Project File Report

Corbett Creek Master Drainage Plan

Final Report ▪ March 2021

Report Prepared For

Town of Whitby
575 Rossland Road East
Whitby, ON L1N 2M8

Central Lake Ontario Conservation Authority
100 Whiting Avenue
Oshawa, ON L1H 3T3

Report Prepared By

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TMIG Project Number 19137

Report Prepared in Association With

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March 22, 2021 PROJECT NUMBER 19137

Mr. Antony Manoharan, P.Eng.
Town of Whitby
575 Rossland Road East
Whitby, ON L1N 2M8

Mr. Louie Jakupi, P.Eng.
Central Lake Ontario Conservation Authority
100 Whiting Avenue
Oshawa, ON L1H 3T3

Dear Antony and Louie:

Re: Corbett Creek Master Drainage Plan
Final Project File Report

I am pleased to submit the Final Project File Report for the Corbett Creek Master Drainage Plan on behalf of the project team at The Municipal Infrastructure Group Ltd. and our partners at Palmer Environmental Consulting Group Inc. and GEO Morphix Ltd.

Should you have any questions regarding this report, please do not hesitate to contact the undersigned.

Sincerely,

THE MUNICIPAL INFRASTRUCTURE GROUP LTD.
A T.Y. LIN INTERNATIONAL COMPANY

Steve Hollingworth, P.Eng.
Director of Stormwater Management
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Executive Summary

Introduction

The Municipal Infrastructure Group Ltd. (TMIG), along with team members GEO Morphix Ltd. (GEO Morphix) and Palmer Environmental Consulting Group Inc. (Palmer), were retained by the Town of Whitby to prepare a Master Drainage Plan (MDP) for the Corbett Creek Watershed. The MDP was completed in partnership with the Central Lake Ontario Conservation Authority (CLOCA).

The purpose of the Corbett Creek MDP was to provide guidance to the Town, CLOCA, and the City of Oshawa in the continued management of the watershed and stream corridors with respect to flooding, creek erosion, natural environmental and resource protection, and development. The study was carried out in accordance with the Master Planning Process Approach No. 2 as outlined in the Municipal Engineers Association “Municipal Class Environmental Assessment” document (October 2000; amended 2007, 2011 and 2015). Approach No.2 includes Phases 1 and 2 of the Municipal Class Environmental Assessment (EA) process where the level of investigation, consultation and documentation are sufficient to fulfill ‘Schedule B’ projects identified within the MDP.

Study Area

The study area (**Figure ES-1**) encompassed the Corbett Creek watershed in its entirety, which is located within the southeastern portion of the Town of Whitby with a portion of the catchment area within the City of Oshawa. In general, it is a small watershed with a drainage area of approximately 14 km^2, draining through the East and West Tributaries that combine at the Corbett Creek Coastal Wetland before discharging to Lake Ontario. The watershed maintains an elongated linear shape that is about 6.3 km long and 2.1 km wide.

In general, the Corbett Creek watershed is fully urbanized and has a very limited number of areas available for future development. The majority of the lands within the watershed were developed prior to the adoption of modern stormwater quantity and quality controls. As a result, there are a number of areas that were identified to have erosion concerns, degraded water quality and flood risk.

Purpose of the Study

The Corbett Creek watershed has experienced and will continue to experience pressures from urban land uses that impact the watershed's form and function, which include flood potential, erosion, and natural heritage health, among other potential impacts. The problem and opportunity statement is as follows:

> **The Corbett Creek Master Drainage Plan is required to determine a long-term plan outlining the preferred methods of watershed management with respect to storm runoff to maintain or improve flood conditions, water quality, erosion, water balance, and aquatic and terrestrial habitat associated with the natural heritage system.**

The purpose of the Corbett Creek MDP was to provide guidance to the Town, CLOCA, and City of Oshawa in the continued management of the watershed and stream corridors with respect to flooding, creek erosion, natural environmental and resource protection, and development.

Public Consultation

A Notice of Study Commencement was prepared and circulated on June 2, 2019 to stakeholders, which included regulatory agencies, First Nations organizations, utilities, and general public through *Whitby This Week* and the Town website.

Two (2) Community Open Houses (COHs) were held in an informal open house format with display boards that presented project information. COH No. 1 was held on September 12, 2019 and provided an overview of the project, presented information on the current conditions of the watershed. COH No.2 was held on January 30, 2020 and presented technical assessments that were completed, such as the hydrology and hydraulic analyses. The recommendations for watershed management were also provided, including the infrastructure projects proposed by the MDP.

At the COHs, feedback from attendees was sought on their concerns of the watershed and on the range of potential management strategies for the watershed. In general, the feedback included concerns of high water levels at homes on Crystal Beach Boulevard (adjacent to the Corbett Creek Coastal Wetland), erosion at specific watercourse locations and overall water quality in Corbett Creek.

First Nations communities expressed their interest in archaeological investigations and site specific environmental studies. Continued consultation with First Nations communities is recommended when MDP projects proceed to detailed design and construction.

A Notice of Study Completion was issued on March 25, 2021.

Recommended Master Drainage Plan

Alternatives for managing a highly urbanized watershed involve: (1) stormwater management to mitigate the impacts of runoff from development on receiving watercourses, such as flooding, poor water quality, and erosion; and (2) implementing measures to address the above noted impacts for areas that have not provided adequate stormwater controls. More specifically, the range of alternatives for the Corbett Creek watershed included:

- Maintaining the status quo and do nothing.
- Enhanced stormwater management criteria for new development or redevelopment to reduce runoff volumes and peak flow rates.
- New SWM controls, including SWM facilities or retrofits to existing facilities to provide increased water quality, water quantity, and/or erosion control.
- Hydraulic structure and watercourse conveyance improvements such as increasing the capacity of culverts or drainage conveyance systems.
- Watercourse and valleyland rehabilitation to mitigate erosion hazards and/or enhance natural features.

The preferred MDP for Corbett Creek (**Figure ES-2**) includes the implementation of enhanced stormwater management (SWM) criteria for development and redevelopment within the intensifications areas of the watershed as well as stormwater management facilities and watercourse rehabilitation projects. The recommended enhanced SWM criteria and projects will improve water quality of stormwater runoff and address erosion concerns in the watershed.

The MDP also recognizes the importance of flood risk mitigation in the watershed due to the presence of CLOCA identified Flood Damage Centres (FDCs) and undersized culverts within the watershed. However, based on the low risk of flood occurrence and damage at the FDCs, the MDP does not recommend flood conveyance projects to be implemented at this time. This is primarily due to the significant costs and challenges to implement improvements to the undersized culverts, the majority of which are not owned by the Town of Whitby. The recommendation is to continually review flood risk, development in the watershed and new information regarding flooding and culvert capacity to assess the need for flood mitigation projects.

Enhanced Stormwater Management Criteria

Enhanced SWM criteria (**Table ES-1**) is recommended for development and redevelopment sites within the Town OP's intensification area around Dundas Street and intensification corridor along Victoria Street.

The benefits to the watershed are relatively minor and require a long-term outlook, however, implementation has few technical challenges or negative impacts to the natural, social/cultural and financial environments.

Table ES-1 Enhanced SWM Criteria

Component	Criteria
Volume / Erosion Control	Runoff from a 5 mm rainfall event must be captured, retained or detained from all new or reconstructed impervious surfaces as a minimum requirement. For sites greater than 5 ha that propose to use a SWM pond, extended detention of the 25 mm storm for 24 hours is required, consistent with current criteria.
Quantity Control	Post-development peak flow rates must not exceed the corresponding pre-development peak flow rates for the 2-year through 100-year design storm events. For redevelopment of existing developed sites, peak flow rates must also be controlled to the capacity allocated to the site in the design of the downstream minor and major drainage systems.
Quality Control	Enhanced protection, corresponding to 80% long-term average removal of suspended solids, according to the MOE Stormwater Management Planning and Design Manual (MOE, 2003). Water quality control measures to be implemented under a hierarchy of SWM practices, as follows: (1) Low impact development measures. (2) Stormwater management facilities such as wet ponds, wetlands and hybrid ponds. (3) Manufactured treatment devices such as oil-grit separators.
Water Balance	Post-development infiltration is required to match pre-development infiltration with remedial measures to the extent

Component	Criteria
	possible, which is consistent with current criteria. As a minimum, redevelopment sites are required to retain a minimum of 5 mm runoff on-site for infiltration, evapotranspiration or reuse.

Master Drainage Plan Projects

The Corbett Creek MDP recommended projects include SWM facilities (**Table ES-2**) and watercourse rehabilitation at erosion hazard sites (**Table ES-3**).

The implementation of SWM facilities within already developed areas of the Corbett Creek watershed is recommended because of the current lack of stormwater management controls in the watershed.

The watercourse rehabilitation projects are recommended for implementation under the MDP to mitigate erosion risks.

Table ES-2 Master Drainage Plan Recommended SWM Facility Projects

Priority	Facility ID	Description	Cost	Timeline
1	SWM Facility C4	Oil-grit separator and plunge pool on East Corbett Creek near intersection of Rossland Road East and Meadow Road Project within Town of Whitby lands	$470,000	5 to 10 years
2	SWM Facility C1	Oil-grit separator and wetland SWM facility on East Corbett Creek near intersection of Burns Street East and Limerick Street Project within Town of Whitby lands	$350,000	5 to 10 years
3	SWM Facility C2	Oil-grit separators and wet pond on West Corbett Creek near Manning Road and Hazelwood Drive Project within Town of Whitby lands	$780,000	5 to 10 years

Table ES-3 Master Drainage Plan Recommended Watercourse Rehabilitation Projects

Priority	Reach	Description	Cost	Timeline
1	EB10	Valley wall protection (localized channel realignment and restoration, valley wall regrading and stabilization, valley wall toe protection with bioengineering). Culvert outlet channel restoration (scour pool, rock weirs for bed grade control, bioengineered banks). Project within Town of Whitby lands	$500,000	2 to 5 years
2	EB11	Culvert outlet channel restoration (armour stone drop structures, valley slope regrading and stabilization). Project within Town of Whitby lands	$300,000	2 to 5 years
3	EB3	Embankment toe protection with bioengineering. Project within Ministry of Transportation lands	$100,000	5 to 10 years
4	WB6	Channel restoration (bed substrate and armour stone for bed grade control, bioengineered banks). Project within Town of Whitby lands	$550,000	5 to 10 years
5	EB7	Channel stabilization (rock weirs for bed grade control, bioengineered banks). Project within City of Oshawa lands	$500,000	5 to 10 years

Implementation Strategy

The implementation strategy for the Corbett Creek MDP identified the next steps for the recommended SWM criteria and projects to proceed with respect to additional studies, agency permits and approvals, timing, and Class EA process requirements. The implementation strategy is generally applicable to the detailed design and construction of capital projects identified in the MDP (i.e., SWM facilities and watercourse rehabilitation). The implementation of enhanced SWM criteria is generally more straightforward and requires the Town to inform development proponents and apply the criteria to assess development applications within the Town OP's intensification areas.

A number of future studies were recommended to enable the detailed design and construction of SWM facilities and watercourse rehabilitation. These following studies generally apply to each project recommended in the MDP, with some exceptions that can be evaluated in detailed design. The studies include:

- Site-specific ecological assessment to confirm boundaries of vegetation communities and presence of Species at Risk and/or Species at Risk habitat, and mitigation measures.
- Archaeological assessments to determine archaeological potential of the project sites, with First Nations community engagement during the studies.
- Geotechnical investigations to determine subsurface soil conditions to inform the detailed design.
- Detailed topographic survey and utilities investigation.
- Natural channel design for watercourse rehabilitation sites to address ecological function and long-term erosional stability.

There are also a number of permits and approvals required to construct the SWM facilities and watercourse rehabilitation. These include:

- A permit will be required for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Ontario Regulation 42/06) from Central Lake Ontario Conservation Authority.
- Engineering Approval from Durham Region for any projects located adjacent to the Region's right-of-way and other infrastructure.
- Input and coordination with or review by a number of municipal departments at the Town of Whitby or City of Oshawa. Confirmation that the project continues to comply with all applicable Town or City policies and by-laws should be sought.
- Depending on construction requirements, registration on the Ministry of the Environment, Conservation and Parks' Environmental Activity and Sector Registry or a Permit to Take Water will be required for construction site dewatering. It is also recommended that consultation with respect to the Endangered Species Act with MECP staff is completed during detailed design.

- Highway Corridor Management permits from the Ministry of Transportation are required for construction works within the right-of-way of provincial highways and adjacent regulated areas.
- A Fisheries and Oceans Canada (DFO) Self-Assessment will be undertaken during detailed design to determine if a review by DFO is warranted.
- Approvals will be required from utility owners for protection and/or relocation of existing above and below ground utilities.

Figure ES-1 Study Area

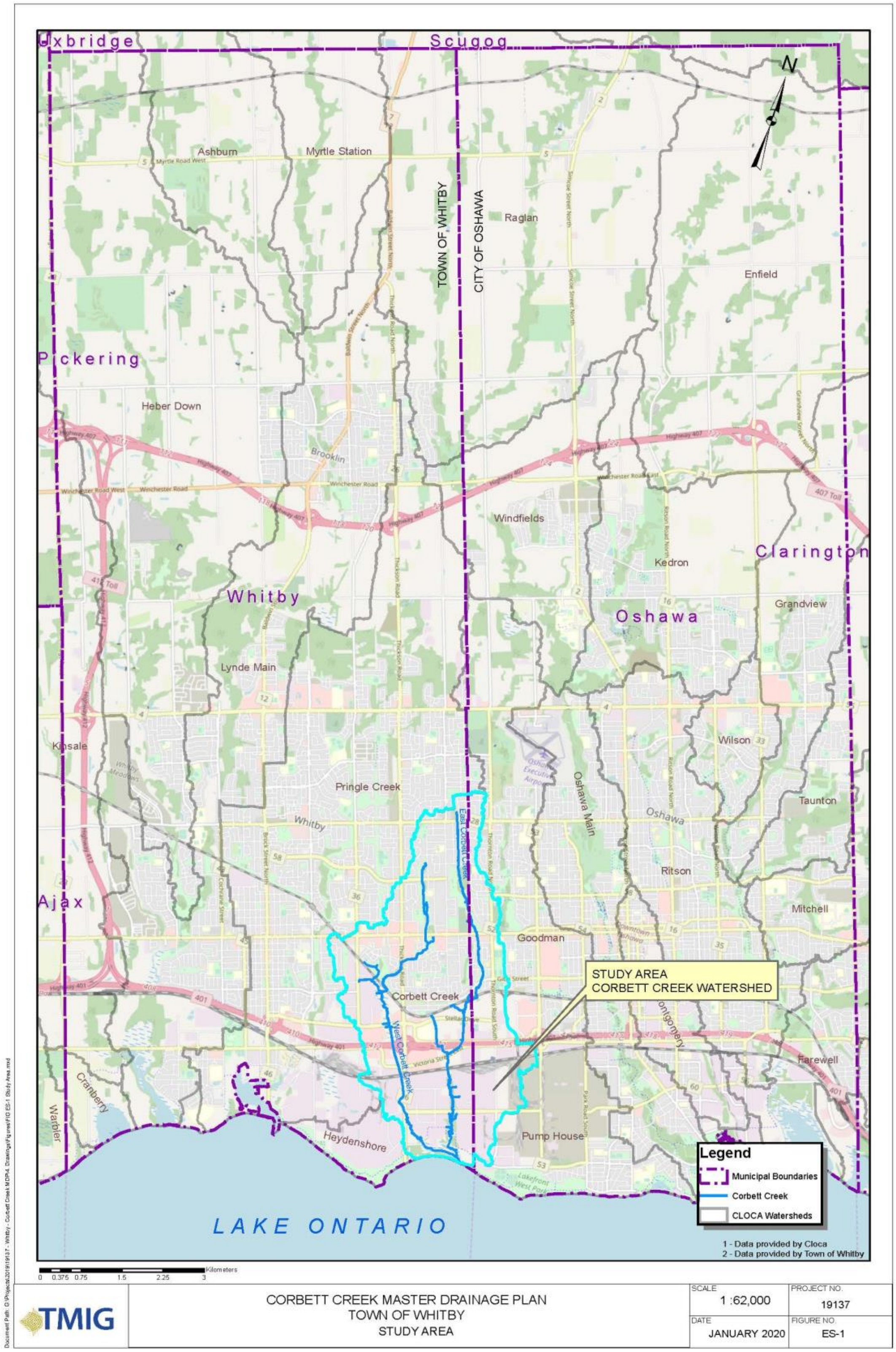
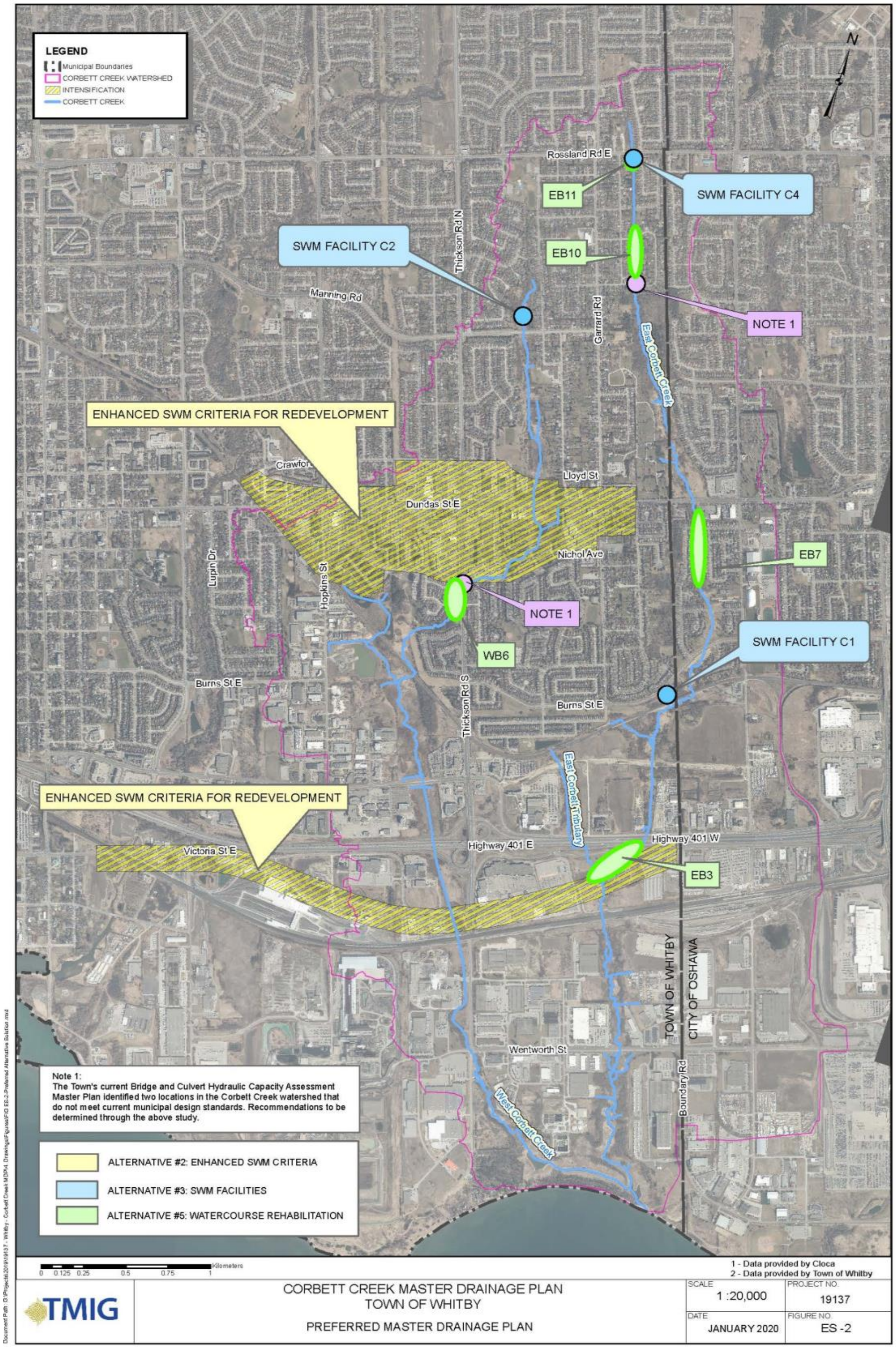


Figure ES-2 Preferred Master Drainage Plan



Contents

Appendices

Figures

Tables

1 Introduction and Background

1.1 Study Overview and Purpose

The Municipal Infrastructure Group Ltd. (TMIG), along with team members GEO Morphix Ltd. (GEO Morphix) and Palmer Environmental Consulting Group Inc. (Palmer), were retained by the Town of Whitby to prepare a Master Drainage Plan (MDP) for the Corbett Creek Watershed. The MDP was completed in partnership with the Central Lake Ontario Conservation Authority (CLOCA).

The study area (**Figure 1-1**) encompassed the Corbett Creek watershed in its entirety, which is located within the southeastern portion of the Town of Whitby with a portion of the catchment area within the City of Oshawa. In general, it is a small watershed with a drainage area of approximately 14 km^2, draining through the East and West Tributaries that combine at the Corbett Creek Coastal Wetland before discharging to Lake Ontario. The watershed maintains an elongated linear shape that is about 6.3 km long and 2.1 km wide.

The purpose of the Corbett Creek MDP was to provide guidance to the Town, CLOCA, and City of Oshawa in the continued management of the watershed and stream corridors with respect to flooding, creek erosion, natural environmental and resource protection, and development. The study was carried out in accordance with the Master Planning Process Approach No. 2 as outlined in the Municipal Engineers Association “Municipal Class Environmental Assessment” document (October 2000; amended 2007, 2011 and 2015). Approach No. 2 includes Phases 1 and 2 of the Municipal Class Environmental Assessment (EA) process where the level of investigation, consultation and documentation are sufficient to fulfill ‘Schedule B’ projects identified within the MDP.

To develop the MDP, the study included several key objectives:

- Identify the existing conditions in the watershed, including the planning environment, physiographic environment, natural heritage, cultural heritage, and engineering environment. More specifically, technical studies were completed to inventory existing conditions hydrogeology, fluvial geomorphology, and ecology as well as hydrology and hydraulic (floodplain) analysis (**Section 0**).
- Develop alternative management strategies for the watershed which may include, but not limited to, stormwater management criteria for development,

new SWM facilities or retrofits to existing facilities, watercourse rehabilitation, and watercourse conveyance improvements (**Section 3**).

- Evaluate the alternative management strategies for their benefits with respect to the technical, natural, social, cultural, and financial environments to select the preferred management strategies (**Section 4**).
- Complete public consultation and prepare the MDP to describe the preferred alternative and outline the implementation strategy (**Sections 5 through 7**).

1.2 Project Background

1.2.1 Overview

The Corbett Creek watershed is fully developed with a limited number of stormwater management controls for water quantity, quality and erosion. A large number of tributaries had been historically straightened and realigned for agriculture, and later for urban development. The watershed also includes several natural heritage features including the Corbett Creek Coastal Wetland Complex. Aside from existing residential, commercial and industrial development, major transportation corridors traverse the watershed, such as Highway 401, Canadian Pacific Railway (CPR) and Canadian National Railway (CNR), while future development includes plans for intensification along several urban corridors.

There are a limited number of drainage studies in the watershed and, of those, several were completed in the 1970s and 1980s when much of the watershed was developed. The studies include the West Corbett Creek Study, Highway 401 to CPR (Dillon, 1976), the Whitby Stormwater Management Study (Dillon, 1982), and the East Corbett Creek Drainage Study (Dillon, 1987). These studies provide historical context for watershed planning at the time, but are generally outdated compared to modern standards and do not provide appropriate guidance for watershed management.

The key background information on the watershed technical studies and information on current and proposed development is described in the following sections. This information, along with the existing conditions review for the watershed, formed the basis for the development and evaluation of alternative solutions to manage the watershed. The location of studies or development discussed herein are shown on **Figure 1-2**.

Figure 1-1 Study Area

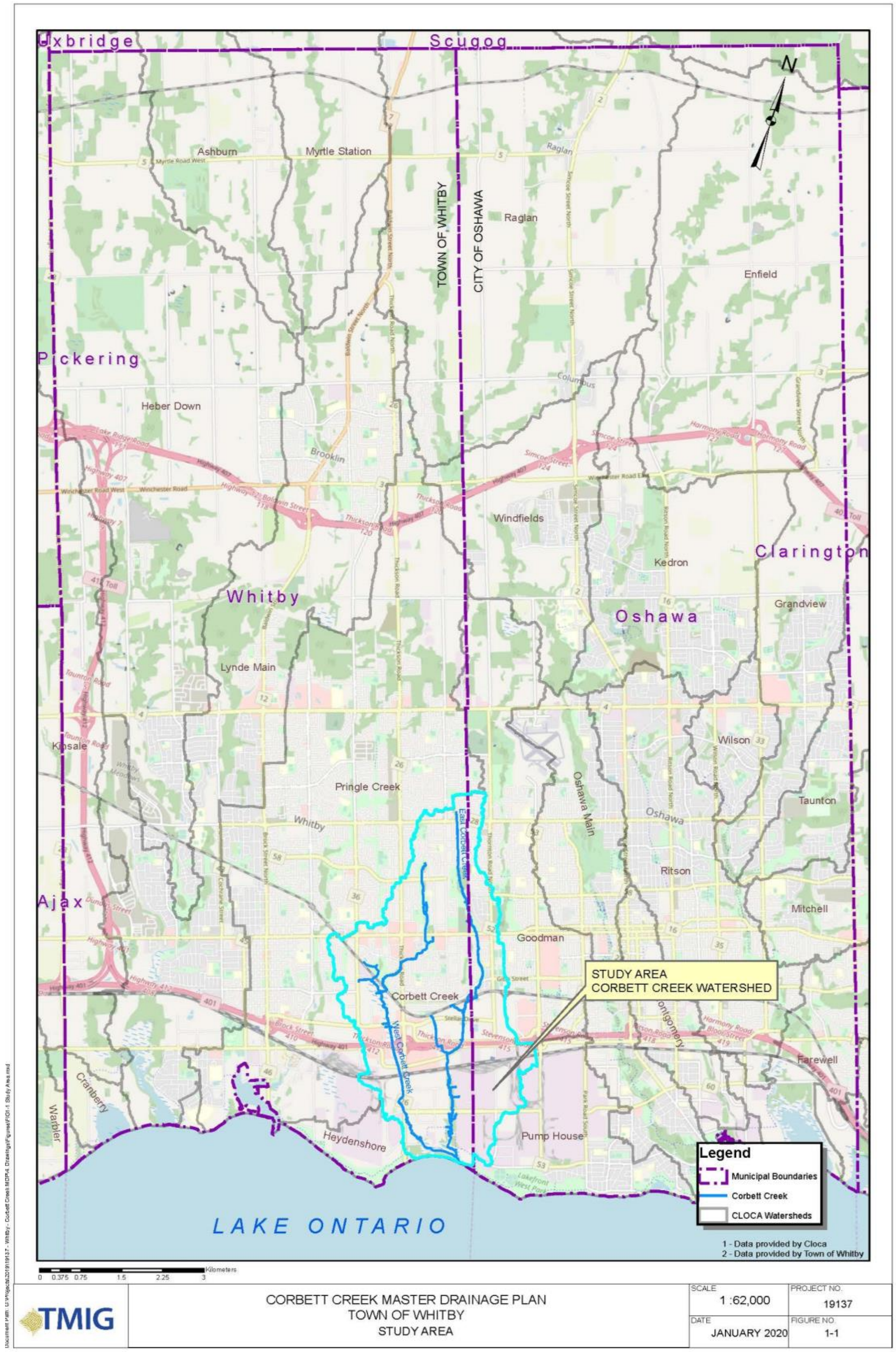
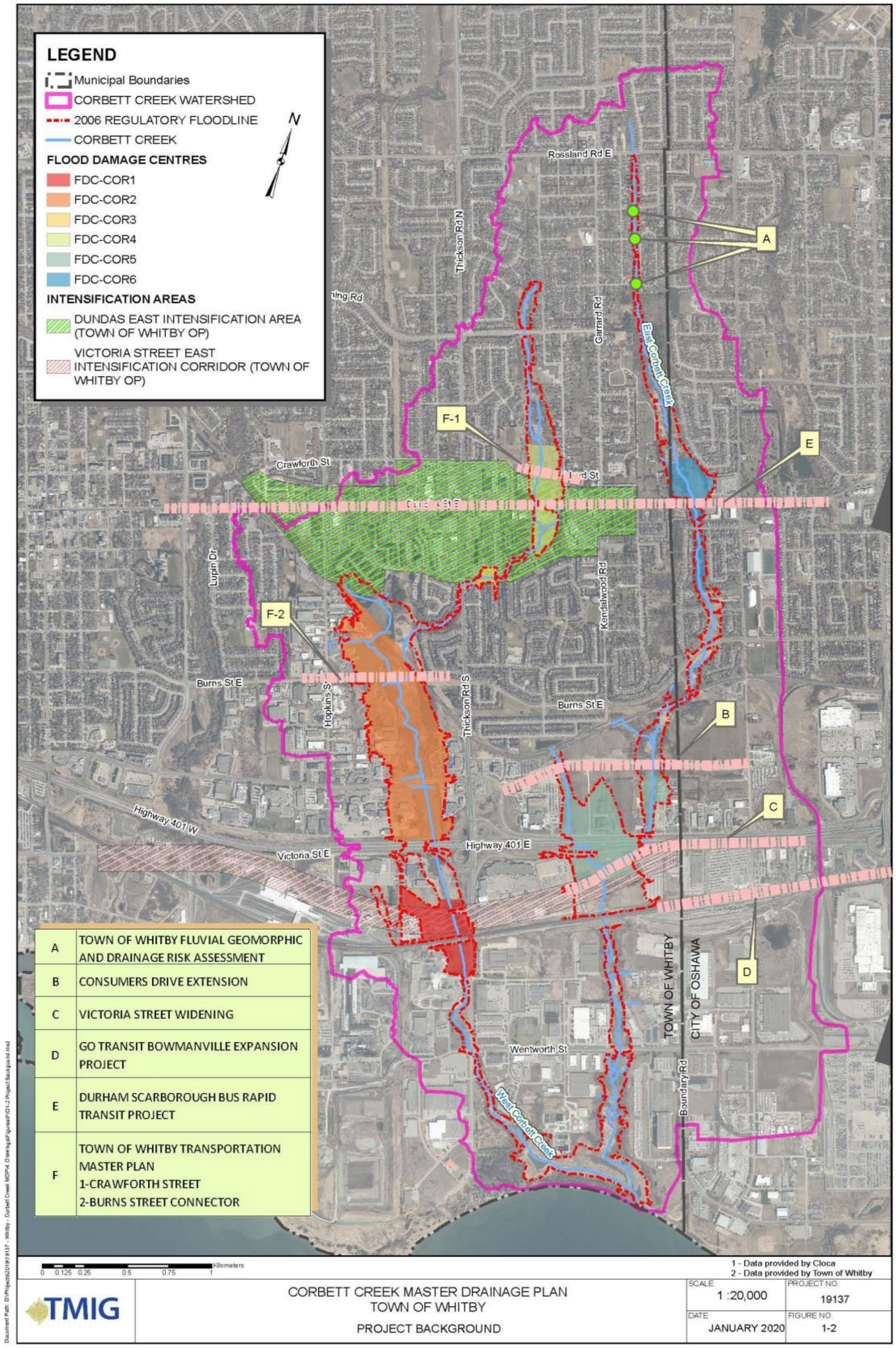


Figure 1-2 Project Background



1.2.2 Historical East and West Corbett Creek Studies

The West Corbett Creek Study (Dillon, 1976) proposed a realignment of the channel between the CPR and Highway 401. The realignment was proposed to accommodate a future extension of Burns Street (that has not been implemented to date).

The East Corbett Creek Drainage Study (Dillon, 1987) examined stormwater management for development north of Dundas Street to Rossland Road. Quantity control facilities were determined to be unfeasible due to the flat grade of the area and the study recommended increased channel conveyance to handle increased runoff from large storm events. Erosion control recommendations include remedial measures for the receiving channel to repair erosion issues as they arise.

1.2.3 Corbett Creek Floodline Mapping Update and Flood Damage Centres

CLOCA completed a floodline mapping update for the Corbett Watershed in 2006 (Greck, 2006), which updated previous work completed in 1982. The floodline mapping update included the development of a hydrologic model for the watershed using Visual OTTHYMO (version 2) for existing and future land use scenarios. A hydraulic model was developed with HEC-RAS (version 3.1.3) to complete hydraulic analysis and establish Regulatory flood limits. Twenty (20) digital flood line maps at 1:2000 scale were prepared.

The Corbett Creek watershed includes some large road and railway structures that impact the hydraulic conditions in the watershed and required the modelling of flood storages to account for the significant storage at the CNR tracks for East and West Corbett Creek.

CLOCA had also completed a Watershed Flood Risk Assessment for their watersheds (CLOCA, 2017) which evaluated flood damage centers (FDCs) to determine the level of flood risk to public and property. Within the Corbett Creek watershed, six (6) FDCs were identified (FOD-COR1 through FOD-COR5 in Whitby and FOD-COR6 in Oshawa). The FDCs within the watershed were not amongst the high or moderate risk FDCs within CLOCA’s watersheds.

The Watershed Flood Risk Assessment evaluated areas in the watershed based on the vulnerability of structures and properties to damage during the Regulatory Flood, public safety, frequency that structures and properties would be affected, and the impacts resulting from flood events using social, business, economic, and environmental factors.

1.2.4 Town of Whitby Fluvial Geomorphic and Drainage Risk Assessment

The Town completed a preliminary risk assessment of crossing structures of 3 m or wider from a fluvial geomorphic and drainage perspective (AECOM, 2012). Within the Corbett Creek watershed, three crossing structures were assessed, which were located on East Corbett Creek between Rossland Road and Dundas Street. Two of the structures (Forest Road and Westwood Street) were identified as top priorities for further study and/or restoration/remediation, ranking no. 2 and no. 7, respectively. Observations within this reach of Corbett Creek from the study include failing gabion, failing channel bed and bank protection and knickpoints. Recommendations from the assessment include a geomorphic study, replacing failing bed and bank protection, removing woody debris upstream of crossings, and removing the knickpoint downstream of crossings.

1.2.5 Town of Whitby Bridge and Culvert Hydraulic Capacity Assessment Master Plan

The Town had initiated a master plan study in January 2019 to identify high risk bridges and culverts based on insufficient hydraulic capacity and flood vulnerable municipal roadways. The study, currently underway by Ecosystem Recovery Inc., includes all watersheds within the Town's limit and includes six bridges/culverts within the Corbett Creek watershed.

Within the Corbett Creek watershed, the culvert at Dundas Street and Thickson Road on West Corbett Creek and the culvert at Forest Road on East Corbett Creek were identified as not meeting current municipal design standards. Recommendations were not yet available for the development of the MDP.

1.2.6 Town of Whitby Urban Flooding Study

The Town had initiated a Town-wide Urban Flooding Study in August 2019 to obtain a better understanding of how the Town's urban storm sewer and overland flow networks will react to large storm events and determine areas that could be subject to surface and basement flooding. The study, currently in progress by Jacobs Engineering, did not have results or recommendations available in time for the development of the MDP.

1.2.7 Town of Whitby Stormwater Quality and Erosion Enhancement Study Update

In September 2019, the Town had completed an update to the 2001 Stormwater Management Facilities Needs Study, known as the Stormwater Quality and Erosion Enhancement Study Update (Ecosystem Recovery, 2019). The study reviewed the Town's 154 outfalls with drainage areas of 5 ha or more and identified new water quality and erosion control opportunities.

A shortlist of 12 enhancement sites were recommended, with options for each site that included floodplain improvements, plunge pools, low impact development SWM features, oil-grit separators, catch basin inserts, and SWM ponds. Three (3) of these recommended enhancement sites are within the Corbett Creek watershed and include enhancements such as plunge pools, oil-grit separators, and SWM ponds. The results of the study and recommended works were considered within the MDP.

1.2.8 Consumers Drive Extension and Victoria Street Widening

Durham Region is currently constructing the Consumers Drive Extension (Stellar Drive) from Thickson Road to Thornton Road, which includes crossings over the East Corbett Creek and a tributary of East Corbett Creek. The Class EA for this project was competed in 2005 (Chisholm Fleming, 2005).

The crossing structures designed for this road include a 10.0 m x 2.0 m concrete box culvert for East Corbett and a 3.5 m x 1.2 m concrete box culvert for the tributary of East Corbett Creek. These structures were installed in 2018 as part of the pre-loading for the road construction. As part of the crossing structure design, hydraulic analysis and a fluvial geomorphic assessment was completed in 2016 (Golder, 2016).

Durham Region is also undertaking the widening of Victoria Street and Bloor Street from Halls Road to Seaboard Gate, which includes a crossing of the East Corbett Creek. The project will not replace the existing crossing structure over the watercourse.

1.2.9 Metrolinx Transit Projects

Metrolinx is currently undertaking the Bowmanville Expansion Project, which includes the extension of the Lakeshore East GO train line from Oshawa to Bowmanville. As part of the extension, a Transit Project Assessment Process (TPAP) was completed in 2011 (with a TPAP Addendum in 2018) that included the evaluation of several routes for the service. Option 1 – CP Alignment was selected as the preferred alternative and required a rail bridge over Highway 401, in vicinity of East Corbett Creek. Since then, Metrolinx issued a public update (May 2019) noting that Option 1 was determined to cost prohibitive and the alignments options are currently being evaluated for cost effectiveness. A preferred alignment option has not been selected.

Metrolinx is also currently completing preliminary technical work and public consultation ahead of a TPAP for the Durham-Scarborough Bus Rapid Transit (BRT) Project. The proposed BRT corridor is located along Dundas Street through the Town of Whitby and King Street through the City of Oshawa, which will potentially impact crossings of East and West Corbett Creek.

1.2.10 Town of Whitby Transportation Master Plan

The Town of Whitby Transportation Master Plan (Dillon, 2010) identified the need for a new east-west arterial connection based on traffic conditions and the future development of higher order transit on Dundas Street. The Burns Street Connection (east) from Hopkins Street to Thickson Road was identified within the corridor protection plan. It would require a future crossing of West Corbett Creek. Mary Street / Crawforth Street from Scott Street to Cochrane Street was also identified in the corridor protection plan. At the east end of this corridor, a crossing of West Corbett Creek and wetland area north of Dundas Street East would be required.

Consultation with the Town of Whitby’s planning department also noted a future Manning Road extension from Garrard Road to Adelaide Avenue that includes a crossing of East Corbett Creek. A Municipal Class Environmental Assessment is required to determine the preferred alignment and configuration of these future road connections.

1.3 Municipal Class Environmental Assessment Process

The planning of major municipal projects or activities is subject to the Ontario Environmental Assessment (EA) Act, R.S.O. 1990, and requires the proponent to complete an Environmental Assessment, including an inventory and description of the existing environment in the area affected by the proposed activity.

The Municipal Class EA process was developed by the Municipal Engineers Association and approved by the Ministry of the Environment, now Ministry of the Environment, Conservation and Parks (MECP), as an alternative method to

Individual Environmental Assessments for recurring municipal projects that were similar in nature, usually limited in scale and with predictable ranges of environmental effects which were responsive to mitigating measures. The latest Municipal Class EA document (October 2000, amended 2007, 2011 & 2015) has been used for this study.

The Class EA provides for the following designations of projects depending upon potential impacts:

Schedule A: Projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects are pre-approved. Schedule A projects generally include normal or emergency operational and maintenance activities.

Schedule A+: Projects are within existing buildings, utility corridors, rights-of-way, and have minimal adverse environmental effects. These projects are pre-approved; however, the public is to be notified prior to project implementation.

Schedule B: Projects have the potential for some adverse environmental effects. The proponent is required to undertake a screening process, involving mandatory contact with directly affected public and relevant review agencies, to ensure they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation.

Schedule C: Projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Class EA document. Schedule C projects require that an Environmental Study Report be prepared and filed for review by the public and review agencies.

This study was carried out in accordance with the Master Planning Process Approach No. 2 as outlined in the Municipal Engineers Association “Municipal Class Environmental Assessment” document (October 2000; amended 2007, 2011 and 2015). Approach No. 2 includes Phases 1 and 2 of the Municipal Class Environmental Assessment (EA) process where the level of investigation, consultation and documentation are sufficient to fulfill ‘Schedule B’ projects identified within the study. The following Class EA planning phases apply:

Phase 1: Identify the problem (deficiency) or opportunity.

Phase 2: Identify and evaluate alternative solutions to address the problem or opportunity by taking into consideration the existing environment, and establish the preferred solution taking into account public and review agency input.

Phase 5: Complete contract drawings and documents, and proceed to construction and operation; monitor construction for adherence to environmental provisions and commitments. Where special conditions dictate, also monitor the operation of the completed facility.

This study will provide the basis for future investigations for specific 'Schedule C' projects identified in the study. Specific Schedule C projects will require the fulfillment of Phases 3 and 4 in a Class EA separate from this study.

The Class EA process also provides an appeal process to change the project status. Under the provisions of the Environmental Assessment Act, there is an opportunity under the Class EA planning process for the Minister to review the status of a project. Members of the public, interest groups and review agencies may request the Minister to require a proponent to comply with Part II of the EA Act, before proceeding with a proposed undertaking. This is known as a "Part II Order" (formerly called "Bump-Up Request").

The Environmental Assessment Act was recently amended through Bill 197, the Covid-19 Economic Recovery Act, 2020. Among other things, the amendments focus the Part II Order request process to issues relating to Aboriginal and treaty rights and set timelines for when the Minister can intervene on his/her own initiative to impose conditions on or bump up a class environmental assessment project.

Any outstanding concerns are to be directed to the proponent for a response, and in the event there are outstanding concerns regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, Part II Order requests on those matters may be addressed in writing to the Minister of the Environment, Conservation and Parks and the Director of the Environmental Assessment Branch. 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 the project.

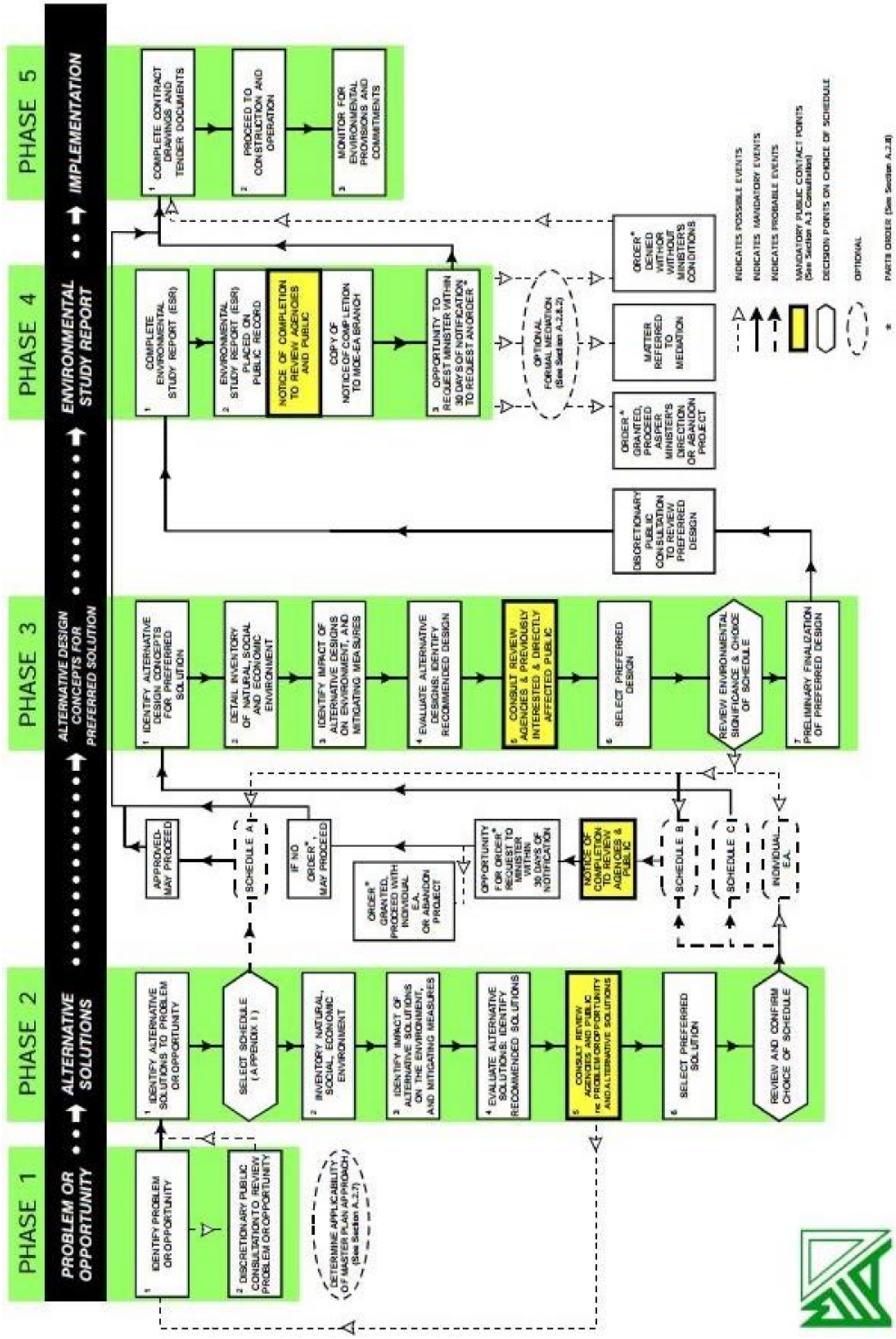
The proponent cannot proceed with the project until at least 30 days after the end of the comment period provided for in the Notice of Completion. Further, the proponent may not proceed after this time if:

- A Part II Order request has been submitted to the Minister regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, or;
- The Director has issued a Notice of Proposed Order regarding the project.

A flow chart describing the Class EA planning and design process is shown on **Figure 1-3.** Note that the flow chart has not been updated to reflect the recent amendments to the Environmental Assessment Act described above.

Revisions to Schedule B projects or a delay in implementing the construction of Schedule B projects exceeding ten (10) years from the Notice of Completion is subject to a review of planning and design process to ensure the project and mitigation measures are still valid. The review shall be documented, and a Revised Notice of Completion shall be issued and include the 30-day review period and Part II Order request process outlined above.

Figure 1-3 Municipal Class EA Planning Flow Chart



1.4 Project Team Organization

The project was completed by a multi-disciplinary team led by TMIG. Key staff involved in the Study are listed in **Table 1-1**. The project was completed under the direction of a technical working group comprised of staff from the Town of Whitby and CLOCA.

Table 1-1 Study Team

Name	Organization	Role
Antony Manoharan, P.Eng	Town of Whitby	Proponent Project Manager
Louie Jakupi, P.Eng	CLOCA	Senior Water Resources Engineer
Steve Hollingworth, P.Eng.	TMIG	Consultant Project Manager and Senior Water Resources Engineer
Tony Dang, P.Eng.	TMIG	Water Resources Engineer
Kevin Tabata, M.Sc.	GEO Morphix	Fluvial Geomorphologist
Jason Cole, M.Sc., P.Geo.	Palmer	Hydrogeologist
Jennifer Paterson, M.Sc.	Palmer	Aquatic Ecologist
Dirk Janas, B.Sc.	Palmer	Terrestrial Ecologist

1.5 Problem and Opportunity Statement

The Corbett Creek watershed has experienced and will continue to experience pressures from urban land uses that impact the watershed’s form and function, which include flood potential, erosion, and natural heritage health, among other potential impacts. The problem and opportunity statement is as follows:

> **The Corbett Creek Master Drainage Plan is required to determine a long-term plan outlining the preferred methods of watershed management with respect to storm runoff to maintain or improve flood conditions, water quality, erosion, water balance, and aquatic and terrestrial habitat associated with the natural heritage system.**

2 Existing Environments

2.1 Planning Environment

The Corbett Creek watershed is located mostly within the Town of Whitby with a portion within the City of Oshawa. Land use within the study area is a mix of residential, commercial, industrial and natural heritage system. In general, residential development is located north of the CPR, while industrial land uses dominant the lands south of the CPR. Commercial developments are clustered along Dundas Street and in the vicinity of Highway 401. Open space (including a cemetery), parks, and natural heritage features are scattered along the stream corridors of the watershed and include the Corbett Creek Coastal Wetland (a Provincially Significant Wetland) along the shores of Lake Ontario. There are a very limited number of greenfield sites in the watershed for future development.

2.1.1 Provincial Policy Statement

The Provincial Policy Statement (PPS) (May 1, 2020) (MMAH, 2020) provides broad land use planning and development policy direction, particularly as it relates to matters of provincial interest including but not limited to stormwater management, natural environment and natural hazards.

The PPS includes policies generally promoting intensification and redevelopment in existing built-up areas (Section 1.1 of the PPS), which will be the predominant mode of future development within the watershed, due to the lack of greenfield availability.

The natural environment policies (Section 2.1 of the PPS) provides direction for the protection of natural heritage features and resources. The PPS defines natural heritage feature (NHF) types and adjacent lands and provides planning policies for each, where development is not permitted or subject to an Environmental Impact Study (EIS) demonstrating no negative impacts on the natural features or their ecological functions.

The Natural Hazard policies (Section 3.1 of the PPS) generally prohibit development in areas at risk of flooding from riverine systems as well as areas that cannot be safely accessed due to excessive flood depths and velocities during severe storm events. The PPS contains some exemptions to these policies, such as designated Special Policy Areas and flood fringe areas where separate policies apply. To note, the Corbett Creek watershed includes a floodplain policy area managed by CLOCA that originated in 1977, prior to establishment of the PPS in 1996. It is known as the West Corbett Creek Floodplain Management Policy, however, it is not designated as a Special Policy Area under PPS policy. Further discussion on the West Corbett Creek Floodplain Management Policy is found in **Section 2.1.6**.

2.1.2 A Place to Grow: Growth Plan for the Greater Golden Horseshoe

A Place to Grow: The Growth Plan for the Greater Golden Horseshoe (May 2019) is another provincial policy document intended to guide future growth in the area (MMAH, 2019). The latest Plan took effect on May 16, 2019 and amended the previous version from 2017. It is generally intended to direct future population and employment growth to existing urban areas. The Town of Whitby does not have a designated Urban Growth Centre, but it is located between the Downtown Pickering and Downtown Oshawa Urban Growth Centres. However, the study area has a priority transit corridor (GO Lakeshore East) that would require Major Transit Station Area designations (and potential intensification) for all stations along the route. The Oshawa GO Station is located within the watershed.

The Plan also directs growth away from areas at risk from flooding and erosion, and also contains policies for the long term protection of natural heritage and biodiversity, including protection of key hydrologic features and their functions. The Plan also contains policies for the conservation of cultural heritage resources.

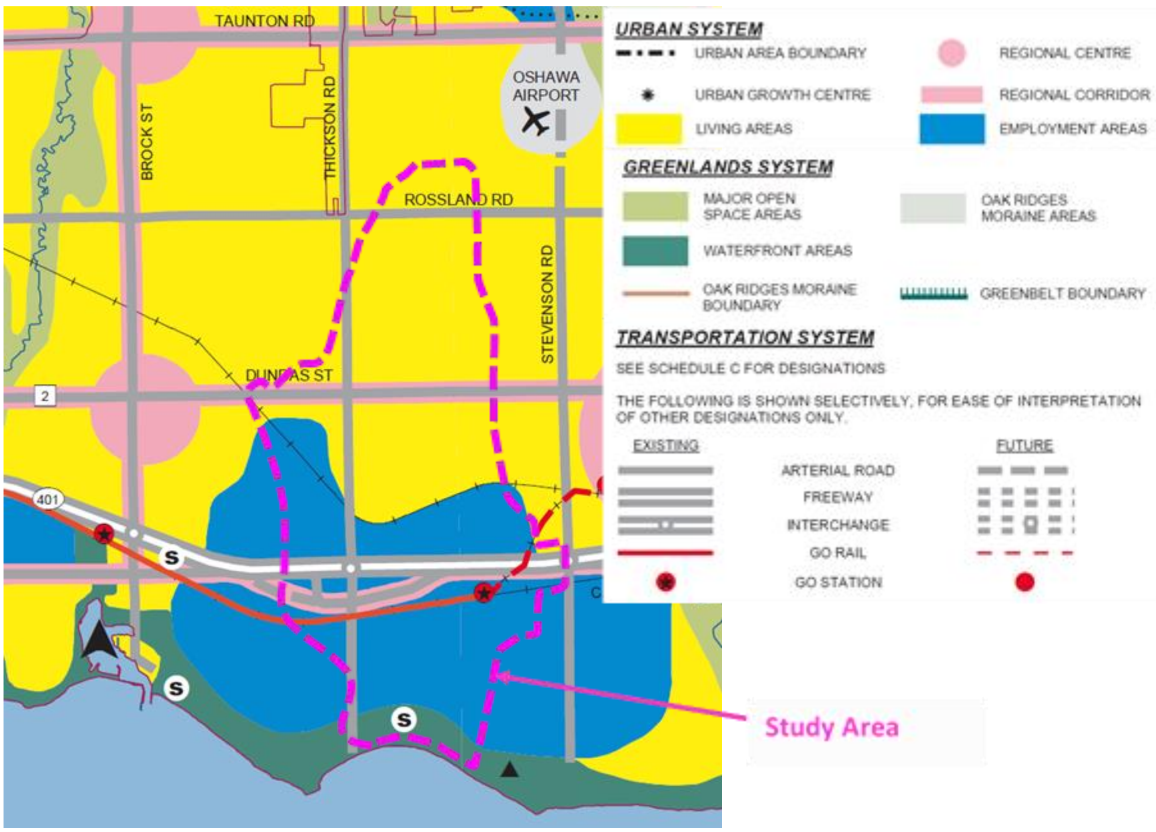
2.1.3 Durham Region Official Plan

The Durham Region Official Plan (Region OP) was initially approved in 1993, and was last consolidated in May 2017 with all amendments to date. The Region has initiated ‘Envision Durham’ to establish a new official plan for the Region to 2041. Watershed planning is supported within the environmental policies of the Region OP (Section 2) as an effective planning tool to protect the Region’s natural resources.

The current Region OP generally designates areas north of the CPR as Living Areas and lands south of the CPR as Employment Areas, with regional corridors traversing the watershed on Dundas Street / King Street and Victoria Street.

Natural environment policies are provided within Section 2 and Schedule ‘B’ of the Region OP, which shows some areas of the study area as Key Natural Heritage and Hydrologic Features, mainly at the Corbett Creek Coastal Wetland and isolated areas along valleylands of the creek. Corbett Creek is not designated as part of the Greenbelt Natural Heritage System (Urban River Valley) (which is sourced from the 2017 Provincial Greenbelt Plan currently in effect). Large portions of the study area are designated as a High Aquifer Vulnerability Area. Policies in the plan prohibit high risk uses in areas outside of urban areas, and new development within urban areas require a contaminant management plan to demonstrate how water resources will be protected. Best management practices are encouraged for existing uses that pose a high risk to groundwater.

Figure 2-1 Durham Region Official Plan - Regional Structure



Excerpt from Schedule A, Map A4 of Region Official Plan

2.1.4 Town of Whitby Official Plan

The Town of Whitby Official Plan (Whitby OP) was initially adopted by council in 1994, and was last consolidated in July 2018, incorporating all amendments to date.

Consistent with the Region OP, the Whitby OP generally designates the areas north of the CPR as residential and lands south of the CPR as general industrial and prestige industrial land use designations. The Whitby OP also identifies areas of mixed use at Dundas Street and Thickson Road, and special activity nodes clustered around Dundas Street and Highway 401 (**Figure 2-2**). The areas around Dundas Street and Victoria Street are also designated as an intensification area and intensification corridor, respectively, under Section 4.2 of the Whitby OP. This designation supports growth in the Town by including policies for long-term density targets, parking form, community services and infrastructure, and urban design.

Section 5 and Schedule C of the Whitby OP provides the environmental policies for the Town. The main relevant environmental policies address the identification and protection of wetlands, the location of the natural heritage system (NHS), restrictions on development within or adjacent to the NHS, and vegetation protection zones (VPZs). Included with Schedule C are locations of former waste disposal sites, of which one (1) is located near the western edge of the Corbett Creek watershed, northwest of the intersection between Hopkins Street and Consumers Drive. Schedule C of the Town OP is provided in **Appendix B** of this report.

Similar to the Region OP, the Whitby OP supports watershed planning, such as the preparation of Master Drainage Plans, and outlines a number of objectives related to the technical level of study and outcomes of the plans (Section 5.3.6). The watershed plans should also consider the Great Lakes Strategy and targets and goals of the *Great Lakes Protection Act*. Major Open Space policies are found in Section 4.9 that are relevant to the watershed.

Appendix 1 of the Town OP provides technical mapping of Environmental Elements, which includes riparian corridors, wetland and woodlands, among other features relevant to the environmental policies of the Town OP. Appendix 2 of Town OP provides mapping for water resource features, such as areas of Highly Vulnerable Aquifers (HVA) and Ecologically Significant Groundwater Recharge Area (ESGRA). Appendices 1 and 2 of the Town OP are provided in **Appendix B** of this report. New development in ESGRAs must demonstrate that groundwater quality and quantity, including groundwater flow paths, will be maintained or enhanced.

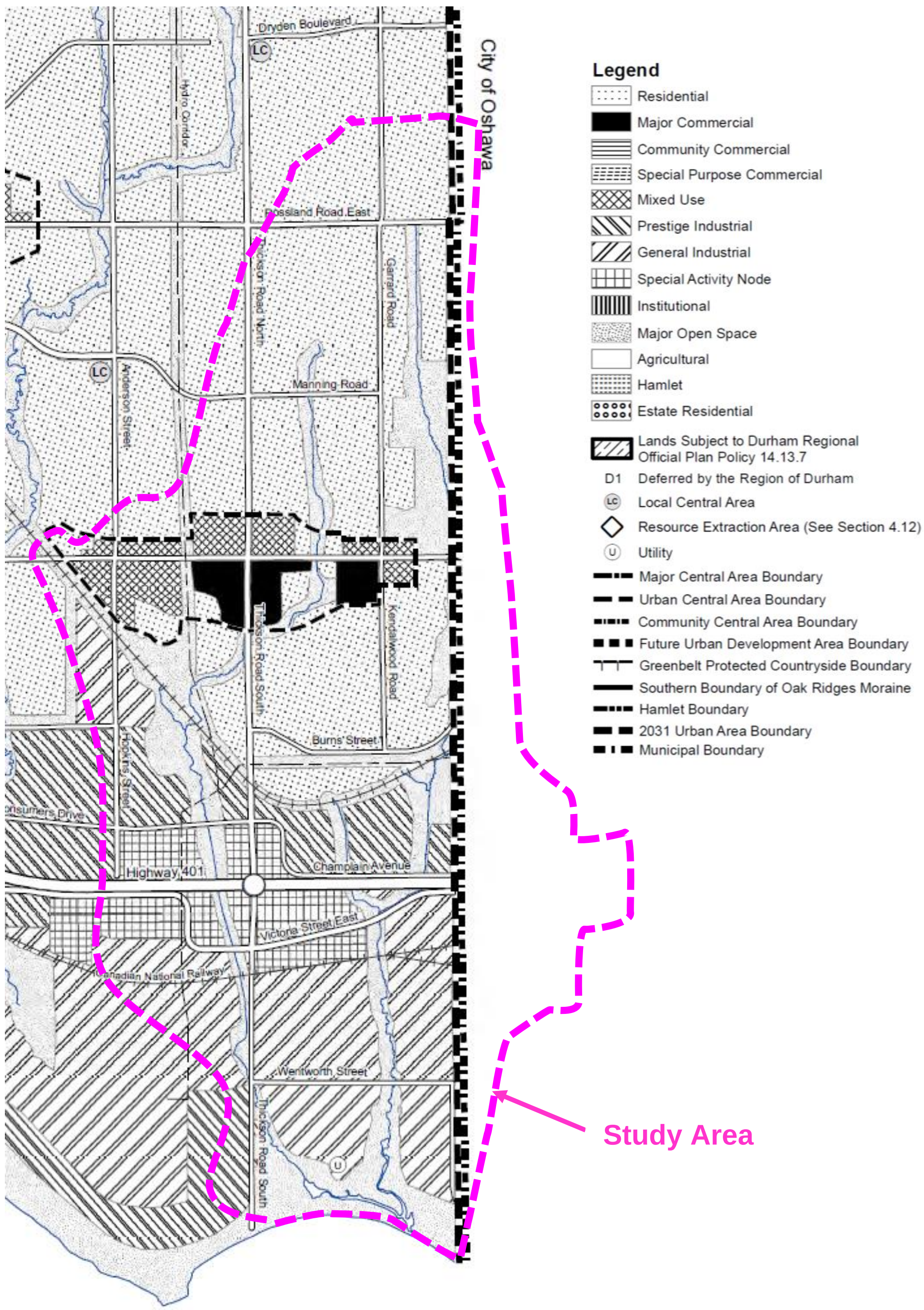
2.1.5 City of Oshawa Official Plan

The City of Oshawa Official Plan (Oshawa OP) was initially approved in 1987 and was last consolidated in November 2018, incorporating subsequent amendments to date. The land use schedule from the Oshawa OP is shown on **Figure 2-3**.

The Corbett Creek watershed occupies a small area within the City of Oshawa along its southwestern border. Land uses are designated residential and commercial north of the CPR, and industrial south of the CPR. The City's designated urban areas and intensification areas are away from the watershed. The corridors and transportation infrastructure identified in the Oshawa OP include the King Street and Victoria/Bloor Street corridors, and the existing and future GO train stations.

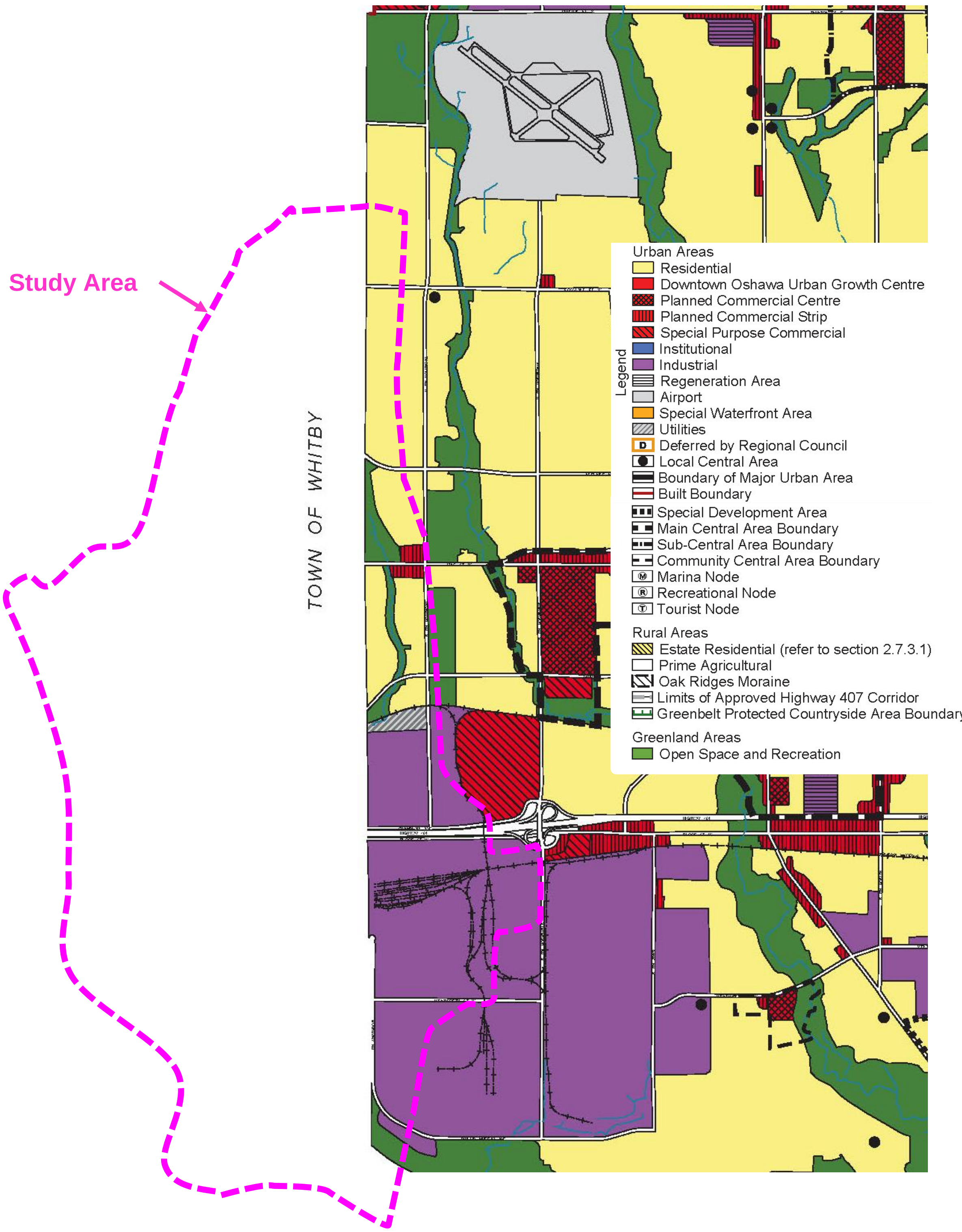
Environmental and watershed planning policies are consistent with the Region OP and Whitby OP, with respect to the management of natural resources. The Oshawa OP identifies hazard lands and the NHS associated with Corbett Creek. A portion of the NHS within the Corbett Creek watershed is designated a Natural Cover Regeneration / Restoration Area to improve connectivity, with policies that generally prohibit development unless an Environmental Impact Study can demonstrate that the net area of NHS is matched or improved and connectivity is enhance, restored or protected.

Figure 2-2 Whitby Official Plan - Land Use (excerpt from Schedule A)



Excerpt from Schedule A of Town Official Plan

Figure 2-3 Oshawa Official Plan - Land Use (excerpt from Schedule A)



Excerpt from Schedule A of City of Oshawa Official Plan

2.1.6 Central Lake Ontario Conservation Authority

Corbett Creek is regulated by CLOCA under Ontario Regulation 42/06. Approvals are required from CLOCA for all activities within 15 m of the limit of the flood plain or stable top-of-slope associated with the Corbett Creek valley corridor, as well as within 120 m of Provincially Significant Wetlands (PSWs) and 30 m of all other wetlands. The current regulated area mapping for the Corbett Creek watershed is provided on **Figure 2-4**

The West Corbett Creek has a floodplain policy area that CLOCA approved as the West Corbett Creek Floodplain Management Policy in 1977. The policy identifies two areas within the West Corbett Creek watershed and contains special policies guiding development that may be permitted and recommendations for a management approach for the subject lands. At that time, provincial technical guides and policies for natural hazard management did not exist. Since 1977, CLOCA has ensured that development within the Floodplain Management Policy for West Corbett Creek has followed the policy guidance to the best of its ability, given over time, new policies related to natural hazard management and natural heritage protection have been developed and applied in conjunction with the intent of the original policy. A copy of the Floodplain Management Policy is included in **Appendix B**.

Given that most of the area that was affected by this policy has been developed, and additional policies related to natural hazard management and natural heritage protection have been put in place, the applicability and purpose of the Policy is no longer valuable. Since the policy has never been adopted into the Town of Whitby Official Plan, and there is no record of the Special Policy being recognized by the Province, it is recommended that CLOCA discontinue the use of the West Corbett Creek Floodplain Management Policy. Future floodplain management practices should be consistent with provincial technical guides and provincial policies for natural hazard management.

2.1.7 Source Water Protection

The Source Protection Plan for the CTC Source Protection Region, which includes the study area, was approved in 2015 (CTC, 2015). The CTC represents the Credit Valley-Toronto and Region-Central Lake Ontario Source Protection Authorities. Further discussion and mapping for source water protection is provided in the Hydrogeology Assessment (**Appendix C**).

Based on the Source Protection Plan, the watershed is not located within any Wellhead Protection Areas (WHPA) or Recharge Management Areas (WHPA-Q), and the study area does not contain any Significant Groundwater Recharge

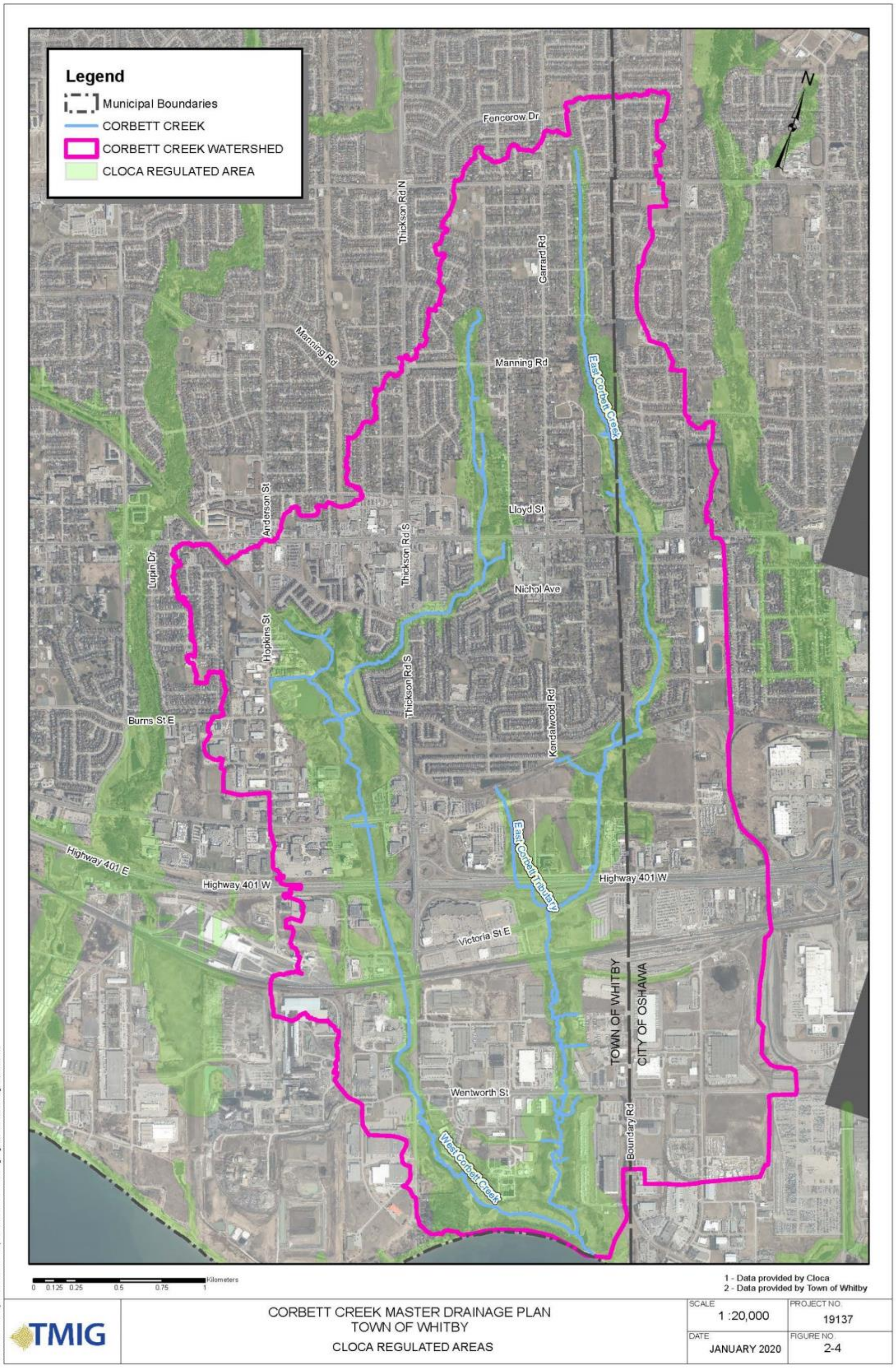
Areas (SGRA). However, the watershed contains Highly Vulnerable Aquifers (HVAs) (**Figure 2-8**).

The southern edge of the watershed near Lake Ontario lies within Intake Protection Zone 2 (IPZ-2) associated with the Oshawa surface water intake. An IPZ-2 is defined as the area around a surface water intake where water can reach the intake within two (2) hours.

The majority of Corbett Creek is not considered an 'event based area' (EBA) as a conduit for potential spills to reach Lake Ontario and water treatment plant intakes, which is classified under Intake Protection Zone 3 (IPZ-3). The exception is the IPZ-3 area around the Corbett Creek Wastewater Treatment Plant. An EBA is an area delineated if modelling indicates that a spill from a specific activity may be transported to an intake and poses a significant threat to drinking water.

Under the CTC Source Protection Plan, Dense Non-Aqueous Phase Liquids (DNAPLs), activities related to waste disposal, livestock grazing or pasturing, fertilizers and pesticides, road salts, snow dumps and fuels have associated restrictions within HVAs and IPZ-2. This restriction applies to all current and future vulnerable areas. If the activity pre-dates the area, it will be considered existing, and will require risk management.

Figure 2-4 CLOCA Regulated Area



2.2 Physiographic Environment

Palmer completed a desktop hydrogeology review of the Corbett Creek watershed to assess hydrogeological features, particularly in relation to stormwater management planning and natural heritage features, and to assess potential impacts of future development on groundwater resources. The existing conditions assessment memorandum by Palmer is provided in **Appendix C**. TMIG has also completed a review of existing hydrologic conditions for the watershed.

2.2.1 Physiography and Topography

The study area is located within the Iroquois Plain physiographic region (Chapman and Putnam, 1984). This region extends as a narrow band about five kilometers in width along the lowland bordering Lake Ontario. Although the dominant soil texture is comprised mainly of permeable silts, sands and gravels, which were deposited along the shores of glacial Lake Iroquois about 12,500 years ago, the underlying deposits of clayey silt till are commonly found at surface. The topography of the region is relatively flat and is characterized by sand and shale plains.

2.2.2 Land Use

The Corbett Creek watershed is nearly fully developed and has been historically altered due to agricultural activity and the development of residential, commercial, and industrial areas, as well as major transportation infrastructure such as railways and highways. CLOCA maintains a GIS database of existing land cover information for the watershed based on 2018 orthophotography that includes coverage for the Town of Whitby and City of Oshawa (**Figure 2-5**). This land cover information was used to generate input parameters for the hydrologic model.

Existing land uses are largely urban, comprising 78% of the watershed area. Urban land uses include areas of urban residential, industrial, commercial, transportation and utility, and manicured green spaces. Unimproved land occupies 12% of the watershed, while wetlands and forest comprise of 8% of the watershed area.

Future land uses (**Figure 2-6**) are based on land use derived from Schedule A of the Whitby OP and Schedule A of the Oshawa OP. It provides an overview of the anticipated land cover within the watershed to be used for modelling and analysis of the MDP. As mentioned in **Section 2.1**, there are a limited number of greenfield sites in the watershed for future development and future land use is expected to be largely similar to existing land use. The estimated future urban land use is 86% compared to 78% in existing conditions.

2.2.3 Hydrology

2.2.3.1 Overview

The Corbett Creek watershed has a total drainage area of approximately 1,466 ha (14.66 km^2), which can generally be divided into two watersheds: East Corbett Creek (823 ha) and West Corbett Creek (643 ha) that confluence near the outlet of the watershed at Lake Ontario. Most of the watercourses have been historically modified and straightened for agriculture drainage. During urban development of the watershed, many of these straightened alignments were maintained. In some reaches, wetlands have formed from the realigned reaches which provide important natural water quality treatment and flood attenuation.

There are no current or historical stream gauging stations within the Corbett Creek watershed maintained by Water Survey Canada or CLOCA. The watershed is expected to generate runoff peaks that are characteristic of highly urbanized watersheds with limited stormwater management controls, namely, high volumes of runoff that peak quickly, relative to an undeveloped or rural watershed. Hydraulic analysis related to peak flow conveyance and flooding in the watershed is discussed in **Section 2.6.3**.

The following sections describe the general drainage characteristics of the watershed through East and West Corbett Creek. Detailed characterizations of the watercourse reaches is provided in **Section 2.3** (Stream Erosion and Fluvial Geomorphology).

2.2.3.2 East Corbett Creek

The headwaters of East Corbett Creek are located northeast of the intersection between Rossland Road East and Garrard Road. East Corbett Creek, as an open channel, begins at a storm sewer outfall about 200 m north of Rossland Road. The channel flows south with major crossings at Manning Road, Dundas Street East, Burns Street East, CPR, Stellar Drive (recent construction), Champlain Road and Highway 401. A tributary of East Corbett Creek originates on downstream side of the CPR and confluences with the main watercourse between Highway 401 and Victoria Street East. From there, the watercourse continues through major crossings at CNR and Wentworth Street before its confluence with West Corbett Creek near Lake Ontario. The watercourse receives runoff from urban stormwater drainage systems, with inputs from storm sewer system outfalls along its length and overland flow through road systems or sheet drainage from properties adjacent to the watercourse.

Overall slope of East Corbett Creek is 0.7%. Wetlands are present within the valley from the CNR to Lake Ontario, as part of the Corbett Creek Coastal Wetland Complex. A small unevaluated wetland area is located north of King Street (in Oshawa).

2.2.3.3 West Corbett Creek

Headwaters of West Corbett Creek are located west of the intersection between Rossland Road East and Garrard Road. The open channel watercourse begins about 200 m north of Manning Road, at a storm sewer outfall. Wetlands within the channel and floodplain are present upstream and downstream of Dundas Street. From Springwood Street to Thickson Road, the watercourse was realigned around residential and commercial development.

Further downstream between CPR and Highway 401, there was a proposed realignment of the channel based on the review of the 1976 West Corbett Creek Study (Dillon, 1976). From 1954 and 1967 air photos, the channel between CPR and CNR appeared to be configured as a straight agricultural drain with a wooded wetland area near the CPR. In existing conditions, the valley consists of marsh vegetation and has a poorly defined channel. The implementation of crossing structures with limited capacity to convey flows from a fully urbanized watershed may have contributed to the current channel form. The valley lands between the CPR and Highway 401 are mapped as unevaluated wetlands in CLOCA’s database. These reaches of West Corbett Creek provide natural water quality treatment and flood attenuation.

Downstream of the CNR, West Corbett Creek maintains a straightened alignment as a historical agricultural drain, up until Wentworth Street. Downstream of Wentworth Street, the channel confluences with East Corbett Creek and discharges to Lake Ontario as part of the Corbett Creek Wetland Complex. The overall channel gradient is 0.7%.

2.2.4 Surficial and Bedrock Geology

The native overburden soils within the watershed, as defined by Ontario Geological Survey (OGS) mapping, are primarily composed of coarse to fine textured glaciolacustrine deposits of sand, gravel, silt and clay from Lake Iroquois, as well as the sand to silt textured till deposits of the Newmarket Till (**Figure 2-7**). Additionally, there are organic and modern alluvial deposits within the study area. These units are described in more detail below.

The Lake Iroquois Glaciolacustrine deposits are widespread in this area and represent the uppermost geologic layer. These deposits vary from sand and gravel beach deposits to fine sands, silts and clays of glaciolacustrine pondings. Nearshore deposits of sand and gravel grade to laminated silt and clay in the offshore areas where water was calmer. These glacial lake sediments are expected to be up to 20 m thick in the lowlands around the shore of Lake Ontario. Considerable erosion and re-deposition of glacial sediments occurred following deglaciation. Organic material accumulated in isolated basins and kettles, particularly where groundwater upwelled. Revegetation of plains and hillsides reduced sediment delivery to watercourses, thereby causing rivers to incise and abandon old floodplains.

The Newmarket Till was deposited, initially into standing water, by a Late Wisconsinan advance of the Laurentide Ice Sheet. It is laterally extensive within the Greater Toronto Area and extends across the entire analysis area. The Newmarket Till has a distinct and consistent lithology (Sharpe et al., 1999), and is a dense, stony, sandy silt diamicton, ranging in thickness from about 5 to 50 m. It occurs as beds 3 to 5 m thick, locally separated by stone lines and sandy interbeds, 1 to 5 m thick (Sharpe et al., 1999). Most drumlins within the analysis area, including those in the southern portion of the subwatershed are composed of Newmarket Till.

There are two bedrock units underlying the study site. The bedrock underlying the southern portion of the area is characterized as the Shadow Lake Formation and is described as nodular to black laminated limestone. This formation is approximately 6 m thick, and dips to the southeast at about 3 m/km. The bedrock underlying the northern portion of the area is characterized as the Georgian Bay formation and is described as shale with minor limestone. This formation is approximately 250 m thick, and dips to the southeast at about 5 m/km.

Figure 2-5 Existing Land Use

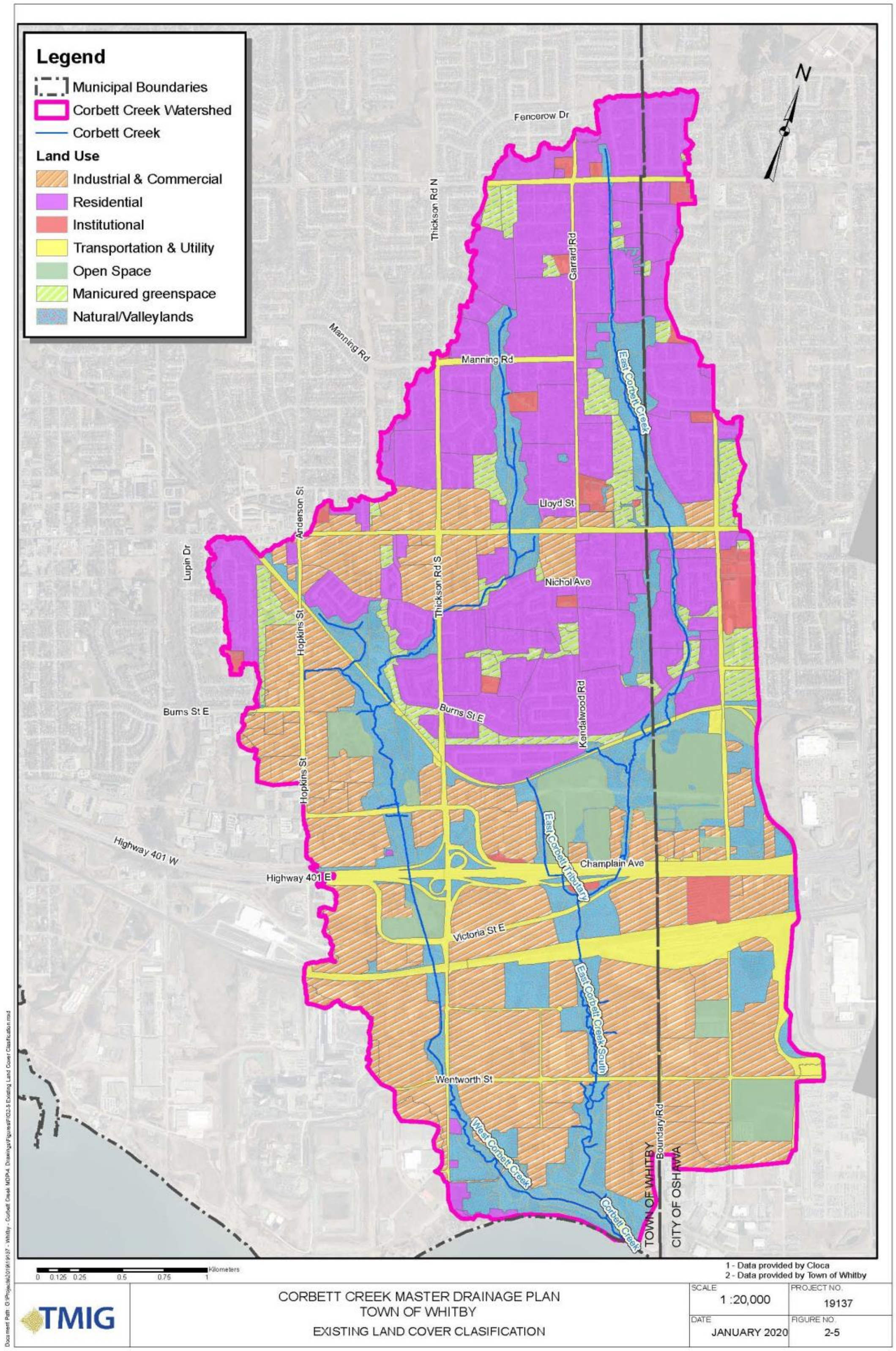


Figure 2-6 Future Land Use

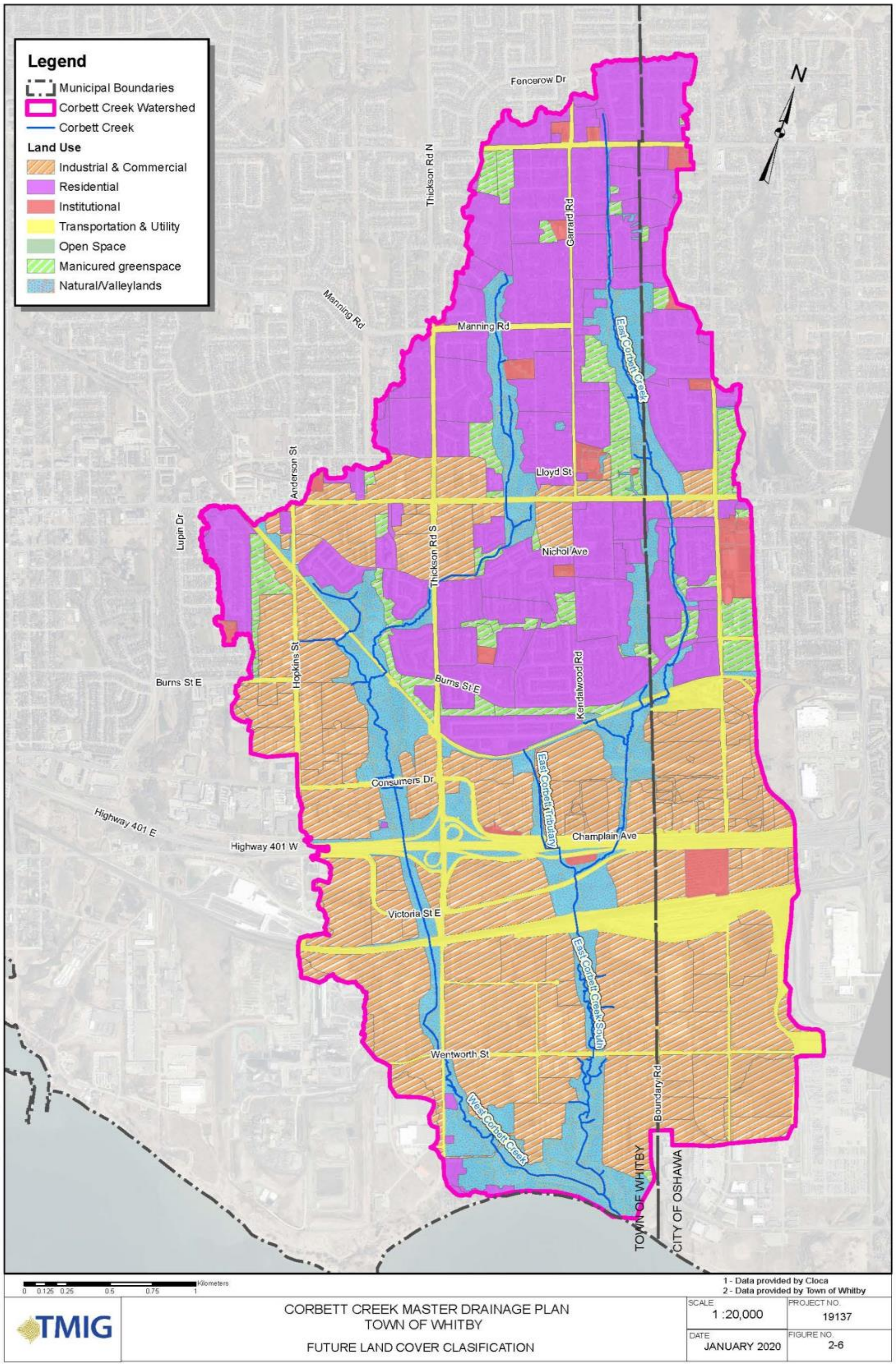


Figure 2-7 Surficial Geology

2.2.5 Groundwater

2.2.5.1 Overview

Hydrostratigraphic units can be subdivided into two distinct groups based on their ability to allow groundwater movement. An aquifer is classically defined as a layer of soil that is permeable enough to permit a usable supply of water to be extracted. An aquitard is a layer of soil that inhibits ground water movement due to its low permeability. In terms of sensitivity to development changes in the watershed, the shallow groundwater flow system is more important than the deep system because it is more vulnerable to human intervention and supports both human and ecologic systems. Shallow groundwater flow within the Corbett Creek watershed is influenced by two key hydrostratigraphic units: the *Newmarket Till Aquitard*, and *Iroquois Plain Shallow Aquifer* comprising sands and silts over clay.

In the northern half of the watershed, where the surficial sands are permeable enough, they form the unconfined *Iroquois Plain Shallow Aquifer*. The high permeability sand and gravel soils at surface form a discontinuous unconfined aquifer, which promotes groundwater flow, recharge and discharge. The water table is typically near surface because the underlying Newmarket Till does not readily permit drainage to depth. Therefore, wetlands and lowland stream headwaters coincide with the Iroquois sands. The low permeability silt and clay plains farther south inhibit both groundwater recharge and discharge. Precipitation and snowmelt in this area runs off the surface directly into stream channels and most groundwater flow at this point enters Lake Ontario directly.

The *Newmarket Aquitard* is a major regional aquitard, given its low hydraulic conductivity (10^{-11} to 10^{-6} m/s, Sharp et al., 1996) and consistent presence throughout the study area. It separates the shallow aquifers from the deep aquifers. Where Newmarket Till is exposed at the surface, such as on the southern portion of the watershed near Lake Ontario, the water table is high within the till because of the poorly drained till soils. In such areas, a well-developed surface drainage network is visible in aerial photographs, and incised surface water channel are present.

2.2.5.2 Groundwater Flow

Water table contours within the study area are expected to subtly reflect the topographic contours in the analysis area, indicating the influence of topography on the shallow groundwater flow system. Regional groundwater flow in the aquifers within the analysis area is south-southeast from the Oak Ridges Moraine towards Lake Ontario, except where major river valleys exist. Locally, groundwater flow paths bend into river valleys and isolated topographic depressions.

Due to poor drainage through the underlying till deposits, shallow perched water table conditions are common within the study area. The water table could be found within 1 m of ground surface depending upon topography.

2.2.5.3 Groundwater Recharge

Recharge is the term used to describe downward flowing groundwater, that is, from the ground surface towards the water table. Of all precipitation that reaches the ground surface, some is lost to evapotranspiration and some runs off the surface directly into streams. The remainder infiltrates into the ground. Recharge areas are important because they replenish the groundwater.

As mentioned, the surficial Iroquois Plain Shallow Aquifer exhibits the greatest rate of groundwater recharge in the analysis area. In the areas of thicker Newmarket Till, runoff exceeds recharge due to these low permeability deposits. Groundwater recharge is not limited to the Iroquois Plain. Topographic highs are generally groundwater recharge zones. For example, groundwater commonly flows slowly downward within ridges between streams and within drumlins. Although groundwater discharge is predominant along the Iroquois shoreline, groundwater flow in the Iroquois Plain Shallow Aquifer is predominantly horizontal due to the Newmarket Aquitard below.

No Significant Groundwater Recharge Areas (SGRAs) (as defined under the Clean Water Act, 2006) were identified within the Corbett Creek Watershed. However, CLOCA identified several high volume recharge areas (HVRAs) within the Corbett Creek Watershed, defined as areas with a recharge greater than or equal to 1.15 mm/year (CTC, 2009).

Ecologically Significant Groundwater Recharge Areas (ESGRAs) have also been identified within the watershed by CLOCA. (**Appendix C**). ESGRAs represent groundwater recharge linkages to ecologically significant features such as coldwater streams and wetlands (CLOCA, 2019). ESGRAs do not necessarily coincide with SGRAs that provide high volumes of recharge to support drinking water systems.

2.2.5.4 Groundwater Discharge

Discharge is defined as upward flowing groundwater that is where the water table intersects the ground surface. Groundwater discharge is important for a variety of reasons. First, it sustains a minimum flow (baseflow) in some streams, commonly even during the dry months of summer. Without groundwater contributions, many fish-bearing streams in the analysis area would dry up periodically throughout the year. Second, it moderates stream temperatures, particularly during hot summer days, and dampens stream temperature fluctuations. Third, groundwater upwelling supports wetland vegetation and animal habitat.

EarthFx (2004) estimates that nearly 90% of the groundwater recharge that occurs between Lake Ontario and the crest of the ORM discharges into stream networks. That study was conducted to the west of this analysis area; however, the geology is very similar and hence the same effect can be expected here.

The headwaters of Corbett Creek originate along breaks in slope within the Iroquois Shoreline physiographic region where high permeability glaciolacustrine sand and silts overlie low permeability Newmarket Till (**Figure 2-7**). Groundwater discharge provides a cold groundwater discharge supported baseflow to these features. According to CLOCA reporting, groundwater discharge areas exist along Corbett Creek that generally correspond with the presence of Iroquois Shoreline deposits. CLOCA has determined through simulations that portions of Corbett Creek are fed by groundwater discharge at rates of up to 5 L/s (CTC Source Protection Committee, 2009). These areas are protected under Section 5 of the Town of Whitby OP.

As Corbett Creek flows over the low permeability tills the watercourses derived much of its water from surface runoff. As such, the surface water temperature and thermal regime increased due to limited moderation by groundwater discharge. The watercourse thermal ratings of Corbett Creek come from the Ministry of Natural Resources and Forestry (MNRF) and provide a preliminary indication of the local groundwater contribution to stream flows. Reaches that provide cold water aquatic habitat likely have a significant baseflow contribution, whereas reaches designated as warm water are likely dominated by surface runoff. This thermal assessment provides further evidence for areas of groundwater discharge. For example, several small streams originate in springs near the Iroquois shoreline and have been defined as “cold water”. Their designation changes to warm water as the decline in cold groundwater volumes eliminates thermal buffering on the clay plain bordering Lake Ontario.

2.2.5.5 Groundwater Supported Wetlands

Some wetlands exist in depressions where surface water becomes trapped due to topography and underlying low permeability sediments. However, many wetlands within the analysis area are associated with areas of groundwater discharge. The high water table and localized groundwater upwelling within the

Iroquois sands provide ideal conditions for wetlands to form. A variety of vegetation species found in such wetlands rely on groundwater, not just as a source of relatively cold water, but also for its particular concentrations of certain minerals. Within the study area, the Corbett Creek Coastal Wetland Complex near Lake Ontario is designated as a Provincially Significant Wetland.

2.2.6 Water Budget

A Geographic Information Systems (GIS) based water budget was completed for the Corbett Creek watershed under existing conditions. This analysis allows for a quantification of groundwater recharge and runoff to provide targets for future stormwater management planning. Water balance calculations used a monthly soil-moisture balance approach (Thornthwaite and Mather, 1957). Details of the water balance methodology and additional discussion on results of the analysis is provided in **Appendix C**.

The estimated water surplus for the total site area is between approximately 370 - 384 mm/year (42% - 44% of the total precipitation), which is consistent with the average surplus calculated over the Credit Valley Watershed, reported as 350 mm/year (CTC, 2009).

The water surplus has two components: a runoff component which is the overland flow when the soil moisture capacity is exceeded, and an infiltration component. Using the method in the MOE SWM Planning and Design Manual (2003) and MOEE (1995) for guidance, it is estimated that approximately 34% (130 mm/year) of the surplus infiltrates, and the remaining 66% (250 mm/year) runs off. This translates to approximately 1,938,915 m^3/year of infiltration and approximately 3,718,730 m^3/year of runoff across the watershed (**Table 2-1**).

For sites with deep water table conditions and high permeability soils, low impact development (LID) practices can significantly improve infiltration and groundwater recharge to maintain the groundwater characteristics of the underlying aquifer. Conversely, for sites with low permeability soils and high water table conditions, the amount of infiltration is limited by the saturated hydraulic conductivity of the soil (i.e., the rate at which water can infiltrate).

Based on the results of the water balance most of the infiltration is expected in the areas associated with coarse grained glaciolacustrine deposits. Infiltration based stormwater management strategies could be effective in areas where infiltration is expected to be high, and which are also outside of the HVA regions. Site specific investigations for local soil and groundwater table conditions must be completed prior to detailed design of development areas. Within areas underlain by low permeability till soils, potentially effective LID measures include infiltration trenches, enhanced swales, bioretention areas. Other factors, such as the depth to the water table, should also be considered when selecting appropriate LID mitigation measures for the site. It is recommended that site-specific investigations to confirm site geology, groundwater conditions, and in-situ soil permeability and hydraulic testing are completed during subsequent stages to assess the feasibility of infiltration LIDs.

Table 2-1 Existing Conditions Water Budget Summary

Total Area (ha)	Potential Infiltration	Potential Runoff
1,400	130.5 mm/year	250.3 mm/year
	1,938,915 m^3/year	3,718,730 m^3/year
	34% of surplus	66% of surplus

2.2.7 Hydrogeology Constraints

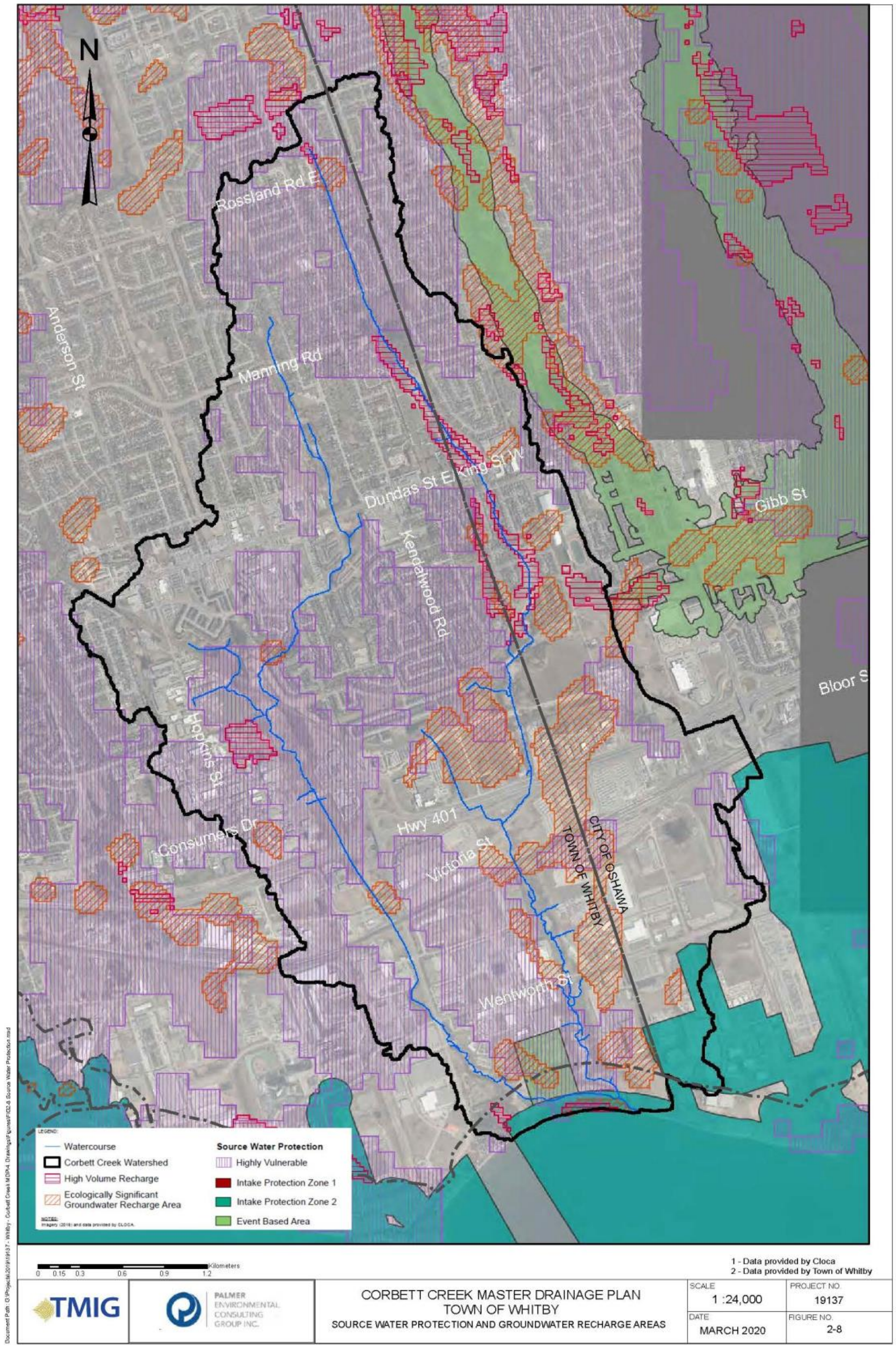
In the context of the watershed's policy framework and based on the results of Palmer's background hydrogeological assessment, a summary discussion of recommendations for hydrogeological constraints is provided in **Table 2-2** and on **Figure 2-8**. These recommendations are based on existing hydrogeologically significant areas as designated through policy and on the identification and protection of environmentally significant and sensitive natural heritage features.

Table 2-2 Preliminary Hydrogeology Constraints

Feature / Area	Data Source	Rationale
Groundwater Recharge Areas ■ HVRAs ■ ESGRAs	■ CLOCA mapping ■ CLOCA reporting ■ GIS-based water balance analysis	Most infiltration is expected in areas corresponding with coarse grained glaciolacustrine deposits. It is recommended that infiltration-based LID strategies should be implemented in regions where infiltration is expected to be high and are outside of HVA designated areas.
Groundwater Discharge Areas	■ CLOCA reporting/analysis	Groundwater discharge areas support coldwater fish communities during summer. Coldwater fish communities are present in Corbett Creek, and therefore

Feature / Area	Data Source	Rationale
		consideration should be given to maintain these conditions.
Central Lake Ontario Source Water Protection – HVA and IPZ/EBA	▪ Source Water Protection Information Atlas (MECP, 2018)	Areas designated as a HVA are susceptible to contamination through the release of pollutants on ground surface. These areas are subject to certain land use policies, including the application and/or handling and storage of road salt. Areas classified as IPZ-2 with a score of 4 and 4.5 are present in the watershed. An IPZ-2 is defined as the area around a surface water intake where water can reach the intake within 2 hours. An Event Based Area (EBA) associated with the Water Pollution Control Plant have been identified. An EBA is an area delineated if modelling indicates that a spill from a specific activity may be transported to an intake and poses a significant threat to drinking water.

Figure 2-8 Source Water Protection and Groundwater Recharge Areas



2.3 Stream Erosion and Fluvial Geomorphology

GEO Morphix completed a desktop and field review of the Corbett Creek watershed to assess existing conditions and identify current or potential creek erosion issues and risks to Town infrastructure and private properties. GEO Morphix's Fluvial Geomorphology and Erosion Hazard Assessment Report is provided in **Appendix D**.

2.3.1 Reach Delineation and Observations

Reaches are generally homogeneous segments of channel used in geomorphological investigations. Each reach is studied semi-independently as it is expected to function in a manner that is at least slightly different from adjoining reaches. More specifically, reaches were defined based on changes in channel planform, channel gradient, physiography, land use and flow (from tributary inputs), soil type and surficial geology, and historical channel modifications. West Corbett Creek was segmented into nine (9) reaches, while East Corbett Creek was segmented 12 reaches (**Figure 2-9**). A summary of the reach characterization and field observations are provided in **Table 2-3** below.

Table 2-3 Reach Defining Characteristics and Key Observations

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
West Corbett Creek	**West Corbett Creek**	**West Corbett Creek**	**West Corbett Creek**	**West Corbett Creek**
WB1	975	Modern alluvial deposits	Marsh, emergent plants, defined flow path.	Defined flow path but no formal channel with defined banks.
WB2	550	Modern alluvial deposits and till	Valley-confined creek, sinuous channel planform, herbaceous riparian vegetation	Channel has meandering planform and migrated into the west valley wall. Erosion was previously addressed through the construction of a

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
				bioengineered slope and channel bank. Bioengineering also previously installed at toe of embankment near the culvert outlet at Wentworth Street and Thickson Road. Two storm sewer outlets near the culvert are partially undermined, suggesting that the channel is downcutting.
WB3	675	Till	Channelized creek, straight channel planform, herbaceous riparian vegetation with shrubs	Previously channelized reach with armouring (likely riprap). Exposed non-woven geotextile throughout reach.
WB4	1980	Fine-textured glaciolacustrine deposits and organic deposits	Marsh, emergent plants, defined flow path	Previously realigned reach between Highway 401 and CPR.
WB5	440	Till	Longitudinally variable channel characteristics (boulder and gravel bed, sinuous and straight channel planform, channelization and natural),	Transitional reach between a marsh channel (WB4) and an armoured channel (WB6).

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
			longitudinally variable riparian vegetation (herbaceous plants, forest)	
WB6	135	Till	Armoured channel (armour stone and gabion), narrow corridor, straight channel planform, herbaceous riparian vegetation and forest	The armoured channel along Thickson Road is in poor condition, with displaced and undermined armour stone and unstable bed. Potential to impact Thickson Road and the residential properties west of the channel.
WB7	375	Till	Armoured channel (gabion), straight channel planform, herbaceous riparian vegetation	In some sections, gabion channel lining has deteriorated exposing the underlying bed material.
WB8	830	Organic deposits	Marsh, emergent plants, defined flow path, online ponds	Online ponds located north and south of Dundas Street.
WB9	785	Till	Unconfined creek, straight channel planform, herbaceous riparian vegetation with shrubs	Channel may have been historically straightened or considered a headwater drainage feature, which often does not have

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
				meandering characteristics.
East Corbett Creek	**East Corbett Creek**	**East Corbett Creek**	**East Corbett Creek**	**East Corbett Creek**
EB1	1170	Modern alluvial deposits	Marsh, emergent plants, defined flow path	Absence of banks and a formal channel.
EB2	780	Modern alluvial deposits	Valley-confined creek, sinuous channel planform, forested riparian zone	Well-developed riffles and pools, frequent knick-points but tree roots effectively prevent headcutting. Banks are generally steep but protected by tree roots or herbaceous plants.
EB3	485	Till	Channelized creek, straight channel planform, herbaceous riparian vegetation	Erosion in the road embankment upstream of the Victoria Street culvert and rip-rap displacement along Victoria Street.
EB4	245	Fine-textured glaciolacustrine deposits	Valley-confined creek, generally straight channel planform, forested riparian zone	Slight meandering planform, with more significant bend near Champlain Avenue that is future potential hazard.
EB5	785	Fine-textured glaciolacustrine deposits	Unconfined creek, straight and low-sinuosity channel planform,	Erosion of outer banks at meander bends and channel migration towards

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
			herbaceous riparian vegetation	railroad embankment. Vertical adjustment also evident from frequent till exposure along base of channel.
EB6	665	Coarse-textured glaciolacustrine deposits	Unconfined creek, straight and low-sinuosity channel planform, herbaceous riparian vegetation	Steep banks and frequent sections of bank that are undercut with slumping.
EB7	560	Coarse-textured glaciolacustrine deposits	Unconfined creek, generally straight channel planform, herbaceous riparian vegetation with trees and shrubs	Unstable channel condition throughout the reach. Exposed concrete pipe encasement on the channel bed upstream of Monahan Avenue. Sediment deposition noted in the form of sand-gravel bars.
EB8	810	Coarse-textured glaciolacustrine deposits	Unconfined creek, generally straight channel planform, herbaceous riparian vegetation with shrubs	Bank failure common due to undermining and till exposures at base of channel.
EB9	550	Coarse-textured glaciolacustrine deposits and till	Unconfined creek, low-sinuosity channel planform, forested riparian zone	Erosion along outer banks, but migration inhibited by dense root network of trees. Sand and gravel deposition on

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
				the bed with large point bars and medial bars.
EB10	350	Till	Valley-confined creek, narrow corridor, low-sinuosity channel planform	Previous erosion protection is in poor condition, especially around the Westwood Road culvert where the bed downstream of the remaining channel protection had degraded and continued progressive loss of protection will result in a perched culvert outlet and scouring of material. The reach has a narrow corridor and relatively high valley walls with residential properties on both sides of the channel. Further degradation of the channel is a potential hazard to the adjacent properties.
EB11	480	Till	Armoured channel (geocell lining), narrow corridor, straight channel planform	The upstream end of the reach is in poor condition. The channel is steep with gabion baskets installed as drop

Reach	Length (m)	Surficial Geology	Characteristics	Key Observations
				structures from the Rossland Road culvert to the bed of the receiving channel, but the gabion baskets have deteriorated and outflanked on the east embankment.
EB12	155	Coarse-textured glaciolacustrine deposits and till	Headwater drainage feature, narrow corridor, straight planform, forested riparian zone	Small woody debris on the bed and uniform boundary material between bed and bank indicating infrequent high flows.

2.3.2 Rapid Geomorphic Assessments

Channel instability was semi-quantified for reaches with largely alluvial channels through the application of the Ontario Ministry of the Environment's Rapid Geomorphic Assessment (RGA) (MOE, 2003). Observations were quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, widening, and planimetric form adjustment. The index produces values that indicate whether the channel is stable/in regime (score less than 0.20), stressed/transitional (score between 0.21 and 0.40), or adjusting (score greater than 0.41). The RGA was developed for application to meandering alluvial channels and is generally not applicable to channels with extensive armouring or certain types of wetland channel.

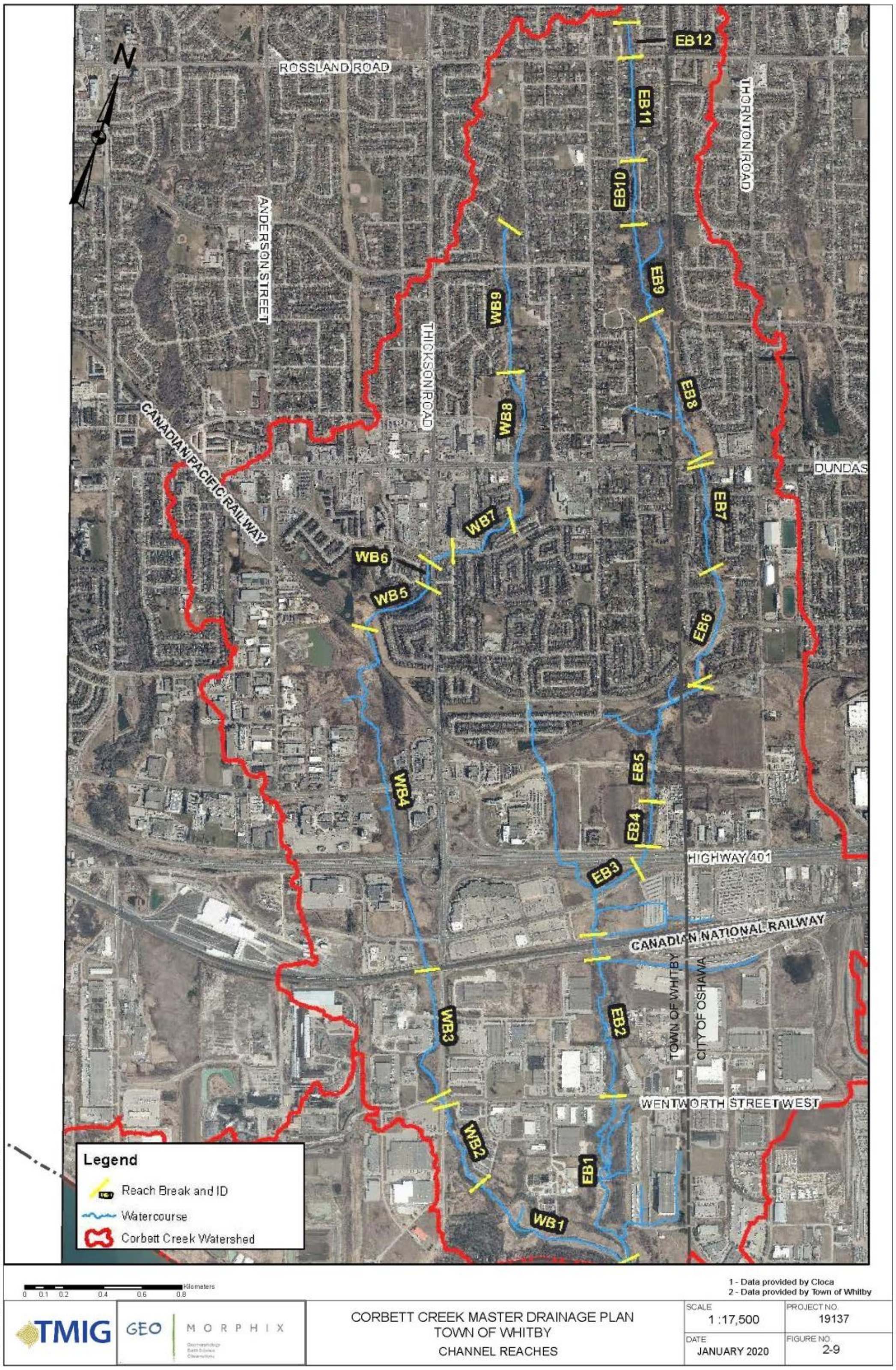
In nine of the 13 reaches that the RGA was applicable, the channel was assessed to be 'in transition' or 'in adjustment'. The results suggest that Corbett Creek, in general, is responding to one or more perturbations to the system, which is not unexpected in an urban environment that has limited stormwater management controls. A potential consequence of a reach 'in transition' or 'in adjustment' in an urban context is the detrimental impacts on adjacent public infrastructure or private properties.

Table 2-4 Rapid Geomorphic Assessment Results

Reach	RGA Score	Condition	Dominant Systematic Adjustment(s)
West Corbett Creek	**West Corbett Creek**	**West Corbett Creek**	**West Corbett Creek**
WB1	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel
WB2	0.22	In transition	Degradation
WB3	0.17	In regime	Widening
WB4	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel
WB5	0.34	In transition	Degradation, widening
WB6	RGA not applicable – Armourstone and gabion-lined channel	RGA not applicable – Armourstone and gabion-lined channel	RGA not applicable – Armourstone and gabion-lined channel
WB7	RGA not applicable – Gabion-lined channel	RGA not applicable – Gabion-lined channel	RGA not applicable – Gabion-lined channel
WB8	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel
WB9	0.12	In regime	Aggradation

Reach	RGA Score	Condition	Dominant Systematic Adjustment(s)
East Corbett Creek	**East Corbett Creek**	**East Corbett Creek**	**East Corbett Creek**
EB1	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel	RGA not applicable – Non-alluvial marsh channel
EB2	0.18	In regime	Widening
EB3	0.24	In transition	Widening
EB4	0.29	In transition	Widening
EB5	0.21	In transition	Aggradation, widening
EB6	0.25	In transition	Aggradation, widening
EB7	0.29	In transition	Aggradation
EB8	0.07	In regime	Degradation
EB9	0.44	In adjustment	Degradation, widening, planform adjustment
EB10	0.34	In transition	Degradation, widening
EB11	RGA not applicable – Geocell-armoured channel	RGA not applicable – Geocell-armoured channel	RGA not applicable – Geocell-armoured channel
EB12	RGA not applicable – Headwater drainage feature	RGA not applicable – Headwater drainage feature	RGA not applicable – Headwater drainage feature

Figure 2-9 Channel Reaches



2.4 Natural Heritage

Palmer completed a desktop ecological review to identify the location, extent, current status, significance, and sensitivity of existing natural resources within the Corbett Creek watershed. The existing conditions assessment memorandum by Palmer is provided in **Appendix E**.

2.4.1 Natural Environment Existing Conditions

2.4.1.1 Aquatic Resources

Corbett Creek supports both warmwater and coolwater fish species. The fish community is varied but comprises mainly members of the Cyprinidae family, namely carps and minnows. Closer to Lake Ontario, there are records of young-of-the-year Northern Pike (*Esox lucius*) and adult Chinook Salmon (*Oncorhynchus tshawytscha*). No provincial or federal species fish Species at Risk (SAR) have been captured in the Corbett Creek watershed. Snapping turtle (*Chelydra serpentine*), a species of Special Concern, have been noted in the Corbett Creek Coastal Wetland near Lake Ontario. The coastal wetland is a drowned river mouth and is monitored as part of the Durham Region Coastal Wetland Monitoring Project (DRCWMP) conducted by CLOCA.

The fish of Corbett Creek and the Corbett Creek Coastal Wetland have been sampled 42 times since 2003 at 17 different sites. Six sites were located in each of East Corbett Creek and West Corbett Creek while the remaining sites were sampled in the Corbett Creek Coastal Wetland. A total of 23 fish species have been caught within the watershed and the wetland (**Table 2-5**).

In East Corbett Creek and West Corbett Creek, the ten combined fish species that have been caught in previous studies are all considered common, tolerant species. In the Corbett Creek Coastal Wetland, most of the 23 fish species captured are common to Lake Ontario. There are several notable species of those observed in the Corbett Creek Coastal Wetland:

- The Logperch, although common in Ontario, is intolerant to environmental perturbations and / or anthropogenic stress.
- The Northern Pike is a cool-water species and its habitat is usually slow, heavily vegetated rivers or the weedy bays of lakes. The Northern Pike spawns in the spring immediately after the ice melts. The breeding grounds include areas that flood only in the spring and early summer and may be dry the remainder of the year. During spawning, Northern Pike swim through

vegetated areas of shallow water, randomly scattering their eggs, which then attach to the vegetation (DFO, 2018).

- Common Carp, Goldfish and Round Goby are non-native fish species. The establishment and spread of non-native species is considered one of the primary causes of the decline of aquatic biodiversity.

  Common Carp are indigenous to Eurasia and have been in Lake Ontario since the late 1800s. Common carp can be an issue due to their large size along with their feeding and spawning actions which can uproot and crush aquatic plants. Plants are the foundation of the marsh ecosystem and the destruction of plants could result in ecosystem collapse.

  Goldfish are often released into ponds, lakes or streams by people who no longer want them. Similar to Common Carp, Goldfish can be an issue due to their feeding habits - they feed mainly on fish eggs, larvae and aquatic plants.

  Round Goby were introduced into Ontario in 1990s and have spread to all five Great Lakes. The concern with Round Gobies is their aggressive eating habits (feed on invertebrates including mussels, and sometimes small fish and fish eggs) and ability to spawn several times each season which has helped them multiply and spread quickly.

Table 2-5 Fish Species Captured in the Corbett Creek Watershed by CLOCA since 2003

Species	East Corbett Creek	West Corbett Creek	Corbett Creek Coastal Wetland
Alewife (*Alosa pseudoharengus*)			X
Banded Killifish (*Fundulus diaphanus*)		X	X
Blacknose Dace (*Rhinichthys obtusus*)	X	X	X
Bluegill			X
Bluntnose Minnow (*Pimephales notatus*)	X	X	X
Brook Stickleback (*Culaea inconstans*)	X	X	X
Brown Bullhead			X

Species	East Corbett Creek	West Corbett Creek	Corbett Creek Coastal Wetland
Common Carp (*Cyprinus carpio*)		X	X
Creek Chub (*Semotilus atromaculatus*)	X	X	X
Emerald Shiner			X
Fathead Minnow (*Pimephales promelas*)	X	X	X
Gizzard Shad (*Dorosoma cepedianum*)			X
Golden Shiner			X
Goldfish (*Carassius auratus*)			X
Largemouth Bass			X
Logperch (*Percina caprodes*)			X
Longnose Dace (*Rhinichthys cataractae*)	X		X
Northern Pike (*Esox lucius*)		X	X
Pumpkinseed (*Lepomis gibbosus*)	X	X	X
Round Goby (*Neogobius melanostomus*)			X
Sunfish species			X
White Sucker (*Catostomus commersonii*)	X	X	X
Yellow Perch			X
Total Number of Species	8	10	23

According to CLOCA's Natural Heritage Aquatic Resources Memo (CLOCA, 2019), the thermal regime of the watershed is coolwater. Water temperature logger data supplied by CLOCA for station TLCE01 indicates that East Corbett Creek is coolwater, while data for station TLCW01 indicates that West Corbett Creek is likely a coolwater system transitioning to a warmwater system (cool-warm). For the seven years of available data, four years were classified as warm water (2005, 2010, 2011, 2012) and three years were classified as cool water (2006, 2009, 2013). Both of these water temperature monitoring sites are at the downstream end of the watershed and there is very limited water temperature data elsewhere in the watershed.

Additional information on the sampling locations and fish species is found in **Appendix E**.

2.4.1.2 Terrestrial Resources

The Corbett Creek Coastal Wetland Complex near Lake Ontario is designated as a Provincially Significant Wetland (PSW). The coastal wetland is approximately 28 ha in size and is home to a variety of fish, amphibians, and benthic invertebrates. The wetland is comprised of 76% marsh and 24% swamp. The wetland periodically closes off from the lake and water levels may differ from Lake Ontario by up to 1 m. The water quality was rated as fair but improving and sediment quality was rated as good (Environment Canada, 2011).

A search of MNRF's Make-a-Map webpage (accessed July 16, 2019) indicates other than the Corbett Creek Coastal Wetland Complex PSW, no other designated areas such as PSW, Areas of Natural and Scientific Interest (ANSI), or Environmentally Sensitive Areas (ESAs) exist within the Corbett Creek watershed. The PSW designation for the Corbett Creek Coastal Wetland Complex extends almost to Wentworth Street along the west tributary and to the railway tracks south of Highway 401 for the east tributary (**Figure 2-11**).

2.4.1.3 Vegetation Communities

Ecological Land Classification (ELC) data from CLOCA outlines the naturalized areas within the Corbett Creek watershed. There are 18 identified different terrestrial and aquatic vegetation community types (**Figure 2-10**). The wetland communities include Meadow Marsh (MAM), Shallow Marsh (MAS), Open Aquatic (OAO), Shallow Aquatic (SAS) as well as Deciduous, Mixed and Thicket Swamps (SWD, SWM, and SWT). The majority of ELC communities are located along the watercourse riparian zone. There are several areas of wetland (marsh / swamp) within the watershed, particularly along West Corbett Creek.

2.4.1.4 Wildlife

Given the urban environment of the watershed, wildlife habitat opportunities within the study area likely include common, generalist, and urban-adapted species (e.g. urban species of birds, Raccoon (*Procyon lotor*), Skunk (*Mephitis mepthitis*) and Grey Squirrel (*Sciurus carolinensis*)).

2.4.2 Species at Risk (SAR)

Information obtained from the Ministry of Natural Resources and Forestry (MNRF) regarding Species at Risk (SAR) indicates 11 SAR records for areas within or in the general vicinity of the watershed. Information regarding these SAR records are summarized in **Table 2-6**. A Common Nighthawk (*Chordeiles minor*), classified as Special Concern by the Province but as federal SAR (Threatened), was reported at the Corbett Creek Coastal Wetland in 2006 (Environment Canada, 2011). DFO aquatic SAR online mapping indicated that there were no aquatic species at risk in the Corbett Creek watershed.

Protection provisions for species and their habitat within the *Endangered Species Act* (ESA) apply to those species listed as Endangered or Threatened on the SAR in Ontario list. The habitats of Species of Special Concern may be protected under the Provincial Policy Statement through designation of significant wildlife habitat.

Table 2-6 Habitat Screening for MNRF SAR Records

Species Grouping	Species	Habitat Requirement Overview
Birds	Bobolink (Threatened)	Bobolink occur and nest mainly in hayfields with the spread of agriculture in its range. Microhabitat requirements include moderate litter depth, high grass-to-legume ratios, and a high proportion of forb cover (e.g., clover). Birds avoid nesting in areas with dense shrub cover and deep litter layer (> 1-2 cm).
	Eastern Meadowlark (Threatened)	The Eastern Meadowlark is most common in native grasslands, pastures and savannahs. It also uses a wide variety of other anthropogenic grassland habitats, including hayfields, weedy meadows, young orchards, golf courses and herbaceous fencerows. Eastern Meadowlarks occasionally nest in row crop fields such as corn and soybean, but these crops are considered low-quality habitat. In hayfields, it prefers older sites due to the availability of short, sparse, patchy stands of grass-dominated vegetation.

Species Grouping	Species	Habitat Requirement Overview
	Eastern Wood-pewee (Special Concern)	Eastern Wood-pewee is mostly associated with the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in forest stands of intermediate age and in mature stands with little understory vegetation.
	Henslow's Sparrow (Endangered)	The Henslow's Sparrow is an area-sensitive grassland obligate; it requires grassland habitat and occurs more frequently and at higher densities in large patches of suitable habitat. In Ontario, Henslow's Sparrow colonies have been located in abandoned fields, lightly grazed pasture, and wet meadows.
	Least Bittern (Threatened)	The Least Bittern breeds strictly in marshes dominated by emergent vegetation surrounded by areas of open water. Most breeding grounds in Canada are dominated by cattails but breeding also occurs in areas with other robust emergent plants and in shrubby swamps. The nests are almost always within 10 m of open water. Access to clear water is essential for the birds to see their prey. This small heron prefers large marshes that have relatively stable water levels throughout the nesting period.
	Loggerhead Shrike (Endangered)	Loggerhead Shrike breeding habitat is characterized by open areas dominated by grasses and/or forbs, interspersed with scattered shrubs or trees and bare ground. Suitable habitat includes pasture, old fields, prairie, savannah, pinyon-juniper woodland, shrub-steppe and alvar. Territory size ranges from 2.7 to 47.0 ha and correlates with the abundance of trees and shrubs – increasing perch density will decrease territory size. Tree and shrub species that are relatively dense and extensively branched are preferred as nest sites.

Species Grouping	Species	Habitat Requirement Overview
	Northern Bobwhite (Endangered)	The Northern Bobwhite requires open habitats that provide a mixture of grasslands, croplands and brush. In Ontario, this species is more common to cropland than to natural grasslands. In the summertime, it requires grasslands to build nests, feed, and rest.
Insects	Monarch (Special Concern)	Monarchs in Canada exist primarily wherever milkweed (*Asclepias*) and wildflowers (such as goldenrod, asters, and Purple Loosestrife) exist. This includes abandoned farmland, along roadsides, and other open spaces where these plants grow.
Vascular Plants	Butternut (Endangered)	Butternut grows best on rich, moist, well-drained loams often found on stream bank sites but may be found on well-drained gravelly sites, especially those of limestone origin. It is seldom found on dry, compact, or infertile soils. Common associates include basswood, black cherry, beech, black walnut, elm, hemlock, hickory, oak, red maple, sugar maple, yellow poplar (tulip-tree), white ash and yellow birch.
	Red Mulberry (Endangered)	In Ontario, Red Mulberry occurs in both sandy soils of forested sites near Lake Erie in Hackberry-Red Cedar-Sugar Maple woodlands and calcareous soils in Sugar Maple-Basswood-White Ash-Red Oak-Hackberry-Ironwood woodlands of the Niagara Escarpment and Erie Islands. Red Mulberry tends to occur in moist forest habitats, such as slopes and benches in the Niagara Escarpment where moisture levels remain high, in floodplain and river valleys, and on swales of the sandspits of Point Pelee, Fish Point on Pelee Island and Pointe aux Pins at Rondeau Provincial Park.
Reptiles	Snapping Turtle (Special Concern)	Snapping turtles spend most of their lives in water. They prefer shallow waters so they can hide under the soft mud and leaf litter, with only their noses exposed to the surface to breathe. During the nesting

Species Grouping	Species	Habitat Requirement Overview
		season, from early to mid-summer, females travel overland in search of a suitable nesting site, usually gravelly or sandy areas along streams. Snapping turtles often take advantage of man-made structures for nest sites, including roads (especially gravel shoulders), dams and aggregate pits.

2.4.3 Environmental Policy

Environmental components within planning policies applicable to the Corbett Creek watershed are summarized in **Section 2.1**, which include official plans for the Region of Durham, Town of Whitby, and City of Oshawa. CLOCA's regulations and policies are also discussed. In additional to those polices, the *Endangered Species Act* (2007, updated through the *More Homes, More Choice Act*, 2019) and the *Migratory Birds Convention Act* (1994) are also relevant where applicable.

Species designated as Threatened or Endangered by the Committee on the Status of Species at Risk in Ontario (COSSARO), other known as Species at Risk in Ontario (SARO), and their habitats (e.g. areas essential for breeding, rearing, feeding, hibernation and migration) are afforded legal protection under the *Endangered Species Act* (ESA).

The *Migratory Birds Convention Act* (1994) and Migratory Birds Regulations (MBR) (2014) protect most species of migratory birds and their nests and eggs anywhere they are found in Canada. General prohibitions under the MBCA and MBR protect migratory birds, their nests, and eggs, and prohibit the deposition of harmful substances in waters and areas frequented by them. The MBR includes an additional prohibition against incidental take, which is the inadvertent harming or destruction of birds, nests or eggs.

2.4.4 Environmental Constraints

The preliminary environmental constraints were identified based on existing natural heritage systems designated through policy and the protection of environmentally significant and sensitive features (**Table 2-7** and **Figure 2-11**). Further site-level investigation for individual projects may be required to confirm the presence of SAR and/or SAR habitat within the Corbett Creek Watershed as specific project areas are identified. Vegetation communities require further site-level study as well, to confirm community boundaries (e.g., wetland and woodland limits) and determine appropriate protection and/or mitigation measures based on an assessment of feature significance.

Table 2-7 Preliminary Environmental Constraints

Natural Environmental Feature / Area	Data Source	Rationale
Provincially Significant Wetland (PSW)	■ LIO Mapping	PSW are those areas identified by the province as being the most valuable, as determined by the application of the Ontario Wetland Evaluation System (OWES). Protection of PSWs is afforded by the Provincial Policy Statement, which precludes development and site alteration within PSWs with potential exceptions for infrastructure.
Natural Heritage Systems designated through Municipal policy	■ Town of Whitby Official Plan Schedule ■ City of Oshawa Official Plan Schedule	These are designated areas that contains ecological features and functions, identified for protection by the Town of Whitby and City of Oshawa. These areas are subject to the policies of the Municipal Official Plans.
Conservation Authority (CA) Regulated Area and wetlands	■ CLOCA Regulated Area Mapping ■ ELC mapping (CLOCA)	CA Regulated Areas provide safeguard for watershed health by preventing pollution and destruction of ecologically sensitive areas such as significant natural features and areas, wetlands, shorelines, valleylands and watercourses. Small wetland pockets that occur outside of CA Regulated Area, but identified through ELC, have been included in this category as they are subject to O. Reg 42/06 even if they are not mapped. The Regulated Area does not represent the development limit, but development within regulated areas does need to take into account possible constraints from natural

Natural Environmental Feature / Area	Data Source	Rationale
		hazards or features. Development within CLOCA Regulated Areas will require a permit under Ontario Regulation 42/06.
Forest, Woodland and Plantation Communities	▪ ELC mapping (CLOCA)	Forest, woodland and plantation communities, identified through ELC, may contain features and functions which support broader designated natural heritage systems. These communities require further study in order to determine appropriate protection measures based on an assessment of feature significance
Cultural Thicket and Meadows	▪ ELC mapping (CLOCA)	These areas are identified for their potential provision of habitat for Species at Risk birds and support function for woodlands or wetlands of the NHS. These communities require further study in order to determine appropriate protection measures based on a screening of potential habitat

Figure 2-10 ELC Vegetation Community Mapping

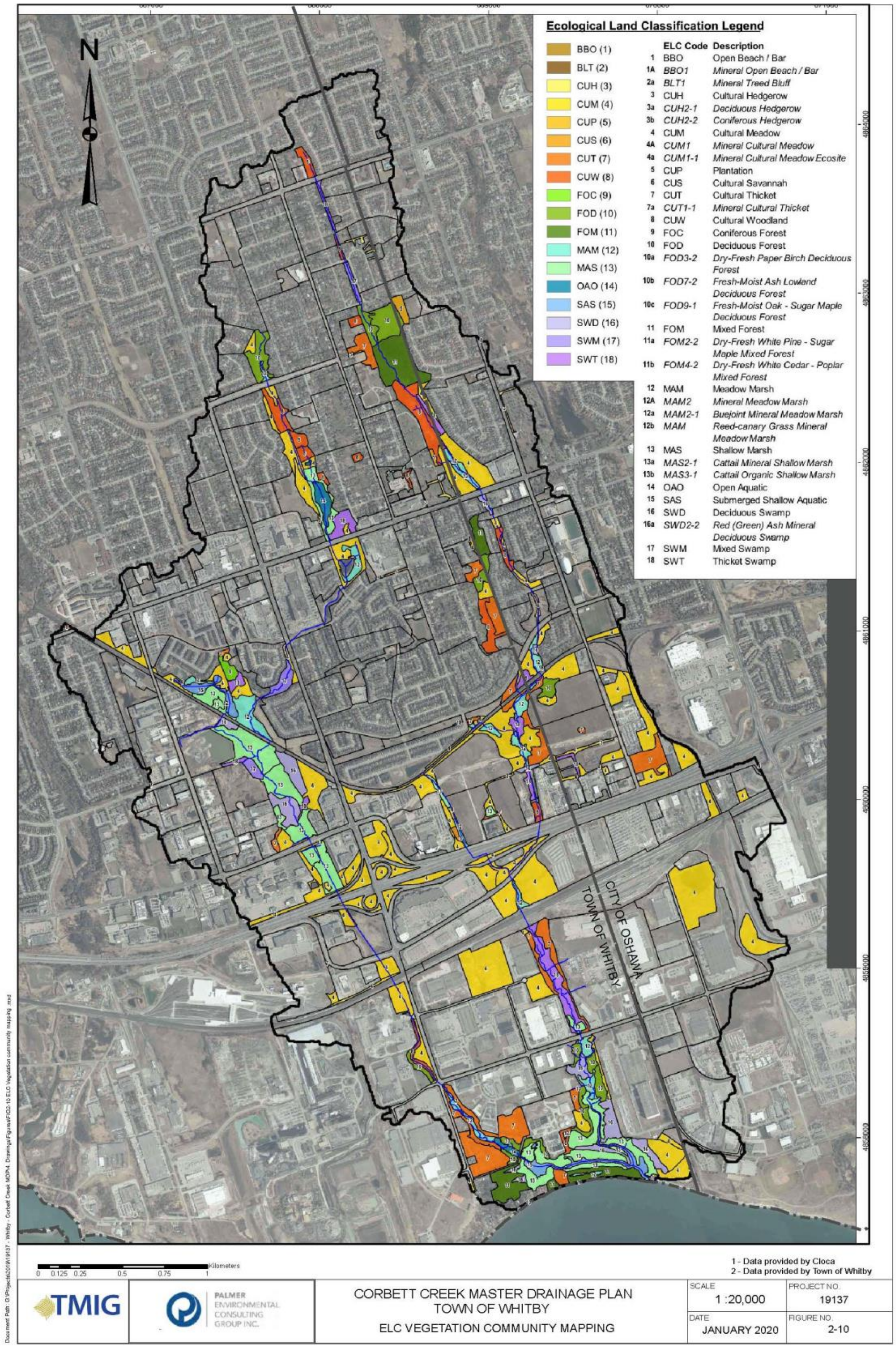
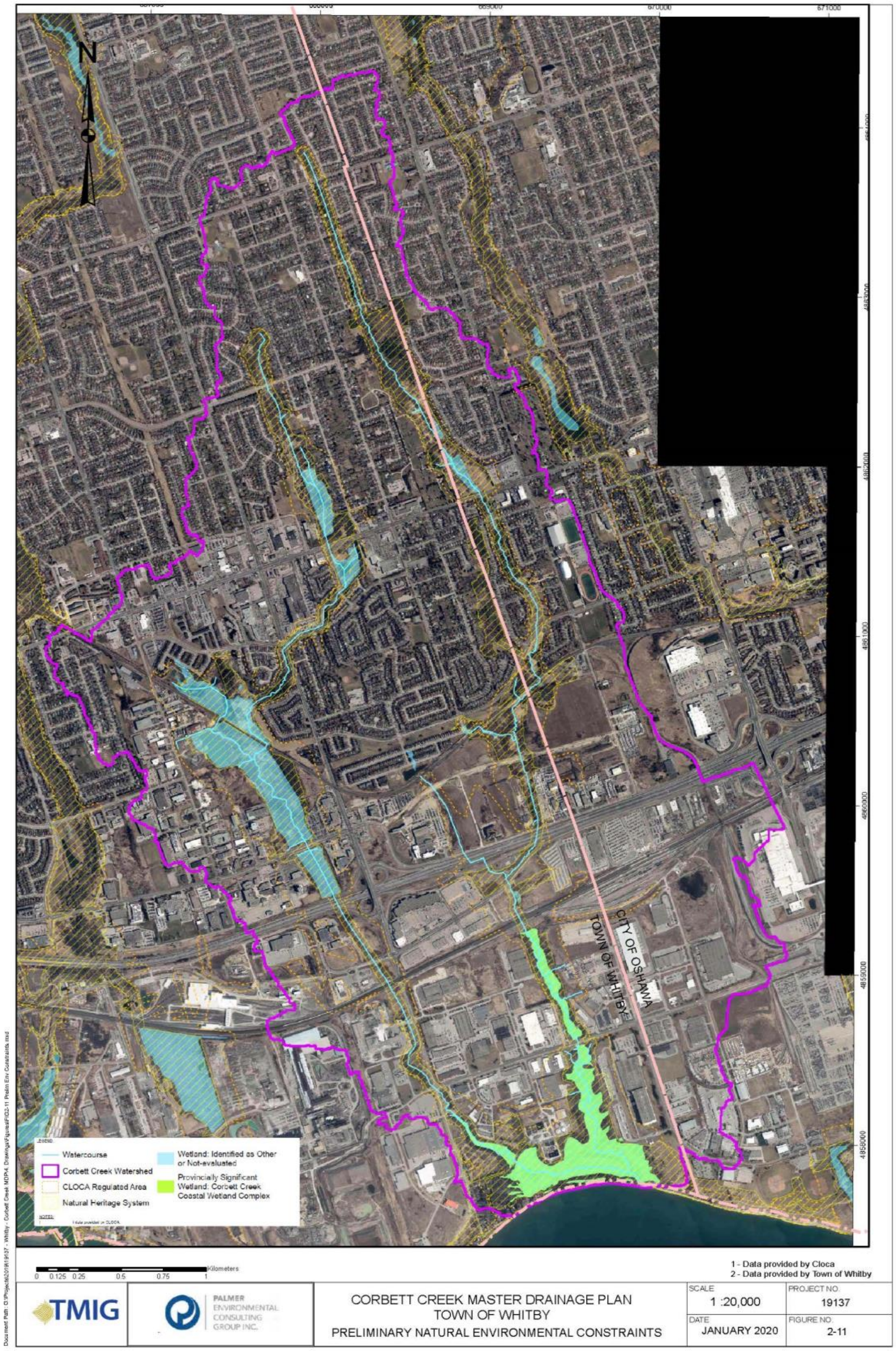


Figure 2-11 Preliminary Natural Environmental Constraints



2.5 Cultural Heritage

2.5.1 Archaeology

The majority of the Corbett Creek watershed has been previously disturbed for development where past construction would have resulted in damage to the integrity of any archaeological resources which may have been present in those areas. However, in and around the Corbett Creek valley, there remains archaeological potential due to its proximity to water.

Archaeological Assessments (AA) are required for any proposed projects identified in this study that are located within previously undisturbed areas along the Corbett Creek valley corridors.

2.5.2 Built Heritage

Based on a review of the Town of Whitby's Heritage Register (Town of Whitby, 2017), there are four (4) buildings within the Corbett Creek watershed that are either Designated Properties under Part IV of the Ontario Heritage Act or non-designated properties that could have cultural value or interested. The single Designated Property is located at 1601 Hopkins Street, within the West Corbett Creek watershed. The listed (non-designated properties) are at 220 Crystal Beach Boulevard, 1750 Dundas Street East and 1830 Rossland Road East.

2.5.3 Recreation

There are several parks in the study area, including Blue Grass Meadows Park located adjacent to West Corbett Creek, north of Dundas Street, and Limerick Park within the East Corbett Creek valley at Burns Street in the City of Oshawa. There are several other parks distributed in residential areas across the watershed. There are no Town of Whitby community centres or recreation centres located within the study area. In the City of Oshawa, the Civic Recreation Complex on Thornton Road is within the study area.

The existing cycling and trail system is generally limited to the Waterfront Trail near Lake Ontario and the trails in and around Blue Grass Meadows Park adjacent to West Corbett Creek. The Waterfront Trail connects to parks to the east and west of the study area. Other trails are found within parks in residential areas. The Town of Whitby Cycling and Leisure Trails Master Plan (IBI Group, 2010) recommends on road bike lanes, shared-use bike lanes, and boulevard multi-use paths along several roadways in the watershed. A multi-use trail is also recommended from Burns Street near West Corbett Creek, which would cross the valley before continuing north through the Town. The Cycling and Leisure Trails Master Plan does not include recommendations for major recreational trails along the Corbett Creek valley corridor. A figure of the recommendations is provided in **Appendix B**.

2.6 Engineering Environment

2.6.1 Hydrologic Modelling

2.6.1.1 Overview

The Corbett Creek watershed has a total drainage area of approximately 1,466 ha (14.66 km^2), which can generally be divided into two watersheds, East Corbett Creek (823 ha) and West Corbett Creek (643 ha) that confluence near the outlet of the watershed at Lake Ontario. The watershed is nearly fully developed and has been historically altered due to agricultural activity and the development of residential, commercial, and industrial areas, as well as major transportation infrastructure such as railways and highways.

The most recent hydrologic modelling for the entire watershed was completed in 2006 during the floodline mapping update (Greck, 2006), referred to herein as the '2006 hydrologic model'. Visual OTTHYMO (Version 2) was used to model existing and future land use scenarios for floodplain mapping.

A new hydrologic model for the watershed was developed for this MDP using Visual OTTHYMO (Version 5). Overall, the purpose of the hydrologic model is to characterize the existing hydrologic conditions in the watershed for a range of rainfall events, including the Regulatory storm event for floodplain mapping. The model was also used to assess the impact of future development and alternative watershed management strategies proposed in this MDP. This recognizes that the model is aimed towards assessing watershed-level impacts and thus excludes major/minor system drainage splits, private stormwater management ponds, and other local or site-level specific information.

The model was developed in consultation with CLOCA using methodology consistent with recent hydrologic modelling updates for several of CLOCA's watersheds, including the adjacent Pringle Creek and Oshawa Creek watersheds. In the following sections discuss the hydrologic modelling scenarios, subcatchment delineation and parameters, rainfall event selection, and results for existing conditions.

2.6.1.2 Hydrologic Modelling Scenarios

The hydrologic model included the following scenarios to assess the MDP alternative solutions and complete floodplain mapping:

- Existing Conditions (2-year to 100-year) – The existing land cover database was used and with average antecedent moisture condition (AMC II). The antecedent moisture condition is an approximation of the level of moisture within the soil, where higher moisture content increases the volume of runoff in the model simulation.
- Existing Conditions Regional (Hurricane Hazel) – The existing land cover database was used with saturated antecedent moisture condition (AMC III), consistent with modelling Hurricane Hazel as the rainfall event.
- Existing Conditions with SWM (2-year to 100-year) – The existing conditions scenario was modelled with the single quantity control SWM facility at the Sunrise Park subdivision (southwest of Thickson Road and Burns Street) (Town of Whitby ID: PD18-01). Private on-site quantity controls or informal storage areas in the floodplain were not considered for this planning scale model.
- Future Conditions Regional (Hurricane Hazel) – The existing conditions scenario was modified to include future land use cover based on the Town of Whitby and City of Oshawa Official Plans.
- Future Climate (2-year to 100-year) – The existing conditions scenario was modelled with rainfall events simulating future climate conditions. Additional information is provided in **Section 2.6.1.5**.

2.6.1.3 Subcatchment Delineation

The subcatchment areas delineated in the 2006 hydrologic model were used as the basis for the updated subcatchment delineation in the MDP hydrologic model. Subcatchment boundaries were refined using topographic information (LiDAR), aerial imagery, and storm sewer information from the Town of Whitby and CLOCA, as well as the watershed boundary delineated as part of the recent Pringle Creek MDP Update (Candevcon, 2018). The subcatchment areas are shown on **Figure 2-12**.

In general, the updated subcatchment boundaries are similar to the 2006 hydrologic model with the following updates / refinements:

- The west watershed boundary was updated to match the recently updated Pringle Creek watershed boundary for the Pringle MDP Update hydrologic update.

- The upstream-most subcatchment of East Corbett Creek (Subcatchment ID: 100) was updated to reflect the subdivision development since the 2006 hydrologic model. In this MDP hydrologic model, only the major flows were considered in the catchment delineation.
- Subcatchment boundaries internal to the Corbett Creek watershed were updated using LiDAR topography data and storm sewer data.
- Large subcatchments were divided to maintain relatively similar area discretization among all subcatchment areas.
- Subcatchments were delineated to consider the recent infrastructure works, such as the construction of the Consumers Drive Extension (Stellar Drive).

2.6.1.4 Modelling Parameters

The hydrologic modelling parameters were generated using currently available data from the Town of Whitby and CLOCA GIS databases, LiDAR topography and other applicable data. The standard parameter values were selected in consultation with CLOCA, to maintain consistency with recent hydrologic model updates for the Pringle Creek, Lynde Creek and Oshawa Creek watersheds. A complete summary of hydrological modelling parameters is provided in **Appendix F**. Descriptions of key parameters are as follows:

- Imperviousness – The percent imperviousness for each subcatchment area was determined using CLOCA's land cover classification (GIS database) to calculate an area-weighted average for total imperviousness (T_{imp}) and directly connected imperviousness (X_{imp}). The GIS database includes ten categories of land cover, each with an assigned T_{imp} and X_{imp}.
- Curve Number – The Curve Number (CN) is a measure of runoff volume potential from a subcatchment area, as assigned by soil type, land use, and antecedent moisture condition. The CN assigned to each subcatchment area was calculated as an area-weighted average of soil type and land use. The CN values were modified for AMC III for the Regional Storm scenarios.
- Initial Abstraction – The initial abstraction (I_a) accounts for the interception and storage of rainfall during the beginning of storm events before runoff is produced. The primary factors influencing initial abstraction are the soil type, vegetative cover, and surface depression storage. The I_a for each subcatchment area was determined through an area-weighted average of I_a values for each land cover category.
- Time to Peak – The time to peak (T_p) represents the time from the beginning of rainfall to the peak of the runoff hydrograph, and is a parameter for non-developed subcatchments areas. In the Corbett Creek hydrologic model, only

Subcatchment Area 107 is modelled as non-developed in existing conditions. The Airport Method was used to calculate the T_p.

- Channel Routing – The hydraulic characteristics of the watercourses, including cross-section, slope and length were measured using LiDAR topography to represent channel routing (i.e., peak flow attenuation in the channel) in the hydrologic model.
- Storage – In the modelling scenarios that include storage, the single existing SWM pond with quantity control was modelled based on the storage / discharge relationship from the facility's design report. There is also informal quantity storage areas upstream of rail berms.

  Storage upstream of the CNR culverts for West Corbett Creek and East Corbett Creek was simulated due to the watershed scale impact of those informal storage areas on upstream flood levels. These storage areas were estimated using a storage-discharge rating curve developed with LiDAR topography and HEC-RAS. Hydrologic flow rates for a range of storm events from the hydrology model (2-year through 100-year and Regional storms) were modelled in HEC-RAS to determine the surface water elevation upstream of the CNR for each storm event. The surface water elevation corresponded to a storage volume estimated with the LiDAR surface. This storage-discharge relationship was inputted to the hydrology model to simulate the storage effects of the CNR culvert on water levels at the CNR to provide starting water surface elevations in the hydraulic model. Routed peak flow rates were not used downstream of the CNR for floodplain modelling.

2.6.1.5 Rainfall

The hydrologic model simulated the 12-hour Chicago distribution and 12-hour Soil Conservation Service (SCS) distribution to compare the peak flow results for the scenarios modelling 2-year through 100-year rainfall. The intensity-duration-frequency (IDF) parameters from the Toronto City Station (formerly Toronto Bloor Street Station) were used for the model's rainfall event. The Chicago rainfall distribution with a 12-hour storm duration was selected as the storm event for 2-year through 100-year scenarios over the SCS distribution. The Chicago distribution provided higher peak flow rate results compared to the SCS distribution, which provides conservatism and also better reflects the urban nature of the watershed. This is consistent with recent modelling completed for the neighbouring Pringle Creek, Oshawa Creek and Lynde Creek watersheds.

The 12 hour rainfall duration was selected to reflect a model simulation period that is long enough to generate 95% of the maximum peak flow rate. The hydrologic model was simulated with a uniform rainfall input of 25 mm/hr for 36 hours to determine the peak flow response over the event duration, where 12 hours was recognized as the duration when the runoff hydrograph's rate of increase had slowed and the 95% of the maximum peak flow rate was reached.

The Regulatory flood for the Corbett Creek watershed is the greater of the flood produced by Hurricane Hazel (Regional Storm) or the 100-year storm, based on the MNR Technical Guide for River & Stream Systems: Flooding Hazard Limit (MNR, 2002). Thus, Hurricane Hazel was modelled in the Regional storm scenario. Areal reduction was not applied to Hurricane Hazel due to the small size (less than 25 km^2) of the watershed.

2.6.1.6 Existing Conditions Peak Flow

The modelled existing conditions peak flow for key flow nodes at East and West Corbett Creek are presented in **Table 2-8** and **Table 2-9**, respectively. Flow nodes are shown on **Figure 2-12**. Full hydrologic modelling results at all flow nodes is provided in **Appendix F**.

Due to the lack of stream flow gauging data in the watershed, the hydrologic model was not calibrated. With that, the parameters selected for the model are generally conservative and also consistent with planning level hydrology modelling for adjacent watersheds (Pringle Creek, Lynde Creek and Oshawa Creek), which also have limited data for calibration.

The 2006 hydrologic model results were compared to the MDP hydrologic model, noting that the 2006 model used a 4-hour Chicago design storm for the 2-year through 100-year return periods (compared to the 12-hour Chicago design storm in the MDP model). The existing conditions MDP hydrologic model results were compared to 2006 future conditions model results, due to high level of urbanization in current conditions that are more similar to conditions of the 2006 future conditions scenario.

The MDP hydrologic model results had some inconsistency with the 2006 hydrologic model, mainly for the 2-year through 100-year storm events. However, there was greater consistency for the Regional Storm between the two models. The difference in results can be attributable to the rainfall duration (i.e., 4 hour vs 12 hour Chicago storm distributions), subcatchment delineation and channel routing parameters between the two models.

Note that the MDP hydrologic model updated and refined the subcatchment delineation and discretization and channel routing parameters with LiDAR topography. The MDP hydrologic model results on a flow per area basis are similar between East and West Corbett Creek, which reflects similarities in watershed characteristics between the two branches of Corbett Creek.

2.6.1.7 Future Conditions Peak Flow

A future conditions scenario was modelled to consider future land cover in the watershed with respect to the Regional storm event and its impact on floodplain mapping. To complete this scenario, the existing conditions land cover GIS layer was modified to reflect the Town of Whitby and City of Oshawa Official Plans, which consisted of modifying the remaining undeveloped sites in the watershed to urban residential or industrial commercial land cover. Undeveloped areas are mainly scattered across the industrial and commercial areas of the watershed south of the CPR and represent about 8% of total watershed area. There are no large greenfield areas in the watershed.

Regional storm event peak flow rates for the future conditions scenario for East and West Corbett Creek are presented in **Table 2-8** and **Table 2-9**, respectively. The future conditions Regional storm event peak flow rates were very similar to existing conditions (difference of about 1% or less). This is due to minimal land use changes in future conditions compared to existing conditions and the timing of hydrograph peaks. The location of the land use changes (mainly in downstream areas of the watershed) had peak flows occur before the peak flow in the main tributaries, and thus the model results showed negligible impact of future land use changes.

Note that the 2-year to 100-year storm events were not modelled under future conditions because undeveloped sites in the watershed are small and isolated, and would be developed with on-site quantity controls quantity to match existing conditions peak flow rates. On a planning level hydrologic model, there would not be an appreciable benefit to model private on-site controls, which an approach consistent with the existing conditions scenario.

Overall, results from the future conditions scenario were not considered for the flood plain mapping and evaluation of alternatives for the MDP due to the minimal difference in results compared to the existing conditions scenario.

Table 2-8 Hydrology Model Output – East Corbett Creek

Storm Event	**Peak Flow Rate (m^3/s) at E3** **King Street** **(213 ha)** (2006 hydrologic model results – future conditions – in parentheses and italics)	**Peak Flow Rates (m^3/s) at E4** **CPR** **(296 ha)** (2006 hydrologic model results – future conditions – in parentheses and italics)	**Peak Flow Rates (m^3/s) at E6** **Highway 401** **(428 ha)** (2006 hydrologic model results – future conditions – in parentheses and italics)	**Peak Flow Rates (m^3/s) at E9** **CNR** **(580 ha)** (2006 hydrologic model results – future conditions – in parentheses and italics)	**Peak Flow Rates (m^3/s) at E11** **Outlet** **(823 ha)** (2006 hydrologic model results – future conditions – in parentheses and italics)
2 Year	6.4 *(7.9)*	7.5 *(8.1)*	10.2 *(13.1)*	12.9 *(27.7)*	13.1 *(25.0)*
5 Year	9.3 *(11.9)*	11.9 *(12.7)*	16.2 *(18.9)*	21.6 *(41.3)*	21.1 *(37.6)*
10 Year	12.0 *(15.2)*	15.4 *(16.0)*	21.0 *(22.8)*	27.7 *(49.9)*	27.2 *(46.8)*
25 Year	15.7 *(19.0)*	18.7 *(20.6)*	26.2 *(27.9)*	34.8 *(60.9)*	35.5 *(60.0)*
50 Year	18.8 *(21.9)*	22.4 *(24.0)*	31.0 *(31.9)*	41.5 *(69.4)*	41.7 *(69.4)*
100 Year	22.5 *(25.7)*	26.1 *(29.1)*	36.0 *(41.5)*	48.9 *(83.3)*	49.0 *(81.0)*
Regional	26.3 *(29.9)*	34.3 *(42.0)*	49.6 *(49.8)*	68.0 *(65.6)*	90.7 *(93.8)*
Regional (Future)	26.3 *(29.9)*	34.3 *(42.0)*	49.6 *(49.8)*	68.8 *(65.6)*	90.9 *(93.8)*

Table 2-9 Hydrology Model Output – West Corbett Creek

Storm Event	**Peak Flow Rates (m^3/s) at W2** **Dundas Street** **(110 ha)** (For comparison, 2006 hydrologic model results, future conditions, in parentheses and italics)	**Peak Flow Rates (m^3/s) at W5** **CPR** **(250 ha)** (For comparison, 2006 hydrologic model results, future conditions, in parentheses and italics)	**Peak Flow Rates (m^3/s) at W9** **Highway 401** **(475 ha)** (For comparison, 2006 hydrologic model results, future conditions, in parentheses and italics)	**Peak Flow Rates (m^3/s) at W10** **CNR** **(525 ha)** (For comparison, 2006 hydrologic model results, future conditions, in parentheses and italics)	**Peak Flow Rates (m^3/s) at W12** **Outlet** **(643 ha)** (For comparison, 2006 hydrologic model results, future conditions, in parentheses and italics)
2 Year	3.0 *(3.8)*	10.3 *(11.9)*	12.9 *(7.7)*	12.7 *(10.8)*	11.9 *(7.8)*
5 Year	4.7 *(5.6)*	16.3 *(18.2)*	21.1 *(11.8)*	20.2 *(15.7)*	18.6 *(12.2)*
10 Year	6.1 *(6.8)*	20.6 *(23.1)*	27.8 *(15.1)*	26.2 *(19.7)*	23.8 *(15.4)*
25 Year	8.7 *(9.4)*	28.1 *(30.1)*	37.2 *(19.4)*	35.4 *(24.3)*	32.3 *(19.7)*
50 Year	10.3 *(10.8)*	32.7 *(35.2)*	43.2 *(23.0)*	41.4 *(27.9)*	38.0 *(23.2)*
100 Year	12.2 *(13.1)*	37.8 *(44.8)*	50.6 *(27.1)*	48.1 *(33.5)*	44.6 *(27.0)*
Regional	13.4 *(13.8)*	31.8 *(36.7)*	57.7 *(48.4)*	62.1 *(53.1)*	72.3 *(58.8)*
Regional (Future)	13.4 *(13.8)*	31.7 *(36.7)*	57.8 *(48.4)*	62.2 *(53.1)*	72.4 *(58.8)*

Figure 2-12 Hydrologic Subcatchment Areas

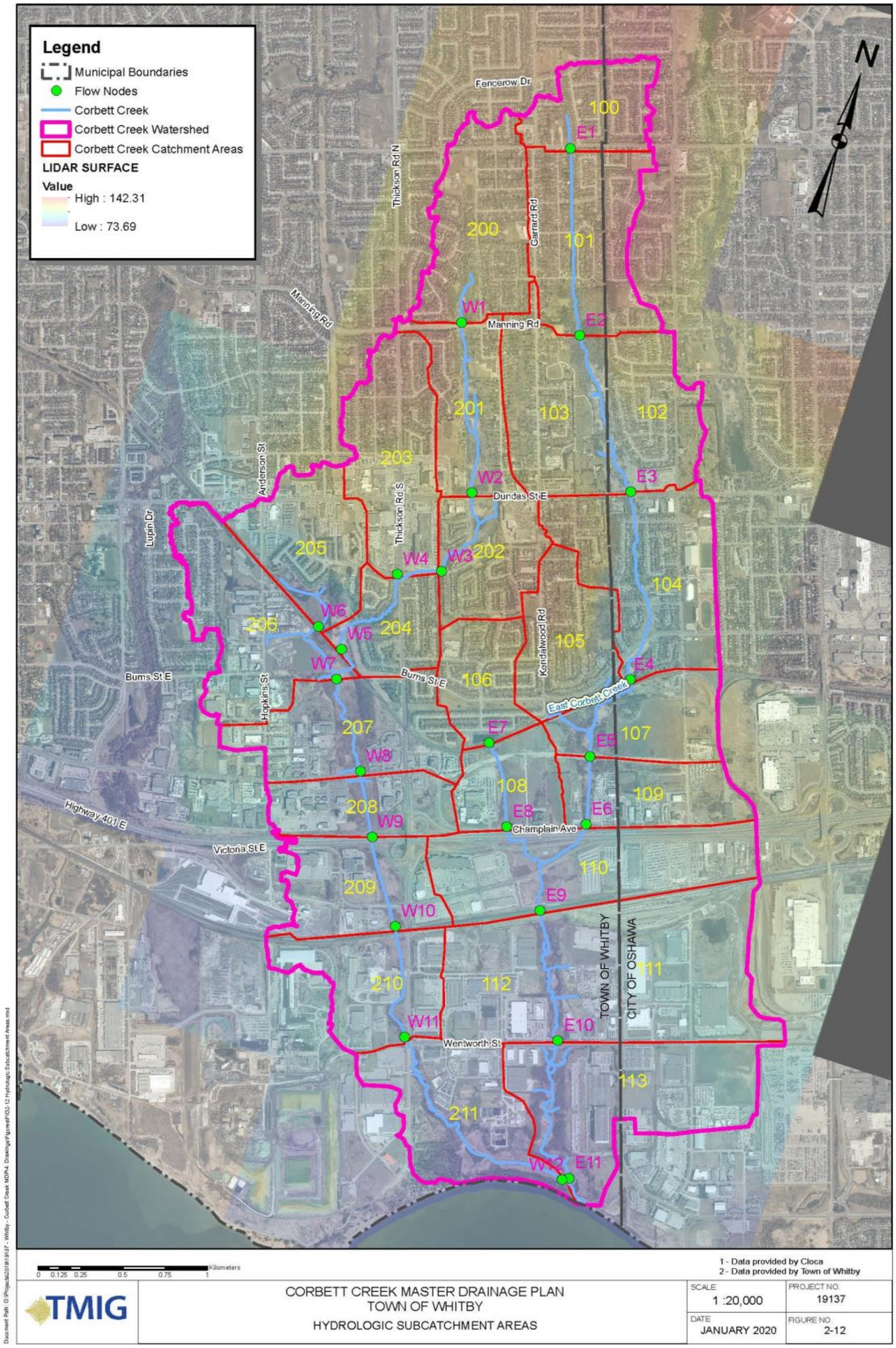
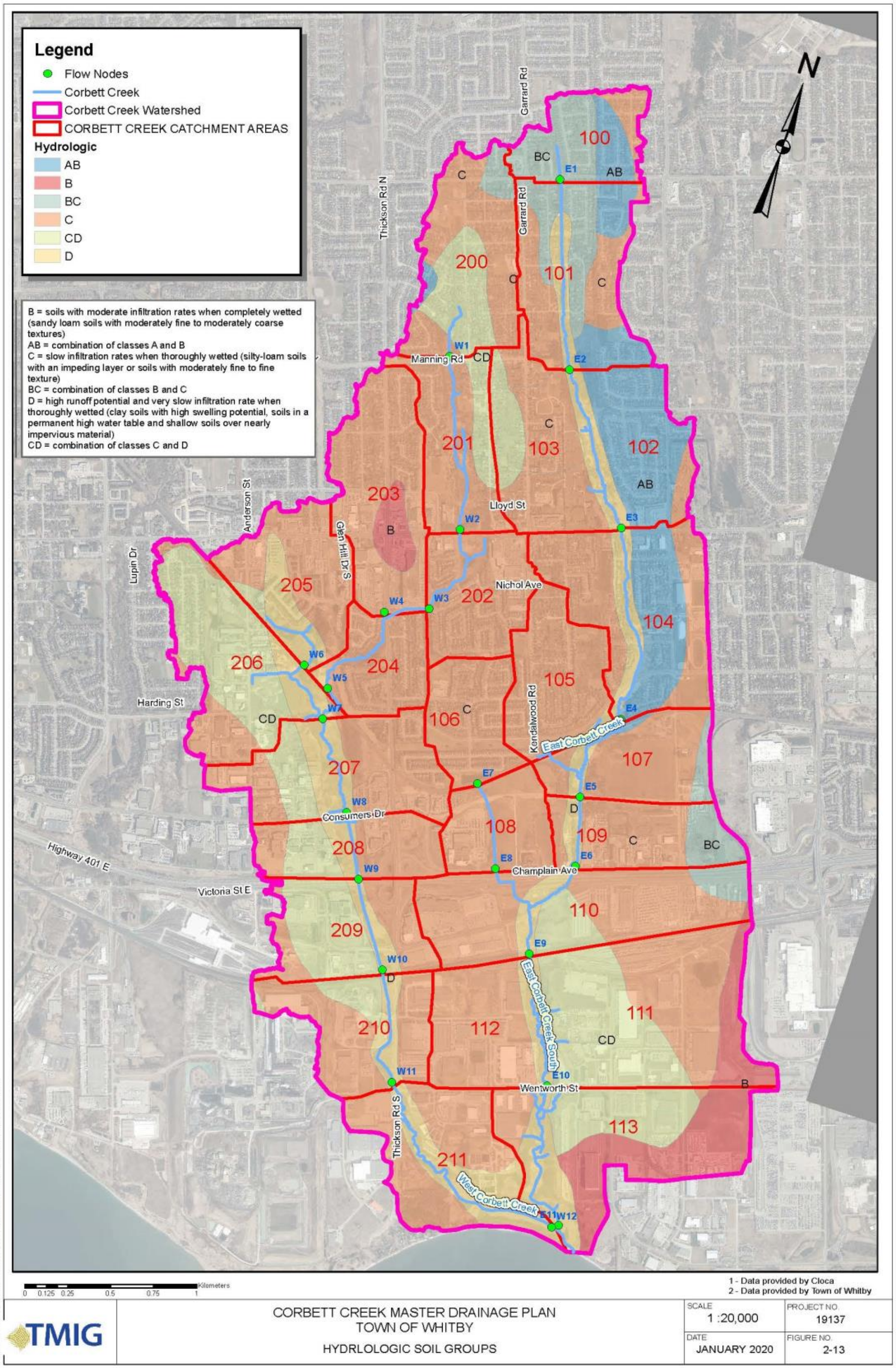


Figure 2-13 Hydrologic Soil Groups



2.6.1.8 Climate Change Considerations

Adaptation and resiliency to future climate change are key considerations in watershed management. The 2018 Companion Guide for the Municipal Class EA Manual encourages proponents to consider both climate change mitigation and adaptation in Municipal Class EA undertakings, but recognizes that the degree to which climate change is considered will vary depending on the type and complexity of the undertaking. Further direction is provided in the MECP on-line guide ‘Considering Climate Change in the Environmental Assessment Process’ (CC Guide) (MOECC, 2017) and Ontario’s Long Term Infrastructure Plan (LTIP) (Ministry of Infrastructure, 2017). The LTIP includes the following guidance related to consideration of climate change:

- ‘Infrastructure, both new and existing, should be resilient, support the resilience of the surrounding community, and be able to adapt to the impacts that Ontario experiences.’
- ‘Infrastructure investments require the application of a “risk lens” to protect their future. Infrastructure planning, design and construction require an understanding of future climatic conditions, vulnerabilities and potential risks to ensure that infrastructure, and infrastructure budgets, will not be compromised by climate change impacts.’

The CC Guide reinforces this position with the following statement:

- ‘In order to reduce future climate-related risks to the local environment, a proponent could consider climate change adaptation measures that increase resilience of any aspect of the proposed project’s design, operation and function which could be susceptible to climate variability.’

Climate change is also discussed in the ‘Technical Guidelines for Flood Hazard Mapping’ (EWRG, 2017), a document that was prepared under the guidance of a steering committee comprised of staff from six Southern Ontario conservation authorities including CLOCA. The guideline notes that future climate change may impact local rainfall intensity-duration-frequency (IDF) curves, which form the basis for return period design storm events that are typically used for the design of water resources infrastructure.

The City of Markham recently completed a review of past and current climate data and a number of other climate change resources during an update to the City’s IDF curves for storm drainage infrastructure. The findings were summarized in the Don Mills Channel Flood Reduction Study (TMIG, 2018). The review showed a slightly decreasing trend in rainfall intensities at Environment Canada’s Toronto Pearson Airport gauge (3% average decrease since 1990), and a slight (1% average) increase in rainfall intensities for the Buttonville Airport rainfall gauge. However, it is recognized that these analyses were based on trends in historic data and not predictions for future climate conditions.

The study further noted that different design storm hyetographs in watershed hydrologic modelling (i.e. 1 hour vs 24 hour storm duration, AES vs SCS vs Chicago distributions) had the potential to influence peak flow rates as much or more than consideration of potential future climate conditions.

A number of recent studies have also attempted to project future climate scenarios in Ontario to assess the impact of climate change to infrastructure (and other impacts). A summary of 100-year return period rainfall for future climate from these studies and methods is found in **Table 2-10**.

- SENES Consultants completed a study to assess future climate and extreme weather for the Durham Region (SENES Consultants, 2013). The study used the Intergovernmental Panel on Climate Change (IPCC) projections of future greenhouse gas emissions with Scenario A1B that generates the highest impact on global warming for the 2040-2049 period. With that, a climate model (British Meteorological Office Hadley Centre) was used to simulate large scale (300 km) climate processes and projections, including return period rainfall events.
- The Ontario Climate Change Data Portal (Ontario CCDP) incorporated high-resolution (25 km) climate projections developed by the University of Regina's Institute for Energy Environment and Sustainable Communities (IEESC). Intensity-duration-frequency (IDF) curves were predicted using IPCC Scenario A1B and generated for 30-year time periods (Wang and Huang, 2013). For this discussion, the IDF curves for the Whitby area were compared between the 1960-1990 period and the 2035-2065 period, for the 12-hour 100-year return period rainfall total.
- Western University had developed an IDF climate change tool (IDF_CC Tool 4.0) used to derive IDF curves for future climate scenarios. The tool allows users to select from multiple greenhouse gas scenarios and Global Circulation Models to simulate future conditions. For this discussion (and generally consistent with the Town's MDPs for Pringle Creek and Lynde Creek), the Toronto City station with data from 1940 to 2017 was used for historically observed data. For future climate, the CanESM2 climate model was selected with Scenario RCP 8.5.
- The Ontario Ministry of Transportation (MTO) approach is based on a climate trend analysis completed by the University of Waterloo to predict future climate from historical observation (1960 to 2010), with projections up to

2060. Similar to the study completed by the City of Markham, these analyses were based on trends in historic data and not predictions for future climate conditions.

Table 2-10 Climate Change Projections

Method	Current 12-hour 100-year Return Period Rainfall	Future 12-hour 100-year Return Period Rainfall	% Difference
SENES Durham Report	76.6 mm (2000-2009 period)	179.2 mm (2040-2049 period)	+134%
Ontario Climate Change Data Portal	124.0 mm (1960-1990 period)	147.6 mm (2035-2065 period)	+19%
Western University IDF_CC Tool 4.0	90.3 mm (1940-2007)	110.7 mm (2040-2070 period)	+23%
MTO IDF Online Application	99.3 mm (2010)	103.2 mm (2050)	+4%

Of the methods outlined above, the SENES study and MTO methods provide the highest and lowest rainfall totals, respectively. The SENES analysis appears to disagree from the Ontario CCDP and Western University results. The SENES report also noted that 10-year historical data was used for the analysis and introduces more uncertainty in the return period analysis. As previously mentioned, the MTO IDF predictions are based on statistical trend analysis of historical data, and not on climate modelling with future scenarios.

With that, the more reasonable approaches to assessing climate change impacts for the watershed are from the Ontario CCDP and Western University IDF_CC Tool, with the IDF_CC Tool providing better agreement for total rainfall in the 100-year return period storm in the current condition (used in the MDP hydrologic model). Note that the IDF_CC Tool can use a number of different scenarios and climate models to predict future IDF curves. The selected configuration of the tool is consistent with other MDPs in Whitby and produced results that agree with the general approach of many conservation authorities in the Greater Toronto Area (which is to recommend increasing rainfall intensities by 20%). It is based on past climate change research that suggested that average annual rainfall amounts could increase by as much as 20% under future climate conditions.

In the future climate scenario for the Corbett Creek hydrologic model, the IDF_CC Tool's future IDF curve was used, with the 12-hour Chicago storm distribution as with other scenarios in the model. The results at key nodes in the watershed are summarized in **Table 2-11** and **Table 2-12**, for East and West Corbett Creek, respectively.

Results of the climate change scenario indicate an increase in peak flows of about 30% compared to the existing condition scenario for the 100-year return period event. For context, a return period analysis was completed on the hydrologic model output. The 100-year return period event from climate change scenario is comparable to the 400-year return period event from the existing conditions scenario. Note that the existing conditions scenario for the watershed is already conservative, in part, to account for a lack of stream flow gauging data in the watershed to compare or calibrate peak flow rates to observed conditions.

It is therefore recommended that the Corbett Creek watershed continue to be managed based on the output from the MDP hydrologic model without considering future climate change conditions. Thus, the MDP alternative selection, evaluation and recommended projects do not consider the climate change scenario results from the MDP hydrologic model. However, this approach should be reviewed periodically as new data or revised methods become available. In the meantime, should a particular project require analysis under predicted future climate conditions, the Western University IDF_CC Tool is the recommended method to estimate rainfall intensities (and subsequent impact on peak flow rates).

Table 2-11 Hydrology Model Output – East Corbett Creek Climate Change Scenario

Storm Event	Peak Flow Rates (m^3/s) at E3 King Street (213 ha)	Peak Flow Rates (m^3/s) at E4 CPR (296 ha)	Peak Flow Rates (m^3/s) at E6 Highway 401 (428 ha)	Peak Flow Rates (m^3/s) at E9 CNR (580 ha)	Peak Flow Rates (m^3/s) at E11 Outlet (823 ha)
100 Year	22.5	26.1	36.0	48.9	49.0
100 Year Climate Change (% difference vs. existing 100-year)	29.0 (+29%)	32.9 (+26%)	45.3 (+26%)	64.1 (+31%)	65.0 (+33%)
Regional	26.3	34.3	49.6	68.0	90.7

Table 2-12 Hydrology Model Output – West Corbett Creek Climate Change Scenario

Storm Event	Peak Flow Rates (m^3/s) at W2 Dundas Street (110 ha)	Peak Flow Rates (m^3/s) at W5 CPR (250 ha)	Peak Flow Rates (m^3/s) at W9 Highway 401 (475 ha)	Peak Flow Rates (m^3/s) at W10 CNR (525 ha)	Peak Flow Rates (m^3/s) at W12 Outlet (643 ha)
100 Year	12.2	37.8	50.6	48.1	44.6
100 Year Climate Change (% difference vs. existing 100-year)	16.0 (+31%)	47.0 (+24%)	65.9 (+30%)	62.5 (+30%)	58.4 (+31%)
Regional	13.4	31.8	57.7	62.1	72.3

2.6.2 Stormwater Management

The majority of the lands within the Corbett Creek watershed were developed prior to the adoption of modern stormwater quantity and quality controls. As such, there are a limited number of traditional stormwater management ponds to control the quantity and quality of runoff discharged to watercourses. Stormwater servicing is generally provided by a minor system with a 5-year storm capacity, where runoff from larger storm events is directed to the major system along right-of-ways and into Corbett Creek.

2.6.2.1 Previous Stormwater Management Studies

Previous stormwater management objectives for Corbett Creek were developed through the Whitby Stormwater Management Study (Dillon, 1982) and the East Corbett Creek Drainage Study (Dillon, 1987). In general, the recommendations from these studies were consistent with standard practice at the time and do not include modern stormwater controls.

The Whitby Stormwater Management Study provided criteria that was applied for the Town's three watersheds, including Corbett Creek. With respect to flooding, quantity control of major runoff events (identified as the 100-year storm event) was not required on the basis that development will be prohibited in flood-prone areas and that the floodplain in future conditions was determined to be similar to existing conditions. Recommended water quality control was to provide post-development peak flow control of the 5-year storm event to pre-development levels, which also provided erosion control.

The East Corbett Creek Drainage Study examined stormwater management for development north of Dundas Street to Rossland Road. Quantity control facilities were determined to be unfeasible due to the flat grade of the area and the study recommended increased channel conveyance to handle increased runoff from large storm events. Erosion control recommendations include remedial measures for the receiving channel to repair erosion issues as they arise.

In general, the recommendations from previous stormwater management studies are out-of-date compared to current practices and are no longer applied by the Town of Whitby.

2.6.2.2 Existing Stormwater Management Criteria

Currently, the Town of Whitby and City of Oshawa refer to specific watershed plans and Master Drainage Plans for SWM criteria to be applied within each watershed. In the absence of an up-to-date watershed plan for Corbett Creek prior to this MDP, SWM criteria was subject to consultation with the Town and CLOCA (Town of Whitby, 2018). The CLOCA Technical Guidelines for Stormwater Management Submissions (CLOCA, 2007, revised 2010) provides an overview of current criteria and design standards for the Corbett Creek watershed. Unless otherwise specified through consultation, the current SWM requirements are summarized as follows:

- Stormwater Quantity – Post-development peak flow rates must not exceed the corresponding pre-development peak flow rates for the 2-year through 100-year design storm events. Regional Storm control is required unless otherwise noted in Master Plans.
- Stormwater Quality – Enhanced protection is required, corresponding to 80% long-term average removal of suspended solids according to the MOE Stormwater Management Planning and Design Manual (MOE, 2003).
- Stream Erosion – Extended detention of the 25 mm storm for 24 to 48 hours is required, unless otherwise specified in Master Plans.
- Water Balance – Post-development infiltration is required to match pre-development infiltration with remedial measures.

The design of stormwater systems and facilities shall adhere to the Town of Whitby's Engineering Design Criteria (2018). SWM design shall also adhere to requirements of other approval agencies such as the MECP, MNRF, DFO and others as needed.

2.6.2.3 Existing Stormwater Management Infrastructure

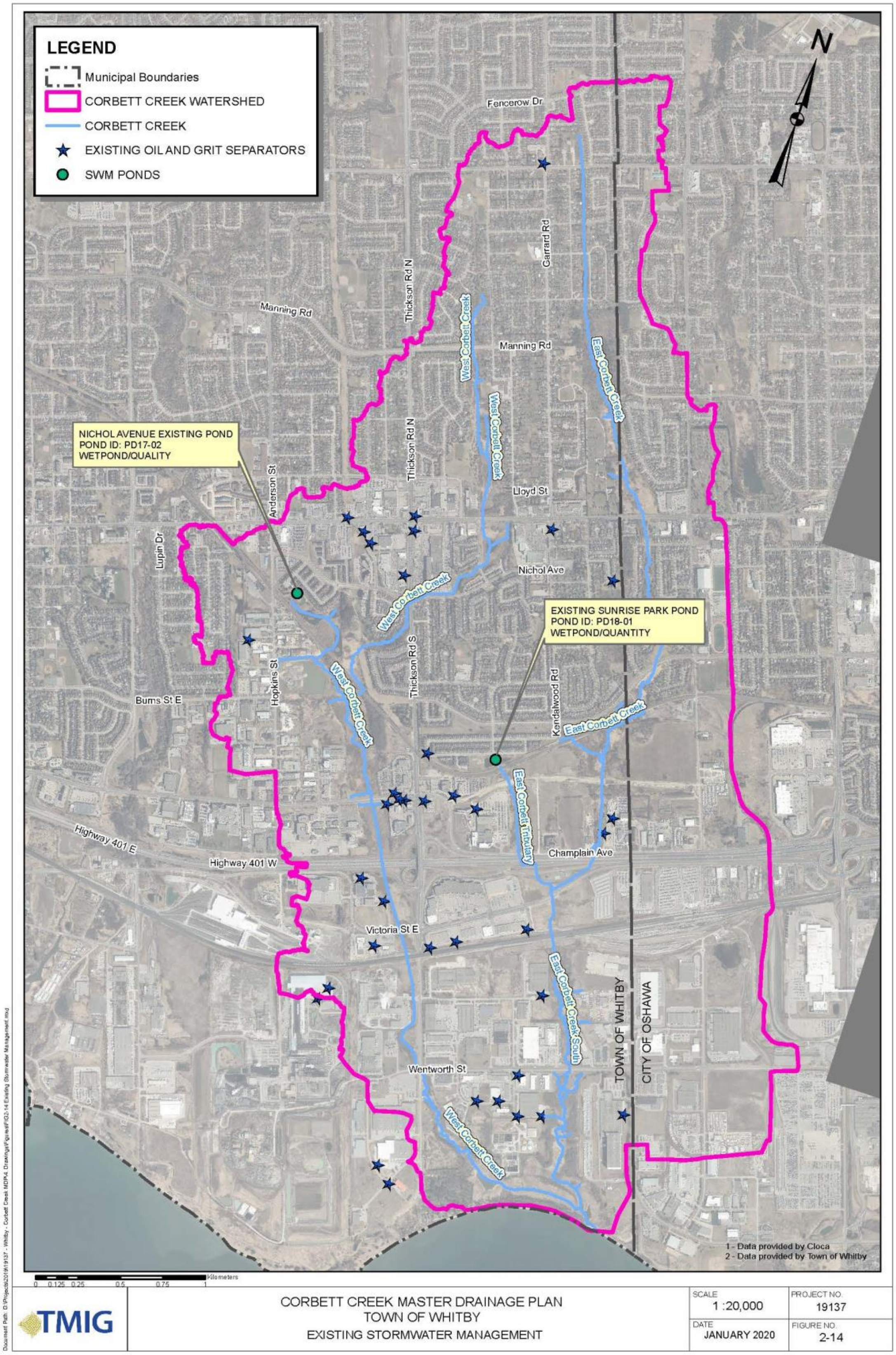
The Town of Whitby maintains a database of SWM facilities within the watershed. With the industrial and commercial development in the watershed, there are also a number of private, on-site SWM facilities, especially for developments constructed within the last two decades.

These private SWM facilities may include, but are not limited to, wet or dry SWM ponds, oil and grit separators, infiltration trenches, or underground storage facilities. The Town's database includes a total of 37 private oil and grit separators and two (2) private wet ponds. Among the Town's (publicly owned) infrastructure, there are two existing SWM ponds within the watershed (**Table 2-13** and **Figure 2-14**). There are no stormwater management ponds within the City of Oshawa that discharge to the Corbett Creek watershed.

Table 2-13 Town's Existing Stormwater Management Facilities

Pond ID	Facility Name	Location	Year Installed	Type	Drainage Area (ha)	Storage (m^3)
PD17-02	Nichol Avenue	End of Gallimere Court	2010	Quality Wet Pond	19.5	7,344
PD18-01	Sunrise Park	Southwest of Thickson Rd. and Burns St.	2008	Quantity and Quality Wet Pond	33.3	16,298

Figure 2-14 Existing Stormwater Management



2.6.3 Hydraulics and Flood Plain Mapping

CLOCA completed a floodline mapping update for the Corbett Watershed in 2006 (Greck, 2006), which updated previous work completed in 1982. The floodline mapping update included the development of a hydrologic model for the watershed using Visual OTTHYMO (version 2) for existing and future land use scenarios. A hydraulic model was developed with HEC-RAS (version 3.1.3) to complete hydraulic analysis.

A floodplain mapping summary with more detailed methodology and maps showing the extent of Regulatory flooding is included in **Appendix G,** along with the output from the HEC-RAS hydraulic model.

The Corbett Creek watershed includes some large road and railway structures that impact the hydraulic conditions in the watershed and required the modelling of flood storages to account for the significant storage at the CNR tracks for East and West Corbett Creek.

A new HEC-RAS hydraulic model for Corbett Creek was created by TMIG, and included the following refinements compared to the 2006 hydraulic model:

- Cross-section updates based on LiDAR topography from CLOCA, surveyed in 2018.
- Survey datum migration was complete for structures in the existing HEC-RAS model, from the Canadian Geodetic Vertical Datum of 1928 (CGVD28) to the Canadian Geodetic Vertical Datum of 2013 (CGVD2013). This was completed in consultation with CLOCA, in anticipation that current and future topographic surveys are completed in CGVD2013, including the LiDAR topography surveyed by CLOCA in 2018.

The Regulatory flood for the Corbett Creek watershed is the greater of the flood produced by Hurricane Hazel (Regional Storm) or the 100-year storm, based on the MNR Technical Guide for River & Stream Systems: Flooding Hazard Limit (MNR, 2002). Therefore, to map the Regulatory flood plain, 100-year flood plain and Regional storm floodplain were modelled and mapped, where the greater of the two flood plains at each HEC-RAS cross-section was selected to represent the Regulatory flood plain.

The Technical Guide (MNRF, 2002) also recommends a number of conservative assumptions be applied to a hydrology model used to generate flows for Regulatory flood plain mapping. This includes a recommendation to not consider any ‘man made’ storage attenuation facilities in the modelling, including stormwater management ponds, dams and storage behind restrictive culverts and bridges. In the Corbett Creek hydraulic model, storage was not considered for reducing downstream flows, but routed water levels upstream of the CNR were incorporated into the modelling.

The updated floodplain mapping is provided on **Figure 2-15** which also shows the 2006 floodplain mapping for comparison. Differences between the MDP updated floodplain mapping and 2006 floodplain mapping are attributable to the more detailed topography from the LiDAR mapping rather than changes in flood levels.

Corbett Creek crossing structures were also reviewed with respect to their conveyance capacity of major storm events. A summary of the hydraulic conditions at crossings that are undersized is provided in **Table 2-14**.

2.6.3.1 Flood Damage Centres

The Flood Damage Centres (FDCs) identified in CLOCA's Watershed Flood Risk Assessment (CLOCA, 2017) were reviewed during the floodplain mapping update. In general, the extent of flooding for the Regulatory storm event was consistent with the 2006 floodplain mapping update that was used in CLOCA's Watershed Flood Risk Assessment. The exceptions include areas where changes in the modelled topography, from more detailed LiDAR topography, resulted in some buildings being excluded from the floodplain compared to the 2006 floodplain mapping update. A summary of the FDCs is provided in **Table 2-15** and **Figures 2-17 to 2-19**.

The updated topography and hydraulic modelling also indicated several homes on Crystal Beach Boulevard, adjacent to the Corbett Creek Coastal Wetland, that are within the Regulatory storm event floodplain. It is recommended that CLOCA review this area according to methods outline in the 2017 Watershed Flood Risk Assessment.

Table 2-14 Summary of Undersized Corbett Creek Crossing Structures

Structure Location	Structure Size	Maximum Storm Event Conveyance Without Overtopping Road/Railway
West Corbett Creek at Dundas Street (WC-12)	1.8 m Width by 1.25 m Height Box Culvert	10-year
West Corbett Creek at Nichol Avenue and Thickson Road (WC-10)	2.9 m Width by 1.8 m Height Box Culvert	10-year
West Corbett Creek at CPR (WC-8)	1.7 m Width by 1.7 m Height Arch Culvert	Less than 2-year
West Corbett Creek at Consumers Drive (WC-7)	Twin 2.3 m Diameter Corrugated Steel Pipes	Less than 2-year, recognizing that downstream backwater effects govern water levels
West Corbett Creek at Highway 401 (WC-6)	5.0 m Width by 3.1 m Height Box Culvert	100-year, recognizing that downstream backwater effects govern water levels
West Corbett Creek at Victoria Street (WC-5)	4.9 m Width by 2.54 m Height Box Culvert	25-year, recognizing that downstream backwater effects govern water levels
West Corbett Creek at CNR (WC-4)	2.3 m Diameter Corrugated Steel Pipe	2-year through culvert with spill through Thickson Road underpass for Regulatory Event
West Corbett Creek at Wentworth Street and Thickson Road (WC-2)	2.69 m Width by 2.08 m Height Arch Culvert	2-year

Structure Location	Structure Size	Maximum Storm Event Conveyance Without Overtopping Road/Railway
East Corbett Creek at Forest Road (EC-10)	Twin 1.49 m Width by 1.12 m Pipe Arch Culverts	50-year
East Corbett Creek at Champlain Avenue and Highway 401 (EC-4)	5.4 m Width by 3.28 m Height Box Culvert	100-year
East Corbett Creek Tributary at Champlain Avenue and Highway 401	1.82 m Width by 0.7 m Height Box Culvert	Less than 2-year
East Corbett Creek Tributary at Ramp to Highway 401 East	1.22 m Width by 0.7 m Height Box Culvert	2-year
East Corbett Creek at Victoria Street (EC-3)	5.0 m Width by 2.7 m Height Box Culvert	10-year, recognizing that downstream backwater effects govern water levels
East Corbett Creek at CNR (EC-2)	1.95 m Diameter Corrugated Steel Pipe	Regulatory, however the crossing causes elevated water levels upstream of the CNR.

Note: Structure IDs and sizes obtained from 2006 HEC-RAS hydraulic model.

Table 2-15 Summary of Flood Damage Centres

Flood Damage Centre	Potential Impacts to Public Safety and Infrastructure	Private Property at Risk of Flood Damages	Change in the number of buildings impacted vs. 2017 FDC Risk Assessment
FDC-COR1 West Corbett Creek upstream and downstream of CNR	Thickson Road underpass is at risk of flooding which impedes emergency vehicle access.	One (3) private commercial building. Two (1) private industrial buildings.	One (1) private commercial building added and one (1) private industrial building excluded from Regulatory floodplain
FDC-COR2 West Corbett Creek at Consumers Drive crossing.	Consumers Drive at risk of flooding which impedes emergency vehicle access.	Four (4) private commercial buildings	Five (5) buildings excluded from Regulatory floodplain
FDC-COR3 West Corbett Creek near intersection of Thickson Road and Nichol Avenue.	Nichol Avenue at risk of flooding which impedes emergency vehicle access.	Two (2) private commercial buildings. One (1) residential house.	No change
FDC-COR4 West Corbett Creek upstream of Dundas Street	Dundas Street at risk of flooding which impedes emergency vehicle access.	Six (6) residential houses.	11 residential houses excluded from Regulatory floodplain.

Flood Damage Centre	Potential Impacts to Public Safety and Infrastructure	Private Property at Risk of Flood Damages	Change in the number of buildings impacted vs. 2017 FDC Risk Assessment
FDC-COR5 East Corbett Creek upstream of Highway 401 and Champlain Avenue	Champlain Avenue, Highway 401, and Victoria Street at risk of flooding which impedes emergency vehicle access. MTO Truck Inspection Station at risk of flood damages.	Two (4) private commercial buildings One (1) MTO building	One (1) private commercial building added and one (1) commercial building excluded from Regulatory floodplain
FDC-COR6 East Corbett Creek upstream of King Street	None – Regulatory peak flows do not overtop King Street	Two (2) residential houses.	One (1) commercial building and eight (8) residential houses excluded from Regulatory floodplain.

Figure 2-15 Regulatory Floodplain

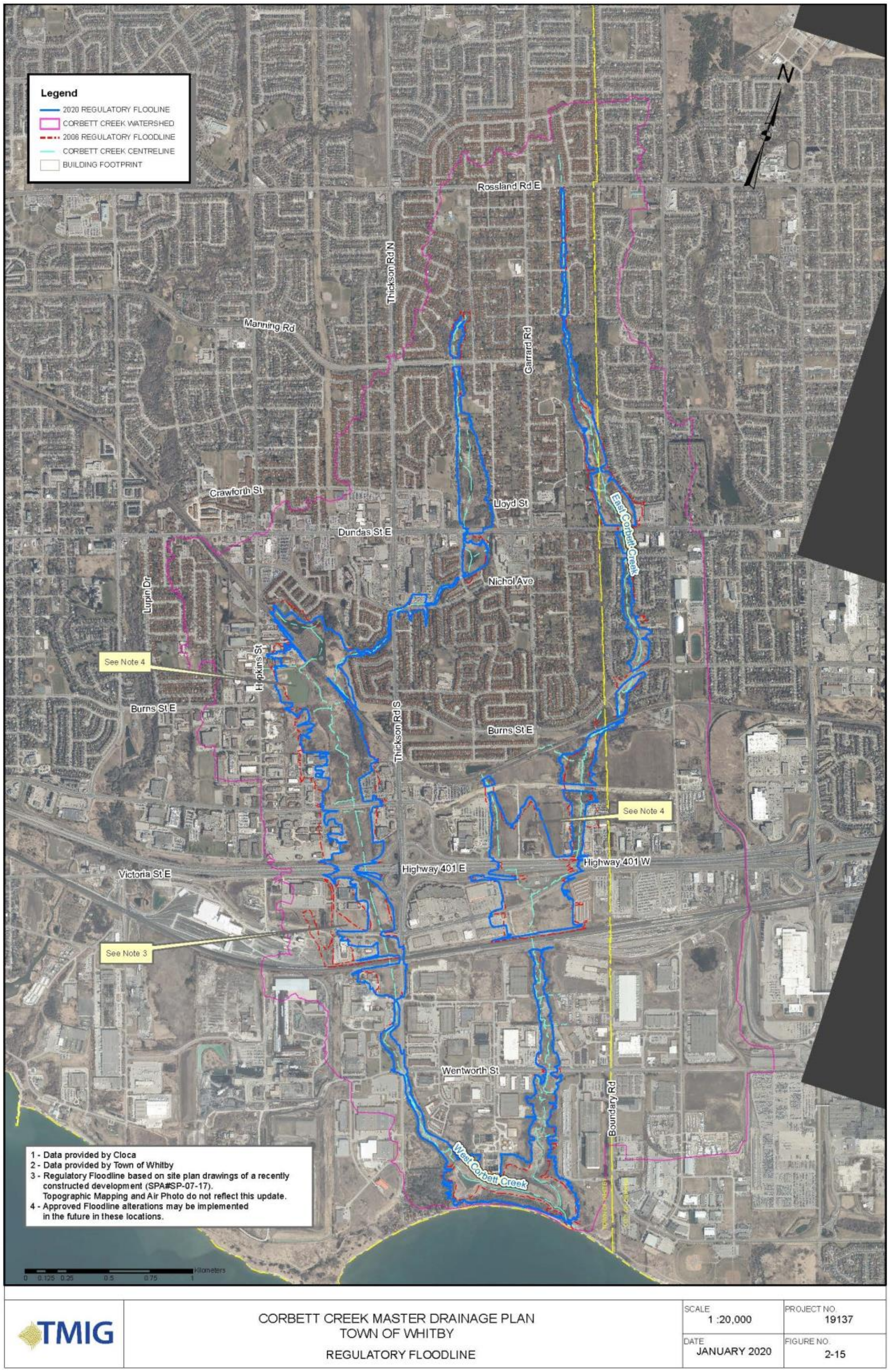


Figure 2-16 Flood Damage Centres (FDC-COR1 and FDC-COR2)

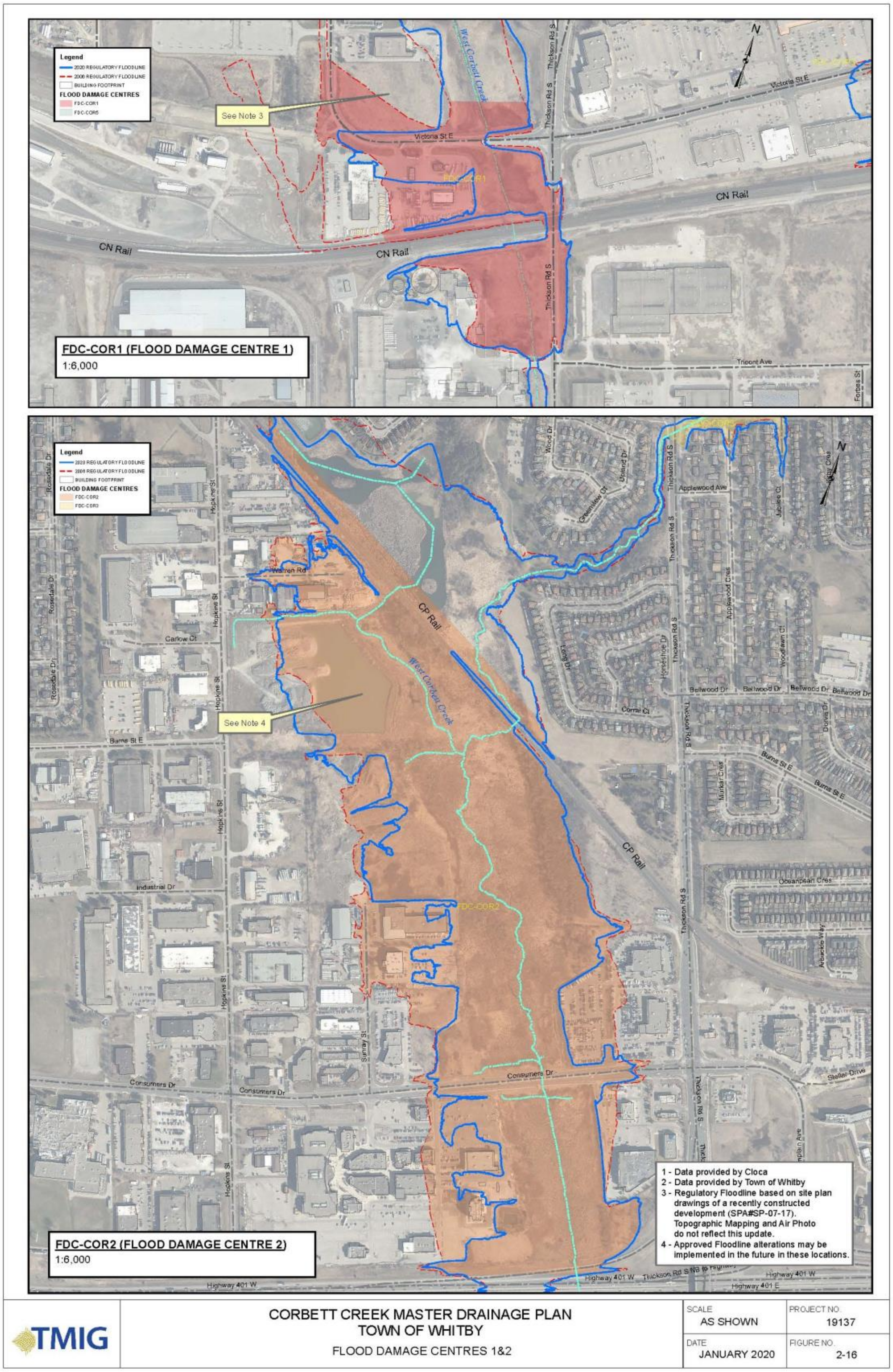


Figure 2-17 Flood Damage Centres (FDC-COR3 and FDC-COR4)

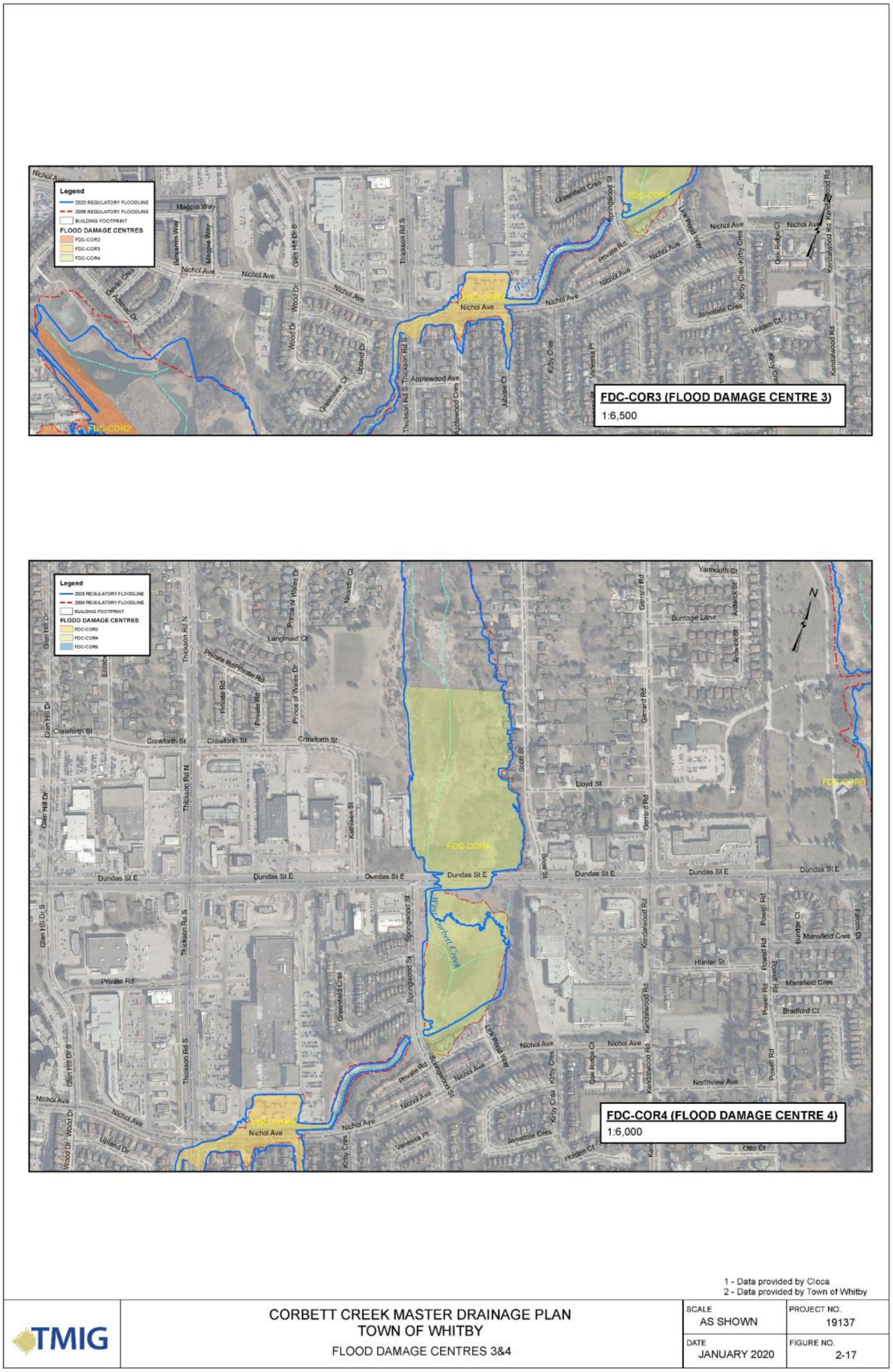
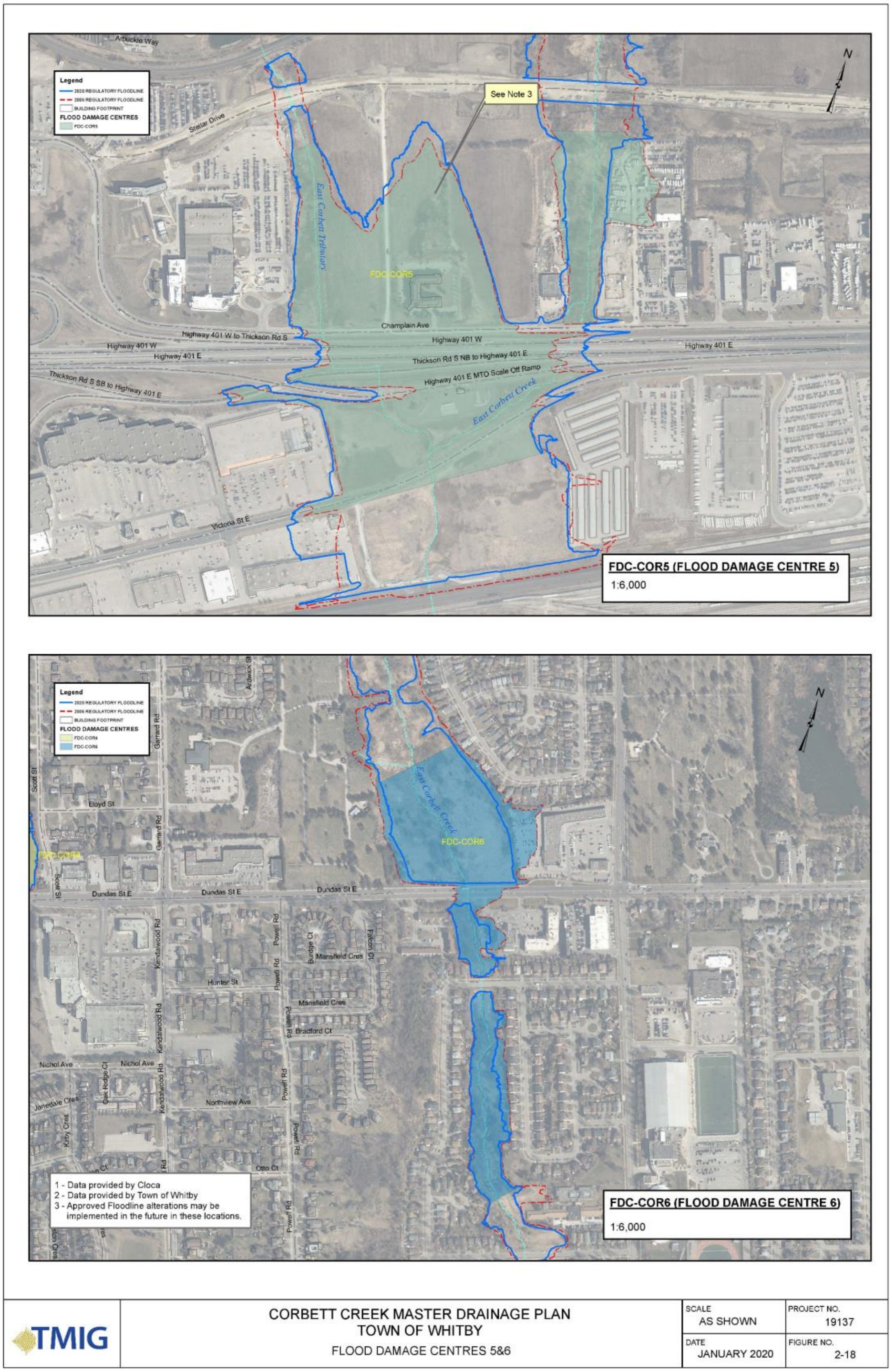


Figure 2-18 Flood Damage Centres (FDC-COR5 and FDC-COR6)



3 Description of Alternative Solutions

3.1 Overview

Alternatives for managing a highly urbanized watershed involve: (1) stormwater management to mitigate the impacts of runoff from development on receiving watercourses, such as flooding, poor water quality, and erosion; and (2) implementing measures to address the above noted impacts for areas that have not provided adequate stormwater controls. More specifically, the range of alternatives for the Corbett Creek watershed can include:

- Maintaining the status quo and do nothing.
- Enhanced stormwater management criteria for new development or redevelopment to reduce runoff volumes and peak flow rates.
- New SWM controls, including SWM facilities or retrofits to existing facilities to provide increased water quality, water quantity, and/or erosion control.
- Hydraulic structure and watercourse conveyance improvements such as increasing the capacity of culverts or drainage conveyance systems.
- Watercourse and valleyland rehabilitation to mitigate erosion hazards and/or enhance natural features.

These general watershed management options were applied to the Corbett Creek watershed to generate the list of potential feasible alternatives described in the following sections. The location of MDP alternatives are shown on **Figure 3-1.**

3.2 Alternative No. 1 – Status Quo (Do Nothing)

The ‘Do Nothing’ alternative is always considered in the environmental assessment process. There may be situations where all feasible alternatives will cause unacceptable impacts to the natural, social and/or cultural environments, or are prohibitively expensive. In such instances, the Do Nothing alternative may be preferred.

In the ‘Do Nothing’ alternative, the Corbett Creek would be managed according to current SWM criteria to future redevelopment and does not include proposed infrastructure or restoration projects to mitigate flooding and erosion issues.

3.3 Alternative No. 2 – Enhanced SWM Criteria

Section 2.6.2 described the current SWM used by the Town and CLOCA for development within the Corbett Creek watershed. While a large portion of the watershed had been developed prior to the implementation of modern SWM criteria, the intensifications areas identified in the Town's OP around Dundas Street and Victoria Street represent opportunities to implement 'enhanced' SWM criteria for redevelopment.

In general, the intensification areas at Dundas Street and Victoria Street are fully developed with commercial land uses. Under current SWM criteria, the redevelopment is required to not exceed pre-development rates and/or any restrictions in the downstream conveyance system, where pre-development conditions are the current conditions with few stormwater controls. Thus, there will not be improvements to the existing condition.

In Alternative 2 (**Figure 3-1**), the intensification areas represent opportunities to implement enhanced SWM criteria for redevelopment, as follows:

- Volume / Erosion Control – Runoff from a 5 mm rainfall event must be captured, retained or detained from all new or reconstructed impervious surfaces as a minimum requirement. For sites greater than 5 ha that propose to use a SWM pond, extended detention of the 25 mm storm for 24 hours is required, consistent with current criteria.
- Stormwater Quantity – Post-development peak flow rates must not exceed the corresponding pre-development peak flow rates for the 2-year through 100-year design storm events, consistent with current criteria. For redevelopment of existing developed sites, peak flow rates must also be controlled to the capacity allocated to the site in the design of the downstream minor and major drainage systems.
- Stormwater Quality – Enhanced protection, corresponding to 80% long-term average removal of suspended solids, according to the MOE Stormwater Management Planning and Design Manual (MOE, 2003). This is consistent with current SWM criteria. Water quality control measures to be implemented under a hierarchy of SWM practices, as follows:
  (1) Low impact development (LID) measures.
  (2) Stormwater management facilities such as wet ponds, wetlands and hybrid ponds for sites larger than 5 ha.
  (3) Manufactured treatment devices such as oil-grit separators.

- Water Balance – Post-development infiltration is required to match pre-development infiltration with remedial measures to the extent possible, which is consistent with current criteria. As a minimum, redevelopment sites are required to retain a minimum of 5 mm runoff on-site for infiltration, evapotranspiration or reuse.

3.4 Alternative No. 3 – SWM Facilities

The Corbett Creek watershed does not have large greenfield areas that can be serviced through new stormwater management infrastructure such as new SWM ponds. The potential to construct new SWM facilities is feasible only on Town owned lands.

The lands adjacent to the Town's existing storm sewer outfalls throughout the watershed were screened for suitability to construct a SWM facility. This was, in part, completed through the Town's Stormwater Quality and Erosion Enhancement Study Update (Ecosystem Recovery, 2019). A total of three (3) locations within the Corbett Creek watershed were identified for the potential to have new SWM enhancements, such as plunge pools, oil-grit separators, and SWM ponds. The report and conceptual designs of the SWM facilities are found in **Appendix B**. The recommended locations were selected considering the following:

- Size of drainage area.
- Presence (or lack) of SWM facilities.
- Available Town property adjacent to an existing outfall.
- Alignment with the Town's objectives with development or infrastructure projects.
- Contributing land use that is not commercial, which could be redeveloped with SWM controls.
- Located within a priority watercourse that is environmentally sensitive or lacking in SWM controls.

In addition, the Town's existing SWM facilities were screened for their retrofit potential to provide improved flooding, water quality and erosion control. The criteria used to screen for retrofit potential was similar to new SWM facilities, but applied to existing SWM facilities. Given that the Town's two wet ponds are relatively modern and provide up-to-date quality and quantity control, there are no recommendations for retrofits. The potential SWM facilities within the watershed are summarized below with locations shown on **Figure 3-1**.

Note that the SWM facilities reference IDs from the Town's Stormwater Quality and Erosion Enhancement Study Update (Ecosystem Recovery, 2019). The estimated costs are also derived from the above study, and are high-level estimates for engineering and construction, ranging between Low (less than $100,000), Medium ($100,000 to $500,000), High ($500,000 to $2 million) and Very High (over $2 million).

- **SWM Facility C1**: Oil-Grit Separator and Wetland SWM Facility on East Corbett Creek (Burns Street East and Limerick Street)

  A wetland SWM facility is proposed downstream of the outfall south of Burns Street, west of East Corbett Creek. The outfall discharges stormwater runoff from the residential development to the north. The proposed permanent pool volume of 931 m^3 and oil-grit separator located upstream of the wetland will provide suspended solids removal. Total contributing drainage area to the outfall is 26.7 ha with an overall imperviousness of 44%.

  Cost: Medium

- **SWM Facility C2:** Oil-Grit Separators and Wet Pond on West Corbett Creek (Manning Road and Hazelwood Drive)

  A wet pond SWM facility is proposed downstream of two outfalls north of Manning Road, at the upstream end of West Corbett Creek. The outfalls discharge stormwater runoff from the residential development to the north. The proposed permanent pool volume of 1,920 m^3 and oil-grit separators located upstream of the wet pond will provide suspended solids removal. Total contributing drainage area to the outfall is 57.0 ha with an overall imperviousness of 50%.

  Cost: High

- **SWM Facility C4:** Oil-Grit Separator and Plunge Pool on East Corbett Creek (Rossland Road West at Inglewood Pl)

  A plunge pool is proposed downstream of the outfall south of Rossland Road that discharges stormwater runoff from the residential development to the north in East Corbett Creek. The proposed plunge pool volume of 105 m^3 and oil-grit separator located upstream of the plunge pool will provide suspended removal. Total contributing drainage area to the outfall is 62.2 ha with an overall imperviousness of 66%.

  Cost: Medium

3.5 Alternative No. 4 – Flood Conveyance Improvements

As described in **Section 2.6.3.1**, the Flood Damage Centres (FDCs) identified by CLOCA (**Figure 3-1**) are relatively low risk FDCs amongst CLOCA's watersheds, nevertheless, improvements to hydraulic structures or conveyance channels can be considered to mitigate flooding impacts to infrastructure and property. In particular, FDC-COR1 and FDC-COR2 are located within the planned intensification corridor along Victoria Street. An overview of potential conveyance improvements at the FDCs is provided as follows. Costs are high-level estimates for engineering, construction and contingencies, ranging between Low (less than $100,000), Medium ($100,000 to $500,000), High ($500,000 to $2 million) and Very High (over $2 million). Order of magnitude costs were determined by assuming $20,000 per metre length of works, consistent with similar projects in other Ontario municipalities, noting that complex projects can readily exceed this cost.

- **FDC-COR1 and FDC-COR2:** West Corbett Creek between CNR and CPR.

  The culvert under the CNR is under capacity for major storm flows and conveyance improvements can be achieved by installing a larger culvert or additional culverts through the rail berm. For context, the estimated total opening size to convey the Regional storm event peak flow rate (62.1 m^3/s) from the hydrologic model is 7 m width by 2 m height, calculated using Manning's equation, assuming full flow and 0.5% slope. The existing culvert is a 2.3 m diameter circular pipe culvert. This will provide a reduced floodplain for the planned intensification area along Victoria Street. It can potentially reduce the floodplain for FDC-COR2 and the severity of overtopping at Highway 401. The estimated length of works for crossing structure improvements is 250 m.

  Cost: Very High

- **FDC-COR3:** West Corbett Creek between CNR and CPR.

  Improvements to the culvert under the intersection could provide more conveyance capacity to relieve flooding upstream of the culvert. The works can potentially be completed at the same time as channel rehabilitation for erosion issues downstream of the culvert. The estimated length of works for watercourse and crossing structure improvements is 300 m.

  Note that the Town's current Bridge and Culvert Hydraulic Capacity Assessment Master Plan (Ecosystem Recovery, 2019) had identified the crossing at Thickson Road and Nichol Avenue as not meeting current municipal design standards. Recommendations from the above study may also apply at this location, once finalized.

Cost: Very High

- **FDC-COR4:** West Corbett Creek upstream of Dundas Street

  The culvert at Dundas Street can potentially be improved to provide increased conveyance capacity. The estimated length of works for crossing structure improvements is 100 m.

  Cost: High to Very High

- **FDC-COR5:** East Corbett Creek upstream of CNR

  The culvert under the CNR is under capacity for major storm flows and conveyance improvements can be achieved by installing a larger culvert or additional culverts through the rail berm. Additional conveyance capacity at the CNR can potentially reduce the severity of overtopping at Highway 401.

  Similar to the CNR crossing for West Corbett Creek, to provide context, the estimated total opening size to convey the Regional storm event peak flow rate (68.0 m3/s) from the hydrologic model is 7.5 m width by 2 m height, calculated using Manning's equation, assuming full flow and 0.5% slope. The existing culvert is a 1.95 m diameter circular pipe culvert. The estimated length of works for crossing structure improvements is 180 m.

  Cost: Very High

- **FDC-COR6:** East Corbett Creek north and south of King Street

  The channel reach and culverts at King Street and Monaghan Avenue are slightly under capacity. The channel and culverts can be reconstructed to provide additional conveyance. The estimated length of works for watercourse and crossing structure improvements is 500 m.

  Cost: Very High

3.6 Alternative No. 5 – Watercourse Rehabilitation

Following the fluvial geomorphological review of Corbett Creek reach conditions, and through desktop erosion hazard analyses, a number of watercourse rehabilitation opportunities were identified to restore channel reaches with erosion or instability concerns.

In an urban context, channel adjustments can have detrimental impacts to adjacent public infrastructure or private properties. The impacts can be mitigated by implementing stormwater management measures or applying development setbacks from the watercourse for new developing areas of a watershed. The Corbett Creek watershed, however, is nearly fully urbanized with limited opportunities to implement the aforementioned measures to existing developed areas or infrastructure.

Thus the watercourse rehabilitation recommendations described for the MDP are located at sites where erosion and instability issues are in close proximity to infrastructure or property (**Figure 3-1**). Potential damage to the adjacent infrastructure or property could occur if not managed. The existing conditions within several reaches are in a state of instability and warrant rehabilitation, which were prioritized based on the risk for impacting infrastructure or adjacent property if these reaches continue to deteriorate. The potential rehabilitation works are recommended based on the preliminary site assessments with conservative cost estimates for detailed design and construction.

Costs are high-level estimates for engineering and construction, ranging between Low (less than $100,000), Medium ($100,000 to $500,000), High ($500,000 to $2 million) and Very High (over $2 million).

- **Reach EB10**

  The erosion protection downstream of the Westwood Road and Forest Road culverts should be restored. Downstream of Forest Road, the channel has eroded into the east valley wall resulting in a near-vertical face that requires rehabilitation. The Westwood Road culvert is also of concern as the bed downstream of the previous erosion protection works has degraded and continued loss of material will result in a perched culvert and scouring under the culvert. The erosion controls downstream of both culverts should be restored, and the stability of the valleys walls be reviewed. Recommended works include:

  - Valley wall protection (localized channel realignment and restoration, valley wall regrading and stabilization, valley wall toe protection with bioengineering)
  - Culvert outlet channel restoration (scour pool, rock weirs for bed grade control, bioengineered banks)

  Cost: Medium to High

- **Reach EB11**

  The 20 m long channel immediately downstream of the Rossland Road culvert is in poor condition. Gabion baskets, implemented as drop structures in the channel, have deteriorated and outflanked, which requires rehabilitation. Continued degradation of the gabion may impact the residential properties on the west side of the channel. Recommended works include culvert outlet channel restoration (armour stone drop structures, valley slope regrading and stabilization)

Cost: Medium

- **Reach EB3**

  Erosion in the road embankment upstream of the Victoria Street culvert and rip-rap displacement along Victoria Street requires repair. Further channel adjustments and migration could potentially impact the road. Recommended works include embankment toe protection with bioengineering.

  Cost: Low

- **Reach WB6**

  The armoured channel is in poor condition along Thickson Road. Further loss of channel armouring may result in lateral erosion and potential impacts to Thickson Road or the residential properties along the west side of the reach. Recommended works include channel restoration (bed substrate and armour stone for bed grade control, bioengineered banks).

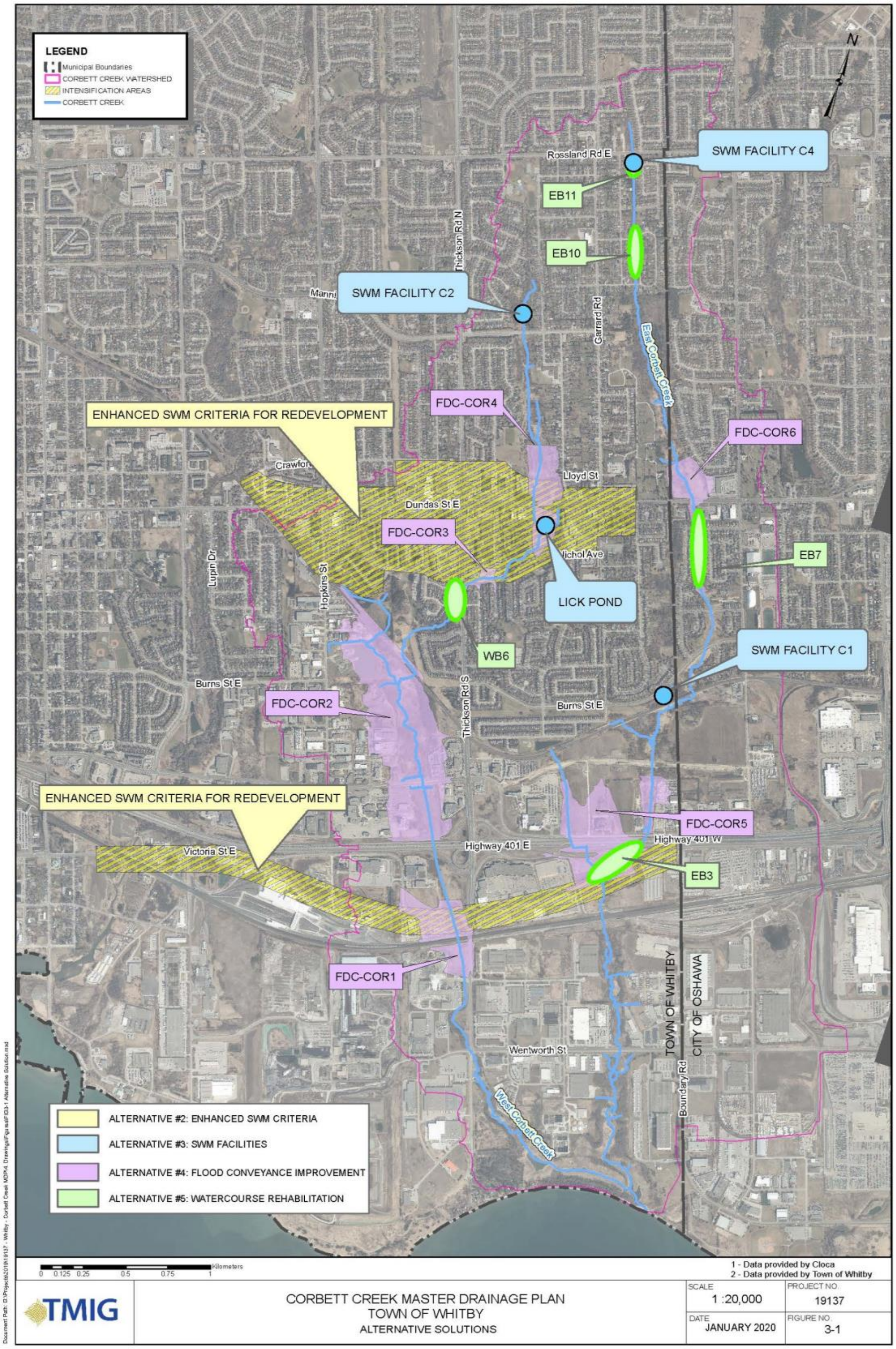
  Cost: Medium to High

- **Reach EB7**

  The reach is unstable with an exposed concrete pipe south of King Street. Continued adjustments of the channel within this reach may impact adjacent local properties or the exposed concrete pipe. Recommended works include channel stabilization (rock weirs for bed grade control, bioengineered banks).

  Cost: Medium to High

Figure 3-1 MDP Alternatives



4 Evaluation of Alternative Solutions

4.1 Evaluation Criteria

The alternative solutions described in **Section 3** were comparatively and qualitatively evaluated based on criteria developed within the following main categories, which represent the broad definition of the environment from the Municipal Class Environmental Assessment:

- **Technical Environment,** which relates to the technical feasibility, effectiveness, constructability, operation and maintenance, and other engineering aspects of the alternative solutions.
- **Natural Environment**, which relates to potential impacts and benefits to the natural and physical components of the environment (i.e., air, land, water and biota) including natural and/or environmentally sensitive areas.
- **Social/Cultural Environment**, which relates to potential impacts and benefits to residents, neighbourhoods, businesses, community character, social cohesion, community features and potential impacts to historical/archaeological remains and heritage features.
- **Financial Environment**, which relates to the capital and maintenance costs of the alternative solutions and potential reductions in future flood damages.

Within each main category, project-specific evaluation criteria were developed based on a review of the Municipal Class EA, the existing conditions of the study area and the alternative solutions being considered. The resulting evaluation criteria are summarized in **Table 4-1**. These evaluation criteria are discussed where applicable for each of the MDP alternatives in **Section 4.2**. A matrix with each alternative evaluated against all evaluation criteria is provided in **Appendix H**.

Table 4-1 Evaluation Criteria

Category	Evaluation Criteria
Technical Environment	Effectiveness in improving flood conditions, water quality, erosion, and water balance for the watershed Challenges to construct or implement the solution, including potential conflicts with existing municipal services and utilities Challenges to secure permits and approvals Potential future maintenance requirements Resiliency to future climate conditions
Natural Environment	Potential impacts on fish habitat and aquatic ecosystems Potential impacts on terrestrial wildlife and ecosystems Potential impacts on known habitat for Species at Risk Potential impacts on groundwater quality and quantity
Social/Cultural Environment	Potential impacts to public safety Potential impacts to the community during construction (noise, dust, traffic restrictions) Potential impacts to the public realm (aesthetics, trails, recreational amenities) Potential for requiring private property Potential impacts to archaeological resources
Financial Environment	Estimated costs of implementation, including property acquisition costs Estimated operations and maintenance (O&M) costs Estimated reduction in future flood damages and erosion damages

4.2 Alternative Evaluation

4.2.1 Alternative No. 1 – Status Quo (Do Nothing)

The Do Nothing alternative is represented by the current conditions of the watershed. The current SWM criteria will be applied (described in **Section 2.6.2**) to the few greenfield sites yet to be developed and also to redevelopment sites will mitigate the watershed impacts (for new development) and maintain current conditions of the watershed. Thus, for the purpose of assessing watershed conditions of the Do Nothing alternative, the current conditions of the watershed were assumed, which represents the best case scenario of the alternative.

Recommendation – The Do Nothing alternative **is not recommended** due to the potential for implementing watershed management strategies and projects described in the other alternatives.

4.2.2 Alternative No. 2 – Enhanced SWM Criteria

Technical Environment – The proposed SWM criteria includes the minimum on-site retention of 5 mm through infiltration, evapotranspiration, and reuse. Water balance benefits are expected as storms with 24-hour volumes of 5 mm or less contribute to about 50% of total average annual rainfall (City of Toronto, 2006). This is greater than the estimated infiltration component of 34% for the Corbett Creek watershed, as described in **Section 2.2.6**. Erosion control benefits are also expected with 5 mm runoff retention for sites less than 5 ha in area that would not typically have a stormwater management pond to provide erosion control. Water quality benefits are also expected from implementing controls that achieve enhanced protection (80% long-term average removal of suspended solids) (MOE, 2003) at redevelopment sites (where controls are not currently in place at most sites).

The implementation of stormwater controls at private redevelopment sites are generally feasible and standard practice for development across the Town and Greater Toronto Area as a whole. However, the timeframe to implement the controls is expected to be long-term, given that properties within the intensifications areas will redevelop over a long period of time.

Natural Environment –Enhanced SWM criteria would be applied to redevelopment sites, and thus would not impact the current natural heritage system through removals. Benefits to the natural environment would include slight improvements to water quality compared to existing conditions as redevelopment occurs.

Social/Cultural Environment – There are generally limited potential impacts to the social/cultural environment, with the exception of providing landscaped LIDs to enhance the public realm on redevelopment projects. For example, tree pits can be used for stormwater management and provide increased tree plantings and tree health in the urban environment.

Financial Environment – Implementing SWM controls to meet enhanced criteria will be predominantly funded by development proponents on private redevelopment projects.

Recommendation – Enhanced SWM criteria for the Town OP’s intensifications areas **is recommended** for the MDP. While the benefits are relatively minor and require a long-term outlook, implementation has few technical challenges or negative impacts to the natural, social/cultural and financial environments.

4.2.3 Alternative No. 3 – SWM Facilities

Technical Environment – The proposed SWM facilities are expected to provide water quality benefits to the watershed, considering that the contributing drainage areas were developed without any stormwater controls. The total watershed area captured by the proposed SWM facilities within the Town’s Stormwater Quality and Erosion Enhancement Study Update (i.e., proposed SWM Facilities C1, C2 and C4) is approximately 145 ha, which represents about 10% of the total watershed area. However, proposed SWM Facilities C1, C2 and C4 will not provide erosion control or quantity control. The proposed SWM Facilities C1, C2 and C4 will use oil-grit separators for a portion of sediment removal. Regular maintenance of the oil-grit separators is required to maintain the effectiveness of sediment removal.

Natural Environment – There is expected to be water quality benefits in the watershed through the reduction of suspended sediment removal from about 10% of the watershed where there are no existing stormwater controls. However, the facilities may not result in measureable benefits to the existing aquatic environment (i.e., restoring downstream habitat for sensitive species). The construction of the proposed SWM facilities is expected to require the removal of large areas of riparian vegetation, however the areas are to be restored with appropriate native vegetation.

Social/Cultural Environment – Given the location of the project sites near or within the Corbett Creek corridor, there is archaeological potential in the area that would need to be assessed. The projects are not located within areas of identified cultural heritage resources. A potential benefit to the social/cultural environment may include the addition of landscaped areas to enhance the public realm adjacent to the proposed SWM Facilities where there is public access (proposed SWM Facility C2). For example, trails or observation points can be added to provide recreational or educational features.

Financial Environment – The range of capital costs to implement SWM Facilities C1, C2 and C4 are $350,000 to $800,000 for each facility, according to the Town’s Stormwater Quality and Erosion Enhancement Study Update (Ecosystem Recovery, 2019).

Recommendation – The implementation of SWM facilities within already developed areas of the Corbett Creek watershed **is recommended** because of the current lack of stormwater management controls in the watershed.

4.2.4 Alternative No. 4 – Flood Conveyance Improvements

Technical Environment – Flood conveyance improvements would alleviate impacts of flooding at flood damage centres, including public safety and property damage. Specifically for FDC-COR1 and FDC-COR5, it would allow for additional development opportunities in the Town OP's intensification corridor along Victoria Street. FDC-COR3 is also partially within the Town OP's intensification area around Dundas Street and Thickson Road and flood conveyance improvements at the Thickson Road and Nichol Avenue culvert would allow redevelopment at an adjacent property.

However, CLOCA's flood risk assessment indicated that FDCs within the Corbett Creek watershed are relatively low risk compared to others within the Town and CLOCA's watersheds. Also, as described in **Section 2.6.3.1**, updated floodplain mapping for the MDP suggests that the number of buildings impacted by the Regulatory Storm is reduced from the previous 2006 floodplain mapping update.

The description of Alternative No. 4 (**Section 3.5**) consists of flood conveyance improvements through two primary methods: increase the size of conveyance structures such as culverts and increase the size of the channel corridor to contain flood flows. With respect to the design, approvals and construction, these flood conveyance works are complex in highly developed watersheds due to a number of potential constraints, including disturbances and modifications to major transportation infrastructure (railways, highways, arterial roads, etc.). Additional challenges include Town property limits and/or the acquisition of private property, construction access, construction phasing, dewatering, and environmental mitigation.

In particular, for flood conveyance improvements at the CNR, the Town will require approval from CNR and Metrolinx to replace or expand the culverts and potentially require easement agreements for new structures.

Natural Environment – Construction activities for flood conveyance improvements will impact the natural environment through disturbances in the watercourse and through construction access routes, which require vegetation removals and increases in sediment to the watercourse. Erosion and sediment controls will be required for construction. Benefits may include the removal of fish barriers within watercourses and at crossing structures as a result of the works.

Social/Cultural Environment – There is archaeological potential at the project sites given their location within the Corbett Creek corridor. Flood conveyance improvements would provide benefits to public safety in areas where emergency vehicle access may be impeded with high water levels on roads during major storm events. With respect to flooding at buildings, there are relatively few buildings in the watershed impacted by the Regulatory storm event, though flood conveyance improvements will mitigate the risk of flood damage and public safety at those buildings. The projects are not located within areas of identified cultural heritage resources.

Financial Environment – In general, flood conveyance improvements are high capital cost projects due to complex construction, lengthy design and approval processes, and the potential need to acquire private property for the works. In **Section 3.5**, high level cost estimate ranges were provided for potential flood conveyance improvements at each flood damage centre, which were mostly greater than $2 million for each project. These order of magnitude costs highlight the major financial commitment required to implement flood conveyance improvements.

Recommendation – The implementation of flood conveyance improvements **is not recommended** at this time because the flood damage centres within the Corbett Creek watershed are of lower risk and the benefits are relatively minor compared to the large financial cost and significant implementation challenges of the projects. This includes several major crossing structures that are not owned by the Town of Whitby. With respect to the Town OP's intensification corridors and areas, the need for development opportunities adjacent to Corbett Creek is not currently substantial (i.e., there are other areas outside the floodplain available for development and redevelopment) and significant effort for flood conveyance improvements is not currently warranted.

However, it is recommended that the Town and CLCOA continually review flood risk, development in the watershed and new information regarding flooding and culvert capacity to assess the need for flood mitigation projects. Future MDP reviews and updates shall revisit this alternative for consideration.

Note that the Town's current Bridge and Culvert Hydraulic Capacity Assessment Master Plan (Ecosystem Recovery, 2019) had identified the crossing at Thickson Road and Nichol Avenue as not meeting current municipal design standards. Recommendations from the above study may apply at this location, once the study has been finalized.

4.2.5 Alternative No. 5 - Watercourse Rehabilitation

Technical Environment – Watercourse rehabilitation to repair erosion sites would mitigate potential damages to infrastructure or property due to further instability in the channel. Construction of the rehabilitation works are generally localized to the erosion sites, however, will require disturbances in the watercourse, surrounding areas, and traffic for construction access routes, staging, and dewatering. While the rehabilitation design is intended to provide more resilient solutions compared to the existing condition (or previous rehabilitation works where applicable), future monitoring and maintenance of the rehabilitated works is recommended.

Natural Environment – Construction activities for watercourse rehabilitation will impact the natural environment through disturbances in the watercourse and through construction access routes, which require vegetation removals and increases to sediment in the watercourse. Erosion and sediment controls will be required for construction. With respect to potential benefits, bioengineering techniques in the watercourse rehabilitation design can provide habitat enhancement to the watercourse.

Social/Cultural Environment – There is archaeological potential at the project sites given their location within the Corbett Creek corridor. The projects are not located within areas of identified cultural heritage resources. Risks to public safety and protection of property and infrastructure would be mitigated through the watercourse rehabilitation works.

Financial Environment – The capital costs to implement watercourse rehabilitation works are generally moderate (between $100,000 and $500,000 per project). The rehabilitation works will mitigate the risk of higher costs to repair/replace infrastructure and property damages from erosion hazards should further deterioration occur.

Recommendation – The watercourse rehabilitation projects **are recommended** for implementation under the MDP to mitigate erosion risks.

4.2.6 Evaluation Summary

A summary of the evaluation and recommended solutions for the Corbett Creek Master Drainage Plan is found in **Table 4-2 to Table 4-5.**

Table 4-2 Technical Environment Evaluation Summary

MDP Alternative	Challenges	Performance
Alternative No. 1: Do Nothing	No challenges, as no works are proposed.	No reduction in frequency and severity of flooding and erosion or improvements in water quality.
Alternative No. 2: Enhanced SWM Criteria	Enhanced SWM criteria are implemented at the time of re-development in intensification areas, on a site by site basis.	Minor reductions in peak flows and improvements in water quality are expected, however, improvements will happened slowly over time.
Alternative No. 3: SWM Facilities	Construction is required near residential areas and/or high traffic areas. Oil-grit separators require frequent maintenance for proper function and effectiveness.	The new SWM facilities will provide water quality treatment for about 10% of the watershed in areas where SWM controls currently do not exist.
Alternative No. 4: Flood Conveyance	Detailed hydrology and hydraulic analysis required to determine channel and crossing structure design. Complicated and lengthy design, approvals and construction processes.	Will reduce flooding impacts at low risk Flood Damage Centres. Protection benefits limited to a small number of buildings. Flooding on emergency access routes will be improved where applicable.
Alternative No. 5: Watercourse Rehabilitation	Construction is required near residential properties or areas of high traffic (arterial and collector roads).	Restored watercourses will be protected from further erosion, however, the areas will continue to be under pressure unless erosion controls are implemented in the upstream contributing drainage area.

Table 4-3 Natural Environment Evaluation Summary

MDP Alternative	Impacts	Benefits
Alternative No. 1: Do Nothing	No impacts, as no works are proposed.	No benefits, as condition of aquatic and terrestrial habitat will remain as existing.
Alternative No. 2: Enhanced SWM Criteria	No additional impact since SWM criteria will be applied when redevelopment occurs at existing sites.	The additional erosion control and water quality control at redevelopment sites will reduce the impact of runoff on the watercourse habitat.
Alternative No. 3: SWM Facilities	Areas of vegetation will need to be removed, and disturbances to receiving watercourse due to construction within the channel.	The additional water quality control will reduce the impact of runoff on the watercourse habitat.
Alternative No. 4: Flood Conveyance	Large areas of vegetation will need to be removed, and disturbances to receiving watercourse due to construction within the channel.	Reconstructed channels and crossing structures to remove barriers to aquatic habitat connectivity and provide overall wider valley corridor with increased vegetation.
Alternative No. 5: Watercourse Rehabilitation	Temporary disturbance from construction activity.	Rehabilitated channels and culverts can potentially remove barriers to aquatic habitat connectivity and provide overall enhanced corridor with bioengineering techniques and vegetation restoration.

Table 4-4 Social/Cultural Environment Evaluation Summary

MDP Alternative	Impacts	Benefits
Alternative No. 1: Do Nothing	No impacts, as no works are proposed.	No benefits, as no works are proposed.
Alternative No. 2: Enhanced SWM Criteria	The implementation of SWM controls will occur at the time of redevelopment.	Public safety is expected to improve incrementally as the watershed impacts from runoff are reduced over time. Potential to implement landscaped LIDs that may enhance the public realm on redevelopment projects.
Alternative No. 3: SWM Facilities	Archaeological potential in previously undisturbed areas.	SWM Facility C2 has the potential to integrate landscape features to enhance the public realm, given its proposed location adjacent to an existing public trail.
Alternative No. 4: Flood Conveyance	Archaeological potential in previously undisturbed areas. Potential disturbances to major transportation routes.	Impacts of flooding (at low risk Flood Damage Centres) will be reduced to increase public safety.
Alternative No. 5: Watercourse Rehabilitation	Archaeological potential in previously undisturbed areas.	Public safety is improved and infrastructure and property is protected from further deterioration of the channel at erosion sites.

Table 4-5 Overall Evaluation Summary

MDP Alternative	Recommendation	Financial Environment
Alternative No. 1: Do Nothing	**Not recommended** Does not reduce the impact of watershed development on flooding, erosion and water quality.	No capital cost but costs will be incurred from future flooding and erosion impacts.
Alternative No. 2: Enhanced SWM Criteria	**Recommended** Enhanced SWM criteria has minimum challenges to implement and is cost effective when implemented as redevelopment occurs. The incremental benefits will be realized over time as the watershed is redeveloped.	No capital cost to the Town for private redevelopment.
Alternative No. 3: SWM Facilities	**Recommended** New SWM facilities at the identified locations will provide water quality treatment to areas of the watershed where SWM controls do not currently exist.	Moderate to high capital costs, expected to total between $300,000 and over $800,000 per project.
Alternative No. 4: Flood Conveyance	**Not Recommended** Flood conveyance improvements are not recommended at this time. Future updates of the MDP should revisit the alternative.	Very high capital costs, estimated to be greater than $2 million per project.
Alternative No. 5: Watercourse Rehabilitation	**Recommended** Restores areas of erosion concern to safeguard against risks to public safety, infrastructure and property. Provides enhancements to the natural environment.	Low to moderate capital costs, estimated between $100,000 and $500,000 per project.

5 Description of the Preferred Alternative

The preferred MDP for Corbett Creek includes the implementation of enhanced SWM criteria for development and redevelopment within the intensification areas of the watershed as well as stormwater management facilities and watercourse rehabilitation projects. The locations of the preferred alternatives are provided on **Figure 5-1**. Project specific location mapping and proposed works are summarized in technical memorandums for each recommended MDP project (**Appendix I**). Site-specific information is also provided on natural heritage, cultural heritage, recommended future studies, permitting / approvals, and impacts and mitigation.

5.1 Enhanced SWM Criteria

Enhanced SWM criteria is recommended for development and redevelopment sites within the Town OP's intensification area around Dundas Street and intensification corridor along Victoria Street, as described in **Section 3.3** and summarized in **Table 5-1**.

Table 5-1 SWM Criteria

Component	Criteria
Volume / Erosion Control	Runoff from a 5 mm rainfall event must be captured, retained or detained from all new or reconstructed impervious surfaces as a minimum requirement. For sites greater than 5 ha that propose to use a SWM pond, extended detention of the 25 mm storm for 24 hours, consistent with current criteria.
Quantity Control	Post-development peak flow rates must not exceed the corresponding pre-development peak flow rates for the 2-year through 100-year design storm events. For redevelopment of existing developed sites, peak flow rates must also be controlled to the capacity allocated to the site in the design of the downstream minor and major drainage systems.
Quality Control	Enhanced protection, corresponding to 80% long-term average removal of suspended solids, according to the MOE

Component	Criteria
	Stormwater Management Planning and Design Manual (MOE, 2003). Water quality control measures to be implemented under a hierarchy of SWM practices, as follows: (1) Low impact development measures. (2) Stormwater management facilities such as wet ponds, wetlands and hybrid ponds. (3) Manufactured treatment devices such as oil-grit separators.
Water Balance	Post-development infiltration is required to match pre-development infiltration with remedial measures to the extent possible, which is consistent with current criteria. As a minimum, redevelopment sites are required to retain a minimum of 5 mm runoff on-site for infiltration, evapotranspiration or reuse.

5.2 MDP Projects

The Corbett Creek MDP recommended projects (**Table 5-2 and Table 5-3**) include SWM facilities and watercourse rehabilitation at erosion hazard sites as outlined in **Sections 3.4 and 3.6**. The prioritization outlined below are relative to the other projects of its kind within the Corbett Creek watershed, recognizing that there are similar project needs in the Town's other watersheds, which may take priority over the MDP recommended projects.

Table 5-2 MDP Recommended SWM Facility Projects

Priority (Note 1)	Facility ID	Description	Cost (Note 1)	Timeline
1	SWM Facility C4	Oil-grit separator and plunge pool on East Corbett Creek near intersection of Rossland Road East and Meadow Road Project within Town of Whitby lands	$470,000	5 to 10 years
2	SWM Facility C1	Oil-grit separator and wetland SWM facility on East Corbett Creek near intersection of Burns Street East and Limerick Street Project within Town of Whitby lands	$350,000	5 to 10 years
3	SWM Facility C2	Oil-grit separators and wet pond on West Corbett Creek near Manning Road and Hazelwood Drive Project within Town of Whitby lands	$780,000	5 to 10 years

Note 1: Priority and cost estimates for recommended SWM facilities are based on recommendations in the Stormwater Quality and Erosion Enhancement Study Update (Ecosystem Recovery, 2019).

Table 5-3 MDP Recommended Watercourse Rehabilitation Projects

Priority	Reach	Description	Cost	Timeline
1	EB10	Valley wall protection (localized channel realignment and restoration, valley wall regrading and stabilization, valley wall toe protection with bioengineering). Culvert outlet channel restoration (scour pool, rock weirs for bed grade control, bioengineered banks). Project within Town of Whitby lands	$500,000	2 to 5 years
2	EB11	Culvert outlet channel restoration (armour stone drop structures, valley slope regrading and stabilization). Project within Town of Whitby lands	$300,000	2 to 5 years
3	EB3	Embankment toe protection with bioengineering. Project within Ministry of Transportation lands	$100,000	5 to 10 years
4	WB6	Channel restoration (bed substrate and armour stone for bed grade control, bioengineered banks). Project within Town of Whitby lands	$550,000	5 to 10 years
5	EB7	Channel stabilization (rock weirs for bed grade control, bioengineered banks). Project within City of Oshawa lands	$500,000	5 to 10 years

5.3 Implementation Strategy

The implementation strategy for the Corbett Creek MDP identifies the next steps for the recommended SWM criteria and projects to proceed with respect to additional studies, agency permits and approvals, funding mechanisms, timing, and Class EA process requirements. The implementation strategy described below is generally applicable to the detailed design and construction of capital projects identified in the MDP (i.e., SWM facilities and watercourse rehabilitation). The implementation of enhanced SWM criteria is generally more straightforward and requires the Town to inform development proponents and apply the criteria to assess development applications within the Town OP's intensification areas.

Project specific information regarding future studies, permitting and approvals is provided in **Appendix I** for each of the MDP projects.

5.3.1 Recommended Future Studies

The detailed design and construction of the MDP's recommended watercourse rehabilitation projects will require a number of additional coordinated studies. The detailed design must consider the recommendations from the studies described below to ensure that the final designs will function as intended, be safe, adhere to the MDP's principles, and meet the requirements for construction approvals.

5.3.1.1 Site Specific Ecological Assessment

The MDP completed a background, desktop review of the natural environment existing conditions and identify preliminary constraints, however, for each recommended MDP project, a site-specific ecological assessment is required. The site-specific assessment will confirm the boundaries of vegetation communities (e.g. wetlands and woodland limits), the presence of Species at Risk and/or Species at Risk habitat, and to determine appropriate protection and/or mitigation measures based on an assessment of feature significance.

5.3.1.2 Archaeological Assessments

Stage 1 archaeological assessments (AA) are required for each project area and shall be completed as soon as possible during detailed design to determine the potential for archaeological resources. If the Stage 1 AA recommends further stages of archaeological assessments, this will also be completed during detailed design. First Nations community engagement is required throughout all future archaeological assessments.

A Stage 1 AA consists of a background review of geographic, land use and historical information, and site inspection to determine if there are areas of archaeological potential. A Stage 2 AA involves a shovel test pit archaeological survey, given that the recommended project sites are generally in an urban setting with manicured or overgrown areas (contrary to greenfield sites on agricultural lands where the field is ploughed and a walking survey is conducted).

Findings from the Stage 2 AA will determine whether a Stage 3 AA (site specific assessment) is required.

5.3.1.3 Geotechnical Investigation

A geotechnical investigation at each project site is generally required to determine the subsurface soil conditions to inform the detailed design. In particular, design recommendations are required for culvert footings, retaining walls, and the slope stability for the embankments repairs, SWM pond berms, and SWM pond liners. All slopes must satisfy minimum safety factors against slope stability and requirements associated with landforms structures where needed. At the crossings, the geotechnical requirements under the CLOCA's policies must be adhered to. The investigation will also determine groundwater levels and requirements for groundwater management (and permits) during construction.

5.3.1.4 Detailed Topographic Survey and Utilities Investigation

Detailed topographic surveys will be required for each project in detailed design, for all areas potentially impacted by the design or the construction staging. The detailed topographic survey will include existing ground elevations, detailed channel elevations, relevant structures (culverts, roads, buildings, etc.), all visible utilities (manholes, hydro poles, lamp posts, etc.), and all markings for verified subsurface utilities. Buried utilities locates will also be required and a detailed utilities investigation may also be necessary.

5.3.1.5 Natural Channel Design

The design of the watercourse rehabilitation sites will need to address a number of important considerations for the ecological function and long-term erosional stability. With respect to erosion, the long-term stability of the channel and embankments will require appropriate toe protection and channel planform design (i.e., pool-riffle sequences) that can mitigate against erosive forces. The low flow channel must also be appropriate for fish habitat and fish passage to support the ecological health of the channel. Recommendations from fluvial geomorphology and fish habitat studies are to be coordinated with the detailed design of rehabilitation sites to incorporate these features.

5.3.2 Permits and Approvals

The complete list of required permits and approvals will be established during detailed design. However, it is expected that the following permits and approvals will be required for construction of the recommended projects.

- **Central Lake Ontario Conservation Authority**: A permit will be required for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Ontario Regulation 42/06).
- **Durham Region**: Engineering Approval will be required for any projects located adjacent to the Region's right-of-way and other infrastructure, such as Victoria Street.
- **Town of Whitby and City of Oshawa**: Formal approvals from the Town or City of Oshawa are not required, as the Town or City of Oshawa would be the proponent and own the lands associated with the MDP projects. However, the detailed design must consider input and be coordinated with or reviewed by a number of municipal departments. Confirmation that the project continues to comply with all applicable Town or City policies and by-laws should be sought.
- **Ministry of the Environment, Conservation and Parks**: Depending on construction requirements, registration on the Environmental Activity and Sector Registry or a Permit to Take Water will be required for construction site dewatering.

  It is recommended that consultation with respect to the Endangered Species Act with MECP staff is completed during detailed design.
- **Ministry of Transportation**: Highway Corridor Management permits are required for construction works within the right-of-way of provincial highways and adjacent regulated areas.
- **Fisheries and Oceans Canada**: A Self-Assessment will be undertaken during detailed design to determine if a review by Fisheries and Oceans Canada is warranted. If the review by Fisheries and Oceans Canada determines that the project will cause serious harm to fish that are part of or that support a commercial, recreational or Aboriginal fishery, it may be necessary to apply for an Authorization (*Paragraph 35(2)(b)*) Fisheries Act Authorization from the Minister of Fisheries and Oceans). As the proposed design will require the realignment and reconstruction of the watercourse reach, there is the possibility that an Authorization may be needed, and therefore, submission of a Request for Project Review to the DFO would be recommended.
- **Utilities**: Approvals will be required from utility owners for protection and/or relocation of existing above and below ground utilities.
- **Rail Authorities**: Consultation with CNR or CPR is recommended for all projects in vicinity of a railway to determine if coordination or approvals are required.

5.3.3 Timing and Class EA Requirements

The implementation strategy recognizes that the MDP's recommended projects will be phased in gradually over time. The application of SWM criteria will be triggered by the future private development and redevelopment projects driven by growth in the watershed, especially in the Town's designated intensification area and corridor along Dundas Street and Victoria Street.

SWM facilities and watercourse rehabilitation sites are projects (**Table 5-4**) that mitigate existing conditions in the watershed and will implemented on a priority basis. In particular, the timing to implement rehabilitation works at risk erosion sites is dependent on the severity of the erosion risk to property and/or infrastructure damage.

The SWM facility projects were identified as Schedule A+ Class EA projects. As noted in **Section 1.3**, these projects are within existing buildings, utility corridors, rights-of-way, and have minimal adverse environmental effects. These projects are pre-approved; however, the public is to be notified prior to project implementation.

Table 5-4 Timing and Class EA Requirements

MDP Component	Projects	Timing	Provisional Class EA Schedule
SWM Criteria	Enhanced SWM Criteria	The enhanced SWM criteria can be immediately effective with the completion of the MDP. The timing of SWM control measures is dependent on the development and redevelopment within the watershed.	Not applicable
SWM Facilities	(1) SWM Facility C4 (2) SWM Facility C1 (3) SWM Facility C2	Long-term, based on Town-wide prioritization of stormwater management capital	Schedule A+

MDP Component	Projects	Timing	Provisional Class EA Schedule
		projects and funding availability. Recommended timing of 5 to 10 years.	
Watercourse Rehabilitation	(1) EB3 (2) EB7 (3) EB10 (4) EB11 (5) WB6	Based on Town-wide prioritization of watercourse rehabilitation projects and funding availability. Recommended timing between 2 to 10 years.	Schedule B

1

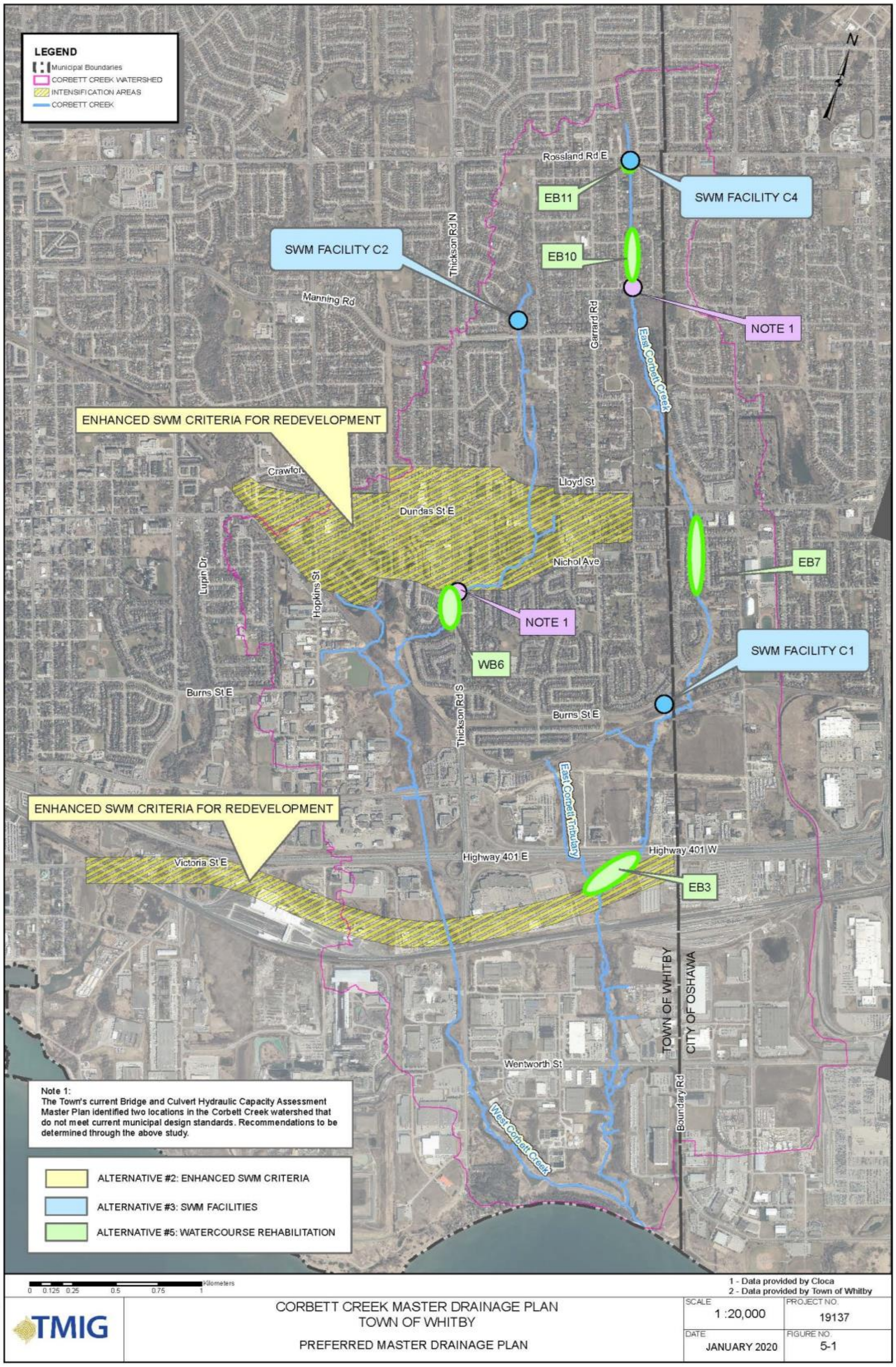
5.4 Monitoring

The establishment of streamflow monitoring stations for the East and West branches of Corbett Creek is recommended, as there is no monitoring data available to calibrate the hydrologic model for the watershed. Long-term streamflow monitoring data will also allow flood frequency analysis to be completed to assess flood risk in the watershed and monitor the impact of climate trends. As discussed in **Section 2.6.1.8**, hydrology model parameters and methodology is very conservative and produces peak flow values that are generally considered higher than actual conditions. With streamflow data, analyses can be refined to better reflect actual conditions, which will lead to more informed decisions for assessing climate change impacts and overall watershed management.

5.5 Future MDP Updates

A periodic review of the MDP every five (5) years is recommended to assess changes in the watershed, progress of recommended projects, monitoring data, the impacts of climate change, and the timing of future revisions.

Figure 5-1 Preferred Master Drainage Plan



6 Potential Construction Impacts and Mitigation

The potential construction impacts of the preferred Corbett Creek MDP projects and recommended mitigation measures are described in the following sections. Project specific impacts and mitigation is provided in **Appendix I** for each of the MDP projects.

6.1 Vegetation and Terrestrial Habitat

The construction of the MDP projects would require the removal of vegetation from the existing channel corridor. The watercourse rehabilitation sites generally consist of a thin band of riparian area, consisting of the following ELC vegetation communities: Cultural Meadow, Deciduous Swamp, Mixed Swamp, Thicket Swamp and/or Cultural Woodland. As described in **Section 5.3.1.1**, a site specific ecological assessment is required for each project to determine specific impacts and mitigation requirements.

Regardless, each site will require a detailed tree inventory and preservation plan will be prepared for the areas potentially impacted by construction. Vegetation clearing should occur outside of the breeding bird season (generally April 1st to August 31st) to prevent nest destruction (see **Section 6.2**). A comprehensive restoration plan will also be needed during detailed design that will comply with the Provincial Policy Statement, the Town's Official Plan, and will demonstrate no net negative impacts on the natural features or their ecological functions associated with the projects.

6.2 Breeding Birds

As previously mentioned in **Section 6.1**, the construction of the MDP projects would remove a considerable amount of vegetation from the existing channel corridor. During detailed design, the need for tree removals will be refined, and assessments will be carried out on any trees that may be removed. It is possible that some of these trees may provide habitat for breeding birds or bats.

The Migratory Bird Convention Act restricts tree removals or any other activity that could be construed as impacting nesting or breeding of a range of bird species generally from April 1st to August 31st. The nesting window should be confirmed during detailed design, and if tree removals cannot occur outside of this window, a qualified biologist will be required to complete a survey to determine the presence of any nesting activity prior to any removals. Bat surveys will also be conducted prior to tree removals and consultation with the MNRF will be completed.

6.3 Surface Water and Aquatic Habitat Protection

The recommended works have the potential to impact fish habitat, and therefore a Self-Assessment will be undertaken during detailed design to determine if a review by Fisheries and Oceans Canada (DFO) is required (see **Section 5.3.2**). Any in-water works could be subject to the warm water fisheries timing window, which only permits construction activity in or near the water between July 1st and March 31st. Fisheries timing windows will need to be confirmed with the MNRF and CLOCA prior to construction.

To prevent accidental introduction of debris into the water, the establishment and use of specific construction access routes is recommended, as well as the use of mitigation techniques that contain sediment, debris and other contaminants within the work site.

Best Management Practices (BMPs) for the protection of aquatic habitat and source water protection will be reviewed at the detailed design stage and incorporated into the detailed design package. The use of erosion and sediment control devices and techniques should adhere to the principles limiting soil mobilization and trapping sediment as close to the source as possible. The Greater Golden Horseshoe Area Conservation Authorities, Erosion and Sediment Control Guidelines for Urban Construction (GGHA, 2006) will be followed for the development and implementation of the comprehensive Erosion and Sediment Control (ESC) plan. BMPs to prevent contaminants from entering surface water and groundwater will also be in place, for example, implementation of appropriate fuel storage and refueling methods during construction.

6.4 Groundwater Management

It is expected that some local dewatering will be required for the construction of the MDP projects. The future geotechnical studies (and potential hydrogeological studies) required for detailed design will help determine the groundwater level and requirements for dewatering. However, any groundwater impacts during construction are likely to be localized and temporary as the anticipated zone of influence will be minimal.

While there are no known contaminated areas in the vicinity of the project sites, a site-specific review is recommended in detailed design. An Ecolog survey is to be conducted to identify potential contaminated areas within the zone of influence of each project and a monitoring, maintenance and mitigation plan shall be developed and implemented if required.

During detailed design, it will be necessary to develop appropriate strategies to minimize, treat and dispose of any dewatering discharge water. Should construction site dewatering requirements be greater than 50,000 L/day, permitting with the MECP will be required. Construction site dewatering of more than 50,000 L/day but less than 400,000 L/day (under normal site conditions) will require registration on the MECP Environmental Activity and Sector Registry (EASR) and fulfillment of EASR regulation monitoring and mitigation requirements. A Permit to Take Water (PTTW) will be required if any of the construction requires dewatering of over 400,000 L/day.

6.5 Soils Management

The proposed projects will involve topsoil stripping, excavation, and filling. All excess and unsuitable materials generated during construction will be managed appropriately. The materials may be reused as a construction material or transported from the site. Materials may also be temporarily stockpiled in preparation for these uses or temporarily removed from the site if required. A construction staging plan will detail the locations and mitigation requirements for stockpiles. Any soil stockpiles will be stabilized in accordance with the Greater Golden Horseshoe Area Conservation Authorities, Erosion and Sediment Control Guidelines for Urban Construction (GGHA, 2006), and any excess fill should be managed in accordance with up to date regulation: “On-Site and Excess Soil Management” (O. Reg. 406/19) and Rules for Soil Management and Excess Soil Quality Standards (MECP, 2019). In addition, a comprehensive ESC plan will be prepared in the detailed design stage.

Although no contaminated wastes are anticipated to exist on the site, if such wastes are encountered either naturally or through the Contractor’s efforts (e.g., diesel spill) they must be taken to an appropriately approved waste disposal site by an appropriately licensed waste disposal carrier as per the operational constraint for the management of contaminated materials, and the MECP’s York Durham District Office be contacted for further guidance. The Contractor will be required to manage all waste materials generated by construction activities in accordance with all provincial and federal regulations/approval requirements.

6.6 Property Impacts

Several MDP recommended projects are located adjacent to residential properties where construction would occur up to the limits of Town owned land. Nevertheless, the Contractor will minimize impacts on adjacent private properties by confining all construction activities to the working area and not entering upon or occupying any private property outside of the working area for any purpose unless written permission from the landowner has been obtained in advance and proof of which is provided to the Town before entering the property. Should access to private property be granted, the property will be restored to its original condition or better following the completion of construction operations.

Pre-construction condition surveys, including photographs, are recommended for properties adjacent the new channel corridor. These surveys document the physical conditions of the structures and other features on the neighbouring properties prior to construction and may assist the Town, property owners and the contractor in the event of a claim for damage.

While the lands are owned and controlled by the Town, an effective communication strategy is needed to inform the residents about the proposed works and the legal limit of their properties.

6.7 Air Quality, Noise and Vibration

The Contractor's activities, specifically the operation of construction equipment, will result in a temporary increase in noise, vibration and dust in the project area during the construction period. It is anticipated that these effects will be short in duration and limited to periods of construction machinery operation, and can be effectively mitigated by providing advance notice of construction to the adjacent property owners, by limiting construction activities to normal working hours, and applying best management practices. A comprehensive list of dust prevention and control measures can be found in Environment Canada's "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" (Cheminfo, 2005).

6.8 Traffic and Transportation

Traffic on roads adjacent to the MDP projects may be temporarily impacted to undertake the works and provide construction access. A traffic management plan will be developed in accordance with Ontario Health and Safety Book 7 to ensure the least possible impact, and standard traffic control measures will be implemented to safely co-ordinate traffic flow. Signage and flagmen will be posted if necessary during these events.

6.9 Post-Construction Impacts and Mitigation

A monitoring program is recommended to verify the effectiveness of many of the mitigation measures described in the preceding sections, which will be documented in an Environmental Management Plan (EMP). The EMP, which will be developed during detailed design, should include monitoring prior to, during and following construction, and should cover hydrometric as well as ecological parameters to measure and verify the success of the project.

7 Public Consultation

7.1 Consultation Approach

The Municipal Class Environmental Assessment (EA) requires contact with the public at certain points during the EA study. The points of public contact for this project are summarized in **Table 7-1**.

Table 7-1 Public Consultation Summary

Point of Contact	Date
Notice of Study Commencement	June 27, 2019
Community Open House No. 1	September 12, 2019
Community Open House No. 2	January 30, 2020
Notice of Completion	March 25, 2021

7.2 Notice of Study Commencement

A Notice of Study Commencement was prepared and circulated on June 27, 2019, on behalf of the Town of Whitby. A copy of the Notice is provided in **Appendix A**. The Notice was mailed directly to relevant agencies, First Nations organizations, and utilities. It was also advertised on July 11, 2019 and July 18, 2019 in *Whitby This Week* and posted on the Town's website. The Notice summarized the purpose and scope of the study and invited interested parties to provide comments. All comment forms received are included in **Appendix A**.

7.3 Community Open House No. 1

The first Community Open House (COH) was held on September 12, 2019 from 6 p.m. to 8 p.m. The COH was hosted at the Town of Whitby's Port Whitby Marina, at 301 Watson Street West. The Notice for COH No. 1 was advertised in *Whitby This Week* on August 29, 2019 and September 5, 2019, posted on the Town's website, and mailed to agencies, First Nations organizations, and other stakeholders who indicated in interest in the study from their response to the

Notice of Commencement. A copy of the Notice of COH No. 1 is included in **Appendix A**.

The purpose of COH No. 1 was to provide an overview of the project, present information on the current conditions of the watershed, and solicit feedback on the range of potential management strategies for the watershed. The COH followed an informal open house format with display boards presenting the project information. The COH provided participants with an opportunity to review and comment on the project information and correspond directly with the project team. A copy of the display boards is included in **Appendix A**. Attendees were encouraged to provide contact information on the sign-in sheet and complete a comment form.

Nine (9) people provided their contact information on the sign-in sheet and two (2) comment forms were received at the COH or shortly after the COH. Copies of the comment forms are included in **Appendix A**. Feedback from the attendees and comment forms is summarized below, with the project team's response also provided.

- Residents of Crystal Beach Boulevard were concerned with high water levels in the adjacent marsh (Corbett Creek Coastal Wetland). High lake levels and wave action have pushed larger stones, which are blocking the Corbett Creek outlet. There was a desire to have the outlet area cleared and opened when it is blocked with sediment and larger material.

  Response: The high water levels were acknowledged to be an issue for residents of that area, especially over the last few years of high lake levels impacting sediment and flow at the outlet. The Town is currently undertaking a Coastal Flood Risk Municipal Class EA to assess the risk of coastal flooding and erosion along the Lake Ontario shoreline. Results from the above study may provide recommendations for addressing sediment accumulation at the outlet.

  With respect to the MDP, the available watershed management strategies and tools (namely, stormwater management criteria, new SWM facilities, watercourse rehabilitation and watercourse conveyance improvements) are unable to appreciably address the issue of sediment accumulation at the outlet from high lake water levels and wave action.

- Mosquitos are a nuisance at the SWM pond and wetland area on West Corbett Creek south of Nichol Avenue.

  Response: Durham Region Health Department has a program to address the presence of mosquito borne diseases, such as West Nile Virus (Vector-borne Disease Control Program).

- Some back yards on Oceanpearl Crescent that adjacent to the hydro corridor have drainage issues and are wet during rainfall events.

  Response: The appropriate departments at the Town have been informed to address the issue.
- A resident discussed the wetland area establishing in Rosedale Park due to poor drainage. The area is permanently wet, with wetland vegetation and frogs living in the area. There are concerns that planned drainage improvements at the park will impact or remove the wetland.

  Response: The Town's improvements in Rosedale Park include the construction of a recreated wetland and naturalization of the area. Construction began in fall 2019.
- Erosion and widening of East Corbett Creek has been observed near residential properties on Londonderry Street in Oshawa. The flow in the creek also overflows the banks during severe storm events.

  Response: This location was reviewed during the fluvial geomorphologic assessment and has been recommended for rehabilitation in the MDP (Channel Reach EB7).

7.4 Community Open House No. 2

The second Community Open House (COH) was held on January 30, 2020 from 6 p.m. to 8 p.m. The COH was hosted at the Town of Whitby's Iroquois Park Sports Centre (Whitney Hall) at 500 Victoria Street West. The Notice for COH No. 2 was advertised in *Whitby This Week* on January 16, 2020 and January 23, 2020, posted on the Town's website, and emailed to agencies, First Nations organizations, and other stakeholders who indicated in interest in the study from their response to previous project Notices or COH No. 1. A copy of the Notice of COH No. 2 is included in **Appendix A**.

The purpose of COH No. 2 was to present the technical assessments that were completed, such as the hydrology and hydraulic analyses. The recommendations for watershed management were also provided, including the infrastructure projects proposed by the MDP. The COH followed an informal open house format with display boards presenting the project information. The COH provided participants with an opportunity to review and comment on the project information and correspond directly with the project team. A copy of the display boards is included in **Appendix A**. Attendees were encouraged to provide contact information on the sign-in sheet and complete a comment form.

Eight (8) people provided their contact information on the sign-in sheet and two (2) comment forms or responses were received at the COH or shortly after the COH. Copies of the comment forms are included in **Appendix A**. Feedback from the attendees and comment forms is summarized below.

- Residents of Crystal Beach Boulevard were concerned that the study did not identify the high water levels along the south shore of the Corbett Creek Coastal Wetland as an area of flooding and that MDP did not provide an alternative to address the issue.

  Response: As noted in **Section 7.3**, with respect to the MDP, the available watershed management strategies and tools (namely, stormwater management criteria, new SWM facilities, watercourse rehabilitation and watercourse conveyance improvements) are unable to appreciably address the issue of sediment accumulation at the outlet from high lake water levels and wave action.

  The Town is currently undertaking a Coastal Flood Risk Municipal Class EA to assess the risk of coastal flooding and erosion along the Lake Ontario shoreline. Results from the above study may provide recommendations for addressing sediment accumulation at the outlet.

- Water quality from existing industrial and commercial areas were not addressed as part of the MDP recommendations.

  Response: The MDP and other Town studies have reviewed opportunities to implement new stormwater management facilities where it is feasible. The MDP recommends three (3) facilities to improve water quality, albeit from existing residential areas. With respect to commercial and mixed-use areas, the MDP’s recommended SWM criteria will require redevelopment sites to implement stormwater controls for water quality. The opportunity to implement these measures are based on the redevelopment of the Town of Whitby’s Official Plan designated intensifications areas along Dundas Street and the Victoria Street corridor.

7.5 Draft Project File Report

Copies of the Draft Project File Report were sent to the MECP, City of Oshawa and Durham Region on April 28, 2020. Comments were received from the City of Oshawa on May 27, 2020 and the MECP on June 1, 2020. Durham Region had previously provided comments on an interim draft report in December 2019 that were addressed.

The City of Oshawa's comments regarding the proposed project located within Oshawa (watercourse rehabilitation project EB7) has initiated discussion between municipal staff from each respective municipality to coordinate the project's implementation, including funding. Comments from the MECP and a response letter was provided to outlined how their concerns were addressed.

All stakeholder correspondence regarding the draft Project File Report are provided in **Appendix A**.

7.6 Notice of Completion

A Notice of Study Completion was issued on March 25, 2021.

The Notice of Completion was advertised in *Whitby This Week* on March 25, 2021, posted on the Town's website and emailed directly to relevant agencies, First Nations organizations, utilities, surrounding property owners, and all other stakeholders who indicated an interest in the study through previous project consultations. A copy of the Notice of Completion is included in **Appendix A**, and includes the locations where the Project File Report could be viewed and instructions on how to provide comments and request a Part II Order.

Note that as of July 1, 2018, a Part II Order Request Form must be used to request a Part II Order. The Part II Order Request Form is available online on the Forms Repository website (http://www.forms.ssb.gov.on.ca/) by searching "Part II Order" or "012-2206E" (the form ID number).

7.7 Indigenous Communities Consultation

Pre-consultation with MECP at the start of the project identified the following indigenous communities with a potential interest in the study:

- Curve Lake First Nation
- Mississaugas of Scugog Island First Nation
- Alderville First Nation
- Hiawatha First Nation
- Huron-Wendat Nation

The First Nations communities identified above are to be consulted when the MDP recommended projects proceed to detailed design and construction, especially with respect to archaeological investigations. In particular, Curve Lake First Nation specifically requested a summary statement indicating how the project will address a number of areas of concern for the First Nation, such as environmental impact, fish and wild game, Aboriginal heritage and cultural values, and endangered species. The recommendation is to continue consultation at the onset of detailed design or other future studies for the MDP projects. **Table 7-2** summaries First Nations community consultation.

Table 7-2 Summary of First Nations Community Consultation

Community	Dates of Contact	Date Response Received	Comments
Alderville First Nation	2019-06-27 (L C) 2019-08-29 (L COH1) 2020-01-17 (E COH2) 2020-11-16 (E Response to comments)	2019-09-11 (E)	Requested to be informed as project moves to construction phase and would appreciate final reports on archaeological or environmental studies.
Curve Lake First Nation	2019-06-27 (L C) 2019-08-29 (L COH1) 2020-01-17 (E COH2) 2020-11-17 (L Response to comments)	2019-08-01 (L)	Requested summary statement indicating how the project will address area of concern regarding environmental impact, endangerment to fish and wild game, Aboriginal heritage and cultural values and endangered species. Indicated concern for archaeological findings, and requested that they be contacted if archaeological investigation is initiated.

Community	Dates of Contact	Date Response Received	Comments
Hiawatha First Nation (Mississaugii of Rice Lake)	2019-06-27 (L C) 2019-08-29 (L COH1) 2019-12-03 (E Follow-up) 2020-01-17 (E COH2)		
Huron-Wendat Nation	2019-06-27 (L C) 2019-08-29 (L COH1) 2020-01-17 (E COH2)	2019-07-04 (E)	No concerns, but they have requested that they be contacted if an archaeological investigation is initiated.
Mississaugas of Scugog Island First Nation	2019-06-27 (L C) 2019-08-29 (L COH1) 2020-01-17 (E COH2)	2019-09-04 (E)	Requested to be informed of open houses.

Legend of correspondence
(L C) – Letter for Notice of Commencement
(L COH1) – Letter for Notice of Community Open House No. 1
(E COH2) – Email for Notice of Community Open House No. 2
(E Follow-up) – Email for follow-up
(T) – Telephone

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