INTEGRATED RESTORATION PRIORITIZATION:

A MULTIPLE BENEFIT APPROACH TO RESTORATION PLANNING

A project of:

Toronto and Region Conservation for The Living City

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX

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1. INTRODUCTION

Toronto and Region Conservation (TRCA) has a long history of implementing ecological restoration programs that strengthen the health of natural systems in the Greater Toronto Area (GTA), especially in the face of rapid land use and climatic changes. Continuing ecological restoration is essential to creating and maintaining a robust and interconnected natural heritage system with functional biodiverse habitat. Natural heritage systems provide a variety of ecosystem services, such as cleaner water and air, which support people and communities as well as improving habitat opportunities for wildlife.

Effective ecological restoration is deeply rooted in TRCA's "Living City Policy and" Living City Vision. The Integrated Restoration Prioritization (IRP) framework presented in this document addresses all four pillars of Building the Living City 10-Years Strategic Plan (TRCA, 2014) as outlined below:

1. **Healthy Rivers and Shorelines:**
   to restore the integrity and health of the region's rivers and waters from the headwaters in the Oak Ridges Moraine, throughout each of the nine watersheds in TRCA's jurisdiction, to the Toronto region waterfront on Lake Ontario
2. **Regional Biodiversity:**
   to protect and restore a regional system of natural areas that provide habitat for plants and animal species, improve air quality and provide opportunities for the enjoyment of nature and recreation
3. **Sustainable Communities:**
   to facilitate broad community understanding, dialogue and action toward integrated approaches to sustainable living and city building that improve the quality of life for residents, businesses and nature
4. **Business Excellence:**
   to pursue continuous improvement in the development and delivery of all programs through creative partnerships, diverse funding sources and careful auditing of outcomes and effectiveness

Specifically the IRP framework contributes to the first two objectives by ensuring TRCA and its partners are effectively planning restoration activities that will have multiple benefits to rivers, shorelines and biodiversity. Ultimately, the IRP will result in a more efficient restoration planning process, helping TRCA and its partners to direct greater resources to priority restoration locations.

The IRP will help select priority restoration areas that benefit sustainable communities. This will contribute to the third objective by highlighting the critical services that natural systems provide in the most needed areas.

Finally, this project will help to ensure the most effective and efficient use of resources and revenue by developing a consistent, integrated and systematic approach to restoration planning, thereby contributing to the fourth objective.

In the past, much of TRCA's restoration work has been opportunistic and occurred mainly where funding or landowner partnership opportunities arose. Given the growing financial and human resources that TRCA invests every year into planning and implementing restoration activities, there is a responsibility to invest the available resources in the most effective and efficient manner.

Over the last several years, TRCA has developed an approach to restoration planning that now acts as the mechanism to assess, select and implement appropriate sites for implementation. This planning method is based on site-specific conditions, the type of opportunity and the severity of the threat/impairment to natural system function. TRCA has been applying this approach across its watersheds and it is proving to be a valuable method for understanding and identifying potential restoration actions. Under this process, thousands of restoration opportunity sites are being identified across the jurisdiction. As a result, it has been challenging to determine how to prioritize restoration efforts and resources such that the planned activities maximize ecosystem function and service benefits at a broader regional scale.

The IRP framework has been developed to overcome this challenge. The prioritization technique has been designed to provide a watershed perspective to site level restoration planning. IRP considers multiple objectives related to terrestrial and aquatic ecosystem health and uses a comprehensive, consistent and repeatable framework in order to help guide restoration planning, resource investment and implementation.

Little Rouge Corridor Restoration Project, TRCA

2. TRCA PLANS AND STRATEGIES

During the development of an integrated approach to restoration planning and prioritization, TRCA's various plans and strategies were considered and were used to be consistent the TRCA Living City Policy. These plans were used to define and shape the base IRP framework. Outlined in this section are the primary plans and strategies incorporated into IRP.

2.1 Watershed Plans

TRCA's Watershed Plans are rooted in sustainability. They recognize that our present day management decisions affect future generations and aim to reconcile the interconnectedness of our economic, social and natural systems (TRCA, 2009). Using the Watershed Plans, IRP focuses on the idea that natural systems need to be healthy and functioning so that sustainable communities and economic systems can work. In practice, IRP facilitates Watershed Plan objectives such as improving stream form, water quality, aquatic habitat, storm water management, flood management, and erosion management, as well as increasing natural cover and improving habitat quality.

2.2 Terrestrial Natural Heritage System Strategy (TNHSS)

The Terrestrial Natural Heritage System Strategy (TNHSS) was developed by TRCA in response to the continued loss of biodiversity and natural cover. TNHSS, based on contemporary ecological principles, encompasses a set of models and tools that allow for the development of a Terrestrial Natural Heritage Target System that strives to increase the quality and quantity of natural cover and biodiversity within the Toronto region (TRCA, 2007b). This system comprises both existing natural cover and potential cover that could be restored, which together achieve TRCA's targets for native biodiversity and set the foundation for a restored and functioning natural system within the Toronto region. TRCA has been actively implementing the TNHSS over the last eight years on numerous fronts, including land use planning, land securement, stewardship and restoration.

2.3 Fisheries Management Plans (FMP)

Fisheries Management Plans (FMPs) were created with the intention of informing the management and protection efforts for TRCA's fisheries and aquatic resources. FMP objectives, which relate to IRP objectives, include improving aquatic habitat, water quality, stream form, hydrologic process and features, storm water management and erosion management (TRCA, 2011).

Upper Mimico Stream Restoration Project, TRCA

3. EVOLUTION OF RESTORATION PLANNING IN TRCA

TRCA and its partners began to formalize restoration planning in 1997. Since then, habitat restoration planning initiatives have evolved and increased in scope and scale. Past restoration planning initiatives are briefly described below:

- **In 1997, the Potential Sites of the Small Scale Aquatic Habitat Enhancement Project was developed by TRCA and adopted for implementation by the Task Force to Bring Back the Don (TRCA, 1997). The resulting document contained a summary of high priority aquatic habitat enhancement projects to be used for implementation. Since the release of this document, a number of projects have been completed using the recommendations made.**

- **The Claireville Natural Area Enhancement Plan was completed in 2000 (TRCA, 2000). The document contains a map that applies levels of priority to areas deemed suitable for various types of restoration (wetland, riparian, lowland forest and upland forest). Using this map and the restoration prescriptions provided within the document, partnerships were forged with the Great Lakes Sustainability Fund, Ontario Power Generation, Friends of Claireville, Toronto Catholic District School Board, and Ducks Unlimited to complete a variety of projects. These projects include the creation of an oxbow wetland, pocket wetlands and forest regeneration.**

- **The Habitat Implementation Plans (HIPs) were initiated in 2003 by TRCA as a means to strategically implement and catalogue restoration projects throughout its jurisdiction. HIP assessments were completed on publicly owned property (primarily TRCA owned). The HIP used selected methodology components from the two previous plans and applied it to a larger scale. Areas were assessed first using Geographic Information Systems (GIS) and then in the field to visually confirm restoration opportunities. Opportunities were cataloged in a database and could be queried based on the information collected in the field in order to identify high priority restoration projects.**

- **Under the title Restoration Opportunities Plan (ROP), TRCA created a process using desktop and field assessment techniques to identify and prioritize restoration opportunities outside of publicly owned lands. The ROP process is rooted in an understanding of topography and drainage to identify restoration opportunities (wetland, riparian and forest). Using GIS, drainage lines and catchment boundaries were derived to determine the probability of intermittent and permanent water flow, as well as depressions in the landscape, to direct potential riparian or wetland restoration projects. Armed with the desktop information, restoration opportunities were identified in the field by trained technicians. Data collected in the field could then be used to help prioritize individual opportunities and resources could be allocated appropriately to restore and protect higher priority sites.**

- **In 2014, restoration opportunities collected from the previous planning initiatives were amalgamated geospatially into the Restoration Opportunities Database (ROD). The ROD is a GIS database of potential restoration sites, generated from orthophotographic interpretation and field assessments. The information stored within the database includes general site descriptions, existing habitat components, potential restoration opportunities, severity of impairment to natural function, ease of implementation and ecological benefit. The ROD can be used for individual project site selection and reach-based restoration planning.**

The IRP framework consolidates the most relevant data sets into a formal and systematic process to help further guide decisions on restoration planning and implementation. The process is a comprehensive, consistent, and repeatable framework that is grounded in defensible science and practical considerations, thereby making it an effective decision support tool to achieve multiple restoration objectives.

4. GOALS AND OBJECTIVES

The IRP framework is based on promoting a healthy ecosystem that allows for ecological processes to function in a self-sustaining manner that is more resilient and adaptable to the ever-increasing pressures of land use and climate changes.

4.1 Goals

The **goal of ecological restoration** is to protect and restore ecosystem function which can lead to enhanced natural system resiliency and can maximize the benefits provided through ecological goods and services.

The **goal of the IRP framework** is to create a consistent and repeatable process to facilitate effective ecological restoration. IRP prioritizes restoration opportunities based on multiple objectives and benefits and will help guide restoration planning and effective resource investment to ensure healthy and functioning ecosystems throughout the Greater Toronto Area.

4.2 Restoration Objectives

In order to achieve the goals discussed above, a list of restoration objectives was established. These objectives are based on identifying ecological impairments (which negatively impact natural processes) and improving ecosystem function:

1. **To restore natural hydrologic processes and associated ecological systems by reversing, repairing or mitigating alterations and impairments (e.g. drained headwater features, poor water quality)**
2. **To restore and/or increase natural cover (e.g. wetland, riparian, forest, and meadow)**
3. **To maximize size, shape and connectivity of natural heritage features**
4. **To enhance landforms and restore soil and soil processes to promote self-sustaining natural communities**

IRP is based on the degree that the above objectives can be achieved through restoration and by the resulting level of benefit to ecosystem function. IRP only prioritizes catchments where the greatest potential benefit is achievable. It does not provide project level guidance to support what specific work should be done within those catchments.

KEY DEFINITIONS

- **Restoring ecosystem function refers to re-establishing the "building blocks" of a healthy natural system to facilitate sustainable natural succession. A healthy natural system relies on functional hydrologic and landform processes, vegetative cover and biodiversity. Impairment occurs when those processes have been altered.**
- **Ecological resilience is the capacity of an ecosystem to withstand damages and recover rapidly after natural or anthropogenic disturbance.**
- **Ecological Goods and Services are defined as the overall benefits to humans arising from a functioning healthy ecosystem, which include, but are not limited to: improved water quality and quantity, air quality, soil stabilization, balanced hydrologic regimes, flood mitigation, and biodiversity.**

5. ECOLOGICAL CONTEXT

Current and historical land use changes, resulting in the transition from an originally natural landscape to urban and rural settlements, continue to have significant impacts on our natural heritage system (Theobald et al., 2011; Hanna & Webber, 2010). Forests, streams, wetlands and headwater drainage features, which are all inherently connected, can become impaired as a result of landscape alterations (e.g. draining a wetland can affect water quality). These alterations may contribute to a variety of impacts to natural system function, which may reduce ecological goods and services that they provide.

According to the Great Lakes Remedial Action Plan, the minimum recommended amount of natural cover needed for marginally healthy and resilient ecosystems is 30 per cent at the watershed level. Current analyses by TRCA indicate that natural cover in the TRCA region stands at approximately 17 per cent and falls as low as 5 per cent in some municipalities (TRCA, 2007a). As population grows, the quality of our natural areas is decreasing.

There are a variety of ways that the natural environment contributes to ecological goods and services. This section highlights some of the more relevant contributions as they relate to IRP objectives.

5.1 Aquatic Systems

Headwater drainage features, wetlands and permanent watercourses provide many ecosystem services, and it is important to recognize the physical processes that influence habitats both in headwater areas and the downstream habitats to which they are connected. Some of the ecosystem services provided by these features are outlined below.

5.1.1 Hydrology

Wetlands and headwater drainage features are important for controlling the flow of water downstream by impeding runoff and promoting infiltration of water into the ground. This contributes to groundwater recharge, flood control, maintaining summer base flow, and filtering pollutants and sediments from the watercourse.

The hyporheic zone is the area of saturated sediment within a watercourse. It is important for water, nutrient and organic matter exchange in streams between the surface and groundwater. Groundwater upwelling provides stream biota with nutrients, while downwelling water provides this zone with dissolved oxygen and organic matter for micro-organisms and invertebrates. Alterations to these areas (e.g. tile drainage or removal of natural cover) will disrupt this zone and could have negative impacts downstream.

5.1.2 Water Quality

Wetlands, headwater drainage features and natural cover can improve water quality and help to mitigate non-point source pollutants (e.g. nutrients and sediments) from urbanization and agricultural land use.

Under natural conditions, sediment production is necessary to maintain geomorphic processes; however, imbalances to the mean supply rate of mobile sediment may result in aggradation (deposition) or degradation (erosion) of the channel resulting in channel instability and an increased probability of sedimentation and erosion issues. Water quality may be impaired as a result of increased sedimentation and erosion from improper agricultural land use practices and urbanization disturbances.

5.1.3 Habitat and Riparian Cover

In aquatic systems, external inputs of organic matter are an important source of energy, food and habitat. Riparian vegetation in headwater areas and permanent watercourses influence the size and structure of woody debris entering a stream, potentially increasing its habitat diversity and organic matter levels.

Headwater drainage features and permanent watercourses with adequate riparian cover play an important role in moderating stream temperature by providing a thermal buffer by way of stream bank shading. Temperature is one of the most important factors controlling in-stream processes and aquatic ecosystem dynamics, such as species metabolism, organic matter decomposition and gas solubility.

Riparian cover also plays a critical role in stabilizing stream banks and intercepting harmful sediment or nutrient inputs. Stream banks in healthy riparian systems are more stable, because they are held together by plant roots. As a result, erosion and subsequent sediment influx rates are decreased. The introduction of harmful nutrients and chemicals is also counteracted by riparian buffers, as the buffer acts as a filter between the input source and the stream.

5.2 Upland Terrestrial Systems

Forests, meadows and partially forested areas such as savannahs provide an irreplaceable ecosystem service for human settlements that improves our standard of living. Some of the ecosystem services provided by these features are outlined below.

5.2.1 Recharge

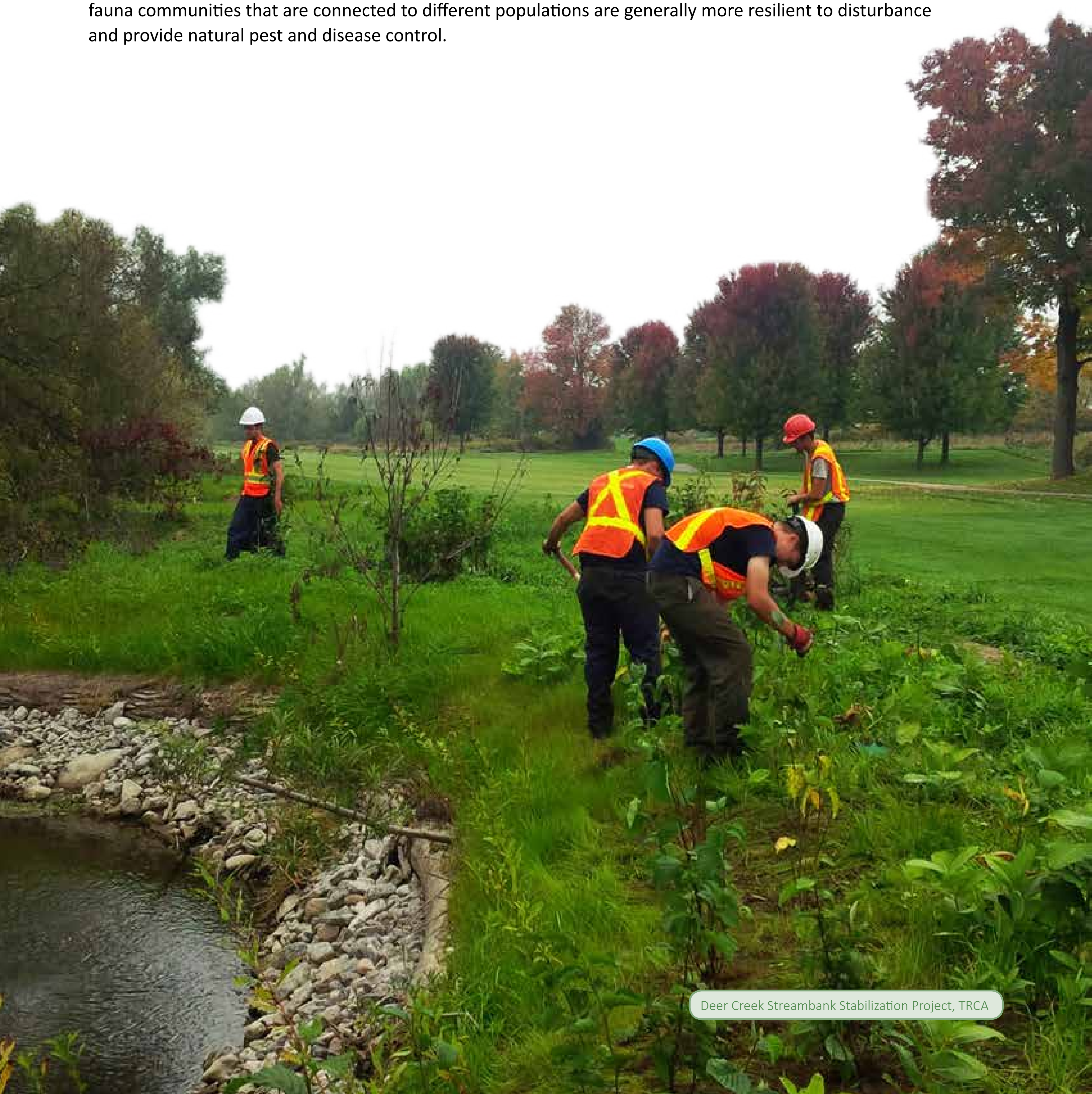
Tree structure and other vegetation allows for the infiltration of rainfall, thereby enhancing the ability of rain to contribute to groundwater. Furthermore, trees regulate local climate through transpiration and shading. This regulation is especially important in urban areas where the presence of an adjacent tree can greatly reduce home energy costs. Trees also enhance air quality by removing pollutants.

5.2.2 Biological Cycling

Healthy soil enhances ecosystem value by supporting vegetation communities and providing habitat for burrowing fauna species and micro-organisms. Microbes, beneficial bacteria and fungi exist in symbiosis with terrestrial flora. Soil with active and healthy biota recycles waste, promoting nutrient cycling, and sequesters carbon, contributing to climate change mitigation.

5.2.3 Habitat Quality and Connectivity

Well-functioning natural areas provide habitat for native flora and fauna and corridors for species movement. Corridors are critical for various animal life stages, from migration and dispersal of young (gene flow) to food and shelter. Many species rely on more than one habitat type to complete their life cycles. Promoting natural connections between vegetated areas and different habitat types is critical to maintaining healthy flora and fauna communities over the long term. Insect and wind pollination is important to the production of fruits, vegetables and seeds. These ecological service supports ecosystem integrity, but is often under threat from agricultural practices and urban expansion as a result of decreased connectivity. Genetically diverse flora and fauna communities that are connected to different populations are generally more resilient to disturbance and provide natural pest and disease control.



Deer Creek Streambank Stabilization Project, TRCA

6. METHODOLOGY

6.1 Overview

The IRP framework involved assimilating the multiple recommendations associated with watershed health and restoration provided by the various watershed and regional level strategies: Watershed Plans, Fish Management Plans, Terrestrial Natural Heritage System Strategy and Restoration Plans. Inclusion of the various plans and strategies meant that the data associated with them were available and could be included in the IRP analysis. The challenge with these data sets was that they were collected for different purposes and at various scales to fulfill individual plans and strategy goals. Therefore, they were rarely consistent in terms of coverage or data collection methods.

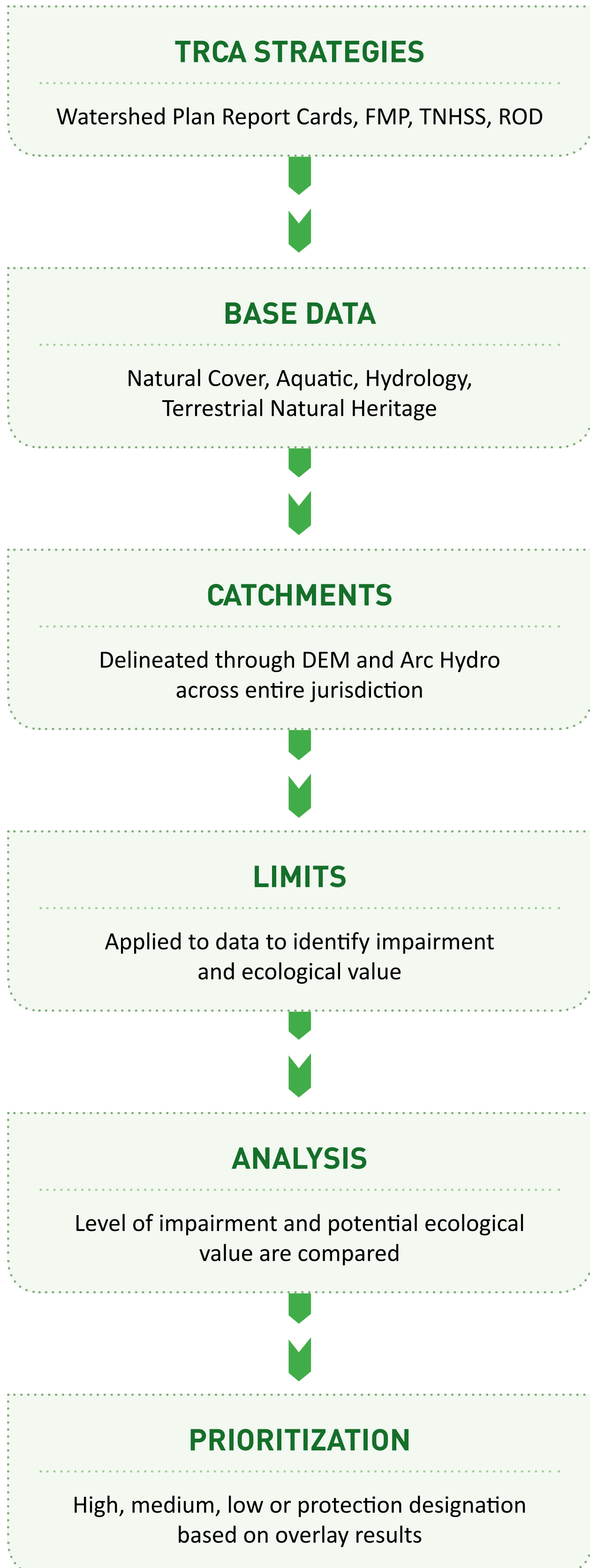
Each available data set was assessed for its usability within the IRP framework. Only those deemed usable were included in the final analysis. Overall, the data collected through the Regional Watershed Monitoring Program (RWMP), some of the region-wide modelling output data, and the orthophoto interpreted data, using a Geographic Information System (GIS), proved to be most consistent data in terms of spatial coverage, structure and format.

TRCA watersheds were sub-divided into manageable and discrete spatial units based on topography and drainage patterns (30 ha catchments on average), to make the technical assessment of the large quantity of available data feasible. The IRP assessment was carried out at this scale to identify relative priorities for restoration across each watershed. This watershed approach is consistent with TRCA's approach to land management, which is the foundation for all Conservation Authorities. The size of the discrete catchments was dependent on the overall coverage of the relevant data.

Catchment delineation was followed by the aggregation and evaluation of each data layer at the catchment level. Thresholds, or limits, were then applied to the evaluated data, indicating a particular criterion or metric. These thresholds classified the state of existing impairment or ecological quality (existing and potential) into categories such as "average", "lower than average" and "higher than average". For each metric, the catchments that met the threshold conditions were given a point, to reflect that they were a priority for restoration under that particular metric (e.g. in-stream water temperature). Final output data comprised a total tally (score) of these priority points. The catchments with higher scores were classified as relatively high priority for restoration. In general, high priority catchments had several impairments to natural system function and had the greatest potential for multiple benefits to natural heritage. Figure 1 illustrates a schematic representation of the IRP framework.

Baxter Property Reforestation Project, TRCA

Figure 1: Schematic representation of Integrated Restoration Planning (IRP) Framework



6.2 Data

To achieve a complete understanding of the available data, different disciplines within TRCA were brought together for a series of meetings. Discussions focused on what the IRP objectives were, what data were available to adequately represent these objectives and how those data were to be used. A long list of data layers was first identified and included the following data sets:

1. **Natural cover (riparian, forest, wetland, meadow)**
2. **Modelled drainage patterns**
3. **Erosion**
4. **Recharge areas**
5. **Discharge areas**
6. **Altered hydrology**
7. **Flow rates and hydro period**
8. **Soils**
9. **Headwaters assessments**
10. **Wildlife species presence**
11. **In-stream temperature**
12. **In-stream barriers**
13. **Water quality**
14. **Corridor connectivity**
15. **Fisheries habitat targets**
16. **Terrestrial Natural Heritage System Strategy (TNHSS)**
17. **TNHSS value surface scores**
18. **Fauna species of concern**
19. **Species at risk**
20. **Official plan future build out scenarios**
21. **Public lands and greenspace**

The data sets were generated under pre-existing TRCA programs via field surveys or through desktop analysis and modelling. The data varied widely in terms of coverage, purpose, scope and accuracy. Thus, to determine usability of the available data, the above list was further evaluated to generate a short list of data that would be included in the final IRP analysis. The four major considerations for this short list were:

RELEVANCE
Are these data a good metric to reflect one or more of the restoration objectives?

SPATIAL COVERAGE
Are these data distributed evenly throughout the study area (TRCA jurisdiction)?

RELIABILITY
Are the data collected, accurate and up to date?

COLLECTION METHOD
Is there a formal process for data collection and will it be collected in the future?

Furthermore, each data set needed to be a suitable metric to reflect at least one of the following four categories, which were created to reflect the restoration objectives and used to describe the natural system within the IRP framework:

EXISTING NATURAL COVER
per cent natural cover within each catchment

ALTERED HYDROLOGY
the degree to which drainage features and watercourses are altered within each catchment as a proxy for potential impairments (e.g. loss of wetland cover, erosion, sedimentation)

AQUATIC CONDITIONS
the quality of habitat conditions within the aquatic environment

TERRESTRIAL NATURAL HERITAGE POTENTIAL
the degree to which a catchment could contribute to natural heritage function if restoration were to occur

Based on the usability considerations of the data as well as their suitability as metrics, a short list of the most relevant data was finalized. This list included the following series of nine data sets:

1. **Wetland cover**
2. **Riparian cover**
3. **Terrestrial cover**
4. **Altered hydrology (note: data generated solely for IRP)**
5. **Water Quality**
6. **In-stream temperature**
7. **In-stream barriers**
8. **Natural heritage system corridor connectivity**
9. **Wetland corridor connectivity**
10. **Ecological value**

General details on the 10 data sets are provided in Table 1. The "Reliability" rating was based on a qualitative assessment after internal discussions with the groups responsible for each data set.

Table 1: List of TRCA data used for IRP framework

NATURAL SYSTEM CATEGORY	DATA TO BE USED AS METRICS	DATA SOURCE	YEAR	SPATIAL COVERAGE	COLLECTION METHOD	RELIABILITY
Existing Natural Cover	Wetland cover	GIS	2013	Jurisdiction	Ortho photo interpretation	Very good
	Riparian cover	GIS	2013	Jurisdiction	Ortho photo interpretation	Very good
	Terrestrial cover	GIS	2013	Jurisdiction	Ortho photo interpretation	Very good
Altered Hydrology	Altered hydrology	Orthophoto analysis	2013	Jurisdiction	Ortho photo interpretation	Good
Aquatic Conditions	Water quality	RWMP	2001-2012	Jurisdiction by watershed	OSAP protocol	Excellent
	In-stream temperature	RWMP	2002-2015	Jurisdiction by watershed	OSAP protocol	Excellent
	In-stream barriers	RWMP/FMP	~ 2000 - 2004	Jurisdiction by watershed	Ortho photo interpretation and field visits	Fair
Terrestrial Natural Heritage Potential	Ecological value	GIS	2005	Jurisdiction	GIS Modelling	Good
	Natural heritage system corridor connectivity	GIS	2015	Jurisdiction by watershed	GIS Modelling	Very good
	Wetland corridor connectivity	GIS	2015	Jurisdiction by watershed	GIS Modelling	Very good

Note: All data were pre-existing except for "Altered Hydrology" as it was determined that no dataset existed that demonstrated this parameter on a consistent and well distributed basis. Further explanation of the data is provided in the Section 4.4.

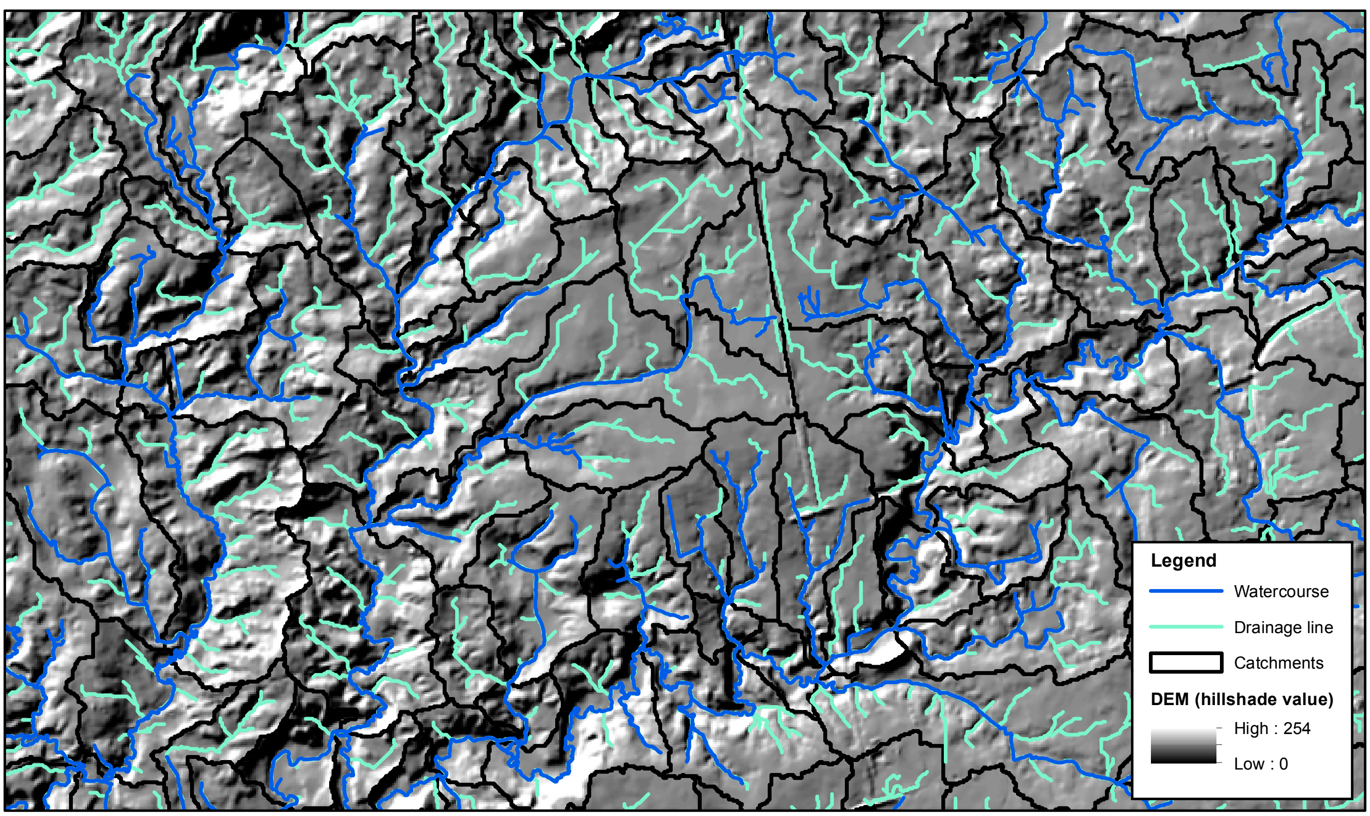
6.3 Delineating the Spatial Unit of Assessment (Catchment Delineation)

For the entire jurisdiction, discrete catchments (the spatial unit of assessment for IRP) were delineated using surficial drainage patterns and ArcHydro modelling. ArcHydro is an Esri ArcGIS application where drainage lines and catchment boundaries are derived from a Digital Elevation Model (DEM). The DEM was generated from real elevation data and has an accuracy of approximately 0.25 metres. The first execution of the IRP analysis used 30 hectare (on average) catchment boundaries.

Catchments are ideal for watershed management decisions as they enable hierarchical division over a complete watershed. These spatial units can be divided down to a finer resolution or aggregated up to a coarser resolution (depending on the data available and specific restoration objectives). This rescaling potential allows for the IRP assessment to be flexible to changes in spatial extent, associated data and management objectives. It is worth noting that for the terrestrial ecosystem data (i.e. terrestrial cover and connectivity), catchment boundaries may be less relevant as these systems are not limited by catchment function. Nevertheless, for the purpose of the IRP (designed to be a watershed-based assessment), catchments are still the appropriate spatial units because they allow for seamless integration of terrestrial, hydrological and aquatic components.

Along with the catchment boundaries, drainage lines were calculated based on drainage area, flow direction and flow accumulation. In most cases, the drainage lines extended beyond the original TRCA watercourse layer, which may have lacked segments such as intermittent streams or swales (e.g. headwater features). The extended drainage lines represent areas of accumulated flow that could indicate possible historical wetland or riparian cover. Identifying these lines and including them in the analysis allowed for a more accurate comparison of existing and potential conditions and demonstrates the hydrologic linkages between catchments. Catchments and drainage lines are demonstrated in Figure 2.

Figure 2: Digital Elevation Model (DEM) and ArcHydro



6.4 Evaluating and Classifying Natural System Functions

Thresholds, or limits, were applied to each data set to identify impaired catchments that may be significant contributors to adverse ecological health, especially when in close proximity to ecologically high functioning areas. The specific limits for each data set are described in further detail within this section of the document. The intent was to highlight areas where restoration of degraded areas could build upon well-functioning areas in an effort to create a critical mass of connected and functional natural resources.

In most cases, catchments that met the designated threshold received one point. The structure of this point system created binary information of zero or one – zero indicating absence of impairment and one indicating presence of impairment – for each data metric. As discussed earlier, ten data sets were used as metrics to reflect impairment in the four categories describing the natural system: natural cover, altered hydrology, aquatic conditions and terrestrial natural heritage potential (Table 1). The total points for each category were summed to identify the level of contribution each catchment had on natural system impairments. These four category sums were then further summed to receive one overall priority score for each catchment. Catchments with higher total scores (greater impairment with higher ecological potential) were considered higher priority than low scoring catchments.

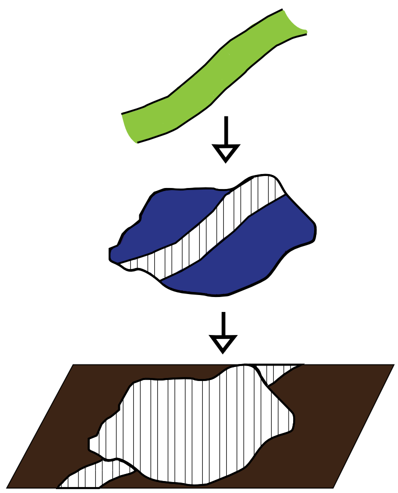
Sections 4.4.1 through 4.4.4 provide further details on the four natural system categories and the metrics that represent them in the IRP assessment. In addition, details on the limits and rationales for what constitutes base level prioritization within the catchment analysis are also provided in the following sections.

Brunetta Way Wetland, TRCA

6.4.1 Natural Cover

The natural cover category was represented by the geospatial data for riparian, wetland, and forest cover, which were used to calculate the per cent area cover for each catchment. Riparian areas were defined by 30 metre buffers around watercourses and headwater drainage features (ArcHydro drainage lines). The area of natural cover within that buffer was used for the per cent area riparian calculation. Wetland areas were identified by amalgamating data provided by TRCA and Ontario Ministry of Natural Resources and Forestry. The forest and successional areas were identified by TRCA via orthophoto interpretation. Note that data reflecting meadow areas were not included as they were determined to be incomplete and inconsistent across TRCA's jurisdiction. As the meadow data become more robust, they should be included in future IRP updates. To ensure that the different natural cover classes were mutually exclusive at any given location, the riparian zones were removed from the wetland and forest/successional zones and then the remaining wetland zones were removed from the forest/ successional zones (Figure 3).

Figure 3: The three metrics representing the natural cover category



The per cent area of natural cover of each of the three classes (riparian, wetland, forest/successional) was calculated within each catchment (using Esri ArcGIS for Desktop 10.2). In addition, per cent cover averages for the three classes were calculated for each watershed. The individual catchment averages were then compared to their respective watershed averages to determine if they fell above or below the natural cover threshold, as indicated in the table below. Catchments that had below average natural cover within their watersheds were given one point for each class. The maximum potential score within the Natural Cover category was 3.

Table 2: Summary of the Natural Cover metrics

METRIC	CATCHMENT LIMIT	RATIONALE
Riparian Cover	Below percent average = 1	Areas in need of more cover
Wetland Cover		
Forest and Successional Cover		

6.4.2 Altered Hydrology

Unlike the other data sets, Altered Hydrology was generated specifically for the IRP analysis. It was determined that there was currently no consistent data across the watershed that met the IRP considerations outlined in Section 4.2. As this information becomes more robust, specifically in urban areas, new data layers could be included in future IRP updates.

Orthophoto interpretation was used to determine the extent of hydrological function that had been altered through anthropogenic causes within each catchment. The purpose of this assessment was to identify the potential for impairment to natural function as it relates to unbalanced erosion and sedimentation processes (for example), which could have downstream impacts. Each catchment was systematically assessed using the criteria outlined in the table below. The assessment was based on identifying common human alterations to the landscape including straightening reaches, agricultural tile drainage, medium to high density development (Center for Watershed Protection, 2004), and on-line ponds. As outlined below, a limit was determined for four alteration categories and prioritization was based on how many of the four limits were met.

Table 3: Altered Hydrology assessment criteria

	ASSESSMENT CRITERIA			
Severity	Straightened Reaches	On-Line Ponds	Potential Drainage Tiles	Med to High Density Development
High (meets at least 1 extreme assessment criteria)	> 80%	not available	not available	>80%
High (meets 3 of 4 criteria)	> 30%	Presence of pond(s) or remnant wetlands	> 50%	>30%
Medium (meets 2 of 4 criteria)	> 30%	Presence of pond(s) or remnant wetlands	> 50%	>30%
Low (meets 0-1 of 4 criteria)	> 30%	Presence of pond(s) or remnant wetlands	> 50%	>30%

Using the limits defined above, the orthophotography, drainage line and elevation data were analyzed within each catchment. For the first step of this assessment, two analysts systematically and separately evaluated the catchments throughout the jurisdiction. For the second step, the analysts re-evaluated the catchments where a difference in rating was identified (e.g. one analyst identified a catchment as high severity, whereas the other marked it medium severity). A third analyst then re-analyzed the contradictory catchments and a final severity score was given. The priority rankings (low, medium, high) were then translated into numeric scores, 0, 1, 2, respectively. These numeric scores became the complete data set for the Altered Hydrology category.

Table 4: Summary of the Altered Hydrology metrics

METRIC	CATCHMENT LIMIT	RATIONALE
Altered Hydrology	Based on the Severity Assessment Criteria (Low = 0; Medium = 1; High =2)	Areas where impairments and threats to hydrologic function are likely and are in need of restoration/remediation

6.4.3 Aquatic Condition

Three metrics were chosen to indicate aquatic conditions: in-stream temperature, barriers and water quality. These data sets were generated from TRCA's RWMP and FMPs, which were used to characterize aquatic conditions and watershed health. For in-stream temperature and water quality, the primary data used were provided by the RWMP, but given the distribution and density of the sampling sites, some FMP data were used to fill large data gaps. Maps of the monitoring station locations can be found in Appendix A. The barriers data were collected through the FMP.

Thermal data were evaluated in terms of the overall stability of in-stream water temperatures (i.e. stable, unstable; based on Wehrly et al., 1999). Benthic (FBI: benthic invertebrate Family Biotic Index) and fish (IBI: fish Index of Biotic Integrity) field data were evaluated as proxies for water quality. TRCA's RWMP recognizes benthic communities as a stronger and more rapidly detectable indication of water quality (Dauer et al., 2000, Rosenberg & Resh, 1993); however, there were a few monitoring stations where only fish sampling data were available. At these sites, the FMP IBI data were used to maintain a relatively even distribution and density of data across the jurisdiction.

The water quality and temperature data were applied to the catchments by classifying reaches of the watercourse and drainage lines based on point monitoring sites. Where a monitoring site fell on the watercourse, all upstream reaches were given the same data value (e.g. stable for temperature or poor for water quality) until another monitoring point was located upstream or until the beginning of the headwater drainage features. This assumes that habitat and water conditions or inputs upstream of each monitoring point are influencing the conditions determined downstream.

Temperature conditions of "unstable" or "extreme" resulted in one point for the in-stream temperature metric and statuses of "stable" and "moderate" received no points. Water quality rankings were given points as follows:

Table 5: Grouping Benthic (FBI) and fish (IBI) data categories

	IBI	FBI
0	good, very good	good, fair
1	fair, poor, no fish	fairly poor, poor, very poor

In regards to barriers, catchments that contained one or more barrier received one point for impairment. Catchments with no barriers received a score of 0. The priority barriers considered in this analysis were dams, weirs and on-line ponds. Culverts were not considered because the data set was incomplete.

Table 6: Summary of the Aquatic metrics

METRIC	CATCHMENT LIMIT	RATIONALE
Temperature	Stable and moderate = 0; Unstable and extreme = 1	Upstream areas that are in need of mitigation to reduce in-stream heating
Priority Barriers	Occurrence = 1	Areas where facilitating fish movement is needed
Water Quality (FBI and IBI)	FBI: fairly poor, poor, very poor = 1; Or IBI: fair, poor, no fish = 1	Upstream areas that are in need of mitigation to improve water quality

6.4.4 Terrestrial Natural Heritage Potential

In conjunction with TRCA's existing Terrestrial Natural Heritage System Strategy, data sets have been generated that illustrate the ecological value (and potential ecological value) of non-urban areas. Metrics under this category combine some of these data sets with a per cent natural cover calculation. This method was designed to identify areas of high ecological potential with below average natural cover. These areas, if restored, would contribute to adjacent catchments with already high terrestrial natural heritage values. In other words, corridor connections would be improved and existing habitat patch sizes and shapes would be enhanced.

The data pertaining to this category were primarily model-generated raster data reflecting: high ecological value areas; the level of connectivity (via natural corridors) between terrestrial habitats; and the level of connectivity between wetland habitats. All calculations and comparisons were executed using ArcGIS 10.2.

For the first metric, ecological value, high priority areas were identified as catchments that met two conditions. First, the ecological value had to be higher than the watershed average and second, the per cent natural cover had to be lower than the watershed average. To determine these conditions, an existing value surface raster quantifying ecological significance was used to calculate average values at the catchment and watershed levels. The per cent area of total natural cover (riparian, wetland and terrestrial combined) was also calculated at the catchment and watershed levels. If a catchment was calculated as above average ecological value and below average total natural cover, it received a point for ecological value. All other catchments received scores of 0.

Identical to the ecological value raster, the second metric, terrestrial connectivity was evaluated using a raster model output. Connectivity values were based on a circuit model analysis previously completed by TRCA. The connectivity averages were calculated at the catchment and watershed levels. Catchments with connectivity values above their respective watershed averages were considered important natural corridors within TRCA jurisdiction. The calculations for natural cover were also required for this metric, to identify areas where low existing natural cover occurred within important corridor connections. Catchments with above average connectivity and below average total natural cover were given a point for impaired terrestrial connectivity.

A similar analysis was completed to describe the third metric in this category, wetland connectedness. For wetland corridors, catchments that had above average wetland connectivity and below average wetland cover were given a point for impaired wetland connectivity. These highlighted catchments reflected areas that were of the highest priority for wetland connectivity but had low existing wetland cover.

Table 7: Summary of the Terrestrial Natural Heritage Potential metrics

METRIC	CATCHMENT LIMIT	RATIONALE
High ecological value surface score with below average cover	Catchments with below average natural cover and above average ecological value = 1	Areas to increase natural cover that are adjacent to areas of significant existing cover
Terrestrial corridors within the TNH target system with below average cover	Catchments with below average natural cover that fall within terrestrial corridors = 1	Areas of low natural cover than can contribute most to connecting areas of good natural cover
Wetland corridors with below average cover	Catchments with below average wetland cover in wetland corridors = 1	Areas of low wetland cover that can contribute most to connect good wetland cover

6.4.5 Total IRP ranking

A sum total of all the metrics within each category was calculated as well as a final sum total for all the categories together. Catchments were ranked as high, medium or low based on how many limits were met. This ultimate prioritization reflects a multi-benefit analysis for each catchment. In other words, a high priority catchment has multiple impairments and restoration could provide multiple benefits to the natural system. The results of the assessment are discussed in Section 7.

It is important to note that the data sets were collected or compared only within the watersheds and then aggregated to present the jurisdictional scenario. Figure 4 presents the map of the watersheds within TRCA's jurisdiction with the catchments overlain.

The IRP results were significantly driven by whether the catchments were situated in an urban, rural or greenspace landscape. Knowing the general land use areas is important to contextualize the results. Figure 5 presents the map that identifies the general land use within TRCA's jurisdiction.

Figure 4: Watersheds within TRCA jurisdiction

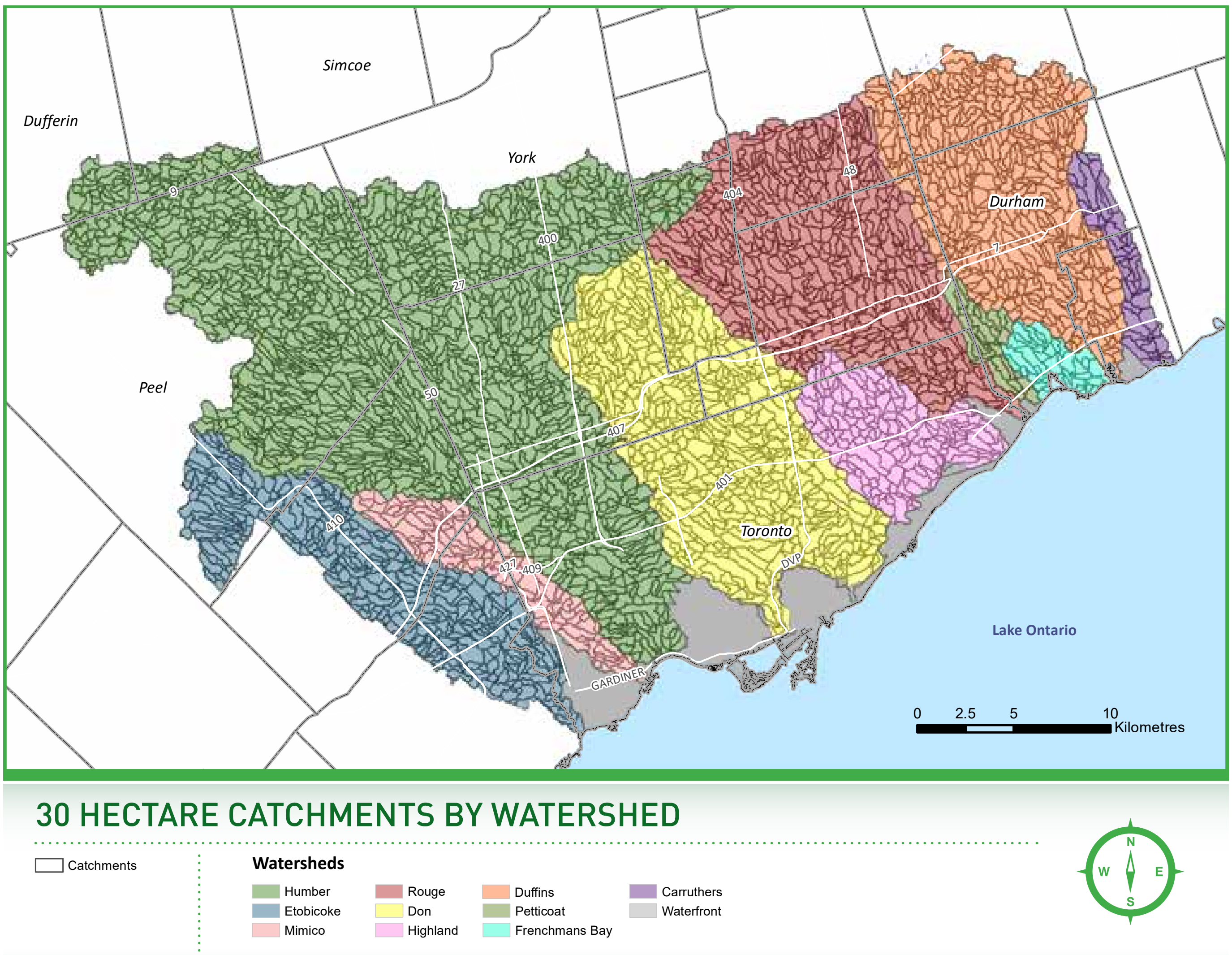
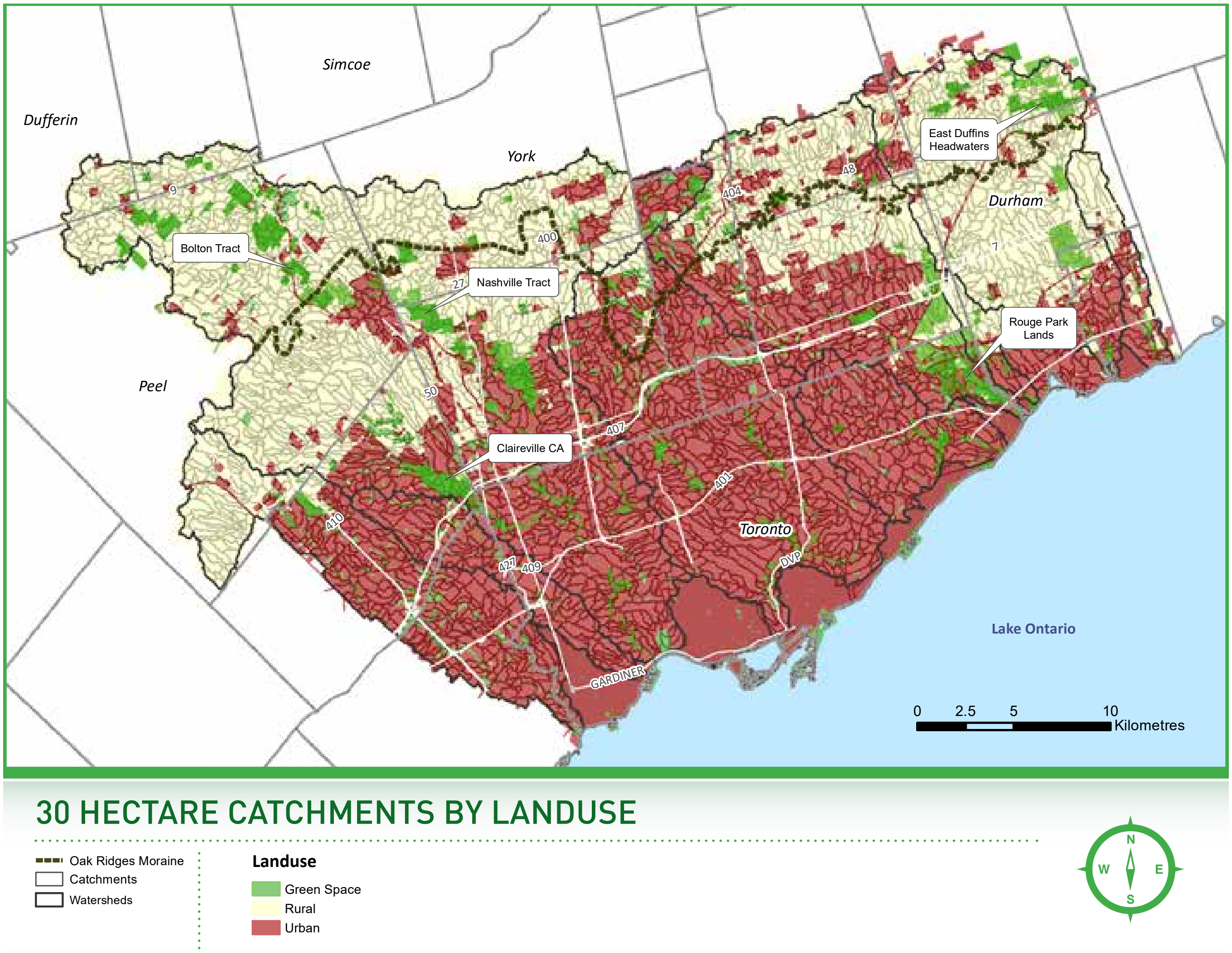


Figure 5: General land use in TRCA jurisdiction

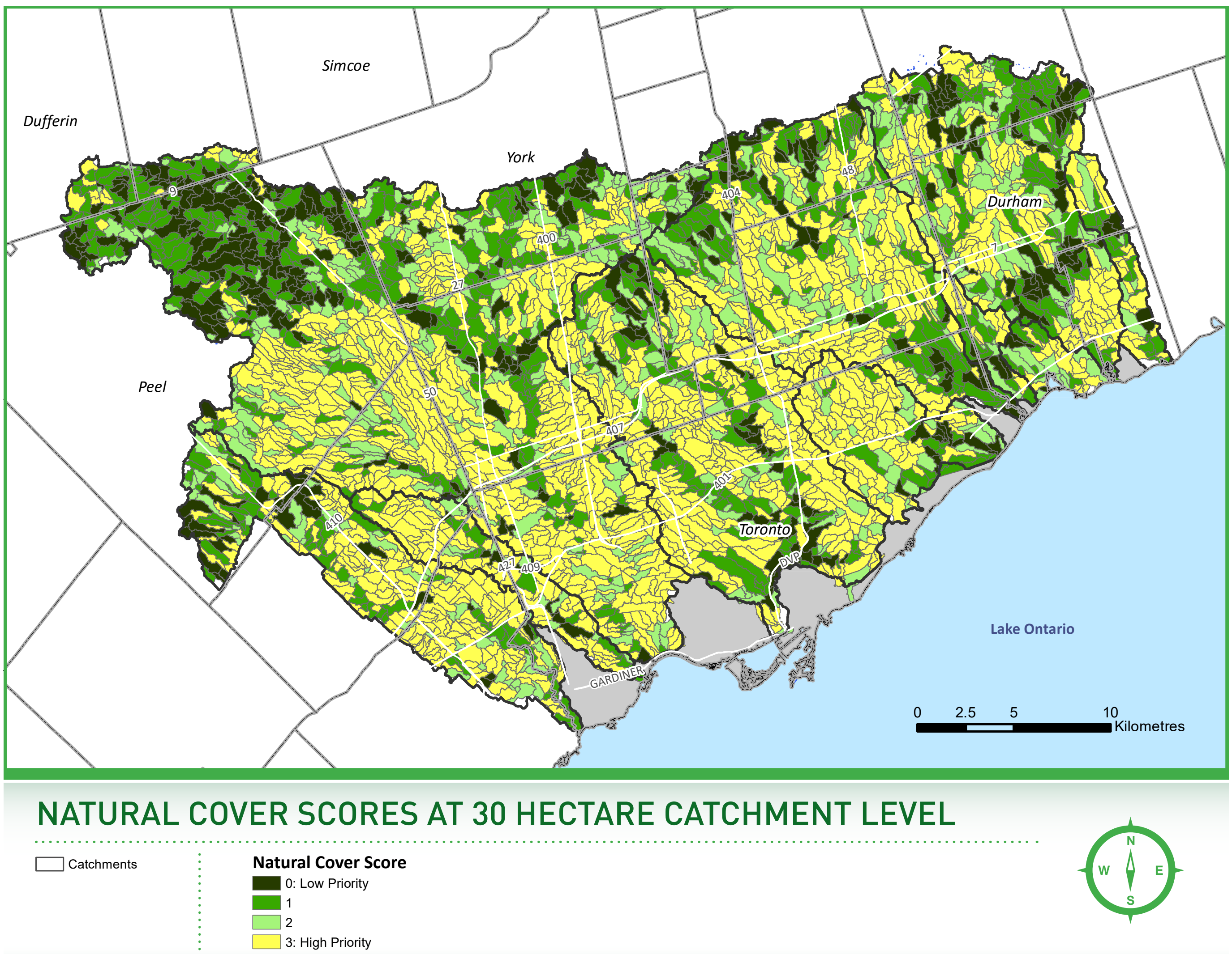


7. RESULTS

7.1 Natural Cover

The final natural cover scores ranged from 0 to 3, with one possible point for each cover type (Figure 6). The results demonstrate that the valley systems generally exhibit above average cover, and that the Oak Ridges Moraine has the most continuous natural cover. The results also highlight large tracts of natural cover such as Nashville Tract, Bolton Tract, East Duffins Headwaters, and the Rouge Park Lands (referenced in Figure 5). Below average coverage was dominant in urban areas. In rural areas, gaps in continuous cover exist, which is demonstrated by the more isolated catchments with below average natural cover.

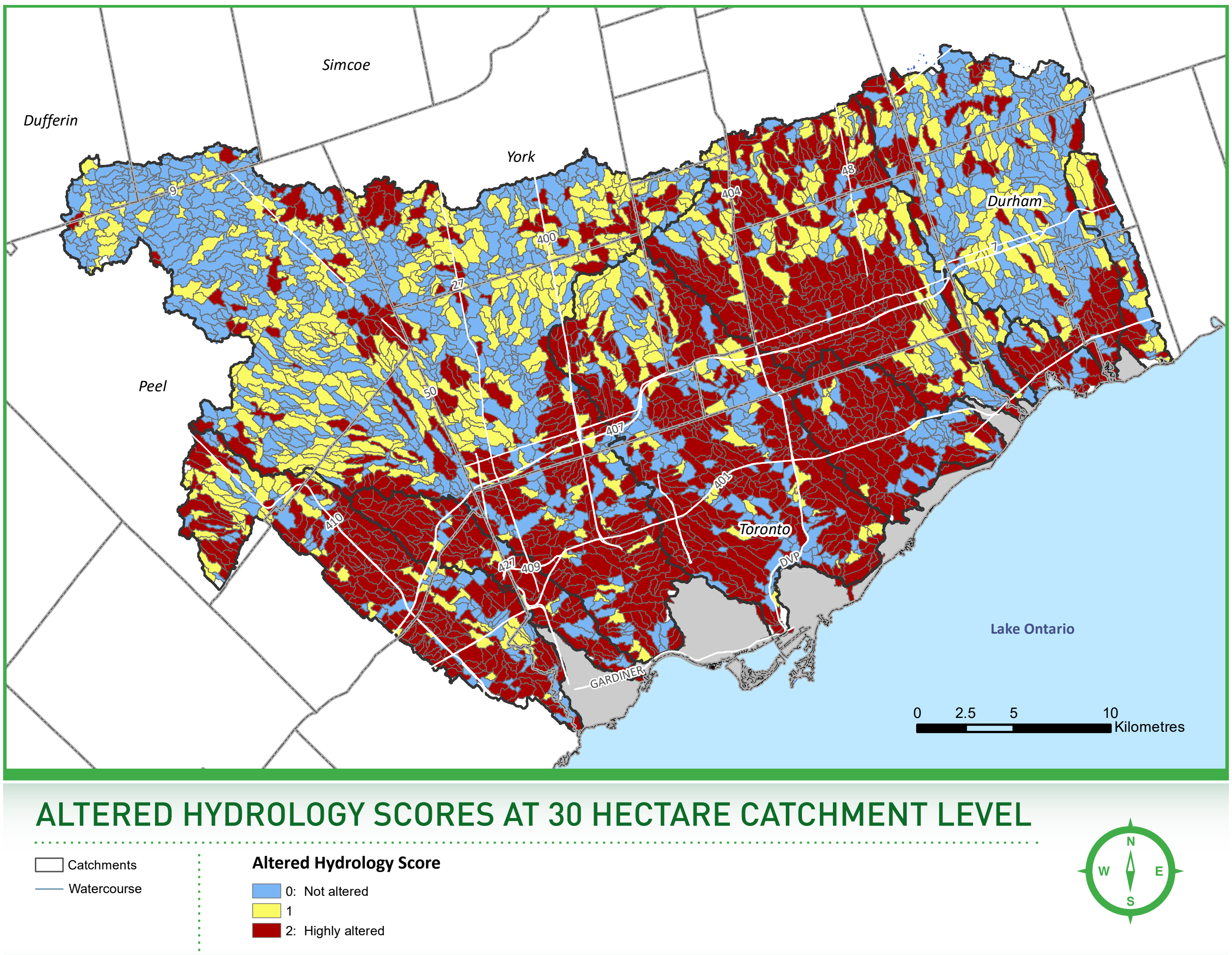
Figure 6: TRCA-wide natural cover scores at 30 hectare catchment level



7.2 Altered Hydrology

The scores for altered hydrology range from 0 to 2 (low to high). The resulting data highlight areas that have been impacted by development and agricultural use (Figure 7). Within urban areas, low alteration catchments are primarily in wide valley systems. Highly altered areas in rural regions are more sporadic, which is reflective of isolated areas of intensive agriculture with significant landform alterations (i.e. straightened channels, tile drains and on-line ponds). The Rouge River watershed exhibits consistently high alteration in both urban and rural areas.

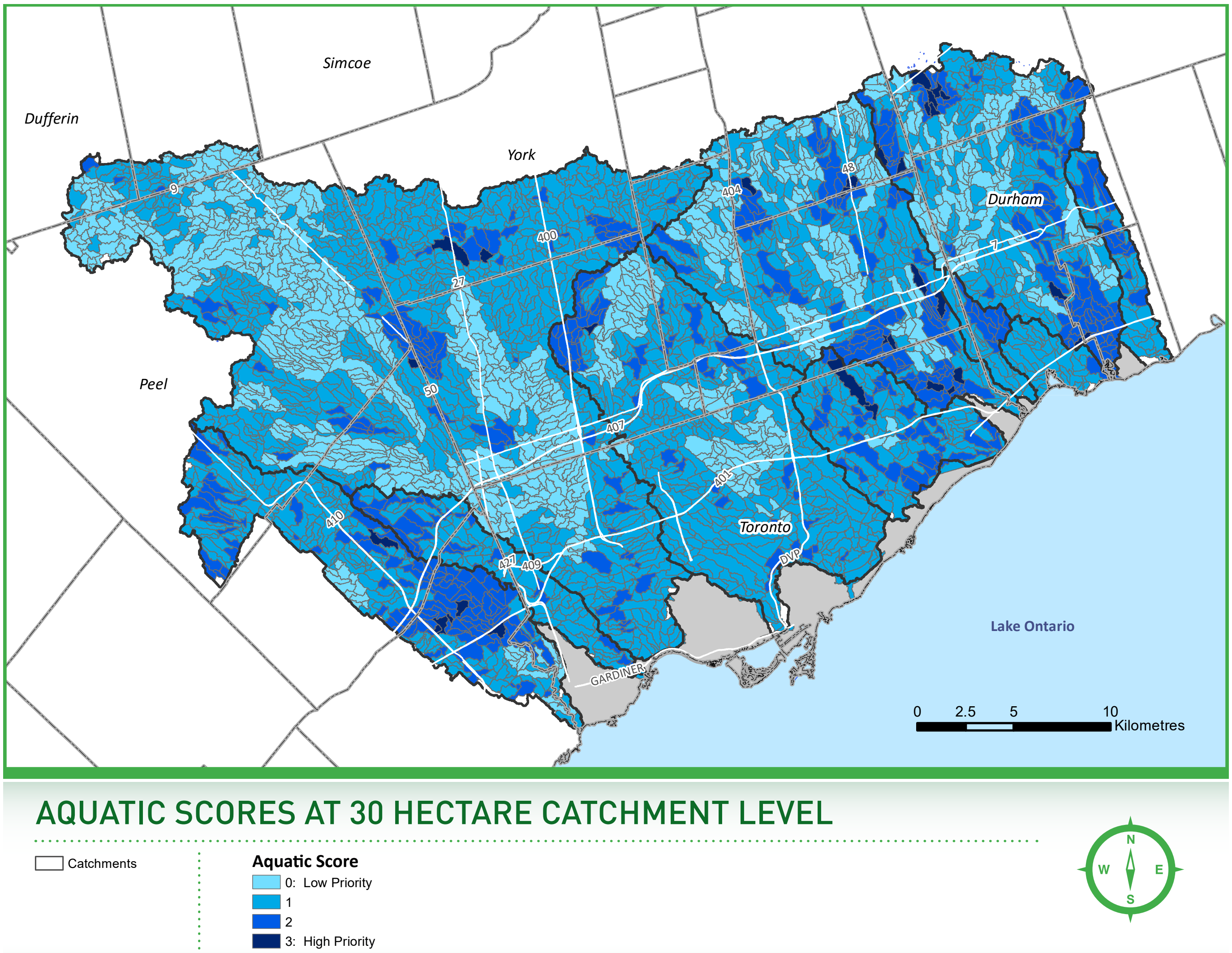
Figure 7: TRCA-wide altered hydrology scores at 30 hectare catchment level



7.3 Aquatic

The final aquatic scores range from 0 to 3, with a possible score for each: a presence of one or more barriers, unstable or extreme water temperatures, and relatively poor water quality. The higher priority areas are fewer and more discrete in the aquatic data than the previous two categories (Figure 8). The aquatic results indicate high priority areas near the edges of the City of Toronto (where transition from rural to urban land-uses are currently occurring) and in the upper Duffins and Rouge watersheds. Lower priority catchments were identified within the mid and northern reaches of TRCA's jurisdiction and the Upper Main Humber sub-watershed.

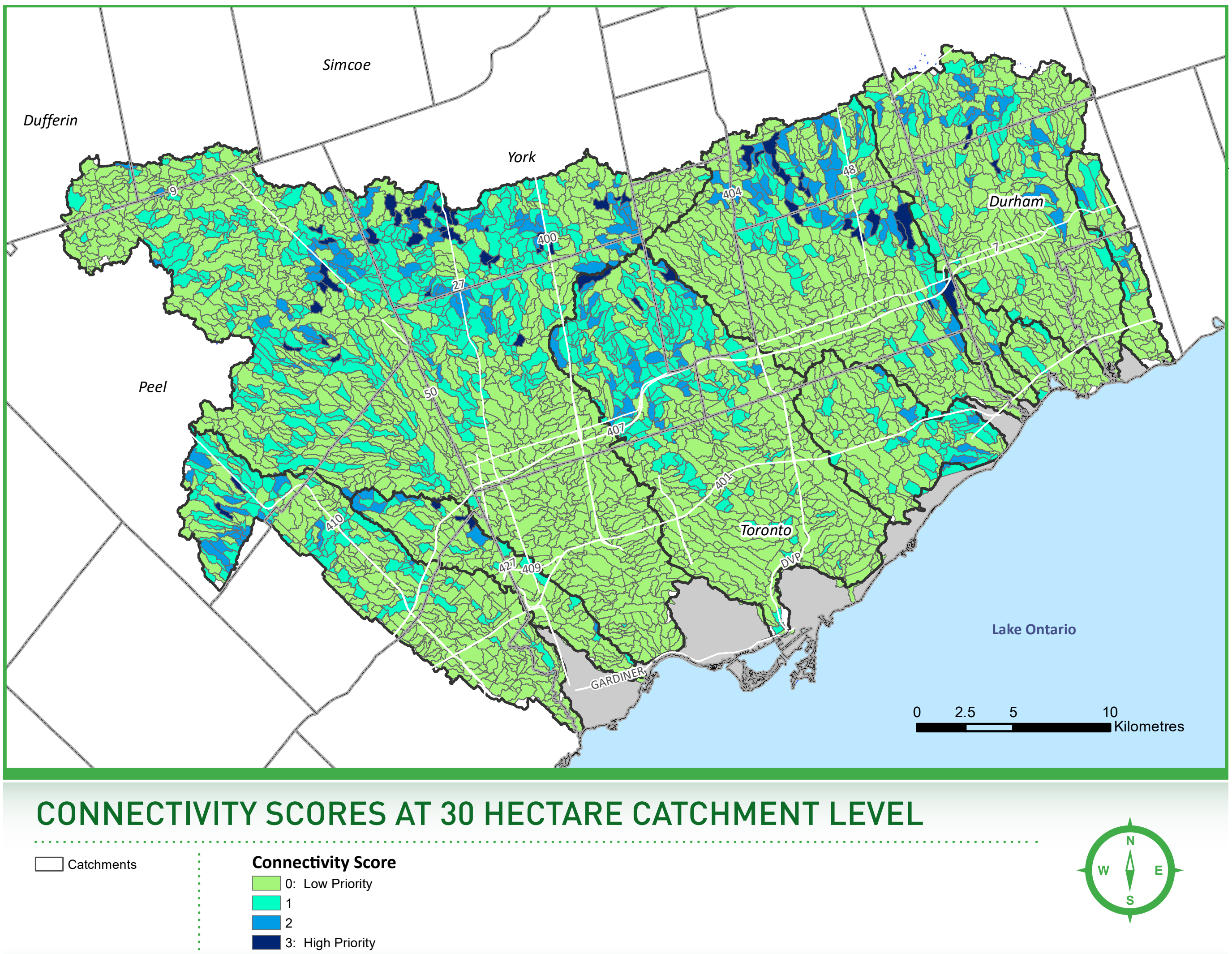
Figure 8: TRCA-wide aquatic scores at 30 hectares catchment level



7.4 Terrestrial Natural Heritage Potential

The total scores for the natural heritage category range up to a maximum of 3, representing low natural cover areas with high terrestrial natural heritage values (Figure 9). Within this category, priority is high from Rouge Park Lands up into the upper Rouge River watershed and within the East Humber sub-watershed. Potential high valued areas are primarily along the southern boundary of the Oak Ridges Moraine (referenced in Figure 5), where development pressures are moving into large expanses of greenspace and agricultural lands. In urban areas, higher scoring catchments are present in the lower Highland watershed, the upper Don watershed, the mid and upper reaches of the Etobicoke Creek watershed, and the headwaters of Mimico Creek watershed.

Figure 9: TRCA-wide terrestrial natural heritage scores at 30 hectare catchment level



7.5 Final IRP Results

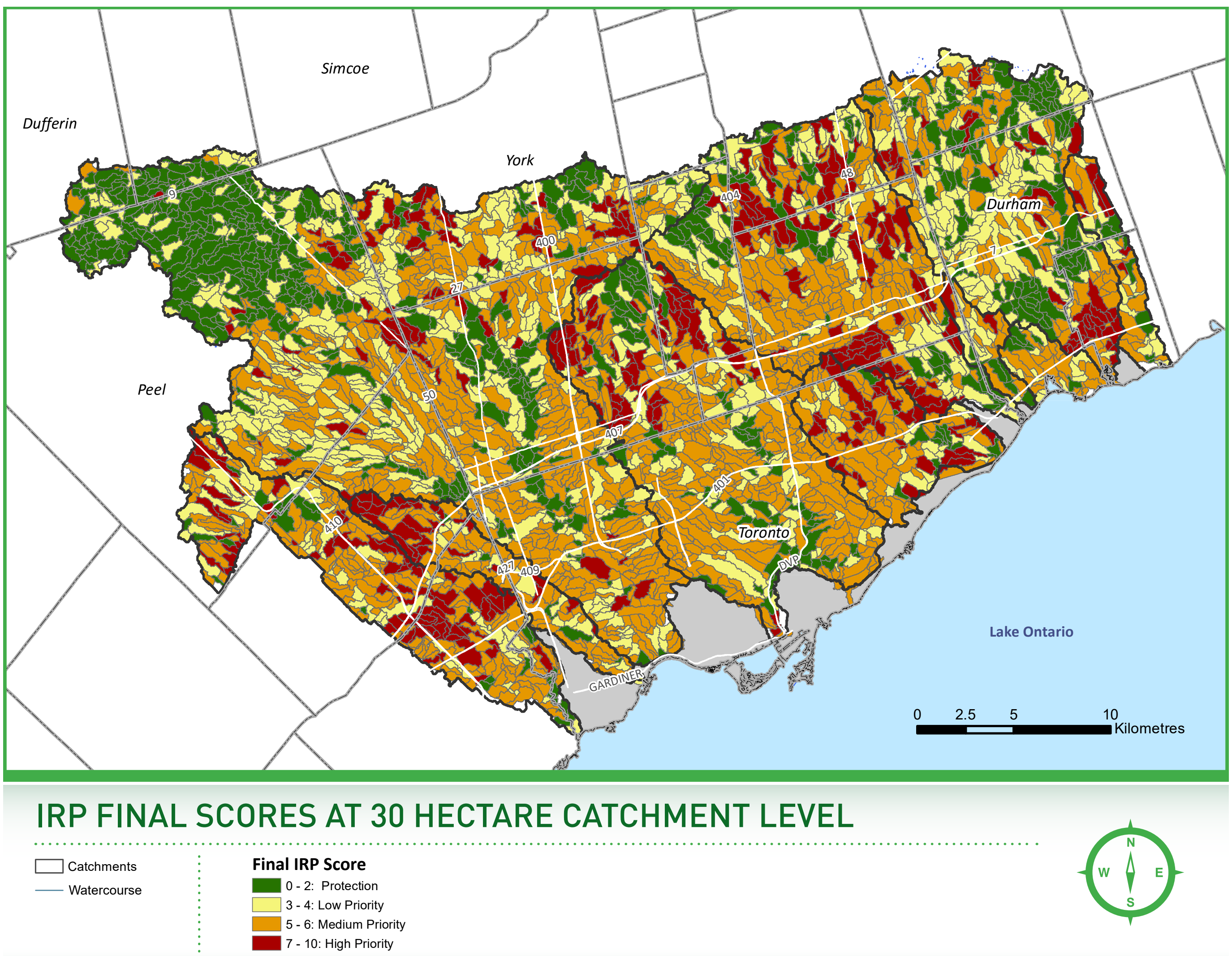
The sum totals for each natural systems category (natural cover, hydrology, aquatic, terrestrial natural heritage potential) result in final catchment scores ranging from 0 to 10 (out of a possible 11 total points) (Figure 10).

The jurisdiction-wide maps of the scores for each individual metric are in Appendix B. This range of scores was ultimately categorized into rankings of "protection" (0-2), "low" (3-4), "medium" (5-6) or "high" (7-10), as shown in Figure 10. Note that the "protection" priority is a special designation given to high-valued natural heritage areas. The intent is to recognize that targeted restoration programs are beneficial in these areas to promote the recovery of high valued systems (e.g. Atlantic Salmon Restoration Program)

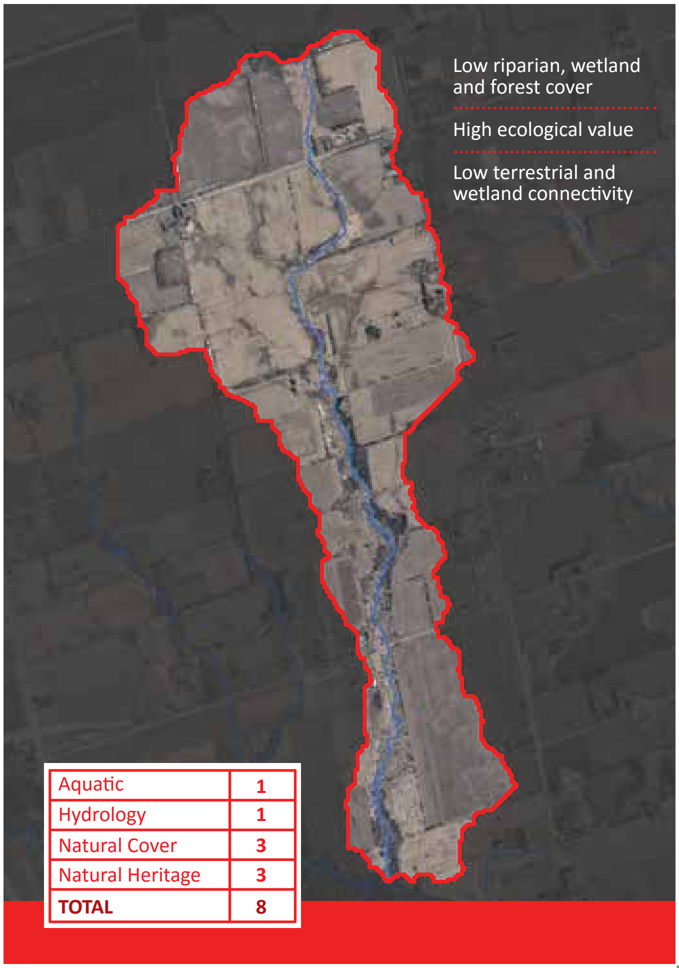
The results show a significant number of high scoring catchments in urban areas. This trend is primarily driven by low natural cover, high altered hydrology and one or more points for low water quality. Large sections of lower priority areas are evident in the upper Main Humber River watershed, upper East Duffins Creek watershed and along wide valley corridors.

To visually demonstrate a high, medium and low scoring catchment, individual catchment examples are identified and discussed in Boxes 1 - 4. Note that the discussions are generalizations based on IRP results, and that no detailed reach-based assessments have been completed.

Figure 10: TRCA-wide final IRP scores and ranks at 30 hectare catchment level



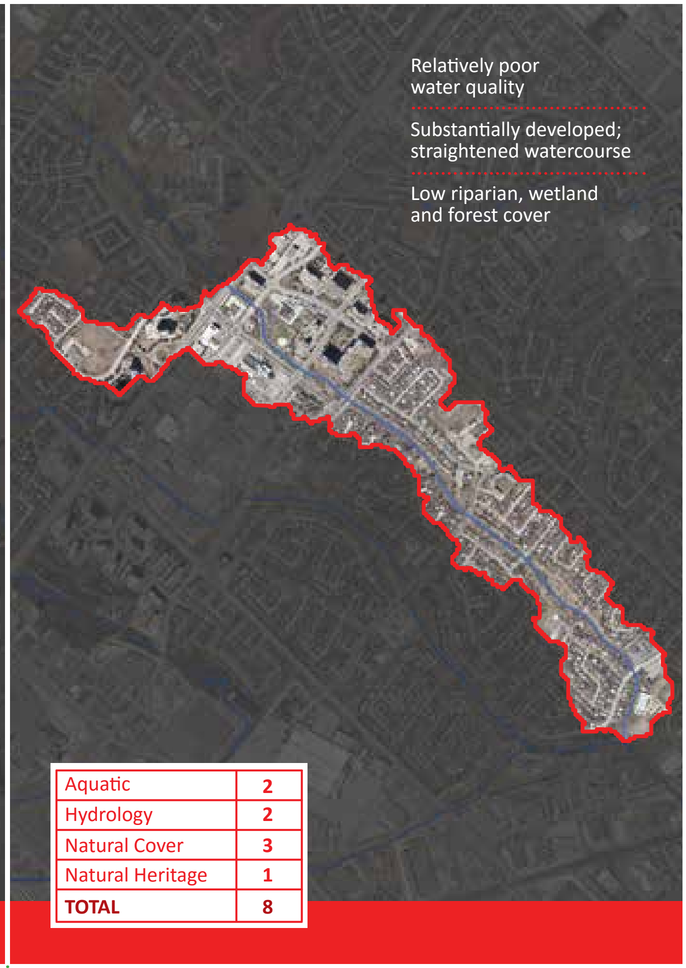
EXAMPLES OF THE PRIORITY CATCHMENTS RESULTING FROM THE IRP ANALYSIS



Aquatic	1
Hydrology	1
Natural Cover	3
Natural Heritage	3
TOTAL	**8**

Box 1

This high scoring catchment is ideal for restoration. There are many opportunities for ecological enhancement such as increasing riparian cover, reversing/mitigating in-stream alterations, and wetland restoration in the agricultural fields. IRP assessment reveals that this catchment is situated well for corridor connectedness, so increasing natural cover would be essential.

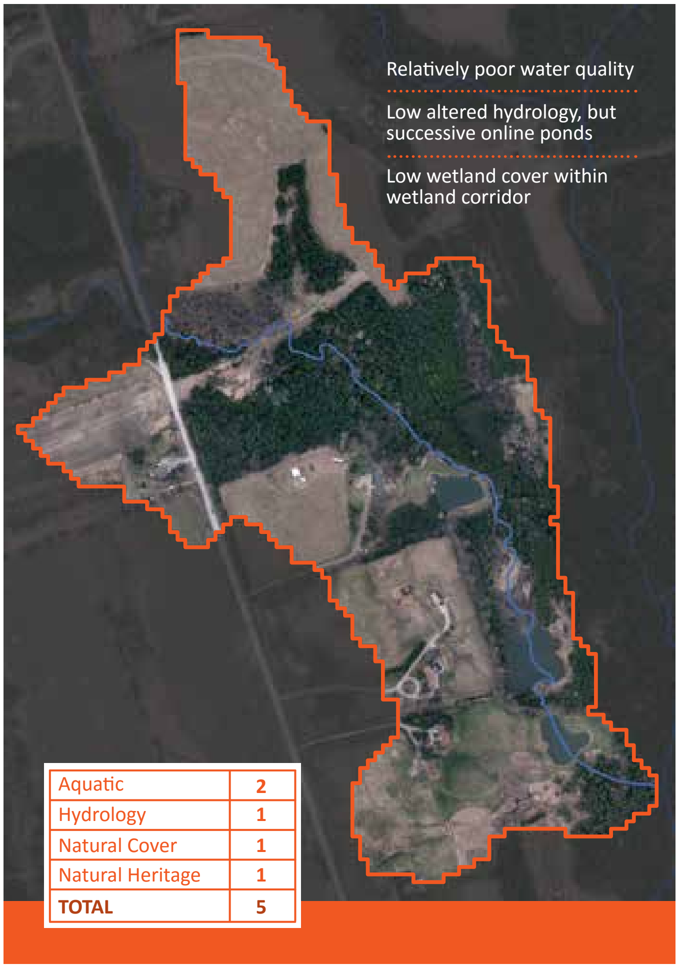


Aquatic	2
Hydrology	2
Natural Cover	3
Natural Heritage	1
TOTAL	**8**

Box 2

This is a typical high scoring catchment in an urban area. A highly altered watercourse traverses the catchment. There is low natural cover, and due to its situation in the watershed, increasing natural cover would have some benefit to natural heritage values. Given its poor aquatic condition, this catchment, and downstream catchments, could benefit from applying Low Impact Development (LID) techniques (green infrastructure) and in-stream improvements.

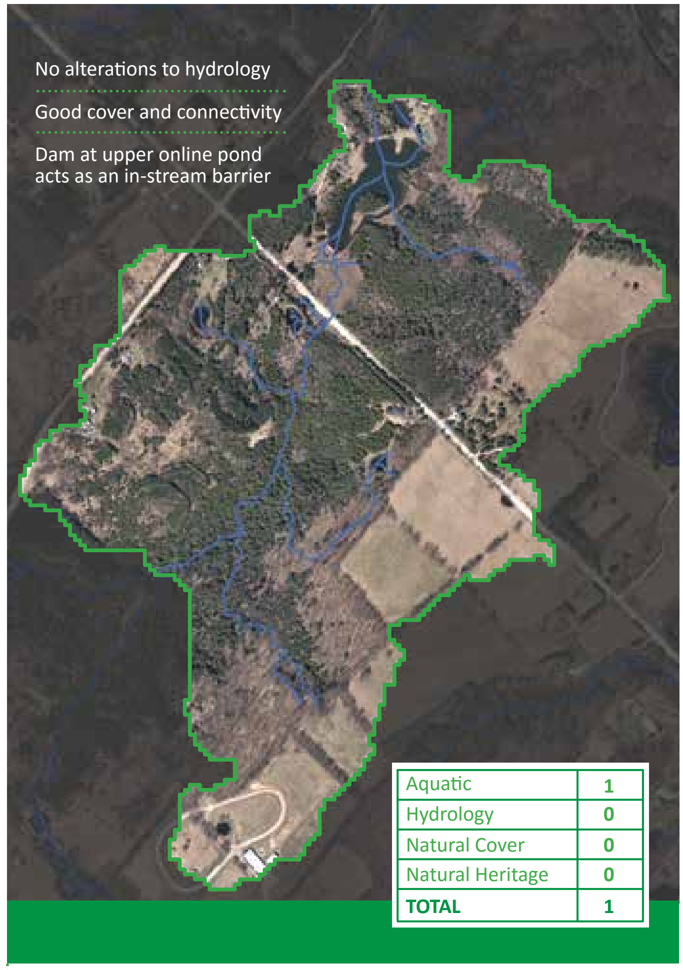
EXAMPLES OF THE PRIORITY CATCHMENTS RESULTING FROM THE IRP ANALYSIS (CONT.)



Aquatic	2
Hydrology	1
Natural Cover	1
Natural Heritage	1
TOTAL	**5**

Box 3

Given the presence of on-line ponds, this catchment could be contributing to the relatively poor water quality data that have been recorded. Due to its relatively good natural cover, the catchment is already contributing well to natural heritage values; however, there is low wetland cover, and it is situated within a good wetland corridor area. Taking the on-line ponds off-line and converting them to more enhanced wetland features could be beneficial to the natural system.



Aquatic	1
Hydrology	0
Natural Cover	0
Natural Heritage	0
TOTAL	**1**

Box 4

This catchment scores zeros in all metrics except for aquatic conditions. The on-line pond is contributing to this result because it is a barrier for fish. This catchment is a good example of how restoring specific features in a "protection" catchment could prove beneficial to the fish species that may be utilizing the area already.

8. DISCUSSION

IRP IS A PROCESS

It is important to understand that the IRP framework is not just about the results. It is also very much about the process. The IRP framework is designed to be a systematic, defensible, transparent, flexible and repeatable process where new or different data can be incorporated into restoration prioritization at multiple scales. This document outlines this process, which is just as important as the results.

REQUIRES INTERPRETATION

IRP is an effective decision support tool that incorporates a wide variety of important restoration considerations into one platform; however, IRP cannot replace human interpretation of ecological conditions and management objectives. Proper interpretation of the data (i.e. what metrics within the analysis are driving the priority; what are some of the data gaps; and local site level knowledge) as well as the site level priorities are also critical to developing a complete understanding of watershed functions and restoration priorities.

TAILORING PRIORITY

The final outputs presented in this document detail priority categories (natural cover, altered hydrology, aquatic conditions, and terrestrial natural heritage potential) as well as a sum total IRP score. Beyond this, the results can be further refined or tailored to specific goals or objectives. For example, if there is an interest in identifying areas to increase riparian cover with the goal of stabilizing in-stream temperatures, isolated queries can be performed on the riparian results (i.e. catchments with below average riparian cover) and the temperature results (i.e. catchments with extreme or unstable temperatures).

RESTORATION FOR "PROTECTION"

IRP identifies priorities based on identifying the need for and benefits of ecosystem restoration. Low priority areas are generally in good ecological condition and may not require extensive site level restoration. However, these areas are often targeted for ecological programs such as the Atlantic Salmon Restoration Program in the Upper Main Humber River sub-watershed and the Upper Duffins watershed, where high ecologically valued areas are a requirement of stocking thereby making nearby habitat improvements a priority. Implementing specific restoration opportunities within these sites could be very beneficial (e.g. removing a barrier to allow fish passage). Therefore, some of the low scoring IRP areas could still be ideal for special restoration programs. Designating these areas as "protection" zones could help guide future actions.

Robinson Creek Stream Restoration site, TRCA.

ADDITIONAL DATA

The prioritization outlined in this document represents a base level assessment of restoration priorities. A determination was made that the data layers used for this IRP were the most relevant and usable in reflecting IRP objectives. However, other overlays that do not currently exist, were too difficult to represent or were not considered robust enough at the time could help to refine future prioritization if they become available. Generally, such data include, but are not limited to:

- **Priority storm water treatment areas or Low Impact Development (LID) priorities**
- **Species At Risk/Species of Conservation Concern priority areas**
- **Flood vulnerable areas**
- **Detailed land use maps to identify specific ecological threat areas**
- **Species management or introduction areas (e.g. Atlantic salmon)**
- **Flora and fauna field surveys**
- **Priority meadow areas**
- **Fluvial geomorphology**
- **Headwater priorities**
- **Future development lands**
- **Urban forest priority areas**
- **Natural System Vulnerable to Climate Change areas**

IRP uses the most current data available. The results of the prioritization analysis should be updated on a regular basis to ensure the most accurate reflection of the current state of our watersheds is being achieved.

APPLYING DATA TO UPSTREAM CATCHMENTS

In regard to the aquatic data that were used, there was an assumption that all upstream areas contribute to the data results acquired from the immediate downstream monitoring station. As described in the "Data" section, this was applied to every catchment upstream of a given monitoring station until the next upstream monitoring station was reached. Increasing the density of monitoring sites could help to improve validity and would provide further details of how upstream conditions contribute to downstream impacts.

MUNICIPAL COMMUNITY PRIORITIES

The parameters of this IRP framework are based strictly on ecological function. Factors beyond the contributions to ecological goods and services (i.e. community stewardship or human health and well-being) were not considered in this analysis. Adding these factors could help determine the locations of initiatives such as Community Action Sites and Sustainable Neighbourhood Action Plan (SNAP). A second level analysis of how communities use natural spaces would help achieve this goal.

MEASURING CHANGE

Most of the data used for the IRP analysis were taken from data sets that are updated on a regular basis. This enables the ability to track changes within catchments over time, as restoration continues or climate change scenarios impact natural systems. It is important to note that some data layers are easier than others in terms of correlating change to specific restoration initiatives. For example, natural cover is easier to use than water quality as a metric with which to measure change. Water quality improvements may be more difficult to correlate to restoration because there are a wide variety of contributors that could change over time.

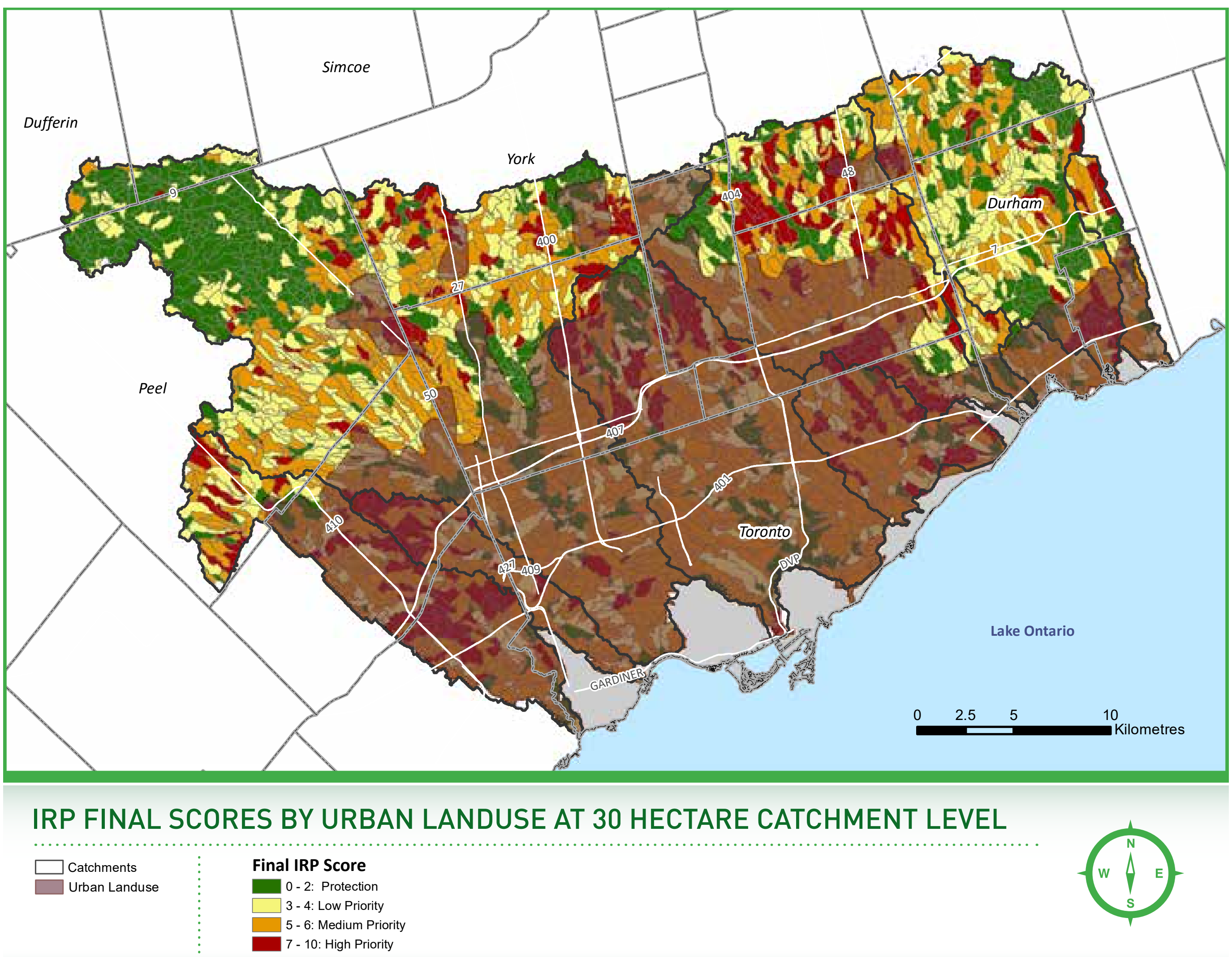
POTENTIAL BIAS TO "GOOD DATA"

Data vary between watersheds. The differences arise depending on when the data were collected, the reason they were collected, and the number of data sets that were collected. There is the potential for future IRP results to be biased toward the most up-to-date data. Analysis of the existing data can highlight gaps in data distribution as well as which watersheds have better quality data sets. For example, the Rouge River watershed has the most up to date RWMP temperature data (using averaged long-term readings) with the best spatial coverage. Some areas in the Humber River watershed have wide data gaps that had to be filled with less extensive data sets (e.g. shorter term readings).

URBAN VS. RURAL APPLICATIONS

Although the results demonstrate the differences between urban and rural landscapes, all data were treated similarly across both landscapes in how they were measured against the predetermined limits. It could be beneficial to apply land use information and direct priority in a manner that recognizes the differences between urban and rural regions (Figure 11). In addition, some restoration practices need to be approached differently if the opportunity is located in an urban or rural landscape. For example, implementing Low Impact Development (LID) measures (e.g. bio-swales, infiltration trenches) applies to urban areas, and Best Management Practice (BMP) activities (e.g. vegetated swales, livestock exclusion fencing around watercourses) applies to rural areas. Both are intended to mitigate threats to water quality and/or quantity, but differ significantly in application and cost.

Figure 11: TRCA-wide final IRP scores and ranks at 30 hectare catchment level with urban overlay



9. UTILITY

IRP is a decision support tool than can be used for a variety of ecosystem and land management decisions. The intent is to facilitate strategic decisions regarding restoration or protection that will have the greatest benefit to ecosystem health. The IRP framework and outputs can be utilized by a variety of initiatives, described below:

REMEDIAL ACTION PLAN (RAP) TARGETS

IRP priority catchments reflect the potential for multiple benefits to both aquatic and terrestrial habitats, if restoration were to occur. IRP could be used as a tool for identifying restoration locations within the RAP Toronto and Region Area of Concern that would contribute most to delisting targets.

COMPENSATION AND PLANNING

IRP priority areas identified in this study could be used as a planning tool in development review. This is especially critical in areas of future development, where natural areas and ecosystem health are currently being threatened. IRP could be used to prioritize municipal natural heritage boundaries and to identify priority protection and/or restoration areas during development planning, Environmental Assessment processes or through off-site compensation when habitat loss is unavoidable.

ENDANGERED SPECIES ACT

IRP could prove critical in providing overall benefit scenarios to satisfy Species at Risk legislation. Priority catchments can be identified and reach plans can be developed as packages for future compensation when needed.

RESTORATION OPPORTUNITIES DATABASE (ROD) AND RESTORATION IMPLEMENTATION ON PUBLIC LANDS

Priority catchments will be the first areas targeted for implementation. TRCA's database of restoration opportunities (ROD) can be accessed and queried to highlight high priority restoration sites within high priority catchments. These areas are potentially the easiest and most effective way to contribute to the overall watershed health targets. In areas where restoration opportunities have not been assessed, IRP can be used to determine where to start assessing in order to focus efforts where the greatest contribution to watershed objectives could be made.

STEWARDSHIP TOOL

Catchment prioritization can be used to direct where Stewardship initiatives should take place, such as private landowner contact, community planting events or Sustainable Neighbourhood Action Plans (SNAP).

FISHERIES MANAGEMENT

Implementing restoration projects within the high priority catchments could greatly benefit fisheries management objectives by improving the hydrologic conditions impacting base flow, water quality, erosion and sedimentation. Coupling IRP with more specific fish management and/or species targeting would help to further prioritize areas for restoration.

WATERSHED PLANS AND STRATEGIES

Implementing restoration projects within high priority catchments can also contribute to achieving the targets set forth by TRCA's various watershed plans. In addition, IRP can be used to inform TRCA reports on overall watershed health. The final results could also be integrated into other watershed specific recommendations developed through the watershed strategy planning process, to further prioritize areas for restoration.

LAND ACQUISITION

IRP can be used to help determine where possible easements or land acquisition initiatives on private lands should be focused, in order to attain maximum natural heritage protection and restoration gains for TRCA and municipal partners.

CLIMATE CHANGE

IRP could be an important tool integrated with TRCA's upcoming Natural System Vulnerability to Climate Change study to understand and strategically mitigate issues related to biotic and abiotic changes on our landscape.

10. NEXT STEPS

The IRP framework described in this document outlines the first execution of the IRP analysis. Future iterations will involve a continuous process of coordinating with interested parties, updating data, and adding supplementary data layers as they become relevant. The overall goal of upcoming IRP iterations will be to continue producing IRP outputs that are relevant to restoration planning, based on the latest, most accurate and most robust data available. Below are some recommendations that will be critical to future development of the IRP process:

A. Synthesize and discuss data gaps with future monitoring plans and undertake actions to fill those gaps;

B. Form an IRP working group with all relevant disciplines to ensure that the IRP process is maximizing the multiple ecosystem functions and services in TRCA and beyond;

C. Include new data layers to enhance the information incorporated into the IRP framework;

D. Expand the framework to include the urban context by establishing a complementary set of objectives and conducting IRP analysis with the most relevant data that further reflects the unique conditions and restoration priorities specific to urban areas; and

F. Develop an interactive geospatial database tool that can be used to identify areas to restore, tailor data to reflect specific objectives, and understand the drivers of restoration prioritization.

G. Collaborate internally with the team involved in the Natural System Vulnerability to Climate Change study to help inform strategic planning initiatives.

Upper Mimico Stream Realignment and Restoration site, TRCA.

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DISCLAIMER:

The Data used to create the maps was compiled from a variety of sources & dates.

TRCA takes no responsibility for errors or omissions in the data and retains the right to make changes & corrections at anytime without notice. For further information about the data on this map, please contact the TRCA GIS Department. (416) 661-6600.

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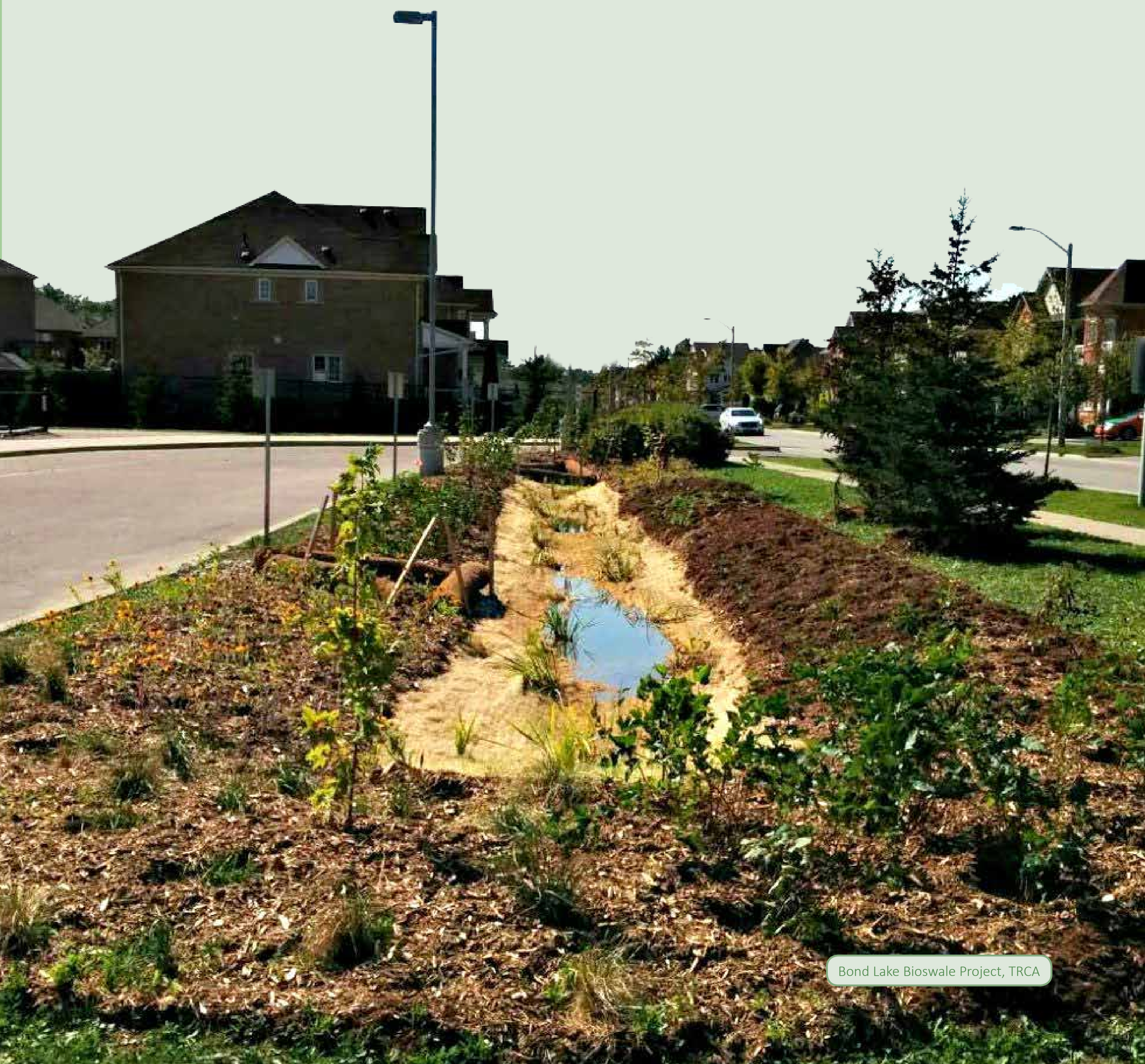
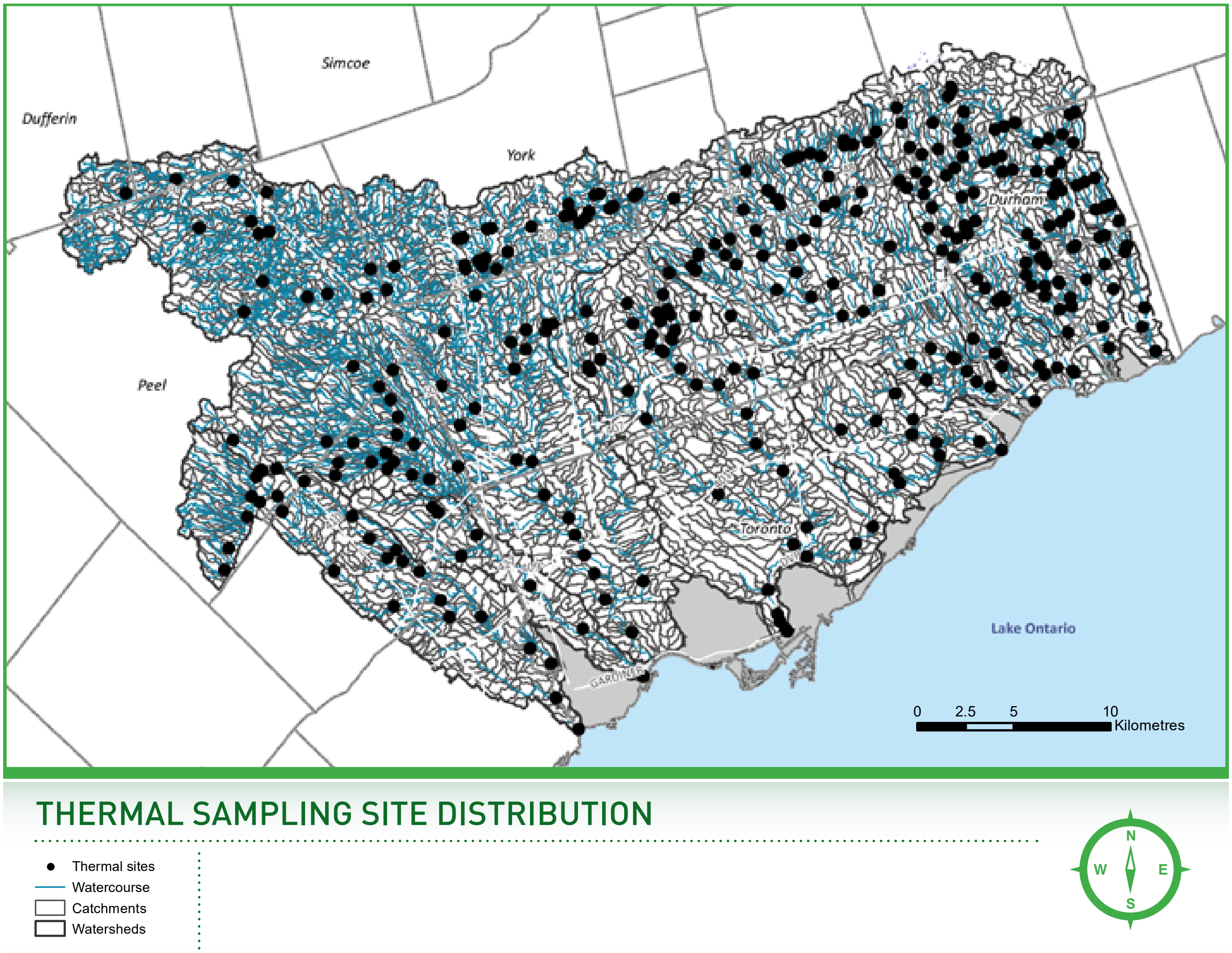
APPENDIX



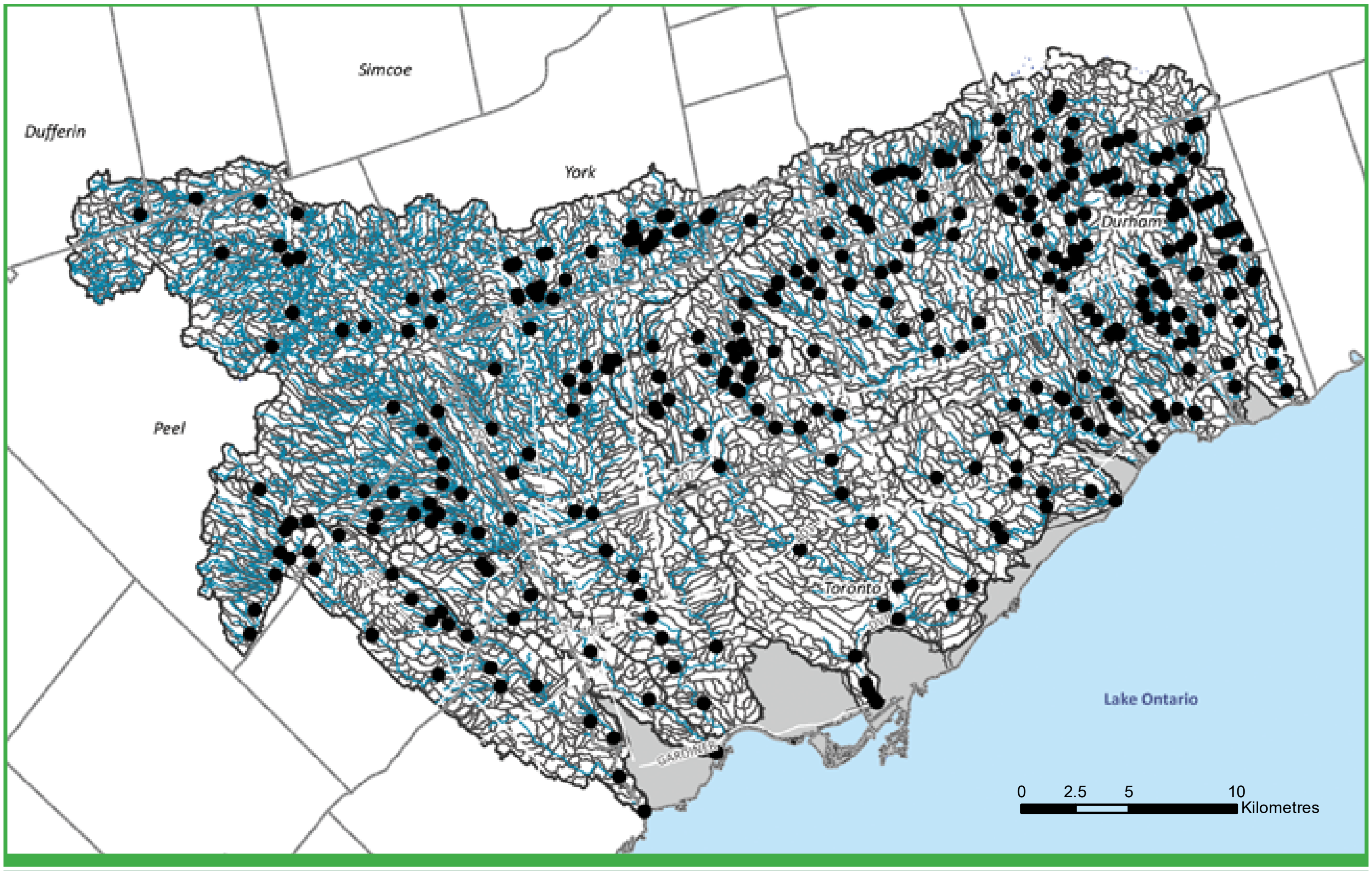
Bond Lake Bioswale Project, TRCA

APPENDIX A:

MONITORING STATION LOCATIONS USED IN IRP FOR WATER QUALITY AND THERMAL DATA



Thermal sampling sites.



WATER QUALITY SAMPLING SITE DISTRIBUTION

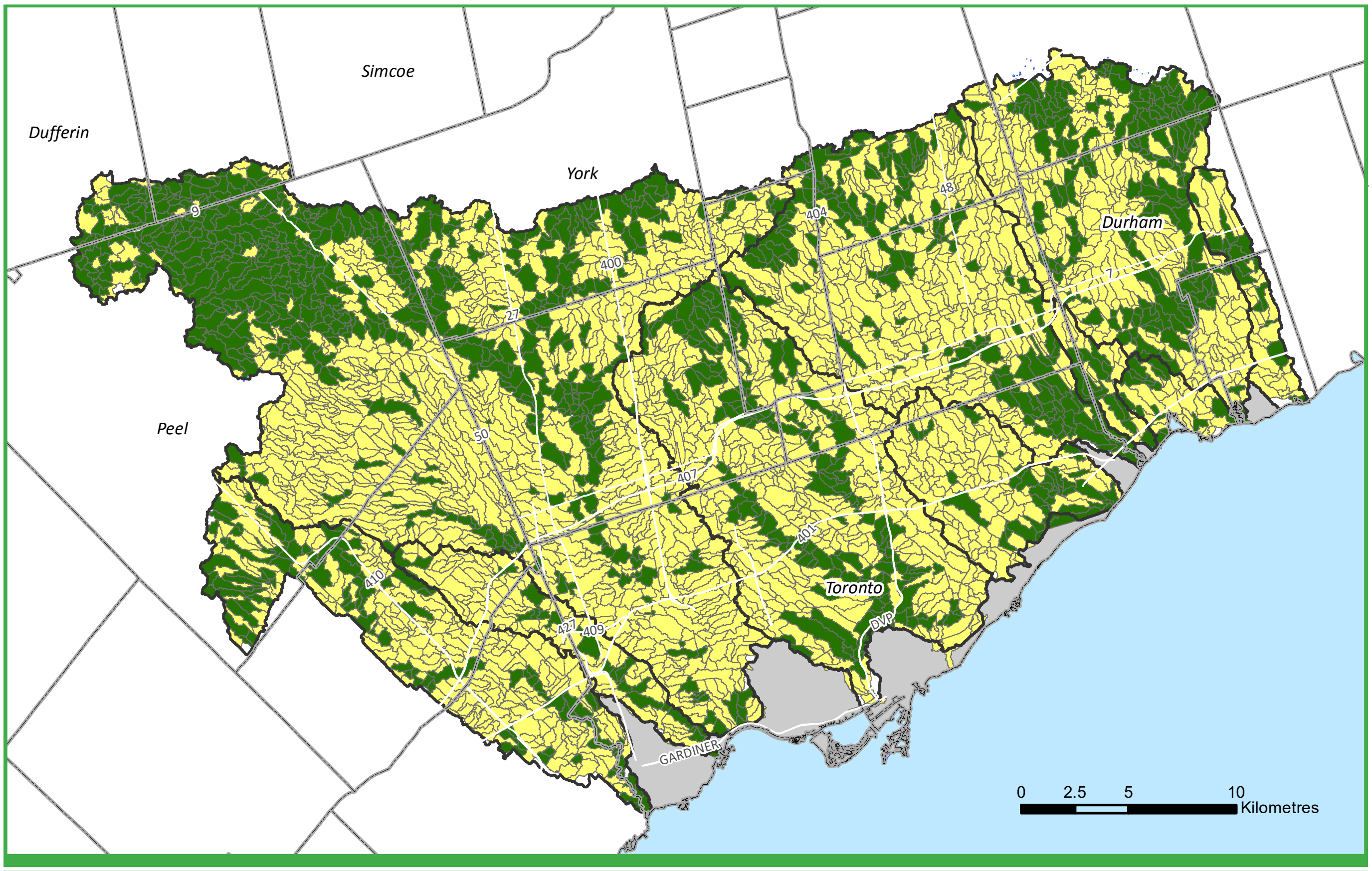
- Thermal sites
- Watercourse
- Catchments
- Watersheds

N W E S

IBI sampling sites.

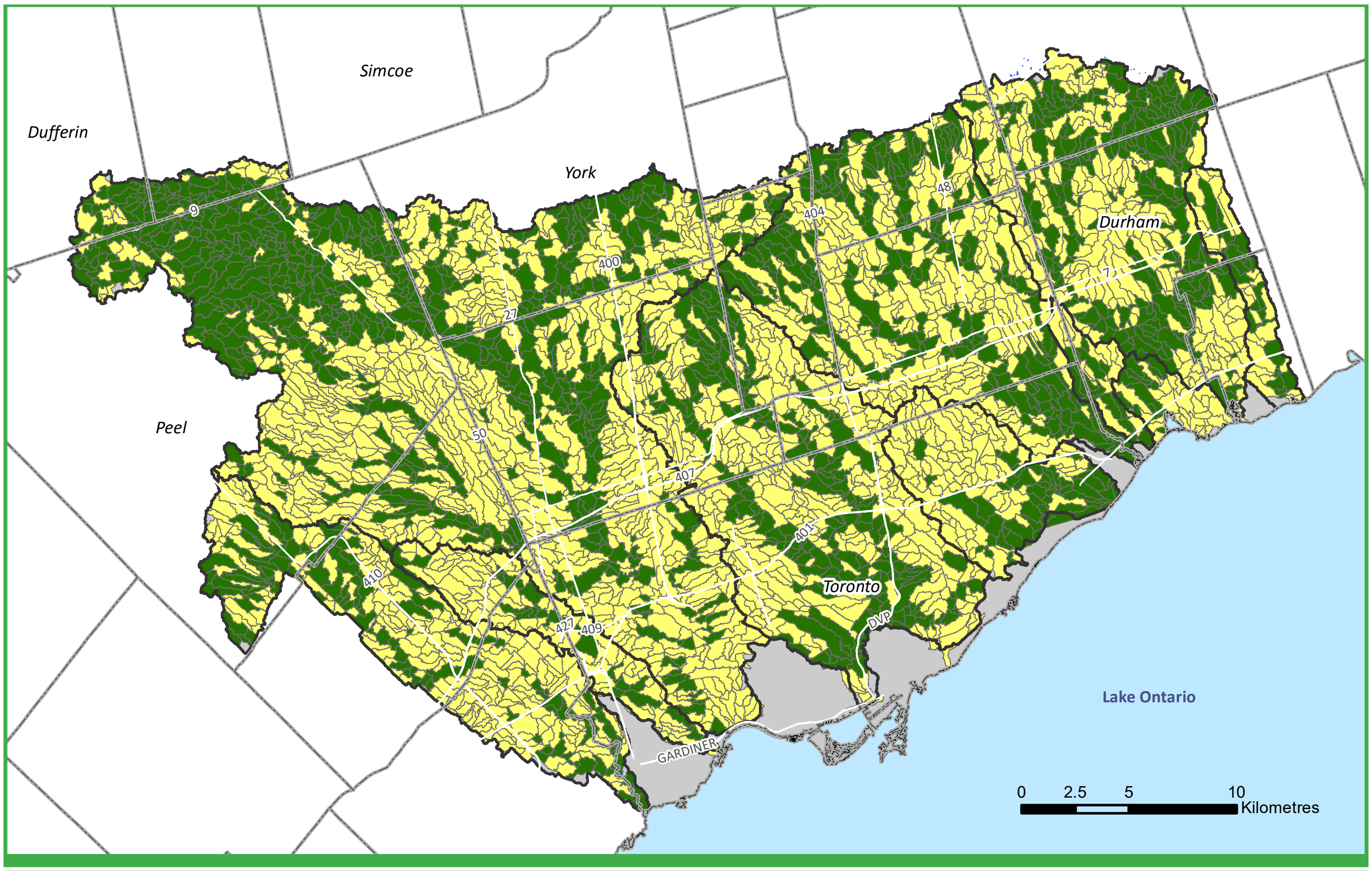
APPENDIX B:

IRP RESULTS FOR THE INDIVIDUAL METRICS



FOREST AND SUCCESSIONAL COVER SCORES AT 30 HECTARE CATCHMENT LEVEL

TRCA catchments (30 ha) with above (1) and below (0) average forest and successional cover within each watershed.



RIPARIAN COVER SCORES AT 30 HECTARE CATCHMENT LEVEL

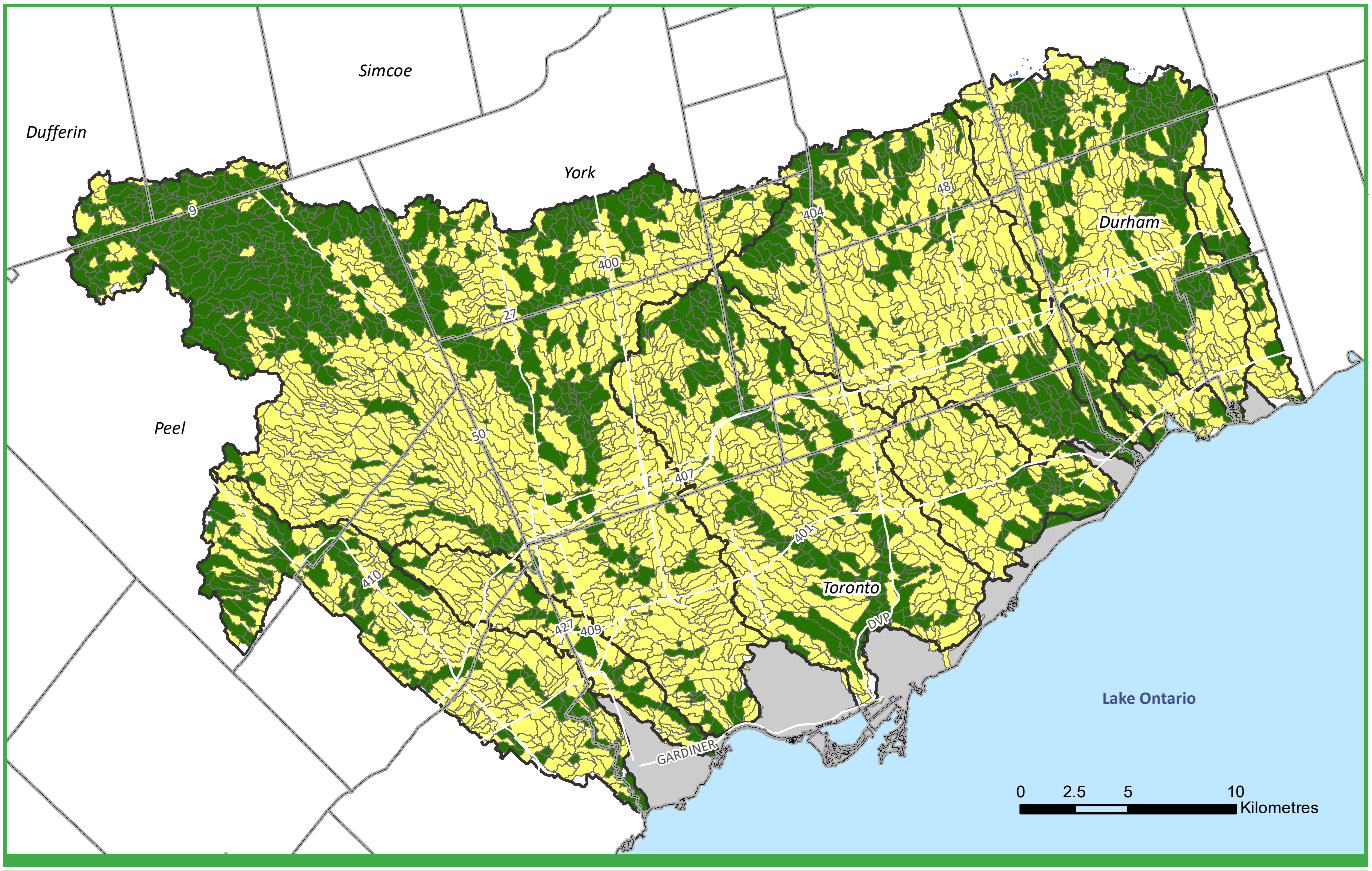
Catchments

Riparian score

0: High Cover

1: Low Cover

TRCA catchments (30 ha) with above (1) and below (0) average riparian cover within each watershed.



WETLAND COVER SCORES AT 30 HECTARE CATCHMENT LEVEL

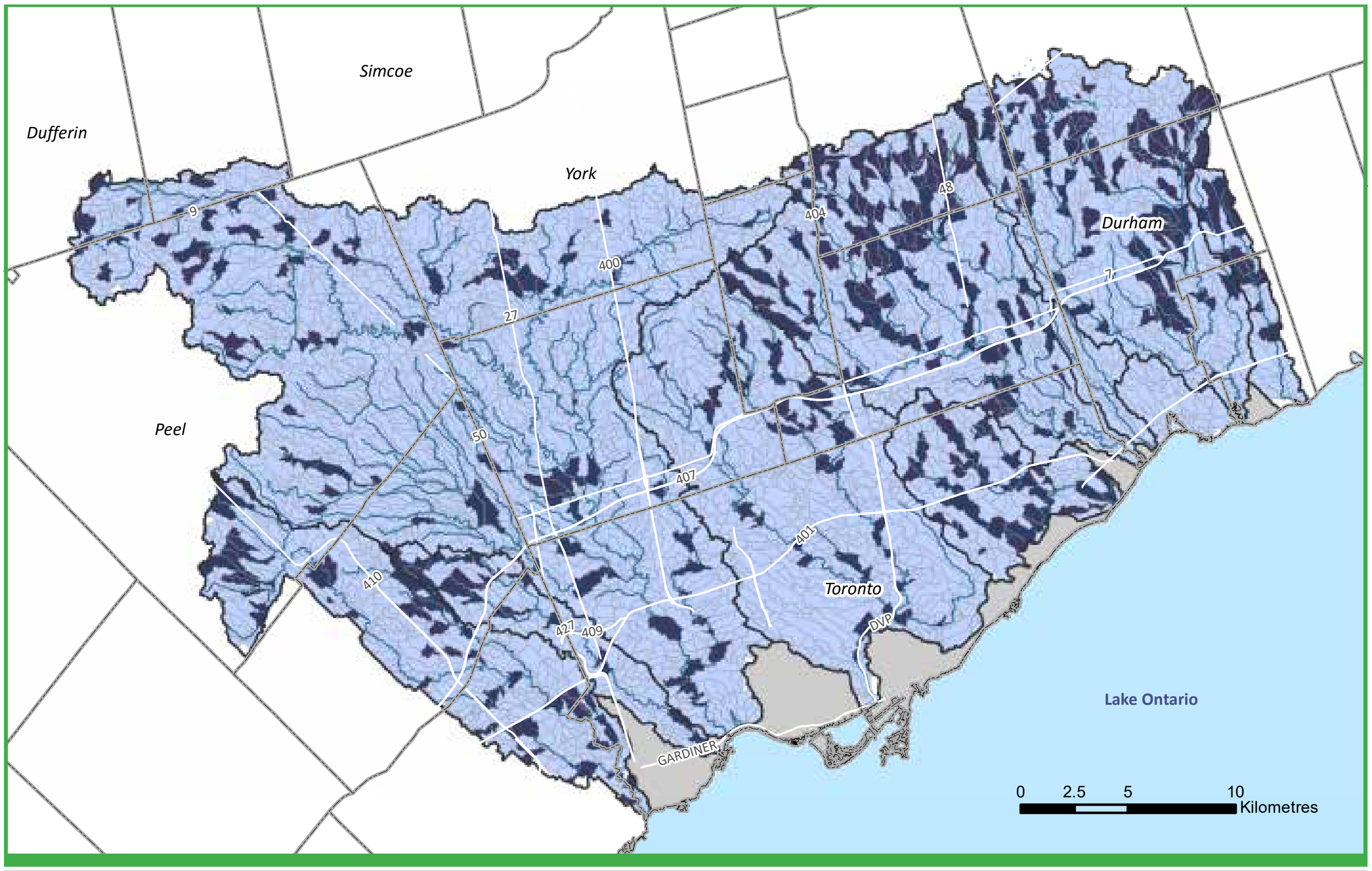
Catchments

Wetland cover

0: High Cover

1: Low Cover

TRCA catchments (30 ha) with above (1) and below (0) average wetland cover within each watershed.



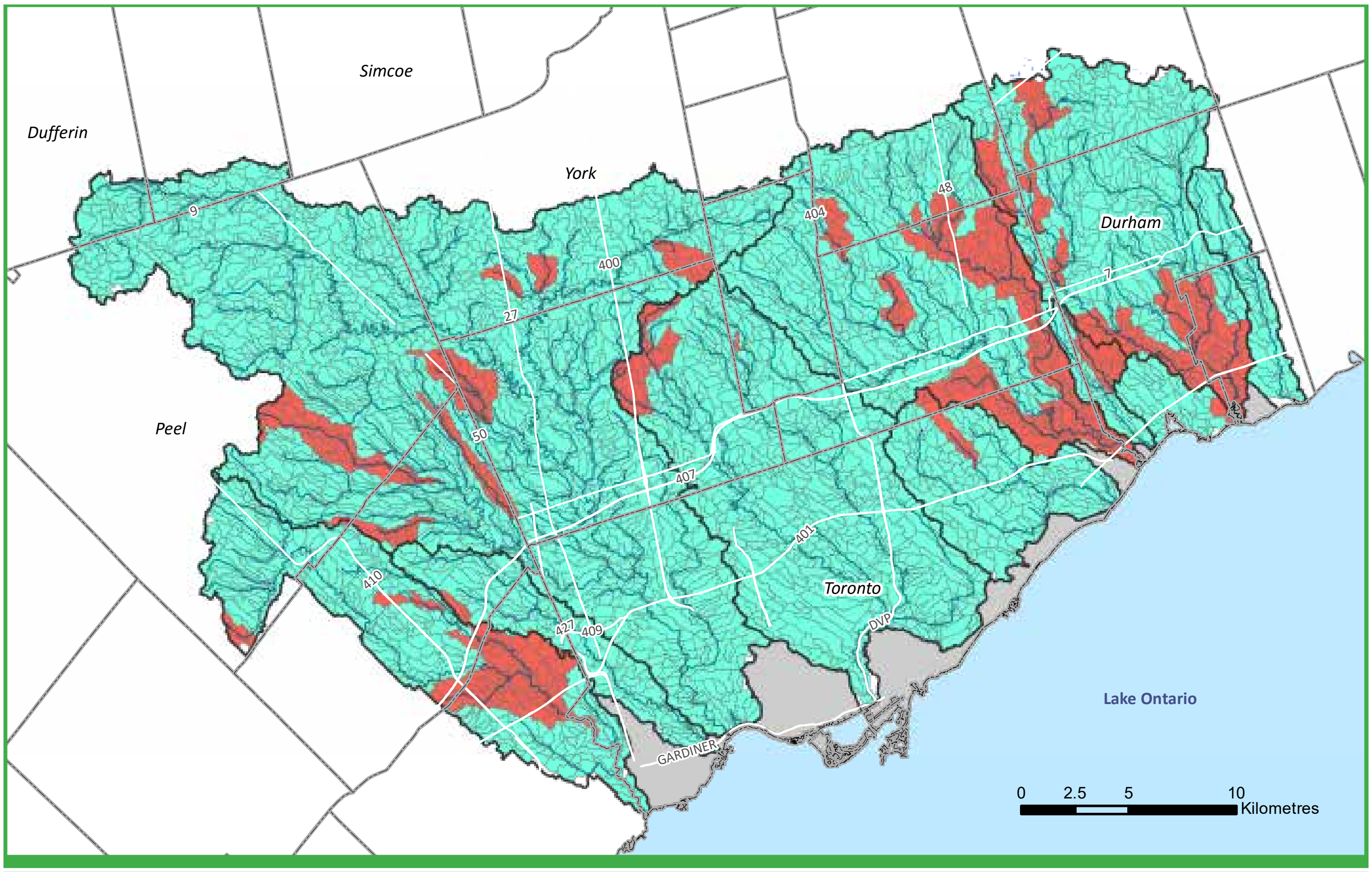
IN-STREAM BARRIER SCORES AT 30 HECTARE CATCHMENT LEVEL

Catchments
Watercourse

Priority Barriers

0: Absent
1: Present

TRCA catchments (30 ha) with one or more (1) and no (0) in-stream barriers within each watershed.



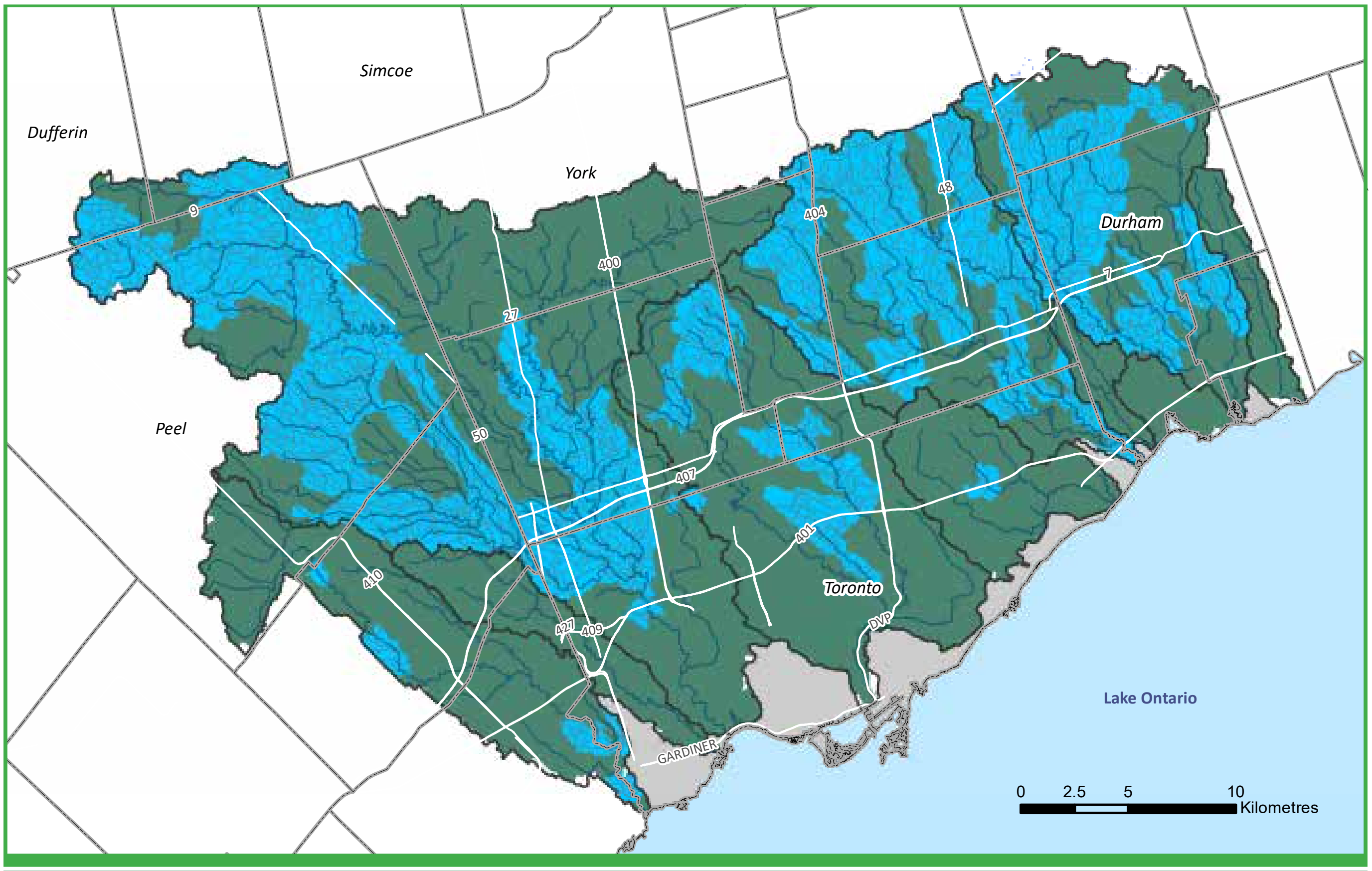
IN-STREAM TEMPERATURE SCORES AT 30 HECTARE CATCHMENT LEVEL

- Catchments
- Watercourse

Thermal regime

- 0: Relatively stable
- 1: Relatively unstable

TRCA catchments (30 ha) with unstable (1) and stable (0) thermal conditions within each watershed.



WATER QUALITY (IBI/FBI) SCORES AT 30 HECTARE CATCHMENT LEVEL

Catchments

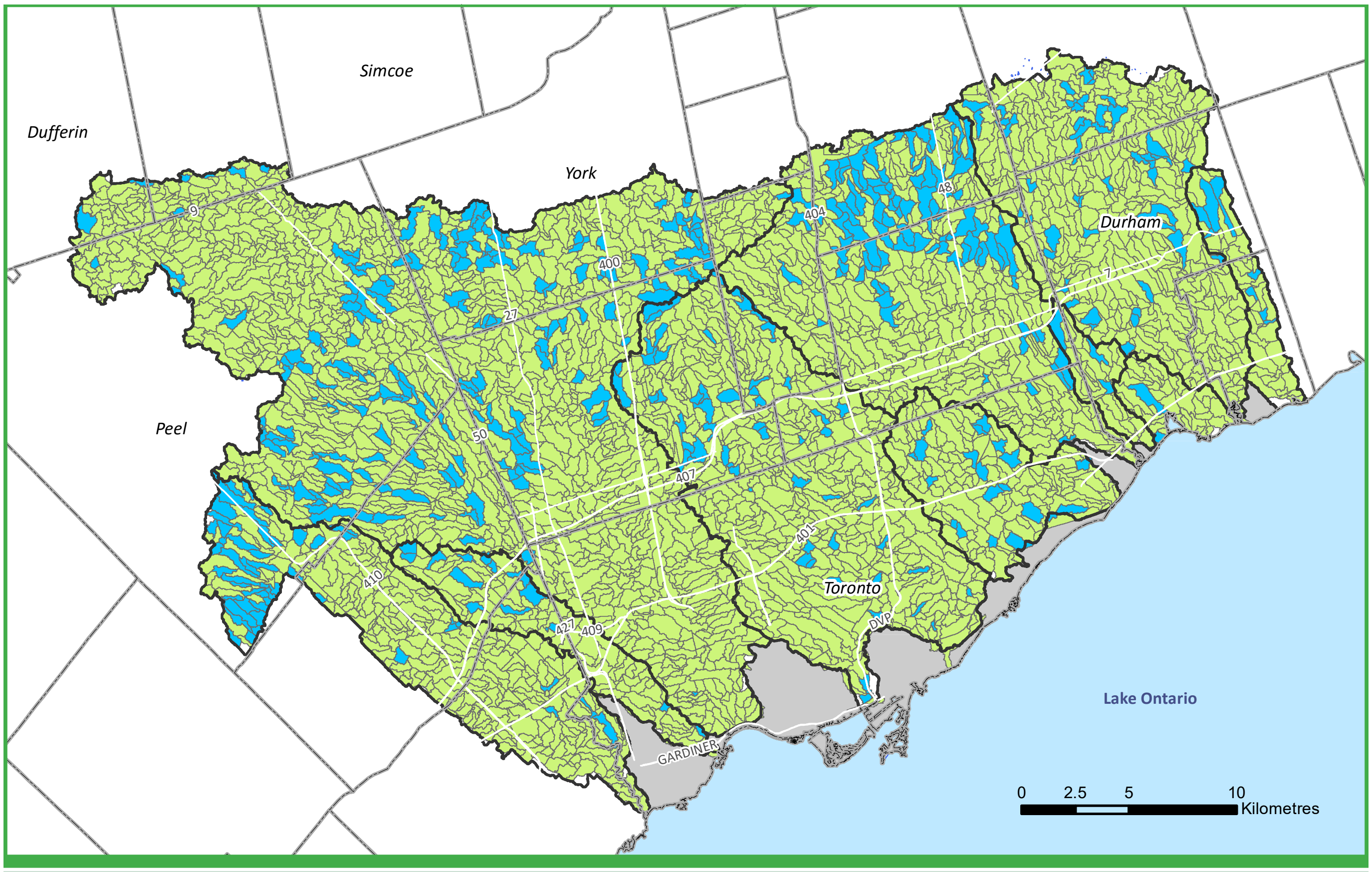
Watercourse

Water quality (IBI/FBI)

0: Relatively good

1: Relatively poor

TRCA catchments (30 ha) with unstable (1) and stable (0) thermal conditions within each watershed.



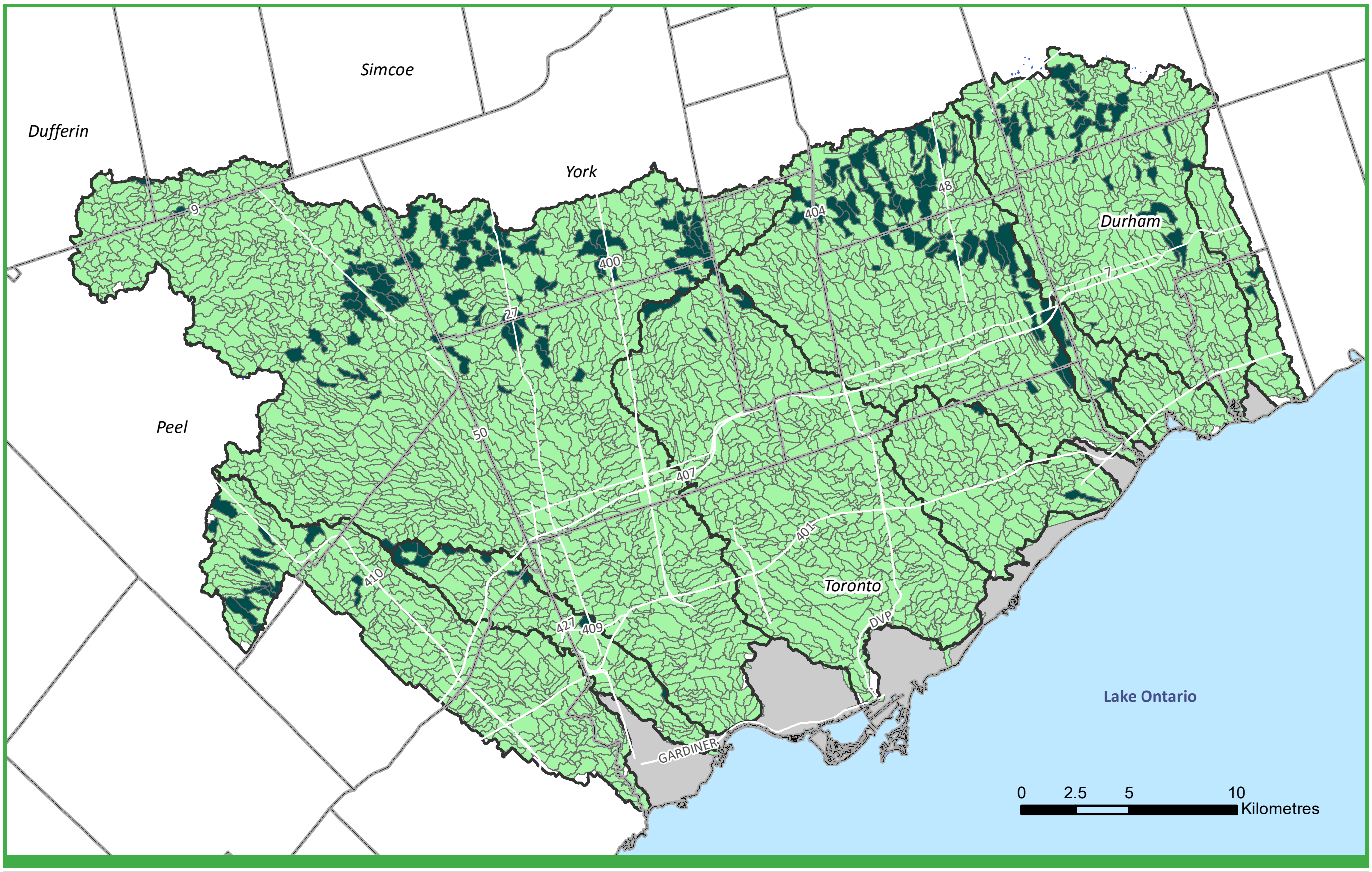
ECOLOGICAL VALUE SCORES AT 30 HECTARE CATCHMENT LEVEL

Catchments

High ecological value, low cover

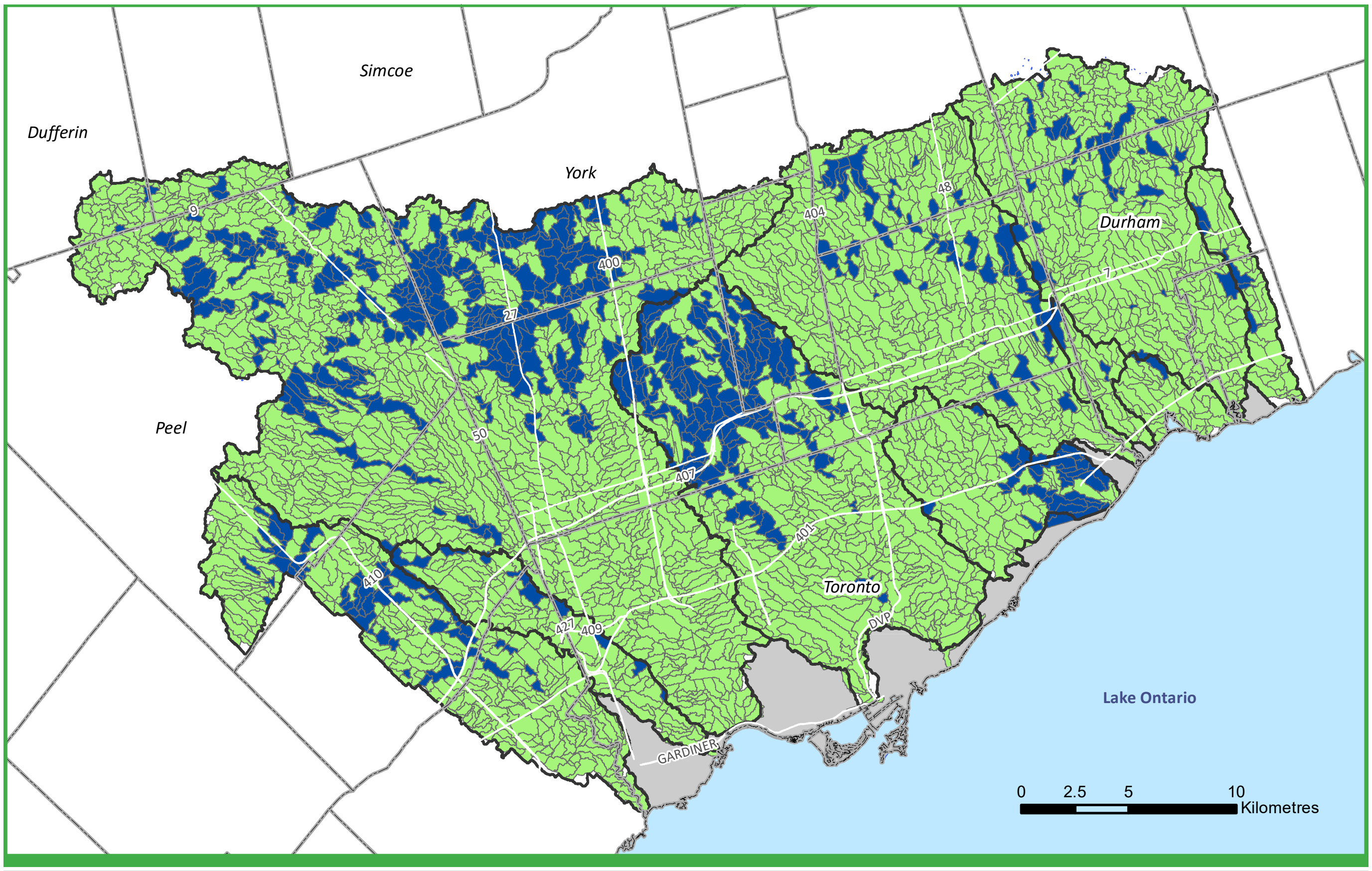
0: Does not meet criteria
1: Meets criteria

TRCA catchments (30 ha) with high average ecological value and low natural cover (1) within each watershed.



TERRESTRIAL CONNECTIVITY SCORES AT 30 HECTARE CATCHMENT LEVEL

TRCA catchments (30 ha) with high value for terrestrial corridor and low natural cover (1) within each watershed.



WETLAND CONNECTIVITY SCORES AT 30 HECTARE CATCHMENT LEVEL

Catchments

Wetland corridors, low cover

0: Does not meet criteria

1: Meets criteria

TRCA catchments (30 ha) with high value for wetland corridor and low natural cover (1) within each watershed.

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