Toronto and Region Conservation Authority

Etobicoke Creek

Watershed Characterization Report

June 2021

EXECUTIVE SUMMARY

Watershed planning helps to characterize overall watershed conditions and identify measures to protect, restore, or enhance the health of the watershed. Watershed characterization is one of the preliminary stages of the watershed planning process.

The last Etobicoke Creek watershed plan was developed in 2002 with a Technical Update completed in 2010 that filled data gaps from the original plan and used updated science. It is important to regularly update watershed plans to review progress from previous plans, reflect current conditions, use the latest science, policies, and best practices, and adjust management approaches.

This Characterization Report presents the findings from extensive monitoring data and technical analyses, organized as follows:

1. Introduction – provides an overview of watershed planning, the geographic context for Etobicoke Creek and land use change since 2002.
2. Existing Watershed Conditions – identifies the findings and results of watershed characterization and comprises the bulk of this report. This section explains the various technical analyses completed, identifies key findings, and presents detailed results for each technical component.
3. Policy Inventory – provides an overview of existing municipal policies as they relate to watershed planning broadly and Etobicoke Creek specifically.
4. Methodology – provides an overview of the technical methodologies used to complete the analyses for each technical component outlined in section 2.
5. Maps – contains the maps referenced as figures throughout the report.

Etobicoke Creek forms the western end of Toronto and Region Conservation Authority's (TRCA) jurisdiction, originating just south of the Oak Ridges Moraine in the Town of Caledon before flowing through the cities of Brampton, Mississauga, and Toronto, where it enters Lake Ontario. Urban land uses currently represent 59.5% of the watershed, up from 53.4% in 2002. Approximately 12.3% of the watershed is currently natural cover, down from 14.1% in 2002. Due to the heavily urbanized nature of Etobicoke Creek, there are issues related to flooding and erosion, water quality, low natural cover, and degraded terrestrial and aquatic habitat.

Figure 1 - North of Mayfield Rd., West of Kennedy Rd. Photo taken Sept 19, 2020

Municipalities within the Etobicoke Creek watershed have varying Official Plan policies to address these watershed issues, but do not contain explicit policies to protect the Water Resource System. This is a more recent provincial policy requirement that should be addressed in municipal policies through the ongoing Municipal Comprehensive Review process. The effectiveness of existing policies will be considered as the watershed planning process unfolds to identify the best management actions to improve existing conditions and mitigate potential future impacts.

The information contained in this Characterization Report will inform the next stage of the watershed planning process: future management scenarios. In the future management scenarios stage, different future land use scenarios will be examined to determine whether watershed conditions are expected to improve, stay the same, or deteriorate. Based on the results from the watershed characterization and future management scenarios stages, a management framework can be developed to inform land use and infrastructure planning that improves watershed conditions. An updated watershed plan can be used to assist TRCA and its municipal partners to ensure a cleaner, healthier, and more sustainable Etobicoke Creek.

Watershed Vision:

Etobicoke Creek watershed is protected and restored to a cleaner, healthier, and more natural state, to sustain its waterways, ecosystems, and human communities.

In the fall of 2020, TRCA engaged local stakeholders and residents on what they would like to see in a watershed vision using an online survey. Variations of a vision based on these results were presented to the Steering Committee, consisting of the municipalities within the watershed, TRCA, Mississaugas of the Credit First Nation, and the Greater Toronto Airport Authority. The vision for Etobicoke Creek noted above reflects survey feedback and was agreed to by Steering Committee members.

Table of Contents

List of Figures

List of Tables

Acronyms

CWQG	Canadian Water Quality Guideline	**LTMP**	Long-Term Monitoring Program
DBH	Diameter at Breast Height (for tree measurements)	**MECP**	Ministry of the Environment, Conservation and Parks
DEM	Digital Elevation Model	**MCFN**	Mississaugas of the Credit First Nation
DCI	Dendritic Connectivity Index	**NHS**	Natural Heritage System
ECWP	Etobicoke Creek Watershed Plan	**ORMGP**	Oak Ridges Moraine Groundwater Program
ELC	Ecological Land Classification	**PCM**	Polycyclic musks
ESGRAs	Ecologically Significant Groundwater Recharge Areas	**PWQO**	Provincial Water Quality Objective
FBI	Family Biotic Index	**RGA**	Rapid Geomorphic Assessment
FVC	Flood Vulnerable Cluster	**RWMP**	Regional Watershed Monitoring Program
GTAA	Greater Toronto Airport Authority	**SGRAs**	Significant Groundwater Recharge Areas
HDF	Headwater Drainage Feature	**SSPR**	Specific Stream Power Ratio
IBI	Index of Biotic Integrity	**TEGWFM**	TRCA Expanded Groundwater Flow Model
IRP	Integrated Restoration Prioritization	**TNHSS**	Terrestrial Natural Heritage System Strategy
KHA	Key Hydrologic Area	**TRCA**	Toronto and Region Conservation Authority
KHF	Key Hydrologic Feature	**WRS**	Water Resource System
LAM	Landscape Analysis Model		

Figure 2 - Bank Erosion Near Tomken Rd. Photo taken Sept 19, 2020

1. INTRODUCTION

This report provides an overview of the current conditions of the Etobicoke Creek watershed and compares trends since the last watershed plan, *Greening Our Watersheds: Revitalization Strategies for Etobicoke and Mimico Creeks*, which was released in 2002. Mimico Creek was not included in the analyses conducted for this characterization report. A separate watershed planning process for Mimico Creek will be undertaken in future years.

Many of the issues identified in the 2002 watershed plan are still present in the watershed, including:

- The flow of water is out of balance (i.e. water in and water out) resulting in flooding and erosion issues.
- Low levels of natural cover, tree canopy and poor habitat quality.
- Water quality issues, particularly chlorides and metals.

In some instances, the 2002 watershed plan established targets for 2025. Where applicable, **Section 2: Existing Watershed Conditions** reports on current conditions relative to those targets. Additionally, trends are assessed relative to two time periods: 2011–2020 (current conditions) and 2002–2010 (baseline conditions). These time periods were chosen due to the timing of the 2002 watershed plan and the *Etobicoke and Mimico Creeks Watershed Technical Update Report* released in 2010 to present updated technical information and fill data gaps from the original 2002 watershed plan. Using these two time periods for the characterization analysis allows for the assessment of trends over time and for reporting on progress related to watershed conditions from the previous watershed plan. Finally, this characterization report uses the latest science and updated data compared to those previous analyses.

There are three potential origins of the name for Etobicoke Creek from the Anishinaabe peoples:

Adoopekog	place of the black alder
Atobi Coake	black alder creek
Eobicoke	the place of the alders

Etobicoke Creek forms the western boundary of the Toronto Purchase (Treaty #13 in 1805) and eastern boundary of the Head of the Lake Treaty (Treaty #14 in 1806). The Toronto Purchase reserved the Mississaugas exclusive fishing rights in Etobicoke Creek. In 2016, the Mississaugas of the Credit First Nation (MCFN) submitted a Water Claim to the Crown, since the water within the traditional territory of the MCFN has never been lawfully surrendered. As a result, the MCFN assert that it has Aboriginal title to all water, beds of water and flood plains in its traditional territory.

1.1 Watershed Planning Context

Watershed planning helps to characterize overall watershed conditions and identify measures to protect, restore, or enhance the health of the watershed. Watershed characterization is one of the preliminary stages of the watershed planning process (see **Figure 3**).

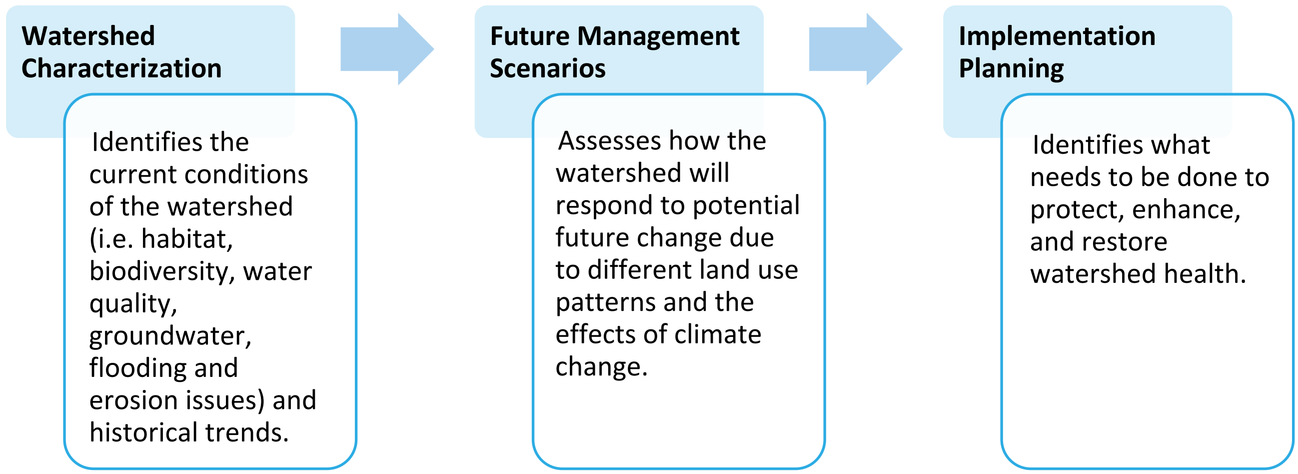

Figure 3 - Overview of the Watershed Planning Process

The development of a watershed plan is a multi-year, multi-partner exercise. For the purposes of the Etobicoke Creek Watershed Plan (ECWP), the main partners involved in plan development are Toronto and Region Conservation Authority (TRCA), City of Toronto, Region of Peel, City of Mississauga, City of Brampton, Town of Caledon, MCFN, and the Greater Toronto Airport Authority (GTAA). Broader stakeholder and public engagement play an important role in the development of the watershed plan to ensure it reflects the perspectives of watershed residents and landowners.

Ultimately, the watershed characterization stage of the watershed planning process sets the context of the current state of the watershed, which will inform subsequent stages in plan development.

Mouth of Etobicoke Creek

Historically, the mouth of Etobicoke Creek was a wetland providing extensive habitat along the Lake Ontario shoreline. When the mouth was surveyed in 1795, the creek entered the lake through two channels that surrounded an island, with a sandbar across the mouth. The land was known to be low lying and subject to flooding. The first engineered alteration of the lower creek was made in 1929 when the sandbar across the mouth was reinforced to allow the extension of an adjacent road.

When Hurricane Hazel hit in 1954, the water level in the channel was at least four times its capacity destroying 56 homes and cottages, resulting in seven deaths and 365 people being left homeless. Over the next few years, municipal governments and the province purchased the land and 164 properties in the flood plain, converting the area into the park now known as Marie Curtis. By 1959, not a trace of the original creek mouth remained. Today, the park’s flood plain lands are owned by TRCA and managed by the City of Toronto.

Provincial policies recognize the watershed as the ecologically meaningful scale for long-term and integrated planning. Additionally, provincial policy directions require municipalities to undertake watershed planning to ensure the protection, enhancement, or restoration of the quality and quantity of water, to inform decisions on the allocation of growth, and to plan water, wastewater, and stormwater infrastructure.

1.2 Geographic Context

The Etobicoke Creek watershed forms the western end of TRCA's jurisdiction. It is a heavily urbanized watershed with eight subwatersheds (See **Figure 12**). The watershed originates just south of the Oak Ridges Moraine in the Town of Caledon, before flowing through the Cities of Brampton, Mississauga, and Toronto, where it enters Lake Ontario. The Etobicoke Creek watershed contains a large amount of industrial and commercial land uses, including the majority of Lester B. Pearson International Airport. The remaining agricultural lands fall within the Headwaters subwatershed, with a portion of that subwatershed falling within the provincial *Greenbelt Plan.*

Table 1 - Geographic Distribution of Watershed

	Size (ha)	Proportion of Watershed Area (%)
Etobicoke Creek Watershed	22,404.3	100
Subwatersheds:		
Lower Etobicoke	1,676.6	7.5%
Little Etobicoke Creek	2,396.3	10.7%
Main Branch	2,025.0	9.0%
Tributary 4	955.4	4.3%
Tributary 3	1,250.7	5.6%
West Branch	2,999.4	13.4%
Spring Creek	4,965.7	22.2%
Headwaters	6,135.3	27.4%
Portion of Watershed by Municipality:		
City of Toronto	2,055.7	9.2%
Region of Peel	20,348.6	90.8%
• City of Mississauga	7,331.6	32.7%
• City of Brampton	7,431.6	33.2%
• Town of Caledon	5,585.4	24.9%

Brampton Esker
A significant geologic feature in the watershed is the Brampton Esker. An esker is a long, winding ridge of sand and gravel deposited by glacial meltwaters which flow through crevasses and channels within or beneath an ice sheet. It is the only esker in TRCA's jurisdiction. The Brampton Esker's northern end is located just to the north of Mayfield Road and runs south for approximately eight kilometres to Queen Street. It is around 1.8 km wide with its eastern edge following Highway 410. The sands and gravels of the Brampton Esker hold and purify water as it percolates downward, making the esker an important groundwater resource and the source of Spring Creek, a tributary of Etobicoke Creek. See **Figure 14** for the location of the Brampton Esker.

1.3 Land Use Change

Assessing land use change at a watershed scale over time helps to understand how different land uses are influencing watershed conditions and provides important context. For the Etobicoke Creek watershed, three time periods, 2019, 2012, and 2002 were used to understand the progression of land use change (i.e. urban, rural, natural). These years were chosen based on the availability of comprehensive land use datasets and to coincide with the previous watershed plan from 2002 and technical update from 2010. TRCA undertook a land use classification alignment exercise and refinement (i.e. quality assurance and quality control) of the layers to ensure as much consistency as possible between the datasets from the different time periods. Even with this refinement, the quality of the datasets from the older time periods is not as high (i.e. detailed) as the most recent dataset. Still, at the watershed scale, this comparison of land use change over time provides important context to understand the rate of urbanization in a heavily developed watershed like Etobicoke Creek. **Table 2** provides an overview of land use change and impervious cover within the watershed. Impervious cover refers to the amount of land that is considered to have a hardened surface (e.g. pavement, building, etc.) preventing the infiltration of water into the ground. Imperviousness is an indicator of watershed health as a high proportion of impervious surfaces is associated with an increase in the severity and duration of peak flows during storm events (i.e. runoff), causing flooding, erosion, and sedimentation. Impervious cover also affects water quality and stream temperature due to runoff from these land uses, which can negatively impact aquatic biodiversity.

Table 2 - Overview of Land Use Change[1]

	2002 (area %)	2012 (area %)	% change from 2002 – 2012 (+ or -)	2019 (area %)	% change from 2012 to 2019 (+ or -)
Urban	53.4%	56.4%	5.6%	59.5%	5.4%
Rural*	32.5%	30.9%	-5.0%	28.2%	-8.5%
Natural	14.1%	12.7%	-9.6%	12.3%	-3.4%
Impervious Cover	42.9%	45.6%	6.3%	47.9%	4.9%

*Rural includes land use classifications such as agriculture, golf courses, open space, hydro corridors, etc. These types of land uses cannot be considered natural, nor can they be considered urban as they still have low amounts of impervious surfaces. See **Appendix A** for a full list of land use classifications summarized as urban, rural, and natural.

Table 2 demonstrates that the Etobicoke Creek watershed is continuing to urbanize with losses of both natural and rural land cover types. The same trend applies to many of the subwatersheds. As of 2019 all the subwatersheds have impervious cover greater than 50% except for the Headwaters. The highest amount of impervious cover for 2019 is present in the Little Etobicoke Creek subwatershed at 68.7%. The Headwaters subwatershed had 14.2% impervious cover for 2019. Natural cover is quite low across the subwatersheds, with

[1] Percent change is calculated based on the difference between the relevant time periods land use area in hectares.

Tributary 4 having the lowest at 6.8% and the Headwaters having the highest at 15.1% in 2019. See **Figure 13** for maps showing the progression of land use change in the watershed.

2. EXISTING WATERSHED CONDITIONS

As part of watershed characterization, TRCA assessed extensive monitoring and land use datasets to provide the most up-to-date information on current conditions and determine how conditions have changed over time (i.e. trends). Technical analyses were completed for numerous watershed components as outlined in **Table 3**.

Table 3 - List of Characterization Analyses Completed

Watershed Component	Technical Analyses Completed
Water Resource System (WRS)	• Delineation of features (e.g. permanent and intermittent streams) and areas (e.g. significant groundwater recharge areas) • Riparian corridors (i.e. transition zones between aquatic and terrestrial habitat) • In-stream barriers (i.e. natural or artificial structures that prevent fish movement) • Fish community health (i.e. species diversity and abundance) • Benthic community health (i.e. bottom dwelling organisms like insects and molluscs) • Aquatic habitat quality (i.e. stream quality as it relates to impervious cover) • Groundwater conditions (i.e. quality and quantity) • Streamflow
Natural Heritage System (NHS) / Urban Forest	• Habitat quantity (i.e. amount of natural cover) • Habitat quality (e.g. patch size, shape, and surrounding land influences) • Terrestrial biodiversity (e.g. plants and animals) • Habitat connectivity (i.e. corridors for wildlife movement) • Climate vulnerabilities (i.e. habitat patches vulnerable to the effects of climate change) • Urban forest (e.g. amount of tree canopy)
Surface Water Quality	• Parameters of concern • Chemicals of emerging concern • Microplastics • Spills
Natural Hazards	• Flood risk, including Flood Vulnerable Clusters (FVCs) • Erosion risk
Stormwater Management	• Inventory of existing stormwater management infrastructure
Restoration Opportunities	• Inventory of existing restoration opportunities and completed restoration projects

The key findings of the Etobicoke Creek characterization analyses are organized into four categories and presented in **Table 4**.

Table 4 - Watershed Characterization Key Findings

	Key Findings
Water Resource System (includes aquatic habitat, in-stream barriers, groundwater conditions, etc.)	• Among larger watersheds in TRCA's jurisdiction (i.e. >200 km^2), Etobicoke Creek has the second highest annual runoff at 402 mm/year, second only to the Don River. • The average habitat health rating for fish is 'fair' and for benthic communities is 'poor'. There has been little to no change in aquatic habitat quality since 2002. • There are a large number of in-stream barriers that prevent the movement of species and only approximately 49.6% natural cover within the riparian corridor (i.e. within 30 metres of streams).
Natural Heritage System / Urban Forest (includes habitat quantity and quality, tree canopy, sensitive species, etc.)	• Approximately 11.7%[2] of the watershed consists of natural cover, which is similar to other heavily urbanized watersheds, with natural cover continuing to decrease (e.g. forest cover). • Generally, habitat quality is poor with some fair quality habitat in the headwaters, but the watershed still supports regional biodiversity including some sensitive plant and animal species, primarily in the headwaters. • Approximately 39% and 18% of the watershed is a priority for regional and local connectivity among habitat patches, respectively. • Existing natural cover is highly vulnerable to the effects of climate change in urban areas. • Urban forest canopy cover (i.e. trees and tall shrubs) is 14.7% and has remained stable from 2009 to 2018.
Water Quality (includes parameters of concern relative to Provincial Water Quality Objectives [PWQO] or Canadian Water Quality Guideline [CWQG])	• Surface water quality is generally poor compared to other TRCA watersheds. Contaminants of particular concern include: ○ Chlorides (e.g. from road salts) ○ Phosphorus (e.g. from fertilizers) ○ *E. coli* bacteria (e.g. from sewage/animal wastes) ○ Metals such as copper and zinc (e.g. from industrial sources and/or roadways) • Exceedances of chlorides and nitrates in groundwater were observed.

[2] The natural cover number referenced in Table 2 (12.3%) includes streams and lakes (i.e. natural cover that is water), whereas the numbers in Tables 4 and 5, and the analyses in Subsection 2.2 exclude water from the natural cover calculations.

	Key Findings
Natural Hazards (includes flooding and erosion)	• There are six FVCs with a total area of 508 hectares (ha). See **Figure 14** for a map of the FVCs. • Most of the watershed can be categorized as medium or high erosion sensitivity.

Table 5 provides further details on watershed conditions and trends for each of these four categories. Trends are assessed as changes from the baseline period (2002–2010) to current conditions period (2011–2020)[3]. Targets for 2025 from the previous watershed plan are also included to assess progress. It is possible that through subsequent stages of the watershed planning process that targets will be updated. Further information on results of characterization analyses for each category can be found in the relevant subsection. See **Section 4: Methodology** for details on the methods and approaches used for each characterization analysis.

Table 5 - Existing Watershed Conditions Summary

	Current Conditions	Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
Water Resource System			
Riparian corridors	49.6% natural cover within the riparian corridor.	+1.1%	75% of the riparian corridor should contain natural cover.
In-stream barriers	134 human-made in-stream structures.	-2.9% No priority barriers identified in the 2010 Technical Update have been mitigated.	Have 50% of priority barriers identified in Category A and B mitigated for fish passage; and 100% of Category C barriers removed in Etobicoke Creek.
Fish community health	40 fish species are present.	No change	IBI rating at three sites in Etobicoke Creek should be improved to 'fair'.
	7 invasive species are present.	No change	

[3] The current conditions column in Table 4 is based on the most recent available data. The trend assessment compares the two referenced time periods based on available data.

[4] *Greening Our Watersheds: Revitalization Strategies for Etobicoke and Mimico Creeks* from 2002 established some 2025 targets for certain watershed components. If applicable, this characterization report identifies that target for comparison with current conditions.

	Current Conditions	Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
			from 'poor' (fish communities).
	Average IBI[5] Score: 22.7 (Fair)	No change The number of fair sites is still 50%.	
Benthic (i.e. insects, worms, molluscs) Community Health	Average FBI[6] Score: 6.57 (Poor)	No change since 2013 for when comparable data was available. No sites have a 'good' FBI rating.	At least 40% of benthic invertebrate stations should have an invertebrate community that is rated as 'good'.
Streamflow[7]	Average annual discharge of 402 mm/year.	Increased by 28% from an average annual discharge of 314 mm/year.	N/A
Groundwater recharge	100 mm/year across rural areas. 5 mm/year across urbanized areas, except for Brampton Esker – estimated at 250 mm/year.	Estimated at 100 mm/year across most of the watershed except for Brampton Esker estimated at 380 mm/year for 2002-2010. Note: Newer models since 2010 question whether groundwater recharge was ever 100 mm/year in the urbanized areas.	Maintain existing annual average watershed recharge rates of 103 mm/year.
Groundwater discharge	Baseflow Index[8] estimated at 0.39, 0.39, and 0.34 for the upper, middle, and lower reaches of the watershed respectively.	Since baseline period: Upper reach – 8.36% increase Middle reach – 25.8% increase Lower reach – 17.2% increase	Increase baseflow from baseline conditions.

[5] IBI stands for Index of Biotic Integrity and measures a set of metrics (number of fish species, presence of sensitive species, abundance, and food chain classifications) to assign a rating of very good (≥38), good (28-37.9), fair (20-27.9), or poor (≤20). See **Subsection 2.1.3: Fish Community Health** for more information.
[6] FBI refers to Family Biotic Index, which is often used to assess the quality of water in rivers and has a rating scale of excellent (0-3.75), very good (3.76-4.25), good (4.26-5.00), fair (5.01-5.75), fairly poor (5.76-6.50), poor (6.51-7.25), or very poor (7.26-10).
[7] Conditions were assessed using a minimum 20-year record, so current conditions are defined as 2000 – 2020, while 1960 – 1990 is used for trend assessment. The ten-year gap between 1990 – 2000 is to separate the periods for trend assessment into distinct periods for easier detection of temporal trends.
[8] Baseflow Index, or BFI, is a measure of the ratio of long-term baseflow to total stream flow and it can be used as a proxy for the slow continuous contribution of groundwater to river flow.

	Current Conditions		Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
			Note: caution should be used when comparing 10-year intervals for hydrogeology. Trends seen over the last twenty years are consistent with natural fluctuation.	
Natural Heritage System / Urban Forest				
Habitat quantity	Area in ha and % (2019)		Change since 2005:	14.1% in 2010 Technical Update, or general qualitative target of no further habitat loss in urbanized watersheds (TRCA, 2007).
	Total natural cover	2,617 ha or 11.7%	Decrease 14%	
	Forest	882 ha or 3.9%	Decrease 16%	
	Successional Forest	119 ha or 0.5%	Increase 165%	
	Meadow	1,106 ha or 4.9%	Changes in methodology for how meadows are calculated prevented change comparison.	
	Wetland	509 ha or 2.3%	Changes in methodology for how wetlands are calculated prevented change comparison.	
Habitat quality	Average LAM Score[9]: 7.51 (Poor)		Majority of patches are poor quality based on 2010 Technical Update.	There should be an increase in the proportion of patch scores that are 'good' and 'fair'.
Terrestrial biodiversity	51 fauna (i.e. animal) species of conservation concern present		Lack of comparable methods between baseline and current time period prevented an assessment of trends.	N/A
	60 vegetation communities of conservation concern in 135 ha			

[9] LAM, known as Landscape Analysis Model, combines the metrics of patch size (larger patches support larger populations), patch shape (habitat fragmentation) and matrix influence (influence of surrounding land uses) to determine an average score. LAM has a rating scale of 13-15 (Excellent), 11 -12 (Good), 9-10 (Fair), 6-8 (Poor), 0-5 (Very poor).

	Current Conditions		**Trend Assessment** Between Baseline (2002–2010) and Current (2011–2020)	**2025 Target[4] (if applicable)**
Habitat connectivity	Area in ha and % (2019)		No data to compare to for baseline period.	N/A
	Regional connectivity (TRCA scale)	677 ha or 3%		
	Regional connectivity (watershed scale)	8,026 ha or 35.8%		
	Local connectivity (forest to forest)	3,335 ha or 14.9%		
	Local connectivity (forest to wetland)	651 ha or 2.9%		
Climate vulnerabilities	Highly vulnerable areas (%)		No data to compare to for baseline period.	N/A
	Habitat patch quality	41% of natural cover		
	Wetlands	2.7% of natural cover		
	Climate sensitive communities	0.1% of natural cover		
	Soil drainage	70% of watershed		
	Ground surface temperature	63% of watershed		
Urban forest (canopy cover for the entire watershed)	3,290 ha or 14.7%		0% change	N/A

	Current Conditions	Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
Urban forest structure, composition, and health (only in urbanized portions of the watershed, excludes agricultural areas)	Structure: 63% of trees are very small, less than 15.2 cm in diameter measured at breast height (DBH).	Structure: Percentage of trees smaller than 15.2 cm DBH has decreased by 1.3% (indicating tree growth).	N/A
	Composition: Ten tree species make up 65% of the population. Approximately 57% of trees are native to south central and southwestern Ontario.	Composition: Dominance of the top ten tree species has remained approximately the same. Proportion of species native to south central and southwestern Ontario decreased by 7%.	
	Health condition: Average condition is 80% (good). 20% are in poor or critical condition, dying or dead.	Health condition: Average condition declined by 4%, with the proportion of trees in poor condition or dead increased by 6%.	
Water Quality[10]			
Total suspended solids (CWQG = 30 mg/L)	88% of samples met 30 mg/L water quality objective.	6% fewer samples met objective in 2015-2019	75% of samples meet water quality objective.
Chloride (CWQG, chronic = 120 mg/L, acute = 640 mg/L)	7% of samples met chronic water quality objective.	Chronic – 6% fewer samples met objective in 2015 – 2019.	
	70% of samples met acute water quality objective.	Acute – 3% more samples met objective in 2015 – 2019.	
Total phosphorus (PWQO = 30 ug/L)	29% of samples met 30 ug/L water quality objective.	2% fewer samples met objective in 2015 – 2019.	

[10] Current conditions are represented as 2015-2019 and baseline is from 2003-2007 so that both time periods are five-years. Water quality samples are routinely taken, and results can vary widely depending on events like storms, spills, etc. Pre-2010 there were only two monitoring stations (80006 and 80007), so trends are only reported for those locations.

	Current Conditions		Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
Nitrates (CWQG = 2.93 mg/L)	94% of samples met 30 ug/L water quality objective.		1% more samples met objective in 2015 – 2019.	
Copper (PWQO = 5 ug/L)	72% of samples met 5 ug/L water quality objective.		26% fewer samples met objective in 2015 – 2019.	
Iron (PWQO = 300 ug/L)	71% of samples met 300 ug/L water quality objective.		No change.	
Zinc (PWQO = 20 ug/L)	78% of samples met 20 ug/L water quality objective.		27% fewer samples met objective in 2015 – 2019.	
E. coli (PWQO = 100 CFU / 100 mL)	21% of samples met 100 CFU/100 mL water quality objective.		8% more samples met objective in 2015 – 2019.	50% of samples meet water quality objective across watershed, with exception of headwaters.
	61% of samples met 100 CFU/100 mL water quality objective in headwaters.			75% of samples meet water quality objective in headwaters.
Natural Hazards				
Flooding (peak flows)	Based on 100-year[11] inflow at points for each of the six FVCs:		Based on change from baseline period[12]:	N/A
	Brampton Central FVC	78.8 m^3/s	-0.7% to +7.0%	
	Avondale FVC West Tributary	23.5 m^3/s	-0.4% to +0.8%	

[11] 100-year refers to a rainfall event that statistically has a one percent chance of occurring in any given year, at any given place. A 100-year storm does not mean that it will only occur once every 100 years.

[12] The Brampton Central and Avondale FVCs are the furthest upstream and closest to the areas of urban expansion in recent years and are thus more sensitive to flows. TRCA's hydrology model does not include all current stormwater management ponds from these recent developments. So, the change in peak flows from baseline period for Brampton Central and Avondale FVCs are reported as a range (best and worst case). All other FVCs are reported as a single percent change.

	Current Conditions		Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
	Avondale FVC East Tributary	29.8 m^3/s	+2.0% to +12.4%	
	Little Etobicoke FVC	37.1 m^3/s	+2.1%	
	Dixie/Dundas FVC	106.9 m^3/s	+2.7%	
	Longbranch FVC	359.0 m^3/s	+0.8%	
	West Mall FVC West Tributary	304.7 m^3/s	+1.0%	
	West Mall FVC East Tributary	36.5 m^3/s	+0.6%	
Developed / Undeveloped land uses in flood plain	507 ha of urban development and 1,451 ha of undeveloped land use in the regulatory flood plain.		N/A	N/A
Erosion sensitive stream reaches	See **Subsection 2.4.2: Erosion Risk** for details			N/A
Erosion hazard sites (actively monitored)	3,550 inventoried erosion control structures (2009 – 2017) 675 infrastructure hazard monitoring sites (within Region of Peel) 138 TRCA-owned or managed erosion control structures 29 erosion hazard sites on private or public property		The number of TRCA inspections of erosion control structures and inventoried sites fluctuates year-to-year based on funding. Municipalities may have their own programs independent of TRCA, which are not included in this inventory.	N/A

	Current Conditions	Trend Assessment Between Baseline (2002–2010) and Current (2011–2020)	2025 Target[4] (if applicable)
Stormwater Management			
Stormwater management facilities	Number of facilities = 77	There were 46 facilities in 2010.	Increase the percentage of urban area treated by stormwater management facilities.
Restoration Planning			
Completed restoration projects	N/A	111 restoration projects completed by TRCA between 2002 – 2019.	N/A

2.1 Water Resource System

The WRS consists of surface water features (e.g. streams, lakes, wetlands) and groundwater areas (e.g recharge areas), and their hydrologic functions. Hydrologic functions are the natural processes that provide the water needed to sustain healthy aquatic (i.e. water-based) and terrestrial (i.e. land-based) ecosystems and human water consumption. Understanding the state of these features and areas, as well as the conditions of aquatic habitat, is important for watershed management due to the many ecosystem benefits provided by the WRS, including maintaining a stable water balance (i.e. flow of water in and out of the system), supporting biodiversity, the timing and duration of flows, and managing water quality.

The components of the WRS are defined by provincial policy as Key Hydrologic Areas (KHAs) or Key Hydrologic Features (KHFs). See **Figure 15** for a map of KHAs and **Figure 16** for a map of KHFs. **Table 6** outlines the area, or length, of the KHFs or KHAs.

Table 6 - Summary of WRS Component Area and Size

	Area (ha) or Length (km)	Watershed Coverage (%)[13]
Key Hydrologic Areas		
Ecologically Significant Groundwater Recharge Areas (ESGRAs)	2,823 ha	12.6
Significant Groundwater Recharge Areas (SGRAs)	122 ha	0.5

[13] Permanent and intermittent streams, and headwater drainage features are summarized only in length by kilometers.

	Area (ha) or Length (km)	Watershed Coverage (%)[13]
Highly Vulnerable Aquifers (HVAs)	6,008 ha	26.8
Significant Surface Water Contribution Areas (SSWCAs)	30 ha	0.1
Key Hydrologic Features		
Inland Lakes	85 ha	0.4
Wetlands	509 ha	2.3
Seepage Areas and Springs	1,002 ha	4.5
Permanent Streams	144 km	N/A
Intermittent Streams	83 km	N/A
Headwater Drainage Features	224 km	N/A

Of the Headwater Drainage Features (HDFs), 54 km (24%) are intermittent, and 170 km (76%) are unknown, meaning they may be permanent, intermittent, ephemeral, or not a feature. More field investigations of all the features would need to be conducted to determine how often water is flowing in these features. Of all the HDFs 104 km (46%) have valued or contributing functions, and 120 km (54%) have limited, or recharge functions based on TRCA's *Evaluation, Classification and Management of Headwater Drainage Features Guidelines*. See **Figure 17** for a map of these features and their classifications.

The following subsections characterize other related components of the WRS that support aquatic habitat and biodiversity, including riparian corridors, in-stream barriers, fish community health, benthic community health, aquatic habitat quality, groundwater conditions, and streamflow.

2.1.1 Riparian Corridors

Riparian corridors are the transition zone between terrestrial and aquatic ecosystems around streams, which act as a buffer that contribute nutrients, shade, and filtration of contaminants from surrounding landscapes, thereby improving overall WRS feature and aquatic habitat health. The riparian corridor refers to the area within 30 m of each side of a stream feature. See **Table 7** for a breakdown of the amount of natural cover within the riparian corridor at the watershed and subwatershed scale.

Table 7 - Percent Natural Cover within Riparian Corridor

	% Natural Cover by Habitat Type[14]			% Natural Cover	% No Natural Cover	Total Area (ha)
	Forest	Meadow	Wetland			
Watershed	**20.6**	**16.1**	**12.9**	**49.6**	**50.4**	**1,809.5**

[14] Beach/Bluff was also accounted for in the riparian corridor analysis but was limited across the watershed at 0.1%, so has not been included in this table.

	% Natural Cover by Habitat Type[14]			% Natural Cover	% No Natural Cover	Total Area (ha)
	Forest	Meadow	Wetland			
Headwaters	18.5	11.2	18.6	48.3	51.7	713.2
Spring Creek	12.8	17.6	17.4	47.8	52.2	369.0
West Branch	25.2	23.9	4.1	53.2	46.8	280.3
Tributary 3	1.2	26.8	8.9	36.9	63.1	86.0
Tributary 4	20.6	0.9	11.7	33.3	66.7	62.6
Main Branch	28.7	23.0	4.1	56.1	43.9	129.3
Little Etobicoke	36.7	23.5	3.8	64.1	35.9	86.1
Lower Etobicoke	47.4	6.6	0.9	56.1	43.9	83.0

Since 2010, there has been a slight increase (1.1%) of natural cover within the riparian corridor, but this increase is only attributable to three subwatersheds (Headwaters at 3.3%, Spring Creek at 3.4% and Main Branch at 2.0%). All other subwatersheds saw declines in natural cover within the riparian corridor. Tributary 3 and West Branch saw the greatest declines of 7.5% and 3.9% respectively. The greatest declines were in meadow habitat at 6.5% across the watershed. This was offset by increases in wetland habitat at 5.8% and forest at 1.7% across the watershed.

2.1.2 In-stream Barriers

Barriers such as dams, weirs, and road crossings can pose a significant challenge for fish movement, whether they are migratory species or not. In-stream barriers reduce access to habitat and effectively reduce the total area of habitat available to species. In total, there are 134 known human-made barriers in the watershed. Only four structures have been removed through restoration projects since the baseline period. Of the existing barriers, 87 do not allow any species to pass, while 47 barriers may be passed by jumping fish species. The highest amount of habitat connectivity can be found within the mid-watershed and headwater areas. See **Figure 18** for a map of barriers and aquatic connectivity.

2.1.3 Fish Community Health

A well-balanced and functioning biological community is a good indicator of a healthy aquatic ecosystem. Fish species are an indicator of ecosystem health because habitat that supports higher fish community diversity is related to water quality, water quantity, thermal regimes (i.e. stream temperatures), and erosion. There are 40 species of fish currently in the watershed. This represents a relatively stable trend compared to the baseline period, which reported 39 fish species present. However, there has been a high degree of species turnover as there are seven new species not detected in the baseline period, and eight other species not currently found in the watershed. Historically (pre-2002), there were 49 species of fish documented in the watershed, including several sensitive and coldwater species (e.g. American Eel, Slimy Sculpin, and Redside Dace) that are likely no longer present. The number of invasive species is stable at seven from the baseline to current period.

Inland lakes (e.g. Heart Lake) and estuaries support communities of fish that are different from streams and can offer a refuge for native fish, making these features highly diverse areas within the watershed. Fish community data was used to determine species richness, community composition, trophic level, and invasive species.

Where data was available, three periods (historical: 1989 – 2000, baseline: 2001 – 2010, and current: 2011 – 2019) were compared to determine the temporal trends of species community composition in Heart Lake and the mouth of Etobicoke Creek. In total, 38 species were detected within Heart Lake and the mouth of Etobicoke Creek across all time periods. Over the three time periods, Heart Lake has predominantly shifted to a fish community mainly composed of warmwater species, whereas the mouth of Etobicoke Creek has shifted to predominantly invasive species. This demonstrates a steady shift towards a lower fish community health with more invasive species within these systems.

Fish community health is rated using a health index known as the IBI scale, which measures the number of fish species, presence of sensitive species, species abundance, and food chain classifications to assign a rating from 'poor' to 'very good'. The overall IBI score for the watershed is at the lower end of the 'fair' rating (23.1). Trends from baseline to current periods revealed no significant change, which indicates that conditions are stable and neither improving nor deteriorating. See **Table 8** for more details on IBI ratings throughout the watershed.

Table 8 - Average Index of Biotic Integrity Ratings

	Average IBI Rating		Trend[15]
	Baseline (2002-2010)	Current (2011-2020)	
Watershed	**22.4 (Fair)**	**23.1 (Fair)**	**No change**
Headwaters	30.2 (Good)	28.3 (Good)	No change
Spring Creek	22.0 (Fair)	23.6 (Fair)	No change
West Branch	22.9 (Fair)	23.0 (Fair)	No change
Tributary 3	18.8 (Poor)	25.3 (Fair)	No change[16]
Tributary 4	17.5 (Poor)	23.3 (Fair)	No change[17]
Main Branch	18.0 (Poor)	16.4 (Poor)	No change
Little Etobicoke[18]	-	-	-
Lower Etobicoke	17.7 (Poor)	18.6 (Poor)	No change
Rating Scale: $\leq$20 (Poor), 20-27.9 (Fair), 28-37.9 (Good), $\geq$38 (Very Good)			

2.1.4 Benthic Community Health

Benthic macroinvertebrates are bottom-dwelling organisms including aquatic insects, crustaceans, molluscs, and worms, which provide an important ecological link between microorganisms and fish communities. They are often used in studies to determine the quality of waters because of their abundance, relative pollution tolerances, limited mobility, and dependence on the surrounding environment of the stream they live in.

[15] Based on a statistical test (i.e. linear regression using *R Software*) to determine trends beyond a reasonable doubt.
[16] As the trend was not significant, the change in health score from baseline to current for Tributary 3 and Tributary 4 may not be certain.
[17] See footnote 16.
[18] Little Etobicoke had no sampling sites from 2002-2020.

Benthic community health is assessed using the FBI rating scale, which is used to assess the quality of water in rivers for these types of organisms on a rating scale from 'very poor' to 'excellent'. The average FBI rating for the watershed is 6.57, or poor, which is one level above the lowest rating. Data on benthic community health is only available since 2013, which means there is no data pre-2010 to compare trends to the baseline period. **Table 9** outlines the FBI ratings across the watershed for the current period (2013-2020 in this case).

Table 9 - Family Biotic Index Ratings

	Family Biotic Index	
	Rating	**Classification**
Watershed	**6.57**	**Poor**
Headwaters	6.29	Fairly Poor
Spring Creek	6.71	Poor
West Branch	6.32	Fairly Poor
Tributary 3	7.53	Very Poor
Tributary 4	6.42	Fairly Poor
Main Branch	6.47	Fairly Poor
Little Etobicoke[19]	-	-
Lower Etobicoke	6.74	Poor
Rating Scale: 0-3.75 (Excellent), 3.76-4.25 (Very Good), 4.26-5.00 (Good), 5.01-5.75 (Fair), 5.76-6.5 (Fairly Poor), 6.51-7.25 (Poor), 7.26-10 (Very Poor)		

2.1.5 Aquatic Habitat Quality

As natural surfaces are converted into impervious surfaces, water does not infiltrate soils and instead flows over these surfaces and directly into streams affecting natural flow, temperature, and water quality regimes. This subsequently impacts aquatic species and ecosystems through changes in aquatic habitat quality. Federal guidance provides recommendations on impervious cover percentages based on a review of scientific literature (See **Figure 4**).

[19] Little Etobicoke had no sampling site from 2013-2020.

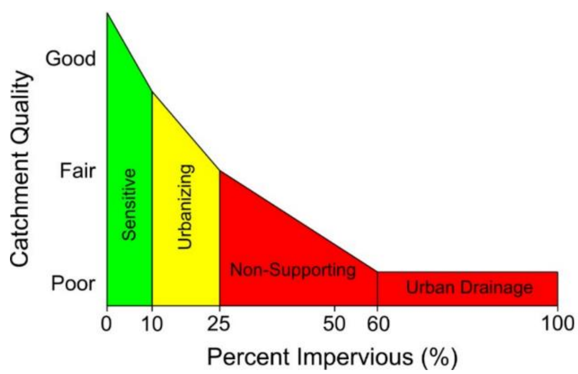

Figure 4 - Overall Stream Quality as it Relates to Impervious Cover

Urban Stream Classification	Sensitive (0-10% Impervious)	Impacted (11-25% Impervious)	Non-supporting (26-100% impervious)
Channel Stability	Stable	Unstable	Highly Unstable
Water Quality	Good	Fair	Fair-Poor
Stream Biodiversity	Good-Excellent	Fair-Good	Poor

For this analysis impervious cover was assessed at three spatial scales, including the watershed, subwatershed and reach contributing area (i.e. smaller areas within the subwatershed tied to particular stream segments). Currently, at the watershed scale, conditions are non-supporting with 47.9% impervious cover. Additionally, only the Headwaters subwatershed has less than 50% impervious cover at 14.2%. Trends at the watershed and subwatershed scales indicate that there have been no improvements (i.e. reductions in impervious cover) since the baseline period. See Table 10 for the changes in impervious cover for the three land use cover datasets (2002, 2012, and 2019).

Table 10 - Percent Impervious Cover for 2002, 2012, and 2019

	Percent Impervious Cover		
	2002	**2012**	**2019**
Watershed	**42.9**	**45.6**	**47.9**
Headwaters	10.0	11.9	14.2
Spring Creek	46.6	50.3	54.1
West Branch	57.2	60.0	61.2
Tributary 3	57.1	65.1	66.8
Tributary 4	48.4	50.4	51.4
Main Branch	57.5	59.5	61.9
Little Etobicoke	64.5	66.8	68.7
Lower Etobicoke	65.0	64.9	65.7

At the reach contributing scale, the headwaters have many catchments that still provide good quality habitat. Currently, there is only a single reach contributing area below the headwaters that is not classified as non-supporting (between 25 and 60% impervious cover). In contrast, in 2002 there were seven reach contributing areas not classified as non-supporting below the headwaters. Figure 5 demonstrates that the watershed is continuing to increase in impervious cover with few areas capable of providing good quality habitat. However, some improvements were observed by loss of impervious cover since 2002, which is demonstrated by the green areas under the percent change map in **Figure 5**.

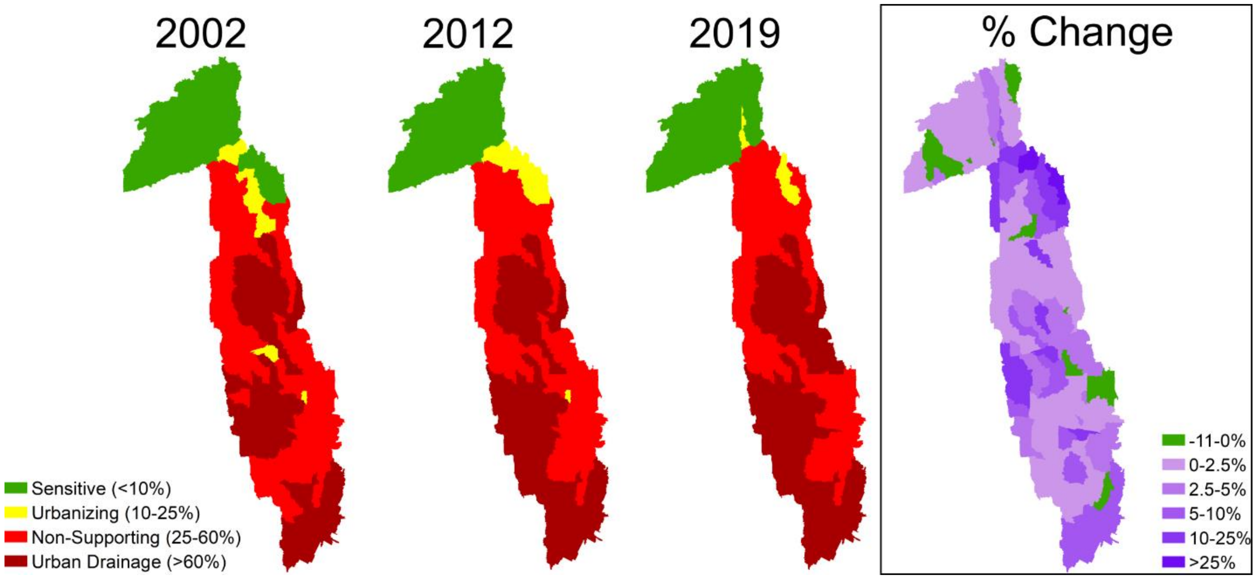

Figure 5 - Catchment Quality Ratings, with % change from baseline (2002) to current (2019).

2.1.6 Groundwater Conditions

Evaluation of groundwater recharge and discharge is heavily reliant on groundwater modelling. Groundwater modelling advancements have been made since the 2010 Technical Update. The Tier 1 (i.e. screening level assessment of water supply and water demand) source water model was used for the 2010 Technical Update. Since then, the York Region Tier 3 (i.e. assesses sustainability, risk, and ecological stress) source model and expanded TRCA model, which includes the Etobicoke Creek watershed, have been developed.

This updated modelling questions whether groundwater recharge was ever as high as 100 mm/year in the urban portions of the watershed, except around the Brampton Esker. Based on the more recent modelling, groundwater recharge is estimated at 100 mm/year in rural areas and 5 mm/year in urbanized portions of the watershed. Groundwater recharge at the Brampton Esker is now estimated at 250 mm/year. Baseflow index is used as a proxy for groundwater discharge, which is discussed further in **Subsection 2.1.7: Streamflow**. Based on the baseflow index, all reaches of the watershed appear to have received increased groundwater discharge since 2010. Caution should be used when comparing 10-year intervals for baseflow, since trends seen over the last twenty years are consistent with natural fluctuation.

At Provincial Groundwater Monitoring Network wells within the watershed, a 30% increase in chlorides was noted for the last ten years, while there was no observable trend for nitrate concentrations. Wells associated with the Mayfield West development observed chlorides and nitrates as a potential threat to groundwater quality.

2.1.7 Streamflow

Figure 6 - Creek channelization under Sandalwood Parkway East. Photo taken Sept 19, 2020

Streamflow refers to the volume of water flowing past a gauge in a watercourse. As land use in a watershed changes, the proportions of overland runoff and baseflow (i.e. portion of water flowing into the stream not associated with runoff) could be expected to change. Increasing impervious cover such as asphalt, concrete, and roofs within a watershed is expected to increase total streamflow and decrease groundwater recharge and evapotranspiration, as less water soaks into the ground and more is diverted into watercourses as runoff. In urbanizing watersheds, the net result of these changes is often to increase total runoff and peak discharge, with the resulting increased erosion leading to enlarged stream channels, reduced stream habitat quality (through removal of coarse bed sediments and woody debris), and water quality impairments. The effects of urbanization on baseflow are more complex, and baseflow has been found to increase or decrease with increasing urban cover in different settings.

An average of 402 mm/year flows into Lake Ontario as streamflow, representing 49% of annual precipitation. Comparing subwatersheds, the highest runoff rate is in Spring Creek (476 mm/year, 58% of annual precipitation) and the lowest are in the Etobicoke Headwaters (321 mm/year, 37% of annual precipitation). Monthly flows are highest in April for the watershed (54 mm/month), while maximum monthly flows occur in March for most subwatersheds. Spring Creek is an exception, with peak monthly flows in January, which is unusual in TRCA's jurisdiction and may be attributable to the highly urbanized nature of this subwatershed (e.g. industrial and airport lands). See **Figure 19** for a map of the differences in annual streamflow across the watershed based on the drainage areas of existing stream gauges.

Of the average annual streamflow (402 mm/year), approximately 125 mm/year is estimated to be baseflow. Baseflows have increased 15% from historical conditions (1960 – 1990), which is likely caused by groundwater being intercepted by underground infrastructure (e.g. pipes, drains) to flow towards watercourses. While increased baseflow may be perceived as benefitting aquatic ecosystems and overall watershed health, the quality of this additional urban baseflow water is uncertain.

Understanding the variability of streamflow conditions is done through ratios such as 10th to 90th percentile, where the 10th percentile is taken to represent average high flows, while the 90th percentile represents average low flows. The ratio for Etobicoke Creek is 16.4, which is the highest 10th to 90th percentile ratio of TRCA's large watersheds, almost twice the magnitude of the next highest (Rouge River at a ratio of 8.84). This indicates that the Etobicoke Creek watershed has a "flashier" hydroperiod with typical high flows being proportionally larger relative to typical low flows. This increases the potential for erosion with implications for aquatic ecosystems.

2.2 Natural Heritage System and Urban Forest

The NHS is made up of natural features and areas (e.g. forests, meadows, wetlands), and linkages to provide habitat connectivity and support natural processes, which are necessary to maintain biodiversity, natural functions, and ecosystems. The urban forest is made up of trees and woody shrubs on all public and private property within the watershed, including urbanized spaces (e.g. along roads) and in natural areas (e.g. forests). Understanding the state of natural cover, habitat quality (i.e. terrestrial ecosystems) and the urban forest is important for watershed management due to the many ecosystem benefits that terrestrial features like forests, meadows and street trees provide, including supporting biodiversity, water retention and filtration, and cleaner air. See **Subsection 3.1: Natural Heritage System Comparison** for an evaluation of municipal NHSs as identified in Official Plans.

As part of watershed characterization, the total amount of natural cover (i.e. habitat quantity), habitat quality, biodiversity, habitat connectivity, climate vulnerabilities, and urban forest quantity, composition, and health were assessed.

2.2.1 Habitat Quantity

The total amount of natural cover in the watershed is 11.7%, compared to approximately 30% and 40% in the Humber River and Duffins Creek watersheds respectively. The Don River, which is another heavily urbanized watershed contains approximately 14% natural cover. Between 2005 and 2019, approximately 400 ha of natural cover was lost. See **Figure 20** for a map of the distribution of natural cover by habitat type in the watershed.

Natural cover is primarily located along the ravines and creeks in the lower area of the watershed and along headwater streams and in larger patches in the upper area of the watershed. The largest patches of natural cover include the Heart Lake Conservation Park and the Cheltenham wetland complex. Forests are located throughout the watershed and many swamps occur within forests in the upper area. Meadows are concentrated in the middle area of the watershed bordering major highways. While these meadows provide some ecosystem function, they likely provide limited habitat for meadow-dependent species, due to the proximity of the highways.

Habitat losses since the baseline period occurred mainly to forests and meadows, with an increase in wetland habitat as show in **Table 11**. This is a result of losses due to development, increases associated with completed restoration projects, and differences between data collection standards and methodologies between 2002 and 2019. Fundamentally, natural cover in the watershed has decreased.

Table 11 - Change in Natural Cover by Habitat Type

Habitat Type	2005		2019	
	ha	% of watershed	ha	% of watershed
Forest	1,046	4.6	882	3.9
Successional forest	72	0.5	119	0.5
Meadow	1,771	7.7	1,106	4.9
Wetland	132	0.6	509	2.3
Total natural cover	3,024	13.4	2,617	11.7

Notes: beach/bluff habitat type is not shown which made up less than 1% of natural cover for both time periods.

Changes to meadows are partially due to losses through development, succession (i.e. change to forest), and differences in data collection standards and methodologies between 2002 and 2019.

Changes to wetlands are partially due to an increase in wetlands due to completed restoration projects, change in classification from forest to wetland (i.e. swamp), and differences in data collection standards and methodologies between 2002 and 2019.

2.2.2 Habitat Quality

On average, the watershed has poor quality habitat. Habitat patches in the middle-lower areas of the watershed tend to be small, linear in shape, and influenced negatively by surrounding urban landscapes. Habitat patches in the upper areas of the watershed tend to be larger and less linear. Fair quality patches are better able to support species of concern compared to poorer quality patches. See **Figure 21** for a map of habitat patch quality rankings.

2.2.3 Terrestrial Biodiversity

Vegetation communities primarily consist of a mix of meadows (30%), natural forests (29%), marshes (11%), swamps (8%), and successional woodlands (5%). Plantations, thickets, hedgerows, bogs, bluffs, and shallow aquatic areas with floating and submerged vegetation are also present but comprise a smaller area. There are 60 different types of vegetation communities of regional concern, covering approximately 8.4% of the total area of natural cover. These communities of concern are concentrated in the upper areas of the watershed especially within the Heart Lake Conservation Park and the Cheltenham wetland complex. The Heart Lake Conservation Park contains several extremely rare wetland communities for TRCA's jurisdiction, including Leatherleaf Shrub Kettle Bog, Tamarack-Leatherleaf Treed Kettle Bog, and Leatherleaf-Forb Shrub Fen. The Arsenal Lands near Marie Curtis Park at the mouth of Etobicoke Creek represent a large area of natural cover relative to other areas in the lower, more urbanized portion of the watershed. Other vegetation communities of concern in the lower area of the watershed occur primarily along the ravines of the creek.

Invasive species are negatively affecting native species communities through competition and displacement. Disturbance of vegetation communities by invasive plant species ranged from none to severe across the watershed with more severe levels of disturbance in urbanized areas.

Based on limited inventory surveys conducted between 2010 and 2019, there are 139 fauna (i.e. animal) species found within the watershed. This is likely an underestimation of the actual number of species. Of these 139 species, 51 are considered to be species of conservation concern. Similar to vegetation communities, these species tend to occur in the more rural northern part of the watershed or near Heart Lake Conservation Park. For example, sensitive forest bird species (e.g. Scarlet Tanager, Veery, Pileated Woodpecker) were primarily located near Heart Lake in larger forest patches. Both Heart Lake and Centennial Park are important habitat for wetland dependent birds such as Sora, Virginia Rail, Marsh Wren, and Swamp Sparrow. Meadows and agricultural areas are essential habitat for many meadow-dependent bird species including Field Sparrow, Vesper Sparrow, Eastern Meadowlark, and Bobolink. The distribution of frogs and toads varied across the watershed with certain species (e.g. Spring Peeper and Wood Frog) only detected in areas outside of urban influence. These species require both wetlands and nearby forest habitat to complete their life cycle.

This shows that the watershed is still capable of supporting these sensitive species, however, their occurrence is primarily outside of the urban influence. Improvements to the amount of habitat and its quality would benefit these species throughout the watershed.

2.2.4 Habitat Connectivity

Several areas of the watershed are important for regional and local wildlife movements (i.e. habitat connectivity). Regional connectivity priorities include areas that are important for connecting high quality habitat patches across TRCA jurisdiction (677 ha) as well as those within Etobicoke Creek Watershed (8,026 ha). These are primarily in the upper reaches of the watershed, where habitat patches are concentrated. These regional connectivity priorities for the jurisdiction and watershed represent areas where habitat enhancements will improve connectivity among the most habitat patches across TRCA's jurisdiction and within the watershed, respectively.

Figure 7 – Wildlife Tunnel Under Heart Lake Road. Installed in 2016.

Local scale connectivity priorities include areas where forest – forest and forest – wetland habitat patches are in close proximity and provide corridors for wildlife. Forest – forest local connectivity priorities (3,335 ha) include most of the linear patches in the lower and middle reaches of the watershed, along with larger areas near Heart Lake and the Cheltenham wetland complex. Forest – wetland local connectivity priorities (651 ha) are more limited within the watershed and include primarily the Heart Lake and Cheltenham areas, along with several areas in the lower reaches of the watershed. These local connectivity priority areas are important locations for mitigation of barriers to movement through enhanced construction practices (e.g. wildlife tunnels under roads – see **Figure 7**).

In the middle and lower portions of the watershed, the linear ravine systems are important corridors for north south movements (e.g. Lake Ontario to upper portions of the watershed). Corridors for east-west movement are limited throughout the developed portions of the watershed.

See **Figure 22** for a map of regional and local connectivity priorities.

2.2.5 Climate Vulnerabilities

TRCA developed a framework to assess the vulnerabilities of existing natural features to climate change. This framework uses five vulnerability indicators: habitat patch quality, climate sensitive vegetation community types, wetland hydrologic vulnerability, mid-afternoon ground surface temperature, and soil drainage. **Table 12** identifies the area and percentage of natural cover, or the watershed, that is highly vulnerable to the impacts of climate change for each of these five indicators.

Table 12 - Climate Vulnerability Indicators and Area

Vulnerability Indicator	Highly Vulnerable Areas (ha)	Highly Vulnerable Areas (%)
Habitat patch quality	1,063	41% of natural cover
Wetlands	70	2.7% of natural cover
Climate sensitive communities	2	0.1% of natural cover
Soil drainage	15,586	70% of watershed
Ground surface temperature	14,026	63% of watershed

Climate change impacts and associated extreme events will exacerbate these vulnerabilities.

2.2.6 Urban Forest

The urban forest is all trees and tall shrubs occurring on public and private lands in natural, rural, and urban areas. One measure of the urban forest is canopy cover, which is the surface area of land covered by the layers of leaves, branches, trunks and stems of trees and tall shrubs when viewed directly from above. In general, ecosystem services and benefits increase as canopy cover increases. The current canopy cover for the Etobicoke Creek watershed is approximately 14.7%. A low canopy cover is expected within the watershed due to the large amount of industrial, commercial and airport lands. The rural portions of the Town of Caledon exhibit limited tree cover, due to the prevalence of agricultural land uses. Most canopy cover in the watershed is found in older residential areas as well as along forested natural areas, particularly around Heart Lake and in areas near Etobicoke Creek and its tributaries. **Table 13** identifies the amount of canopy cover (as a percentage) in each subwatershed, as well as percent change in canopy cover. See **Figure 23** for a map of the distribution of canopy cover.

Table 13 – Total Canopy Cover and Trends by Watershed and Subwatershed

	Total Canopy Cover (As a proportion of total area in %)	**Trend Assessment** (% change since 2009)
Watershed	**14.7**	**0**
Headwaters	12.9	+1.8
Spring Creek	14.5	-3.6

	Total Canopy Cover (As a proportion of total area in %)	**Trend Assessment** (% change since 2009)
West Branch	17.9	+2.4
Tributary 3	6.5	-16.7
Tributary 4	13.3	-5.0
Main Branch	14.2	-4.3
Little Etobicoke	14.0	-2.1
Lower Etobicoke	22.9	+9.4

Canopy cover was assessed by land use types across the watershed. Forested areas contribute the most to total canopy cover at 28% and residential areas contributing 27%. The cities of Toronto, Mississauga and Brampton have set municipal-wide targets for canopy cover of 40%, 15–25%, and 25% respectively. Within the Etobicoke Creek watershed, canopy cover targets are not met. Canopy cover is 23% for Toronto, 11% for Mississauga and 18% for Brampton. Canopy cover in the Caledon portion of the watershed is 11%, but no municipal target has been set. While established canopy cover targets are municipal-scale, it is important to consider watershed-scale targets, especially in such a heavily urbanized watershed. Although natural cover land use types (i.e. forests) contribute significantly to canopy cover in all municipalities, the high level of urbanization and limited land for significant natural area expansion necessitates enhancements to canopy cover in residential and other built-up land use types. Industrial, commercial, agricultural and transportation land uses contribute only 20% of canopy cover despite occupying a large amount of land within the watershed. Though planting opportunities in these land uses may be restricted, plantings in parking lots, road right-of-ways, and between farm fields can significantly increase canopy cover. Through this watershed planning process, the establishment of watershed-based canopy cover targets will be considered.

In an urban forest it is important to have trees of various ages and sizes to ensure that there are mature trees to replace older trees as they die and make up for tree losses that occur at all ages. Further, as trees grow, they provide significantly more ecosystem services, such as air pollution removal and reduced rainwater runoff. Across the developed portions of the Etobicoke Creek watershed, 63% of trees are very small (less than 15.2 cm DBH), indicating they are juveniles and recently planted. **Figure 8** shows the proportion of trees by size class. It is important to protect medium and large trees because of the benefits they provide, as well as care for small trees to increase the likelihood they reach maturity.

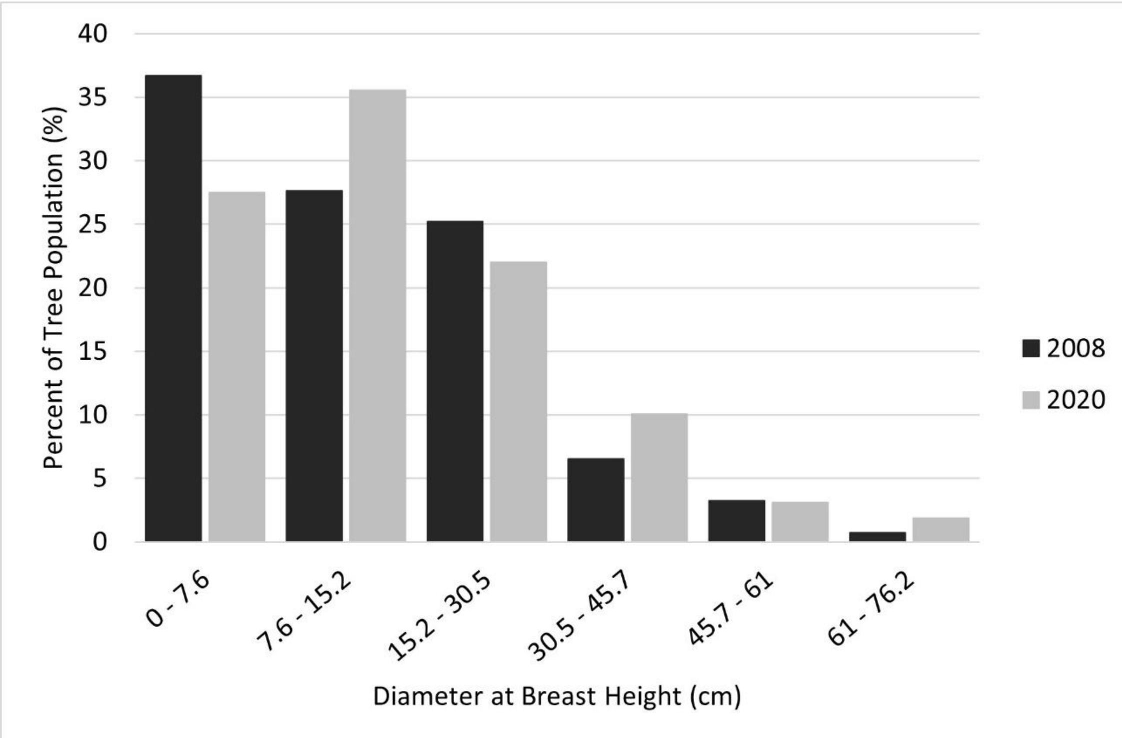

Figure 8 - Percentage of tree population in each size class by DBH

A greater diversity of tree species supports more ecosystem services and increases urban forest resilience. Within the urbanized portion of the watershed, ten species contribute 65% of the urban forest. The top five most common species each made up more than 5% of the total tree population, which is above the recommended maximum of 5% for any one species. Of the top three most abundant species, two are invasive species: European buckthorn at 13.1% and Norway maple at 8.6% of the total tree population. Northern white cedar made up 11.3% of the population, Green ash 7.6%, and Manitoba maple 7.1%, all of which are native. Overall, industrial and commercial areas had the greatest percentage of non-native species.

There are indications that tree health has declined in urbanized areas since 2008. The percentage of trees in good or excellent condition was 74% in 2008, compared to 69% in 2020. The proportion of trees that were in poor or critical condition, dying or dead increased from 14% in 2008 to 20% in 2020. Trees within natural areas had a higher percentage in poor or critical condition, dying or dead at 33%. The decrease of conditions for trees in natural areas could be partially due to the presence of ash trees, which make up 16% of the population in natural areas. Field crews noted that signs of invasive insects such as emerald ash borer and gypsy moth were present at some field plots. Emerald ash borers were observed to play a role in the decline of ash trees within several field plots.

Based on this assessment, the current state of the urban forest in the Etobicoke Creek watershed needs management intervention to increase canopy cover, particularly in land use types and subwatersheds with low canopy cover, increase species diversity and evenness, and monitor and protect trees and tree health across all age classes. A healthier, diverse, and better distributed urban forest provides more ecosystem services and is more resilient to storms and diseases.

2.3 Water Quality

Characterizing water quality is important to understand the overall health of the watershed and is tied to the health of fish, vegetation, and other aquatic life. Tracking changes in water quality over time (i.e. trends) helps to identify threats to the watershed and how land use changes are influencing water quality.

Only three of the ten water quality parameters identified in **Table 5** are currently meeting targets at the watershed scale. At the subwatershed scale there are additional locations of concern. Chloride concentrations exceeded water quality objectives for the protection of aquatic life from chronic effects (e.g. decreased reproductive output) at all water quality stations. However, the highest concentrations are in the Tributary 3 and Little Etobicoke Creek subwatersheds. Lower Etobicoke and Tributary 4 had the highest concentrations of phosphorus. High amounts of metals are present in the Lower Etobicoke, Main Branch, and Tributary 3 subwatersheds. *E. coli* continues to be a concern throughout the watershed, but is particularly problematic in the Tributary 4 and Little Etobicoke Creek subwatersheds. See **Figure 24** for a map of location specific water quality concerns in the Etobicoke Creek watershed.

Between 2003–2007 and 2015–2019, concentrations of:

- Total Suspended Solids, nitrates and iron remained similar
- Chloride, phosphorus, copper, and zinc increased
- *E. coli* decreased

The three parameters (chlorides, phosphorus, and *E. coli*) that had the lowest number of samples meeting water quality objectives are discussed below. Following the discussion of these three parameters is additional information on chemicals of emerging concern, microplastics, and spills.

2.3.1 Chlorides

High chloride concentrations are related to the amount of urban development in the watershed. Sources of chlorides include road salt application, leaching from salt storage facilities, industrial discharge, fertilizers, and natural sources. On February 17, 2016, Tributary 3 recorded the highest chloride concentration of 6,470 mg/L of all samples reviewed, which is equivalent to about 32% of the average chloride concentration in seawater.

2.3.2 Phosphorus

In general, phosphorus concentrations have declined in streams entering Lake Ontario between 1979 and 2011, predominantly due to reducing phosphorus concentrations in detergents. Regardless of general declines, phosphorus concentrations in the Etobicoke Creek watershed continue to be high. Probable sources of phosphorus include fertilizers, animal wastes, and sanitary sewage.

2.3.3 E. coli

E. coli are a group of bacteria commonly found in the intestines of warm-blooded animals and indicate the presence of fecal waste in water. Probable sources of *E. coli* include stormwater outfalls, wildlife, livestock, domestic animals, and organic fertilizers. A 2018 research project tracked the sources of fecal contamination at several sites along Etobicoke Creek between Highway 407 and Marie Curtis Park (i.e. the mouth of Etobicoke Creek) following a record-setting, extreme rain event (126 mm over 24 hours) and over the two days prior to the event. Prior to the rain event, *E. coli* counts were highest at stormwater outfalls. During the rain event, *E. coli* counts were highest in beach and creek samples. Overall, these results suggest that stormwater outfalls may be a major source of *E. coli* in Etobicoke Creek.

2.3.4 Chemicals of Emerging Concern

Over 200 chemicals of emerging concern have been identified in the Great Lakes. These chemicals include industrial chemicals, household chemicals, fragrances, pharmaceuticals, personal care products, disinfectants, pesticides, and nanomaterials. Several of these chemicals have been studied within the Etobicoke Creek watershed.

Polycyclic musks (PCMs) are used as fragrances in many personal care products, including soaps, shampoo, detergents, and deodorants. PCMs are a concern because their chemical structure is similar to persistent organic pollutants, which are known to have carcinogenic and negative developmental and reproductive effects. In a 2019 study, Etobicoke Creek had a similar PCM concentration to Mimico Creek and the lower Humber River, but had lower concentrations than Highland Creek and the Don River. Urban sites had higher PCM concentrations compared to rural sites and sources included stormwater, illegal sewer cross connections, and wastewater treatment plant discharges.

Chemicals of emerging concern have many effects on the natural environment, including a range of negative effects on aquatic life. It is important to manage these chemicals at their source before they enter waterways.

2.3.5 Microplastics

Microplastics are plastic particles less than 5 mm long. They have been found throughout the world and in the Great Lakes. Microplastics slowly degrade releasing toxic chemicals and causing effects on wildlife. Microplastics accumulate along beaches, throughout the water column, and in sediments. Etobicoke Creek has the highest number of microplastic particles per kg of dry sediment of all tributaries (i.e. streams and rivers) along the Canadian shoreline of Lake Ontario.

Figure 9 - Microplastic nurdles found by TRCA in Etobicoke Creek (November 16, 2016) during field surveys showing a collection of nurdles (left), and nurdles free-floating in the water column (right).

Nurdles are the raw plastic material used in the production of plastic products ranging from plastic bags to car parts. Of the 66 watersheds studied along the north shore of Lake Ontario, Etobicoke Creek had the highest number of plastic manufacturers, and plastic related distributors, and service businesses. Further research and monitoring are needed to determine the impact of restrictions and bans, determine the watershed sources (e.g. variation within the watershed, concentrations at stormwater or combined sewer outfalls) to inform how to minimize, or eliminate, microplastic pollution and modify current practices to treat microplastic pollution before it enters waterways. Within the Etobicoke Creek watershed, commercial fragments were chemically identified as polyethylene and polyethylene methacrylate, suggesting that companies manufacturing these compounds could be spilling these plastics into the watershed. Etobicoke Creek also had a high number of "black particles" in stormwater compared to the Humber or Don River watersheds. These black particles consisted of Vine Black carbon with Raman or Copolymer Ethylene-Vinyl Acetate (EVA) Rubber. These particles can come from the manufacturing industry or tire wear (e.g. on highways or airports).

2.3.6 Spills

Accidental spills or intentional discharges of contaminants to streams negatively impact water quality and aquatic life. The Etobicoke Creek watershed contains a large amount of industrial and urban land uses, which increases the likelihood of spills. TRCA and municipalities work in collaboration with the Ministry of the Environment, Conservation and Parks (MECP) to communicate information on recent spills and coordinate monitoring/clean-up efforts to achieve the best possible outcome when a spill occurs.

Between 2003 and 2005, 247 spills occurred in the Etobicoke Creek watershed. Of these spills, most were to land, followed by water and air, and were primarily caused by equipment failure. Between 1988 and 2000, most spills within the Etobicoke Creek watershed occurred in the industrial areas of Brampton and Mississauga, and at Pearson International Airport.

As part of this watershed characterization, TRCA attempted to obtain more recent spill data from MECP, but due to Covid-19 delays, the request was not completed in time for inclusion in this report.

It is very likely that Etobicoke Creek continues to be heavily impacted by spills and would benefit from improved spill response and management planning.

2.4 Natural Hazards

One of the main responsibilities of TRCA is to protect life and property from natural hazards (i.e. riverine flooding and erosion risks). As part of watershed characterization, TRCA assessed the current flood and erosion risks in the watershed.

2.4.1 Flooding

Riverine flood risk is well understood within the Etobicoke Creek watershed; floodplain mapping and the underlying hydrology model have been updated within the last decade. Riverine flooding occurs when water levels rise, and the streams overtop their banks. Urban flooding, on the other hand, is caused by limited capacity of stormwater infrastructure or drainage systems. Historically, flood risk has generally increased as a result of urbanization, which alters the volume, intensity, and timing of runoff to streams. This is especially true for areas that were built without stormwater management features in place (i.e. developments pre-1980s). The results of comparing existing flood risk to the baseline period show insignificant changes in 100-year flood peak flows to most of the FVCs. The exceptions were the Brampton Central and Avondale FVCs, which showed flow increases around 7% and 12% respectively. However, the presence of new stormwater management ponds not included in the hydrology model means these increases are likely overestimated. Design information was not available for any interim or ultimate stormwater management ponds servicing recent developments.

Figure 10 - High peak flows after storm event, south of QEW. Photo taken Jan 12, 2020

On average, flow increases appear to correspond with the measured changes in the watershed's total imperviousness between baseline and current conditions. There are also insignificant changes to peak flows from the Hurricane Hazel storm between baseline and current conditions.

Six of the 41 FVCs within TRCA's jurisdiction are located in the Etobicoke Creek watershed. These six FVCs represent approximately 2.3% of the area of the watershed. **Table 14** identifies the storm events at which flooding becomes an issue for each FVC.

Table 14 - Flood Risk by Storm Event

Flood Vulnerable Cluster	Risk by Storm Event
Brampton Central	Risk at > 100-year event
Avondale	Risk at 5-year event and above

Flood Vulnerable Cluster	Risk by Storm Event
Little Etobicoke	Risk at > 100-year event
Dixie/Dundas	Risk at 5-year event and above
Longbranch	Risk at 5-year event and above
West Mall	Risk at 25-year and above

The Regulatory Flood Plain is the approved standard used in a particular watershed to define the limit of the flood plain for regulatory purposes. Within TRCA's jurisdiction, Regulatory Flood Plain is based on the regional storm (i.e. Hurricane Hazel event), or the 100-year flood, whichever is greater.

Table 15 identifies the amount of developed (e.g. buildings and infrastructure) and undeveloped (e.g. open space and natural) land within the Regulatory Flood Plain by subwatershed.

Table 15 - Developed / Undeveloped Land Use in the Regulatory Flood Plain

	Developed Land (ha)	Undeveloped Land (ha)
Headwaters	21	574
Spring Creek	335	271
West Branch	76	275
Tributary 3	8	21
Tributary 4	5	29
Main Branch	20	145
Little Etobicoke	24	53
Lower Etobicoke	18	83

Developed land is susceptible to flooding under the most severe storm events. Under the Regulatory Storm, Spring Creek breaches its riverbanks at multiple locations through Avondale, causing extensive overland flooding through developed areas. Development and redevelopment should contribute to the prevention, elimination, and reduction in risk from flooding, erosion, and slope instability.

2.4.2 Erosion Risk

Erosion is a natural part of stream evolution. Erosion becomes a hazard when a changing stream negatively impacts infrastructure or property. Additionally, erosion rates can significantly increase due to land uses such as increased urbanization, which increase flow volumes and velocity in streams. Rerouting natural drainage patterns and concentrating runoff to stormwater outfalls can increase the risk for erosion as well. This erosion characterization attempts to quantify the types and magnitude of potential erosion risk areas based on fluvial geomorphological sensitivity, as well as the location of infrastructure.

To determine erosion sensitivity of stream reaches for each subwatershed, values for Specific Stream Power Ratio (SSPR), erosion control structure density, cross sectional changes, rapid geomorphic assessment (RGA), and shear stress ratio were assessed. Parameter rating thresholds for each of these values were determined and weight averaged to obtain an overall sensitivity value (see **Subsection 4.4.2: Erosion Risk** for details on the thresholds and parameter weights). **Table 16** provides a summary of erosion sensitive stream reaches by subwatershed for 2020 and sensitive stream reaches as reported in the 2010 Technical Update (see **Figure 25** for the corresponding map of these stream reaches). The methodology used to assess erosion sensitivity in this watershed characterization report is not the same as used in 2010, due to uncertainty regarding the methodology used in 2010.

Table 16 - Reach Based Erosion Sensitivity

Subwatershed*	Reach	2010 Erosion Sensitivity**	2020 Erosion Sensitivity
Headwaters	TE8	Moderate	High
	E25	High	Moderate
	E26	Moderate	Moderate
	E27	High	Moderate
	E28	High	High
	E29	-	Moderate
	E30	Moderate	Low
Spring Creek	S1	High	High
	S2	Moderate	High
	S3	Low	High
	S4	High	High
	S5	Moderate	High
	S6	Moderate	High
	S7	Moderate	High
West Branch	E17	Moderate	High
	E18	Moderate	High
	E19	Moderate	Moderate
	E20	Moderate	Moderate
	E21	High	Moderate
	E22	Moderate	Moderate
Tributary 4	R1	High	High
	R2	Moderate	High
	R3	High	High
Main Branch	E12	High	High
	E13	Moderate/High	Moderate
	E14	-	Moderate
	E15	High	High
	E16	Moderate	High

Subwatershed*	Reach	2010 Erosion Sensitivity**	2020 Erosion Sensitivity
Little Etobicoke	LE1	Moderate/High	High
Lower Etobicoke	E1	Moderate	High
	E2	High	High
	E3	Moderate	High
	E6	High	Moderate
	E7	Moderate	High
	E8	Moderate	Moderate

Notes:

*There are no sites in Tributary 3 with data for 2020 or 2010.

**Additional sites were established for monitoring in 2020 that were not included in 2010.

Based on this analysis, all the analyzed reaches of Spring Creek and Tributary 4 show a high erosion sensitivity rating. Of all the analyzed reaches, only one, in the Headwaters, has a low erosion sensitivity rating. Figure 11 below shows the overall sensitivity map for the reaches assessed as well as individual parameter sensitivity maps for shear stress, SSPR, EC structures, RGA, and cross-sections.

- Shear stress represents the force of flowing water against the channel cross section.
- SSPR refers to the increase in specific stream power (i.e. energy expended by water against channel bed and banks per unit channel width) from a rural (pre-urbanization) state, which is assumed to be in equilibrium, to current conditions.
- EC structures is based on the density of these structures in a specified area.
- RGA is a classification technique based on the presence and/or absence of key indicators of channel instability such as exposed tree roots, bank failure, excessive deposition, etc.
- Cross-sections refers to the changes to channel area, average depth, and width at the top of bank elevation.

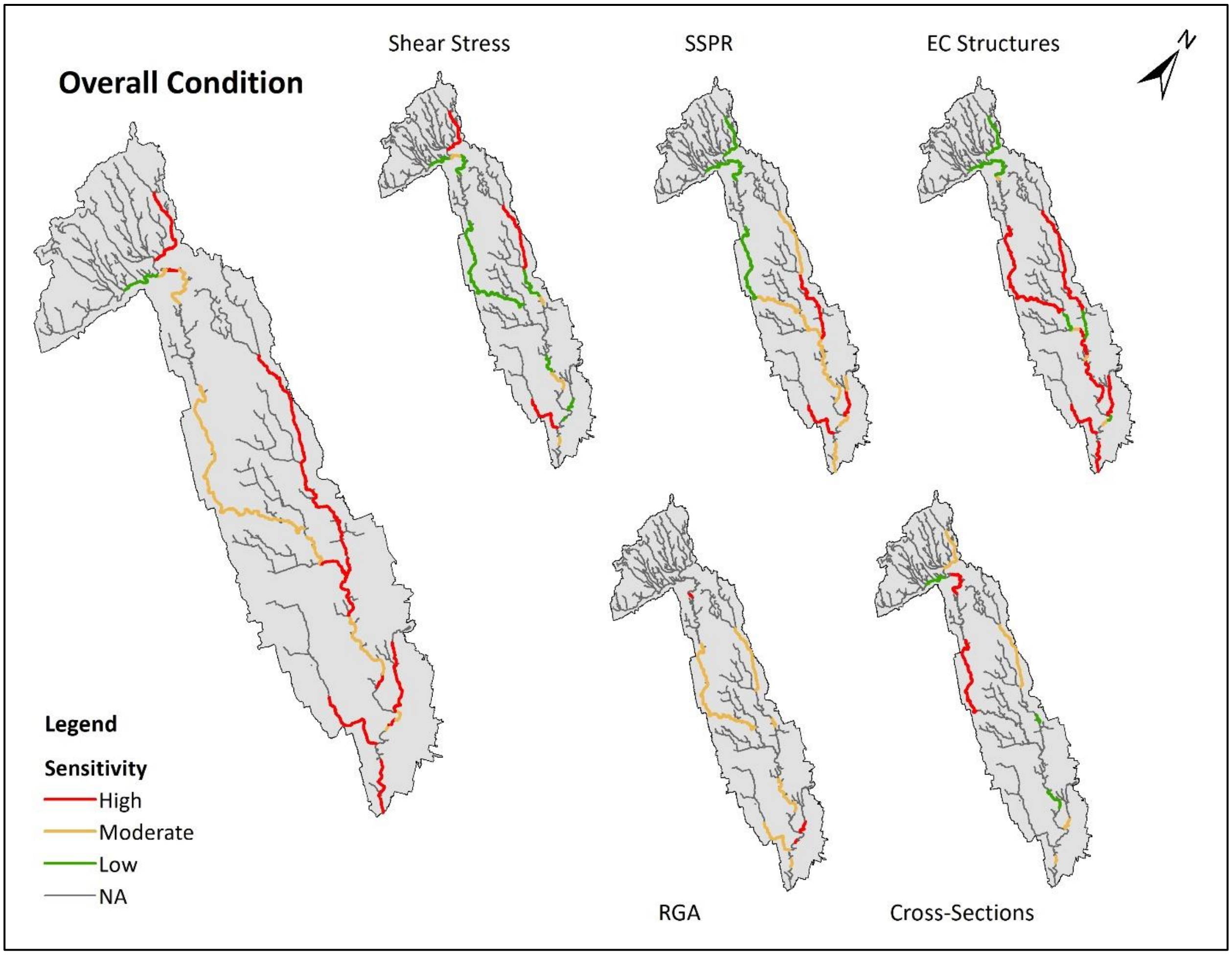

Figure 11 - Erosion Sensitivity

The majority of the watershed can be categorized as exhibiting moderate or high erosion sensitivity. This is not unexpected since the watershed is largely urbanized with significant portions lacking stormwater management controls. **Table 17** summarizes the results for each of the parameters that were used to calculate overall erosion sensitivity by subwatershed and identifies trends for that parameter, if applicable.

Table 17 - Summary of Erosion Parameter Results

	Specific Stream Power Ratio	Erosion Control Structure Density	Cross Sectional Changes	Rapid Geomorphic Assessment	Erosion Pin Results	Shear Stress Ratio
Headwaters	Lowest in watershed	Lowest in watershed	Stable, increases at one location	Increase in instability	Increasing trend	High ratio at one site
Spring Creek	Average	High	Stable	Increase in instability	No obvious increase	Range of ratios

	Specific Stream Power Ratio	Erosion Control Structure Density	Cross Sectional Changes	Rapid Geomorphic Assessment	Erosion Pin Results	Shear Stress Ratio
West Branch	Average	High	Increasing at two locations	Increase in instability	Decreasing trend	Low ratio
Tributary 3	Above average	Low	No data	No data	No data	No data
Tributary 4	High	High	Increasing	Increase in instability	Increasing trend	Low ratio at one site
Main Branch	Average	Average	Stable	Increase in instability	Decreasing trend	Low and moderate ratios
Little Etobicoke	Highest in watershed	Highest in watershed	No data	Transition-ing	No data	High ratio at one site
Lower Etobicoke	Average	High	Stable	Stable	No data	Low and moderate ratios

In addition to characterizing the erosion sensitivity of stream reaches, TRCA assesses erosion risk to infrastructure on public and private property through programs with municipal partners:

- Peel Infrastructure Hazard Monitoring Program
- Brampton City Wide Erosion Hazard Monitoring
- Toronto Water Steep Ravine Inventory

Of the 138 erosion control structures that TRCA actively monitors as assets or part of maintenance responsibilities, 132 are low priority, two are medium priority, and four are high priority. See **Figure 26** for a map of these locations.

Of the 675 active Peel Infrastructure Hazard Monitoring Program inspection sites monitored in the watershed, 522 are low priority, 83 are medium priority, and 52 are high priority. The remaining 18 sites are not assigned due to issues accessing the sites. See **Figure 27** for a map of these locations.

Of the 29 active erosion hazard sites annually monitored on public and private property, 11 are medium priority, while the remaining 18 have a low priority ranking. See **Figure 28** for a map of these locations.

As existing erosion control structures age and become weathered during storm events, there is a need to triage inspections, to characterize the risk of erosion to infrastructure and property.

The City of Mississauga also has an erosion assessment program. Since 2010, six erosion control projects have been completed in Little Etobicoke Creek primarily to stabilize banks and stormwater outfalls.

2.5 Stormwater Management

Stormwater is precipitation that is either absorbed into the ground or flows along the surface (i.e. direct runoff) into storm sewers, streams, and lakes. In a heavily urbanized watershed, stormwater management infrastructure is important for controlling runoff. Without adequate stormwater management infrastructure, runoff will degrade water quality, increase channel erosion, increase streamflow, and peak flows during storm events. Prior to the 1980s, stormwater management focused solely on flood control. Since then, stormwater management infrastructure has evolved to incorporate mitigation measures for water quantity, water quality, and erosion control. As a result, more recent urban development in the Etobicoke Creek watershed has stormwater management infrastructure, while older developments may lack any stormwater management controls. See **Table 18** for a breakdown of watershed/subwatershed area with water quantity/flood control and quality/erosion control.

Table 18 – Proportion of Watershed/Subwatershed with Stormwater Controls

	Area with Quantity/Flood Control (%)	Area with Quality/Erosion Control (%)
Watershed	**17.4**	**18.8**
Headwaters	8.4	8.4
Spring Creek	28.0	44.8
West Branch	12.3	3.3
Tributary 3	62.8	46.2
Tributary 4	19.6	0.0
Main Branch	6.3	22.0
Little Etobicoke	21.9	14.5
Lower Etobicoke	0.0	0.0

Notes:

Information for private facilities is not available. Statistics only include facilities owned by municipalities, GTAA, and MTO.

Some facilities were designed to provide both quantity/flood and quality/erosion controls.

The summary outlined in **Table 18** is based on the drainage area of stormwater management facilities. In other words, the storm sewer network area that is draining to each facility. There are a total of 77 stormwater management facilities in the watershed. Of these facilities, 64 had known functions based on data provided by municipalities and other stormwater management facility operators. The facilities with unknown functions (i.e. quantity/flood or quality/erosion controls) are not included in the summary above. Due to the urbanized nature of this watershed and the different ages of development, improvements to stormwater management infrastructure would likely have significant benefits to watershed conditions. Municipal stormwater master planning, as required by provincial policy, presents an opportunity to strategically examine stormwater management improvement opportunities at the watershed scale.

It is important to note that the 2010 Technical Update indicated that approximately 30% of the urban area of the watershed had some form of stormwater controls. Since 2010, a portion of the Headwaters subwatershed has become urbanized. As a result, this analysis was expanded beyond urban areas to include the entire watershed. This analysis and the 2010 Technical Update both noted that there are facilities with unknown functions, indicating a need for better tracking of stormwater management infrastructure within watersheds.

2.6 Restoration Planning

Restoration planning is a vital tool to improve watershed conditions in an urbanized and impaired watershed like Etobicoke Creek.

TRCA uses a systematic approach to restoration planning that involves prioritizing catchments where the greatest ecological benefit is achievable and then recording site-level information for terrestrial and aquatic restoration opportunities. TRCA's Integrated Restoration Prioritization (IRP) framework considers multiple objectives related to ecosystem health and uses a comprehensive, consistent, and repeatable framework to guide restoration planning, resource investment and implementation (See *Integrated Restoration Prioritization: A Multiple Benefit Approach to Restoration Planning*, 2016 for more information). The IRP methodology calculates results for a series of metrics and assigns a high, medium, low, or protection score at the catchment scale. In other words, a high priority catchment has multiple impairments and restoration could provide multiple benefits to the watershed. The protection score is a special designation given to high-value natural heritage areas where targeted restoration programs are beneficial to promote the recovery of high valued systems. See **Table 19** for a breakdown of IRP scores within the Etobicoke Creek watershed and **Figure 29** for the corresponding map.

TRCA uses site-level information to catalogue restoration opportunities to further guide specific restoration projects in support of TRCA and municipal objectives related to natural heritage, fisheries, climate change, previous watershed plans, and the Toronto Area of Concern Remedial Action Plan. Since 2002, there have been 1,718 restoration opportunities catalogued in the Etobicoke Creek Watershed. See **Table 19** for a breakdown of the type of aquatic and terrestrial restoration opportunities catalogued.

A total of 111 TRCA restoration projects have been completed since 2002. See **Figure 30** for a map of completed restoration projects. **Table 19** outlines the types of restoration projects completed. In some cases, more than one type of restoration was completed at a single site, which is why the total for the types of projects is greater than 111.

As part of this watershed planning process, restoration opportunities are being updated to increase coverage and reflect current conditions.

Table 19 - Restoration Planning in Etobicoke Creek

	Type of Opportunity / IRP Score	Number
IRP Catchments	High	89 (27.5% of watershed)
	Medium	147 (45.4% of watershed)

	Type of Opportunity / IRP Score	Number
	Low	63 (19.4% of watershed)
	Protection	25 (7.7% of watershed)
Restoration Opportunity Sites	**Aquatic**	
	Barrier	81
	Blockage/restriction	11
	Culvert	31
	Erosion	64
	Floodplain impairment	1
	Informal crossing	22
	Lack of watercourse shading	5
	Morphological issue	86
	On-line pond	10
	Outfall	282
	Sediment loading	2
	Riparian[20]	552
	Terrestrial	
	Best management practice	35
	Green infrastructure	38
	Invasive species management	2
	Forest	239
	Meadow	60
	Wetland	155
	Wetland complex	42
	Total Restoration Opportunities	**1,718**
Completed Restoration Projects by Type (Since 2002)	Wetland projects	13
	Stream projects	8
	Planting projects	101
	Shoreline projects	2

[20] For restoration planning, riparian typically falls within terrestrial assessments, but can address aquatic issues. Since riparian corridors are a transition zone and were characterized as part of the Water Resource System, it has been included under aquatic within this table.

	Type of Opportunity / IRP Score	Number
Completed Restoration Projects by Subwatershed (Since 2002)	Headwaters	19
	Spring Creek	16
	West Branch	21
	Tributary 3	7
	Tributary 4	3
	Main Branch	18
	Little Etobicoke	20
	Lower Etobicoke	7
	Total Number of Sites (Some sites involved more than one type of restoration project)	**111**

3. POLICY INVENTORY

Provincial policies require municipalities to use the watershed as the ecologically meaningful scale for integrated and long-term planning to protect, enhance, and restore the quality and quantity of water, the WRS, and NHS. As part of watershed characterization, TRCA, in collaboration with its municipal partners, has conducted an inventory of existing municipal policies, strategies, guidelines, standards, etc., that are relevant to Etobicoke Creek and watershed planning broadly. This inventory does not evaluate the effectiveness of these policies. Identifying opportunities to improve policies and their implementation will be conducted in subsequent stages of the watershed planning process. Within the framework of TRCA's regulatory authority, opportunities to ensure consistency and alignment between TRCA and municipal policies and guidelines will be explored.

As part of this inventory of existing policies, municipal Official Plans, master plans, major strategies, secondary plans, development standards or guidelines, and bylaws were reviewed. **Table 20** identifies whether municipal Official Plans have policies related to watershed planning components and identifies relevant strategies, guidelines, standards, etc., for each municipality in the watershed. Since municipal policies and plans are routinely updated, this inventory is not intended to be comprehensive, but rather a general overview of the existing policy framework as it relates to the Etobicoke Creek watershed. Additionally, this inventory does not list studies or environmental assessments related to infrastructure planning or natural hazard mitigation. **Subsection 3.1: Natural Heritage System Comparison**, compares current municipal NHSs as identified in Official Plans to TRCA's Terrestrial Natural Heritage System Strategy (TNHSS) from 2007.

Table 20 - Policy Inventory

	City of Toronto	Region of Peel	City of Mississauga	City of Brampton	Town of Caledon
Official Plans					
Water Resource System[21]	N	Y[22]	N	N	N
Natural Heritage System / Urban Forest	Y	Y	Y	Y	Y
Surface Water Quality	Y	Y	Y	Y	N
Groundwater Quality / Quantity	Y	Y	Y	Y	Y

[21] While each Official Plan speaks broadly to protecting water, current Official Plans do not speak to water resources as an integrated system. This is expected to change as municipalities update their Official Plans to conform to current provincial policies.
[22] Region of Peel's Official Plan has a section on Water Resources (3.4) and water resources are discussed in other parts of the Official Plan. However, the WRS is not identified in the context of the natural environment section of the Official Plan like the NHS (except in relation to the Greenbelt Plan).

	City of Toronto	Region of Peel	City of Mississauga	City of Brampton	Town of Caledon
Natural Hazards	Y	Y	Y	Y	Y
Stormwater Management / Green Infrastructure	Y	Y	Y	Y	N[23]
Restoration Opportunities	Y	Y	Y	Y	Y
Master Plans / Major Strategies					
Site Specific / General Master Plans	Centennial Park Master Plan (under development)	N/A	Dundas Connects Master Plan (2018)	Brampton's Environment (Grow Green) Master Plan (2014)	N/A
			Burnhamp-thorpe Sustainable Neighbour-hood Action Plan (2015)	Downtown Etobicoke Creek Revitalization Study (2014)	
				Brampton Eco Park Strategy (2019)	
				County Court Sustainable Neighbour-hood Action Plan (2012)	
				Bramalea Sustainable Neighbour-hood Action Plan (2021)	
WRS / NHS	Ravine Strategy (2020)	N/A	Natural Heritage and Urban Forest Strategy (2014)	Natural Heritage and Environmental Management Strategy (2015)	N/A

[23] Stormwater management is addressed in relevant secondary plans for the Town of Caledon, but there are no broad directional policies within the Official Plan.

	City of Toronto	Region of Peel	City of Mississauga	City of Brampton	Town of Caledon
	Natural Environment Trails Strategy (2013)		Future Directions, Parks and Forestry Master Plan (2014)	Parks and Recreation Master Plan (2017)	
	Toronto Biodiversity Strategy (2019)				
Urban Forest	Sustaining and Expanding the Urban Forest: Toronto's Strategic Forest Management Plan – 2012 – 2022	Peel Region Urban Forest Strategy (2011)	Urban Forest Management Plan (2014)	Brampton One Million Trees Program *Urban Forest Management Plan under development (2021)	N/A
Stormwater Management	Wet Weather Flow Master Plan (Recent Update 2017)	*Region of Peel has begun the process to develop a Stormwater Servicing Master Plan for regional roads*	Stormwater 2021 – 2024 Business Plan *Stormwater Master Plan under development	N/A	N/A
Climate Change	Toronto's Resilience Strategy (2019)	Climate Change Master Plan (2020 – 2030)	Climate Change Action Plan (2019)	Community Energy and Emissions Reduction Plan (2020)	Resilient Caledon – Community Climate Change Action Plan (2020 – 2050)
Secondary Plans					
Of relevance to Etobicoke Creek watershed	Sherway Area Secondary Plan	N/A	Lakeview Local Area Plan	*Includes several Secondary Planning Areas as identified in Schedule G of the Official Plan*	Mayfield West and Mayfield West Phase 2

	City of Toronto	Region of Peel	City of Mississauga	City of Brampton	Town of Caledon
Guidelines / Standards					
Of relevance to Etobicoke Creek watershed / watershed planning	Dundas Street West / Highway 427 Planning Framework (2011)	N/A	Green Development Standards (2012)	Sustainable Community Development Guidelines – Part 8 (2013)	Mayfield West and Mayfield West Phase 2 Community Design Plans
	Sherway Centre Design Guidelines			Sustainability Metrics (2014)	Green Development Program
	Toronto Green Standard – Version 3				
	Complete Streets Guidelines (Chapter 7 – Green Infrastructure)				
	Wet Weather Flow Management Guidelines (2006)				
Bylaws					
Of relevance to watershed planning	Toronto Green Roof Bylaw	N/A	Private Tree Protection By-law 254-12	Tree Preservation By-law 317 – 2012	Woodland Conservation By-law
	Tree Protection Bylaws		Stormwater Fees and Charges By-law 0135-2015	Stormwater Charge By-law 82-2020	
	Ravine and Natural Feature Protection Bylaw		Erosion and Sediment Control By-law 512-91	By-law to Protect and Conserve Topsoil 30-92	
			Storm Sewer By-law 0259-2005		

3.1 Natural Heritage System Comparison

Comparing municipal NHS mapping, as identified in Official Plans, to TRCA's recommended NHS is important to look for overlaps, differences, and opportunities to protect, enhance, and restore natural heritage features. See **Table 21** for a comparison of TRCA's NHS (recommended NHS for Peel Region from 2018 and refined NHS for Toronto from 2010) and Municipal NHSs by the amount of overlap in the systems, features that are only present in TRCA's NHS, and features that are only present in municipal NHSs.

Table 21 - Comparison of Natural Heritage Systems

	Overlap (ha)	Overlap (% of watershed)	TRCA Only (ha)	TRCA Only (% of watershed)	Municipal Only (ha)	Municipal Only (% of watershed)
Watershed	**1,824**	**8.1**	**1,904**	**8.5**	**435**	**1.9**
Toronto	185	0.8	34	0.2	123	0.6
Mississauga	386	1.7	519	2.3	32	0.1
Brampton	717	3.2	446	2.0	190	0.8
Caledon	536	2.4	905	4.0	89	0.4

Notes: 'Overlap' refers to natural heritage features present in both municipal NHS's and the TRCA NHS. 'TRCA only' refers to natural heritage features that are only present in TRCA's NHS. 'Municipal only' refers to natural heritage features that are only present in a municipal NHS.

Combining 'overlap' and 'municipal only' NHS means that currently 10% of the watershed is included in a NHS from municipal Official Plans. The amount of overlap (8.1% of the watershed) indicates some shared objectives around NHS planning. However, the discrepancies demonstrate opportunities to improve NHS planning in the watershed.

TRCA's recommended NHS includes an additional 8.5% of the watershed not included in a municipal NHS. Over 900 ha of woodlands, wetlands, and headwater streams in the northern part of the watershed are only included in TRCA's recommended NHS. Open spaces (e.g. meadows, open areas) in the southern portion of the watershed where there may be opportunities for habitat restoration are also not included in any municipal NHS. Of the additional 8.5% of the watershed that could be incorporated into a municipal NHS, 4% is in Caledon, 2.3% in Mississauga, 2% in Brampton, and 0.2% in Toronto. There are also areas that have been developed since 2007 and digitizing errors reducing the amount of area from the additional 8.5% of the watershed that could be incorporated into any future NHS.

Many built-up areas and active recreation areas are included in the municipal only NHS features (1.9% of the watershed), which should not necessarily be considered natural heritage features. This includes parking lots and manicured lawns within Heart Lake Conservation Park, areas overlapping roads near Highway 10 and Mayfield Road, baseball fields, roads, and buildings.

Through the development of this watershed plan, there will be an opportunity to better align NHS objectives and ensure existing natural heritage features are adequately protected in policy while identifying potential areas for enhancement and restoration.

4. METHODOLOGY

This section provides an overview of the methods and approaches that were used to characterize each of the technical components of watershed planning discussed in **Section 2: Existing Watershed Conditions**.

4.1 Water Resource System

For the components of the WRS (KHAs and KHFs) a variety of methods were used to delineate each component, as outlined in **Table 22**

Table 22 - WRS Delineation Methodologies

	Methods
Key Hydrologic Areas	
Ecologically Significant Groundwater Recharge Areas (ESGRAs)	Outputs from the ORMGP reverse particle tracking model were used to predict likely recharge and discharge of groundwater throughout TRCA's jurisdiction. Pairing outputs from the expanded groundwater model with data from highly dependent groundwater ecosystems (i.e. fish, flora, and fens data) helped to determine where ESGRAs are likely to be found on the landscape.
Significant Groundwater Recharge Areas (SGRAs)	This layer was developed to satisfy requirements of the *Source Protection Plan* for the Credit Valley, Toronto and Region and Central Lake Ontario region (CTC-SPC 2015) under the *Clean Water Act* (2006).
Highly Vulnerable Aquifers (HVAs)	This layer was developed to satisfy requirements of the *Source Protection Plan* for the Credit Valley, Toronto and Region and Central Lake Ontario region (CTC-SPC 2015) under the *Clean Water Act* (2006).
Significant Surface Water Contribution Areas (SSWCAs)	This layer consists of areas of overlap between SGRAs and ESGRAs. In other words, volume contributions are identified by SGRAs and the surface water component is addressed by the recharge-discharge connections to sensitive receiving features as identified by ESGRAs.
Key Hydrologic Features	
Inland Lakes	TRCA's inland lakes layer was produced through an orthophotography interpretation exercise. Since satellite imagery was used to delineate features, all waterbody types are included in this layer, such as lakes, ponds, stormwater management ponds, and artificial ponds (e.g. golf courses). This layer was refined to remove overlaps with the wetland layer.
Wetlands	The refined wetland layer was derived from TRCA's Ecological Land Classification (ELC) wetland data, Ministry of Natural Resources and Forestry wetland data, and natural cover wetland data. A quality assurance and quality control process was completed using the latest orthophotography imagery from 2019.
Seepage Areas and Springs	Seepage areas and springs were mapped by creating a layer consisting of two parts: 1. A linear layer describing where groundwater discharge in the stream is predicted to be stronger than the regional average stream discharge 2. A polygon layer describing areas with strong potential for groundwater discharge at surface (i.e. water seeping out of the ground, at least during

	Methods
	part of the year). This layer was refined to eliminate areas of extensive urban land cover, where subsurface and surface infrastructure interferes with discharge processes. The discharging layer is a product from TRCA's Expanded Groundwater Flow Model (TEGWFM). The second layer identifies areas where upward hydraulic gradients may be found at the ground surface. Both these layers were combined and refined to remove areas with land cover classes defined as urban areas (e.g. airport, commercial, industrial, road, residential, commercial, etc.).
Permanent Streams and Intermittent Streams	The following data was used to classify segments of watercourses as permanent, intermittent, or unknown: • Field collected data from 2012, 2017 and 2020 for the Headwaters subwatershed • 2020 baseflow data for the entire watershed • 2018/2019 Southern Central Ontario Ortho Photography (SCOOP) imagery • Groundwater model (TEGWFM) • Digital Elevation Model (DEM)
Headwater Drainage Features	A desktop review of potential HDF sampling sites was completed using 2.5 ha drainage lines based on TRCA's DEM. Due to resource constraints, HDF sampling locations were identified only at points where drainage lines occurred at road crossings within the Headwaters subwatershed. A total of 97 sampling locations were field validated in May 2020 with a repeat visit for those with water in September 2020 to characterize each HDF. At each sampling location the flow type and feature type were determined for feature classification. Additional data sources were used to aid classification where field data was not available outside the Headwaters subwatershed and in instances where current and past field data or upstream and downstream data conflicted. Field-collected feature type and flow condition data from 2012, 2017 and 2020 as well as 2020 baseflow data, TEGWFM data, and wetland data were used to classify the hydrological functions of the watercourse or HDF. Based on these data, each feature was classified as having Important, Valued /Contributing, or Limited/Recharge hydrology functions according to TRCA's *Evaluation, Classification and Management of Headwater Drainage Features Guidelines*. In general, features classified as permanent were deemed to have important hydrology functions. Features that were classified as intermittent were deemed to have valued or contributing hydrology functions. Lastly, features that were classified as unknown permanency, were deemed either as valued/contributing or limited/recharge, using the wetlands and groundwater data to aid classification. These are preliminary assessments that could be further verified through the collection of additional field data.

4.1.1 Riparian Corridors

Riparian corridors were assessed for the baseline and current periods through a desktop GIS analysis. The amount of natural cover within the riparian corridor was quantified for each land use dataset (2002, 2012, and 2019). The riparian corridor is calculated as the perpendicular distance from the centreline by:

$$RC = 0.5(Wb) + 30$$

RC is the riparian corridor width in metres and *Wb* is the average bankfull width of the stream in metres. To account for riparian corridors associated with lentic systems (i.e. ponds and lakes), the following method was applied. Where open water data were available (e.g. areas identified as open water in land cover data), a 30 metre buffer was applied around the open water polygon. These corridor calculations were combined with the calculations for streams.

The analysis on riparian natural cover was conducted by stream order (i.e. stream size based on a hierarchy of tributaries), where *RC* was calculated for each stream order type. Summaries of total natural cover and by habitat type (i.e. meadow, forest, and wetland) were tabulated.

4.1.2 In-stream Barriers

Aquatic connectivity was assessed by updating human-made barrier inventory records. Natural barriers were not considered. Overall connectivity for fish passage was summarized using the Dendritic Connectivity Index (DCI). This analysis provides individual stream segment connectivity of segments between barriers and provides an assessment where there is more (higher DCI values) or less (lower DCI values) connected habitat within the aquatic system.

4.1.3 Fish Community Health

There are 14 sites that are sampled for fish species every three years (when possible) as part of the Regional Watershed Monitoring Program (RWMP) using single pass electrofishing (without block nets).

Fish community IBI scores were calculated using the method from Steedman (1988). Two modifications of Steedman's work were made, including the exclusion of blackspot and brook trout presence/absence (since there is no concrete evidence of Brook Trout presence within the watershed). As a result, the IBI score had a maximum value of 45 instead of 50. To determine if changes in scores between periods were beyond a reasonable doubt, a statistical test was completed (permuted *t*-test was conducted using *R software*).

The state of the fish assemblages within Heart Lake and the mouth of Etobicoke Creek (estuary) were characterized using electrofishing records of the Lakefront Environmental Monitoring Program from 1989 to 2019. Each transect was approximately 1,000 seconds of electrofishing with transects parallel to the shoreline to survey the nearshore (littoral) zone. Surveys were completed across three time periods (historical: 1989-2000, baseline: 2001-2010, current: 2011-2019) for Heart Lake and the mouth of Etobicoke Creek. To assess differences among areas and changes through time, species richness, Shannon index (H), and the number of invasive species were summarized for each period. Fish community assemblages were also compared using statistical tests across time periods (using a Principal Component Analysis [PCA]) of species presence-absence for both Heart Lake and the mouth of Etobicoke Creek. Using the ordination biplots of the PCA, community similarity was visualized across time. Analyses were completed using the *vegan* package in R Software.

4.1.4 Benthic Community Health

There are 14 sites that are sampled annually for benthic macroinvertebrate species (when possible) as part of the RWMP. TRCA's sampling method was changed in 2013 to match the provincial standard and thus only data since 2013 was used. The sampling method involves collecting three samples in each reach: two riffles and one depositional area (pool). Data were summarized using FBI which has values that range from 0 to 10 and increase as water quality decreases. Low values are assigned to groups which are sensitive to organic pollution while high values suggest groups which are tolerant to organic pollution. Each tolerance value is used in a weighted average calculation, following:

$$FBI = \sum \frac{x_i * t_i}{N}$$

X_i is the number of individuals within a taxon, t_i is the tolerance value of a taxon, and N is the total number of organisms in the sample. Average FBI ratings were assessed for 2013 – 2020 at the watershed, subwatershed, and site scale. To determine if values at sites were trending in a particular direction a statistical test was completed (linear regression was conducted using *R Software* to assess if trends that were observed were beyond a reasonable doubt.

4.1.5 Aquatic Habitat Quality

The percent impervious cover was calculated using a desktop GIS analysis. To do this, land uses were assigned an imperviousness value calculated by summarizing the area as a function of the runoff coefficient (i.e. Directly Connected Impervious Area [DCIA]), such that:

$$A_{IC} = A_{LU} * \text{DCIA}/100$$

A_{LU} is the area of land use in hectares, *DCIA* is the runoff coefficient, and A_{IC} is the impervious area in hectares. The overall impervious cover (IC) percentage for each land use period is calculated by:

$$IC = (TA_{IC}/TA) * 100$$

TA_{IC} is the total area of impervious cover in hectares, *TA* is the total area in the watershed and *IC* is the overall impervious cover percentage for the watershed. Percent impervious cover was calculated for three time periods based on land cover data (2002, 2012, and 2019). Impervious results are interpreted as four classes, including: sensitive (<10%), urbanizing (10-25%), non-supporting (25-60%), and urban drainage (>60%).

4.1.6 Groundwater Conditions

The Tier 3 Water Budget represents improvements to the Tier 1 and Tier 2 Water Budgets in terms of the model simulation and more accurate estimates of groundwater movement between and across subwatershed boundaries but did not originally include the Etobicoke Creek watershed. The ORMGP worked with TRCA to extend the York Tier 3 model into the Etobicoke Watershed to model ESGRAs across the entire TRCA jurisdiction.

With respect to groundwater discharge, the ORMGP has developed a surface water and climate analysis tool in the Shiny application, which allows for evaluation of trends. The Shiny application calculates Boxpots and Baseflow Index with 14 separation methods. Boxpots follow the method of McGill et al. 1978, where box represents the 25% to 75% quantile, while the center line represents the median (50%). Monthly BFI given by the monthly median of calculated baseflow and are bounded by the 95% confidence interval.

The ORMGP database was reviewed for all wells with groundwater quality data in the watershed. Groundwater quality data includes all monitoring stations with a single water sample but only groundwater quality stations operated by TRCA or ORMGP were carried forward.

4.1.7 Streamflow

Daily streamflow data for both Water Survey of Canada and TRCA stream gauges was downloaded from the ORMGP website (oakridgeswater.ca). Data was downloaded from ORMGP because it is automatically put into a standard three-column .csv format (date, flow, flag) with standardized date formatting. Most data analysis was completed in R Studio, a graphical user interface for R, using R version 3.6.2 as well as a series of external packages (jsonlite, lubridate, date, zoo, xts, broom, plyr, dplyr, tidyr, formattable, lmomco, caTools, ggplot2, dygraphs, scales, segmented, DT, RSQLite, cvequality). Additional analyses of low flow return periods, and of long-term average streamflow and baseflow, were completed using tools on the ORMGP website in the surface water and climate analyses section.

Annual and monthly baseflow were estimated by taking the median among average daily baseflow values computed using 14 different baseflow separation techniques. Daily baseflow estimates using the various methods were computed using sHydrology tools obtained from oakridgeswater.ca. This is in line with standard practice in hydrology, where taking the median value of an ensemble of different methods to estimate baseflow is generally recommended.

4.2 Natural Heritage System and Urban Forest

This subsection outlines methods associated with habitat quantity, habitat quality, biodiversity, climate vulnerability, and the urban forest.

4.2.1 Habitat Quantity

Natural cover within the watershed boundary was determined by combining TRCA's 2017 natural cover layer with South Central Ontario Orthophotography (SCOOP) imagery from 2018/2019. Quality assurance and quality control was conducted on the combined layer. Refinements to TRCA's wetland layers were included in the natural cover analysis.

4.2.2 Habitat Quality

The Landscape Analysis Model (LAM) used the refined natural cover layer to determine habitat quality within the watershed. LAM ranks habitat patch quality based on a scoring and ranking system that classifies patches from "poor" to "excellent" quality based on their size, shape, and matrix influence. Quality ranks for habitat mosaics (i.e. adjoining forests and wetlands were considered as one functioning patch) were evaluated. Meadows were kept separate to ensure marginal lands, such as roadside areas, within the habitat class were not mixed with other natural cover types.

4.2.3 Terrestrial Biodiversity

TRCA's terrestrial monitoring program collects data on flora, fauna and vegetation communities using both inventory surveys and Long-Term Monitoring Program (LTMP) plots.

Inventory surveys are conducted by biologists between April and October. Biologists map the locations of species detections and vegetation communities using Ecological Land Classification protocol. These data are a snapshot of species present at the time of the survey, and are an underestimation of both species richness.

LTMP plots exist across TRCA's jurisdiction in forest, wetland, and meadow habitat types. The purpose of LTMP plots is to detect regional trends (e.g. temporal and spatial) in vegetation (i.e. tree health, shrub and sapling regeneration, ground flora, invasive species), breeding bird, and frogs/toads. Data from four forest bird plots, two forest vegetation plots, three wetland bird plots, two wetland vegetation transects, four frog plots, and one meadow bird plot were used for this analysis.

4.2.4 Habitat Connectivity

Habitat connectivity analysis was completed as part of TRCA's *Crossing Guidelines for Valley and Stream Corridors*. Regional connectivity refers broadly to connectivity among all high-quality habitat patches in a particular region (e.g. TRCA's jurisdiction, or watershed scale). High quality habitat patches (L1-L3) from the TNHSS were selected for maintaining and, if possible, enhancing regional connectivity at both the jurisdictional and watershed scales. Only the top 50% of connectivity priorities were included for regional connectivity at the jurisdictional and watershed scales. Local connectivity was mapped using the concept of habitat networks, which reflects the areas where potential wildlife movements within their general daily and seasonal movement capacity are more likely. The focus was on two specific groups of species that move between: wetlands and forests (includes most amphibians) and, forests to forests (includes most small mammals and salamanders). The resulting habitat network layers were identified as priority areas for local connectivity.

4.2.5 Climate Vulnerabilities

Each of the five climate vulnerability indicators was assigned a score of low (0), medium (1), or high (2) based on the criteria outlined in **Table 23**.

Table 23 - Climate Vulnerability Indicator Scoring Methods

Vulnerability Indicator	Scoring Method
Ground surface temperature	Score is based on three classes (low = 13 - 28°C, medium = 29 - 36°C, high = 37 = 47°C).
Climate sensitive vegetation	Score considers hydrology, fertility, and dynamics (i.e. interaction between factors). Wetland communities were scored using only fertility and dynamics. Non-wetland communities were scored using hydrology, fertility, and dynamics.
Habitat patch quality	Score is based on habitat patch L-rank from the LAM model (low = L1 or L2, medium = L3, high = L4 or L5).
Soil drainage	Score is based on combined soil drainage classifications from provincial data (low = well drained, medium = imperfectly drained, high = very poorly drained; areas with urban cover are considered high).

Vulnerability Indicator	Scoring Method
Wetlands	Score is based on number of potential water sources (low = all three sources, precipitation, groundwater, and surface water, medium = precipitation plus one of the other two sources, high = only precipitation).

4.2.5 Urban Forest

The percent canopy cover was assessed using i-Tree Canopy and leaf-on Google Earth imagery from 2018 and 2009. A total of 3,300 random sample points were generated across the watershed by i-Tree Canopy. A technician classified these points as tree/tall shrub, herbaceous/low shrub, bare ground, impervious buildings, impervious roads, impervious other, or agriculture. The proportion of canopy cover in the watershed was estimated as the ratio of the number of tree/tall shrub points to the total number of sample points. The same sample points were also used to estimate the canopy cover percentage for each subwatershed and land use type. A net canopy cover change was obtained by subtracting the baseline canopy cover from current canopy.

To ensure quality, the classification of a random subset of points was checked by the project lead and supporting research scientists. It can be difficult to distinguish tall shrubs/trees from lower shrubs and tall herbaceous. Google Street view was consulted where necessary.

A current canopy cover map was prepared by combining two existing land cover maps for Peel Region and Toronto. Land cover for Peel Region was mapped by B.A. Blackwell and Associates Ltd. at a resolution of 50 cm in 2015, while the City of Toronto updated their land and forest cover map in 2018. The tree canopy land cover class from each land cover dataset was extracted and merged into a single tree canopy map. The data were improved by removing erroneously mapped tree canopy in agricultural and airport zones. A 50 m x 50 m grid was created for the watershed and the percentage canopy cover per grid cell was computed.

Urban forest structure, composition, and health were assessed within the developed portions of the watershed (i.e. all of the Toronto, Mississauga, and Brampton portions of the watershed, as well as Mayfield West in Caledon) using i-Tree Eco protocols and software. Field data were collected in 2020 for plots in Caledon, Mississauga, and Brampton and combined with field data collected in 2018 for the City of Toronto's Tree Canopy Study. Current conditions were compared to 2008 urban forest data from Toronto, Mississauga, and Brampton (no data available for Caledon). Changes between the current conditions and 2008 should be interpreted with caution as the 2020 study area was slightly larger than the 2008 study area and included more field plots.

4.3 Water Quality

Water quality data collected through the RWMP was used in this analysis. The RWMP currently monitors water quality monthly at eight stations within the Etobicoke Creek watershed, two of which are monitored in partnership with the Provincial Water Quality Monitoring Network administered by MECP.

Data from all eight stations for the years 2015 – 2019 were used to determine current conditions. These results were compared to data from 2003 – 2007 at two stations (80006 and 80007). See **Figure 24** for locations of water quality stations.

4.4 Natural Hazards

This subsection outlines methods associated with flooding and erosion risk.

4.4.1 Flooding

Land use change between the baseline and current time periods results in changes to hydrologic response, which may affect flows to the FVCs and associated risk. Developing baseline and current conditions hydrologic models from a calibrated base model and applying a set of design storms matched to statistical flood frequency is an efficient method for quantifying watershed hydrology under different land use scenarios.

The 2013 Etobicoke Creek Hydrology Update (MMM Group Ltd.) was selected as the base hydrologic model for characterizing riverine flood risk. The model was developed on the Visual OTTHYMO (VO) platform. To ensure that the model is grounded in the physical characteristics of the watershed, the predictive capability of the model was tested through rigorous calibration and validation. Flood frequency analyses were performed on the calibration streamflow gauges to determine an appropriate set of return period design storms.

The base hydrologic model uses topographic information and sewershed data to discretize the watershed into 280 subcatchments ranging in size from two hectares (e.g. urban drainage boundaries) to 500 ha (e.g. homogenous rural areas), averaging 80 ha. Current stormwater infrastructure for which information is available (e.g. ponds, bypasses, splits, etc.) was incorporated using the appropriate model commands.

Based on total imperviousness (TIMP), the subcatchments are assigned computational routines for estimating urban or rural runoff response. As a general practice, subcatchments with a TIMP of 20% are considered urban and assigned the STANDHYD command. It is possible for the model to have a lower imperviousness than observed. The STANDHYD command requires users to input the portion of the TIMP that is directly connected to a drainage system (XIMP), which is the effective impervious area. XIMP is typically estimated from land use maps. TIMP can be similarly estimated or measured using orthographic imagery. To account for the variation of similar land uses across municipalities and over time, conservatism is typically built into land use mapping and can result in higher TIMP values than direct measurement.

The baseline and current conditions vector files contain attributes for TIMP and XIMP based on land use maps. Before these attributes can be used in the model, they are preprocessed in ArcGIS by intersecting the vector file of the model subcatchments with each land use condition. This discretizes the land uses along the subcatchment boundaries and assigns the respective subcatchment name attribute. The resultant attribute table is then exported to Microsoft Excel where subcatchment average TIMP and XIMP is calculated using look-up and summation formulae. Computational routines are assigned based on TIMP; borderline cases (e.g. +/- 1% TIMP) are verified based on contemporaneous orthographic imagery. TIMP and XIMP values are then imported into the VO environment using its native batch assign function.

After modifying the base hydrologic model for baseline and current conditions, design storms with the standard return periods of 2, 5, 10, 25, 50 and 100-year can be simulated with a 12-hour AES distribution. Since the baseline and current conditions models are structurally identical to the base models, the flows were extracted from the same nodes for a relative comparison.

4.4.2 Erosion Risk

As mentioned in **Subsection 2.4.2: Erosion Risk**, parameter rating thresholds and weights were assigned to values for SSPR, erosion control structure density, cross sectional changes, RGA, erosion pin results and shear stress. Based on the thresholds, an overall value was assigned to each parameter: low = 1, moderate = 2, and high = 3. **Table 24** outlines the rating thresholds assigned to each parameter.

Table 24 - Erosion Threshold Assigned Values

	Shear Ratio	SSPR	Erosion Control Density	RGA	Cross Sections	Overall Value
Low	< 1	< 2.6	< 5	≤ 0.2	< 10	≤ 4/3
Moderate	≥ 1, ≤ 2	≥ 2.6, < 3.2	≥ 5, <10	> 0.2, < 0.4	≥ 10, < 30	> 4/3, < 2
High	> 2	≥ 3.2	≥ 10	≥ 0.4	≥ 30	≥ 2

The weights for each parameter are listed in **Table 25**.

Table 25 - Erosion Parameter Weights

Data Availability	Weights				
	Shear Ratio	SSPR	Erosion Control Density	RGA	Cross Sections
All data available	0.3	0.2	0.1	0.1	0.3
No cross sections data	0.4	0.3	0.15	0.15	0
No RGA data	0.3	0.2	0.1	0	0.4
No cross sections or RGA data	0.5	0.3	0.2	0	0
Only erosion control and SSPR data available	0	0.67	0.33	0	0

The data required for analyses undertaken to determine changes in channel geometry and overall morphological changes were informed through detailed geomorphic assessments. These assessments were undertaken over about 20 years at various sites across the watershed. In general, field methods aligned with the methods described in TRCA's *Stormwater Management Criteria Manual*.

To calculate SSPR, specific stream power values from various land use scenarios are compared using the Stream Power Index for Networks (SPIN) tool. For the purposes of this characterization, the SSPR was calculated for each reach containing a monitoring station, each subwatershed based on SPIN tool segment length, and over the entire watershed.

An erosion threshold assessment was undertaken to define the theoretical hydraulic conditions at the various monitoring sites at which sediment can be expected to be entrained and transported within the channel and thus contributing to erosion. The threshold flow represents a critical discharge at which substrate of a defined size class (typically the median grain size) can potentially be entrained. Similarly, a threshold velocity and threshold hydraulic radius and depth can also be defined. To determine the threshold flows (or critical discharge), a critical shear stress and/or critical velocity first needs to be determined. Depending on the substrate characteristics, several methods can be used (listed below):

- Modified Shields Method based on Julien (1995)
- Permissible Shear Velocities (Chow, 1959)
- Komar (1987)
- Fischenisch (2001)
- Wilcock & Crowe (2003)

The method that suited the substrate characteristics the most was chosen for each site. The critical discharge was then determined from the critical shear and/or critical velocity. In addition to the critical shear stress (τ_{crit}), the mean boundary shear stress (τ_o) was also determined for the bankfull channel. The shear stress ratio, the ratio of the mean boundary to the critical shear stress (τ_o:τ_{crit}) was then determined. When the shear stress ratios are above 1, it indicates that the substrate of median grain size can be expected to be entrained by bankfull flow.

4.5 Stormwater Management

Data on stormwater management facilities was provided by the City of Toronto, City of Mississauga, City of Brampton, Town of Caledon, Greater Toronto Airport Authority, and Ministry of Transportation. The data was provided in many different formats and was correlated with existing TRCA data on stormwater management infrastructure. The lack of spatial data prevented comprehensive visual mapping of the state of stormwater management in the watershed. As mentioned in **Subsection 2.5: Stormwater Management**, there were 13 of the 77 stormwater management facilities for which there was no information on their functions.

Ministry of Transportation information included facilities along Highway 407. Additionally, it is unclear if Region of Peel owns any stormwater management facilities along regional roads.

4.6 Restoration Planning

TRCA's IRP methodology is outlined in *Integrated Restoration Prioritization: A Multiple Benefit Approach to Restoration Planning* (2016). The methodology for collecting, cataloguing, and prioritizing restoration opportunities planning data is outline in TRCA's *Restoration Opportunities Planning Primer* (2019).

5. MAPS

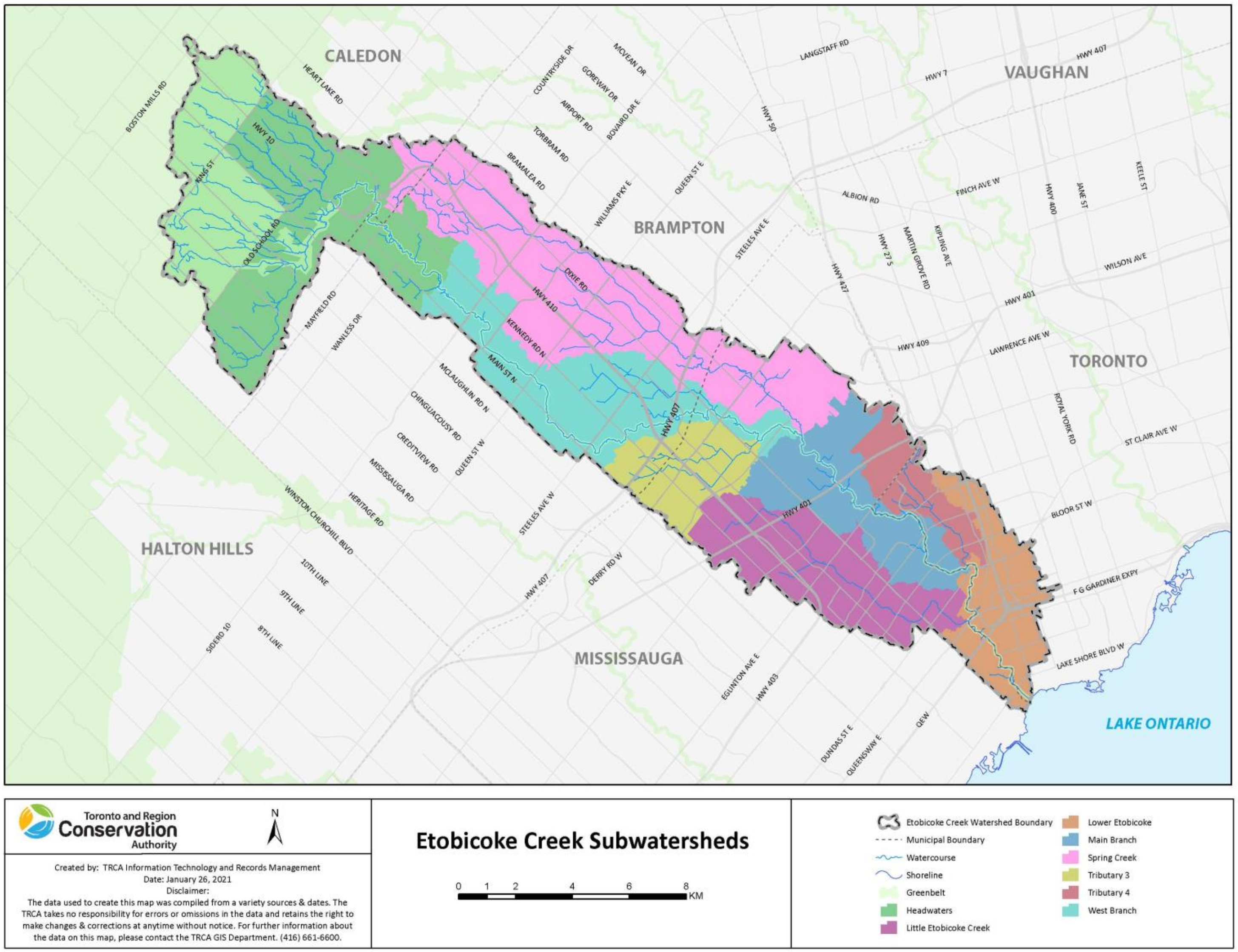

Figure 12 - Etobicoke Creek Subwatersheds

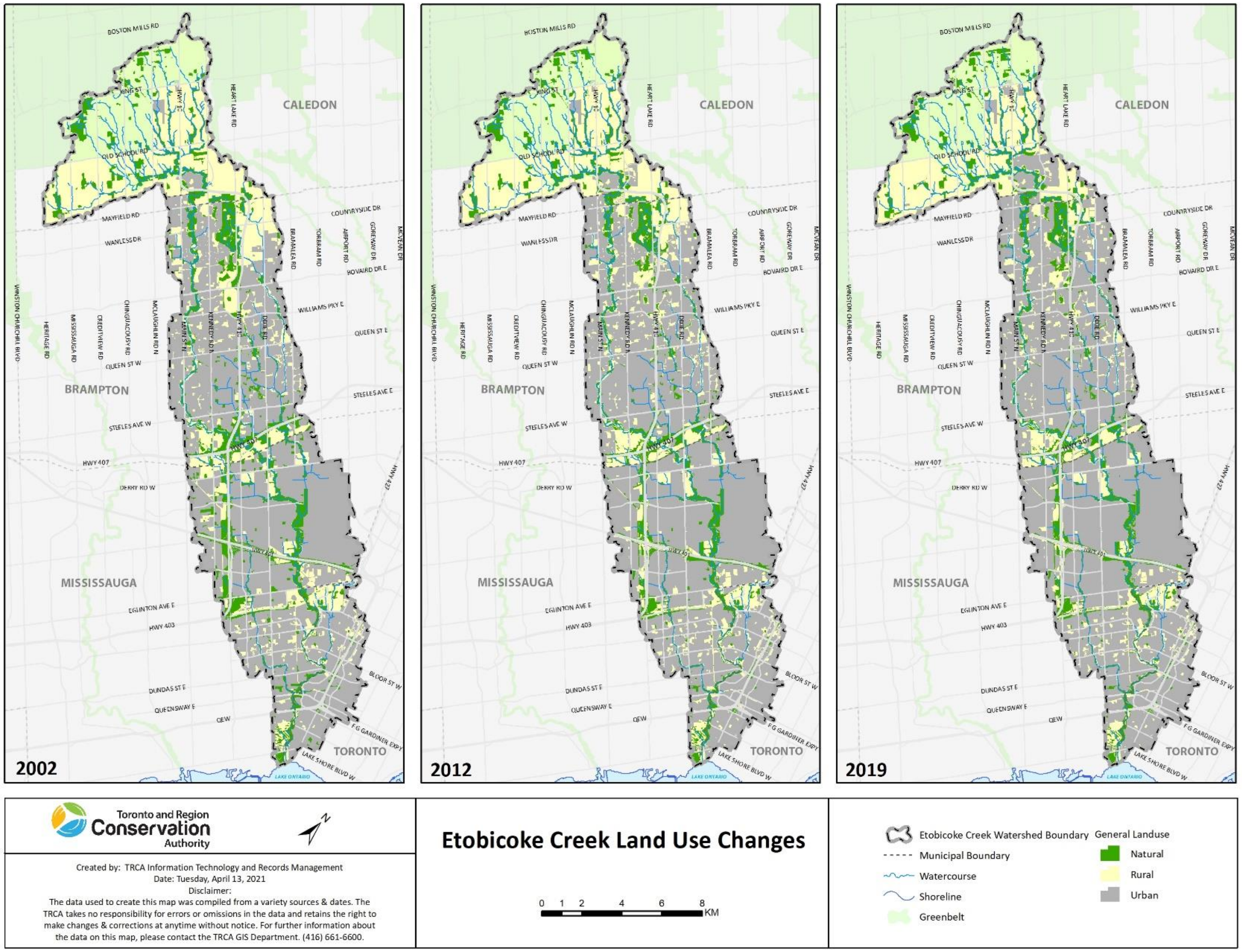

Figure 13 - Progression of Land Use Change

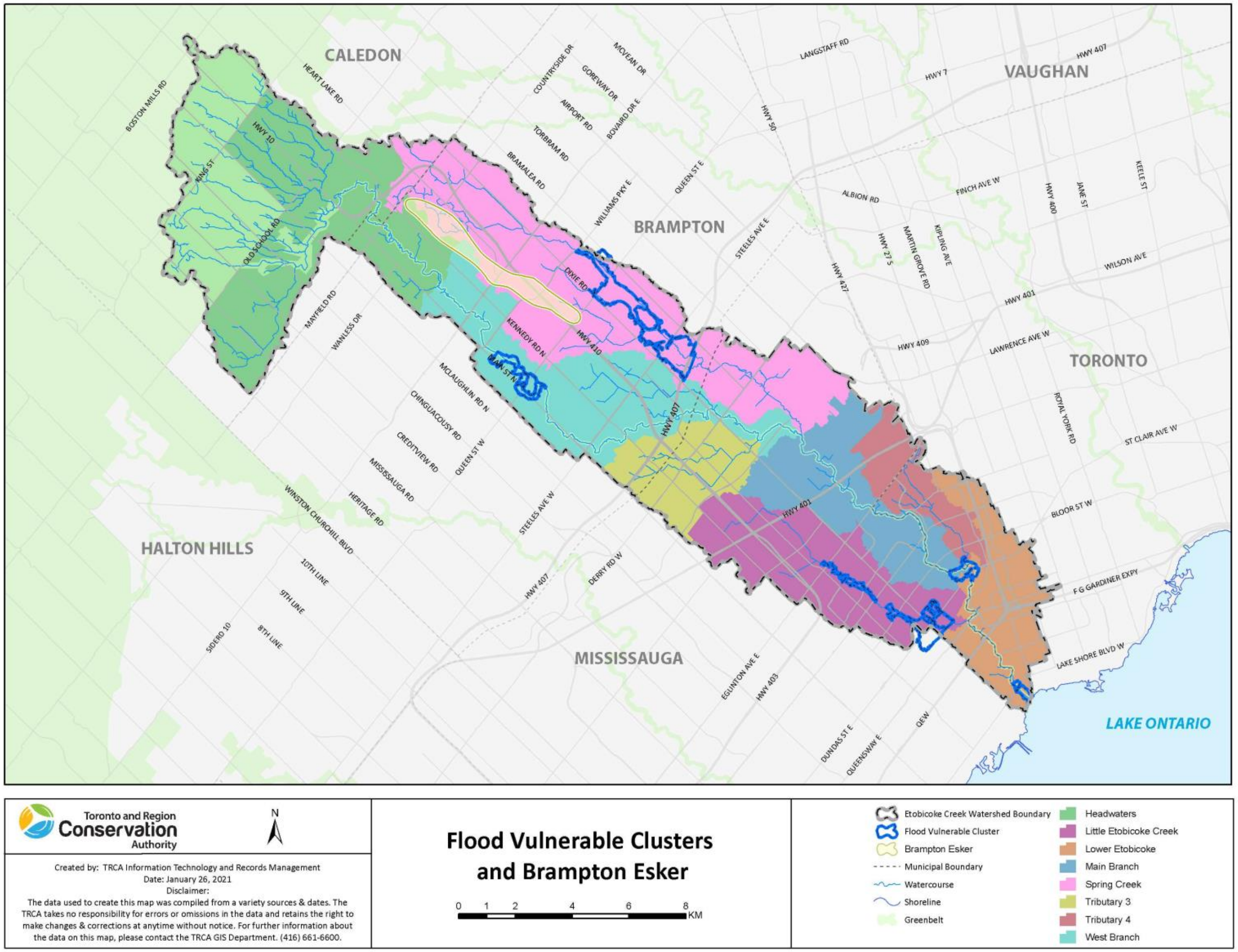

Figure 14 - Flood Vulnerable Clusters and Brampton Esker

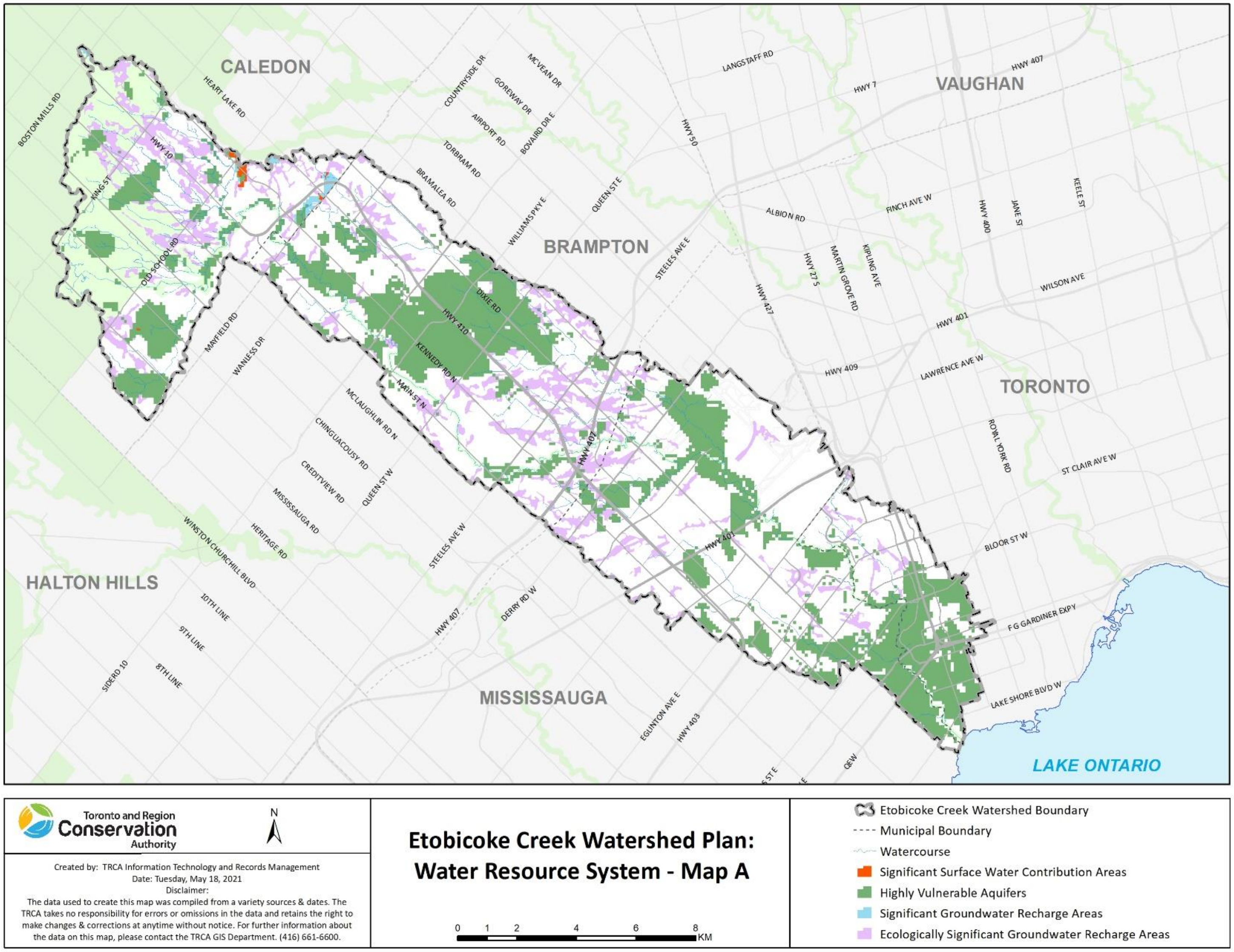

Figure 15 - Water Resource System - Key Hydrologic Areas

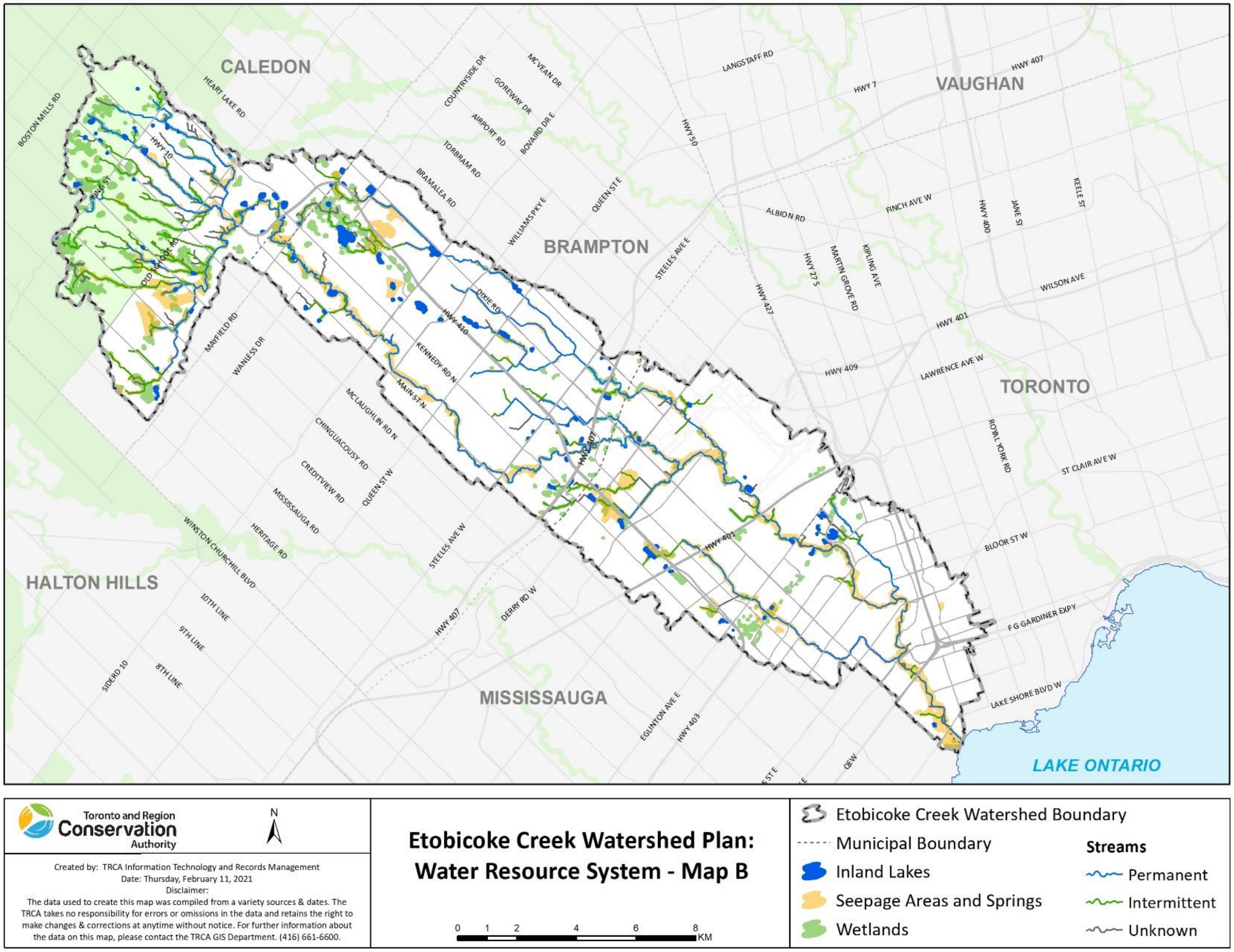

Figure 16 - Water Resource System - Key Hydrologic Features

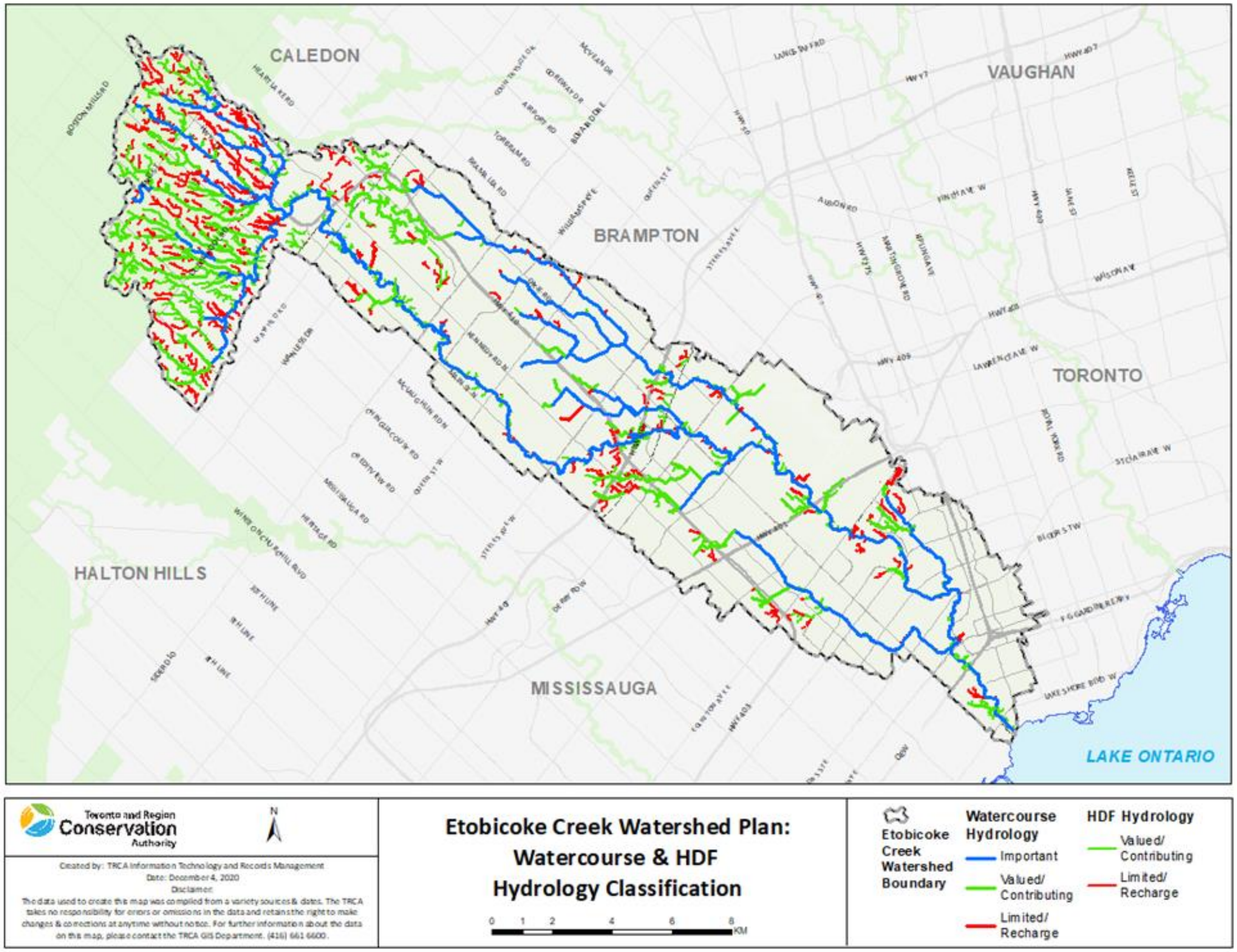

Figure 17 - Stream and Preliminary HDF Classification

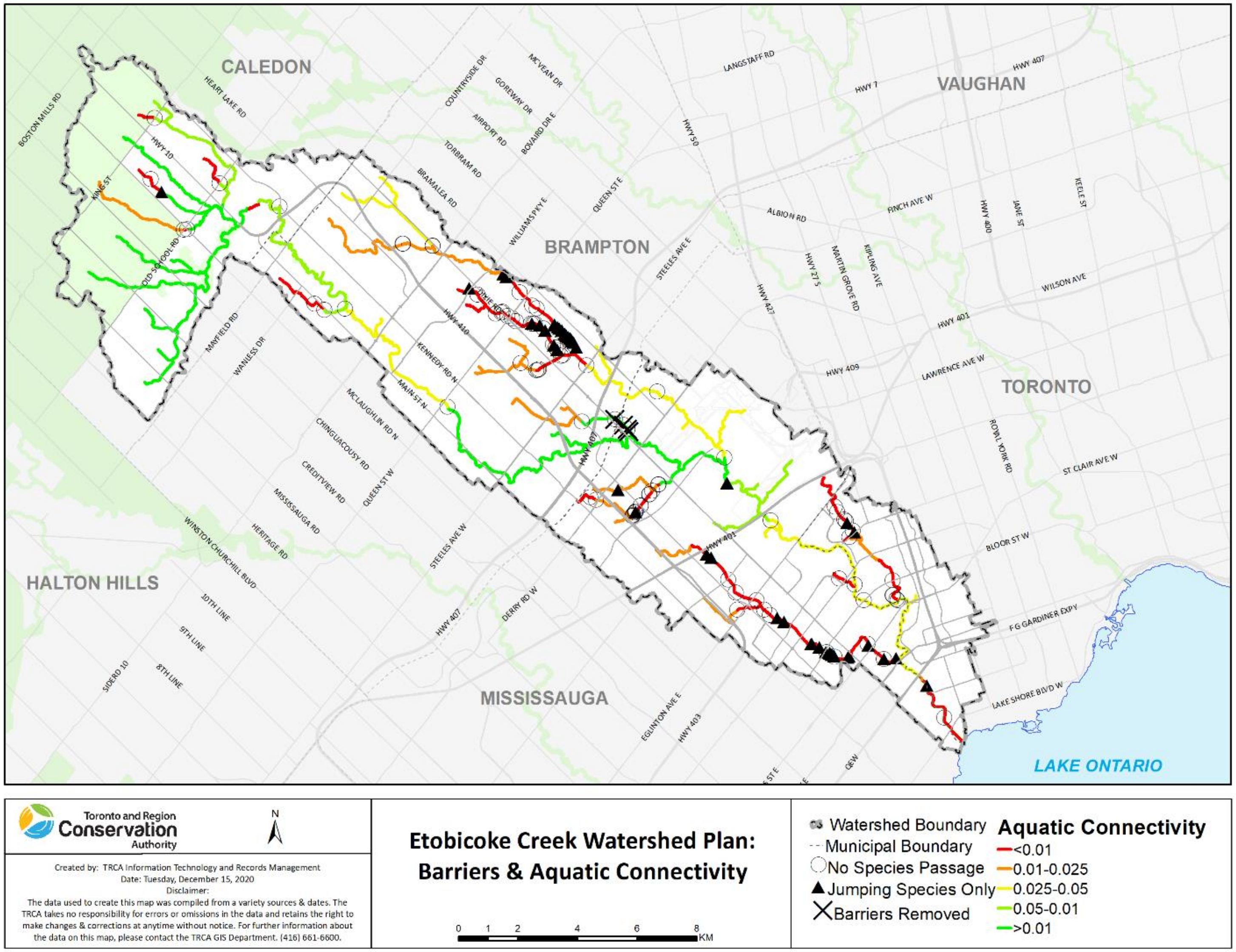

Figure 18 – In-stream Barriers and Aquatic Connectivity (Green is high connectivity; red is low connectivity stream segments)

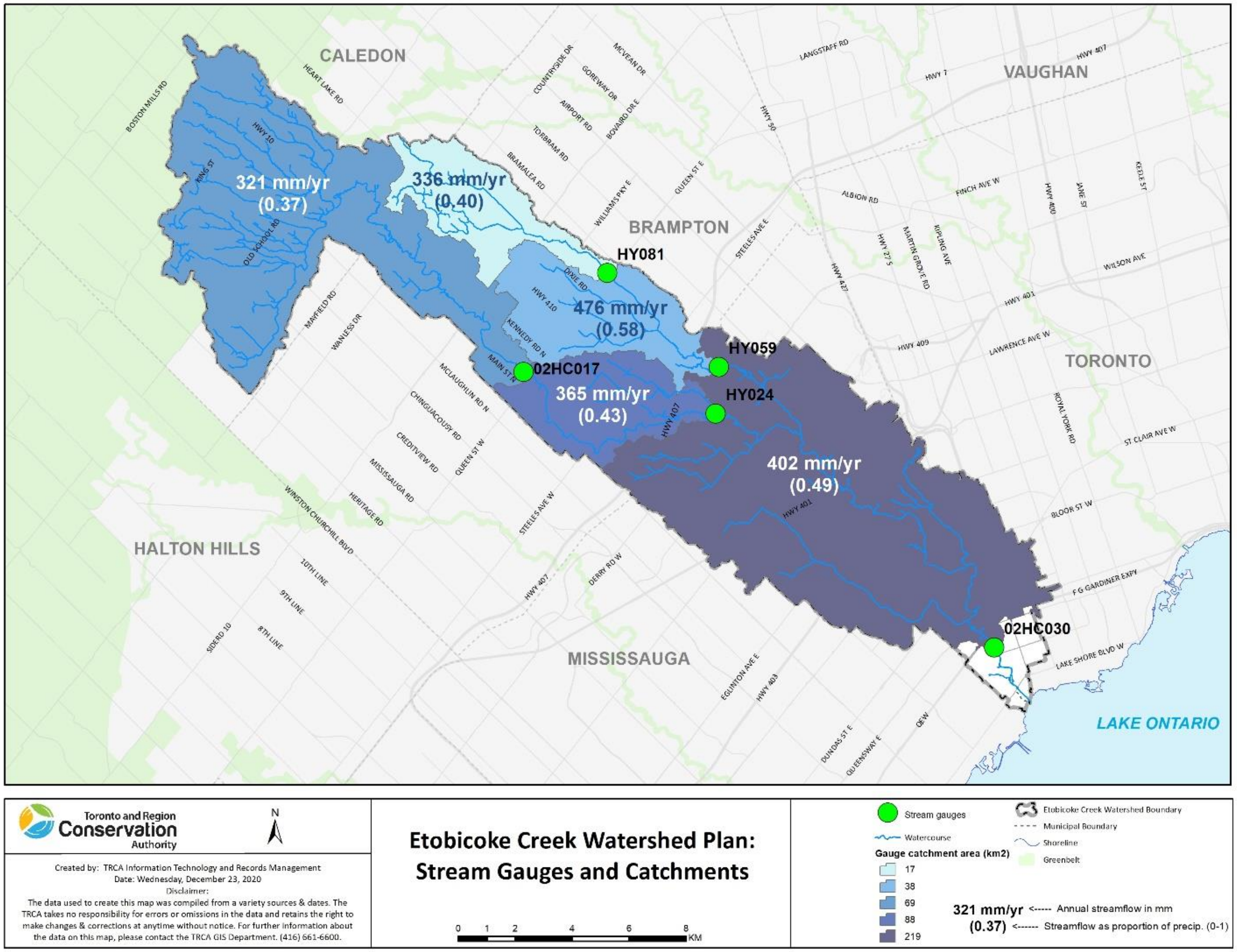

Figure 19 - Annual Streamflow Associated with Stream Gauges

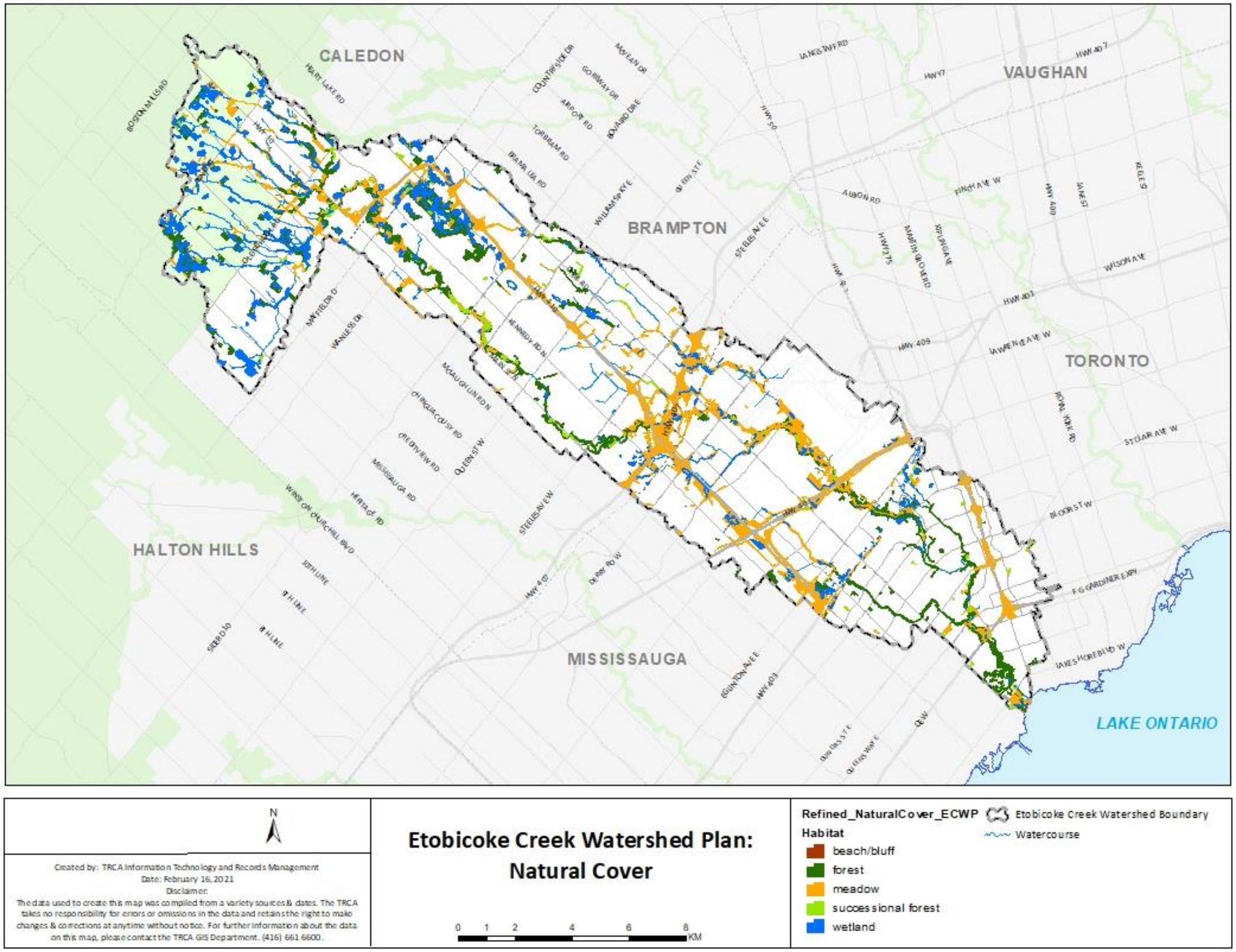

Figure 20 - Natural Cover Distribution

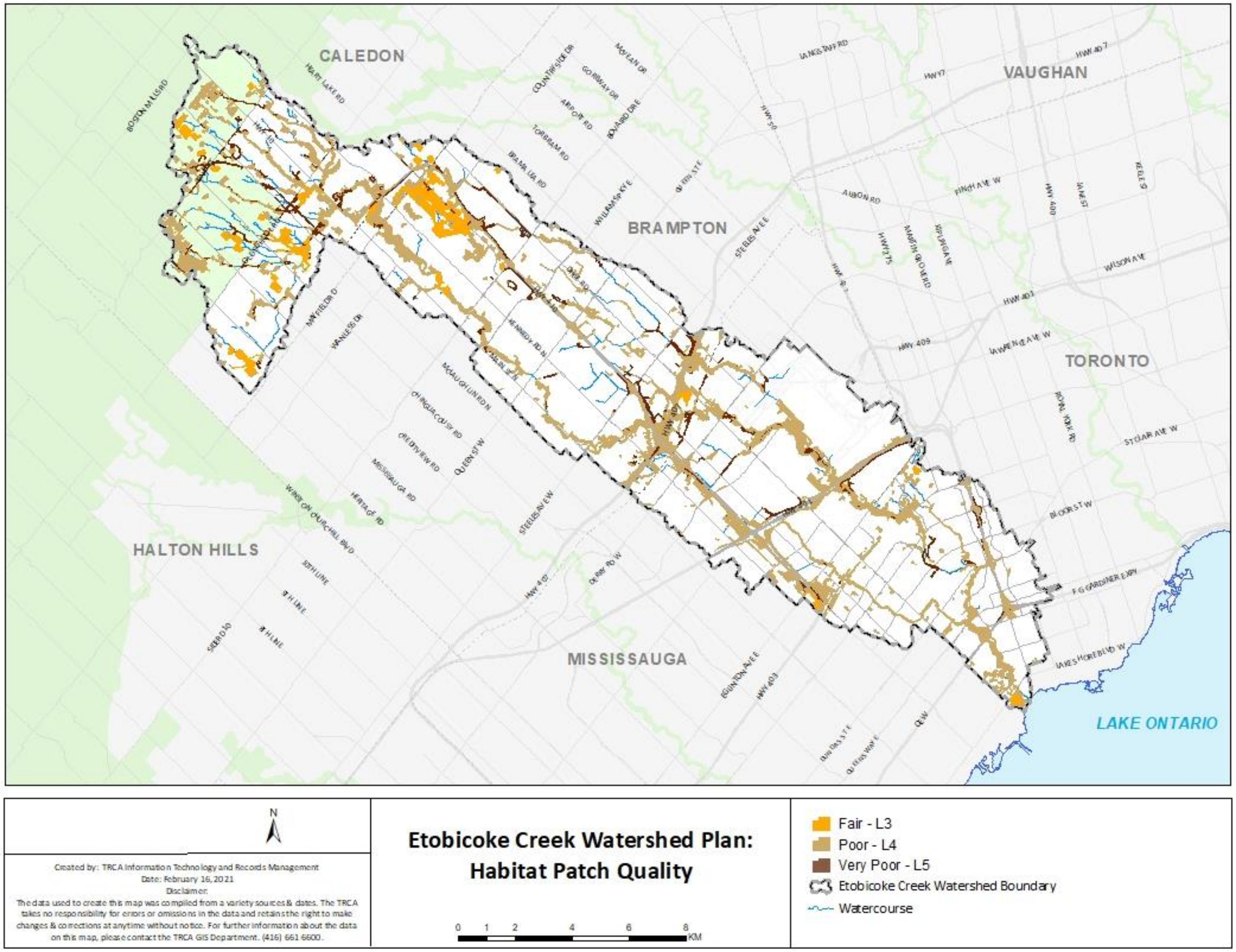

Figure 21 - Habitat Quality

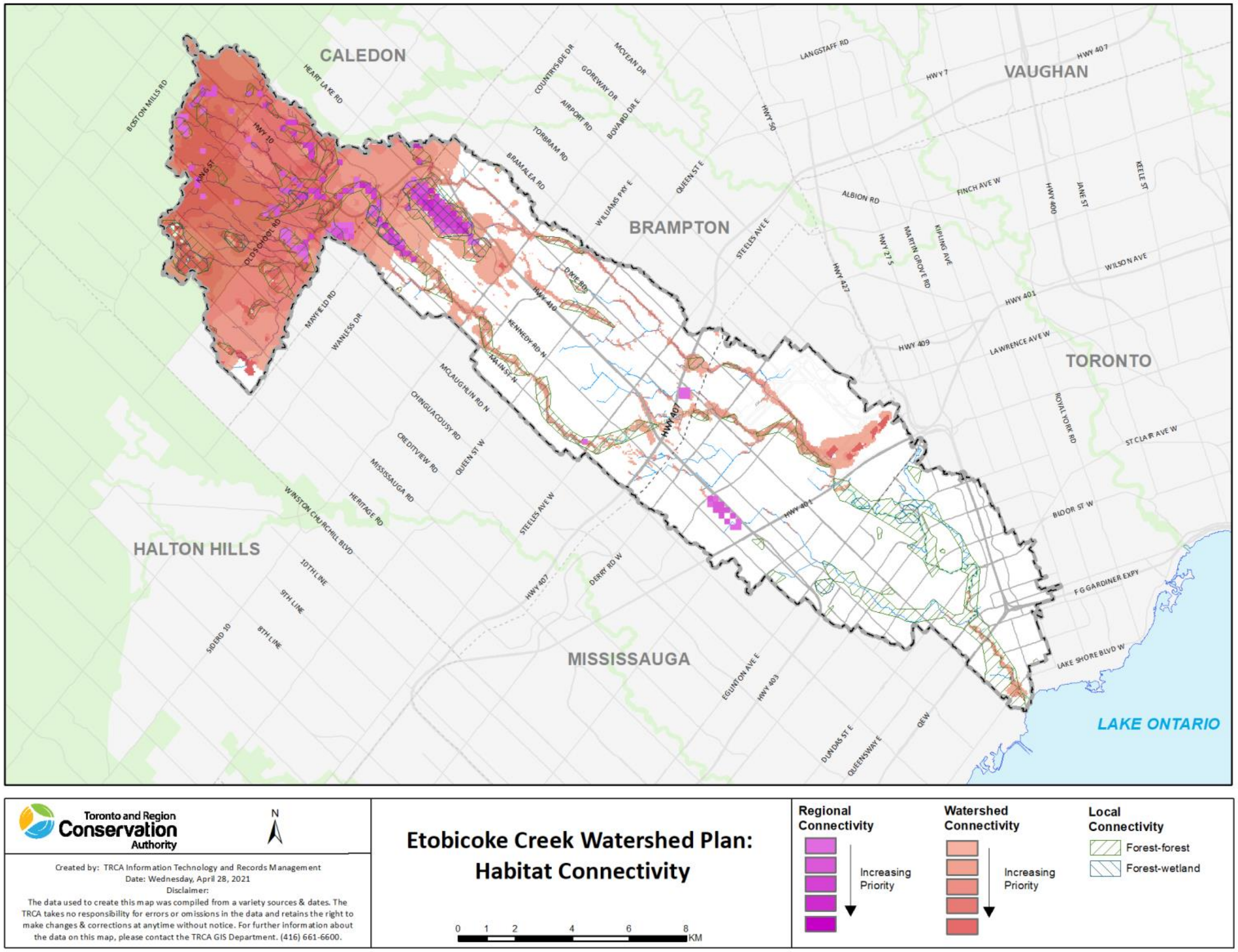

Figure 22 - Regional and Local Habitat Connectivity

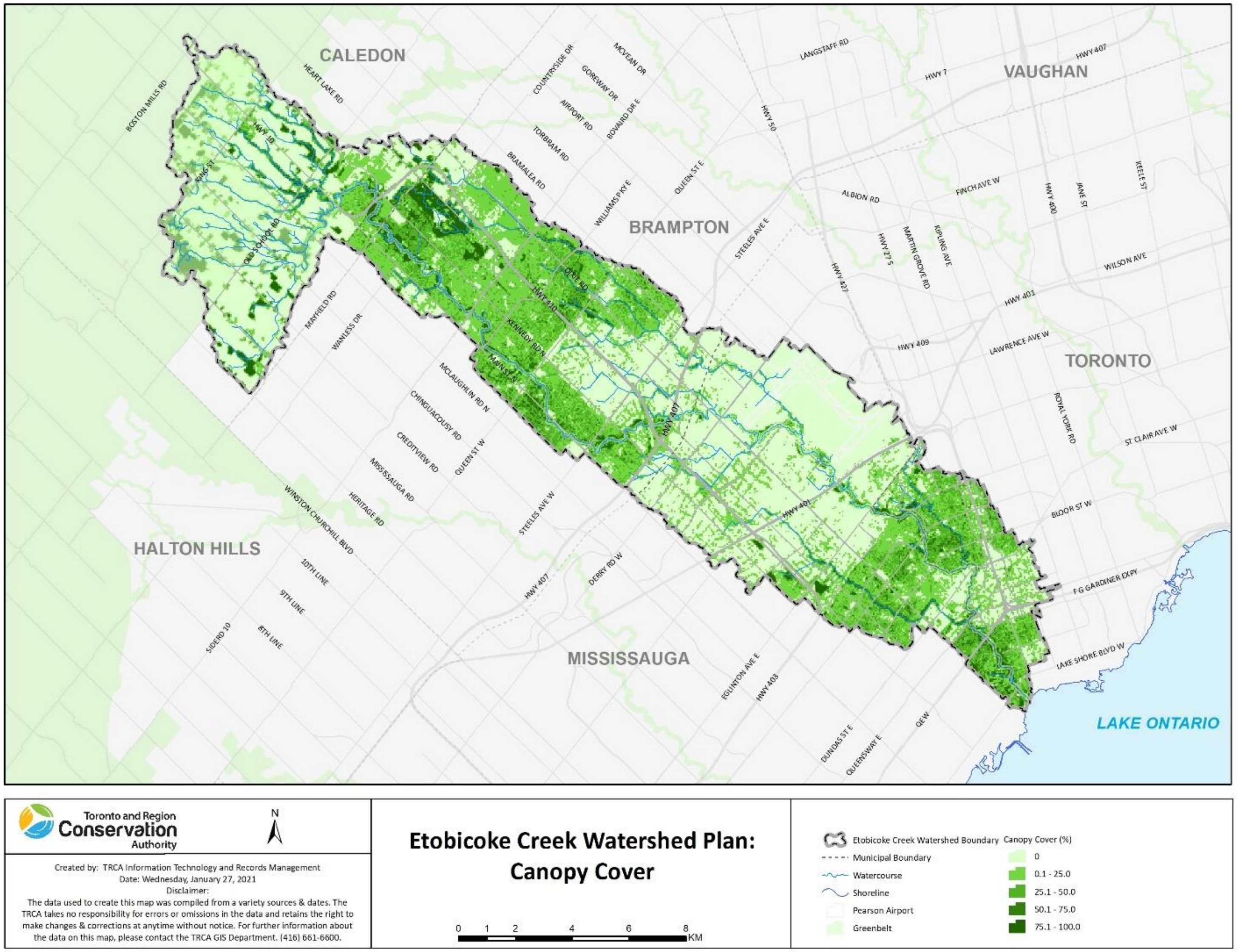

Figure 23 - Current Canopy Cover Distribution

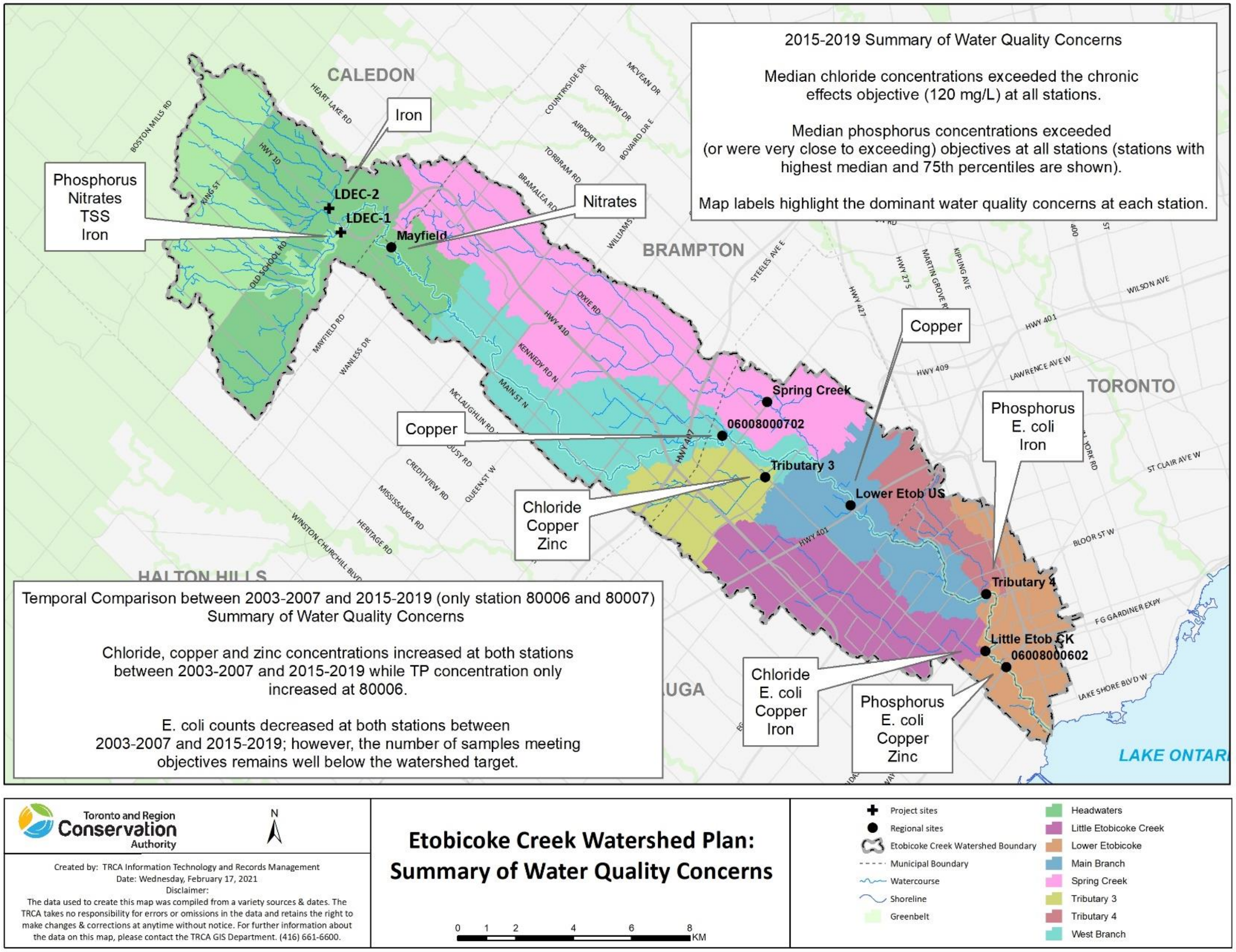

Figure 24 - Summary of Water Quality Concerns

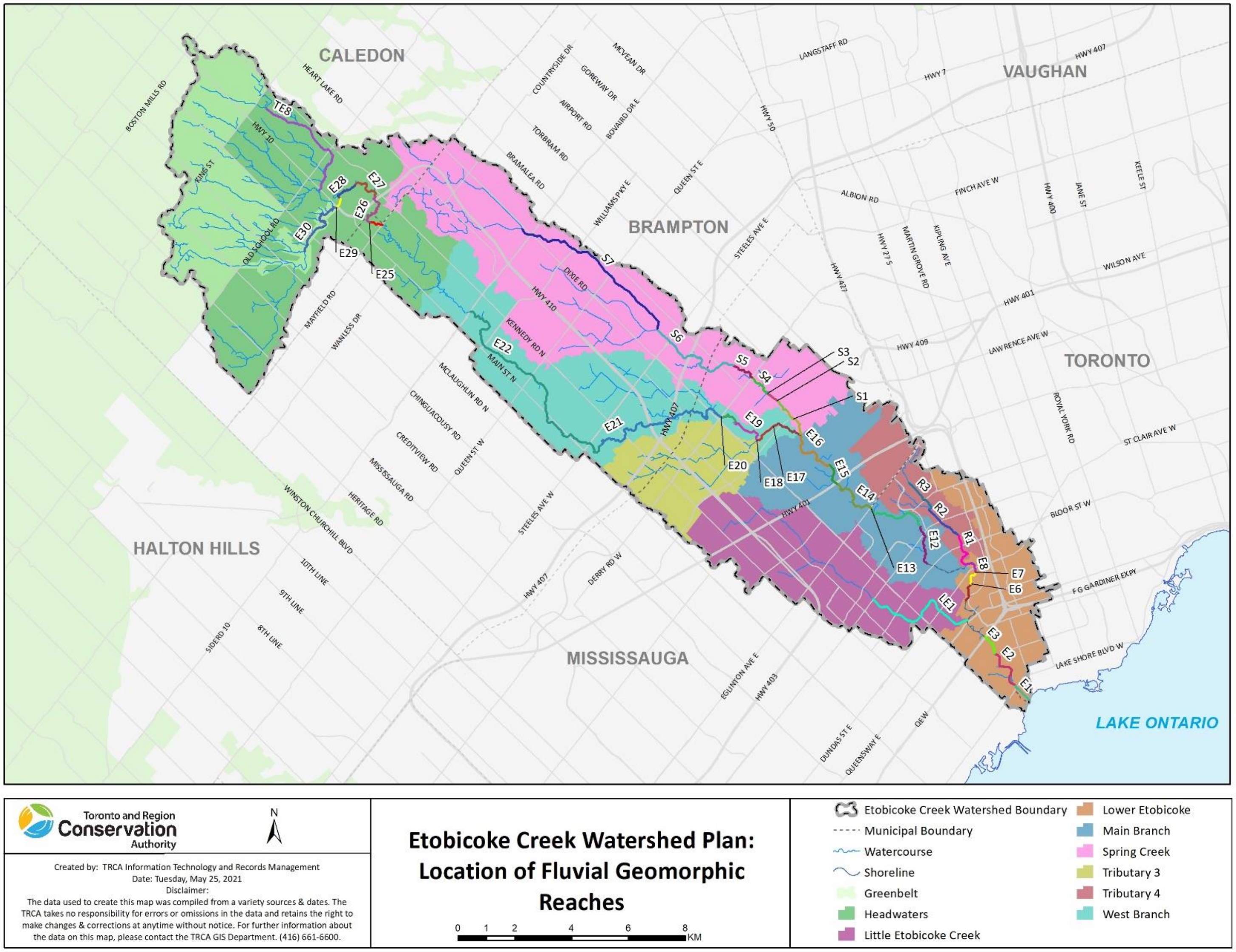

Figure 25 - Location of Fluvial Geomorphic Reaches

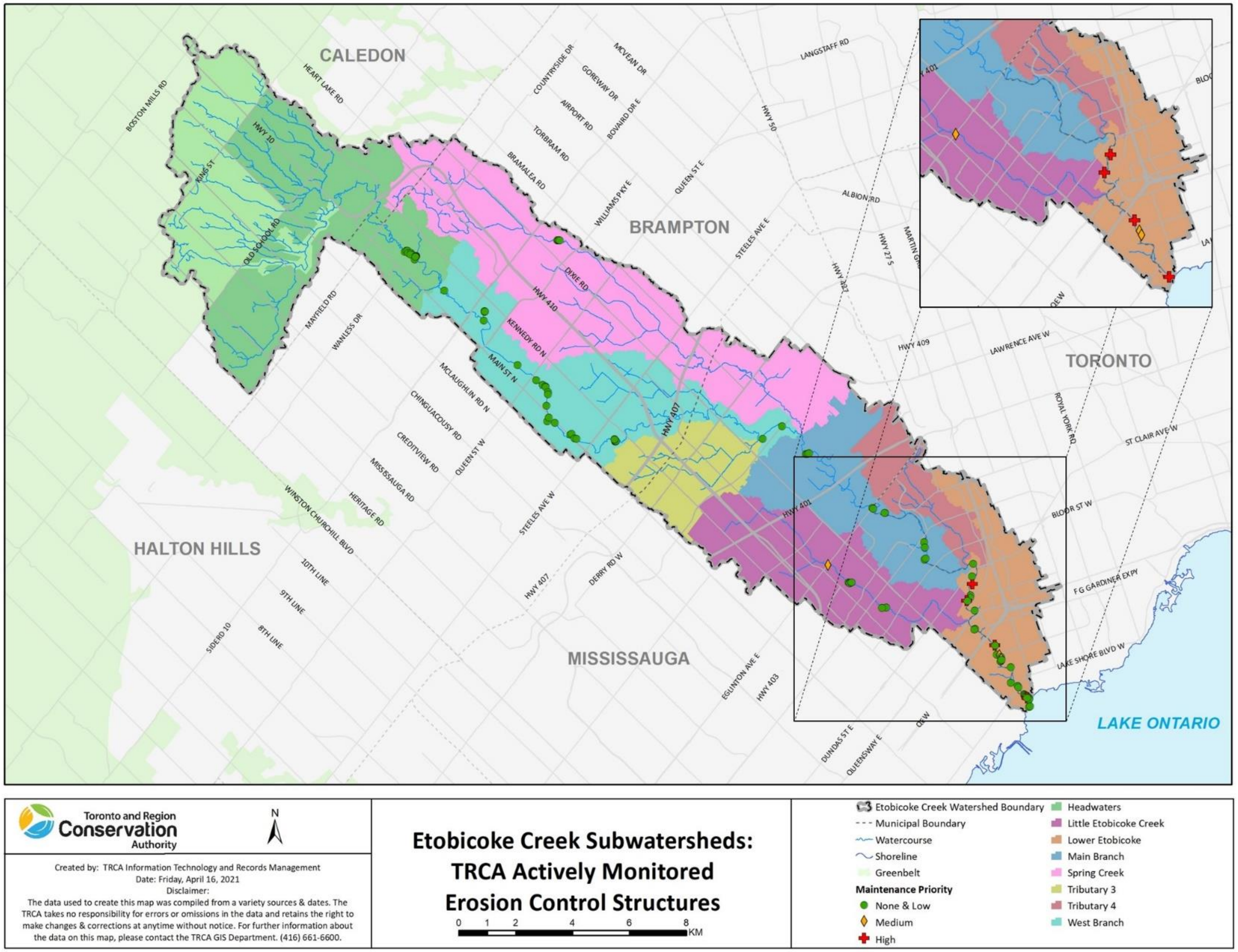

Figure 26 - TRCA Actively Monitored Erosion Control Structures

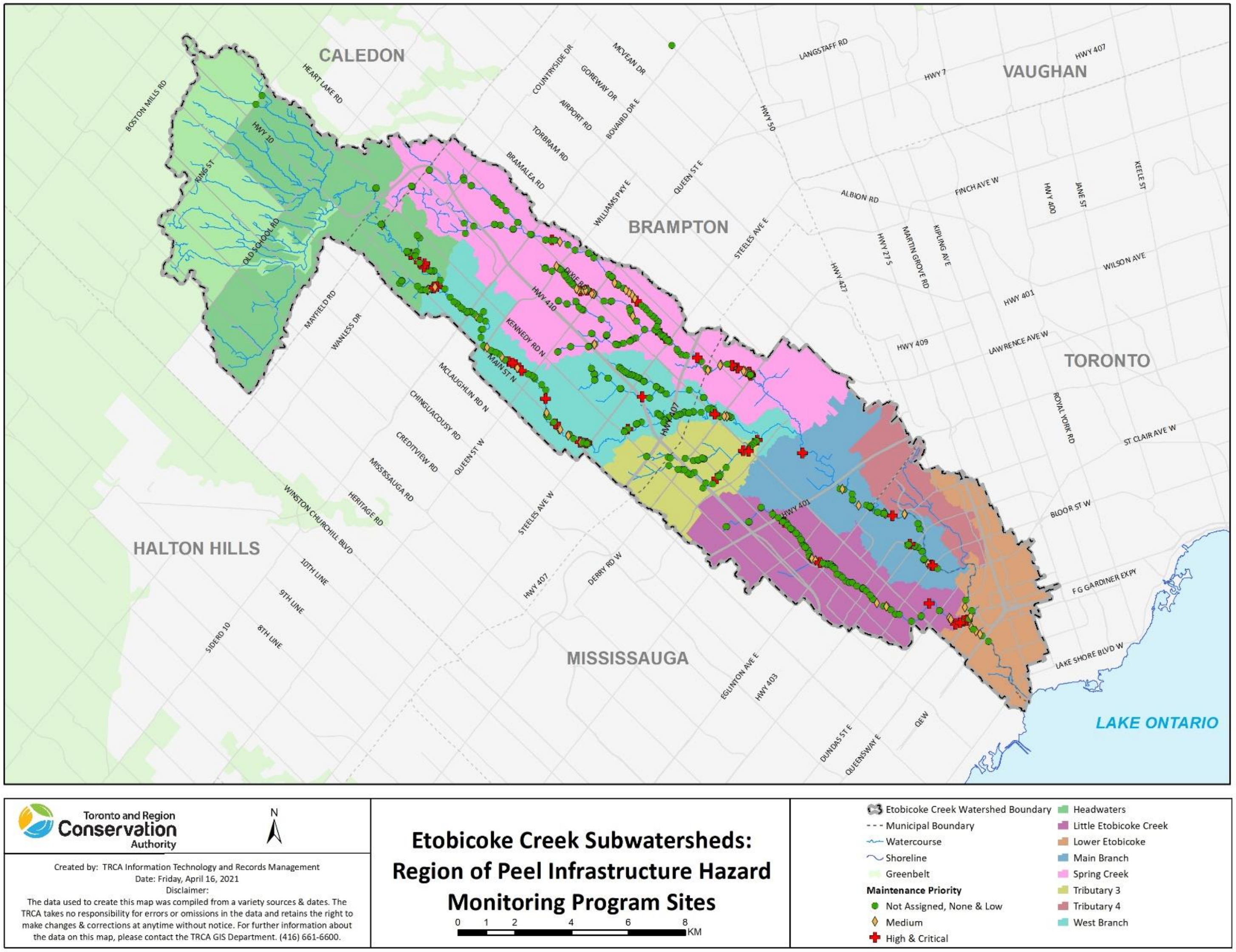

Figure 27 - Peel Infrastructure Hazard Monitoring Program Sites

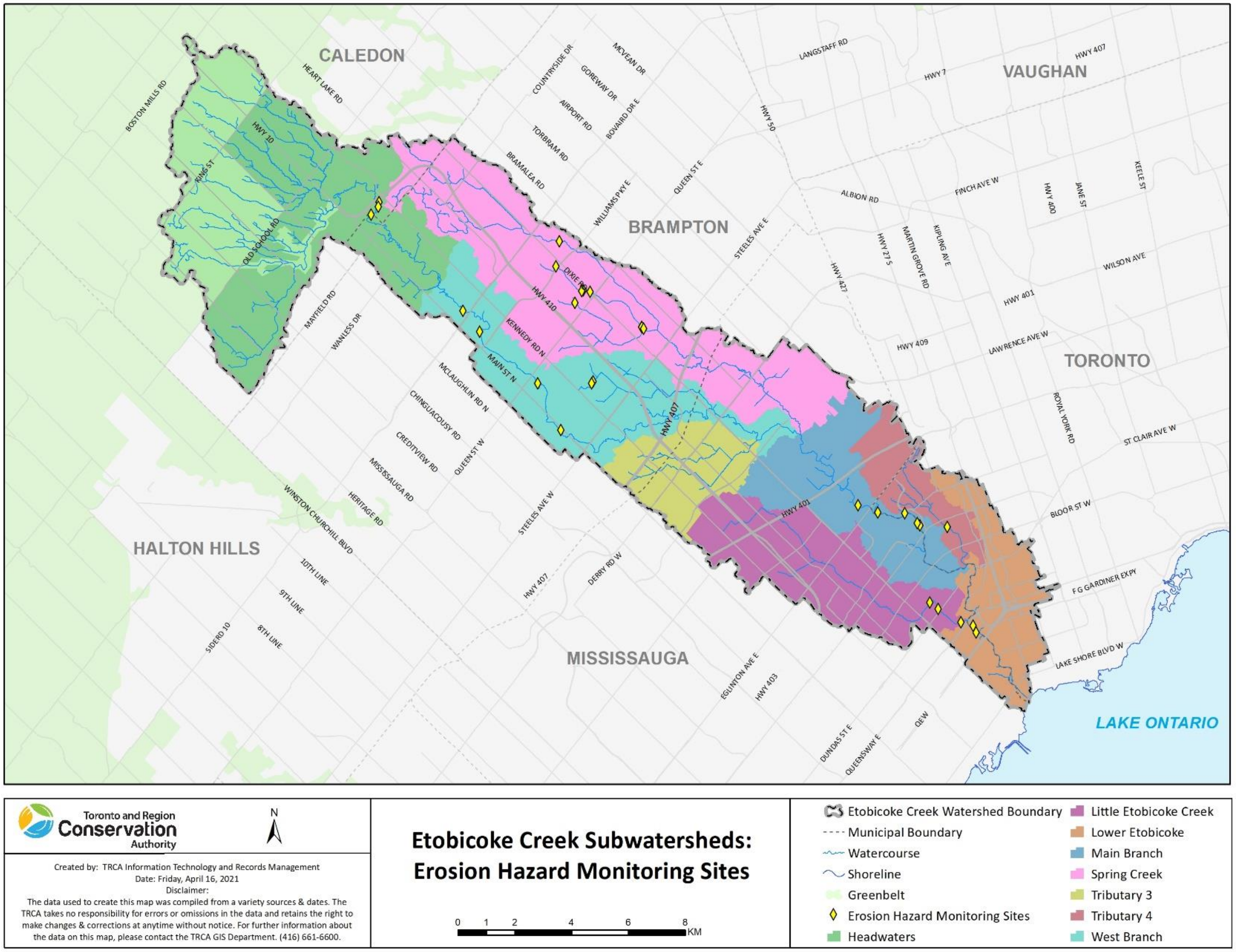

Figure 28 - Erosion Hazard Monitoring Sites

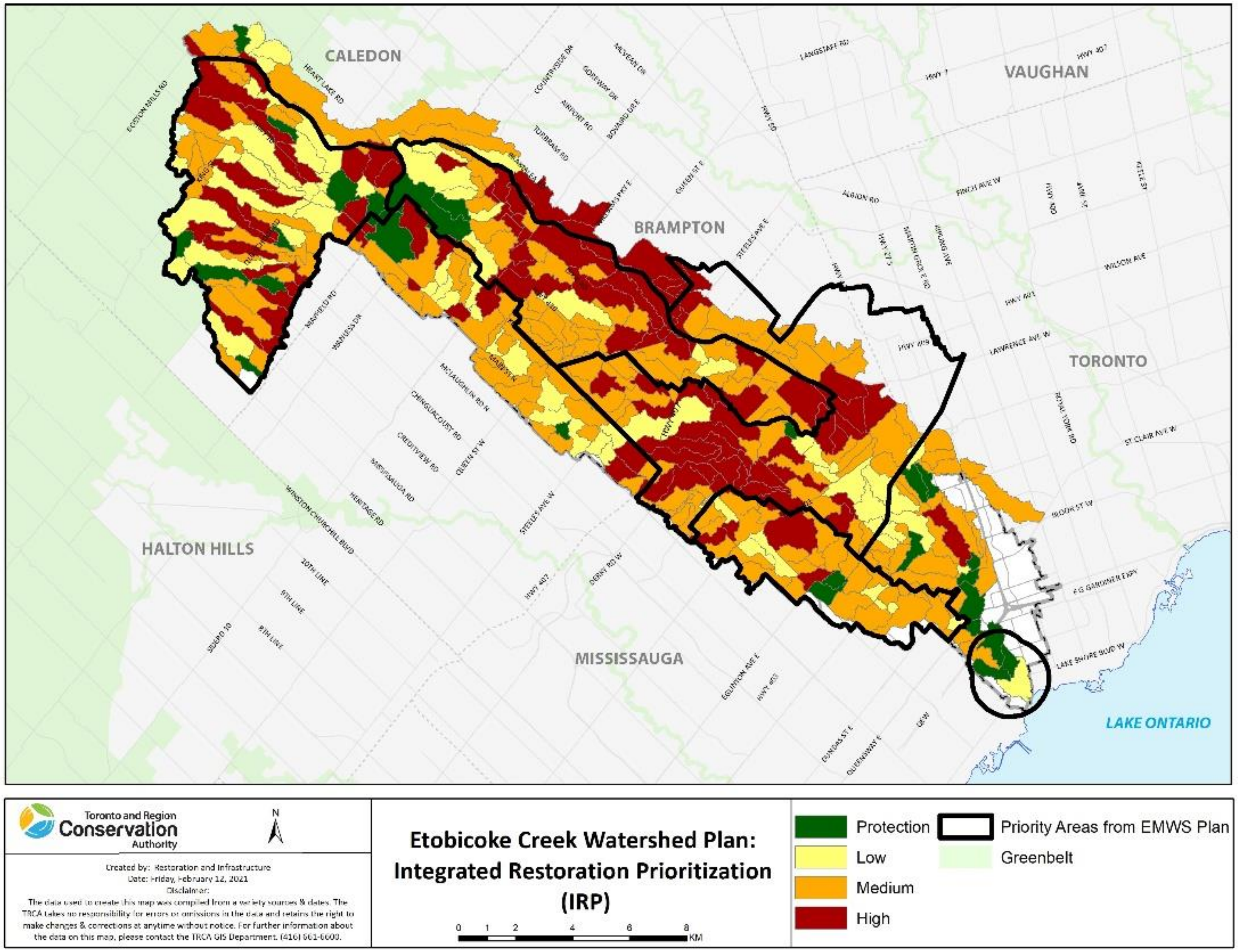

Figure 29 - Integrated Restoration Prioritization Scores

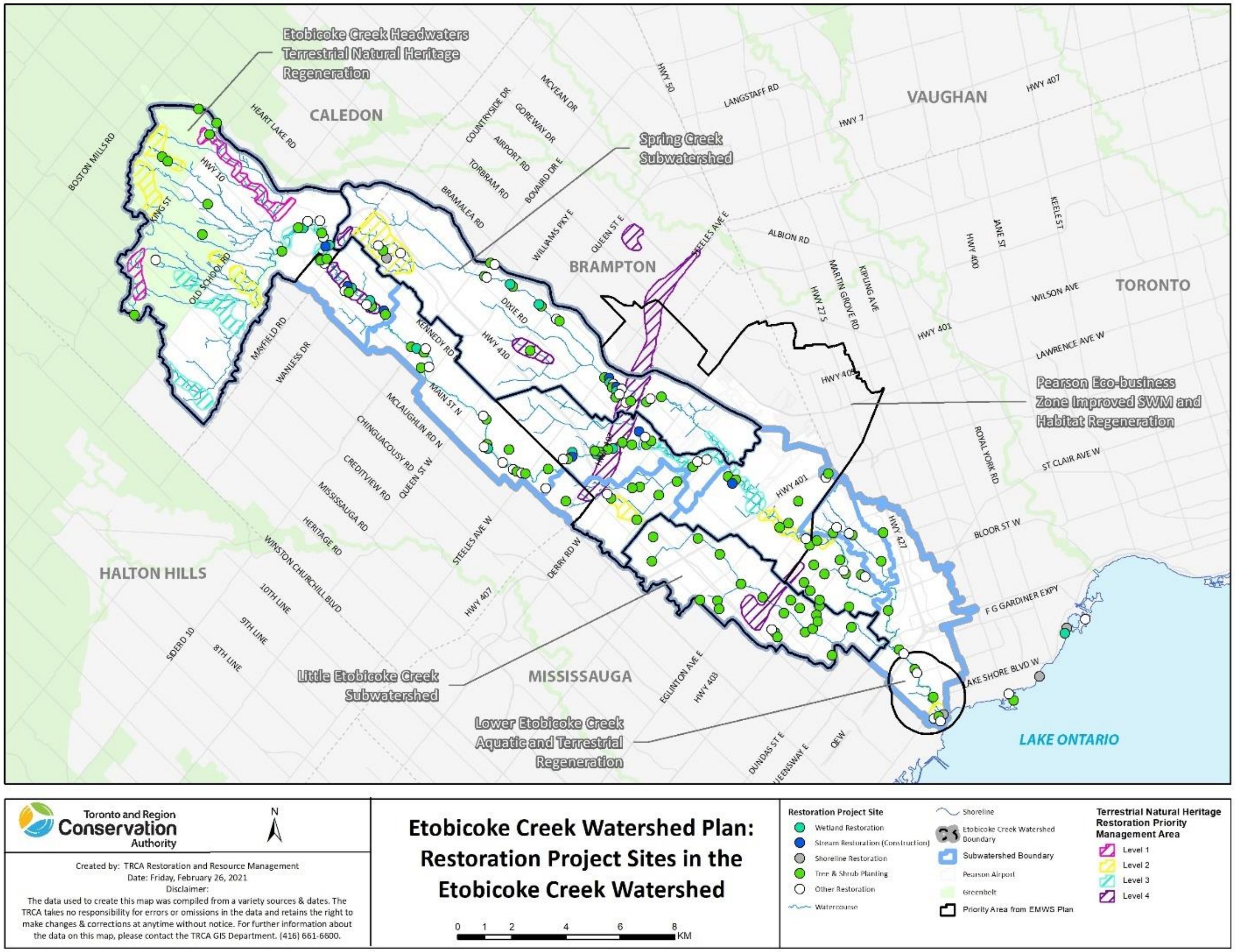

Figure 30 - Restoration Project Sites

6. GLOSSARY

Biodiversity
The variability among organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species and ecosystems.

Headwater Drainage Features
Ill-defined, non-permanently flowing drainage features that may not have defined beds and banks.

Highly Vulnerable Aquifer
Aquifers, including lands above the aquifers, on which external sources have or are likely to have a significant adverse effect.

Hydrologic Function
The functions of the hydrologic cycle that include the occurrence, circulation, distribution and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things.

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

Riparian
The areas adjacent to water bodies such as streams, wetlands and shorelines. Riparian areas form transitional zones between aquatic and terrestrial ecosystems.

Seepage Areas and Springs
Sites of emergence of groundwater where the water table is present at the ground surface.

Significant Groundwater Recharge Area
An area that has been identified:

a. as a significant groundwater recharge area by any public body for the purposes of implementing the Provincial Policy Statement, 2020;
b. as a significant groundwater recharge area in the assessment report required under the Clean Water Act, 2006; or

c. as an ecologically significant groundwater recharge area delineated in a subwatershed plan or equivalent in accordance with provincial guidelines.

For the purposes of this definition, ecologically significant groundwater recharge areas are areas of land that are responsible for replenishing groundwater systems that directly support sensitive areas like cold water streams and wetlands.

Urban Forest
All trees, shrubs and understorey plants, as well as the soils that sustain them, occurring on public and private property in natural, urban, and rural areas.

Water Resource System
A system consisting of ground water features and areas and surface water features (including shoreline areas), and hydrologic functions, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption. The water resource system will comprise key hydrologic features and key hydrologic areas.

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APPENDIX A

Below is a full list of land use classifications summarized by urban, rural, and natural general land classifications. Each of these specific land use classifications are assigned an impervious value that is used as part of hydrology modelling and other technical disciplines. The impervious values vary by land use classification and are either designated as total imperviousness (TIMP values) or the portion of imperviousness connected to a sewer system (XIMP values) depending on the analysis being undertaken. The summary below only includes the TIMP impervious values for each specific land use classification.

Specific Land Use Classification	TIMP Value (Total Impervious Cover)	General Land Use (Urban, Rural or Natural)
Aggregate extraction	*Case specific (one site present in Caledon)*	Rural
Agricultural	0%	Rural
Airport	45%	Urban
Beach/bluff	0%	Natural
Cemetery	35%	Rural
Estate Residential	40%	Rural
Forest	0%	Natural
Golf Course	0%	Rural
High Density Residential	80%	Urban
Industrial	95%	Urban
Institutional	80%	Urban
Lacustrine (water)	100%	Natural
Landfill	*Case specific (if present)*	Rural
Low/Medium Density Residential	60%	Urban
Meadow	0%	Natural
Commercial/Mixed Commercial Entertainment	95%	Urban
Railway	60%	Urban
Riverine (water)	100%	Natural
Roads	90%	Urban
Rural Residential	20%	Rural
Successional Forest	0%	Natural
Wetlands	0%	Natural
Recreational/Open Space	10%	Rural

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