The Town of Whitby

Bridge and Culvert Master Plan Environmental Study Report

Final Report – May 2021
Revised October 28, 2021

Submitted By:

ecosystem recovery inc.
PROFESSIONAL ENGINEERS

Prepared For:

Whitby

Ecosystem Recovery Inc.
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May 7, 2020 Ref: 1837

The Town of Whitby
Antony Manoharan, P.Eng.
Water Resources Project Manager
Town of Whitby
3050 Garden Street, #102
Whitby, Ontario L1R 2G6

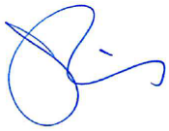
Re: Town of Whitby – Bridges and Culverts Master Plan

Dear Mr. Manoharan,

Please find attached the **Bridge and Culvert Master Plan Report (Final)** which includes a summary of the Notice of Completion Public Review Period consultation (Appendix I). The report summaries the planning, consultation and evaluation process undertaken throughout the Master Plan study. The report also identifies the preferred alternatives and associated mitigation measures and implementation plan.

We trust that you will find our report satisfactory and look forward to working with you in the future.

Sincerely,
Ecosystem Recovery Inc.



Jeff Prince, P.Eng.
Senior Project Manager

jeff.prince@ecosystemrecovery.ca

Encl.
Bridges and Culverts Master Plan Report

Table of Contents

Page

Tables

Figures

Appendices

1. Executive Summary

1.1 Introduction

Ecosystem Recovery has been engaged by the Town of Whitby (the Town) to complete the Bridge and Culvert Master Plan. Master Plans are long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. They examine an infrastructure system, in this case the bridges and culverts within Whitby, to outline a framework for prioritizing future upgrades and replacements. At a minimum, Master Plans address Phases 1 and 2 of the Municipal Class Environmental Assessment (EA) process. This Bridge and Culvert Master Plan is being undertaken in accordance with Approach #2 which requires the preparation of a Master Plan upon completion of Phases 1 and 2 of the EA process where the level of investigation, consultation and documentation are sufficient to fulfil the requirements of Schedule B projects.

The Town owns more than 2000 water crossing structures along creeks and ditches which include 49 bridges and culverts with a span greater than 3 m, 103 culverts with a span less than 3 m, and approximately 1900 driveway culverts. In 2017, the Town experienced catastrophic failure at several culvert crossings underneath municipal roadways resulting in road failure and extended road closure. The failures were generally attributable to poor culvert condition and undersized hydraulic capacity.

The goal of this Master Plan is to develop a prioritization list of culverts and bridges that have a high risk of failure due to undersized hydraulic capacity. The prioritization list will allow the Town to proactively replace and upsize these crossings over the next 10 to 20 years. To achieve this goal the following objectives have been identified:

- Survey all town owned crossings (bridges and culverts) to confirm size and hydraulic parameters;
- Complete hydrology and hydraulic modeling at all town owned crossings;
- Compare hydraulic modeling results to bridge and culvert design criteria;
- Undertake a risk assessment to determine the crossings that pose the highest risk to the public from failure due to undersized hydraulic capacity;
- Develop design alternatives for the highest risk crossings that meet the design criteria and reduce the risk of failure;
- Determine the preferred alternative at each of the highest risk crossings by evaluating the relative impacts of each alternative;
- Identify mitigation measures and permitting requirements for the preferred alternatives that will be implemented during detailed design; and
- Prioritize replacement works for the highest risk crossings to inform future Town capital budgets.

The Master Plan process ensures a comprehensive and environmentally sound planning process, which is open to public participation, to select the preferred solution at the highest risk crossings. The project will ensure the preferred alternatives are selected based on the following considerations:

- Future land use changes, consistent with the Town's Official Plan, and future growth and development;
- Climate change projections and related impacts on future rainfall events; and
- Integrated risk assessment which considers flooding in conjunction with impact and vulnerability factors.

This report documents the need and justification for the project, the planning process undertaken to select the preferred alternatives, and measures to mitigate impacts.

1.2 Study Area

The study area is the Town of Whitby boundary and includes all cross culverts, culverts and bridges owned by the Town. The study area includes the Lynde Creek, Pringle Creek, and Corbett Creek watersheds which fall under the jurisdiction of the Central Lake Ontario Conservation Authority (CLOCA). **Figure ES-1** presents the study area and relevant points of interest including the crossing locations, major watercourses and watersheds.

1.3 Preferred Alternatives

A hydrology and hydraulic assessment was completed for all 152 Town owned watercourse crossings. The assessment found that 93 of the 152 crossings are undersized and fail to meet the Ministry of Transportation Ontario (MTO) Highway Drainage Design Standards. Replacement of all 93 undersized crossings within the next 10 years is not feasible due to the significant capital costs. Therefore, a risk assessment process was used to identify the highest priority crossings that are most likely to fail from flooding and pose the greatest risk to the public if failure were to occur. A risk matrix was developed to assign risk rankings: No Risk, Low Risk, Medium Risk, High Risk and Highest Risk. The risk assessment identified 12 watercourse crossings as Highest Risk. These crossings are located on Arterial roads with high traffic volumes and cause the road to flood more frequently than other crossings (i.e. 25-year to 50-year return period). The Highest Risk crossings are shown in **Figure ES-2** along with the secondary priority crossings which represent the High Risk ranking crossings.

Design alternatives were assessed for the 12 Highest Risk watercourse crossings and evaluated based on technical, socio-economic, natural environment and cost opportunities and constraints. The preferred alternatives are presented in **Table ES-1** and prioritized based on a simplified cost benefit analysis considering

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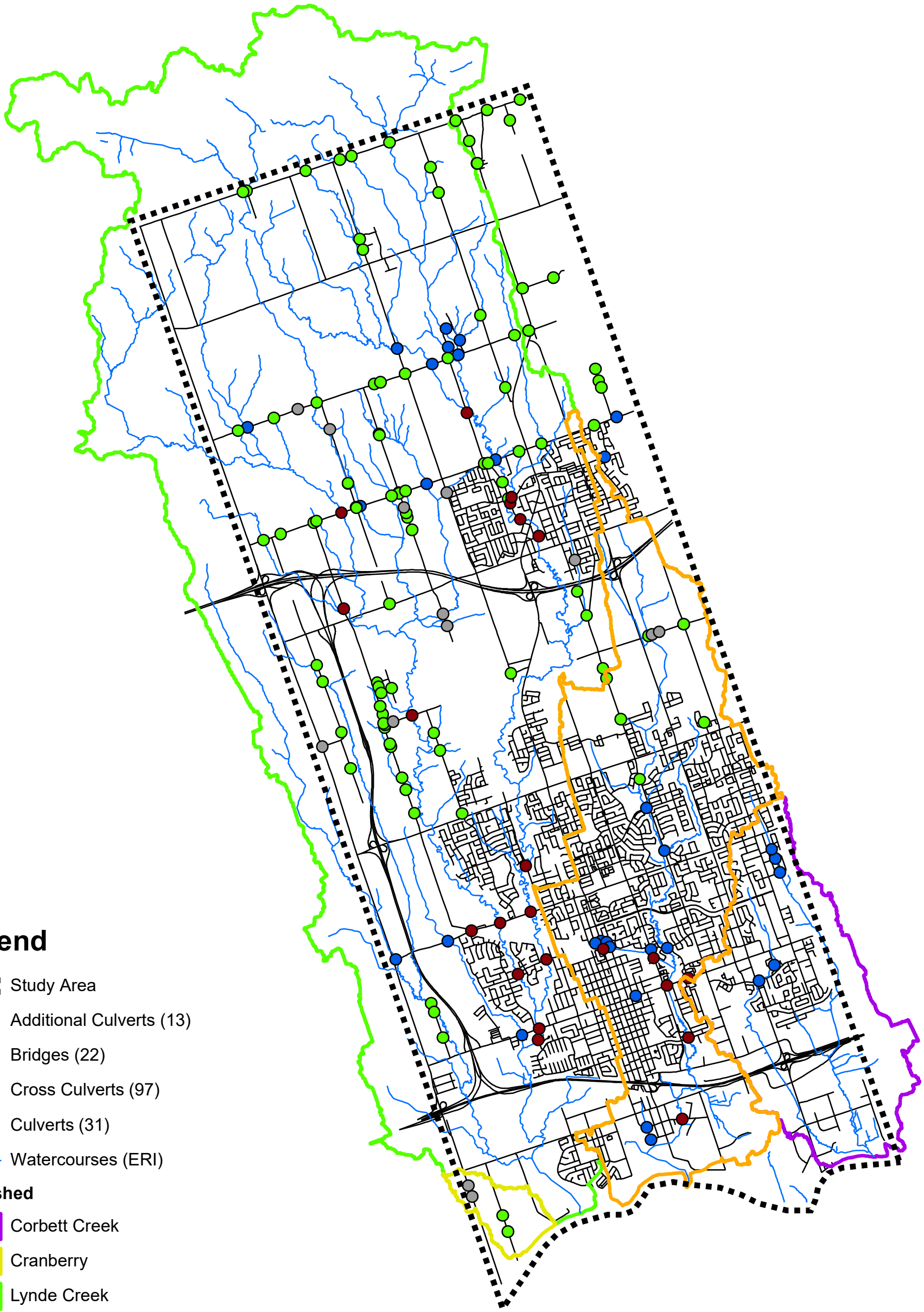

Legend

- Study Area
- Additional Culverts (13)
- Bridges (22)
- Cross Culverts (97)
- Culverts (31)
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

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Figure ES-1
Study Area

0 1.25 2.5 5 Kilometers

NAD 1983 UTM 17

1:75,000

Project: 1837 Whitby Bridge/ Culvert Master Plan
Date: 2020/03/11

N W E S

Data Sources: Ecosystem Recovery Inc., 2020:
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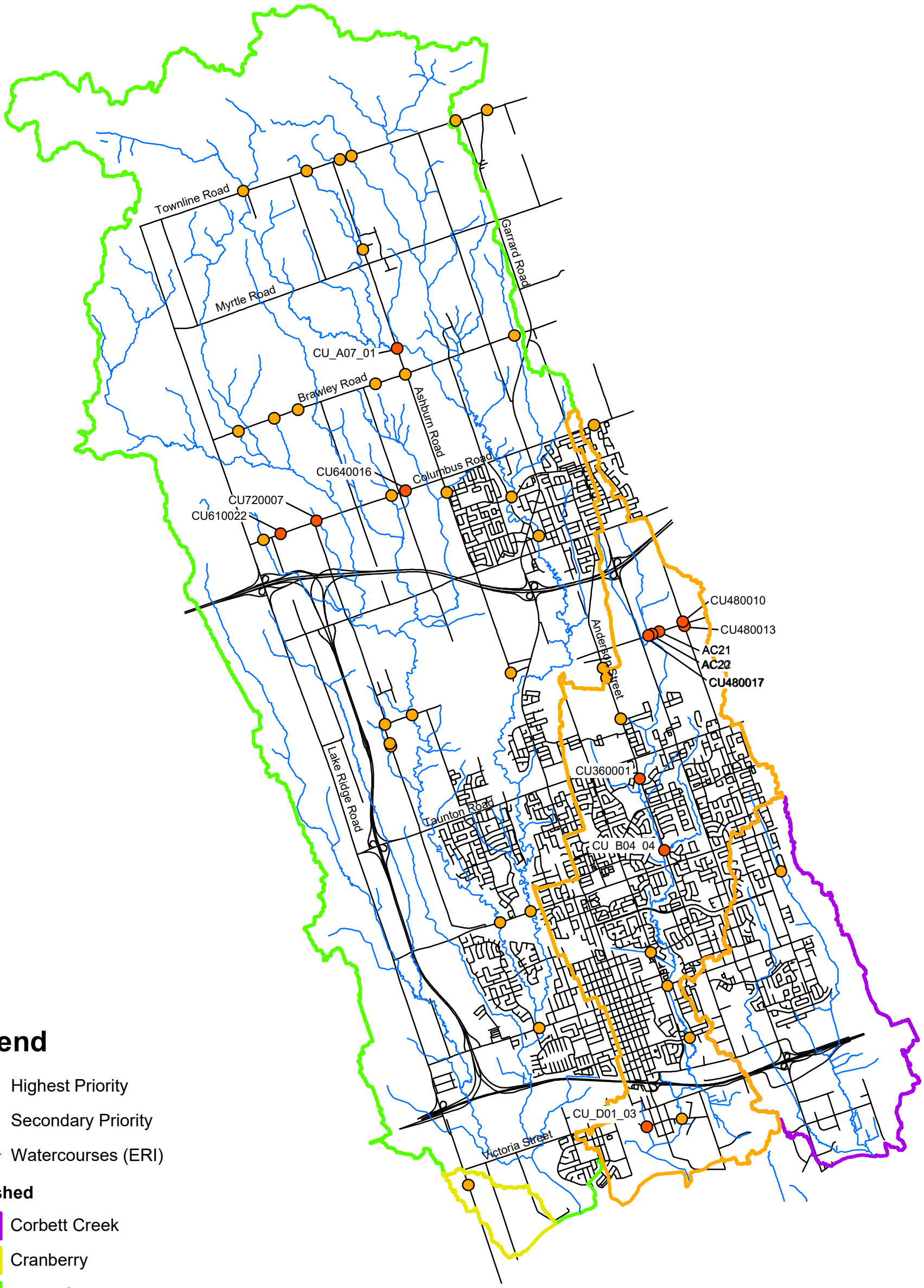

Legend

- Highest Priority
- Secondary Priority
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

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Figure ES-2

Priority Crossings for Replacement and Upsizing

0 1.25 2.5 5 Kilometers

NAD 1983 UTM 17

1:75,000

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capital cost estimates and the relative improvement to flood risk. Further studies are required at two crossings before feasible design alternatives can be confirmed as noted in **Table ES-1**.

Table ES-1-1. Preferred Alternatives for the Highest Risk Crossings.

Priority	Facility ID	Road Name	Existing Culvert / Bridge	Preferred Alternative	Capital Cost	EA Schedule
Within 2 years	**CU610022**	Columbus Road West	800 mm diameter circular CSP culvert	Twin 900 mm diameter circular CSP culverts.	$190,000	Schedule B
	CU720007	Columbus Road West	1050 mm diameter circular CSP culvert	Twin 1100 mm diameter circular CSP culverts	$220,000	Schedule B
2 to 5 years	**CU_A07_01**	Ashburn Road	5550 mm span x 3500 mm rise arch CSP culvert	Replace with a 10 m span bridge.	$1,740,000	Schedule B
	CU640016	Columbus Road West	500 mm diameter Circular CSP culvert	Triple 1200 mm diameter circular CSP culverts	$220,000	Schedule B
5 to 10 years	**CU360001**	Anderson Street	3300 mm span x 2000 mm rise CSP culvert	Twin 5100mm x 1800mm concrete box culverts.	$1,940,000	Schedule B
10 to 20 years	**CU480010**	Garrard Road	600 mm diameter circular CSP culvert	Raise intersection 300 mm and install twin 1200 mm diameter circular CSP culverts	$210,000	Schedule B
	CU480013	Garrard Road	400 mm diameter circular CSP culvert	Raise intersection 300 mm and install triple 1030 mm span x 740 mm rise CSP arch culverts	$200,000	Schedule B
	CU480017, AC20 & AC21	Conlin Road	CU480017: Twin 1050 mm diameter circular CSP culverts	Replace CU480017 with twin 3500 mm x 1000 mm concrete box culverts.	$980,000	Schedule B
			AC20: Twin 1050 mm diameter circular CSP culverts	Maintain existing AC20 relief culverts.		No proposed works at AC20.
			AC21: Twin 1050 mm diameter circular CSP culvert	Maintain existing AC21 relief culverts.		No proposed works at AC20.
To be Determined	**CU_B04_04**	Anderson Street	3080 mm span x 1510 mm rise concrete box culvert	The downstream Rossland Road East crossing is undersized and back floods the Anderson Street culvert. The Town should consult with the Region of Durham to determine opportunities to upsize the Rossland Road East crossing before developing design alternatives for the Anderson Street culvert.		Separate Schedule B EA required following further consultation with Region.
	CU_D01_03	Watson Street West	Twin 1800 mm span x 1200 mm rise concrete box culvert	Adding two 1800 mm span x 1200 mm rise concrete box culverts (total of four box culverts) prevents the road overtopping for the design flow. The Rowe Channel will need to be widened to accommodate the culverts which requires property acquisition and relocation of two storm sewer outfalls The Town needs to complete detailed investigations to determine the feasibility of widening the Rowe Channel considering the existing site constraints.		Separate Schedule B EA required following completion of additional site specific investigations.

1.4 Implementation and Next Steps

Before implementation of the preferred alternatives, capital funding will be required. This will be a major factor dictating the implementation schedule of the prioritization list. Based on the allocation of capital budget towards culvert and bridge replacements, implementation at the relevant crossings can commence. This will include detailed design, permitting and construction. Design and permitting for culvert and bridge replacements typically takes 8 to 12 months.

The construction timing window for in-water works will be dependant on fish species present and consultation with CLOCA, the Ministry of Natural Resources and Forestry (MNRF) and the Department of Fisheries and Oceans (DFO). Construction for culvert and bridge replacements typically occurs between July 15 and September 30, outside the breeding bird sensitive timing window and the spring and fall fish spawning periods.

Detailed design will include the following items:

- Design of the crossings based on structural design criteria, hydraulic capacity (including update of hydrology modeling to account for future stormwater management), meander belt and fluvial processes considerations, fish and wildlife passage including Species-at-Risk, slope stability, soil quality, groundwater conditions, and presence of wetlands;
- Completion of terrestrial and aquatic investigations to define baseline natural heritage conditions, identify Species-at-Risk, support permitting and approvals and determine construction timing and mitigation strategies;
- A geotechnical assessment should be conducted by a geotechnical engineer to evaluate the potential structural damage due to settlement from any potential construction dewatering (including the effects of the water taking on surrounding structures and any railroads within the zone of influence of the projects), regarding potential basal heaving during construction, and identifying anything required related to the monitoring and mitigation plan.
- The impact of construction water-taking should be assessed, and a comprehensive discharge, monitoring, maintenance and mitigation plan should be developed to prevent any undesirable potential impacts to groundwater or surface water features and users.
- The impact on any designated source protection areas under the influence of each project's construction activities should be assessed. Any applicable policies of the relevant source protection plan shall be adhered to.
- The MECP has commenced a remediation project in Pringle Creek upstream from Whitby Harbour. The Watson Street East Bridge (BR_D07_06) is in the direct local area of the Ministry's work. The Town will contact the MECP Central Region Office when the Town commences EA work related to this bridge and identify that this crossing is located in the vicinity of the MECP's Pringle Creek Remediation work. The federal Department of Fisheries and Oceans will also be notified when this EA and design work commences as they have long term ongoing work related to contamination in Whitby Harbour.
- MECP Species at Risk permitting which could include a net benefit permit;
- DFO Request for Review;
- CLOCA permits and approvals;
- Stage 1 and 2 Archaeological Assessments;
- Cultural Heritage Impact Assessment; and,
- Ongoing consultation with the Alderville First Nation, Curve Lake First Nation, and other Indigenous Communities prior to Stage 1 and 2 Archaeological Assessments and during the detailed design phase.

1.5 Consultation

As part of the Municipal Class EA planning process, the following steps were undertaken to inform stakeholders, study area residents, review agencies and Indigenous communities about the project, and to solicit comments at key stages of the study process:

- Publication of newspaper notices for all project milestones, including Notices of Study Commencement, Public Information Centre (PIC), and Study Completion.
- Direct correspondence with agencies and Indigenous communities via email.
- Placement of notices, PIC material and reports on the Town of Whitby's website.
- A PIC / Open House to obtain input from the public, review agencies, and stakeholders.

1.6 Conclusion and Recommendations

This Master Plan and Municipal Class EA covers the process required to ensure that the culvert and bridge study and proposed replacement works meet the requirements of the Environmental Assessment Act. The goal

of the Master Plan is to develop a set of feasible design alternatives for the Town owned watercourse crossings that are at high risk of failure due to flooding. Using a risk assessment based approach the study identified 12 crossings that are significantly undersized with a high likelihood of road flooding and are located on high traffic volume roads (arterial roads), where flooding and failure (e.g. road washout) would have significant potential consequences.

The preferred solution is comprised of a set of preferred design alternatives that include replacement of, improvements to, or further studies for the 12 crossings. A preliminary screening of the preferred alternatives found that any significant impacts to the environment can be addressed by incorporating established mitigation measures during detailed design and construction.

Based on the Class EA and the above conclusions, it is recommended that:

1. Following the Master Plan documentation filing and clearance, and the Town securing appropriate funding, the recommended works proceed to the detailed design phase, including approvals and permitting, based on the prioritization list provided in **Table ES-1**.
2. The EA commitments and mitigation measures identified in **Section 12** of this report be implemented during detailed design and construction.

2. Introduction

2.1 Study Purpose and Objectives

Ecosystem Recovery has been engaged by the Town of Whitby (the Town) to complete the Bridge and Culvert Master Plan. The Master Plan is being undertaken to address Municipal Class EA Schedule B projects in accordance with the Ontario Municipal Engineers Association (MEA) Municipal Class EA document (October 2000 as recently amended in 2015), which is approved under the Ontario *Environmental Assessment Act (EAA)*.

The Town owns more than 2000 water crossing structures along creeks and ditches which include 49 bridges and culverts with a span greater than 3 m, 103 culverts with a span less than 3 m, and approximately 1900 driveway culverts. In 2017, the Town experienced catastrophic failure at several culvert crossings underneath municipal roadways resulting in road failure and extended road closure. The failures were generally attributable to poor culvert condition and undersized hydraulic capacity.

The Town requires a road map to prioritize future culvert and bridge replacement capital works to proactively address high flood risk crossings. The purpose of the project is to provide a comprehensive and environmentally sound planning process, which is open to public participation, to select the preferred solution to replace and upsize high flood risk crossings. Study objectives include:

- Undertake hydrology and hydraulic analysis at culverts and bridges to determine compliance with the Town of Whitby and Ministry of Transportation design standards;
- Prioritize replacement of the highest risk crossings using a risk assessment approach;
- Engage with relevant stakeholders and the public to identify concerns at crossings within the Town of Whitby;
- Identify a range of design alternatives at each of the highest risk crossings to reduce flood risk and address concerns raised during the planning process;
- Identify measures needed to mitigate impacts associated with the preferred alternative; and
- Document the study process in compliance with Phase 1 and 2 of the Municipal Class EA Schedule ‘B’ planning process.

Additionally, the project will ensure the preferred alternative is selected based on the following considerations:

- Future land use changes, consistent with the Town’s Official Plan, and expected future growth and development;
- Climate change projections and related impacts on future rainfall events; and
- Integrated risk assessment which considers flooding in conjunction with impact and vulnerability factors.

2.2 Study Area

The study area is defined by the Town of Whitby boundary and includes all cross culverts, culverts and bridges owned by the Town. The study area includes the Lynde Creek, Pringle Creek, Corbett Creek watersheds which fall under the jurisdiction of the Central Lake Ontario Conservation Authority (CLOCA). **Figure 2-1** presents the study area and relevant points of interest including the crossing locations, major watercourses and watersheds.

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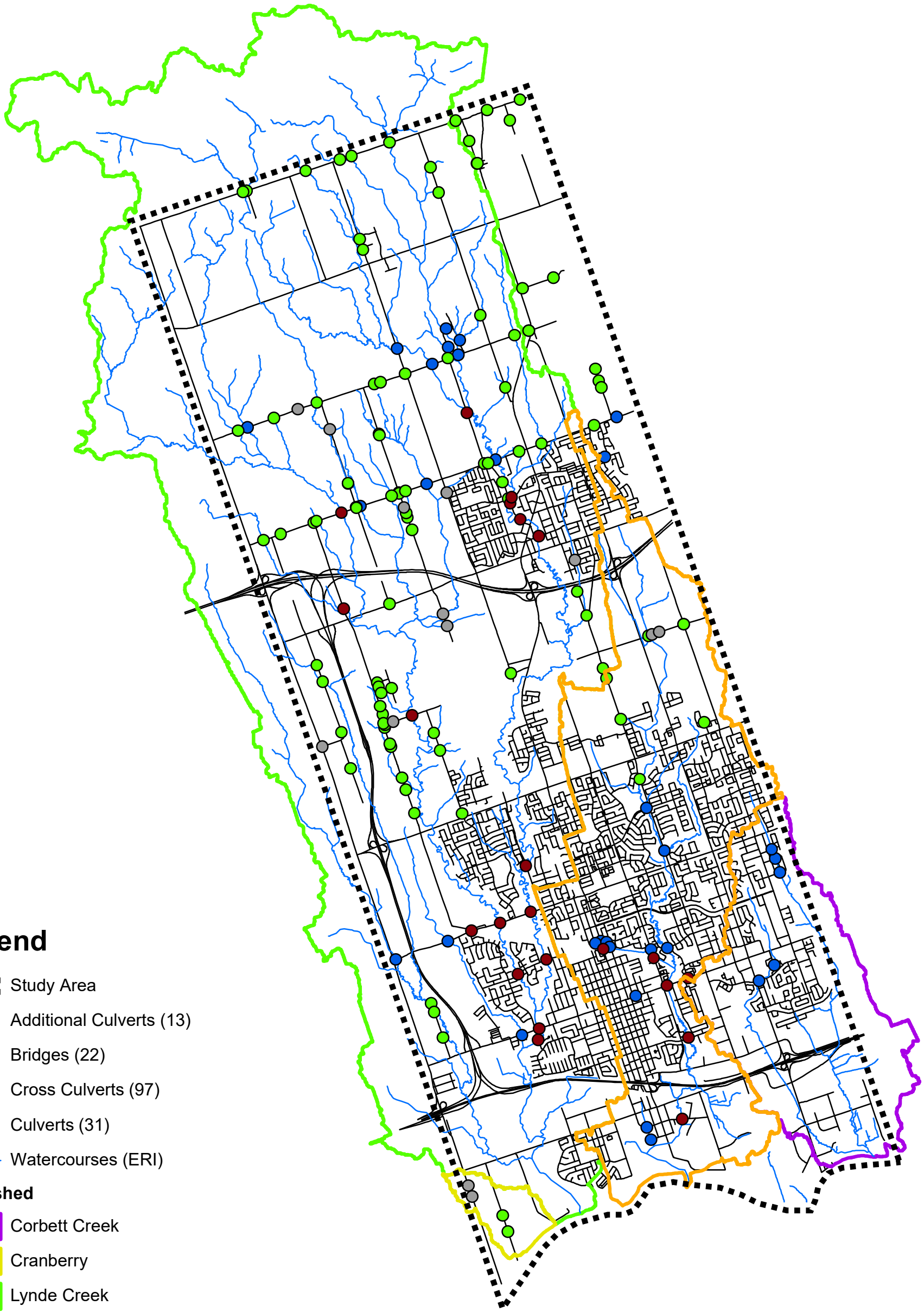

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- Study Area
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Whitby Bridge and Culvert Master Plan

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Figure 2-1
Study Area

0 1.25 2.5 5 Kilometers

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1:75,000

Project: 1837 Whitby Bridge/ Culvert Master Plan
Date: 2020/03/11

N W E S

Data Sources: Ecosystem Recovery Inc., 2020:
Contains data provided by the Town of Whitby
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Contains public sector information made available under The Regional Municipality of Durham's Open Data License.

2.3 Municipal Class Environmental Assessment Process

This Bridge and Culvert Master Plan is being conducted in accordance with the requirements for Master Plans under Section A.2.7 of the Municipal Engineers Association Municipal Class Environmental Assessment Act (October 2000, as amended in 2007 and 2011). The Master Plan approach recognizes the importance of planning a group of related projects as part of an overall system. This helps define the justification and context of individual projects with respect to the larger system in order to meet the needs of the community.

The Municipal Class EA process defines four approaches for undertaking a Master Plan. This Master Plan is being undertaken in accordance with Approach #2 which requires the preparation of a Master Plan upon completion of Phases 1 and 2 of the EA process where the level of investigation, consultation and documentation are sufficient to fulfil the requirements of Schedule B projects.

The Municipal Class EA process defines four types of projects (referred to as Schedule A, A+, B, or C), classified based on the anticipated level of environmental impact, and for some projects, the anticipated construction costs. The Municipal Class EA Companion Guide (2018) provides guidance on which schedule should be applied to certain infrastructure works.

Based on the companion guide the following schedules may apply to projects recommended in this Master Plan:

- **Schedule A**:
  - Culvert repair and replacement where the capacity of the culvert is not increased beyond the minimum municipal standard or the capacity required to adequately drain the area, whichever is greater, and where there is no change in drainage area; and
  - Reconstruction of a water crossing where the reconstructed facility will be for the same purpose, use, capacity (hydraulic or road capacity) and at the same location.
- **Schedule A+**:
  - Construction of a new culvert or increase culvert size due to change in the drainage area.
- **Schedule B**:
  - Reconstruction of a water crossing where the reconstructed facility will not be for the same purpose, use, capacity (hydraulic or road capacity) or at the same location and the estimated construction cost is less than 2.6 Million Dollars.
- **Schedule C**:
  - Reconstruction of a water crossing where the reconstructed facility will not be for the same purpose, use, capacity (hydraulic or road capacity) or at the same location and the estimated construction cost is greater than 2.6 Million Dollars.

The EA process follows a set of mandatory steps set out under five phases (Phases 1 to 5) to ensure a consistent and defensible approach is applied. Schedule B projects must complete Phase 1 and 2 of the EA process, including mandatory public consultation and documentation, before moving to Phase 5 (Implementation). The Master Plan Report documents the planning process undertaken through Phases 1 and 2 including identification of the preferred solution. The Report is then made available for public and agency review and comment. If during the review process outstanding concerns regarding potential adverse impacts to constitutionally protected Aboriginal treaty rights, a Part II Order may be requested to the Minister of the Environment Conservation and Parks (MECP, formerly MOECC). The phases relevant to Schedule B projects are presented in **Figure 2-2**.

Typically, Master Plan Reports are revisited on a 5 to 10 year basis to ensure that conditions with respect to the social, economic, and natural environments are consistent with the evaluation in the Master Plan. If conditions have changed sufficiently to prevent implementation of the preferred alternative, an addendum to the Master Plan may be prepared for a specific project.

Section A.4.3. of the Municipal Engineers Association Municipal Class Environmental Assessment Act identifies that a Lapse of Time of 10 years or greater between the filing of Master Plan and implementation of the project

would trigger a review of the planning and design process, as well as current conditions, to ensure that the Environmental Assessment is still valid.

2.3.1 Public Review of this Report and Next Steps

This Master Plan report is available for public review and comment for a 39 calendar day period starting on December 24, 2020 and ending on January 31, 2021. Placing the Master Plan report for public review completes the planning stage of the project. A public notice (Notice of Completion) was published to announce commencement of the review period. Due to the COVID-19 restrictions and closure of public facilities, hard copies of the Master Plan report will not be available at the Town of Whitby offices.

If, after reviewing this report, you have questions or concerns regarding specific projects recommended through the Master Plan, please follow this procedure:

1. Contact Mr. Antony Manoharan at the address below to discuss your questions or concerns:

   Antony Manoharan, P. Eng.
   Water Resources Project Manager
   Town of Whitby
   3050 Garden Street, #102
   Whitby, Ontario L1R 2G6
   Telephone: 905.430.4307 ext. 4925
   Email: manoharana@whitby.ca

2. If your concerns remain, the Town of Whitby will attempt to resolve the concerns as best it can. If there are outstanding concerns regarding potential adverse impacts to constitutionally protected Aboriginal treaty rights, you may request the Minister of the Environment, Conservation and Parks (MECP), formerly MOECC, to issue an order requiring the Municipality to comply with Part II of the *EAA* before proceeding with the specific projects associated with the issue(s). This is called a Part II Order request.

   The Part II Order request process only applies to Schedule B projects in this Master Plan and is specific to the Schedule B project or projects associated with the outstanding concerns; the Town of Whitby may proceed with other projects recommended in this report that are not associated with the outstanding concerns.

   A Part II Order may only be requested if there are outstanding concerns that a project may adversely impact constitutionally protected Aboriginal and treaty rights.

   In addition, the Minister may issue an order on his or her own initiative within a specified time period. The Director will issue a Notice of Proposed Order to the proponent if the Minister is considering an order for the project within 30 days after the conclusion of the comment period on the Notice of Completion. At this time, the Director may request additional information from the proponent. Once the requested information has been received, the Minister will have 30 days within which to make a decision or impose conditions on your project.

   This means the Municipality cannot proceed with the project until at least 30 days after the end of the comment period provided for in the Notice of Completion. Further, the proponent may not proceed after this time if:
   - a Part II Order request has been submitted to the Ministry regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, or
   - the Director has issued a Notice of Proposed Order regarding the project.

3. After reviewing the Part II Order request and the relevant project detail, the Minister may make one of the following decisions:

    - Deny the request;
    - Deny the request with conditions;
    - Refer the matter to mediation; or
    - Issue a Part II Order whereby the Municipality will be required to prepare a Terms of Reference and a project-specific EA for the undertaking.

    Part II Order requests regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights must be submitted in writing to the Minister of the Environment, Conservation and Parks. The request must be sent to the following address within the 30-day review period:

    Minister Jeff Yurek
    Ministry of the Environment, Conservation and Parks
    777 Bay Street, 5th Floor
    Toronto, ON M7A 2J3
    minister.mecp@ontario.ca

    and

    Director, Environmental Assessment Branch
    Ministry of the Environment, Conservation and Parks
    135 St. Clair Avenue West, 1st Floor
    Toronto, ON M4V 1P5
    EABDirector@ontario.ca

If no Part II Order requests are received, the Municipality may proceed with detailed design and construction of the recommended projects as presented in this report.

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. All comments, with the exception of personal information, will become part of the public record.

2.4 Project Team

The project team for the Master Plan is presented in **Table 2-1**.

Table 2-1. Project Team.

Town of Whitby	Ecosystem Recovery Inc.
• Antony Manoharan, P.Eng. (Project Manager) • Gautam Singh, P.Eng. • Heamapriyan Tharumaratinam	• Jeff Prince, P.Eng, Project Manager • Adam Spargo, B.Sc, Water Resources Specialist • Brent Smolarz, E.I.T., Water Resources Engineering Intern • Jake Carman, E.I.T., Water Resources Engineering Intern

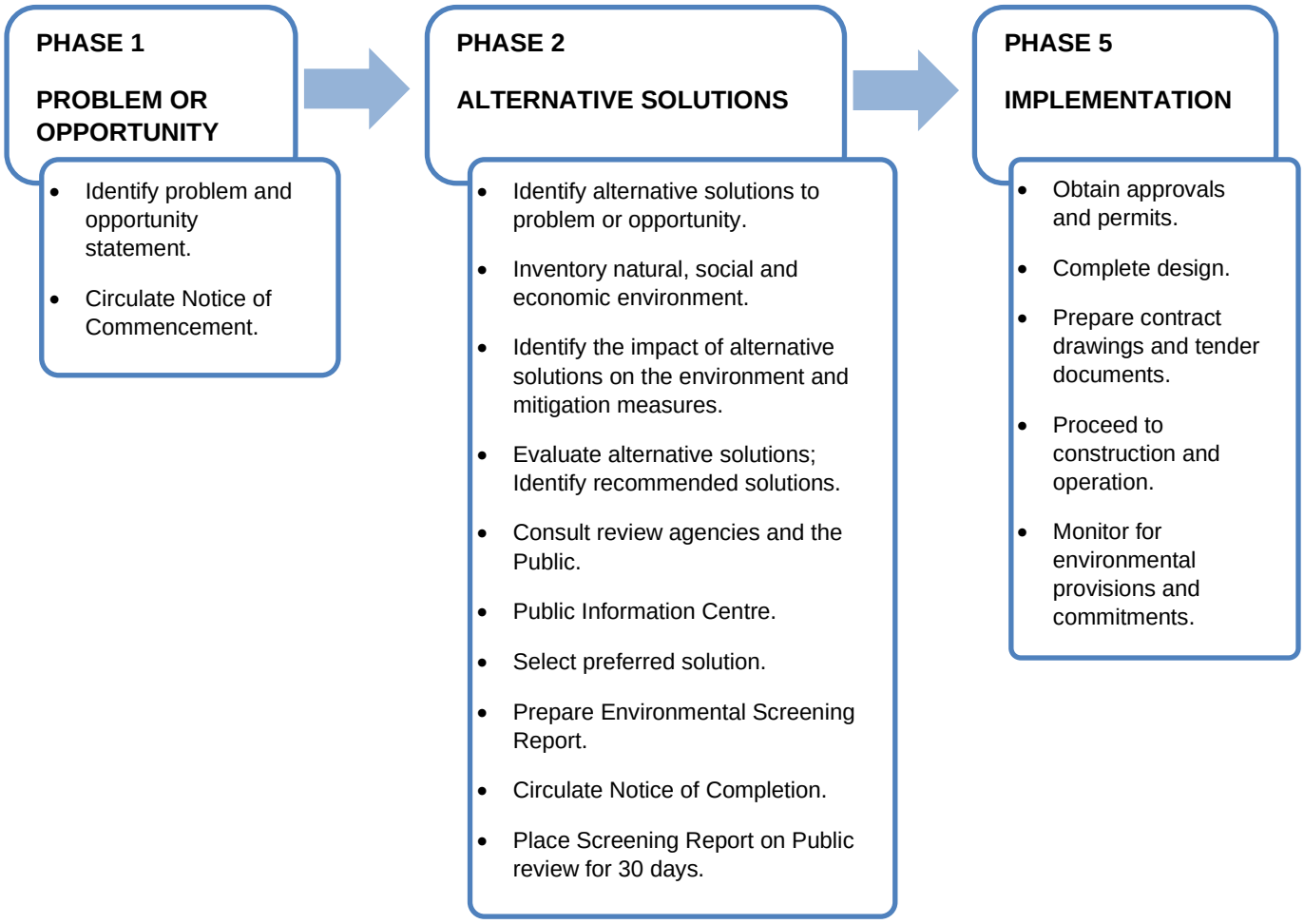

Figure 2-2. Municipal Class Environmental Assessment Planning and Design Process for Schedule B Projects (modified from MEA, 2007).

2.5 Problem Statement

Phase 1 of the Municipal Class EA planning process requires the proponent (i.e. the Town of Whitby) to first document factors leading to the conclusion that the improvement is needed, and to develop a clear statement of the identified problems or opportunities to be investigated. As such, the Problem / Opportunity Statement is the principle starting point in the undertaking of a Municipal Class EA and becomes the central theme and integrating element of the Project. The following Problem / Opportunity statement has been developed for this Master Plan:

> In 2017, the Town of Whitby experienced catastrophic failure at several culvert crossings underneath municipal roadways resulting in road failure and extended road closures. The failures were generally attributable to poor culvert condition and undersized hydraulic capacity. The Town owns more than 2000 water crossing structures along creeks and ditches which include 22 bridges, 28 structural culverts, 101 cross culverts, and approximately 1900 driveway culverts. To proactively manage this large infrastructure inventory, the Town requires a road map to prioritize future culvert and bridge replacement capital works at high flood risk crossings. The identification of high flood risk crossings must be informed by detailed hydrology and hydraulic assessment that can identify crossings with a high likelihood of flooding that presents a significant consequence to the environment and the public.

3. Background

This section provides a summary of relevant background studies that have informed the Master Plan process. A map showing the crossings that were included in background studies is provided in **Figure 3-1**.

3.1 Previous Studies

3.1.1 Pringle Creek Master Drainage Plan – 2018

Overview

The Pringle Creek Master Drainage Plan Update (February 2018) was completed for the Town of Whitby in partnership with CLOCA by Candevcon Ltd. The Master Drainage Plan Update represents an update to the previous Master Drainage Plan Update undertaken in 1999 for the Pringle Creek subwatershed. The original Master Drainage Plan was completed in 1989.

The Master Drainage Plan Update included detailed hydrology modeling of existing and future conditions, hydraulic modeling of Pringle Creek and its tributaries, and assessment of existing and future fluvial geomorphology and stream erosion issues. Water resources targets were reviewed and updated to alleviate existing problems associated with flooding, erosion, and stormwater quality, and to minimize the potential for new problems associated with future land use change. The recommendations of the Master Drainage Plan Update address flood hazard, water quality, natural feature restoration and enhancement, and stormwater management. The Master Drainage Plan recommends upsizing at 12 hydraulic structures for flood hazard management. These recommendations are presented in **Table 3-1**.

Table 3-1. Pringle Creek Master Drainage Plan Watercourse Crossing Replacement Recommendations.

Asset ID	Location	Ownership
N/A	Thickson Road (Main Branch)	Region of Durham
CU_B04_03	Dryden Boulevard (Main Branch)	Town of Whitby
CU_C09_06	Bradley Drive (Main Branch)	Town of Whitby
BR_D07_03	Dundas Street East (Main Branch)	Town of Whitby
N/A	Victoria Street (Main Branch)	Region of Durham
N/A	Thickson Road (East Tributary)	Region of Durham
CU360001	Anderson Street (Main Branch)	Town of Whitby
BR_D07_05	Burns Street (Main Branch)	Town of Whitby
N/A	Brock Street (Main Branch)	Region of Durham
N/A	Highway 401 (Main Branch)	Province
N/A	Rossland Road (Main Branch)	Region of Durham
CU480017	Conlin Road (Main Branch)	Town of Whitby

N/A = Not Applicable

Relevance to this Master Plan

The hydrology and hydraulic models developed for the Master Drainage Plan Update have been used to assess the Town owned culverts and bridges within this Master Plan.

3.1.2 Lynde Creek Master Drainage Plan Update – In Progress

Overview

The Lynde Creek Master Drainage Plan is currently in the process of being updated, following from the 1988 Master Drainage Study and 2012 Lynde Creek Watershed Plan. A working draft of the Master Plan Project File Report was available at the time of preparing this Master Plan. The Master Drainage Plan included a review of

road and rail crossings that fail to meet design standards and are at risk of flooding. A total of 11 structures were identified as high priority and recommended for upsizing. The structures are presented in **Table 3-2**.

Table 3-2. Lynde Creek Master Drainage Plan Update High Priority Crossings Upgrade Recommendations.

Asset ID	Location	Ownership	Road Class
	Bryant Side Road (Myrtle Creek)	Town of Scugog	N/A
BR_D07_01	Bell Drive (Lynde Creek)	Town of Whitby	Local Road
	Highway 401 (Lynde Creek)	Province	N/A
CU210001	Halls Road North (Kinsale Creek)	Town of Whitby	Arterial Road
	Victoria Street West (Kinsale Creek)	Region of Durham	N/A
N/A	Sideline 2 (Heber Creek)	Township of Pickering	N/A
	Myrtle Road West (Ashburn Tributary)	Region of Durham	N/A
CU920010	Townline Road West (Ashburn Creek)	Town of Whitby	Collector Road
	Myrtle Road West (Ashburn Creek)	Region of Durham	N/A
CU_A07_01	Ashburn Road (Ashburn Creek)	Town of Whitby	Arterial Road
	Cedarbrook Trail (Ashburn Creek)	Town of Whitby	Local Road

N/A = Not Applicable

Relevance to this Master Plan

The recommended watercourse crossing upgrades have been reviewed against the findings of this Master Plan to ensure consistency between the two studies.

3.1.3 Lynde Creek Watershed Existing Conditions Report – 2008

Overview

The 2008 Existing Conditions Watershed Report was completed by CLOCA as part of the Lynde Creek Master Drainage Plan Update. The watershed plan is intended to examine the health and functionality of the Lynde Creek watershed and ensure future land use planning is undertaken to promote a healthy and sustainable watershed. The report provides the hydrology and hydraulic modeling developed by CLOCA for the Lynde Creek subwatershed.

Relevance to this Master Plan

The hydrology developed for the Watershed Plan has been used to assess Town owned culverts and bridges within this Master Plan.

3.1.4 Lynde Creek Watershed – Floodplain Mapping Report – 2008

Overview

CLOCA commissioned Earth Tech to complete a floodplain mapping update for Lynde Creek watershed. The floodplain mapping update included survey of hydraulic structures, conversion of the existing HEC2 hydraulic model to HEC-RAS, inclusion of revised hydrology modeling, development of georeferenced floodlines and identification of flood vulnerable infrastructure. Recommendations for flood proofing and bridge/culvert replacements were provided to reduce flood risk to vulnerable infrastructure.

Relevance to this Master Plan

The Lynde Creek HEC-RAS model has been used to complete the hydraulic assessment in this Master Plan.

3.1.5 Corbett Creek Master Drainage Plan – In Progress

Overview

The Town of Whitby, in partnership with CLOCA, are currently undertaking a Municipal Class EA study for the preparation of a Master Drainage Plan for the Corbett Creek Watershed. The Master Drainage Plan will provide guidance to the Town of Whitby, CLOCA and the City of Oshawa in the continued management of the Corbett Creek Watershed and stream corridors, with respect to flooding, creek erosion, resources protection and development. Floodplain mapping for the watershed will also be updated as part of the study.

Relevance to this Master Plan

The Corbett Creek Master Drainage Plan includes an update to the existing hydrology and hydraulic modeling for the watershed. The existing modeling has been used in the hydraulic capacity assessment completed in this Master Plan. The findings and recommendations of the Corbett Creek Master Drainage Plan should be reviewed against the findings and recommendations of this Master Plan to ensure consistency across the two studies.

3.1.6 Cross Culvert Inspections Summary Report – 2017

Overview

Visual inspections of 111 cross culverts were performed in 2017. Each culvert was characterized based on factors such as size, span, length, grade, percent filled, and overall condition. In addition, all maintenance requirements, costs and timelines for replacement or repair are provided were identified. Of the 111 culverts, 28 were identified as requiring some form of repair, rehabilitation or replacement. All maintenance requirements were recommended to be completed by the Town within a one year period. The recommendations from the cross culvert inspection report are presented in **Table 3-3**.

Table 3-3. 2017 Cross Culvert Inspections Recommendations (Chisholm, Fleming & Associates, 2017).

Asset ID	Condition Rating	Recommendation	Timing
CU000005	2 (Major damage)	Replace culvert.	Within 1 year
CU420025	5 (Excellent condition)	Add rock protection and support east end.	1 to 5 years
CU420027	5 (Excellent condition)	Provide rock protection, support base of gabions.	Within 1 year
CU420028	1 (Failure or potential failure)	Replace culvert.	1 to 5 years
CU510017	4 (Minor defects)	Replace culvert.	1 to 5 years
CU520025	1 (Failure or potential failure)	Repair or replace.	Within 1 year
CU620004	1 (Failure or potential failure)	Replace culvert.	Within 1 year
CU630003	1 (Failure or potential failure)	Reinstate culvert.	1 to 5 years
CU640013	5 (Excellent condition)	Support west end. Place rock protection.	1 to 5 years
CU640017	4 (Minor defects)	Repair concrete.	1 to 5 years
CU660004	1 (Failure or potential failure)	Remove or reinstate culvert.	1 to 5 years
CU660019	1 (Failure or potential failure)	Replace culvert. Provide slope protection at east end.	1 to 5 years
CU670001	4 (Minor defects)	Repair 2 m^2 concrete in old section. Repair gabions.	1 to 5 years
CU680003	3 (Moderate defects)	Concrete repairs 3 m^2.	1 to 5 years
CU750001	3 (Moderate defects)	Repair east end.	1 to 5 years
CU780010	3 (Moderate defects)	Repair gabion retaining wall. Repair shoulder, install guide rail.	Within 1 year
CU780011	4 (Minor defects)	Repair both ends.	1 to 5 years
CU780012	3 (Moderate defects)	Install guide rail.	Within 1 year
CU810005	2 (Major damage)	Replace culvert.	6 to 10 years
CU820006	5 (Excellent condition)	Repair undercutting. Provide rock protection at outlet.	6 to 10 years
CU850011	5 (Excellent condition)	Place rock protection at south west end to prevent erosion.	1 to 5 years

Asset ID	Condition Rating	Recommendation	Timing
CU870006	2 (Major damage)	Place rock protection and support undercut ends. Replace culvert.	1 to 5 years
CU950022	2 (Major damage)	Replace culvert.	6 to 10 years
CU960013	1 (Failure or potential failure)	Replace 5m at both ends.	Within 1 year
CU960014	3 (Moderate defects)	Replace culvert.	6 to 10 years
CU980002	2 (Major damage)	Replace culvert.	1 to 5 years
CU990010	3 (Moderate defects)	Replace south end.	6 to 10 years
CU210001	4 (Minor defects)	Provide rock protection downstream repair scour pool.	1 to 5 years

Relevance to this Master Plan

The condition of cross-culverts has been considered in developing the prioritization of future works to address flood risk.

3.1.7 Municipal Structure Inspection Report (OSIM) – 2018

Overview

A detailed visual inspection of bridge and culvert structures within the Town of Whitby was undertaken in accordance with the Ontario Structure Inspection Manual (OSIM). The purpose of the report is to ensure that structures remain at an acceptable level of safety, which includes the identification of maintenance and replacement timelines for bridge and culvert structures. The report identified 22 bridges and culverts for replacement or rehabilitation within the next 10 years (2018 to 2028).

Relevance to this Master Plan

The OSIM recommendations have been considered in this Master Plan when developing the prioritization list for future works.

3.1.8 Fluvial Geomorphic and Drainage Preliminary Risk Assessment of 3m or Wider Water Crossing Structures – 2012

Overview

A preliminary risk assessment of water crossing structures with a span of 3 m or greater within the Town's Urban Boundary was undertaken (39 crossings in total), with the intent of developing a rehabilitation and maintenance program for the watercourse crossings. The study also included a risk assessment for hydraulic performance and flooding, as well as erosion and scour risks, based on the Town of Whitby and the Ontario Ministry of Transportation (MTO) standards. The assessment identified several crossings as high flood risk with respect to depth and severity. The report provided a combined ranking system based on fluvial and drainage components of the risk assessments, which recommended hydraulic improvements at the top 10 priority sites within a 5 year timeframe. The top 10 priority sites are presented in **Table 3-4**.

Table 3-4. 2012 Fluvial Geomorphic and Drainage Preliminary Risk Assessment (Chisholm, Fleming & Associates, 2017).

Priority Scoring	Asset ID	Road Name	Road Class	Watercourse
1	BR_D07_03	Dundas Street East	Arterial	Pringle Creek
2	CU_09_09	Forest Road	Local	Corbett Creek – East branch
3	BR_D07_02	Dundas Street West	Arterial	Lynde Creek
4	CU_C09_06	Bradley Drive	Collector	Pringle Creek
5	BR_A08_01	Cedarbrook Trail	Local	Ashburn Creek
6	CU_A07_01	Ashburn Road	Arterial	Ashburn Creek

Priority Scoring	Asset ID	Road Name	Road Class	Watercourse
7	CU_09_08	Westwood Road	Local	Corbett Creek – East branch
8	CU_A07_03	Brawley Road West	Arterial	Ashburn Creek
9	BR_D07_06	Watson Street East	Arterial	Pringle Creek
10	BR_D07_01	Jeffery Street	Local	Lynde Creek

Relevance to this Master Plan

The recommendations from the 2012 study have been reviewed against the findings of this Master Plan to assist in prioritizing replacement and upsizing works.

3.1.9 Other Studies

Other relevant studies reviewed to support this Master Plan include:

- CLOCA Technical Guidelines for Stormwater Management Submissions (2010);
- CLOCA Flood Damage Centres Upgrading (2017);
- CLOCA Lynde Creek Watershed Plan (2012);
- CLOCA Watershed Flood-Risk Assessment (2017);
- MTO Provincial Engineering Memorandum #2016-14 – Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Infrastructure (2016);
- Natural Resources Canada (NRCAN) Case Studies on Climate Change in Floodplain Mapping Volume 1 (2018); and,
- Public Safety Canada, National Disaster Mitigation Program – Risk Assessment Information Template.

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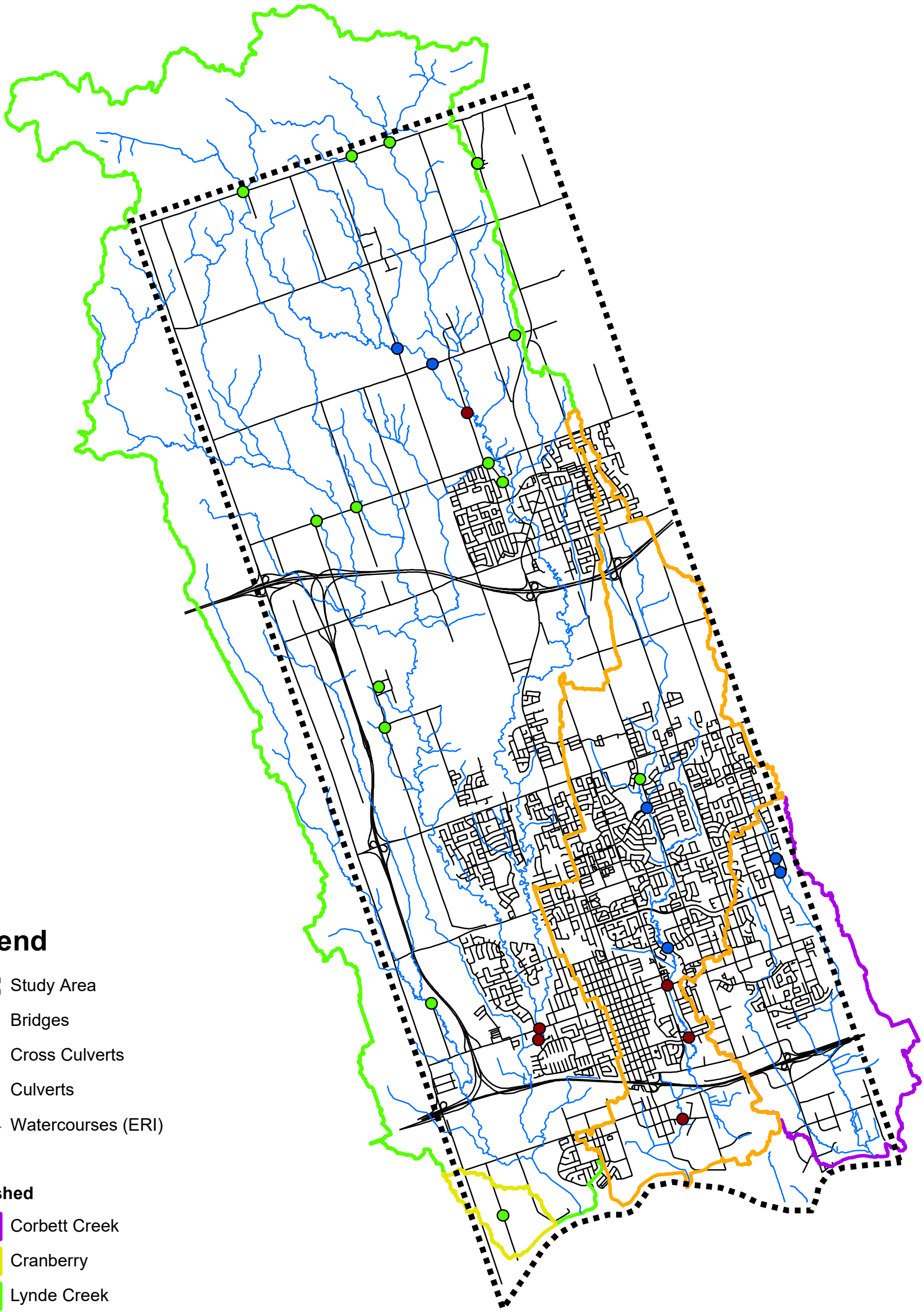

Legend

- Study Area
- Bridges
- Cross Culverts
- Culverts
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

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Figure 3-1

Crossing Replacements Identified in Background Studies

0 1.25 2.5 5 Kilometers

NAD 1983 UTM 17

1:75,000

Project: 1837 Whitby Bridge/ Culvert Master Plan
Date: 2020/03/11

N W E S

Data Sources: Ecosystem Recovery Inc., 2020:
Contains data provided by the Town of Whitby
Contains data licensed under CLOCA Standard Data License v1.0
Contains public sector information made available under The Regional Municipality of Durham's Open Data License.

4. Existing Environment

The description of the existing environment has been developed through a review of available background information.

4.1 Socio-Economic Environment

4.1.1 Existing and Future Land Use

Land use within the Town of Whitby is generally split around Highway 407 with agricultural land and the Community of Brooklin north of Highway 407 and residential and commercial / industrial land use south of Highway 407. Open space and forested areas are generally found in conservation areas and along the creek valley corridors. The Town of Whitby Official Plan (OP) land use is presented in **Figure 4-1**. The policies and designations of the OP direct development expected to occur in the Municipality to 2031 (Whitby, 2018). The OP includes an expansion of the Urban Area to direct 45 % of new residential development and redevelopment to the Central Areas. This includes an expansion to the Brooklin growth boundary. One of the main drivers for increased flood risk at culvert and bridge crossings is the increase in runoff generated by expansion of impervious areas associated with urban development (residential, commercial, and industrial land use). Therefore, culverts and bridges in the Central Area of Whitby will be most susceptible to increased flood risk.

The future land use has been used in the hydrology and hydraulic modeling. Provincial legislation requires new development to provide water quality control through stormwater management to prevent flooding in receiving watercourses. Water quality control guidelines require no increase in the 2-year to 100-year return period peak flows. These same return period flows are used to size culverts and bridges to meet the design standards (refer to **Section 5.0** for design standards). The hydrology and hydraulic analysis presented in Section 8 does not account for stormwater management controls at culverts located on unregulated watercourse (that is, watercourses not included in existing CLOCA hydraulic modeling). This produces a more conservative estimate of flood risk at unregulated culverts. We recommend that during detailed design for unregulated culverts recommended as Highest Priority in **Section 8.3,** hydrology modeling be updated to account for future stormwater management, as appropriate.

4.2 Archaeological and Cultural Heritage

4.2.1 Archaeology

There is a high potential for archaeological resources, especially Indigenous resources, to occur near watercourses and watercourse crossings. However, because the Study Area encompasses the entire Town of Whitby and not just the watercourse crossings project areas, a Stage 1 Archaeological Assessment for the Study Area has not been completed to support the Master Plan report. Instead, the Stage 1 Archaeological Assessment for each crossing recommended for replacement under this Master Plan will be completed during detailed design (prior to ground disturbance) once the project area has been defined and Archaeological potential within the project area can be determined. If a Stage 1 Archaeological Assessment identifies potential for archaeological resources to be present within the project area, a Stage 2 Archaeological Assessment (and further archaeological assessment, if recommended by the Stage 2 report) will also be undertaken during detailed design and prior to ground disturbance.

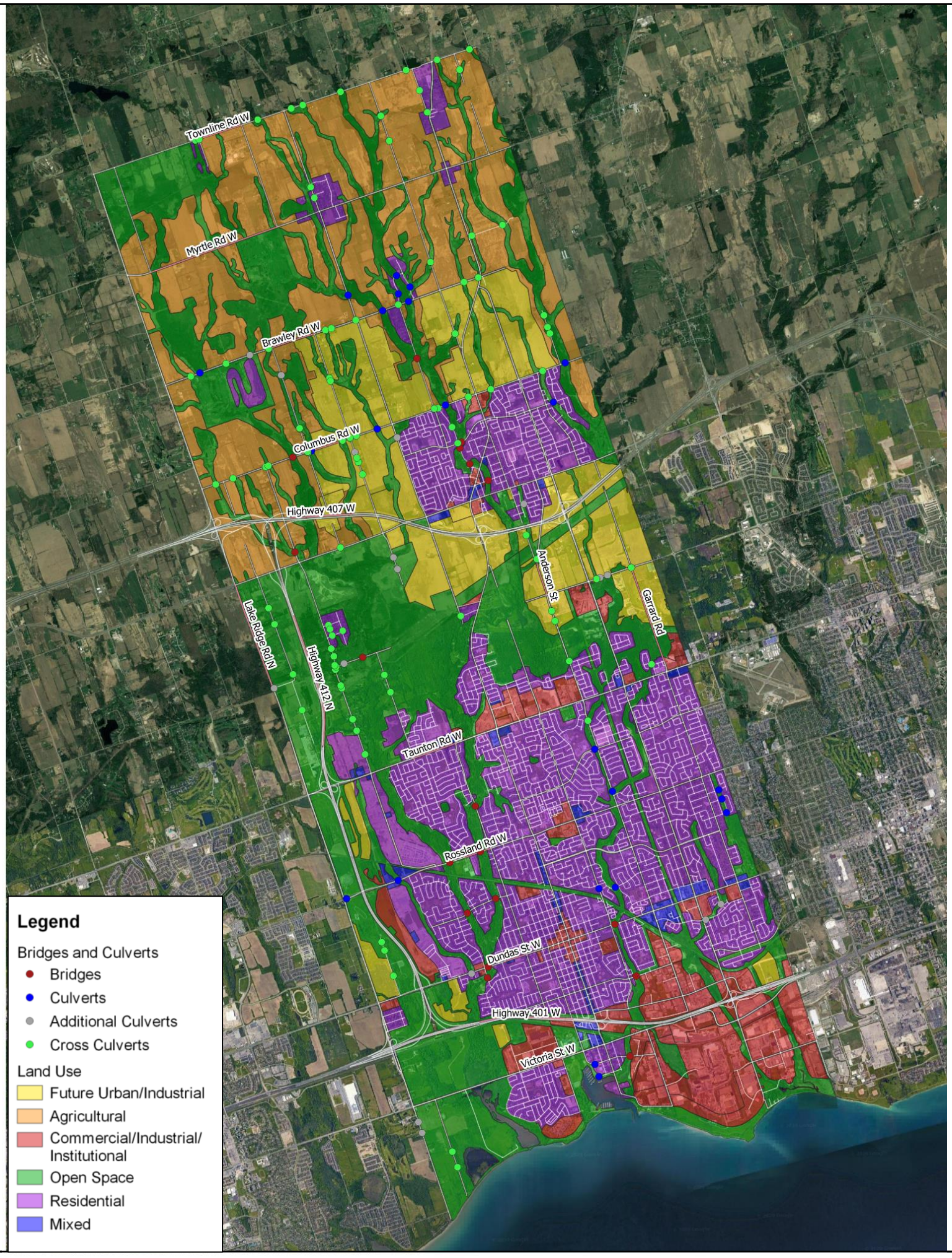

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Figure 4-1
Official Plan Land Use Types

0 1600 3200 m

NAD 1983 UTM 17N

1:65,000

Project: 1837 Whitby Bridge/Culvert Master Plan
Date: 2020/04/24

N W E S

Data Sources
Land Use Types: Town of Whitby
Roads: Town of Whitby
Aerial Image: Google Satellite

4.2.2 Cultural and Built Heritage

A cultural landscape is generally considered as a collection of individual built heritage features and other related features that together form a broader complex. Built heritage features are typically individual buildings or structures, such as bridges, associated with a variety of human activities, such as historical settlement and patterns of architectural development.

Heritage Districts

Brooklin Village Heritage Conservation District

The Brooklin Village Heritage Conservation District spans an area roughly bound by Montgomery Avenue to the west, Queen Street to the east, Carnwith Drive West to the north, and Winchester Road East to the south. This rural area was first settled by European pioneers in the 1820s. The establishment of a flour mill in the 1840s spurred further development, and the town was officially renamed Brooklin in 1847. Today, this district is surrounded by newly built subdivisions. However, the essential elements of the old village core remain largely intact.

The main heritage features within the town of Brooklin include Baldwin Street (the commercial main street), landmark buildings, and the characteristic large green spaces between buildings that allow for views of Lynde Creek and forested areas (streetscape porosity). The heritage homes in this district are a mix of wood frame and brick masonry construction, built in various traditional mid-nineteenth to mid-twentieth century styles. They are mainly single detached homes with a green forecourt, placed on uniquely shaped lots due to diagonal street alignment within the town. Many of these heritage homes are concentrated on Baldwin Street, Cassels Road, Winchester Road East and Princess Street.

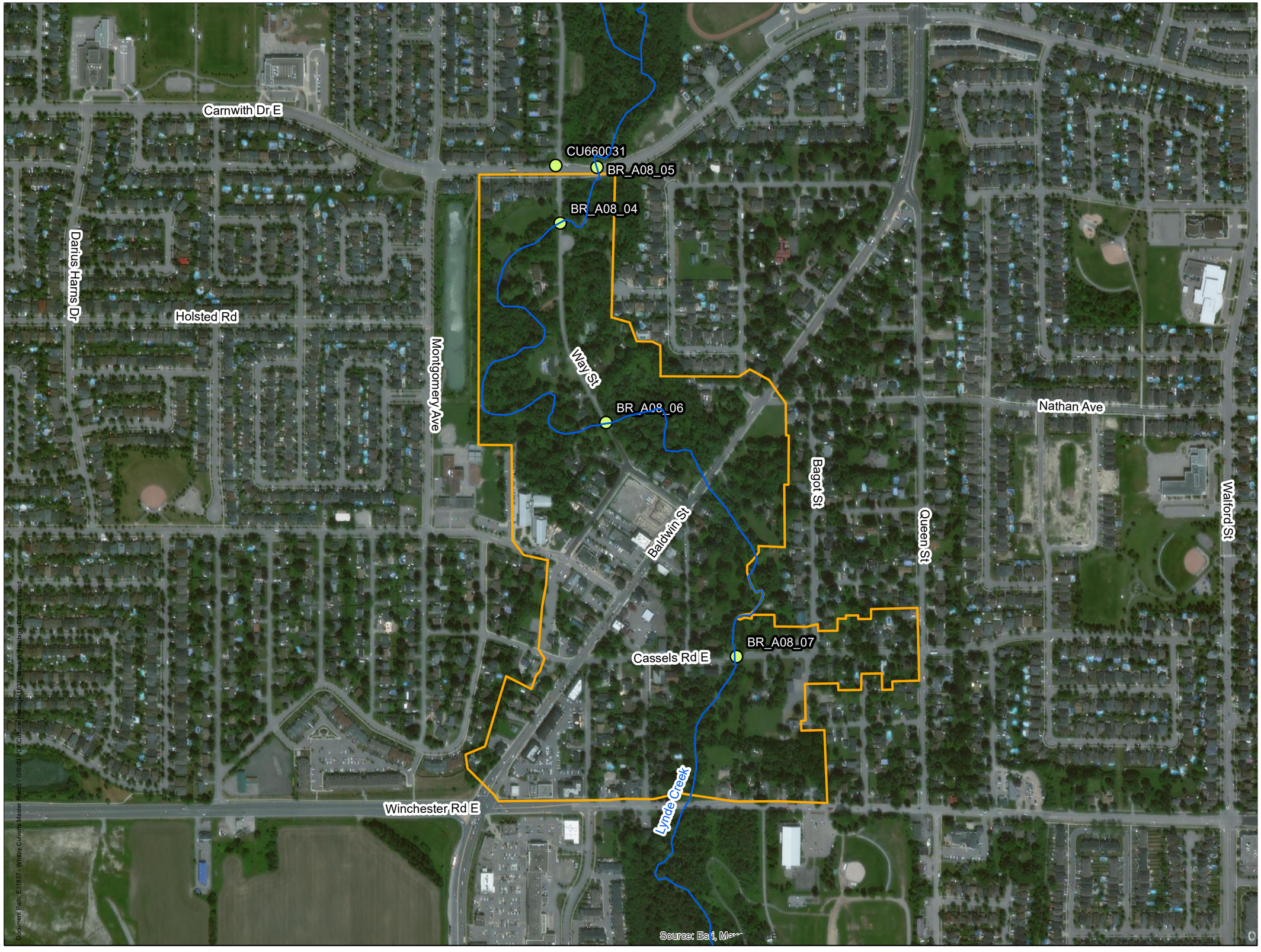
The Brooklin Village Heritage Conservation District boundary is shown in **Figure 4-2** along with Town of Whitby owned crossings.

Werden's Plan Neighbourhood Heritage Conservation District

The Werden's Plan Neighbourhood Heritage Conservation District (WPNHCD) is roughly bound by Henry St to the west, Brock St S to the east, Dundas St W to the north and James St to the south. This area was first surveyed into 200-acre farm lots in 1795. Asa Werden, a businessman and pioneer, purchased a 200-acre lot south of Dundas St. in 1821 and commissioned a subdivision plan for these lands in 1854. The resulting subdivision contained 64 uniform full blocks and 8 half blocks. Real estate speculation and a drop in demand for grain led to a stall in development in the Whitby township between the 1850s and the mid mid-twentieth century. As a result, many of the heritage homes first erected in the mid-nineteenth century were preserved within the district. The WPNHCD contains the most historical residential streetscapes in downtown Whitby. In 2019, the WPNHCD plan was adopted to preserve the small-town character of the neighborhood.

Most of the buildings within this district are single family detached houses. These homes span a diverse variety of sizes and architectural styles from the mid-nineteenth century onwards. This diversity showcases a social mixing dynamic characteristic of small towns. Many of the heritage houses are situated within a large green envelope consisting of spacious front and side yards and a deeper backyard, supporting many mature trees and shrubs. Gable or hip roofs, red brick, as well as open or enclosed porches are common features of these heritage homes. Other historical buildings within this district include the Ontario County Courthouse, the Methodist Tabernacle, and the Ontario County Registry office.

The Werden's Plan Neighbourhood Heritage Conservation District boundary is shown in **Figure 4-3** along with Town of Whitby owned crossings.



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Whitby Bridge and Culvert Master Plan

Figure 4-2
Brooklin Heritage Conservation District Culverts

Legend

- Watercourse Crossing
- Watercourse
- Brooklin Heritage Conservation District Boundary

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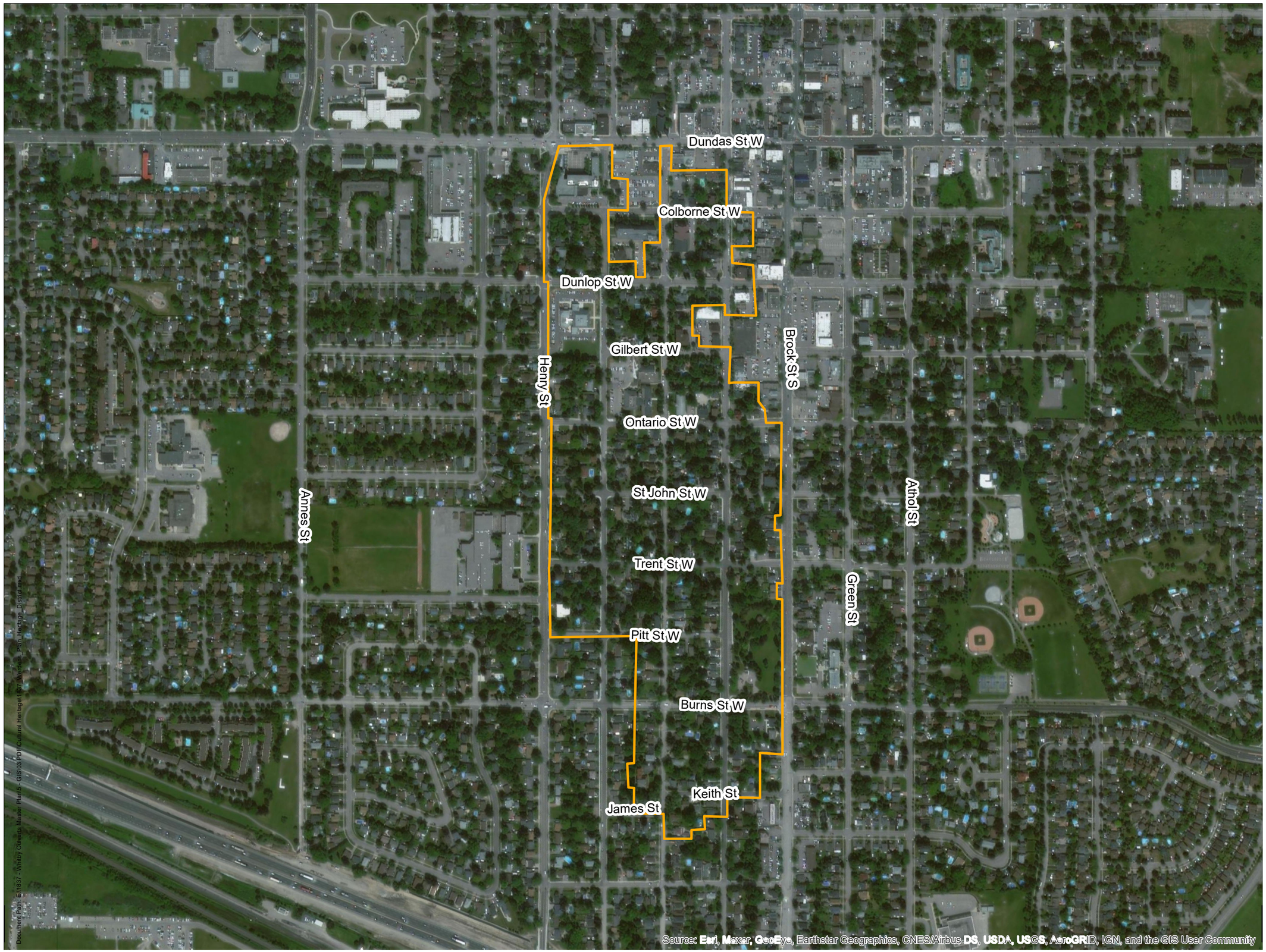
0 75 150 300
Meters

NAD 1983 UTM 17N	**1:6,000**
Project: 1837 - Whitby Bridge and Culvert Master Plan Date: 2020/11	N W E S

Data Sources: Ecosystem Recovery Inc., 2020:



Document Path: E:\1837 - Whitby Culverts Master Plan\5 - GIS\03 PDF\Cultural Heritage\1837_Werdens_Plan_Heritage_District.mxd

Whitby Bridge and Culvert Master Plan

Figure 4-3
Werden's Plan Heritage Conservation District Culverts

Legend

- Watercourse Crossing
- Werden's Plan Heritage Conservation District

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0 75 150 300
Meters

NAD 1983 UTM 17N	**1:6,000**
Project: 1837 - Whitby Bridge and Culvert Master Plan Date: 2020/11	N W E S

Data Sources: Ecosystem Recovery Inc., 2020:

Heritage Properties

According to the Provincial Register of Provincial Heritage Properties, there are no known provincial heritage properties in Whitby

A search of the Town of Whitby Municipal Heritage Register was conducted to identify designated and listed buildings in Whitby. The Heritage Register identified 218 designated properties and 205 listed properties. The properties are presented in **Table 4-1**.

Potential Built and Cultural Heritage Resources at Crossings

The MHTSCI have developed the Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes checklist to help determine whether projects may impact cultural heritage. The checklist has been completed for the highest priority crossings that are completing the Schedule B Class EA process. This is described further in Section 9.3 under site specific studies. Where the checklist determines that a crossing is not identified as a potential cultural heritage resource, no further cultural heritage study is required. Archaeology Assessments will be required at detailed design as noted in **Section 4.2.1**.

Table 4-1. Designated and Listed Heritage Properties in the Town of Whitby.

Address	Location	Status	Address	Location	Status
7143 Ashburn Rd	Brooklin	Designated	25 Station Rd	Ajax	Listed
9060 Baldwin St N	Brooklin	Designated	450 Myrtle Rd W	Ashburn	Listed
360 Columbus Rd E	Brooklin	Designated	695 Myrtle Rd W	Ashburn	Listed
7035 Country Lane	Brooklin	Designated	710 Myrtle Rd W	Ashburn	Listed
60 Queen St	Brooklin	Designated	725 Myrtle Rd W	Ashburn	Listed
21 Albert St	Brooklin	Designated - Brooklin HCD	745 Myrtle Rd W	Ashburn	Listed
30 Bagot St	Brooklin	Designated - Brooklin HCD	760 Myrtle Rd W	Ashburn	Listed
36 Bagot St	Brooklin	Designated - Brooklin HCD	8490 Duffs Rd	Ashburn	Listed
56 Bagot St	Brooklin	Designated - Brooklin HCD	860 (740) Brawley Rd W	Ashburn	Listed
3 Baldwin St	Brooklin	Designated - Brooklin HCD	920 Brawley Rd W	Ashburn	Listed
6 Baldwin St	Brooklin	Designated - Brooklin HCD	9225 Heron Rd	Ashburn	Listed
9 Baldwin St	Brooklin	Designated - Brooklin HCD	1 Thomas St	Brooklin	Listed
11 Baldwin St	Brooklin	Designated - Brooklin HCD	105 Colston Ave	Brooklin	Listed
12 Baldwin St	Brooklin	Designated - Brooklin HCD	131 Baldwin St	Brooklin	Listed
16 Baldwin St	Brooklin	Designated - Brooklin HCD	138 Baldwin St	Brooklin	Listed
19 Baldwin St	Brooklin	Designated - Brooklin HCD	139 Baldwin St	Brooklin	Listed
20 Baldwin St	Brooklin	Designated - Brooklin HCD	141 Baldwin St	Brooklin	Listed
22 Baldwin St	Brooklin	Designated - Brooklin HCD	15 Queen St	Brooklin	Listed
23 Baldwin St	Brooklin	Designated - Brooklin HCD	170 Columbus Rd W	Brooklin	Listed
24 Baldwin St	Brooklin	Designated - Brooklin HCD	20 Charles St	Brooklin	Listed
28 Baldwin St	Brooklin	Designated - Brooklin HCD	26 George St	Brooklin	Listed
31 Baldwin St	Brooklin	Designated - Brooklin HCD	31 Duke St	Brooklin	Listed
38 Baldwin St	Brooklin	Designated - Brooklin HCD	33 Duke St	Brooklin	Listed
40 Baldwin St	Brooklin	Designated - Brooklin HCD	540 Winchester Rd W	Brooklin	Listed
41 Baldwin St	Brooklin	Designated - Brooklin HCD	5515 Garrard Rd	Brooklin	Listed
42 Baldwin St	Brooklin	Designated - Brooklin HCD	59 Bagot St	Brooklin	Listed
44 Baldwin St	Brooklin	Designated - Brooklin HCD	625 Columbus Rd W	Brooklin	Listed
45 Baldwin St	Brooklin	Designated - Brooklin HCD	680 Winchester Rd W	Brooklin	Listed
46 Baldwin St	Brooklin	Designated - Brooklin HCD	90 Queen St	Brooklin	Listed
47 Baldwin St	Brooklin	Designated - Brooklin HCD	1085 Columbus Rd W	Coronation Gardens	Listed
48 Baldwin St	Brooklin	Designated - Brooklin HCD	1120 Columbus Rd W	Coronation Gardens	Listed
49 Baldwin St	Brooklin	Designated - Brooklin HCD	1225 Columbus Rd W	Coronation Gardens	Listed
51 Baldwin St	Brooklin	Designated - Brooklin HCD	7261 Cochrane St	Coronation Gardens	Listed
53 Baldwin St	Brooklin	Designated - Brooklin HCD	740 Columbus Rd W	Coronation Gardens	Listed
55 Baldwin St	Brooklin	Designated - Brooklin HCD	7762 Cochrane St	Coronation Gardens	Listed
56 Baldwin St	Brooklin	Designated - Brooklin HCD	840 Columbus Rd W	Coronation Gardens	Listed
57 Baldwin St	Brooklin	Designated - Brooklin HCD	1265 Myrtle Rd W	Dagmar	Listed

Address	Location	Status	Address	Location	Status
58 Baldwin St	Brooklin	Designated - Brooklin HCD	5805 Halls Rd N	Kinsale	Listed
61 Baldwin St	Brooklin	Designated - Brooklin HCD	4600 Coronation Rd	Macedonian Village	Listed
63 Baldwin St	Brooklin	Designated - Brooklin HCD	4615 Coronation Rd	Macedonian Village	Listed
64 Baldwin St	Brooklin	Designated - Brooklin HCD	100 Myrtle Rd W	Myrtle	Listed
65 Baldwin St	Brooklin	Designated - Brooklin HCD	115 Myrtle Rd E	Myrtle	Listed
66 Baldwin St	Brooklin	Designated - Brooklin HCD	25 Myrtle Rd E	Myrtle	Listed
67 Baldwin St	Brooklin	Designated - Brooklin HCD	325 Hamers Rd	Myrtle	Listed
68 Baldwin St	Brooklin	Designated - Brooklin HCD	75 Myrtle Rd E	Myrtle	Listed
71 Baldwin St	Brooklin	Designated - Brooklin HCD	8 Myrtle Rd W	Myrtle	Listed
72 Baldwin St	Brooklin	Designated - Brooklin HCD	9240 Baldwin St N	Myrtle	Listed
75 Baldwin St	Brooklin	Designated - Brooklin HCD	9365 Baldwin St N	Myrtle Station	Listed
79 Baldwin St	Brooklin	Designated - Brooklin HCD	9455 Baldwin St N	Myrtle Station	Listed
85 Baldwin St	Brooklin	Designated - Brooklin HCD	9465 Baldwin St N	Myrtle Station	Listed
86 Baldwin St	Brooklin	Designated - Brooklin HCD	9485 Baldwin St N	Myrtle Station	Listed
91 Baldwin St	Brooklin	Designated - Brooklin HCD	9560 Mud Lake Rd	Myrtle Station	Listed
95 Baldwin St	Brooklin	Designated - Brooklin HCD	9585 Baldwin St N	Myrtle Station	Listed
99 Baldwin St	Brooklin	Designated - Brooklin HCD	101 Brock St S	Town of Whitby	Listed
110 Baldwin St	Brooklin	Designated - Brooklin HCD	102 Brock St S	Town of Whitby	Listed
5 Campbell St	Brooklin	Designated - Brooklin HCD	104 Brock St N	Town of Whitby	Listed
6 Campbell St	Brooklin	Designated - Brooklin HCD	104 Brock St S	Town of Whitby	Listed
9 Campbell St	Brooklin	Designated - Brooklin HCD	106 Dundas St W	Town of Whitby	Listed
3 Cassels Rd E	Brooklin	Designated - Brooklin HCD	107 Brock St S	Town of Whitby	Listed
14 Cassels Rd E	Brooklin	Designated - Brooklin HCD	107 Kent St	Town of Whitby	Listed
19 Cassels Rd E	Brooklin	Designated - Brooklin HCD	108 Brock St S	Town of Whitby	Listed
20 Cassels Rd E	Brooklin	Designated - Brooklin HCD	109 Brock St S	Town of Whitby	Listed
23 Cassels Rd E	Brooklin	Designated - Brooklin HCD	110 Brock St N	Town of Whitby	Listed
25 Cassels Rd E	Brooklin	Designated - Brooklin HCD	110 Centre St N	Town of Whitby	Listed
31 Cassels Rd E	Brooklin	Designated - Brooklin HCD	111 Brock St N	Town of Whitby	Listed
39 Cassels Rd E	Brooklin	Designated - Brooklin HCD	111 Dunlop St W	Town of Whitby	Listed
42 Cassels Rd E	Brooklin	Designated - Brooklin HCD	111 Euclid St	Town of Whitby	Listed
44 Cassels Rd E	Brooklin	Designated - Brooklin HCD	1117 Brock St S	Town of Whitby	Listed
45 Cassels Rd E	Brooklin	Designated - Brooklin HCD	112 Brock St S	Town of Whitby	Listed
49 Cassels Rd E	Brooklin	Designated - Brooklin HCD	1124 Brock St S	Town of Whitby	Listed
51 Cassels Rd E	Brooklin	Designated - Brooklin HCD	113 Brock St S	Town of Whitby	Listed
52 Cassels Rd E	Brooklin	Designated - Brooklin HCD	113 Byron St N	Town of Whitby	Listed
55 Cassels Rd E	Brooklin	Designated - Brooklin HCD	113 Kent St	Town of Whitby	Listed
56 Cassels Rd E	Brooklin	Designated - Brooklin HCD	1132 Brock St S	Town of Whitby	Listed
57 Cassels Rd E	Brooklin	Designated - Brooklin HCD	115 Brock St N	Town of Whitby	Listed
60 Cassels Rd E	Brooklin	Designated - Brooklin HCD	115 Kent St	Town of Whitby	Listed
62 Cassels Rd E	Brooklin	Designated - Brooklin HCD	116 Brock St S	Town of Whitby	Listed
64 Cassels Rd E	Brooklin	Designated - Brooklin HCD	116 Dundas St W	Town of Whitby	Listed
65 Cassels Rd E	Brooklin	Designated - Brooklin HCD	117 Brock St N	Town of Whitby	Listed
68 Cassels Rd E	Brooklin	Designated - Brooklin HCD	117 Euclid St	Town of Whitby	Listed
69 Cassels Rd E	Brooklin	Designated - Brooklin HCD	118 Cedar St	Town of Whitby	Listed
70 Cassels Rd E	Brooklin	Designated - Brooklin HCD	120 Centre St N	Town of Whitby	Listed
1 Cassels Rd W	Brooklin	Designated - Brooklin HCD	120 Watson St W	Town of Whitby	Listed
3 Cassels Rd W	Brooklin	Designated - Brooklin HCD	121 Brock St N	Town of Whitby	Listed
4 Cassels Rd W	Brooklin	Designated - Brooklin HCD	121 Green St	Town of Whitby	Listed
14 Church St	Brooklin	Designated - Brooklin HCD	122 Brock St N	Town of Whitby	Listed
16 Church St	Brooklin	Designated - Brooklin HCD	122 Brock St S	Town of Whitby	Listed
90 Colston Ave	Brooklin	Designated - Brooklin HCD	122 John St E	Town of Whitby	Listed
7 Durham St	Brooklin	Designated - Brooklin HCD	123 Brock St S	Town of Whitby	Listed
8 Durham St	Brooklin	Designated - Brooklin HCD	124 Brock St S	Town of Whitby	Listed
10 Durham St	Brooklin	Designated - Brooklin HCD	124 Dundas St W	Town of Whitby	Listed
11 Durham St	Brooklin	Designated - Brooklin HCD	125 Pine St	Town of Whitby	Listed
12 Durham St	Brooklin	Designated - Brooklin HCD	125 Wellington St	Town of Whitby	Listed
13 Durham St	Brooklin	Designated - Brooklin HCD	126 Brock St S	Town of Whitby	Listed
15 Durham St	Brooklin	Designated - Brooklin HCD	129 Perry St	Town of Whitby	Listed

Address	Location	Status	Address	Location	Status
17 Durham St	Brooklin	Designated - Brooklin HCD	134 Front St E	Town of Whitby	Listed
19 Durham St	Brooklin	Designated - Brooklin HCD	135 Perry St	Town of Whitby	Listed
21 Kinsmen Ct	Brooklin	Designated - Brooklin HCD	141 Pine St	Town of Whitby	Listed
22 Kinsmen Ct	Brooklin	Designated - Brooklin HCD	143 Brock St S	Town of Whitby	Listed
37 Pearl St	Brooklin	Designated - Brooklin HCD	147 Perry St	Town of Whitby	Listed
40 Pearl St	Brooklin	Designated - Brooklin HCD	1508 Dufferin St	Town of Whitby	Listed
41 Pearl St	Brooklin	Designated - Brooklin HCD	1509 Rossland Rd E	Town of Whitby	Listed
42 Pearl St	Brooklin	Designated - Brooklin HCD	1516 Dufferin St	Town of Whitby	Listed
47 Pearl St	Brooklin	Designated - Brooklin HCD	153 Perry St	Town of Whitby	Listed
53 Pearl St	Brooklin	Designated - Brooklin HCD	154 Pine St	Town of Whitby	Listed
2 Price St	Brooklin	Designated - Brooklin HCD	1600 Dufferin St	Town of Whitby	Listed
6 Price St	Brooklin	Designated - Brooklin HCD	1601 Brock St S	Town of Whitby	Listed
10 Price St	Brooklin	Designated - Brooklin HCD	1604 Dufferin St	Town of Whitby	Listed
12 Price St	Brooklin	Designated - Brooklin HCD	1608 Dufferin St	Town of Whitby	Listed
14 Price St	Brooklin	Designated - Brooklin HCD	1612 Dufferin St	Town of Whitby	Listed
15 Price St	Brooklin	Designated - Brooklin HCD	163 Brock St N	Town of Whitby	Listed
18 Price St	Brooklin	Designated - Brooklin HCD	1675 Victoria St W	Town of Whitby	Listed
1 Princess St	Brooklin	Designated - Brooklin HCD	1701 Dufferin St	Town of Whitby	Listed
2 Princess St	Brooklin	Designated - Brooklin HCD	171 Brock St N	Town of Whitby	Listed
5 Princess St	Brooklin	Designated - Brooklin HCD	1716 Dufferin St	Town of Whitby	Listed
6 Princess St	Brooklin	Designated - Brooklin HCD	1750 Dundas St E	Town of Whitby	Listed
8 Princess St	Brooklin	Designated - Brooklin HCD	1751 Dufferin St	Town of Whitby	Listed
9 Princess St	Brooklin	Designated - Brooklin HCD	1801 Dufferin St	Town of Whitby	Listed
10 Princess St	Brooklin	Designated - Brooklin HCD	1830 Rossland Rd E	Town of Whitby	Listed
11 Princess St	Brooklin	Designated - Brooklin HCD	200 Henry St	Town of Whitby	Listed
12 Princess St	Brooklin	Designated - Brooklin HCD	202 Mary St W	Town of Whitby	Listed
15 Princess St	Brooklin	Designated - Brooklin HCD	204 Brock St N	Town of Whitby	Listed
16 Princess St	Brooklin	Designated - Brooklin HCD	205 Brock St N	Town of Whitby	Listed
18 Princess St	Brooklin	Designated - Brooklin HCD	205 Perry St	Town of Whitby	Listed
20 Princess St	Brooklin	Designated - Brooklin HCD	206 Brock St N	Town of Whitby	Listed
21 Princess St	Brooklin	Designated - Brooklin HCD	206 Palace St	Town of Whitby	Listed
23 Princess St	Brooklin	Designated - Brooklin HCD	208 Centre St N	Town of Whitby	Listed
24 Princess St	Brooklin	Designated - Brooklin HCD	208 Henry St	Town of Whitby	Listed
2 Roebuck St	Brooklin	Designated - Brooklin HCD	209 John St W	Town of Whitby	Listed
6 Roebuck St	Brooklin	Designated - Brooklin HCD	210 Henry St	Town of Whitby	Listed
10 Roebuck St	Brooklin	Designated - Brooklin HCD	212 John St W	Town of Whitby	Listed
3 Vipond Rd	Brooklin	Designated - Brooklin HCD	213 Kent St	Town of Whitby	Listed
6 Vipond Rd	Brooklin	Designated - Brooklin HCD	215 Dundas St E	Town of Whitby	Listed
8 Vipond Rd	Brooklin	Designated - Brooklin HCD	215 Mary St E	Town of Whitby	Listed
1 Way St	Brooklin	Designated - Brooklin HCD	216 Mary St E	Town of Whitby	Listed
3 Way St	Brooklin	Designated - Brooklin HCD	220 Centre St N	Town of Whitby	Listed
5 Way St	Brooklin	Designated - Brooklin HCD	220 Crystal Beach Blvd	Town of Whitby	Listed
7 Way St	Brooklin	Designated - Brooklin HCD	221 Trent St E	Town of Whitby	Listed
9 Way St	Brooklin	Designated - Brooklin HCD	222 Euclid St	Town of Whitby	Listed
25 Way St	Brooklin	Designated - Brooklin HCD	224 Brock St S	Town of Whitby	Listed
26 Way St	Brooklin	Designated - Brooklin HCD	225 Palace St	Town of Whitby	Listed
38 Way St	Brooklin	Designated - Brooklin HCD	239 Wellington St	Town of Whitby	Listed
56 Way St	Brooklin	Designated - Brooklin HCD	243 Wellington St	Town of Whitby	Listed
60 Way St	Brooklin	Designated - Brooklin HCD	269 Water St	Town of Whitby	Listed
68 Way St	Brooklin	Designated - Brooklin HCD	300 Dundas St W	Town of Whitby	Listed
10 Winchester Rd E	Brooklin	Designated - Brooklin HCD	300 High St	Town of Whitby	Listed
12 Winchester Rd E	Brooklin	Designated - Brooklin HCD	300 Mary St W	Town of Whitby	Listed
14 Winchester Rd E	Brooklin	Designated - Brooklin HCD	301 Brock St N	Town of Whitby	Listed
18 Winchester Rd E	Brooklin	Designated - Brooklin HCD	301 Colborne St E	Town of Whitby	Listed
20 Winchester Rd E	Brooklin	Designated - Brooklin HCD	302 Brock St N	Town of Whitby	Listed
24 Winchester Rd E	Brooklin	Designated - Brooklin HCD	3040 Brock St N	Town of Whitby	Listed
28 Winchester Rd E	Brooklin	Designated - Brooklin HCD	305 Centre St N	Town of Whitby	Listed
52 Winchester Rd E	Brooklin	Designated - Brooklin HCD	305 John W	Town of Whitby	Listed

Address	Location	Status	Address	Location	Status
58 Winchester Rd E	Brooklin	Designated - Brooklin HCD	305 Mary St E	Town of Whitby	Listed
60 Winchester Rd E	Brooklin	Designated - Brooklin HCD	306 Centre St N	Town of Whitby	Listed
62 Winchester Rd E	Brooklin	Designated - Brooklin HCD	307 Brock St N	Town of Whitby	Listed
64 Winchester Rd E	Brooklin	Designated - Brooklin HCD	309 Brock St N	Town of Whitby	Listed
66 Winchester Rd E	Brooklin	Designated - Brooklin HCD	310 Brock St N	Town of Whitby	Listed
70 Winchester Rd E	Brooklin	Designated - Brooklin HCD	311 Brock St N	Town of Whitby	Listed
72 Winchester Rd E	Brooklin	Designated - Brooklin HCD	312 Cochrane St	Town of Whitby	Listed
10 Woodington Cr	Brooklin	Designated - Brooklin HCD	312 Walnut St W	Town of Whitby	Listed
170 Myrtle Rd E	Myrtle	Designated	314 Brock St N	Town of Whitby	Listed
175 Myrtle Rd E	Myrtle	Designated	316 Palace St	Town of Whitby	Listed
535 Myrtle Rd W	Myrtle	Designated	316 Colborne St E	Town of Whitby	Listed
780 Myrtle Rd W	Myrtle	Designated	318 Dundas St E	Town of Whitby	Listed
7675 Thickson Rd N	North of Brooklin	Designated	326 Dundas St E	Town of Whitby	Listed
173 Brock St N	Whitby	Designated	3825 Coronation Rd	Town of Whitby	Listed
1200 Brock St S	Whitby	Designated	401 Green St	Town of Whitby	Listed
122 Byron St N	Whitby	Designated	401 Reynolds St	Town of Whitby	Listed
126 Byron St N	Whitby	Designated	404 Athol St	Town of Whitby	Listed
128 Byron St N	Whitby	Designated	416 Mary St W	Town of Whitby	Listed
130 Byron St N	Whitby	Designated	417 Green St	Town of Whitby	Listed
202 Byron St N	Whitby	Designated	420 Euclid St	Town of Whitby	Listed
207 Byron St N	Whitby	Designated	420 Mary St W	Town of Whitby	Listed
210 Byron St N	Whitby	Designated	424 Euclid St	Town of Whitby	Listed
300 Byron St N	Whitby	Designated	425 Dundas St E	Town of Whitby	Listed
407 Byron St N	Whitby	Designated	4670 Baldwin St S	Town of Whitby	Listed
124 Byron St N	Whitby	Designated	4840 Country Lane	Town of Whitby	Listed
202 Centre St N	Whitby	Designated	504 Dundas St W	Town of Whitby	Listed
301 Centre St S	Whitby	Designated	506 John St W	Town of Whitby	Listed
800 Centre St S	Whitby	Designated	510 Palace St	Town of Whitby	Listed
1733 Dufferin St	Whitby	Designated	520 Kent St	Town of Whitby	Listed
519 Dundas St E	Whitby	Designated	528 Dundas St E	Town of Whitby	Listed
132 Dundas St W	Whitby	Designated	536 Centre St N	Town of Whitby	Listed
28 Flint Cres	Whitby	Designated	601 Green St	Town of Whitby	Listed
299 Front St W	Whitby	Designated	606 Walnut St W	Town of Whitby	Listed
1300 Giffard St	Whitby	Designated	614 Walnut St W	Town of Whitby	Listed
1001 Green St	Whitby	Designated	618 Athol St	Town of Whitby	Listed
520 Henry St	Whitby	Designated	6472 Country Lane	Town of Whitby	Listed
9210 Heron Rd	Whitby	Designated	67 Harbourside Dr	Town of Whitby	Listed
1601 Hopkins St	Whitby	Designated	700 Gordon St	Town of Whitby	Listed
508 John St W	Whitby	Designated	724 Dundas St W	Town of Whitby	Listed
300 Taunton Rd W	Whitby	Designated	780 Garden St	Town of Whitby	Listed
601 Victoria St E	Whitby	Designated	814 Brock St N	Town of Whitby	Listed
500 Victoria St W	Whitby	Designated	8300 Ashburn Rd	Town of Whitby	Listed
604 Brock St S	Whitby	Designated - Werden's HCD	8870 Ashburn Rd	Town of Whitby	Listed
900 Brock St S	Whitby	Designated - Werden's HCD	8940 Ashburn Rd	Town of Whitby	Listed
208 Byron St S	Whitby	Designated - Werden's HCD	8960 Ashburn Rd	Town of Whitby	Listed
300 Byron St S	Whitby	Designated - Werden's HCD	8970 Ashburn Rd	Town of Whitby	Listed
402 Byron St S	Whitby	Designated - Werden's HCD	9005 Ashburn Rd	Town of Whitby	Listed
404 Byron St S	Whitby	Designated - Werden's HCD	9035 Ashburn Rd	Town of Whitby	Listed
413 Byron St S	Whitby	Designated - Werden's HCD	911 Athol St	Town of Whitby	Listed
501 Byron St S	Whitby	Designated - Werden's HCD	925 Green St	Town of Whitby	Listed
508 Byron St S	Whitby	Designated - Werden's HCD	107 Winchester Rd E	Windfields	Listed
400 Centre St S	Whitby	Designated - Werden's HCD	76 Winchester Rd E	Windfields	Listed
401 Centre St S	Whitby	Designated - Werden's HCD			
416 Centre St S	Whitby	Designated - Werden's HCD			
513 Centre St S	Whitby	Designated - Werden's HCD			
312 Colborne St W	Whitby	Designated - Werden's HCD			
319 Dunlop St W	Whitby	Designated - Werden's HCD			

Address	Location	Status	Address	Location	Status
301 Gilbert St E	Whitby	Designated - Werden's HCD			
306 Gilbert St W	Whitby	Designated - Werden's HCD			
219 Keith St	Whitby	Designated - Werden's HCD			
300 King St	Whitby	Designated - Werden's HCD			
400 King St	Whitby	Designated - Werden's HCD			
600 King St	Whitby	Designated - Werden's HCD			
616 King St	Whitby	Designated - Werden's HCD			
210 Trent St W	Whitby	Designated - Werden's HCD			

4.3 Natural Environment

The following natural environment characterization was completed using a variety of available background sources. These sources were reviewed to provide a high-level description of the identified significant natural heritage features, preliminary Ecological Land Classification (ELC) communities, as well as potential Species at Risk (SAR) known to occur within the study area to help identify preliminary constraints and opportunities related to future culvert and bridge replacement work. It is anticipated further detailed inventories will occur during detailed design for each of the preferred alternatives selected. The following background reports, and online sources were reviewed:

- The Lynde Creek Watershed Existing Conditions Report - Central Lake Ontario Conservation Authority (CLOCA) (2008);
- The Approved Updated Assessment Report for the Central Lake Ontario Source Protection Area/CTC Source Protection Region, CLOCA (2015);
- CLOCA's Ecological Land Classification mapping (CLOCA Open Data, 2020);
- The Ontario Breeding Bird Atlas, Squares 17PJ57, 17PJ56, 17PJ67, 17PJ66, 17PJ65 (2006);
- The Ontario Butterfly Atlas, Squares 17PJ57, 17PJ56, 17PJ67, 17PJ66, 17PJ65 (TEA, 2017);
- The Ontario Mammal Atlas (Dobbyn, 1966);
- The Ontario Reptile and Amphibian Atlas (ORAA; Ontario Nature, 2016);
- eBird: An online database of bird distribution and abundance [web application] (Cornell Lab of Ornithology, 2020);
- iNaturalist (2020);
- Department of Fisheries and Oceans Species at Risk Mapping Tool;
- The Natural Heritage Information Centre (NHIC) Make-a-Map tool (MECP, 2020);
- The Town of Whitby Official Plan Appendix 1 (Technical Mapping of Environmental Elements) (Town of Whitby, 2017); and
- Aerial photography.

4.3.1 Existing Conditions

The study area is comprised of three watersheds; Lynde Creek, Pringle Creek and Corbett Creek. To date, CLOCA has completed a Watershed Plan for the Lynde Creek watershed. The following presents a brief description of each watershed within the study area.

Lynde Creek Watershed: The Lynde Creek Watershed is the largest of the three watersheds contained by the study area. It spans approximately 13,000 ha, roughly from Lake Ridge Road east to Ashburn Road, and from north of Townline Road south to the Whitby Harbour. The northern portion of this watershed is predominantly rural, with agricultural fields and golf courses. The watershed also encompasses a large portion of the town of Whitby and a part of the community of Brooklin, which contain single family dwellings, commercial spaces, and industrial developments.

Pringle Creek Watershed: According to the Port Whitby sustainable Community Plan, the Pringle Creek watershed drains an area of 3,082 ha (ARUP, 2010). It spans the area roughly bound by Ashburn Road east to

Garrard Road, and from Columbus Road south to the Whitby Harbour. Most of this area is developed into single family dwellings, commercial space, and industrial land use areas.

Corbett Creek Watershed: The Corbett Creek watershed has a total drainage area of 1,466 ha, and can be largely divided into two watersheds; West Corbett Creek (643 ha) and East Corbett Creek (823 ha) (TMIG, 2020). It is located on the southeast corner of the study area, roughly bound by Anderson Street, Thornton Road, Rossland Road, and the waterfront. The majority of this area contains commercial and industrial developments.

4.3.1.1 Terrestrial Environment

Terrestrial ecosystems are those associated with land including, but not limited to, forests, meadows, thickets and wetlands. These ecosystems provide habitat for a variety of plants and wildlife species, some of which are rare or sensitive. Culvert and bridge replacement works have the potential to disturb or remove riparian vegetation and associated wildlife habitat during construction works. It is therefore important to identify existing features & potential significant species that will need consideration during the detailed design phase for each preferred alternative. The following sections present features and significant species known for the three watersheds as obtained through a desktop natural heritage review.

Designated Natural Areas

Designated Natural Areas are identified by relevant agencies, and municipalities through legislation, policies, or management plans, and are known to have distinct or significant value added to an area. These areas may have a variety of ecological, recreational, and/or aesthetic features and functions that are important and warrant preservation. Examples of these types of areas include the Niagara Escarpment; Oak Ridges Moraine; National and Provincial Parks; Provincially and Locally Significant Wetlands (LSW's & PSW's); Designated heritage rivers; Environmentally Sensitive Areas (ESA); Environmentally Sensitive Policy Areas (ESPA); Provincially Significant Areas of Natural and Scientific Interest (ANSI); Conservation Authority parks/Open Space lands; Stewardship lands; and Land trust areas. The following sections present the identified Natural Areas located within each watershed as per reviewed background documents.

Significant Wetlands: Wetlands include areas that are either seasonally or permanently flooded by shallow water, or areas where the water table is close enough to the surface to provide enough water to support the formation of hydric soil. Wetlands are thus defined by the dominance of hydrophilic or water tolerant plants (MNRF, 2013). Wetlands may be classified as significant at either the local or provincial level using the Ontario Wetland Evaluation System (OWES), which assigns point values to a particular wetland based on biological, social, hydrological, and special features components. An evaluated wetland may be classified as Provincially Significant, Locally Significant, or not significant. The wetlands located within each watershed are presented in **Table 4-2**, **Table 4-3** and **Table 4-4**.

Table 4-2. Lynde Creek Watershed Significant Wetlands

Lynde Creek Watershed Significant Wetlands	
Lynde Creek Coastal Wetland Complex - Provincial	Whitby Harbour Wetland Complex - Provincial
Heber Down Wetland Complex - Provincial	Cranberry Marsh – Provincial
Chalk Lake Wetland Complex - Provincial	Dagmar Station Wetland – Local
Whitby-Oshawa Iroquois Beach Wetland Complex – Provincial	Shoal Point Wetlands
Rossland Road Wetland Complex	Carruther's Creek Wetland Complex
Salem Road Wetland Complex	Nonquon River Headwater Wetland Complex
Glen Major Wetland Complex	Le Vays Marsh

Table 4-3. Pringle Creek Watershed Significant Wetlands

Pringle Creek Watershed Significant Wetlands	
Whitby-Oshawa Iroquois Beach PSW - Provincial	Lynde Creek Coastal Wetland Complex – Provincial
Whitby Harbour Wetland Complex - Provincial	

Table 4-4. Corbett Creek Watershed Significant Wetlands

Corbett Creek Watershed Significant Wetlands	
Corbett Creek Coastal Wetland Complex - Provincial	Corbett Creek Coastal Marsh
Thickson's Marsh	

Areas of Natural and Scientific Interest (ANSI): The Ministry of Natural Resources and Forestry (MNRF) identifies ANSIs as areas of land or water with significant value to scientific study, natural heritage, appreciation, protection, or education. These areas must be evaluated to contain natural landscapes or features of either life science or earth science values (Ontario Geohub, 2020). The ANSI's identified in the Lynde Creek and Pringle Creek watersheds are presented in **Table 4-5** and **Table 4-6**, respectively. There were no ANSI's identified in the Corbett Creek watershed.

Table 4-5. Lynde Creek Watershed ANSIs

Lynde Creek Watershed ANSI	
Kinsale Raised Shoreline Earth Science ANSI - Regional	Chalk Lake Life Science ANSI - Provincial (Candidate)
Lynde Creek (Whitby Formation) Earth Science ANSI-Regional	Nonquon Headwaters Life Science ANSI - Regional
Heber Down Iroquois Beach Earth Science ANSI - Provincial (Candidate)	Lynde Shores Coastal Wetland Life Science ANSI (Ontario Hospital Marsh) – Provincial

Table 4-6. Pringle Creek Watershed ANSIs

Pringle Creek Watershed ANSI	
Lynde Shores Coastal Wetlands (Ontario Hospital Marsh)	Life Science ANSI - Provincial

Environmentally Sensitive Areas (ESA): The Environmentally Sensitive Areas Mapping Study prepared by Gartner Lee Ltd. (1978) on behalf of CLOCA identifies areas of significant terrain, forests, wildlife, or fisheries within the Central Lakes jurisdiction based on several criteria. Identified ESAs may be assigned a level of sensitivity between low and high, with high sensitivity areas presenting as highly sensitive to disturbance. The Lynde Creek Watershed Existing Conditions Report (CLOCA, 2008) has identified medium and high sensitivity ESAs within the vicinity of the Lynde Creek watershed. The ESAs identified for the Lynde Creek and Pringle Creek watersheds are presented in **Table 4-7** and **Table 4-8**, respectively. No ESAs were identified during background review for the Corbett Creek Watershed.

Table 4-7. Lynde Creek Watershed ESAs

Lynde Creek Watershed ESAs	
Lynde Shores	Upper Lynde Creek to Chalk Lake
Lynde Creek Valley	Northeast Tributary
Lynde Valley – Iroquois Beach	Westerly Creek Valleys
Anderson Street Woods	West Lynde Creek Valley (Till Plain)
South Dagmar Forest	Dagmar Forest
Chalk Lake Woods	Upper Lynde Creek to Chalk Lake
The Northeast Tributary	

Table 4-8. Pringle Creek Watershed ESAs

Pringle Creek Watershed ESAs	
Anderson Street Woods	Pringle Creek Woods

Conservation Areas: The conservation areas identified during the desktop review for the Lynde Creek and Pringle Creek Watersheds are presented in **Table 4-9** and **Table 4-10**, respectively. No conservation areas were identified within the Corbett Creek Watershed.

Table 4-9. Lynde Creek Watershed Conservation Areas

Lynde Creek Conservation Areas	
Crow's Pass Conservation Area	Lynde Shores Conservation Area
Heber Down Conservation Area	

Table 4-10. Pringle Creek Watershed Conservation Areas

Pringle Creek Conservation Areas
Lynde Shores Conservation Area

Vegetation Communities and Plants

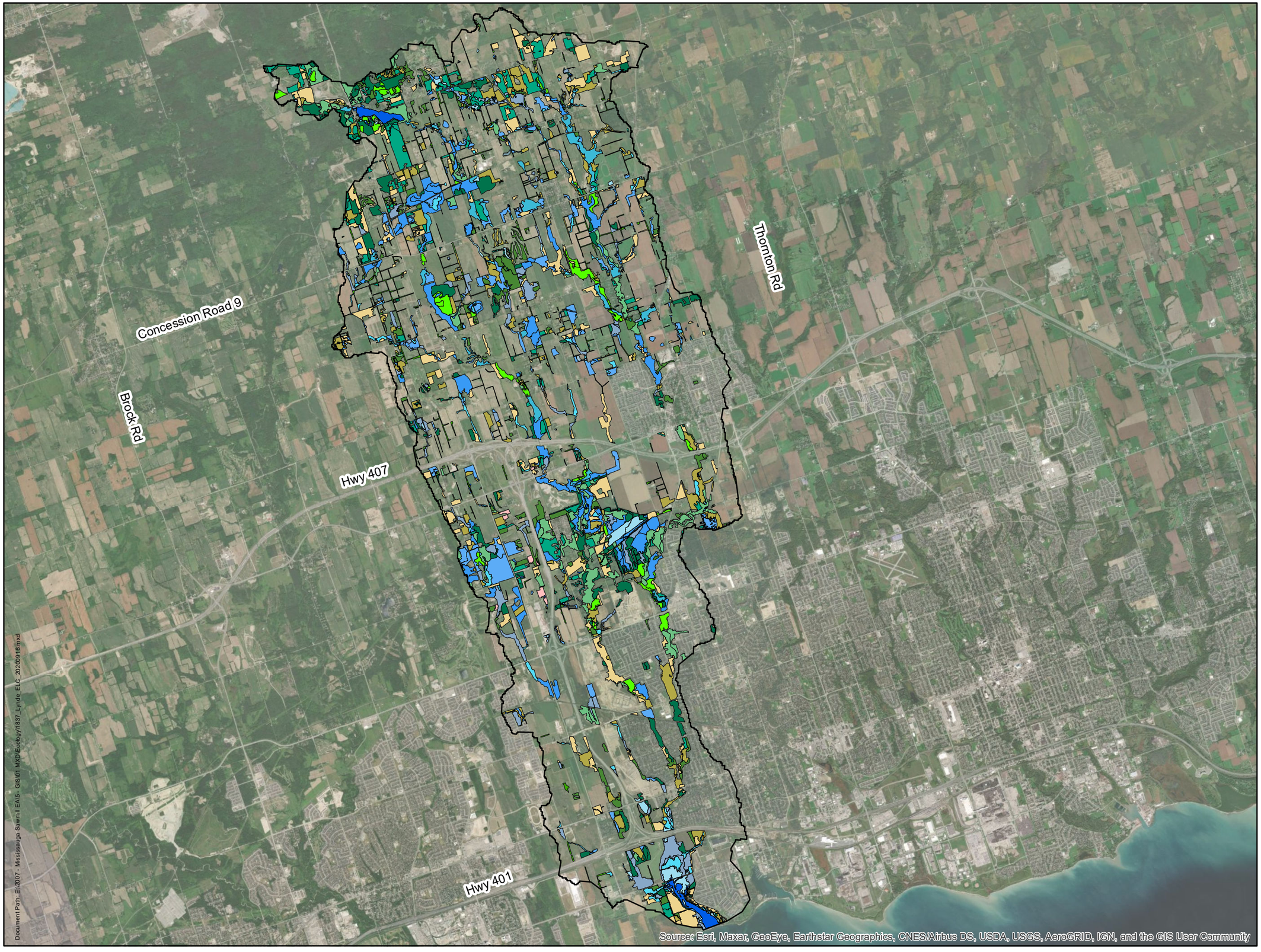
The following section describes the Ecological Land Classification (ELC) communities that have been delineated by CLOCA within the three watersheds. ELC communities were delineated according to the Ecological Land Classification (ELC) Manual for Southern Ontario (Lee et al., 1998). This classification system strives to simplify complex natural variation into an acceptable number of distinguishable ecosystem units (Bailey et al. 1978).

Lynde Creek Watershed

In total, 58 different ELC ecosites have been delineated within the Lynde Creek Watershed. These communities can be divided into cultural, beach/bar, forest, and wetland communities. The dominant ELC ecosite delineated within the watershed are wetlands occupying 45% of the communities, followed by forest (28%), cultural communities (26%) and beach/bar communities (1%). **Table 4-11** provides a summary of the communities identified by CLOCA. The percentages presented are not based on land cover but rather show which ELC ecosites are represented within the watershed. The location of these communities is shown in **Figure 4-4**.

Table 4-11. Lynde Creek Watershed Ecological Land Classification Units

Cultural	
CUH – Hedgerow	CUP3 – Coniferous Plantation
CUH1 – Hedgerow	CUS – Cultural Savannah
CUH2 – Treed Hedgerow	CUS1 – Mineral Cultural Savannah
CUM – Cultural Meadow	CUT – Cultural Thicket
CUM1 – Mineral Cultural Meadow	CUT1 – Mineral Cultural Thicket
CUP – Plantation	CUW – Cultural Woodland
CUP1 – Deciduous Plantation	CUW1 – Mineral Cultural Woodland
CUP2 – Mixed Plantation	
Fen	
FEO – Open Fen	FET – Treed Fen
FEO1 – Open Fen	FET1 – Treed Fen
FES – Shrub Fen	
Forest	
FOC – Coniferous Forest	FOD8 – Fresh-Moist Poplar-Sassafras Deciduous Forest
FOC4 – Fresh-Moist White Cedar Coniferous Forest	FOD9 – Fresh-Moist Oak-Maple-Hickory Deciduous Forest
FOD – Deciduous Forest	FOM – Mixed Forest
FOD3 – Dry-Fresh Poplar-Paper Birch Deciduous Forest	FOM3 – Dry-Fresh Hardwood-Hemlock Mixed Forest
FOD4 – Dry-Fresh Deciduous Forest	FOM4 – Dry-Fresh White Cedar Mixed Forest
FOD5 – Dry-Fresh Sugar Maple Deciduous Forest	FOM5 – Dry-Fresh Paper Birch-Poplar-Conifer Mixed Forest
FOD6 – Fresh-Moist Sugar Maple Deciduous Forest	FOM6 – Fresh-Moist Hemlock Mixed Forest
FOD7 – Fresh-Moist Lowland Deciduous Forest	FOM7 – Fresh-Moist White Cedar-Hardwood Mixed Forest
Marsh	
MAM – Meadow Marsh	MAS – Shallow Marsh
MAM1 – Bedrock Meadow Marsh	MAS2 – Mineral Shallow Marsh
MAM2 – Mineral Meadow Marsh	MAS3 – Organic Shallow Marsh
Open Water	
OAO – Open Water	
Shallow Water	
SAM – Mixed Shallow Aquatic	SAS – Submerged Shallow Aquatic
Swamp	
SWC – Coniferous Swamp	SWM3 – Birch-Poplar Mineral Mixed Swamp
SWC1 – White Cedar Mineral Coniferous Swamp	SWM4 – White Cedar Organic Mixed Swamp
SWD – Deciduous Swamp	SWT – Thicket Swamp
SWD2 – Ash Mineral Deciduous Swamp	SWT2 – Mineral Thicket Swamp
SWD3 – Maple Mineral Deciduous Swamp	SWM – Mixed Swamp
SWD4 – Mineral Deciduous Swamp	SWM1 – White Cedar Mineral Mixed Swamp
Beach	
BBT1 – Mineral Tree Beach/Bar	



Whitby Culverts Master Plan

Figure 4-5
Lynde Creek Ecological Land Classification

Legend

- Lynde Creek Watershed

ELC Community Code

- BBT: Mineral Treed Beach/Bar
- CUH: Hedgerow
- CUM: Cultural Meadow
- CUP: Plantation
- CUS: Cultural Savannah
- CUT: Cultural Thicket
- CUW: Cultural Woodland
- FEO: Open Fen
- FES: Shrub Fen
- FET: Treed Fen
- FOC: Coniferous Forest
- FOD: Deciduous Forest
- FOM: Mixed Forest
- MAM: Meadow Marsh
- MAS: Shallow Marsh
- OAO: Open Aquatic
- SAM: Mixed Shallow Aquatic
- SAS: Submerged Shallow Aquatic
- SWC: Coniferous Swamp
- SWD: Deciduous Swamp
- SWM: Mixed Swamp
- SWT: Thicket Swamp

ecosystem recovery inc. PROFESSIONAL ENGINEERS

0 1,050 2,100 4,200
Meters

NAD 1983 UTM 17N	1:85,000
Project: 1837 - Whitby Culverts Master Plan Date: 2020/09	N W E S

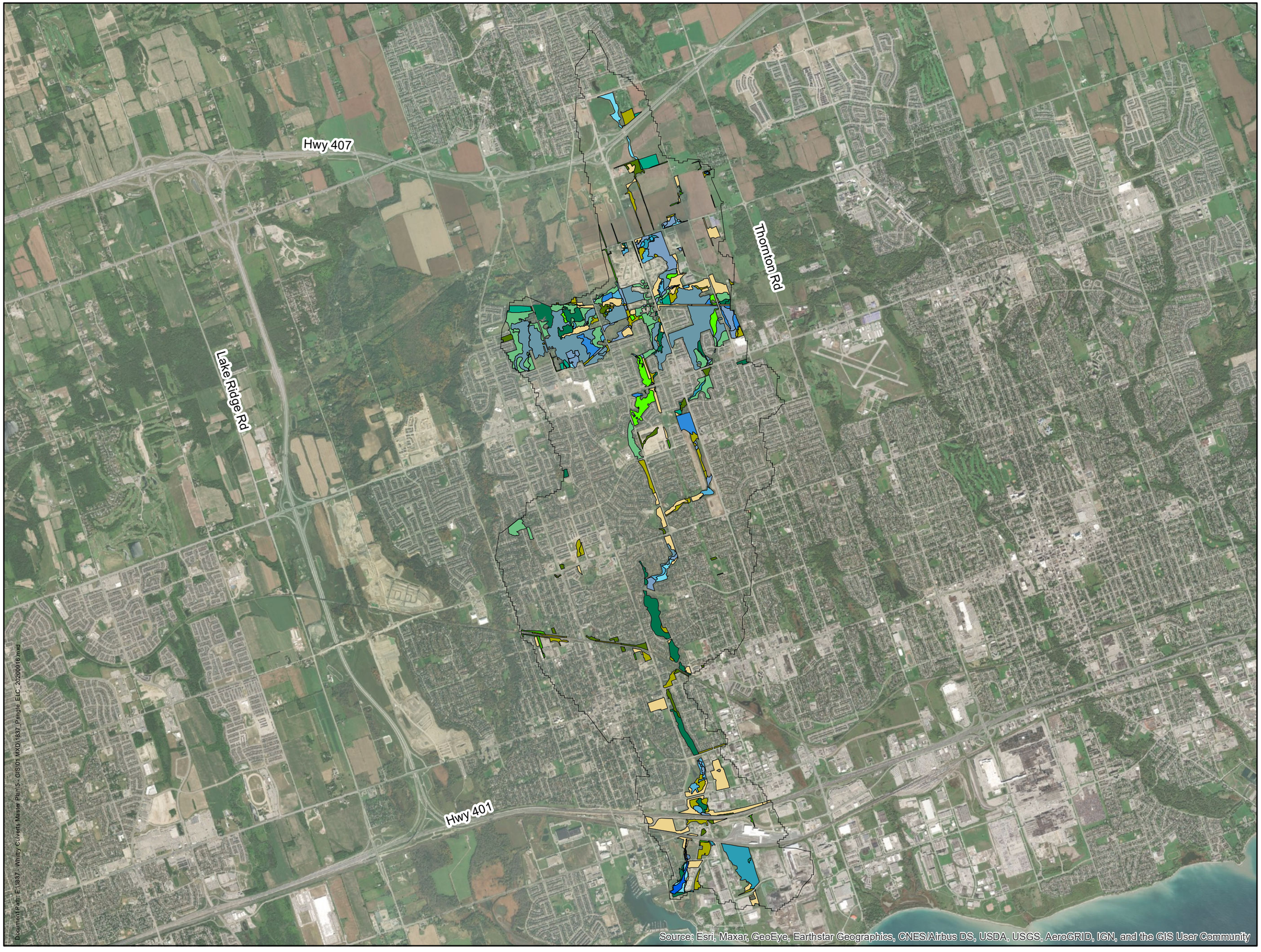
Data Sources: Ecosystem Recovery Inc., 2020:

Pringle Creek Watershed

In total, 35 different ELC ecosites have been delineated within the Pringle Creek Watershed. These communities can be divided into cultural, bluff, forest, and wetland communities. The dominant ELC ecosite delineated within the watershed are wetlands occupying 43% of the communities, followed by cultural communities with 28%, then forest communities with 26% and bluff communities occupying 1% of the delineated communities. **Table 4-12** presents a summary of those communities as identified by CLOCA. Please note the percentages presented are not based on land cover but rather show which ELC ecosites are represented within the watershed. The location of these communities can be seen on **Figure 4-5**.

Table 4-12. Pringle Creek Watershed Ecological Land Classification Units

Bluff	
BLO – Open Bluff	
Cultural	
CUH – Hedgerow	CUP3 – Coniferous Plantation
CUW1 – Mineral Cultural Woodland	CUP – Plantation
CUH2 – Treed Hedgerow	CUT – Cultural Thicket
CUM – Cultural Meadow	CUT1 – Mineral Cultural Thicket
CUM1 – Mineral Cultural Meadow	CUW – Cultural Woodland
Forest	
FOC – Coniferous Forest	FOM – Mixed Forest
FOC4 – Fresh-Moist White Cedar Coniferous Forest	FOM2 – Dry-Fresh White Pine-Maple-Oak Mixed Forest
FOD – Deciduous Forest	FOM6 – Fresh-Moist Hemlock Mixed Forest
FOD5 – Dry-Fresh Sugar Maple Deciduous Forest	FOM7 – Fresh-Moist White Cedar-Hardwood Mixed Forest
FOD6 – Fresh-Moist Sugar Maple Deciduous Forest	
Marsh	
MAM – Meadow Marsh	MAS – Shallow Marsh
MAM2 – Mineral Meadow Marsh	
Open Water	
OAO – Open Water	
Shallow Water	
SAS – Submerged Shallow Aquatic	SAM – Mixed Shallow Aquatic
SAS1 – Submerged Shallow Aquatic	
Swamp	
SWC – Coniferous Swamp	SWM – Mixed Swamp
SWC1 – White Cedar Mineral Coniferous Swamp	SWM1 – White Cedar Mineral Mixed Swamp
SWD – Deciduous Swamp	SWM4 – White Cedar Organic Mixed Swamp
SWD2 – Ash Mineral Deciduous Swamp	SWT – Thicket Swamp



Document Path: E:\1837 - Whitby Culverts Master Plan\5- GIS\01 MXD\1837_Pringle_ELC_20200916.mxd

Whitby Culverts Master Plan

Figure 4-6
Pringle Creek Ecological Land Classification

Legend

- Pringle Creek Watershed

ELC Community Code

- BLO: Open Bluff
- CUH: Hedgerow
- CUM: Cultural Meadow
- CUP: Plantation
- CUT: Cultural Thicket
- CUW: Cultural Woodland
- FOC: Coniferous Forest
- FOD: Deciduous Forest
- FOM: Mixed Forest
- MAM: Meadow Marsh
- MAS: Shallow Marsh
- OAO: Open Aquatic
- SAM: Mixed Shallow Aquatic
- SAS: Submerged Shallow Aquatic
- SWC: Coniferous Swamp
- SWD: Deciduous Swamp
- SWM: Mixed Swamp
- SWT: Thicket Swamp

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0 625 1,250 2,500
Meters

NAD 1983 UTM 17N	1:50,000
Project: 1837 - Whitby Culverts Master Plan Date: 2020/09	N W E S

Data Sources: Ecosystem Recovery Inc., 2020:

Corbett Creek Watershed

In total, 28 different ELC ecosites have been delineated within the Corbett Creek Watershed. These communities can be divided into cultural, forest, and wetland communities. The dominant ELC ecosite delineated within the watershed are wetlands occupying 39% of the communities, followed by cultural communities with 32%, and forest communities occupying 29% of the delineated communities. **Table 4-13** presents a summary of those communities. Please note these percentages are not based on land cover but rather which ELC ecosites are represented within the watershed. The location of these communities can be seen on **Figure 4-6**.

Table 4-13. Corbett Creek Watershed Ecological Land Classification Units

Cultural	
CUH – Hedgerow	CUM1 – Mineral Cultural Meadow
CUH2 – Treed Hedgerow	CUP – Plantation
CUT – Cultural Thicket	CUW – Cultural Woodland
CUT1 – Mineral Cultural Thicket	CUS – Cultural Savannah
CUM – Cultural Meadow	
Forest	
FOC – Coniferous Forest	FOD9 – Fresh-Moist Oak-Maple-Hickory Deciduous Forest
FOD – Deciduous Forest	FOM – Mixed Forest
FOD3 – Dry-Fresh Poplar-Paper Birch Deciduous Forest	FOM2 – Dry-Fresh White Pine-Maple-Oak Mixed Forest
FOD7 – Fresh-Moist Lowland Deciduous Forest	FOM4 – Dry-Fresh White Cedar Mixed Forest
Marsh	
MAM – Meadow Marsh	MAS – Shallow Marsh
MAM2 – Mineral Meadow Marsh	MAS2 – Mineral Shallow Marsh
MAS3 – Organic Shallow Marsh	
Open Water	
OAO – Open Water	
Shallow Water	
SAS – Open Aquatic	
Swamp	
SWD – Deciduous Swamp	SWM – Mixed Swamp
SWD2 – Ash Mineral Deciduous Swamp	SWT – Thicket Swamp

Whitby Culverts Master Plan

Figure 4-6
Corbett Creek Ecological Land Classification

Legend

- Corbett Creek Watershed

ELC Community Code

- CUH: Hedgerow
- CUM: Cultural Meadow
- CUP: Plantation
- CUS: Cultural Savannah
- CUT: Cultural Thicket
- CUW: Cultural Woodland
- FOC: Coniferous Forest
- FOD: Deciduous Forest
- FOM: Mixed Forest
- MAM: Meadow Marsh
- MAS: Shallow Marsh
- OAO: Open Aquatic
- SAS: Shallow Aquatic
- SWD: Deciduous Swamp
- SWM: Mixed Swamp
- SWT: Thicket Swamp

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0 375 750 1,500
Meters

NAD 1983 UTM 17N	1:30,000
Project: 1837 - Whitby Culverts Master Plan Date: 2020/09	N W E S

Data Sources: Ecosystem Recovery Inc., 2020:

4.3.1.2 Aquatic Environment

Aquatic ecosystems are those associated with bodies of water such as but not limited to pools, ponds, lakes, rivers, streams and wetlands. These systems provide habitat for a variety of wildlife species, some of which are rare or sensitive to disturbance. The following presents a high level review of background aquatic information available for each of the three watersheds.

Lynde Creek

The Lynde Creek watershed is made up of the Ashburn, Myrtle Station, Heber Down, Kinsale and Lynde Main subwatersheds. The Watershed Plan identified approximately 37 fish species, representing 12 families, known to occur within the Lynde Creek watershed (CLOCA, 2008). Of the anadromous fish of Lake Ontario that migrate upriver to spawn, only brook trout and rainbow trout were observed during fish monitoring in Lynde Creek and its tributaries (CLOCA, 2008). The Lynde Creek Watershed fish records are presented in **Table 4-14**.

The following temperature regimes occur in the Lynde Creek subwatersheds:

- Cool and Coldwater: Lynde Main, Heber Down, Kinsale, Ashburn, Myrtle Station.
- Warm water: Lynde Main, Heber Down, Kinsale, Myrtle Station.

Table 4-14. Lynde Creek Watershed Fish Records

Scientific Name	Common Name	S-RANK	ESA	COSEWIC	SARA	Locally Significant
Amia calva	Bowfin	S4				
Anguilla rostrata	American Eel	S1?	END	THR		
Alosa pseudoharengus	Alewife	SNA				
Dorosoma cepedianum	Gizzard Shad	S4				
Clinostomus elongatus	Redside Dace	S2	END	END	END	
Cyprinus carpio	Common Carp	SNA				
Notemigonus crysoleucas	Golden Shiner	S5				
Notropis atherinoides	Emerald Shiner	S5				
Notropis heterolepis	Blacknose Shiner	S5				
Notropis hudsonius	Spottail Shiner	S5				
Notropis rubellus	Rosyface Shiner	S4				
Notropis stramineus	Sand Shiner	S4				
Chrosomus eos	Northern Redbelly Dace	S5				
Pimephales notatus	Bluntnose Minnow	S5				
Pimephales promelas	Fathead Minnow	S5				
Rhinichthys atratulus	Blacknose Dace	S5				
Rhinichthys cataractae	Longnose Dace	S5				
Semotilus atromaculatus	Creek Chub	S5				
Cyprinella spiloptera	Spotfin Shiner	S4				
Luxilus cornutus	Common Shiner	S5				
Catostomus commersonii	White Sucker	S5				
Esox lucius	Northern Pike	S5				
Culaea inconstans	Brook Stickleback	S5				
Ambloplites rupestris	Rock Bass	S5				
Lepomis gibbosus	Pumpkinseed	S5				
Micropterus dolomieu	Smallmouth Bass	S5				
Micropterus salmoides	Largemouth Bass	S5				
Pomoxis nigromaculatus	Black Crappie	S4				
Etheostoma caeruleum	Rainbow Darter	S4				

Scientific Name	Common Name	S-RANK	ESA	COSEWIC	SARA	Locally Significant
Etheostoma nigrum	Johnny Darter	S5				
Perca flavescens	Yellow Perch	S5				
Percina caprodes	Logperch	S5				
Sander vitreus vitreus	Walleye	S5				
Lethenteron appendix	American Brook Lamprey	S3				
Oncorhynchus mykiss	Rainbow Trout	SNA				
Salvelinus fontinalis fontinalis	Brook Trout	S5				
Cottus bairdii	Mottled Sculpin	S5				
Noturus flavus	Stonecat	S4				
Ameiurus nebulosus	Brown Bullhead	S5				

Pringle Creek

The Pringle Creek watershed is classified as having a cool water thermal regime (CLOCA, 2015). Cold, cool, and warmwater fish species have been documented in Pringle Creek during annual fisheries monitoring programs conducted by CLOCA. The Whitby Habour is a known migratory corridor for Pacific Salmon in the fall, and for Rainbow Trout in the spring. In total, 38 fish species were identified by CLOCA, NHIC and iNaturalist. These species are presented in **Table 4-15**.

Table 4-15. Pringle Creek Watershed Fish Records

Scientific Name	Common Name	S-RANK	ESA	COSEWIC	SARA	Locally Significant
Amia calva	Bowfin	S4				
Anguilla rostrata	American Eel	S1?	END	THR		
Alosa pseudoharengus	Alewife	SNA				
Dorosoma cepedianum	Gizzard Shad	S4				
Carassius auratus	Goldfish	SNA				
Clinostomus elongatus	Redside Dace	S2	END	END	END	
Cyprinus carpio	Common Carp	SNA				
Notemigonus crysoleucas	Golden Shiner	S5				
Notropis atherinoides	Emerald Shiner	S5				
Notropis hudsonius	Spottail Shiner	S5				
Chrosomus eos	Northern Redbelly Dace	S5				
Pimephales notatus	Bluntnose Minnow	S5				
Pimephales promelas	Fathead Minnow	S5				
Rhinichthys atratulus	Blacknose Dace	S5				
Rhinichthys cataractae	Longnose Dace	S5				
Semotilus atromaculatus	Creek Chub	S5				
Semotilus corporalis	Fallfish	S4				
Luxilus cornutus	Common Shiner	S5				
Catostomus commersonii	White Sucker	S5				
Fundulus diaphanus	Banded Killifish	S5				
Esox lucius	Northern Pike	S5				
Culaea inconstans	Brook Stickleback	S5				
Gasterosteus aculeatus	Threespine Stickleback	S4				
Aplodinotus grunniens	Freshwater Drum	S5				
Ambloplites rupestris	Rock Bass	S5				
Lepomis gibbosus	Pumpkinseed	S5				
Lepomis macrochirus	Bluegill	S5				

Scientific Name	Common Name	S-RANK	ESA	COSEWIC	SARA	Locally Significant
Micropterus dolomieu	Smallmouth Bass	S5				
Micropterus salmoides	Largemouth Bass	S5				
Etheostoma nigrum	Johnny Darter	S5				
Perca flavescens	Yellow Perch	S5				
Percina caprodes	Logperch	S5				
Sander vitreus vitreus	Walleye	S5				
Neogobius melanostomus	Round Goby	SNA				
Oncorhynchus tshawytscha	Chinook Salmon	SNA				
Oncorhynchus mykiss	Rainbow Trout	SNA				
Salmo trutta	Brown Trout	SNA				
Ameiurus nebulosus	Brown Bullhead	S5				

Corbett Creek

Corbett Creek is considered to have a cool water thermal regime that is transitioning to warmwater. In total, 21 fish species have been documented in Corbett Creek by CLOCA since 2003, including both warmwater and coolwater fish species. (TMIG, 2020). For a full list of these species, please see **Table 4-16**.

Table 4-16. Corbett Creek Watershed Fish Records

Scientific Name	Common Name	S-RANK	ESA	COSEWIC	SARA	Locally Significant
Alosa pseudoharengus	Alewife	SNA				
Dorosoma cepedianum	Gizzard Shad	S4				
Carassius auratus	Goldfish	SNA				
Cyprinus carpio	Common Carp	SNA				
Notemigonus crysoleucas	Golden Shiner	S5				
Notropis atherinoides	Emerald Shiner	S5				
Pimephales notatus	Bluntnose Minnow	S5				
Pimephales promelas	Fathead Minnow	S5				
Rhinichthys atratulus	Blacknose Dace	S5				
Semotilus atromaculatus	Creek Chub	S5				
Catostomus commersonii	White Sucker	S5				
Fundulus diaphanus	Banded Killifish	S5				
Esox lucius	Northern Pike	S5				
Culaea inconstans	Brook Stickleback	S5				
Lepomis gibbosus	Pumpkinseed	S5				
Lepomis macrochirus	Bluegill	S5				
Micropterus salmoides	Largemouth Bass	S5				
Perca flavescens	Yellow Perch	S5				
Percina caprodes	Logperch	S5				
Neogobius melanostomus	Round Goby	SNA				
Ameiurus nebulosus	Brown Bullhead	S5				

4.3.1.3 Species at Risk

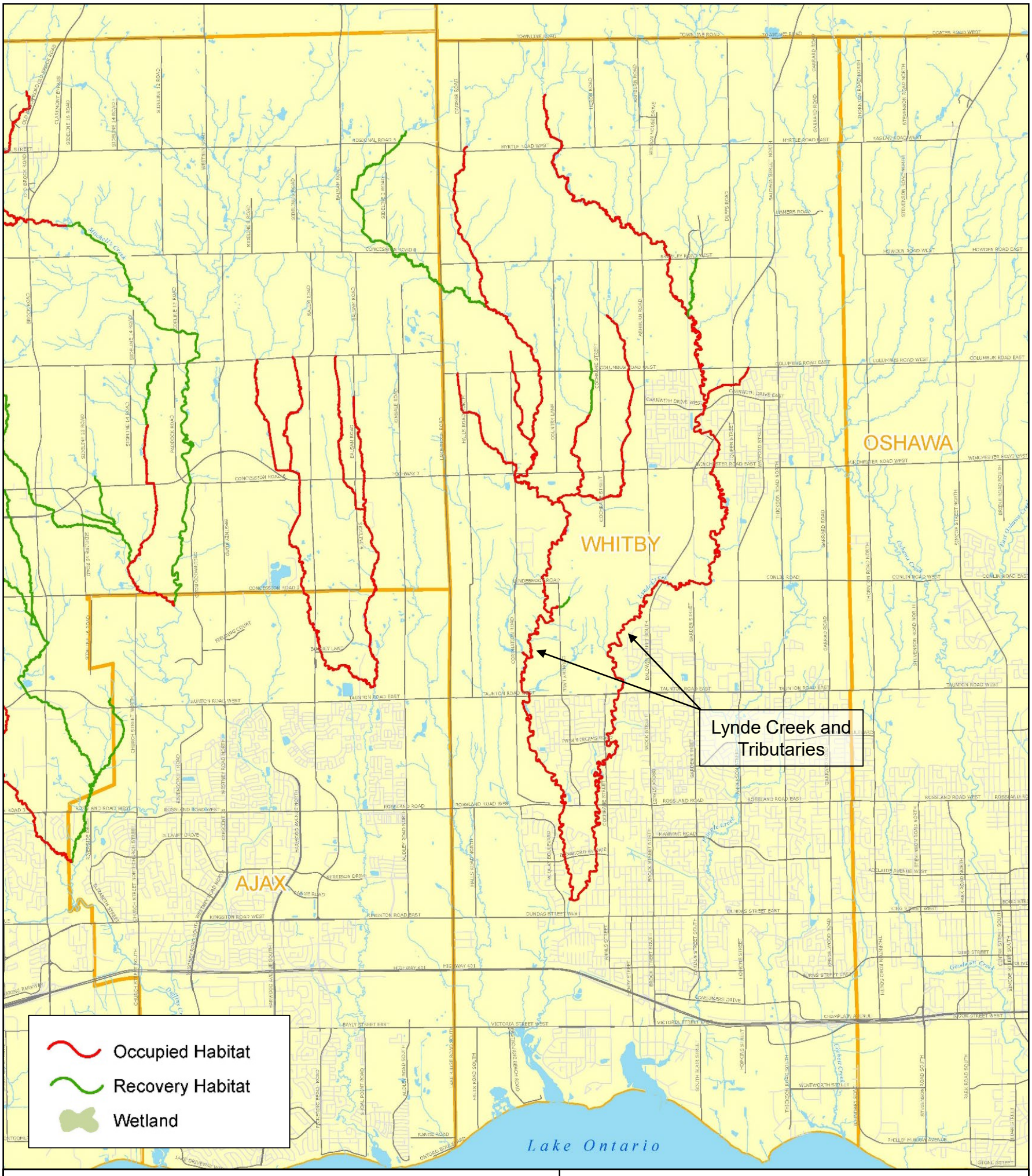
A desktop review was conducted referencing NHIC, eBird, iNaturalist, the Ontario Breeding Bird Atlas, the Butterfly Atlas of Ontario, the Lynde Creek Watershed Existing Conditions Report, the Ontario Mammal Atlas, and the Ontario Reptile and Amphibian Atlas to identify records for Species at Risk (SAR) and Species of Conservation Concern (SCC) within the respective watersheds. SAR species are those classified as Endangered (END) or Threatened (THR) under the Endangered Species Act. SCC are those species given Special Concern (SC) status under the *Endangered Species Act*, or Threatened or Endangered status under the Species at Risk Act. All of the species identified below will require consideration during the detailed design phases of the selected preferred alternatives.

Lynde Creek Watershed

In total, 55 SAR and SCC were identified to have the potential to occur in the Lynde Creek watershed (see **Table 4-17**). This included one amphibian, 36 birds, one fish, four mammals, one mollusc, seven plants, and five reptiles. Among these, there were 19 END, 13 THR, and 22 SC species. For a full list of these species along with their habitat requirements, please see table in **Appendix A**. The Region of Durham, in partnership with Conservation Authorities, has identified the occurrence of occupied and recovery Redside Dace habitat within the Region. Reaches in the study area with occupied and recovery habitat are shown in **Figure 4-7**.

Table 4-17. Lynde Creek Potential Species at Risk

Western Chorus Frog (*Pseudacris triseriata)*	Eastern Meadowlark (*Sturnella magna), THR*	Yellow Rail (*Coturnicops noveboracensis), SC*
Acadian Flycatcher *(Empidonax virescens), END*	Least Bittern (*Ixobrychus exilis), THR*	Redside Dace (*Clinostomus elongatus), END*
Barn Owl (*Tyto alba), END*	Louisiana Waterthrush (*Parkesia motacilla), THR*	Monarch (*Danaus plexippus), SC*
Golden Eagle (*Aquila chrysaetos), END*	Bald Eagle (*Haliaeetus leucocephalus), SC*	Eastern Small-footed Myotis (*Myotis leibii), END*
Henslow's Sparrow (*Centronyx henslowii), END*	Black Tern (*Chlidonias niger), SC*	Northern Myotis (*Myotis septentrionalis), END*
King Rail (*Rallus elegans), END*	Canada Warbler (*Cardellina canadensis), SC*	Tri-colored Bat (*Perimyotis subflavus), END*
Kirtland's Warbler (*Setophaga kirtlandii), END*	Common Nighthawk (*Chordeiles minor), SC*	Eastern Pondmussel (*Ligumia nasuta), SC*
Loggerhead Shrike *(Lanius ludovicianus), END*	Eastern Wood-pewee (*Contopus virens), SC*	Butternut (*Juglans cinerea), END*
Northern Bobwhite (*Colinus virginianus), END*	Evening Grosbeak (*Coccothraustes vespertinus), SC*	Cherry Birch (*Betula lenta), END*
Piping Plover (*Charadrius melodus), END*	Golden-winged Warbler (*Vermivora chrysoptera), SC*	Red Mulberry (*Morus rubra), END*
Prothonotary Warbler (*Protonotaria citrea), END*	Grasshopper Sparrow (*Ammodramus savannarum), SC*	White Wood Aster (*Eurybia divaricata), THR*
Yellow-breasted Chat (*Icteria virens), END*	Horned Grebe (*Podiceps auritus), SC*	Wild Hyacinth (*Camassia scilloides), THR*
American White Pelican (*Pelecanus erythrorhynchos), THR*	Olive-sided Flycatcher (*Contopus cooperi), SC*	Common Hoptree (*Ptelea trifoliata), SC*
Bank Swallow (*Riparia riparia), THR*	Peregrine Falcon (*Falco peregrinus), SC*	Riddell's Goldenrod (*Solidago riddellii), SC*
Barn Swallow (*Hirundo rustica), THR*	Red-headed Woodpecker (*Melanerpes erythrocephalus), SC*	Spiny Softshell (*Apalone spinifera), END*
Bobolink (*Dolichonyx oryzivorus), THR*	Rusty Blackbird (*Euphagus carolinus), SC*	Blanding's Turtle (*Emydoidea blandingii), THR*
Cerulean Warbler (*Setophaga cerulea), THR*	Short-eared Owl (*Asio flammeus), SC*	Eastern Hog-nosed Snake (*Heterodon platirhinos), THR*
Chimney Swift (*Chaetura pelagica),THR*	Wood Thrush (*Hylocichla mustelina), SC*	Northern Map Turtle (*Graptemys geographica), SC*
Snapping Turtle (*Chelydra serpentina), SC*		



Whitby Bridge and Culvert Master Plan

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Figure 4-5
Redside Dace Habitat, 2013

0 1 2 3 4
Kilometers

NAD 1983 UTM 17N

NTS

Project: 1837 Whitby Bridge/Culvert Master Plan
Date: 2020/03/11

Data Sources:
Region of Durham, 2013

Pringle Creek Watershed

A desktop review identified 35 potential SAR and SCC as having potential to occur in the Pringle Creek watershed (see **Table 4-18**). This included one amphibian, 21 birds, one insect, one fish, four mammals, one mollusc, one plant, and five reptiles. Among these there were 10 END, 8 THR, and 16 SC species. For a full list of these species along with their habitat requirements, please see **Appendix A.**

Table 4-18. Pringle Creek Potential Species at Risk

Henslow's Sparrow (Centronyx henslowii), END	Grasshopper Sparrow (Ammodramus savannarum), SC	Eastern Small-footed Myotis (Myotis leibii), END
Loggerhead Shrike (Lanius ludovicianus), END	Peregrine Falcon (Falco peregrinus), SC	Northern Myotis (Myotis septentrionalis), END
Northern Bobwhite (Colinus virginianus), END	Evening Grosbeak (Coccothraustes vespertinus), SC	Tri-colored Bat (Perimyotis subflavus), END
Chimney Swift (Chaetura pelagica), THR	Rusty Blackbird (Euphagus carolinus), SC	Tri-colored Bat (Perimyotis subflavus), END
Least Bittern (Ixobrychus exilis), THR	Black Tern (Chlidonias niger), SC	Eastern Pondmussel (Ligumia nasuta), SC
Barn Swallow (Hirundo rustica), THR	Canada Warbler (Cardellina canadensis), SC	Red Mulberry (Morus rubra), END
Bank Swallow (Riparia riparia), THR	Red-headed Woodpecker (Melanerpes erythrocephalus), SC	Spiny Softshell (Apalone spinifera), END
Bobolink (Dolichonyx oryzivorus), THR	Horned Grebe (Podiceps auritus), SC	Blanding's Turtle (Emydoidea blandingii), THR
Eastern Meadowlark (Sturnella magna), THR	Wood Thrush (Hylocichla mustelina), SC	Eastern Hog-nosed Snake (Heterodon platirhinos), THR
Bald Eagle (Haliaeetus leucocephalus), SC	Eastern Wood-pewee (Contopus virens), SC	Snapping Turtle (Chelydra serpentina), SC
Common Nighthawk (Chordeiles minor), SC	Monarch (Danaus plexippus), SC	Northern Map Turtle (Graptemys geographica), SC

Corbett Creek Watershed

A desktop review identified 41 potential SAR and SCC has having potential to occur in the Corbett Creek watershed (see **Table 4-19**). This included one amphibian, 30 birds, one insect, four mammals, one mollusc, one plant, and three reptiles. Among these there were 12 END, 9 THR, and 19 SC species. For a full list of these species along with their habitat requirements, please see Table in **Appendix A.**

Table 4-19. Corbett Creek Potential Species at Risk

Western Chorus Frog (Pseudacris triseriata)	Bobolink (Dolichonyx oryzivorus), THR	Wood Thrush (Hylocichla mustelina), SC
Golden Eagle (Aquila chrysaetos), END	Eastern Meadowlark (Sturnella magna), THR	Olive-sided Flycatcher (Contopus cooperi), SC
Henslow's Sparrow (Centronyx henslowii), END	Cerulean Warbler (Setophaga cerulea), THR	Eastern Wood-pewee (Contopus virens), SC
Loggerhead Shrike (Lanius ludovicianus), END	Bald Eagle (Haliaeetus leucocephalus), SC	Monarch (Danaus plexippus), SC
Northern Bobwhite (Colinus virginianus), END	Common Nighthawk (Chordeiles minor), SC	Eastern Small-footed Myotis (Myotis leibii), END
Yellow-breasted Chat (Icteria virens), END	Peregrine Falcon (Falco peregrinus), SC	Northern Myotis (Myotis septentrionalis), END
Prothonotary Warbler (Protonotaria citrea), END	Evening Grosbeak (Coccothraustes vespertinus), SC	Tri-colored Bat Perimyotis subflavus
Acadian Flycatcher (Empidonax virescens), END	Rusty Blackbird (Euphagus carolinus), SC	Tri-colored Bat (Perimyotis subflavus), END
Chimney Swift (Chaetura pelagica),THR	Black Tern (Chlidonias niger), SC	Eastern Pondmussel (Ligumia nasuta), SC
Least Bittern (Ixobrychus exilis), THR	Canada Warbler (Cardellina canadensis), SC	Red Mulberry (Morus rubra), END

Eastern Whip-poor-will (Antrostomus vociferus), THR	Golden-winged Warbler (Vermivora chrysoptera), SC	Blanding's Turtle (Emydoidea blandingii), THR
Barn Swallow (Hirundo rustica), THR	Red-headed Woodpecker (Melanerpes erythrocephalus), SC	Snapping Turtle (Chelydra serpentina), SC
Bank Swallow (Riparia riparia), THR	Horned Grebe (Podiceps auritus), SC	Northern Map Turtle (Graptemys geographica), SC
Bobolink (Dolichonyx oryzivorus), THR	Yellow Rail (Coturnicops noveboracensis), SC	
Eastern Meadowlark (Sturnella magna), THR	Short-eared Owl (Asio flammeus), SC	

Permit/Authorization or Registration under the ESA may be required for any of the potential SAR identified above. Surveys should be completed for the presence of these species during detailed design to further understand permitting needs.

4.3.2 Natural Heritage Considerations

The recommendations and general best management practices described below are general in nature and appropriate for a Master Planning Report. Detailed impact assessments and the provision of detailed recommendations for each location should be completed at the detailed design stage for each specific location and scoped based on the footprint of proposed work.

Detailed Field Investigations

The following surveys should be conducted at each selected preferred alternative location:

- **Vegetation Community Classification Surveys** – Vegetation communities should be assessed and defined into Ecological Land Classification (ELC) units as per the MNRF's guidelines (Lee et al, 1998). A summary of disturbance factors, community conditions, detailed plant species list and representative photographs should also be recorded for each vegetation patch.
- **Aquatic habitat surveys** – Aquatic habitat surveys should be completed at each selected preferred alternative location.
- **Breeding Bird Surveys –** Breeding bird surveys are to be completed to determine the presence/absence of species. Breeding bird surveys should be completed between May 24 and July 10 to capture use of bird species during the breeding bird period. Surveys should consist of two site visits during the peak breeding period.
- **Reptile and Amphibian Surveys** – Surveys to determine the presence of herpetofauna should include daytime searches throughout each study area should be conducted to determine the location for amphibian call surveys or reptile areas searches. Amphibian call surveys should be conducted in accordance with the standard protocols of the Marsh Monitoring Program, and reptile surveys should follow MNRF protocols.
- **Bat Cavity Tree Inventory** – A cavity tree inventory should be completed, whereby suitable cavities will be identified and assessed for quality, as per MNRF guidance documents. A Bat and Bat Habitat Impact Assessment should then be completed to determine the need for further studies.
- **Agency Consultation** – Further consultation with the MECP, DFO and CLOCA may be required once detailed field investigations have been completed to discuss potential impacts of the proposed works and permitting implications.

Species at Risk Specific Surveys

Once the preferred alternatives have been selected and the above field investigations have been completed species specific surveys for Species at Risk may be required for the species listed in Section 4.2.1.3. to understand permitting implications.

Wildlife Passage

Wildlife play a crucial role in our environment and require consideration during all levels of planning. Using the information provided in CLOCA's Wildlife Corridor Protection & Enhancement Plan (March, 2015), opportunities to improve or add wildlife passage at each preferred alternative will be considered during the detailed design stage. Regional, Landscape and Local Corridors already identified by CLOCA within each watershed should receive consideration. Design recommendations for each preferred alternative should consider what target species group (mammals, reptiles and/or amphibians, fish) are being considered when design features (openness ratio, length, width, terrestrial movement etc.) are being recommended.

General Best Management Practices at each location should include the consideration of the following for any development and construction works:

Aquatic Construction Timing Windows

Construction timing will be dependant on the sensitive fish timing windows for each watercourse. The timing windows are determined by the species present in the watercourses. The Department of Fisheries and Oceans (DFO) provides the sensitive timing windows for the Southern Region of Ontario for some common species, some of which are as follows (DFO, 2013):

- Brook Trout – October 1st to May 31st (Fall spawning);
- Rainbow Trout – March 15th to June 15th (Spring spawning); and
- Other/Unknown Spring spawning species – March 15th to July 15th.

Both Brook Trout and Rainbow Trout are known to occur in the Lynde Creek watershed. The appropriate timing window for any proposed culvert or bridge replacement should be determined through consultation with CLOCA and DFO during the detailed design and permitting phase.

Breeding Birds and Vegetation Clearing Timing Window

The federal Migratory Birds Convention Act is applied through The Regulations Respecting the Protection of Migratory Birds that states that "[…] no person shall disturb, destroy or take a nest, egg […] of a migratory bird." This law protects all birds aside from the introduced species European Starling, House Sparrow, and Rock Pigeon. Bird nests that are destroyed during the course of construction and other related activities is referred to as "incidental take" and is illegal except under the authority of a permit obtained through the Canadian Wildlife Service (CWS, 2014).

Requirements under the Migratory Birds Convention Act may apply to any culvert and bridge replacement where vegetation clearing is required. No vegetation clearing is permitted during the breeding bird nesting period. Generally, the period during which vegetation clearing is prohibited:

- April 1st to August 31st.

Vegetation Clearing and Bats

In addition to the above timing window, to mitigate for potential impacts to SAR bats and bat habitat, vegetation removal should avoid the bat active season:

- April 1st to October 15th.

4.4 Contaminated Sites

4.4.1 Waste Disposal Sites

The MECP Waste Disposal Site Inventory identifies six inactive sites in the study area. An additional five former waste disposal sites are identified in the Town of Whitby Official Plan Schedule C. These sites are presented in **Table 4-20**.

There are no active waste disposal sites within the study area.

Table 4-20. Waste Disposal Sites

Waste Disposal Site No.	General Location	Source	Closure Year	Crossings that could be impacted by Waste Disposal Site
A 390506	Whitby Harbour	MECP / Town of Whitby OP Schedule C	1979	BR_D07_06 (Watson Street East, Pringle Creek)
A 390501	Between Ashburn Road and Cochrane Street, approximately 500 m south of Highway 407	MECP / Town of Whitby OP Schedule C	1983	AC16 and AC5 located on Cochrane Street approximately 800 m west of the site.
X 7082	Chelmsford Drive near Pringle Creek and Highway 407	MECP	1976	Nearest crossings are Winchester Road East (Regional Road) and Highway 407 (Provincial Road). Possible consideration for BR_A08_07 (Cassels Road East, Pringle Creek)
X 7083	D'Hillier Park Area near Lynde Creek	MECP / Town of Whitby OP Schedule C	Not specified	BR_D07_02 (Dundas Street West, Lynde Creek)
X 7084	Consumers Drive between Pringle Creek and Hopkins Street.	MECP / Town of Whitby OP Schedule C	1968	BR_D07_05 (Burns Street East, Pringle Creek)
X 7085	Port Whitby	MECP	Not specified	BR_D07_06 (Watson Street East, Pringle Creek)
Not Identified	South of Highway 401 between Thickson Road South and South Blair Street.	Town of Whitby OP Schedule C	Not specified	Catchment drains to Lake Ontario. No crossings with potential impact.
Not Identified	Victoria Street East approximately 200 m east of South Blair Street.	Town of Whitby OP Schedule C	Not specified	Located within the Pringle Creek floodplain. BR_D07_06 (Watson Street East Bridge) is located approximately 350 m downstream of the site.
Not Identified	Located at or near the Peel Park.	Town of Whitby OP Schedule C	Not specified	Approximately 550 m east of crossing BR_D07_05 (Burns Street East Bridge).
Not Identified	West of Brock Street North between Woodlands Avenue and Dryden Boulevard.	Town of Whitby OP Schedule C	Not specified	Area has been fully developed with no crossings in the vicinity of the site.
Not Identified	Approximate address is 5015 Baldwin Street.	Town of Whitby OP Schedule C	Not specified	Site is near Lynde Creek, however, there are no town owned crossings along this reach.
Not Identified	Taunton Road East approximately 300 m east of Garrard Road.	Town of Whitby OP Schedule C	Not specified	Nearest town owned crossing is CU480022.

4.4.2 Pringle Creek and Whitby Harbour

The MECP has commenced a remediation project in Pringle Creek upstream from Whitby Harbour. The Watson Street East Bridge (BR_D07_06) is in the direct local area of the Ministry's work. The MECP Central Region Office must be contacted and consulted with prior to undertaking any works at the Watson Street East Bridge. Additionally, the federal Department of Fisheries and Oceans (DFO) has ongoing long-term work associated with contamination in Whitby Harbour that may be impacted by works at the Watson Street East Bridge (BR_D07_06), Watson Street West Culvert (CU_D01_03) and the Front Street West Culvert (CU_D01_02). The DFO should be consulted prior to any works associated with these three crossings.

5. Regulatory Requirements and Design Standards

This section of the report provides the Provincial and Municipal guidelines and standards relevant to the study.

5.1 Planning Context

The following provides a high level overview of the current applicable planning policies relevant to the Bridge and Culvert Master Plan.

5.1.1 Provincial Policy Statement (2020)

The Provincial Policy Statement (PPS) (2020) is the complimentary policy document to the Planning Act (2005). Issued under the authority of Section 3 of the Planning Act, the PPS provides direction on matters of provincial interest related to land use planning and development and promotes the provincial "policy-led" planning system that recognizes and addresses the complex interrelationship among environmental, economic and social factors in land use planning. As a key part of Ontario's policy-led planning system, the Provincial Policy Statement sets the policy foundation for regulating the development and use of land. It provides for appropriate development while protecting resources of provincial interest, public health and safety, and the quality of the natural environment. Key policies relevant to this Master Plan include the following:

- Section 1.6: Infrastructure and Public Service Facilities (including stormwater and transportation systems);
- Section 2.1: Natural Heritage;
- Section 2.2: Water
- Section 2.6: Cultural Heritage and Archaeology;
- Section 3.0: Protecting Public Health and Safety.

Relevance to Study: The above policies were considered in the development and evaluation of alternatives. Policy 3.1.3 of the PPS cites the potential impacts of climate change that may increase the risk associated with natural hazards are to be considered. Climate Change has been considered in this study when developing peak flows for proposed bridge and culvert replacements.

5.1.2 Source Water Protection

Section A.2.10.6 of the MEA Municipal Class EA document directs proponents, including the Town of Whitby to consider Source Water Protection (SWP) in the context of the Clean Water Act (CWA). Projects proposed within a vulnerable area are required to consider policies in the applicable Source Protection Plan (SPP), including their impact with respect to the project. A Watershed-based SPP contains policies to reduce existing and future threats to drinking water in order to safeguard human health through addressing activities that have the potential to impact municipal drinking water systems. The CTC (Credit Valley-Toronto and Region-Central Lake Ontario) Source Water Protection Plan is the relevant SPP for the study area which includes Lynde Creek, Pringle Creek and Corbett Creek. The following items summarise the source water protection relevant to this Master Plan:

- The Lynde Creek Watershed originates in the Oak Ridges Moraine and drains into Lake Ontario through Lynde Creek Marsh, a provincially significant wetland. The Heber Down Conservation Area is located in the middle of the watershed and the Lake Iroquois Beach crosses through the centre of the watershed in an east west direction.
- The Oak Ridges Moraine represents the most significant recharge area in the Lynde Creek watershed and the Lake Iroquois Beach is the second most important recharge zone.
- The Pringle Creek Watershed originates in the Lake Iroquois Beach and northern surrounding lands, draining into Lake Ontario through the Whitby Harbour Provincially Significant Wetland.

- There are no municipal wells within the study area and the municipal water supply comes from Lake Ontario. Private wells are used in some small settlement areas including Myrtle Station, Almond Village, Ashburn and Macedonian Village.
- Surface water quality is generally good with some elevated levels of phosphorous, nitrates and copper (decreasing or no trend) and increasing trends observed with chlorides. Chloride levels, while increasing, are below ecosystem-based standards. Nitrate, phosphorus, and copper levels are often above the standards and are likely associated with nutrient application in agricultural and non-agricultural lands for nitrate and phosphorus and historical industrial land-use for copper.
- The surface water in streams within the study area is important for supporting the ecosystem and are also used for irrigation and other non-drinking water purposes. Lynde Creek has a moderate groundwater stress level and a significant surface water stress level during summer months. The Pringle Creek and Corbett Creek watersheds have low stress levels for both groundwater and surface water.
- There are no significant drinking water quantity or quality threats from activities, conditions, or issues identified in the Highly Vulnerable Aquifers within the study area.
- There are no significant drinking water quantity or quality threats from activities, conditions, or issues identified in the Significant Groundwater Recharge Areas within the study area.
- There are no significant drinking water quantity threats related to municipal drinking water supplies around the Lake Ontario drinking water intakes.
- South of Lyndebrook Road, Lynde Creek and it's tributaries are considered Event Based Areas for the Lake Ontario municipal water intake zone. Contaminant spills in the Event Based Areas could have significant impacts on municipal water supply.
- Lake Ontario, Whitby Harbour, the mouth of Lynde Creek and immediately surrounding areas fall within the Intake Protection Zone 2 for the municipal water supply intake.

The primary concern from culvert and bridge replacement projects with respect to source water protection is impacts to surface water and groundwater from sediment releases and contaminant spills during construction. Construction bypass pumping and diversions are required to isolate the construction zone. Geotechnical and hydrogeological investigations should be undertaken at detailed design to determine bypass and dewatering requirements. Spills management should be implemented during construction to prevent sediment and hydrocarbon releases to the waterway.

5.1.3 Green Belt Plan (2017)

The Greenbelt Plan (2017) was established and approved under the Greenbelt Act, 2005. The study area falls within the Greenbelt Plan geographic area and, as such, all planning decision must conform with the Greenbelt Plan. The Plan was developed to prevent the loss of critical agricultural land, natural heritage features and water resource systems from urbanization. Limits to urbanization are identified in the Plan, along with natural and agricultural areas that should be protected.

Key sections and policies relevant to this Master Plan include the following:

- 2.4 Lands within the Protected Countryside Area;
- 3.2.2 Natural Heritage System Policies;
- 3.2.3 Water Resource System Policies;
- 3.2.4 Key Hydrologic Areas;
- 3.2.5 Key Natural Heritage Features and Key Hydrologic Features Policies; and
- 4.0 General Policies for the Protected Countryside.

Relevance to Study: The Study Area falls within the designated Protected Countryside and Natural Heritage System of the Greenbelt Plan Area. Protection and natural heritage and water resource systems has been considered when developing replacement alternatives for bridge and culvert projects included in this study.

5.1.4 Growth Plan for the Greater Golden Horseshoe (2020)

The Growth Plan for the Greater Golden Horseshoe (2020) was established and approved under the Places to Grow Act, 2005. The Growth Plan's framework supports complete communities, which includes a strong economy, a clean and healthy environment, and social equity. This includes limiting growth in flood hazard areas.

In addition, the Growth Plan sets out population and employment forecasts for all upper and single tier municipalities in order to better coordinate planning and accommodate growth in complete communities within the Greater Golden Horseshoe (GGH).

Relevance to Study: The Master Plan has considered future growth plans when estimating peak flows and identifying flood risk.

5.1.5 Oak Ridges Moraine Conservation Plan (2017)

The Oak Ridges Moraine Conservation Plan (ORMCP, 2017) was established and approved under the Oak Ridges Moraine Conservation Act, 2001. All planning decisions for projects that fall within the Oak Ridges Moraine must comply with the ORMCP. The ORMCP provides land use and resource management planning direction on how to protect the Moraine's ecological and hydrological features and functions. The ORMCP applies the following land use designations: Natural Core Areas, Natural Linkage Areas, Countryside Areas, and Settlement Areas.

The north section of the Lynde Creek subwatershed is located within the Oak Ridges Moraine Conservation Plan Area and includes the Natural Core Area, Natural Linkage Area, and the Countryside Area which includes the Rural Settlement Area. The northern study area limits also capture Category 1 and Category 2 of the Landform Conservation Area. Any bridge or culvert replacement projects within the Oak Ridges Moraine Conservation Plan Area should consider the protection of ecological and hydrological features during the design and construction phases.

5.2 Design Standards

The hydrologic and hydraulic assessment in this Master Plan was performed in accordance with the following documents:

- Town of Whitby Design Criteria and Engineering Standards (July 2019);
- Ministry of Natural Resources and Forestry (MNRF) Technical Guide – River and Stream Systems: Flooding Hazard Limit (2002);
- MTO Drainage Management Manual (1997);
- MTO Highway Drainage Design Standards (2008), which supersede Directive B-100;
- MTO Provincial Engineering Memorandum #2016-03 (March 31, 2016);
- CAN/CSA-S6-14 Canadian Highway Bridge Design Code (CHBDC);
- MTO Guide for Preparing Hydrology Reports for Water Crossings.

The existing capacity of each crossing was evaluated with respect to road classification provided by the Town of Whitby.

MTO's Highway Drainage Design Standards identify two drainage systems for assessing hydraulic capacity:

- Surface Drainage (SD) systems refer to crossings that convey primarily road surface drainage. For the purpose of this assessment, SD crossings are considered culverts with a catchment area less than 10 ha.
- Watercourse (WC) refers to crossings that convey flow on regulated and non-regulated watercourses. For the purpose of this assessment, WC crossings are considered bridges and culverts with a catchment area greater than 10 ha.

5.2.1 Flow Classification

Design Flow and Check Flow

Sections WC-1, SD-1, SD-13 of the Highway Drainage Design Standards have been used to determine the design flow criteria and are presented in **Table 5-1**.

Section WC-1 of the Highway Drainage Design Standards has been used to determine the check flow criteria presented in **Table 5-1.**

Table 5-1. Design Flow Classification.

Road Classification	Design Flow			Check Flow
	Surface Drainage	Watercourse		
		Span < 6.0 m	Span > 6.0 m	
Local	5-year	10-year	25-year	100% of 100-year
Collector	10-year	25-year	50-year	115% of 100-year
Rural Arterial	10-year	25-year	50-year	115% of 100-year
Urban Arterial	10-year	50-year	100-year	130% of 100-year

Regulatory Flow, Relief Flow and MNRF Flood Hazard Guidelines

The Regulatory storm varies with geographical area as identified in the Highway Drainage Design Standards (MTO, 2008). The Regulatory storm is defined as the Hurricane Hazel design storm event for the Lynde Creek and Corbett Creek watersheds and the 100-year event for the Pringle Creek watershed. The Town of Whitby design standards require new roadway culverts and bridges to pass the Regulatory flow to avoid adverse backwater effects, but do not provide guidance for existing structures.

MTO's Highway Drainage Design Standards state the Regulatory flow may be used to size crossings for routes which must remain useable during Regulatory flow conditions (WC-1, Section 1.1.3).

Where conveyance of the Regulatory flow is not required, Relief Flow over the roadway should be conveyed safely to limit flood risk to road users. MTO has adopted MNRF's flood hazard recommendations as outlined in the Technical Guide on River and Stream Systems: Flooding Hazard Limit (MNRF, 2002). The Highway Drainage Design Standards WC-13 stipulates that where Relief Flow is provided during the Regulatory flow the maximum depth of flow on the roadway shall not exceed 0.3 m and the product of the velocity and depth on the roadway shall not exceed 0.8 m^2/s. This criterion has been considered in the hydraulic assessment.

The Regulatory flow has only been assessed for Regulated crossings (i.e. crossings in a CLOCA HEC-RAS model) and unregulated crossings with a catchment area greater than 100 ha.

5.2.2 Design Criteria

The design criteria used to assess the hydraulic capacity of culverts and bridges were developed from the MTO Highway Drainage Design Standards (2007) and are presented in **Table 5-2** and **Table 5-3** respectively. The relevant MTO Design Standards are also provided.

Hydraulic design standards for sizing culverts are intended to prevent the following two modes of failure of the crossing and roadway embankment:

- Flooding of the roadway causing washout of the road embankment; and
- High water levels upstream of the culvert creating hydraulic head pressure against the roadway embankment and causing failure.

Flooding of the roadway is prevented through application of the freeboard criterion. Hydraulic pressure against the roadway embankment is prevented by limiting the maximum flood depth upstream of the crossing. The MTO flood depth criterion presented in **Table 5-2** varies based on the culvert rise (or diameter):

- For culverts with a rise less than 3.0 m the maximum flood depth should not exceed 1.5 times the culvert rise, presented as HW/D < 1.5, where HW = upstream water depth and D = the culvert rise. This allows the culvert obvert to become submerged during the design flow leading to pressure flow through the culvert and a build up of hydraulic head pressure against the road embankment.
- For culverts with a rise between 3.0 m and 4.5 m the maximum flood depth should not exceed 4.5 m, presented as HW < 4.5 m. This recognises that for large culverts under high road embankments where the freeboard criterion does not limit the flood depth, the ratio of HW/D may result in very deep water that causes significant hydraulic head pressure against the embankment. By limiting the water depth to 4.5 m, as a culvert gets larger, the head pressure against the road embankment does not increase, reducing the risk of embankment failure.

Additional design considerations including scour protection to prevent undermining and countersinking to improve fish passage conditions should be reviewed at detailed designed. These site specific considerations have not been reviewed in detail in the EA.

Table 5-2. Culvert Design Criteria.

Road Classification	Design Flow				Check Flow (MTO Standard WC-1)	Regulatory Event - Relief Flow over the Road (MTO Standard WC-13)
	Flood Depth (MTO Standard WC-7)		Freeboard to Road (MTO Standards SD-13 and WC-7)			
	Rise less than 3.0 m	Rise between 3.0 m and 4.5 m	Surface Drainage (SD)	Watercourse (WC)		
Local	HW/D < 1.5	HW < 4.5 m	0.3 m	0.3 m	Road should not overtop	•Depth < 0.3 m. •Velocity x Depth < 0.8 m2/s.
Collector, Rural Arterial, Urban Arterial	HW/D < 1.5	HW < 4.5 m	0.3 m	1.0 m		

HW: Refers to the water depth immediately upstream of the culvert
D: Refers to the culvert rise (or diameter)

Table 5-3. Bridge Design Criteria.

Road Classification	Design Flow		Check Flow	Regulatory Flow (Relief Flow over the Road)
	Clearance to Bridge Soffit (MTO Standard WC-2)	Freeboard to Road (MTO Standard WC-2)		
Local	0.3 m	0.3 m	Road should not overtop	•Depth < 0.3 m. •Velocity x Depth < 0.8 m^2/s.
Collector, Rural Arterial, Urban Arterial	1.0 m	1.0 m		

5.3 Climate Change Consideration

Climate change is expected to cause an increase in intensity and frequency of extreme rainfall events. This will increase the 2-year to 100-year peak flows within the Town of Whitby watercourses. Municipal infrastructure, including culverts and bridges, should be designed to account for the future increase in flows. In this study, peak flows used to assess design alternatives were increased to account for climate change using estimates derived from downscaling studies that apply future warming scenarios to intensity duration frequency (IDF) curves.

5.3.1 Ontario Ministry of Transportation

MTO, in partnership with the University of Waterloo undertook a study to investigate trends in historical rainfall records across Ontario. The study identified a regional scale upwards trend in extreme precipitation that ranged from 0.95% to 2.75% per decade for the 10-minute and 24-hour duration storm, respectively. The findings of the

study were incorporated into the MTO IDF Lookup Tool where a user can obtain an IDF curve for a specified location for the year 2010 and any year into the future.

On October 28, 2016, MTO released Provincial Engineering Memorandum #2016-14, titled Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Systems. PEM #2016-14 specifies that the future rainfall IDF values shall be used to size culverts and bridges.

ERI obtained IDF curves for the study area for the years 2010 (current conditions) and 2100 (expected lifespan of replacement infrastructure). The rainfall volume for the 2010 and 2100 IDF curves was compared for the 25-year and 100-year events and is presented in **Table 5-4**. The increase in rainfall volume from 2010 to 2100 ranges from 6% to 12% using the MTO IDF Curves.

5.3.2 University of Western Ontario IDF Curve Study

Simonovic and Peck (2009) assessed the change in the City of London IDF curves under two climate change scenarios, lower bound and upper bound. Climate change modified rainfall data was developed by applying Global Circulation Model outputs to observed rainfall data. The modified data was then used to develop IDF curves. The study found that all return period rainfall events increased in magnitude. The increase in rainfall volume ranged between 10.7% and 34.9% with an average of approximately 21% (Simonovic and Peck, 2009). Simonovic and Peck (2009) recommended the City of London increase IDF curves by 20% for the assessment and sizing of stormwater infrastructure. The percentage increase in rainfall volume for the 25-year and 100-year return period events is presented in **Table 5-4**.

Table 5-4. Percentage Increase in Rainfall Volume Based on the 2010 and 2100 MTO IDF Curves and the University of Western Ontario IDF Curve Study.

Storm Duration	25-year Return Period Percentage Increase in Rainfall Volume		100-year Return Period Percentage Increase in Rainfall Volume	
	MTO IDF Curve Comparison	University of Western Ontario Upper Bound Climate Change Scenario	MTO IDF Curve Comparison	University of Western Ontario Upper Bound Climate Change Scenario
1-hour	7%	21%	6%	21%
2-hour	8%	24%	6%	24%
6-hour	10%	26%	8%	26%
12-hour	11%	27%	10%	28%
24-hour	12%	20%	11%	21%

5.3.3 Climate Change Summary

The University of Western Ontario IDF Curve Study recommended an increase of 20% to IDF curves. This is more conservative than the MTO 2100 IDF curve which produced a maximum increase of 12%. For the purpose of this Master Plan, the more conservative University of Western Ontario study was applied to the hydrology and hydraulic assessment by increasing peak flow estimates by 20% to account for future climate change conditions. This approach is consistent with the approach adopted for the Lynde Creek Master Drainage Plan Update.

6. Bridge and Culvert Inventory

6.1 Field Investigations

ERI staff completed an inspection of all culverts and bridges included in the Master Plan. A detailed culvert inventory data sheet was developed to record the culvert identification, size, length, inverts, number of barrels, type, material, upstream and downstream culvert treatment, crossing angle, road type, road surface material, overtopping elevation, and location. Additionally, the data sheet includes considerations from a geomorphic and ecological perspective, including active channel processes, erosion, deposition, channel lowering, fish passage potential, overall stability, and enhancement opportunities.

Field survey was undertaken at all crossings to confirm existing conditions and support the hydraulic assessment. The survey was completed using a combination of total station and GPS survey. Total station survey was used at all bridges and at culverts with significant vegetation cover. Survey was completed in NAD83 UTM Zone 17N projection. The survey included upstream and downstream channel invert, culvert invert and obvert, bridge soffit, road centreline and other relevant features.

6.2 Changes to the Inventory

A summary of the bridge and culvert inventory is provided in **Table 6-1**.

The Town of Whitby classifies culverts into two categories:

- Culverts: have a total span greater than 3 m.
- Cross culverts: have a total span less than 3 m.

A desktop review using available topographic data was conducted to identify culverts not included in the existing bridge and culvert inventory. The review identified 14 additional cross culverts that were missing from the Town inventory. These crossings were added to the study.

Field investigations identified 11 crossings that have been removed or are not watercourse crossings. These are summarized below.

Table 6-1. Town of Whitby Bridge and Culvert Inventory Summary.

Crossing Type	Bridges	Culverts	Cross Culverts	Total Crossings
Original inventory provided by the Town of Whitby	22	31	97	150
Additional crossings identified through desktop review	0	0	13	13
Crossings removed from the inventory	-4	-6	-1	-11
Total crossings included in this Master Plan	**18**	**25**	**109**	**152**

Bridges BR_B04_02, BR_C04_03, BR_C04_04, BR_D07_04

These bridges are rail or road bridges at rail grade separations and are not watercourse crossings. Therefore, the bridges have not been included in this Master Plan. Photos of the bridges are presented below.

Photograph 1: Bridge BR_B04_02 at Rossland Road West

Photograph 2: Bridge BR_C04_03 at Brock Street North

Photograph 3: Bridge BR_C04_04 at Garden Street

Photograph 4: Bridge BR_D07_04 at Dundas Street East

Culverts CU_C09_01, CU_C09_02, CU_C09_03 and CU_C09_04

These culverts are connected, forming a single structure that diverts flow in Ash Creek around the rail grade separation at Brock Street North. The Pringle Creek HEC-RAS model terminates at the downstream end of the crossing. A hydraulic assessment of the structure would have been completed to support the grade separation design. Therefore, the culverts have not been included in this Master Plan.

Culvert CU_D01_01

This culvert historically conveyed flows under Dundas Street. The culvert has since been converted to an inlet structure for the Dundas Street trunk storm sewer and the culvert has not been included in this Master Plan.

Culvert CU_D01_05

This culvert is located at the intersection of Nichol Avenue and Thickson Road. The Region of Durham has confirmed that this culvert is owned by the Region, therefore, the culvert has been removed from this study.

Culvert CU420004

This culvert was removed to facilitate the construction of a new stormwater management facility. Drainage originally conveyed by the culvert is now directed to the facility.

6.3 Regulated and Unregulated Crossings

To aid in the description of the hydrology and hydraulic assessment process, crossings were defined as either Regulated or Unregulated crossings based on the following classification:

- Regulated crossings: Crossings within the limits of a CLOCA HEC-RAS model.
- Unregulated crossings: Crossings outside the limits of a CLOCA HEC-RAS.

The hydrology and hydraulic modeling methodology presented in **Section 8** differs for Regulated and Unregulated crossings based on the availability of existing hydrology and hydraulic modeling provided by CLOCA. A summary of the number of Regulated and Unregulated crossings is provided in **Table 6-2**.

Table 6-2. Classification of Regulated and Unregulated Crossings.

Crossing Type	Bridges	Culverts	Cross Culverts	Total Crossings
Regulated Crossings	18	24	15	**57**
Unregulated Crossings	0	1	94	**95**
Total crossings included in this Master Plan	18	25	109	**152**

A full list of culverts and bridges included in the study is presented in **Table 6-3** and shown in **Figure 6-1** to **Figure 6-5**.

Following direction from the Town of Whitby, for the purpose of assessing risk, the road classification for Watson Street East, Brawley Road West, Townline Road West and Halls Road North was downgraded to prioritize the Highest Risk towards arterial roads with high traffic volumes. The road re-classifications are as follows:

- Watson Street East: reclassified from Rural Arterial to Collector.
- Brawley Road West: reclassified from Rural Arterial to Collector.
- Townline Road West: reclassified from Rural Arterial to Collector.
- Halls Road North: reclassified from Rural Arterial to Local.

These re-classifications are reflected in **Table 6-3**.

Table 6-3. Town of Whitby Bridge and Culvert Inventory.

Asset Number	Road Name	Road Classification	Description
Unregulated Crossings			
CU000004	Halls Rd S	Local	660 mm Diameter Circular CSP Culvert
CU000005	Halls Rd S	Local	800 mm Diameter Circular CSP Culvert
CU210011	Halls Rd N	Local	700 mm Diameter Circular CSP Culvert
CU210012	Halls Rd N	Local	450 mm Diameter Circular CSP Culvert
CU410009	Halls Rd N	Local	400 mm Diameter Circular CSP Culvert
CU420015	Coronation Rd	Collector	450 mm Diameter Circular CSP Culvert
CU420024	Coronation Rd	Collector	600 mm Diameter Circular CSP Culvert
CU420025	Coronation Rd	Collector	1200 mm Diameter Circular CSP Culvert
CU420026	Coronation Rd	Collector	1200 mm Diameter Circular CSP Culvert
CU420027	Coronation Rd	Collector	600 mm Diameter Circular CSP Culvert
CU420028	Coronation Rd	Collector	1200 mm Diameter Circular CSP Culvert

Asset Number	Road Name	Road Classification	Description
CU420029	Lynde brook Rd	Rural Arterial	950 mm Diameter Circular CSP Culvert
CU430004	Country Lane	Local	900 mm Diameter Circular CSP Culvert
CU430005	Country Lane	Local	750 mm Diameter Circular CSP Culvert
CU460005	Anderson St	Rural Arterial	550 mm span x 430 mm rise Ellipse CSP Culvert
CU460006	Anderson St	Rural Arterial	450 mm Diameter Circular CSP Culvert
CU460014	Anderson St	Rural Arterial	600 mm Diameter Circular CSP Culvert
CU480010	Garrard Rd	Rural Arterial	600 mm Diameter Circular CSP Culvert
CU480013	Garrard Rd	Rural Arterial	400 mm Diameter Circular CSP Culvert
CU480022	Birchpark Dr	Local	1300 mm span x 900 mm rise Ellipse CSP Culvert
CU510008	Halls Rd N	Local	1200 mm Diameter Circular CSP Culvert
CU510016	Halls Rd N	Local	600 mm Diameter Circular CSP Culvert
CU510017	Coronation Rd	Collector	600 mm Diameter Circular CSP Culvert
CU520025	Park Rd	Local	450 mm Diameter Circular CSP Culvert
CU520035	Coronation Rd	Collector	750 mm Diameter Circular CSP Culvert
CU520052	Park Rd	Local	250 mm Diameter Circular CSP Culvert
CU520053	Park Rd	Local	300 mm Diameter Circular CSP Culvert
CU520057	Ward St	Local	450 mm span x 350 mm rise Ellipse CSP Culvert
CU520061	Coronation Rd	Collector	600 mm Diameter Circular CSP Culvert
CU550024	Ashburn Rd	Rural Arterial	450 mm span x 300 mm rise Ellipse CSP Culvert
CU560002	St Thomas St	Local	400 mm Diameter Circular HDPE Culvert
CU610022	Columbus Rd W	Rural Arterial	800 mm Diameter Circular CSP Culvert
CU620004	Coronation Rd	Local	450 mm Diameter Circular CSP Culvert
CU630003	Country Lane	Local	450 mm Diameter Circular CSP Culvert
CU630019	Country Lane	Local	700 mm Diameter Circular CSP Culvert
CU640001	Cochrane St	Local	300 mm Diameter Circular CSP Culvert
CU640007	Cochrane St	Local	450 mm Diameter Circular CSP Culvert
CU640013	Cochrane St	Local	400 mm Diameter Circular CSP Culvert
CU640016	Columbus Rd W	Rural Arterial	500 mm Diameter Circular CSP Culvert
CU640017	Cochrane St	Local	500 mm Diameter Circular CSP Culvert
CU660004	Way St	Local	400 mm Diameter Circular CSP Culvert
CU660019	Way St	Local	600 mm Diameter Circular CSP Culvert
CU660031	Way St	Local	400 mm Diameter Circular CSP Culvert
CU680003	Columbus Rd E	Rural Arterial	1850 mm Diameter Circular Concrete Culvert
CU700002	Columbus Rd W	Rural Arterial	Twin 1050 mm Diameter Circular CSP Culvert
CU710003	Brawley Rd W	Collector	600 mm Diameter Circular CSP Culvert
CU710004	Brawley Rd W	Collector	900 mm Diameter Circular CSP Culvert
CU720007	Columbus Rd W	Rural Arterial	1050 mm Diameter Circular CSP Culvert
CU730003	Country Lane	Local	500 mm span x 300 mm rise Ellipse CSP Culvert
CU730033	Columbus Rd W	Rural Arterial	1250 mm Diameter Circular CSP Culvert
CU740003	Cochrane St	Local	300 mm Diameter Circular CSP Culvert
CU740004	Brawley Rd W	Collector	450 mm Diameter Circular CSP Culvert
CU740010	Brawley Rd W	Collector	600 mm Diameter Circular CSP Culvert
CU740027	Cochrane St	Local	500 mm Diameter Circular CSP Culvert
CU740042	Cochrane St	Local	600 mm Diameter Circular CSP Culvert
CU750001	Cedarbrook Trail	Local	450 mm Diameter Circular CSP Culvert
CU760024	Columbus Rd W	Rural Arterial	900 mm Diameter Circular CSP Culvert
CU760025	Duffs Rd	Local	750 mm Diameter Circular CSP Culvert
CU770008	Brawley Rd W	Collector	600 mm Diameter Circular CSP Culvert
CU770009	Brawley Rd W	Collector	600 mm Diameter Circular CSP Culvert

Asset Number	Road Name	Road Classification	Description
CU770010	Columbus Rd E	Rural Arterial	1700 mm span x 1600 mm rise Concrete Box Culvert
CU840008	Brawley Rd W	Collector	500 mm span x 300 mm rise Ellipse CSP Culvert
CU860004	Brawley Rd W	Collector	600 mm Diameter Circular CSP Culvert
CU860005	Duffs Rd	Local	1200 mm Diameter Circular CSP Culvert
CU870006	Brawley Rd W	Collector	Twin 900 mm span x 600 mm rise Ellipse CSP Culvert
CU880003	Hamers Rd	Local	760 mm Diameter Circular CSP Culvert
CU930007	Grouse Ct	Local	600 mm Diameter Circular CSP Culvert
CU940018	Ashburn Rd	Collector	2500 mm span x 1250 mm rise Concrete Box Culvert
CU940022	Townline Rd W	Collector	800 mm Diameter Ellipse CSP Culvert
CU940023	Ashburn Rd	Collector	400 mm Diameter Circular CSP Culvert
CU950022	Townline Rd W	Collector	450 mm Diameter Circular CSP Culvert
CU950023	Townline Rd W	Collector	450 mm Diameter Circular CSP Culvert
CU970009	Townline Rd W	Collector	600 mm Diameter Circular CSP Culvert
CU970010	Duffs Rd	Local	600 mm Diameter Circular CSP Culvert
CU970011	Duffs Rd	Local	1200 mm Diameter Circular CSP Culvert
CU980002	Mud Lake Rd	Local	600 mm Diameter Circular CSP Culvert
CU980003	Mud Lake Rd	Local	600 mm Diameter Circular CSP Culvert
CU980005	Mud Lake Rd	Local	350 mm Diameter Circular CSP Culvert
CU980010	Townline Rd E	Collector	400 mm Diameter Circular CSP Culvert
CU990010	Townline Rd E	Collector	1200 mm Diameter Circular CSP Culvert
CU990011	Garrard Rd	Local	600 mm Diameter Circular CSP Culvert
CU_A07_09	Calistoga Dr	Local	3000 mm span x 1400 mm rise Concrete Box Culvert
AC01	Lake Ridge Rd	Rural Arterial	500mm Diameter Circular CSP Culvert
AC02	Lake Ridge Rd	Rural Arterial	400mm Diameter Circular CSP Culvert
AC03	Peleshok Dr	Local	Twin 500mm Diameter Circular CSP Culvert
AC04	Cochrane St	Local	1500mm span x 1000mm rise Ellipse CSP Culvert
AC05	Brawley Rd W	Collector	450mm Diameter Circular CSP Culvert
AC06	Cochrane St	Local	450mm Diameter Circular CSP Culvert
AC08	Lyndebrook Rd	Rural Arterial	400mm Diameter Circular CSP Culvert
AC15	Country Ln	Local	750mm Diameter Circular CSP Culvert
AC18	Ashburn Rd	Rural Arterial	2000mm span x 900mm rise Concrete Box Culvert
Regulated Crossings			
CU210001	Halls Rd N	Local	2400 mm Diameter Circular CSP Culvert
CU360001	Anderson St	Urban Arterial	2000 mm Diameter Circular CSP Culvert
CU480017	Conlin Rd	Rural Arterial	Twin 1050 mm Diameter Circular CSP Culvert
AC20	Conlin Rd	Rural Arterial	Twin 1050 mm diameter Circular CSP Culvert – Relief for CU480017
AC21	Conlin Rd	Rural Arterial	Twin 1050 mm diameter Circular CSP Culvert – Relief for CU480017
CU500015	Halls Rd N	Local	1000 mm Diameter Circular CSP Culvert
CU570013	St Thomas St	Local	880 mm Diameter Circular Concrete Culvert
CU720006	Brawley Rd W	Collector	1200 mm Diameter Circular CSP Culvert
CU730010	Country Lane	Local	900 mm Diameter Circular CSP Culvert
CU730011	Country Lane	Local	800 mm Diameter Circular CSP Culvert
CU730013	Country Lane	Local	1000 mm Diameter Circular CSP Culvert
CU780010	Garrard Rd	Local	2400 mm Diameter Circular CSP Culvert
CU780011	Garrard Rd	Local	Twin 1200 mm Diameter Circular CSP Culvert
CU780012	Garrard Rd	Local	Twin 1200 mm Diameter Circular CSP Culvert
CU880004	Hamers Rd	Local	1500 mm Diameter Circular CSP Culvert
CU920010	Townline Rd W	Collector	1500 mm Diameter Circular CSP Culvert
CU960013	Townline Rd W	Collector	3000 mm span x 1950 mm rise Arch CSP Culvert

Asset Number	Road Name	Road Classification	Description
CU_A07_01	Ashburn Rd	Rural Arterial	5550 mm span x 3500 mm rise Arch CSP Culvert
CU_A07_02	Brawley Rd W	Collector	5000 mm span x 3000 mm rise Arch CSP Culvert
CU_A07_03	Brawley Rd W	Collector	5100 mm span x 3200 mm rise Ellipse CSP Culvert
CU_A07_04	Brawley Rd W	Collector	4600 mm span x 2700 mm rise Arch CSP Culvert
CU_A07_05	Columbus Rd W	Rural Arterial	3000 mm span x 2000 mm rise Ellipse CSP Culvert
CU_A07_06	Columbus Rd W	Rural Arterial	Twin 6100 mm span x 2700 mm rise Concrete Box Culvert
CU_A07_07	Columbus Rd W	Rural Arterial	6000 mm span x 3000 mm rise Concrete Box Culvert
CU_A07_08	Carnwith Dr E	Urban Arterial	2400 mm span x 1400 mm rise Concrete Box Culvert
CU_A07_09	Calistoga Dr	Local	3000 mm span x 1400 mm rise Concrete Box Culvert
CU_A07_10	Calistoga Dr	Local	6000 mm span x 2300 mm rise Arch CSP Culvert
CU_A07_11	Petaluma Ct	Local	6000 mm span x 2000 mm rise Arch CSP Culvert
CU_A07_12	Columbus Rd W	Rural Arterial	3100 mm span x 1750 mm rise Concrete Box Culvert
CU_B04_01	Rossland Rd W	Rural Arterial	6000 mm span x 2800 mm rise Concrete Box Culvert
CU_B04_02	Rossland Rd W	Rural Arterial	5600 mm span x 1500 mm rise Concrete Box Culvert
CU_B04_03	Dryden Blvd	Urban Arterial	Twin 4000 mm span x 2750 mm rise Concrete Box Culvert
CU_B04_04	Anderson St	Urban Arterial	3080 mm span x 1510 mm rise Concrete Box Culvert
CU_C09_05	Garden St	Urban Arterial	Twin 3000 mm span x 2000 mm rise Concrete Box Culvert
CU_C09_06	Bradley Dr	Rural Arterial	Twin 3800 mm span x 2450 mm rise Concrete Box Culvert
CU_C09_07	Harold St	Local	3860 mm span x 2480 mm rise Arch CSP Culvert
CU_C09_08	Westwood Rd	Local	3050 mm span x 1820 mm rise Concrete Box Culvert
CU_C09_09	Forest Rd	Local	1650 mm span x 1100 mm rise Ellipse CSP Culvert
CU_D01_02	Front St W	Local	3000 mm span x 1220 mm rise Concrete Box Culvert
CU_D01_03	Watson St W	Rural Arterial	Twin 1800 mm span x 1130 mm rise Concrete Box Culvert
CU_D01_04	Springwood St	Rural Arterial	Twin 3050 mm span x 1800 mm rise Concrete Box Culvert
CU_D01_06	Dundas St W	Urban Arterial	2750 mm span x 2150 mm rise Ellipse CSP Culvert
AC14	Duggan Ave	Local	2400 mm span x 1200 mm rise Concrete Box Culvert
AC16	Cochrane St	Local	2630 mm span x 1640 mm rise Arch CSP Culvert
BR_A08_01	Cedarbrook Trail	Local	10 m span Bridge
BR_A08_02	Columbus Rd W	Rural Arterial	8.3 m span Bridge
BR_A08_03	Coronation Rd	Local	3.11 m span Bridge
BR_A08_04	Way St	Local	12.2 m span Bridge
BR_A08_05	Carnwith Dr W	Urban Arterial	22.2 m span Bridge
BR_A08_06	Way St	Local	10.4 m span Bridge
BR_A08_07	Cassells Rd E	Rural Arterial	12.1 m span Bridge
BR_A08_08	Lyndebrook Rd	Rural Arterial	12.2 m span Bridge
BR_B04_01	Cochrane St N	Local	16.55 m span Bridge
BR_B04_03	Rossland Rd W	Rural Arterial	15.55 m span Bridge
BR_B04_04	Rossland Rd W	Rural Arterial	15.6 m span Bridge
BR_C04_01	Bonacord Ave	Urban Arterial	14.6 m span Bridge
BR_C04_02	Bonacord Ave	Urban Arterial	14.75 m span Bridge
BR_D07_01	Jeffery St	Local	28.1 m span Bridge
BR_D07_02	Dundas St W	Urban Arterial	18.6 m span Bridge
BR_D07_03	Dundas St E	Urban Arterial	15.7 m span Bridge
BR_D07_05	Burns St E	Urban Arterial	9.6 m span Bridge
BR_D07_06	Watson St E	Collector	12.1 m span Bridge

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North View

Central View

Upper South View

Lower South View

Legend

- Figure Extents
- Additional Culverts (13)
- Bridges (18)
- Cross Culverts (96)
- Culverts (25)
- Bridges and Culverts Not Included in Study (11)
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

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Figure 6-1

Bridge and Culvert Inventory (Overview)

0 1.25 2.5 5 Kilometers

NAD 1983 UTM 17

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Project: 1837 Whitby Bridge/ Culvert Master Plan
Date: 2020/09/23

N W E S

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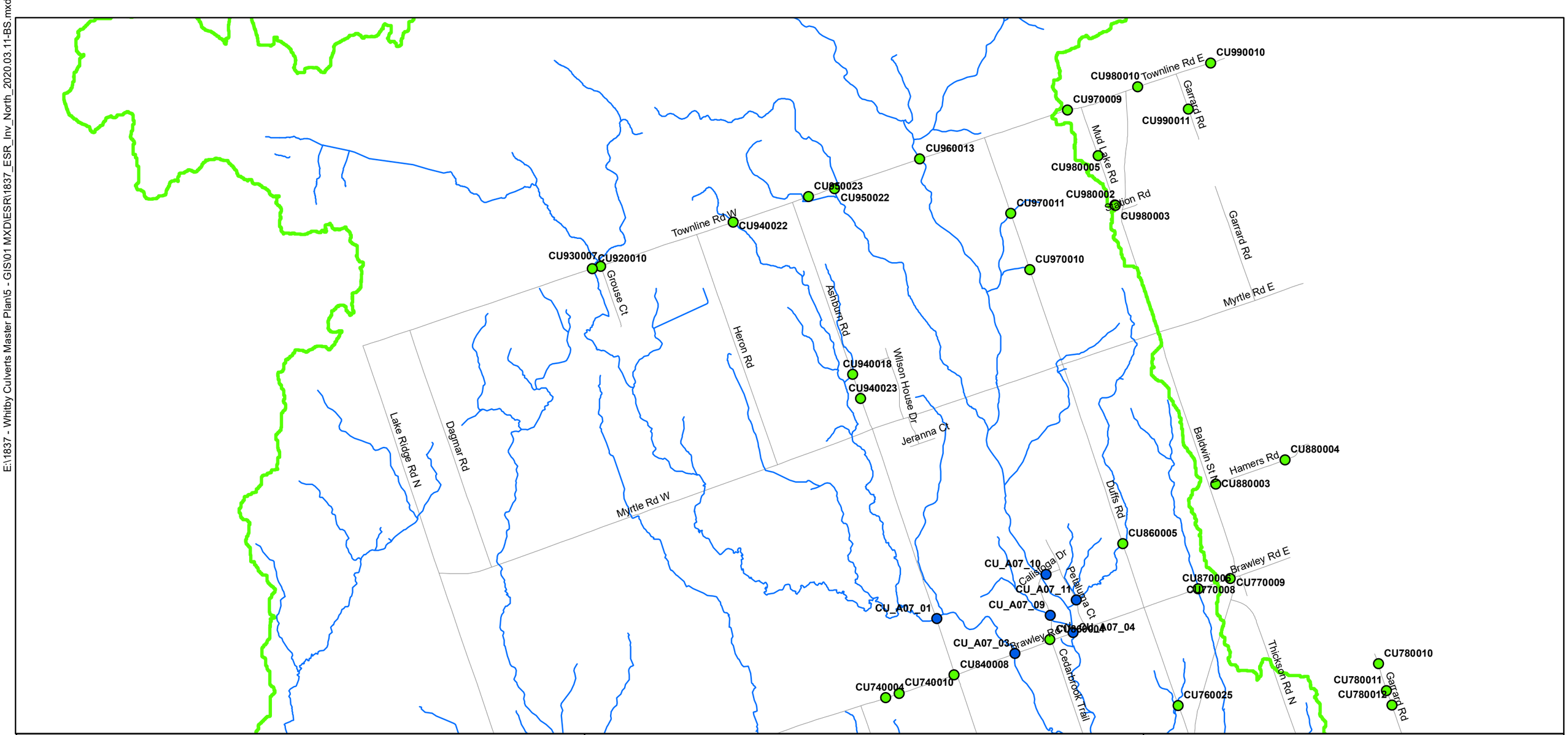

Legend

- Additional Culverts (13)
- Bridges (18)
- Cross Culverts (96)
- Culverts (25)
- Bridges and Culverts Not Included in Study (11)
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 6-2

Bridge and Culvert Inventory (North View)

0 0.5 1 2 Kilometers

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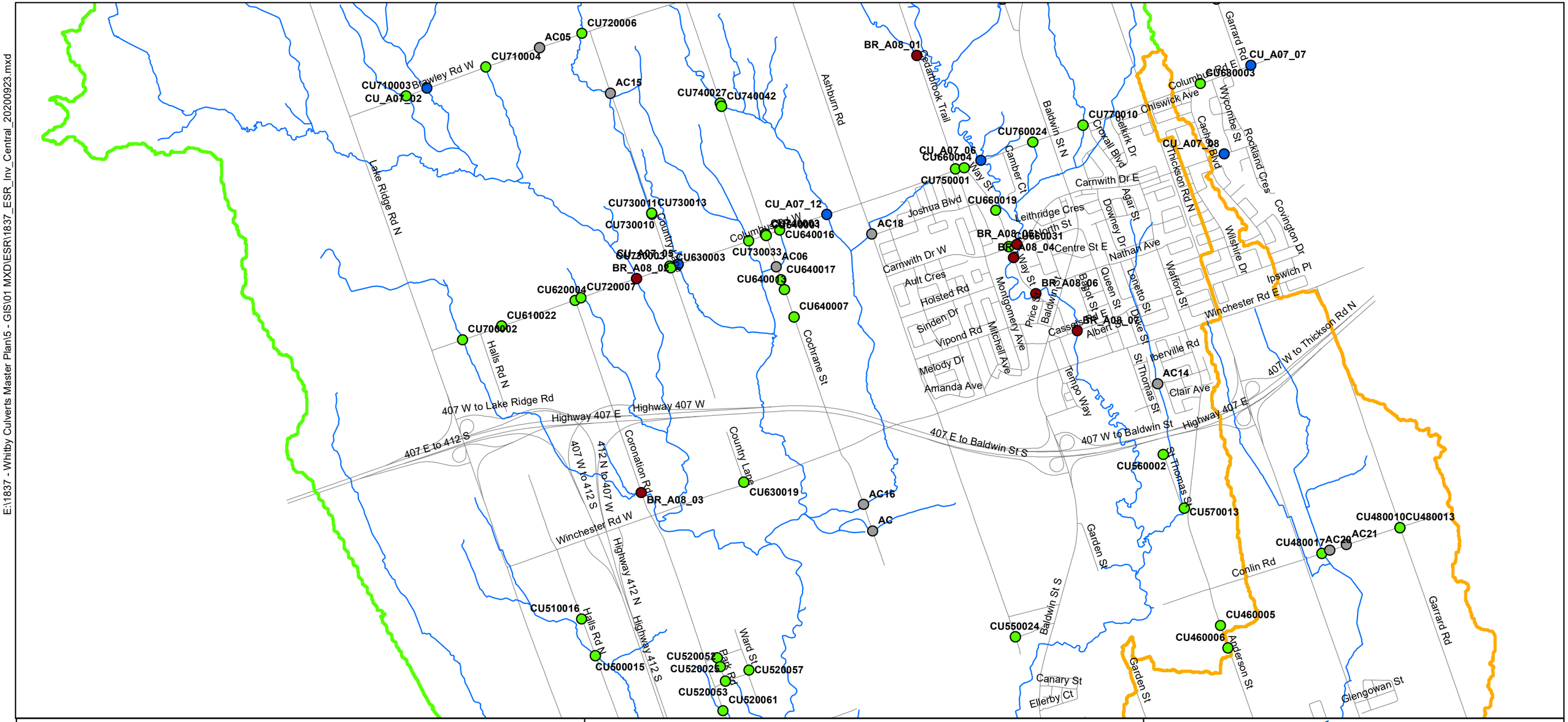

Legend

- Additional Culverts (13)
- Bridges (18)
- Cross Culverts (96)
- Culverts (26)
- Bridges and Culverts Not Included in Study (11)
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 6-3

Bridge and Culvert Inventory (Central View)

0 0.5 1 2 Kilometers

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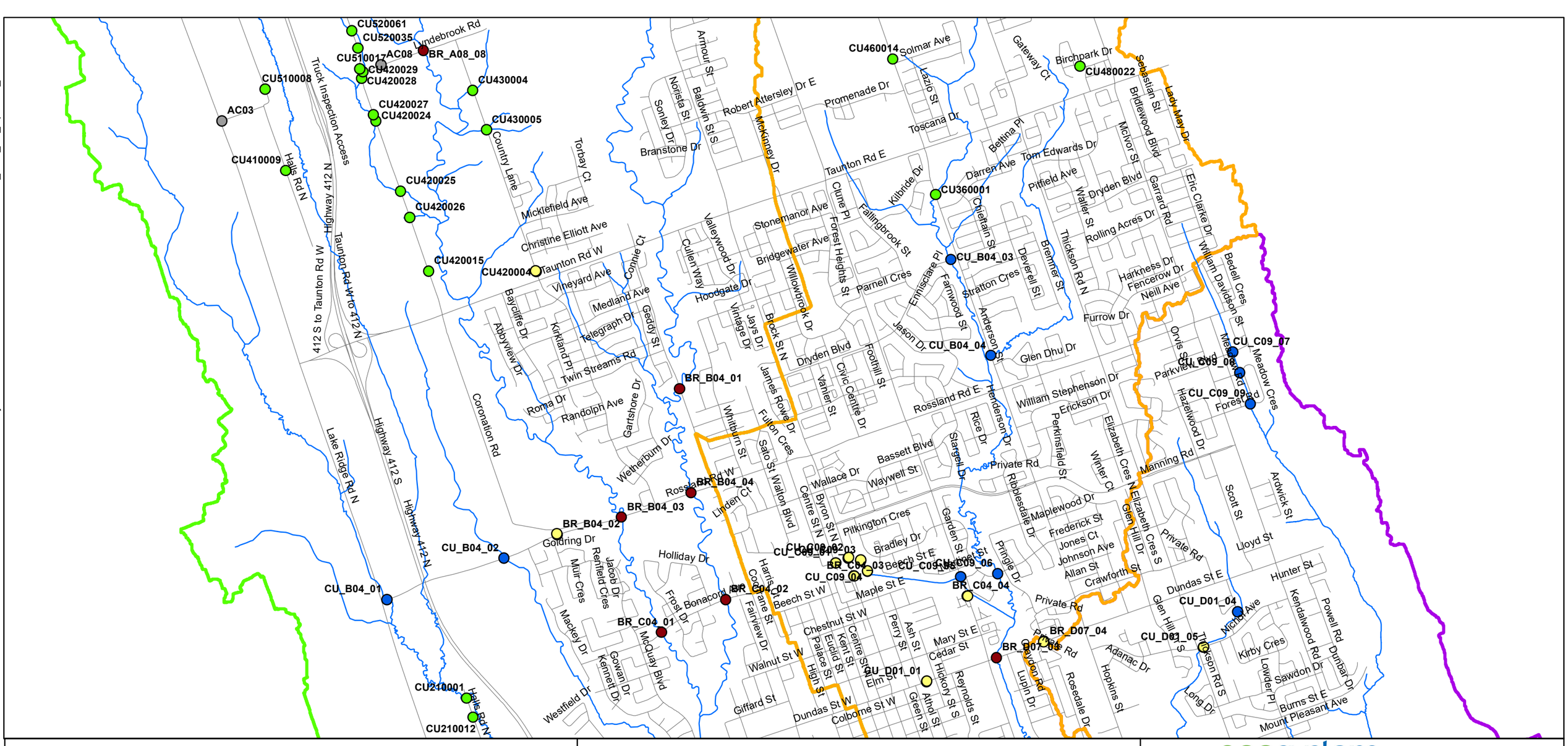

Legend

- Additional Culverts (13)
- Bridges (18)
- Cross Culverts (96)
- Culverts (25)
- Bridges and Culverts Not Included in Study (11)
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 6-4

Bridge and Culvert Inventory (Upper South View)

0 0.5 1 2 Kilometers

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Date: 2020/12/22

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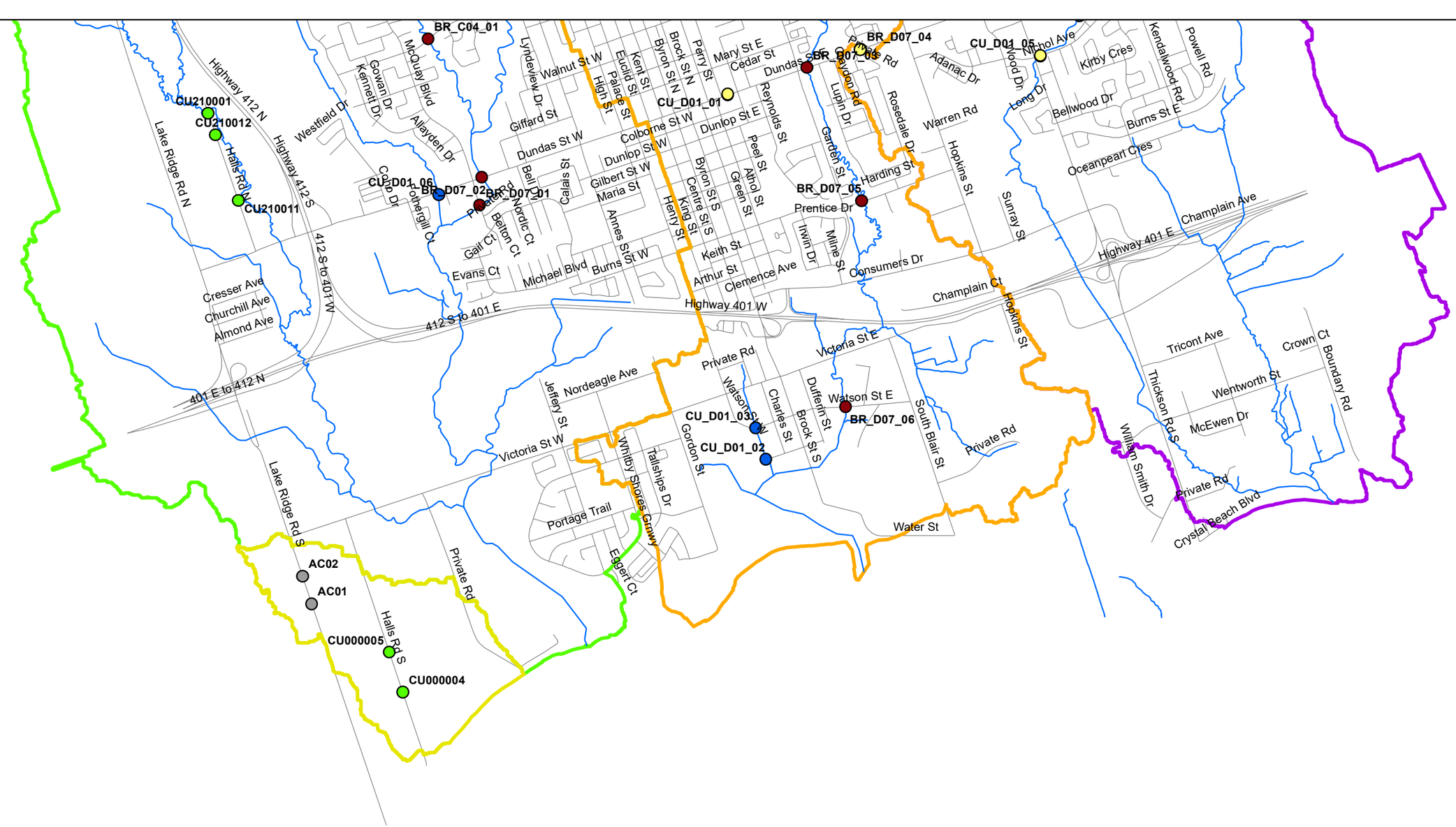

Legend

- Additional Culverts (13)
- Bridges (22)
- Cross Culverts (97)
- Culverts (31)
- Bridges and Culverts Not Included in Study (11)
- Watercourses (ERI)

Watershed

- Corbett Creek
- Cranberry
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 6-5

Bridge and Culvert Inventory (Lower South View)

0 0.5 1 2 Kilometers

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Date: 2020/12/22

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7. Risk Assessment Process

7.1 Risk Assessment Criteria

A risk assessment matrix was developed to facilitate the prioritization of culvert and bridge replacements at structures that failed to meet the design criteria. The risk assessment matrix is based on ISO 31000:2018, Risk Management – Guidelines. The risk assessment matrix considers two decision making criteria; Likelihood and Consequence. The definition and categories for the two criteria are described below.

7.1.1 Likelihood

Likelihood represents the probability that failure of the crossing due to flooding will occur. The Likelihood criteria is determined using the design criteria and the return period for flooding of the road. Four categories for Likelihood were defined:

- **No Likelihood – Unlikely to fail due to hydraulic capacity**:
  - Crossing meets the design flow criteria (flood depth, freeboard, clearance);
  - The road does not overtop during the design flow;
  - the road does not overtop during the check flow; and,
  - If the Regulatory storm overtops the road it meets the relief flow criteria.
- **Low Likelihood – Failure may occur during Regulatory storm**:
  - Crossing meets the design flow criteria (flood depth, freeboard, clearance);
  - The road does not overtop during the design flow;
  - The road does not overtop during the check flow; and
  - The Regulatory storm overtops the road and fails to meet the relief flow criteria.
- **Medium Likelihood – Failure may occur during the check flow and Regulatory storm**:
  - Crossing fails to meet the design flow criteria (flood depth, freeboard, clearance);
  - The road does not overtop during the design flow;
  - The road overtops during the check flow; and
  - The Regulatory storm overtops the road and fails to meet the relief flow criteria.
- **High Likelihood – Failure may occur during the design flow, check flow and Regulatory storm**:
  - Crossing fails to meet the design flow criteria (flood depth, freeboard, clearance);
  - The road overtops during the design flow;
  - The road overtops during the check flow; and
  - The Regulatory storm overtops the road and fails to meet the relief flow criteria.

7.1.2 Consequence

Consequence refers to the potential impact from the undesired event if it were to occur. Because the flood damages or risk to life associated with each structure is unknown, the Consequence criteria has been inferred from the following two indicators that can be determined with available GIS mapping and are expected to correlate well with actual flood risk:

- **Road Class**: Road classes are primarily based on traffic volumes. A higher flood risk is expected when flooding occurs on high volume road. The Town of Whitby road classification has been used to categorize Consequence for this indicator, i.e. local, collector and arterial roads.
- **Surrounding Lot Density**: A higher surrounding lot density is expected to increase flood damages and risk to life. The number of lots within 100 m for cross culverts and 150 m for bridges and structural culverts was used to define lot density. In this study, all bridges and structural culverts are located on regulated watercourses with defined floodplains where development is limited. In comparison, cross culverts are typically located on drainage ditches in closer proximity to buildings. To remove potential bias in the risk assessment towards cross culverts on small channels or drainage ditches, the buffer distance was increased for bridges and structural culverts. Lot density was categorized as follows:

- **Low Density**: Less than 10 lots.
- **Medium Density**: Between 10 and 20 lots.
- **High Density**: Greater than 20 lots.

Using these two indicators, four categories for Consequence were defined:

- **Low**: Culvert or bridge is on a local road and the surrounding lot density is low to medium.
- **Medium**: Culvert or bridge is on a local road with high surrounding lot density or is on a collector road with low surrounding lot density.
- **High**: Culvert or bridge is on a collector road and the surrounding lot density is medium to high.
- **Very High**: Culvert or bridge is on an arterial road and the surrounding lot density is low, medium or high.

7.2 Risk Assessment Rankings

A risk assessment matrix was developed to determine risk rankings using the Likelihood and Consequence categories described above. The matrix is presented in **Table 7-1**.

Table 7-1. Risk Assessment Matrix.

		Consequence				
	Road Type	Local	Local	Collector	Collector	Arterial
	Lot Density	Low, Medium	High	Low	Medium, High	Low, Medium, High
	Score	1	2		3	4
Likelihood	**High Likelihood – Failure may occur during the design flow, check flow and Regulatory storm**: ○ Crossing fails to meet the design flow criteria (flood depth, freeboard, clearance); ○ The road overtops during the design flow; ○ The road overtops during the check flow; and ○ The Regulatory storm overtops the road and fails to meet the relief flow criteria.	3	Medium Risk	High Risk		Highest Risk	Highest Risk
	Medium Likelihood – Failure may occur during the check flow and Regulatory storm: ○ Crossing fails to meet the design flow criteria (flood depth, freeboard, clearance); ○ The road does not overtop during the design flow; ○ The road overtops during the check flow; and ○ The Regulatory storm overtops the road and fails to meet the relief flow criteria.	2	Medium Risk	Medium Risk		High Risk	High Risk
	Low Likelihood – Failure may occur during Regulatory storm: ○ Crossing meets the design flow criteria (flood depth, freeboard, clearance); ○ The road does not overtop during the design flow; ○ The road does not overtop during the check flow; and ○ The Regulatory storm overtops the road and fails to meet the relief flow criteria.	1	Low Risk	Low Risk		Low Risk	Low Risk
	No Likelihood – Unlikely to fail due to hydraulic capacity: ○ Crossing meets the design flow criteria (flood depth, freeboard, clearance); ○ The road does not overtop during the design flow; ○ the road does not overtop during the check flow; and, ○ If the Regulatory storm overtops the road it meets the relief flow criteria.	0	No Risk	No Risk		No Risk	No Risk

8. Existing Conditions Assessment

8.1 Hydrology

8.1.1 Regulated Crossings

Visual Otthymo (VO2) hydrology models were provided by CLOCA for regulated crossings. Peak flows were obtained directly from these models. No further hydrology modeling was completed for regulated crossings.

Additional Considerations for the Pringle Creek Subwatershed

As part of the 2019 Pringle Creek Master Drainage Plan Update, peak flows were developed for Pringle Creek and its tributaries for 3 future flow scenarios:

1. Future uncontrolled flows (i.e. fully developed land use with no stormwater management).
2. Future controlled flows (i.e. fully developed land use with stormwater management).
3. Future uncontrolled flows with climate change.

The future uncontrolled flows are approximately double the future controlled flows. Review of the HEC-RAS model using the future uncontrolled flows identified that all crossings on Pringle Creek overtop the road during the design flow and would be considered Highest Risk using the risk assessment approach presented in Section 6. Additionally, the very high peak flows require impractical design alternatives to reduce flood risk and convey the design and check flows. The water surface profile for the Pringle Creek lower reach under the future uncontrolled flow scenario and the future controlled flow scenario are presented in **Figure 8-1** and **Figure 8-2** respectively. The future uncontrolled flow scenario water surface profile highlights the significant flooding at road and rail crossings through the reach that would occur if stormwater management controls are not considered.

Based on this review, it was determined that the Pringle Creek regulated crossings should be designed based on the future controlled flows, accounting for the peak flow control provided by future stormwater management infrastructure that is required under provincial and municipal legislation and guidelines.

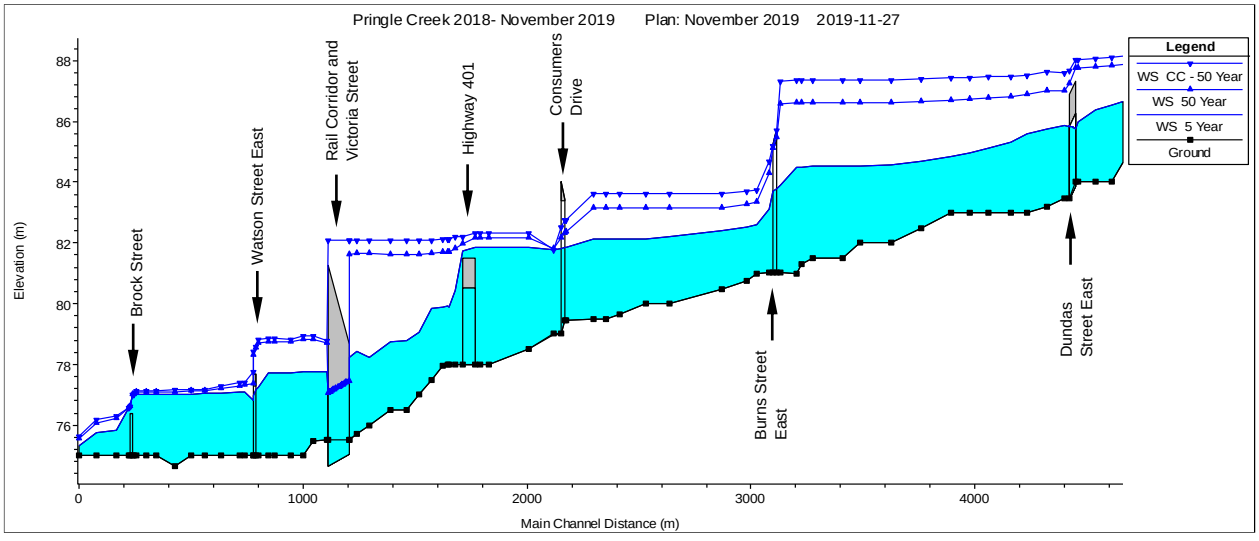

Figure 8-1. Pringle Creek Water Surface Profile from Lake Ontario to Dundas Street East - Future Uncontrolled Flows.

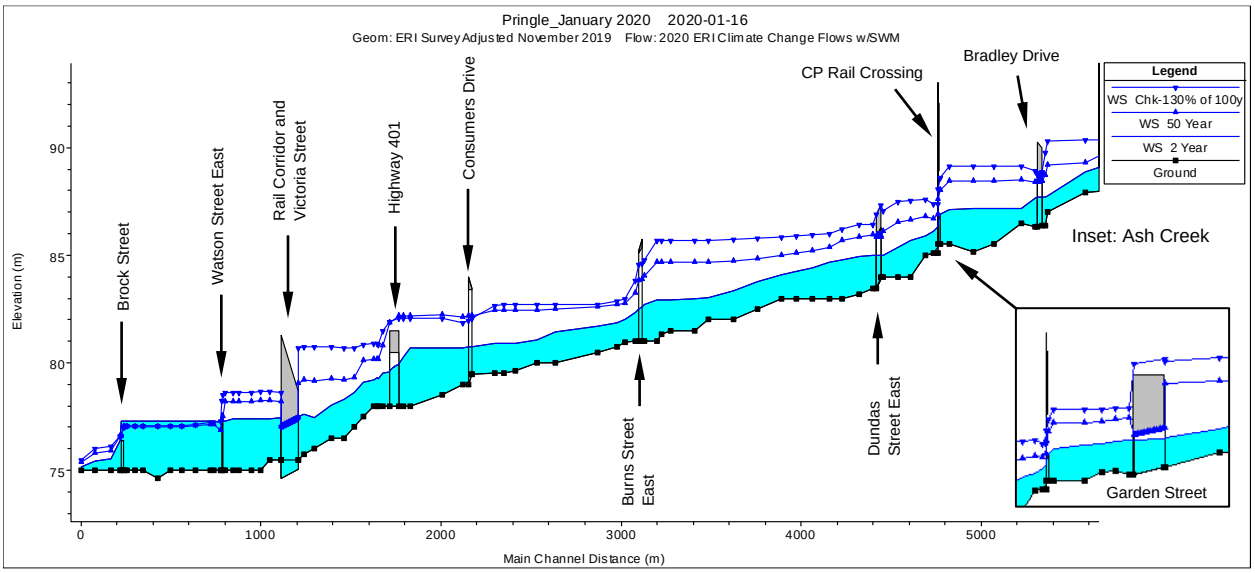

Figure 8-2. Pringle Creek Water Surface Profile from Lake Ontario to Bradley Drive – Future Controlled Flows. Inset: Ash Creek from the CNR Rail Crossing to Garden Avenue.

8.1.2 Unregulated Crossings

No existing hydrology modeling was available for unregulated crossings. Therefore, hydrology modeling was required to estimate peak flows at unregulated crossings. The hydrology modeling software, Visual Otthymo was selected for consistency with the existing CLOCA hydrology modeling for regulated crossings.

Catchment areas were developed using 1 m contour data provided by the Town of Whitby. Curve Number (CN), Time of Concentration (T_c), Time to Peak (T_p) and Initial Abstraction (Ia) were estimated using available soil and future land use data. Soil data was obtained from the Ontario Detailed Soil Survey obtained from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). Future land use data was provided by the Town of Whitby.

Design storms used to develop peak flows were obtained from the corresponding CLOCA watershed VO2 models (i.e. Lynde Creek, Pringle Creek and Corbett Creek).

A summary of the hydrology model input parameters and peak flow estimates is presented in **Table 8-1**. Detailed existing conditions hydrologic modeling calculations and results are provided in **Appendix B**.

Table 8-1. Summary of Hydrology Parameters.

Asset ID	Model Input Parameters			Design Flows (m^3/s)					
	Catchment Area (ha)	Time to Peak (hrs)	Curve Number	2-year	5-year	10-year	25-year	50-year	100-year
CU000004	18.4	0.4	70	0.2	0.3	0.5	0.7	0.9	1.0
CU000005	52.5	0.7	72	0.4	0.8	1.0	1.4	1.8	2.1
CU210011	8.0	0.3	90	0.3	0.5	0.6	0.8	1.0	1.1
CU210012	13.9	0.4	81	0.3	0.6	0.7	1.0	1.2	1.4
CU410009	31.1	0.8	57	0.1	0.2	0.3	0.4	0.6	0.7
CU420015	6.1	0.4	86	0.2	0.3	0.3	0.5	0.6	0.6
CU420024	93.8	1.1	54	0.2	0.4	0.6	0.9	1.2	1.4
CU420025	113.8	1.3	54	0.2	0.5	0.6	1.0	1.3	1.6
CU420026	25.2	0.7	54	0.1	0.2	0.2	0.3	0.4	0.5
CU420027	86.1	1.1	54	0.2	0.4	0.5	0.9	1.1	1.4

Asset ID	Model Input Parameters			Design Flows (m^3/s)					
	Catchment Area (ha)	Time to Peak (hrs)	Curve Number	2-year	5-year	10-year	25-year	50-year	100-year
CU420028	52.8	0.9	56	0.1	0.3	0.4	0.6	0.8	1.0
CU420029	51.4	0.9	56	0.1	0.3	0.4	0.6	0.8	1.0
CU430004	76.2	0.9	66	0.4	0.8	1.0	1.5	1.9	2.2
CU430005	15.0	0.6	46	0.0	0.1	0.1	0.2	0.2	0.3
CU460005	3.9	0.3	81	0.1	0.2	0.2	0.3	0.4	0.4
CU460006	4.4	0.3	81	0.1	0.2	0.2	0.3	0.4	0.5
CU460014	3.7	0.4	76	0.1	0.1	0.2	0.2	0.3	0.3
CU480010	34.8	0.4	83	0.8	1.4	1.9	2.5	3.0	3.6
CU480013	18.3	0.3	90	0.7	1.2	1.6	2.1	2.4	2.8
CU480022	16.9	0.5	78	0.3	0.5	0.7	0.9	1.1	1.3
CU510008	33.5	0.6	66	0.2	0.4	0.6	0.9	1.1	1.3
CU510016	9.2	0.4	68	0.1	0.2	0.2	0.4	0.5	0.5
CU510017	1.8	0.4	49	0.0	0.0	0.0	0.0	0.0	0.1
CU520025	0.4	0.4	58	0.0	0.0	0.0	0.0	0.0	0.0
CU520035	1.4	0.3	49	0.0	0.0	0.0	0.0	0.0	0.0
CU520052	0.2	0.3	58	0.0	0.0	0.0	0.0	0.0	0.0
CU520053	0.6	0.3	58	0.0	0.0	0.0	0.0	0.0	0.0
CU520057	1.4	0.4	58	0.0	0.0	0.0	0.0	0.0	0.0
CU520061	31.9	0.7	58	0.1	0.2	0.3	0.5	0.6	0.8
CU550024	2.4	0.3	82	0.1	0.1	0.1	0.2	0.2	0.3
CU560002	0.1	0.3	80	0.0	0.0	0.0	0.0	0.0	0.0
CU610022	16.4	0.4	81	0.4	0.7	0.9	1.2	1.4	1.6
CU620004	0.5	0.3	90	0.0	0.0	0.0	0.1	0.1	0.1
CU630003	1.5	0.4	83	0.0	0.1	0.1	0.1	0.1	0.2
CU630019	2.3	0.3	84	0.1	0.1	0.1	0.2	0.2	0.3
CU640001	0.4	0.3	84	0.0	0.0	0.0	0.0	0.0	0.0
CU640007	1.2	0.3	84	0.0	0.1	0.1	0.1	0.1	0.1
CU640013	2.1	0.3	81	0.1	0.1	0.1	0.2	0.2	0.2
CU640016	22.4	0.4	81	0.5	0.9	1.1	1.6	1.9	2.2
CU640017	3.1	0.3	80	0.1	0.1	0.2	0.2	0.3	0.3
CU660004	0.2	0.3	89	0.0	0.0	0.0	0.0	0.0	0.0
CU660019	2.1	0.3	88	0.1	0.1	0.2	0.2	0.2	0.3
CU660031	2.2	0.4	88	0.1	0.1	0.2	0.2	0.2	0.3
CU680003	221.8	0.9	79	2.9	5.2	6.8	9.1	10.9	12.7
CU700002	127.2	0.7	74	1.1	2.1	2.7	4.0	5.0	5.8
CU710003	28.0	0.5	77	0.4	0.7	0.9	1.3	1.6	1.8
CU710004	36.9	0.4	76	0.5	1.0	1.3	1.8	2.3	2.7
CU720007	52.5	0.5	81	1.0	1.8	2.2	3.0	3.7	4.2
CU730003	3.2	0.3	82	0.1	0.2	0.2	0.3	0.3	0.4
CU730033	96.8	0.7	76	1.0	1.9	2.4	3.5	4.3	5.0
CU740003	0.8	0.3	83	0.0	0.0	0.0	0.1	0.1	0.1
CU740004	17.6	0.4	80	0.4	0.6	0.8	1.1	1.4	1.5
CU740010	9.6	0.4	82	0.2	0.4	0.5	0.7	0.8	1.0
CU740027	2.6	0.3	84	0.1	0.1	0.2	0.2	0.3	0.3
CU740042	53.0	0.7	74	0.5	0.9	1.2	1.7	2.1	2.4
CU750001	0.5	0.3	88	0.0	0.0	0.0	0.1	0.1	0.1
CU760024	6.7	0.3	81	0.2	0.3	0.4	0.5	0.6	0.7
CU760025	21.0	0.4	79	0.4	0.7	0.9	1.3	1.6	1.9

Asset ID	Model Input Parameters			Design Flows (m^3/s)					
	Catchment Area (ha)	Time to Peak (hrs)	Curve Number	2-year	5-year	10-year	25-year	50-year	100-year
CU770008 / CU770009	5.0	0.3	80	0.1	0.3	0.3	0.4	0.5	0.6
CU770010	123.3	0.6	77	1.4	2.6	3.4	4.8	5.9	6.8
CU840008	4.9	0.3	82	0.1	0.2	0.3	0.4	0.5	0.5
CU860004	2.3	0.3	82	0.1	0.1	0.1	0.2	0.2	0.3
CU860005	98.4	1.0	78	0.9	1.7	2.1	3.0	3.7	4.2
CU870006	60.7	0.6	78	0.7	1.4	1.8	2.5	3.1	3.5
CU880003	31.4	0.5	78	0.6	1.0	1.4	1.9	2.2	2.6
CU930007	1.1	0.3	84	0.0	0.1	0.1	0.1	0.1	0.1
CU940018	62.0	0.6	78	0.8	1.5	1.9	2.7	3.3	3.8
CU940022	44.2	0.5	76	0.5	1.0	1.3	1.9	2.4	2.8
CU940023	4.4	0.3	72	0.1	0.1	0.1	0.2	0.3	0.3
CU950022	98.1	1.0	66	0.4	0.9	1.2	1.8	2.3	2.6
CU950023	36.4	0.5	72	0.3	0.7	0.9	1.4	1.8	2.1
CU970009	32.8	0.4	75	0.6	1.1	1.4	2.0	2.4	2.8
CU970010	24.1	0.4	81	0.6	1.0	1.2	1.7	2.1	2.4
CU970011	46.2	0.4	81	1.1	1.9	2.4	3.3	4.0	4.5
CU980002 / CU980003	15.3	0.4	73	0.2	0.4	0.6	0.8	1.0	1.2
CU980005	3.2	0.4	74	0.1	0.1	0.2	0.2	0.3	0.3
CU980010	13.5	0.4	72	0.2	0.4	0.6	0.8	1.0	1.2
CU990010	61.3	0.6	72	0.7	1.3	1.9	2.6	3.2	3.8
CU990011	3.5	0.3	77	0.1	0.2	0.2	0.3	0.3	0.4
CU_A07_09	42.2	0.5	76	0.5	1.0	1.2	1.8	2.2	2.6
AC01	5.6	0.4	66	0.0	0.1	0.1	0.2	0.2	0.3
AC02	8.6	0.3	67	0.1	0.2	0.2	0.4	0.5	0.5
AC03	14.3	0.5	68	0.1	0.2	0.3	0.5	0.6	0.7
AC05	15.3	0.4	75	0.2	0.4	0.5	0.8	1.0	1.2
AC06	29.2	0.5	81	0.6	1.0	1.3	1.8	2.2	2.5
AC08	2.0	0.3	45	0.0	0.0	0.0	0.0	0.0	0.1
AC15	11.0	0.4	78	0.2	0.4	0.5	0.7	0.8	0.9
AC18	88.4	0.8	78	0.9	1.8	2.2	3.2	3.9	4.5

8.2 Hydraulics

8.2.1 Regulated Crossings

HEC-RAS Model Updates

HEC-RAS models were provided by CLOCA for regulated crossings. The HEC-RAS models were updated to include the topographic survey completed at each crossing as part of this study. A summary of the updates made at each crossing is provided in **Table 8-2**. Generally, updates were made in the following instances:

- The channel bottom was above the culvert or bridge invert in the HEC-RAS model, but the field inspection identified the culvert invert was not buried (i.e. below the channel bottom);
- The culvert diameter or bridge substructure and superstructure did not match the field survey;
- The cover over the culvert or bridge was ±0.2 m compared to the field survey; and
- Investigation of the hydraulic model suggested that further detail at downstream and upstream cross-sections was required to adequately assess the crossing. Further cross-section detail was obtained from the South Central Ontario Orthophotography Project LiDAR data obtained from Land Information Ontario.

Table 8-2. Summary of Modifications to the CLOCA HEC-RAS Models.

Facility ID	Road Name	Water-course	HEC-RAS Reach / River Station	Modifications to Model
CU_C09_07	Harold Street	Corbett	Corbett / 5057.5	Culvert changed from arch to pipe arch. Diameter and rise updated to match survey.
CU_C09_08	Westwood Rd	Corbett	Corbett / 5053.5	Culvert dimensions updated to match survey.
CU_C09_09	Forest Rd	Corbett	Corbett / 5048.5	Culvert changed from pipe arch to arch. Culvert dimensions updated to match survey.
CU_D01_04	Springwood St	Corbett	Corbett / 605	Culvert span, rise and road cross-section updated to match survey.
CU_D01_05	Nichol Ave	Corbett	Corbett / 545	Culvert span, rise and road cross-section updated to match survey.
CU_A07_06	Columbus Rd W	Lynde	Lynde 6 / 6495	Culvert rise updated to match survey. Upstream and downstream channel cross-section updated to match survey.
BR_A08_05	Carnwith Dr W	Lynde	Lynde 5 / 5237.5	Crossing not in model. Added based on survey data and LiDAR.
BR_B04_04	Rossland Rd W	Lynde	Lynde 4 / 3642	Upstream and downstream cross-sections updated based on survey data.
BR_C04_02	Bonacord Ave	Lynde	Lynde 4 / 2283	Road centreline profile updated based on survey data and LiDAR.
CU_A07_02	Brawley Rd W	Lynde	Heber 5 / 7552	Culvert span, rise and road cross-section updated to match survey.
BR_A08_08	Lyndebrook Rd	Lynde	Heber 2 / 9468	Road centreline profile updated based on survey data. Upstream and downstream cross-sections updated based on survey data and LiDAR.
BR_C04_01	Bonacord Ave	Lynde	Heber 1 / 943	Ineffective flow areas updated to better match road elevations.
CU730011	Country Lane	Lynde	HeberT2 - 3 / 4497	Culvert type and dimensions updated as per survey data.
CU_A07_05	Columbus Rd W	Lynde	HeberT2 - 3 / 3957	Culvert rise updated to match survey. Entry loss coefficient changed from 0.9 to 0.7 to reflect mitered inlet and outlet treatment. Upstream and downstream cross-sections lowered as follows to tie in with surveyed culvert data: - Station 4054: lowered 0.19 m, - Station 3981: lowered 1.05 m, - Station 3968: lowered 1.5 m, - Station 3936: lowered 1.4 m, - Station 3886: lowered 1.46 m, and - Station 3833: lowered 0.85 m.
CU_A07_12	Columbus Rd W	Lynde	HeberT2a - 2 / 3765	Culvert updated to match survey. Upstream and downstream channel cross-section updated to match survey.
CU920010	Townline Rd W	Lynde	Ashburn 2 / 9657	Culvert type and dimensions updated as per survey data.
CU_A07_01	Ashburn Rd	Lynde	Ashburn 1 / 2549	Culvert span and rise updated to match survey.
CU_A07_03	Brawley Rd W	Lynde	Ashburn 1 / 1502	Culvert span and rise updated to match survey.

Facility ID	Road Name	Water-course	HEC-RAS Reach / River Station	Modifications to Model
CU960013	Townline Rd W	Lynde	Myrtle 3 / 6479	Culvert type and dimensions updated as per survey data.
CU_A07_10	Calistoga Dr	Lynde	Myrtle 2 / 2092.5	Crossing not in model. Added based on survey data. Upstream cross-sections interpolated from downstream cross-section and updated to include survey data.
CU_A07_04	Brawley Rd W	Lynde	Myrtle 1 / 1424	Culvert diameter, rise and road cross-section updated to match survey. Entry loss coefficient changed from 0.9 to 0.7 to reflect mitered inlet and outlet treatment.
CU_A07_11	Petaluma Ct	Lynde	MyrtleT1 - 1 / 108	Crossing not in model. Added based on survey data. Upstream cross-sections interpolated from downstream cross-section and updated to include survey data.
CU_B04_01	Rossland Rd W	Lynde	Kinsale 4 / 7995	Culvert updated to match survey.
CU210001	Halls Rd N	Lynde	Kinsale 3 / 5833	Culvert dimensions updated to match survey. Downstream channel cross-section updated to match survey.
CU500015	Halls Rd N	Lynde	Kinsale T3 / 7879	Culvert dimensions updated to match survey
CU570013	St. Thomas St	Lynde	LyndeT2 - 1 / 524	Culvert type and dimensions updated as per survey data.
CU_B04_02	Rossland Rd W	Lynde	LyndeT1 - 1 / 2844	Crossing not in model. Added based on survey data. Upstream cross-sections interpolated from downstream cross-section and updated to include survey data.
CU_D01_06	Dundas St W	Lynde	LyndeT1 - 1 / 245	Culvert span rise and road cross-section updated to match survey.
CU780011	Garrard Rd	Oshawa	Raglan-T3 - 1 / 2538.969	Culvert type and dimensions updated as per survey data.
CU480017 / AC20 / AC21	Colin Rd	Pringle	Pringle 3 / 13900	Culvert inverts updated to match survey. Upstream and downstream channel profile was above the culvert invert. Upstream and downstream cross-sections were re-cut from the SCOOP LiDAR data. This included stations 13934.2, 13876.8 and 13805.7. Relief culverts AC20 and AC21 added to crossing.
CU360001	Anderson St	Pringle	Pringle 3 / 10110	Ineffective flow at upstream and downstream cross-sections were incorrect and preventing flow across the road at the low point. Ineffective flow areas updated. Culvert inverts updated to match survey. Upstream and downstream cross-sections did not match survey. Upstream and downstream cross-sections were re-cut from the SCOOP LiDAR data. This included stations 10111.9 and 10089.1.
CU_B04_03	Dryden Blvd	Pringle	Pringle 3 / 9345	Culvert dimensions updated to match survey. Upstream and downstream channel cross-section updated to match survey.
CU_B04_04	Anderson St	Pringle	East Tributary 1 / 50	Culvert dimensions updated to match survey. Upstream and downstream channel cross-section updated to match survey.
CU_C09_06	Bradley Dr	Pringle	Pringle 2 / 5470	Culvert dimensions updated to match survey. Upstream and downstream channel cross-section were revised to prevent channel partially filling the culvert opening - field survey results indicated that the culvert was not partially blocked or embedded.
BR_D07_03	Dundas St E	Pringle	Pringle 1 / 4575	Existing model shows culverts obstructed by upstream and downstream cross-sections. Upstream and downstream cross-section updated based on survey data and LiDAR and culverts no longer obstruct.
BR_D07_05	Burns St E	Pringle	Pringle 1 / 3250	Upstream and downstream cross-sections updated based on survey data.
BR_D07_06	Watson St E	Pringle	Pringle 1 / 990	Road centreline profile updated based on survey data and LiDAR. Brock Street bridge updated to a 32 m span bridge based on data provided by the Town of Whitby. Ineffective flow areas at Brock Street were incorrectly modeled. The ineffective flow areas extended up to the bridge guardrail elevation and prevented spill to the north and south over low points in the road profile. Ineffective flow areas at Brock Street were updated to allow spill. This lowers the tailwater condition at the Watson Street East bridge.
CU_D01_02	Front St W	Pringle	Rowe Channel / 138.5	Culvert changed from CSP Arch to Concrete Box to match survey. Upstream cross-section updated as per survey data. Downstream channel cross-section lowered 0.34 m to match surveyed channel invert.

Hydraulic Assessment Results

Following is a summary of the existing conditions hydraulic assessment results for the 65 regulated crossings:

- 18 bridges were categorized as regulated crossings and were assessed using CLOCA HEC-RAS models:
  - 5 of the 18 bridges meet the design flow criteria for freeboard (0.3 m for local roads and 1.0 m for collector and arterial roads), clearance (0.3 m for local roads and 1.0 m for collector and arterial roads) and prevent to road overtopping during the check flow.
  - 13 of the 18 bridges are **undersized** and fail to meet the design criteria and/or cause the road to overtop during the check flow event. These 13 crossings are presented in **Table 8-3**.
    - Of the 13 bridges that are undersized, 2 cause the road to overtop during the design flow.

- 19 cross culverts and 24 culverts (43 culvert crossings) were categorized as regulated crossings and were assessed using CLOCA HEC-RAS models:
  - 22 of the 43 culvert crossings meet the design flow criteria for freeboard (0.3 m for local roads and 1.0 m for collector and arterial roads) and flood depth (water depth < 1.5 x culvert rise or diameter) and prevent the road overtopping during the check flow.
  - 21 of the 43 culvert crossings are **undersized** and fail to meet the design criteria and/or cause the road to overtop during the check flow event. These 21 crossings are presented in **Table 8-4**.
    - Of the 21 culvert crossings that are undersized, 13 cause the road to overtop during the design flow.

Detailed existing conditions hydraulic analysis calculations and results are provided in **Appendix B**. The bridges and culverts that failed to meet the design criteria are presented in **Table 8-3** and **Table 8-4** respectively.

Table 8-3. Regulated Bridge Crossings Failing to meet the Design Criteria.

Facility ID	Description	Road Name	Road Classification	Design Flow			Meets Design Criteria	Check Flow Overtops Road
				Return Period	Clearance (m)	Freeboard (m)		
BR_A08_01	10 m span Bridge	Cedarbrook Trail	Local Road	25-year	Overtops		Fails	Overtops
BR_A08_03	3.11 m span Bridge	Coronation Rd	Local Road	10-year	0.0	0.4	Fails	Overtops
BR_A08_05	22.2 m span Bridge	Carnwith Dr W	Urban Arterial	100-year	0.5	1.3	Fails	No
BR_A08_07	12.1 m span Bridge	Cassells Rd E	Rural Arterial	50-year	0.9	1.3	Fails	No
BR_A08_08	12.2 m span Bridge	Lyndebrook Rd	Rural Arterial	50-year	-0.2	0.9	Fails	No
BR_B04_01	16.55 m span Bridge	Cochrane St N	Local Road	25-year	0.1	1.4	Fails	No
BR_B04_03	15.55 m span Bridge	Rossland Rd W	Rural Arterial	50-year	-0.5	1.0	Fails	No
BR_B04_04	15.6 m span Bridge	Rossland Rd W	Rural Arterial	50-year	-0.1	1.7	Fails	No
BR_D07_01	28.1 m span Bridge	Jeffery St	Local Road	25-year	0.1	0.4	Fails	Overtops
BR_D07_02	18.6 m span Bridge	Dundas St W	Urban Arterial	100-year	-0.3	0.6	Fails	No
BR_D07_03	15.7 m span Bridge	Dundas St E	Urban Arterial	100-year	-0.9	0.1	Fails	Overtops
BR_D07_05	9.6 m span Bridge	Burns St E	Urban Arterial	100-year	0.3	0.6	Fails	No
BR_D07_06	12.1 m span Bridge	Watson St E	Rural Arterial	50-year	Overtops		Fails	Overtops

Page revised October 28, 2021, to correct typographical error which incorrectly stated Culvert CU_B04_03 (Dryden Blvd at Pringle Creek) as failing to meet the design criteria. HEC-RAS model results indicate the crossing meets the design criteria.

Table 8-4. Regulated Culvert Crossings Failing to meet the Design Criteria.

Facility ID	Description	Road Name	Road Classification	Design Flow			Meets Design Criteria	Check Flow Overtops Road
				Return Period	HW/D	Freeboard (m)		
CU210001	2400 mm Diameter Circular CSP	Halls Rd N	Rural Arterial	25-year	Overtops		Fails	Overtops
CU360001	2000 mm Diameter Circular CSP	Anderson St	Urban Arterial	50-year	Overtops		Fails	Overtops
CU480017 / AC20 / AC21	3 x Twin 1050 mm Diameter Circular CSP culverts (6 barrels total)	Conlin Rd	Rural Arterial	25-year	Overtops		Fails	Overtops
CU500015	1000 mm Diameter Circular CSP	Halls Rd N	Local Road	10-year	0.8	0.3	Fails	No
CU570013	880 mm Diameter Circular CP	St Thomas St	Local Road	10-year	1.7	0.2	Fails	Overtops
CU730010 / CU730011 / CU730013	Multiple Barrels	Country Lane	Local Road	10-year	Overtops		Fails	No
CU780010	2400 mm Diameter Circular CSP	Garrard Rd	Local Road	10-year	Overtops		Fails	No
CU780011	Twin 1200 mm Diameter Circular CSP	Garrard Rd	Local Road	10-year	Overtops		Fails	No
CU780012	Twin 1200 mm Diameter Circular CSP	Garrard Rd	Local Road	10-year	Overtops		Fails	Overtops
CU880004	1500 mm Diameter Circular CSP	Hamers Rd	Local Road	10-year	0.7	1.2	OK	Overtops
CU920010	1500 mm Diameter Circular CSP	Townline Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU960013	3000 mm span x 1950 mm rise Arch CSP	Townline Rd W	Rural Arterial	25-year	0.8	3.6	OK	Overtops
CU_A07_01	5550 mm span x 3500 mm rise Arch CSP	Ashburn Rd	Rural Arterial	25-year	Overtops		Fails	Overtops
CU_A07_03	5100 mm span x 3200 mm rise Ellipse CSP	Brawley Rd W	Rural Arterial	25-year	0.8	3.1	OK	Overtops
CU_B04_04	3080 mm span x 1510 mm rise Concrete Box	Anderson St	Urban Arterial	50-year	Overtops		Fails	Overtops
CU_C09_05	Twin 3000 mm span x 2000 mm rise Concrete Box	Garden St	Urban Arterial	50-year	2.1	0.4	Fails	Overtops
CU_C09_09	1650 mm span x 1100 mm rise Ellipse CSP	Forest Rd	Local Road	10-year	Overtops		Fails	Overtops
CU_D01_02	3000 mm span x 1220 mm rise Concrete Box	Front St W	Local Road	10-year	Overtops		Fails	Overtops
CU_D01_03	Twin 1800 mm span x 1130 mm rise Concrete Box	Watson St W	Rural Arterial	25-year	Overtops		Fails	Overtops

8.2.2 Unregulated Crossings

The hydraulic analysis for unregulated crossings was completed using standard inlet and outlet control calculations. All unregulated crossings are culverts.

Inlet control calculations were based on the MTO design nomographs (Design Chart 2.32 & 5.39). Outlet control calculations were completed based on tailwater conditions and head loss through the culvert.

Outlet control calculations incorporate head losses within the culvert as well as the downstream water elevations. The effective tailwater (TW) elevations were estimated using critical depth or observed high water mark near the culvert.

Following is a summary of the existing conditions hydraulic assessment results for the 99 unregulated crossings:

- 90 cross culverts and 1 culvert (91 total culvert crossings) were categorized as unregulated crossings and were assessed using standard inlet and outlet control calculations:

Page revised October 28, 2021, to correct typographical error which incorrectly stated Culvert CU_B04_03 (Dryden Blvd at Pringle Creek) as failing to meet the design criteria. HEC-RAS model results indicate the crossing meets the design criteria.

- 33 of the 91 unregulated culvert crossings meet the design flow criteria for freeboard (0.3 m for local roads and 1.0 m for collector and arterial roads) and flood depth (water depth < 1.5 x culvert rise or diameter) and prevent the road overtopping during the check flow.
- 58 of the 91 unregulated culvert crossings are **undersized** and fail to meet the design criteria and/or cause the road to overtop during the check flow event. These 56 crossings are presented in **Table 8-5**.
    - Of the 56 culvert crossings that are undersized, 23 overtop during the design flow.

Detailed existing conditions hydraulic analysis calculations and results are provided in **Appendix B**. The culverts that failed to meet the design criteria and / or cause the road to overtop during the check flow are presented in **Table 8-5**.

Table 8-5. Unregulated Crossings Failing to meet the Design Criteria.

Facility ID	Description	Road Name	Road Classification	Design Flow			Meets Design Criteria	Check Flow Overtops Road
				Return Period	HW/D	Freeboard (m)		
CU000004	660 mm Diameter Circular CSP	Halls Rd S	Local	10-year	1.1	0.4	OK	Overtops
CU000005	800 mm Diameter Circular CSP	Halls Rd S	Local	10-year	1.3	0.2	Fails	Overtops
CU210011	700 mm Diameter Circular CSP	Halls Rd N	Rural Arterial	10-year	1.1	1.3	OK	Overtops
CU210012	450 mm Diameter Circular CSP	Halls Rd N	Rural Arterial	25-year	Overtops		Fails	Overtops
CU410009	400 mm Diameter Circular CSP	Halls Rd N	Local	10-year	1.6	0.5	Fails	Overtops
CU420015	450 mm Diameter Circular CSP	Coronation Rd	Collector	10-year	2.2	0.4	Fails	Overtops
CU420024	600 mm Diameter Circular CSP	Coronation Rd	Collector	25-year	Overtops		Fails	Overtops
CU420027	600 mm Diameter Circular CSP	Coronation Rd	Collector	25-year	Overtops		Fails	Overtops
CU420029	950 mm Diameter Circular CSP	Lynde brook Rd	Rural Arterial	25-year	0.8	0.9	Fails	No
CU460005	550 mm span x 430 mm rise Ellipse CSP	Anderson St	Rural Arterial	10-year	1.1	0.5	Fails	Overtops
CU460006	450 mm Diameter Circular CSP	Anderson St	Rural Arterial	10-year	1.3	0.4	Fails	Overtops
CU460014	600 mm Diameter Circular CSP	Anderson St	Rural Arterial	10-year	0.7	0.6	Fails	No
CU480010	600 mm Diameter Circular CSP	Garrard Rd	Rural Arterial	25-year	Overtops		Fails	Overtops
CU480013	400 mm Diameter Circular CSP	Garrard Rd	Rural Arterial	25-year	Overtops		Fails	Overtops
CU510017	600 mm Diameter Circular CSP	Coronation Rd	Collector	10-year	0.3	0.9	Fails	No
CU520035	750 mm Diameter Circular CSP	Coronation Rd	Collector	10-year	0.3	0.8	Fails	No
CU520061	600 mm Diameter Circular CSP	Coronation Rd	Collector	25-year	1.7	1.9	Fails	No
CU550024	450 mm span x 300 mm rise Ellipse CSP	Ashburn Rd	Rural Arterial	10-year	1.4	0.4	Fails	Overtops
CU610022	800 mm Diameter Circular CSP	Columbus Rd W	Rural Arterial	25-year	1.7	0.0	Fails	Overtops
CU640001	300 mm Diameter Circular CSP	Cochrane St	Local	5-year	0.5	0.3	Fails	No
CU640013	400 mm Diameter Circular CSP	Cochrane St	Local	5-year	0.8	0.3	Fails	Overtops
CU640016	500 mm Diameter Circular CSP	Columbus Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU660031	400 mm Diameter Circular CSP	Way St	Local	5-year	2.6	0.4	Fails	Overtops
CU680003	1850 mm span x 1850 mm rise Concrete Box	Columbus Rd E	Rural Arterial	25-year	1.3	0.7	Fails	Overtops
CU700002	Twin 1050 mm Diameter Circular CSP	Columbus Rd W	Rural Arterial	25-year	1.5	0.1	Fails	Overtops
CU710003	600 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU710004	900 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU720007	1050 mm Diameter Circular CSP	Columbus Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU730003	500 mm span x 300 mm rise Ellipse CSP	Country Lane	Local	5-year	1.1	0.1	Fails	Overtops
CU730033	1250 mm Diameter Circular CSP	Columbus Rd W	Rural Arterial	25-year	1.6	0.3	Fails	Overtops

Facility ID	Description	Road Name	Road Classification	Design Flow			Meets Design Criteria	Check Flow Overtops Road
				Return Period	HW/D	Freeboard (m)		
CU740003	300 mm Diameter Circular CSP	Cochrane St	Local	5-year	0.7	0.3	OK	Overtops
CU740004	450 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU740010	600 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	10-year	1.7	0.0	Fails	Overtops
CU740042	600 mm Diameter Circular CSP	Cochrane St	Local	10-year	Overtops		Fails	Overtops
CU760025	750 mm Diameter Circular CSP	Duffs Rd	Local	10-year	1.7	2.2	Fails	Overtops
CU770008 CU770009	Twin 600 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	10-year	0.7	0.8	Fails	No
CU840008	500 mm span x 300 mm rise Ellipse CSP	Brawley Rd W	Rural Arterial	10-year	Overtops		Fails	Overtops
CU860004	600 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	10-year	0.6	0.6	Fails	No
CU870006	Twin 900 mm x 600 mm CSP Ellipse	Brawley Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
CU880003	760 mm Diameter Circular CSP	Hamers Rd	Local	10-year	Overtops		Fails	Overtops
CU940022	800 mm Diameter Ellipse CSP	Townline Rd W	Collector	25-year	Overtops		Fails	Overtops
CU940023	400 mm Diameter Circular CSP	Ashburn Rd	Collector	10-year	1.2	0.4	Fails	Overtops
CU950022	450 mm Diameter Circular CSP	Townline Rd W	Collector	25-year	Overtops		Fails	Overtops
CU950023	450 mm Diameter Circular CSP	Townline Rd W	Collector	25-year	Overtops		Fails	Overtops
CU970009	600 mm Diameter Circular CSP	Townline Rd W	Collector	25-year	Overtops		Fails	Overtops
CU970010	600 mm Diameter Circular CSP	Duffs Rd	Local	10-year	Overtops		Fails	Overtops
CU980002 CU980003	600 mm and 400 mm Diameter Circular CSP Culverts	Mud Lake Rd	Local	10-year	1.6	0.4	Fails	Overtops
CU980005	350 mm Diameter Circular CSP	Mud Lake Rd	Local	5-year	1.8	0.1	Fails	Overtops
CU980010	400 mm Diameter Circular CSP	Townline Rd E	Collector	25-year	Overtops		Fails	Overtops
CU990010	1200 mm Diameter Circular CSP	Townline Rd E	Collector	25-year	1.2	0.9	Fails	Overtops
AC01	1250 mm Diameter Circular CSP	Cochrane St	Local	10-year	1.2	0.9	OK	Overtops
AC02	400 mm Diameter Circular CSP	Lake Ridge Rd	Rural Arterial	10-year	2.4	0.1	Fails	Overtops
AC03	500 mm Diameter Circular CSP	Peleshok Dr	Local	10-year	1.2	0.4	OK	Overtops
AC05	450 mm Diameter Circular CSP	Brawley Rd W	Rural Arterial	25-year	Overtops		Fails	Overtops
AC06	450 mm Diameter Circular CSP	Cochrane St	Local	10-year	Overtops		Fails	Overtops
AC18	2000 mm span x 900 mm rise Concrete Box Culvert	Ashburn Rd	Rural Arterial	25-year	1.2	0.7	Fails	No

8.3 Risk Assessment Results

8.3.1 Highest Priority Crossings

The risk assessment was applied to the hydraulic analysis results to determine the risk ranking for all crossings. The risk rankings are presented in **Table 8-6** and shown in **Figure 8-3** to **Figure 8-7**. A total of 12 bridges and culverts were classified as having the Highest Risk and are presented in **Table 8-7.** These crossings are located on arterial or collector roads (i.e. higher traffic volumes) and overtop the roadway during the design event. They represent those crossings that are significantly undersized (hydraulically), are most likely to fail, and have the highest potential consequence to road users if failure does occur. A complete summary of risk rankings for all crossings is provided in **Appendix B**.

The road classification of the following roads was downgraded to prioritize the Highest Risk towards arterial roads with higher traffic volumes. The road re-classifications were provided by the Town of Whitby.

- Watson Street East: reclassified from Rural Arterial to Collector.
- Brawley Road West: reclassified from Rural Arterial to Collector.
- Townline Road West: reclassified from Rural Arterial to Collector.
- Halls Road North: reclassified from Rural Arterial to Local.

Table 8-6. Summary of Risk Rankings.

Risk Ranking	Unregulated Crossings	Regulated Crossings	Total
No Risk	28	14	42
Low Risk	6	11	17
Moderate Risk	28	17	45
High Risk	24	12	36
Highest Risk	5	7 [A]	12
Total	91	61	152

[A] *Includes AC20 and AC21 at CU480017 (Conlin Road) which provide relief flow during high flow events. All three culvert crossings are considered as one crossing for the purpose of developing design alternatives.*

Table 8-7. Summary of the Highest Risk Crossings.

Facility ID	Description	Road Name	Road Type	Watercourse
Unregulated Crossings				
CU480010	600 mm Diameter Circular CSP Culvert	Garrard Road	Rural Arterial	n/a
CU480013	400 mm Diameter Circular CSP Culvert	Garrard Road	Rural Arterial	n/a
CU610022	800 mm Diameter Circular CSP Culvert	Columbus Road West	Rural Arterial	n/a
CU640016	500 mm Diameter Circular CSP Culvert	Columbus Road West	Rural Arterial	n/a
CU720007	1050 mm Diameter Circular CSP Culvert	Columbus Road West	Rural Arterial	n/a
Regulated Crossings				
CU480017 / AC20 / AC21	3 x Twin 1050 mm Diameter Circular CSP culverts (6 barrels total)	Conlin Road	Rural Arterial	Pringle Creek
CU360001	3300 mm span x 2000 mm rise CSP Culvert	Anderson Street	Urban Arterial	Pringle Creek
CU_A07_01	5550 mm span x 3500 mm rise Arch CSP Culvert	Ashburn Road	Rural Arterial	Ashburn Creek
CU_B04_04	3080 mm span x 1510 mm rise Concrete Box Culvert	Anderson Street	Urban Arterial	East Tributary, Pringle Creek
CU_D01_03	Twin 1800 mm span x 1200 mm rise Concrete Box Culvert	Watson Street West	Collector	Rowe Channel

8.3.2 Secondary Priority Crossings

If the Town of Whitby secures additional funding to extend the proposed replacement works, the next priority would be to address the crossings classified as High Risk through the risk assessment process. A total of 36 crossings were identified as High Risk. These crossings are presented in **Table 8-8**. Design alternatives have not been developed for the High Risk crossings and future project-specific Municipal Class Environmental Assessments would be required for upsizing these crossings.

Table 8-8. High Risk Crossings Identified in the Existing Conditions Assessment.

Facility ID	Description	Road Name	Road Type	Watercourse
Unregulated Crossings				
CU420024	600 mm diameter circular CSP culvert	Coronation Road	Collector	n/a
CU420027	600 mm diameter circular CSP culvert	Coronation Road	Collector	n/a
CU420029	950 mm diameter circular CSP culvert	Lynde brook Road	Rural Arterial	n/a
CU460005	550 mm span x 430 mm rise ellipse CSP culvert	Anderson Street	Rural Arterial	n/a
CU460006	450 mm diameter circular CSP culvert	Anderson Street	Rural Arterial	n/a

Facility ID	Description	Road Name	Road Type	Watercourse
CU460014	600 mm diameter circular CSP culvert	Anderson Street	Rural Arterial	n/a
CU550024	450 mm span x 300 mm rise ellipse CSP culvert	Ashburn Road	Rural Arterial	n/a
CU680003	1850 mm diameter circular concrete culvert	Columbus Road East	Rural Arterial	n/a
CU700002	Twin 1050 mm diameter circular CSP culvert	Columbus Road West	Rural Arterial	n/a
CU710003	600 mm diameter circular CSP culvert	Brawley Road West	Collector	n/a
CU710004	900 mm diameter circular CSP culvert	Brawley Road West	Collector	n/a
CU730033	1250 mm diameter circular CSP culvert	Columbus Road West	Rural Arterial	n/a
CU740004	450 mm diameter circular CSP culvert	Brawley Road West	Collector	n/a
CU840008	500 mm span x 300 mm rise ellipse CSP culvert	Brawley Road West	Collector	n/a
CU870006	900 mm span x 600 mm rise ellipse CSP culvert	Brawley Road West	Collector	n/a
CU940022	800 mm diameter Ellipse CSP culvert	Townline Road West	Collector	n/a
CU940023	400 mm diameter circular CSP culvert	Ashburn Road	Collector	n/a
CU950022	450 mm diameter circular CSP culvert	Townline Road West	Collector	n/a
CU950023	450 mm diameter circular CSP culvert	Townline Road West	Collector	n/a
CU970009	600 mm diameter circular CSP culvert	Townline Road West	Collector	n/a
CU980010	400 mm diameter circular CSP culvert	Townline Road East	Collector	n/a
AC02	400 mm diameter circular CSP culvert	Lake Ridge Road	Rural Arterial	n/a
AC05	450 mm diameter circular CSP culvert	Brawley Road West	Collector	n/a
AC18	2000 mm span x 900 mm rise concrete box culvert	Ashburn Road	Rural Arterial	n/a
Regulated Crossings				
CU920010	1500 mm diameter circular CSP culvert	Townline Road West	Collector	Ashburn Creek
CU_C09_05	3000 mm span x 2000 mm rise concrete box culvert	Garden Street	Urban Arterial	Ash Creek
CU_C09_09	1650 mm span x 1100 mm rise ellipse CSP culvert	Forest Road	Local	Corbett Creek
BR_A08_05	22.2 m span bridge	Carnwith Drive West	Urban Arterial	Lynde Creek
BR_A08_07	12.1 m span bridge	Cassells Road East	Rural Arterial	Lynde Creek
BR_A08_08	12.2 m span bridge	Lyndebrook Road	Rural Arterial	Lynde Creek
BR_B04_03	15.55 m span bridge	Rossland Road West	Rural Arterial	Lynde Creek
BR_B04_04	15.6 m span bridge	Rossland Road West	Rural Arterial	Lynde Creek
BR_D07_02	18.6 m span bridge	Dundas Street West	Urban Arterial	Lynde Creek
BR_D07_03	15.7 m span bridge	Dundas Street East	Urban Arterial	Pringle Creek
BR_D07_05	9.6 m span bridge	Burns Street East	Urban Arterial	Pringle Creek
BR_D07_06	12.1 m span bridge	Watson Street East	Collector	Pringle Creek

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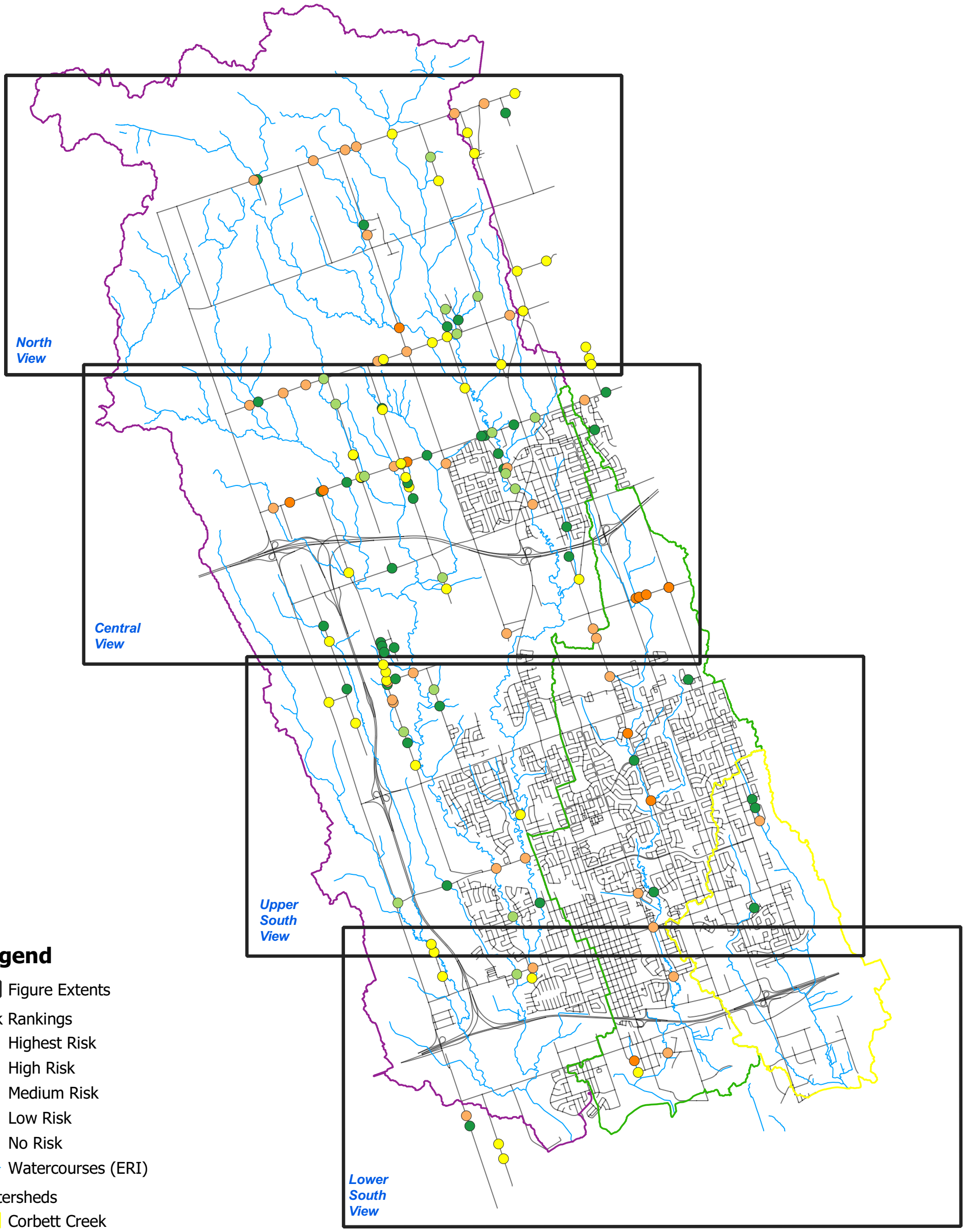

Legend

- Figure Extents

Risk Rankings

- Highest Risk
- High Risk
- Medium Risk
- Low Risk
- No Risk
- Watercourses (ERI)

Watersheds

- Corbett Creek
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

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Figure 8-3

Bridge and Culvert Risk Rankings (Overview)

0 2.5 5 km

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Project: 1837 Whitby Bridge and Cuvlvert Master Plan
Date: 23/9/2020

Data Sources: Ecosystem Recovery Inc., 2020:
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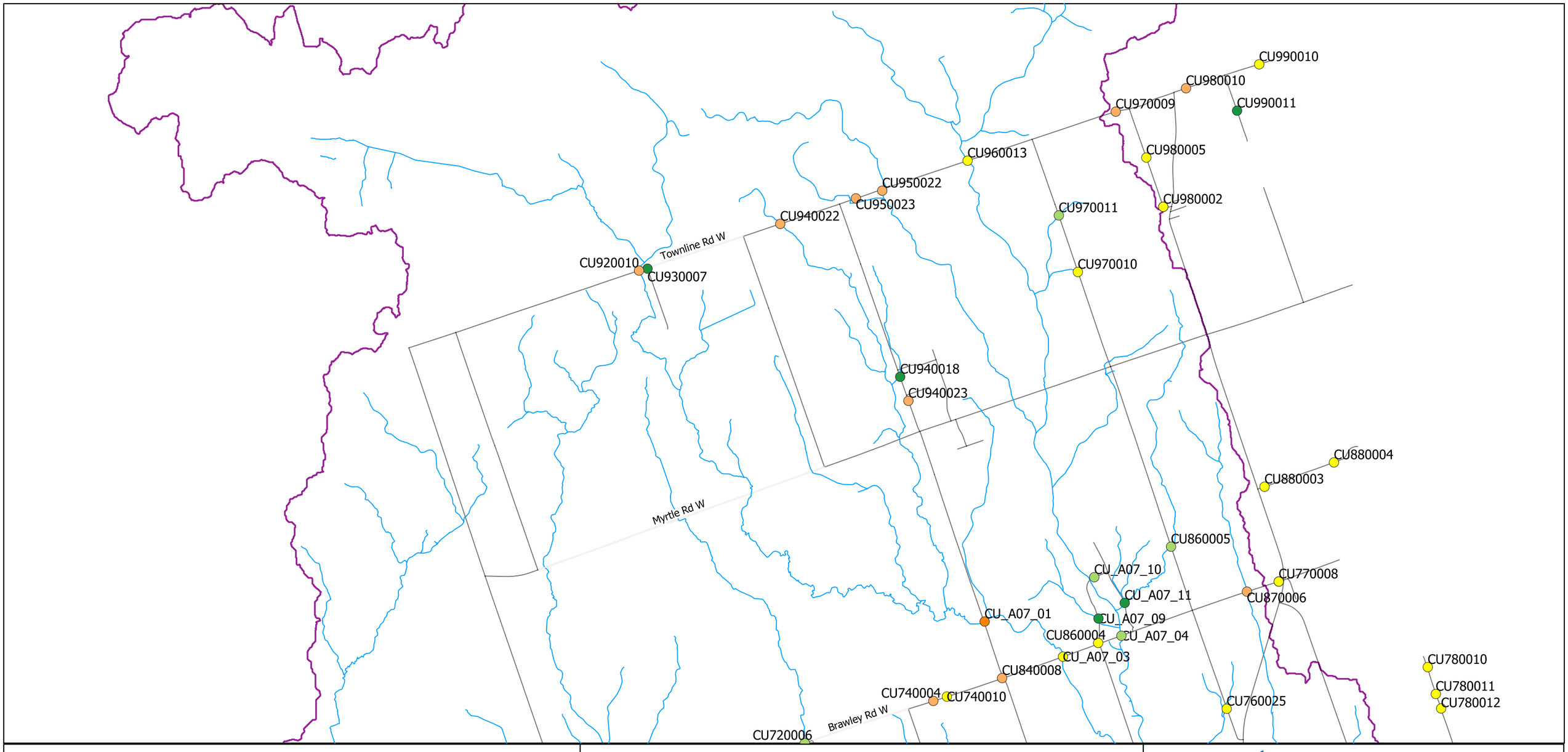

Legend

Risk Rankings
- Highest Risk
- High Risk
- Medium Risk
- Low Risk
- No Risk

Watercourses (ERI)

CLOCAScientificWatersheds
- Corbett Creek
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

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Figure 8-4

Bridge and Culvert Risk Rankings (North View)

0 2 4 km

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Date: 23/9/2020

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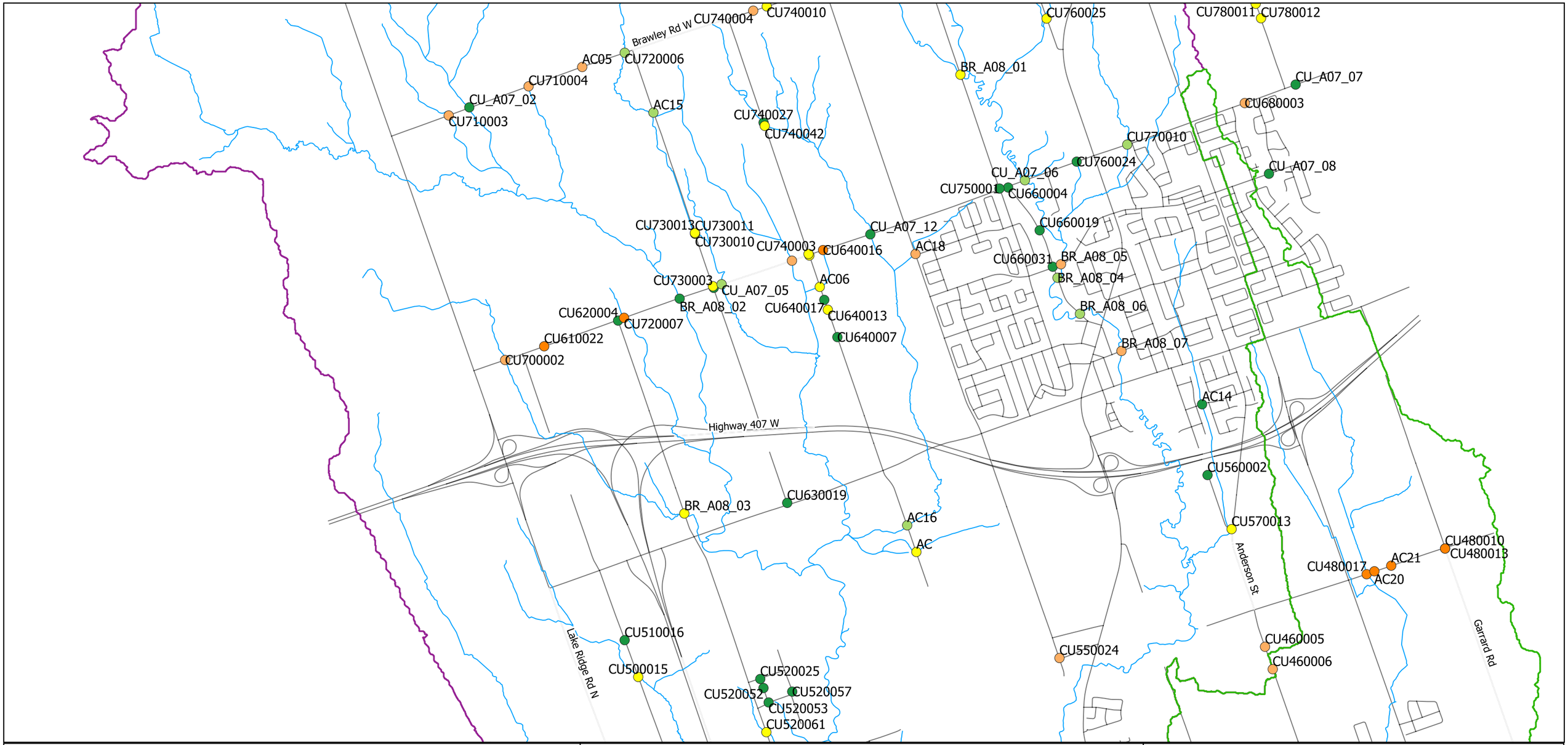

Legend

Risk Rankings
- Highest Risk
- High Risk
- Medium Risk
- Low Risk
- No Risk

Watercourses (ERI)

CLOCAScientificWatersheds
- Corbett Creek
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 8-5
Bridge and Culvert Risk Rankings (Central View)

0 2 4 km

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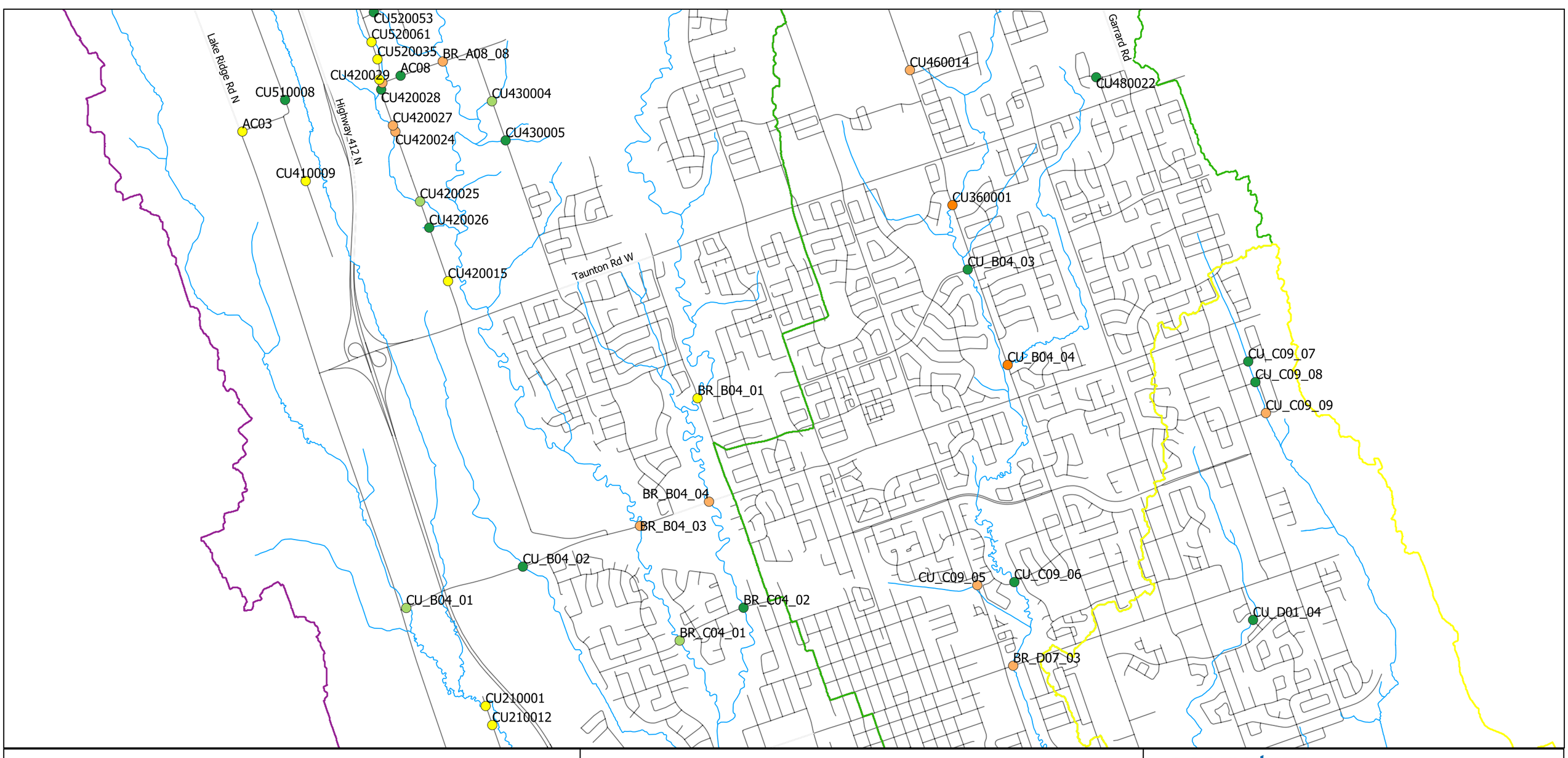
Project: 1837 Whitby Bridge and Cuvlvert Master Plan
Date: 23/9/2020



Legend

Risk Rankings
- Highest Risk
- High Risk
- Medium Risk
- Low Risk
- No Risk

Watercourses (ERI)

CLOCAScientificWatersheds
- Corbett Creek
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 8-6

Bridge and Culvert Risk Rankings (Upper South View)

0 2 4 km

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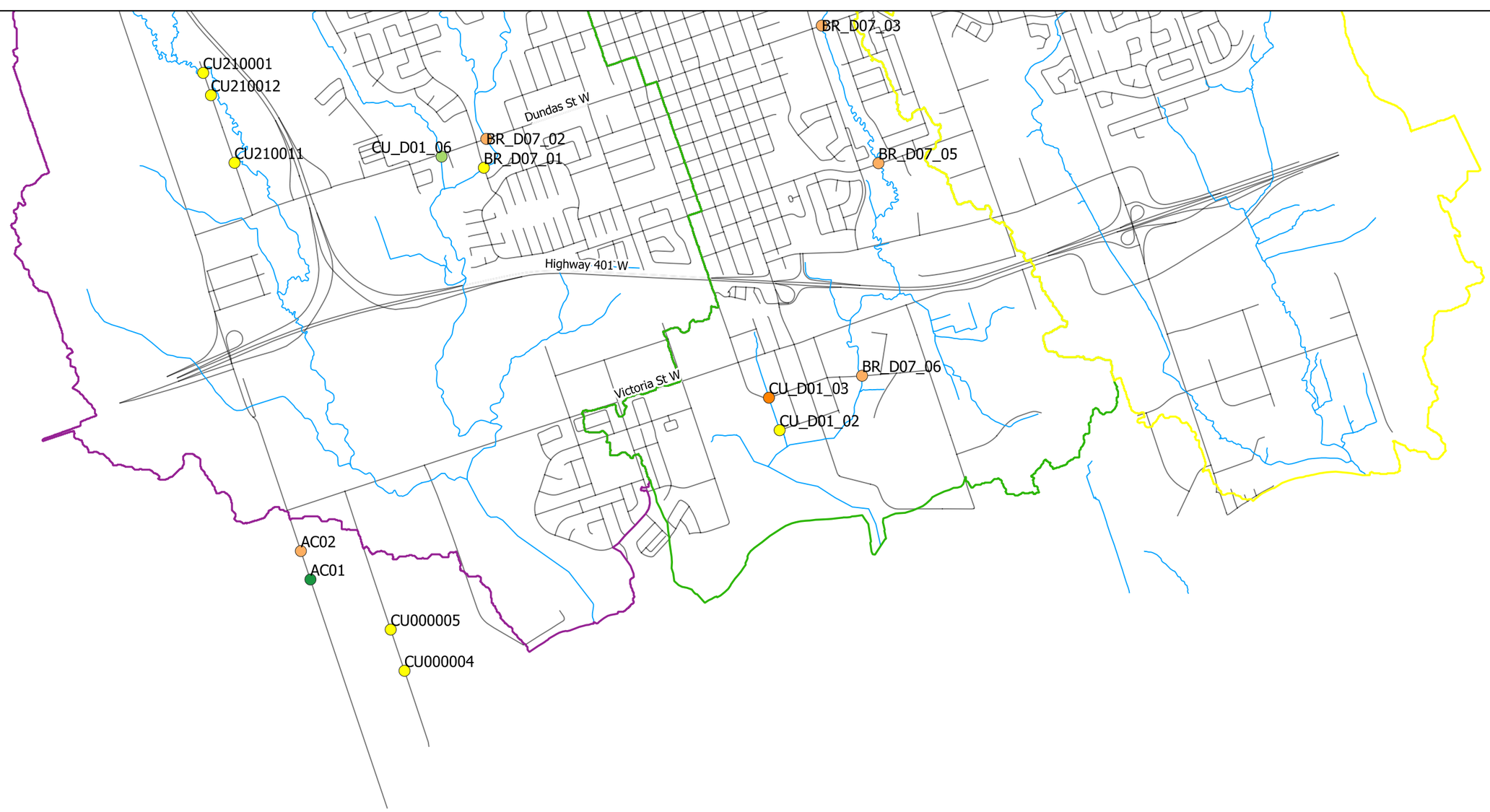

Legend

Risk Rankings
- Highest Risk
- High Risk
- Medium Risk
- Low Risk
- No Risk

Watercourses (ERI)

CLOCAScientificWatersheds
- Corbett Creek
- Lynde Creek
- Pringle Creek

Whitby Bridge and Culvert Master Plan

Figure 8-7

Bridge and Culvert Risk Rankings (Lower South View)

0 2 4 km

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Date: 23/9/2020

8.4 Climate Change Comparison

As described in Section 5.2, the impact of climate change on peak flows has been included when assessing design alternatives for the highest risk crossings. However, the Town of Whitby also wanted to understand the potential implications of considering climate change on existing culverts to better predict potential infrastructure costs associated with climate change. To achieve this, a comparison of existing conditions hydraulic capacity with and without the influence of climate change on peak flows was undertaken. The existing conditions hydraulic assessment completed in **Section 8.2** was updated using peak flows with climate change impacts. That is, peak flows were increased by 20% as per the summary provided in **Section 5.2**. The existing conditions climate change calculations are provided in **Appendix C**. This comparison is intended to be standalone for use by Town staff in determining future action on climate change. The risk assessment completed in **Section 8.3** has not been updated to reflect the results presented in this section.

The total number of crossings failing to meet the design criteria under climate change conditions are presented in **Table 8-9** along with the total number of crossings failing to meet the design criteria under present day conditions (i.e. no climate change) from **Section 8.2**.

The addition of climate change impacts on peak flows increased the number of crossings that do not meet the design criteria from 93 to 104. Culverts that do not meet the design criteria are at a greater risk of failure due to flood related risk and will require upsizing in the future. Additionally, those culverts already failing to meet the design criteria under present day conditions (without climate change) will require larger upsizing to meet the design criteria under future climate change conditions.

Table 8-9. Crossings Failing to Meet the Design Criteria with and without Climate Change.

Crossing Type	Number Failing to Meet the Design Criteria		Increase due to Climate Change
	Without Climate Change	With Climate Change	
Bridges	13	15	2
Culverts	23	27	4
Cross Culverts	57	62	5
Total	93	104	11

9. Identification and Evaluation of Alternative Solutions

9.1 Developing Design Alternatives at the Highest Risk Crossings

The opportunities and constraints associated with addressing hydraulic capacity to meet the design criteria are unique at each crossing. Therefore, a consistent and repeatable approach is required for the study. The methodology for developing design alternatives at each crossing is presented in **Figure 9-1**. The primary objective of the proposed conditions analysis is to identify feasible design alternatives that meet the design criteria. Where site constraints prevent the development of a feasible design alternative that meets the design criteria, secondary design alternatives were identified within the site constraints to increase hydraulic capacity and reduce flood risk by preventing the road overtopping during the design flow.

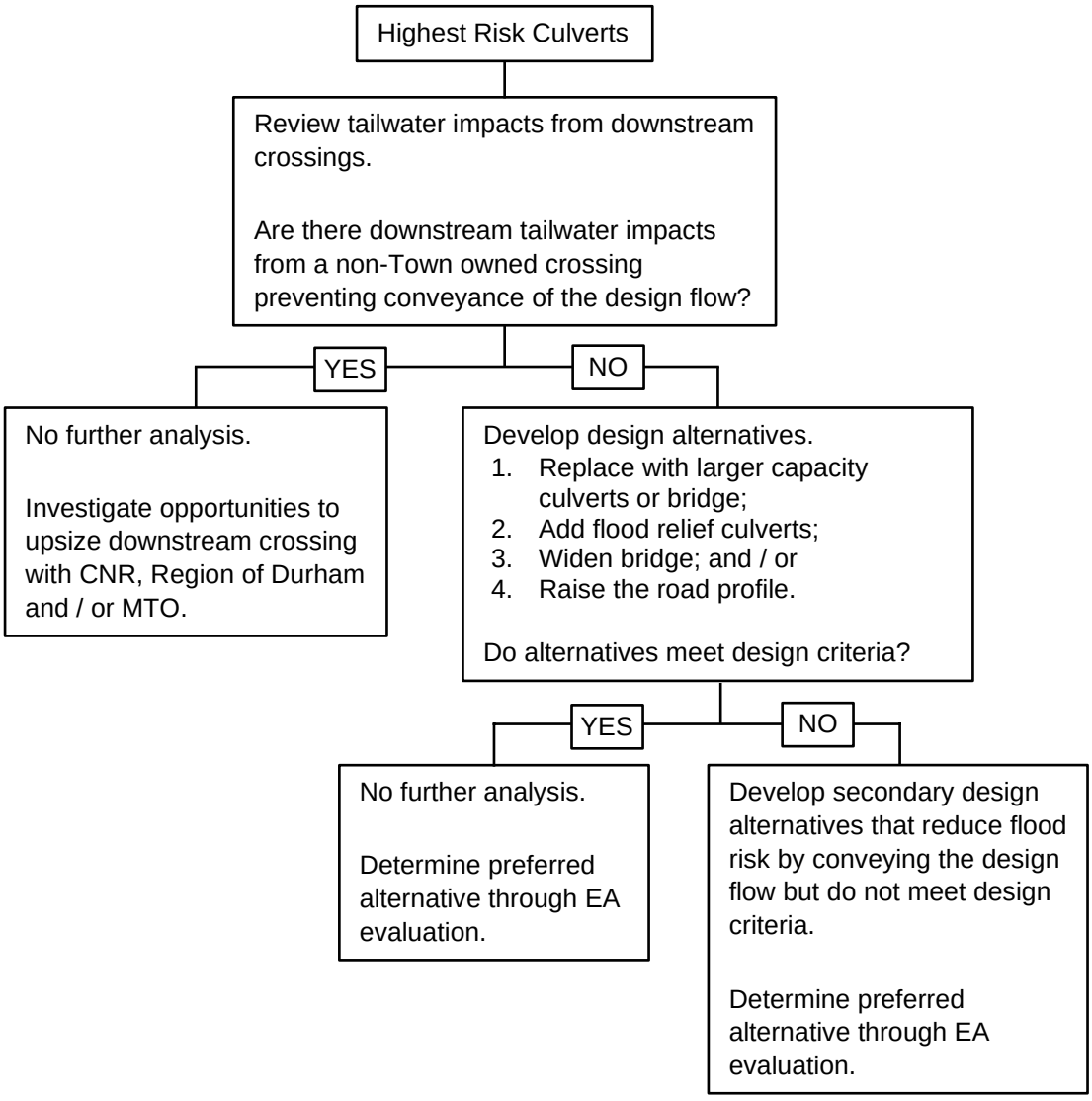

Figure 9-1. Design Alternative Development Methodology Flow Chart.

The broader list of replacement options considered at each crossing, as appropriate, are listed below:

1. Replace with larger capacity culverts or bridge:
   - Upsize existing circular CSP or concrete box culvert;
   - Change culvert type, i.e. circular CSP to concrete box or CSP arch culvert;

- Add additional culvert barrels; and
- Replace culvert with a single span bridge.

2. Add relief culverts:
   - Install relief culverts in the overbank area to convey high flows; and
   - Install relief culverts outside bridge abutments.
3. Widen bridge span.
4. Raise the road profile:
   - Raise the road to allow larger capacity culverts.

When developing feasible design alternatives, the following additional constraints required furthering consideration:

- **Available Cover**: Some crossings have very shallow cover (< 0.5 m) which fails to meet the minimum cover requirements and prevents replacing existing culverts with larger structures. Shallow cover also makes it difficult to meet the 1.0 m freeboard criterion because culverts in shallow cover must be flowing partially full during the design flow. In these cases, opportunities to install multiple barrels and / or raise the road profile were considered.
- **Tailwater Controlled Crossings**: In some cases, the tailwater at a Town owned crossing submerges the culvert obvert, bridge soffit or road due to a downstream undersized crossing. In these cases, it is not possible to meet the design criteria at the subject crossing without upsizing the downstream crossing. Where the downstream crossing is not owned by the Town (i.e. owned by CN Rail, the Region of Durham or MTO), it is recommended that the Town investigate opportunities to upsize the downstream crossing before addressing hydraulic conditions at the subject crossing. Therefore, design alternatives were not developed for tailwater controlled crossings. A summary is provided for each tailwater controlled crossing.
- **Adjacent Property Boundaries**: In some locations, adjacent property boundaries limited the width and number of replacement and relief culverts constraints. In general, a 3 m buffer to the adjacent property line was applied to design alternatives to allow for appropriate excavation depth for installation and / or maintenance works with minimal disruption to adjacent properties.

9.2 Design Alternatives Hydraulic Assessment

9.2.1 Regulated Crossings

The design alternatives for Highest Risk regulated crossings are presented in **Table 9-1**. Design alternatives were developed to meet the design criteria as far as practically possible.

The detailed hydraulic analysis for each design alternative is provided in **Appendix D**.

Tailwater Constraints due to Downstream Crossings

Tailwater constraints limited the development of design alternatives at two locations:

- Culvert CU_B04_04 – Anderson Street at Pringle Creek East Tributary; and
- Culvert CU_D01_03 – Watson Street West at Rowe Channel.

Further discussion is provided below for these two crossings along with recommendations for further consultation and investigation.

Culvert CU_B04_04 – Anderson Street at Pringle Creek East Tributary

Culvert CU_B04_04 is a 3080 mm span x 1510 mm rise concrete box culvert with 0.82 m cover to the road centerline. The culvert is located on Anderson Street. The downstream water level at the crossing submerges the culvert obvert during the 2-year event and floods Anderson Street during the design flow and check flow events.

The high design flow and check flow downstream water levels are created by the Rossland Road East culvert located approximately 350 m downstream of Anderson Street, as shown **Figure 9-2**. Additionally, the Coscan Weir controls the 2-year water level at Anderson Street. Therefore, it is not feasible to reduce flood risk and meet the design criteria by upsizing the Anderson Street culvert without upsizing the Rossland Road East crossing and removing the Coscan Weir. Proposed alternatives were not considered for culvert CU_B04_04. The Town of Whitby should investigate opportunities to increase the hydraulic capacity at Rossland Road East with the Region of Durham and remove the Coscan Weir before upgrading culvert CU_B04_04.

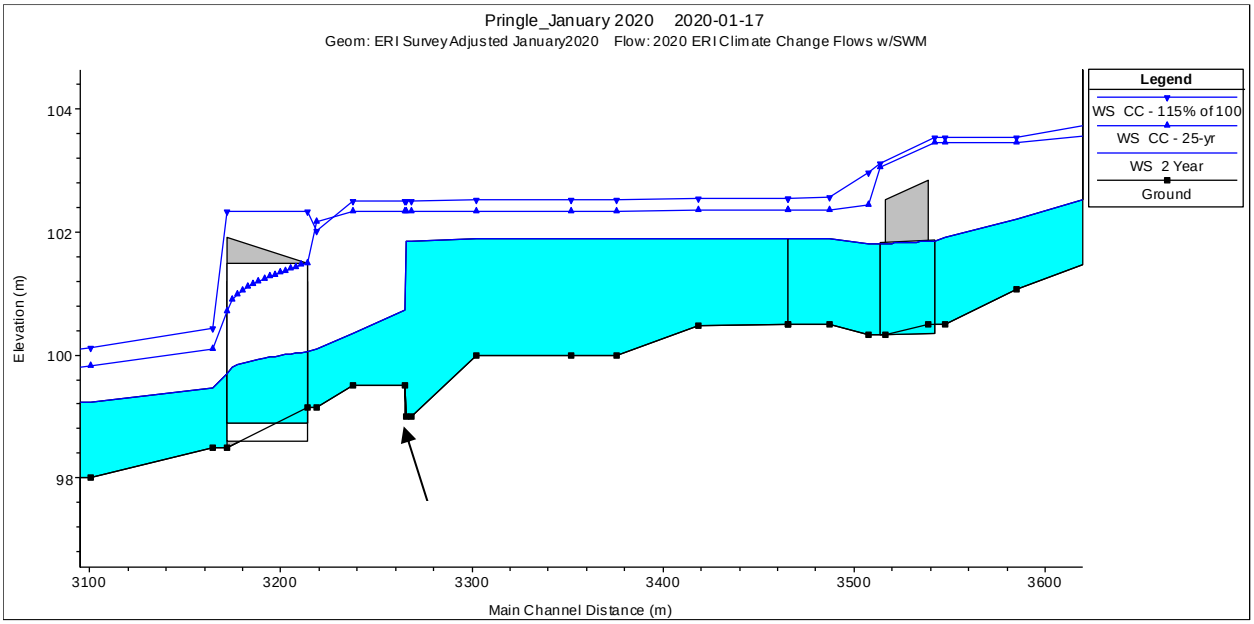

Figure 9-2. Water Surface Profile for Pringle Creek and the Pringle Creek East Tributary from Rossland Road East to Anderson Street (Culvert CU_B04_04).

Culvert CU_D01_03 – Watson Street West at Rowe Channel

Culvert CU_D01_03 is a twin 1800 mm span x 1200 mm rise concrete box culvert with 0.75 m cover to the road centerline. The culvert is located on Watson Street West and is shown in **Photograph 5**. The downstream water level at the crossing submerges the culvert during the 2-year and design flow events and is above the road during check flow event. The downstream water level is controlled by the tailwater from the Front Street West culvert and Lake Ontario located approximately 220 m and 300 m downstream of Watson Street West, respectively. The water surface profile for the Rowe Channel is shown in **Figure 9-3**.

The downstream Front Street West culvert has very little effective conveyance capacity due to the proximity to Lake Ontario, as shown in **Photograph 6**. The Front Street West culvert essentially acts to stabilize normal water levels between Lake Ontario and the Rowe Channel while high flows are conveyed over Front Street West. To reduce the tailwater impact on the Watson Street West culvert, Front Street West would have to be raised significantly to facilitate replacement and upsizing of the Front Street West culvert. The surrounding infrastructure and properties prevent raising Front Street West, therefore the tailwater conditions at Watson Street West culvert cannot be addressed.

Considering the tailwater conditions cannot be addressed, conveying the check flow event is not feasible because the check flow tailwater is above the Watson Street West road elevation. Conveying the design flow (25-year) could be achieved with significant upsizing of the subject crossing. Increasing the crossing capacity by adding an additional two 1800 mm span x 1200 mm rise concrete box culverts (total of four box culverts) prevents the road overtopping during the design flow. Adding the additional two box culverts would require widening the Rowe Channel by approximately 4.0 m upstream and downstream of the crossing. This would

require property acquisition from adjacent landowners and relocation of two storm sewer outfalls that discharge directly into the Rowe Channel downstream of the culvert outlet. Further detailed investigations are required to determine the feasibility of widening the Rowe Channel.

Photograph 5: Culvert CU_D01_03 outlet

Photograph 6: Front Street West Culvert Inlet during Low Flow Conditions

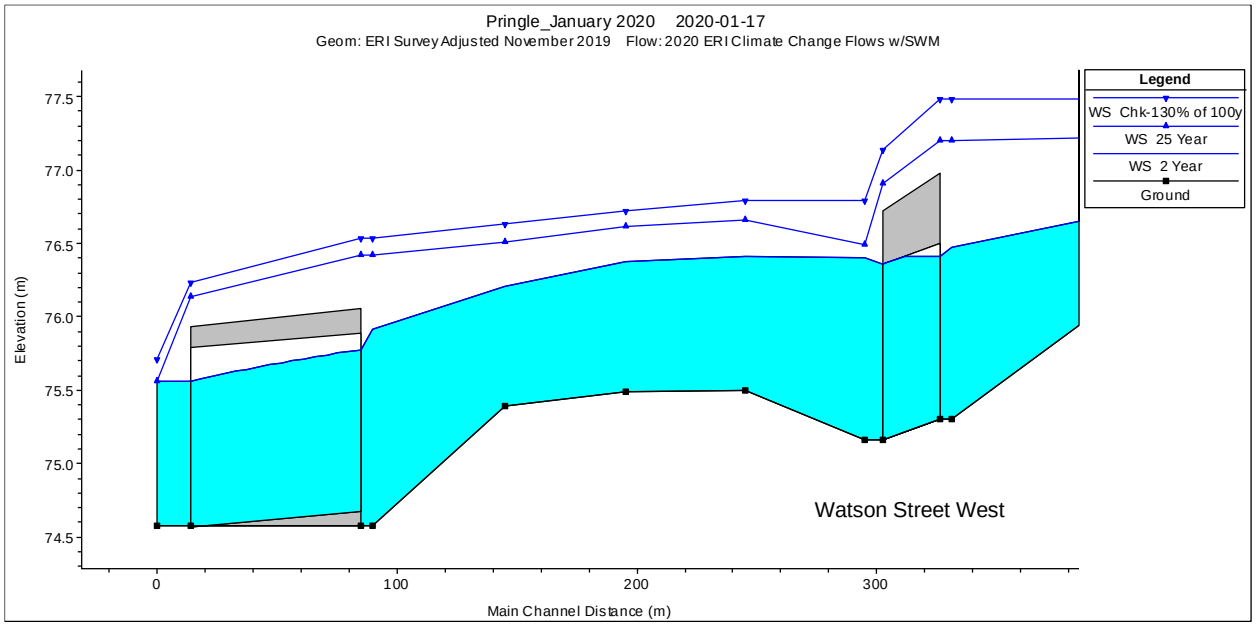

Figure 9-3. Water Surface Profile for the Rowe Channel from Lake Ontario to Watson Street West (Culvert CU_D01_03).

Table 9-1. Design Alternatives for Regulated Crossings.

Asset Number	Alter-native	Description	Cover (m)	Are Design Criteria Met?		Does the Road Overtop?	
				Flood Depth	Freeboard	Design Flow	Check Flow
CU360001 Anderson Street Pringle Creek	Existing	3300 mm x 2000 mm diameter CSP arch culvert.	0.62	**NO***	**NO**	**YES**	**YES**
	Alt. A	Triple 1800mm diameter circular CSP culverts.	0.7	**NO***	**NO**	**YES**	**YES**
	Alt. B	Twin 5100 mm x 1800 mm concrete box culverts.	0.7	**NO***	**NO**	**YES**	**YES**
	Alt. C	Raise Road 0.5 m and install twin 4000 mm x 1800 mm concrete box culverts.	0.7	Yes	**NO**	No	**YES**
CU480017 / AC20 / AC21 Conlin Road Pringle Creek	Existing	3 x Twin 1050 mm Diameter Circular CSP culverts (6 barrels total)	0.31	**NO***	**NO**	**YES**	**YES**
	Alt. A	Triple 1050 mm diameter circular CSP culverts.	0.31	**NO***	**NO**	**YES**	**YES**
	Alt. B	Twin 3500 mm x 1000 mm concrete box culverts.	0.36	Yes	Yes	No	No
CU_A07_01 Ashburn Road Ashburn Creek	Existing	5550 mm x 3500 mm CSP arch culvert.	1.02	**NO***	**NO**	**YES**	**YES**
	Alt. A	Single 6000 mm span x 3600 mm rise concrete box culvert.	0.92	**NO***	**NO**	**YES**	**YES**
	Alt. B	Twin 3900 mm span x 3600 mm rise concrete box culverts.	0.92	Yes	Yes	No	**YES**
	Alt. C	Twin 4800 mm span x 3600 mm rise concrete box culverts.	0.92	Yes	Yes	No	No
	Alt. D	Replace with a 10 m span bridge.	n/a	Yes	Yes	No	No

Notes: Bold text indicates failure to meet a given design criterion.
NO* identifies flood depth criterion is not met because the road is overtopped during the design flow.

9.2.2 Unregulated Crossings

The design alternatives for the Highest Risk unregulated crossings area presented in **Table 9-2** and the detailed calculations are provided in **Appendix D**.

Table 9-2. Design Alternatives for Unregulated Crossings.

Asset Number	Alter-native	Description	Cover (m)	Design Criteria		Does the Road Overtop for the Design Flow?	Does the Road Overtop for the Check Flow?
				Flood Depth	Free-board		
CU480010 (Garrard Road)	Existing	600 mm Diameter Circular CSP Culvert	0.77	**NO**	**NO**	**YES**	**YES**
	Alt. A	Triple 1000 mm diameter circular CSP culverts	0.37	Yes	**NO**	No	No
	Alt. B	4 x 900 mm span x 600 mm rise concrete box culverts	0.77	Yes	**NO**	No	No
	Alt. C	Raise intersection 300 mm and install twin 1200 mm diameter circular CSP culverts	0.47	Yes	**NO**	No	No
	Alt. D	Raise intersection 300 mm and install twin 1200 mm span x 900 mm rise concrete box culverts	0.77	Yes	**NO**	No	No
CU480013 (Garrard Road)	Existing	400 mm Diameter Circular CSP Culvert	0.37	**NO**	**NO**	**YES**	**YES**
	Alt. A	Raise intersection 300 mm and install triple 1030 mm span x 740 mm rise CSP arch culverts	0.33	Yes	**NO**	No	**YES**
	Alt. B	11 x 450 mm diameter circular CSP culverts	0.32	Yes	**NO**	No	**YES**
CU610022 (Columbus Road West)	Existing	800 mm Diameter Circular CSP Culvert	0.50	**NO**	**NO**	**YES**	**YES**
	Alt. A	Twin 900 mm diameter circular CSP culverts	0.40	Yes	**NO**	No	No
CU640016 (Columbus Road West)	Existing	500 mm Diameter Circular CSP Culvert	1.09	**NO**	**NO**	**YES**	**YES**
	Alt. A	Single 1200 mm diameter circular CSP culvert	0.39	Yes	Yes	No	**YES**
	Alt. B	Triple 1200 mm diameter circular CSP culverts	0.39	Yes	Yes	No	No
	Alt. C	Twin 900 mm span x 600 mm rise concrete box culverts	0.99	Yes	**NO**	No	No
	Alt. D	Twin 1500 mm span x 900 mm rise concrete box culverts	0.69	Yes	Yes	No	No
CU720007 (Columbus Road West)	Existing	1050 mm Diameter Circular CSP Culvert	1.40	**NO**	**NO**	**YES**	**YES**
	Alt. A	Single 1800 mm diameter circular CSP culvert	0.65	Yes	Yes	No	No
	Alt. B	Twin 1100 mm diameter circular CSP culverts	1.35	Yes	Yes	No	No
	Alt. C	Single 1500 mm span x 1200 mm rise concrete box culvert	1.25	Yes	Yes	No	No

Note: Bold text identifies design criteria that have not been met.

There were 3 crossings with very shallow cover where raising the road profile was considered:

- **CU480010 and CU480013 at Garrard Road**: Both culverts are located at the intersection of Garrard Road and Conlin Road. Culvert CU480013 requires 11 x 450 mm circular CSP culverts to prevent the road overtopping during the design flow. Raising the intersection 300 mm provides additional cover to install twin and triple barrel options at each crossing to prevent the road overtopping during the design flow. The check flow will continue to overtop the road at culvert CU480013. The approaches to the intersection will also need to be raised. There are no driveways impacted by the grade change, however, there are hydro poles located at the intersection that may need to be relocated.

- **Culvert CU610022 at Columbus Road West**: The culvert has shallow cover and the road is currently overtopped during the design flow. Replacing the existing 800 mm circular CSP with twin 900 mm circular CSP culverts prevents the road from overtopping during the design and check flow, however, the freeboard criteria is not met. The road would need to be raised significantly (approximately 0.5 m) or multiple additional barrels installed for the crossing to meet the freeboard criteria.

9.3 Site Specific Studies

The following site specific studies were completed at the Highest Risk crossings to support the evaluation of alternatives and the development of mitigation measures.

9.3.1 Cultural Heritage

None of the Highest Risk crossings are located within the Brooklin Village Heritage Conservation District or the Werden's Plan Neighbourhood Heritage Conservation District.

There are no known records of cemeteries or heritage properties within 150 m of the Highest Risk crossings.

The Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes checklist was completed for each of the Highest Risk crossings. The completed checklists are included in **Appendix E**. The Highest Risk crossings were not identified as potential cultural heritage resources, in which case no further cultural heritage study is required. Archaeology Assessments will be required at detailed design.

9.3.2 Social Environment

Site specific environmental conditions have been determined based on a review of surrounding land use and environmental conditions. Figures showing the individual site study areas (150 m around the crossing) are provided in **Appendix F**. A summary of the surrounding social environment is provided below:

- **CU_A07_01**: Located within Town of Whitby Natural Heritage System in Major Open Space land use designation and in the Greenbelt Natural Heritage System within the Protected Countryside. Surrounding land use is Agricultural.
- **CU610022**: Located within Town of Whitby Natural Heritage System in Major Open Space land use designation. Surrounding land use is Agricultural.
- **CU720007**: Located within Town of Whitby Natural Heritage System in Major Open Space land use designation. Surrounding land use is Agricultural.
- **CU640016**: Located within Town of Whitby Natural Heritage System in Major Open Space land use designation. Surrounding land use is Future Urban/Industrial.
- **CU480010 and CU480013**: Located within Town of Whitby Future Urban/Industrial land use designation. Surrounding land use is Future Urban/Industrial and Natural Heritage System in Major Open Space.
- **CU480017**: Located within Town of Whitby Natural Heritage System in Major Open Space land use designation. Surrounding land use is Future Urban/Industrial and Commercial/Industrial/Institutional.
- **CU360001**: Located within Town of Whitby Natural Heritage System in Major Open Space land use designation. Surrounding land use is Residential.

9.3.3 Natural Heritage and Species at Risk

A site specific desktop review of natural heritage features and potential Species at Risk was completed for each of the Highest Risk crossings. The review is provided in **Appendix F**. A summary of the findings is presented in **Table 9-3**.

Table 9-3. Results of the Site Specific Natural Heritage Desktop Review.

Asset Number	Site Specific Features
CU_A07_01	Ashburn Creek is located within the Ashburn Creek subwatershed, which contains cold and warm water tributaries.
	Located within the Town of Whitby Natural Heritage System.
	Located within the Greenbelt Natural Heritage System within the Protected Countryside.
	Located within CLOCA Regulation Limits.
	Historical records of redside dace have been recorded in Ashburn Creek.
	21 Candidate SAR and Species of Conservation Concern (SOCC).
	24 Candidate Significant Wildlife Habitat (SWH).
	6 ELC communities have been delineated by CLOCA within the study area. • FOC, FOM, CUM, SWT, MAM, CUH. MNRF delineated Woodlands occur within the study area.
	CLOCA Identified Wildlife Crossing.
CU610022	Located within Heber Down subwatershed, which contains cold and warm tributaries.
	Located within the Town of Whitby Natural Heritage System.
	Redside dace has been recorded within 1 km of the crossing.
	23 Candidate SAR and Species of Conservation Concern (SOCC).
	16 Candidate Significant Wildlife Habitat (SWH).
	1 ELC community has been delineated by CLOCA within the study area. • CUT. MNRF delineated Woodlands occur within the study area.
CU720007	Located within Heber Down subwatershed, which contains cold and warm tributaries.
	Located within the Town of Whitby Natural Heritage System.
	Located within the CLOCA Regulation limits.
	Redside dace is confirmed within the watercourse.
	23 Candidate SAR and Species of Conservation Concern (SOCC).
	19 Candidate Significant Wildlife Habitat (SWH).
	4 ELC communities have been delineated by CLOCA within the study area. • CUW, CUM, MAM, CUH. MNRF delineated Woodlands occur within the study area.
CU640016	Located within Heber Down subwatershed, which contains cold and warm tributaries.
	Located within a riparian corridor.
	Located within the Town of Whitby Natural Heritage System.
	Partially located within CLOCA regulation limits.
	Redside dace has been recorded within 1 km of the study area.
	26 Candidate SAR and Species of Conservation Concern (SOCC).
	21 Candidate Significant Wildlife Habitat (SWH).
	1 ELC community has been delineated by CLOCA within the study area. • SWD. MNRF delineated Woodlands occur within the study area.
CU480010 and CU480013	Located within the Pringle Creek Watershed, a coolwater system.
	Partially located within CLOCA Regulation limits.
	27 Candidate SAR and Species of Conservation Concern (SOCC).
	21 Candidate Significant Wildlife Habitat (SWH).
	2 ELC communities have been delineated by CLOCA within the study area. • SWT, MAM.
	Study area contains 1 Provincially Significant Wetland.

Asset Number	Site Specific Features
CU480017	Located within the Pringle Creek Watershed, a coolwater system.
	Located within the Town of Whitby Natural Heritage System.
	Located within a riparian corridor.
	Located within CLOCA regulation limits.
	27 Candidate SAR and Species of Conservation Concern (SOCC).
	33 Candidate Significant Wildlife Habitat (SWH).
	4 ELC communities have been delineated by CLOCA within the study area. • MAS, SAS, CUM, CUT. MNRF delineated Woodlands occur within the study area.
	Study area within the Whitby-Oshawa Iroquois Beach Wetland Complex (Provincially Significant Wetland).
CU360001	Located within the Pringle Creek Watershed, a coolwater system.
	Located within the Town of Whitby Natural Heritage System.
	Located within a riparian corridor.
	Located within CLOCA regulation limits.
	23 Candidate SAR and Species of Conservation Concern (SOCC).
	20 Candidate Significant Wildlife Habitat (SWH).
	3 ELC communities have been delineated by CLOCA within the study area. • FOC, FOM, SWC. MNRF delineated Woodlands occur within the study area.
	Study area contains 1 Provincially Significant Wetland.

9.4 Evaluation of Alternatives

A key component of the Class EA process is the evaluation of each design alternative with respect to the social, environmental and economic impacts to identify the preferred alternative. The evaluation criteria developed to assess the design alternatives is presented in **Table 9-4**. These criteria are further refined at each crossing, as required, based on individual site constraints. Redside Dace are present in the Lynde Creek watershed. Culvert and bridge replacements within Lynde Creek should have consideration for opportunities to improve Redside Dace habitat and passage. The location of known and predicted Redside Dace is shown in **Figure 4-7** in **Section 4**.

Table 9-4. Municipal Class EA Evaluation Criteria.

Category	Criteria	Indicator
Socio – Economic Environment	Flood Risk	• Reduce flood risk to private property. • Reduces flood risk to road users. • Property acquisition.
Natural Environment	Terrestrial Environment	• Habitat and tree removal.
	Aquatic Environment	• Impacts to Species at Risk – Redside Dace. • Opportunity to improve fish passage.
Archaeological and Cultural Heritage	Archaeology	• Potential for Archaeological Resources.
	Built and Cultural Heritage	• Impact to Heritage Properties.
Technical	Design / Function	• Ability to meet design standards.
	Construction and Implementation	• Constructability (staging, grading constraints, utility conflicts).
	Approvals and Compliance	• Permitting requirements (CLOCA, MNRF, DFO). • Climate change and infrastructure resiliency.
Cost	Construction Cost	• Capital Costs • Property Acquisition Costs

The evaluation of alternatives for regulated and unregulated crossings are provided in **Table 9-5** and **Table 9-6** respectively.

Table 9-5. Design Alternative Evaluation for Regulated Crossings.

Asset Number	Existing Crossing	Alter-native	Description	Technical			Archaeological and Cultural Heritage	Socio - Economic		Natural Environment		Cost	
				Meets Design Standards	Constructability	Approvals and Compliance		Flood Risk	Property Impacts / Acquisition	Terrestrial	Aquatic	Capital Costs	
CU360001 Anderson Street Pringle Creek	3300 mm x 2000 mm diameter CSP arch culvert.	Alt. A	Triple 1800mm diameter circular CSP culverts.	Flood Depth: No Freeboard: No Check Flow: No	Significantly widens cross-section. Channel works required.	Approvals required from: CLOCA and DFO.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Small improvement in flood risk compared to existing.	Widening cross-section should not impact private property	Tree clearing required within road ROW and floodplain.	Instream channel works required. Reduction in culvert span may impede fish passage	Moderate	
		Alt. B	Twin 5100mm x 1800mm concrete box culverts.	Flood Depth: No Freeboard: No Check Flow: No	Similar constructability as Alt. A.	Same approvals as Alt A.	Similar impacts to Alt A.	Conveys the design and check flow safely over the roadway. Reduces flood risk.	Similar property impacts as Alt. A	Similar impacts as Alt. A.	Larger span structure provides opportunity to improve fish passage and habitat.	High	**Preferred**
		Alt. C	Raise Road 0.5 m and install twin 4000 mm x 1800 mm concrete box culverts.	Flood Depth: Yes Freeboard: No Check Flow: No	Similar constructability as Alt. A plus raising the road will impact side roads and driveways.	Same approvals as Alt A.	Similar impacts to Alt A.	Reduces flood risk to road users during design flow but increases flood risk to upstream properties during the design, check and regulatory flows.	Potential property impacts due to raising the road.	Additional tree clearing required to raise road.	Raising the road increases flow through the culverts leading to higher flow velocity. May impede fish passage. Will require mitigation measures.	Highest	
CU480017 / AC20 / AC21 Conlin Road Pringle Creek	3 x Twin 1050 mm Diameter Circular CSP (6 barrels total)	Alt. A	Add 1050 mm diameter circular CSP culver (7 barrels total).	Flood Depth: No Freeboard: No Check Flow: No	Installation of a third barrel will require road works.	Approvals required from: CLOCA and DFO.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Limited reduction in flood risk.	No anticipated property impacts	Limited tree clearing.	Existing culvert is likely a barrier to fish passage. No change from existing conditions.	Moderate	
		Alt. B	Replace CU480017 with Twin 3500 mm x 1000 mm concrete box culverts and maintain AC20 and AC21.	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Total crossing width = 7 m. Significant widening of cross-section. Channel works required.	Same approvals as Alt A.	Similar impacts to Alt A.	Reduces flood risk to road users and meets design standards.	Channel works on private property may be required to accommodate structure.	Downstream tree clearing required to construct culvert.	Opportunity to improve fish passage at the crossing.	Highest	**Preferred**
CU_A07_01 Ashburn Road Ashburn Creek	5550 mm x 3500 mm CSP arch culvert.	Alt. A	Single 6000 mm span x 3600 mm rise concrete box culvert.	Flood Depth: No Freeboard: No Check Flow: No	Road reconstruction required.	Approvals required from: CLOCA, MNRF (SAR) and DFO.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Does not reduce flood risk.	Upstream construction extends into private property.	Tree removal required.	Redside Dace have been identified in Ashburn Creek. Opportunity to improve fish passage and habitat.	High	
		Alt. B	Twin 3900 mm span x 3600 mm rise concrete box culverts.	Flood Depth: Yes Freeboard: Yes Check Flow: No	Similar constructability as Alt. A plus widening cross-section.	Same approvals as Alt A.	Similar impacts to Alt A.	Reduces flood risk for design flow but not check flow.	Similar property impacts as Alt. A	Similar impacts as Alt. A.	Similar opportunity as Alt. A.	High	
		Alt. C	Twin 4800 mm span x 3600 mm rise concrete box culverts.	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Similar constructability as Alt. B with larger widening.	Same approvals as Alt A.	Similar impacts to Alt A.	Significantly reduces flood risk and meets design standards.	Similar property impacts as Alt. A	Similar impacts as Alt. A.	Similar opportunity as Alt. A.	High	
		Alt. D	Replace with a 10 m span bridge.	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Additional design requirements for bridge.	Same approvals as Alt A.	Similar impacts to Alt A.	Similar flood risk reduction as Alt. C.	Similar property impacts as Alt. A	Similar impacts as Alt. A.	Single span bridge provides greatest opportunity for Redside Dace passage and habitat.	Highest	**Preferred**

Table 9-6. Design Alternative Evaluation for Unregulated Crossings.

Asset Number	Existing Crossing	Alter-native	Description	Technical			Archaeological and Cultural Heritage	Socio - Economic		Natural Environment		Cost	
				Meets Design Standards	Constructability	Approvals and Compliance		Flood Risk	Property Impacts / Acquisition	Terrestrial	Aquatic	Capital Costs	
CU480010 (Garrard Road)	600 mm diameter circular CSP culvert.	Alt. A	Triple 1000 mm diameter circular CSP culverts	Flood Depth: Yes Freeboard: No Check Flow: Yes	Difficult to construct at existing intersection. Hydro pole present.	No approvals required.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Reduces flood risk at the crossings and intersection.	Property acquisition may be required at intersection.	No expected terrestrial impacts or tree clearing.	Culvert located on drainage ditch. No expected aquatic impacts.	Moderate	
		Alt. B	4 x 900 mm span x 600 mm rise concrete box culverts	Flood Depth: Yes Freeboard: No Check Flow: Yes	Larger span than Alt. A = more challenging construction.	No approvals required.	Similar impacts to Alt A.	Similar flood risk reduction as Alt. A.	Similar property impacts as Alt. A.	Same terrestrial impacts as Alt. A.	Same aquatic impacts as Alt. A	High	
		Alt. C	Raise intersection 300 mm and install twin 1200 mm diameter circular CSP culverts	Flood Depth: Yes Freeboard: No Check Flow: Yes	More challenging construction due to road raising at intersection.	No approvals required.	Similar impacts to Alt A.	Similar flood risk reduction as Alt. A.	Similar property impacts as Alt. A.	Same terrestrial impacts as Alt. A.	Same aquatic impacts as Alt. A	Moderate to High	**Preferred**
		Alt. D	Raise intersection 300 mm and install twin 1200 mm span x 900 mm rise concrete box culverts	Flood Depth: Yes Freeboard: No Check Flow: Yes	Similar constructability as Alt. C.	No approvals required.	Similar impacts to Alt A.	Similar flood risk reduction as Alt. A.	Similar property impacts as Alt. A.	Same terrestrial impacts as Alt. A.	Same aquatic impacts as Alt. A	High	
CU480013 (Garrard Road)	400 mm diameter circular CSP culvert.	Alt. A	Raise intersection 300 mm and install triple 1030 mm span x 740 mm rise CSP arch culverts	Flood Depth: Yes Freeboard: No Check Flow: No	Challenging construction due to road raising at intersection.	No approvals required.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Reduces flood risk at the crossings and intersection.	Property acquisition may be required at intersection.	No expected terrestrial impacts or tree clearing.	Culvert located on drainage ditch. No expected aquatic impacts.	Moderate to High	**Preferred**
		Alt. B	11 x 450 mm diameter circular CSP culverts	Flood Depth: Yes Freeboard: No Check Flow: No	It is not feasible to install 11 culverts at a single crossing. Therefore, this alternative has been pre-screened.								
CU610022 (Columbus Road West)	800 mm diameter circular CSP culvert.	Alt. A	Twin 900 mm diameter circular CSP culverts.	Flood Depth: Yes Freeboard: No Check Flow: Yes	Alternative is constructible at the existing crossing.	Approvals required from: CLOCA and DFO.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Reduces flood risk for the design flow.	No expected property impacts.	No tree clearing expected.	Culvert located on drainage ditch. No expected aquatic impacts.	Moderate	**Preferred**
CU640016 (Columbus Road West)	500 mm diameter circular CSP culvert.	Alt. A	Single 1200 mm diameter circular CSP culvert	Flood Depth: Yes Freeboard: Yes Check Flow: No	Simplest construction of all alternatives.	Approvals required from: CLOCA and DFO.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Reduces flood risk for design flow.	Construction may extend into private property.	No tree removal expected.	Culvert located on drainage ditch. No expected aquatic impacts.	Moderate	
		Alt. B	Triple 1200 mm diameter circular CSP culverts	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Significant widening of cross-section	Same approvals as Alt A.	Similar impacts to Alt A.	Reduces flood risk for design and check flow. Meets design standards.	Similar property impacts as Alt. A.	Possible tree removal to accommodate construction.	Similar impact as Alt. A.	Moderate to High	**Preferred**
		Alt. C	Twin 900 mm span x 600 mm rise concrete box culverts	Flood Depth: Yes Freeboard: No Check Flow: Yes	Similar constructability as Alt. B.	Same approvals as Alt A.	Similar impacts to Alt A.	Reduces flood risk for design and check flow.	Similar property impacts as Alt. A.	Similar impact as Alt. B.	Similar impact as Alt. A.	Moderate to High	
		Alt. D	Twin 1500 mm span x 900 mm rise concrete box culverts	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Similar constructability as Alt. B. Less cover provided for box culvert.	Same approvals as Alt A.	Similar impacts to Alt A.	Similar flood risk reduction as Alt. B.	Similar property impacts as Alt. A.	Similar impact as Alt. B.	Similar impact as Alt. A.	High	
		Alt. C	Triple 1150 mm span x 820 mm rise CSP arch culverts	Flood Depth: Yes Freeboard: No Check Flow: No	Similar constructability as Alt. B.	Same approvals as Alt A.	Similar impacts to Alt A.	Similar flood risk reduction as Alt. B.	Similar property impacts as Alt. A.	Same impact as Alt. A.	Similar impact as Alt. A.	Moderate	
CU720007 (Columbus Road West)	1050 mm diameter circular CSP culvert.	Alt. A	Single 1800 mm diameter circular CSP culvert	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Constructible within the road ROW. Cover reduced.	Approvals required from: CLOCA and DFO.	Archaeological potential. Stage 1 AA required. No built heritage sites present.	Mitigates flood risk and meets design standards.	Works within Municipal road ROW.	Vegetation clearing may be required upstream of culvert.	Culvert located on drainage ditch. No expected aquatic impacts.	Moderate	
		Alt. B	Twin 1100 mm diameter circular CSP culverts	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Additional cover compared to Alt A.	Same approvals as Alt A.	Similar impacts to Alt A.	Same as Alt. A.	Similar property impacts as Alt. A.	Same impact as Alt. A.	Similar impact as Alt. A.	Moderate	**Preferred**
		Alt. C	Single 1500 mm span x 1200 mm rise concrete box culvert	Flood Depth: Yes Freeboard: Yes Check Flow: Yes	Reduced span compared to Alt. B	Same approvals as Alt A.	Similar impacts to Alt A.	Same as Alt. A.	Similar property impacts as Alt. A.	Same impact as Alt. A.	Similar impact as Alt. A.	Moderate to High	

10. Preferred Alternative, Approvals and Cost Estimates

The preferred alternative at each crossing is presented in **Table 10-1** based on the evaluation provided in Section 8. Approval requirements and cost estimates are also provided in **Table 10-1**. A full description of the approvals required for crossing replacements is provided in **Section 13.2**.

Table 10-1. Preferred Alternative for the Highest Risk Crossings.

Facility ID	Road Name	Watercourse	Existing Culvert	Preferred Alternative	Approval Requirements	Estimated Capital Costs
Regulated Crossings						
CU360001	Anderson Street	Pringle Creek	3300 mm span x 2000 mm rise CSP Culvert	Twin 5100mm x 1800mm concrete box culverts.	• CLOCA • DFO • MECP	$1,940,000
CU480017 / AC20 / AC21	Conlin Road	Pringle Creek	3 x Twin 1050 mm Diameter Circular CSP Culvert (6 barrels total)	Replace CU480017 with twin 3500 mm x 1000 mm concrete box culverts and maintain AC20 and AC21 relief culverts.	• CLOCA • DFO • MECP	$980,000
CU_A07_01	Ashburn Road	Ashburn Creek	5550 mm span x 3500 mm rise Arch CSP Culvert	Replace with a 10 m span bridge.	• CLOCA • MECP (Redside Dace) • DFO	$1,740,000
CU_B04_04	Anderson Street	East Tributary, Pringle Creek	3080 mm span x 1510 mm rise Concrete Box Culvert	Downstream tailwater from the Rossland Road East crossing submerges the Anderson Street crossing for the 2-year event and prevents feasible design alternatives at this location. Opportunities to increase hydraulic capacity at Rossland Road East should be investigated with the Region of Durham before upgrading culvert CU_B04_04.		
CU_D01_03	Watson Street West	Rowe Channel	Twin 1800 mm span x 1200 mm rise Concrete Box Culvert	Increasing the crossing capacity by adding an additional two 1800 mm span x 1200 mm rise concrete box culverts (total of four box culverts) prevents the road overtopping during the design flow. However, adding the additional two box culverts would require widening the Rowe Channel by approximately 4.0 m upstream and downstream of the crossing. This requires property acquisition from adjacent landowners and relocation of two storm sewer outfalls that discharge directly into the Rowe Channel immediately downstream of the culvert outlet. Detailed investigations are required to determine the feasibility of widening the Rowe Channel considering the significant site constraints.		
Unregulated Crossings						
CU480010	Garrard Road	n/a	600 mm Diameter Circular CSP Culvert	Raise intersection 300 mm and install twin 1200 mm diameter circular CSP culverts	No approvals required.	$210,000
CU480013	Garrard Road	n/a	400 mm Diameter Circular CSP Culvert	Raise intersection 300 mm and install triple 1030 mm span x 740 mm rise CSP arch culverts	No approvals required.	$200,000
CU610022	Columbus Road West	n/a	800 mm Diameter Circular CSP Culvert	Twin 900 mm diameter circular CSP culverts.	• CLOCA • DFO • MECP	$190,000
CU640016	Columbus Road West	n/a	500 mm Diameter Circular CSP Culvert	Triple 1200 mm diameter circular CSP culverts	• CLOCA • DFO • MECP	$220,000
CU720007	Columbus Road West	n/a	1050 mm Diameter Circular CSP Culvert	Twin 1100 mm diameter circular CSP culverts	• CLOCA • DFO • MECP	$220,000

11. Consultation Program

Community consultation, including residents, agencies, stakeholders, Indigenous communities and those potentially impacted by the project, is an integral part of the Class EA process. The purpose of the Consultation Program is to provide an opportunity for stakeholder groups and the public to gain an understanding of the project and the EA process, provide feedback regarding the key concerns, and have input into the design solutions developed through the project.

A summary of the consultation activities undertaken throughout the Whitby Bridge and Culvert Master Plan is provided in this section. The Consultation documentation and the Stakeholder Contact List developed throughout the study are provided in **Appendix G**.

11.1 Public Consultation and Public Information Centre

Public notices were issued throughout the course of the study to notify the stakeholders and the public of the project status, public information centres (PIC), and to invite feedback. Public notices issued during the Class EA are provided in **Table 11.1**.

Table 11-1. Public Notices.

Notice	Publication Date	Publications
Notice of Commencement	January 30, 2019	• Emailed / mailed to the Stakeholder Contact List. • Published on the Town of Whitby website (www.whitby.ca/notices). • Published in the Whitby This Week newspaper.
Notice of Public Information Centre	November 28, 2019	• Emailed / mailed to the Stakeholder Contact List. • Published on the Town of Whitby website www.whitby.ca/notices). • Published in the Whitby This Week newspaper.
Notice of Completion	December 24, 2020	• Emailed / mailed to the Stakeholder Contact List. • Published on the Town of Whitby website www.whitby.ca/notices). • Published in the Whitby This Week newspaper.

11.1.1 Public Information Centre (PIC)

A PIC was held on Tuesday, December 10, 2019 from 6:00 pm to 8:00 pm at the Town of Whitby Council Chambers. The PIC provided local residents with the following information:

- Introduction to the project;
- Summary of the Class EA process;
- Overview of the culvert and bridge locations;
- Summary of the hydraulic modeling results and the risk assessment;
- Identification of design alternatives at the Highest Risk crossings; and
- Next steps.

The PIC was held in an open house format and was attended by 2 members of the public in addition to the Town of Whitby and ERI staff.

No comment sheets were received. The residents identified concerns with flooding at Halls Road North where flooding over the road had been observed.

11.1.2 Additional Public Input

No additional public input was received throughout the project via email or mail.

11.2 Agency Consultation

Similar to the above notification process, review agencies were contacted throughout the study. The following provides a summary of consultation with responding agencies.

11.2.1 Central Lake Ontario Conservation Authority (CLOCA)

CLOCA received the Notice of Project Commencement, the Notice of PIC and the Notice of Project Completion. CLOCA, through the Town of Whitby, provided hydrology and hydraulic models for the regulated crossings and background reports relevant to the four subwatersheds within the study area.

CLOCA provided a digital response to the Notice of PIC on December 4, 2019 indicating their regulatory and policy interests and noting a wide range of factors beyond hydraulic capacity that will influence design and sizing of culvert and bridge replacements, such as meander belts and fluvial processes, fish and wildlife passage, slope stability, soil quality, groundwater conditions, and wetlands. The full CLOCA response is included in **Appendix G**.

CLOCA also provided an emailed response on December 19, 2019 after reviewing the PIC display boards. The importance of considering additional factors in design and sizing was reiterated. These factors include DFO review, SAR, fish passage, climate change, as well as reiterating the factors mentioned above. Some general comments and suggestions for inclusion in the report were listed as well. The complete email is included in **Appendix G**.

A copy of the draft Master Plan report was provided to CLOCA for review. CLOCA provided review comments on . The project team provided responses to CLOCA comments on September 16, 2020 and CLOCA comments were included in the current version of the Master Plan report. CLOCA's review comments and the project team responses are included in **Appendix G**

11.2.2 Ministry of Environment Conservation and Park (MECP)

The MECP provided an initial response to the notice of commencement dated March 25, 2019; this full response is included in **Appendix G**.

The response identified 'areas of interest' with guidance regarding the ministry's interest with respect to the Class EA process. The letter indicated that the project should identify those which are applicable to this project and ensure that they are met as part of the project. These areas of interest included:

- Source Water Protection;
- Climate Change;
- Planning and Policy;
- Air Quality, Dust and Noise;
- Ecosystem Protection and Restoration;
- Surface Water;
- Groundwater;
- Contaminated Soils;
- Excess Materials Management;
- Servicing and Facilities;
- Mitigation and Monitoring;
- Consultation; and
- Class EA Process.

MECP provided review comments on a draft version of the Master Plan report. Initial comments were received on June 19, 2020. The comments primarily addressed concerns that the Master Plan did not provided sufficient detail to meet the requirements of Schedule B projects.

The project team provided responses to MECP on September 10, 2020 and MECP provided further clarification and comments on September 17, 2020. A review meeting was held with MECP and project team staff to determine the necessary steps to update the Master Plan report to meet the requirements for Schedule B projects.

MECP provided review comments on a revised version of the Master Plan on December 18, 2020. These comments were addressed in the current version of the Master Plan report.

All consultation documents related to MECP's review are provided in **Appendix G**.

11.2.3 Ministry of Heritage, Sport, Tourism and Culture Industries

The Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI) provided a response to the notice of completion on March 29, 2019. The key areas of concern included:

- **Identifying Cultural Heritage Resources**: While some cultural heritage resources may have already been formally identified, others may be identified through screening and evaluation. Indigenous communities may have knowledge that can contribute to the identification of cultural heritage resources, and we suggest that any engagement with Indigenous communities includes a discussion about known or potential cultural heritage resources that are of value to these communities.
- **Archaeological Resources**: The Master Plan project may impact archaeological resources and the project team should screen the project with the MTCS Criteria for Evaluating Archaeological Potential and Criteria for Evaluating Marine Archaeological Potential to determine if archaeological assessments will be needed for subsequent project-driven Municipal Class EAs.
- **Built Heritage and Cultural Heritage Landscapes**: The MTCS Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes should be completed to help determine whether your Master Plan project may impact cultural heritage resources. A determination of whether the Master Plan project area impacts potential or known heritage resources of cultural heritage value or interest should be used in the evaluation of alternatives.

MHSTCI provided review comments on the draft Master Plan report. The primary concern raised by MHSTCI was the need for additional information with respect to Archaeological, Built and Cultural Heritage within the study to identify the potential impacts as part of the alternative assessment. MHSTCI also reviewed a revised version of the Master Plan report and provided additional comments. MHSTCI's comments and the additional information have been incorporated into current Master Plan report. Full copies of MHSTCI's correspondence and comments are provided in **Appendix G**.

11.2.4 Transport Canada

A response from Transport Canada to the Notice of Project Commencement was received on February 19, 2019. It noted that Transport Canada does not require receipt of all project specific Municipal Class EA related notifications, and requests a self-assessment of projects by proponents to determine whether the project will include (1) interaction with federal property and / or waterways, and (2) whether it will require approval by Transport Canada under its posted acts.

The Navigation Protection Act applies to works interacting with navigable waters set out under the Act and is relevant to the bridge and culvert crossings included in the project. The full email correspondence is included in **Appendix G**.

11.3 Indigenous Consultation

The following section provides a summary of the Indigenous Consultation undertaken throughout the Class EA. All Indigenous communication is provided in **Appendix H**.

The Indigenous communities contact list was developed by conducting a search of the Aboriginal and Treaty Rights Information System (ATRIS) to confirm the location and nature of established a potential Indigenous and Treaty rights which may relate to the study area. The following Indigenous communities have a treaty right which may apply to the study area:

- Curve Lake First Nation;
- Huron-Wendat Nation Council;
- Six Nations Council;
- Mississaugas of Scugog Island First Nation;
- Chippewas of Rama First Nation;
- Alderville First Nation;
- Williams Treaty First Nation;
- Mississaugas of Scugog Island First Nation;
- Huron-Wendat Nation Council; and
- Hiawatha First Nation.

The communities were contacted by mail and / or email throughout the Class EA process. Responses were received from two First Nations communities. The key concerns are summarised below and the full responses are provided in **Appendix H**.

Alderville First Nation

Email correspondence received from Dave Simpson:

Thank you for the notification of this project. I guess the one thing we are always concerned about is the fish and fish habitat when projects are being undertaken near or on the waterways. So, we would appreciate any updates as the project moves forward and any studies that are carried out in regard to this project.

Response from the Town of Whitby:

At the detailed design stage, our biologist will consult with MNRF and DFO on the fish and fish habitat concerns and incorporate required remedial measures into the designs.

Curve Lake First Nation

Letter received from Chief Emily Whetung:

Based on the information that you have provide us with respect to the Bridge/Culvert Master Plan – Hydraulic Capacity Assessment, Curve Lake First Nation may require a Special Consultation Framework for this project.

In order to assist us in providing you with timely input, it would be appreciated if you could provide a summary statement indicating how the project will address the following areas that are of concern to our First Nation within our Traditional and Treaty Territory: possible environmental impact to our drinking water; endangerment to fish and wild game; impact on Aboriginal heritage and cultural value; and to endangered species; lands; savannas, etc.

Response from the Town of Whitby:

A response was provided to Curve Lake First Nation describing the assessment process to identify the highest risk crossings and select the preferred alternatives including the evaluation of the environmental, social, cultural, and economical opportunities and constraints. Redside Dace are known to occur in the Lynde Creek watershed. Selection of the preferred alternatives has considered opportunities to improve habitat and fish passage for Redside Dace.

Additionally, the response indicated that construction impacts to water quality and aquatic wildlife and habitat are a significant concern and will receive specific attention during detailed design and construction. A Stage 1 Archaeological Assessments will also be undertaken at each crossing during detailed design, at which time, Curve Lake First Nation will be contacted.

A list of mitigation measures that will be implanted at each project site during detailed design and construction was also provided in the response.

12. Implementation and Timing

This section provides the proposed implementation strategy for the 12 Highest Risk crossings (**Section 12.1**) and a consolidated list of lower priority crossings where preliminary proposed sizing has been developed (**Section 12.2**) and crossings that require replacement due to poor structural condition (**Section 12.3**). This Master Plan is completing the Schedule B EA process for the 12 Highest Risk crossings only.

12.1 Highest Priority Crossings

The prioritization of the preferred design alternatives for the Highest Risk crossings has been developed based on a simplified cost benefit analysis considering the capital cost estimates at each crossing and the relative improvement to flood risk achieved by implementing the design alternative. The prioritization is presented in **Table 12-1**. Implementation includes detailed design, approvals and permitting and construction. A map showing the highest priority and secondary priority crossings is shown in Error! Reference source not found..

Table 12-1. Implementation and Timing of Highest Priority Crossings.

Priority	Facility ID	Road Name	Existing Culvert / Bridge	Preferred Alternative	Capital Cost	EA Schedule
Within 2 years	**CU610022**	Columbus Road West	800 mm diameter circular CSP culvert	Twin 900 mm diameter circular CSP culverts.	$190,000	Schedule B
	CU720007	Columbus Road West	1050 mm diameter circular CSP culvert	Twin 1100 mm diameter circular CSP culverts	$220,000	Schedule B
2 to 5 years	**CU_A07_01**	Ashburn Road	5550 mm span x 3500 mm rise arch CSP culvert	Replace with a 10 m span bridge.	$1,740,000	Schedule B
	CU640016	Columbus Road West	500 mm diameter Circular CSP culvert	Triple 1200 mm diameter circular CSP culverts	$220,000	Schedule B
5 to 10 years	**CU360001**	Anderson Street	3300 mm span x 2000 mm rise CSP culvert	Twin 5100mm x 1800mm concrete box culverts.	$1,940,000	Schedule B
10 to 20 years	**CU480010**	Garrard Road	600 mm diameter circular CSP culvert	Raise intersection 300 mm and install twin 1200 mm diameter circular CSP culverts	$210,000	Schedule B
	CU480013	Garrard Road	400 mm diameter circular CSP culvert	Raise intersection 300 mm and install triple 1030 mm span x 740 mm rise CSP arch culverts	$200,000	Schedule B
	CU480017, AC20 & AC21	Conlin Road	CU480017: Twin 1050 mm diameter circular CSP culverts	Replace CU480017 with twin 3500 mm x 1000 mm concrete box culverts.	$980,000	Schedule B
			AC20: Twin 1050 mm diameter circular CSP culverts	Maintain existing AC20 relief culverts.		No proposed works at AC20.
			AC21: Twin 1050 mm diameter circular CSP culvert	Maintain existing AC21 relief culverts.		No proposed works at AC20.
To be Determined	**CU_B04_04**	Anderson Street	3080 mm span x 1510 mm rise concrete box culvert	The downstream Rossland Road East crossing is undersized and back floods the Anderson Street culvert. The Town should consult with the Region of Durham to determine opportunities to upsize the Rossland Road East crossing before developing design alternatives for the Anderson Street culvert.		Separate Schedule B EA required following further consultation with Region.
	CU_D01_03	Watson Street West	Twin 1800 mm span x 1200 mm rise concrete box culvert	Adding two 1800 mm span x 1200 mm rise concrete box culverts (total of four box culverts) prevents the road overtopping for the design flow. The Rowe Channel will need to be widened to accommodate the culverts which requires property acquisition and relocation of two storm sewer outfalls The Town needs to complete detailed investigations to determine the feasibility of widening the Rowe Channel considering the existing site constraints.		Separate Schedule B EA required following completion of additional site specific investigations.

12.2 Lower Priority Crossings for Future Consideration

Following direction from the Town of Whitby, the road classification for Watson Street East, Brawley Road West, Townline Road West and Halls Road North was downgraded to prioritize the Highest Risk towards arterial roads with high traffic volumes. There are 10 crossings on these roads where the road overtops during the design flow. A preferred replacement option was developed for each of the 10 crossings and are presented in **Table 12-2**. These locations are not identified as Highest Priority, however, the preferred replacement options have been provided here to support future road improvement projects where culvert or bridge replacement may be considered. Future standalone Environmental Assessments will be required for the culverts and bridges identified in **Table 12-2**.

Table 12-2. Replacement Options for Consideration in Future Road Improvement Projects.

Facility ID	Road Name	Existing Culvert / Bridge	Preferred Alternative	Capital Cost
CU210012	Halls Road North	450 mm diameter circular CSP culvert	Reclassify road as local road and install single 900 mm diameter circular CSP culvert.	$180,000
CU210001	Halls Road North	2400 mm diameter circular CSP culvert	Reclassify road as local road and install a single 5200 mm span x 1900 mm rise concrete box culvert.	$2,490,000
CU710003	Brawley Road West	600 mm diameter circular CSP culvert	Single 1000 mm diameter circular CSP culvert	$200,000
CU710004	Brawley Road West	900 mm diameter Circular CSP culvert	Triple 900 mm diameter circular CSP culverts	$200,000
CU740004	Brawley Road West	450 mm diameter circular CSP culvert	Raise the road 320 mm and install twin 700 mm diameter circular CSP culverts	$300,000
CU840008	Brawley Road West	500 mm span x 300 mm rise ellipse CSP culvert	Raise the road 300 mm and install twin 500 mm diameter circular CSP culverts	$300,000
CU870006	Brawley Road West	900 mm span x 600 mm rise ellipse CSP culvert	Twin 1100 mm diameter circular CSP culverts	$310,000
CU920010	Townline Road West	1500 mm diameter circular CSP culvert	4500 mm span x 2000 mm rise concrete box culvert.	$1,290,000
AC05	Brawley Road West	450 mm circular CSP culvert	Raise the road 200 mm and install 2 x 600 mm diameter circular CSP culverts	$350,000
BR_D07_06	Watson Street East	12.1 m span bridge	Replace existing 12.1 m span bridge with a 26 m span bridge. Raise existing bridge soffit and road elevation if feasible.	$9,980,000

12.3 Crossings Requiring Replacement due to Structural Condition

The 2018 OSIM condition inspections, completed by TSI Inc, identified 22 bridges and culverts for replacement or rehabilitation within the next 10 years (2018 to 2028). These crossings are presented in **Table 12-3** and should be implemented concurrently with the Highest Risk crossings identified in **Table 12-1**. The existing conditions hydraulic assessment results and the risk rank has been included. Crossings currently meeting the design standards could be replaced with a similar sized culvert or bridge opening. Culvert CU_A07_01 at Ashburn Road was identified as a Highest Risk crossing and is included in the prioritization list in **Table 12-1**.

Additionally, the 2017 cross culvert inspections, completed by Chisholm, Fleming & Associates, 2017, identified 28 cross culverts requiring some form of repair, rehabilitation or replacement. **Table 12-4** provides the cross culverts with major condition issues that should be addressed concurrently with the Highest Risk crossings identified in **Table 12-1**. Recommended replacement sizes have also been provided.

Any crossing replacements identified in **Table 12-3** and **Table 12-4** that do not require upsizing to provide additional hydraulic capacity would be considered Schedule A projects and pre-approved under the MCEA process. All Schedule A/A+ projects will require relevant permitting and approvals and those located within the Greenbelt are subject to the policies of the Greenbelt Plan. Any crossings requiring upsizing will require a project-specific Class EA prior to commencing detailed design and construction.

Table 12-3. 2018 OSIM Crossing Rehabilitation and Replacement Recommendations.

Facility ID	Road Name	Road Classification	OSIM Evaluation	Master Plan Risk Rank	Master Plan Hydraulic Assessment
CU_A07_05	Columbus Rd W	Rural Arterial	Poor Condition. Recommended for replacement in 2019	Medium Risk	Meets design standards, overtops Regulatory
CU_B04_01	Rossland Rd W	Rural Arterial	Poor Condition. Recommended for rehabilitation in 2019	Medium Risk	Meets design standards, overtops Regulatory
CU_A07_07	Columbus Rd W	Rural Arterial	Poor Condition. Recommended for rehabilitation in 2020	No Risk	Meets design standards, conveys Regulatory
BR_A08_04	Way St	Local Road	Poor Condition. Recommended for rehabilitation in 2020	Low Risk	Fails to meet design standards
CU_A07_06	Columbus Rd W	Rural Arterial	Poor Condition. Recommended for rehabilitation in 2021	Medium Risk	Meets design standards, overtops Regulatory
BR_A08_03	Coronation Rd	Local Road	Poor Condition. Recommended for rehabilitation in 2021	Low Risk	Fails to meet design standards
BR_A08_02	Columbus Rd W	Rural Arterial	Poor Condition. Recommended for rehabilitation in 2022	No Risk	Meets design standards, conveys Regulatory
CU_A07_01	Ashburn Rd	Rural Arterial	Fair Condition. Recommended for rehabilitation in 2023	Highest Risk	Overtops during design flow
CU_B04_02	Rossland Rd W	Rural Arterial	Poor Condition. Recommended for rehabilitation in 2023	No Risk	Meets design standards, conveys Regulatory
CU_C09_09	Forest Rd	Local Road	Fair Condition. Recommended for rehabilitation in 2023	Medium Risk	Overtops during design flow
BR_A08_01	Cedarbrook Trail	Local Road	Poor Condition. Recommended for rehabilitation in 2023	Medium Risk	Overtops during design flow
CU_A07_03	Brawley Rd W	Rural Arterial	Fair Condition. Recommended for rehabilitation in 2024	High Risk	Fails to meet design standards
CU_C09_07	Harold St	Local Road	Fair Condition. Recommended for rehabilitation in 2024	No Risk	Meets design standards, conveys Regulatory
CU_C09_08	Westwood Rd	Local Road	Fair Condition. Recommended for rehabilitation in 2024	No Risk	Meets design standards, conveys Regulatory
BR_D07_01	Jeffery St	Local Road	Fair Condition. Recommended for rehabilitation in 2024	Low Risk	Fails to meet design standards
CU_B04_03	Dryden Blvd	Urban Arterial	Fair Condition. Recommended for rehabilitation in 2025	High Risk	Fails to meet design standards
BR_A08_08	Lyndebrook Rd	Rural Arterial	Fair Condition. Recommended for rehabilitation in 2026	High Risk	Fails to meet design standards
CU_A07_04	Brawley Rd W	Rural Arterial	Fair Condition. Recommended for rehabilitation in 2027	Medium Risk	Meets design standards, overtops Regulatory
BR_A08_06	Way St	Local Road	Fair Condition. Recommended for rehabilitation in 2028	Low Risk	Fails to meet design standards

Table 12-4. 2017 Cross Culvert Inspections Crossings with Major Condition Issues.

Asset ID	Road Name	Road Classification	Condition Rating[1]	2017 Recommendation and Timing	Risk Rank	Hydraulic Assessment	Replacement Option	Cost
CU000005	Halls Road South	Rural Arterial	2	Replace. 1 year	Low Risk	Check flow overtops	Replace with twin 800 mm diameter circular CSP culverts	$180,000
CU420028	Coronation Road	Local Road	1	Replace. 1 to 5 years	Low Risk	Meets design criteria	Replace with similar sized culvert	$200,000
CU520025	Park Road	Local Road	1	Replace. 1 year	No Risk	Meets design criteria	Replace with similar sized culvert	$160,000
CU620004	Coronation Road	Local Road	1	Replace. 1 year	No Risk	Meets design criteria	Replace with similar sized culvert	$160,000
CU630003	Country Lane	Local Road	1	Reinstate culvert. 1 to 5 years	No Risk	Meets design criteria	Replace with similar sized culvert	$160,000
CU660004	Way Street	Local Road	1	Replace. 1 to 5 years	No Risk	Meets design criteria	Replace with similar sized culvert	$160,000
CU660019	Way Street	Local Road	1	Replace. Provide slope protection. 1 to 5 years	No Risk	Meets design criteria	Replace with similar sized culvert	$170,000
CU950022	Townline Road West	Collector	2	Replace. 6 to 10 years	High Risk	Overtops Design Flow	Replace with twin 1030 mm span x 740 mm rise arch CSP culverts. Sizing prevents the road overtopping during the design flow but fails to meet the freeboard criteria and the road continues to overtop during the check flow. Significant upsizing is required to convey the check flow.	$200,000
CU960013	Townline Road West	Collector	1	Replace 5 m at both ends. 1 year	High Risk	Check flow overtops	Replace with twin 2400 mm diameter circular CSP culverts	$570,000
CU980002	Mud Lake Road	Local Road	2	Replace. 1 to 5 years	Low Risk	Fails to meet design criteria	Replace with twin 700 mm circular CSP culverts	$200,000

[1] *Condition Ratings: 1 – Failure or potential failure, 2 – Major damage.*

13. EA Commitments and Mitigation Measures

13.1 Commitments and Future Studies

Upon completion of the Master Plan and EA process, all culvert and bridge replacements will require detailed design and permitting prior to moving to construction. Detailed design and permitting will include the following items:

- Design of the crossings based on structural design criteria, hydraulic capacity (including update of hydrology modeling to account for future stormwater management), meander belt and fluvial processes considerations, fish and wildlife passage including Species-at-Risk, slope stability, soil quality, groundwater conditions, and presence of wetlands;
- Completion of terrestrial and aquatic investigations to define baseline natural heritage conditions, identify Species-at-Risk, support permitting and approvals and determine construction timing and mitigation strategies;
- A geotechnical assessment should be conducted by a geotechnical engineer to evaluate the potential structural damage due to settlement from any potential construction dewatering (including the effects of the water taking on surrounding structures and any railroads within the zone of influence of the projects), regarding potential basal heaving during construction, and identifying anything required related to the monitoring and mitigation plan.
- The impact of construction water-taking should be assessed, and a comprehensive discharge, monitoring, maintenance and mitigation plan should be developed to prevent any undesirable potential impacts to groundwater or surface water features and users.
- The impact on any designated source protection areas under the influence of each project's construction activities should be assessed. Any applicable policies of the relevant source protection plan shall be adhered to.
- The MECP has commenced a remediation project in Pringle Creek upstream from Whitby Harbour. The Watson Street East Bridge (BR_D07_06) is in the direct local area of the Ministry's work. The Town will contact the MECP Central Region Office when the Town commences EA work related to this bridge and identify that this crossing is located in the vicinity of the MECP's Pringle Creek Remediation work. The federal Department of Fisheries and Oceans will also be notified when this EA and design work commences as they have long term ongoing work related to contamination in Whitby Harbour.
- MECP Species at Risk permitting which could include a net benefit permit;
- DFO Request for Review;
- CLOCA permits and approvals;
- Stage 1 and 2 Archaeological Assessments;
- Cultural Heritage Impact Assessment; and,
- Ongoing consultation with the Alderville First Nation, Curve Lake First Nation, and other Indigenous Communities prior to Stage 1 and 2 Archaeological Assessments and during the detailed design phase.

Site Specific field investigations should be completed at each location to confirm the natural heritage conditions and to survey for the presence of SAR. This should include the following:

- **Vegetation Community Classification Surveys** – Each community should be assessed and defined into Ecological Land Classification (ELC) units as per the MNRF's guidelines (Lee et al, 1998). A summary of disturbance factors, community conditions, detailed plant species list and representative photographs should also be recorded for each vegetation patch.
- **Aquatic Habitat surveys** – Aquatic habitat surveys should be completed at appropriate locations.
- **Breeding Bird Surveys –** Conduct breeding bird surveys to determine the presence/absence of species within the study area. Breeding bird surveys should be completed between May 24 and July 10 to capture

use of bird species during the breeding bird period. Surveys should consist of two site visits during the peak breeding period.

- **Reptile and Amphibian Surveys** – To survey for the presence of herpetofauna, daytime searches throughout each study area should be conducted to determine the location for amphibian call surveys or reptile areas searches. Amphibian call surveys should be conducted in accordance with the standard protocols of the Marsh Monitoring Program, and reptile surveys should follow MNRF protocols.
- **A Tree Inventory** – Consultation with the Town of Whitby should be completed to understand requirements for a tree inventory at detailed design.
- **Bat Cavity Tree Inventory** – A cavity tree inventory should be completed, whereby suitable cavities will be identified and assessed for quality, as per MNRF guidance documents. A Bat and Bat Habitat Impact Assessment should then be completed to determine the need for further studies.

13.2 Mitigation Measures

The replacement of culvert and bridge crossings will result in impacts to the existing environment. Construction impacts to aquatic habitat are a significant concern and should receive specific attention during detailed design and construction. Traffic safety impacts are also a significant concern to be addressed during detailed design and construction.

The design alternatives developed in this study have only considered hydraulic capacity when sizing bridges and culverts. During detailed design the proposed design should include structural design criteria, hydraulic capacity, meander belt and fluvial processes, fish and wildlife passage including Species-at-Risk, slope stability, soil quality, groundwater conditions, and presence of wetlands. The hydraulic assessment completed as part of this study should be revisited during detailed design to confirm the proposed design continues to meet the design standards.

Table 13-1 presents the recommended minimum mitigation measures that should be implemented during design and construction to manage the potential impacts to the existing environment. These mitigation measures should be further developed during detailed design. Project specific Species at Risk (SAR) and natural heritage next steps and mitigation measures are also provided in **Table 13-2** to **Table 13-8**. Further development of the natural heritage mitigation measures will be required after targeted natural heritage field surveys have been completed.

Table 13-1. Mitigation Measures Relevant to All Projects.

Potential Impacts	Mitigation Measures
Erosion and Sedimentation	During Detailed Design: • Develop an Erosion and Sediment Control Plan including the protection of terrestrial and aquatic natural areas. • A wet weather contingency management plan should be developed. During Construction: • Implement and monitor erosion and sedimentation control strategy. • Any areas disturbed by construction will be restored and stabilized as soon as practically possible.
Aquatic Environment	During Detailed Design: • Obtain the appropriate approvals and permits from DFO and CLOCA. During Construction: • Adhere to the Fisheries Act including the Fisheries Timing Window in which construction activities would not proceed from March 15th to July 30th (to be confirmed during detailed design). • Construction activities near water or in-water should take place within the low flow period in the late summer to avoid or minimize impacts. • If in-water works are to occur, fish relocations may be required. A scientific license to Collect Fish will be required from MNRF. • Adhere to Sediment and Erosion Control Strategy. • Re-fueling stations should be located a minimum of 30 m from watercourses to avoid potential for spills entering watercourses.

Potential Impacts	Mitigation Measures
Terrestrial Environment	During Construction: • Restrict removal of trees and vegetation to work area specified in construction contract. • Fence barriers for tree protection should be installed outside the drip-line of trees identified for protection and in the vicinity of exposure to damage by machinery. • Construction vehicle access should be limited to existing roadways and construction paths to avoid vegetation clearing. • In order to address root damage, it will be necessary to prune roots of adjacent trees during grading and excavation.
Wildlife	During Detailed Design: • Prepare a detailed wildlife observation protocol to ensure mitigations measures are followed.
Surface Water and Groundwater	During Detailed Design: • The impact of water-taking should be assessed, and a comprehensive discharge, monitoring, maintenance and mitigation plan should be developed to prevent any undesirable potential impacts to groundwater or surface water features and users. • The impact on any designated source protection areas under the influence of each project's construction activities should be assessed. Any applicable policies of the relevant source protection plan shall be adhered to. • Areas of groundwater upwelling and discharge areas should be identified. If any of these areas exist within any project influence, these areas should be monitored during construction to prevent any undesirable impacts to the biota and fish spawning zones, and cold-water fisheries. • Undertake a hydrogeological investigation during detailed design that should include an assessment of nearby groundwater wells.
Contaminated Sites and Areas	During Detailed Design: • If potential contaminated areas are located within a project's zone of influence, a monitoring, maintenance and mitigation plan should be developed during detailed design to prevent any undesirable impacts during the implementation of each project from these potential contaminated areas. • Since the removal or movement of soils may be required, appropriate tests to determine contaminant levels from previous land uses or dumping should be undertaken. If the soils are contaminated, appropriate disposal methods and locations should be identified, consistent with Part XV.1 of the Environmental Protection Act (EPA) and Ontario Regulation 153/04, Records of Site Condition, which details the new requirements related to site assessment and clean up. • If contaminated areas are present, contact MECP's York-Durham District Office for further consultation during detailed design.
Excess Soil Management	During Detailed Design and Construction: • Activities involving the management of excess soil management shall be completed in accordance with O. Reg. 406/19 and the MECP's guidance document titled "Management of Excess Soil – A Guide for Best Management Practices" (2014)
Air Quality	During Construction: • Require contractor to implement provisions for dust control. • Require contractor to halt work in event that dust emissions are found to be unacceptable. • The MECP recommends that non-chloride dust-suppressants be applied. For a comprehensive list of fugitive dust prevention and control measures that could be applied, refer to Cheminfo Services Inc. Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities. Report prepared for Environment Canada. March 2005.
Noise	During Construction: • Ensure all equipment is in good working order with muffler devices. • Restrict working hours to appropriate times and avoid construction during early morning, evenings and weekends.

Potential Impacts	Mitigation Measures
Utilities	During Detailed Design: • Identify the location of all utilities within the project area. • Consult with utility companies as required.
Railroads	During Detailed Design: • Consult with railroad authorities to identify potential impacts to rail infrastructure and develop appropriate mitigation measures.
Control of Inadvertent Spills	During Construction: • Store all oils, lubricants, fuels, and chemicals in secure areas. • Re-fueling stations should be constructed in a manner to prevent soil and/or surface and groundwater contamination from any leaks or spills. • An emergency response kit should be made available at each re-fueling station in case of a spill. • All on-site crew members operating construction vehicles should be appropriately trained in handling a potential spill and have WHMIS Training. • All chemical transfer/maintenance should be conducted within the refueling station areas.
Archaeology	During Detailed Design: • As soon as possible during detailed design a Stage 1 Archaeological Assessment that includes a site inspection will be completed for each crossing to determine the potential for archaeological resources. If the Stage 1 assessment recommends further stages of archaeological assessment this will be completed during detailed design. During Construction: • If any archaeological and/or historical resources are discovered: o Require contractor to halt work in the area of the discovery, until permitted to resume by the MTCS. o Require contract administration to notify the MTCS (Archaeological Unit) of the discovery. • If human remains are identified all work will halt until the proper authorities have been notified.
Traffic Management and Access	During Detailed Design and Construction: • Follow Ontario Traffic Manual Book 7, Temporary Conditions. • Prepare Traffic Management Plan including staging drawings and consider: o Lane reductions and traffic volume review; o Temporary detour routes; and o Property access. • Provide advanced notification to affected property owners prior to construction.
Adjacent Landowner Notifications	During Detailed Design and Construction: • Notify adjacent landowners in the vicinity of the construction activities due to potential impacts to air quality, noise, and traffic.

Table 13-2. CU_A07_01 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Ashburn Creek is located within the Ashburn Creek subwatershed, which contains cold and warm water tributaries.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1, unless otherwise specified by CLOCA or MNRF.
Located within the Town of Whitby Natural Heritage System.	Complete field surveys to confirm extent of vegetation communities.	• Protective fencing should be installed prior to all construction to define the construction limits and mitigate against impacts to the surrounding natural environment. • The construction footprint shall be oriented/delineated to minimize impact, preserving natural heritage features, and avoiding sensitive features. • ESC controls should be applied as recommended in the ESC management plan.
Located within the Greenbelt Natural Heritage System within the Protected Countryside.	Design and construction are subject to the Policies of Section 4 of the Greenbelt Plan.	General infrastructure policies under Section 4.2.1 of the Greenbelt Plan that are relevant to the site include: • Planning, design and construction practices shall minimize, wherever possible, the amount of the Greenbelt, and particularly the Natural Heritage System and Water Resource System, traversed and/or occupied by such *infrastructure*; • Planning, design and construction practices shall minimize, wherever possible, the *negative impacts* on and disturbance of the existing landscape, including, but not limited to, impacts caused by light intrusion, noise and road salt; • Where practicable, existing capacity and co-ordination with different *infrastructure* services shall be optimized so that the rural and existing character of the Protected Countryside and the overall hierarchy of areas where growth will be accommodated in the *GGH* established by the Greenbelt Plan and the Growth Plan are supported and reinforced; • New or expanding *infrastructure* shall avoid *key natural heritage features*, *key hydrologic features* or *key hydrologic areas* unless need has been demonstrated and it has been established that there is no reasonable alternative; • Where *infrastructure* does cross the Natural Heritage System or intrude into or result in the loss of a *key natural heritage feature*, *key hydrologic feature* or *key hydrologic areas*, including related *landform features*, planning, design and construction practices shall minimize *negative impacts* on and disturbance of the features or their related functions and, where reasonable, maintain or improve *connectivity*; • New or expanding *infrastructure* shall avoid *specialty crop areas* and other *prime agricultural areas* in that order of priority, unless need has been demonstrated and it has been established that there is no reasonable alternative; and • Where *infrastructure* crosses *prime agricultural areas*, including *specialty crop areas*, an *agricultural impact assessment* or equivalent analysis as part of an environmental assessment shall be undertaken.
Located within CLOCA Regulation Limits.	Apply for CLOCA regulatory limit permit (O. Reg 42/06).	• Adhere to recommendations or requirements of permitting.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Historical records of redside dace have been recorded in Ashburn Creek.	Conduct an aquatic habitat assessment to evaluate the creek conditions within the study area. Further Agency Consultation (MNRF, DFO) will be required to determine permitting.	• Specific mitigation should comply with DFO recommendations • Work should be conducted between July 1 to September 15 to avoid sensitive timing windows, unless otherwise specified by CLOCA or MNRF. • Implement ESC measures to ensure sediment does not enter the watercourse. • Monitoring of water quality upstream, within, and downstream of the construction limits shall be undertaken daily while construction is occurring and recorded to verify compliance. Should turbidity levels exceed guidelines, construction work shall cease, until appropriate ESC measures can be installed to reach compliance levels. • Contractor practices shall comply with all permitting requirements and legislation. Open communication between contractor and contract administration shall ensure compliance.
21 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SOCC: • Breeding bird survey • Turtle basking survey • Tree inventory and health assessment • Vegetation inventory and ELC survey Consult with MECP.	• If SAR species are confirmed site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act Window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. • No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP. • Reptile and amphibian exclusion fencing may be required during construction to prevent animals from entering the construction area.
24 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
6 ELC communities have been delineated by CLOCA within the study area. • FOC, FOM, CUM, SWT, MAM, CUH. MNRF delineated Woodlands occur within the study area.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wooded areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Consideration should be given to installation of protective fencing adjacent to any tree not identified for removal. Proper installation and maintenance are necessary to reduce the risk of potential impacts. • Consideration should be given to the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Minimize vegetation removal and revegetate as soon as possible. • Refueling should not occur within 30 m of the natural features.
CLOCA Identified Wildlife Crossing.	Consultation with CLOCA regarding wildlife passage requirements at the crossing.	• Exclusionary fencing should be established around the study area prior to all works. • Maintain or improve wildlife passage.
Property Impacts: Upstream construction will likely extend onto private property.	Consult with affected property owners at detailed design.	• To be determined through consultation with property owners.

Table 13-3. CU610022 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Located within Heber Down subwatershed, which contains cold and warm tributaries.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1.
Located within the Town of Whitby Natural Heritage System.	Complete field surveys to confirm extent of vegetation communities.	• Protective fencing should be installed prior to all construction to define the construction limits and mitigate against impacts to the surrounding natural environment. • The construction footprint shall be oriented/delineated to minimize impact, preserving natural heritage features, and avoiding sensitive features. • ESC controls should be applied as recommended in the ESC management plan.
Redside dace has been recorded within 1 km of the crossing.	Conduct an aquatic habitat assessment to evaluate the creek conditions within the study area. Further agency consultation (MNRF, DFO) will be required to determine permitting.	• Specific mitigation should comply with DFO recommendations • Work should be conducted between July 1 to September 15 to avoid sensitive timing windows, unless otherwise specified by CLOCA or MNRF. • Sediment and erosion control measures, including but not limited to exclusion fencing, silt fencing, erosion blankets, appropriate dewatering practices, etc. should be established to ensure sediment does not enter the watercourse.
23 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SCC: • Breeding bird survey • Turtle basking survey • Tree inventory and health assessment • Vegetation inventory and ELC survey Consult with MECP.	• If SAR species are confirmed, site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. • No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP.
16 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
1 ELC community has been delineated by CLOCA within the study area. • CUT. MNRF delineated Woodlands occur within the study area.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wooded areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Consideration should be given to the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Refueling should not occur within 30 m of the natural features.

Table 13-4. CU720007 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Located within Heber Down subwatershed, which contains cold and warm tributaries.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1.
Located within the Town of Whitby Natural Heritage System.	Complete field surveys to confirm extent of vegetation communities.	• Protective fencing should be installed prior to all construction to define the construction limits and mitigate against impacts to the surrounding natural environment. • The construction footprint shall be oriented/delineated to minimize impact, preserving natural heritage features, and avoiding sensitive features. • ESC controls should be applied as recommended in the ESC management plan.
Located within the CLOCA Regulation limits.	Apply for CLOCA regulatory limit permit (O. Reg 42/06).	• Adhere to recommendations or requirements of permitting.
Redside dace is confirmed within the watercourse.	Conduct an aquatic habitat assessment to evaluate the creek conditions within the study area. Further agency consultation (MNRF, DFO) will be required to determine permitting needs.	• Specific mitigation should comply with DFO recommendations • Work should be conducted between July 1 to September 15 to avoid sensitive timing windows, unless otherwise specified by CLOCA or MNRF. • Sediment and erosion control measures, including but not limited to exclusion fencing, silt fencing, erosion blankets, appropriate dewatering practices, etc. should be established to ensure sediment does not enter the watercourse. • Monitoring of water quality upstream, within, and downstream of the construction limits shall be undertaken daily while construction is occurring and recorded to verify compliance. Should turbidity levels exceed guidelines, construction work shall cease, until appropriate ESC measures can be installed to reach compliance levels. • Contractor practices shall comply with all permitting requirements and legislation. Open communication between contractor and contract administration shall ensure compliance.
23 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SCC: • Breeding bird survey • Turtle basking survey • Tree inventory and health assessment • Vegetation inventory and ELC survey Consult with MECP upon completion of field investigations.	• If SAR species are confirmed, site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP.
19 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
4 ELC communities have been delineated by CLOCA within the study area. • CUW, CUM, MAM, CUH. MNRF delineated Woodlands occur within the study area.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wooded areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Consideration should be given to the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Refueling should not occur within 30 m of the natural features.

Table 13-5. CU640016 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Located within Heber Down subwatershed, which contains cold and warm tributaries.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1.
Located within a riparian corridor.	Complete field surveys to confirm extent of riparian vegetation.	• In general, impacts to the riparian corridor will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
Located within the Town of Whitby Natural Heritage System.	Complete field surveys to confirm extent of vegetation communities.	• Protective fencing should be installed prior to all construction to define the construction limits and mitigate against impacts to the surrounding natural environment. • The construction footprint shall be oriented/delineated to minimize impact, preserving natural heritage features and avoiding sensitive features. • ESC controls should be applied as recommended in the ESC management plan.
Partially located within CLOCA regulation limits.	Apply for CLOCA regulatory limit permit (O. Reg 42/06).	• Adhere to recommendations or requirements of permitting.
Redside dace has been recorded within 1 km of the study area.	Conduct an aquatic habitat assessment to evaluate the creek conditions within the study area. Further agency consultation (MNRF, DFO) to determine permitting needs.	• Specific mitigation should comply with DFO recommendations. • Work should be conducted between July 1 to September 15 to avoid sensitive timing windows, unless otherwise specified by CLOCA or MNRF. • Sediment and erosion control measures, including but not limited to exclusion fencing, silt fencing, erosion blankets, appropriate dewatering practices, etc. should be established to ensure sediment does not enter the watercourse.
26 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SCC: • Breeding bird survey • Turtle basking survey • Tree inventory and health assessment • Vegetation inventory and ELC survey Consult with MECP.	• If SAR species are confirmed, site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP.
21 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
1 ELC community has been delineated by CLOCA within the study area. • SWD. MNRF delineated Woodlands occur within the study area.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wooded areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Implement the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Minimize vegetation removal along riparian zone and revegetate as soon as possible. • Refueling should not occur within 30 m of the natural features.
Property Impacts: Construction may extend onto private property.	Consult with affected property owners at detailed design.	• To be determined through consultation with property owners.

Table 13-6. CU480010 and CU480013 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Located within the Pringle Creek Watershed, a coolwater system.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1.
Partially located within CLOCA Regulation limits.	Apply for CLOCA regulatory limit permit (O. Reg 42/06).	• Adhere to recommendations or requirements of permitting.
27 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SCC: • Breeding bird survey. • Turtle basking survey. • Tree inventory and health assessment. • Vegetation inventory and ELC survey. Consult further with MECP upon completion of field investigations.	• If SAR species are confirmed, site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP.
21 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
2 ELC communities have been delineated by CLOCA within the study area. • SWT, MAM.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wetland areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Consideration should be given to the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Refueling should not occur within 30 m of the natural features.
Provincially Significant Wetland approximately 100 m downstream of the crossings.	Confirmation of wetland limits as per the Ontario Wetland Evaluation System guidelines.	• Refueling or stockpiling should not occur within 30 m of the wetland. • Ensure construction limits, including site access, are outside of the wetland boundary.
Property Impacts: Property acquisition may be required at the intersection to accommodate additional culverts.	Consult with affected property owners at detailed design.	• To be determined through consultation with property owners.

Table 13-7. CU480017 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Located within the Pringle Creek Watershed, a coolwater system.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1.
Located within the Town of Whitby Natural Heritage System.	Complete field surveys to confirm extent of vegetation communities.	• Protective fencing should be installed prior to all construction to define the construction limits and mitigate against impacts to the surrounding natural environment. • The construction footprint shall be oriented/delineated to minimize impact, preserving natural heritage features, and avoiding sensitive features. • ESC controls should be applied as recommended in the ESC management plan.
Located within a riparian corridor.	Complete field surveys to confirm extent of riparian vegetation.	• In general, impacts to the riparian corridor will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
Located within CLOCA regulation limits.	Apply for CLOCA regulatory limit permit (O. Reg 42/06).	• Adhere to recommendations or requirements of permitting.
27 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SCC: • Breeding bird survey. • Turtle basking survey. • Tree inventory and health assessment. • Vegetation inventory and ELC survey. Consult further with MECP upon completion of field investigations.	• If SAR species are confirmed, site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP. • Reptile and amphibian exclusion fencing may be required during construction to prevent animals from entering the construction area.
33 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
4 ELC communities have been delineated by CLOCA within the study area. • MAS, SAS, CUM, CUT. MNRF delineated Woodlands occur within the study area.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wooded areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Consideration should be given to installation of protective fencing adjacent to any tree not identified for removal. Proper installation and maintenance are necessary to reduce the risk of potential impacts. • Consideration should be given to the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Minimize vegetation removal and revegetate as soon as possible. • Refueling should not occur within 30 m of the natural features.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Study area within the Whitby-Oshawa Iroquois Beach Wetland Complex (Provincially Significant Wetland).	Confirmation of wetland limits within the study area following the Ontario Wetland Evaluation System guidelines.	• Protective fencing should be established around the boundary of the wetland prior to all works to prevent accidental intrusion. • Necessary vegetation removals within the wetland should occur outside of breeding bird window of April 1 – August 31. • Refueling or stockpiling should not occur within 30 m of the wetland. • Minimize vegetation removal and revegetate as soon as possible. • A wetland planting plan may be required depending on extent of work and area of impact.
Property Impacts: Channel works on private property may be required to accommodate structure.	Consult with affected property owners at detailed design.	• To be determined through consultation with property owners.

Table 13-8. CU360001 Project Specific Mitigation Measures.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Located within the Pringle Creek Watershed, a coolwater system.	Confirm timing window with MNRF and DFO.	• Adhere to corresponding MNRF timing windows for in-water works. • If both spring spawning and fall spawning windows apply, in water work must occur between July 15 to October 1.
Located within the Town of Whitby Natural Heritage System.	Confirm mapping of feature.	• Protective fencing should be installed prior to all construction to define the construction limits and mitigate against impacts to the surrounding natural environment. • The construction footprint shall be oriented/delineated to minimize impact, preserving natural heritage features, and avoiding sensitive features. • ESC controls should be applied as recommended in the ESC management plan.
Located within a riparian corridor.	Confirm mapping of feature.	• In general, impacts to the riparian corridor will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
Located within CLOCA regulation limits.	Apply for CLOCA regulatory limit permit (O. Reg 42/06).	• Adhere to recommendations or requirements of permitting.
23 Candidate SAR and Species of Conservation Concern (SOCC).	Conduct the following wildlife surveys to confirm presence of SAR and SCC: • Breeding bird survey. • Turtle basking survey. • Tree inventory and health assessment. • Vegetation inventory and ELC survey. Consult further with MECP upon completion of field investigations.	• If SAR species are confirmed, site specific mitigation should be determined in consultation with the MECP. • Vegetation removal should occur outside of the Migratory Bird Convention Act window of April 1 – August 31. • A wildlife scientific collector's permit may be required before any water works may be performed. A relocation plan should be developed if a species is found. No water-related works should be completed during the turtle hibernation period between October to April, unless this area has already been cleared and isolated with exclusion fencing. • If SAR trees or plants are identified, additional permitting may be required, and a relocation plan may be needed. Details to be determined in consultation with the MECP. • Reptile and amphibian exclusion fencing may be required during construction to prevent animals from entering the construction area.
20 Candidate Significant Wildlife Habitat (SWH).	Confirm the presence of SWH through site visits.	• In general, impacts to SWH will be minimized through the implementation of other mitigation measures such as: installation of protective fencing, minimizing the construction footprint to only the areas required for proposed works and conducting works outside of sensitive timing windows for wildlife.
3 ELC communities have been delineated by CLOCA within the study area. • FOC, FOM, SWC. MNRF delineated Woodlands occur within the study area.	Conduct an ELC survey to confirm ecotypes. Tree removal permitting from the Town of Whitby to comply with tree removal bylaws.	• Minimize construction footprint to limit encroachment into adjacent vegetation communities. • If possible, orient vehicle and equipment access route outside of wooded areas. • Implement ESC measures to ensure sediment does not enter the watercourse. • Consideration should be given to installation of protective fencing adjacent to any tree not identified for removal. Proper installation and maintenance are necessary to reduce the risk of potential impacts. • Consideration should be given to the Clean Equipment Protocol during construction activities to prevent the spread of invasive species into adjacent features. • Minimize vegetation removal and revegetate as soon as possible. • Refueling should not occur within 30 m of the natural features.

Site Specific Feature	Next Steps	Recommended Mitigation Measures
Study area contains 1 Provincially Significant Wetland.	Confirmation of wetland limits within the study area following the Ontario Wetland Evaluation System guidelines.	• Protective fencing should be established around the boundary of the wetland prior to all works to prevent accidental intrusion. • Necessary vegetation removals within the wetland should occur outside of breeding bird window of April 1 – August 31. • Refueling or stockpiling should not occur within 30 m of the wetland. • Minimize vegetation removal and revegetate as soon as possible. • A wetland planting plan may be required depending on extant of work and amount if impact.

13.3 Approvals

During detailed design and prior to construction, approvals will be required from several government review agencies. The necessary approvals are further described below.

Department of Fisheries and Oceans (DFO)

Any construction activities that will occur in-water or within the high water mark will require a Request for Project Review to DFO to confirm their permitting expectations under the Fisheries Act, as applicable. The DFO have removed the Self Assessment process for in-water works.

Ministry of the Environment Conservation and Parks (MECP)

MECP will be provided an opportunity to review and comment on final design documents including all environmental protection contingencies proposed during the detailed design phase.

A Permit to Take Water (PTTW) under the Ontario Water Resources Act will be required for any water takings that exceed 50,000 L/day, with the exception of certain water taking activities that have been prescribed by the Water Taking EASR Regulation – O. Reg. 63/16. These prescribed water-taking activities require registration in the EASR instead of a PTTW. The following water takings are prescribed activities under the Water Taking EASR Regulation: surface water takings that are more than 50,000 L/day and are for road construction purposes that meet specified criteria about the purpose, rate or location of the water taking; and construction site dewatering involving more than 50,000 L/day and less than 400,000 L/day.

A Species at Risk screening shall be conducted during detailed design. All crossings within the Lynde Creek watershed will require approval from MECP due to the potential presence of Redside Dace habitat.

Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI)

A Stage 1 Archaeological Assessment and site inspection will be required for all proposed culvert and bridge replacement works prior to commencing with detailed design. Additionally, a Stage 2 Archaeological Assessment will also be required for any potentially undisturbed land that will be impacted by the proposed crossing replacements. The Stage 1 archaeological assessment must be conducted by a licensed archaeologist and must follow the requirements set out in the *Standards and Guidelines for Consultant Archaeologists* (Ontario Government 2011).

A Cultural Heritage Impact Assessment will be required at detailed design for all proposed crossings replacements.

The Curve Lake First Nations community have requested that they be engaged during future Stage 1 archaeological assessments to provide cultural context for the study area.

Central Lake Ontario Conservation Authority (CLOCA)

A permit under Ontario Regulation 157/06 – Development, Interference with Wetlands and Alterations to Shorelines and Watercourses will be obtained as part of detailed design. CLOCA will require approvals from MNRF and DFO prior to approving a permit.

14. Conclusions and Recommendations

This Master Plan and Municipal Class EA covers the process required to ensure that the culvert and bridge study and proposed replacement works meet the requirements of the Environmental Assessment Act. The goal of the Master Plan is to develop a set of feasible design alternatives for the Town watercourse crossings that are at high risk of failure due to flooding. Using a risk assessment based approach the study identified 12 crossings that are significantly undersized with a high likelihood of road flooding and are located on high traffic volume arterial roads, where flooding and failure (e.g. road washout) would have significant potential consequences.

The preferred solution is comprised of a set of preferred design alternatives that include replacement of, or improvements at, the 12 crossings. A preliminary screening of the preferred alternatives found that any significant impacts to the environment can be addressed by incorporating established mitigation measures during detailed design and construction.

Based on the Class EA and the above conclusions, it is recommended that:

1. Following the Master Plan documentation filing and clearance, and the Town securing appropriate funding, the recommended works proceed to the detailed design phase, including approvals and permitting, based on the prioritization list provided in **Section 12**.
2. The EA commitments and mitigation measures identified in **Section 13** be implemented through detailed design and construction.