CITY OF PICKERING, HAMLET OF CLAREMONT

CLAREMONT DRAINAGE PLAN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

FINAL REPORT

NOVEMBER 28, 2022

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CITY OF PICKERING, HAMLET OF CLAREMONT

PROJECT NO.: TPB168152
DATE: NOVEMBER 28, 2022

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Executive Summary

Introduction

WSP E&I Canada Limited (WSP)., formerly Wood Environment & Infrastructure Solutions Canada Limited (Wood); has been retained by the City of Pickering (City) to assess the Hamlet of Claremont's (Hamlet) drainage system and to develop recommendations for measures to improve its performance. The study is intended to develop a comprehensive drainage improvement plan for the Hamlet that will address current drainage concerns and provide an implementation plan for the management of flooding in the area.

The Hamlet is located in the Region of Durham in Southern Ontario, north of Lake Ontario. It is a part of the Greater Toronto Area and has a population of approximately 1,200 as of the 2016 census. The Hamlet is a largely rural community located adjacent to the West Duffins Creek valley. The community is characterized by a mixture of agricultural lands and rural estate and low-density residential land uses. Drainage throughout the Hamlet is currently serviced by a series of roadside ditches, swales, culverts and storm sewers. The area's drainage system reflects the standards prevalent during the era of construction with mixed use of roadside ditches and driveway culverts, storm sewers with curbs or gutters, and natural outlets for overland drainage.

The City has received periodic drainage complaints of nuisance flooding within both public and private properties, sometimes resulting from blocked driveway culverts, road cross culverts, and debris within roadside ditches in the Hamlet.

The Hamlet has been the subject of previous drainage system assessments, which were initiated in response to flooding incidents, however the previous studies did not assess the entirety of the Hamlet's drainage system and did not follow the formal Municipal Class EA process. A Class EA study is required to complete a holistic analysis of the drainage system located within the Study Area (indicated in Figure 1), and to identify deficiencies and recommend projects to improve the drainage system and determine the appropriate level of service.

Class Environmental Assessment Process

The Hamlet of Claremont Drainage Plan Class Environmental Assessment is considered to be a Master Plan (Approach #2, Schedule B) as per the Municipal Engineers Association (MEA) Class EA process (ref. Municipal Class Environmental Assessment, MEA 2015). Under *Approach #2*, Schedule B projects which are to be implemented in accordance with the recommendations provided in this Master Plan would not require filing of a Project File for public review before the detailed design and implementation stages. Master Plans are one form of Class EA document representing long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles.

Summary of Existing Drainage Conditions

To develop an understanding of the existing drainage conditions, site visits were conducted and input from the local community was requested. Records of historical flooding events was provided by residents and the City.

The existing drainage system performance has been also assessed using a computer PCSWMM integrated hydrologic/ hydraulic model which was calibrated using observed flow and rainfall data. Through modelling and input from the community and stakeholders, an understanding of local issues for both the minor system (storm sewers and culverts) and major system (overland drainage) has been determined as per the following:

Deficient storm sewer and culvert capacity (capacity < 5-year storm):

- Franklin Street Storm Sewer – indicated as surcharging to surface; existing 300 mm diameter storm sewer constructed in 1997.
- Central Street Storm Sewer between Franklin and Canso Street – indicated as surcharging to surface; existing 450 mm to 600 mm diameter storm sewers constructed in 1997.
- Canso Street Storm Sewer between Central Street and the Canso Street Outlet – indicated as surcharged; existing 675 mm to 910 mm diameter storm sewers constructed in 1991.
- William Street Storm Sewer between David Street and Central Street – indicated as surcharged; existing 675 mm diameter storm sewer constructed in 1991.

Deficient overland flow capacity (excessive roadway depths for 100-year storm):

- Franklin Street (Urban) - sag point south of Joseph Street.
- Franklin Street (Rural) – north of Joseph Street.
- Barber Street (Rural) – insufficient ditch capacity.
- Barclay Street (Rural) – insufficient ditch capacity.
- Livingston Street (Semi-Rural) – insufficient ditch capacity.
- Wixson Street (Semi-Urban) – roadway crown overtopped.
- Canso Street (Urban) – roadway crown overtopped at sag.
- Old Brock Road (Rural) – insufficient ditch capacity.

Additional identified areas of concern:

- Numerous crushed or filled culverts
- Numerous filled ditches
- Standing water in ditches (various locations)

Alternative Assessment

Alternatives to address both minor and major drainage systems have been determined. A long-list of alternatives has been screened by considering alternative performance, costing and feasibility. A short-list of alternatives has undergone detailed assessment and evaluation as required by the MEA Class EA process with functional, environmental, social, economic and constructability evaluation categories. The short-listed alternative assessment has focused on resolving various drainage issues throughout the community with the preferred alternatives being divided between north of Central Street, Central Street and south of Central Street.

The preferred alternatives for the areas of concern which convey runoff to or from the Central Street drainage system would mitigate the major and minor system performance deficiencies. The preferred alternatives include storm sewer upgrades, installing new storm sewers, and implementing additional catch basins (ref. Table EX.1).

The implementation of these preferred alternatives would result in increased peak flow rates to the Central Street drainage system, particularly from the Franklin Street drainage improvements. Therefore, the Central Street drainage system would require to be upgraded prior to implementing the contributing drainage system improvements. The implementation of the preferred alternatives for the areas of concern which convey runoff to or from the Central Street drainage system are considered to be a high priority, and should be constructed following the construction of the Central Street preferred alternative.

The preferred alternative for the Central Street drainage system, and for the mitigation of the increased peak flow rates due to the contributing area drainage system improvements, is to divert runoff from the East Channel control manhole westward via a diversion storm sewer to three (3) proposed underground SWM storage tanks within the Central Street ROW at the intersection with Williams Street / Canso Drive. The SWM tanks would discharge to the Canso Drive storm sewer and the West Channel outfall located behind the residential property at 4994 Canso Drive. This preferred alternative would mitigate the peak flow rates discharging to the East and West channels, while also mitigating the Central Street major and minor system performance deficiencies.

The preferred alternative of upsizing the Central Street storm sewer from Franklin Street to Williams Street / Canso Drive, in addition to the upsizing of storms sewers which contribute to Central Street, has been recommended for implementation to address the ongoing drainage deficiencies to the major and minor systems. Three (3) underground stormwater management tanks will be required to address the peak flow rate increases to the West Channel outfall, at Canso Drive.

The preliminary cost for the construction of all the recommended works is the $5,474,000 with an additional $435,000 for road restoration works following construction. The preliminary annual operations and maintenance cost of the preferred alternative is estimated at $3,000 based on annual inspection, debris removal and cleanout every eight(8) years .

Implementation

Prior to detailed design of the preferred alternatives, the following should be conducted:

1. A Stage 2 archaeological assessment by means of test pit survey should be conducted in those areas of archaeological potential as identified in the Stage 1 Archaeological Assessment (ref. Appendix G), and a pedestrian archaeological survey should be conducted at 5-m intervals on open agricultural fields.
2. Site-specific inventories of the key Natural Heritage features (if works are proposed within minimum areas of influence) and the habitat of SAR should be conducted to determine the need for additional assessment (ref. Figure 13).
3. Based on a wetland assessment of the East and West Wetlands, additional flow monitoring, a groundwater characterization, and hydrological continuous simulation modeling is required in addition to further consultation with TRCA for the West Wetland.

Table EX-1. Summary of the Preferred Alternatives and the Prioritization

PRIORITY	LOCATION	PREFERRED ALTERNATIVE	MUNICIPAL CLASS EA SCHEDULE	EA STATUS
High	William Street / Canso Drive	Upsize the storm sewers from Henry Street to the outfall at the West Channel (250 m (+/-) of 1050 mm diameter storm sewer).	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
High	Central Street	Upsize storm sewers from Franklin Street to William Street / Canso Drive and construct three (3) underground SWM tanks within the Central Street ROW; 400 m (+/-) of storm sewers ranging in size from 750 mm to 975 mm.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
High	Franklin Street	Install new storm sewers on Franklin Street from 100 m north of Joseph Street to Joseph Street, increase the storm sewer sizes on Franklin Street from Joseph Street to Central Street, and install four (4) twin catch basins, two (2) single catch basins, and three (3) ditch inlet catch basins; the total length of storm sewer is 280 m (+/-) ranging in diameter from 600 mm to 750 mm.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
High	Old Brock Road	Implement new storm sewers and catch basins on Old Brock Road from 170 m (+/-) north of Joseph Street to Henry Street; catch basins should also be installed on Joseph Street. The existing 375 mm diameter and 60 m (+/-) long storm sewer north of Central Street would be increased to 450 mm diameter.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.

PRIORITY	LOCATION	PREFERRED ALTERNATIVE	MUNICIPAL CLASS EA SCHEDULE	EA STATUS
High	Wixson Street	Install ten (10) single new catch basins and two (2) twin catch basins on Wixson Street between Lane Street and Central Street. Increase the diameter of the existing 450 mm 85 m (+/-) long storm sewer north of Central Street to be 525 mm diameter.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Lane Street	Regrade the east side of the Lane Street and Old Brock Road intersection to convey drainage away from the intersection. Re-profile the existing east Old Brock Road ditch.	Schedule A	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Livingston Street	Reprofile the east Livingston Street ditch, twin the existing 375 mm CSP culvert that traverses the roadway, and reprofile the easement ditch between Livingston Street and the East Channel.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Canso Drive – Acorn Lane	Upsize the existing 300 mm diameter storm sewers on Canso Drive and Acorn Lane, 90 m (+/-) and 85 m (+/-) respectively, to be 450 mm diameter, and implement a storage tank within the Canso Drive boulevard.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Wellington Street	Do nothing; the reduction in peak flow rates discharging to the East Channel will mitigate the impacts to the Wellington Street roadside ditches, however, will not fully mitigate the risk of flooding to the adjacent properties.	N/A	

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1 INTRODUCTION

1.1 PURPOSE / OVERVIEW

WSP E&I Canada Limited (WSP); formerly Wood Environment & Infrastructure Solutions Canada (Wood) has been retained by the City of Pickering (City) to assess the Hamlet of Claremont's (Hamlet) drainage system and to develop recommendations for measures to improve its performance. The study is intended to develop a comprehensive drainage improvement plan for the Hamlet that will address current drainage concerns and provide an implementation plan for the management of flooding in the area.

This document represents the final Claremont Drainage Plan Class EA report. This report documents the review of background information provided as part of this study, establishes a baseline characterization of the study area (i.e. soils, land use, topography) and drainage infrastructure, identifies and evaluates alternatives to address the ongoing drainage issues, and the selection of a preliminary preferred alternative. A summary of the recommended drainage system improvements in provided accordingly along with a preliminary prioritization.

1.2 STUDY BACKGROUND

The Hamlet is located in the Region of Durham in Southern Ontario, north of Lake Ontario. It is a part of the Greater Toronto Area and has a population of approximately 1,200 as of the 2016 census. The Hamlet is a largely rural community located adjacent to the West Duffins Creek valley. The community is characterized by a mixture of agricultural lands and rural estate and low-density residential land uses (ref. Figure 1).

Drainage throughout the Hamlet is currently serviced by a series of roadside ditches, swales, culverts and storm sewers. The area's drainage system reflects the standards prevalent during the era of construction with mixed use of roadside ditches and driveway culverts, storm sewers with curbs or gutters, and natural outlets for overland drainage (ref. Appendix A for site reconnaissance photographs).

In 2009/2010, the City retained a Consultant to undertake an analysis of the drainage system in Claremont, following some flooding incidents on Franklin Street. The study provided findings regarding the storm sewers on Franklin Street and Central Street. However, the scope of the subject analysis was determined to be too narrow to assess and improve the overall drainage system in the central area of the Hamlet. As a part of the study, a PCSWMM model of the drainage system was created. The model included storm sewers on William Street, Wixson Street, Franklin Street, Dow Street and Central Street. The results of the 2009/2010 analysis determined that the drainage system is largely undersized. The study recommended improvements to the drainage system, which included providing a 10-year capacity storm sewer on Central Street and 5-year capacity storm sewers elsewhere.

In 2012, the City received drainage complaints from properties located along Livingston Street and Bovingdon Place, about a poorly functioning ditch due to excessive vegetation growth. The City retained a consultant in 2013 to complete a design for the ditch cleanout, and secure the necessary approvals from Toronto and Region Conservation Authority (TRCA) and Ministry of Northern Development, Mines, Natural Resources, and Forestry (MNDMNRF) prior to construction. During the design process, subsurface utilities mapping determined that the TransCanada pipeline is only 1.3 m below the surface of the ditch, and a minimum allowable cover of 1.2 m over the pipeline is required. Given this restriction, the maximum possible slope that could be achieved on the ditch was 0.5%. It was hence determined that this gentle slope would be too difficult to construct with precision and would promote more vegetation growth, which would prevent the ditch from functioning properly.

In recognition of the foregoing, the City of Pickering initiated this Class EA Study to more broadly and comprehensively formalize the understanding of the legacy of drainage problems facing the Hamlet, and to systematically and consultatively develop a Drainage Plan to address the Hamlet's drainage concerns.

1.3 CLASS ENVIRONMENTAL ASSESSMENT PROCESS

The Ontario Environmental Assessment Act provides for *"…the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management in Ontario of the environment."* An approved Class Environmental Assessment (Class EA) document describes the process that a proponent must follow for a class or group of undertakings in order to satisfy the requirements of the Environmental Assessment Act, and represents a method of obtaining an approval under the Environmental Assessment Act and provides an alternative to carrying out individual environmental assessments for each separate undertaking or project within the class.

The Hamlet of Claremont Drainage Plan Class Environmental Assessment is considered to be a Master Plan as per the Municipal Engineers Association (MEA) Class EA process (ref. Municipal Class Environmental Assessment, MEA 2015). Master Plans are one form of Class EA document representing long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. The following characteristics distinguish the Master Planning Process from other processes:

a. The scope of Master Plans is broad and usually includes an analysis of the system in order to outline a framework for future works and developments. Master Plans are not typically undertaken to address a site-specific problem.

b. Master Plans typically recommend a set of works which are distributed geographically throughout the study area and which are to be implemented over an extended period of time. Master Plans provide the context for the implementation of the specific projects which make up the plan and satisfy, as a minimum, Phases 1 and 2 of the Class EA process (ref. Figure 1.1). Notwithstanding that these works may be implemented as separate projects, collectively these works are part of a larger management system. Master Plan studies in essence conclude with a set of preferred alternatives and, therefore, by their nature, Master Plans will limit the scope of alternatives which can be considered at the implementation stage.

The Hamlet of Claremont Drainage Plan has been prepared in accordance with the Municipal Engineers Association (MEA) Class Environmental (Class EA) procedures. This Class EA was originally envisioned as to be completed under Approach #2 of the Municipal Class EA process. However, at the conclusion of the Study, based on the preferred alternatives identified, and the information available to satisfy Class EA documentation and consultation requirements, this Study was concluded under Approach #1 of the Municipal Class EA process. *Approach # 1* involves the preparation of a Master Plan document at the conclusion of Phases 1 and 2 of the Municipal Class EA process. *Approach # 1* addresses Phases 1 and 2 of the Class EA process (ref. Figure 1.1). Under *Approach #1*, Schedule B projects would require the filing of the Project file for public review while Schedule C projects would have to fulfil Phases 3 and 4 prior to filing an Environmental Study Report (ESR) for public review. However, as discussed in Section 7 of this report, this Master Plan only proposed Schedule A/A+ projects. These projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.

The Terms of Reference outlined a three (3) part task-based work plan as follows.

Part 1: Project Initiation (Problem Definition and Site Analysis)

Part 1 represents Phase 1 of the Municipal Class Environmental Assessment Process (ref. Figure 1.1). For this Class Environmental Assessment, that has included conducting a background review of available documents, drawings, mapping and modelling and receiving input from agency stakeholders and the public. Based the background review, an initial problem statement was prepared, which was revised as assessment of the Hamlet proceeded. Assessment of the Hamlet included existing drainage conditions, soils, the natural heritage system, cultural heritage, and an Archaeological Stage 1 Investigation.

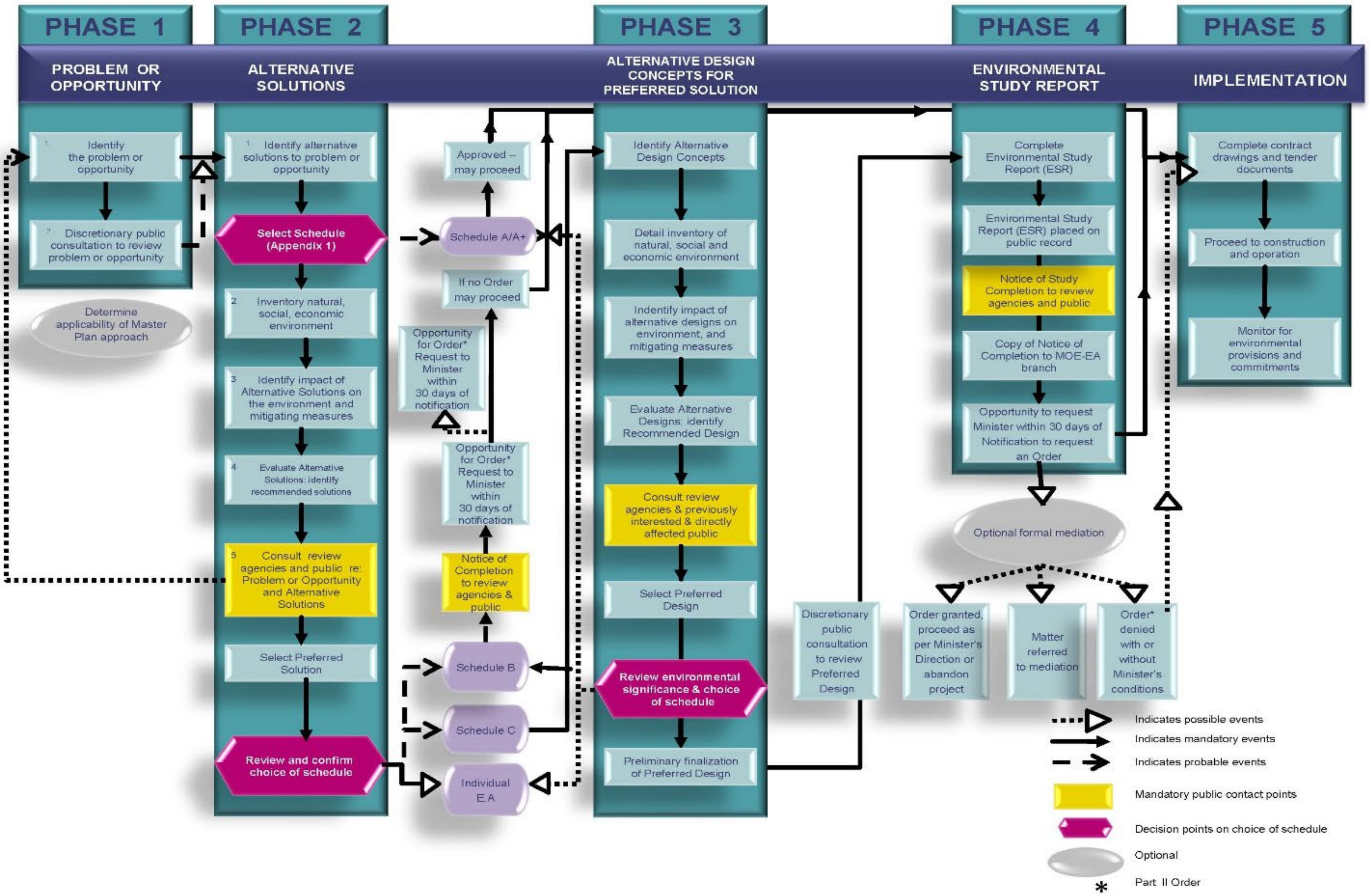
Part 2: Development of Alternatives, Alternative Analysis and Preferred Alternatives

Part 2 represents Phase 2 of the Municipal Class Environmental Assessment Process (ref. Figure 1.1). A long list of drainage improvement alternatives has been developed and subsequently assessed based on evaluation criteria (functional, environmental, social, economic, and constructability) to determine a short-list of alternatives, which underwent a detailed assessment to facilitate selection of the preferred alternatives.

Part 3 Project File (Reporting)

Part 3 Project File represents Phase 2 (ref. Figure 1.1) of the Municipal Class Environmental Assessment Process, the Project File Report. Following selection of the preferred alternatives, the Project File Report is prepared and is then placed on public record for review by the public and review agencies. A Notice of Study Completion is circulated, allowing the public and agencies thirty (30) days to review the report and provide comments. As part of the review process, any individual can request an order (i.e., Section 16 Order Request) from the Minister of the Ministry of the Environment, Conservation and Parks (MECP) to require higher level of study or to impose conditions on the projects. Such requests would be possible only for those Schedule ‘B’ and ‘C’ projects identified in the Master Plan which are subject to the Municipal Class EA, and not the Master Plan itself. As noted previously, and detailed in Section 7 of this report, this Master Plan only proposed Schedule A/A+ projects. These projects are exempted from the requirements of the Environmental Assessment Act. Accordingly, these projects will not be subject to Section 16 Order Request process. These projects can proceed to detailed design phase.

Figure 1.1. Municipal Class Environmental Assessment Process (ref. Municipal Class Environmental Assessment, MEA 2015)



1.4 PUBLIC/AGENCY CONSULTATION

As noted, the Claremont Drainage Plan is subject to the Class EA process; as such it has been conducted according to the requirements outlined in the governing MEA, Municipal Class EA process. The study approach has been established to meet the following objectives:

i. Protection of the environment, including natural, social and economic components of the environment.
ii. Participation of a broad range of stakeholders in the study process to allow for sharing of ideas, education, testing of creative solutions and developing alternatives.
iii. Documentation of the study process in compliance with all phases of the Municipal Class EA process.

The Municipal Class EA requires notification of, and consultation with, relevant stakeholders (ref. Appendix M for Public Consultation). The Project Team has ensured that stakeholders were notified early in the planning process, and throughout the study as per the following:

1.4.1 NOTICE OF STUDY COMMENCEMENT

The Notice of Commencement for the Study was issued on February 22, 2017. The notice was published in the Pickering News Advertiser for two (2) consecutive weeks, and copies of the notice were mailed out to stakeholders, review agencies, First Nations, as well as local residents. A copy of the notice, distribution list and responses from review agencies are included in Appendix M.

1.4.2 MEETINGS

- The consultation process also included one meeting with local residents held on March 9, 2020, and one meeting with Geranium Homes and engineering consultant held on December 10, 2020.
- Public Information Centre No. 1 (November 20, 2020 to December 11, 2020).
- Public Information Centre No. 2 (August 19, 2021, to September 16, 2021)

The first Public Information Centre (PIC#1) was posted on the City's website on November 20, 2020, for the review and commenting period until December 11, 2020. The PIC#1 was advertised in the Pickering News Advertiser for two consecutive weeks, and copies of the notice were mailed out to stakeholders, review agencies, First Nations, as well as local resident.

Four (4) Local residents provided comments via comment form or email to the project team regarding the material presented within PIC#1. Comments were also received from two (2) the stakeholders and one (1) reviewing agency, Toronto and Region Conservation Authority (TRCA); the comments are provided within Appendix M.

The second Public Information Centre (PIC#2) was posted on the City's website on August 19, 2021, with comments due on September 16, 2021. The PIC#2 was advertised in the Pickering News Advertiser for two consecutive weeks, and copies of the notice were mailed out to stakeholders, review agencies, First Nations, as well as local residents.

Six (6) Local residents submitted comments via the comment form or email to the project team; the comments are summarized within Appendix M. One (1) stakeholder provided comments in addition to comments received by TRCA and the Region of Durham.

1.5 INDIGENOUS ENGAGEMENT

Indigenous engagement is a key component of the Class EA process. The MECP delegated the procedural aspects of the duty to consult to the City in its response to the Notice of Commencement on December 7, 2020. Copies of all Indigenous engagement documents can be found in Appendix N.

1.5.1 IDENTIFICATION OF INDIGENOUS NATIONS

In consultation with the MECP, the City sought direction on the identification of Indigenous Nations that may have an interest in the Municipal Class Environmental Assessment. Request for confirmation was submitted to the MECP on December 7, 2020. Upon confirmation from the MECP, an email including the Notice of On-line PIC were sent to the following Indigenous Nations on November 20, 2020:

- Alderville First Nation (AFN);
- Curve Lake First Nation (CLFN);
- Hiawatha First Nation (HFN); and
- Mississaugas of the Scugog Island First Nation (MSIFN);

Based on understood Indigenous Nation specific consultation protocols, individual communications were issued to the Nations. Due to the COVID-19 pandemic, several Indigenous Nations identified preference for communications to be through email only. The Nations were initially contacted on August 8, 2021, and August 19, 2021. These two communications shared details about the second online engagement event that took place between August 19 to September 16, 2021.

1.5.1.1 *ALDERVILLE FIRST NATION*

Following the August 8, 2021 correspondence, a phone call was held between AFN and Wood. As a follow-up to the phone call, Wood sent an email on August 19, 2021 to inquire if the Nation had any comments or concerns about the Project. AFN responded and identified they had no concerns and that they would be interested in the study reports (e.g. Species at risk, archaeological reports). Wood responded stating that the Nation would be kept informed about their items of interest.

1.5.1.2 *CURVE LAKE FIRST NATION*

On February 2, 2021, CLFN sent an email containing a letter which outlined the Nation's concerns with the Claremont Drainage Plan. CLFN was concerned about the drinking water, the endangerment of fish and wild game, as well as the potential Aboriginal heritage that could be discovered. Wood responded to these concerns on April 1, 2021, and offered to discuss the project further via a virtual meeting.

Wood followed up with CLFN on July 20, 2022 to better understand CLFN's Special Consultation Framework and discuss some of the concerns raised in February 2021. Wood offered to set up a meeting to discuss the Project and reminded CLFN of the PIC materials available for review and comment. Wood followed-up on via phone call and email on July 28, 2022. On August 2, 2022, Francis Chua Consulting, on behalf of CLFN responded identifying that there is interest in having a meeting and provided suggested dates and times. Wood followed-up on August 8, 2022 and September 8, 2022 to confirm the date and time for the meeting. No further response was received from Francis Chua Consulting or CLFN.

1.5.1.3 *HIAWATHA FIRST NATION*

Following the August 8, 2021 correspondence, HFN responded and identified that they had no questions or concerns at this time.

1.5.1.4 *MISSISSAUGAS OF THE SCUGOG ISLAND FIRST NATION*

WSP followed up with MSIFN on July 20, 2022 to share the Project website and request any comments or concerns on the Project. On the same day, MSIFN responded noting that they reviewed the Project website and do not have any comments on the PIC materials. However, MSIFN requested the Master Plan Report for review when it is completed.

1.6 PROJECT ORGANIZATION/MANAGEMENT

This drainage assessment has been directed and reviewed by a Project Team, which has been comprised of representatives from various departments at the City of Pickering and Toronto Region Conservation Authority. The Project Team has consisted of staff from the following organizations:

Proponent: City of Pickering

Marilee Gadzovski, Division Head, Water Resources and Development Services (Involved for the review of the Existing Conditions Report only)
Irina Marouchko, Senior Water Resources Engineer – Water Resources and Development Services

Stakeholder Agency: Ministry of Environment Conservation and Parks (MECP)

Erinn Lee, Regional Environmental Planner
Mimi Santano Carrasco, Environmental Planner

Stakeholder Agency: **Toronto and Region Conservation Authority (TRCA)**

Caroline Mugo, Senior Planner
Shauna Fernandes, Senior Planning Ecologist
Catalina Herrera, Planning Ecologist
Sukhmani Bola, Water Resources Engineer

Consultant: **WSP E&I Canada Limited (WSP; formerly Wood)**

Ron Scheckenberger, Project Advisor
Steve Chipps, Senior Project Manager
Patrick MacDonald, Project Engineer

1.7 REPORTING OVERVIEW

The report describes the background information, field reconnaissance and outlines the analyses of the Hamlet's drainage system under existing conditions while identifying a long list of mitigation measures that could be implemented to address the existing drainage deficiencies. The long list of alternatives for drainage system improvements has been reviewed and screened to a short list of alternatives that have been evaluated for the various streets within drainage performance deficiencies to select a series of preferred alternatives. Details regarding the analyses completed, including field photographs, hydrologic/hydraulic models, and calculations are provided within the respective appendices.

2 PHASE 1 – IDENTIFICATION AND DESCRIPTION OF THE PROBLEM

2.1 DEFINITION OF THE DRAINAGE PLAN STUDY AREA

Drainage throughout the Hamlet is currently serviced by a series of roadside ditches, swales, culverts and storm sewers. The area's drainage system reflects the standards prevalent during the era of construction with mixed use of roadside ditches and driveway culverts, storm sewers with curbs or gutters, and natural outlets for overland drainage (ref. Appendix A for site reconnaissance photographs). As such, the drainage infrastructure within the community was not built to meet formal or current engineering standards

2.2 IDENTIFICATION OF THE PROBLEM

There is a lack of capacity in the major (overland) and minor (storm sewer) drainage systems which has resulted in an increased frequency of flooding to private property and within the public rights of way. The City initiated the study to complete a comprehensive analysis of the existing drainage system, identify deficiencies, and develop a drainage management strategy to address the deficiencies.

2.3 PROBLEM STATEMENT

The City has received periodic drainage complaints of nuisance flooding within both public and private properties, sometimes resulting from blocked driveway culverts, road cross culverts, and debris within roadside ditches in the Hamlet.

The Hamlet has been the subject of previous drainage system assessments, which were initiated in response to flooding incidents, however the previous studies did not assess the entirety of the Hamlet's drainage system and did not follow the formal Municipal Class EA process. A Class EA study is required to complete a holistic analysis of the drainage system located within the Study Area (indicated in Figure 1), and to identify deficiencies and recommend projects to improve the drainage system and determine the appropriate level of service.

3 PHASE 2- IDENTIFICATION AND EVALUATION OF ALTERNATIVE SOLUTIONS TO THE PROBLEM

3.1 BACKGROUND INFORMATION AND DOCUMENTATION

Various datasets of background information have been used for this assessment which include monitoring data, Geographic Information Systems (GIS) mapping, reports and drawings and modelling data. A summary description of the information used for this assessment has been provided in the following.

3.1.1 MONITORING DATA

Monitoring data which includes measured rainfall data and local flow monitoring data, collected by Wood, are provided in Appendix B while the discharge rating curves are provided within Appendix C. Flow data were recorded in 15-minute intervals at three (3) locations; one (1) monitoring location within the City's storm sewer network and two (2) monitoring locations within open channel systems within the study area. Data were collected for the period between April 2017 to November 2017.

3.1.2 TECHNICAL DRAWINGS AND MAPS

The City of Pickering provided a CAD base map for the Hamlet, which included 1-meter interval contour data, mapping of storm water management infrastructure such as storm sewers, maintenance holes, catch basins, swales, outfalls, as well as aerial imagery for the study area. Additional data provided includes road right-of-way limits, building footprints and property parcels.

In addition to the aforementioned information, the City of Pickering and Toronto Region Conservation Authority have supplied reports, drawings and other documentation as per the following:

i. Joseph Street – Plan and Profile (City of Pickering, October 1973)
ii. Lane Street – Plan and Profile (City of Pickering, November 1973)
iii. Lorn Street – Plan and Profile (Town of Pickering, August 1975)
iv. David Street – Plan and Profile (City of Pickering, August 1976)
v. Dow Street – Plan and Profile (City of Pickering, October 1976)
vi. Henry Street – Plan and Profile (City of Pickering, October 1976)
vii. Livingston Street – Plan and Profile (City of Pickering, June 1977)
viii. Central Street, Regional Road 5 Plan and Profile (1986).

ix. Claremont Estates – Plan and Profile of William Street (Cosburn Patterson Wardman Ltd, March 1987)
x. Plan of Survey of Part of Lot 19, Concession 8 and Part of Lots 7,8,9,10,14,15 and Block 22 (1988).
xi. Regional Road 5 – Plan and Profile (Region of Durham, August 1991)
xii. County Creek Estates – Plan and Profile for Acorn Lane and Canso Drive, (John Hudspith Associates Limited – October 1991)
xiii. Plan of Survey of Part of Lots 1,2,4,7,8,12,13,14 (1992).
xiv. Central Street, Regional Road 5 Plan and Profile (Paul Theil and Associates – May 1996)
xv. XMPL Subdivision Phase II - Plan and Profile for Acorn Lane, (David Schaeffer Engineering Ltd, October 1997)
xvi. Wixson Street – Plan and Profile (City of Pickering, February 1998)
xvii. Claremont Estates – Phase II – Plan and Profile of Tom Thomson Court (David Schaeffer Engineering Ltd, April 2006)
xviii. Victoria Street – Plan and Profile (City of Pickering, July 2007)
xix. Wellington Street – Plan and Profile (City of Pickering, July 2007)
xx. Claremont Park Master Plan - Concept Plan (January 2016).
xxi. Sewer CCTV Inspection by Eye-View (Completed October 2017).

3.1.3 TOPOGRAPHIC SURVEY

In order to fill gaps related to topography for areas with missing information, specifically related to surface drainage features including open channels, culverts and roadside ditches, Wood's survey crew was deployed. These data have been incorporated into the hydraulic modelling of the Hamlet, as discussed in further detail in Section 4.

3.1.4 REPORTS

The following documents and reports (ref. Appendix D) considered relevant to the project objectives, have been reviewed:

"Study of Road Improvements for RR No. 5", Paul Theil Associates Limited (May 1996)

The study was undertaken to examine proposed improvements to Rural Road No. 5 proposed through Claremont. The study investigated the study area's existing conditions and developed a hydrologic model using OTTHYMO89 to assess the existing drainage network. The objective of the study was to model the area and develop a strategy to improve the existing road drainage and alleviate impacts where possible.

The recommended approach was a 'Natural Drainage' approach which included conveyance by ditches or shallow swales along Central Street. The report also investigated several existing drainage issues which were pre-existing in the area.

“XMPL Phase II Subdivision’ Hydrogeologic Study”, Jagger Hims (March 2010)

This report was prepared in support of the application for approval of the Draft Plan of Subdivision ‘XMPL Phase II’. The study was undertaken to document the availability of ground water to service the 26-lot residential development, and to assess the impacts of subsurface sewage disposal systems. The properties are located on Acorn Lane, Kodiak St, and Carpenter Ct. which is west of the subject study area. The report indicated that there were signs of a high groundwater table within all but one of the test pits. The report identified that the high-water table was between 0.45 m and 1.25 m below ground surface.

“Claremont Flooding Analysis Solutions”, AECOM Canada Ltd. (July 2010)

This memorandum summarized the results of several PCSWMM hydrologic modelling assessments developed to evaluate various alternatives for mitigating drainage issues within the Hamlet. The drainage issues had been previously investigated in earlier reports commissioned in response to basement flooding in the study area. The memorandum evaluated nine (9) proposed alternatives on the basis of cost and effectiveness in flood reduction. The alternative recommended was Alternative 9, which was to provide a 10-year storm sewer on Central Street and 5-year storm sewers elsewhere.

“2012 Duffins Creek Hydrology Update”, Aquafor Beech Limited (February 2013)

The purpose of the report was to update the hydrologic model of the Duffins Creek Watershed. The key objectives of the study were to capture land use changes, update Stormwater management criteria, develop flood control criteria, and assess impacts to Regional Storm flows associated with proposed future developments. The hydraulic model was initially developed in 1979 by James F. MacLaren Limited, and was periodically updated to reflect changes within the watershed.

The model was prepared using Visual OTTHYMO version 2.1, with model parameters derived from TRCA’s GIS database. The watershed was divided into 56 subcatchments, where data were available stormwater management facilities were incorporated into the model. The model was calibrated using existing rainfall data and data from streamflow gauges.

The report prescribed an updated stormwater control strategy based on pre-development unit flow rates for each subcatchment. The prescribed control strategies were expected to mitigate the large flow increases which would otherwise occur without control. It would also better match existing flow rates on the West, East and downstream branches of Duffins Creek.

“City of Pickering Stormwater Design Guidelines” (As of: January 2017)

The City of Pickering has developed Stormwater Design Guidelines for developers, engineers and architects for preparing development plans in the City of Pickering. The goal of the manual is to provide technical tools and guidelines to comply with the City’s stormwater management requirements and infrastructure design standards (current). Various relevant standards have been identified as per the following:

- Minor Systems shall be sized to capture and convey the 5 Year Storm.
- Major Systems shall be sized to capture and convey the Regulatory Event to a safe outlet without flooding adjacent properties and should provide a minimum of 300 mm of freeboard from the maximum water surface elevation of the major system flow path to the minimum opening of structures. The Regulatory Event is defined as the larger of the 100 year storm or the Regional Storm.
- Local Roadway's which are utilized as a major drainage system shall be designed such that flow depth resultant of the Regulatory Event is limited to the lesser of 150 mm above the roadway crown, or the right-of-way (ROW) limit.
- Culverts servicing 'rural local' roadways shall be sized to convey at least the 25 year storm, Culverts servicing 'urban local' roadways shall be sized to convey at least the 50 year storm.

3.1.5 MODELLING DATA

The following modelling data were provided by the City of Pickering and/or the Toronto and Region Conservation Authority:

- HEC-RAS hydraulic model for Duffins Creek (ref. TRCA Duffins Creek Floodline Mapping Study: Catchments 13, 14 and 27, October 2003). The hydraulic model does not include the drainage features contained within the study area.
- PCSWMM model developed as part of an earlier drainage study (AECOM, 2013). The model was not discretized to sufficiently account for inlet capacity constraints within the study area. The model did not extend south of Central Street.

3.2 STUDY AREA CHARACTERISTICS

The identified study area, shown on Figure 1, generally consists of low-density residential areas, with agricultural external drainage areas contributing to the runoff to residential drainage systems; the residential drainage systems discharge to flow-through wetlands prior to out-letting to tributaries of Duffins Creek. There are multiple drainage conveyance systems within the low-density residential study area, and are summarized as follows:

- Rural roadway with storm sewers
- Urban roadway with storm sewers
- Rural roadway with ditches
- Mixed rural and urban roadway with ditches and storm sewers
- Storm sewer system
- Open channel – overland flow

The mixture of drainage practices were likely implemented at various stages of the community's development, and prior to the generally accepted current drainage practices. The mixture of drainage practices were also implemented to convey runoff during frequent, storm events, and likely were not designed to convey the runoff generated during less frequent, larger storm events.

The following sub-sections further discuss the study area characteristics.

3.2.1 SOILS

Surficial soils data for the study area (as available from Agriculture Canada – Ontario Soil Survey Reports) suggest that the surficial geology within the Hamlet is characterized as medium textured Glaciolacustrine deposits (silt, sand, and minor clay). The dominant soil group for the study area was identified as 'Woburn' which corresponds to a Loam to Silt Loam NRCS soil classification.

The City of Pickering also provided a Hydrogeologic Study (Jagger Hims Ltd, March 2000), which indicated that there were signs of a high groundwater, west of the study area (now Carpenter Crescent and Kodiak Street). The study identified that the high-water table was interpreted as between 0.45 m and 1.25 m below ground surface. The soils identified for the area were reasonably consistent with those identified by the Ontario Soil Survey report (Agriculture Canada, 1956).

3.2.2 LAND USE

The existing land use within the Hamlet is primarily residential, with some institutional land use (schools, church), and parkland/agricultural areas. Figure 1 provides an aerial overview of the study area. Residential development in the Hamlet is generally older (1850's or newer), and consists of single detached residences, with larger backyard areas, which are typically well-vegetated (with extensive tree coverage).

3.3 STUDY AREA INVESTIGATION

Site investigations of the study area have been conducted as part of this study (ref. Appendix A). Initial site visits of the drainage features and crossings occurred on March 27, 2017 to identify suitable locations for the installation of flow monitoring equipment. An additional site visit was conducted on September 25, 2017 to review existing drainage features, crossings, as well as document existing conditions.

The investigations identified that there was standing water within a number of ditches, and several culverts were damaged/crushed. Standing water within ditches is generally attributable to localized grading issues. Within the Hamlet of Claremont, standing water is considered to be attributable to shallow ditch/channel grades and localized pools/depressions., as well as the presence of a high groundwater table (ref. Jagger Hims Ltd, March 2000).

The drainage systems within the Study Area include urban (curb and gutter with storm sewers and catch basins), semi-urban (curb, gutter outlets mixed sewer and ditch servicing), rural (ditches and driveway culverts), and a hybrid-rural (roadside ditches with storm sewers and ditch inlets). The locations of these drainage systems are presented on Figure 2.

Although it is understood that future infill/intensification will be limited within the Hamlet, as part of the site reconnaissance, several new homes were noted to be recently constructed or currently under construction. In general, the new homes are larger than older existing homes, which would in turn would contribute to additional runoff to local drainage systems, due to increased lot coverage.

3.4 NATURAL HERITAGE SYSTEM

3.4.1 FEDERAL LEGISLATION

Species at Risk Act

The Species at Risk Act (SARA) was passed into law in 2002 and was last amended 2 March 2022. The purpose of SARA is to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species, and to manage species to prevent further risk to their status. Only species listed as Threatened, Endangered, or Extirpated under Schedule 1 are afforded both individual and habitat protection under SARA. Outside of federal lands, SARA legislation only applies to the following:

- Migratory Birds (i.e., those species listed under Article I of the Migratory Birds Convention Act, 10994) that are also included on Schedule 1 of SARA. This does not include the species' critical habitat; however, it does include residences of migratory birds which have residence descriptions; and
- Aquatic Species that fall under Schedule 1 of SARA.

SARA prohibitions may be applied through ministerial order on public or private lands if provincial legislation or voluntary measures to not adequately protect federally listed species, their residences, and/or their critical habitats.

Migratory Birds Convention Act

The Migratory Birds Convention Act (MBCA) was passed in 1917, updated in 1994, and the last amendment was on 12 December 2017. The MBCA prohibits harming and/or killing most species of birds and/or destroying or collecting their eggs or nests. The MBCA does not permit the incidental take of a migratory bird or its nest, with some exceptions. Protected species are listed under Article I of the MBCA. These species are native or naturally occurring in Canada and are species that are known to occur regularly in Canada. Most birds found in the Property Boundary receive protection under the MBCA, and nearly all of the remaining species receive similar protection under the Provincial Fish and Wildlife Conservation Act, 1997.

The MBCA, together with the Migratory Birds Regulations (C.R.C., c. 1035), last amended on 18 June 2020, are federal legislative requirements that are binding on members of the public and all levels of government, including federal and provincial. The “incidental take” of migratory birds and the disturbance, destruction or taking of the nest of a migratory bird is prohibited. No permit can be issued for the incidental take of migratory birds.

Bird species not regulated under the MBCA include Rock Dove, American Crow, Brown-headed Cowbird, Common Grackle, House Sparrow, Red-winged Blackbird, and European Starling. Conversely, if the species identified is protected under Ontario’s Endangered Species Act, 2007 (ESA) or SARA, additional restrictions may apply.

Environment and Climate Change Canada (ECCC) and the Canadian Wildlife Service have compiled nesting calendars that show the variation in nesting intensity by habitat type and nesting zone within broad geographical areas distributed across Canada. While this does not mean nesting birds will not nest outside of these periods, the calendars can be used to reduce the risk of encountering a nest.

Fisheries Act

The Fisheries Act came into effect in 1985 and was last amended to reflect the modernization of the Act on 28 August 2019. The Fisheries Act provides for the management and control of fisheries, the conservation and protection of fish, the protection of fish habitat, and the prevention of pollution. The Fisheries Act prohibits the killing of fish as well as harmful alteration, disruption, or destruction of fish habitat, and prohibits the deposition of deleterious substances into waters frequented by fish.

Fisheries and Oceans Canada (DFO) have developed measures to protect fish and fish habitat, required to be implemented by projects. In the even that proponents cannot completely implement the measures to protect fish and fish habitat, then they can determine if the [Interim] Standards and Codes of Practices apply to their Project. If the Project is not eligible for either of these approaches, then the Project submits a Request for Project Review and initiates a file with DFO to determine the potential impacts of a Project on fish and fish habitat and to assess the need for any authorizations under the Fisheries Act.

3.4.2 PROVINCIAL LEGISLATION

Endangered Species Act

The Ontario Endangered Species Act (ESA) was passed into law in 2007 and came into effect on 30 June 2008, and was last amended on 19 October 2021. In Ontario, SAR are determined by the Committee on the Status of Species at Risk in Ontario (COSSARO). If a species is listed under the ESA as Extirpated, Endangered, or Threatened, Section 9 of the ESA prohibits killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling, leasing, trading or offering to buy, sell, lease or trade a member of the species. Similarly, Section 10 of the ESA prohibits the damage or destruction of the habitat of all Endangered and Threatened species. Habitat is broadly characterized within the ESA as the area prescribed by regulation as the habitat of the species or an area on which the species depends directly or indirectly, to carry out its life processes, including reproduction, rearing of young, hibernation, migration or feeding.

Habitat is specifically defined for some species. Species listed as Special Concern are not afforded protection under Section 9 and 10 of the ESA; however, they are protected under SWH.

Destruction of SAR and their habitats constitutes a contravention of the ESA unless authorized by the Ministry of the Environment, Conservation and Parks (MECP). The MECP may authorize damage to habitat or individuals through registration or permit.

Fish and Wildlife Conservation Act

The Fish and Wildlife Conservation Act (FWCA) was established in 1997 and was last amended on 3 June 2021. The FWCA applies to 'wildlife', which is defined as "an animal that belongs to a species that is wild by nature, and includes game wildlife and specially protected wildlife" (Section 1 (1))."

Those species considered "specially protected wildlife" include those specially protected amphibians, birds, invertebrates, mammals, and reptiles, as identified within Schedules 6 to 11 under the FWCA. The FWCA is managed by the Ministry of Northern Development, Mines, Natural Resources and Forestry (MNDMNRF) and applies to all wildlife as defined under the FWCA. In instances where wildlife will require collection or relocation at any point in the project (i.e., through trapping/collection and relocation), permits and approvals under the FWCA may be required.

Planning Act

The Planning Act is provincial legislation that sets out the ground rules for land use planning in Ontario. Established in 1990, the Planning Act was last amended on 1 January 2022. The Act describes how land use may be controlled and who may control them. The Planning Act also provides the basis for developing regional and municipal official plan documents to guide development. Municipally, the Project falls under the jurisdiction of the City of Pickering Official Plan. The Provincial Policy Statement (PPS) is issued under Section 3 of the Planning Act by the Ministry of Municipal Affairs and Housing (MMAH). Under the Planning Act, the PPS is applicable province-wide and provides overall policy directions on matters of provincial interest related to land use planning and development. Regional plans, municipal official plans, and the PPS work together to establish and protect natural features.

Provincial Policy Statement

The PPS came into effect in 1995 and has been amended several times since - in 1997, 2005, 2014, and most recently in 2019. The latest PPS came into effect on 1 May 2020. The PPS provides policy direction on matters of provincial interest related to land use planning and development (Ministry of Municipal Affairs and Housing, 2020). The PPS is comprised of various policies on development and land use patterns, resource protection and management, and public health and safety. The PPS provides policies specific to natural heritage and states that natural features must be protected for the long term. The following sections of the PPS are relevant to this report. Section 2 of the PPS provides direction for the wise use and management of resources, including the protection of natural areas and features. Relevant natural heritage policies are in Section 2.1 of the PPS and generally states that the diversity and connectivity of natural heritage (including surface and groundwater features) should be maintained, restored or, where possible, improved. Section 2.2 of the PPS relates more specifically to water resources and supports planning authorities to protect, improve, and restore the quality and quantity of water.

Policy 2.1.4 lists significant natural heritage features where development and site alteration is not permitted in (concerning Ecoregion 7E):

- significant wetlands; and
- significant coastal wetlands.

Policy 2.1.5 lists significant natural heritage features where development and site alteration is not permitted unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions, including (concerning Ecoregion 6E):

- significant woodlands;
- significant valleylands;
- significant wildlife habitat (the Significant Wildlife Habitat Technical Guide (MNRF 2000) and Ecoregion schedules were prepared by the Ministry of Natural Resources and Forestry (MNRF) to assist planning authorities and other participants in the land use planning system);
- significant areas of natural and scientific interest; and
- coastal wetlands that are not subject to policy 2.1.4(b).

Policy 2.1.6 states development and site alteration are not permitted in fish habitat except in accordance with provincial and federal requirements.

Policy 2.1.7 states development and site alteration are not permitted in the habitat of endangered species and threatened species, except in accordance with provincial and federal requirements.

Policy 2.1.8 states development and site alteration are not permitted on adjacent lands to the natural heritage features and areas identified in policies 2.1.4, 2.1.5 and 2.1.6 unless the ecological function of the adjacent lands has been evaluated and it has been demonstrated that there will be no negative impacts on the natural features or on their ecological functions. Adjacent lands for the purposes of policy 2.1.8 are lands contiguous to a specific natural heritage feature or area where it is likely that development or site alteration would have a negative impact on the feature or area. The extent of the adjacent lands may be recommended by the Province or based on municipal approaches which achieve the same objectives.

Negative impacts in regard to natural heritage features and areas means "degradation that threatens the health and integrity of the natural features or ecological functions for which an area is identified due to single, multiple or successive development or site alteration activities".

Development, in the context of the PPS, means the creation of a new lot, a change in land use, or the construction of buildings and structures requiring approval under the Planning Act, but does not include activities that create or maintain infrastructure (Infrastructure includes sewage and water systems and transit and transportation corridors and facilities) authorized under an environmental assessment process or works subject to the Drainage Act.

The PPS provides overall policy direction and is informed by and should be read in conjunction with other provincial, regional, and municipal plans. The more stringent of policies apply unless otherwise explicitly stated.

Oak Ridges Moraine Conservation Act

The Oak Ridges Moraine Conservation Act (ORMCA) was passed into law in 2001 and was last amended on 1 June 2021. The ORMCA was established to protect the ecological and hydrological integrity of the Oak Ridges Moraine. The Oak Ridges Moraine Conservation Plan (ORMCP) Regulation defines the land use and planning policies consistent with the Act.

The Study Area falls within the Rural Settlement Area (Countryside Area) of the ORMCP area. Land use patterns within Settlement Areas will support the development of complete communities. The ORMCP encourages rural uses that:

- 13 (1)(c) protect and restore natural areas and features that sequester carbon and provide ecological functions, including water storage, to help reduce the impacts of climate change;
- 13 (2)(a) maintain, and where possible improve or restore the ecological integrity of the plan area;
- 13(2)(b) maintain, and where possible improve or restore, the health, diversity, size, and connectivity of key natural heritage features, key hydrological features and the related ecological functions;
- 13 (2)(c) maintain the quantity and quality of groundwater and surface water;
- 13(2)(d) maintain groundwater recharge;
- 13(2)(e) maintain natural stream form and flow characteristics;
- 13(2)(f) protect landform features;

Infrastructure uses are permitted with respect to land in Countryside Areas, subject to Parts III and IV of the ORMCP. Minimum area of influence for Key Natural Heritage Features (KNHFs) and minimum vegetation protection zones are required to be confirmed in accordance with the policies outlined in Part III of the ORCMP.

Development and Site Alteration within the ORMCP area must conform with the policies of the ORCMP. Works supporting flood or erosion control projects are permitted but only after all alternatives have been considered. A Natural Heritage Evaluation may be required for work within the minimum area of influence that relates to a KNHF. A hydrological evaluation may be required for work within the minimum area of influence of a key hydrologic feature.

Conservation Authorities Act

The Conservation Authorities Act (CAA) was established in 1990 and was last amended on1 October 2021. The CAA authorizes the formation of conservation authorities in Ontario and addresses their roles, responsibilities, and governance in resource management and environmental protection. The purpose of the CAA is “to provide for the organization and delivery of programs and services that further the conservation, restoration, development and management of natural resources in watersheds in Ontario.”

Section 28 of the CAA sets out prohibited activities that include development in areas that could be unsafe for development because of natural processes associated with flooding or erosion and interference with, or alterations to, watercourses, wetlands, or shorelines.

Each of Ontario's 36 conservation authorities has its own Section 28 Ontario Regulation. The core mandate of conservation authorities is to undertake watershed-based programs to protect people and property from flooding and other natural hazards and conserve natural resources for economic, social, and environmental benefits (Conservation Ontario, 2021). In the Study Area, the CAA is applied via the Toronto and Region Conservation Authority (TRCA).

3.4.3 MUNICIPAL LEGISLATION

Regional Municipality of Durham (Upper Tier)

The 2020 Durham Regional Official Plan (ROP) is based on a Regional Structure, which includes a continuous Greenlands System that is integrated with both the Urban and Rural Systems, to protect and connect the Oak Ridges Moraine, key natural heritage, and key hydrologic features. Development or Site Alteration within Key Natural Heritage Features and/or Hydrologic Features and their vegetation protection zones is generally not permitted; flood and erosion control projects demonstrated to be necessary in the public interest and after all alternatives have been considered are exempt from this restriction.

City of Pickering (Lower Tier)

The 2019 City of Pickering Official Plan (OP) sets out the land use policy directions for long-term growth and development in the City of Pickering. The City of Pickering has an Open Space System which plays a role in maintaining ecological health and improving ecological and hydrological integrity of the Natural Heritage System. This OP recognizes the policies of the ORMCP and caries forward with the requirement for the identification of KNHFs and NHFs, minimum areas of influence, and minimum vegetation protection zones.

Development and Site Alteration must conform with the policies of the OP. Works supporting flood or erosion control projects are permitted but only after all alternatives have been considered. A Natural Heritage Evaluation may be required for work within the minimum area of influence that relates to a KNHF. A hydrological evaluation may be required for work within the minimum area of influence of a key hydrologic feature.

3.4.4 EXISTING CONDITIONS

Natural Environment

Natural Heritage Systems

Documented features associated with Natural Heritage Systems identified under the Durham Regional Plan and the City of Pickering Official Plan are present within the Study Area. Key Natural Heritage and Hydrologic Features have also been identified within the Study Area.

Key Natural Heritage Features (Significant Woodlands and Significant Valleylands) are present within the Study Area (Figure 13).

Key Hydrological Features are present, associated with intermittent and permanent drainages/watercourses within the Study Area (Figure 13). In some places, wetlands are associated with the drainage/watercourse features (Figure 13).

The entirety of the Study is encompassed by Groundwater Recharge Areas, while select areas within the Study Area are identified as High Aquifer Vulnerability Areas (Figure 13).

Terrestrial Environment

The Study Area is situated within Ecoregion 6E, the Lake Simcoe-Rideau Ecoregion, which extends from Lake Huron in the west to the Ottawa River in the east and includes most of the Lake Ontario shore and the Ontario portion of the St. Lawrence River Valley and is the second most densely populated ecoregion in Ontario. Flora in this ecoregion is relatively diverse with hardwood forests dominated by Sugar Maple (*Acer saccharum*), American Beech (*Fagus grandifolia*), White Ash (*Fraxinus americana*), Eastern Hemlock (*Tsuga canadensis*), and numerous other species are found where substrates are well developed on upland sites. Lowlands, including rich floodplain forests, contain Green Ash (*Fraxinus pennsylvanica*), Silver Maple (*Acer saccharinum*), Red Maple (*Acer rubrum*), Eastern White Cedar (*Thuja occidentalis*), Yellow Birch (*Betula alleghaniensis*), Balsam Fir (*Abies balsamea*), and Black Ash (*Fraxinus nigra*) (Crins, 2009).

High-level ELC data was provided to Wood by the TRCA (Figure 13). No ELC community information was available for the Study Area; however, delineations for portions of the surrounding area were provided with the following vegetation communities delineated as follows:

- CUM1-A Native Forb Meadow;
- CUW1-A3 Native Deciduous Successional Woodland;
- CUT1-E Red Osier Dogwood Deciduous Thicket;
- FOM7-1 Fresh-Moist White Cedar - Sugar Maple Mixed Forest;
- FOC4-1 Fresh-Moist White Cedar Coniferous Forest;
- FOM6-1 Fresh-Moist Sugar Maple - Hemlock Mixed Forest; and
- MAM2-2 Reed Canary Grass Mineral Meadow Marsh.

Generally, based on aerial interpretation, the Study Area appears to be comprised of manicured and anthropogenic vegetation communities associated with residential dwellings. Other vegetation communities that may be present based on high-level aerial imagery interpretation include agricultural areas, cultural meadows, riparian areas, and hedgerows.

Wildlife and Wildlife Habitat

Characteristic mammals of Ecoregion 6E – Lake Simcoe-Rideau Ecoregion include White-tailed Deer (*Odocoileus virginianus*), Common Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), and Woodchuck (*Marmota monax*). Wetland habitats are used by many species of water birds and shorebirds, including Wood Duck (*Aix sponsa*), Great Blue Heron (*Ardea herodias*), and Wilson's snipe (*Gallinago delicata*). Open upland habitats are used by species such as Field Sparrow (*Spizella pusilla*), Grasshopper Sparrow (*Ammodramus savannarum*), and Eastern Meadowlark (*Sturnella magna*). Upland forests support populations of species such as Hairy Woodpecker (*Leuconotopicus villosus*), Wood Thrush (*Hylocichla mustelina*), Scarlet Tanager (*Piranga olivacea*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*). Reptiles and amphibians found in this ecosystem include American Bullfrog (*Lithobates catesbeianus*), Northern Leopard Frog (*Lithobates pipiens*), Spring Peeper (*Pseudacris crucifer*), Red-spotted Newt (*Notophthalmus viridescens viridescens*), Snapping Turtle (*Chelydra serpentina*), Eastern Gartersnake (*Thamnophis sirtalis sirtalis*), and Northern Watersnake (*Nerodia sipedon sipedon*) (Crins, 2009).

The Study Area is primarily characterized by a suburban altered environment. Wildlife and wildlife habitat associated with suburban environments are expected with limited opportunity for significant wildlife habitat or significant congregations of wildlife. Potential for significant wildlife habitat (amphibian corridor, amphibian breeding, marsh bird breeding) was identified as part of the TRCA Wetland Water Balance Risk Evaluation (Appendix E).

Aquatic Environment

The Study Area is located within the Duffins Creek Watershed (TRCA 2018). Rural areas dominate the north of the watershed, while the southern portions are urban or urbanizing. Historically, Duffins Creek watershed was dominated by vast forests; however, agricultural practices have negatively impacted the local ecosystem. Duffins Creek's 81 kilometres of streams are in relatively good condition and are dominated by cold water aquatic communities such as sculpin, trout, and numerous other fish species.

A total of 17 fish species were identified for the watercourses within the Study Area through background information review consisting of cold, cool, and warmwater species. Redside Dace, which is listed as an endangered species by both the federal and provincial governments was also identified.

Table 3.1. Fish Species known to the Study Area

COLDWATER FISH SPECIES	COOLWATER FISH SPECIES	WARMWATER FISH SPECIES
Redside Dace (Clinostomus elongatus)	Brassy Minnow (Hybognathus hankinsoni)	Brown Bullhead (Ameiurus nebulosus)
Brook Trout (Salvelinus fontinalis)	Blacknose Dace (Rhinichthys atratulus)	Fathead Minnow (Pimephales promelas)
American Brook Lamprey (Lethenteron appendix)	Common Shiner (Luxilus cornutus)	Pumpkinseed (Lepomis gibbosus)
Slimy Sculpin (Cottus cognatus)	Creek Chub (Semotilus atromaculatus)	
	Longnose Dace (Rhinichthys cataractae)	
	Mottled Sculpin (Cottus bairdii)	
	Northern Redbelly Dace (Chrosomus eos)	

COLDWATER FISH SPECIES	COOLWATER FISH SPECIES	WARMWATER FISH SPECIES
	Rainbow Darter (Etheostoma caeruleum)	
	Smallmouth Bass (Micropterus dolomieu)	
	White Sucker (Catostomus commersonii)	

Species at Risk

Data from the NHIC identifies five faunal species at risk within the four 1-km squares surrounding the Study Area, as shown below (Table 3.2). No SAR plants have been previously reported within the Study Area. This however does not rule out the possibility of SAR plants occurring within the potential impact footprint. For example, Black Ash (F. nigra) is a SAR wetland species which was formerly common in the province so is often not included in NHIC database searches. While it is possible this species occurs within the wetlands, it is unlikely; additionally, this species is currently subject to a Minister's Order temporarily pausing protections under the Endangered Species Act (O. Reg. 23/22, 2022). Screening through the NHIC does not preclude the project from proponent responsibility in avoiding contravention of the Endangered Species Act.

Whereas the Study Area is highly suburban and previously modified and there is likely limited potential for Species at Risk and/or their habitats, there remains the potential that Species at Risk and/or their habitats could occur within the Study Area. Species at Risk that may occur include those that are habituated to anthropogenic influences and are often associated with anthropogenic structures, such as Barn Swallow. Species may also include those that are dependent on anthropogenic features throughout parts of their life processes, such as Little Brown Myotis, a common resident of anthropogenic structures during the maternity roosting period, and Chimney Swift, who may use chimneys during migratory and reproductive periods. Depending on the crop rotation associated with the agricultural lands, Bobolink and Eastern Meadowlark may occur (e.g., if hay or if left to fallow).

Table 3.2. Species identified through NHIC within the Study Area

OGF ID	COMMON NAME	SCIENTIFIC NAME	SARO STATUS	COSEWIC STATUS	ATLAS NAD83 IDENT
1038534	Henslow's Sparrow	Ammodramus henslowii	END	END	17PJ5070
1038534 1033933 1038443 1034024	Redside Dace	Clinostomus elongatus	END	END	17PJ5070 17PJ4969 17PJ5069 17PJ4970
1033933 1034024	Eastern Meadowlark	Sturnella magna	THR	THR	17PJ4969 17PJ4970
1033933	Bobolink	Dolichonyx oryzivorus	THR	THR	17PJ4969
1033933	Eastern Wood-pewee	Contopus virens	SC	SC	17PJ4969

3.4.5 *POTENTIAL ENVIRONMENTAL IMPACTS, PROPOSED MITIGATION, AND APPROVALS*

Impacts

Terrestrial Environment: There is the potential for removal of vegetation associated with improvements to drainage function within the Hamlet of Claremont. Extent of vegetation removals are not known at this time, and vegetation communities that may be affected have not been identified or delineated. Generally, the area where improvements are being considered to reduce flooding is a suburban neighbourhood characterized by paved roads, sidewalks, manicured lawns, horticultural plantings, and sparse, retained native trees. No direct removals are currently proposed to Key Natural Heritage Features.

Wildlife and Wildlife Habitat: There is the potential for removal of vegetation associated with improvements to drainage function in the Hamlet of Claremont. Removal of vegetation may have impacts to wildlife and wildlife habitat. Vegetation removals have yet to be quantified and are not known at this time. Construction noise, duration, lighting, and dust may have impacts on resident wildlife. The Project is along a busy road which may have previously affected wildlife populations currently residing in the Study Area – species present are expected to be those generally tolerant of disturbance and human presence, though field surveys have not been completed to confirm this assumption.

Aquatic Environment: There is the potential for alteration to Study Area hydrology which may affect watercourses that drain towards Lake Ontario. Alterations to local drainage may result in increased or reduced flows to watercourses during storm events, deviating from known baseline conditions. Where fish occupied, these changes could have impacts on resident fishes and their habitats, and potential implications to downstream fish and habitats. Unmitigated, proposed works could affect water quality, erosion, and temperature regulation.

Wetlands: Potential impacts to wetland hydrology have been identified. An assessment of the risk associated with the changes to local hydrology was completed following TRCA's Wetland Water Balance Risk Evaluation (TRCA 2017) and is included in Appendix E. Risk to wetlands downstream of the drainage plan area have been characterized as low to high depending on the magnitude of hydrological change and the sensitivity of species and their habitats (flora and/or fauna) known to the Study Area.

Species at Risk: Species at Risk have been identified within the Study Area. Currently, proposed works are not known to affect Species at Risk and/or their habitats (general or regulated). Preliminary Screening for Species at Risk and their habitats should be completed following MECP guidelines for proponents (MECP 2019) in order to complete due diligence during subsequent phases of the Project.

Detailed assessment of impacts for all of the above-listed natural heritage features should be developed through subsequent project phases and in consultation with authorities having jurisdiction.

Mitigation

Preliminary mitigation measures have been developed to reduce, to the greatest extent possible, the potential effects of the Project on the natural environment. These mitigations are intended to be starting points and should be further developed throughout subsequent Project stages. Consultation with authorities having jurisdiction may be required to further develop these mitigations through the design phase and support the creation of targeted Project-specific mitigations.

- Confirm presence or no detection of natural heritage features and Species at Risk and their habitats during future design phases through targeted field inventories, as required.
- Through design stages, confirm risk evaluation per TRCA's Wetland Water Balance Risk Evaluation.
- Vegetation removals are recommended to take place between November 1 and March 31; outside of the breeding bird window and the SAR bat roosting window.
- The limits of the work area may be bounded with exclusionary fence. Sediment fence may contribute to the exclusion of some wildlife (e.g., herptiles) from the work area, if it is properly installed and maintained.
  - Sediment fence that is intended to have the dual function of wildlife exclusion should be installed by March 1st and remain in place, intact, until the completion of the works.
  - It is recommended that daily integrity checks are completed on sediment fence.
  - Ensure that no wildlife is trapped within the area enclosed by sediment fence.
- Other Erosion and Sediment Control (ESC) measures should be considered and applied in consultation with a qualified practitioner in order to reduce the risk of sedimentation into the watercourses.
- Implement measures to ensure water quality is maintained or improved throughout the life of the Project and through to decommissioning (effective life of the system).
- Stormwater discharging from storage tank(s) to receive temperature mitigation to address temperature criteria and align with requirements for downstream fish and fish habitat. Consult with DFO and MECP as required with respect to temperature requirements.
- Engage directly with DFO through the RFR process to address Redside Dace and its Critical Habitat (if identified) if impacts are anticipated during the design phase.
- All applicable authorizations and/or permits must be acquired in support of any necessary aquatic works.
- Immediately prior to the initiation of construction activities, the Project Area should be searched by a qualified biologist for the presence of wildlife, including SAR, and/or habitat features.
  - Where appropriate, authorized, and legal (i.e., certain permits or authorizations may be required to relocate some wildlife), wildlife found within the work area will be allowed to disperse and/or relocated to suitable habitat outside of the Project work area.

- In the unlikely event that Project activities result in any injured or orphaned wildlife, the injured or orphaned wildlife will be immediately transferred to a local wildlife rehabilitation facility.
- Confirm in-water work window with DFO. If watercourse is associated with Redside Dace, July 1 to September 15 of any given year is considered the workable window.
- If any SAR are encountered during the execution of the Project, then works should cease and MECP will be contacted immediately.
- Where vegetation rehabilitation is required following removals, native species suitable to compliment, and known to occur within, existing vegetation communities should be used. The use of non-native, invasive, species should be avoided.

Approvals

A summary of permits and approvals that may be required for the project is provided below:

- Consultation with Fisheries and Oceans Canada (DFO) may be required given the presence of Redside Dace. This species is considered Endangered federally and a permit under SARA may be required for in-water work.
- Consultation with the Ministry of Environment, Conservation and Parks may be required given the presence of Redside Dace. This species is considered Endangered provincially and a permit under the ESA may be required for in-water work, work within the meander belt + 15 metres, or work affecting a contributing or occupied watercourse. Opportunities for regulatory exemption could be explored by the proponent.
- If in-water works are proposed and salvage of wildlife or fish is required, a license from the MNDMNRF will be required to authorize the scientific collection.
- The Toronto and Region Conservation Authority administers permits for works within regulated areas under the Conservation Authorities Act. The Study Area includes regulated areas associated with watercourses. Early consultation with the TRCA is recommended during the design phase to establish Terms of Reference for any additional natural heritage investigations required to support the issuance of any required permits.
- Development and Site Alteration within the ORMCPA must conform with the policies of the ORCMP. Works supporting flood or erosion control projects are permitted but only after all alternatives have been considered. A Natural Heritage Evaluation may be required for work within the minimum area of influence that relates to a KNHF.

Summary

Improvements to the existing drainage in the Hamlet of Claremont may intersect with several environmental constraints, including Key Hydrological Features (permanent/intermittent streams, wetlands), Key Natural Heritage Features (wetlands, woodlands, significant wildlife habitat, fish habitat), and SAR and/or their habitats. In advance of the execution of any drainage improvements, site-specific inventories of these features (if works are proposed within minimum areas of influence) and the habitat of SAR should be conducted to determine the need for additional assessment (e.g., Natural Heritage Evaluation), mitigation, and permitting.

3.5 CULTURAL HERITAGE ASSESSMENT

A cultural heritage assessment has been completed in support of the Municipal Class EA and is provided within Appendix F. Currently, there is only one listed property within the study area: The Mason's Union Lodge, Brougham Union at 4953 Old Brock Road, which is protected by an easement agreement with the City of Pickering under Section 37 of the Ontario Heritage Act. However, this cultural heritage assessment has recorded 64 heritage resources or potential heritage resources near the proposed drainage infrastructure improvements. It is recommended that this area be considered for a Heritage Conservation District, Part V of the Ontario Heritage Act in order to further protect its uniqueness and sense of place.

The effects due to the drainage improvements that are anticipated would likely result in impacts on vegetation, and view-scapes. These impacts are characterized from low to high, based primarily on the distance of resources and vegetation from the right-of-way or impact zone. The impacts of this project are characterized as low.

Nevertheless, potential property encroachment during drainage work should be sensitive to the rural character of the identified and potential heritage resources. Moreover, any required post-construction landscaping should employ heritage plantings and heritage themes to help conserve and enhance the cultural heritage character near the heritage resources.

The following mitigation measures are recommended:

- Construction fencing and tree hoarding should be installed around and in front of those heritage resources which are closer to the project work, at a sufficient distance to ensure that there will be no direct construction impacts as a result of the movement of construction equipment or machinery;
- Standard construction techniques should be used where possible, excluding all avoidable construction techniques (such as deep foundation work or piling) that could cause structural damage to heritage resources;
- All trees that cannot be saved should be replaced with large caliper nursery stock that are appropriate for roadside use (i.e. salt resistant). Replacement trees should replicate as closely as possible the heritage appearance, assortment and placement of the current trees;
- Wherever possible, the projected drainage work should be engineered to ensure that the heritage character of the buildings and landscapes is not unduly impacted or obscured;
- Due to the concentration of heritage resources with special character and/or historical association, Claremont should be considered for a Heritage Conservation District under Part V of the Ontario Heritage Act in order to protect its uniqueness and sense of place. This would allow the City of Pickering to adopt a district plan for the Hamlet to guide future change in the village by creating policies and guidelines for the conservation, protection and enhancement of the area's special character.

3.6 ARCHAEOLOGICAL ASSESSMENT

This archaeological assessment was triggered by a Municipal Class Environmental Assessment (EA) for anticipated infrastructure improvements. The archaeological assessment was conducted prior to any project related land alterations. A development plan is currently unavailable.

In support of the Municipal Class EA and in anticipation of infrastructure improvements, a Stage 1 archaeological assessment background study has been conducted for the Hamlet Study Area to assess the archaeological potential based on its historical use and its potential for early Euro-Canadian (early settler) and pre-contact Aboriginal occupation. The objectives of a Stage 1 background study are as follows:

- Provide information about the study area's geography, history, previous archaeological fieldwork and current land condition;
- Evaluate in detail the property's archaeological potential which will support recommendations for a Stage 2 assessment for all or parts of the study area if warranted;
- Recommend appropriate strategies for Stage 2 assessment if warranted.

The archeological assessment concluded that undisturbed portions of the study area have archaeological potential for three principal reasons:

- the presence of a number of watercourses within the study area
- A clear pattern of pre-contact Aboriginal and historic Euro-Canadian land use in the vicinity as demonstrated by the presence of eight previously registered archaeological sites within a 1-km radius;
- The fact that the Hamlet is an historic settlement and contains historically important transportation routes.

Areas of archaeological potential comprise approximately 79.5% (55.2 ha) of the study area (Appendix G: Figures 6a-i). This also includes the areas previously assessed as noted on Figures 6e and 6f, Appendix G (TLA, 2012). Areas where archaeological potential has been removed as a result of existing infrastructure associated with current roadways constitute approximately 16% (11.2 ha). Areas that have been previously assessed (AMICK 2014, Appendix G: Figures 6e and 6f) make up 4.5% (3.2 ha) and require no further assessment.

In light of these results, the following recommendations have been made:

- Prior to land alteration, a Stage 2 archaeological assessment by means of test pit survey should be conducted in those areas of archaeological potential where ploughing is not viable (approximately 50 hectares). If archaeological resources are found their exact distribution should be documented and any diagnostic artifacts recovered and inventoried. Upon the discovery of cultural materials, the test pit survey grid should be continued to determine whether there are enough archaeological resources to meet the criteria for making a recommendation to carry out a Stage 3 assessment.

- Prior to land alteration, a Stage 2 archaeological assessment by means of pedestrian survey should be conducted at 5-m intervals on open agricultural fields (approximately 5.2 hectares) shown as having archaeological potential. The fields must first be ploughed by means of mouldboard ploughing and provisional disk harrowing to provide for at least 80% ground surface visibility.
- The section of the study area that has been previously assessed, does not require further archaeological assessment (approximately 3.2 ha).
- The remainder of the study area that has had archaeological potential removed does not require further archaeological assessment (approximately 11.2 ha).

3.7 DRAINAGE SYSTEM ASSESSMENT

In order to assess the existing performance of the drainage system, an integrated hydrologic/ hydraulic model of the drainage system has been developed to identify the peak flow rates for various storm frequencies and in turn assess corresponding hydraulic conditions.

3.7.1 HYDROLOGIC AND HYDRAULIC MODELLING

3.7.2 MODEL SELECTION

Hydrologic and hydraulic analyses of the Hamlet have been previously completed using the PCSWMM integrated hydrologic/ hydraulic modelling platform

PCSWMM combines hydrologic modelling (i.e. simulated storm runoff response from land areas), with hydraulic modelling (i.e. calculated water surface elevations and velocities within storm sewers, road surfaces, open watercourses, culverts). The integration of hydrologic and hydraulic analyses facilitates the determination of ponding areas, backflow in pipes, surcharging of manholes, tailwater conditions (which may affect upstream storage and flow capacity within pipes), capacity at inlets to the sewer network (which would reduce the amount of runoff entering the sewer network and increase the amount of runoff conveyed overland during storm events), and depth of flooding of overland conveyance systems; these capabilities of the PCSWMM software make it particularly well-suited for analyzing rural and urban drainage systems such as those within the Hamlet.

Further, PCSWMM is capable of applying both event methodology for single storm events and continuous simulation of a long-term period of record for multiple storm events. For this assessment the Event Methodology using synthetic design storms has been used. PCSWMM is capable of accounting for various conditions at outlets (i.e. open/unobstructed/free-flowing, partially/completely submerged to a constant depth, time-varying depth conditions, gated conditions). The hydraulic routing component within PCSWMM can be based on unsteady state (i.e. time-varying flow) conditions using Kinematic Wave or Dynamic Wave routing techniques of the core St. Venant equations (which combine continuity and momentum equations to solve for 1-dimensional flow). The dynamic wave routing technique is the full solution of this set of equations, and is thus capable of accounting for complex hydraulic situations such as pressure and reverse flow. The kinematic wave routing technique is a simplified solution which is more appropriate for simplified flow conditions. Given the expected surcharging and complex hydraulics within the study area, dynamic wave routing has been applied in this case. The numerical stability of the PCSWMM platform allows for complex networks and systems to be readily modelled in the unsteady state condition, with little to no requirement for network simplification.

PCSWMM employs the United States EPA-SWMM computational engine as its base, thus modeling files created in PCSWMM can be opened and executed within the EPA-SWMM program, as well as PCSWMM. This also provides an additional degree of reliability and quality assurance to the modelling program.

3.7.3 MODELLING DATA

PCSWMM requires the following input data for completing an integrated hydrologic and hydraulic analysis:

- Drainage areas and directly connected impervious coverages for the land segments contributing to the conveyance system of interest.
- Soils information (infiltration parameters) for the soils underlying the land segments, including initial abstraction/depression storage
- Surface slopes for the contributing drainage areas.
- Land use characteristics for both the pervious and impervious components of the land segments in order to establish the "roughness" of the surface.
- Length, size, and inverts of storm sewer networks.
- Material of the sewer network.
- Manhole rim elevations (based on topographic mapping or survey)
- Cross-sections and elevations of the surface drainage system (i.e. roads).
- Locations of storm sewer inlets (catch basins, ditch inlets)
- Elevation and surface area relationships for surface storage zones (i.e. channels or designated off-line storage areas).

The details for the Hamlet's storm drainage system have been obtained based upon the following information to develop the models for the major-minor system:

- Storm sewer, culvert, maintenance hole, and catch basin mapping
- Topographic survey data
- Watercourse mapping
- Road mapping
- Property boundary mapping
- 1 m elevation contour data
- Aerial photography

A considerable effort has been spent as part of the model construction to ensure accurate modelling of the storm drainage system; this has been complemented by multiple topographic surveys as noted previously, as well as review of the resulting data.

3.7.4 STORM EVENTS

As noted, an event-based methodology has been selected for this study, through the application of synthetic design storms. Based on the City of Pickering's Stormwater Management Guidelines, a 12-hour AES synthetic design storm has been adopted, with a 15-minute time step. The synthetic design storms' hyetographs are provided in Appendix H, rainfall depths have been summarized in Table 3.3.

Table 3.3. City of Pickering, 12-hour AES Synthetic Frequency Design Storms Rainfall Depths

FREQUENCY STORM	2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
Rainfall Depth (mm)	45.9	59	67.6	78.5	86.7	94.7

3.7.5 HYDROLOGIC PARAMETERS

Hydrologic parameters have been established on the basis of existing land use conditions; namely land use as evident on the aerial photography provided (ref. Figure 1).

The subcatchments within the study area have been established based on a review of the topographic data (contours/spot elevations) provided by the City, as well as a review of the plan and profile drawings. Subcatchments have been discretized in order to reflect the drainage system geometry based upon catch basin and lateral locations. The delineated subcatchments are presented in Figure 3.

Based on the subcatchment delineation, subcatchment parametrization has been established based upon the mapping data provided for this study, and available tools and techniques within the PCSWMM modelling software. The following provides further details regarding the parameterization of the subcatchments within the PCSWMM hydrologic model.

- Imperviousness has been calculated based upon the aerial photography provided (2012). Impervious areas were mapped and an area weighting approach used to calculate each subcatchments' imperviousness.
- Catchment slope has been calculated using the contour mapping provided.
- Catchments flow lengths have been directly measured as the sheet flow length (i.e. back of the property line to the roadway)
- Manning's roughness coefficients of 0.013 and 0.200 have been applied for impervious and pervious overland flow components respectively
- Base depression storage depths of 1 and 5 mm have been applied for impervious and pervious catchment portions respectively; depression storage was adjusted during the model validation process.

- Infiltration has been simulated using the Green and Ampt Infiltration methodology, with soil parameters based upon underlying soil types.
- Ontario Base Soils Mapping (OBSM) (ref. Soil Survey Report 23 – Soil Survey of Ontario County) identified the study area soils as 'Woburn'; a calcareous brown loam till with good drainage characteristics. In order to further validate the OBSM surficial soils, the data have been compared to select borehole log data from geotechnical reports; the results of this comparison are presented in Table 3.4.

Figure 3.1. Ontario Base Soils Mapping (ref. Soil Survey Report 23, October 1979)

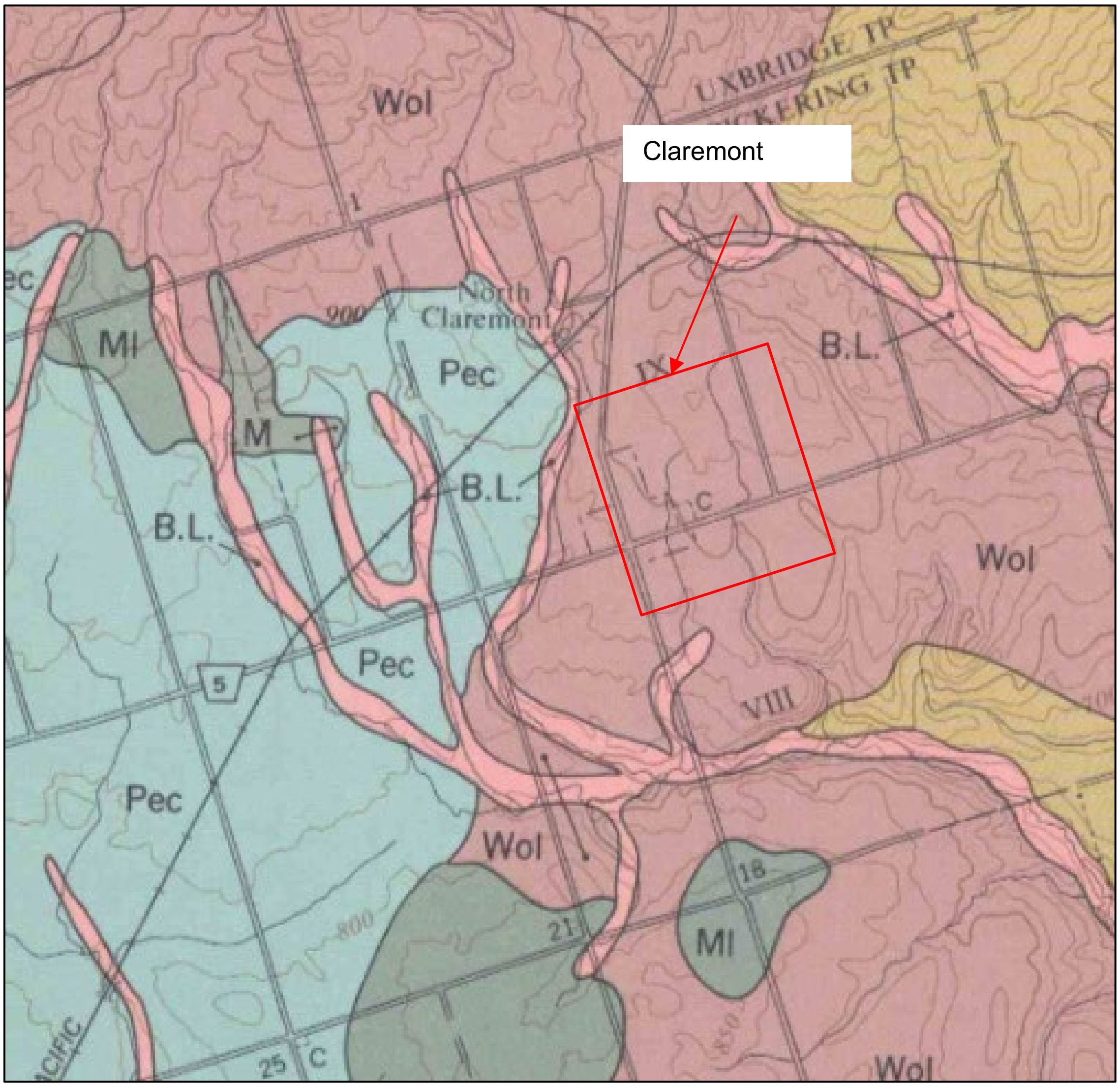


Table 3.4. Comparison of Geotechnical Reports and Ontario Base Soils Mapping

GEOTECHNICAL REPORTS DATA - AUTHOR / REPORT - DESCRIPTION	GEOTECHNICAL REPORTS DATA - DEPTH (MBG)	GEOTECHNICAL REPORTS DATA - SOIL DESCRIPTION	ONTARIO BASE SOILS MAPPING
V.A Wood Associates Limited Carpenter Ct Borehole 6, July 19, 1988.	0.13 -1.9	Very stiff brown Clayey Silt Till with traces of coarse sand and gravel. damp	Wol brown loam till (Hyd. Grp B)
V.A Wood Associates Limited Carpenter Ct Borehole 10, July 19, 1988.	0.3 - 2.9	Compact to very dense brown Silty Sand Till with some gravel	Wol brown loam till (Hyd. Grp B).

From this comparison, it is considered that the surficial soils mapping is reasonably consistent with the more resolute geotechnical borehole data; however, variability is evident. It is suggested that the OBSM data can reasonably be applied for the determination of infiltration.

Infiltration parameters have been adjusted during model calibration/validation. Subcatchment parameterization details are provided in Appendix I.

3.7.6 HYDRAULIC PARAMETERS

Hydraulic links have been incorporated into PCSWMM based on the following:

- Both the minor (storm sewers, culverts) and major systems (open channels, ditches roadways) have been modelled.
- Data for storm sewers and culverts have been entered directly into PCSWMM based upon data from the background information provided, as well as supplementary data obtained through survey.
- Surcharge height has been added to hydraulic nodes as required to ensure no loss of flow under surcharge conditions.
- Culvert overflow sections have been added as required to allow for spill, should culverts become sufficiently surcharged; elevations have been estimated based on available data, and overflow widths have been approximated accordingly.
- Open channel sections have been entered based on results from the topographic survey, or where not available, elevation contour data and typical representative channel sections have been used.
- A roughness value of 0.013 has been applied for concrete and PVC sewers/culverts, and a value of 0.024 has been applied for CSP sewers/culverts.
- Conduit exit losses have been applied to account for the hydraulic losses associated with sharp bends. Head loss coefficients from Urban Drainage Design Manual, U.S. Department of Transportation, Publication No. FHWA-NH1-01-021 August 2011, Hydraulic Engineering Circular No. 22 (FHWA HEC-22) have been applied for this purpose.

- Several different types of roadway sections have been modelled:
  - Urban (curb and gutter roadways with storm sewers)
  - Semi-urban (curb and gutter roadways, with a mix of ditches and storm sewers)
  - Rural (ditched roadways with no storm sewers)
  - Hybrid-Rural (ditched roadways with storm sewers)

  The roadway sections have been modelled based on the background information provided. For rural roadways, ditch sections have been modelled individually, with weir sections added to allow for overflow between sections, should flows reach the roadway crown elevation.

- Inlet Functions have been incorporated to represent the interaction between the minor and major systems through inlets (catch basins, ditch inlet grates, etc.). In order to ensure model stability under surcharge and reverse flow conditions, inlet functions have been modelled as orifices (bottom orifices for grates and covers, and side orifices for catch basin leads). Calculations for catch basin grates (including catch basin manholes) have been based on an opening area of 0.125 m2 per standard catch basin (OPSD 400.110). This value has then been multiplied by the number of catch basins being represented to determine the equivalent opening area for which a representative square orifice has been applied. Orifices representing catch basin leads have been based on an equivalent opening area equal to an assumed 250 mm diameter pipe size per catch basin (300 mm diameter pipe size for double catch basins).

3.7.7 MODEL VALIDATION

The performance of the PCSWMM model has been validated using rainfall data and flow data collected between May and November of 2017. The rainfall data were collected by a gauge located on the Dr. Nelson F. Tomlinson Community Centre roof, setup and operated by Wood for this study. Flow data were collected using gauges setup at the three (3) monitoring locations (as summarized in Table 3.5, gauge locations have been depicted on Figure 1).

Table 3.5. Characterization of Flow Monitoring Locations

FLOW GAUGE LOCATION ID	DRAINAGE AREA (HA)	IMP. (%)	LOCATION NOTES
1	16.3	16.8	Central Street, within 'Control Manhole'
2	16.5	16.5	Ditch, south of Central Street Sewer outfall
3	20.2 - 36.5	28.3	Watercourse, west of Canso Street outfall

The total rainfall depth and peak rainfall intensity recorded for each storm event selected for the hydrologic model calibration/validation is summarized in Table 3.6. These storm events have been selected as their rainfall depths were greater than 10 mm; it is noted that shorter duration events with greater intensity are generally preferable, as the runoff response is more easily observed and contribution/influence of baseflow is not as apparent. The monitoring data for the selected storms are included in Appendix B.

Table 3.6. Select Storm Events Extracted from Rainfall Monitoring Data

RAINFALL EVENT NO.	RAINFALL DATE	TOTAL RAINFALL (MM)	PEAK RAINFALL INTENSITY (MM/HR)	STORM DURATION (HR)	NOTES
1	April 27, 2017	10.6	23.2	2	-
2	April 30, 2017	41.4	13.6	23	2 Cells
3	May 4, 2017	39.2	4.0	30	-
4	May 30, 2017	23.8	44.0	3.5	2 Cells
5	June 23, 2017	51.6	26.4	9	Double Peak
6	June 26, 2017	32.8	44.8	4	-

As part of the model validation, subcatchment parameters for hydraulic conductivity, suction head, and initial moisture deficit have been refined to improve upon the correlation between the simulated peak flows and total runoff volumes generated by the PCSWMM model, versus observed through monitoring. Refinements have been applied to several subcatchment parameters and the PCSWMM model has been executed for several iterations in order to support the validation process.

The model parameters adjusted as part of this validation assessment were the Green and Ampt infiltration parameters, the depression storage for pervious and impervious segments, as well as subcatchment routing for the pervious land segments. The percentage of runoff routed between sub-areas has been varied between 15 - 45 %. Routing 35 % of the impervious area to pervious, was determined to more effectively account for disconnected downspouts within residential areas.

A summary of the initial and validated model parameters for the PCSWMM model is provided in Table 3.7. A tabular summary of the validation results is provided in Table 3.8, and scatter plot comparisons of the model output versus observed is included in Appendix J.

Table 3.7. Initial and Final Parameters for the PCSWMM Model

MODEL PARAMETER	INITIAL VALUE	FINAL VALUE
Hydraulic Conductivity (mm/hr)	3.3	2.5
Suction Head (mm)	89.9	110
Initial Moisture Deficit	0.110	0.35
Depression Storage – Pervious (mm)	5	4/8
Depression Storage – Impervious (mm)	1	3
Subcatchment Routing[1]: Pervious Percent Routed [1]	0	25 – 55

Note: [1] The subcatchment routing parameter controls how subcatchments' runoff is routed between pervious and impervious land segments. Using the 'Pervious' options routes a user defined percentage of runoff from the impervious area onto the pervious land segment; allowing additional infiltration to occur.

Table 3.8. Model Validation Summary

FLOW MONITORING LOCATION	PEAK FLOW - TRENDLINE SLOPE	PEAK FLOW – R^2	RUNOFF VOLUME - TRENDLINE SLOPE	RUNOFF VOLUME – R^2
Central Street Outlet	1.08	0.98	0.77	0.96
Control Manhole	1.46	0.87	0.77	0.93
Canso Outlet	1.15	0.81	1.25	0.90

The results of the model validation indicate that the adjusted PCSWMM model, with the refined subcatchment parameters, reasonably approximates peak flows and runoff volumes. The slope of the trend line for peak flow ranged between 1.08 and 1.46, and for runoff volumes ranged from 0.77 to 1.25 all with reasonably strong correlation coefficients ($R^2 > 0.70$) which is indicative of a good validation. The Canso Street Outlet ranged between 0.94 to 1.19 for two (2) out of the three (3) storm events, with a strong correlation coefficient for all simulations (~ > 0.70). A review of the observed hydrographs and the simulated hydrographs suggest that the timing of the peak flow rates and the shape or form of the hydrographs are within reason represent a reasonable comparison of the results; the hydrographs are presented within Appendix J for visual inspection. Based upon the foregoing results, the validated and refined PCSWMM hydrologic models have been advanced for use in the assessment of drainage system performance.

3.7.8 HYDROLOGIC RESULTS

Hydrologic modelling has been conducted using PCSWMM for the 5 and 100 year storm events based on the 12 hour AES design storm distribution previously described. Table 3.9 presents the simulated peak flow results at nodes of interest for the 5 and 100 year storm events. For comparison, the 1996 Paul Theil Associates Limited (PTAL), Stormwater Management Study for Regional Road 5, using an unvalidated OTHHYMO89 hydrologic model determined the 100 year peak flow to be 0.42 m3/s at the south side of the control manhole on Central Street and 1.24 m3/s at the sewer outlet to the channel located in the school. The current PCSWMM integrated hydrologic/ hydraulic modelling has determined 100 peak flows of 0.82 m3/s (95% greater than PTAL flow) at the southside of the control manhole (not including a 0.50 m3/s contributing flow over the road) and 1.90 m3/s (55% greater than PTAL flow) at the sewer outlet to the channel. As such the peak flows determined using the validated modelling are considered to be significantly higher than the flows determined in the previous Paul Theil Associates study. The difference in peak flows can be attributed to several factors:

- PTAL used the 1 hr AES storm (100 yr: 55.3mm), while this Class EA has used the City of Pickering's 12 hr AES storm (100 yr: 94.7mm).
- The PCSWMM model integrates hydrologic and hydraulic modelling, resulting in a more representative drainage system performance. The PTAL modelling was a simplified single purpose hydrologic model.
- The PCSWMM model has been validated using observed flows and rainfall, while the PTAL modelling was not validated.

— The PCSWMM modelling has used aerial mapping to determine impervious coverages. The PTAL modelling was based on estimations of impervious coverages using topographic mapping.

Table 3.9. Simulated Peak Flows at Nodes of Interest

JUNCTION NODE	MINOR / MAJOR	LOCATION	CATCHMENT SERIES	AREA (HA)	PEAK FLOW (M^3/S) 5 YEAR	PEAK FLOW (M^3/S) 100 YEAR
T-3-97-MH05	Minor	Manhole - Intersection of Franklin and Joseph	100	10.72	0.105	0.112
J49	Major	Major System – Franklin Street and Joseph Street	100	10.72	0.381	0.937
J183	Major	Franklin Street – Spill to Remnant Channel	100	11.67	0.037	0.378
J173	Major	Franklin Street – Spill to rear yard of 1764 Central Street	100	12.4	0.362	0.687
D96-3-S05	Minor	Manhole at Intersection of Franklin Street and Central Street	100	14.8	0.303	0.340
CMH_A	Minor	Central Street – Control Manhole – Flow West	100	16.34	0.204	0.202
CMH_B	Minor	Central Street – Control Manhole – Flow East	100	16.34	0.578	0.824
J40	Major	Central Ditch/Channel – Upstream of Wellington Street Culvert Crossing	200	20.39	0.628	1.606
J41	Major	Central Ditch/Channel – Downstream of Wellington Street Culvert Crossing	200	22.21	0.751	1.913
J69	Major	Central Ditch/Channel – at Junction with Community Center East Ditch	200	23.87	0.822	2.071
J9_1	Major	Central Ditch/Channel – Confluence with Livingston Street Ditch	200	3.06	1.095	2.659

JUNCTION NODE	MINOR / MAJOR	LOCATION	CATCHMENT SERIES	AREA (HA)	PEAK FLOW (M^3/S) 5 YEAR	PEAK FLOW (M^3/S) 100 YEAR
J13	Major	Central Ditch/Channel – Upstream of Bovingdon Place Culvert	200	32.36	1.034	2.794
J14	Major	Central Ditch/Channel – Downstream of Bovingdon Place Culvert	200	35.53	1.075	2.887
J76	Major	Canso Street Outlet	400	36.18	1.075	1.895

3.7.9 HYDRAULIC SYSTEMS ASSESSMENT

Hydrologic/hydraulic analyses have been conducted to determine the performance of the minor (storm sewer and culvert) and major (roadway, ditch, and open channel) drainage systems within the study area. The minor system has been evaluated based upon simulated incidences of flooding and surcharging during the 5 year storm event, with particular emphasis upon the occurrence of flooding. The minor/major system model has been used for this assessment, using an event methodology as described previously.

Simulated results under existing land use conditions for selected conduits are presented within Appendix K by indicating whether a storm sewer has no surcharging, less than or greater than 50% surcharge to the surface or floods (surcharges to the surface). The hydraulic results with respect to capacity have been presented graphically on Figures 4 and 5. As a further check, the results within Appendix K provide an indication of the storm sewer flow capacity (based on full flow calculated using Manning's equation) versus the simulated peak flows via the $Q_{peak}/Q_{capacity}$ column. Some of the sewers have been noted as surcharged even though the storm sewer capacity is above the peak flow; in these cases surcharging is considered to be attributable to the influence of tailwater conditions and energy losses (due to bends, expansion/contraction, etcetera).

Based on the results presented in Appendix K, a large proportion of the selected conduits are at capacity and become surcharged or flooded during a 5-year storm event, suggesting that in general, the minor drainage system lacks 5-year conveyance capacity.

Under the 100-year storm event, the majority of the selected conduits would be expected to be flooded or surcharged, which is consistent with the expected performance of the minor system under such a formative storm event. Conduits which indicate un-surcharged conditions are typically culverts rather than storm sewers, which are usually designed to a higher standard by conveying at least the 10-year storm event.

The results of the PCSWMM hydrologic/hydraulic analyses for major overland flow have been reviewed further in order to identify the incidences of flooding of the major system during severe storm events. The overland system consists of roadways, ditches, open channels, overland drainage routes through residential lots at roadway sags, and drainage easements in rear yards. Current practice for major drainage systems is to provide for safe and positive conveyance of flows, either within road rights-of-way or if possible within publicly owned overland drainage systems. However, the Hamlet of Claremont overland drainage system was not designed to current practice when the community and roadways were established during the mid to late 1800's; the standards prevalent during the era of construction with a mixed use of roadside ditches, storm sewers with curbs or gutters, and natural outlets for overland drainage. Furthermore, previous drainage design standards likely did not size infrastructure for the less frequent storm events, rather for the frequent storm events. This has led to capacity deficiencies which result in periodic flooding of private and public properties. The Hamlet has a number of locations where the flood depths during major events are considered problematic.

The depth of flooding within major system conduits has been determined for both the 5- and 100-year storms and summarized within Appendix K. Within rural roadway types, flows would be conveyed by roadside ditches, before being captured either locally by catch basin manholes (on semi-urban streets) or by inlets/culverts at the downstream limits (for fully rural roadways). For fully urban streets, flows would be conveyed by the roadway directly from the lowest elevation in the gutter. Summarized results present both maximum depths for key locations of interest, as well as a qualitative assessment with respect to whether or not simulated depths are within the right-of-way, less than or greater than 50% to buildings, and at or beyond buildings. Flow depths within ditches (not associated with public rights-of-way) have been characterized as flow within or beyond the ditch limits. Major system performance, for the 100-year design storm, with respect to depth capacity is also illustrated graphically in Figure 5.

Based on the results provided within Appendix K, under a 5-year storm event the selected sections of roadway as expected would largely be expected to contain flow within the ditch (rural sections) or below the roadway crown (urban sections), with the exception of two roadway sections along Wixson Street (which has a nominal exceedance of the crown height) and Franklin Street (which has a poorly defined major system outlet and undersized minor system). These results are generally consistent with those presented within Appendix K for the minor system.

Under a 100-year storm event, the selected sections of roadway have variable performance, with a number of rural roadway sections indicating depths in excess of ditch capacity, but below roadway crowns. Although these results suggest that roadway ingress/egress during flooding would not be affected, there may still be the potential for spill towards private property, given that in many cases adjacent properties are below roadway crown elevations. With respect to urban roadway sections, multiple sections would be anticipated to have flow depths in excess of the roadway crowns. Those locations with the highest simulated flow depths appear to be at roadway sag points, which again is to be expected given the tendency for localized ponding in these areas.

In general, those sections of roadway which display the highest simulated overland flooding depths for the 100-year storm event include (Ref. Figure 5):

- Franklin Street (Urban) – Sag point north of Central Street
- Franklin Street (Rural) – At Joseph Street intersection
- Central Street (Semi-Rural) – Floods at various ditch inlets

- Wixson Street (Urban) – floods at intersection with Central Street
- Barclay Street (Rural) – The ditch exceeded, below crown.
- Canso Street (Urban) – Sag at outlet to west channel
- William Street (Urban) - At intersection with Central Street
- Henry Street (Semi-Rural) – Low crown height
- Acorn Lane (urban) – At sag in road at outlet

3.7.10 LOCAL DRAINAGE ISSUES

In addition to the drainage issues identified by the hydrologic/hydraulic modelling, there are additional localized drainage issues are not directly captured by the analytical assessment (nuisance flooding and ponding in particular). To summarize some of the primary local drainage issues reported by residents include (Ref. Figure 6):

- Poor ditch grading and standing water along Barber Street
- Poor ditch grading and standing water along Lorn Street
- Frequent ditch and roadway flooding along Franklin Street
- Rear yard flooding reported along Barclay Street
- Local drainage deficiency along Franklin Street at a low point, drainage overtops Franklin Street major system and flows to property's rear yard.
- Rear yard flooding reported along the central portion of the East Channel, west of Livingston Street; the channel is partially conveyed through private property and with a poorly defined longitudinal profile.
- Local drainage deficiency where central channel crosses Bovingdon Place; flooding within yards
- Local drainage deficiency along Old Brock Road; ponding along road way
- Joseph Street drainage deficiency at Wixson Street; lack of major system capacity.
- Poor grading and standing water along Wixson Street (sump pumps discharge to street)

3.7.11 SUMMARY OF EXISTING DRAINAGE SYSTEM CONCERNS

The existing minor and major drainage systems have been characterized to determine performance constraints and identified concerns. Local drainage issues have also been considered, based on information reported by City staff, as well as the information supplied by residents. Figure 6 provides a compilation of all of these identified drainage issues within the Hamlet. Based on this compilation, the following locations are considered to be of primary concern with under sized storm sewer for the contributing drainage area, and should be addressed further as part of the subsequent alternative assessment process:

Deficient storm sewer and culvert capacity (capacity < 5-year storm):

- Franklin Street Storm Sewer – indicated as surcharging to surface; existing 300 mm diameter storm sewer constructed in 1997.
- Central Street Storm Sewer between Franklin and Canso Street – indicated as surcharging to surface; existing 450 mm to 600 mm diameter storm sewers constructed in 1997.
- Canso Street Storm Sewer between Central Street and the Canso Street Outlet – indicated as surcharged; existing 675 mm to 910 mm diameter storm sewers constructed in 1991.
- William Street Storm Sewer between David Street and Central Street – indicated as surcharged; existing 675 mm diameter storm sewer constructed in 1991.

Deficient overland flow capacity (excessive roadway depths for 100-year storm):

- Franklin Street (Urban) - sag point south of Joseph Street.
- Franklin Street (Rural) – north of Joseph Street.
- Barber Street (Rural) – insufficient ditch capacity.
- Barclay Street (Rural) – insufficient ditch capacity.
- Livingston Street (Semi-Rural) – insufficient ditch capacity.
- Wixson Street (Semi-Urban) – roadway crown overtopped.
- Canso Street (Urban) – roadway crown overtopped at sag.
- Old Brock Road (Rural) – insufficient ditch capacity.

Additional identified areas of concern:

- Numerous crushed or filled culverts
- Numerous filled ditches
- Standing water in ditches (various locations)

4 LONG-LIST OF ALTERNATIVES FOR DRAINAGE SYSTEM IMPROVEMENTS

The following “long-list” of potential management alternatives has been compiled for consideration to address the minor and major drainage system deficiencies.

4.1 MINOR SYSTEM (STORM SEWERS AND CULVERTS)

A long-list of alternatives to mitigate the surcharge and flooding conditions for the minor system during the 5 year storm event, as well as to alleviate the depth of flooding during the 100 year storm event, has been developed. The following alternatives have been advanced for consideration in order to address the deficiencies associated with minor system performance during the 5-year storm event:

i. Do Nothing
ii. Increase size of affected storm sewers/culverts, or twinning
iii. Implement super pipes to provide on-line storm water quantity control
iv. Implement on-site storm water management for individual private properties
v. Implement off-line storage areas within available public spaces
vi. Retrofit existing storm water management facilities to provide additional quantity control
vii. Diversions (local inter-catchment)
viii. Roof leader/foundation drain disconnection
ix. Low Impact Development (LID) Best Management Practices (BMPs) (other than Alternative viii)
x. New drainage outlets (relief systems) to Duffins Creek, using new storm sewers
xi. Inlet Control Devices (ICDs)
xii. Combinations of the above

The following alternatives have been screened from further consideration in the drainage system assessment.

— *Alternative (iii) (Implement super pipes to provide on-line storm water quantity control)* is a potential alternative, however typically requires significant storage to effectively reduce peak flows to a level that does not result in flooding. Super pipes also consume considerable amount of space within the right-of-way or other public lands and are typically cost prohibitive. The equivalent storage of a super pipe can usually be implemented with less expensive prefabricated plastic storage chambers. The potential for utility conflicts is high. This alternative is typically one of the last considered in reducing flood potential. As such, this alternative has been screened from further consideration.

- *Alternative (iv) (Implement on-site storm water management for individual private properties)* is considered to be problematic given the predominant land use (single detached residential), wide spread use of septic tanks within the Hamlet, and lack public control; to obtain any significant quantity control benefit a large number of private residences would be required to participate (which may not be feasible). Additionally, in many areas residences are already considered to be completely disconnected (i.e. no direct impervious connection). Given the anticipated difficulty in achieving sufficient landowner consent, and the limited benefit to quantity control, this alternative has been screened from further consideration.
- *Alternative (vi) (Retrofit existing SWM facilities)* is not considered to be a viable option, as there are no existing SWM facilities within the Hamlet. This alternative has hence been screened from future consideration.
- *Alternative (viii) (Roof leader/foundation drain disconnection).* Based on the site reconnaissance and information provided by the City of Pickering, there do not appear to be many connected roof leaders or foundation drains (to the storm sewer). In some instances, roof leaders were noted to be directed to driveways rather than pervious surfaces, however these locations are considered to be a small percentage. Accordingly, this alternative has been screened from future consideration.
- *Alternative (xi) (Inlet Control Devices)* – implemented within catch basins ICDs can be a low cost and effective approach to reducing the inflow to the minor system, therefore preventing surcharging of the minor system. However, this may not be an appropriate solution due to the major system performance during the 100-year storm event which would be exacerbated with increased flow peak flow rates from the effect of the inlet control devices on the catch basins (CBs will fill and flows will bypass CBs and add to the major system flow).

Accordingly, the short-listed alternatives considered for addressing the minor system capacity deficiencies are:

- *Alternative (i) (Do Nothing)* does not address the issues associated with deficient infrastructure capacity and flooding. Although this alternative functionally does not improve hydraulic conditions, it may be the selected alternative for some situations where there is limited benefit from improving the drainage system. Further, as part of the Municipal MEA Class EA process the Do Nothing alternative has to be assessed and cannot be screened from consideration.
- *Alternative (ii) (Increase size of affected storm sewers/culverts, or twinning)* is typically one of the most effective, although there are possible issues with respect to cost and existing utility conflicts, as well as required ground cover.
- *Alternative (v) (Implement off-line storage areas within available public spaces)* is considered possible, however limited space is available based on the existing development of the study area; Claremont Memorial Park is the only public space other than the municipal rights-of-way within the study area. Off-line storage can be implemented either as surface storage or subsurface storage; surface storage would likely not be favourable due to a reduction in useable public space, while subsurface storage would be more expensive.
- *Alternative (vii) (Local Diversions)* is possible, and can be an effective option, however, this alternative assumes that there is a system with sufficient residual capacity to accept the additional flow, and that a diversion is possible given existing grades.

— *Alternative (ix) (LID BMPs)* or source controls, are typically applied to new greenfield development where they can be more readily incorporated into the urban planning fabric, although can be an effective approach to reduce runoff at source in retrofit and reconstruction areas (both for public roadways or private properties). However, the applicability of LID BMPs can be constrained by site-specific limitations (such as available space within the ROW, grading constraints, utilities, soils, groundwater levels, etc.); several 2-laned streets within Claremont have a narrow ROW of approximately 7-8 m, with limited to no available space to implement source controls. While the groundwater conditions within the study are not formally documented, discussions with residents and City staff have indicated that there is a high groundwater table within Claremont which would hinder the implementation of LID BMPS. As common practice, LID BMPS are usually designed to capture and infiltrate runoff from the more frequent storm events, such as the 25 mm storm event up to the 5-year storm event. The localized implementation of LID BMPs could benefit individual properties and address minor surface ponding concerns, although the implementation of widescale LID BMPs on private and public properties would likely take several years, potentially, decades to implement, and would not provide short term benefits for the mitigation of the minor system performance deficiencies.

— *Alternative (x) (New Drainage Outlets - relief systems using storm sewers)* could be considered (new outlets to Duffins Creek) where grades and locations are appropriate. Given established drainage pathways, it may be simpler to increase capacity of existing pathways; however, the potential for new drainage outlets should be considered further.

— *Alternative (xii) (Combinations)* is likely an appropriate solution where no single alternative is sufficient to fully address the drainage deficiencies.

The short list of minor system alternative is presented in Table 4.1 and has been advanced for further consideration to the areas with drainage issues.

Table 4.1. Minor System Short Listed Alternatives

ALTERNATIVE #	ALTERNATIVE	FRANKLIN STREET	CENTRAL STREET	WIXSON STREET	OLD BROCK ROAD	WILLIAM STREET - CANSO DRIVE	CANSO DRIVE AT ACORN LANE
i	Do Nothing	X	X	X	X	X	X
ii	Increase Storm Sewer/Culvert Size or Twin	X	X	X	X	X	X
v	Off-line Storage		X				
vii	Local Diversion		X				
ix	LID BMPs						X
x	New Drainage Outlet		X				
xii	Combinations	X	X	X	X	X	X

4.2 MAJOR SYSTEM (OVERLAND DRAINAGE SYSTEMS)

A long list of alternatives to mitigate major system flooding during the 100-year storm event has been developed. The following specific alternatives have been advanced for consideration:

i. Do Nothing
ii. Increase size of storm sewers and culverts to reduce depth of flooding of the major system to within acceptable limits
iii. Implement new storm sewers to alleviate surface ponding and improve major system conveyance
iv. Implement super pipes to provide on-line storm water quantity control
v. Implement on-site storm water management for individual private properties
vi. Implement on/off-line storage areas within available public spaces
vii. Retrofit existing storm water management facilities to provide additional quantity control to mitigate these conditions
viii. Modify grading on private property to mitigate flooding.
ix. Modify grading within road right of way or other public property to mitigate flooding.
x. Low Impact Development Best Management Practices (LID BMPs)
xi. New major system (overland) outlets
xii. Improve major system capacity with the implementation of curb and gutter.
xiii. Improve major system capacity by re-ditching (re-sectioning) the existing ditches
xiv. Combinations of the above.

Consistent with the alternatives screened to address the minor system performance deficiencies, alternatives iv, v, and vi have been screened from further consideration. The following alternatives have been initially screened from further consideration:

- *Alternative(viii) (Modify grading on private property to mitigate flooding)* could be conducted to a limited extent to either reduce or eliminate potential flooding from open watercourses, overland flow routes across private property, or rear yard drainage features. Such works would be limited in scope however, and would require agreement from affected landowners (which may not be forthcoming) and would potentially also require compensation measures.
- *Alternative (x) (LID BMPs)* is generally more appropriate for managing smaller storm events, rather than major flood events. Although this approach should be encouraged for addressing localized minor system deficiencies, its effectiveness to address major system deficiencies is considered limited. This option has therefore been screened from future consideration.
- *Alternative (xi) (New overland outlets)* is not feasible given the limited amount of available public property and the difficulty and costs involved with obtaining required property (either through purchase or easement agreements) from private landowners.

- *Alternative (xii) (Improve major system capacity with the implementation of curb and gutter)* can be considered in isolated locations. There are limitations to this alternative as it could prevent drainage conveyance to the roadway from the surrounding properties if the elevation of the ROW is not lower than the surrounding properties. This alternative has been implemented on Franklin Street as a temporary solution to mitigate the major system capacity deficiencies and conveyed to private property from the ROW.

Accordingly, the short-listed strategies to mitigate the impacts of flooding of private property during the 100-year storm event include:

- *Alternative (i) (Do Nothing)* functionally does not improve hydraulic conditions. It may be the selected alternative for situations where there is limited benefit from improving the drainage system. As part of the Municipal Class EA process the Do Nothing alternative has to be assessed and cannot be screened from consideration.
- *Alternative (ii) (Increase size of storm sewers and culverts to reduce depth of flooding of the major system to within acceptable limits)* is a potential alternative to be considered when overland flow through private property is to be limited or reduced. Typically, this alternative would only be considered for short lengths due to the high cost.
- *Alternative (iii) (Implement new storm sewers to alleviate surface ponding and improve major system conveyance)* would mitigate the excess flow conveyed via the major system and would provide long term solution to the major system drainage deficiencies. An existing receiving storm sewer system would be required otherwise a new outlet would need to be constructed.
- *Alternative (ix) (Modify grading within road right of way or public property to mitigate flooding)* can be conducted to a limited extent to either reduce or eliminate potential flooding from roadways on private or public property. Any modifications of road grading within Toronto Region Conservation Authority's regulated areas would require approval.
- *Alternative (xiii) (Improve major system capacity by re-ditching (re-sectioning) the existing ditches)* would be a community wide recommendation which would include regular and manicuring of the ditches to provide unobstructed conveyance within the ditches. Furthermore, where possible, it is recommended that selected ditches be re-sectioned or re-ditched to increase the capacity within the ditches. While additional groundwater level data is required prior to implementing any LID BMP features such as infiltration trenches, it is anticipated that there are high static and seasonal high groundwater levels as noted from the City Staff, Claremont residents, and the available groundwater data. The high groundwater levels would likely prevent inclusion of infiltration trenches within the ditched as a long-term alternative for mitigating the ditch capacity issues.
- *Combinations (Alternative xiv)* is likely an appropriate solution where no single alternative is sufficient to fully address issues.

The short list of major system alternative is presented in Table 4.2 and has been advanced for further consideration to the areas with drainage issues.

Table 4.2. Major System (ROW) Short Listed Alternatives

ALTERNATIVE #	ALTERNATIVE	FRANKLIN STREET	CENTRAL STREET	WIXSON STREET	OLD BROCK ROAD	WELLINGTON STREET	LIVINGSTON STREET	LANE STREET
i	Do Nothing	X	X	X	X	X	X	X
ii	Increase Storm Sewer/Culvert Size or Twin	X	X	X	X			
iii	Implement new storm sewers	X						
ix	Modify Grading on Public Property		X					X
xiii	Re-Ditching					X	X	X
xiv	Combinations	X	X	X	X	X	X	X

5 SHORT-LISTED ALTERNATIVE ASSESSMENT

5.1 EVALUATION

Evaluation Methodology

In order to assess the various short-listed minor and major drainage system improvements, an evaluation framework, has been advanced to assess the suitability of each alternative against appropriate "evaluation factors". The evaluation factors consist of considerations related to a two-tier hierarchy of potential impacts/issues organized by Evaluation Category, which have been supplemented by more detailed and specific Evaluation Criteria.

Evaluation Category

A broad description of considerations under each category includes:

i. **Functional** – Extent or effectiveness of how the alternative performs as related to the mitigation of surcharging and flooding.
ii. **Environmental** – Potential environmental impacts or benefits that alternatives may have on Natural Heritage Features, wildlife, vegetation, Species at Risk, groundwater, streams and rivers, and including erosion and water quality.
iii. **Social** – Impacts/issues relating to the interaction of the community/neighbourhood with the implementation of the various alternatives.
iv. **Economic** – Capital costs and cost-benefits of the alternative including operations and maintenance.
v. **Constructability** – Construction considerations related to accessibility for machinery and the potential impact of construction techniques and access on private property.

Evaluation Criteria:

Specific evaluation criteria relevant to each Evaluation Category have been summarized in Table 5.1.

Table 5.1. Hamlet of Claremont Drainage System Alternatives Evaluation Approach

EVALUATION CATEGORY	EVALUATION CRITERIA	CRITERIA DESCRIPTION
Functional	Extent to which the Alternative Mitigates the Drainage System Flow Capacity Deficiencies	Each alternative, to varying degrees, provides opportunities to improve the existing storm system (minor and major) flow capacity.
Environmental	Impacts to Aquatic Systems (stream bank, erosion, water quality), , changes in flow regime, erosion and water quality, and also temporary upheaval	Any alternative which would result in degradation of the creek systems (including erosion) or would result in decreased water quality would be considered a negative. Alternatives which are beneficial would be considered positive.
Environmental	Impacts to Terrestrial Environments (Wildlife, Vegetation, Trees)	Alternatives which would result in negative effects if left unmitigated resulting in deleterious impacts to terrestrial environments. Alternatives that avoid removal of trees, native vegetation, and wildlife habitat are preferred.
Environmental	Degree to which the alternative impacts the Natural Heritage System, identified Key Natural Heritage Features (KNHFs), Key Hydrologic Features (KHFs), and Species at Risk.	Alternatives which would result in negative effects if left unmitigated resulting in deleterious impacts to the NHS, identified KNHFs, KHFs, and Species at Risk are not preferred. Alternatives that avoid removal or encroachment into the NHS, KNHFs, KHFs, and Species at Risk habitat are preferred.
Social	Ability to Improve Public Safety	Depending on reduced flooding risk within both private and/ or public property, public safety would be improved to varying degrees.
Social	Impacts on Private Properties	Relates to the change in flood risk on private lands.
Social	Impact on Public Lands	Depending on the alternative there are varying degrees of impact to flooding conditions on public lands including roadways.
Economic	Capital Costs	Lower costs are preferred over higher costs.
Economic	Operations and Maintenance Costs	Lower costs are preferred over higher costs.
Constructability	Ease of Construction and Accessibility	Depending on the selected alternative, the machinery and materials required to construct will vary. The ease and accessibility of alternative construction will vary depending upon alternative location.
Constructability	Construction staging and timing	Depending on the alternative and the extent of the proposed works, the project may need to be staged (multiple phases), and may require multiple years to construct.

6 DETAILED ASSESSMENT OF THE SHORT-LISTED ALTERNATIVES

While drainage system alternatives have been identified for the primary areas of concern based on the existing conditions PCSWMM modelling and site observations, addressing the lack of a major system outlet at Franklin Street is paramount to mitigating the drainage issues within the Hamlet. As noted within Section 7.1.10, the Franklin Street storm sewer is surcharged during a 5-year storm event while the road sag on Franklin Street causes ponding and conveyance of runoff from the ROW through private property during the 100-year storm event. The approach undertaken for this assessment has been to conduct the alternative assessment for Franklin Street to inform the Claremont drainage system preferred alternative. The alternative assessment for the other areas of concern has been undertaken to coincide with the Franklin Street preferred alternative.

In addition to the Franklin Street drainage deficiencies, it will be shown that the preferred alternatives for several areas of concern will result in increased conveyance to the Central Street storm sewer system and will need to be addressed with quantity controls. Two (2) quantity control locations have been identified as the Central Street primary alternatives which include the following:

- *Alternative 1* - Diverting runoff to an offline underground storage tank within Claremont Memorial Park and discharge to the ditch on Old Brock Road
- *Alternative 2* – Convey runoff to three (3) online underground storage tanks within the Central Street ROW at the intersection William Street / Canso Drive intersection.

The preferred sub alternatives for several areas of concern which discharge to the Central Street primary alternative or convey drainage from the Central Street would be common for both primary alternatives. The areas of concern that discharge to or from Central Street are summarized as follows:

- Franklin Street
- Wixson Street
- Old Brock Road
- Williams Street
- Canso Drive
- East Channel
- West Channel

The selection of the preferred alternatives for the foregoing areas of concern has been undertaken prior to selecting the preferred alternative for Central Street, as these will inform quantity controls for the Central Street preferred alternative.

Mitigation alternatives have not been directly considered for the East Channel of West Channel as is it not feasible to undertaken construction efforts within these areas due to their locations within or behind private property, in addition to grading constraints. As such, mitigation of the channel capacity deficiencies has been indirectly proposed through the implementation of the sub alternatives and primary alternatives. The benefits of these alternatives to the channel capacity deficiencies are discussed in the subsequent sections.

Alternatives have also been considered for areas of concern that do not contribute to or receive drainage from the Central Street drainage system. These areas of concern include the following locations:

- Lane Street
- Canso Drive at Acorn Lane
- Livingston Street
- Wellington Street

The selection of the preferred alternatives for the foregoing areas of concern would not impact or inform the primary alternatives. Nevertheless, the preferred alternatives for the areas that do not contribute to or receive drainage from the Central Street drainage system would be common for the Central Street primary alternatives.

6.1 FRANKLIN STREET

The existing conditions assessment identified that the Franklin Street 300 mm storm sewer was undersized for the 12.2 ha (+/-) drainage area that is conveyed to the storm sewer; the storm sewer has been simulated to surcharge to the surface during a 5-year storm event. The storm sewer is 177 m (+/-) in length, commencing at the intersection of Franklin Street and Joseph Street, discharging to the Central Street storm sewer.

In addition to the undersized storm sewers, the Franklin Street roadway sag, 30 m (+/-) north of Central Street prevents major system conveyance to Central Street and conveys runoff through private property during less frequent storm events. The Central Street (Regional Road 5) ROW elevation could be lowered to provide an outlet for the Franklin Street major system, however, this would require coordination with the Region of Durham and would result in significant construction impacts to the properties fronting onto Central Street.

A temporary solution to address the major system deficiencies at the Franking Street sag was the construction of a barrier curb to prevent flow conveyance from the ROW through to the rear yard of the private property. This temporary solution will not address the minor system deficiencies. As such the following long-term alternatives have been considered for implementation:

Do Nothing: This alternative does not mitigate the major or minor system deficiencies on Franklin Street or the potential impacts to the residential properties on Franklin Street. The flood damage and operations and maintenance costs associated with the clean up and repairs incurred due to major storm events would continue.

Increase Storm Sewer Size: The existing 300 mm diameter storm sewer would be increased to 600 mm diameter commencing at Joseph Street for 50 m (+/-) and to 750 mm diameter for 130 m (+/-), to Central Street to convey the 100-year storm event peak flow rate. This would mitigate the storm sewers surcharging to the surface up to and including the 100-year storm event while also mitigating the depth of ponding on the Franklin Street ROW. Four (4) additional twin catch basins and two (2) additional single catch basins would be required on Franklin Street to provide conveyance from the Franklin Street ROW to the upsized storm sewer.

Storm sewers downstream on Central Street would also need to be upsized to convey the increased peak flow rates. The existing Central Street storm sewer between Franklin Street and the East Channel is surcharged above the obvert elevation during the 5-year storm event and should be upsized to provide appropriate flow conveyance; the alternative assessment for the Central Street storm sewer system are summarized within Section 10.5 Central Street.

Implement New Storm Sewers: A storm sewer would be implemented from the north end of Franklin Street to Joseph Street and discharge to the Franklin Street storm sewer. Presently, there is no storm sewer at this section of roadway and runoff from the 7.9 ha (+/-) agricultural external drainage area is conveyed to the Franklin Street roadside ditches prior to capture through the ditch inlets on both sides of the road near Joseph Street; the ditch inlets convey the runoff to the existing 300 mm diameter storm sewer. The capacity of both ditches is exceeded under existing conditions during a 5-year storm event, and the runoff from the ditches is conveyed southward on Franklin Street to the sag in the ROW. Implementing a new storm sewer from the north end of Franklin Street to Joseph Street with three (3) additional ditch inlet catch basins would reduce the flow conveyed to the ditches and address the ditch capacity constraints. The ditches should not be replaced with a curb and gutter cross section as the ditches provide informal water quality treatment for the contributing drainage area.

Combination: The strategic combination of the preceding alternatives of implementing a new storm sewer from the north end of Franklin Street to Joseph Street and increasing the storm sewer size from Joseph Street to Central Street has been considered to address the performance capacity of the storm sewer and roadway drainage. A new 600 mm diameter storm sewer would be implemented from the north end of Franklin Street to Joseph Street to connect to the upsized 600 mm storm sewer south of Joseph Street. This has been selected as the **Preferred Alternative**.

6.2 WIXSON STREET

The performance of the Wixson Street storm sewer for the existing conditions assessment has been simulated as surcharged during the 5-year storm event, for approximately 400 m of storm sewer. There is approximately 180 m (+/-) of 450 mm diameter storm sewer from Central Street northward, while the remainder of the storm sewer is 300 mm in diameter. The cause of the surcharging is two-fold; there is insufficient capacity within the storm sewer to convey the 5-year peak flow rate, and there is a backwater condition caused by the undersized Central Street storm sewer.

The Wixson Street major system is generally flat with no ditches or curb and gutter. The major system has been simulated as surcharged beyond the ROW to the homes for both the 5 and 100-year storm events for 76 m (+/-) north of Central Street. The available storm sewer and manhole data indicates the elevation of the Central Street ROW is greater than the Wixson Street ROW elevation, which would prevent a major system outlet from Wixson Street to Central Street. This could be mitigated by lowering the Central Street ROW. Significant modifications to the Wixson Street ROW, such as implementing curb and gutter or raising the ROW, are not feasible; the ROW is narrow with a width of 7.5 m (+/-) and while such modifications would likely improve conveyance to Central Street, the drainage from the private properties to the ROW would be impacted and could cause further flooding risks.

Do Nothing: This alternative does not mitigate the major or minor system deficiencies on Wixson Street or the potential impacts to the residential properties on Wixson Street. The flood damage and operations and maintenance costs associated with the cleanup and repairs incurred due to major storm events would continue.

Increase Storm Sewer Size: The last two (2) sections of the Wixson Street storm sewer would be increased in diameter from 450 mm to 525 mm for 85 m (+/-) and to 600 mm for 7 m (+/-). Additionally, ten (10) single catch basins and two (2) twin catch basins would be constructed and connected to the existing and proposed storm sewer sections to mitigate the major system performance. The Wixson Street storm sewer would not be surcharged during the 5-year storm event and the performance of the major system would be improved to not flow beyond the ROW to the homes. This has been selected as the **Preferred Alternative**.

6.3 OLD BROCK ROAD

The capacity of the existing Old Brock Road east ditch, between Lane Street and Joseph Street, has been simulated as exceeded during the 100-year storm event. The ditch is 300 m (+/-) in length with a flood risk to the adjacent residential and commercial properties. The capacity of the Joseph Street ROW, between Wixson Street and Old Brock Road, has also been simulated as exceeded during the 100-year storm event. The section of roadway is approximately 85 m (+/-) in length, with residential buildings constructed at the limits of the ROW. Drainage from Joseph Street is conveyed westward toward Old Brock Road. There is a flood risk to those residential buildings during the 100-year storm event.

In addition to the ditch capacity exceedance, the 375 mm diameter, 62 m (+/-) long Old Brock Road storm sewer, between Henry Street and Central Street, has been simulated as surcharged to the surface during the 5-year storm event.

Do Nothing: This alternative does not mitigate the drainage system deficiencies on Old Brock Road or the potential impacts to the residential properties on Old Brock Road. The flood damage and operations and maintenance costs associated with the cleanup and repairs incurred due to major storm events would continue.

Implement New Storm Sewers: A 450 mm diameter storm sewer and ditch inlet catch basin would be installed on Old Brock Road, in addition to installing two (2) double catch basins on Joseph Street between Wixson Street and Old Brock Road. The storm sewer would commence 130 m south of Lane Street with a ditch inlet catch basin, approximate to where the capacity of the ditch is exceeded. The storm sewer would extend to Central Street where the existing 375 mm diameter storm sewer would be replaced, with a total length of 350 m (+/-) of new storm sewer. The proposed storm sewer would discharge to the proposed Central Street storm sewer and ultimately discharge to the West Channel, as per the existing conditions, with no change to the drainage outlet.

The proposed storm sewer would reduce the runoff conveyed via the major system and mitigate the major and minor drainage system deficiencies on Old Brock Road, and the major system drainage system deficiencies on Joseph Street. This has been selected as the **Preferred Alternative**.

6.4 WILLIAM STREET-CANSO DRIVE

The existing 675 mm diameter storm sewers on William Street and Canso Drive, totaling 210 m (+/-), are surcharged during the 5-year storm event and surcharged to the surface during the 100-year storm event. In addition to the runoff conveyed to the storm sewer from William Street and Canso Drive, the storm sewers also convey the flow from Central Street and the upstream contributing drainage area of 15.8 ha (+/-). The storm sewers discharge to the West Channel at the west end of the pedestrian walkway; the storm sewer within the pedestrian walkway is a 910 mm diameter CSP.

The flow is contained to the ROW during the 100-year storm event, however, there is a major system spill of 1.0 m^3/s from Canso Drive to the West Channel through the pedestrian walkway located between 4994 and 4996 Canso Drive. GIS data received from the City indicates that there is a 6 m (+/-) easement adjacent to the pedestrian walkway. The William Street and Canso Street major systems consist of curb and gutter. Major system drainage on William Street is conveyed north to south to the Central Street ROW; conveyance beyond Central Street is impeded as the elevation of Central Street is greater than William Street. Major system drainage on Canso Drive is conveyed from Central Street to the sag in the road at the pedestrian walkway, located 100 m (+/-) south of Central Street. The crest of Canso Drive is located 220 m (+/-) south of Central Street.

Do Nothing: This alternative does not mitigate the major or minor system deficiencies on William Street and Canso Drive or the potential impacts to the residential properties on William Street and Canso Drive. The flood damage and operations and maintenance costs associated with the cleanup and repairs incurred due to major storm events would continue.

Increase Storm Sewer Size: The storm sewers on William Street and Canso Drive would be increased in diameter from 675 mm to 1050 mm. Similarly, the 910 mm diameter CSP within the pedestrian walkway would be increased to 1050 mm diameter. There is a depth of cover constraint, particularly at the Canso Drive sag, as such, the slope of the storm sewer pipes would be limited to 0.5 % (+/-). The upsized storm sewers would provide sufficient capacity beyond the 5-year storm event and would be surcharged between the obvert and the rim elevation during the 100-year storm event. Furthermore, the depth of flow within the ROW would be reduced and there would be no flow from the Canso Drive ROW through the pedestrian walkway. This has been selected as the **Preferred Alternative**.

6.5 CENTRAL STREET

The existing conditions assessment identified the Central Street storm sewer as either surcharged or surcharged to the surface during the 5-year storm event, from Franklin Street to William Street/Canso Drive. The storm sewer is surcharged to the surface during the 100-year storm event, totaling 530 m (+/-) of storm sewer. Furthermore, the Barclay Street ditches, which discharge to the East Channel control manhole, are exceeded due to the surcharging of the Central Street storm sewers. There are two (2) minor system outlets for this storm sewer system; the first is located at the East Channel, 80 m (+/-) west of Franklin Street, where a control manhole diverts flow to the East Channel, while a diversion sewer provides conveyance westward to the second outlet. The second outlet is at the Canso Drive storm sewer which discharges to the West Channel.

The Central Street major system outlets are consistent with the minor system outlets. There are limited major system deficiencies on Central Street between Franklin Street and William Street/Canso Drive as the Central Street ROW is generally greater in elevation than the perpendicular side streets, which prevents major system conveyance from the side streets to the Central Street ROW. Notwithstanding, there are two (2) locations within the identified section of roadway with simulated performance deficiencies during the 100-year storm event; the first is located at the south ditch, between Barclay Street and Victoria Street while the second located at the north ditch west of Dow Street. In addition to these locations, there are also three (3) locations with observed capacity deficiencies, however, have not been simulated with capacity deficiencies; two (2) are located at the north ditch on Central Street both east and west of Barber Street, while the third location is located at the north ditch east of Victoria Street.

The recommended storm sewer diameter increases for Wixson Street, Old Brock Road, and William Street would result in additional capacity requirements for the Central Street storm sewer which conveys the minor system flow from the noted side streets to the respective outlet. Furthermore, the recommended Franklin Street storm sewer has been sized to convey the peak flow rate for the 100-year storm event, and the receiving Central Street storm sewer will also have to convey the 100-year Franklin Street peak flow rate.

An increase to the Central Street storm sewer capacity to convey the Franklin Street 100-year storm event peak flow rate will result in peak flow rate increases to the East Channel. This is unacceptable as there is a simulated existing condition capacity deficiency for the East Channel in addition to observed capacity issues. Undertaking channel rehabilitation works is not an option for the East Channel as noted within Section 1.2 due to grading constraints and limited depth of cover on the TransCanada pipeline. The City has requested that the peak flow rates be reduced to the East Channel to mitigate the capacity deficiencies.

Furthermore, there is a documented wetland toward the downstream limit of the East Channel, located between Livingston Street and Claremont Memorial Park, which extends southwest beyond Old Brock Road. The less frequent storm event peak flow rates (2-year storm event and less) cannot be reduced to this wetland area nor the channel further downstream as there is potential Redside Dace habitat, which is a Species at Risk.

Due to the potential increase in peak flow rate, a quantity control storage facility is required to mitigate the peak flow rates conveyed to the East Channel. Two (2) locations have been identified for an underground SWM storage tank; Claremont Memorial Park, and within the Central Street ROW at the intersection with William Street/Canso Street. A description of each alternative is provided below.

Do Nothing: This alternative does not mitigate the major or minor system deficiencies on Franklin Street or the potential impacts to the residential properties on Franklin Street. The flood damage and operations and maintenance costs associated with the clean up and repairs incurred due to major storm events would continue.

Combination 1, Diversion and Offline Storage – Claremont Memorial Park: Increase the storm sewer size from 450 mm diameter to 750 mm diameter, from Franklin Street to the manhole located 50 m (+/-) west of Franklin Street. The next leg of storm sewer would be increased from 450 mm diameter to a 735 mm x 1145 mm horizontal elliptical pipe and would discharge to the control manhole at the East Channel outlet. A horizontal elliptical pipe has been selected due to depth of cover constraints upstream of the control manhole. Four (4) orifice controls would be required to maintain the existing conditions peak flow rates while also conveying flow westward to the proposed storage tank; the orifice dimensions are summarized in Table 6.1.

Table 6.1. East Channel Control Manhole Orifice Stage and Sizing

ORIFICE STAGE	DISCHARGE LOCATION - EAST CHANNEL	DISCHARGE LOCATION - CENTRAL STREET STORM SEWER
Primary	50 mm Diameter orifice	390 mm Diameter orifice
Secondary	3000 mm x 460 mm (W x H) Rectangular orifice	500 mm x 600 mm (W x H) Rectangular orifice

As noted within Table 6.1, the four (4) orifices vary in size and geometry, while the largest orifice is the secondary orifice for the East Channel, at 3000 mm x 460 mm, which would necessitate a 3600 mm diameter control manhole to be installed to implement the orifice controls. The orifice control dimensions could be optimized at the next stages of planning and design as the discharge peak flow rates have been established through this assessment. The existing 600 mm diameter pipe from the control manhole to the outfall would be replaced with a 735 mm x 1145 mm horizontal elliptical pipe. This outfall pipe would need to be increased otherwise the upstream storm sewers would surcharge to the surface during less frequent storm events. Consequently, the outfall headwall would also have to be replaced.

A comparison of the existing and proposed conditions peak flow rates discharged to the East Channel from the control manhole are provided in Table 6.2.

Table 6.2. East Channel Outfall at Central Street 2-100 Year 12 Hour AES Peak Flow Rate Comparison (m^3/s)

SCENARIO	2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
Existing Condition	0.294	0.580	0.745	1.016	1.190	1.354
Proposed Condition	0.299	0.537	0.683	0.849	0.959	1.048
Difference (m^3/s)	+0.005	-0.043	-0.062	-0.168	-0.231	-0.306
Difference (%)	+1.84	-7.46	-8.34	-16.49	-19.40	-22.60

As shown in Table 6.2, the proposed 2-year storm event peak flow rate is maintained while the 5-year and 100-year peak flow rates have been reduced by 7.5 % to 22.6 % respectfully. The excess flow conveyed to the control manhole would be conveyed to the revised Central Street diversion storm sewer.

The existing 450 mm diameter diversion storm sewer that is conveyed westward on Central Street to the Canso Drive would be replaced with a 675 mm storm sewer that is conveyed westward to Victoria Street and would discharge to a 2,950 m^3 (+/-) underground SWM storage tank located below the baseball diamond within Claremont Memorial Park. As such, no flow would be conveyed from the East Channel control manhole to the West Channel via Central Street. The tank would have a footprint area of 2,700 m^2 (+/-) and a depth of 1.1 m (+/-). A 300 mm diameter outlet pipe would be installed from the SWM storage tank to a new outfall located on the west ditch downstream of the driveway culvert at 4934 Old Brock Road, approximately 100 m (+/-) south of the Claremont Memorial Park baseball diamond. The outlet pipe cannot be extended further south on Old Brock Road as it would interfere with the TransCanada pipeline that traverses Old Brock Road. The Old Brock Road west ditch is conveyed to the East Channel, at the downstream end of the 1200 mm diameter CSP culvert that traverses Old Brock Road. A comparison of the existing conditions and proposed conditions peak flow rates that would be discharged to the East Channel downstream of Old Brock Road is provided in Table 6.3.

Table 6.3. East Channel Downstream of Old Brock Road 2-100 Year 12 Hour AES Peak Flow Rate Comparison (m^3/s)

SCENARIO	LOCATION	2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
Existing Condition	East Channel	0.714	1.471	1.979	2.695	3.085	3.492
Existing Condition	Old Brock Road West Ditch	0.055	0.087	0.106	0.129	0.145	0.162
Existing Condition	Total	0.768	1.558	2.085	2.824	3.230	3.654
Proposed Condition	East Channel	0.688	1.483	1.972	2.551	2.847	3.214

SCENARIO	LOCATION	2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
Proposed Condition	Old Brock Road West Ditch	0.059	0.093	0.113	0.136	0.154	0.171
Proposed Condition	Total	0.747	1.576	2.085	2.687	3.001	3.385
Difference (m^3/s)	Total	-0.022	+0.017	-0.001	-0.137	-0.230	-0.269
Difference (%)	Total	-3.04	+1.19	-0.04	-5.07	-7.45	-7.70

As shown within Table 6.3, the peak flow rates conveyed to the East Channel downstream of Old Brock Road would be reduced for the 2, 10, 25, 50, and 100-year storm events, while there would be a moderate peak flow increase of 1.19 % (+/-) for the 5-year storm event. The capacity of the Old Brock Road west ditch has been reviewed within the PCSWMM model; there is sufficient capacity within the ditch to convey the 100-year storm event peak flow rate of 0.17 m^3/s as the longitudinal slope has been estimated at 5.4 % (+/-).

The Central Street storm sewer from Wixson Street to William Street / Canso Drive would also be upgraded to mitigate the surcharging conditions and provide capacity for increased flow rates from the upgraded storm sewers on Wixson Street, Old Brock Road, and Williams Street. The existing Central Street storm sewers range from 450 mm to 600 mm diameter while the upgraded storm sewers would be 600 mm to 825 mm diameter. As noted, no flow would be conveyed from the East Channel control manhole to the West Channel via Central Street. The alternative is shown graphically within Figure 7. A comparison of the existing conditions and proposed conditions peak flow rates that would be discharged to the West Channel outfall at Canso Drive is provided in Table 6.4.

Table 6.4. West Channel Outfall at Canso Drive 2-100 Year 12 Hour AES Peak Flow Rate Comparison (m^3/s)

SCENARIO	2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
Existing Condition	0.945	1.410	1.571	1.959	2.273	2.426
Proposed Condition	0.691	1.000	1.192	1.429	1.600	1.758
Difference (m^3/s)	-0.254	-0.410	-0.379	-0.530	-0.673	-0.668
Difference (%)	-26.84	-29.08	-24.12	-27.05	-29.61	-27.54

As shown within Table 6.4, the peak flow rates for the 2-year through 100-year storm events would be reduced at the West Channel outfall by 0.25 m^3/s to 0.67 m^3/s (+/-). The Central Street storm sewer performance from Franklin Street to Williams Street / Canso Drive would be improved such that the storm sewers would convey the 5-year storm event with available capacity, while the Central Street major system performance deficiencies would be mitigated. Additionally, the performance of the Barclay Street ditches would be improved as the Central Street storm sewer would not be surcharged at the East Channel control manhole. The major and minor system performance results are shown on Figures 9 and 10 respectively.

While the peak flow rates would be reduced to the East and West channels as shown in Tables 6.2 and 6.3, there would no change to the volume of runoff conveyed to the wetlands from the contributing drainage area. The impact to the wetlands is further discussed in the Wetland Assessment (Ref. Appendix E).

The implementation of a new storm sewer on Victoria Street may likely be unfavourable to the Claremont community. Victoria Street was repaved within the last 10 years and new construction activities on Victoria Street may be viewed as an unnecessary cost to the residents of the Hamlet. Consequently, the residents would benefit from improved public safety both on private and public property, and flooding impacts would be mitigated to private property.

Similarly, the underground SWM tank may be unfavourable at the baseball diamond within Claremont Memorial Park as rehabilitation would be required following construction, and this may be regarded as an unnecessary cost to the residents of the Hamlet for an existing baseball diamond. However, the construction staging and timing of the SWM tank within the park would be less restrictive and would be considered beneficial. To that end, the SWM tank would need to be constructed prior to implementing the storm sewer upgrades for the area contributing to the SWM tank; the storm sewers could be constructed in an upstream direction. Similarly, the storm sewer upgrades for the area contributing to the West Channel would also need to be constructed in an upstream direction; these storm sewers could be constructed concurrently with the area contributing to the SWM tank as there is no proposed connection between the storm sewer systems.

A review of available drawings from the City has demonstrated that there is limited information regarding existing utilities within the ROW. Known utilities include gas lines, Bell Canada communication lines, and hydro poles, in addition to the existing storm sewers. However, the identified utilities are not consistent for the full length of the ROW. City Staff have indicated that the properties within the Hamlet are serviced with dug/drilled wells and septic tanks; sanitary sewers and water mains have not been identified within the available drawings.

A preliminary cost to implement the storm sewer diversion and offline SWM tank storage within Claremont Memorial Park, in addition to the sub alternatives for the side streets, would be $6,518,000 with preliminary annual operations and maintenance costs of $3,000 (ref. Appendix L). It is anticipated that all the disturbed roadways would be restored to the existing conditions where applicable; the preliminary road restoration cost for all the proposed works would be $514,000. Wood will also note that there is an opportunity to coordinate the proposed drainage upgrades with the reconstruction of Central Street by the Region as a joint venture, as Central Street is a Regional Road. The evaluation of this alternative is provided in Table 6.6.

Combination 2, Offline Storage – Central Street ROW at Canso Drive: The storm sewer upgrades from Franklin Street to the East Channel control manhole as noted for the Claremont Memorial Park storage alternative would be consistent for this alternative. The existing 450 mm diameter Central Street diversion storm sewer from the East Channel control manhole would be replaced with a 675 mm diameter storm sewer to Wixson Street. The existing Central Street 450 mm diameter storm sewer west of Wixson Street would be upgraded to a 750 mm diameter storm sewer, increasing in size to a 975 mm diameter storm sewer east of Williams Street / Canso Drive. Underground storage tanks would also be required for this alternative to mitigate the peak flow rate increases to the West Channel due to the increased flow through the diversion storm sewer at the East Channel control manhole.

Three (3) SWM tanks would be required within the Central Street ROW near Williams Street / Canso Drive to mitigate the peak flow rate increases to the West Channel; the volumes of the tanks would be 840 m^3, 980 m^3, and 480 m^3 (+/-). While one tank with an equivalent combined volume of the three (3) tanks would likely be preferrable, the tanks have been proposed to be primarily within the boulevard on both sides of the road such that the full closure of the road would not been required during the construction period. The location of the tanks would also provide a corridor at the centreline of the road should additional utilities need to be implemented in the future. The preliminary layout of the tanks has been placed 3 m from the property line to facilitate excavation without impacting private property. The preferred layout locations could be undertaken as the next stages of planning and design. The alternative is shown graphically within Figure 8.

A comparison of the existing conditions and proposed conditions peak flow rates that would be discharged to the West Channel outfall at Canso Drive is provided in Table 6.5.

Table 6.5. West Channel Outfall at Canso Drive 2-100 Year 12 Hour AES Peak Flow Rate Comparison (m^3/s)

SCENARIO	2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
Existing Condition	0.945	1.410	1.571	1.959	2.273	2.426
Proposed Condition	0.722	1.135	1.385	1.649	1.688	1.733
Difference (m^3/s)	-0.223	-0.275	-0.186	-0.310	-0.585	-0.693
Difference (%)	-23.57	-19.50	-11.84	-15.82	-25.74	-28.57

The peak flow rates shown within Table 6.5 demonstrate that the discharge at the West Channel would be reduced by 0.22 m^3/s to 0.69 m^3/s (+/-) for the 2 to 100-year storm events respectively. The Central Street storm sewer performance would be improved to convey the 5-year storm event with available capacity, while the Central Street major system performance deficiencies would be mitigated. The major and minor system performance results are shown on Figures 11 and 12 respectively.

Consistent with the Claremont Memorial Park SWM tank alternative, there would no change to the volume of runoff conveyed to the wetlands from the contributing drainage area.

The construction impacts due to the implementation of a SWM tanks within Central Street may likely be unfavourable to the Claremont community as there would be vehicular and pedestrian traffic impacts during the construction period. Furthermore, the construction staging and timing would be more restrictive for construction within the ROW. To that end, the SWM tank would need to be constructed prior to implementing the storm sewer upgrades for the area contributing to the SWM tank; the storm sewers could be constructed in an upstream direction. Consequently, the construction of the Franklin Street storm sewer upgrades would not be constructed until all the downstream storm infrastructure was constructed.

Plastic rectangular storage tanks (or approved equivalent) have been identified for implementation within the Central Street ROW. A plastic storage tank that can be sealed should be selected to prevent interaction with groundwater (there is evidence to suggest there is a high groundwater table within the study area), while the tanks should be designed to sustain a 60 Ton load with a minimum cover of 800 mm. Additional details can be established at the next stages of planning and design.

Similarly, to the Claremont Memorial Park SWM tank alternative, there is limited information regarding existing utilities within the Central Street ROW. Known utilities include gas lines, Bell Canada communication lines, and hydro poles, in addition to the existing storm sewers; the identified utilities are not consistent for the full length of the ROW.

A preliminary cost to implement the storm sewer diversion and offline SWM tank storage within the Central Street ROW, in addition to the sub alternatives for the side streets, would be $5,474,000 with preliminary annual operations and maintenance costs of $3,000 (ref. Appendix L). It is anticipated that the roadways would be restored to the existing conditions where applicable; the restoration costs for the Central Street ROW alternative would be less than the Claremont Memorial Park alternative, at $435,00. Wood will also note that there is an opportunity to coordinate the proposed drainage upgrades with the reconstruction of Central Street by the Region as a joint venture, as Central Street is a Regional Road. The evaluation of this alternative is provided in Table 6.6.

6.6 CANSO DRIVE-ACORN LANE

The exiting 300 mm diameter storm sewers on Canso Drive and Acorn Lane and the existing 500 mm diameter storm sewers through the easement to the rear yards of the properties on Acorn Lane have been simulated as surcharged above the obvert during the 5-year storm event. The 300 mm diameter storm sewer on Canso Drive has been simulated as surcharged to the surface during the 100-year storm event. Standing water has also been observed at the outfall to the 500 mm storm sewer in the easement to the rear yards of the properties on Acorn Lane.

There is no outlet for the flow conveyed to the sag at the intersection of Canso Drive and Acorn Lane. The simulated depth of ponding at the sag during the 100-year storm event is 0.36 m(+/-).

Do Nothing: This alternative does not mitigate the major or minor system deficiencies on Canso Drive at Acorn Lane or the potential impacts to the residential properties on Canso Drive at Acorn Lane. The flood damage and operations and maintenance costs associated with the cleanup and repairs incurred due to major storm events would continue.

Increase Storm Sewer Size: The existing 300 mm diameter storm sewers on Canso Drive and Acorn Lane would be replaced with 450 mm diameter storm sewers to mitigate the surcharging during the 5-year storm event.

Offline Storage: A 312 m^3 SWM tank would be constructed within the east boulevard on Canso Drive, to mitigate flooding at the sag in the ROW and storm sewer surcharging during the 100-storm event.

LID BMPs: There is potential to implement an infiltration gallery, dependent on the seasonal high groundwater levels within the area; records indicate they are high in Claremont) and infiltration rates. The infiltration gallery would promote groundwater recharge and should be considered at the next stages of planning and design.

Combination: The strategic combination of the preceding alternatives of upsizing the existing 300 mm diameter storm sewer to 450 mm diameter and implementing offline storage within the Canso Drive boulevard has been considered to improve drainage conveyance and mitigate ponding water during major storm events. The mitigation efforts at this location are considered to be of low priority as there is limited risk of flooding to the residential properties, and this would be considered nuisance flooding or standing water. This has been selected as the **Preferred Alternative**.

6.7 LANE STREET

The drainage on Lane Street, at the north end of the Hamlet of Claremont, is conveyed east to west. East of Wixson Street, the runoff on the south side of Lane Street is conveyed to Wixson Street, while west of Wixson Street the runoff is conveyed west to Old Brock Road and southward on Old Brock Road. The runoff on the north side of Lane Street is conveyed to the Old Brock Road intersection, where it is conveyed northward within the Old Brock Road roadside ditch. The Lane Street cross section has been estimated from online data (Google Street View ™) in lieu of onsite measurements. An existing sidewalk and curb are located on the south side of the street while there is a shallow, 2 cm (+/-) deep, asphalt gutter on the north side of the street which outlets to the Old Brock Road ditch.

The PCSWMM model simulation has not indicated drainage issues on Lane Street as the model is likely not sufficiently discretized; notwithstanding, correspondence from a resident has indicated that standing water has been observed on the east side of the intersection of Lane Street and Old Brock Road during major storm events. It is anticipated that the standing water at the intersection has been caused by poor grading at the intersection. Appropriate alternatives have been reviewed for this localized area.

Do Nothing: This alternative does not mitigate the major system deficiencies on Lane Street or the potential impacts to the residential properties on Lane Street. The flood damage and operations and maintenance costs associated with the cleanup and repairs incurred due to major storm events would continue.

Re-Ditching: The Old Brock Road northeast and southeast ditches would be re-ditched to provide improved drainage conveyance away from the intersection of the Old Brock Road and Lane Street. Ponding would be reduced at the intersection once improvements have been made to the outlets.

Modify Grading on Public Property: There are limited opportunities to improve the grading on Lane Street as the ROW is relatively narrow at 10 m wide (+/-) for two (2) lanes of traffic and a sidewalk, and the area is developed. Furthermore, the longitudinal regrading of Lane Street However, the road grade and the crown within the ROW could be improved, particularly at the intersection of Lane Street and Old Brock Road. An increase to the road crown would increase the slope on both sides of the road to ensure runoff is conveyed to both sides of the roadway and to the ditches on Old Brock Road, while also mitigating the ponding at the intersection.

Combination: The strategic combination of the preceding alternatives of re-ditching the east Old Brock Road ditches and modifying the grading within the Lane Street ROW has been considered to improve drainage conveyance from the intersection and mitigate ponding water during major storm events. This has been selected as the **Preferred Alternative**.

6.8 WELLINGTON STREET

The existing Wellington Street north ditches between Victoria Street and Livingston Street have been simulated as exceeded during the less frequent storm events. A review of the results has shown that the ditches are exceeded at the sag in the road, where the East Channel traverses the road via a 750 mm CSP culvert, while the ditches are not exceeded near Victoria Street or Livingston Street. The East Channel through this area is surcharged, and causing a backwater condition within the ditches which impedes the conveyance within the ditches. The proposed Central Street storm sewer upgrades and revised orifice controls at the East Channel control manhole would reduce the peak flow rate conveyed to the channel, however, would not fully mitigate the surcharged East Channel or the impact to the Wellington Street ditches. It is anticipated that the exceedance of the ditches during the 100-year storm event would not impact the residential structures on the north side of Wellington Street, however, the flow may encroach on the front yards of the private properties.

Ditch Re-Profiling: Re-profiling the ditches would not improve the ditch performance due to the flow rates conveyed to the East Channel, which will impact the drainage from the ditches.

Do Nothing: This alternative does not mitigate the major system deficiencies on Wellington Street or the potential impacts to the residential properties on Wellington Street. The flood damage and operations and maintenance costs associated with the clean up and repairs incurred due to major storm events would continue. This has been selected as the **Preferred Alternative**.

6.9 LIVINGSTON STREET

The capacity of the existing east ditch on Livingston Street has been simulated as exceeded during the 100 year storm event, from Wellington Street to the easement ditch at the East Channel, a distance of 175 m (+/-). There is a 375 mm CSP culvert that traverses Livingston Street; this culvert conveys runoff from the east ditch to the easement ditch as the culvert does not provide sufficient capacity. The easement ditch between the Livingston Street and the East Channel has also been simulated as exceeded. There is potential for the flow within the ditches to exceed the banks and spill onto private property, however, it is not anticipated that any residential buildings would be impacted on Livingston Street. Standing water has also been observed in the east ditch, south of the 375 mm CSP culvert. The following alternatives have been considered for Livingston Street.

Do Nothing: This alternative does not mitigate the ditch performance deficiencies on Livingston Street or the potential impacts to the residential properties on Livingston Street. The flood damage and operations and maintenance costs associated with the clean up and repairs incurred due to major storm events would continue.

Twin Existing Culvert: The existing 375 mm CSP culvert would be twinned to provide greater flow capacity from the Livingston Street east ditch to the easement ditch.

There would be moderate construction impacts as the road would have to undergo opencut excavation to install the culvert; the duration of the construction is not anticipated to be a lengthy process and could likely be completed within a single day.

Ditch Re-Profiling: The east Livingston Street ditch and the easement ditch would be re-profiled to provide additional conveyance capacity. There is sufficient space within the ROW to widen the Livingston Street east ditch from 1.8 m (+/-) wide to 2.5 m wide. Similarly, the easement ditch would be reprofiled from a 3.5 m (+/-) wide and 0.25 m (+/-) v-ditch to a 1.5 m (+/-) bottom width trapezoidal ditch with a depth of 0.25 m (+/-). The easement ditch would likely still be exceeded at the downstream end at the confluence with the East Channel, however, the depth of flow at the upstream end would be contained to the ditch.

Combination: The strategic combination of the preceding alternatives of re-ditching the east Livingston Street ditch and the easement ditch in addition to twinning the 375 mm has been considered to improve drainage conveyance and mitigate ponding water during major storm events. The mitigation efforts at this location are considered to be of low priority as there is limited risk of flooding to the residential properties, and this would be considered nuisance flooding or standing water. This has been selected as the Preferred Alternative**.**

Table 6.6. Evaluation of the Central Street (Regional Road 5) Drainage Alternatives

EVALUATION CATEGORY	EVALUATION CRITERIA	DO NOTHING - COMMENT	DO NOTHING - GRADE	DIVERSION TO A SWM TANK WITHIN CLAREMONT MEMORIAL PARK - COMMENT	DIVERSION TO A SWM TANK WITHIN CLAREMONT MEMORIAL PARK - GRADE	DIVERSION TO SWM TANKS WITHIN THE CENTRAL STREET ROW - COMMENT	DIVERSION TO SWM TANKS WITHIN THE CENTRAL STREET ROW – GRADE
Functional	Effectiveness	• No improvement	-1	• Mitigates the major and minor drainage system deficiencies	+1	• Mitigates the major and minor drainage system deficiencies	+1
Environmental	Impacts to Aquatic Systems	• Not applicable	0	• The East Channel peak flow rates would be maintained at the Old Brock Road culvert • The West Channel peak flow rate would be reduced at the Canso Drive outfall	0	• The East Channel peak flow rates would be maintained at the Old Brock Road culvert • The West Channel peak flow rate would be reduced at the Canso Drive outfall	0
Environmental	Impacts to Terrestrial Systems	• Not applicable	0	• No significant impacts anticipated to the terrestrial systems	0	• No significant impacts to the terrestrial systems	0
Environmental	Impacts to NHS, KNHF, KHFs, Species at Risk	• Not applicable	0	• Reduction in peak flow rate and flow volumes could affect wetland downstream of Canso Drive outfall. • Reduction in peak flow rate and flow volumes could affect contributing flow characteristics to Redside Dace habitat	-1.0	• Reduction in peak flow rate and flow volumes could affect wetland downstream of Canso Drive outfall. • Reduction in peak flow rate and flow volumes could affect contributing flow characteristics to Redside Dace habitat	-1.0
Social	Improve Public Safety	• No improvement	-1	• Reduced flooding would improve public safety	+1	• Reduced flooding would improve public safety	+1
Social	Impacts to Private Property	• No improvement	-1	• The flooding impacts to private properties would be mitigated	+1	• The flooding impacts to private properties would be mitigated	+1
Social	Impacts to Public Property	• No improvement	-1	• There would be construction impacts to the Claremont Memorial Park and the ROW	-1.0	• There would be construction impacts to the ROW	-0.5
Economic	Capital Costs	• Not applicable	0	• Preliminary capital cost $6,518,000 • Road restoration cost $514,000	-1	• Preliminary capital cost $5,474,000 • Road restoration cost $435,000	-0.5
Economic	Operations and Maintenance Costs	• Not applicable	0	• Preliminary annual operations and maintenance cost $3,000	-0.5	• Preliminary annual operations and maintenance cost $3,000	-0.5
Constructability	Ease of Construction and Accessibility	• Not Applicable	0	• Construction impacts to recently improved public park and Victoria Street	-1	• Construction impacts to the Central Street (Regional Road 5) ROW requires Region of Durham approval	-0.5
Constructability	Construction Staging and Timing	• Not Applicable	0	• Staging and timing would be less restrictive due to implementation within the park	-0.5	• Staging and timing would be more restrictive due to implementation within the Central Street ROW	-0.5
Results			-4		-2.0		-0.5

7 PREFERRED ALTERNATIVES, PRIORITIZATION AND IMPLEMENTATION

7.1 PRIORITIZATION

Drainage system improvements have been recommended for Central Street based on their functional performance (i.e. their ability to address the identified drainage system deficiency), as well as other criteria related to environmental, social, economic and constructability considerations. Drainage system improvements have also been recommended for the areas that convey runoff to the Central Street drainage system or convey flow from the Central Street drainage system; the functional performance is the primary criteria for these areas of concern. Similarly, recommendations have been provided for areas of concern that do not receive or convey drainage to or from Central Street; the functional performance is also the primary criteria for these areas, however, these areas are considered to be of lower priority due to a lower risk of flooding impacts or frequency.

The preferred alternatives for the areas of concern which convey runoff to or from the Central Street drainage system would mitigate the major and minor system performance deficiencies. The preferred alternatives include storm sewer upgrades, installing new storm sewers, and implementing additional catch basins. The preferred alternatives are summarized within Table 7.1. The implementation of these preferred alternatives would result in increased peak flow rates to the Central Street drainage system, particularly from the Franklin Street drainage improvements. Therefore, the Central Street drainage system would require to be upgraded prior to implementing the contributing drainage system improvements. The implementation of the preferred alternatives for the areas of concern which convey runoff to or from the Central Street drainage system are considered to be a high priority, and should be constructed following the construction of the Central Street preferred alternative.

The preferred alternative for the Central Street drainage system, and for the mitigation of the increased peak flow rates due to the contributing area drainage system improvements, is to divert runoff from the East Channel control manhole westward via a diversion storm sewer to three (3) proposed underground SWM storage tanks within the Central Street ROW at the intersection with Williams Street / Canso Drive. The SWM tanks would discharge to the Canso Drive storm sewer and the West Channel outfall located behind the residential property at 4994 Canso Drive. This preferred alternative would mitigate the peak flow rates discharging to the East and West channels, while also mitigating the Central Street major and minor system performance deficiencies. The preliminary cost for the construction of all the recommended works is the $5,474,000 with an additional $435,000 for road restoration works following construction. The preliminary annual operations and maintenance cost of the preferred alternative is estimated at $3,000. During detailed design the possibility of placing storage on Canso Drive should be assessed.

Central Street (Regional Road 5) is owned by the Region of Durham and coordination and approval with the Region of Durham is required to implement the proposed works within Central Street. The Region has indicated that Central Street will be reconstructed as part of a separate project undertaking.

The preferred alternatives for the areas of concern that do not contribute to Central Street, such as Lane Street, Livingston Street, and Canso Drive at Acorn Lane, (ref. Table 7.1) are considered to be of lower priority and these works should be undertaken following the completion of the Central Street preferred alternative.

7.2 IMPLEMENTATION

The following should be considered prior to conducting detailed design of the preferred alternatives:

1. A Stage 2 archaeological assessment by means of test pit survey should be conducted in those areas of archaeological potential as identified in the Stage 1 Archaeological Assessment (ref. Appendix G), and a pedestrian archaeological survey should be conducted at 5-m intervals on open agricultural fields.

2. Site-specific inventories of the key Natural Heritage features (ref. Figure 13) and the habitat of SAR should be conducted to determine the need for additional assessment, mitigation, and permitting.

3. Additional assessment of the West and East Wetlands as indicated in Section 7.3 Wetland Assessment.

Table 7.1. Summary of the Preferred Alternatives and the Prioritization

PRIORITY	LOCATION	PREFERRED ALTERNATIVE	MUNICIPAL CLASS EA SCHEDULE	EA STATUS
High	William Street / Canso Drive	Upsize the storm sewers from Henry Street to the outfall at the West Channel (250 m (+/-) of 1050 mm diameter storm sewer).	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
High	Central Street/ Canso Street	Upsize storm sewers from Franklin Street to William Street / Canso Drive and construct three (3) underground SWM tanks within the Central Street ROW; 400 m (+/-) of storm sewers ranging in size from 750 mm to 975 mm. The potential to include some storage on Canso Street should be assessed during detailed design.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
High	Franklin Street	Install new storm sewers on Franklin Street from 100 m north of Joseph Street to Joseph Street, increase the storm sewer sizes on Franklin Street from Joseph Street to Central Street, and install four (4) twin catch basins, two (2) single catch basins, and three (3) ditch inlet catch basins; the total length of storm sewer is 280 m (+/-) ranging in diameter from 600 mm to 750 mm.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
High	Old Brock Road	Implement new storm sewers and catch basins on Old Brock Road from 170 m (+/-) north of Joseph Street to Henry Street; catch basins should also be installed on Joseph Street. The existing 375 mm diameter and 60 m (+/-) long storm sewer north of Central Street would be increased to 450 mm diameter.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.

PRIORITY	LOCATION	PREFERRED ALTERNATIVE	MUNICIPAL CLASS EA SCHEDULE	EA STATUS
High	Wixson Street	Install ten (10) single new catch basins and two (2) twin catch basins on Wixson Street between Lane Street and Central Street. Increase the diameter of the existing 450 mm 85 m (+/-) long storm sewer north of Central Street to be 525 mm diameter.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Lane Street	Regrade the east side of the Lane Street and Old Brock Road intersection to convey drainage away from the intersection. Re-profile the existing east Old Brock Road ditch.	Schedule A	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Livingston Street	Reprofile the east Livingston Street ditch, twin the existing 375 mm CSP culvert that traverses the roadway, and reprofile the easement ditch between Livingston Street and the East Channel.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Canso Drive – Acorn Lane	Upsize the existing 300 mm diameter storm sewers on Canso Drive and Acorn Lane, 90 m (+/-) and 85 m (+/-) respectively, to be 450 mm diameter, and implement a storage tank within the Canso Drive boulevard.	Schedule A+	Schedule A and A+ projects are exempted from the requirements of the Environmental Assessment Act. These projects can proceed to detailed design phase.
Low	Wellington Street	Do nothing; the reduction in peak flow rates discharging to the East Channel will mitigate the impacts to the Wellington Street roadside ditches, however, will not fully mitigate the risk of flooding to the adjacent properties.	N/A	

7.3 WETLAND ASSESSMENT

Drainage from the Hamlet of Claremont is primarily conveyed to two (2) channels, identified as the East and West Channel, which convey runoff to two (2) wetlands features downstream of and within the channels. The Claremont Drainage Plan MCEA preferred alternative has recommended to divert flow from the East Channel to the West Channel while also implementing stormwater management quantity controls. The proposed quantity controls would largely mitigate potential peak flow rate increases at the West Channel, however, there would be an increase in the runoff volume discharged at the storm sewer outfall to the West Channel based on the City of Pickering 2 -100 year AES 12 hour design storm events. Consequently, there would be a reduction in the runoff volume discharged at the storm sewer outfall to the East Channel.

The Wetland Water Balance Risk Evaluation (TRCA, November 2017) has been used to determine the hydrological impact to the two (2) wetlands; a surrogate approach has been used based on the change in runoff volume rather than the change in imperviousness or catchment size (ref. Appendix E). The increase in runoff volume to the West Wetland would be greater than 10 % and less than 25 % and the magnitude of runoff volume change (hydrological change) would be considered Medium as per Table 2 within the Wetland Water Balance Risk Evaluation (TRCA, November 2017). The decrease in runoff volume to the East Wetland would be less than 10 % and the magnitude of runoff volume change (hydrological change) would be considered Low as per Table 2 within the Wetland Water Balance Risk Evaluation (TRCA, November 2017).

A desktop review of available resources has been completed to evaluate the ecological sensitivity of the wetlands:

- The data indicated that there are low sensitivity vegetation species within the West Wetland, and limited data for the East Wetland; conservatively, a medium sensitivity has been used for the East wetland vegetation species.
- The data was reviewed for known fauna within the wetlands; the combined sensitivities of known fauna within the wetlands is High due to the presence of High sensitivity species, the Northern Leopard Frog.
- The overall sensitivity ranking for flora within the subject wetlands is Medium (conservative estimate in absence of formal species list).
- Significant Wildlife Habitat for high sensitivity species (amphibians) is thought to be present in the subject wetlands based on observations of multiple amphibian species; as such, the sensitivity rating is High.

The subsequent wetland hydrological sensitivity and ecological sensitivity have been reviewed in reference to the Project Risk Decision Tree within the Wetland Water Balance Risk Evaluation (TRCA, November 2017). The magnitude of hydrological change (Medium and Low) and the sensitivity of the wetland (High) were considered, and the decision tree points to High (west wetland) and Low (east wetland) risk under these parameters (ref. Appendix E).

Due to the high sensitivity of the west wetland, additional flow monitoring, a groundwater characterization, and hydrological continuous simulation modeling is required in addition to further consultation with TRCA. The east wetland does not require additional monitoring due to the evaluation sensitivity of a low risk; further non-continuous hydrological monitoring would be required.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The following conclusions have been prepared based on the findings of this study:

1. A validated PCSWMM hydrologic/hydraulic model has been developed to simulate the existing Hamlet of Claremont drainage system to identify areas of concern based on the performance of the major and minor conveyance systems. The model has been validated with six (6) observed rainfall events recorded from April 27, 2017, to June 26, 2017, which coincides to flow data recorded at three (3) locations. The model has been simulated with the City 5- and 100-year 12-hour AES design storm events.

2. Storm sewers identified with insufficient capacity during the 5-year storm event include Franklin Street, Central Street between Franklin Street and Canso Drive, Canso Drive south of Central Street and William Street between Henry Street and Central Street. Major systems (roadways) that do not have adequate flow capacity include Franklin Street, Barclay Street, Livingston Street, Wixson Street, Canso Street, and Old Brock Road.

3. A cultural heritage assessment has been completed and identified one (1) property, The Mason's Union Lodge, Brougham Union at 4953 Old Brock Road, which is protected by an easement agreement with the City of Pickering under Section 37 of the Ontario Heritage Act. However, this cultural heritage assessment has recorded 64 heritage resources or potential heritage resources near the proposed drainage infrastructure improvements.

4. A Stage 1 archaeological assessment background study has been conducted For the Claremont Study Area to assess the archaeological potential based on its historical use and its potential for early Euro-Canadian (early settler) and pre-contact Aboriginal occupation. The archeological assessment concluded that undisturbed portions of the study area have archaeological potential due to the presence of watercourses within the study area, a clear pattern of pre-contact Aboriginal and historic Euro-Canadian land use in the vicinity, and due to the historic nature of the Hamlet which contains historically important transportation routes.

5. Improvements to the existing drainage in the Hamlet of Claremont may intersect with several environmental constraints, including Key Hydrological Features (permanent/intermittent streams, wetlands), Key Natural Heritage Features (wetlands, woodlands, significant wildlife habitat, fish habitat), and SAR and/or their habitats.

6. The wetland hydrological sensitivity and ecological sensitivity have been reviewed as per the supporting Wetland Assessment; the Wetland Assessment was completed at the request of TRCA. The magnitude of hydrological change (Medium and Low) and the sensitivity of the wetland (High) were considered according to the Wetland Water Balance Risk Evaluation (TRCA, November 2017); the wetlands are considered to be, High (west wetland) and Low (east wetland) risk under these parameters.

8.2 RECOMMENDATIONS

The following recommendations have been prepared based on the findings of this study:

1. The preferred alternative of upsizing the Central Street storm sewer from Franklin Street to Williams Street / Canso Drive, in addition to the upsizing of storms sewers which contribute to Central Street, has been recommended for implementation to address the ongoing drainage deficiencies to the major and minor systems. Three (3) underground stormwater management tanks will be required to address the peak flow rate increases to the West Channel outfall, at Canso Drive. The preliminary cost for the construction of all the recommended works is the $5,474,000 with an additional $435,000 for road restoration works following construction. The preliminary annual operations and maintenance cost of the preferred alternative is estimated at $3,000.

2. Construction within rights of way such as Central Street (Regional Road 5) can be disruptive to the existing community and natural environment. As such, construction impacts should be mitigated to limit the disruption to the community and through traffic while ensuring that appropriate restoration measures are applied to the ROW and private property if required. Excessive construction noise and dust could impact the natural heritage systems (i.e. vegetation, wetlands, birds, and other wildlife). Mitigation measures should be considered at the next stages of planning and design to address short-term impacts while ensure there are no long-term impacts to these systems.

3. To mitigate the impacts to the cultural heritage of the community during construction, a series of recommendations have been provided which are summarized as implementing construction fencing at cultural heritage resources, applying standard construction techniques, replacing trees where necessary, and the projected drainage work should be engineered to ensure that the heritage character of the buildings and landscapes is not unduly impacted or obscured.

4. Prior to implementing the recommended drainage system improvements, a Stage 2 archaeological assessment by means of test pit survey should be conducted in those areas of archaeological potential, and a pedestrian archaeological survey should be conducted at 5-m intervals on open agricultural fields.

5. In advance of the execution of any drainage improvements, site-specific inventories of the key Natural Heritage features (if works are proposed within minimum areas of influence) and the habitat of SAR should be conducted to determine the need for additional assessment (e.g., Natural Heritage Evaluation), mitigation, and permitting.

6. Additional flow monitoring, a groundwater characterization, and hydrological continuous simulation modeling is required in addition to further consultation with TRCA for the West Wetland as recommended within the supporting Wetland Assessment. The east wetland was considered a low risk following the wetland sensitivity evaluation and does not require additional monitoring due, however, further non-continuous hydrological monitoring would be required.

7. To provide improved water quality to the West and East drainage outlets, as discussed with TRCA, water quality measures in the way of oil/grit separators (OGS) units should be considered during detailed design. Thermal mitigation measures should also be considered at each drainage outlet during detailed design.

8. As part of detailed design there will be the need for consultation with regulatory agencies to confirm the need for additional technical investigations, develop project specific mitigation measures and confirm permitting requirements, including activities involving the management of excess soils as per O. Reg. 406/19.

APPENDIX A

FIELD RECONNAISSANCE

APPENDIX B

MONITORING DATA FOR SELECT STORM EVENTS

APPENDIX C

RATING CURVE DEVELOPMENT

APPENDIX D

BACKGROUND INFORMATION

APPENDIX E

NATURAL HERITAGE SYSTEMS - WETLAND ASSESSMENT

APPENDIX F

CULTURAL HERITAGE ASSESSMENT

APPENDIX G

STAGE 1 ARCHAEOLOGICAL ASSESSMENT

APPENDIX H

CITY OF PICKERING IDF RELATIONSHIPS AND DESIGN STORMS

APPENDIX I

HYDROLOGIC / HYDRAULIC MODEL PARAMETERIZATION

APPENDIX J

HYDROLOGIC / HYDRAULIC MODEL CALIBRATION / VALIDATION

APPENDIX K

EXISTING CONDITION MAJOR AND MINOR SYSTEM PERFORMANCE RESULTS

APPENDIX L

PRELIMINARY COST ESTIMATES

APPENDIX M

PUBLIC CONSULTATION

APPENDIX N

INDIGENOUS CONSULTATION