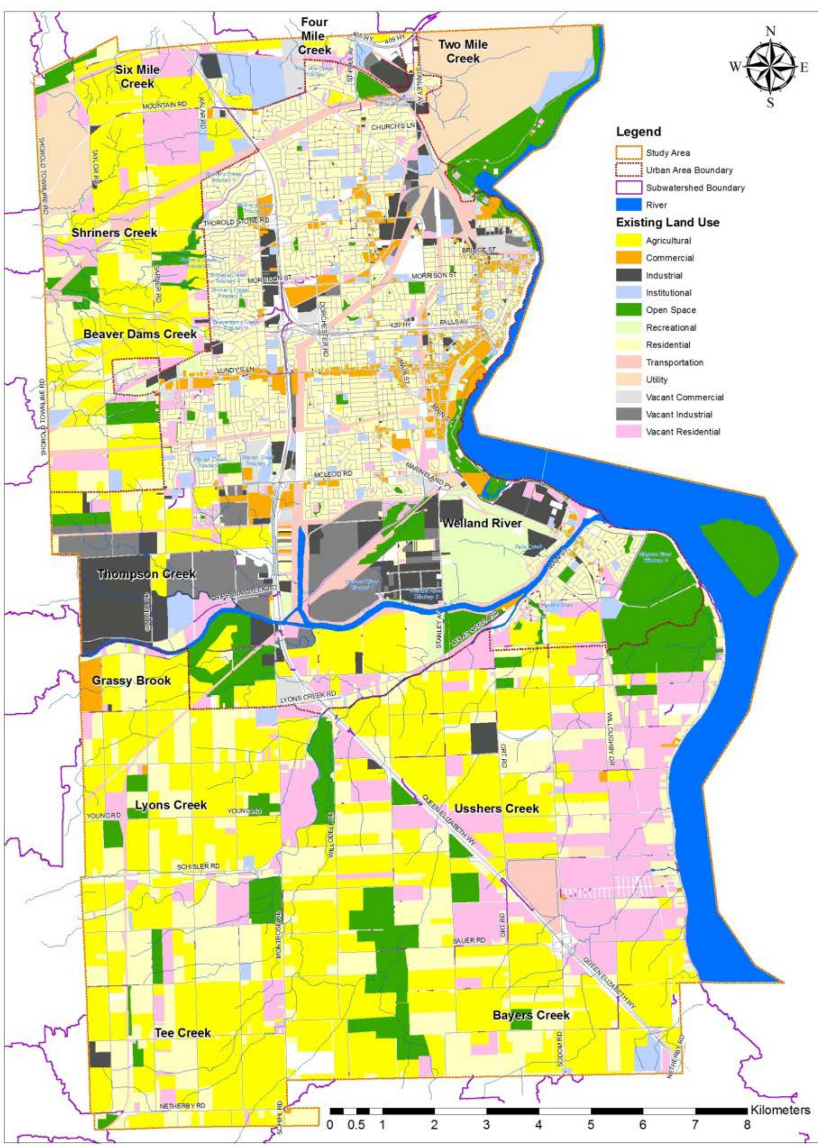
Prepared for:

The City of Niagara Falls

CITY OF NIAGARA FALLS

CORWIN DRAINAGE ENVIRONMENTAL ASSESSMENT STUDY

FINAL REPORT



Aquafor Beech Ltd.

2600 Skymark Ave,
Bldg 6, Suite 202
Mississauga, ON
L4W 5B2

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Reference: 66202

EXECUTIVE SUMMARY

INTRODUCTION

Aquafor Beech Limited (Aquafor) was retained by the City of Niagara Falls to undertake the Corwin Drainage Environmental Assessment (EA) Study.

The City of Niagara Falls has experienced several basement flooding events over the period of a couple decades. The storm events overwhelmed the existing storm sewers and potential cross connections to the sanitary sewer system which resulted in over 100 reports of basement flooding due to backup of water through the floor drains or plumbing, etc.

The study area is bounded by Lundy's Lane to the north, Dunn Street and the hydro corridor south of McLeod Avenue to the south, Allendale Avenue and Drummond Road to the east and the Hydro Electric Power Canal (HEPC) to the west. The approximate study area is approximately 452 ha.

Figure E-1: Study Area and Area of Flood Risk

STUDY PURPOSE

The study purpose has been defined as follows:

- To identify the causes of flooding and address issues related to combined sewer overflows and extraneous infiltration/inflow to the Region of Niagara's sewer system; and
- To identify and evaluate the alternative solutions to alleviate these issues.

MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT (EA) PROCESS

The current study has been classified as a Schedule 'B' project and follows Phases 1 and 2 of the planning and design process with Phase 5 to follow at a subsequent stage. This report outlines Phases 1 and 2 of the EA process.

PHASE 1 – PROBLEM AND OPPORTUNITY DEFINITION

Over the last 10 years, the City of Niagara Falls has experienced several rainfall events that have triggered incidents of basement flooding in various areas across the City. The primary types of problems within the study area are related to:

- Flooding of properties and buildings
- Combined sewer overflows (CSO's)
- Extraneous inflow/infiltration to the City's sanitary system

The opportunities of the Corwin EA study include:

- Propose remedial works to mitigate future flooding
- Prevent or eliminate CSO's
- Reduce extraneous inflow & infiltration (I&I) into the Region of Niagara's sanitary system
- Provide a level of service which is consistent with municipal standards; and
- Improve the operational and structural condition of the storm sewer system.

PUBLIC CONSUTATION

Public consultation activities for the Corwin study are summarized below:

- A Notice of Study Commencement was published July, 2018;
- One Public Information Centre (PIC) was held. The PIC described the study area, defined problems and opportunities as well as a long list of alternatives, evaluation criteria and the preliminary preferred solution.

A summary of the public consultation process, contact lists, materials and comments can be found in Appendix A.

PHASE 2 - EVALUATION OF ALTERNATIVE SOLUTIONS

DEFINITION OF EXISTING CONDITIONS

A variety of information was collected and reviewed in Phase 1 in order to define the existing conditions. The information is summarized in Technical Memoranda 1 to 4 in Appendix B. In summary the following tasks were undertaken to define existing conditions.

1) **Existing Document Review and Summary**
   - All relevant background documents addressing the issues primarily from the Corwin Drainage Area perspective with some at the City-wide perspective were reviewed and the relevant findings from the documents were summarized;
2) **Flow Monitoring Review and Field Assessment**
   - A summary of the 2014 City-wide flow monitoring and the storm sewer flow monitoring plan undertaken by the City and Consultant for the Corwin Drainage Area Study was provided;
3) **Data Gap Analysis**
   - A data gap analysis summarizing the gaps based on findings from the existing hydraulic and hydrologic model for the sanitary, combined and storm systems was undertaken;
4) **Topographic and Geotechnical Assessment**
   - Topographic and geotechnical work was undertaken to better define items such as cover elevations, invert elevations, pipe sizes etc.;
5) **McLeod CSO/SSO Tank Field Investigation**
   - A field investigation and assessment of the McLeod Road tank functionality in order to provide a clear perspective of the conveyance infrastructure was undertaken;
6) **Hydrologic and Hydraulic Modelling**
   - A hydrologic and hydraulic modelling exercise was undertaken in order to define both the existing level of service together with the frequency, type, extent and location of flooding issues.

General findings of the above assessment included the following:

- The current storm sewers primarily servicing the northern section of the Corwin drainage area north of Dunn Street are under capacity for the 5-Year storm event;
- There is significant downstream surface flooding along Carlton Avenue;
- There is an existence of combined sewer overflows (CSO's) primarily in the northern section of the Corwin Drainage Area that contributes to basement flooding;
- The McLeod CSO/SSO facility is non-functional with no flow (controlled or uncontrolled) entering from the minor system and should be permanently decommissioned;

DEVELOPMENT AND ASSESSMENT OF REMEDIAL MEASURES

The following sections outline remedial measures associated with the storm, combined and sanitary systems in the study area in order to alleviate basement and surface flooding. The performance of remedial measures associated with each system are based on the 5- and 100-year design storms. This section outlines the evaluation criteria and presents alternative control measures. The outcome of this section is the identification of preferred solutions to address basement and surface flooding within the study area.

LEVEL OF SERVICE CRITERIA

The target level of service for the minor system is to maintain the hydraulic grade line 1.8 m below the ground surface (approximate depth of the basement floor) for events up to the 100year design storm. In addition, for the 100 year storm depths of water on the roadway should not exceed 300 mm in order to prevent flooding of homes from the roadway. The 5-year and 100-year design storm event model results are used as a basis to develop alternatives to alleviate flooding for the remedial measures for the storm sewer (minor) system.

DEVELOPMENT OF ALTERNATIVES

There are two primary reasons that homes in the area flood. The first involves undersized storm sewers in the upper part of the sewershed. The second involves an undersized storm trunk sewer that runs along Caledonia Street. Common elements to all alternatives (except the Do Nothing alternative) include new storm sewers in the upper part of the sewershed together with removal of CSO's along Franklin Avenue. The alternatives as described below primarily relate to the provision of a new storm trunk sewer which will discharge to the HEPC canal.

The four alternatives that were considered include:

1) Alternative 1 - Do Nothing
2) Alternative 2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands
3) Alternative 3 - Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street
4) Alternative 4 - Construction of Storage Tanks along Carlton Avenue and Dunn Street

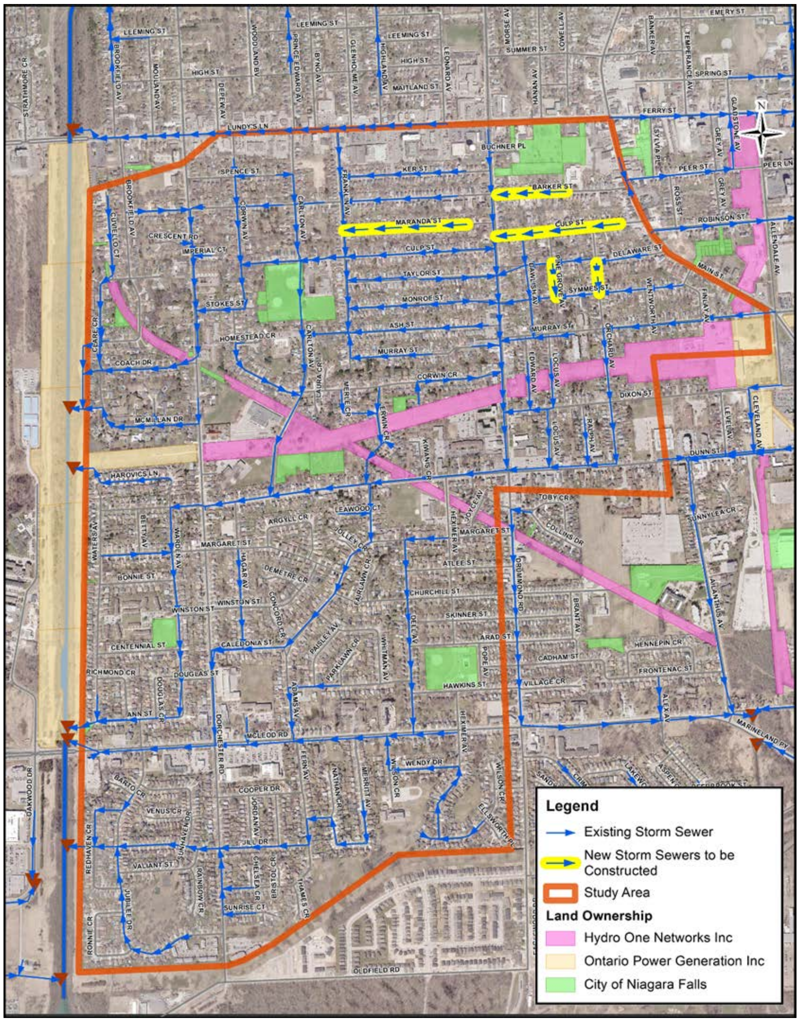

Figure E-2: Common Elements for Development of Alternatives

REMOVAL OF CSO's

The City provided data on the locations of CSO's within the defined Study Area. An additional field survey was conducted by City staff to confirm the configuration of the CSO structures. Locations of the CSO's within the study area are summarized below:

- Franklin Avenue & Culp Street,
- Monroe Street & west side of Franklin Avenue,
- Ash Street and Carlton Ave, and
- Ash Street and Franklin Avenue

Sizing of remedial measures is accomplished using the computer model. New sewer elements or remedial measures were added to the system model, sizes and lengths were estimated, CSO's were removed and then simulations were performed until the model showed acceptable results based on the level of service criteria associated with the storm systems.

EVALUATION CRITERIA

In order to evaluate the alternative solutions identified in the previous sections, evaluation criteria were established in order to select the preferred alternative. The evaluation criteria include:

- Natural heritage considerations,
- Economic considerations;
- Socio-cultural considerations; and
- Technical considerations.

SELECTION OF THE PREFERRED ALTERNATIVE

Based on the results of the alternatives evaluation and in consultation with the City, agencies and the public, Alternative 2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands was selected as the preferred alternative. This alternative has a nominal impact on the natural environment, is preferred with respect to impact on adjacent businesses, residents and commuters, is the least costly alternative and is technically feasible. Further approvals from Hydro One and Ontario Power Generation will be required.

Figure E-3: Preferred Alternative

COMBINED AND SANITARY SEWER SYSTEM

The existing combined and sanitary H&H model by GM Blue Plan was reviewed and modified to reflect a decommissioned McLeod Tank facility. The existing model was run under the 1981 Average Year event to determine the frequency and extent of CSO's within the system. It was concluded that under average-year conditions, CSO's do not occur at the South-Side High-Lift station into the HEPC and that the proposed construction of new storm sewers together with the removal of four (4) as part of the overall solution will assist in further reducing CSO's.

CLIMATE CHANGE

The Master Plan Update Study (MPUS – 2016) completed by Aquafor , based on historical rainfall data in the City, recommended using a five (5) percent increase in the current IDF to project for climate change, Under a 100-Year plus 5% climate change factor, there is a nominal change in the surcharge state of the major and minor systems.

IMPEMENTATION

The next steps for implementation of the preferred alternative will include:

- Conceptual design
- Detailed design and associated investigations
- Approvals
- Contract document preparation and tender;
- Implementation Phasing; and
- Construction

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1.0 Introduction

1.1 Overview of Study

Aquafor Beech Limited was retained by the City of Niagara Falls to undertake the Corwin Drainage Environmental Assessment (EA) Study. The City of Niagara Falls has experienced several basement flooding events over the last few decades. The storm events overwhelmed the existing storm sewers which resulted in numerous basement flooding complaints due to backup of water into houses. The primary objective of this study is to reduce ongoing flooding issues. Items with respect to the structural and operational condition of the stormwater and wastewater collection systems are also assessed, and alternative solutions are proposed for the alleviation of basement and surface flooding.

1.2 Study Area

The study area is bounded by Lundy's Lane to the north, Dunn Street and the hydro corridor south of McLeod Avenue to the south, Allendale Avenue and Drummond Road to the east and the Hydro Electric Power Canal (HEPC) to the west. The approximate study area is 452 ha and is shown in Figure 1-1.

Figure 1-1: Corwin Drainage Study Area

1.3 Background

The City Council has approved the City Wide Master Drainage Plan Update Study (MDPUS) report at the Council Meeting on April 25, 2017. The MDPUS had identified a number of flooding problem areas, where there are reported flooding incidents associated with the storm sewer system. Problem Areas 19 and 20 (Figure 2) were identified and centered on the following intersections:

- Murray Street and Franklin Avenue;
- Corwin Crescent and Merle Crescent;
- Dunn Street and Caledonia Street; and
- Dunn Street and Ralph Avenue.

The study will address issues relating to Flooding Issues and Combined Sewer Overflows (CSOs).

1.4 Class Environmental Assessment Process

The objective is to provide a strategic plan, drainage policies and a capital strategy in order to define ongoing capital, operation and maintenance, and the long-term growth and sustainability of the City's drainage system infrastructure.

The study is being planned under the requirements set out in the Municipal Class Environmental Assessment (MCEA) document dated October 2000, amended in 2011 and 2015. The MCEA process provides members of the public and interest groups an opportunity to provide input at key stages of the study.

The Municipal Class Environmental Assessment (Class EA), Municipal Engineers Association (MEA) document (October 2000, as amended in 2007, 2011 and 2015), describes the process that municipalities must follow in order to meet Ontario's Environmental Assessment requirements for water, wastewater and road projects, including Master Plans. Depending on the individual project or Master Plan to be completed, there are different processes that municipalities must follow to meet Ontario's Environmental Assessment requirements.

Class Environmental Assessments (Class EAs) are prepared for approval by the Minister of the Environment. A Class EA is an approved planning document that defines groups of projects and activities and the Environmental Assessment (EA) process which the proponent commits to for each project undertaking. Provided the process is followed, projects and activities included under the Class EA do not require formal review and approval under the EA Act. In this fashion, the Class EA process expedites the environmental assessment of smaller, recurring projects.

This Class Environmental Assessment document reflects the following five key principles of successful planning under the Environmental Assessment Act.

- Consultation with affected parties early on, such that the planning process is a cooperative venture.
- Consideration of a reasonable range of alternatives.
- Identification and consideration of the effects of each alternative on all aspects of the environment.
- Systematic evaluation of alternatives in terms of their advantages and disadvantages, to determine their net environmental effects.
- Provision of clear and complete documentation of the planning process followed, to allow "traceability" of decision-making with respect to the project.

The accompanying flow chart (Figure 1-2) illustrates the process followed in the planning and design of projects covered by this Class Environmental Assessment. The five phases, as defined in the flow chart, are summarized in the document as follows:

Phase 1: Identify the problem or deficiency.

Phase 2: Identify alternative solutions to the problem, by taking into consideration the existing environment, and establish the preferred solution taking into account public and agency review and input. At this point, identify approval requirements (e.g., Ontario Water Resources Act, Lakes and Rivers Improvement Act, and Environmental Protection Act) and determine the appropriate schedule for the project and proceed through the appropriate phases (**Figure 1.2**).

Phase 3: Examine alternative methods of implementing the preferred solution, based upon the existing environment, public and government agency input, anticipated environmental effects, and methods of minimizing negative effects and maximizing positive effects.

Phase 4: Document, in an Environmental Study Report, a summary of the rationale and the planning, design, and consultation process of the project as established throughout the above phases, and make such documentation available for scrutiny by review agencies and the public.

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

Public and agency consultation is also an important and necessary component of the five phases.

The Municipal Engineers Association's Class EA document classifies projects as Schedule A, B or C depending on their level of environmental impact and public concern.

- **Schedule 'A'** projects are generally routine maintenance and upgrade projects; they do not have big environmental impacts or need public input. Schedule 'A' projects are all so routine that they are generally pre-approved without any further public consultation.

- **Schedule 'B'** projects have more environmental impact and do have public implications. Examples would be stormwater ponds, river crossings, expansion of water or sewage plants beyond up to their rated capacity, new or expanded outfalls and intakes, and the like. Schedule 'B' projects require completion of Phases 1 and 2 of the Class EA process.

- **Schedule 'C'** projects have the most major public and environmental impacts. Examples would be storage tanks and tunnels with disinfection, anything involving chemical treatment, or expansion beyond a water or sewage plant's rated capacity. Schedule 'C' projects require completion of Phases 1 through 4 of the Class EA process, before proceeding to Phase 5 implementation.

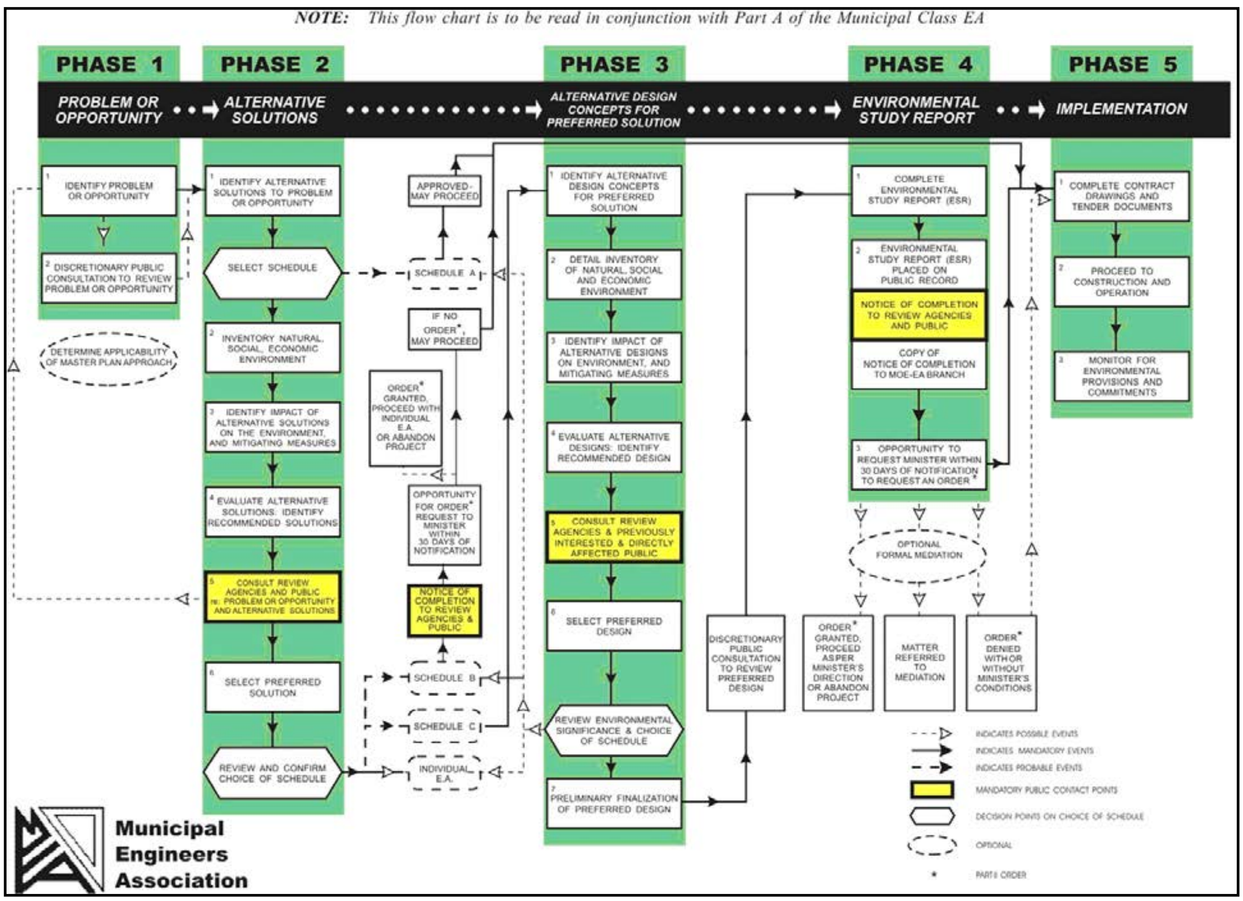

Figure 1-2: Municipal Class Environmental Assessment Planning and Design Process

The current study has been classified by the City as a **Schedule B** project and follows Phases 1 and 2 of the planning and design process with Phase 5 to follow at a subsequent stage. This report outlines Phases 1 and 2 of the EA process.

1.5 Study Purpose and Primary Tasks

The study purpose has been defined as follows:

- To identify the causes of flooding and address issues related to combined sewer overflows and extraneous infiltration/inflow to the Region of Niagara's sewer system,
- To identify & evaluate the alternative solutions to alleviate these issues.

The primary tasks which were undertaken as part of this study and the associated chapters in which information is provided are summarized below:

Chapter 1 – Provide study background and define the study purpose;

Chapter 2 – Define the problems and opportunities associated with the study;

Chapter 3 – Background data;

Chapter 4 – Summarize existing conditions within the study area;

Chapter 5 – Define existing storm, sanitary and combined sewer system;

Chapter 6 – Present and evaluate the alternative solutions;

Chapter 7 – Present and select the preferred alternative;

Chapter 8 – Present preliminary design details for the preferred alternative;

Chapter 9 – Provide implementation considerations;

Chapter 10 – Climate Change and impact on storm water infrastructure;

Chapter 11 – Provide conclusions and recommendations.

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Public Consultation A comprehensive public consultation program (see Appendix A) was incorporated into the EA study and included the following components:

• Stakeholder List – A mailing list was created and maintained throughout the study. It included local community groups, institutions and ratepayer associations within the study area, as well as members of the public who requested to be added to the list via telephone, email or comment sheets submitted during public consultations.

• Newspaper Notices – Notices were placed in the Niagara Falls Review to announce the commencement of the EA study during the last week of June and the first two weeks of July 2018 and to publicize each public consultation event throughout the study process. The notices provided a description of the study, invited the public to attend the consultation event, and identified ways to obtain more information.

• Direct Mail – Direct mail was used for the invitation letter for the PIC.

- Public Information Centres (PICs) – One PIC was held. The PIC consisted of an open house where participants had the opportunity to view display boards and speak with members of the project team and City staff. Feedback Forms were distributed at the PIC to encourage participants to submit written comments.

- General Meetings – A few meetings were held with City staff and one meeting was with Hydro One staff.

- Project Website – A project website (https://niagarafalls.ca/city-hall/capital-projects/130-corwin-drainage-area-environmental-assessment-study.cp) was created to serve as a portal for project description, project schedule, etc. The website was promoted in the Notice of Study Commencement and PIC notice.

Copies of all public consultation materials and meeting summaries can be found in Appendix A.

1.5.1 Public Notification

A Notice of Study Commencement was published in July 2018 on the City's website (https://niagarafalls.ca/notices). The notice introduced the study, explained the Municipal Class EA process and identified means of providing input.

Prior to the Public Information Centre, a notice was distributed to all residents within the study area. The PIC notice included a description of the study, invited the public to attend the event, and identified ways to obtain more information.

1.5.2 Public Information Centre #1

Public Information Centre (PIC) #1 was held on December 9, 2019 from 4:00-8:00 pm at the Gale Centre, Niagara Falls. The purpose of the PIC was to:

- Review the study purpose and study area
- Provide an overview of keys tasks completed
- Present existing conditions and alternative solutions
- Present the evaluation process and preferred alternatives
- Receive community input on the key problems and proposed evaluation criteria; and
- Discuss next steps in the EA process.

The format of the meeting consisted of an open house from 4:00-8:00 pm. Approximately 50 people participated in the PIC.

During the open house, participants were able to review display boards that focused on various aspects of the EA. Members of the EA project team and City staff were available at the open house to answer questions informally and respond to feedback.

During the PIC, many participants took the opportunity to provide input by completing a Feedback Form. A total of 12 Feedback Forms were collected.

The two discussion questions were:

1. Considering the questionnaire results and issues the project team has identified to date, what are the key issues, problems or opportunities (within the parameters of the study) that we should be aware of? Have we missed anything?
2. The next step in the study process is the development of alternative solutions to address the problems and issues identified, as well as criteria to evaluate those alternatives. As the project team begins to think about developing evaluation criteria, what are the key factors they should keep in mind?

A summary of public comments can be found in the PIC #1 summary report in Appendix A.

2.0 Problem and Opportunity Identification

2.1 General

Phase 1 of the Municipal Class Environmental Assessment process involves identification of the problem to be resolved together with the opportunities to resolve the problem. Provided below is a summary of the problem(s) and opportunity(ies).

2.2 Identification of Problems and Opportunities

Over the last 20 years, the City of Niagara Falls has experienced several rainfall events that have triggered incidents of basement flooding in various areas across the City. Figure 2-1 illustrates the general areas where flooding has occurred within the Corwin drainage area. The primary types of problems within the related to:

- Flooding of properties and buildings;
- Combined sewer overflows (CSO's); and
- Extraneous inflow/infiltration to the City's sanitary system.

The opportunities of the Corwin EA study include:

- Propose remedial works to mitigate future flooding;
- Prevent or eliminate CSO's;
- Reduce extraneous inflow & infiltration (I&I) into Niagara's sanitary system;
- Provide a level of service which is consistent with municipal standards; and
- Improve operational and structural conditions of the storm water system.

Figure 2-1: Corwin Area Subject to Flooding Issues

3.0 Background Data

3.1 General

This section will review background data that was received to perform this study. Reference should also be made to *Technical Memorandums 1 to 4* which was submitted October 22nd, 2018 and which describe the following key topics -

1. Existing Document Review and Summary
   All relevant background documents addressing the issues primarily from the Corwin Drainage Area perspective with some at the City-wide perspective were reviewed and with the relevant documents summarized;

2. Flow Monitoring Review and Field Assessment
   This section summarizes the 2014 City-wide flow monitoring and provides detail on the storm sewer flow monitoring plan undertaken by the City and Consultant for the Corwin Drainage Area Study;

3. Data Gap Analysis
   The data gap analysis summarizes the gaps based on findings from the existing hydraulic and hydrologic model for the sanitary, combined and storm systems and includes gaps found in all of the City-provided data prior to undertaking the work;

4. Topographic and Geotechnical Assessment
   The topographic and geotechnical work was undertaken to better define items such as inverts, pipe sizes etc. A summary of the CCTV work is provided in this section;

5. McLeod CSO/SSO Tank Field Investigation
   The field investigation and assessment of the McLeod tank functionality and a clear perspective of the conveyance infrastructure from the subsequent field survey and CCTV investigation is summarized.

6. Hydrologic and Hydraulic Modelling
   The H&H modelling is summarized and includes an assessment of the existing model, data gaps found and how they were addressed, model development addressing the expansion of the model for the Corwin area and the existing conditions assessment.

3.2 Background Studies

The review of background information is based on many documents and studies relevant to technical background, planning framework, and data management related to stormwater quantity and quality management. The information was categorized as follows:

1. **Policy Framework**
    - o Planning Act
    - o Conservation Authorities Act
    - o Drainage Act
    - o Ontario Water Resources Act
    - o Clean Water Act
    - o Lakes and Rivers Improvement Act
    - o Species at Risk Act
    - o Fisheries Act

2. **Municipal Planning Review**
    - o Master Drainage Plan Update Study (2017)
    - o City of Niagara Falls Official Plan (2015)
    - o Engineering Design Guidelines Document (2012)
    - o City of Niagara Falls Master Drainage Plan (1981)

3. **Environmental Planning and Watershed-Based Review**
    - o Lower Welland River Characterization Report (NPCA, 2011)
    - o South Niagara Falls Watershed Report (NPCA (2008)
    - o Niagara River Remedial Action Plan – Stage 2 (2009)
    - o Niagara River Remedial Action Plan – (Update 2012)
    - o 2012 Watershed Report Cards (NPCA, 2012)
    - o Water Quality Monitoring Program (NPCA, 2009)
    - o Niagara Water Quality Protection Strategy (2004)

4. **Technical Direction Review**
    - o City of Niagara Falls Sewer System Analysis (CG&S, 1996)
    - o Niagara Falls Pollution Control Plan (CH2MHILL, 2008)

3.2.1 Policy Framework

The following presents a summary of key federal, provincial and local acts and regulations affecting stormwater related issues within the study area:

3.2.1.1 Planning Act

The Planning Act promotes sustainable economic development in a healthy natural environment. The Act enables municipalities to regulate land use and development at the local or regional level, subject to a provincial policy framework.

A few provisions in the Planning Act are relevant to stormwater management. They include:

- Ensuring adequate provision of sewage and water services, ensuring the orderly development of safe and healthy communities, and protecting public health and safety (Section 2);
- Enabling the provincial government to issue policy statements on matters of provincial interest, and requiring municipalities to have regard for such policy statements (Section 3), and

- Empowering municipalities to prohibit or restrict the use of land, or the erection or use of buildings or structures, particularly in areas containing significant natural heritage or land that is “a sensitive groundwater recharge area, or headwater area, or land that contains a sensitive aquifer” (Section 34(1)).

3.2.1.2 Conservation Authorities Act

The Conservation Authorities Act was established by the Province of Ontario in 1946 and gave CAs jurisdiction over natural areas based on delineation by watershed (MOE and MNR, 1993). Accordingly, Water and related land management are the responsibility of CAs working in conjunction with the municipalities. The CAs are to establish regulations dealing with environmental protection of their watershed’s resources. Regulations made under the Conservation Authorities Act must be consistent across the province and be compliant with the Planning Act.

3.2.1.3 Drainage Act

The Drainage Act provides a procedure for the construction, improvement and maintenance of drainage works. Not all ditches and buried pipes in a city are considered municipal drains. An engineer's report generally classifies a ditch or pipe as a municipal drain. Under Section 74 of the Drainage Act, municipalities are responsible to maintain municipal drainage systems within their jurisdiction (Ontario, 1990e).

3.2.1.4 Ontario Water Resources Act

The Ontario Water Resources Act (OWRA) is one of the most important pieces of legislation governing water quality and quantity in the province. It provides for the protection and conservation of water, and the control of the quality of drinking water supplied to the public.

3.2.1.5 *Clean Water Act*

The Clean Water Act and five associated regulations came into effect with the intent to ensure that communities are able to protect their drinking water supplies through developing collaborative, locally driven, science-based protection plans (referred to as Source Water Protection Plans). Communities are developing these plans to identify potential risks to local water sources and take action to reduce or eliminate the risks. Municipalities are working with Conservation Authorities and the local community in meeting these goals.

3.2.1.6 *Lakes and Rivers Improvement Act*

The Lakes and Rivers Improvement Act regulates public and private use of lakes and rivers, regulates construction, repair and use of dams, and prohibits deposit of refuse, matter or substances into lakes and rivers contrary to the purposes of the Act. It is administered by the MNR (Ontario, 1990d).

3.2.1.7 *Species at Risk Act*

The federal Species at Risk Act (SARA) and provincial Endangered Species Act (ESA) perform a similar function of protecting at-risk plant and wildlife species and their habitats, and providing a basis for the recovery or maintenance of species that are in decline. Under these Acts, it is prohibited to kill, harm, harass, or capture regulated species, and to destroy their critical habitats. Species which have been identified under these Acts are designated as Endangered, Threatened, or Special Concern based on their current status (e.g., degree of decline, severity or immediacy of threats). Related to the current study, stormwater runoff from farm operations, lawns, golf courses, urbanization, and other pollution sources may carry contaminants, adversely affecting critical habitat and water quality for aquatic SAR (Department of Justice Canada, 2002). Decreases in water quality are a common threat affecting many aquatic SAR. Terrestrial species, similarly, are often affected by habitat alteration or loss which can occur through construction and development.

3.2.1.8 *Fisheries Act*

The Fisheries Act focuses on the protection of fish and aquatic habitat. It prohibits the deposit (direct discharging, spraying, releasing, spilling, leaking, seeping, pouring, emitting, emptying, throwing, dumping or placing) of harmful substances into waters frequented by fish, such as oceans, rivers, lakes, creeks, and streams, or into storm drains that lead to such waters. A harmful substance would alter or degrade water quality such that it would harm fish or fish habitat. A harmful substance can also be stormwater, wastewater, or other effluent that contains a substance in such quantity or concentration that it would, if deposited to waters frequented by fish, degrade or alter fish or fish habitat (DFO, 2006).

3.2.2 Municipal Planning Review

3.2.2.1 Master Drainage Plan Update Study (2017)

The purpose of this project was to undertake a Master Drainage Plan Update Study (MDPUS) which satisfies the City’s 2011-2014 strategic priorities in terms of a well-planned city, infrastructure sustainability, and proposed a well-planned infrastructure system that is sustainable and ecologically sound.

The primary intention of the MDPUS study was to develop the remedial recommendations for the flooding areas related to the surcharging of the storm sewer system, the problem areas associated with the combined and sanitary sewer system would be addressed through other studies.

3.2.2.2 City of Niagara Falls Official Plan (2015)

The City’s Official Plan provides a framework for the development and redevelopment of lands and guide growth and development within the City. The Official Plan for the City of Niagara Falls is to be brought into conformity with the policies of the Regional Official Plan.

The Corwin drainage area is largely unchanged from the existing land use with the majority zoned for residential usage and major commercial along Lundy's Lane.

3.2.2.3 Engineering Design Guidelines Document (2012)

The Engineering Design Guidelines document provides a set of guidelines in terms of engineering design practices for planning land development and redevelopment within the City of Niagara Falls. The scale of application of the document is focused on subdivisions, and can be integrated with federal, provincial, and local planning documents at higher scales of influence and requirements. With respect to stormwater management, the document indicates that the MOE Stormwater Management Planning and Design Manual (MOE, 2003) should be referenced for stormwater quantity and quality management studies.

3.2.2.4 City of Niagara Falls Master Drainage Plan (1981)

The City of Niagara Falls Master Drainage Plan is an update for the 1968 Report on Flood Control and Pollution Abatement. The document includes a map for the storm sewer system that had been constructed between 1968 and 1980 and proposes a storm sewer system to cover gaps that were not addressed in the 1968 report. Accordingly, the proposed works would provide separate trunk storm sewers for all areas served by combined sewers, as well as all undeveloped areas which will require stormwater outlets. Appendix B of the 1981 report includes a separate report discussing environmental analysis and impact review within the Beaverdam's creek drainage system.

3.2.2.5 Pollution Prevention & Control Plan Study Update (GM Blue Plan, 2017)

The Pollution Prevention & Control Plan Study Update aimed at ensuring the ongoing sustainability and operability of the City's wastewater infrastructure as well as fostering an environment of continuous improvement through the use of Customer Service Levels and Key Performance indicators. The plan supports all of the City's 2015 – 2018 Strategic Priorities with the exception of transportation-based objectives.

This 2017 PPCP has been built on the foundation of preceding PPCP plans yet has been enhanced to address broader issues. This 2017 PPCP addresses the following key areas:

- Continued prioritization of addressing wet weather flows and management of conveyance, storage and overflow conditions;
- New focus to incorporate growth conditions within the service area and incorporate Regional growth driven strategies;
- Enhanced focus on the optimization of the existing wastewater system. This has been achieved through a detailed examination of the hydraulic capacity, condition and performance of the system. This analysis involved the entirety of the City's wastewater collection system infrastructure where previous studies assessed only large diameter trunk collection system assets;
- Enhanced review of the impact of maintenance of the system versus only capital expenditures;
- Enhanced review of the impact in achieving regulatory and growth requirements; and
- Enhanced review of the environmental and basement flooding resiliency expectations of the users of the system.

Several recommendations including capital projects and programs, maintenance and operations improvement, hydraulic modelling improvements have been discussed throughout this report.

3.2.3 Environmental Planning and Watershed-Based Review

Seven (7) environmental planning and watershed-based studies were reviewed in order to provide a watershed context for the City of Niagara Falls Master Drainage Plan Update Study (MDPUS). These documents include:

1. Lower Welland River Characterization Report (NPCA, 2011)
2. South Niagara Falls Watershed Report (NPCA, 2008)
3. Niagara River Remedial Action Plan – Stage 2 (2009)
4. Niagara River Remedial Action Plan – (Update 2012)
5. 2012 Watershed Report Cards (NPCA, 2012)
6. Water Quality Monitoring Program (NPCA, 2009)
7. Niagara Water Quality Protection Strategy (2004)

As a result, a brief characterization of the study area was developed, where key environmental features and functions were addressed. These include:

- Subwatershed coverage
- Surficial geology and physiography
- Hydrology
- Hydrogeology
- Natural Heritage
- Water Quality

3.2.4 Technical Direction Review

As part of the background review, the following key technical documents related to sewer system analysis and stormwater management were reviewed:

- City of Niagara Falls Sewer System Analysis (CG&S, 1996)
- Niagara Falls Pollution Control Plan (CH2MHILL, 2008)
- Shriners Creek Stormwater Management Study (Falcone and Smith, 1990)
- Chippewa Pollution Control Study (CG&S, 1998)
- Master Drainage Plan Update Study (Aquafor Beech Limited, 2017)
- Pollution Prevention & Control Plan Study Update (GM Blue Plan, 2017)

3.3 Rainfall and Flow Monitoring

Aquafor and City staff identified three (3) locations for additional flow monitoring within the storm sewer system. Site selection criteria included both technical and safety considerations. Four (4) key technical site selection considerations include:

1. Flow monitoring stations must characterize flow generation from known flooding areas (reported flood location clusters). These areas are fully-characterized through the data collection and the enhanced field survey including downspout connection investigation and catchbasin-type-location inventory. These locations provide ideal monitoring sites for future remedial option performance evaluation (measure before and after implementing remedial options);

2. Stations were located to capture the flow from representative tributary areas so that the results can be generated to other non-monitored areas;
3. Stations were located in satisfactory hydraulic sewer conditions to allow for the highest accuracy and reliability;
4. Flow monitoring locations were located in readily-accessible locations, preferably away from high-traffic control requirement areas or deep sewers.

The City's operations staff confirmed and finalized the flow monitoring locations in June 2018 and the flow monitors were installed at the locations listed below in August, 2018 as summarized in Figure 3-1.

- Dunn Street west of Drummond Road (Later, it was relocated to one pipe further downstream along Dunn Street)
- Dunn Street and Carlton Avenue intersection (Later, it was relocated to one pipe further upstream along Carlton Avenue)
- McLeod Road and Jubilee Drive

The High-Lift Rain Gauge was deemed sufficient (within 2 km of the study area) by City staff for flow monitoring and calibration of the model.

The selected storm flow monitors, along with the associated manhole locations and nearest street intersections are summarized in Table 3-1.

Table 3-1: Flow Monitor Summary

FM Name		Rain Gauge	Sewer System	Catchment Area (ha)	Install Date	Pipe Diameter (mm)
NF13_2018_MCDSTM	McLeod Road	South Side RG	Storm	181.48	2018-07-31	1800
NF14_2018_DUNN	Dunn Street	South Side RG	Storm	80.07	2018-07-31	1050
NF15_2018_CARLTON	Carlton Avenue	South Side RG	Storm	59.53	2018-08-10	900

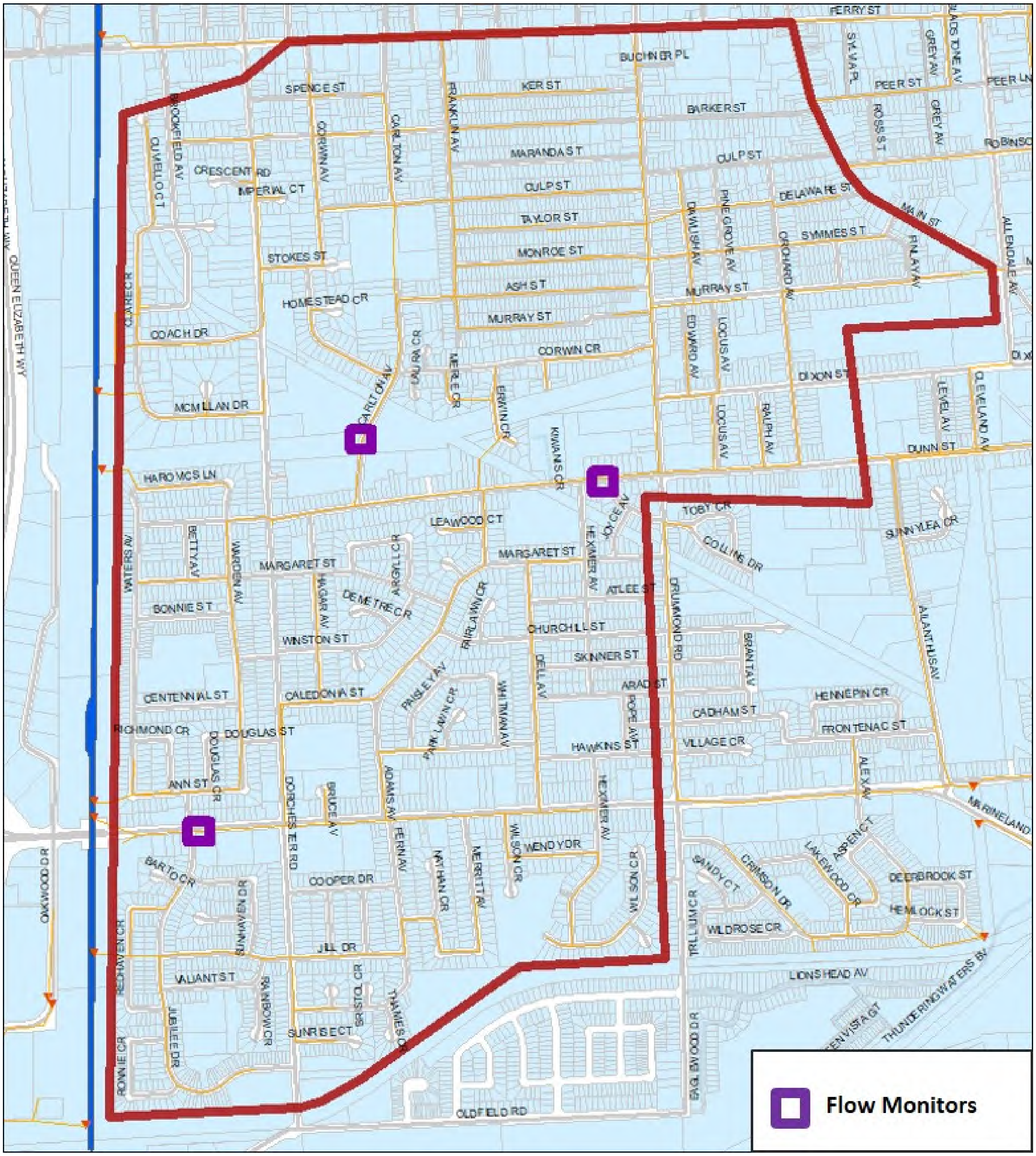


Figure 3-1: Flow Monitor Locations

3.4 CCTV Inspection

CCTV inspections were carried out by the City of Niagara Falls contractor BRS Construction for the combined sewers upstream of the McLeod Tank based on the recommendation by Aquafor for a field survey in the June 13th, 2018 meeting with City Staff. The key findings are summarized in Section 3.5 below. City staff performed further CCTV work during March 2019 for the sewers and CSO's within the Corwin drainage area.

3.5 McLeod CSO/SSO Tank Field Investigation

The McLeod Road CSO/SSO facility is located south of McLeod Road immediately upstream of the outfall to the HEPC. The original function of the facility was primary treatment of combined and sanitary sewer overflows from the trunk combined sewer draining an area of approximately 215 ha. Drawings of the facility date back to 1948 which is assumed to be around the time the facility and outfall were constructed. A field inspection was undertaken by City and Aquafor staff at which time it was determined that the facility is no longer utilized and that the current drawings of the local infrastructure were incorrect.

City operations staff located, and field investigated the combined system maintenance holes (MHs) near the McLeod CSO/SSO tank with CCTV/dye testing. An understanding of the network connections was sketched and compared to the existing as-built drawings and GIS data. A detailed summary of this assessment can be found in *Technical Memorandum 1 to 4 - Section 7*.

3.6 Upstream CSO Field Investigation

It was confirmed from the maintenance hole field surveys that cross connections exist along Franklin Ave. The cross connections are summarized below:

- The northern section of the storm system along Franklin Ave outlets into the 825mm storm sewer on Culp St and flows westbound. A separate subcatchment starts south of Culp St at maintenance hole DMH_01610 and drains southbound;

- There are two catch basins (CB) in the area that are connected to the sanitary sewer system; one is located at the intersection of Monroe St and Franklin Ave, the CB on west side of Franklin Ave discharges into SMH_03252; the other is at Ash St and Carlton Ave intersection, the CB at NE corner connects to the sanitary manhole SMH_03279;

- At Ash St and Franklin Ave intersection maintenance hole DMH_01450 is connected to the adjacent sanitary sewer SGM_04518, the sanitary sewer pipe breaks into the storm maintenance hole.

4.0 Existing Conditions

4.1 Study Area

The Study Area is bounded by Dorchester Road and Main Street to the west and east respectively, and Lundy's Lane and Dunn St to the north and south. Stormwater flows are currently collected and conveyed to the Hydro Electric Power Canal (HEPC) via five (5) storm sewer outfalls as shown in Figure 1-1. The general topography indicates surface drainage is directed to the Hydroelectric Power Canal (HEPC) to the west for approximately 75% of the drainage area with the remaining areas draining to the south and east. The approximate drainage divide is along a line west of Drummond Road.

4.2 Natural Environment

This section will describe natural heritage features and functions within and directly adjacent to the Corwin Drainage EA study area.

4.2.1 Terrestrial Ecology

The study area is heavily dominated by urban development and contains few remnant terrestrial natural heritage features. The NPCA's Watershed Explorer online mapping resource was used to identify and characterize these remnant terrestrial vegetation communities; this information is displayed on Figure 4-1. According to the data published on the Watershed Explorer website, the identified features include mainly small deciduous forest patches with some hedgerows and small meadow areas. Overall, however, the study area does not contain any large and/or contiguous areas of terrestrial habitat.

The Niagara Falls Slough Forest Wetland Complex, which has been designated a provincially significant feature, is located to the south of Oldfield Road, just outside of the study area boundary. The study area as a whole fall within the Niagara River Corridor Important Bird Area, a globally-recognized area providing significant habitat function for gulls, waterfowl, and other bird species, which includes a broad corridor along the entire length of the Niagara River from Lake Erie to Lake Ontario. There are no other designated areas of features of ecological significance in the immediate vicinity of the study area.

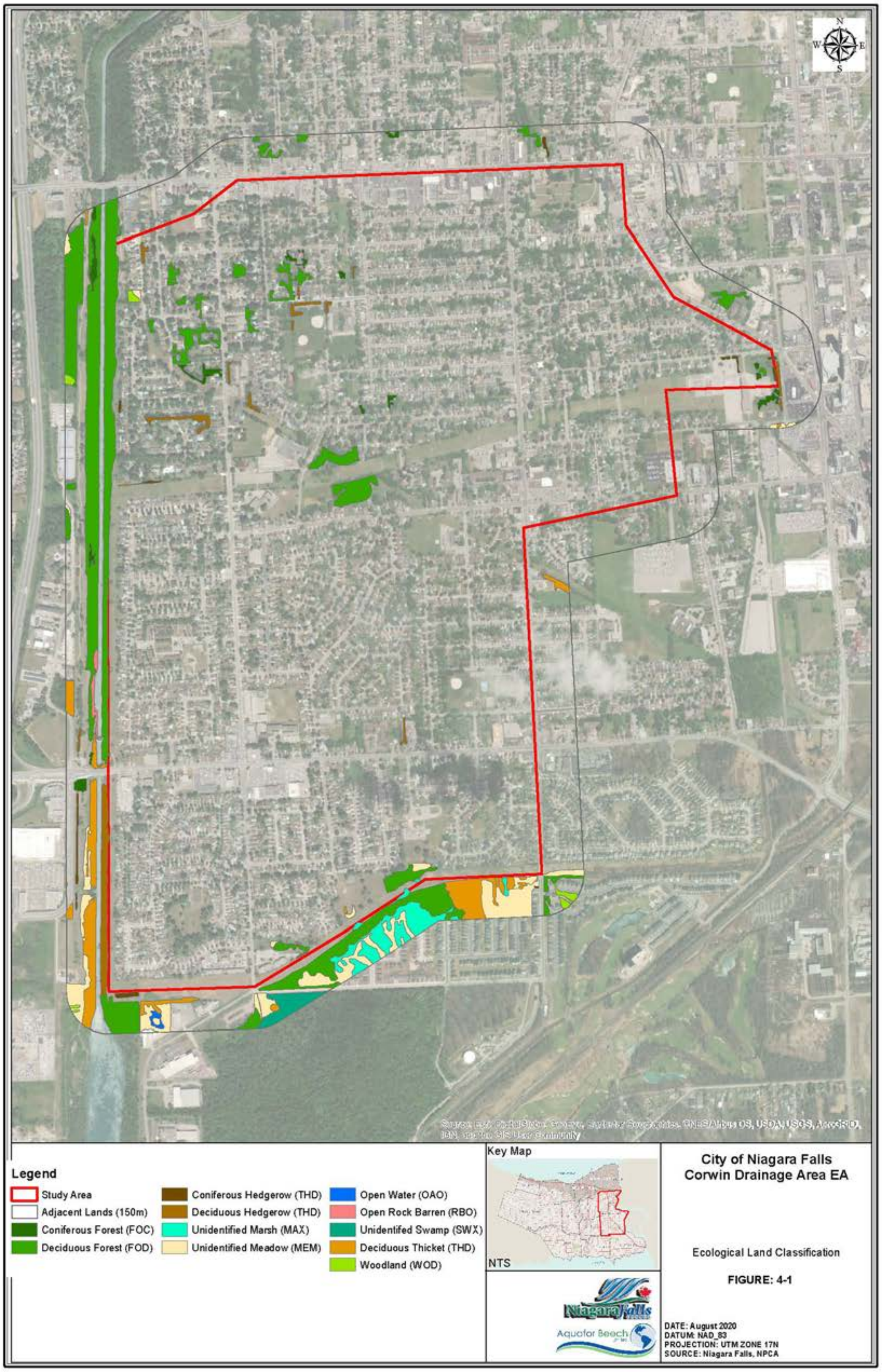


Figure 4-1: Ecological Land Classification

4.2.2 Aquatic Ecology

Existing mapping does not indicate the presence of any surface water features (e.g., creeks, rivers, ponds) within the study area boundary.

The Hydro Electric Power Canal is found on the study area's western boundary. This feature is directly connected to the Welland River and the Chippewa Canal; these three features meet at a confluence upstream (south) of the study area known as "Triangle Island" where flow is directed into the Power Canal. The Power Canal extends from the confluence at Triangle Island to the hydro dam itself at the outlet to the Niagara River.

There is no published Watershed Plan available which includes the study area. However, mapping included in the nearby Lower Welland River Characterization Report (NPCA, 2011) indicates that fish habitat provided by the Power Canal has been categorized mainly as "Marginal: Type 3" although a portion at the south end, adjacent to the southern ~300 m of the study area, is categorized as "Important: Type 2". The Characterization Report (NPCA, 2011) defines these types of fish habitat as:

- Type 2: habitat may have the presence of sensitive species or habitat during certain times of the year and is "ideal for enhancement or restoration projects".
- Type 3: typically contains common species with no sensitive species or habitat, consisting of channelized or artificially created watercourses.

The Characterization Report along with the Niagara River Watershed Fish Community Assessment Report (Yagi and Blott, 2012) note that this section of waters is regarded as a separate Aquatic Resource Area (ARA) due to its change in aquatic habitat and community structure. The Fish Community Assessment Report notes that fish community assessments downstream of the confluence at Triangle Island demonstrated evidence of fish entrainment through the Power Canal towards the Queenston Reservoir through a number of canal syphons. The report suggests that the Power Canal acts as a sink to fish species, directing high flows (and therefore also fish) through rheotaxis into the Power Canal and Queenston Reservoir and away from the Welland River.

4.2.3 Species at Risk

Online aquatic Species at Risk (SAR) mapping published by Fisheries and Oceans Canada (DFO) indicates that the following aquatic SAR are found or are potentially found in the Power Canal adjacent to the study area:

- Grass Pickerel (*Esox americanus vermiculatus*) – Special Concern
- Kidneyshell (*Ptychobranchus fasciolaris*) – Endangered
- Round Hickorynut (*Obovaria subrotunda*) – Endangered
- Spotted Sucker (*Minytrema melanops*) – Special Concern

Further, the Ontario Ministry of Natural Resources and Forestry's (MNRF's) "Make A Map: Natural Heritage Areas" website, which accesses the public database of SAR occurrence records for the province, indicates additional aquatic SAR potentially present in the area:

- Eastern Pondmussel (*Ligumia nasuta*) – Endangered provincially, Special Concern federally

While the DFO mapping notes that the aforementioned SAR are found or are potentially found in the Power Canal, they also note that the Power Canal does not contain critical habitat for those same species. As noted in the Lower Welland River Characterization Report (NPCA, 2011), the habitat present within most of the Power Canal is categorized as Type 3 or “Marginal”. Furthermore, the Fish Community Assessment Report (Yagi and Blott, 2012) suggests that the Power Canal may act as a habitat sink. Therefore, these species are likely only present in the Power Canal due to flow diversion from the Chippewa Canal and Welland River and the subsequent entrainment of aquatic species, with no evidence of critical spawning and rearing areas, migration routes, over-wintering areas, or productive feeding areas within the Power Canal as noted above.

However, if present, these aquatic species could be impacted by flood control/drainage works within the study area either directly, via construction associated with outlet structures or any other work at the canal banks, or indirectly, by changes to the quality of water being discharged to the canal.

Potential habitat for terrestrial SAR is very limited in the study area. The above-noted MNRF website did not indicate any past records of terrestrial wildlife SAR for which suitable habitat is still present in the study area. Numerous plant SAR and other provincially rare but unregulated plant species were noted to have been documented in the vicinity, however, and these species could feasibly still be found in remnant natural vegetation patches. Examples include:

- Butternut (*Juglans cinerea*) – Endangered
- White Wood Aster (*Eurybia divaricata*) – Threatened
- Deerberry (*Vaccinium stamineum*) – Threatened
- Eastern Flowering Dogwood (*Cornus florida*) – Endangered

A comprehensive screening and assessment will be necessary at later project stages to determine habitat suitability for terrestrial plant SAR if the selected alternative could impact any areas of remnant natural vegetation.

4.3 Socio-Economic Environment

4.3.1 Proposed Land Use

The Corwin drainage area is largely unchanged from the existing land use with the majority of land zoned for residential usage with some commercial areas located along major roads. From the City of Niagara Falls Official Plan, no significant changes in land use within the drainage area are expected.

4.3.2 Transportation

In this study area, Lundy’s Lane, Dunn Street & McLeod Road are east-west thoroughfare and Drummond Road & Dorchester Road are two main roads that runs along north-south. Historically these routes served as the primary transportation routes going back to the period of the first British settlement of Drummondville. Presently, these roads are considered collector and arterial routes that also serve as access routes for City Emergency Services.

4.4 Archeological Assessment

The archeological assessment is discussed in Section 8.1 as the proposed works are impacted by the recommendations from the archeological survey.

4.5 Soil and Groundwater

4.5.1 Surficial Geology

Figure 4-1 shows the City soils are primarily clay and silt (approximately 79% of the study area) especially the southern and western portions of the City (i.e. South Niagara Falls and Beaverdams and Shriners Creeks subwatersheds). The Corwin study area is dominated by silt and sandy soils in the northern half of the study area and clay silt in the southern half.

Geotechnical investigations were undertaken by several firms for upgrades to the water and sewer systems within the Corwin Drainage Area. Geotechnical reports by AMEC, Coffey, GHD and Landteck completed between 2013 and 2015 were compiled and the borehole location and soil type findings is summarized in Figure 4-2. In total, borehole investigations at 39 sites were identified within the study area. The general findings summarized below:

4.5.2 Sub-Grade Soil Conditions

Available geological map data of the study area indicates that the predominant native soils are coarse textured glaciolacustrine deposits of sand, gravel, and minor silt and clay. The subgrade soils encountered in the boreholes are generally consistent with the background information. The findings are summarized below:

- Generally, at all sites, fill was encountered within the first 1m to 2.2m below the pavement structure;
- The north half of the study area approximately north of Margaret Avenue and the hydro corridor is dominated by silt, sand and sandy silt soil types; and
- The southern portion of the study area is generally silt-clay.

4.5.3 Groundwater

The findings in the reports indicate that groundwater conditions are expected to vary according to the time of the year and seasonal precipitation levels. During wet weather, water is expected to be perched in numerous soil fissures and fill deposits that will require dewatering efforts during construction depending on the depth of construction.

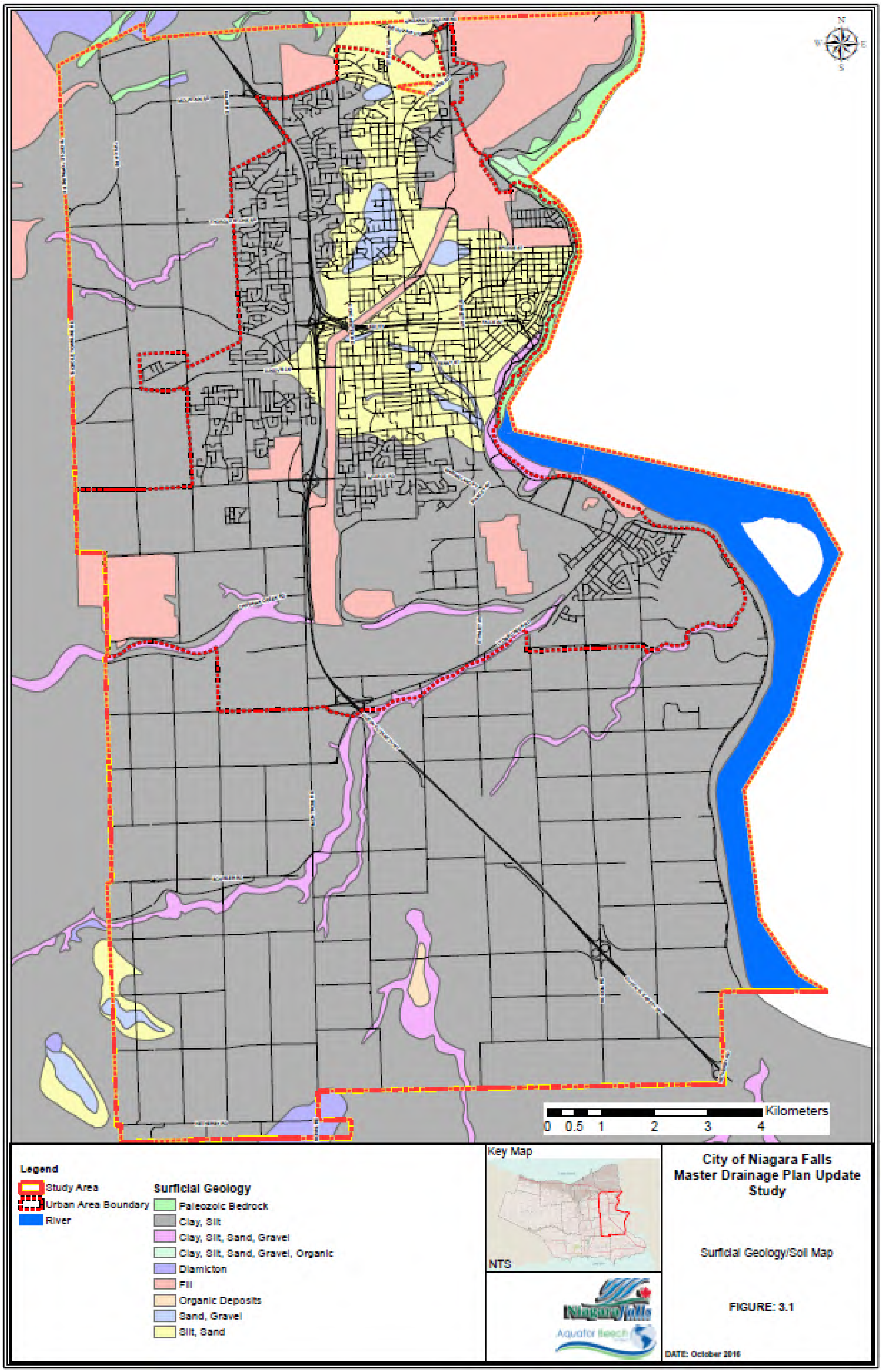


Figure 4-2: Surficial Geology

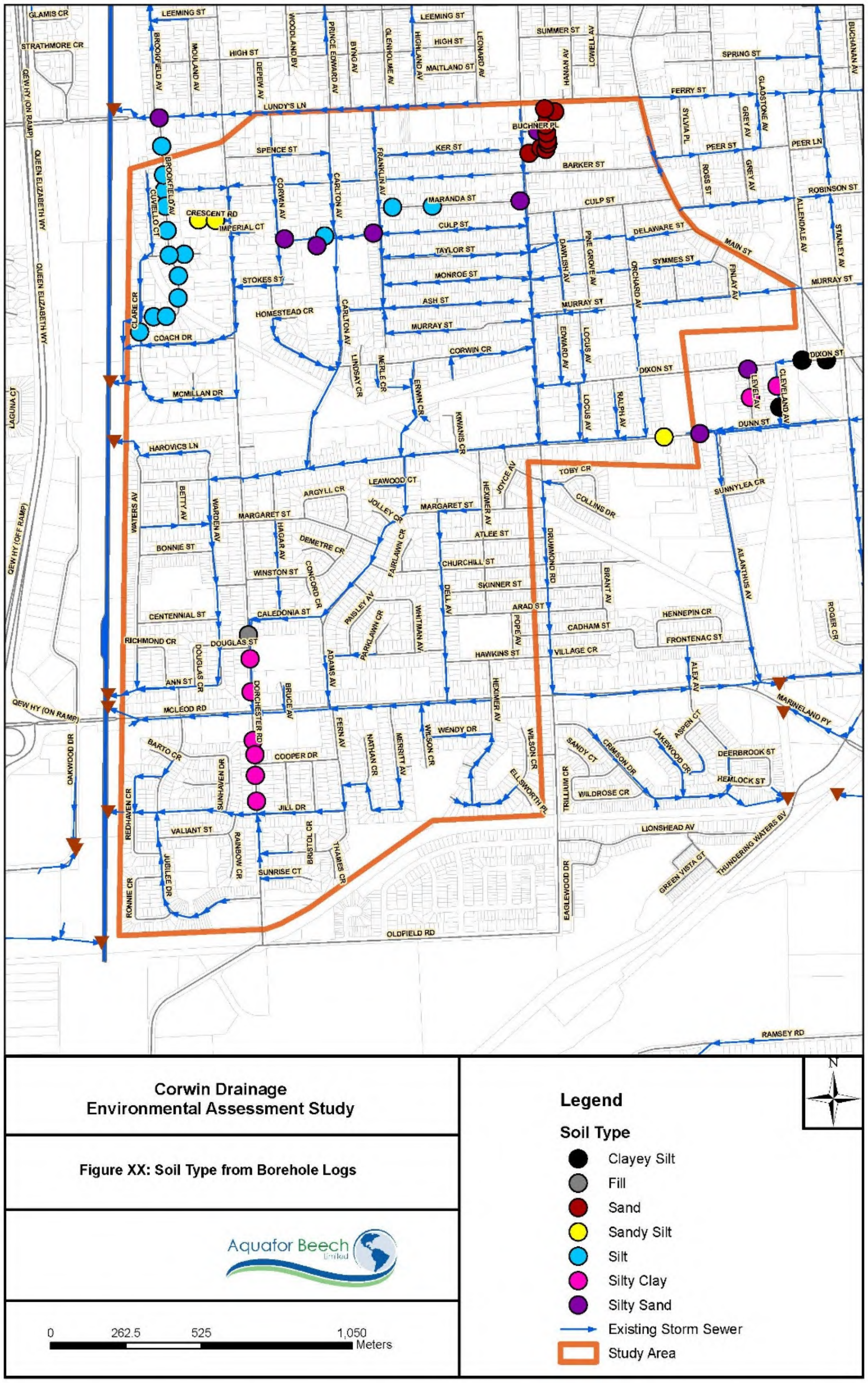


Figure 4-3: Borehole Locations and Findings

5.0 Existing Storm, Sanitary and Combined Sewer Systems

5.1 General

This section will detail the hydrologic and hydraulic model completed in InfoSWMM and will summarize the existing model and scenarios, model update, flow monitoring and calibration and assessment of the performance of the existing drainage system.

There were two models that were reviewed and modified during the study. One was the city-wide InfoSWMM H&H which was developed by GM Blue plan. This model includes a city-wide sanitary/combined network and city-wide trunk storm drainage network. This model was reviewed and checked for gaps in the model network, model & simulation parameters and rainfall data. The data gaps were summarized, and a methodology developed to close the gaps such that there will be confidence in the results while establishing the existing conditions. Please refer to Technical Memorandums 1 through 4 for more details.

The other model was XPSWWM which was developed by Aquafor Beech Limited during the MDPUS study. This model contains only the storm sewer network. The ongoing flooding issues of the study area were also related to storm sewer system. So, the XPSWWM storm sewer model was converted to InfoSWMM and then simulated to resolve the flooding issues. Afterward, the sanitary/combined system of the GM Blue Plan InfoSWMM model was simulated to investigate the impact of CSO's. The combined sewer assessment is limited to the impact on CSO's as a result of the proposed works in this area.

5.2 Model Expansion and Development

The converted InfoSWMM storm sewer model was expanded and supplemented with the City's GIS data. For areas that connect to the combined system, as-built drawings and field survey results were used to update the model which was then calibrated and validated.

5.2.1 Subcatchments

Pipe-by-pipe delineation for all sewers is required to accurately calibrate the model. As such, subcatchment areas defined in the MDPUS using XPSWMM were imported into the InfoSWMM model as part of the model expansion and subcatchment area re-definition.

5.2.2 Catch Basin Capacities

The number and type of catch basins (CB) were defined at each node. Also, a head-discharge relationship based on the inlet type was assigned to each node.

5.2.3 Major System

The MDPUS model did not include a major (overland flow) system.

The major system is the overland flow system where runoff is conveyed along the surface to the CB's that then inlet to the minor system. The minor system consists of the combined, sanitary and storm sewer system. Flows attenuate in the major system when the minor system surcharges to the surface.

The major system was added in the model. InfoSWMM has a tool called 'Create Dual-Drainage' which helped build most of the overland flow system. In some areas that had a shorter road length or at intersections of the roads then the major system was created manually.

5.3 Calibration and Validation

Model calibration is achieved by changing model parameters to produce results matching the measurements within a reasonable accuracy in terms of peak flows, runoff volumes and water levels. Model validation involves testing the calibrated model performance using a different set of measurements than the calibration period to ensure the repeatability of the model results.

For both the calibration and validation processes, observed rainfall data was used to simulate the response of the sewer systems. Observed flow at each monitoring location was used to verify the flow predicted by the model for a range of rainfall events.

5.3.1 Wet Weather Calibration and Validation

The focus of the calibration for this study was to compare the observed flows to simulated flows for the August 18, 2018 event. The key parameters for calibration include depression storage for different runoff surfaces, initial infiltration loss, and absolute values of runoff surfaces. The calibration process was considered complete once a reasonable agreement between the observed and simulated runoff volumes and peak flows was achieved.

Once the model calibration was completed for the chosen storm event, the model was re-analyzed to compare the measured and modelled data for the two chosen rainfall events (on October 6, 2018 and May 25, 2019) for model validation.

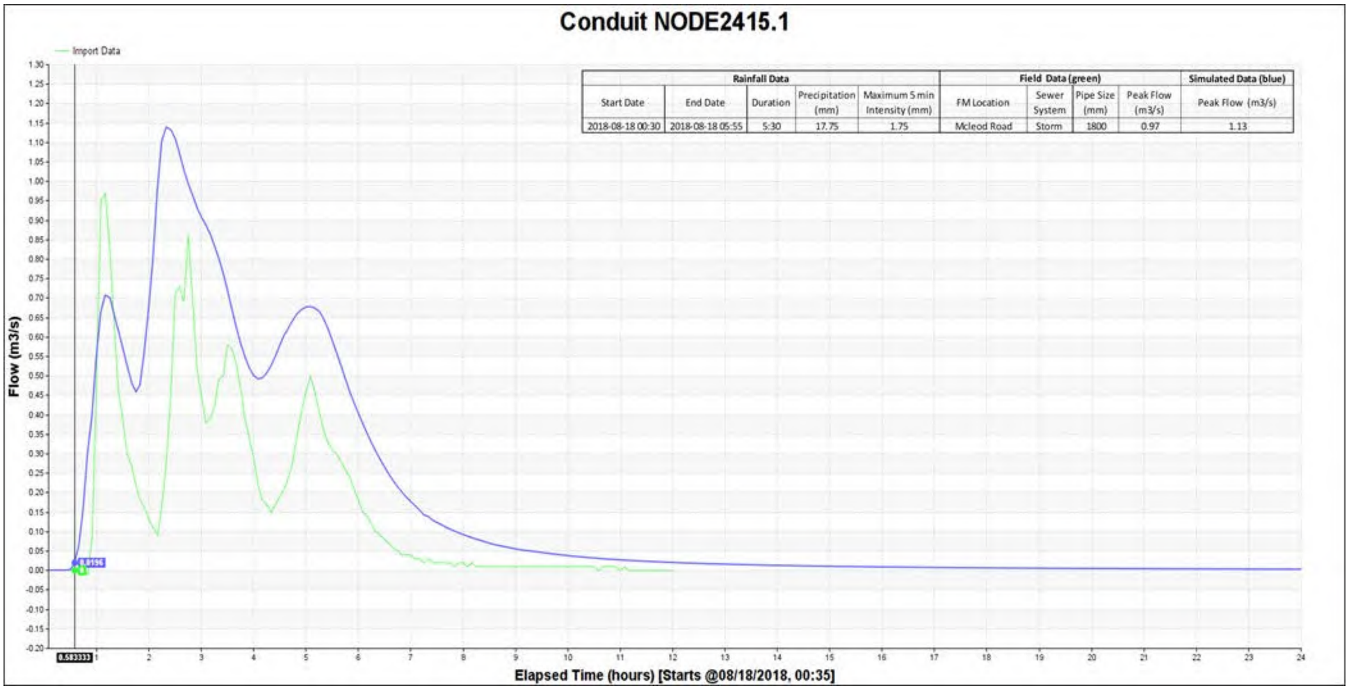
Table 5-1: Rainfall Data for Calibration and Validation

Rainfall Data				
Date	Duration	Precipitation (mm)	Maximum 1 hour Intensity (mm)	Maximum 5 min Intensity (mm)
2018-08-18 00:30	5:30	17.75	5.75	1.75
2018-10-06 07:00	1:30	7.25	5.75	1
2019-05-25 08:25	1:45	14	8	4.25

The figures below illustrate representative calibration and validation results between the monitored versus modelled runoff volumes and peak flows for the three flow monitoring locations.

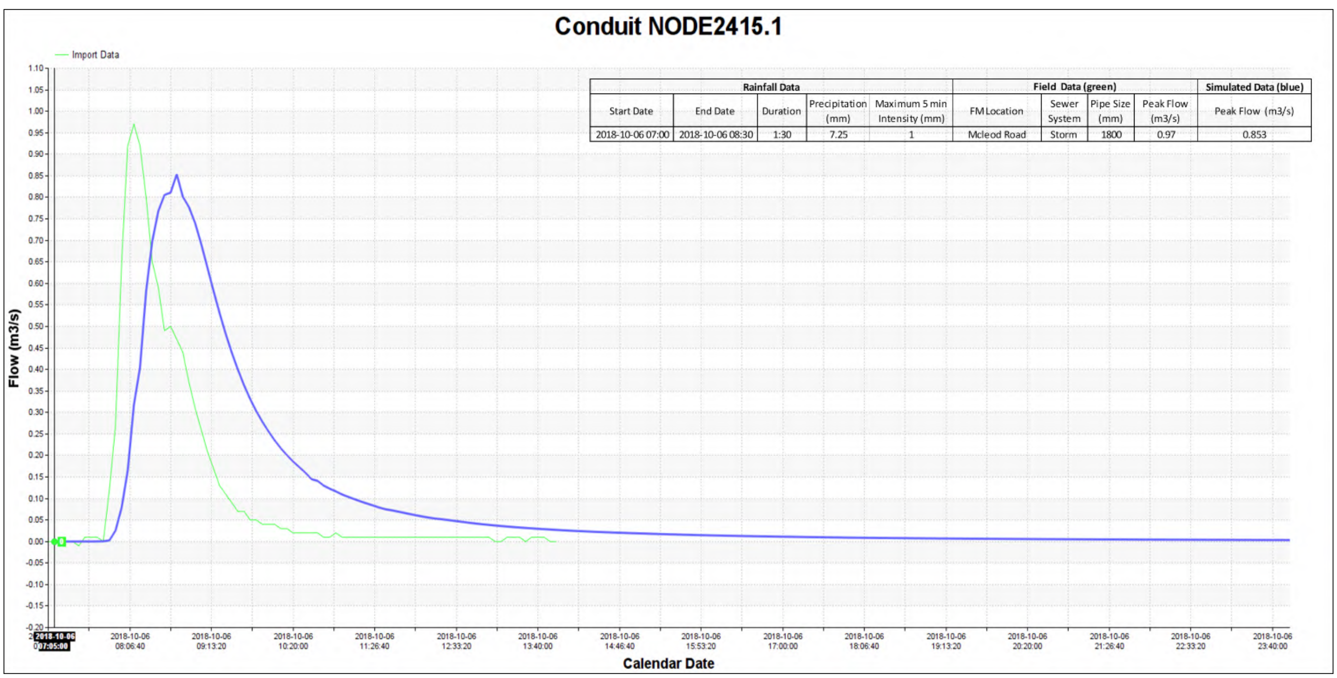
The comparison between modelled and observed results indicates reasonable consistency. Some results may have shown inconsistency due to equipment error.

McLeod Road FM (NF13_2018_MCDSTM)



Rainfall Data					Field Data (green)				Simulated Data (blue)
Start Date	End Date	Duration	Precipitation (mm)	Maximum 5 min Intensity (mm)	FM Location	Sewer System	Pipe Size (mm)	Peak Flow (m3/s)	Peak Flow (m3/s)
2018-08-18 00:30	2018-08-18 05:55	5:30	17.75	1.75	Mcleod Road	Storm	1800	0.97	1.13

Figure 5-1: McLeod Road Calibration Results - 18-August-2018



Rainfall Data					Field Data (green)				Simulated Data (blue)
Start Date	End Date	Duration	Precipitation (mm)	Maximum 5 min Intensity (mm)	FM Location	Sewer System	Pipe Size (mm)	Peak Flow (m3/s)	Peak Flow (m3/s)
2018-10-06 07:00	2018-10-06 08:30	1:30	7.25	1	Mcleod Road	Storm	1800	0.97	0.853

Figure 5-2: Validation Results - 6 October, 2018

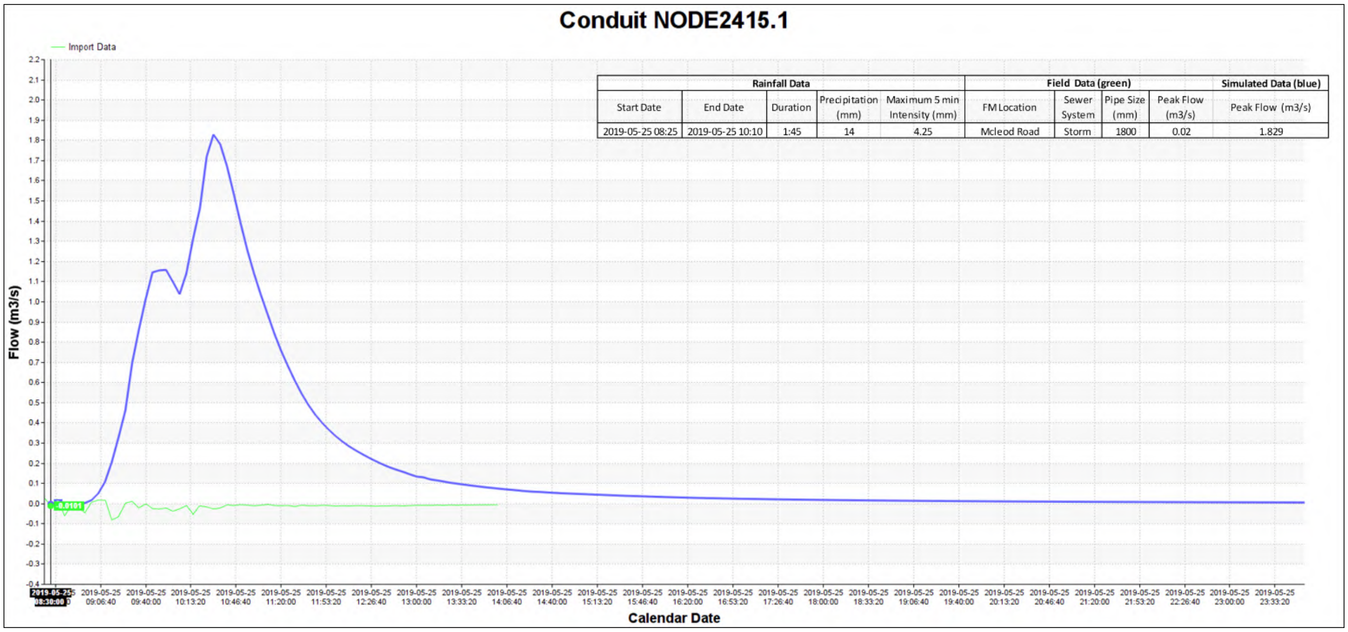


Figure 5-3: Validation Results - 25 May, 2019

Dunn Street FM (NF14_2018_DUNN)

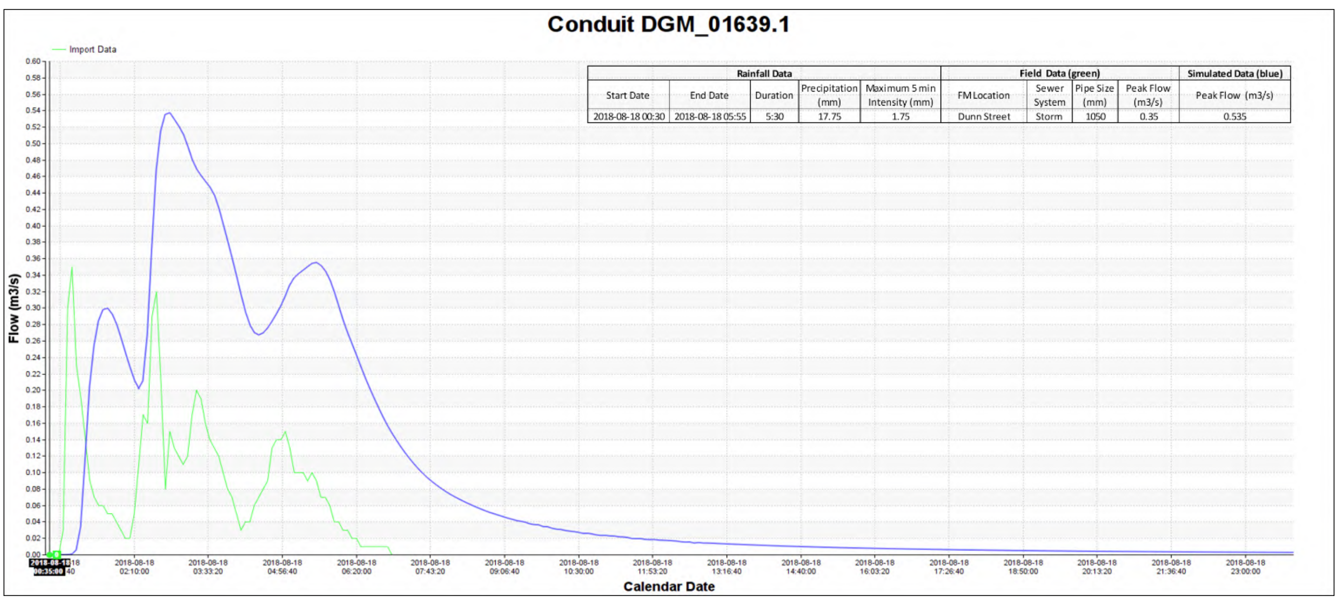


Figure 5-4: Calibration Results - 18 August, 2018

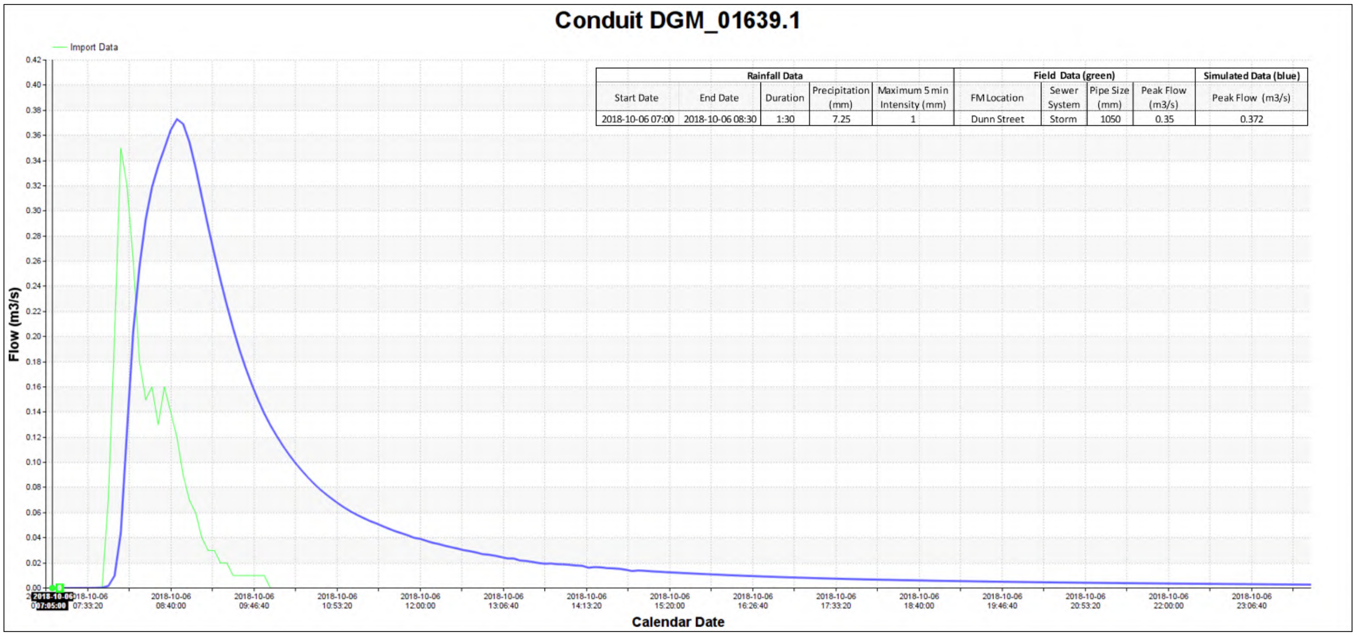


Figure 5-5: Validation Results - 6 October, 2018

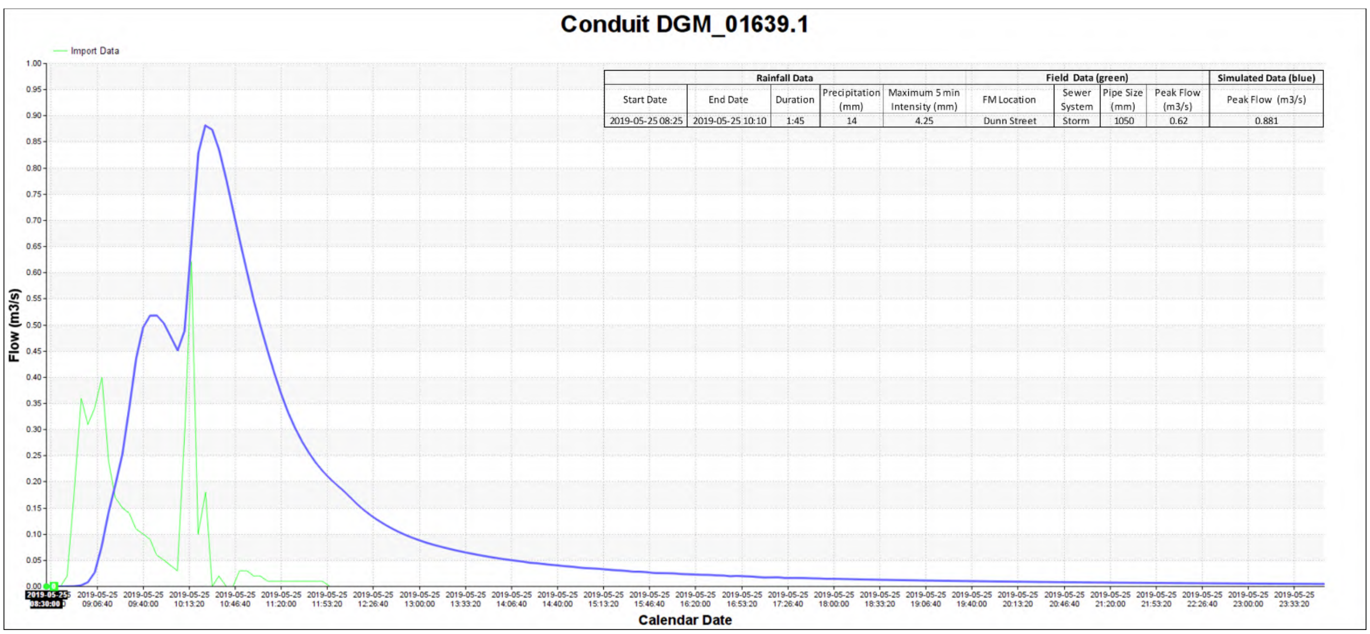


Figure 5-6: Validation Results - 25 May, 2019

Carlton Avenue FM (NF15_2018_CARLTON)

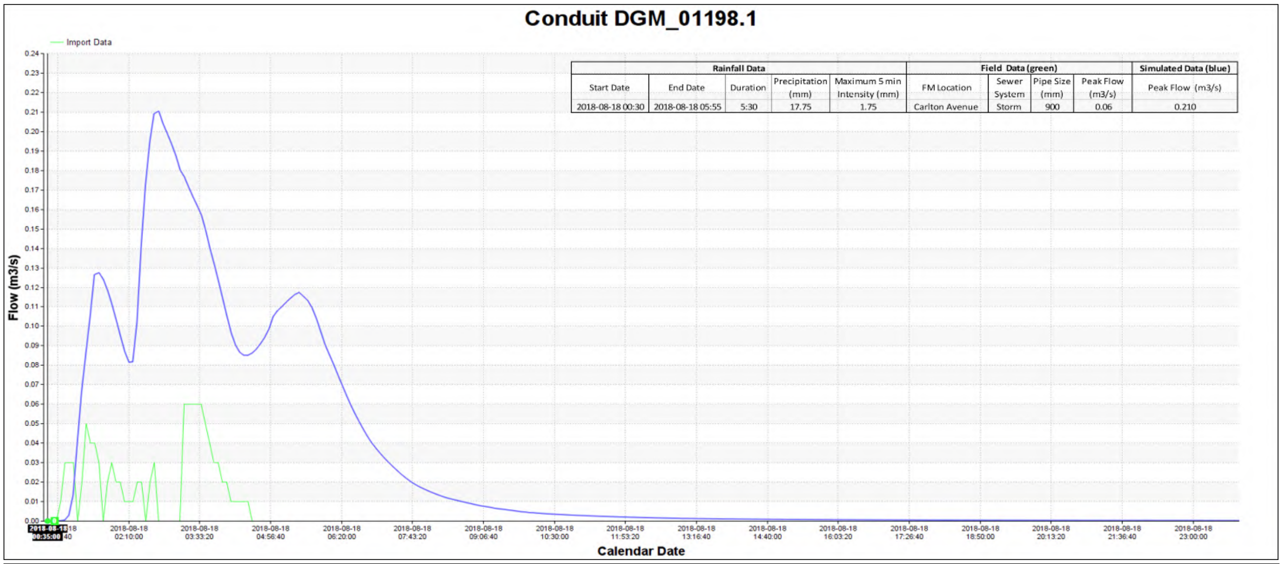


Figure 5-7: Calibration Results - 18 August, 2018

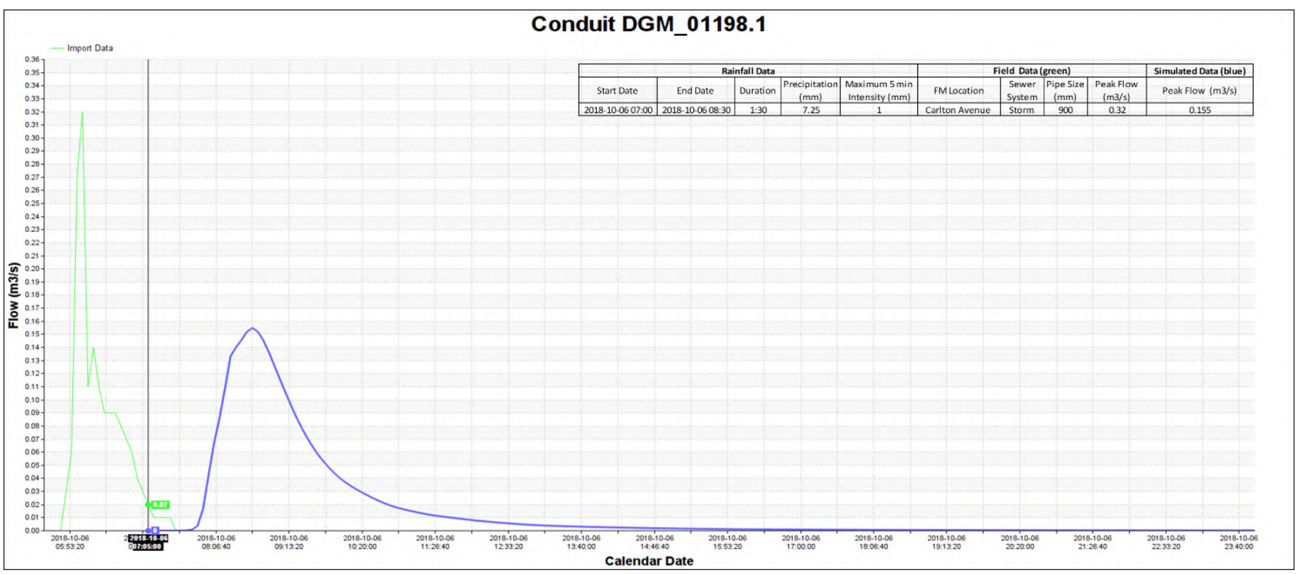


Figure 5-8: Validation Results - 6 October, 2018

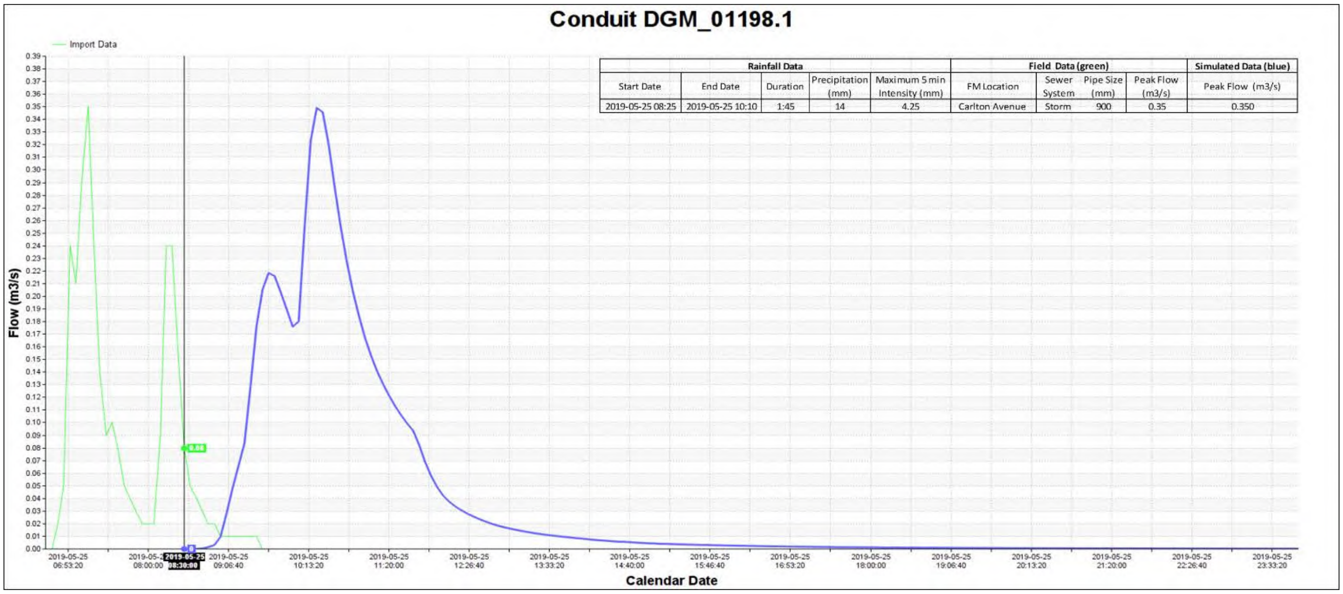


Figure 5-9: Validation Results - 25 May, 2019

5.4 Assessment of Existing Conditions

Recent wet weather events have resulted in flooding of properties and buildings within the study area. There are several potential causes of the flooding that has occurred. This study addresses flooding that occurs as a result of water entering the house through uncovered window wells, doors, etc. (overland flooding) or water entering the basement through the floor drain or foundation.

The 1:5-year and 1:100-year 4-hour Chicago storms were chosen to assess system performance under existing conditions. It was anticipated that the 1:5-year storm would be suitable to assess the minor system performance and capacity limitations; whereas the 1:100-year storm would be suitable to assess major system performance.

The design criteria for the two events are illustrated in Figure 5-10. The desired level of service for the 1:5-year storm event is that the maximum hydraulic grade line (HGL) shall be maintained at an elevation at least 1.8m below the ground elevation, whereas for the 100-year event, the HGL criteria would remain the same and overland flows would be limited to a surface ponding depth of 300 mm.

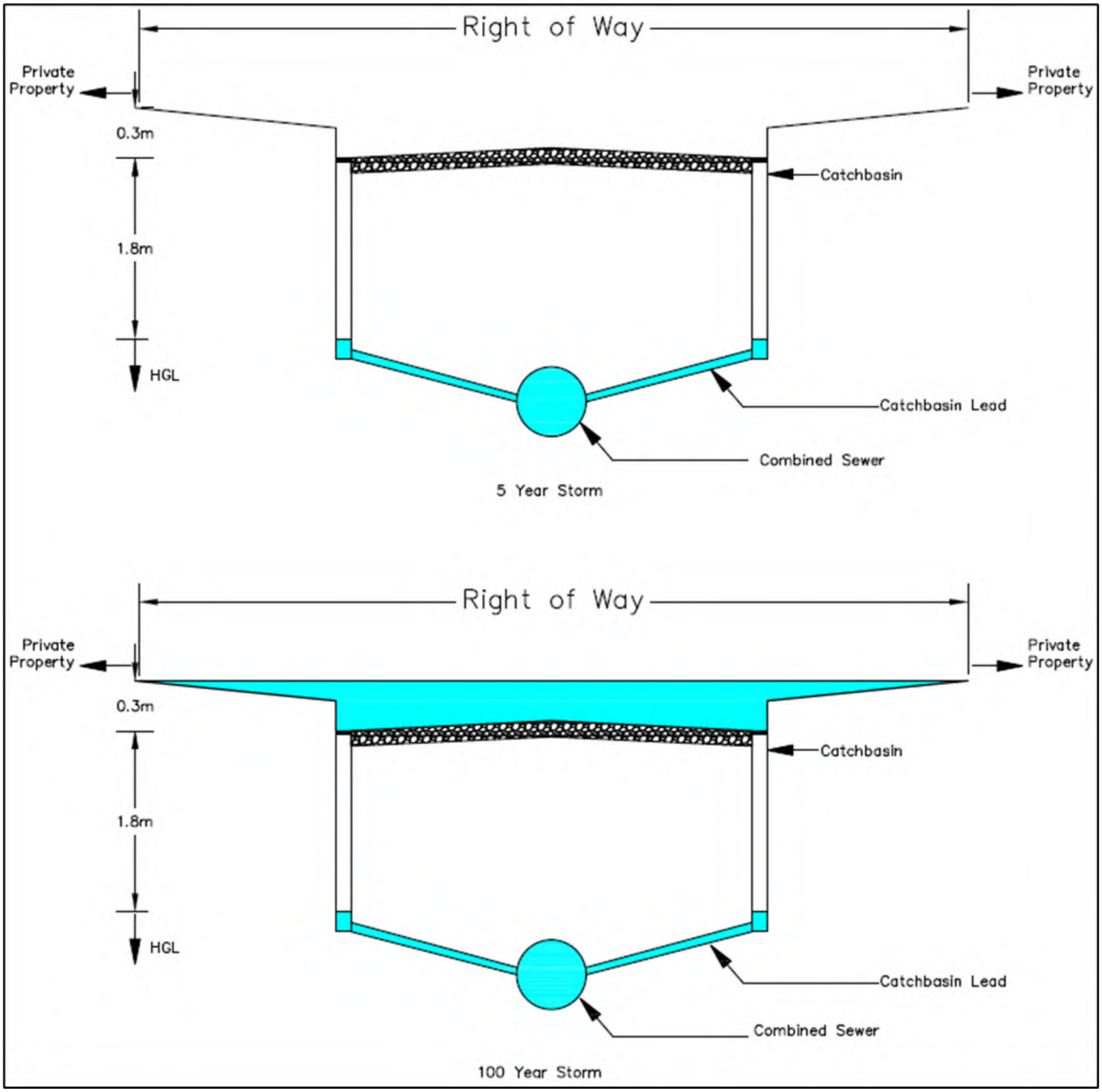


Figure 5-10: Storm Drainage Level of Service Criteria

The model simulation was completed for both the 5-year and 100-year design storm events, with the flooding results shown in Figure 5-11 through 5-14.

The 5-year storm drainage simulation results indicate that sewer surcharging of the minor (storm sewer) system shown in Figure 5-11 occurs primarily at the upstream portions of the study area. One of the reasons behind this flooding problem is the undersized trunk sewer along Caledonia Street which is causing the sewers upstream to back up. The modelling results for the major (overland) system on Figure 5-12 indicates that sewer surcharging in the upstream areas of the sewer system may not necessarily translate into surface flooding impacting private properties. However, roadway capacity issues under the 5-year on Culp St. and downstream on Caledonia are consistent with an under-capacity major/minor system. The consistency of sewer surcharging locations also indicates that the upstream sewer system is considerably undersized as well relative to the 1:5 year Level of Service.

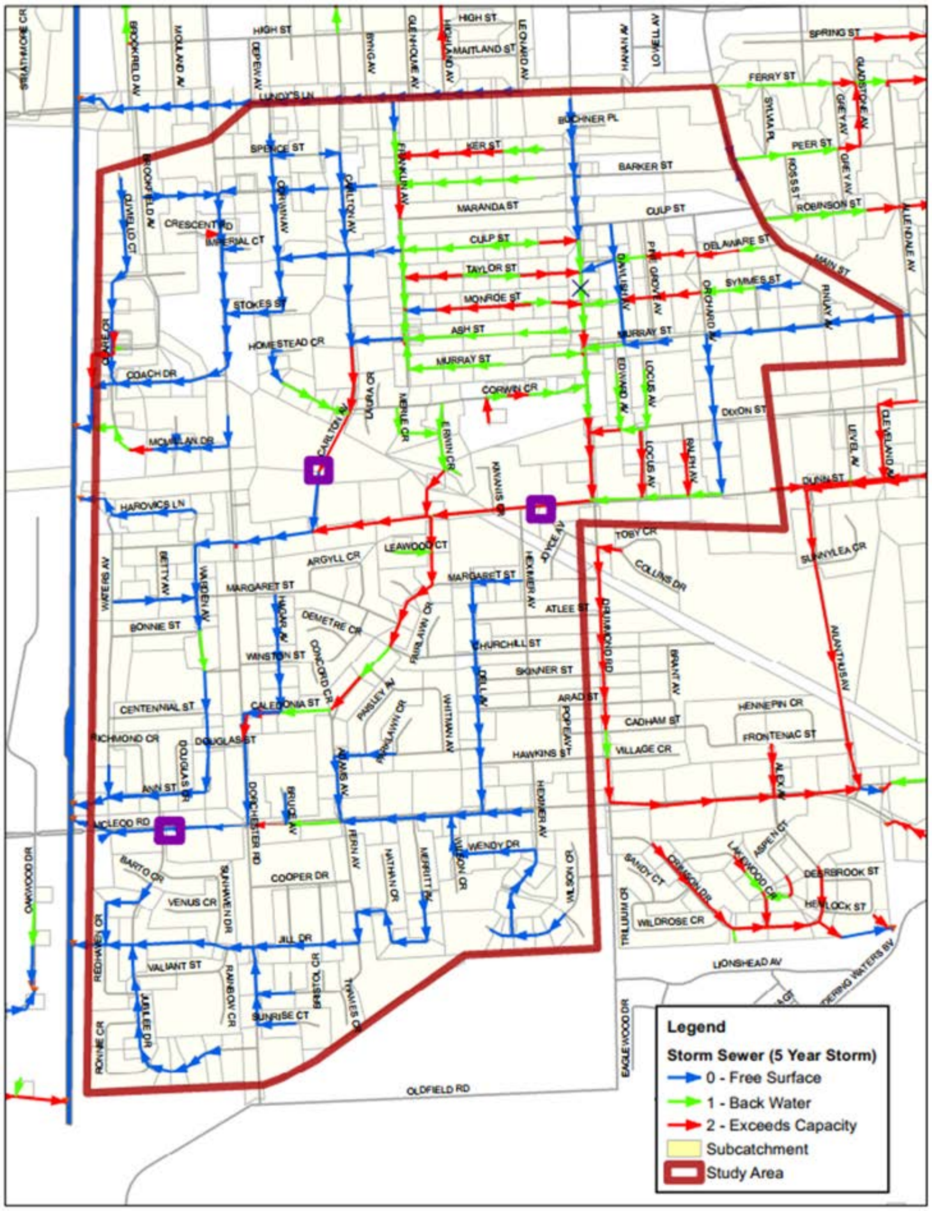


Figure 5-11: Minor System (Existing Conditions) 5 Year Event

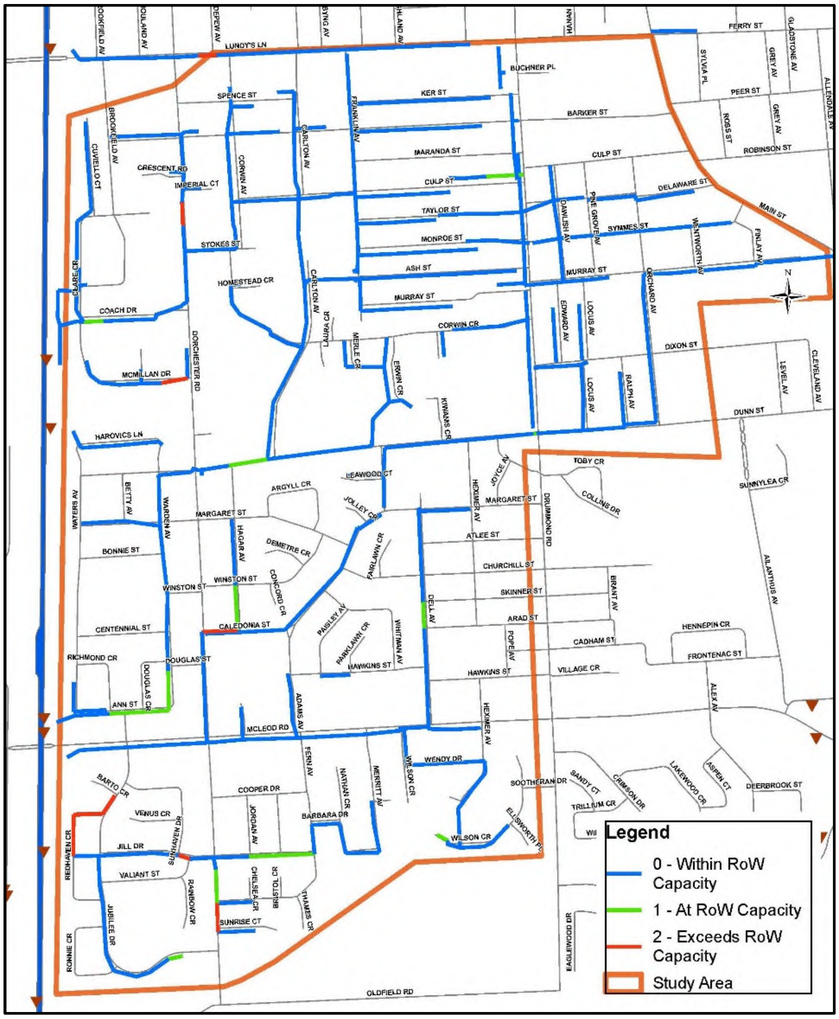


Figure 5-12: Major System (Existing Conditions) 5 Year Event

Figure 5-13 indicates that under a 100-year storm event, almost half of the sewers would be surcharged, with an increased degree of surface flooding. During the 100-year design event, if the depth of the major system flow is less than 300 mm, the target level of service is considered to be satisfied. As shown in Figure 5-14, the capacity of the RoW on Culp St. is exceeded from surcharging of the minor system. Also, the model result shows surcharging of the RoW extends into other areas, including Carlton Ave. where the minor system is surcharged to the surface.

These modelling results are used to develop and evaluate alternative remedial measures and size the preferred solutions for the study area.

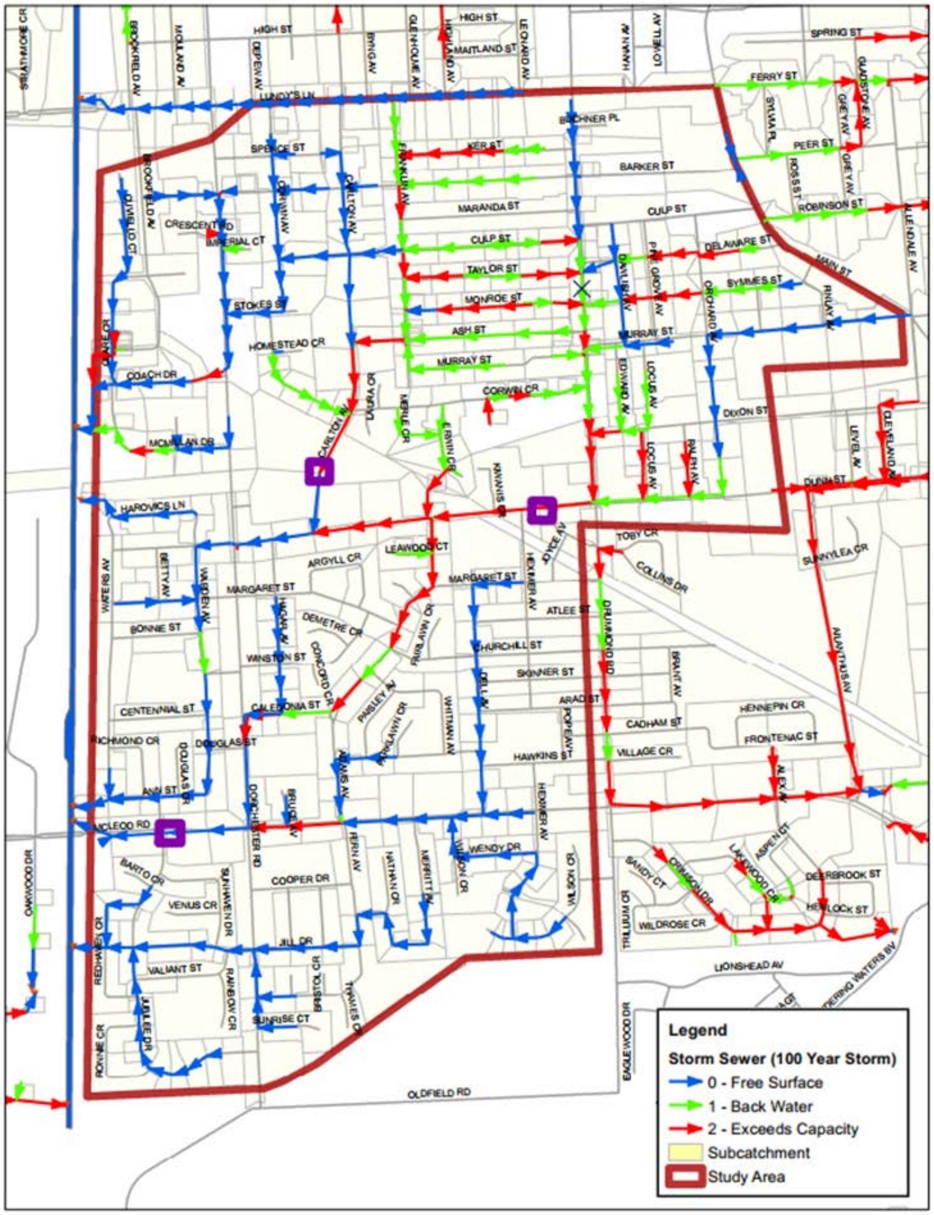


Figure 5-13: Minor System (Existing Conditions) 100 Year Event

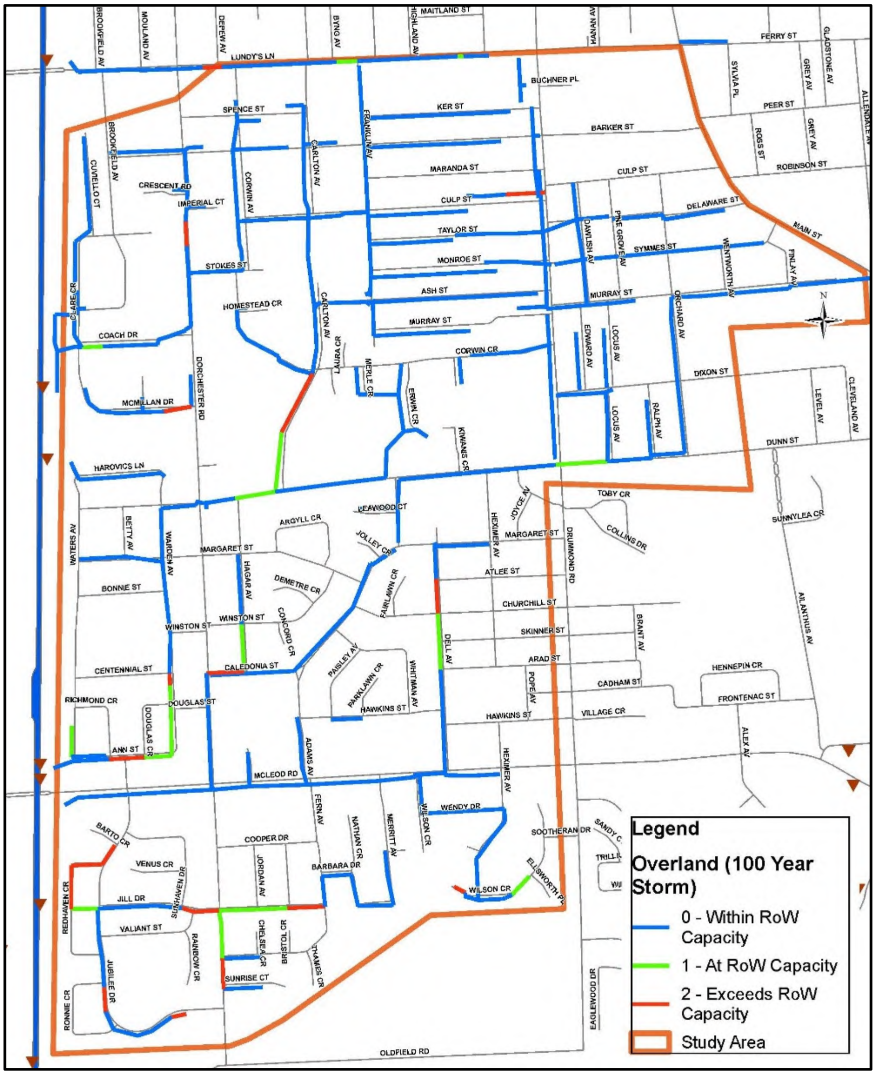


Figure 5-14: Major System (Existing Conditions) 100 Year Event

6.0 Evaluation of Alternatives

6.1 General

The following section considers remedial measures associated with storm and combined systems in the study area to alleviate property and street flooding. The performance of remedial measures associated with the combined & storm systems are based on both the 5-year and 100-year design storm. This section outlines the evaluation criteria and presents alternatives control measures. The outcome of this section is the identification of preferred solutions to address property and street flooding in the Corwin study area.

It should be emphasized that the development and evaluation of alternatives will only address property and street flooding that is attributed to public property issues.

6.2 Level of Service Criteria

The target level of service for the minor system is to maintain the hydraulic grade line 1.8 m below the ground elevation for events up to the 100-year design storm with not more than 300 mm surface ponding during the 100-year design storm. The modeling results suggest that there is localized flooding in the minor system. Figure 5-11 and Figure 5-13 highlights the system performance under the various design storm conditions. The 5-year and 100-year design storm event model results are used as a basis to develop alternatives to alleviate flooding for the remedial measures for the minor (storm sewer) system.

6.3 Generalized Approach - Development of alternatives

The alternative solutions should collectively address issues relating to flooding and the accompanying lack of capacity of the present storm system. Remedial measures to address existing flooding fall into one of four categories:-

- Alternative 1 - Do Nothing
- Alternative 2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands
- Alternative 3 - Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street
- Alternative 4 - Construction of Storage Tanks along Carlton Avenue and Dunn Street

Before modelling the 4 alternatives, the proposed InfoSWMM model was modified and expanded with building of new and upgraded sewers and removal of combined sewers and CSO's.

Minor System Improvements

The primary issues related to existing flooding issues include:

- Undersized **local** storm sewers and lack of proper overland flow routes, and
- Undersized **storm** trunk sewer network to convey flows from areas susceptible to flooding to a receiving body of water

Model expansion with new **local** storm sewers is assumed to occur for all alternatives except for the “Do Nothing” approach. Any of the other three (3) alternatives will require new sewers to be constructed along Barker Street, Maranda Street, Culp Street, Pine Grove Avenue and Orchard Avenue . These streets currently have no storm sewers. The proposed model is updated with new storm sewers along those streets. The following figure shows the location of the new storm sewers.

The three (3) alternatives require significant upgrades to the trunk storm sewer system to meet the level of service criteria. Additionally, these alternatives also take into consideration that the existing combined sewers overflows (CSO’s) along Franklin Avenue are to be removed as described below and that all storm flows within the local flooding area are to be directed to the storm sewers.

The results in Figures 5-11 and 5-13 indicate storm sewers in a state of surcharge along Ker Street, Culp Street, Taylor Street, Monroe Street, Ash Street, Murray Street, Franklin Avenue, Dixon Street and Drummond Road under both the 1:5 year and 1:100-year events. As a result, it is recommended that these sewers be upgraded under future works to mitigate surface flooding risk.

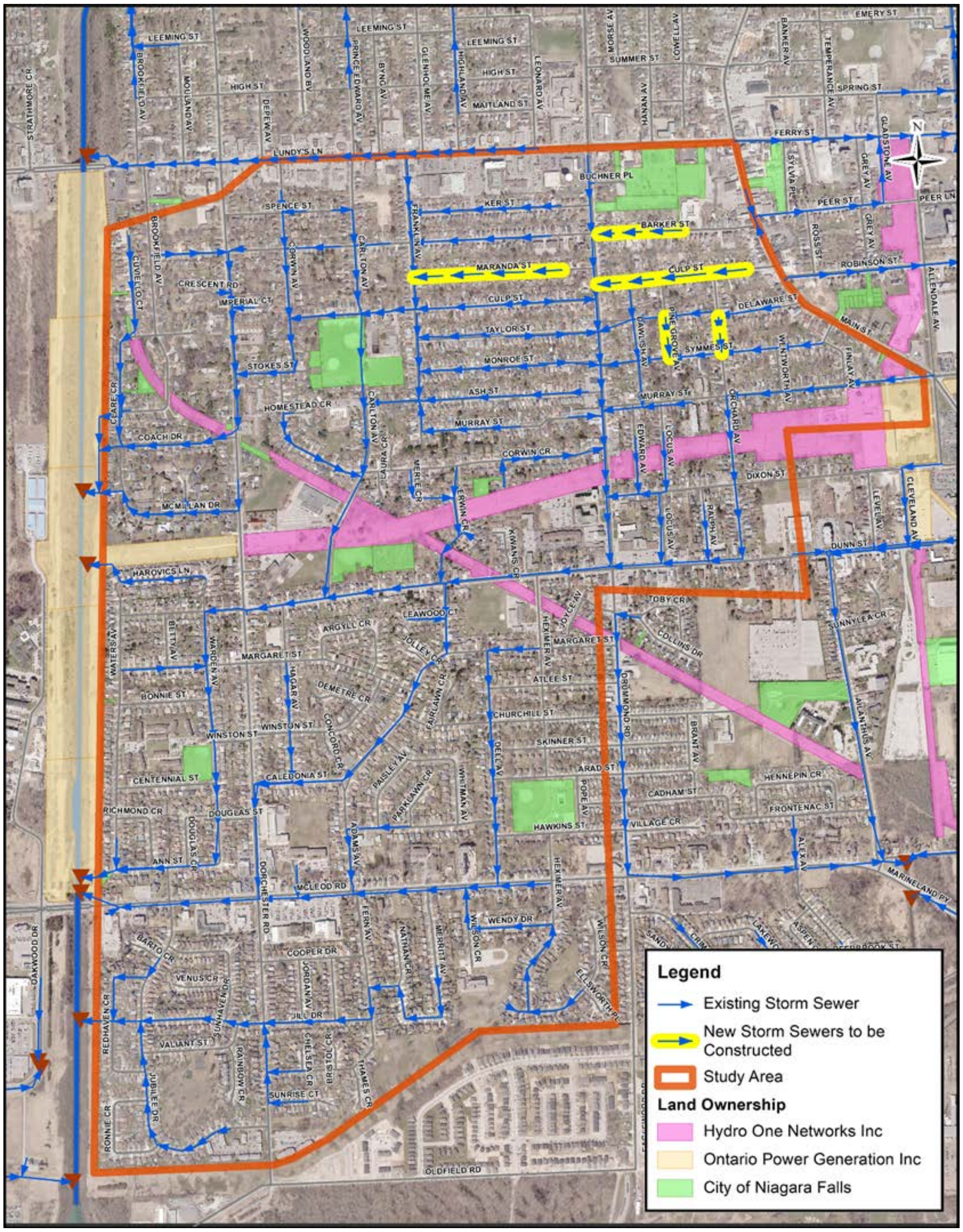


Figure 6-1: New Storm Sewers as part of Common Elements for all Alternatives (except "Do Nothing" Approach)

Removal of CSO's

The City provided data on the locations of CSO's within the defined Study Area. An additional field survey was conducted by City staff to confirm the configuration of the CSO structures. Locations of the CSO's within the study area are summarized below:

- Franklin Avenue & Culp Street,
- Monroe Street & west side of Franklin Avenue,
- Ash Street and Carlton Ave, and

- Ash street and Franklin Avenue

Sizing of remedial measures is accomplished using the computer model. New sewer elements or remedial measures were added to the system model, sizes and lengths were estimated, CSO's were removed and then simulations were performed until the model showed acceptable results based on the level of service criteria associated with the storm systems.

6.3.1 Alternative 1 – "Do Nothing"

The first alternative, "do nothing", entails no changes to the system. No local sewer improvement is assumed in the "do-nothing" scenario with no resulting changes in the drainage systems. This would not reduce frequency or extent of existing flooding issues. Therefore, it will cause significant disruption to home owners who experience flooding.

In addition, combined sewer overflows which occur within the Region of Niagara sewer system would occur at the current rate.

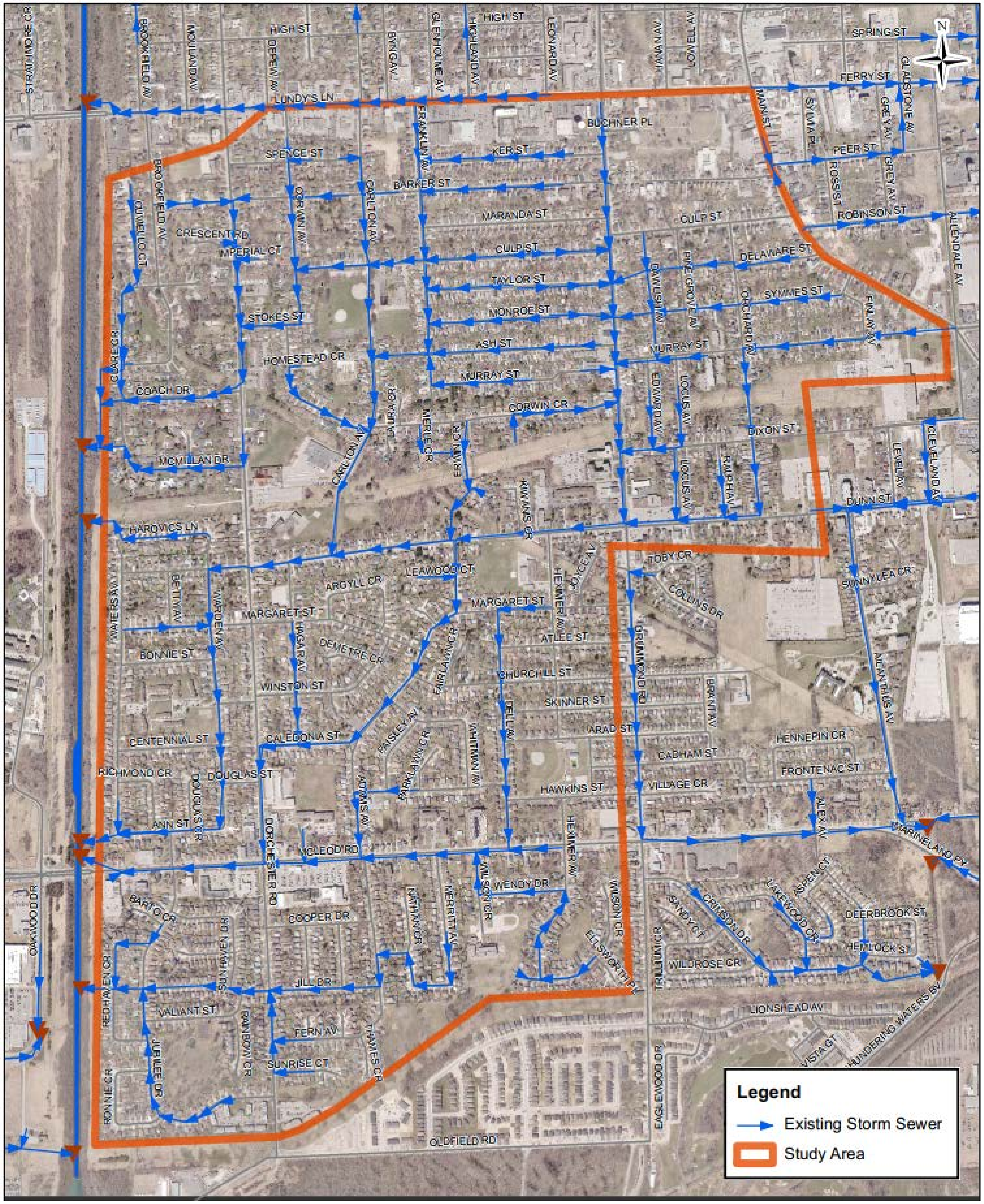


Figure 6-2: Alternative 1 - "Do Nothing"

6.3.2 Alternative 2 – Construction of new storm trunk Sewer within OPG and Hydro One Lands

This alternate would involve construction of a new storm trunk sewer within the Ontario Power Generation (OPG) and Hydro One lands. The trunk sewer would outlet to the Hydro Canal. The approximate length of the storm trunk sewer is 1200 m.

Implementation of this alternative would require further discussion and approvals from OPG and Hydro One. Please refer to the figure below.

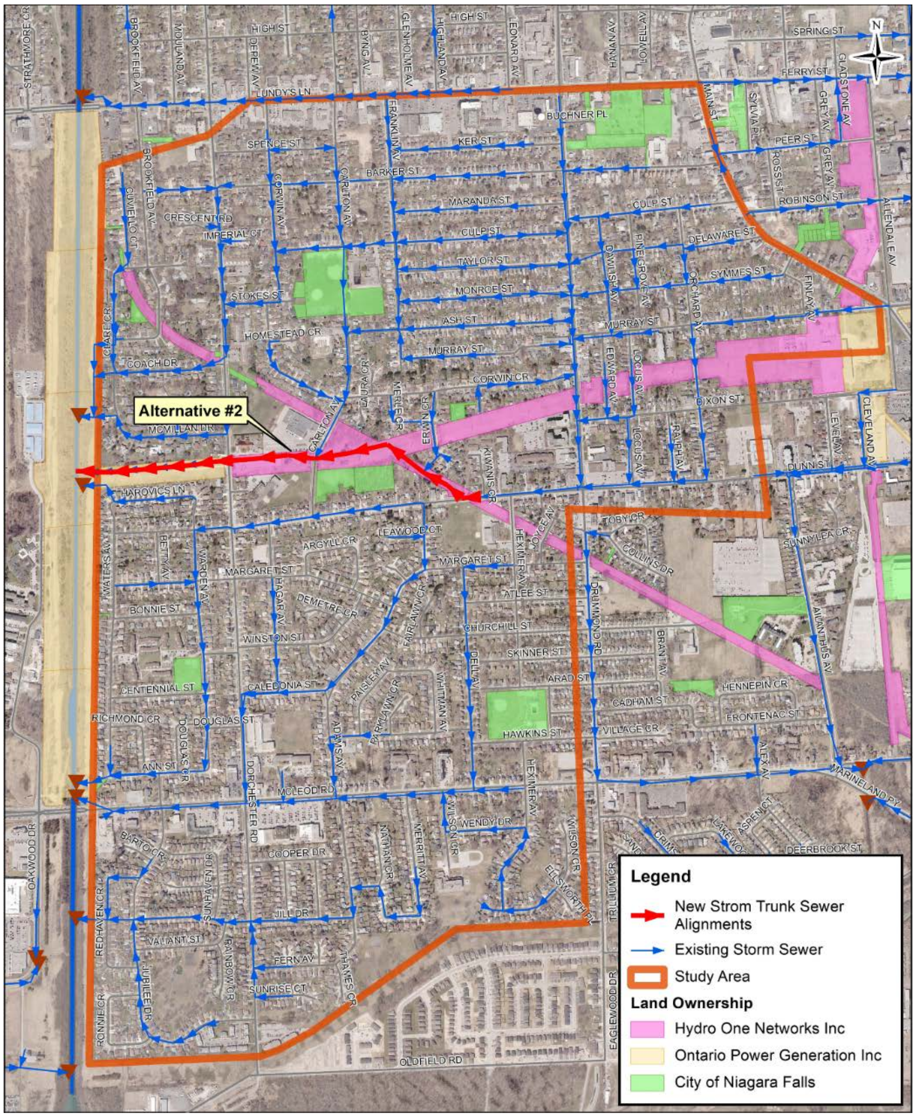


Figure 6-3: Alternative 2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands

6.3.3 Alternative 3 – Construction of new storm trunk Sewer along Warden Avenue and Caledonia Street

This alternative would involve construction of a larger storm trunk sewer system along Warden Avenue & Ann Street as well as Caledonia Street, Dorchester Road & McLeod Road. The trunk sewers would outlet to the Hydro Canal. The approximate length of the new storm trunk sewer is approximately 2870 m.

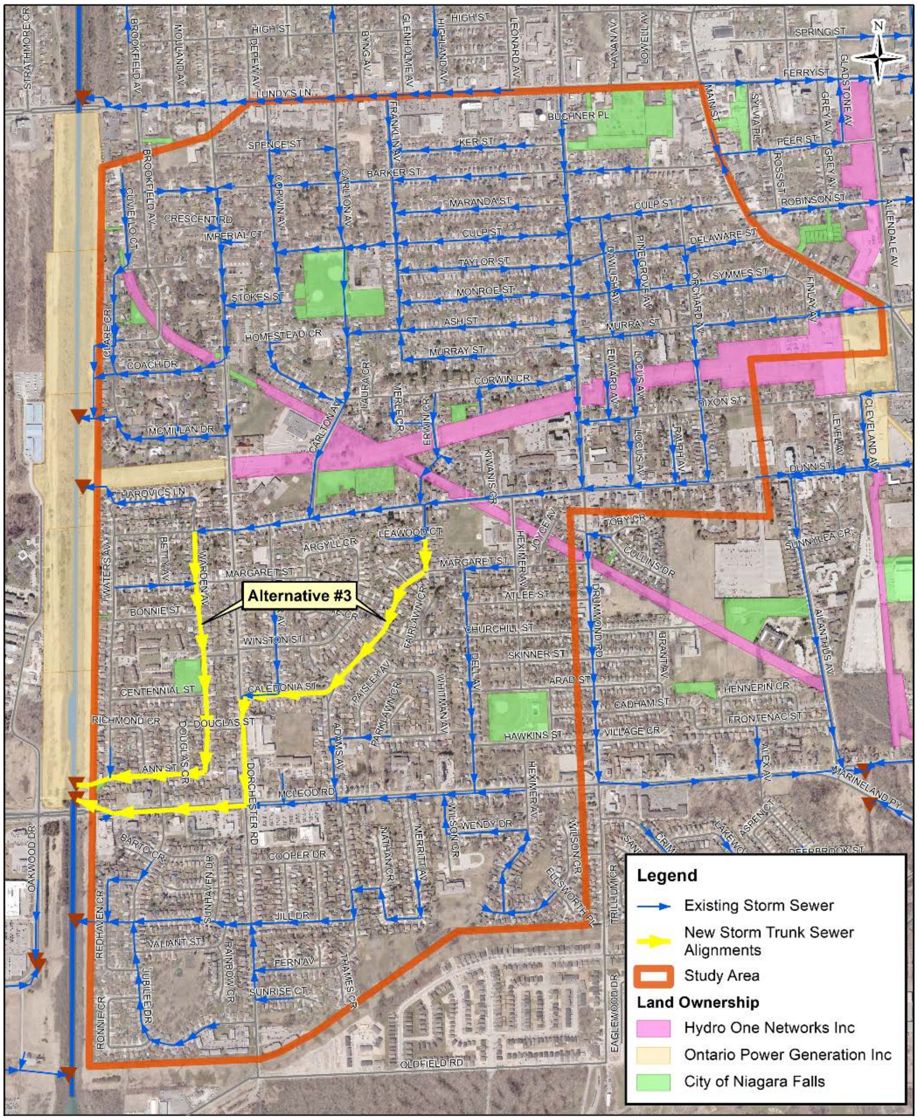


Figure 6-4: Alternative 3 - Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Streets

6.3.4 Alternative 4 – Construction of Storage Tanks along Carlton Avenue and Dunn Street

The alternative would involve construction of storage tanks within the existing storm sewer network. Storage tanks, located along Carlton Avenue and Dunn Street, would control storm flows to the capacity of the existing storm sewers located along Warden Avenue and Caledonia Street. Total length of the storage tanks would be 800m approximately.

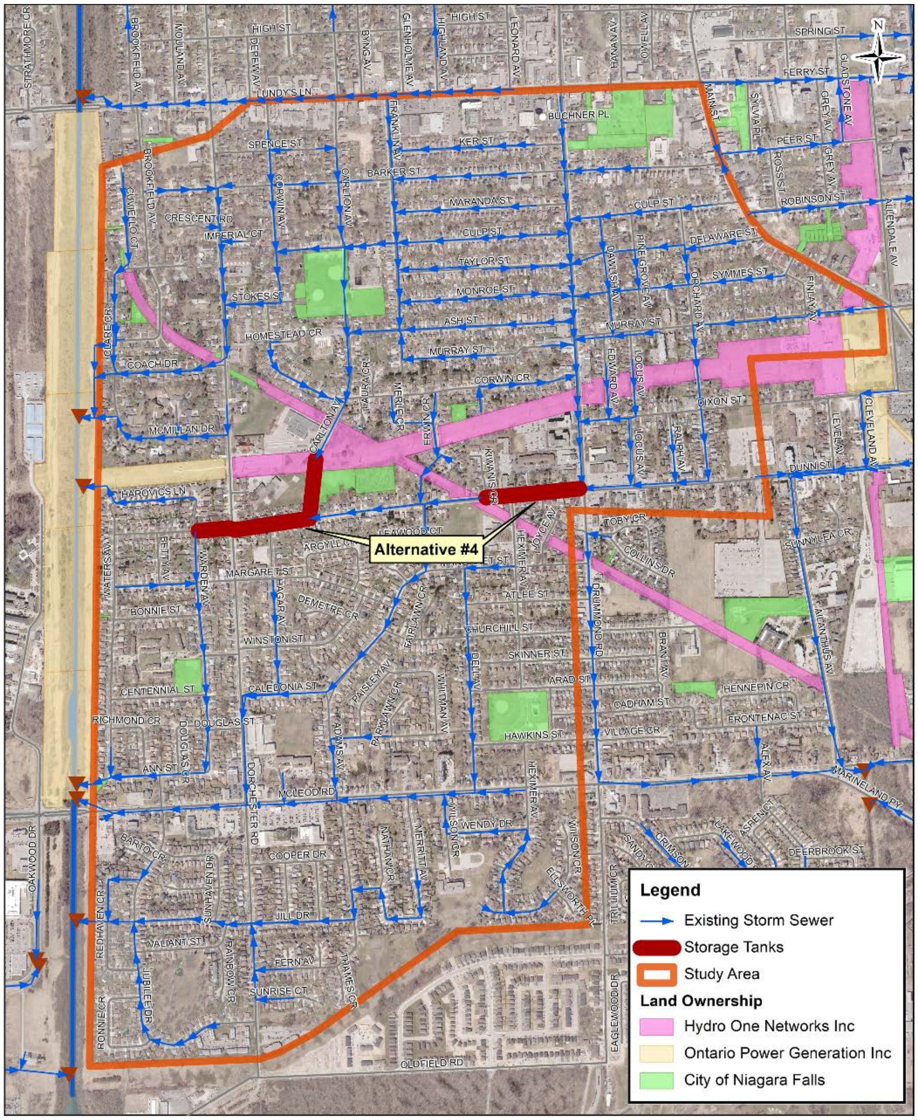


Figure 6-5: Alternative 4 - Construction of Storage Tanks along Carlton Avenue and Dunn Street

6.4 Description of Evaluation Criteria

As part of the Municipal Class Environmental process, each alternative must be evaluated based on a set of Natural Environment, Economic, Socio-Cultural and Economic criteria. One additional category, Technical, was also included as part of this assessment. The set of criteria was developed by Aquafor Beech Limited and reviewed by the City.

A score was then established through a multidisciplinary evaluation process for each alternative design for each of the criteria which were established. The score for each option ranged from least preferred (designated by ○) to most preferred (designated by ●)

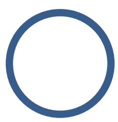
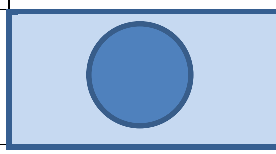
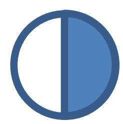
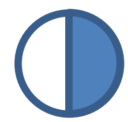
A score (or assessment) of ○ indicated that the alternative scored the lowest in relation to the criteria. Alternatively, an assessment of ● indicated that the option scored the highest in satisfying the respective criteria. Three intermediate assessments (◔ ◑ ◕) were also used to evaluate the alternatives. The overall preferred option was then based on an aggregate score from the criteria.

6.5 Evaluation of Alternatives

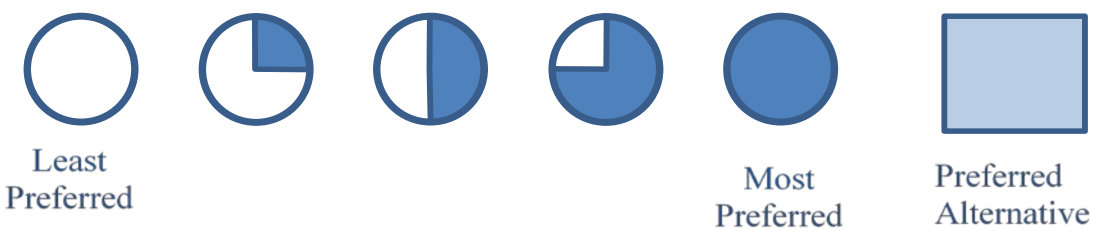
In the evaluation methodology proposed, the best ranking corresponds to ● and is the preferred solution. The worst ranking is the least desirable alternative. The evaluation of the alternative solutions is presented in Table 6.5.1 with additional information on the scoring of the alternatives for each criterion summarized below:

Table 6-1: Evaluation of Alternatives

Evaluation Criteria	**Alternative #1 Do Nothing**	**Alternative #2 Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands**	**Alternative #3 Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street**	**Alternative #4 Construction of Storage Tanks along Carlton Avenue and Dunn Street**
Natural Environment	• No Impact on terrestrial or aquatic resources	• Minor impact on terrestrial or aquatic resources associated with construction	• Minor impact on terrestrial or aquatic resources associated with construction	• Minor impact on terrestrial or aquatic resources associated with construction
Economic	• Lowest overall cost excluding costs associated with ongoing surface and basement flooding and combined sewer overflows	• Lowest overall cost of the three alternatives which resolve flooding issues	• Second lowest overall cost of the three alternatives which resolve flooding issues	• Highest overall cost of the three alternatives which resolve flooding issues
Socio-Cultural	• Significant disruption to home owners who experience flooding	• Minor impact on urban green space/ recreational use • Least disruption to community during construction	• Minor impact on urban green space/ recreational use • Significant disruption to community during construction	• Minor impact on urban green space/ recreational use • Significant disruption to community during construction

Evaluation Criteria	Alternative #1 Do Nothing	Alternative #2 Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands	Alternative #3 Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street	Alternative #4 Construction of Storage Tanks along Carlton Avenue and Dunn Street
Socio-Cultural	• This alternative would not reduce frequency or extent of existing flooding issues	• This alternative is technical feasible • Permits from Hydro One and Ontario Power Generation will be required	• Alternative may have minor technical limitations associated with crossing existing infrastructure	• Alternative may have technical limitations due to size of storage tanks
Overall Alternative Rank				

Legend



7.0 Selection and Description of the Preferred Alternative

Based on the results of the alternatives evaluation and in consultation with the City and the public, **“Alternative #2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands”** was selected as the preferred alternative.

This alternative will have a minor impact on the natural environment during construction. The impacts associated with construction will be more than offset by the reduction in flooding of properties and buildings as well as reduction in Combined Sewer Overflows to the Hydro Canal.

Alternative #2 is the most cost effective of the three technical alternatives that were considered and should have the least technical issues to address. Figure 7.1 below shows the Preferred Alternative. Further approvals from Hydro One and Ontario Power Generation will be required.

Figure 7-1: Preferred Alternative

8.0 Removal of Combined Sewer Overflows (CSO's)

The primary issues for the combined and sanitary system within the Study Area is the presence of combined sewer overflows (CSO's). As noted in Section 2.2 there is also the CSO facility at McLeod Ave that is non-functional.

Implementation of the preferred storm alternative will have several benefits to the existing combined and sanitary sewer system. In general, the benefits will include separation of storm runoff from the existing combined sewer system and potential reduction of CSO frequency and volumes as well as the opening up of capacity in the existing combined sewer system (the availability of extra capacity may be used to accommodate intensification).

MECP Procedure F-5-5

The MECP Procedure F-5-5, which is a supporting document for Guideline F-5 "Levels of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters", is intended to protect all waterways from the effects of CSO. The City established a Pollution Prevention Control Plan (PPCP) and completed the 2017 PPCP Update with GM Blue Plan for an enhanced wet weather flow protection program. The alternatives presented for the storm drainage system are predicated on the introduction of new storm sewers where none currently exist for an enhanced level of control of and prevention of CSO's upstream. Additionally, the criteria also states that during a 7-month period commencing within 15 days of April 1st, capture and treat for an average year, all dry weather flow plus 90% of the volume resulting from wet weather flow that is above dry weather flow.

8.1 H&H Model and Assessment Summary

The H&H model of the existing Combined and Sanitary system and the storm drainage system was prepared in InfoSWMM by GM Blue Plan. There are two separate model networks associated with the InfoSWMM model:

- combined and sanitary network: Includes existing conditions, intensification, future growth and I&I reduction scenarios
- storm network: Includes existing trunk minor system model

The Combined and Sanitary sewer model was reviewed and assessed for gaps in the model network, model & simulation parameters and rainfall data per Appendix B that were addressed prior to running the existing conditions. Flow and water level into the combined and sanitary system is calculated in the model and is based on domestic dry weather flow derived from flow monitoring and inflow and infiltration (I&I) generated by rainfall and simulated through RDII.

The H&H model was checked for the representation of CSOs, wet weather inflow into the sanitary system via the connected catch basins were modelled as wet-weather flow subcatchment areas draining to the sanitary maintenance hole. As part of the development of solutions to the storm drainage system and reduction in basement flooding risk, the following works were undertaken:

- CSO's within the study area were disconnected including the three (3) overflows along Franklin Avenue;

- Surface runoff entering the combined system via catch basins was reallocated to proposed new storm sewers along Culp Street, Barker Street, Maranda Street, Orchard Avenue and Pine Grove Avenue;
- The sewers around the McLeod Tank area were checked to reflect the conditions found in the Field Survey (Error! Reference source not found.**8-1).** The conduit connecting SMH 04761 and SMH 06163 that represents the CSO into the McLeod Tank was deactivated to reflect the non-functional state of the McLeod Tank facility and the closing of the sluice gate overflow structure.

To check on the conveyance capacity impacts of removing CSO's, the combined and sanitary existing conditions model was run for the 1981 typical year storm with the McLeod facility deactivated.

Figure 8-2 shows the locations of the CSO sites. The existing onditions model was run and it was found that there were no overflows at any of the sites as shown. With the model showing no CSO's for existing conditions there was no need to run proposed conditions scenario.

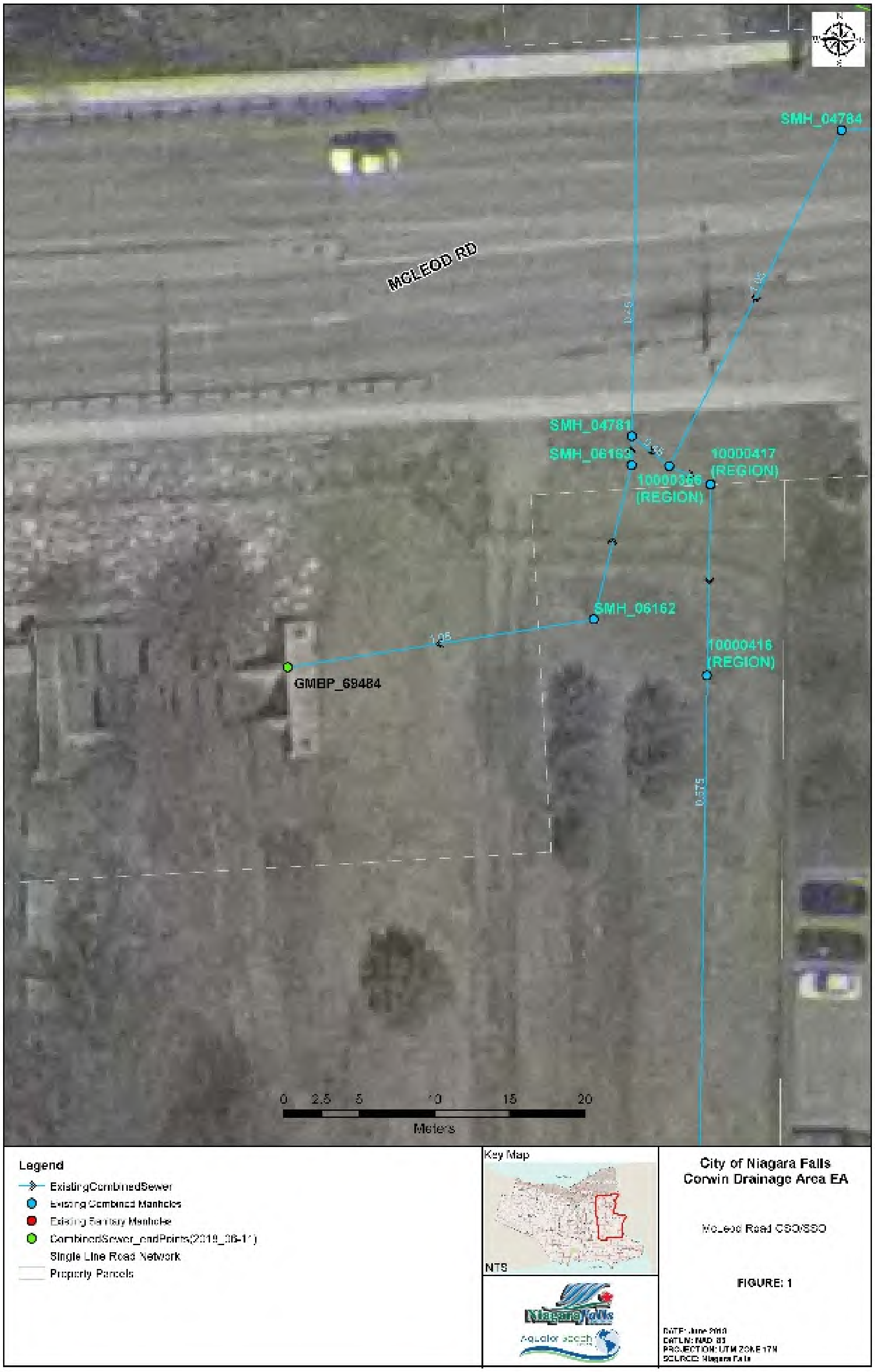


Figure 8-1: McLeod Tank Overflow

Figure 8-2: Summary of 1981 Typical Storm on Combined and Sanitary Sewer System

9.0 Implementation Considerations

This chapter will summarize implementation considerations associated with the various elements. The steps will include

- Preliminary Design
- Detail deign and geotechnical Investigation
- Archeologic Investigation
- Approvals
- Contract document preparation and tender
- Implementation Phasing
- Construction

9.1 Preliminary Design

The preliminary design for this project will be undertaken after submission and approval of the Environmental Assessment report. The preliminary design is expected to be 30% design and shall include identification of all service or utility conflicts and relocation, alignment of preliminary sewer separations, and confirmation of sewer grade lines and necessary hydraulic free board in the sewer systems. This will also include major aspects of constructability plan, access/egress locations and staging areas and cost estimates.

9.2 Detailed Design and Geotechnical Investigation

The detail design stage can be initiated, once the preliminary design is complete. The detail design package should include the preparation of 60%, 90% and final design drawings for review by the City and relevant stakeholders. The primary steps involved in the preparation of detail design drawings include –

- Site assessments including infrastructure assessment, tree assessment, topographic survey, archaeology and utility investigations.
- General Plan - (detailing structure, property lines and services);
- Site plan (including site access, staging and stockpile area delineation);
- Plan and profile drawings with associated infrastructure, new and proposed storm sewer;
- Traffic management plan;
- Tree Inventory and Landscape restoration plan (including tree removal, preservation
- and planting plan); and
- Construction phasing and staging

Geotechnical Investigation

A geotechnical investigation is recommended to characterize subsurface conditions. This will relate to -

- Geotechnical laboratory soil testing on selected samples (as required) to characterize the index properties including water content and grain size distribution. As part of the geotechnical investigation selected soil samples will be analyzed to obtain preliminary information about the chemical quality of the site soils;
- Existing road profile and base conditions, suggested pavement structure requirements;
- Subsurface conditions at the all proposed new and upgraded storm sewers;
- Groundwater elevations through the installation of piezometers in selected boreholes to facilitate ground water level monitoring, according to Ontario Regulation 389/09;
- Pipe bedding considerations;
- Off-site soil disposal options; and
- Dewatering during construction

9.3 Archeological Investigation

A ***Stage 1*** Archaeological Assessment for the study area was undertaken by Archaeological Services Inc. (ASI). All activities carried out during this assessment were completed in accordance with the Ontario Heritage Act (1990, as amended in 2018) and the 2011 Standards and Guidelines for Consultant Archaeologists (S & G), administered by the Ministry of Tourism, Culture and Sport (MTCS 2011). A copy of the report can be found in Appendix C.

Figure 9-1 shows the extent of the study area for the field archeological survey.

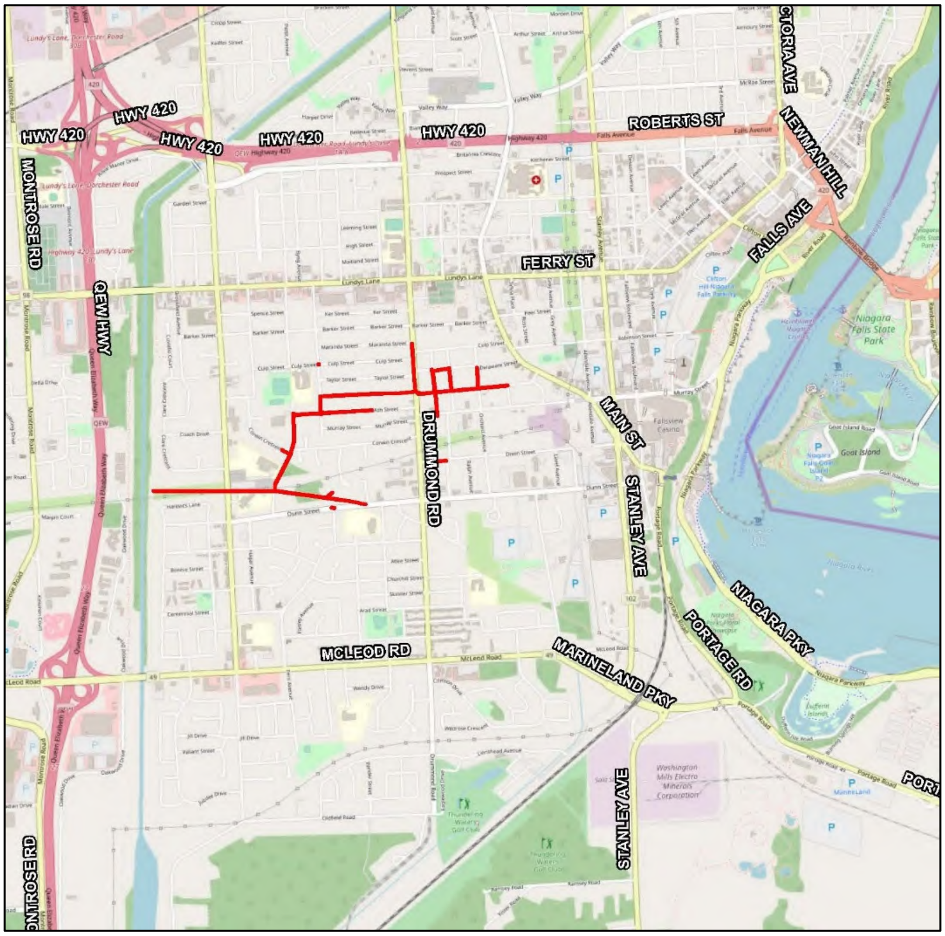


Figure 9-1: Archeological Assessment Study Area Extent

The Stage 1 Archeological Assessment states that the Stage 1 background study determined that 16 previously registered archeological sites are located within one kilometre of the study area and that parts of the study area will require a Stage 2 assessment. The study also notes that the remainder of the study area has extensive land disturbance and therefore does not require further archeological assessment. Based on the above, the report makes the following recommendations:

1. For proposed works that extend outside of the RoW's where archeological potential is indicated, these lands will require a Stage 2 archaeological assessment by test pit survey at five metre intervals, prior to any proposed construction activities right-of-way. Areas highlighted in green in **Figure 9-2**. exhibit archaeological potential Error! Reference source not found. and illustrates a representative area along Carlton Ave. crossing the hydro corridor.
2. According to the *Standards and Guidelines for Consultant Archaeologists* (S & G), Section 2.1.2, a test pit survey is required on terrain where ploughing is not viable, such as wooded areas, properties where existing landscaping or infrastructure would be damaged, overgrown farmland with heavy brush or rocky pasture, and narrow linear corridors up to 10 metres wide.
3. The remainder of the Study Area does not retain archaeological potential on account of deep and extensive land disturbance or has been previously assessed. These lands do not require

further archaeological assessment; and should the proposed works extend beyond the current Study Area, further Stage 1 archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

Figure 10: Corwin Drainage Study Area - Results of the Property Inspection

Figure 9-2: Archeological Potential

9.4 Approvals

A meeting was held with Hydro One on August 29,2019. As per the correspondence with Hydro One dated August 29, 2019 (see Appendix A) the following conditions for approval of the proposed works within the hydro corridor include:

- Consideration be given to the existing high-voltage electrical transmission infrastructure and provision for future lines;
- Consideration be given for secondary land uses within the corridor for (i.e. pipelines, watermains, parking, etc);
- A Class EA will be required for any proposed works that impact transmission infrastructure / facilities that may require 6 to 18 months depending on the level of assessment required; and
- Line clearances and Hydro One facility access must be maintained and any construction activities must maintain the minimum safe electrical distance from transmission line conductors as specified in OHSA for the respective line voltage.

Further Discussion and approvals will be required from OPG and Hydro One to implement the preferred alternative. In addition, agency approvals from utility companies and other relevant agencies will be required at the design and construction stages.

9.5 Contract document preparation and tender

A tender document shall be prepared for the project with the intent that the proposed works be publicly tendered. The tender will be consistent with the requirements of the City of Niagara Falls standards. The package shall include several sections common to most tenders, as well as sections on:

- Special specifications;
- Schedule of prices;
- Detailed Cost Estimate based on tender schedule of prices; and
- Final detailed design drawings.

9.6 Implementation Phasing

The phasing and timing of the proposed works will be determined by the following three criteria.

- Construction must start from the storm sewer outlet and progress upstream;
- Construction may be coordinated with ongoing road reconstruction programs; and
- Construction, where possible, should address high priority areas (from a flooding perspective) first.

9.7 Construction

The proposed construction timing will be based on subsequent discussions within the City and will be integrated with the proposed timing for the proposed storm sewer works as well as the proposed road construction in order to minimize the level of inconvenience to residents, businesses and commuters.

10.0 Climate Change and Impact on Stormwater Infrastructure

Climate change has the potential to alter rainfall patterns in Ontario as more moisture in a warmer atmosphere is expected to cause an increase in extreme weather events and result in less climate predictability from year-to-year. A change in the intensity and/or frequency of rainfall events could have both acute and long-term effects on municipal stormwater management. Rainfall events that produce a larger volume of water than the design flow can result in many complications. If a sufficient outlet or emergency overflow is not provided, large volumes of water can cause surcharging of the storm sewer systems, resulting in flooding in upstream urban areas.

10.1 Findings from Master Plan Study Update

The United States Environmental Protection Agency (USEPA) developed a tool to help analyze the impacts of climate change using the USEPA Stormwater Management Model (SWMM). The **Storm Water Management Model Climate Adjustment Tool (SWMM-CAT)**is a software utility that provides near (2020 to 2049) and far (2045 to 2074) term climate change projections, in the form of percentage changes in monthly temperature, evaporation and rainfall data, and 24-hour rainfall design storm intensity and return period, from their current parameter values. SWMM-CAT provides a set of location-specific adjustments that were derived from global climate change models run as part of the World Climate Research Programme (WCRP)Coupled Model Intercomparing Project Phase 3 (CMIP3) archive. Additional details on the program can be found in the SWMM-CAT User's Manual (USEPA, 2014), including the Climate Resilience Evaluation and Awareness Tool (CREAT) it employs to generate the near and far term climate changes (USEPA, 2012).

Per the Master Plan Update Study (MPUS, 2016) by Aquafor, the USEPA tool was the most developed tool at the time of the MPUS and was selected to assess the near and long-term rainfall data and project future IDFs for the City for the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-yr return periods. Using data from five (5) city rain gauges for the data period from January 1998 though April 2015, this data was entered into the SWM-CAT model.

The MPUS assessed the possible impacts of future climate change on the required capacities and volumes of the proposed solutions for SWM and CSO control, and basement flooding (for various levels of control), and suggested that a climate change sensitivity analysis be conducted, considering the impacts of increasing the rainfall records/design storms by 5% to 15%, in increments of 5%.

It was concluded that a five (5) percent climate change scenario most closely reflects the findings of the Niagara Falls precipitation modelling data for near and far term climate change projections, and the 5% and 10% scenarios mirror the results of the screening assessment of the potential impacts climate change on combined sewer overflow (CSO) mitigation in the Great Lakes Region (USEPA, 2008); and provide a reasonable basis for considering the potential impacts of climate change on the SWM and CSO and basement flooding control measures included in the Niagara Falls MDPUS. The recommendation going forward was to increase the current IDF by 5% to account for the impacts of climate change.

10.2 Climate Change Scenario

To simulate the response of the proposed drainage network including both the minor system and major system to the climate change runoff event, the recommended five (5) percent increase to the 100-Year, 4hr Chicago storm IDF was applied to the rainfall event intensity across each time interval using the InfoSWMM model.

The results show that a Climate Change Impact of a five percent increase results in a nominal change in the number of sewers exceeding conveyance capacity within the existing storm sewer system (Figure 10-1) and a slight increase in the extent of flooding of the overland (major system) (Figure 10-2).

In general, the results show that a five percent increase in the 100-Year storm to represent predicted climate change conditions has a nominal change from the 100-Year event.

Figure 10-3 shows the number sewers surcharged with climate change scenario for the proposed condition model while Figure 10-4 shows the extent for which overland flooding exceeds 0.3 m depth in the major system for climate change scenario for the proposed condition model with the elimination of surface flooding along Carlton Avenue.

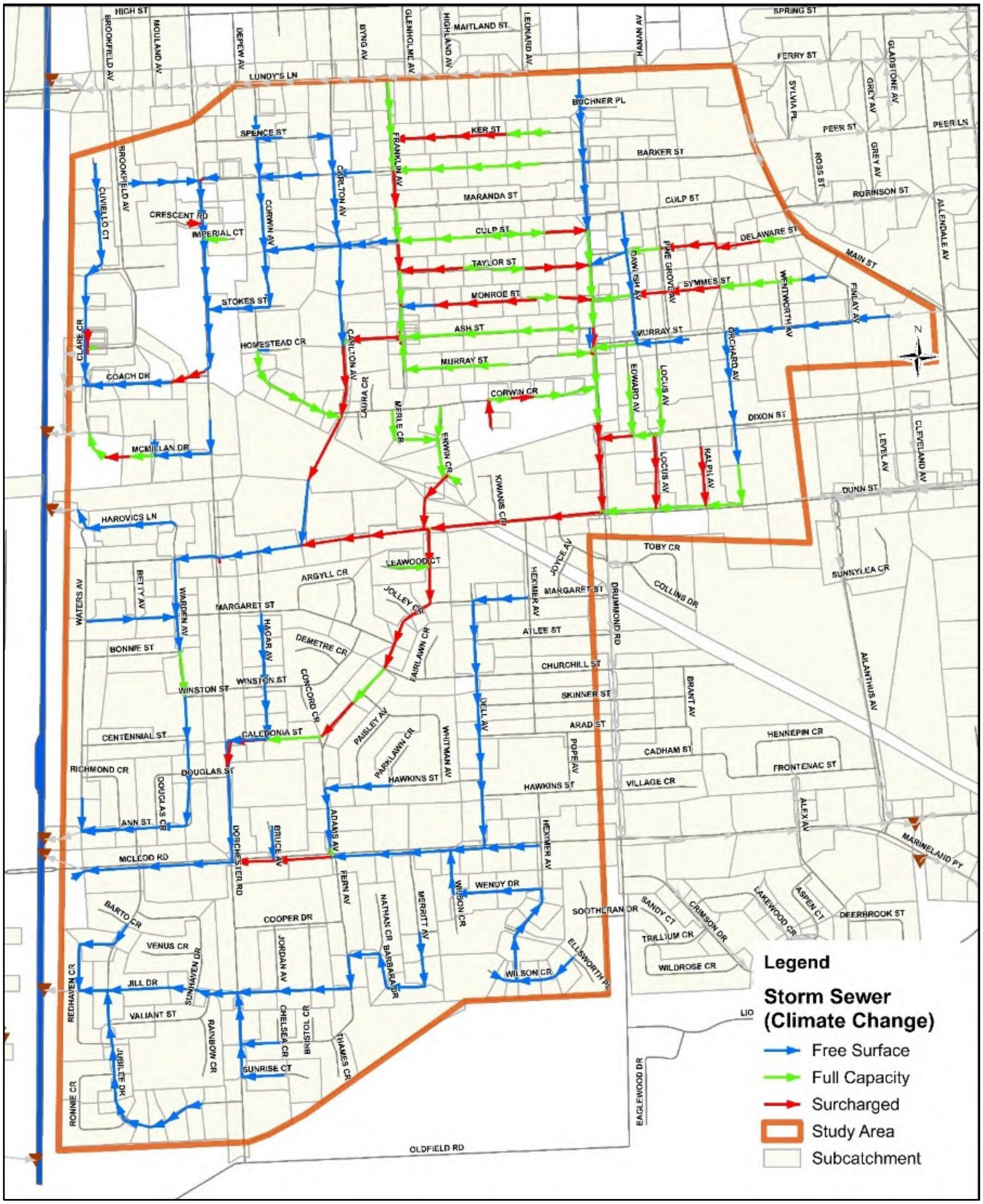


Figure 10-1: Minor System (Existing Conditions) under Climate Change

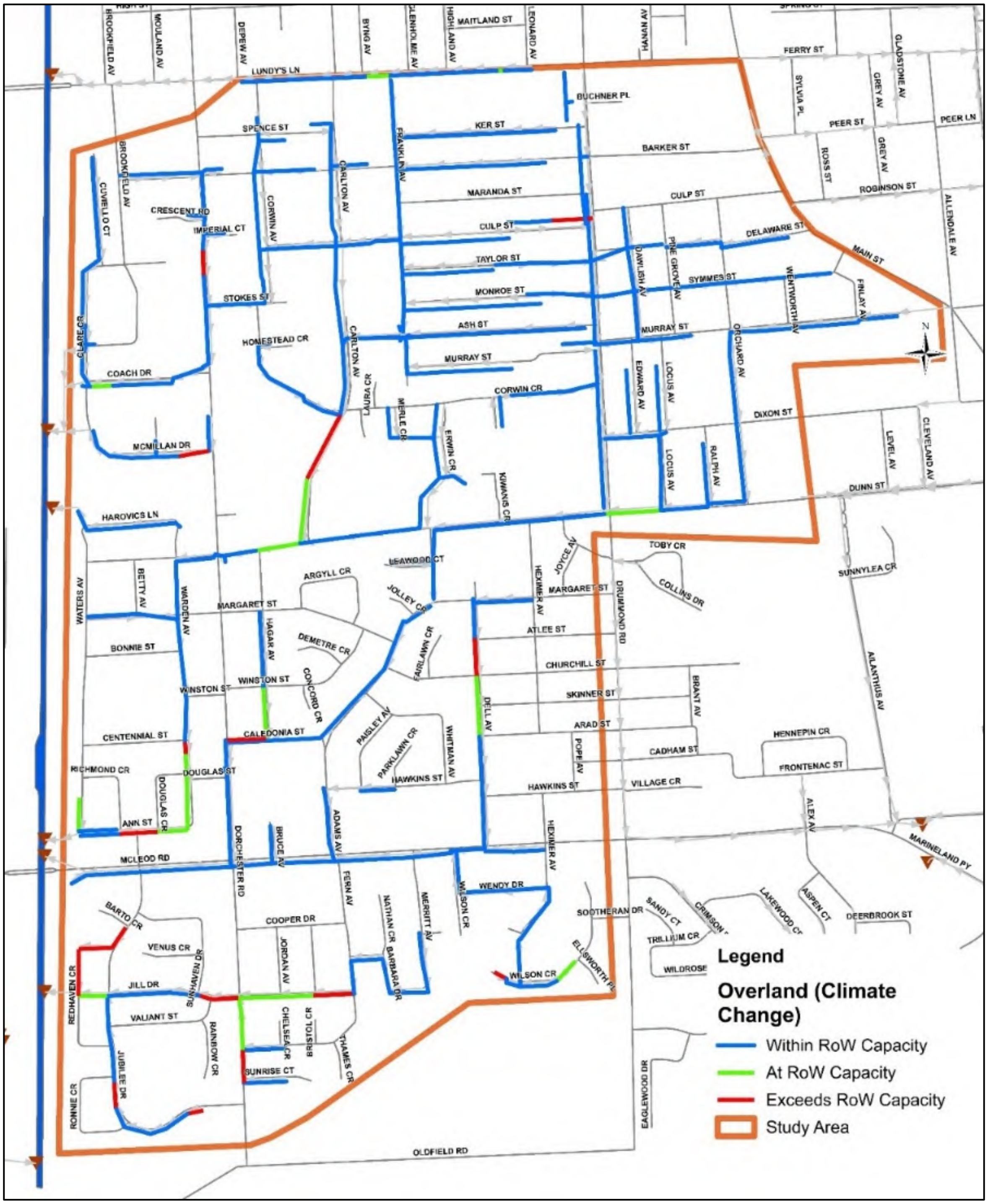


Figure 10-2: Major System (Existing Conditions) under Climate Change

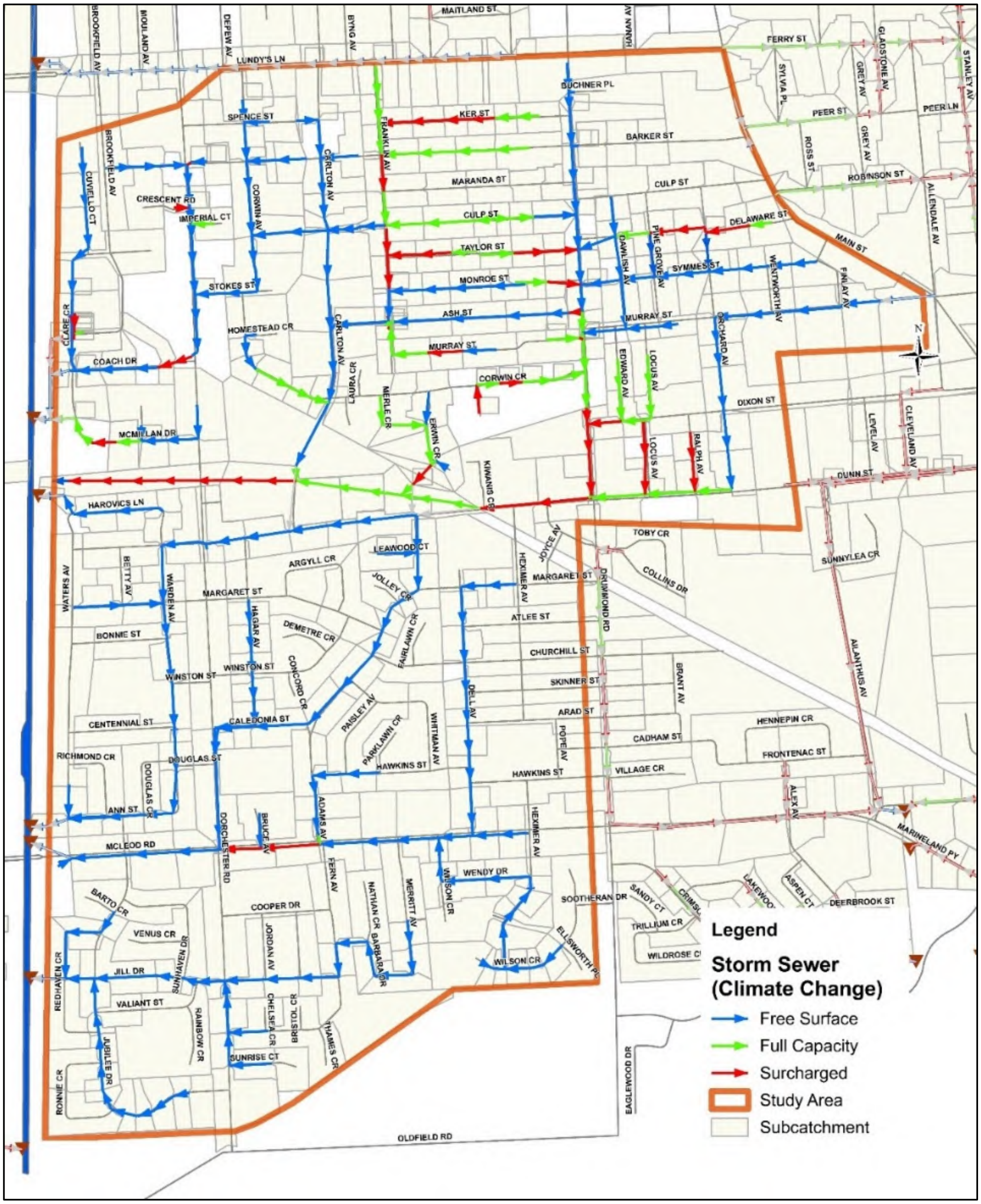


Figure 10-3: Minor System (Preferred Alternative) under Climate Change

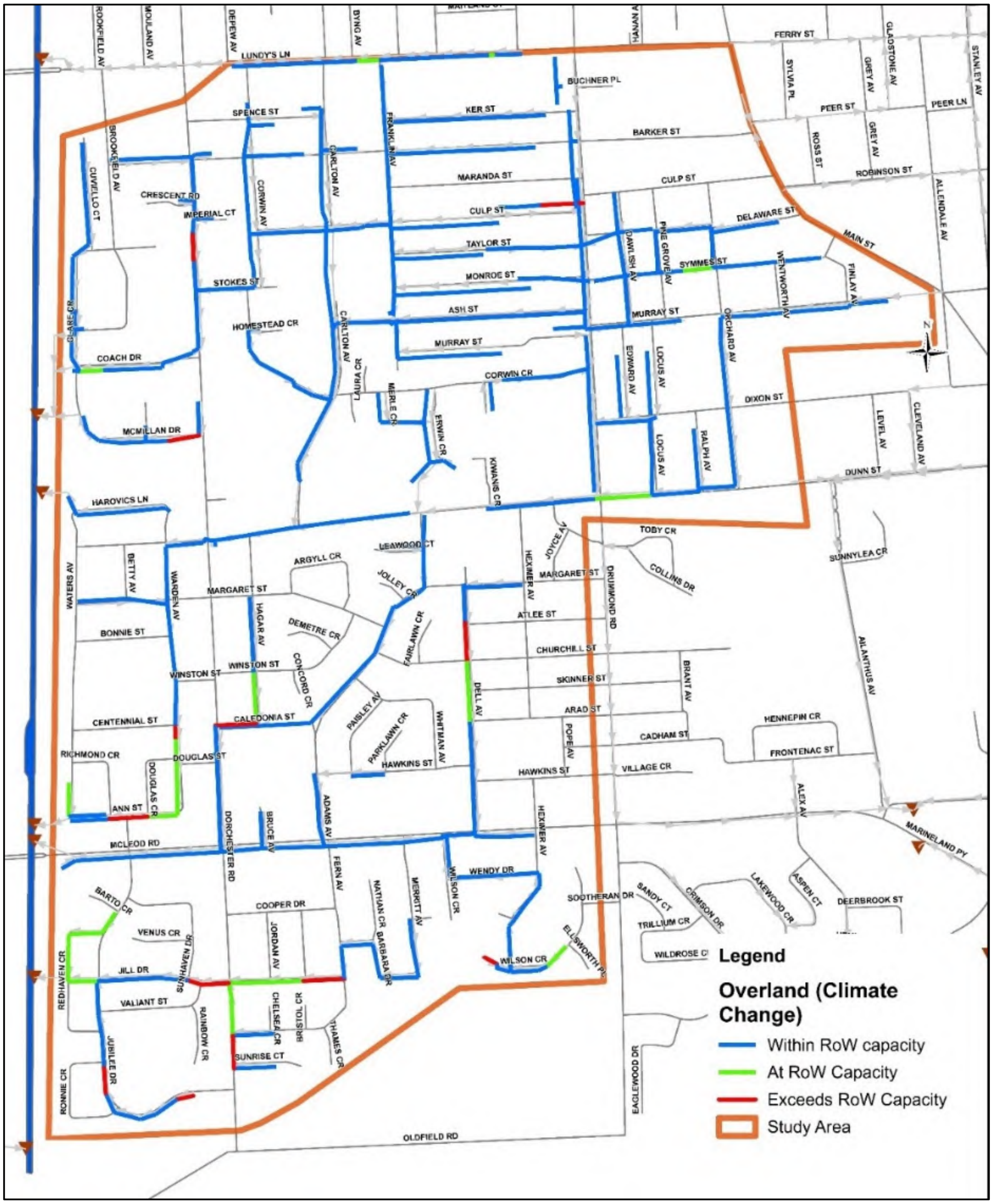


Figure 10-4: Major System (Preferred Alternative) under Climate Change

11.0 Conclusions and Recommendations

This study was completed following the Class Environmental Assessment process and will therefore address Phases 1 and 2 of the EA process for any Schedule 'B' projects. Subsequent phases will also include completion of preliminary and detail design drawings followed by construction and monitoring, as required, for the preferred alternative solution.

The primary problem as identified in this study, relates to flooding of properties and buildings during wet weather events. This study addresses flooding that occurs as a result of water entering the house through uncovered window wells, doors, etc. (overland flooding) or water entering the basement through the floor drain or foundation.

A program involving closed circuit television video (CCTV), smoke field inspection, flow monitoring and hydraulic modelling was undertaken to better define the causes and extent of flooding. The analysis also showed that flooding would occur relatively frequently (flooding in low lying areas would occur for the 5-year storm or greater). The primary issues related to flooding include:

1. Undersized local storm sewers and lack of proper overland flow routes
2. Undersized storm trunk sewer network to convey flows from areas susceptible to flooding to a receiving body of water

A variety of alternatives which included the following were considered:

- Alternative 1 - Do Nothing
- Alternative 2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands
- Alternative 3 - Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street
- Alternative 4 - Construction of Storage Tanks along Carlton Avenue and Dunn Street

The Preferred Alternative, which was selected based on the evaluation approach as outlined in Chapter 7, meets the objective of mitigating flooding issues associated with the storm and combined sewer system. The components of the Preferred alternative include construction of a new storm trunk sewer within OPG and Hydro One Lands and building of new storm sewers & upgrading of existing sewers in the flood prone areas within the study boundary.

Recommendations for the implementation of the Preferred Alternative are summarized below:

1) Implementation of the Preferred Alternative that includes:
    a. Sewer separation with the construction of new storm sewers where none currently exist; and
    b. A new trunk storm sewer withing the OPG and Hydro One corridor
2) A Stage 2 Archeological Survey be conducted prior to construction in the area of Culp Street crossing the Hydro One corridor;
3) With respect to the hydro corridor, consultation with Hydro One and OPG will be required to determine the scope of work required for the design and construction of the recommended storm trunk sewer and outfall;

4) Stage construction such that construction proceeds upstream from the proposed outfall, prioritizes high flood risk areas first and be coordinated with on-going road reconstruction projects; and
5) Obtain the required agency approvals from:
    a. Ministry of Environment Conservation and Parks (MECP) for the construction of the recommended storm sewer and outfall works;
    b. Niagara Peninsula Conservation Authority (NPCA) for ecological impacts (if any) during construction
    c. City Divisions including:
        i. Municipal Works – Infrastructure and Asset Management;
        ii. Environmental Services
        iii. Transportation Engineering, and
        iv. Parks, Recreation and Culture

Appendices

A - Public and Agency Consultation
B - Technical Memoranda 1 to 4
C - Stage 1 Archeological Survey
D - InfoSWMM Model

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-1

Notice of Public Information Centre No. 1

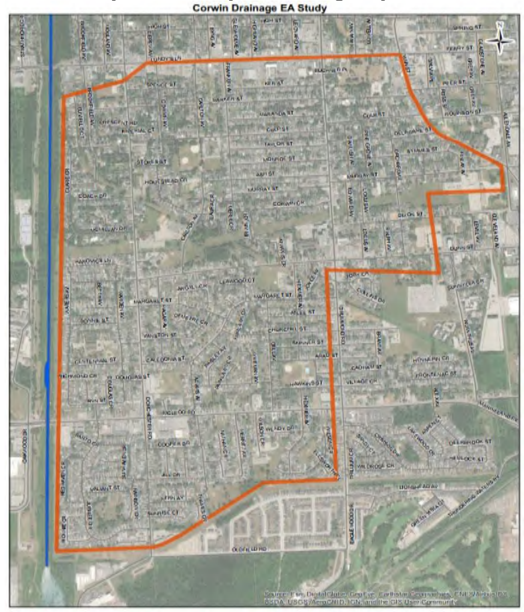
June 2020

Notice of Study Commencement and Public Information Centre No.1 City of Niagara Falls Corwin Drainage Environmental Assessment (EA) Study

Project Background

The City of Niagara Falls has initiated a Municipal Class Environmental Assessment (EA) to address issues related to basement & surface flooding and Combined Sewer Overflow (CSOs). The objective of this study is to provide a strategic plan, drainage policies and a capital strategy in order to define ongoing capital, operation and maintenance, and the long term growth and sustainability of the City's drainage system infrastructure.

Corwin Drainage EA Study



The Process

This study is being undertaken as a Schedule B project under the Municipal Class Environmental Assessment (EA) process. The study is being planned under the requirements set out in the Municipal Class Environmental Assessment (MCEA) document dated October 2000, amended in 2011 and 2015.

The MCEA process provides members of the public and interest groups an opportunity to provide input at the key stages of the study.

Public input and comments are invited for incorporation into the various phases of this project. Comments received from the public will be considered in the development of the alternatives.

A Public Information Centre has been planned to: define existing issues and opportunities; present existing conditions for stormwater infrastructure and environmental conditions; present a list of alternatives that address existing issues & outline subsequent steps in the process. The time and location of the Public Information Centre is as follows:

Date:	09/12/2019
Time:	2:00 pm to 8:00 pm
Location:	Memorial Room Gale Centre Niagara Falls, ON

For further information, please contact one of the individuals identified below:

Joe Colasurdo, C.E.T.
Project Manager
Municipal Works
City of Niagara Falls,
4310 Queen Street
Niagara Falls, ON L2E 6X5
Phone: 905-356-7521 Ext. 4359
Fax: 289-296-0048

Dave Maunder, M.Sc., P.Eng.
Consultant Project Manger
Aquafor Beech Limited
#6-202-2600 Skymark Avenue
Mississauga, ON L4B 5B2
Tel: 905-629-0099 x290
E-mail: maunder.d@aquaforbeech.com

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-2

Sign-in Sheet

June 2020

CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Public Meeting

December 9th, 2019
4:00 p.m. – 8:00 p.m.

SIGN-IN SHEET

Please Print Clearly

Name	Address	Phone #	E-mail

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-3

Comment Sheets

June 2020

CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: ________________________________ **Email:** ______________________________________

Address: ____

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

____
____
____
____

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

____
____
____
____

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

____
____
____
____

4. **Do you have any comments regarding the study?**

____
____
____
____

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

Joe Colasurdo, Project Manager, City of Niagara Falls
4310 Queen Street, Niagara Falls, Ontario L2E 6X5
Tel: 905-356-7521 ext. 4359

By Email: jcolasurdo@niagarafalls.ca

All comments and information received from individuals, stakeholder groups and agencies regarding this study are being collected to assist the City of Brantford in completing the North-East End Flood Remediation Study. Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act and with the exception of personal information, all information provided will become part of the public record.

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-4

Public Consultation Displays

June 2020

Welcome to the

City of Niagara Falls

Corwin Drainage Environmental Assessment (EA) Study

Public Information Centre #1

View displays and discuss the study with project staff

Feel free to ask questions and fill out a comment sheet

Purpose of this Study

Study Purpose

The City of Niagara Falls has initiated a study which will follow Schedule B of the Municipal Class Environmental Process. The study will address issues relating to:

- Flooding Issues,
- Combined Sewer Overflows (CSOs)

The objective is to provide a strategic plan, drainage policies and a capital strategy in order to define ongoing capital, operation and maintenance, and the long term growth and sustainability of the City's drainage system infrastructure.

The study is being planned under the requirements set out in the Municipal Class Environmental Assessment (MCEA) document dated October 2000, amended in 2011 and 2015. The MCEA process provides members of the public and interest groups an opportunity to provide input at the key stages of the study.

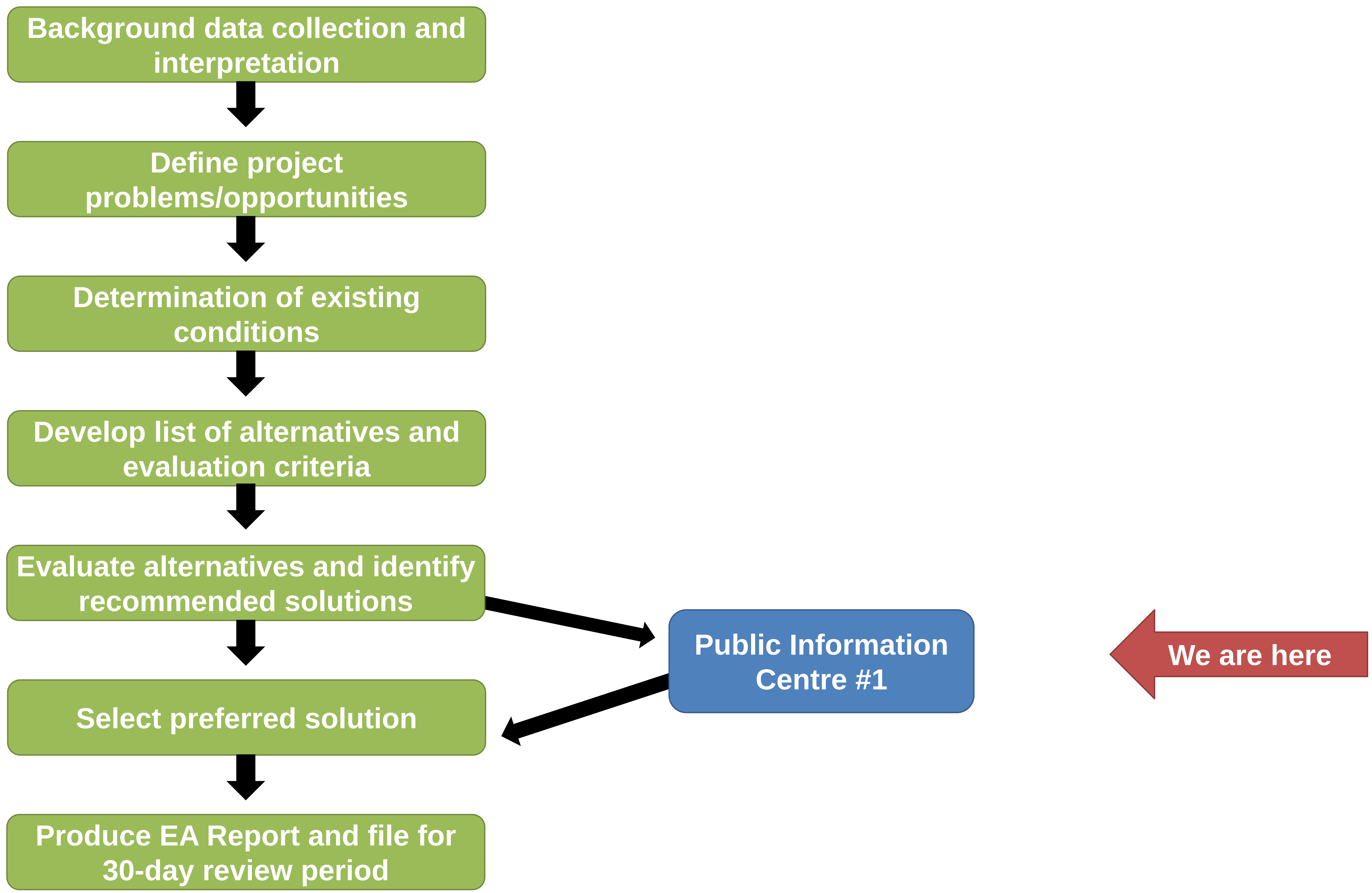
Niagara Falls CANADA Aquafor Beech Limited

Objective of Tonight's Meeting

- Provide background on the study,
- Summarize existing conditions within the study area,
- Present a series of alternatives that address existing issues,
- Present a preliminary Preferred Alternative,
- Outline the next steps in the study process, and
- Receive your feedback and answer your questions.

Municipal Class Environmental Assessment Process

This study is being undertaken as a Schedule B project under the Municipal Class Environmental Assessment (EA) process. The flow chart illustrates the key steps to be undertaken as part of the EA process.



Study Area

Corwin Drainage EA Study

The study area is bounded approximately by Lundy's Lane to the north, Stanley Avenue to the east, McLeod Road to the south and the Hydro Canal to the west. The approximate study area is 452 ha.

The study is primarily residential with some commercial/industrial properties located along the major roads.

Niagara Falls CANADA

Aquafor Beech Limited

Problem Statement

Flooding of properties and buildings occurs within the study area during some wet weather events. The purpose of this study is to identify the causes of flooding and propose remedial works to mitigate future flooding.

The study will also address the issue related to combined sewer overflows and extraneous infiltration/inflow to the Region of Niagara's sewer system.

The accompanying figure illustrates the general location of buildings and properties which have reported flooding.

There are several potential causes of the flooding that has occurred.

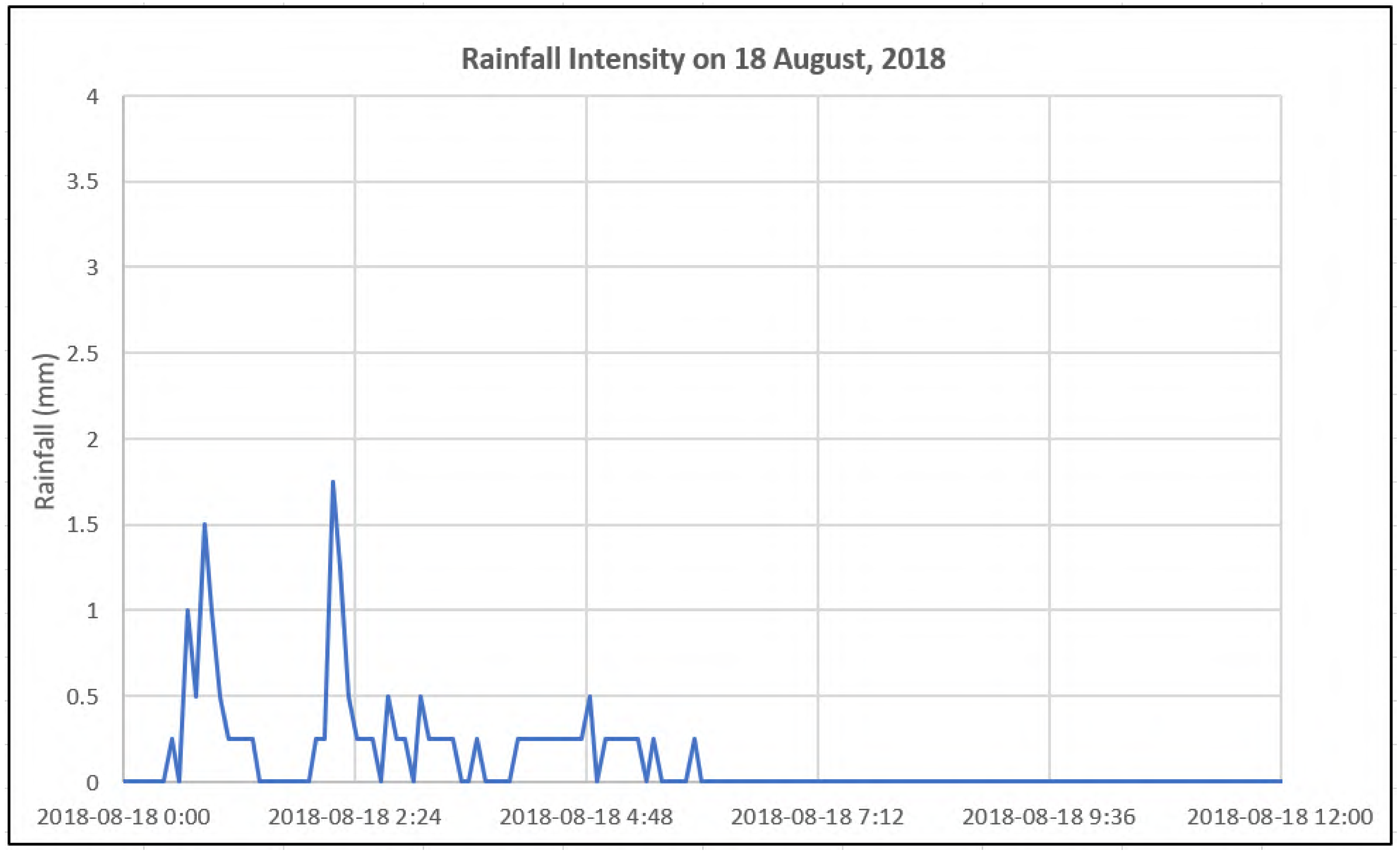
This study addresses flooding that occurs as a result of water entering the house through uncovered window wells, doors, etc.(overland flooding) or water entering the basement through floor or foundation drains (basement flooding).

Niagara Falls CANADA

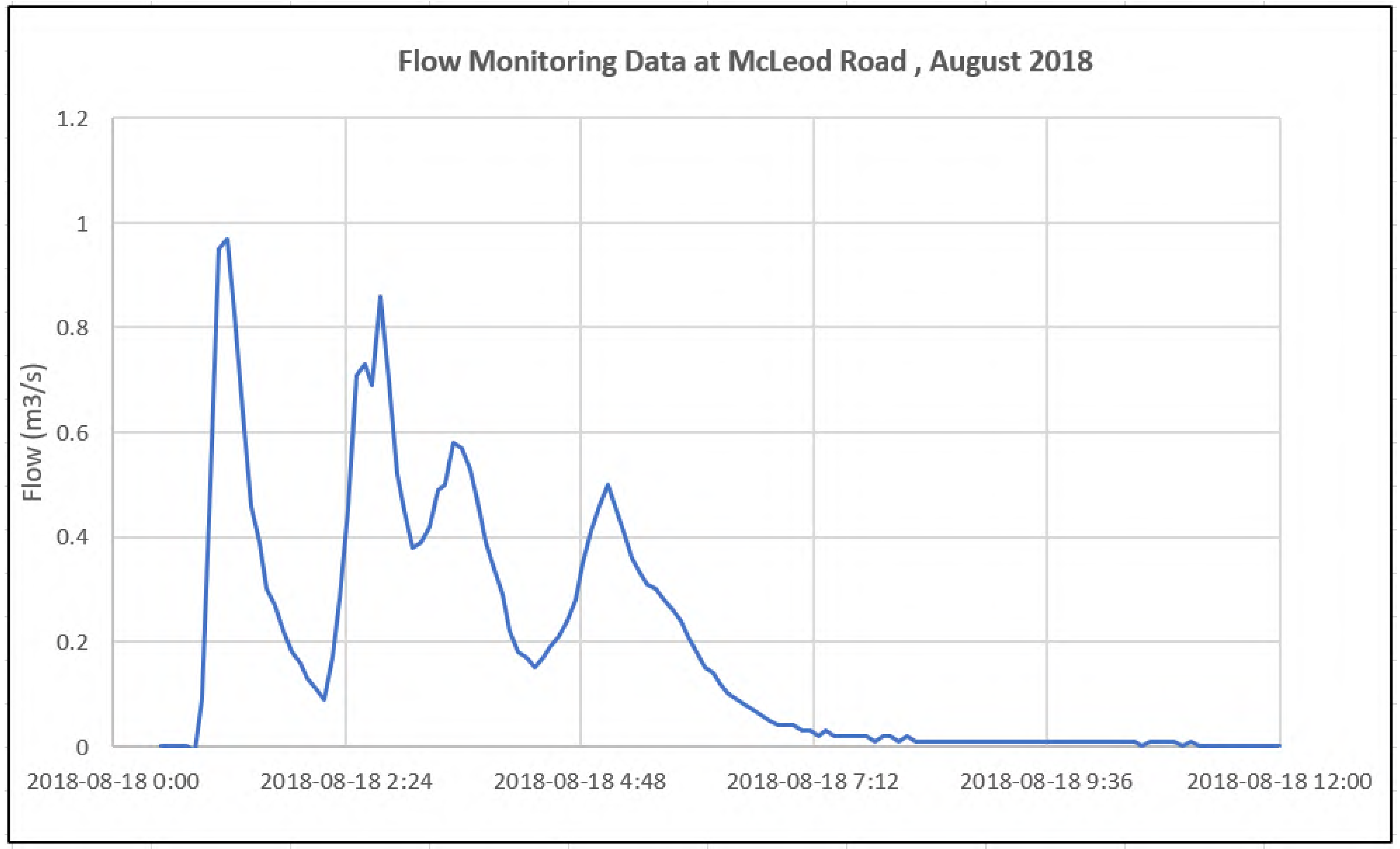
Aquafor Beech Limited

Overview of Key Tasks Completed

- ❑ Review of available background information including :
  - As-built drawings and plumbing records,
  - Closed Conduit Television (CCTV) records,
  - Flooding records, and
  - Rainfall and flow monitoring



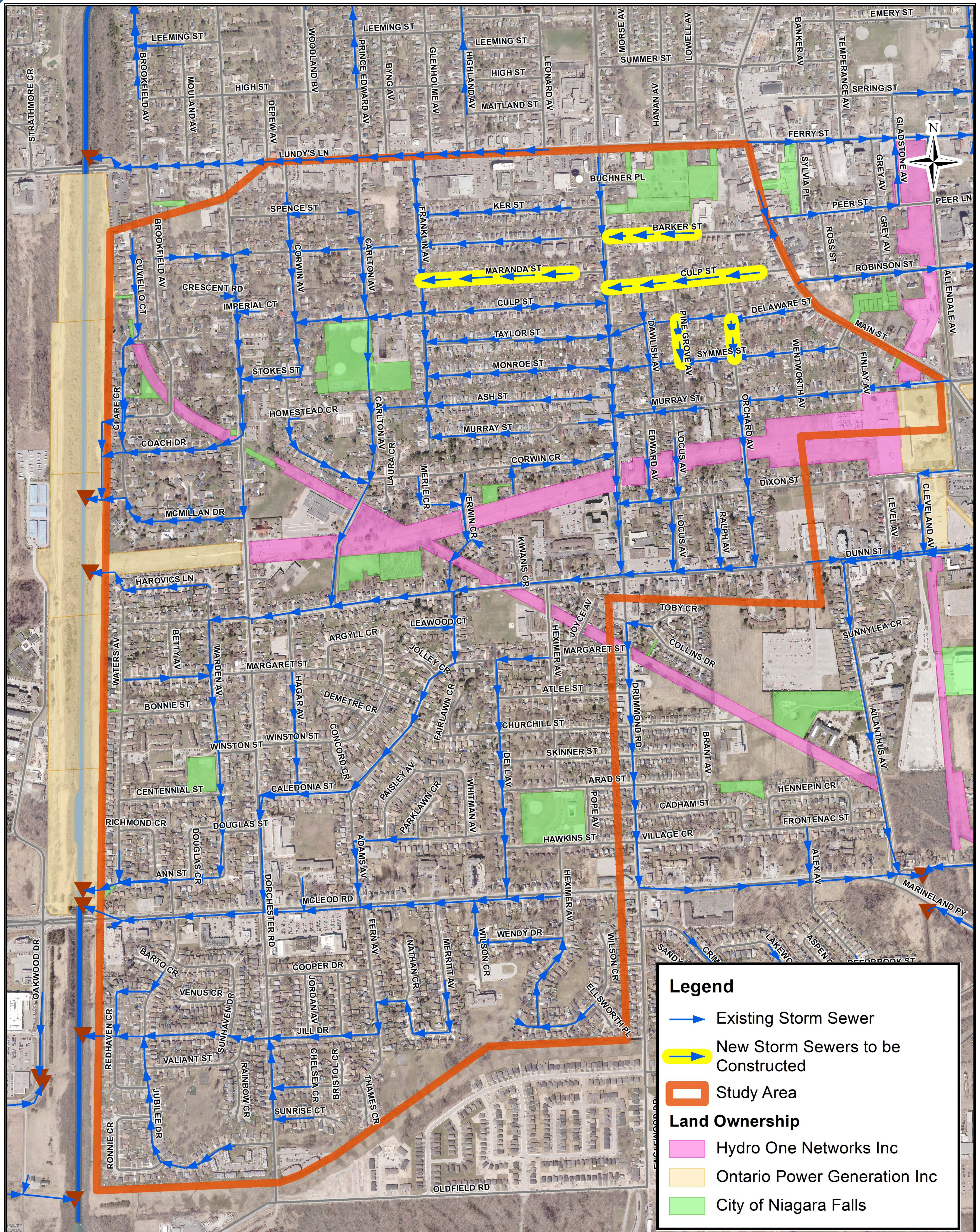
- ❑ Additional field investigation
  - McLeod Road CSO/SSO outfall investigation
  - Archeological assessment



- ❑ Development of a computer model with storm, sanitary and combined sewers

Niagara Falls CANADA Aquafor Beech Limited

Alternative Solutions



The primary issues related to flooding include:

1. Undersized local storm sewers and lack of proper overland flow routes
2. Undersized storm trunk sewer network to convey flows from areas susceptible to flooding to a receiving body of water

The accompanying figure shows streets where new storm sewers will be constructed in order to resolve the issue relating to undersized local storm sewers (item 1 above).

Alternative Solutions

The alternatives to alleviate issues related to the undersized storm trunk sewer network were assessed.

The criteria as provided below were then used to evaluate each alternative. This approach will assist in determining which alternative should be selected as the Preferred Alternative.

Evaluation Criteria

Natural Environment

- Potential impact on terrestrial systems (vegetation, trees, wildlife)
- Potential impact on aquatic system, aquatic life and aquatic vegetation

Economic

- Capital Costs
- Operating/maintenance costs

Socio-Cultural

- Impact on urban greenspace/recreational use (trees, parks, open spaces)
- Disruption to community during construction

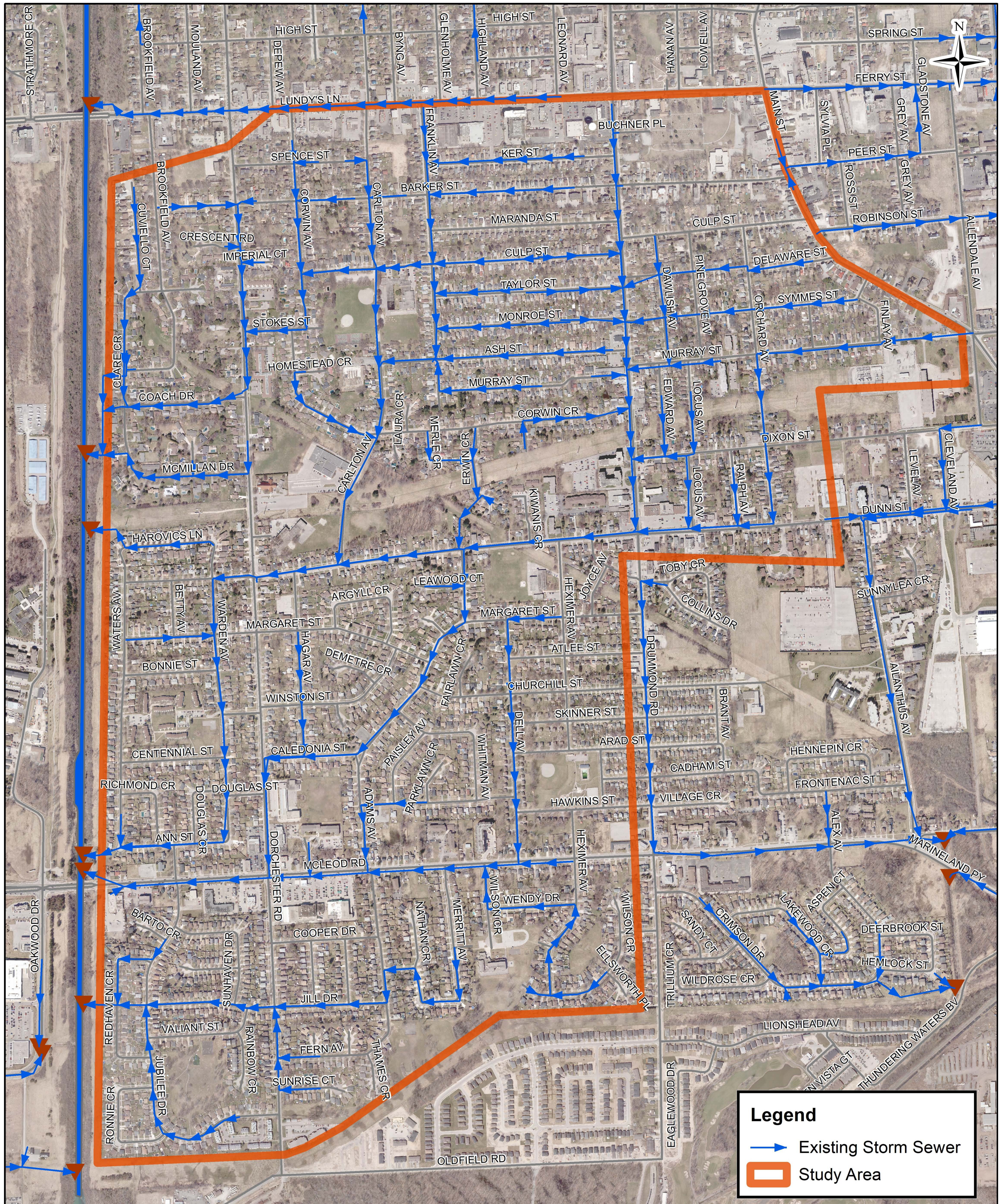
Technical

- Effectiveness of alternate solution
- Permits and approvals

Niagara Falls CANADA Aquafor Beech Limited

Alternative Solution #1

Alternative #1 – Do Nothing



This alternative would not reduce frequency or extent of existing flooding issues. Therefore it will cause significant disruption to home owners who experience flooding.

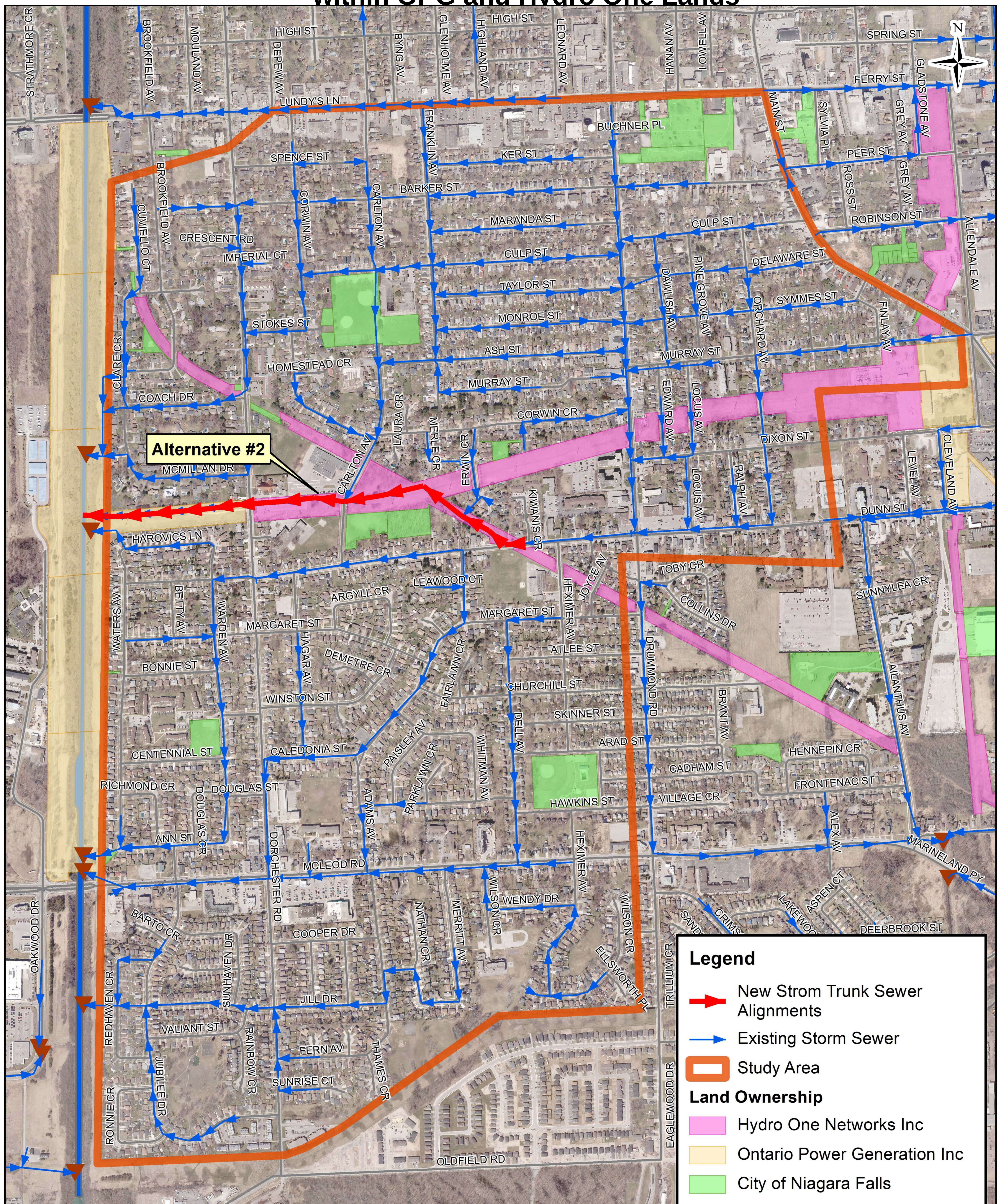
In addition combined sewer overflows which occur within the Region of Niagara sewer system would occur at the current rate.

Niagara Falls CANADA

Aquafor Beech Limited

Alternative Solution #2

Alternative #2 - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands

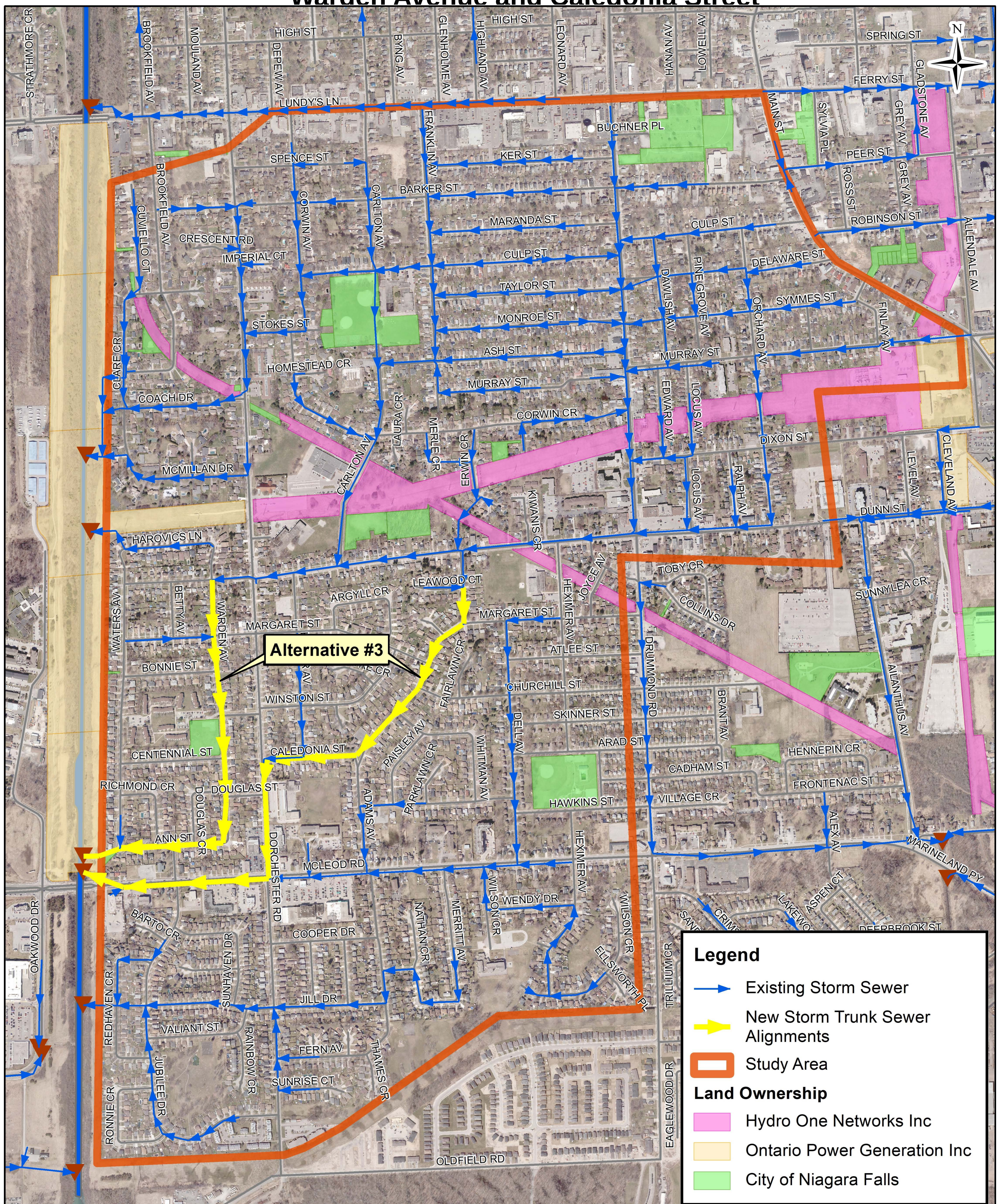


This alternate would involve construction of a new storm trunk sewer within the Ontario Power Generation (OPG) and Hydro One lands. The trunk sewer would outlet to the Hydro Canal. The approximate length of the storm trunk sewer is 1200 m. Implementation of this alternative would require further discussion and approvals from (OPG) and Hydro One.

Niagara Falls CANADA
Aquafor Beech Limited

Alternative Solution #3

Alternative #3 - Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street



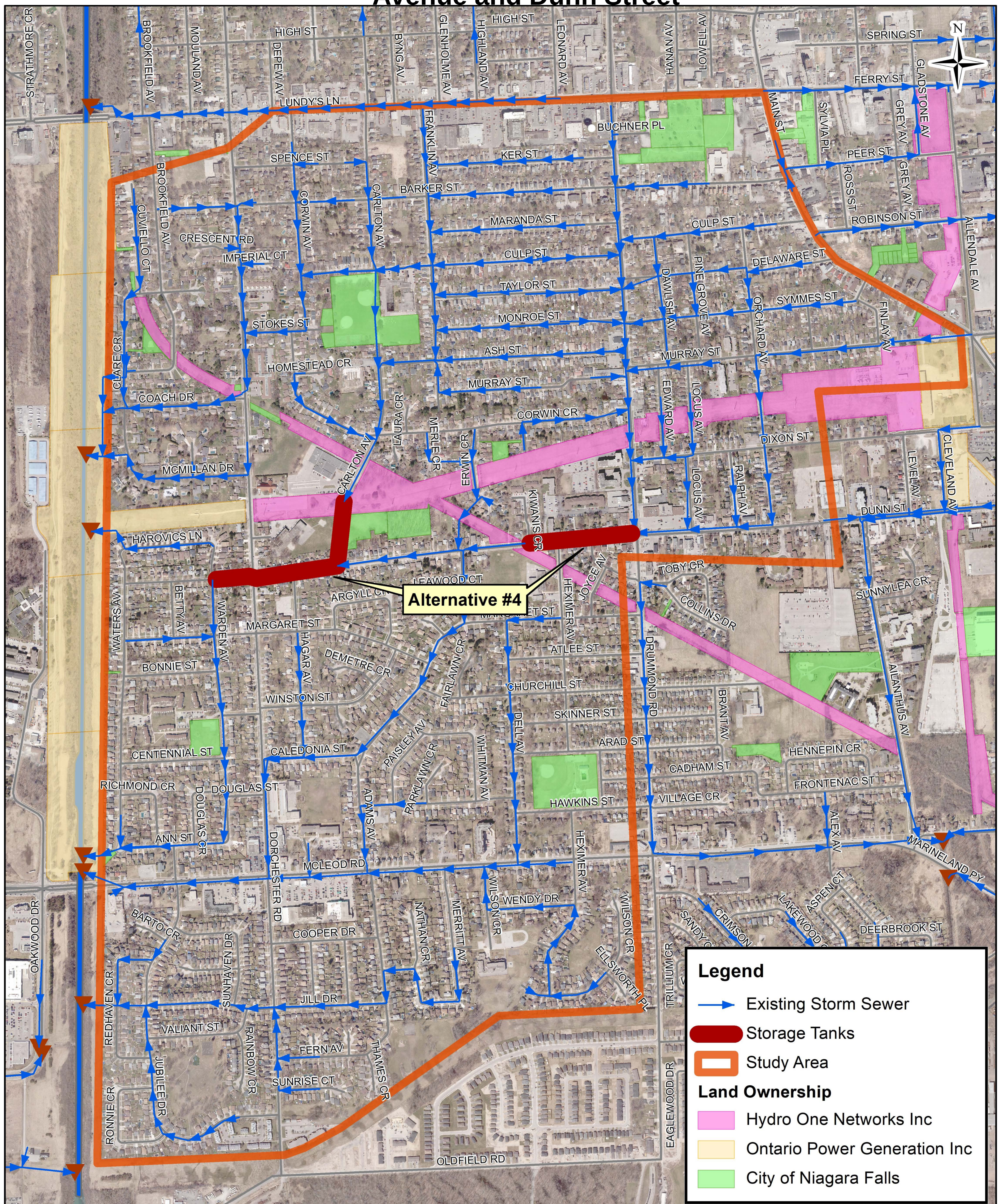
This alternative would involve construction of larger storm trunk sewer system along Warden Avenue & Ann Street and Caledonia Street, Dorchester Road & McLeod Road. The trunk sewers would outlet to the Hydro Canal.The approximate length of the storm trunk sewer is 2870 m.

Niagara Falls CANADA

Aquafor Beech Limited

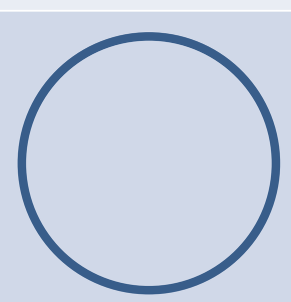
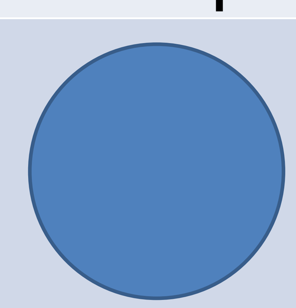
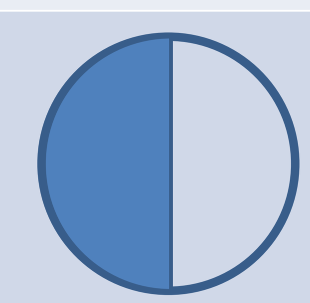
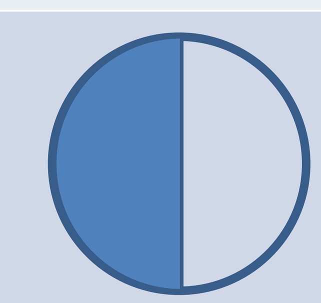
Alternative Solution #4

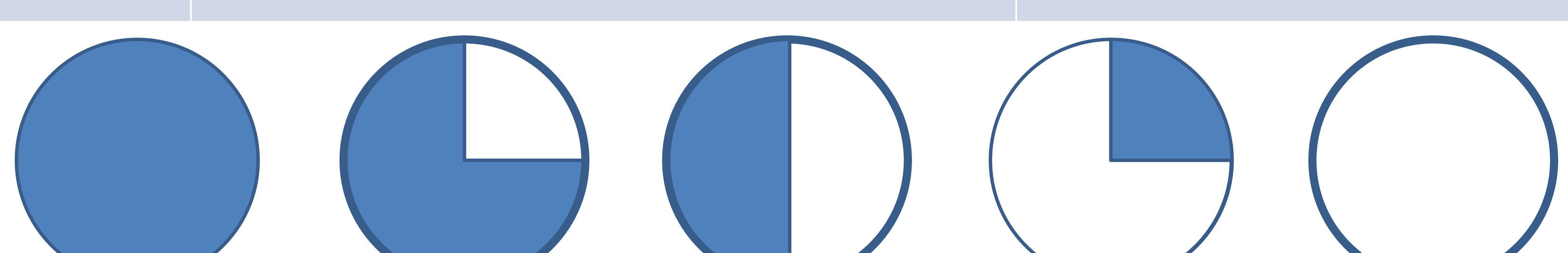
Alternative #4 - Construction of Storage Tanks along Carlton Avenue and Dunn Street



The alternative would involve construction of storage tanks within the existing storm sewer network. Storage tanks, located along Carlton Avenue and Dunn Street, would control storm flows to the capacity of the existing storm sewers located along Warden Avenue and Caledonia Street. Total length of the storage tanks would be 800m approximately.

Evaluation of Alternatives

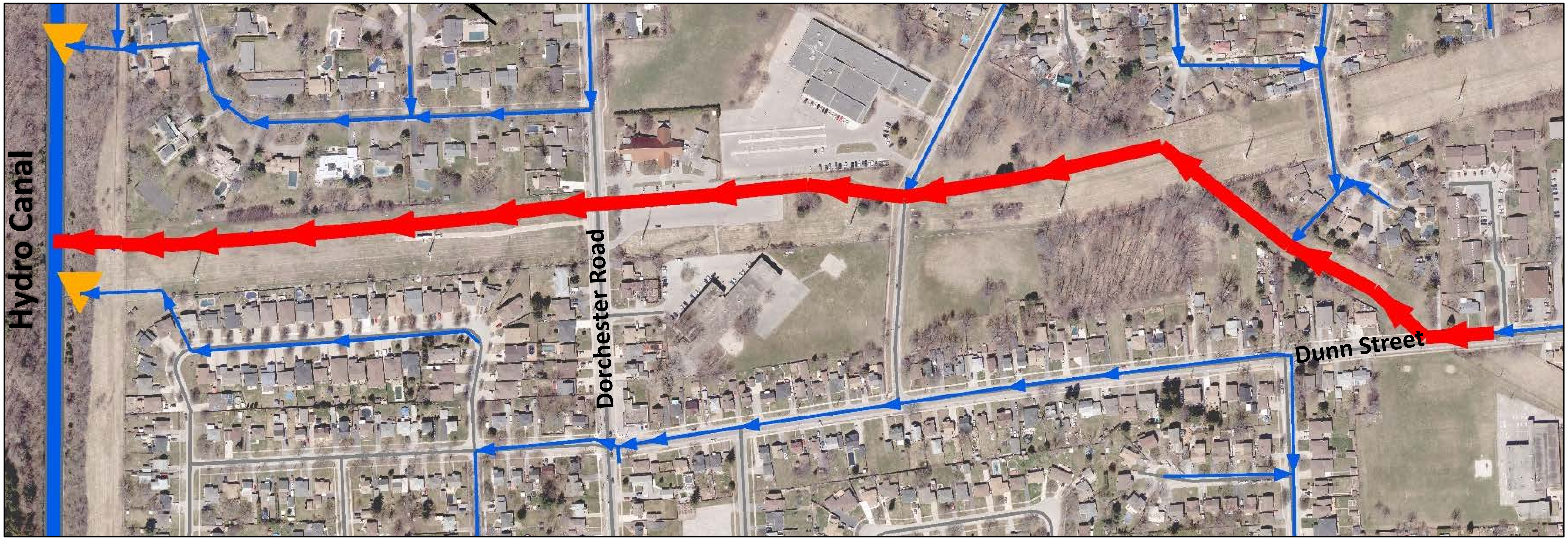
Evaluation Criteria	Alternative #1 Do Nothing	Alternative #2 Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands	Alternative #3 Construction of a New Storm Trunk Sewer along Warden Avenue and Caledonia Street	Alternative #4 Construction of Storage Tanks along Carlton Avenue and Dunn Street
Natural Environment	• No Impact on terrestrial or aquatic resources	• Minor impact on terrestrial or aquatic resources associated with construction	• Minor impact on terrestrial or aquatic resources associated with construction	• Minor impact on terrestrial or aquatic resources associated with construction
Economic	• Lowest overall cost excluding costs associated with ongoing surface and basement flooding and combined sewer overflows	• Lowest overall cost of the three alternatives which resolve flooding issues	• Second lowest overall cost of the three alternatives which resolve flooding issues	• Highest overall cost of the three alternatives which resolve flooding issues
Socio-Cultural	• Significant disruption to home owners who experience flooding	• Minor impact on urban green space/ recreational use • Least disruption to community during construction	• Minor impact on urban green space/ recreational use • Significant disruption to community during construction	• Minor impact on urban green space/ recreational use • Significant disruption to community during construction
Technical	• This alternative would not reduce frequency or extent of existing flooding issues	• This alternative is technical feasible • Permits from Hydro One and Ontario Power Generation will be required	• Alternative may have minor technical limitations associated with crossing existing infrastructure	• Alternative may have technical limitations due to size of storage tanks
Overall Alternative Rank				

Most Preferred  **Least Preferred**

Preliminary Preferred Alternative

The evaluation of the alternatives illustrates that Alternative #2 "Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands" is the Preliminary Preferred Solution.

This alternative will have a minor impact on the natural environment during construction. The impacts associated with construction will be more than offset by the reduction in flooding of properties and buildings as well as reduction in Combined Sewer Overflows to the Hydro Canal. Alternative #2 is the most cost effective of the three technical alternatives that were considered and should have the least technical issues to address. Further approvals from Hydro One and Ontario Power Generation will be required.



Next Steps

After this Public Information Centre the study team will consider verbal and written comments in order to refine the project problems and opportunities as well as the recommended solutions.

For more information on this project, or to submit your comments or feedback, and, to be placed on our mailing list, please contact:

Joe Colasurdo, Project Manager
Municipal Works
City of Niagara Falls
4310 Queen Street
Niagara Falls, ON L2E 6X5
Phone: (905) 356-7521 Ext. 4359
Fax: (289) 296-0048
jcolasurdo@niagarafalls.ca

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-5

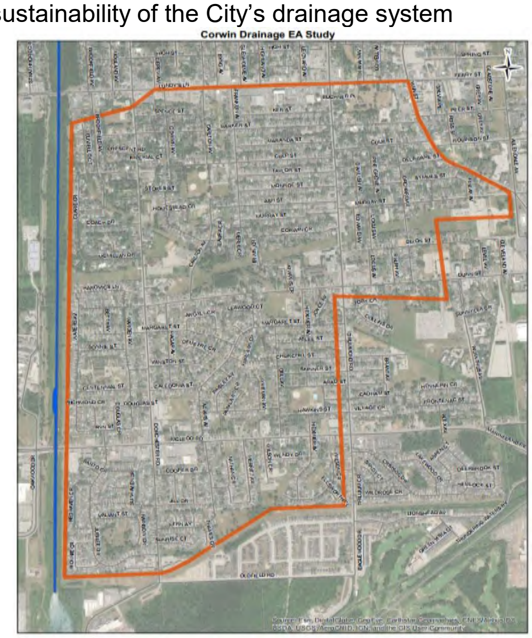
Agency Consultation

June 2020

Notice of Study Commencement and Public Information Centre No.1 City of Niagara Falls Corwin Drainage Environmental Assessment (EA) Study

Project Background

The City of Niagara Falls has initiated a Municipal Class Environmental Assessment (EA) to address issues related to basement & surface flooding and Combined Sewer Overflow (CSOs). The objective of this study is to provide a strategic plan, drainage policies and a capital strategy in order to define ongoing capital, operation and maintenance, and the long term growth and sustainability of the City's drainage system infrastructure.



The Process

This study is being undertaken as a Schedule B project under the Municipal Class Environmental Assessment (EA) process. The study is being planned under the requirements set out in the Municipal Class Environmental Assessment (MCEA) document dated October 2000, amended in 2011 and 2015.

The MCEA process provides members of the public and interest groups an opportunity to provide input at the key stages of the study.

Public input and comments are invited for incorporation into the various phases of this project. Comments received from the public will be considered in the development of the alternatives.

A Public Information Centre has been planned to: define existing issues and opportunities; present existing conditions for stormwater infrastructure and environmental conditions; present a list of alternatives that address existing issues & outline subsequent steps in the process. The time and location of the Public Information Centre is as follows:

Date: 09/12/2019
Time: 2:00 pm to 8:00 pm
Location: Memorial Room
Gale Centre
Niagara Falls, ON

For further information, please contact one of the individuals identified below:

Joe Colasurdo, C.E.T.
Project Manager
Municipal Works
City of Niagara Falls,
4310 Queen Street
Niagara Falls, ON L2E 6X5
Phone: 905-356-7521 Ext. 4359
Fax: 289-296-0048

Dave Maunder, M.Sc., P.Eng.
Consultant Project Manger
Aquafor Beech Limited
#6-202-2600 Skymark Avenue
Mississauga, ON L4B 5B2
Tel: 905-629-0099 x290
E-mail: maunder.d@aquaforbeech.com

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-6

Project Stakeholders Contact List

June 2020

Project Stakeholders and Notifications Contacts

City

Kent Schachowskoj, Infrastructure and Asset Management, kschachowskoj@niagarafalls.ca

James Sticca City Environmental Services, jsticca@niagarafalls.ca

Marianne Tikky, Municipal Roadways, mtikky@niagarafalls.ca

Mathew Bilodeau, Transportation Engineering, mbilodeau@niagarafalls.ca

Kathy Moldenhauer , Parks, Recreation and Culture, kmoldenhauer@niagarafalls.ca

Niagara Region

Lisa Vespi, Senior Project Manager, lisa.vespi@niagararegion.ca

OPG

Ralph Curitti, Plant System Support Manager, Ralph.Curitti@opg.com

Hydro One

Jim Oriotis, Senior Real Estate Coordinator, jim.oriotis@hydroone.com

MOECC

Barb Slattery, EA/Planning Coordinator, barbara.slattery@ontario.ca

Sylvain Campbell, Water Inspector, sylvain.campbell@ontario.ca

MTO

Teepu Khawja, Regional Director, Central Region, teepu.khawja@ontario.ca

MNRFA

Ian Hagman, District Manager, Guelph District, ian.hagman@ontario.ca

NPCA

Gregg Furtney, Watershed Management Director, gfurtney@npca.ca

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-7

Agency Communications

June, 2020

islam.n@aquaforbeech.com

Subject:	Corwin Drainage EA Project - City of Niagara Falls & OPG Mtg
Location:	OPG Building - Stanley Service Centre Conference Room, 2600 Stanley Avenue, Niagara Falls
Start:	Tue 2019-09-10 1:30 PM
End:	Tue 2019-09-10 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	KINNEAR Jo-Ann -OPERATIONS

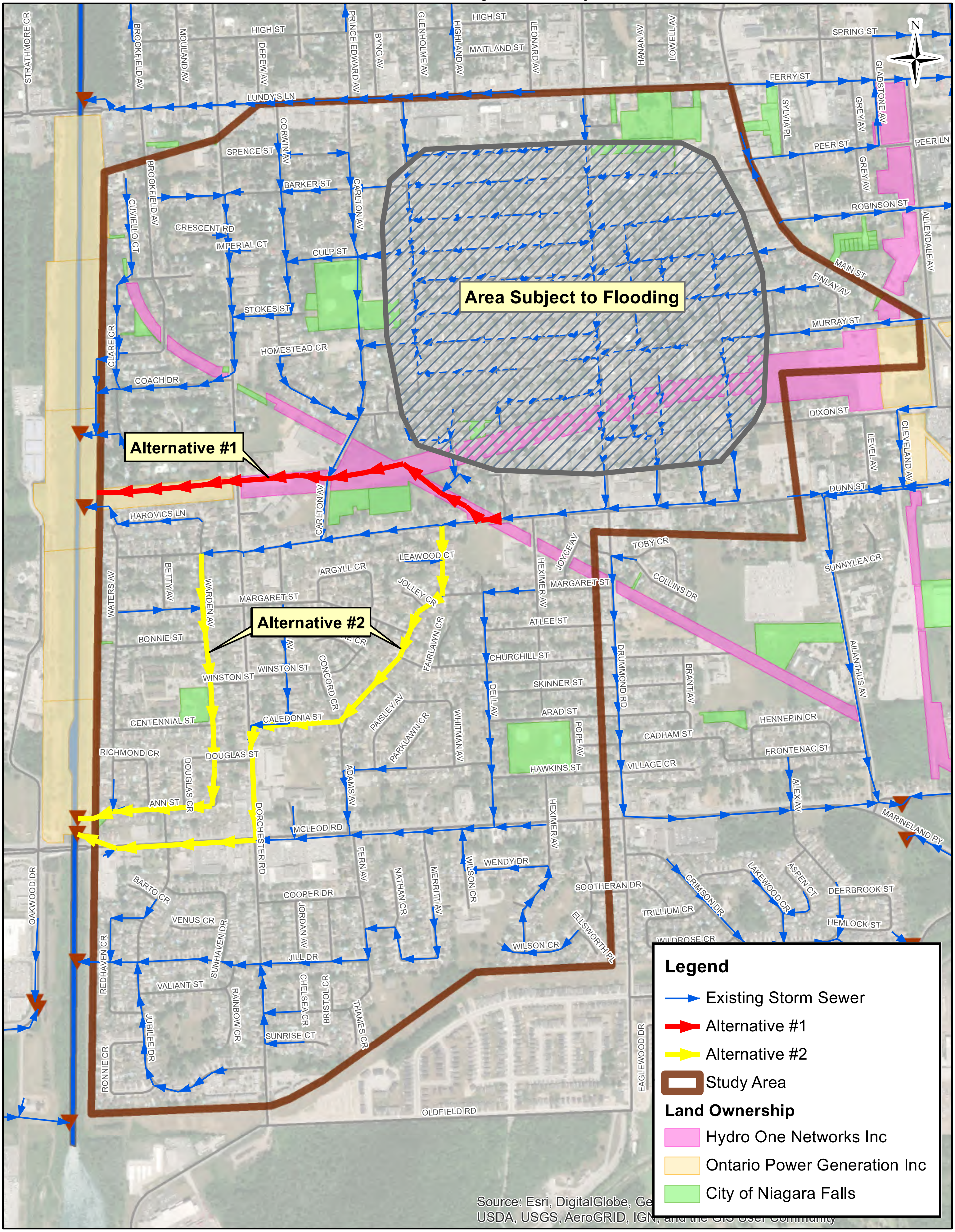
Your meeting was found to be out of date and has been automatically updated.

Updated meeting details:

Start Time

Sent by Microsoft Exchange Server

Corwin Drainage EA Study



September 3, 2019

Re: Potential Trunk Sewer Alignment – Corwin Area – City of Niagara Falls

Attention:
Jim Oriotis
Senior Real Estate Coordinator
Southwest Ontario & Niagara Region
Hydro One Networks Inc.

Aquafor is currently undertaking the Corwin Drainage Environmental Assessment Study for the City of Niagara Falls. The objective of the study is to reduce basement and surface flooding within the Corwin Drainage Area. In order to achieve this objective, several storm trunk sewer relief alternatives are being considered. One of the alternatives involves lands owned by Hydro One or OPG.

The attached figure shows the proposed alignment. The proposal includes the construction of a storm trunk sewer (approximately 1.8 m to 2.4 m in diameter – approximate depth 3 to 6 m). The alignment as shown accurately reflects the proposed route. The location of the proposed sewer within the proposed alignment is flexible. Construction and maintenance of the proposed trunk sewer would require an easement of approximately 10 m in width. The anticipated construction period is the summer of 2021. This timing will, however, be dependent upon several factors which will be defined by the City.

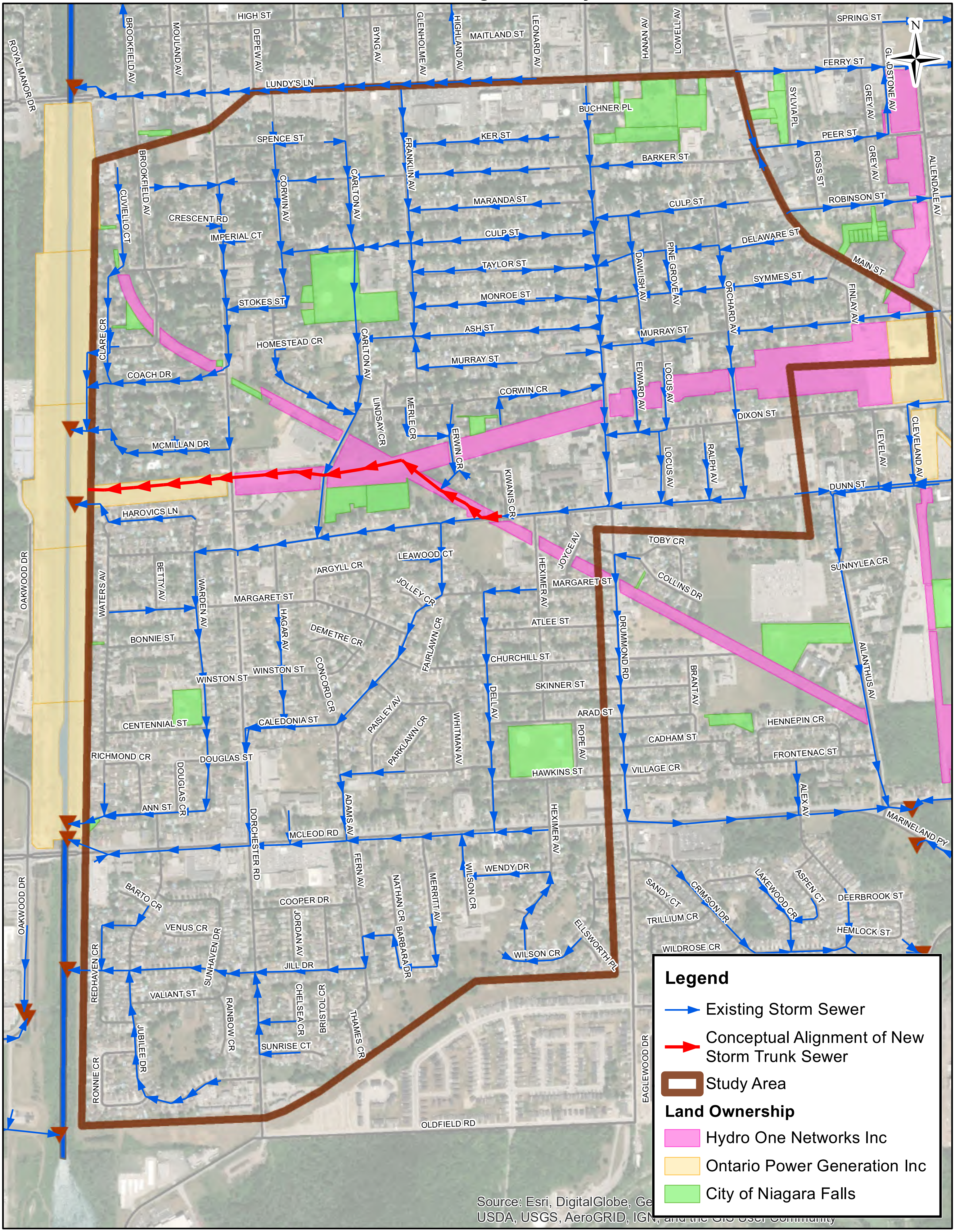
We received your letter dated August 29,2019 and hope that the information provided above provides some clarification. Should you require any further information or wish to arrange a meeting please contact the undersigned. Please copy Livia McEachern and Joe Colasurdo from the City of Niagara Falls on any correspondence.

Yours truly

David Maunder
President
Aquafor Beech Limited

CC:
Ms. L. McEachern
Mr. J. Colasurdo

Corwin Drainage EA Study



Hydro One Networks Inc
483 Bay St
Toronto, ON

August 29, 2019

Re: CORWIN DRAINAGE AREA

Attention:
Dave Maunder, M.Sc., P.Eng
Project Manager
Aquafor Beech Ltd.

In our preliminary assessment, we have confirmed that Hydro One has existing high voltage Transmission facilities within your study area. At this point in time we do not have enough information about your project to provide you with meaningful input with respect to the impacts that your project may have on our infrastructure. As such, this response does not constitute any sort of approval for your plans and is being sent to you as a courtesy to inform you that we must be consulted on your project.

In addition to the existing infrastructure mentioned above, the affected transmission corridor may have provisions for future lines or already contain secondary land uses (i.e. pipelines, watermains, parking, etc). Please take this into consideration in your planning.

Also, we would like to bring to your attention that should (CORWIN DRAINAGE AREA) result in a Hydro One station expansion or transmission line replacement and/or relocation, an environmental assessment (EA) will be required as described under the Class Environmental Assessment for Minor Transmission Facilities (Hydro One, 2016). This EA process would require a minimum of 6 months to be completed and associated costs will be allocated and recovered in accordance with the Transmission System Code. Furthermore, to complete an EA it can take from 6 months (to complete a Class EA Screening Process) to 18 months (to complete a Full Class EA Process) based on the level of assessment required for the EA. In order to achieve speedy completion of the EA, Hydro One will need to rely on studies and/or reports completed as part of the EA for your project.

Please allow the appropriate lead-time in your project schedule in the event that your proposed development impacts Hydro One infrastructure to the extent that it would require modifications to our infrastructure.

In planning, please note that developments should not reduce line clearances or limit access to our facilities at any time in the study area of your Proposal. Any construction activities must maintain the electrical clearance from the transmission line conductors as specified in the Ontario Health and Safety Act for the respective line voltage.

Please note that the proponent will be held responsible for all costs associated with modification or relocation of Hydro One facilities, as well as any added costs that may be incurred due to increase efforts to maintain our facilities.

Be advised that any changes to lot grading and/or drainage within or in proximity to Hydro One transmission corridor lands must be controlled and directed away from the transmission corridor.

We reiterate that this message does not constitute any form of approval for your project. Hydro One must be consulted during all stages of your project. Please ensure that all future communications about your project are sent to Jim Oriotis electronically at Jim.Oriotis@hydroone.com.

Sent on behalf of,

Secondary Land Use
Asset Optimization
Strategy & Integrated Planning
Hydro One Networks Inc.

islam.n@aquaforbeech.com

From: islam.n@aquaforbeech.com
Sent: August 29, 2019 1:05 PM
To: 'Livia McEachern'; jcolasurdo@niagarafalls.ca
Cc: 'Dave Maunder'
Subject: RE: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hi Livia,
Thanks for the email. I will be preparing the required map with all the relevant information.
I do have PDF maps showing city owned property , can you please send me the shapefiles of these lands?

Also, do you have shapefiles of **OPG lands** and **Hydro One lands**? Could please send those as well?

Thanks for your help.
Nadia

From: Dave Maunder <maunder.d@aquaforbeech.com>
Sent: August 29, 2019 12:21 PM
To: 'Nadia Islam' <islam.n@aquaforbeech.com>
Subject: FW: Meeting Request - Corwin Drainage EA - City of Niagara Falls

---

From: Livia McEachern <lmceachern@niagarafalls.ca>
Sent: Thursday, August 29, 2019 12:02 PM
To: Joe Colasurdo <jcolasurdo@niagarafalls.ca>; Dave Maunder (maunder.d@aquaforbeech.com) <maunder.d@aquaforbeech.com>; Nadia Volpe (nvolpe@jdbarnes.com) <nvolpe@jdbarnes.com>
Subject: FW: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hello,

I just spoke with Jim Oriotis from Hydro One (please see the email chain below). He is looking for an electronic package from us (pdfs only) via email directly to him. The package should include as much detail as we currently have on the alternatives, specifically the alternatives involving Hydro One lands. He would also like the alternatives to clearly note OPG land, City land, and Hydro One lands on all mapping. Dave, Nadia, can you ensure that a package is prepared and submitted to Jim? Please copy myself and Joe.

Jim will then review the information with Staff and comment back. At that time he will indicate if a meeting is necessary, if more information is requested, etc. Unfortunately due to other pressing commitments they could not commit to a meeting at this time and Jim believed this was the quickest option.

Please note that Jim cautioned that there are a number of areas in Niagara Falls where the Hydro One/OPG land agreements, etc., have been recorded incorrectly. They have been working to correct the situation. He will review this particular area to look for similar errors. Due to this additional step, they may require more review time than is typical.

Thank you,
Livia

From: Jim.Oriotis@HydroOne.com [mailto:Jim.Oriotis@HydroOne.com]
Sent: Thursday, August 29, 2019 11:26 AM
To: Livia McEachern
Cc: Joe Colasurdo
Subject: RE: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hello Livia,

Please call to arrange our discussion.

Jim

Jim Oriotis
Senior Real Estate Coordinator
Southwest Ontario & Niagara Region
Hydro **One** Networks Inc.
185 Clegg Road
Markham, ON L6G 1B7
Tel: 905.946.6261
Cell: 647.938.6261
Fax: 905.946.6242
Email: jim.oriotis@hydroone.com

From: Livia McEachern <lmceachern@niagarafalls.ca>
Sent: Thursday, August 29, 2019 10:22 AM
To: WU Liping (Philip) <philip.wu@HydroOne.com>; ORIOTIS Jim <Jim.Oriotis@HydroOne.com>; 'Gian.Minichini@HydroOne.com' <Gian.Minichini@HydroOne.com>
Cc: Joe Colasurdo <jcolasurdo@niagarafalls.ca>
Subject: RE: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hello,

As noted previously, City of Niagara Falls staff is requesting a meeting with you and our Consultant, Aquafor Beech, regarding the Corwin Drainage EA. The study has identified a strong alternative that would utilize Hydro One lands to access the OPG hydro canal as a storm outfall. Please provide a time that is convenient for this meeting.

I have included Joe Colarsurdo on this email. Joe is a new project manager at the City and will be the permanent replacement for Guangli Zhang on this project. Please feel free to contact either Joe or myself to set up the meeting.

Thank you,
Livia

Livia McEachern, P.Eng. | Project Manager | Municipal Works - Engineering | City of Niagara Falls
4310 Queen Street | Niagara Falls, ON L2E 6X5 | (905) 356-7521 ext 4288 | Fax (289) 296-0048 | lmceachern@niagarafalls.ca

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From: Livia McEachern
Sent: Wednesday, August 21, 2019 12:57 PM
To: 'Philip.Wu@HydroOne.com'; 'Jim.Oriotis@HydroOne.com'; 'Gian.Minichini@HydroOne.com'
Subject: RE: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hello,
Please confirm your availability to meet in early September.

From: Livia McEachern
Sent: Thursday, August 8, 2019 9:25 AM
To: 'Philip.Wu@HydroOne.com'
Cc: 'Jim.Oriotis@HydroOne.com'; Gian.Minichini@HydroOne.com
Subject: RE: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hello Philip,

My apologies for excluding you on the first email. I found a later document including you as a contact for Hydro One. Please see the email below requesting a meeting.

Thank you,
Livia McEachern

From: Livia McEachern
Sent: Thursday, August 8, 2019 9:18 AM
To: Jim.Oriotis@HydroOne.com; 'Gian.Minichini@HydroOne.com'
Subject: Meeting Request - Corwin Drainage EA - City of Niagara Falls

Hello Jim, Gian,

I would like to request a meeting with you both in regards to the Corwin Drainage EA project. For your reference I have included a copy of the commencement notice. I have recently taken temporary management of this project from the previous Project Manager, Guangli Zhang. Ms. Zhang has you both listed in the file folder as the contacts for Hydro One. Should there be a need to make a correction please advise.

Our project team, consisting of City staff and our Consultant Aquafor Beech, would be happy to come to your offices to meet with you and discuss the project scope, objectives and alternatives. At this time a strong alternative is the installation of a new trunk storm system across City, OPG and Hydro One Lands, as well as a new outfall to the canal. We are looking for an early September (pre September 13th) date of availability if possible. Please provide a date and time that may be of convenience to you.

Thank you for your time,
Livia McEachern

Livia McEachern, P.Eng. | Project Manager | Municipal Works - Engineering | City of Niagara Falls
4310 Queen Street | Niagara Falls, ON L2E 6X5 | (905) 356-7521 ext 4288 | Fax (289) 296-0048 | lmceachern@niagarafalls.ca

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix A-8

Public Consultation

June 2020

CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 7559 Redhaven Cr.

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

The Redhaven / Ronnie Area seems to be sinking & backyards fill with water at low points. Causing loss of trees etc. this has become a real issue in the last 2 years. our basement had flooding which we addressed with some repairs. to walls.

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

We don't want this to become a bigger issue causing more loss of trees etc. Nothing grows there because of clay base and water

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

Not quite sure what this means?

4. **Do you have any comments regarding the study?**

Not at this time but I hope our area is really included

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

Joe Colasurdo, Project Manager, City of Niagara Falls

4310 Queen Street, Niagara Falls, Ontario L2E 6X5

Tel: 905-356-7521 ext. 4359

By Email: jcolasurdo@niagarafalls.ca

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6751 Dunn Street

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

Our property sits lower then the other houses next to us we are at ~~the~~ the corner of Dunn & ~~Carlton~~ Carlton. Back yard ~~~~ continues to flood. The sewer on ~~Ca~~ Carlton next to our house barely has any water going down. which leave a huge pond on the corner. We have called the city about this. Also the sewer has backed up in our basement 10 times and we have owned the house for 5 years.

2. ~~**Do you have any comments / concerns regarding the preliminary preferred alternative?**~~

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

4. **Do you have any comments regarding the study?**

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6318 Skinner St.

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

My residence is always flooded with water. I called the City Office and have it checked last year but no concrete solution was done. my two next door neighbours have the same issue. In fact, a lot of residents along Skinner have their sewage line excavated.

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

I would like the area of Skinner should also be considered and evaluated. The city records will show many residents have complained about sewage backup and floodings

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

4. **Do you have any comments regarding the study?**

no comment as of now. I just need my concerns be addressed.

Thank you for taking the time to complete this comment sheet!

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT
Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6187 + 6153 Main St NFO

1. Do you have any additional information regarding the existing conditions that you would like to share with the project team?

Has The Study Looked At The Impact of the Open Crater Hole At The Abandoned Condo Project Located on The Old Coca Cola Factory Property (Main + Robinson) From All The Digging of Infrastructure And The Open Hole Filled With Water? And Has it Affected The Water Table?

2. Do you have any comments / concerns regarding the preliminary preferred alternative?

Alternative #1 Looks Best

3. Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?

4. Do you have any comments regarding the study?

Thank you for taking the time to complete this comment sheet!

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6049 Delaware St.

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

1) Errors are shown in the existing infrastructure of Drummondville area (ie Culp St, Delaware St, etc). You are showing existing storm where combined sewers exists. Confirm before any final design.
2) Severe backyard flooding occurs from overland flow at the school yard of Princess Margaret causing loss of field & backyard for Ash Street residences.
3) (*)

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

Agree w/ Alternative #2 if current sewers are accounted for ie. Alternative Solutions Board needs to account for many more storm sewers in older areas

(Also)

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

Please show expected timeline; Alt#2 least problematic.

4. **Do you have any comments regarding the study?**

Any thought to connecting to the older underground OPG canal? where is it in the plan?
Possible storage tank @ City Park by Princess Margaret School to accept more flows then orifice to existing Corwin pipe?
(redirect areas to this) *

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name [redacted]

Address: 7020 McMILLAN DR

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

our backyard is moist in the spring. Sump pump runs continously in the spring

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

I don't see alot of Environmental options available.
It is a sin to have raw sewage ~~into~~ dumped into the river with overflow.
There are no price tags available. → after all tax payers will be paying.
The scope of the study is too small

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

I worry the hydro right of way work be disruptive and effect drainage of our Backyard.

4. **Do you have any comments regarding the study?**

I feel there should have been a presentation and better preparation from consultants.
Consultant present was not forthcoming with much information

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT
Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 5930 Symmes St

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

I have ponding in my backyard. On the city block I have 30 houses with my property being the lowest. No catch basin was ever installed, it is up to me to pump water to the street. I have regraded my property but the issue is still happening.

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

4. **Do you have any comments regarding the study?**

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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Niagara Falls CANADA

Aquafor Beech

CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT
Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6365 BARKER ST NF.

1. Do you have any additional information regarding the existing conditions that you would like to share with the project team?

(6365) Barker St is flat - sidewalks are level with road. Large volumes of rain or melted snow often flood street and sidewalk. In colder temps, it freezes creating treacherous surfaces to walk and drive on. Storm sewers are frequently clogged, so water pools around them too.

B/w Franklin and Drummond

2. Do you have any comments / concerns regarding the preliminary preferred alternative?

It doesn't address any of our concerns

I am glad to see more storm sewers being added to our neighbourhood though

3. Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?

No, because they are nowhere near our home...

4. Do you have any comments regarding the study?

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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NiagaraFalls CANADA

Aquafor Beech

CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT
Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 7122 Warden Ave N.F

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

We agree with alternative #2. We feel this is the least disruption to private property.

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

We have concerns that ~~bringing~~ bringing the extra construction through the streets in Dorchester/McLeod area would be more expensive, disruptive, and might lead to more problems in our area.

4. **Do you have any comments regarding the study?**

We hope that it will move forward - Alternative #2.

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT
Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 7067 Warden Ave, Niagara Falls, ON. [redacted]

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

Our home is the last home built in 1959 by George Schneider Sr in the subdivision (Delta). The homes built on Centennial St. were built about 10 → 15 years later. At the back of their properties an east-west french drain (ditch) existed until one neighbour filled in their backyard which on back.

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

Hopefully Alternative #2 will help relieve the excess water coming from Lundy's Lane draining south. Which may help anyone south of the hydro field as well.

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

Possible flooding or disruption of their neighbourhood during construction.

4. **Do you have any comments regarding the study?**

Thank you for conducting the study and communicating with us as it is very much appreciated.

Thank you! [redacted]

Thank you for taking the time to complete this comme[redacted]

Please return the completed comment sheet by **December 30th , 2019**

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1) (Continued) - flooded out his neighbours, so they raised their backyard properties + filled in their ditch. As a result, the older homes on Douglas, Warden, etc started to experience flooding in their backyards. We have lived @ our home for 35 years. Through our vegetable garden, we have composted annually + it has raised the level of our backyard somewhat. The 2 neighbours behind us on Douglas have a sump pump together to push the water out of their backyard onto the road to remove it for decades.

Our driveway which is old tar runs with water every time it rains heavily as it runs parallel to the previous French Drain. We will eventually place gravel for our driveway when we replace it.

We spent $10,000. to completely waterproof our basement approx. 15 years ago. and we have not seen any water in our basement since. Our soil is lovely Willoughby clay and the top soil was stripped when the homes were built + not replaced.

CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT
Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6980 HAGAR AVE

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

MY BACKYARD THIS LAST YEAR IS ~~RE~~ FLOODING MORE THAN USUAL. BACKYARD IS LOWER THAN SURROUNDING LOTS AND MY BACK NEIGHBOURS YARDS WERE BUILT HIGHER THAN MINE. IF FLOODING GETS WORSE WILL REACH MY HOUSE AND THE YARD IS BASICALLY ~~A~~ WATER PIT

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

#2 ALTERNATIVE LOOKS THE MOST PROMISING IN NOT CAUSING DISRUPTION OF THE SERVICES.

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

4. **Do you have any comments regarding the study?**

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th , 2019**

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CORWIN DRAINAGE AREA ENVIRONMENTAL ASSESSMENT

Comment Sheet

Your input will assist in creating a comprehensive plan that can be implemented in partnership with the community. Please take a few minutes and provide us with your thoughts and comments on the following questions.

Name: [redacted]

Address: 6851 Hagar Ave

1. **Do you have any additional information regarding the existing conditions that you would like to share with the project team?**

(1) 2+ CSO @ Franklin & Ash - almost every rainfall event water flows between storm and sanitary
(2) At least 9 catchbasins tied to sanitary sewer on Franklin
(3) Over

2. **Do you have any comments / concerns regarding the preliminary preferred alternative?**

Yes see item (4) above, the solution down Caledonia and on Warden could be cheaper if additional size of storm required was constructed directly above existing storm sewer utilizing the same MH

3. **Do you have any concerns about the potential impacts the preliminary preferred alternatives may have on the adjacent properties?**

(1) Yes, the storm sewer proposed does not remove any catchbasins from the system and is only operating as a transmission corridor Over

4. **Do you have any comments regarding the study?**

As previously noted

Thank you for taking the time to complete this comment sheet!

Please return the completed comment sheet by **December 30th, 2019**

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1. (3) Combined sewer on Dorchester needs to be separated.

(4) Catchbasins tied to some sanitary sewers on areas of storm sewers constructed in 1980 or earlier, can be found ~~by~~ after snow storm these catchbasins will not have snow on catchbasin, catchbasins tied to storm will have snow on them

(5) Recommended solution is the same as 1980 RV Anderson report that were not followed due to cost of using hydro lands

---

3. (2) The study boards ~~due~~ ~~does~~ do not cover the elimination of the ± GSO at Franklin & Ash ~~until these~~ and the catchbasins on Franklin or the combined sewer on Dorchester Road.

(3) The study does not cover the seperation of other combined sewers in the area. These above items should be completed before the final solution is approved because ~~they~~ this will eliminate a significant amount of storm flow in the sanitary sewer

Appendix B: Technical Memorandums 1 to 4

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix B

Technical Memorandums 1 to 4

- Background Review
- Data Gap Analysis
- Field Investigation and Flow Monitoring Plan
- Hydrologic and Hydraulic Model Review

June 2020

Submitted to:
City of Niagara Falls

City of Niagara Falls
Corwin Drainage EA Study
Technical Memorandums 1 to 4

June 22nd, 2020

Aquafor Beech Limited

Reference: 66202

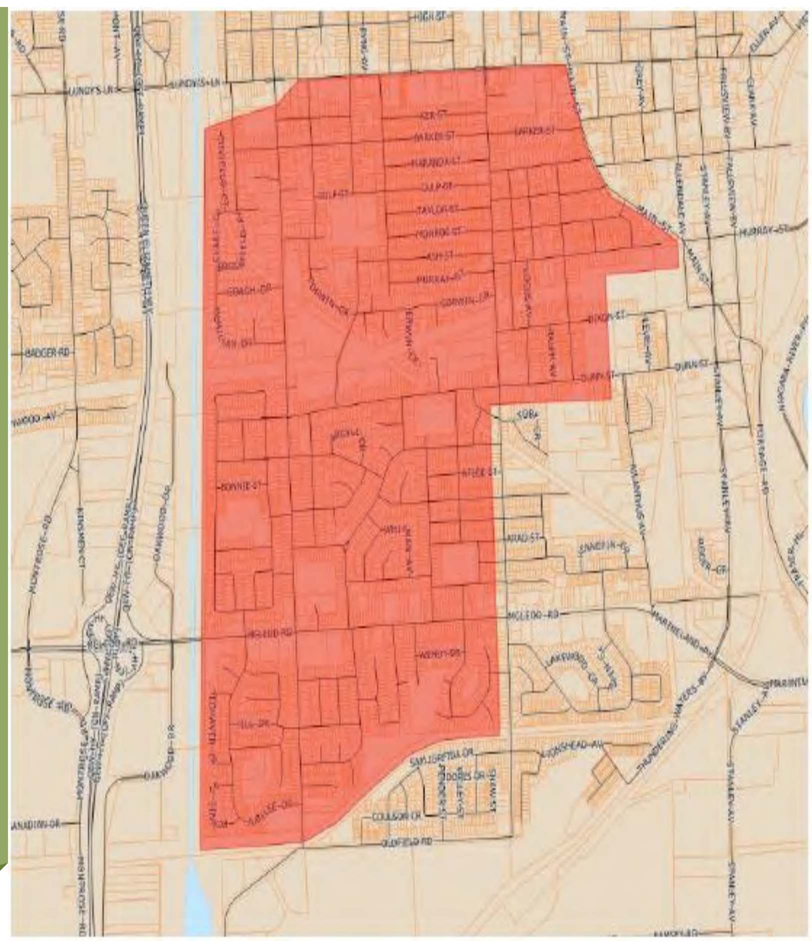

TABLE OF CONTENTS

1 INTRODUCTION

1.1 General

Aquafor Beech has been retained by the City of Niagara Falls (CoNF) to undertake the Corwin Drainage Environmental Assessment (EA) Study under Schedule 'C' that includes the possibility of a new sewer outfall and new sewers on non-City-owned lands. The primary objective is to reduce ongoing basement flooding issues. Items with respect to extraneous flows, MOECC F-5-5 and the structural and operational condition of the stormwater and wastewater collection systems will also be assessed, and alternative solutions proposed for the alleviation of basement and surface flooding.

Previous studies show that the drainage infrastructure system within the City of Niagara Falls has been under increasing stress due to new development, population growth, and a growing tourism industry, leading to increased levels of combined sewer overflows (CSO) and basement flooding within the City

The study will build primarily on the recently completed Master Drainage Plan Update Study (MDPUS) as well as the Pollution Prevention & Control Plan Update Study (PP&CPUS). The MDPUS, which was completed as a Master Plan has addressed Phase 1 of the EA, particularly since over 150 residents attended the PIC. The Phase 1 component of the study will be revisited to ensure all aspects of this study are addressed.

This document contains the following sections:

1. Introduction
   This section is an introduction to Technical Memorandums 1 through 4.

2. Study Area Boundaries and System Mapping
   This section looks at the preliminary and refined study areas and the rationale for the refinements.

3. Existing Document Review and Summary
   All relevant background documents addressing the issues primarily from the Corwin Drainage Area perspective with some at the City-wide perspective were reviewed and with the relevant documents summarized. (Technical Memorandum #1)

4. Flow Monitoring Review and Field Assessment
   This section summarizes that 2014 City-wide flow monitoring and provides detail on the storm sewer flow monitoring plan undertaken by the City and Consultant for the Corwin Drainage Area Study. (Technical Memorandum #1)

5. Data Gap Analysis
   The data gap analysis summarizes the gaps based on findings from the existing hydraulic and hydrologic model for the sanitary, combined and storm systems and includes gaps found in all of the City-provided data prior to undertaking the work. (Technical Memorandum #2)

6. Topographic and Geotechnical Assessment
   The topographic and geotechnical work was undertaken to better define items such as inverts, pipe sizes etc. A summary of the CCTV work is provided in this section. (Technical Memorandum #3)

7. McLeod CSO/SSO Tank Field Investigation
   The field investigation and assessment of the McLeod tank functionality and a clear perspective of the conveyance infrastructure from the subsequent field survey and CCTV investigation is summarized in this section (Technical Memo #4).

8. Hydrologic and Hydraulic Modelling
   The H&H modelling is summarized and includes an assessment of the existing model, data gaps found and how they were addressed, model development addressing the expansion of the model for the Corwin area and the existing conditions assessment.

1.2 Problem Definition and Objective

The Corwin Drainage Area EA Study is based upon the recommendations provided in the MDPUS for Problem Areas 19 and 20 to address the problems associated with flooding problems due to frequent storms. Recommendations for flooding alleviation were provided in the MDPUS.

The overall objective is to assess the existing conditions and generate alternatives for the combined, sanitary and storm systems along with preliminary design for basement flooding and surface flooding protection for existing and future conditions. The recommendations from the MDPUS will also be assessed as part of the development of the preliminary design.

2 STUDY AREA BOUNDARIES & SYSTEM MAPPING

Problem Areas 19 and 20 (Figure 1) are part of the study area identified as identified as part of the MDPUS. This study recommended that a new trunk storm sewer be constructed in order to discharge flows into the Hydro Electric Power Canal (HEPC) via a new outfall. One of the study components is to review the drainage areas for both sanitary and storm sewer systems and examine the interactions between these sub-catchments. As part of the MDPUS it was confirmed that the existing trunk sewer running along Caledonia St. was significantly undersized. Thus, the proposal to provide an outlet which would service the immediate area and relieve downstream sewers was developed. As part of the MDPUS it was also acknowledged that the final area to be serviced by the proposed storm trunk sewer along the Hydro lands would be based on a closer assessment of the topography and thus the feasibility of bringing in specific areas.

Figure 2.1 illustrates the sewershed area serviced by the proposed trunk storm sewer from the MDPUS to address Problem Areas 19 and 20 identified from flooding records. The Study Area as defined in the MDPUS is bounded by Dorchester Road and Main Street to the West and east respectively, and Lundy's Lane and Dunn St to the north and south.

Figure 2.2 shows the expanded study area boundary. The expanded area is bound by Lundy's Lane to the north, Dunn Street and the hydro corridor south of McLeod Avenue to the south, Allendale Avenue and Drummond Road to the east and the HEPC to the west. The boundary was refined based on the following steps:

- Review of the relevant sections of the RFP discussing the study area;
- Meetings with City staff in May and June of 2018;
- Collection and analysis of the GIS layers and as-built drawings provided in the Consultant Package provided by the CoNF;
- Review of the MDPUS;
- Tracing of the storm and combined sewer drainage in the model
- Analysis of the outfalls (existing and proposed from the MDPUS) along the HEPC.

The area is primarily residential with a mixture of road cross sections. Some streets have storm sewers while a few streets are serviced by combined sewers. Stormwater flows are currently collected and conveyed to the Hydro Electric Power Canal (HEPC) via five (5) storm sewer outfalls.

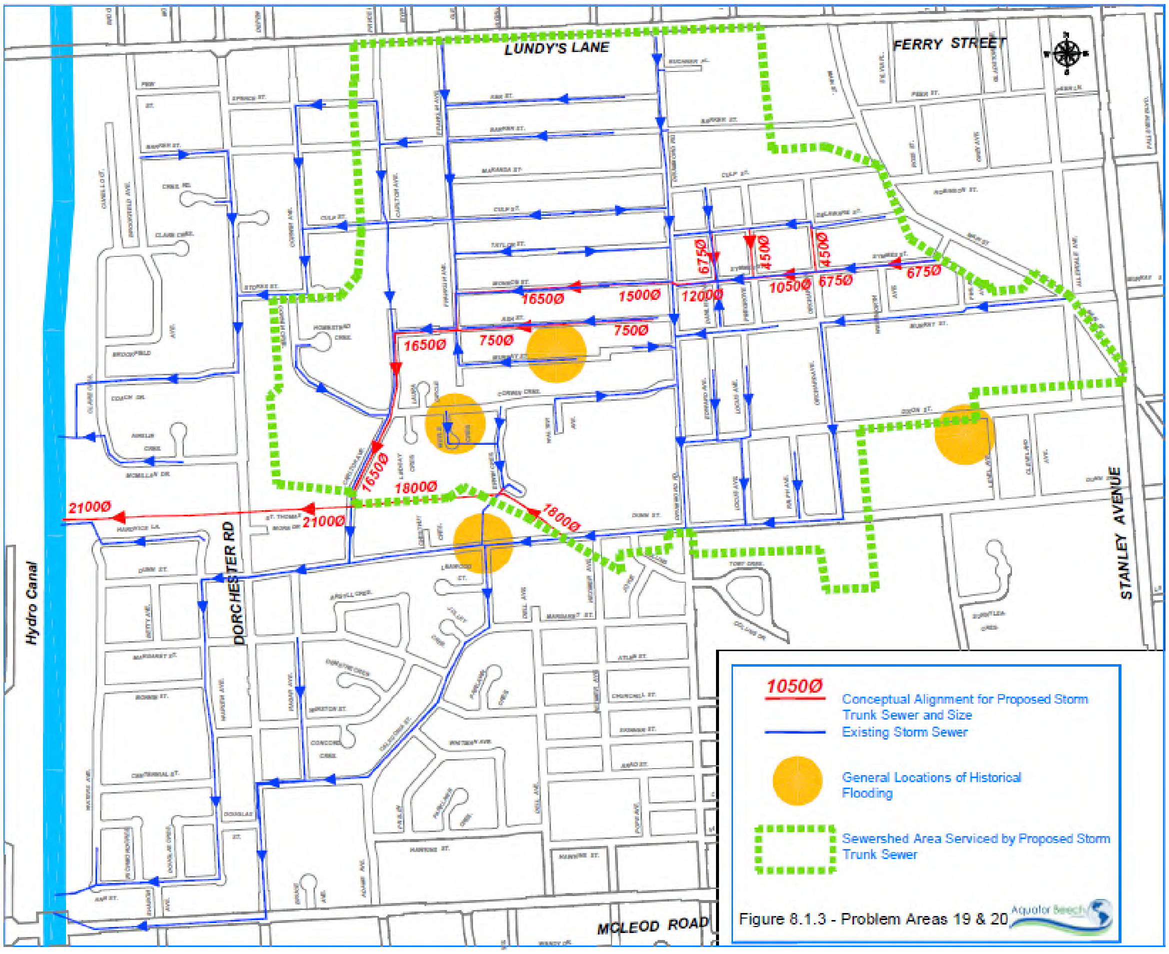

Figure 2.1: Study Area for Proposed Works Addressing Problem Areas 19&20 (MDPUS, 2017)

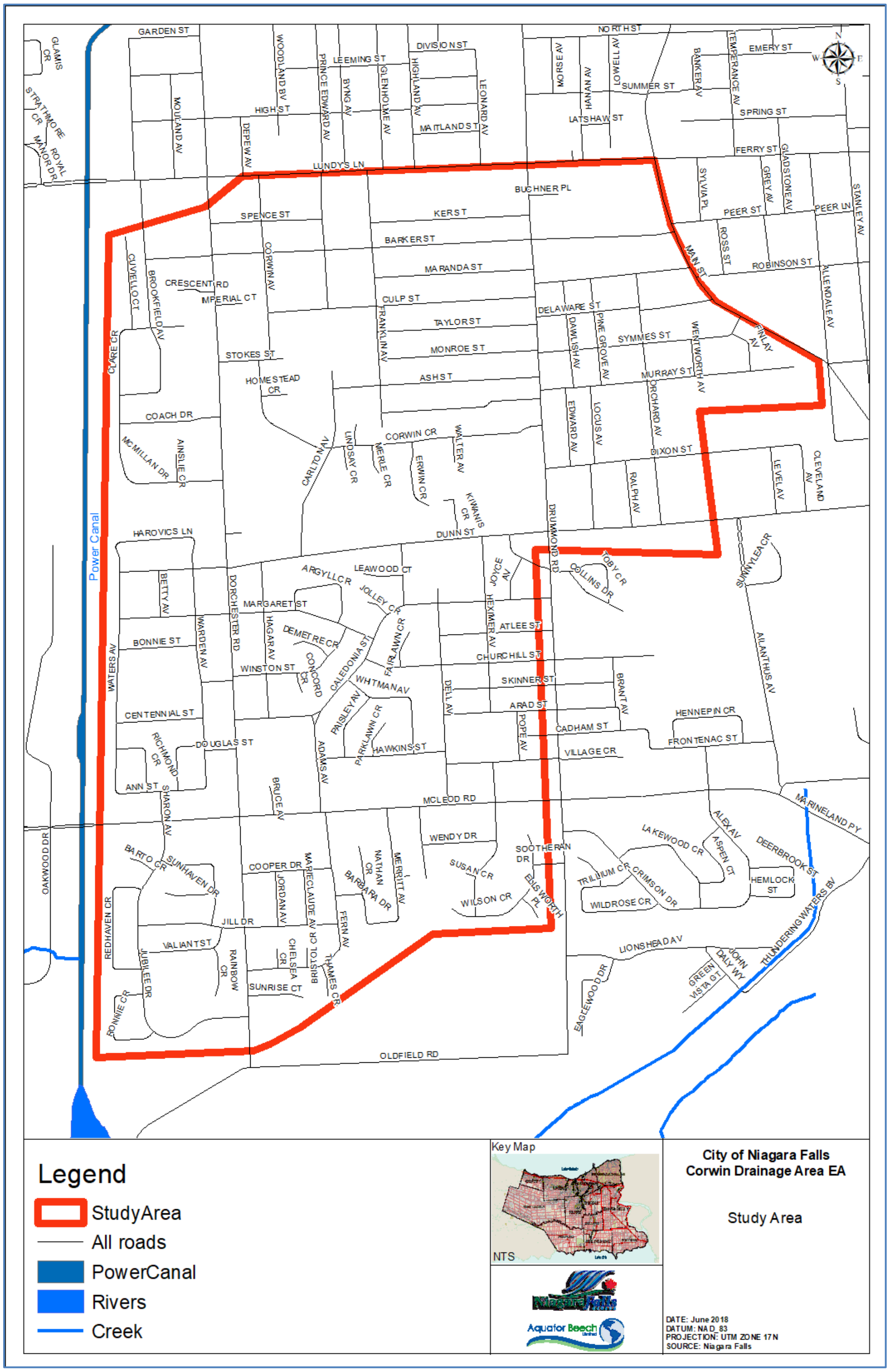

Figure 2.2: Refined Corwin Study Area

3 EXISTING DOCUMENT REVIEW AND SUMMARY

3.1 General

This section will review previous studies concerning storm/combined sewer system and pollution control plant in order to provide a technical basis and direction with relevance to the Corwin Drainage Area EA. Relevant policy documents that represent the municipal and the environmental processes governing the study area are also reviewed and cross-referenced with concurrent City programs and practices in relation to stormwater management within the study area.

The review of background information is based on many documents and studies relevant to technical background, planning framework, and data management related to stormwater quantity and quality management. The information was categorized as follows:

1. **Policy Framework**
    a. Planning Act
    b. Conservation Authorities Act
    c. Drainage Act
    d. Ontario Water Resources Act
    e. Clean Water Act
    f. Lakes and Rivers Improvement Act
    g. Species at Risk Act
    h. Fisheries Act

2. **Municipal Planning Review**
    a. Master Drainage Plan Update Study (2017)
    b. City of Niagara Falls Official Plan (2015)
    c. Engineering Design Guidelines Document (2012)
    d. City of Niagara Falls Master Drainage Plan (1981)

3. **Environmental Planning and Watershed-Based Review**
    a. Lower Welland River Characterization Report (NPCA, 2011)
    b. South Niagara Falls Watershed Report (NPCA (2008)
    c. Niagara River Remedial Action Plan – Stage 2 (2009)
    d. Niagara River Remedial Action Plan – (Update 2012)
    e. 2012 Watershed Report Cards (NPCA, 2012)
    f. Water Quality Monitoring Program (NPCA, 2009)
    g. Niagara Water Quality Protection Strategy (2004)

4. **Technical Direction Review**
    a. City of Niagara Falls Sewer System Analysis (CG&S, 1996)
    b. Niagara Falls Pollution Control Plan (CH2MHILL, 2008)

5. **Data Review and Data Gap Analysis**
    a. Official Plan data
    b. Storm sewer data
    c. Stormwater management facilities
    d. Environmental features

In the following sections, a review of the above-mentioned reports is carried out, with synthesis of key findings, issues, and recommendations. Gaps are identified and analyzed within the review, and recommendations are presented regarding the way forward. It is also noted that the figures below show the approximate location of the Corwin Drainage Area delineated by a red rectangular boundary

3.2 Background Information Summary

3.2.1 Policy Framework

The following presents a summary of key federal, provincial and local acts and regulations affecting stormwater related issues within the study area:

3.2.1.1 The Planning Act

The Planning Act promotes sustainable economic development in a healthy natural environment. The Act enables municipalities to regulate land use and development at the local or regional level, subject to a provincial policy framework.

A few provisions in the Planning Act are relevant to stormwater management. They include:

- Ensuring adequate provision of sewage and water services, ensuring the orderly development of safe and healthy communities, and protecting public health and safety (Section 2);
- Enabling the provincial government to issue policy statements on matters of provincial interest, and requiring municipalities to have regard for such policy statements (Section 3), and
- Empowering municipalities to prohibit or restrict the use of land, or the erection or use of buildings or structures, particularly in areas containing significant natural heritage or land that is “a sensitive groundwater recharge area, or headwater area, or land that contains a sensitive aquifer” (Section 34(1)).

3.2.1.2 Conservation Authorities Act

The Conservation Authorities Act was established by the Province of Ontario in 1946 and gave CAs jurisdiction over natural areas based on delineation by watershed (MOE and MNR, 1993). Accordingly, Water and related land management are the responsibility of CAs working in conjunction with the municipalities. The CAs are to establish regulations dealing with environmental protection of their watershed’s resources. Regulations made under the Conservation Authorities Act must be consistent across the province and be compliant with the Planning Act.

3.2.1.3 Drainage Act

The Drainage Act provides a procedure for the construction, improvement and maintenance of drainage works. Not all ditches and buried pipes in a city are considered municipal drains. An engineer's report generally classifies a ditch or pipe as a municipal drain. Under Section 74 of the Drainage Act, municipalities are responsible to maintain municipal drainage systems within their jurisdiction (Ontario, 1990e).

3.2.1.4 Ontario Water Resources Act

The Ontario Water Resources Act (OWRA) is one of the most important pieces of legislation governing water quality and quantity in the province. It provides for the protection and conservation of water, and the control of the quality of drinking water supplied to the public. The following items in the Act are relevant to stormwater management:

- Under the Act, stormwater is included in the definition as sewage and, as such, requires to be managed properly.
- Prohibits the discharge of polluting material in or near water (Section 30);
- Prohibits or regulates the discharge of sewage (Section 31);
- Enables the issuance of orders requiring measures to prevent, reduce or alleviate impairment of water quality;
- Enables the designation and protection of sources of public water supply (section 33);
- Requires approvals for water works (Section 52);
- Requires approvals for sewage works (Section 53);
- Designates and regulates areas of public water or sewage services (Section 74)

3.2.1.5 Clean Water Act

The Clean Water Act and five associated regulations came into effect with the intent to ensure that communities are able to protect their drinking water supplies through developing collaborative, locally driven, science-based protection plans (referred to as Source Water Protection Plans). Communities are developing these plans to identify potential risks to local water sources and take action to reduce or eliminate the risks. Municipalities are working with Conservation Authorities and the local community in meeting these goals.
The main principles that are followed in developing a plan include:

- Require local communities to look at the existing and potential threats to their water and set out and implement the actions necessary to reduce or eliminate significant threats.
- Empower communities to act to prevent threats from becoming significant.
- Require public participation on every local source protection plan. This means everyone in the community gets a chance to contribute to the planning process.
- Require that all plans and actions are based on sound science.

3.2.1.6 Lakes and Rivers Improvement Act

The Lakes and Rivers Improvement Act regulates public and private use of lakes and rivers, regulates construction, repair and use of dams, and prohibits deposit of refuse, matter or substances into lakes and rivers contrary to the purposes of the Act. It is administered by the MNR (Ontario, 1990d).

3.2.1.7 Species at Risk Act

The Species at Risk Act was created to protect wildlife species from becoming extinct in two ways: by providing for the recovery of Species at Risk (SAR) due to human activity; and by ensuring through sound management that species of special concern don't become endangered or threatened. It includes prohibitions against killing, harming, harassing, capturing or taking SAR, and against destroying their critical habitats. Stormwater runoff from farm operations, lawns, golf courses, urbanization, and other pollution sources may carry contaminants, adversely affecting critical habitat and water quality for SAR (Department of Justice Canada, 2002).

3.2.1.8 Fisheries Act

The Fisheries Act focuses on the protection of fish and aquatic habitat. It prohibits the deposit (direct discharging, spraying, releasing, spilling, leaking, seeping, pouring, emitting, emptying, throwing, dumping or placing) of harmful substances into waters frequented by fish, such as oceans, rivers, lakes, creeks, and streams, or into storm drains that lead to such waters. A harmful substance would alter or degrade water quality such that it would harm fish or fish habitat. A harmful substance can also be stormwater, wastewater, or other effluent that contains a substance in such quantity or concentration that it would, if deposited to waters frequented by fish, degrade or alter fish or fish habitat (DFO, 2006).

3.2.2 Municipal Planning Review

3.2.2.1 Master Drainage Plan Update Study (2017)

The purpose of this project was to undertake a Master Drainage Plan Update Study (MDPUS) which satisfies the City's 2011-2014 strategic priorities in terms of a well-planned city, infrastructure sustainability, and proposed a well-planned infrastructure system that is sustainable and ecologically sound.

The primary intention of this MDPUS study was to develop the remedial recommendations for the flooding areas related to the surcharging of the storm sewer system, the problem areas associated with the combined and sanitary sewer system would be addressed through other studies.

3.2.2.1.1 Key deliverables and findings

The key deliverable of the MDPUS is the development of a baseline storm sewer trunk system network model and the assessment of performance scenarios for existing and proposed conditions within the existing urban area. The baseline storm sewer trunk system network model will serve as the basis upon which the City can further assess the storm sewer system throughout the City of Niagara Falls.

Other deliverables of the MDPUS are listed below:

- Receiving Stream Habitats and Geomorphic Conditions Report
- Climate Change Considerations Technical Memo
- Intensity-Duration-Frequency (IDF) Curves Update Memo
  Storm Sewer and Stormwater Pond Technical Assessment Report

3.2.2.1.2 Key recommendations

The Recommended Solution for Problem Areas 19 & 20 within Corwin Drainage EA, includes the following:

- Installation of 4,000m of new storm sewer to provide additional capacity (Carlton Avenue, Ash Street, Monroe Street, Symmes Street, Dawlish Avenue, Pinegrove Avenue and Orchard Avenue).
- Coordination with the appropriate stakeholder (Hydro One) should be undertaken for the construction of the new trunk storm sewer.

3.2.2.1.3 Key Gaps in the study

- The XPSWMM model for storm sewer trunk system does not include pipes smaller than 600 mm diameter.
- Connectivity of the sewer system was not confirmed via a field program.
- The XPSWMM model is not calibrated due to lack of flow monitoring data in the study area.

3.2.2.2 City of Niagara Falls Official Plan (2015)

The City's Official Plan provides a framework for the development and redevelopment of lands and guide growth and development within the City. the Official Plan for the City of Niagara Falls is to be brought into conformity with the policies of the Regional Official Plan.

According to the City of Niagara Official Plan, during the latter part of the 1980's, the City experienced a record high growth based upon housing starts and building permit values. The following Schedules illustrate land use designations within the City:

- Schedule A: City boundaries including urban and rural parts, and environmental protection areas;
- Schedule A2: Urban Structure Plan
- Schedule A3: Garner South Secondary Plan
- Schedule B: Phasing of Development

Policy 13.35.5 states that "Prior to any development, a master site plan shall be registered on title which shall identify the staging of development. Detailed site plans for each stage of development shall be added as an amendment to the master plan. Site plan agreements will be used to implement the findings of required archeological, environmental impact, and stormwater management studies.

Policy 13.51.2 notes that "The community shall be developed in an attractive landscaped setting with appropriate buffering and landscaped setbacks from adjacent land uses. Any on-site stormwater management facilities shall be designed in such a way as to contribute to the aesthetics of the development".

The Corwin drainage area is largely unchanged from the existing land use with the majority zoned for residential usage and major commercial along Lundy's Lane.

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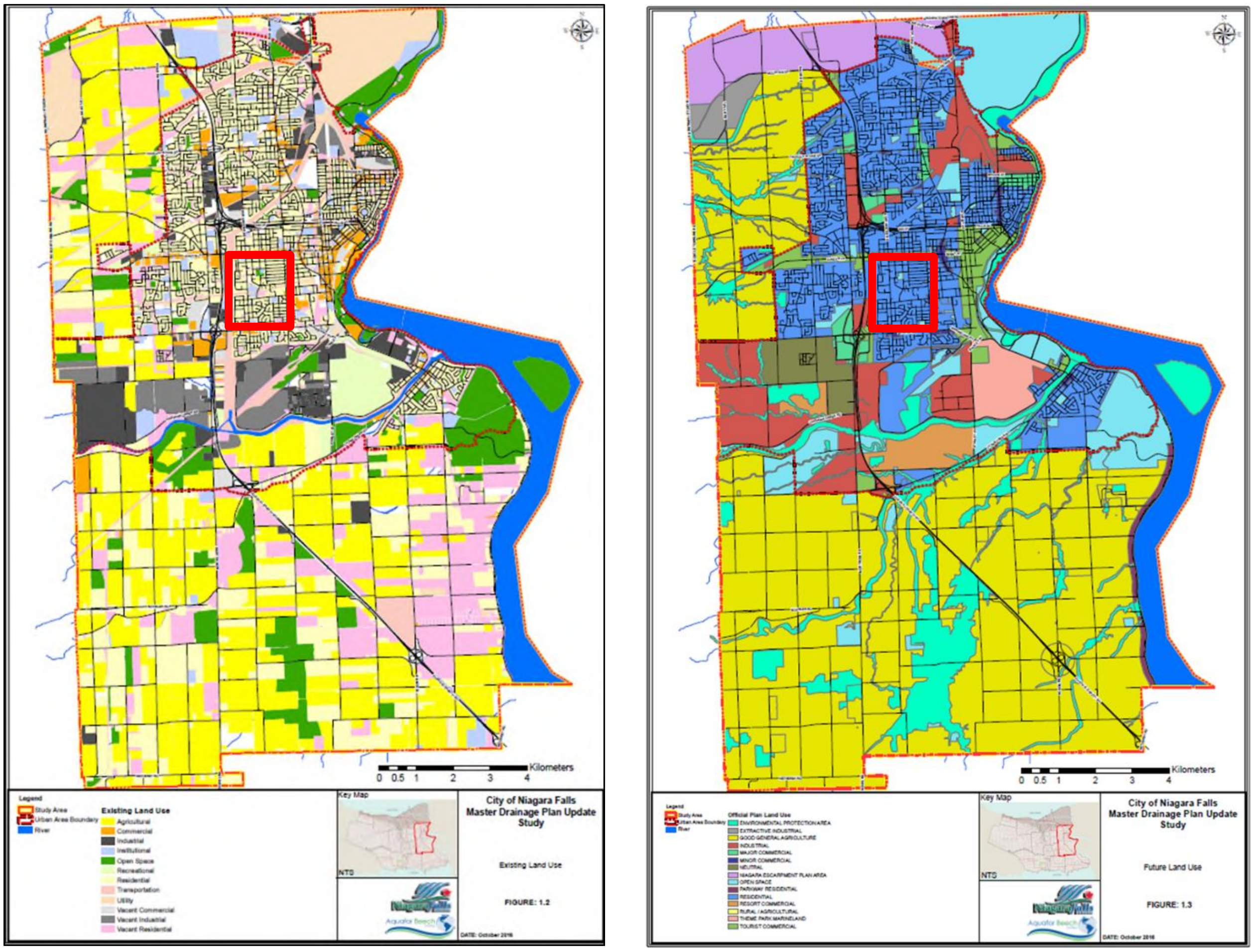

Figure 3.1: Existing and Future Land Use (MDPUS, 2017)

3.2.2.3 Engineering Design Guidelines Document (2012)

The Engineering Design Guidelines document provides a set of guidelines in terms of engineering design practices for planning land development and redevelopment within the City of Niagara Falls. The scale of application of the document is focused on subdivisions, and can be integrated with federal, provincial, and local planning documents at higher scales of influence and requirements.

With respect to stormwater management, the document indicates that the MOE Stormwater Management Planning and Design Manual (MOE, 2003) should be referenced for stormwater quantity and quality management studies. The document provides common practices for hydrologic analysis including rainfall-runoff analysis, minor/major drainage analysis, and erosion and sedimentation control. Detailed standards and criteria related to stormwater management facilities design and maintenance are presented for non-residential and recreational land uses.

3.2.2.4 City of Niagara Falls Master Drainage Plan (1981)

The City of Niagara Falls Master Drainage Plan is an update for the 1968 Report on Flood Control and Pollution Abatement. The document includes a map for the storm sewer system that had been constructed between 1968 and 1980 and proposes a storm sewer system to cover gaps that were not addressed in the 1968 report. Accordingly, the proposed works would provide separate trunk storm sewers for all areas served by combined sewers, as well as all undeveloped areas which will require stormwater outlets. Appendix A of the report includes a separate report discussing environmental analysis and impact review within the Beaverdam's creek drainage system.

3.2.2.4.1 Key deliverables and findings

The key findings are summarized below

1. Inadequacy of the combined trunk sewer system to handle stormwater runoff. Inadequacies could cause damage due to basement flooding.
2. Numerous unknown cross connections that preclude accurate determination of local drainage areas and cause of flooding

3.2.2.4.2 Key recommendations

1. Conversion of existing combined sewers to either strictly storm or sanitary,
2. Combined sewage retention ponds or tanks, discharging to the WPCP
3. Adoption (continuation) of using the Rational Method to estimate surface runoff.
4. Continue to use the 5-year storm in all sewered areas within the City
5. Use the 25-year Welland curve for areas served by open channels

3.2.2.4.3 Key Gaps in the study

1. The study was based on the 1968 minor drainage assessment and topographic details; therefore, it did not carry out a detailed field survey, and only visual confirmation of general topographic features was conducted.
2. No infiltration allowances were made or recommended for stormwater quantity and quality management

3.2.3 Environmental Planning and Watershed-Based Review

Seven (7) environmental planning and watershed-based studies were reviewed in order to provide a watershed context for the City of Niagara Falls Master Drainage Plan Update Study (MDPUS). As a result, a brief characterization of the study area was developed, where key environmental features and functions were addressed. These include:

- Subwatershed coverage
- Surficial geology and physiography
- Hydrology
- Hydrogeology
- Natural Heritage
- Water Quality

3.2.3.1 Overview of watershed-based issues

There have been several studies and reports that cover issues related to watersheds covering the City of Niagara Falls, and consequently shaping and impacting its environmental health and municipal infrastructure sustainability. These documents include:

1. Lower Welland River Characterization Report (NPCA, 2011)
2. South Niagara Falls Watershed Report (NPCA, 2008)
3. Niagara River Remedial Action Plan – Stage 2 (2009)
4. Niagara River Remedial Action Plan – (Update 2012)
5. 2012 Watershed Report Cards (NPCA, 2012)
6. Water Quality Monitoring Program (NPCA, 2009)
7. Niagara Water Quality Protection Strategy (2004)

These documents range in their focus and complexity from large-scale interest such as the Niagara River Remedial Action Plan; which has identified areas of concern (AOCs) within the Niagara River watershed including the City of Niagara Falls, to smaller-scale focus such as subwatershed characterization reports (i.e. Lower Welland and South Niagara Falls).

In the following sections, a summary of key environmental characteristics of the study area is presented and is based on the above-mentioned documents.

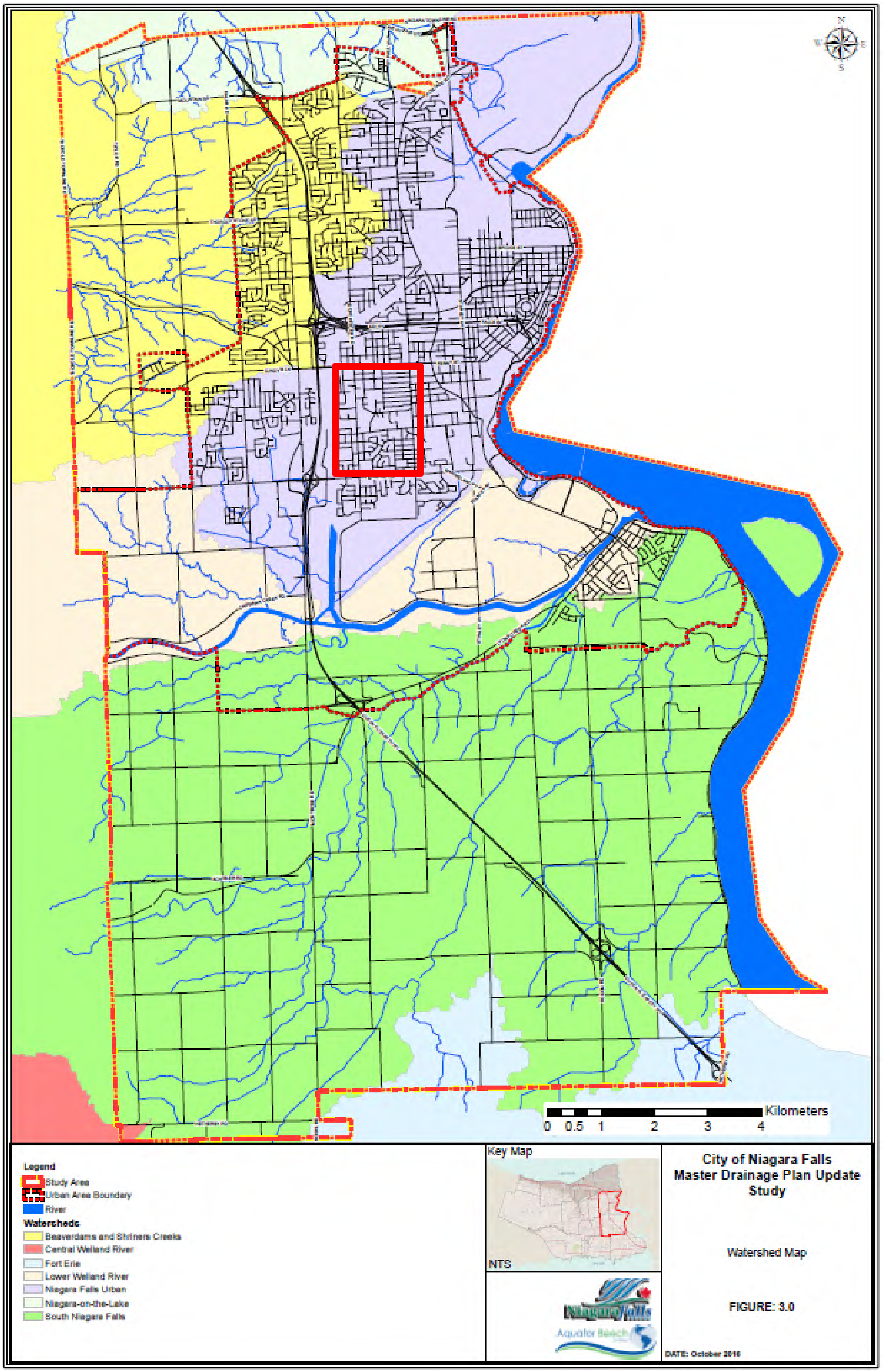

Figure 3.2: Watershed Map (MDPUS, 2017)

3.2.3.2 Subwatershed coverage

The Niagara Peninsula Conservation Authority (NPCA) watershed serves approximately 500 000 people and covers an area of 2424 square kilometres encompassing the entire Niagara Region and the City of Niagara Falls. The NPCA watershed is comprised of over 202 subwatersheds of varying sizes.

As shown in **Figure 3**, the City of Niagara Falls is primarily covered by the following six (6) subwatersheds (from north to south) (Table 4.1): The Niagara Falls Urban Subwatershed covers 21% of the total area of the City of Niagara Falls.

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3.2.3.3 Surficial Geology

Figure 4 shows the City dominated by clay and silt soils (approximately 79% of the study area) especially the southern and western portions of the City (i.e. South Niagara Falls and Beaverdams and Shriners Creeks subwatersheds). The Corwin study area is dominated by silt and sandy soils in the northern half of the study area and clay silt in the southern half.

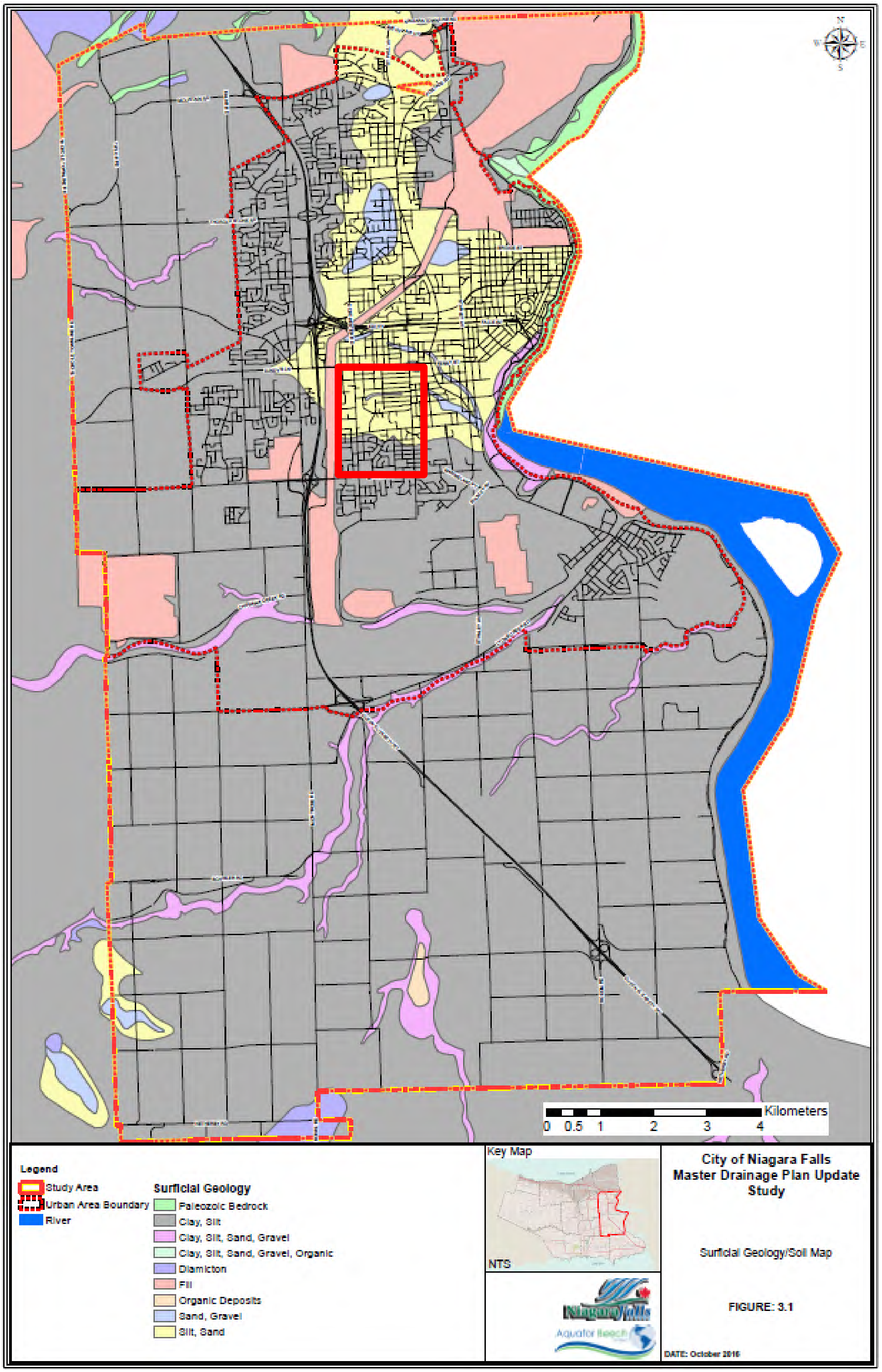

Figure 3.3: Surficial Hydrology (MDPUS, 2017)

3.2.3.4 Hydrology

As indicated earlier, the City of Niagara Falls is covered by six (6) subwatersheds. These subwatershed includes several watercourses and tributaries that runs through the City. Within the urban study area, the key watercourses along with the average stream flows area summarized below (CH2MHILL, 2008):

1. Welland River: 50 m^3/s
2. Niagara River: 5,380 m^3/s
3. HEPC: 1,980 m^3/s

The Niagara Peninsula Conservation Authority monitors stream flow, rainfall and other meteorological information at locations across the watershed. Meteorological stations within the City include:

1. Kalar Road SPS Precipitation Station
2. Niagara Falls Fire Station

3.2.3.5 Hydrogeology

There are primarily four soil groups that characterize the soil types in the study area including soils from the Niagara, Welland, Malton, and Peel groups. The Corwin Drainage Area is dominated by the Niagara and Welland soil groups which area summarized below:

- Niagara soils are imperfectly drained and moderately to slowly permeable. Groundwater levels are usually close to the surface until late spring and this soil group has moderate to high water-holding capacities.
- Welland soils are poorly drained and slowly permeable except during the summer months when surface cracking increases their permeability. Like the Niagara soils, groundwater levels remain close to the surface most of the year.

3.2.3.6 Natural Heritage

3.2.3.6.1 Terrestrial Ecology

The City of Niagara Falls is covered by a wealth of natural heritage features, especially within the South Niagara Falls subwatershed (**Figure 6**). The NPCA has summarized the forest cover and conditions within the subwatersheds covering the City of Niagara Falls (NPCA, 2012). The Corwin study area is contained within the urban sub-watershed with some woodlands but overall no forest cover.

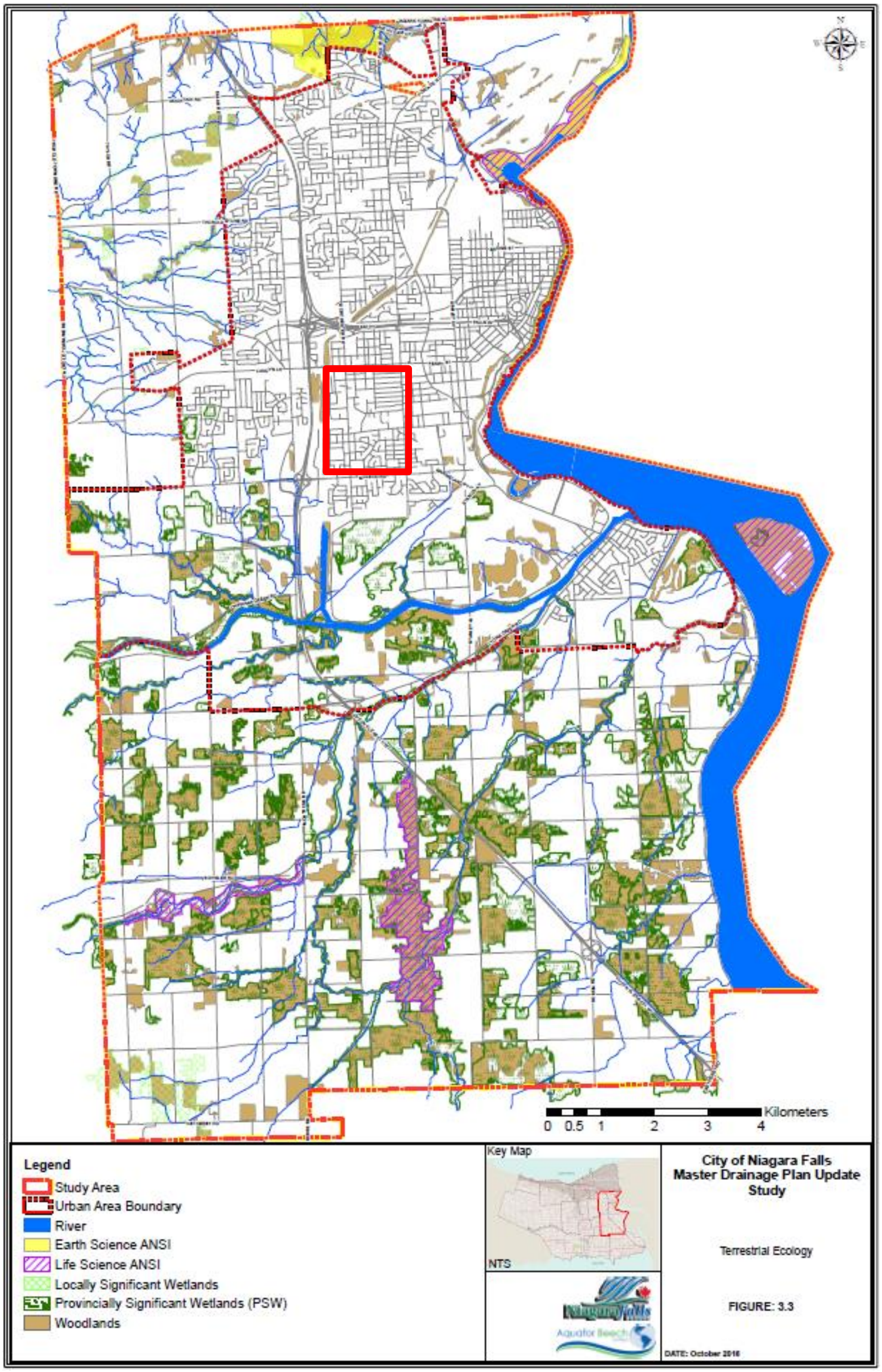

Figure 3.4: Terrestrial Ecology (MDPUS, 2017)

3.2.3.7 Aquatic Ecology

Fish habitat types within the City of Niagara Falls are classified into three categories:

- critical habitat (Type 1),
- important habitat (Type 2) and
- marginal habitat (Type 3).

The Corwin study area has only marginal habitat due to its drainage to the HEPC.

3.2.3.8 Water Quality

Highly vulnerable aquifers are mostly located within the Niagara Falls Urban subwatershed including the northern half of the Corwin study area and extend to the north and north west within the Niagara on the Lake subwatershed and the Beaverdams and Shriner's Creeks subwatershed (**Figure 3.5**).

Surface water quality measurements included Total Phosphorus and E. coli, in addition to Benthic Biotic Index within subwatersheds covering the City of Niagara Falls. Surface water quality grades for the NPCA watersheds range from C to F with the majority of watersheds scoring D. The water quality results covering the City of Niagara Falls are detailed in the watershed report cards (NPCA, 2012).

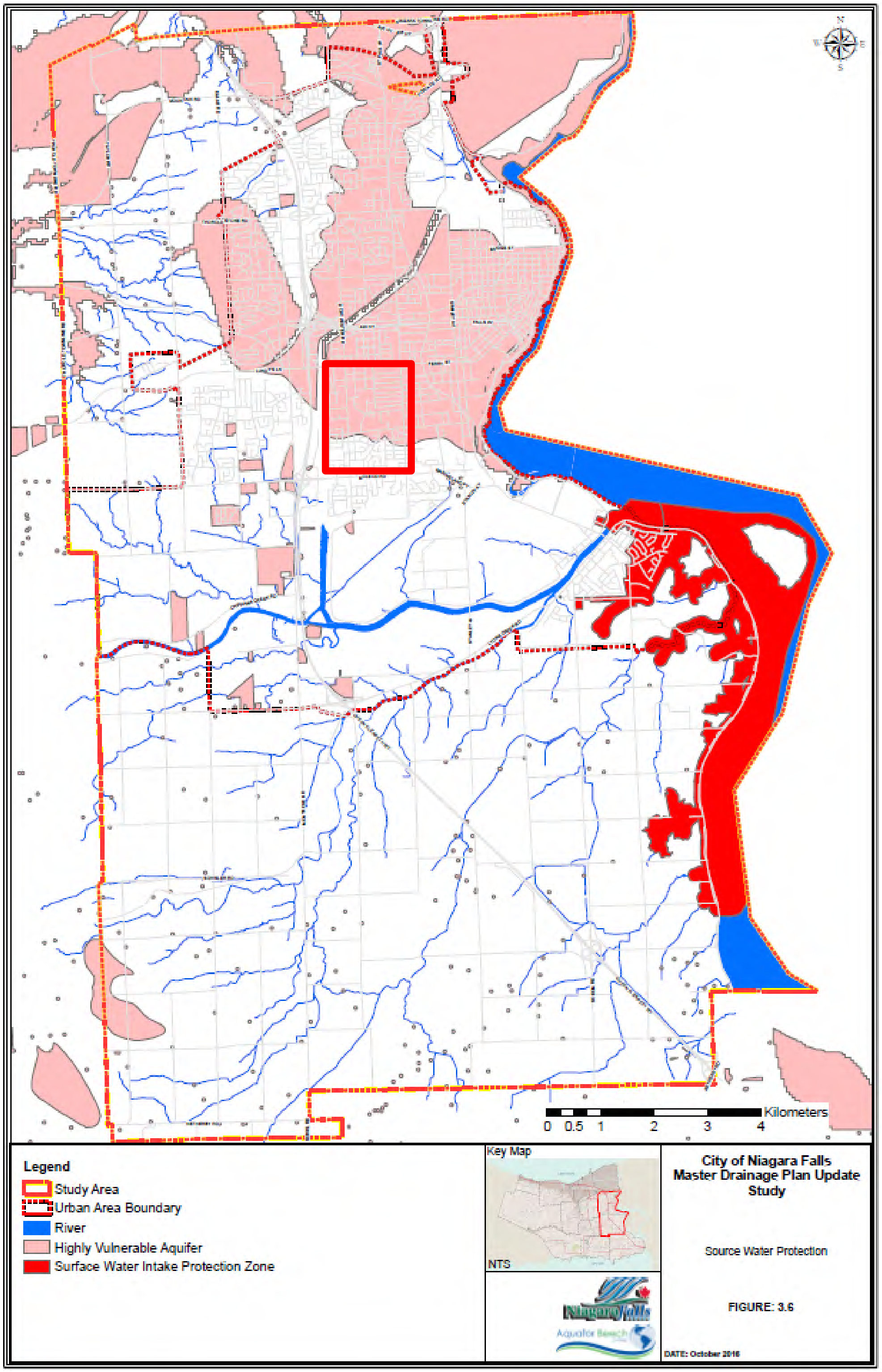

Figure 3.5: Source Water Protection (MDPUS, 2017)

3.2.4 Technical Direction Review

As part of the background review, the following key technical documents related to sewer system analysis and stormwater management were reviewed:

1. City of Niagara Falls Sewer System Analysis (CG&S, 1996)
2. Niagara Falls Pollution Control Plan (CH2MHILL, 2008)
3. Shriners Creek Stormwater Management Study (Falcone and Smith, 1990)
4. Chippewa Pollution Control Study (CG&S, 1998)

3.2.4.1 City of Niagara Falls Sewer System Analysis (CG&S, 1996)

The City of Niagara Falls Sewer System Analysis and CSO Abatement Study proposes a strategy for mitigating combined sewer overflow pollution. The study analyzed the CSO and storm sewer system using a hydrologic/hydraulic model that was developed to investigate the effects of wet weather I/I flows in the following sewer system components:

a. Main sanitary sewer trunks.
b. Combined sewer overflow structures
c. As a result of pumping and backwater effects
d. In-line storage within the system; and
e. To assess the capacity of the collection system

3.2.4.1.1 Key Findings

Discharge Volumes

The study evaluated discharge volumes to five (5) watercourses within the urban study area (Table 3.1). The Corwin study area contributes to the discharge volumes to the HEPC.

Table 3.1: Discharge Volumes to Receiving Waters (m^3/season, April 1 to October 31)

Receiver	Stormwater	Storm Sewer Dry Weather Discharge	CSO	Totals	Percent Distribution
HEPC	633,510	13,119	293,170	939,799	44.5%
Niagara River	98,719	1,482	589,831	690,033	33%
Welland River	164,084	4,194	965	169,243	8%
Pell's Creek	10,933	-	-	10,933	0.5%
Shriner's Creek	271,714	23,841	806	296,361	14%
Totals	1,178,960	42,637	884,772	2,106,369	100%

Loading Assessment

Contaminant loadings observed within the system are presented in Table 3.2.

Table 3.2: Contaminant Loading from All Sources

Source	TP (kg/season)	BOD (kg/season)	E.coli (cfu/hr)	TSS (kg/season)
Stormwater	354	8,205	1.9×10^{11}	51,900
CSO	1,000	39,081	3.0×10^{11}	9,113,200
I/I	7	82	6.1×10^{8}	12,600
Total	1,361	47,368	4.9×10^{11}	9,177,700

3.2.4.1.2 Key Recommendations

The study indicated that the priority of pollution control works is recommended for the HEPC for CSO abatement among the other receivers.

Best management practices are recommended to improve the quality of and reduce the volumes of dry weather base flows. Practices include:

- Sampling and flow monitoring,
- CCTV inspection,
- Repair of cracks,
- Inspection and removal of any sanitary cross-connections,
- Catchbasin cleaning,
- Street sweeping, and
- Anti-litter regulations

The implementation plan includes:

- Capacity improvements
- Elimination of CSO's
- Stormwater control

3.2.4.2 Niagara Falls Pollution Control Plan (CH2MHILL, 2008)

The study documents a Pollution Control Plan (PCP) for the upgrade or the expansion of the existing sewage infrastructure to address current issues and manage anticipated growth. In order to provide for an improved and sustainable infrastructure, recent studies (e.g. the City of Niagara Falls Pollution Control Plan, 2008) recommended updating combined sewer mapping and capital works database, in addition to system-wide policies and capital works.

A hydrologic and hydraulic model (XPSWMM) was used to assess the sewer system within the City. The model was originally developed in the 1996 study (CG&S, 1996) and primarily represented the sanitary trunk sewer system. The model was used to assess existing and future conditions and management scenarios under the Pollution Control Plan alternatives.

The model was calibrated using 14 monitoring stations in 2006 and 2007, and dry and wet weather flows were simulated and compared to observed data

3.2.4.2.1 Key relevant deliverables and findings

Review of Current Projects (March, 2006)

Based on previous assessments, including the 1981 Master Plan report, there have been upgrades to the municipal system. These upgrades were documented in the Pollution Control Plan study as of March 2006 and involve sewer separation (Stanley Ave., Stanford Ave., McRae Ave and Sinnicks Ave), pumping station (Central Pumping Station) and the installation of high-rate treatment facilities (High-Lift Pumping Station and Muddy Run Pumping Station)..

Combined Sewer Overflows

The existing sewer infrastructure for the City of Niagara Falls consists of a network of storm, sanitary, and combined sewers, and sixteen (16) pumping stations. The sanitary and combined sewer systems discharge to the Niagara Falls-Stamford WPCP which is operated by the Regional Municipality of Niagara. There are presently 25 active combined sewer overflows (CSO) that are used for relief of surcharge and excess flows. The storm outfalls generally discharge to the Niagara River, the Welland River, the HEPC Canal, and to the tributaries of Shriners Creek and Pell's Creek. The CSO locations discharging to the HEPC from the Corwin Study Area include:

- Dunn & Caledonia
- Dunn & Dorchester
- Margaret & Warden
- McLeod Road

3.2.4.2.2 Key Recommendations

1. The Pollution Control Plan recommended the following actions:
    a. System-wide policy and programs, including continuing the implementation of the following programs and policies:
        i. Water Conservation
        ii. Roof Leader Disconnection Program
        iii. Lot grading control
        iv. Cross Connection control program
        v. Sewer flushing
        vi. CCTV inspections
2. Capital Works (Table 3.4)

Table 3.3: Capital Works Implementation (March, 2006)

CSO location	Recommended Alternative	Estimated Capital Cost	Priority Rank	Recommended Implementation Period
1. Dorchester Road PS	Sewer Separation	$1,650,000		2008-2010
2. Stanley Avenue	Sewer Separation	$3,500,000	3	2008-2012
3. Taro North	Weir/Overflow Adjustment	$10,000	4	2008
4. General Abrasive	Weir/Overflow Adjustment	$10,000	6	2008
5. Royal Manor PS	Weir/Overflow Adjustment	$10,000	7	2008
6. Bender Hill PS	Sewer Separation	$2,500,000	5	2011-2012
7. High Lift PS	HRT Facility	$5,200,000	2	2022-2026

3. Data Management

   The study recommended the following data management practices:

   a. **Updated Combined Sewer Mapping:** A GIS based map kept up to date showing pipes within the system which are still combined

   b. **Capital Works Database:** A GIS based database should be developed to show system improvements which address problem areas and alleviate CSOs and basement flooding.

   c. **Pump Station Records/Database:** A database should be developed and kept up to date with current pump station information.

   d. **Annual Report**: It is recommended that an annual report be prepared that provides a compilation and summary of the Data Management components 1, 2, and 3 above.

   e. **PCP Updates**: It is recommended that the PCP be updated every five years to determine the implementation success of the PCP and the future needs.

4 FLOW MONITORING PROGRAM REVIEW AND FIELD ASSESSMENT

This section summarizes both the City of Niagara Falls Flow Monitoring Program developed by GM Blue Plan in 2014, what currently exists for flow monitoring in the system as well as the subsequent field assessment recommended by A4B and conducted by the City of Niagara Falls for this EA.

4.1 Review of 2014 Flow Monitoring Program Report

4.1.1 General

The report summarizes the development of the flow monitoring program for the City of Niagara Falls Pollution Control Plan (2014). The project involved the selection of sites suitable for the installation of in sewer flow monitors to support a long-term flow-monitoring program including the analysis and quality control of the resulting flow data. The flow-monitoring program was conducted by City of Niagara Falls Staff via the use of 22 flow monitoring sites. This effort was supported by the Region of Niagara and a flow-monitoring contractor supplying seven flow meters and one additional flow meter, respectively, for a total of 30 sites

.

4.1.2 Flow Monitoring Locations

Sites selected were considered based on the need to provide the following:

- A hydraulic mass balance across the wastewater collection system network.
- Detailed flow monitoring in areas of repeated or systemic flooding,
- Calculation of dry weather and wet weather flow profiles for each of the 26 sewer catchment areas

Figure shows the 2014 flow monitoring locations. The flow monitors were assigned to the closest rain gauge within a 2 km radius of the monitoring site. For the Corwin drainage area, Flow Monitor NF05 for the sanitary system is the only one of relevance from this study.

Quality review of the selected monitoring sites was conducted that involved the review of three aspects of the flow data to determine and correct hardware issues, depth measurement adjustments and response to changes in the diurnal flow pattern:

- DWF magnitude and scattergraphs
- Manual site depth check and calibration
- Diurnal pattern validation

Flow monitors were relocated if the data quality was poor over a two-week period

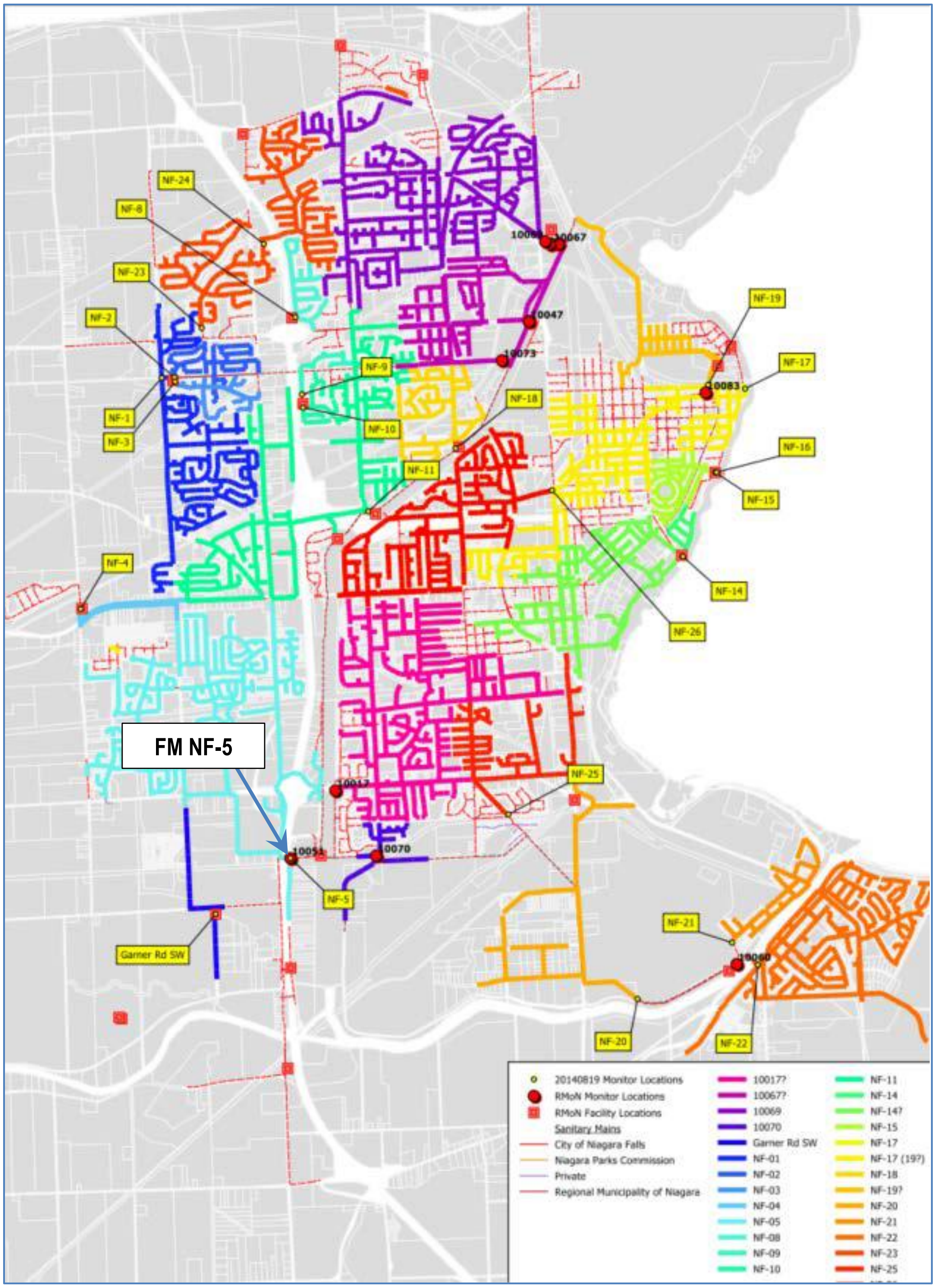

Figure 4.1: 2014 Flow Monitoring Locations (GMBP, 2014)

4.1.3 Key Findings

Table 4.1 from the report summarizes the results of the flow monitoring program for the City. In total, seven (7) rainfall events were selected as critical event characterized through the establishment of minimum rainfall depth and intensity criteria; these criteria are not specified in the report.

Table 4.1: 2014 Flow Monitoring Results (GMBP, 2014)

							Critical Events and CVs for 2014						
							May 13	June 3	July 7	July 8	July 27	July 29	September 5
Rain Gauge	**Flow Monitor**	**Location**	**Catchment (ha)**	**Population Equivalent**	**ADWF (L/s)**	**Per Cap. (L/s)**	**Total Rain 56.75**	**Total Rain 14.75**	**Total Rain 17.25**	**Total Rain 14.00**	**Total Rain 28.75**	**Total Rain 40.25**	**Total Rain 26.75**
Kalar SPS	1	West Influent to Kalar Road PS	110.9	3741	2.6	51							
	2	East Influent to Kalar Road PS	34.0	1723	1.2	50	15.5	3.9	5.4	6.8		13.0	
	3	North Influent to Kalar Road PS	19.7	658	2.0	183	4.0	0.4			1.3	4.9	4.0
	4	South Influent to Lundy Lane PS	51.7	4630	3.9	50			1.6	1.8	2.1	4.7	4.1
	8	East Influent to Rolling Acres PS	27.0	570	4.7	315			6.9	7.2			2.2
	10	South Influent to Meadowvale PS	13.2	638	0.1	1	3.0	0.1	0.1	0.3	0.1	0.6	0.2
	11	North Influent to Dorchester PS	130.1	6056	31.7	306	22.1	7.3	4.3	5.1	3.7	6.0	6.0
	12	West Influent to Dorchester PS	122.6	6953	26.7	176			13.9				
	23	South Influent Cardinal Drive	167.5	4347	16.3	191			1.9	3.1	2.3	6.0	2.5
	24	North Influent Canterburry Cr.	82.3	1965	11.4	229			3.7	5.8	3.7	9.8	2.5
Rain Gauge	**Flow Monitor**	**Location**	**Catchment (ha)**	**Population Equivalent**	**ADWF (L/s)**	**Per Cap. (L/s)**	**Total Rain 42.50**	**Total Rain 18.25**	**Total Rain 15.25**	**Total Rain 17.50**	**Total Rain 26.75**	**Total Rain 38.25**	
WWTP	14	East Influent to Bender Hill PS	7.4	344	0.5	90	8.4		6.7	8.8			
	18	Main Influent to Drummond Road PS	70.0	3119	8.0	145			5.6	2.4			
	26	West Influent Stanley and Valleyway	176.0	6482	3.3	43							
	AMG	Central PS	524.6	29628	245.7	501							32.6
	Regional	*10059 Thorold Stone Rd Permanent Meter*											
	Regional	*10073 Portage Rd 2014 Permanent Meter*											
	Regional	*10083 Park St 2014 Temporary Meter*											
Rain Gauge	**Flow Monitor**	**Location**	**Catchment (ha)**	**Population Equivalent**	**ADWF (L/s)**	**Per Cap. (L/s)**	**Total Rain 35.75**	**Total Rain 13.00**	**Total Rain 17.25**	**Total Rain 16.75**		**Total Rain 52.75**	**Total Rain 34.00**
WTP	20	East Influent Chippawa Parkway	155.3	19283	8.3	17			3.4	5.5			2.7
	21	South Influent Chippawa Parkway	44.7	3738	8.8	57			3.1	3.3			
	22	West Influent Main and Lyons Creek	152.0	4326	27.6	196			7.1	8.2			9.9
	25	South Influent Crimson Drive	181.7	7463									
	Regional	*10060 SS Low Lift 2014 Permanent Meter*											
Rain Gauge	**Flow Monitor**	**Location**	**Catchment (ha)**	**Population Equivalent**	**ADWF (L/s)**	**Per Cap. (L/s)**	**Total Rain 35.75**	**Total Rain 13.00**	**Total Rain 17.25**	**Total Rain 16.75**		**Total Rain 52.75**	**Total Rain 34.00**
SS Highlift SPS	*Regional*	*10051 Oakwood 2014 Permanent Meter*											
	Regional	*10017 McLeod 2014 Permament Meter*											
	Regional	*10070 Dorchester Rd 2014 Permanent Meter*											

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- Shaded cells indicate that the flow meter was either not installed or did not pass quality review at the time of the event.
- Regional sites underwent quality review for these events however RDII CV was not calculated.

4.1.4 Key Gaps / Limitations

- For the Corwin Drainage Area, there is only one sanitary sewer monitor located within the catchment area. Furthermore, there are no storm sewer flow monitors. Meetings with the CoNF were heled in June 2018 to define the flow monitoring required for the storm system which is discussed below in Section 4.2.

4.2 Field Assessment

The objective of the field assessment is fill in the gaps in the data required to accurately assess the drainage system that includes determining the locations for additional flow monitoring and investigating areas of missing and questionable data.

4.2.1 General

Aquafor and the City of Niagara Falls discussed the need for additional flow monitoring data for the Corwin drainage area as well as field investigation to trace the sewers around the McLeod Avenue CSO/SSO tank and possible cross-connections between the storm and sanitary systems at various locations within the drainage area in meetings held in June and July 2018. Field surveys were carried out by City staff in July and August of 2018.

Key components of the field survey may include:

- Determine locations for flow monitors;
- Assessment of cross-connections and CSO's;
- Smoke and Dye Testing;
- MH survey to confirm structure, system connectivity and invert elevations;
- CCTV inspections;
- Private property inspections;
- Topographic and Geo-technical survey of the study area.

City staff indicated that an additional three (3) flow monitors would be made available to supplement Flow Monitor NF 5 near the South-Side High Lift Pumping Station. Aquafor reviewed the sewer network provided in the model to pre-select potential locations for flow monitoring of the storm sewer system.

4.2.2 Key Findings

The following summarizes the results of the field survey to update and expand the hydrologic and hydraulic model and well as studies that may need to be carried out.

4.2.2.1 Flow Monitoring Locations

Aquafor and City staff identified three (3) locations for additional flow monitoring within the storm sewer system. Site selection criteria includes both technical and safety considerations. High vehicular traffic sites are less preferred if the same technical objective can be achieved in less trafficked areas. In addition, all flow monitoring stations were intrinsically safe area-velocity meters. Four (4) key technical site selection considerations include:

1. Flow monitoring stations must characterize flow generation from known flooding areas (reported flood location clusters). These areas are fully-characterized through the data collection and the enhanced field survey including downspout connection investigation and catchbasin-type-location

inventory. These locations provide ideal monitoring sites for future remedial option performance evaluation (measure before and after implementing remedial options);
2. Stations were located to capture the flow from representative tributary areas so that the results can be generated to other non-monitored areas;
3. Stations were located in satisfactory hydraulic sewer conditions to allow for the highest accuracy and reliability;
4. Flow monitoring locations were located in readily-accessible locations, preferably away from high-traffic control requirement areas or deep sewers.

The City's operations staff confirmed and finalized the flow monitoring locations in June, 2018 and were installed in the locations listed below in August, 2018 as summarized in Figure 4.2:

- Dunn Street west of Drummond Road
- Dunn Street and Carlton Avenue intersection
- McLeod Road and Jubilee Drive

The High-Lift Rain Gauge was deemed sufficient (within 2 km of the study area) by City staff for flow monitoring and calibration of the model.

4.2.2.2 CSO's and Cross Connections

City operations staff located, and field investigated the combined system maintenance holes (MHs) near the McLeod CSO/SSO tank with CCTV/dye test. An understanding of the network connections was sketched and compared to the existing as-built drawings and GIS data. A detailed summary of this assessment can be found in Section 7.

It was confirmed with the maintenance hole field surveys that cross connections exist along Franklin Ave. The cross connections area summarized below:

- The northern section of the storm system along Franklin Ave outlets into the 825mm storm sewer on Culp St and flows westbound. A separate subcatchment starts south of Culp St at maintenance hole DMH_01610 and drains southbound;
- There are two catch basins (CB) in the area that are connected to the sanitary sewer system; one is located at the intersection of Monroe St and Franklin Ave, the CB on west side of Franklin Ave discharges into SMH_03252; the other is at Ash St and Carlton Ave intersection, the CB at NE corner connects to the sanitary manhole SMH_03279;
- At Ash St and Franklin Ave intersection maintenance hole DMH_01450 is connected to the adjacent sanitary sewer SGM_04518, the sanitary sewer pipe breaks into the storm maintenance hole.

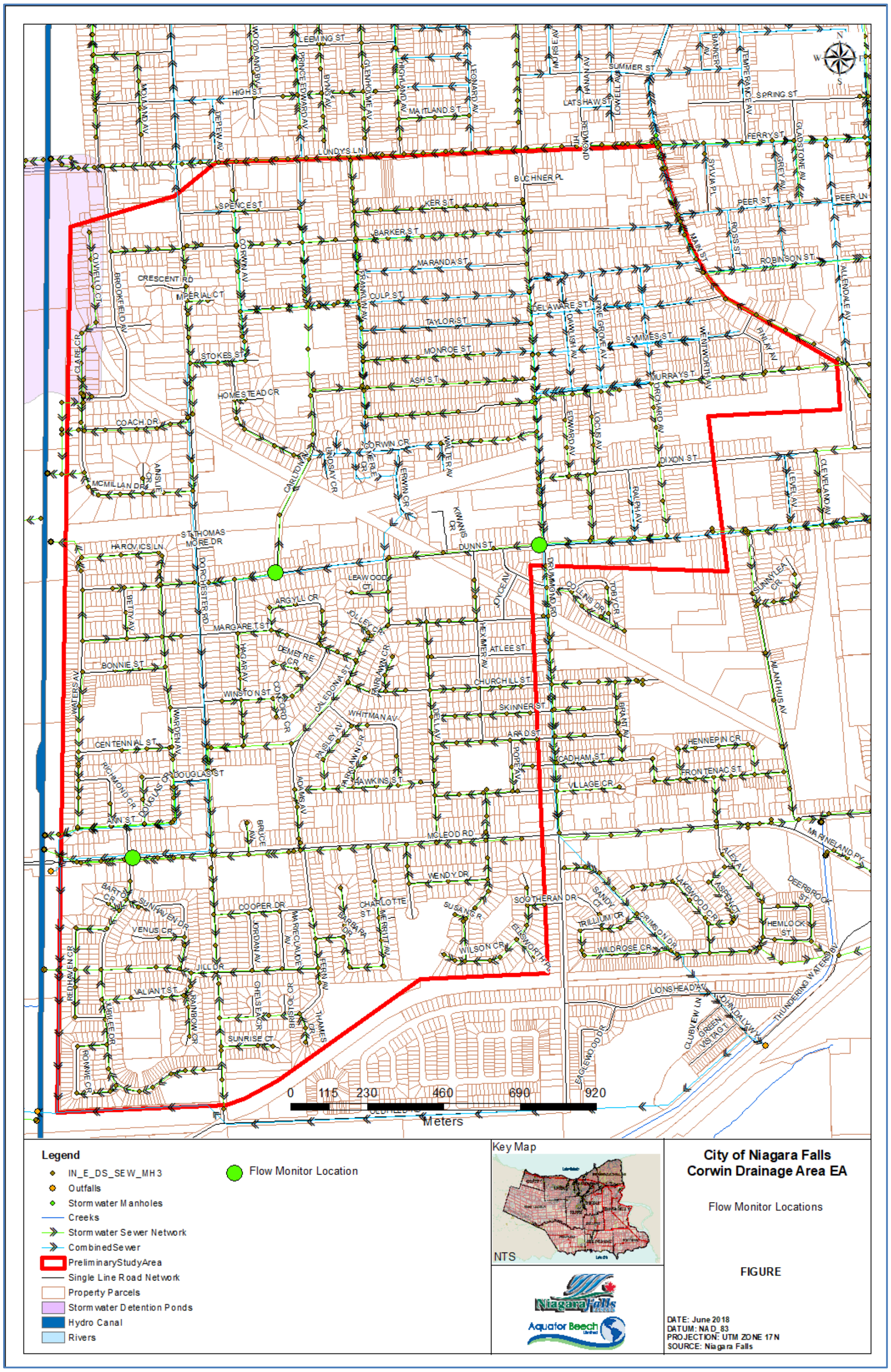


Figure 4.2: Proposed FM Locations

4.2.2.3 Smoke and Dye Testing

Smoke and dye testing are used to trace the connections to private properties as well as the minor system connections upstream and downstream. For private property investigations, smoke and dye testing is used primarily to trace the connectivity of downspouts and foundation drains to the storm and sanitary systems. For sewer infrastructure dye testing traces the downstream connectivity or the minor system.

For private properties smoke and dye testing will be recommended based on an assessment of private property.

Dye testing is recommended in the area around the McLeod tank to confirm that flows are directed into the trunk sewer draining to the South Side High Lift station.

4.2.2.4 MH Field Survey

A MH inspection program will be recommended based on an assessment of the hydraulic and hydrologic model to determine missing / questionable invert elevations found in the Data Gap Analysis.

4.2.2.5 CCTV Inspections

CCTV inspections were carried out by the CoNF contractor BRS Construction for the combined sewers upstream of the McLeod Tank based on the recommendation for a field survey in the June 13th, 2018 meeting with City Staff with the key findings summarized in Section 4.2.2.2.

City staff indicated that further CCTV work in pending for the sewers in the Corwin drainage area.

4.2.2.6 Private Property Inspections

As discussed, private property inspections will be required to confirm connection of the downspouts to the sewer system. A visual assessment will be conducted using desktop assessment prior to recommending a field review of properties where connection is suspected or if the property is in one of the flood clusters identified in the MPUS.

4.2.2.7 Topographic and Geotechnical Survey

The Topographic and Geotechnical Survey Is detailed in Section 6.

5 DATA GAP ANALYSIS

A gap analysis was conducted on the model and infrastructure data to determine areas where more information would be needed to update the model, confirm the flow direction and the cross connections between the storm and sanitary (combined) sewer systems.

A review of the data gaps is summarized below:

Table 5.1: Data Gap Summary Table

Data Gap	Resolution
H&H Model	
The InfoSWMM Storm Sewer model contains only the trunk system (pipes >= 600 mm diameter) that is not calibrated;	The City's GIS network, XPSWMM model network data from the MDPUS, as-built drawings and field survey data were used to expand the network and fill in the gaps in the model.
The physical interconnections between the storm and combined systems are not modelled. Rather the interconnections are represented as storm subcatchments draining to a sanitary node.	The physical connections were created in InfoSWMM to model the overflows.
Storm subcatchment parameters for depression storage are constant throughout the drainage area and are not adjusted for each subcatchment area.	The subcatchment parameters will be adjusted during the model calibration.
Storm subcatchment areas not defined pipe-by-pipe for combined system.	Subcatchment areas to be delineated for combined system
Number and type of Catch Basins are not defined in the model.	CB head discharge curves for each storm node to be added into the model based on field survey.
Not all CSO locations are represented in the model.	As-built drawings and field survey results used to input CSO locations.
The major overland system is not represented in the model.	The major system will be added based on road cross-sections derived from as-built drawings.
Infrastructure and As-built Data	
The City's GIS database contains all pipes and nodes for the storm sewer system, however there are significant gaps in the invert elevation data for pipes and nodes	XPSWMM model from MDPUS and as-built drawings used to supplement data to update the model.
The infrastructure connectivity around the McLeod CSO/SSO facility is not clear between the as-built drawings and the model	A field investigation and follow-up CCTV work confirmed the connectivity of the system.
Monitoring Data	
There is no storm sewer flow monitoring data for calibration of the model.	Flow monitors installed by the City in three (3) locations of the storm sewer system.
Updated drawings area required for streets reconstructed since the MDPUS.	Current drawings provided by the CoNF.

6 MCLEOD CSO/SSO TANK FACILITY FIELD INVESTIGATION

6.1 General

The McLeod Road CSO/SSO facility is located south of McLeod Road immediately upstream of the outfall to the HEPC. The original function of the facility was primary treatment of combined sewer and sanitary sewer overflows from the trunk combined sewer draining an area of approximately 215 ha. Drawings of the facility date back to 1948 which is assumed to be around the time the facility and outfall were constructed. **Figure 6.1** shows the location of the tank (south west corner) in relation to the surrounding infrastructure and the HEPC.

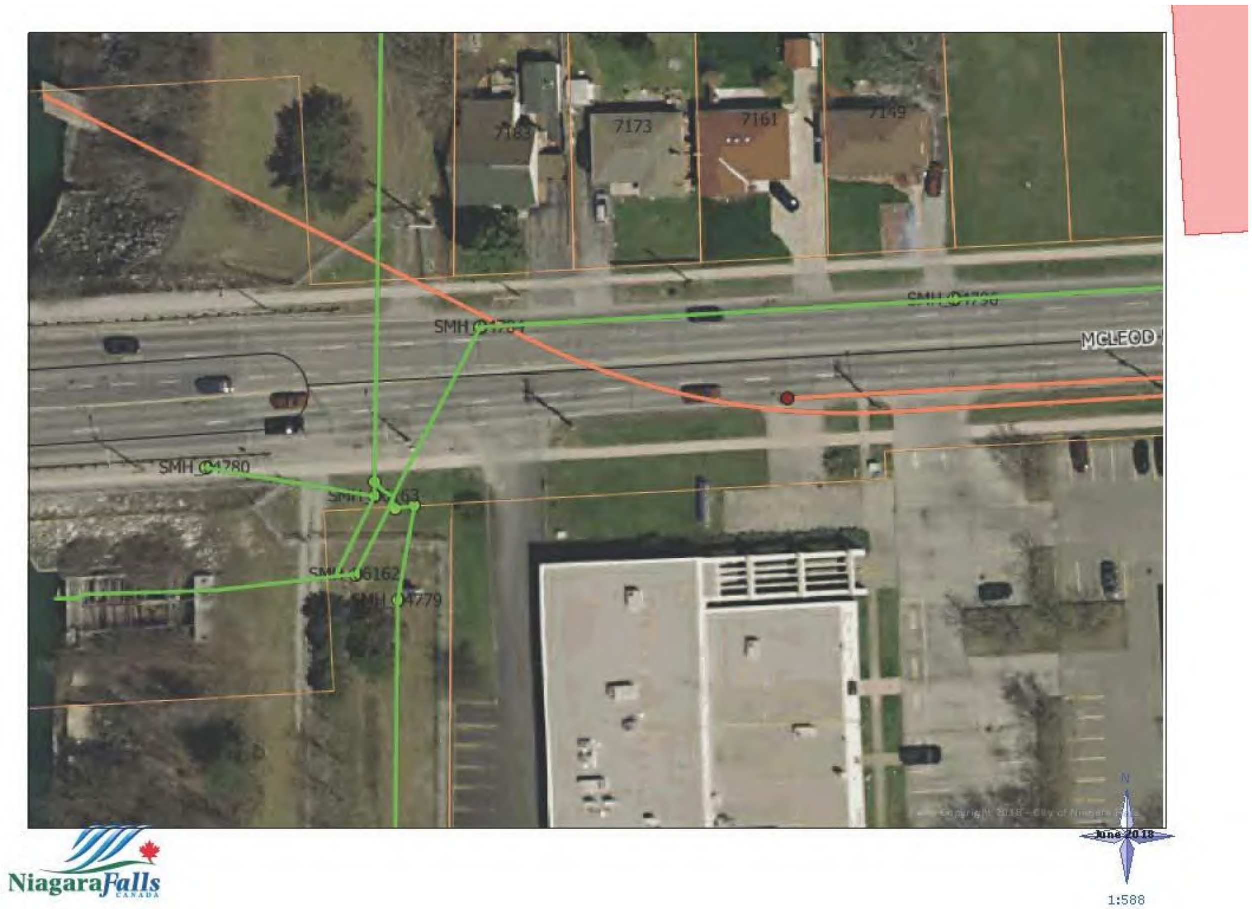


Figure 6.1: McLeod CSO/SSO Tank Location

6.2 Objective

The objective of the investigation was to establish the existing condition of the facility and outfall, confirm the layout of the sewer network and location of the overflow structures that drain towards the facility and investigate its possible permanent decommissioning.

6.3 Field Investigation

The field investigation of the tank and outfall was conducted in June and July 2018. The investigation ascertained the current condition of the tank and outfall as well as the surrounding sewer infrastructure.

6.4 Review of As-built Drawings

The City provided the as-built drawings for the tank and HEPC as well as the control structure upstream of the tank.

Figure 6.2 depicts the as-built drawing of the tank. The settling tank is designed with two main spillways where flows are attenuated in a series of chambers where flows overflow into the next chamber via a plate baffle that aids in maintaining laminar flow. Flows exit the settling tank and are discharged to the HEPC via a 1,050 mm (42 inch) diameter outfall. Flows that exceed the tank capacity are bypassed via a 1,050 mm (42 inch) overflow sewer conveyed directly to the outfall.

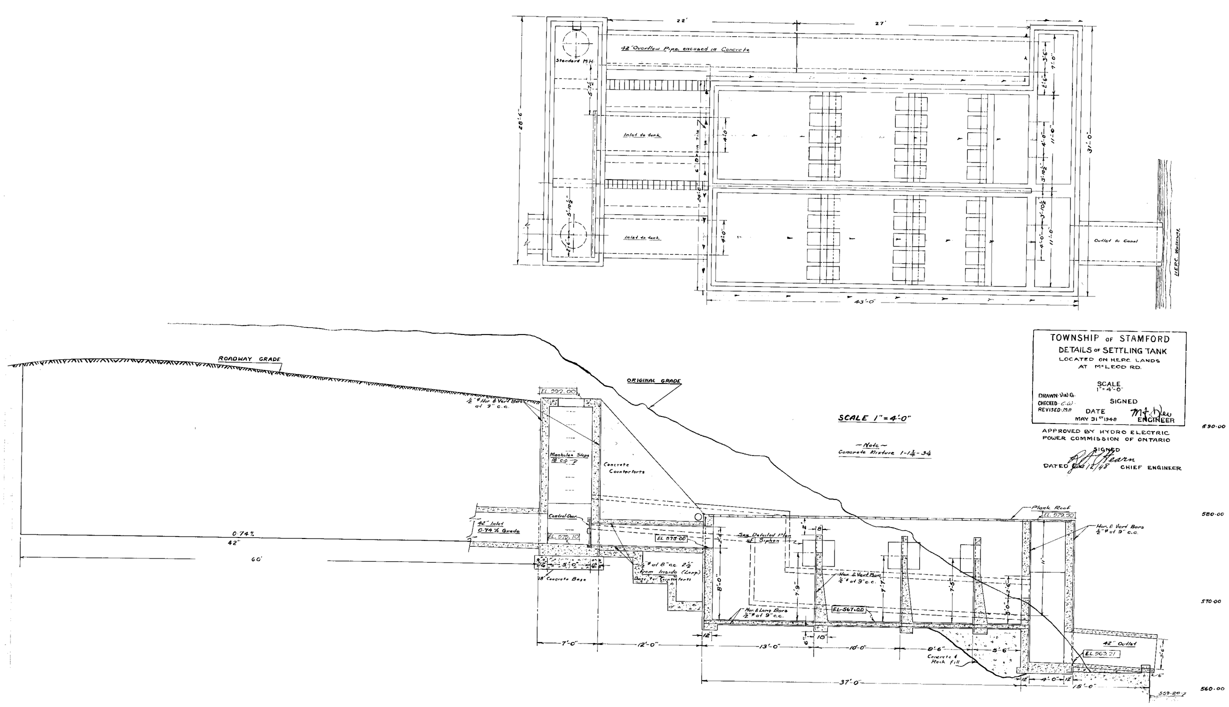


Figure 6.2: McLeod CSO/SSO As-Built Drawing

6.5 Site Condition Survey

A field visit was conducted on June 13th, 2018 to ascertain the current conditions of the facility and assess its state of functionality. The investigation revealed that the facility is non-functional. Figure 6.3 shows the condition of the upstream and downstream ends of the facility. A large amount of vegetation resulting from accumulated sediments and general dis-use exists in within the settling tank with the tank structure in a state of disrepair; the tank is non-functional from the original design. No evidence of flow movement through the tank chambers was observed at the time of the investigation (rainfall for the previous month was minimal, therefore there would have been insufficient amounts of rainfall for overflow conditions).

Figure 6.3: McLeod CSO/SSO Tank and Control Structure

The outfall at the far side of the tank that outlets into the HECP was not investigated due to its location in the HEPC that did not allow for accessible viewing.

6.6 Follow-up Field Survey Summary

The City conducted a follow-up field survey of the surrounding sewer infrastructure leading to and around the facility to determine if the tank still receives upstream flows. The field survey included physical observation and measurements of inverts, dye testing and CCTV. The understanding of the of the infrastructure upstream of the tank is summarized below and is shown in Figure 7.4 (Model data shown to the left in comparison to the field sketch on the right):

City operations staff located, and field investigated the combined system MHs near the McLeod CSO/SSO tank with the CCTV/dye test. An understanding of the network connections was sketched as per Figure 6.4. Maintenance holes SMH_04784 and 10000366 were suspected to be connected to each other, with a weir in the sewer to detent the combined flow. A review of the as-built drawings also indicated that two MHs in the model (SMH_04781 and SMH_06163) are part of the same structure in Regional MH10000366 and verified in the field survey. Primary flow is directed to the trunk sewer draining towards the South-Side High Lift station while an overflow sewer to the tank still exists and currently listed as active, however, given the state of the facility, it is assumed that all flow is directed to the trunk sewer draining to the high-lift station. It is noted that at the time of this report, additional CCTV of the said part of the system has yet to be completed to confirm field observations.

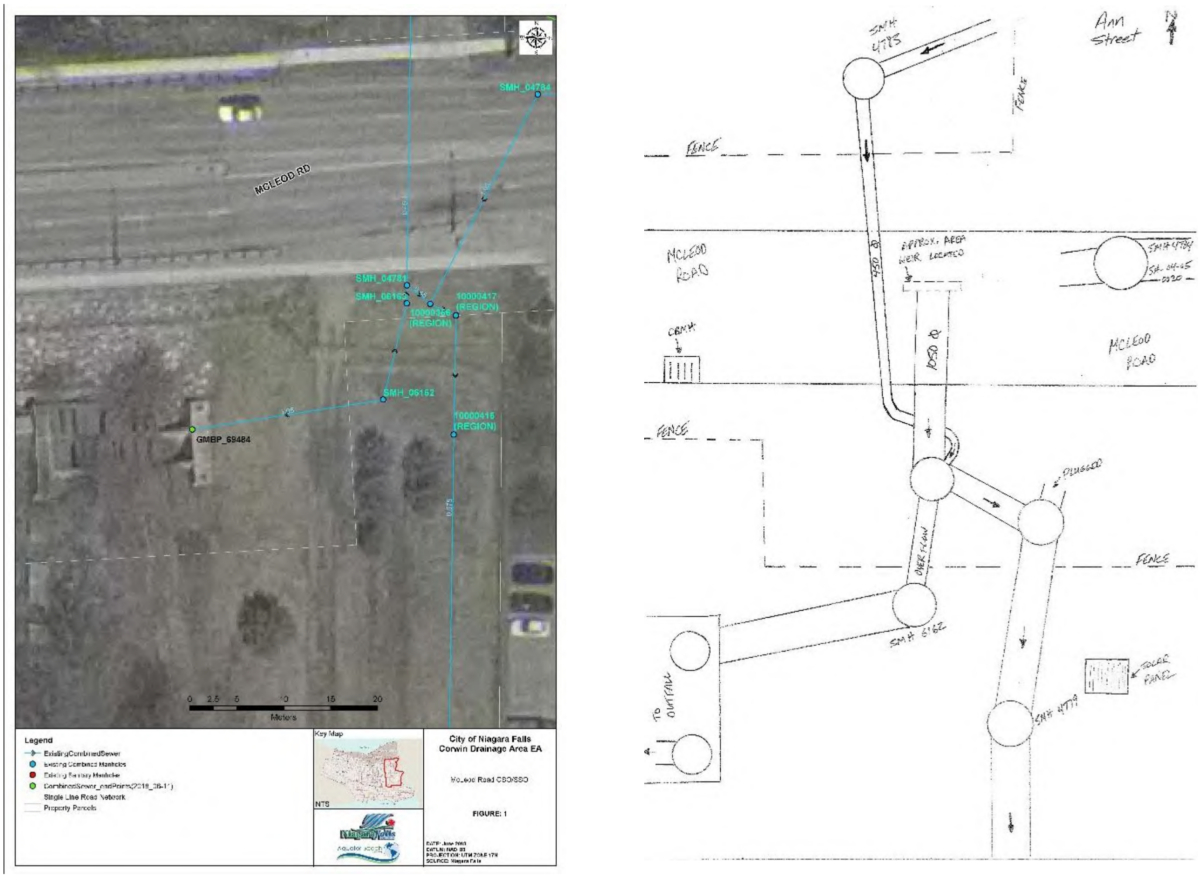


Figure 6.4: McLeod Tank Field Verification

6.7 Key Findings and Recommendations

The results of the field investigation of the McLeod tank are summarized below:

- Given the tank's non-functional state and the conditions at the time of the field investigation, it is likely that the tank no longer receives flows, however if an event did result in overflow towards the tank, these flows are very likely bypassed directly to the HEPC via the 1,050 mm diameter bypass sewer;
- The baseline hydraulic model will need to be updated with the field survey results to reflect the existing conditions at the McLeod CSO/SSO outfall;
- The City has indicated its desire to permanently decommission the McLeod Avenue CSO/SSO facility as part of the preferred solutions. Therefore, each of the alternative solutions will eliminate the McLeod Avenue outfall.

7 HYDROLOGIC AND HYDRAULIC MODEL

7.1 General

This section will detail the hydrologic and hydraulic model completed in InfoSWMM and will summarize the existing model and scenarios, model update, flow monitoring and calibration and assessment of the performance of the existing drainage system.

7.2 Baseline Model Review and Gap Analysis

The City-wide InfoSWMM H&H model was reviewed and checked for gaps in the model network, model and simulation parameters and rainfall event data. The data gaps were summarized, and a methodology developed to close the gaps such that there will be confidence in the results going forward to establish the existing conditions. The model

7.2.1 Model Overview

The InfoSWMM model received contained the following networks and rainfall event data:

- City-Wide Sanitary and Combined Network
- City-Wide Trunk Storm Drainage Network
- Rainfall Event data for the following design storms
    - 2yr, 5yr, 10yr, 25yr, 25yr, 50yr and 100 yr 4h Chicago Design Event
    - Average WWF
    - Average DWF

It was noted that this was primarily a minor system model with no major system defined. Additionally, the level of service is not defined.

The model contains the following scenarios:

- Existing Conditions
- 25% I&I Reduction from Existing
- 50% I&I Reduction from Existing
- 75% I&I Reduction from Existing
- 2014 Growth Scenario

7.2.2 Review of the Minor and Major System Model

The minor system represents the sewers and associated conveyance and storage infrastructure while the major system represents the overland drainage flows. This section assesses and summarizes the existing model for both systems and identifies gaps in the data and potential resolutions as well as methodology for updating the existing model to reflect the study area conditions.

7.2.2.1 Minor System

The minor system consists of the combined, sanitary and storm sewer system. A schematic is presented in Figure 7.1 depicting the typical connections from house to sewer for a fully separated area.

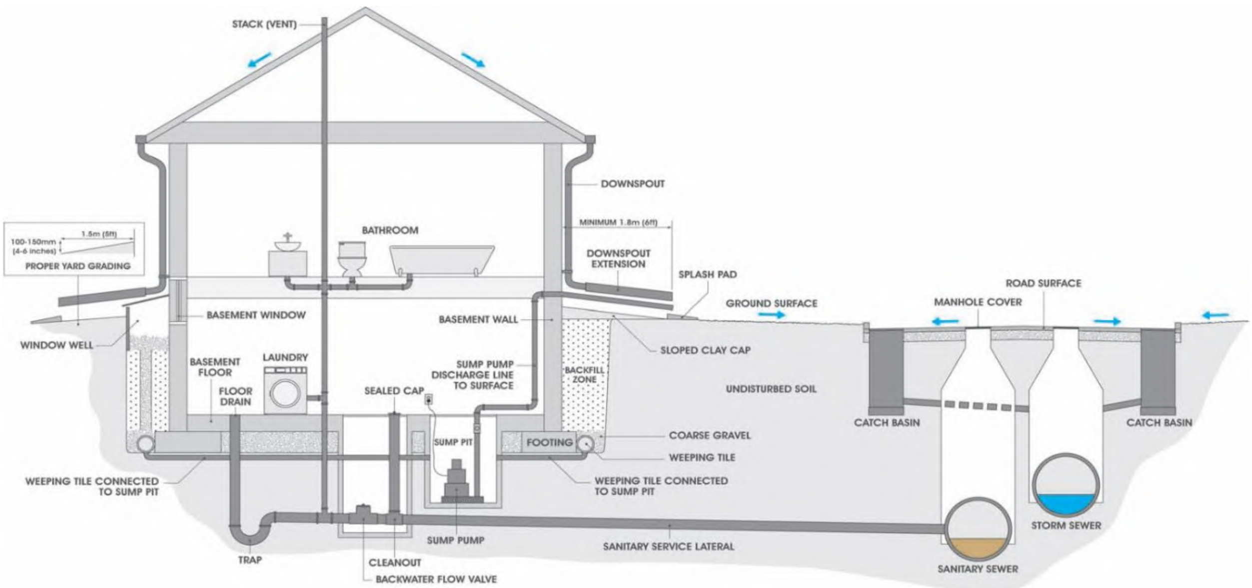


Figure 7.1: Minor System Overview

Sanitary flows are conveyed to the wastewater treatment facility. The storm sewer is a system designed to carry rainfall runoff and other drainage (excess rain and ground water from impervious surfaces such as paved streets, parking lots, sidewalks and roofs). Given that the northern part of the study area has combined sewers, it is important to incorporate those sections that overflow into the sanitary sewer.

Based on discussions with the City, cross connections exist between the storm and sanitary system in the form of catch basins connected to the sanitary system and storm overflows into the sanitary system. The model as it exists does not capture the cross connections explicitly, but rather has storm subcatchment areas associated with sanitary nodes receiving direct inflow of wet weather flow.

The InfoSWMM model does not explicitly address downspout connectivity. Connection of downspouts to the minor system is a major contributor to inflow into the minor system. Downspout disconnection can be simulated using a combination of node and orifice to represent the roof downspout. Surcharging of the "roof" node will represent the disconnected portion that is directed to the surface.

7.2.2.1.1 Wastewater System

The sanitary and combined model is an "all pipes" model with pipe sizes ranging from 200 mm and up and shown in Figure 7.2. There are 1,100 pipes in the study area ranging in sizes from 200 mm to 1050 mm.

For the Corwin study area, the main outlet for the combined and sanitary sewer is the south-side High-Lift Pumping Station with CSO discharge to the McLeod Road outfall. There are currently 8 CSO's that were identified in the model.

There are no sanitary subcatchment areas associated with each pipe in InfoSWMM. The parameters for the wastewater system for nodes and conduits include the initial flow determined by the average diurnal flow pattern for dry weather flow (DWF) based on drainage area population and RDII parameters for inflow and infiltration into the system.

The sanitary and combined system appears to be complete in the InfoSWMM model, however questionable data existed for the sewers in and around the McLeod CSO/SSO tank area. The field survey conducted as part of the field assessment revealed that the tank has been rendered inactive and that additional CCTV work is required to assess the connectivity with the trunk sewer draining to the South Side High Lift Pumping Station beyond the south west end of the study area.

For the partially separated areas, storm subcatchments appear to have been defined for nodes where inflow via catch basins or cross connections from the trunk storm sewer system exist; these will be refined to include connectivity of the major and minor system.

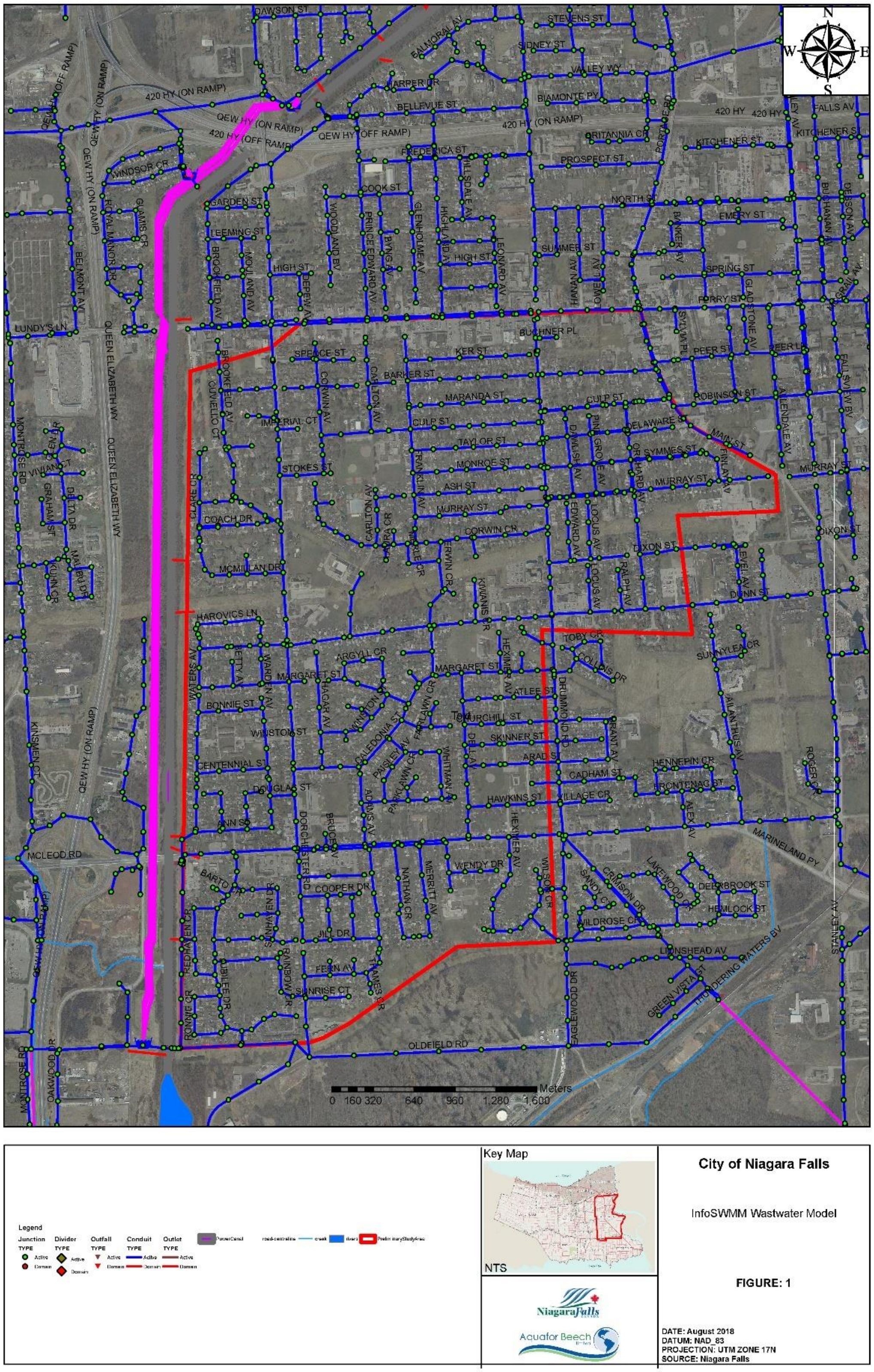


Figure 7.2: InfoSWMM Wastewater Model (CoNF)

7.2.2.1.2 Storm Sewer System

The storm model is a trunk sewer model with pipe sizes ranging from 600 mm diameter and up. There are approximately 330 pipes modelled within the study area draining towards four (4) outfalls at the HEPC as shown in Figure 7.3.

As part of this study, the model needs to be expanded to include all pipes as well as cross connections between the storm and sanitary sewer. The XPSWMM model from the MDPUS will be used as the basis for expanding the storm sewer network that will be supplemented with the City's GIS data for storm sewers smaller than 600 mm diameter. For areas that connect to the combined system, as-built drawings and field survey results will be used to update the model which will be validated prior to the model calibration.

<u>Subcatchments</u>

The storm subcatchment delineation in the InfoSWMM model follows an approach using a combination of pipe-by-pipe and lumped subcatchment areas along with storm subcatchments defined in the combined area to represent inflow into the sanitary system via surface flow from either catchbasins connected to the sanitary system or to represent I&I. The subcatchment delineations in the model are shown in Figure 7.4. In our experience, pipe-by-pipe delineation for all sewers is required to accurately calibrate the model. As such, subcatchment areas defined in the MDPUS using XPSWMM are to be imported into the InfoSWMM model as part of the model expansion and subcatchment area re-definition.

The subcatchment parameters are based on the land-use and include: percent impervious, depression storage, ground infiltration and flow length. The model uses a constant value of 5% for depression storage and the ground infiltration uses the InfoSWMM default. For calibration purposes, the depression storage value will be adjusted where necessary to better reflect actual conditions.

For ground infiltration, updated bore hole information is required to input the appropriate soils and Horton infiltration parameters. The ground infiltration parameters will reflect the different soil regimes in the north and south parts of the study area as mentioned in Section 3.

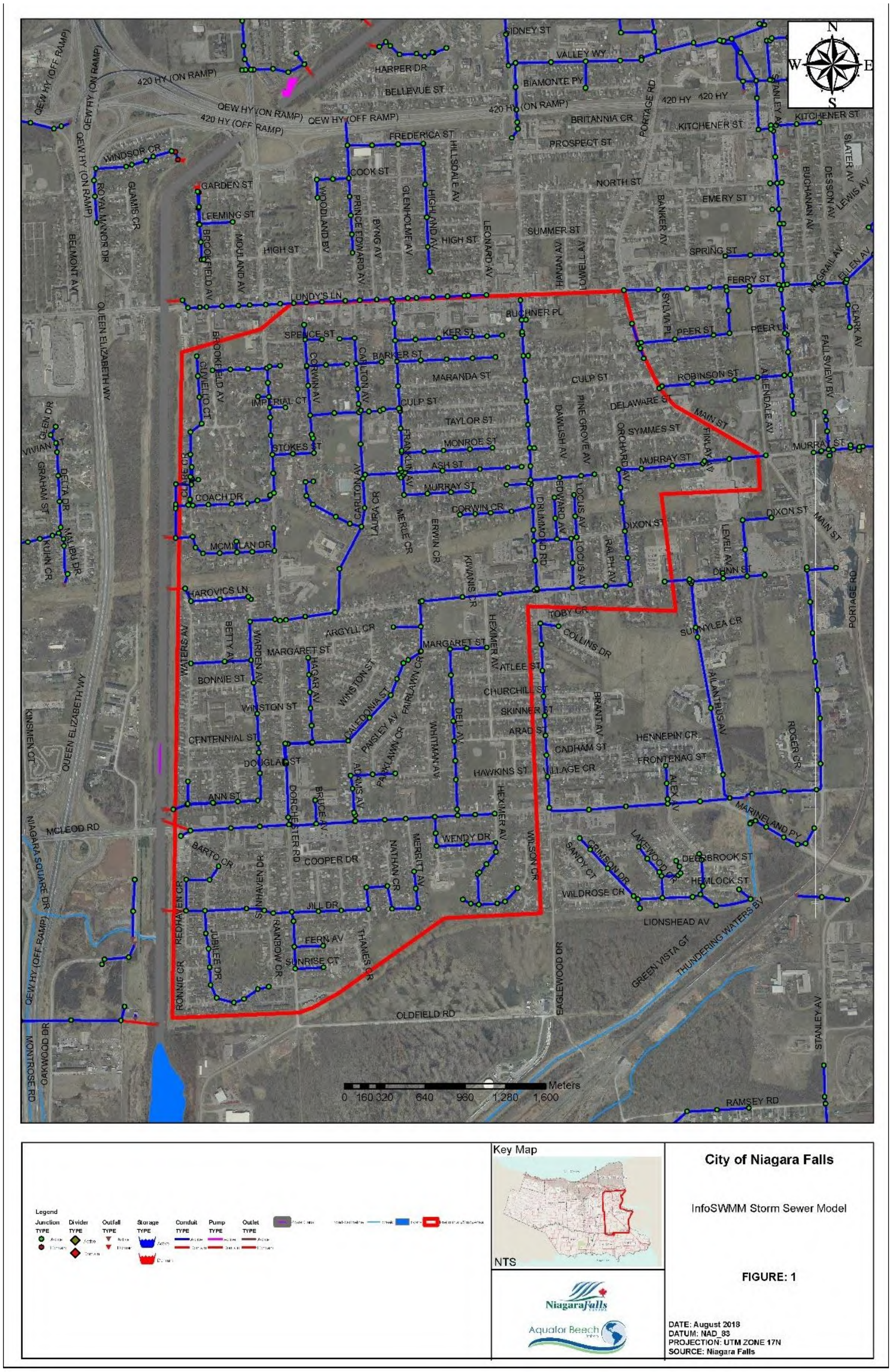


Figure 7.3: InfoSWMM Stormwater Model (CoNF)

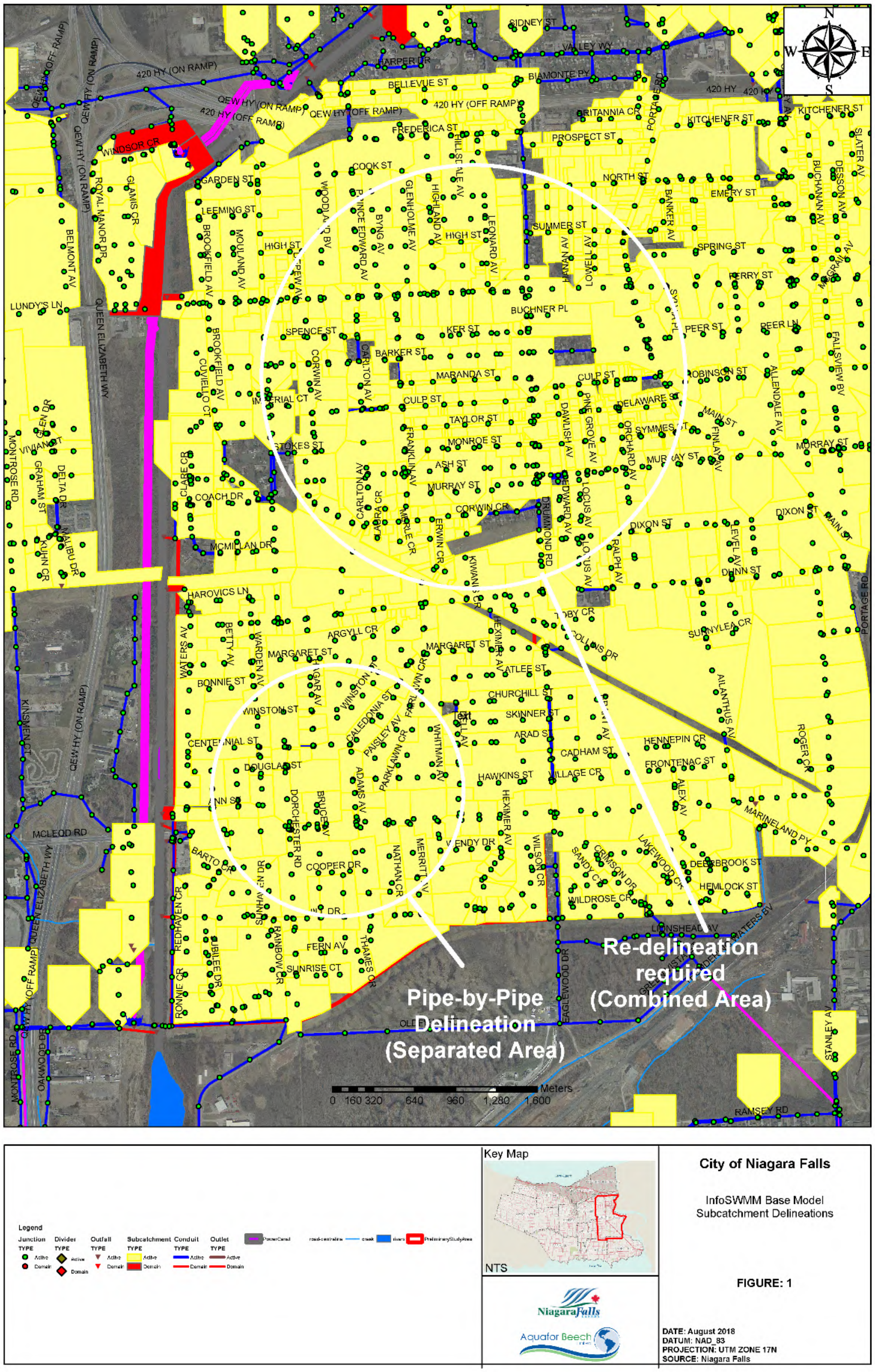


Figure 7.4: InfoSWMM Base Model Subcatchment Delineations

Catch Basin Inlet Capacities

The number types of catch basins are not defined and will be determined at each node. In InfoSWMM, catch basins at each node can be defined by the head-discharge relationship. The catch basin inlet capacities will have to be defined based on inlet type to determine the flows entering the system and the accumulated ponding depth on the road right-of-way. The governing head-discharge relationship based on the type of catch basin grate and the lead pipe will be verified and assigned to each node. The City of Toronto's Basement Flooding InfoWorks CS Modelling Studies Guideline provides an excellent reference for head-discharge relationships based on catch basin and manhole cover type at various slopes and will be added to the model.

7.2.2.2 Major System

The major system has not been defined in the model.

The major system is the overland flow system where runoff is conveyed along the surface to the CB's that inlet to the minor system. Flows attenuate in the major system when the minor system surcharges to the surface. Currently there is no major system defined in the model.

When rain falls it is important to understand where the runoff goes, as this flow pattern will define the amount of water in each of the sewer systems. For example, if the roof downspout is directly connected to the storm sewer then virtually all of the water will make its way to the storm sewer system. Alternatively, if the downspout discharges to the ground then some of the flow will infiltrate into the ground, thereby reducing the amount of flow which makes its way to the storm sewer system.

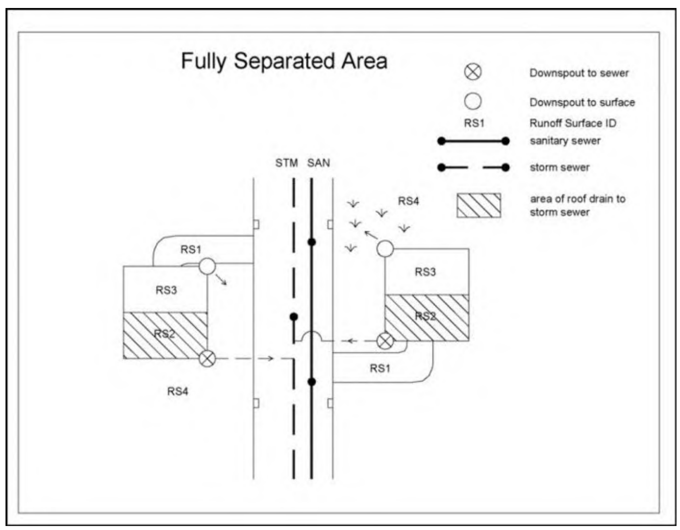


Figure 7.5: Runoff Surfaces

InfoSWMM has a dual drainage tool to help define the major system. The streets are modelled as wide shallow open channels to reflect the appropriate geometry, cross section and channel roughness. The overland channel invert levels are set at the MH cover elevations so that flows into the overland channels can occur when there is flooding out of the maintenance holes from the minor drainage system or when the flow is restricted into the minor system at the catchbasin based on the catchbasin inlet capture capacity. The inlet capture capacity of the catchbasin defines the limit of inflow/outflow between the pipe and overland networks.

The typical roadway channels defined to represent local and collector roads consisted of user defined cross sections. The typical cross sections are derived from the local and regional road-right-of-way specifications. Typical configurations for a road cross sections include a right-of-way (ROW) width of 20 metres with a height

of 0.30 metres for local roads, and a ROW width of 26 metres and a height of 0.30 metres for collector roads. In the Corwin study area, there are older sections where the cross sections narrow to as little as 6.0 metres for the right-of-way width. Adjustments are made to the network as necessary, such as additional nodes, overland segments, invert adjustments, etc., to replicate the overland flow paths predominately associated with roadways. The accompanying graphic below illustrates a typical urban roadway cross section
.

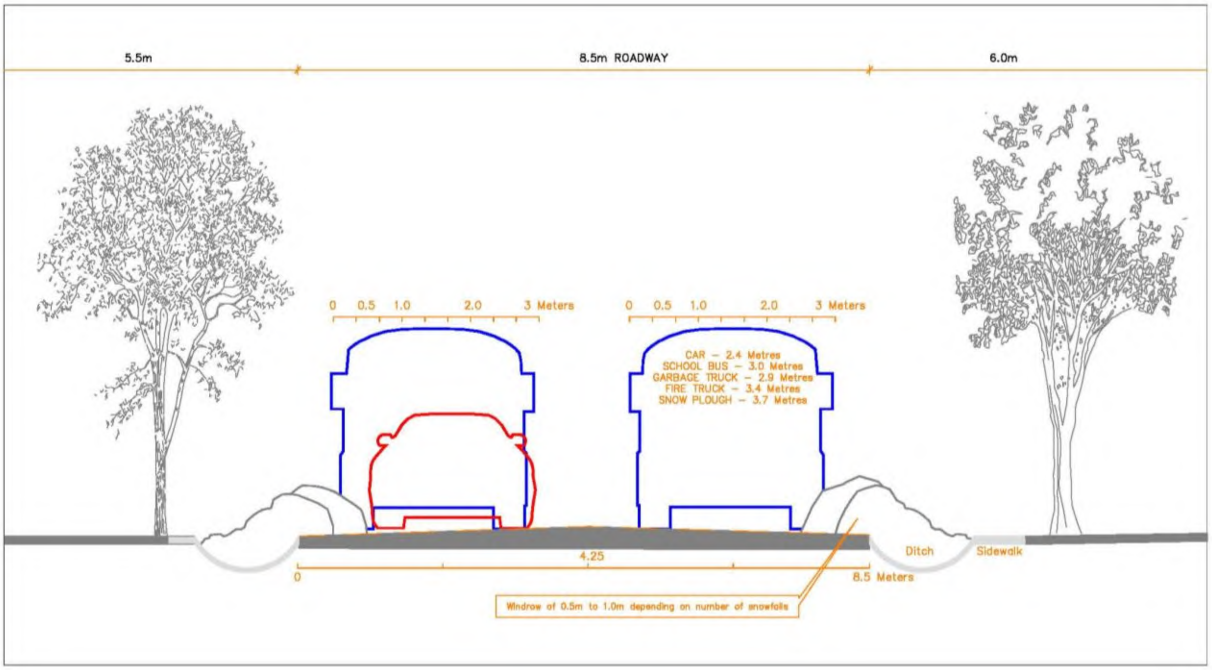


Figure 7.6: Major System Example

7.2.3 Design Storm Events

The following design events are included in the existing model:

- 2yr, 5yr, 10yr, 25yr, 25yr, 50yr and 100 yr 4h Chicago Design Event

The design event is based on the 4-hour Chicago Storm. The typical year (25 mm) event was added to the model that is based on the local IDF. These events are used to model the updated existing conditions and proposed solutions.

Event scenarios that were run in the City-wide model reflected the general conditions of: existing, I&I reduction targets of 25%, 50% and 75%, and future growth to 2041. For the purposes of this study, the MOECP has developed a climate change tool that will be used to model various climate change scenarios that will be detailed in the existing conditions assessment.

7.2.4 Data Gap Analysis

The objective of the gap analysis is summarized below:

- Identify and summarize data gaps in the model for the study area;
- Develop the methodology to update the model.

An initial validation of the InfoSWMM model was conducted to identify any anomalies that occurred in the pipe network. The following table summarizes the findings in the gap analysis:

Table 7.1: Observed Data Gaps in the H&H Model

Data Gap	Resolution
The InfoSWMM Storm Sewer model contains only the trunk system (pipes >= 600 mm diameter) that is not calibrated;	The City's GIS network, XPSWMM model network data from the MDPUS, as-built drawings and field survey data were used to expand the network and fill in the gaps in the model.
The physical interconnections between the storm and combined systems are not modelled. Rather the interconnections are represented as storm subcatchments draining to a sanitary node.	The physical connections created in InfoSWMM to model the overflows.
Storm subcatchment parameters for depression storage are constant throughout the drainage area and are not adjusted for each subcatchment area.	The subcatchment parameters adjusted during the model calibration.
Storm subcatchment areas not defined pipe-by-pipe for combined system.	Subcatchment areas manually re-delineated for combined system
Number and type of Catch Basins are not defined in the model.	CB head discharge curves for each storm node added into the model based on field survey.
Not all CSO locations are represented in the model.	As-built drawings and field survey results used to input CSO locations.
The City's GIS database contains all pipes and nodes for the storm sewer system, however there are significant gaps in the invert elevation data for pipes and nodes	XPSWMM model from MDPUS and as-built drawings used to supplement data to update the model.
The infrastructure connectivity around the McLeod CSO/SSO facility is not clear between the as-built drawings and the model	A field investigation and follow-up CCTV work confirmed the connectivity of the system.
The major overland system is not represented in the model.	The major system will be added based on road cross-sections derived from as-built drawings using the InfoSWMM dual drainage tool
There is no storm sewer flow monitoring data for calibration of the model.	Flow monitors installed by the City in three (3) locations of the storm sewer system.
Updated drawings area required for streets reconstructed since the MDPUS.	Current drawings provided by the CoNF used to update the model.

7.3 Existing Storm, Sanitary and Combined Sewer Systems

7.3.1.1 General

This section will detail the hydrologic and hydraulic model completed in InfoSWMM and will summarize the existing model and scenarios, model update, flow monitoring and calibration and assessment of the performance of the existing drainage system.

There were two models that were reviewed and modified during the study. One was the city-wide InfoSWMM H&H which was developed by GM Blue plan. This model includes a city-wide sanitary/combined network and city-wide trunk storm drainage network. This model was reviewed and checked for gaps in the model network, model & simulation parameters and rainfall data. The data gaps were summarized, and a methodology developed to close the gaps such that there will be confidence in the results while establishing the existing conditions. Please refer to Technical Memorandums 1 through 4 for more details.

The other model was XPSWWM which was developed by Aquafor Beech Limited during the MDPUS study. This model contains only the storm sewer network. The ongoing flooding issues of the study area were also related to storm sewer system. So, the XPSWWM storm sewer model was converted to InfoSWMM and then simulated to resolve the flooding issues. Afterward, the sanitary/combined system of the GM Blue Plan InfoSWMM model was simulated to investigate the impact of CSO's. The combined sewer assessment is limited to the impact on CSO's as a result of the proposed works in this area.

7.3.2 Model Expansion and Development

The converted InfoSWMM storm sewer model was expanded and supplemented with the City's GIS data. For areas that connect to the combined system, as-built drawings and field survey results were used to update the model which was then calibrated and validated.

7.3.2.1 Subcatchments

Pipe-by-pipe delineation for all sewers is required to accurately calibrate the model. As such, subcatchment areas defined in the MDPUS using XPSWMM were imported into the InfoSWMM model as part of the model expansion and subcatchment area re-definition.

7.3.2.2 Catch Basin Capacities

The number and type of catch basins (CB) were defined at each node. Also, a head-discharge relationship based on the inlet type was assigned to each node.

7.3.2.3 Major System

The MDPUS model did not include a major (overland flow) system.

The major system is the overland flow system where runoff is conveyed along the surface to the CB's that then inlet to the minor system. The minor system consists of the combined, sanitary and storm sewer system. Flows attenuate in the major system when the minor system surcharges to the surface.

The major system was added in the model. InfoSWMM has a tool called 'Create Dual-Drainage' which helped build most of the overland flow system. In some areas that had a shorter road length or at intersections of the roads then the major system was created manually.

7.3.3 Calibration and Validation

Model calibration is achieved by changing model parameters to produce results matching the measurements within a reasonable accuracy in terms of peak flows, runoff volumes and water levels. Model validation involves testing the calibrated model performance using a different set of measurements than the calibration period to ensure the repeatability of the model results.

For both the calibration and validation processes, observed rainfall data was used to simulate the response of the sewer systems. Observed flow at each monitoring location was used to verify the flow predicted by the model for a range of rainfall events.

7.3.3.1 Wet Weather Calibration and Validation

The focus of the calibration for this study was to compare the observed flows to simulated flows for the August 18, 2018 event. The key parameters for calibration include depression storage for different runoff surfaces, initial infiltration loss, and absolute values of runoff surfaces. The calibration process was considered complete once a reasonable agreement between the observed and simulated runoff volumes and peak flows was achieved.

Once the model calibration was completed for the chosen storm event, the model was re-analyzed to compare the measured and modelled data for the two chosen rainfall events (on October 6, 2018 and May 25, 2019) for model validation.

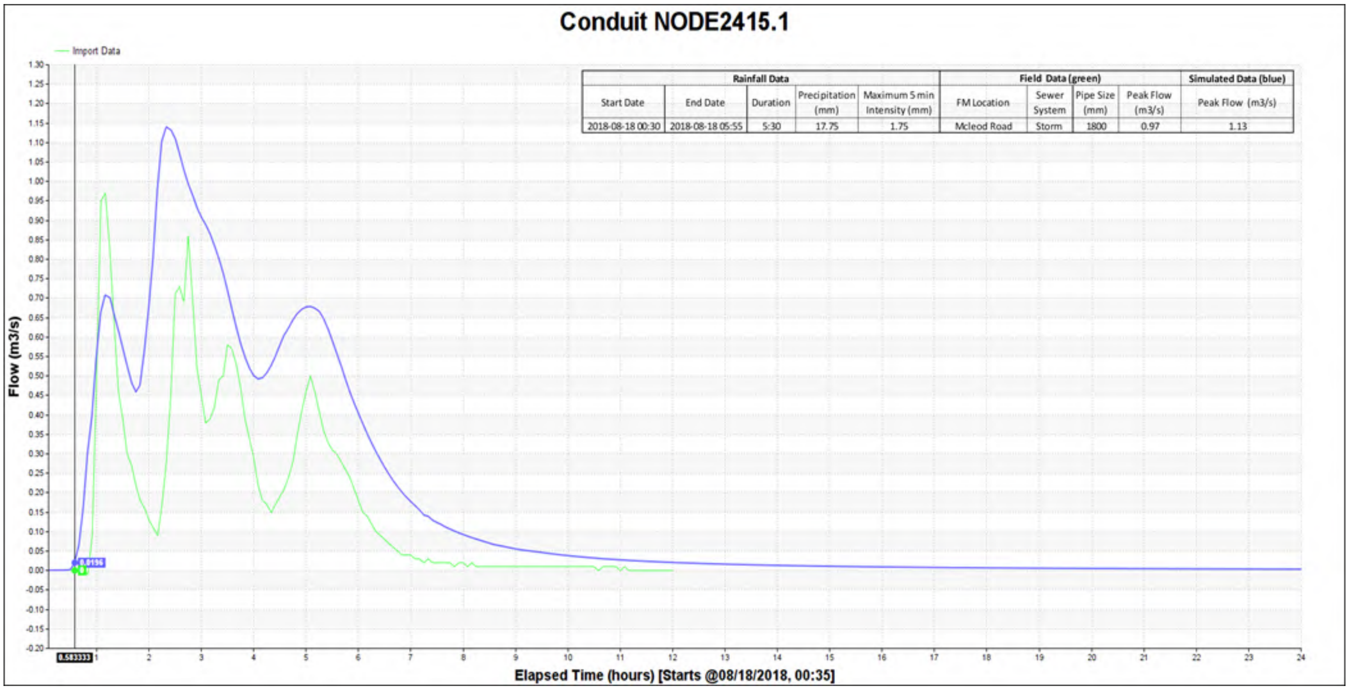
Table 7-2: Rainfall Data for Calibration and Validation

Rainfall Data				
Date	Duration	Precipitation (mm)	Maximum 1 hour Intensity (mm)	Maximum 5 min Intensity (mm)
2018-08-18 00:30	5:30	17.75	5.75	1.75
2018-10-06 07:00	1:30	7.25	5.75	1
2019-05-25 08:25	1:45	14	8	4.25

The figures below illustrate representative calibration and validation results between the monitored versus modelled runoff volumes and peak flows for the three flow monitoring locations.

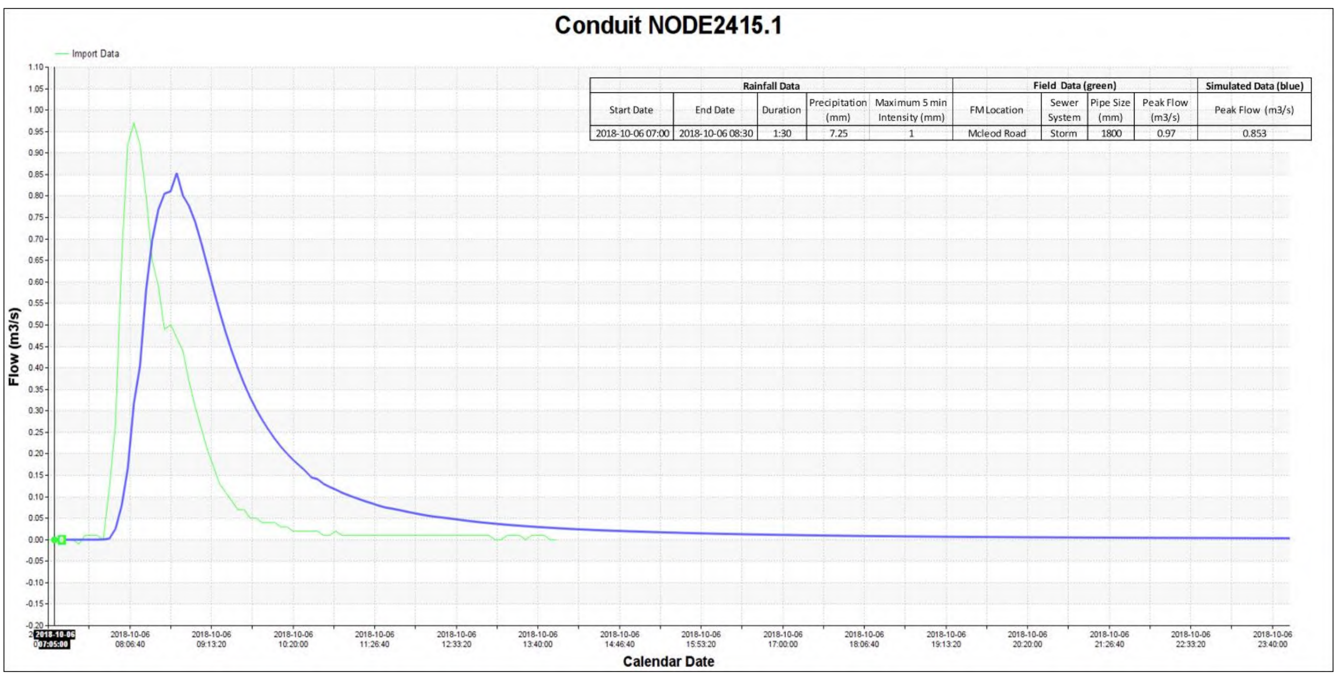
The comparison between modelled and observed results indicates reasonable consistency. Some results may have shown inconsistency due to equipment error.

McLeod Road FM (NF13_2018_MCDSTM)



Rainfall Data					Field Data (green)				Simulated Data (blue)
Start Date	End Date	Duration	Precipitation (mm)	Maximum 5 min Intensity (mm)	FM Location	Sewer System	Pipe Size (mm)	Peak Flow (m3/s)	Peak Flow (m3/s)
2018-08-18 00:30	2018-08-18 05:55	5:30	17.75	1.75	Mcleod Road	Storm	1800	0.97	1.13

Figure 7-7: McLeod Road Calibration Results - 18-August-2018



Rainfall Data					Field Data (green)				Simulated Data (blue)
Start Date	End Date	Duration	Precipitation (mm)	Maximum 5 min Intensity (mm)	FM Location	Sewer System	Pipe Size (mm)	Peak Flow (m3/s)	Peak Flow (m3/s)
2018-10-06 07:00	2018-10-06 08:30	1:30	7.25	1	Mcleod Road	Storm	1800	0.97	0.853

Figure 7-8: Validation Results - 6 October, 2018

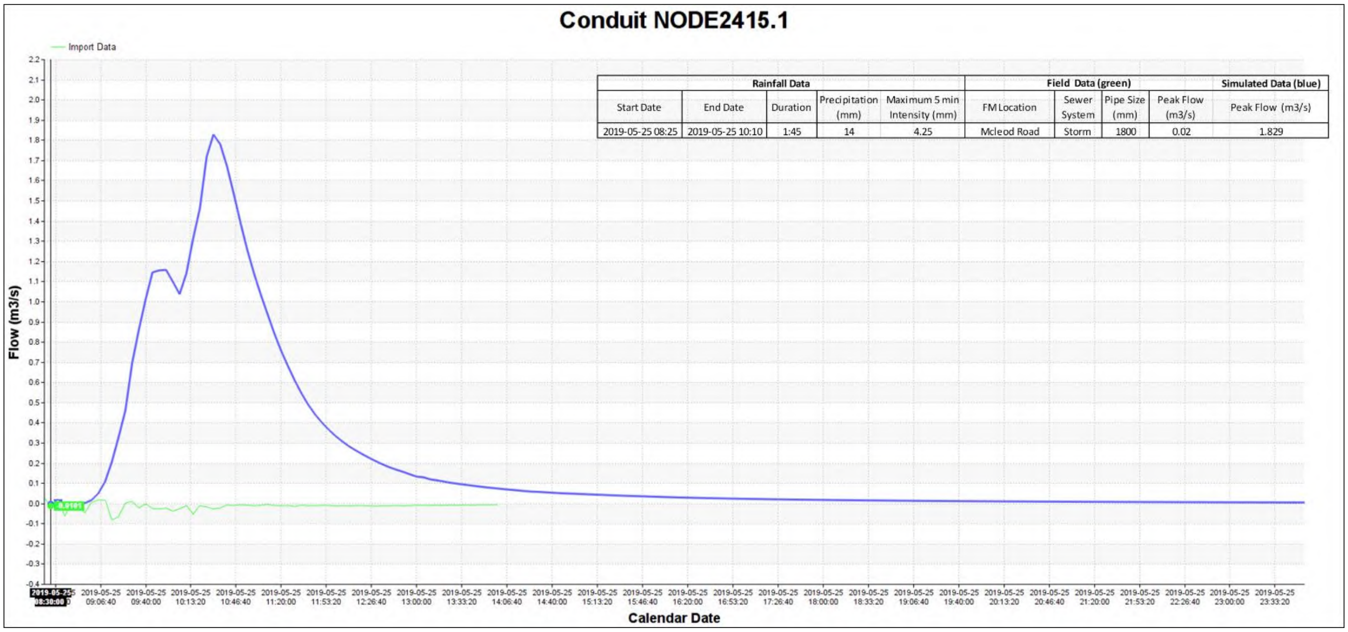


Figure 7-9: Validation Results - 25 May, 2019

Dunn Street FM (NF14_2018_DUNN)

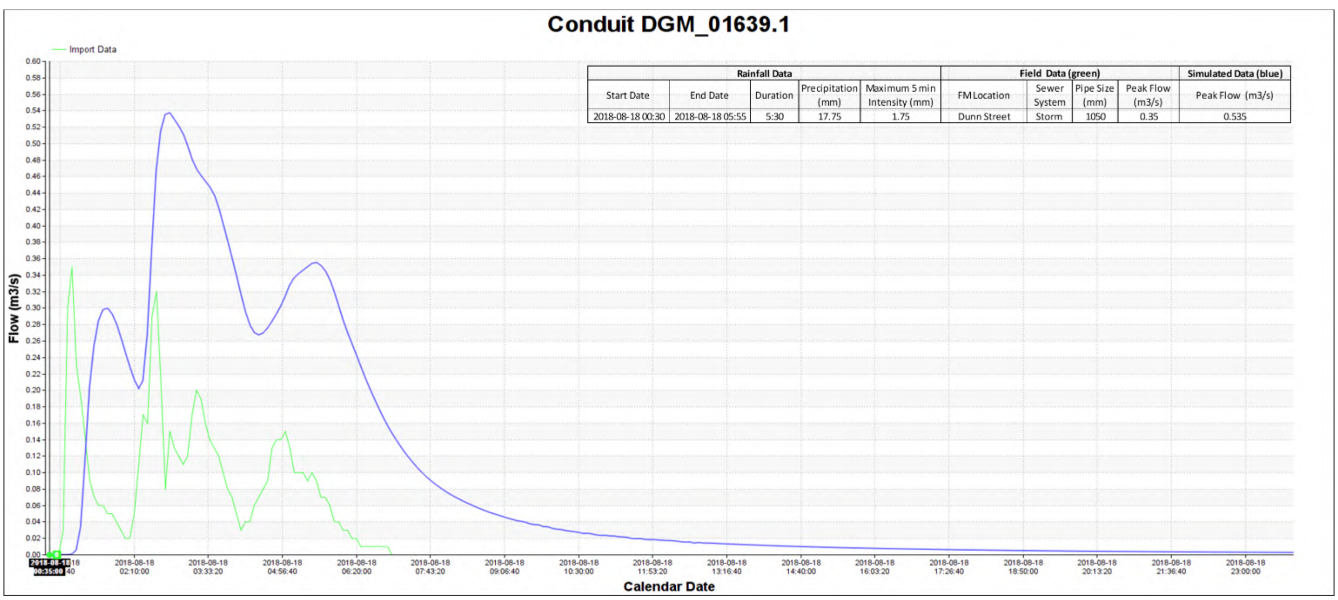


Figure 7-10: Calibration Results - 18 August, 2018

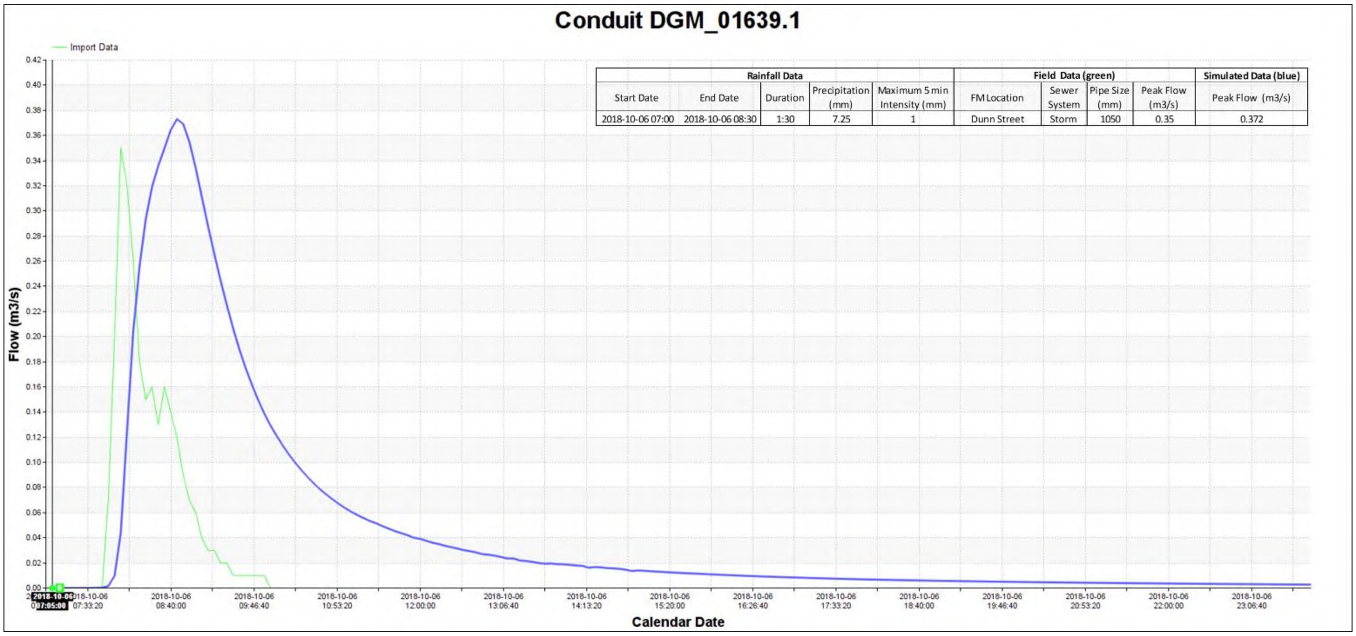


Figure 7-11: Validation Results - 6 October, 2018

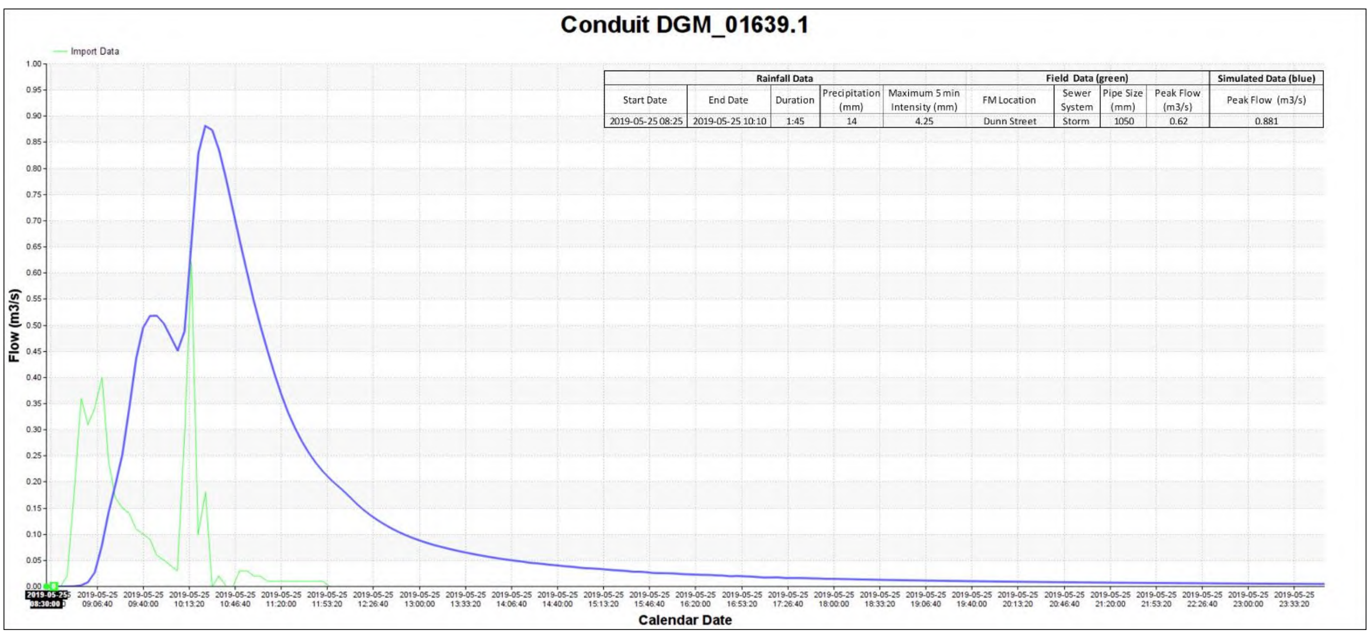


Figure 7-12: Validation Results - 25 May, 2019

Carlton Avenue FM (NF15_2018_CARLTON)

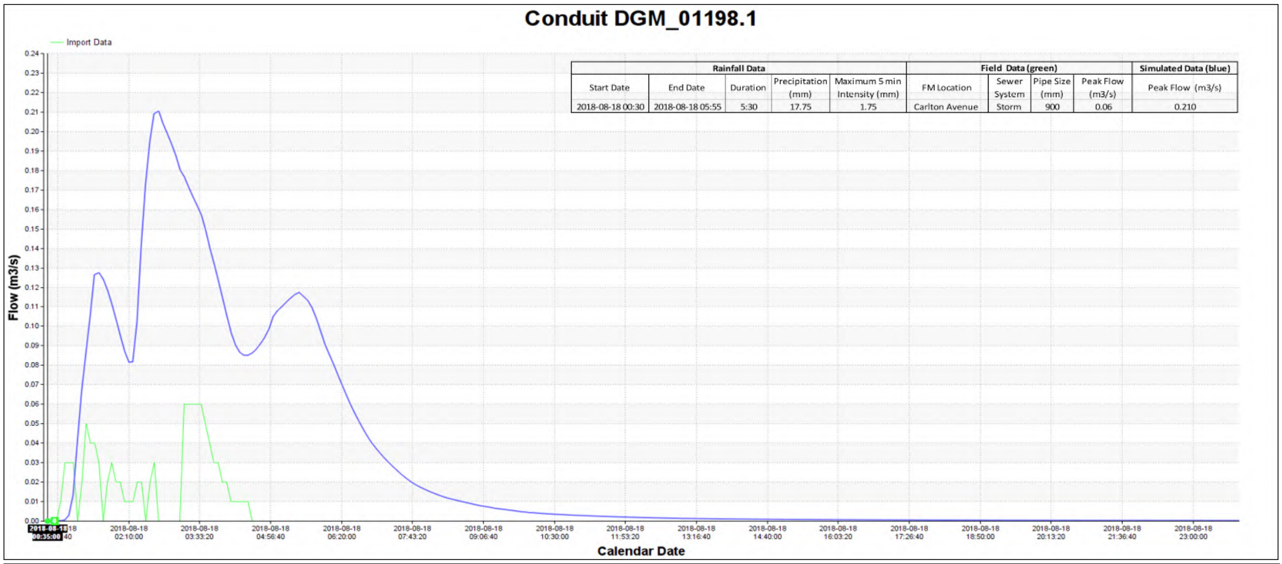


Figure 7-13: Calibration Results - 18 August, 2018

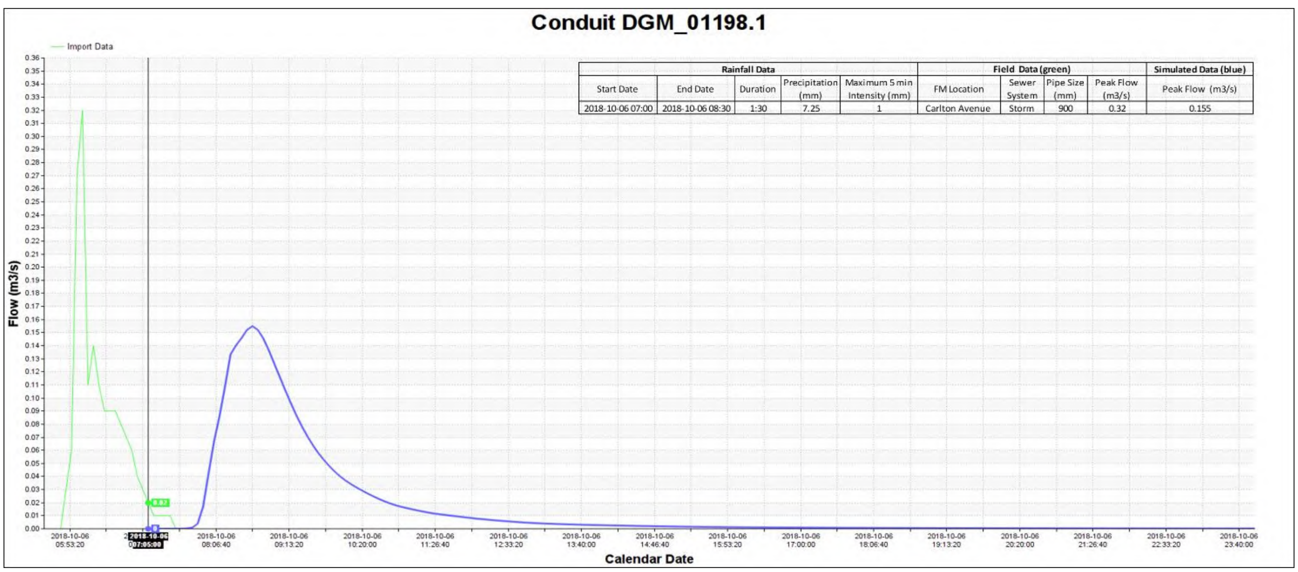
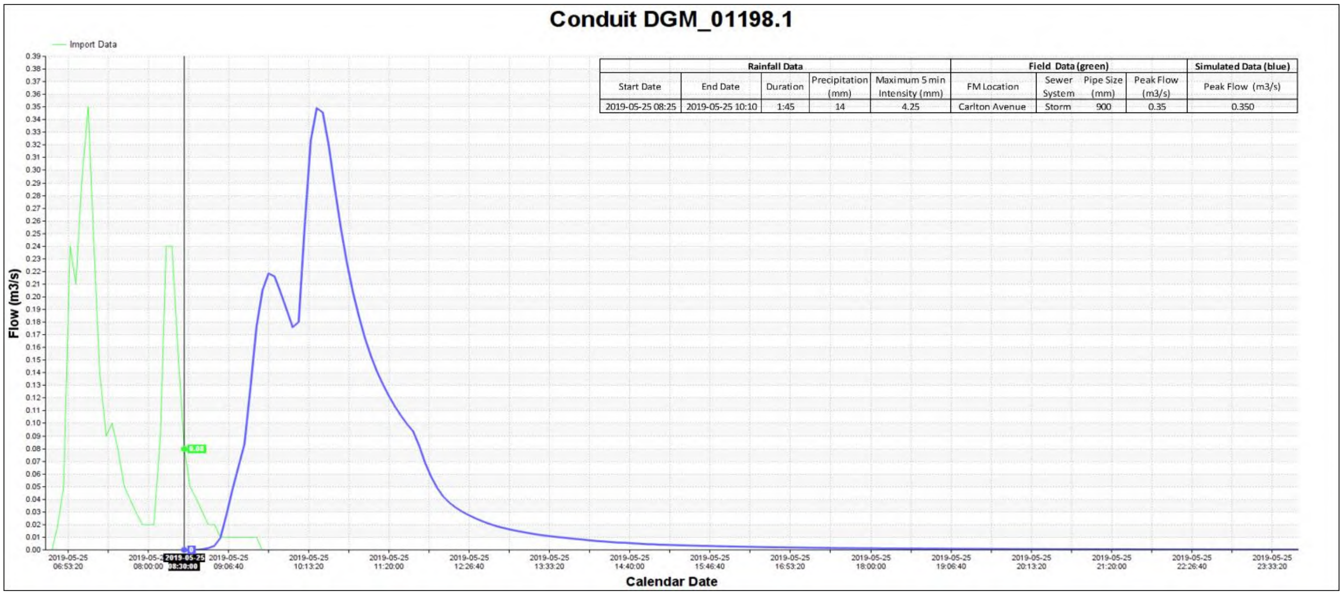


Figure 7-14: Validation Results - 6 October, 2018



Rainfall Data					Field Data (green)				Simulated Data (blue)
Start Date	End Date	Duration	Precipitation (mm)	Maximum 5 min Intensity (mm)	FM Location	Sewer System	Pipe Size (mm)	Peak Flow (m3/s)	Peak Flow (m3/s)
2019-05-25 08:25	2019-05-25 10:10	1:45	14	4.25	Carlton Avenue	Storm	900	0.35	0.350

Figure 7-15: Validation Results - 25 May, 2019

8 ASSESSMENT OF EXISTING CONDITIONS

Recent wet weather events have resulted in flooding of properties and buildings within the study area. There are several potential causes of the flooding that has occurred. This study addresses flooding that occurs as a result of water entering the house through uncovered window wells, doors, etc. (overland flooding) or water entering the basement through the floor drain or foundation.

The 1:5-year and 1:100-year 4-hour Chicago storms were chosen to assess system performance under existing conditions. It was anticipated that the 1:5-year storm would be suitable to assess the minor system performance and capacity limitations; whereas the 1:100-year storm would be suitable to assess major system performance.

The design criteria for the two events are illustrated in Figure 8-1. The desired level of service for the 1:5-year storm event is that the maximum hydraulic grade line (HGL) shall be maintained at an elevation at least 1.8m below the ground elevation, whereas for the 100-year event, the HGL criteria would remain the same and overland flows would be limited to a surface ponding depth of 300 mm.

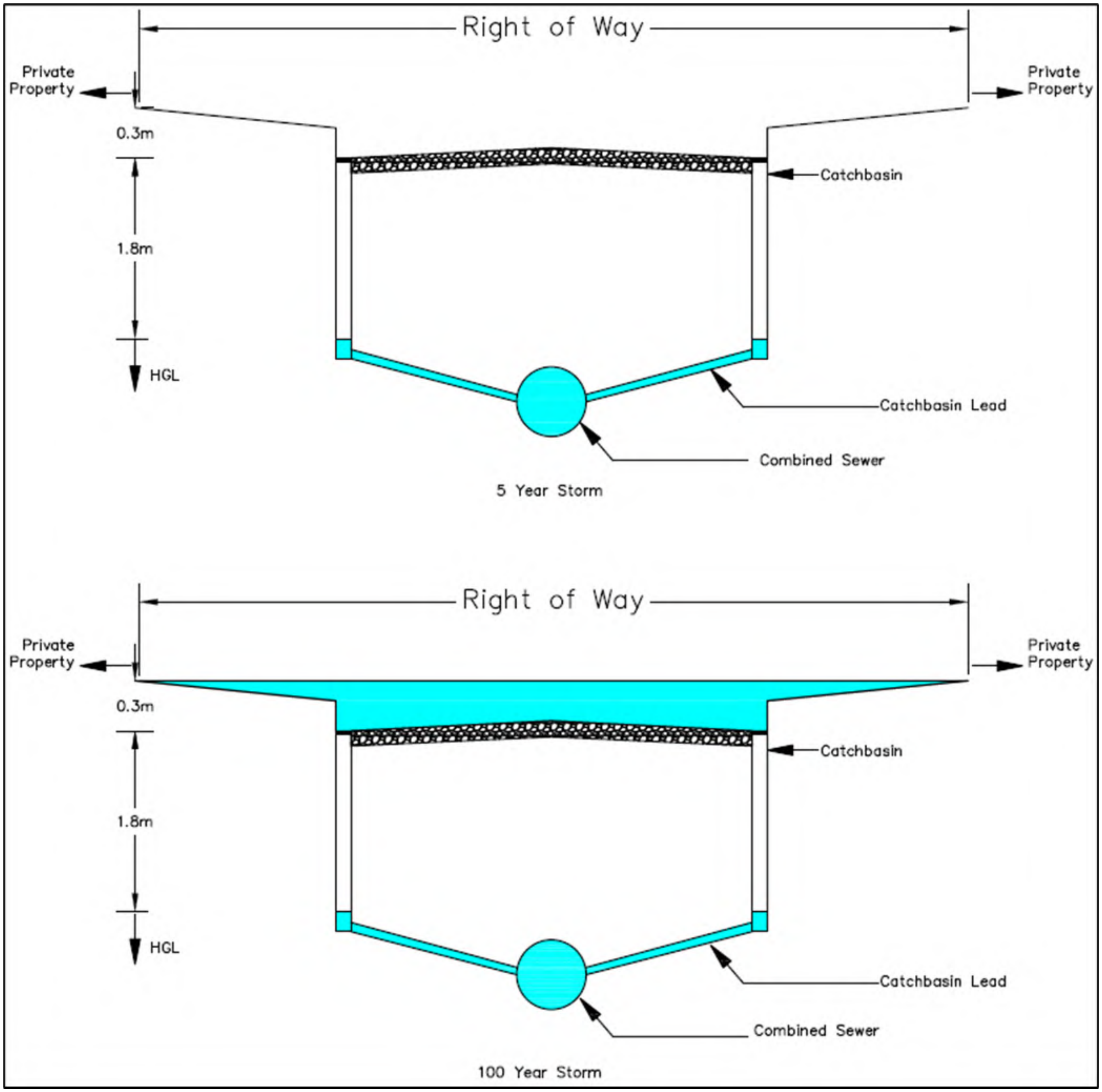


Figure 8-1: Storm Drainage Level of Service Criteria

The model simulation was completed for both the 5-year and 100-year design storm events, with the flooding results shown in Figure 9-2 through 9-5.

The 5-year storm drainage simulation results indicate that sewer surcharging of the minor (storm sewer) system shown in Figure 8-2 occurs primarily at the upstream portions of the study area. One of the reasons behind this flooding problem is the undersized trunk sewer along Caledonia Street which is causing the sewers upstream to back up. The modelling results for the major (overland) system on Figure 8-3 indicates that sewer surcharging in the upstream areas of the sewer system may not necessarily translate into surface flooding impacting private properties. However, roadway capacity issues under the 5-year on

Culp St. and downstream on Caledonia are consistent with an under-capacity major/minor system. The consistency of sewer surcharging locations also indicates that the upstream sewer system is considerably undersized as well relative to the 1:5 year Level of Service.

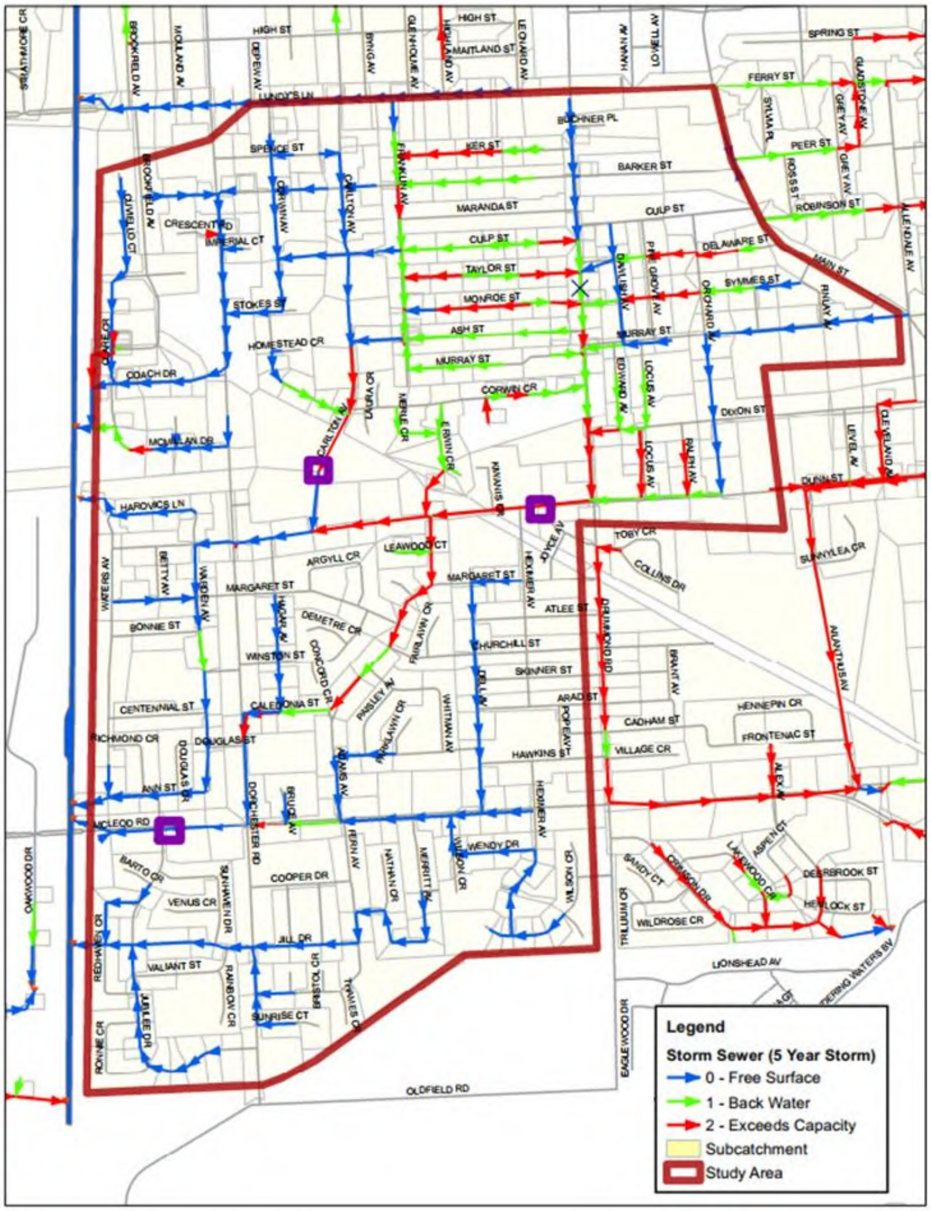


Figure 8-2: Minor System (Existing Conditions) 5 Year Event

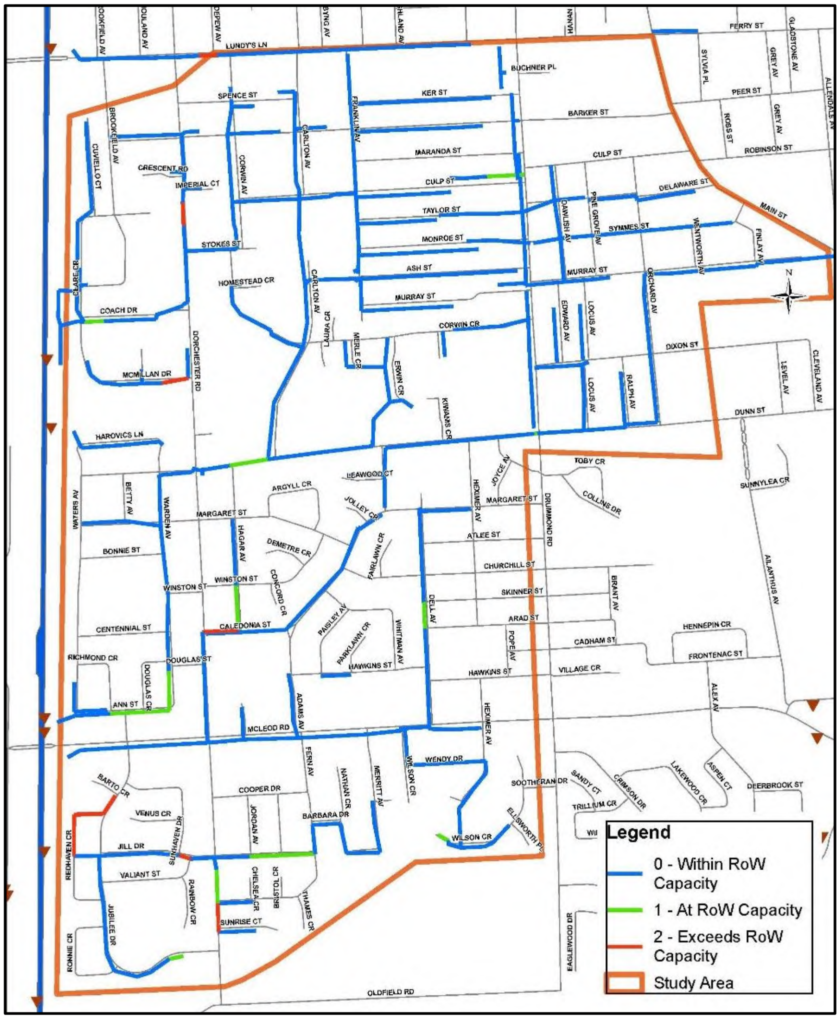


Figure 8-3: Major System (Existing Conditions) 5 Year Event

Figure 8-4 indicates that under a 100-year storm event, almost half of the sewers would be surcharged, with an increased degree of surface flooding. During the 100-year design event, if the depth of the major system flow is less than 300 mm, the target level of service is considered to be satisfied. As shown in Figure 8-5, the capacity of the RoW on Culp St. is exceeded from surcharging of the minor system. Also, the model result shows surcharging of the RoW extends into other areas, including Carlton Ave. where the minor system is surcharged to the surface.

These modelling results are used to develop and evaluate alternative remedial measures and size the preferred solutions for the study area.

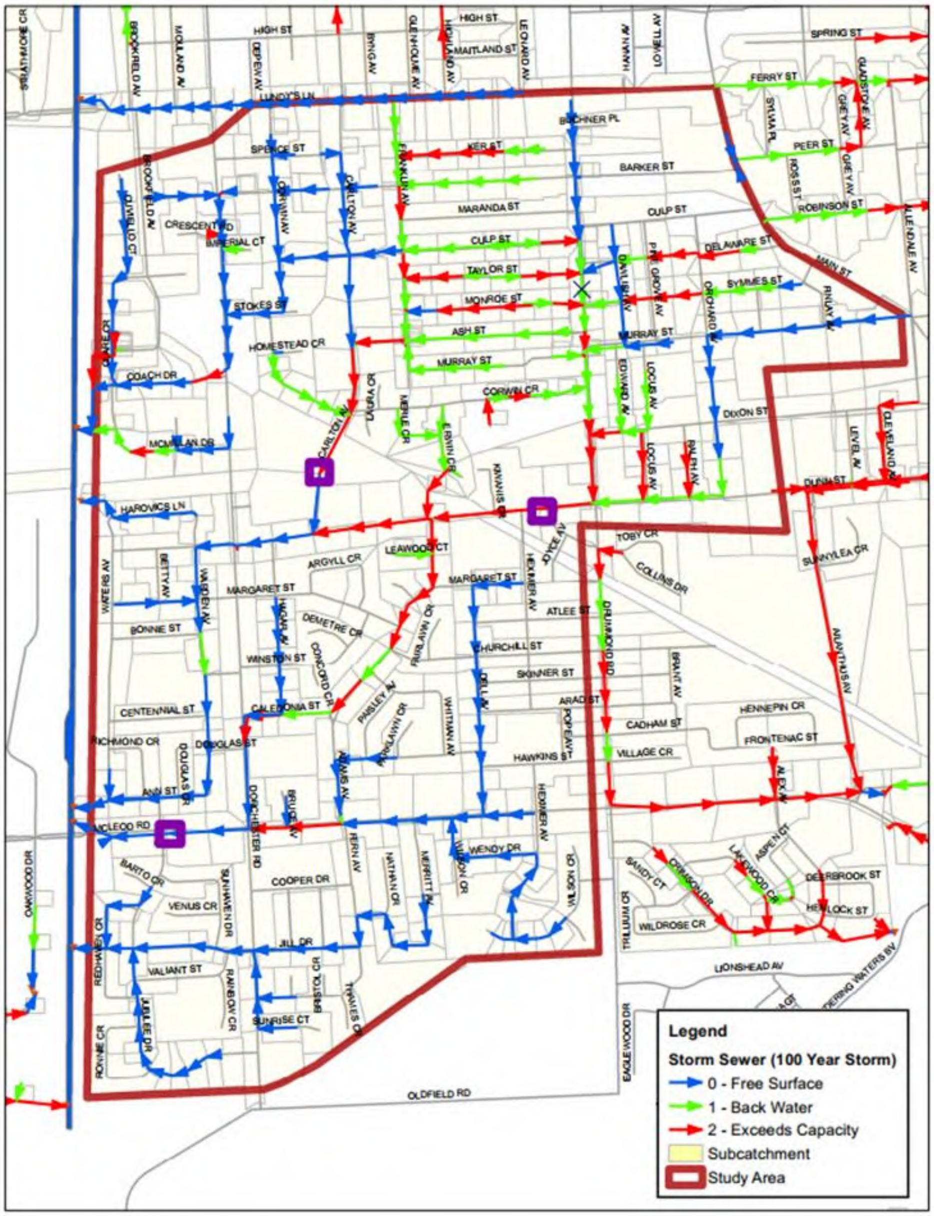


Figure 8-4: Minor System (Existing Conditions) 100 Year Event

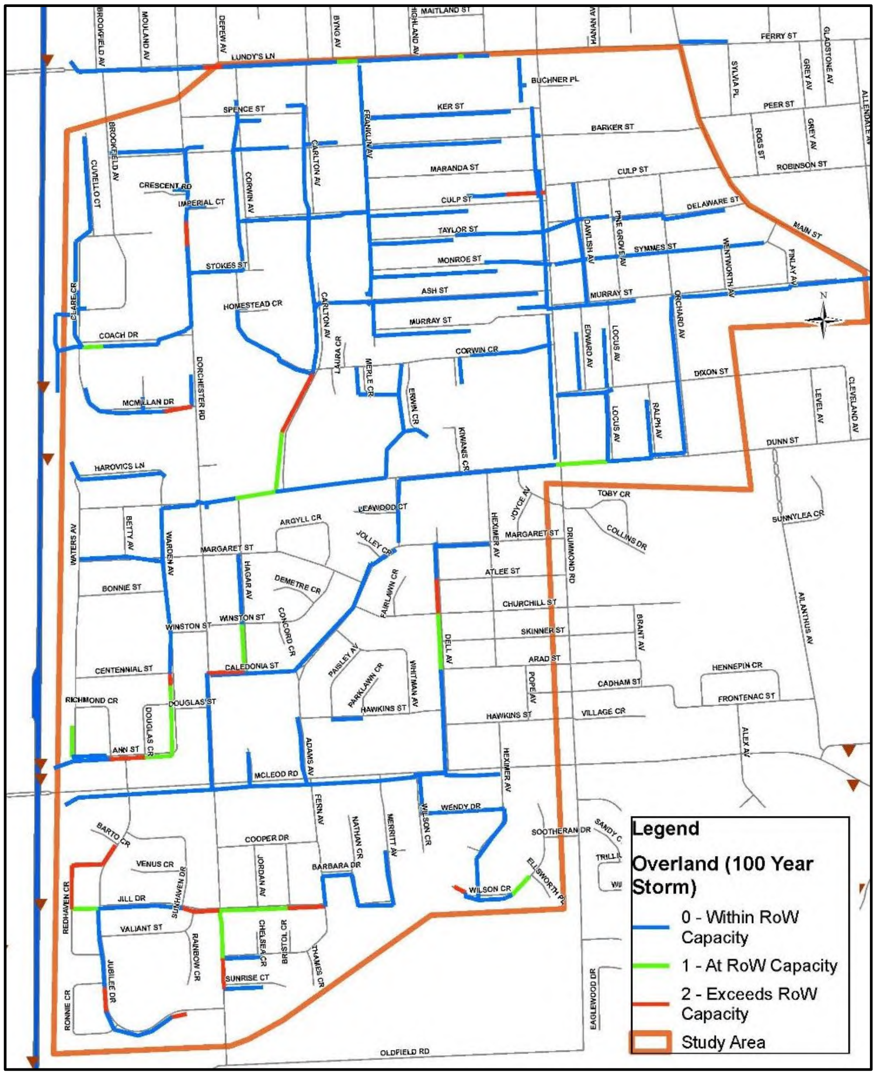


Figure 8-5: Major System (Existing Conditions) 100 Year Event

Appendix C: Archeological Study Report

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix C

Stage 1 Archeological Assessment

June 2020

STAGE 1 ARCHAEOLOGICAL ASSESSMENT
CORWIN DRAINAGE
PART OF LOTS 146, 147, 157-159
(FORMER TOWNSHIP OF STAMFORD, COUNTY OF WELLAND)
CITY OF NIAGARA FALLS
REGIONAL MUNICIPALITY OF NIAGARA, ONTARIO

ORIGINAL REPORT

Prepared for:

Aquafor Beech Ltd.
2600 Skymark Avenue, Suite 202 Building 6
Mississauga, ON L4W 5B2

Archaeological Licence #P383 (Williams)
Ministry of Tourism, Culture and Sport PIF# P383-0137-2019
ASI File: 17EA-106

13 September 2019

ASI Providing Archaeological & Cultural Heritage Services
528 Bathurst Street Toronto, ONTARIO M5S 2P9
416-966-1069 F 416-966-9723 asiheritage.ca

Stage 1 Archaeological Assessment
Corwin Drainage
Part of Lots 146, 147, 157-159
(Former Township of Stamford, County of Welland)
City of Niagara Falls
Regional Municipality of Niagara, Ontario

EXECUTIVE SUMMARY

ASI was contracted by client to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the Corwin Drainage Study in the City of Niagara Falls. This project involves the proposed storm sewer construction within an area approximately bounded by Dunn Street to the south, Maranda Street to the north, Wentworth Avenue to the east and the Hydro Canal to the west.

The Stage 1 background study determined that 16 previously registered archaeological sites are located within one kilometre of the Study Area. The property inspection determined that parts of the Study Area exhibits archaeological potential and will require Stage 2 assessment.

In light of these results, the following recommendations are made:

1. The Study Area exhibits archaeological potential. If impacted, these lands require Stage 2 archaeological assessment by test pit survey at five metre intervals, prior to any proposed construction activities outside of the existing right-of-way;

2. The remainder of the Study Area does not retain archaeological potential on account of deep and extensive land disturbance or has been previously assessed. These lands do not require further archaeological assessment; and,

3. Should the proposed work extend beyond the current Study Area, further Stage 1 archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

PROJECT PERSONNEL

Senior Project Manager:	Lisa Merritt, MSc. (P094) *Partner / Director* *Environmental Assessment Division*
Project Coordinator:	Katrina Thach, Hon. BA (R1225) *Archaeologist / Project Coordinator* *Environmental Assessment Division*
Project Director (Licensee):	Blake Williams, MLitt (P383) *Associate Archaeologist \ Technical writer* *Environmental Assessment Division*
Project Manager:	Eliza Brandy, MA (R1109) *Associate Archaeologist / Project Manager* *Environmental Assessment Division*
Field Director:	Andrew Clish, BES (P046) *Senior Archaeologist / Senior Field Director, Laboratory and Fieldwork Services, Operations Division*
Report Preparation:	Eliza Brandy
Graphics:	Jonas Fernandez, MSc (R281) *Archaeologist / Assistant Manager - Fleet & Geomatics Specialist* *Operations Division*
Report Reviewer:	Lisa Merritt

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1.0 PROJECT CONTEXT

Archaeological Services Inc. (ASI) was contracted by client to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the Corwin Drainage Study in the City of Niagara Falls. This project involves the proposed storm sewer construction within an area approximately bounded by Dunn Street to the south, Maranda Street to the north, Wentworth Avenue to the east and the Hydro Canal to the west (Figure 1).

All activities carried out during this assessment were completed in accordance with the *Ontario Heritage Act* (1990, as amended in 2018) and the 2011 *Standards and Guidelines for Consultant Archaeologists* (S & G), administered by the Ministry of Tourism, Culture and Sport (MTCS 2011).

1.1 Development Context

All work has been undertaken as required by the *Environmental Assessment Act*, RSO (Ministry of the Environment 1990 as amended 2010) and regulations made under the Act, and are therefore subject to all associated legislation. This project is being conducted in accordance with the Municipal Engineers' Association document *Municipal Class Environmental Assessment* (2000 as amended in 2007, 2011 and 2015).

Authorization to carry out the activities necessary for the completion of the Stage 1 archaeological assessment was granted by Aquafor Beech Ltd. on July 15, 2019.

1.2 Historical Context

The purpose of this section, according to the S & G, Section 7.5.7, Standard 1, is to describe the past and present land use and the settlement history and any other relevant historical information pertaining to the Study Area. A summary is first presented of the current understanding of the Indigenous land use of the Study Area. This is then followed by a review of the historical Euro-Canadian settlement history.

1.2.1 Indigenous Land Use and Settlement

Southern Ontario has been occupied by human populations since the retreat of the Laurentide glacier approximately 13,000 years before present (BP) (Ferris 2013). Populations at this time would have been highly mobile, inhabiting a boreal-parkland similar to the modern sub-arctic. By approximately 10,000 BP, the environment had progressively warmed (Edwards and Fritz 1988) and populations now occupied less extensive territories (Ellis and Deller 1990).

Between approximately 10,000-5,500 BP, the Great Lakes basins experienced low-water levels, and many sites which would have been located on those former shorelines are now submerged. This period produces the earliest evidence of heavy wood working tools, an indication of greater investment of labour in felling trees for fuel, to build shelter, and watercraft production. These activities suggest prolonged seasonal residency at occupation sites. Polished stone and native copper implements were being produced by approximately 8,000 BP; the latter was acquired from the north shore of Lake Superior, evidence of extensive exchange networks throughout the Great Lakes region. The earliest evidence for cemeteries dates to approximately 4,500-3,000 BP and is indicative of increased social organization, investment of labour into social infrastructure, and the establishment of socially prescribed territories (Ellis et al. 1990; Ellis et al. 2009; Brown 1995:13).

Between 3,000-2,500 BP, populations continued to practice residential mobility and to harvest seasonally available resources, including spawning fish. The Woodland period begins around 2500 BP and exchange and interaction networks broaden at this time (Spence et al. 1990:136, 138) and by approximately 2,000 BP, evidence exists for macro-band camps, focusing on the seasonal harvesting of resources (Spence et al. 1990:155, 164). By 1500 BP there is macro botanical evidence for maize in southern Ontario, and it is thought that maize only supplemented people's diet. There is earlier phytolithic evidence for maize in central New York State by 2300 BP - it is likely that once similar analyses are conducted on Ontario ceramic vessels of the same period, the same evidence will be found (Birch and Williamson 2013:13–15). Bands likely retreated to interior camps during the winter. It is generally understood that these populations were Algonquian-speakers during these millennia of settlement and land use.

From the beginning of the Late Woodland period at approximately 1,000 BP, lifeways became more similar to that described in early historical documents. Between approximately 1000-1300 Common Era (CE), the communal site is replaced by the village focused on horticulture. Seasonal disintegration of the community for the exploitation of a wider territory and more varied resource base was still practised (Williamson 1990:317). By 1300-1450 CE, this episodic community disintegration was no longer practised and populations now communally occupied sites throughout the year (Dodd et al. 1990:343). From 1450-1649 CE this process continued with the coalescence of these small villages into larger communities (Birch and Williamson 2013). Through this process, the socio-political organization of the First Nations, as described historically by the French and English explorers who first visited southern Ontario, was developed. By 1600 CE, the communities within Simcoe County had formed the Confederation of Nations encountered by the first European explorers and missionaries. In the 1640s, the traditional enmity between the Haudenosaunee[1] and the Huron-Wendat (and their Algonkian allies such as the Nippissing and Odawa) led to the dispersal of the Huron-Wendat.

Samuel de Champlain in 1615 reported that a group of Iroquoian-speaking people situated between the Haudenosaunee and the Huron-Wendat were at peace and remained "la nation neutre". In subsequent years, the French visited and traded among the Neutral, but the first documented visit was not until 1626, when the Recollet missionary Joseph de la Roche Daillon recorded his visit to the villages of the Attiwandaron, whose name in the Huron-Wendat language meant "those who speak a slightly different tongue" (the Neutral apparently referred to the Huron-Wendat by the same term). Like the Huron-Wendat, Petun, and Haudenosaunee, the Neutral people were settled village agriculturalists. Several discrete settlement clusters have been identified in the lower Grand River, Fairchild-Big Creek, Upper Twenty Mile Creek, Spencer-Bronte Creek drainages, Milton, Grimsby, Eastern Niagara Escarpment and Onondaga Escarpment areas, which are attributed to Iroquoian populations. These settlement clusters are believed by some scholars to have been inhabited by populations of the Neutral Nation or pre- (or ancestral) Neutral Nation (Lennox and Fitzgerald 1990).

The Neutral village of Onyahrah (translated as neck or strip of land between two lakes) was located on both sides of the Niagara Falls, including present day Niagara-on-the-Lake, and another village was located near what is now St. David's along Four Mile Creek. It is believed that the Iroquoian word

[1] The Haudenosaunee are also known as the New York Iroquois or Five Nations Iroquois and after 1722 Six Nations Iroquois. They were a confederation of five distinct but related Iroquoian–speaking groups – the Seneca, Onondaga, Cayuga, Oneida, and Mohawk. Each lived in individual territories in what is now known as the Finger Lakes district of Upper New York. In 1722 the Tuscarora joined the confederacy.

Onguiaahra (translated as ‘the strait’ or ‘thundering waters’) was anglicized by missionaries in the seventeenth century to Niagara (Walker 2018).

Between 1647 and 1651, the Neutral were decimated by epidemics and ultimately dispersed by the Haudenosaunee, who subsequently settled along strategic trade routes on the north shore of Lake Ontario for a brief period during the mid seventeenth-century. Compared to settlements of the Haudenosaunee, the “Iroquois du Nord” occupation of the landscape was less intensive. Only seven villages are identified by the early historic cartographers on the north shore, and they are documented as considerably smaller than those in New York State. The populations were agriculturalists, growing maize, pumpkins, and squash. These settlements also played the important alternate role of serving as stopovers and bases for Haudenosaunee travelling to the north shore for the annual beaver hunt (Konrad 1974).

Shortly after dispersal of the Wendat and their Algonquian allies, Ojibwa began to expand into southern Ontario and Michigan from a “homeland” along the east shore of Georgian Bay, west along the north shore of Lake Huron, and along the northeast shore of Lake Superior and onto the Upper Peninsula of Michigan (Rogers 1978:760–762). This history was constructed by Rogers using both Anishinaabek oral tradition and the European documentary record, and notes that it included Chippewa, Ojibwa, Mississauga, and Saulteaux or “Southeastern Ojibwa” groups. Ojibwa, likely Odawa, were first encountered by Samuel de Champlain in 1615 along the eastern shores of Georgian Bay. Etienne Brule later encountered other groups and by 1641, Jesuits had journeyed to Sault Sainte Marie (Thwaites 1896:11:279) and opened the Mission of Saint Peter in 1648 for the occupants of Manitoulin Island and the northeast shore of Lake Huron. The Jesuits reported that these Algonquian peoples lived “solely by hunting and fishing and roam as far as the “Northern sea” to trade for “ Furs and Beavers, which are found there in abundance” (Thwaites 1896-1901, 33:67), and “all of these Tribes are nomads, and have no fixed residence, except at certain seasons of the year, when fish are plentiful, and this compels them to remain on the spot” (Thwaites 1896-1901, 33:153). Algonquian-speaking groups were historically documented wintering with the Huron-Wendat, some who abandoned their country on the shores of the St. Lawrence because of attacks from the Haudenosaunee (Thwaites 1896-1901, 27:37).

Other Algonquian groups were recorded along the northern and eastern shores and islands of Lake Huron and Georgian Bay - the “Ouasouarini” [Chippewa], the “Outchougai” [Outchougai], the “Atchiligouan” [Achiligouan] near the mouth of the French River and north of Manitoulin Island the “Amikouai, or the nation of the Beaver” [Amikwa; Algonquian] and the “Oumisagai” [Missisauga; Chippewa] (Thwaites 1896-1901, 18:229, 231). At the end of the summer 1670, Father Louys André began his mission work among the Mississagué, who were located on the banks of a river that empties into Lake Huron approximately 30 leagues from the Sault (Thwaites 1896-1901, 55:133-155).

After the Huron had been dispersed, the Haudenosaunee began to exert pressure on Ojibwa within their homeland to the north. While their numbers had been reduced through warfare, starvation, and European diseases, the coalescence of various Anishinaabek groups led to enhanced social and political strength (Thwaites 1896-1901, 52:133) and Sault Sainte Marie was a focal point for people who inhabited adjacent areas both to the east and to the northwest as well as for the Saulteaux, who considered it their home (Thwaites 1896-1901, 54:129-131). The Haudenosaunee established a series of settlements at strategic locations along the trade routes inland from the north shore of Lake Ontario. From east to west, these villages consisted of Ganneious, on Napanee Bay, an arm of the Bay of Quinte; Quinte, near the isthmus of the Quinte Peninsula; Ganaraske, at the mouth of the Ganaraska River; Quintio, at the mouth of the Trent River on the north shore of Rice Lake; Ganatsekwyagon (or Ganestiquiagon), near the mouth of the Rouge River; Teyaiagon, near the mouth of the Humber River; and Quinaouatoua, on the portage between the western end of Lake Ontario and the Grand River (Konrad 1981:135). Their locations near the mouths of the Humber and Rouge Rivers, two branches of the Toronto Carrying Place, strategically linked these settlements with the upper Great Lakes through Lake Simcoe. The inhabitants of these villages were agriculturalists, growing maize, pumpkins and squash, but their central roles were that of portage starting points and trading centres for Iroquois travel to the upper Great Lakes for the annual beaver hunt (Konrad 1974; Williamson et al. 2008:50–52). Ganatsekwyagon, Teyaiagon, and Quinaouatoua were primarily Seneca; Ganaraske, Quinte and Quintio were likely Cayuga, and Ganneious was Oneida, but judging from accounts of Teyaiagon, all of the villages might have contained peoples from a number of the Iroquois constituencies (ASI 2013).

During the 1690s, some Ojibwa began moving south into extreme southern Ontario and soon replaced, the Haudenosaunee by force. By the first decade of the eighteenth century, the Michi Saagiig Nishnaabeg (Mississauga Nishnaabeg) had settled at the mouth of the Humber, near Fort Frontenac at the east end of Lake Ontario and the Niagara region and within decades were well established throughout southern Ontario. In 1736, the French estimated there were 60 men at Lake Saint Clair and 150 among small settlements at Quinte, the head of Lake Ontario, the Humber River, and Matchedash (Rogers 1978:761). This history is based almost entirely on oral tradition provided by Anishinaabek elders such as George Copway (Kahgegagahbowh), a Mississauga born in 1818 near Rice Lake who followed a traditional lifestyle until his family converted to Christianity (MacLeod 1992:197; Smith 2000). According to Copway, the objectives of campaigns against the Haudenosaunee were to create a safe trade route between the French and the Ojibwa, to regain the land abandoned by the Huron-Wendat. While various editions of Copway's book have these battles occurring in the mid-seventeenth century, common to all is a statement that the battles occurred around 40 years after the dispersal of the Huron-Wendat (Copway 1850:88; Copway 1851:91; Copway 1858:91). Various scholars agree with this timeline ranging from 1687, in conjunction with Denonville's attack on Seneca villages (Johnson 1986:48; Schmalz 1991:21–22) to around the mid- to late-1690s leading up to the Great Peace of 1701 (Schmalz 1977:7; Bowman 1975:20; Smith 1975:215; Tanner 1987:33; Von Gernet 2002:7–8).

Robert Paudash's 1904 account of Mississauga origins also relies on oral history, in this case from his father, who died at the age of 75 in 1893 and was the last hereditary chief of the Mississauga at Rice Lake. His account in turn came from his father Cheneebeesh, who died in 1869 at the age of 104 and was the last sachem or Head Chief of all the Mississaugas. He also relates a story of origin on the north shore of Lake Huron (Paudash 1905:7-8) and later, after the dispersal of the Huron-Wendat, carrying out coordinated attacks against the Haudenosaunee. Francis Assikinack, an Ojibwa of Manitoulin Island born in 1824, provides similar details on battles with the Haudenosaunee (Assikinack 1858:308–309).

Peace was achieved between the Haudenosaunee and the Anishinaabek Nations in August of 1701 when representatives of more than twenty Anishinaabek Nations assembled in Montreal to participate in peace negotiations (Johnston 2004:10). During these negotiations captives were exchanged and the Iroquois and Anishinaabek agreed to live together in peace. Peace between these nations was confirmed again at council held at Lake Superior when the Iroquois delivered a wampum belt to the Anishinaabek Nations.

From the beginning of the eighteenth century to the assertion of British sovereignty in 1763, there is no interruption to Anishinaabek control and use of southern Ontario. While hunting in the territory was shared, and subject to the permission of the various nations for access to their lands, its occupation was by Anishinaabek until the assertion of British sovereignty, the British thereafter negotiating treaties with them. Eventually, with British sovereignty, tribal designations changed (Smith 1975:221–222; Surtees 1985:20–21). According to Rogers (1978), by the twentieth century, the Department of Indian Affairs had divided the "Anishinaubag" into three different tribes, despite the fact that by the early eighteenth century, this large Algonquian-speaking group, who shared the same cultural background, "stretched over a thousand miles from the St. Lawrence River to the Lake of the Woods." With British land purchases and treaties, the bands at Beausoleil Island, Cape Croker, Christian Island, Georgina and Snake Islands, Rama, Sarnia, Saugeen, the Thames, and Walpole, became known as "Chippewa" while the bands at Alderville, New Credit, Mud Lake, Rice Lake, and Scugog, became known as "Mississauga." The northern groups on Lakes Huron and Superior, who signed the Robinson Treaty in 1850, appeared and remained as "Ojibbewas" in historical documents.

In 1763, following the fall of Quebec, New France was transferred to British control at the Treaty of Paris. The British government began to pursue major land purchases throughout Ontario in the early nineteenth century, and entered into negotiations with various Nations for additional tracts of land as the need arose to facilitate European settlement.

Following the 1764 Niagara Peace Treaty and the follow-up treaties with Pontiac, the English colonial government considered the Mississaugas to be their allies since they had accepted the Covenant Chain. The English administrators followed the terms of the Royal Proclamation and insured that no settlements were made in the hunting grounds that had been reserved for their use (Johnston 1964; Lytwyn 2005). In 1784, under the terms of the "Between the Lakes Purchase" signed by Sir Frederick Haldimand and the Mississaugas, the Crown acquired over one million acres of land in-part spanning westward from near modern day Niagara-on-the-Lake along the north shore of Lake Ontario to modern day Burlington (Aboriginal Affairs and Northern Development Canada 2016a).

The eighteenth century saw the ethnogenesis in Ontario of the Métis, when Métis people began to identify as a separate group, rather than as extensions of their typically maternal First Nations and paternal European ancestry (Métis National Council n.d.). Métis populations were predominantly located north and west of Lake Superior, however, communities were located throughout Ontario (MNC n.d.; Stone and Chaput 1978:607,608). During the early nineteenth century, many Métis families moved towards locales around southern Lake Huron and Georgian Bay, including Kincardine, Owen Sound, Penetanguishene, and Parry Sound (MNC n.d.). Recent decisions by the Supreme Court of Canada (Supreme Court of Canada 2003; Supreme Court of Canada 2016) have reaffirmed that Métis people have full rights as one of the Indigenous people of Canada under subsection 91(24) of the Constitution Act, 1867.

The Study Area is within Treaty 381, the Niagara Purchase, signed in 1781 between the Crown and the Chippewa and Mississaugas for the tract of land which had not been agreed upon in the 1764 Niagara Peace Treaty on the west side of "the Straits" that lead from Lake Erie to Lake Ontario at Niagara Falls (Aboriginal Affairs and Northern Development Canada 2016b).

1.2.2 Euro-Canadian Land Use: Township Survey and Settlement

Historically, the Study Area is located in the Former Stamford Township, County of Welland in part of Lots 146, 147, 157-159.

The S & G stipulates that areas of early Euro-Canadian settlement (pioneer homesteads, isolated cabins, farmstead complexes), early wharf or dock complexes, pioneer churches, and early cemeteries are considered to have archaeological potential. Early historical transportation routes (trails, passes, roads, railways, portage routes), properties listed on a municipal register or designated under the *Ontario Heritage Act* or a federal, provincial, or municipal historic landmark or site are also considered to have archaeological potential.

For the Euro-Canadian period, the majority of early nineteenth century farmsteads (i.e., those that are arguably the most potentially significant resources and whose locations are rarely recorded on nineteenth century maps) are likely to be located in proximity to water. The development of the network of concession roads and railroads through the course of the nineteenth century frequently influenced the siting of farmsteads and businesses. Accordingly, undisturbed lands within 100 m of an early settlement road are also considered to have potential for the presence of Euro-Canadian archaeological sites.

The first Europeans to arrive in the area were transient merchants and traders from France and England, who followed Indigenous pathways and set up trading posts at strategic locations along the well-traveled river routes. All of these occupations occurred at sites that afforded both natural landfalls and convenient access, by means of the various waterways and overland trails, into the hinterlands. Early transportation routes followed existing Indigenous trails, both along the lakeshore and adjacent to various creeks and rivers (ASI 2006).

Stamford Township

The land within Stamford Township was partly acquired by the British from the Mississaugas in 1764, while the remainder was purchased in 1781. The first township survey was undertaken in 1784, and the first legal settlers occupied their land holdings in the same year. The township was originally named Mount Dorchester but was renamed after a borough on the Welland River in Lincolnshire, England. Stamford was initially settled by disbanded soldiers, mainly Butler’s Rangers, following the end of the American Revolutionary War. Stamford was the location of the Battle of Lundy’s Lane in 1814. During the late eighteenth and the nineteenth centuries a number of notable settlements were established within Stamford Township. Many of these, including Chippawa, which was first settled in the early 1790s and had a post office by 1801, still exist as communities or neighbourhoods within the City of Niagara Falls. Other early settlements in Stamford Townships include Clifton (1832), Elgin (1840s) and Drummondville (1831). Stamford Township was amalgamated into the Regional Municipality of Niagara in 1970 (Armstrong 1985:147; Boulton 1805:89; Crossby 1873:86; Mika and Mika 1983; Rayburn 1997:68, 328; Scott 1997:48–49; Smith 1975:176; Winearls 1991:640).

Drummondville

The village of Drummondville was located at the intersection of Portage Road (now Main Street), Ferry Street and Lundy’s Lane. Part of the village was in existence as early as 1831, when the name “Drummondville” was selected in honour of Sir Gordon Drummond who was a British General in Upper Canada during the War of 1812. Other parts of the village were surveyed and developed by the City of the Falls Company which owned part of this land during the mid nineteenth century. The community contained a brewery, taverns and hotels, four churches, burial grounds, grammar school, telegraph office, several stores, and town hall during the 1870s. The village was famous for its “observatories” near the battlefield which had become tourist attractions by the mid- nineteenth century. The population numbered 1,000 in 1873. In 1882, the name was changed to the village of Niagara Falls.

The height of land located at Lundy’s Lane and Drummond Road contained the burial ground and first Presbyterian Church in Niagara Falls, and this was the site where the Battle of Lundy’s Lane was fought in July 1814. This battle is widely recognised as the bloodiest battle of the War of 1812. The troops under General Drummond managed to hold the height of land despite a sustained and intense attack from the American forces; this battle is noted as one of the turning points during the War of 1812 and effectively ended the American offensive in Upper Canada. An old Methodist burial ground is located directly across the street on the north side of Lundy’s Lane. One of the first tourist destinations in Niagara Falls was

Fralick's Tavern, a frame structure built around 1836 located directly north of the battlefield site. The site currently operates as a museum (Crossby 1873:104; Seibel 1967).

1.2.3 Historical Map Review

The 1815 Map of the Niagara District in Upper Canada (Nesfield 1815), 1862 Map of the Counties of Lincoln and Welland (Tremaine and Tremaine 1862), and the 1876 Illustrated Historical Atlas of the Counties of Lincoln and Welland,Township of Stamford page (Page 1876), were examined to determine the presence of historic features within the Study Area during the nineteenth century (Table 1; Figures 2-4).

It should be noted, however, that not all features of interest were mapped systematically in the Ontario series of historical atlases, given that they were financed by subscription, and subscribers were given preference with regard to the level of detail provided on the maps. Moreover, not every feature of interest would have been within the scope of the atlases.

In addition, the use of historical map sources to reconstruct/predict the location of former features within the modern landscape generally proceeds by using common reference points between the various sources. These sources are then geo-referenced in order to provide the most accurate determination of the location of any property on historic mapping sources. The results of such exercises are often imprecise or even contradictory, as there are numerous potential sources of error inherent in such a process, including the vagaries of map production (both past and present), the need to resolve differences of scale and resolution, and distortions introduced by reproduction of the sources. To a large degree, the significance of such margins of error is dependent on the size of the feature one is attempting to plot, the constancy of reference points, the distances between them, and the consistency with which both they and the target feature are depicted on the period mapping.

Table 1: Nineteenth-century property owner(s) and historical features(s) within or adjacent to the Study Area

	1862		*Map Title*	
Lot #	**Property Owner(s)**	**Historical Feature(s)**	**Property Owner(s)**	**Historical Feature(s)**
146	None	None	None	battlegrounds
147	John Kerr J.P Edward A. C. Pew Hervey Pew	Kelso Farm Sunnyside	Charles Blathwayth Henry Spence W. Kerr W. E. Tench	None None None Battleground, house, orchards
157	Estate of Late John Misner Cranley Kirby	None	A.J.C. Lundy George Kirkley	None orchards
158	John Kerr J.P Edward A. C. Pew Hervey Pew	Kelso Farm Sunnyside None	Heaslip Henry Spence W. Kerr W. E. Tench	None None None None
159	Lands of Falls Company	None	Lands of Falls Company	House (2)

The 1815 map illustrates the Study Area was located in proximity to Lundy's Lane, and the historic battle site from the ware of 1812. The Lundy house is also illustrated. The 1862 map illustrates that Drummond Road, Dunn Street, and Dorchester Road were historically surveyed. The village of Drummondville is shown just east of the Study Area along Main Street. By 1877, additional subdivided lots are shown on the south side of Lundy's Land with houses. Numerous battlefields are noted with crossed swords on the map, including on the east and west sides of Drummond Road at Murray Street and near Culp Street.

1.2.4 Twentieth-Century Mapping Review

The 1906 National Topographic System (NTS) Niagara Sheet and the 1954 and 1995 aerial photograph of Niagara Falls (Brock University 2018) were examined to determine the extent and nature of development and land uses within the Study Area (Figures 5-7).

The 1906 map indicates numerous houses adjacent to the Study Area along Drummond Road, Dunn Street, and Dorchester Roads. The topography is shown to be relatively flat and consists of a rural landscape. The battleground at Lundy's Lane is shown. The 1954 photography indicates substantial residential subdivision construction within and surrounding the Study Area. The hydro corridor is also depicted, as well as the hydro canal. The 1995 aerial shows that the Study Area has remained relatively unchanged since the late twentieth century.

1.3 Archaeological Context

This section provides background research pertaining to previous archaeological fieldwork conducted within and in the vicinity of the Study Area, its environmental characteristics (including drainage, soils or surficial geology and topography, etc.), and current land use and field conditions. Three sources of information were consulted to provide information about previous archaeological research: the site record forms for registered sites available online from the MTCS through "Ontario's Past Portal"; published and unpublished documentary sources; and the files of ASI.

1.3.1 Current Land Use and Field Conditions

A review of available Google orthoimagery since 2002 shows that the Study Area has remained relatively unchanged.

A Stage 1 property inspection was conducted on August 22, 2019 that noted the Study Area is located along the existing right-of-ways (ROWs) within the Corwin neighbourhood of the City of Niagara Falls. Stormwater flows are currently collected and conveyed to the Hydro Electric Power Canal (HEPC) via five storm sewer outfalls. The Study Area runs from the hydro canal through the hydro corridor and along the backyards of houses that front onto Dunn Street, following the existing sewer alignments. The proposed sewer departs the existing utilities along Carlton Avenue between Dunn Street and Corwin Crescent along a treed area and grassy boulevard.

1.3.2 Geography

In addition to the known archaeological sites, the state of the natural environment is a helpful indicator of archaeological potential. Accordingly, a description of the physiography and soils are briefly discussed for the Study Area.

The S & G stipulates that primary water sources (lakes, rivers, streams, creeks, etc.), secondary water sources (intermittent streams and creeks, springs, marshes, swamps, etc.), ancient water sources (glacial lake shorelines indicated by the presence of raised sand or gravel beach ridges, relic river or stream channels indicated by clear dip or swale in the topography, shorelines of drained lakes or marshes, cobble beaches, etc.), as well as accessible or inaccessible shorelines (high bluffs, swamp or marsh fields by the edge of a lake, sandbars stretching into marsh, etc.) are characteristics that indicate archaeological potential.

Water has been identified as the major determinant of site selection and the presence of potable water is the single most important resource necessary for any extended human occupation or settlement. Since water sources have remained relatively stable in Ontario since 5,000 BP (Karrow and Warner 1990:Figure 2.16), proximity to water can be regarded as a useful index for the evaluation of archaeological site potential. Indeed, distance from water has been one of the most commonly used variables for predictive modeling of site location.

Other geographic characteristics that can indicate archaeological potential include: elevated topography (eskers, drumlins, large knolls, and plateaux), pockets of well-drained sandy soil, especially near areas of heavy soil or rocky ground, distinctive land formations that might have been special or spiritual places, such as waterfalls, rock outcrops, caverns, mounds, and promontories and their bases. There may be physical indicators of their use, such as burials, structures, offerings, rock paintings or carvings. Resource areas, including; food or medicinal plants (migratory routes, spawning areas) are also considered characteristics that indicate archaeological potential (S & G, Section 1.3.1).

The Study Area is located within till moraines, sand plains, and clay plains of the Haldimand Clay Plain physiographic region of southern Ontario (Chapman and Putnam 1984). The Study Area is also adjacent to a glacial beach ridge (Figure 8). The clay sediments that cover the region were deposited in glacial Lake Warren around 12,500 B.P. (Chapman and Putnam 1984:21). Several poorly defined morainic ridges run east and west and provide minor topographic features directing stream drainages towards the east. The Niagara Falls Moraine is most pronounced at Lundy's Lane where it is topped by a relict beach of Lake Warren (Chapman and Putnam 1984: 51-52). The ridge of the moraine likely presented a linear feature along which travel was oriented. Indeed, the historical alignment of Lundy's Lane along this feature indicates that it was probably built upon a preexisting Indigenous trail.

Figure 9 depicts surficial geology for the Study Area. The surficial geology mapping demonstrates that the Study Area is underlain by coarse-textured glaciolacustrine deposits of sand, gravel, minor silt and clay, some of which are identified as littoral deposits (Ontario Geological Survey 2010). Natural soils and drainage within the Study Area could not be identified (Kingston and Presant 1989).

The Study Area is within two kilometres of the Niagara River and Niagara Falls. The river flows for 51 kilometres, from Lake Erie north into Lake Ontario over Niagara Falls. The Study Area is north of the Welland River, which drains the Niagara Peninsula from west to east to outlet into the Niagara River at Chippewa. Historically these waterways have been heavily modified for canals to serve as transportation routes as well as hydroelectric power generation. The Study Area is adjacent to the Hydro Electric Power Canal (HEPC) which diverts water from the Welland River at Montrose to the Sir Adam Beck No. 2 Generating Station on the Niagara River near Queenston.

1.3.3 Previous Archaeological Research

In Ontario, information concerning archaeological sites is stored in the Ontario Archaeological Sites Database (OASD) maintained by the MTCS. This database contains archaeological sites registered within the Borden system. Under the Borden system, Canada has been divided into grid blocks based on latitude and longitude. A Borden block is approximately 13 km east to west, and approximately 18.5 km north to south. Each Borden block is referenced by a four-letter designator, and sites within a block are numbered sequentially as they are found. The Study Area under review is located in Borden block *AgGs*.

According to the OASD, 16 previously registered archaeological sites are located within one kilometre of the Study Area, none of which are within 50m (Ministry of Tourism, Culture and Sport 2018). A summary of the sites is provided below.

Table 2: List of previously registered sites within one kilometre of the Study Area

Borden #	Site Name	Cultural Affiliation	Site Type	Researcher
AgGs-37	Harovics	Pre-Contact Indigenous	Scatter	MPPAI 1987
AgGs-108	Lundy's Lane	Euro-Canadian	Tavern	Pearce 1997; WEIS 2006
AgGs-109	Drummond Hill Cemetery	Euro-Canadian; Pre-Contact Indigenous	Cemetery; Findspot	WEIS 2001; ASI 2001
AgGs-203	Roaring River	Early-Middle Archaic	Scatter	ASI 1999
AgGs-292	n/a	Late Woodland	Findspot	WEIS 2006
AgGs-293	n/a	Early Archaic	Findspot	WEIS 2006; Detritus Consulting 2014
AgGs-294	n/a	Pre-Contact Indigenous	Scatter	WEIS 2006; Detritus Consulting 2014
AgGs-295	n/a	Late Woodland	Findspot	WEIS 2006
AgGs-296	n/a	Early-Middle Archaic	Camp	WEIS 2006; Detritus Consulting 2016
AgGs-298	n/a	Early Archaic	Camp	WEIS 2006; Detritus Consulting 2016
AgGs-326	Loretto	Late Archaic – Late Woodland; Euro-Canadian	Midden; House	ASI 2010, 2012
AgGs-377	Barker Lundy	Pre-Contact Indigenous; Euro-Canadian	Unknown	ASI 2013, 2015, 2016
AgGs-405	Allendale Avenue	Pre-Contact Indigenous	Scatter	TGAA 2047
AgGs-406	n/a	Late Archaic, Woodland	Camp	ASI 2017; ARA 2017
AgGs-407	n/a	Pre-Contact Indigenous; Euro-Canadian	Camp; Unknown	ASI 2017; ARA 2017
AgGs-408	n/a	Euro-Canadian	Homestead	ASI 2017

ARA - Archaeological Research Associates Ltd.
MPPAI – Mayer, Pihl, Poulton & Assoc. Inc.
TGAA – Thomas G Arnold and Assoc.
WEIS – Wood Environment & Infrastructure Solutions

According to the background research, one previous reports detail fieldwork within 50 m of the Study Area.

ASI (2009) conducted a Stage 1 archaeological assessment as part of the Phase 1 Drummond Road Detailed Design from Lundy's Lane to McLeod Road. Phase 1 includes Drummond Road from Dixon Street to Ker Street. The property inspection determined that the Drummond Road ROW has been heavily disturbed and therefore, does not exhibit archaeological site potential.

2.0 FIELD METHODS: PROPERTY INSPECTION

A Stage 1 property inspection must adhere to the S & G, Section 1.2, Standards 1-6, which are discussed below. The entire property and its periphery must be inspected. The inspection may be either systematic or random. Coverage must be sufficient to identify the presence or absence of any features of archaeological potential. The inspection must be conducted when weather conditions permit good visibility of land features. Natural landforms and watercourses are to be confirmed if previously identified. Additional features such as elevated topography, relic water channels, glacial shorelines, well-drained soils within heavy soils and slightly elevated areas within low and wet areas should be identified and documented, if present. Features affecting assessment strategies should be identified and documented such as woodlots, bogs or other permanently wet areas, areas of steeper grade than indicated on topographic mapping, areas of overgrown vegetation, areas of heavy soil, and recent land disturbance such as grading, fill deposits and vegetation clearing. The inspection should also identify and document structures and built features that will affect assessment strategies, such as heritage structures or landscapes, cairns, monuments or plaques, and cemeteries.

The Stage 1 archaeological assessment property inspection was conducted under the field direction of Andrew Clish (P046) of ASI, on August 22, 2019, in order to gain first-hand knowledge of the geography, topography, and current conditions and to evaluate and map archaeological potential of the Study Area. It was a visual inspection only and did not include excavation or collection of archaeological resources. Fieldwork was only conducted when weather conditions were deemed suitable and seasonally appropriate, per S & G Section 1.2., Standard 2. Previously identified features of archaeological potential were examined; additional features of archaeological potential not visible on mapping were identified and documented as well as any features that will affect assessment strategies. Field observations are compiled onto the existing conditions of the Study Area in Section 7.0 (Figure 10) and associated photographic plates are presented in Section 8.0 (Plates 1-16).

3.0 ANALYSIS AND CONCLUSIONS

The historical and archaeological contexts have been analyzed to help determine the archaeological potential of the Study Area. These data are presented below in Section 3.1. Results of the analysis of the Study Area property inspection are presented in Section 3.2.

3.1 Analysis of Archaeological Potential

The S & G, Section 1.3.1, lists criteria that are indicative of archaeological potential. The Study Area meets the following criteria indicative of archaeological potential:

- Previously identified archaeological sites (see Table 2);
- Water sources: primary, secondary, or past water source (Niagara River);
- Early historic transportation routes (Drummond Road, Dunn Street, and Dorchester Road); and

- Proximity to early settlements (Drummondville, War of 1812 battlegrounds)

According to the S & G, Section 1.4 Standard 1e, no areas within a property containing locations listed or designated by a municipality can be recommended for exemption from further assessment unless the area can be documented as disturbed. The Municipal Heritage Register was consulted and one property adjacent to the Study Area are Listed or Designated under the Ontario Heritage Act: 6123 Drummond Road is adjacent to the Study Area and is a Listed circa 1840 house.

These criteria are indicative of potential for the identification of Indigenous and Euro-Canadian archaeological resources, depending on soil conditions and the degree to which soils have been subject to deep disturbance.

3.2 Analysis of Property Inspection Results

A 3 m buffer was applied to the proposed sewer alignment. The property inspection determined that part of the Study Area exhibits archaeological potential (Plate 4; Figure 10: areas highlighted in green). If impacted, these areas will require Stage 2 archaeological assessment prior to any development. According to the S & G Section 2.1.2, test pit survey is required on terrain where ploughing is not viable, such as wooded areas, properties where existing landscaping or infrastructure would be damaged, overgrown farmland with heavy brush or rocky pasture, and narrow linear corridors up to 10 metres wide.

Part of the Study Area has been previously assessed along Drummond Road (ASI 2009) and does not require further work (Figure 10: areas highlighted in light red).

The remainder of the Study Area follows the existing storm sewer alignment and will have been subjected to deep soil disturbance events and according to the S & G Section 1.3.2 do not retain archaeological potential (Plates 1-16; Figure 10: areas highlighted in yellow). These areas do not require further survey.

3.3 Conclusions

The Stage 1 background study determined that 16 previously registered archaeological sites are located within one kilometre of the Study Area. The property inspection determined that parts of the Study Area exhibit archaeological potential.

4.0 RECOMMENDATIONS

In light of these results, the following recommendations are made:

1. The Study Area exhibits archaeological potential. If impacted, these lands require Stage 2 archaeological assessment by test pit survey at five metre intervals, prior to any proposed construction activities outside of the existing right-of-way;

2. The remainder of the Study Area does not retain archaeological potential on account of deep and extensive land disturbance or has been previously assessed. These lands do not require further archaeological assessment; and,

3. Should the proposed work extend beyond the current Study Area, further Stage 1 archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

NOTWITHSTANDING the results and recommendations presented in this study, ASI notes that no archaeological assessment, no matter how thorough or carefully completed, can necessarily predict, account for, or identify every form of isolated or deeply buried archaeological deposit. In the event that archaeological remains are found during subsequent construction activities, the consultant archaeologist, approval authority, and the Cultural Programs Unit of the MTCS should be immediately notified.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

ASI also advises compliance with the following legislation:

- This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, RSO 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological field work and report recommendations ensure the conservation, preservation and protection of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

- It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological field work on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act.*

- Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with sec. 48 (1) of the *Ontario Heritage Act*.

- The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

- Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48(1) of the Ontario Heritage Act and may not be altered, nor may artifacts be removed from them, except by a person holding an archaeological license.

6.0 REFERENCES CITED

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7.0 MAPS

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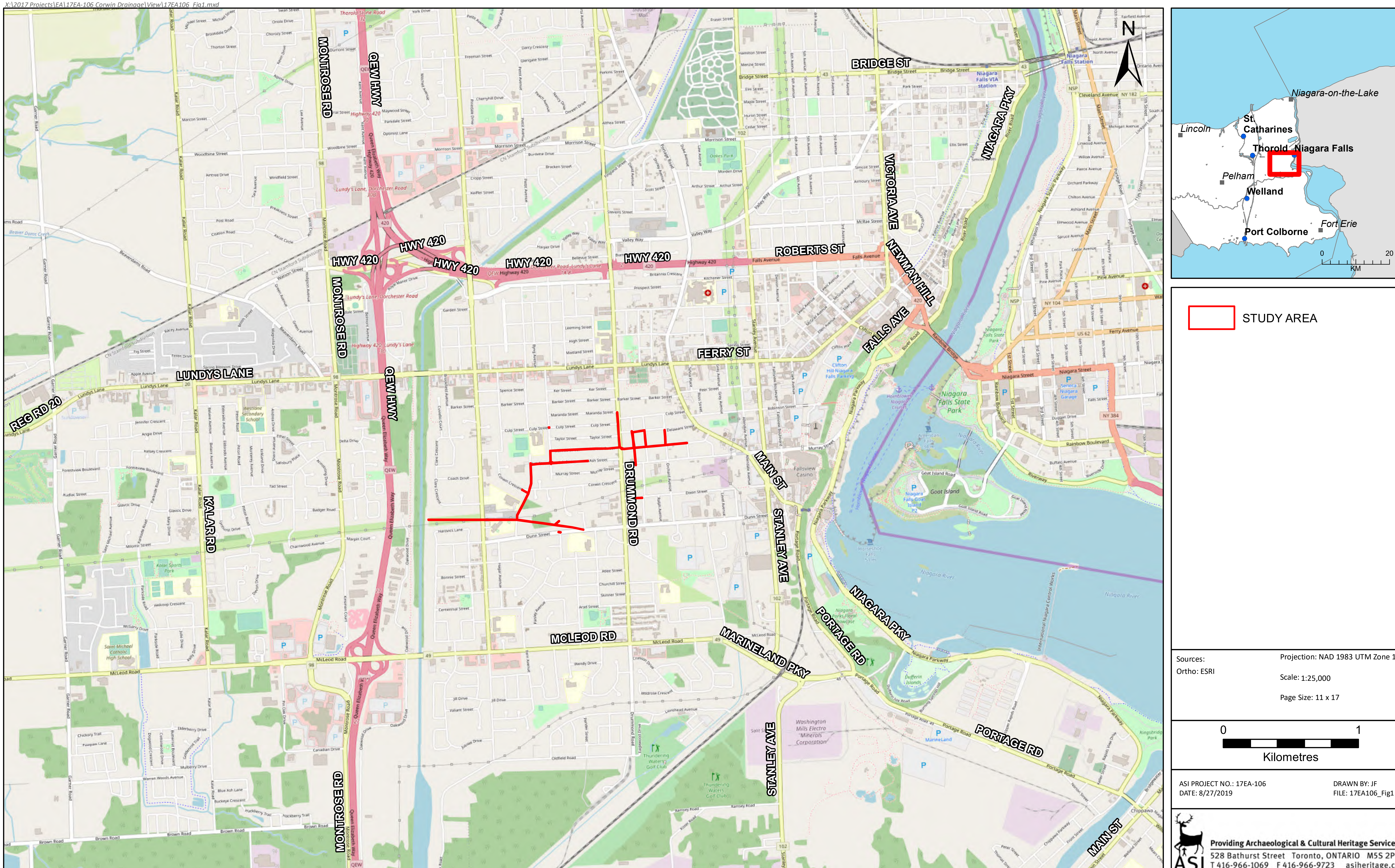

Figure 1: Corwin Drainage Study Area

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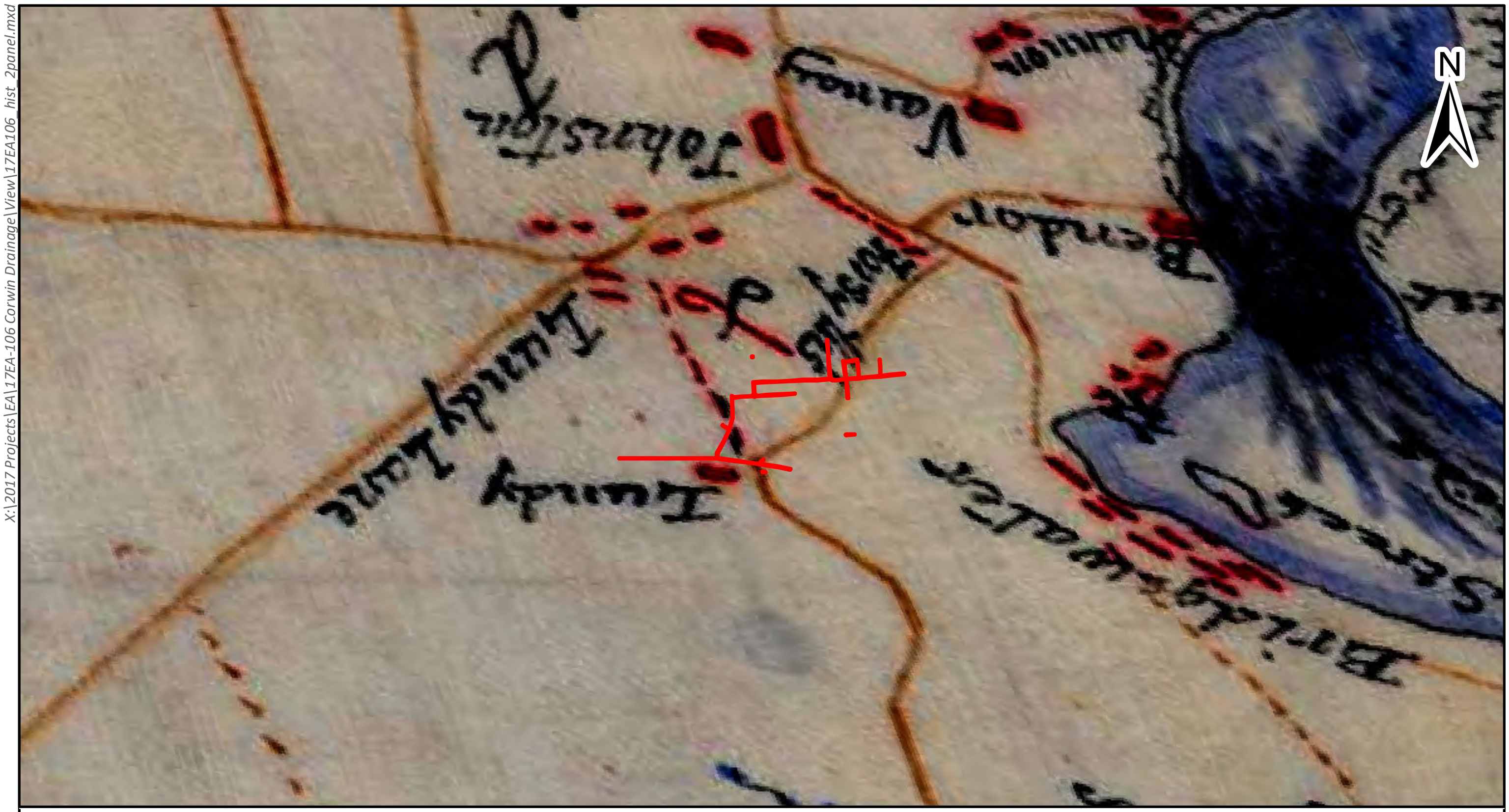

Figure 2: Study Area (Approximate Location) Overlaid on the 1815 Map of the Niagara District in Upper Canada

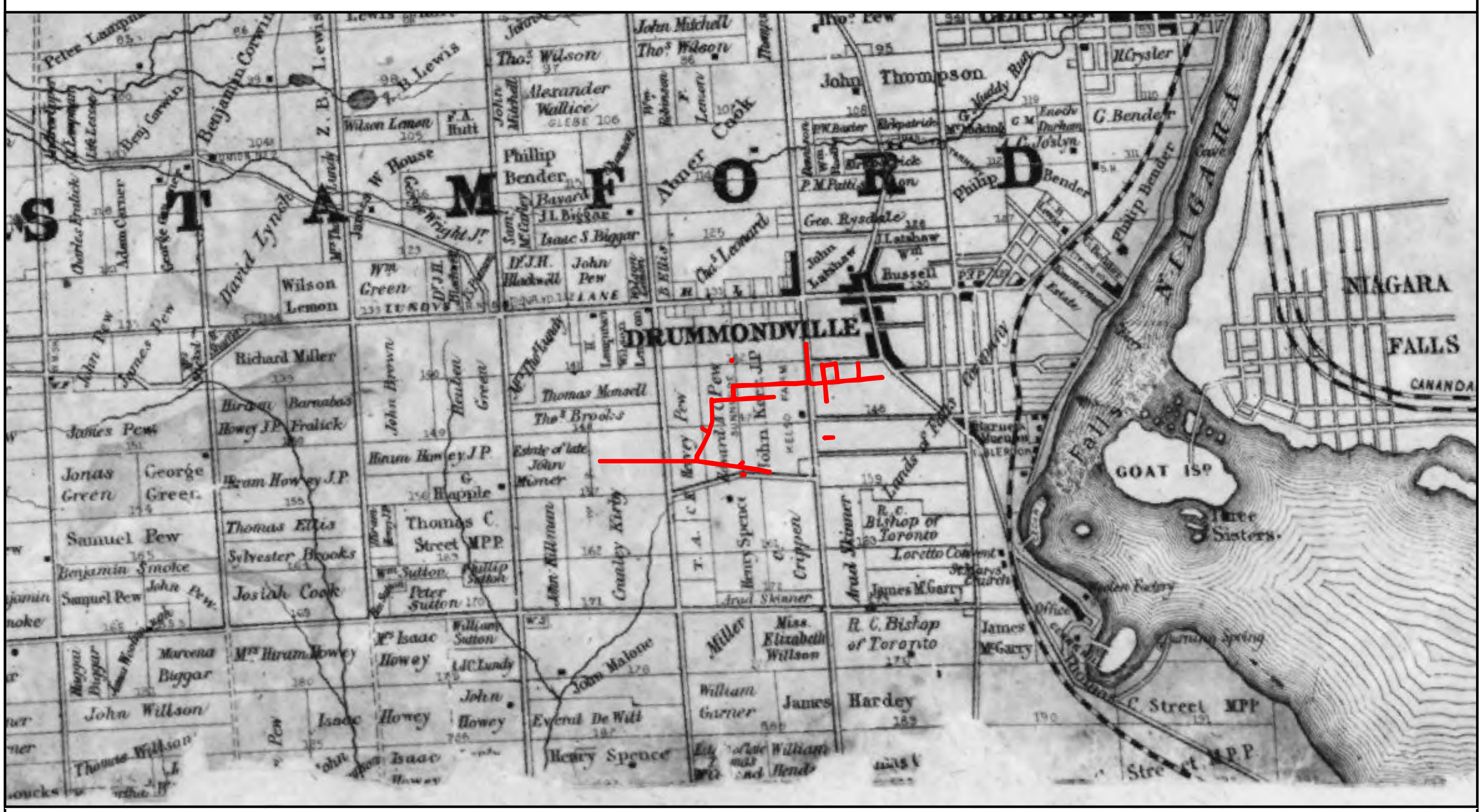

Figure 3: Study Area (Approximate Location) Overlaid on the 1862 Map of the Counties of Lincoln and Welland

ASI

STUDY AREA

Sources:
1815 Map of the Niagara District in Upper Canada
1862 Map of the Counties of Lincoln and Welland

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Scale: 1:50,000
Page Size: 8.5 x 11

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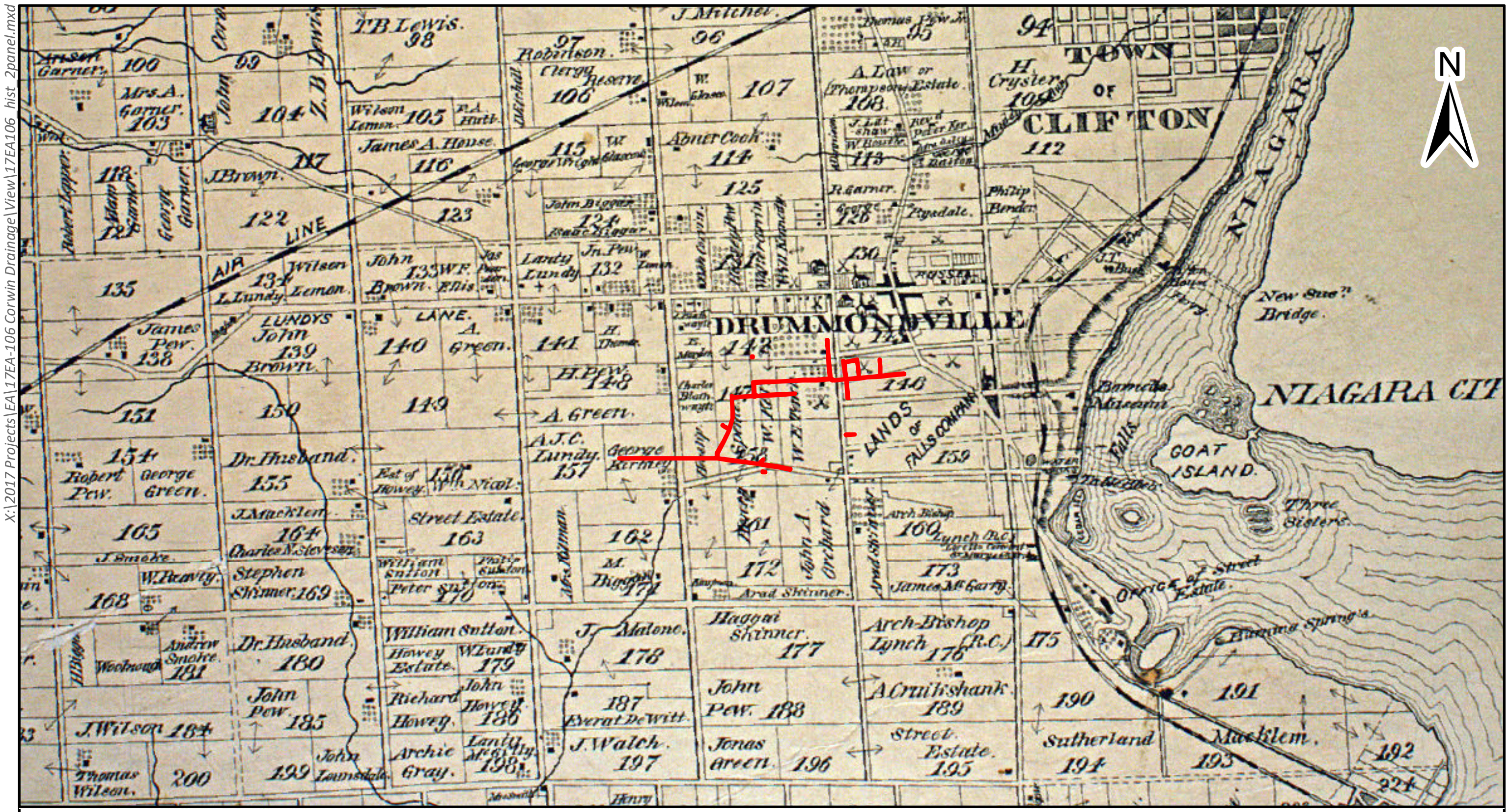

Figure 4: Study Area (Approximate Location) Overlaid on the 1876 Illustrated Historical Atlas of the Township of Stamford

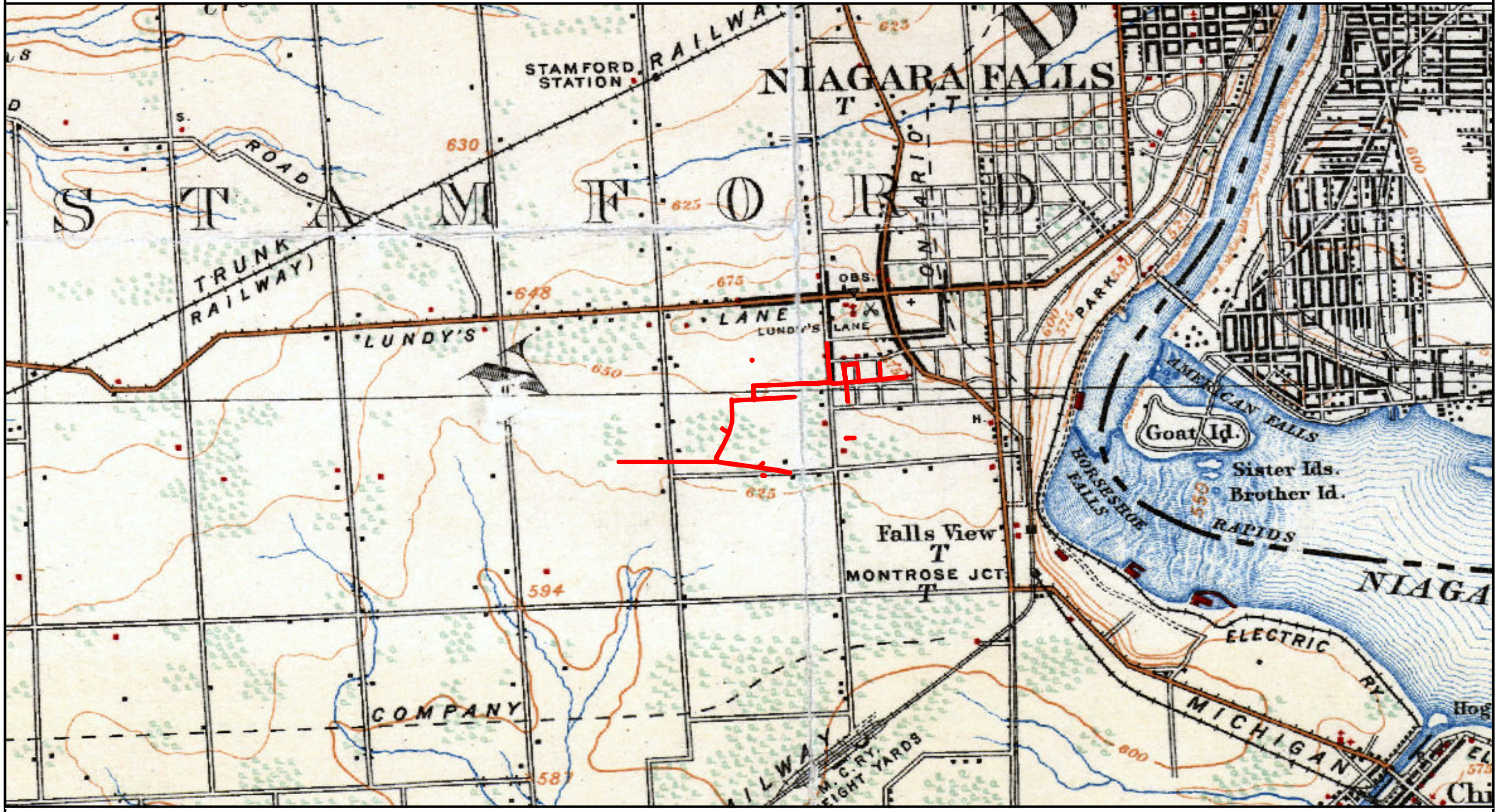

Figure 5: Study Area (Approximate Location) Overlaid on the 1906 NTS Niagara Sheet

ASI

STUDY AREA

Sources:
1876 Illustrated Historical Atlas of the Township of Stamford
1906 NTS Niagara Sheet

Projection: NAD 1983 UTM Zone 17N
Scale: 1:50,000
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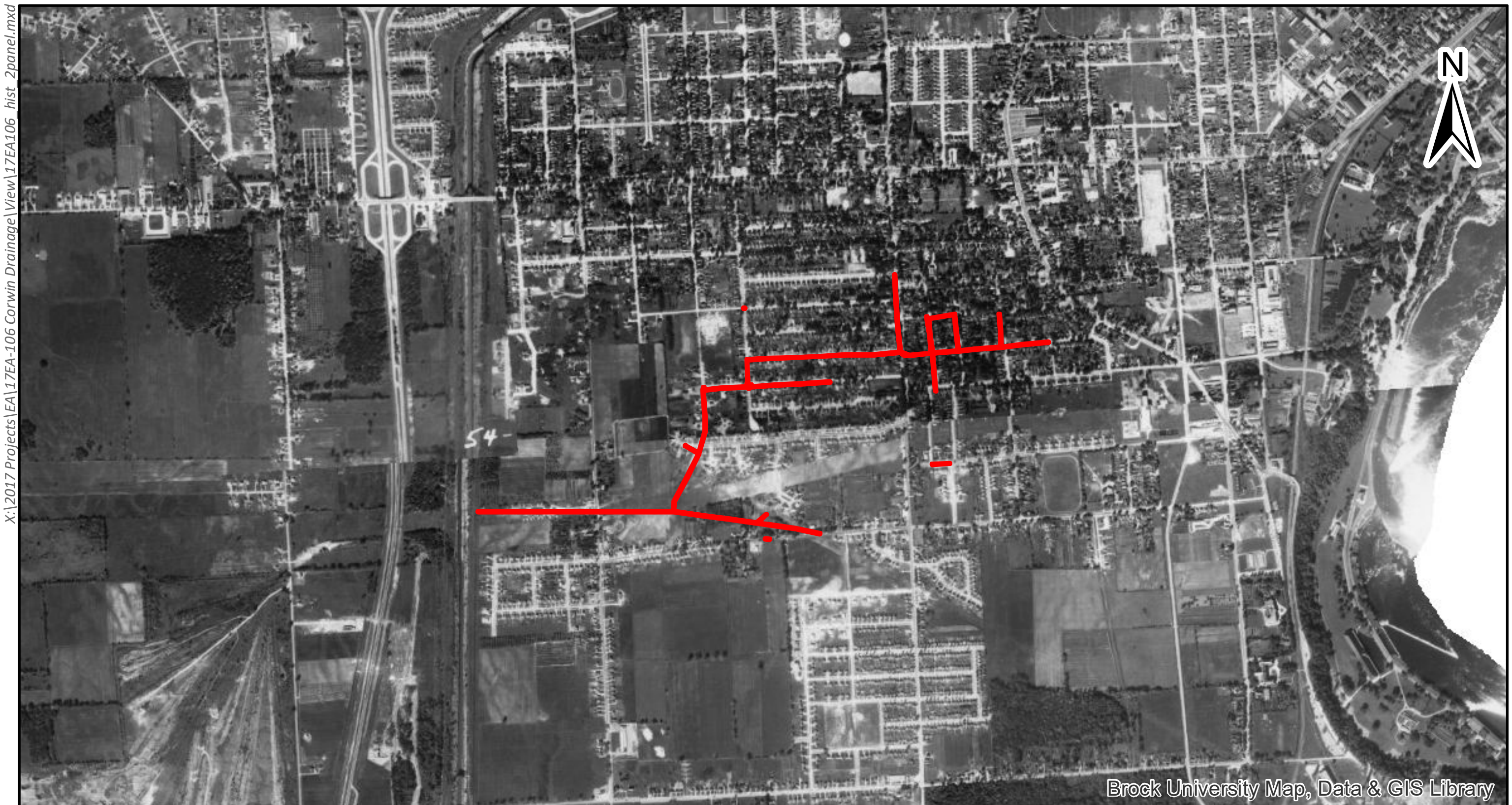

Figure 6: Study Area (Approximate Location) Overlaid on the 1954 Aerial Photography of Niagara

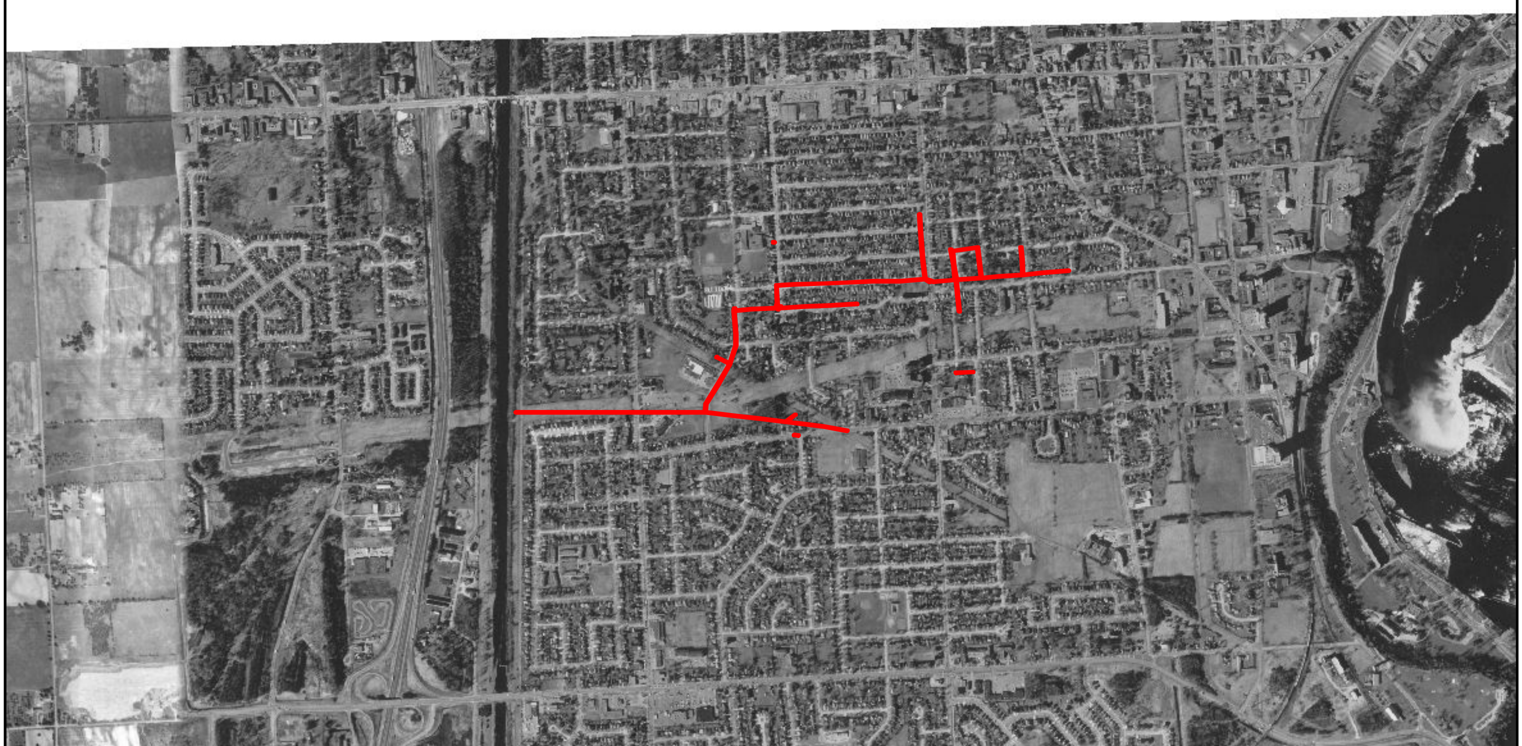

Figure 7: Study Area (Approximate Location) Overlaid on the 1995 Aerial Photography of Niagara

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STUDY AREA

Sources:
Aerial Survey of Ontario
1954
Aerial Survey of Ontario
1995

Projection: NAD 1983 UTM Zone 17N
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ASI PROJECT NO.: 17EA-106
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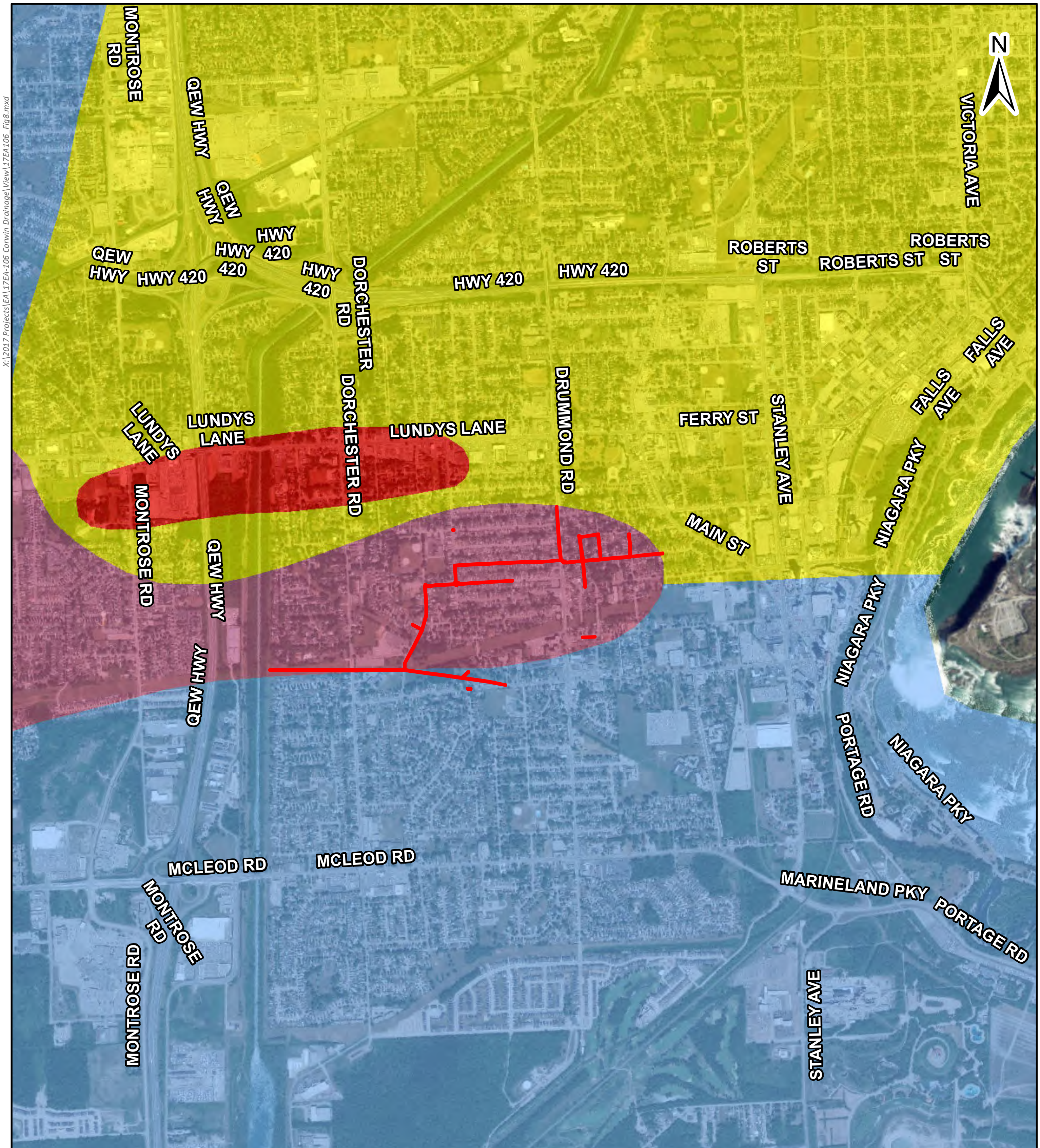

STUDY AREA
14: Beaches
12: Clay Plains
11: Sand Plains
2: Till Moraines

Sources:
Physiography of Southern Ontario; Ontario Geological Survey, 2007

Projection: NAD 1983 UTM Zone 17N
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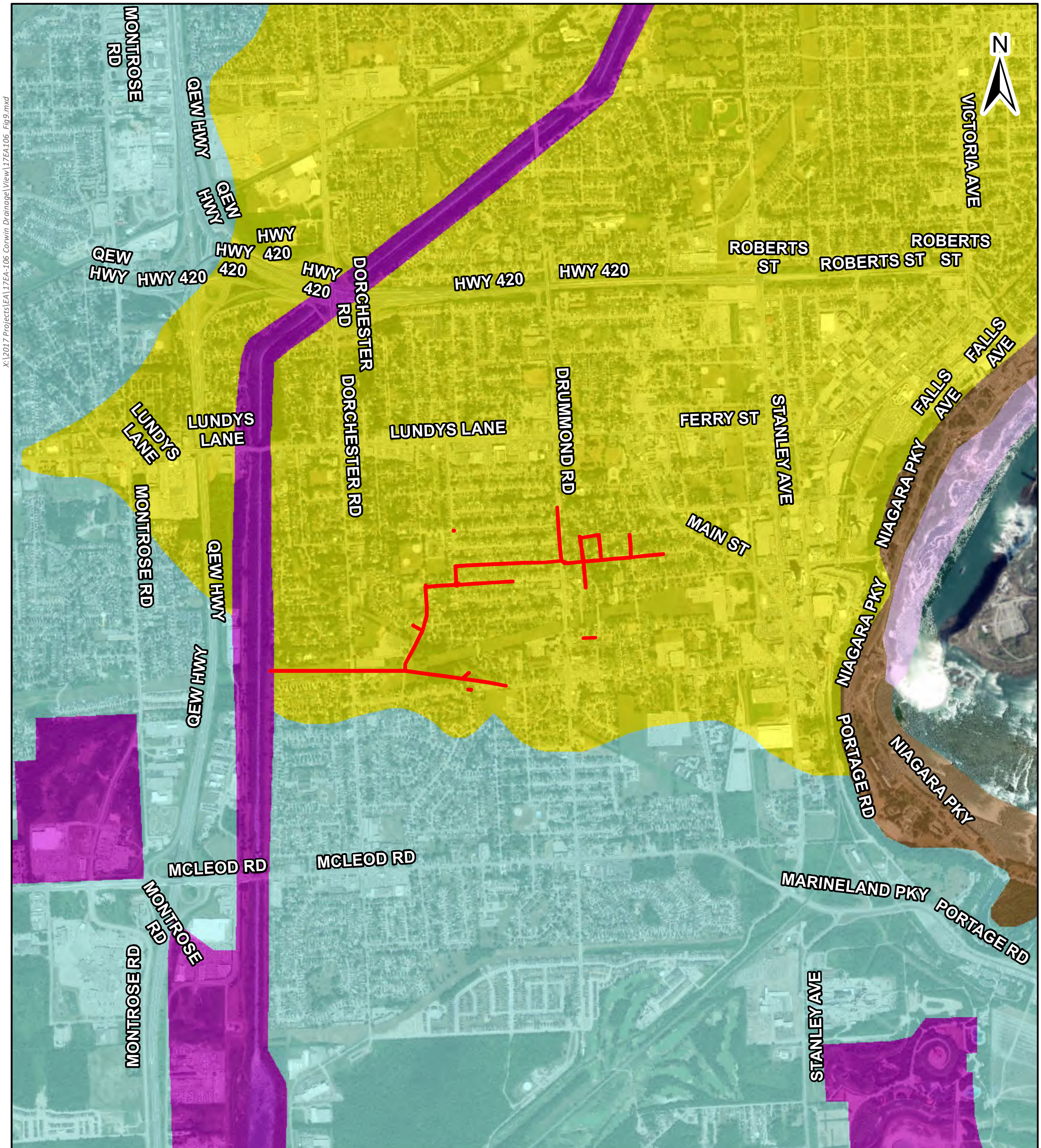
Figure 8: Study Area - Physiographic Landforms



STUDY AREA	9b: Littoral-foreshore deposits	
3: Paleozoic bedrock	12: Older alluvial deposits	
8a: Massive-well laminated	21: Man-made deposits	
9: Coarse-textured glaciolacustrine deposits		

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Sources:
Physiography of Southern Ontario; Ontario Geological Survey, 2007

Projection: NAD 1983 UTM Zone 17N
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Figure 9: Study Area - Surficial Geology

Figure 10: Corwin Drainage Study Area - Results of the Property Inspection

8.0 IMAGES


Plate 1: [E] view of hydro corridor; proposed sewer follows existing infrastructure and is disturbed, no potential


Plate 2: [W] view of hydro corridor; proposed sewer follows existing infrastructure and is disturbed, no potential


Plate 3: [W] view of hydro corridor; proposed sewer follows existing infrastructure and is disturbed, no potential


Plate 4: [N] view Carlton Ave.; proposed sewer is east of disturbed ROW and requires Stage 2 survey


Plate 5: [E] view of hydro corridor; proposed sewer follows existing infrastructure and is disturbed, no potential


Plate 6: [W] view of wooded area north of Dunn St.; proposed sewer follows existing infrastructure and is disturbed, no potential

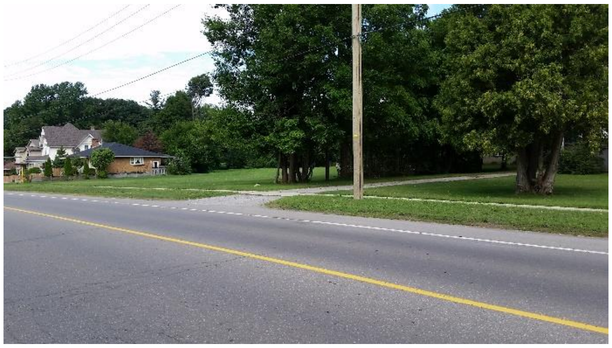
Plate 7: [W] view of Dunn St.; proposed sewer follows existing infrastructure and is disturbed, no potential

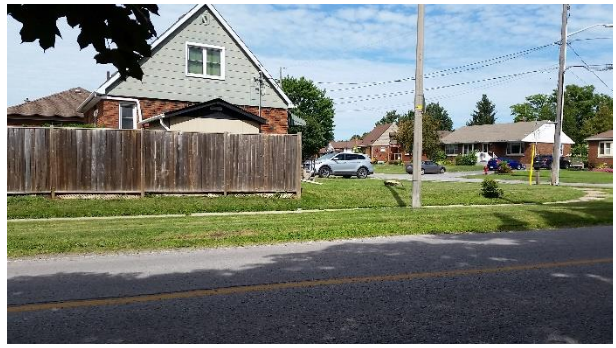
Plate 8: [NW] view of Carlton St. and Corwin Cres.; proposed sewer follows existing infrastructure and is disturbed, no potential


Plate 9: [NE] view of Carlton St.; proposed sewer is within disturbed ROW, no potential


Plate 10: [E] view of Ash St.; proposed sewer is within disturbed ROW, no potential


Plate 11: [W] view of Ash St.; proposed sewer is within disturbed ROW, no potential


Plate 12: [E] view of Monroe St.; proposed sewer is within disturbed ROW, no potential


Plate 13: [W] view of Monroe St.; proposed sewer is within disturbed ROW, no potential


Plate 14: [S] view of Dawlish Ave.; proposed sewer is within disturbed ROW, no potential

Plate 15: [S] view of Orchard Ave.; proposed sewer is within disturbed ROW, no potential

Plate 16: [W] view of Symmes St.; proposed sewer is within disturbed ROW, no potential

Corwin Drainage Area Master Plan and Class Environmental Assessment Study

Appendix D

InfoSWMM Model Overview

November 2020

1.0 Overview of InfoSWMM Model

The H&H model files as summarized below, are submitted electronically

The modelling platform used is InfoSWMM version 14.5. The original GM Blue Plan model was also completed in InfoSWMM and was used per the terms of reference.

There were two models that were reviewed and modified during the study. One was the city-wide InfoSWMM H&H which was developed by GM Blue plan. This model includes a city-wide sanitary/combined network and city-wide trunk storm drainage network. This model was reviewed and checked for gaps in the model network, model & simulation parameters and rainfall data. The data gaps were summarized, and a methodology developed to close the gaps such that there will be confidence in the results while establishing the existing conditions. Please refer to Appendix B for more details.

The other model was XPSWWM which was developed by Aquafor Beech during the MDPUS study. This model contains only the storm sewer network. The ongoing flooding issues of the study area were also related to storm sewer system. The XPSWWM storm sewer model was converted to InfoSWMM and then simulated to resolve the flooding issues.

The major system (overland flow system where runoff is conveyed along the surface to the CB's that then inlet to the minor system) was added in the model. InfoSWMM has a tool called 'Create Dual-Drainage' which helped build most of the overland flow system. In some areas that had a shorter road length or at intersections of the roads then the major system was created manually. After adding the major system to the storm model, the model was calibrated to flow monitoring data collected at three locations within the existing storm sewer system.

Model calibration was achieved by changing model parameters to produce results matching the measurements within a reasonable accuracy in terms of peak flows, runoff volumes and water levels. Model validation involved testing the calibrated model performance using a different set of measurements than the calibration period to ensure the repeatability of the model results.

For both the calibration and validation processes, observed rainfall data was used to simulate the response of the sewer systems. Observed flow at each monitoring location was used to verify the flow predicted by the model for a range of rainfall events.

The alternative solutions collectively addressed issues relating to flooding and the accompanying lack of capacity of the present storm system. Remedial measures to address existing flooding fall into one of four categories: -

Before modelling the alternatives, the proposed InfoSWMM storm system model was modified and expanded with new local storm sewers to be constructed along Barker Street, Maranda Street, Culp Street, Pine Grove Avenue and Orchard Avenue; These streets currently have no storm sewers. CSO's were removed as part of the baseline alternative. The sanitary/combined system of the GM Blue Plan InfoSWMM model was simulated to investigate the impact of CSO's. The combined sewer assessment is limited to the impact on CSO's as a result of the proposed works in this area.

2.0 InfoSWMM Model Network and Output Files

The model network along with the model outputs have been submitted as summarized in Table 1:

Table 1: Model Network Files Summary

Model File	Scenario	Description
NIAGARA_FALLS_2017_All-Pipe_Growth_CP_Jan2020	Existing Conditions – Sanitary / Combined System	This model was originally submitted by GM Blue Plan. The sanitary and combined network that included the locations of the CSO's was evaluated for existing conditions to determine the impact of the five-year design storm on CSO loads.
South_Ex_cor	Existing Conditions – Storm System	The XPSWMM model developed for the MDPUS by Aquafor Beech was converted to InfoSWMM. The major system was added in and the model was calibrated.
South_Prop_cor1	Proposed Conditions – Storm System with new/upgraded local storm sewers and removal of CSO locations	Preferred Alternative - Construction of a New Storm Trunk Sewer within OPG and Hydro One Lands

The modelling files include the following file types:

- InfoSWMM Database (*.ISDB)
- InfoSWMM Output (*.OUT)

The database and scenario output files area accessible through opening ArcMap and activating the InfoSWMM session. The model outputs include: peak flow, velocity, depth of flow and state of surcharge.

All model network and output files referred to in this Appendix have been submitted to the City of Niagara Falls digitally as part of the Environmental Asssessment report.