Figures

Tables

2.0 WATERSHED CHARACTERIZATION

The Watershed Characterization provides an overview of the *watershed* in the Toronto Region Source Protection Area (TRSPA). It is noted that the source protection jurisdiction covers the area that is managed by Toronto and Region Conservation (TRCA) where the Authority manages the conservation lands and conducts the monitoring programs, as shown in **Figure 2.1**.

The data and mapping in this Assessment Report summarize the information available as of September 2009; they rely heavily on the technical work and reporting of the watershed plans and ongoing monitoring by TRCA's municipal partners. Many agencies have been involved in the collection and assessment of data that supports the analyses presented in this Assessment Report. For a complete listing of data sources see **Appendix A**. The assessment process is described in **Appendix B**.

This chapter is organized into the following categories:

- **Local Watershed Description:** Information on natural characteristics of the study area;
- **Ecology:** Information on natural cover, aquatic habitats, and species at risk;
- **Water Systems and Water Use:** Information on how water is used by drinking water systems, and how much is drawn from both *aquifer* and *surface water* sources.
- **Water Quality and Trends:** Information on water quality (*groundwater* and *surface water*) and trends in watershed to determine if water quality is getting better, getting worse, or staying the same; and
- **Land Use:** Information on where people live and how they utilize the landscape.

Aquifer: An underground layer of water-bearing sediments (e.g., sand, gravel) or permeable rock from which groundwater can be usefully extracted via a water well.

Groundwater: Water located beneath the ground surface in soil pore spaces and in fractured rock.

Hydrologic cycle: The continuous movement of water on, above and below the surface of the earth.

Surface water: Water occurring in lakes, rivers, streams that may be used as a source of drinking water. As water moves in a cycle (hydrologic cycle), the two sources of drinking water (groundwater and surface water) interact; this may cause contaminants to move between the groundwater and surface water systems.

Watershed: An area where many sources of surface water drain into the same place.

This description provides a framework to assist in answering two important questions about the drinking water in this area:

- What is its condition?
- What impact do land and water activities have on the sources of drinking water?

To understand the risk to drinking water sources in any one area, the system must be reviewed as a whole. All sources that support drinking water systems must be assessed, including municipal and privately owned ones. Therefore, the TRSPA study area covers both groundwater and Lake Ontario sources, even where there are no groundwater sources for municipal drinking water. About 97% of the population in the TRSPA receives its drinking water from treatment plants that source water from Lake Ontario, while 3% receives drinking supplies from groundwater (aquifer) sources.

2.1 LOCAL WATERSHED DESCRIPTION

The characterization of the TRSPA has been detailed in the report entitled *Interim Watershed Characterization Report*, herein called the Characterization Report, which referenced a variety of data sets, and background studies completed through collaboration with various private and public organizations. A summary of the data sources used is provided in Appendix A.

The Characterization Report was peer reviewed by municipal and provincial representatives, as well as private consultants, but this was undertaken before the finalization of the *Technical Rules*. Additional work was undertaken in 2008/2009 with the data so that this Assessment Report could present a more updated characterization of the Source Protection Area.

The Characterization Report contains the foundation technical data and information upon which the summary below has been based. The findings of the Characterization Report were based on data sets, and studies undertaken at the TRCA, and by those made available through collaboration with various private and public organizations. Where possible, the data and information has also been updated in an attempt to bridge the time gap to 2009.

The key effort by the TRCA was to take the outputs of background source protection documents, existing watershed plans, and current municipal reports and to make the data and mapping as consistent as possible across the entire TRSPA. This was a significant challenge as most data collection, mapping, and analysis had been conducted on a municipal or watershed basis, and edge mapping issues were identified. These issues included model inputs (e.g., land use classifications, land cover) as well as model outputs (e.g., recharge, runoff, evapotranspiration). Edge mapping issues were resolved through the use of new provincial datasets such as SOLRIS as well as new modelling studies across the entire jurisdiction (e.g., Tier 1 Water Budget). The maps and analysis included in this Assessment Report represent the best efforts of the TRCA to maintain consistent, geo-referenced data across both political and watershed boundaries.

A complete discussion of the hydrologic cycle and the hydrology of these watersheds is included in **Chapter 3**, but some of the key characteristics are summarized below. Most of the information presented was derived from a 1:1000 Digital Elevation Model (DEM) using Geographic Information Systems (GIS) tools such as Arc Hydro. The overall characteristics of the nine watersheds are summarized in **Table 2.1**. Data regarding the Strahler Stream Orders (Stream Order 1 is a headwater stream while Stream Order 6 represents a major river) are provided in **Table 2.2** and a map showing the stream order distribution across the landscape is presented in **Figure 2.2**.

Figure 2.1: Toronto and Region Source Protection Area Watersheds and Subwatersheds

Table 2-1: Watershed Characteristics for Toronto and Region Source Protection Area Watersheds

Watershed	Area (km^2)	Stream Length (m)	Stream Density (m/km^2)	Basin Slope (%)	Mean Annual Flow (m^3/sec)	Mean Annual Discharge (m^3/yr)
Etobicoke	212	239,000	1.1	3.3	2.3	71,365,968
Mimico	77	58,000	0.8	3.4	0.8	25,364,271
Humber	911	1,133,000	1.2	6.0	6.8	215,593,572
Don	358	372,000	1.0	5.2	4.0	124,693,344
Highland	102	116,000	1.1	4.1	1.1	34,973,424
Rouge	333	427,000	1.3	4.4	*2.9	*92,053,584
Petticoat	27	27,000	1.0	3.8	0.5	17,155,584
Frenchman's Bay	27	35,000	1.3	4.0	> 0.3*	NA
Duffins	287	331,000	1.2	6.1	2.6	80,353,728
Carruthers	38	48,000	1.3	3.8	0.4	11,731,392

Notes:

NA = Not available — no gauge on the watercourse.

** Gauges located in middle reaches of the watershed; underestimate of the total discharge to Lake Ontario.*

Table 2-2: Strahler Stream Orders for Toronto and Region Source Protection Area Watersheds

Stream Order	Etobicoke Creek		Mimico Creek		Humber River		Don River		Highland Creek	
	km of Stream	*Percent of Total*	*km of Stream*	*Percent of Total*	*km of Stream*	*Percent of Total*	*km of Stream*	*Percent of Total*	*km of Stream*	*Percent of Total*
1	116	49	21	37	512	45	190	51	59	51
2	49	21	10	18	261	23	91	24	29	25
3	24	10	4	8	160	14	21	6	21	18
4	49	21	22	38	105	9	61	16	7	6
5	0	—	0	—	63	6	9	2	0	—
6	0	—	0	—	32	3	0	—	0	—
Total	239	100	58	100	1133	100	372	100	116	100

Stream Order	Rouge River		Petticoat Creek		Frenchman's Bay		Duffins Creek		Carruthers Creek	
	km of Stream	*Percent of Total*	*km of Stream*	*Percent of Total*	*km of Stream*	*Percent of Total*	*km of Stream*	*Percent of Total*	*km of Stream*	*Percent of Total*
1	186	44	17	49	19	70	168	51	28	57
2	110	26	11	32	5	19	85	26	9	19
3	53	12	7	19	3	10	36	11	11	23
4	47	11	—	—	0	—	35	11	—	—
5	31	7	—	—	0	—	5	2	—	—
Total	427	100	35	100	27	100	331	100	48	100

Figure 2.2: Strahler Classes of Streams

2.2 ECOLOGY

2.2.1 Natural Land Cover

Naturally vegetated areas are described for the TRSPA according to a Terrestrial Natural Heritage System Strategy (TNHSS) approach. The overarching goal of this work is conservation of the region's native *biodiversity*. The natural cover in a watershed, including forest, *successional*, *wetland*, beach/bluff, and meadow habitats, is evaluated as a functional unit based on three indicators of ecological health and function:

- Quantity of natural cover;
- Quality of natural cover; and
- Distribution.

"Healthy" watersheds have many naturally vegetated areas that are well distributed across the watershed. Naturally vegetated watersheds promote a natural hydrologic cycle and the maintenance of water quality by preventing excessive nutrients or contaminants and sediment from entering surface and subsurface waters.

Biodiversity: the variation of life forms within a given ecosystem.

Natural heritage: The legacy of natural objects and attributes encompassing the countryside and natural environment, including plants and animals.

Successional areas: Ecosystems that are undergoing the gradual process of change that results from one community gradually replacing another.

Wetland: Land that is seasonally or permanently covered by shallow water, as well as land where the water table is close to or at the surface. In either case, the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants.

Quantity of Natural Cover

The breakdown of natural cover by type within the TRSPA is shown in **Table 2.3**. In 2002, the estimated extent of natural cover in the TRSPA was approximately 63,347 hectares (ha), or 25% of the total land surface. However, the quantity of natural cover in the region is currently not enough to sustain the region's biodiversity.

Table 2-3: Breakdown of Natural Cover by Type (2002, remotely sensed)

Habitat	Hectares	% of Jurisdiction
Forest*	33,850	14
Successional	3,150	1
Wetland**	2,572	1
Beach/Bluff	161	<0.1
Meadow	23,614	9
Total	**63,347**	**25**

Notes:

** Forest cover includes areas that may be forested wetlands (swamps)*
*** The amount of wetland cover has been fine tuned using actual site level data as discussed in the section on wetlands and is not subdivided by wetland type.*

Land in the TRSPA has been classified into one of four planning areas:

- **Built-up**: lands that are developed (urbanized);
- **Designated greenfields**: lands designated for urban expansion that are not yet built (as of 2002);
- **Agricultural and rural**: lands not currently proposed for urban expansion and characterized by various agricultural and rural uses; and
- **Greenbelt**: Legislatively protected lands containing a large proportion of existing forest and wetland cover with agricultural/rural uses and very limited urban expansion opportunities (i.e., Greenbelt, Oak Ridges Moraine and Niagara Escarpment).

Table 2.4 shows the amount of natural cover (all types) within each of the planning areas. Most of the natural cover occurs in the greenbelt area, which has 44% natural cover. This greenbelt area represents about one-third of the TRSPA but contains nearly half of the region's natural cover. In contrast, only 13% of the built-up area and 12% of the agricultural and rural area contain natural cover. The designated greenfield area (see **Section 2.5**) currently contains 37% natural cover, but is subject to future development.

Table 2-4: Existing (2002) Natural Cover within the Four Planning Areas in the Region

Planning Area	**Area**		**Natural Cover** *(forest, wetland, meadow, and coastal)*	
	Hectares	***% of Region***	***Hectares***	***% of Area***
Built-up	119,393	48	15,231	13
Designated Greenfield	28,527	11	10,695	37
Agricultural and Rural	23,298	9	2,825	12
Greenbelt	78,008	31	34,596	44
Total Region	**249,225**	**100**	**63,347**	**25**

Quality of Natural Cover (Size, Shape and Matrix Influence)

The quality of natural cover indicator at a landscape scale consists of the size, shape, and matrix values of naturally vegetated areas. TRCA staff used a landscape analysis model incorporating these three parameters to assess the quality of the natural cover.

In terms of size, the larger a natural habitat patch, the more opportunity there is to support a range of species and natural processes. The habitat patches found in the TRSPA's jurisdiction average about three ha, which is very small and not conducive to providing resources for area-sensitive species and promoting natural processes. However, these small patches actually represent only a small amount in hectares of the total natural cover in the TRSPA. Most of the region's natural cover is found in patches of 50 ha or more. Unfortunately, there are relatively few of these larger patches and they are generally found in the northern parts of the TRSPA on the Oak Ridges Moraine. Individually, the large patches may be highly functioning in terms of natural processes, but their scarcity limits their influence.

The shape of a habitat patch is important in that it is the edge of a habitat patch where any negative influence from the adjacent land uses is exerted. Higher habitat values are associated with compact patches such as circles and squares since these areas have a small amount of edge in relation to the total area. The network of roads in the jurisdiction defines the edge of many patches and the farming practice of maintaining square or rectangular woodlots creates the higher range of shape values in the rural parts of the region. Habitat values tend to be lower in valley lands (where much of the remaining habitat is found in urbanized portions of the landscape) because habitat patches tend to be long, narrow, and often convoluted, with a high amount of edge relative to their total area. However, these areas are still important for biodiversity in an urban context, and provide key corridor functions and aquatic values related to stream buffering.

The matrix value is a measure of the influence the surrounding land uses have on a habitat patch. The most sensitive species tend to occur in the northern rural areas of the region where the natural cover is the greatest. This is because each habitat patch receives a relatively positive influence from the presence of other nearby natural areas and the agricultural matrix. Natural areas within the urban dominated matrix (in the south) are subjected to a number of negative impacts, such as soil compaction, changes in hydrology, competition from non-native invasive species, pollution (air and water), and other disturbances associated with human use.

Distribution of Natural Cover

As mentioned above and shown in **Figure 2.3**, the distribution of the remnant terrestrial natural cover in the region is skewed toward the north and, to some extent, the east of the TRSPA. In addition, more of the higher quality patches are also found in the north. At the opposite end of the spectrum are the more urbanized landscapes of the south and southwest, where there are large gaps between smaller patches of habitat. Although less than optimal, these poorer quality patches continue to perform local ecological functions and together they still contribute to the TRSPA terrestrial natural system.

Wetlands

Wetlands represent about 1% of the land base in the TRSPA, or 2,572 ha. The greatest proportion of wetland occurs on the Oak Ridges Moraine from Highway 404 west to the Niagara Escarpment. The highest concentrations of wetlands exist around the town of Oak Ridges, in Richmond Hill and within the Centreville Creek subwatershed of the Humber River.

TRSPA wetlands are primarily *swamps* and *marshes*, but also include *bogs* and *fens*. To produce the mapping shown in **Figure 2.4**, TRCA staff refined remotely sensed landscape analysis, which consists of evaluated and unevaluated wetlands derived from a combination of information from two sources.

For the evaluated wetland component, boundaries from the MNR Land Information Data Subscription (LIDS) project were utilized. The age of wetland boundaries within this dataset is varied, ranging from the mid-1980s through to the present. The dataset includes all evaluated wetlands (i.e., both provincially significant and locally significant wetlands).

Bog: Nutrient-poor wetlandscharacterized by spongy peat deposits, acidic waters, and a floor covered by a thick carpet of sphagnum moss. Bogs receive all or most of their water from precipitation and are very rare across the TRSPA.

Fen: Nutrient-rich, peat-forming wetland that receives water from surface water or groundwater flow. They are usually less acidic than bogs, and are very rare across the TRSPA.

Marsh: Wetland frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions (e.g., cattails).

Swamp: Any wetland dominated by woody plants such as trees and shrubs.

Figure 2.3: Natural Cover

Figure 2.4: Wetlands

The wetlands from MNR are "open files," meaning that the boundaries can be adjusted based on new information from time to time. This dataset was last updated in August 2005.

The unevaluated wetland mapping was derived from a second source of information—Ecological Land Classification (ELC) vegetation surveys conducted by the TRCA. While data were collected on a large number of sites, coverage is not complete across the TRSPA (as of 2009, site level information was available for about 65% of the natural cover).

Riparian Vegetation

The data for *riparian* cover are not complete for the entire TRSPA and some are out of date. TRCA staff has identified the need to update this information for the TRSPA watersheds in a consistent fashion.

2.2.2 Aquatic Habitats

Aquatic ecological integrity consists of living (*biotic*) and non-living (*abiotic*) components of the ecosystem and their related functional processes (e.g., stream flow, temperature, and *biogeochemical* cycles). Alterations to these historic and/or evolutionary functional relationships often result in aquatic ecosystem re-organization. Landscape change is one activity that can affect the functional relationships between terrestrial and aquatic ecosystems. In the TRSPA, the lowest portions of the watersheds are the most urbanized, and aquatic ecosystems have been observed that have gone through, or are in the process of, re-organization.

Abiotic: Non-living chemical and physical factors in the environment.

Biogeochemical: The cycles of chemical elements, such as carbon and nitrogen, and their interactions with and incorporation into living things.

Biotic: Relating to, produced by, or caused by living organisms.

Cumulative: Increasing in effect, size, quantity, and so on by successive additions.

Synergistic: combined or cooperative action.

Index of Biotic Integrity (IBI): Indicator of overall stream health.

Riparian: The vegetated areas close to or within a water body that directly or indirectly contribute to fish habitat by providing a variety of functions such as shade, cover, and food production areas.

These ecosystems typically exhibit lower overall species abundance and diversity, have the lowest stream health scores (*Index of Biotic Integrity* (IBI)), and have generalist (tolerant) species that dominate the aquatic community. The rural, middle, and more natural upper portions of the watersheds exhibit the greatest ecological integrity, and support the majority of the remaining aquatic species abundance and diversity. With future growth planned in these middle and upper portions of the watersheds, there is an expectation that these ecosystems will experience increasing levels of stress, resulting in further change to aquatic ecological integrity.

Fish species are often used as a convenient measure of the health of the aquatic system as they are relatively easy to sample and identify. As well, their ecological requirements are relatively well understood for a number of diagnostic parameters. Species numbers and distribution can provide a good measure of aquatic ecological condition. However, pinpointing thresholds at which aquatic ecosystem integrity or individual species are put at risk is difficult owing to the *synergistic* and *cumulative* effects of changes to water quality, quantity, *riparian* vegetation, temperature, human use, and a host of other factors. However, the continued presence of species over time, or changes in the numbers and locations of sensitive species provides an indirect measure of aquatic ecological integrity and can be used as an indicator of broader environmental change.

Of the three indicators for aquatic habitat health (water depth, stream flow, and stream temperature), the most useful for analysis and reporting is stream temperature. The habitat requirements and tolerances for fish species regarding stream temperature are well understood in the TRSPA. Specific habitat requirements for fish using the other two indicators, water depth and stream flow, are not well understood and/or defined. Stream flow requirements are being developed by Fisheries and Oceans Canada from a habitat perspective, but species preferences are not widely available and/or known.

Stream Temperature

Empirical: Information gained by means of observation, experience, or experiment.

Headwaters: Area of a watershed where a major river system originates.

Morphology: The pattern and geometry of a river channel, including the network of tributaries within the drainage basin.

Empirical measurements of stream temperature are reasonably well documented for the TRSPA, though some gaps do exist. Where available, fish community data have been correlated with temperature data to produce mapping that defines watercourses as cold water or warm water habitat (see **Figure 2.5**). The *headwater* areas are the main locations of coldwater habitat, while the middle reaches of the Humber, Rouge, and Duffins watersheds are cool water habitat. The remaining stream reaches, primarily in the urbanizing and urban areas, are defined mostly as warm water ecosystems.

Generally speaking, streams determined to be coldwater habitat support fish species such as Brook trout (*Salvelinus fontinalis*) that have known lethal upper limits for temperature and display less tolerance for other stressors (e.g., dissolved oxygen, turbidity, sedimentation) as compared to species that occupy relatively warmer waters. However, it is important to note that sensitive aquatic species occupy a range of habitats from cool to warm. In particular, the Redside dace (*Clinostomus elongatus*), which is an endangered species, and Rainbow darter (*Etheostoma caeruleum*) both provide good indication of overall water quality and stream flow conditions in watercourses.

Redside dace are still relatively common within the middle reaches of the Humber and Rouge rivers and Duffins Creek. In addition, there are small, confined populations remaining within the Don River and Carruthers Creek. Redside dace are *extirpated* from the lower reaches of all watersheds and entirely from the Etobicoke, Mimico and Highland creeks, likely due to urbanization without stormwater management and channelization. The greatest threat to this species is still urbanization and the associated increases in surface water drainage and changes to stream *morphology*.

Rainbow darter were last reported in the Don River watershed in 1984. However, in the neighbouring Rouge River watershed they are still present in good numbers. They are also still found in Duffins Creek and, to a lesser extent, in the Humber River. Similar to the Redside dace, the loss of Rainbow darter in the Don River was likely caused by urbanization without stormwater management.

Figure 2.5: Thermal Classifications of Watercourses

Stream Flow

> **Instream:** The area within the wetted perimeter of a defined stream channel.

Flow within the watersheds begins in the headwater streams and wetland ecosystems, which "exert critical influences on the character and quality of downstream waters" (*Meyer, 2003*). These aquatic habitats are formed, to a large degree, by the groundwater system, and help to drive downstream aquatic ecosystem processes by influencing and/or maintaining water quality, quantity, and temperature. There are a number of aquatic species that are reliant on or influenced by the amount of groundwater that enters the watercourses. Brook trout is one species that is reliant on groundwater discharge and is sensitive to changes in groundwater and related water temperature. Even a minor change in overall temperature (2°C) can cause Brook trout to abandon the habitat. If this happens during the fall spawning season, it could impact Brook trout reproductive success.

Naturally reproducing Brook trout remain in only three of the TRSPA watersheds (Rouge and Humber rivers, and Duffins Creek). In the Rouge River watershed, the existing populations of Brook trout only occur within the uppermost reaches of the headwater streams. The total flow volume in these reaches is dominated by baseflow (i.e., groundwater), which results in high quality, coldwater habitat. Past fish occurrence records in the Rouge River watershed suggest that Brook trout had a larger downstream range than they do currently.

Being a relatively clean source of water, groundwater discharge helps to buffer the water quality of many urban and rural streams. Flow in these streams has a high component of surface water runoff. This runoff introduces many contaminants that can impact the aquatic ecosystem (e.g., suspended sediments, nutrients, organic compounds, and metals).

In general, an increase in total stream flow volume and rate has been the focus of concern in urbanizing watersheds. These increases cause impacts to stream morphology and can result in "wash-down" of individual fish to areas where stream habitat is inappropriate or degraded. Some are even pushed downstream of an impassable barrier such that they cannot return to their preferred habitat.

Flow Barriers

Water depth, as it relates to defining a habitat feature, is generally reported qualitatively (e.g., shallow pond or pool, deep reservoir) and defines the likely suite of organisms that may occupy that habitat. Summer low flow conditions in streams can be of concern for fish both for the quality of habitat and for movement within the stream. The majority of TRSPA watersheds have *instream* barrier mapping fully or partially completed - Etobicoke, Mimico and Highland creeks (full), Rouge and Don rivers (partial), and Duffins Creek (partial).

2.2.3 Species at Risk

There are two levels of legislation that identify species at risk. The federal legislation *Species at Risk Act (SARA), 2003* defines those species at risk of local extirpation within Canada. Ontario's species at risk are defined by the *Endangered Species Act, 2007.* There are a number of species that have been recorded within the TRSPA as being at risk. These species are listed in **Table 2.5**. Six of the species are of particular relevance to source water protection because of their dependence on high quality stream or wetland habitats; they are described below.

Table 2-5: Species at Risk Known within the Toronto and Region Source Protection Area

Scientific Name	Common Name	Provincial Status[1]	Federal Status[2]
Plants			
Juglans cinerea	Butternut	Endangered	Endangered
Morus rubra	Red mulberry	Endangered	Endangered
Panax quinquefolius	American ginseng	Endangered	Endangered
Trichophorum planifolium	Bashful bulrush	Endangered	Endangered
Liatris spicata	Spike blazing-star	Threatened	Threatened
Birds			
Ixobrychus exilis	Least bittern	Threatened	Threatened
Falco peregrinus	Peregrine falcon	Threatened	Threatened
Chaetura pelagica	Chimney swift	Threatened	Threatened
Caprimulgus vociferus	Whip-poor-will	Threatened	No status
Wilsonia citrina	Hooded warbler	Special Concern	
Empidonax virescens	Acadian flycatcher	Endangered	Endangered
Protonotaria citrea	Prothonotary warbler	Endangered	Endangered
Melanerpes erythrocephalus	Red-headed woodpecker	Special Concern	Threatened
Vermivora chrysoptera	Golden-winged warbler	Special Concern	Threatened
Dendroica cerulea	Cerulean warbler	Special Concern	Special Concern
Icteria virens virens	Yellow-breasted chat	Special Concern	Special Concern
Asio flammeus	Short-eared owl	Special Concern	Special Concern
Chordeiles minor	Common nighthawk	Special Concern	Threatened
Wilsonia canadensis	Canada warbler	Special Concern	Threatened
Amphibians			
Ambystoma jeffersonianum	Jefferson salamander	Threatened	Threatened

Scientific Name	Common Name	Provincial Status[1]	Federal Status[2]
Reptiles			
Emydoidea blandingii	Blandings turtle	Threatened	Threatened
Chelydra serpentine	Snapping turtle	Special Concern	No status
Lampropeltis triangulum	Milksnake	Special Concern	Special Concern
Thamnophis saurituas	Eastern ribbonsnake	Special Concern	Special Concern
Insects			
Danaus plexippus	Monarch butterfly	Special Concern	Special Concern
Gomphus quadricolor	Rapids clubtail	Endangered	Endangered
Fish			
Clinostomus elongatus	Redside dace	Endangered	Special Concern
Salmo salar	Atlantic salmon	Extirpated (L. Ont. Population)	No status
Anquilla rostrata	American eel	Endangered	No status
Acipenser fulvescens	Lake sturgeon	Threatened	No status

Notes:

[1] *As of May 5, 2010*
[2] As of December 11, 2009

Redside dace

Redside dace was up-listed to "endangered" under the *ESA* in February 2009. This species appears to be sensitive to changes in overall flow regime, thermal condition, riparian alteration, and turbidity/siltation. It prefers pool habitats in second and third order watercourses within the headwater streams in the TRSPA. No specific water quality parameters other than temperature have been reported that describe a potential level of impact to this specific species. The TRSPA watersheds support upwards of half of the Canadian populations of Redside dace. They are found in the Humber, Don, and Rouge rivers, and Duffins and Carruthers creeks watersheds.

Extirpated: A species that still exists somewhere in the world, but is no longer found in the study area.

Vernal pools: Temporary pools of water used by amphibians for breeding in the spring.

Atlantic salmon

Atlantic salmon were *extirpated* from TRSPA watersheds and require coldwater headwater tributaries for spawning. A program to reintroduce this species has been underway for several years in the Duffins Creek watershed.

Jefferson salamander

The Jefferson salamander was up-listed to "threatened" under the *ESA*. This salamander is dependant on high-quality wetlands and *vernal pools* for breeding. Currently TRCA staff is aware of three locations where this species is found: the upper Rouge and upper East Humber rivers (on the Oak Ridges Moraine) and the lower East Humber River.

Blanding's turtle

The Blanding's turtle is a threatened species under the *ESA.* This species is dependant on large, open wetlands that are fairly secluded. There is one known occurrence of this species in the lower Rouge River.

Least bittern

The Least bittern is a threatened species under the *ESA*. There are six known locations of Least bittern in the TRSPA: four in the upper Humber River and two on the Lake Ontario waterfront. This species is dependant on large cattail marshes with open water, which are rare across the study area.

Acadian flycatcher

The Acadian flycatcher is an endangered species under the *ESA.* It often nests near water and is known to be present in three areas of the TRSPA: the lower East Humber River, upper East Humber River, and the mid reaches of the Duffins Creek watershed.

Other species

Several freshwater mussels are also listed under the *SARA* legislation but there are no known *SARA* listed mussel species within the TRSPA. As more surveys are conducted over time, however, there is potential for one of the *SARA* listed species to be found. At this time, no formal surveys have been conducted across the TRSPA; only incidental collections are being made. The terrestrial inventory work undertaken by TRCA over the last decade has highlighted some disturbing trends in the numbers and distribution of species and habitats within the conservation authority's jurisdiction. Of the 1,111 known native flora and fauna species, 693 are no longer found within the urbanized portions of the watershed. As urbanization expands within the watersheds, there is a concern that this trend will continue.

TRCA has used a system of ranks and scores based on the Terrestrial Natural Heritage System Strategy (TNHSS) (*TRCA, 2007*) that considers the sensitivities and ecological needs of the species as well as the species' abundance, rather than a system that only classifies a species or habitat as "rare" or "not rare." The system is used to identify species and habitats of conservation concern and is designed to incorporate a preventative approach. It considers species, vegetation communities, and habitat patches that may:

- Not be rare in the TRSPA's jurisdiction, but that may have disappeared from significant portions of it;
- Be vulnerable to land use changes, as observed in urban areas;
- Contribute to the overall biodiversity of the jurisdiction; or
- Indicate environmental quality.

TRCA considers these species and habitats of conservation concern when looking at the protection, management, and restoration of the natural heritage system within its watersheds. TRCA has not undertaken a formal ranking process to identify those aquatic species at highest risk of extirpation from local watersheds. However, through ongoing assessments of the historical dataset, staff has determined that certain species are likely to be extirpated in advance of other species as the surrounding landscape is altered from its natural condition. These species are listed in **Table 2.5**.

The majority of these species at the highest risk of extirpation from the TRSPA watersheds prefer pools, slow moving water, or wetland habitat in streams. Additionally, many of the species are sensitive to water quality changes including higher turbidity, temperature, siltation, and chemical contaminants. However, no specific studies have been undertaken to relate detailed water quality information to the aquatic species present in watercourses.

2.3 WATER SYSTEMS AND WATER USE

The municipal water systems within the TRSPA are primarily surface water based, with Lake Ontario as the source. In the northern parts of the TRSPA, however, groundwater supplies are utilized for a number of communities.

The five Lake Ontario surface water systems located within the TRSPA are shown in **Figure 2.6**, summarized in **Table 2.6**, and briefly described in this section. Other systems are located outside the TRSPA (i.e., Arthur P. Kennedy (formerly Lakeview) Water Treatment Plant (WTP) in Mississauga) and will be captured by the other SPAs, although they may supply residents within the area. Detailed information on each of these intakes can be found in the respective Lake Ontario Collaborative reports (*Stantec, 2008a and b*).

The Assessment Report must also describe:

- Municipal drinking water systems that serve residences;
- Regulation 170 and 252 systems, including those that provide drinking water or that serve designated or public facilities (such as community centres, camp grounds, churches, schools, etc.); and
- Private water wells that serve residences.

2.3.1 Municipal Surface Water Sources and Water Treatment Plants (WTPs)

City of Toronto Municipal Residential Systems

The City of Toronto Municipal Residential Water Supply System consists of four water filtration plants, 18 pumping stations, ten major underground storage reservoirs, four elevated storage tanks, and approximately 510 km of trunk watermains and 5,015 km of distribution watermains. The water for the water treatment plants listed below is drawn from intakes that extend up to 5,400 m into Lake Ontario:

- R.L. Clark Water Filtration Plant;
- Island Filtration Plant;
- R.C. Harris Water Filtration Plant; and
- F.J. Horgan Water Filtration Plant.

The plant capacities are provided in **Table 2.6**. As part of the assessment of Lake Ontario supplies completed by Stantec (*2008a*), operator interviews were conducted for each of the four City of Toronto WTPs to identify potential concerns regarding these supplies. The following concerns were noted:

- R.L. Clark WTP: pathogen fluctuations (*E. coli, Cryptosporidium*, and *Giardia*) related to discharge from Humber and GE Booth (formerly Lakeview) Wastewater Treatment Plants (WWTPs), pesticide and herbicide levels, sodium levels related to road de-icing, WWTP bypasses, combined sewer overflow (CSO), urban runoff discharged through storm sewers, and the presence of two nearby marinas;
- Island WTP: no known issues/concerns (active intakes are deep and far offshore);
- R.C. Harris WTP: pathogen fluctuations from Ashbridges Bay WWTP, the nearby presence of Ashbridges Marina and Bluffers Point Marina, storm sewer outfalls, Don River, lake *seiches*, and annual up-welling and *downwelling*; and
- F.J. Horgan WTP: bulk chemical storage and spills from industrial facilities, Canadian National (CN) rail line, and Highland Creek WWTP.

  .

Seiche: Periodic fluctuation of water level caused by atmospheric disturbance (e.g., rapid changes in atmospheric pressure, rapidly-moving weather fronts, and major shifts in the directions of strong winds) passing over a body of water.

Downwelling: Downward movement of water caused by combinations of weather (e.g., wind speed, barometric pressure, temperature), water temperature, and surface currents.

Table 2-6: Lake Ontario Municipal Drinking Water Intakes

Water System	Population Served	Intakes	Intake Depth (m)	Intake Length (m)	Capacity (m^3/day)	Average Monthly Use (m^3/day)	Average Annual Use (m^3)	Comments/Data Sources
R.C. Harris (Toronto)	3,200,000	Northeast	15	2,232	950,000	168,000	61,365,000	All four systems are part of the Toronto water supply system that services approximately 3.2 million residents in the City of Toronto and southern portion of York Region (Data from Toronto Water, 2006; OCWA, 2007; EarthTech, 2001b).
		Southwest	15	2,125				
R.L. Clark (Toronto)		1	11	1,610	615,000	415,000	151,475,000	
F.J. Horgan (Toronto)		1	18	2,925	570,000	359,000	131,035,000	
Island (Toronto)		East	83	4,848	410,000	176,000	62,240,000	
		Middle	83	4,662				
		West	83	4,696				
		Shallow - West	11	828	NOT IN SERVICE			
		Shallow - East	17	690				
Ajax (Durham)	188,028	1	18	2,392	163,500	NA	NA	Serves Town of Ajax and City of Pickering (MOE, 2006b) (Most data from Simcoe, 2000; capacity from MOE, 2006a).

Notes:

There is a Region of Peel intake that services TRSPA residents, but it is located in the Credit Valley Source Protection Area.
Intake lengths are all measured from the shoreline
ML = megalitres (1,000,000 Litres)
NA = Not Available

Figure 2.6: Locations of Municipal Surface Water Intakes

Durham Region Municipal Residential Systems

The Durham Region Municipal Residential Systems within the TRSPA consists of the Ajax WTP. This is a surface water treatment facility that supplies water primarily for residents in the Town of Ajax and in the City of Pickering, as well as other residents, as required. *Raw water* is drawn from Lake Ontario through the 2.1 m diameter intake pipe extending 2,500 m into the lake. The treatment plant facility has a rated capacity of 163.5 mL/day (36 MIGD).

As with the City of Toronto systems, part of the assessment of Lake Ontario supplies completed by Stantec (*2009*) included operator interviews for the Durham Region treatment plants to identify potential concerns regarding these supplies. The following concerns were not based on conclusive scientific evidence but on the fact that there are existing activities in the area near Ajax Water Supply System which may have potential impact:

- Taste and odour in late summer/early fall;
- Turbidity from Duffins Creek WWTP;
- Industrial discharges to the nearshore environment;
- Salt runoff from Highway 401; and
- Pickering Nuclear Generating Station (radionuclides greater than background).

Raw Water: Water that is in a drinking-water system or in plumbing that has not been treated in accordance with, (a) the prescribed standards and requirements that apply to the system, or (b) such additional treatment requirements that are imposed by the license or approval for the system.

2.3.2 Municipal Groundwater Systems

There are five groundwater-based large municipal residential drinking water systems in the TRSPA, as shown in **Figure 2.7**. In the Region of Peel there is one system in Palgrave-Caledon East, and in York Region there are systems in Kleinburg, Nobleton, King City, and Stouffville.

The municipal system in Uxville, although included in **Figure 2.7**, is not considered to be a residential system since it services an industrial park. It was designated for inclusion in this report by a council resolution from the Durham Region. This sixth system is discussed separately under designated municipal drinking water systems.

In addition, there are three groundwater-based large municipal residential drinking water systems in CVC and SGBLS whose WHPAs extend into TRSPA, these being the Region of Peel's Cheltenham system, Orangeville, and the Region of York's Newmarket-Aurora system.

Data regarding the five municipal residential drinking water systems, within TRSPA, and Uxville and their wells are summarized in **Table 2.7**. Annual monitoring reports are publicly available from the regions or over the internet (www.peelregion.ca, www.york.ca, and www.region.durham.on.ca). Each of the six systems is characterized below, including treatment and monitoring programs.Data regarding municipal residential drinking water systems whose WHPAs extend into TRSPA from other Source Protection Areas are outlined in their respective Assessment Reports.

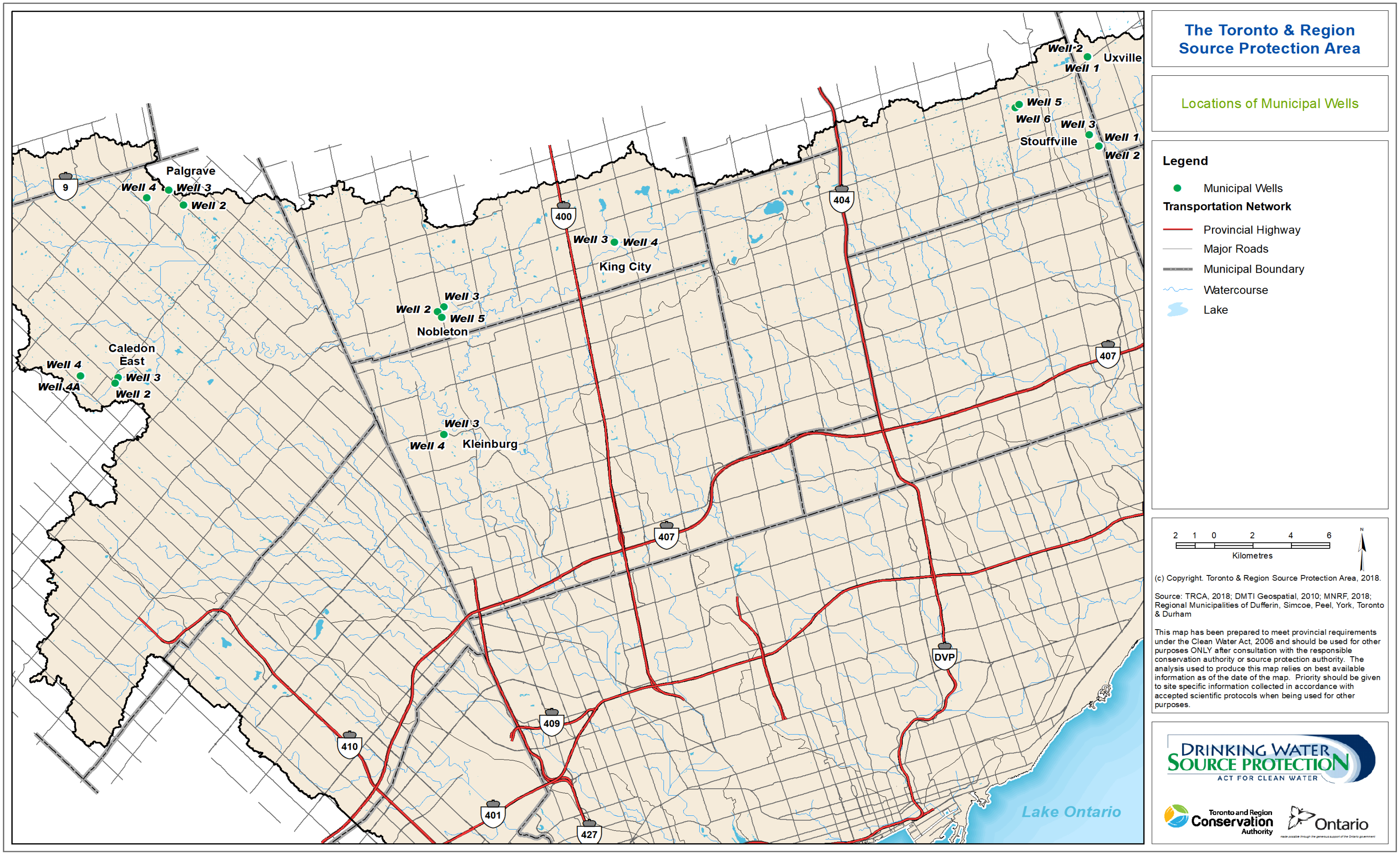

Figure 2.7: Locations of Municipal Wells

Table 2-7: Municipal Groundwater-Based Drinking Water Supply

Water System	Population Served [1]	Well	Well Depth (m)	Aquifer	Capacity (L/s)	Average Monthly Use (m^3)	Average Annual Use	Comments/ Data Sources
Palgrave	3,670	PAL-2	47	Oak Ridges	30.3	6,103	73,232	[1]Census Canada, 2001 Region of Peel, 2008a,b
		PAL-3	82	Thorncliffe	68.1	40,579	486,944	
		PAL-4	91	Thorncliffe	30.3	6,103	73,232	
Caledon East	5,582	CE-3	48	Oak Ridges	8.1	3,045	36,538	[1]Census Canada, 2001 Region of Peel, 2008c,d
		CE-4	57	Thorncliffe	45.0	33,053	396,632	
		CE-4A	58	Thorncliffe	75	25,100	304,150	
Kleinburg	4,595	KLB-3	77	Scarborough	38.0	30,562	366,750	[1]Census Canada, 2001 York Region, 2008a
		KLB-4	79	Scarborough	60.6			
Nobleton	3,513	NB-2	112	Scarborough	22.7	6,669	80,034	[1]Census Canada, 2001 York Region, 2008b NB-5 based on useage in 2015 and 2016
		NB-3	94	Scarborough	22.7	25,293	303,512	
		NB-5	101	Scarborough	28.9	20,505	205,046	
King City	5,600	KC-3	105	Thorncliffe	11.1	18,169	218,028	[1]Census Canada, 2001 York Region, 2008c
		KC-4	105	Thorncliffe	11.0	30,641	367,694	

Water System	Population Served [1]	Well	Well Depth (m)	Aquifer	Capacity (L/s)	Average Monthly Use (m^3)	Average Annual Use	Comments/ Data Sources
Whitchurch-Stouffville	27,000	STF-1	102	Thorncliffe	4.8	20,045	240,535	Wells 5 and 6 are under the direct influence of surface water[1] Census Canada, 2001 York Region, 2008d
		STF-2	106	Thorncliffe	5.7	19,688	236,254	
		STF-3	29	Oak Ridges	19.3	46,709	560,509	
		STF-5	15	Oak Ridges	19.0	36,699	440,389	
		STF-6	21	Oak Ridges	15.6	32,678	392,134	
Uxville	NA (non-residential)	Well 1	61	Oak Ridges	22.0	1,008	12,097	[1]Census Canada, 2001 Durham Region, 2008a
		Well 2	61	Oak Ridges		80	964	

Region of Peel Residential Groundwater Systems

Palgrave-Caledon East Drinking Water System

The Palgrave-Caledon East Drinking Water System is groundwater-based. Water is pumped from three municipal wells in Palgrave (PAL):

- PAL-2;
- PAL-3 (outside the TRSPA); and
- PAL-4.

PAL-2 is screened within the lower portion of the Oak Ridges Aquifer Complex. PAL-3 and PAL-4 are screened in the Thorncliffe Aquifer that occupies deep bedrock valley systems in the area. PAL-3 is located a few hundred metres north of the TRSPA boundary, in the South Georgian Bay-Lake Simcoe Source Protection Region. It is mentioned in this Assessment Report for completeness, particularly since the WHPA extends into the TRSPA.

The water treatment process consists of iron removal and disinfection. Iron is removed through oxidization by sodium hypochlorite followed by greensand filtration. Sodium hypochlorite (chlorine) is also used for primary and secondary disinfection.

In Caledon East (CE) water is pumped from three municipal wells:

- CE-3;
- CE-4; and
- CE-4A.

CE-3 is screened in the Oak Ridges Aquifer Complex. Raw water is treated with sodium hypochlorite (chlorine) for primary and secondary disinfection. CE-4 and CE-4A are screened in the Thorncliffe Aquifer Complex. The water treatment process includes iron removal and disinfection. Iron is removed through oxidization by sodium hypochlorite followed by greensand filtration. Sodium hypochlorite (chlorine) is used for primary and secondary disinfection.

York Region Residential Groundwater Systems

Between 2003 and 2009, York Region conducted wellhead protection studies for all their wells within the TRSPA. In addition, in 2007 a comprehensive *Water Quality Characterization and Issues Identification* study was completed for all York Region groundwater supply systems (Genivar, 2007). The results of this latter study showed that the shallow and deep groundwater supplies of York Region consistently meet the Ontario Drinking Water Quality Standards (ODWQS). The shallow groundwater supplies, prior to treatment, are susceptible to influence from anthropogenic (human) activities such as nutrient application and de-icing materials. To proactively monitor changes in the groundwater quality, York Region has several sentry wells (wells used for monitoring water levels and water quality within WHPAs) that form part of the region’s groundwater monitoring program. York Region samples raw water quarterly at all municipal water supply wells to test for inorganic compounds. In addition, a selected number of sentry wells are tested once per year and microbial samples are obtained weekly from the treated water supply. York Region has municipal water supplies at Kleinburg, Nobleton, King City, and Whitchurch-Stouffville. Each is outlined in greater detail below.

Kleinburg

York Region operates two production wells servicing Kleinburg (KLB) in the City of Vaughan:

- KLB-3; and
- KLB-4.

The water supply is now provided from two wells, since KLB-2 was decommissioned by York Region in 2013. Water treatment for the Kleinburg wells includes the addition of chlorine for disinfection. Sodium silicate is also added to keep the iron in suspension so it does not precipitate out and stain plumbing fixtures and laundry. Following treatment, water can enter the distribution system from the single well pumphouse.

Nobleton

York Region operates three production wells servicing Nobleton (NB) in the Township of King. The following wells provide the water supply:

- NB-2;
- NB-3; and
- NB-5.

Water treatment for the Nobleton wells includes the addition of chlorine for disinfection. Sodium silicate is added to the water following chlorination to reduce the potential for iron to precipitate out and stain plumbing fixtures and laundry in the serviced area. Treated water enters the distribution system from three points: NB-2, NB-3 and NB-5. Currently, one storage tank services the community of Nobleton.

King City

York Region operates the following two production wells servicing King City (KC) in the Township of King:

- KC-3; and
- KC-4.

Water treatment for the King City wells includes the addition of chlorine for disinfection. Sodium silicate is also added to keep the iron in suspension so it does not precipitate out and stain plumbing fixtures and laundry. Following treatment, water enters the distribution system from the two points. There is currently one storage tank servicing the community of King City.

Whitchurch-Stouffville

The water supply in Whitchurch-Stouffville is a blended lake-based and groundwater-based system. The Stouffville (STF) water system includes five production wells servicing the Town of Whitchurch–Stouffville. In 2009, York Region added a connection to provide surface water from the City of Toronto water system (Lake Ontario). Water treatment for the Stouffville wells includes the addition of chlorine for disinfection. Sodium silicate is also added to keep the iron in suspension so it does not precipitate out and stain plumbing fixtures and laundry. Sodium silicate is not added to STF-5 and STF-6 as very low iron levels are present in the shallow groundwater. The groundwater from Stouffville STF-5 and STF-6 receives additional disinfection through an ultraviolet (UV) system, given that the water in these wells is classified as GUDI. Following treatment, water enters the distribution system from three points:

- STF-3 (at the storage tank location);
- STF-5 and STF-6 combined (at the reservoir location); and

- STF-1 and STF-2 combined (at the reservoir location).

There are currently two storage tanks and two reservoirs servicing the community of Stouffville. York Region also operates two booster pumping stations: a small one in Stouffville that supplies water to a number of homes in the Highway 48/Bloomington area, and a second on Tenth Line, near well STF-3.

Designated Municipal Drinking Water Systems (Groundwater)

Uxville Drinking Water Supply

The Uxville well supply system is a groundwater treatment facility operated by the Durham Region that supplies potable water to commercial and industrial consumers in the Uxville Industrial Park development in the Township of Uxbridge. Although it is not a municipal residential system, the Durham Region passed a Council Resolution in 2009 directing TRCA to include it in this Assessmenet Report.

The production well is approved for a capacity of 1,898 m^3/day (0.42 MIGD). A standby well is located at the same site. The treatment process includes chlorination at the main well building. The distribution system delivers the treated water through 2.8 km of watermains and includes a 1,134 m^3 capacity elevated tank for storage and pressure equalization. Sodium hypochlorite is used for disinfection.

Between 2000 and 2004 the Durham Region completed wellhead protection studies for its groundwater-based drinking water systems. Following these studies, the region installed six sentry wells strategically located upgradient of the municipal supply well for monitoring of non-microbiological parameters. The surface water quality in the stormwater management pond located beside the municipal wellhead is also monitored. All measured parameters in Uxbridge and Uxbridge Industrial Park sentry wells were below the applicable ODWQS (Jagger Hims, 2007).

2.3.3 Other Water Use

In addition to documenting municipal drinking water supplies, the *Clean Water Act, 2006* (*CWA)* specifies that assessment reports must also map and describe:

- O. Reg. 170/03 systems, including those that provide drinking water or that serve designated or public facilities (such as community centres, campgrounds, churches, schools, and so on). Provincial data show that 159 O. Reg. 170/03 water systems exist in the TRSPA; and
- Private wells, of which there are an estimated 7,964 within the TRSPA.

The locations of the known O. Reg. 170/03 systems across the TRSPA are shown in **Figure 2.8**. The locations of Permits to Take Water (PTTW) for surface water use are shown on **Figure 2.9** and the PTTW locations for groundwater use are shown on **Figure 2.10**. Most people in the TRSPA live in the south, close to Lake Ontario, and receive their drinking water from lake-based intakes. In addition, the lake-based systems now service communities north of Toronto such as Bolton, Richmond Hill, Thornhill, and Markham, which were once serviced by groundwater-based systems.

Figure 2.8: Other Drinking Water Systems

Figure 2.9: Locations of Permitted Surface Water Use (2002-2005)

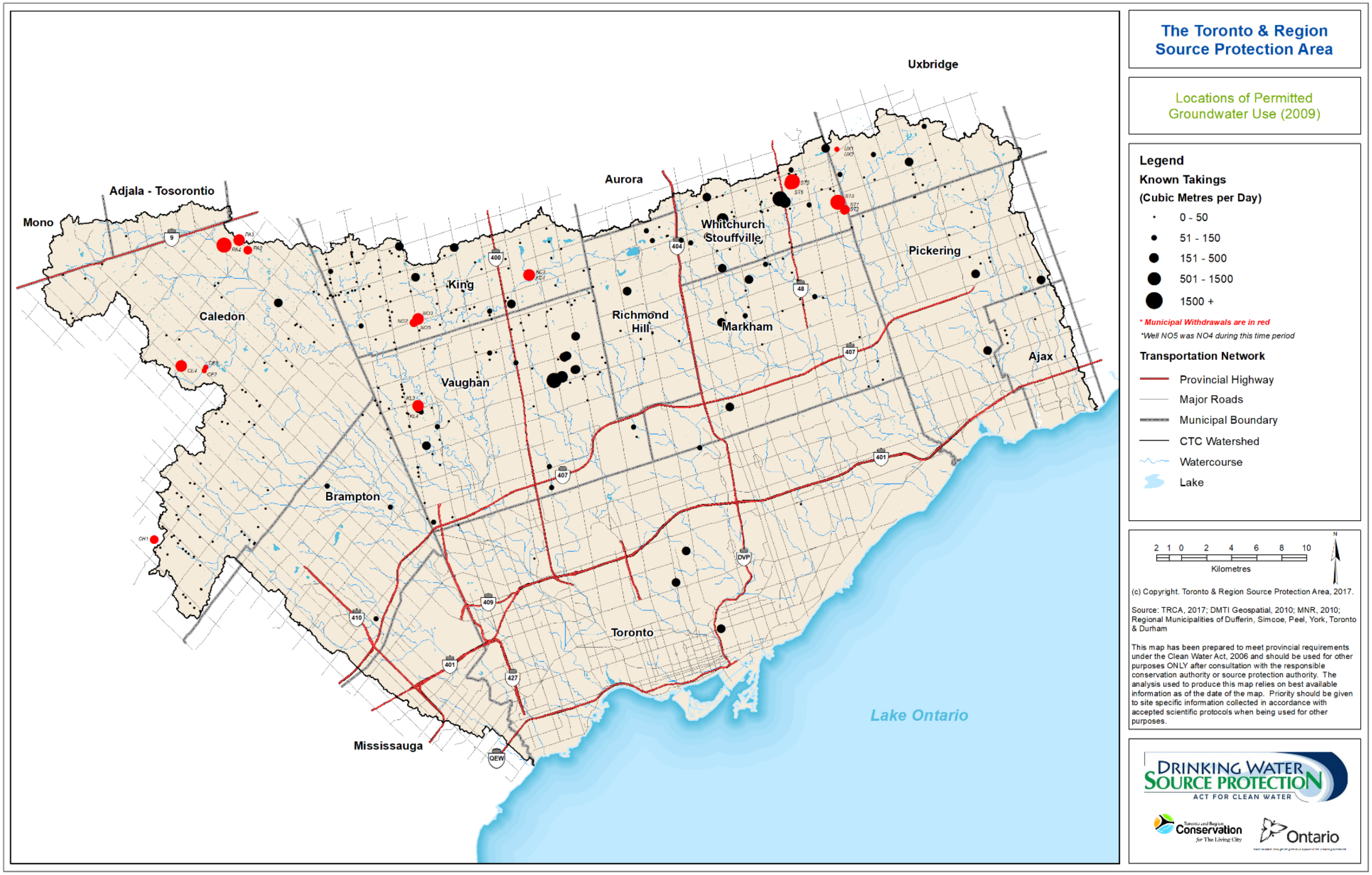

Figure 2.10: Locations of Permitted Groundwater Use (2009)

2.4 WATER QUALITY AND TRENDS

As described in **Section 2.3**, most of the municipal drinking water supplies for the study area come from Lake Ontario. However, several communities in the northern part of the TRSPA jurisdiction rely on groundwater supplies. In addition, about 60,000 rural residents rely on individual private wells.

In this chapter, the general water quality of groundwater and surface water is assessed against water quality objectives and standards that exist to assess ecosystem components and drinking water supplies. It should be noted that the ecosystem-based standards and objectives for surface water vary from drinking water standards that are used to assess drinking water for potential human health impacts.

A wide range of natural and human factors influence water quality. The most important natural influences relate to climate and geology. Both of these can affect how much water is available, and the water quality. Human activities, such as agriculture, industry, and urban development, can have a negative impact on ground and surface water quality. Therefore, uncovering both the natural and human factors in an area is a key for understanding what controls the quality of the water.

It is essential to identify the present surface and groundwater quality, as well as the long-term trends. This helps in understanding whether water quality is improving, getting worse or staying the same.

2.4.1 TRSPA Lake Ontario Drinking Water Intake Water Quality

The Lake Ontario drinking water intakes have provided a consistent source of high quality water to the residents of the TRSPA and neighbouring areas. Each of the upper tier municipalities tests the source and treated waters regularly, and reports are available to the public via the internet. The following pages document the Lake Ontario water supply systems within the TRSPA and provide a succinct summary of the testing programs as well as the overall water quality.

City of Toronto Drinking Water Intakes Water Quality

As mentioned previously, City of Toronto intakes are between 1 km and 5.4 km offshore and at depths of up to 80 m. This minimizes the potential for onshore events such as heavy rainfall to adversely affect finished water quality. City of Toronto samples the treated drinking water at each operating plant every four hours to confirm the absence of bacteria. Overall, more than 50,000 pathogen tests are done at the filtration plants every year, to monitor incoming water and process water quality, as well as the finished product. Additionally, approximately 20,000 bacteriological tests are done on water samples collected from the distribution system to ensure that degradation does not occur following treatment.

Although fecal coliform and/or *E. coli* bacteria were detected in a few samples of the raw water, none were detected in either the treated or distribution water samples. No other parameters were detected above the ODWQS in either the raw water or the treated water. The 2008 Annual Report is included in **Appendix B4**. For more information, see the City of Toronto Water website at www.toronto.ca/water/supply.

Durham Region Drinking Water Intake Water Quality

The Ajax drinking water system draws water from Lake Ontario, with the intake located about 2.5 km offshore at a depth of about 18 m below the surface. As with the Toronto systems, the long intake length provides isolation from nearshore human activities and influences. Extensive water quality testing is conducted by Durham Region, including for pathogens, metals, nutrients, hydrocarbons, herbicides, pesticides, and radioactivity.

Although during testing fecal coliform and/or *E. coli* bacteria were detected in the raw water, none were detected in either the treated or distribution water samples. No other parameters were detected above the ODWQS criteria in either the raw water or the treated water. The 2009 Annual Report is included in **Appendix B4**. For more information, visit the Durham Region website at: https://www.durham.ca/en/living-here/about-water.aspx

Region of Peel Drinking Water Intake Water Quality

A number of residents in the TRSPA receive their drinking water from Lake Ontario treated through the South Peel Drinking Water System operated by the Region of Peel. Since the intakes for the water treatment plants are located within the Credit Valley Source Protection Area, the discussion of quality, vulnerability and threats are included in the report for that Source Protection Area. For more information, visit the Region of Peel website at:

https://www.peelregion.ca/drinking-water/quality-reports.asp

2.4.2 Contaminants of Emerging Concern

Contaminants of emerging concern include pharmaceuticals, personal care products, endocrine disruptors, antibiotics, and antibacterial agents. The public has expressed concern regarding the implications of these trace contaminants in finished drinking water and the issue has been highlighted in many publications. Justice O'Connor's recommendations in Part II of the Walkerton Report (2002) include the statement that "water providers must keep up with scientific research on endocrine disrupting substances and disseminate the information". Pharmaceuticals and personal care products are found where people or animals are treated with medications, and where people use personal care products. These contaminants are often found in rivers, streams, lakes and groundwater influenced by wastewater treatment plants.

The Ministry of the Environment and Climate Change recently released the findings of their survey of the occurrence of pharmaceuticals and other emerging contaminants in samples of source and treated water collected in 2005 and 2006 (MOE, 2010). The samples were collected from 17 different drinking water systems and were analyzed for 46 compounds including antibiotics, hormones, pharmaceuticals, and biosphenol A. Samples were drawn primarily from lake and river source waters, from treated drinking water, and from three groundwater based systems. Of the compounds analyzed, 23 were detected in surface source water and 22 were detected in finished drinking water at concentrations well below the maximum acceptable daily intake levels for drinking water.

The report suggests that an individual would have to drink thousands of glasses of water in a day to reach the maximum acceptable level for the compounds detected. The Ministry of the Environment's report also indicated that existing treatment processes reduce the concentrations of most frequently detected compounds. Although at this time, future studies have not been defined, it is expected that work will continue in this area both in the academic and regulatory environment as this remains an important subject of public concern.

2.4.3 Pathogens

Lake Ontario is the source of drinking water for approximately 6 million Canadians. Despite this importance, there has been little systematic investigation of the occurrence of waterborne pathogens other than total coliforms and *E. coli* in the offshore waters that serve as the source water for many communities around Lake Ontario. Waterborne pathogens can enter the lake from a wide variety of potential sources of fecal pollution, including river and stream discharges, sewage treatment plant outfalls, storm sewers (combined and separated), and numerous other shoreline sources ranging from wildlife droppings to diverse urban and agricultural runoff activities. Once in the lake, waterborne pathogen persistence and transport can be influenced by a variety of physical, chemical, and biological processes such as: alongshore and offshore water movements, upwelling and downwelling events, precipitation events and flooding, seasonal fluctuations in water temperature, levels of nutrients and other biota in the water, and changes in climate and lake water levels. A better understanding of the occurrence of waterborne pathogens in offshore waters in Lake Ontario is needed to help water treatment plants continue to provide safe drinking water supplies for millions of Canadians living around the lake. However, it must be noted that drinking water standards have not yet been developed for several pathogens.

As part of the Lake Ontario Collaborative, a study was undertaken to investigate the occurrence of waterborne pathogens in offshore source water used by selected drinking water treatment plants on Lake Ontario. The study sought to establish a benchmark of waterborne pathogen occurrence that can be used to understand future trends in source water quality that may be influenced by aspects ranging from climate change, to increasing urbanization, and to changes in wastewater infrastructure or land uses around Lake Ontario. The study also investigated the value of different microbial water quality indicators in offshore settings, applying source tracking tools to identify sources of fecal contamination and pathogens at offshore locations, and providing data on waterborne pathogen occurrence to support quantitative microbial risk assessments of Lake Ontario sources of drinking water. The study focused on three drinking water treatment plants in the vicinity of the mouth of the Credit River in western Lake Ontario as a pilot to simulate the Lake Ontario Collaborative water treatment plants. The results of this study are presented in the *Progress Report on Investigation of Waterborne Pathogen Occurrence in Source Water of Lake Ontario Drinking Water Treatment Plants near the Credit River (2007-2008*) (Edge *et al*., 2008).

2.4.4 TRSPA Watersheds and Great Lakes Agreements

As part of the information used to undertake the threats inventory and issues evaluation for the lake-based water systems described in **Section 2.3.1**, data were incorporated from the Great Lakes Surveillance Program, a program conducted by Environment Canada under the *Great Lakes Water Quality Agreement* between Canada and the United States.

To achieve water quality goals and objectives set under the Great Lakes Water Quality Agreement, Canadian and U.S. federal governments are developing Lakewide Action and Management Plans (LAMP) in conjunction with the Province of Ontario and the states within the Great Lake watersheds. Lakewide Action and Management Plans are broad plans to restore and protect water quality in each Great Lake (Environment Canada, 2005). Information compiled as part of the Lake Ontario LaMP was incorporated into the technical studies completed for the TRSPA water supply systems.

The work undertaken and described in this report contributes to the achievement of Goal 6 under Annex 3: Lake and Basin Sustainability under the *Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem* (Environment Canada, 2007). This report also addresses two key results identified under Goal 6 of Annex 3 by identifying and assessing the risks to drinking water sources on Lake Ontario (Result 6.1), and developing knowledge and understanding of water quality and water quantity issues of concern to Lake Ontario (Result 6.2).

The Toronto and Region Area of Concern (AOC) extends from the Rouge River to Etobicoke Creek, and is one of 40 locations around the Great Lakes where local environmental degradation may be causing harm to the wider Great Lakes system. Toronto and Region is the only AOC in the CTC region. The primary causes of this degradation are population growth, increasing urbanization, and stormwater. The clean-up, or remediation, of an AOC occurs through a mandated process called a Remedial Action Plan, or RAP. An individualized RAP is required for each AOC, and an AOC cannot be considered remediated until all stages of the RAP have been completed and documented. The RAP documentation process occurs at the end of each of the three stages:

- Stage 1: Environmental Conditions and Problem Definition;
- Stage 2: Goals, Options, and Recommendations; and
- Stage 3: Evaluation of Remedial Measures and Confirmation of Restoration of Uses.

The status of an AOC is determined by assessing the state of local environmental conditions against fourteen different Beneficial Use Impairments (BUIs), as identified in the *Great Lakes Water Quality Agreement* (Annex 2, 1987). Each BUI describes a human or ecological use of the ecosystem that has been lost or impaired as the result of environmental degradation. An AOC is therefore considered impaired when local conditions meet the descriptions of one or more BUIs. The Toronto and Region AOC is currently deemed to have eight beneficial use impairments, three beneficial uses that are not impaired, and three beneficial uses that require further assessment.

Stage I of the formal *Toronto and Region Remedial Action Plan* was initiated in 1987, and the Stage I report *Environmental Conditions and Problem Definition* was released in 1989. The Toronto and Region RAP principles and goals (the criteria for removing Toronto and Region from the list of AOCs) were provided in the Stage 2 report *Clean Waters, Clear Choices* (1994). Toronto and Region is currently in Stage 3 (implementation) of the RAP process. Two major interim reports, *Clean Waters, Healthy Habitats* (2001) and *Moving Forward* (2007, released 2009), have been issued that detail environmental monitoring results, achievements in remediation initiatives, as well as how conditions in Toronto and Region's compare against the BUI criteria. Although the challenges are many, the Toronto and Region RAP team believes the Toronto and Region could, with the requisite government investment, be in a position to prepare the Stage 3 RAP report and seek delisting as an area of concern by 2020. Please see https://torontorap.ca/ for more information.

The Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement is a good faith agreement between the eight U.S. Great Lakes states and the provinces of Ontario and Quebec. The agreement is intended to implement the *Great Lakes Charter* and the *2001 Great Lakes Charter Annex*. The agreement sets out objectives for the signatories related to collaborative water resources management and the prevention of significant impacts related to diversions, withdrawals and losses of water from the Great Lakes Basin (Ministry of Natural Resources, 2005). The agreement also lists conditions under which transfers of water from one Great Lake watershed into another (intra-basin transfer) can occur.

Currently, 97 percent of the population in TRSPA receives drinking water from the five surface water intakes located in Lake Ontario. Most of the wastewater is discharged to Lake Ontario, including waters that are transferred across the Lake Ontario and Lake Huron divides to serve the communities of Aurora and Newmarket. Under the *Sustainable Water Resources Agreement*, York Region received a permit to allow for Lake Ontario to be transferred into the Lake Huron watershed, with return flow to Lake Ontario, to serve the towns of Aurora and Newmarket. Drinking water is pumped from Region of Peel and Toronto Lake Ontario water plants to York Region’s extensive water system which includes the communities of Markham, Richmond Hill, Vaughan, Aurora, and Newmarket. This new permit required approval from all Great Lakes states and provinces and is the first permit of this type under the 2005 Sustainability Agreement.

As required by the *Safe Drinking Water Act, 2002*, Drinking water systems are required to monitor their water quality to ensure it meets provincial standards. This usually involves sending water samples to laboratories specially licensed to test drinking water. O. Reg. 170/03 provides detailed requirements for sampling, analysis, and reporting of drinking water quality. The latest public reports on municipal drinking water quality for the TRSPA jurisdiction are included in **Appendix B4**.

2.4.5 Lake Ontario Raw Water Quality Summary

In general, the source of drinking water was found to be of high quality. Operating authorities reported the source as excellent, predictable, and easy to work with. Fluctuations in raw water quality were the result of seasonal, weather-related events. This report used data from the 2004–2009 Annual Drinking Water Quality Reports published by the City of Toronto, Region of Peel, York Region, and the Regional Municipality of Durham.

Contaminants of emerging concern (pharmaceuticals, personal care products, endocrine disruptors, antibiotics, and antibacterial agents) were sampled from groundwater, lake, river source waters, and from treated drinking water, and were analyzed for compounds including antibiotics, hormones, pharmaceuticals, and biosphenol A. The analyses revealed that the observed concentrations were found to compare well below any maximum acceptable daily intake levels for drinking water.

Pathogen issues have not been identified for the Lake Ontario intakes, and there has been little systematic investigation of the occurrence of waterborne pathogens other than total coliforms and *E. coli* in the offshore waters. Therefore, a better understanding of the occurrence of waterborne pathogens in offshore waters in Lake Ontario is needed to help water treatment plants continue to provide safe drinking water supplies for millions of Canadians living around the lake.

Canadian and U.S. federal governments have established *The Great Lakes Water Quality Agreement* and the *Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement*. Under these agreements, Lakewide Management Plans (LaMP) are being completed. These plans will address the risks to drinking water sources and develop knowledge and understanding of water quality and water quantity issues of concern to Lake Ontario.

2.4.6 TRSPA Surface Water Quality (Inland Watercourses)

Inland watercourses are not used for drinking water supplies within the TRSPA. However, the creeks and rivers located in the TRSPA drain directly into Lake Ontario and have the potential to contribute pollutants to the lake. These pollutants, including sediments and nutrients, as well as organic and inorganic contaminants, contribute to the overall water quality of the near-shore of Lake Ontario.

Data from the MOECC Provincial Water Quality Monitoring Network (PWQMN) and TRCA's Regional Watershed Monitoring Program (RWMP) have been analyzed for 2003–2007 (locations shown in **Figure 2.11**). This program includes the collection of grab samples once per month at 36 stations and therefore the results represent ambient water quality conditions. Where applicable, water quality results are compared to numerical objectives (e.g., Provincial Water Quality Objectives (PWQO)) to determine if surface water quality within the TRSPA meets these objectives. In addition, trends over time are presented for stations where sufficient historical data are available. For additional information, please refer to the report *Source Water Protection: Surface Water Quality Update* (TRCA, 2009), included in **Appendix B2.**

Total Suspended Solids (TSS)

TSS represents the amount of particulate matter (e.g., silt, clay, organic and inorganic matter, etc.) suspended in water. Some common sources of TSS, include runoff from construction sites and agricultural fields as well as eroding stream channels. TSS can act as a transport vector for contaminants such as metals. Elevated concentrations of TSS can cause clogging and abrasion of fish gills. TSS can also cause habitat changes such as smothering of fish spawning and nursery areas.

No stations had *median* TSS concentrations higher than the PWQO of 30 mg/L (CCME, 2002). Many stations had individual readings that exceeded the objective. The highest median TSS concentrations were in the mid-reaches of the Humber and Rouge River watersheds, although it should be noted that the sampling is typically conducted during dry weather conditions, which may not be representative of typical flow conditions.

Figure 2.11: Regional Monitoring Network Locations

Construction activities associated with ongoing changes in land use from agricultural to urban likely contributed to elevated stream sediment concentrations in these areas. No relationship was found between *median* TSS concentrations and urban land cover. Of the six sites with sufficient TSS data for temporal analysis, five sites showed a decreasing trend in TSS.

Chloride (Road Salt)

Chloride is the primary component of road salts applied to roads and parking lots for de-icing during the winter. Chloride can be toxic to aquatic organisms with acute effects at high concentrations and chronic effects at lower concentrations. The median results show that, in general, chloride concentrations are highest near the watershed outlets and decrease toward the headwaters. Median chloride concentrations for 44% of the sites monitored exceeded the British Columbia PWQO of 150 mg/L (BC MOE, 2003). The median concentration at two sites (6% of the total) exceeded the 600 mg/L maximum objective (BC MOE, 2003). Six sites (17%) had maximum concentrations below 150 mg/L. These stations are located in the predominantly rural upper reaches of the Humber River, Rouge River, and Duffins Creek. The 75th *percentile* at 11 sites (29%) was greater than the 600 mg/L upper limit.

Eutrophication: ecosystem responses to elevated nutrient concentrations that lead to changes in animal and plant populations and degradation of water and habitat quality.

Median: One type of average, found by arranging the values in ascending order and then selecting the one in the middle.

Percentile: in statistics, a value on a scale of one hundred that indicates whether a distribution is above or below it.

A significant positive linear relationship between urban land cover and median chloride concentrations suggests that stream concentrations of chloride are closely associated with the density of road networks upstream of the sites. All 12 stations that had sufficient data for trend analysis showed increasing chloride concentrations over time, reflecting the general increase in urbanization over the last three decades.

Total Phosphorus

Phosphorus is an element that stimulates plant and algae growth. At elevated concentrations, phosphorus can have negative effects on receiving waters, such as *eutrophication*. This can cause reduced biodiversity, decreases in ecologically sensitive species, increases in tolerant species, and anoxia. Common sources of phosphorus include fertilizers and sanitary sewage effluent.

Median phosphorus concentrations for 77% of the sites monitored exceeded the PWQO of 0.03 mg/L (OMOEE, 1994). Only eight sites had median phosphorus concentrations at or below 0.03 mg/L, of which five were located in the Duffins Creek watershed. The highest median phosphorus concentration (0.16 mg/L) was measured at station 85014 at the mouth of the Don River. Station 85014 is located approximately 1.5 km downstream of the North Toronto WWTP. A significant positive relationship was found between median total phosphorus concentrations and urban land cover. In general, total phosphorus concentrations have decreased over time. With the exception of two stations, all stations showed a decrease in total phosphorus over time. This decrease can be largely attributed to the decommissioning of several sewage treatment plants within the TRSPA, restrictions imposed on phosphates in detergents, and programs aimed at reducing phosphorus from municipal sources.

Nitrogen Compounds

Leachate: The liquid produced when water percolates through any permeable material, particularly landfills.

Nitrogen compounds (e.g., nitrate, unionized ammonia) are nutrients with sources and effects similar to phosphorus. Nitrite and unionized ammonia are potentially toxic to aquatic organisms at elevated concentrations. Some sources of nitrogen compounds include septic tanks, fertilizers, and landfill *leachate*.

All stations monitored had median nitrate values below the 2.93 mg/L PWQO (OMOEE, 1994). Several sites had individual sampling points that were above the objective. In particular, Station DM 6.0 at the outlet of Taylor–Massey Creek (in the Don River watershed) had the highest median nitrate value at 2.34 mg/L, followed by station 104037 in Mitchell's Creek (in the Duffins Creek watershed) with a median value of 2.06 mg/L. The reason for the high nitrate levels at DM 6.0 is unclear, but Station 104037 is located less than 1 km downstream from a golf course, which may be influencing the nitrate concentrations at this location.

The median and 75th percentiles of unionized ammonia concentrations at all stations except one were less than the PWQO of 0.02 mg/L (OMOEE, 1994). Station 85014 located at the mouth of the Don River had significantly higher concentrations of unionized ammonia. The median unionized ammonia concentration at this station was 0.06 mg/L, which exceeds the PWQO of 0.02 mg/L. Station 85014 is located approximately 1.5 km downstream from the North Toronto WWTP.

A significant positive relationship exists between the percentage of urban land cover and both median unionized ammonia and nitrate concentrations but there were insufficient data for temporal trend analysis for either parameter.

Selected Metals

Many metals occur naturally in the environment but may be elevated in surface waters due to anthropogenic sources. Metals can be toxic to fish and other aquatic organisms at varying concentrations. Metals commonly enter waterways through urban runoff, industrial discharge, pesticides, and fertilizers. An example of a metal found in the surface water within the TRSPA is copper. Sources of copper include the weathering of copper minerals, brake line deterioration in vehicles, industrial processes, fungicides, and insecticides. Copper strongly adsorbs to particulate matter (e.g., soil particles) and therefore tends to accumulate in stream sediments. Because a variety of organisms live in or are in contact with the stream bed, sediments act as an important route of exposure for aquatic organisms (CCME, 1999). Research has shown that elevated copper concentrations in the aquatic environment are usually associated with urbanized and industrial areas (MOE, 2003).

The median results for most stations across the TRSPA are below the PWQO of 5 µg/L (OMOEE, 1994). Three stations (8%) had median copper concentrations exceeding the PWQO:

- Station MM003WM, located downstream of Pearson International Airport; and
- Stations HU1RWMP and 83012, located in the highly urbanized Black Creek subwatershed of the Humber River watershed (this subwatershed also has few stormwater management facilities).

The lowest median copper concentrations were recorded in the headwaters of the Humber and Rouge rivers. There was a strong, positive relationship between median copper concentrations and urban land use. However, due to changes in analytical methodology over time, copper results were not analyzed for temporal trends.

Pesticides

Pesticides comprise various compounds used to control weeds and insects. The most obvious effect of pesticides on fish and other wildlife is acute poisoning but certain pesticides can also affect the reproductive potential of fish and wildlife. Pesticides can also cause health effects in humans, such as infertility and cancer.

Pesticide samples for the Don and Humber rivers were collected from 1998 to 2002 as part of the *Occurrence of Lawn Care and Agricultural Pesticides in the Don and Humber River Watersheds (1998–2002*) report (Environment Canada *et al*., 2008). Eleven pesticides and one metabolite were detected in surface waters of the Don and Humber rivers watersheds. These included 2, 4-D, atrazine, bromacil, carbofuran, chlorpyrifos, cypermethrin, diazinon, dicamba, MCPP, metolachlor, metribuzin, and desethyl atrazine (an atrazine metabolite). Approximately 72% of samples contained at least one pesticide attributed to lawn care. Water quality criteria were exceeded for four pesticides: diazinon, atrazine, carbofuran, and chlorpyrifos. Diazinon exceeded the PWQO of 0.08 µg/L (OMOEE, 1994) for over one-quarter of the samples taken. For the other three pesticides, less than 1% of the samples taken exceeded their respective objectives.

Pathogens (E. coli)

E. coli bacteria comprise a large and diverse group and are commonly found in the intestines of warm-blooded animals. *E. coli* are used to indicate the presence of fecal waste in water. Some strains of *E. coli* can cause human illness (e.g., diarrhoea, urinary tract infections). Common sources of *E. coli* include sewage from improper sewer connections, CSO, inputs from wildlife and livestock, and organic fertilizers.

In general, *E. coli* concentrations were lowest in the headwaters and increased downstream toward stream outlets. Median *E. coli* levels at 89% of the sites monitored were above the PWQO of 100 CFU/100 mL (OMOEE, 1994). Samples in the Don River watershed and older urbanized portions of the Humber River, Etobicoke Creek, and Mimico Creek watersheds often receive untreated stormwater and some areas also have CSOs. High *E. coli* loadings from tributaries may contribute to waterfront beach closings. The lowest *E. coli* concentrations were in Duffins Creek and the upper reaches of the Humber and Rouge rivers where urbanization is lowest. Four sites (11%) had median *E. coli* values less than the 100 CFU/100 mL PWQO. These sites were located in the Humber and Rouge rivers and Duffins Creek watersheds. A significant positive relationship was found between urban land use and median *E. coli* counts. There were insufficient data for temporal trend analysis of *E. coli* data.

2.4.7 Tributary Loadings to Lake Ontario

It is important to recognize that the Niagara River accounts for 80% of the flow entering Lake Ontario. The Niagara River is the largest single source of materials entering the lake and has a dominating influence on the chemistry of the entire lake. However, contaminants from other water courses can influence near shore water quality along the TRSPA shoreline of Lake Ontario following major storm events. These events typically occur in the summer months, and during periods of snow melt or rainfall induced runoff during frozen ground periods over winter. Whether drinking water plant intakes witin TRSPA jurisdiction are affected depends on mixing and circulations patterns in the lake. Watershed inputs can, under certain “in-lake” mixing conditions impact the quality of source waters entering the municipal drinking water treatment plants.

Daily load data illustrates that a few large events occur each year that transport a significant proportion of the load to the lake. It is during these periods that watershed influences will likely be observed at drinking water intakes in Lake Ontario. When and where spikes of turbidity occur at the intakes will depend upon physical mixing and transport functions of the nearshore zone. Lake wide modelling studies, undertaken as part of IPZ-3 studies (**Chapter 5**) can be of assistance in interpreting what constitutes important local watershed runoff events. Of course, an extreme storm can occur at any time including the summer months.

Between 2007 and 2009, 12 surveys of the pathogen indicator *E. coli* were completed in Lake Ontario. These surveys were taken at varying distances along transects which extended 3 km offshore. At the same time, wet weather samples were collected for *E. coli* in Duffins Creek and Carruthers Creek. The surveys extended from Carruthers Creek in the east to the Rouge River in the west. Water temperature, currents, and water quality were measured hourly to confirm the transport and dilution of pathogens.

These measurements represent periods when the lake was under the influence of watershed discharge. They also include upwelling and downwelling conditions in the lake.

ODWS: Water quality standards through which the Provincial Government of Ontario regulates drinking water quality. Standards contain maximum allowable concentrations (MAC) for major inorganic and organic parameters in water.

Figure 2.12 presents observations of *E. coli* in Duffins Creek near the outlet to Lake Ontario. These samples were taken during, or shortly after a storm, and may not represent the maximum values of *E. coli*. Surface water samples taken along the lake transects, approximately 24 hours after the runoff (or runoff from the storm) allow for mixing (dilution) and transport of pathogens along the nearshore. As evident in **Figure 2.12**, spikes in *E. coli* counts trend or tend to increase with creek discharge, but factors such as water temperature, turbidity, etc., have a significant role in the determination of the actual magnitude of *E. coli* counts in Duffins Creek. There appears to be no direct relationship between stream discharge and *E. coli* counts.

It should be noted that the Ajax drinking water intake is located almost 2 km offshore in about 18 m of water, specifically to avoid influences from watershed and storm sewer discharges. While the sampling did not capture all the runoff events, they do provide an indication of in-lake pathogen responses from the watersheds. Counts of *E. coli* in Colony Forming Units (CFU) in Duffins Creek are generally much higher than observed in TRCA's monthly routine monitoring program. Patterns in *E. coli* counts in Carruthers watershed are similar to those reported for Duffins Creek. The Carruthers watershed at 38 km^2 in drainage area contributes significantly less watershed runoff to the nearshore and therefore has a smaller effect on the nearshore water quality. It is important to note that the graph of *E. coli* counts is presented on a log scale, and that the results show a spread of over three orders of magnitude in *E. coli* counts (i.e., range of 10-10,000 CFU/100 ml).

In **Figure 2.13**, sampling dates for lake transects are shown as blue vertical bars in the upper graph of 2008 water temperatures. This graph illustrates that the nearshore areas are routinely under the influence of up and down welling mixing and watershed inputs. Conductivity spikes in the bottom plot, in **Figure 2.13** are functions of runoff from Duffins Creek. The magnitude of conductivity changes, indicates the effect of this creek on nearshore water quality. The three large spikes in conductivity shown for late April, August and November are indications of major runoff events from Duffins Creek that may have a significant effect on nearshore water quality.

Surface water samples were collected for *E. coli* testing at all transect stations during 12 surveys between 2007 and 2009. None of the sites showed *E. coli* counts above 50 CFU/100 ml near the Ajax Drinking Water Plant intake. In fact, across the entire waterfront, *E. coli* samples were routinely close to or below the detection limit of the laboratory. Lake water that is 100 m or more offshore typically meets the *ODWS*. In addition, based on these 12 surveys, we concluded that the Duffin Water Pollution Control

Plant does not have a major influence effect on pathogen counts - an indication that disinfection techniques employed in the treatment of sewage are very effective. **Figure 2.14** through **Figure 2.17** shows typical patterns in *E. coli* across the waterfront in response to watershed and stormwater inputs. Counts greater than 50 CFU/100 ml are typically confined to the immediate nearshore close to watershed and storm sewers outlets. Under the right conditions, large runoff events from the watersheds and storm drainages could result in elevated pathogens at the drinking water intake. For this to occur, large numbers of *E. coli* would have to be present and the plumes from the watersheds would need to be circulated offshore towards the intake, and coincide with mixing process (downwelling) that would transport pathogens down towards the intake. Based upon these surveys and observations of raw water, the nearshore areas of western Durham provide a good source of drinking water. This conclusion is expected to be consistent for the other Lake Ontario intakes within the TRSPA, given the similar intake and shoreline characteristics.

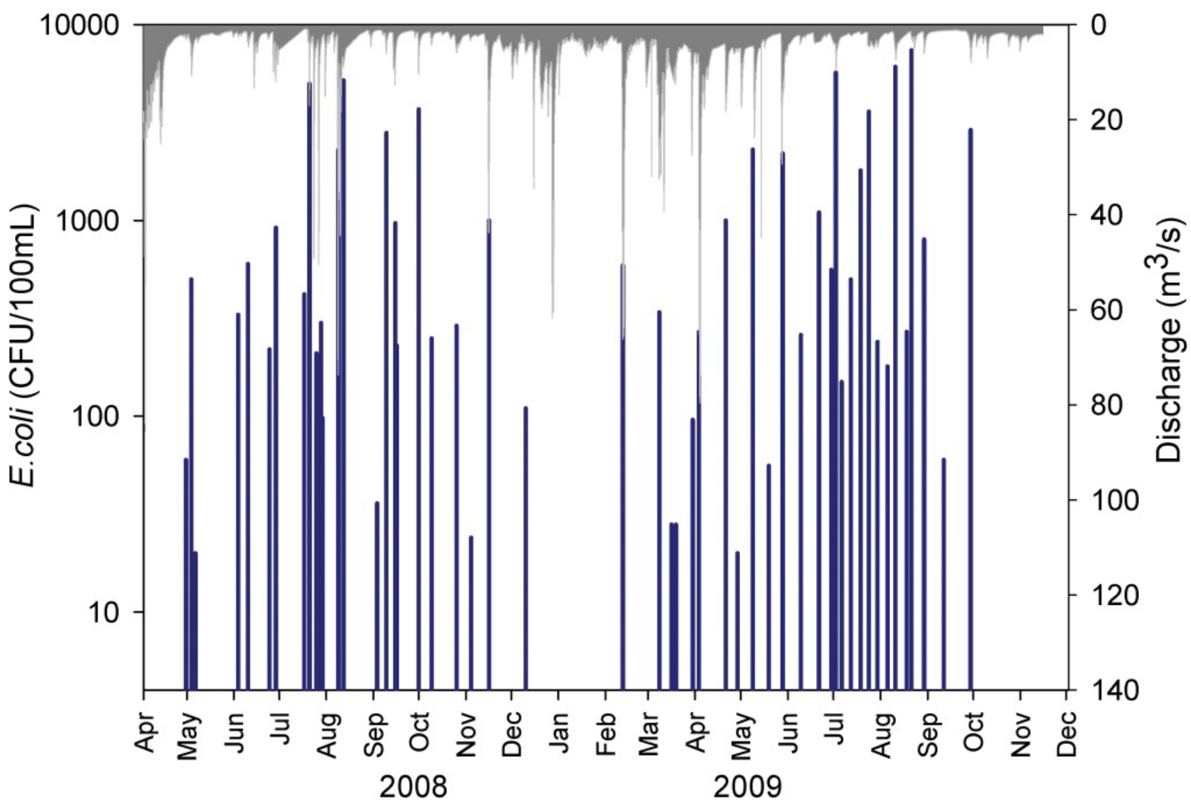

Figure 2.12: Wet weather *E. coli* counts in Duffins Creek

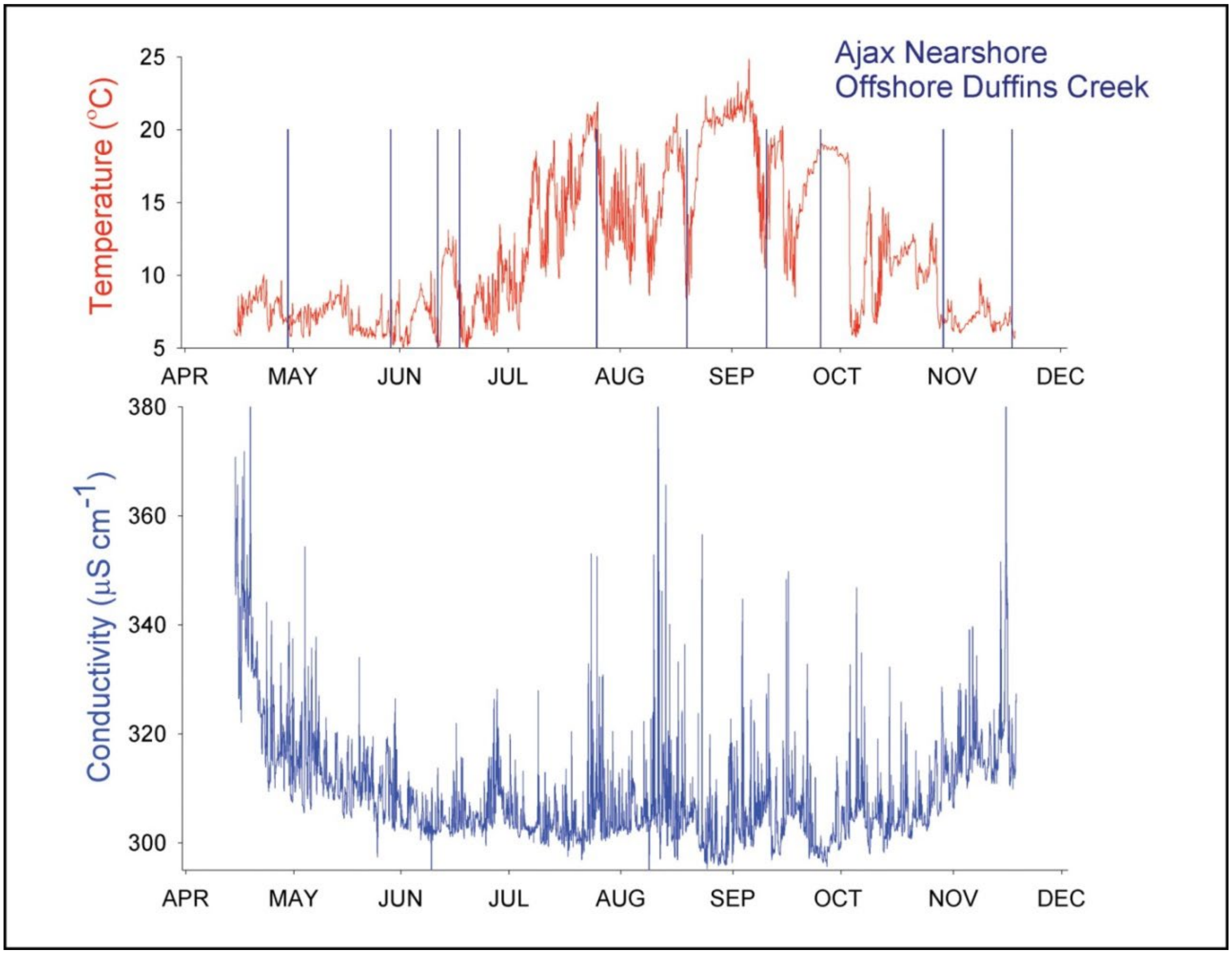

Figure 2.13: 2008 Temperature and Conductivity measurements offshore of Duffins Creek

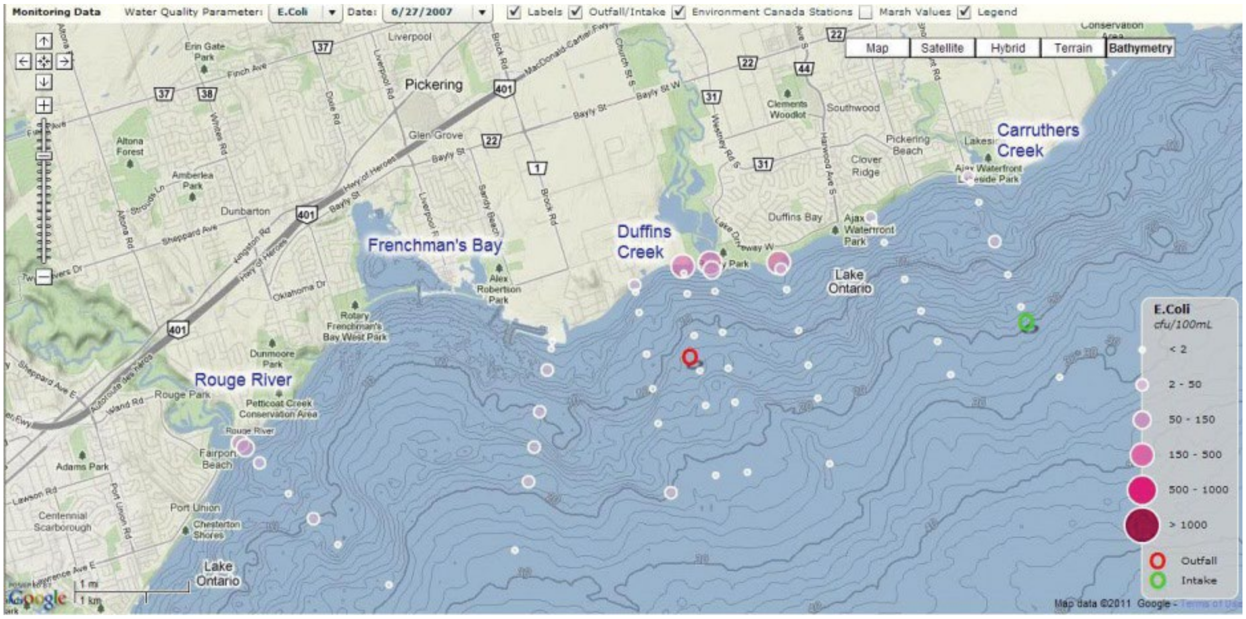

Figure 2.14: Transect *E. coli* counts June 27, 2007

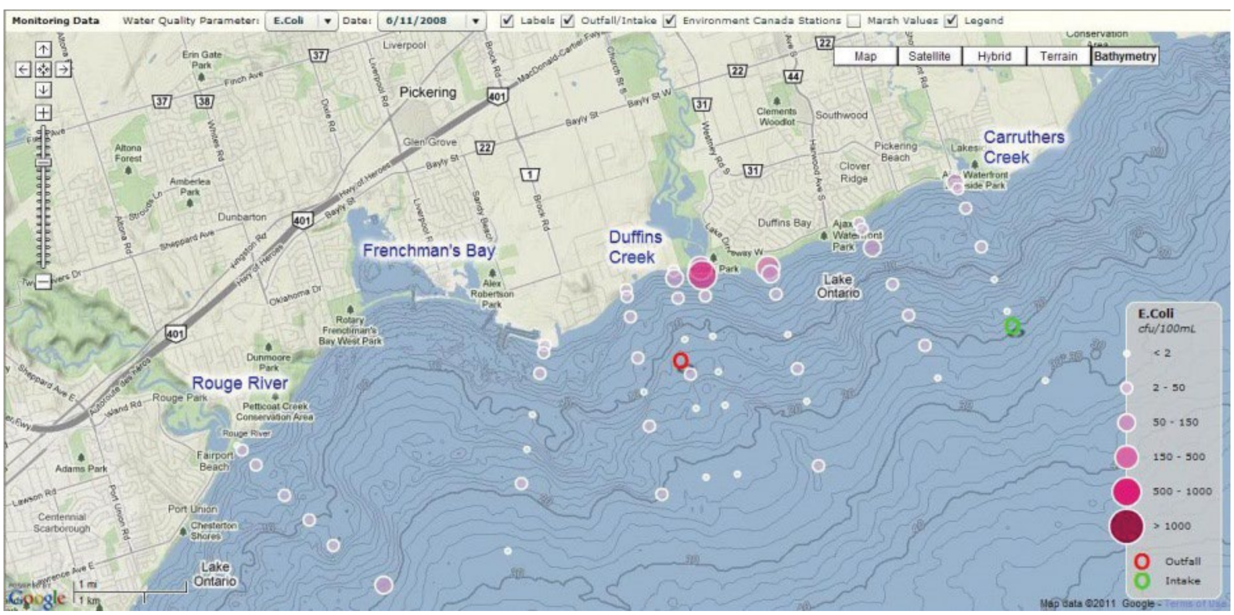

Figure 2.15: Transect *E. coli* counts June 11, 2008

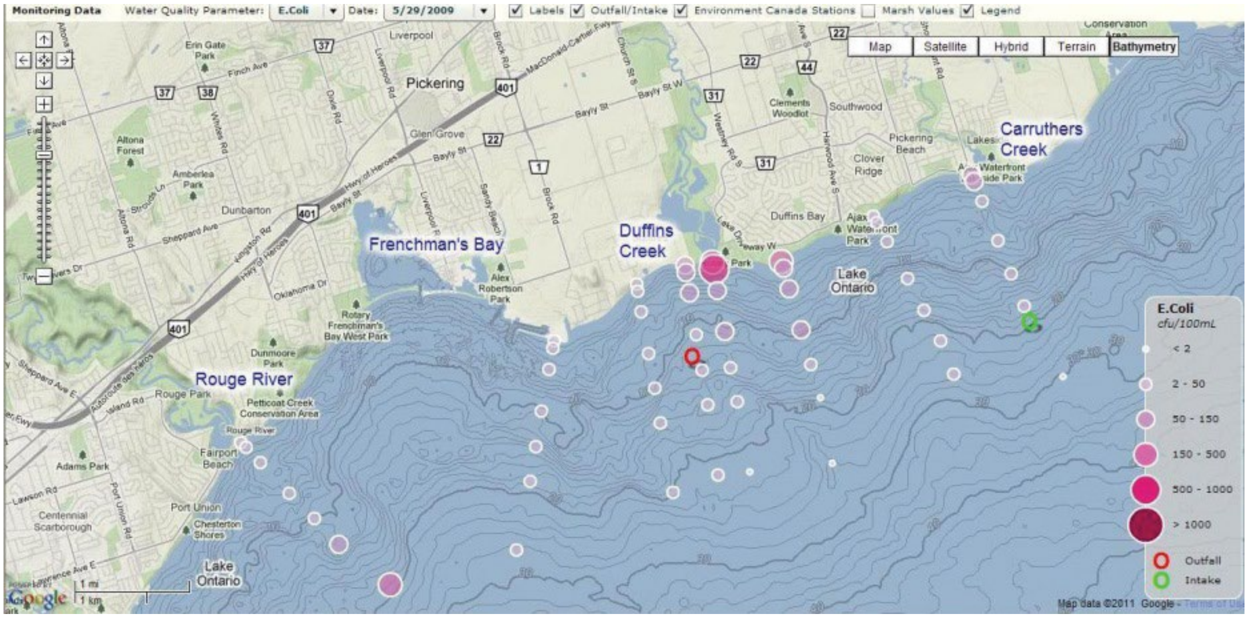

Figure 2.16: Transect *E. coli* counts May 29, 2009

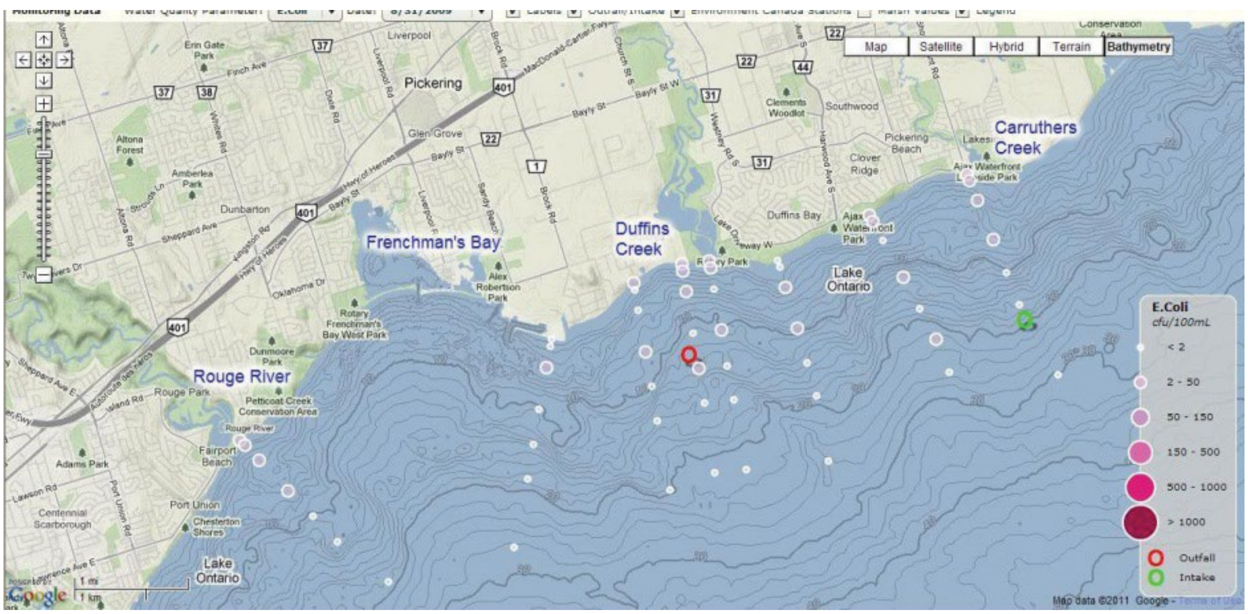

Figure 2.17: Transect *E. coli* counts August 31, 2009

2.4.8 Groundwater Quality

Provincial Groundwater Monitoring Network

While long-term groundwater data trends for specific sites within the TRSPA watersheds are not available, there have been a number of studies conducted that provide an indication of background groundwater quality. These studies include:

- Duffins Creek and Rouge River watersheds (Sibul *et al*., 1977; Howard and Beck, 1986);
- Landfill investigations (M.M. Dillon Limited, 1990; Interim Waste Authority, 1994; Golder Associates, 1994); and
- *York Region Water Quality Study* (Genivar, 2007).

The first extensive study of groundwater quality in the TRSPA was conducted by the MOE in 1970 and 1974, and involved the analysis of 44 groundwater samples from the Duffins Creek and Rouge River drainage basins (Sibul *et al*., 1977). Groundwater within the shale bedrock was found to be of poor quality, particularly for sodium and sulphate, consistent with subsequent analyses conducted for landfill investigations (M.M. Dillon Limited, 1990; Interim Waste Authority, 1994) and unpublished data from sampling by the University of Toronto during the summer of 2000 (Gerber, unpublished data).

Groundwater quality does not appear to vary significantly within any of the three aquifer complexes within the unconsolidated deposits above bedrock (Sibul *et al*., 1977; Howard and Beck, 1986), and appears to be of generally good quality for domestic use. Local occurrences of natural high hardness and iron values have been documented. Methane has been reported in both the Thorncliffe and Scarborough aquifers, either from the decomposition of organic materials (i.e., trees) in the aquifer, or from the underlying shale. Locally elevated levels above drinking water criteria for nitrates and chlorides were believed to represent contamination (Sibul *et al*., 1977).

A subsequent analysis of 260 groundwater samples in the Duffins Creek and Rouge River basin between 1982 and 1984 also revealed the presence of elevated chloride and nitrate values attributed to road salt and nitrate fertilizer contamination, respectively (Howard and Beck, 1986). Current groundwater quality concerns are isolated occurrences of:

- Nitrates and bacteria associated with septic system effluent entering private wells; and
- Chloride values above ODWQS (250 mg/L) in private wells situated next to salted roadways.

Genivar Inc. completed a comprehensive assessment of water quality on behalf of the Regional Municipality of York in 2007. This study concluded that there were no groundwater quality issues associated with municipal drinking water wells within the York Region portion of the TRSPA, although increasing trends of key indicator parameters were identified in the shallow wells in Stouffville (Genivar, 2007). As described above, the Regional Municipalities of Peel, York, and Durham conduct regular chemical sampling of both raw drinking water supplies and sentry wells and no water quality issues have been documented.

Region of Peel

As previously mentioned, the Region of Peel has six drinking water supply wells that service the communities of Caledon East and Palgrave. These wells range in depth from 47 to 91 m, and are therefore well protected from human activities at ground surface. Region staff samples the raw and treated drinking water at both wells according to the schedule and parameter list in the regulations under the *Safe Drinking Water Act*. Additional pathogen tests are performed on water samples collected from the distribution system to ensure that degradation does not occur following treatment.

In 2008, only two occurrences of total coliform bacteria were detected in the raw water, and none were detected in either the treated or distribution water samples. No other parameters were detected above the ODWQS criteria in either the raw water or the treated water. The 2008 Annual Report is included in **Appendix B4**. For more information, visit the Region of Peel website at https://www.peelregion.ca/pw/water/.

York Region

York Region has 12 drinking water supply wells that service the communities of Kleinburg, Nobleton, King City, and Whitchurch–Stouffville. These wells range in depth from 15 to 112 m below ground surface. Region staff samples the raw and treated drinking water at all wells according to the schedule and parameter list in the regulations under the *Safe Drinking Water Act*. Additional pathogen tests are performed on water samples collected from the distribution system to ensure that degradation does not occur following treatment.

Only one occurrence of total coliform bacteria was detected in 2009 in the raw water for a shallow well in Stouffville. No other pathogens were detected in either the treated or distribution water samples. No other parameters were detected above the ODWQS criteria in either the raw water or the treated water. The 2009 Annual Report is included in **Appendix B4**. For more information, visit the York Region website at https://www.york.ca/wps/portal/yorkhome/environment/yr/waterandwastewater.

Durham Region

Durham Region has two drinking water supply wells that service a commercial/industrial area known as the Uxville Industrial Park. These wells extend over 60 m below ground, and therefore the wells are protected from human activities at ground surface. Region staff samples the raw and treated drinking water at both wells according to the schedule and parameter list in the regulations under the *Safe Drinking Water Act*. Additional pathogen tests are performed on water samples collected from the distribution system to ensure that degradation does not occur following treatment.

Only one occurrence of total coliform bacteria was detected in 2008 in the raw water of Uxville (200 CFU/100 ml). No other pathogens were detected in either the treated or distribution water samples. No other parameters were detected above the ODWQS criteria in either the raw water or the treated water. The 2008 Annual Report is included in **Appendix B4**. For more information, visit the Durham Region website at: https://www.durham.ca/en/living-here/about-water.aspx.

TRCA in partnership with the MOECC initiated sampling in 13 selected Provincial Groundwater Monitoring Network (PGMN) wells in September 2003. The list of parameters to be sampled was extensive, including general chemistry (i.e., pH, specific conductance, alkalinity, anions, cations), a full suite of organic parameters (volatile organics, semi-volatile organics, phenols, chlorinated phenols, herbicides, pesticides, polychlorinated biphenyls (PCBs)), and nutrients

Kjeldahl nitrogen: A measure of total organic nitrogen in a soil or water sample.

(nitrate, nitrite, ammonia, total *Kjeldahl nitrogen*). This was followed by further sampling of selected wells for general chemistry in 2003 and 2004. A summary of the data is provided in **Appendix B3.**

Sampling under this program was suspended at the request of the MOECC while issues surrounding the sampling of groundwater wells under the revised O. Reg. 903 were resolved. Sampling of six wells resumed in 2006, when dedicated pumps were installed by a certified water well technician. This sampling program is summarized in **Table 2.8**. Given the limited dataset, it is not yet possible to derive statistical trends from the data. However, it should be noted that no health-related parameters analyzed exceeded the ODWS.

General Chemistry in Groundwater

Two investigations conducted within the Duffins Creek watershed near Whitevale provide insight into the natural chemical evolution of groundwater as it flows through the groundwater flow system (Interim Waste Authority, 1994; M.M. Dillon Limited, 1990). Shallow groundwater within the Oak Ridges Aquifer and the water table within the Halton Till and Glacial Lake Iroquois deposits are generally dominated by calcium and bicarbonate ions. At greater depth within the Newmarket Aquitard, which separates the Oak Ridges and Thorncliffe Aquifer systems, groundwater is dominated by sodium and sulphate ions with lower concentrations of calcium, magnesium and bicarbonate.

The groundwater from the sampled wells contains large amounts of calcium-magnesium-bicarbonate in all three primary aquifer systems. This is common for groundwater in southern Ontario, and well below the ODWS.

Sodium and Chloride in Groundwater

Five PGMN wells have elevated sodium. Four of these are in the Oak Ridges Aquifer and either close to major roadways (W-326-2, W-329) or screened directly above sodium-rich marine shale bedrock (W-327, W-326-3). One well in the Scarborough Aquifer has elevated sodium (W-325). This well is affected by the underlying bedrock.

Chloride concentrations in the PGMN wells range from a low of 1 mg/L at the Claremont Field Centre to a high of 723 mg/L in High Park, Toronto. Elevated chloride concentrations are usually from road salting (e.g., W-328, a shallow well beside Highway 9), and the marine shales of the Georgian Bay Formation (e.g., W-326-3, a deep well in Pickering). One well, at the Kortright Centre for Conservation in Vaughan (W-075), has a chloride concentration of 80–120 mg/L, and is likely being affected by the nearby septic system for the visitor centre.

Nutrients in Groundwater

Phosphorus has low mobility in the groundwater system, and most of the measured concentrations have been below 50 μg/L. On occasion, highly elevated values have been detected in several wells (e.g., 18,700 μg/L in W-075), but these may be artifacts of the sampling process, since other samples from the same wells have had measured concentrations at or below the typical 50 μg/L. There are also no apparent upward or downward trends in the data.

Nitrogen compounds, such as nitrate, are commonly associated with human influences such as septic systems, fertilizer application, and agricultural activities. Natural sources include wildlife, such as large populations of waterfowl in wetlands. Nitrate values in the PGMN wells are generally less than 1 mg/L, well below the ODWQS of 10 mg/L. The highest concentration confirmed was 7.1 mg/L in W-382, a shallow well at Milne Park, in Markham. This well is directly *downgradient* of a subdivision, and is likely affected by local application of lawn fertilizers. All

> **Downgradient:** A downward hydrologic slope that causes groundwater to move toward lower elevations.

wells exhibit stable concentrations of nitrate over time, with the exception of W-330, which is located in a subdivision in Caledon East. This well, like that of W-382, is likely influenced by local application of lawn fertilizers, but the concentration is less than 3 mg/L.

Table 2-8: Provincial Groundwater Monitoring Network Well Summary

Well	Location	Watershed	Formation	Elevated Parameters	Comments
W-006	Bruce's Mills	Rouge	Oak Ridges	iron, hardness	Shallow well in conservation area
W-010	Claremont Field Centre, Pickering	Duffins	Scarborough	iron, sodium, chloride, hardness	Confined aquifer in conservation area, close to bedrock
W-011	Claremont Field Centre, Pickering	Duffins	Thorncliffe	iron, hardness	Confined aquifer in conservation area
W-012	Claremont Field Centre, Pickering	Duffins	Shallow	iron, hardness	Shallow well in conservation area
W-017	Earl Bales Park, North York	Don	Scarborough	choride, sodium, iron, manganese, hardness	Deep well near bedrock
W-021	Heart Lake Conservation Area	Etobicoke	Oak Ridges	sodium, chloride, iron, manganese, hardness	Unconfined aquifer near Heart Lake Road
W-059	Summit Golf Course	Rouge	Oak Ridges	hardness	On the site of a golf course
W-060	Nobleton	Humber	Thorncliffe	iron, manganese, hardness	Confined aquifer
W-061	Nobleton	Humber	Scarborough	iron, sodium, chloride, hardness	Deep well close to bedrock
W-075	Kortright Centre, Vaughan	Humber	Thorncliffe	chloride, sodium, hardness	Close to the Kortright Centre septic system
W-325	High Park, Toronto	Humber	Scarborough	chloride, sodium, hardness	Just above shale bedrock
W-326-2	Taunton Rd., Pickering	Duffins	Shallow	iron, sodium, chloride, hardness	Downgradient of Taunton Road
W-326-3	Taunton Rd., Pickering	Duffins	Thorncliffe	iron, sodium, chloride, hardness	Downgradient of Taunton Road
W-327	King St., Bolton	Humber	Thorncliffe	chloride, sodium, iron, hardness	Confined aquifer beside King Street
W-328	Highway 9/Airport Rd., Mono Mills	Humber	Bedrock	chloride, sodium, nitrate, hardness	Exposed limestone bedrock adjacent to Highway 9
W-329	Old Church Rd., Caledon East	Humber	Oak Ridges	chloride, sodium, iron, hardness	Adjacent to Old Church Road
W-330	Miles Dr., Caledon East, ON	Humber	Thorncliffe	chloride, sodium, iron, hardness	Subdivision in Caledon East
W-366	Heart Lake Conservation Area	Etobicoke	Oak Ridges	manganese, hardness	Unconfined aquifer, not near roadway
W-367	Goreway Dr., Brampton	Humber	Oak Ridges	chloride, sodium, hardness	Just above shale bedrock
W-382	Milne Park, Markham	Rouge	Oak Ridges	nitrate	North of the Milne Park Reservoir

Selected Metals in Groundwater

Metals are typically associated with industrial processes, including historical application of pesticides containing arsenic, landfills, coal-fired generating plants, and deposition of fill materials. Natural sources of metals in the TRSPA are generally limited, with the exception of common elements such as aluminum, iron, and manganese, all of which are found in both the sediments and bedrock of the TRSPA. No elevated concentrations of other metals have been detected above the ODWQS.

Pesticides in Groundwater

Pesticides are associated with lawn care and turf management, as well as agricultural activities, although the *Cosmetic Pesticides Ban Act,* 2008 and O. Reg. 63/09 now prohibit the use of such products for cosmetic use. No herbicides, pesticides, or their breakdown products have been detected in groundwater samples above the ODWQS in either the PGMN sampling or in sampling programs completed by the regions of Peel, York, or Durham.

Pathogens in Groundwater

Pathogens (viruses and bacteria) are commonly associated with agricultural activities and septic systems, but other human sources, such as pet waste, and natural sources, such as waterfowl in wetlands can introduce pathogens into the groundwater system. However, the common illness-causing bacteria generally do not survive in the groundwater environment because of low oxygen and nutrient levels. Therefore, bacteria in groundwater are usually associated with contamination from surface water because of poor well installation or maintenance. Bacteria have not been detected in any of the PGMN wells in the TRSPA, nor in any of the sentry well sampling programs by the regions of Peel, York, or Durham.

2.5 LAND USE

2.5.1 Population Distribution and Density

Studies undertaken on behalf of the Province to support the *Growth Plan for the Greater Golden Horseshoe, 2006* (Growth Plan) project major population growth and urbanization in the TRSPA to the year 2031 (Hemson, 2005). Increases in population and employment growth are projected to be in the range of 45% from 2001 to 2031. **Table 2.9** shows the forecasted growth in upper and single tier municipalities within the TRSPA along with two recent population estimates.

TRSPA does not cover the entire region of Peel, York, and Durham. Therefore, the 2006 census watershed population estimates and the MNRF population estimates are also included in **Table 2.9**. The MNR population estimate is provided by the Province as the basis of apportionment for the conservation authority municipal levy funding. With an estimated 3.8 million residents living in TRSPA watersheds in 2006, and close to 50% growth forecast by 2031, there will continue to be significant stress to the natural environment from overuse and cumulative negative impacts from urban development.

The upper third of the TRSPA watersheds have relatively low population density and are largely rural in nature. Local municipalities such as Caledon, King, Whitchurch–Stouffville and Uxbridge have population densities of fewer than 500 people per square kilometre. These areas will maintain their characteristics in the future due to the requirements of the *Oak Ridges Moraine Conservation Plan, 2002* (ORMCP) and the *Greenbelt Plan, 2005*, both of which restrict urban growth on these lands to existing designated settlement areas. In subsequent discussions in this document, this upper third of the TRSPA will be referred to as the *Greenbelt Area* (see **Figure 2.18**). For definitions of provincial land-use planning designations identified in this report please refer to provincial policies noted above.

Population distribution is currently concentrated in the lower two-thirds of the TRSPA, as shown in **Figure 2.19**. Here, population densities range from highs of 3,900 people per square kilometre in the City of Toronto to 2,000 people per square kilometre in the surrounding "905" municipalities of Mississauga, Ajax, and the southern portions of Markham, Richmond Hill, and Brampton. In subsequent discussions in this document, these urbanized lands will be referred to as the *Built-up Area*.

The remaining undeveloped lands to the north, but still within the approved urban boundary will be referred to as the *Designated Greenfield Area*. The lands outside the urban boundary, extending to the southern limit of the *Greenbelt Area*, will be identified as the Agricultural and Rural Area (see **Figure 2.18**). Full urban build-out, likely beyond 2031, is expected to coincide with the southern limit of the *Greenbelt Area*, eventually encompassing the lower two thirds of the TRSPA watersheds.

The *City of Brampton Official Plan* and the Growth Plan provide two examples of current and future population densities within this area. For the period 2002 to 2007, Brampton planned for an average residential density of 30 housing units/hectare. This density contrasts with the Growth Plan requirements where new development in designated greenfield areas is to be built at a density of not fewer than 50 people and jobs per hectare. Furthermore, the Growth Plan sets out a target to be achieved by 2015 that a minimum of 40% of all new residential growth will occur as intensification in the *Built-up Area*.

Additionally, density targets have been proposed for various Urban Growth Centres as follows:

- In Toronto, 400 residents and jobs per hectare; and
- In other centres such as Markham Centre, downtown Brampton, and Pickering, 200 residents and jobs combined per hectare.

The remaining 60% of new residential growth is proposed to take place in *Designated Greenfield A*reas at a density target of not fewer than 50 residents and jobs per hectare.

Table 2-9: Population Projections

Municipality	Population			
	2001[1]	**2031 Forecast[1]**	**2006 Census[2]**	**MNR, 2009[3]**
Toronto	2,590,000	3,080,000	2,503,275	2,124,651
Peel	1,030,000	1,640,000	442,927	456,991
York	760,000	1,500,000	690,656	618,541
Durham	530,000	960,000	175,959	165,427
Town of Mono	n/a[4]	n/a[4]	370	333
Adjala-Tosorontio	n/a[4]	n/a[4]	675	394
TOTAL	**4,910,000**	**7,180,000**	**3,813,862**	**3,366,340**

Notes:
1) Data for 2001 and 2031 from The Growth Plan for the Greater Golden Horseshoe *(MPIR, 2006), and includes persons located outside of the TRSPA. 2) 2006 Census data with persons located outside of the TRSPA removed (Census Canada, 2006). 3) MNR population estimate for TRCA jurisdiction provided by the Province as the basis of apportionment for the Conservation Authority municipal levy, 2009. 4) n/a: Population data for Mono and Adjala–Tosorontio not available from this data source.*

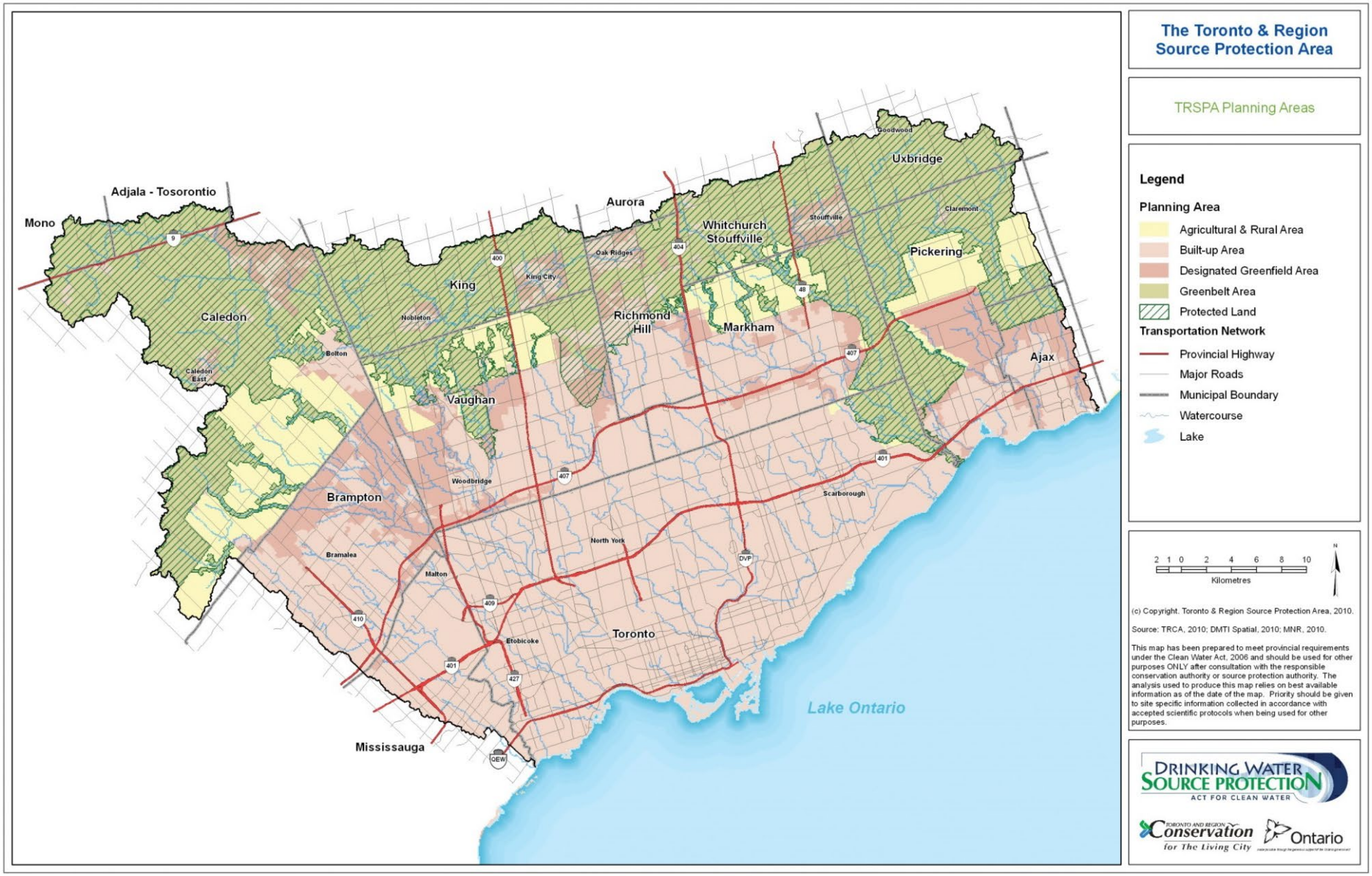

Figure 2.18: TRSPA Planning Areas

Figure 2.19: Population Distribution (2006 Census)

Land Use Types

Settlement Areas

The lower two-thirds of the TRSPA watersheds are devoted to settlement while the lower third has been urbanized for many years and is undergoing revitalization in many places. This area includes much of the Built-up Area with a mix of residential, commercial and industrial uses, and intensification areas such as connecting transit corridors and urban growth centres.

Brownfield and Greyfield lands are also associated with the settlement areas. The middle third of the watersheds contain lands that have been urbanized in the last 20 or 30 years. Population densities range from a high of 3,900 people per square kilometre in the south central parts of the TRSPA to an average of 1,500 to 2,500 people per square kilometre in the urban “905” municipalities surrounding Toronto.

Designated Growth Areas

South of the Greenbelt Area, all lands within the TRSPA are governed by the Growth Plan. The Growth Plan envisions that urbanization will take place from the Lake Ontario waterfront to the southern boundary of the Greenbelt Area, (i.e., from the lower reaches of the TRSPA watersheds to the upper middle reaches of those watersheds). Lands within the current urban boundary of a municipality, but not yet built out, are identified as Designated Greenfield Areas, to accommodate future growth. Some of these lands are currently in the planning process for near-term urbanization, while others may remain in agricultural use for ten or more years before urban development occurs. The Growth Plan requires that Designated Greenfield Areas be built out to a density of not fewer than 50 people and jobs per hectare.

Rural Areas

The remaining lands to the north of the existing urban boundary (Built-up Area), but below the Greenbelt Area are largely used for agriculture. They are currently designated as Agricultural and Rural Areas (**Figure 2.18**), but are expected to become the future Designated Greenfield Area when urban boundaries are expanded. These Agricultural and Rural Area lands south of the Greenbelt boundary are expected to be built out in the future on full municipal services at the Growth Plan density of not fewer than 50 people and jobs per hectare.

Within the Greenbelt Area, there are a number of settlement areas in the rural portions of the region, including Nobleton, King City, and Stouffville. Additionally, there are several hamlets or estate residential areas such as Palgrave and Claremont. These areas are subject to either the ORMCP or the *Greenbelt Plan* and, as such, will generally have their future growth limited to infill and growth already being planned for within their existing urban boundaries. The two provincial plans place restrictions on expanding the settlement or hamlet boundaries. Land uses in these areas may cover the full range of urban uses, including residential, industrial, commercial, and institutional, but residential uses predominate. Generally, these lands are serviced with municipal communal water supplies. The smaller centres are serviced by private septic systems for wastewater treatment, while the larger centres such as Stouffville, Nobleton, Caledon East, Oak Ridges, and King City have changed to, or are transitioning to, municipal wastewater servicing.

Urban Residential Development

The most recently compiled information (2002) on land use based on the Southern Ontario Land Resource Information System (SOLRIS) is shown in **Figure 2.20**. Urban residential development is included in the “Built-up areas” on the figure. SOLRIS is a landscape-level inventory of natural, rural and urban areas maintained by the Ministry of Natural Resources.

Figure 2.20: Land Use (2002)

The largest communities in TRSPA are Brampton, Mississauga, Toronto, Vaughan, Richmond Hill, Markham, Pickering, and Ajax. The Growth Plan identifies a number of Urban Growth Centres within these municipalities. These centres are to be built out at densities of 200 people and jobs per hectare in the “905” region, and 400 people and jobs per hectare in Toronto urban growth centres.

These urban lands also include large stable residential communities within the Built-up Area that may see limited increases in density over time, as well as Greyfield and Brownfield lands that may be redeveloped to higher densities.

Industrial/Commercial Sectors Distribution

Industrial and commercial land use is included in the Built-up areas (**Figure 2.18**). The distribution of commercial and industrial land uses has shifted somewhat, from the historical concentration of these land uses in the City of Toronto to a more widespread distribution in the outlying areas. For example, many former factory and Brownfield lands along the Lake Ontario waterfront have been, or are in the process of being, cleaned up and converted into lofts, condominiums, and mixed-use developments.

Numerous office jobs have been relocated from the “416” to the “905” regions, while industrial plants in the “905” region, such as the Chrysler Assembly Plant in Brampton, have been expanded. Additionally, major employment areas, including industrial and commercial operations, have been built all around Pearson International Airport. While residential and employment uses are often segregated at the local scale by traditional land use designations and zoning, the continuous radiating growth of the Greater Toronto Area (GTA) over time means that, on this larger GTA scale, there are large pockets of residential and employment lands intermixed throughout the region. This pattern of mixing uses, at least on the regional scale, is in accordance with Smart Growth concepts, which seek to place residential and employment lands close together to minimize commuting challenges.

Many new employment lands are being developed in the "905" regions, with a major difference being that these employment lands are not the traditional heavy industrial factories, but rather large prestige industrial developments comprising office campuses, warehouses, and commercial malls. While the level of air, water, and land pollution and contamination is often lower from these uses than their industrial facility predecessors, the sprawling, low-density, and land-intensive nature of these areas, including high percentage of impervious surfaces (i.e., rooftops, driveways, parking lots), results in less infiltration of precipitation and greater amounts of surface runoff.

Brownfields

Brownfield lands are primarily found on industrial lands, especially on older sites located in the lower portions of the watershed and closer to the lakeshore. These lands can include many older, large industrial sites, such as port lands, refineries, and factories, typically with soils exhibiting some level of contamination. Many of these lands are undergoing planning, clean-up, and redevelopment processes, with conversion to mixed use or residential condominium developments. The vast majority of these lands are on full municipal lake-based water and wastewater services.

Existing or Former Landfills

Currently there are no operational sanitary solid waste landfills or proposed sites in the TRSPA. However, there are numerous closed orabandoned landfill sites within the watersheds (**Figure 2.21)** as well as operational composting facilities. TRCA updated the landfill inventory in 2007, with input from the MOECC and regional partners, to produce **Figure 2.21.**

Figure 2.21: Known Landfill Locations

Most of these sites (approximately 100) are in the southern portions of the watersheds, in areas that are fully municipally serviced from Lake Ontario. There are ten to 12 former landfills in the upper reaches of the watersheds, in areas serviced by groundwater—either municipally supplied communal water systems such as Palgrave-Caledon East, or private wells.

Mining and Aggregate Extraction

There are no active mines or quarry sites in the TRSPA. However, there are several existing licensed sand and gravel pits within the upper portions of the jurisdiction, concentrated principally in the eastern watersheds. These sites are located primarily in Uxbridge in the headwater areas of Duffins Creek on the Oak Ridges Morraine, in Whitchurch–Stouffville, and in the headwater areas of the Rouge River on the Oak Ridges Morraine. There are a few small pits in central and west York Region, and in north-east Peel Region in the upper Humber River watershed on the Oak Ridges Morraine, with scattered areas of high potential aggregate lands westerly across the Oak Ridges Morraine.

Some of the existing sand and gravel sites include both dewatering and below water table extraction. Virtually all of these operating sites are located in the upper portions of the watersheds in rural areas where residents depend on private water and wastewater services.

The ORMCP restricts locations of new pits (prohibited in Natural Core Areas), introduces strict new requirements where they are permitted (i.e., no extraction within 1.5 m of the water table in Natural Linkage Areas), and introduces requirements for enhanced rehabilitation.

Oil and Gas

There are no oil or gas reserves known in the TRSPA, although the Georgian Bay shale has been identified as a shale gas exploration target. This emerging resource has been identified in the U.S., but has not been fully explored in Canada.

Forestry Operations

The only forestry operations within TRSPA are local Christmas tree farms, which are covered under agricultural land uses.

Transportation

A number of major "400" series highways cross the TRSPA, including Highways 400, 401, 404, 407, 410, and 427 plus other similar scale routes, such as the QEW, Don Valley Parkway, and the Gardiner Expressway. Two of the routes that run north–south, Highways 400 and 404, traverse the Oak Ridges Morraine, which is a major recharge area to the groundwater aquifers underlying the upper portions of the TRSPA watersheds. The remainder of the roads, particularly those running east–west, are largely contained within the urbanized portions of the watersheds that are fully municipally serviced from Lake Ontario. Given that this is the most densely populated area in all of Canada, there are also numerous major arterial and collector roads as well as local roads.

Numerous rail lines and associated facilities are also located within the TRSPA. The associated major facilities such as inter-modal terminals and rail yards are almost all located within the existing or designated urban areas, and on lands designated for industrial uses. Generally, only the rail lines themselves traverse the upper reaches of the watersheds where the population is dependent on groundwater.

The TRSPA is also home to one major international airport (Pearson) as well as several smaller local-scale airports, including Buttonville and the Billy Bishop airport. These facilities are also situated within existing urban areas on full municipal services. Future transportation infrastructure being planned in areas currently serviced by groundwater may include the northwards extension of Highway 427, the eastward extension of Highway 407, and the airport on federal lands in north Pickering.

Wastewater Treatment

Given the largely rural nature of the Greenbelt lands, including the Oak Ridges Morraine, most of the properties are serviced with private individual water and wastewater systems. Villages, hamlets, and estate residential communities, such as Palgrave, generally have partial municipal services with municipal communal water supplies and private, individual on-site septic systems. Major existing settlement areas on the moraine are generally (or soon will be) on full municipal services. Additionally, there are several golf course communities approved, but not built that utilize private communal wastewater treatment systems. Often the treated effluent is used, or proposed to be used, for spray irrigation on the golf course.

All of the urban lands covered by the Growth Plan (the Built-up Area and Designated Greenfield Area) within TRSPA watersheds are currently serviced by, or proposed to be serviced by, municipal water supplies and sewers, such as the York-Durham Sewer System, the South Peel Servicing Scheme, or the City of Toronto water and wastewater system. This includes all lands from the lakeshore up to the southern boundary of the Greenbelt Area, and is estimated to include 98% of the entire population and industrial and commercial enterprises within the TRSPA.

The major municipal wastewater treatment facilities discharge their treated effluent into Lake Ontario. Several smaller treatment plants that discharged to surface water streams have been decommissioned in the recent past, including Bolton and Stouffville. One facility is still in operation on the Humber River (in Kleinburg, with an upgrade pending), a second services the community of Nobleton, and a third discharges into the lower Don River in Toronto. Virtually all new growth and development within TRSPA watersheds will be fully serviced by Lake Ontario supply, except where legislation such as the Greenbelt Plan prohibits the expansion or introduction of lake-based water and sewer services (to control growth).

Stormwater Management

A wide variety of structural and non-structural best management practices are used to achieve the desired level of stormwater control to reduce the effect of runoff from developed areas. The adoption of a “treatment train” approach, including lot level, conveyance, and end-of-pipe controls, is considered the most effective approach to the management of urban runoff because it ensures a wide range of opportunities for the implementation of protection measures. Traditionally, best management practices were often engineering structures, but they are costly to construct and maintain and are designed for mitigation purposes. Each form of control is designed to treat stormwater before entering the receiving watercourse through a settling or infiltration process, and through the attenuation and reduction of flow volumes and velocities.

There were generally no stormwater management controls implemented within TRSPA’s jurisdiction prior to 1975. Therefore, the majority of the City of Toronto and older areas in Mississauga, Brampton, Richmond Hill, Markham, and Vaughan do not have stormwater facilities, as shown in **Figure 2.22**. However, as can also be seen in **Figure 2.22**, stormwater management ponds are present in the outlying subdivisions to the north.

The evolution of stormwater management in TRSPA’s jurisdiction was influenced by the findings of the *Rouge Urban Drainage Study (RUDS),* which was undertaken by a partnership of staff from TRCA and Rouge River watershed municipalities. This study concluded that stormwater management strategies need to be applied on a watershed basis to be effective (MMM, 1988). The importance of peak flow control to meet flood control objectives was confirmed, but it was determined that different levels of control are required depending on the location within the watershed. It was also determined that water quality control and the development of erosion control requirements based upon in-stream erosion control criteria were required to prevent the degradation of the downstream aquatic system.

The recommendations of the RUDS study were incorporated into stormwater management criteria used by TRCA staff and those of partner municipalities, which have been implemented during the planning and permitting processes. In addition, the partners continue to identify new stormwater management strategies through such initiatives as the municipal stormwater management facility maintenance programs, and the *City of Toronto Wet Weather Flow Master Plan*. Toronto's effort focused on addressing issues related to controlling and reducing the impacts of CSOs, stormwater discharges, and inflow and infiltration in the city (Aquafor Beech Limited, 2003). In addition, stormwater management retrofit studies were prepared for the Town of Markham and Town of Richmond Hill. TRCA staff completed an urban construction sediment control study (Greenland International Consulting Inc., 1999; and 2001) that evaluated the effectiveness of the erosion and sediment control measures at three active construction sites, increased awareness of the issue, and made recommendations for improvement to the design and review process.

The findings from the TRCA study in 2001 reaffirmed that current erosion and sediment control practices have limited success with a significant amount of sediment still entering adjacent watercourses, and that water quality and in-stream habitat are being impaired as a result. Additional efforts are required to identify best management practices that require fewer resources, involve a greater number of stakeholders, and focus on keeping the water as clean as possible from the moment it falls to the ground (at the source) to the time it enters streams and rivers. Keeping the water clean at the source will help to alleviate liability and financial strain on municipalities for operations and maintenance, reduce development costs related to engineering structures, and ultimately result in improved watershed health.

These efforts will depend on the cooperation of all stakeholders including homeowners, developers, consultants, contractors, and government agencies to make changes in their day-to-day management practices, development standards, operating procedures, and lifestyle choices.

Agricultural Resources

Lands with agricultural uses occur primarily in the upper one-third of the watersheds, within the Greenbelt Area, and to the south at the edge of the urban boundaries. Additionally, there are lands within the approved urban settlement boundary that are still in agricultural uses, but these uses will cease in the near term as permitted development is approved and built out. Similarly, lands between the existing urban boundary and the southern limit of the Greenbelt Plan are identified in the Growth Plan as the Agriculture and Rural Area, with the expectation that at least some of these lands will be the subject of future urban boundary expansions. Those lands would be serviced by lake-based full municipal services.

Within the TRSPA, agricultural lands include high quality prime agricultural areas. Agricultural uses include pastureland of horse farms and cattle operations, and active cropping, such as corn and soybeans. There is also limited greenhouse production, specialty crops, market gardens to serve the urban market, plant nurseries to serve the landscaping needs of the large urban market, and urban agriculture associated with Rouge Park and the Claireville Conservation Area.

Recreation

Golf courses are a significant recreational land use within TRSPA's jurisdiction. As of 2010, there were over 100 golf courses scattered throughout the TRSPA jurisdiction that rely on groundwater and/ or surface water sources, from either direct withdrawals or from municipal services. A map showing these golf course locations is shown in **Figure 2.23**.

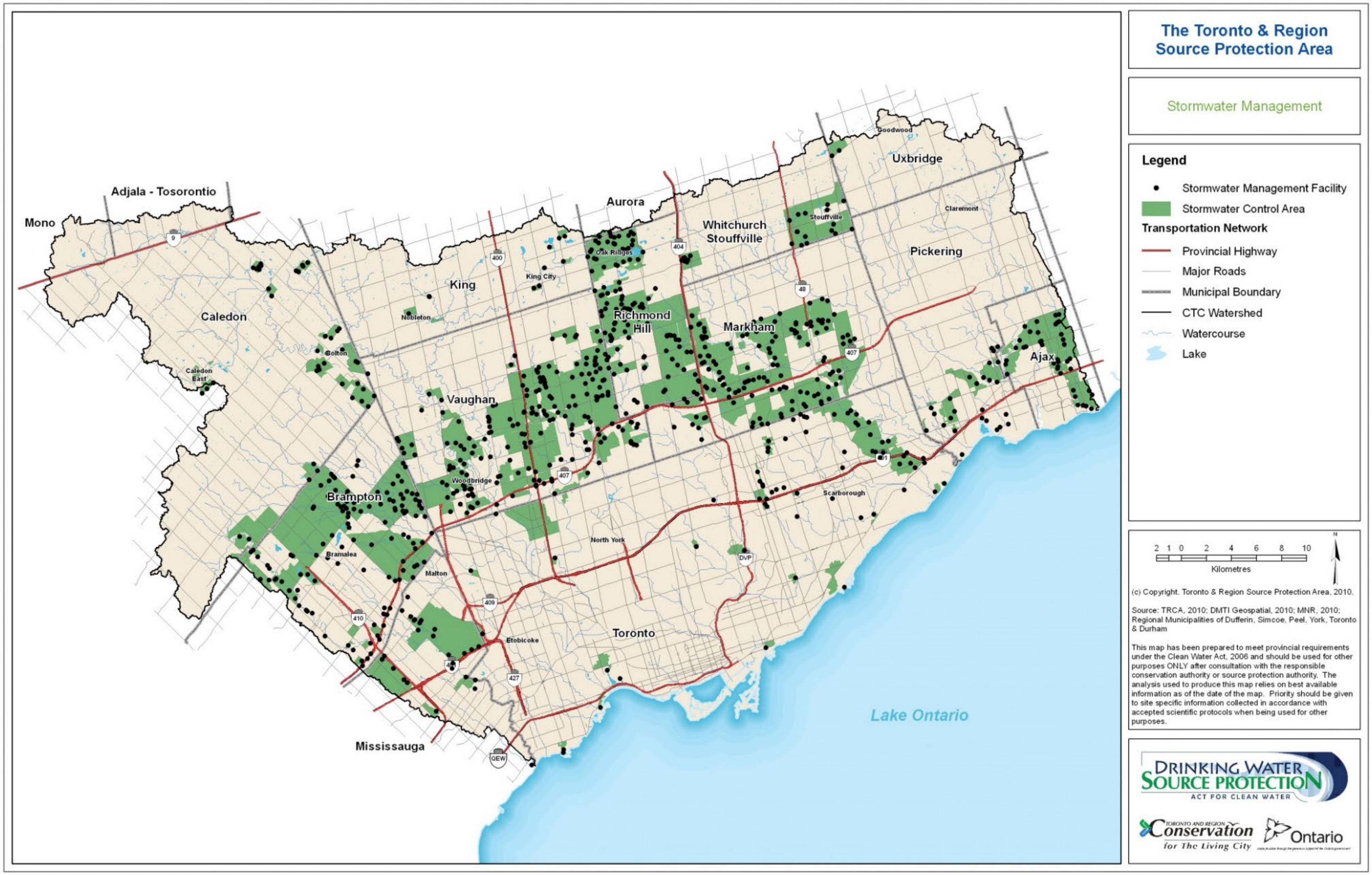

Figure 2.22: Stormwater Management

Protected Areas

The ORMCP was filed by the Province as a regulation in April 2002, under the ORMCA. The ORMCP generally pertains to lands in the headwater areas of the major creeks and rivers in the TRSPA, including the Humber, Don and Rouge rivers, and Duffins Creek. The ORMCP provides protection for environmental features and functions throughout the ORMCP area and limits urban growth and development to existing defined settlement areas. Approximately one-third of the entire moraine within the TRSPA currently comprises environmental features, such as wetlands, woodlands, and stream and valley corridors. These and other features are protected across the landscape. Outside of settlement areas, the features plus a minimum vegetation protection zone of 30 m around them, are protected from development and site alteration.

Within Protected Countryside, the Greenbelt Plan also gives protection to the Natural Heritage System, including water resources. The Greenbelt Plan limits new urban uses and urban expansion within the Protected Countryside designation. It does, however, permit and encourage rural and countryside uses, such as agriculture, aggregate extraction, and major recreational uses. The Greenbelt Area, which includes lands in the Oak Ridges Morraine, Niagara Escarpment, Rouge Park, and the Protected Countryside, is shown in **Figure 2.18**.

South of the Greenbelt Area, regional and local municipalities have identified protected environmental features as their Greenlands or Natural Heritage System. Lands identified and defined in accordance with the *Provincial Policy Statement*, such as provincially significant wetlands or significant forests and valleylands, are generally protected from development. Similarly, publicly owned lands, such as conservation areas, also are securely protected and often included within the Greenlands or Natural Heritage Systems. Other lands identified as linkages or restoration opportunities generally do not have the same level of protection, but may be restored to a natural state and included in a Greenlands System as conditions of the development approvals process.

2.5.2 Managed Lands

The *Technical Rules* require an evaluation of 'Managed Lands' which means land to which agricultural source material, commercial fertilizer or non-agricultural source material is applied, based on land use documented in the Municipal Property Assessment Corporation (MPAC) dataset. This dataset may under-represent hobby farms, which may not have sufficient agricultural activity to be classed as farming operations. These analyses are related to the potential for these nutrients to pose a threat to the quality of drinking water supplies (municipal and non-municipal). Nutrient application is listed on the provincial Tables of Drinking Water Threats as a prescribed threat. The study team must also assess the drinking water source protection vulnerable areas for livestock density for the same reason. Additionally, assessment of the percentage of impervious cover is required as an indicator of the area where de-icing salt may be applied and potentially result in deteriorated water quality. These analyses and findings are presented in **Chapter 5**.

2.5.3 First Nations Reserves and Federal Lands

There are no First Nations reserves within the TRSPA jurisdiction.

Because Federal Lands are excluded from requirements under the CWA, the *Technical Rules* require the identification of Federal Lands across SPAs in assessment reports. For the TRSPA, these lands are shown on **Figure 2.24.**

Figure 2.23: Known Golf Course Locations

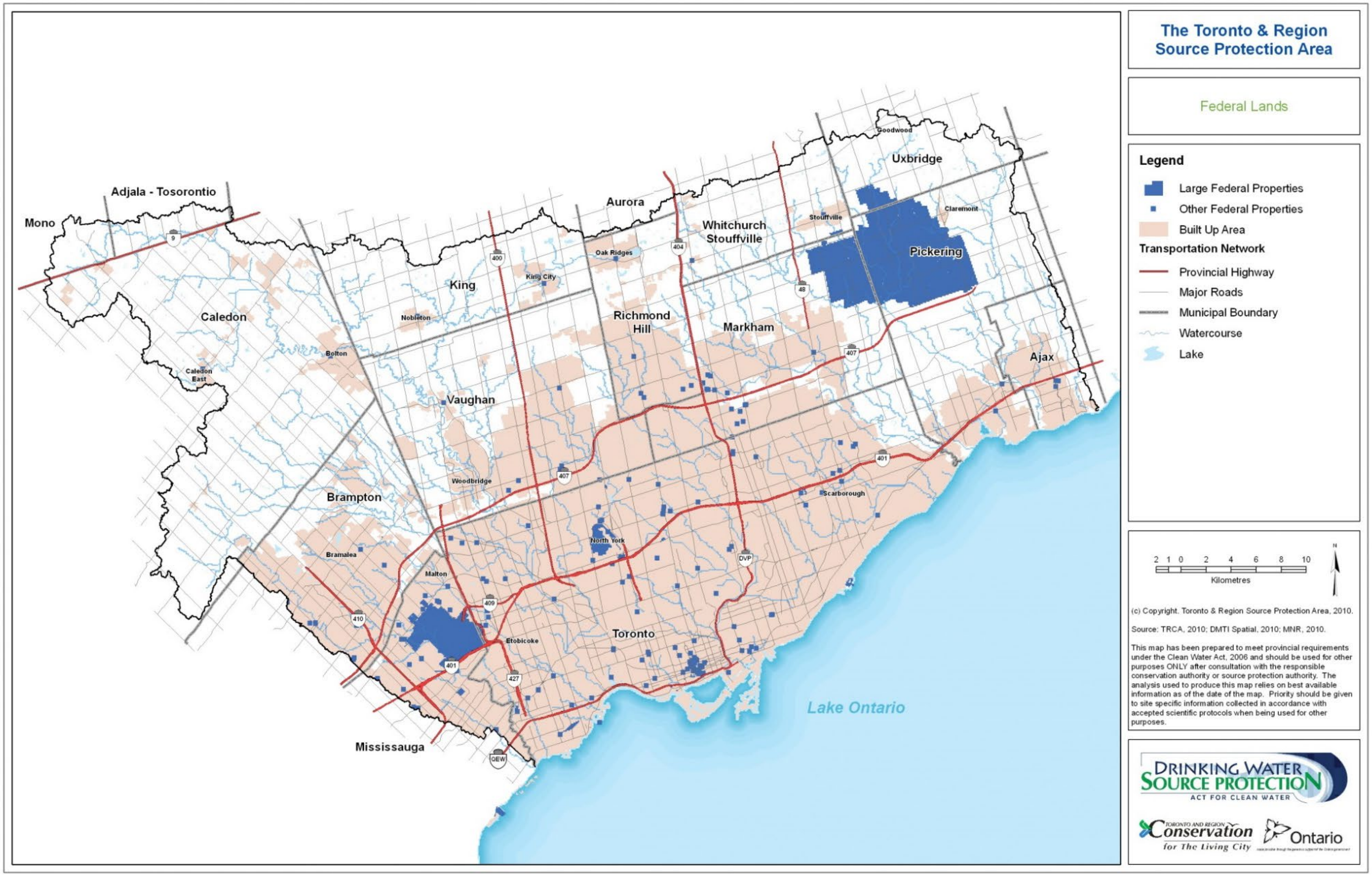

Figure 2.24: Federal Lands

2.6 SUMMARY

The naturally vegetated areas within the TRSPA are concentrated in the north due to a long history of agricultural uses in the south together with more recent urbanization south of the Oak Ridges Morraine. The natural cover falls short of the Environment Canada guidelines for forest and wetland cover of 30% and 10% respectively (Environment Canada, 2004). In the TRSPA approximately 16% of the land base is naturally vegetated forest and wetland. While the quality of the natural cover in the region (based on the size, shape, and matrix influence) ranges from “poor” to “excellent”, higher quality habitats are found only in the northern parts of the watersheds away from existing urban areas. In the southern, urbanized portions of the watersheds the habitats are generally “poor” in quality. They represent remnant habitats that are small, narrow, sparsely distributed, and heavily influenced by the adjacent urban land use. Within the agricultural and rural zones most of the habitats are “fair” in terms of their quality. As growth continues in the TRSPA, habitat quality is predicted to decline further. To sustain the region’s biodiversity and provide natural processes that contribute to healthy watersheds, the amount of natural cover must increase.

The highest quality aquatic habitats within the TRSPA are found in the headwater areas on the Oak Ridges Morraine, which are characterized by baseflow-dominated, coldwater streams, and the largest wetland areas. These stream reaches generally contain the most vulnerable species, with the exception of some like the Redside dace, which prefer the cool water reaches of the middle tributaries.

All TRSPA watersheds have been affected by urbanization, which has had significant impact on the natural hydrologic cycle. Cleared and paved lands within TRSPA watersheds have resulted in a loss of infiltration, which in turn generates increased flows that have caused significant erosion and loss of aquatic habitat in many areas. Highly urbanized watersheds, such as the Highland and Mimico creeks have been further impacted by past engineering practices that sought to convey the increased runoff as quickly as possible to streams via storm sewers and concrete channels. This practice has resulted in many wetlands and small streams being enclosed or buried. Urbanization has also resulted in floodplain encroachments, which have reduced natural storage capacity. Seasonal variations in stream flow caused by vegetative cover and infiltration are no longer as prominent as they were in the past and more urbanized watersheds exhibit a rapid hydrologic response, which poses a flood hazard.

All of the urban lands within TRSPA watersheds are currently serviced by, or are proposed to be serviced by, municipal water supplies and sewer systems. This includes all lands from the lakeshore up to the southern boundary of the Greenbelt Area, plus the larger centres in the Greenbelt and Oak Ridges Moraine. These urban lands are estimated to include 98% of the entire population and industrial and commercial enterprises within the TRSPA. While the vast majority of the population will be serviced by the Lake Ontario-based water supply system, municipal groundwater wells will continue to provide water to towns and villages on the Oak Ridges Morraine and Greenbelt lands. It is these lands and waters that may be subject to potential impacts from ongoing rural uses such as aggregate and agricultural operations, golf courses, historic closed landfills, and the spreading of road salt.

While the ongoing clean-up of brownfield sites in urban areas will help to improve environmental quality over time, additional stormwater impacts from ongoing urbanization and intensification will likely increase pollutant loadings to streams and ultimately to Lake Ontario. With an estimated 3.8 million residents living in TRSPA watersheds in 2006, and close to 50% growth forecast by 2031, there will continue to be significant stress to the natural environment from overuse and cumulative negative impacts from urban development.

Water is utilized within the TRSPA for a number of uses. The largest volume of water is drawn from Lake Ontario for municipal water supplies. Groundwater is also used extensively, particularly across the northern portion of the TRSPA. In addition, golf courses and agricultural operations withdraw water from surface water sources, primarily for crop or turf irrigation. Industrial water use is very limited, except in unserviced areas. Groundwater pressure control is mainly temporary in nature and used predominately for construction purposes (excepting permanent groundwater control in a residential area in Richmond Hill).

Major sectors of water withdrawals in the TRSPA, include golf course irrigation, and municipal water supplies, which withdraw significantly more than other high use sectors at approximately 4 to 6 million m^3/ year. Aquaculture, industrial and agricultural takings are also of significance, which combined withdraw approximately 1 million m^3/year.

Surface water quality for the streams and rivers across the TRSPA has been documented several times (e.g., TRCA, 1998; TRCA, 2003) with the general conclusion that water quality issues are correlated to the amount of urbanization. The 2003–2007 results are consistent with this broad finding. The Duffins Creek watershed, along with the upper Humber and Rouge river watersheds continue to exhibit the best water quality within the TRSPA's jurisdiction. Lower levels of urbanization, larger riparian buffers, and groundwater contributions are all believed to have a role in the high-quality surface water in these areas.

Non-point sources of contamination from urbanization (e.g., stormwater runoff) are the largest contaminant contributor to water within the TRSPA's jurisdiction, but point sources such as WWTPs and the Pearson International Airport also contribute to the degradation of surface water quality. Continued routine efforts such as the treatment of urban runoff via stormwater ponds as well as innovative actions (e.g., biological phosphorus removal at WWTPs) are required to maintain and improve the water quality in the TRSPA.

All of the urban lands within TRSPA watersheds are currently serviced by, or proposed to be serviced by, municipal water supplies and sewer systems. This includes all lands from the lakeshore up to the southern boundary of the Greenbelt Area, plus the larger centres in the Greenbelt and Oak Ridges Moraine. These urban lands are estimated to include 98% of the entire population and industrial and commercial enterprises within the TRSPA. While the vast majority of the population will be serviced by the Lake Ontario-based water supply system, municipal groundwater wells will continue to provide water to towns and villages on the Oak Ridges Morraine and Greenbelt lands. It is these lands and waters that may be subject to potential impacts from ongoing rural uses such as aggregate and agricultural operations, golf courses, historic closed landfills, and the spreading of road salt.

While the ongoing clean-up of brownfield sites in the urban areas will help to improve environmental quality over time, additional stormwater impacts from ongoing urbanization and intensification will likely increase pollutant loadings to streams and ultimately to Lake Ontario. With an estimated 3.8 million residents living in TRSPA watersheds in 2006, and close to 50% growth forecast by 2031, there will continue to be significant stress to the natural environment from overuse and cumulative negative impacts from urban development.

Water is utilized within the TRSPA for a number of uses including:

- Municipal supply;
- Communal supply;
- Private domestic supply;

- Agricultural use;
- Industrial use;
- Golf course irrigation; and
- Groundwater pressure control.

Although the largest volume of water is drawn from Lake Ontario for municipal water supplies, groundwater is also used across the northern portion of the TRSPA. In addition, golf courses and agricultural operations withdraw water from surface water sources, primarily for crop or turf irrigation. Industrial water use is very limited, except in unserviced areas. Groundwater pressure control is used for purposeful groundwater extraction to maintain the groundwater level at a particular elevation. This is usually in areas with strong upward flow gradients, where groundwater flooding of basements and parking garages has been an issue in the past (i.e., Richmond Hill, Markham). Many of the permits for groundwater pressure control are temporary in nature and used predominately for construction purposes.

Daily loads calculations illustrate that a few large storm events occur each year that transport a significant proportion of the sediment and contaminant loads to the lake. It is during these periods that watershed influences will likely be observed at drinking water intakes in Lake Ontario. When and where spikes of turbidity occur at the intakes will depend upon physical mixing and transport functions of the nearshore zone. Lake wide modelling studies, undertaken as part of IPZ-3 studies (**Chapter 5**) can be of assistance in interpretation of what constitutes important local watershed runoff events.

Groundwater quality across the TRSPA is generally good, with naturally elevated iron, manganese, and hardness in the deeper groundwater. Locally elevated chloride concentrations have been detected in the shallow groundwater system, and are associated with the application of road salt. The deep groundwater system contains naturally elevated chloride from the shale bedrock.