Highland Creek Watershed Greening Strategy

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Prepared in partnership with the City of Toronto

EXECUTIVE SUMMARY

The Highland Creek watershed is facing some daunting challenges, and investments in the watershed are critical to improving its ecological health and human well-being outcomes. Much of the watershed was developed between the 1950s and 1970s, during which time the landscape was quickly and drastically altered. Urbanization and loss of natural cover in the watershed have resulted in impacts on the hydrologic regime, with significant impacts to in-stream flooding and erosion, water quality, and aquatic habitat.

This Highland Creek Watershed Greening Strategy (Highland Greening Strategy) has been developed to support the Highland Creek Geomorphic Systems Master Implementation Plan (HCGSMIP). The HCGSMIP established a framework for undertaking stream restoration projects across the watershed to protect infrastructure from channel erosion and improve aquatic systems and in-stream water quality over approximately two decades. The approach is that the stream restoration project would initially be built, and then the opportunities for additional enhancement of the riparian/terrestrial habitat of the Highland Creek valley system would be implemented. Ideally, the stream restoration and the greening component would be designed in tandem to ensure greening opportunities are not missed. The Highland Greening Strategy has been broadened beyond the scope of the HCGSMIP to include both the valley system as well as tableland opportunities.

While there would be benefits from implementing any greening project within the watershed, the Highland Greening Strategy strategically prioritizes greening opportunities organized around four greening principles focused on natural cover, aquatic habitat, green infrastructure and land securement. Together, these greening principles aim to protect, restore and enhance natural cover and aquatic habitat, optimize the watershed and human-health benefits of greening, and protect and expand the size and connectivity of the natural system, while ensuring that these investments are made efficiently. Site selection criteria for each greening principle were used to identify:

- Priority Greening *Sites* for Greening Principle #1 (Natural Cover) and Greening Principle #2 (Aquatic Habitat); and
- Priority Greening *Areas* for Greening Principle #3 (Green Infrastructure) and Greening Principle #4 (Land Securement), where greening would provide the greatest overall benefit to meet the objective of a particular greening principle.

Overall, the Highland Greening Strategy is intended as a tool to help with planning of greening projects undertaken by the City of Toronto and the Toronto and Region Conservation Authority (TRCA).

To the extent possible within the limits of the study scope, this strategy is intended to be comprehensive and integrated, and to guide municipal greening interests over the next 25 years, or until the strategy is updated or a watershed plan is developed. It is recommended that this strategy be updated 10 years following approval to track progress if a watershed plan is not completed in the intervening years. Greening efforts in the Highland Creek watershed will be driven by a variety of projects ranging from those intended to broadly improve watershed health, human well-being, and community engagement, to projects that are intended to compensate for loss or alteration of specific ecological habitats. This strategy outlines a transparent and strategic approach for identifying the best locations for greening, and some constraints, along with preliminary details to guide the type of greening project that should occur there. Opportunities for implementation will coincide with environmental assessments associated with implementing the City of Toronto's Wet Weather Flow Master Plan (WWFMP) and the HCGSMIP.

The strategy will also support the objectives of the Toronto Ravine Strategy and other City of Toronto initiatives. It willalso promote further greening opportunities as redevelopment and public infrastructure renewal (e.g. through enhancements, offsets and/or ecosystem compensation) occurs throughout the watershed to protect ecological function and resilience. Ultimately, any chosen sites would need to undergo more detailed site assessment and require coordination between city and TRCA staff and local councillors where appropriate prior to implementation.

HOW TO READ THIS DOCUMENT

The Highland Greening Strategy consists of four sections, a glossary, references, and two appendices. The following is a brief overview of what information is provided in each section.

Section 1: Introduction

An introduction provides an overview of the context and rationale for developing a greening strategy for the Highland Creek watershed.

Section 2: Guiding Principles

Outlines the approach to prioritizing watershed greening, identifies the four greening principles, an explanation of why each greening principle is needed for the Highland Creek watershed, and site selection criteria that guide the selection of greening opportunities.

Section 3: Greening Opportunities

Identifies the top 10 Priority Greening Sites for Greening Principle #1 (Natural Cover) and Greening Principle #2 (Aquatic Habitat), as well as Priority Greening Areas for Greening Principle #3 (Green Infrastructure) and Greening Principle #4 (Land Securement).

Section 4: Implementation of Greening Opportunities

Lists and describes important considerations for planning and implementing greening projects in the Highland Creek watershed.

Glossary: Provides definitions of terms used in the Highland Greening Strategy.

References: Lists documents sourced in the development of the Highland Greening Strategy.

Appendix A: Provides additional site-level information for Priority Greening Sites and all potential restoration opportunities.

Appendix B: Consists of a hydraulic modelling exercise conducted to determine the impacts of planting riparian vegetation along the channelized sections of Highland Creek and its tributaries. The results of this analysis can be used to inform where and how riparian plantings may be undertaken without exacerbating existing flood lines.

Highland Map Viewer

This is an interactive map viewer that displays Priority Greening Sites, or Areas, for each greening principle, along with data layers used in the selection process. This map viewer is intended for use by Toronto and Region Conservation Authority (TRCA) and City of Toronto staff with planning, coordination and implementation of greening projects in the Highland Creek Watershed.

Note: If you are unable to access the hyperlink for the map viewer, please contact a staff member of TRCA's GIS group, or email info@trca.ca requesting the access link to the Highland map viewer.

The Map Viewer can be used to:

1. Find the Highland Creek Watershed Greening Strategy, which is on the welcome page.
2. Explore Greening Principle # 1: Natural Cover, to zoom in on each of the priority sites for this principle
3. Explore Greening Principle #2: Aqautic Habitat, to zoom in on each of the priority sites for this principle
4. Explore Greening Principle #3: Green Infrastructure, to zoom in on each of the priority sites for this principle
5. Explore Greening Principle #4: Land Securement, to zoom in on priority areas for this principle
6. Explore all data layers for each principle, data layers used for site selection and all supporting data layers

The viewer is designed to be intuitive allowing the user to select which data layers they wish to view and print maps accordingly. Below is a screenshot of Greening Principle #2: Aquatic Habitat selected from the left sidebar and the legend selected on the right sidebar.

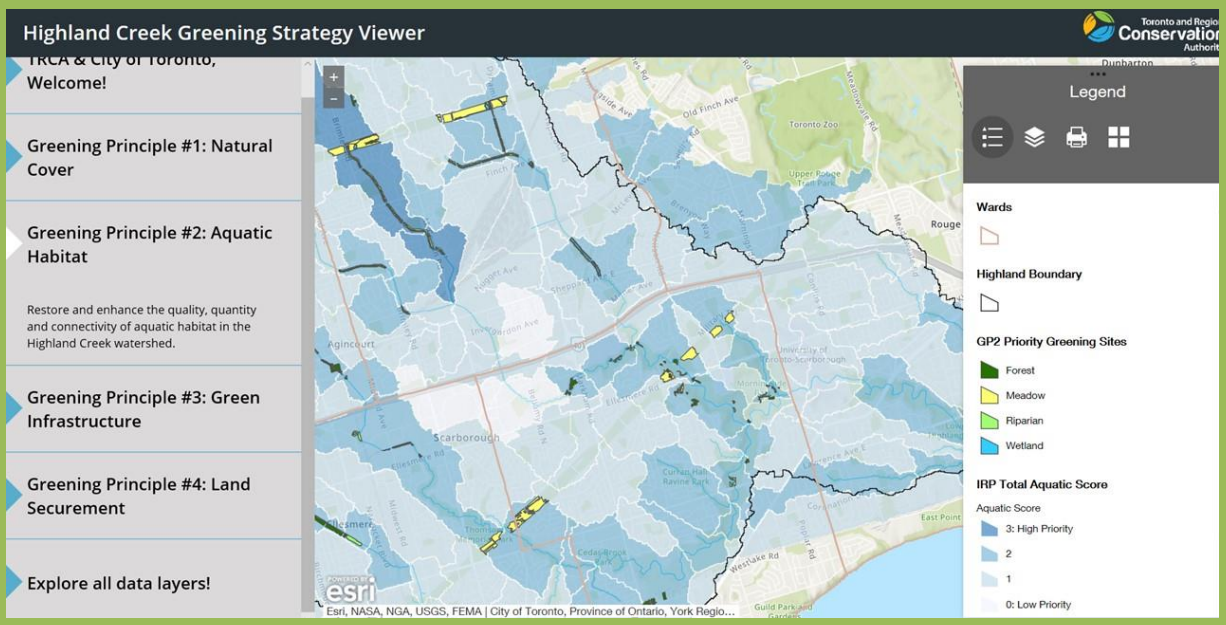


Table of Contents

List of Figures

List of Tables

ACRONYMS

DFO	Department of Fisheries and Oceans
FBI	Family Biotic Index
FVC	Flood Vulnerable Cluster
HCGSMIP	Highland Creek Geomorphic Systems Master Implementation Plan
IBI	Index of Biotic Integrity
IRP	Integrated Restoration Prioritization
LCA	Life Cycle Assessment
LEAF	Local Enhancement and Appreciation of Forests
ROP	Restoration Opportunities Planning
SNAP	Sustainable Neighbourhood Action Program
STEP	Sustainable Technologies Evaluation Program
TRCA	Toronto and Region Conservation Authority
WSE	Water Surface Elevation
WWFMP	Wet Weather Flow Master Plan

1. INTRODUCTION

The Highland Greening Strategy identifies Priority Greening Sites that strategically and transparently prioritize greening opportunities within the Highland Creek watershed. Priority Greening Sites are organized around four Greening Principles that focus on natural cover, aquatic habitat, green infrastructure and land securement. These principles collectively aim to help protect, restore and enhance natural cover and aquatic habitat, optimize watershed health, contribute to social well-being through community greening, and increase the size of the natural system through land securement.

This Strategy is primarily focused on increasing habitat quantity through the identification of areas for additional wetland, riparian, forest or meadow habitat. The Strategy can be used by TRCA and the City of Toronto when looking for beneficial restoration projects and how to coordinate them with other works in the Highland Creek watershed (i.e. City of Toronto Ravine Strategy). The City of Toronto Ravine Strategy has identified a significant portion of the Highland Creek watershed as two of its Priority Investment Areas. The key difference between this Strategy and the Ravine Strategy, is that the Highland Greening Strategy is focused on habitat quantity, whereas the Ravine Strategy is a more broadly-focused framework that aims to ensure a healthy, resilient ravine system that connects people with nature. The Priority Investment Areas of East Highland Creek and Morningside Park, and Lower Highland Creek identified in the City's Ravine Strategy have a high percentage of natural cover compared to other parts of the Highland Creek watershed and were therefore not prioritized by TRCA for restoration opportunities as part of this Strategy. These two Strategies are complementary and will both provide significant benefits to the Highland Creek watershed (see **Subsection 4.1** for more information on the complementary nature of the Ravine Strategy).

Greening efforts in the Highland Creek watershed will be driven by a variety of projects ranging from those intended to improve overall watershed health, or to compensate for the loss or alteration of specific ecological habitats, to projects focused on promoting landowner stewardship and engaging the local watershed community in nature appreciation. This strategy outlines considerations that should be applied to ensure that projects are coordinated appropriately, and advice and direction to help guide the planning of greening projects at the site level.

To the extent possible within the limits of the study scope, the Highland Greening Strategy is intended to be comprehensive and integrated, and to guide municipal greening interests over the next 25 years, or until an updated strategy or watershed plan is developed. It is recommended that this strategy be updated 10 years following approval to track progress if a watershed plan is not completed in the intervening years. It is important to recognize that this strategy may not be able to address all issues related to the aquatic ecosystem, stormwater management, and natural hazards (i.e. flooding and erosion) within the watershed due to the limitations of available information in advance of the completion of a comprehensive watershed plan[1]. The Highland Greening Strategy will serve as a bridging document to guide the selection of greening opportunities until a watershed plan is developed for Highland Creek. The best available information was used in developing this strategy, some of which may not be current.

[1] Watershed plans are documents that comprehensively integrate watershed issues and strategically prioritize actions that are needed to address these issues.Toronto and Region Conservation Authority (TRCA) is currently developing the next generation of its watershed planning program, which will identify the scope and schedule of future watershed plans.

1.1. Background and Context

Urbanization and Resulting Watershed Issues

The Highland Creek watershed is one of the most urban of the nine watersheds in TRCA's jurisdiction and is contained largely within the City of Toronto. Much of the watershed was developed between the 1950s and 1970s, during which time the landscape was quickly and drastically altered. Planning practices during this time prescribed that tablelands were for built form and floodplains contained within valleylands should be brought into public ownership. This led to a number of impacts to the aquatic and terrestrial systems within the watershed, as detailed in **Table 1**.

In order to prevent small wastewater treatment plants from discharging into rivers within the city and improve riverine oxygen concentrations, trunk gravity sewers were built in valleylands to convey wastewater to regional treatment plants, located on the Lake Ontario waterfront. This permitted small local wastewater treatment plants to be decommissioned. The sewers, watermains and utilities that were required to support development criss-crossed the valleys and paralleled the creek itself. Many headwater sections of Highland Creek were straightened, following existing rural municipal drains where they existed, and its tributaries hardened. Stormwater was not managed, riparian areas were lost, and on the tablelands agricultural fields and natural cover, such as forests and wetlands, were replaced with sprawling low-rise subdivisions and strip malls. In turn, the fishery of the Highland Creek watershed that once supported Atlantic Salmon has become severely impaired.

Table 1 - Existing Watershed Conditions

Key Watershed Issues	Sub-Issue	Existing Conditions
Aquatic Habitat	Imperviousness	Average of 55.1% imperviousness across the Highland Creek watershed[2].
	Riparian Corridor (30 meter buffer on each side of stream)	Approximately 39.9% natural cover within the riparian corridor of Highland Creek[3]. This compares to an average of 51.2% across TRCA's watersheds.
	Aquatic Barriers	See Highland Map Viewer for data layer of instream barriers.
Terrestrial Habitat	Natural cover	Approximately 9.9% natural cover throughout the watershed; consisting of 5.9% forest, 0.3% wetland, 3.0% meadow and 0.6% successional. This is one of the lowest levels of natural cover in TRCA's jurisdiction.

[2] Significant impairment in stream water quality and quantity is highly likely above 10% impervious cover and can often begin before this threshold is reached. In urban systems that are already degraded, a second threshold is likely reached at the 25 to 30% level.

[3] Higher amounts of riparian natural cover convey the greatest overall benefit to biodiversity and aquatic ecosystem health.

Key Watershed Issues	Sub-Issue	Existing Conditions
		See **Figure 1** for a map of existing natural cover.
	Habitat quality	Average quality condition of poor (L4) based on Landscape Analysis Model (LAM)[4]. Rating scale: Excellent (L1), Good (L2), Fair (L3), Poor (L4), Very Poor (L5). Approximately 600 hectares of habitat is poor (L4), 417 hectares is very poor (L5), and 30 hectares is fair (L3).
Water Quality	Parameters of Concern	Water quality data for this watershed show that chlorides, dissolved oxygen, *E. coli*, and total phosphorus often do not meet established water quality guidelines. The Water Quality Index (WQI)[5] for Highland Creek is 31.8, which corresponds to a poor rating. Rating Scale: 0 – 44 = poor, 45 – 64 = marginal, 65 – 79 = fair, 80 – 94 = good, 94 – 100 = excellent
Natural Hazards	Flooding	The Highland Creek watershed contains three Flood Vulnerable Clusters (FVC)[6]: • Progress Business Park – located on the Markham branch of the East Highland Creek between Finch Ave E and Bellamy Rd N at Corporate Drive. Ranked[7] **7 out of 41** for FVC's within TRCA's jurisdiction. • Kennedy Commons – located on the Bendale branch of the West Highland Creek from Sheppard Ave E south to McCowan Rd. Ranked **13 out of 41**. • Dorset Park – located on the Dorset Park branch of the West Highland Creek near Birchmount Rd and Ellesmere Rd, and west of Midland Ave at Lawrence Ave. South properties at risk farther downstream at Brimley Rd. Ranked **17 out of 41**.

[4] The LAM is based on principles of landscape ecology and uses a GIS based technique to summarize the quality of all habitat patches based on their size, shape and impacts from surrounding land uses (i.e. matrix influence).
[5] The WQI is a tool for summarizing water quality conditions from multiple parameters into a single measure of water quality per site. The WQI represents the number of parameters that exceed their guidelines, as well as the frequency and magnitude of those exceedances. Score on a scale of 0 – 100, with higher values indicating higher water quality.
[6] A FVC is a sub-area within the regulatory storm flood plain that contains multiple existing structures and/or roads for which a single, comprehensive flood remediation approach may be viable.
[7] FVC rankings are determined based on weighting of four categories, availability of data, and stakeholder input. The four categories are: building related damages (e.g. dollar value structure and content damages) accounting for 50% of total risk score, community impacts (e.g. institutional buildings such as schools and recreation facilities) accounting for 10% of total risk score, social vulnerability (e.g. demographic factors such as age, income, housing tenure) accounting for 20% of total score, and disruption to infrastructure (e.g. roads) accounting for 20% of total score.

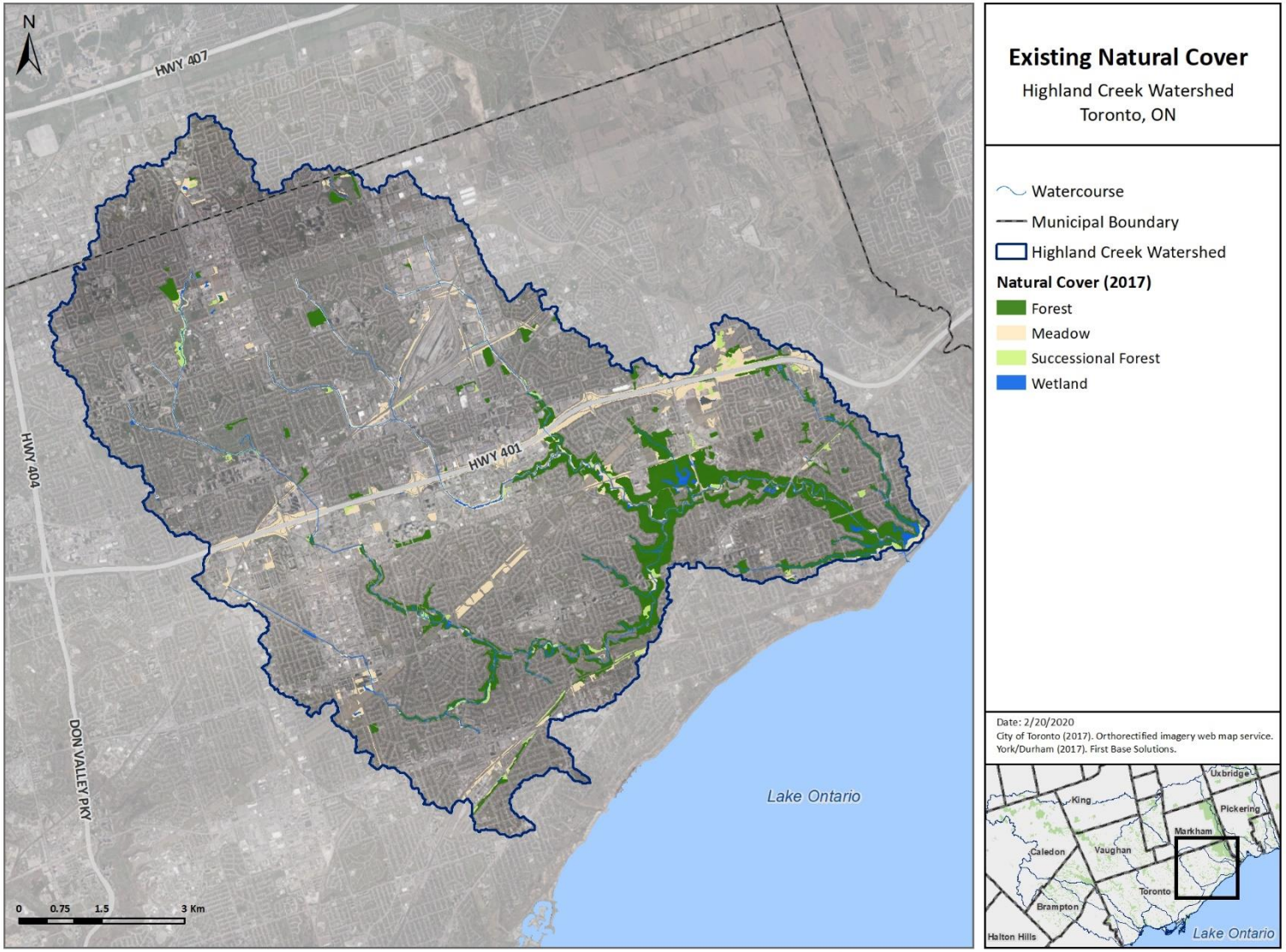


Figure 1 - Existing Natural Cover

Wet Weather Flow Master Plan

By the 1990s, scientists were beginning to understand the impacts of urbanization and loss of natural cover on the hydrologic regime, with predictable impacts to in-stream flooding and erosion, water quality, and aquatic habitat. Recognizing these impacts, the City of Toronto embarked on a substantial study of wet weather flow, which included stormwater and combined sewer overflows. The WWFMP identified Highland Creek as a priority watershed. Additionally, during this period, more robust climate change modelling was painting a clearer picture of how significant increases in carbon dioxide and other greenhouse gasses were causing our global climate to change and it was predicted that these changes would impact our planet. In urban centres, such as Toronto, significant and predictable impacts included heat stress, and alterations to flooding and erosion, in addition to the impacts of urbanization to which the city's watercourses were still adjusting.

The WWFMP examined the ability of stormwater management methods to mitigate the effects of urbanization on the hydrologic cycle, following the hierarchical principle of managing stormwater first at the source, secondly through conveyance, and finally at the end of the pipe. It concluded that stormwater management measures on the tableland had some benefits, but that direct intervention using stream restoration projects were necessary to reduce erosion and improve the geomorphic conditions and biophysical habitats of Highland Creek. The study recommended that, where feasible, elements of stream restoration should include enlarged channels and changes in channel sinuosity based on the principles of natural channel design, to accommodate the increased flows caused by urbanization.

The WWFMP recognized that ecological function in the Highland Creek watershed should be improved. In the 1990s, TRCA, the City of Scarborough and the Ministry of Natural Resources worked together to develop the *Draft Highland Creek Watershed Fisheries Management Plan*. The Highland Creek Fisheries Management Plan confirmed that stormwater management measures alone would be insufficient to meet the fish habitat and community targets, and that in-stream measures would be needed. The Fisheries Management Plan conceptually identified numerous in-stream works that emphasized fish barrier removal, riparian plantings and habitat enhancements coincident with major channel works. Restoration projects were often completed in conjunction with the environmental assessment and emergency repair projects needed to secure the existing infrastructure.

Highland Creek Geomorphic Systems Master Implementation Plan

Subsequent to completing the WWFMP, the City of Toronto initiated a number of environmental assessments to improve the geomorphic stability of the Highland Creek watershed and address at-risk infrastructure. Around the same time, multiple emergency repairs were undertaken as infrastructure was close to the point of failure or had already failed. Significant brainstorming among staff at the City of Toronto, TRCA, the Ministry of Natural Resources and Forestry, and the Department of Fisheries and Oceans (DFO), regarding a long-term solution for Highland Creek, resulted in the consulting company Aquafor Beech being hired by the City of Toronto to build on the recommendations of the WWFMP through the development of the HCGSMIP. The HCGSMIP was the first attempt by the City of Toronto, and perhaps the first Canadian municipality, to take a watershed-based approach to developing this type of urban watercourse restoration plan. The plan was intended to simultaneously address the

combined objectives of infrastructure protection and replacement, and aquatic and terrestrial habitat enhancement[8] in a valleyland setting.

Based on the leadership of DFO, and other partners, a complementary Master Plan Environmental Assessment study was undertaken by Parish Geomorphic in parallel to the HCGSMIP for a valley segment of the Highland Creek watershed known as VS4/4a. By focusing on a defined geographic area within the watershed, the VS4/4a study developed a solution for 1.6 km of the Markham Branch of the creek where there had been multiple repeat exposures of the sanitary trunk sewer during the 1990s and 2000s. The solution involved using the principles of natural channel design, expanding the channel width by 2-3 times, decreasing the channel sinuosity to avoid valley wall contacts, and required the removal of a large number of trees due to the larger channel footprint. The restoration works resulting from the VS4/4a study were completed between 2011 and 2015.

Simultaneous to initiating the HCGSMIP and VS4/4a studies, on August 19, 2005, a significant storm centred on the northern part of the Highland Creek watershed in the cities of Markham and Toronto caused significant levels of flooding and erosion. Over the course of three days, which was the time it took for the runoff event to subside, Highland Creek moved laterally one to several meters at multiple locations, and a large sanitary trunk sewer paralleling the creek in Morningside Park broke. Sewage spilled into the river, flowing into Lake Ontario, resulting in an emergency containment and repair.

The HCGSMIP established a new methodology for managing this alpine-like river, with its sandy substrates and flashy flows. To protect the infrastructure, not only did the stormwater need to be managed, but the vertical and lateral channel migration had to be controlled in a manner that allowed for natural channel migration and protected the existing infrastructure. The HCGSMIP established a framework for undertaking stream restoration projects across the watershed to protect infrastructure from channel erosion and improve aquatic systems and in-stream water quality over approximately a two decade time frame. Working to protect the most vulnerable sections of infrastructure first, the HCGSMIP recommends that reaches or valley segments be studied in more detail, and mitigated following a prescribed methodology. Because the stream power of Highland Creek, particularly downstream of Hwy 401 is equivalent to that of an alpine (i.e. Canadian Rocky Mountain) river system, specific stream design methodologies are needed to mitigate this extreme erosive power.

Towards a Riverine Fish Habitat Model for Highland Creek

Paralleling work on the HCGSMIP, Golder Associates undertook a modeling exercise: Towards a Riverine Fish Habitat Model for Highland Creek. The study was intended to build on the Fisheries Management Plan and develop a restoration implementation methodology for ensuring that the long-term fish community targets developed and established as part of the Fisheries Management Plan would be achieved. At this same time, TRCA and the City of Toronto further recognized that restoring ecological function to the watershed required attention to not only the in-stream and riparian habitats, but the forests and meadowlands as well. The *Toronto Ravine Strategy* further confirmed that significant investment in stream geomorphology, infrastructure maintenance and improvements, and ecosystem restoration for the watershed is a priority.

[8] It is the premise of the HCGSMP that instream restoration constructed on a reach or longer basis will provide a significant benefit to restoration of aquatic habitat. The focus is the biophysical component of aquatic habitat rather than the biochemical basis.

Path Forward for the Highland Creek Watershed

The City of Toronto's commitment to restoring the watershed's ecosystem through the Highland Greening Strategy dates back to the WWFMP, and the original emergency repair works of the large sanitary sewer following the storm event in 2005. Since the time that TRCA agreed to develop the Highland Greening Strategy, climate change knowledge has improved, additional studies of the watershed have been completed, and strategies for restoration and remedial action have been developed. Green infrastructure, the Ravine Strategy, greenspace planning, stream geomorphology, and ecosystem restoration opportunities have now all converged. The Highland Greening Strategy is meant to complement and support existing strategies and plans by strategically prioritizing greening opportunities within the watershed.

Operationally, the approach is that the stream restoration project associated with the HCSGMIP would initially be implemented, followed by additional enhancement of the riparian and terrestrial system of the Highland Creek valley system according to the priorities identified in this strategy. This Highland Greening Strategy also includes greening opportunities and priorities in tableland areas. Within the City of Toronto, the Highland Greening Strategy will be especially beneficial to Parks, Forestry and Recreation division staff.

2. GUIDING PRINCIPLES

It is clear that the Highland Creek watershed is facing some daunting challenges, and investments in the watershed are critical to improving its ecological health and human well-being outcomes. While there would be benefits from implementation of any greening project within the watershed, a series of greening principles and site selection criteria have been developed to guide the selection of Priority Greening Sites to ensure that these investments are efficiently made, and that projects are:

1. Prioritized transparently;
2. Undertaken strategically to maximize benefits and build ecosystem resilience to the ongoing impacts of urbanization and climate change;
3. Coordinated appropriately with other projects to ensure that they occur in the appropriate order; and
4. Developed to adequately compensate for ecological impacts from current or planned future infrastructure and public use works within the watershed.

2.1 Approach to Prioritizing Watershed Greening

As part of its role in managing watersheds, TRCA has developed a number of strategies and plans for improving watershed conditions throughout its jurisdiction. Some of the key strategies and plans include:

- *Watershed plans* which assess overall watershed conditions and stressors and then identify and prioritize measures to protect, restore or enhance the health of the watershed.
- *Fisheries Management Plans* also assess watershed conditions and stressors and recommend priority actions to improve these conditions with a focus on the management of the aquatic ecosystem.
- The target *Terrestrial Natural Heritage System Strategy* was developed for TRCA's jurisdiction in 2007 in response to the continued loss of biodiversity and natural cover. This system comprises both existing and potential natural 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. Refinements to the Terestrial Natural Heritage System were made at the watershed scale as part of the Highland Greening Strategy and can be viewed through the Highland Map Viewer.

While a watershed plan or Fisheries Management Plan is not currently in place for the Highland Creek watershed, much is known about the watershed through TRCA's routine monitoring programs and data collection. Using priorities from some of the key TRCA strategies as the foundation, TRCA's approach to watershed greening includes layering priorities with identified restoration opportunities to prioritize greening opportunities in the Highland Creek watershed. Implementation of greening opportunities will provide water management, climate resilience, aquatic habitat, natural cover, and community well-being benefits.

Integral to the prioritization of watershed greening projects in Highland Creek are the innovative approaches TRCA has developed to strategically guide decisions on restoration planning throughout its jurisdiction. The Integrated Restoration Prioritization (IRP) framework identifies priority catchments across TRCA's watersheds where restoration efforts would provide the greatest number of benefits to

aquatic and terrestrial ecological functions based on the priorities outlined in TRCA's key strategies and plans. From these priority catchments, restoration projects can be further prioritized using the Restoration Opportunities Planning (ROP) database that identifies on-the-ground details and opportunities.

Integrated Restoration Prioritization Methodology[9]

TRCA designed the IRP methodology to provide a watershed perspective to site level restoration planning through the consideration of multiple objectives related to terrestrial and aquatic ecosystem health. IRP uses a comprehensive, consistent and repeatable framework to help guide restoration planning by prioritizing catchments based on the following objectives:

1. 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. Restore and/or increase natural cover (i.e. forest, meadow, riparian and wetland);
3. Maximize size, shape and connectivity of natural heritage features and areas;
4. Enhance landforms and restore soil and soil processes to promote self-sustaining natural communities.

The IRP framework has initially been applied to all nine watersheds within TRCA's jurisdiction, with a particular emphasis on headwater areas. The application of the IRP framework to the Highland Creek watershed represents the first application to a fully urbanized watershed.

IRP sub-divides TRCA watersheds into 30 ha catchments, on average, based on topography and drainage patterns. Each catchment is then assessed using available data pertaining to four ecological conditions, including: existing natural cover, altered hydrology, aquatic condition and terrestrial natural heritage connectivity, after which these four factors are integrated (**Figure 22**). A summary of the metrics used to determine each ecological condition is provided below. The complete methodology for the framework is outlined in *Integrated Restoration Prioritization: A multiple benefit approach to restoration planning*.

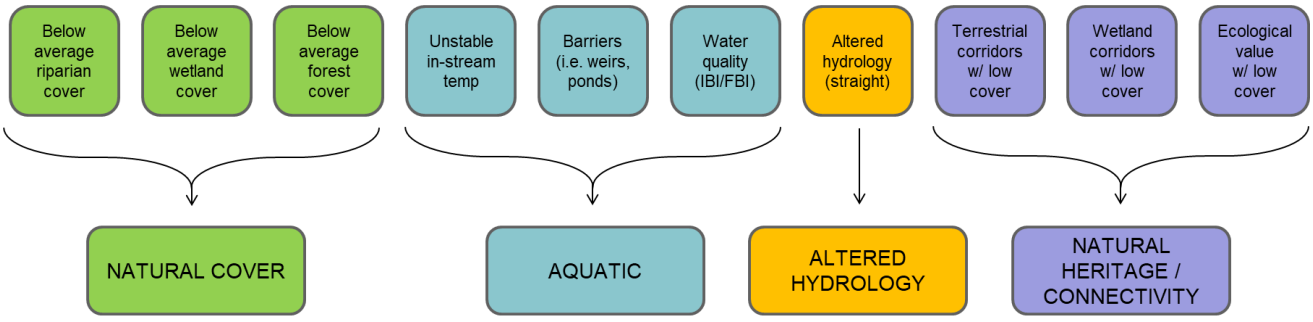


Figure 2 - Integrated Restoration Prioritization (IRP) framework

[9] East Highland and Morningside Park and the Lower Highland have been identified as Priority Investment Areas within the Toronto Ravine Strategy. The prioritization of sites within the larger Highland Creek watershed is a result of TRCA's methodology based on ecological principles and this does not preclude alternate site prioritization to take advantage of opportunities to coordinate with other projects (major municipal capital works).

Existing Natural Cover

Existing natural cover is represented by three metrics in the IRP framework: percent riparian cover, percent wetland cover, and percent forest cover. These metrics were calculated within each catchment based on the 2013 natural cover evaluation performed by TRCA. Catchment values for each metric were then compared against average percentages for the entire watershed. Catchments with below average cover for a particular metric were given a score of 1, indicating that the catchment was in need of more cover of that particular type. A total natural cover score was then calculated as the sum of the scores for riparian, wetland and forest cover, indicating catchments that are low (1), medium (2) and high (3) priority for natural cover.

Altered Hydrology

Orthophoto interpretation was used to determine the extent of altered hydrology across TRCA's jurisdiction according to the method outlined by the Center for Watershed Protection. Four metrics were visually assessed using GIS analysis of 2015 imagery for the region to determine the severity of altered hydrology: percent of straightened reaches, presence of online ponds, presence of tile drainage, and presence urban cover. Each catchment was ranked as having an overall low (0), medium (1), or high (2) amount of hydrologic alteration.

Aquatic Condition

Three metrics were chosen to indicate aquatic condition: in-stream temperature, in-stream barriers and water quality. Thermal data were evaluated to determine whether in-stream water temperatures were stable and moderate, or unstable and extreme, corresponding to a score of 0 or 1, respectively. In-stream barriers were assessed based on the presence of field-verified barriers such as dams, weirs or online ponds. A score of 1 was assigned if one or more barriers were present within a catchment. Water quality was evaluated using the benthic invertebrate Family Biotic Index (FBI). Where FBI values were not available, the fish Index of Biotic Integrity (IBI) was used. If a catchment ranked 'fairly poor' to 'very poor' for benthic invertebrates (according to the FBI) or 'fair', 'poor', or 'none' for fish (according to the IBI), it was assigned a score of 1, indicating impaired aquatic conditions. If a catchment was evaluated as having of an aquatic impairment, the assessment was applied to all relevant upstream catchments. A total aquatic score was then calculated as the sum of the scores for in-stream temperature, in-stream barriers, and water quality, indicating catchments that are low (1), medium (2) and high (3) priority for aquatic restoration.

Terrestrial Natural Heritage/Connectivity

Three metrics were used in conjunction with the natural cover layer to reflect terrestrial natural heritage connectivity: ecological value surface, terrestrial habitat connectivity, and wetland connectivity. Based on various ecological criteria (e.g. distance from natural or urban areas, etc.) an ecological value surface raster and scoring method was developed for existing and potential cover areas. If a catchment received a higher than average watershed score for ecological value surface and a lower than average natural cover score it was assigned a score of 1, identifying it as a priority catchment for restoration. In addition to the ecological surface value layer, predictive terrestrial habitat connectivity and wetland connectivity layers have been developed to provide information about the relative contribution of a particular location to maintaining the overall connectivity of existing habitat patches. Catchments assessed as having above average terrestrial habitat connectivity and/or wetland connectivity scores, and corresponding below average natural or wetland cover, respectively, were assigned a score of 1 and considered a priority for restoration in order to improve spatial cohesion among habitat patches and build resilient habitat networks. A total connectivity score was calculated by combining the scores for each of the three metrics, with a score of 3 being indicative of higher priority catchments.

Integration

Based on the number of impairments for the ecological conditions described above, and the potential natural heritage benefit that could be realized if restoration was undertaken, each catchment was ranked high, medium or low for overall restoration priority. For example, a catchment was deemed to be 'high priority' if it had multiple impairments (e.g. poor water quality, low natural cover, significantly altered hydrology, etc.) and if restoration is expected to generate ecological benefits (e.g. an important natural corridor exists there). The sum of the score for each of the ecological conditions considered (natural cover, altered hydrology, aquatic condition, terrestrial natural heritage connectivity) were added to generate a final catchment score ranging from 0 to 11. Special designation of 'protection' has been given to very low scoring catchments in order to highlight the importance of maintaining resiliency in these areas through strategic restoration actions (e.g. in-stream barrier removal or invasive species control). The IRP scoring can then be used as a screening tool to further refine and prioritize potential opportunities identified through restoration opportunities planning.

Restoration Opportunities Planning

ROP is TRCA's process for identifying and cataloguing potential restoration opportunities based on the existing level of aquatic and terrestrial habitat impairment and the anticipated ecological improvements the project would offer. The ROP data are based on survey methods that allow technicians to perform consistent and repeatable desktop and field assessments of restoration opportunities. Surveys have a strong hydrological focus and are designed to be rapid, streamlined, and strategic. The ROP process is divided into two analyses: terrestrial opportunities and stream opportunities. Identification of terrestrial restoration opportunities involves desktop and/or field assessment of terrestrial habitats (i.e. forest, meadow, riparian and wetlands). ArcGIS software is utilized to view orthophotos, digital elevation models, and ArcHydro modelled drainage lines. The ArcHydro lines calculate and delineate drainage patterns on the landscape, which often reveal critical wetland or headwater drainage feature restoration opportunities. Identification of stream restoration opportunities involve field assessments to identify impairments and restoration solutions associated with in-stream aquatic habitats. Desktop analyses can be completed for assessing stream opportunities but have limited capacity to identify specific in-stream aquatic impairments (e.g. erosion, failing culverts, barriers, etc.).

It is noted that while some aquatic restoration opportunities have been documented, comprehensive individual stream restoration opportunities have not be collected or mapped for the entire Highland Creek watershed. As such, mapping that documents opportunities for improving aquatic habitat or for compensating for loss of aquatic habitat to address the 'no-net loss' requirements of permitting agencies are not comprehensively documented in this Highland Greening Strategy. The greening priorities described later in this document under Greening Principle #2, emphasize the greening of the riparian zone associated with high priority aquatic catchments as this provides many benefits to the aquatic ecosystem, including shade and temperature regulation, nutrients, and stabilization of channel banks by the vegetated root structure. In addition, mitigating known barriers and restoring hardened channels could assist with achieving "no net loss" requirements. Removing barriers increases access by fish to other watershed areas to complete their lifecycle processes and restoration of hardened channels would provide habitat value where there previously was none. Both of these would benefit the aquatic ecosystem and increase fish productivity.

See **Figure 3** for all identified restoration opportunities in the Highland Creek watershed. As restoration occurs at the Priority Greening Sites identified for each greening principle in the following sections, additional restoration opportunities should be considered, including land securement.

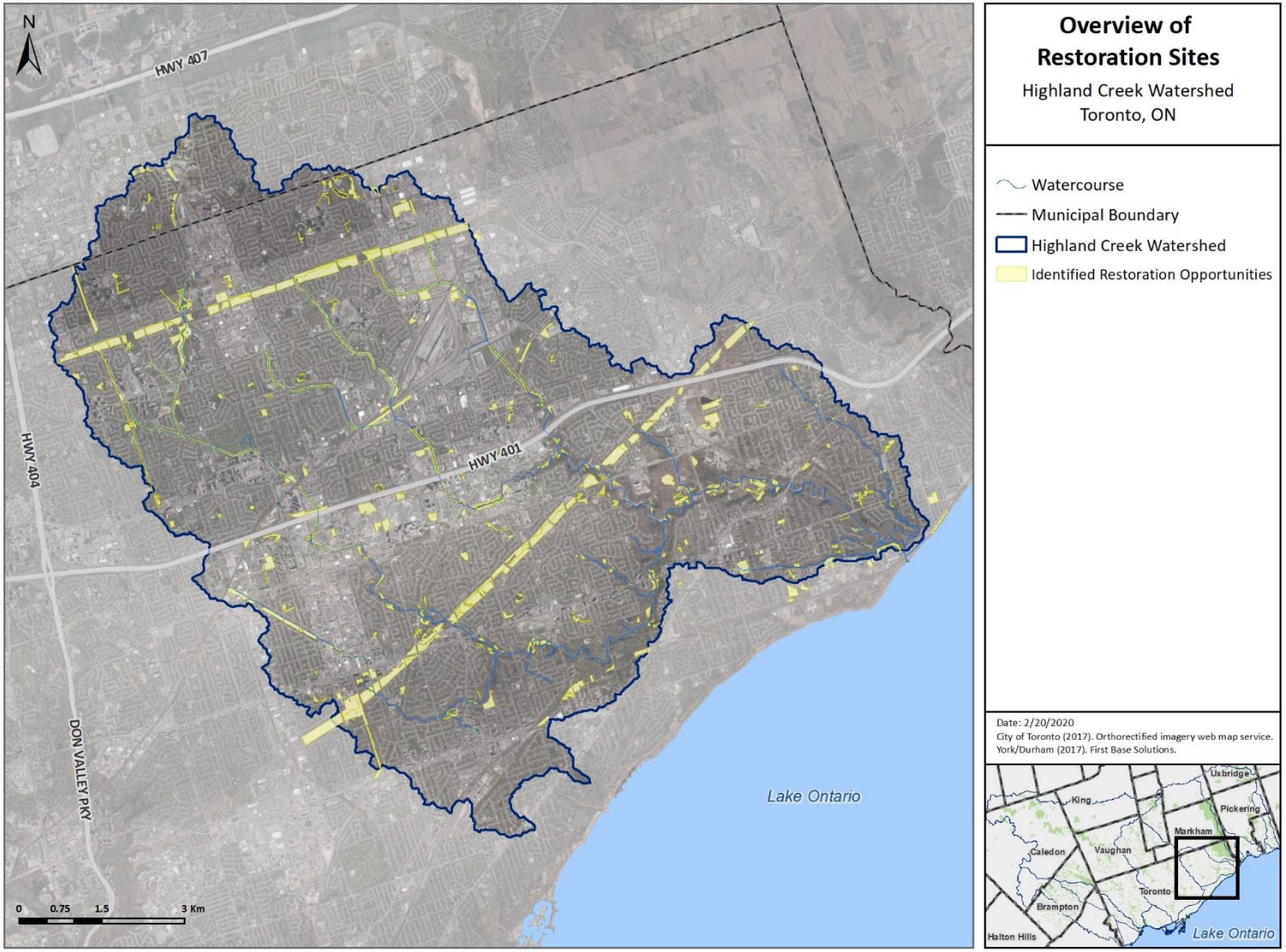


Figure 3 - All Potential Restoration Opportunities

2.2 Strategic Greening Principles

Priority Greening Sites will be identified through four greening principles and corresponding site selection criteria. The greening principles and site selection criteria will apply when considering greening opportunities and are customizable to the greening effort being proposed. Generally, the principles are summarized as follows:

- **Greening Principle #1 (Natural Cover):**
  Protect, restore, and enhance natural cover
- **Greening Principle #2 (Aquatic Habitat):**
  Restore and enhance aquatic habitat
- **Greening Principle #3 (Green Infrastructure):**
  Implement green infrastructure to maximize ecosystem service benefits.
- **Greening Principle #4 (Land Securement):**
  Protect and expand the size and connectivity of the natural system.

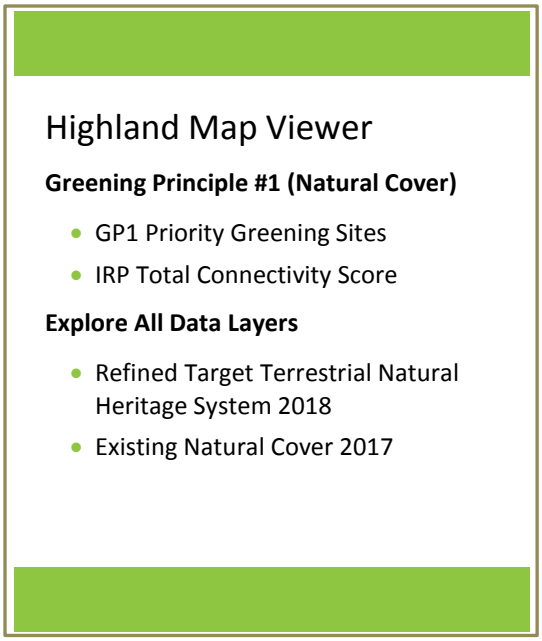
Priority Greening Sites and Areas identified through the site selection process for each greening principle are outlined in the **Section 3 (Greening Opportunities)** of this document with additional site level details in **Appendix A**. Implementation of greening projects should be coordinated appropriately with other projects. Implementation considerations related to planned infrastructure upgrades and maintenance, natural hazard management, and ravine and natural feature protection are outlined in the **Section 4 (Implementation of Greening Opportunities)**.

Greening Principle #1 (Natural Cover)

Protect, restore and enhance the quality, quantity and connectivity of natural cover in the Highland Creek watershed for its ecological benefits.

Rationale:

The amount of natural cover remaining within the urbanized Highland Creek watershed (approximately 11%) is well below the target recommended in TRCA's *Terrestrial Natural Heritage System Strategy*. Protecting existing natural cover is paramount to ensuring degradation of the health of the Highland Creek watershed does not continue and can be reversed. Restoring areas of potential natural cover to forest, meadow, riparian and wetland habitats where it increases the size, shape, and connectivity of existing habitat patches will make conditions more favourable for terrestrial species within the watershed. Locations where terrestrial restoration projects can occur on existing public lands are likely the easiest to implement, so prioritizing these lands will facilitate quick ecological gains. Lands that offer larger restoration and enhancement opportunities where there are areas of



relatively low natural cover and where there are gaps in connectivity between habitat patches usually provide the most ecological benefits.

Site Selection Criteria:

a. Prioritize areas that provide the greatest benefit to the quality, quantity and connectivity of natural cover within the watershed by selecting restoration opportunities (from TRCA's ROP database) according to the following:
    i. Prioritize restoration opportunities located in high, then medium, priority catchments using Terrestrial Natural Heritage Connectivity in TRCA's IRP mapping; and
    ii. Prioritize restoration opportunities that demonstrate the greatest total restoration potential within publicly-owned land. Consider the total sizes of combined restoration opportunities for forest, meadow, riparian and wetland habitats. For larger restoration sites (e.g. hydro corridors), only the portions of the project located within high or medium priority catchments are prioritized for natural cover improvements.
b. Coordinate implementation of projects to maximize value and efficiency of restoration efforts. See **Section 4 (Implementation of Greening Opportunities)** for detailed considerations.

Greening Principle #2 (Aquatic Habitat)

Restore and enhance the quality, quantity and connectivity of aquatic habitat in the Highland Creek watershed.

Rationale:

Restoring riparian areas with naturally meandering streams and natural vegetation, and removing concrete-lined channels will make conditions more favourable for aquatic species within the watershed. Removing barriers will also provide opportunities for aquatic species to move between habitats for their lifecycle functions. Implementation of in-stream restoration as recommended by the HCGSMIP will generate improvements to the biophysical aquatic habitat conditions of the creek. Additional habitat restoration opportunities should be coordinated with implementation of the HCGSMIP. Locations where aquatic restoration projects can occur on existing public lands are likely the easiest to implement, so prioritizing these lands will facilitate quick ecological gains. Lands that offer larger restoration and enhancement opportunities where there are areas of relatively low aquatic function and where there are gaps in riparian connectivity between habitats usually offer the most ecological benefits.

Site Selection Criteria:

a. Prioritize areas that provide the greatest benefit to the quality, quantity and connectivity of the aquatic system by selecting restoration opportunities (from TRCA's ROP database) according to the following:
    i. Prioritize restoration opportunities located in high, then medium, priority catchments using Total Aquatic Score in TRCA's IRP mapping; and

Highland Map Viewer

Greening Principle #2 (Aquatic Habitat)

- GP2 Priority Greening Sites
- IRP Total Aquatic Score

Explore All Data Layers

- Evaluation of Floodplain Roughness to Guide Riparian Plantings
- Potential Crossing Improvements
- Potential Channel Improvements
- Aquatic Barriers 2018

ii. Prioritize restoration opportunities that demonstrate the greatest total restoration potential within publicly-owned land. Consider the total sizes of combined restoration opportunities for forest, meadow, riparian, and wetland habitats. For larger restoration sites (e.g. hydro corridors), only the portions of the project located within high or medium priority catchments are prioritized for aquatic habitat improvements[10].

b. Coordinate implementation of projects to maximize value and efficiency of restoration efforts. See **Section 4 (Implementation of Greening Opportunities)** for detailed considerations.

Note: the Highland Greening Strategy does not provide mapping of opportunities for improving aquatic habitat or compensating for the loss of aquatic habitat to address 'no-net loss' requirements by aquatic habitat permitting agencies. However supporting data layers available in the Highland Map Viewer, including confirmed aquatic barriers, can be used to help meet this requirement.

Greening Principle #3 (Green Infrastructure)

Implement green infrastructure in urban portions of the Highland Creek watershed to maximize ecosystem service benefits and address multiple watershed issues or opportunities.

Rationale:

Implementing green infrastructure, particularly in urban environments can provide important ecological benefits to restore natural system function and in some cases improve biodiversity.Various forms of appropriately designed green infrastructure can help to protect and improve terrestrial and aquatic biodiversity by supporting ecological functions across the landscape, including the natural heritage system. In turn, this provides other ecosystem services towards improving human well-being. For example, green infrastructure projects, such as installing low impact development stormwater management practices, can help protect public safety, property and infrastructure by reducing the risk of flooding and erosion. Further, urban tree planting initiatives (i.e. street trees, parkland trees or natural area trees) help to reduce the urban heat island effect, which also improves community resilience to the effects of climate change. While implementing green infrastructure anywhere within the watershed would be beneficial, here we prioritize areas where the need is greatest based on the criteria below.

Site Selection Criteria:

a. Prioritize areas that maximize ecosystem service benefits according to the following:

Highland Map Viewer

Greening Principle #3 (Green Infrastructure)

- GP3 Priority Greening Areas
- IRP Total Score

Explore All Data Layers

- Identified Restoration Opportunities
- Priority Neighbourhoods for Urban Tree Canopy Enhancements
- Catchments Upstream of Flood Vulnerable Clusters
- Ecologically Significant Groundwater Recharge Areas (ESGRAs)
- Surficial Geology
- Depth to groundwater

[10] Restoration opportunities outside of the riparian zone but within a priority catchment are still considered Priority Greening Sites for improving aquatic conditions. It is important to consider headwater drainage features beyond the watercourse layer and restore where possible to improve water storage, infiltration, and evapotranspiration. This is especially true in heavily altered landscapes, such as the Highland Creek watershed where most natural headwater features have been severely altered or removed.

i. Select highest priority sites that overlap with the following data layers:
   - High and medium priority neighbourhoods for urban tree canopy enhancement;
   - High and medium priority catchments using Total Score in TRCA's IRP mapping; and
   - Catchments upstream of Flood Vulnerable Clusters.

b. Where redevelopment or retrofits are planned, capitalize on the opportunity presented to implement green infrastructure solutions regardless of their priority catchment.

c. Coordinate implementation of projects to maximize value and efficiency of restoration efforts. See **Section 4 (Implementation of Greening Opportunities)** for detailed considerations.

Greening Principle #4 (Land Securement)

Protect and expand the size and connectivity of the natural system in the Highland Creek watershed by adequately securing[11] and restoring privately-owned lands, and exploring redevelopment opportunities to restore natural cover and address multiple watershed issues or opportunities.

Rationale:

TRCA's target *Terrestrial Natural Heritage System Strategy* recommends that at least 30% of its jurisdiction should be comprised of natural cover in order to maintain regional biodiversity. The amount of natural cover within the Highland Creek watershed (approximately 11%) is already far below this recommended target, so it is critically important to protect and restore as much natural cover as possible. Given that the watershed is nearly fully built-out, there are limited opportunities to restore natural cover beyond existing public lands. Public lands are also constrained by multiple uses, such as recreation, infrastructure, and utilities. For these reasons, an approach to strategically increasing the size and connectivity of the natural system is needed, while simultaneously addressing other watershed issues by exploring private land securement opportunities.

Site Selection Criteria:

a. Prioritize areas that increase the size of the natural system according to the following:

   i. Select sites that overlap with and integrate as many of the following data layers as possible:
      - Locations where the floodline extends onto private property
      - Private properties that contain a stream feature and could expand the natural heritage system by connecting public lands (IRP Private Parcel Strategy)
      - Areas where the Refined Terrestrial Natural Heritage System (TRCA 2018) intersects private property
      - Locations where vegetation communities, flora, and fauna of conservation concern (L1-L3) intersect with private property

[11] TRCA secures property rights in one or a combination of the following ways: fee simple, leasehold, easement, covenant, or stewardship agreements (TRCA, 2016).

- Locations where Environmentally Significant Areas designated in the City of Toronto Official Plan extend onto private property
- Locations where current and historic wetlands intersect on private property

b. Each candidate property will be evaluated on its suitability for securement according to the factors outlined in TRCA's *Greenlands Acquisition Project 2016–2020*.

Refer to **Section 4 (Implementation of Greening Opportunities)** for further discussion about opportunities for land securement that can be explored to assist with implementation of Greening Principle #4 (Land Securement).

3. GREENING OPPORTUNITIES

3.1 Priority Greening Sites and Areas

Priority Greening Sites and Areas were identified according to the site selection criteria for each greening principle. This prioritization process creates a hierarchy of greening opportunities in the Highland Creek watershed that best address each of the greening principles. The Highland Map Viewer should be used for detailed maps of each Priority Greening Site. **Appendix A** provides additional details for each of the Priority Greening Sites associated with Greening Principle #1 (Natural Cover) and Greening Principle #2 (Aquatic Habitat). For these two Greening Principles, ground-truthed site-level information has been identified for each Priority Greening Site, including the type (i.e. forest, meadow, riparian and wetland), size, and location of restoration opportunities. This information allows greening efforts to be customized to meet specific project goals. Note that all restoration needs to ultimately be ground-truthed and coordinated with the appropriate City of Toronto and TRCA groups, and any other relevant landowners or land managers. In addition, any relevant activities (e.g. plantings in existing manicured parklands) should be coordinated with local councillors. Some of the priority sites are part of ongoing restoration.

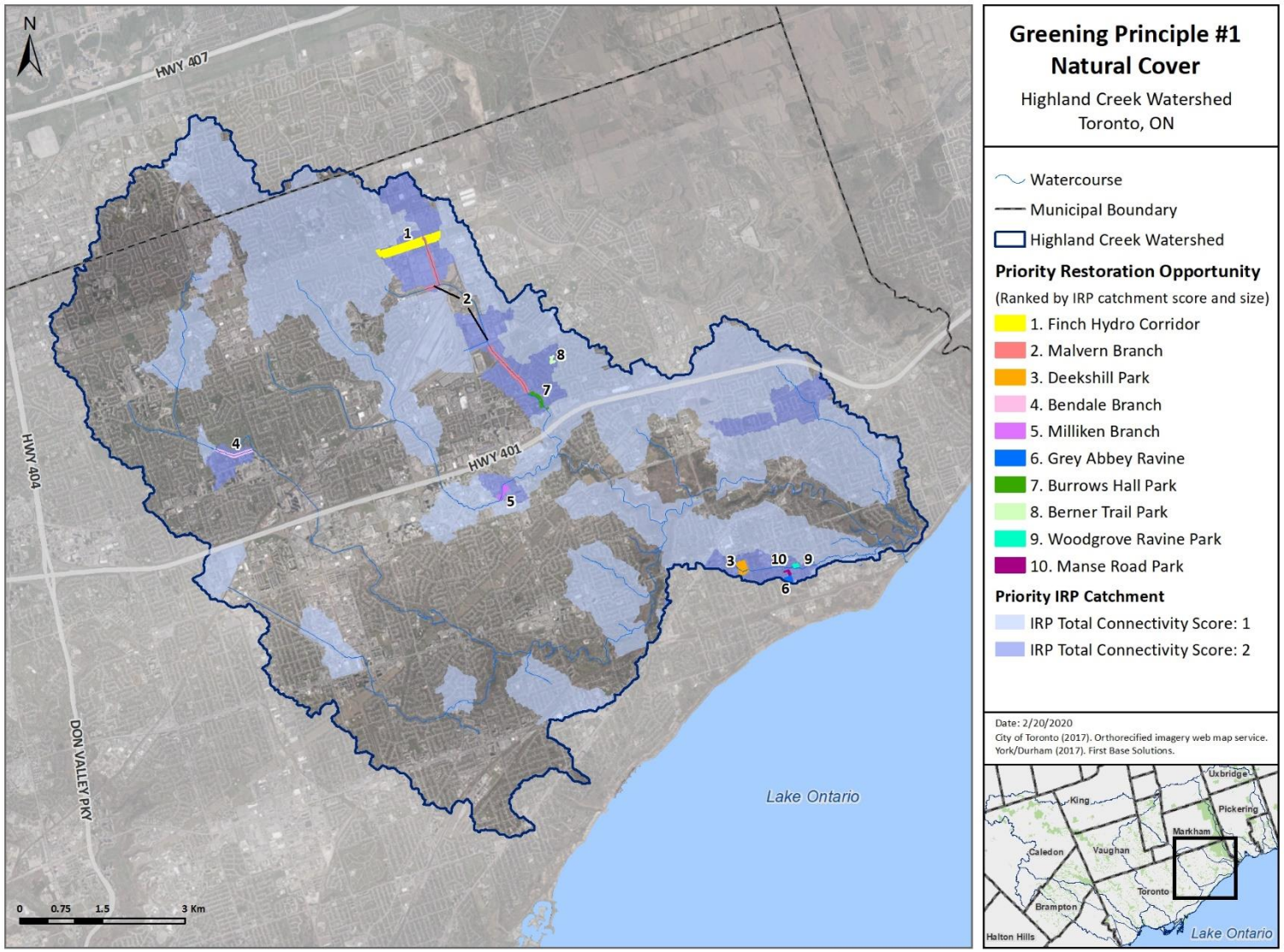
Greening Principle #1 (Natural Cover) Priority Greening Sites

The top 10 Priority Greening Sites that address Greening Principle #1 (Natural Cover) based on the site selection criteria are provided below, in order of priority, and are shown in Error! Reference source not found.**4**.

1. Finch Hydro Corridor
2. Malvern Branch
3. Deekshill Park
4. Bendale Branch
5. Milliken Branch
6. Grey Abbey Ravine
7. Burrows Hall ParkBerner Trail Park
9. Woodgrove Ravine Park
10. Manse Road Park

Greening Principle #1 (Natural Cover):

Protect, restore and enhance the quality, quantity and connectivity of natural cover in the Highland Creek watershed for its ecological benefits.



Disclaimer: The data used to create this map was compiled from a variety of sources and 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 TRCA. 416.661.6600

Figure 4 – GP #1 - Priority Greening Sites

Greening Principle #2 (Aquatic Habitat) Priority Greening Sites

The top 10 Priority Greening Sites that address Greening Principle #2 (Aquatic Habitat) based on the site selection criteria are provided below, in order of priority, and are shown in Error! Reference source not found.**5**.

1. Finch Hydro Corridor
2. Miliken Branch
3. Goldhawk Park
4. The Meadoway
5. L'Amoreaux Park
6. Bendale Branch
7. Shropshire Corridor
8. Malvern Branch
9. Morningside Park
10. Go Railway South

Greening Principle #2 (Aquatic Habitat):

Protect, restore and enhance the quality, quantity and connectivity of natural cover in the Highland Creek **watershed for its ecological benefits.**

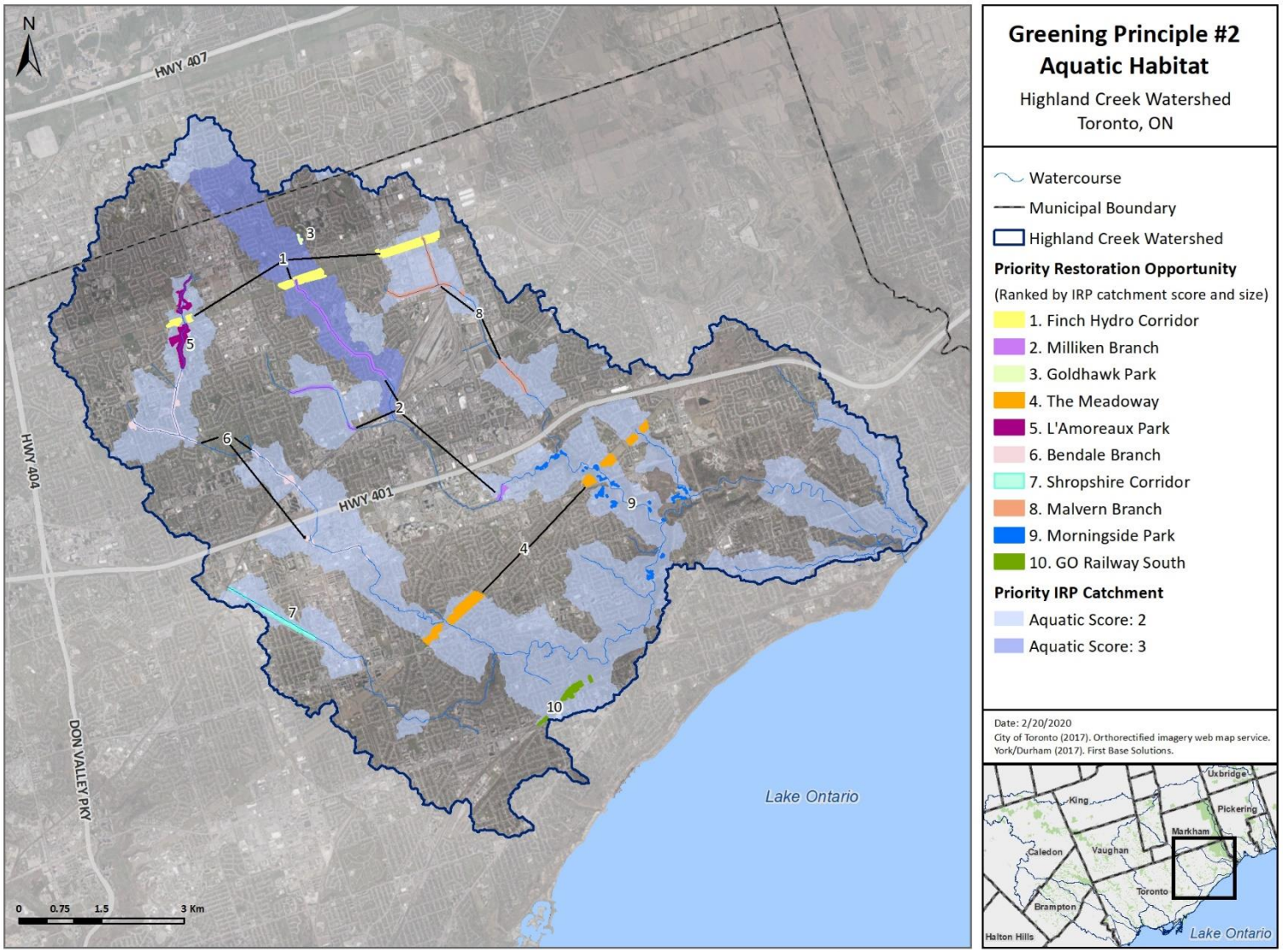


Figure 5 – GP #2 - Priority Greening Sites

Greening Principle #3 (Green Infrastructure) Priority Greening Area

Greening Principle #3 (Green Infrastructure):

Implement green infrastructure in urban portions of the Highland Creek watershed to maximize ecosystem service benefits and address multiple watershed issues or opportunities.

Since the potential restorable area in the Highland Creek watershed is low due to existing urbanization, further examination of current public greenspace, residential boulevards, and public/private parking lots for green infrastructure and low impact development opportunities was needed. **Error! Reference source not found.6** identifies the Priority Greening Area[12] within the Highland Creek watershed where implementation of green infrastructure should be prioritized in order to maximize ecosystem service benefits and address multiple watershed issues or opportunities. This area is located upstream of known flood vulnerable clusters, has been noted as having low tree canopy cover, is impaired in terms of low natural cover (i.e. forest, meadow, riparian, wetland), has altered hydrology, has poor water quality scores, and contributes to natural heritage system connectivity.

Programs that enhance the urban tree canopy through backyard greening on residential and commercial properties within the Priority Greening Area will help to meet the objectives of Greening Principle #3 (Green Infrastructure) and additional support for these programs should be considered. TRCA continues to encrouage the use of low impact development and green infrastructure techniques through its reviews of development and permit applications.

Restoration opportunities (from TRCA's ROP database) located within the Priority Greening Area for Greening Principle #3 (Green Infrastructure) should explore opportunities to implement green infrastructure as a component of greening projects. Additional green infrastructure opportunities in the Priority Greening Area require access to private lands or coordination with existing infrastructure or development projects to inform implementation. To aid in planning of green infrastructure projects, land use information has been mapped to help inform approaches to additional green infrastructure. Detailed information regarding appropriate green infrastructure for specific land uses is provided in **Section 4 (Implementation of Greening Opportunities)** as well as key spatial layers that might help guide where existing conditions could support certain types of green infrastructure (e.g. backyard tree planting, blue roof installation, road right of way low impact development, permeable parking lot retrofits, etc).

[12] A priority area was chosen for Greening Principle #3 (Green Infrastructure), as opposed to selected greening sites, due to limited field information available for private properties not examined as part of the ROP assessment process.

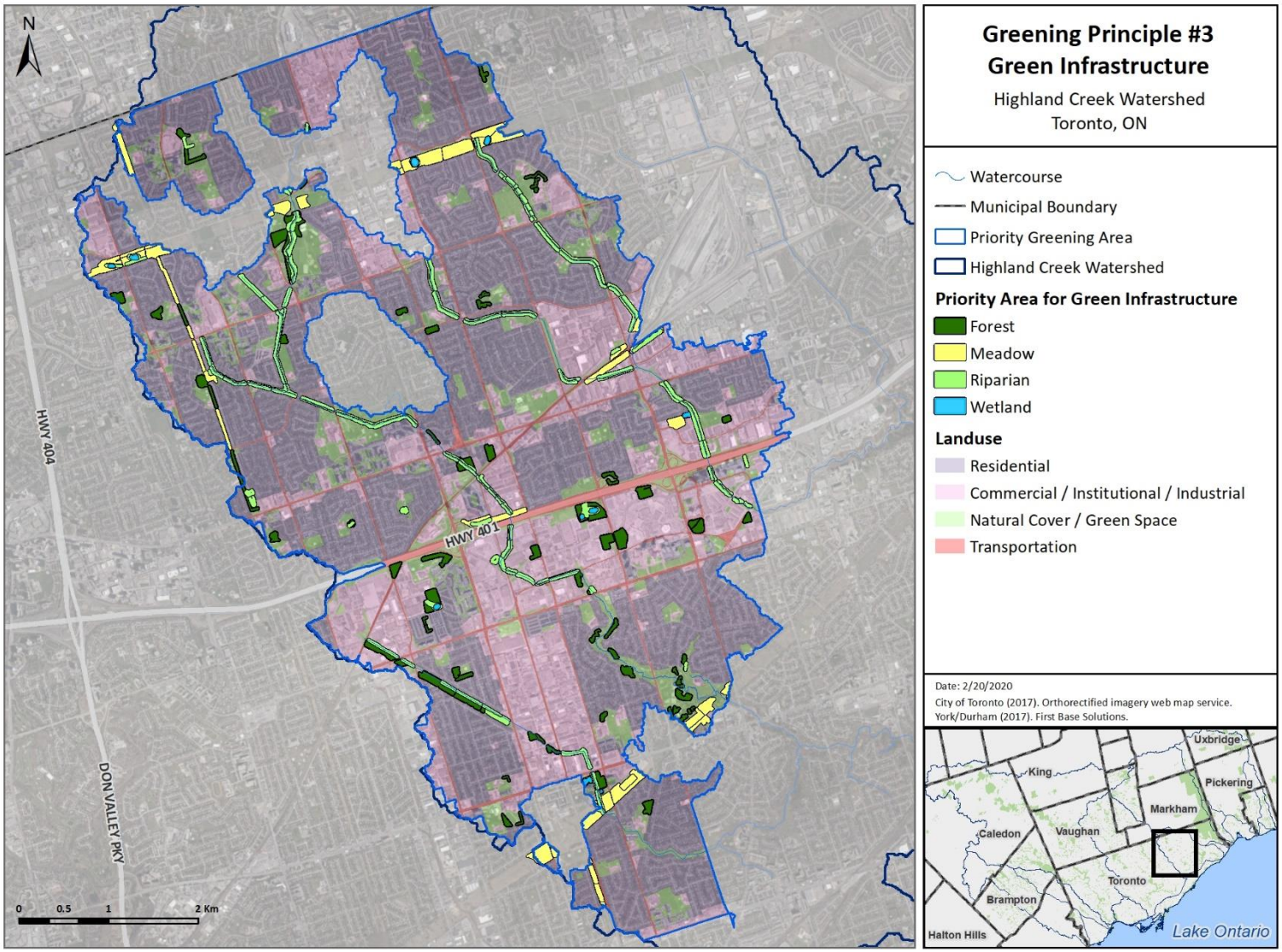


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Figure 6 – GP #3 - Priority Greening Areas

Greening Principle #4 (Land Securement) Priority Greening Areas

A "multiple hits" analysis was used to identify Priority Greening Areas for land securement. Because the data layers used in the site selection criteria were developed using multiple spatial scales, a standardized spatial unit was derived by dividing the watershed into 25 ha hexagonal units. Each hexagon was then analyzed and assigned a score based on the number of criteria layers found within that geographic area, with a higher score being assigned to hexagons that had more criteria layers[13]. The resultant Priority Greening Areas for Greening Principle #4 (Land Securement) are shown in **Figure 7**. Although there would be benefit to securing and restoring any privately-owned lands within the watershed, the Priority Greening Areas where 5 or 6 of the site selection criteria occur in the same hexagonal unit will provide the greatest opportunity to protect and expand the size and connectivity of the natural system within the Highland Creek watershed.

Greening Principle #4 (Land Securement):

Protect and expand the size and connectivity of the natural system in the Highland Creek watershed by adequately securing and restoring privately-owned lands, and exploring redevelopment opportunities to restore natural cover and address multiple watershed issues or opportunities.

The highest Priority Greening Areas include[14]:

- Mouth of Highland Creek
- Waterbridge Wy & Rockport Dr, Lower Centennial Creek
- Holmcrest Tri & Cherryhill Ave, Lower Centennial Creek
- Kingston Rd & Asterfield Dr., Highland Creek
- Old Kingston Rd (UofT Scarborough), Highland Creek
- Military Trl & Lash Crt
- Rossander Crt & Perivale Cre, Dorset Park Branch

[13] Maps depicting the individual criteria layers are available from TRCA, however due to privacy concerns, only the multiple-hits analysis mapping results are shown herein.

[14] Priority Greening Areas for Greening Principle #4 (Land Securement) have not been prioritized in any particular order. Each candidate property should be evaluated on its suitability for securement as outlined in the site selection criteria.

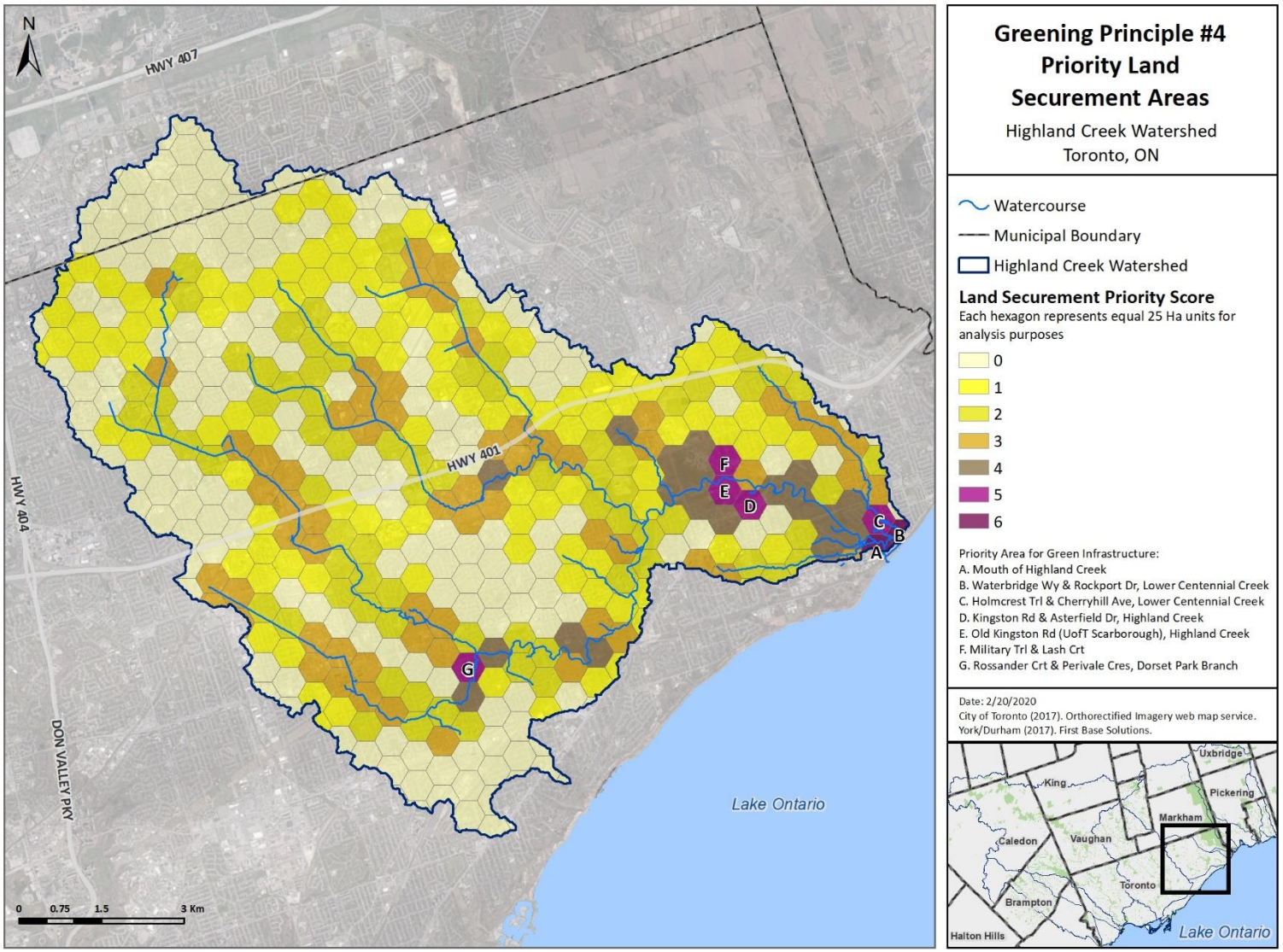

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Figure 7 – GP #4 - Priority Land Securement Areas

4. IMPLEMENTATION OF GREENING OPPORTUNITIES

4.1 Opportunities for Implementation

Greening efforts in the Highland Creek watershed will be driven by a number of complementary TRCA and City of Toronto strategies and initiatives. These initiatives will range from those intended to broadly improve watershed health, human well-being, and environmental community engagement, to projects that are intended to restore or enhance specific sites, compensate for loss or alteration of specific habitats and enhance urban tree canopy. Opportunities for implementation will coincide with infrastructure planning processes associated with implementing the WWFMP and HCGSMIP, as well as City of Toronto infrastructure renewal work such as roads, public building/property renovations, stormwater and water supply and wastewater works. In all cases, applicable permit approvals should be obtained prior to initiating a project. In areas regulated by TRCA, permits may be required for projects and will provide an opportunity for TRCA and the City of Toronto to identify synergies between known projects.

This section outlines the potential connections between greening opportunities identified in the Highland Greening Strategy and City of Toronto priorities identified through existing and ongoing strategies and initiatives. In this section, we further discuss some of the mechanisms and associated consideration pertaining to a number of the key opportunities for implementing greening projects in the Highland Creek Watershed, such as redevelopment opportunities, ecosystem mitigation and compensation, community engagement and land securement.

Complementary Initiatives

Biodiversity Strategy for Toronto

Vision: Imagine a Toronto with flourishing natural habitat and an urban environment that supports a great diversity of wildlife. Envision a city whose residents treasure their daily encounters with the remarkable and inspiring work of nature, and the variety of plants and animals with whom we share this place. A Toronto that aspires to be world leader through citizens who take pride and engage in the protection, restoration and enhancement of our flor and fauna.

Potential connections to greening opportunities: The Biodiversity Strategy implements the natural environment policies of the Official Plan and is aligned with the Ravine Strategy to address shared issues including invasive species management, the use of native plant material and ecological integrity. Priorities identified in Greening Principle #1 (Natural Cover) and Greening Principle #2 (Aquatic Habitat) of the Highland Greening Strategy directly support the principles of the Biodiversity Strategy by expanding and restoring terrestrial and aquatic ecosystems and their functions.

Sustaining and Expanding the Urban Forest: Toronto's Strategic Forest Management Plan

Vision: A healthy and expanding urban forest, incorporating sound urban forestry practices and community partnership.

Potential connections to greening opportunities: Implementation of greening projects within Priority Greening Sites or Areas identified in the Highland Greening Strategy can help to achieve the Strategic Forest Management Plan goal of protecting, maintaining and expanding the urban forest to achieve a healthy, sustainable forest with a canopy cover of 40%.

Toronto Complete Streets Guidelines

Vision: Toronto's vision for complete streets is built on the vision for streets in the City's Official Plan. There is a deep interdependence between how we design our streets and the people of the city, the health of our communities and the strength of our economy. Toronto's streets must serve a multitude of roles, functions and users. Complete streets should be designed for people, for placemaking and for prosperity.

Potential connections to greening opportunities: The benefits of including elements of green infrastructure in street design is explicitly recognized in Toronto's Complete Streets Guideline and is further supported where street improvements are contemplated in the transportation corridors of the Priority Greening Area identified in Greening Principle #3 (Green Infrastructure) of the Highland Greening Strategy.

Toronto Parkland Strategy

Vision: The Parkland Strategy is a 20-year plan that will guide long-term planning for new parks and expansion and improved access to existing parks. It will aid in the decision-making and prioritization of investment in parkland across the city.

Potential connections to greening opportunities: The Priority Greening Areas identified in Greening Principle #4 (Land Securement) of the Highland Greening Strategy could support and provide additional rationale for expanding access to existing parks where these areas within the watershed coincide with priorities of the Parkland Strategy.

Toronto Pollinator Protection Strategy

Vision: Toronto is home to diverse pollinator communities that contribute to resilient ecosystems and enhance urban biodiversity.

Potential connections to greening opportunities: The strategy identifies six priorities to achieve the vision including: creating and enhancing habitat, designing and connecting green spaces, partners and building relationships, investing and incentivizing, education and training, and celebrating and recognizing achievements. Actions associated with the priorities align with the Highland Creek Greening Principles.

Toronto Ravine Strategy

Vision: A ravine system that is a natural, connected sanctuary essential for the health and well-being of the city, where use and enjoyment support protection, education and stewardship.

Potential connections to greening opportunities: Implementation of the Ravine Strategy has identified ten Priority Investment Areas including high-level estimates of the capital funding required to address issues, including ecological and user experience concerns. East Highland Creek and Morningside Park and Lower Highland Creek have been identified as Priority Investment Areas in the Ravine Strategy over the next ten years. See **Table 2** for an overview of the Priority Greening Sites, or Areas, established as part of the Highland Greening Strategy that are within or outside of the two Priority Investment Areas in the Highland Creek watershed identified as part of the Ravine Strategy.

Table 2 - Priority Greening Sites or Areas within Ravine Strategy Priority Investment Areas

Highland Greening Strategy – Greening Principle	Sites within / outside of Ravine Strategy – Priority Investment Areas
Greening Principle 1 – Natural Cover (ten sites total)	All sites are outside of the Priority Investment Areas. This is not surprising since the Highland Greening Strategy is focused on increasing natural cover through restoration planting across the watershed to improve overall amount and connectivity of habitats, and the Ravine Strategy is focused on protecting areas of high existing ecological value from planned capital works and nearby population growth.
Greening Principle 2 – Aquatic Habitat (ten sites total)	Two of the ten sites have portions located within the Priority Investment Areas. These are site 4, the Meadoway and site 9, Morningside Park. Both of these Priority Greening Sites consist of several patches of restoration opportunities. Of the priority patches for the Meadoway, 7.2% of the identified restoration opportunities are within the Priority Investment Areas. For Morningside Park, 91.5% of the identified restoration opportunities are within the Priority Investment Areas. For Priority Greening Sites outside the Priority Investment Areas, these sites were selected for their benefit to aquatic habitat in other parts of the watershed.
Greening Principle 3 – Green Infrastructure (numerous areas)	All areas are outside of the Priority Investment Areas. This Greening Principle is focused on areas within the watershed where green infrastructure (e.g. LID or urban canopy) would be most beneficial, which is primarily in heavily urbanized portions of the watershed away from the ravine features.
Greening Principle 4 – Land Securement	Six of the seven identified hexagons for land securement are within the Priority Investment Areas. Land securement is supported by the Ravine Strategy (Action #10), so there is strong alignment between the two strategies. TRCA and the City of Toronto will collaborate to secure these areas in a manner consistent with both strategies.

Toronto's Resilience Strategy

Vision: Toronto's first Resilience Strategy sets out a vision, goals and actions to help Toronto survive, adapt and thrive in the face of any challenge, particularly climate change and growing inequities.

Potential connections to greening opportunities: Several actions within the Resilience Strategy support the Highland Greening Strategy, including advancing a system of green and blue infrastructure.

Ecosystem Mitigation and Compensation

Redevelopment or infrastructure renewal projects could be an opportunity to implement greening projects within the watershed as a means of mitigating ecological impacts from these projects. Greening opportunities could be explored as part of the redevelopment or infrastructure renewal process. Impacts to natural cover resulting from redevelopment or infrastructure renewal projects should be avoided wherever possible. This is particularly important in the most sensitive areas of the watershed, such as:

- the City of Toronto's environmentally significant areas,
- provincially or locally significant wetlands,
- Areas of Natural and Scientific Interest,
- significant valleylands,
- woodlands,
- wildlife habitat,
- fish habitat,
- communities and species of local conservation concern, and
- habitat of endangered and threatened species.

However, not all impacts can be mitigated. If works within or adjacent to these areas cannot be avoided, a high level of effort to protect and restore ecosystem functions before, during, and following construction will be required.

Where impacts to natural features are unavoidable, mitigation should be implemented to the extent possible. Restoration of disturbed habitats and other available areas within the project area should be undertaken. If a residual, unavoidable loss of ecosystem services remains following mitigation, City bylaws and TRCA's *Guideline for Determining Ecosystem Compensation* should be consulted to determine appropriate ecosystem compensation procedures. The applicable bylaw or guideline depends on the nature and scale of the impacts proposed. In instances where species at risk could be impacted, achieving overall benefit to the species under federal or provincial species-at-risk legislation may be required. Compensation outcomes should strive to fully replace the same level of lost ecosystem structure and function near where the loss occurs (on-site compensation is preferred), and where possible, to achieve an overall gain. "Like-for-like" ecosystem compensation (e.g. restoring a forest to address impacts to a forest) is the preferred approach in most cases.

Given the extent of urbanization and the limited opportunities for restoration within the Highland Creek watershed, it may not always be possible to restore the same ecosystem type that was lost. Other forms of natural cover may be considered for compensation, but replacement sites must occur within the same municipality and subwatershed as the natural cover that has been removed. The site selection criteria for Greening Principle #1 (Natural Cover) and Greening Principle #2 (Aquatic Habitat) can further help to prioritize the selection of compensation sites. While it is recognized that forms of green infrastructure (e.g. implementing low impact development measures) provide watershed and community health benefits and should be encouraged, they should not be considered when compensating for natural feature losses.

Community Engagement

Stewardship and education opportunities should be explored or continued in order to enhance the engagement of community residents in greening projects to help integrate green infrastructure with

other greening priorities to maximize ecosystem service benefits where they align with the priorities identified in the Highland Greening Strategy. Where appropriate, emphasis should be on engagement opportunities within Neighbourhood Improvement Areas, nurturing existing and seeking new partnerships with culturally diverse organizations, religious groups, Indigenous communities, and other community members. The Highland Creek watershed is a multicultural area with a population around 430,000 people. Visible minorities represent 76% of the population with 51% of residents living in apartment buildings. Some of the recommended restoration projects and educational programs to focus on include:

- Work with community groups and other partners to facilitate restoration, particularly tree planting projects and invasive species control, of Priority Greening Sites identified for Greening Principles #1 (Natural Cover) and Greening Principle #2 (Aquatic Habitat). Examples of programs include Toronto's Community Stewardship Program and TRCA's Community Engagement and Outreach Programs.
- Educate the community about the negative effects of illegal dumping and encroachment on aquatic habitat through community outreach targeting homeowners who live adjacent to ravines and waterways within the watershed.
- Continue ongoing community outreach and engagement initiatives, including TRCA's Greening Your Grounds workshops, to promote lot-level stormwater management, targeting residential homeowners within the Priority Greening Area for Greening Principle #3 (Green Infrastructure).
- Develop education and engagement programs to promote lot-level stormwater management, targeting industrial and commercial businesses within the Priority Greening Area for Greening Principle #3 (Green Infrastructure).
- Implement demonstration projects across the watershed to showcase low impact development measures and to encourage implementation of low impact development technologies on private property, within the Priority Greening Area for Greening Principle #3 (Green Infrastructure).
- Support community outreach and education to prepare residents for flooding with priority placed on flood vulnerable clusters.
- Promote stewardship through planting and incentive programs available for property owners such as Local Enhancement & Appreciation of Forests' (LEAF) tree planting programs, TreeMobile and City of Toronto's Tree for Me program, particularly within the Priority Greening Areas identified for Greening Principle #3 (Green Infrastructure) and Greening Principle #4 (Land Securement).
- Educate the community about the negative effects of non-native invasive plants and the benefits of native plant gardening through community outreach (e.g. Grow Me Instead guide) targeting homeowners that live next to natural areas.
- Initiate TRCA's youth engagement and employment program within the City of Toronto and target promotion to schools located within Neighbourhood Improvement Areas. Continue to host interpretive walks and other outreach programs, such as the Highland Creek Salmon Festival, in order to engage the local watershed community in nature appreciation.
- Explore opportunities to develop and implement Sustainable Neighbourhood Retrofit Action Plans (SNAPs) and the Partners in Project Green (PPG) program, in collaboration with the City and local stakeholders, as a way to coordinate delivery and amplify action on multiple local greening initiatives on public and private lands.

Land Securement

Land securement in key areas will help to expand the natural system and build resilience to future climate and population growth impacts within the Highland Creek watershed. While fee simple purchase of properties may be challenging given current land prices, there are a few potential opportunities for land securement, in addition to stewardship, that can be explored to assist with implementation of Greening Principle #4 (Land Securement). Some of these opportunities are briefly described below:

- TRCA's compensation guideline includes consideration of offsetting lost land base to ensure that the cumulative effects of lost natural cover do not reduce the overall size of the natural heritage system, and instead promotes expansion over time. There may be opportunities to secure land, in addition to promoting restoration of those lands, through implementation of this guideline.
- Redevelopment will continue to occur in the Highland Creek watershed over time. As redevelopment occurs, there may be opportunities to secure hazard-prone or sensitive natural heritage lands through parkland dedication processes or other municipal acquisition tools.
- There may be opportunities that arise through government funding or incentive programs (e.g. Ecological Gifts Program) bequeaths, and/or philanthropic partnerships that could be leveraged to secure or mitigate high risk hazard areas or secure lands with ecologically sensitive habitats.

Environmental Sustainability and Associated Co-benefits

Consideration for environmental sustainability issues and the associated co-benefits should be included in the implementation process for each project. Incorporation of sustainability will help each project address issues that contribute co-benefits to the Highland Greening Strategy that are core issues and benefits to the strategic direction of the City of Toronto and contribute to the sustainability of the region.

Sustainability can be readily integrated into the implementation process for each project by applying a set of sustainability lenses. Sustainability lenses are a set of perspectives that prompt users to consider the sustainability costs, benefits and consequences of their decisions. The two lenses recommended for consideration through implementation of greening projects are a) Climate Mitigation/Adaptation; and b) Community Benefits.

Climate Mitigation/Adaptation

TransformTO is the City of Toronto's ambituous climate action strategy approved by council in 2017. Incorporating a Climate Mitigation/Adaptation lens to the implementation of each greening project will align project outcomes with the City's climate strategy. Climate issues that should be addressed through this lens include:

- What is the net Life Cycle Assessment (LCA) carbon emissions associated with each project?
- How can the project be modified to reduce net LCA emissions or make the project carbon positive?
- Can the project contribute to the City's adaptation to climate change? If so, how and by how much?
- Can the project contribute to increased resilience of the City? If so, how and by how much?

Tools for addressing these questions are still evolving and TRCA would work with City staff and other experts in developing and applying these tools.

Community Benefits

The City of Toronto's community benefits framework offers a way for government and other institutions to multiply the impact of their spending. Community benefits can be leveraged by infrastructure projects that are funded through City procurement processes, or incentivized by the City. The Community Benefits Framework utilizes City funded infrastructure projects to achieve desired outcomes. Some of the desired outcomes include targeted hiring and training opportunities, providing economic opportunities, reducing poverty, and support for community priorities among Indigenous peoples and equity seeking groups in Toronto. Specific issues and questions to include in each implementation project should be identified in consultation with the City's Community Benefits Framework and appropriate City of Toronto staff.

4.2 Project Coordination

Once a decision has been made to initiate a greening project, detailed site-level considerations should be applied to ensure that projects occur in the appropriate order to maximize the value and efficiency of efforts. It is also important to work with both City of Toronto and TRCA staff to ensure that appropriate staff are consulted and projects are sufficiently coordinated. Ideally, the infrastructure projects and the greening component would be designed in tandem to ensure that greening opportunities are not missed. The factors described in this section should be considered before a greening project is initiated. Data layers identified in this section should be consulted in order to help determine which implementation considerations are appropriate for each project.

City of Toronto Infrastructure

Consideration should be given to coordinating greening opportunities with future infrastructure works. The intent is that stream restoration projects needed to address the geomorphic system within the riparian zone/meander belt as outlined in the HCGSMIP would be constructed first, followed by implementing greening projects locally in the vicinity of the stream restoration project.

In locations where HCGSMIP or WWFMP projects have been identified in close proximity to Priority Greening Sites, greening projects must be coordinated with the City of Toronto to ensure that:

1) Planned infrastructure projects must be completed in advance of greening projects; and
2) Restoration work completed in this area must not interfere with future access to infrastructure. Consideration should be given to the type, size, location and anticipated maintenance required for any greening projects.

Project to be coordinated with:	Data layers to be considered:

City of Toronto – Toronto Water	• Geomorphic Systems Master Implementation Plan
	  ○ Feasible Stormwater Management Facility Retrofits
	  ○ Restoration Project Sites
	• Watermain crossing
	• Sanitary Sewer Crossing
	• Stormwater Management Ponds

Natural Hazard Management

Greening projects that involve a component focused on stream enhancements should ensure that existing natural hazard issues are addressed first, where appropriate. Natural hazards include riverine flooding, riverine erosion, and geotechnical slope instability. If natural hazard issues cannot be addressed or may become more severe upon implementation of a proposed greening project, the greening projects should be avoided until these hazard issues have been resolved.

Flooding

In order to determine the impacts of planting riparian vegetation along the channelized sections of Highland Creek and its tributaries, a hydraulic modelling exercise was undertaken by TRCA. In this modelling exercise, the roughness coefficient (i.e. resistance to flow) within the study area was changed to reflect the potential increase in vegetative cover, informing whether restoration in these areas would affect the existing floodlines. The results of this analysis can be used to inform where and how riparian plantings may be undertaken without exacerbating existing flood lines. The results also inform where riparian plantings are not appropriate unless channel capacities are modified or issues in flood vulnerable clusters are resolved first. Overall, the results recommended that conveyance within flood control channels be maintained, therefore planting is not recommended within concrete-lined flood control channel. Instead it is recommended that vegetation and debris within these channels be removed. Plantings should also be avoided in the vicinity of hydraulically constraining structures, such as bridges and culverts, as an increase in roughness in these areas will result in reduced conveyance through an already constraining flow structure.

The branches of Highland Creek studied included the Dorset Park Branch, West Bendale Branch, Markham Branch & Malvern Branch. Many of these channels were initially constructed as flood control channels some of which are still concrete-lined. Three of the branches are also known Flood Vulnerable Clusters (FVC), including Dorset Park FVC on the Dorset Park Branch, Kennedy Commons FVC on the West Bendale Branch, and Progress Business Park FVC on the East Markham Branch. Detailed methodology and mapping results showing appropriate and inappropriate areas for planting can be found in **Appendix B**. Coordination with TRCA and/or the City of Toronto would be required prior to implementing greening along any of the channels assessed through this modelling exercise.

Erosion

Comprehensive erosion monitoring in the City of Toronto is currently being undertaken by TRCA. From this monitoring data, TRCA has developed a database that prioritizes erosion risks associated with fluvial geomorphic processes across the city, including the Highland Creek watershed. A fluvial geomorphologist should be consulted prior to initiating a greening project in the vicinity of high priority areas for erosion remediation to ensure that erosion risks do not jeopardize the future success of the restoration efforts.

A greening project could follow an erosion project and increase the scope of the original restoration plan for the erosion works. This would require detailed restoration opportunity review in the vicinity and should include forest and invasive management opportunities.

Geotechnical Instability

Ravine banks may be unstable (or could become unstable in the long-term) in areas where certain geotechnical processes are occurring along valley slopes. Over-steepened valley slopes (greater than 3:1) or where the toe of a slope is within 15 m from the watercourse may lead to eventual slope failure and threaten the success of the restoration effort over time. On the other hand, restoration may also

help to delay the initiation of slope instability and time to trigger the failure in some cases. It is important to check with a geotechnical engineer to determine whether geotechnical stability is in question before implementing stream restoration projects.

Project to be coordinated with:	Data layers to be considered:
TRCA – Engineering Services	• Evaluation of Floodplain Roughness to Guide Riparian Plantings • Flood Vulnerable Clusters • Floodline • Potential Crossing Improvements • Potential Channel Improvements • Erosion Hazard: Score =/> 70 • Erosion Structure: High Priority
TRCA – Policy Planning	• Crest of Slope

Ravine and Natural Feature Protection

While greening projects will likely ultimately benefit the natural heritage system, it is important to understand the existing features, functions, and sensitivities of the surrounding area to ensure that greening projects properly mitigate any potential impacts during implementation. All works must take into account the level of protection of the area, existing features, and wildlife to design plans that are not in conflict with existing conditions or species-at-risk within the ravine system. It is also critical that all necessary permits are adequately secured before a project proceeds. When projects are located within the ravine or natural heritage system it is important to first determine:

- the boundary of the feature
- whether the proposed Natural Heritage System, Environmentally Significant Areas, or evaluated wetlands are located within or adjacent to the project site
- the presence of aquatic barriers that could be mitigated as part of a greening project
- flora, fauna, and vegetation documented within or adjacent to the project site that may affect how a project proceeds (e.g. requiring special permits prior to initiating work)

Project to be coordinated with:	Data layers to be considered:
City of Toronto – Planning	• Toronto ravine by-law • Greenbelt[15] • Environmentally Significant Areas • Areas of Natural and Scientific Interest (ANSI)
City of Toronto Planning	• MNRF wetlands[16]
TRCA – Development Planning	
TRCA – Development Planning	• TRCA regulation mapping
TRCA – Research and Knowledge Management	• Refined Terrestrial Natural Heritage System (TRCA 2018) • Aquatic barriers

[15] The province is the source of data related to the Greenbelt.
[16] Ibid.

TRCA – Environmental Monitoring and Data Management	• Ecological Land Classification (ELC) • Flora and fauna

Other Considerations

There may be other data layers available from other strategies and plans that may be of interest to greening project coordinators. Below, a number of those known initiatives are listed for consideration, but note that this is not an exhaustive listing, or additional strategies or plans may be initiated in future.

Project to be coordinated with:	Data layers to be considered:
City of Toronto - Planning	• Trails ○ Existing Cycling Network ○ Proposed Cycling Network
TRCA – Greenspace Conservation	• TRCA Trails Strategy

4.3 Greening Approaches at the Site Level

Site-specific considerations are needed to confirm the appropriateness of greening projects at the local scale. Below, additional advice and direction are provided to help guide the planning of greening projects at the site level.

Restoration opportunities have been identified in the Highland Creek watershed for forest, meadow, riparian, and wetland habitats. The restoration and enhancement approaches typically employed by TRCA for each habitat type are outlined below and should be utilized to help address greening projects intended to improve the quality and quantity of natural cover and aquatic habitat. Additional considerations are provided for the implementation of green infrastructure projects.

Forest Habitat

Two types of restoration opportunities for forest habitat have been identified in the Highland Creek watershed: reforestation and forest enhancement.

Reforestation focuses on increasing the total amount of existing forest cover and enhancing species richness by providing additional and improved habitat, providing corridors and linkages to other habitats, and increasing the width of buffers along watercourses. Native, site-appropriate and climate resilient species should be selected. A combination of coniferous, deciduous, and berry producing wildlife shrub nodes should be used to promote a diversity of wildlife habitats that provide food, shelter and nesting opportunities. Structural reforestation using large woody debris should be placed in and around planting zones to increase plant survival by retaining soil moisture and moderating drought, while providing structural habitat, wildlife cover and organic material that would be present in mature woodlands.

Some areas within the Highland Creek watershed have been identified for forest enhancement. These areas are existing woodlots that have suffered some form of degradation and could be improved by intervention. A common example of this is informal trail systems causing compaction and limited

understory. Techniques for enhancement might include understory planting, access restriction, and invasive species control.

Forest restoration creates benefits such as:

- Enhanced biodiversity
- Increased wildlife habitat for food, shelter, and nesting opportunities
- Improved habitat connectivity
- Ecosystem services, including carbon sequestration, soil stabilization, reduced soil and air temperature, etc.
- Climate change mitigation and adaptation

For compensation projects, the size of forest offset requirements will be determined based on the area of forest loss and the area of proposed reforestation (i.e. the area of forest enhancement is not counted).

Meadow Habitat

To restore meadow habitat and the ecological services they provide, TRCA strategically selects locations where meadows are complementary to existing or proposed land use or natural cover, and/or provide specialized habitat for species of conservation concern. Proper site preparation is very important to the success of any meadow project and will vary depending on site conditions. Following site preparation, TRCA will plant/seed the area with native wildflowers and grasses. Habitat features can be installed to enhance terrestrial functions, such as downed woody debris, raptor poles, snake hibernacula, and nest boxes. Monitoring and maintenance are critical to meadow restoration in the absence of natural disturbances, such as fire or grazing. Without a maintenance regime, meadows in Ontario will typically succeed into forest communities. Maintenance will need to occur throughout the life of the meadow project to ensure native seed establishment, minimize the expansion of invasive species, and promote meadow biodiversity. Invasive species are a significant threat to the long-term ecological integrity of a meadow. Maintenance regimes will vary depending on site characteristics and restoration goals.

Meadow restoration creates benefits such as:

- Support of pollinator services
- Improved wildlife habitat for foraging, breeding, nesting, and overwintering for open country species
- Enhanced natural corridors and connectivity for wildlife
- Carbon absorption, climate change mitigation
- Improved resilience of greenspaces

Utility corridors have been identified as prime candidates for meadow habitat restoration since woody vegetation is maintained by utility companies. Projects like **The Meadoway** in the Gatineau Hydro Corridor have been instrumental in piloting the conversion of turf grass into productive meadow habitat, while not impeding the management and operational requirements of the site.

Riparian Habitat

Historical and current land use changes continue to have significant impacts on natural features. Streams and riparian areas in the Highland watershed have become impaired as a result of various landscape alterations. These alterations may contribute to a variety of impacts to natural system function, which may reduce the ecological services that streams provide.

To mitigate impairments to streams and riparian areas and the ecological services they provide, the City of Toronto and TRCA restore these areas through natural channel design, bank stabilization works, planting of the riparian zone and barrier removal or mitigation throughout our watersheds. Ultimately, the streams in the Highland watershed run into Lake Ontario and restoration in the headwaters and lower reaches can have a direct influence on the water quality and habitat along the waterfront.

Restoring riparian habitat is particularly important to improve overall health of aquatic systems. 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. These external inputs of organic matter are an important source of energy, food and habitat. Headwater drainage features and permanent watercourses with adequate riparian cover also 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.

Riparian restoration creates benefits such as:

- Improved hydrology and water quality
- Increased stream bank shading to help moderate stream temperatures
- Stabilized stream banks
- Increased habitat diversity and availability

Wetland Habitat

Wetland restoration generally refers to rehabilitating a degraded wetland or re-establishing a wetland that has been drained or removed from the landscape. Small changes to reverse altered hydrologic conditions can often restore a wetland to its former state (i.e. removing agricultural drainage systems). Wetland creation refers to constructing a wetland in a location that was never a wetland in the past. When creating wetlands, existing conditions must be assessed to determine whether hydrologic conditions can be created or optimized to sustain a new wetland habitat. Created wetlands are often built to treat run-off from agricultural sites or urban outfalls.

There are opportunities to enhance some of the low wet areas within the watershed to create scattered wetland pockets. Enhancement work may involve more direct measures, such as subtle changes in contours and drainage to embellish the existing wetland area and diversity of water depths. Wetland creation/enhancement projects can help to improve water quantity and quality, attenuate stream flows, help to reduce sedimentation and erosion and provide wildlife habitat. In addition, some low wet areas would benefit from planting wet shrub thickets as a buffer and to complement and expand upon the existing habitat mosaic, enhancing peak flow attenuation and ground water recharge.

Wetland restoration creates benefits such as:

- Improved biodiversity
- Increased wildlife habitat
- Flood attenuation

- Improved water quality
- Recreational opportunities
- Improved habitat connectivity

Green Infrastructure

Green infrastructure, in the form of gardens, street trees and other landscape features, including low impact development stormwater management practices, will help restore and improve ecosystem function and biodiversity, help to store and attenuate flows from extreme precipitation events, with added benefits of providing cooling effects in urban neigbourhoods. Greening projects could incorporate green infrastructure by providing additional natural features (e.g. vegetation, naturalized ponds), regulating hydrologic conditions (e.g. stabilizing base and peak flows, water infiltration, water storage/evapotranspiration), and enhancing ecological processes and connectivity (e.g. wildlife movement, pollination).

While implementing green infrastructure anywhere within the watershed will have benefits, the greatest benefit for flooding and natural heritage will be gained by implementing green infrastructure within the Priority Greening Area for Greening Principle #3 (Green Infrastructure). Error! Reference source not found. identifies the primary land uses within the Priority Greening Area to help inform the type of green infrastructure that may be most appropriate for each land use category.

Land Use Categories in Priority Greening Area for Greening Principle #3 (Green Infrastructure) and appropriate types of greening considerations include:

- **Commercial, institutional, industrial:** Roofs and parking lots are the dominant features to manage stormwater. Consider green roofs, blue roofs, permeable paving, bioretention, swales, stormwater tree cells and planters, and rainwater cisterns.
- **Residential:** Creative use of front yards, boulevards and backyards should be encouraged to manage stormwater. Boulevard bioretention, vegetated swales, tree planting, rain gardens and rain harvesting (barrels and cisterns) appropriate for this type of land use.
- **Transportation:** Corridors include road right-of-ways, ditches, and curbs. Tree planting along road right-of-ways (especially highways) should consider stormwater planters and tree cells. Other greening measures include bioretention, infiltration trenches, exfiltration storm sewer systems, and vegetated swales. Note that green infrastructure can be designed with road safety features in mind (e.g. bioretention bumpout, trees for traffic calming).
- **Greenspace:** It may be possible in manicured or some hardened areas of ravines and city greenspace to restore lands to natural cover, such as forest, meadow, riparian, and wetlands habitats. Urban wetlands or raingardens around catchbasins, and the addition of trees and shrubs, or pollinator gardens should be promoted instead of manicured lawn in parklands, where appropriate.

Low Impact Development Stormwater Management Practices

Low impact development stormwater management practices can include lot-level, conveyance, and end-of-pipe measures. This section provides an overview of low impact development techniques that may be considered for greening projects within the Highland Creek watershed. The Sustainable Technologies Evaluation Program (STEP) *Low Impact Development Stormwater Management Planning and Design Guide* should be referenced for best practices and site-level considerations before implementing low impact development projects. STEP has also developed a Treatment Train Tool that allows the stormwater benefits of low impact development to be quantified for different low impact

development configurations, which is a good resource for project designing. Toronto's *Green Streets Technical Guidelines* provide further direction for the planning, design, integration and maintenance of a range of green infrastructure options appropriate for Toronto street types and conditions.

- **Bioretention:** As a stormwater filter and infiltration practice, bioretention temporarily stores, treats and infiltrates runoff. Bioretention techniques include the installation of a filter bed (a mixture of sand, fine and organic material), mulch ground cover and plants adapted to the conditions of a stormwater practice. Bioretention is designed to capture small storm events or the water quality storage requirement. An overflow or bypass is necessary to pass large storm event flows.
- **Green roofs:** Green roofs consist of a thin layer of vegetation installed on top of a conventional flat or sloped roof. Green roofs can offer benefits such as improved energy efficiency, reduced urban heat island effects, and create habitat for insects and birds. From a hydrologic perspective, the green roof acts like a lawn or meadow by storing rainwater in the growing medium and ponding areas. Excess rainfall enters underdrains and overflow points and is conveyed in the building drainage system. After the storm, a large portion of the stored water is evapotranspired by the plants, evaporates or slowly drains away.
- **Infiltration practices:** On sites suitable for underground stormwater infiltration practices, there are a variety of facility design options to consider, such as bioswales, infiltration trenches and infiltration chambers. Suitable sites include those where the water table is at sufficient depth (>1 m below the depth of the facility). These facilities have the smallest footprint in pervious soils such as sand and gravel. Where appropriate, these facilities can be installed below road right-of-ways, boulevards, parking lots, and parks adjacent to impervious surfaces. In general, paved or landscaped areas downstream of existing catchbasins and upstream of stormwater outfalls are all places to consider these technology retrofits.
- **Permeable pavement:** Permeable pavements, an alternative to traditional impervious pavement, allow stormwater to drain through them and into a stone reservoir where it is infiltrated into the underlying native soil or temporarily detained. They can be used for low traffic roads, parking lots, driveways, pedestrian plazas and walkways. Permeable pavement is ideal for sites with limited space for other surface stormwater best management practices.
- **Rainwater harvesting:** Rainwater harvesting is the process of intercepting, conveying and storing rainfall for future use. The rain that falls upon a catchment surface, such as a roof, is collected and conveyed into a storage tank. When harvested rainwater is used to irrigate landscaped areas, the water is either evapotranspired by vegetation or infiltrated into the soil, thereby helping to maintain predevelopment water balance.
- **Swales:** Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff. Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. A dry swale is a design variation that incorporates an engineered soil media bed and optional perforated pipe underdrain system. Where development density, topography and depth to water table permit, enhanced grass swales are a preferred alternative to both curb and gutter and storm drains as a stormwater conveyance system. When incorporated into a site design, they can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.
- **Vegetated filter strips:** Vegetated filter strips are gently sloping, densely vegetated areas that treat runoff as sheet flow from adjacent impervious areas. They function by slowing runoff velocity and

filtering out suspended sediment and associated pollutants, and by providing some infiltration into underlying soils. Vegetation may be comprised of a variety of trees, shrubs and native plants to add aesthetic value as well as water quality benefits.

Urban Tree Planting and Backyard Greening

Urban tree planting and backyard greening, including industrial and commercial opportunities, should be explored throughout the Priority Greening Area for Greening Principle #3 (Green Infrastructure). Often municipal tree canopy targets cannot be met on municipal lands alone. Therefore, to achieve tree canopy goals the City must encourage and promote trees to be planted on private properties. Greening projects might include: backyard greening (planting native trees and shrubs, downspout disconnection to native rain gardens), street trees, parkland trees, natural area trees, and stormwater planters.

Priority neighbourhoods for enhancing the urban tree canopy have been identified based on where the need and opportunities are greatest as determined by satellite imagery interpretation. Urban street tree planting projects should be prioritized in neighbourhoods where existing tree canopy is lowest, and where these trees could also provide the most watershed benefits. See the Map Viewer for priority neighbourhoods for urban tree canopy enhancement.

GLOSSARY OF TERMS

Ecological integrity: Which includes hydrological integrity, means the condition of ecosystems in which:

a. the structure, composition and function of the ecosystems are unimpaired by the stresses from human activity;
b. natural ecological processes are intact and self-sustaining; and
c. the ecosystems evolve naturally.

(*Greenbelt Plan*, 2017)

Ecosystem services: benefits people obtain from ecosystems. There are four categories of ecosystem services, including provisioning services (e.g. food, drinking water), regulating services (e.g. carbon regulation, water purification), cultural services (e.g. recreational, spiritual), and supporting services (e.g. nutrient recycling and soil formation) (Adapted from Millennium Ecosystem Assessment, 2005).

Flood vulnerable cluster: sub-area within the *Regulatory Storm Flood Plain* containing multiple existing structures and/or roads for which a single, comprehensive flood remediation approach may be viable (TRCA, 2014).

Geomorphic systems: in this context are river processes that govern the movement of sediment and erosion or deposition on the river bed and banks.

Green infrastructure: Natural and human-made elements that provide ecological and hydrologic functions and processes. Green infrastructure can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs (*Growth Plan*, 2019).

Green street: A green street is a road or street that incorporates green infrastructure, which includes natural and human-made elements such as trees, green walls, and low impact development stormwater infrastructure that provide ecological and hydrological functions and processes.

Low impact development: An approach to stormwater management that seeks to manage rain and other precipitation as close as possible to where it falls to mitigate the impacts of increased runoff and stormwater pollution. It typically includes a set of site design strategies and distributed, small-scale structural practices to mimic the natural hydrology to the greatest extent possible through infiltration, evapotranspiration, harvesting, filtration, and detention of stormwater. Low impact development can include, for example: bioswales, vegetated areas at the edge of paved surfaces, permeable pavement, rain gardens, green roofs, and exfiltration systems. Low impact development often employs vegetation and soil in its design, however, that does not always have to be the case and the specific form may vary considering local conditions and community character (*Growth Plan*, 2019).

Natural cover: includes lands occupied by naturally and culturally occurring native or non-native vegetation (e.g. forest, wetland, or meadow) that is not characterized as agricultural or urban land uses (TRCA, 2014).

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 (*Growth Plan, 2019*).

Urban tree canopy: the urban forest, or urban tree canopy, consists of valleyland and tableland trees, street, park, and yard trees all in an urban setting, which make an important contribution to the beauty and ecological function of the urban landscape; the older ravine system, under pressure from increasing population due to intensification targets, is bolstered by this green infrastructure (TRCA, 2014).

Watershed Planning: Planning that provides a framework for establishing goals, objectives, and direction for the protection of water resources, the management of human activities, land, water, aquatic life, and resources within a watershed and for the assessment of cumulative, cross-jurisdictional, and cross-watershed impacts.

Watershed planning typically includes: watershed characterization, a water budget, and conservation plan; nutrient loading assessments; consideration of climate change impacts and severe weather events; land and water use management objectives and strategies; scenario modelling to evaluate the impacts of forecasted growth and servicing options, and mitigation measures; an environmental monitoring plan; requirements for the use of environmental best management practices, programs, and performance measures; criteria for evaluating the protection of quality and quantity of water; the identification and protection of hydrologic features, areas, and functions and the interrelationships between or among them; and targets for the protection and restoration of riparian areas. Watershed planning is undertaken at many scales, and considers cross-jurisdictional and cross-watershed impacts. The level of analysis and specificity generally increases for smaller geographic areas such as subwatersheds and tributaries (*Growth Plan*, 2019).

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APPENDIX A

This appendix provides an overview of all the potential restoration opportunities in the Highland Creek watershed, as well as the Priority Greening Sites for Greening Principles 1 and 2.

Table 3 identified all potential restoration sites within TRCA's ROP database. See **Figure 3** or the map viewer for a visual representation of these sites.

Table 3 - All Potential Restoration Sites

Restoration Site (alphabetical order)	**Size of restoration opportunity by habitat type (ha)**				**Total size of potential habitat restoration (size in ha)**	**Amount of site publicly owned (size in ha)**	**Amount of site privately owned (size in ha)**
	Forest	**Meadow**	**Riparian**	**Wetland**			
1 Toyota Place	0.000	0.000	0.170	0.000	0.170	0.000	0.170
110 Grangeway Ave	1.689	0.000	0.000	0.000	1.689	0.000	1.689
1100 Bellamy Rd N	0.430	0.000	0.000	0.000	0.430	0.000	0.430
165 Tapscott Rd	1.485	0.000	0.000	0.000	1.485	0.000	1.485
1680 Brimley Rd	1.340	0.000	0.000	0.000	1.340	0.000	1.340
1750 Brimley Rd	2.978	0.000	1.297	0.268	4.543	0.000	4.543
184 Galloway Rd	0.208	0.000	0.000	0.000	0.208	0.000	0.208
1845 Birchmount Rd	2.430	0.000	0.535	0.143	3.108	0.000	3.108
2075 McNicoll Ave	0.000	2.728	0.000	0.000	2.728	0.000	2.728
211 Prudential Dr	0.000	0.000	0.258	0.275	0.533	0.000	0.533
2150 McNicoll Ave	0.659	0.000	0.272	0.226	1.157	1.157	0.000
2250 Markham Rd	2.092	0.000	0.000	0.000	2.092	0.019	2.072
2265 Markham Rd	1.044	0.000	0.000	0.000	1.044	0.028	1.016
25 Borough Dr	2.026	0.000	0.000	0.000	2.026	0.000	2.026
28 Blaisdale Rd	0.083	0.000	0.000	0.000	0.083	0.000	0.083
288 Clayton Dr	0.263	0.000	0.030	0.015	0.308	0.000	0.308
290 Scarborough Golf Club Rd	0.542	0.000	0.000	0.000	0.542	0.476	0.065

Restoration Site (alphabetical order)	Size of restoration opportunity by habitat type (ha)				Total size of potential habitat restoration (size in ha)	Amount of site publicly owned (size in ha)	Amount of site privately owned (size in ha)
	Forest	Meadow	Riparian	Wetland			
3 Clayton Dr	0.523	0.000	0.000	0.000	0.523	0.000	0.523
30 Milner Ave	0.231	1.214	0.000	0.000	1.444	0.000	1.444
31 Tapscott Rd	0.452	0.000	0.000	0.000	0.452	0.000	0.452
3159 Lawrence Ave E	0.141	0.062	0.000	0.000	0.203	0.000	0.203
3450 McNicoll Ave	3.819	0.361	1.219	0.085	5.484	0.000	5.484
38 Pullman Crt	0.722	0.204	0.000	0.000	0.926	0.001	0.924
385 Passmore Ave	0.395	0.000	0.000	0.000	0.395	0.000	0.395
400 Passmore Ave	0.083	0.000	0.000	0.000	0.083	0.000	0.083
4171 Sheppard Ave E	0.988	0.000	0.000	0.000	0.988	0.000	0.988
44 Milner Ave	0.000	0.000	0.107	0.191	0.299	0.000	0.299
465 Coronation Dr	0.835	0.000	0.000	0.000	0.835	0.000	0.835
500 Progress Ave	1.337	0.000	0.000	0.000	1.337	0.000	1.337
55 Mike Myers Dr	0.782	0.000	0.000	0.000	0.782	0.000	0.782
7077 Kennedy Rd	0.459	0.000	0.000	0.000	0.459	0.000	0.459
80 Dale Ave	0.550	0.000	1.251	0.288	2.090	2.090	0.000
85 Executive Crt	0.000	0.000	0.034	0.015	0.049	0.000	0.049
Albert Campbell Collegiate Institute	0.532	0.000	0.000	0.000	0.532	0.532	0.000
Amberdale Ravine	0.188	0.000	0.086	0.000	0.275	0.275	0.000
Appleby Cres E/S	0.412	0.000	0.000	0.000	0.412	0.000	0.412
Beechgrove Ravine	2.701	0.000	0.000	0.000	2.701	0.861	1.839
Bendale Branch	2.892	0.000	14.949	0.000	17.841	14.886	2.955
Berner Trail Park	0.445	0.000	0.000	0.000	0.445	0.445	0.000
Beverly Glen Park	0.693	0.000	0.000	0.000	0.693	0.693	0.000
Birkdale Ravine	1.687	0.000	0.000	0.000	1.687	1.687	0.000
Bramber Woods Park	0.160	0.000	0.000	0.000	0.160	0.160	0.000
Bridgeport Dr	1.614	0.000	0.000	0.000	1.614	0.000	1.614

Restoration Site (alphabetical order)	Size of restoration opportunity by habitat type (ha)				Total size of potential habitat restoration (size in ha)	Amount of site publicly owned (size in ha)	Amount of site privately owned (size in ha)
	Forest	Meadow	Riparian	Wetland			
Brindlewood (Unknown)	3.400	0.000	0.610	0.000	4.010	0.000	4.010
Brooks Road	0.806	0.000	0.750	0.000	1.556	1.556	0.000
Burrows Hall Park	0.572	0.000	0.578	0.000	1.150	0.996	0.154
Canmore Park	0.213	0.000	0.083	0.000	0.296	0.296	0.000
Cedar Ridge Park	0.346	0.000	0.000	0.000	0.346	0.346	0.000
Cedarbrook Park	1.155	0.031	0.972	0.000	2.158	2.158	0.000
Centennial Creek	0.232	0.000	0.000	0.000	0.232	0.097	0.135
Centennial Park	1.136	0.000	0.299	0.019	1.454	1.454	0.000
Chartland Park	0.508	0.000	0.000	0.000	0.508	0.508	0.000
Chester Le Park	0.837	0.000	0.000	0.000	0.837	0.837	0.000
City of Toronto Open Space	0.745	0.000	0.046	0.040	0.831	0.086	0.745
Colonel Danforth Park	1.529	0.567	0.468	1.312	3.876	3.841	0.035
Confederation Park	1.003	0.000	0.138	0.000	1.140	1.140	0.000
Cornell Park	0.654	0.000	0.251	0.000	0.905	0.905	0.000
Curran Hall Ravine Park	1.010	0.000	0.079	0.000	1.089	1.089	0.000
Deekshill Park	2.743	0.000	0.898	0.000	3.641	3.331	0.311
Denison St S	2.227	0.000	0.050	0.014	2.292	0.000	2.292
Donwood Park	0.284	0.000	0.000	0.000	0.284	0.284	0.000
Dorset Park	1.692	0.000	0.000	0.000	1.692	0.881	0.810
Finch Hydro Corridor (McNicoll Hydro Corridor)	1.602	76.369	3.343	2.346	83.660	78.267	5.393
Dorset Park Branch	2.168	0.000	2.218	0.229	4.615	1.049	3.567
Future TTC Bus Garage	0.000	6.384	0.000	0.000	6.384	6.384	0.000
Glamorgan Park	1.311	0.000	0.000	0.000	1.311	1.311	0.000
GO Railway North	0.000	4.878	0.877	0.000	5.755	0.000	5.755
GO Railway South	4.829	0.422	0.344	0.000	5.596	5.494	0.102
Goldhawk Park	0.477	0.000	0.112	0.131	0.721	0.487	0.234

Restoration Site (alphabetical order)	Size of restoration opportunity by habitat type (ha)				Total size of potential habitat restoration (size in ha)	Amount of site publicly owned (size in ha)	Amount of site privately owned (size in ha)
	Forest	Meadow	Riparian	Wetland			
Greenspire Rd E/S	0.000	0.000	0.520	0.000	0.520	0.520	0.000
Greenvale Park	0.289	0.000	0.000	0.000	0.289	0.289	0.000
Grey Abbey Ravine	5.384	0.000	0.000	0.430	5.814	5.592	0.222
Hague Park	0.931	0.000	0.109	0.000	1.040	0.927	0.113
Harvest Moon Park	0.294	0.000	0.000	0.000	0.294	0.294	0.000
Havendale Park	0.975	0.000	0.000	0.000	0.975	0.975	0.000
Heron Park	0.027	0.000	0.000	0.000	0.027	0.027	0.000
Highgate Park	0.000	0.000	0.410	0.000	0.410	0.410	0.000
Highland Creek Park	1.015	0.000	1.108	0.000	2.124	2.124	0.000
Highland Heights Park	0.413	0.000	0.000	0.000	0.413	0.413	0.000
Hunters Glen Park	0.865	0.000	0.000	0.000	0.865	0.829	0.037
Huntingwood Dr	0.230	0.000	0.000	0.000	0.230	0.000	0.230
Inglewood Heights Park	0.000	0.000	0.327	0.000	0.327	0.327	0.000
Knob Hill Park	0.641	0.000	0.188	0.000	0.828	0.828	0.000
Knott Park	0.400	0.000	0.000	0.000	0.400	0.400	0.000
L'Amoreaux Park	5.963	0.000	5.967	0.000	11.930	11.346	0.584
Lawson Rd S N	0.307	0.000	0.000	0.000	0.307	0.307	0.000
Lower Highland Creek	0.144	0.000	0.000	0.000	0.144	0.144	0.000
Lower Highland Creek Park	1.835	0.000	1.313	0.233	3.381	3.381	0.000
Lusted Park	0.682	0.000	0.000	0.000	0.682	0.682	0.000
Lynngate Park	0.195	0.000	0.096	0.000	0.291	0.291	0.000
Malvern Branch	0.560	3.393	7.966	0.000	11.919	8.359	3.560
Manse Road Park	0.216	0.000	0.000	0.000	0.216	0.216	0.000
McCowan Park	3.076	0.000	0.000	0.000	3.076	3.076	0.000
Mcgregor Park	0.583	0.000	0.000	0.000	0.583	0.000	0.583
McLevin Ave S	1.502	0.000	0.000	0.000	1.502	1.502	0.000

Restoration Site (alphabetical order)	Size of restoration opportunity by habitat type (ha)				Total size of potential habitat restoration (size in ha)	Amount of site publicly owned (size in ha)	Amount of site privately owned (size in ha)
	Forest	Meadow	Riparian	Wetland			
Megan Park	0.411	0.000	0.384	0.000	0.795	0.795	0.000
Milliken Branch	3.200	0.000	18.379	0.000	21.579	20.215	1.364
Milliken Park	1.588	0.796	1.529	0.635	4.547	4.547	0.000
Mondeo Park	0.175	0.000	0.000	0.000	0.175	0.175	0.000
Morningside Park	4.097	1.092	3.376	2.538	11.103	11.103	0.000
MTO Lands	0.906	2.754	0.358	0.000	4.018	2.557	1.460
MTO ROW	0.527	0.000	0.284	0.000	0.811	0.000	0.811
Muirlands Park	0.245	0.000	0.000	0.000	0.245	0.245	0.000
North Bendale Park	0.566	0.000	0.809	0.000	1.375	1.375	0.000
North Bridlewood Park	1.102	0.000	0.000	0.000	1.102	1.097	0.005
Passmore Ave	0.795	0.000	0.000	0.000	0.795	0.000	0.795
Port Union Village Common	0.489	0.000	0.000	0.000	0.489	0.489	0.000
Pringdale Ravine	0.145	0.000	0.000	0.000	0.145	0.145	0.000
Rosebank Park	1.033	0.000	0.391	0.000	1.424	1.424	0.000
Scarborough Hydro Green Space	0.000	7.466	0.426	0.000	7.892	7.018	0.875
Scarborough SWM	0.028	0.000	0.057	0.000	0.086	0.086	0.000
Scottfield Dr	0.626	0.000	0.000	0.062	0.688	0.000	0.688
Shropshire Hydro Corridor	7.055	0.000	2.704	0.000	9.760	7.418	2.342
Snowhill Park	0.461	0.000	0.000	0.000	0.461	0.461	0.000
SRT Expansion	0.998	0.000	0.000	0.000	0.998	0.998	0.000
State Crown Blvd S	0.317	0.000	0.000	0.000	0.317	0.000	0.317
Tabor Hill Memorial Park	0.803	0.000	0.000	0.000	0.803	0.803	0.000
Terry Fox Park	1.114	0.000	0.163	0.000	1.277	1.277	0.000
The Meadoway (Gatineau Hydro Corridor)	0.889	112.690	1.503	1.413	116.495	116.350	0.146
Thomson Memorial Park	2.209	0.000	0.000	0.000	2.209	2.209	0.000
Trudelle Park	0.000	0.122	0.000	0.000	0.122	0.122	0.000

Restoration Site (alphabetical order)	Size of restoration opportunity by habitat type (ha)				Total size of potential habitat restoration (size in ha)	Amount of site publicly owned (size in ha)	Amount of site privately owned (size in ha)
	Forest	Meadow	Riparian	Wetland			
UTSc	1.519	6.191	1.659	1.921	11.291	0.010	11.281
Vradenberg Park	0.620	0.000	0.000	0.000	0.620	0.587	0.033
Wanita Park	0.985	0.187	0.416	0.000	1.588	1.524	0.064
Warden Park	0.578	0.000	0.051	0.000	0.629	0.629	0.000
West Hill Park	0.613	0.000	0.000	0.000	0.613	0.613	0.000
White Haven Park	0.366	0.000	0.000	0.000	0.366	0.366	0.000
Woodgrove Ravine Park	0.403	0.000	0.000	0.000	0.403	0.403	0.000
Zaph Ave E/S	0.651	0.000	0.000	0.000	0.651	0.651	0.000
Zaph Ravine	0.161	0.000	0.000	0.000	0.161	0.161	0.000

Table 4 identifies the ten priority sites associated with Greening Principle 1 – Natural Cover and provides an overview of the size of the restoration opportunity by habitat type and land ownership. See **Figure 4** or the map viewer for a visual representation of these sites.

Table 4 - GP #1 Priority Greening Sites

Restoration Site	GP1 Priority #	Highest Terrestrial Natural Heritage/ Connectivity IRP Score	Ownership	Size of Restoration Opportunities				
				Forest	Meadow	Riparian	Wetland	Total (Public & Private)
Finch Hydro Corridor	1	Medium priority (2)	Public – 13.13 ha Private – 0.22 ha	0 ha	12.27 ha	0.75 ha	0.34 ha	13.35 ha
Malvern Branch	2	Medium priority (2)	Public – 4.65 ha Private – 0.12 ha	0 ha	0.01 ha	4.76 ha	0 ha	4.77 ha
Deekshill Park	3	Medium priority (2)	Public – 3.33 ha Private – 0.31 ha	2.74 ha	0 ha	0.90 ha	0 ha	3.64 ha

Restoration Site	GP1 Priority #	Highest Terrestrial Natural Heritage/ Connectivity IRP Score	Ownership	Size of Restoration Opportunities				
				Forest	Meadow	Riparian	Wetland	Total (Public & Private)
Bendale Branch	4	Medium priority (2)	Public – 1.93 ha Private – 0 ha	0 ha	0 ha	1.93 ha	0 ha	1.93 ha
Milliken Branch	5	Medium priority (2)	Public – 1.35 ha Private – 0.01 ha	1.14 ha	0 ha	0.22 ha	0 ha	1.36 ha
Grey Abbey Ravine	6	Medium priority (2)	Public – 1.16 ha Private – 0.22 ha	1.38 ha	0 ha	0 ha	0 ha	1.38 ha
Burrows Hall Park	7	Medium priority (2)	Public – 0.68 ha Private – 0.01 ha	0.57 ha	0 ha	0.11 ha	0 ha	0.69 ha
Berner Trail Park	8	Medium priority (2)	Public – 0.45 ha Private – 0 ha	0.45 ha	0 ha	0 ha	0 ha	0.45 ha
Woodgrove Ravine Park	9	Medium priority (2)	Public – 0.40 ha Private – 0 ha	0.40 ha	0 ha	0 ha	0 ha	0.40 ha
Manse Road Park	10	Medium priority (2)	Public – 0.22 ha Private – 0 ha	0.22 ha	0 ha	0 ha	0 ha	0.22 ha

Table 5 identifies the ten priority sites associated with Greening Principle 2 – Aquatic Habitat and provides an overview of the size of the restoration opportunity by habitat type and land ownership. See **Figure 5** or the map viewer for a visual representation of these sites.

Table 5 - GP #2 Priority Greening Sites

Restoration Site	GP2 Priority #	Highest Aquatic IRP Score	Ownership	Size of Restoration Opportunities				
				Forest	Meadow	Riparian	Wetland	Total (Public & Private)
Finch Hydro Corridor	1	High priority (3)	Public – 25.84 ha Private – 1.84 ha	0.72 ha	25.59 ha	0.84 ha	0.53 ha	27.68 ha
Milliken Branch	2	High priority (3)	Public – 10.31 ha Private – 1.35 ha	1.14 ha	0 ha	10.52 ha	0 ha	11.66 ha
Goldhawk Park	3	High priority (3)	Public – 0.45 ha Private – 0 ha	0.45 ha	0 ha	0 ha	0 ha	0.45 ha
The Meadoway	4	Medium priority (2)	Public – 23.02 ha Private – 0.15 ha	0.10 ha	22.74 ha	0.21 ha	0.12 ha	23.17 ha
L'Amoreaux Park	5	Medium priority (2)	Public – 10.57 ha Private – 0.15 ha	5.75 ha	0 ha	4.97 ha	0 ha	10.72 ha
Bendale Branch	6	Medium priority (2)	Public – 10.22 ha Private – 2.94 ha	2.88 ha	0 ha	10.27 ha	0 ha	13.15 ha
Shropshire Corridor	7	Medium priority (2)	Public – 7.42 ha Private – 2.34 ha	7.05 ha	0 ha	2.70 ha	0 ha	9.75 ha
Malvern Branch	8	Medium priority (2)	Public – 6.78 ha Private – 1.35 ha	0.20 ha	0.93 ha	7.00 ha	0 ha	8.13 ha
Morningside Park	9	Medium priority (2)	Public – 5.91 ha Private – 0 ha	2.84 ha	0.98 ha	1.92 ha	0.17 ha	5.91 ha

Restoration Site	GP2 Priority #	Highest Aquatic IRP Score	Ownership	Size of Restoration Opportunities				
				Forest	Meadow	Riparian	Wetland	Total (Public & Private)
Go Railway South	10	Medium priority (2)	Public – 5.21 ha Private – 0.10 ha	4.55 ha	0.42 ha	0.34 ha	0 ha	5.31 ha

APPENDIX B

This appendix explains the evaluation process of floodplain roughness to guide riparian plantings that may occur as part of the implementation of the Highland Greening Strategy. Enhancing the riparian vegetation can produce local hydraulic impacts and hence result in a change in floodplain extents. An increase in floodplain elevation resulting in an increase in floodplain extents is undesirable. Therefore, it is imperative that prior to changing the type of vegetation, the impact of the change in vegetation be studied. **Please contact TRCA's engineering staff if you need more information.**

A hydraulic modelling exercise was undertaken to determine if the enhancement of riparian vegetation would affect the existing floodlines. This appendix outlines the methodology, results and conclusions of that modelling exercise. Areas where riparian plantings may be undertaken have also been specified along with other recommendations.

This exercise focused on the channelized sections of Highland Creek that are generally located north of the hydro corridor that runs in a north-west direction south of Highway 401. The branches of Highland Creek studied include the Dorset Park Branch, West Bendale Branch, Markham Branch & Malvern Branch. Many of these channels were initially constructed as flood control channels some of which are still concrete-lined. Three of the branches are also known flood damage centers and are included in TRCA's Flood Vulnerable Clusters (FVCs) database, namely, Dorset Park on the Dorset Park Branch, Kennedy Commons on the West Bendale Branch, and Progress Park on the East Markham Branch (see the map viewer for locations of the FVCs).

Methodology

Prior to the commencement of this exercise, a general methodology was decided on, in conjunction with Watershed Planning & Reporting, and Restoration Projects staff. The study utilizes the existing Highland Creek HEC-RAS hydraulic model constructed for the purposes of determining the regulatory floodplain extents. In order to examine whether a change in riparian vegetation has impacts on flood elevations, the Manning's n parameter was adjusted. Four proposed conditions scenarios were modelled where a different treatment of Manning's n was used for each scenario.

The resulting water surface elevations for each proposed condition were compared to the water surface elevations resulting from the existing conditions as represented in the existing model. The comparisons were made for the 1:100-year flow and the Regional flow. These flows were chosen because the City of Toronto has expressed that they are particularly interested in the 100 year flows and the TRCA is interested in looking at the Regional flows which form for the basis of the floodplain mapping program.

Proposed Riparian Greening Areas

Slopes and top of bank of the channelized water courses that appeared to have limited tree

and shrub cover were delineated as areas for riparian plantings. Low flow channels were omitted from having riparian planting potential. The widths of the delineated riparian polygons range from 2.5 m to about 30 m. The majority of the widths are within the 15 m to 20 m range. Polygons within 30 m of a watercourse are considered to have an impact and are generally classified as riparian. All delineations were performed using aerial photographs. A large portion of the delineated riparian polygons were field verified in 2011.

Manning's n

Manning's n is a roughness coefficient that represents the resistance to flood flows in channels and floodplains. The factors that affect channel and floodplain roughness vary from the physical form of the channel (meandering tendencies and channel geometry changes) to the nature of the channel (materials in the channel, surficial irregularities such as obstructions in the channel). It is commonly used in hydraulic models that utilize energy equations within the standard step procedure to determine water surface elevations for a given discharge. To represent the increase in roughness caused by the increase in riparian vegetation, the Manning's n value is increased.

For the typical floodplain mapping projects, TRCA uses standard values which are presented in **Table 6**.

Table 6 - Standard Manning's Roughness Coefficients for TRCA Watershed Hydraulic Modelling

Land Use	Description and Conditions	"n" Value[17]
Channel Component		
Watercourse/ Channel	• low flow channel • extends typically from bank to bank	0.035
Hydraulic Structures	• culvert crossings (e.g., corregated metal, concrete open/closed footing etc.) • bridge crossings	Variable[18]
Floodplain Component		
Urban Uses (Impervious)	• Road crossings, existing parking lots or any large impervious surfaces etc. • typically located within valley and stream corridors • Does not include structures or buildings (to be modelled using available ineffective flow	0.025

[17] Manning's "n" values represent average values based on literature data assuming flooding conditions.
[18] Refer to HEC-2 and/or HEC-Ras User's Manual for further details.

Land Use	Description and Conditions	"n" Value[17]
	area options)[2]	
Urban Uses (Pervious)	• Existing uses including municipal parks, playing fields, golf courses etc. • typically located within valley and stream corridors • Regular maintenance of area is required	0.050
Natural Areas	• Pasture, meadow, agricultural, riparian vegetation, brush and forest • located within urban and/or rural land use setting • typically located within valley and stream corridors • Not subject to regular maintenance • Assumes regeneration of open space type uses including pasture, meadow and agricultural uses within floodplain areas (Consistent with TRCA's VSCMP and Natural Heritage Strategies)	0.080
Flood Control Channels	• Flood control channels and associated works designed specifically for flood flow conveyance (eg., trapezoidal lined and un-lined channels etc.) • "n" value based on original design or maximum allowable value determined through a sensitivity analysis • Regular maintenance of area is required	Variable[19]

[19] Ibid

Figure 8 shows an example of riparian plantings with the associated *n* values.

Figure 8 - Example Plantings and Associated Roughness

As per TRCA's standard table, Manning's n (*n*) value of 0.035 is typically used for the low flow channel and it typically extends bank to bank. However, in the case of hydraulic structures, the channel roughness can be variable. A value of 0.035 typically represents a roughness within a channel with stony bottom and weedy banks for excavated or dredged channels that are characterized as "earth winding and sluggish". The value of 0.035 also characterizes "natural streams". Within this context, a natural stream is a non-excavated/non-dredged channel with a top width less than 100 feet at flood stage which is relatively straight and is characterized by stones and weeds. Please refer to the appended documents for details on ranges of the Manning's n values for a variety of scenarios.

The floodplain is typically modelled using one of three values – 0.025, 0.050 and 0.08. These values represent the urban impervious, the urban pervious and the natural areas that will not be maintained, respectively. The floodplain component of flood control channels, however, may be modelled using the design Manning's n values or a maximum allowable value as determined through a sensitivity analysis.

Existing Conditions Model

The existing HEC-RAS model has a very non-detailed and a conservative representation of channel floodplain roughness as required by TRCA standards for the purposes of modelling the regulatory flood. Each cross section has three zones of *n* values: left overbank, channel and right overbank. At almost all cross sections, *n* values at both left and right overbanks were equal. These overbank/floodplain roughness values range from 0.025 to 0.08 which represent roughness ranging from urban impervious to fully regenerated natural areas.

Since the existing model provides a non-detailed representation of roughness, an additional scenario – "Updated Existing Conditions" scenario was modelled wherein the channel and floodplain roughness were updated for two pilot study branches– the East Markham Tributary and the Malvern Tributary. Within these reaches, the landuse mapping was used to update both the floodplain and channel roughness. Additionally, the channel bank stations were adjusted to reflect the appropriate location of channel roughness.

Proposed Conditions Model

The following four proposed conditions scenarios were modelled:

- Proposed 1 (P1): Building on the existing conditions, cross sections within the Highland Riparian study area with Manning's n (*n*) values of less than 0.08 (0.02 to 0.063) were increased to 0.08 – in the floodplains only
- Proposed 2 (P2): Same as Proposed 1, and additionally, cross sections with *n* values of 0.08 were increased to 0.1 (25% increase) – in the floodplains only
- Proposed 3 (P3): Same as existing conditions but with an increase in in-channel *n* values to 0.08 within the Highland Riparian study area.
- Proposed 4 (P4): Same as the updated existing conditions but with the Manning's n within the riparian areas of part of the pilot study reaches were increased to 0.1. An updated existing conditions model was used wherein a few pilot reaches (East Markham Tributary & Malvern Branch of Highland Creek) were updated to reflect a more detailed floodplain and channel roughness. The reaches within the study area that did not have Flood Vulnerable Areas were chosen as the pilot reaches.

For the first scenario (P1), the overbank *n* values for all cross sections within the Highland Riparian area were increased to 0.08. For the second scenario, the floodplain roughness was represented by two *n* values 0.08 and 0.1. A total of 169 cross sections were represented by a floodplain roughness of 0.08; whereas the rest (222 cross sections) were represented by a floodplain roughness of 0.1. In the third scenario, the floodplain roughness was left unchanged (same as the existing conditions model). However, the in-channel roughness values within the Highland Riparian areas were increased to 0.08. The fourth proposed conditions scenario was built on the updated existing conditions. Two pilot study branches were chosen – Malvern Branch and East Markham Tributary. The reaches within the study area that did not have Flood Vulnerable Clusters were chosen as the pilot reaches. Within the pilot study area, the floodplain riparian areas were assigned a roughness of 0.1.

The roughness values chosen are fairly conservative. A floodplain *n* value of 0.08 represents a maximum value for light brush and trees (summer conditions). Whereas a value of 0.1 represents medium to dense brush in summer. It is anticipated that as part of the Highland Greening Strategy, the riparian plantings within the channelized sections of Highland Creek will be limited to shrubs and not trees. It is also expected that only the upper part of the side slopes of the trapezoidal channel that are above the low flow channel (in non-concrete lined channels) and the overbank areas will be planted.

Given the type of plantings proposed in the riparian areas, the choice of the floodplain roughness values is quite conservative. Furthermore, P2 is more conservative than P1 as it represents dense brush. The roughness values chosen also account for the assumption that the channel will have minimal maintenance, if any. The choice of the *n* values is also in keeping with TRCA's standard Manning's n roughness values. Scenario P3, is fairly conservative since it assumes that the entire channel will be planted. This option was also included because the bank stationing in the existing model does not align with the limits of the proposed riparian planting area. Therefore, part of the proposed planting area is within an area that is identified by the model to be "in-channel".

Scenario P4 offers the most accurate representation of Manning's n in both the proposed riparian areas and the remaining areas of the floodplain. The updated existing conditions model was further updated such that the delineated riparian areas outside the designated "in-channel" area was assigned a Manning's n value of 0.1 which, as mentioned previously, is representative of medium to dense brush in summer. This roughness value is a fairly accurate representation of the expected long-term established vegetation.

Results and Analysis

100-year Flow Results

Table 7 presents the water surface elevation (WSE) differences between the existing conditions and the proposed conditions for the four scenarios modelled (P1, P2, P3 & P4) for the 100-year event. Of the two scenarios where only the floodplain roughness was changed, the proposed scenario P2 generally shows larger increases in WSE than P1. The highest increase in the WSE is 0.14 m. The highest increases were noted at two locations – West Bendale Branch east of Kennedy Road and at the Markham Branch south of Hwy 401. At these locations, the difference in the lateral flood extents is negligible. Both the proposed conditions with riparian plantings and the existing conditions for the 100-year flood result in floodplain extents that are largely contained with the same area.

The WSE increases (above the WSE under the existing conditions scenario) for the P3 scenarios are significantly higher compared to the P2 scenario with the largest increase being 1.64 m. The largest increases were noted within the West Bendale Branch -west of Kennedy Road, East Markham Branch west of McCowan Road and Malvern Branch. **Please contact TRCA for these data sets.**

Table 7 - 100-year Water Surface Elevation Differences and Summary Statistics

Summary Statistics	P1-Ex	P2-Ex	P3-Ex	P4-UpEx
Min (m)	0.01	0.01	0.01	0.01
Max (m)	0.11	0.14	1.64	0.73
Mean (m)	0.01	0.02	0.51	0.17
Standard Deviation (m)	0.01	0.02	0.37	0.16
# of XS > 5 cm change	3	5	399	46*

Summary Statistics	P1-Ex	P2-Ex	P3-Ex	P4-UpEx
# of XS with an increase	148	192	448	66*
*Note: P4 scenario shows fewer total cross sections that show increases because changes were only made to two pilot study branches of Highland Creek in this scenario.				

Though the WSE appears to be significant, the mapping of these elevations on a DEM suggests that the lateral extents are not expected to change significantly if the floodplain roughness were to increase likely due to the fact that the flood is contained within the valley. However, an increase in the in-channel roughness causes a significant increase in the water surface elevations and the lateral flood extents in some areas.

Within the pilot study reaches for P4, the 100-year WSE results show that increases as high as 0.73 m can be expected. Within the East Markham Tributary reach, most of the increases were noted at the downstream end of the reach and at other locations downstream of a bridge or culvert. However, an examination of the flood extent polygon shows that no increase in existing flooding extents is expected. Within the Malvern Branch, the highest increases were noted at Malvern-1, the upstream-most reach and at immediately upstream of Sheppard Ave.

Regional Flow Results

Table 8 presents the WSE differences between the existing conditions and the proposed conditions for the four scenarios modelled (P1, P2, P3 & P4) for the Regional event.

The number of locations where WSE increased were noted under the regional event are much larger than those noted in the 100-year event. The number of cross sections showing large increases (i.e. greater than 5 cm, for the most conservative proposed conditions scenario (P3) is 405). This is very significant since it exceeds the number the total number of cross sections (391) that intersect with the proposed areas of riparian planting.

Table 8 - Regional Water Surface Elevations Differences and Summary Statistics

Summary Statistics	P1-Ex	P2-Ex	P3-Ex	P4-UpEx
Min (m)	0.01	0.01	0.01	0.01
Max (m)	0.13	0.16	1.85	0.77
Mean (m)	0.02	0.03	0.48	0.17
Standard Deviation (m)	0.02	0.03	0.36	0.17
# of XS > 5 cm change	14	46	405	56
# of XS with an increase	189	252	447	72
*Note: P4 scenario shows fewer total cross sections that show increases because changes were only made to two pilot study branches of Highland Creek in this scenario.				

Similar to the 100-year event, of the scenarios where only the floodplain roughness was changed, the P2 scenario shows the largest increases. The highest increase is 0.16 m. As with the 100-year event, the floodplain extents under proposed conditions (P2) do not appear to be very different from those under existing conditions.

For the P3 scenario, the average increase in the Water Surface Elevation was determined to be 0.48 m and the maximum increase was determined to be 1.85 m. These increases are fairly large compared to the P2 scenario. The increase in Manning's n from a range of 0.015 - 0.035 to a value of 0.08 is substantial and hence such results are expected.

Within the pilot study reaches, the Regional WSE results show that increases as high as 0.77 m can be expected. Within the East Markham Tributary reach, most of the increases were noted at the downstream end of the reach and at other locations downstream of a bridge or culvert. However, an examination of the flood extent polygon shows that no increase in existing flooding extents is expected. Within the Malvern Branch, the highest increases were noted at Malvern-1, the upstream-most reach and at immediately upstream of Sheppard Ave. An increase in floodplain extents was noted at Malvern-1.

Conclusions

1. Based on the modelled results & available information, the largest increase in water surface elevations (WSE) happens under the P3 scenario. The largest expected increases are 1.64 m for 100-year flow and 1.85 m for a regional flow.
2. The largest increases occur in the West Bendale Branch (upstream of Kennedy Road), East Markham Branch (upstream of Sheppard Ave) and Malvern Branch of the Highland Creek.
3. Within the pilot study reaches, water surface elevation increases as high as 0.77 m were noted. However, in almost all areas, the increase in the WSE did not result in increase in floodplain extents, Malvern-1 reach being the exception. The WSE increases were noted to mainly occur downstream of hydraulically constraining structures such as bridges and culverts. It must be noted that the absence of increase in lateral floodplain extents do not imply a lack of increase in flood risk.
4. Potential flooding impacts of stormwater outfalls backwatering as a result of increased vegetation in the vicinity of the outfalls were not examined in this exercise. The locations of stormwater outfalls must be considered prior to any riparian plantings.
5. Areas where plantings may be supported are shown in **Figure 9**. However, it must be noted that any reach identified as "Yes" may also have other constraining factors that must be taken into consideration before any riparian plantings.

Recommendations

1. A reassessment of the hydraulic work should be completed once the updated model is available.
2. Based on our current understanding of the hydraulic conditions of the watershed, additional riparian plantings within the following areas are not supported without further

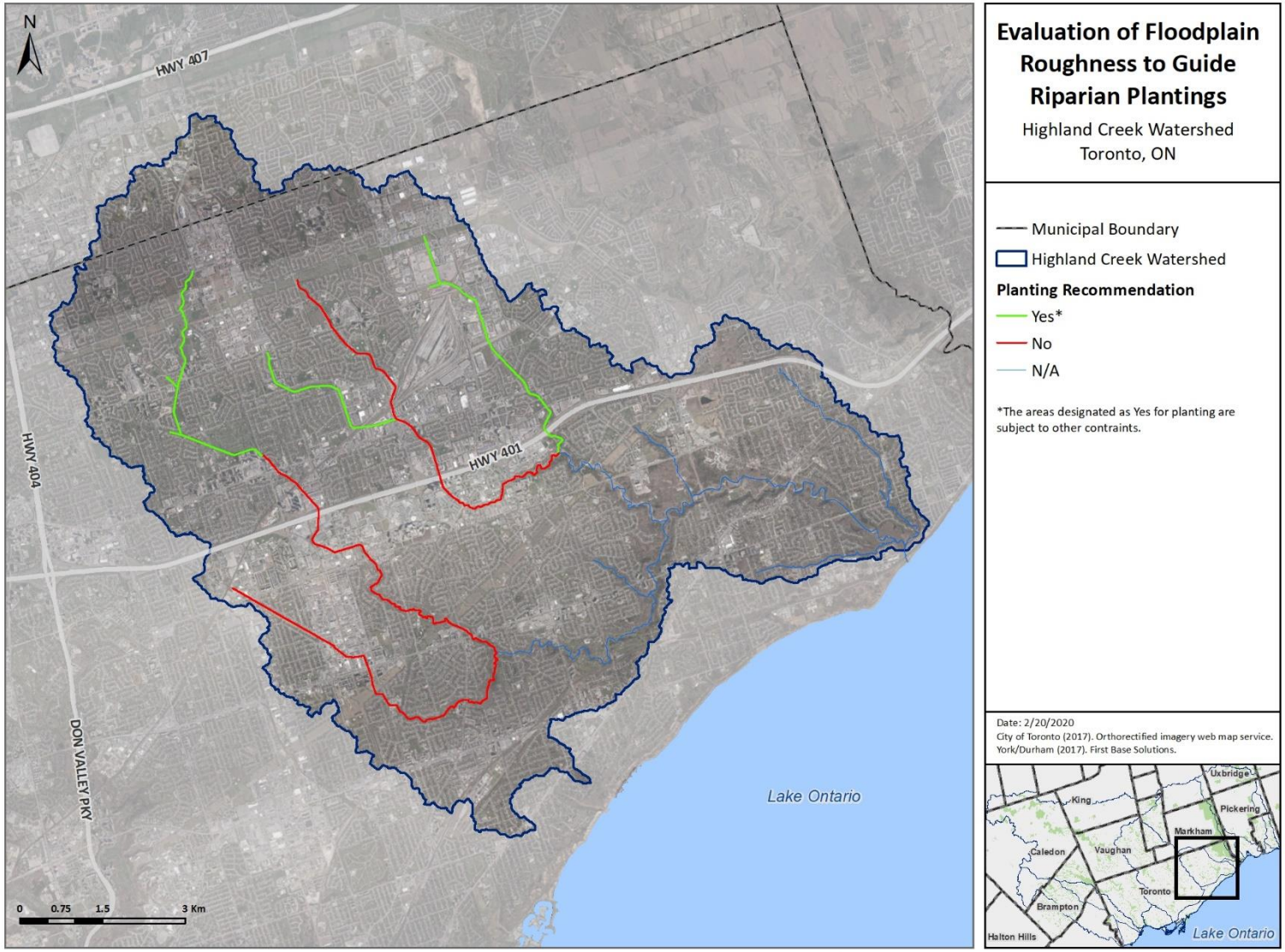
site-specific modelling:

a. Locations identified as Flood Vulnerable Clusters. TRCA and the City of Toronto will be undertaking a Flood Remediation Environmental Assessment to determine flood mitigation measures within the East Markham branch south of Hwy 401 for that FVC.
b. It is recommended that the conveyance within the flood control channels be maintained. Therefore, Engineering Services does not recommend plantings within the concrete-lined flood control channels. Instead it is recommended that vegetation and debris within concrete channels be removed.
c. Plantings should be avoided in the vicinity of hydraulically constraining structures, such as bridges and culverts as an increase in roughness in these areas will result in reduced conveyance through an already constraining flow structure. This will adversely affect WSE, and potentially the flood extents.

3. Plantings may be undertaken within areas outside of the FVCs and outside the concrete- lined flood control channels. Such areas would be the flat areas adjacent to the top of banks. The upper side slopes of the trapezoidal channels may also be planted. However, further detailed site-specific study would be required. Within these specified constraints, plantings may be undertaken in the following reaches:
    a. West Bendale branch of Highland Creek upstream of Kennedy Road
    b. East Markham Tributary of Highland Creek
    c. East Markham branch of Highland Creek upstream of Finch Ave
    d. Malvern branch of Highland Creek (with the exception of Malvern -1 reach, which is the upstream reach that showed an increase in floodplain extents)
4. There are a number of City of Toronto stormwater outfalls within the study area. When implementing the riparian plantings, it is recommended that a suitable buffer be maintained from the outfall, depending on their location and elevation, to avoid potential backwater and flooding issues. The City of Toronto should also be consulted to determine the appropriate buffer distance.
5. It should also be noted that Toronto Water does not permit planting of trees within a 10 m bank centered about a trunk sewer, i.e., 5 m on either side of the sewer centerline. Prior to undertaking riparian plantings, Toronto Water should be consulted to confirm sewer alignment related constraints.
6. If riparian plantings are desired in areas other than those recommended in this study, a detailed site-specific study is recommended. If channel conveyance inhibited by proposed vegetation is to be implemented, a change in channel dimensions (i.e. channel widening and/or deepening, may be required). Any such channel modification would require specific geomorphic assessments and hydraulic modelling to determine if natural channel design principles can be supported.
7. Proposed plantings should be evaluated on a case-by-case basis starting with priority sites. The flood risk associated with the specific plantings should be evaluated, at a minimum, using the technical guidelines established in the Ministry of Natural Resources and Forestry's Technical Guide for River and Stream Systems: Flooding Hazard Limit. There may be other site-specific requirements depending on the landuse and the associated risks.
8. Toronto Water should be consulted regarding the site-specific studies which could impact

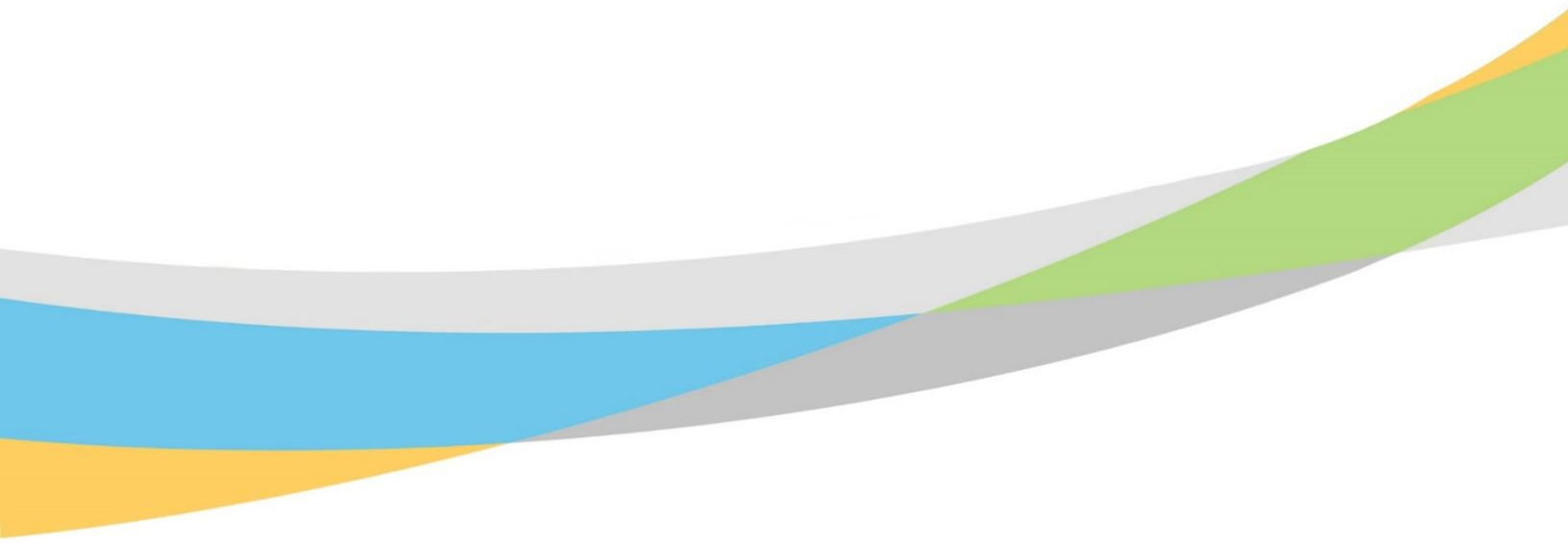
City infrastructure and/or City property.

9. Please contact TRCA for data layers containing water surface elevation (WSE) results at all cross sections in the study area, and the hydraulic model. The WSE data layer can be used to help determine the appropriate locations for increasing the riparian cover within Highland Creek watershed.



Disclaimer: The data used to create this map was compiled from a variety of sources and 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 TRCA. 416.661.6600

Figure 9 - Recommended Riparian Plantings

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