajax (+7.1 days)	Uxbridge (-33.8 days)
7	Uxbridge (+5.1˚C)	Clarington (+7 days)	Scugog (-33.3 days)
8: least change	Whitby (+4.8˚C)	Oshawa (+6.6 days)	Brock (-33.8 days)

All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the RCP 8.5 emissions scenario.

* Extreme heat days refer to the number of days where temperatures exceed 35˚C.

** Extreme cold days refer to the number of days where temperatures fall below -20˚C.

Data source: Adapted from Delaney et al. 2020. [1]

Although warming is projected to happen throughout the Region, the rate of warming is anticipated to happen most quickly Oshawa and Brock. Additionally, there is strong evidence that the northern municipalities of Scugog, Uxbridge and Brock are expected to see the greatest increase in number of extreme heat days compared to the southern municipalities.

On average, the Region is expected to see a reduction of approximately 30 fewer extreme cold days each year by the end of the century. Although variation across municipalities in terms of the total number of lost extreme cold days is anticipated, the southern municipalities are projected to lose more extreme cold days than those in the north.

Changes in Precipitation

Changes in precipitation amounts are also projected to vary across the Region, however, the total amount of change is less certain than it is for temperature.

Table A4.4.2 summarizes projected changes expected for each of Durham's local municipalities in terms of average and extreme precipitation amounts by the 2071 to 2100 projection period under the RCP 8.5 emissions scenario. Municipalities are ranked from the greatest increase in precipitation amounts to lowest. It is important to keep in mind that the projected changes represent ensemble averages and consequently variability which is key in understanding and projecting precipitation changes at a local level that may have been lost through the averaging process. Nevertheless, all these projected increases in total and extreme precipitation are significant.

Table A4.4.2 | Projected changes in average and extreme precipitation for each of Durham Region's local municipalities by 2100, ranked from most to least projected change.

Ranking	Projected changes	
	Total precipitation	Extreme precipitation***
1: most change	Oshawa (+31%)	Ajax (+29mm in 1 day)
2	Clarington (+31%)	Scugog (+29mm in 1 day)
3	Brock (+31%)	Whitby (+28mm in 1 day)
4	Pickering (+27%)	Clarington (+28mm in 1 day)
5	Ajax (+27%)	Oshawa (+27mm in 1 day)
6	Whitby (+27%)	Pickering (+26mm in 1 day)
7	Uxbridge (+27%)	Uxbridge (+25mm in 1 day)
8: least change	Scugog (+27%)	Brock (+23mm in 1 day)

All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the RCP 8.5 emissions scenario.

*** Extreme precipitation refers to the maximum precipitation amount (mm) that falls within one day

Data source: Adapted from Delaney et al. 2020. [1]

Tables A4.4.3 to **A4.4.10** below provide a summary of key climate change projections for each of Durham's 8 local municipalities. For a comprehensive list of all climate parameter projections for both the RCP 8.5 and RCP 4.5 scenarios, refer to the 2020 OCC Report. [1]

Climate Projections: City of Pickering

Table A4.4.3 | A summary of key climate change trends for the City of Pickering under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	8.5	10.1	12.2	Increasing
Annual average number of days above 35˚C	0.2	0.8	2.8	8.5	Increasing
Annual average number of days above 30˚C	7.6	12.5	23.1	42.0	Increasing
Annual average number of days below -20˚C	8.6	6.0	3.0	0.8	Decreasing
Annual average number of days below -10˚C	49.0	33.0	22.2	11.6	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1059.2	1132.3	1205.3	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	50.3	55.0	59.6	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	71.3	76.7	83.9	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.9	3.1	3.3	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	178 days	193 days	215 days	Increasing

Historical (1971 to 2000); short term (20011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: Town of Ajax

Table A4.4.4 | A summary of key climate change trends for the Town of Ajax under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	8.5	10.1	12.1	Increasing
Annual average number of days above 35˚C	0.2	0.7	2.0	7.3	Increasing
Annual average number of days above 30˚C	7.6	10.4	19.7	38.9	Increasing
Annual average number of days below -20˚C	8.6	6.4	3.2	1.0	Decreasing
Annual average number of days below -10˚C	49.0	32.1	21.1	11.9	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1059.2	273.9	301.3	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	51.8	57.6	62.6	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	72.9	79.7	87.4	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.9	3.0	3.3	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	176 days	193 days	214 days	Increasing

Historical (1971 to 2000); short term (20011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: Town of Whitby

Table A4.4.5| A summary of key climate change trends for the Town of Whitby under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	8.4	9.8	11.8	Increasing
Annual average number of days above 35˚C	0.2	2.4	5.7	13.2	Increasing
Annual average number of days above 30˚C	7.6	18.3	30.3	49.5	Increasing
Annual average number of days below -20˚C	8.6	7.6	3.9	0.9	Decreasing
Annual average number of days below -10˚C	49.0	39.0	27.2	14.0	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1059.2	1132.3	1205.3	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	51.3	56.6	61.8	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	73.3	78.3	86.6	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.9	3.1	3.3	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	182 days	196 days	217 days	Increasing

Historical (1971 to 2000); short term (2011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: City of Oshawa

Table A4.4.6 | A summary of key climate change trends for the City of Oshawa under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	8.4	9.8	11.8	Increasing
Annual average number of days above 35˚C	0.2	2.4	5.7	13.2	Increasing
Annual average number of days above 30˚C	7.6	18.3	30.3	49.5	Increasing
Annual average number of days below -20˚C	8.6	7.6	3.9	0.9	Decreasing
Annual average number of days below -10˚C	49.0	39.0	27.2	14.0	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1388.0	1132.3	1241.9	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	51.6	55.9	60.9	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	102.5	78.1	85.5	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	3.8	3.1	3.4	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	177 days	193 days	214 days	Increasing

Historical (1971 to 2000); short term (2011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: Municipality of Clarington

Table A4.4.7 | A summary of key climate change trends for the Municipality of Clarington under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	8.6	10.0	12.2	Increasing
Annual average number of days above 35˚C	0.2	0.6	2.1	7.2	Increasing
Annual average number of days above 30˚C	7.6	10.9	20.8	40.3	Increasing
Annual average number of days below -20˚C	8.6	6.6	3.3	1.0	Decreasing
Annual average number of days below -10˚C	49.0	33.8	22.9	12.2	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1059.2	1132.3	1241.9	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	51.7	56.1	61.3	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	73.1	78.4	86.0	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.9	3.1	3.4	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	178 days	194 days	215 days	Increasing

Historical (1971 to 2000); short term (2011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: Township of Uxbridge

Table A4.4.8 | A summary of key climate change trends for the Township of Uxbridge under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	8.5	10.1	12.1	Increasing
Annual average number of days above 35˚C	0.2	4.0	8.3	16.7	Increasing
Annual average number of days above 30˚C	7.6	22.5	34.7	53.8	Increasing
Annual average number of days below -20˚C	8.6	8.5	4.4	1.1	Decreasing
Annual average number of days below -10˚C	49.0	41.7	29.2	15.2	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1022.7	1095.8	1205.3	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	47.8	52.7	58.4	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	70.0	74.4	82.4	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.8	3.0	3.3	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	183 days	195 days	217 days	Increasing

Historical (1971 to 2000); short term (2011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: Township of Scugog

Table A4.4.9 | A summary of key climate change trends for the Township of Scugog under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	9.1	10.7	12.2	Increasing
Annual average number of days above 35˚C	0.2	3.8	8.4	16.8	Increasing
Annual average number of days above 30˚C	7.6	22.5	35.3	54.9	Increasing
Annual average number of days below -20˚C	8.6	8.9	4.6	1.1	Decreasing
Annual average number of days below -10˚C	49.0	42.1	30.1	15.7	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1059.2	1132.3	1205.3	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	51.5	57.2	62.4	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	73.9	79.0	86.7	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	2.9	3.1	3.3	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	185 days	197 days	219 days	Increasing

Historical (1971 to 2000); short term (2011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Climate Projections: Township of Brock

Table A4.4.10 | A summary of key climate change trends for the Township of Brock under the RCP 8.5 scenario.

Climate Parameter	Historical	Short Term	Medium Term	Long Term	Climate Trend
Temperature					
Mean annual temperature (˚C)	7.0	6.0	10.0	12.3	Increasing
Annual average number of days above 35˚C	0.2	3.6	7.9	16.2	Increasing
Annual average number of days above 30˚C	7.6	21.9	34.2	53.9	Increasing
Annual average number of days below -20˚C	8.6	9.2	4.8	1.1	Decreasing
Annual average number of days below -10˚C	49.0	42.7	30.5	15.7	Decreasing
Precipitation					
Total average annual precipitation (mm)	949.7	1095.8	1132.3	1241.9	Increasing
Annual average maximum amount of precipitation falling in 1 day (mm)	33.8	55.2	52.3	56.9	Increasing
Annual average maximum amount of precipitation falling in 3 days (mm)	54.9	67.6	74.1	80.8	Increasing
Annual average simple daily intensity index (SDII) (mm/day)	2.6	3.0	3.1	3.4	Increasing
Agricultural parameters					
Average growing season length for climate period	163 days	183 days	191 days	216 days	Increasing

Historical (1971 to 2000); short term (2011 to 2040); medium term (2041 to 2080); long term (2081 to 2100). All climate change parameters are averages of the NA-CORDEX's 16 model runs based on the high emissions RCP 8.5 scenario.

Data source: Adapted from Delaney et al 2020. [1]

Additional Resources

GUIDE TO CONDUCTING A CLIMATE CHANGE ANALYSIS AT THE LOCAL SCALE: LESSONS LEARNED FROM DURHAM REGION

Ontario Climate Consortium (OCC)

2020

This document guides Ontario municipalities, conservation authorities, and the broader community on how to develop local climate projections in 2020.

In a Durham Region context, is also provides climate projections for Durham Region as a whole, regional conservation authorities and local municipalities under both the RCP 8.5 and RCP 4.5 emission scenarios.

References

[1] F. Delaney, P. Ng, K. Dokoska, G. Milner, K. Potter and M. Notaro, "Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region," Ontario Climate Consortium, Toronto, 2020.