Credit Valley Conservation
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Black Creek Subwatershed Study: Management, Implementation, and Monitoring Plan
Phase 3 Study

Prepared by: Credit Valley Conservation,
Ecosystem Recovery Inc., North South Environmental

January 2020

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Resolution #101/19: Approval of CVC *Black Creek Subwatershed Study, Management, Implementation and Monitoring Plan, Phase 3 Study*

Date: November 8, 2019

THEREFORE BE IT RESOLVED THAT *the report entitled "Completion of the Black Creek Subwatershed Study" be received and appended to the minutes of this meeting as Schedule 'E'; and*

THAT *the Board of Directors approve the Black Creek Subwatershed Study; and*

THAT *Staff be directed to seek endorsement of the study from local and regional municipal councils; and*

THAT *copies of the Black Creek Subwatershed Study be provided to the Town of Halton Hills, Halton Region and the local MPP; and further*

THAT *CVC staff incorporate the implementation recommendations of the subwatershed study into the budget and work plans.*

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ACKNOWLEDGEMENTS

Credit Valley Conservation would like to acknowledge those **Municipal Agencies** whose jurisdiction extends into the Black Creek subwatershed, and who provided valuable input throughout this Phase III Management, Implementation and Monitoring Plan.

Halton Region
County of Wellington
Town of Halton Hills
Town of Erin

Credit Valley Conservation would also like to acknowledge the **Technical Committee** for their contributions to this subwatershed study. Their expertise spans across a range of specialty areas.

Credit Valley Conservation ..... Adrienne Ockenden
Credit Valley Conservation ..... Amanjot Singh
Credit Valley Conservation ..... Aviva Patel
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Credit Valley Conservation ..... Josh Campbell
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Credit Valley Conservation ..... Liam Murray
Credit Valley Conservation ..... Lisa Brusse
Credit Valley Conservation ..... Mark Eastman
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Credit Valley Conservation ..... Phil James
Credit Valley Conservation ..... Rod Krick
Credit Valley Conservation ..... Scott Sampson
Credit Valley Conservation ..... Sherwin Watson-Leung
Credit Valley Conservation ..... Tim Mereu
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North South Environmental..... Samantha Hughes

Credit Valley Conservation would also like to acknowledge the members of the **Steering Committee** for their valuable comments, suggestions and guidance throughout the development of this study.

Credit Valley Conservation ..... Alexandra Veglio

County of Wellington..... Jameson Pickard
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Conservation and Parks..... Lisai Shen
Ministry of Natural Resources..... Mark Heaton
Niagara Escarpment Commission..... Kim Peters
OMAFRA..... Peter Roberts
Halton Region ..... Behnam Doulatyari
Halton Region ..... Gena Ali
Town of Halton Hills..... Keith Hamilton
Town of Halton Hills..... Melissa Ricci
Town of Halton Hills..... Steve Burke
Town of Halton Hills..... Steve Grace

Members of the **Focus Group** are also acknowledged for they provided valuable input during the public consultation process. Their intimate knowledge of the study area was invaluable in the course of the study. Members of the focus group included concerned residents, local interest groups, and conservation organizations.

Special thanks are extended to the many **Private Landowners** in the subwatershed that gave us permission to access their property for data collection. The data we collected will help us to characterize the current condition of the subwatershed, consider the impact of various land uses on the environmental and water-related features of the subwatershed, and prepare a plan with recommendations for the appropriate management and stewardship of this subwatershed for future generations.

Table of Contents

List of Figures

List of Tables

List of Appendices

PREFACE

Credit Valley Conservation (CVC) and its member municipalities have a history of partnering together to develop watershed-based studies. These have included the Credit River Water Management Strategy Update (2007) and the Credit River Watershed Natural Heritage System (CRWNHS) (2015). The findings of these studies provide watershed wide guidance. The limitations of these studies lie in their ability to provide guidance for a smaller geographic area. As a result, since the early 1990s, CVC and its member municipalities have been developing Subwatershed Plans to provide more geographically specific guidance.

The development of watershed studies, subwatershed plans, and more specifically the Black Creek Subwatershed Study is a voluntary activity where all partners have collaborated to develop a road map to protecting, restoring, and enhancing the ecological integrity of the Black Creek subwatershed's features, functions and linkages, and to protect and enhance the quantity and quality of surface water and groundwater resources for environmental and human uses.

The Black Creek Subwatershed Study is only one of many management strategies that guide the use and protection of resources within the subwatershed. As such, the Black Creek Subwatershed Plan is a guidance document only. This study does not constitute a mandatory, legally binding document. Rather, it contains a comprehensive list of recommendations both to protect and enhance the environment, as resources and time become available. As partnerships are formed and resources permit, it is our intent that this document will direct us to where we should undertake activities to progressively protect the Black Creek subwatershed. As a tool in the planning process, The Black Creek Subwatershed Study provides guidance, which is further refined as information is collected at the site level.

As a critical tool for the adaptive management of the Credit River watershed, data is regularly collected at select monitoring sites and stations by CVC in all subwatersheds, including in the Black Creek subwatershed. Collecting data precisely to inform the characterization of a subwatershed is conversely a much more comprehensive and lengthy undertaking that often takes years to complete and is therefore conducted at less frequent intervals.

In the case of the Black Creek subwatershed, the historical and baseline data collected for the Background Report of the subwatershed study was gathered from 2007 to 2008 and was used to document existing subwatershed information and identify gaps in the data. Field work was then conducted in 2008 and 2009 to fill in the data gaps to help characterize the subwatershed. This work, along with information from other relevant reports and studies, informed the Phase 1 Characterization Report released in 2012.

Predominantly because there has been little change in land use, development, and population with regard to the Black Creek subwatershed in the last 10 years, the data collected for the Phase 1 Characterization Report continues to be applicable today. Comparing the land use map from 2018 in Figure 11 provided in this report with the land

uses map from 2009 in Figure 2.1.3 from the Phase 1 Characterization Report (2012) illustrates that —for the purposes of a characterization — changes in land uses and activities in the Black Creek subwatershed since 2009 have been negligible.

Moreover, an assessment of policy updates within the last decade has concluded that there have not been any significant changes in polices affecting the Black Creek subwatershed, which would demand an updated inventory and characterization. However, some policies have changed as the study has progressed through the different phases, and effort has been made to address those policy changes, which are reflected in the development of this Phase 3 report. Therefore, while potentially perceived by the public as being dated, current reviews of land use and policies have determined that the 2008-2009 data from the Phase 1 Characterization Report is still considered scientifically accurate and valid and continues to provide a relevant characterization of the Black Creek subwatershed today for the development of the current Phase 3 Management, Implementation and Monitoring Plan.

BLACK CREEK SUBWATERSHED STUDY SUMMARY

The Black Creek subwatershed, also known as Subwatershed 10, is one of 20 subwatersheds forming the Credit River watershed. The Black Creek Subwatershed Study has been completed to document the natural heritage characteristics of the subwatershed, to establish long term objectives for managing the watershed, to identify opportunities and threats, and to present a comprehensive management plan that will guide the CVC, the area municipalities, landowners and industry in protecting and restoring the subwatershed moving forward. As illustrated on Figure E 1, the majority of the subwatershed is in Halton Hills, with the northern part of the headwaters extending into the Town of Erin. The subwatershed is predominately rural with a mix of agricultural lands and an extensive natural heritage system including parts of the Niagara Escarpment. Acton and the western limit of Georgetown are the largest municipalities in the subwatershed.

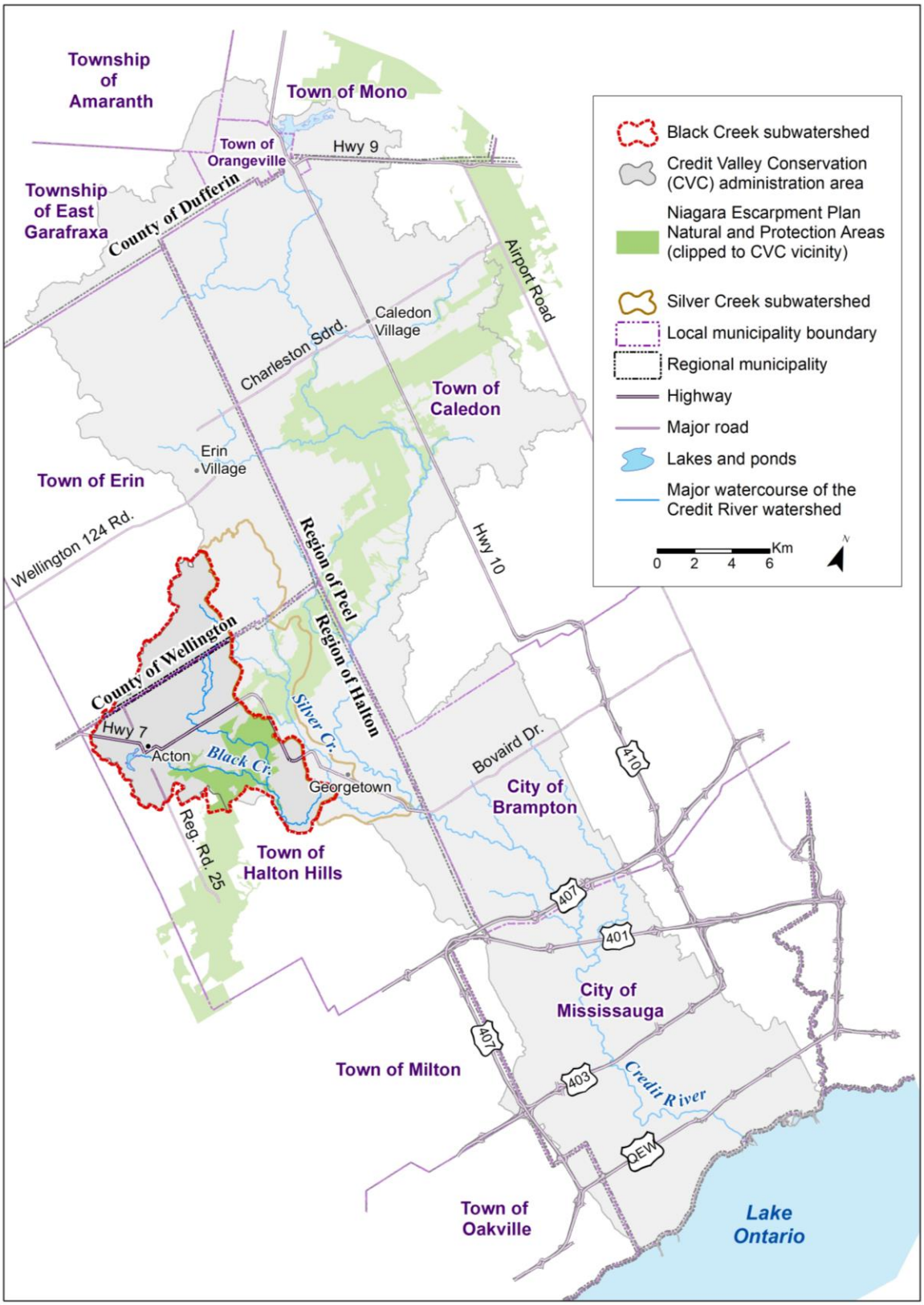
The Black Creek Subwatershed Study was completed in three phases.

- *Black Creek Subwatershed Study Phase 1 Characterization Report (CVC et al., 2012)* - focused on developing a sound understanding of the features, functions and linkages of the environmental resources in the Black Creek subwatershed. From this work, goals and objectives were established.
- *Black Creek Subwatershed Impact Assessment Phase 2 Study (CVC et al., 2014) -* identified the threats, measured the impacts against the goals and objectives identified in Phase 1, and evaluated measures to mitigate land use practices. A set of six management scenarios were evaluated using groundwater and surface water hydrologic and hydraulic models to identify changes in existing conditions and variances from the subwatershed study goals and objectives. From this study, a preferred management strategy was determined for the subwatershed.
- *Black Creek Subwatershed Study: Management, Implementation, and Monitoring Plan (CVC et al., 2019)* – provides guidance, recommendations and implementation measures for a broad range of activities including upgrading or implementing new municipal infrastructure, protecting groundwater quality and quantity, improving surface water quality including Fairy Lake, guiding protection and restoration activities associated with watercourse and natural heritage features, implementation of new urban development and aggregate resource extraction.

While the Phase 3 report focuses on recommendations and implementation, understanding the previous two phases is helpful in clarifying how the management plans and recommendations were developed. Therefore, a summary has been provided herein regarding the scope and findings of both Phase 1 and Phase 2.

Phase 1 - Subwatershed Characterization

Over the last 50 years, Black Creek has significantly improved in condition; where once it received discharge from local tannery operations and minimally treated sanitary sewage, it is now habitat to one of the healthiest populations of Brook Trout in the CVC watershed. While conditions have improved, today the subwatershed is experiencing additional stressors from urban growth, aggregate operations, agricultural activities and external factors such as climate change.



Watercourses (CVC, 2018); Lakes and ponds (CVC, 2017); Black Creek subwatershed (CVC, 2009); Niagara Escarpment Plan land use designations (Ontario Ministry of Natural Resources and Forestry, 2018)

Figure E 1 The location of the Black Creek subwatershed within the Credit River watershed

The Black Creek subwatershed includes 56 per cent anthropogenic land uses while 44 per cent is natural. The land use can be further characterized as follows:

- Urban and Rural Development (19.4 per cent),
- Aggregate Extraction (2.4 per cent),
- Agriculture (34.3 per cent),
- Forest and Wooded Swamp (24 per cent),
- Wetland (13 per cent),
- Plantations (2 per cent), and
- Old Fields (4.6 per cent).

In characterizing the subwatershed, Phase 1 addressed a broad range of focus areas, including: hydrogeology and water balance, surface water conveyance and fluvial geomorphology, terrestrial ecology, surface water quality, benthic invertebrates, and aquatic ecology. For each of these disciplines an in-depth understanding of the subwatershed was developed, along with an understanding of the interdependence of each of them. The characterization demonstrated that the groundwater recharge is critical to maintaining the availability of potable water and in maintaining the ecological health of the Black Creek subwatershed. As a key example, the relationship between groundwater discharge and surface water features is an integral part of the coldwater fishery sustained in much of Black Creek.

Based on the findings, the subwatershed has been divided into seven subcatchment zones based on commonalities in features, such as surface water flow characteristics, natural landscapes, and land use activities. These seven zones were also ultimately used to establish management priorities. The seven zones are illustrated on Figure E 2.

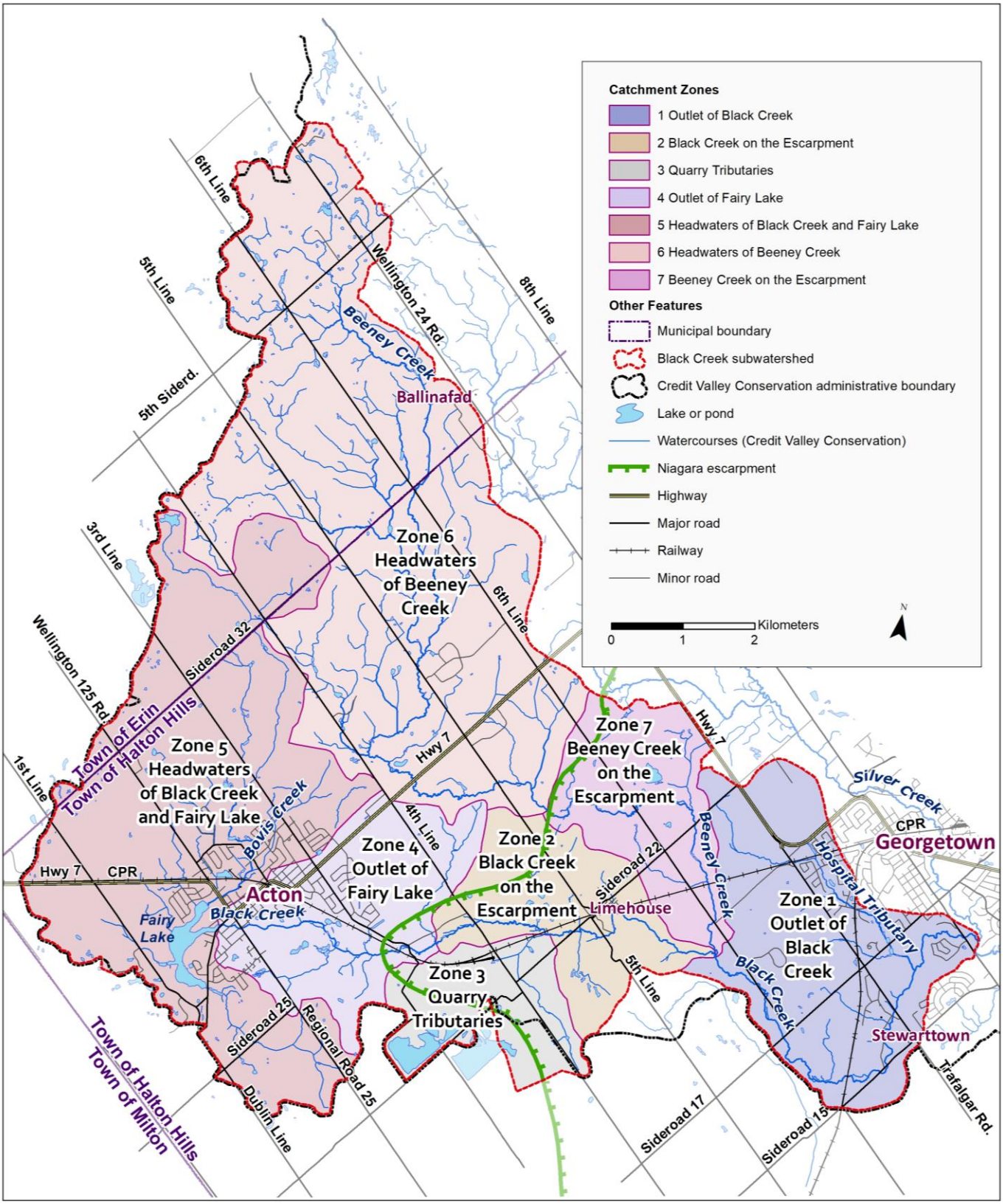
Following the Phase 1 characterization, the Goals and Vision for the Black Creek subwatershed were developed from the input provided by the public, landowners, and businesses present at the focus group meetings, as well as input from the Technical and Steering Committee.

<u>Goals</u>

1. Protect, enhance, and restore Black Creek;
2. Manage the Black Creek subwatershed through planning, stewardship, education, and monitoring;
3. Enhance our knowledge of the Black Creek human development and natural features, and animal and plant populations; and
4. Involve, educate, and collaborate with the Black Creek communities and stakeholders.

<u>Vision</u>

1. Ensuring human uses are in harmony with the environment;
2. Providing a healthy, natural heritage system linking land, water, and stream banks;
3. Maintaining healthy, diverse, and self-sustaining populations of plants and animals;
4. Fostering restoration and enhancement of natural features, functions, and linkages;
5. Valuing the Black Creek subwatershed by using its resources sustainably;
6. Ensuring public health and safety; and,
7. Ensuring a sustainable and healthy Black Creek for present and future generations.



Watercourses (CVC, 2018); Lakes and ponds (CVC, 2017); Subcatchment zones (CVC, 2009); Physiography of Southern Ontario (Ontario Geological Survey, 1972)

Figure E 2 The seven subcatchment zones of the Black Creek subwatershed

To translate the goals and vision into meaningful measurable targets and recommendations, ten (10) objectives were developed. All of the objectives are considered to be of equal importance in achieving the overall goals and vision of the Black Creek subwatershed.

1. **Promote Awareness**: Increase awareness of the linkages between healthy water, healthy lifestyle, and the economic viability of rural and urban land uses.
2. **Increase Knowledge**: Increase knowledge about the wise use of surface and groundwater, having regard to both human and ecological need.
3. **Increase participation**: Increase participation in stewardship actions, in particular priority areas identified in the subwatershed study. Promote the need for environmental stewardship and better understanding of the importance of natural features and functions of the Credit River watershed.
4. **Preserve Hydrologic Cycle**: Preserve and re-establish the natural hydrologic cycle.
5. **Maintain, enhance or restore watercourse function**: Maintain, enhance or restore natural stream processes to achieve a balance of flow and sediment transport.
6. **Reduce Erosion**: Manage stream flow to reduce erosion impacts on habitats and property.
7. **Minimize Flood Risk:** Minimize risk to human life and property due to flooding.
8. **Maintain groundwater levels and baseflow:** Maintain groundwater levels and baseflows (groundwater discharge to streams) to sustain watershed functions and human uses.
9. **Maintain or enhance water quality**: Maintain or enhance water and sediment quality to achieve ecological integrity.
10. **Protect, restore or enhance ecosystem**: Protect, restore or enhance the integrity of the watershed ecosystem through an integrated network of natural areas, habitats and connecting links.

Phase 2 - Impact Assessment

Completing an impact assessment is important to gain a better understanding on how different actions and activities throughout the subwatershed affect the environment. The results of the impact assessment provide the context and guidance needed to address different environmental concerns that were identified, and to protect the healthy natural areas from future changes. Potential impacts from uncontrolled stormwater, increased groundwater takings, and urbanization all negatively impact our natural areas if not mitigated properly.

In total six alternative scenarios were developed and compared for existing and future land uses. The future land use scenarios conform to the Provincial Growth Plan for the Greater Golden Horseshoe (Places to Grow), as defined in the Official Plans (OP) of the member municipalities within the study area to the year 2031. The potential influences of each of the alternative management scenarios on the existing and potential future conditions of the Black Creek subwatershed were assessed using a modelling approach.

The six management scenarios that were evaluated included:

- ***Scenario 1: Baseline Conditions*** – existing land use conditions with no additional stormwater management (SWM) measures;
- ***Scenario 2: Business as Usual*** - the application of the existing approach to SWM to new development based on OP 2031;
- ***Scenario 3: Low Impact Development (LID) in New Development*** - the application of LID SWM practices to new areas of urban development;
- ***Scenario 4a: LID in New Development and Retrofitting of LID to Existing Development*** - the application of LID SWM practices to new development and to previously developed areas through retrofitting;
- ***Scenario 4b*** – consistent with Scenario 4a plus enhanced NHS; and,
- ***Scenario 4c*** – consistent with Scenario 4a plus enhanced NHS and implementation of agricultural BMPs.

It was concluded that the need for and effectiveness of each management scenario varied across the seven catchment zones. In response the recommended management scenarios vary from zone to zone, although broadly speaking Scenario 4c is preferred because it achieved the level of environmental protection and restoration that is required to maintain or enhance current environmental conditions without further damage.

Table E 1 summarizes the management procedures applicable to the seven catchment zones, including high priority and secondary priority catchment zones. The assignment of a high priority ranking versus a secondary ranking is based on the specific characteristics and relative benefits that will be derived from implementing the proposed measures. The priorities can broadly be summarized as follows:

- Adopt the enhanced NHS throughout the subwatershed, which includes elements defined under existing policies and practices (Greenbelt Plan, Halton Region NHS, Niagara Escarpment Commission), as well as additional lands based on stewardship (Credit River Watershed NHS);
- Implement LID as a holistic approach to SWM (i.e. through a treatment train approach) in all new developments in zones 1, 4 and 5;
- Implement LID as a holistic approach to SWM in existing developed areas through retrofitting existing land/infrastructure at a rate greater than 25 per cent of the land area in zones 1, 4, and 5; and
- Implement land management and infrastructural agricultural BMPs in zones 2, 5, 6 and 7.

Table E 1 Prioritization of Management Practices

Zone	Enhanced NHS	Agricultural BMPs	LID New Development	LID Retrofit in Existing Developed Areas
1	✓		✓✓	✓✓
2	✓	✓		
3	✓			
4	✓✓		✓✓	✓
5	✓✓	✓✓	✓	✓✓
6	✓	✓✓		
7	✓	✓		

Note: High priority implementation identified by two red check marks (✓✓); Secondary priority implementation is identified

Phase 3 - Management, Implementation and Monitoring

The Management, Implementation and Monitoring Plan presents the actions needed to protect and sustain the natural and human environment from known stressors, including: existing development, new development, rural activities, flooding and natural hazards, and resource extraction activities.

The Management, Implementation and Monitoring Plan was developed by a technical committee consisting of CVC staff, consultants, and municipal partners, with the assistance of the steering committee and focus groups. The Management Plan was completed to align with municipal and provincial planning documents and has been organized based on land use. The study also supports the CTC Source Protection Plan (*Source Protection Committee, 2015*). Overall, the plan aims to ensure land use and management decisions are carried out in a manner that:

- Examines the impacts of site decisions in a subwatershed and watershed context;
- Plans for long-term change and unexpected events;
- Avoids exploitive land uses that will deplete natural heritage features and impair associated functions;
- Avoids, where possible, the adverse impacts of development on ecological features and functions;
- Implements land use and management practices that are compatible with the natural features of the area; and
- Restore or enhance existing environmental conditions previously impacted by land use activities.

The Management, Implementation and Monitoring Plan has been divided into eight sections. They are grouped by land use activities, flooding and natural resources.

In total, 75 recommendations were developed. Each recommendation includes anticipated outcomes, implementation tools, timelines, and a list of the partners responsible for implementation. The recommendations are colour coded to reflect one of four implementation categories: policy, programming, land use planning and projects.

Land Use Activities

1. Existing Urban Development: Identifies opportunities to mitigate impacts from existing urban development on the subwatershed.
2. New Development: Provides direction for future studies, measures to mitigate impacts from new development, and strategies for the protection of important features and functions of the watershed.
3. Rural Land Use: Identifies opportunities to mitigate existing rural land use impacts on the subwatershed.
4. Aggregate Extraction: Identifies measures that aim to minimize impacts of aggregate extraction on the natural environment.
5. Conservation Properties: Identifies measures that provide direction to the management of conservation lands from the perspective of education, stewardship and land management.

Flooding

6. Natural Hazards: Identifies protection, management and remedial measures to manage flood and erosion risks to people and property.

Natural Resources

7. Natural Heritage: Identifies the natural heritage system, as well as aquatic and terrestrial restoration priorities to protect core areas and maintain and restore connectivity across the subwatershed.
8. Water Management: Identifies measures intended to guide both long term sustainability of groundwater, as well as the management of water takings and wastewater discharge from the perspective of the natural environment.

The recommendations address the broad range of activity in the Black Creek subwatershed. However, three key areas of focus have been identified that will help to guide the management and implementation plan by ensuring that our actions will generate the most positive impact. These include water quality, environmental resiliency and groundwater.

Water Quality: Nutrient levels (specifically Total Phosphorus (TP)) and chloride exceed Provincial Water Quality Objectives (PWQOs) in the Black Creek subwatershed due to various land use activities, including urbanization, stormwater runoff, waste water treatment plant discharge, and agricultural activities. TP will need to be managed by various mitigation techniques in urban and rural areas, before it has the chance to travel into Fairy Lake and downstream throughout the rest of the subwatershed. Chloride may be managed

through the careful application of road salt in the winter and by having contractors and maintenance staff properly trained on the negative impacts of salt on our environment.

Environmental Resiliency: In order to maintain and enhance the environmental features of Black Creek, a resilient and holistic approach is needed to protect and enhance the healthy areas and rehabilitate the areas of degradation. Terrestrial resiliency requires the healthiest areas to be protected, managed and enhanced where necessary, in order to retain the biodiversity of the area. Aquatic resiliency requires the most impaired areas to be restored back to a more natural and functional system, with restoration techniques including natural channel design, bank stabilization and riparian plantings with an increased buffer width. Addressing both the terrestrial and aquatic areas will lead to a more diverse and robust environmental system with more capacity to respond to change.

Groundwater: The protection of groundwater quantity and quality is a key requirement of the management plans for the Black Creek subwatershed. Groundwater is a critical resource from the perspective of both potable water supply and the sustaining of natural features. Groundwater quantity is deemed to be moderately stressed, based on results from the Phase 2 study and the CTC Source Protection Plan (*Source Protection Committee, 2015*). To reduce groundwater stress, measures must be taken to maintain recharge through permeability of the landscape and management of potential pollutants.

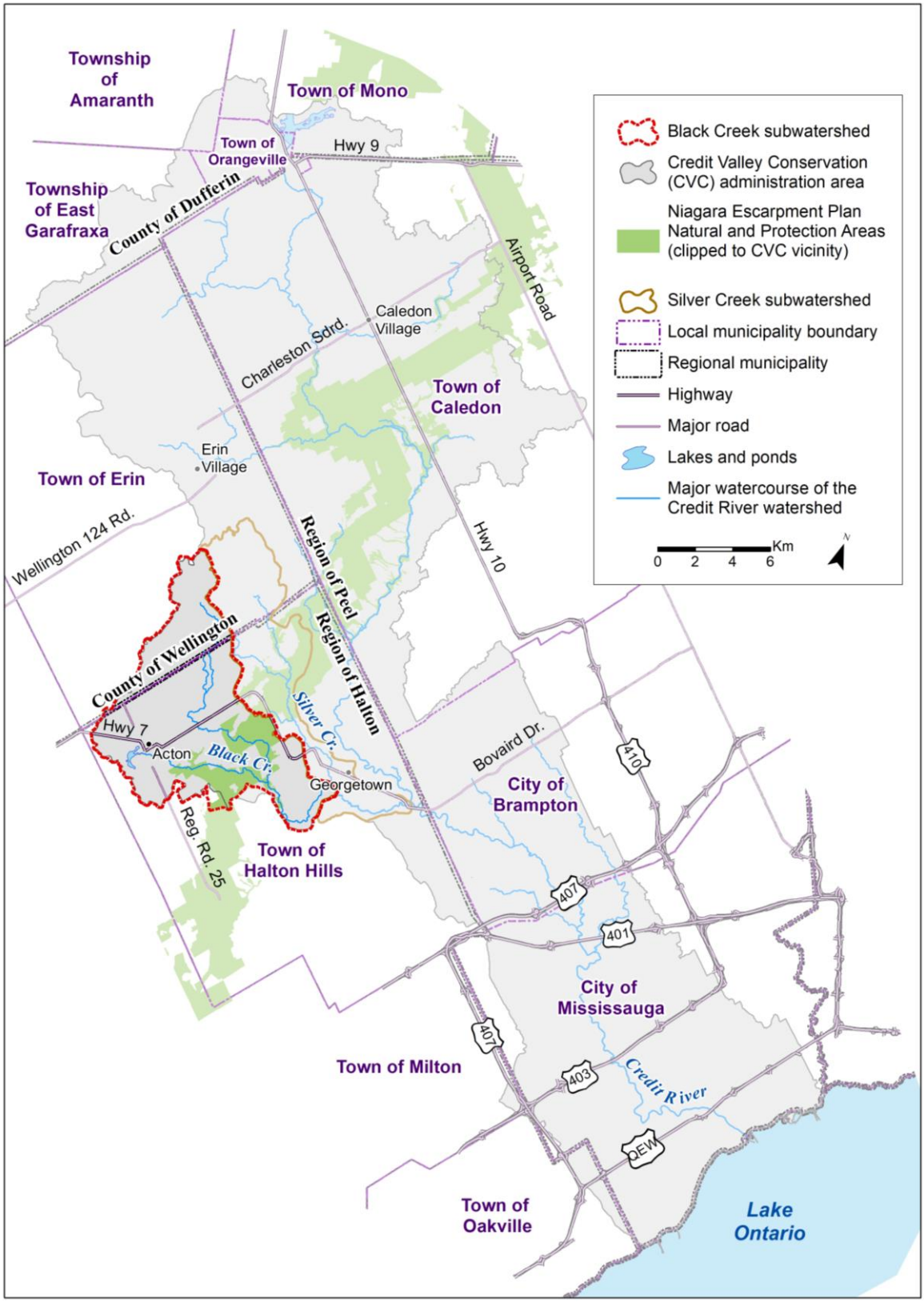
1. INTRODUCTION

The Black Creek subwatershed, also known as Subwatershed 10, is one of 22 subwatersheds forming the Credit River watershed. The Black Creek Subwatershed Study has been completed to document the environmental characteristics of the subwatershed, to establish long term objectives for managing the watershed, to identify opportunities and threats, and to present a comprehensive management plan that will guide the CVC, the area municipalities, landowners and industry in protecting and managing the subwatershed moving forward.

As illustrated on Figure 1, the majority of the subwatershed is in Halton Hills, with the northern part of the headwaters extending into the Town of Erin. The subwatershed is predominately rural with a mix of agricultural lands and an extensive natural heritage system including parts of the Niagara Escarpment. Acton and the western limit of Georgetown are the largest municipalities in the subwatershed.

Given the complexity of management issues within the study area it is important that management recommendation from the Black Creek Subwatershed Study be integrated with initiatives being undertaken by Wellington County, Halton Region, and Halton Hills. As such, the initial scope of the project has evolved to reflect the needs of municipal partners and affected agencies (e.g. Credit Valley Conservation Authority (CVC), Ministry of Natural Resources and Forestry (MNRF), and Ministry of the Environment, Conservation and Parks (MECP)). As such the subwatershed study:

(1) Provides the Regional Municipality of Halton, Town of Halton Hills, the Niagara Escarpment Commission (NEC) and Wellington County with information and technical recommendations to help assess the potential impacts associated with current and future land use changes, the expansion of municipal servicing and the extraction of aggregate resources.



Watercourses (CVC, 2018); Lakes and ponds (CVC, 2017); Black Creek subwatershed (CVC, 2009); Niagara Escarpment Plan land use designations (Ontario Ministry of Natural Resources and Forestry, 2018)

Figure 1 The location of the Black Creek subwatershed within the Credit River watershed

(2) Supports the complementary Source Water Protection study, the Tier 3 Water Budget, and the Water Quantity Risk Assessment.

(3) Supports the management of the adjacent subwatershed, the Silver Creek subwatershed (also referred to by CVC as Subwatershed 11), as Black Creek is a major tributary of Silver Creek.

1.1 Study Overview

Through the Black Creek Subwatershed Study process, CVC and project partners have completed four studies. The study phasing is illustrated in Figure 2.

Background

The first step of the study involved completing a scoping exercise to assess the available data and information, including examining historical conditions. This exercise resulted in the preparation of *the Black Creek Subwatershed Study, Background Report* (CVC et al. 2009) that documents existing subwatershed information and identifies gaps in the data.

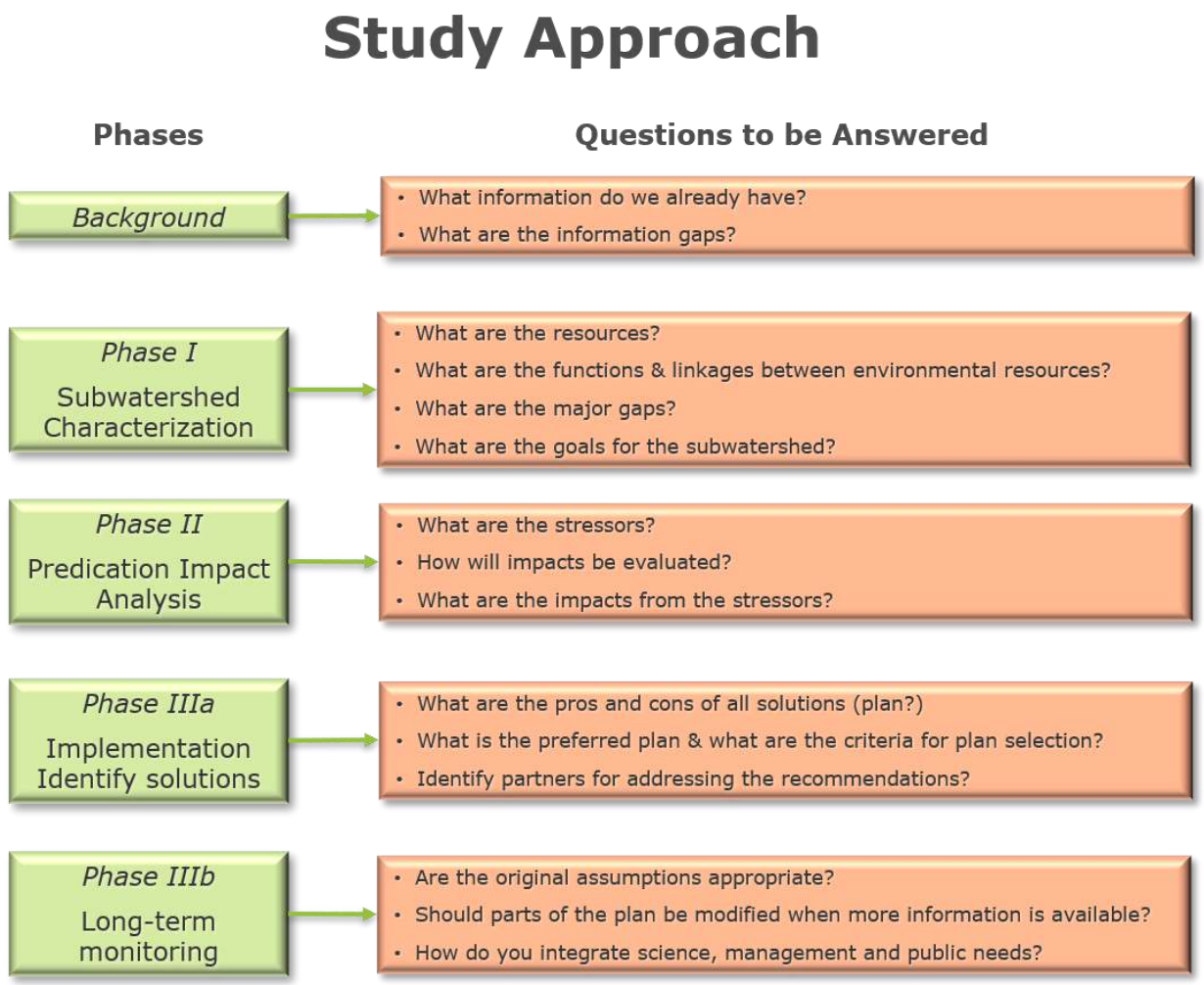


Figure 2 Subwatershed Study Process

Phase I – Subwatershed Characterization

The next step in the study process involved conducting field investigations to fill in the data gaps to help characterize the subwatershed. The majority of the field work for the Black Creek Subwatershed Study was completed in 2008 and 2009. The findings of the field work have been summarized in the *Black Creek Subwatershed Study Phase 1 Characterization Report* (CVC et al., 2012*)*, which describes the features, functions and linkages of the environmental resources in the Black Creek subwatershed. From this work, goals and objectives are developed for the Black Creek subwatershed.

Phase II -Prediction Impact Analysis

The *Black Creek Subwatershed Impact Assessment Phase 2 Study* (CVC et al., 2014*)*, the next step in the subwatershed planning process, identified the threats, measured the impacts against the goals and objectives identified in Phase 1, and evaluated measures to mitigate land use practices. A set of six land use scenarios were evaluated using groundwater and surface water hydrologic and hydraulic models to identify changes in existing conditions and variances from the subwatershed study goals and objectives. From this study, a preferred management strategy was determined for the subwatershed.

Phase III – Implementation and Monitoring

The final phase of the subwatershed planning process as presented in this report, the *Black Creek Subwatershed Management, Implementation, and Monitoring Phase 3 Study*, establishes the recommendations and implementation measures for achieving the best outcomes for the Black Creek subwatershed. The Implementation Plan is designed to reinforce the identified goals and objectives. The Implementation Plan identifies partners who can work together addressing various recommendations and the steps to be undertaken to achieve the established goals. The monitoring program identifies the process for measuring changes in the subwatershed over time. This monitoring will assess whether the assumptions made within the subwatershed study are appropriate and may trigger the need to refine our understanding of the environmental conditions or change our implementation actions.

1.2 Guiding Framework

Through the completion of Phase I the Goals and Vision for the Black Creek subwatershed were developed from the input provided by the public, landowners, and businesses present at the focus group meetings, as well as comments provided through public open house meetings and from input from the Technical and Steering Committee. The Goals and Vision, presented in Figure 3, were adopted by the technical and steering committee as a guiding framework for the Black Creek Subwatershed Plan.

OUR GOALS FOR BLACK CREEK

1. Protect, enhance, and restore Black Creek;
2. Manage the Black Creek subwatershed through planning, stewardship, education, and monitoring;
3. Enhance our knowledge of the Black Creek human development and natural features, and animal and plant populations; and
4. Involve, educate, and collaborate with the Black Creek communities and stakeholders.

OUR VISION OF BLACK CREEK

1. Ensuring human uses are in harmony with the environment;
2. Providing a healthy, natural heritage system linking land, water, and stream banks;
3. Maintaining healthy, diverse, and self-sustaining populations of plants and animals;
4. Fostering restoration and enhancement of natural features, functions, and linkages;
5. Valuing the Black Creek subwatershed by using its resources sustainably;
6. Ensuring public health and safety; and,
7. Ensuring a sustainable and healthy Black Creek for present and future generations.

Figure 3 Goals and Vision for the Black Creek subwatershed

To translate the goal and vision into meaningful measurable targets and recommendations, ten (10) objectives were developed. All the objectives are considered to be of equal importance in achieving the overall goals and vision of the Black Creek subwatershed.

1. **Increase awareness:** Increase awareness of the linkages between healthy water, healthy lifestyle, and the economic viability of rural and urban land uses
2. **Increase Knowledge:** Increase knowledge about the wise use of surface and groundwater, having regard to both human and ecological need.
3. **Increase participation:** Increase participation in stewardship actions, in particular priority areas identified in the subwatershed study. Promote the need for environmental stewardship and better understanding of the importance of natural features and functions of the Credit River watershed.
4. **Preserve Hydrologic Cycle**: Preserve and re-establish the natural hydrologic cycle.
5. **Maintain, enhance or restore watercourse function:** Maintain, enhance or restore natural stream processes to achieve a balance of flow and sediment transport.
6. **Reduce Erosion:** Manage stream flow to reduce erosion impacts on habitats and property
7. **Minimize Flood Risk:** Minimize risk to human life and property due to flooding
8. **Maintain groundwater levels and baseflow:** Maintain groundwater levels and baseflows (groundwater discharge to streams) to sustain watershed functions and human uses.
9. **Maintain or enhance water quality:** Maintain or enhance water and sediment quality to achieve ecological integrity.
10. **Protect, restore or enhance ecosystem:** Protect, restore or enhance the integrity of the watershed ecosystem through an integrated network of natural areas, habitats and connecting links.

1.3 Phase 3 - Management and Implementation Plan Report

This document is the last in a series of reports that together comprise the Black Creek Subwatershed Study. The report is intended to be read as a stand-alone document. The report addresses the following:

- Integrates the results of the Characterization (Phase 1) and the Impact Assessment (Phase 2) to understand the form, function, and features of the subwatershed and how they will be influenced by planned future activities;
- Develops recommendations to achieve the preferred management strategy that was determined in Phase 2;
- Develops an implementation plan that identifies strategies, roles, responsibilities, and timelines to guide the implementation of the recommendations; and

- Identifies a process for ongoing evaluation to inform status of subwatershed health, implement recommendations, and necessity for updates.

The intended outcome of the Management and Implementation Plan is to maintain, enhance, and restore key functions and linkages that are important to the health of the subwatershed. To this end the recommendations and implementation plan are aimed at ensuring land use and management decisions are carried out in a manner that:

- Examines the impacts of site decisions in a subwatershed and watershed context;
- Plans for long-term change and unexpected events;
- Avoids exploitive land uses that will deplete natural heritage features and impair associated functions;
- Avoids, where possible, the adverse impacts of development on ecological features and functions;
- Implements land use and management practices that are compatible with the natural features of the area; and
- Restore or enhance existing environmental conditions previously impacted by land use activities.

The report is organized in six chapters. The following provides an overview of each of the chapters.

Chapter 1 provides a brief **overview** of Black Creek and the Subwatershed Study approach, study area, study goals and vision, and a summary of concurrent studies, which should be considered in coordination with this study.

Chapter 2 provides a summary of **existing conditions,** entailing a description of the features, functions, and linkages of the environmental resources in the Black Creek subwatershed, including the environmental and water related issues.

Chapter 3 provides a summary of the **future challenges,** including an overview of the planned changes in land use and water resource management, and the effect of these changes, and the resulting implication for the adoption of best management practices (BMPs).

Chapter 4 presents the **Management Plan** for the preferred management strategy for specific areas of the Black Creek subwatershed. Chapter 4 provides recommendations for protecting, rehabilitating, and/or enhancing groundwater and surface water resources, natural heritage, and fisheries and aquatics. The Management Plan provides recommendations in eight key areas: (1) existing urban development; (2) new development; (3) rural land uses; (4) aggregate extraction; (5) conservation lands; (6) flooding and natural hazards; (7) natural heritage; and (8) water management.

Chapter 5 presents the **Implementation Plan** for the recommendations outlined in the Management Plan. Chapter 5 summarizes implementation considerations, including roles, responsibilities, and timelines, and provides recommendations on strategies for implementation of the Management Plan recommendations. Future studies have also been outlined as projects used to help with the implementation of recommendations.

Chapter 6 contains the **Monitoring** program for the Black Creek subwatershed. The program will assess the environmental changes in the subwatershed, evaluate compliance with the plan's goals and objectives, and provide information that will assist custodians of the plan with implementation, updating, and adaptive management.

2. SUMMARY OF EXISTING CONDITIONS

The *Black Creek Subwatershed Study: Phase 1 Characterization Report* (CVC et al., 2012) provides a comprehensive understanding of the natural form, functions, and features of the Black Creek subwatershed. Significant findings from the Phase 1 study are presented in this chapter.

Over the last 50 years, Black Creek has significantly improved in condition; where once it received discharge from local tannery operations and minimally treated sanitary sewage, it is now habitat to one of the healthiest populations of Brook Trout in the CVC watershed. While conditions have improved, today the subwatershed is experiencing additional stressors from urbanization, aggregate operations, agricultural activities and external factors such as climate change.

2.1 Key Characteristics and Land Use

The Black Creek subwatershed is located in the middle-west part of the Credit River watershed. It drains an area of 80 km^2, representing approximately 8 per cent of the Credit River watershed. As illustrated in Figure 1, the majority of the subwatershed is in Halton Hills, with the northern part of the headwaters extending into the Town of Erin. In addition to Georgetown and Acton, the rural clusters of Limehouse and Ballinafad are located either wholly or partially within the Black Creek subwatershed boundary.

Black Creek is the dominate watercourse in the watershed, extending from Fairy Lake in the west to its outfall to Silver Creek in Georgetown. Beeney Creek represents the primary tributary, flowing from the Town of Erin in the north to its outfall east of Limehouse.

The Niagara Escarpment bisects the subwatershed between Acton and Georgetown, in a north-south direction, greatly influencing the characteristics of the subwatershed, wetlands, and coldwater fishery. The escarpment contains protected core areas that conserve significant ecological features and thus offer refuge for complex plant and animal communities.

Table 1 summarizes and compares key land uses as measured in 2013 and 2018. Differences between the two periods of time are within the margin of error associated with land use interpretation hence it can be concluded that there has been little change over the six-year period.

The Black Creek subwatershed includes 56 per cent anthropogenic land uses. This includes urban and rural development (19.4 per cent), aggregate extraction (2.5 per cent) and agriculture (34.3 per cent). The remaining 44 per cent of the subwatershed is natural.

Table 1 Land Use in the Black Creek subwatershed

	2013 Land Use (used for the Phase 2)		2018 Land Use	
	(ha)	(% of total)	(ha)	(% of total)
Anthropogenic				
Urban & Rural Development	1520	19.0	1550	19.4
Inactive Aggregate	45	0.6	46	0.6
Active Aggregate	166	2.1	146	1.8
Agriculture	2809	35.0	2744	34.3
Sub-total	**4539**	**56.7**	**4485**	**56.0**
Natural				
Wet Meadow	-	-	33	0.4
Forest & Wooded Swamp	-	-	1923	24.0
Wetland	-	-	1041	13.0
Plantations	-	-	158	2.0
Old Fields	-	-	370	4.6
Sub-total	**3471**	**43.3**	**3525**	**44.0**
Total	**8010**	**100.0**	**8010**	**100.0**

Fairy Lake, a large man-made lake located on the west side of Acton accept discharge from the western headwaters of Black Creek. This lake is experiencing ongoing sedimentation and water quality issues; however, it supports a diverse warmwater fish population and is quite popular for angling.

Despite the warming effects of Fairy Lake, coldwater fish habitats dominate the lower reaches of Black Creek and many of the smaller tributaries. This is a result of the escarpment providing Black Creek with sufficient groundwater discharge to support healthy populations of Brook Trout, a native species indicative of a healthy aquatic environment.

Protection of groundwater recharge areas that contribute to groundwater upwelling in the watercourses is essential to maintaining thermal conditions and important spawning areas for trout.

2.2 Subcatchment Zones

The Black Creek subwatershed has been divided into seven subcatchments based on commonalities in geology, soil maps, land cover information, streamflow data, streambed profiles, topographic maps, and uniform and consistent surface water flow characteristics. The zones include:

- Zone 1 - Outlet of Black Creek
    - This zone contains the main Black Creek channel from the confluence with Beeney Creek downstream to the confluence with Silver Creek near 8th Line, as well as a small tributary located on the east side of Trafalgar Road near Maple Avenue.
    - Significant urban development encompassing the western edge of Georgetown, as well as large agriculture and natural areas.
    - Coldwater habitat in the most downstream reach of Black Creek before it enters Silver Creek.
- Zone 2 - Black Creek on the Escarpment
    - This zone contains the main branch of Black Creek from upstream of 4th Line to the confluence with Beeney Creek almost at 6th Line.
    - Limited urban development but considerable intensive agriculture and some aggregate extraction. Nearly half of the zone contains natural areas.
    - Coldwater habitat in the reach of Black Creek where it crosses the Niagara Escarpment
- Zone 3 - Quarry Tributaries
    - This zone contains only a few tributaries and is dominated by the Acton Quarry.
    - Half the zone contains natural areas, while approximate one-third is aggregate.
    - Warmwater habitat.
- Zone 4 - Outlet of Fairy Lake
    - This zone includes the Black Creek reach downstream of Fairy Lake to past 3rd Line and another larger tributary flowing in from the north and joining Black Creek close to the downstream end of the zone.
    - Significant urban development associated with the south half of Acton.
    - Other major land uses include intensive agriculture and natural areas.
    - Coldwater habitat. In downstream section.
    - WWTP located in this reach and discharges approximately 2 km downstream of Fairy Lake.
- Zone 5 - Headwaters of Black Creek and Fairy Lake
    - This zone includes Fairy Lake and its tributaries.
    - Includes the northern portion of Acton, intensive agriculture, and natural areas.
    - Includes the headwaters of Black Creek before entering Fairy Lake.
    - Warmwater habitat.
    - Substantial urban development compared to other zones with channel modifications.

- Zone 6 - Headwaters of Beeney Creek
    - This zone, situated in the north eastern half of the subwatershed, contains most of Beeney Creek and extends from the headwaters downstream to past 5th Line and is bordered by Silver Creek subwatershed to the east.
    - Dominant land uses are agriculture (intensive and non-intensive) and natural areas.
    - Diverse thermal characteristics with both warm and coldwater species, significant agricultural area having impacts to riparian habitat
- Zone 7 - Beeney Creek on the Escarpment
    - This zone contains the lower reach of Beeney Creek downstream of 5th Line south of Highway 7 to the confluence with Black Creek. This zone contains a significant natural area with some agriculture.
    - Coldwater habitat, with the escarpment being a barrier to fish passage.

Figure 4 illustrates the seven subcatchment zones. Appendix A highlights some features of each zone, while also providing additional text detailing each zone. In particular, the table summarizes key characteristics related to land use, physiography, surficial geology, groundwater supply, catchment storage and flow modification, flood risk to buildings, geomorphology and fisheries. The presentation of information throughout this study is based on the zone delineation, as this is the smallest scale that the subwatershed was examined at through the study process.

2.3 Subwatershed Characteristics

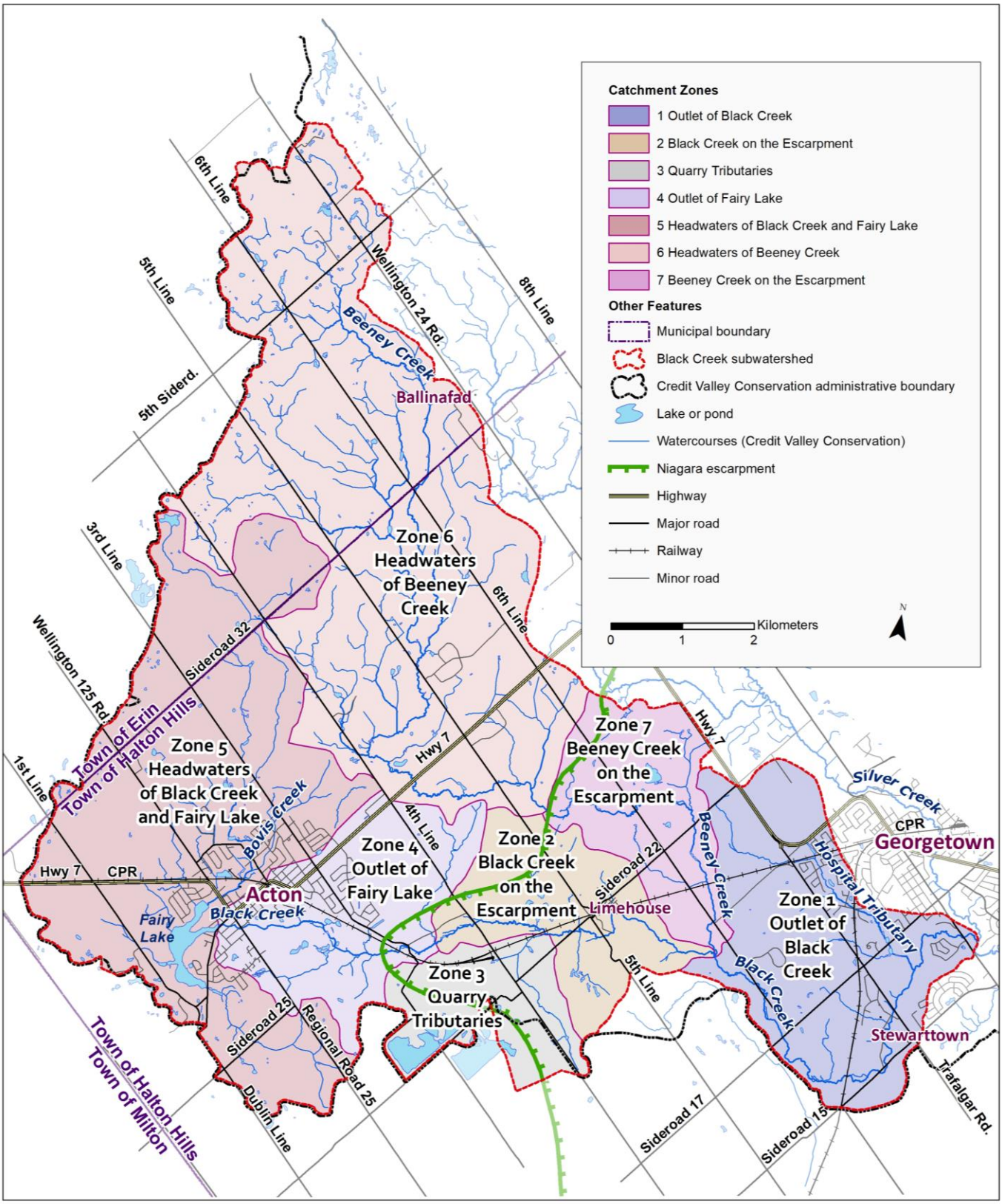
Watershed characteristics can be best described by providing a discipline-specific overview. The following provides an overview of watershed characteristics related to hydrogeology and water balance, surface water conveyance and fluvial geomorphology, terrestrial ecology, surface water quality, benthic invertebrates, and aquatic ecology. Each of these disciplines was more fully addressed in the *Black Creek Subwatershed Study Phase 1 Characterization Report* (CVC et al., 2012).

2.3.1 Hydrogeology and Source Water Protection

The Phase 1 Characterization Report included an understanding of hydrogeologic function in the Black Creek subwatershed. Broadly the focus was two-fold: an understanding of recharge and discharge as it relates to sustaining wetlands and watercourses, and an understanding of water availability and vulnerability from the perspective of municipal water supply as defined through source water protection plans.

At the outset an understanding of the geology of the subwatershed was developed as it represents the foundation of the hydrogeologic regime. The geology can be divided into several major components within this sub-basin:

- Bedrock geology (the type and nature of the crust of rock under the land or exposed)
- Overburden geology (the type and nature of material overlaying the bedrock)
- Topography (the elevations of bedrock and surficial materials that create the form of the landscape)



Watercourses (CVC, 2018); Lakes and ponds (CVC, 2017); Subcatchment zones (CVC, 2009); Physiography of Southern Ontario (Ontario Geological Survey, 1972)

Figure 4 The seven subcatchment zones in the Black Creek subwatershed

The next step was to develop a conceptual flow model of the water movements (recharge, discharge, groundwater flow and surface water flow) of the subwatershed and the implications to resource features found in the area. This conceptual understanding is then combined with an analysis of the results from the other disciplines to create an understanding of how the Black Creek subwatershed functions from a hydrogeologic perspective. As illustrated on Figure 5, the completed analysis demonstrated that the areas with the highest recharge rates extend in two north-south bands, one along the western edge of the subwatershed in Zone 5 and Zone 6, and the other across the middle of the subwatershed partially overlapping with the Niagara Escarpment. The areas surrounding Black Creek downstream of Fairy Lake and extending to the outlet of the subwatershed are typically net discharging zones. A section of Beeney Creek just north of 20th Sideroad is a losing stream where the creek crosses the Acton/Georgetown buried bedrock valley. As well, Black Creek, east of the Limehouse notch where the buried valley resumes, loses as much as 40-70 per cent of flow to groundwater recharge.

Within the area encompassing the Acton Quarry (zone 3), groundwater discharge zones are most common at upstream points on headwater streams or within the topographic lows by the Acton Quarry operations. Discharge to these areas is thought to be intermittent and controlled in part by the seasonal changes in groundwater levels and dewatering operations at the quarry. This area has moderate recharge potential.

Groundwater is the sole source of municipal drinking water in the Black Creek subwatershed. Within the subwatershed up to 5326 m^3/d of groundwater was available for pumping for municipal supply to service Acton in 2012 (AquaResource and AECOM, 2012). In addition, a portion of the available 19,135 m^3/d of groundwater pumped in 2012 for municipal supply to service Georgetown was drawn from the groundwater supply within the Black Creek subwatershed boundary (AquaResource and AECOM, 2012).

Parallel to this subwatershed study, the subwatershed has been an integral part of the source water protection initiatives undertaken by the Region of Halton and the CTC Source Protection Committee. The Complete CTC Source Protection Plan (*https://ctcswp.ca/protecting-our-water/the-ctc-source-protection-plan/).,*along with the Credit Valley Source Protection Authority's Assessment report (CTC Source Protection Committee, 2015), delineates the vulnerable drinking water source area and describes proactive measures to safeguard the water quality and quantity of municipal drinking water systems. Additional details regarding source water protection is addressed in the Water Management Plan (Section 4.8). Key areas of concern for groundwater quantity are the Acton Well Head Protection Area (WHPA) Q1/Q2 Groundwater Quantity Threat Area (significant risk level) and the Georgetown WHPA Q1/Q2 Future Groundwater Quantity Threat Area (moderate risk level), which were delineated through the work in the Halton Hills Tier Three Water Budget and Local Area Risk Assessment (CTC Source Protection Committee, 2015). These areas are illustrated on Figure 5.

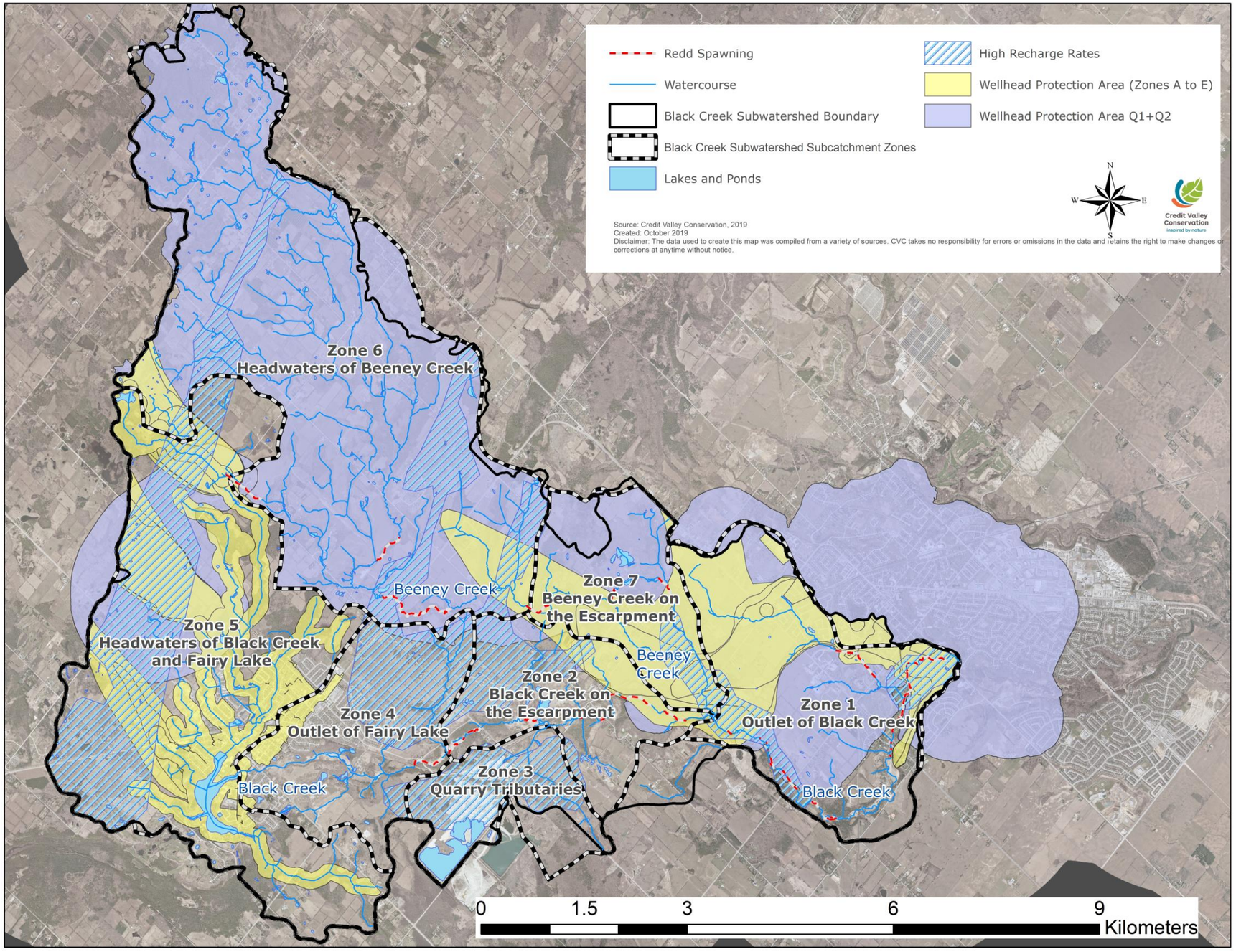


Figure 5 Water Resource System

2.3.2 Surface Water Conveyance and Fluvial Geomorphology

The Niagara Escarpment creates three distinct fluvial geomorphic regions within the Black Creek subwatershed: above, within, and below the escarpment. Reaches located above the escarpment are characterized by meadow channels, which are typically narrow and deep with limited pool-riffle development and grass/wet meadow vegetation, as well as cedar forest channels, which are wide and shallow with sand/cobble beds and notable areas of bank erosion. Reaches located within the Niagara Escarpment are typically steep and confined with exposed bedrock outcrops, some step-pool sequences, waterfalls and cascade sections. Reaches below the escarpment are characterized by forest and meadow channels. The channels are typically shallower and wider than those above the escarpment.

Overall, watercourse and their floodplain have not been significantly altered along Black Creek except in the communities of Acton, Limehouse, and Stewarttown where development has encroached into the regulatory floodplain. However, the flow regime has been altered through surface water and groundwater takings, the discharge of processed water, and runoff associated with urban development. Due to the age of development of Acton, 55 per cent of urban runoff is uncontrolled, 40 per cent is controlled by stormwater management facilities, and a further 5 per cent is controlled through recent retrofitting. Similarly, within the older area of Georgetown that falls within the Black Creek subwatershed all urban runoff is uncontrolled.

There are significant flood plain storage areas, specifically along the main branch of Black Creek located immediately upstream of the Niagara Escarpment and downstream through the deep valley section, providing flood attenuation. Fairy Lake also provides significant storage for small runoff events, while providing much less storage for larger runoff events. Along Beeney Creek there is limited flood plain storage with the exception of lands located upstream of the Eighth Line.

The channel through Georgetown has been surrounded by residential areas as well as a golf course. In addition, there is a number of dams in this reach located near Mill Pond Drive and Stewarttown Road, as well as other artificial flow control structures. In Acton, the creek is often contained within an armoured channel with some sections of piped flow in old quarry lands. The Acton WWTP downstream of Fairy Lake outlets into a wet meadow channel that is deep and incised, with several beaver dams and multiple branches flowing through the valley. In addition, there are numerous sections of channels in both the urban and rural areas of Acton where there are manicured lawns and agricultural fields to the edge of the channel.

2.3.3 Flood Hazards

Updated floodline mapping was carried out in November 2010 for CVC by AMEC Earth & Environmental and is documented in the report entitled "Flood Line Mapping Studies: Black, Silver and Snow's Creeks" (2010). The updated floodline mapping study includes Black, Silver and Snow's Creek. The study provides detailed information regarding the extent of flooding, as well as the location of flood vulnerable buildings. Flood vulnerable structures along Black Creek are focused in Acton and Stewarttown. Figure 6 illustrates the extent of

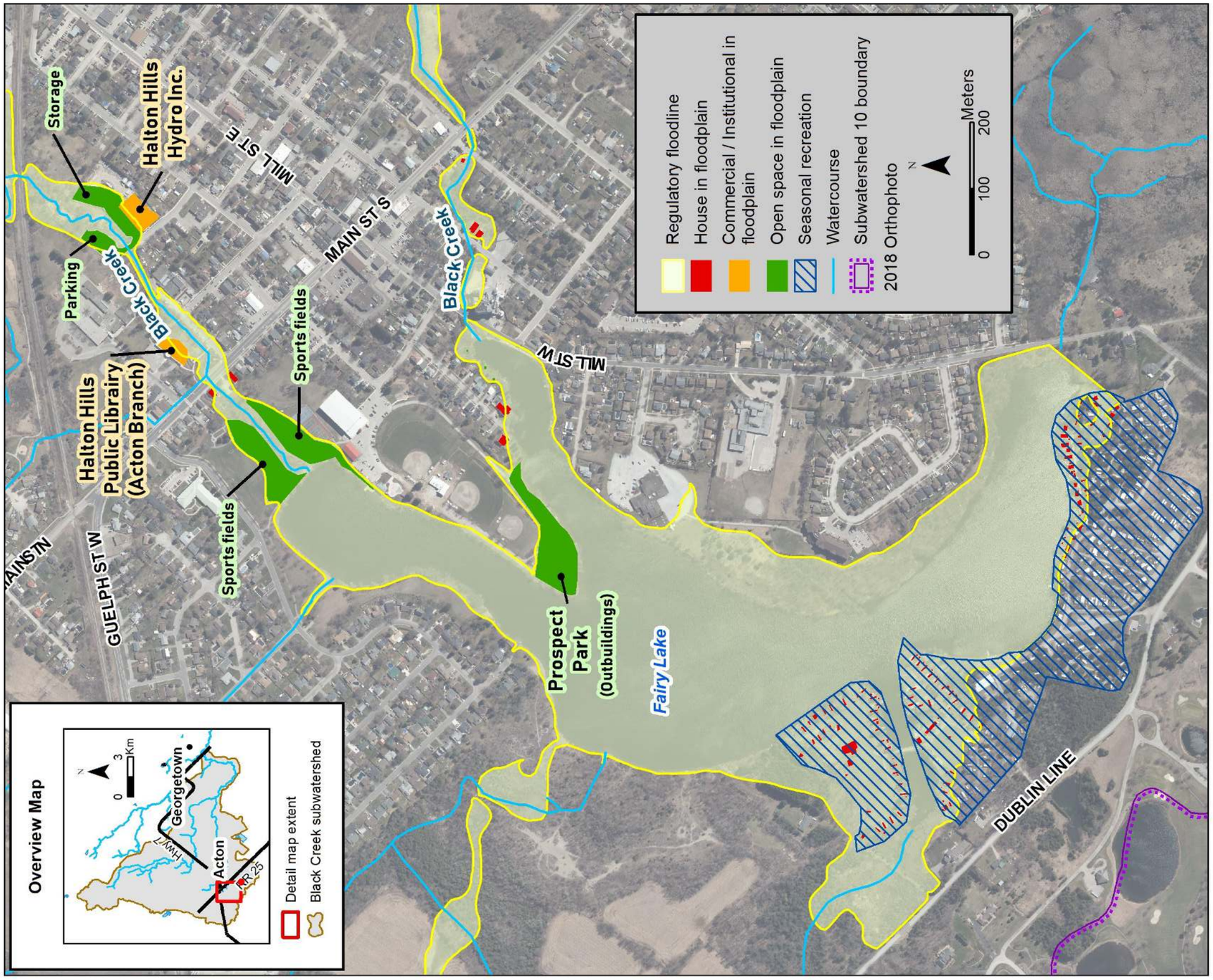
the Black Creek Regulatory floodplain in Acton, while Figure 7 illustrates the extent of the Regulatory Floodplain in the vicinity of Stewarttown.

Table 2 provides a summary of the different types of structures and properties along Black Creek that are within the Regulatory Floodplain. The flood vulnerable properties are generally found adjacent to Fairy Lake in Acton or in Stewarttown immediately west of Georgetown. The extent of flood vulnerability can be summarized as follows:

1. Houses: In Acton there are six houses in the floodplain, while there are 21 in the Stewarttown area.
2. Seasonal Recreational: In Acton along the south end of Fairy Lake there are approximately 76 seasonal recreation buildings in the floodplain. The majority of these are trailers.
3. Commercial: In Stewarttown the Georgetown Little Theatre Studio is in the floodplain.
4. Institutional: In Acton there are two institutional properties that abut the floodplain. These include the Acton Branch of the Halton Hill Public Library and offices of Halton Hills Hydro.
5. Agricultural: In Stewarttown on Mill Pond Drive there is one agricultural building in the floodplain.

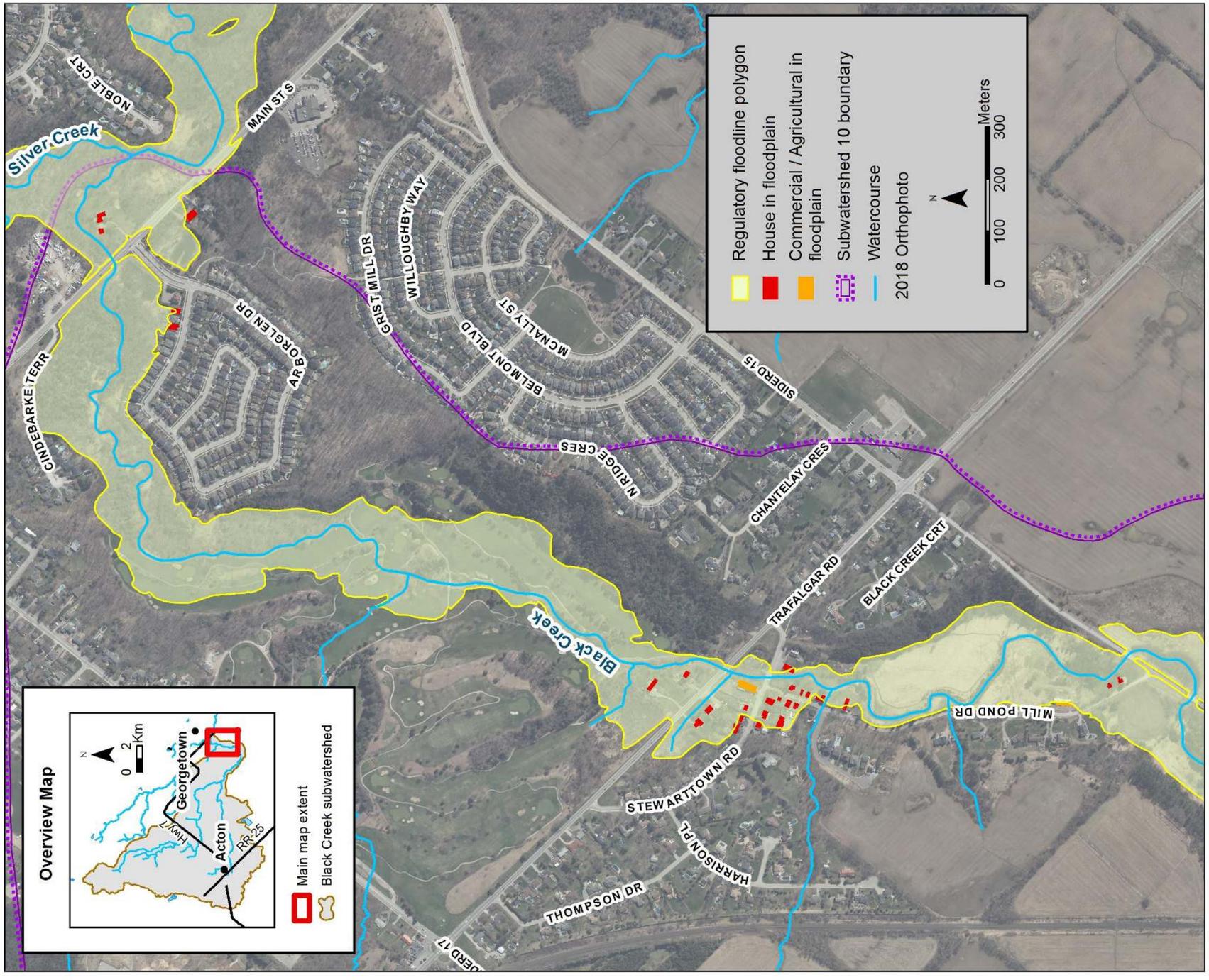
Table 2 Structures in the Regulatory Floodplain

Structures in the Regulatory Floodplain			
Type of Structure or Land Use	**Number of Structures**		
	Fairy Lake (south end)	**Acton**	**Stewarttown**
Houses	-	6	21
Seasonal Recreation	76	-	-
Commercial	-	-	1
Institutional	-	2	-
Agricultural	-	-	1
Out Buildings	-	2	4



This map is not a plan of survey. The data displayed are derived from sources with different accuracies and all boundaries should therefore be considered approximate. Regulatory floodline polygons (CVC, 2018); Buildings (CVC, 2018 and Town of Halton Hills, 2017); Watercourses (CVC, 2018); Orthophoto (CVC, 2018); Floodplain objects (CVC, 2018)

Figure 6 Black Creek and Fairy Lake Floodplain and flood vulnerable structures in Acton



This map is not a plan of survey. The data displayed are derived from sources with different accuracies and all boundaries should therefore be considered approximate. Regulatory floodline polygons (CVC, 2018); Buildings (CVC, 2018 and Town of Halton Hills, 2017); Watercourses (CVC, 2018); Orthophoto (CVC, 2018); Floodplain objects (CVC, 2018)

Figure 7 Black Creek floodplain and flood vulnerable structures in the vicinity of Stewarttown

2.3.4 Terrestrial Characterization

As listed in Table 1 in Section 2.1, 44 per cent of the subwatershed is natural. This includes 14 per cent forests and 10 per cent wooded swamps. Environment Canada (2004b) recommends a minimum of 30 per cent forest coverage, in order to maintain forest interior species and area sensitive species. As such, the present extent of forest coverage in the Black Creek subwatershed falls short of this target.

Wetlands make up approximately 13 per cent of the Black Creek subwatershed. This number meets Environment Canada's recommended guideline for wetland coverage at the subwatershed level.

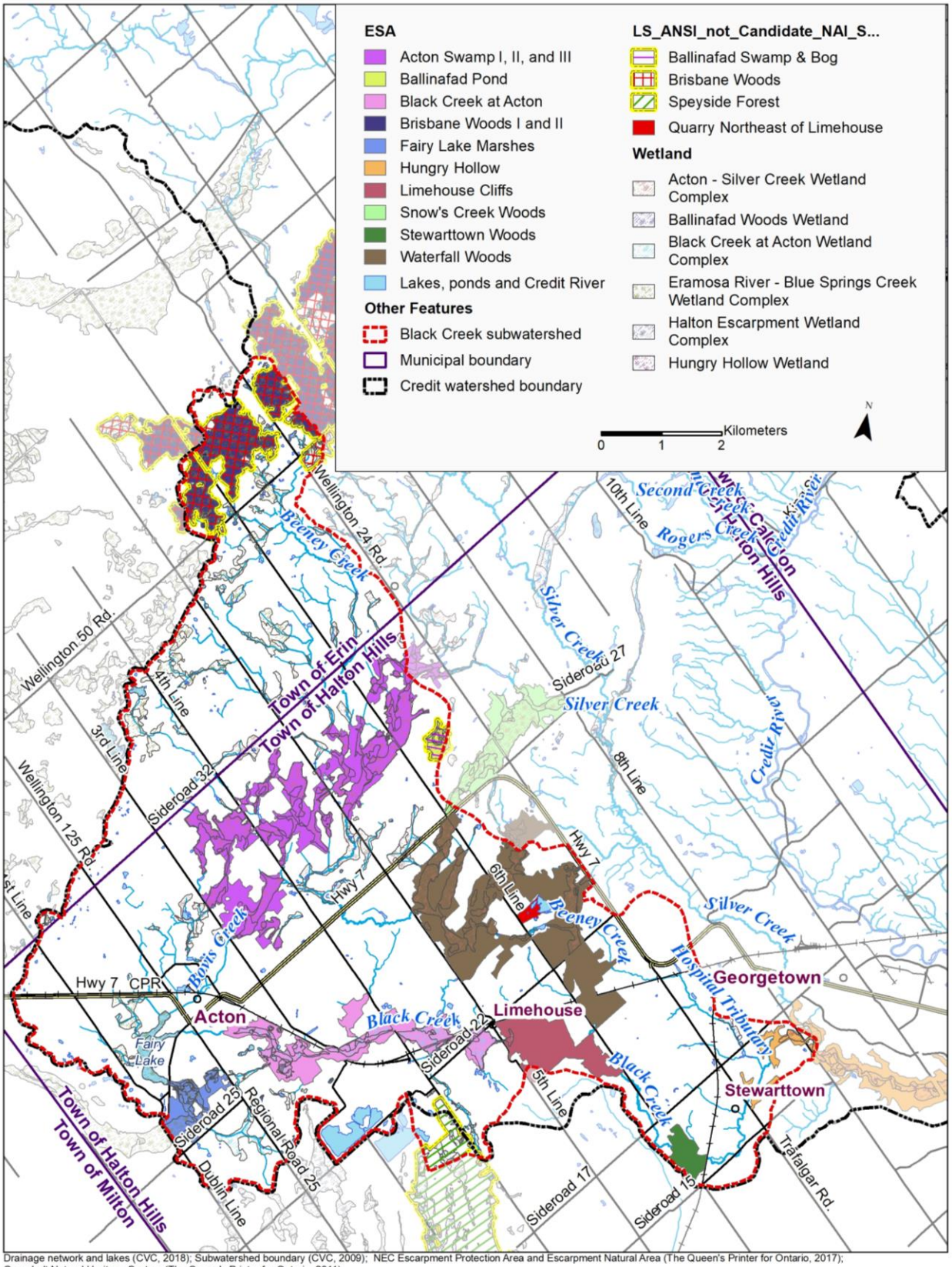
Almost 90 per cent of all amphibian, reptile, bird, and mammal species in the Credit River watershed depend on more than one terrestrial community for completion of their life cycle (CVC 2002a, 2002b, 2002c, and unpublished data). Therefore, apart from size, habitat patches containing a diversity of communities are likely to support a greater number of plant and wildlife species (OMNR 1999). As illustrated on Figure 8 and Figure 9, within the Black Creek subwatershed, the following significant features sustain important ecological functions.

1. Areas of Natural and Scientific Interest (ANSI) – Ballinafad Swamp and Bog Life Science ANSI, Brisbane Woods Life Science ANSI, Speyside Forest Life Science ANSI, and Quarry Northeast of Limehouse Earth Science ANSI

2. Environmentally Significant Areas (ESA) - Acton Swamp I, II and III ESAs, Ballinafad Pond ESA, Black Creek at Acton ESA, Brisbane Woods I and II ESAs, Fairy Lake Marshes ESA, Hungry Hollow ESA, Limehouse Cliffs ESA, Snow's Creek Woods ESA, Stewarttown Woods ESA, and Waterfall Woods ESA
3. Provincially Significant Wetlands (PSW) - Acton-Silver Creek Wetland Complex, Ballinafad Ridge Wetland Complex, Black Creek at Acton Wetland Complex, Crewsons Corners Swamp, Eramosa River-Blue Springs Creek Wetland Complex, Halton Escarpment Wetland Complex, Hungry Hollow Wetland

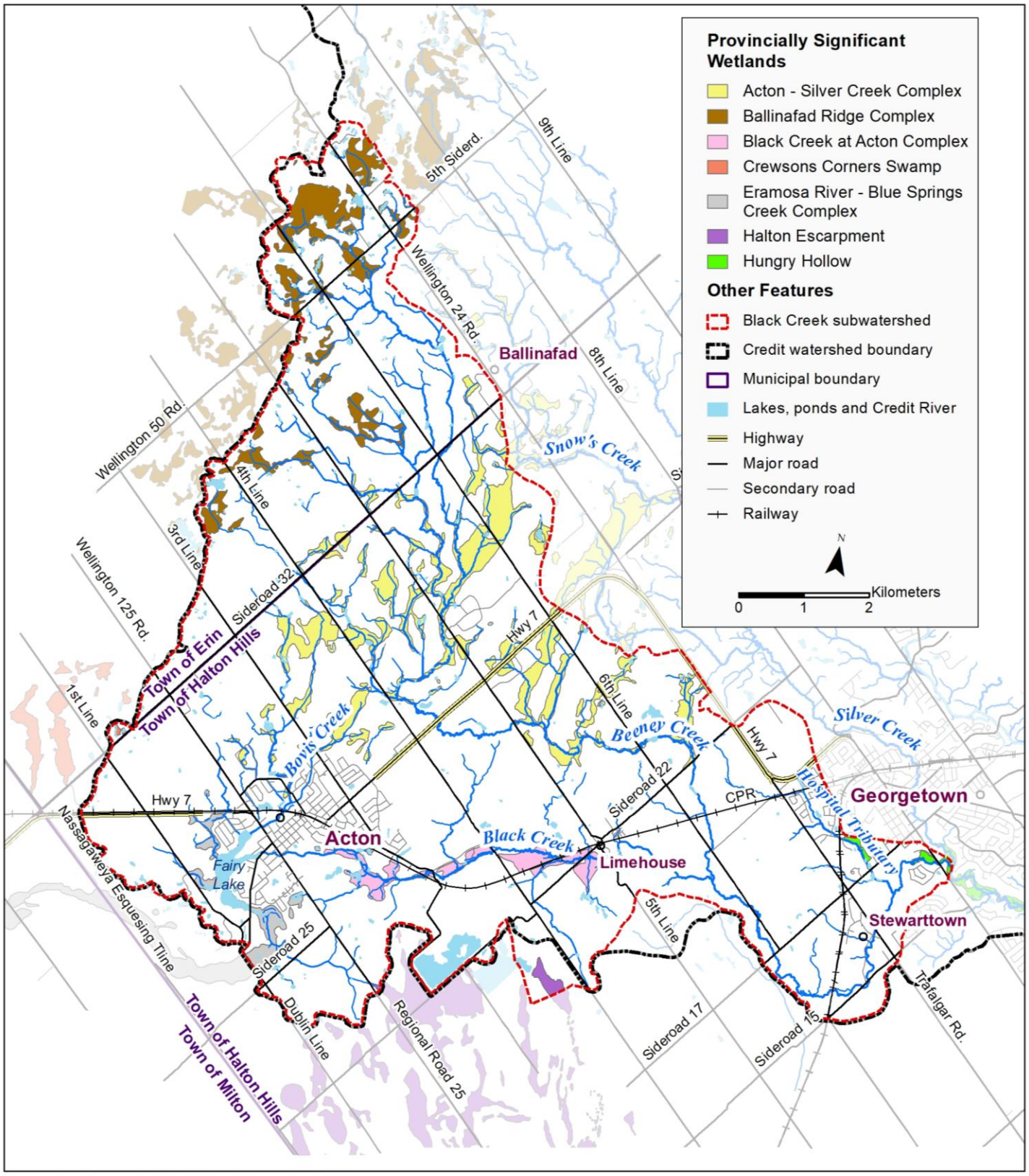
2.3.5 Surface Water Quality Characterization

The water quality of the Black Creek subwatershed ranges from "good" to "marginal" based on the Water Quality Index (WQI) developed by Canadian Council of Ministers of the Environment (CCME) with an overall "good" water quality rating for the entire subwatershed.



Drainage network and lakes (CVC, 2018); Subwatershed boundary (CVC, 2009); NEC Escarpment Protection Area and Escarpment Natural Area (The Queen's Printer for Ontario, 2017); Greenbelt Natural Heritage System (The Queen's Printer for Ontario, 2011)

Figure 8 Black Creek subwatershed Areas of Natural and Scientific Interest (ANSI) and Environmentally Significant Areas (ESA)



Lakes, ponds and watercourses (CVC, 2019); Wetlands (OMNRF, 2006)

Figure 9 Black Creek subwatershed Provincially Significant Wetlands (PSW)

Water Quality Index Rating System	
Excellent	water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.
Good	water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
Marginal	water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
Fair	water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Poor	water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

Source: Canadian Council of Ministers of the Environment (CCME, 2014)

Water quality is good in the headwaters of Black Creek and Beeney Creek, although phosphorous, aluminum, iron, and E. coli levels are elevated slightly above Provincial Water Quality Objectives (PWQOs). This suggests potential impacts from agricultural land use in these reaches.

Further downstream, Fairy lake is mostly sustained by surface water inflows, with groundwater contributing only five per cent of the water budget during average conditions (AECOM, 2009). Management of the Fairy Lake catchment area is important as most of the input is from surface water, which is impacted by external activities and internal processes, including agricultural activities, discharge of storm sewers, septic systems from the seasonal trailer park, and direct input of fecal matter from waterfowl. For more details on the water quality of Fairy Lake, refer to the Town of Halton Hills Fairy Lake Water Quality Study (AECOM, 2009).

Discharge from Fairy Lake, as well as groundwater discharge directly to the creek provide wastewater assimilation for the Acton Wastewater Treatment Plant (Acton WWTP). The Acton WWTP effluent into Black Creek discharges approximately 2 km downstream of Fairy Lake. Impacts on the water quality of Black Creek are evidenced by elevated nutrient, chloride and metal levels, resulting in a "fair" water quality ranking. The Acton WWTP is currently (2018) rated at 4500 m^3/d and approved to a rated capacity of 5600 m^3/day after achieving an annual reduction of 96.4 kg/year of TP loading into Black Creek by mitigating existing uncontrolled point source loads in the urban area.

2.3.6 Benthic Invertebrates Characterization

The majority of stations sampled in the Black Creek subwatershed showed a relatively high proportion of sensitive species of aquatic invertebrate. Most streams sampled within the subwatershed indicate unimpaired water quality conditions based on the benthic macroinvertebrate community. Three locations — the headwaters of Beeney Creek, Beeney Creek downstream of Highway 7, and the south headwaters Black Creek tributary to Fairy Lake — had benthic macroinvertebrate communities that indicated possible impairment. These three sites were located in rural tributaries with agricultural land use dominating the

area surrounding and upstream of the site. While land use practices may have some influence on the health of these sites, it is expected that in some cases low flow or intermittent conditions leading to low oxygen levels may be a natural limitation on the macroinvertebrate communities.

2.3.7 Aquatic Characterization

The Black Creek subwatershed supports a mix of cold, cool, and warmwater fish communities. Figure 10 illustrates key aquatic characteristics as described below. Contrary to many systems, most of Black Creek cools as it flows downstream due to the input of groundwater in the lower subwatershed, largely from the Niagara Escarpment.

Beeney Creek is a mostly coolwater system in its upper reaches with the tributary along 4th Line supporting coldwater species. As it flows south, groundwater inputs are sufficient to support Brook Trout to the crossing at 6th Line.

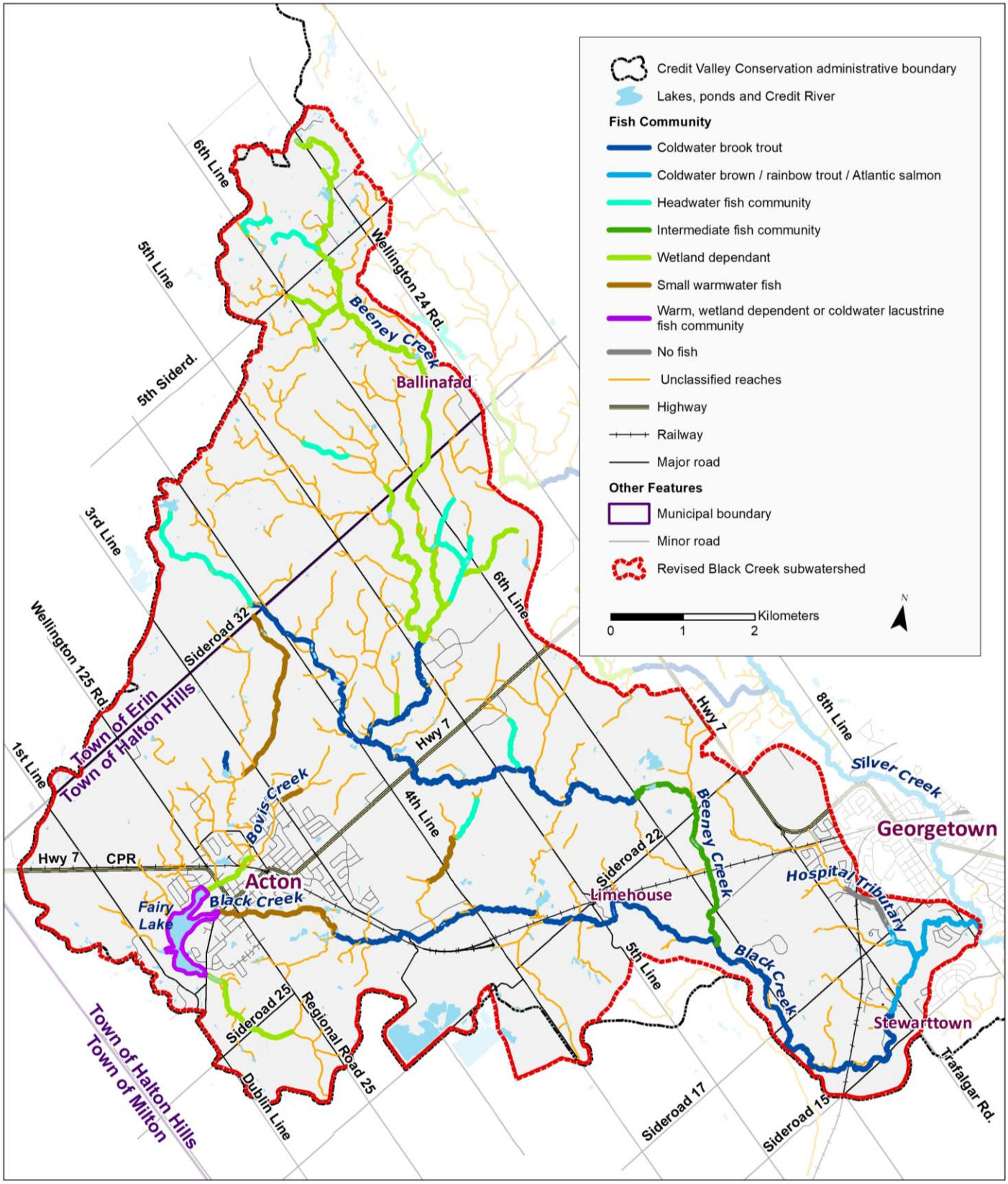
The headwaters of Black Creek and Fairy Lake are warmwater, although the Davidson well area, northeast of Fairy Lake, does have sufficient groundwater input to classify it as coldwater.

Downstream of Fairy Lake, Black Creek cools and supports a Brook Trout community along the remainder of its length. Atlantic Salmon have been stocked in some reaches between Limehouse and Stewarttown. Downstream of the Stewarttown dam, Brook Trout are mostly absent and are replaced by introduced Brown and Rainbow Trout. Known Brook Trout spawning areas are centred on Beeney Creek near Highway 7 and along 4th Line, Black Creek upstream of Limehouse and Stewarttown, with potential spawning located in numerous other locations. The number of spawning locations appears to be lower than that recorded historically, particularly upstream of Stewarttown and in the tributary crossing Maple Avenue east of 7th Line (Trafalgar Road).

Fish habitat is typical of an area with a rural-urban mix, and the issues in the subwatershed are not different from other subcatchments. Land use change, lack of riparian cover, increases in impervious area, stream channelization, instream barriers (and their resulting on-line ponds), all impact the health of fisheries and habitat quality in Black Creek.

2.3.8 Watershed Report Card (2018)

While detailed characterization of the Black Creek subwatershed was carried out in 2007 and 2008, continued targeted monitoring has indicated conditions have remained relatively consistent. Analysis of current monitoring data carried out by CVC in the Integrated Watershed Monitoring Program (IWMP) shows that the overall health of the Black Creek subwatershed is rated as “fair” to “good,” as presented in CVC’s most recent Watershed Report Card (2018). Since Black Creek is less urbanized than some of the other subwatersheds, the environmental quality of its features is still healthy.



Fish communities (CVC, 2019); Lakes and ponds (CVC, 2019); Black Creek subwatershed boundary (CVC, 2009)

Figure 10 Black Creek fish communities

3. IMPACT ASSESSMENT AND FUTURE CHALLENGES

3.1 Introduction

Understanding management challenges in Black Creek provides the necessary context to inform the measures needed to offset the impacts to the features and functions within the subwatershed.

Historically, Black Creek, downstream of Acton, was significantly impaired as a result of industrial and tannery discharges. Through advancements in our understanding and better management practices, Black Creek is in better condition. However, there are many subwatershed-wide management issues that relate to the manner in which land is used and the relationship between land use, water quantity, and water quality. In addition, the ongoing process of urbanization and climate change are issues of general concern that affect many facets of human and environmental health.

As well, Black Creek is a major tributary of Silver Creek and, as such, the management of Black Creek subwatershed will directly affect Silver Creek – a subwatershed impacted by the growth of Georgetown.

3.2 Overview of Future Challenges

The Black Creek Subwatershed Study was triggered as a result of a number of current issues and the resulting influence of their cumulative impact. The list below outlines the anticipated changes that are expected to influence Black Creek over the next 10 to 15 years and that have been considered as part of the Management and Implementation Plan.

- Future Urban Development: Increased population growth which is met with increased groundwater water taking, decreased recharge, increased urban runoff, and increased discharge from the wastewater treatment plant;
- Existing Urban Development: Uncontrolled stormwater management in existing urban areas;

- Agricultural Activities: Intensive agricultural practices (such as cultivated fields producing crops) resulting in soil and nutrient losses, absence of riparian cover, and nutrient-enriched runoff entering the surface water system;
- Aquatic Connectivity: Channelization, straightening and armouring of portions of Black Creek, limited riparian cover in urban areas, the presence of dams and impoundments throughout the subwatershed, and the management of Fairy Lake dam;
- Aggregate Management: Aggregate extraction and management of non-active aggregate sites; and
- Natural Heritage System: Lack of connectivity resulting in isolation of features, presence of roadways further comprising linkages and survivability of fauna, and poor riparian and forest cover.

Description of Expected Changes

Over the next 10 to 15 years, the Black Creek subwatershed will be faced with population growth, climate change, aging infrastructure, agriculture intensification, and the increasingly limited ability of the receiving environment to absorb these impacts.

In accordance with Halton Region's document Sustainable Growth (2007), the residential and employee population in Halton Region is expected to grow up to 780,000 and 390,000 respectively, by which the Town of Halton Hills is expected to increase up to 94,000 and 43,000, respectively.

The Black Creek Subwatershed Study area comprises a small portion of the expected growth, mostly concentrated to the Town of Acton. By 2031 the population is expected to increase by 4,600 people, an increase of 47 per cent (CVC, 2014). To properly service the increased population, both municipal groundwater takings and WWTP discharges will increase. The expansion to the WWTP will result in effluent discharge making up 45 per cent of low flows conditions in Black Creek.

Table 3 summarizes the changes to land use and water resource use by 2031 in the study catchment area.

To date, the change in land cover and population has resulted in encroachment and loss of natural and riparian areas. With increased development to meet 2031 population growth targets, a further reduction in natural and agricultural cover is expected. If not properly considered, this may result in a loss of appropriate size and shape of natural areas impacting habitat availability and affecting population size and survival rates of native species. Aside from impact to the quality of the natural heritage system in Black Creek, this will also result in greater change to the water balance of the area, reducing both evapotranspiration and infiltration and increasing runoff.

Table 3 Current and 2031 projected changes to land use and water resource use

	Current Land Uses (2018)	Future Land Uses (2031)
Population	9,700	11,500
Urban	16%	19%
Natural Areas	44%	36%
Agriculture	34%	25%
Acton Groundwater Pumping Rate (m^3/day)	5,660	8,340
WWTP Discharge (m^3/day)	5,600	7,000

Source: Prospect Park Well Field Re-rating & Water Purification Plant Expansion: Class EA Environmental Study Report, February 2015. Expansion of the Acton Wastewater Treatment Plant, September 2010.

The Black Creek subwatershed contains a substantial amount of wetlands (13%) and significant woodlands (24%). The subwatershed benefits from the Niagara Escarpment, as it bisects between Acton and Georgetown, in a north-south direction, greatly influencing the subwatershed's natural heritage features. This protected area provides a healthy and diverse vegetative community and wildlife habitat. The escarpment contains protected core areas that conserve significant ecological features and thus offer refuge for complex plant and animal communities. The subwatershed also benefits from the protection of the Greenbelt Natural Heritage System and Halton Region's Natural Heritage Systems policies.

However, as intensified agricultural activities and urbanization continues, terrestrial environmental features can become more and more isolated on the landscape, degrading their function and limiting their connectivity to the larger natural heritage system (NHS). Within the subwatershed, roadways and their continued expansion comprise a significant barrier to wildlife mortality, movement, and NHS linkage. The majority of the biodiversity is found within the protected features; however, continued protection of these areas is vital.

In addition to barriers on the terrestrial landscape, there are also barriers to connectivity in the aquatic environment of Black Creek, such as dams that impede fish movement and hydrologic connectivity in several locations. Some of these barriers are identified as being high priorities for restoration to remove ecological barriers and improve connectivity.

The connection of the terrestrial and aquatic system has been found to be insufficient, as determined through riparian cover in both rural and urban areas, and with continued urban and agricultural intensification pressures, riparian cover is expected to worsen. While buffers do not replace habitat or compensate for fragmentation of habitat, they are an important planning tool that help protect remnant natural heritage features and their associated functions from some of the impacts from adjacent rural and urban land uses (Beacon et al., 2012). Buffers will play an important role in attenuating sediment and pollutants, screen against human disturbances (e.g. noise), serve as habitat transition zones, and contribute to protection by maintaining microclimates and limiting spread of invasive species.

From a water management perspective, there has been evidence that municipal groundwater taking has historically reduced water availability for surface water features.

The combination of increased groundwater demand and a reduction in recharge will impact Black Creek both from a water quality and habitat perspective, as groundwater withdrawal will reduce the per cent of streamflow originating from groundwater. The potential threat, and in turn importance, of groundwater quantity to the subwatershed is exhibited in the Credit Valley Conservation, Toronto and Region Conservation Authority, and Central Lake Ontario Conservation Authority Source Water Protection Plan (CTCSWP), in which the majority of zones 5, 6 and 7 are encapsulated by a Wellhead Protection Area – Quantity(WHPA-Q).

As an extension of the issues presented by increased groundwater withdrawal and decreased groundwater recharge, fish habitat, wetlands, and associated ecological functions would be threatened by existing and future urban development activities without the provision of additional water management practices.

For example, currently 55 per cent of the urban area lacks sufficient stormwater controls. This existing lack of stormwater controls and the potential for continued sole reliance on end-of-pipe stormwater management practices will result in a greater amount of precipitation that will directly enter Black Creek because of decreased opportunity for infiltration and evapotranspiration. While stormwater management ponds effectively attenuate runoff intensity, they do not always mitigate the impact of the excess runoff volume entering the stream, which can cause stream erosion, instability and ecological impacts.

Furthermore, human health is tightly linked to the health of the natural environment. Healthy ecosystems are adaptable, resilient, self-sustaining, and support diverse native flora and fauna as well as associated ecological functions. Ecosystems are also valued for the services or benefits they provide to human health and well-being. Services include:

- flood moderation
- water purification
- waste and pollutant mitigation
- temperature moderation
- erosion prevention
- soil formation
- crop pollination
- biological pest control
- aesthetics, and
- recreation.

3.3 Phase 2 Impact Assessment

Through the *Black Creek Subwatershed Impact Assessment Phase 2 Study* (CVC et al., 2014*)*, the potential influences of alternative management scenarios on the existing and potential future conditions of the Black Creek subwatershed were assessed using a modelling approach.

In total six alternative scenarios were developed and compared for existing and future land uses. The future land use scenarios conform to the Provincial Growth Plan for the Greater Golden Horseshoe (Places to Grow), as defined in the Official Plans (OP) of the member municipalities within the study area to the year 2031.

The six management scenarios that were evaluated included:

- ***Scenario 1: Baseline Conditions*** – existing land use conditions with no additional stormwater management (SWM) measures;
- ***Scenario 2: Business as Usual*** – the application of the existing approach to SWM to new development based on OP 2031;
- ***Scenario 3: Low Impact Development (LID) in New Development*** – the application of LID SWM practices to new areas of urban development;
- ***Scenario 4a: LID in New Development and Retrofitting of LID to Existing Development*** – the application of LID SWM practices to new development and to previously developed areas through retrofitting;
- ***Scenario 4b*** – consistent with Scenario 4a plus enhanced NHS; and,
- ***Scenario 4c*** – consistent with Scenario 4a plus enhanced NHS and implementation of agricultural BMPs.

In the case of Scenario 4b and 4c the enhanced NHS would include areas defined and protected under existing legislation, regulations and policies and would include additional lands based on generally accepted ecological concepts that have been adopted as part of the approved Credit River Watershed Natural Heritage System (CRWNHS). As development within the CRWNHS lands is not currently prohibited under existing legislation, regulation, and policies, long-term preservation would be achieved through stewardship-based measures, such as increased buffers. The continued or enhanced implementation of agriculture best management practices associated with Scenario 4c would be achieved by working with the farming community to encourage the adoption of BMPs, most notably an increase in buffer widths around surface water features.

Evaluation Methodology

Following the establishment of the alternative scenarios, a step-wise approach was employed to evaluate the potential effects of each scenario on the existing conditions of the Black Creek subwatershed. This approach included: establishing measurable parameters and targets associated Objective 4 to Objective 10 described in Section 1.3; modelling to measure the environmental response to each of the six alternative scenarios, and;

determining whether the six alternative scenarios degrade, maintain or enhance existing conditions by scoring the environmental response of each against the targets associated with the environmental objectives for the Black Creek subwatershed. A complete description of the methodology and results is found in the Phase 2 Impact Assessment (CVC et al., 2014).

Table B1 to Table B6 in Appendix B provides a comprehensive list of the parameters and targets established for each of the objectives. In completing the analysis three different models or methods were applied to each of the management scenarios.

- Hydrological Simulation Program – Fortran (HSP-F) used to measure changes in water quality and environmental flow characteristics such as baseflow and bankfull flows
- Guelph All-Weather Storm-Event Runoff (GAWSER) – used to measure changes in peak flow rates
- Finite Element subsurface FLOW system (FEFLOW) – used to measure changes in groundwater
- GIS – used to assess impact on size and integrity of the characteristics of the natural heritage system

Each of these models had previously been developed for the Black creek subwatershed. HSP-F was developed as part of the Credit River Water Management Strategy Update (CVC et al. 2007) to aid in understanding water quality response in the watershed to various development scenarios, GAWSER was used to develop estimates of peak flows across the Credit River watershed to aid in understanding flood risk and updating flood hazard mapping. FEFLOW was developed as part of the Halton Tier 3 Groundwater Flow Model (reference) as a tool in developing source water protection requirements.

Once modelling of all scenarios was complete a common rating system was developed to quantify the extent to which each target was met. Details are provided in Table 4, which presents the results for the entire watershed where a separate rating is provided for each objective. Table 5 provides a summary of the total score for Zones 1, 2, 4, 5 and 7. Separate scores were not generated in Phase 2 for Zone 3 and Zone 6. The derailed scoring for the Zones is presented in Table B7 to Table B11 in Appendix B.

The results in Table 4 indicate that overall score across the watershed decreases from existing conditions for Scenario 2 and Scenario 3, while it increases for the variations of Scenario 4. The results in Table 5 provide a more refined understanding of the consequence of the various management scenarios.

More detailed discussion regarding the results and the selection of the preferred management strategy is provided in Section 3.4.

Table 4 Evaluation Results for the Black Creek subwatershed

Evaluation Results for the Entire Black Creek Subwatershed							
Objective	**Related Objective**	**Total Score of Indicators**					
		Scenario 1 (baseline)	**Scenario 2**	**Scenario 3**	**Scenario 4a**	**Scenario 4b**	**Scenario 4c**
4	Hydrology	4.7	4.7	4.9	5.1	5.1	5.0
5	Stream Processes (bed mobilization)	6.2	5.5	6.3	6.5	6.6	6.8
6	Stream Processes (stream formation)	6.5	6.5	6.1	6.2	6.2	6.6
7	Flooding	7.0	7.0	6.8	6.8	6.8	7.3
8	Groundwater Quantity	3.8	3.4	3.8	5.3	5.4	5.2
9	Water Quality	5.8	4.2	5.5	6.1	6.3	6.6
9	Groundwater Quality	6.3	5.8	5.8	5.8	6.2	6.3
10	Natural Heritage Features	3.2	2.8	2.8	3.9	8.0	10.0
TOTAL SCORE (Maximum 80)		**44**	**40**	**42**	**46**	**51**	**54**
Yellow = maintains existing conditions (score within 1 of existing conditions) Green = improvement over existing conditions Red = degradation of existing conditions							

Table 5 Summary of Evaluation Results for Individual Zones

Zone	Total Score of Indicators						
	Maximum Score	**Scenario 1 (baseline)**	**Scenario 2**	**Scenario 3**	**Scenario 4a**	**Scenario 4b**	**Scenario 4c**
1	60	28	24	26	30	30	31
2	60	42	39	41	43	44	45
4	60	41	37	42	47	46	47
5	60	40	37	39	41	42	42
7	60	19	19	19	20	20	23
Total	**80**	**44**	**40**	**42**	**46**	**51**	**54**

Colour Code:
Yellow = maintains existing conditions (score within 1 of existing conditions)
Green = improvement over existing conditions
Red = degradation of existing conditions

The evaluation summarized below provides a "big picture" comparison to illustrate the relative merits of the different approaches to land use, stormwater management, the establishment of an enhanced NHS, and the adoption of enhanced BMPs for agriculture. The detailed analysis is documented in the Phase 2 Impact Assessment. Based on the evaluation results, the following general conclusions can be made:

- Scenario 2 "*Business as Usual*": This scenario represents the worst case in terms of the degradation of existing environmental conditions, with the overall score dropping from 44 to 40. The most notable impacts were to stream bed mobilizing flows (e.g. flushing flow, bankfull and wetted perimeter), water quality, groundwater quantity and quality, and natural heritage features.
- Scenario 3 "*LID SWM in New Development*": This scenario was an improvement over Scenario 2, with the score dropping from 44 to 42. There continued to be some degradation in water quality, groundwater quantity and quality, and natural heritage features.
- Scenario 4a "*LID SWM in New Development and Retrofit in Existing Development*": This scenario represents an across the board improvement with the overall score increasing from 44 to 46.
- Scenario 4b "*LID SWM in New Development and Retrofit in Existing Development and protection of an enhanced NHS*": This scenario provides additional improvement particularly as it relates to the natural heritage features. The overalls core increases from 44 to 51. In addition, it is recognized that the establishment of an enhanced NHS would provide other environmental and social benefits not addressed by this study. For example, larger and higher quality habitats to preserve native biodiversity, the sequestration of carbon dioxide for climate change mitigation and more recreation opportunities to support healthy living.
- Scenario 4c "*LID SWM in New Development and Retrofit in Existing Development and protection of an enhanced NHS and implementation of enhanced agricultural practices*": This scenario provides additional improvements compared to existing conditions, most notably in water quality, groundwater quality, and the natural heritage features. The overalls core increases from 44 to 54. There are also other long-term benefits to agriculture through the adoption of agricultural BMPs that are not addressed by this study, such as enhanced long-term productivity of agriculture and contributions to biodiversity.
- The pattern of existing land use and of proposed future land uses under Halton Region's OP 2031 vary considerably in each of the seven Black Creek subwatershed catchment zones as previously illustrated in Figure 4. These zonal differences are reflected in the characterization of existing conditions and in the modelling results. The responses predicted by the model within different zones highlight which scenario(s) provide(s) the greatest benefits and identify priority areas (catchment zones) for implementation of appropriate measures to improve the Black Creek subwatershed.

The following provides some discussion as to how each scenario impacts the various technical disciplines that have been used to describe subwatershed characteristics. More details are found in the Phase 2 Impact Assessment report.

Hydrology

1. Stream flow volume will increase within sections of the watershed directly affected by new urban development under "business as usual" management (Scenario 2). This impact can be mitigated by the implementation of LID (Scenario 3).
2. Peak small flood flow volumes will increase within sections of the watershed directly affected by new urban development under "business as usual" management (Scenario 2). This impact can be mitigated by the implementation of LID in new development areas (Scenario 3), and existing conditions can be enhanced through retrofitting existing urban areas with LID and through the implementation of an enhanced NHS (Scenarios 4a and 4b).
3. September (worst case month) low streamflow is reduced when new urban development occurs under "business as usual" management (Scenario 2). This impact can be mitigated by the implementation of LID in new development areas (Scenario 3) and LID retrofitting in existing urban areas (Scenarios 4a).
4. Impervious surfaces and their negative impact on groundwater infiltration will become worse under "business as usual" management (Scenario 2). This impact can be mitigated within all zones through the implementation of LID in new development, LID retrofitting, an enhanced NHS, and enhanced agriculture (Scenarios 3, 4a, 4b and 4c).

Stream Processes

5. The frequency of high pulse stream flow will increase under "business as usual" management (Scenario 2) in urban and rural zones directly impacted by development. This impact can be mitigated with implementation of the full suite of mitigation measures: LID in new development, LID retrofitting, an enhanced NHS, and enhanced agriculture (Scenarios 3, 4a, 4b and 4c).
6. The flow volume of frequent flood events (5-year or more frequent) directly impacted by development are difficult to mitigate with implementation of LID SWM. However, implementation of an enhanced NHS and enhanced agriculture can significantly reduce flow volumes, particularly within rural areas, and this can contribute to the improvement of the Black Creek subwatershed.

Flooding

7. The impact of flooding on infrastructure (including buildings, public lands, and roads) within urban zones will increase under "business as usual" management (Scenario 2). This impact can be reduced by the implementation of LID in new development areas (Scenario 3), LID retrofitting in existing urban areas (Scenario 4a), and through the implementation of an enhanced NHS (Scenario 4b).

8. The impact of flooding on infrastructure within rural zones and within zones downstream of rural zones can be significantly reduced through the adoption of the enhanced agricultural practices (Scenario 4c).

Groundwater

9. Groundwater recharge and the associated groundwater levels will be reduced under "business as usual" management (Scenario 2). This impact can be partially mitigated through implementation of LID in new development areas (Scenario 3), and improvement over existing conditions can be achieved through the implementation of LID retrofitting in existing urban areas (Scenario 4a).

10. Natural vegetation cover within a 100-metre protection zone of wellhead (WHPA-A) is negatively impacted by "business as usual" management (Scenario 2). This impact can be mitigated through implementation of an enhanced NHS (Scenario 4b) and enhanced agriculture (Scenario 4c). Reference the current CTC Source Protection Plan for current regulations within the wellhead protection areas (https://ctcswp.ca/protecting-our-water/the-ctc-source-protection-plan/).

Water Quality

11. The condition of water quality in the Black Creek subwatershed will be further impaired by "business as usual" management (Scenario 2), and implementation of LID SWM (Scenarios 3 and 4a) is not sufficient to maintain or improve some existing water quality conditions as future development proceeds. Maintaining and improving water quality parameters is dependent on the implementation of LID SWM plus the implementation of an enhanced NHS and enhanced agricultural practices (Scenarios 4b and 4c).

Natural Heritage System

12. For many of the Black Creek subwatershed objectives and associated components related to hydrology, stream processes, flooding, and water quality, the impact of new development and an improvement over existing conditions can be achieved with the implementation of an enhanced NHS (Scenario 4b) and enhanced agriculture BMP's (Scenario 4c), which, in part, relies on increased protection of natural cover.

13. Implementation of an enhanced NHS (Scenario 4b) and enhanced agriculture (Scenario 4c) results in the achievement of the Black Creek subwatershed coverage targets for stream buffers (75%), total forest cover (30%), interior forest (10%), and wetland cover (10%).

3.4 Preferred Management Strategy

The need for and effectiveness of each management scenario varies across the seven zones that define the Black Creek subwatershed. In response the recommended management scenarios vary from zone to zone, although broadly speaking Scenario 4c is preferred. Table 6 summarizes the management procedures applicable to the seven subwatershed zones with further description as follows:

1. Adopt the enhanced NHS throughout the subwatershed, which includes elements defined under existing policies and practices, as well as additional lands based on stewardship;
2. Implement LID and green infrastructure as a holistic approach to SWM (i.e. through a treatment train approach) in all new developments in zones 1, 4 and 5;
3. Implement LID and green infrastructure as a holistic approach to SWM in existing developed areas through retrofitting existing land/infrastructure at a rate greater than 25% in zones 1, 4, and 5; and
4. Implement enhanced infrastructural and non-infrastructural agricultural BMPs in zones 2, 5, 6 and 7.

Table 6 Subwatershed zones with the suggest enhancement that should be implemented

Zone	Enhanced NHS	Enhanced Agriculture BMPs	LID New Development	LID Retrofit in Existing Developed Areas
1	✓		✓	✓
2	✓	✓		
3	✓			
4	✓		✓	✓
5	✓	✓	✓	✓
6	✓	✓		
7	✓	✓		

4. MANAGEMENT PLAN

4.1 Overview of the Management Plan Structure

The Black Creek subwatershed is facing many challenges – some remnant of past actions, some a result of current practices, and some expected as we move into the future. To protect the natural resources of the Black Creek subwatershed for current and future generations, the Management Plan provides a guide to achieve the goal, vision and objectives of the Black Creek subwatershed. This guidance intends to protect the form, function, and linkages of the Black Creek subwatershed, and, in doing so, provides a roadmap for managing the cumulative impacts of existing and future changes found through the characterization (Phase 1) and Impact Assessment (Phase 2).

The Management Plan presents the actions needed to protect and sustain critical resources from known stressors, including: existing development, new development, rural activities, flooding and natural hazards, and resource extraction activities. The Management Plan has been designed to achieve the Black Creek Subwatershed Study goal, vision and preferred land use management strategy and is geared towards finding compatible uses to protect both the natural environment and the benefits it provides, while meeting the continued growing needs of our society. Overall, the Management Plan aims to ensure land use and management decisions are carried out in a manner that:

- examines the impacts of site decisions in a subwatershed and watershed context (see Figure 1 and Figure 4);
- plans for long-term change and unexpected events;
- avoids exploiting land uses that will deplete natural resources and impair associated functions;
- avoids (where possible) and minimizes the adverse impacts of development on ecological processes;

- implements land use and management practices that are compatible with the natural potential of the area; and,
- enhances existing conditions previously impacted by land-use activities.

The Management Plan has been developed with the intent of implementing the preferred land use management strategy. The preferred management strategy ("Scenario 4c"), as informed by the Phase 2 Impact Assessment, entails the adoption of the following approaches:

- Protection, restoration, and enhancement of the NHS currently defined under existing policies and practices, and the inclusion of natural heritage features and buffer elements outside of this area (Figure 18);
- Application of agricultural BMPs across the subwatershed;
- Implementation of a holistic approach to SWM (i.e. through a treatment train approach) in all new developments; and,
- Implementation of a holistic approach to SWM in existing developed areas through retrofitting at a rate greater than 25 per cent.

Given the diversity of land-use and spatial variability in physical and natural characteristics of the Black Creek subwatershed, the focus of the preferred land use management strategy (Scenario 4c) was further refined to target specific land use management practices to catchments within the subwatershed based on their ability to achieve the subwatershed objectives (methodology for determining priorities is outlined in Appendix A of Phase 2 Impact Assessment).

Table 7 summarizes where to focus land use management practices. This table builds on Table 6 from Section 3.4 (Preferred Management Strategy); however, it has been further refined to identify high priority and secondary priority catchment zones. The assignment of a high priority ranking versus a secondary ranking is based on the specific characteristics and relative benefits that will be derived from implementing the proposed measures.

Table 7 Prioritization of land use management practices

Zone	Enhanced NHS	Agricultural BMPs	LID New Development	LID Retrofit in Existing Developed Areas
1	✓		✓✓	✓✓
2	✓	✓		
3	✓			
4	✓✓		✓✓	✓
5	✓✓	✓✓	✓	✓✓
6	✓	✓✓		
7	✓	✓		

Note: High priority implementation identified by two red check marks (✓✓); Secondary priority implementation is identified by one check mark (✓).

The information contained in the Management Plan is based on:

- Findings of the Black Creek Subwatershed Phase 1 Characterization Report and the Phase 2 Impact Assessment Report.
- The expertise of CVC staff and consultants in the disciplines of hydrology, hydraulics, hydrogeology, fluvial geomorphology, water quality, fisheries, and terrestrial and wetland ecology.
- Findings and recommendations from concurrent studies.
- Input from municipal staff at the Town of Halton Hills, Halton Region and County of Wellington.
- Input from provincial government ministries and agencies, including the MECP, the MNRF, the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), and the NEC.
- Input from stakeholders from across the subwatershed.
- Building climate change resiliency into the subwatershed.

The Management Plan was developed by a technical committee consisting of CVC staff, consultants, municipal partners, and with the assistance of the steering committee and focus groups. The Management Plan was completed to align with municipal and provincial planning documents and has been organized based on land use.

The Management Plan has been divided into eight sections. As listed below, they can be grouped by land use activities, flooding and natural resources. They are listed as follows:

Land Use Activities

1. Existing Urban Development (Section 4.2): Identifies opportunities to mitigate impacts from existing urban development on the health of the subwatershed.
2. New Development (Section 4.3): Provides direction for future studies, measures to mitigate impacts from new development, and strategies for the protection of important features and functions of the watershed.
3. Rural Land Use (Section 4.4): Identifies opportunities to mitigate existing rural land use impacts on the health of the subwatershed.
4. Aggregate Extraction (Section 4.5): Identifies measures that aim to minimize impacts of aggregate extraction on the natural environment.
5. Conservation Properties (Section 4.6): Identifies measures that provide direction to the management of conservation lands from the perspective of education, stewardship and land management.

Flooding

6. Natural Hazards (Section 4.7): Identifies protection, enhancement, and restoration measures to manage flood and erosion risks.

Natural Resources

7. Natural Heritage (Section 4.8): Identifies a NHS, and aquatic and terrestrial restoration priorities to protect core areas, maintain and restore connectivity across the system and enhance natural area on adjacent lands.
8. Water Management (Section 4.9): Identifies measures intended to guide both long term sustainability of groundwater, as well as the management of water and wastewater from the perspective of the natural environment.

Building resiliency in the Black Creek subwatershed will ensure there is a sustainable and healthy watershed for the present and future generations. One of the goals of the study is to protect, enhance and restore Black Creek, which can be done by partnering with Halton Region, municipalities, community groups, and government agencies. Leveraging expertise and knowledge will help manage the subwatershed, as various experts will be able to work collaboratively to reach our goals and ensure human uses are in harmony with the environment.

In an effort to make each management plan self-contained, the reader will find that there is repetition of content between the Management Plan sections. This is intentional so that the reader can find all relevant information in one place without the need to look elsewhere to fill in the gaps.

Following the Management Plan, the Implementation Plan (Chapter 5) provides direction on how, when, and what resources are available to implement the recommendations made for Black Creek subwatershed.

4.2 Existing Development

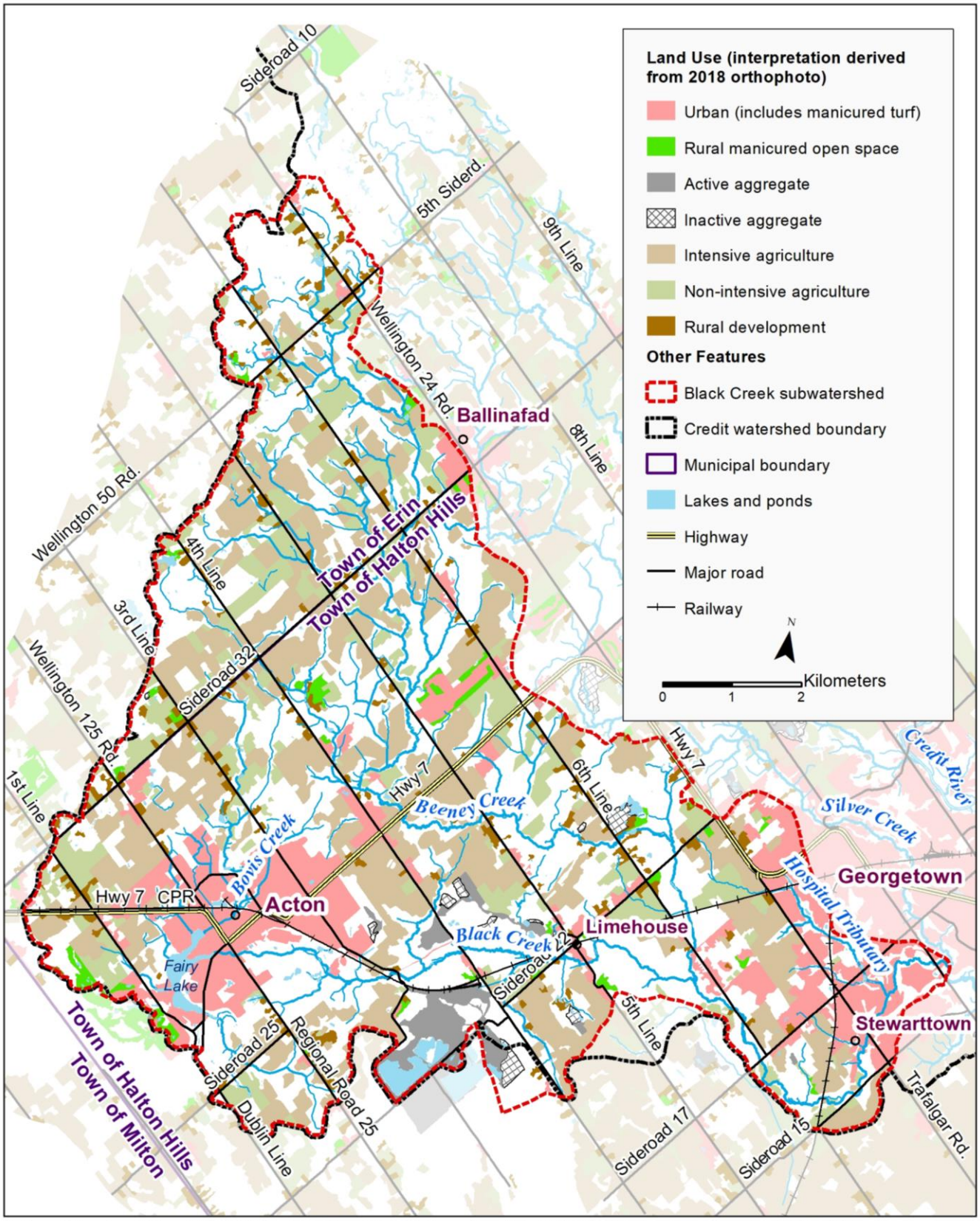
Alteration of the subwatershed and drainage networks to accommodate urbanization have contributed to degradation of water quality, a decrease in groundwater availability, flow changes and ultimately impacts to the geomorphological condition of the receiving surface water system. These impact aquatic health and habitat, increase risk from erosion and flooding, and may limit the available long-term water resources in the area.

Figure 11 illustrates the extent of urban areas in the Black Creek subwatershed. Current urban development makes up 16 per cent of the Black Creek subwatershed. Due to the age of development of Acton, 55 per cent of stormwater runoff is uncontrolled, 40 per cent is controlled, and 5 per cent has recently been retrofitted to be controlled. Similarly, within the older area of Georgetown that falls within the Black Creek subwatershed 100 per cent of urban runoff is uncontrolled.

Fairy Lake and the urbanized area of Acton is also a contributor of phosphorus into Black Creek, which is discussed in more detail below. The Management Plan reflects the overall watershed benefits that can be achieved through management practices that focus on managing existing urban runoff.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of existing development are highlighted in green below.

1) Increase Awareness	**2) Increase Knowledge**	3) Increase Participation	**4) Maintain Natural Hydrologic Cycle**	**5) Maintain, Enhance or Restore Watercourse Function**
6) Reduce Erosion	7) Minimize Flood Risk	**8) Maintain groundwater levels and baseflow**	**9) Maintain or enhance water quality**	**10) Protect, restore or enhance Ecosystem**



Drainage Network and Lakes (CVC, 2017); Ecological Land Classification and Land Use (CVC, 2017); Subwatershed Boundary (CVC, 2009)

Figure 11 Black Creek existing (2018) land use

The Phase 2 Impact Assessment identified the need to ultimately achieve at least a 25 per cent uptake in low impact development (LID) throughout existing urban areas. By focusing on improvements to managing storm water runoff in existing areas, there will also be a direct benefit to the protection, enhancement, and restoration of both aquatic habitat (Section 4.8) and groundwater (see Section 4.9).

To this end the management plan for Existing Development focuses on three priority areas.

1. Implementation of LID and other green infrastructure practices in urban areas to aid in replicating more natural hydrologic characteristics, such as enhancing infiltration or attenuating runoff rates;
2. Implementation of pollution prevention in industrial and commercial areas to improve water quality; and
3. Implementation of management practices to improve water quality in Fairy Lake.

The following three sections address management requirements for each of these three focus areas. A complete list of recommendations for directing the implementation of the Existing Land Use management plan are provided in the Implementation Plan (Chapter 5).

Green Infrastructure and LID Measures

Green infrastructure, including Low Impact Development (LID), is defined as the natural vegetative systems and green technologies that collectively provide a multitude of economic, environmental and social benefits. This includes:

- urban forests and woodlots
- bioswales, engineered wetlands and stormwater ponds
- wetlands, ravines, waterways and riparian zones
- meadows and agricultural lands
- green roofs and green walls
- urban agriculture, and
- parks, gardens and grassed areas.

It also includes soil in volumes and qualities adequate to sustain green infrastructure and absorb water, as well as technologies like porous pavements, rain barrels and cisterns, which are typically part of green infrastructure support systems. The green technologies in this definition replicate the functions of the hydrologic cycle, such as stormwater storage, evapotranspiration, and filtration (Green Infrastructure Ontario Coalition, 2019).

Implementation of different LID and other green infrastructure projects in urban areas can be accomplished along roadways, on private lands, and in parks and in parking lots. In all cases detailed site assessments, including localized impacts on the water table, will need to be completed to confirm the appropriate design.

Roadways

Table 8 provides examples of measures that can be implemented along existing roadways. LID will help to reduce total suspended solids (TSS) and total phosphorous (TP) concentrations and will filter that stormwater runoff before it enters the natural environment. LID projects can be added during reconstruction and resurfacing activities, which would be a relatively simple and cost-effective approach, since construction will already be taking place. To focus efforts, Figure 12 provides targeted neighbourhoods where implementation of LID measures would have the most benefit to the system, as well as to the immediate area. These areas represent locations where there are limited or no existing SWM facilities and where the conditions appear to be favourable for the implementation of LID measures.

Public Land Management

Public lands represent significant contributions to the value of a community and watershed. The Grey to Green Retrofit Guide for Public Lands (CVC, 2012), defines key public lands as parks, schools, municipal facilities, and places of worship.

Public Lands are areas designated to have important social and health benefits for the community, as well as for enhancing the NHS. However, if not protected properly, public lands can be inhibited from fulfilling important environmental/ecological functions, such as SWM, aquifer regeneration, air quality filtration, and provision of natural habitat. Approximately 1.5 per cent of the subwatershed consists of public lands distributed throughout Acton and Georgetown.

Many of the parks are good candidates for improved SWM practices, including establishing naturalization or no-mow zones. Some simple adjustments in management of turf can result in significant improvements in SWM. Additionally, increasing the planting diversity by simply planting trees or creating flower beds and planting perimeter shrubs can also result in improvements to watershed health. Parks have both passive and active uses. In both areas, it is possible to integrate LID and green infrastructure practice through consultation of stakeholder groups.

Increasing the tree canopy also has many benefits, such as increased biodiversity and habitat, reduced urban heat island effects, and visual appearance. Trees can be added in as a component of a green infrastructure project or just general tree planting throughout existing developed areas.

For detailed information on different low impact development options throughout the Black Creek subwatershed, and suitable locations, see Appendix C. In addition, see Appendix D for a description of a GIS Screening tool that can be used for LID implementation.

Table 8 Existing Development examples that provide an opportunity for improving SWM

Example Picture of Existing Conditions	Existing Conditions	Potential SWM Opportunities
	Residential street with existing rural cross section, street profile with a sidewalk on one side and ditches on both sides. Electrical utilities above ground.	• Linear bioretention between driveways • Perforated pipes to promote infiltration or filtration
	Residential street with a curb and gutter street profile. Sidewalks on both sides. Electrical utilities above ground.	• Linear bioretention where space allows • Perforated pipes to promote infiltration or filtration
	Major arterial road with rural cross-section. No sidewalks. Electrical utilities above ground.	• Linear bioretention • Perforated pipes to promote infiltration or filtration
	Industrial street with a rural cross-section	• Enhanced grass swale to aid in attenuation • Perforated pipes to promote filtration

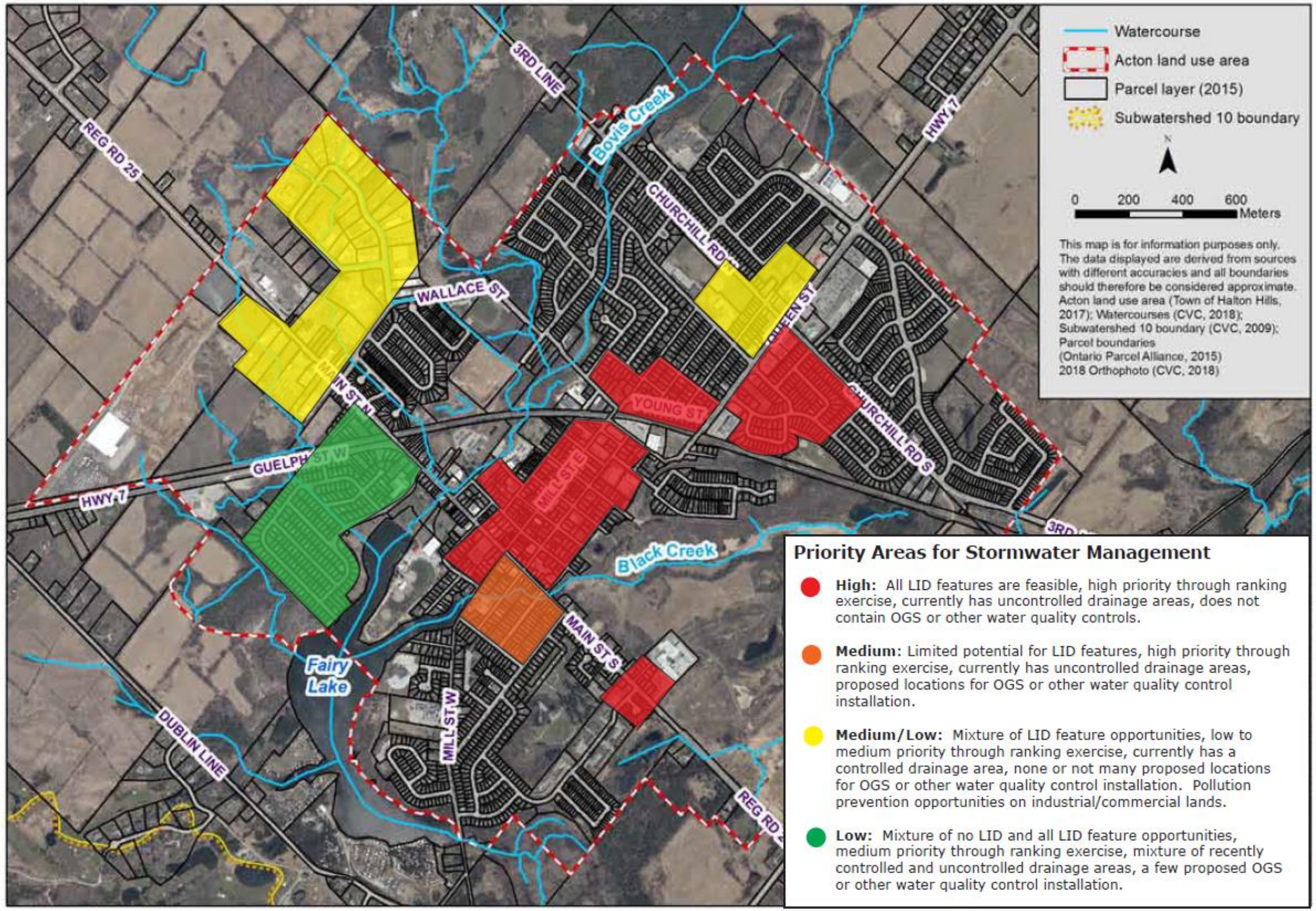


Figure 12 Priority Areas for Stormwater Management in Acton

Pollution Control Measures

The goal of pollution prevention is to reduce the quantity of contaminants entering the environment as a measure to improve the quality of surface and groundwater sources. Appendix C provides a list of pollution prevention measures that can be implemented to achieve a reduction in both point and non-point sources of pollution within the subwatershed.

Table 9 lists specific pollution prevention practices that apply to only some of the industrial, commercial, and institutional (ICI) properties. Commercial and industrial lands in the Black Creek subwatershed covers approximately 1.6 per cent of the land use in Black Creek subwatershed. Primarily these areas are located within Acton and scattered throughout portion of Georgetown and the rural hamlets of Halton Hills. The commercial and industrial lands are broken down by the Town's Zoning into several categories such as Hamlet commercial, Downtown Commercial, Institutional, Employment etc. each with its own particular standards. All of the practices have to be identified based on site specific locations.

The implementation of pollution prevention measures within the urban areas of the Black Creek subwatershed should be focused on addressing both point and non-point sources of pollution. Ultimately, pollution prevention is intended to lead to improvements in water quality for both public health and aquatic habitat, which is most effectively done through education, outreach, and assistance with implementation. See Appendix C for detailed information on projects that can be carried out in the Black Creek subwatershed on the various types of ICI lands.

A key contributor to the phosphorus levels within Black Creek relate to discharge from the Acton WWTP. Halton Region completed a study to examine the potential to offset TP loadings in relation to the proposed Acton WWTP expansion. In response to this study, Halton Region and the Town of Halton Hills will be installing a series of Oil Grit Separators (OGSs) and stormwater treatment systems throughout the upstream area of the WWTP that currently lacks SWM and sufficient TP reduction measures.

Table 9 Examples of pollution prevention practices for Industrial and Commercial Properties

		Industrial and Commercial Properties		
		Low Risk (local commercial property)	**Medium Risk** (employment lands and business parks)	**High Risk** (larger industrial properties)
Maintenance Logs		✓	✓	✓
Common* Pollution Prevention Practices	Dumpster Management	✓	✓	✓
	Turf Management	✓	✓	✓
	Landscaping and Grounds Care	✓	✓	✓
	Snow and Ice Management	✓	✓	✓
	Outdoor Storage	✓	✓	✓
	Parking Lot Maintenance	✓	✓	✓
Inspection Logs			✓	✓
Tailored* Pollution Prevention Practices	Vehicle Maintenance and Repair			✓
	Vehicle Washing			✓
	Fueling Stations			✓
	Grease Management			✓
	Other site specific			✓
Consultation Plan				✓

*Common pollution prevention practices that apply to all industrial and commercial properties

Fairy Lake

Findings from an AECOM (2009) report indicate that water quality in Fairy Lake is affected by both internal processes and external processes. Elevated concentrations of metals, nutrients, salt, TP, ammonia, and bacteria were recorded at the Tyler and Elmore Street stormwater outfall locations into Fairy Lake. It is outlined in the background studies that the lake has an overall warming effect on temperature but also moderates diurnal fluctuations. The influence of the lake on water temperature in Black Creek is the primary concern for Fairy Lake outflow due to the impact on downstream aquatic habitat. A direct benefit from Fairy Lake is the low flow augmentation and wastewater assimilation that it provides. Table 10 provides a list of management approaches that can be taken to improve the quality and function of Fairy Lake.

Table 10 Overview of management recommendations for Fairy Lake

Management Component	Management Approaches
Waterfowl	Waterfowl contribute to the high E. coli and TP levels within the lake and should be controlled through measures such as: • Public education to stop feeding waterfowl. • Deter geese access to the lake shoreline (e.g. shoreline naturalization in Prospect Park and residential areas; dog scaring techniques; and, installing a wire mesh over open water). • Control population through egg oiling or grass repellent.
Riparian Vegetation	Under existing conditions, the width of vegetative buffers along the shoreline is minimal or non-existent due to residential, trailer, and park lawn maintenance. Recommendations include: • Establish no-mow buffer along the shoreline within residential properties. • Enhance riparian buffer in public areas (e.g. Rotary Park Prospect Park existing buffer is < 3 m wide; this should be enhanced to a minimum of 5 meters and an ideal buffer of 10-15 m, based on OMAFRA (2008)). • Riparian vegetation should provide variable composition to trap airborne pollutants, provide shade to surface water, and enhance aquatic and terrestrial habitat.
Aquatic Vegetation	Public concerns (including the presence of blue-green algae) have previously been raised regarding aquatic vegetation. Recommendations include: • Public education should be undertaken regarding benefits of aquatic vegetation (aquatic habitat, nutrient uptake, ecology), and removal of vegetation from the lake should be discouraged. • Biological control of some aquatic plants (e.g. Eurasian watermilfoil control through introduction of weevils) can be further explored.
Nutrient	Nutrient inputs to the lake can be reduced by the following measures: • Minimize/mitigate use of fertilizers in property maintenance along the shoreline. • Establish a vegetated/naturalize buffer between lawn and shoreline (minimum width of 15m). • Minimize turf area in proximity to the shoreline to discourage geese. • Manage pet waste (e.g. develop 'stoop and scoop' program). • Provide runoff control through lawns (capture stormwater, downspout disconnection). • Verifying that the septic bed associated with Breezes Trailer Park is in good condition and does not leak nutrients into the lake.

Management Component	Management Approaches
Water Temperature	Reduction in water temperatures can occur through: • Establishing riparian buffers along the shoreline to provide shade. • Placing a shade screen over portions of shallow open water. This screen would be placed over the water on a seasonal basis to reduce thermal warming effects.
Water Quality	Reduction in upstream contaminant loading is a long-term goal. Actions that can enhance water quality include: • Control urban runoff at source through on-site treatment. • Reduce metal loadings in catchment areas of the Tyler and Elmore outfalls (consider SWM methods, such as Jellyfish, OGS). • Implement agricultural BMPs to reduce nutrient loading. to surface water (e.g. buffers, nutrient application, etc.). • Implement BMPs for salt applications to reduce the total amount of salt applied and/or is ultimately conveyed to the lake. • Develop 'Stoop and Scoop' program to reduce pathogen and bacteria loading to the lake. • Install aeration devices to enhance DO.

4.3 New Development

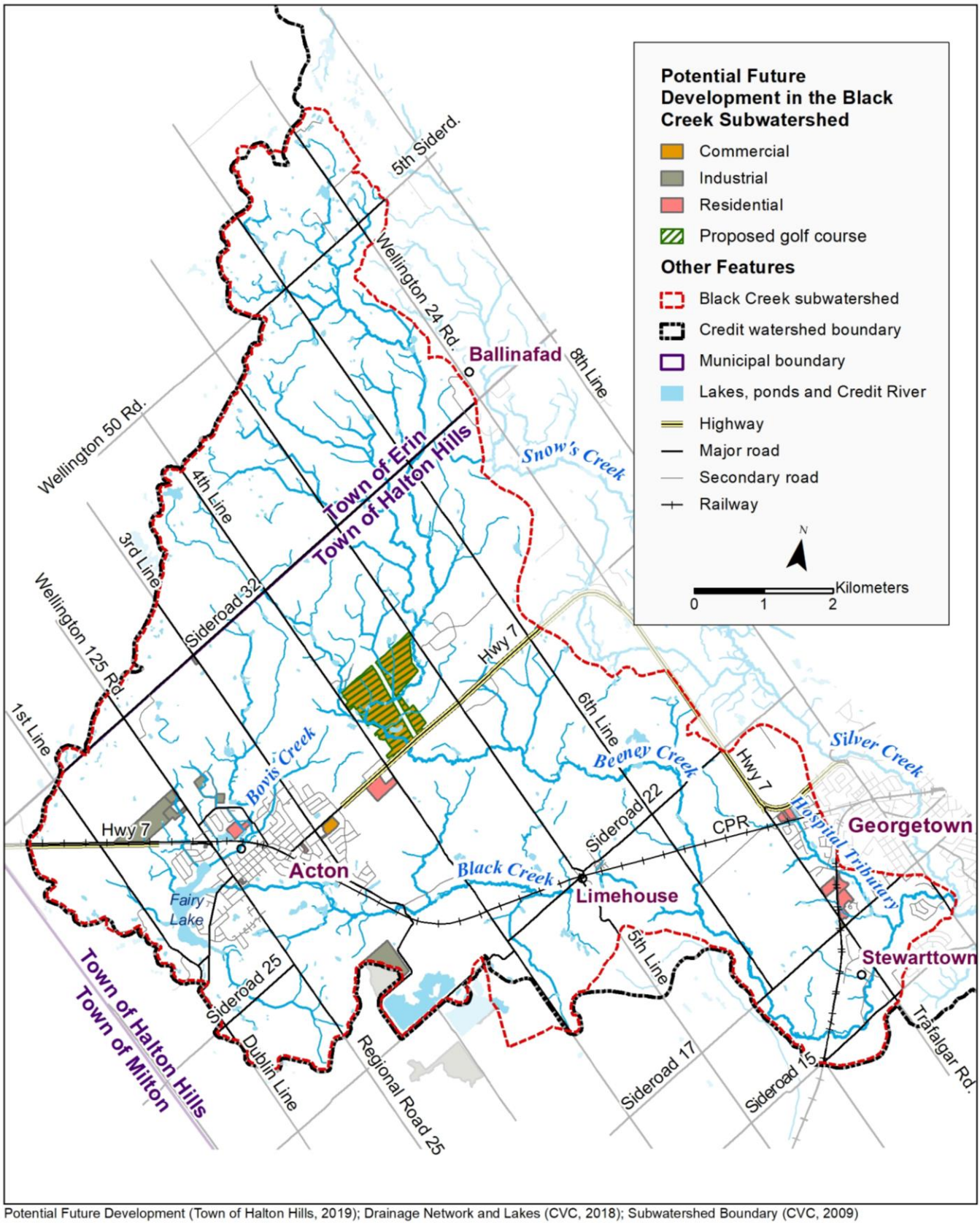
Based on 2031 projected growth and Municipal Official Plans, urban development in the Black Creek subwatershed is expected to increase from the current 14 per cent of total land cover to 19 per cent of the total land cover. Figure 13 exhibits known future development sites within the Black Creek subwatershed. Most of this development is planned to occur in Zones 1, 4 and 5. More details are found in the Town of Halton Hills' Official Plan maps, included herein as Appendix E.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of new development are listed as follows.

1) Increase Awareness	**2) Increase Knowledge**	3) Increase Participation	**4) Maintain Natural Hydrologic Cycle**	**5) Maintain, Enhance or Restore Watercourse Function**
6) Reduce Erosion	7) Minimize Flood Risk	**8) Maintain groundwater levels and baseflow**	**9) Maintain or enhance water quality**	**10) Protect, restore or enhance Ecosystem**

Impacts of new development that would be experienced in the Black Creek subwatershed include increased groundwater takings, increased impervious cover and stormwater runoff, increased wastewater discharge, and potential impacts on the surrounding natural areas.

The overall objective of the management plan for New Development is to provide guidance for new development with a focus on three key areas: natural heritage, stormwater management, and the natural stream network. Adhering to current CVC guidelines and policies to ensure there is environmental protection and restoration during expansion and growth.



Potential Future Development (Town of Halton Hills, 2019); Drainage Network and Lakes (CVC, 2018); Subwatershed Boundary (CVC, 2009)

Figure 13 Black Creek potential future development (2019) land use

Natural Heritage

In support of future potential development, documentation of site characteristics is necessary to identify features and functions within the proposed development area. Likewise, the role of the development area within the larger spatial and temporal continuum of function, processes, and linkages to the various physical, biological, aquatic, and environmental attributes of the subwatershed should also be established. Updating site characteristics will be required to respect the NHS while allowing new development, which will guide appropriate mitigation, ensuring connection and reconnection to the NHS. Development proponents are encouraged to consult the municipality, Ontario Ministry of Natural Resources and Forestry (MNRF), Ontario Ministry of Environment, Conservation and Parks (MECP), and CVC early in the process to develop an Environmental Impact Assessment (EIA), identify any features or areas of concern, and information sources. All relevant ecological inventories should be conducted at the appropriate time of the year using standardized protocols appropriate for the governing organizations.

The Background Report and Phase 1 Characterization Report contain background data and information that will provide an overview of existing conditions and management considerations of the Black Creek subwatershed. A thorough review of these reports is recommended as part of any future study process to ensure full appreciation of the relationship between the proposed development area and the larger scale subwatershed conditions and processes and to identify overall management objectives for the Black Creek subwatershed, which can be reviewed in Section 4.8. Since the baseline data collection of this subwatershed occurred in 2008 and 2009, additional baseline characterization will be likely necessary as part of any future development project. The extent of any additional data collection requirements should be determined at the outset of the development process through consultation with the Halton Region, Halton Hills, and CVC.

Halton Region requires preparation of an EIA where proposed development lands are located within or adjacent to key feature constraint areas, the Halton Region Natural Heritage System and/or the Greenbelt Natural Heritage System.

This study recommends incorporating the natural heritage system as identified in Section 4.8 of this study into the next update of the municipal official plan. This natural heritage system is a refinement of the provincial and municipal systems to address the health and function of the Black Creek subwatershed. New development should also refer to Figure 24 to consider incorporating the recommended priority stewardship and restoration actions into site plans. Lastly, the implementation of the recommendations in the following stormwater management and stream network sections will address impacts and improve the health and function of the natural heritage system of the Black Creek subwatershed.

Stormwater Management

In new development areas SWM will be achieved by applying a treatment train approach. Collectively the treatment train will include: infiltration to maintain or exceed existing recharge rates; filtration or detention to improve water quality; volume control to reduce

downstream erosion potential; and, peak flow to reduce downstream flood risk. In support of any development applications, a complete stormwater management report shall be submitted to the municipality and CVC, documenting all design and criteria information for the development site.

For the Black Creek subwatershed the design criteria for SWM will be as follows:

- Water balance: Subject to policies of the approved CTC Source Water Protection Plan (CTC, 2015) and further guidance provided in the Water Management Plan (Section 4.8), maintain or enhance existing site water balance.
- Water quality: Design criteria for water quality should be established on a reach by reach basis but as a minimum should adhere to the Ministry of Environment, Conservation and Parks (MECP) requirements.
- Water temperature: Design criteria should also be established on a reach by reach basis. In reaches supporting coldwater species and other target species, it is recommended that SWM controls ensure discharge temperatures meet ambient stream temperature or temperatures within an acceptable range. It is recommended that monitoring of water temperature in proximity to the proposed development area (upstream, downstream of site, and of any tributary confluence) during different seasons is recommended to define conditions in addition to those already established as part of the Phase 1 Characterization Report. Predevelopment monitoring should be conducted for a length of time that best supports gaining a baseline understanding. Temperature monitoring is most relevant during the summer. Following the monitoring, specific targets should be established that will maintain water temperature from the perspective of the Credit River Fisheries Management Plan (Absolute maximum summer water temperatures should not exceed 26°C for coldwater, 28°C for mixed water, and 30°C for warm water).
- Runoff volume: After discounting for infiltration, filtration and extended detention, post development runoff volume for the 2-year storm to be no greater than predevelopment runoff volume.
- Peak flow: Post development peak flows in receiving watercourse to be equal to or less than existing peak flows for all design storms up to the 100-year storm event.

The design criteria will be met using the following treatment train hierarchy:

- LID to achieve water balance:
    - Subject to policies of the Approved Source Water Protection Plan (CTC, 2015) and further guidance provided in the Water Management Plan (Section 4.8), design LID measures to maintain or enhance existing infiltration rates.
    - In line with the policies of the Approved Source Water Protection Plan (CTC, 2015), where pre-development recharge cannot be maintained on site within a WHPA-Q (Figure 31 in Section 4.9 Water Management), implement and maximize off-site recharge enhancement to compensate for any predicted loss of recharge from the development.

- Source, conveyance and end-of-pipe controls:
    - Should be applied to new developments as part of a treatment train approach to SWM, in which stormwater BMPs are applied in succession along a stormwater flow path. SWM measures in new development should be planned, designed and implemented in accordance with the most current version of the following:
        - CVC and TRCA Low Impact Development Stormwater Management Planning and Design Manual (TRCA and CVC, 2010, updated to Wiki format 2019)
        - MECP Stormwater Retention Targets (MECP, 2003)
        - MECP SWM Planning and Design Manual. (MECP, 2003)
- Where LID measures are used as part of a treatment train and opportunities for infiltration are limited due to site conditions or constraints associated with the Approved Source Water Protection Plan (CTC, 2015), subject to Municipal and Provincial approval consider incorporating filtration or water re-use in to the design of the LID measures as a method of improving water quality, reducing runoff and delaying runoff timing.

Stream Network

In support of any development application where the form or function of the existing stream network may be altered, a Geomorphic Assessment Report should be prepared and submitted to CVC. The report shall adhere to current CVC guidelines. This will ensure that natural hazards are appropriately managed and should identify were development impacts can be offset by aquatic habitat restoration measures outlined in Appendix H. It should also give consideration to headwater drainage features.

Erosion is a natural process by which watercourses and channel features are maintained. Erosion becomes a hazard when there is a risk to property or infrastructure. Management of erosion processes occurs through defining the spatial extent of anticipated channel migration defining erosion hazard limits, mitigating effects of land use induced hydrologic changes, and managing the effects of anthropogenic measures.

With any new development erosion management should follow the mitigation strategies outlined in Section 4.7 Natural Hazards, Table 13, including:

- Delineation of erosion hazards following MNRF (2002) and CVC (2015) guidelines (in particular, Fact Sheet I);
- Definition of channel corridor, which will be used as a constraint for development;
- Management of existing and proposed in channel structures to minimize erosion risk;
- Management/development of riparian buffers in accordance with CVC landscaping guidelines;
- Compliance with CVC's Dam Safety Program;
- Compliance with CVC geomorphology guidelines (Fact Sheet III) with regard to any proposed or modified watercourse crossings;
- Completion of a detailed erosion threshold analysis; and,

- Ensuring that existing condition flows (bankfull, flushing flows and high flow pulses) are maintained or enhanced.

Development activities have the potential to negatively impact natural stream processes. Conversely, they are often an opportunity to enhance or restore natural processes and the balance of flow and sediment transport, where previous alterations have impacted watercourses. Furthermore, restoration can be a tool to help manage stream flow and erosion impacts on habitat and property, which can potentially be exacerbated by new development.

4.4 Rural Lands

Management of the Black Creek subwatershed agricultural resources is important for the health and productivity of the Credit River watershed both now and into the future. Agricultural lands provide important ecosystem services, including supporting functions (e.g. soil formation, nutrient cycling, primary production), provisioning (e.g. food and fiber), regulating (e.g. climate regulation, water regulation, and pollination), and cultural functions (e.g. spiritual and religious, recreation, aesthetic, inspirational, educational, sense of place, and cultural heritage) (World Resources Institute, 2003). The proposed management plan is intended not only to reduce or mitigate impacts of agricultural land use practices on Black Creek and its tributaries, but also to maintain and enhance agricultural resources for future generations.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of rural lands are listed as follows:

1) Increase Awareness	**2) Increase Knowledge**	**3) Increase Participation**	4) Maintain Natural Hydrologic Cycle	5) Maintain, Enhance or Restore Watercourse Function
6) Reduce Erosion	7) Minimize Flood Risk	8) Maintain groundwater levels and baseflow	**9) Maintain or enhance water quality**	**10) Protect, restore or enhance Ecosystem**

The Black Creek subwatershed is one of the most intensively farmed locations within the Credit River watershed and has one of the highest risks to water quality contamination from agriculture. Based on 2011 census data, there were 60 farms within the subwatershed with a total of 3,650 hectares farmed. Of this, 44 per cent (1,590 ha) are owned and 56 per cent (2,060 ha) are rented. Within the Black Creek subwatershed there are a total of 31 livestock farms, which is the second highest number of livestock farms per subwatershed within the Credit River watershed. Of these 31 livestock farms, 11 are cattle and 10 are horse and equine, with the remaining 10 being comprised of honey bees, goats, and llamas. The majority of acreage in agricultural use supports cash crops of corn, soy, wheat, and alfalfa hay. This land use is typically coincident with the use of herbicides, insecticides, fungicides, and commercial fertilizers. Livestock (dairy, beef, and equine) grazing is also prevalent in the watershed.

Based on tracking of the adoption of BMPs within the subwatershed by CVC, it appears that more landowners are implementing agricultural BMPs. Practices, such as rotational grazing, and green manure plow down, have grown in use between 2006 and 2011; however, there is significant room for improvement.

A key concern identified through the Phase 1 study report is the TP concentration in surface water of Beeney Creek and Black Creek. As part of the Dillon (2010) Acton Total Phosphorus Management Study – Rural Offsets, BMPs that could reduce TP loading to receiving watercourses were identified.

Table 11 provides a summary of the BMPs by zone. Locations for implementation are identified on Figure 14. Further information on BMP implementation and guidance can be obtained from the Wellington Rural Water Quality Program and various BMP guideline documents produced by OMAFRA.

Based on the analyses provided by Dillon (2010) and this Subwatershed Study, opportunities for water quality enhancement through implementing agriculture BMPs are greatest in Zone 5 and Zones 7. By increasing buffer widths on agricultural properties around watercourses, water quality and quantity issues can be improved.

Figure 15 shows the various buffer widths and their corresponding level of achieving buffer function. Since agricultural properties rely on their land as a source of income, it may not be possible to implement large buffer areas at all times, but different ranges can be applied in different situations to achieve the best possible outcome.

Headwater drainage features (zero and first order) are often ephemeral (periodically flowing, especially after precipitation events) or intermittent (seasonal) features that, despite their small size, exert an important influence on the hydrograph of the main channel. Similarly, the small depressions that occur within a landscape provide water storage opportunities that attenuate flow conditions and delay water delivery to the surface drainage network (i.e. they may become part of a continuous surface drainage feature during specific precipitation events). Management of agricultural lands to maximize productivity often includes installing tile drains to manage soil moisture. Routing of water through a subsurface drainage network alters the hydrograph of flows in the receiving channel, reduces organic material contributions and seasonal aquatic habitat.

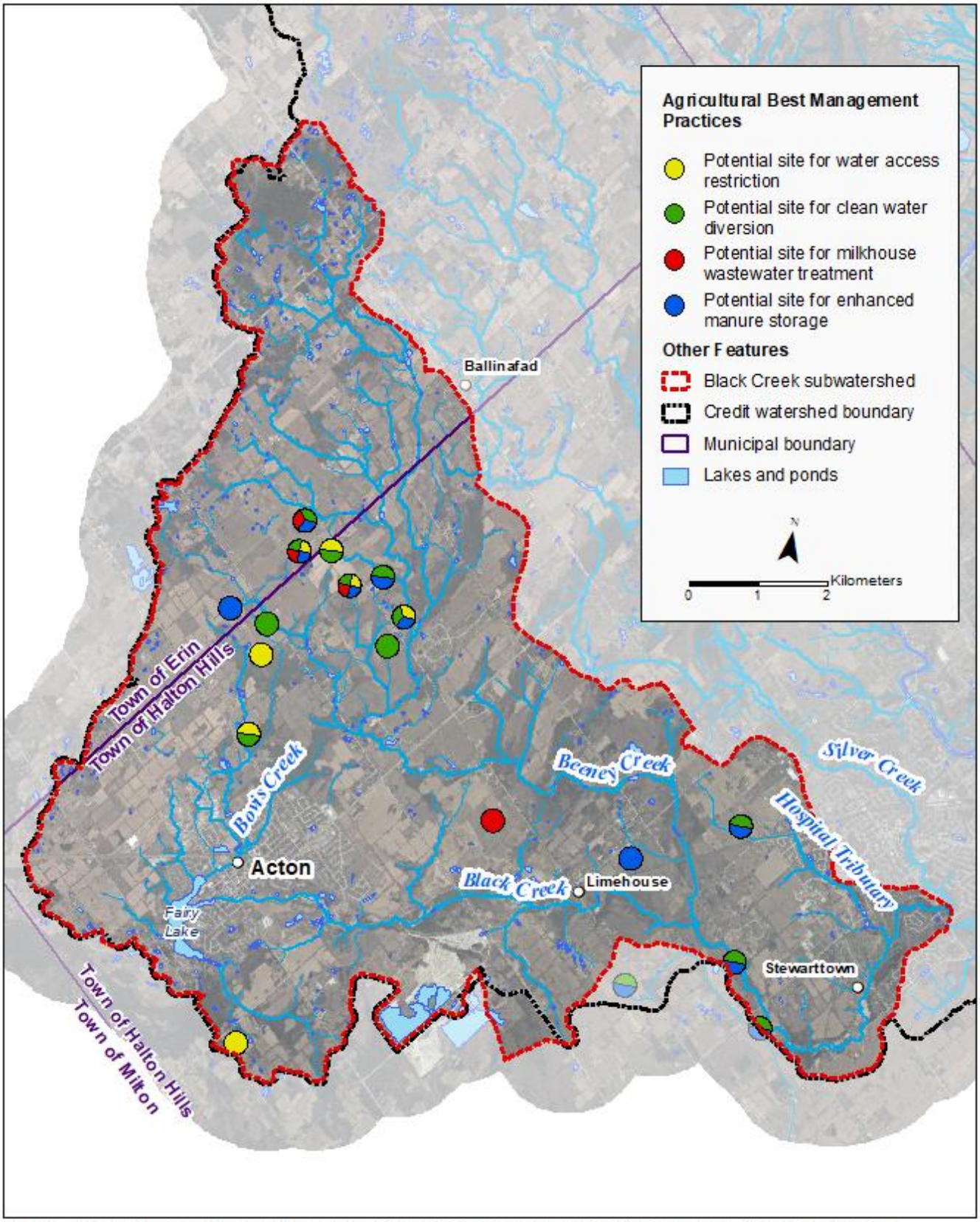
Table 11 BMPs to mitigate water quality impacts and enhance soil conditions

BMPs for Water Quality	Locations for maximized benefit within the subwatershed and number of farms identified by Dillon (2010) (Zone: # of farms)	Description
Enhanced Manure Storage Facility/ Structure	Zone 1: 3 Zone 5: 1 Zone 6: 5 Zone 7: 1	Constructing or repairing a storage facility/structure to provide proper manure storage (e.g. concrete, steel, earthen, or roofed structure) to replace stacked manure pile, or building berm, settling basin, and/or buffer strip to treat feedlot manure (Dillon, 2010).
Milkhouse Wastewater Treatment	Zone 2: 1 Zone 6: 3	Constructing or expanding a nutrient storage facility (e.g. sediment tank, treatment trench, etc.) for a dairy operation that is capable of holding the waste for a minimum number of days or installing treatment facility for milkhouse wastewater, which may include flocculator, vegetated filter strips, constructed wetlands, lagoons, or ponds (Dillon, 2010).
Clean Water Diversion / Barnyard Runoff Control	Zone 1: 3 Zone 5: 2 Zone 6: 7	Installing clean water diversion structures such as eaves troughs, berms, or ditches that direct clean water away from barnyards and other sources of contamination. As well, implementing any permanent technique to prevent rain and snow from becoming contaminated is also considered in this BMP (Dillon, 2010). Specific guidance is provided in "Best Management Practices: Water Management" from OMAFRA (1993).
Livestock Access Restriction to Waterways	Zone 5: 3 Zone 6: 4	Installing or repairing fencing to restrict livestock access to watercourses to reduce the potential for contamination (Dillon, 2010). Restricting livestock will also provide important habitat enhancement for species such as the Atlantic Salmon "Lake Ontario Atlantic Salmon Restoration Program: Phase 3 Habitat Plan 2016-2020" (2018).
Nutrient Management Plans	Zone 5: n/a* Zone 6: n/a*	Complete and implement a plan regarding nutrient storage, handling, and application to encourage effective use of available nutrient resources, avoid nutrient loss, optimize yields, and protect both groundwater and surface water. This includes maintaining suitable buffers/separation distances between active land use and watercourse (see "Best Management Practices: Nutrient Management

BMPs for Water Quality	Locations for maximized benefit within the subwatershed and number of farms identified by Dillon (2010) (Zone: # of farms)	Description
		Planning (Revised Edition, 2006)" from OMAFRA for details), and to improve water quality, increased buffer widths should be achieved throughout the subwatershed. Figure 15 summarizes the recommended buffer widths based on the project objective. This table should guide the restoration and enhancement efforts to mitigate the identified issue.
Pesticides	Zone 5: n/a* Zone 6: n/a* Zone 7: n/a*	Integrated pest management strategies pertaining to pest identification, pesticide application (nozzle size, spray height), and establish 15 m buffer width between field and watercourse.
Maintenance	Zone 5: n/a* Zone 6: n/a* Zone 7: n/a* Zone 2: n/a*	Locate feed, salt and shade structures away from riparian areas; establish equipment maintenance areas away from watercourse.
Buffers/ Separation Distances	Zone 5: n/a* Zone 6: n/a* Zone 7: n/a* Zone 2: n/a*	Establishment of riparian buffers around watercourses aids in the management of surface runoff, particularly as it pertains to water quality. Buffers also provide shade to watercourses, which will contribute to a reduction of surface water temperatures. Figure 15 summarizes the recommended buffer widths based on the project objective This table should guide the restoration and enhancement efforts to mitigate the identified issue.
Erosion Control	Across subwatershed	Implement measures to control soil erosion on farmland, such as grass waterways, water and sediment control basins, stream bank stabilization (including ditchbank seeding), contour terraces (Wellington, 2015).
Cover Crops	Across subwatershed	Establish over-wintering crops (living or dead) that provide soil protection, reduce surface erosion, and promote biological nitrogen fixation (WRWQP, 2013). Cover Crops are also referred to as 'green manure' and also contribute to increasing organic matter, controlling pests and disease, and preventing mineral leaching.

BMPs for Water Quality	Locations for maximized benefit within the subwatershed and number of farms identified by Dillon (2010) (Zone: # of farms)	Description
Green Manure Plow Down	Across subwatershed	Boost fertility by growing crop and turning it under, as part of crop rotation instead of fertilizer.
Retiring Sensitive Lands	Across subwatershed	In areas that are not economically productive (i.e. yield is less than break-even point in, for example, hydrologically active lands), retiring the land from active agriculture may be a sound business decision. Conversion of lands to natural heritage or to alternative low intensity but potential economically viable land uses (e.g. bee hives, Christmas trees, maple tree tapping, etc.) could be considered.

*n/a: represents that there is no data available for that zone for the specific BMP



Agricultural best management practices (Dillon Consulting Limited and Halon Region, 2010); Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009)

Figure 14 Agricultural BMP opportunities throughout Black Creek

Supporting documen-tation for buffer function	Buffer function category	< 5 m	5 – 10 m	11 – 20 m	21 – 30 m	31 – 40 m	41 – 50 m	51 – 60 m	61 – 70 m	71 – 80 m	81 – 90 m	91 – 100 m	101 -1 110 m	111 – 120 m	>120 m
Watercourses and water bodies															
+	Water quantity	Data indicate that site specific buffers are inadequate to mitigate water quantity													
+, +++[1]	Water quality														
+, ##[2]	Screening of Human Disturbance / Changes in Land Use														
+, #	Hazard mitigation	Should be based on consideration of hazards but may overlap with buffer zones													
+, ++	Core habitat protection[3]														
Wetlands															
+	Water quantity	Data indicate that site specific buffers are inadequate to mitigate water quantity													
+, +++	Water quality														
+, ++	Screening of Human Disturbance / Changes in Land Use														
#	Hazard mitigation	Should be based on consideration of hazards but may overlap with buffer zones													
#, +, ++	Core habitat protection[3]														
Upland woodlands and forests															
	Water quantity	Insufficient data													
	Water quality	Insufficient data													
#, ##	Screening of Human Disturbance / Changes in Land Use														
#	Hazard mitigation	Should be based on consideration of hazards but may overlap with buffer zones													
##	Core habitat protection[3]														

Legend

	Low likelihood of achieving buffer function
	Moderate likelihood of achieving buffer function
	High likelihood of achieving buffer function

[1]*"+" represent empirical studies that tested buffer effectiveness for this function category; "+" = few, "++" = more than a few, "+++" = many; from Beacon Environmental Limited (2012).*

[2]*"#" represent empirical or technical studies that did not test buffer effectiveness per se, but provide data that can inform buffer determination; "#" = few, "##" = more than a few, "###" = many; from Beacon Environmental Limited (2012).*

[3]*Note that core habitat protection beyond tree root protection should occur through natural heritage planning rather than through buffer design.*

Figure 15 Ranges of buffer widths to natural heritage features based on current science (from Beacon Environmental Limited 2012) from the Credit Valley Conservation Natural Heritage System Strategy Phase 3, September 2015

Management of agricultural lands to promote future sustainability is an important consideration. This will ensure food production and availability of genetic resources into the future. Intensive agriculture land use can deplete nutrients from soils and decrease productivity over time. Best Management Practices should be implemented to reduce potential for soil erosion, enhance soil formation processes, and replenish nutrients in a manner that efficiently matches nutrient application with the amount of nutrients removed from the soil by the harvested crop. Methods to protect soil are similar to those which benefit water quality and include cover crops and erosion control structures as outlined in Table 11.

The majority of land that makes up the NHS belongs to rural landowners. As such, the majority of opportunities that exist in the Black Creek subwatershed are geared towards rural landowners and support good agricultural practices and water management. Good agricultural and water management practices will ultimately address stressors that affect the water quality and habitat availability in the subwatershed.

For the complete list of subsequent implementation recommendations that were developed to mitigate these issues for rural land, see the Implementation Plan (Chapter 5).

4.5 Aggregate

This management plan identifies measures to be applied to aggregate operations, in order to prevent or minimize impacts on the natural heritage and water resources of the Black Creek subwatershed. The measures focus on connections and interactions with the surrounding environment and are not specific to aggregate operations. However, they are intended to highlight the key priorities from a subwatershed perspective.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of aggregate operations are listed as follows.

1) Increase Awareness	2) Increase Knowledge	3) Increase Participation	**4) Maintain Natural Hydrologic Cycle**	**5) Maintain, Enhance or Restore Watercourse Function**
6) Reduce Erosion	7) Minimize Flood Risk	**8) Maintain groundwater levels and baseflow**	**9) Maintain or enhance water quality**	10) Protect, restore or enhance Ecosystem

As described in the Phase 1 and Phase 2 reports, aggregate operations make up less than three per cent of the land use by area within the Black Creek subwatershed, with the only aggregate activity being the Acton Quarry in Zone 3 and sand and gravel pits in Zone 2. The Acton Quarry has been in operation since the early 1900s, and with recent approval to expand will remain active for the foreseeable future. As such, the quarry will continue to have a significant impact on land use and the environment within the Black Creek subwatershed. In consideration of this, it is important to implement a management strategy to mitigate the influence of past and future aggregate operations in the subwatershed. Where aggregate activity takes place within the Niagara Escarpment Plan area, then the Niagara Escarpment commission (NEC) will act as the lead agency, ensuring that the proposed management recommendations are integrated into new aggregate licences.

While aggregate extraction typically occurs with minimal influence on groundwater and surface water conditions and the natural environment, some forms of aggregate extraction, such as below-watertable extraction, bring a greater risk of influencing hydrological conditions and natural features and require more extensive planning and review. Activities associated with aggregate extraction that may influence the natural environment include dewatering and associated discharge for bedrock extraction, as well as the creation of pit lakes following below-watertable extraction of sand and gravel.

From the perspective of subwatershed management, Table 12 is a summary of management recommendations that should be continually implemented and addressed during active aggregate extraction. The recommendations focus on: maintaining recharge, contiguous riparian zones, channel form and existing natural heritage species; protecting wetlands and critical discharge zones; and, improving natural area connections. It is recognized that quarries and aggregate operations are required to have rehabilitation plans, and that typically they will address the listed recommendations.

Table 12 Management recommendations for existing and new aggregate sites

Indicator	Management Recommendation for Existing Aggregate Sites
Maintaining Recharge Areas	• Where available, review groundwater quality monitoring data to identify any potential influence on groundwater quality. • Encourage progressive rehabilitation to protect recharge functions of aggregate sites. • Review any proposed changes to rehabilitation plans and/or post-aggregate land uses to ensure that recharge functions are protected (e.g. avoid large-scale importation of fill material where it may reduce recharge rates). • Consider opportunities for public ownership/management of rehabilitated aggregate sites to ensure protection of recharge functions and water quality.
Protecting Major Wetlands	• Where available, frequently review monitoring data (e.g. annual Acton Quarry monitoring reports) to identify any potential influence on nearby wetlands. • Review any proposed changes to rehabilitation plans and/or post-aggregate land uses to ensure that hydrological inputs and required setbacks from wetland are maintained or enhanced.
Maintaining Contiguous Riparian Zone	• Review any proposed changes to rehabilitation plans and/or post-aggregate land uses to ensure that riparian zones are maintained or enhanced.
Protecting Critical Discharge Areas	• Where available, review groundwater level, baseflow, and temperature monitoring data (e.g. annual Acton Quarry monitoring reports) to identify any potential influence on nearby discharge areas. • Review any proposed changes to rehabilitation plans and/or post-aggregate land uses to ensure that groundwater levels, gradients, and temperatures are maintained.
Maintaining Channel Form	• Where available, review discharge and flow monitoring data (e.g. annual Acton Quarry monitoring reports) to identify potential contributions to channel instability. • Work with proponent to manage discharge in a way that avoids impacts to channel form.
Maintaining Existing Natural Heritage Species	• Review any proposed changes to rehabilitation plans and/or post-aggregate land uses to ensure that conditions are optimized for natural heritage species to the greatest extent possible.
Improving Natural Area Connections	• Encourage progressive rehabilitation to natural areas where appropriate. • Review any proposed changes to rehabilitation plans and/or post-aggregate land uses to ensure that natural areas are increased where feasible. • Consider opportunities for public ownership/management of rehabilitated aggregate sites to ensure protection of natural area connections.

4.6 Conservation Properties

This management plan identifies key priorities from a subwatershed perspective specific to management and ownership of conservation authority lands.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of existing development are listed as follows.

1) Increase Awareness	**2) Increase Knowledge**	**3) Increase Participation**	4) Maintain Natural Hydrologic Cycle	5) Maintain, Enhance or Restore Watercourse Function
6) Reduce Erosion	7) Minimize Flood Risk	8) Maintain groundwater levels and baseflow	9) Maintain or enhance water quality	**10) Protect, restore or enhance Ecosystem**

Credit Valley Conservation owns two properties in the Black Creek subwatershed and holds conservation easements on an additional two properties. All four properties total 80.35 ha, and account for 1.01 per cent of the total land area of the subwatershed. The most significant land holding is Limehouse Conservation Area (LCA), a property designated as part of the Niagara Escarpment Park and Open Space System in the Niagara Escarpment Plan.

The LCA property also contains a locally significant earth science ANSI, as well as a locally significant life science ANSI. The environmental features of Limehouse were studied in 1977 by Halton Region, and the property was designated as an ESA in 1978. LCA fulfilled several criteria for designation, including presence of a distinctive landform, high quality plant and

animal communities, remnant habitat, and rare/endangered species. CVC designated the property as an ESA in 1979. For additional information on the LCA, refer to Appendix F.

CVC monitors visitation at LCA through trail counters placed at access points on 22nd Sideroad and 5th Line. Visitation statistics show that visitors are typically Bruce Trail users or day use walkers. LCA is most popular during fall colours: peak visitation occurs in October.

The Bruce Trail is the main recreational feature on the property. Access to the Bruce Trail is afforded from the main parking on 5th Line, as well as by additional access points on 5th Line and 22nd Sideroad. A portion of LCA is leased to the Town of Halton Hills to operate as a municipal park and recreational facility. The municipality maintains an area of manicured lawn, a parking lot, a portable washroom, and two baseball diamonds.

CVC recommends that a management plan be developed for LCA. A management plan outlines the vision for a conservation area, identifies projects, policies and programs, as well as a means for achieving them. It will enable the holistic management of visitation, user experience, cultural heritage resources, and NHSs. The management plan will address recreation programming, natural heritage management and cultural heritage.

Additionally, CVC will continue to pursue the acquisition of significant lands in the Black Creek subwatershed, working with Halton Region. CVC's Greenlands Securement Strategy (2004) is currently being updated and will include a new evaluation process for identifying and prioritizing land acquisitions.

For the complete list of implementation recommendations that were developed to mitigate these issues for natural resource areas, see the Implementation Plan (Chapter 5).

4.7 Natural Hazards (Flooding, Erosion)

While Black Creek and its tributaries are assets that provide numerous benefits from public and environmental health perspectives, watercourses also have inherent natural hazard risks, such as flooding and erosion. This chapter presents a plan for managing natural hazards and reducing risk to human health and safety, property, and infrastructure.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of natural hazards are listed as follows.

1) Increase Awareness	2) Increase Knowledge	3) Increase Participation	**4) Maintain Natural Hydrologic Cycle**	**5) Maintain, Enhance or Restore Watercourse Function**
6) Reduce Erosion	**7) Minimize Flood Risk**	8) Maintain groundwater levels and baseflow	9) Maintain or enhance water quality	**10) Protect, restore or enhance Ecosystem**

This management plan is structured in three parts addressing: flood hazards, dam safety and removal, and erosion. A complete list of recommendations for directing the implementation of the Natural Hazards management plan are provided in the Implementation Plan (Chapter 5).

Flood Hazards

Flood vulnerable properties are generally found adjacent to Fairy Lake in Acton or in Stewarttown immediately west of Georgetown. In Acton the regulatory floodplain includes six houses, the Acton Branch of the Halton Hill Public Library, offices of Halton Hills Hydro, and 76 seasonal recreation buildings adjacent to Fairy Lake. In Stewarttown the regulatory floodplain includes 21 houses and the Georgetown Little Theatre Studio.

All of the structures within the floodplain have been there for some time. Current CVC regulatory policies require that new development be placed outside of the Regulatory floodplain. In addition, CVC regulations provide clear guidance related to renovating or reconstructing the existing flood vulnerable structures.

In addition to the Regulatory Flood used for floodplain mapping, peak flows and flood elevations for events with return periods ranging from 2 years to 100 years aid in the design of municipal infrastructure. The 2-year to 100-year flow rates and flood elevations are also documented in the "Flood Line Mapping Studies: Black, Silver and Snow's Creeks" (2010), although the flow rates are being updated by CVC currently and can be provided upon request.

In existing urban areas within the Black Creek subwatershed, peak flow rates for all return periods have increased due to the impact of urbanization without the provision for SWM measures. This increase in flow rates and corresponding runoff volumes has: contributed to an increase in flood risk along Back Creek; increased erosion potential; increased summer streamflow temperature; and, contributed to a decrease in baseflow. In turn, these changes add additional stress to downstream aquatic habitat and stream stability.

Moving forward, implementation of the green infrastructure and LID measures presented in management plans for Existing Development (Section 4.2) will aid in restoring and maintaining the natural hydrologic characteristics of Black Creek and its tributaries. Additional benefit will be gained by re-establishing and naturalizing stream corridors in Acton.

Dam Safety and Removal

For the most part, dams located in the Black Creek watershed are remnants of past agricultural practices. Today these dams and their function are integrated into the natural heritage fabric of the subwatershed. Dams represent both a risk and an opportunity moving forward. They represent a risk in that due to their age they can fail, resulting in both environmental impacts and risk to both public safety and downstream infrastructure. In contrast, improved aquatic habitat and risk reduction represents an opportunity associated with dam removal.

In total, 85 dams and online ponds have been identified within the Black Creek subwatershed, 22 of which have been categorized as high or very high priority for removal. Many of these are located on spring sources and small headwater channels, isolating only relatively short sections of channel. However, cumulatively they are believed to have a significant impact on water temperature. Figure 16 illustrates low, medium and high priority

dams for removal in the Black Creek subwatershed. Figure 17 provides an illustration of the steps typically undertaken in dam removal. The example shown is on Beeney Creek.

Dam Maintenance: Most dams situated within the Black Creek subwatershed are in private ownership but fall under the Lakes and Rivers Improvement Act (LRIA), which provides the MNRF with the legislative authority to govern the design, construction, operation, maintenance, and safety of dams in Ontario. CVC and MNRF meet with private dam owners to make them aware of their responsibilities and requirements with respect to dams and online ponds. CVC and MNRF may work with landowners to implement restoration actions and mitigate the impacts of a dam and online pond, where resources are available. Dam owners should be familiar with the operation, maintenance, and inspection requirements of their structures and recognize that appropriate and timely operating and maintenance practices are essential to the safety and integrity of the structure.

Dam Removal: Dams and online ponds may provide a variety of ecological, economic, and societal services, such as wetland and fish habitat, flood mitigation, hydropower, water supply, aesthetics, and recreation. These dams also have the potential to impact negatively riverine ecosystems and function, including: habitat fragmentation; alteration of natural hydrology and flow regime; disruption of geomorphic processes and sediment transport; and, degradation of water quality, particularly increasing water temperature. These impacts are compounded with an increasing number of additional stressors to sensitive coldwater and other fish communities, such as climate change, urbanization, water quality, and increasing river water temperatures.

All dam mitigation projects must consider the appropriate economic, social, environmental, and cultural environments when determining the appropriate mitigation measures for a specific site. There may be several permitting and planning requirements involved including the Conservation Authorities Act, LRIA, the Environmental Assessment Act, and others.

Erosion

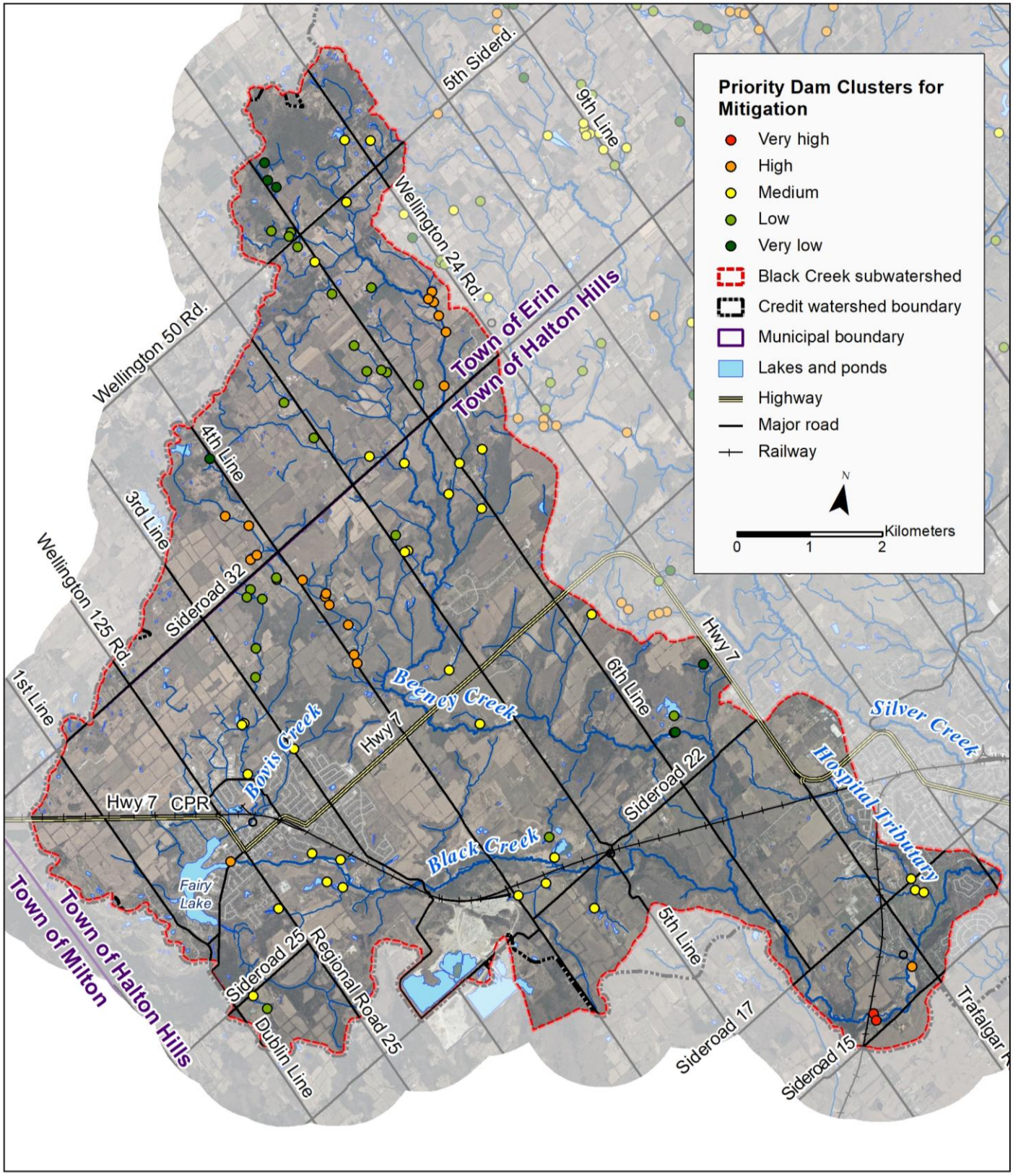
Erosion is a natural and necessary process in all watercourses and is a mechanism through which channel changes are made. The products of erosion are used to replenish sediment previously transported from riffles, to build depositional bars, and to establish new floodplains. When erosion is accelerated in response to changes in flow regime (e.g. higher peak flows, longer duration of high flows, more frequent flooding events), then excess sediment loading may occur, which may be stored as temporary bars but may also adversely affect aquatic habitat. Acceleration of erosion increases the rate of meander migration and planform development, which can increase risk to infrastructure (e.g. roads, sanitary sewers) and private property. Management of erosion risk is intended to protect both the built and natural environments.

Management of erosion processes occurs through defining the spatial extent of anticipated channel migration (meander belt), defining erosion hazard limits (e.g. slope instability), mitigating effects of land use induced hydrologic changes (e.g. SWM), and managing the effects of anthropogenic measures. Since erosion and channel migration are considered natural and necessary processes, in the long term it is more cost-effective to move

structures and infrastructure that are within the channel corridor (e.g. sanitary sewer, trail) away from the channel than to establish and maintain erosion control measures.

Table 13 summarizes measures that can be implemented to mitigate the consequence of erosion. These measures specifically address hazard limits, channel corridors, alteration to flow regimes, structures in the channel corridor, bank erosion as well as dam and road crossings.

For the complete list of recommendations that were developed to mitigate the impact of natural hazards, see Chapter 5.



Dam Mitigation (CVC, 2019); Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009)

Figure 16 Priority Dam Clusters for Mitigation

Pond upstream of dam traps fine sediment. The dam itself is a sediment and fish barrier.

Development of native plant assemblage, which provides suitable habitat for native invertebrates.

Once the dam had been removed, installation of Christmas trees along the bank to help trap sediment sped up the recovery. Deposited fine sediment is becoming vegetated, and Beeney Creek is narrowing.

A pool-riffle morphology is developing in the narrowed watercourse.

Vegetation is becoming established.

Figure 17 Dam removal and assisted natural recovery on Beeney Creek

Table 13 Mitigation strategies for erosion hazards

Erosion Hazard Component	Protection, Enhancement and Restoration Measures to Mitigate Natural Hazards	Applicable Development	
		Existing	New
Hazard limit	Delineation of erosion hazard areas (e.g. valley slope, channel banks) should be defined based on guidelines provided by MNRF (2002) and CVC (2014, 2015). These guidelines should inform the proposed placement of any development in proximity to a watercourse. Setbacks should be established from the top of valley slopes as per CVC guidelines to provide protection from future potential slope failure.	✓	✓
Channel corridor	A channel corridor that contains natural channel features and functions, including the regional floodline and meander belt, should be defined and used as a constraint for development in urbanizing areas. The corridor also provides connectivity for migration of terrestrial species.		✓
Erosion Threshold Analysis	Land use change can lead to changes to in channel flows which in turn change erosion and deposition processes within watercourses. This can result in channel instability, degraded aquatic habitat and can create downstream hazards by increasing rates of bed and bank erosion. An erosion threshold analysis should comply with CVC Fluvial Geomorphic Guidelines (which are currently being updated). Erosion thresholds determine the magnitude of flows required to potentially entrain and transport sediment in a channel. Erosion thresholds provide information on the sensitivity of the morphology of representative reaches to changes in flow frequency and magnitude. Comply with CVC guidelines (Fact sheet II).		✓

Erosion Hazard Component	Protection, Enhancement and Restoration Measures to Mitigate Natural Hazards	Applicable Development	
		Existing	New
Structures within channel corridor	Where erosion poses a risk to trails, roads, manholes, movable structures, utilities, subsurface infrastructure, or other elements, then movement of these features or elements should be considered prior to undertaking any erosion mitigation measures.	✓	✓
Property or structures adjacent to, or in, the channel corridor	Where erosion poses a risk to public safety and/or private property, then erosion mitigation measures should be implemented to provide protection. The measures should minimize interference with natural channel processes that do not contribute to risk at the area of concern and should thus not restrict channel movement unnecessarily. Erosion mitigation measures should incorporate enhancements to the aquatic and terrestrial environments to the extent possible while addressing the erosion risk.	✓	
Excess bank erosion/Aquatic habitat impacts	Riparian buffers (OMAFRA, 2008) should be established along streams to enhance the structural stability of valley slopes and channel banks. In addition to reducing rates of erosion and volume of sediment loading, aquatic and terrestrial enhancements will occur. Buffers also provide a benefit to water quality by capturing and trapping airborne pollutants and suspended pollutants in surface water runoff. The Ecological Buffer Review Guideline prepared for CVC (Beacon 2012) should be used to determine appropriate buffer width. In new development areas, riparian areas will be landscaped based on CVC landscaping guidelines	✓	✓

Erosion Hazard Component	Protection, Enhancement and Restoration Measures to Mitigate Natural Hazards	Applicable Development	
		Existing	New
Flows	No increase in bankfull flows as represented by the 2-year return storm relative to the historic (1980-2005) 2-year return storm. Aim to maintain or enhance flushing flows (200% of mean annual flow and wetted perimeter) and high flow pulses compared to baseline.		✓
Dams	Dam Safety Programs should be implemented by dam owners to ensure that all dams are properly maintained and operated. The objective is to reduce risk of flooding and erosion due to dam failure and to ensure continued dam function.	✓	✓
Road Crossings	Any bridge or culvert should be properly sized to avoid excess scour or erosion immediately upstream and downstream of the watercourse crossing	✓	✓

4.8 Natural Heritage

This management plan identifies the recommended Black Creek NHS, as well as the aquatic and terrestrial restoration priorities, which are intended to protect core areas, maintain and restore connectivity across the system, and enhance natural areas on adjacent lands.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of natural heritage are listed as follows.

1) Increase Awareness	**2) Increase Knowledge**	**3) Increase Participation**	**4) Maintain Natural Hydrologic Cycle**	**5) Maintain, Enhance or Restore Watercourse Function**
6) Reduce Erosion	7) Minimize Flood Risk	**8) Maintain groundwater levels and baseflow**	**9) Maintain or enhance water quality**	**10) Protect, restore or enhance Ecosystem**

As noted, the Natural Heritage management plan focuses on both the NHS and priority restoration areas. Each is addressed in separate sections in the following pages. In order to maintain and expand an integrated network of natural areas and connecting links, a set of policies, land use planning designations, and priority restoration measures are recommended for both terrestrial and aquatic environments. A complete list of recommendations for implementation are provided in the Implementation Plan (Chapter 5).

Natural Heritage System

A NHS is a connected network of natural features and areas designed to support natural processes necessary to maintain the long-term health and resiliency of natural ecosystems, natural functions, and biodiversity. The health of subwatersheds is closely linked to the size, quality, distribution and management of natural areas. The intent of this section is to provide recommendations that will assist in protecting and linking existing natural areas. Ultimately, it is through the maintenance and creation of contiguous natural areas that maximum benefits can be derived in terms of protecting and enhancing our natural heritage.

The Black Creek NHS is illustrated in Figure 18. It was generated by merging the provincial, regional, and Credit River NHSs together, providing multiple ecological and hydrological benefits at different scales. The Black Creek NHS is comprised of:

- Credit River Watershed Natural Heritage System (CRWNHS)
- Wellington County Greenlands System
- Greenbelt Plan Natural Heritage System
- NEC Escarpment Protection Areas (EPA) and Escarpment Natural Areas (ENA)
- Subwatershed Land Use Plans
- Halton Region OP - Halton Region Natural Heritage System
- Town of Halton Hills OP

Figure 19 (Acton) and Figure 20 (Stewarttown) provide an expanded view of the NHS in the two main population centres in the subwatershed.

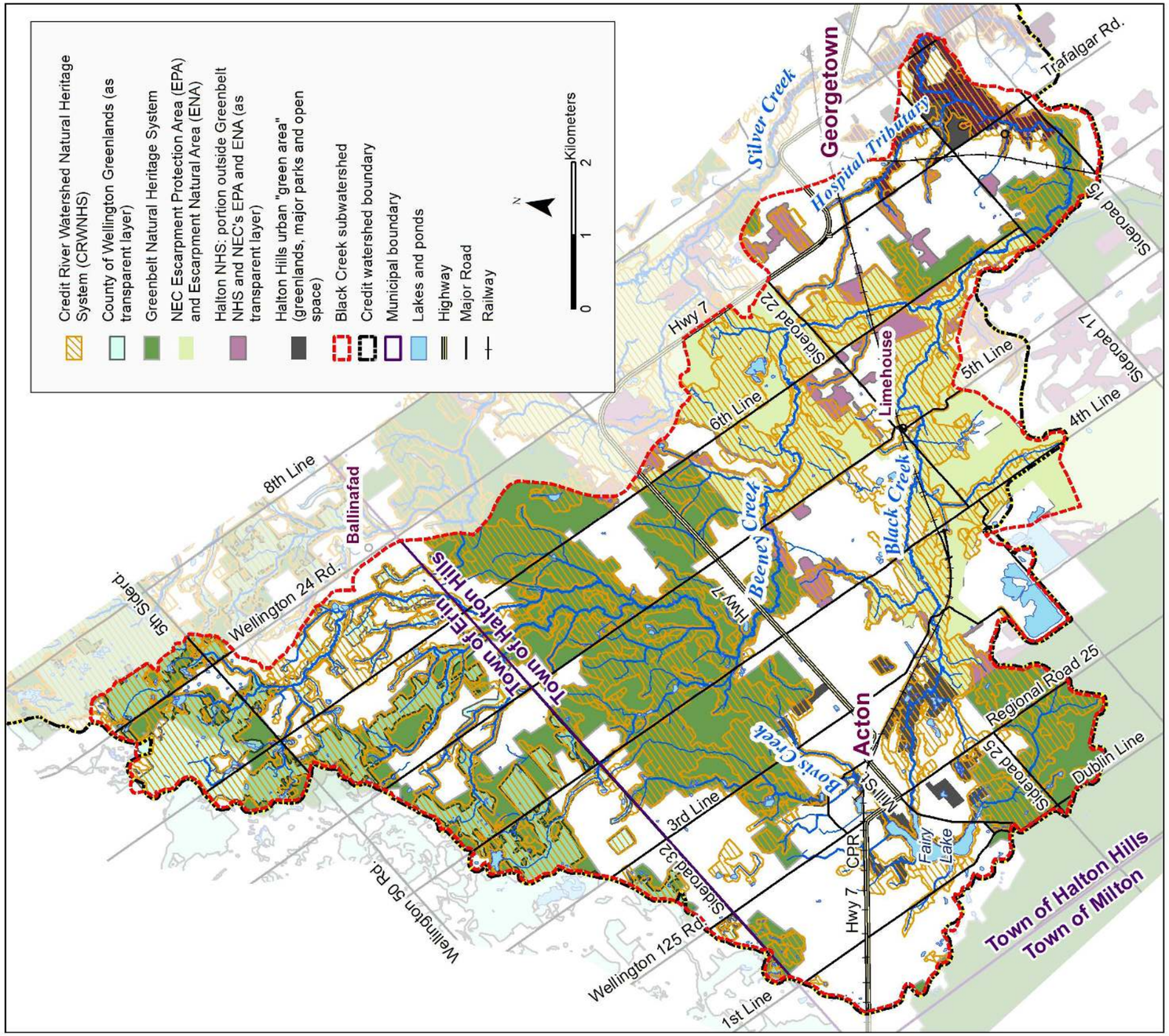
Many parts of the different systems overlap. As illustrated in Figure 22 the Halton Region Natural Heritage System consists of the Greenbelt Natural Heritage System and the Regional Natural Heritage System. The Regional Natural Heritage System is a systems approach to protecting and enhancing natural features and functions and is scientifically structured. Halton Hills established a Greenlands System in accordance with the requirements of the Halton Region OP. The intent of the Greenlands System is to maintain, as a permanent landform, an interconnected system of natural and open space areas that will preserve areas of significant ecological value while providing, where appropriate, and some opportunities for recreation.

As illustrated in Figure 21, Wellington County's Greenlands System is comprised of core greenlands and greenlands – and is intended to include those features and areas which are part of Wellington's natural heritage or areas in which may pose a threat to public safety. Core greenlands are identified in policy and are protected.

Current development planning within the subwatershed should follow the natural heritage systems and policies outlined by Halton Region, the Town of Halton Hills, and Wellington County to protect a larger and more connected NHS.

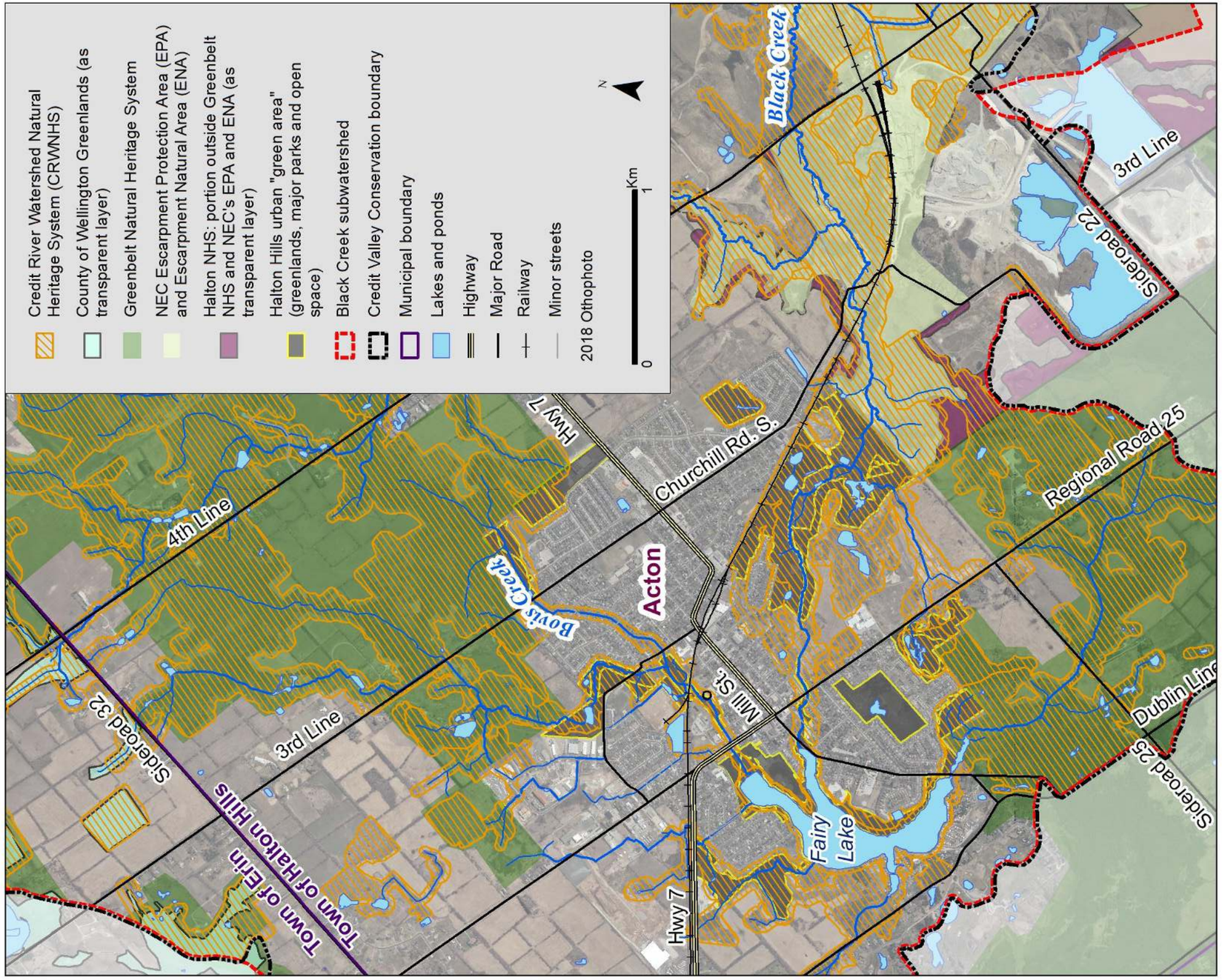
To understand the existing state of protection of natural features, an examination of similarities and differences of each of the various land use plans and natural heritage strategies was undertaken. The merging of the various natural heritage systems helped to examine how multiple ecological and hydrological benefits are achieved at different scales – provincial, regional, subwatershed, and municipal. Detailed review of the similarities and differences are presented in Appendix G. Recommendations are provided in two key areas:

1. Areas within the Black Creek subwatershed that contribute to subwatershed health, and which may be considered for protection in Municipal OP update processes, and;



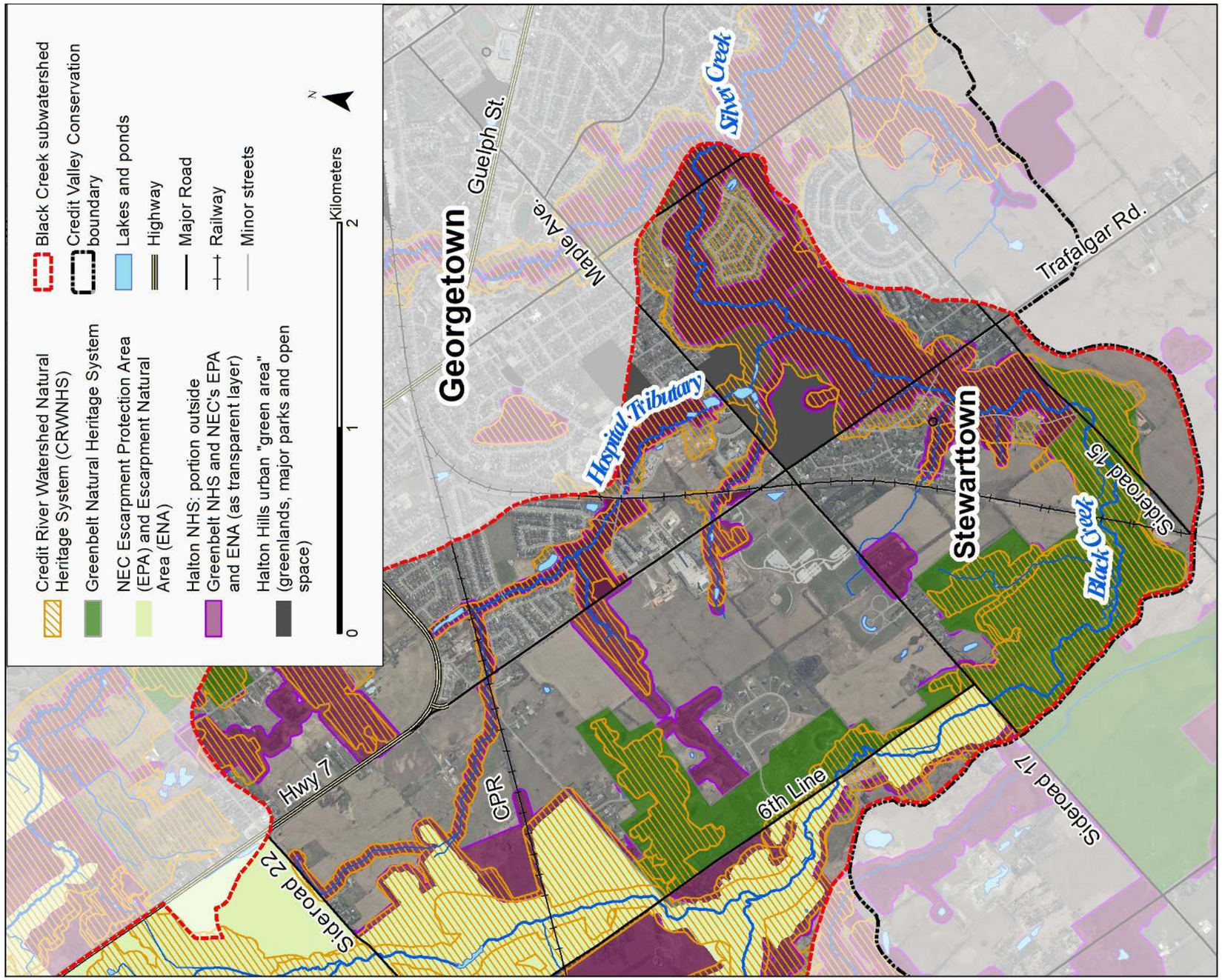
Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009); Credit River Natural Heritage System (CVC, 2015); Wellington Greenlands (County of Wellington, 2016); Halton NHS (Halton Region, 2015); Halton Hills urban green area (Town of Halton Hills, 2016); NEC Escarpment Protection Area and Escarpment Natural Area (The Queen's Printer for Ontario, 2017); Greenbelt Natural Heritage System (The Queen's Printer for Ontario, 2011)

Figure 18 Black Creek Natural Heritage System



Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009); Credit River Natural Heritage System (CVC, 2015); Wellington Greenlands (County of Wellington, 2016); Halton NHS (Halton Region, 2015); Halton Hills urban green area (Town of Halton Hills, 2016); NEC Escarpment Protection Area and Escarpment Natural Area (The Queen's Printer for Ontario, 2017); Greenbelt Natural Heritage System (The Queen's Printer for Ontario, 2011)

Figure 19 Black Creek Natural Heritage System - Acton



Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009); Credit River Natural Heritage System (CVC, 2015); Wellington Greenlands (County of Wellington, 2016); Halton NHS (Halton Region, 2015); Halton Hills urban green area (Town of Halton Hills, 2016); NEC Escarpment Protection Area and Escarpment Natural Area (The Queen's Printer for Ontario, 2017); Greenbelt Natural Heritage System (The Queen's Printer for Ontario, 2011)

Figure 20 Black Creek Natural Heritage System - Stewarttown

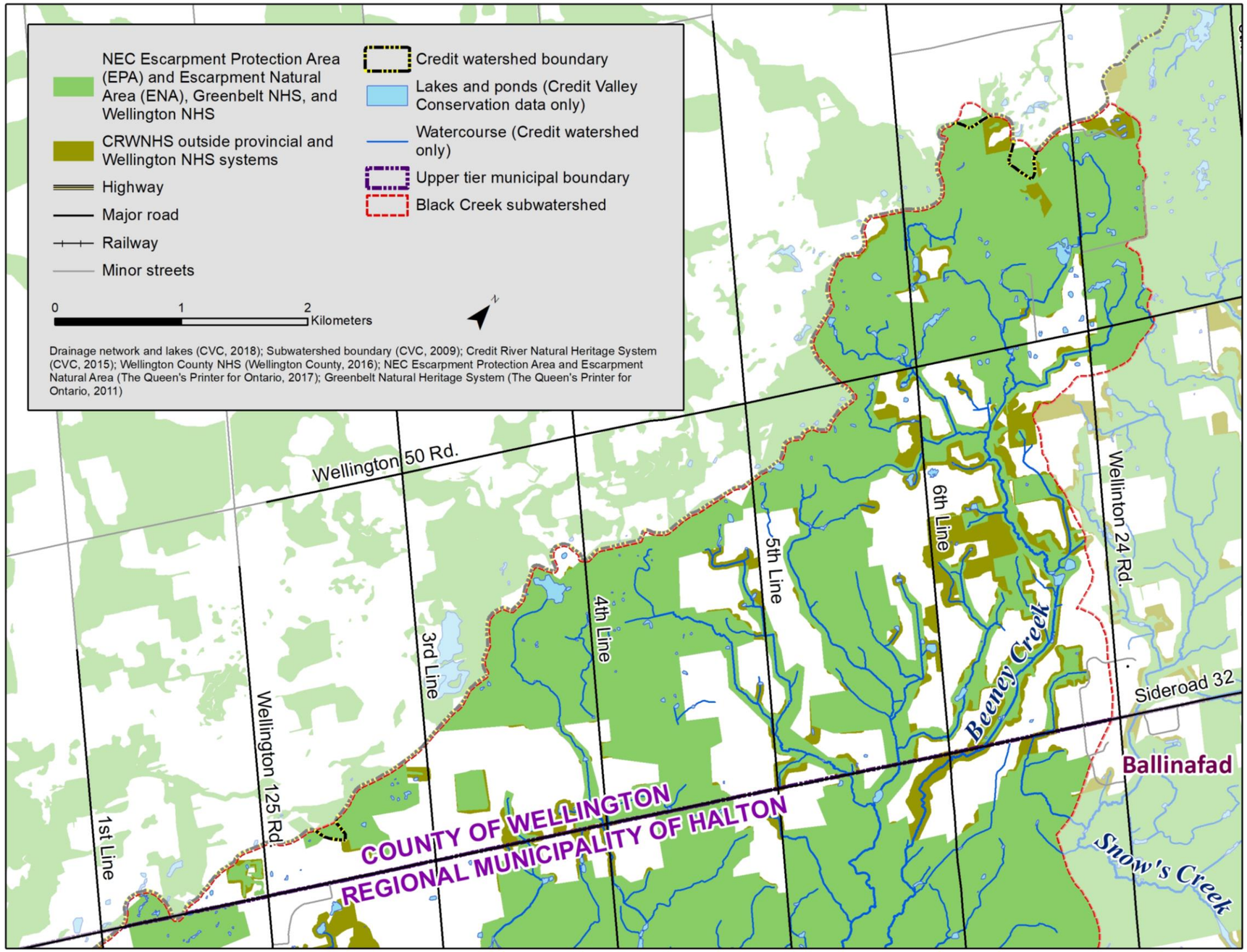


Figure 21 County of Wellington and provincially protected lands and Credit River watershed Natural Heritage System lands

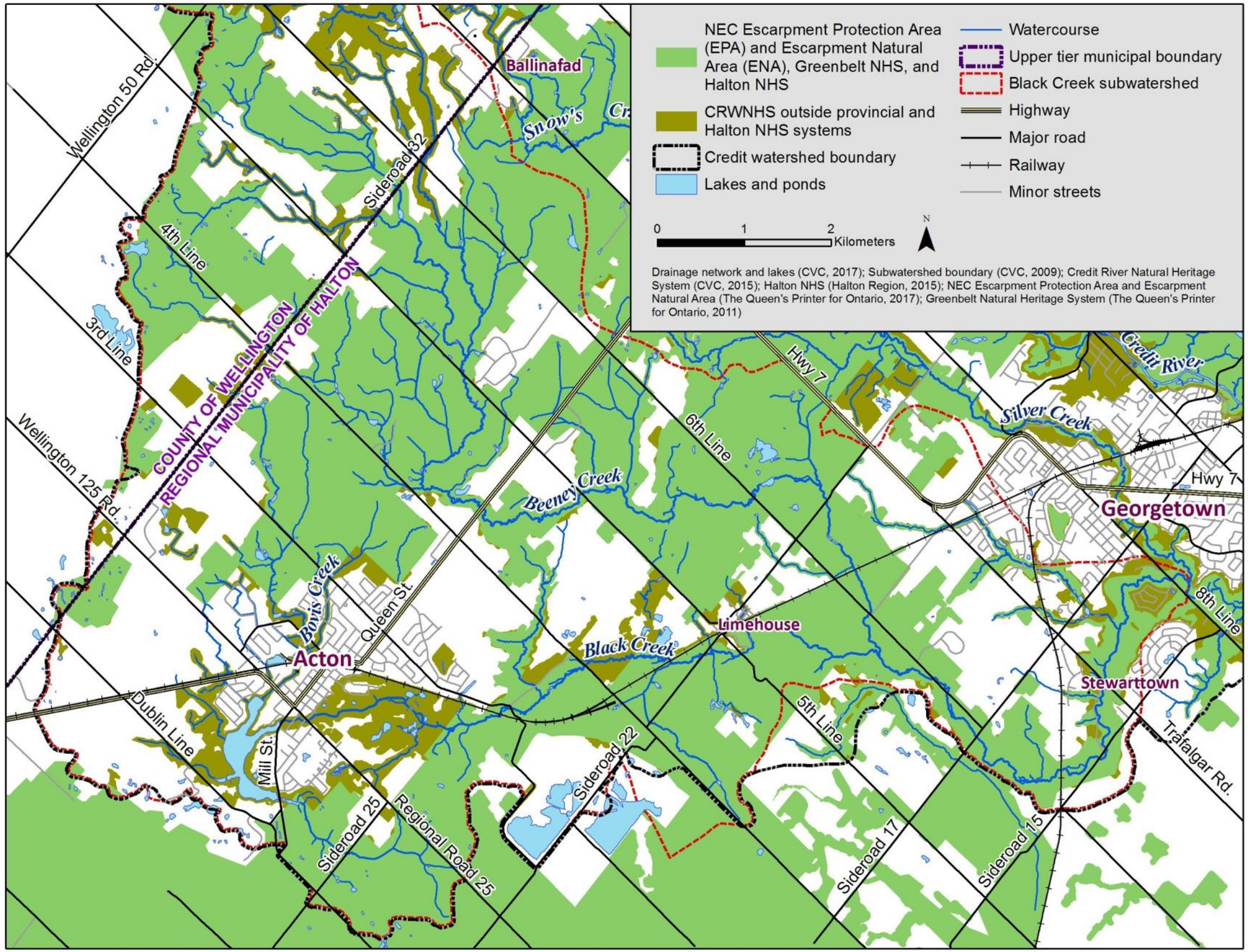
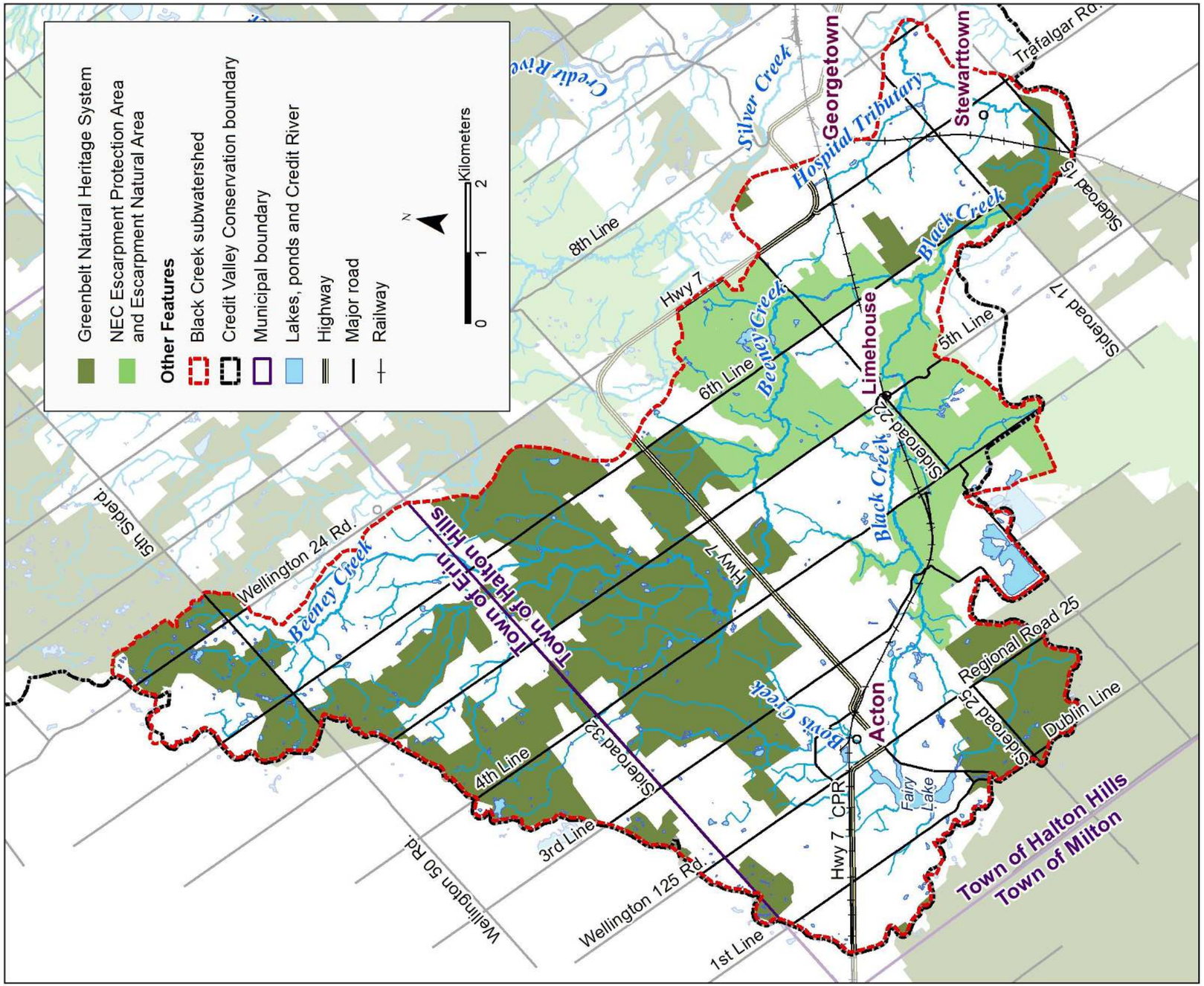


Figure 22 Halton Region and provincially protected lands and Credit River watershed Natural Heritage System lands



Drainage network and lakes (CVC, 2018); Subwatershed boundary (CVC, 2009); NEC Escarpment Protection Area and Escarpment Natural Area (The Queen's Printer for Ontario, 2017); Greenbelt Natural Heritage System (The Queen's Printer for Ontario, 2011)

Figure 23 Greenbelt NHS and NEC area throughout Black Creek

2. Guidance on the management of natural heritage systems within the Black Creek subwatershed, in order to enhance their contribution to subwatershed health through restoration and stewardship activities.

This plan encourages local and regional governments to consider using the proposed natural heritage system for Black Creek to refine the natural heritage system in their official plans.

The protection and restoration of the natural heritage system will help municipalities:

- Protect people and property from risks associated with natural hazards;
- Protect sources water protection areas;
- Protect or enhance the quantity and quality of surface water and groundwater;
- Mitigate impacts of climate change;
- Protect significant natural heritage features and areas; and
- Maintain and enhance biodiversity and the long-term ecological health and function of the Black Creek subwatershed.

Restoration of Priority Areas

This section focuses on the identification of priority opportunities within the subwatershed for the purpose of implementing the restoration measures associated with the NHS. Terrestrial, riparian and watercourse restoration are address separately below.

Protection of existing features and functions is the most cost-effective and efficient means of ensuring ecosystem heath including biophysical and chemical characteristics. However, it is also critical to undertake restoration where ecosystem health has been compromised (CVC, 2015). The restoration approach is to maintain and restore natural processes.

Terrestrial Restoration

Priority terrestrial restoration areas are illustrated in Figure 24. Priorities were identified based on areas that would most benefit from improved ecological health and integrity in the subwatershed. This approach is viewed to be the most effective and efficient in terms of utilizing the limited resources available for implementing projects. As illustrated, terrestrial restoration is grouped into the following five categories: grassland bird habitat management, source water protection stewardship, coniferous plantation management, interior and linkage expansion, as well as urban stewardship. Appendix H provides detailed information on restoration opportunities in the NHS.

Riparian and Watercourse Restoration

As outlined in the CVC Integrated Watershed Restoration Strategy (CVC, 2015), healthy watersheds provide a range of ecosystem services including water quality, resilience to climate change, and maintenance of healthy habitats that contribute to water quality and quantity moderation. Protection of existing features and functions is the most cost-effective and efficient means of ensuring ecosystem heath including biophysical and chemical

characteristics. However, it is also critical to undertake restoration where ecosystem health has been compromised (CVC, 2015). Restoration is the *process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed* (SER, 2004). It assists in re-establishing desired targets for ecosystem composition, structure and function.

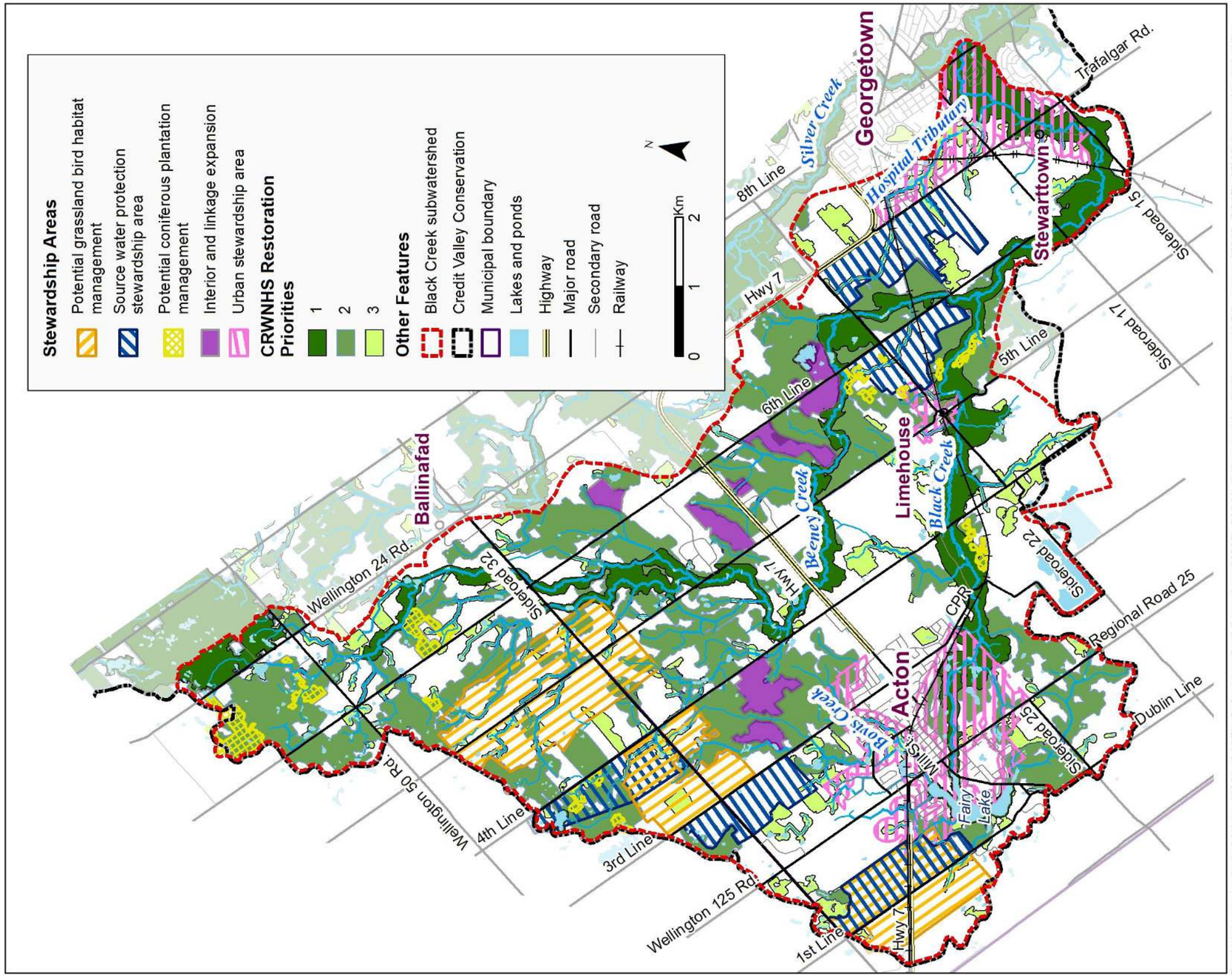
Ideally, watershed restoration should be a comprehensive, long term and adaptive process. Focus should not only be on addressing impacts, but also to managing contributing stressors at both landscape and site level scales. Stressors are defined as the proximate human activities or processes that have caused, or are causing, or may cause destruction, degradation, and/or impairment of biodiversity targets (Salafsky et al 2008). Stressors cause impacts which influence ecological attributes and the underlying processes which sustain them. Therefore, managing and eliminating stressors is central to restoration activities (CVC, 2015).

As presented in Appendix H, in support of this management plan watercourse restoration opportunities were documented across the watershed. The first part of Appendix H (Section 1.4) presents a series of five guidance sheets in support of different types of restoration. As listed below, the first focuses on riparian restoration while the remainder focus on watercourse and aquatic restoration.

1. Riparian Zone Management
2. Channel Realignment
3. Dam Mitigation and Removal
4. Floodplain and Wetland Restoration
5. In Stream Enhancement

The second part of Appendix H presents a series of ten maps that can guide restoration across the subwatershed. Each map documents priority dams for mitigation scored from low to high, priority riparian planting scored from low to high, and identification of representative sites for restoration. The maps are listed as follows.

- Zone 1 (Figure H-1)
- Zone 1 Hospital Tributary, (Figure H-2)
- Zone 2 (Figure H-3)
- Zone 3 (Figure H-4)
- Zone 4 (Figure H-5)
- Zone 4 Beadmore Tannery Site, (Figure H-6)
- Zone 5 (Figure H-7)
- Zone 5 Bovis Creek, (Figure H-8)
- Zone 6 (Figure H-8)
- Zone 7 (Figure H-9)
- Zone 8 (Figure H-10)



Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009); Subwatershed 10 stewardship areas (CVC, 2017); NHS restoration priorities (CVC, 2017)

Figure 24 Locations of priority opportunity areas and activities throughout the Black Creek subwatershed

For two key reasons a formal prioritization and ranking exercise was not carried out to determine aquatic restoration priorities within Black Creek. Firstly, in most cases it is considered that further investigations (monitoring or feasibility studies) are required to confirm the restoration opportunities that have been identified. Secondly, numerous external drivers including land owner support and funding opportunities play a role in determining which become priority sites and these are unknown factors at this time.

A restoration workshop was held with the CVC technical steering committee. This included specialists in aquatic ecology, fluvial geomorphology, landscape architecture, water resources (including flood risk and green infrastructure specialists) and water quality. The committee agreed on six priority areas for further investigation of restoration potential. These include:

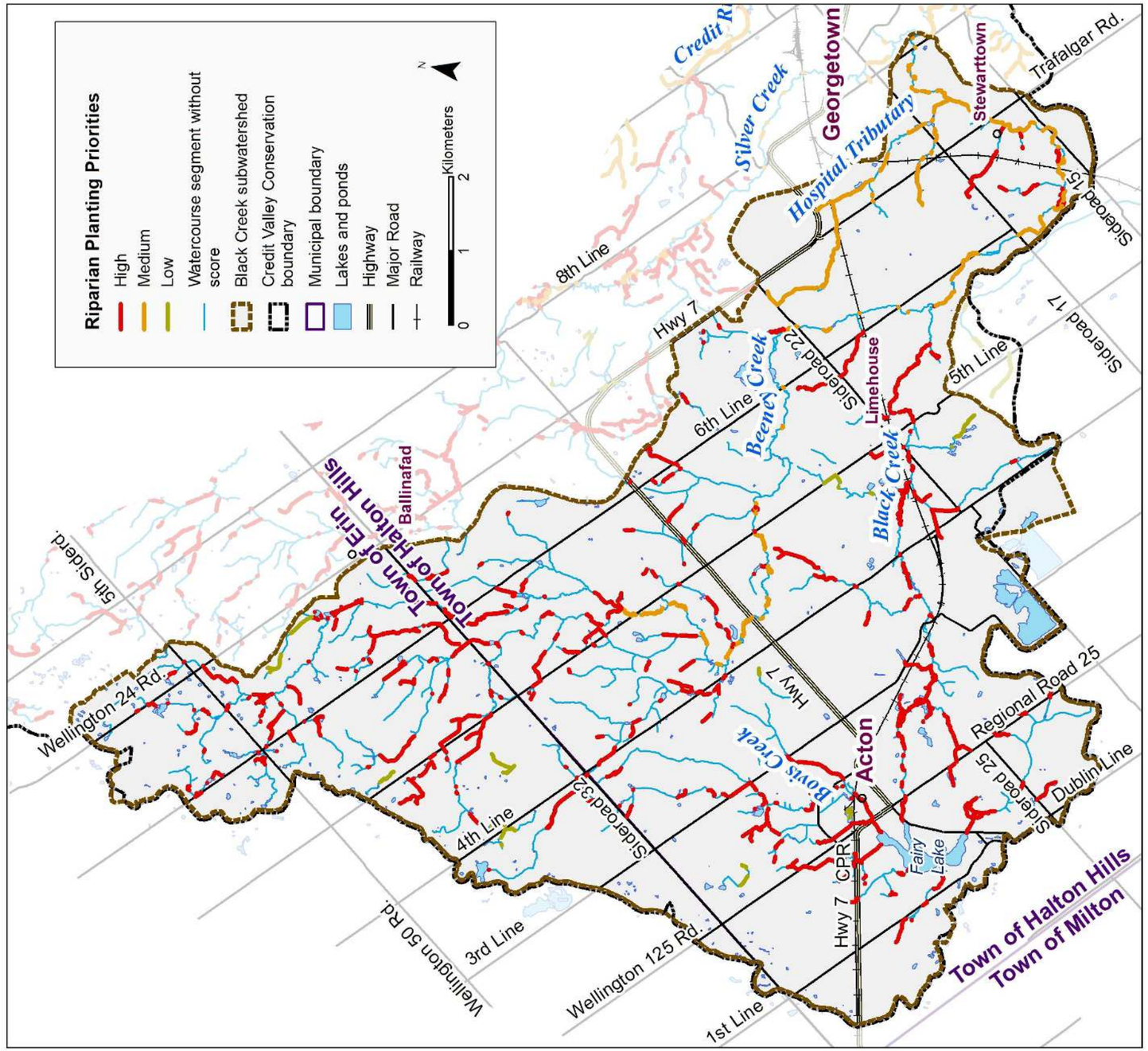
1. Riparian planting throughout the subwatershed
2. The Beardmore site on Black Creek
3. Bovis Creek
4. The Dams and barriers downstream of Davidson Well
5. Hospital Tributary
6. Mitigation of Dam 680 upstream of Stewarttown Dam

(1) *Riparian Planting*

One of the main limiting factors to habitat quality identified in previous phases of the subwatershed study was the lack of riparian vegetation. It was noted that many channels flow through agricultural fields, pasture, or had manicured lawns to the edge of the channel. Figure 26 identifies the location of priority riparian restoration opportunities along Black Creek. Refined detail is provided in Figures 1 to 10 of Appendix H. Some of the areas with highest potential are the headwater channels in zones 5, 6 and 7.

Figure 25 illustrates example locations for riparian planting. The example on the left does not have any riparian planting as manicured grass extends to the water's edge. The example on the right has an adequate riparian buffer although it would benefit from trees and taller shrubs to provide shade and thermal mitigation.

Figure 25 Example candidate locations for riparian planting along Black Creek and a Black Creek Tributary



Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009); Riparian Planting Priorities (CVC, 2018)

Figure 26 Priority areas identified as needing riparian plantings

(2) *The Beardmore site on Black Creek*

The Beardmore site was developed in the mid to late 1800s and at one point was the largest tannery in Canada. In 2006 a clean-up operation was completed. This included dismantling buildings, removal of a PCB storage facility and relocation of contaminated soil from several spray fields. However, Black Creek and its floodplain, which were heavily modified though the industrial use of the area, have not been restored.

The creek has been realigned and straightened. There are lengths of various types of hard bank protection and several abandoned crossings. Further downstream where hard bank protection is not present, the channel is entrenched and disconnected from its floodplain. The riparian corridor is uniform and simple.

Figure 6 of Appendix H provides a more detailed description of the existing conditions at the Beardmore site along with recommendations for restoration actions. These include:

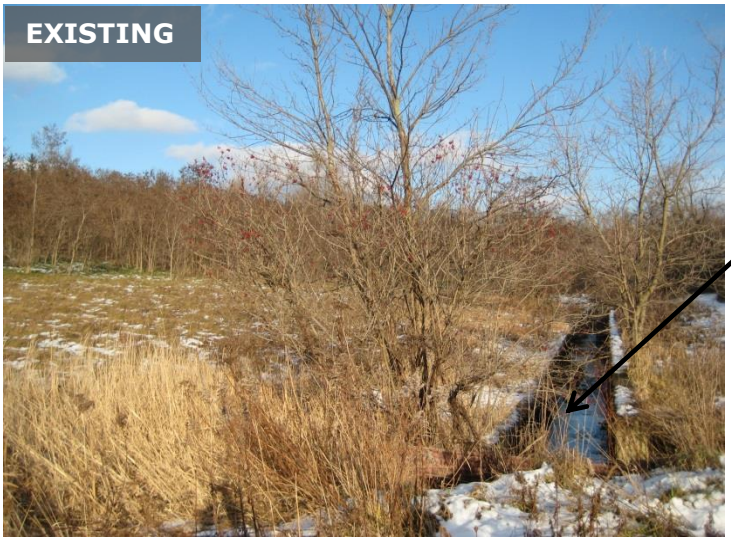
- Realigning the creek to a more sinuous planform using natural channel design principles
- Removing or burying hard bank and bed material
- Removing crossings or replacing crossings with clear span structures wider than the bankfull channel width
- Establishing a complex riparian zone
- Reconnecting the creek to the floodplain (e.g. through removing embankments)
- Creating a mosaic of habitats on the floodplain

Figure 27 illustrates how these measures could improve the geomorphic processes, aquatic habitat and riparian zone through a section of the Beardmore site.

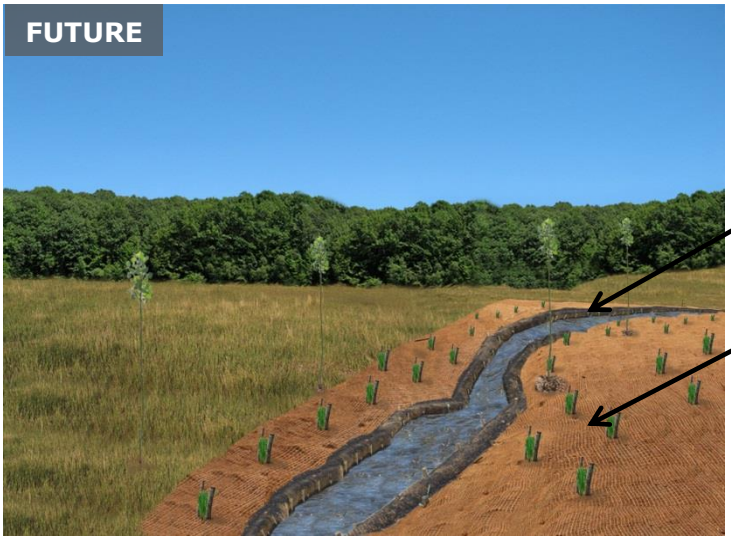
To establish how beneficial restoration would be in this reach, it is recommended that a monitoring program should be established. This should include monitoring of water temperature to establish whether temperature is a limiting factor for brook trout spawning along with monitoring of bed, bank, and crossing structures to establish risk of failure.

(3) *Bovis Creek*

Bovis Creek has been significantly impacted by urbanization of the Acton area. Impacts include channel hardening, realignment and widening, road crossings, elimination of long stretches of riparian zones, changes to flow regime and thermal impacts. This presents an opportunity to restore over 1.8km of creek and associated habitat. A feasibility study should be completed to consider options for a holistic approach to restoring Bovis Creek. Figure 8 of Appendix H provides a more detailed description of the existing conditions along with recommendations for restoration actions, including:



Existing Black Creek is straightened and contained in a hardened channel. It provides flow conveyance with very little habitat diversity. It appears to be disconnected from its floodplain. Structures and crossings appear to be in poor condition.



Realigned Black Creek dug into the adjacent floodplain. Development of a more sinuous planform with varied in channel morphology. Re-established floodplain connectivity.

Riparian planting completed, and riparian zone fenced off to allow establishment of vegetation.

Some natural adjustment of the creek planform would be anticipated to occur over time.

Complexity and density of the riparian zone would increase over time.

Figure 27 Illustration of Black Creek restoration through Beardmore Tannery site

- Removing sections of concrete bed and banks
- Creating of a narrower, more sinuous planform which could have significant habitat, temperature and sediment transport benefits
- Establishing a complex riparian zone
- In channel enhancements and riparian planting
- Improvements to the reach upstream of Fairy Lake (e.g. realigning the creek through the edge of the park, improvements such as bank grading and reconnecting the creek to the floodplain or channel narrowing)

Figure 25 shows how creating a narrower, more sinuous channel within the existing corridor could enhance the system visually as well as having benefits for geomorphic processes, habitat, temperature and sediment transport.

(4) *The Dams and barriers downstream of Davidson Well (see Appendix H Figure 7)*

The dams on this tributary to Bovis Creek upstream of Fairy Lake have previously been identified as barriers for brook trout. Monitoring is required to confirm presence of brook trout upstream of the dams. If brook trout are present, then this would be a high priority site for mitigation works within the Black Creek watershed. One mitigation option for managing the impacts of dams is dam removal, this could include in-channel works, channel realignment or allowing the channel to adjust naturally upstream and downstream of the structure. Figure 17 in Section 4.7 shows a time lapse of a similar project completed on Beeney Creek by CVC in collaboration with a private land owner.

(5) *Mitigation of Dam 680 upstream of Stewarttown Dam (see Appendix H Figure 1)*

Dam 680 has been identified as a very high priority dam for mitigation within CVC's jurisdiction. Mitigation of this dam and the adjacent, lower priority, dam should be pursued. (See Section 4.7 for more information on dam mitigation.)

Existing creek is contained within an over-wide, straight and hardened channel. It has significantly limited habitat and no potential to recover naturally.

New creek planform developed within the existing footprint. Coir logs or similar used to create a narrower cross section. Groundwater connection re-established.

Riparian planting completed.

Over time, complexity of in channel and riparian habitat would increase. In addition to supporting warm water fisheries, the system would provide habitat for a range of terrestrial and aquatic species.

Figure 28 Illustration of Bovis Creek restoration

(6) *Hospital Tributary (see Appendix H Figure 2)*

Functionally, the Hospital Tributary should be part of the Credit River - Hungry Hollow Centre of Biodiversity. However, past and existing land use practices have negatively impacted this ravine resulting in the tributary and its associated natural areas being excluded from the Centre for Biodiversity. Addressing and mitigating these impacts would reconnect and improve the function of both the Hospital Tributary and the Centre for Biodiversity. This would result in a significant rehabilitation and enhancement of the Credit River - Hungry Hollow Centre of Biodiversity. Opportunities for restoration include:

- Mitigating of online ponds and stormwater management facilities.
- Engaging The Club at North Halton for opportunities to improve property management adjacent to the watercourses (specifically with regards to the riparian zone).
- Selective removal of excess woody material to facilitate sediment transport in the channel. Potential local channel works may be required to initiate recovery.
- Removing sediment barrier (small weir) downstream of footbridge.
- Monitoring and managing invasive species.
- Conducting a water balance assessment. Identifying sources of groundwater contributions to the tributary/ ravine system to inform land management such as opportunities for thermal and baseflow mitigation.
- Reviewing existing stormwater management facilities to determine opportunities for improved system function. Address through Town's stormwater management strategy.
- Considering geomorphic processes and fish passage requirements for any future proposed road crossings (including structure width, stream bed profile and material size). This should include assessment of the knickpoint downstream of Princess Anne drive when appropriate.

Headwater Drainage Feature Assessment (CVC, TRCA, 2014)

Headwater streams exert an important influence on the ecological health, stability, and sustainability of the downstream receiving watercourses through flow attenuation, sediment production, trapping of excess sediment, and input of organic matter. A Headwater Drainage Feature Assessment should be completed to identify and prioritize a management strategy for headwater features (Evaluation, Classification and Management of Headwater Drainage Features Guidelines, January 2014). This includes consideration of all zero and first order features and surface depressions that enable water storage/infiltration and which may only be ephemerally connected to the drainage network during a hydrologic year. Treatment of headwater drainage features is determined through the Guidelines based on existing function.

4.9 Water Management

This management plan focuses on the protection of groundwater in the Black Creek subwatershed. It specifically addresses source water protection and the maintenance of existing recharge rates in existing and proposed urban areas. It also addresses the need to consider water, wastewater and stormwater as a complete and inter-related system.

Section 1.2 (Guiding Framework) of this Phase 3 report lists ten overarching objectives for the Black Creek subwatershed. The objectives specific to the management of existing development are listed as follows.

1) Increase Awareness	**2) Increase Knowledge**	3) Increase Participation	**4) Maintain Natural Hydrologic Cycle**	**5) Maintain, Enhance or Restore Watercourse Function**
6) Reduce Erosion	7) Minimize Flood Risk	**8) Maintain groundwater levels and baseflow**	9) Maintain or enhance water quality	**10) Protect, restore or enhance Ecosystem**

Source Water Protection

Source water is any untreated water found in rivers, lakes and underground aquifers, which is used for the supply of raw water for municipal drinking water systems. Source water protection is the action taken to protect that raw source of municipal drinking water from overuse and contamination.

Halton Hills residents in the Credit Valley Source Protection Area receive municipal water supply through Acton and Georgetown water systems owned and operated by the Regional Municipality of Halton. The Acton system contains five wells within three well fields – Fourth Line, Davidson (Third Line) and Prospect Park – while the Georgetown system has seven wells within three well fields - Lindsay Court, Princess Anne, and Cedarvale.

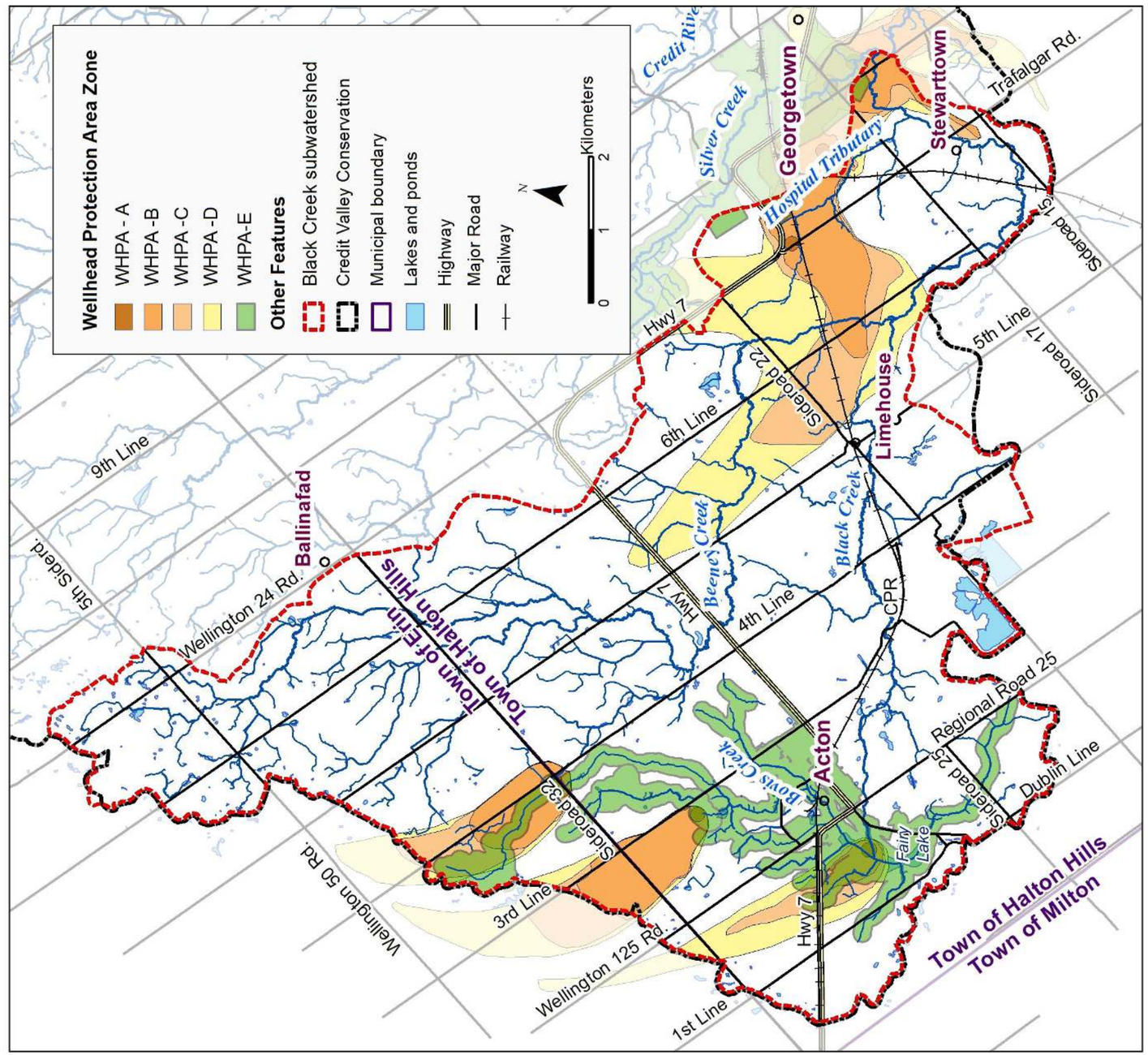
The Black Creek subwatershed and the municipal groundwater takings in the Town of Halton Hills fall within the CTC Source Protection Region, which includes the Credit Valley, Toronto and Region, and Central Lake Ontario Conservation Authority (also designated as Source Protection Authorities) jurisdictions. The approved CTC Source Protection Plan (Source Protection Committee, 2015) is a strategy comprising a set of policies designed to protect municipal sources of drinking water from contamination and overuse. The CTC Source Protection Plan can be found at *https://ctcswp.ca/protecting-our-water/the-ctc-source-protection-plan/.* The CTC Source Protection Plan, along with the Credit Valley Source Protection Authority's Assessment report, delineates the vulnerable drinking water source area and describes proactive measures to safeguard the water quality and quantity of municipal drinking water systems. The policies of the CTC Source Protection Plan that apply to the Town of Halton Hills municipal groundwater takings within the Black Creek subwatershed are derived from multiple technical studies and summarized in the following approved reports:

- Approved Updated Assessment Report: Credit Valley Source Protection Area (CVC, July 2015);
- Halton Hills Tier Three Water Budget and Local Area Risk Assessment – Final Risk Assessment Report (AquaResource and AECOM, October 2014).

Between these two reports, several Well Head Protection Areas (WHPAs) and Issue Contributing Areas (ICAs) were identified within the Black Creek subwatershed that apply to the Halton Region municipal wellfields. These areas are illustrated in Figure 29 and Figure 30 respectively. WHPAs are essentially time of travel zones, indicating how quickly a contaminant spilled within the respective zone will arrive at the well. ICAs are delineated zones where a particular contaminant that is a concern or that has already been observed in the monitoring data may have an impact on the municipal source. Planned enhanced infiltration (LIDs) in these areas must consider quality concerns.

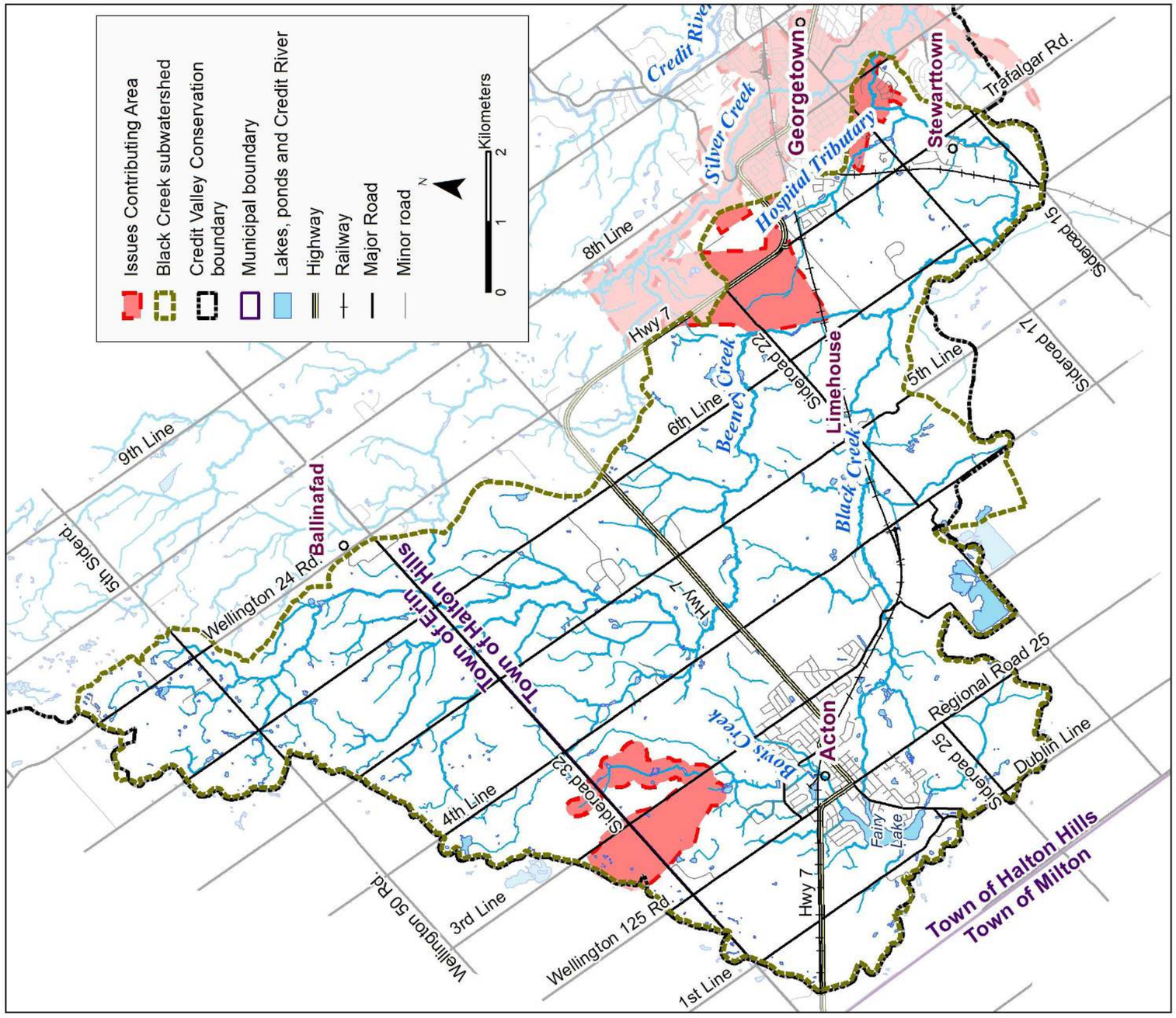
The main groundwater quality issues identified through the technical studies and summarized in the Approved Updated Assessment Report: Credit Valley Source Protection Authority are the ICAs for nitrates (for the Acton Davidson wellfield) and for sodium and/or chloride (for the Georgetown wellfields). These ICAs are further described below.

The main groundwater quantity issues were identified through the Halton Hills Tier Three Water Budget and Local Area Risk Assessment – Final Risk Assessment Report. The main areas of concern for groundwater quantity are the Acton WHPA Q1/Q2 Groundwater Quantity Threat Area (significant risk level) and the Georgetown WHPA Q1/Q2 Future Groundwater Quantity Threat Area (moderate risk level). These areas are illustrated on Figure 31 and further described below.



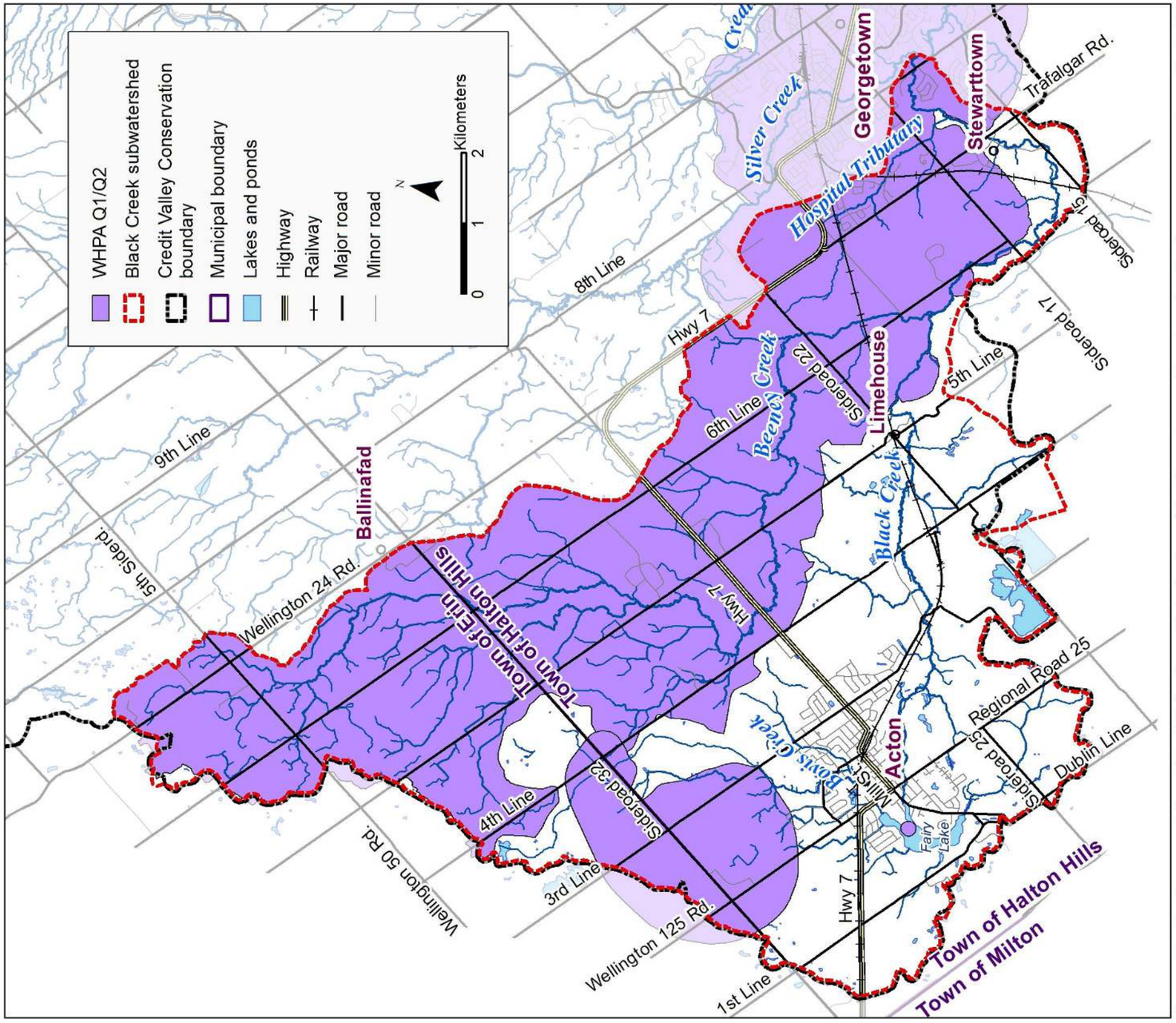
Approved Updated Assessment Report (Credit Valley Source Protection Area, (https://www.ctcswp.ca/the-science/credit-valley-spa-assessment-report/), July 27, 2015); Drainage Network and Lakes (CVC, 2017); Black Creek Subwatershed Boundary (CVC, 2009)

Figure 29 Wellhead Protection Areas in the Black Creek subwatershed
Refer to https://ctcswp.ca/ for the most up-to-date information.



Approved Updated Assessment Report (Credit Valley Source Protection Area, (https://www.ctcswp.ca/the-science/credit-valley-spa-assessment-report/), July 27, 2015);
Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009;

Figure 30 Issue Contributing Areas in the Black Creek subwatershed
Refer to https://ctcswp.ca/ for the most up-to-date information.



Approved Updated Assessment Report (Credit Valley Source Protection Area, (https://www.ctcswp.ca/the-science/credit-valley-spa-assessment-report/), July 27, 2015); Drainage network and lakes (CVC, 2017); Subwatershed boundary (CVC, 2009)

Figure 31 Groundwater Quantity Threat Areas in the Black Creek subwatershed
Refer to https://ctcswp.ca/ for the most up-to-date information.

The CTC Source Protection Committee has recommended (through the approved Source Protection Plan) that the Tier Three groundwater model be utilized to assess the potential impacts of any proposed new water takings or proposed increases to takings at existing wells.

In order to ensure an integrated approach to water management in the subwatershed, it is important to highlight the areas where groundwater management overlaps with management of surface water and natural features and where there are opportunities for agencies to approach water management in a coordinated manner.

Integration opportunities for management of groundwater, surface water, and natural features include monitoring programs and review of new development and water takings.

Opportunities for pollution prevention and stewardship directed at improving groundwater quality should be based on the groundwater threats assessment completed through Source Water Protection. Two target land use areas found in Black Creek include:

- Agricultural Areas:
  - ICA for nitrates (e.g. septic systems, fertilizer application, agricultural source material storage and applications, pesticide application, and livestock); and,
  - WHPAs with vulnerability scores > 8 (e.g. septic systems, fertilizer application, agricultural source material storage and applications, and livestock).

- Urbanized Areas:
  - ICA for sodium/chloride (e.g. application of road salt or other de-icing, septic systems, and SWM facility discharges); and,
  - WHPAs with vulnerability scores > 8 (e.g. septic systems, industrial activities, and SWM facility discharges).

Climate change has the potential to influence groundwater resources in several ways, including:

- Changes in groundwater recharge rates due to differing precipitation patterns and rates of evapotranspiration; and
- Increasing groundwater takings for irrigation purposes to offset changes in precipitation patterns and increased temperature and evaporation.

While the precise future influences of climate change on groundwater resources cannot be predicted, the summary of potential impacts provided above generally suggests the potential for reduced groundwater supplies and functions due to reductions in groundwater recharge and an increase in groundwater takings. These potential impacts are similar to the identified impacts of increased urban development and increased impervious cover.

Maintenance of Groundwater Recharge

The overall management objective for groundwater in the subwatershed is to maintain and enhance existing conditions so that groundwater resources will be maintained for municipal and private supplies and to support stream baseflows (dry weather flows supported by groundwater discharge), aquatic habitat, and wetlands. This overall objective will be met through maintaining and enhancing recharge through implementation of a treatment train approach to SWM or LID measures in both existing and new developments and avoiding decreases of groundwater levels resulting from municipal and private water takings. Maintenance of groundwater recharge relates directly to the Existing Development management plan (Section 4.3) and the New Development management plan (Section 4.4). The goals have to be mindful of the issues identified in source water protection analyses for the area, given that groundwater is a municipal source of drinking water.

For the Black Creek Subwatershed Impact Assessment, AECOM completed an impact assessment for groundwater conditions through groundwater modelling of several potential land use and water taking scenarios. The groundwater modelling results are presented in detail in the Black Creek Subwatershed Phase 2 Report, and the key findings that inform the groundwater management plan are described in the following paragraphs.

A business as usual approach will lead to further reductions in groundwater recharge from development and corresponding reduction in discharge to watercourses and wetlands. Acton and Georgetown municipal wells already have identified water quantity risks.

Achieving an improvement in groundwater levels and discharge relative to existing conditions requires both implementation of LID in new development and retrofitting in existing urban areas to offset the predicted increased water takings and impervious cover. These approaches must consider where groundwater issues have been identified so as not to exacerbate identified water quality concerns.

The proposed groundwater management plan is based on the CTC Source Protection Plan, identified groundwater threats areas and the key findings of the Black Creek Subwatershed Impact Assessment groundwater modelling scenarios. The groundwater management plan addresses both existing development and new development, as described as follows.

1. Existing Development: Based on the finding of the Black Creek Subwatershed Impact Assessment groundwater modelling scenarios, the main direction of the groundwater management plan is to implement LID measures in existing developed areas, in order to achieve an overall increase in groundwater recharge. The groundwater management plan includes direction for where enhanced recharge could occur without creating significant groundwater quality impacts or an increase in groundwater levels in locations where negative impacts (e.g. wet basements) may occur.

2. New Development: Similar to areas of existing development, the main direction of the groundwater management plan for new development is to implement LID measures to achieve an overall increase in groundwater recharge in the subwatershed. The

groundwater management plan includes direction for where enhanced recharge could occur without creating significant groundwater quality impacts or an increase in groundwater levels in locations where negative impacts (e.g. wet basements) may occur.

3. Implementation of LID measures to enhance recharge should be feasible in most areas of existing and future development within the Black Creek subwatershed. However, there are a few constraints based on the documented issues and potential risks of impacts to groundwater quality and the potential limitations posed in areas where groundwater levels are close to ground surface. Follow the recommendations and guidance outlines in the most recent CTCSWP (https://ctcswp.ca/app/uploads/2019/10/RPT_20190325_Amended_CTCSPP_FNL.pdf)

Water Resource System

Identification of the water resource system is a key policy requirement within the Provincial Policy Statement (PPS) Growth Plan and the Greenbelt Plan. The PPS (2014) states that the identified water resource system is intended to maintain hydrological and ecological linkages and functions between groundwater and surface water components to sustain healthy aquatic and terrestrial ecosystems, human water consumption and supplying industries, including agriculture. The water resource system therefore includes areas necessary to protect drinking water supplies, areas of hydrological significance and identification of vulnerable and/or sensitive groundwater and surface water features that should be protected, mitigated or enhanced in land use planning. Collectively, the Growth Plan refers to these as key hydrologic features, key hydrologic areas, and key natural heritage features. A benefit of integrating the water resource and NHSs is the focus on sustaining ecological function, maintaining biodiversity and supporting recreational opportunities. The water resource system is similar to the NHS in that it provides a systems-based approach to supply clean drinking water, manage wastewater and stormwater, support recreational opportunities and supply industries, including agriculture.

The water resource system is a key focus of watershed planning and forms the basis for stormwater, drinking water and wastewater management plans. Such plans consider effects to water quantity and quality. The Black Creek subwatershed consists of communities (Acton and Georgetown) that rely on groundwater takings as their drinking source and have a wastewater treatment plant that outlets to the creek, requiring the creek to assimilate the effluent without causing harmful environmental effects. Understanding of the water resource system also informs land use planning and future development options so that important linkages and connections are maintained within the water resource system and between the natural heritage and water resource systems. Identification of core areas, linkages and corridors amongst the natural heritage and water resource system is part of the watershed planning process.

The PPS and provincial plans speak to the water resource system and introduce multiple terms and concepts. Based on the policies included within the provincial plans, the water

resource system includes the following components, which are necessary to the ecological and hydrological integrity of the watershed (PPS, 2014):

- Groundwater features and areas
- Surface water features (including shorelines)
- Natural Heritage features and areas

Figure 32 shows all the applicable water features in the water resources system of the Black Creek subwatershed. By combining the groundwater features, surface water features and some natural heritage features, we are able to get a more holistic understanding of how water moves and relates to other landscapes throughout the subwatershed. These connections are important to be aware of and should be considered in the future planning of land use changes, as well as with different restoration and stewardship opportunities. Water and the natural heritage features have a strong relationship, as water is required to support many of those areas, such as wetlands and valleylands, and the flora and fauna rely on adequate water quality and quantity. These natural heritage features also help to improve the water quality and quantity, which results in having a more robust natural water cycle.

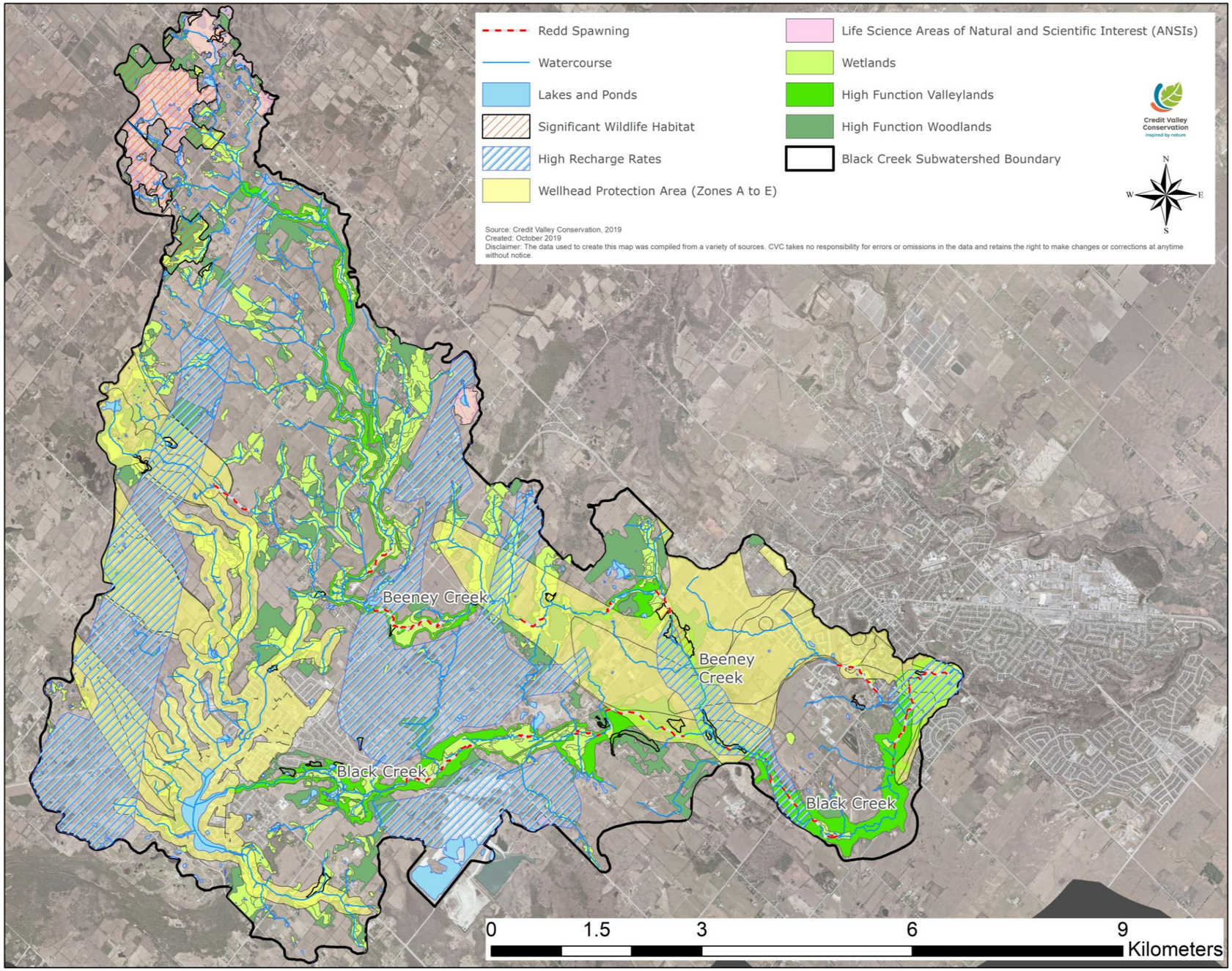


Figure 32 Water Resource System overlaid with Key Ecological Features

5. IMPLEMENTATION PLAN

A key part of the Phase 3 report is the recommendations that comprise the Implementation Plan. The recommendations help determine which areas of the watershed need the most help and ways to address those concerns. CVC has worked with our municipal partners in the Black Creek subwatershed to develop a comprehensive Implementation Plan that is founded on the following objectives.

Purpose of the Implementation Plan

- Use the Subwatershed Study to coordinate and integrate efforts between the Region, Town and CVC
- Encourage community groups to get involved in various projects
- Look for funding opportunities to help with implementation
- Leverage resources and expertise in order to receive the best outcomes
- Use education and outreach to inform members of the community

The successful implementation of the subwatershed study Management and Implementation Plan recommendations will involve the commitment and participation from many stakeholders. Appendix I provides a summary of the roles and responsibilities of each of the stakeholders, the applicable legislation, existing and potential policies and programs that are available to implement the Management Plan recommendations and the specific implementation plans for existing urban development, new development, rural land use, natural hazard lands, aquatic and terrestrial lands, and natural resource areas.

Table 14 presents the key implementation recommendations for the Black Creek subwatershed. Each recommendation includes anticipated outcomes, implementation tools, timelines, and a list of the partners responsible for implementation. The recommendations are colour coded to reflect one of four categories:

Colour	Code
Blue	Policy Recommendations
Green	Program Recommendations
Grey	Land Use Planning Recommendations
Orange	Project Based Recommendations

The recommendations are structured to correspond to the structure of the various management plans detailed in Chapter 4 of this subwatershed study. They are repeated as follows:

Land Use Activities

1. Existing Urban Development: Opportunities to mitigate impacts from existing urban development on the health of the subwatershed.
2. New Development: Direction to mitigate impacts from new development and strategies for the protection of important features and functions of the watershed.
3. Rural Land Use: Opportunities to mitigate existing rural land use impacts on the health of the subwatershed.
4. Aggregate Extraction: Measures that aim to minimize impacts of aggregate extraction on the natural environment.
5. Conservation Properties: Direction to manage conservation lands from the perspective of education, stewardship and land management.

Flooding

6. Natural Hazards: Measures specific to managing flood risk and erosion potential.

Natural Resources

7. Natural Heritage: The NHS, as well as aquatic and terrestrial restoration, priorities.
8. Water Management: Measures to guide both long-term sustainability of groundwater, as well as the management of water and wastewater from the perspective of the natural environment.

There are many working partnerships within the subwatershed that rely on accurate and recent data. As much of the monitoring of the subwatershed is funded publicly, it would be beneficial to both the Conservation Authority and the various government partners (Region, Town, etc.) to share this information more frequently with each other. It would be beneficial to explore opportunities to improve communication between various municipal departments, employees, government organizations, and academia that all rely on and update similar information. Transferring information to each other more effectively will reduce the amount of monitoring and research required.

Tracking progress is important, as there are many different partners involved, and monitoring the health of the subwatershed in combination with the implementation of recommendations is important. Having regular input from Halton Region and the Town of Halton Hills will help keep CVC informed and continue our working relationships, which will aid in implementation. Recognizing issues and tackling them as partners will lead to more successful outcomes, as resources and expertise can be shared to reach the same common goals for Black Creek.

CVC is looking forward to working with our various partners and stakeholders throughout the subwatershed to implement our recommendations, which will help enhance and protect the beautiful Black Creek area to ensure a healthy and vibrant environment now and into the future.

Priority Implementation Focus

All recommendations outlined in Chapter 5 are important for the enhancement and protection of the Black Creek subwatershed. However, three priority issues have been identified in Black Creek that will help to guide the management and implementation plan by ensuring that areas of focus receive the most positive impact on our actions. These include:

Water Quality: Nutrient levels (specifically Total Phosphorus (TP)) and chloride exceed Provincial Water Quality Objectives (PWQOs) in the Black Creek subwatershed due to various land use activities, including urbanization, stormwater runoff, waste water treatment plant discharge, and agricultural activities. TP will need to be managed by various mitigation techniques in urban and rural areas, before it has the chance to travel into Fairy Lake and downstream throughout the rest of the subwatershed. Chloride may be managed through the careful application of road salt in the winter and by having contractors and maintenance staff properly trained on the negative impacts of salt on our environment.

Environmental Resiliency: In order to maintain and enhance the environmental features of Black Creek, a resilient and holistic approach is needed to protect and enhance the healthy areas and rehabilitate the areas of degradation. Terrestrial resiliency requires the healthiest areas to be protected, managed and enhanced where necessary, in order to retain the biodiversity of the area. Aquatic resiliency requires the most impaired areas to be restored back to a more natural and functional system, with restoration techniques including natural channel design, bank stabilization and riparian plantings with an increased buffer width. Addressing both the terrestrial and aquatic areas will lead to a more diverse and robust environmental system with more capacity to respond to change.

Groundwater: The protection of groundwater quantity and quality is a key requirement of the management plans for the Black Creek subwatershed. Groundwater is a critical resource from the perspective of both potable water supply and the sustaining of natural features. Groundwater quantity is deemed to be moderately stressed, based on results from the Phase 2 study and the CTC Source Protection Plan (*Source Protection Committee, 2015*). To reduce groundwater stress, measures must be taken to maintain recharge through permeability of the landscape and management of potential pollutants.

Table 14 Recommendations and Implementation Strategy

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
EXISTING DEVELOPMENT – Section 4.2	**1.1**: Town of Halton Hills to install OGSs and other LID stormwater improvement technologies upstream of the WWTP for existing urban area with uncontrolled stormwater outlets	4, 5	1, 9, 12, 13, 14, 16	• Offset 98.4 kg of TP loadings to Black Creek to accommodate WWTP expansion	• MECP Environmental Compliance Approval requirement	X			X	X	X								The Town of Halton Hills has agreed to lead the design and construction. Halton Region is funding the works. CVC will support the design and permitting activities.
	1.2: The Impact Assessment identified the need to achieve a greater than 25% uptake in LID measures throughout the existing urban land use. For Capital Budget Forecasting, LID complemented with other green infrastructure practices should be included to increase the per centage of existing urban area with controlled SWM.	1, 4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase local recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• CVC's Grey to Green Guidance Documents	X			X	X	X								LID retrofits to increase recharge should be avoided in areas where groundwater levels are within 1 m of ground surface. Local soil and groundwater conditions should be revised prior to design of LID retrofits in areas of existing development. In all WHPAs with vulnerability scores of 8 or higher and in ICAs for sodium and/or chloride and nitrates, LID retrofits should be restricted to measures that promote infiltration of rooftop and yard runoff.
	1.3: The Town of Halton Hills should adopt a target of achieving a 25% or greater uptake of LID infiltration practices within existing developed areas. Implementation of stormwater infiltration practices should be done in light of recommendations provided in section 4.2.	1, 4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Incorporate anticipated costs into capital budget for upcoming projects • Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study		X		X	X	X								LID retrofits to increase recharge should be avoided in areas where groundwater levels are within 1 m of ground surface. Local soil and groundwater conditions should be revised prior to design of LID retrofits in areas of existing development. In all WHPAs with vulnerability scores of 8 or higher and in ICAs for sodium and / or chloride and nitrates, LID retrofits should be restricted to measures that promote infiltration of rooftop and yard runoff.
	1.4: To achieve an uptake rate of 25% within the priority urban areas, LID can be most appropriately positioned and Figure 12 to target neighbourhoods that would most benefit from the uptake of stormwater measures.	4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Incorporate anticipated costs into capital budget for upcoming projects • Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study	X			X	X	X								

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
EXISTING DEVELOPMENT – Section 4.2	**1.5**: Coordinate work currently being done through the Downspout Disconnection Program to incorporate other initiatives.	1, 4, 5	1, 2, 3, 4, 5, 6, 8, 9	• Increase groundwater recharge and infiltration by directing roof water to vegetated/grassed surfaces.	• Enhanced Halton Region Downspout Disconnection Program and Sump Pump Program		X		X	X	X								Halton Region provides a downspout disconnection program across Halton Region. The current program covers 100% of the eligible costs to disconnect downspouts from the sanitary sewer system, up to a maximum of $500. Downspout disconnection subsidy is part of Halton's Enhanced Basement Flood Prevention Subsidy Program. Visit Halton.ca for details.
	1.6: Town of Halton Hills should implement a tree canopy strategy to determine the current per centage of tree canopy cover, set a target, identify potential threats to existing cover and identify implementation measures for meeting the specified target.	1, 2, 3, 4, 5, 6	3, 4, 6, 8, 9, 12, 14, 15, 16, 17	• Improve human health, SWM and ecological benefits through the identification and implementation of a canopy cover target to increase tree cover in the Town of Halton Hills.	• Region of Halton By-Law 121-05 (Tree Cutting By-Law) – to prevent / regulate the removal of trees • Town of Halton Hills Green Development Standard Study • CVC's Tree Planting Program	X			X	X	X	X							Town of Halton Hills is currently preparing a tree canopy strategy. Halton Region already has a tree canopy replacement requirement that should be considered.
	1.7: Halton Region and Town of Halton Hills should continue with water conservation programs focused on reducing outdoor water usage, specifically in Acton.	1, 4, 5	1, 2, 3	• Reduce the amount of potable water used for outdoor lawn maintenance. • Increase awareness of, and respect for, Halton Region's Outdoor Water Use Program.	• Region of Halton Outdoor Water Use Program • Region of Halton Rain Barrel Sales Events • Imagine Halton Hills: Integrated Community Sustainability Strategy • Sustainable Neighbourhood Retrofit Action Plan (SNAP) project	X			X	X	X							Coordinate with Downspout Disconnection Program in Acton and Georgetown.
	1.8: Municipal partners and CVC should encourage all property owners to adopt BMPs for irrigation, vehicle maintenance, dumpster management, outdoor storage material, outdoor fueling stations, spill response, vehicle washing, lawn fertilizers, de-icing materials and parking lot maintenance. A pollution prevention plant would help to: (1) reduce fertilizers and de-icing materials; (2) encourage the use of sustainable lawn practices; (3) develop an educational campaign that communicates the impacts of driveway car washing, auto maintenance, water softeners on local streams; and (4) encourage improved dumpster management in residential properties.	All zones	1, 2, 3, 9, 10, 11, 12, 13, 14, 16	• To reduce non-point sources of nutrients, chlorides, deleterious substances, TSS and metals from public lands. • Improve stormwater quality. • Reduce contaminants entering local waterways. • Potentially increase biodiversity through different lawn practices.	• Corporate Strategic Plans, Greening Initiatives • Stewardship • Urban Design Guidelines requiring design to be cognizant of the goal of minimizing the use of fertilizers and de-icing materials • Stewardship Town of Halton Hills Green Development Standard Study • Yellow Fish Road Program • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • CVC's Greening Corporate Grounds and Your Green Yard • Town of Halton Hills Public Works • CTC Source Water Protection	X			X	X	X		X	X					Halton Region already has guidance and direction for homeowners, which can be a resource for the Town to use. Refer to the CTC Source Water Protection website, as it offers the most up-to-date information. Visit https://ctcswp.ca/ for more information.

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EXISTING DEVELOPMENT – Section 4.2	**1.9**: County of Wellington, Town of Erin should with help from CVC develop a salt management pollution prevention strategy.	1, 2, 3, 4, 5, 6	1, 3, 9, 10, 11, 12, 13, 14, 16	• Improve surface water and groundwater quality through the reduction of chloride loading.	• Planning Act – Halton Region OP, County of Wellington OP – water resource protection policies and subwatershed study policies • Smart about Salt or equivalent contractors • CTC Source Water Protection Plan		X		X	X	X		X	X					CTC Source Protection Plan – reduced loadings to groundwater will benefit efforts to reduce the moderate potential threat to municipal drinking water wells in Acton and Georgetown, as per the Drinking Water Threats in Issues Contributing Areas Report.
	1.10: Acton to support upgrades to existing water softener units to a model that is more water and salt efficient.	1, 4, 5	1, 3, 9, 12, 13, 16	• Reduce the amount of sodium and chloride discharged to the Black Creek to improve water quality.	• Grant program would need to be created		X			X	X							X	Water softeners are no longer identified as threats to water quality under the Clean Water Act. Any grant programs would be targeted towards identified threats to municipal wellheads. Additionally, chloride is not identified as an issue in Acton. There is a long-standing study on water softeners led by Region of Waterloo, along with City of Guelph, and they have created a website for info: https://watersoftenerfacts.ca/
	1.11: CVC to monitor the TP efficiency of installed OGSs and other LID stormwater technology systems provide.	4, 5	18	• Monitor TP capture to inform future studies/use.	• MECP Environmental Compliance Approval requirement	X			X	X									Halton Region will fund work by CVC to monitor the efficiency of TP removal. Results will inform future design work.

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EXISTING DEVELOPMENT – Section 4.2	**1.12**: The following recommendations are made to improve the management of Fairy Lake and to improve its ability to meet the many functions it provides to Black Creek and the community. • Waterfowl contribute to the high E. coli levels within the lake and should continue to be controlled through measures, such as public education to stop feeding waterfowl and egg management. • Under existing conditions, the width of vegetative buffers along the shoreline is minimal or non-existent; as such the no-mow buffer along the shoreline should be maintained and expanded where possible. • Public education should be undertaken regarding benefits of aquatic vegetation (aquatic habitat, nutrient uptake, ecology); removal of vegetation from the lake should be discouraged. • Assess the feasibility of establishing a forebay at outlet structures and tributary inlets to facilitate sediment trapping and removal. • Continue monitoring blue-green algae outbreaks and assess management options.	4, 5	1, 3, 4, 9, 15, 16, 17, 18	• Improved water. quality at Fairy Lake • Improved habitat for native species. • Enhanced natural area for recreation, including swimming and fishing.	• Imagine Halton Hills: Integrated Community Sustainability Strategy • Stewardship • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines		X		X		X								If resources are available, then OGS units could be installed and recommended through capital budget projects.
	1.13: Reduce concentrations of metals, nutrients, salt and bacteria at Tyler Ave. and Elmore Street outfalls into Fairy Lake through upstream pollution prevention reduction program.	5	1, 3, 9, 12, 13, 14, 16	• Improve water quality in Fairy Lake and downstream.	• Stewardship • LID Implementation – CVC's Grey to Green guidance documents		X		X		X								
NEW DEV' T – 4.3	**2.1**: It is recommended that additional environmental studies be undertaken to inform future development plans.	1, 4, 5	1, 2, 4, 8, 10, 11, 12, 18	• More informed development practices based on local conditions and environmental needs.	• Environmental Assessment • Stewardship	X	X	X	X	X	X								
	2.2: It is recommended that future Environmental Impact Assessments consider the management recommendations outlined in Section 4.3.	1, 4, 5	1, 2, 4, 8, 10, 11, 12, 18	• More informed development practices based on local conditions and environmental needs.	• CTC Source Water Protection Tier 3 Study • CRWNHS	X	X	X	X	X	X								

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
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NEW DEVELOPMENT – Section 4.3	**2.3**: Town of Halton Hills and the County of Wellington can continue to require that source conveyance and end-of-pipe controls be applied to new developments as part of a treatment train approach to SWM, in which stormwater BMPs are applied in succession along a stormwater flow path. SWM measures in new development should be planned, designed and implemented in accordance with the most current version of the following: • CVC and TRCA Low Impact Development Stormwater Management Planning and Design Manual • MECP Stormwater Retention Targets • MECP SWM Planning and Design Manual	1, 4, 5, 6	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Improve water quality. • Encourage infiltration and source controls to reduce erosion and flooding impacts downstream. • Re-use of water on site.	• Planning Act – conditions of draft plan/conditions of site plan approval requiring treatment train approach to SWM; support tools include MECP SWM Guidelines and CVC/TRCA LID Guidelines • Planning Act – require development proponents to undertake detailed investigations of local soil and groundwater conditions, in order to identify the most appropriate SWM system for the site • Town of Halton Hills Green Development Standard Study	X			X	X	X		X						LID measures to increase recharge should be avoided in areas where groundwater levels are within 1 m of ground surface. Local soil and groundwater conditions should be revised prior to design of LID retrofits in areas of existing development. In all WHPAs with vulnerability scores of 8 or higher and ICAs for sodium and/or chloride and nitrates, LID retrofits should be restricted to measures that promote infiltration of rooftop and yard runoff.
	2.4: All new development should achieve a water balance retention target and provide post development peak flows to pre-development levels for all storms, including 2-, 5-, 10-, 25-, 50- and 100-year storms. Implementation of stormwater infiltration practices should be done in light of recommendations provided in section 4.3.	1, 4, 5	4, 8	• Enhanced groundwater recharge. • Enhanced stormwater quality. • Encourage infiltration and source controls to reduce erosion and flooding impacts downstream. • Re-use of water on site.	• Town of Halton Hills Green Development Standard Study • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • CVC's Greening Corporate Grounds and Your Green Yard	X			X	X	X								
	2.5: In line with the policies of the Approved Source Water Protection Plan (CTC, 2015), where pre-development recharge cannot be maintained on site within a WHPA-Q (Figure 31), implement and maximize off-site recharge enhancement to compensate for any predicted loss of recharge from the development. Figure 29, Figure 30, Figure 31 and Figure 32 can be used to guide compensation opportunities that provide the best opportunity for improving conditions within the subwatershed.	1, 4, 5, 6	4, 5, 6, 8, 10	• Maintain or enhance the existing overall groundwater recharge within the subwatershed.	• Planning Act – conditions of draft plan/site plan approval	X			X	X	X		X						

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NEW DEVELOPMENT – Section 4.3	**2.6:** In support of any new development, documentation of site characteristics is necessary to identify features and functions within the proposed development area. Include reports on: • Natural Heritage System • Stormwater Management • Stream Network and Geomorphology Reports should be submitted to CVC, Halton Region, the Town of Halton Hills and any other applicable partners to ensure conformity with current policies and guidelines.	1, 4, 5, 6	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 17	• Ensure the NHS is protected and enhanced where opportunities are available • Ensure LID is being considered in development and stormwater is managed on site • Ensure stream network is protected and enhanced without further degradation due to development	• Planning Act – conditions of draft plan/site plan approval • Halton Region NHS • Credit River watershed NHS • STEP LID Planning and Design Guide • MECP Guidelines for Stormwater Management • Environmental Impact Assessment (EIA)	X			X	X	X	X	X	X					
	2.7: Effort should be made to mimic the ecohydrologic regime of receiving wetland features.	1, 2, 3, 4, 5, 6	4	• Maintain existing extent and hydrologic function of wetlands.	• Planning Act – conditions of draft plan/site plan approval	X			X	X	X		X						
	2.8: All development (new and retrofits) should preserve and restore topsoil to ensure proper drainage and SWM control.	All zones	4	• Enhanced infiltration of water on-site.	• TRCA Preserving and Restoring Healthy Soil: Best Practices for Urban Construction. • Green Development Standards	X			X	X	X								
RURAL LANDS – Section 4.4	**3.1**: Halton Region should consider developing a rural water quality program to support the uptake of agricultural BMPs.	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 9, 11, 12, 13, 14, 16	• Improved water quality. • Improved riparian buffers. • Removal of on-line dams, resulting in improved water quality (including thermal impacts) and quantity.	• Halton Region OP Agriculture and Water Resource policies • ALUS (Alternative Land Use Services) Canada • Grand River Conservation Authority Rural Agricultural Strategy	X			X	X									The program could be modelled after the successful County of Wellington/Grand River Conservation Authority Rural Water Quality Program.
	3.2: Work with the agricultural community to implement BMPs, as prioritized in Figure 14.	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 9, 11, 12, 13, 14, 16	• Improved water quality and temperature. • Improved riparian buffers.	• County of Wellington Rural Water Quality Program • Nutrient Management Act • Source Protection Act • Environmental Farm Plan • Stewardship – CVC Land Owner Action Fund • Canadian Agricultural Partnership (CAP) • MNRF Managed Forest Tax Incentive Program (MFTI) • Wellington Green Legacy Programme, • Halton Woodlands Stewardship Program • ALUS Canada	X			X	X	X		X		X				Within Halton, the program could be modelled after the successful County of Wellington/Grand River Conservation Authority Rural Water Quality Program.

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						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
RURAL LANDS – Section 4.4	**3.3**: Increased buffer widths could be achieved throughout the Black Creek subwatershed and specifically in the areas identified in Figure 15.	1, 2, 3, 4, 5, 6	1, 3, 5, 9, 13, 14, 15, 16	• Improved water quality and temperature. • Improved riparian buffers. • Enhanced NHS adjacent to watercourses.	• County of Wellington Rural Water Quality Program • Nutrient Management Act • Source Protection Act • Environmental Farm Plan • Stewardship – CVC Land Owner Action Fund • CVC Country Stewardship • Ontario Soil and Crop Improvement Association (OSCIA) • CAP • MNRF MFTIP • Wellington Green Legacy Programme • Halton Woodlands Stewardship Program	X			X	X	X		X		X				Within Halton, the program could be modelled after the successful County of Wellington Rural Water Quality Program.
	3.4: The management of surface water runoff should, where feasible, include channel daylighting and/or treatment through on-site wetlands, where nutrient absorption can occur.	1, 2, 3, 4, 5, 6	3, 4, 5, 6, 9, 13, 14	• Improved water quality and temperature. • Improved riparian buffers. • Enhanced NHS adjacent to watercourses.	• County of Wellington Rural Water Quality Program • CVC Permit pursuant to O. Reg. 160/06 • Environmental Farm Plan • Stewardship – CVC Land Owner Action Fund • CVC Country Stewardship	X			X	X	X		X		X				Within Halton, the program could be modelled after the successful County of Wellington Rural Water Quality Program.
	3.5: It is recommended that CVC work in partnership with subwatershed municipalities and landowners to increase implementation of agricultural BMPs in line with Table 11.	1, 2, 4, 5, 6, 7	1, 3, 5, 9, 13, 14, 15, 16	• Improved water quality and temperature. • Improved riparian buffers. • Enhanced NHS adjacent to watercourses. • Healthy farms with protected resources.	• County of Wellington Rural Water Quality Program • Nutrient Management Act • Source Protection Act • Environmental Farm Plan • Stewardship – CVC Land Owner Action Fund • OSCIA • CAP • MNRF MFTIP • Wellington Green Legacy Programme • Halton Woodlands Stewardship Program	X			X		X		X		X				
	3.6: Agricultural producers and rural non-farm landowners in priority 1 & 2 areas of NHS, Greenbelt Natural Heritage System and NEC (EPA and ENA) (refer to NHS section for accompanying mapping), BMPs (e.g. Environmental Farm Plan, Rural Water Quality improvements) or stewardship initiatives on agricultural lands within the NHS in the Black Creek subwatershed be explored to support the implementation of the NHS.	1, 2, 5, 6, 7	1, 2, 3, 4, 5, 10, 15, 16, 17, 18	• Improved riparian buffers. • Enhanced NHS adjacent to watercourses. • Long-term preservation and conservation of portions of the NHS to assist with resilience, enhancement and restoration of the system.	• County of Wellington Rural Water Quality Program • Nutrient Management Act • Source Protection Act • Environmental Farm Plan • Stewardship – CVC Land Owner Action Fund • OSCIA • CAP • MNRF MFTIP • Wellington Green Legacy Programme • Halton Woodlands Stewardship Program		X		X	X	X		X		X				Working together with various partners and stakeholders will help to leverage expertise and available funds. Implementing BMPs will have benefits beyond water quality improvements.

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RURAL LANDS – 4.4	**3.7**: Fencing should be erected to protect headwater streams in the Black Creek subwatershed to limit cattle and horse access to the watercourses, allowing establishment of buffer strips and riparian zones, as identified in the Riparian Zone Management Summary above.	5, 6, 7	5, 6, 9, 16	• Enhanced water quality. • Reduced erosion. • Increase in aquatic habitat and biodiversity.	• County of Wellington Rural Water Quality Program • Nutrient Management Act • Source Protection Act • Environmental Farm Plan • Stewardship – CVC Land Owner Action Fund; OSCIA Growing Forward 2, • MNRF MFTIP • Wellington Green Legacy Programme • Halton Woodlands Stewardship Program	X			X		X		X					X	
AGGREGATE – Section 4.5	**4.1**: If opportunities arise, explore ways to enhance quarry restoration that will enhance the Black Creek subwatershed NHS.	3	15, 16, 17	• Enhance the natural features and functions within the NHS. • Increased public awareness and knowledge through stewardship and education. • Increased public access to natural areas. • Improved water quality and enhanced tree canopy cover.	• Aggregate Resources Act – quarry rehabilitation plan • Stewardship/Volunteer opportunities through community tree planting events • NEC	X			X	X	X				X			X	
CONSERVATION PROPERTIES – Section 4.6	**5.1**: It is recommended that a management plan be developed for Limehouse Conservation Area (LCA).	7	3,4, 5, 8, 9, 11, 14, 15, 16, 17, 18	• Maintain current environmental and cultural heritage features. • Enhance user experience, while protecting resources. • Produce specific recommendations and actions for LCA.	• Region of Halton OP • Town of Halton Hills OP • Various CVC policies	X			X	X	X								
	5.2: CVC should continue to pursue the acquisition of significant lands in the Black Creek subwatershed.	1, 2, 3, 4, 5, 6, 7	1, 2, 3,4, 5, 8, 9, 11, 14, 15, 16, 17, 18	• Maintain extent and hydrologic functions of existing wetlands. • Maintain or enhance the extent of riparian zones. • Maintain channel structure. • Maintain existing heritage species. • Improve natural area connections. • Provide recreational opportunities for the surrounding communities. • Provide education and cultural attractions.	• County of Wellington OP • Region of Halton OP Plan • Town of Halton Hills OP		X		X	X	X		X						

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NATURAL HAZARDS – Section 4.7	**6.1**: It is recommended to prevent an increase in flood elevations and to reduce flood elevations in existing urban areas through stormwater retrofit opportunities consistent with the recommendations made in Section 4.2, in new development through a treatment train approach to stormwater management consistent with recommendations, and through surface drainage network improvements in both existing and proposed urban areas (e.g. re-establishing channel corridors with floodplain storage) in Section 4.7 and 4.8. In doing so, no additional structures should be at risk from flooding.	1, 4, 5	7	• Reduced flood risk. • Enhanced stormwater quality. • Enhanced floodplain areas.	• CVC and TRCA Low Impact Development Stormwater Management Planning and Design Manual • MECP Stormwater Retention Targets • MECP Stormwater Management Planning and Design Manual • Town of Halton Hills Green Development Standard Study • STEP training • CVC's Greening Corporate Grounds and Your Green Yard	X			X	X	X								
	6.2: When there may be an opportunity, effort should be made to either remove existing structures from within the floodplain limits or to lower the floodline elevations.	1, 2, 3, 4, 5, 6	7	• Reduce risk to life and property due to flooding and erosion events.	• Planning Act – condition of draft plan/site plan approval. • O. Reg. 160/06 – CVC Permit	X			X	X	X		x						
	6.3: No structures should be built within the Regional Storm Floodplain. Floodlines should be confirmed/defined in advance of any new development areas. Additions to existing development should only take place in accordance with CVC policy.	1, 2, 3, 4, 6	7	• Reduce risk to life and property due to flooding and erosion events.	• Planning Act – condition of draft plan/site plan approval. • O. Reg. 160/06 – CVC Permit	X			X	X	X		X						
	6.4: Stormwater retrofit opportunities that reduce the volume of surface water runoff to each of the outfalls through source control (e.g. downspout disconnection) should be considered (Section 4.2).	1, 4, 5	4, 8	• To increase the per centage of existing urban area with controlled SWM. • To increase local recharge and infiltration. • To reduce stream erosion through the provision of water quantity controls upstream. • Reduce flood risks.	• Planning Act – conditions of draft plan approval/conditions of site plan approval requiring the use of LID measures in site design • Stewardship – consider expanding SNAP to older urban areas of Acton and Georgetown; consider expanding Greening Corporate Grounds and Your Green Yard programs to Acton and Georgetown	X			X	X	X								

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NATURAL HAZARDS – Section 4.7	**6.5**: Opportunities to infiltrate and/or store water along the conveyance route of stormwater pipes should be implemented, as opportunity arises, to effectively reduce and/or delay the volume of water conveyed to Black Creek and its tributaries.	1, 4, 5	4, 8	• To increase the per centage of existing urban area with controlled SWM. • To increase local recharge and infiltration. • To reduce stream erosion through the provision of water quantity controls upstream. • Reduce flood risks.	• Planning Act – conditions of draft plan approval/conditions of site plan approval requiring the use of LID measures in site design • Stewardship – consider expanding SNAP to older urban areas of Acton and Georgetown; consider expanding Greening Corporate Grounds and Your Green Yard programs to Acton and Georgetown	X			X	X	X								
	6.6: Runoff volume and peak flow attenuation will be required for any proposed land use changes (e.g. quarry expansion, urban development (new, infill)) as per the targets.	1, 3, 4, 5	4	• To increase the per centage of existing urban area with controlled stormwater management. • To increase local recharge and infiltration. • To reduce stream erosion through the provision of water quantity controls upstream. • More natural hydrologic cycle.	• Town of Halton Hills – Planning, Public Works • Halton Region – Planning, Public Works • NEC	X	X	X	X	X	X								
	6.7: Landowners manage dams to mitigate flood and erosion hazards and to minimize adverse effects on the natural environment, as well as maintain dams and ponds consistent with responsibilities outlined in the Lake and Rivers Improvement Act (LRIA).	1, 2, 3, 4, 5, 6	7	• Reduce risk of flooding due to dam failure and to ensure continued dam function.	• LRIA • CVC's Dam Safety Program – all dams owned/managed by CVC • CVC Dam Stewardship Program		X		X									X	
	6.8: Reduction targets for the range of flood events should be based on geomorphic and hydraulic assessments of the watercourse, in order to determine whether any hydrologic and/or hydraulic relevant to maintaining a dynamically functioning watercourse, terrestrial vegetation, and aquatic habitat condition are exceeded. Peak flow targets that would enhance existing conditions (e.g. lead to improved channel stability) should be identified through these separate assessments.	4, 5, 6, 7, 16	6, 7	• More accurate reduction targets. • Maintain and enhance the watercourses of the subwatershed. • Improved stream function.	• CVC's Fluvial Geomorphic Guidelines • CVC Watershed Planning and Regulation Policies (2010) • Rapid Geomorphic Assessment (RGA) (MECP 2003)		X		X	X	X		X						

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NATURAL HAZARDS – Section 4.7	**6.9**: It is recommended that enhancement targets should be developed by considering the storage potential (e.g. through the hydrograph recession constant) in the subwatershed under historical land use patterns (e.g. forest, agriculture) in comparison to existing conditions. Appropriate target setting could occur through separate study in conjunction with studies undertaken to support proposed development.	All zones	4, 5, 6, 8, 9, 11	• Enhanced riparian zones with reduced erosion potential. • Reduced peak flow. • Enhanced water quality.	• CVC's Fluvial Geomorphic Guidelines • CVC Watershed Planning and Regulation Policies (2010) • RGA (MECP 2003)		X		X	X	X		X						
	6.10: It is recommended that through Acton, where opportunities exist to daylight any, or portions of, enclosed watercourses, then this should be undertaken. Such consideration may be most feasible when repair and/or replacement of pipes is necessary. Where feasible, providing connection to a floodplain and re-introducing a sinuous channel with aquatic habitat features should be incorporated into the design. This will enable opportunities for water storage, infiltration and a delay in water delivery to the downstream watercourse. Similar benefits can occur where naturalization of previously straightened and/or hardened channels occurs.	4, 5	3, 4, 5, 6, 9, 13, 14	• Improved water quality and temperature. • Improved riparian buffers. • Enhanced NHS adjacent to watercourses.	• CVC Permit pursuant to O. Reg. 160/06 • Stewardship – CVC • Town of Halton Hills – Planning, Public Works	X	X	X	X	X	X								
	6.11: It is recommended that Table 13 (Mitigation Strategies for Erosion Hazards) be used to guide actions to mitigate erosion hazards for the protection, enhancement and restoration of Black Creek subwatershed.	All zones	5, 6, 15	• Allow natural erosion processes to take place to maintain natural sediment supplies and to maintain natural channel processes. • Protect life and property from erosion, while minimizing the impact of erosion protection measures on the aquatic and terrestrial environment.	• Environmental Assessment Act • O. Reg. 160/06 – CVC Permit	X	X	X	**Depends on location and proponent**										

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						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.1**: The Black Creek NHS should be used to guide future OP updates, policies and restoration efforts.	All zones	15, 16, 17	• Identification of, and policies that support the maintenance of, a connected NHS. • Long-term protection of key natural heritage features, functions and linkages between them. • Enhanced resilience and ability to adapt to climate change and other environmental factors, such as invasive species.	• CRWNHS • County of Wellington NHS Halton Region Natural Heritage System • Greenbelt Plan • Niagara Escarpment Plan		X		X	X	X		X						
	7.2: The Wellington County Greenlands system should more fully implement a "systems approach" to the development of an NHS for the County. This may include the identification and mapping of buffers to natural heritage features, ecological linkage areas among natural heritage features and enhancement areas adjacent to natural heritage features. A modelling approach similar to that undertaken to create the CRWNHS may be used to assist in providing a better understanding of the importance of ecological relationships among key natural heritage features.	5, 6	15, 17	• Identification of, and policies that support the maintenance of, a connected NHS. • Long-term protection of key natural heritage features, functions and linkages between them. • Enhanced resilience and ability to adapt to climate change and other environmental factors, such as invasive species.	• County of Wellington OP	X			X				X		X				
	7.3: The County of Wellington OP policies and mapping schedules could more comprehensively employ a "system approach" to the identification and protection of an NHS.	5, 6	15, 16, 17	• Protection and enhancement of specific features of concern. • Greater attention given to specific areas. • A more robust and inclusive NHS.	• CRWNHS • Natural area inventories • Additional NHS exercises • County of Wellington – Planning		X						X						
	7.4: County of Wellington and CVC should review the differences between their respective mapping databases related to watercourses, flood plains and hazardous lands.	5, 6	16, 17, 18	• Accurate and consistent mapping of natural hazards, in order to effectively implement the natural hazard policies of the PPS and CVC's O. Reg. 160/06.	• County of Wellington OP and Comprehensive Zoning By-Law O. Reg. 160/06	X							X						

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.5**: In the development of the NHS, consideration may be given to the protection of areas identified by the Source Water Information Atlas for the province, in order to contribute to the protection of key hydrologic areas and functions.	All zones	2, 4, 8, 10, 11	• Protection of drinking water sources. • Enhanced groundwater recharge and baseflow conditions. • Protection and enhancement of specific features of concern.	• Source Water Information Atlas • Growth Plan for the Greater Golden Horseshoe • CTC Source Water Protection Plan	X							X						
	7.6: Within the Greenbelt Plan area, the Halton Region NHS policies and mapping should consider including additional regionally/locally important natural heritage features or areas (woodlands, watercourses, headwater drainage features, restoration areas etc.), such as those identified by the CRWNHS or as identified through subwatershed or regional/local scale natural heritage exercises (e.g. natural area inventories).	All zones	15, 16, 17	• Protection and enhancement of specific features of concern. • Greater attention given to specific areas. • A more robust and inclusive NHS.	• CRWNHS • Natural area inventories • Additional NHS exercises		X		X	X									
	7.7: Within the Niagara Escarpment Plan Mineral Resource Extraction Areas, Halton Region should consider the identification of natural heritage features and areas supporting important ecological functions (e.g. linkage, buffering) through additional studies.	1, 2, 3, 4, 5, 6	15, 16, 17	• Enhanced natural heritage protection.	• NEC • Niagara Escarpment Plan Mineral Resource Extraction Area	X				X	X								
	7.8: Halton Region and CVC should continue to collaborate to review similarities and differences between the CRWNHS and the Halton Region NHS to ensure that the mapping in both systems reflects the most up-to-date information.	All zones	16, 17, 18	• Consistent mapping between approval/review agencies potentially leading to improved NHS protection.	• OP Amendment and/or OP Review to refine the limits of the Halton Region NHS	X			X	X									
	7.9: Planning for the South Acton Special Study Area should further consider incorporating the results of the Black Creek Subwatershed Study in mapping of the NHS and the further development of natural heritage protection policies.	4, 5	16, 17	• Maintain and enhance the existing natural heritage features and functions within the study area and identify linkages within and adjacent to the study area.	• Town of Halton Hills OP/Secondary Plan for South Acton		X		X	X	X								

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.10**: It is recommended that Figure 18 and Figure 26 direct terrestrial enhancement and restoration opportunities in the Black Creek subwatershed. Figure 24 outlines the priority types of enhancement and restoration measures and identifies priority locations for implementation of these measures.	1, 2, 3, 4, 5, 6	1, 2, 17	• Increased awareness of connection between land use, individual decisions regarding water use, SWM and a healthy ecosystem. • Improved water quality and quantity management. • Increased volunteer base to implement restoration activities. • Implementation of agricultural BMPs on rural lands. • Educational programs provided to both homeowners and residents, and industrial and commercial properties to improve and increase biodiversity through landscaping.	• Expand Stream of Dreams into Acton and Georgetown schools, festivals, community organizations. • Implement SNAP in Acton and Georgetown. • Expand Greening Corporate Yards and Your Green Yard programs into Acton and Georgetown • CVC's Conservation Youth Corps and Branch Out programs • Expand Trout Unlimited's Yellow Fish Road Program into Acton and Georgetown	X			X	X	X		X	X			X		CVC currently has these programs throughout the Region of Peel, but there are limited funds to provide this programming to Halton Region. CVC's help would be based on funding opportunities and support from the Region and municipalities.
	7.11: A comprehensive headwaters drainage features management plan should be developed to give appropriate consideration to maintaining form, or at least the function, of this important part of the channel network.	5, 6, 7	1, 3, 5, 6, 9, 16	• Improved water quality and quantity management. • Implementation of agricultural BMPs on rural lands. • Enhanced natural stream processes. • Protection from further erosion and degradation.	• CVC's Fluvial Geomorphic Guidelines • CVC Watershed Planning and Regulation Policies (2010) • RGA (MECP 2003) • Cumulative Erosion Index (OME, 2003) and the Cumulative Effective Work Index (Rowney and MacRae, 1992)		X		X	X	X		X	X					
	7.12: Riparian plantings to increase width and quality should be undertaken throughout the subwatershed, as identified in Figure 24, but should be focused in the following areas: The headwater channels in zones 5, 6 and 7; Throughout the Club at North Halton Golf course; and, • In the reaches identified in Restoration Option 1.	5, 6, 7	5, 6, 9, 16	• Enhanced water quality. • Reduced erosion. • Increase in aquatic habitat and biodiversity.	• Stewardship • Expand Stream of Dreams into Acton and Georgetown schools, festivals, community organizations. • Implement SNAP in Acton and Georgetown. • Expand Greening Corporate Yards and Your Green Yard programs into Acton and Georgetown • CVC's Conservation Youth Corps and Branch Out programs		X		X		X		X					X	
	7.13: Removal of Phragmites should be undertaken in Zone 4, as indicated in the Riparian Zone Management Summary.	4	16	• Protect and enhance natural areas downstream. • Reduce the spread of an invasive species throughout the watershed.	• CVC's Invasive Species Program	X			X		X								

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.14**: Black Creek, through the Beardmore site, should be restored consistent with the following principals: • Realigning the creek to a more sinuous planform; • Using natural channel design principles; • Removing or burying hard bank and bed material; • Removing crossings or replacing crossings with clear span structures wider than the bankfull channel width; • Establishing a complex riparian zone; • Reconnecting the creek to the floodplain (e.g. through removing embankments); and, • Creating a mosaic of habitats on the floodplain.	4, 5	4, 5, 9, 14, 16	• Improved stream function and connectivity for all species. • More natural hydrologic function. • Improved water quality. • Increased infiltration.	• Stewardship • CVC's Brook Trout Strategy • Natural channel design principles		X		X	X	X						X		
	7.15: A feasibility study should be completed to consider options for a holistic approach to restoring Bovis Creek.	4, 5	4, 5, 9, 14, 16	• Improved stream function and connectivity for all species. • More natural hydrologic function. • Improved water quality.	• Stewardship		X		X	X	X						X		
	7.16: In coordination with the recommendations presented in River of the Dammed: A Fisheries Based Dam Mitigation Prioritization Tool, the following three dams should be investigated for implementation of mitigation measures: • Dam ID 55: Beeney Creek at 6th Line (BE4); • Dam ID 56: Black Creek at 15th Side Road (two dams); and, • Dam 680 upstream of Stewarttown Dam.	1, 7	5, 16	• Enhanced habitat for Brook Trout. • Improved stream function and connectivity for all species. • More natural hydrologic function.	• CVC's River of the Dammed: A Fisheries Based Dam Mitigation Prioritization Tool • CVC's Brook Trout Strategy		X												

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.17**: Dam 680 has been identified as a very high priority dam for mitigation within CVC's jurisdiction. Mitigation of this dam and the adjacent, lower priority, dam should be pursued. Options for restoration are provided in Appendix H; however, further investigation is required to determine which of the options identified would be most appropriate at these locations.	1	5	• Improved stream function and connectivity for all species. • More natural hydrologic function.	• CVC's River of the Dammed: A Fisheries Based Dam Mitigation Prioritization Tool		X												
	7.18: The dams on this tributary to Bovis Creek upstream of Fairy Lake have previously been identified as barriers for Brook Trout. Monitoring is required to confirm presence of Brook Trout upstream of the dams. If Brook Trout are present, then these would be a high priority site for mitigation works within the Black Creek subwatershed. Further investigation is required to determine which of the options identified in Restoration Option 3 would be most appropriate at these locations.	5	5, 16	• Enhanced habitat for Brook Trout. • Improved stream function and connectivity for all species. • More natural hydrologic function.	• CVC's River of the Dammed: A Fisheries Based Dam Mitigation Prioritization Tool • CVC's Brook Trout Strategy		X												

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.19:** Mitigating of online ponds and stormwater management facilities. • Engaging The Club at North Halton for opportunities to improve property management adjacent to the watercourses. • Selective removal of excess woody material to facilitate sediment transport in the channel. Potential local channel works may be required to initiate recovery. • Removing sediment barrier downstream of footbridge. • Monitoring and managing invasive species. • Conducting a water balance assessment. Identifying sources of groundwater contributions to the tributary/ ravine system to inform land management such as opportunities for thermal and baseflow mitigation. • Reviewing existing stormwater management facilities to determine opportunities for improved system function. • Considering geomorphic processes and fish passage requirements for any future proposed road crossings.	1	2, 3, 4, 5, 8, 9, 15, 16	• Extension of the Credit River - Hungry Hollow Center of Biodiversity to include Hospital Tributary • Enhanced habitat for Brook Trout. • Improved stream function and connectivity for all species. • More natural hydrologic function.	• Stewardship • CVC's Brook Trout Strategy • Natural channel design principles • CVC Hospital Tributary Geomorphology Reconnaissance 2019 • CVC/ TRCA LID Design Guide • Town of Halton Hills stormwater management strategy. • Potential SNAP west of Main Street		X	X	X	X					X		X	X	Some actions are short or medium term. Some actions are opportunistic if there are redevelopment activities or government funding programs (such as replacing road crossings and stormwater management retrofits).
	7.20: Through the development of the South Acton Community, the Town and CVC should work together to promote natural heritage awareness and stewardship within the new community. This is important to promote the need for environmental stewardship and better understanding of the importance of natural features and functions of the Black Creek subwatershed.	4, 5	1, 2, 3	• Increased awareness of connection between land use, individual decisions regarding water use, SWM and a healthy ecosystem. • Improved water quality and quantity management. • Increased volunteer base to implement restoration activities.	• CVC Stewardship Programs • Halton Hills Town Sustainability Implementation Committee		X		X		X							X	

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
NATURAL HERITAGE – Section 4.8	**7.21**: Stewardship activities should include engaging the community in: a natural channel design project; • restoration of stream and valleyland corridors; • community involvement in flora and fauna inventory; and, • maintenance of CVC land and trails (i.e. managing invasive species, plantation management). CVC volunteer opportunities are posted online, and more positions should be created to get local community members involved.	1, 2, 3, 4, 5, 6	3, 5, 9, 16, 18	• Improved stream corridor through natural channel design. • Increased awareness of stream corridor processes through stewardship. • Increased volunteer involvement. • Flora and fauna inventory.	• CVC Stewardship Program • Potential to develop STEP Program • Imagine Halton Hills: Integrated Community Sustainability Strategy		X		X	X	X								
	7.22: To support implementation of integrated water management, for monitoring programs, locations, types of data collection, and frequency of data collection should be developed with consideration of groundwater, surface water, and natural features significance. Key opportunities in the subwatershed include streamflow monitoring for Beeney Creek, which should consider baseflow conditions and fish habitat, and monitoring of wetlands within the zone of influence for municipal groundwater takings. An integrated approach to establishing and reviewing these monitoring programs will help ensure efficient and effective collection of monitoring data that will help to assess potential hydrologic impacts to natural features and help establish protective trigger levels for mitigated actions, as has been done for the Cedarvale wellfield monitoring program.	1, 5, 7	18	• Better understanding of environmental conditions throughout the subwatershed. • Ensure baseflow conditions are being met in Beeney Creek. • Ensure wetlands are not negatively impacted from groundwater use.	• CVC's Integrated Water Management Program • CVC's real-time water quality monitoring program • MECP Permit to Take Water (PTTW) • Town of Halton Hills and/or Halton Region monitoring programs		X		X	X	X								

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
WATER MANAGEMENT – Section 4.9	**8.1**: LID retrofits to increase recharge should be avoided in areas where existing groundwater levels are within 1 m of ground surface.	1, 2, 7	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Reduce the risk of basement flooding. • Implement different LID techniques, such as water reuse.	• STEP training • TRCA and CVC LID Design Guidelines	X													
	8.2: In general, infiltration of runoff from rooftops and vegetated areas is appropriate for infiltration in all areas; however, infiltration of runoff from impervious surfaces, such as roads and parking lots, may increase the potential for groundwater quality impacts in vulnerable areas.	All zones	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Incorporate anticipated costs into capital budget for upcoming projects • Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study	X			X	X	X								
	8.3: To improve the understanding of areas of high groundwater levels in the subwatershed, detailed investigations of local soil and groundwater conditions in areas of new development should be reviewed prior to design of LID measures.	1, 4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Incorporate anticipated costs into capital budget for upcoming projects • Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study	X			X	X	X								
	8.4: For LID retrofits in existing development, infiltration of runoff from rooftops onto vegetated areas is appropriate for infiltration in all areas; however, infiltration of runoff from impervious surfaces, such as roads and parking lots, may increase the potential for groundwater quality impacts in vulnerable areas.	1, 4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study	X			X	X	X								

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
WATER MANAGEMENT – Section 4.9	**8.5**: While groundwater quality impacts are not typically associated with implementation of LID measures, a conservative approach should be taken within increased areas of identified aquifer vulnerability, as well as ICAs. Therefore, for the following areas (as shown in Figure 30), LID implementation should be restricted to measures that only promote infiltration of roof and yard runoff: • All WHPAs with vulnerability scores of 8 or higher; and • ICAs for sodium/chloride and nitrates.	All zones	10, 11	• Enhanced infiltration and groundwater recharge. • Protected groundwater. • Diversion of polluted stormwater.	• Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study • CTC Source Water Protection Study	X			X	X	X								Work with CTC Source Water Protection. Refer to https://ctcswp.ca/ for the most up-to-date information.
	8.6: For areas of new development where maintaining groundwater recharge may not be feasible, development proponents should identify other locations in the subwatershed where groundwater recharge would be enhanced, typically through LID retrofits, to compensate for any decrease of groundwater recharge that cannot be avoided by new development.	1, 4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Incorporate anticipated costs into capital budget for upcoming projects • Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study	X			X	X	X								
	8.7: Consistent with the Tier Three study: • Municipal water conservation programs should be maintained and/or enhanced; and • The hydrologic function of Beeney Creek should be maintained by evaluating the potential impacts of land use changes, water takings, and climate change on the creek. Existing monitoring program should be reviewed to ensure that Beeney Creek, and other sensitive hydrologic features, are adequately included. Locating a continuous streamflow gauge at the downstream end of Beeney Creek should be considered.	1, 2, 3, 4, 5, 6	1, 2, 3, 18	• Decreased water use through conservation programs. • Enhanced understanding of impacts to hydrologic function of Beeney Creek.	• MECP PTTW • CTC Source Water Protection Plan	X			X	X	X								Refer to https://ctcswp.ca/ for the most up-to-date information.

	Recommendation	Focus Zone	Overall Objective(s)*	Outcomes	Implementation Tool(s)	Timeline			Partners										Notes
						Short (1-4 years)	Medium (5-9 years)	Long (10-15 years)	CVC	Halton Region	Town of Halton Hills	Conservation Halton	Wellington County	Town of Erin	Gov' t. of Ontario	Federal Gov' t.	NGOs	Landowners /Public	
WATER MANAGEMENT – Section 4.9	**8.8**: Integration of water management between agencies should include sharing of monitoring and water taking data, and a coordinated approach to review of potential impacts from future development and water takings. Review of new water takings should be coordinated between MECP and CVC to ensure effective sharing of available monitoring data and so that impact assessments will appropriately consider the concerns and mandates of all agencies involved.	All zones	1, 2, 4, 8, 10, 11	• Protection of groundwater as a resource and environmental need. • Maintain and enhance the current groundwater recharge and infiltration rates.	• MECP PTTW	X			X		X		X		X				
	8.9: Pollution prevention should include educational programs for BMPs and promotion of stewardship opportunities. Key areas for focus include the two identified ICAs and the WHPAs for the municipal groundwater takings in Halton Hills.	1, 4, 5	1, 2, 10, 11, 12	• Improve stormwater quality. • Reduce contaminants entering local waterways. • Potentially increase biodiversity through different lawn practices.	• Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • CVC's Greening Corporate Grounds and Your Green Yard • Town of Halton Hills Public Works	X			X	X	X								Halton Region already has guidance and direction for homeowners, which can be a resource for the Town to use.
	8.10: The groundwater management approach recommended for existing and new development, namely the infiltration of stormwater, for existing and new development (i.e. enhance groundwater recharge through LID retrofits in existing development and implementation of LIDs in new development), is recommended here, as it is an appropriate measure to offset the potential impacts of climate change.	1, 4, 5	1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 17	• Increase the per centage of existing urban area with controlled SWM. • Increase groundwater recharge and infiltration. • Reduce stream erosion through the provision of water quantity controls upstream. • Improve stormwater quality.	• Incorporate anticipated costs into capital budget for upcoming projects • Environmental Assessments pursuant to the Environmental Assessment Act • Implementation of MECP Stormwater Management Guidelines and CVC/TRCA LID Guidelines at detailed design • STEP training • Town of Halton Hills Green Development Standard Study	X			X	X	X								
	8.11: Based on review of the existing and potential future aggregate activity in the Black Creek subwatershed, the management recommendations outlined in Table 12 (management recommendations for existing and new aggregate sites) are provided in connection to the key subwatershed ecosystem health indicators described in the Phase 1 and Phase 2 reports.	2, 3	8, 11, 15, 18	• Maintain recharge areas. • Maintain critical discharge areas. • Use monitoring data to inform future decisions related to quarry expansion.	• Aggregate Resources Act • NEC • Stewardship • Land acquisition	X			X	X	X				X			X	

*Overall Objectives are based on those objectives listed in Table 6.3.1 (Black Creek Subwatershed Targets and Objectives) in the Black Creek Subwatershed Study Phase 1 Report and are summarized as follows:

Objective #	Objective
1	Demonstrate and promote awareness of the linkages between healthy water, healthy lifestyle and the economic viability of rural and urban land uses and promote the wise use of surface water and groundwater, having regard for both human and ecological needs.
2	Promote the wise use of surface water and groundwater, having regard for both human and ecological needs.
3	Promote the need for environmental stewardship and better understanding of the importance of natural features and functions of the Credit River watershed.
4	Preserve and re-establish the natural hydrologic cycle.
5	Maintain, enhance or restore natural stream processes to achieve a balance of flow and sediment transport.
6	Maintain stream flow to reduce erosion impacts on habitats and property.
7	Minimize risk to human life and property due to flooding.
8	Maintain groundwater levels and baseflows (groundwater discharge to streams) to sustain watershed functions, human uses and climate change.
9	Maintain or enhance water and sediment quality to achieve ecological integrity.
10	Protect drinking water sources.
11	Protect groundwater quality to support watershed functions.
12	Reduced toxins through pollution prevention.
13	Improve water quality in rivers and Lake Ontario for body contact recreation.
14	Maintain or enhance water aesthetics (including odour, turbidity and clarity).
15	Protect, restore or enhance the integrity of the watershed ecosystem through an integrated network of natural areas, habitats and connecting links.
16	Protect, restore or enhance native terrestrial and aquatic plant and animal species, community diversity and productivity.
17	Promote integrated resource management of the aquatic and terrestrial systems and areas within the watershed for plant, animal and human use.
18	Conduct research to identify and promote the social benefits of the watershed system (recreational, educational, cultural, psychological, economic and tourism).

Colour-coding legend for reference for the Implementation Plan

Colour	Code
Blue	Policy Recommendations
Green	Program Recommendations
Grey	Land Use Planning Recommendations
Orange	Project Based Recommendations

6. MONITORING

Fundamental to subwatershed planning is adaptive environmental management (AEM). To ensure the process of AEM is achieved, monitoring is needed. A subwatershed monitoring program will assess the environmental changes in the subwatershed, evaluate compliance with the plan's goals and objectives, and provide information that will assist custodians of the plan with implementation and updating.

Subwatershed plans are "living documents," meaning they are intended to be updated as new information becomes available and as recommendations are implemented. This refers to the ability of the Management and Implementation Plans to be refined using an AEM approach. AEM means making decisions as part of an on-going process. Monitoring the results of actions provides a flow of information that may indicate the need to change a course of action or certain management elements.

The objectives of the monitoring program are to:

a) gauge the effect of land use changes in the subwatershed relative to existing conditions, targets, and goals;
b) assess effectiveness of recommended management actions within the subwatershed; and,
c) provide the necessary information on subwatershed health for revisions, updating, and/or development of new management measures, if conditions are deviating from objectives, targets, and goals of the subwatershed plan.

The Subwatershed Study monitoring program will be carried out on several levels:

1. **Subwatershed Study Implementation:** Current operational monitoring will inventory the applications of the plan to ensure that any recommendations being implemented are tracked and progress is recorded.
2. **CVC's Existing Monitoring Program:** Existing CVC programs, including the Integrated Watershed Management Program (IWMP) and real-time monitoring, will measure the changes in trends over time and provide an indication of the health of the Credit River watershed and its subzones. Figure 33 illustrates the existing monitoring network.
3. **Impact Monitoring:** There are identified threats to Black Creek that should be monitored to manage their impact. This includes more rigorous monitoring of Fairy Lake for sedimentation and water quality issues.
4. **Subwatershed Health:** Monitoring to determine the health of the subwatershed by carrying out comparison monitoring relative to the baseline monitoring completed for Phase 1. This monitoring would happen on a 5-10-year rotation. This monitoring will measure the effectiveness of the subwatershed plan.
5. **Restoration Performance Monitoring:** Site specific monitoring related to the implementation of terrestrial and aquatic restoration projects in the subwatershed. Generally, the monitoring is conducted to gauge the performance of the specific restoration effort and is complementary to CVC's existing monitoring programs.

The following provides greater detail on the recommended monitoring plan for the subwatershed.

6.1 Subwatershed Study Implementation

CVC should track the implementation of the subwatershed plan recommendations. The tracking should include all implementation initiatives irrespective of what organization led implementation. To allow the public and community organizations to provide input, effort should be made to include the tracking on CVC's website with clear instructions on how individual or community initiatives can be submitted to CVC for inclusion in the tracking record.

CVC's stewardship monitoring program currently tracks program uptake and community involvement but does not look at outcome measures, such as changes in behaviour, attitude, understanding, and awareness. Gaining a better understanding of the effectiveness of stewardship and outreach initiatives will assist CVC in streamlining their program delivery, provide municipalities and other funding sources with a better understanding of the gains made in communities, and provide meaningful feedback to community members in terms of how their community is responding to stewardship efforts and changes in environmental education.

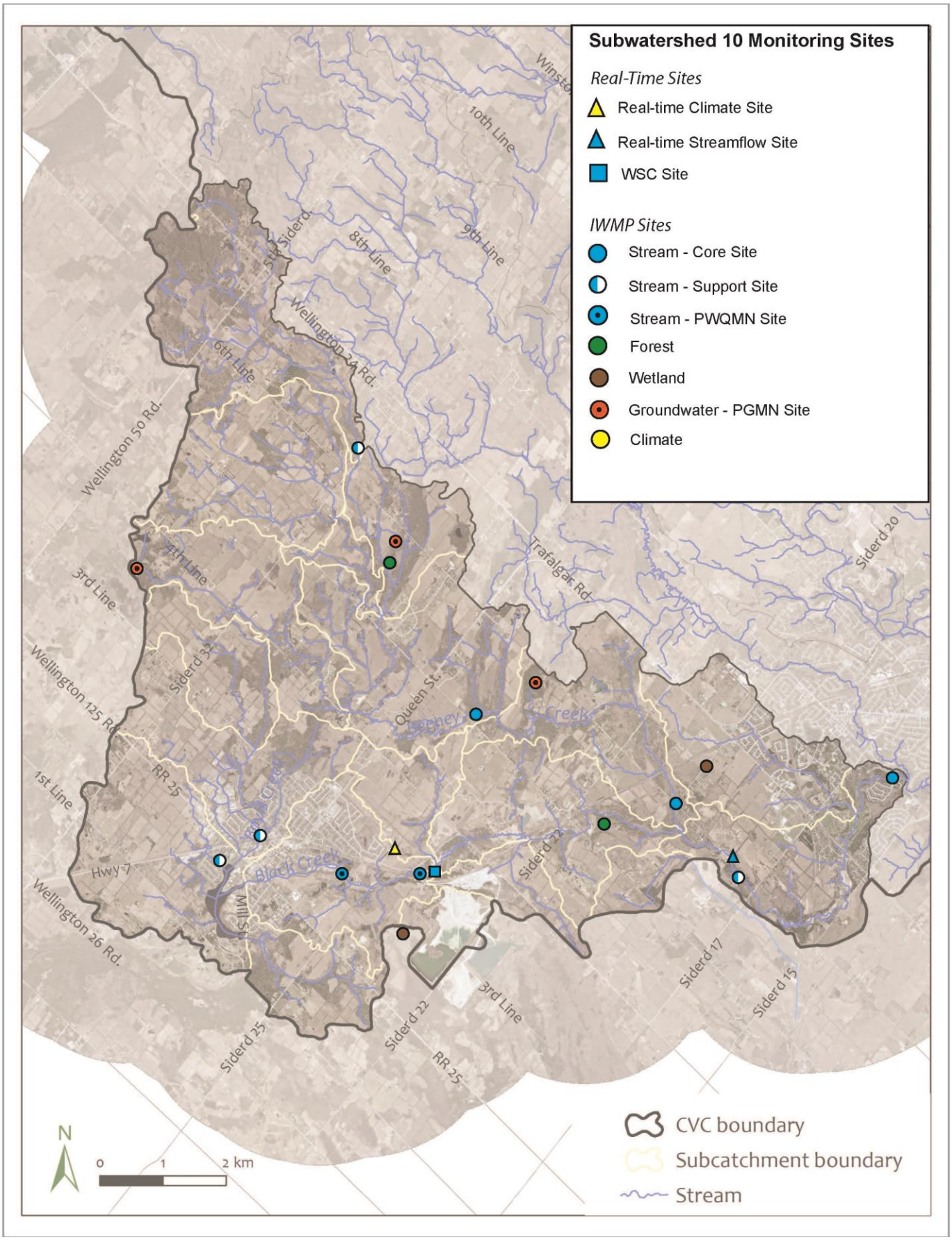

Figure 33 Black Creek existing monitoring sites

6.2 General Recommendations on Existing Monitoring Within Black Creek

1. The Province should continue to maintain the existing Provincial Water Quality Monitoring Network (PWQMN) with support from CVC.
2. CVC should continue to support the IWMP.
3. CVC should continue to maintain the continuous real-time flow monitoring station.
4. Currently there is one real-time stream flow monitoring station at the downstream end of Black Creek subwatershed. As funding permits, CVC should increase the network of continuous monitoring stations, and municipalities should support the development of an increased network of continuous water quantity and quality monitoring stations to assist with decision making.
5. CVC should continue and enhance restoration performance monitoring where applicable to ensure that restoration efforts are achieving their desired outcomes.

6.3 Impact Monitoring

Threats to Black Creek are outlined in Chapter 4. These include land use changes, increased water use, and changes to natural areas. If funding is available, comprehensive monitoring plans should be developed with all partners for monitoring of these impacts, and funding should be sought to support monitoring efforts.

6.4 Subwatershed Health

On a 5-year to 10-year rotation starting in 2021, CVC and project partners should implement an intensive year-long monitoring program that replicates the Phase 1 Characterization monitoring program, if funding and time permits. This will allow for comparison with baseline information collected as part of the Phase 1 Study and provide an indication on the effectiveness of the Subwatershed Study.

The Black Creek subwatershed is under a number of stresses, including associated soil and nutrient losses due to: agricultural practices, intensive agricultural operations (animal husbandry), groundwater and surface water withdrawal, aggregate extraction, loss of natural riparian areas, impacts from Fairy Lake, dams and impoundments, the Acton WWTP, urban development and its associated increases in impervious surfaces, and the management of stormwater. By having a robust monitoring network, CVC is able to track the impact of these stressors over time to ensure there are fewer negative impacts to the environment. By repeating some of the monitoring that was carried out in Phase 1 we can see the changes that have occurred over the past ten years, which will help us to better choose recommendations to implement and areas that need targeted attention.

In addition to the Black Creek Subwatershed Study, there are other concurrent studies in the subwatershed that are dealing with water-related issues. These other studies also monitor different aspects of the subwatershed and provide us with valuable information, as they can be quite detailed in specific disciplines, which is more in-depth than what CVC could carry out as a monitoring program alone.

While some zones within the Black Creek subwatershed show signs of stress and degradation, overall health and productivity of the subwatershed appears to be good. In light of some anticipated urban growth, new or altered aggregate operations, changes to agricultural activities, and stresses, such as climate change, the monitoring of subwatershed ecosystem health indicators will play a critical role in subwatershed management to ensure subwatershed goals and objectives are met.

6.5 Restoration Performance Monitoring

CVC conducts site specific restoration performance monitoring to gauge the success and changes associated with ecological restoration projects. The parameters monitored are specific to the project and can include a variety of biotic (fisheries, vegetation survival, herpatile, etc.) and abiotic (water quality, fluvial geomorphology, soil conditions, groundwater, etc.) measures that are complimentary to existing watershed monitoring programs.

GLOSSARY OF TERMS AND ACRONYMS

AEM – Adaptive Environmental Management

ALUS - Alternative Land Use Services

ANSI – Area of Natural and Scientific Interest – Areas of land and water containing natural landscapes or features that have been identified by the Ontario Ministry of Natural Resources as having life (ecologic) science or earth (geologic) science values related to protection, scientific study, or education (OMMAH 2005*d*). These areas are recognized and protected under the Ontario's Planning Act, Provincial Policy Statement, Oak Ridges Moraine Conservation Plan, Niagara Escarpment Plan, Greenbelt Plan, Growth Plan, and municipal official plans.

BMPs – Best Management Practices – Are science-based farming activities designed to help minimize potential environmental impacts, such as sediment and nutrient runoff into water bodies.

CA – Conservation Area

CAP - Canadian Agricultural Partnership

CCME – Canadian Council of Ministers of the Environment

CRWNHS – Credit River Watershed Natural Heritage System

CTC – Credit Valley Conservation, Toronto and Region Conservation Authority, Central Lake Ontario Conservation Authority

CVC – Credit Valley Conservation – A community-based environmental organization originally formed by an Act of provincial government and dedicated to conserving, restoring, developing and managing natural resources on a watershed basis.

CWP – Centre for Watershed Protection

DO – Dissolved Oxygen

EA – Environmental Assessment

EIR – Environmental Implementation Report

ENA – Environmental Natural Area

Enhanced NHS – Enhanced Natural Heritage System - Areas defined and protected under existing legislation, regulations and policies and would include additional lands based on generally accepted ecological concepts that have been adopted as part of the approved Credit River Watershed Natural Heritage System (2014).

EPA – Environmental Protection Area

ESA – Environmentally Significant Area – Areas of land and water containing natural landscapes which contain or support natural forms, features, or attributes deemed to be significant or essential, using a set of approved criteria, in the context of the watershed or municipality which have been designated by conservation authorities, and incorporated into conservation authorities' policies and municipal official plans.

GTA – Greater Toronto Area

HDF – Headwater Drainage Feature

ICA – Issue Contributing Area

ICI – Industrial, Commercial and Institutional properties/land-uses

IWMP – Integrated Watershed Monitoring Program – An intensive, long-term monitoring program implemented by CVC which measures key environmental indicators.

LCA – Limehouse Conservation Area

LID – Low Impact Development

LID TT TOOL – Low Impact Development treatment train tool

LRIA – Lakes and Rivers Improvement Act

LSRCA – Lake Simcoe Region Conservation Authority

MECP – Ministry of Environment, Conservation and Parks (2018)

MOECC – Ministry of the Environment and Climate Change (2014-2018)

MOE – Ministry of the Environment (prior to name change June 2014)

NEC – Niagara Escarpment Commission

NHIC – Natural Heritage Information Centre – Acquires, maintains, updates, and makes available data on the province's rare species, vegetation communities, and natural areas. The NHIC is part of the Ontario OMNR Fish and Wildlife Branch. The NHIC contributes to OMNR's role in protecting the genetic, species and ecosystem diversity of Ontario.

NHS – Natural Heritage System

OGS – Oil Grit Separator

OMAFRA – Ontario Ministry of Agriculture, Food, and Rural Affairs

OSCIA - Ontario Soil and Crop Improvement Association

MFTI - Managed Forest Tax Incentive Program

MECP - Ontario Ministry of Environment, Conservation and Parks

MOECC – Ontario Ministry of Environment and Climate Change – Provincial government is responsible for protecting clean and safe air, land and water to ensure healthy communities, ecological protection and sustainable development for present and future generation of Ontarians (MOE 2009*a*).

MNRF – Ontario Ministry of Natural Resources and Forestry – A provincial agency working to promote healthy, sustainable ecosystems and conserve biodiversity (the variety of life on Earth). They conduct scientific research and apply the findings to develop effective resource management policies. The Ministry of Natural Resources also manages Ontario's Crown land, promotes economic opportunities in the resource sector and enhances opportunities for outdoor recreation (OMNR 2010).

OP – Official Plan – A legal document that contains goals, objectives and policies that manage growth and direct physical change and its effects on the social, economic, and natural environment of municipalities.

OSCIA – Ontario Soil and Crop Improvement Association – A non-profit farm organization that communicates and facilitates responsible, economic management of soil, water, air, and crops.

PPS – Provincial Policy Statement –Issued under the authority of Section 3 of the *Planning Act.* It provides direction on matters of provincial interest related to land use planning and development and promotes the provincial "policy-led" planning system.

PTTW – Permit to Take Water – A permit required when the total volume of water obtained from either a surface or groundwater source exceeds 50,000 L/day.

PWQMN – Provincial Water Quality Monitoring Network – A network of partnerships including MOE, Conservation Authorities, municipalities and Ontario Parks who collect surface water quality information from rivers and streams across Ontario.

PWQO – Provincial Water Quality Objective – Are numerical and narrative criteria which serve as chemical and physical indicators representing a satisfactory level for surface waters (i.e. lakes and rivers) and groundwater of the Province. The PWQO are set at a level of water quality which is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water. The Objectives for protection of recreational water uses are based on public health and aesthetic considerations.

RGA – Rapid Geomorphic Assessments – Is a type of channel assessment technique developed by MOE to assess reaches in urban channels. RGA's involve recording evidence of

channel instability. The instability features for each category are tallied and used to calculate a reach stability index, which corresponds to a stability classification (MOE 2003*a*).

RSAT – Rapid Stream Assessment Techniques – Is a type of channel assessment that provides a broader view than RGA by also considering the ecological function of the stream (Galli 1996). Observations are made of instream habitat, water quality, riparian conditions, and biological indicators. RSAT scores are used to rank the channel as maintaining a poor, fair, good, or excellent degree of stream health.

SNAP - Sustainable Neighbourhood Retrofit Action Plan

SPP – Source Protection Plan

SWM – Stormwater Management

TP – Total Phosphorus – The sum of all phosphorus forms.

TSS – Total Suspended Solids

TRCA – Toronto and Region Conservation Authority

Urban Living – Refers to the impacts to our environment caused by people living in urban centres, which includes habitat loss, increase in impervious surfaces, increase stormwater runoff, increased groundwater takings and wastewater discharge, winter salt application, and encroachment on natural areas.

WHPA – Wellhead Protection Area – Protection of all or part of the area surrounding a well from which the well's groundwater is drawn.

WHPA Q1/Q2 - Wellhead Protection Area with a focus on quantity. WHPA-Q1 refers to the area where activities that take water without returning it to the same source may be a threat. WHPA-Q2 refers to the area where activities that reduce recharge may be a threat. Source Protection Plan policies must be developed to address significant water quantity threats.

WHPA (A through E) – Wellhead Protection Area with a focus on quality. Wellhead Protection Areas are areas on the land around a municipal well, the size of which is determined by how quickly water travels underground to the well, measured in years. For source protection planning, the Clean Water Act, 2006 required that a standard 100-metre radius circle be provided around each municipal well; this is called WHPA-A. WHPA-B represents the 2-year time of travel; WHPA-C represents the 5-year time of travel; and WHPA-D represents the 25-year time of travel. WHPA-E represents municipal wells that are under the direct influence of surface water. The size and shape of each WHPA (B, C, D or E) is a function of how water travels underground.

WQI – Water Quality Index – An index that provides a convenient method of mathematically summarizing complex arrays of multivariate water quality data into simple

water quality descriptors that facilitate easy communication of the water's status to general audiences. Refer to Section 4.6.2.4 and 4.6.3.4 for more information.

WRWQP – Wellington County Rural Water Quality Program

WWTP – Wastewater Treatment Plant – The site where raw wastewater is processed before it is discharged back to the environment.

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Appendix A – Seven Catchment Zones

Appendix B – Scenario Evaluation from Phase 2 Impact Assessment Report

Appendix C – LID Opportunities and Characterization (LID Management and Implementation Plan)

Appendix D – GIS Screening Tool for LID Implementation

Appendix E – Town of Halton Hills Official Plan Maps

Appendix F – Limehouse Conservation Area Characterization and History

Appendix G – NHS Information and Maps – North-South Environmental

Appendix H – Riparian and Watercourse Restoration

Appendix I – Guide to Roles, Responsibility, and Existing Policies for Implementing Recommendations