City of Hamilton

Flooding and Drainage Improvement Framework

February 2022

City of Hamilton

1266 South Service Road, Unit C31
Stoney Creek, ON, L8E 5R9
905-643-6688

GMBP Project: 621085

PEOPLE | ENGINEERING | ENVIRONMENTS

February 23, 2022
Our File: 621085

Christina Cholkan, MEL, P.Eng.
Senior Project Manager – Water/Wastewater Planning
Public Works
Hamilton Water, City of Hamilton

Re: Flooding and Drainage Improvement Framework Report

Dear Christina:

We are pleased to submit this Final Project Report for the Flooding and Drainage Improvement Framework.

If you have any questions or require any additional information, please contact the undersigned.

Yours truly,

GM BLUEPLAN ENGINEERING LIMITED & WOOD PLC

Per:

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EXECUTIVE SUMMARY

i. Study Drivers and Objectives

The "Flooding and Drainage Improvement Framework" (the Framework) was initiated in the summer of 2021 and has involved a holistic review of the City's combined sewer system, with the goal of developing a framework that outlines a long-term management strategy to address existing flooding and drainage issues. The Framework has been structured to provide a high-level roadmap and actionable next steps for the City to better plan for a program of long-term capital improvements and to coordinate these improvements and upgrades within the combined sewer system.

The main purpose of the Framework has been to review the combined sewer system, on a sewershed basis, in order to establish a better understanding of the local system's configuration, performance, and potential contributors to flooding, leading to an identification of priorities including potential short and long-term solutions. The key objectives of the Framework are as follows:

- Holistic review of the recommendations from the Draft Flooding and Drainage Master Servicing Study (FDMSS) for the combined sewer system
- Identification of potential issues
- Develop long-term management vision and objectives
- Identify short-term localized upgrade options to address priority flooding issues
- Provide basis for prioritization of the upgrade options
- Provide preliminary costing and timeline details to support the short and long-term capital planning process
- Provide a framework and high-level roadmap to support the implementation of recommended solutions

The Framework recommendations are based on a high-level screening and prioritization of available management options with the goal of establishing an overall strategy to address both short and long-term flooding and drainage issues.

ii. Study Limitations

All analyses and recommendations presented in this Framework are based on the best available information including leveraging existing and ongoing studies No new field investigations nor modelling studies were completed in support of this project due to time constraints. Through this process, data gaps and/or data uncertainties were noted as outlined in **Section 3.2** of the Framework; however, no supplemental field verification was completed. The system analyses were completed at a high-level to assess the relative conditions and performance of the system, with the stated objective of identifying priority areas of potential concern and likely remediation solutions, and to support the prioritization of the potential recommendations.

Additional investigations and/or studies will be required to address existing data/information gaps and to confirm the scope of major project and/or program recommendations. These next steps are presented in **Section 7.4** of the Report.

iii. System Management Objectives and Strategy

The Framework recommends a long-term management vision that strives to develop a robust wastewater and stormwater collection system that satisfies the following management objectives:

- Minimize the frequency, severity, and extent of basement flooding causing property damage

- Minimize the frequency and severity of surface flooding that poses a general risk to public safety or has the potential to cause property damage
- Minimize the frequency, duration, and total volume of wastewater and combined sewer discharge to the environment
- Provide sufficient system capacity to support existing uses and growth needs
- Provide system resiliency to address the potential impacts of climate change

To achieve the above management vision, the following program and strategy has been proposed.

In the short-term, the strategy is focused on conveyance improvements and storage infrastructure to address the priority objectives related to minimizing basement flooding and surface ponding issues within the identified priority areas while striving to reduce total combined sewer overflows to the environment.

In the long-term, a “Managed Sewer Separation” strategy is proposed to address the objectives related to reducing stormwater inflows to the combined sewer system, environmental stewardship, and climate change adaptation, ultimately seeking to eliminate the combined sewer system where possible.

iv. Managed Sewer Separation Program

The “Managed Sewer Separation” program consists of the City adopting the long-term objective (30+ years) of converting the combined sewer system into separated stormwater and wastewater systems and then proceeding to plan future infrastructure to be in-line with this objective. As “Managed Sewer Separation” proceeds or nears completion, there may reach a point in each subcatchment where combined sewer overflow events have been greatly reduced to the point of diminishing returns on further separation.

Under the proposed separation program, it is generally recommended that, where possible, the existing combined sewer network be used as the future wastewater conveyance sewer and that the stormwater be managed via a new stormwater sewer network, which can leverage the City’s existing storm and relief sewer systems.

To facilitate the implementation of a “Managed Sewer Separation” the City will need to:

- **Establish performance targets for the separated sewers**
- **Develop guiding storm sewer outfall and trunk sewer strategy**

The establishment of performance objectives and the development of trunk sewer strategies, including outlet locations, will need to be developed through the completion Environmental Assessment (EAs) studies. It is anticipated portions of each catchment may not be separated due to technical, financial, and social cultural constraints or due to not being required to address sewer capacity and CSO overflow requirements. When developing the “Managed Sewer Separation” strategies, special care should be given to the neighbourhoods with non-standard and legacy sewer system confirmation where alternative system performance objectives requirements may be needed and consider if the continuation of Special Policy Area criteria is reasonable.

As the City continues to implement the “Managed Sewer Separation” program, the City will need to continuously monitor and track the overall system’s performance. A program review every 5 to 10 years should be undertaken to quantify the system impacts and update the official strategy to account for any changes in growth, impacts of climate change, or other major system based infrastructure upgrades/strategy.

v. Solutions Categorization and Prioritization

The project recommendations have been prioritized into short-term, medium-term, and long-term recommendations. In addition to the timelines, the project recommendations have been categorized into one of four project types, as follows:

- **Studies, Investigations, and Policies**
- **Priority Area Projects**
- **Potential Projects**
- **Managed Sewer Separation**

vi. Program Recommendations

The program's short-term recommendations are focused on three primary outcomes consisting of:

- Establish/confirm the City's long-term management strategy, including the establishment of clear system performance targets and the development/updating of system policy and bylaws necessary to support the management strategy
- Completion of the field investigations, studies, and Environmental Assessments (EAs) necessary to fill data gaps and confirm/further define the long-term program recommendations
- Implementation of capital projects within priority (high-risk) areas that have been previously identified through other localized planning studies and/or have been determined to have high relative system benefit and do not require additional studies to be completed

The full scope of projects proposed to be implemented within the first 10 years will be subject to City's final vision and management philosophy recommendations, which will ultimately determine the pace of capital project implementation. Several priority projects have been identified through the City's ongoing planning process. The implementation of these projects and others will be subject to the outcomes of the field investigations, studies, and Environmental Assessments (EAs), and will be governed by the final system performance targets.

vi.i Infrastructure Recommendations

Section 7 provides a summary of the CSO catchment level recommendation with estimated costs and timelines. A detailed accounting of the projects by catchment are included in **Appendix A** and detailed costing and timing breakdown is included in **Appendix C**

vi.ii Supporting Policies and Studies

In addition to the infrastructure recommendations the studies, investigations, and policies outlined in the Implementation Plan are recommended to support scoping of the Framework recommendations and to confirm the combined system performance objectives.

vii. Implementation Plan

The implementation strategy is outlined as follows.

vii.i 2022-2025 (0-3 Years)

Initial activities will be primarily focused on establishing the appropriate policy and funding necessary to support the implementation of the relevant recommendations. Key planning priorities in the initial stage include:

- City adoption of the recommendation for studies and confirmation of the long-term "Managed Sewer Separation" strategy.
- **STR-9 Stormwater and LID Policy Update** - The review, updating, and approval of the policy recommendations outlined in **Section 7.4.1** in the Framework.
- **STR-10 Stormwater User Rate Study** - The City's Stormwater User Rate is currently underway. Related incentive programs will encourage private property owners to manage stormwater from private properties and implement BMPs such as rain gardens and permeable pavers.
- **STR-8 All-Pipes Model Update** - The City should initiate an update and enhancement to its existing model with a focus on the stormwater system and local sewer performance assessments.

Further, it will be critical that the City initiate the required investigations and studies necessary to implement the more significant infrastructure recommendations in high priority areas and to support implementation of "Managed Sewer Separation". The highest priority studies include:

- **STR-6 Iona Creek Sewer Separation EA** Completion of the Iona Creek Sewer Separation EA, which will outline the preferred upgrade strategy for the high priority Royal CSO. The subject EA was also identified as a high priority project to address water quality concerns and potential CSO overflows to Chedoke Creek (Chedoke Creek Water Quality Study, 2021).
- **STR-1 West End Sewer Separation Study and New Outfall EA** – Completion of the first "Managed Sewer Separation" feasibility study and EA. The study will outline the long-term separation strategy for the west end of the combined sewer area.

It is anticipated that during this timeframe, the City can begin the implementation of system upgrades that were previously validated through past/ongoing supporting studies or projects with clearly defined scope and/or areas that do not require extensive study and/or consultation. As such, these projects can be quickly transitioned to design and implementation.

vii.ii 2025-2027 (3-5 Years)

During the 3-5 year timeframe, the required investigations and studies necessary to implement the more significant infrastructure recommendations in high priority areas are proposed to be completed. The proposed sewer separation and outfall studies will support the implementation of "Managed Sewer Separation" across the City's combined sewer system **(STR-2** & **STR 3** within the Framework**).**

During this stage, it is expected that the City will continue to implement system upgrades that have been previously validated through supporting studies or consisting of projects with clearly defined scope. Upon completion of the hydraulic model update, the City can begin transitioning to the implementation of more complex recommendations that required additional investigations and studies, to confirm upgrade scopes.

vii.iii 2028-2032 (5-10 Years)

Once the major investigations and studies have been completed and supporting policies and tools are updated, the City will transition primarily to the implementation of system upgrades. Following completion of the "Managed Sewer Separation" feasibility studies and EAs, the City can prioritize the application of "opportunistic" implementation of system separation, aligned with other system upgrade and rehabilitation projects. "Opportunistic" implementation of separation projects may still move forward during earlier timelines in the program; however, the completion of the "Managed Sewer Separation" feasibility studies and EAs will provide clarity and efficiency of implementation in future separation projects.

It is during this timeframe that the City can initiate the System Wide Interceptor feasibility study and EA, as well as the Scoped Capacity Assessment of the North Mountain Area (**STR-4** Scoped Capacity Assessment of North Mountain Area and **STR 5** Interceptor Feasibility Study and EA), as the need and capacity requirements of the Western Interceptor Sewer and upgrades to the North Mountain system will be

impacted by the scope and extent of sewer separation. It is recommended that these studies be initiated following the completion of the "Managed Sewer Separation" feasibility studies and EAs.

Finally starting approximately in 2032 and continuing on a 5 to 10-year period, a program review should be undertaken to quantify the extent of system performance improvements and update the management strategy to account for any changes in growth, impacts of climate change, or other major system-based infrastructure upgrades/strategy.

vii.iv Medium-Term (10-20 Years)

The medium-term recommendations focus on addressing the remaining priority area projects. It is also within the medium-term timeframe that the larger scale, system-based solutions may be implemented. Further, the "Managed Sewer Separation" program is anticipated to continue on an "opportunistic" basis.

vii.v Long-Term (20+ Years)

The long-term recommendations are focused on the City's implementation of the "Managed Sewer Separation" program. Once the priority areas projects have been completed, it is anticipated that the City would transition to a more structured and guided "Managed Sewer Separation" program with the goal of targeting full separation of CSO catchments on a priority basis.

viii. Capital Program Summary

Capital program costs have been calculated in the short (0-10 year), medium (10-20 year), and long (20+ year) terms. **Table i** provides a summary of the overall program budget and schedule of recommendations. Additional details are available in **Appendix C,** which provides a breakdown of each recommendation's implementation schedule including general scope, additional studies, fieldwork requirements, estimated timeframe, and budget.

Table i: Summary of capital program and implementation timelines

Category	Timeline			Total ($)
	0-10 Years	10-20 Years	20+ Years	
Studies	$ 5M			**$ 5M**
Priority Area Projects (Recommended)	$ 214M	$ 93M		**$ 307M**
Potential Projects (Further Study)	$ 96M	$ 146M		**$ 242M**
Managed Sewer Separation	$ 52M	$ 19M	$ 404M	**$ 475M**
Total ($)	**$ 367M**	**$ 258M**	**$ 404M**	**$ 1,029M**

The full/final program cost will be subject to change based on the further refinement of the final performance targets, and associated studies and investigations. The long-term costs are proposed to be re-evaluated on an approximate 10-year basis as the current costing includes a 20+ year projection with indeterminate timeline.

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APPENDICES

1 FLOODING AND DRAINAGE IMPROVEMENT FRAMEWORK BACKGROUND

1.1 Study Introduction

The City of Hamilton is a single tier municipality responsible for the management and operation of the local water, wastewater, and stormwater systems. The current City of Hamilton was formed in 2001 through the amalgamation of six (6) former municipalities and as such, the City's wastewater and stormwater systems are a complex collection of systems that were built out over more than 150 years under numerous design philosophies and standards.

Notably, the buildout of large portions of the City's stormwater and wastewater system predates modern standards related to separated sewer systems. Furthermore, much of the existing stormwater and wastewater infrastructure in the City of Hamilton does not account for contemporary environmental considerations and stormwater management approaches; these systems were also designed to climate conditions and performance targets that do not account for the current climate or modern industry performance standards. Newer portions of the City's collection system were constructed with separated wastewater and stormwater sewers; however, substantial portions of separated wastewater system currently continue to drain into the combined sewer system. Evidence of the City's wastewater and stormwater system past practices is particularly pronounced within the older portions of the City of Hamilton based on:

- Extensive use of combined sewers
- Enclosure and channelization of natural drainage courses
- Absence of gravity based major overland flow routes to safely convey stormwater in excess of the local minor-system sewer capacity to natural drainage outlets
- General absence of stormwater management facilities

Due to increased urbanization, growth intensification, and increases in the frequency and intensity of rainfall events due to climate change, the original design capacity of the City's legacy combined sewer system has become strained, resulting in the combined sewer system capacity being frequently overloaded. Over the past 60 years, in an effort to address the identified combined system capacity issues and environmental concerns relating to combined sewer overflows (CSOs), the City has completed numerous upgrades to the combined sewer system to address legacy issues specific to flooding and overflows to the environment. Major efforts to-date have included the construction of:

- Major trunk interceptor sewers, such as the Western Sanitary Interceptor, to divert flows away from untreated discharges to the environment and instead, redirected flows towards the City's Wastewater Treatment Plant (Woodward Treatment Plat)
- Increased primary capacity at Woodward Treatment Plant
- Combined sewage storage tanks to capture excess flows during peak periods, to be safely returned to the treatment system during low flows
- Relief sewers to locally divert stormwater and combined sewer flows away from undersized combined sewers
- Localized sewer separation projects

More recent initiatives have also included:

- Application of Low Impact Development (LID) practices to provide localized enhancements in runoff management

- Application of enhanced stormwater management controls for re-development and infill development that generally result in a reduction of peak flows and runoff volumes generated from the development sites
- Use of real-time controls (RTC) to maximize the use of the available system capacity and storage in an effort to minimize system overflows and flooding risks
- Removal of extraneous flows entering the separated sanitary sewers to reduce total flows that are potentially contributing to capacity constraints in the downstream combined sewer system.

These more recent initiatives have been effective and have been focused on addressing both system-wide issues, as well as local issues or area-specific concerns. These measures and others have resulted in reductions in wastewater release to the environment; however, overflows to the environment still occur, and several areas within the City remain at risk of flooding. Furthermore, within the last decade, the City has experienced several storm events with sufficient severity that the City's wastewater and stormwater systems have been overwhelmed resulting in both localized and widespread flooding affecting residents and businesses.

1.2 Study Drivers and Objectives

In 2017 the City initiated the Flooding and Drainage Master Servicing Study (FDMSS) in an effort to identify areas at risk of flooding and develop potential solutions within the combined sewershed. The scope of the FDMSS involved developing an improved understanding of the City's combined sewer system performance and identifying preliminary upgrade recommendations to address the system's existing performance constraints. The findings were presented to the City, in draft, in September 2019. The preliminary upgrade recommendations identified through the draft FDMSS were substantial and remained unendorsed by the City as they did not outline a clear prioritization and implementation process. The City advanced a third-party review, the Flooding and Drainage Master Servicing Study – Peer Review DRAFT (Jemma Consultants, GM BluePlan, Wood, 2020) of the preliminary draft recommendations with the objectives of:

- Completing a high-level validation of the system upgrade needs and program costs
- Evaluating how variations in the system performance targets would impact the scope of needed upgrades

The current study, referred to as the "Flooding and Drainage Improvement Framework" (the Framework) was initiated in the summer of 2021 and has involved a holistic review of the City's combined sewer system, with the goal of developing a framework that outlines a long-term management strategy to address existing flooding and drainage issues. The Framework has been structured to provide a high-level roadmap and actionable next steps for the City to better plan for a program of long-term capital improvements and to coordinate these improvements and upgrades within the combined sewer system.

The main purpose of the Framework has been to review the combined sewer system, on a sewershed basis, in order to establish a better understanding of the local system's configuration, performance, and potential contributors to flooding, leading to an identification of priorities including potential short and long-term solutions. The key objectives of the Framework are as follows:

- Holistic review of the recommendations from the Draft FDMSS for the combined sewer system
- Identification of potential issues
- Develop long-term management vision and objectives
- Identify short-term localized upgrade options to address priority flooding issues
- Provide basis for prioritization of the upgrade options identified under the short-term upgrades
- Provide preliminary costing and timeline details to support the short and long-term capital planning process
- Provide a framework and high-level roadmap to support the implementation of recommended solutions

The development of the Framework, has focused on:

- Providing a high-level understanding of what areas are experiencing flooding, drainage, and conveyance issues
- The frequency and causes of these issues
- And identifying potential solutions and prioritizing those solutions.

The Framework has considered various technical factors including: the topography of the areas, the natural and built environments, the natural and piped drainage through the areas, the extent of separated wastewater and stormwater sewer networks, and the combined sewer networks and facilities.

1.3 Study Limitations

All analyses and recommendations presented in this Framework are based on the best available information including leveraging existing and ongoing studies and the City's existing "all pipes" model that was developed by Aquafor Beech in 2019 (Note - Flooding and Drainage Master Servicing Study report and its associated models remain in draft and has not been approved by the City). No new field investigations nor modelling studies were completed in support of this project due to time constraints. While some additional desktop review of combined sewer system performance data was completed, these additional analyses relied on the existing model and available reported data. Through this process, data gaps and/or data uncertainties were noted as outlined in **Section 3.2**; however, no supplemental field verification was completed. The system analyses were completed at a high-level to assess the relative conditions and performance of the system, with the stated objective of identifying priority areas of potential concern and likely remediation solutions, and to support the prioritization of the potential recommendations.

Due to the previously noted limitations, the analysis completed through the Framework should not be used as the sole basis of technical requirements within the subsequent implementation of the Framework. Additional investigations and/or studies will be required to address existing data/information gaps and to confirm the scope of major project and/or program recommendations. These next steps are presented in **Section 7.4**.

2 SYSTEM OVERVIEW

2.1 System Context

The Framework has focused on the City's combined sewer system which is generally encompassed by the area west of Red Hill Creek, North of Mohawk Road and east of the historical City of Hamilton and Town of Dundas boundary. A portion of separated wastewater and stormwater collection systems, located between the Lincoln M. Alexander Parkway and Mohawk Road, is conveyed to the combined system north of Mohawk Road and as such, has been included in the study area. **Figure 1** depicts the approximate limits of the City's combined sewer system, encompassing the majority of the historical City of Hamilton boundary. In addition to managing, collecting, and conveying local wastewater and stormwater flows, the combined system also receives wastewater flows from the separated Mountain, Stoney Creek, and Ancaster systems, as well as surplus flows (flows which exceed the capacity of the Dundas WWTP) from the Dundas and Waterdown systems.

The combined sewer system's original design and construction predates the City's existing wastewater treatment plant (Woodward WWTP) and was predominately constructed as several smaller sewer systems. Initially these combined sewer systems directly discharged into the Hamilton Harbour and then subsequently, these systems were directed to one of several rudimentary treatment plants. Under current/existing conditions, all combined sewer flows within the system are directed to one of two interceptor sewers, the Western interceptor or the Red Hill interceptor. These interceptor sewers collect combined sewer flows from the legacy sewer network and convey the flows to the Woodward Avenue Wastewater Treatment Plant (WWTP). During periods of high system flows, generally resulting from stormwater events and/or snow melt runoff, the trunk sewers and interceptor sewer capacity are exceeded, and excess flows are directed to one of 33 system overflows, as shown in **Figure 1**.

Since construction of the Woodward WWTP and the interceptor sewers, the City has continued to upgrade the combined system in an effort to support growth, improve the level of service, and reduce combined sewer overflows to the environment. During that time, management philosophies have evolved ranging from:

- Construction of storage tanks to capture excess flows during peak periods to reduce overflow volumes
- Construction of local relief sewers to locally divert stormwater flows from undersized combined sewers
- Localized sewer separation projects

The above initiatives have been effective but were predominantly focused on addressing local issues or area-specific concerns.

The combined sewer system design basis is to collect and convey both wastewater and stormwater to the Woodward WWTP in a way that avoids surface and basement flooding; however, the City has experienced changes since the construction of the existing legacy system which include:

- The existing system was built out over 100 years and was designed using a wide variety of design standards, which in many cases no-longer reflect current conditions. This has resulted in issues such as:
    - Shallow sewer depths that restrict available system freeboard and/or may impact local users
    - Undersized sewer capacity to accommodate current flows
    - Sewer design practices that may result in additional extraneous flows entering the system, further restricting available capacity

- The effects of climate change that result in increased frequency and severity of major rainfall and snow melt events, increasing the likelihood and severity of flooding
- Impact of urbanization over time, which results in increased impervious coverage and increased population density, which have generally increased peak system flows
- An increase in regulatory requirements and the publicly desired performance criteria, resulting in high sewer system capacity requirements

2.2 CSO Catchment Description

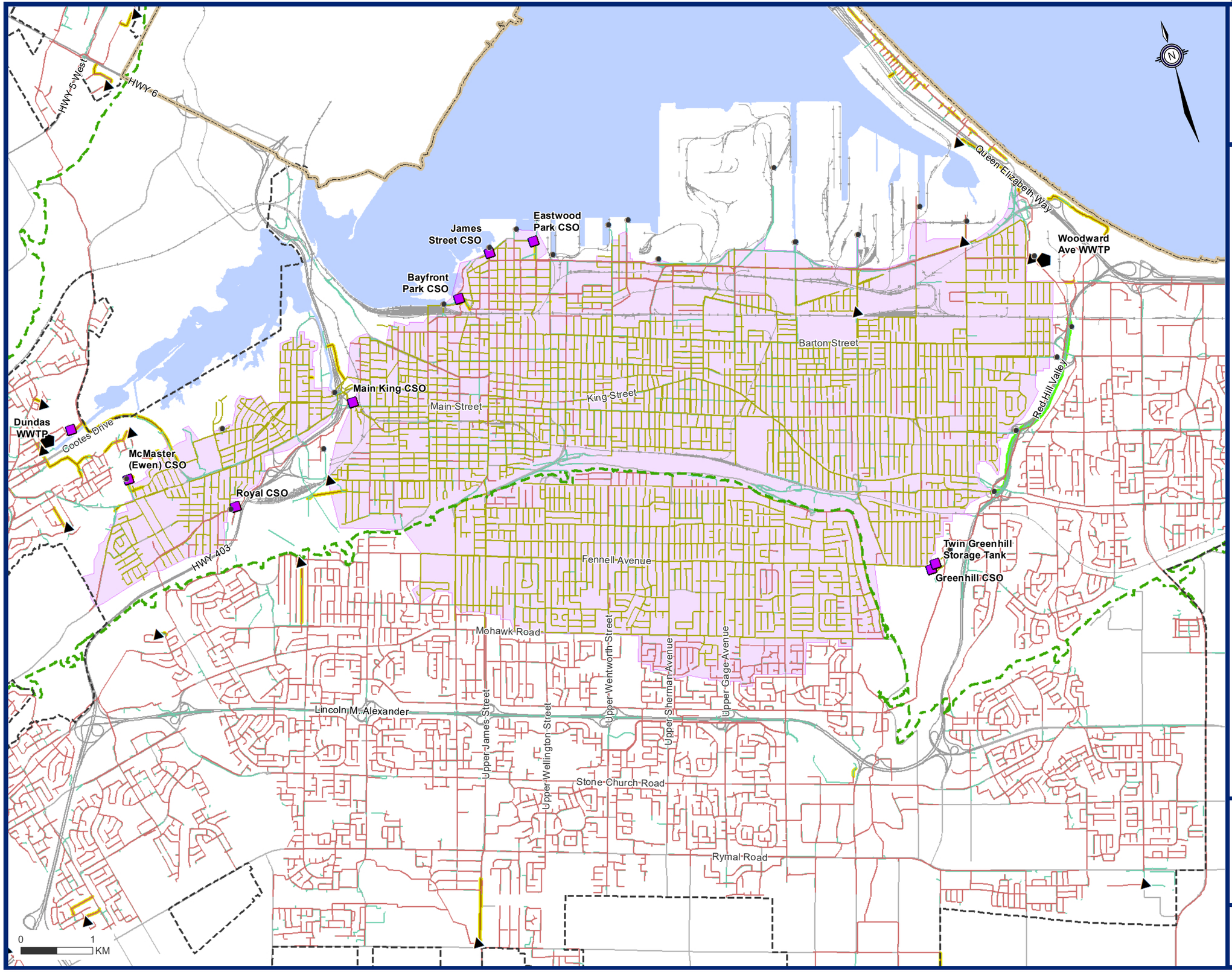
For the purposes of the Framework, the City's combined sewer system has been subdivided into 24 combined sewer overflow (CSO) catchments, consistent with the discretization completed by others (i.e. as part of the Draft FDMSS). The preceding represents each distinct sewer system contributing to the 33 CSO outfalls and 9 CSO tanks within the City's combined sewer system.

Figure 2 depicts the 24 CSO Catchments. A general overview/description of each CSO catchment is provided in the sections which follow, and further detail is provided in **Appendix A**.

For the purpose of the Framework, each of the 24 CSO catchments has been further subdivided into smaller subcatchments which generally average 40-50 ha to allow for a more in-depth and localized assessment of performance and allow for the development of more local solutions. This has resulted in 108 individual subcatchment areas. It should be noted that the process of establishing and refining subcatchment areas has resulted in differences in the overall boundaries when compared to the discretized 24 CSO catchment completed by others for the Draft FDMSS. Based on discussions with the City of Hamilton, it has been considered preferred for the Framework to preserve the original 24 CSO catchment boundaries for the guidance summaries, despite these minor differences in the boundaries.

Hamilton

Flooding and Drainage
Improvement Framework



Wastewater Infrastructure

- Wastewater Treatment Plant (WWTP)
- Wastewater Pumping Station
- Outfalls
- CSO Tanks

Sewer Main Types

- Sanitary Mains
- Combined Mains
- Storm Mains
- Sanitary Forcemain
- Red Hill Super Pipe
- Study Drainage Area

General Features

- Escarpment
- Railway
- City Boundary
- Urban Boundary

Figure #1

Study Area

Existing Sewer System

BluePlan ENGINEERING wood.

December 2021
621085-001
NAD 1983 UTM Zone 17N

Hamilton

Flooding and Drainage
Improvement Framework

HWY-5 West
HWY-6
Queen Elizabeth Way
Eastwood Park CSO
James Street CSO
Bayfront Park CSO
Woodward Ave WWTP
Barton Street
King Street
Main Street
Main King CSO
Red Hill Valley
Dundas WWTP
Cootes Drive
McMaster (Ewen) CSO
Royal CSO
HWY-403
Twin Greenhill Storage Tank
Greenhill CSO
Fennell Avenue
Mohawk Road
Upper James Street
Upper Wellington Street
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Lincoln M. Alexander
Stone Church Road
Rymal Road
1
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Wastewater Infrastructure

- Wastewater Treatment Plant (WWTP)
- Wastewater Pumping Station
- CSO Tanks
- Outfalls

CSO Catchments

- 1, AinslieWood
- 2, McMaster
- 3, Westdale
- 4, Churchill Park
- 5, Aberdeen-Hilcrest
- 6, Main King-1
- 7, Main King-2
- 8, Bayfront CSO
- 9, James CSO
- 10, Eastwood Park CSO
- 11, Wellington CSO
- 12, Wentworth CSO
- 13, Birch CSO
- 14, Gage CSO
- 15, Ottawa CSO
- 16, Kenilworth CSO
- 17, Strathearne CSO
- 18, Parkdale CSO
- 19, Dunn/Woodward CSO
- 20, Melvin CSO
- 21, Queenston CSO
- 22, Lawrence CSO
- 23, Rosedale
- 24, Mountain

General Features

- Railway
- City Boundary
- Urban Boundary

Figure #2

CSO Catchments

Existing Sewer System

BluePlan wood.

December 2021
621085-006
NAD 1983 UTM Zone 17N

Document Path: W:\Hamilton\621000\621085 Hamilton FDMSS Framework\4 Work In Progress\GIS and Data\621085-006-CSO Catchments.mxd

2.2.1 Ainslie Wood

The Ainslie Wood CSO catchment is located in the western portion of the City's combined sewer system comprising the boroughs of Ainslie Wood North, Ainslie Wood East, and Ainslie Wood West, covering an area of approximately 270 ha. The CSO catchment primarily drains to two separate trunk systems with the north trunk system following Sanders Blvd. and the southern trunk system following Iona Ave. to the Royal CSO tank. The northern portion of the catchment drains to the McMaster CSO catchment. The southern portion drains to the trunk infrastructure within the Highway 403 corridor, with overflows entering the Royal CSO tank and discharging into the headwaters of Chedoke Creek once at capacity. The Ainslie Wood CSO catchment was subdivided into 5 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.2 McMaster

The McMaster CSO catchment is located in the western portion of the City's combined sewer system comprising the boroughs of Cootes Paradise A, Ainslie Wood East, and Westdale South, covering an area of approximately 78 ha. The CSO catchment primarily drains to the trunk system following Sterling St. into the Westdale CSO catchment. The McMaster CSO catchment's overflows are discharged into the headwaters of Cootes Paradise through an outfall along Sterling St. The McMaster CSO catchment was not subdivided into additional subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.3 Westdale CSO

The Westdale CSO catchment is located in the western portion of the City's combined sewer system comprising the borough of Westdale South, covering and area of approximately 84 ha. The CSO catchment primarily drains to a single trunk sewer that follows Sterling Street to King Street. The catchment ultimately drains to the Main and King Storage tank and overflow structure via the adjacent Churchill Park CSO catchment. There is also an internal overflow from the combined sewer at Sterling Street that discharges to the headwaters of Cootes Paradise. The Westdale CSO catchment was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.4 Churchill Park

The Churchill Park CSO catchment is located in the northwestern portion of the City's combined sewer system comprising the borough of Westdale North, covering an area of approximately 64 ha. The CSO catchment primarily drains to the trunk system within King St. W to Glen Rd. The catchment ultimately drains to the Highway 403 corridor, where over-capacity flows are directed to the Main-King CSO tank. Flows exceeding the CSO tank capacity are discharged into Chedoke Creek through the outfall at Glen Rd. and the Highway 403 corridor. The Churchill Park CSO catchment was not subdivided into additional subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.5 Aberdeen-Hillcrest

The Aberdeen-Hillcrest CSO catchment is located in the southwestern-central portion of the City's combined sewer system comprising the borough of Kirkendall South, covering an area of approximately 110 ha. The eastern portion of the CSO catchment primarily drains to the trunk system within Locke St. S, south of Aberdeen Ave., while the central and western portions of the catchment primarily drain to the trunk within Dundurn St. S, south of Aberdeen Ave. The combined sewer system drains to the Main-King-1 CSO catchment, while the relief/combined sewer overflows drain to either the Main-King-1 CSO catchment or the outfall within the headwaters of Chedoke Creek. There are no CSO tanks within the Aberdeen-Hillcrest CSO catchment. The Aberdeen-Hillcrest CSO catchment was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.6 Main and King 1

The Main-King-1 CSO catchment is located in the southwestern-central portion of the City's combined sewer system comprising the boroughs of Strathcona, Kirkendall North, Mohawk, Durand, Corktown, Southam, and Centremount, covering an area of approximately 326 ha. The CSO catchment primarily drains to the west through the trunk systems within Dundurn St. S, Locke St. S, Queen St. S, and Main St. W. The combined sewer system drains to the trunk infrastructure within the Highway 403 corridor, where over-capacity flows are directed to the Main-King CSO tank. Flows exceeding the CSO tank capacity are discharged into Chedoke Creek through the outfall at Glen Rd. The Main-King-1 CSO catchment was subdivided into 7 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.7 Main and King 2

The Main-King-2 CSO catchment is located in the northwestern-central portion of the City's combined sewer system comprising the borough of Strathcona, covering an area of approximately 36 ha. The CSO catchment primarily drains to the east through the trunk systems within Hunt St. to Head St. and crossing Victoria Park into the Bayfront CSO catchment. The relief/CSO system drains along King St. W to the trunk infrastructure within the Highway 403 corridor, where over-capacity flows are directed to the Main-King CSO tank. Flows exceeding the CSO tank capacity are discharged into Chedoke Creek through the outfall at Glen Rd. The Main-King-2 CSO catchment was not subdivided into additional subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.8 Bayfront CSO

The Bayfront CSO catchment is located in the northwestern-central portion of the City's combined sewer system comprising the boroughs of Strathcona and Central, covering an area of approximately 111 ha. The CSO catchment primarily drains to the northeast through the trunk systems within York Blvd., Locke St. N, Queen St. N, Barton St. W, Caroline St. N, and MacNab St. N into the James CSO catchment. The relief/CSO system drains along Barton St. W and MacNab St. N to the Bayfront CSO tank. Flows exceeding the CSO tank capacity are discharged into Hamilton Harbour through the outfall between Bayfront Park and the rail corridor. The Bayfront CSO catchment was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.9 James CSO

The James CSO catchment is located in the northwestern portion of the City's combined sewer system comprising the borough of North End West, covering an area of approximately 30 ha. The CSO catchment primarily drains to the northeast through the trunk systems within James St. N into the Eastwood Park CSO catchment. Over-capacity flows drain along James St. N to the James Street CSO tank. Flows exceeding the CSO tank capacity are discharged into Hamilton Harbour through the outfall at the north end of James St. N. The James CSO catchment was not subdivided into additional subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.10 Eastwood Park CSO

The Eastwood Park CSO catchment is located in the northwestern portion of the City's combined sewer system comprising the boroughs of North End East, covering an area of approximately 33 ha. The CSO catchment primarily drains to the east through the trunk systems within Burlington St. E into the Wellington CSO catchment. Over-capacity flows drain along Ferguson Ave. N and Catharine St. N to the Eastwood Park CSO tank. Flows exceeding the CSO tank capacity are discharged into Hamilton Harbour through either the outfall at the north end of Ferguson Ave. N or the outfall at the north end of Catharine St. N. The Eastwood Park CSO catchment was not subdivided into additional subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.11 Wellington CSO

The Wellington CSO catchment is located in the central portion of the City's combined sewer system comprising the boroughs of the North End East, Industrial Sector A and Keith, Central, Beasley, Landsdale, Durand, Corktown, and Stinson, covering an area of approximately 436 ha. The CSO catchment primarily drains to the north through the trunk systems within Ferguson Ave. N, Catharine St. N, and Wellington St. N, into the Burlington St. trunk sewer. The Burlington St trunk sewer is conveyed east to the Wentworth CSO catchment. The relief/CSO system drains along Wellington St. N to the outfall within Hamilton Harbour at the north end of Wellington St. N, across Burlington St. There are no CSO tanks within the Wellington CSO catchment. The Wellington CSO catchment was subdivided into 9 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.12 Wentworth CSO

The Wentworth CSO catchment is located in the central portion of the City's combined sewer system comprising the boroughs of the Industrial Sector A and Keith, Industrial Sector B and Keith, Landsdale, Gibson, Stinson, and St. Clair, covering an area of approximately 323 ha. The CSO catchment primarily drains to the north through the trunk system within Wentworth St. N into the Burlington St. trunk sewer. The Burlington St trunk sewer is conveyed east to the Birch CSO catchment. The relief/CSO system drains along Wentworth St. N to the outfall to Hamilton Harbour at the north end of Wentworth St. N. There are no CSO tanks within the Wentworth CSO catchment. The Wentworth CSO catchment was subdivided into 6 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.13 Birch CSO

The Birch CSO catchment is located in the central portion of the City's combined sewer system comprising the boroughs of the Industrial Sector B and Keith, Industrial Sector C, Gibson, and Stipley, covering an area of approximately 168 ha. The CSO catchment primarily drains to the north through the trunk system within Birch Ave. into the Burlington St. trunk sewer. The Burlington St trunk sewer is conveyed east to the Gage CSO catchment. The relief/CSO system drains along Birch Ave. to the outfall to Hamilton Harbour at the north end of Birch Ave., across Burlington St. There are no CSO tanks within the Birch CSO catchment. The Birch CSO catchment was subdivided into 3 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.14 Gage CSO

The Gage CSO catchment is located in the central portion of the City's combined sewer system comprising the boroughs of the Industrial Sector C, Industrial Sector D, Stipley, Crown Point West, Crown Point East, Blakeley, Delta West, and Delta East, covering an area of approximately 497 ha. The CSO catchment primarily drains to the north through the trunk system within Gage Ave. N into the Burlington St. trunk sewer. The Burlington St trunk sewer is conveyed east to the Ottawa CSO catchment. The relief/CSO system drains along Gage Ave. N to the outfall to Hamilton Harbour at the north end of Depew St., across Industrial Dr. There are no CSO tanks within the Gage CSO catchment. The Gage CSO catchment was subdivided into 12 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.15 Ottawa CSO

The Ottawa CSO catchment is located in the northern portion of the City's combined sewer system comprising the borough of Industrial Sector D, Industrial Sector E, Crown Point East and Crownpoint West, covering an area of approximately 87 ha. The CSO catchment primarily drains to a single trunk sewer that follows Ottawa Street to Nikola Tesla Boulevard. The catchment ultimately drains to the Parkdale Storage tank via the adjacent Kenilworth CSO catchment. There is also an internal overflow from the combined sewer at Ottawa Street that discharges to the harbour through industrial lands. The Ottawa CSO catchment

was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.16 Kenilworth CSO

The Kenilworth CSO catchment is located in the northern portion of the City's combined sewer system comprising the borough of Delta East, Bartonville, Homeside, Crown Point East and Industrial Sector F, covering an area of approximately 311 ha. The CSO catchment primarily drains to a single trunk sewer that follows Kenilworth Avenue to Nikola Tesla Boulevard. The catchment ultimately drains to the Parkdale Storage tank via the adjacent Strathearne CSO catchment. There is also an internal overflow from the combined sewer at Kenilworth Avenue that discharges to the harbour through industrial lands. The Kenilworth CSO catchment was subdivided into 8 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.17 Strathearne CSO

The Strathearne CSO catchment is located in the northern portion of the City's combined sewer system comprising the borough of Normanhurst, Glenview West, Homeside, Bartonville, McQuesten West, Industrial Sector E, and Industrial Sector G, covering an area of approximately 358 ha. The CSO catchment primarily drains to a single trunk sewer that follows Strathearne Avenue to Nikola Tesla Boulevard. The catchment ultimately drains to the Parkdale Storage tank via the adjacent Parkdale CSO catchment. There is also an internal overflow from the combined sewer at Strathearne Avenue that discharges to the harbour through industrial lands. The Strathearne CSO catchment was subdivided into 7 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.18 Parkdale CSO

The Parkdale CSO catchment is located in the northeastern portion of the City's combined sewer system comprising the borough of Parkview West, and Industrial Sector G, covering an area of approximately 120 ha. The CSO catchment primarily drains to a single trunk sewer that follows Parkdale Avenue to Nikola Tesla Boulevard. The catchment ultimately drains to the Western Sanitary Interceptor and Parkdale Storage tank and Combined Sewer Pumping Station. The Pumping Station has an internal overflow from the combined sewer at Parkdale Avenue that discharges to the harbour through the industrial lands. The Parkdale CSO catchment was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.19 Dunn Woodward CSO

The Dunn-Woodward CSO catchment is located in the northeastern portion of the City's combined sewer system comprising the borough of McQuesten East, McQuesten West, Parkview East, and Parkview West, covering an area of approximately 130 ha. The CSO catchment primarily drains to a single trunk sewer that follows Woodward Ave and then Glow Ave. The catchment ultimately drains to the Woodward Wastewater Treatment Plan via Glow Ave. There is also an internal overflow from the combined sewer at Parkdale Avenue that discharges to the Parkdale CSO Tank in the Parkdale CSO Catchment. Notably; Dunn-Woodward CSO-1 drains towards Parkdale CSO Tank via Nikola Tesla, rather than via Glow Ave, and could have been included in Parkdale CSO catchment but was maintained in Dunn-Woodward CSO for overall consistency with the previous study. The Dunn-Woodward CSO catchment was subdivided into 3 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.20 Melvin CSO

The Melvin CSO catchment is located in the eastern portion of the City's combined sewer system comprising the borough of McQuesten East and McQuesten West, covering an area of approximately 61 ha. The CSO catchment primarily drains to a single trunk sewer that follows Melvin

Avenue. The catchment ultimately drains to the Red Hill Super Pipe. There is also an internal overflow from the combined sewer at Melvin Avenue that formerly discharged to Red Hill Creek but is blocked by stop logs and requires manual removal to allow discharge. The Melvin CSO catchment is represented by 1 subcatchment. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.21 Queenston CSO

The Queenston CSO catchment is located in the eastern portion of the City's combined sewer system comprising the borough of Glenview East and McQuesten West, covering an area of approximately 28 ha. The CSO catchment primarily drains to a single trunk sewer that follows Queenston Road to Red Hill Valley. The catchment ultimately drains to the Red Hill Super Pipe and Queenston Road CSO. There is also an internal overflow from the combined sewer at Queenston Road that formerly discharged to Red Hill Creek but is blocked by stop logs and requires manual removal to allow discharge. The Queenston CSO catchment is represented by 1 subcatchment. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.22 Lawrence CSO

The Lawrence CSO catchment is located in the eastern portion of the City's combined sewer system comprising the boroughs of Bartonville and Glenview West, covering an area of approximately 88 ha. The CSO catchment primarily drains to a single trunk sewer on Lawrence Rd which drains easterly. The catchment ultimately drains to the Lawrence Road CSO and Red Hill Super Pipe with a connection to Strathearne CSO-7. The Lawrence CSO formerly had an overflow to Red Hill Creek but is blocked by stop logs and requires manual removal to allow discharge. The Lawrence CSO catchment was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.23 Rosedale

The Rosedale CSO catchment is located in the southeastern portion of the City's combined sewer system comprising the borough of Rosedale, covering an area of approximately 78 ha. The CSO catchment primarily drains to a single trunk sewer on Cochrane Ave which drains northerly. The catchment ultimately drains to the Lawrence Road CSO and Red Hill Super Pipe via the adjacent Lawrence CSO catchment. The Rosedale CSO catchment was subdivided into 2 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

2.2.24 Mountain

The Mountain CSO catchment is located in the southern portion of the City's combined sewer system comprising nineteen (19) boroughs from the escarpment to Mohawk Rd, covering an area of approximately 1244 ha. The CSO catchment primarily drains to a single trunk sewer that follows Fennel Ave to discharge flows to the east. The catchment ultimately drains into the Red Hill Superpipe, for further conveyance to the Woodward WWTP, as well as to the Greenhill CSO Storage tanks via the adjacent Rosedale catchment. There is also an internal overflow from the combined sewer at the Greenhill CSO Complex that discharges to the Red Hill Valley Creek. The Mountain catchment was subdivided into 27 subcatchments. Further detail and mapping of the CSO catchments is provided in **Appendix A**.

3 SYSTEM ANALYSIS APPROACH

3.1 Supporting Information

In order to assess the existing combined sewer system through the Framework, relevant background and supporting information has been reviewed at a high level, consistent with the scope of this assessment, which has focussed the effort on a desktop review of existing information. The following supporting information has been used through this review, to develop the system performance metrics and prioritization, as described further in subsequent sections.

It should be clearly noted that the MIKE Urban modelling completed as part of the draft FDMSS by others has been provided by the City of Hamilton in “as is” condition for information purposes only and has not been approved for use by the City.

- **Previous Reports (Area-Wide)**
  - Flooding and Drainage Master Servicing Study (FDMSS) - Final Draft Report. Aquafor Beech Limited, September 23, 2019. (Note Final Draft Report is not approved by the City)
  - Lower East End Storm Drainage Study (LEEDS). McCormick Rankin Corporation (MRC), April 2009.
- **Previous Reports (Primary Studies for Specific Areas)**
  - Chedoke Creek Water Quality Study – Water Quality Improvement Framework. GM BluePlan Engineering and Wood, April 2021.
  - Woodward Avenue and Glow Avenue Sewer Separation Memo – Conceptual Design. IBI, May 7, 2021.
  - Roxborough School Area Re-Development Preliminary Feasibility Study – Phase 1. Wood, February 2017.
  - Rosedale Neighbourhood SWM Facility at King’s Forest Golf Course Stormwater Management Design Brief. WSP, April 5, 2018.
  - Kenilworth Underpass Flood Remediation Works. McCormick and Rankin, October 24, 2012.
- **Previous Modelling**
  - MIKE Urban Modelling (Dual Drainage) as completed for the draft FDMSS. Aquafor Beech Limited, September 2019.
  - MIKE Urban Modelling (All Pipes) – Most Recent Version as supplied by the City of Hamilton (Hatch, 2020)
- **GIS and Base Mapping Data**
  - GIS Layers from the draft FDMSS
    - Sewershed Boundaries
    - Subcatchment Boundaries
    - Hydraulic Modelling Data Output
      - Pipe Sizes, Slopes and Depths
      - 5-Year Storm Event Pipe Layer Results
      - 100-Year Storm Event Overland Flow (Roadway) Results
  - City Supplied GIS Data and Layers
    - HANSEN Flooding Database
    - Sewer System Infrastructure (Combined, Sanitary, Storm and Relief)
    - Backflow Valves
    - Land Use
  - Other Base Data
    - SWOOP 2015 Digital Elevation Model (DEM)

3.2 Combined Drainage System Assessment Methodology

A key driver for the current Framework is the City's need for a more structured understanding of potential hydraulic deficiencies and related constraints across the combined sewer system. This understanding is critical to evaluate CSO catchment areas of relatively higher priority for flood remediation (as described further in **Section 4.4**) and also to better understand the potential root causes of flooding, in order to target potential solutions.

To this end, the available data described in **Section 3.1** have been reviewed to determine a suite of discrete assessment factors which could be applied to evaluate and rank system performance. As described in **Section 2**, these factors were subsequently applied to evaluate the 108 discrete sub-catchment areas at a relatively consistent scale across the combined sewer area. These findings have then been "rolled up" to the overall 24 CSO catchments. The following describes the discrete system assessment factors which have been considered as part of the current study.

In general, scoring of the factors has been applied on a 1 to 5 approach, with 5 indicating the highest priority (most problematic) and 1 indicating the lowest priority (least problematic). Depending on the factor, the scoring follows a 1-5 scoring, or more fixed 1, 3, 5 scoring. Scoring considerations are described further in the following summaries.

Furthermore, there are clearly a number of limitations with the available data, which has an impact on the accuracy of the screening assessment, which necessarily relies on these data. Limitations have been noted as part of the description of the various assessment factors.

3.2.1 HANSEN Flooding Records

3.2.1.1 Scoring Approach

Understanding which areas in the combined sewershed have previously experienced flooding, and which areas have experienced it repeatedly, is considered an important consideration to acknowledge actual constraints and issues in the combined sewer area.

The City maintains a database of flooding incidents (as reported by the public), known as the HANSEN Database (per the software vendor name). Incidents are added by customer service agents as they are reported, and generally associated with a property address/location. Each report also notes the type of flooding call including: SBU (sewer back up on sewer main), SLBU (sewer lateral back up in basement) and EFLOD (property flooded through groundwater or storm). There have been over 11,000 HANSEN records reported for the combined sewer area between 2011 and 2021, the majority of which are related to the sewer system.

Data from the City's rainfall gauges and CSO records have been used to screen HANSEN records which appear to be due to rainfall events as opposed to those which may have been due to more localized causes. The data for rainfall events have been further assessed to differentiate between single events (i.e. flooding only for one formative storm event) and areas which have been repeatedly flooded for multiple different events. The available data have been filtered to a suite of 50 different rainfall events which are presented in **Appendix B**.

Consideration has also been given to the spatial extent of the reported flooding per the HANSEN records; (i.e. whether the issues are more localized or more widespread).

A 1-3-5 scoring system has been applied for this data. Scoring has been based on percentage of HANSEN calls per total number of parcels within subcatchment during the 50 storm events plus a lag time of 7 days following the storm event:

- 1 Score: 0% of properties
- 3 Score: 0% - 1% of properties

- 5 Score: >1% of properties

3.2.1.2 Limitations

A major assumption with respect to the HANSEN data is that all owners of properties affected by a flooding event have consistently reported it to the City, and that it is then incorporated and properly coded into the database. In practice, this is not likely the case. Not all residents affected may notify the City, for a variety of possible reasons. As such, it is possible that there are additional affected areas that are not considered in the current dataset.

In addition, there may be areas which are still experiencing potentially flood causing conditions (i.e. sewer surcharging) but do not experience basement flooding due to the implementation of backflow valves.

The data used are also limited to the timeframe of availability. HANSEN data from between 2011 and 2021 were used; however, the data were filtered to specifically only account for HANSEN flooding calls related to rainfall events. There are limitations in the assumptions made in the definition of a rainfall event, as well as the lag time of 7-days from rainfall completion for reporting to occur.

3.2.2 Sewer Depth and Land Use

3.2.2.1 Scoring Approach

Sewer depth is a key consideration for overall flooding risk specific to surcharged water levels. Where combined sewers are shallower, there is less freeboard (clearance) relative to basement levels in the event that the sewers surcharge (i.e. exceed the full flow pipe capacity). Areas with shallower sewers would therefore be assumed to be at a higher risk of basement flooding. The available sewer depths from the MIKE Urban modelling have been used as a proxy, as they are considered more complete than the data within the City's GIS database. Basements have generally been assumed at 1.8 m +/- below grade. As such, combined or sanitary sewers with inverts at this grade or shallower would be considered particularly high risk. It has been assumed that the majority of the properties in the CSO service area would all be directly connected to the sewer system.

A further consideration has been given to the existing land uses, with a greater priority given to residential areas (which would be assumed to have basements), as compared to other land uses (such as industrial/commercial, which may not have basements).

A 1-3-5 scoring system has been applied for these data. Scoring has been based on the percentage of pipes and the land use:

- 1 Score: Remainder of subcatchments which do not trigger a "3" or a "5" score (i.e., subcatchments that are primarily non-residential or predominantly residential associated sewers without depth concerns per the below criteria)
- 3 Score: >= 10% of sewers associated with residential land use have a combined/sanitary sewer invert < 2.8 m bgs
- 5 Score: >= 1% of sewers associated with residential land use have a combined/sanitary sewer invert < 1.8 m bgs

3.2.2.2 Limitations

As noted, the sewer inverts from the draft FDMSS MIKE Urban modelling have been used as the basis for the assessment. GM BluePlan and Wood have not verified or validated any of the available information. It has been assumed that the modelling data are reasonable and representative of the actual sewer depths. It has also been assumed that all combined and sanitary sewers are classified/coded correctly within the available data (as opposed to storm or relief sewers).

3.2.3 Sewer Age and Condition

3.2.3.1 Scoring Approach

In some cases, the risk of flooding may be worsened by the condition of the sewer system, namely areas where combined/sanitary sewers are old and/or in poor structural condition. This may potentially lead to conveyance capacity and/or operational issues, or increased levels of inflow/infiltration (i.e. cracked pipes).

A 1-3-5 scoring system has been applied for these data. Scoring has been based on the Water Research Center (WRc) condition score of the pipe where available, with a secondary consideration for pipe age where applicable:

- 1 Score: Predominantly young Infrastructure (< 50 years) with no condition concerns
- 3 Score: Catchment with >= 65% of infrastructure is > 50 years since installation (>50 years old)
- 5 Score: Catchment with >= 15% of infrastructure in the catchment has a WRc score of “3” or greater

The WRc scoring methodology is a method of ranking asset condition based on the level of defect following visual (CCTV) inspection of the asset. Assets are ranked on a 1-5 scale, with 5 indicating poorest condition based on defects (collapsed or collapse imminent), and 1 indicating assets in acceptable structural condition.

3.2.3.2 Limitations

Similar to the data from the HANSEN database, the accuracy of this assessment is premised on the accuracy of the data with respect to sewer age and condition. It has been assumed for the purpose of this assessment that the data supplied by the City are reasonably accurate.

3.2.4 Simulated Minor System (Sewer) Results – 5-Year Hydraulics

3.2.4.1 Scoring Approach

The draft dual drainage MIKE Urban modelling completed as part of the FDMSS has been used for the Framework. Several potential issues have been noted with the modelling data (provided “as is” by the City and not formally approved); this is discussed further in **Section 3.2.4.2**. As noted in the project limitations, use of this information understandably comes with caveats including the requirement for future updates.

The minor system (sewer) data have been extracted from the supplied modelling. The focus has been upon the data for the combined and sanitary sewer pipes (as classified by the MIKE Urban (MU) attribute “Network Type Number (NETTYPENO)” in the modelling), given that surcharging within these pipes would have a direct potential impact to basement flooding (as opposed to relief and storm sewer pipes, which may not directly impact basement flooding, as they are likely not directly connected to the service connection laterals).

The focus for this assessment factor has been placed upon the simulated results for the 5-year storm event. It should be noted that the City’s design standard for combined sewers is the 10-year storm event (to 85% capacity) as per Section G.2.1.2 of the Comprehensive Development Guidelines and Financial Policies Manual (2019). The 5-year storm event is the design standard for new storm sewers (as per Section G.2.1.1). Given the known capacity limitations within the combined sewer system, the 5-year storm event has been considered a more appropriate basis for ranking simulated minor system performance. A further discussion with respect to Level of Service (LOS)/performance criteria is provided in **Section 4.1**.

Model results have been extracted with respect to numerous parameters, including peak flow (which was used to estimate the ratio to the simulated full flow capacity as estimated from the pipe attributes and Manning’s Equation), and simulated peak hydraulic gradeline (HGL).

A 1-5 scoring system has been applied for these data. Scoring has been based on simulated HGL less than 1.8 m below ground surface (<1.8 mbgs) for the Combined (MU attribute NETTYPENO=3) and Sanitary (MU attribute NETTYPENO=1) pipes as a percentage of length in each subcatchment:

- 1 Score: 0% of the length
- 2 Score: < 10% of the length
- 3 Score: 10% – 20% of the length
- 4 Score: 20% - 25% of the length
- 5 Score: >25% of the length

3.2.4.2 Limitations

The accuracy of the Framework assessment is clearly dependent on the accuracy of the draft FDMSS modelling results. As noted, the modelling was provided “as is” by the City for use in this study and has not been officially endorsed or recommended for use. Notwithstanding, the draft FDMSS modelling remains the most currently available source of information for the study area. GM BluePlan and Wood have not, as part of the scope of the Framework, re-run the modelling or made any changes to the received files and have used the modelling as received for the extraction of results.

GM BluePlan and Wood (with Jemma Consultants Limited) previously completed a Peer Review of the FDMSS (Draft of February 6, 2020) and noted potential issues and concerns with the modelling. Additional issues of concern have been noted as part of the extraction of results for the current summary.

Ultimately modelling updates or corrections are not included in part of the scope of the current Framework study, which is a higher-level drainage improvement assessment. The modelling data have been applied as another source of information to assist in prioritizing areas for improvement. Ultimately recommendations for model updates and improvements have been noted in subsequent sections.

The following technical limitations/concerns are noted with respect to the minor system components:

- No sensitivity analysis provided to confirm that the SCS 6 hour is the most appropriate design storm distribution
    - Existing conditions modelling provided with 3-hour Chicago distribution (used in current study) whereas the proposed conditions modelling provided with 6-hour SCS distribution.
- It is unclear if all recently completed infrastructure upgrades are reflected in the model, or the cut-off date for any such upgrades.
- Pipe classifications do not all appear consistently correct (i.e. sanitary, combined, storm, and relief pipes)
- CSO Tanks not being fully utilized during 100-year storm event simulation may indicate inaccuracies in contributing pipes and/or CSO tank geometry:
    - HP05PS012 (Parkdale CSO Tank) simulated at maximum of 63% full (by volume) during 100-year storm event
    - HH05CS01 (James CSO Tank) simulated at maximum of 67% full (by volume) during 100-year storm event
- External flows not captured in minor system (i.e. Ainslie Woods at Iona Drive)

3.2.5 Simulated Major System (Roadway) Results – 100-Year Hydraulics

3.2.5.1 Scoring Approach

The draft dual drainage MIKE Urban modelling from the FDMSS (as described in the previous section) has also been used to extract simulated major overland flow (i.e. roadway) hydraulic results for the 100-year storm event. The 100-year storm event is the City’s design basis for overland capacity assessments (for new/greenfield developments) per the Comprehensive Development Guidelines and Financial Policies

Manual (2019). It is noted that in older existing areas of the City, overland flow routes may not achieve this current standard. A further discussion with respect to LOS/performance criteria is provided in **Section 4.2**.

The simulated maximum overland flow depths for the 100-year event (relative to the gutter) have been extracted accordingly from the modelling. Such analyses typically consider standard road right-of-way (ROW) geometries/elevations for comparison purposes, such as 0.15 m (gutter elevation) or 0.30 m (typically the elevation of the public ROW and approximate point at which private property would begin to be affected). The City's capacity guidelines consider depths relative to the roadway crown, which would vary depending on the class and width of the roadway (i.e. number of lanes).

For the current Framework, the assessment has considered the percentages of conduits (overland flow routes) with links (roadway segments) indicating flow depths for the 100-year event as being greater than 0.15 m. It should be noted that typically a depth of 0.30 m is used as a threshold for flooding risk determination (i.e. potential private side impacts); however, based on a review of the draft FDMSS modelling results, there is a low number of such occurrences, which is considered questionable given the overall lack of well defined overland flow routes within the older neighbourhoods and known capacity constraints within the minor system. In order to provide a relative classification summary to allow for a comparison between subcatchments, the lower threshold of 0.15 m has been applied.

A 1-3-5 scoring system has been applied for these data. Scoring has been based on the extent of simulated depths in major system conduits greater than 0.15 m, as a percentage of length in each subcatchment:

- 1 Score: 0% of the length
- 3 Score: 0% - 5 % of the length
- 5 Score: > 5% of the length

3.2.5.2 Limitations

Data and analysis limitations with respect to the major system would generally be consistent with those noted for the minor system, as they have been extracted from the same draft FDMSS MIKE Urban modelling files. The following is noted with respect to the major system components:

- Modelling was not re-calibrated/validated following addition of the major system elements and associated inlet capacity functions (i.e. against the previous minor system modelling or against actual flow monitoring data)
- Assumptions regarding roof leader disconnection (50 to 75% disconnection) have not been clearly validated
- Inlets have all been assigned a fixed capacity (55 L/s per) with an assumption of 2 inlets per MH; no consideration has been given for higher capacity at sag points, or variation with head.
- Unclear on how the model accounts for situations where maximum overland depth exceeds 0.3 m
- Modelling appears to allow surface storage at major system nodes in addition to the primary storage through the overland (roadway) elements, which may lead to an over estimation of available surface storage and an under estimation of the extent and severity of surface ponding/flooding
    - MIKE Urban applies a storage element above manholes to attenuate flows during flooding events; the documentation does not adequately address this potential flow loss which may explain the relatively small overland flow depths simulated within the major system during the 100-year storm event.
- Only two roadway cross sections (20 m and 26 m) were used to represent all major system conduits throughout the study area, which may not be reasonable
- There is a discrepancy between 100-year depth results per the supplied modelling and the Final Draft FDMSS Report; it is unclear which represents the final version; however, the current analyses for the Framework have applied the modelling results.

3.2.6 Overland Flow Routes (Topographic)

3.2.6.1 Scoring Approach

Overland flow routes represent the pathways of major storm flows when the capacity of the minor system (i.e. sewers) is exceeded. In newer developments, the grading design is required to explicitly consider a continuous overland flow route to an appropriate receiver (typically a watercourse). In older areas, such as the combined sewer area of the City of Hamilton, overland flow routes were typically not considered in the original grading design. This is further complicated by a lack of suitable receivers, given the historical practice of filling of former watercourses. This results in a number of locally depressed areas without suitable outlets, which in turn tend to have higher flooding potential, both for surface flooding but also increased inflows to sewer systems due to the higher surface ponding.

In order to assess overland flow routes, the best available topographic data for the City has been employed, which is considered to be the Province of Ontario's SWOOP 2015 Digital Elevation Model (DEM). The 2015 DEM has been used to determine overland flow routes based on flow accumulation using GIS tools. Different sizes of discrete contributing drainage areas have been considered in order to determine a reasonable level of resolution for overland flow paths. Based on a sensitivity analysis, a threshold of 5 ha drainage area has been used for the assessment.

Overland flow routes have been considered in combination with the assessment of localized surface depressions (as noted in a subsequent section). The number of intercepting depression storage areas (>0.30 m depth) has been used to quantify how effective/continuous the overland flow route is in the subject subcatchment. The greater the number and extent of intercepting depression storage areas, the less continuous the overland flow route would be, and the more problematic overland flow would be expected to be, due to a preponderance of ponding areas.

A 1-5 scoring system has been applied for these data. Scoring has been based on the surface area of depression storage areas connected to major overland flow paths as a percentage of the total subcatchment area:

- 1 Score: <2.5% of the area
- 2 Score: 2.5% - 5% of the area
- 3 Score: 5% - 10% of the area
- 4 Score: 10% - 15% of the area
- 5 Score: >15% of the area

3.2.6.2 Limitations

As noted, the overland flow route analysis has used the best currently available topographic data, namely data from the Provincial SWOOP 2015 project. It is noted that while considered reasonable for the current assessment, the dataset is not as accurate/resolute as more recent LiDAR data collection projects undertaken by the Province for areas east of Hamilton.

These data may not represent any more recent changes in topography due to construction or other works. In addition, the data do not consider drainage due to culverts and/or bridges. As such, caution should be taken when interpreting the model results in those areas (such as embankments for railway lines or similar features).

3.2.7 Inlet Capacity

3.2.7.1 Scoring Approach

The City of Hamilton has provided its GIS database of catchbasins within the combined sewer study area limits. The supplied data include partial data (not complete) on different grate types, as well as whether the unit is a single (on grade) or double (at sag point) catchbasin unit. Given the potential large difference in capacities, the analysis for the Framework has been developed in consideration of the different potential

inflows associated with these two primary catchbasin types (i.e. single on grade vs. double at sag). Design Chart 4.14 from the MTO Drainage Management Manual (1997) suggests a typical maximum inlet capacity for single catchbasins of approximately 0.06 m^3/s, or 60 L/s (which is reasonably consistent with the 55 L/s assumed in the draft FDMSS modelling). By contrast, Design Chart 4.19 indicates that a twin (double) catchbasin at a sag point would have an approximate inlet capacity of 0.4 m^3/s (or 400 L/s) at a peak depth of 0.3 m (the variation in capacity with depth is also evident from the chart). For the current assessment, these values have been used to estimate individual inlet capacity and then these values have been summed to develop the total inlet capacity per hectare, for each of the subcatchment areas.

It should be noted that the expected range of values differs depending on the land use involved. Areas with higher percentages of greenspace (such as the Niagara Escarpment, or large parks) would reasonably be expected to have a lower value of inlet capacity. The completed assessment does not differentiate between land use, given the higher-level scope associated with this Framework study. Notwithstanding this should be considered in the interpretation of results.

It is noted that greater inlet capacity would be expected to assist with reducing the potential for surface ponding and flooding but could also result in overloaded combined sewers if the inlet capacity is excessive. In general, it is noted that the capacity of the combined sewer itself is likely a greater limitation; as such, this assessment has been premised on the assumption that relatively higher inlet capacity is a positive factor (lower score), and a relatively lower inlet capacity is a negative factor (higher score). Notwithstanding, it is acknowledged that further review of specific locations may be warranted to identify locations where Inlet Control Devices (ICDs) may be appropriate, to restrict flows to problematic sewer reaches.

A 1-5 scoring system has been applied for these data. Scoring has been based on the estimated total inlet capacity normalized using subcatchment area:

- 1 Score: >350 L/s/ha
- 2 Score: 175 L/s/ha – 350 L/s/ha
- 3 Score: 250 L/s/ha – 300 L/s/ha
- 4 Score: 300 L/s/ha – 250 L/s/ha
- 5 Score: <175 L/s/ha

3.2.7.2 Limitations

The inlet capacity assessment has been completed based on the GIS database supplied by the City of Hamilton. The reasonableness of the assessment is therefore directly correlated to the accuracy of the data provided.

3.2.8 Surface Depressions (Topographic)

3.2.8.1 Scoring Approach

The same topographic data employed for the assessment of overland flow routes (i.e. SWOOP 2015) have also been used to assess the extent and severity of local surface depressions. An iterative analysis has been completed to determine a reasonable threshold depth of ponding. Based on this approach, 0.30 m has been considered a representative depth to depict formative depressional areas. The analytical mapping tools within ArcGIS have similarly been employed to delineate contiguous areas with depths in excess of 0.30 m. These areas have then been assessed for each subcatchment area, to identify the relative percentage of area occupied by depressions.

A 1-5 scoring system has been applied for these data. Scoring has been based on depression areas as a percentage of the subcatchment area:

- 1 Score: <5% of the area
- 2 Score: 5% - 10% of the area
- 3 Score: 10% - 15% of the area

- 4 Score: 15% - 20% of the area
- 5 Score: >20% of the area

3.2.8.2 Limitations

The data for this analysis are based on the same SWOOP 2015 data described previously. Similar limitations as those noted for the assessment of overland flow routes would again apply.

4 SYSTEM PERFORMANCE AND PRIORITIZATION

4.1 Performance Criteria Context

New storm and sanitary sewer systems in the City of Hamilton are required to be designed to meet the performance criteria outlined in the City's Engineering Guidelines for Servicing Land Under Development Applications (Hamilton, 2012), and the City's Comprehensive Development Guidelines and Financial Policies Manual (2019). The criteria for new sewers are generally outlined as follows:

- Construction of separate wastewater and stormwater sewer systems, which prohibits foundation drains, weeping tiles, and roof drainage from discharging into the wastewater system
- Minimum sewer cover depth of 2.75m
- Wastewater sewer design flows at maximum of 75% full flow capacity
- Storm Sewers - 5-year design flows at maximum of 85 % full flow capacity
- Combined Sewers – 10-year design flows at maximum of 85% full flow capacity

Furthermore, the City's Criteria and Guidelines for Stormwater Infrastructure Design (Hamilton, 2009) outlines the requirement for the major stormwater system to safely convey the 100-year design storm, with different allowable flow depths based on the road classification.

Most of the City's existing combined sewer systems, which were designed prior to the City's current design standards, do not meet the above listed criteria. It should be noted that the original City of Hamilton combined sewer design criteria from 1942 to 1992 was approximately an 18-year event. From 1992 until amalgamation in 2000, a 50-year event was used (as per Table 1 from the Hamilton Storm Drainage Policy, May 2004). No comparison of the rainfall IDF used for these criteria (as compared to the City's currently approved IDF) is currently available to assess the effective design standard of these criteria.

Notwithstanding the City's greenfield standard requiring separated wastewater and stormwater sewers for new construction, the majority of the existing combined sewer system would need to be upgraded to meet the City's sewer depth and or capacity requirements. Additionally, many neighbourhoods within the combined sewer area have a substandard major stormwater system which is either not fully defined or lacks sufficient safe outlets to receivers. This is evident based on the results of the system assessment presented in **Section 3.2** with respect to surface depressions and overland flow routes.

4.2 FDMSS – Combined System Level of Service Objectives

In recognition of the legacy challenges of the combined sewer system, the City has applied a risk management level of service objective for the combined sewer system that is built on minimizing the risk of basement flooding and managing total system overflows to the environment. The City's ongoing Water, Wastewater, and Stormwater Master Plan has identified the following provisional performance targets for the combined sewer system:

- Manage peak sewer hydraulic grade line (HGL) to below the basement flooding risk level of 1.8 m below ground surface under a 5-year design storm event
- System overflows to meet the Ministry of the Environment, Conservation, and Parks' (MECP's) F-5--5 criteria of capturing 90% of total wet weather flows for the 7 months period starting from April to October
- Major flow system to safely capture and convey the 100-year design storm to a stormwater management facility or suitable outlet

The assessment conducted for the draft FDMSS used the above provisional performance targets. It is anticipated through the completion of the Water, Wastewater, and Stormwater Master Plan that the combined sewer system general performance targets will be confirmed; however, as identified in

Section 7.4, additional investigations will be required to further confirm the applicable and achievable criteria that will be attainable for the ultimate design basis for each CSO catchment.

4.3 Summary of System Issues

The methodology and criteria described in **Section 3.2** have been used to assess the 108 individual subcatchments. These results have then been aggregated at the overall CSO catchment level. Detailed summary sheets for each of the 24 CSO catchments are included in **Appendix 'A'**. These sheets include the detailed results for the application of the 8 criteria presented in **Section 3.2**. In order to also provide an overall area-wide understanding of performance, the City-wide figures are presented in their entirety in **Figure 3** through **Figure 10**, which follow the preceding evaluation criteria.

The historic flooding records indicate the highest reported areas in the west end (Westdale, Churchill Park, and Main-King 1) and the north end (Wentworth, Birch, Gage, Kenilworth, Parkdale and Dunn Woodward), as well as the Rosedale area.

The sewer depth results indicate relatively few problematic areas. The worst scoring areas are select areas in the north end, which is logical given the proximity to Hamilton Harbour and flatter overall grades in these areas. The Aberdeen Hillcrest and Main King 1 areas also have shallower pipes; while the reason for this is unclear, it may relate to the age of the homes and infrastructure within these areas and the difference between modern and historical design standards.

The sewer age and condition results indicate the highest scoring (poorest age/condition) areas in the east end of the City, both above and below the Mountain. High scoring areas are also noted in the Wentworth, Birch, and Gage catchments.

The minor system capacity (modelling) results indicate variable performance; however, in general, the worst scoring areas are located in the lower City, and in particular towards the north end.

The major system capacity (modelling) results generally indicate low scoring (i.e. minimal simulated issues with overland flow for the 100-year storm event). As noted, however, there is generally a low degree of confidence in these results, as far more overland flow deficiencies would be reasonably expected given the known capacity constraints in the minor (sewer) system and the lack of continuous overland flow routes. Notwithstanding, the results indicate only a few areas with high scoring, in particular the north-west area of the Mountain (Upper Wellington to Upper Wentworth) and the Rosedale area (which is known to have issues with overland drainage, due to the railway line berm at the north end of the catchment).

The major overland flow capacity (topographic) results indicate variable results across the study area, however again the poorest areas are generally located in the north end and also the east end (Rosedale and Lawrence areas).

The inlet capacity results indicate a higher degree of variability across the study area. Areas along the base of the escarpment tend to indicate higher scoring (i.e. poorer inlet capacity coverage), however this is generally considered attributable to the higher proportion of green space, which as a limitation of the approach, skews the calculations. In general, higher scores (lower inlet capacity) are again noted along the north end; however, scores in these areas may also be biased by the large industrial properties which would have a greater proportion of private catchbasins and on-site drainage features. As noted previously, the inlet capacity criteria should also be interpreted with caution as excess inlet capacity in some areas may result in excess flow being directed to the combined sewer system, which can cause adverse surcharging conditions.The surface depression (topographic) results are generally similar to those for the major overland flow assessment.

The preceding results have been aggregated (considering the relative weight and importance of each criteria) to determine an overall prioritization; this is discussed further in **Section 4.4**.

Hamilton

Flooding and Drainage
Improvement Framework

HWY 5 West
HWY 6
Queen Elizabeth Way
Barton Street
King Street
Main Street
Cootes Drive
HWY 403
Fennell Avenue
Mohawk Road
Upper James Street
Upper Wellington Street
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Red Hill Valley
Lincoln M. Alexander
Stone Church Road
Rymal Road
0 1 KM

Heat Map - Hansen Calls

Scoring*
- 1
- 3
- 5
- External

General Features
- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

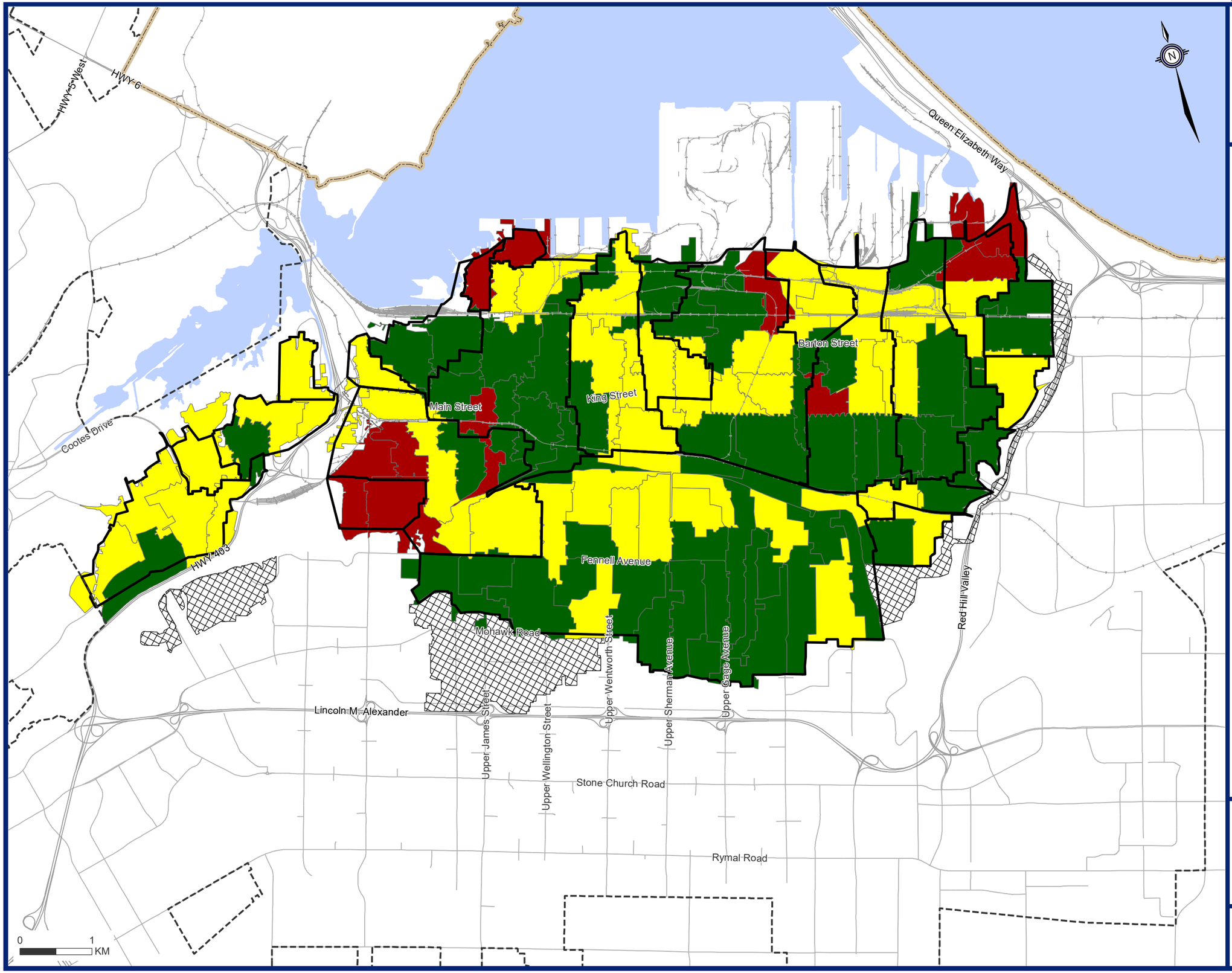
Figure #3
HANSEN Flooding Records Heat Map
Existing Sewer System

BluePlan ENGINEERING wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

Hamilton

Flooding and Drainage Improvement Framework



Heat Map - Sewer Depth & Land Use

Scoring*

- 1
- 3
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

Figure #4

Sewer Depth & Land Use Heat Map

Existing Sewer System

BluePlan wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

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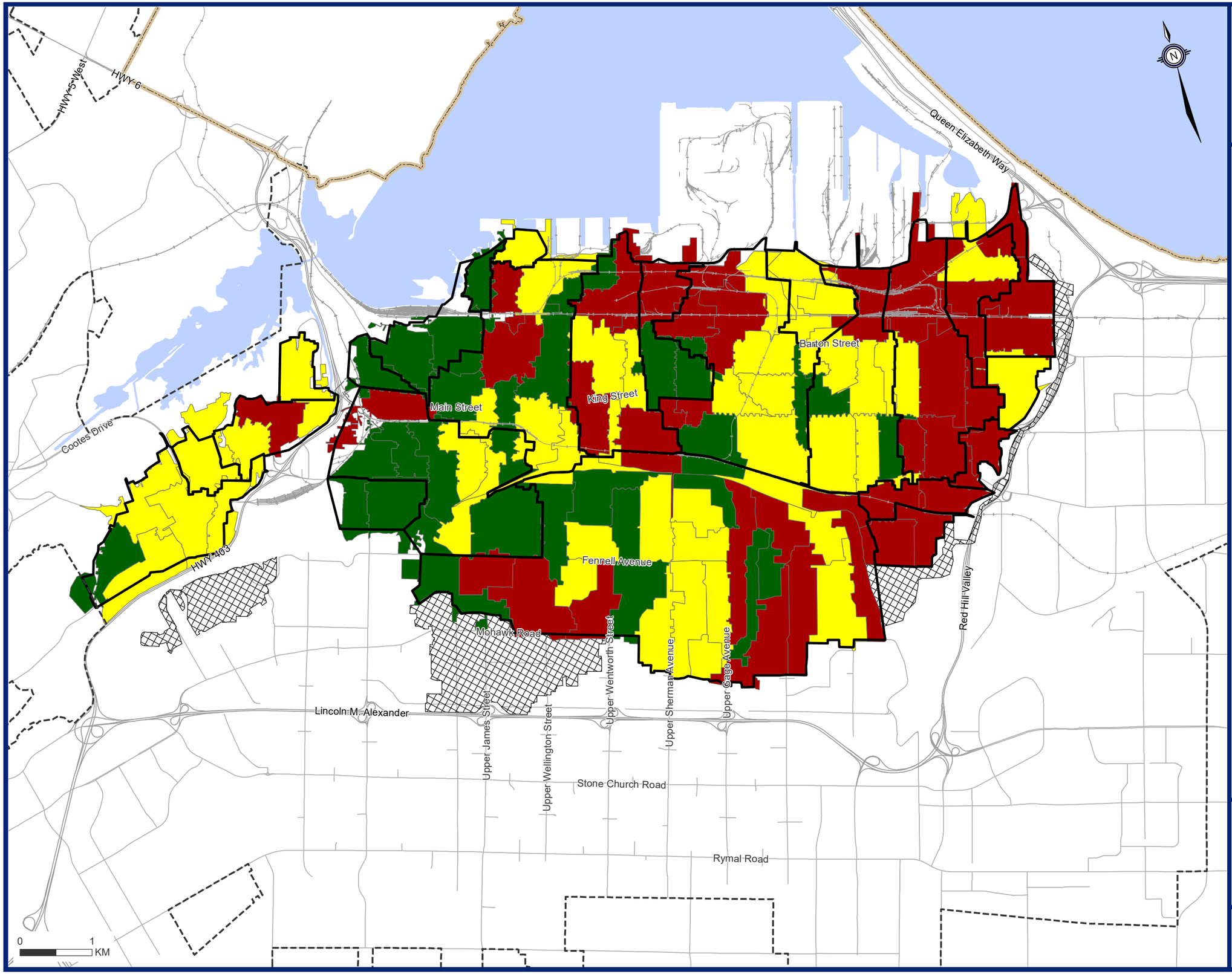
Hamilton

Flooding and Drainage Improvement Framework



Heat Map - Age & Condition

Scoring*

- 1
- 3
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

Figure #5

Sewer Age & Condition Heat Map

Existing Sewer System

BluePlan wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

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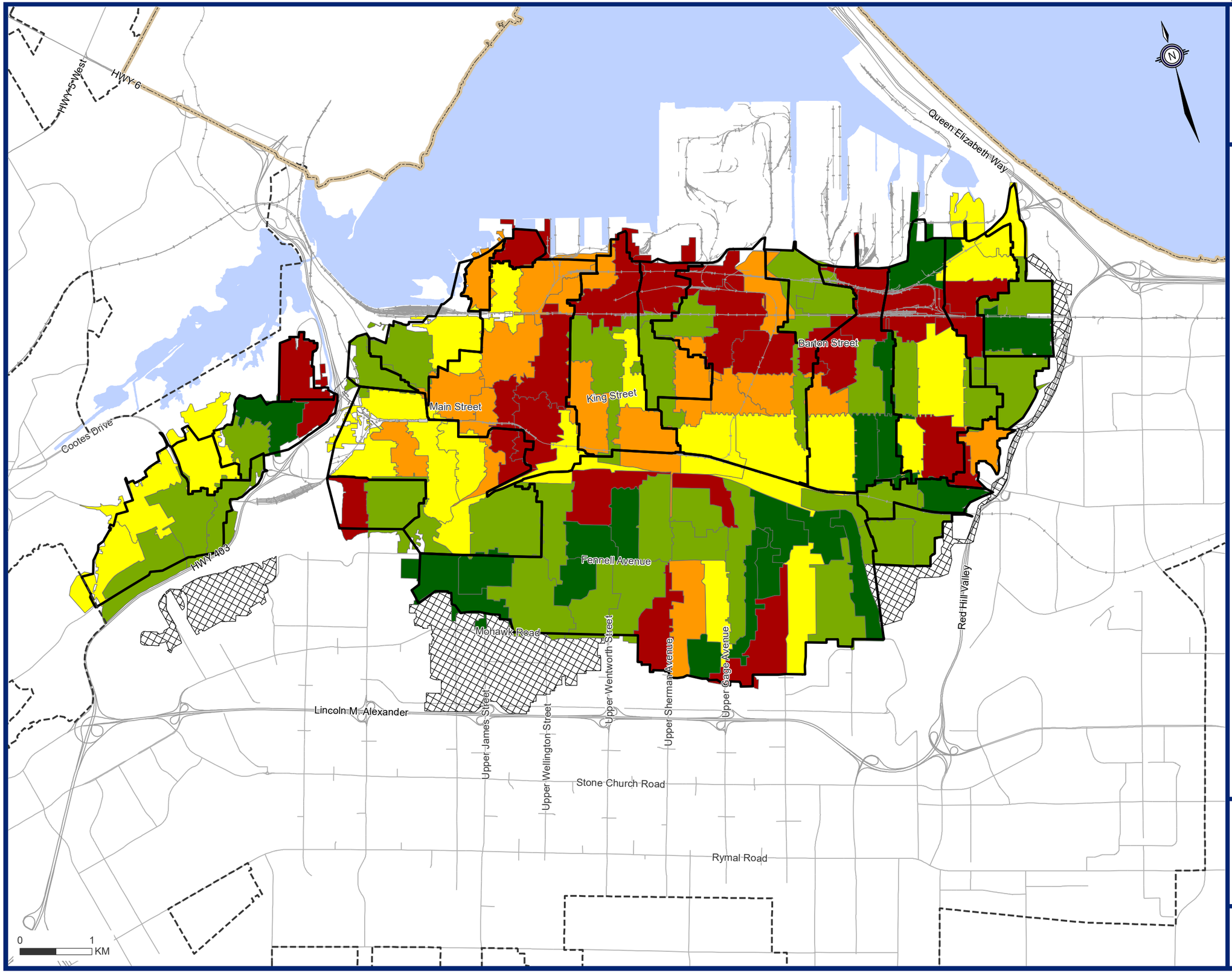
Hamilton

Flooding and Drainage
Improvement Framework



Heat Map - Minor System (5-Year)

Scoring*

- 1
- 2
- 3
- 4
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

Figure #6
Simulated Minor System Heat Map
Existing Sewer System

BluePlan ENGINEERING wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

Hamilton

Flooding and Drainage
Improvement Framework

HWY 5 West
HWY 6
Queen Elizabeth Way
Barton Street
King Street
Main Street
Cootes Drive
HWY 403
Fennell Avenue
Mohawk Road
Red Hill Valley
Upper James Street
Upper Wellington Street
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Lincoln M. Alexander
Stone Church Road
Rymal Road
0
1
KM

Heat Map - Major System (100-Year)

Scoring*

- 1
- 3
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

Figure #7
Simulated Major System Heat Map
Existing Sewer System

BluePlan ENGINEERING wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

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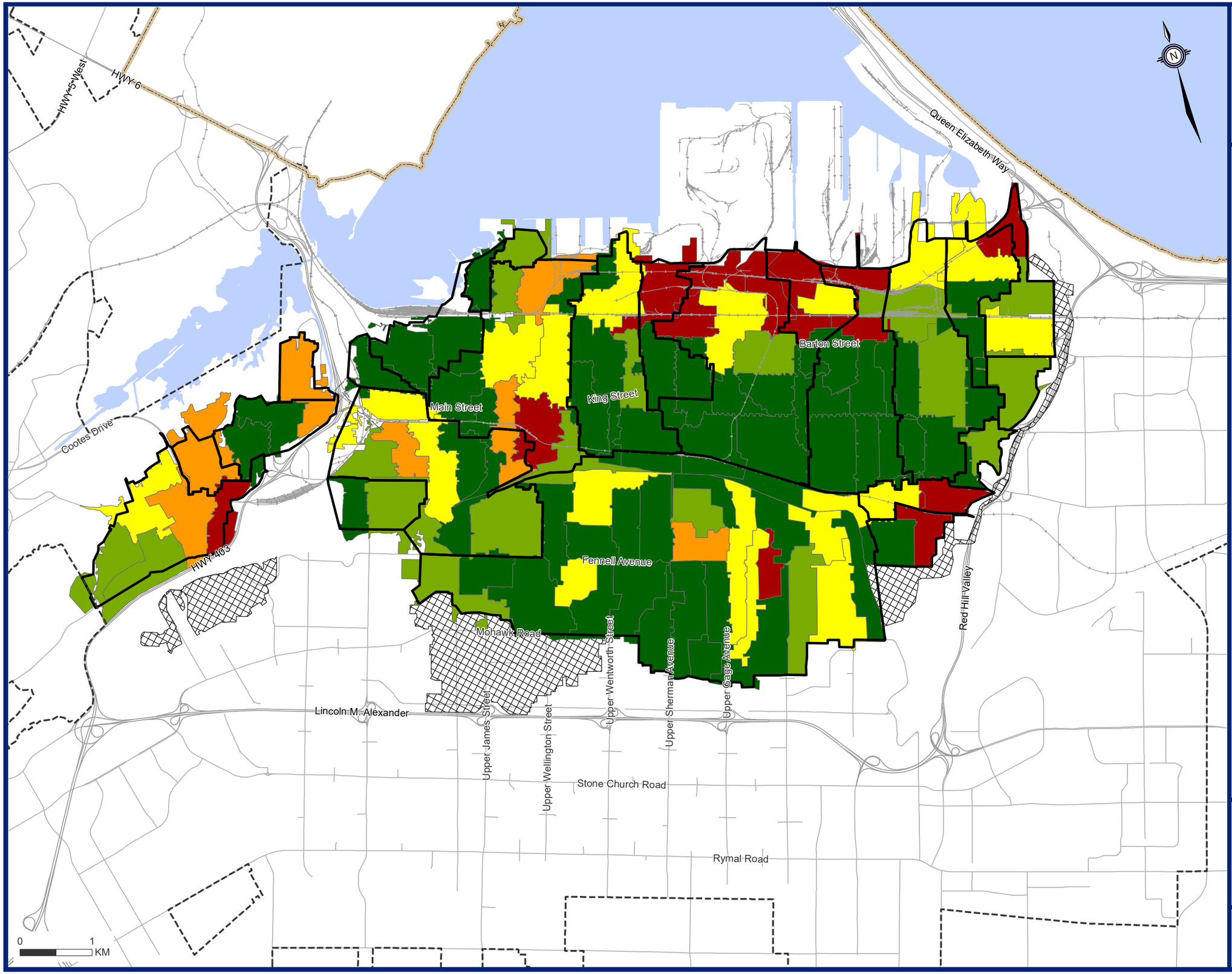
Hamilton

Flooding and Drainage
Improvement Framework



Heat Map - Overland Flow Routes

Scoring*

- 1
- 2
- 3
- 4
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

Figure #8
Overland Flow Routes Heat Map
Existing Sewer System

BluePlan ENGINEERING wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

Hamilton

Flooding and Drainage
Improvement Framework

HWY 5 West
HWY 6
Queen Elizabeth Way
Cootes Drive
HWY 403
Main Street
King Street
Barton Street
Fennell Avenue
Mohawk Road
Upper James Street
Upper Wellington Street
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Red Hill Valley
Lincoln M. Alexander
Stone Church Road
Rymal Road

0 1 KM

Heat Map - Inlet Capacity

Scoring*

- 1
- 2
- 3
- 4
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

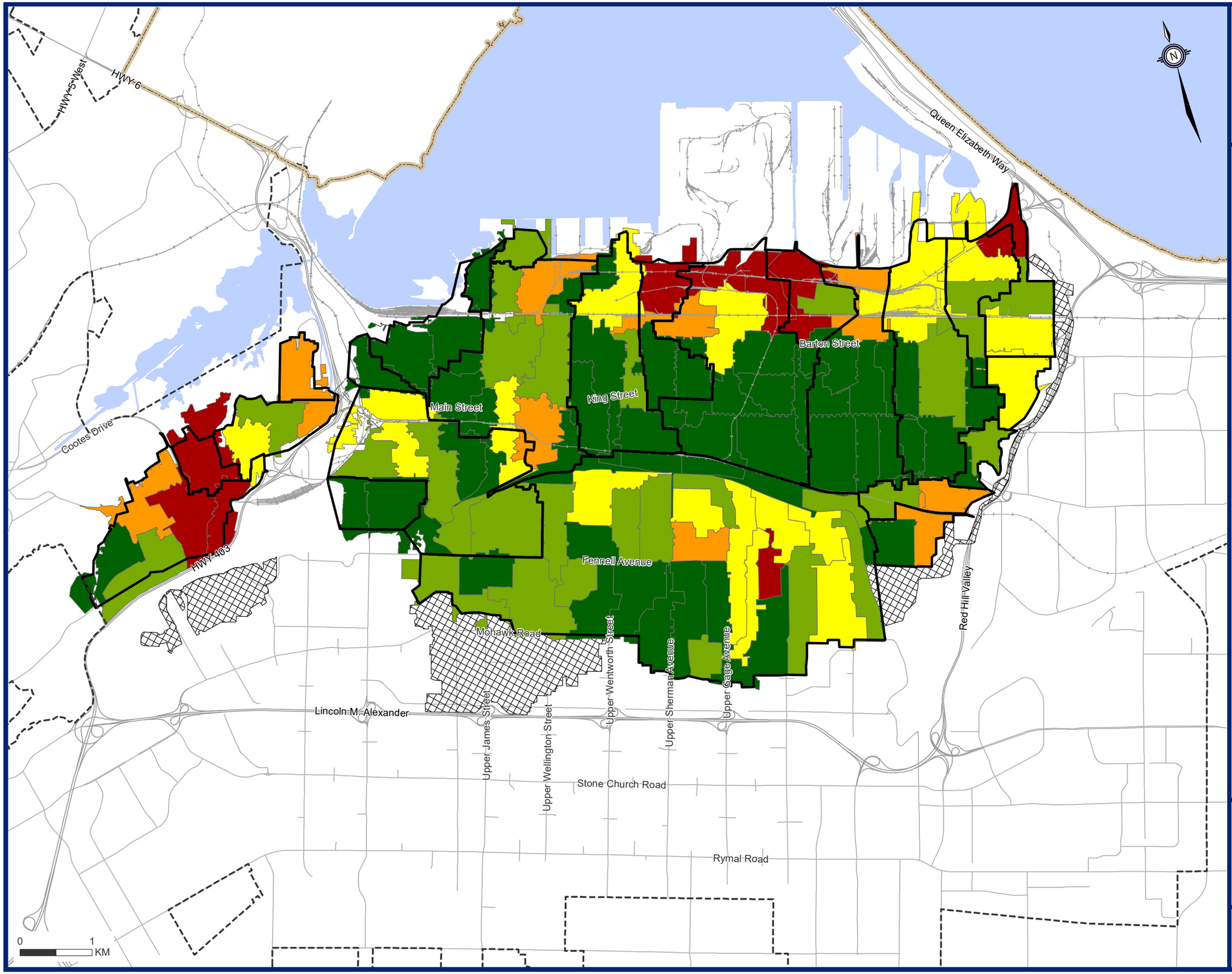
Figure #9
Inlet Capacity
Heat Map
Existing Sewer System

BluePlan Engineering wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

Hamilton

Flooding and Drainage
Improvement Framework



Heat Map - Surface Depressions

Scoring*

- 1
- 2
- 3
- 4
- 5
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

* Note: Scoring from 1 to 5 indicates least problematic subcatchments (score of "1") to most problematic subcatchments (score of "5") following the descriptions provided in Section 3.2.

Figure #10
Surface Depressions Heat Map
Existing Sewer System

BluePlan ENGINEERING wood.

February 2022
621085-007
NAD 1983 UTM Zone 17N

4.4 System and Area Prioritization

The evaluation related to the 8 assessment factors (and their associated criteria) has provided valuable information on the issues and performance of the combined system. Notably, certain factors are considered more impactful to the assessment than others. As such, a weighting factor approach has been applied to add greater or lesser weight (relative to a base weighting of 1.0) to the various factors based on their significance in setting system priorities. The applied weighting is presented in **Table 1**.

Table 1: Applied weighting for assessment factors in area prioritization

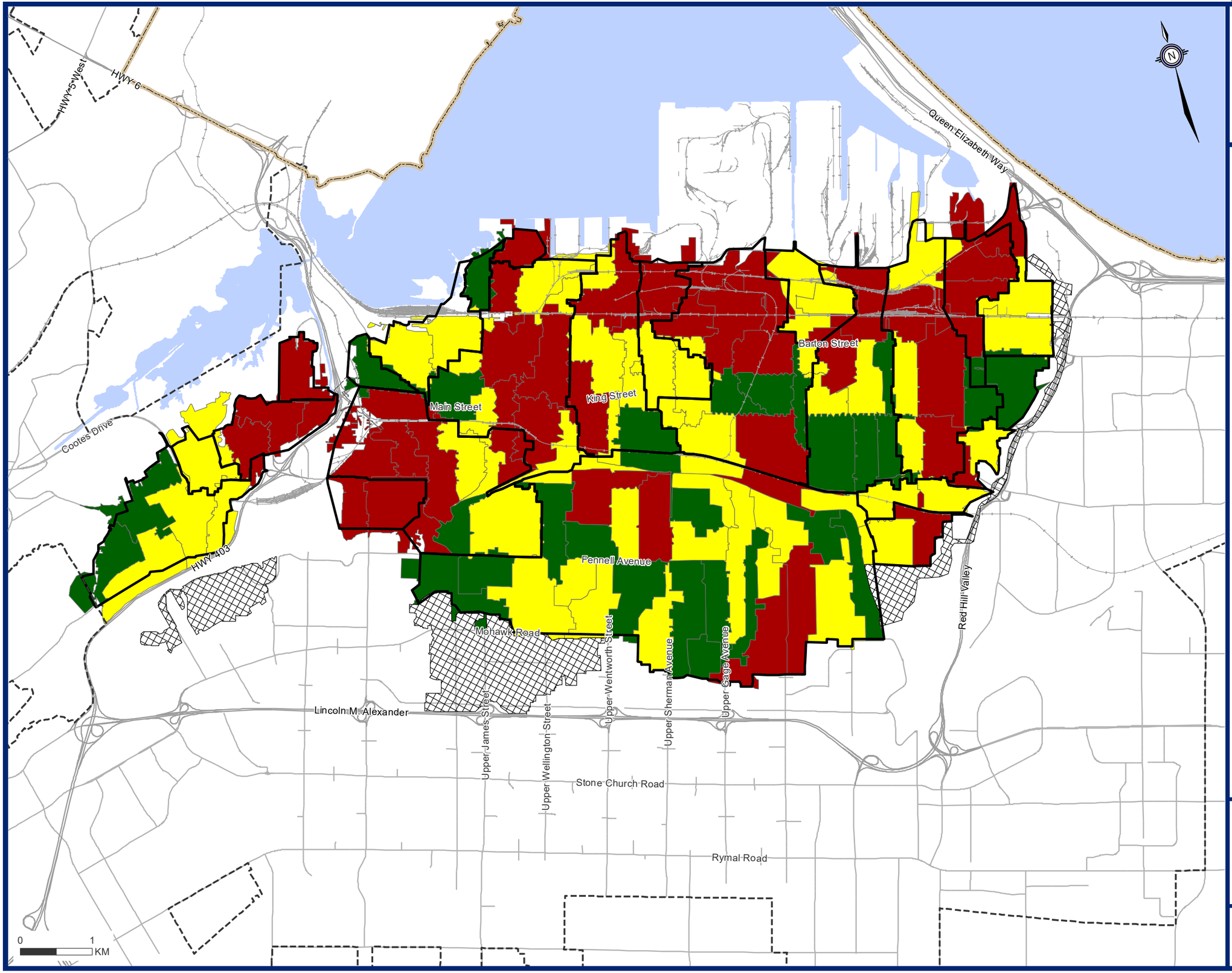
Assessment Factor	Proposed Weighting	Rationale
Historic Flooding	3.0	Highly important/critical parameter – based on actual observed instances of flooding
Sewer Depth	0.5	Overall is more of a physical constraint than a prioritization factor
Sewer Age and Condition	1.5	Considered a slightly higher priority factor to drive infrastructure renewal
Minor System (Model)	2.0	After historic flooding, likely the most important parameter despite concerns regarding uncertainties in modelling results; provides a means to consistently assess sewer system deficiencies
Major System (Model)	1.0	Lower confidence in modelling results however provides some indication of potentially deficient areas on a relative basis
Overland Flow (Topo)	1.5	Considered a better overall indicator of spatial extent of overland flow deficiencies, also integrates surface depressions
Inlet Capacity	0.5	Lower utility as a prioritization factor given complexity of interpreting results at this scale (i.e. implications of land use, capacity of receiving sewer system)
Surface Depressions (Topo)	0.5	Somewhat duplicative of the overland flow results, and thereby may over-estimate potential for areas near valleys etcetera

The weighting factors presented in **Table 1** have been applied to each of the individual assessment factors for the 108 individual subcatchments, in order to generate an overall net prioritization for each of the subcatchments. These results are included in the catchment summary sheets in **Appendix 'A'**. The aggregation and overall prioritization have also considered the data uncertainty. Data uncertainty included factors such as conflicting dataset results (modelled major system vs. overland flow/surface depressions, historic flooding records vs. simulated minor system capacity, etcetera). In general, a higher priority has been assigned to subcatchments and catchments with a greater degree of data certainty. That said, the City will need to be aware of these data limitations when planning next steps, and establish a process of comprehensively resolving unknowns and data gaps.

Figure 11 presents the overall subcatchment prioritization on an area-wide basis. Individual catchment network prioritization summaries are also included in **Appendix 'A'**. A summary of the results, as aggregated by higher level CSO catchment, is presented in **Table 2**.

Hamilton

Flooding and Drainage
Improvement Framework



Overall Priority Ranking

- High
- Medium
- Low
- External

General Features

- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

Figure #11

Overall Subcatchment Priority

Existing Sewer System

BluePlan ENGINEERING wood.

December 2021
621085-007
NAD 1983 UTM Zone 17N

Table 2: Summary of CSO Catchment prioritization

CSO Catchment	Total Number of Subcatchments	Low Priority Subcatchments	Med Priority Subcatchments	High Priority Subcatchments	Overall Net Priority
AinslieWood	5	2	3	0	Medium
McMaster	1	0	1	0	Medium
Westdale	2	0	0	2	High
Churchill Park	1	0	0	1	High
Main King 1	7	1	2	4	High
Main King 2	1	1	0	0	Low
Aberdeen Hillcrest	2	0	0	2	High
James CSO	1	1	0	0	Low
Eastwood Park CSO	1	0	0	1	High
Bayfront CSO	2	0	2	0	Medium
Wellington CSO	9	1	3	5	High
Wentworth CSO	6	1	3	2	Medium
Birch CSO	3	0	2	1	Medium
Gage CSO	12	3	4	5	High
Ottawa CSO	2	0	2	0	Medium
Kenilworth CSO	8	4	2	2	Medium
Strathearne CSO	7	1	3	3	High
Parkdale CSO	2	0	0	2	High
Dunn Woodward CSO	3	0	2	1	Medium
Melvin CSO	1	1	0	0	Low
Queenston CSO	1	0	1	0	Medium
Lawrence CSO	2	0	2	0	Medium
Rosedale	2	0	1	1	High
Mountain	27	12	11	4	Low
TOTAL	**108**	**28**	**44**	**36**	**N/A**

It is noted that the overall net CSO Catchment priority, per **Table 2**, has at this stage been prepared for information purposes only. In many cases CSO Catchments contain a large number of subcatchments, which may have varying priorities; i.e. a CSO Catchment with an overall “Low” or “Medium” priority may still contain several “High” priority subcatchment areas which should continue to be local priorities for remedial measures. This is particularly true for catchments with a larger number of subcatchments. For example, the Mountain CSO catchment contains 4 high priority subcatchments; however, it is considered a low priority due to both its size and the overall evaluation results.

There are a total of 36 high priority subcatchments as noted in **Table 2**. These subcatchments are presented in **Table 3** for clarity. **Figure 12** presents a map outlining only the subcatchments that are “high-priority” with a “low data uncertainty” per **Table 3**.

Table 3: High-priority subcatchments and associated data uncertainty

CSO Catchment	Subcatchment	Area (ha)	Data Uncertainty
Westdale	1	42.9	Low
Westdale	2	39.6	Low
Churchill Park	1	63.7	Medium
Main King 1	1	47.1	Medium
Main King 1	2	35.1	Medium
Main King 1	3	32.1	Medium
Main King 1	4	56.6	Medium
Aberdeen Hillcrest	1	29.3	High

CSO Catchment	Subcatchment	Area (ha)	Data Uncertainty
Aberdeen Hillcrest	2	81.1	High
Eastwood Park CSO	1	33.1	Low
Wellington CSO	2	29.4	Low
Wellington CSO	3	63.2	Low
Wellington CSO	4	61.1	Low
Wellington CSO	7	43.7	Low
Wellington CSO	8	54.3	Low
Wentworth CSO	2	65.9	Medium
Wentworth CSO	5	53.9	Medium
Birch CSO	1	79.7	High
Gage CSO	1	65.9	High
Gage CSO	2	45.8	High
Gage CSO	3	43.8	High
Gage CSO	4	47.3	Medium
Gage CSO	12	105.3	Medium
Kenilworth CSO	1	50.4	Medium
Kenilworth CSO	2	41.0	Medium
Strathearne CSO	2	68.8	Medium
Strathearne CSO	4	78.3	Low
Strathearne CSO	6	57.4	Low
Parkdale CSO	1	52.4	Medium
Parkdale CSO	2	67.4	High
Dunn-Woodward CSO	1	37.1	Medium
Rosedale	3	33.1	Low
Mountain	4	62.8	High
Mountain	5	72.4	Medium
Mountain	17	52.1	Medium
Mountain	22	54.4	Medium

The high priority subcatchments are generally distributed across the combined system study area, however, there are clusters in a few areas, including:

- West Hamilton (Westdale, Churchill Park, Main King 1 and Aberdeen Hillcrest)
- Wellington CSO area
- North End (Wentworth, Birch, Gage, Kenilworth Strathearne, Parkdale, and Dunn-Woodward CSOs)

The subcatchment and CSO catchment prioritization results have been used in developing preferred options and solutions, as described further in **Section 7**.

Hamilton

Flooding and Drainage Improvement Framework

Subcatchment
- High Priority and Low Data Uncertainty

General Features
- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

HWY 5 West
HWY 6
Queen Elizabeth Way
Barton Street
Main Street
King Street
Cootes Drive
HWY 403
Fennell Avenue
Mohawk Road
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Red Hill Valley
Lincoln M. Alexander
Upper James Street
Upper Wellington Street
Stone Church Road
Rymal Road

0 1 KM

Figure #12
Subcatchments With High Priority and Low Data Uncertainty
Existing Sewer System

BluePlan wood.

February 2022
621085-009
NAD 1983 UTM Zone 17N

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5 MANAGEMENT STRATEGY

5.1 Combined System - Management Vision

The adoption of clear, achievable, and measurable objectives is essential to support the proper planning, design, implementation, and monitoring of management strategies for the City's combined sewer systems. In the absence of clear objectives, the City is ultimately unable to appropriately define the specific long-term system needs, prioritize projects, monitor progress, or effectively achieve stakeholder buy-in to the overall strategy.

The final program recommendations of the Framework have been developed and prioritized on the basis of both short-term and long-term management visions.

The **short-term management vision** is based on addressing the highest priority objectives specific to mitigating the high-risk basement and surface flooding areas.

The **long-term management vision** is based on improving overall system resiliency against flooding risks, while also addressing the system objectives related to environmental stewardship, such as the reduction in untreated CSO discharges to receiving watercourses or water bodies and reduced requirements at Woodward WWTP, and climate change adaptation.

5.2 Combined System - Management Objectives

As noted, the Framework recommends a long-term management vision that strives to develop a robust wastewater and stormwater collection system that satisfies the following management objectives:

- Minimize the frequency, severity, and extent of basement flooding causing property damage
- Minimize the frequency and severity of surface flooding that poses a risk to public safety or has the potential to cause property damage
- Minimize the frequency, duration, and total volume of wastewater and combined sewer discharged to the environment
- Provide sufficient system capacity to support existing uses and growth needs
- Provide system resiliency to address the potential impacts of climate change

5.3 Combined System - Management Strategy

To achieve the above management vision and objectives, the following strategy has been proposed.

In the short-term, the strategy is focused on addressing the priority objectives related to minimizing basement flooding and surface ponding issues within the identified priority areas while striving to reduce total combined sewer overflows to the environment. The short-term strategy predominately focuses on conveyance improvements and storage infrastructure, with the goal of meeting the risk -based level of service objectives discussed earlier.

In the long-term, a "Managed Sewer Separation" strategy is proposed to address the objectives related to reducing stormwater inflows to the combined sewer system, environmental stewardship, and climate change adaptation. The "Managed Sewer Separation" strategy will seek to enhance the combined sewer system performance and strive to reach system performance in line with the current and future design criteria and level of service.

Further, an enhanced Low Impact Development (LID) practice policy for roadway reconstruction and redevelopment sites is recommended to address the objectives related to stormwater volume reduction, climate change adaptation, water quality improvements, and potentially further mitigating the impacts of redevelopment (through peak flow control and LID implementation) within the combined sewer system.

5.4 Managed Sewer Separation Program

The "Managed Sewer Separation" program consists of the City adopting the long-term objective (30+ years) of converting the combined sewer system into separated stormwater and wastewater systems and then proceeding to plan future infrastructure to be in-line with this objective. As "Managed Sewer Separation" proceeds or nears completion, there may reach a point in each subsystem where combined sewer overflow events have been greatly reduced to the point of diminishing returns on further separation. Through regular monitoring, the City may determine an "optimum" point where further separation of the combined system is no longer recommended or required in certain subcatchments, based on financial feasibility or other constraints.

Under the proposed separation program, it is generally recommended that the existing combined sewer network be used as the future wastewater conveyance sewer and that the stormwater be managed via a new stormwater sewer network, which can leverage the City's existing storm and relief sewer systems.

To facilitate the implementation of a "Managed Sewer Separation" the City will need to:

- **Establish performance targets for the separated sewers:** In each CSO Catchment, identify the sewer capacity, basement protection requirements, and acceptable overflows criteria. This will become the basis of future system design and will be used to identify when the performance targets of the program have been achieved.
- **Develop guiding storm sewer outfall and trunk sewer strategy:** Clearly identify the routing and sizing of the proposed trunk stormwater sewer system which can then be used to guide and inform progressive separation of the combined system.

The establishment of performance targets and the development of trunk sewer strategies, including outlet locations, will need to be developed separately for each CSO catchment through the completion Environmental Assessment (EAs) studies. When establishing the local performance targets, the EAs should give consideration for achieving full separation of the CSO catchment and to achieving similar performance targets used for new sewers in the City's existing separated areas; however, it is anticipated portions of each CSO catchment may not be practically separated due to technical, financial, and social/cultural constraints or due to diminishing returns associated with sewer capacity and CSO overflow requirements.

Implementation of the "Managed Sewer Separation" program will involve the following process:

- Prior to development of the trunk sewer strategies for each CSO catchment:
    - Local sewer separation projects will be advanced either to address local basement flooding and surface ponding issues within priority areas, or as part of other local infrastructure improvements, such as the roadway renewal program.
    - When addressing local capacity issues related to basement flooding and surface ponding, sewer separation should be considered as the default approach and alternate short-term solutions should only be advanced if separation is found to be technically or financially unfeasible.
    - Where local sewer separation is being completed in advance of the trunk sewer being constructed, the storm sewers should be built as relief sewers, temporarily discharging to

the existing combined sewer until such time that the new storm trunk sewer is constructed. The sewers should be designed to adhere to the guiding trunk storm sewer strategy.

- All planned road reconstructions should similarly adopt the preceding approach, in order to advance sewer separation opportunistically.

- Following the development of the trunk sewer strategies for each CSO catchment, the above recommendations remain valid; however, the following additional considerations apply:
  - Buildout of the new trunk sewers should start at the outlet working up through the system. These upgrades should be done by strategically targeting higher priority CSO catchments. The selection of CSO catchments should be based on reducing basement flooding risk and reducing total overflows to the environment.
  - The driver for new capital projects should be based on timing for implementation of trunk sewers supporting broader separation of subcatchments.
  - Combined sewers may remain in some localized areas when the costs/complications of sewer separation do not justify the net benefits and/or provide limited positive impact on system performance.

As the City continues to implement the “Managed Sewer Separation” program, the City will need to continuously monitor and track the overall system’s performance. Examples of municipalities who have previously or are currently phasing out combined sewers and CSOs include the City of Toronto, the City of Ottawa, the City of Brantford, and the City of St. Catharines. A program review every 5 to 10 years should be undertaken to quantify the system impacts and update the official strategy to account for any changes in growth, impacts of climate change, or other major system based infrastructure upgrades/strategy. Further, once widespread separation has been achieved within an individual CSO catchment, the program review can evaluate the potential for the decommissioning or repurposing of any existing storage facilities and/or overflows.

5.5 Special Policy Areas

Several areas within the City’s combined sewer system have existing sewer network configurations and depths that do not meet either the City’s existing 2.85 m sewer depth requirement or the typical basement flood risk criteria based 1.8 m sewer depth requirement. Within these areas, an alternative to the system-wide performance targets may be required.

Figure 13 highlights those existing neighbourhoods/subcatchments with shallow sewers where Special Policy Area criteria, allowing for reduced sewer HGL and/or land use restrictions, should be considered. When developing the short-term program recommendations, areas with shallow sewers have been cross-referenced against land use and flooding records to ensure upgrade recommendations are in line with the local risk profile, based on sewer surcharging, likelihood of presence of basements, sewer condition, and historic flooding frequency.

When developing the “Managed Sewer Separation” strategies, special consideration should be given to the neighbourhoods highlighted in **Figure 13** to determine the best long-term sewer strategy and consider if the continuation of Special Policy Area criteria is reasonable.

Hamilton

Flooding and Drainage
Improvement Framework

Potential Special Policy Areas
- Shallow Pipe Areas

General Features
- Railway
- CSO Catchment Boundary
- City Boundary
- Urban Boundary

HWY 5 West
HWY 6
Queen Elizabeth Way
Barton Street
King Street
Main Street
Cootes Drive
HWY 403
Fennell Avenue
Mohawk Road
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Red Hill Valley
Lincoln M. Alexander
Upper James Street
Upper Wellington Street
Stone Church Road
Rymal Road
0 1 KM

Figure #13
Subcatchments With Shallow Pipes Potential Special Policy Areas
Existing Sewer System

BluePlan ENGINEERING wood.

December 2021
621085-007
NAD 1983 UTM Zone 17N

5.6 Low Impact Development Practices Policy

As previously noted, and further to the “Managed Sewer Separation” program, the City should strengthen existing City bylaws and design standards, as well as implement the standard practice of requiring Low Impact Development (LID) Best Management Practices (BMPs) for redevelopment sites and roadway reconstruction projects.

Distributed LID BMPs can help reduce runoff volumes and thus preserve capacity in the receiving drainage system infrastructure and build additional capacity and resiliency in the sewer system to support the potential impacts of growth and climate change. LID BMPs can also provide stormwater quality treatment benefits, typically when used as part of a “treatment train” with pre-treatment through more traditional “grey” infrastructure such as oil/grit separators, catch basins inserts or equivalent.

With respect to the combined sewer area, the greatest benefit is in runoff volume reduction. Many other municipalities in Southern Ontario mandate a minimum on site retention target which in turn requires that designers incorporate an LID BMP strategy to accomplish this requirement. Requirements in other municipalities include:

- City of Kitchener: retention of a minimum volume of 12.5 mm (Policy MUN-UTI-2003)
- City of Mississauga: retain and manage first 5 mm of rainfall on site (Development Requirements – Section 8 Storm Drainage Design Requirements)
- City of Toronto: retain all runoff from a small rainfall event – typically 5 mm (Wet Weather Flow Management Guidelines)

Other municipalities encourage and recommend (but do not require) stormwater retention (typically the first 5 mm of rainfall), including the City of Burlington, the Town of Oakville (for the older portion of the Town to provide resiliency for the impacts of climate change), and the City of Markham (to achieve erosion control for developments less than 5 ha), as well as the City of Hamilton in limited form (for ICI lands specifically).

Credit Valley Conservation (CVC) has produced a series of documents on the implementation of LID measures into different types of development. Reference is made to CVC’s “Grey to Green Road Retrofits” guideline document which provides tools to help planners and designers incorporate LID measures into road designs.

6 MANAGEMENT OPTIONS

A wide range of potential options have been considered through the Framework to address basement flooding and surface ponding issues within the priority areas (subcatchments) of the combined sewer area. In locations where previous studies or investigations have been completed, available servicing options were reviewed and validated against the short-term and long-term management strategies and were carried forward where appropriate.

6.1 System Level Options

Beyond the assessment of localized subcatchment-level management options, a set of system-wide options were also considered. Each of the system-wide options can be incorporated to support one or more of the following:

- Address local flooding issues
- Form integral elements of the City's "Managed Sewer Separation" program
- Support growth capacity

Ultimately each of the system-wide options will require further evaluation through dedicated feasibility investigations and potential Environmental Assessment (EA) studies. A key consideration of these future studies will be to evaluate the individual projects' long-term need and benefit in the context of the cumulative impacts of the "Managed Sewer Separation" programs. Prior to the initiation of these feasibility investigations and EA studies, the system-wide options should be further evaluated within the City's Water & Wastewater & Stormwater Master Servicing Plan to determine if these options should be screened out or carried forward for further investigation. The City's Water & Wastewater & Stormwater Master Servicing Plan will allow for a more systematic and comprehensive screening of these system-wide options while allowing for considerations of system growth context and other potential system upgrade needs and/or strategies. The proposed system-level options considered in this Framework are as follows:

- Option 1: Western Interceptor Twinning
- Option 2: Upper-Mountain Storm Trunk
- Option 3: Below-Mountain Interceptor

The proposed system-level options are presented in **Figure 14**.

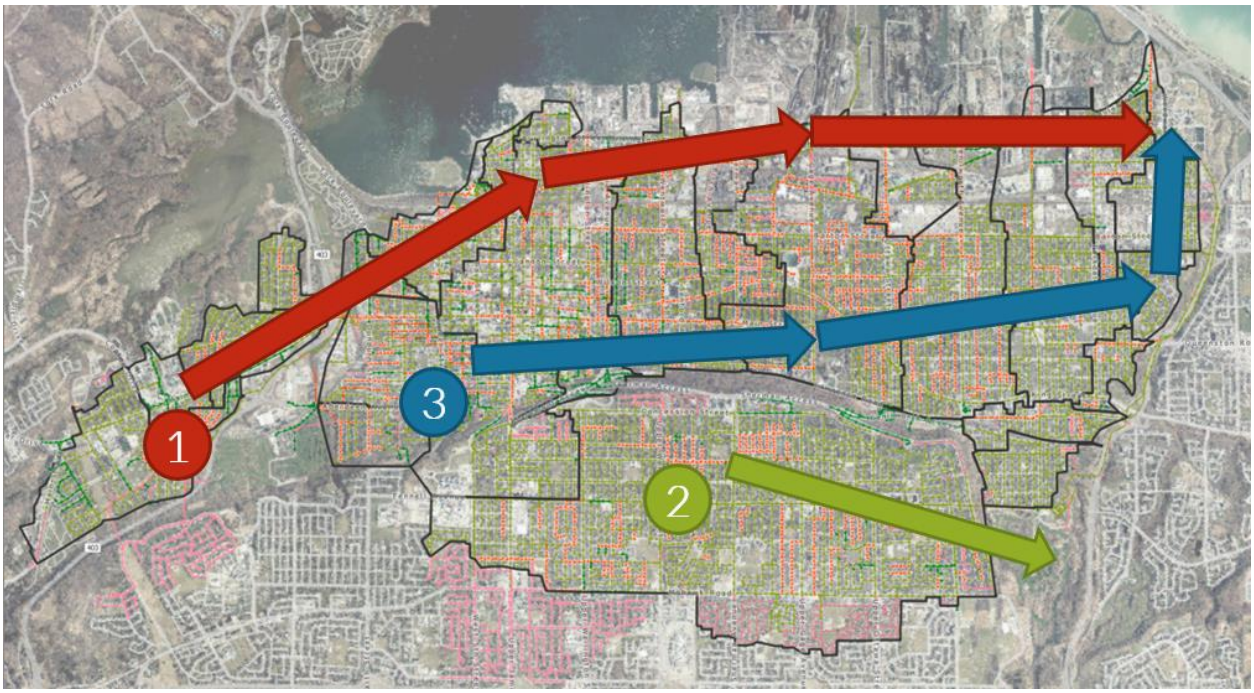


Figure 14: Proposed system-level options

6.1.1 Option 1: Western Interceptor Twinning

The current western interceptor collects a significant portion of the combined sewer system flows, including flows from the western portion of the historic City of Hamilton limits, and the central/northern portion of the historic City of Hamilton limits. The interceptor sewer conveys combined sewer flows from west to east, ultimately discharging at the Woodward WWTP. The implementation of a twinned interceptor sewer along the existing alignment of the western interceptor would provide increased capacity and potential for increased resiliency against combined sewer overflows. The alignment of the existing western interceptor allows for the majority of the 24 CSO catchments to be serviced, and the implementation of a twinned sewer along this alignment would provide the flexibility to phase the implementation of a “Managed Sewer Separation” program, while also reducing the potential for CSO release events and support long-term CSO elimination. The twinning of the western interceptor also has the potential to support planned growth in the City, predominantly focused on intensification. The twinning also provides the potential for water quality improvements within Chedoke Creek and Hamilton Harbour through the diversion and collection of existing overflows to these systems. In addition, the twinning provides redundancy for ageing infrastructure by providing a more practical way to execute replacement or rehabilitation of the existing WSI, and thereby improving the security of service for these necessary future operations.

6.1.2 Option 2: Upper Mountain Storm Trunk

The upper mountain storm trunk would support sewer separation within the Mountain CSO catchment and external contributing areas by providing trunk infrastructure and an outfall to Red Hill Creek, likely via Greenhill Avenue, which is consistent with the existing combined sewer trunk. This storm trunk would greatly reduce wet weather flows to the Greenhill and Red Hill Superpipe CSOs, and provide additional capacity in these systems, reducing the frequency of CSO discharges to Red Hill Creek. Portions of the Mountain CSO catchment are partially separated under existing conditions, and the implementation of stormwater trunk infrastructure would provide the opportunity to increase available capacity within the combined system, supporting the conversion of the Mountain CSO catchment into a separated system. Details pertaining to the outlet location and the requirement of any controls or discussion of stormwater

release rate would need to be studied and appropriately established prior to further consideration of an upper mountain storm trunk. The approach for an appropriate outfall and drop structure on the Niagara Escarpment would be an initial investigation; these components have been reviewed further as part of the sewershed specific assessment for the Mountain and Rosedale areas.

6.1.3 Option 3: Below-Mountain Interceptor

The below-mountain interceptor would intercept combined sewer flows between the base of the escarpment and the downtown core. The implementation of the below-mountain interceptor would free capacity in the western interceptor, as well as the trunk infrastructure conveying flows to the western interceptor. There is potential for the below-mountain interceptor to capture flows from the majority of the catchments below the mountain, and it could be aligned to support wastewater growth needs within a portion of the City's downtown and along the LRT corridor. The proposed below-mountain interceptor would also provide the opportunity to oversize the trunk pipe and use the extra capacity for storage during larger events. There are also potential opportunities to use the waterworks corridor (utility corridor between approximately Main and Ottawa and the Woodward WWTP) to minimize public ROW impacts during construction should the waterworks corridor fit with the selected alignment upon completion of a feasibility study.

The below-mountain interceptor as currently considered would be a combined trunk sewer; however, it should be noted that a trunk storm sewer could be considered instead. This would, however, take longer to implement, given the need to have separated storm sewers to connect to the trunk. Localized storm trunk interceptors were considered as part of the LEEDS study and have been considered again as part of the long-listing of options for individual sewersheds.

6.2 Long-List of Options

Within each CSO catchment and associated subcatchments, the general upgrade and management options as presented in **Table 4** have been considered.

6.3 Option Screening Methodology

Within each of the 24 CSO catchments, a systematic method for the screening of options to address high priority areas has been undertaken. This systematic method follows the decision tree as presented in **Figure 15**. In general terms, the following screening method has been applied:

- Reviewed areas for locally-specific studies and determined if the recommendations are reasonable and aligned with "Managed Sewer Separation" program
- Determined existing degree of sewer separation and confirmed whether to proceed with full separation
- Considered potential for short-term works that can be readily implemented based on existing system model/data and available City records and other system data
- Considered the most appropriate solutions to address the identified basement flooding and surface ponding issues
- Considered site-specific opportunities and constraints

While all options have been considered, only those options carried forward for implementation or further study are summarized within this report. The outcomes of the option screening could be one of the following:

- **Recommended / Carry Forward**: Option is recommended for implementation following completion of recommended studies or Environmental Assessments (EAs). Although Technical Feasibility of implementation of projects in this category have not been verified, their system benefit is anticipated to immediately improve performance in the highest risk areas. This category of recommendations also includes projects that have been recommended through previous studies and validated under this review.

- **Further Study**: Option requires a feasibility study to assess the potential for implementation as it:
    - Consists of a more complex project and feasibility of implementation is unknown.
    - Is grouped with a suite of options and further assessment is needed to confirm if all or partial implementation of all options is required to high-risk areas.
- **Screened Out**: Option has not been considered feasible or is not recommended for further study or implementation.

The details of combined sewer system upgrades and re-configuration required to implement the proposed "Managed Sewer Separation" strategy have not been developed or evaluated through the Framework. The "Managed Sewer Separation" strategies are intended to be further assessed through subsequent Environmental Assessments (EAs) and servicing studies. Recommendations for combined sewer system upgrades will be based on addressing the short-term management vision and objectives.

6.4 CSO Catchment Level - Option Recommendations

Appendix A provides a detailed CSO catchment level options analysis and recommendations. **Table 4** provides the advantages and disadvantages of the long-list of options which have been considered at the local level.

Table 4: Description of long-list of options with advantages and disadvantages

Options	Description/Function	Advantage	Disadvantage
Combined Sewer Upgrades	Upgrades or replacement of undersized or poor condition infrastructure to increase capacity of system	• Ability to "future-proof" capacity • Can mitigate capacity concerns • Potential to address climate change impacts	• High cost • Requires confirmation of downstream capacity • Coordination required with other infrastructure works
Sewer Diversion / Interceptor Sewer	Diversion of combined sewer flows to sewers with existing available capacity	• Small diversions can have large positive impact • Can be comparatively cost efficient • Can prevent property damage and flooding	• Requires study / understanding of downstream condition and capacity of new connection • Interceptor sewers can be large and expensive
Sewer Rehabilitation	Repair of sewers in-situ (ex. re-lining)	• Can be cost efficient if existing / future capacity is not a concern • Minimal service interruptions	• Often decreases theoretical capacity • Requires cost-benefit analysis
Sewer Separation	The implementation of a separate stormwater and wastewater conveyance system to replace the combined system (the existing combined sewer may be preserved/re-used for wastewater conveyance depending on characteristics)	• Increases capacity of existing system • Brings system into compliance with current design philosophy and standards • Reduces or eliminates risk of combined / sanitary sewer overflow • Ability for phased implementation	• High cost (may be reduced if combined sewer can be re-used) • Requires downstream stormwater outfall and trunk infrastructure constructed / planned to be fully effective
Storage	Holding of stormwater, wastewater, or combined flows until the peak has passed, and capacity is available	• Diversity in options (superpipe, pond, underground storage cisterns, etc.) • Controlled release rate / reduces peak flowrate • Option to implement infiltration technology (stormwater only)	• Often requires large space for implementation • High likelihood of utility conflicts in underground storage • Potential for use conflicts in surface storage solutions • Typically high cost
Major System Drainage Improvements	Re-grading / conveyance of major system to provide pathway for major storm flows	• Major system upgrades can protect low-lying buildings or roadways	• Re-grading not often practical due to existing buildings and infrastructure • High expense to convey major system underground
New Minor System Outlets	Implementation of new minor system outfalls to watercourses	• New minor system outlets can make implementation of new storm systems or upgrade of existing systems more cost effective	• Requires assessment of environmental impact of any new outfalls
Inlet Controls (Capacity restrictions)	Reduce peak stormwater contributions to minor (sewer) system and increase capacity of subsurface system	• Low-cost • Utilizes predominantly existing infrastructure and major-system capacity • Increases available capacity in underground network by holding back stormwater at surface	• Requires established major system flow path / surface storage capacity • Potential for increased maintenance at inlets to prevent clogging
Low Impact Development practices and Green Infrastructure	Mimics naturalized (pre-urbanized) stormwater systems by promoting evapotranspiration and infiltration, and lowering surface runoff volume and flowrates	• Can provide benefits to water quality, runoff volume and limited peak flow control • Manages water at the source instead of downstream • Component of holistic strategy to managing stormwater and building resilience to climate change • Can provide some increased available capacity within the underground infrastructure	• Requires extensive uptake to have a significant system benefit • Requires regular maintenance to manage stormwater efficiently • Implementation often requires dedicated land / space • Focus is on smaller more frequent events rather than larger flooding events
Private Property Measures	Processes or technologies designed to manage or treat stormwater on private property prior to conveyance to the municipal system, as well as technologies that prevent sewer backflow onto private property	• Opportunity to improve system through infill land development • May reclaim capacity through City policies of over-control (100Y post to 2Y pre- peak flow) • No / limited capital cost to City • Does not require additional land	• Requires enforcement and / or bylaw intervention to ensure continued function • Backflow prevention requires regular maintenance by the property owner to ensure intended functionality

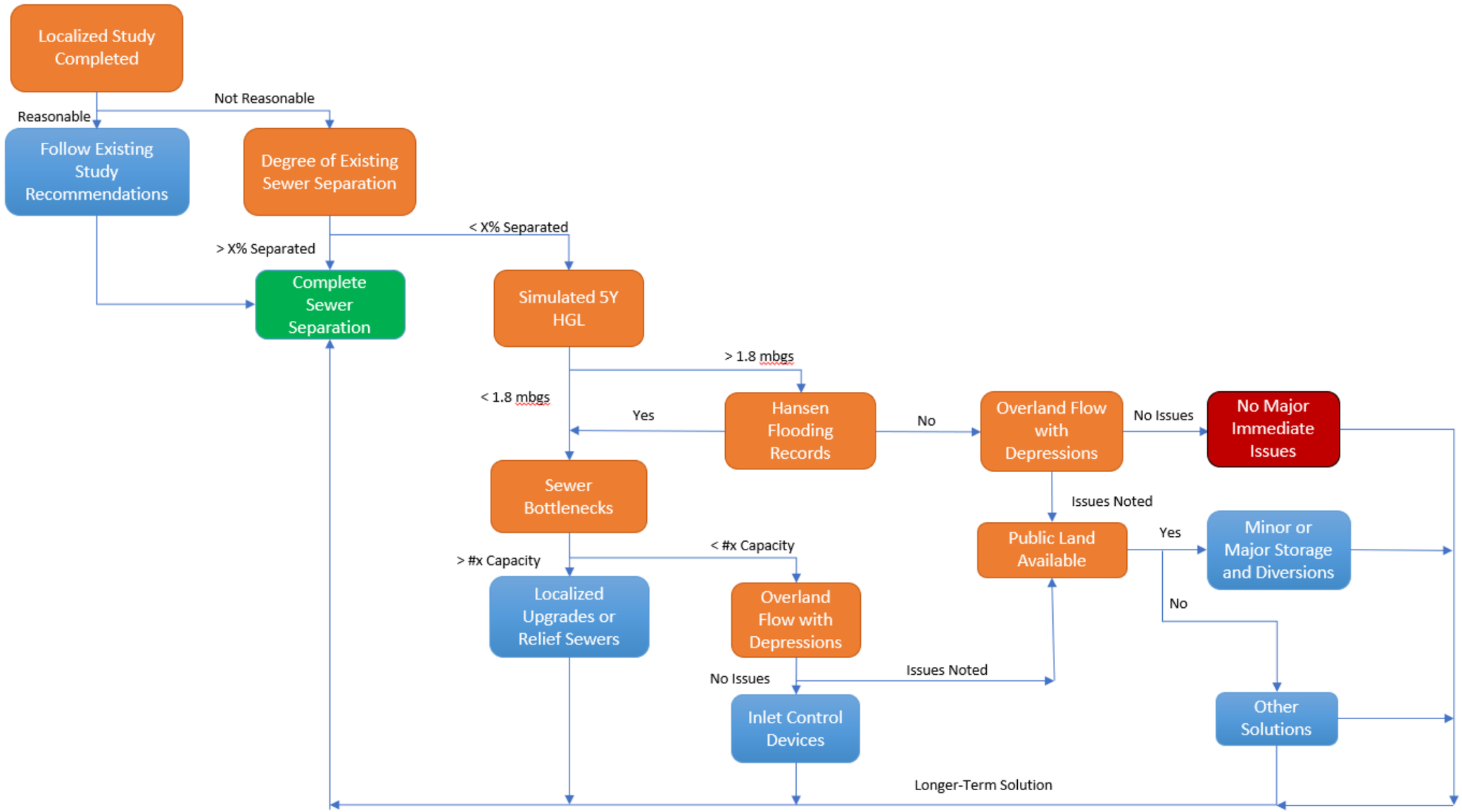


Figure 15: High-level decision tree for project consideration

7 RECOMMENDATIONS

As outlined in **Section 4**, the final magnitude of required system upgrades will be dependent on the City's performance targets attainable in the system; however, it is anticipated that through the full implementation of the studies, investigations, and priority area projects, the minimum service objectives as identified in **Section 4.2** will be attained. The final confirmation of potential projects and "Managed Sewer Separation" projects will be dependent on the outcomes of the identified studies and investigations.

7.1 Options Categorization and Prioritization

Those options that have been identified as having merit in addressing the basement flooding and surface ponding issues have been categorized and prioritized based on the methodology presented in **Section 3.2**. The solutions within the CSO catchments and the overall combined system have been prioritized based on the:

- Local Risk
- Magnitude of the local existing basement flooding and surface ponding issues
- Expected effectiveness in reducing the impacts associated with identified issues
- Availability of pre-existing investigations, studies, or other information to validate the issues and recommendations
- Extent of additional investigations, studies, and/or other pre-implementation requirements
- Expected construction timeline
- Potential alignment with other City initiatives and/or the dependency on other projects such as future required outfalls or trunk infrastructure

Based on a largely balanced consideration of the above factors, the project recommendations have been prioritized into short-term, medium-term, and long-term recommendations. In addition to the timelines, the project recommendations have been categorized into one of four project types, as follows:

- **Studies, Investigations, and Policies:** Identified studies, investigations, and new policies needed to support feasibility and scoping of the Framework recommendations and to confirm the combined system performance targets. (ref. **Table 6**, **Table 7,** and **Table 8**)
- **Priority Area Projects:** Capital projects that address basement flooding and surface ponding issues within priority (high-risk) areas. These represent projects that have been previously identified through other localized planning studies and/or were found to have high relative system benefit through the Framework assessment. Note, these projects still require further feasibility confirmation and technical validation prior to implementation, as they were only reviewed at a high-level due to the scope of the Framework. ("Recommended" in **Table 5**)
- **Potential Projects:** Capital projects that potentially address basement flooding and surface ponding issues within priority (high-risk) areas. These represent projects that will require additional investigation to confirm their feasibility, scope, and the expected system benefit. ("Further Study" in **Table 5**)
- **Managed Sewer Separation:** Capital projects that support the "Managed Sewer Separation" strategy and do not directly address basement flooding and surface ponding issues within priority (high-risk) areas.

7.2 Recommendation Timeline

The following outlines the recommended timelines for each of the proposed projects.

7.2.1 Short -Term (0-10 years)

The program's short-term recommendations are focused on three primary outcomes consisting of:

- Establish/confirm the City's long-term management strategy, including the establishment of clear system performance targets and the development/updating of system policy and bylaws necessary to support the management strategy
- Completion of the field investigations, studies, and Environmental Assessments (EAs) necessary to fill data gaps and confirm/further define the long-term program recommendations
- Implementation of capital projects within priority (high-risk) areas that have been previously identified through other localized planning studies and/or have been determined to have high relative system benefit and do not require additional studies to be completed

The full scope of projects proposed to be implemented within the first 10 years will be subject to City's final vision and management philosophy recommendations, which will ultimately determine the pace of capital project implementation. Several priority projects have been identified through the City's ongoing planning process. The implementation of these projects and others will be subject to the outcomes of the field investigations, studies, and Environmental Assessments (EAs), and will be governed by the final system performance targets.

Recommendations within the short-term timeline have been distilled further into the following timelines for preliminary implementation purposes:

- **0-3 years:** Projects that require minimal background works prior to implementation, due to either the complexity of the proposed option, or the presence of previously completed background studies recommending the project implementation
- **3-5 years:** Short-term projects with higher priority that can not be implemented immediately due to the need for further study or technical validation
- **5-10 years:** Short-term projects with a medium-to-lower priority that can not be implemented immediately due to the need for further study or technical validation

Further context on the short-term implementation timing and plan is provided in **Section 7.5**.

It should be noted that the City may commence components of the "Managed Sewer Separation" in the short term; however, it is expected that once the "Managed Sewer Separation" strategy has been developed for a given area (CSO Catchment) that these projects will begin to be implemented on an "opportunistic" basis and will be initiated through other City initiatives such as the roadway renewal programs, major redevelopment projects, or other major infrastructure programs. It is advised that the City consider changing the driver of storm sewer capital works from a "roadworks based prioritization" to a prioritization based on the availability of dedicated storm sewer outfalls and supporting trunk sewers, in order to ensure the benefits of managed sewer separation are realized.

7.2.2 Medium – Term (10-20 years)

The medium-term recommendations focus on addressing the remaining priority area projects. It is also within the medium-term timeframe that the larger scale, system-based solutions may be implemented. Further, the "Managed Sewer Separation" program is anticipated to continue on an "opportunistic" basis.

7.2.3 Long-Term (20 +Years)

The long-term recommendations are focused on the City's implementation of the "Managed Sewer Separation" program. Once the priority areas projects have been completed, it is anticipated that the City would transition to a more structured and guided "Managed Sewer Separation" program with the goal of targeting full separation of CSO catchments on a priority basis.

7.3 Infrastructure Recommendations

Table 5 provides a summary of the CSO catchment level recommendations with estimated costs and timelines. A detailed accounting of the projects by catchment is included in **Appendix A** and detailed costing and timing breakdown is included in **Appendix C**

Table 5: Summary of Infrastructure Recommendations by CSO Catchment

	Option Overview	Cost ($)	Screening	Priority	Timeline
Ainslie Wood	Option 1: Creek separation along Iona Ave (AW-1)	$19.8M	Recommended	High	0 - 3 years
	Option 2: Sewer separation along Ainslie Wood South (AW-2)	$22.1M	Recommended	Medium	5 - 10 years
	Option 3a: Sewer separation along Ainslie Wood North (AW-3a)	$9.7M	Recommended	Medium	5 - 10 years
	Option 3b: Collector sewer for sewer separation along Ainslie Wood North (AW-3b)	$5.8M	Recommended	Medium	5 - 10 years
	Option 4: Stormwater storage within Alexander Park (AW-4)	$1.8M	Further Study	Medium	3 - 5 years
	Managed sewer separation (AW-SWR)	$15.1M	Recommended	Medium	20+ years
McMaster	Option 1: Upgrade of trunk sewer to outlet to accommodate Ainslie Wood sewer separation (MCM-1)	$4.2M	Further Study	Medium	5 - 10 years
	Managed sewer separation (MCM-SWR)	$9.1M	Recommended	Low	20+ years
Westdale	Option 1: North end sewer separation (WD-1a)	$8.5M	Further Study	High	3 - 5 years
	Option 1b: North end sewer separation (WD-1b)	$4.0M	Further Study	High	3 - 5 years
	Option 2: Dalewood Middle School Storage (WD-2)	$-	Screened Out	-	-
	Option 3: Westdale Secondary School Storage (WD-3)	$12.5M	Further Study	Medium	5 - 10 years
	Option 4: South end sewer separation (WD-4a)	$8.0M	Further Study	High	5 - 10 years
	Option 4: South end sewer separation (WD-4b)	$5.0M	Further Study	High	5 - 10 years
	Option 5: Deepen local sewers during asset renewal (WD-5)	$-	Recommended	Medium	5 - 10 years
	Managed sewer separation (WD-SWR)	$13.8M	Recommended	High	20+ years
Churchill Park	Option 1: LID implementation (CP-1)	$2.5M	Recommended	Medium	5 - 10 years
	Option 2: Superpipe storage (CP-2)	$10.9M	Further Study	Medium	5 - 10 years
	Managed sewer separation (CP-SWR)	$14.0M	Recommended	High	5 - 10 years
Main-King-1	Option 1a: Hill St Park Storage (MK1-1a)	$0.7M	Further Study	High	3 - 5 years
	Option 1b: Upstream major system storage (Durand Park) (MK1-1b)	$0.3M	Further Study	High	3 - 5 years
	Option 2: Trunk Sewer Upgrade (MK1-2)	$-	Screened Out	-	-
	Option 3: Bold St Separation (MK1-3)	$2.1M	Further Study	High	3 - 5 years
	Option 4: Managed Separation in east end (MK1-4)	$31.5M	Further Study	Medium	10 - 20 years
	Option 5: Divert Bold St stormwater to HAAA (MK1-5)	$12.1M	Further Study	High	3 - 5 years
	Managed sewer separation (MK1-SWR)	$22.0M	Recommended	Medium	20+ years
Main-King-2	Managed sewer separation (MK2-SWR)	$6.0M	Recommended	Low	20+ years
Aberdeen Hillcrest	Option 1a: Sewer Separation with Aberdeen Hillcrest – 1 (AH-1a)	$5.5M	Recommended	High	3 - 5 years
	Option 1b: Sewer Separation with Aberdeen Hillcrest – 1 (AH-1b)	$9.6M	Recommended	High	3 - 5 years
	Option 2: Extend storm sewer along Aberdeen Ave (AH-2)	$6.9M	Further Study	Medium	5 - 10 years
	Managed sewer separation (AH-SWR)	$2.8M	Recommended	Medium	20+ years
James	Managed sewer separation (JM-SWR)	$5.2M	Recommended	Low	20+ years
Eastwood Park	Option 1: Eastwood Park LID (EP-1)	$-	Screened Out	-	-
	Managed sewer separation (EP-SWR)	$8.2M	Recommended	Low	20+ years
Bayfront	Option 1: Managed sewer separation (BF-SWR)	$18.5M	Recommended	Low	20+ years
Wellington	Option 1a: Managed sewer separation within existing separated areas (WL-1a)	$0.4M	Recommended	High	10 - 20 years
	Option 1b: Trunk infrastructure for managed sewer separation within existing separated areas (WL-1b)	$47.3M	Recommended	High	10 - 20 years
	Option 2: Relief sewer for surface depression (WL-2)	$2.1M	Further Study	Low	5 - 10 years
	Option 3: Wellington St relief sewer extension (WL-3)	$2.1M	Further Study	Medium	5 - 10 years
	Option 4: Flow monitoring with potential relief sewer extension (WL-4)	$3.7M	Recommended	Medium	5 - 10 years
	Option 5: Inlet control device implementation (WL-5)	$0.1M	Further Study	Medium	5 - 10 years
	Managed sewer separation (WL-SWR)	$44.5M	Recommended	High	20+ years

	Option Overview	Cost ($)	Screening	Priority	Timeline
Wentworth	Option 1 Separate northern sewer network (WN-1)	$11.2M	Recommended	High	5 - 10 years
	Option 2: Condition assessment and infrastructure renewal with upsizing (WN-2)	$-	Recommended	High	3 - 5 years
	Option 3: East Ave N storm sewer (WN-3)	$1.4M	Further Study	High	5 - 10 years
	Option 4a: Asset renewal with managed separation (WN-4a)	$-	Recommended	Medium	10 - 20 years
	Option 4b: Asset renewal with managed separation (WN-4b)	$-	Recommended	Medium	10 - 20 years
	Managed sewer separation (WN-SWR)	$35.7M	Recommended	Medium	20+ years
Birch	Option 1: Disconnect underpass local pipe from relief pipe and implement upstream inlets (BR-1)	$0.2M	Recommended	High	3 - 5 years
	Option 2: Extend relief sewer within Birch Ave to ultimate storm outfall (BR-2)	$18.4M	Further Study	Medium	10 - 20 years
	Option 3: Construct pumping station at Birch Ave and CN Railway underpass if required (BR-3)	$12.6M	Further Study	Medium	10 - 20 years
	Managed sewer separation (BR-SWR)	$25.4M	Recommended	Medium	20+ years
Gage	Option 1: LEEDS Report recommendations (GG-1)	$5.0M	Recommended	High	3 - 5 years
	Managed sewer separation (GG-SWR)	$55.6M	Recommended	High	20+ years
Ottawa	1. ICDs along Dalkeith Ave and Craigmiller Ave (OT-1)	$0.1M	Recommended	Medium	0 - 3 years
	2a. Complete separation along Grenfell Street (Bayfield to Kenilworth) to existing storm sewer (OT-2a)	$3.4M	Recommended	Medium	3 - 5 years
	Managed Sewer Separation (OT-SWR)	$2.1M	Recommended	Medium	20+ years
Kenilworth	1. Separation on Edgemont (Lawrence to Main) (KN-1)	$5.7M	Recommended	Medium	5 - 10 years
	2. Relief Sewer on Kenilworth (Central to Main) (KN-2)	$3.4M	Recommended	Low	10 - 20 years
	2. a) Sewer Separation on Crosthwaite Street (Central to Main) (KN-2a)	$1.9M	Recommended	Medium	3 - 5 years
	2. b) Sewer Separation on Main Street (Kenilworth to Garside) (KN-2b)	$1.5M	Recommended	Medium	3 - 5 years
	2. c) Storm Sewer diversion on Maple Ave (KN-2c)	$0.8M	Further Study	Low	10 - 20 years
	3. Relief Sewers on Hope and Allan (KN-3)	$2.0M	Recommended	Medium	5 - 10 years
	4. Overflow connection at Harmony and Britannia (KN-4)	$0.7M	Further Study	Low	10 - 20 years
	4. a) Complete sewer separation on Barton (Harmony to Kenilworth) (KN-4a)	$2.2M	Recommended	High	3 - 5 years
	5. ICDs on Cope Street from Main to Britannia (KN-5)	$0.1M	Recommended	High	0 - 3 years
	5. a) Additional ICDs on adjacent streets (Garside, Cameron, Barons) (KN-5a)	$0.3M	Recommended	High	0 - 3 years
	6. Sewer Separation on Ellis Ave (KN-6)	$1.9M	Further Study	Medium	5 - 10 years
	6. a) Storage in RT Steel Park (KN-6a)	$0.6M	Further Study	Medium	5 - 10 years
	7. Trunk storm sewer on Strathearne Ave (KN-7)	$-	Further Study	-	-
	7. a) Trunk storm sewer on waterworks corridor (KN-7a)	$29.2M	Further Study	Low	10 - 20 years
	Managed Sewer Separation (KN-SWR)	$26.7M	Recommended	Medium	20+ years
Strathearne	1. Trunk storm sewer on Strathearne Ave (ST-1)	$36.7M	Recommended	High	3 - 5 years
	1. b) Separation on Barton (Walter to Strathearne) (ST-1b)	$5.6M	Recommended	Medium	5 - 10 years
	1. c) Separation on Vansitmart (Weir to Strathearne) (ST-1c)	$1.4M	Further Study	Medium	5 - 10 years
	2. a) Parkdale Park Storage (ST-2a)	$1.4M	Further Study	Low	10 - 20 years
	2. b) Viscount Montgomery PS Storage (ST-2b)	$0.6M	Further Study	Low	10 - 20 years
	2. c) Montgomery Park Storage (ST-2c)	$2.3M	Further Study	Low	10 - 20 years
	2. d) Mahoney Park Storage (ST-2d)	$2.9M	Further Study	Low	10 - 20 years
	2. e) Fairfield Park Storage (ST-2e)	$0.4M	Further Study	Low	10 - 20 years
	3. Relief sewers on Queenston and Walter (ST-3)	$5.4M	Recommended	Medium	5 - 10 years
	4. Maintain culverts over rail line at Division, Cope, Tragina and Weir (ST-4)	$1.7M	Recommended	Medium	3 - 5 years
	5. Additional inlets along south side of railway - Weir to Strathearne (ST-5)	$0.1M	Recommended	Medium	3 - 5 years
	6. Relief sewer on Britannia from Weir to Strathearne (ST-6)	$2.1M	Further Study	Low	10 - 20 years
	Managed Sewer Separation (ST-SWR)	$35.7M	Recommended	High	20+ years

	Option Overview	Cost ($)	Screening	Priority	Timeline
Lawrence	1. Regrade of Glenholme Ave (LW-1)	$1.2M	Recommended	Low	10 - 20 years
	2. Storm trunk on Lawrence Road from Bettina to Red Hill (LW-2)	$12.7M	Recommended	Medium	5 - 10 years
	2. a) Storm trunk on Lawrence from Cochrane to Bettina (LW-2a)	$7.4M	Recommended	Medium	5 - 10 years
	2. b) Storm trunk on Cochrane to pick up depressed area on Dunkirk (LW-2b)	$3.6M	Further Study	Low	10 - 20 years
	3. Glenholme Ave Separation Sewer from Lawrence Rd to complete separation of Glendee Rd (LW-3)	$0.9M	Recommended	Low	10 - 20 years
	Managed Sewer Separation (LW-SWR)	$17.8M	Recommended	Medium	20+ years
Rosedale	1a Kings Forest SWMR outlet through Greenhill and Park (RS-1a)	$-	Further Study	-	-
	1b Kings Forest SWMF outlet through Whitehouse Road and Kings Forest Park (RS-1b)	$3.4M	Recommended	High	3 - 5 years
	1c Kings Forest SWMF outlet through golf course path (RS-1c)	$-	Screened Out	-	-
	1d Kings Forest SWMF outlet via Cochrane Road (RS-1d)	$-	Screened Out	-	-
	1e Kings Forest SWMF outlet via Dumbarton Ave (RS-1e)	$-	Screened Out	-	-
	2 Increased Inlet Capacity on Dunkirk Dr (RS-2)	$0.2M	Further Study	Low	10 - 20 years
	3 Major System Relief Sewer from Dunkirk Dr (RS-3)	$1.5M	Further Study	Low	10 - 20 years
	4 New Storm Sewer to Red Hill via Montrose, Erin and Dundonald (RS-4)	$10.4M	Recommended	High	3 - 5 years
	5 New Storm Sewer Outfall for the Mountain (RS-5)	$16.7M	Further Study	Low	10 - 20 years
	Managed Sewer Separation (RS-SWR)	$12.8M	Recommended	High	20+ years
Queenston	1. Relief sewer on Central Ave from Glencarry to Parkdale (QN-1)	$0.5M	Recommended	High	3 - 5 years
	2. Relief sewers or separation on Beland Street (QN-2)	$2.8M	Recommended	Low	10 - 20 years
	Managed Sewer Separation (QN-SWR)	$2.0M	Recommended	Medium	20+ years
Parkdale	1. Relief sewer on Mahoney Ave and Adeline Ave (PK-1)	$1.9M	Recommended	Low	10 - 20 years
	2. Sewer Separation along Mead Ave (PK-2)	$2.3M	Further Study	Medium	5 - 10 years
	2 a) Connection from Mead Ave to Dunn Ave (PK-2a)	$0.9M	Further Study	Medium	5 - 10 years
	2 b) Sewer Separation Outlet via Brampton St (PK-2b)	$-	Screened Out	-	-
	3. Sewer Separation on Brighton Ave (PK-3)	$2.3M	Recommended	Medium	5 - 10 years
	Managed Sewer Separation (PK-SWR)	$10.7M	Recommended	High	20+ years
Dunn Woodward	1. Local Separation on Brighton Ave (DW-1)	$-	Recommended	-	-
	2. Brampton St Storm Sewer Outfall to Red Hill Valley (DW-2)	$5.2M	Recommended	High	3 - 5 years
	3. Inlet Control Devices Rennie St (DW-3)	$0.1M	Recommended	Medium	0 - 3 years
	3. a) Relief sewer/upgrade on Rennie Street (DW-3a)	$2.7M	Further Study	Low	10 - 20 years
	4. Woodward Ave Separation Sewer (DW-4)	$15.4M	Further Study	Medium	10 - 20 years
	Managed Sewer Separation (DW-SWR)	$12.7M	Recommended	Medium	20+ years
Melvin	1. ICDs along Melvin from Adair to Talbot (ML-1)	$0.1M	Recommended	High	0 - 3 years
	2. ICDS along Glengrove and Armstrong (ML-2)	$0.1M	Recommended	High	0 - 3 years
	3. Storm sewer connection to proposed trunk on Woodward (ML-3)	$-	Screened Out	-	-
	3. a) Storm sewer along Melvin to Red Hill (ML-3a)	$1.5M	Further Study	Medium	5 - 10 years
	Managed Sewer Separation (ML-SWR)	$8.1M	Recommended	Low	20+ years
Mountain	1. a) New storm sewer from Mohawk Road to Buttermilk Falls via Mohawk Sports Park (MT-1a)	$10.4M	Recommended	Medium	5 - 10 years
	1. b) LID or Storage within Mohawk Sports Park to mitigate flow increases (MT-1b)	$5.0M	Further Study	Medium	5 - 10 years
	1. c) Separated storm sewer on Mohawk Road (Upper Ottawa to Mountain Brow) (MT-1c)	$19.8M	Recommended	Low	10 - 20 years
	1. d) Extend storm sewer on Mohawk Road to Upper Sherman (MT-1d)	$14.9M	Recommended	Low	10 - 20 years
	1. e) Storm sewer trunk to Red Hill via Upper Ottawa (MT-1e)	$-	Screened Out	-	-
	2. a) Potential storm sewer trunk for Mountain via Fennell Ave (MT-2a)	$3.1M	Further Study	Low	10 - 20 years
	2. b) Potential storm sewer trunk for Mountain via High Street (MT-2b)	$-	Screened Out	-	-
	Managed Sewer Separation (MT-SWR)	$10.4M	Recommended	Low	20+ years

7.4 Supporting Policies and Studies

In addition to the infrastructure recommendations presented in **Section 7.3**, the following studies, investigations, and policies are recommended to support scoping and implementation of the Framework recommendations and to confirm the combined system performance targets.

7.4.1 Policy Recommendations

It is recommended that the City review, update, and/or implement the policies summarized in **Table 6**. The majority of these policies will help to support the implementation of the long-term vision and "Managed Sewer Separation". Adoption of the policies will be essential in ensuring that growth within the City does not contribute to combined system flooding issues and that future upgrades account for the potential impacts of climate change. **Table 6** provides an overview of the policy recommendations.

Table 6: Overview of policy recommendations

Proposed Policy Addition / Modification	Policy Description
Protective Plumbing Program (P3)	• Continue private property support programs for detached residences (backflow preventer valves, downspout disconnections, installation of a sump pump in combination with a backflow valve) • Consider enhancing the subsidy if feasible • Consider expanding the program to higher density residential units as well as commercial and industrial properties
Redevelopment Sites Stormwater Management Policy	• The City is currently in the process of developing requirements for Low Impact Development (LID) Best Management Practices (BMPs) for redevelopment sites in the City • Recommended that the in-progress policy be reviewed and strengthened City-wide • Continue the target requirement for on-site over control of peak flows (100-year post to 2-year pre) and water quality controls (assuming a future separation); subject to technical feasibility based on localized modelling or pilot studies • This enhanced stormwater management policy will provide benefits to the combined system with the retroactive treatment of stormwater on redevelopment sites, which previously received no treatment
Retrofits for Road Rehabilitation Projects / LID BMP Policy	• Requires contemporary stormwater management to be considered for implementation through all future road rehabilitation projects subject to feasibility, including quantity control (partial or full, depending on feasibility) and quality control • Once "Managed Sewer Separation" strategy has been identified for a given area through the Sewer Separation Studies and Outfall EAs, sewer separation or relief sewers should be considered as a default for all planned road reconstruction projects • Many other municipalities are retrofitting their roads with stormwater management source controls (i.e. LID BMPs) and this work is being screened through rigorous cost/benefit tools • The policy and practices will need to be consistent with the City's current standards

Proposed Policy Addition / Modification	Policy Description
LID BMP Policy / Stormwater User Rate	• Involves development and prioritization of an LID BMP Policy / Stormwater User Rate • "Managed Sewer Separation" strategy to be incorporated into the City's Stormwater User Rate analysis, which is currently underway • Incentive program will encourage private property owners to manage stormwater from private properties and implement BMPs such as rain gardens and permeable pavers • Similar stormwater user rates have been implemented in numerous Southern Ontario municipal centres and can provide sustainable funding to stormwater services
Wet Weather Flow in Separated Sewers Policy	• Involves the development of a policy and related guidance for new development throughout the City • The policy and practices for separated sewer system should include more stringent criteria related to wet weather flow allowances (inflow and infiltration) entering into the wastewater sewers in the infrastructure serving new developments • The policy should ensure that all future construction practices address wet weather flows • Could include mandatory flow monitoring in newly installed systems prior to the City's acquisition of the sewer assets

7.4.2 Managed Sewer Separation Environmental Assessments

Implementation of a "Managed Sewer Separation" program across the City's combined sewer system will require a clear outfall and trunk sewer plan. Early development of the separation strategy will:

- Provide long-term clarity on the cost required to implement sewer separation
- Provide clarity on the local (CSO Catchment) implementation needs and program timelines
- Gain stakeholder buy-in to the overall strategy, and provide the City with additional flexibility and plan certainty to implement interim solutions to address immediate high-risk needs
- Allow for the City to align sewer separation activities with other initiatives, such as the roadway renewal program

The following "Managed Sewer Separation" Environmental Assessments (EAs) are recommended. The basis of these studies will include a review of the collective combined sewer system and CSO catchments that are tributary to each of the major receiving systems and develop a detailed outfall and trunk sewer plan. The EAs will identify the number, and proposed locations of new outfalls and the retrofit requirements of existing outfalls, as necessary. Additionally, the EAs will identify the trunk sewer infrastructure needed to support separation of the combined sewer system (see Section 5). The design of local sewers (areas with a tributary drainage system generally less than 20 ha) is not anticipated to be included in the scope of these EAs. **Table 7** provides a brief overview of the proposed EAs, while **Figure 16** provides a map of the proposed EA study areas.

Table 7: Proposed "Managed Sewer Separation" EAs

Study ID	Study Name	Study Area	Study Cost	Need	Study Timeline
STR-1	West End Sewer Separation Study and New Outfall EA (Chedoke and Cootes Paradise)	West End catchments	$500,000	Immediate	0-3 years
STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$1,000,000	Short Term	3-5 years
STR-3	Hamilton Harbour Sewer Separation Study and New Outfall EA	Lower City catchments	$1,000,000	Short Term	3-5 years
STR-4	Scoped Capacity Assessment of North Mountain Area	Mountain	$200,000	Medium Term	5-10 years

Hamilton

Flooding and Drainage
Improvement Framework

Wastewater Infrastructure

- Wastewater Treatment Plant (WWTP)
- Wastewater Pumping Station
- CSO Tanks
- Outfalls

StudyID

- STR-1 West End Sewer Separation Study and New Outfall EA
- STR-2 Red Hill Sewer Separation Study and New Outfall EA
- STR-3 Hamilton Harbour Sewer Separation Study and New Outfall EA
- STR-4 Scoped Capacity Assessment of Mountain Area

General Features

- Railway
- City Boundary
- Urban Boundary

Dundas WWTP
James Street CSO
Eastwood Park CSO
Bayfront Park CSO
Main King CSO
McMaster (Ewen) CSO
Royal CSO
Woodward Ave WWTP
Twin Greenhill Storage Tank
Greenhill CSO
STR-1
STR-2
STR-3
STR-4
HWY-5 West
HWY-6
HWY-403
Cootes Drive
Main Street
King Street
Barton Street
Queen Elizabeth Way
Red Hill Valley
Fennell Avenue
Mohawk Road
Upper James Street
Upper Wellington Street
Upper Wentworth Street
Upper Sherman Avenue
Upper Gage Avenue
Lincoln M. Alexander
Stone Church Road
Rymal Road
0 1 KM

Figure #16
Managed Sewer Separation Studies & Outfall EAs
Existing Sewer System

BluePlan wood.

December 2021
621085-008
NAD 1983 UTM Zone 17N

Document Path: W:\Hamilton\621085\Hamilton FDMSS Framework\4 Work In Progress\GIS and Data\621085-008-Outfall Catchments.mxd

7.4.3 Supporting Studies, Tools, and Programs

The following studies, tools, and programs as presented in **Table 8** are recommended to support the short and long-term implementation of the Framework recommendations.

Table 8: Proposed supporting studies, tools, and programs

Study / Report ID	Study/Report Name	Study Scope	Study Cost	Need	Study Timeline
STR-5	Interceptor Feasibility Study and EA	Feasibility of the Western Sanitary Interceptor twinning or Below-Mountain Interceptor (study requirement to be confirmed and informed by the Master Plan)	$500,000	Medium Term	5-10 years
STR-6	Iona Creek Sewer Separation EA	Separation of the Iona Creek stormwater flows currently entering and overloading the stormwater system within the Ainslie Wood CSO catchment.	$250,000	Immediate	0-3 years
STR-7	3D visual pipe model SUE	Application of Subsurface Utility Engineering (SUE) technology to couple an all-pipes model with 3D visual render to better understand system connectivity and utility conflicts.	$250,000	Short Term	3-5 years
STR-8	All-Pipes Model Update	Major update (or potential new build) of the City's all-pipes model using flow monitoring results for calibration and new infrastructure/development information. To be completed on an approximate 2–5-year basis.	$1,000,000	Immediate	0-3 years
STR-9	Stormwater and LID Policy Update	Update the existing City-wide stormwater policy to include requirements for implementation of LID BMPs in infill and new construction scenarios, as well as include tools for enforcement of stormwater violations.	$100,000	Immediate	0-3 years
STR-10	Stormwater User Rate Study	Build and implement a stormwater user rate program to recover stormwater related expenses through the ultimate users. This includes a comprehensive study of stormwater related costs and methodology for user rates.	$500,000	Immediate	0-3 years

7.5 Implementation Plan – Short-Term Recommendations

The implementation plan of the short-term recommendations is outlined below. Detailed timelines for each individual short-term project recommendation have been outlined in **Table 5**.

7.5.1 2022-2025 (0-3 Years)

Initial activities are proposed to be primarily focused on establishing the appropriate policy and funding necessary to support the implementation of the relevant recommendations; key planning priorities in the initial stage include:

- City adoption of the recommendation for studies and confirmation of the long-term "Managed Sewer Separation" strategy.
- **STR-9** – Stormwater and LID Policy Update: The review, updating, and approval of the policy recommendations outlined in **Section 7.4.1**. Ensuring that all City policies are updated and aligned with proposed short and long-term management vision will be required to ensure that the City proceeds with a strategic and consistent approach.
- **STR-10** - Stormwater User Rate Study: The City's Stormwater User Rate is currently underway. Related incentive programs will encourage private property owners to manage stormwater from private properties and implement BMPs such as rain gardens and permeable pavers. A Stormwater User Rate has been implemented in numerous Southern Ontario municipal centres and can provide sustainable funding to stormwater services.
- **STR-8** - All-Pipes Model Update: A robust hydraulic model of the City's wastewater and stormwater model will be a critical tool to support the ongoing analysis and management of the City's sewer systems. The City should initiate a substantial update and enhancement to its existing model with increased focus on the stormwater system and local sewer performance assessments. The updated model will help support future planning and design of the system upgrade recommendations.

Further, it will be critical that the City initiate the required investigations and studies necessary to implement the more significant infrastructure recommendations in high priority areas and to support implementation of "Managed Sewer Separation". The highest priority studies include:

- **STR-6** – Completion of the Iona Creek Sewer Separation EA, which will outline the preferred upgrade strategy for the high priority Royal CSO. The subject EA was also identified as a high priority project to address water quality concerns and potential CSO overflows to Chedoke Creek (Chedoke Creek Water Quality Study, 2021).
- **STR-1** – Completion of the first "Managed Sewer Separation" feasibility study and EA. The study will outline the long-term separation strategy for the west end of the combined sewer area.

It is anticipated that during this timeframe (0 to 3 years), the City can begin the implementation of system upgrades that were previously validated through past/ongoing supporting studies or projects with clearly defined scope and/or areas that do not require extensive study and/or consultation. As such, these projects can be quickly transitioned to design and implementation. **Table 5** provides an initial prioritization of Infrastructure projects.

7.5.2 2025-2027 (3-5 Years)

During the 3-5 year timeframe, the required investigations and studies necessary to implement the more significant infrastructure recommendations in high priority areas are proposed to be completed. The proposed sewer separation and outfall studies will support the implementation of "Managed Sewer Separation" across the City's combined sewer system **(STR-2 and STR 3).**

During this stage, it is expected that the City will continue to implement system upgrades that have been previously validated through supporting studies or consisting of projects with clearly defined scope. Upon completion of the hydraulic model update, the City can begin transitioning to the implementation of more complex recommendations that required additional investigations and studies, to confirm the upgrade scopes. **Table 5** provides an initial prioritization of Infrastructure projects.

7.5.3 2028-2032 (5-10 Years)

Once the major investigations and studies have been completed and supporting policies and tools are updated, the City will transition primarily to the implementation of system upgrades. Further, following completion of the "Managed Sewer Separation" feasibility studies and EAs, the City can prioritize the application of "opportunistic" implementation of system separation, aligned with other system upgrade and rehabilitation projects. It is important to note that "opportunistic" implementation of separation projects may still move forward during earlier timelines (0-3 years and 3-5 years) in the program; however, the completion of the "Managed Sewer Separation" feasibility studies and EAs will provide clarity and efficiency of implementation in future separation projects.

It is during this timeframe that the City can initiate the System Wide Interceptor feasibility study and EA, as well as the Scoped Capacity Assessment of the North Mountain Area **(STR-4 and STR 5),** as the need and capacity requirements of the Western Interceptor Sewer and upgrades to the North Mountain system will be impacted by the scope and extent of sewer separation. It is recommended that these studies be initiated following the completion of the "Managed Sewer Separation" feasibility studies and EAs.

Finally starting approximately in 2032 and continuing on a 5 to 10-year period, a program review should be undertaken to quantify the extent of system performance improvements and update the management strategy to account for any changes in growth, impacts of climate change, or other major system-based infrastructure upgrades/strategy. Further, once widespread separation has been achieved within an individual CSO catchment, the program review can evaluate the potential for the decommissioning or repurposing of any existing storage facilities and/or overflows.

7.6 Capital Program Costing Methodology

7.6.1 Capital Projects Cost Estimating

The capital program cost estimation framework is based on an overall unit cost approach, based on internal (GM BluePlan & Wood) cost estimates interpolated from historical projects and data. In this approach, high-level project costs have been generated through unit rates with added contingency and other additional costs, based on uncertainty. Due to the high-level nature of the cost estimation, sewer sizes have been simplified into four categories and assumed based on sewer classification. The unit rates that have been used in the Framework are provided in **Table 9**.

Table 9: Sewer classification and unit rates used in costing estimation

Sewer Classification	Average Sewer Size (related to classification) (mm)	Unit Cost ($/m)
Large Trunk	2400	$8,555
Trunk	1500	$5,077
Collector	900	$3,559
Local	450	$2,153

In addition to linear underground infrastructure, there are projects that are recommended or require further study which include LID BMPs, storage facilities, inlet control devices, and re-grading or installation of new inlets. The unit rates used for these non-sewer projects are provided in **Table 10**.

Table 10: Non-sewer project classification and unit rates used in costing estimation

LID BMP/ Storage Classification	Units	Unit Cost ($)
LID BMP (linear)	m	$600
Underground storage (road)	m^3	$1,000
Underground storage (boulevard/vegetation)	m^3	$750
Above-ground storage	m^3	$200
Superpipe	m	$10,000
Inlet Control Devices	m	$50
Additional Inlets (catchbasins)	#	$200
Re-Grading and Paving	m	$2,000

Further, added contingencies or additional costs for each project have been factored into the costs which are dependent on factors such as:

- Project location (open space, collector road, arterial road, etc.)
- Project complexity (low, medium, high)
- Base construction cost

These contingency percentages are presented in **Table 11**, **Table 12**, and **Table 13 (ref. Appendix C)**.

Table 11: Contingency based on installation location/road type

Installation Location / Road Type	Construction Uplift	Provisional & Allowance
Boulevard/Open Space	0%	10%
Local or Collector Road	20%	10%
Arterial or Congested / High-value Area	30%	10%
Arterial and Congested / High-value Area	35%	10%

Table 12: Contingency based on total base construction costs

Construction costs	Consultant Study/Design/CA
<$10M	15%
$10M - $50M	12%
$50M +	10%

Table 13: Contingency based on project complexity/uncertainty

Project Complexity / Uncertainty Contingency	Additional Construction Costs	Project Contingency
Low	10%	11.5%
Medium	15%	18.0%
High	20%	29.0%

The costing of targeted priority upgrades as part of the Framework Study should be considered Class D (30% error range) planning level estimates, suitable to support the capital planning process and will be refined following subsequent investigations, as outlined in the implementation plan. Further information on the calculation methodology including the formulas for contingency are provided in **Appendix C**.

7.6.2 Managed Sewer Separation Cost Estimating

Costing of the “Managed Sewer Separation” was estimated based on a review of the each CSO Catchment’s total length of existing sewers, the current rate (percentage) of existing separation, and previously developed cost estimates for combined sewer separation from the Draft FDMSS (Aquafor Beech, 2019).

The “Managed Sewer Separation” program costs on a CSO Catchment level were estimated by taking the Draft FDMSS (Aquafor Beech, 2019) total length of sewer upgrades and upgrade costs by CSO Catchment, and then adjusting the CSO Catchment separation costs up or down based on the magnitude of each CSO Catchment’s separation cost compared against the average separation cost across all CSO Catchments. The “Managed Sewer Separation” program costs have then been further adjusted to account for the removal of the length of pipe (from a total pipe length accounting perspective) for the projects proposed for each CSO catchment in **Section 7.3**.

The total “Managed Sewer Separation” program costs are summarized in **Table 14** and further breakdown of costing methodology are presented in **Appendix C**.

Table 14: Summary of "Managed Sewer Separation" costs

CSO Catchment	Approx. Draft FDMSS Length of Separation (m)	Unit Cost ($/m)	Draft FDMSS Cost Estimate for Separation ($)	Approx. Length of Framework Capital Projects (m)	Adj. Factor	Managed Sewer Separation Cost ($)
Aberdeen Hilcrest CSO	4,025	$2,360	$9,500,000	2,840	0.29	$2,797,548
Ainslie Wood CSO	21,842	$1,549	$33,838,201	12,100	0.45	$15,093,622
Bayfront CSO	17,113	$1,078	$18,454,000	-	-	$18,454,000
Birch CSO	17,338	$1,549	$26,860,187	950	0.95	$25,388,265
Churchill Park CSO	8,674	$1,734	$15,042,000	600	0.93	$14,001,558
Dunn Woodward CSO	10,337	$1,984	$20,505,000	1,030	0.90	$18,461,899
Eastwood Park CSO	5,278	$1,549	$8,176,734	-	-	$8,180,000
Gage CSO	33,157	$1,729	$57,323,000	1,000	0.97	$55,594,143
James CSO	5,390	$957	$5,156,000	-	-	$5,156,000
Kenilworth CSO	27,628	$1,701	$46,984,000	2,975	0.89	$41,924,714
Lawrence CSO	6,429	$2,912	$18,722,000	1,515	0.76	$14,310,276
Rosedale CSO	9,192	$1,549	$14,239,616	570	0.94	$13,356,929
Main-King-1 CSO	27,922	$1,271	$35,475,000	10,590	0.62	$22,020,351
Main-King-2 CSO	3,854	$1,549	$5,970,323	-	-	$5,970,000
McMaster CSO	5,865	$1,549	$9,085,793	-	-	$9,090,000
Melvin CSO	5,822	$1,399	$8,144,000	115	0.98	$7,983,132
Mountain CSO[1]	117,545	$1,164	$136,866,000	-	-	$7,650,000
Ottawa CSO	3,459	$1,583	$5,477,000	450	0.87	$4,764,480
Parkdale CSO	8,748	$2,057	$18,000,000	1,465	0.83	$14,985,767
Queenston CSO	2,669	$1,982	$5,289,000	650	0.76	$4,000,885
Strathearne CSO	32,384	$1,549	$50,169,882	3,400	0.90	$44,902,690
Wellington CSO	33,509	$1,549	$51,912,499	4,810	0.86	$44,458,682
Wentworth CSO	27,866	$1,465	$40,834,000	3,470	0.88	$35,749,144
Westdale CSO	14,713	$1,549	$22,793,910	5,830	0.60	$13,759,684

Note 1: Mountain CSO Catchment "Managed Separation Cost" estimated only for area south of Mohawk Road
Note: Shaded rows carry forward extrapolated Draft FDMSS system-wide unit cost

The costs associated for the "Managed Sewer Separation" have been provided to support the long-term capital planning and user rate recommendations. These costs assume the construction of a new, local storm pipe is required, while any existing combined sewers will be repurposed as sanitary sewers. The cost estimates also assume 100% separation, and do not explore the specifics of partial separation. The costing estimate should be considered a Class D (30% error range) planning level estimate.

It is anticipated that following the completion of the recommended feasibility investigations and Environmental Assessment (EA) studies, the costing assessment for the proposed sewer separation projects will be further refined. Cost estimation of the three (3) system-level solutions as described in **Section 6.1** was not completed as part of the Capital Program.

7.7 Capital Program Summary

The Recommended Capital Program is detailed in **Appendix C**. The high-level summary is presented in **Table 15**.

Capital program costs have been calculated in the short (0-10 year), medium (10-20 year), and long (20+ year) terms. **Table 15** provides a summary of the overall program budget and schedule of recommendations. Additional details are available in **Appendix C,** which provides a breakdown of each recommendation's implementation schedule including general scope, additional studies, fieldwork requirements, estimated timeframe, and budget.

Table 15: Summary of capital program and implementation timelines

Category	Timeline			Total ($)
	0-10 Years	10-20 Years	20+ Years	
Studies	$ 5M			**$ 5M**
Priority Area Projects (Recommended)	$ 214M	$ 93M		**$ 307M**
Potential Projects (Further Study)	$ 96M	$ 146M		**$ 242M**
Managed Sewer Separation	$ 52M	$ 19M	$ 404M	**$ 475M**
Total ($)	**$ 367M**	**$ 258M**	**$ 404M**	**$ 1,029M**

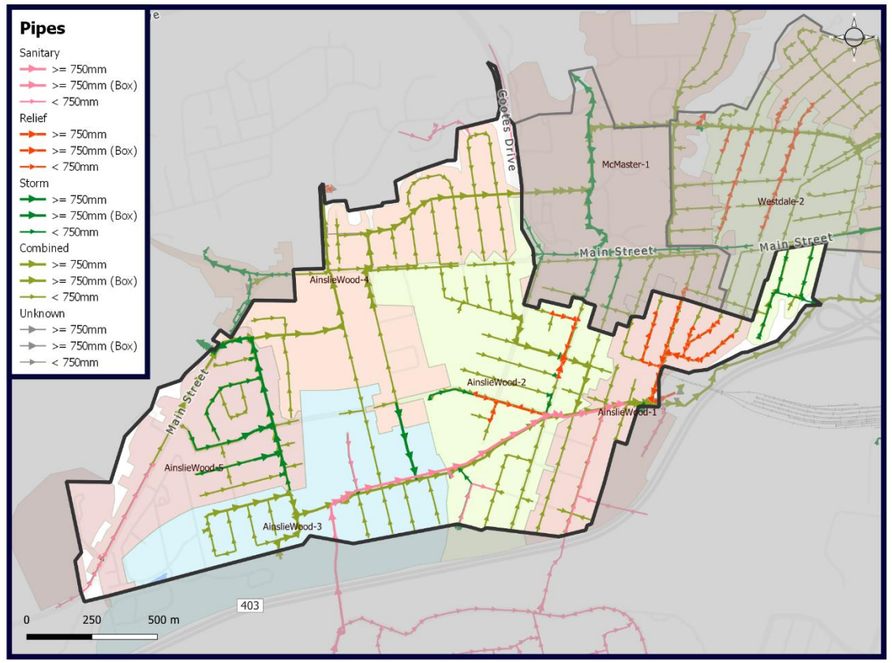
The high-level costing presented in **Table 15** has been calculated following the methodology presented in **Section 3.2** and **Section 7.6.** The full/final program cost will be subject to change based on the further refinement of the final performance targets, and associated studies and investigations. The long-term costs are proposed to be re-evaluated on an approximate 10-year basis as the current costing includes a 20+ year projection with indeterminate timeline.

APPENDIX A: CSO CATCHMENT SHEETS

CSO Catchment Ainslie Wood

Catchment Summary

Overview	The Ainslie Wood CSO catchment is located in the southwestern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Ainslie Wood North • Ainslie Wood East • Ainslie Wood West The Ainslie Wood CSO catchments contains five (5) subcatchments.	
Catchment Metrics	Area (ha)	270
	Total Length of Sewers (km)	36.4
	Length of Combined Sewers (km)	24.8
	Length of Sanitary Sewers (km)	4.1
	Length of Storm Sewers (km)	4.7
	Length of Relief Sewers (km)	2.3
	Storage Tanks (# and Name)	2 Tanks: • Royal CSO Tank • McMaster (Ewen) CSO Tank

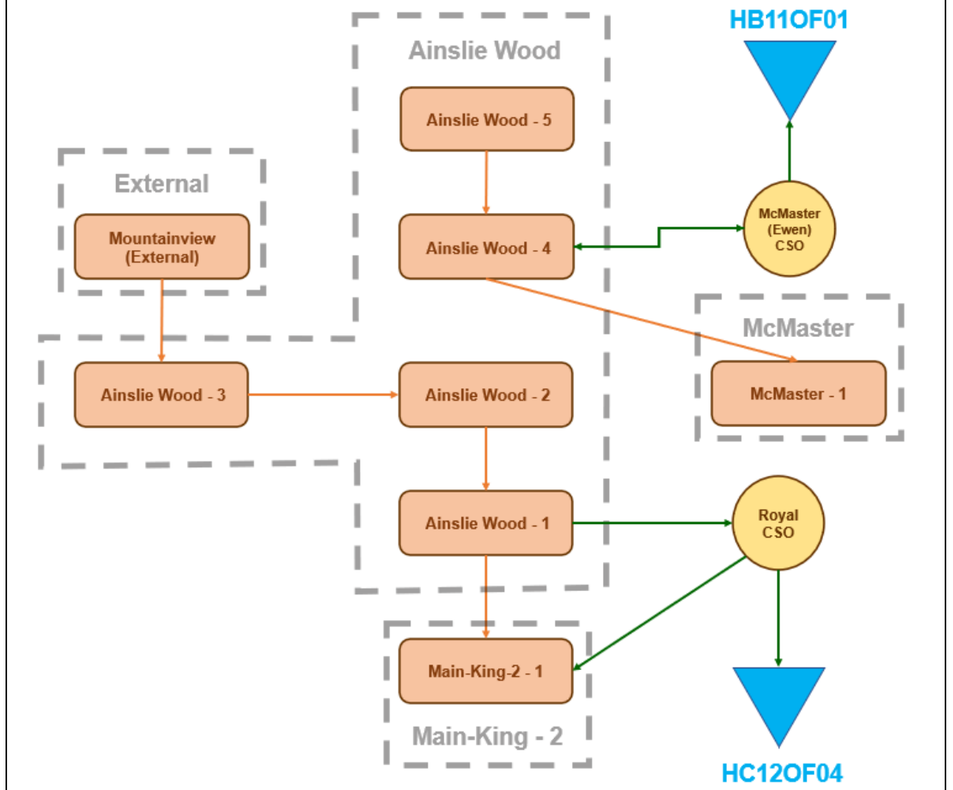


CSO Catchment Ainslie Wood

Minor System Overview

The sanitary and combined systems are defined by the following features:

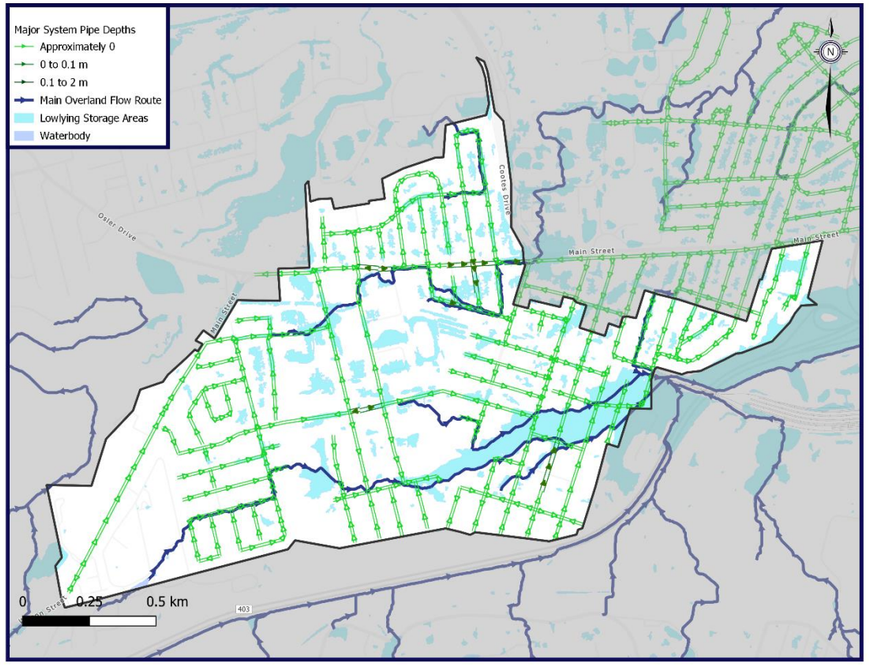
- External upstream receiving catchment from the Mountainview subdivision
- Two (2) minor system outlets from catchment including:
  - McMaster catchment at College Crescent
  - Highway 403 corridor at Stroud Park and Paul St.
- The Combined Sewer Overflow (Relief) pipe outlets at Stroud Park into the Royal CSO tank
- The minor system trunk for the southern portion of the catchment follows Iona Ave to Royal Ave then to the Highway 403 corridor, discharging into the Main King-2 CSO catchment
- The minor system trunk for the northern portion of the catchment follows Sanders Blvd discharging into the McMaster catchment at College Cres



CSO Catchment Ainslie Wood

Major System Overview

- The Ainslie Wood catchment has a significant number of isolated ponding areas which do not appear to be connected to the major system
- The major system appears to convey along the following alignments:
  - Northern portion of catchment (Sanders Blvd) major system discharges to forested area north of Thorndale Cres
    - Ainslie Wood-4 → External
  - Central portion of catchment (Main St W) major system discharges along Cootes Dr and College Ct
    - Ainslie Wood-4 → Ainslie Wood-3 → McMaster-1
  - Southern portion of catchment (Iona Ave and Royal Ave) major system discharges to Highway 403 corridor/Chedoke Creek
    - Ainslie Wood-3 → Ainslie Wood-2 → Ainslie Wood-1 → External



Summary of Previous Studies

Ainslie Wood / Westdale Neighbourhoods Class Environmental Assessment (City of Hamilton & McCormick Rankin Corp., 2003):

- Implementation of on-site controls for future development and redevelopment
- Cash-in-lieu program for future development areas with no on-site controls
- Partial sewer separation:
  - Extension of existing partially separated areas
- Remediation of existing localized problems
  - High Priority:
    - General local problems (P-4) including surface flooding, sewer backup and possible sanitary cross-connection.
  - Medium Priority:
    - Mitigate/enhance storm sewer outfalls (P-1);
    - Mitigate stream erosion sites (P-2); and
    - Retrofit existing commercial/industrial areas with on-site controls (P-6).
  - Low Priority:
    - Mitigate existing sewer capacity restrictions (identified through further hydraulic investigations) (P-3).

Chedoke Creek Water Quality Study (GM Blueplan & Wood, 2021):

- Separation of headwaters of Chedoke Creek along Iona Ave
- Inlet controls within combined sewer area

CSO Catchment Ainslie Wood

Summary of Planned Works	• Iona Ave Sewer Separation EA (as discussed in Chedoke WQ Framework, to take creek flows offline from contribution to d/s Royal & Main/King CSO tanks)

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Ainslie Wood - 1	1	3	3	2	1	5	4	5
Ainslie Wood - 2	1	3	3	2	1	4	3	5
Ainslie Wood - 3	1	1	3	2	1	2	5	2
Ainslie Wood - 4	1	3	3	3	1	3	2	4
Ainslie Wood - 5	1	3	1	3	1	2	4	1

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Ainslie Wood - 1	Medium	High	
Ainslie Wood - 2	Medium	High	
Ainslie Wood - 3	Medium	High	
Ainslie Wood - 4	Low	High	
Ainslie Wood - 5	Low	High	

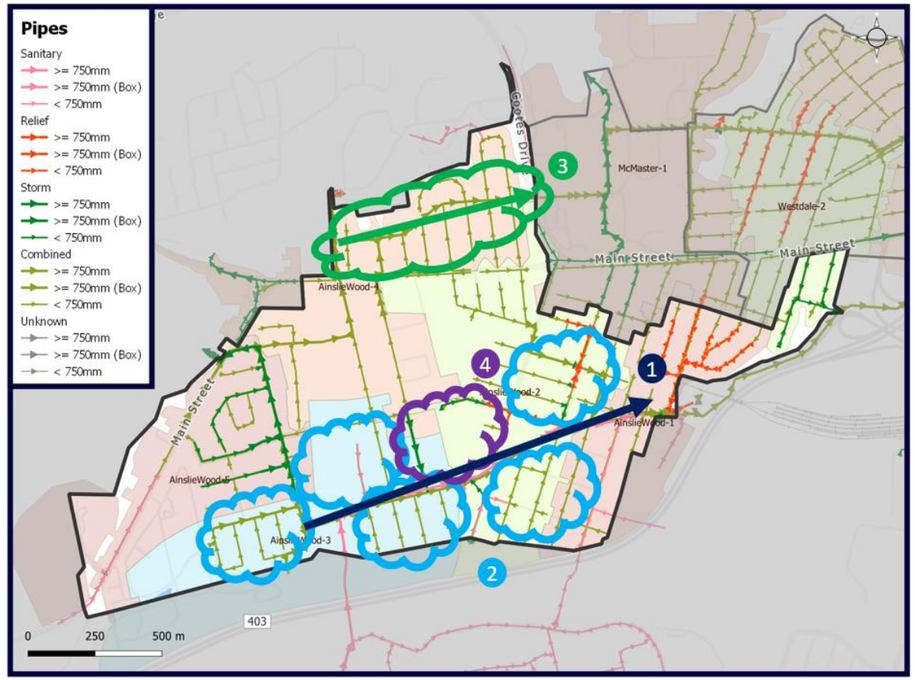
Issues and Options

Summary of Key Issues	• External flows from mountain are intercepted by the combined system along Iona Ave (not well accounted for in model) • Significant isolated depressions within Ainslie Wood-2 & Ainslie Wood-4 • Surcharging along Main St W / Chilton St E – external flows entering system and possibly catchment size delineation required • HGL concerns within north end of Ainslie Wood-4	

CSO Catchment Ainslie Wood

Summary of Potential Options

- 1) (AW-1) Separation of upper tributary to Chedoke Creek along Iona Ave
- 2) (AW-2) Sewer separation within southern portion of Ainslie Wood, connecting into potential Iona Ave creek separation
- 3) (AW-3) Sewer separation within northern portion of Ainslie Wood, connecting into separated system within McMaster-1 catchment (capacity dependent)
- 4) (AW-4) Major system diversion/storage for Ainslie Wood-2 & Ainslie Wood-4 within Alexander Park

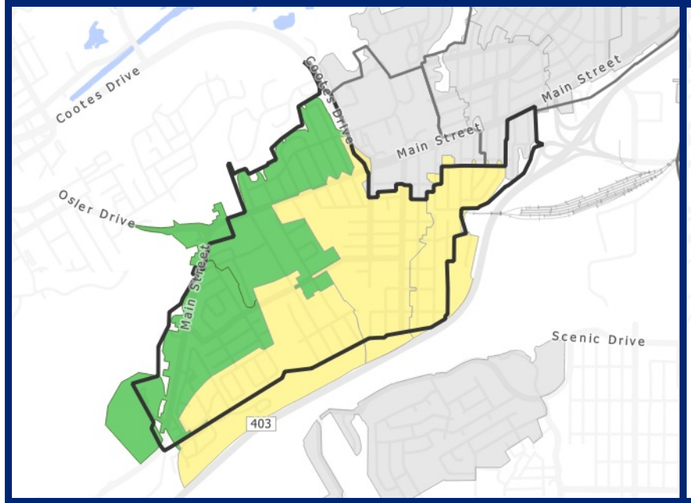


Option Evaluation

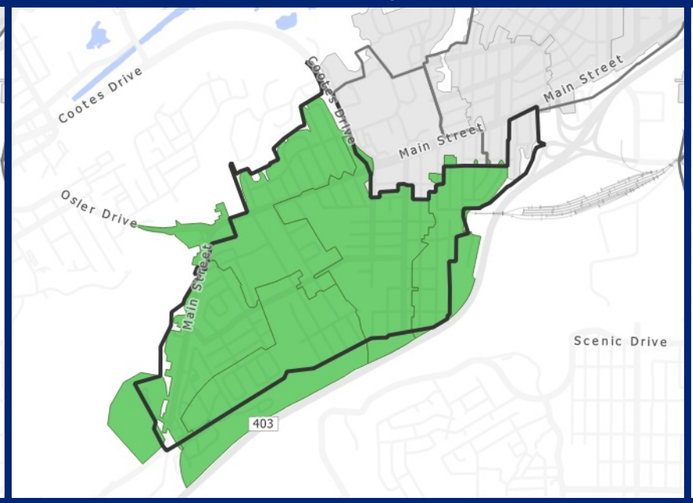
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1: Creek Separation along Iona Ave (AW-1)	• Frees up capacity in combined system • Reduces clean flows to CSO • Long-term solution	• High cost of implementation • Outlet to MTO lands – regulatory hinderance	Local Solution Substantial Benefit	$19.8M	Recommended	High Priority Immediate (0 – 3 Years)	STR-1 STR-6
Option 2: Sewer Separation along Ainslie Wood South (AW-2)	• Frees up capacity in combined system • Reduces clean flows to CSO • Can utilize Option 1- creek separation as trunk/outfall • Long-term solution	• High cost of implementation	Local Solution Substantial Benefit	$22.1M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None

CSO Catchment Ainslie Wood							
Option 3: Sewer Separation along Ainslie Wood North (AW-3a)	• Frees up capacity in combined system • Reduces clean flows to CSO • Long-term solution	• High cost of implementation	Local Solution Substantial Benefit	$9.7M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
Option 3: Collector Sewer for Sewer Separation along Ainslie Wood North (AW-3b)	• Frees up capacity in combined system • Reduces clean flows to CSO • Long-term solution	• High cost of implementation	Local Solution Substantial Benefit	$5.8M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
Option 4: Stormwater Storage within Alexander Park (AW-4)	• Potential to address existing depression storage and major system flooding • Utilizes existing public space	• High cost of implementation • Requires either major system modifications or underground conveyance	Local Solution Moderate Benefit	$1.8M	Further Study	Medium Priority Short Term (3 – 5 Years)	None
Managed Sewer Separation (AW-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$15.1M	Recommended	Medium Priority Future Planning (20+ Years)	STR-1

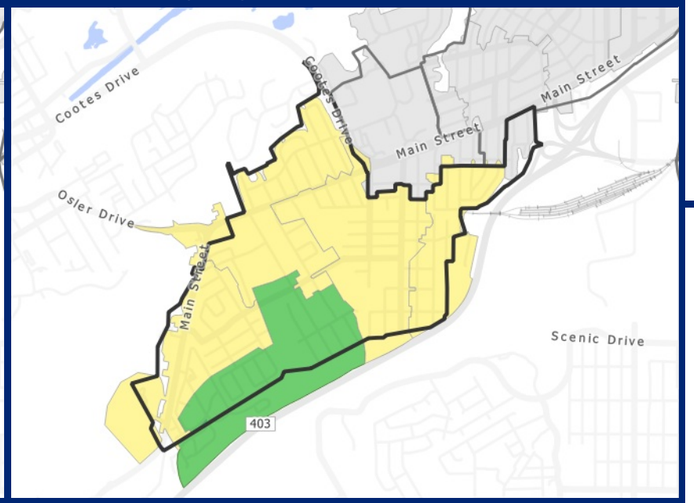
Overall Priority Ranking



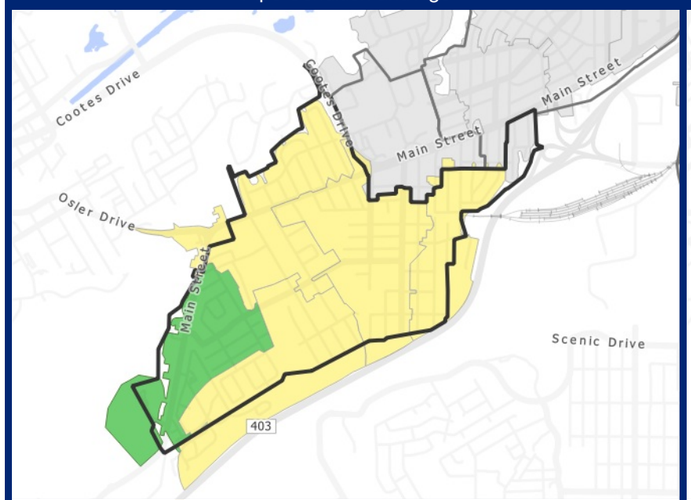
Hansen Flooding Calls



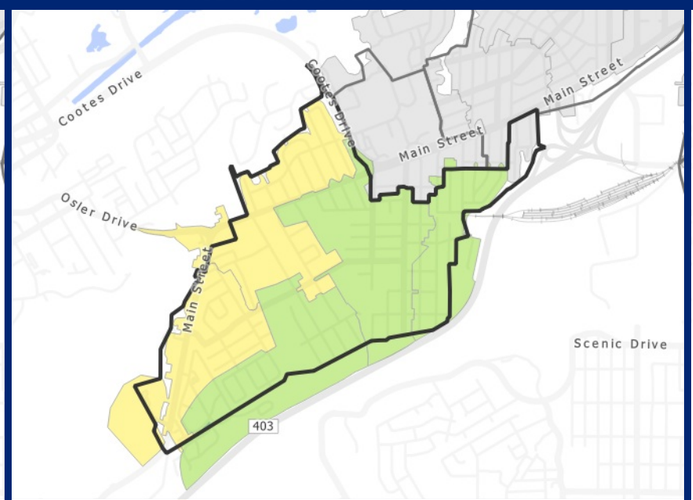
Pipe Depth for Residential Connections



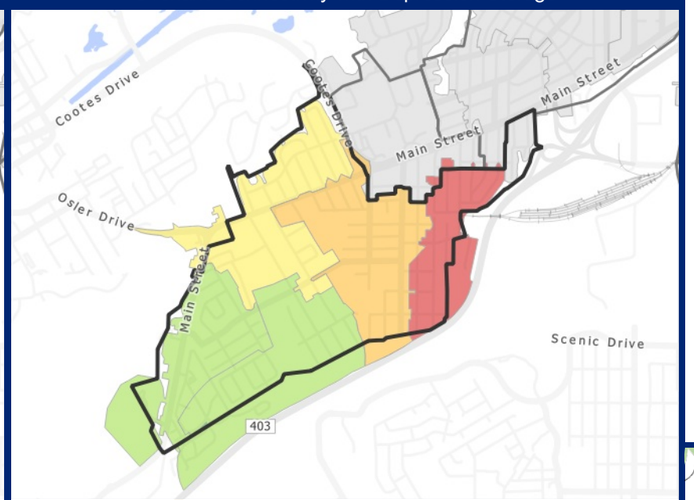
Pipe Condition and Age



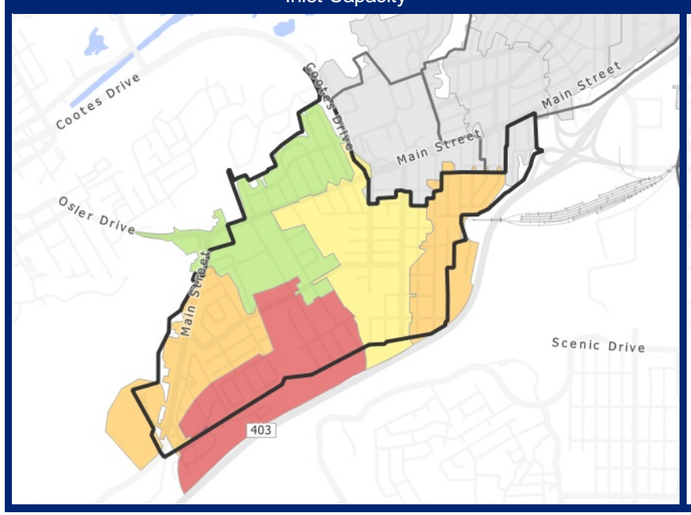
HGL to Basement Elevation of 1.8 m



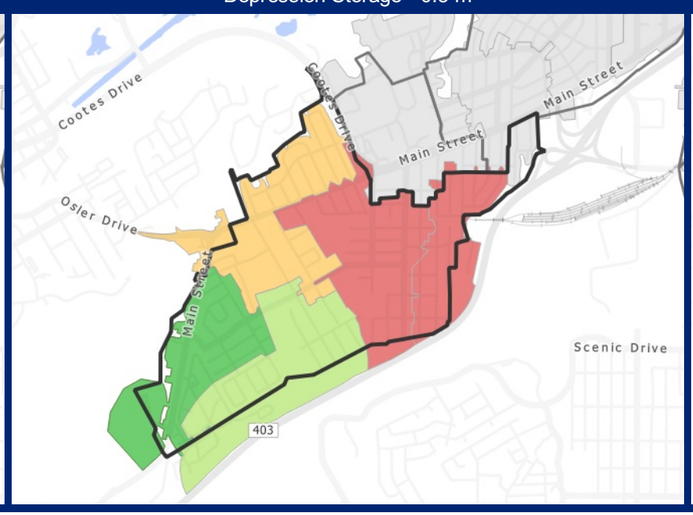
Overland Connectivity with Depression Storage



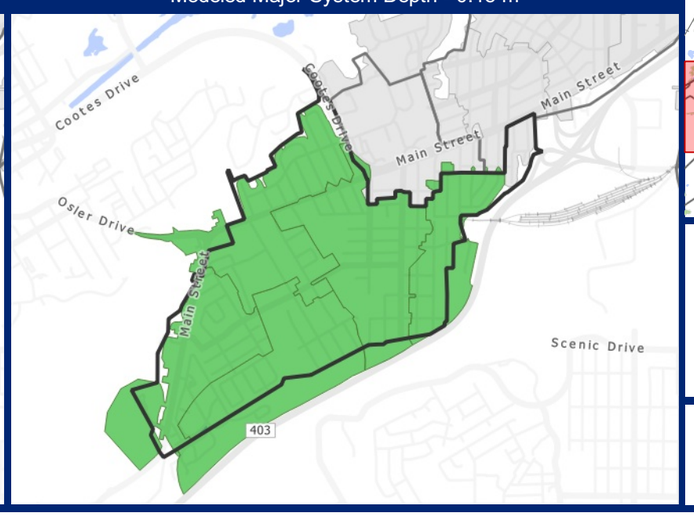
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

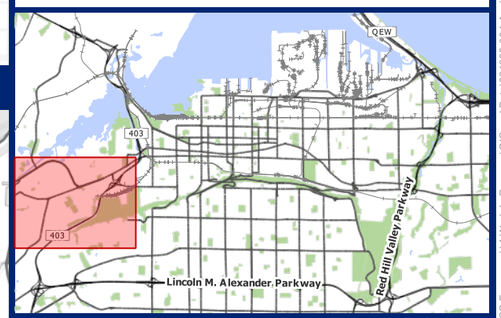


Figure 1 of 24

AinslieWood

Results Analysis

BluePlan ENGINEERING

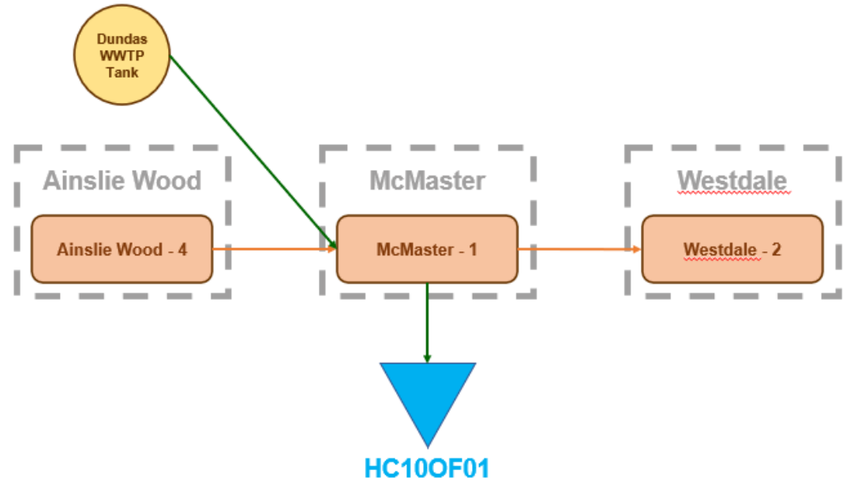
September, 2021
621085-004
Projection EPSG:26917

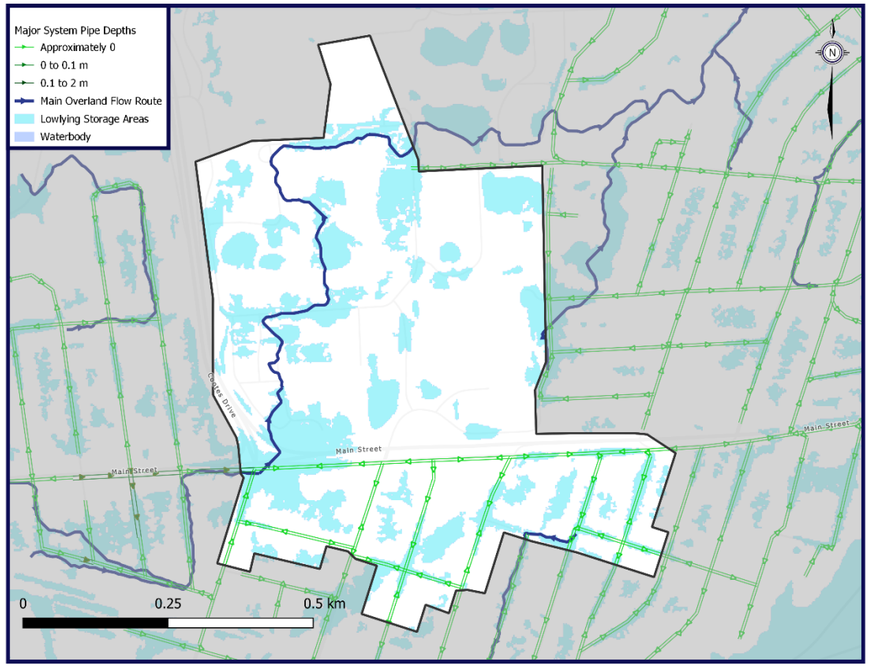
CSO Catchment McMaster

Catchment Summary

Overview	The McMaster CSO catchment is located in the western portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Cootes Paradise A • Ainslie Wood East • Westdale South The McMaster CSO catchments contains one (1) subcatchment.	
Catchment Metrics	Area (ha)	78
	Total Length of Sewers (km)	6.2
	Length of Combined Sewers (km)	5.4
	Length of Sanitary Sewers (km)	0.6
	Length of Storm Sewers (km)	0.1
	Length of Relief Sewers (km)	0.1
	Storage Tanks (# and Name)	

CSO Catchment McMaster

Minor System Overview	The sanitary and combined system are defined by the following features:
	• The McMaster CSO catchment generally drains towards the north and east
	• External upstream receiving catchment from Ainslie Wood 4
	  ○ Conveyed along Sanders Blvd through College Ct. and University Ave northeast through to Sterling St. and the Westdale 2 subcatchment
	• External upstream receiving catchment from Dundas Wastewater Treatment Plant equalization tank
	  ○ Conveyed along Cootes Dr. through to College Ct. and University Ave northeast through to Sterling St. and the Westdale 2 subcatchment
	• One (1) minor system outlet from the catchment:
	  ○ Stormwater outfall through the center of McMaster campus, discharging to Cootes Paradise
	• No relief pipes, CSO tanks, or CSO outfalls exist within the McMaster catchment
	• Stormwater is collected through a separated system within the southern portion of the catchment and is conveyed through the McMaster campus to the ultimate outfall
	• Combined sewer system flows are conveyed northeast to the trunk within Sterling St., entering the Westdale 2 subcatchment
		

Major System Overview	• The McMaster catchment has one primary overland flow route which follows the western border of the catchment, conveying stormwater north, then east along the northern limit of the catchment
	  ○ The overland flow rout ultimately discharges into headwaters of Cootes Paradise
	  ▪ Ainslie Wood 2 → McMaster → External (Cootes Paradise)
	• The following is a description of the surface depressions within the catchment, including any overland connectivity:
	  ○ Large surface depression at Main Street and Cootes Drive, along the primary overland flow path
	  ○ Large depressions along the overland flow route within the western portion of the McMaster catchment
	  ○ Isolated surface depressions throughout the McMaster campus
	  ○ Isolated surface depressions within most local roads, and Main Street, along the southern portion of the catchment
	• Surface depressions within the McMaster campus may have adequate private drainage connectivity or may be utilized for surface storage as part of a potential private collection and conveyance system for the university
	• No significant major system flow depths per the overland model results
		

CSO Catchment McMaster

Summary of Previous Studies	**Ainslie Wood / Westdale Neighbourhoods Class Environmental Assessment (City of Hamilton & McCormick Rankin Corp., 2003):**
	• Implementation of on-site controls for future development and redevelopment
	• Cash-in-lieu program for future development areas with no on-site controls
	• Partial sewer separation:
	  ○ Extension of existing partially separated areas
	• Remediation of existing localized problems
	  ○ High Priority:
	  ▪ General local problems (P-4) including surface flooding, sewer backup and possible sanitary cross-connection.
	  ○ Medium Priority:
	  ▪ Mitigate/enhance storm sewer outfalls (P-1);
	  ▪ Mitigate stream erosion sites (P-2); and
	  ▪ Retrofit existing commercial/industrial areas with on-site controls (P-6).
	  ○ Low Priority:
	  ▪ Mitigate existing sewer capacity restrictions (identified through further hydraulic investigations) (P-3).

Summary of Planned Works	

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
McMaster - 1	1	3	3	3	1	4	4	5

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
McMaster - 1	Medium	Low	

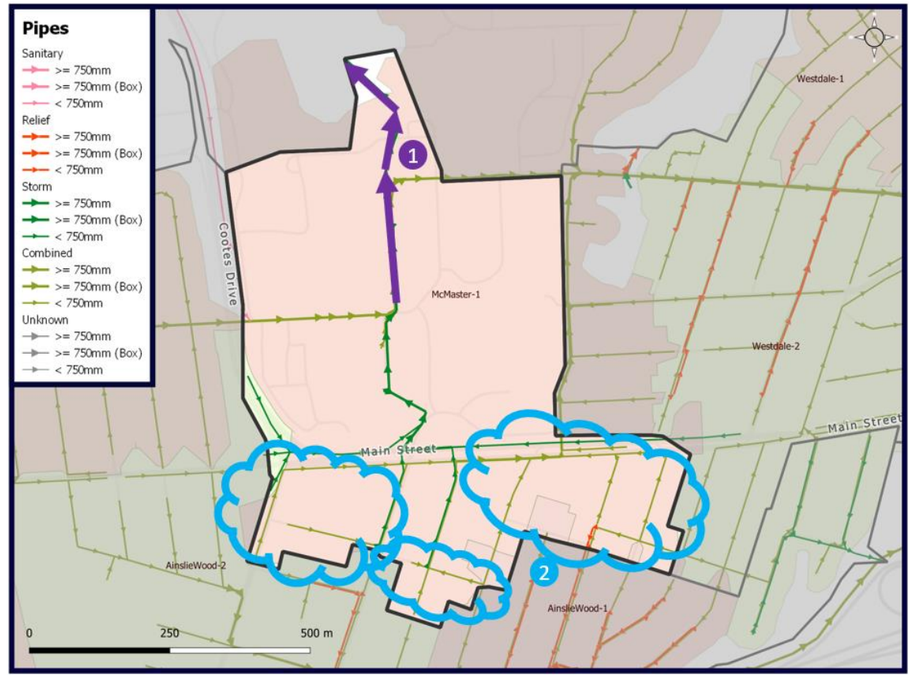
Issues and Options

Summary of Key Issues	• Partially separated system with minimal system concerns • Many areas with surface depressions; however, surface depressions are predominantly focused within private property such as McMaster University • Few isolated segments of pipe with poor condition ratings	

CSO Catchment McMaster

Summary of Potential Options

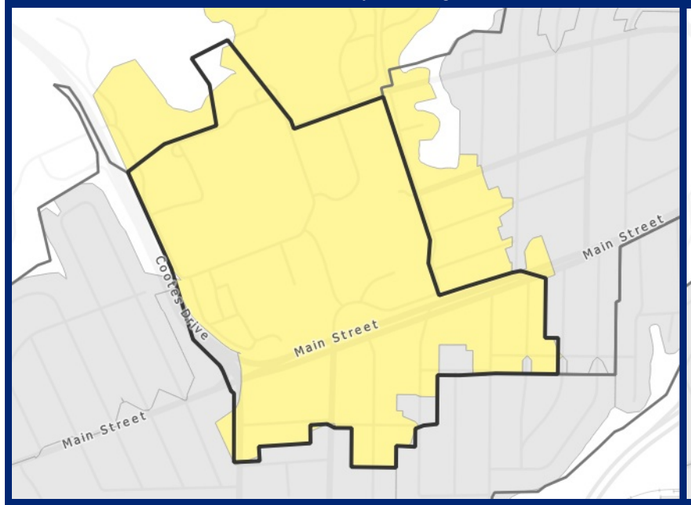
- 1) (MCM-1) Upgrade of trunk storm sewer to outlet to accommodate Ainsile-Wood sewer separation
- 2) (MCM-SWR) Managed Sewer Separation



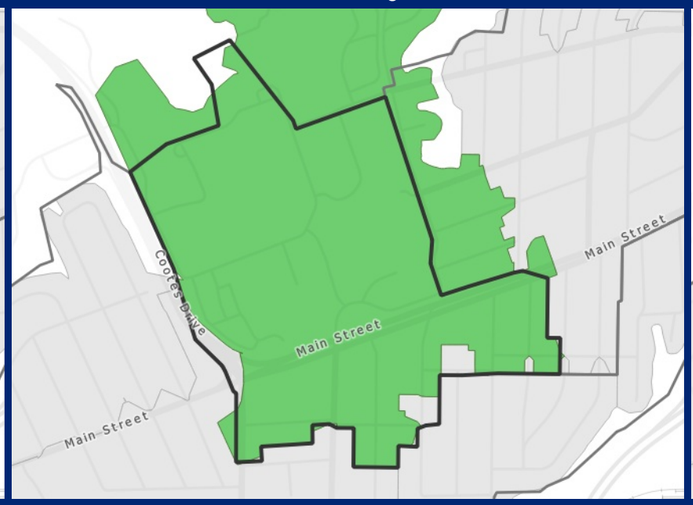
Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1: Storm trunk upgrade (MCM-1)	• Supports separation of Ainslie-Wood catchment	• Limited benefit within McMaster catchment • Storm sewer appears to be within easement or private property • Challenge with coordination through university	Local Solution Substantial Benefit	$4.2M	Further Study	Medium Priority Medium Term (5 – 10 Years)	STR-1
Option 2: Managed Sewer Separation (MCM-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$9.1M	Recommended	Low Priority Future Planning (20+ Years)	None

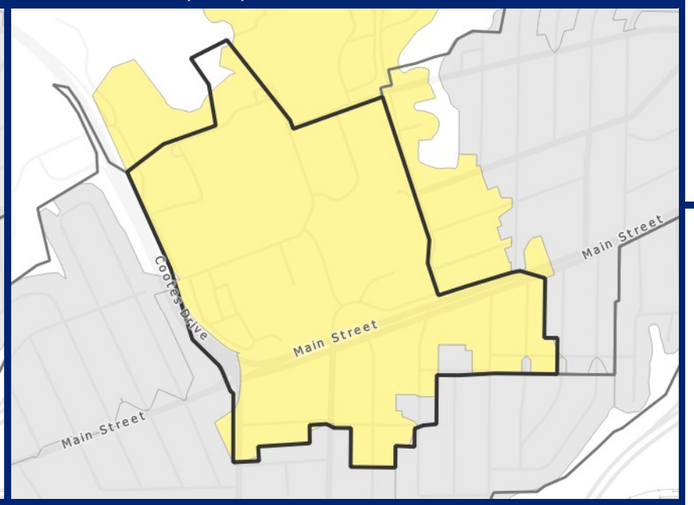
Overall Priority Ranking



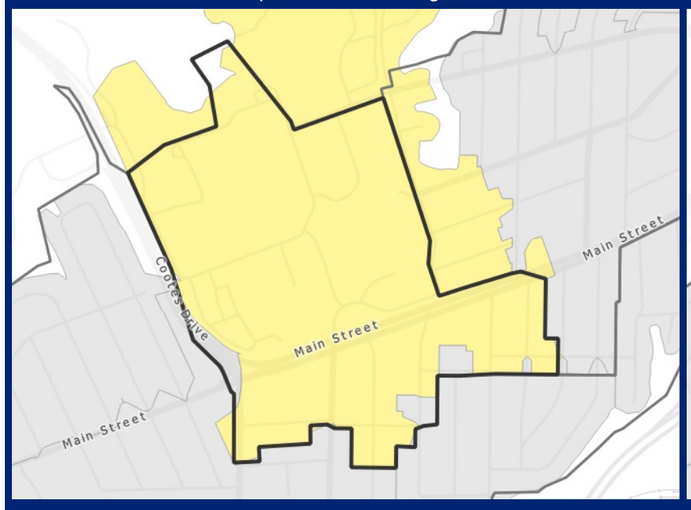
Hansen Flooding Calls



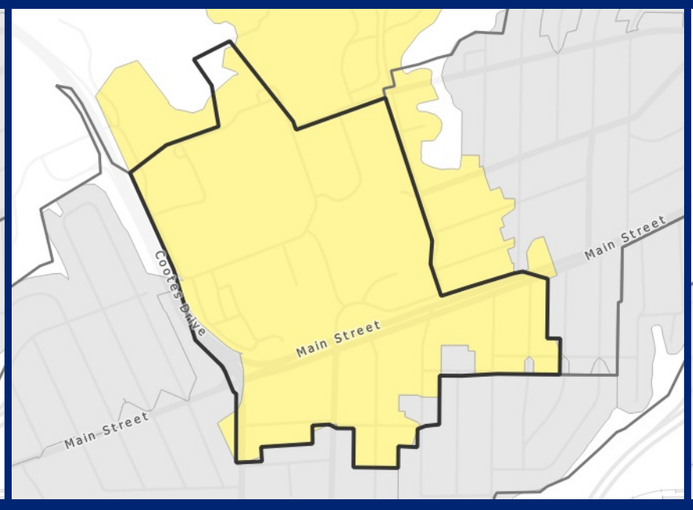
Pipe Depth for Residential Connections



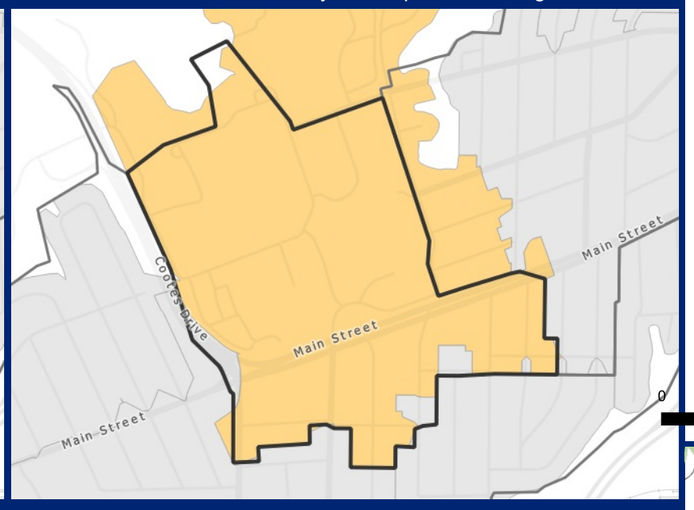
Pipe Condition and Age



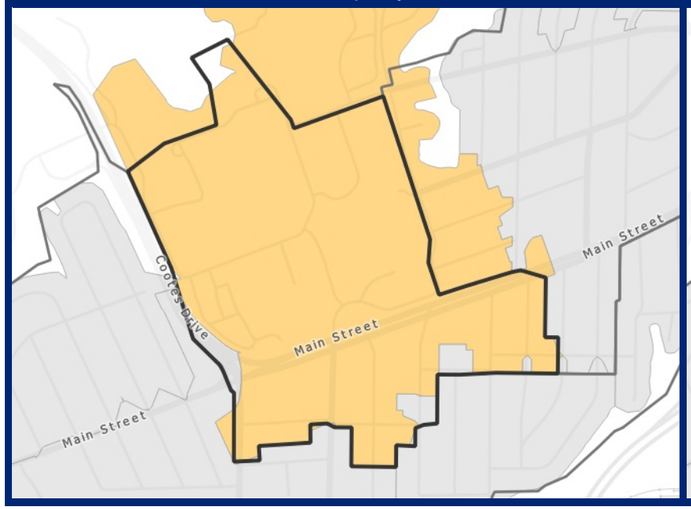
HGL to Basement Elevation of 1.8 m



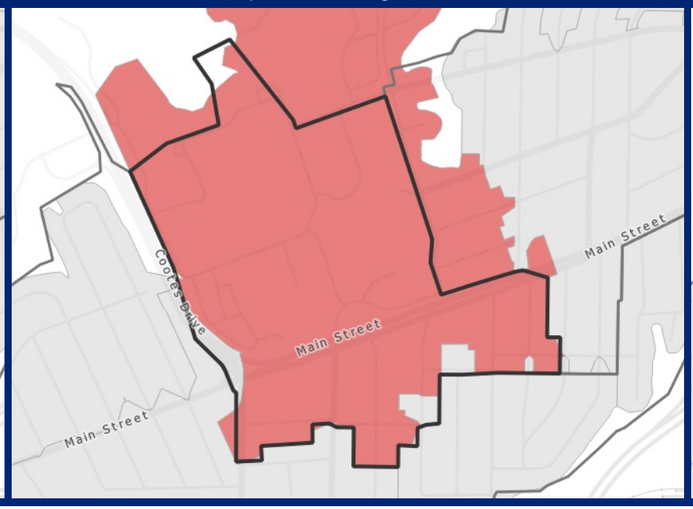
Overland Connectivity with Depression Storage



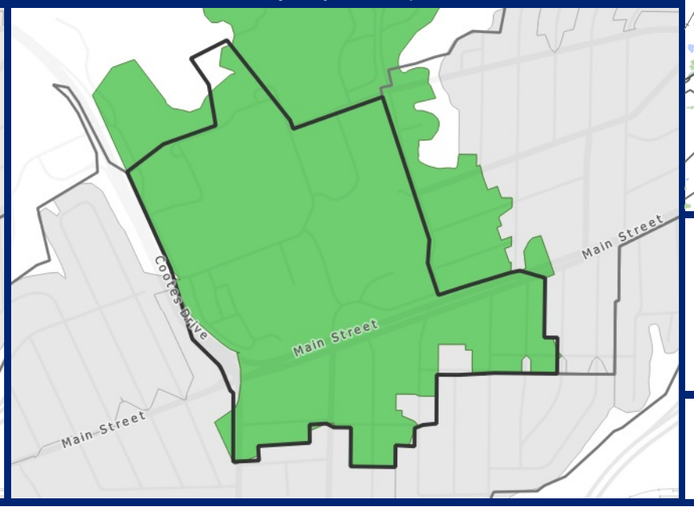
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

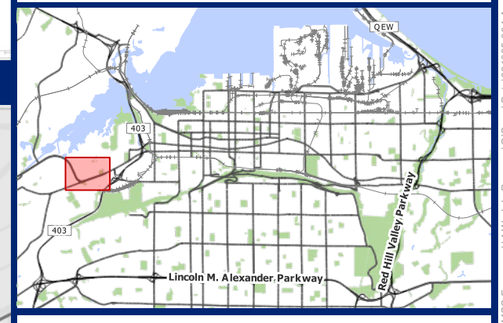


Figure 2 of 24

McMaster

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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CSO Catchment Westdale

Catchment Summary

Overview

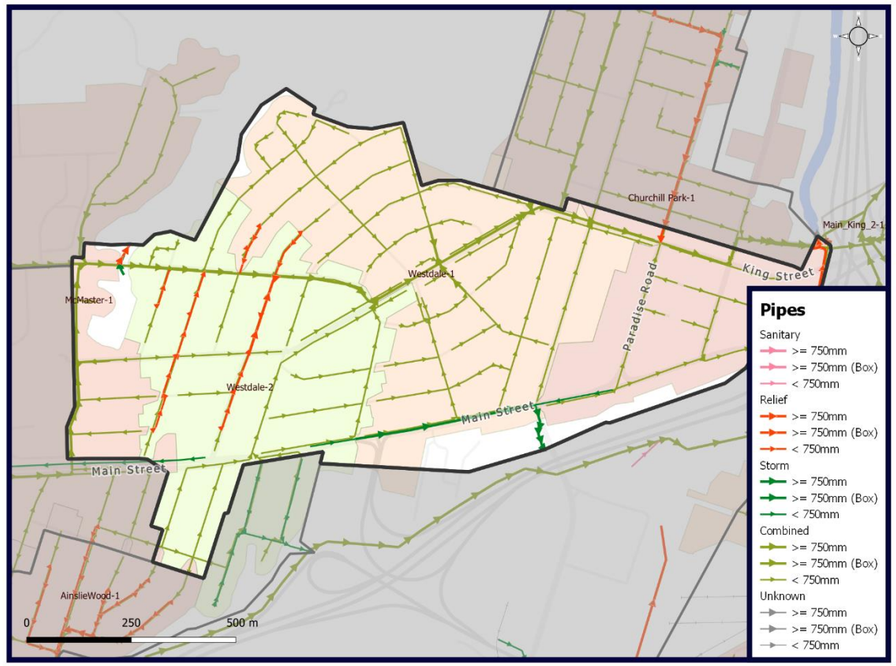
The Westdale CSO catchment is located in the western portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Westdale South

The Westdale CSO catchments contains two (2) subcatchments.

Catchment Metrics

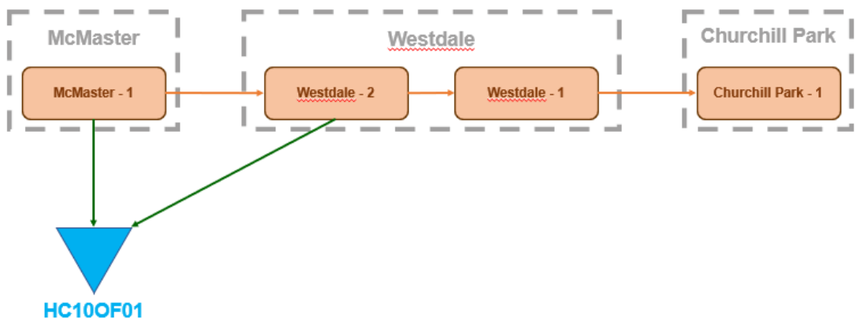
Area (ha)	82
Total Length of Sewers (km)	17.2
Length of Combined Sewers (km)	15.9
Length of Sanitary Sewers (km)	0.1
Length of Storm Sewers (km)	0.0
Length of Relief Sewers (km)	1.2
Storage Tanks (# and Name)	



Minor System Overview

The sanitary and combined system are defined by the following features:

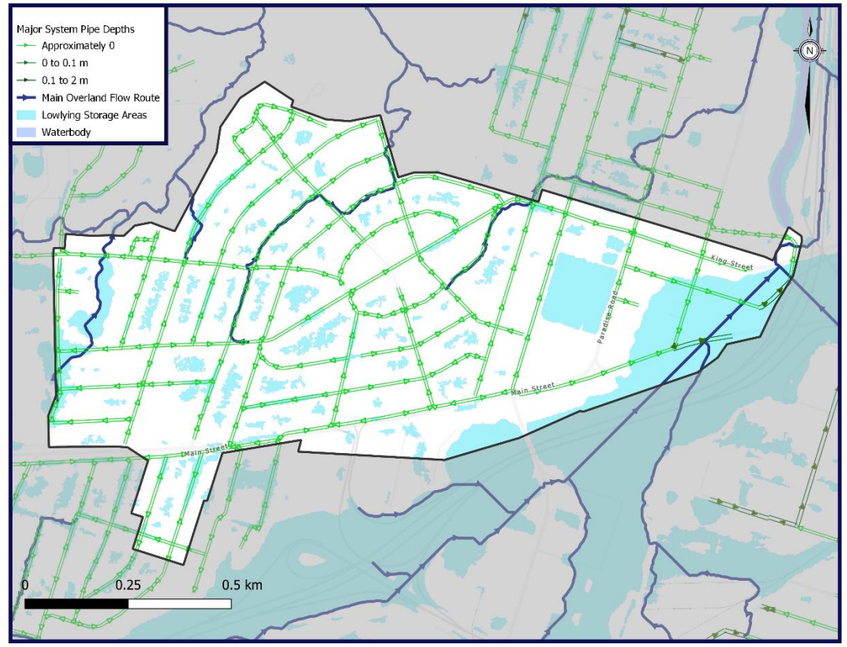
- The Westdale CSO catchment generally conveys flows from west to east
  - Trunk infrastructure is within Sterling St. to King St. W
- External upstream receiving catchment from McMaster is conveyed through the Sterling St. and King St. W trunk infrastructure to the Churchill Park 1 subcatchment
- There is one (1) minor/combined system outfall within the catchment
  - Relief sewers within the Westdale 2 subcatchment direct over-capacity combined sewer flows to Sterling St., and ultimately to the outfall at the headwaters of Cootes Paradise
- There are no CSO tanks within the Westdale CSO catchment
- Combined sewer system flows from within the Westdale CSO catchment are conveyed both north and south from local sewers to the trunk infrastructure within the east-west Sterling St. and King St. W
- The City has indicated that the infrastructure in the Westdale CSO catchment contains deep trunks beneath the local sewers which are shallow and connect through the tops of the deep trunk sewers



CSO Catchment Westdale

Major System Overview

- The McMaster CSO catchment contains three (3) primary overland flow routes as described below:
  - Between Whitton Rd. and Forsyth Ave. N, as headwaters of Cootes Paradise
    - Westdale 2 → External
  - Following Haddon Ave. to Paisley Ave. N, Cline Ave. N, and then Marion Ave. N, conveying from southwest to northeast, ultimately discharging into Cootes Paradise
    - Westdale 2 → Westdale 1 → External
  - Along South Oval to King St. W, entering the Churchill Park 1 subcatchment
    - Westdale 1 → Churchill Park 1
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - Large surface depression at Forsyth Ave. S at the beginning of the western overland flow route
  - Large disconnected surface depression at Westdale Secondary School
  - Numerous isolated surface depressions within residential rear-yards
- Major system flow depths > 0.1m within the eastern-most portion of the Westdale CSO catchment (Churchill Park 1 subcatchment)



Summary of Previous Studies

Ainslie Wood / Westdale Neighbourhoods Class Environmental Assessment (City of Hamilton & McCormick Rankin Corp., 2003):

- Implementation of on-site controls for future development and redevelopment
- Cash-in-lieu program for future development areas with no on-site controls
- Partial sewer separation:
  - Extension of existing partially separated areas
- Remediation of existing localized problems
  - High Priority:
    - General local problems (P-4) including surface flooding, sewer backup and possible sanitary cross-connection.
  - Medium Priority:
    - Mitigate/enhance storm sewer outfalls (P-1);
    - Mitigate stream erosion sites (P-2); and
    - Retrofit existing commercial/industrial areas with on-site controls (P-6).
  - Low Priority:

Mitigate existing sewer capacity restrictions (identified through further hydraulic investigations) (P-3).

Summary of Planned Works

- Sterling weir - RTC Ph 2 (currently in detailed design)

Analysis Summary

CSO Catchment Westdale

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Westdale - 1	5	3	5	1	1	1	1	2
Westdale - 2	5	1	3	2	1	1	1	3

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Westdale - 1	High	Low	
Westdale - 2	High	Low	

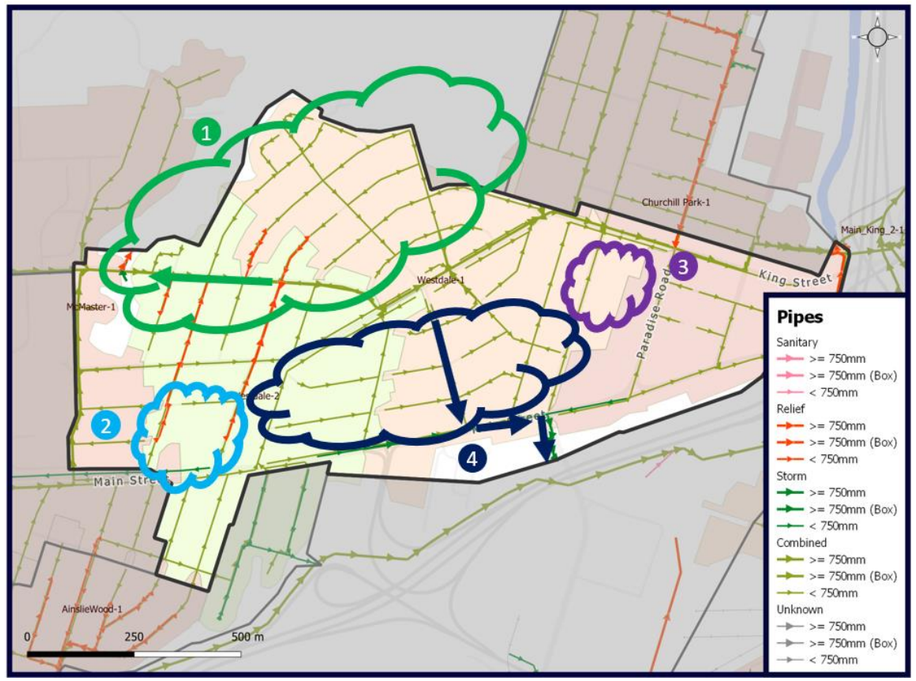
Issues and Options

Summary of Key Issues

- High levels of historic flooding
- Historic surcharging at downstream E-W trunk to the NE (King Street West) based on City flow monitoring data
- Sewers possibly sized for a lower level of service historically (< 2yr) with area and infrastructure designed approximately 100 years ago (~1920)
- High percentage of poor condition pipes within catchment

Summary of Potential Options

- 1) (WD-1) North end sewer separation with outfall to existing eastern watercourse
- 2) (WD-2) Underground storage or implementation of CSO tank at Dalewood Middle School
- 3) (WD-3) Underground storage or implementation of CSO tank at Westdale Secondary School
- 4) (WD-4) Sewer separation in south end to existing Main Street West storm sewer and outfall
- 5) (WD-5) Deepening of local sewers during asset renewal

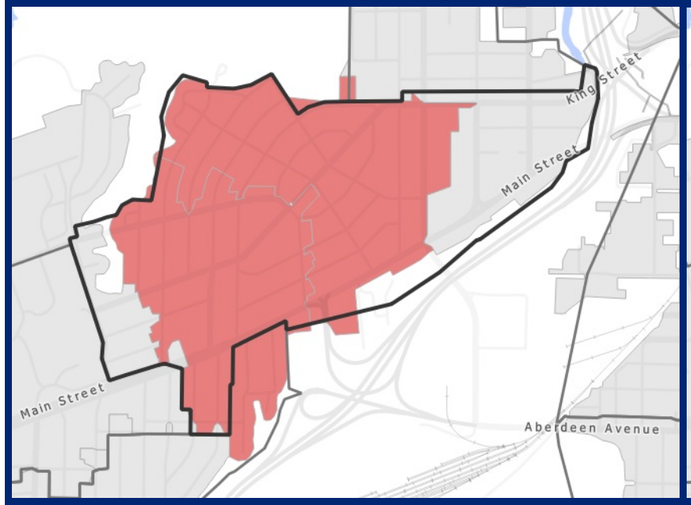


Option Evaluation

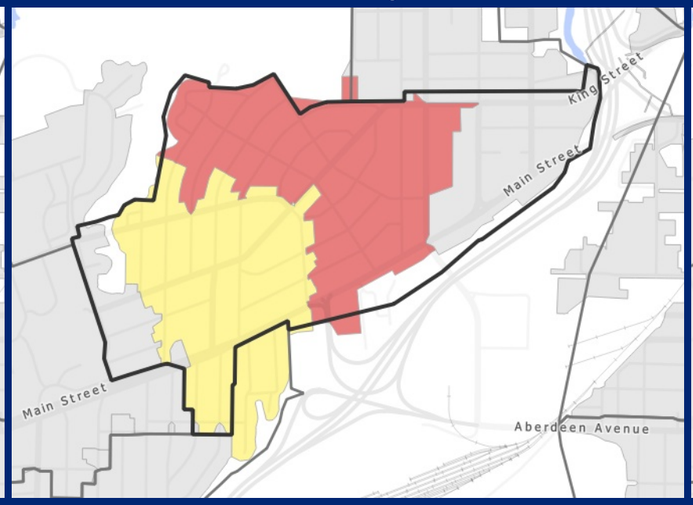
CSO Catchment Westdale							
Option	**Advantages**	**Disadvantages**	**System Benefit**	**Cost**	**Outcome**	**Priority and Timeline**	**Pre-Requisite Works**
Option 1: North end sewer separation (WD-1a)	• Frees up capacity in combined system • Reduces CSO flows • Long term benefit to local system • Utilizes existing outfall location • Short term implementation as relief sewer with future storm conversion	• High implementation costs	Local Solution Substantial Benefit	$8.5M	Further Study	High Priority Short Term (3 – 5 years)	STR-1
Option 1: North end collector sewer separation (WD-1b)	• Frees up capacity in combined system • Reduces CSO flows • Long term benefit to local system • Utilizes existing outfall location • Short term implementation as relief sewer with future storm conversion	• High implementation costs	Local Solution Substantial Benefit	$4.0M	Further Study	High Priority Short Term (3 – 5 years)	STR-1
Option 2: Dalewood Middle School Storage (WD-2)	• Reduces CSO overflows to existing watercourse	• Requires significant change in existing combined system • Existing CSO pipes in area conflict	Local Solution Limited Benefit	-	Screened Out	-	
Option 3: Westdale Secondary School Storage (WD-3)	• Provides protection against basement flooding locally	• Requires addition of CSO sewer pipe or local plumbing direction • Short-term solution	Local Solution Limited Benefit	$12.5M	Further Study	Medium Priority Medium Term (5 – 10 years)	None
Option 4: South end sewer separation (WD-4a)	• Frees up capacity in combined system • Utilizes existing stormwater infrastructure (capacity dependent) • Long term benefit to local system	• High implementation costs	Local Solution Substantial Benefit	$8.0M	Further Study	High Priority Medium Term (5 – 10 years)	STR-1
Option 4: South end collector sewer separation (WD-4b)	• Frees up capacity in combined system • Utilizes existing stormwater infrastructure (capacity dependent) • Long term benefit to local system	• High implementation costs	Local Solution Substantial Benefit	$5.0M	Further Study	High Priority Medium Term (5 – 10 years)	STR-1
Option 5: Deepen local sewers during asset renewal (WD-5)	• Provides increased protection against basement flooding	• Potential utility conflicts	Local Solution Moderate Benefit	-	Recommended	Medium Priority Medium Term (5 – 10 years)	None

CSO Catchment Westdale							
Managed Sewer Separation (WD-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$13.8M	Recommended	High Priority Future planning (20+ years)	None

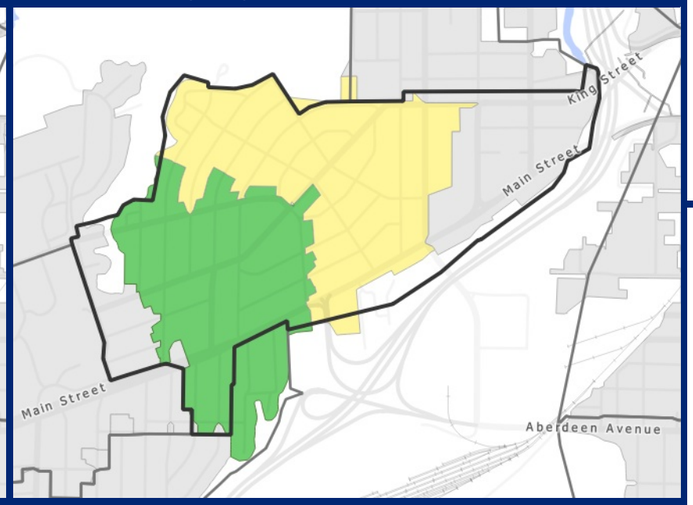
Overall Priority Ranking



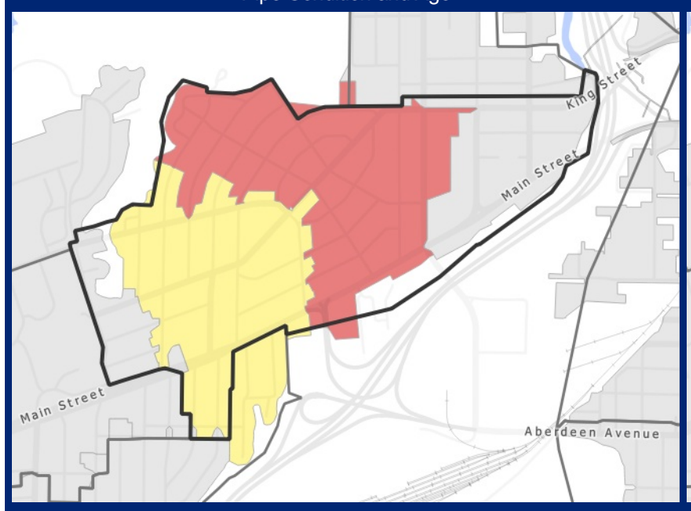
Hansen Flooding Calls



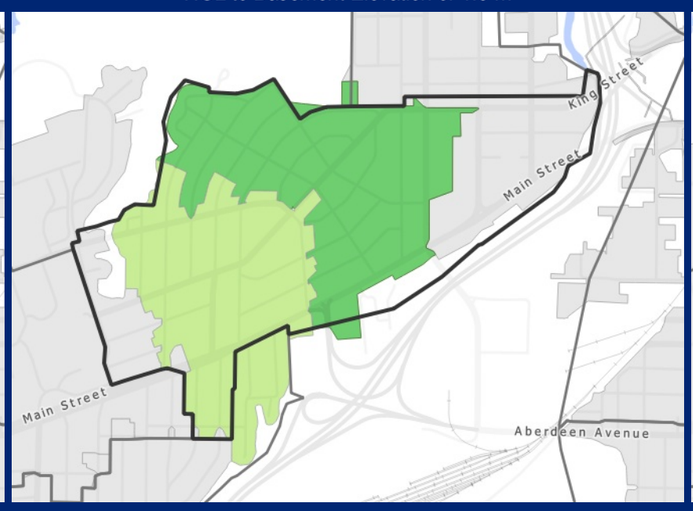
Pipe Depth for Residential Connections



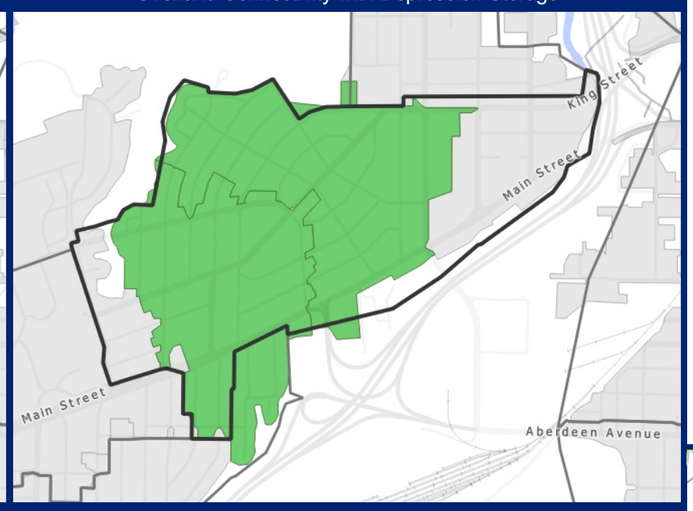
Pipe Condition and Age



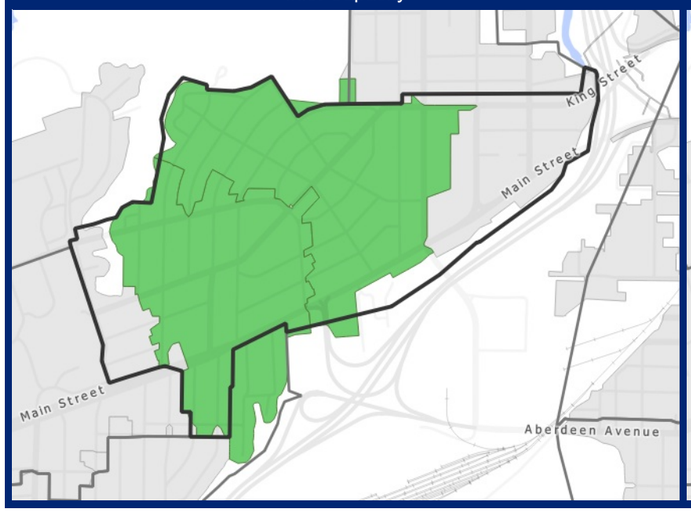
HGL to Basement Elevation of 1.8 m



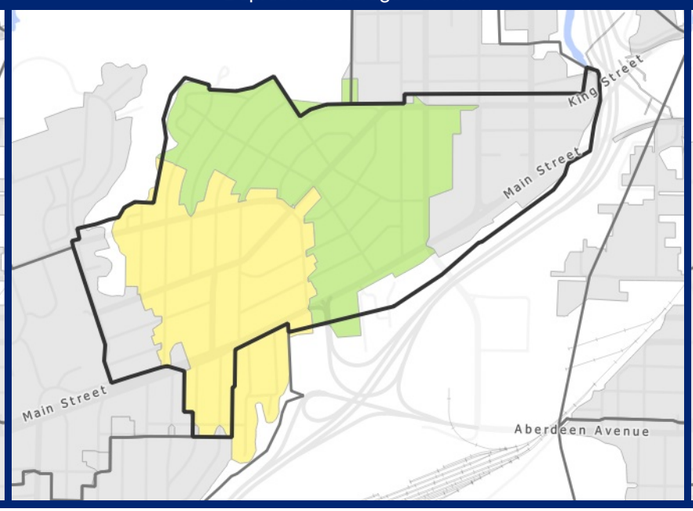
Overland Connectivity with Depression Storage



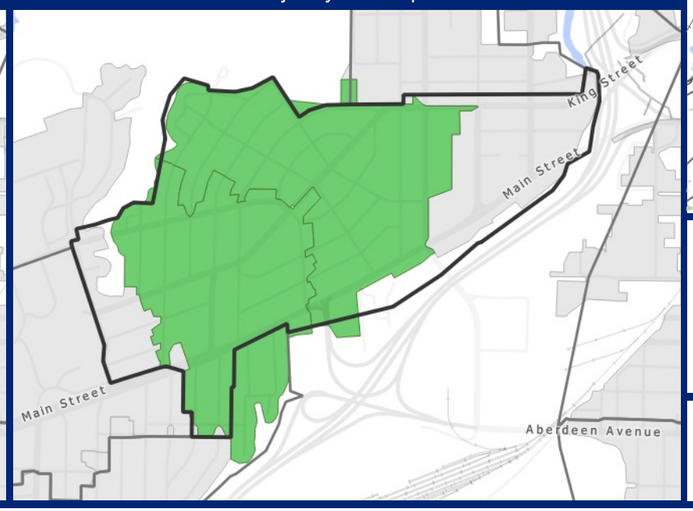
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

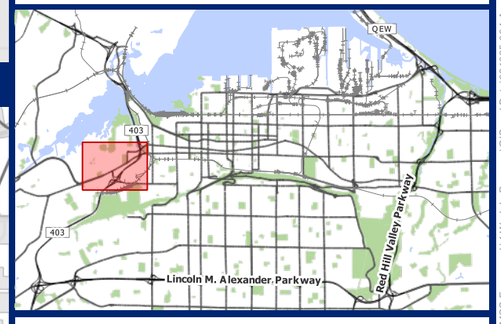


Figure 3 of 24

Westdale

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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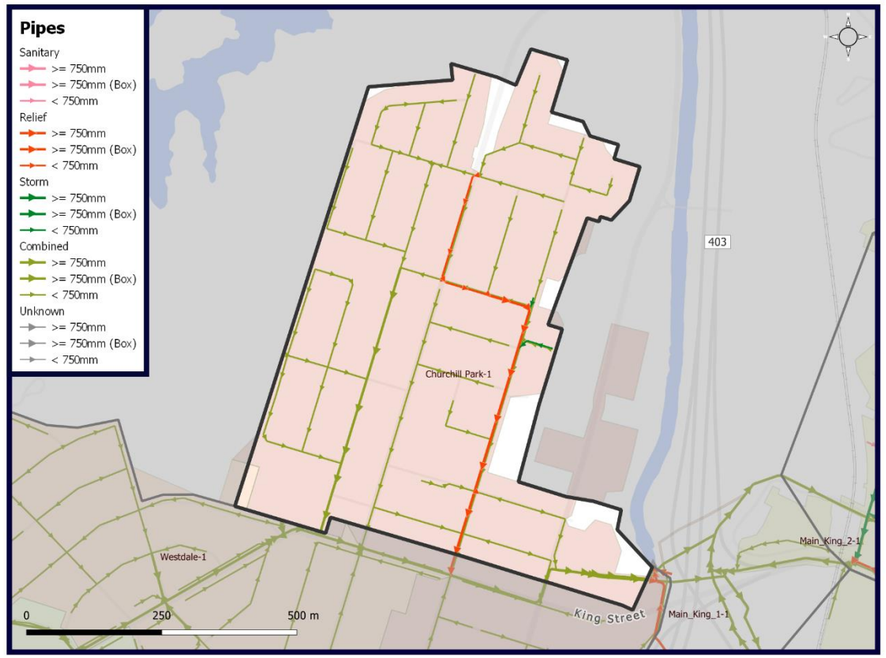
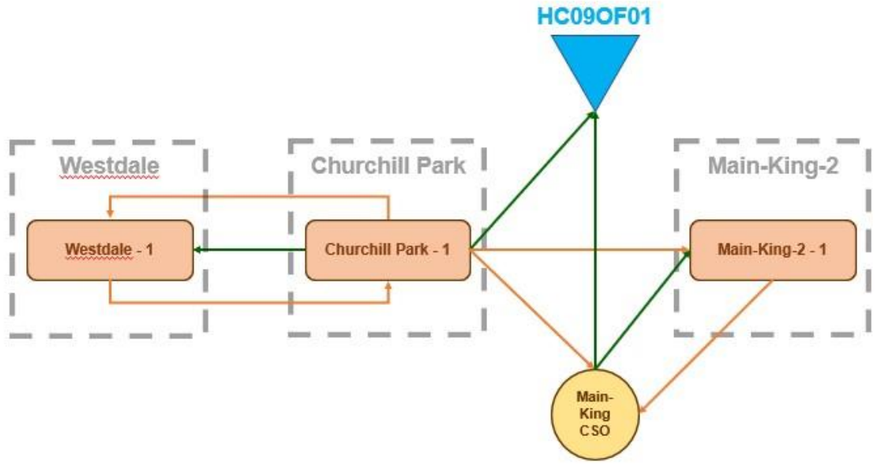
CSO Catchment Churchill Park

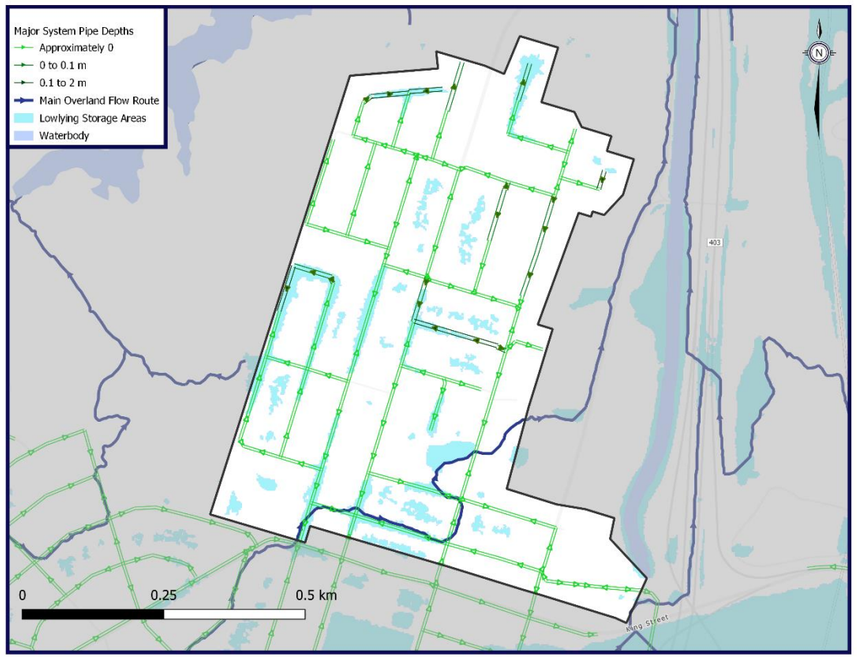
Catchment Summary

Overview	The Churchill Park CSO catchment is located in the northwestern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Westdale North The Churchill Park CSO catchments contains one (1) subcatchment.	
Catchment Metrics	Area (ha)	64
	Total Length of Sewers (km)	11.6
	Length of Combined Sewers (km)	10.1
	Length of Sanitary Sewers (km)	0.0
	Length of Storm Sewers (km)	0.1
	Length of Relief Sewers (km)	1.4
	Storage Tanks (# and Name)	



CSO Catchment Churchill Park

Minor System Overview	The sanitary and combined system are defined by the following features:
	• The Churchill Park CSO catchment generally conveys flows to the east from all directions
	  ○ Trunk infrastructure is within King St. W to Glen Rd.
	  ○ Infrastructure north of King St. W convey combined flows south to King St. W
	  ○ Infrastructure south of King St. W convey combined flows north to King St. W
	• External upstream receiving catchment from Westdale 1 is conveyed through the King St. W and Glen Rd. trunk infrastructure across the Highway 403 corridor to the Main-King 2 CSO catchment
	• There is one (1) combined sewer overflow outfall within the catchment
	  ○ The outfall is within the Highway 403 corridor and discharges directly to headwaters of Chedoke Creek
	  ○ Over-capacity combined sewer flows are directed through the combined sewer trunk infrastructure within Glen Rd.
	  ○ The CSO outfall is understood to protect downstream infrastructure/capacity limitations, as there are multiple sewer networks with relief sewers to the CSO outfall
	• There are no CSO tanks within the Churchill Park catchment
	• A relief sewer directs over capacity flows from north to south along Longwood Rd. N, Norwood Rd., and Paradise Rd. N, discharging to the combined sewer system within King St. W
		

Major System Overview	• The Churchill Park CSO catchment contains one (1) primary overland flow route as described below:
	  ○ Roughly along Glen Rd. and Paradise Rd. N, through the City owned Coronation Arena lands, to Macklin St. N and ultimately discharging to Chedoke Creek
	  ▪ Westdale-1 → Churchill Park-1 → External
	• The following is a description of the surface depressions within the catchment, including any overland connectivity:
	  ○ Large surface depressions along primary overland flow path at the following locations:
	  ▪ Bond St N at border of Westdale-1 subcatchment
	  ▪ Glen Rd., including the intersection of Longwood Rd. N
	  ▪ Surface depression west of Paradise Rd. N and north of Dufferin St. (just west of the Coronation Arena lands)
	  ○ Isolated surface depressions within the following road right-of-way locations:
	  ▪ Desjardins Ct. (major system flow depth > 0.1m)
	  ▪ Intersection of Parkview Dr. and Uplands Ave. (modeled major system flow depth > 0.1m)
	  ▪ Bond St. N north of Devon Pl.
	  ▪ Kipling Rd. between Devon Pl. and Parkside Dr. (major system flow depth > 0.1m at top end of Kipling Rd.)
	  ▪ Parkside Dr. between Kipling Rd. and Glen Rd.
	  ▪ Longwood Rd. N at Roanoke Rd. (major system flow depth > 0.1m)
	• Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
	  ○ Kenmore Rd. south of Franklin Ave.
	  ○ Paradise Rd. N south of Franklin Ave.
	  ○ Freeland Ct.
	  ○ Bond St. N north of Franklin Ave.
		

CSO Catchment Churchill Park

Summary of Previous Studies	**Modelling and Development of Flood Alternatives for the Churchill Park Neighbourhood Area Environmental Assessment Study (Aquafor Beech Ltd., 2016)** • Recommendation for complete sewer separation with implementation of Low Impact Development (LID) • Requires construction of new trunk sewer system to Chedoke Creek along Glen Rd and Bond St N
Summary of Planned Works	• Proposed sewer separation, including a new outlet. Works not completed due to ongoing FDMSS at the time. • Marion Ave N - plans to shift water to park but project was cancelled ○ TMIG recommended shifting flow into park, superseded by AB report.

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Churchill Park - 1	5	3	3	5	3	4	3	4

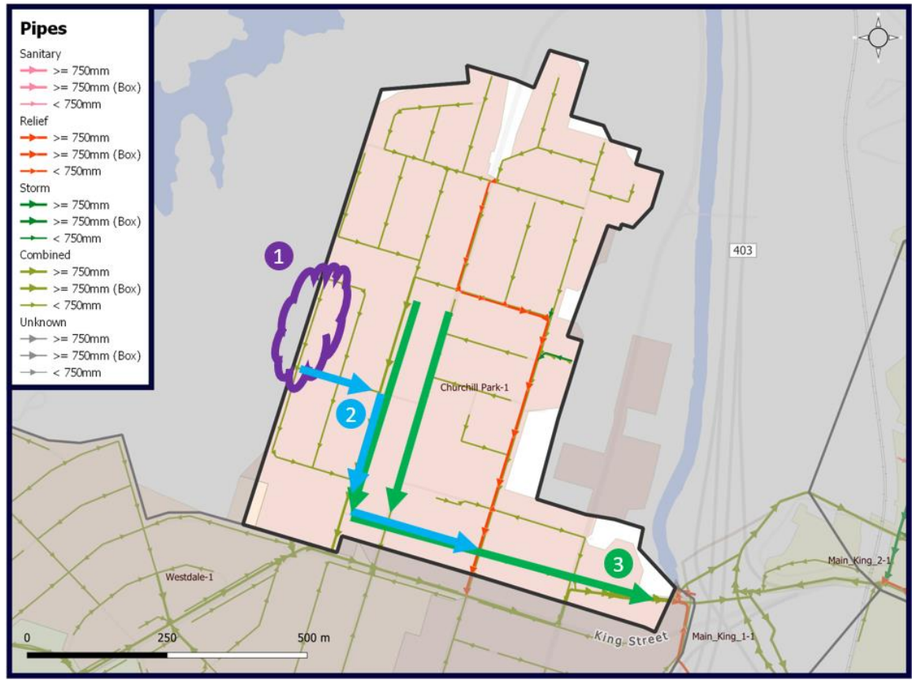
Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Churchill Park - 1	High	High	

Issues and Options

Summary of Key Issues	• Low point on west end – LID feature designed to capture overland flow within nearby area
	  ○ Modifications required to correct inlet location to adequately collect designed flows
	• High ponding noted along Parkside Drive
	• Capital program in area includes road reconstruction, but on hold until decision made about sewers in area – known hot spot
	• Dike in this area creates grading issues for solutions of overland flow on west end
	• Local residents flooded in July 2020
	• Model shows high levels of minor system surcharging to basement elevation and surface
	• Surface depressions along overland flow route at Bond St N, Glen Rd, Longwood Rd N, and Dufferin St
	  ○ Possibly causing ponding within RoW and private property from upstream overland flows	

CSO Catchment Churchill Park

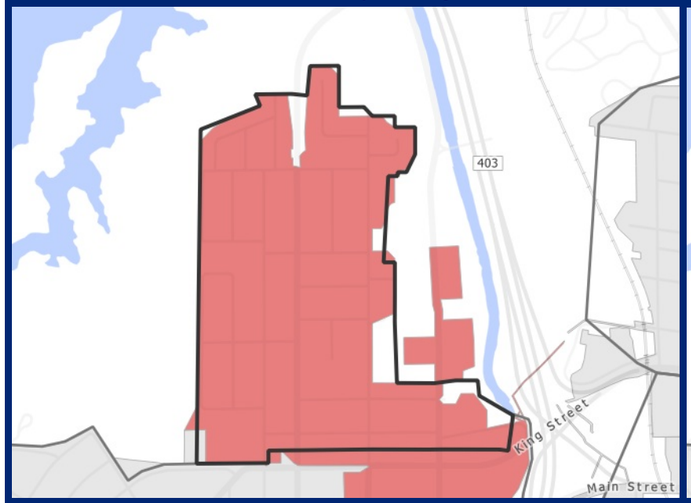
Summary of Potential Options	• 1) (CP-1) Implementation of new LID within Parkside Dr. • 2) (CP-2) Superpipe storage along Bond St N, Glen Rd., Longwood Rd N, and Dufferin St • 3) (CP-SWR) Managed Sewer Separation	

Option Evaluation

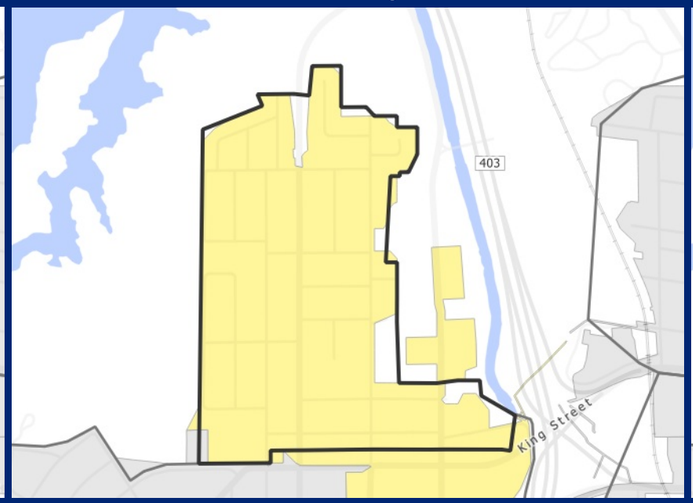
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1: LID implementation (CP-1)	• Utilize nearby field and open space	• Recent reconstruction requiring additional disturbance	Local Solution Limited Benefit	$2.5M	Recommended	Medium Priority Medium Term (5 – 10 years)	None
Option 2: Superpipe storage (CP-2)	• Potential to “piggyback” on sewer separation works • Reduces flooding at depression points	• High cost of implementation • Limited benefit/protection available • Dependent on availability / abundance of inlets	Local Solution Limited Benefit	$10.9M	Further Study	Medium Priority Medium Term (5 – 10 years)	None

CSO Catchment Churchill Park							
Option 3: Managed Sewer Separation (CP-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$14.0M	Recommended	High Priority Medium Term (5 – 10 years)	None

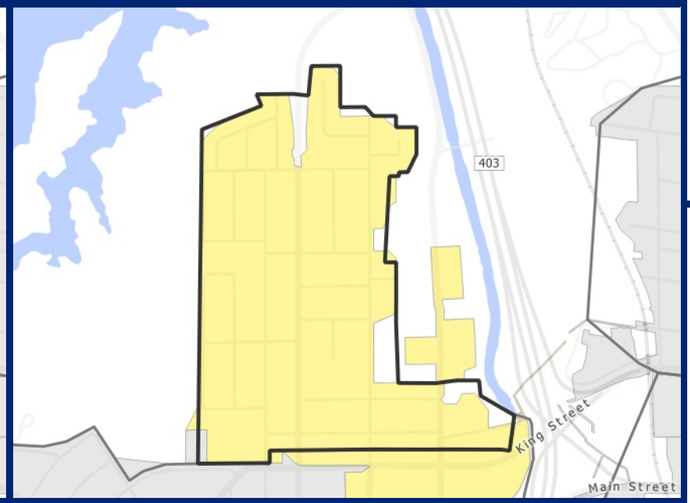
Overall Priority Ranking



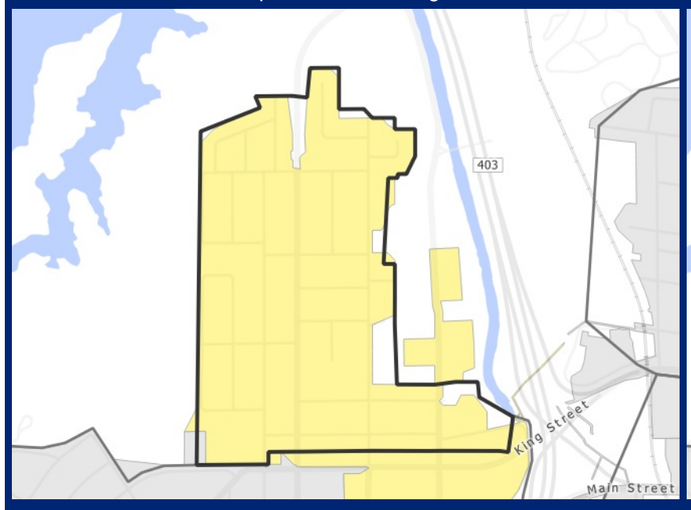
Hansen Flooding Calls



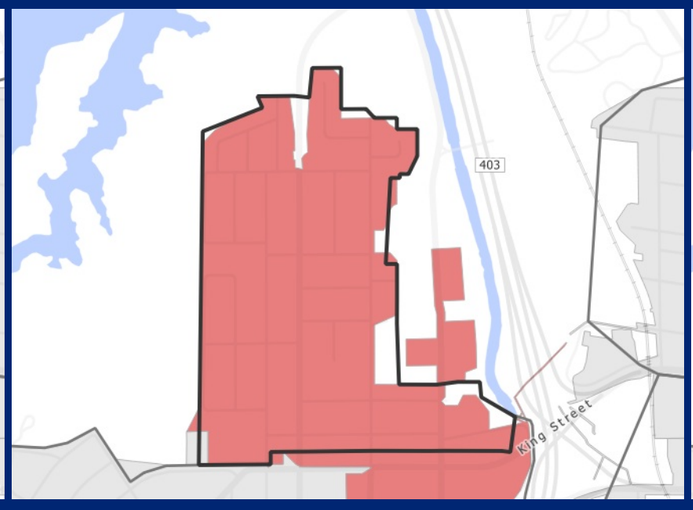
Pipe Depth for Residential Connections



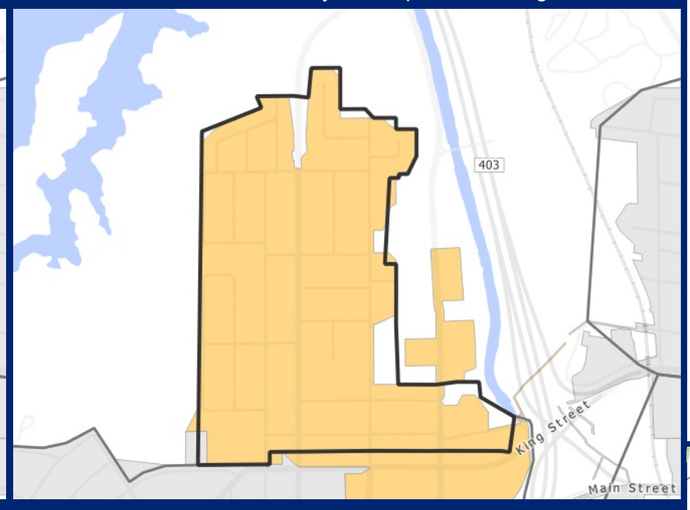
Pipe Condition and Age



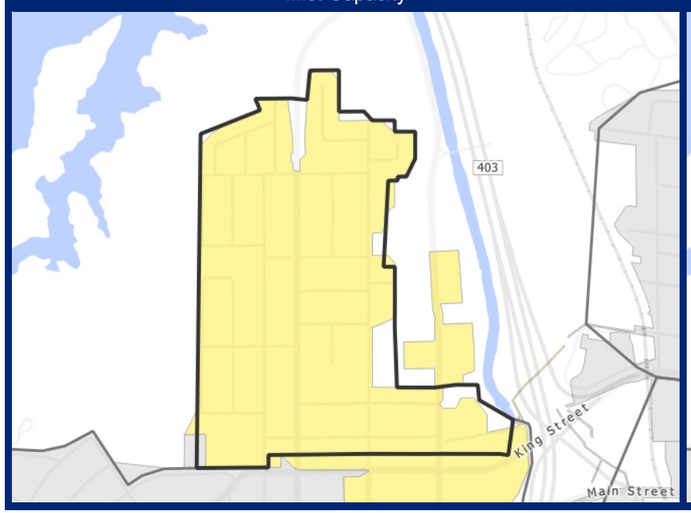
HGL to Basement Elevation of 1.8 m



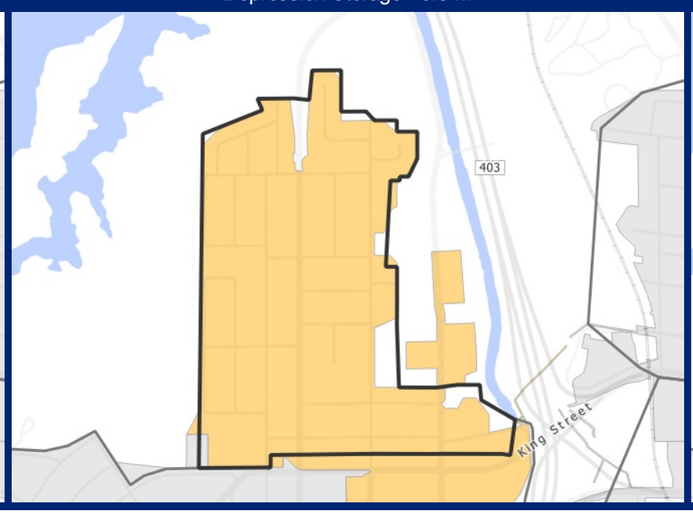
Overland Connectivity with Depression Storage



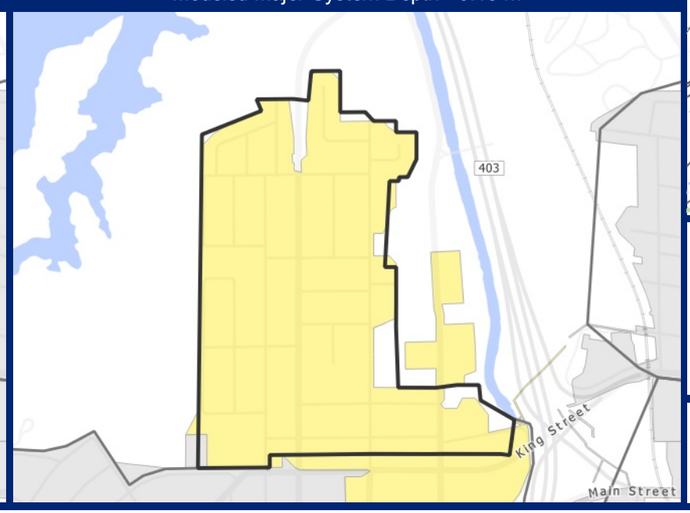
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

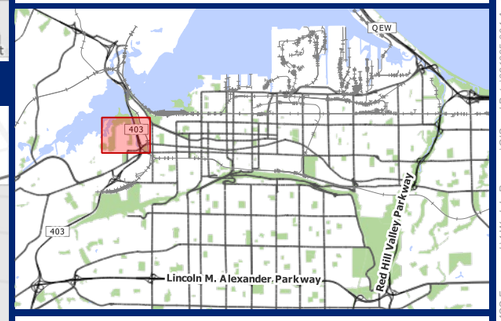


Figure 4 of 24

Churchill Park

Results Analysis

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September, 2021
621085-004
Projection EPSG:26917

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CSO Catchment Main-King 1

Catchment Summary

Overview

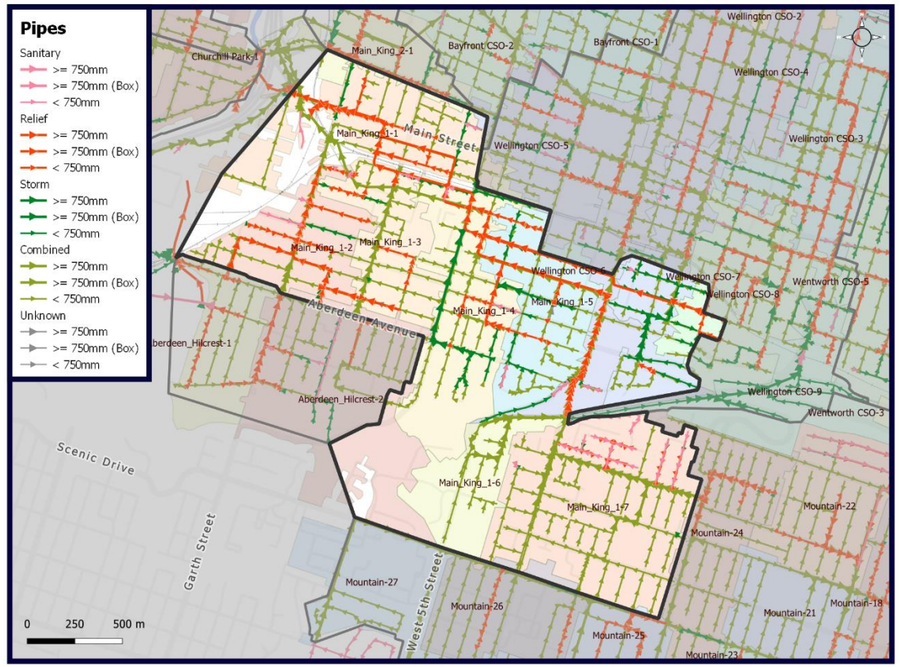
The Main-King 1 CSO catchment is located in the western-central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Strathcona
- Kirkendall North
- Mohawk
- Durand
- Corktown
- Southam
- Centremount

The Main-King 1 CSO catchments contains seven (7) subcatchments.

Catchment Metrics

Area (ha)	326
Total Length of Sewers (km)	64.0
Length of Combined Sewers (km)	42.7
Length of Sanitary Sewers (km)	3.2
Length of Storm Sewers (km)	6.3
Length of Relief Sewers (km)	11.6
Storage Tanks (# and Name)	

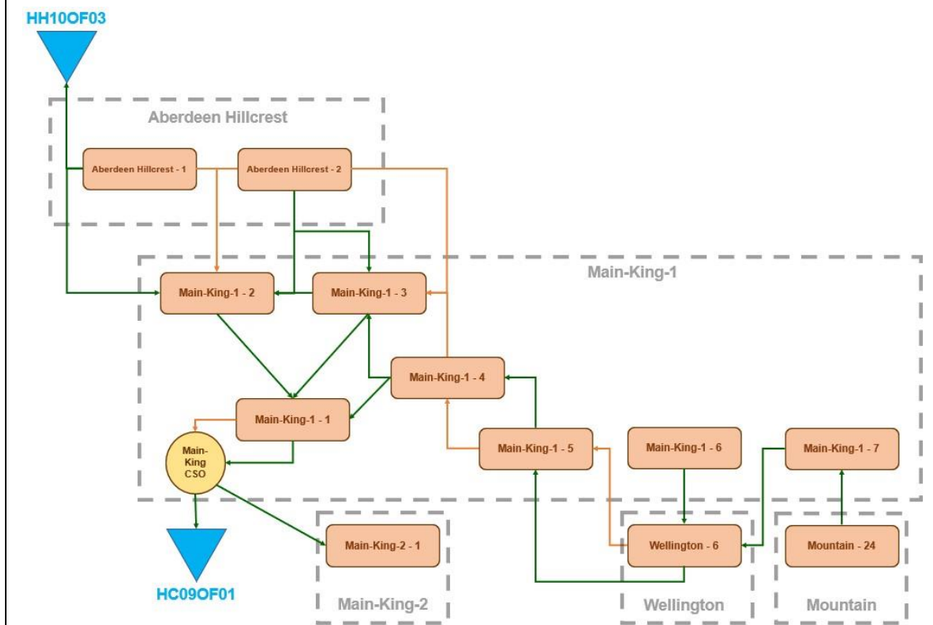


CSO Catchment Main-King 1

Minor System Overview

The sanitary and combined system are defined by the following features:

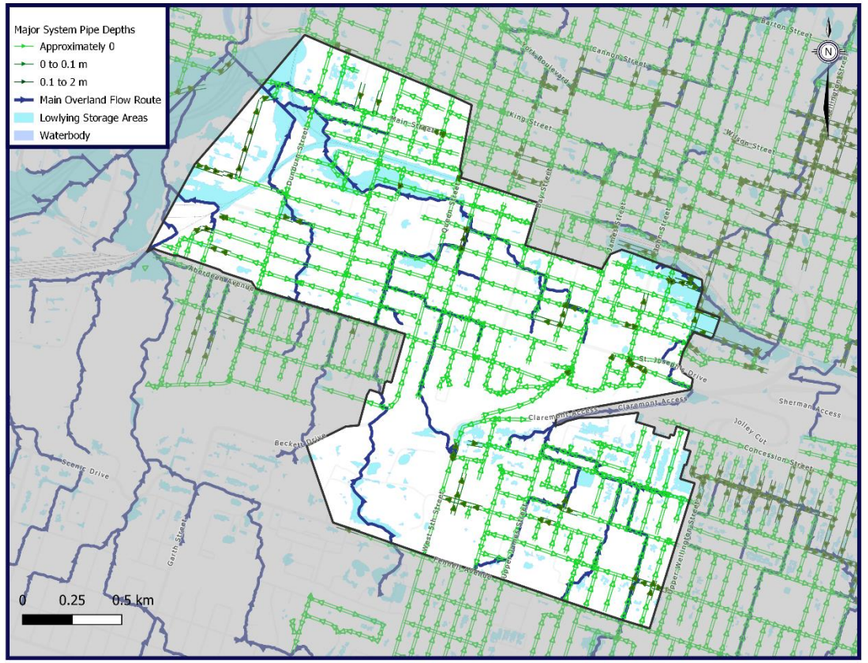
- The Main-King-1 CSO catchment generally conveys flows from southeast to northwest
  - There is combined sewer trunk infrastructure within Robinson St. to Hess St. S to Bold St., conveyed to the Main-King-2-1 CSO Catchment
  - There are trunk sewers within Dundurn St. S, Locke St. S, and Queen St. S which enter the Bold St. trunk system ultimately conveyed to the Main-King-2-1 subcatchment
- External upstream receiving catchments from Aberdeen Hillcrest-1, Aberdeen Hillcrest-2, Mountain-24, and Wellington-6 are conveyed through the trunk infrastructure entering the system at various locations and being conveyed through to the Main-King-2-1 subcatchment
- There is one (1) combined sewer overflow outfall within the catchment
  - The outfall discharges into Chedoke Creek within the Highway 403 corridor
  - Over-capacity combined sewer flows first discharge to the Main-King CSO tank and then discharge to the outfall if the Main-King CSO tank becomes over capacity
  - Relief sewers throughout the catchment convey combined sewer flows to the Main-King CSO Tank



CSO Catchment Main-King 1

Major System Overview

- The Main-King-1 CSO catchment contains two (2) primary overland flow routes as described below:
  - Conveying Major flows from the Main-King-1-7 subcatchment, the flow path splits into multiple segments conveying overland flow from south to north, through the Clairemont Access, entering the Wellington-8 subcatchment
  - Multiple flow paths within Main-King-1-1 through Main-King-1-6 conveying overland flows generally from south/southeast to northwest, ultimately discharging into the Highway 403 corridor
    - Aberdeen Hillcrest-2 subcatchment is conveyed overland through the Main-King-1-2 subcatchment
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - Large surface depressions within the Main-King-1-7 subcatchment, predominantly within private property and not connected to the overland flow path
  - Large surface depression along Bold St. from Queen St. S to Locke St. S with connectivity to the overland flow path. The surface depression continues west from Locke St. S along Blanshard St. to the Hill St. Park
  - Large surface depression within the railway corridor
  - Pockets of surface depressions throughout the Main-King-1 CSO catchment with connectivity to overland flow path
- Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Along the alignment of Chatham St. and Frid St.
  - Clustering east of West 5th St, within the Main-King-1-6 subcatchment
  - Clustering at the intersection of MacNab St. S and Charlton Ave. W
  - Large section at the northeast corner of the catchment in the location of the railway corridor and GO Train station



Summary of Previous Studies

Summary of Planned Works

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Main-King 1 - 1	3	3	5	3	3	3	2	3
Main-King 1 - 2	5	5	1	3	3	2	3	2
Main-King 1 - 3	5	5	1	4	1	4	3	3
Main-King 1 - 4	5	3	1	3	3	3	4	2
Main-King 1 - 5	1	1	3	3	1	1	3	1

CSO Catchment Main-King 1								
Main-King 1 - 6	1	3	3	3	1	1	5	2
Main-King 1 - 7	3	3	1	2	1	2	4	2

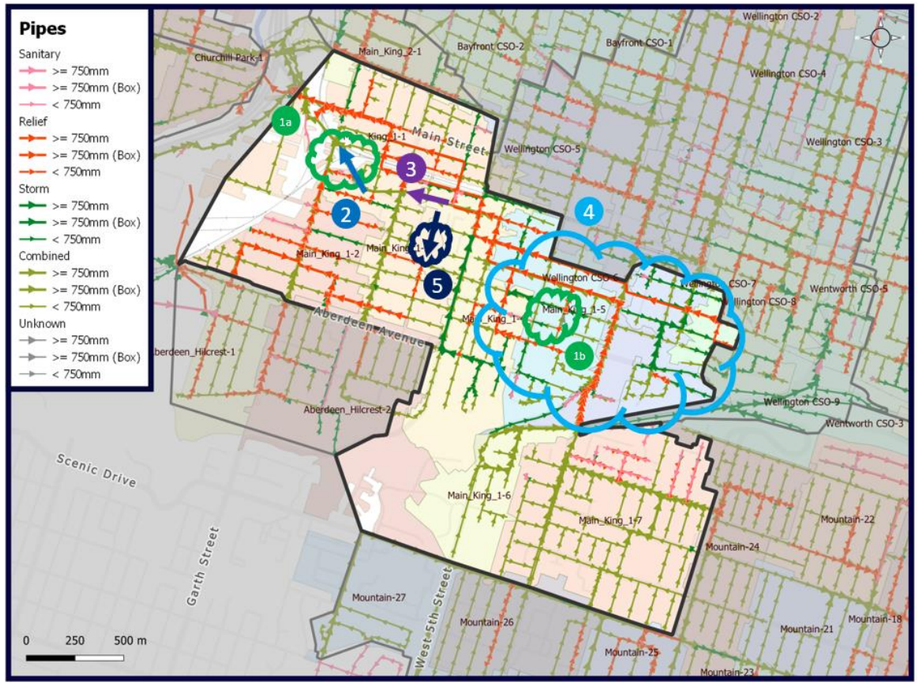
Sub Catchment Prioritization			
	Catchment Priority	Data Uncertainty	Commentary
Main-King 1 - 1	High	Medium	
Main-King 1 - 2	High	Medium	
Main-King 1 - 3	High	Medium	
Main-King 1 - 4	High	Medium	
Main-King 1 - 5	Medium	Medium	
Main-King 1 - 6	Low	Medium	
Main-King 1 - 7	Medium	Medium	

Issues and Options		
Summary of Key Issues	• Surface depressions within private backyards in Main-King 1 - 7, at the top of the escarpment • Large surface depression with overland flow route connectivity along Bold St to Hill St, with further investigation required to confirm conveyance at the railway junction • Limited pipes in poor condition throughout the catchment with no hot-spots or clustered networks of poor condition pipes • Some moderate to shallow sewers (1.8m to 2.8m deep) within Main-King 1 - 2, 1 - 3, and 1 - 4 • Isolated pipe surcharging throughout catchment within local sewers • Large number of Hansen flooding calls within catchment with specific hot spots along Bold Street with overland connected surface depressions (August 2020)	

CSO Catchment Main-King 1

Summary of Potential Options

- 1a) (MK1-1a) Utilize Hill St Park for storage/detention of overland stormwater (possible major system conveyance required)
- 1b) (MK1-1b) Utilize upstream parks for upstream major system storage (Durand Park
- 2) (MK1-2) Upgrade approx. 250 m of undersized trunk sewer beneath Hill St Park and railway tracks
- 3) (MK1-3) Sewer separation within Bold St to nearby relief sewer at Locke St S
- 4) (MK1-4) Proceed with managed sewer separation in east end
- 5) (MK1-5) Divert Bold St major system flows to storage at Hamilton Amateur Athletic Association Grounds (HAAA confirm City owned)

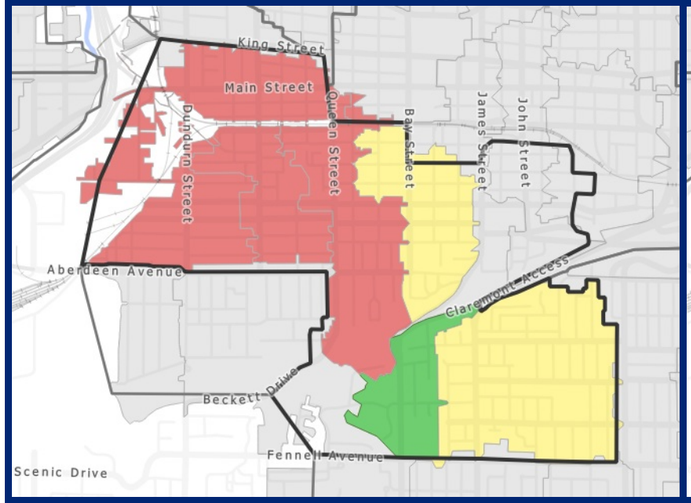


Option Evaluation

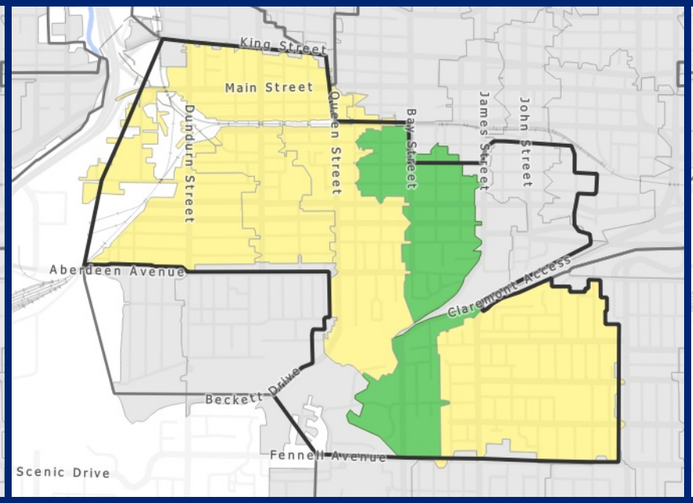
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1a: Hill St Park Storage (MK1-1a)	• Open space relatively close to location of potential major flooding	• Proximity to railway (lower than surrounding grade)	Local Solution Moderate Benefit	$670K	Further Study	High Priority Short Term (3 – 5 years)	None
Option 1b: Upstream major system storage (Durand Park) (MK1-1b)	• Major system flow attenuation and protection against downstream major system flooding	• Potentially minor impacts as at the most upstream end of flow path	Local Solution Moderate Benefit	$270K	Further Study	High Priority Short Term (3 – 5 years)	None

CSO Catchment Main-King 1							
Option 2: Trunk Sewer Upgrade (MK1-2)	• Potential reduction in upstream surcharging	• Relief sewers in place may be designed to prevent need for upgrade • Potential conflicts with railway RoW • High cost to upgrade small stretch of pipe	Local Solution Moderate Benefit	-	Screened Out	-	
Option 3: Bold St Separation (MK1-3)	• Small area with recommended separation	• Separated sewer would discharge into combined relief sewer • Benefit not guaranteed as existing combined sewer is currently connected to proposed relief sewer	Local Solution Limited Benefit	$2.1M	Further Study	High Priority Short Term (3 – 5 years)	None
Option 4: Managed Separation in east end (MK1-4)	• Existing storm sewers in place connected to relief sewers	• Requires investigation into storm trunk infrastructure backbone	System Wide Solution Substantial Benefit	$31.5M	Further Study	Medium Priority Long Term (10 – 20 years)	None
Option 5: Divert Bold St stormwater to HAAA (MK1-5)	• Large space for potential underground storage and attenuation of major system	• Interruption of facility • Logistics of major system conveyance	Local Solution Moderate Benefit	$12.1M	Further Study	High Priority Short Term (3 – 5 years)	None
Managed Sewer Separation (MK1-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$22.0M	Recommended	Medium Priority Future Planning (20+ years)	None

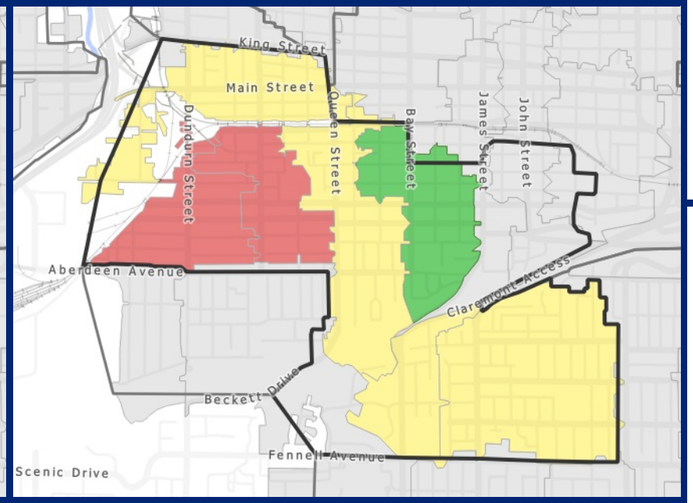
Overall Priority Ranking



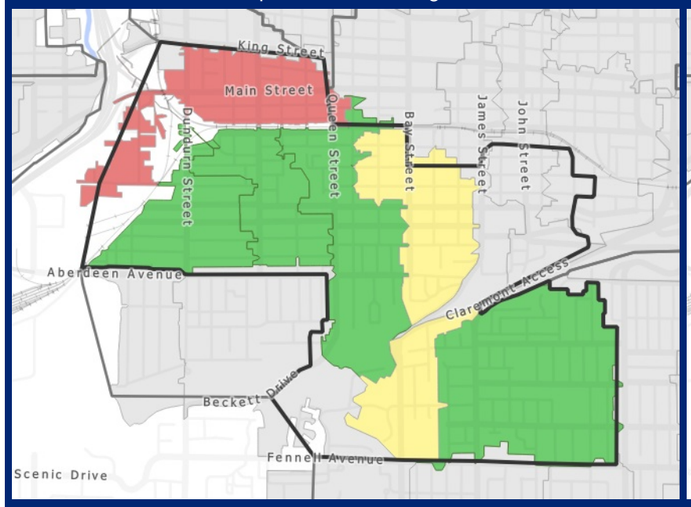
Hansen Flooding Calls



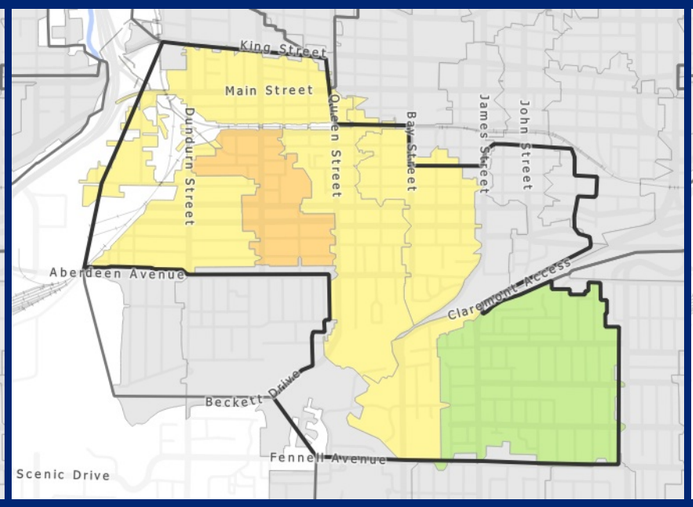
Pipe Depth for Residential Connections



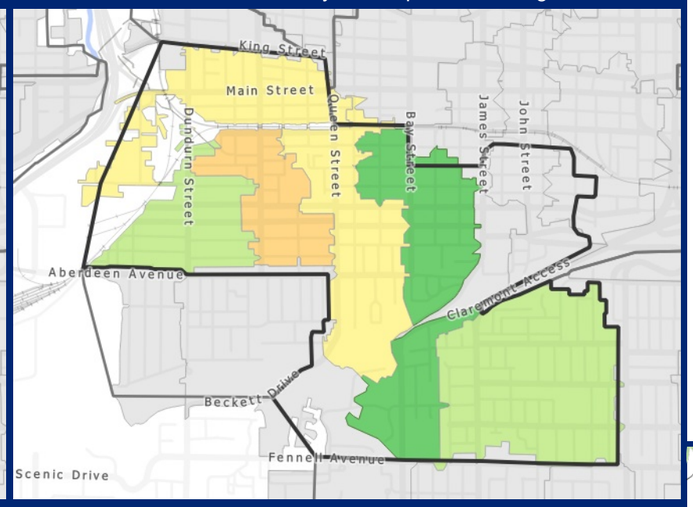
Pipe Condition and Age



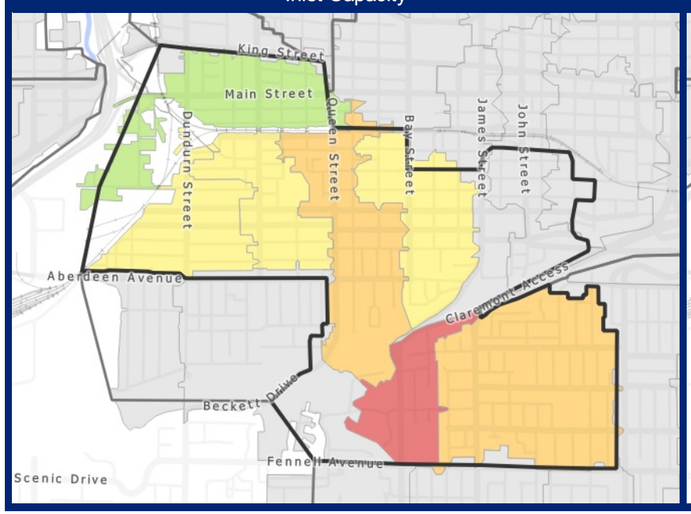
HGL to Basement Elevation of 1.8 m



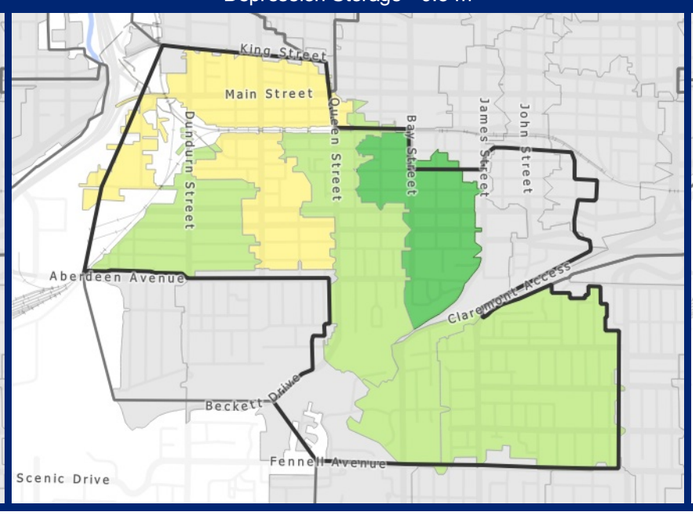
Overland Connectivity with Depression Storage



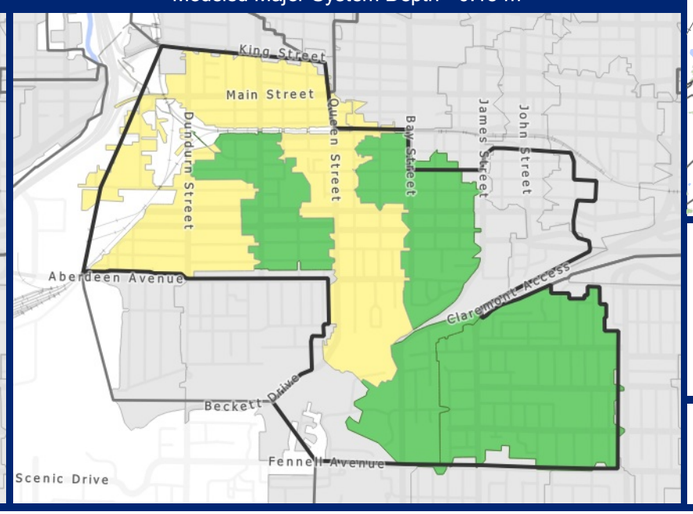
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
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- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

N

0 0.5 1 km

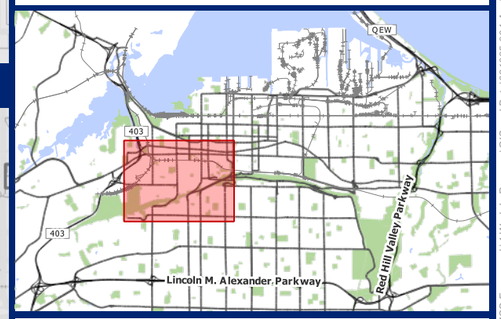


Figure 5 of 24

Main King-1

Results Analysis

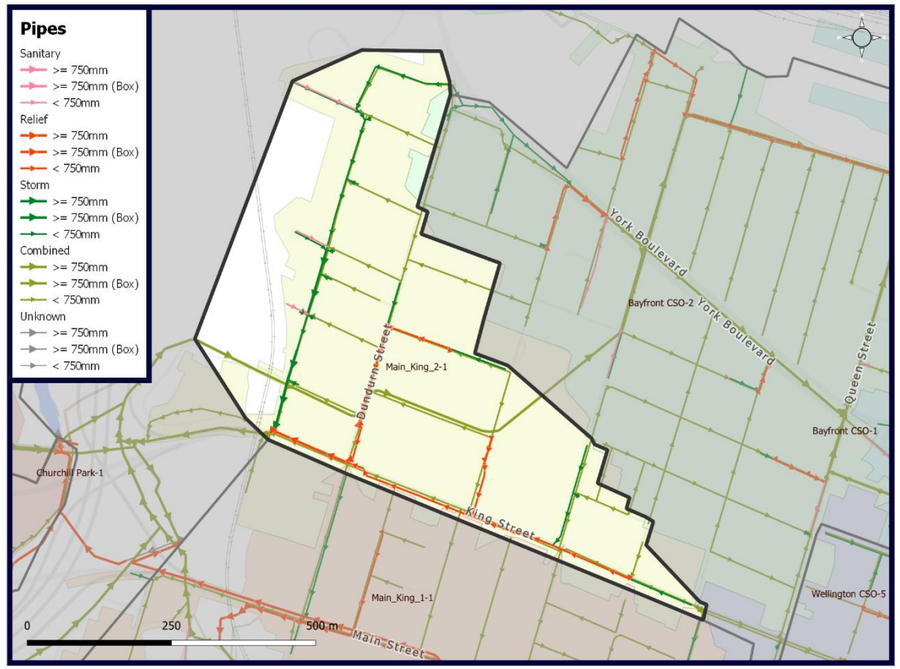
BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Main-King 2

Catchment Summary

Overview	The Main-King 2 CSO catchment is located in the southwestern-central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Strathcona The Main-King 2 CSO catchments contains one (1) subcatchment.	
Catchment Metrics	Area (ha)	36
	Total Length of Sewers (km)	9.6
	Length of Combined Sewers (km)	6.5
	Length of Sanitary Sewers (km)	0.2
	Length of Storm Sewers (km)	1.6
	Length of Relief Sewers (km)	1.3
	Storage Tanks (# and Name)	

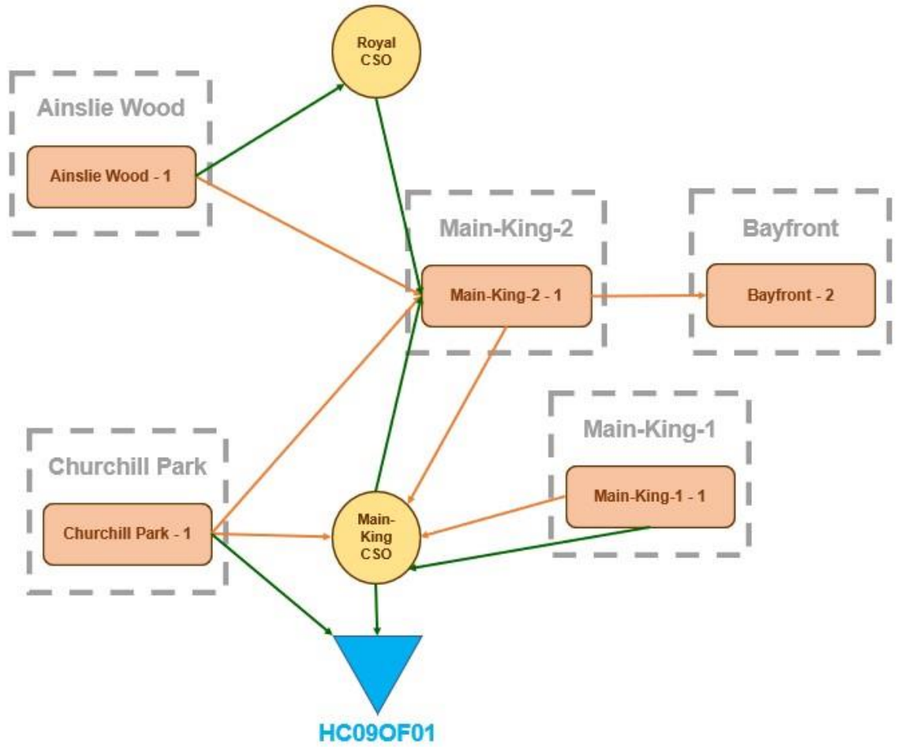


CSO Catchment Main-King 2

Minor System Overview

The sanitary and combined system are defined by the following features:

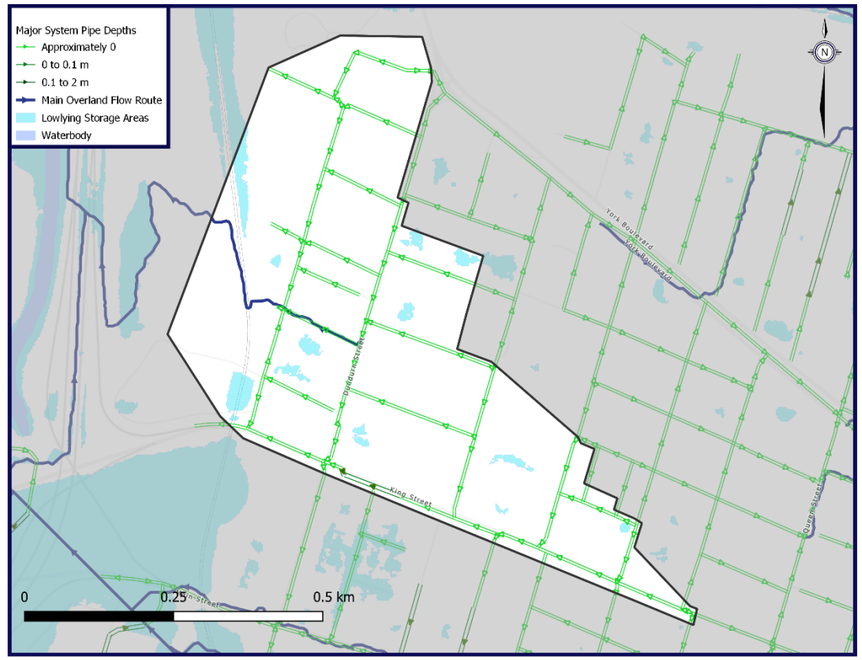
- The Main-King 2 CSO catchment generally conveys flows from west to east
  - Trunk infrastructure is within Hunt St. to Head St., then crossing Victoria Park to the Bayfront-2 subcatchment
- External upstream receiving catchments from Churchill Park-1, Ainslie Wood-1, and Main King-1-1 are conveyed through the trunk infrastructure entering the system at the Highway 403 corridor through to the Bayfront-2 subcatchment
- The Main-King CSO tank is shared between Main-King-1 and Main-King-2, and releases overflows to the CSO outfall at the Churchill Park CSO catchment, within the Highway 403 corridor to Chedoke Creek through relief sewers
  - Relief sewers along Dundurn St. N, Strathcona Ave. N, and King St. W convey combined sewer flows to the Main-King CSO tank
  - Storm sewers exist along Locke St. N, Lamoreaux St., and Breadalbane St., conveying stormwater to the combined/relief sewers within King St. W and ultimately the Main-King CSO tank
- The system is predominantly separated between combined sewers and storm/relief sewers; however, the storm and relief sewers do not discharge directly to Chedoke Creek and appear to re-join the combined sewer system at the downstream end of the system



CSO Catchment Main-King 2

Major System Overview

- The Main-King-2 CSO catchment contains one (1) primary overland flow routes as described below:
  - Baker St. conveying overland flows to the Kay Drage Park, and ultimately to Chedoke Creek
    - Main-King-2-1 → External
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - There are limited surface depressions within the catchment
- There are no modeled major system flow depths > 0.1m within the Main-King-2 CSO catchment



Summary of Previous Studies

Summary of Planned Works

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Main-King 2 - 1	1	3	1	2	1	1	4	1

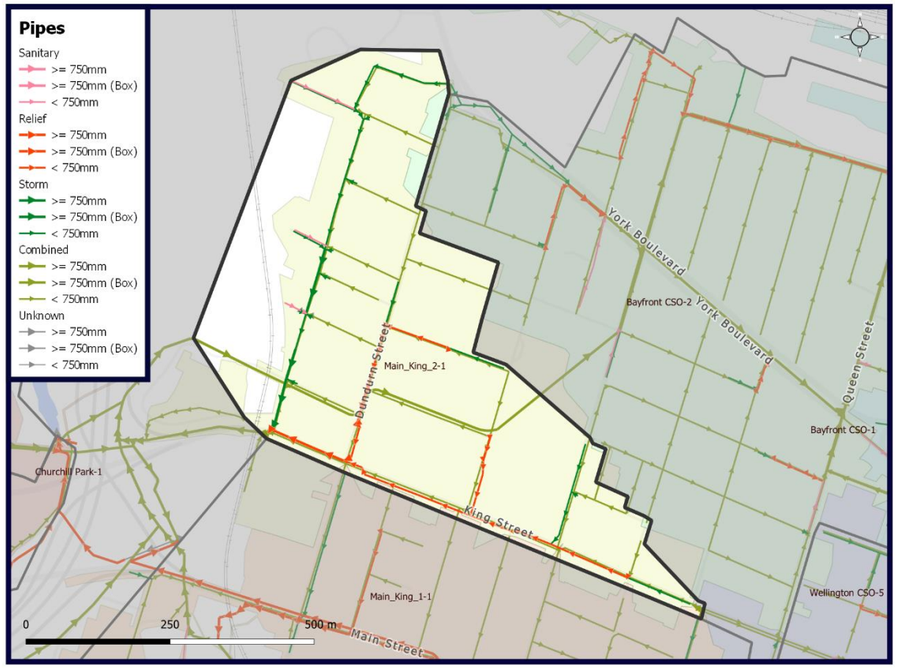
Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Main-King 2 - 1	Low	High	

CSO Catchment Main-King 2

Issues and Options

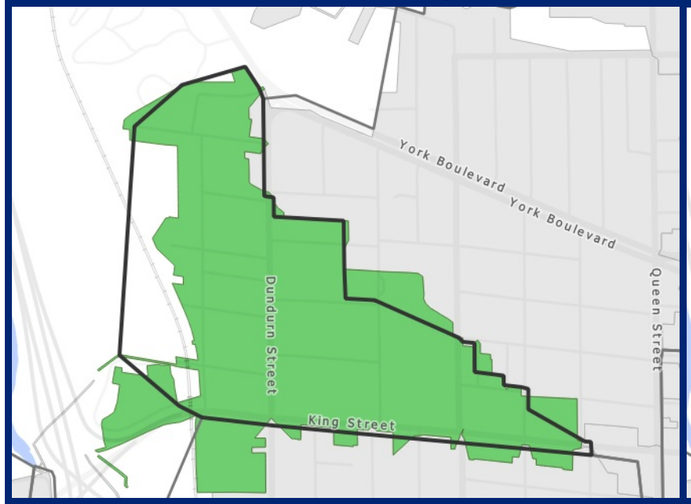
Summary of Key Issues	• Partial sewer separation completed within catchment with conveyance back to combined system
Summary of Potential Options	• 1) (MK2-SWR) Managed Sewer Separation



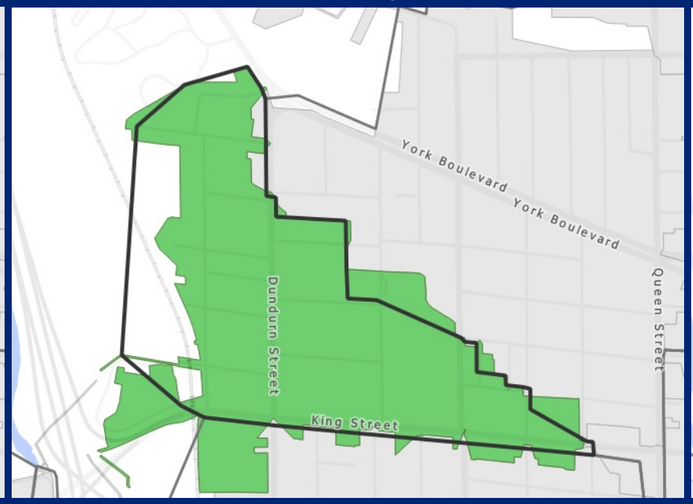
Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Managed Sewer Separation (MK2-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$6.0M	Recommended	Low Priority Future Planning (20+ years)	None

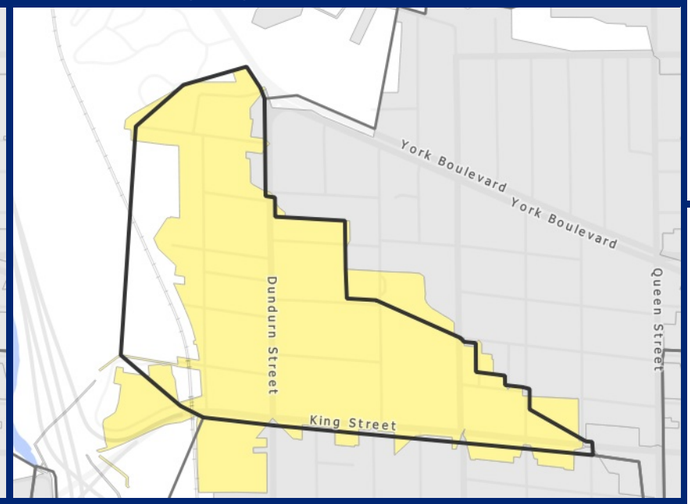
Overall Priority Ranking



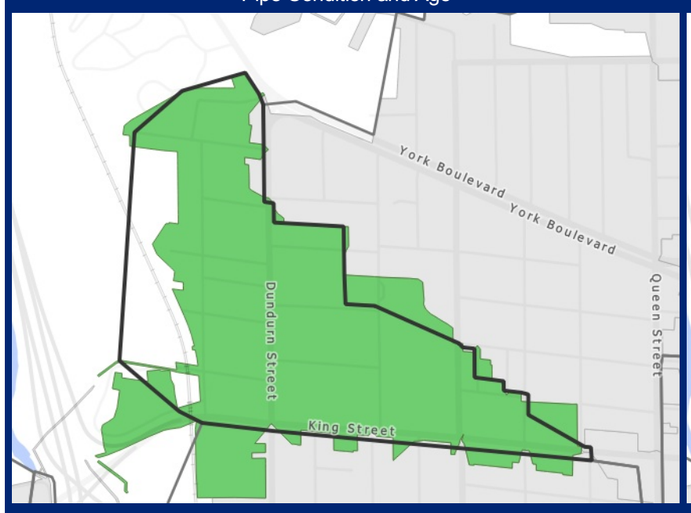
Hansen Flooding Calls



Pipe Depth for Residential Connections

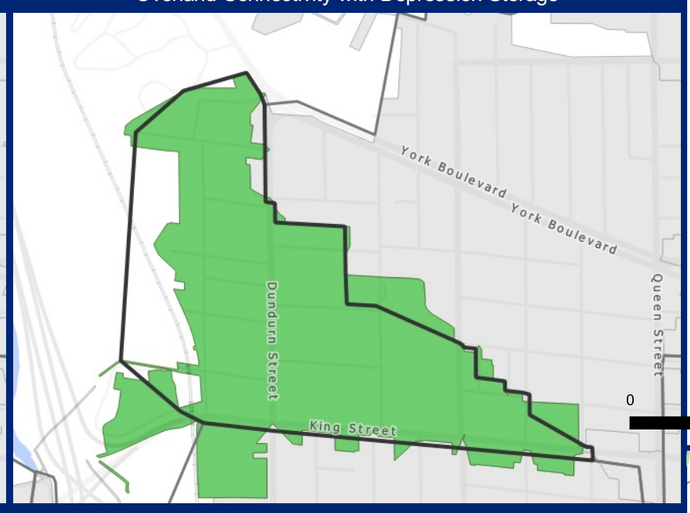


Pipe Condition and Age

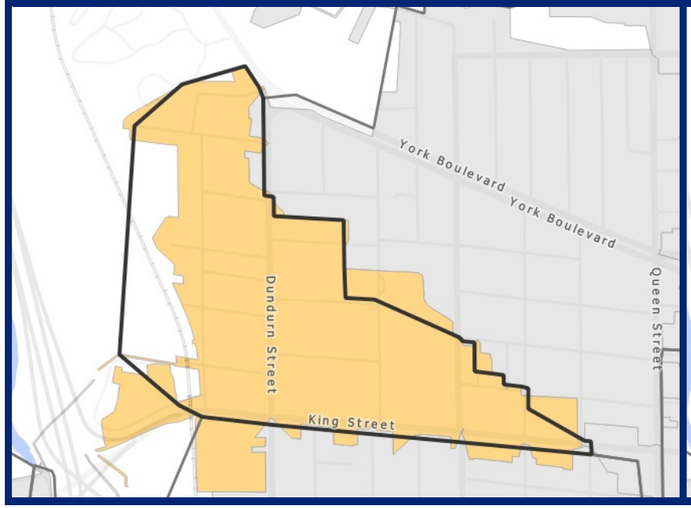


HGL to Basement Elevation of 1.8 m

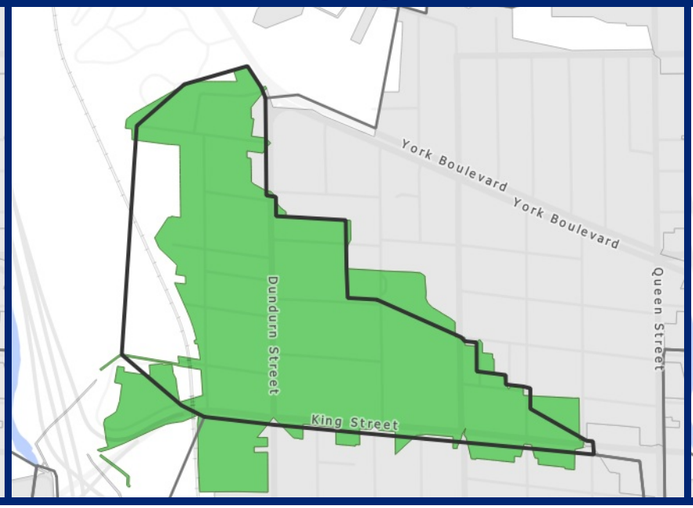
Overland Connectivity with Depression Storage



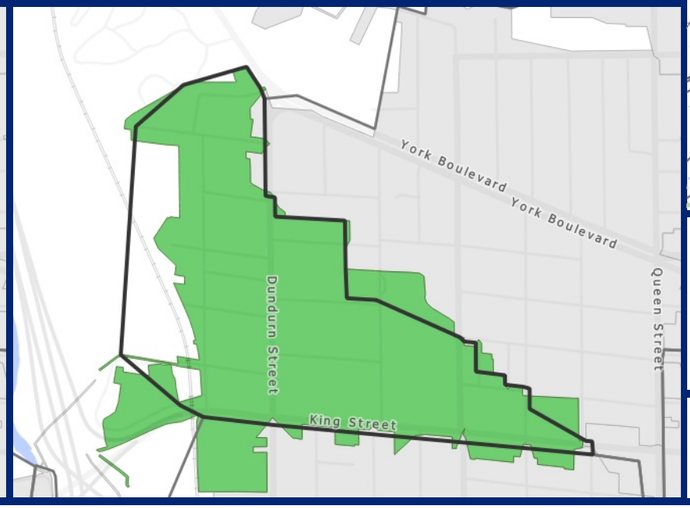
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

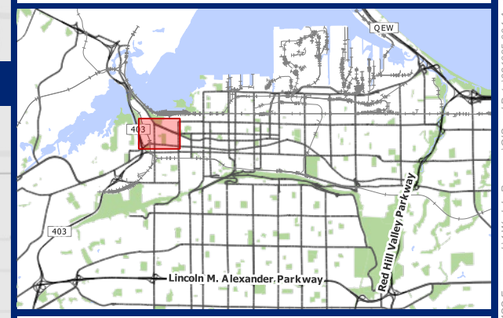


Figure 6 of 24

Main King-2

Results Analysis

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September, 2021
621085-004
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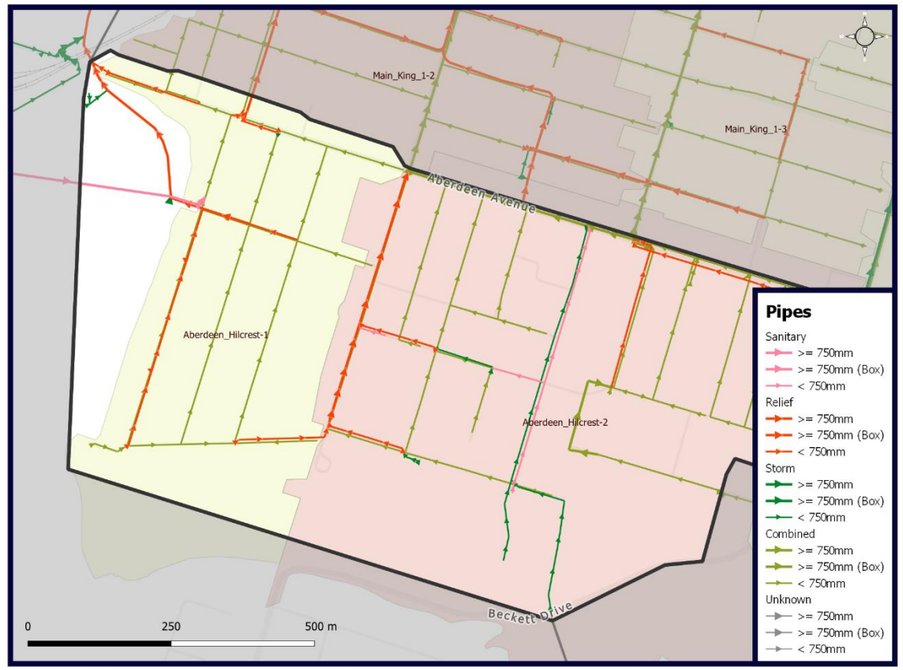
CSO Catchment Aberdeen Hillcrest

Catchment Summary

Overview	The Aberdeen Hillcrest CSO catchment is located in the southwestern-central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Kirkendall South The Aberdeen Hillcrest CSO catchments contains two (2) subcatchments.	
Catchment Metrics	Area (ha)	110
	Total Length of Sewers (km)	16.3
	Length of Combined Sewers (km)	8.9
	Length of Sanitary Sewers (km)	1.2
	Length of Storm Sewers (km)	2.5
	Length of Relief Sewers (km)	3.6
	Storage Tanks (# and Name)	

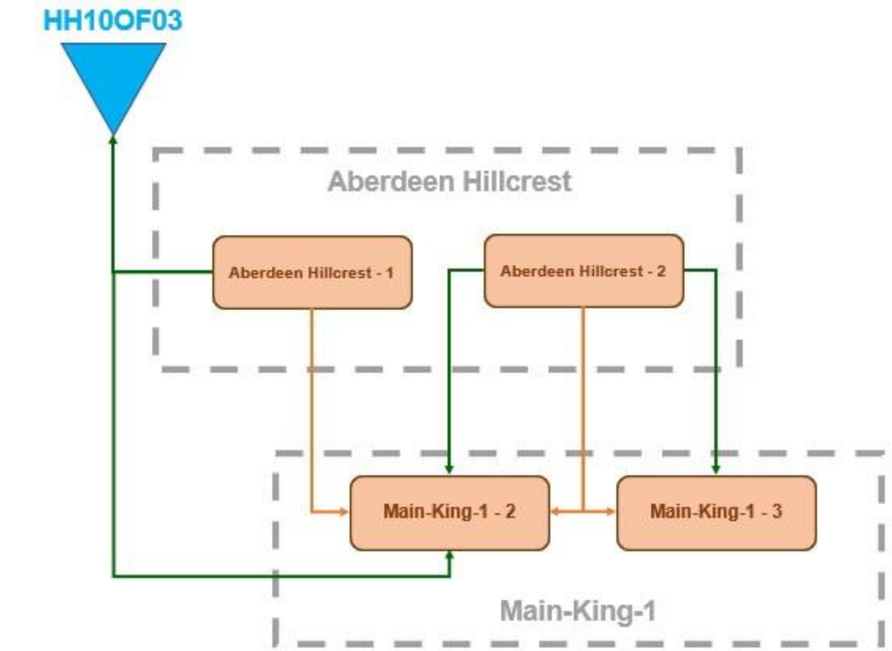


CSO Catchment Aberdeen Hillcrest

Minor System Overview

The sanitary and combined system are defined by the following features:

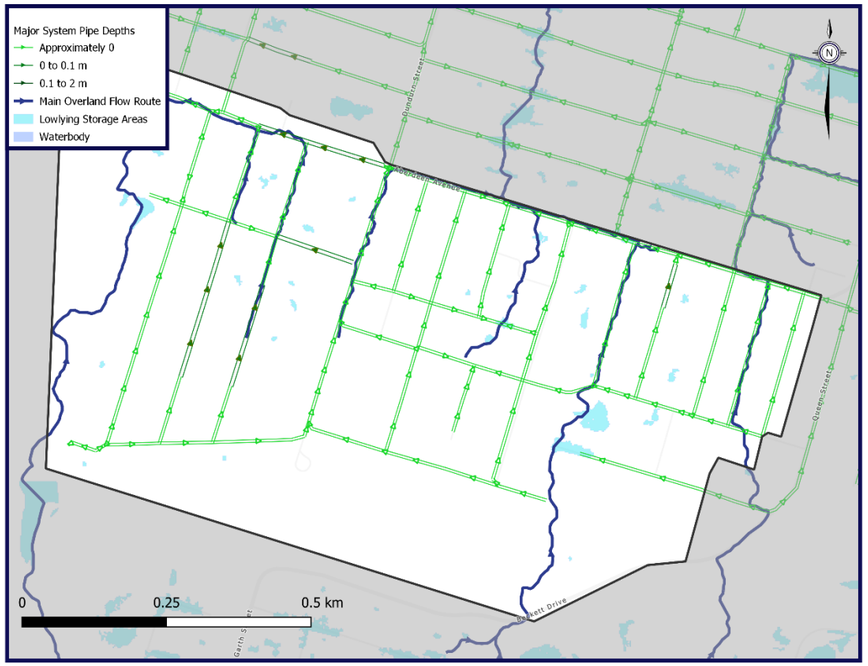
- The Aberdeen Hillcrest CSO catchment generally drains from south to north
  - There is combined sewer trunk infrastructure within Aberdeen Ave.
  - Combined sewer flows within Aberdeen Hillcrest-1 are conveyed to Main-King-1-2 through MacDonald Ave. and Hawthorne Ave.
  - Combined sewer flows within Aberdeen Hillcrest-2 are conveyed to Main-King-1-2 through Dundurn St. S and Main-King-1-2 through Locke St. S
- There is one (1) combined sewer overflow outfall within the catchment
  - The outfall is within the Highway 403 corridor and discharges to headwaters of Chedoke Creek
  - Relief sewers within Chedoke Ave., Glenside Ave., and Aberdeen Ave. convey excess combined sewer flows to the outfall
- Relief sewers within Dundurn Ave. S convey excess combined sewer flows to the Main-King-1-2 subcatchment through Dundurn Ave. S
- Relief sewers within Undermount Ave. and Aberdeen Ave. east of Undermount Ave convey excess combined sewer flows to the Main-King-1-3 subcatchment through Locke St. S



CSO Catchment Aberdeen Hillcrest

Major System Overview

- The Aberdeen Hillcrest CSO catchment contains three (3) primary overland flow routes as described below:
  - Two branches from Hyde Park Ave. and Flatt Ave., north to Aberdeen Ave. and ultimately west to the headwaters of Chedoke Creek
    - Aberdeen Hillcrest-1 → External
  - Two branches, one from Dundurn St. S and one along Undermount Ave. (beginning at the top of the escarpment) to Aberdeen Ave., conveying overland flows north through residential properties at the intersection of Aberdeen Ave. and Cottage Ave.
    - Aberdeen Hillcrest-2 → Main-King-1-2
  - One branch along Mapleside Ave. from the top of the escarpment (Mohawk College) to Kent St.
    - Mountain-27 → Aberdeen Hillcrest-2 → Main-King-1-3
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - Large surface depressions along private road at St. Joseph's Hospital, atop the escarpment
  - Limited isolated surface depressions within remainder of the catchment
- Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Fairmount Ave. just south of Aberdeen Ave.
  - Aberdeen Ave. from Dundurn St. S to Flatt Ave. (partially within identified overland flow route)
  - Glenside Ave. from Dundurn St. S to Hyde Park Ave.
  - Hyde Park Ave. south of Glenside Ave. (partially within identified overland flow route)
  - Flatt Ave. south of Glenside Ave. (just south of identified overland flow route)



Summary of Previous Studies

Aberdeen-Hillcrest Area Sewer Separation Conceptual Design Report (XCG Consultants Ltd., 2011)

- Facilitates decommissioning of Aberdeen Sewage Pumping Station (SPS)
- Provides two (2) options for sewer separation within the Aberdeen Hillcrest – 1 subcathchment including:
  - Option 1: separation into four (4) quadrants draining to an upgraded storm culvert at the CPR bridge, the existing storm outlet at Glenside Ave, the existing storm outlet at Dundurn St., and a new storm outlet at the southwest corner of the subcatchment at Hillcrest Ct.
  - Option 2: Option 1: separation into four (4) quadrants draining to an upgraded storm culvert at the CPR bridge, the existing storm outlet at Glenside Ave, the existing storm outlet at Dundurn St., and the western portion of the subcatchment draining to a relief outlet pipe along Chedoke Ave to Glenside Ave.
- Option 2 was selected as the preferred option

Summary of Planned Works

- Decommissioning of Aberdeen SPS and connection of overflow to the future MIP trunk sewer
- Sewer separation was proposed in this area by XCG in a previous study. Recommendations were not implemented. FDMSS was to verify

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Aberdeen Hillcrest - 1	5	5	1	5	1	1	5	1

CSO Catchment Aberdeen Hillcrest

Aberdeen Hillcrest - 2	3	5	1	2	1	2	5	1

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Aberdeen Hillcrest - 1	High	High	
Aberdeen Hillcrest - 2	High	High	

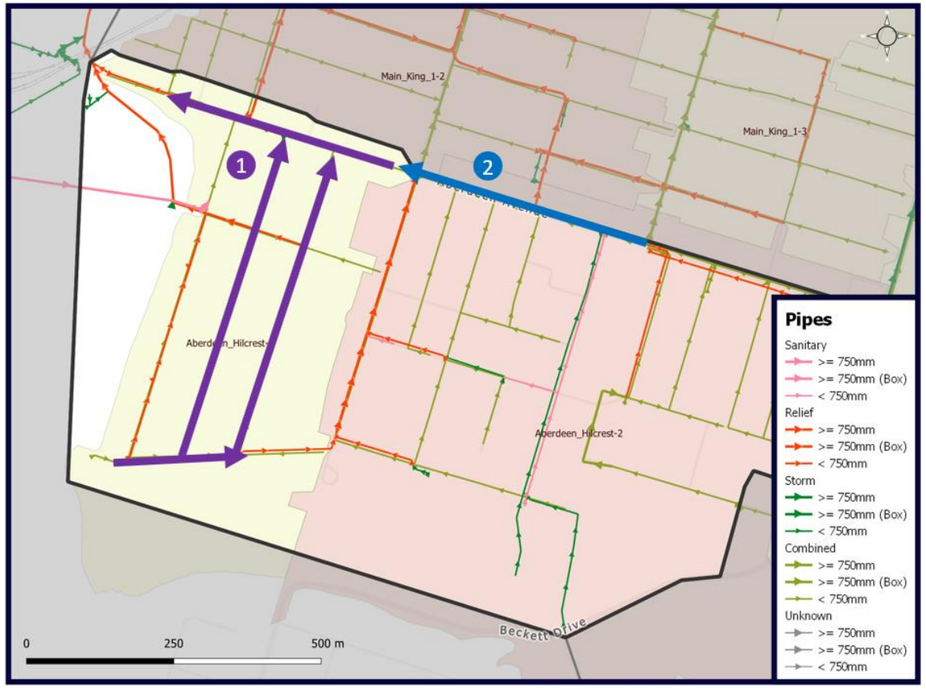
Issues and Options

Summary of Key Issues

- Significant amount of clean water being captured from escarpment
- Existing pump station to be decommissioned
- Limited inlet capacity within subcatchment
  - Skewed analysis due to escarpment flow area, likely not significant issue
  - Major system analysis shows adequate overland flow routes and limited depression storage, likely indicates limited inlet capacity as non-issue

Summary of Potential Options

- 1) (AH-1) Move forward with XCG recommendations for sewer separation
- 2) (AH-2) Extend Aberdeen Ave proposed storm sewer into Aberdeen Hillcrest - 2

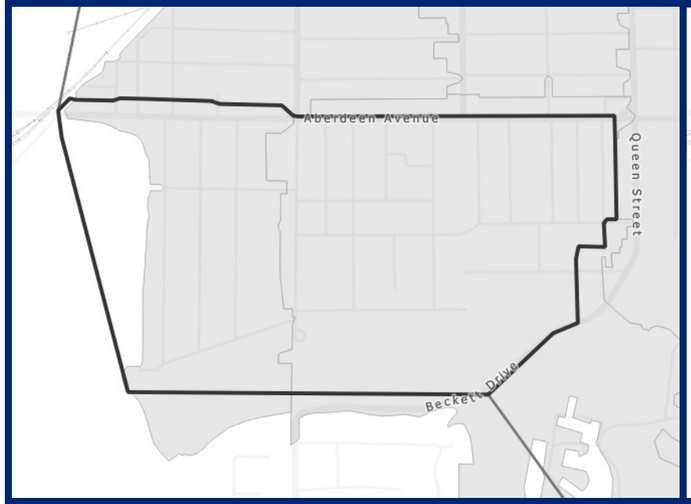


Option Evaluation

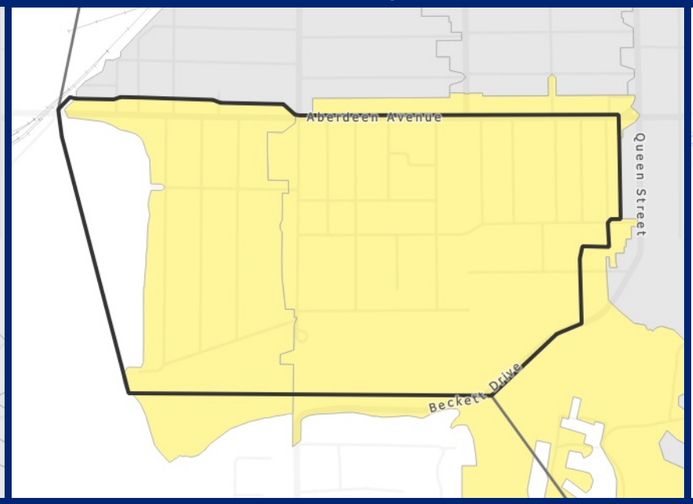
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works

CSO Catchment Aberdeen Hillcrest							
Option 1: Sewer Separation with Aberdeen Hillcrest – 1 (AH-1a)	• Addresses long-term solution via separation • Addresses minor system surcharging	• High cost of implementation	Local Solution Moderate Benefit	$5.5M	Recommended	High Priority Short Term (3 – 5 years)	None
Option 1: Trunk Infrastructure for Sewer Separation with Aberdeen Hillcrest – 1 (AH-1b)	• Addresses long-term solution via separation • Addresses minor system surcharging	• High cost of implementation	Local Solution Moderate Benefit	$9.6M	Recommended	High Priority Short Term (3 – 5 years)	None
Option 2: Extend storm sewer along Aberdeen Ave (AH-2)	• May be able to use the backbone of the Aberdeen Hillcrest - 1 solution (depth dependent) • Provides backbone for separation of Aberdeen Hillcrest - 2 • Long-term solution	• Requires consideration in downstream sizing	Local Solution Moderate Benefit	$6.9M	Further Study	Medium Priority Medium Term (5 – 10 years)	None
Managed Sewer Separation (AH-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$2.8M	Recommended	High Priority Future Planning (20+ years)	None

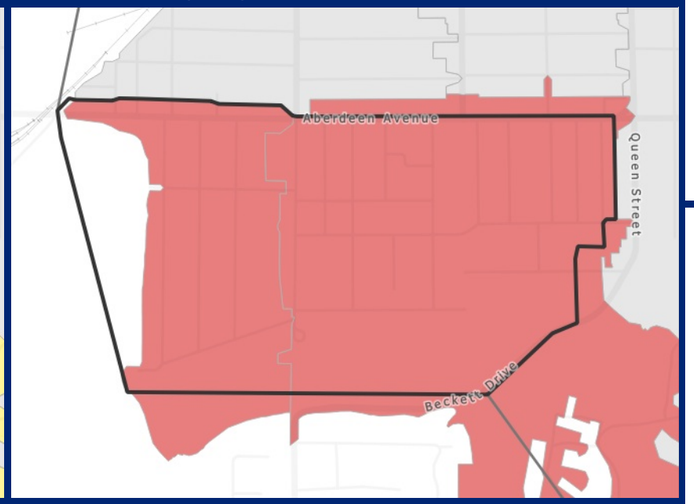
Overall Priority Ranking



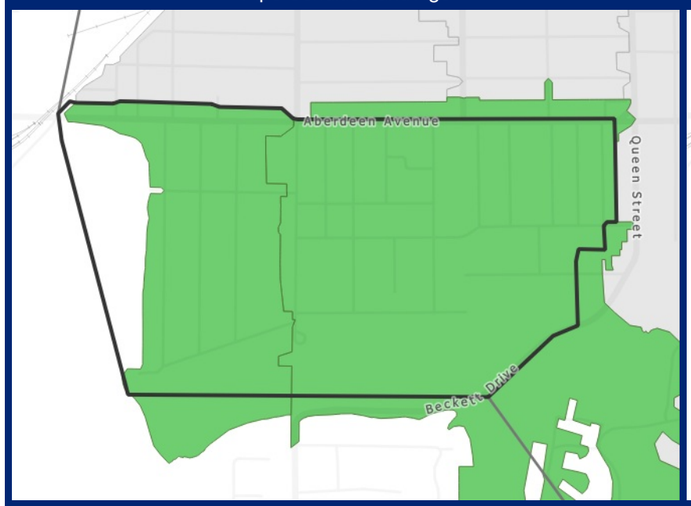
Hansen Flooding Calls



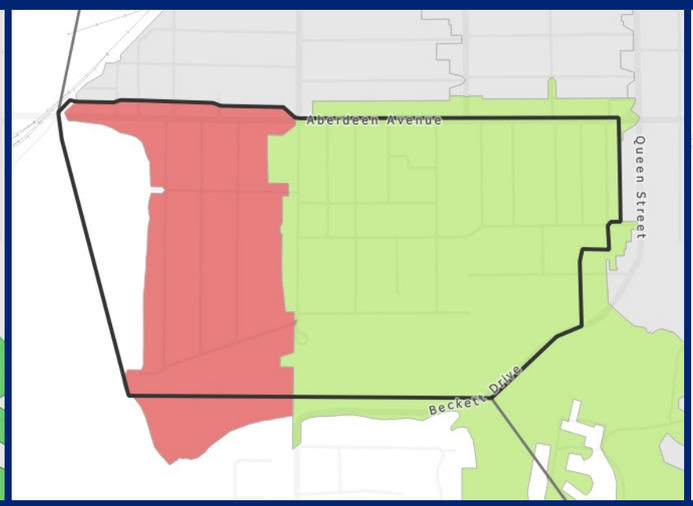
Pipe Depth for Residential Connections



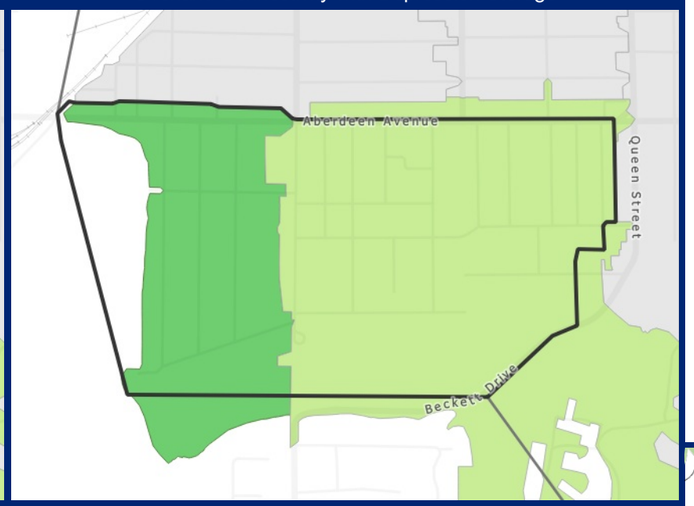
Pipe Condition and Age



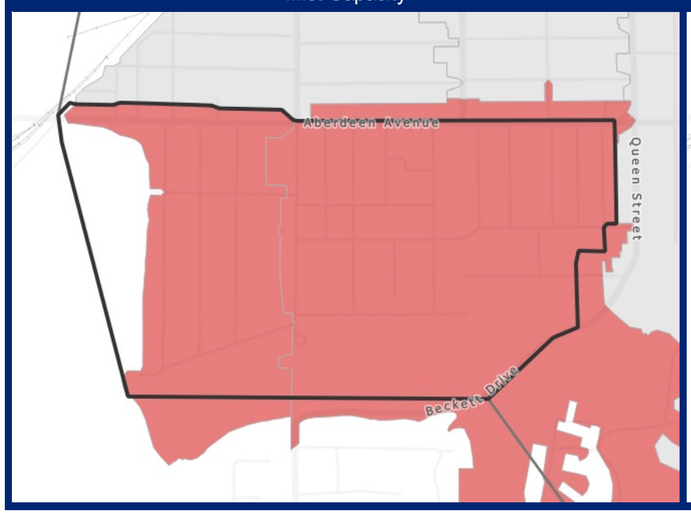
HGL to Basement Elevation of 1.8 m



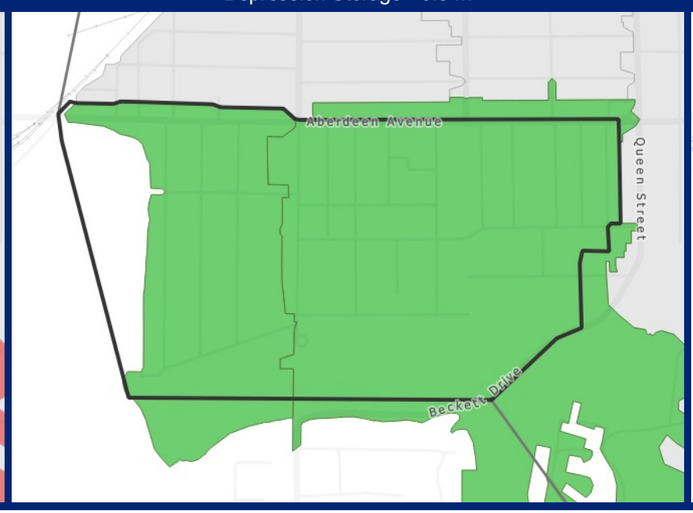
Overland Connectivity with Depression Storage



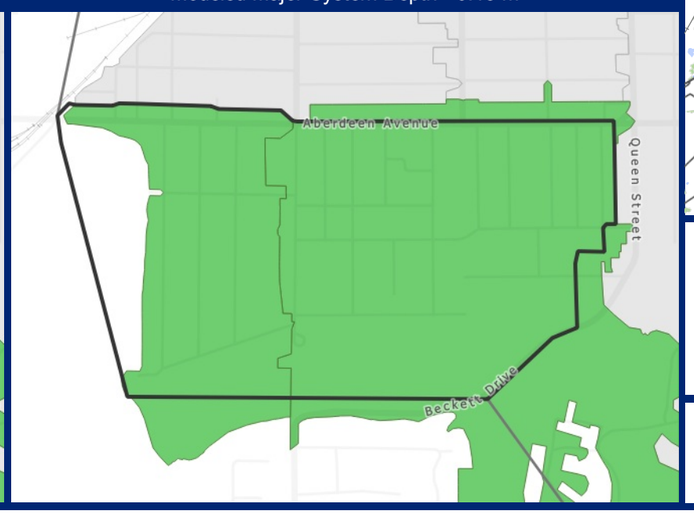
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

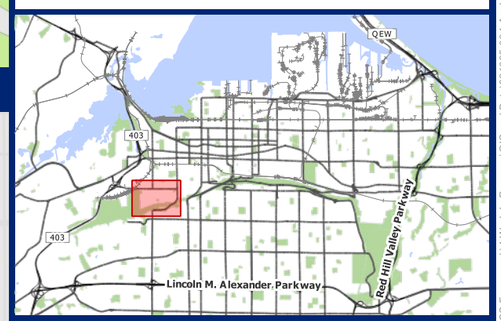


Figure 7 of 24

Aberdeen-Hilcrest

Results Analysis

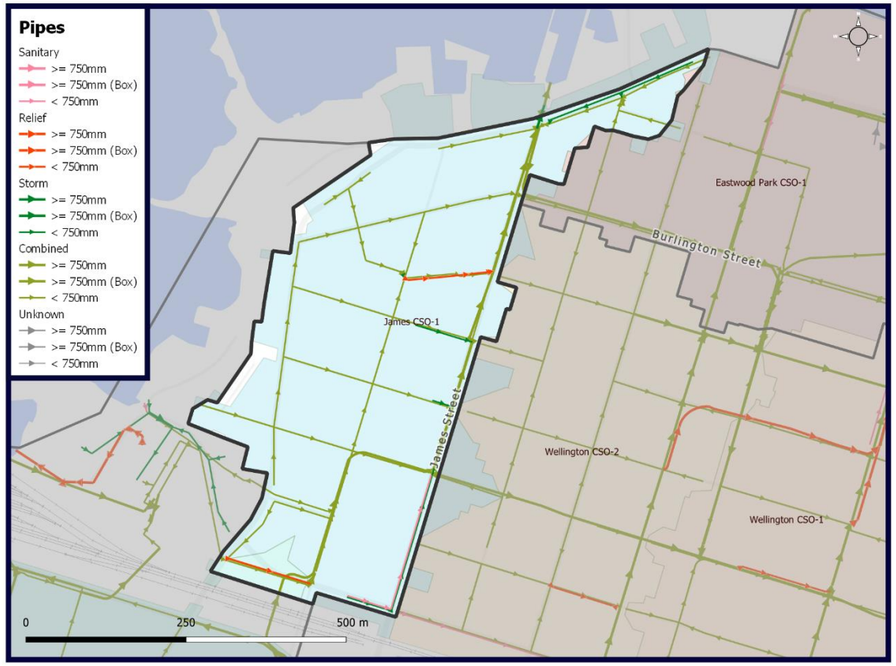
BluePlan Engineering

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment James

Catchment Summary

Overview	The James CSO catchment is located in the northwestern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • North End West The James CSO catchments contains one (1) subcatchment.	
Catchment Metrics	Area (ha)	30
	Total Length of Sewers (km)	7.1
	Length of Combined Sewers (km)	6.0
	Length of Sanitary Sewers (km)	0.3
	Length of Storm Sewers (km)	0.7
	Length of Relief Sewers (km)	0.2
	Storage Tanks (# and Name)	

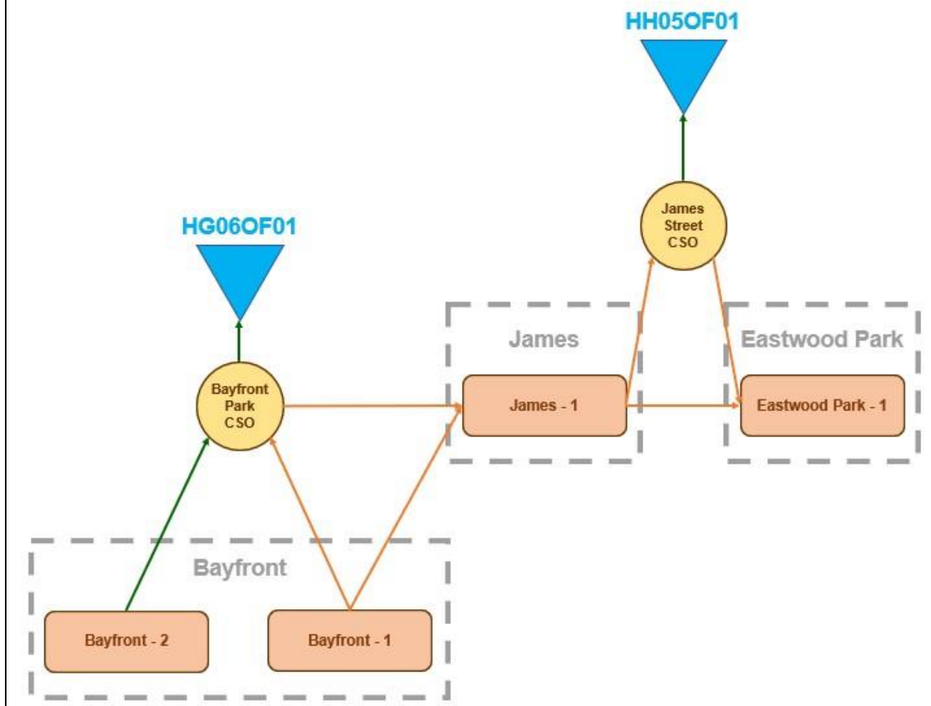


CSO Catchment James

Minor System Overview

The sanitary and combined system are defined by the following features:

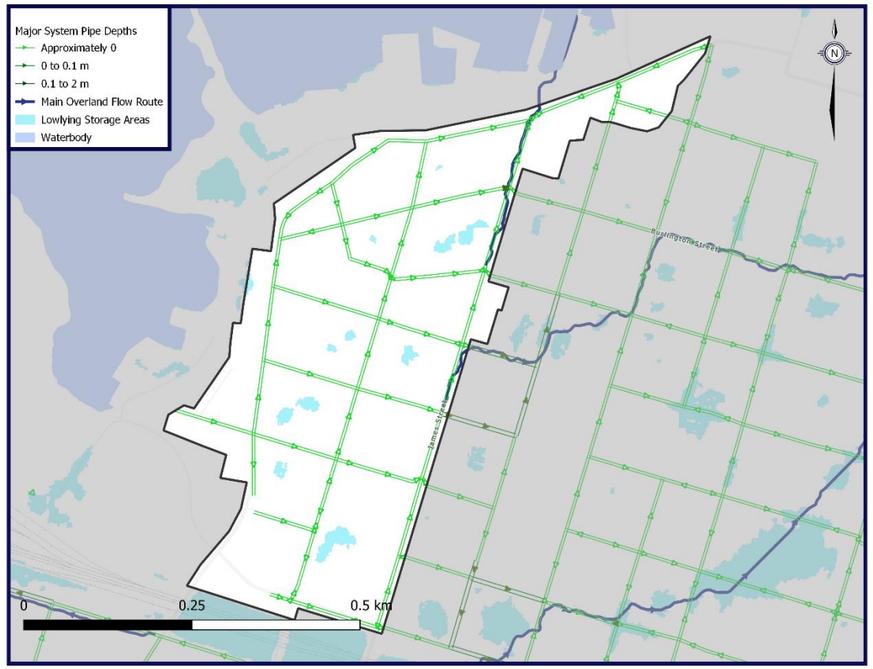
- The James CSO catchment generally conveys flows from south to north
  - Combined trunk infrastructure is located within James St. N and discharges to Burlington St. E
  - There is a trunk sewer within MacNab St. N to Ferrie St. E which appears to bypass the James CSO catchment local system and convey flows from the Bayfront CSO catchment and Bayfront Park CSO tank to the Wellington CSO catchment
- There is one (1) combined sewer overflow outfall within the catchment
  - The outfall is north of James St. N, and discharges into the harbour
  - Over-capacity combined sewer flows first discharge to the James Street CSO tank and then discharge to the outfall if the James Street CSO tank becomes over capacity
  - The James Street CSO tank discharges to the Eastwood Park CSO catchment through Burlington St. E
- There are minimal relief sewers within the James CSO catchment



CSO Catchment James

Major System Overview

- The James CSO catchment contains two (2) primary overland flow routes as described below:
  - Along James St. N from Wood St. W to the harbour
    - James-1 → External
  - A small section of James St. N from Picton St. W to MacAulay St., entering the Wellington-2 subcatchment
    - James-1 → Wellington-2
- There are limited isolated surface depressions within the catchment, with most occurring on private properties and not the road right-of-way
- No significant major system flow depths per the overland model results



Summary of Previous Studies

DRAFT - DMAF CSO Outfall Backflow Preventor Installations Preliminary Design Report (RVA, 2021)

- June 2019 had high lake levels which caused lake water to flow back through storm outfalls
- Surcharged both storm sewers and connected CSO tanks
- Study provides effects and data on the following outfalls:
  - Bayfront Park Outfall
  - Strathearne Gate
  - Pier 8 Outfall

Draft study, outcome not confirmed and results in progress

Summary of Planned Works

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
James - 1	1	5	1	4	1	1	1	1

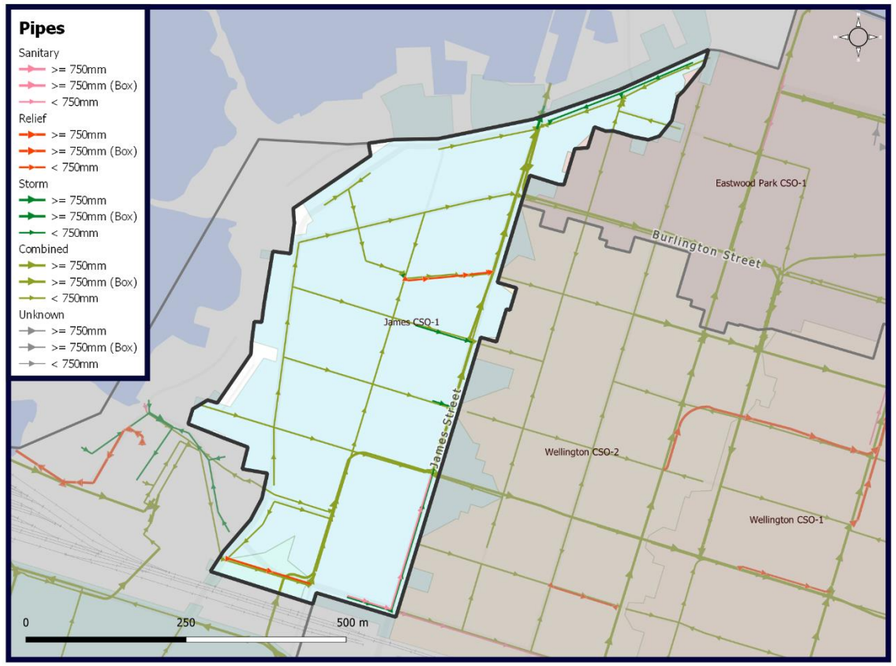
CSO Catchment James

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
James - 1	Low	High	

Issues and Options

Summary of Key Issues	• Shallow sewers throughout catchment • Outfalls within catchment sensitive to lake levels from 2019 Lake Ontario historic high water event
Summary of Potential Options	• 1) (JM-SWR) Managed sewer separation

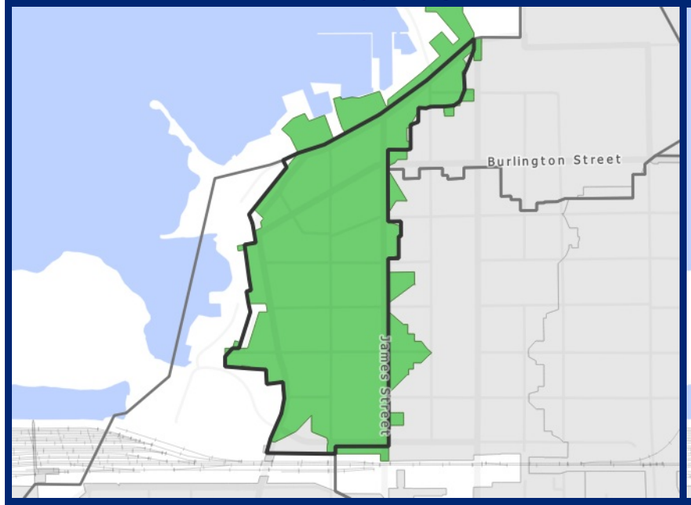


Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works

CSO Catchment James							
Managed Sewer Separation (JM-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$5.2M	Recommended	Low Priority Future Planning (20+ years)	None

Overall Priority Ranking



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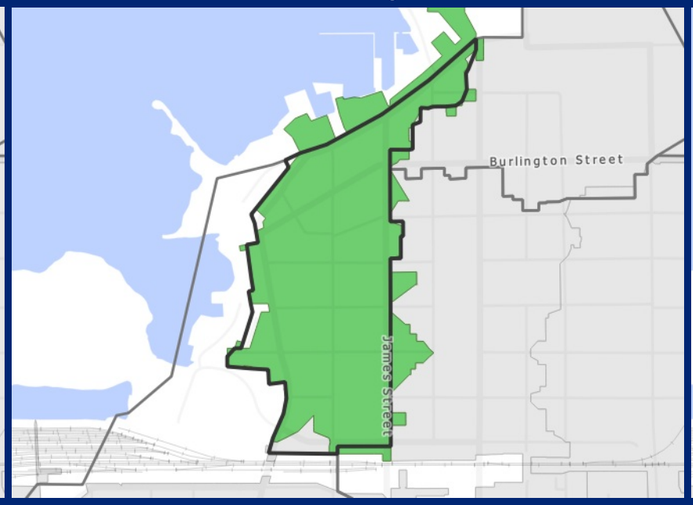

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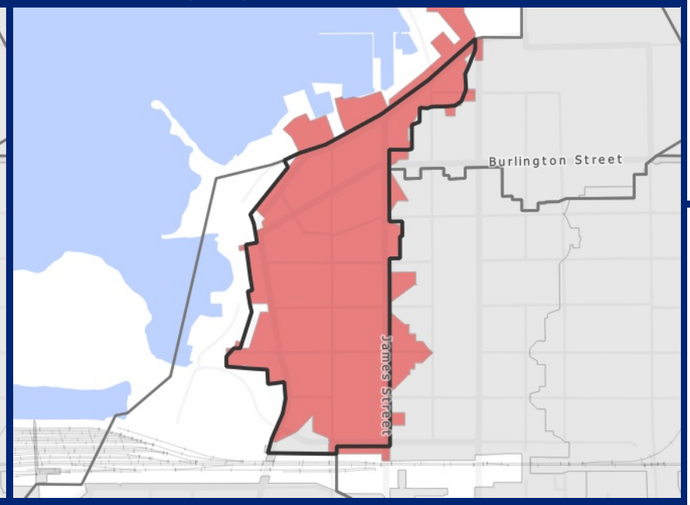
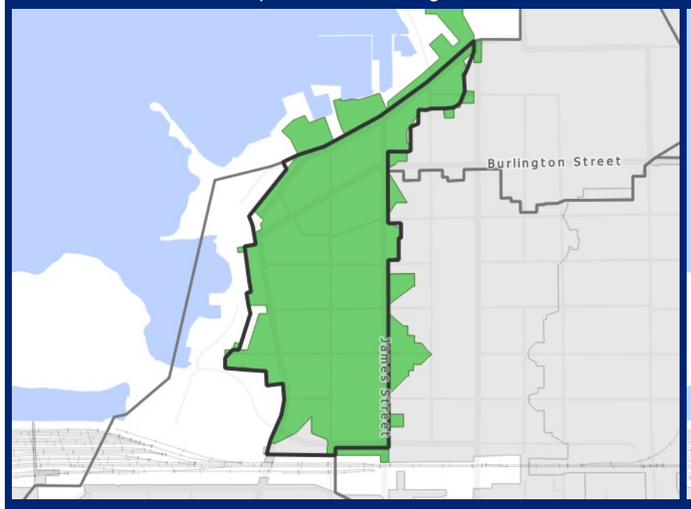
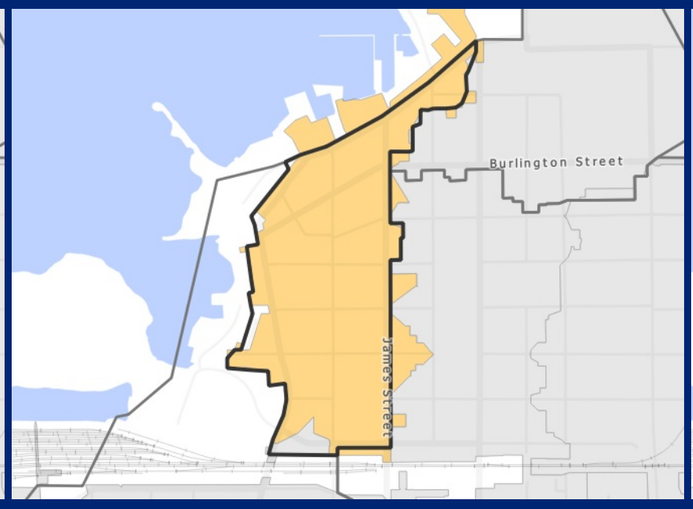


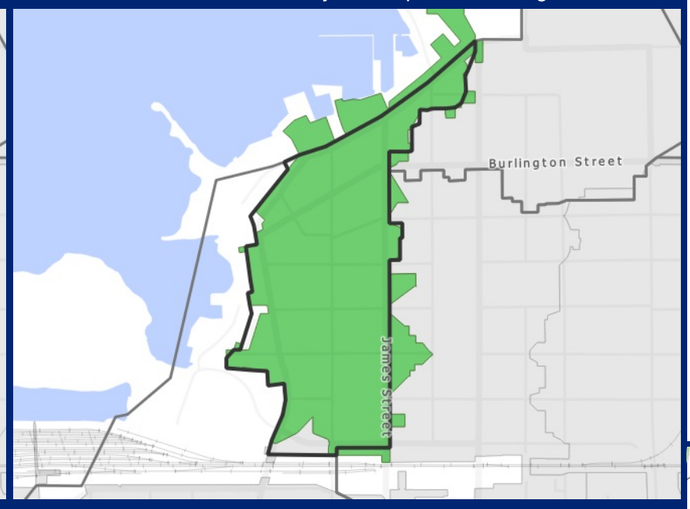
Pipe Condition and Age



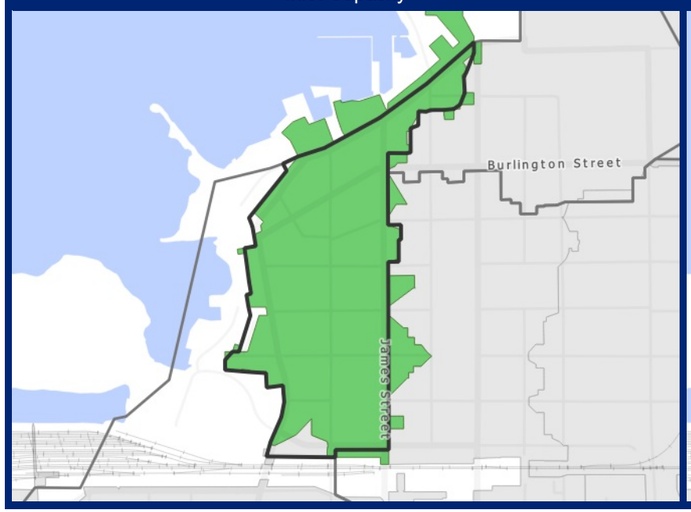
HGL to Basement Elevation of 1.8 m



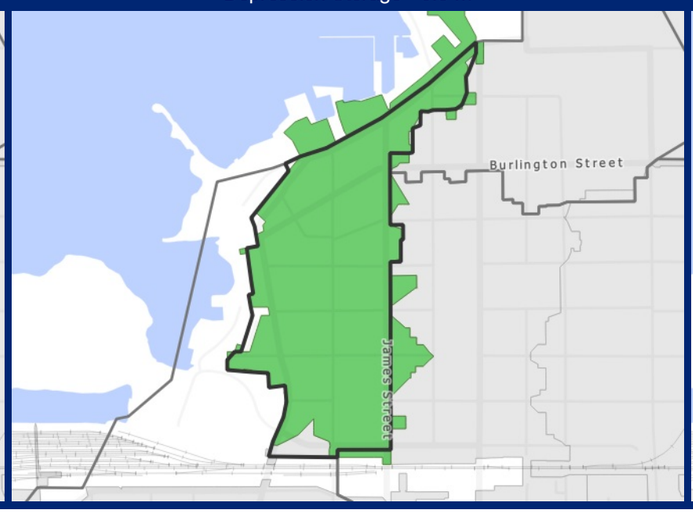
Overland Connectivity with Depression Storage



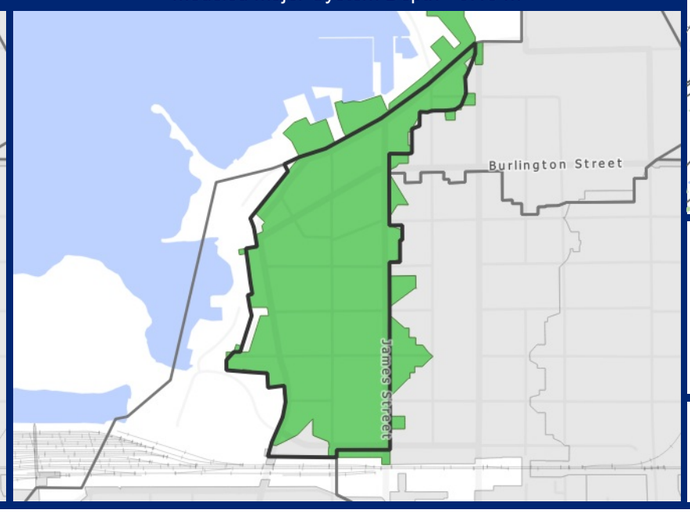
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

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0 0.5 1 km

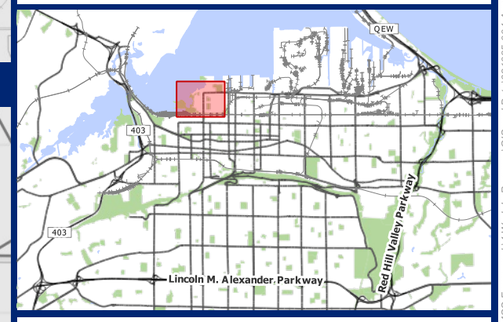


Figure 8 of 24

James CSO

Results Analysis

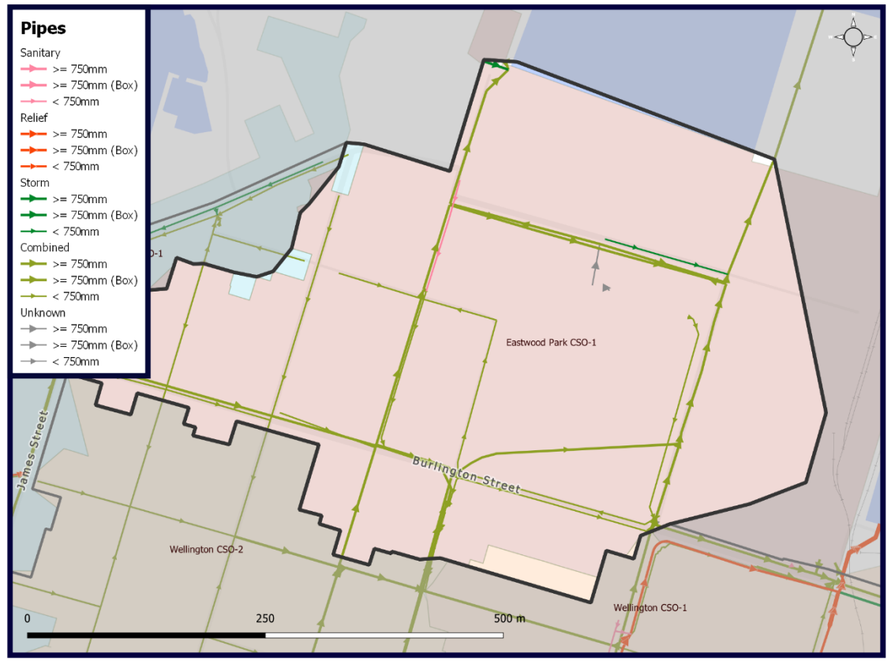
BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Eastwood Park

Catchment Summary

Overview	The Eastwood Park CSO catchment is located in the northeastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • North End East The Eastwood Park CSO catchments contains one (1) subcatchments.	
Catchment Metrics	Area (ha)	33
	Total Length of Sewers (km)	6.0
	Length of Combined Sewers (km)	5.5
	Length of Sanitary Sewers (km)	0.1
	Length of Storm Sewers (km)	0.2
	Length of Relief Sewers (km)	0.2
	Storage Tanks (# and Name)	

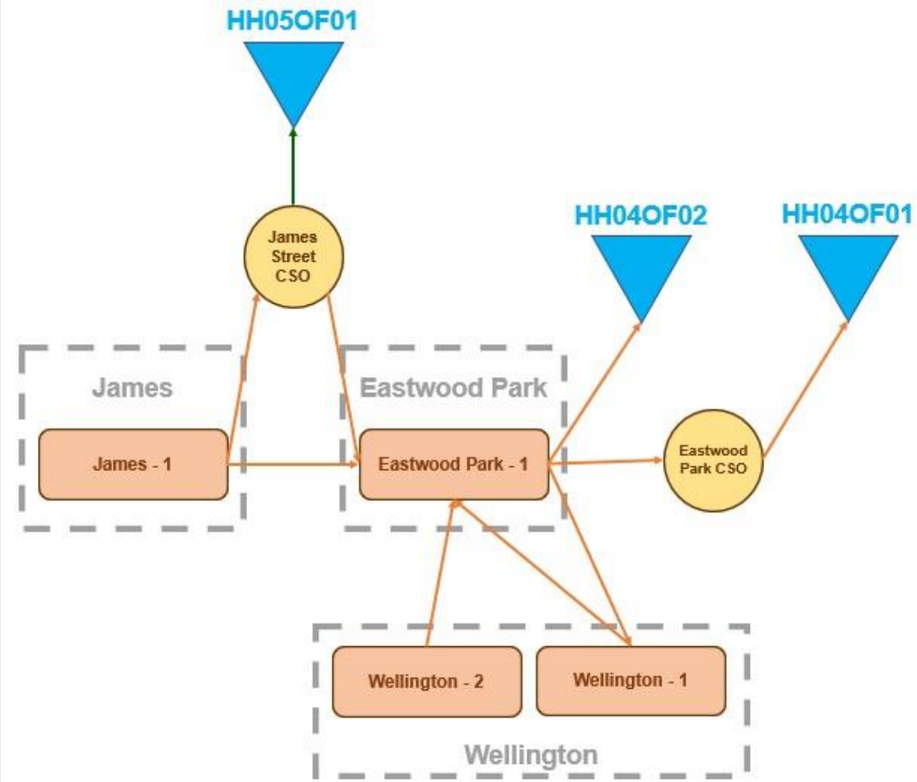


CSO Catchment Eastwood Park

Minor System Overview

The sanitary and combined system are defined by the following features:

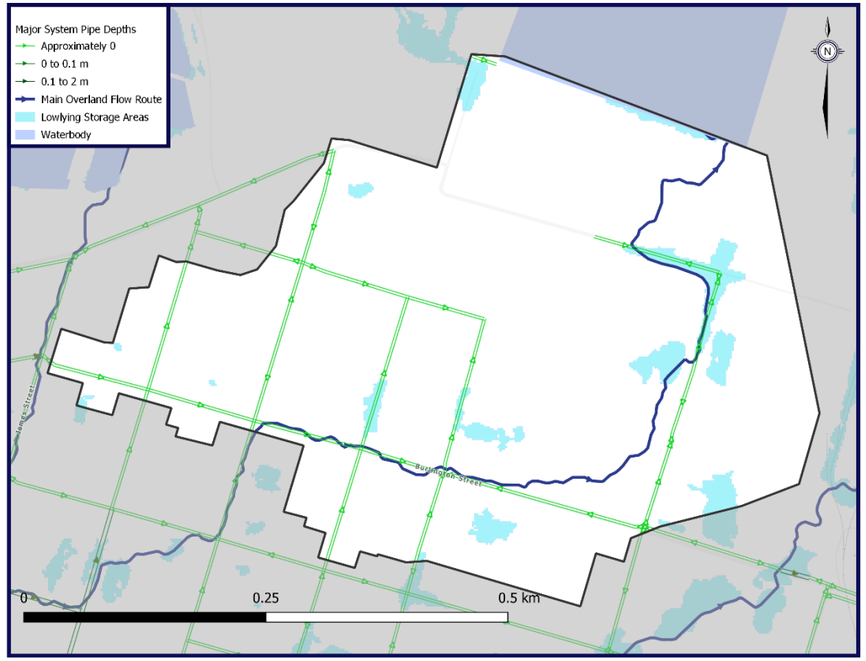
- The Eastwood Park CSO catchment generally conveys flows to the north from the south and west
  - Trunk infrastructure is located within Burlington St. E, Ferguson Ave N., Catharine St. N, and Dock Service Rd.
- External upstream receiving catchments conveyed as follows:
  - James Street CSO tank flows conveyed from James-1 subcatchment through Eastwood Park-1 subcatchment to Wellington-2 subcatchment
  - Combined sewer flows from the Wellington-2 subcatchment conveyed north to Eastwood Park CSO tank
  - Combined sewer flows from the Wellington-1 subcatchment conveyed north to Eastwood Park CSO tank
- There are two (2) combined sewer overflow outfalls within the catchment with one (1) CSO tank
  - Over-capacity combined sewer flows from the Wellington and Eastwood Park CSO catchments are conveyed to the Eastwood Park CSO tank
    - The Eastwood Park CSO tank is conveyed to the Burlington St E combined sewer as capacity becomes available
    - The Eastwood Park CSO tank discharges to both CSO outfalls within the catchment when the tank's capacity has been exceeded
- There are no relief sewers within the Eastwood Park CSO catchment



CSO Catchment Eastwood Park

Major System Overview

- The Eastwood Park CSO catchment contains one (1) primary overland flow route as described below:
  - Conveying overland flow from the Wellington-2 subcatchment, the overland flow route enters the catchment at John St. and travels east along Burlington St. E, then crosses Eastwood Park following Ferguson Ave N to the discharge into the harbour
    - Wellington-2 → Eastwood Park-1 → External
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - There is a large surface depression along the primary overland flow route at the intersection of Ferguson Ave. N and Dock Service Rd.
  - There are multiple isolated surface depressions within Eastwood Park
  - There are limited surface depressions within the industrial lands throughout the catchment
- There are no significant modeled major system flow depths > 0.1m



Summary of Previous Studies

DRAFT - DMAF CSO Outfall Backflow Preventor Installations Preliminary Design Report (RVA, 2021)

- June 2019 had high lake levels which caused lake water to flow back through storm outfalls
- Surcharged both storm sewers and connected CSO tanks
- Study provides effects and data on the following outfalls:
  - Bayfront Park Outfall
  - Strathearne Gate
  - Pier 8 Outfall
- Draft study, outcome not confirmed and results in progress

Summary of Planned Works

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Eastwood Park - 1	1	5	3	5	3	2	4	2

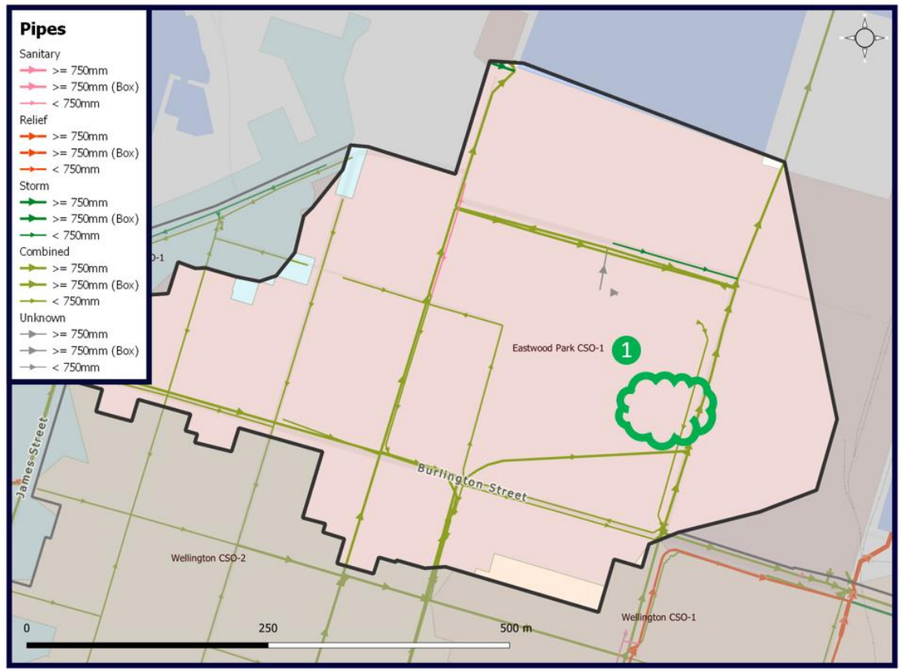
CSO Catchment Eastwood Park

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Eastwood Park - 1	High	Low	

Issues and Options

Summary of Key Issues	• Shallow sewers within catchment including the local sewers north of Burlington St and some sewers within Burlington St • Poor condition pipes within catchment, including trunk sewer within Catharine St N • Surcharging sewers predominantly within Mary St, Brock St, and Catharine St N • Surface depression with overland flow connectivity at NE corner of Eastwood Park • Outfalls within catchment sensitive to lake levels from 2019 Lake Ontario historic high water event
Summary of Potential Options	• 1) (EP-1) LID within Eastwood Park to mitigate potential surface flooding at NE corner

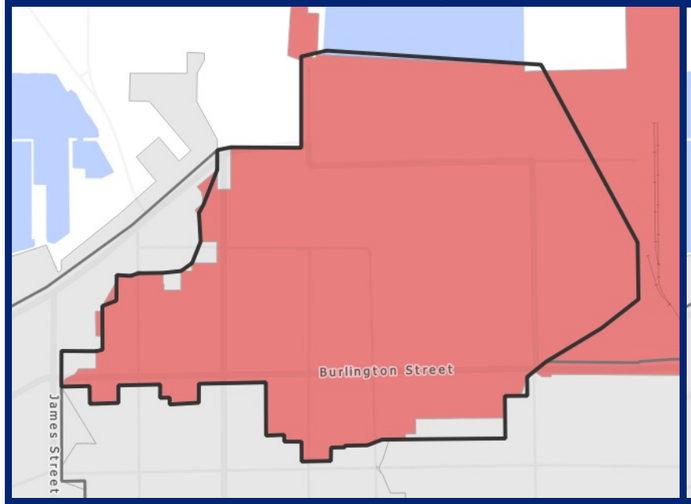


Option Evaluation

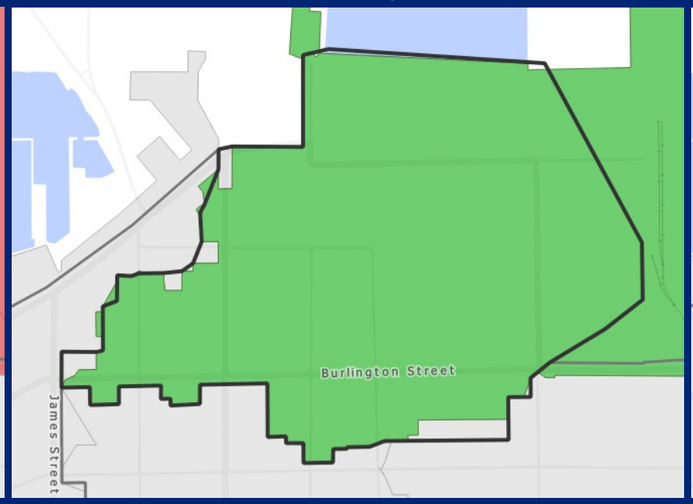
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1: Eastwood Park LID (EP-1)	• Potential to divert existing major system depressions to open area for infiltration	• Proximity to the lake has risk of saturated ground / less-than ideal infiltration conditions • Limited benefit as there are no homes in this area	Local Solution Limited Benefit	-	Screened Out	-	

CSO Catchment Eastwood Park							
Managed Sewer Separation (EP-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$8.2M	Recommended	Low Priority Future Planning (20+ years)	None

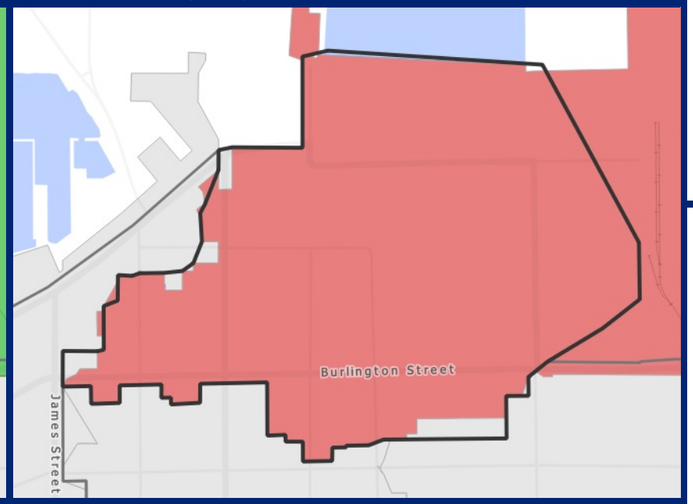
Overall Priority Ranking



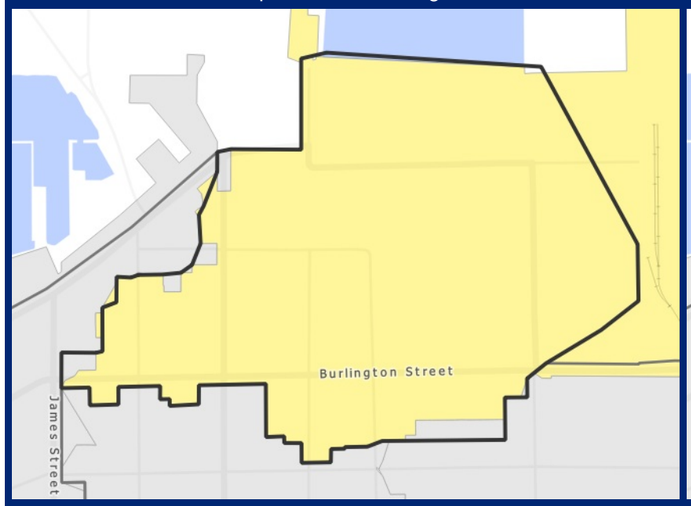
Hansen Flooding Calls



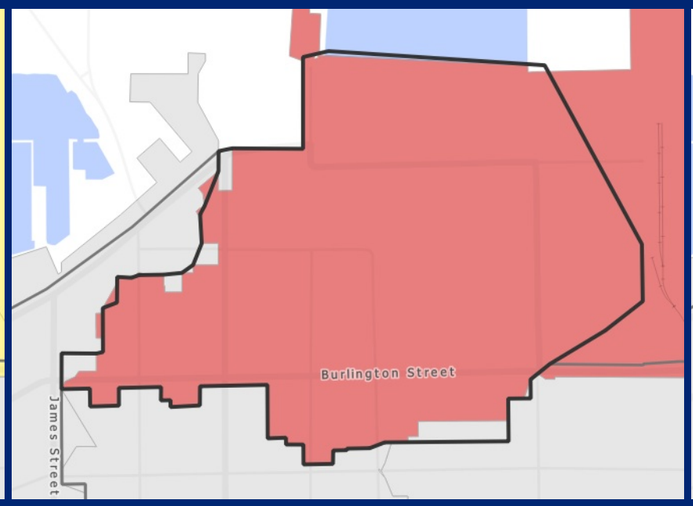
Pipe Depth for Residential Connections



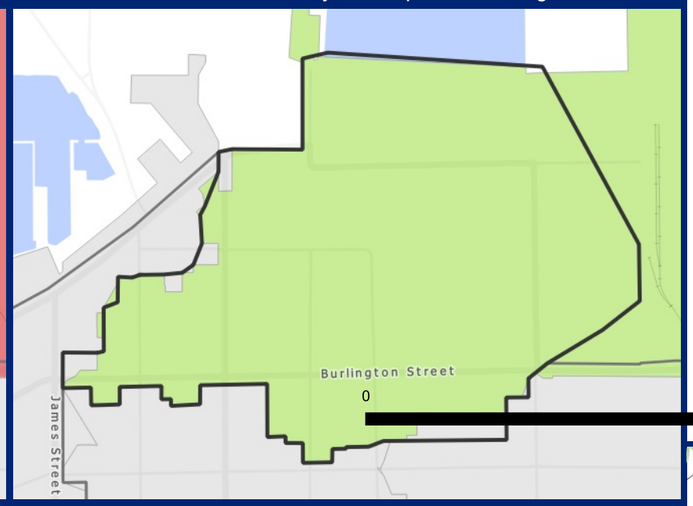
Pipe Condition and Age



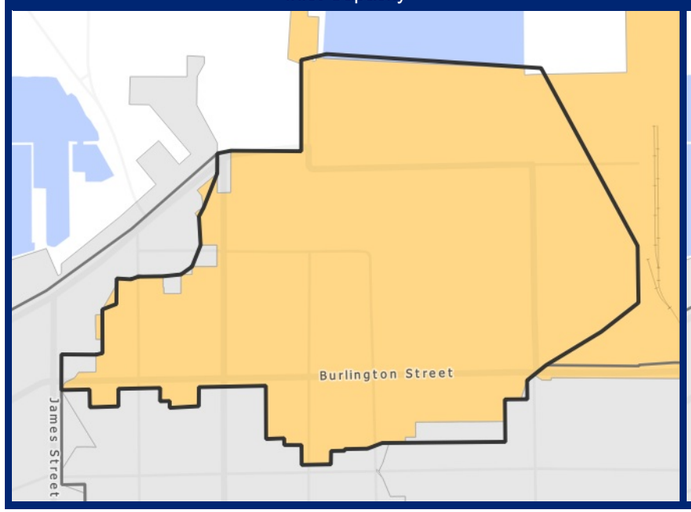
HGL to Basement Elevation of 1.8 m



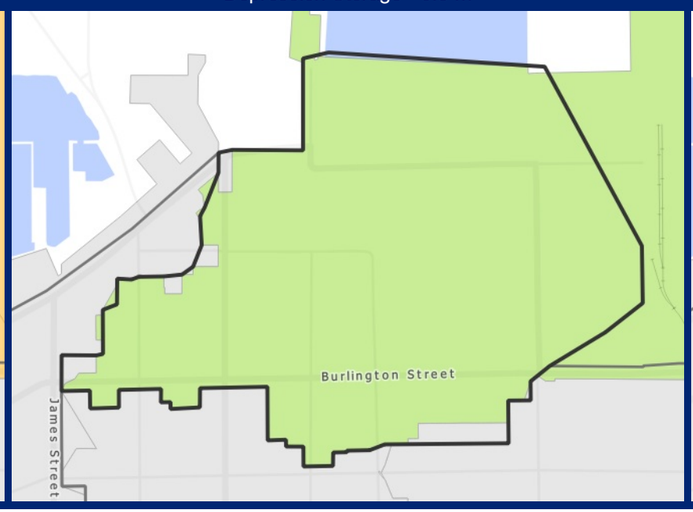
Overland Connectivity with Depression Storage



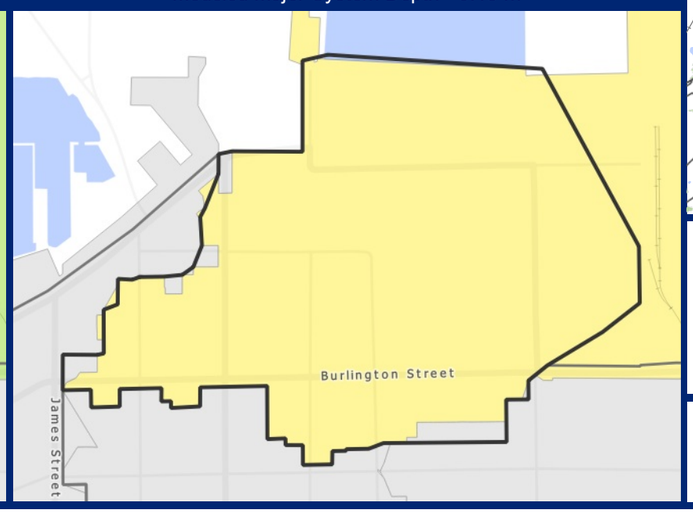
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

Figure 9 of 24

Eastwood Park CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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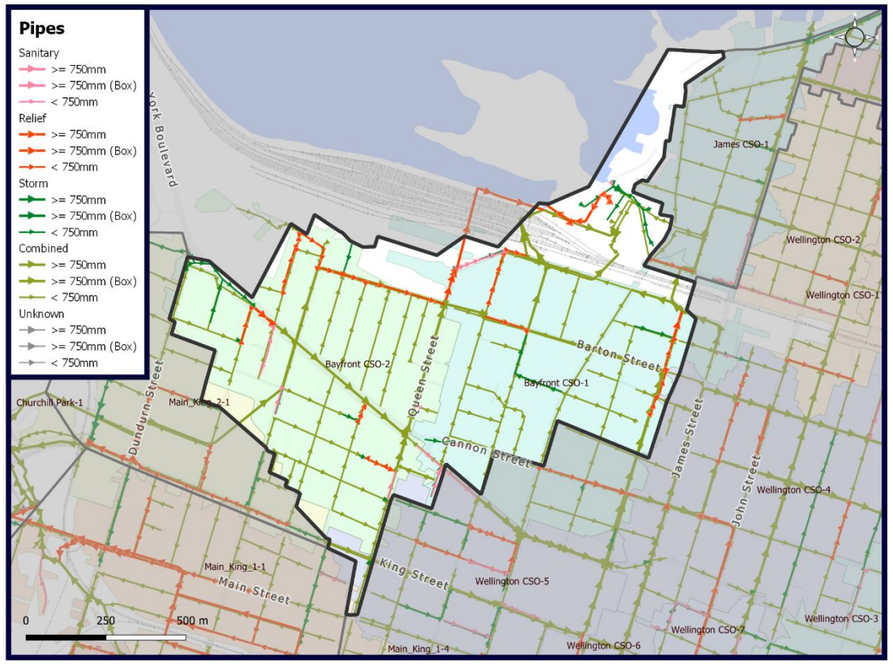
CSO Catchment Bayfront

Catchment Summary

Overview	The Bayfront CSO catchment is located in the northeastern-central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Strathcona • Central The Wellington CSO catchments contains two (2) subcatchments.	
Catchment Metrics	Area (ha)	111
	Total Length of Sewers (km)	28.1
	Length of Combined Sewers (km)	21.6
	Length of Sanitary Sewers (km)	1.0
	Length of Storm Sewers (km)	2.1
	Length of Relief Sewers (km)	3.4
	Storage Tanks (# and Name)	

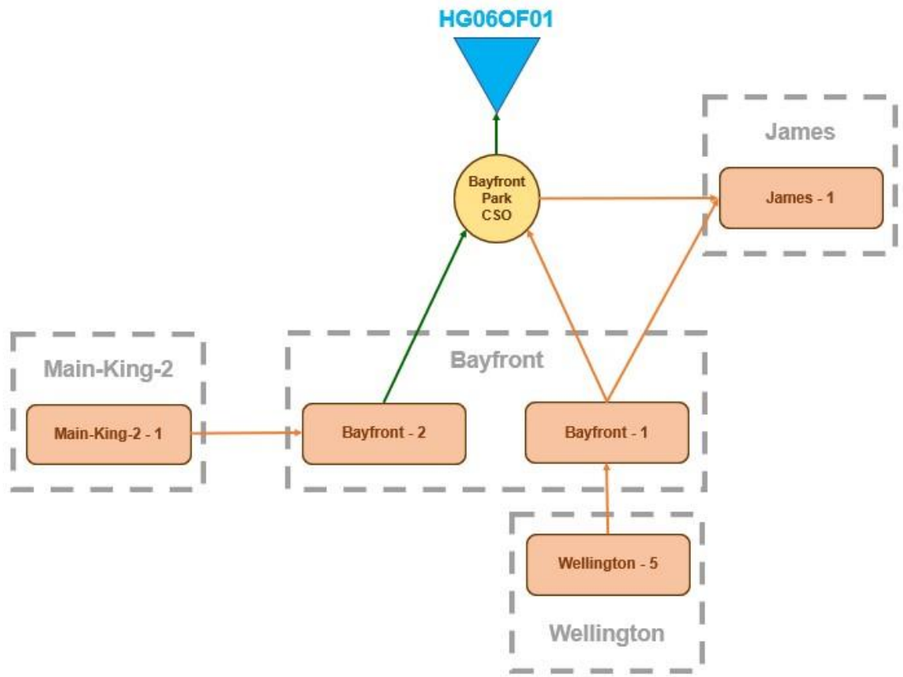


CSO Catchment Bayfront

Minor System Overview

The sanitary and combined system are defined by the following features:

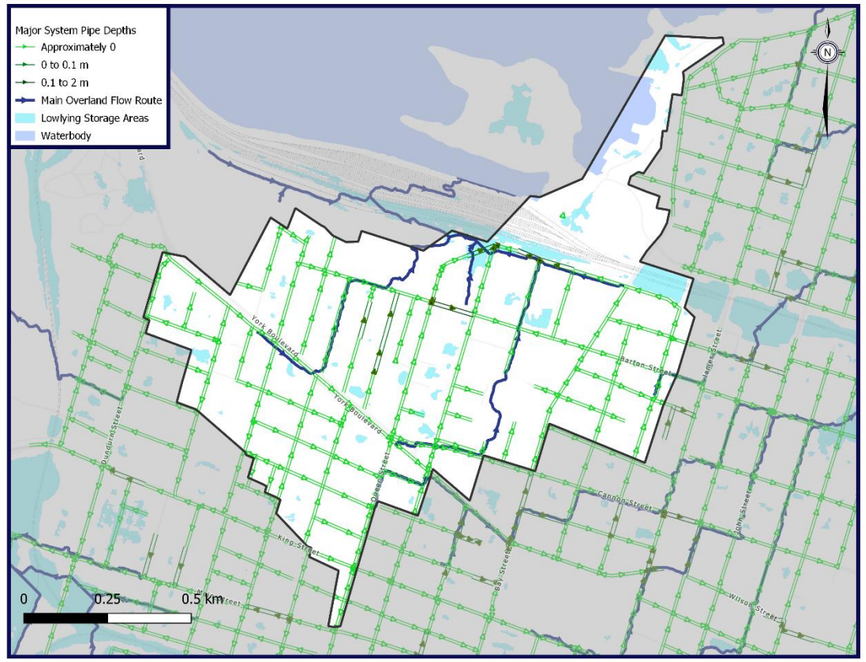
- The Bayfront CSO catchment generally conveys flows south towards Bayfront Park and the James CSO catchment
  - Trunk infrastructure is located within Locke St. N, Queen St. N, Caroline St. N, Stuart St., York Blvd., and Barton St. W
  - Stormwater within the Bayfront-2 subcatchment south of York Blvd. is conveyed south to York Blvd. and south along Queen St. N to Barton St. W
  - The Barton St. W combined sewer conveys the majority of the catchment combined flows to MacNab St. N where it is then conveyed into the James CSO catchment
- External upstream sewer flows are conveyed as follows:
  - Main-King-2-1 combined sewer flows are conveyed through the Locke St. N trunk sewer to the Barton St. W trunk sewer
  - Wellington-5 combined sewer flows are conveyed through the MacNab St. N trunk sewer through to the James CSO catchment
- There is one (1) combined sewer overflow outfall within the catchment
  - The outfall is located south of Bayfront Park, between the park and the railway freight depot
- The Bayfront Park CSO tank is located within Bayfront Park and discharges through the Bayfront CSO outfall once full
  - Tank contents are pumped to the combined sewer at the intersection of Strachan St. W and Bay St. N once capacity becomes available
  - Relief sewers along Barton St. W and north of Queen St. N convey combined sewer overflow to the Bayfront Park CSO tank



CSO Catchment Bayfront

Major System Overview

- The Bayfront CSO catchment contains two (2) primary overland flow routes as described below:
  - Beginning at York Blvd. and Inchbury St., travelling east along York Blvd. and north along Magill St., ultimately crossing the rail freight depot and discharging to the bayfront waterfront area
    - Bayfront-2 → External
  - Beginning at York Blvd. and Queen St. W, travelling east to Cannon St. W and then south to Caroline St. N. Overland flows are conveyed along Stuart St. and ultimately discharge to the bayfront waterfront area
    - Bayfront-1 → External
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - Isolated surface depressions located throughout the Bayfront CSO catchment, predominantly within private yards/properties
  - Large surface depression along the rail freight depot connected to the overland flow path
- Modeled major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Ray St. N, south of Barton St. W
  - Oxford St., south of Barton St. W
  - Barton St. W, east of Queen St. N
  - Along Stuart St.



Summary of Previous Studies

DRAFT - DMAF CSO Outfall Backflow Preventor Installations Preliminary Design Report (RVA, 2021)

- June 2019 had high lake levels which caused lake water to flow back through storm outfalls
- Surcharged both storm sewers and connected CSO tanks
- Study provides effects and data on the following outfalls:
  - Bayfront Park Outfall
  - Strathearne Gate
  - Pier 8 Outfall
- Draft study, outcome not confirmed and results in progress

Summary of Planned Works

- MECP is pushing City in Direction to separate because they would not allow increase in size in Park Street N – City planned to change plumbing in undersized pipe but Ministry would not allow it.

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Bayfront - 1	1	1	1	3	3	1	3	1

CSO Catchment Bayfront

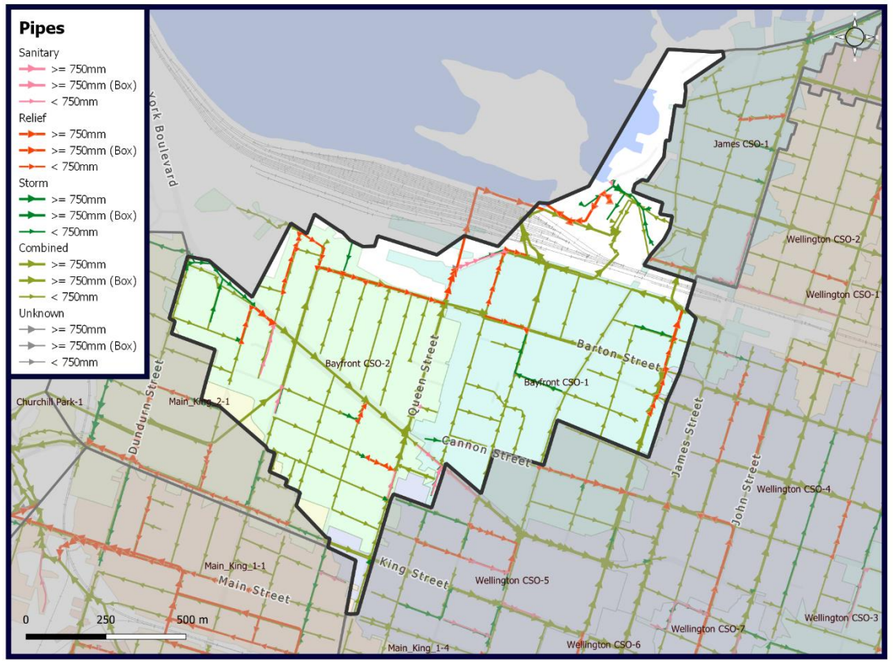
Bayfront - 2	3	1	1	2	1	1	4	1

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Bayfront - 1	Medium	Medium	
Bayfront - 2	Medium	Medium	

Issues and Options

Summary of Key Issues	• Outfalls within catchment sensitive to lake levels from 2019 Lake Ontario historic high water event • System surcharging at Stuart St and Hess St N junction with complicated connectivity between storm, sanitary, combined, and relief systems • Clustered Hansen calls along Magill St overland flow path ○ Location of Hansen calls has moderately shallow sewers (1.8 m – 2.8 m deep) • Overall moderate sewer depth throughout catchment
Summary of Potential Options	• 1) (BF-SWR) Managed sewer separation

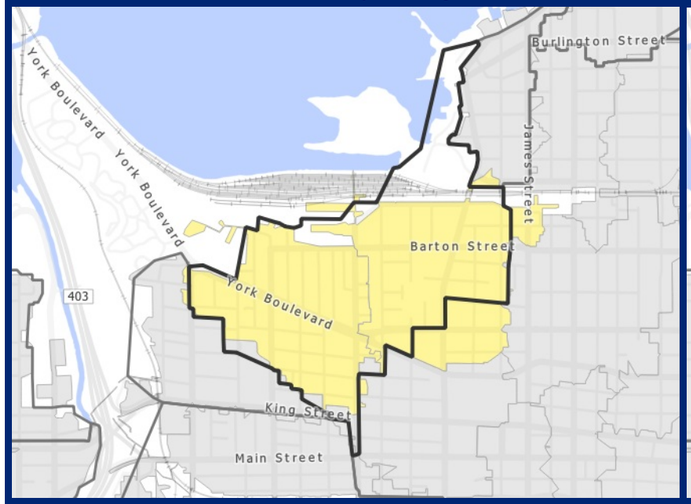


Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works

CSO Catchment Bayfront							
Managed Sewer Separation (BF-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$18.5M	Recommended	Low Priority Future Planning (20+ years)	None

Overall Priority Ranking



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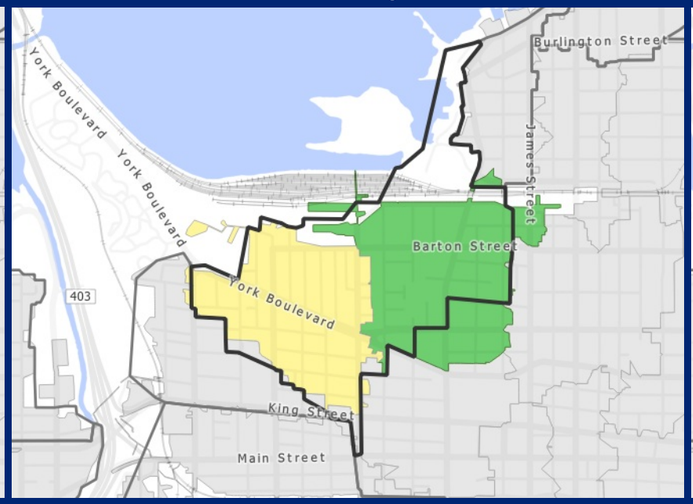
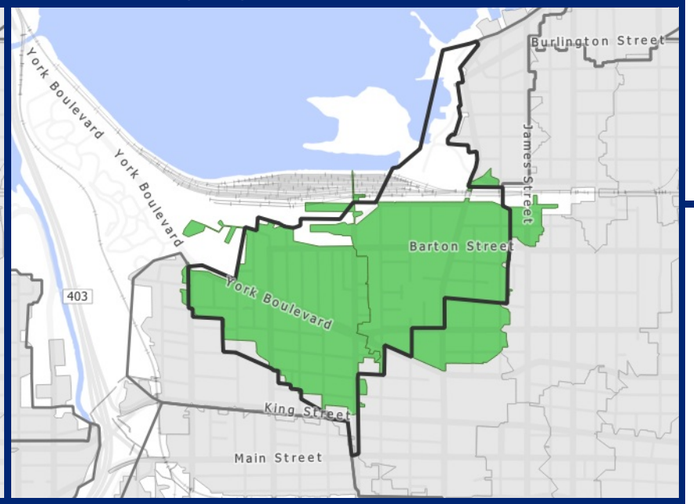
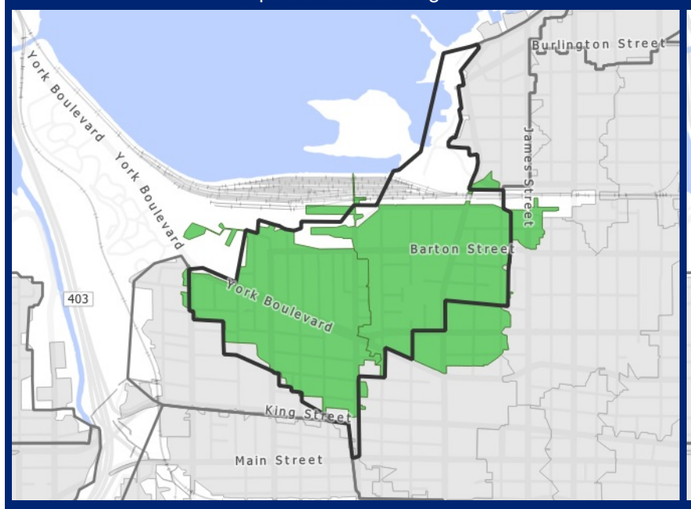


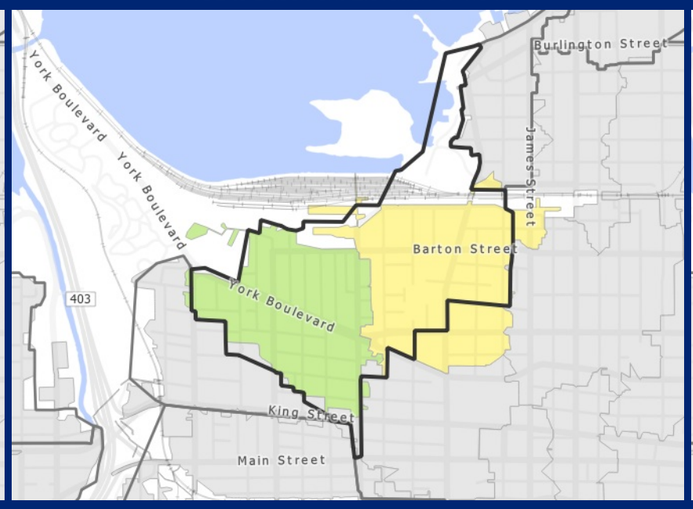
Pipe Depth for Residential Connections



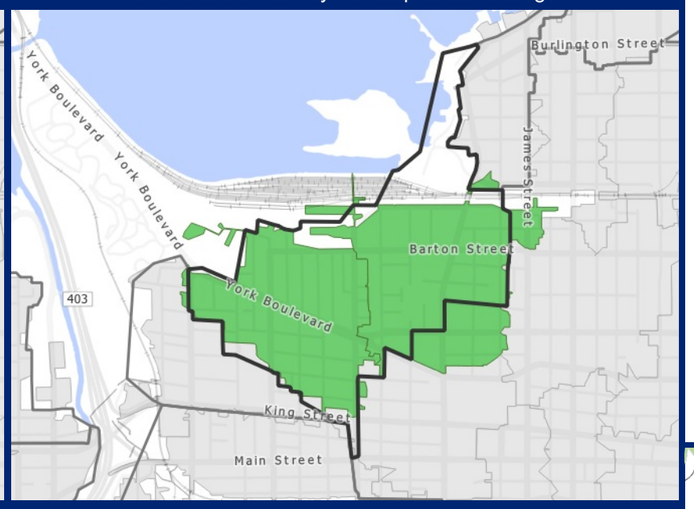
Pipe Condition and Age



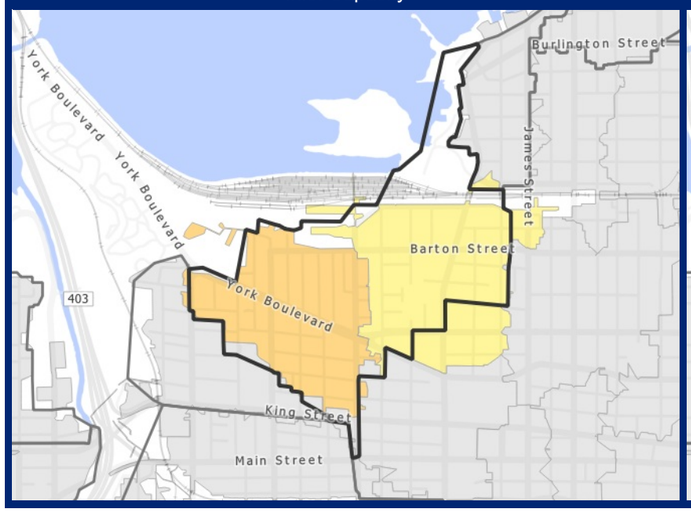
HGL to Basement Elevation of 1.8 m



Overland Connectivity with Depression Storage



Inlet Capacity



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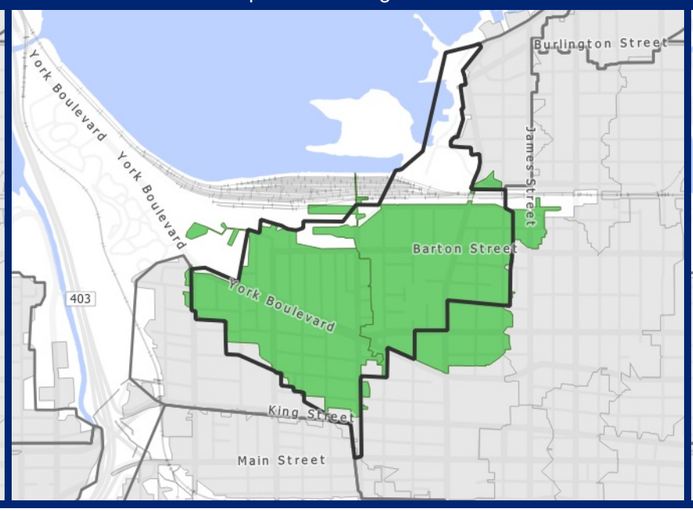
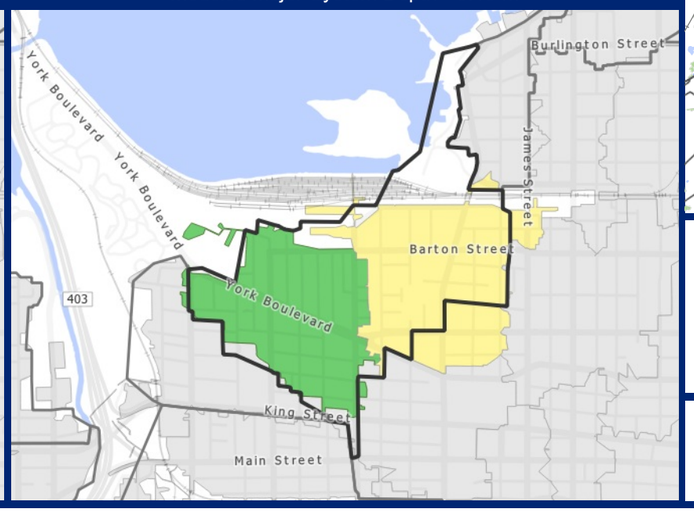


Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
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- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

N

0 0.5 1 km

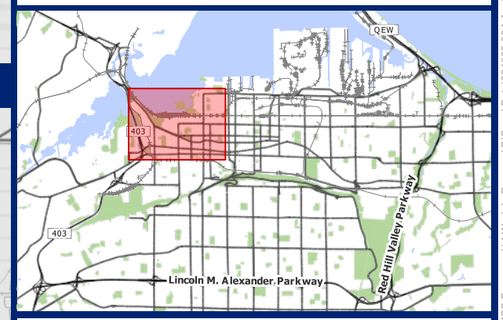


Figure 10 of 24

Bayfront CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Wellington

Catchment Summary

Overview

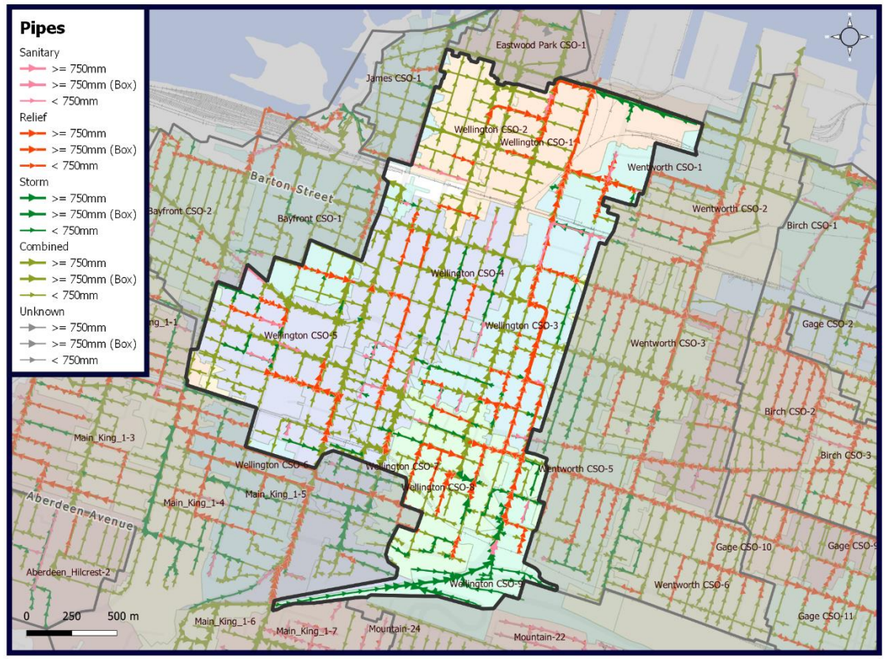
The Wellington CSO catchment is located in the central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- North East End
- Industrial Sector A and Keith
- Central
- Beasley
- Landsdale
- Durand
- Corktown
- Stinson

The Wellington CSO catchments contains nine (9) subcatchments.

Catchment Metrics

Area (ha)	436
Total Length of Sewers (km)	90.5
Length of Combined Sewers (km)	58.2
Length of Sanitary Sewers (km)	3.9
Length of Storm Sewers (km)	14.8
Length of Relief Sewers (km)	13.7
Storage Tanks (# and Name)	

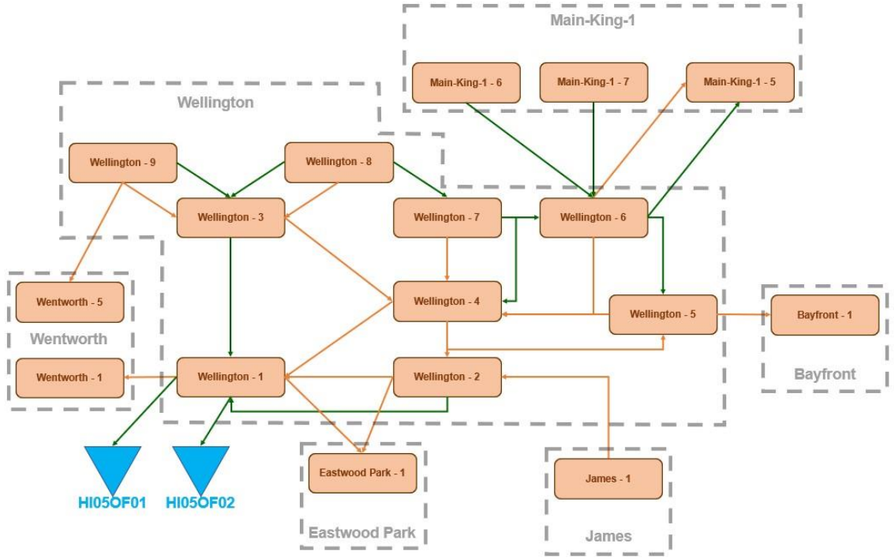


CSO Catchment Wellington

Minor System Overview

The sanitary and combined system are defined by the following features:

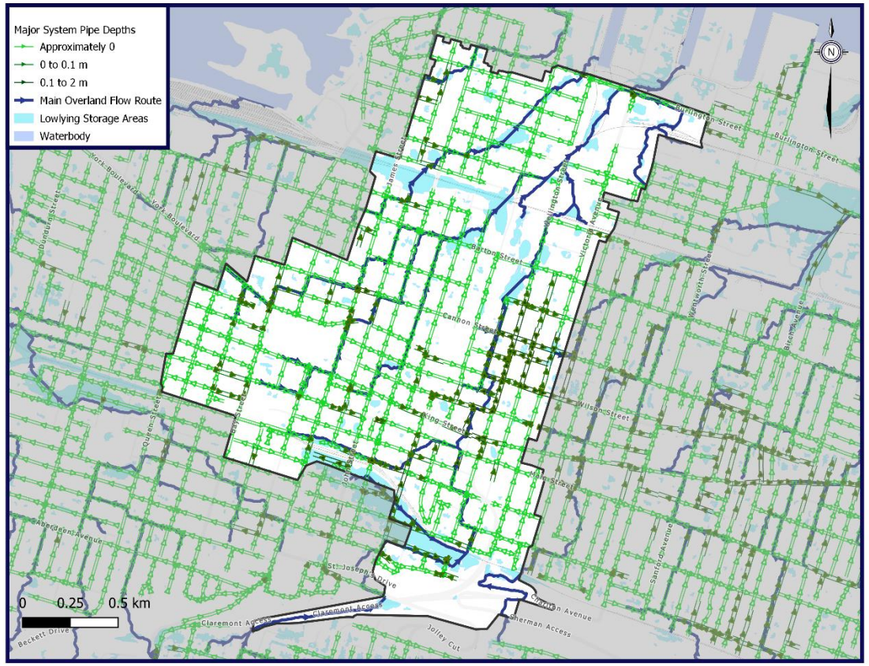
- The Wellington CSO catchment generally conveys flows from south to north and west to east
  - There is combined trunk infrastructure in the following north-south streets, conveying combined sewer flows south:
    - Macnab St. N and S
    - James St. N and S
    - John St. N
    - Catharine St. N
    - Spring St. and Cathcart St.
    - The northern portion of Wellington St. N
    - The northern portion of Ferguson Ave. N
  - There is combined trunk infrastructure in the following east-west streets:
    - King St. W and York Blvd., west of MacNab St. N conveying combined sewer flows to MacNab St. N
    - Robert St., west of Wellington St. N, conveying combined sewer flows to Wellington St. N
    - Barton St. E, west of Ferguson Ave. N, conveying combined sewer flows to Ferguson Ave. N
    - Ferrie St. E, conveying combined sewer flows east
    - Burlington St. E, conveying combined sewer flows east
- There is one (1) combined sewer overflow outfall within the catchment
  - The outfall is at the northmost end of Wellington St. N, discharging directly into the harbour
    - Relief sewers from both Wellington St. N and Ferguson Ave. N convey excess combined sewer flows to the outfall
- The relief sewer within Wellington St. extends from the outfall at the harbour to the bottom of the escarpment, approximately at Sherman access
  - This relief sewer captures CSO flows from the eastern portion of the Wellington CSO catchment including east-west connection relief sewers
  - Wellington-3, Wellington-8, and Wellington-9 are directly serviced by this relief sewer network
- Multiple relief sewers within Wellington-4, Wellington-5, Wellignton-6, and Wellington-7 service the western portion of the Wellington CSO catchment



CSO Catchment Wellington

Major System Overview

- The Wellington CSO catchment contains two (2) primary overland flow routes as described below:
  - One branch which flows from southwest to northeast, beginning at approximately James St. and Barton St. conveying overland flow diagonally across the northern end of the catchment to the outfall at the north end of Wellington St. N
  - Multiple branches which reach across the majority of the catchment, conveying overland flow to the discharge point at the north end of Emerald St. N
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - Large surface depressions within the railway corridor north of Barton St. E, with connectivity along the overland flow path
    - This rail corridor is known to be at a lower grade than the surrounding streets. As such, caution should be exercised in understanding the overland flow path connectivity in this area
  - Large surface depression along the overland flow route located at the intersection of Barton St. and Mary St.
  - Large surface depression along the overland flow route located southwest of Wellington St. N and Barton St. E
  - Large surface depressions between the escarpment and southern rail corridor with overland flow connectivity
  - Small pockets of isolated surface depressions throughout the Wellington CSO catchment
- Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Single-block stretches within the southern and western portions of the Wellington CSO catchment
  - Large cluster between Barton St. E and Main St. E, just east of Ferguson Ave.



Summary of Previous Studies

Summary of Planned Works

- Downtown Secondary Plan Area (approximate) will be completed after FDMSS by ~end of the year. More detailed study with goal of identifying upgrades needed for servicing intensification.

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Wellington - 1	1	3	3	4	3	4	3	4
Wellington - 2	1	3	5	3	1	2	3	2
Wellington - 3	1	1	1	5	5	3	2	2
Wellington - 4	3	1	5	4	3	3	3	2

CSO Catchment Wellington								
Wellington - 5	1	1	1	4	1	1	3	1
Wellington - 6	1	5	3	4	1	1	1	1
Wellington - 7	1	1	1	5	3	4	1	3
Wellington - 8	1	1	3	5	5	5	2	4
Wellington - 9	1	1	3	3	1	2	4	1

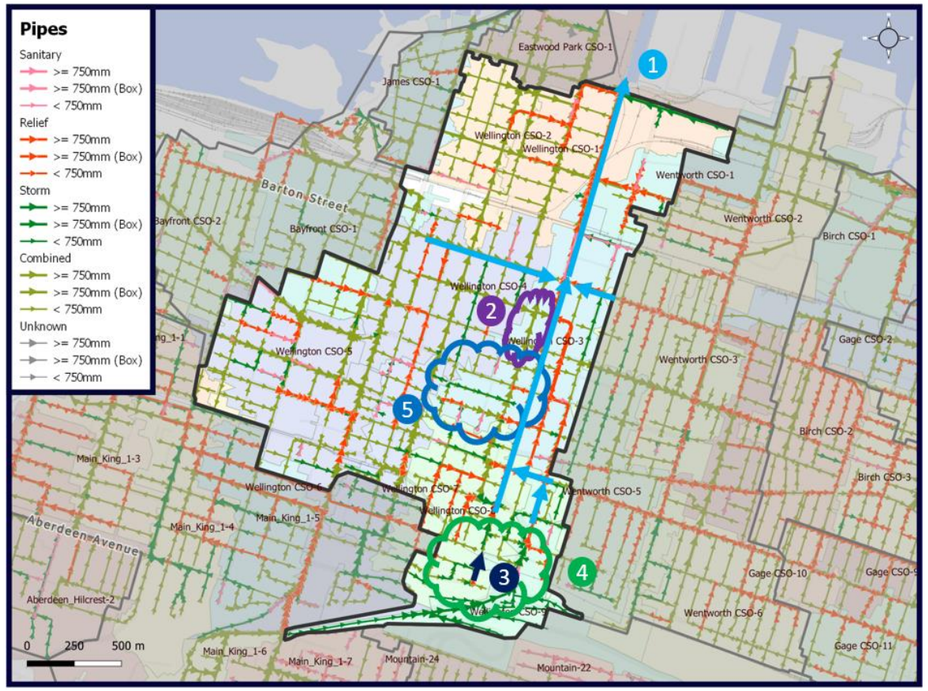
Sub Catchment Prioritization			
	Catchment Priority	Data Uncertainty	Commentary
Wellington - 1	Medium	Medium	
Wellington - 2	High	Low	
Wellington - 3	High	Low	
Wellington - 4	High	Low	
Wellington - 5	Low	Low	
Wellington - 6	Medium	Low	
Wellington - 7	High	Low	
Wellington - 8	High	Low	
Wellington - 9	Medium	Low	

Issues and Options

CSO Catchment Wellington

Summary of Key Issues	• Significant amount of industrial/commercial flat roofs directly connected to system throughout the catchment
	• Number of basements not certain within area
	• Surface depressions connected to overland flow path in the following locations:
	  ○ Railway corridor north of Barton St (bisects multiple overland flow paths)
	  ○ Barton St and Mary St intersection (grocery store plaza)
	  ○ Cathcart St north of Cannon St
	  ○ Large surface depression south of Hamilton Go Centre due to elevated railway tracks and berm – further investigation required to confirm culverts / adequate flow route
	• High levels of modeled minor system surcharging within Wellington - 3, Wellington - 7, and Wellington - 8 subcatchments
	• Major system depth in model high within Wellington - 3 and Wellington - 8 subcatchments

Summary of Potential Options	• 1) (WL-1) Continued sewer separation for existing partially-separated areas – trunk network to be defined to support separation • 2) (WL-2) Provide relief sewer to capture surface depression at Cathcart St south of Barton • 3) (WL-3) Relief/storm sewer extension within Wellington St S from south of Young St to north of Young St to isolate existing storm system from combined system • 4) (WL-4) Flow monitoring within SE corner of Wellington catchment to confirm model results with potential diversion of sanitary flows from Spring St combined sewer and West Ave relief sewer to Victoria Ave relief sewer • 5) (WL-5) Implement inlet control devices where major system is adequate to restrict stormwater flows to combined and relief sewers within King St E and surrounding streets, just west of Victoria St

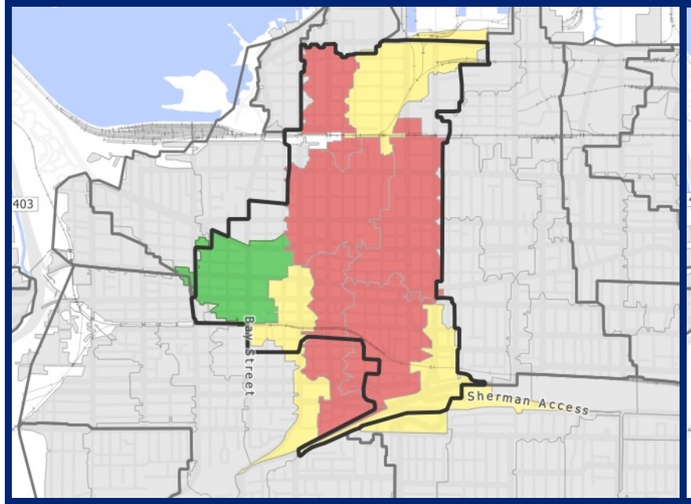


Option Evaluation

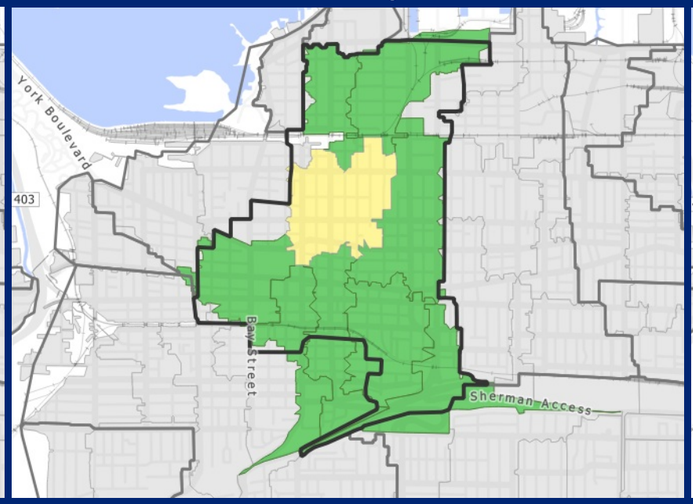
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1: Managed sewer separation within existing separated areas (WL-1a)	• Leverages existing works completed to provide separated storm sewers • Provides additional capacity to existing combined and relief sewers	• Requires detailed planning to determine optimal trunk layout configuration • High potential for utility conflicts	System Wide Solution Substantial Benefit	$390K	Recommended	High Priority Long Term (10 – 20 years)	None
Option 1: Managed sewer separation with trunk planning (WL-1b)	• Leverages existing works completed to provide separated storm sewers • Provides additional capacity to existing combined and relief sewers	• Requires detailed planning to determine optimal trunk layout configuration • High potential for utility conflicts	System Wide Solution Substantial Benefit	$47.3M	Recommended	High Priority Long Term (10 – 20 years)	None

CSO Catchment Wellington							
Option 2: Relief sewer for surface depression (WL-2)	• Protects public right-of-way and cluster of homes from flooding	• May cause downstream capacity concerns • Lower priority as no existing flooding Hansen calls in location • Low-traffic area	Local Solution Limited Benefit	$2.1M	Further Study	Low Priority Medium Term (5 – 10 years)	None
Option 3: Wellington St relief sewer extension (WL-3)	• Isolates existing storm system south of Young from combined system • Majority of existing linear infrastructure in place north and south of railway line	• Potential conflicts with railway corridor • Limited number of residences would benefit from project	Local Solution Limited Benefit	$2.1M	Further Study	Medium Priority Medium Term (5 – 10 years)	None
Option 4: Flow monitoring with potential relief sewer extension (WL-4)	• Utilize available capacity in nearby relief sewer • Free up capacity in existing surcharging relief and combined sewers	• Hansen calls do not match model results – confirmation required • Potentially high-cost solution in high-traffic areas	Local Solution Moderate Benefit	$3.7M	Recommended	Medium Priority Medium Term (5 – 10 years)	None
Option 5: Inlet control device implementation (WL-5)	• Potential to protect residents along King St from basement flooding • Affected streets are along existing overland flow route	• Arterial/commuter streets provide risk with surface ponding	Local Solution Moderate Benefit	$80K	Further Study	Medium Priority Medium Term (5 – 10 years)	None
Managed Sewer Separation (WL-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$44.5M	Recommended	High Priority Future Planning (20+ Years)	None

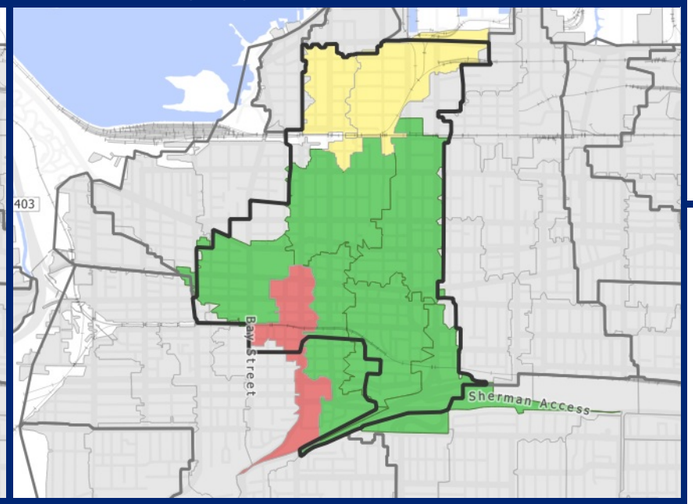
Overall Priority Ranking



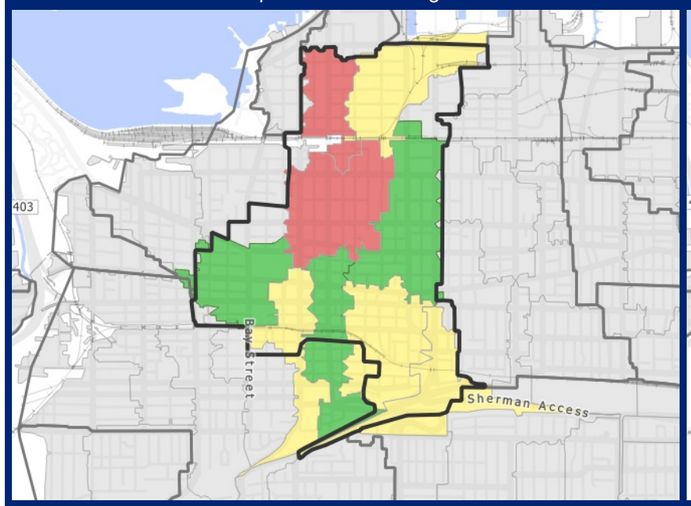
Hansen Flooding Calls



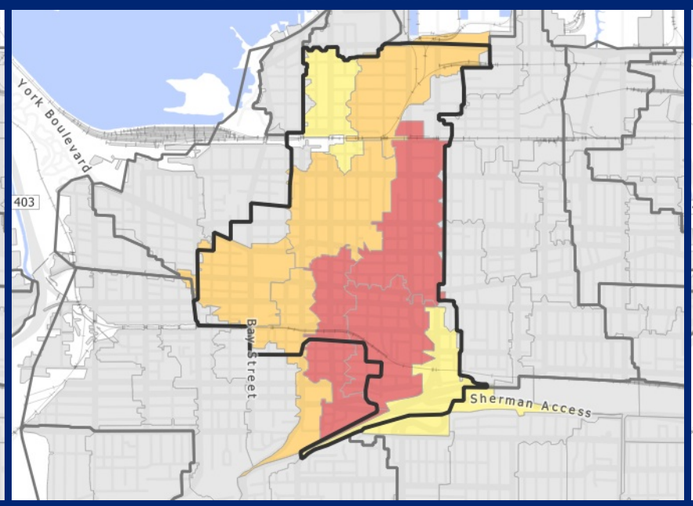
Pipe Depth for Residential Connections



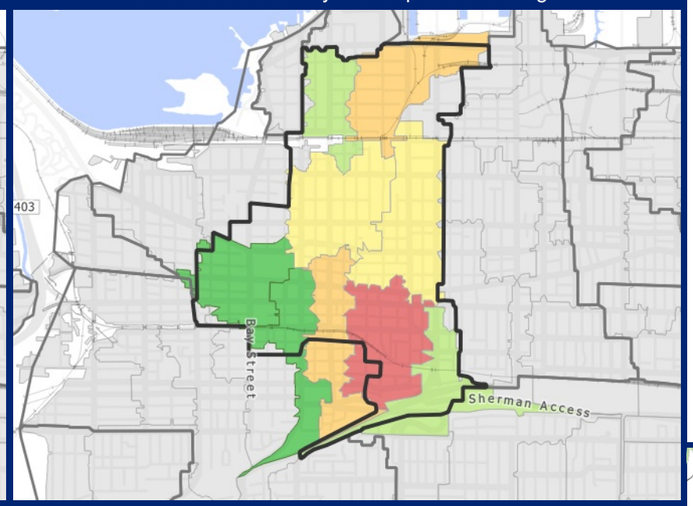
Pipe Condition and Age



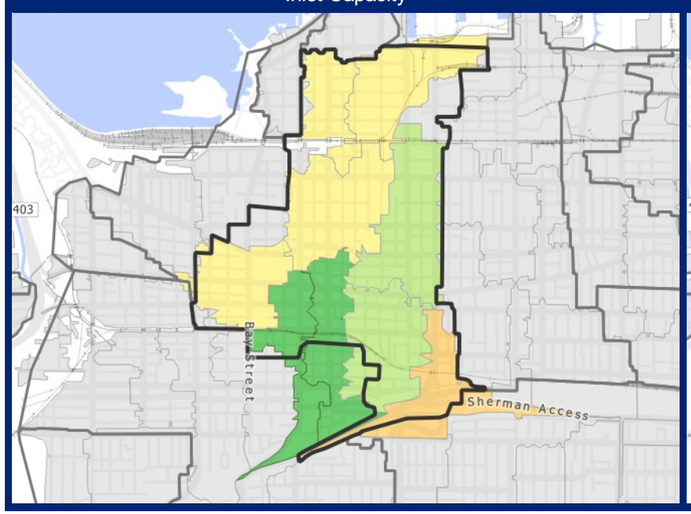
HGL to Basement Elevation of 1.8 m



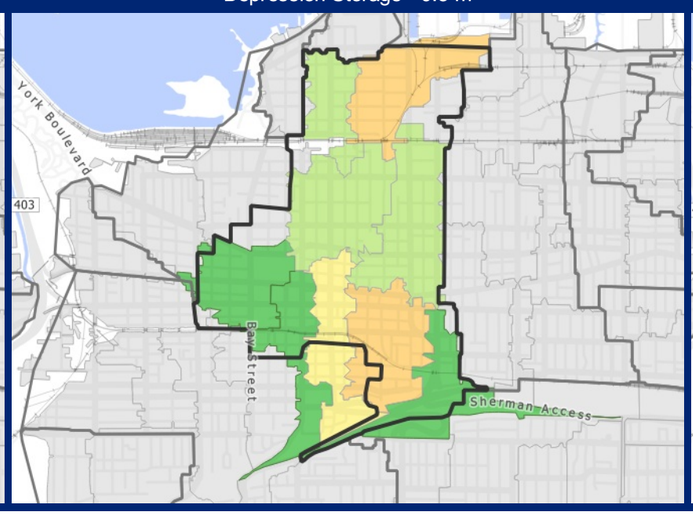
Overland Connectivity with Depression Storage



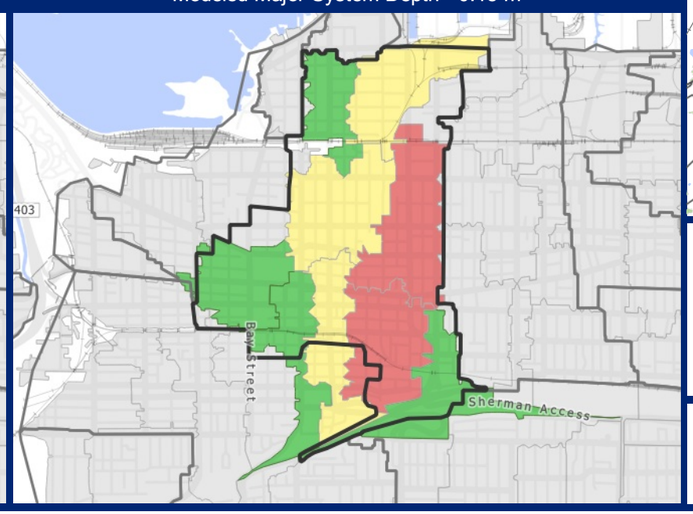
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

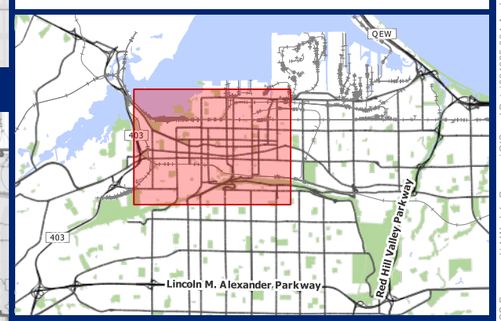


Figure 11 of 24

Wellington CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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CSO Catchment Wentworth

Catchment Summary

Overview

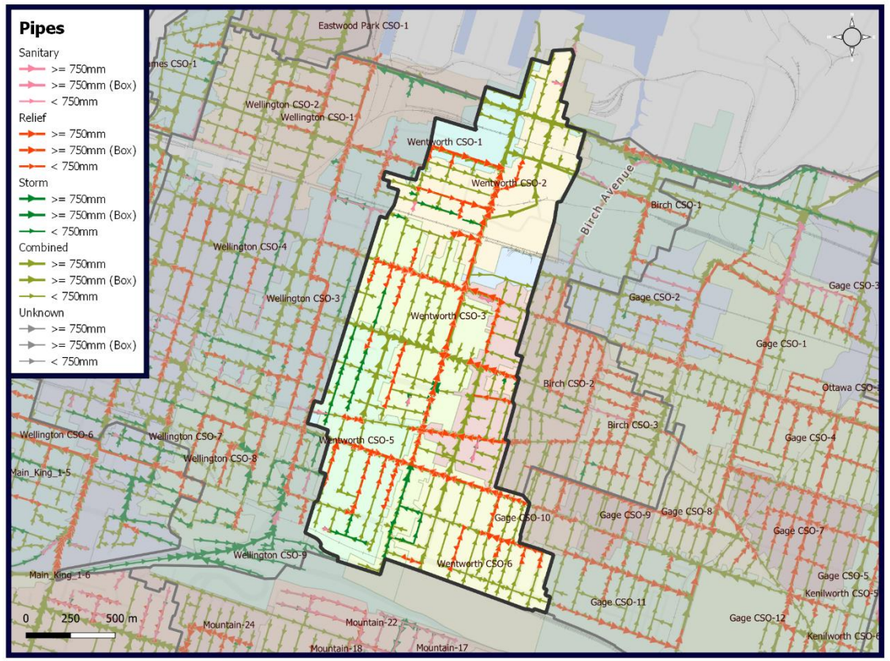
The Wentworth CSO catchment is located in the central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Industrial Sector A and Keith
- Industrial Sector B and Keith
- Landsdale
- Gibson
- Stinson
- St. Clair

The Wentworth CSO catchments contains six (6) subcatchments.

Catchment Metrics

Area (ha)	323
Total Length of Sewers (km)	59.5
Length of Combined Sewers (km)	42.7
Length of Sanitary Sewers (km)	1.0
Length of Storm Sewers (km)	4.6
Length of Relief Sewers (km)	11.3
Storage Tanks (# and Name)	

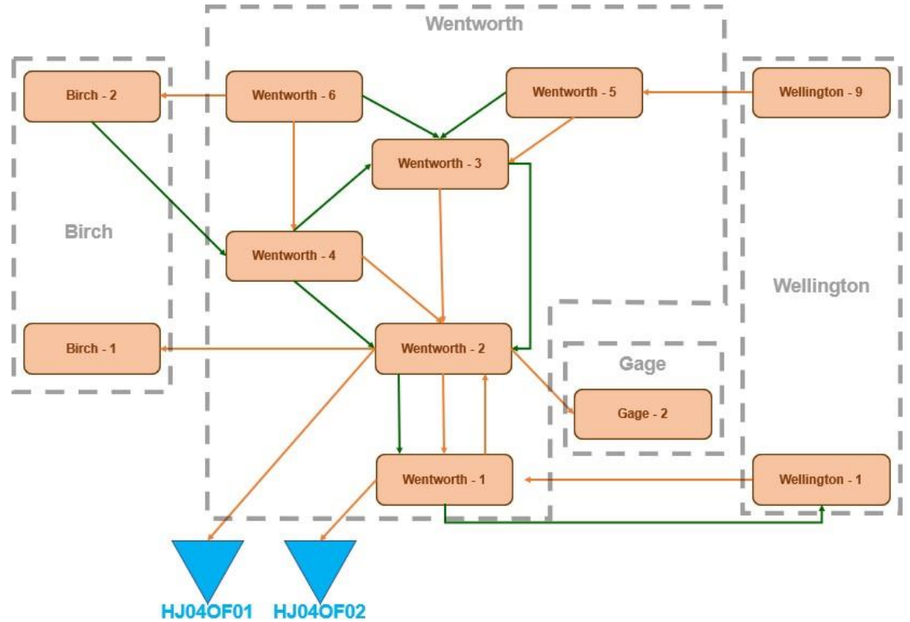


CSO Catchment Wentworth

Minor System Overview

The sanitary and combined system are defined by the following features:

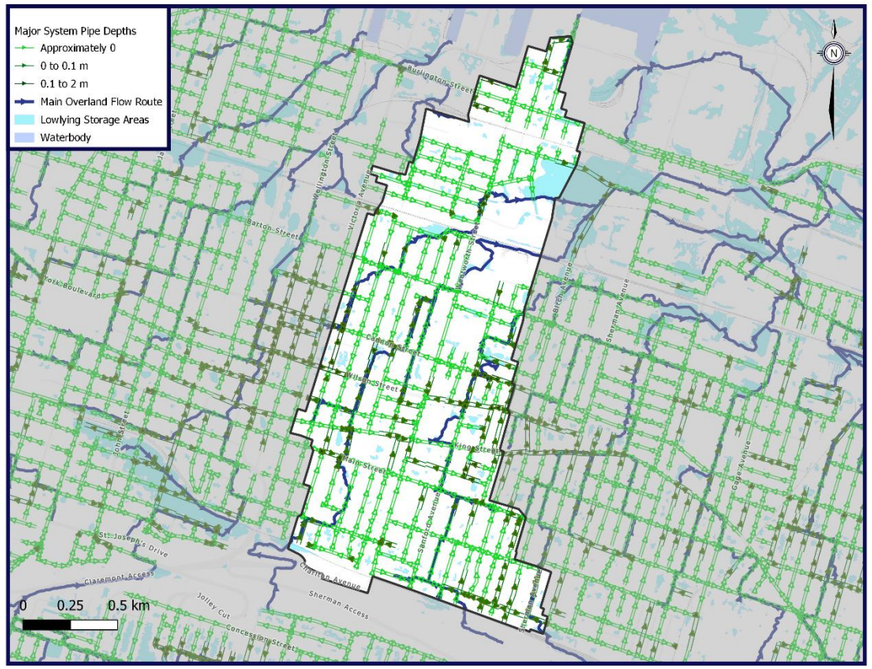
- The Wentworth CSO catchment generally conveys flows from south to north and west to east
  - There is combined trunk infrastructure in the following north-south streets, conveying combined sewer flows south:
    - The northern portion of Sanford Ave. N
    - The northern portion of Tisdale St. N
    - Wentworth St. N
  - There is combined trunk infrastructure in the following east-west streets:
    - Cannon St. E
    - Mars Ave
    - Brant St.
    - Burlington St. E
- There are two (2) combined sewer overflow outfalls within the catchment
  - The outfall at the northmost end of Wentworth St. N, discharging directly into the harbour
  - The outfall at the northmost end of Hillyard St., discharging directly into the harbour
- The relief sewer system is described as follows:
  - Multiple north-south relief sewers convey over-capacity combined sewer flows from north of Main St. E to the relief sewer within Main St. E
  - The relief sewer within Main St. E conveys over-capacity combined sewer flows to the relief sewer within Wentworth St. S and Wentworth St. N
  - Relief sewers within King St. E also convey over-capacity combined sewer flows to the relief sewer within Wentworth St. N
  - Multiple east-west sewers within the Wentworth CSO catchment convey over-capacity combined sewer flows to the relief sewer within Wentworth St. N
- There are no CSO tanks within the Wentworth CSO catchment



CSO Catchment Wentworth

Major System Overview

- The Wentworth CSO catchment contains three (3) primary overland flow routes as described below:
  - Two branches direct overland flows from the southwest to the northeast, crossing through the Wentworth-5, Wentworth-3, and Wentworth-2 subcatchments into the Birch-1 subcatchment, where the two branches join
    - Wentworth-3 → Wentworth-2 → Birch-1
    - Wellington-9 → Wentworth-5 → Wentworth-3 → Wentworth-2 → Birch-1
  - One overland flow patch directs major-system stormwater from south to north within the eastern portion of the Wentworth CSO catchment, eventually conveyed east into the Birch CSO catchment
    - Wentworth-6 → Wentworth-4 → Birch-2 → Gage-2 → Gage-1
- The following is a description of the surface depressions within the catchment, including any overland connectivity:
  - There are numerous small surface depressions throughout the catchment with no overland flow connectivity
  - Tisdale St. N, south of Cannon St. E has a surface depression with overland connectivity
  - There are multiple surface depressions with overland connectivity south of the railway corridor
- Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Large clusters between Cannon St. E and Main St. E with partial overland connectivity
  - Large cluster in the southeast portion of Wentworth-6, along Cumberland Ave. and west of Sherman Ave. S
  - Overland connected clusters along both Clyde St. and East Ave. N



Summary of Previous Studies

Summary of Planned Works

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Wentworth - 1	1	1	1	4	3	1	3	1
Wentworth - 2	1	3	5	5	3	3	4	3
Wentworth - 3	3	3	3	2	3	1	3	1
Wentworth - 4	1	3	3	3	5	2	2	2

CSO Catchment Wentworth								
Wentworth - 5	3	1	5	4	5	1	3	1
Wentworth - 6	1	3	5	4	1	1	5	1

Sub Catchment Prioritization			
	Catchment Priority	Data Uncertainty	Commentary
Wentworth - 1	Medium	Low	
Wentworth - 2	High	Medium	
Wentworth - 3	Medium	High	
Wentworth - 4	Medium	High	
Wentworth - 5	High	Medium	
Wentworth - 6	Low	Low	

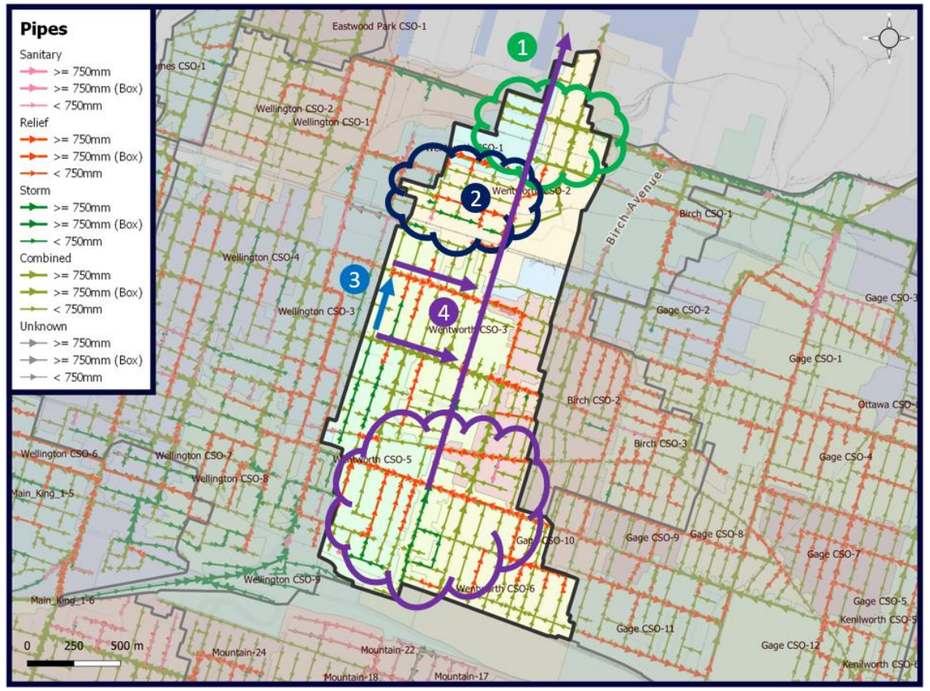
Issues and Options		

Summary of Key Issues	• Subcatchment is one of highest CSO contributors but CSO appears to be protecting basements from flooding sufficiently
	• Pocket of known flooding NE of Barton St
	• Many local sewers in poor condition across catchment
	• Sewer surcharging concerns and pipe condition concerns within Wentworth - 2, Wentworth - 5, and Wentworth - 6
	  ○ Local sewers surcharging north of Brant St
	  ○ East Ave N from Barton St E to Wilson St
	  ○ Huron St and Minto Ave
	  ○ SE corner of the Wentworth - 6 catchment including Eastbourne Ave, Main St E, Delaware Ave, Cumberland Ave, St. Clair Blvd, and Sherman Ave S
	• Surface depressions along the overland flow path in the following locations:
	  ○ Tisdale St N just south of Cannon St E
	  ○ Intersection of Victoria Ave N and Cannon St E
	  ○ Huron St and Minto Ave
	  ○ Birge Park (bound by railway corridor)	

CSO Catchment Wentworth

Summary of Potential Options

- 1) (WN-1) Separate storm sewers within north end of catchment due to proximity to outfall location
- 2) (WN-2) Perform sewer inspections to confirm condition and replace poor condition infrastructure – consideration for increasing size of infrastructure during replacement
- 3) (WN-3 Extend East Ave N storm sewer north of Cannon St to Barton St
- 4) (WN-4) Prioritized asset renewal within catchment with planning for concurrent storm sewer separation (managed sewer separation)

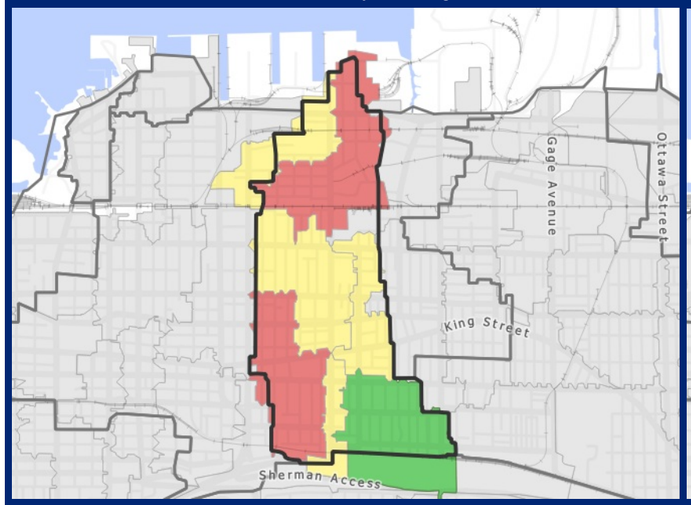


Option Evaluation

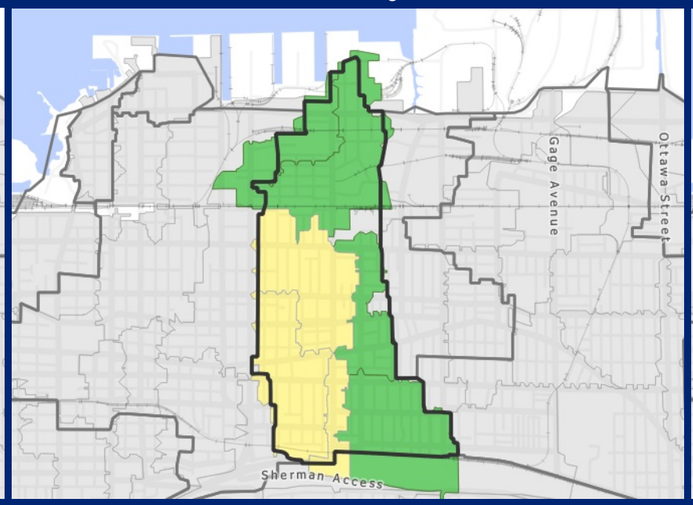
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1 Separate northern sewer network (WN-1)	• Proximity to outlet • Protection against basement flooding as there are existing Hansen calls and model projected surcharging	• Requires consideration for storm trunk infrastructure to outlet	Local Solution Moderate Benefit	$11.2M	Recommended	High Priority Medium Term (5 – 10 years)	None
Option 2: Condition assessment and infrastructure renewal with upsizing (WN-2)	• Condition of pipes may be causing Hansen flooding calls in area – infrastructure upsizing upon renewal would add additional protection against flooding	• Potential redundancy in works upon future managed sewer separation	Local Solution Moderate Benefit	-	Recommended	High Priority Short Term (3 – 5 years)	None

CSO Catchment Wentworth							
Option 3: East Ave N storm sewer (WN-3)	• Frees up capacity within local surcharging sanitary network • Option to renew poor condition sanitary sewer concurrently	• Limited benefit to East Ave N homes	Local Solution Limited Benefit	$1.4M	Further Study	High Priority Medium Term (5 – 10 years)	None
Option 4: Asset renewal with managed separation (WN-4a)	• Many locations with Hansen calls have poor asset condition – asset renewal with consideration for separation	• Requires consideration for trunk alignment and design	System Wide Solution Substantial Benefit	-	Recommended	Medium Priority Long Term (10 – 20 years)	None
Option 4: Asset renewal with managed separation (WN-4b)	• Many locations with Hansen calls have poor asset condition – asset renewal with consideration for separation	• Requires consideration for trunk alignment and design	System Wide Solution Substantial Benefit	-	Recommended	Medium Priority Long Term (10 – 20 years)	None
Managed Sewer Separation (WN-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$35.8M	Recommended	Medium Priority Future Planning (20+ years)	None

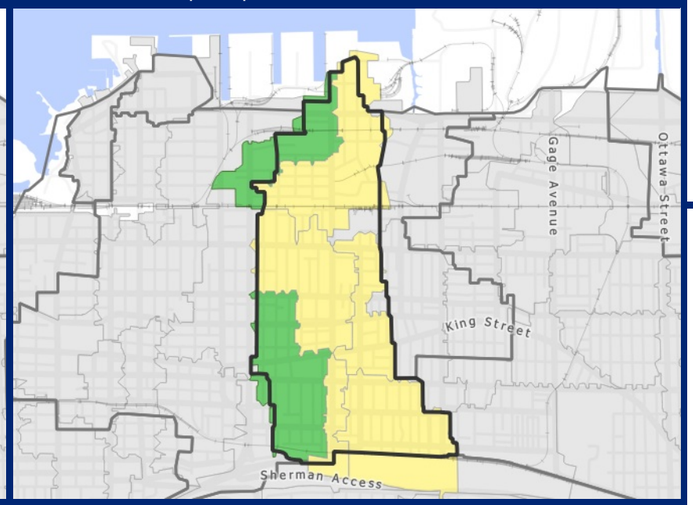
Overall Priority Ranking



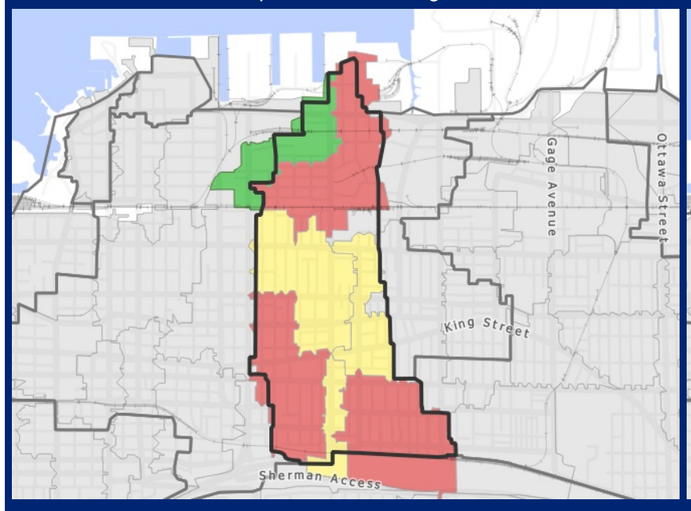
Hansen Flooding Calls



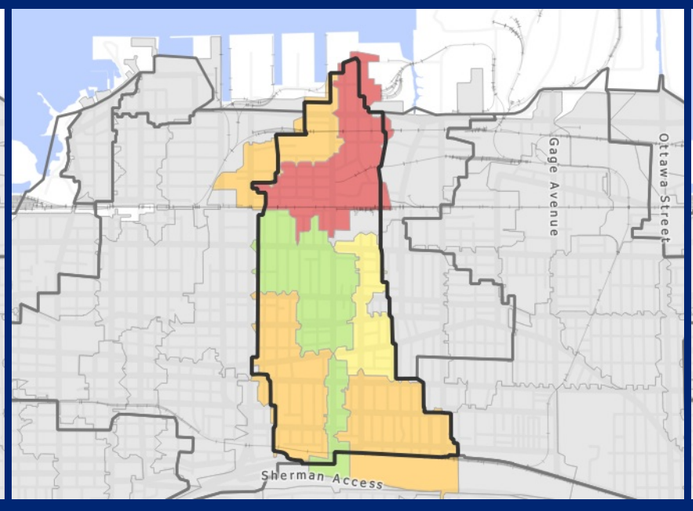
Pipe Depth for Residential Connections



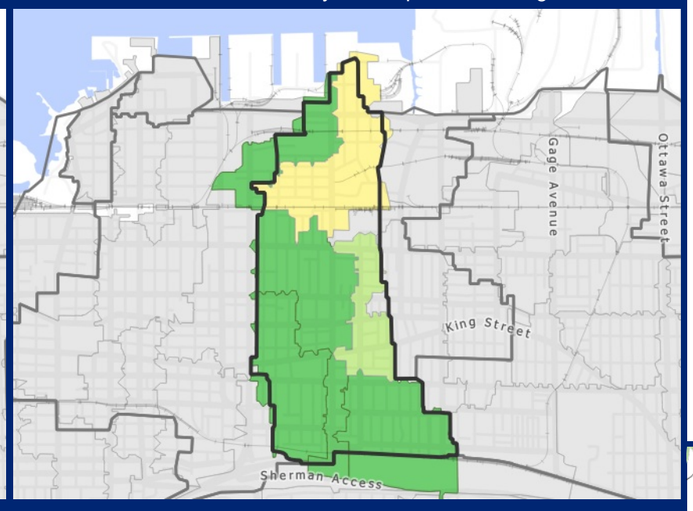
Pipe Condition and Age



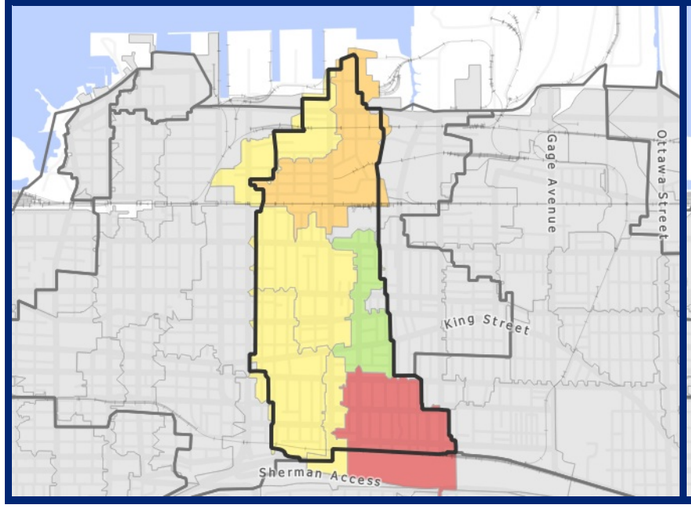
HGL to Basement Elevation of 1.8 m



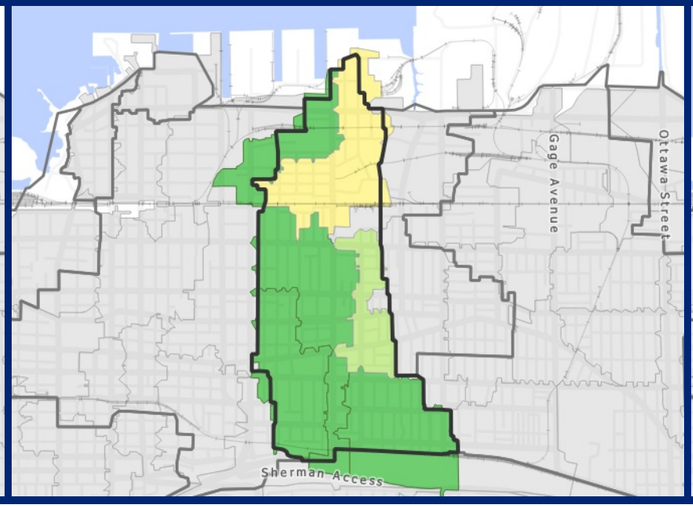
Overland Connectivity with Depression Storage



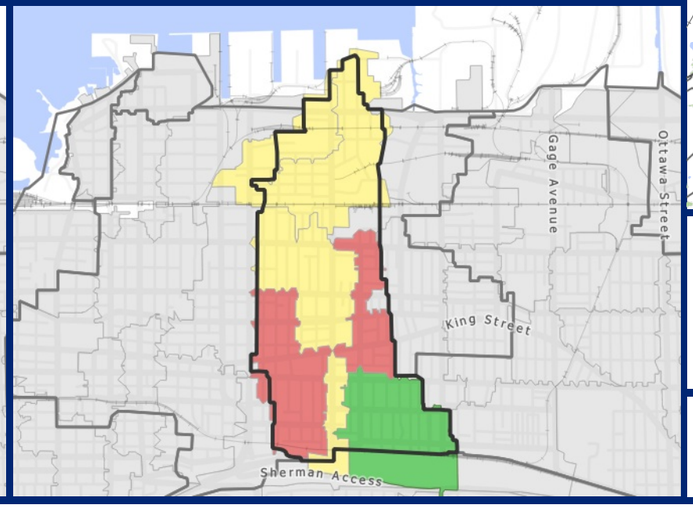
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

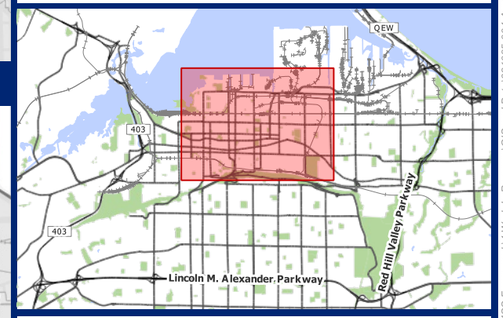


Figure 12 of 24

Wentworth CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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CSO Catchment Birch

Catchment Summary

Overview

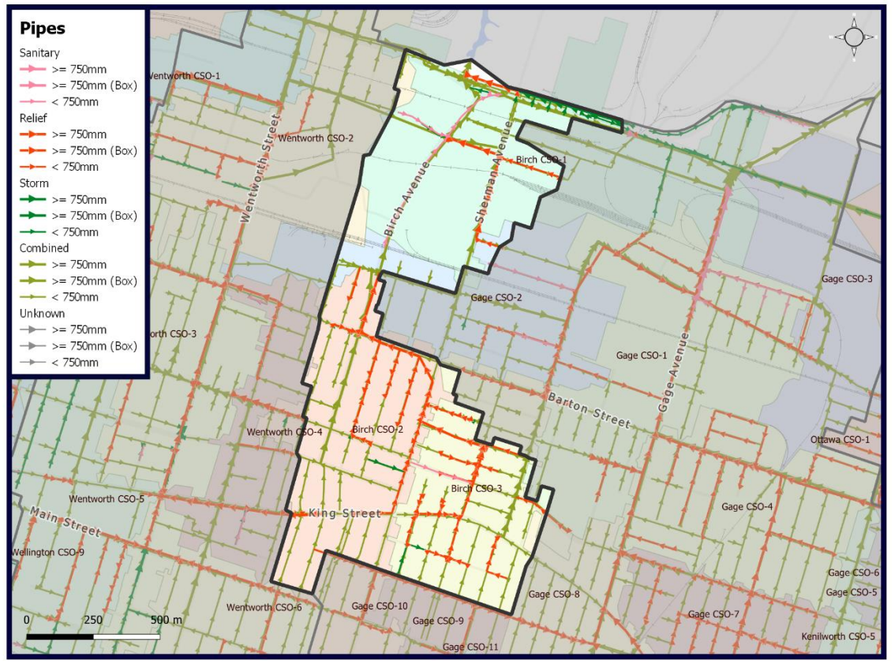
The Birch CSO catchment is located in the central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Industrial Sector B and Keith
- Industrial Sector C
- Gibson
- Stipley

The Birch CSO catchments contains three (3) subcatchments.

Catchment Metrics

Area (ha)	168
Total Length of Sewers (km)	38.3
Length of Combined Sewers (km)	26.1
Length of Sanitary Sewers (km)	1.7
Length of Storm Sewers (km)	3.2
Length of Relief Sewers (km)	7.3
Storage Tanks (# and Name)	

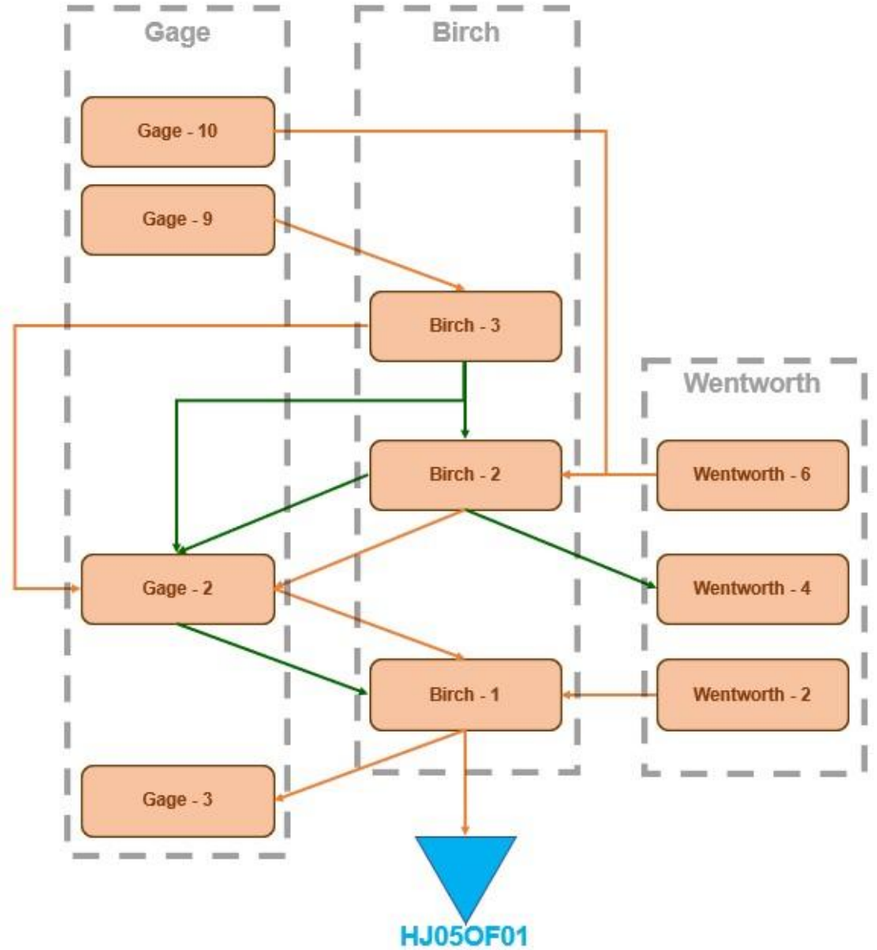


CSO Catchment Birch

Minor System Overview

The sanitary and combined system are defined by the following features:

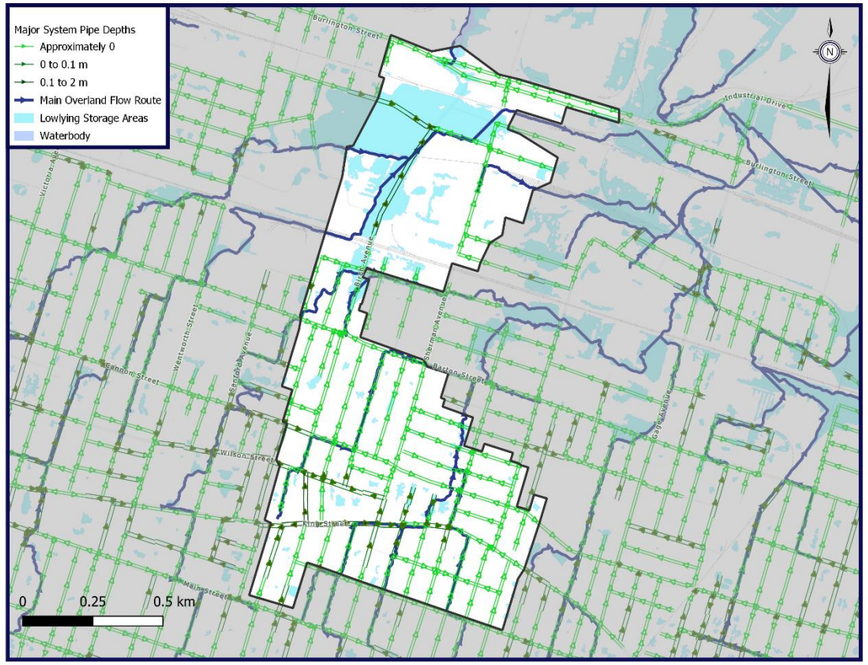
- The Birch CSO catchment generally conveys flows from south to north and east along Burlington St.
  - The primary combined sewer trunk within the Birch CSO catchment is within Birch Ave., conveying combined sewer flows to the trunk within Burlington St. E
  - There are combined trunk sewers within Brant St. and Sherman Ave. N, in the north end of the Birch CSO catchment, conveying combined sewer flows to a trunk within the corridor north of Gerrard St.
- There is one (1) combined sewer overflow outfall within the catchment
  - The outfall is located at the northmost end of Birch Ave., discharging to the harbour north of Burlington St. E
  - There are no combined sewer overflow tanks within the Birch CSO catchment
- The relief sewer system is described as follows:
  - Relief sewer trunk within Rosemont Ave., conveying over-capacity combined sewer flows west to the relief sewer trunk within Sherman Ave. N
  - Sherman Ave. N relief sewer trunk conveyed south to Barton St. E
  - Barton St. E relief sewer trunk conveyed west to Birch Ave with multiple local relief sewer connections south of Barton St. E
  - Birch Ave. relief sewer trunk directing south to the railway corridor, with connectivity to the combined sewer trunk
  - Relief sewer trunk within Burlington St. E with storm sewer connectivity within Burlington St. E, discharging to the outfall within the harbour



CSO Catchment Birch

Major System Overview

- The Birch CSO catchment contains three (3) primary overland flow routes as described below:
  - The southmost overland flow route conveys stormwater from west to east across the Birch-1 subcatchment from Wentworth-2 to within the eastern portion of the Birch-1 subcatchment
    - Wentworth-2 → Birch-1
    - This overland flow path does not have an identified outlet
    - This overland flow path has large surface depressions across the entire flow path; however, there may be inconsistencies due to the railway tracks and the overland flow model not accounting for culverts
  - An overland flow path passes through the Birch-2 subcatchment from Wentworth-4 to Gage-2, flowing from west to east
    - Wentworth-6 → Wentworth-4 → Birch-2 → Gage-2 → Gage-1
    - There is a large surface depression along the overland flow path at the railway underpass nearby Princess St. at Birch Ave.
  - There are multiple overland flow paths that travel from south to north and connect along Barton St. E and convey into Gage-2
    - Gage-9&10 → Birch-3 → Gage-2 → Gage-1
    - Birch-2 → Gage-2 → Gage-1
- Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Cluster within the southwestern portion of the Birch CSO catchment along King St. E, Wilson St., and surrounding roads with partial overland flow connectivity
  - Birch Ave south of the railway underpass nearby Princess St. at Birch Ave. with overland flow connectivity and within a large surface depression
  - Brant St. west of Birch Ave within a large surface depression



Summary of Previous Studies

Lower East End Storm Drainage Study and Stormwater Management Investigation (McCormick Rankin Corp., 2009)

- The outlet at Birch Ave is partially submerged and may contain debris blocking a clear pathway
- All of the combined trunk sewers in the LEED study area depend on the Western Sanitary Interceptor (WSI) to convey flows to the Woodward Avenue Wastewater Treatment Plant
- Problem Area A: Birch Ave underpass at the CN Railway floods frequently due to:
  - Depression area associated with the underpass which is on the major overland flow route for 190 ha area
  - Limited number of inlets servicing the sag
  - Obvert of the trunk relief sewer is higher than underpass sag point causing surcharge flooding
    - Potential solution of providing large upstream rurb inlets to intercept overland flows north of Princess St and disconnect the local sewer from the relief trunk at the sag
- Problem Area C: King St at Sherman Ave combined sewer has limited capacity
  - Potential solution of providing combined sewer overflow to the storm relief sewer near the intersection of King Street and Sherman
  - Avenue or to modify the existing combined sewer overflow at King Street and Proctor Boulevard to direct more flow to the storm relief sewer that conveys flow east along King Street starting at Holton Avenue
- Potential for large scale tunnel trunk beginning within the eastern border of the Gage catchment
  - Alignment within either Hamilton Water Works Corridor starting at Ottawa St or along Maple Ave from Kenilworth Ave to Strathearne Ave

CSO Catchment Birch

Summary of Planned Works	• Birch Ave. Drainage Improvements (separate PCSWMM model being developed for this project to support development of a new maintenance facility) ○ City is considering building new transit facility near Burlington with potential to rectify flooding between Barton and Burlington. ○ Located just behind 330 Wentworth City Property ○ Study to be completed in October 2021 using PCSWMM. ○ Study does not look at improvements south of Barton, with a focus currently on storage. ○ Goal of 1-in-100 year LOS to protect busses at underpass.

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Birch - 1	1	1	5	5	5	5	5	5
Birch - 2	3	3	1	2	3	1	2	1
Birch - 3	3	3	1	4	1	1	2	1

Sub Catchment Prioritization

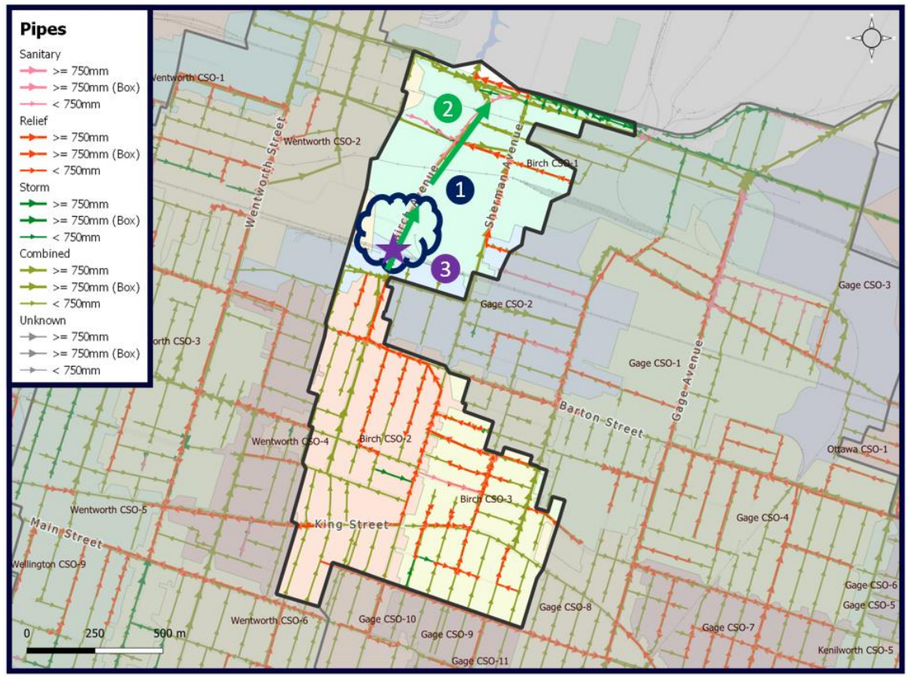
	Catchment Priority	Data Uncertainty	Commentary
Birch - 1	High	High	
Birch - 2	Medium	High	
Birch - 3	Medium	High	

Issues and Options

CSO Catchment Birch

Summary of Key Issues	• Birch Ave outfall backed up in 2019 due to high lake levels all the way to Barton St.
	  ○ LEEDS study stated that the outlet is partially submerged and may contain debris blocking a clear pathway
	• Sewer depth is an issue in the north end of Birth and there and there are significant capacity concerns
	• Large events have significant flooding (up to 2m) due to low points/sags.
	  ○ Significant sag at CN Railway underpass causing flooding due to combination of overland flow path and relief sewer obvert elevation relative to sag elevation
	• Overland flow route along Birch with potential to store overland flows.
	• Significant surface depressions within catchment; however, discrepancies may be present due to railway tracks and potential culverts not captured in analysis
	• Infrastructure is in poor condition within portions of the catchment
	• The minor system model shows multiple isolated locations with surcharging including:
	  ○ Surcharging to basement elevation north of the CN Railway underpass
	  ○ Surcharging to basement elevation along King St E between Sherman Ave S and Barnesdale Ave including nearby surcharging along Fairholt Rd N and S, Garfield Ave N and S, Barnesdale Ave S, and Carrick Ave
	• Proposed LRT within King St corridor

Summary of Potential Options	• 1) (BR-1) Disconnect local sewer from relief and add upstream catchbasins to intercept major system flows (Recommendations of LEEDS Report) • 2) (BR-2) Extend relief sewer within Birch Ave to ultimate storm outfall and convert relief system to stormwater system • 3) (BR-3) Construct lift station if flooding of underpass not mitigated by Option 1

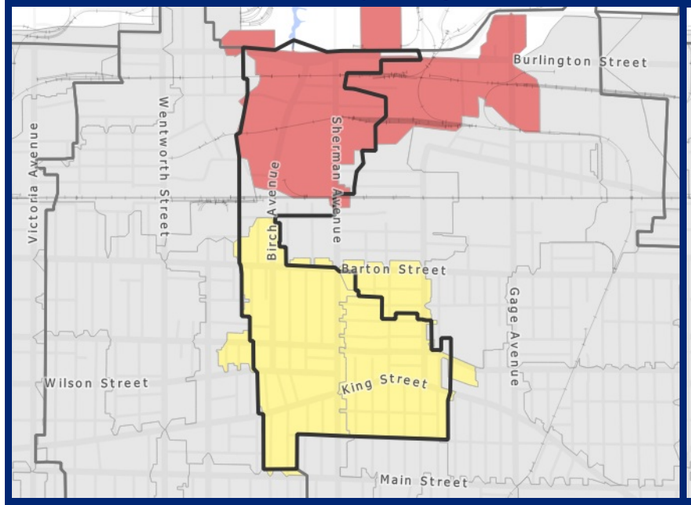


Option Evaluation

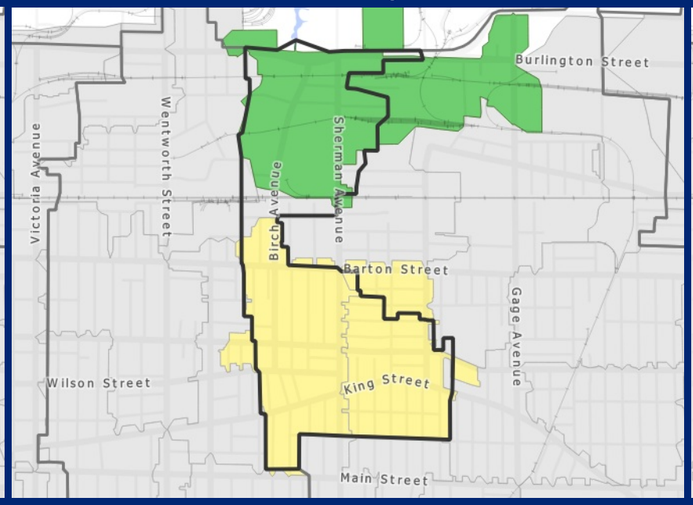
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
Option 1: Disconnect underpass local pipe from relief pipe and implement upstream inlets	• Lower cost to address localized flooding • Straightforward implementation	• Road sag still would not have major system outlet	Local Solution Moderate Benefit	$210K	Recommended	High Priority Short Term (3 – 5 years)	None
Option 2: Extend relief sewer within Birch Ave to ultimate storm outfall	• Lays foundation for future separation • Oversizing of pipe beneath CN Railway potential to convey major system	• Potential depth concerns related to existing underpass • Cost of implementation	System Wide Solution Substantial Benefit	$18.4M	Further Study	Medium Priority Long Term (10 – 20 years)	None

CSO Catchment Birch							
Option 3: Construct pumping station at Birch Ave and CN Railway underpass if required	• Protects underpass against future flooding • Ability to convey major system flows at underpass	• Ongoing maintenance • Cost of implementation • Addresses very localized issue – minimal external benefit	Local Solution Limited Benefit	$12.7M	Further Study	Medium Priority Long Term (10 – 20 years)	None
Managed Sewer Separation (BR-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$25.4M	Recommended	Medium Priority Future Planning (20+ years)	None

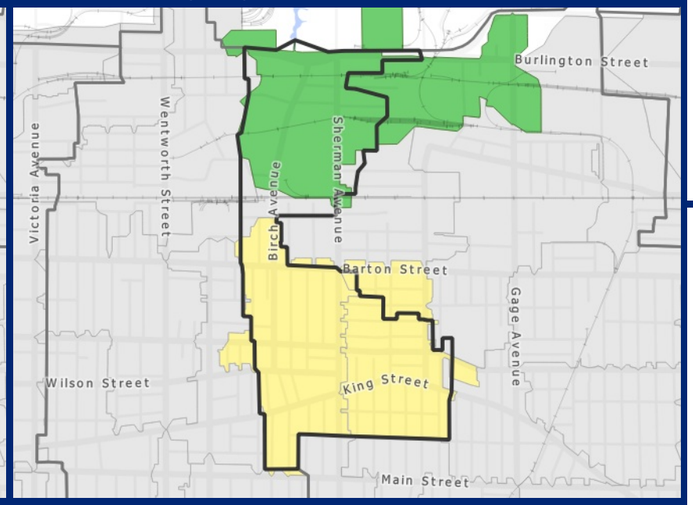
Overall Priority Ranking



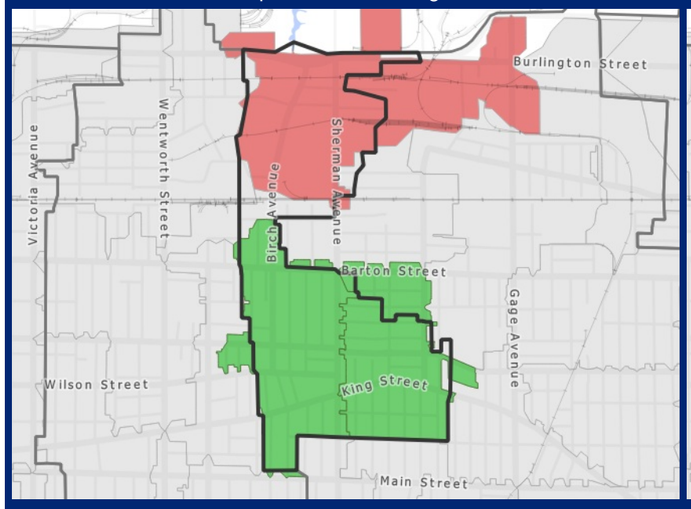
Hansen Flooding Calls



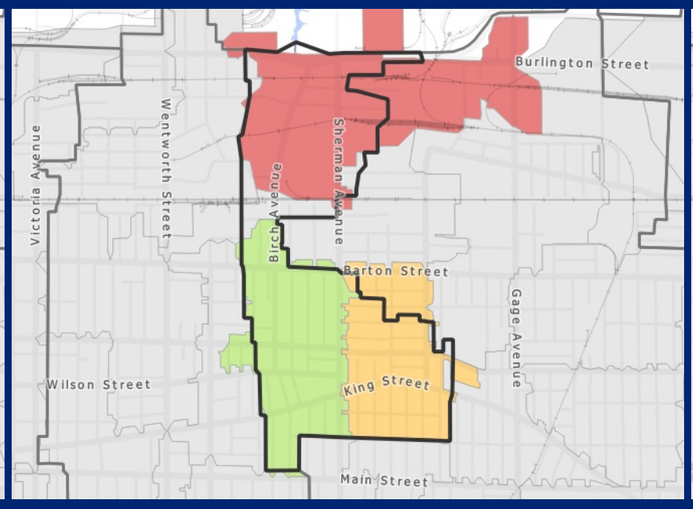
Pipe Depth for Residential Connections



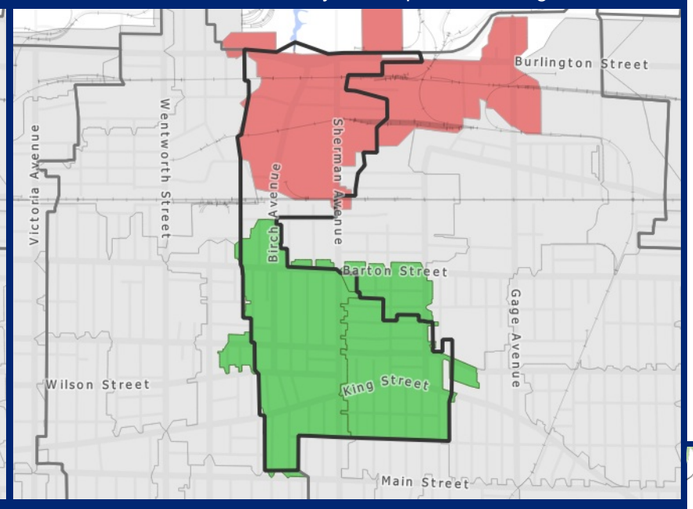
Pipe Condition and Age



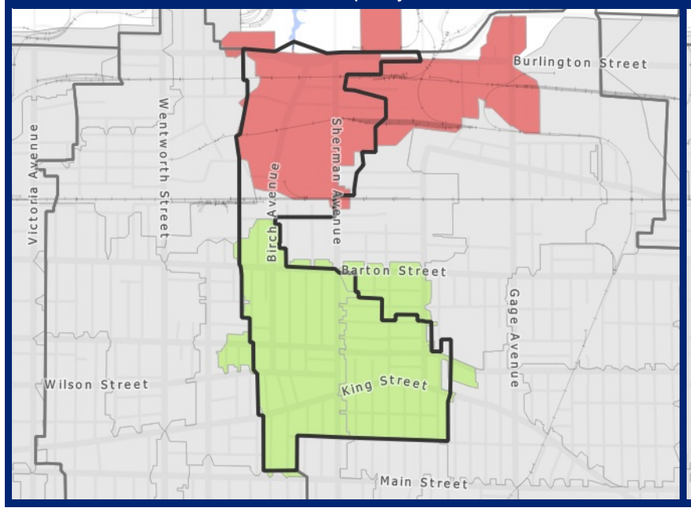
HGL to Basement Elevation of 1.8 m



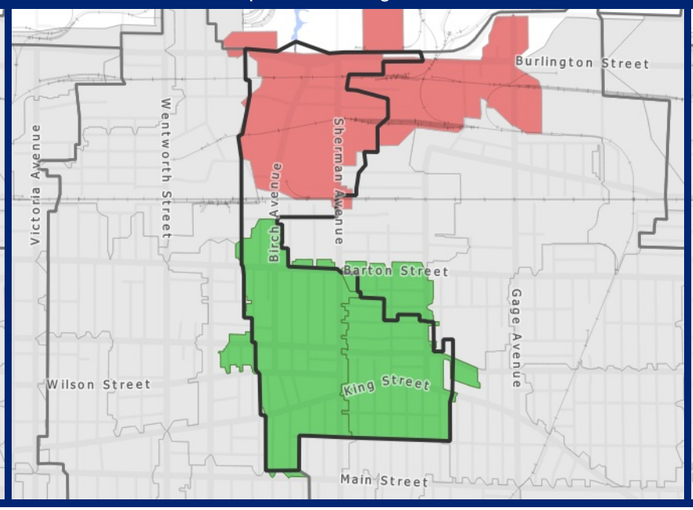
Overland Connectivity with Depression Storage



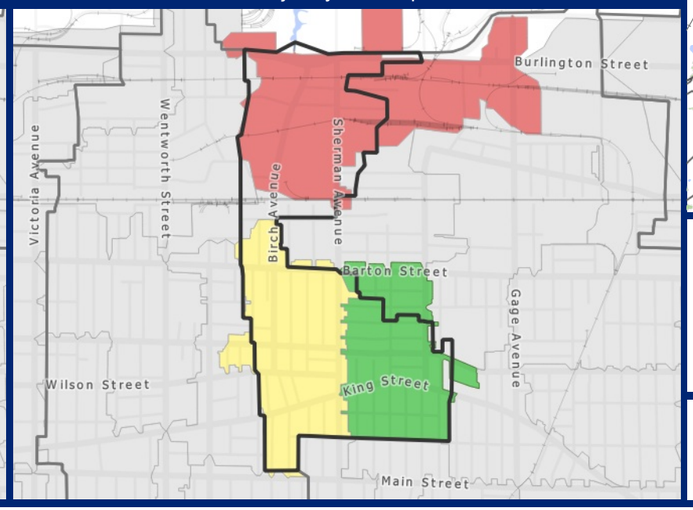
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

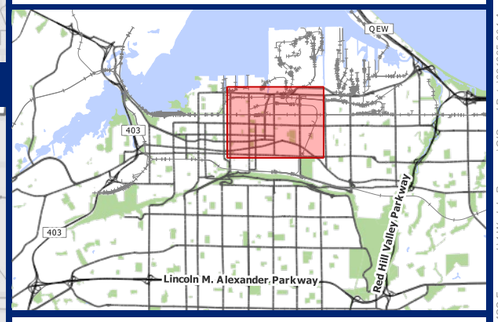


Figure 13 of 24

Birch CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

Document Path: W:\Hamilton\621000\621085 Hamilton FDMSS Framework\4 Work In Progress\GIS and Data\621085-004-Analysis Results.qgz

CSO Catchment Gage

Catchment Summary

Overview

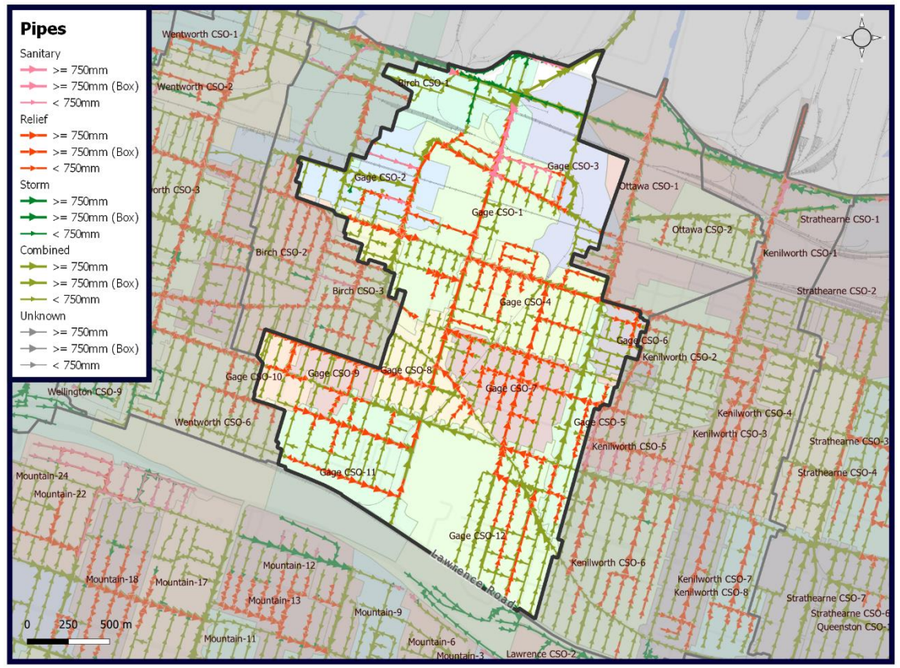
The Gage CSO catchment is located in the central portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Industrial Sector C
- Industrial Sector D
- Stipley
- Crown Point West
- Crown Point East
- Blakeley
- Delta West
- Delta East

The Gage CSO catchments contains twelve (12) subcatchments.

Catchment Metrics

Area (ha)	497
Total Length of Sewers (km)	87.3
Length of Combined Sewers (km)	58.7
Length of Sanitary Sewers (km)	1.5
Length of Storm Sewers (km)	3.9
Length of Relief Sewers (km)	23.1
Storage Tanks (# and Name)	

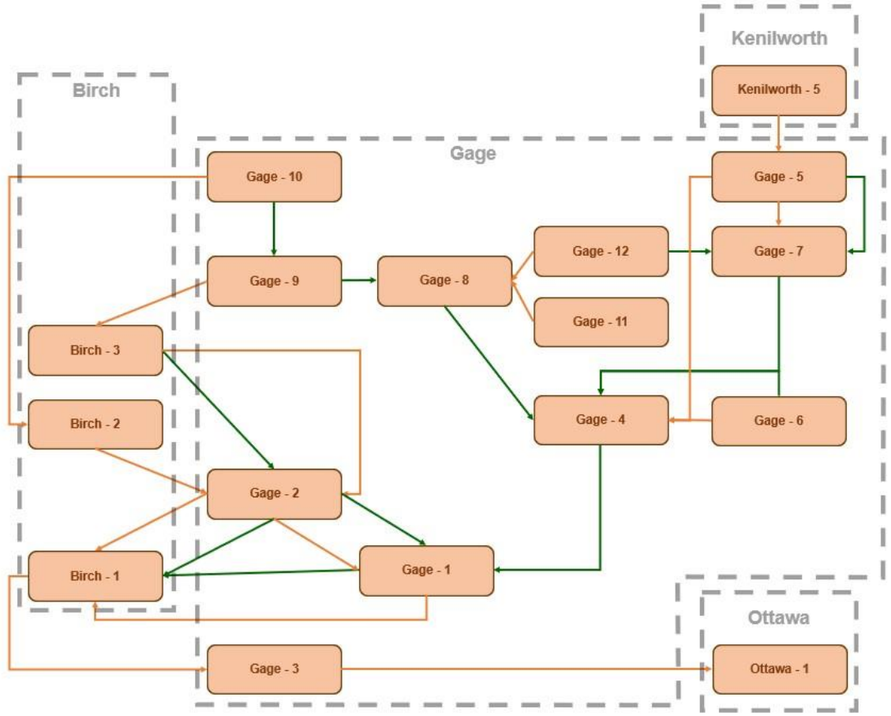


CSO Catchment Gage

Minor System Overview

The sanitary and combined system are defined by the following features:

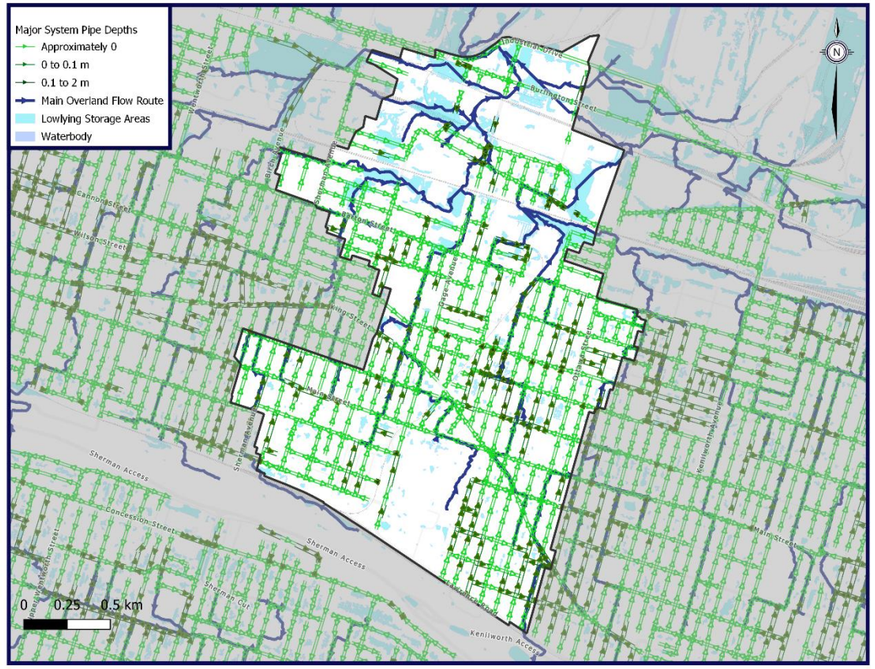
- The Gage CSO catchment generally conveys flows from south to north and east along Burlington St.
  - The predominant north-south combined trunk sewer is within Gage Ave., discharging into Burlington St. E
  - The following combined trunk sewers convey flows into the Gage Ave. combined trunk sewer:
    - Maplewood Ave.
    - Dunsmure Re.
    - Roxborough Ave into Kensington Ave. N into Barton St. E, with Barton St. E conveying to the Gage Ave. trunk
    - Lottridge St. to Beach Rd. which conveys into the Gage Ave. trunk
  - The Depew St. combined sewer trunk conveys combined flows directly to the Barton St. E trunk
- There in one (1) combined sewer overflow outfall within the catchment
  - The outfall is at the northern limits of the CSO catchment, discharging north of Industrial Dr. in line with Depew St. directly into the harbour
- The relief trunks within the Gage CSO catchment follow the rough alignment of the combined sewer trunks within the catchment
  - The relief sewers discharge into combined infrastructure within Burlington St. E at Gage Ave., with overflow flows going to the catchment CSO outfall



CSO Catchment Gage

Major System Overview

- The Gage CSO catchment contains three (3) primary overland flow routes as described below:
  - The eastern limits of the Gage CSO catchment has an overland flow route which conveys flows south along the Gage/Kenilworth catchment borders
    - Gage-12 → Kenilworth-6 → Kenilworth-5 → Gage-5 → Gage-6 – Kenilworth-2
    - There are no major surface depressions along the overland flow route
  - The central overland flow route conveys flows south along Belmont Ave.
    - Gage-12 → Gage-7 → Gage-4 →Gage-3 → Ottawa-1
    - There are large surface depressions along the major flow route within Gage-3 at the railway corridor
  - The western overland flow route conveys flows south along Balsam Ave. and Gage Ave. N
    - Gage11&12 → Gage-8 → Gage-1
    - There is no outlet for the overland flow route, with the route terminating within Gage-1
    - There are large surface depressions along the overland flow path just north of the railway corridor
- There are limited surface depressions within the Gage CSO catchment which are not connected to the overland flow routes
- Major system flow depths are > 0.1m (without the presence of significant surface depressions) in the following locations:
  - Large clusters east of gage park with partial overland flow connectivity
  - Large clusters at the south end of the central overland flow route, along Cannon St., Roxborough Ave., Rosslyn Ave. and Belmont Ave.
  - Isolated areas surrounding the streets along the railway corridor



CSO Catchment Gage

Summary of Previous Studies

Lower East End Storm Drainage Study and Stormwater Management Investigation (McCormick Rankin Corp., 2009)

- Gage-Lottridge, Gage-Main Trunk, Gage-Cannon, and Gage-Barton focus areas within LEEDS Report
- All of the combined trunk sewers in the LEED study area depend on the Western Sanitary Interceptor (WSI) to convey flows to the Woodward Avenue Wastewater Treatment Plant

- Gage-Lottridge has a number of depression areas within focus area, and there were two (2) historic watercourses within the focus area
  - Four (4) localized problem areas are outlined in the report for the Gage-Lottridge focus area with street-specific upgrades or solutions recommended. The following are the locations of interest:
    - Problem Area A: Fairholt Road North with relief sewer upgrade solutions proposed within Barnesdale Avenue between King Street and Cannon Street
    - Problem Area B: Barton Street between Prospect Street and Melrose Avenue with further study required to determine the nature of the flooding
    - Problem Area C: Beechwood Avenue west of Barnesdale Avenue with modification to the existing combined sewer overflow at Beechwood Avenue west of Barnsdale Avenue recommended combined with additional inlets on Beechwood Avenue and Rosemont Avenue and possible Somerset Avenue and Cannon Street
    - Problem Area D: Spadina Avenue between Main Street and Dunsmure Road
- Gage-Main Trunk has three (3) major overland flow paths extending north from the Niagara Escarpment and no historic watercourses within the focus area
  - Six (6) localized problem areas are outlined in the report for the Gage-Main Trunk focus area with street-specific upgrades or solutions recommended. The following are the locations of interest:
    - Problem Area A: Grosvenor Avenue south of Justine Avenue with a siphon at Justine Avenue which has been recommended for removal due to potential blockages
    - Problem Area B: The area roughly bounded by Albert Street, Maplewood Avenue, Main Street, and Gage Avenue with the recommendation to provide a new storm relief sewer on Main Street from the existing 600 mm storm relief sewer at Prospect Street to the existing 1650 mm storm relief sewer on Gage Avenue
    - Problem Area C: Located on Rothsay Avenue and Kensington Avenue between Lawrence Road and Maple Avenue, primarily on Rothsay Avenue. The recommendation includes the implementation of a stormwater detention area via an enhanced wet meadow within the eastern portion of Gage park
    - Problem Area D: Balmoral Avenue between Montclair Avenue and Maple Avenue which does not include a sewer upgrade recommendation and instead recommends downspout disconnection
    - Problem Area E: London Street and Ottawa Street between Lawrence Road and King Street with proposed remedial measure of providing a new combined sewer overflow at the intersection of London Street and King Street and modifying the existing combined sewer overflow at the intersection of Ottawa Street and King Street
    - Problem Area F: Known surface flooding on Lawrence Road south of Gage Park with recommendation to clean existing inlets along Lawrence Road and Gage Park storm sewers
- Gage-Cannon Trunk has three major depression areas within the focus area, and there were two (2) historic watercourses within the focus area
  - One (1) localized problem area is outlined in the report for the Gage-Cannon focus area with street-specific upgrades or solutions recommended. Residents around Glendale Ave and Cannon St have frequent basement flooding. Water is claimed to pond to knee depth at Belmont Ave and Cannon St. The following is the location of interest:
    - Problem Area A: Rosslyn Avenue and Kensington Avenue between Main Street and Cannon Street with recommended upgrade to the local combined sewer on Rosslyn Avenue from King Street to Roxborough Avenue. In conjunction with this, the existing combined sewer overflow at the intersection of Rosslyn Avenue and Roxborough Avenue would have to be modified
- Gage-Barton Trunk has three (3) major depression areas within the focus area, and there were three (3) historic watercourses within the focus area
  - Four (4) localized problem areas are outlined in the report for the Gage-Barton focus area with street-specific upgrades or solutions recommended. The following are the locations of interest:
    - Problem Area A: Beach Road near the intersection with Depew Street has potential minor surface flooding with recommendation for additional inlets within the intersection
    - Problem Area B: Whitfield Avenue between Birmingham Street and Gage Avenue with the remedial action of additional inlets in the area and disconnection of roof leaders
    - Problem Area C: Biggar Avenue between Sherman Avenue and Lottridge Street with the recommendation of upgrading the local combined sewer on Biggar Avenue
    - Problem Area D: Barton Street between Kensington Avenue and Gage Avenue with recommendations to provide additional connections between the combined sewer and the storm relief sewer along Barton Street between Kensington Avenue and Gage Avenue, and ensure catchbasins are also being properly maintained

- Potential for large scale tunnel trunk beginning within the eastern border of the Gage catchment
  - Alignment within either Hamilton Water Works Corridor starting at Ottawa St or along Maple Ave from Kenilworth Ave to Strathearne Ave
  - The LEEDS report has indicated that further investigation is required to determine the feasibility of a large-scale relief trunk

Summary of Planned Works

- Remediation work within Gage catchment (Class EA Study)
- Some overland flow is being re-routed to Gage Park.
- Various recommendations from LEEDS report are planned to proceed

Analysis Summary

CSO Catchment Gage								
	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Gage - 1	1	1	5	5	3	3	4	3
Gage - 2	1	1	5	2	3	5	4	4
Gage - 3	1	5	3	4	3	5	5	5
Gage - 4	3	3	3	5	3	2	3	1
Gage - 5	1	1	1	2	3	1	2	1
Gage - 6	1	1	3	5	1	1	1	1
Gage - 7	1	3	3	4	3	1	2	1
Gage - 8	1	3	3	4	1	1	2	1
Gage - 9	1	3	5	4	1	1	4	1
Gage - 10	1	3	5	2	1	1	3	1
Gage - 11	1	1	1	3	3	1	5	1
Gage - 12	5	1	3	3	1	1	4	1

Sub Catchment Prioritization			
	Catchment Priority	Data Uncertainty	Commentary
Gage - 1	High	High	
Gage - 2	High	High	
Gage - 3	High	High	
Gage - 4	High	Medium	
Gage - 5	Low	Medium	
Gage - 6	Medium	Low	

CSO Catchment Gage			
Gage - 7	Low	Medium	
Gage - 8	Low	Medium	
Gage - 9	Medium	Medium	
Gage - 10	Medium	Medium	
Gage - 11	Medium	Medium	
Gage - 12	High	Medium	

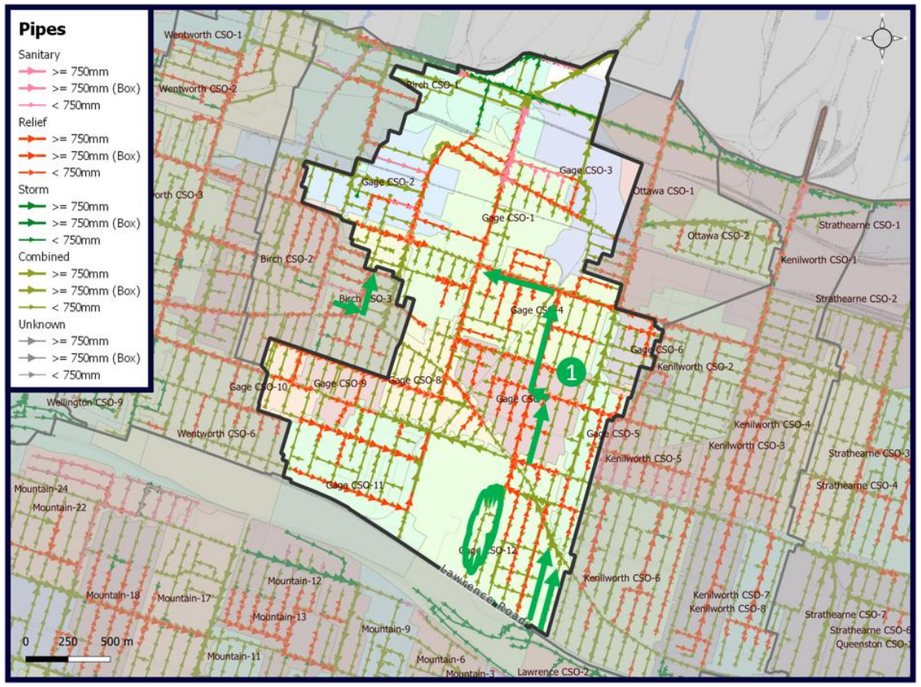
Issues and Options

Summary of Key Issues

- Concerns regarding inlet capacity within catchment boundaries including historical inlet maintenance deficiencies per LEEDS report
- Shallow sewers within north end of catchment
- Minor system surcharging to basement elevation in large portions of catchment
- Some isolated locations with inadequate major overland drainage – additional information within LEEDS report
- Poor overall condition of pipes within western portion of catchment
- History of basement flooding and major system flooding within catchment per LEEDS report

Summary of Potential Options

- 1) (GG-1) Proceed with recommendation from LEEDS Report including implementation of sewer separation as outlined and implementation of relief sewers where outlined.

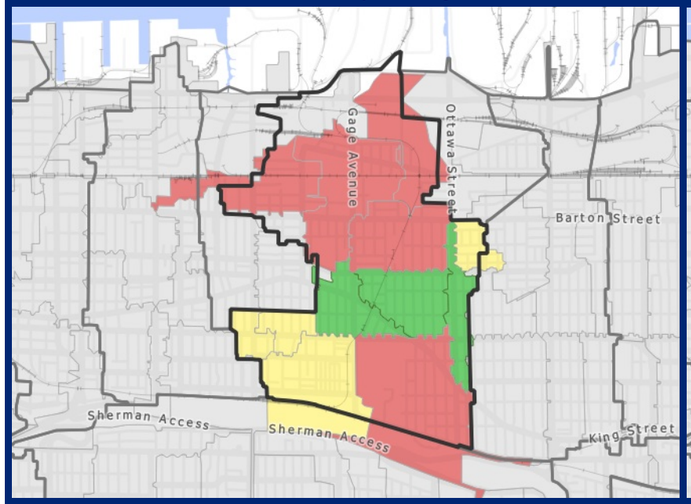


Option Evaluation

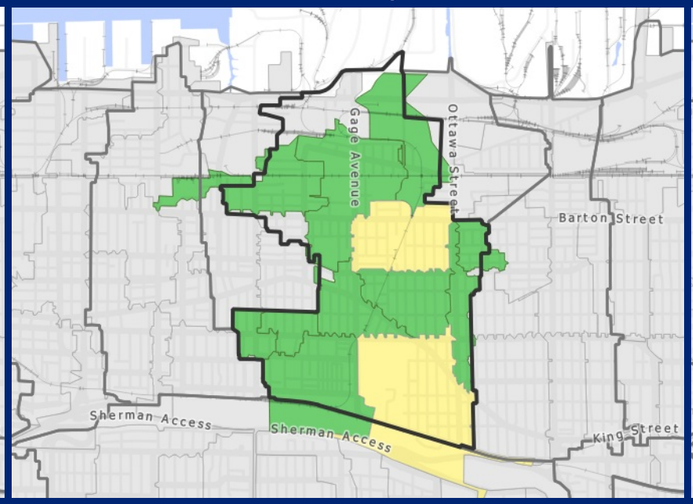
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works

CSO Catchment Gage							
Option 1: LEEDS Report recommendations (GG-1)	• Localized recommendations • Infrastructure for relief sewers has potential to be used for future storm sewer network	• Many individual projects with small reach for each individual project benefit	Local Solution Limited Benefit	$5.0M	Recommended	High Priority Short Term (3 – 5 years)	None
Managed Sewer Separation (GG-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System-Wide Solution Substantial Benefit	$55.6M	Recommended	High Priority Future Planning (20+ years)	None

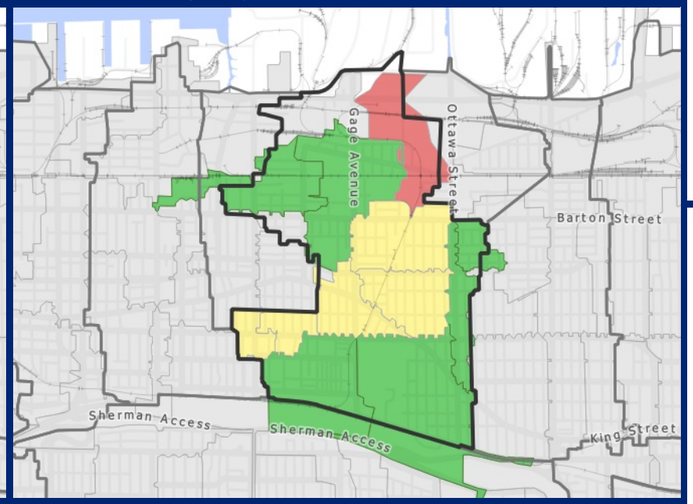
Overall Priority Ranking



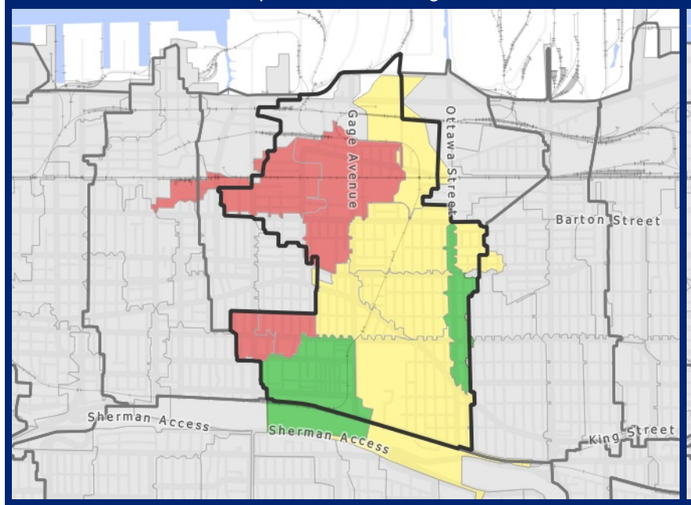
Hansen Flooding Calls



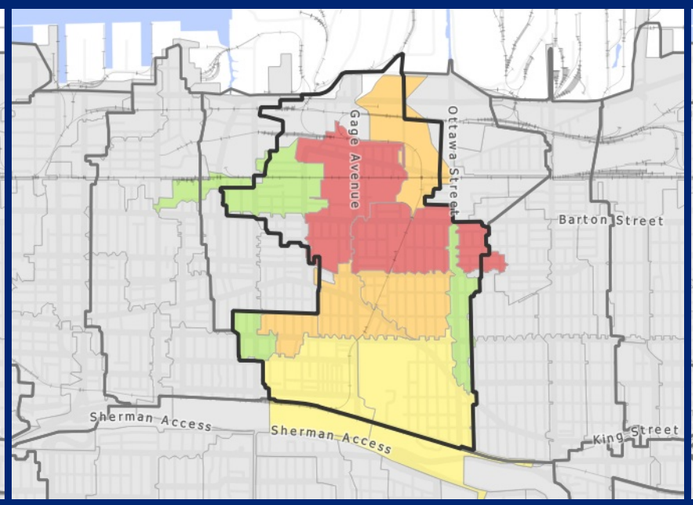
Pipe Depth for Residential Connections



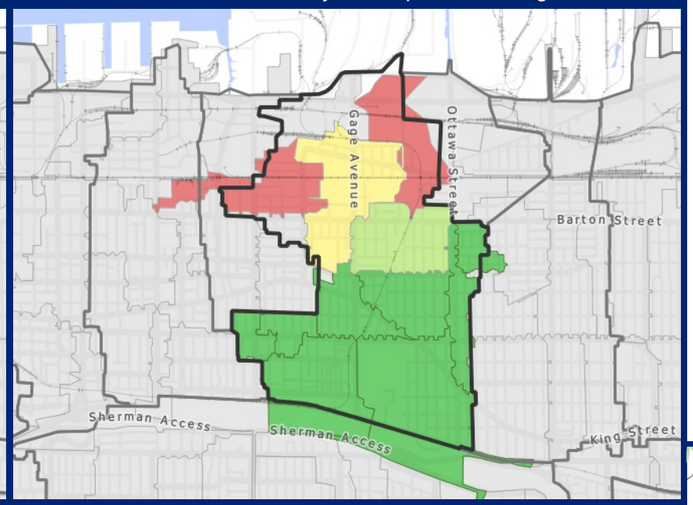
Pipe Condition and Age



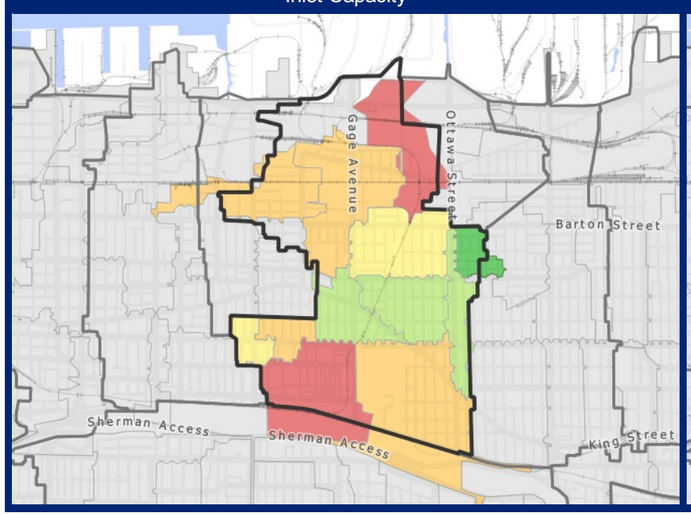
HGL to Basement Elevation of 1.8 m



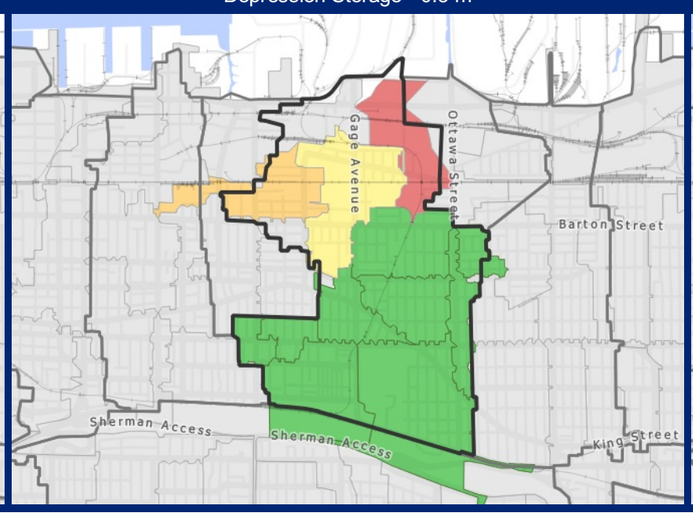
Overland Connectivity with Depression Storage



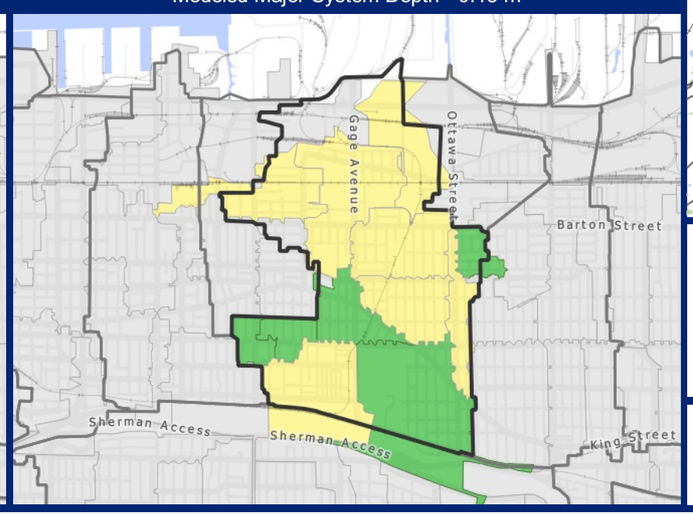
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

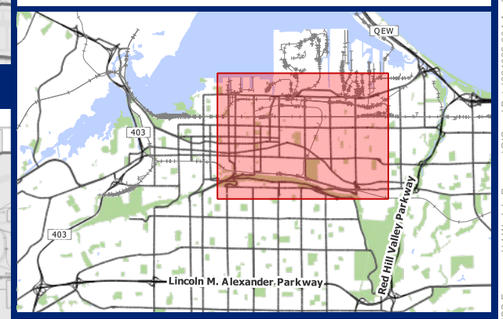


Figure 14 of 24

Gage CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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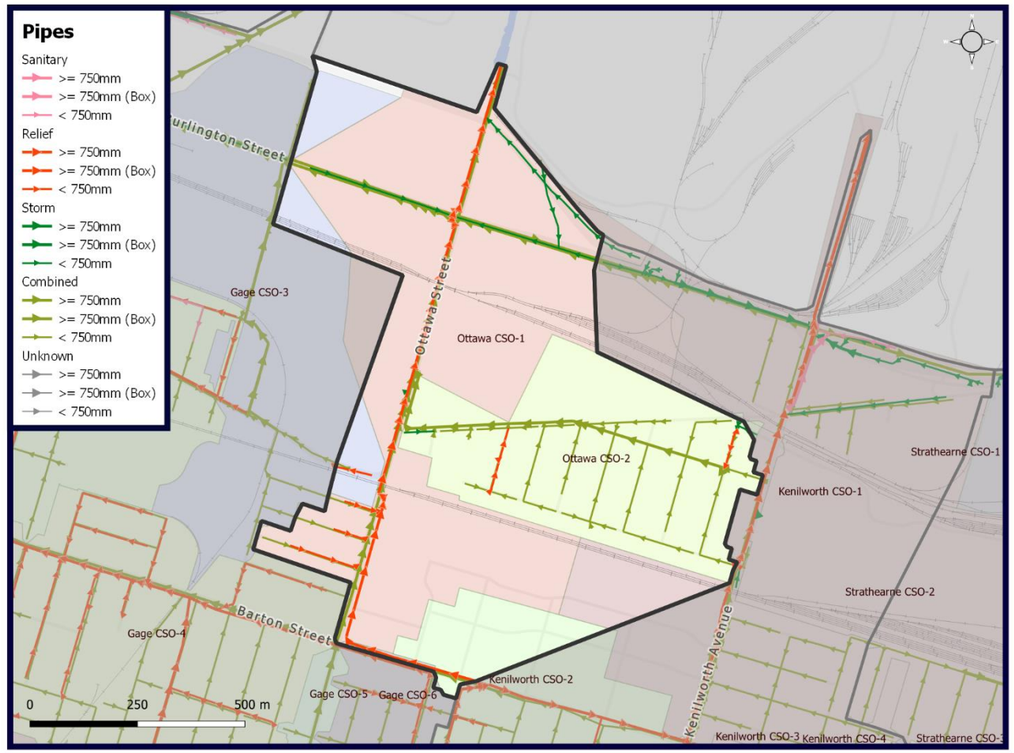
CSO Catchment Ottawa

Catchment Summary

Overview	The Ottawa CSO catchment is located in the northern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Industrial Sector D • Industrial SectorE • Crown Point West (northeastern corner) • Crown Point East (northwestern portion) The Ottawa CSO catchments contains two (2) subcatchments.	
Catchment Metrics	Area (ha)	86.8
	Total Length of Sewers (km)	10.6
	Length of Combined Sewers (km)	7.0
	Length of Sanitary Sewers (km)	0.0
	Length of Storm Sewers (km)	1.6
	Length of Relief Sewers (km)	2.0
	Storage Tanks (# and Name)	N/A

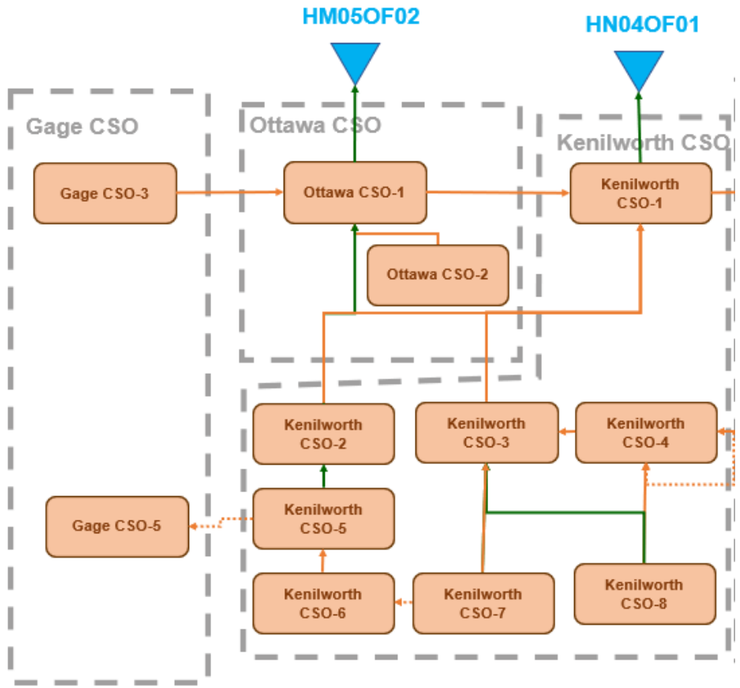


CSO Catchment Ottawa

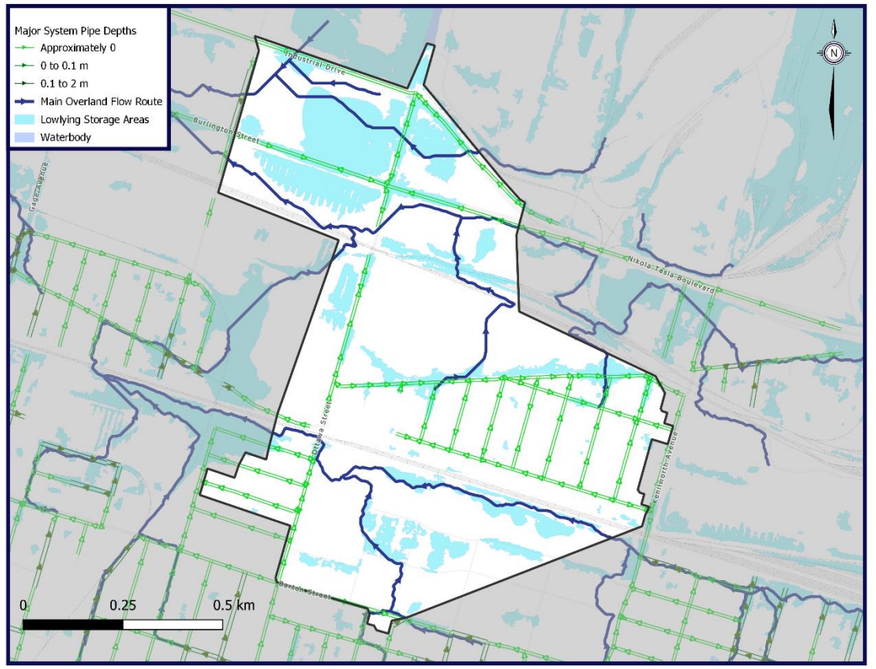
Minor System Overview

The Ottawa CSO catchment generally drains toward a trunk sewer on Ottawa Street which conveys flows north towards Industrial Drive.

- Ottawa CSO-2 collects and conveys combined sewer flows from the area north of the rail line towards Beach Road and then west towards Ottawa Street.
- Ottawa CSO-1 collects combined sewer flows from north of Barton Street and from the east and west of Ottawa Street along Ottawa Street towards Industrial Drive, ultimately discharging into the lake in the Industrial Sector.
- A relief sewer is also running along Ottawa Street towards the lake



CSO Catchment Ottawa

Major System Overview	The Ottawa CSO catchment major system generally drains towards Beach Road and Burlington Street where there is available depression storage. Overland flows from Ottawa CSO appear to spill into across the rail line in two locations to storage locations on the south side of Burlington Street and Nikola Tesla Boulevard. Overland flow depths are generally below 100mm in total depth. These depression storage areas are ultimately connected to overland flow routes the ultimately discharge directly into the lake through the industrial sector.	
Summary of Previous Studies	**Lower East End Storm Drainage Study and Stormwater Management Investigation (McCormick Rankin Corp., 2009)** <u>Ottawa Trunk Focus Area (Gage CSO-6, Kenilworth CSO-2, potential solution to Problem Area C contributes to Ottawa CSO-1)</u> • The Ottawa Trunk focus area is generally bounded by McAnulty Boulevard to the north, the utility easement to the south, Kenilworth Avenue to the east and Grosvenor Avenue to the west. • All combined sewers in LEED study area depend on the WSI to convey flows to WWTP • **Problem Area C:** There are five (5) flooding reports along Campbell Avenue at Agnes Street and along Agnes Street between Campbell Avenue and Argyle Avenue. ○ A potential remedial measure for this problem area is to provide a new storm relief sewer from the existing storm relief sewer on Barton Street at Agnes Avenue to the existing storm relief sewer on Ottawa Street at Dalhousie Avenue, **this measure is recommended.** ▪ This measure was implemented in 2011 with a 1050 mm storm sewer running west along Barton St East from Agnes St, and then north along Ottawa St to Dalhousie Ave.	
Summary of Planned Works	• No known works at this time.	

CSO Catchment Ottawa

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Ottawa CSO-1	1	3	3	2	1	5	4	5
Ottawa CSO-2	1	3	3	2	1	3	4	2

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Ottawa CSO-1	Medium	Low	
Ottawa CSO-2	Medium	Low	

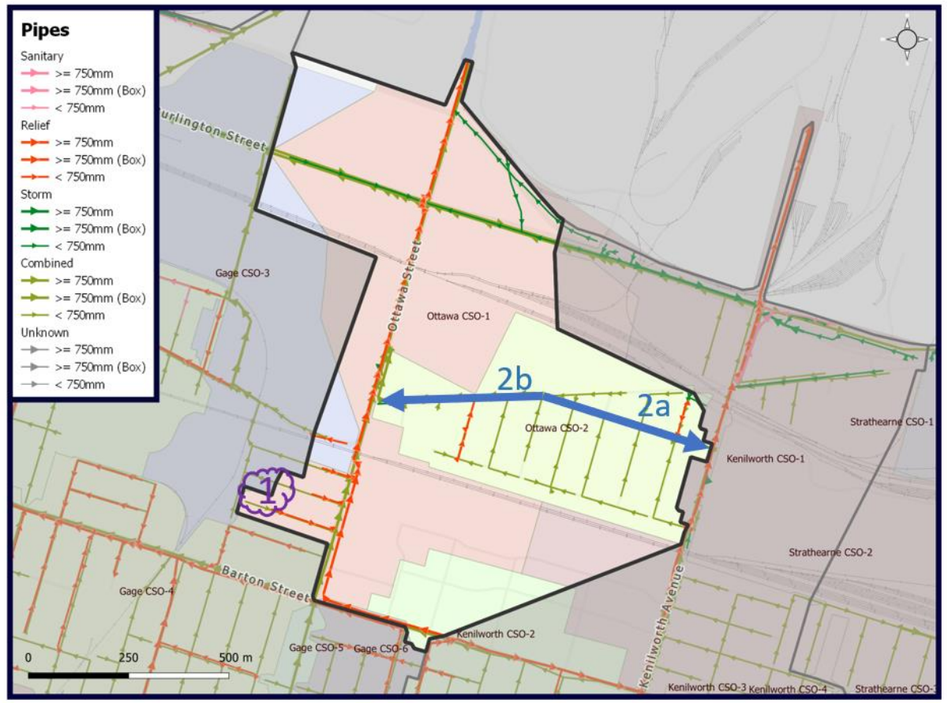
Issues and Options

Summary of Key Issues	• Genererally the Ottawa CSO catchment has large surface depression areas connected to the major overland flow path. The large surface depressions are mostly located on private property within the industrial areas.
	• Ottawa CSO-2 shows multiple Hansen calls clustered within the residential neighbourhood between Grenfell St and McAnulty Blvd.
	  ○ Large surface depression connected to overland flow path on Beach Rd crossing of rail tracks potentially contributing
	  ○ Relief sewer on Kenilworth Ave potentially available as outlet
	  ○ Large depression area in The Centre on Barton plaza along major overland flow path for significant drainage area may have culverts conveying flow across the rail tracks which would not be reflected in the overland flow paths.
	• Ottawa CSO-1 Dalkeith Ave and Craigmiller Ave were separated in 2008 and connected to the relief sewer on Ottawa St North
	  ○ Hansen calls at addresses for sewer backups in 2018 at properties which appear outside limits of separation
	  ○ HGL <1.8 mbgs in vicinity of Hansen calls	

CSO Catchment Ottawa

Summary of Potential Options

1) (OT-1) Ottawa CSO-1 Dalkeith Ave and Craigmiller Ave consider Inlet Control Devices (ICDs) to prevent potential major system backup from rail tracks into minor system
   a) Consider major system relief
2) Ottawa CSO-2 complete separation of residential area
   a) (OT-2a) Grenfell St to Kenilworth Ave relief sewer, or
   b) Grenfell St to Beach Rd to Ottawa St relief sewer

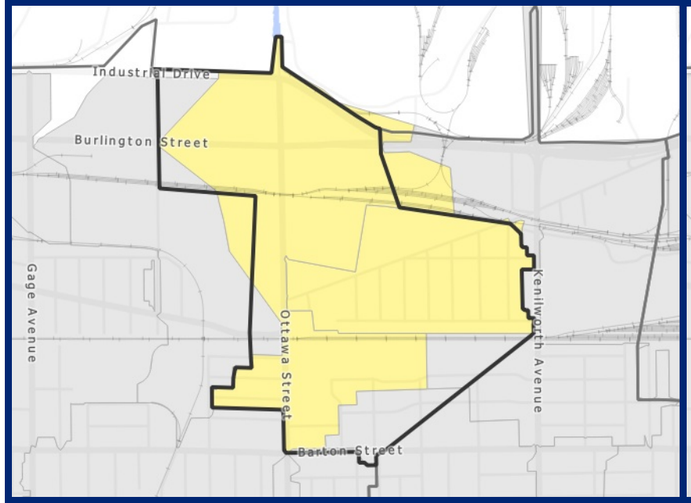


Option Evaluation

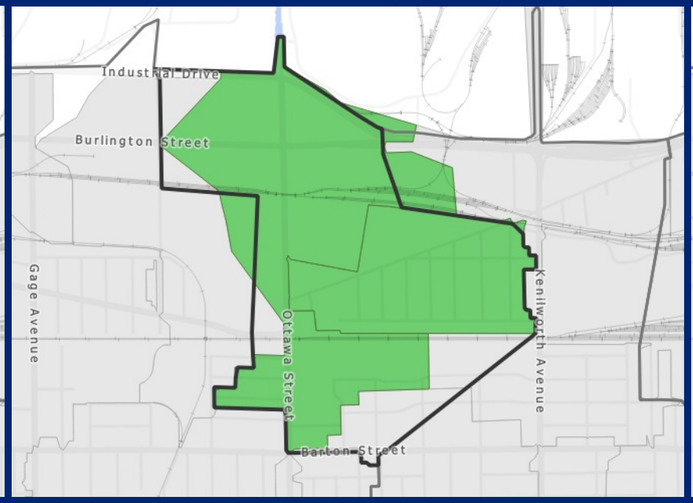
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. ICDs along Dalkeith Ave and Craigmiller Ave (OT-1)	• Ease and speed of implementation of ICDs • Low cost • Removes storm flows and volumes from combined sewer system • Partially separated receiver on Ottawa Street	• Low number of Hansen calls • Localized benefit • Still potential for backflow from trunk on Ottawa Street	Local Solution Limited Beneift	$50K	Recommended	Medium Priority Immediate Term (0 – 3 Years)	None

CSO Catchment Ottawa							
2a. Complete separation along Grenfell Street (Bayfield to Kenilworth) to existing storm sewer (OT-2a)	• Key initial separation to allow balance of the area to proceed (7 hansen calls in that area) • Suggested diversion to Kenilworth (partially separated sewers available) rather than combined sewers on Ottawa	• Need to confirm ability of Kenilworth sewer to receive additional flows • Connection to sewer on Kenilworth – traffic impacts	Local Solution Moderate Benefit	$3.4M	Recommended	Medium Priority Short Term (3 – 5 Years)	None
Managed Sewer Separation (OT-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$26.7M	Recommended	Medium Priority Future Planning (20+ Years)	None

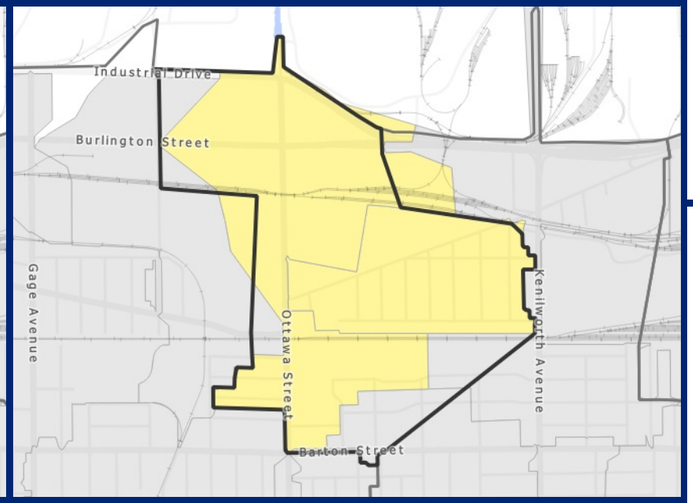
Overall Priority Ranking



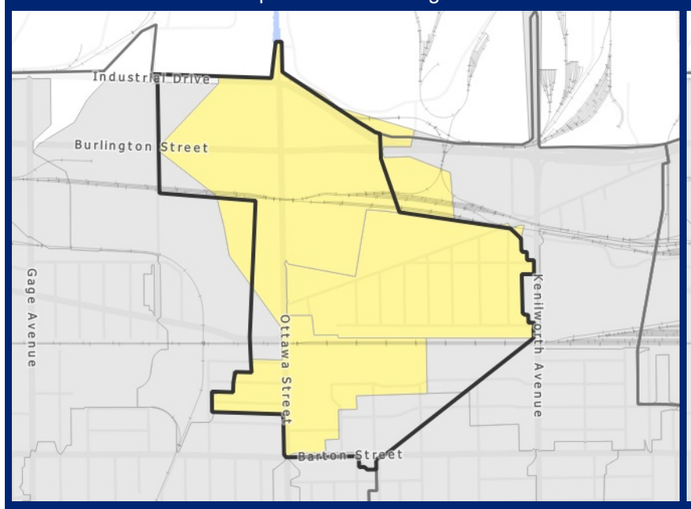
Hansen Flooding Calls



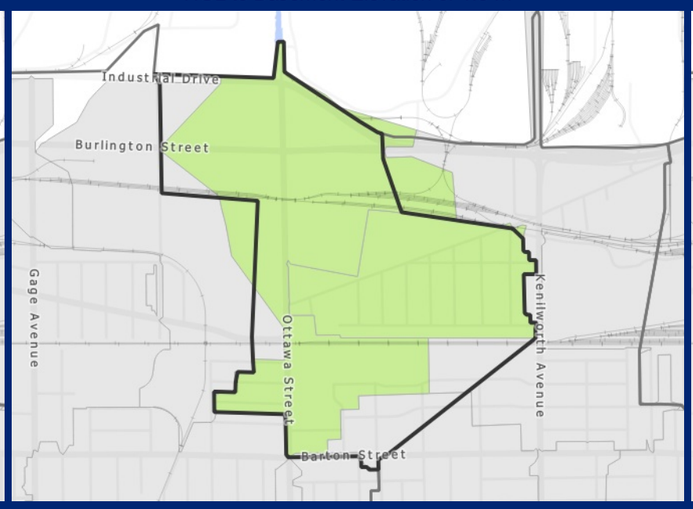
Pipe Depth for Residential Connections



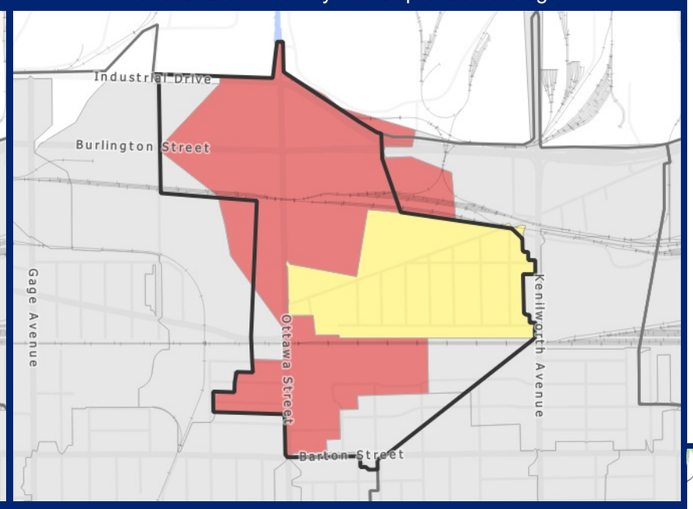
Pipe Condition and Age



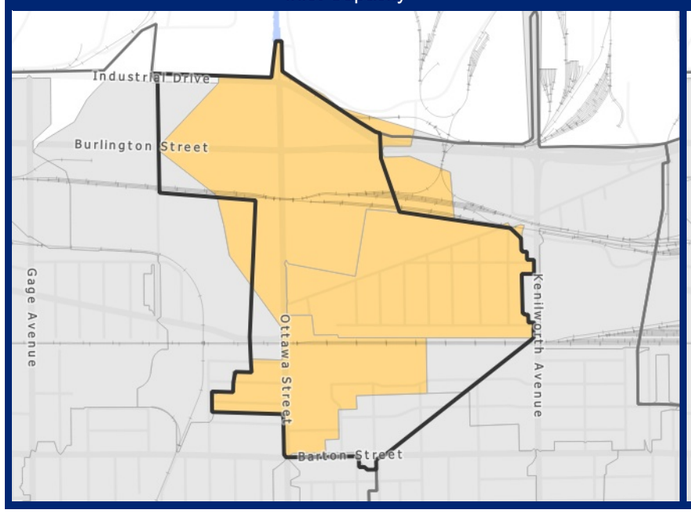
HGL to Basement Elevation of 1.8 m



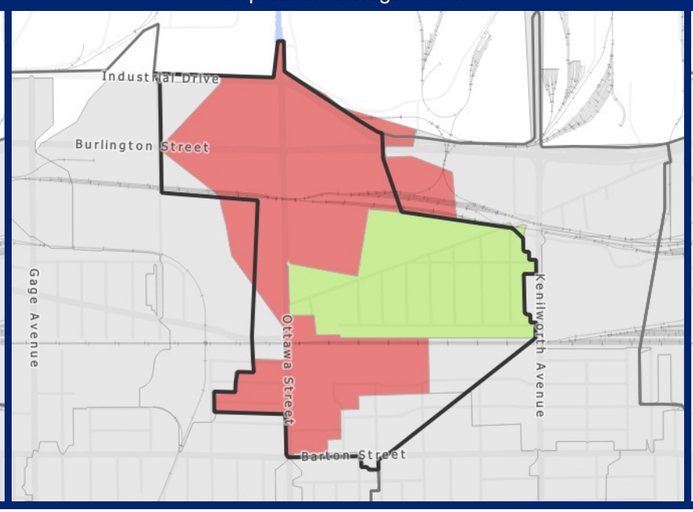
Overland Connectivity with Depression Storage



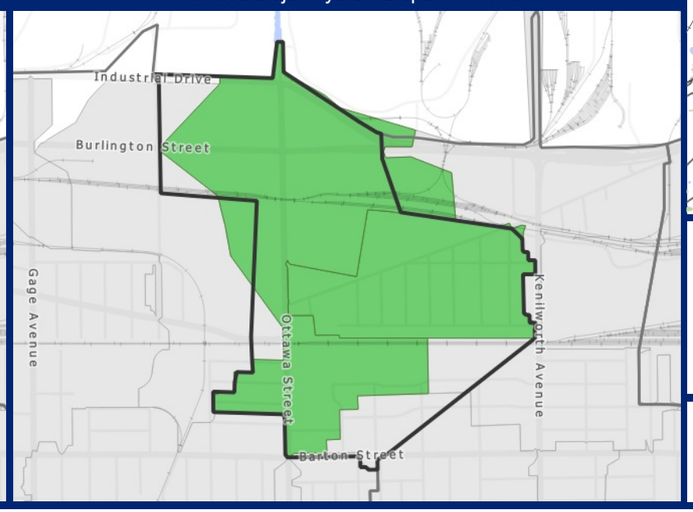
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

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0 0.5 1 km

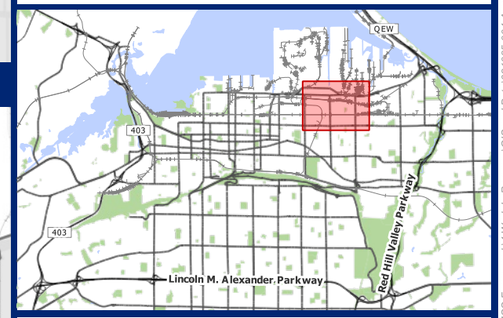


Figure 15 of 24

Ottawa CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Kenilworth

Catchment Summary

Overview

The Kenilworth CSO catchment is located in the southeastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

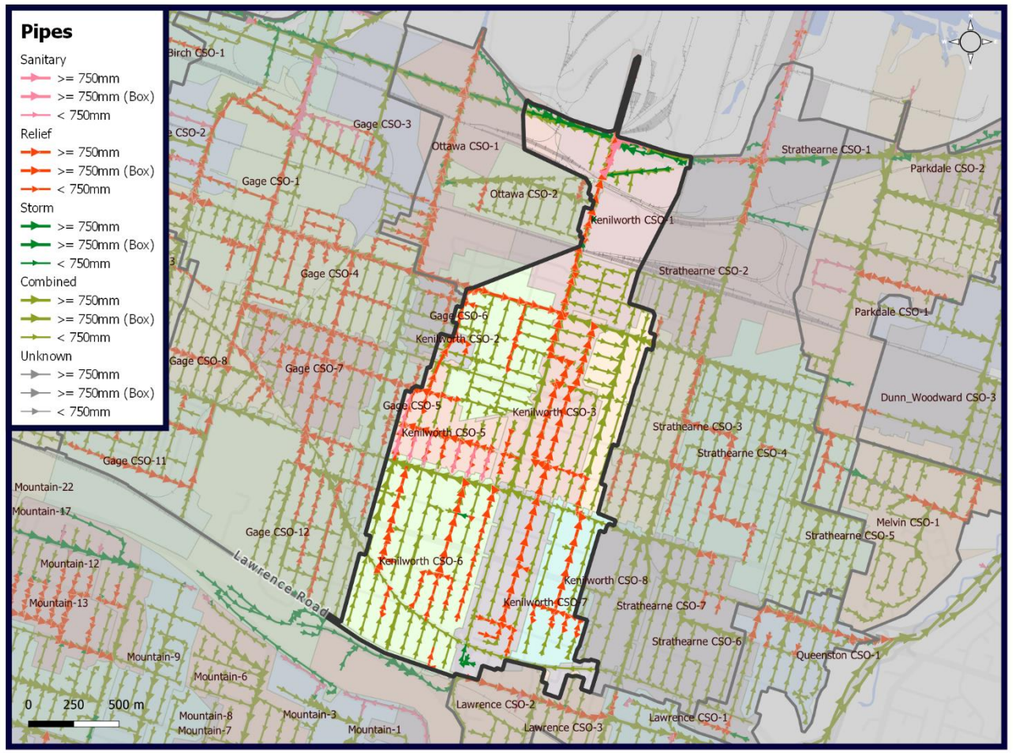
- Delta East
- Bartonville
- Homeside
- Crown Point East
- Industrial Sector

The Kenilworth CSO catchments contains eight (8) subcatchments.

City owned corridor running northeast from Main St East and Ottawa St North to Woodward Ave south of Nikola Tesla Blvd interchange crosses Kenilworth CSO between Main St East and Britannia Ave.

Catchment Metrics

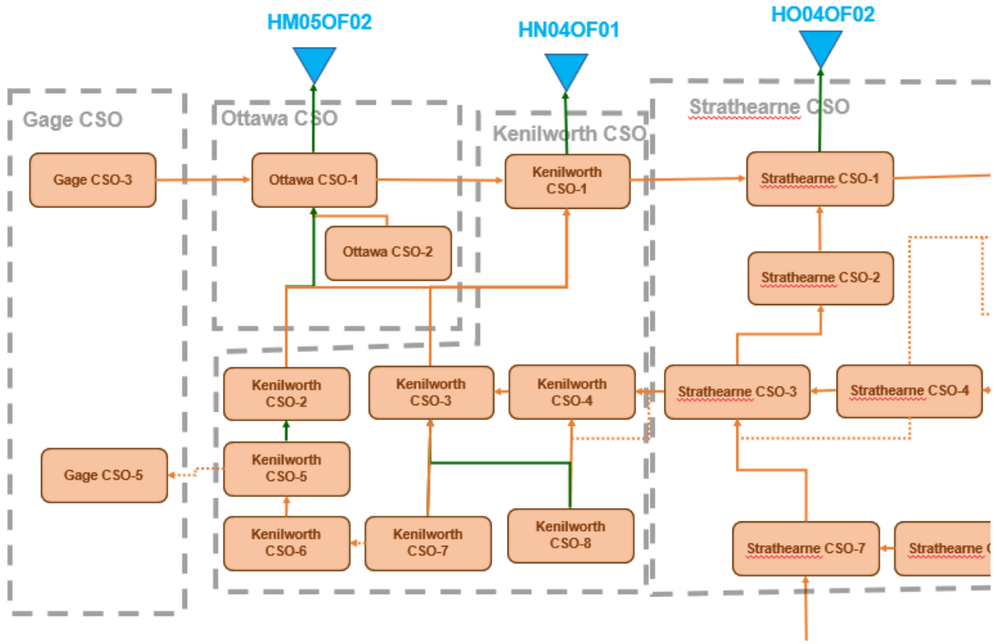
Area (ha)	310.5
Total Length of Sewers (km)	61.1
Length of Combined Sewers (km)	42.6
Length of Sanitary Sewers (km)	1.8
Length of Storm Sewers (km)	2
Length of Relief Sewers (km)	14.8
Storage Tanks (# and Name)	N/A



CSO Catchment Kenilworth

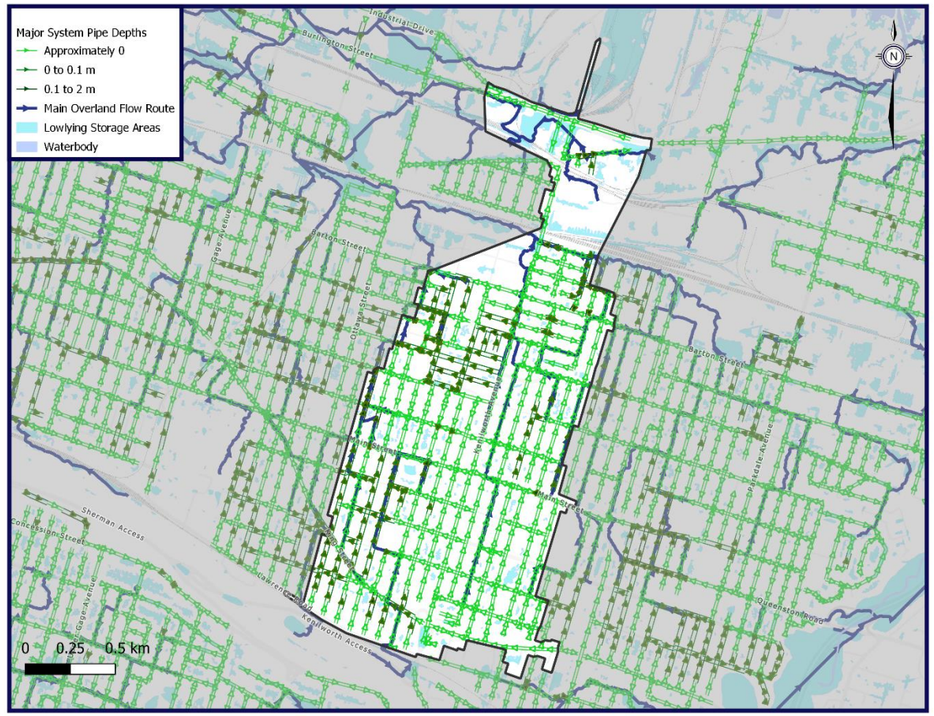
Minor System Overview

- General
  - Combined sewer flows from the catchment area around Kenilworth Ave are collected and directed north along Kenilworth Ave
- Kenilworth CSO-8
  - Combined sewer flow from north of Lawrence Road are conveyed north towards Main Streets and then north along Kenilworth Ave and are combined with the flows in the Kenilworth CSO-7
- Kenilworth CSO-7
  - Combined sewer flow from north of Lawrence Road are conveyed north towards Main Streets and then south along Kenilworth Ave and are combined with the flows in the Kenilworth CSO-3
- Kenilworth CSO-6
  - Combined sewer flow from north of Lawrence Road are conveyed north towards King or Main Streets and then west towards Edgemont Street where flows are conveyed north and are combined with the flows in the Kenilworth CSO-5 subcatchment.
- Kenilworth CSO-5
  - Combined sewer flow from north of Main Street are conveyed north towards Dunsmure Road towards Graham Avenue and Province Street where the flows are directed north towards Cannon Street and combined with flows in the Kenilworth CSO-2 subcatchment.
- Kenilworth CSO-4
  - Combined sewer flows from north of Main Street are conveyed north along Cope Street and Tragina Avenue towards Barton Street where the flows are collected and directed west towards Kenilworth Ave where flow are connected to the Kenilworth CSO-3 subcatchment
- Kenilworth CSO-3
  - Combined sewer flows from north of Main Street are conveyed north along Crosthwaite, Garside, Cameron, and Barons Avenues towards Hope and Harmony Avenues as well as Barton Street where the flows are collected and directed west towards Kenilworth Ave where flow are connected to the Kenilworth CSO-1 subcatchment.
- Kenilworth CSO-2
  - Combined sewer flows from the west side of Kenilworth Ave are conveyed north along Robins, Ellis, and Frederick Avenues towards Barton Street and then east along Barton Street towards Kenilworth Ave where flows are connected to the Kenilworth CSO-1 subcatchment.
- Kenilworth CSO-1
  - Combined sewer flows from the east and west side of Kenilworth Ave are conveyed from the south to the north along Kenilworth Ave towards Nikola Tesla Boulevard.



Major System Overview

- General
  - Overland flows from the catchment area around Kenilworth Ave are collected and directed north along overland flow paths towards the rail lines and then west through depression storage areas along the rail lines. The overland flow paths cross the rail lines east of Gage Ave and are directed towards depression storage on the south side of Nikola Tesla Blvd.
- Kenilworth CSO-8
  - Overland flows from North of Lawrence Rd are conveyed north towards Main St and then north along Tragina Ave and are combined with the flows in the Kenilworth CSO-7. Very limited depression storage areas within the subcatchment. Major system depths are low through the subcatchment.
- Kenilworth CSO-7
  - Overland flows from North of Lawrence Rd are conveyed north towards Main St and then south along Crosthwaite Ave via overland flow routes and are combined with the flows in the Kenilworth CSO-3. Very limited depression storage areas within the subcatchment. Major system depths are low through the subcatchment.
- Kenilworth CSO-6
  - Overland flow from north of Lawrence Rd are conveyed north towards Main St and then west along Main St via overland flow paths north and are combined with the flows in the Kenilworth CSO-5 subcatchment. Very limited depression storage areas within the subcatchment. Major sytem depths are low through the subcatchment.
- Kenilworth CSO-5
  - Overland flow from north of Main St are conveyed north towards depression area along Dunsmure Rd and through overland flow routes north towards Kenilworth CSO-2 subcatchment. Significant major system depths are modelled along Edgemont St.
- Kenilworth CSO-4
  - Overland flows from north of Main St are conveyed north along Cope St and Tragina Ave towards Barton St where the flows are collected and directed north along an overland flow path towards Tragina Ave. Very limited depression areas within the subcatchment. Major system depths are low through the subcatchment.
- Kenilworth CSO-3
  - Overland flows from north of Main St are conveyed north towards Barton St where the flows are collected and directed west towards Kenilworth Ave where flow are connected to the Kenilworth CSO-1 subcatchment. Very limited depression storage within the subcatchment. Major system depths are low through the subcatchment.
- Kenilworth CSO-2
  - Overland flows from the west side of Kenilworth Ave are conveyed north towards Barton St towards depression storage along Barton St. Overland flow depths more than 150mm through large portions of the subcatchment.
- Kenilworth CSO-1
  - Overland flows from the southern portion of the subcatchment east and west side of Kenilworth Ave are conveyed northerly along Kenilworth Ave towards depression areas along Kenilworth Ave and to the west along the rail lines. Overland flows from the northern portion of the subcatchment are directed north towards depression area on the south side of Nikola Tesla Blvd. Overland flow depths are generally low, however depths up to approximately 150mm are present along Dunbar Ave.



Summary of Previous Studies	**Kenilworth Ave N 1500 mm Sewer Construction from Merchison Ave to Burlington St (Rankin Construction, April 2015)**
	• Final sewer inspection report by Public Works Department shows combined sewer installed on Kenilworth Ave N
	
	Kenilworth Ave N from Merchison Ave to Burlington St East Road and Sidewalk Reconstruction, 1500 mm Combined Sewer and Replacement of 900 mm, 300mm, 200 mm & 150 mm Watermains Memo to Accompany MOE ECA Application fro Proposed 1500 mm Combined Sewer and Proposed Storm Sewer Works (AECOM, April 25, 2013)
	• 1500 mm sewer along Kenilworth Ave North from existing 1500 mm sewer at McAnulty Blvd to the new WSI at Burlington St East
	  ○ To alleviate flooding below the CNR bridge underpass up to and including the 10 year storm
	
	Kenilworth Underpass Flood Remediation Works (McCormick and Rankin, October 24, 2012)
	• Underpass on primary overland flow route for approximately 73 ha
	• Recommended 1500 mm combined sewer
	
	Lower East End Storm Drainage Study and Stormwater Management Investigation (McCormick Rankin Corp., 2009)
	• LEEDs Ott-Main Trunk B-2 complete separation of Edgemont St South between Maple Ave and Main St East
	  ○ Could connect into Edgemont St North relief sewer
	  ○ Hansen data from current study shows historic flood calls on Edgemont south of King St East suggesting separating all of Edgemont St South may be preferred
	• LEEDs Ott-Main Trunk C-1 implemented in 2013 with 300 mm storm sewer
	• LEEDs Ott-Main Trunk D-2 implemented in 2013 with 450 mm storm sewer
	• LEEDs Ott-Main Trunk E-1 provide a new combined sewer overflow at intersection of Wexford Ave and Maple Ave. Possibly implemented at same time as D-2?
	• LEEDs Ott-Main Trunk F-1 area separated in 2012 contributing to relief sewer on Dunsmure Rd to Edgemont St North
	• LEEDs Ott-Main Trunk F-3 ICDs already implemented
	• LEEDs Ott-Main Trunk F-4 ICDs already implemented
	
	• LEEDs Ott Trunk A-1 implemented in 2010 by separating street with storm and combined sewer
	• LEEDs Ott Trunk B-1 possibly implemented in 2010 along with A-1
	• LEEDs Ott Trunk C-1 implemented in 2011 with a 1050 mm storm sewer running west along Barton St East from Agnes St, and then north along Ottawa St to Dalhousie Ave.
	
	• LEEDs Kenilworth Trunk A-2 relief sewer on Kenilworth Ave from Central Ave to Main St with a connection on Maple Ave from Croswaite Ave to Kenilworth Ave
	• LEEDs Kenilworth Trunk A-4 modify CSO connection to storm sewer at Cameron Ave and Central Ave. Appears to be implemented, connection is surcharged during 5-year storm event.
	• LEEDs Kenilworth Trunk A-5 upgrade relief sewer on Garside Ave between Main St and Dunsmure Rd, possibly implemented in 2012 using 1050 mm storm sewer.
	• LEEDs Kenilworth Trunk C-3 provide storm relief sewer on Dunsmure Rd between Tuxedo Ave and Kenilworth Ave
	  ○ 600 mm storm sewer installed in 1991, possible data gap in LEEDs?
	
	• LEEDs Kenilworth-Cope Trunk A-2 provide CSO connection at Kenilworth Ave and Roxborough Ave
	  ○ 300 mm CSO connection installed in 1979, possible data gap in LEEDs?
	  ○ Connection not included in current model
	• LEEDs Kenilworth-Cope Trunk B-1 implemented in 2014 with 450 mm storm sewer from Baron Ave N at Dunsmure Rd to Tragina Ave at Main St East
	• LEEDs Kenilworth-Cope Trunk D-1 provide storm relief sewers on Allan Ave and Hope between Cope St and Harmony Ave.
	• LEEDs Kenilworth-Cope Trunk D-2 upgrade the existing combined sewer on Cope St from Allan Ave to Albany Ave
	  ○ Only recommended with remedial measure for Ottawa Trunk Problem Area C (implemented in 2011)
	• LEEDs Kenilworth-Cope Trunk E-1 provide connection from existing combined trunk sewer at McAnulty Blvd along Kenilworth Ave to existing sanitary at Beach Rd
	• LEEDs Kenilworth-Cope Trunk E-2 implemented in 2015 with 450 mm storm sewer
	  ○ Not in current model
	• LEEDs Kenilworth-Cope Trunk E-3 increase inlet capacity upstream of underpass
	• LEEDs Kenilworth-Cope Trunk G-1 provide overflow connection at Harmony Ave and Britannia Ave
	
	<u>Tunnel Concept</u>
	• Potential for large scale tunnel trunk beginning within the eastern border of the Gage catchment
	  ○ Alignment within either Hamilton Water Works Corridor starting at Ottawa St or along Maple Ave from Kenilworth Ave to Strathearne Ave
	  ○ The LEEDs Report has indicated that further investigation is required to determine the feasibility of a large-scale relief trunk
	• Tunnel to discharge to Western Sanitary Interceptor and to Hamilton Harbour via new overflow sewer
	• Preliminary review indicates pumping station not required to convey flows below existing sewers to the Harbour (utilities and infrastructure conflicts not assessed)

CSO Catchment Kenilworth

Summary of Planned Works	• Reconstruction of Barton St between Ferguson Ave N and Kenilworth Ave undergoing functional design.

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Kenilworth - 1	1	3	5	5	3	5	1	4
Kenilworth - 2	3	1	3	5	1	1	4	1
Kenilworth - 3	3	3	3	2	1	1	2	1
Kenilworth - 4	1	3	3	1	1	1	3	1
Kenilworth - 5	1	5	1	4	5	1	1	1
Kenilworth – 6	1	1	3	3	3	1	3	1
Kenilworth – 7	1	1	3	1	1	1	2	1
Kenilworth - 8	1	1	1	1	3	1	4	1

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Kenilworth - 1	High	Medium	
Kenilworth - 2	High	Medium	
Kenilworth - 3	Medium	Low	
Kenilworth - 4	Low	Medium	
Kenilworth - 5	Medium	High	
Kenilworth – 6	Low	Low	
Kenilworth – 7	Low	Medium	
Kenilworth - 8	Low	Medium	

CSO Catchment Kenilworth

Issues and Options

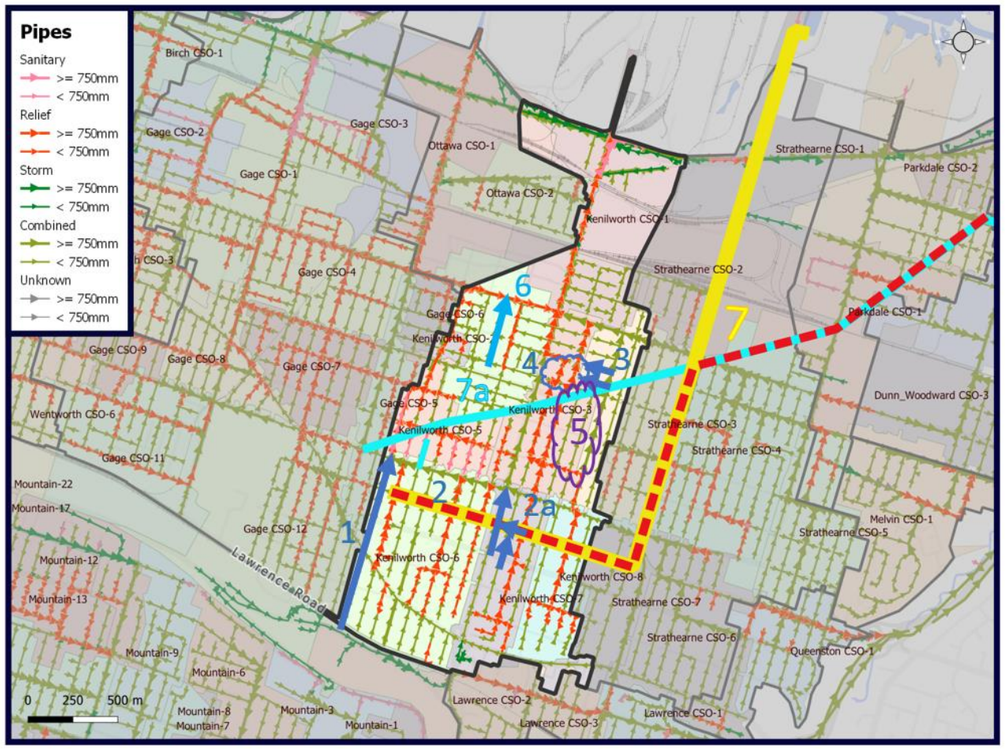
Summary of Key Issues

- Generally the Kenilworth CSO is almost separated via trunk relief sewers on Kenilworth Ave with connections up to King St East
- Kenilworth CSO-8 shows the major system as medium and inlet capacity as moderate.
  - 5 Hansen records on Auburn Ave between Normandy Rd and Monterey Ave
- Kenilworth CSO-7 shows no major issues
  - Scattered Hansen calls along Crosthwaite Ave South and Cameron Ave S
  - 4 Hansen calls at Main St East and Garside Ave N along overland flow path
- Kenilworth CSO-6 shows the major system, minor system and inlet capacity as medium
  - 4 Hansen records on Park Row South between Central Ave and Monterey Ave
    - 750 mm storm sewer and 525 mm combined sewer along this reach
  - 4 Hansen Records on Edgemont St South between Lawrence Rd and King St East
  - HGL within 1.8 mbgs on Graham Ave South between King St East and Maple Ave
    - 4 Hansen records along reach
    - Two 300 mm combined sewers along reach
    - Overland flow route along reach potentially receiving major system flows from Kenilworth Access
- Kenilworth CSO-5 shows minor system as moderate and major system as high
  - HGL < 1.8 mbgs at north end of CSO-5 between Cannon St and Edinburgh Ave
    - Overland flow path runs through high HGL areas
- Kenilworth CSO-4 shows inlet capacity as medium
  - 10 Hansen flooding records on Cope St between Main St East and Britannia Ave
- Kenilworth CSO-3 shows historic flooding records as medium, minor system and inlet capacity as minor
  - 6 Hansen records on Cameron Ave North between Main St East and Britannia Ave
  - HGL <1.8 mbgs on Barons Ave North on overland flow path between Roxborough Ave and Britannia Ave
- Kenilworth CSO-2 shows minor system as high and inlet capacity as moderate with historic flooding records as medium
  - HGL <1.8 mbgs for majority of sewers
  - 4 Hansen records on Britannia Ave between Kenilworth Ave and Robinson Ave
  - Major system shown to have significant depths on Cannon St and Cambrige Ave
- Kenilworth CSO-1 shows minor system and overland flow as high, major system as moderate and surface depressions as moderate
  - HGL <1.8 mbgs on Vansitmart Ave, Harrison Ave, Division St and Dunbar Ave
    - Overland flow route on Division St and Dunbar Ave
- LEEDs Ott-Main Trunk B-2 complete separation of Edgemont St South between Maple Ave and Main St East
  - Hansen data from current study shows historic flood calls on Edgemont south of King St East suggesting separating all of Edgemont St South may be preferred

CSO Catchment Kenilworth

Summary of Potential Options

1. (KN-1) LEEDs Ott-Main Trunk B-2 complete separation of Edgemont St South between Maple Ave and Main St East – Extend to Lawrence Rd
2. (KN-2) LEEDs Kenilworth Trunk A-2 relief sewer on Kenilworth Ave from Central Ave to Main St with a connection on Maple Ave from Croswaite Ave to Kenilworth Ave
    a. (KN-2a) Extend to Croswaite Ave and Central Ave
    b. (KN-2b) Consider directing to relief sewer on Garside Ave South
    c. (KN-2c) Consider utilizing Maple Ave instead of Main St East to convey relief flows east/west
3. (KN-3) LEEDs Kenilworth-Cope Trunk D-1 provide storm relief sewers on Allan Ave and Hope between Cope St and Harmony Ave (preferred option over D-2)
4. (KN-4) LEEDs Kenilworth-Cope Trunk G-1 provide overflow connection at Harmony Ave and Britannia Ave
    a. (KN-4a) Consider completing separation on Barton St East between Harmony Ave and Kenilworth Ave
5. (KN-5) Consider ICDs on Cope St between Main St East and Britannia Ave to provide relief in interim until separation can proceed
    a. (KN-5a) Consider expanding to adjacent streets with flooding records (Garside, Cameron, Barons)
6. (KN-6) Separation on Ellis Ave
    a. (KN-6a) Potential for storage in R.T. Steel Park to reduce impacts on Barton St East
7. (KN-7) Trunk storm sewer on Strathearne Ave
    a. (KN-7a) Trunk storm sewer on waterworks corridor



Option Evaluation

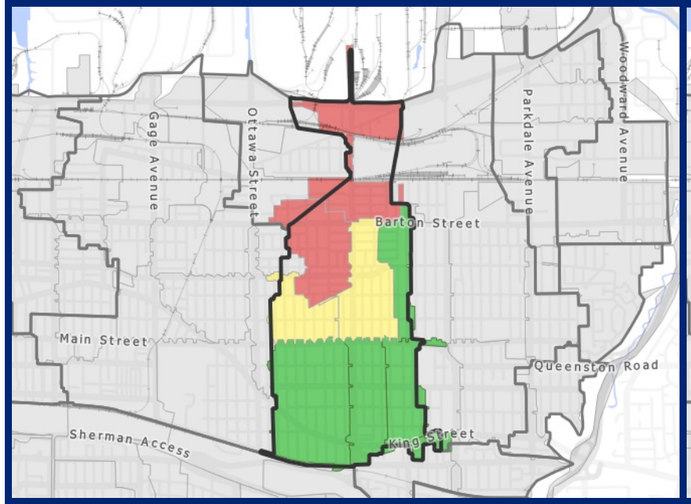
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. Separation on Edgemont (Lawrence to Main) (KN-1)	• Would address a relatively higher number of Hansen calls • Would remove flow from downstream combined system, separated storm sewer available downstream • Potential future connection to waterworks corridor trunk • Previous LEEDS recommendation	• Longer/more involved reconstruction • Does not benefit side streets or other areas (other than small amount on Maple Street) • Potential impacts to storm trunk to be confirmed	Local Solution Moderate Benefit	$5.7M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None

CSO Catchment Kenilworth							
2. Relief Sewer on Kenilworth (Central to Main) (KN-2)	• Previous LEEDs recommendation • Flow reduction to combined sewer system •	• No Hansen calls noted in this area • Relatively limited local benefit • Upstream area would remain unseparated but potential to include • Need for work at Main Street (arterial road) to be completed for full separation connection •	Local Solution Limited Benefit	$3.4M	Recommended	Low Priority Long Term (10 – 20 Years)	None
2. a) Sewer Separation on Crosthwaite Street (Central to Main) (KN-2a)	• Relatively higher number of Hansen calls on this street • Flow reduction to combined sewer system •	• Upstream area would remain unseparated but potential to include • Need for work at Main Street (arterial road) to be completed for full separation connection, or consider diversion to separated sewer via Maple •	Local Solution Moderate Benefit	$1.9M	Recommended	Medium Priority Short Term (3 – 5 Years)	None
2. b) Sewer Separation on Main Street (Kenilworth to Garside) (KN-2b)	• Key link to separated sewers north of Main to allow areas to the south to be separated • Hansen records on this section of Main Street as well •	• Arterial roadway will make construction challenging •	System Wide Solution Moderate Benefit	$1.5M	Recommended	Medium Priority Short Term (3 – 5 Years)	None
2. c) Storm Sewer diversion on Maple Ave (KN-2c)	• Local street with no existing sewer services, construction would be easier than on Main Street or busier streets •	• Need for this work to be confirmed through further study, may not be necessary if doing other more direct separation works •	Local Solution Limited Benefit	$800K	Further Study	Low Priority Long Term (10 – 20 Years)	None
3. Relief Sewers on Hope and Allan (KN-3)	• Previous LEEDS recommendation • 1 Hansen call on each street • Would need to confirm extent of backflow from trunk on Cope •	• More localized benefit only • Ease of construction – small diameter sewers on local streets •	Local Solution Limited Benefit	$2.0M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
4. Overflow connection at Harmony and Britannia (KN-4)	• Previous LEEDS recommendation • 2 Hansen calls in this •	• Need for this work to be confirmed through further study • Separated/relief sewers already present on Archibald and Harmony • Britannia is a busier street, complexity of construction	Local Solution Limited Benefit	$680K	Further Study	Low Priority Long Term (10 – 20 Years)	None

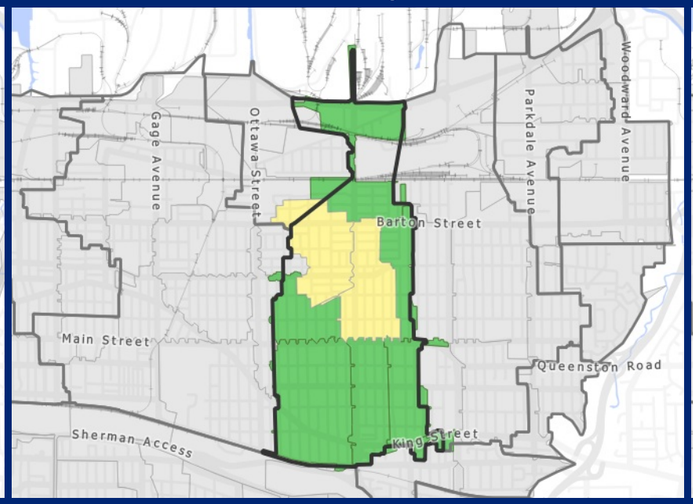
CSO Catchment Kenilworth							
4. a) Complete sewer separation on Barton (Harmony to Kenilworth) (KN-4a)	• Key link to allow connection of separated sewers on these streets •	• Barton Street is an arterial road, complexity of construction staging •	System Wide Solution Substantial Benefit	$2.2M	Recommended	High Priority Short Term (3 – 5 Years)	None
5. ICDs on Cope Street from Main to Britannia (KN-5)	• Ease and speed of installation • Relatively low cost • Reduction in storm flows to the combined sewer system • High number of Hansen calls in this area, interim solution until infrastructure permits separation	• Would not prevent inflows from external areas (Cope combined sewer receives drainage from three separate areas) •	Local Solution Moderate Benefit	$60K	Recommended	High Priority Immediate Term (0 – 3 Years)	None
5. a) Additional ICDs on adjacent streets (Garside, Cameron, Barons) (KN-5a)	• Ease and speed of installation • Relatively low cost • Reduction in storm flows to the combined sewer system • High number of Hansen calls in this area, interim solution until infrastructure permits separation • Synergy with proposed ICDs on Cope Street	• Would not prevent inflows from external areas •	Local Solution Moderate Benefit	$250K	Recommended	High Priority Immediate Term (0 – 3 Years)	None
6. Sewer Separation on Ellis Ave (KN-6)	• Ease of construction – small diameter sewers on local street • 3 Hansen calls noted on the section of roadway • Partially separated sewers available to receive separation on Barton • Can also disconnect from Britannia at upstream end	• Still potential for backflow from sewers on Barton •	Local Solution Moderate Benefit	$1.9M	Further Study	Medium Priority Medium Term (5 – 10 Years)	None
6. a) Storage in RT Steel Park (KN-6a)	• Could help mitigate overall impacts to downstream receiver • Directly inline with proposed sewer works, available open space in the park •	• Further technical assessment required to confirm feasibility • Confirm no potential for sanitary/combined backflow •	Local Solution Limited Benefit	$620K	Further Study	Medium Priority Medium Term (5 – 10 Years)	None

CSO Catchment Kenilworth							
7. Trunk storm sewer on Strathearne Ave (KN-7)	• Previous LEEDS recommendation • Would benefit both Strathearne and Kenilworth catchments; key link for both areas to allow future separation of a broad area • High potential long-term benefit in storm flow reduction	• Complexities around existing trunk combined and storm sewers, Dofasco property and railway crossing • Likely need for tunnelling • Need to assess impacts to harbour • High cost and time to construct	System Wide Solution Substantial Benefit	$36.7M	Further Study (Note Duplication of Strathearne Option 1)	High Priority Short Term (3 – 5 Years)	STR-3
7. a) Trunk storm sewer on waterworks corridor (KN-7a)	• Previous LEEDS recommendation • Makes full use of proposed Strathearne trunk and enables separation of a large area • Potential easier construction along greenfield corridor other than watermains (as opposed to street work)	• Multiple road crossings still required, infrastructure conflicts • Tunnelling still likely required • High cost and time to construct •	System Wide Solution Substantial Benefit	$29.2M	Further Study	Low Priority Long Term (10 – 20 Years)	None
Managed Sewer Separation (KN-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$26.7M	Recommended	Medium Priority Future Planning (20+ Years)	None

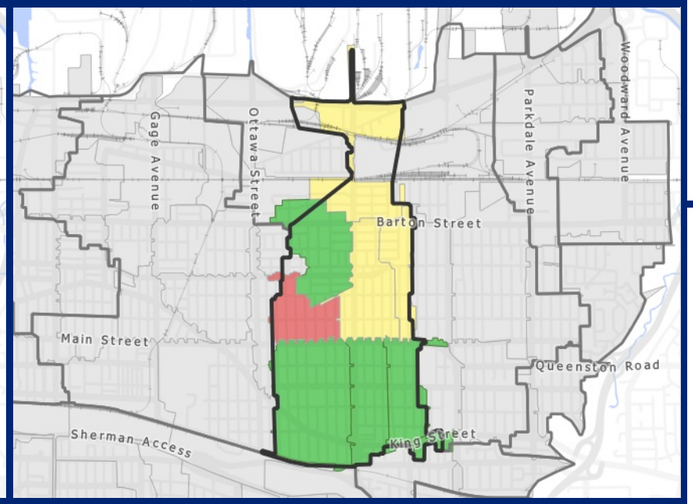
Overall Priority Ranking



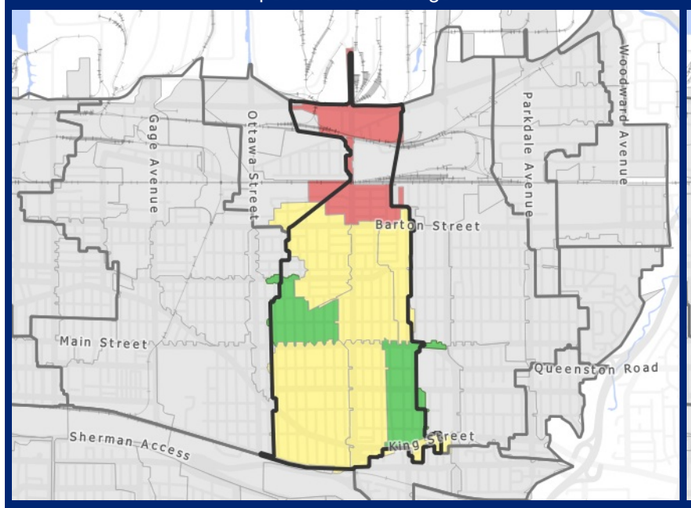
Hansen Flooding Calls



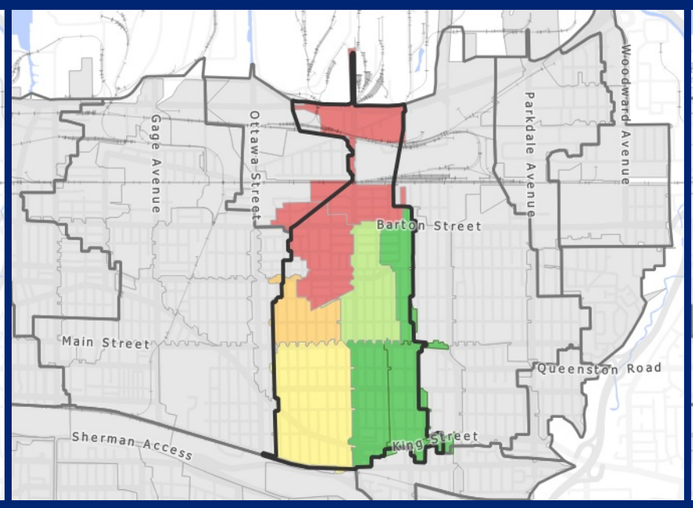
Pipe Depth for Residential Connections



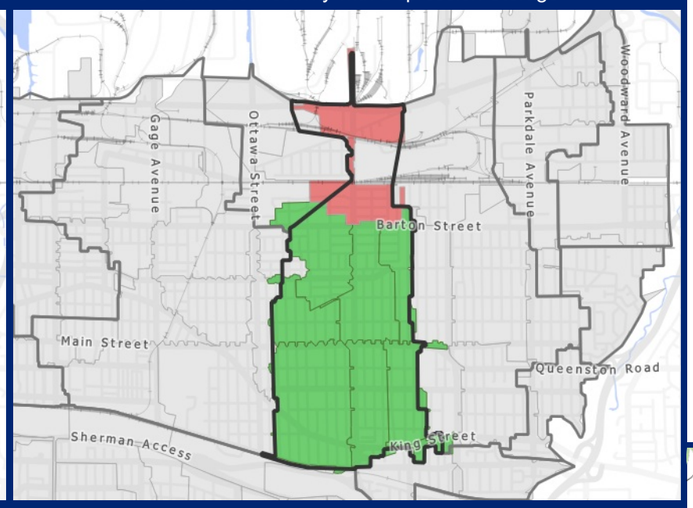
Pipe Condition and Age



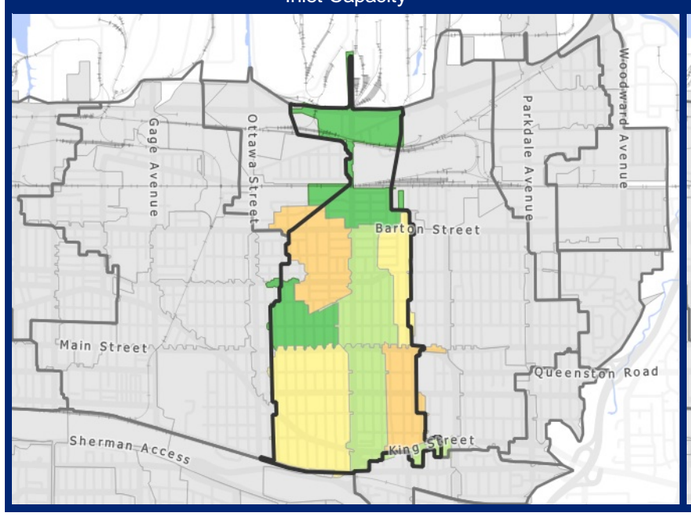
HGL to Basement Elevation of 1.8 m



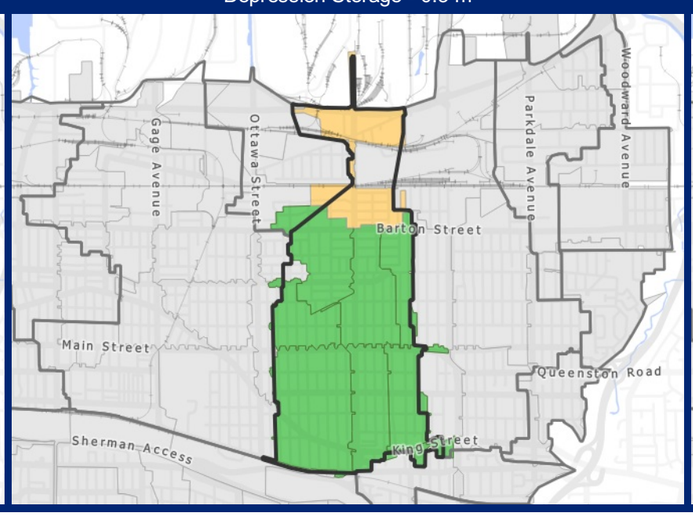
Overland Connectivity with Depression Storage



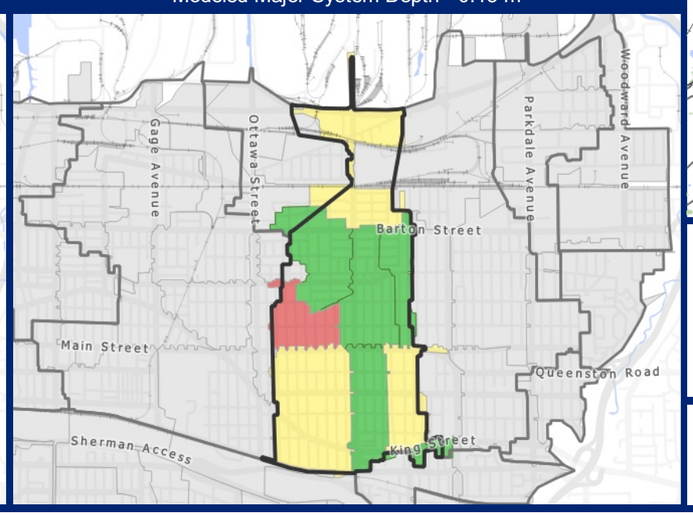
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

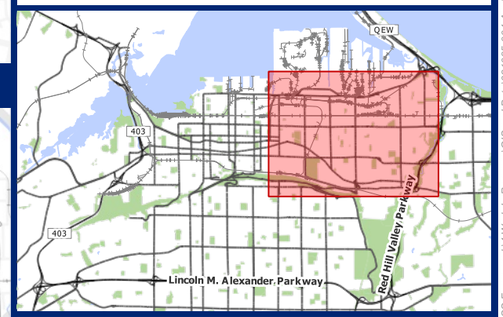


Figure 16 of 24

Kenilworth CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

Document Path: W:\Hamilton\621000\621085 Hamilton FDMSS Framework\4 Work In Progress\GIS and Data\621085-004-Analysis Results.qgz

CSO Catchment Strathearne

Catchment Summary

Overview

The Strathearne CSO catchment is located in the eastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

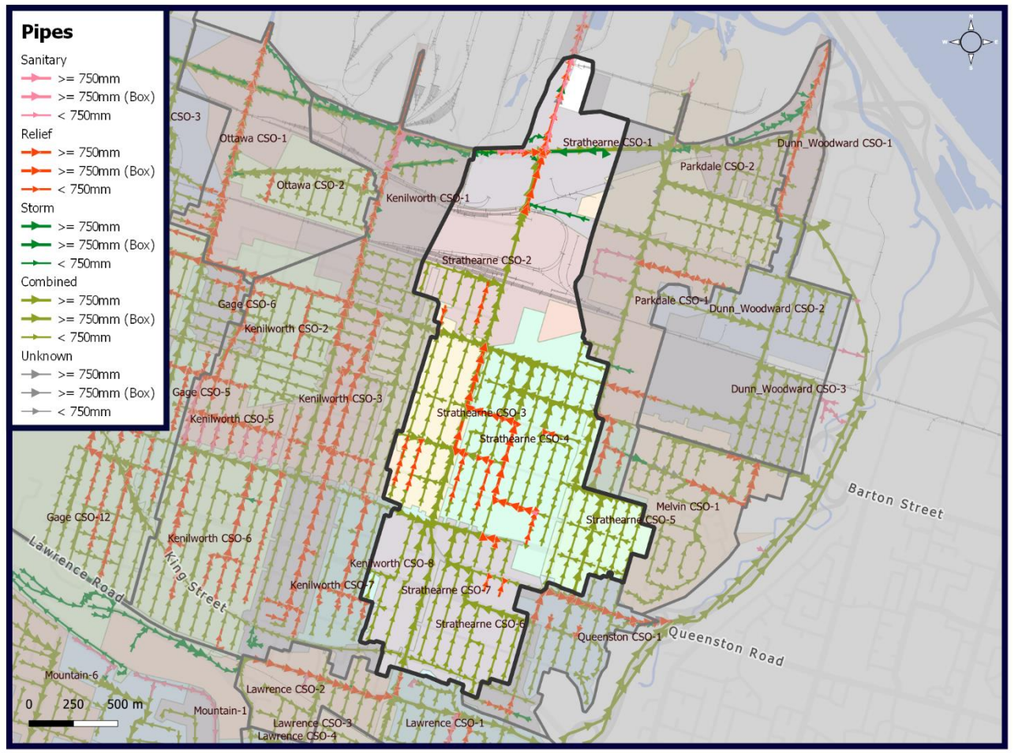
- Normanhurst
- Glenview West
- Homeside (eastern portion)
- Bartonville (northeastern portion)
- Mcquesten West (southwestern portion)
- Industrial Sector E
- Industrial Sector G

The Strathearne CSO catchments contains seven (7) subcatchments.

City owned corridor running northeast from Main St East and Ottawa St North to Woodward Ave south of Nikola Tesla Blvd interchange crosses Strathearne CSO between Britannia Ave and the CN rail tracks.

Catchment Metrics

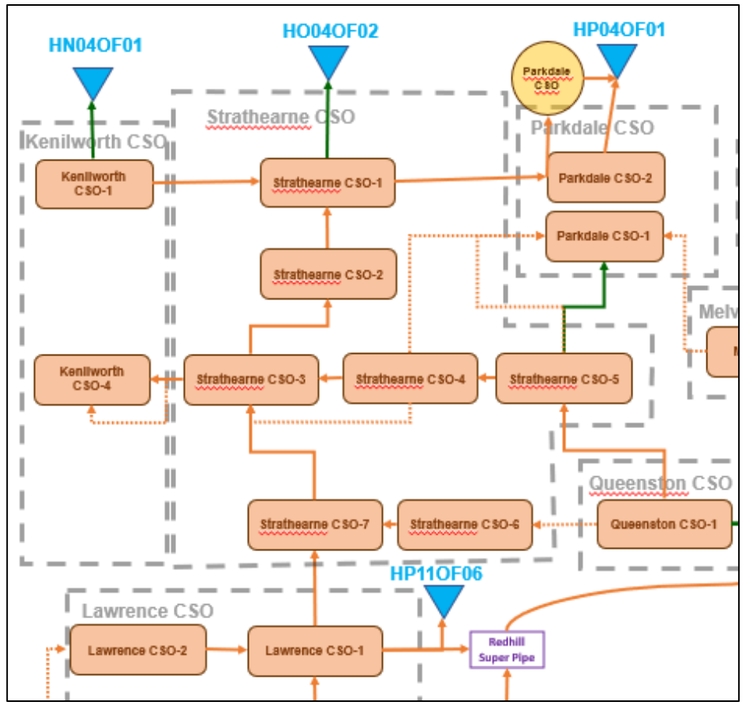
Area (ha)	358.2
Total Length of Sewers (km)	48.7
Length of Combined Sewers (km)	39.5
Length of Sanitary Sewers (km)	1.1
Length of Storm Sewers (km)	1.3
Length of Relief Sewers (km)	6.8
Storage Tanks (# and Name)	N/A



CSO Catchment Strathearne

Minor System Overview

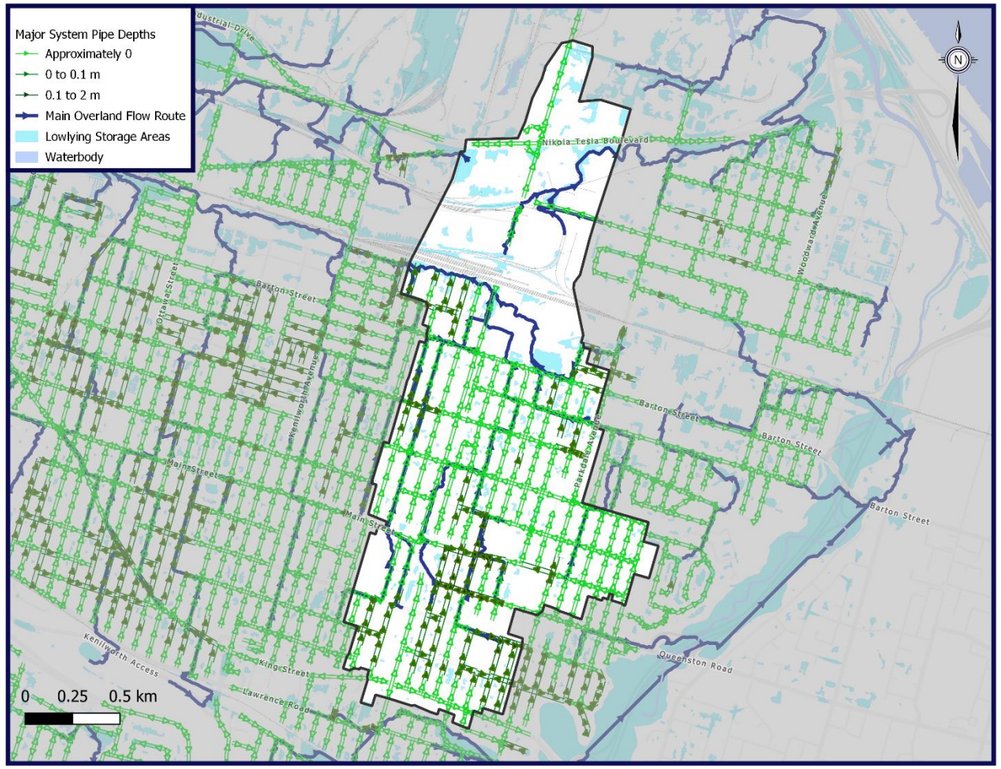
- External minor system flows from Lawrence CSO contribute to Strathearne CSO-7 in the Cochrane Rd trunk combined sewer.
- Strathearne CSO-6 and Strathearne CSO-7 convey minor system flows through combined sewers to Strathearne Ave.
  - Combined sewers outlet to Strathearne CSO-3 on Strathearne Ave
- Strathearne CSO-7 has a combined sewer connetion to Kenilworth CSO-8 on Main St East
- Strathearne CSO-6 has a combined sewer connection to the Queenston CSO on Queenston Rd.
- Strathearne CSO-5 conveys minor system flows to Parkdale Ave N and Melvin Ave
  - Relief sewer flows outlet to Parkdale CSO-1
  - Combined sewer flows outlet to Strathearne CSO-4
- Strathearne CSO-4 conveys combined sewer flows north to Barton St East
  - Relief sewers convey runoff west to Strathearne Ave on Roxborough Ave and Britannia Ave
  - Combined and relief sewers outlet to Strathearne CSO-3 on Strathearne Ave at Barton St East
- Strathearne CSO-3 conveys the combined sewer flows in the Strathearne Ave trunk sewer
  - Outlet combined and relief sewers to Strathearne CSO-2 on Strathearne Ave
  - There is a secondary combined sewer outlet on Barton St East at Weir St North towards Kenilworth CSO-4
- Strathearne CSO-2 conveys flows north to Strathearne CSO-1 in the Strathearne Ave trunk combined sewer
- Strathearne CSO-1 conveys flows from the Strathearne Ave trunk sewer into the Western Sanitary Interceptor (WSI)
  - Relief sewers between Brampton St and outlet to Hamilton Harbour at end of Strathearne Ave spit.
  - WSI conveys combined sewer flows east into Parkdale CSO and towards the Woodward Wastewater Treatment Plant



CSO Catchment Strathearne

Major System Overview

- Overland flows through the Strathearne CSO generally flow from south to north.
- Strathearne CSO-7 overland flows drain north to Strathearne CSO-3 on Fairfield Ave
- Strathearne CSO-6 overland flows drain into Strathearne CSO-4 at Walter Ave S
    - Major system flows simulated to ponded area at northeast corner of Viscount Montgomery Public School
        - Intersection of Summerhill Ave and Central Ave
    - Significant major system flows in Strathearne CSO-6
- Strathearne CSO-5 has significant ponding on Britannia Ave along an overland flow route
    - Overland flows drain to Melvin Ave which conveys the overland flow to Julien Ave north to Mahony Park on Barton St East
        - Large ponded area along overland flow route in Mahony Park
- Strathearne CSO-4 overland flows are conveyed north along Tolton Ave and Walter Ave North
- Strathearne CSO-3 overland flows are conveyed north along Fairfield Ave
- Strathearne CSO-2 overland flows are conveyed west along the rail tracks through ponded areas to Dunbar Ave in Kenilworth CSO-1
- Strathearne CSO-1 overland flows are conveyed east into Parkdale CSO-2 along the south side of Nikola Tesla Blvd
    - Through ponded areas



CSO Catchment Strathearne

Summary of Previous Studies

Lower East End Storm Drainage Study and Stormwater Management Investigation (McCormick Rankin Corp., 2009)

- LEEDs Strathearne Trunk South A-1 provide relief sewer from Queenston Ave and Termoli Crt to the existing storm relief sewer at Walter Ave and Dunsmure Rd

- LEEDs Strathearne Trunk Northwest A-1 maintain culvert at north end of Weir St, Tragina Ave, Cope St, and Division St near the CN rail tracks
- LEEDs Strathearne Trunk Northwest A-2 add inlets to underutilized trunk combined sewer between Weir St and Strathearne Ave, south of the rail tracks
- LEEDs Strathearne Trunk Northwest B-3 implemented in 2004 with 600 mm storm sewer and CSO connection at Paling Ave and Dunsmure Rd
  - In current model as combined sewer
- LEEDs Strathearne Trunk Northwest C-1 provide a relief sewer on Britannia Ave between Weir St N and Strathearne Ave with CSOs at each intersection

- LEEDs Strathearne Trunk Northeast A-4 block combined sewers on Julian Ave and Ivon Ave to limit HGL in Dunsmure Rd combined sewer
- LEEDs Strathearne Trunk Northeast A-5 provide new CSOs on Dunsmure Rd between Adeline Ave and Walter Ave

- LEEDs Parkdale Trunk B-1. B-2 and B-3 were recommended in combination
  - B-3: 600 mm storm sewer installed in 2017 on Adair Ave, presumed that B-1 and B-2 were also implemented
- LEEDs Parkdale Trunk D-1 ensure CSO at Glassco Ave and Roxborough Ave maximized
  - 975 mm storm sewer on Glassco Ave N not connected to combined sewer on Roxborough Ave according to current model

<u>Tunnel Concept</u>

- Potential for large scale tunnel trunk beginning within the eastern border of the Gage catchment
  - Alignment within either Hamilton Water Works Corridor starting at Ottaw St or along Maple Ave from Kenilworth Ave to Strathearn Ave
  - The LEEDs Report has indicated that further investigatiojn is required to determine the feasibility of a large-scale relief trunk
- Tunnel to discharge to Western Sanitary Interceptor and to Hamilton Harbour via new overflow sewer
- Preliminary review indicates pumping station not required to convey flows below existing sewers to the Harbour (utilities and infrastructure conflicts not assessed)

Summary of Planned Works

- Road construction work between Britannia and Roxborough – separated storm sewer
- Strathearne trunk, North of Brampton has lining study going on, but lining would increase flooding substantially
  - Flow monitoring proposed/ongoing
  - Significant number of upstream sewers are already separated and only require connectivity to separate completely – bottlenecked north of Brampton

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Strathearne CSO-1	1	1	5	1	1	3	5	3
Strathearne CSO-2	1	3	5	5	1	2	5	3
Strathearne CSO-3	3	3	3	2	1	1	3	1
Strathearne CSO-4	3	1	5	3	3	2	4	2
Strathearne CSO-5	1	1	5	2	1	1	3	1

CSO Catchment Strathearne								
Strathearne CSO-6	1	1	5	5	5	1	3	1
Strathearne CSO-7	1	1	5	3	1	1	4	1

Sub Catchment Prioritization			
	Catchment Priority	Data Uncertainty	Commentary
Strathearne CSO-1	Medium	Low	Railway & Industrial lands reduces certainty
Strathearne CSO-2	High	Medium	Railway reduces certainty. High HGL & age adds to priority
Strathearne CSO-3	Medium	Low	
Strathearne CSO-4	High	Low	
Strathearne CSO-5	Low	Low	
Strathearne CSO-6	High	Low	
Strathearne CSO-7	Medium	Low	

CSO Catchment Strathearne

Issues and Options

Summary of Key Issues	• Strathearne CSO-7
	  ○ HGL <1.8 mbgs for approximately half of subcatchment
	• Strathearne CSO-6 shows major system flow route issues with high simulated depths through the subcatchment
	  ○ Significant ponding in major system shown at northeast corner of Viscount Montgomery Public School (intersection of Summerhill Ave and Central Ave)
	  ○ HGL <1.8 mbgs for majority of subcatchment
	• Strathearne CSO-5 shows medium inlet capacity and relatively minor concerns for HGL
	  ○ HGL <1.8mbgs on Parkdale Ave North
	• Strathearne CSO-4 shows historic flooding
	  ○ Hansen calls along alignment of relief sewer on Walter Ave North to Britannia Ave
	  ○ Cluster of calls in vicinity of Melvin Ave between Walter Ave North and Normanhurst Ave
	  ▪ Combined system, no separation at this location
	• Strathearne CSO-3 shows historic flooding
	  ○ Distributed across the subcatchment
	  ○ Cluster of 3 Hansen records on Weir St North, north of Dunsmure Rd
	• Strathearne CSO-2 shows minor system issues
	  ○ HGL <1.8 mbgs for approximately half of subcatchment
	  ○ Inlet capacity likely overestimated due to large private areas without CB data
	• Strathearne CSO-1
	  ○ Inlet capacity likely overestimated due to large private areas without CB data	

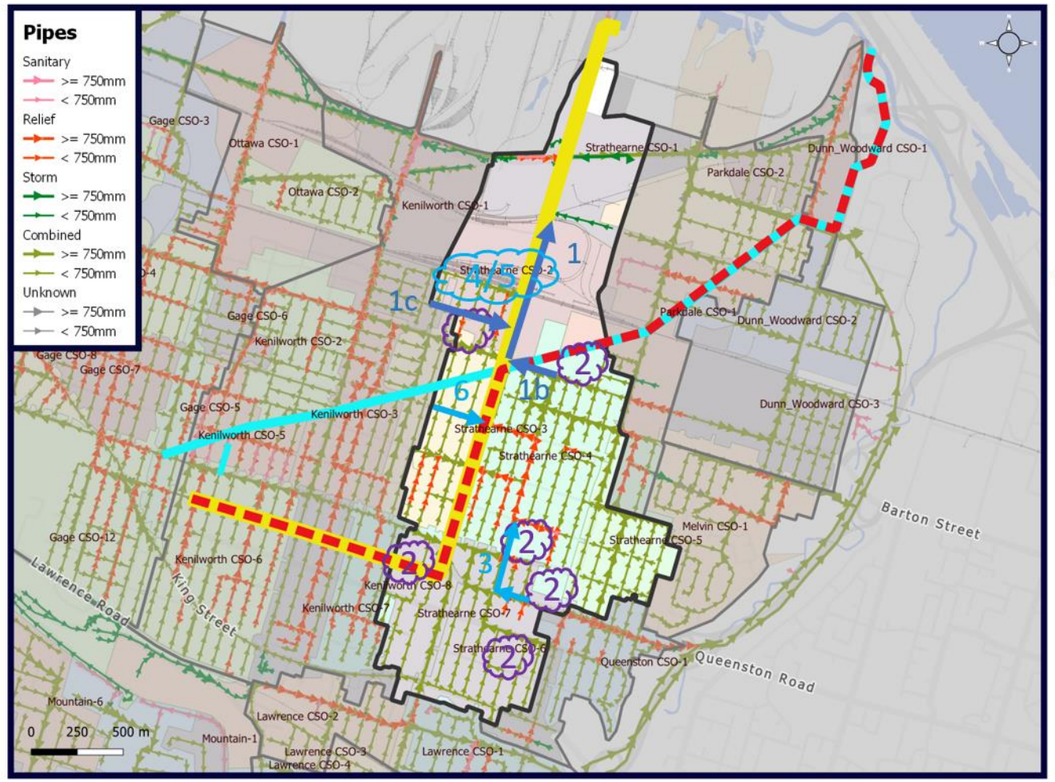
CSO Catchment Strathearne

Summary of Potential Options

1. a) (ST-1) Complete separation along Strathearne Ave in Strathearne CSO-2 (Barton St East to Brampton St) to provide outlet for relief sewers in Strathearne CSO-4 and Strathearne CSO-3
    - Lining of sewer investigation ongoing north of Brampton St, may suggest this strategy is not viable. Twin sewer instead?

    b) (ST-1b) Consider extending on Barton St to Walter Ave North to pick up cluster of Hansen calls on Melvin Ave between Shelby Ave and Walter Ave
    - Are these flooding incidents related to backup on trunk?

    c) (ST-1c) Consider connection on Vansitmart
    i. Are these flooding incidents related to backup on trunk?
2. Potential storage options on major overland flow routes:
    a. (ST-2a) Parkdale Park to reduce overland flows in Strathearne CSO-6 contributing to Strathearne CSO-4
        i. Consider connecting to Viscount Montgomery Public School ponded areas via greenspace + property acquisition (2 homes on Summerhill Ave)
    b. (ST-2b) Viscount Montgomery Public School to reduce ponding at intersection of Summerhill Ave and Central Ave
    c. (ST-2c) Montgomery Park to reduce overland flows from Strathearne CSO-7 contributing to Strathearne CSO-3 along Fairfield Ave.
    d. (ST-2d) Mahony Park to reduce overland flows from Strathearne CSO-4 contributing to ponded area on Strathearne CSO-2
    e. (ST-2e) Fairfield Park to reduce overland flows from Strathearne CSO-3 contributing to ponded area on Strathearne CSO-2
3. (ST-3) LEEDs Strathearne Trunk South A-1 provide relief sewer from Queenston Ave and Termoli Crt to the existing storm relief sewer at Walter Ave and Dunsmure Rd
4. (ST-4) LEEDs Strathearne Trunk Northwest A-1 maintain culvert at north end of Weir St, Tragina Ave, Cope St, and Division St near the CN rail tracks
5. (ST-5) LEEDs Strathearne Trunk Northwest A-2 add inlets to underutilized trunk combined sewer between Weir St and Strathearne Ave, south of the rail tracks
    - Current model suggests this combined sewer remains underutilized
6. (ST-6) LEEDs Strathearne Trunk Northwest C-1 provide a relief sewer on Britannia Ave between Weir St N and Strathearne Ave with CSOs at each intersection



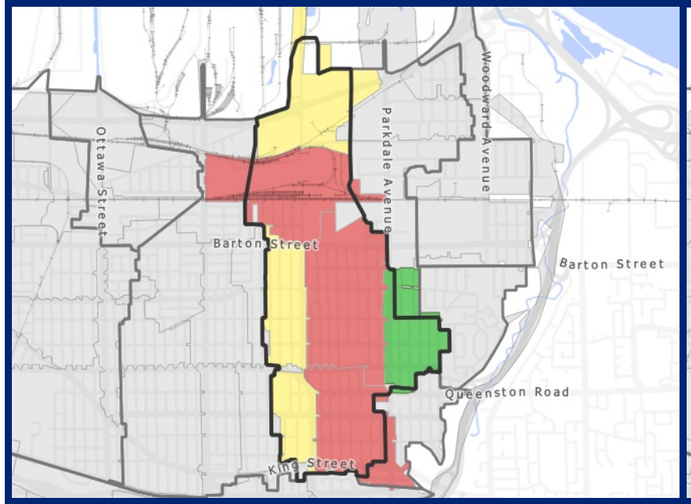
Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. Trunk storm sewer on Strathearne Ave (ST-1)	• Previous LEEDS recommendation • Would benefit both Strathearne and Kenilworth catchments; key link for both areas to allow future separation of a broad area • High potential long-term benefit in storm flow reduction	• Complexities around existing trunk combined and storm sewers, Dofasco property and railway crossing • Likely need for tunnelling • Need to assess impacts to harbour • High cost and time to construct	System Wide Solution Substantial Benefit	$36.7M	Recommended	High Priority Short Term (3 – 5 Years)	STR-3

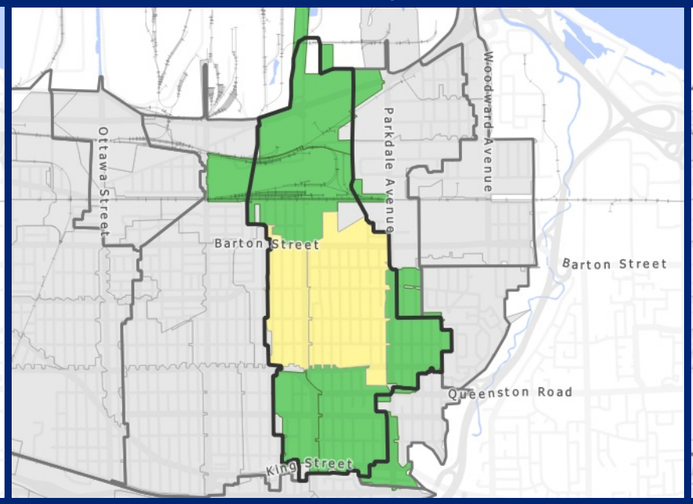
CSO Catchment Strathearne							
1. b) Separation on Barton (Walter to Strathearne) (ST-1b)	• Important link for separation after Strathearne to allow separation of all side streets • Potential benefit to flow reduction to combined sewer and separation • Cluster of Hansen calls immediately south on Melvin	• Could still complete now but better to wait until strathearne storm trunk in place; means likely delay • Complexity of constructing on Barton Street (arterial road)	System Wide Solution Substantial Benefit	$5.6M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
1. c) Separation on Vansitmart (Weir to Strathearne) (ST-1c)	• Would allow separation of side streets once Strathearne is in place • Potential benefit to flow reduction to combined sewer and separation • Could construct stub as part of Strathearne to facilitate this work thereafter • Localized cluster of Hansen Calls	• Likely requires Strathearne in place first, delay	Localized Solution Moderate Benefit	$1.4M	Further Study	Medium Priority Medium Term (5 – 10 Years)	None
2. a) Parkdale Park Storage (ST-2a)	• Lower cost item which could be implemented more readily • Could help address overland flow issues and decrease inflows to combined sewer system	• Requires further study to confirm effectiveness • Potential impact to usability of park, need to assess	System Wide Solution Limited Benefit	$1.4M	Further Study	Low Priority Long Term (10 – 20 Years)	None
2. b) Viscount Montgomery PS Storage (ST-2b)	• Lower cost item which could be implemented more readily • Could help address overland flow issues and decrease inflows to combined sewer system	• Requires further study to confirm effectiveness • Potential impact to usability of park, need to assess	System Wide Solution Limited Benefit	$640K	Further Study	Low Priority Long Term (10 – 20 Years)	None
2. c) Montgomery Park Storage (ST-2c)	• Lower cost item which could be implemented more readily • Could help address overland flow issues and decrease inflows to combined sewer system	• Requires further study to confirm effectiveness • Potential impact to usability of park, need to assess	System Wide Solution Limited Benefit	$2.3M	Further Study	Low Priority Long Term (10 – 20 Years)	None
2. d) Mahoney Park Storage (ST-2d)	• Lower cost item which could be implemented more readily • Could help address overland flow issues and decrease inflows to combined sewer system	• Requires further study to confirm effectiveness • Potential impact to usability of park (baseball fields – active usage), need to assess	System Wide Solution Limited Benefit	$2.9M	Further Study	Low Priority Long Term (10 – 20 Years)	None

CSO Catchment Strathearne							
2. e) Fairfield Park Storage (ST-2e)	• Lower cost item which could be implemented more readily • Could help address overland flow issues and decrease inflows to combined sewer system	• Requires further study to confirm effectiveness • Potential impact to usability of park, need to assess	System Wide Solution Limited Benefit	$410K	Further Study	Low Priority Long Term (10 – 20 Years)	None
3. Relief sewers on Queenston and Walter (ST-3)	• Consistent with LEEDs • Connects separated area at upstream end with partially separated sewers at downstream • Potentially allow for separation of additional areas on Queenston and Walter • Overall benefit in flow/volume reduction to combined sewer system	• Challenges of constructing on Queenston Road (arterial) • More limited local Hansen calls	System Wide Solution Moderate Benefit	$5.4M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
4. Maintain culverts over rail line at Division, Cope, Tragina and Weir (ST-4)	• Consistent with LEEDs • Importance for overland flow drainage and limiting ponding	• Likely have to deal with private ownership, complexity • Low Hansen calls	Local Solution Moderate Benefit	$1.7M	Recommended	Medium Priority Short Term (3 – 5 Years)	None
5. Additional inlets along south side of railway - Weir to Strathearne (ST-5)	• Consistent with LEEDs • Ease and speed of implementation • Low cost	• Should confirm additional inlet capacity will not worsen conditions for other areas • Potential need to couple with road reconstruction, increases costs	Local Solution Moderate Benefit	$90K	Recommended	Medium Priority Short Term (3 – 5 Years)	None
6. Relief sewer on Britannia from Weir to Strathearne (ST-6)	• Consistent with LEEDs • Would intercept multiple side streets and divert towards Strathearne – benefits downstream and allows upstream separation	• Further assessment required to confirm necessity; recent construction in this area? • Not necessary if constructing trunk in waterworks corridor?	System Wide Solution Limited Benefit	$2.1M	Further Study	Low Priority Long Term (10 – 20 Years)	None
Managed Sewer Separation (ST-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$35.7M	Recommended	Medium Priority Future Planning (20+ Years)	None

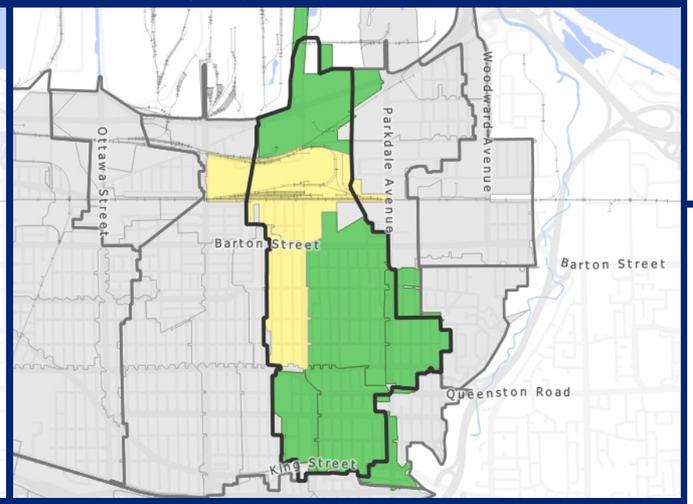
Overall Priority Ranking



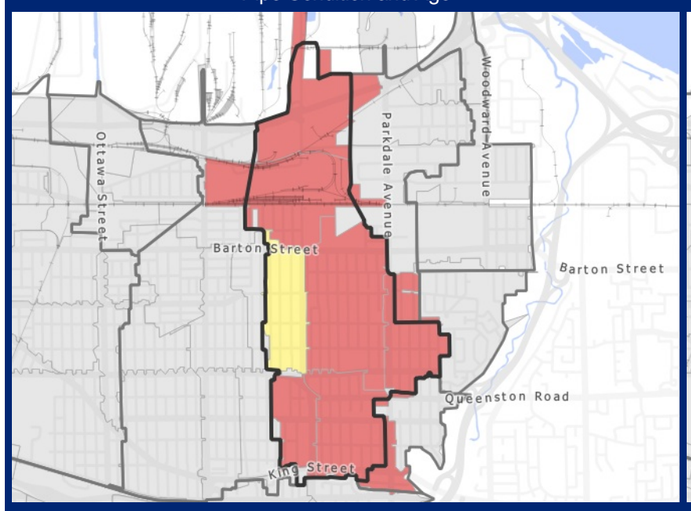
Hansen Flooding Calls



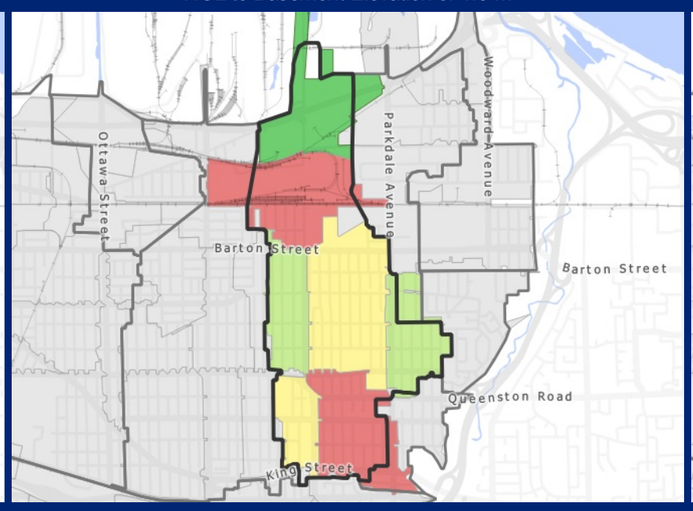
Pipe Depth for Residential Connections



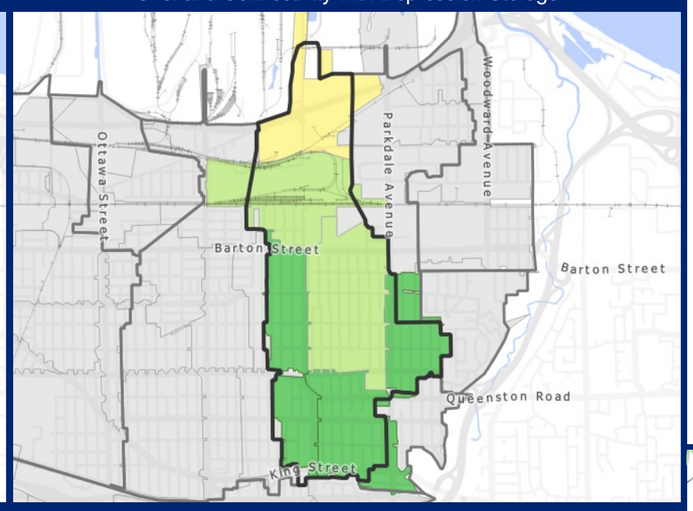
Pipe Condition and Age



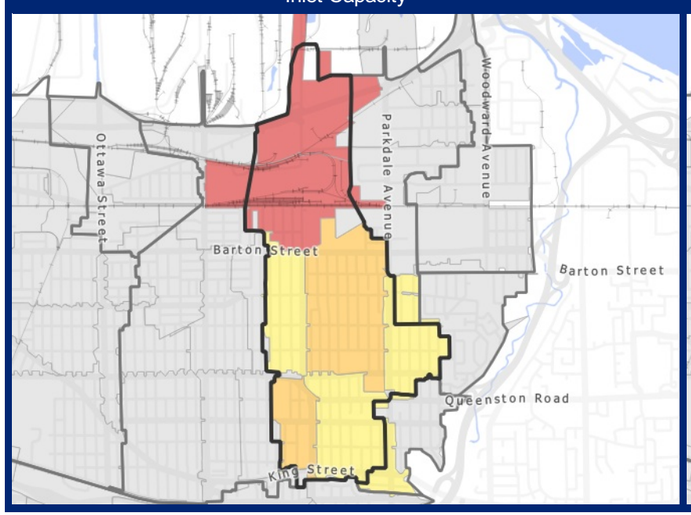
HGL to Basement Elevation of 1.8 m



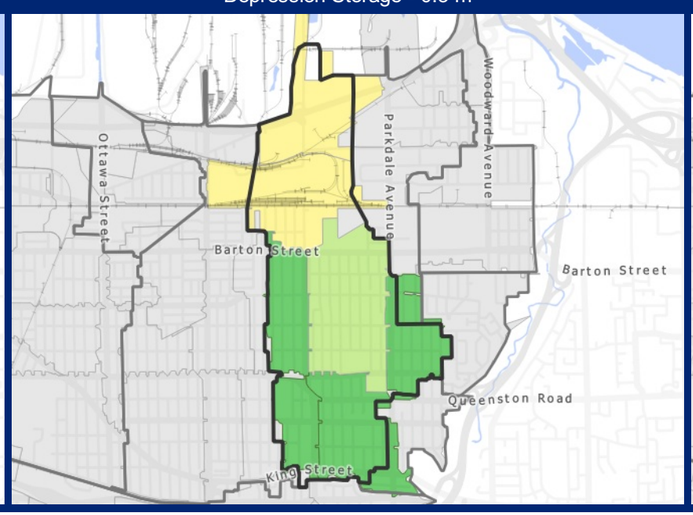
Overland Connectivity with Depression Storage



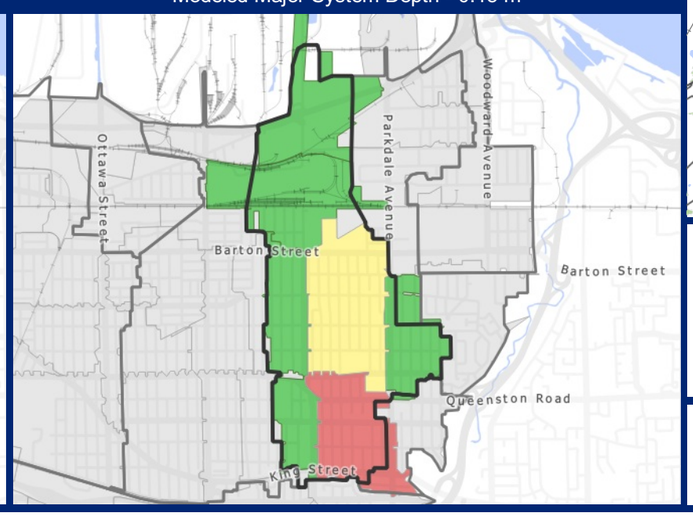
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

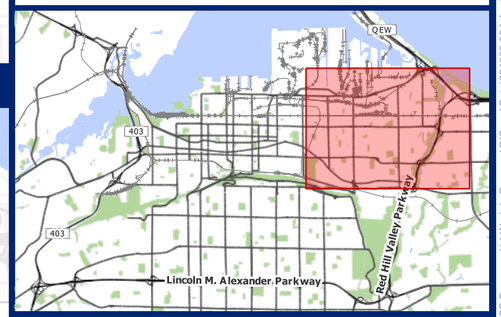


Figure 17 of 24

Strathearne CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

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CSO Catchment Parkdale CSO

Catchment Summary

Overview

The Parkdale CSO catchment is located in the northeastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Parkview West
- Industrial Sector G

Minor contributing areas from:

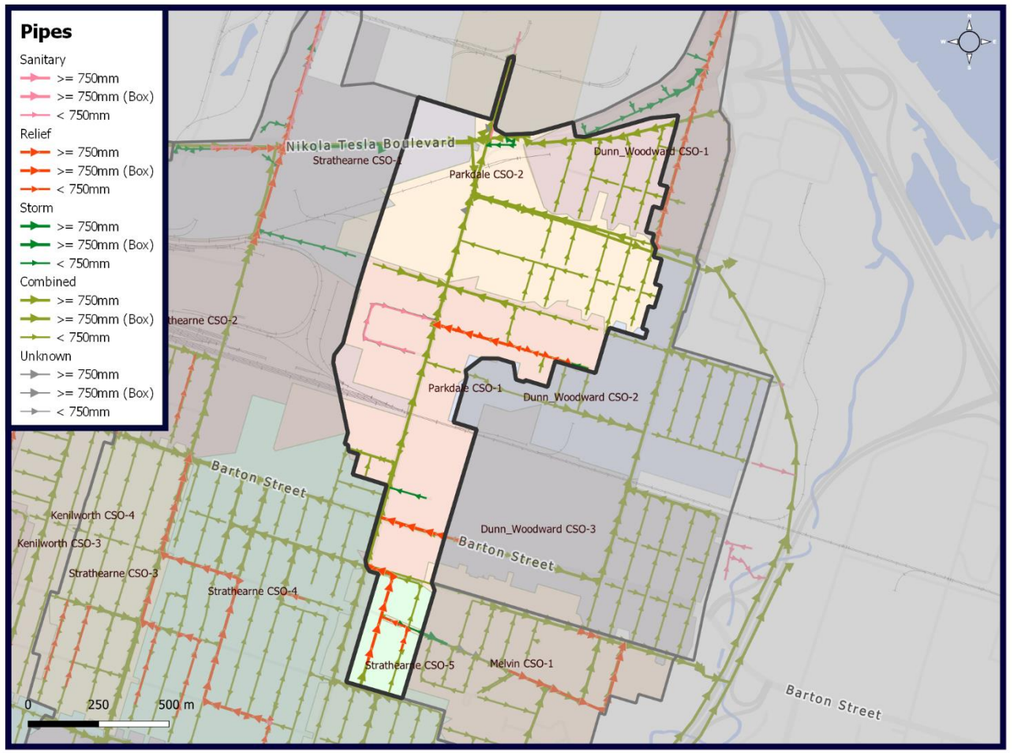
- McQuesten West (north west)
- Normanhurst (north east)

The Parkdale CSO catchments contains two (2) subcatchments.

City owned corridor running northeast from Main St East and Ottawa St North to Woodward Ave south of Nikola Tesla Blvd interchange crosses Parkdale CSO between CN rail tracks and Glow Ave.

Catchment Metrics

Area (ha)	119.8
Total Length of Sewers (km)	12.4
Length of Combined Sewers (km)	9.6
Length of Sanitary Sewers (km)	0.9
Length of Storm Sewers (km)	0.9
Length of Relief Sewers (km)	0.9
Storage Tanks (# and Name)	N/A

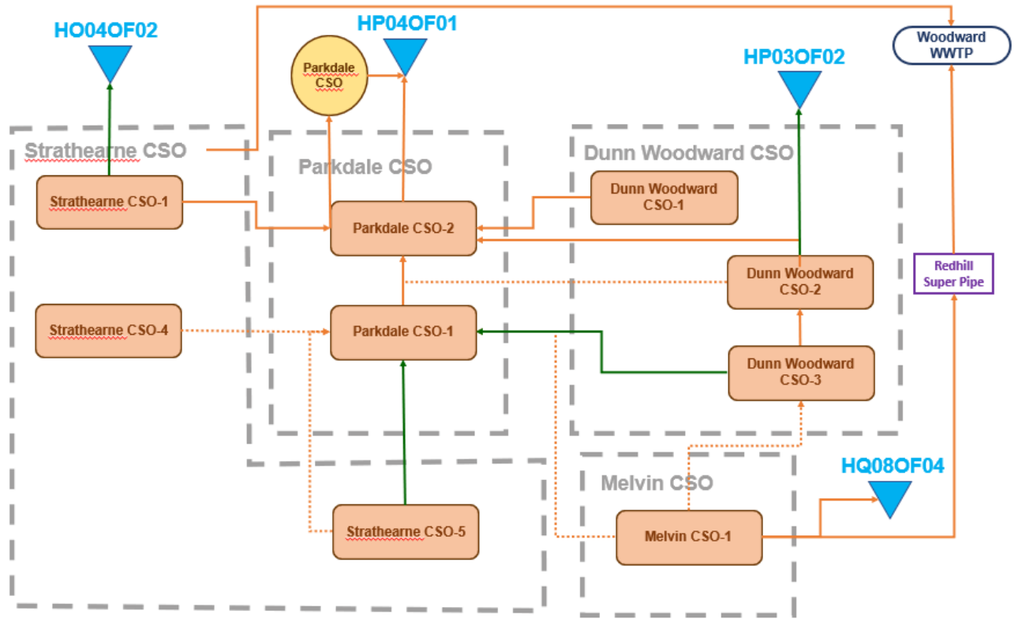


CSO Catchment Parkdale CSO

Minor System Overview

The Parkdale catchment has been divided into two (2) subcatchments.

- Parkdale CSO-1 conveys flows from a relief sewer on Glassco Ave N along the Parkdale Ave trunk sewer
- The trunk receives flows from a relief sewer on Barton St from Dunn Woodward CSO-3
- Parkdale CSO-2 receives combined sewer flows from the Parkview West neighbourhood and industrial Sector G
- Connection to the Parkdale Ave CSO Tank and outlet at the north end of Parkdale Ave N
- Trunk connection from Strathearne CSO to Woodward Wastewater Treatment Plant travels through Parkdale CSO-2 with connections to the combined system at Parkdale Ave N and Glow Ave
- Combined sewer flows from Dunn Woodward CSO-1 contribute to Parkdale CSO-2 on Nikola Tesla Blvd

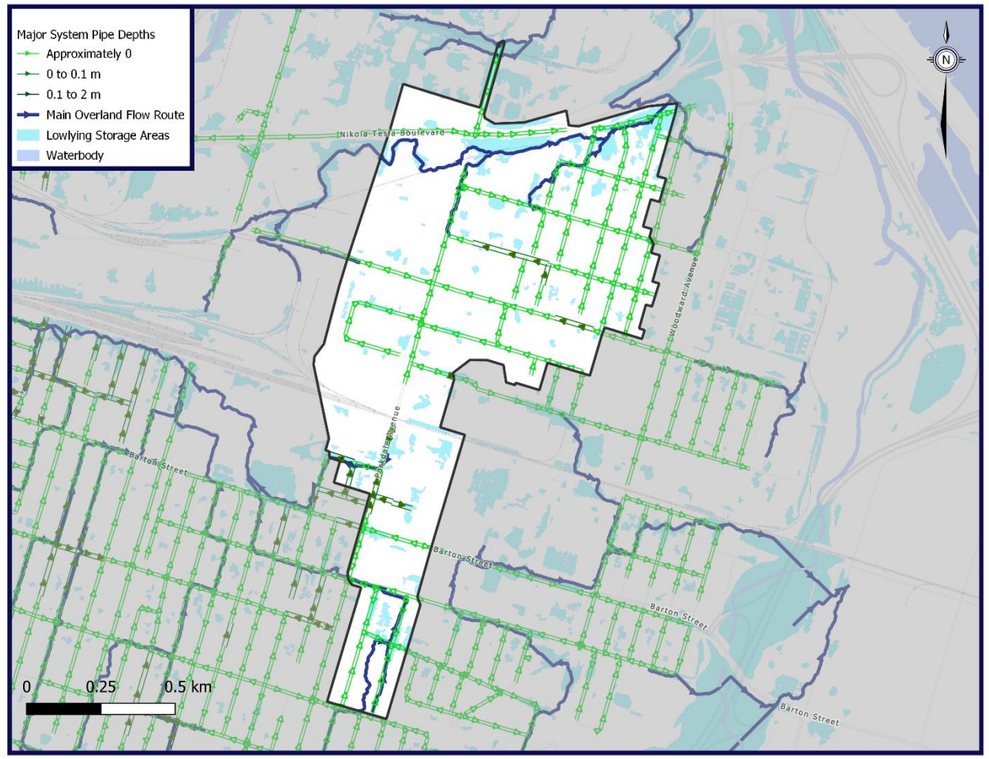


CSO Catchment Parkdale CSO

Major System Overview	• The Parkdale CSO does not have overland flow routes which traverse the CSO catchment.
	  ○ Parkdale CSO-1 has an overland flow route which contributes flow to Strathearne CSO-4
	  ○ Parkdale CSO-2 has overland flow routes along Nikola Tesla Blvd from Strathearn CSO-1 and flowing into Dunn Woodward CSO-1
	• No significant major system flows

Summary of Previous Studies	**Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)** • Recommendation for sewer separation and implementation of low impact development practices **LEEDs – Lower East End Storm Drainage Study and Stormwater Management Investigation – Draft Study Report (MRC, April 2009)** • Parkdale CSO catchment outside of study area

Summary of Planned Works	• Study underway to assess the Parkdale Pumping Station (study not provided to Wood/GMBP for review)
	  ○ Operations notes that pumping station not used often but was used within last year.
	  ○ Pumping station noted to be protecting 2 neighbourhoods
	• Woodward Ave storm separation sewer conceptual design from Barton St East to Dunn Ave via Woodward Ave and Glow Ave



CSO Catchment Parkdale CSO

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Parkdale CSO-2	5	5	3	3	1	3	5	3
Parkdale CSO-1	1	3	5	5	3	1	4	2

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Parkdale CSO-2	High	High	
Parkdale CSO-1	High	Medium	

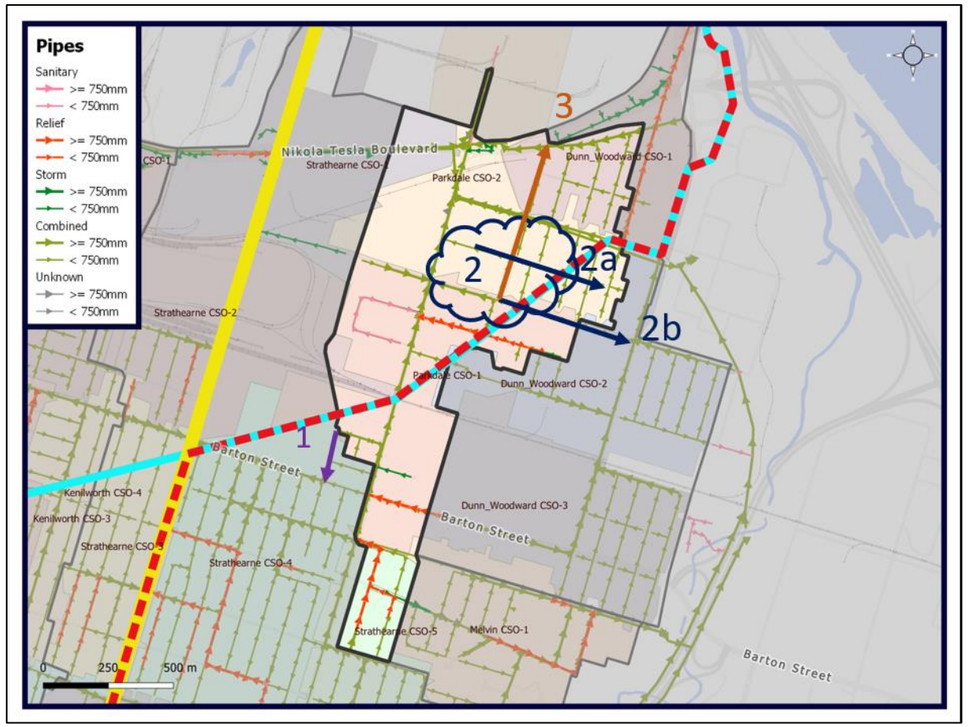
Issues and Options

Summary of Key Issues	• Limited sewer separation on Burland Cres Mahony Ave and Morley St • Water works corridor between Brampton St and Dunn Ave • Parkdale CSO-2 has historic flooding • Inlet capacity is low, although this may be due to the large industrial areas without CB data • HGL to surface along Burland Crescent in separated sanitary (Parkdale CSO-1) • HGL <1.8 mbgs on Mead Ave west of Knox Ave, Brighton Ave, and Burgess Ave south of Mead Ave (Parkdale CSO-2) ○ Brighton Ave south of Mead Ave and Burgess Ave south of Mead Ave convey minor flows to Mead Ave west of Knox Ave • Surcharged trunk circular sewer upstream of connection to box sewer at Parkdale Ave N and Glow Ave, potentially undersized • Mahony Ave appears to be partially separated but not reflected in the Modelling • Alternatives with new infrastructure impacting Red Hill Creek subject to Joint Stewardship Board (Indigenous) consultation as part of broader study of new potential storm outfalls to Red Hill Creek	

CSO Catchment Parkdale CSO

Summary of Potential Options

1. (PK-1) Short term relief sewer on Mahony Ave and Adeline Ave **(Recommend)**
   a. Consider connection to future Barton St East separation sewer
2. (PK-2) Consider separation for high HGL streets (Mead Ave) **(Further Study)**
   a. (PK-2a) Consider connecting via Mead Ave to Dunn Ave or,
   b. (PK-2b) Connecting via Brampton St to Woodward Ave
3. (PK-3) Consider separation sewer on Brighton Ave to include portion of Brighton Ave in Dunn-Woodward CSO-1 **(Further Study)**

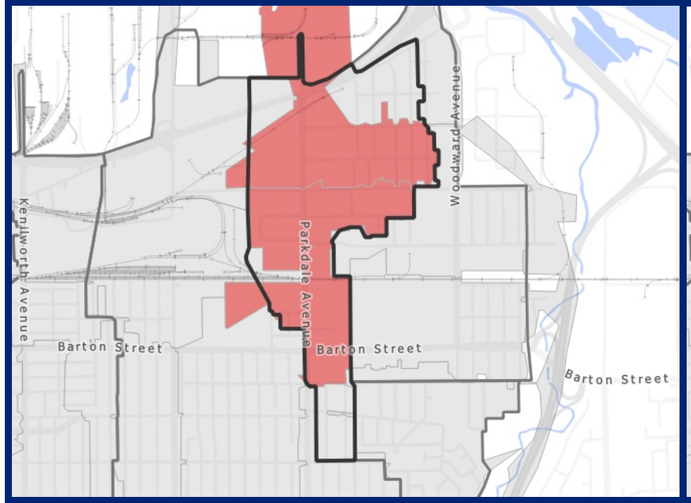


Option Evaluation

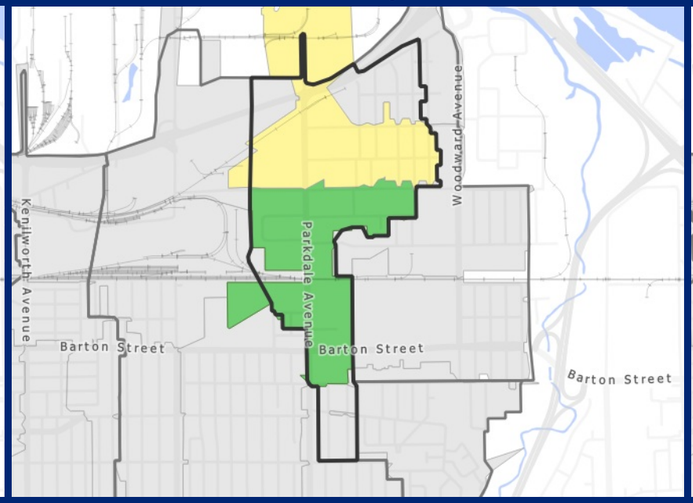
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. Relief sewer on Mahoney Ave and Adeline Ave (PK-1)	• Overall high priority area for remediation • Provide HGL relief in short term • Ease of construction on local streets	• Limited Hansen records • Issues with connections to arterial roads (Barton and Parkdale)	Local Solution Limited Benefit	$1.9M	Recommended	Low Priority Long Term (10 – 20 Years)	None

CSO Catchment Parkdale CSO							
2. Sewer Separation along Mead Ave (PK-2)	• High simulated HGL issues on Mead could be addressed by this work • Would allow for separation on this street as well as connected side streets	• Would need connection on Dunn to go first, but could be done in combination • Limited Hansen calls on Mead Ave	Local Solution Moderate Benefit	$2.3M	Further Study	Medium Priority Medium Term (5 – 10 Years)	None
2 a) Connection from Mead Ave to Dunn Ave (PK-2a)	• Allow for separation of other areas	• Limited benefit in and of itself, more to allow other areas	System Wide Solution Moderate Benefit	$900K	Further Study	Medium Priority Medium Term (5 – 10 Years)	None
2 b) Sewer Separation Outlet via Brampton St (PK-2b)	• Provide relief to high HGL on Brampton St	• Woodward recently constructed, separation sewer not planned in near term, so unlikely to proceed • Dunn relief/storm considered a preferred option			Screened Out		None
3. Sewer Separation on Brighton Ave (PK-3)	• Can proceed before Woodward Ave separation • Potential to relieve HGL on Brighton Ave in Dunn-Woodward CSO-1	• New outlet needed in vicinity of Leaside Park	Local Solution Moderate Benefit	$2.3M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
Managed Sewer Separation (PK-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$12.7M	Recommended	Medium Priority Future Planning (20+ Years)	None

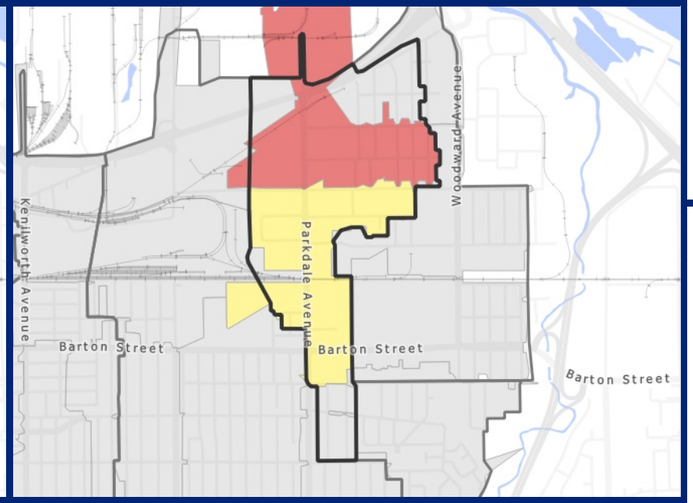
Overall Priority Ranking



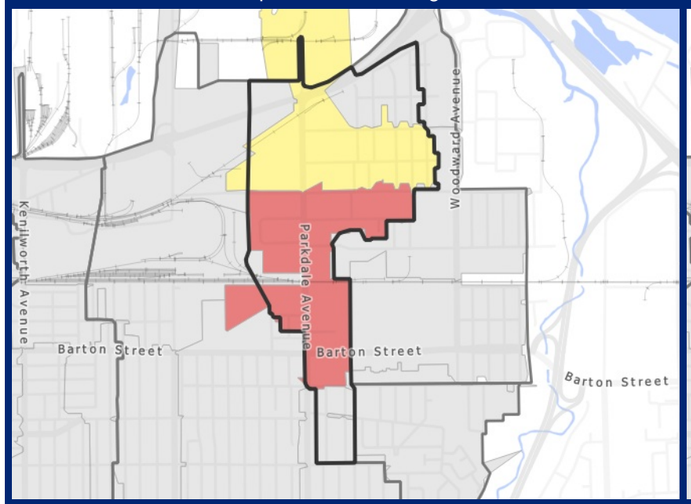
Hansen Flooding Calls



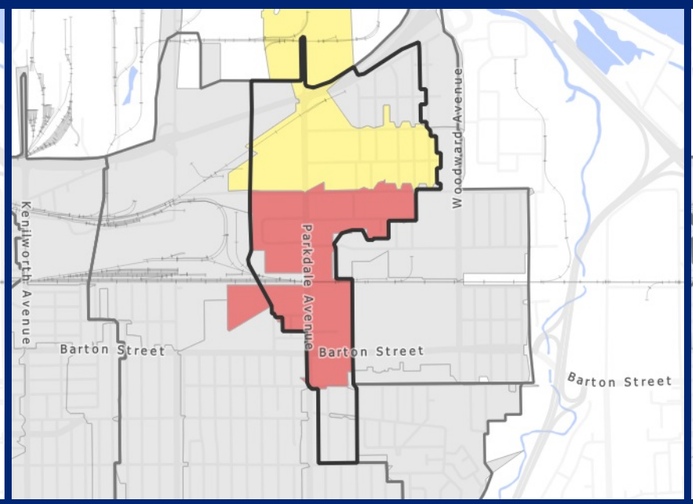
Pipe Depth for Residential Connections



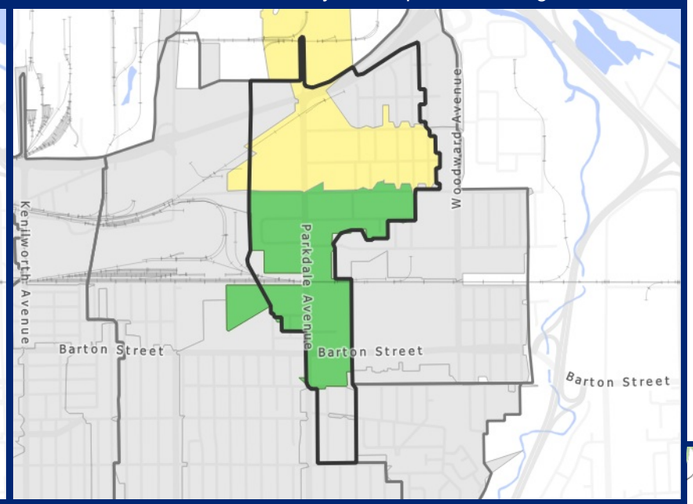
Pipe Condition and Age



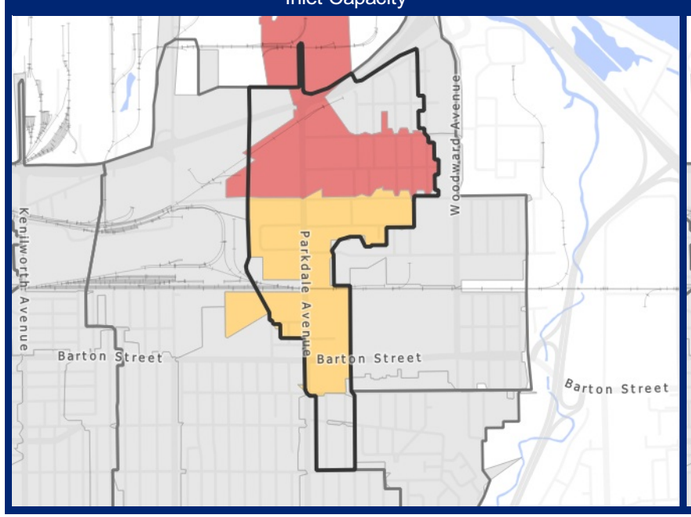
HGL to Basement Elevation of 1.8 m



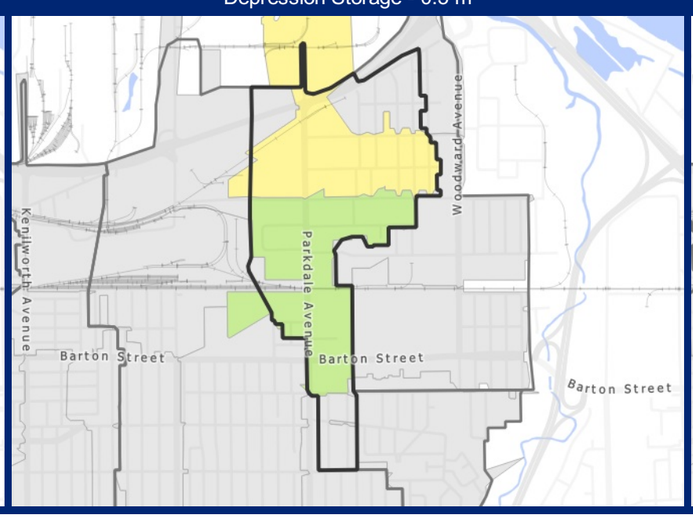
Overland Connectivity with Depression Storage



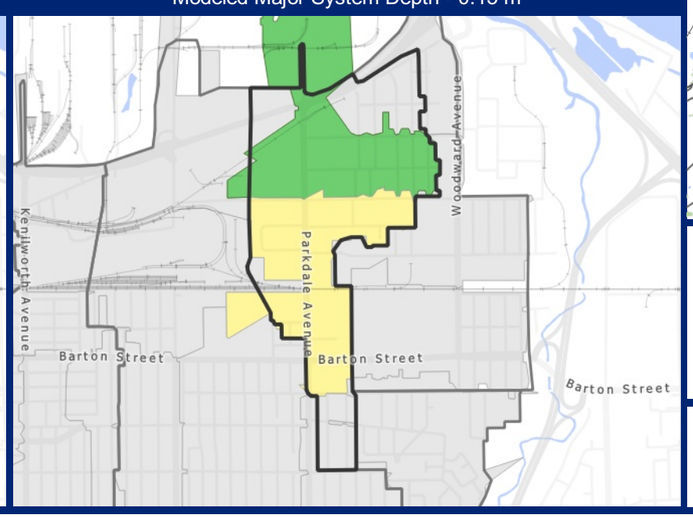
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

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- Catchment Boundary
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- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

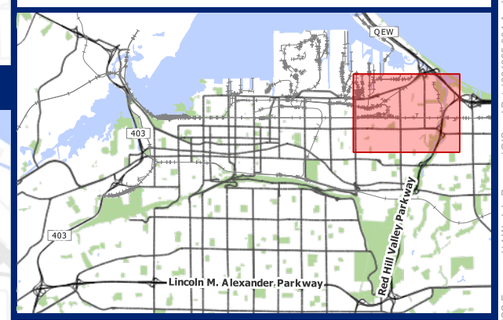

Figure 18 of 24

Parkdale CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
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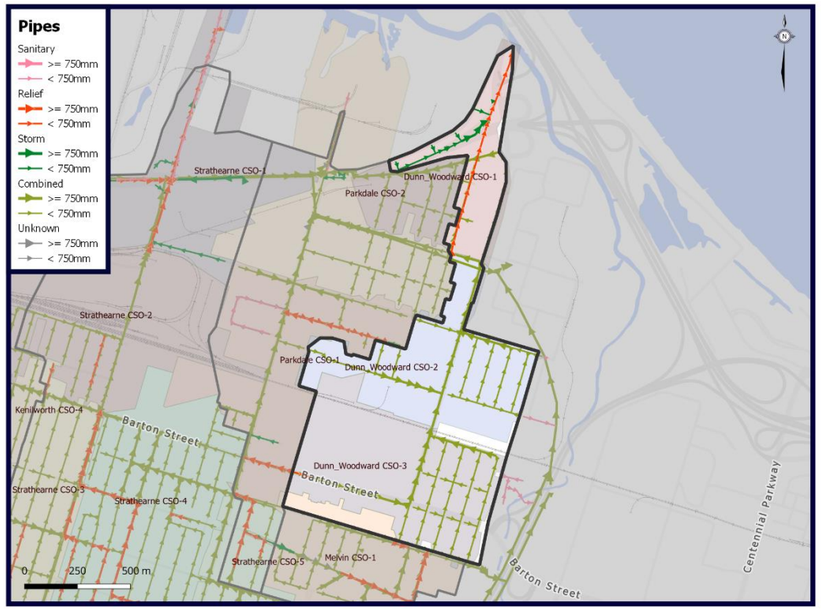
CSO Catchment Dunn-Woodward

Catchment Summary

Overview	The Dunn-Woodward CSO catchment is located in the northeastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • McQueston East and West • Parkview East and West The Dunn-Woodward CSO catchments contains three (3) subcatchments. City owned corridor running northeast from Main St East and Ottawa St North to Woodward Ave south of Nikola Tesla Blvd interchange crosses Parkdale CSO between Glow Ave and Woodward Ave.	
Catchment Metrics	Area (ha)	129.5
	Total Length of Sewers (km)	14.1
	Length of Combined Sewers (km)	12.2
	Length of Sanitary Sewers (km)	0
	Length of Storm Sewers (km)	0.7
	Length of Relief Sewers (km)	1.1
	Storage Tanks (# and Name)	N/A

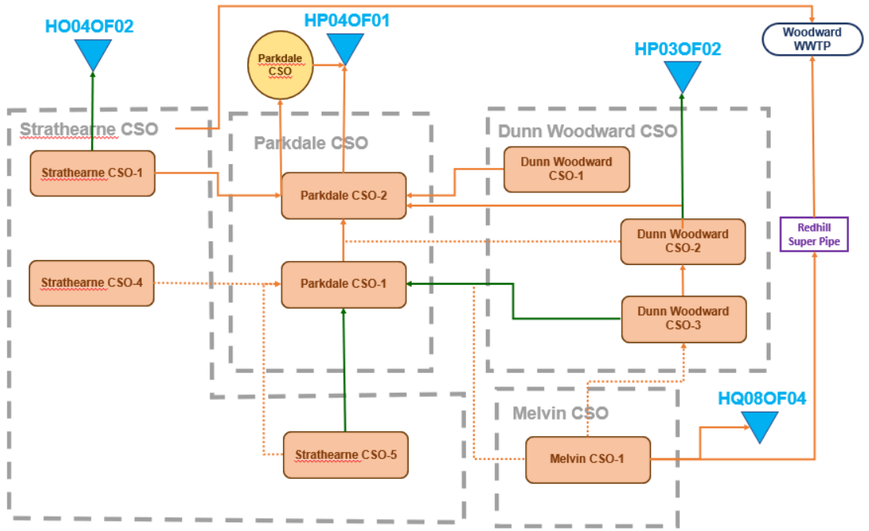


CSO Catchment Dunn-Woodward

Minor System Overview

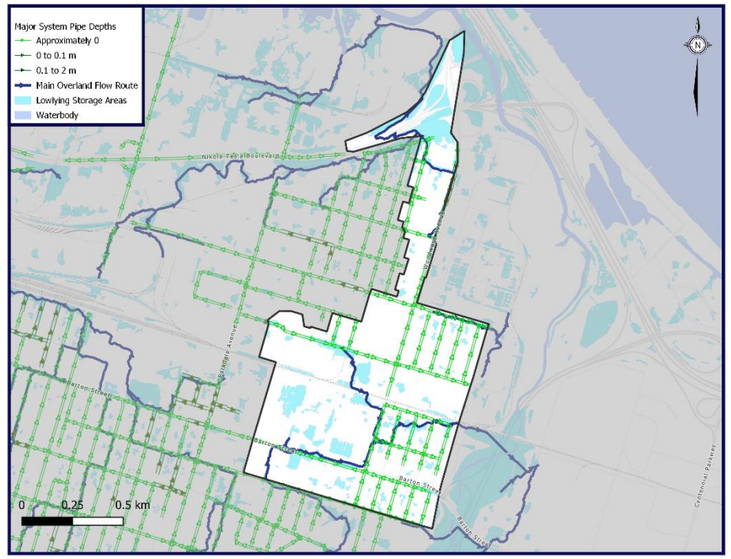
The Dunn-Woodward CSO catchment generally drains toward a trunk sewer on Woodward Ave which conveys flows north.

- Dunn-Woodward CSO-3 conveys combined sewer flows to Woodward Ave trunk sewer
  - Connection to Melvin CSO combined sewers at Woodward Ave
  - Relief sewer connection to Parkdale CSO-2 on Barton St East
  - Outlets to the north into Dunn-Woodward CSO-2 at the rail tracks on Woodward Ave
- Dunn-Woodward CSO-2 conveys combined sewer flows to Woodward Ave
  - Receives combined flows from Dunn-Woodward CSO-3 via Woodward Ave trunk sewer
  - Flow split connection to Parkdale CSO-1 at Brampton St
  - Outlets to the west into Parkdale CSO-2 via Glow Ave
    - Relief storm sewer on Dunn Ave flows through Dunn-Woodward CSO-1
      - Outlets to north at Woodward Ave interchange with Nikola Tesla Blvd
    - Glow Ave combined sewer connects to interceptor conveying flows east to Woodward Ave WWTP at Glow Ave and Parkdale Ave
- Dunn-Woodward CSO-1 conveys combined sewer flows west to Nikola Tesla Blvd
  - Combined sewers outlet to Parkdale CSO-2
    - Connected to Parkdale CSO tank
  - Relief sewer outlets to north at Woodward Ave interchange
    - Combined sewers not connected
    - Storm sewers on Nikola Tesla Blvd and Windermere Rd connected



Major System Overview

- External overland flows from Melvin CSO contribute to Dunn-Woodward CSO-3 at a low point on Melvin Ave through commercial properties to Barton St East
  - Major system shows a low point on Barton St East west of Woodward Ave
  - Large pockets of ponded areas on private property near rail tracks
- Overland flow travels east on Barton St East to Woodward Ave
  - Conveys flow northeast via Vansitmart Ave through residential area to the rail tracks
    - Outlets to Redhill Valley
  - Overland flows from west portion of Dunn-Woodward CSO-3 contribute to overland flow at rail tracks
  - No major system connection at rail tracks
- Overland flow through Dunn-Woodward CSO-1 flows north to Leaside Park where it crosses Nikola Tesla Blvd and outlets downstream of the Woodward Ave interchange
  - External overland flow from Parkdale CSO-2 flows east into Dunn-Woodard CSO-1
  - Large ponded area south of Woodward Ave interchange
- No significant major system flow depths within catchment



CSO Catchment Dunn-Woodward

Summary of Previous Studies	**Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)**
	• Recommendation for sewer separation and implementation of low impact development practices
	
	Conceptual Design, Woodward Avenue and Flow Avenue Sewer Separation Memo (IBI, May 7, 2021)
	• Future storm separation sewer along Woodward Ave and Glow Ave
	  ○ Conceptual design in support of Barton Street East Sewer Separation Project (Extents of separation not identified/confirmed by City)
	  ▪ Connect Barton Street East to the existing relief sewer outlet at Dunn Ave
	  ○ Two options considered for connecting to existing CSO sewer system
	  ○ Option 1 recommended
	  ▪ Proposed 1800 mm diameter storm sewer cross over the existing 600 mm diameter combined sewer on Glow Ave
	
	Barton Street East Sewer Separation Project
	• Report not available at the time of writing

Summary of Planned Works	• Proposed separation storm sewer from Woodward Ave to Glow Ave at Dunn Ave.
	  ○ To be connected to combined in interim
	  ○ To provide connection from Barton St East Sewer Separation Project
	  ○ Small NE neighbourhood (unknown location) was not recommended for separation
	  ▪ Potential to include in separation

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Dunn-Woodward CSO - 1	1	5	5	3	1	5	3	5
Dunn-Woodward CSO - 2	1	1	5	2	1	2	5	2
Dunn-Woodward CSO - 3	1	1	5	1	1	3	4	3

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Dunn-Woodward CSO - 1	High	Medium	Combined sewers contribute flows to Parkdale CSO rather than Dunn-Woodward CSO which runs through subcatchment
Dunn-Woodward CSO - 2	Medium	Medium	
Dunn-Woodward CSO - 3	Medium	Low	Trunk sewer replacement in progress

CSO Catchment Dunn-Woodward

Issues and Options

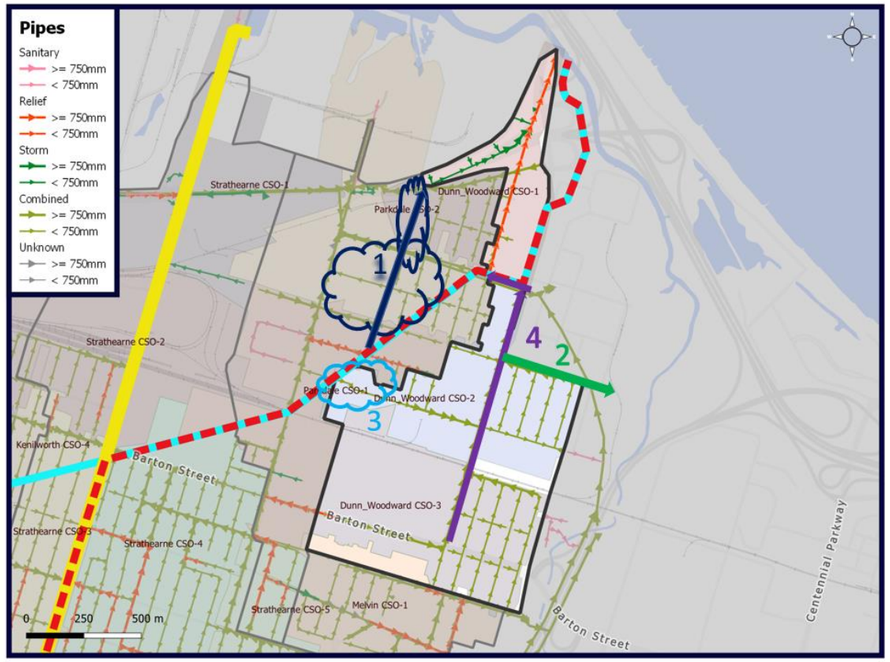
Summary of Key Issues

- Woodward Avenue reconstructed semi-recently using concrete road base (limits of construction unknown), unlikely for future works in near term
- Minimal separation currently, however relief sewer on Dunn Ave provides potential outlet for separation
  - Dunn Ave relief sewer proposed as outlet for separation sewer proposed on Woodward Ave from Barton St East
- Woodward Ave Wastewater Treatment Plant located at boundary of Dunn-Woodward CSO-1 and Dunn-Woodward CSO-2
  - Interceptor connects from Strathearne CSO through Parkdale CSO-2
- High ranking for depression storage and major system in Dunn-Woodward CSO-1 due to Woodward Ave and Nikola Tesla interchange sag point which does not consider culvert connections
- HGL<1.8 mbgs in Dunn-Woodward CSO-1 along Woodward Ave
  - One reach in residential area with HGL <1.8 mbgs
  - Brighton Ave has HGL <1.8 mbgs (not connected to Brighton Ave sewers in Parkdale CSO but same HGL issue)
  - Portion of Woodward Ave not currently proposed for separation
- Surcharged 750 mm pipe on Rennie St may be contributing to high HGL at top of reach
- Reach of trunk sewer on Woodward Ave north of Barton St East shown as surcharged, no HGL impacts

- Alternatives with new infrastructure impacting Red Hill Creek subject to Join Stewardship Board (Indigenous) consultation. A specific study assessing new separated storm sewer outfalls to Red Hill Creek (watershed wide) is recommended.

Summary of Potential Options

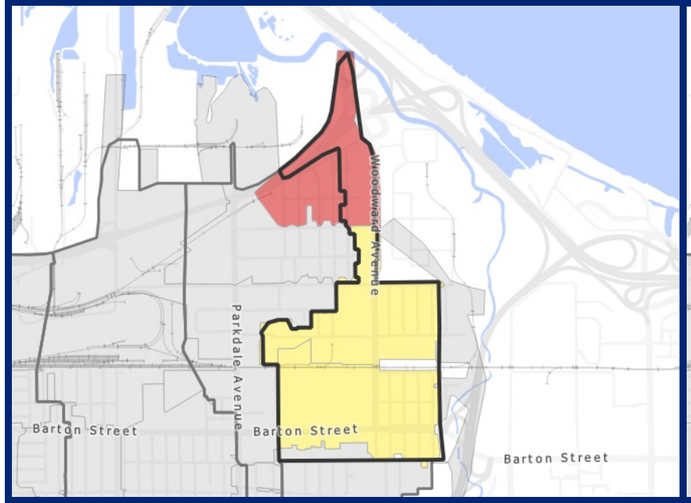
1. (DW-1) Brighton Ave local separation/relief sewer to Leaside Road or Nikola Tesla Blvd (Common with Parkdale Option 1)
   - Potential to connect separation sewers from Mead Ave along Brighton to provide relief for Parkdale CSO-2
   - Potential to connect to Burland Cres and Morley St separated sewers within Parkdale CSO-1
2. (DW-2) Brampton St separated storm sewer and new outfall to Red Hill Valley
   - Local cluster of Hansen calls
   - Potential to re-direct sanitary flows to trunk sanitary pipe rather than combined sewer on Woodward
3. (DW-3) Rennie Street HGL could be mitigated through inlet control devices
   - A) Potentially install relief sewer on Rennie Street to bypass bottleneck 750 mm
4. (DW-4) Local study to provide sewer separation along Woodward Ave from Barton St East to Dunn Ave relief sewer via Glow Ave
   - Long term solution due to recent road reconstruction of Woodward Ave
   - Previous planned works for separation connecting Barton St East (no consideration for combined flows within Dunn-Woodward CSO)
   - Potential to be sized to provide capacity for local combined sewers



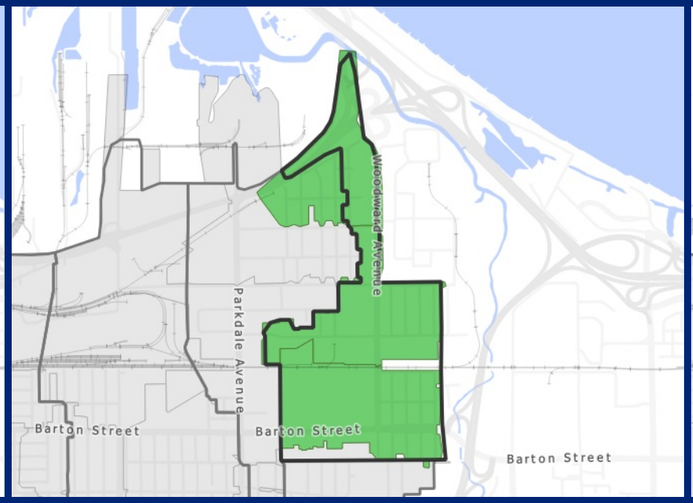
CSO Catchment Dunn-Woodward							
Option Evaluation							
Option	**Advantages**	**Disadvantages**	**System Benefit**	**Cost**	**Outcome**	**Priority and Timeline**	**Pre-Requisite Works**
1. Local Separation on Brighton Ave (DW-1)	• Potential to connect high HGL sewers from Parkdale CSO-2 on Mead Ave • Potential to connect to separated sewers in Parkdale CSO-1	• No outlet at end of Brighton (storm on Nikola Tesla is 375 mm) • Outlet would likely be within MTO buffer limits • Alternative is additional infrastructure along Leaside	Local Solution Moderate Benefit	$2.3M	Recommended (Note: Duplication of PK-3)	Medium Priority Medium Term (5 – 10 Years)	None
2. Brampton St Storm Sewer Outfall to Red Hill Valley (DW-2)	• Allows for future separation of residential area to the south with high number of Hansen calls • Potentially can also re-direct sanitary flows to trunk sanitary sewer to avoid backwater from combined sewer on Woodward • Decreases load on combined sewer	• Will require further study to ensure no impacts to Red Hill Creek (outfall study) and requires engagement with indigenous community • Would still require follow up disconnection of area to the south thereafter; need staging/sequencing plan or include those areas in same project	Local Solution Moderate Benefit	$5.2M	Recommended	High Priority Short Term (3 -5 Years)	ST-2 (Red Hill Sewer Separation Study and New Outfall EA)
3. Inlet Control Devices Rennie St (DW-3)	• Low cost option • Ease of installation • Relatively direct benefit to reducing storm flows to combined sewer	• May worsen road ponding during storm events • May be more of a localized benefit in reducing storm inflows	Local Solution Limited Benefit	$80K	Recommended	Medium Priority Immediate (0 – 3 Years)	None
3. a) Relief sewer/upgrade on Rennie Street (DW-3a)	• Identified bottleneck in sewer system that would benefit from additional capacity, potential reduction in HGL	• Could potentially worsen conditions downstream (additional flow conveyance) • Upgrade of combined sewers rather than full separation, however could be structured as a “relief” approach	Local Solution Limited Benefit	$2.7M	Further Study	Low Priority Long Term (10-20 Years)	None
4. Woodward Ave Separation Sewer (DW-4)	• Potential to provide outlet for future separation of local combined sewers • Provides connection to outlet for Barton St East separation sewer	• Long term due to recent reconstruction of Woodward Ave (concrete road base) • Currently proposed alignment does not capture high HGL reach on Woodward Ave • Does not connect to Brighton Ave • High cost item	System Wide Solution Moderate Benefit	$15.4M	Recommended	Medium Priority Long Term (10-20 Years)	None

CSO Catchment Dunn-Woodward							
Managed Sewer Separation (DW-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$12.7M	Recommended	Medium Priority Future Planning (20+ Years)	None

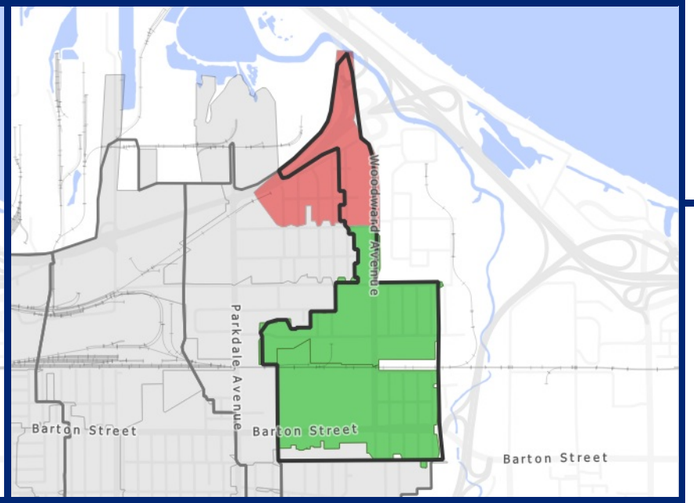
Overall Priority Ranking



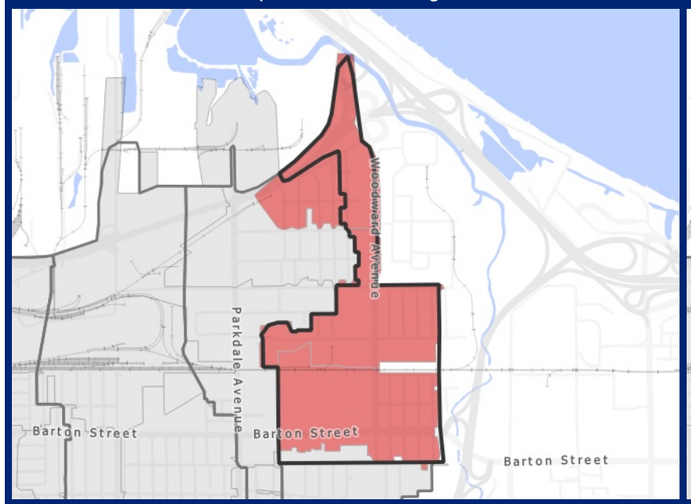
Hansen Flooding Calls



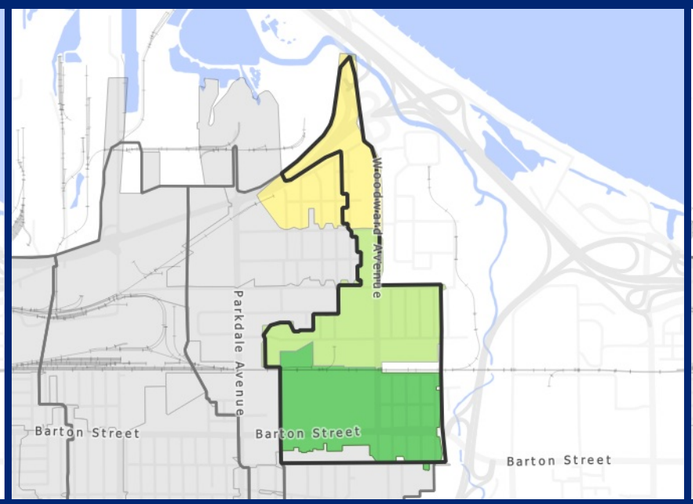
Pipe Depth for Residential Connections



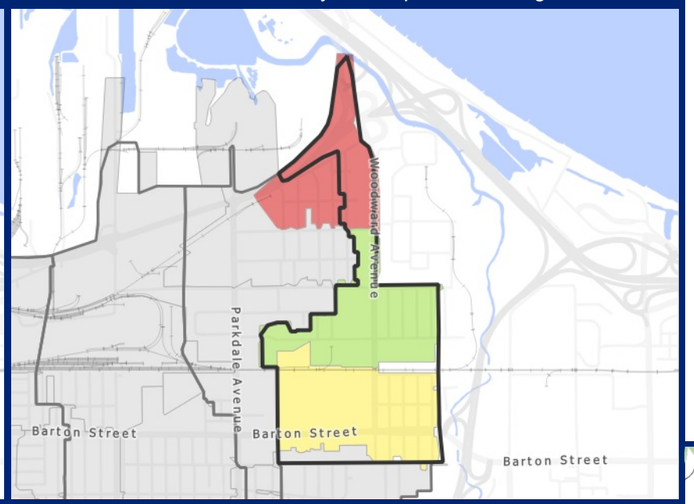
Pipe Condition and Age



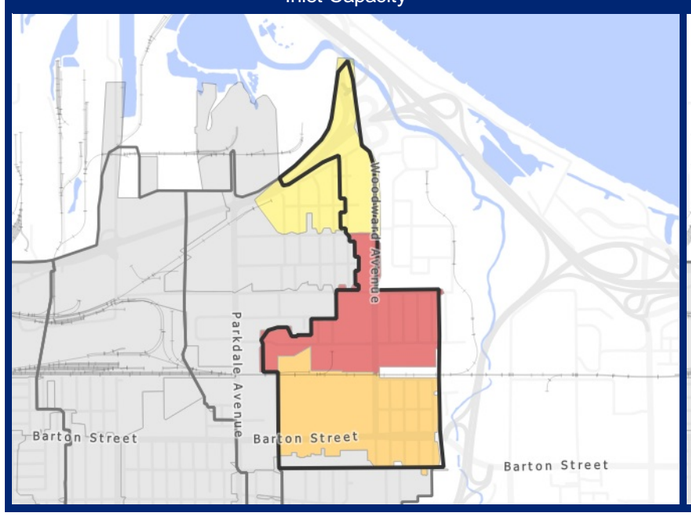
HGL to Basement Elevation of 1.8 m



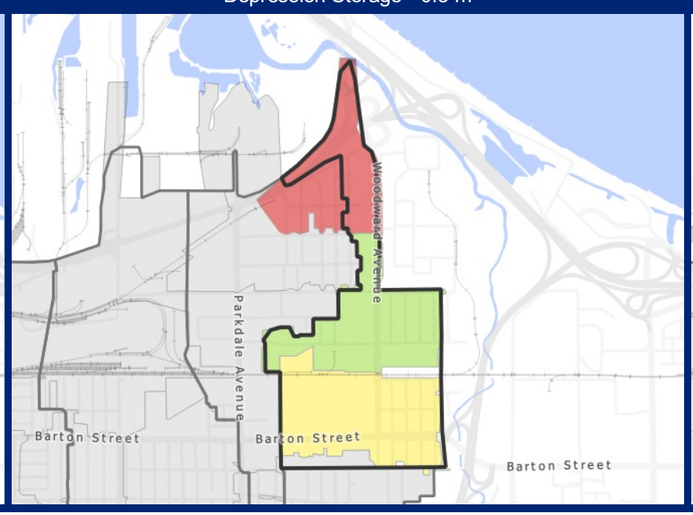
Overland Connectivity with Depression Storage



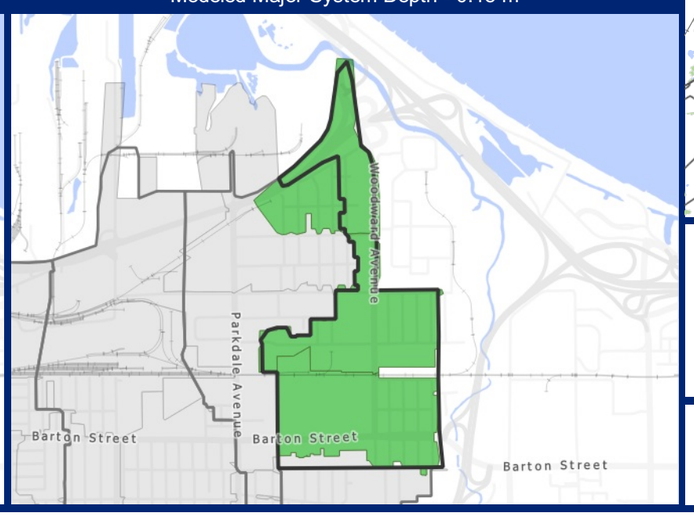
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

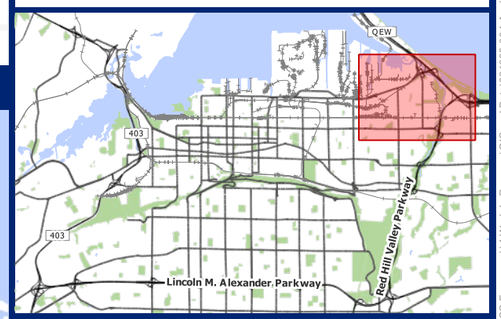


Figure 19 of 24

Dunn/Woodward CSO

Results Analysis

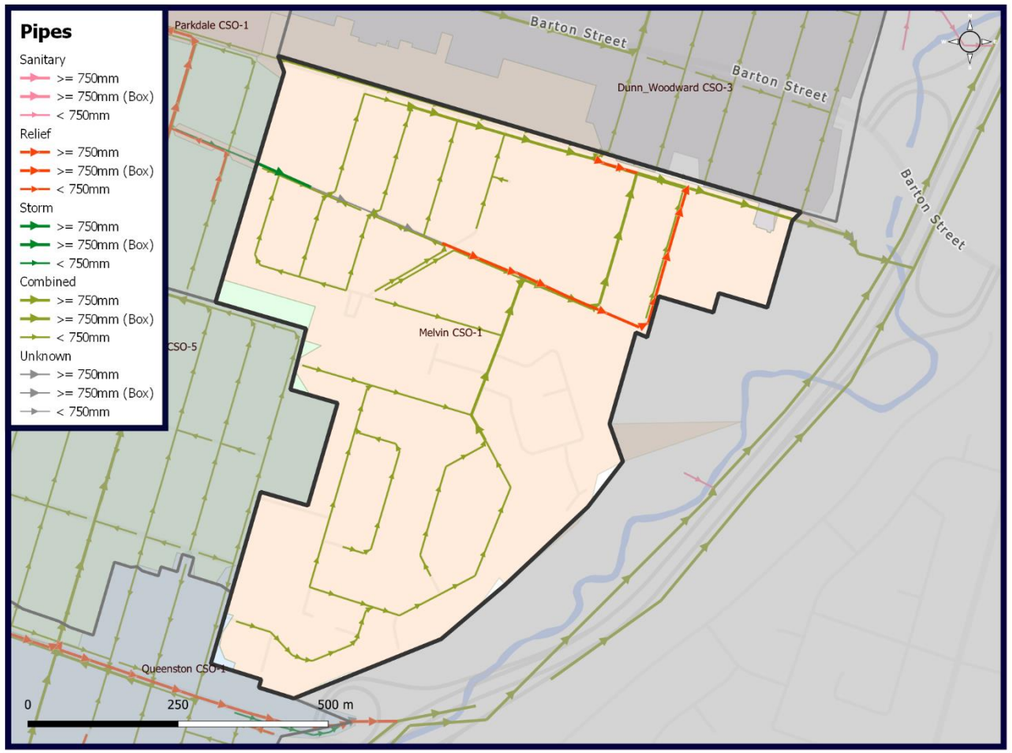
BluePlan Engineering

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Melvin

Catchment Summary

Overview	The Melvin CSO catchment is located in the northeastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • McQuesten East • McQuesten West The Melvin CSO catchments contains only a single subcatchment.	
Catchment Metrics	Area (ha)	60.8
	Total Length of Sewers (km)	7.9
	Length of Combined Sewers (km)	6.8
	Length of Sanitary Sewers (km)	0.0
	Length of Storm Sewers (km)	0.2
	Length of Relief Sewers (km)	0.7
	Storage Tanks (# and Name)	N/A

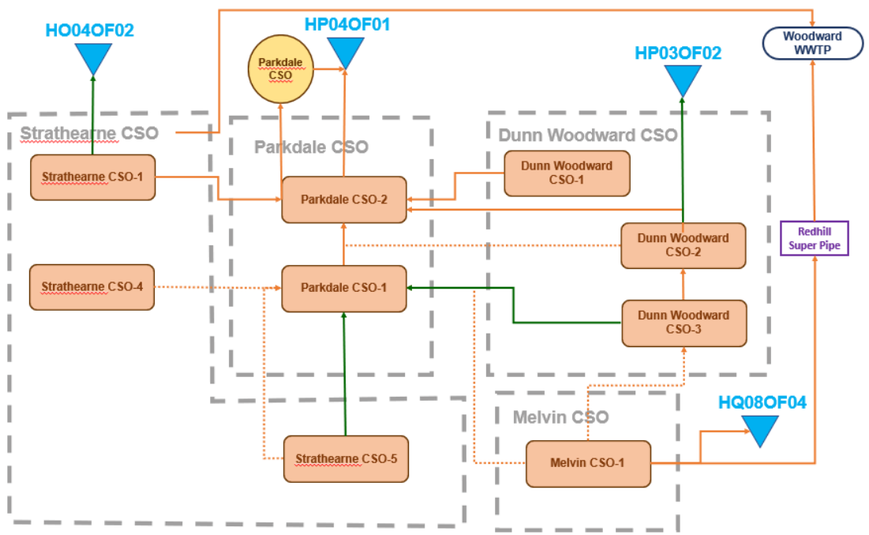


CSO Catchment Melvin

Minor System Overview

The Melvin CSO catchment generally drains toward a trunk sewer on Woodward Ave which conveys flows north.

- Melvin CSO-1 conveys combined sewer flows to Woodward Ave trunk sewer
  - Connection to Dunn-Woodward CSO-3 combined sewers at Woodward Ave
- Relief sewer along Britannia Avenue and Eastwood Street connecting at Melvin Ave upstream of the Woodward Ave trunk sewer.

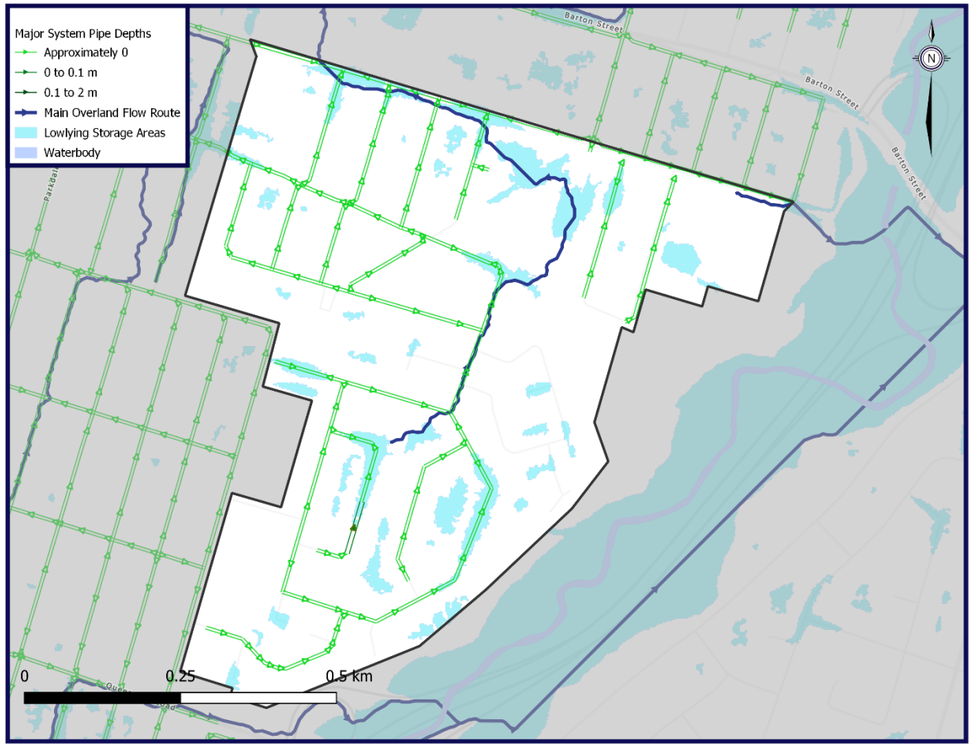


CSO Catchment Melvin

Major System Overview

The Melvin CSO catchment major system generally drains to the north towards Melvin Ave. Overland flows discharge to Dunn-Woodward CSO-3 at a low point on Melvin Ave through commercial properties to Barton St East.

- Major system shows several low points along Melvin Ave
- No significant overland flow depths shown in this catchment



Summary of Previous Studies

Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)

- Recommendation for sewer separation and implementation of low impact development practices

Roxborough School Area Re-Development Preliminary Feasibility Study – Phase 1 – (Wood, February 2017)

- Feasibility study which determined that a new storm sewer outfall to Red Hill Creek would be beneficial and achievable
- Would allow for a separation of sewers for the development area (6 ha) and external areas south of Glengrove (10 ha)
- Recommendations for future study were noted
- Led to subsequent Functional Servicing reports for the development, including storm sewer outfall
- Outfall concept ultimately not supported by indigenous community
- Current concept would separate sewers for development only, sub-surface storage tank to restrict peak flows outletting to Queenston Road trunk sewer

Summary of Planned Works

- Consultants working on assessment of Roxborough neighbourhood development site
-

CSO Catchment Melvin

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Melvin CSO-1	1	3	3	2	1	2	2	3

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Melvin CSO-1	Low	High	

Issues and Options

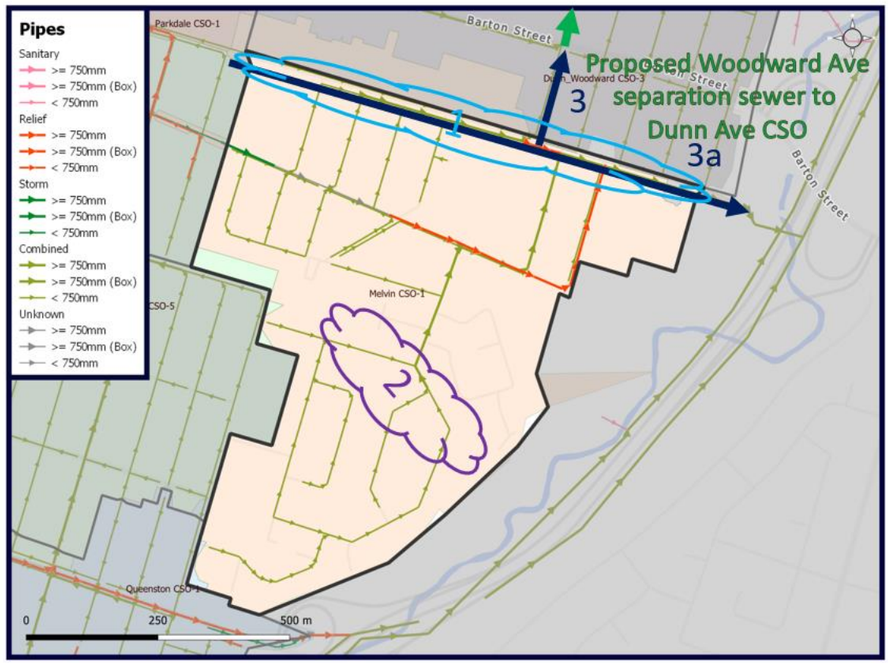
Summary of Key Issues

- High number of Hansen records in areas along Britannia (Glassco to Lewis) and Roxborough Park area (Lang, Hayes, Bingham and Armstrong)
- Relief sewer constructed on Britannia Ave (Glassco to Eastwood)
- Connects to relief sewer on Melvin Ave and then ultimately to RHVP superpipe
- Infill/intensification pressures in this area

Summary of Potential Options

1. (ML-1) Consider ICDs on Melvin Ave in interim to reduce potential for sewer lateral backups
2. (ML-2) Consider ICDs on Glengrove Ave and Armstrong Ave
3. (ML-3) Connect Melvin Ave and Britannia Ave to proposed Dunn-Woodward Ave separation sewer
   a) (ML-3a) Alternatively, provide new separated outlet along Melvin Ave

- (ML-OUT) Alternatives with new infrastructure impacting Red Hill Creek subject to Joint Stewardship Board (Indigenous) consultation and completion of a study to assess new outfalls to Red Hill Creek comprehensively

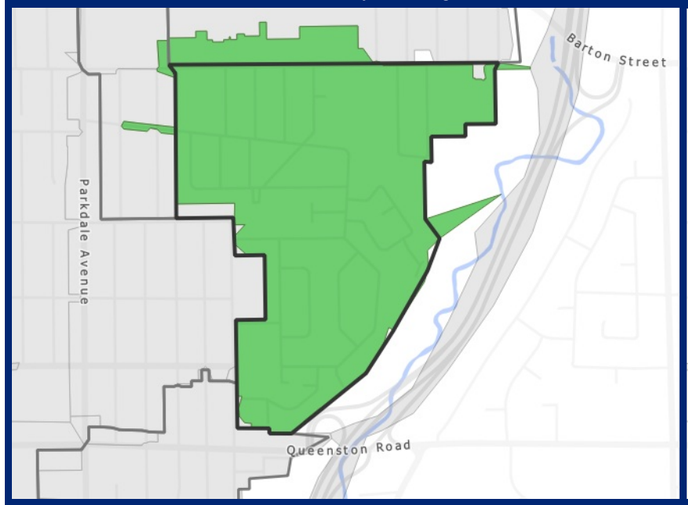


CSO Catchment Melvin

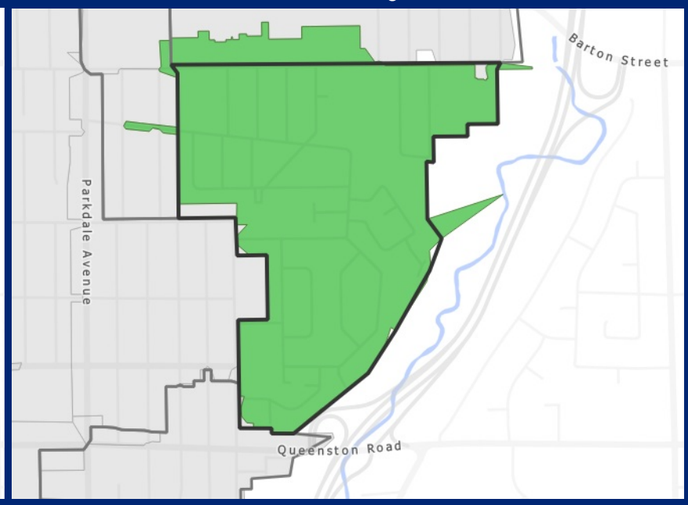
Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. ICDs along Melvin from Adair to Talbot (ML-1)	• Ease and speed of implementation • Low Cost • Cluster of Hansen calls in this area • Potential benefit in reduction of peak storm inflows to combined sewer system	• Typically further assessment required to confirm no roadway flooding impacts • Arterial street, may require construction staging strategy	Local Solution Moderate Benefit	$90K	Recommended	High Priority Immediate Term (0 – 3 Years)	None
2. ICDS along Glengrove and Armstrong (ML-2)	• Ease and speed of implementation • Low Cost • Known flooding issues in these areas • Potential benefit in reduction of peak storm inflows to combined sewer system	• Typically further assessment required to confirm no roadway flooding impacts, particularly as sag point located on Armstrong	Local Solution Moderate Benefit	$70K	Recommended	High Priority Immediate Term (0 – 3 Years)	None
3. Storm sewer connection to proposed trunk on Woodward (ML-3)	• Provide separation/relief for this area	• Lengthy implementation likely given recent reconstruction of Woodward • Need to upsize sewers on Woodward significantly to account for these flows would results in high costs			Screened Out		
3. a) Storm sewer along Melvin to Red Hill (ML-3a)	• Partially separated infrastructure already in place on Melvin • Benefit in reducing peak flows and volumes to Red Hill super pipe CSO to allow capacity for other areas • Local benefit in reduced flows and surcharging	• Need for overall study of new outfalls to Red Hill Creek and associated impact assessment • Cost and timeline for implementation	System Wide Solution Moderate Benefit	$4.5M	Further Study	Medium Priority Medium Term (5 – 10 Years)	STR-2
Managed Sewer Separation (ML-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$8.1M	Recommended	Medium Priority Future Planning (20+ Years)	None

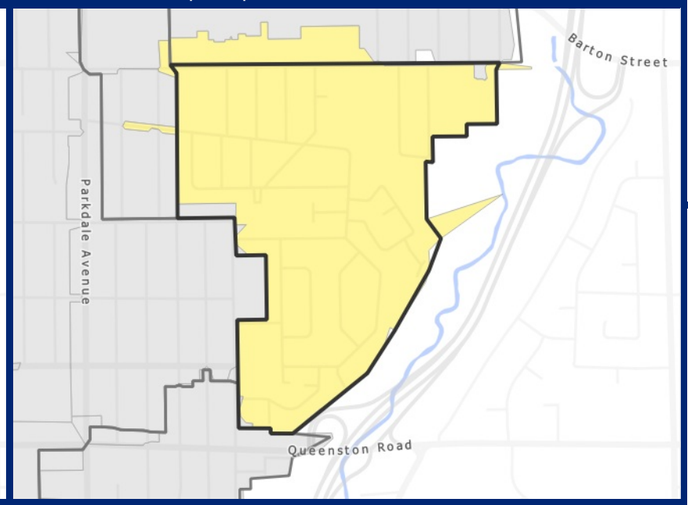
Overall Priority Ranking



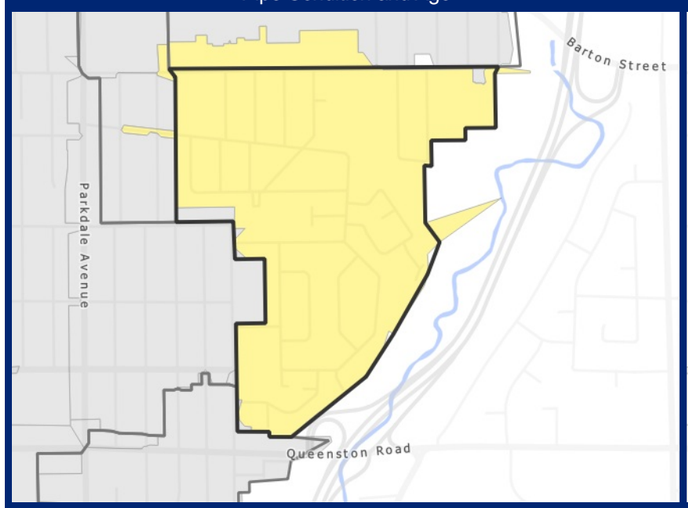
Hansen Flooding Calls



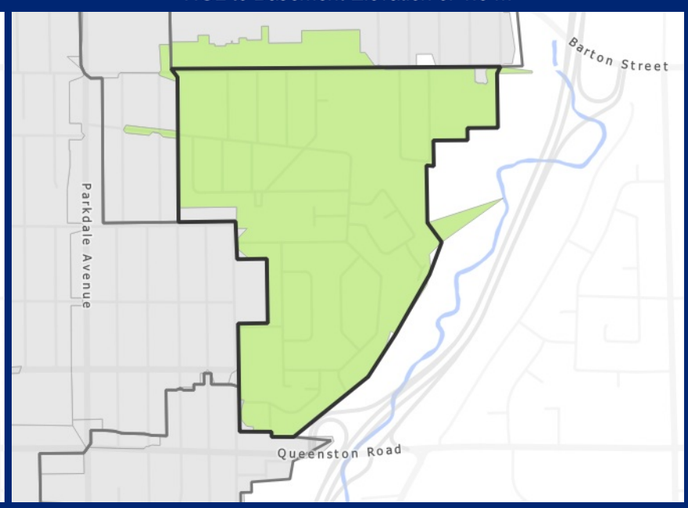
Pipe Depth for Residential Connections



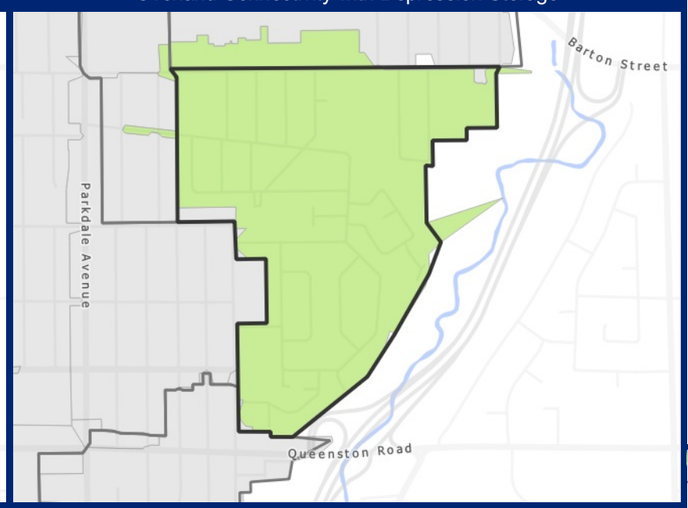
Pipe Condition and Age



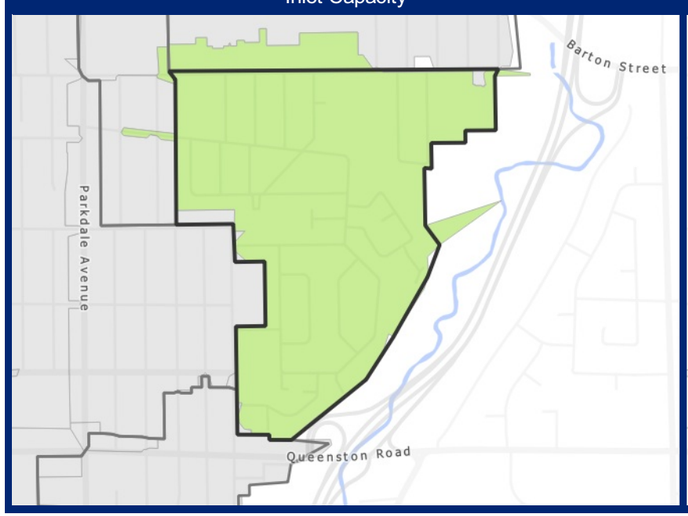
HGL to Basement Elevation of 1.8 m



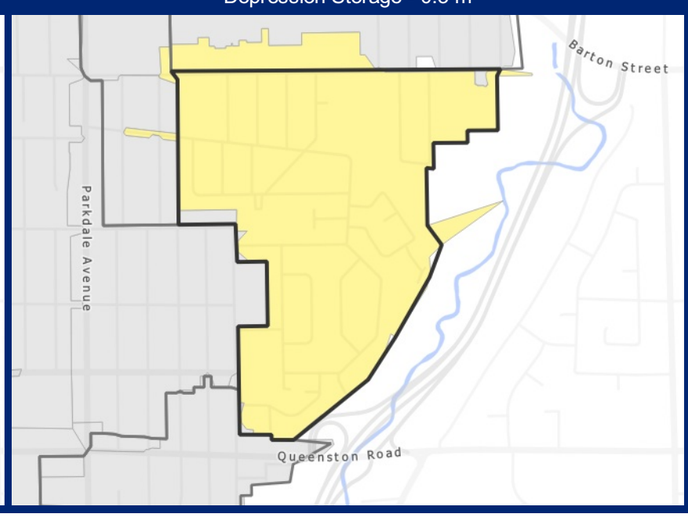
Overland Connectivity with Depression Storage



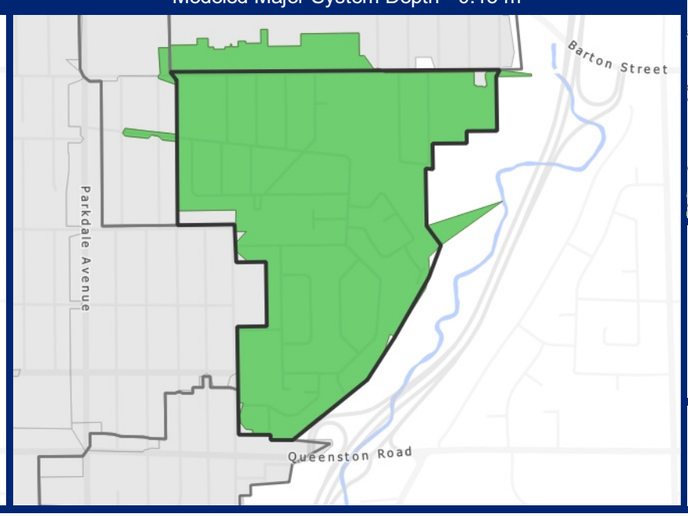
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

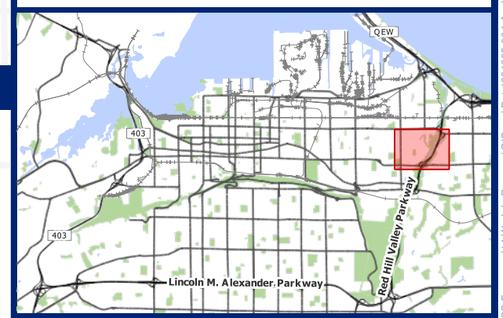


Figure 20 of 24

Melvin CSO

Results Analysis

BluePlan ENGINEERING

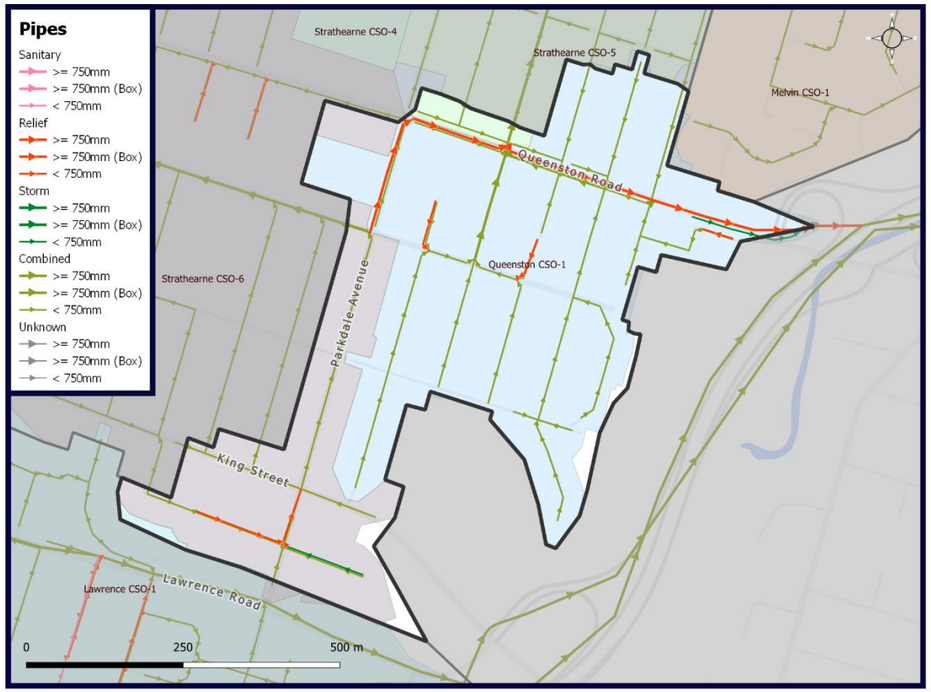
September, 2021
621085-004
Projection EPSG:26917

Document Path: W:\Hamilton\621000\621085 Hamilton FDMSS Framework\4 Work In Progress\GIS and Data\621085-004-Analysis Results.qgz

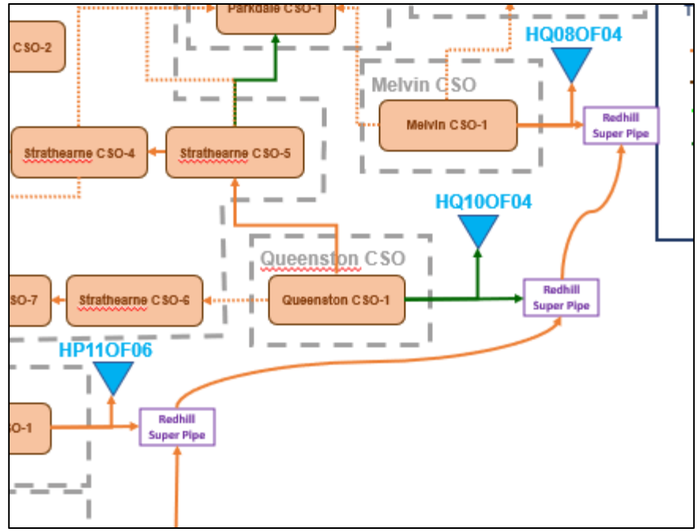
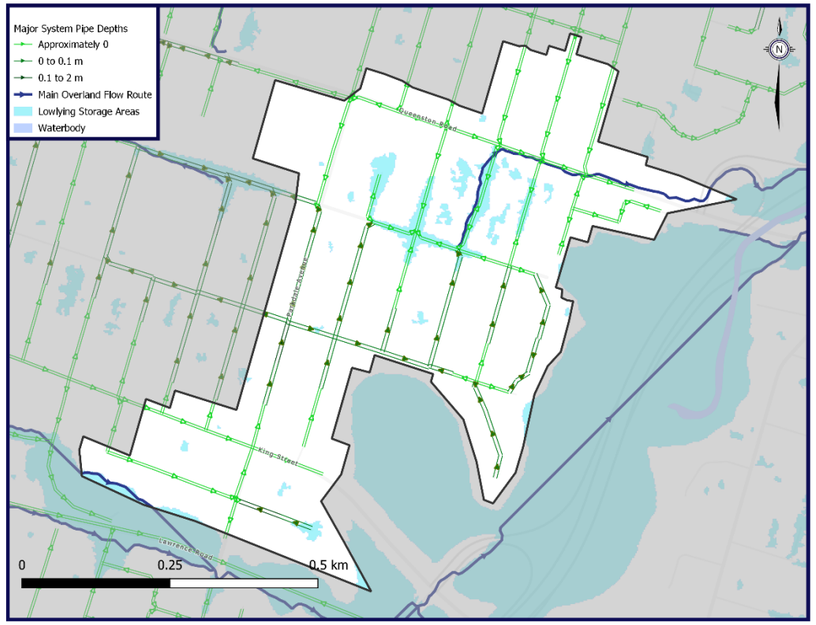
CSO Catchment Queenston

Catchment Summary

Overview	The Queenston CSO catchment is located in the northeastern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton: • Glenview East • McQuestion West The Queenston CSO catchments contains only a single subcatchment.	
Catchment Metrics	Area (ha)	27.9
	Total Length of Sewers (km)	5.4
	Length of Combined Sewers (km)	4.0
	Length of Sanitary Sewers (km)	0.0
	Length of Storm Sewers (km)	0.2
	Length of Relief Sewers (km)	1.2
	Storage Tanks (# and Name)	N/A



CSO Catchment Queenston

Minor System Overview	The Queenston CSO catchment generally drains toward a trunk sewer on Queenston Road which conveys flows north towards the Strathearne catchment. • Queenston CSO-1 conveys combined sewer flows from the north and south towards Queenston Road trunk sewer. • A relief sewer is also running along Queenston Road towards the Red Hill Valley Parkway.	
Major System Overview	The Queenston CSO catchment major system generally drains towards Central and Delena Avenues where there is available depression storage. Overland flows appear to discharge into Red Hill Valley at Central Avenue and Reid Avenue South. • Localized areas of increased flow depth up to approximately 150mm in the upstream areas in the southern portion of the catchment.	

CSO Catchment Queenston

Summary of Previous Studies	**Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)** • Recommendation for sewer separation and implementation of low impact development practices **Lower East End Storm Drainage Study and Stormwater Management Investigation (McCormick Rankin Corp., 2009)** <u>Parkdale Trunk Focus Area</u> • The Parkdale Trunk focus area is generally bounded by Melvin Avenue to the north, the Niagara Escarpment to the south, Reid Avenue to the east and Parkdale Avenue to the west. • All combined sewers in LEED study area depend on the WSI to convey flows to WWTP • **Problem Area A:** There are eight (8) flooding reports along Glencarry Avenue. Glencarry Avenue is serviced by local combined sewers which flow to Central Avenue. o The fourth potential remedial measure is to provide a storm relief sewer on Central Avenue from the combined sewer on Glencarry Avenue to the existing storm relief sewer on Parkdale Avenue, **this is recommended.**
Summary of Planned Works	No current planned works for Queenston CSO-1 are known at this time

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Queenston CSO-1	1	1	5	4	1	2	2	2

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Queenston CSO-1	Medium	Medium	

Issues and Options

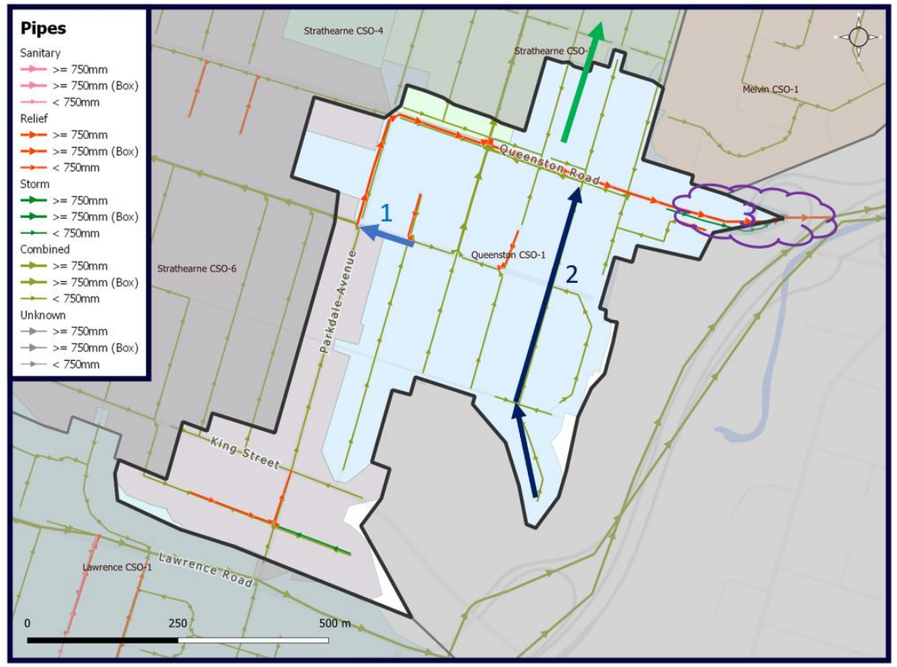
Summary of Key Issues	• HGL analysis suggests that areas in the southern portion of the catchment near Beland and Lucerne Avenues may be undersized o Surcharged sewers on Beland Ave S may be causing high HGL on Reid Ave S, Lucerne Ave and Beland Crt • Alternatives with new infrastructure impacting Red Hill Creek subject to Joint Stewardship Board (Indigenous) consultation and completion of a comprehensive assessment of potential new outfalls to Red Hill Creek.	

CSO Catchment Queenston

Summary of Potential Options

1. (QN-1) LEEDs Parkdale Trunk A-4 provide a storm relief sewer on Central Avenue from the combined sewer on Glencarry Avenue to the existing storm relief sewer on Parkdale
2. (QN-2) Local separation or relief sewers along Beland and Lucerne Avenue

   (QN-OUT) Further study required to confirm full separation of Queenston Rd relief sewer to provide local outlet
   a. Storm sewer outfall study to Red Hill Valley with consultation with the Joint Stewardship Board and completion of a comprehensive impact assessment to highlight the balance of CSOs versus new storm outfalls.

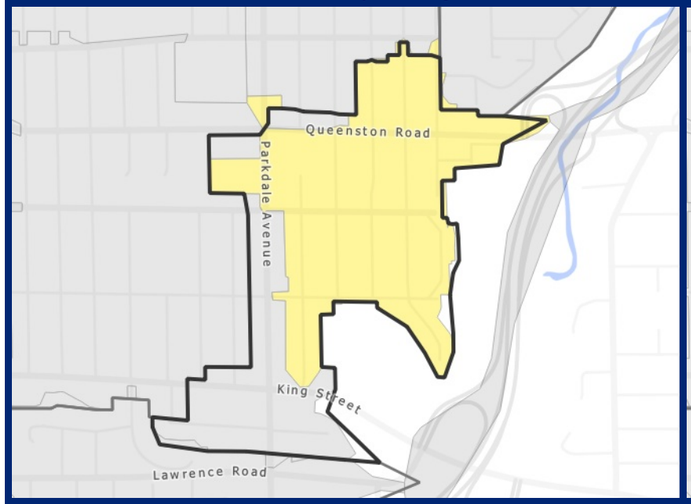


Option Evaluation

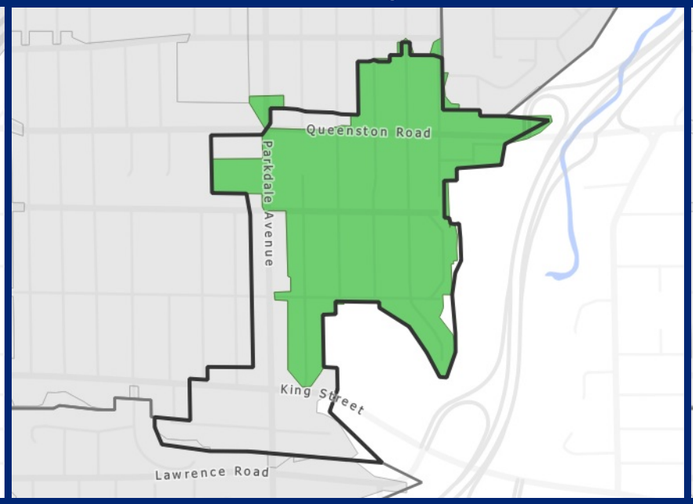
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. Relief sewer on Central Ave from Glencarry to Parkdale (QN-1)	• LEEDs recommended solution • Fairly scoped works that would be beneficial to complete separation of this area • Typical benefit of flow reduction to combined sewer system	• Scoped benefit to local area	Local Solution Moderate Benefit	$490K	Recommended	High Priority Short Term (3 – 5 Years)	None
2. Relief sewers or separation on Beland Street (QN-2)	• Typical benefits of sewer separation with reduced surcharge and volume reduction to combined system • Allows separation of side streets (Reid) • Deep separated sewers on Queenston	• Minimal Hansen calls	Local Solution Limited Benefit	$2.8M	Recommended	Low Priority Long Term (10 – 20 Years)	None

CSO Catchment Queenston							
New outfall to Red Hill Creek (QN-OUT)	• Allow for separation of upstream area • Reduction in flows to combined sewer system, additional capacity preserved in Red Hill Superpipe CSO	• Need for preceding study and evaluation • High cost and timeline to implement	System Wide Solution High Benefit	$3.0M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
Managed Sewer Separation (QN-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$2.0M	Recommended	Medium Priority Future Planning (20+ Years)	None

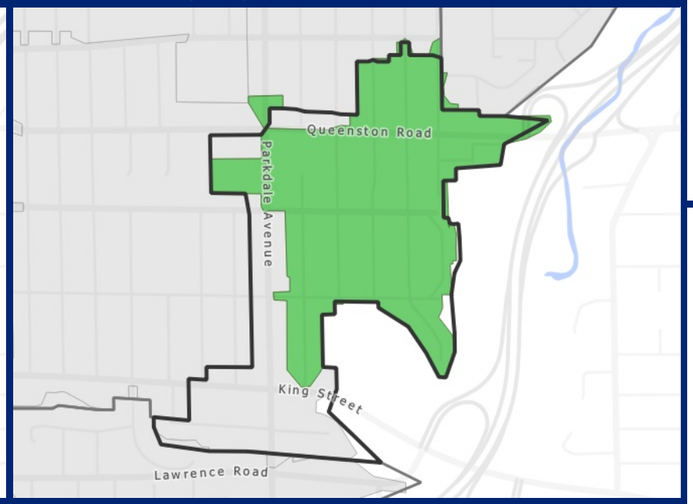
Overall Priority Ranking



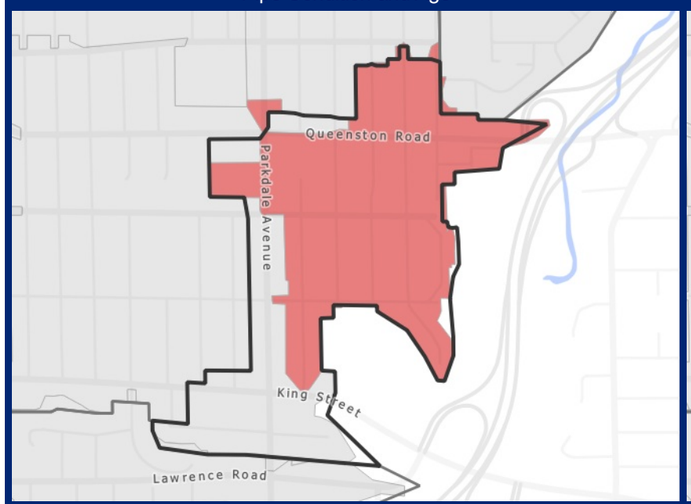
Hansen Flooding Calls



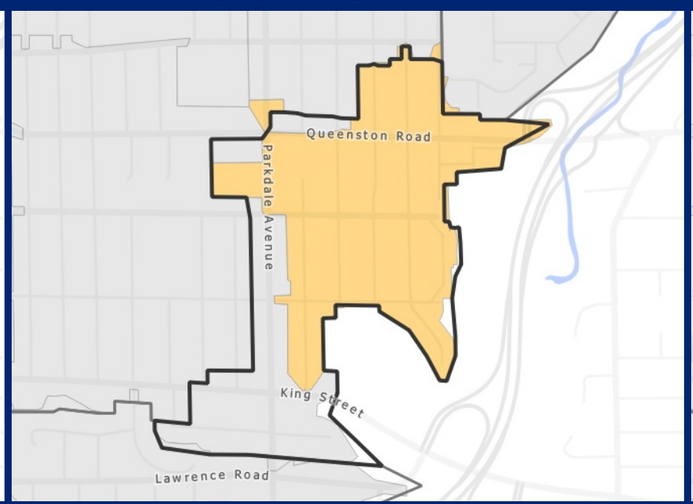
Pipe Depth for Residential Connections



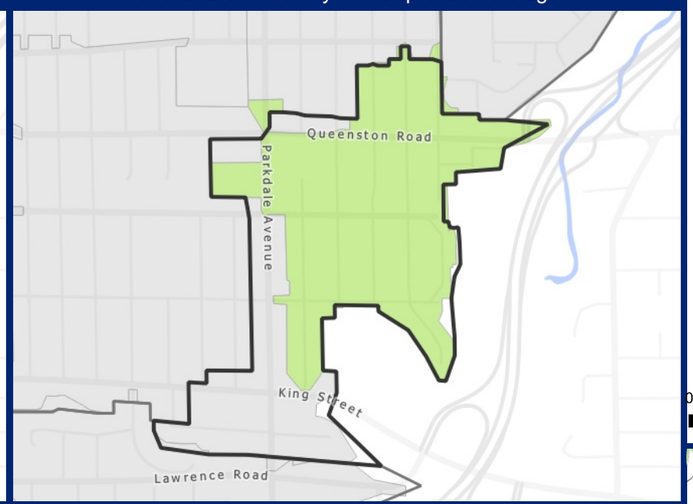
Pipe Condition and Age



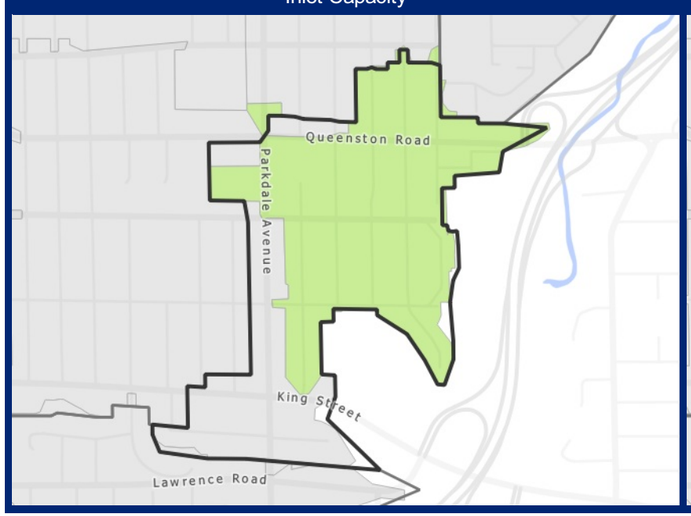
HGL to Basement Elevation of 1.8 m



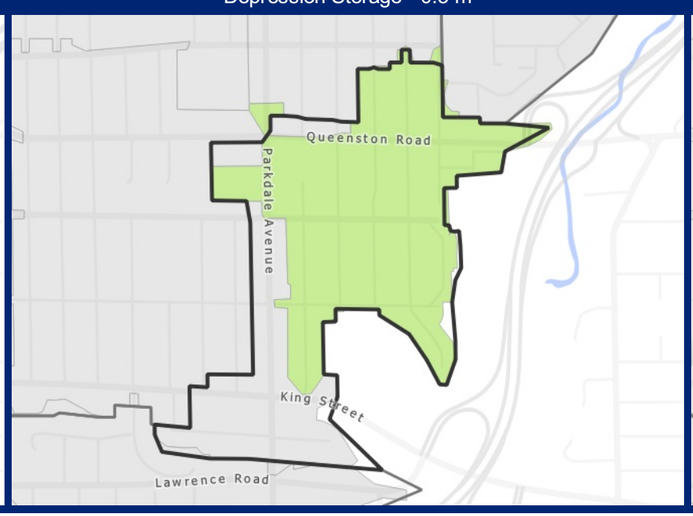
Overland Connectivity with Depression Storage



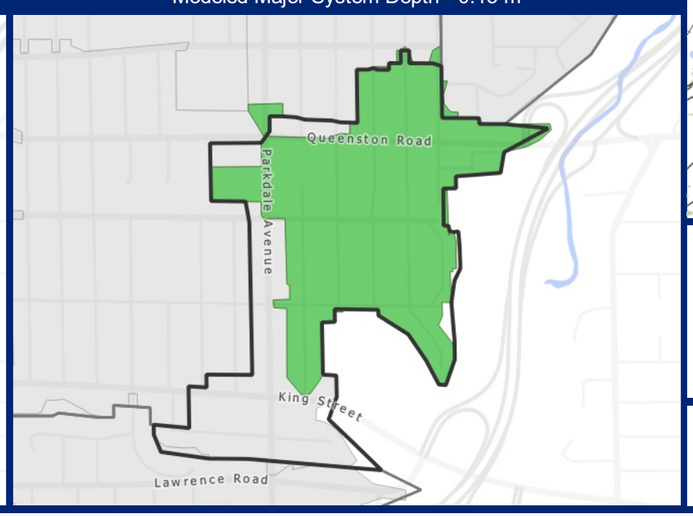
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

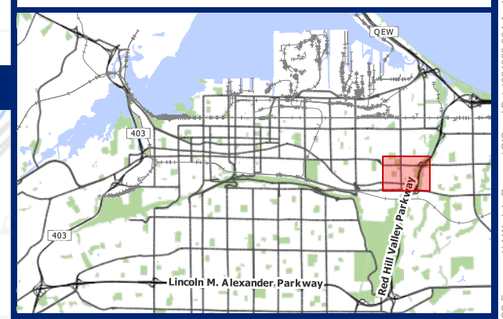


Figure 21 of 24

Queenston CSO

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Lawrence

Catchment Summary

Overview

The Lawrence CSO catchment is located in the eastern portion of the City's combined sewer system. The catchment primarily covers the northern extents of the Rosedale neighbourhood and includes the southern portions of the two boroughs:

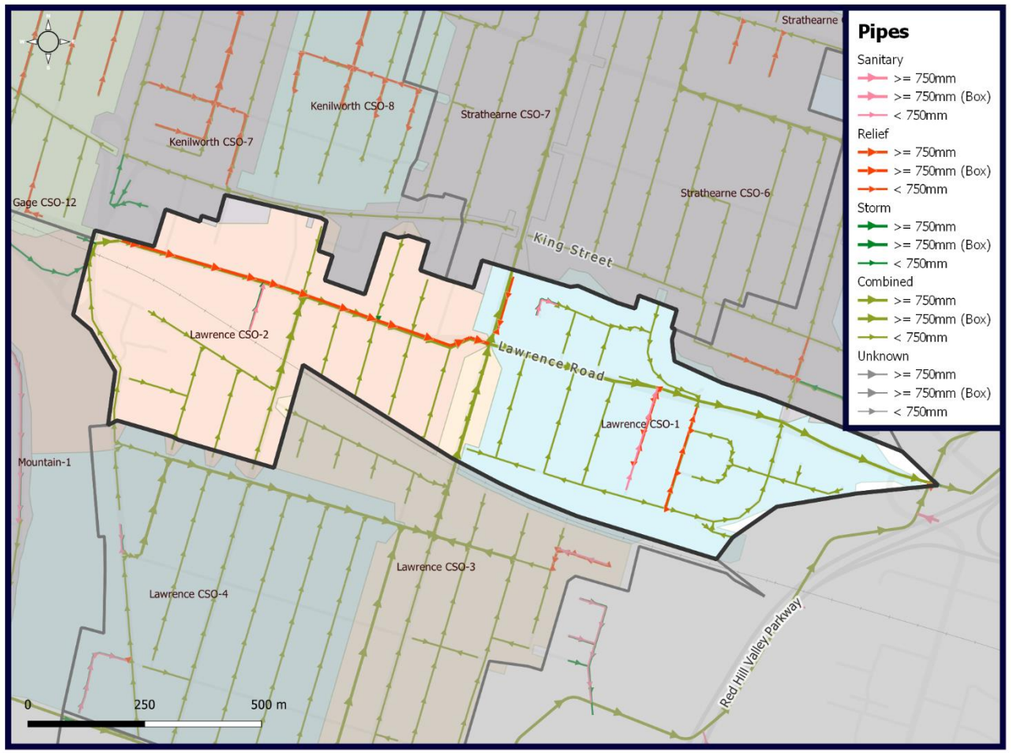
- Bartonville
- Glenview West

As well as the escarpment flows from the Delta East neighbourhood.

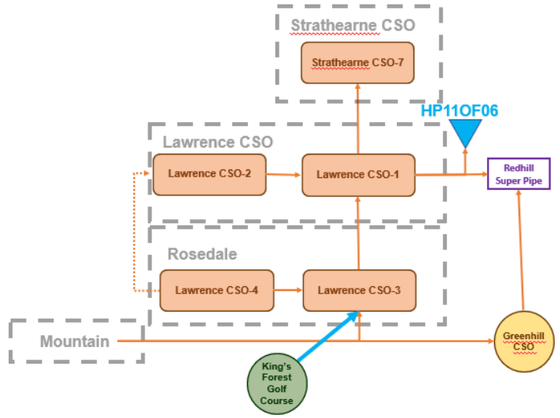
The Lawrence CSO catchments contains two (2) subcatchments.

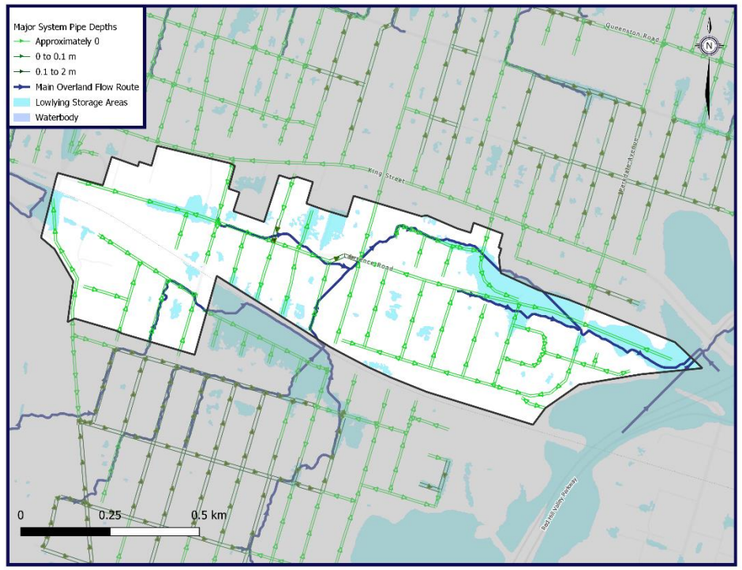
Catchment Metrics

Area (ha)	88.2
Total Length of Sewers (km)	11.9
Length of Combined Sewers (km)	8.7
Length of Sanitary Sewers (km)	0.4
Length of Storm Sewers (km)	1.3
Length of Relief Sewers (km)	1.4
Storage Tanks (# and Name)	N/A



CSO Catchment Lawrence

Minor System Overview	The Lawrence CSO catchment receives combined sewer flows from the Rosedale catchment via a trunk sewer on Cochrane Road and conveys them east to the Redhill Valley super pipe system and Lawrence CSO via Lawrence Road.
	• Lawrence CSO-2 generally runs west to east along Lawrence Rd
	  ○ Receives runoff from the escarpment in storm sewers on the Kenilworth Access
	  ○ Combined sewers connected from south of the tracks via Rosedale Ave
	  ▪ Combined sewer flow split at Kimberly Dr and Montrose Ave connects to Lawrence CSO-4
	  ○ Relief storm sewer runs from Kenilworth Access to Cochrane Rd via Lawrence Rd
	  ○ Outlets to Lawrence CSO-1 at Cochrane Rd
	  ▪ Connection to Strathearne CSO-7
	• Lawrence CSO-1 has a trunk sewer on Lawrence Rd from Cochrane Rd to the Lawrence CSO and Redhill Valley Superpipe east of Mount Albion Rd
	  ○ Southwestern combined sewers direct runoff to west and enter Lawrence Rd trunk at Cochrane Road
	  ○ Eastern and northern combined sewers convey runoff north to Lawrence Rd trunk sewer
	  ▪ Relief sewers on Martin Rd conveys flows from Hixon Rd north to Lawrence Road
	  ▪ Bettina Ave has sanitary and relief sewers, i.e. separated
	  ○ Outlets to Redhill Valley Super pipe and Lawrence CSO
		

Major System Overview	Overland flows through Lawrence CSO catchment generally flow from west to east toward Redhill Valley.
	• Overland flow from the Dunkirk Dr ponded area in the Rosedale catchment is shown to continue flowing north past the rail tracks along Cochrane Rd
	  ○ Overland flow from the west on Lawrence Rd connects at Cochrane Rd
	• Overland flow shown to travel through residential area to Glendee Ct where it continue s to flow east
	• Large ponded area connected to overland flow path along Lawrence Rd beginning at Glenholm Ave and continuing east to Red Hill Valley
	• First reach west of Cochrane Rd on Lawrence Rd shown to have significant depth in the major system
	  ○ Major system from Rosedale catchment not connected at the rail tracks likely contributes to underestimation of major system depths in Lawrence CSO
	• Overland flows from Kennilworth Access shown to contribute to Gage CSO-12 and Kenilworth CSO-6
		

CSO Catchment Lawrence

Summary of Previous Studies	**Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)** • Recommendation for sewer separation and implementation of low impact development practices **LEEDs – Lower East End Storm Drainage Study and Stormwater Management Investigation – Draft Study Report (MRC, April 2009)** • Lawrence Road is southern limit of LEEDs study area • Lawrence CSO is outside of LEEDs Focus Area boundary
Summary of Planned Works	• WSP study ongoing for SWM facility on golf course upstream of Rosedale catchment may provide relief from major system flows contributing into Lawrence CSO ○ See Rosedale catchment planned works for more detail

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Lawrence CSO - 1	1	1	5	1	1	5	3	4
Lawrence CSO - 2	1	3	5	2	1	3	4	2

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Lawrence CSO - 1	Medium	Medium	
Lawrence CSO - 2	Medium	Medium	

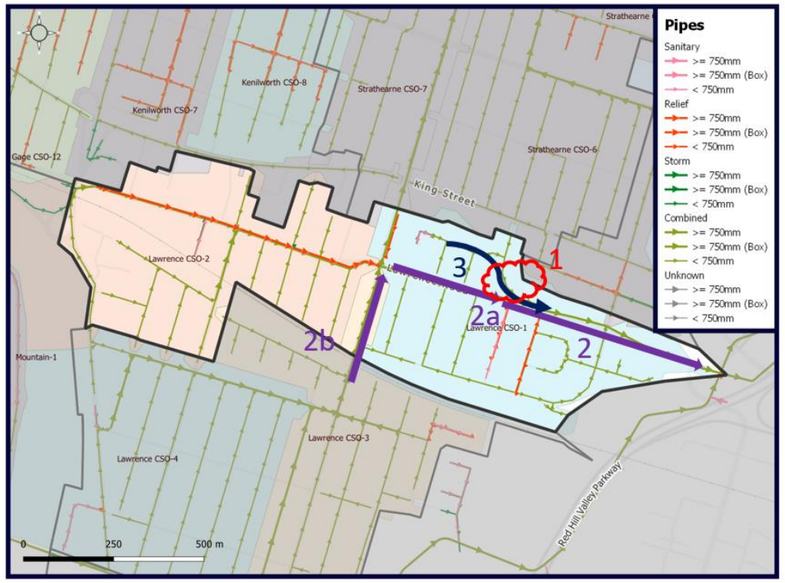
Issues and Options

Summary of Key Issues	• Large ponded area in Lawrence CSO-1 connected to overland flow path along Glenholme Ave and Lawrence Rd ○ Although HGL not noted as high, Glenholme Ave has potential to receive major overland flows off of Lawrence Rd as it is lower than Lawrence Rd at its end. • Ponded area on Lawrence Rd west of Rosedale Ave • Pocketed ponded areas throughout catchment • Medium inlet capacity, Lawrence CSO-2 likely underestimated due to escarpment area • Aging sewer infrastructure with shallow pipes in Lawrence CSO-2 • Alternatives with new infrastructure impacting Red Hill Creek subject to Joint Stewardship Board (Indigenous) consultation and completion of a comprehensive assessment of potential storm sewer outfalls to Red Hill Creek.	

CSO Catchment Lawrence

Summary of Potential Options

1. (LW-1) Potential regrade of Glenholme Ave to resolve major overland flow off of Lawrence Rd
2. (LW-2) Complete sewer separation along Lawrence Rd from Redhill Valley to Bettina Ave
   a. (LW-2a) Consider continuing separation to Cochrane Rd
   b. (LW-2b) Consider depth/size to provide major system relief for Dunkirk Dr ponded area
3. (LW-3) Complete sewer separation of Glenholme Ave up to Glendee Ct

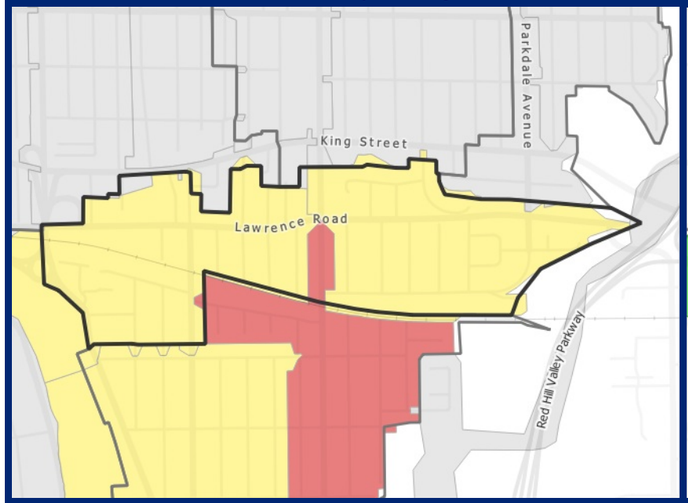


Option Evaluation

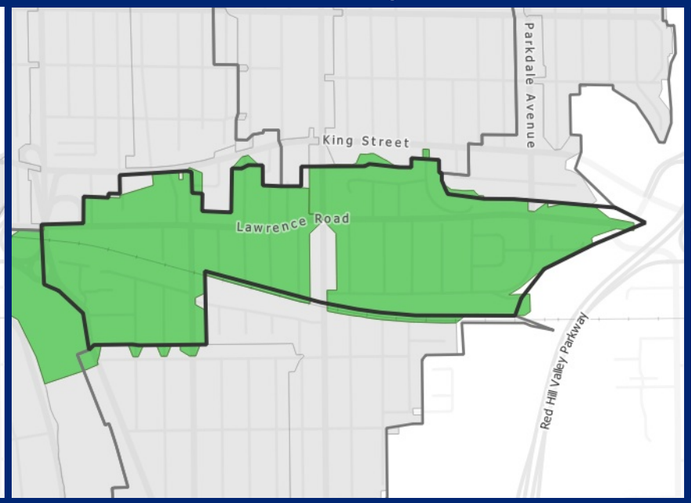
Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1. Regrade of Glenholme Ave (LW-1)	• Relatively straightforward project on a local road	• Limited benefit • May be constrained by existing tie-in grades and grade of Lawrence Road	Local Solution Limited Benefit	$1.2M	Recommended	Low Priority Long Term (10 – 20 Years)	None
2. Storm trunk on Lawrence Road from Bettina to Red Hill (LW-2)	• Provide major flow relief for overland flows coming down Lawrence Rd • Connects separated Bettina Ave • Provide outlet for relief sewer on Martin Rd • Provides outlet to separate Glenholme Ave and Glendee Ct • Reduce combined flows to Lawrence CSO	• Does not eliminate ponding on Glenholme Ave • Requires precursor study of outfall feasibility • High cost and likely long duration • Work on arterial roadway will complicate construction	System Wide Solution Substantial Benefit	$15.7M	Recommended	Medium Priority Medium Term (5 – 10 Years)	STR-2

CSO Catchment Lawrence							
2. a) Storm trunk on Lawrence from Cochrane to Bettina (LW-2a)	• Logical extension of primary project, would benefit greater overall area • Likely constructed in tandem if approved • Typical benefits of reduced flows to combined sewer system as well as reduced upstream surcharging	• High cost and likely long duration	System Wide Solution Substantial Benefit	$7.4M	Recommended	Medium Priority Medium Term (5 – 10 Years)	None
2. b) Storm trunk on Cochrane to pick up depressed area on Dunkirk (LW-2b)	• Connects relief sewer from Kenilworth Access to outlet at Redhill Valley • Potential to connect Dunkirk Dr ponded area for major system relief • Reduce combined flows to Lawrence CSO/Strathearne CSO	• Requires further study to determine how far south sewer should potentially extend and benefit	System Wide Solution Moderate Benefit	$3.6M	Further Study	Low Priority Long Term (10 – 20 Years)	None
3. Glenholme Ave Separation Sewer from Lawrence Rd to complete separation of Glendee Rd (LW-3)	• Provides outlet to separated portion of Glendee Ct • Provide relief for potential major overland flows from Lawrence Rd to Glenholme Ave • Reduce combined flows to Lawrence CSO	• Localized and limited overall benefit • Limited Hansen calls •	Local Solution Limited Benefit	$0.9M	Recommended	Low Priority Long Term (10 – 20 Years)	None
Managed Sewer Separation (LW-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$17.8M	Recommended	Medium Priority Future Planning (20+ Years)	None

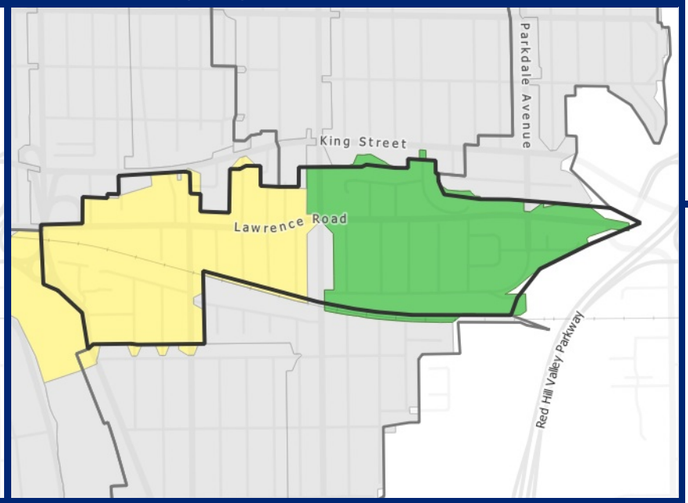
Overall Priority Ranking



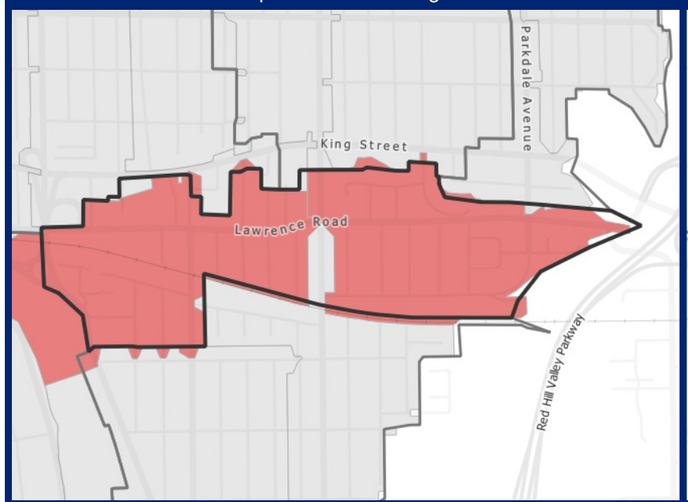
Hansen Flooding Calls



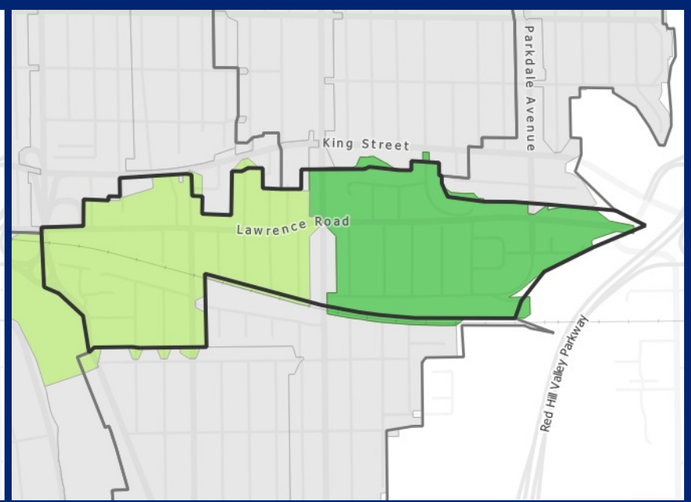
Pipe Depth for Residential Connections



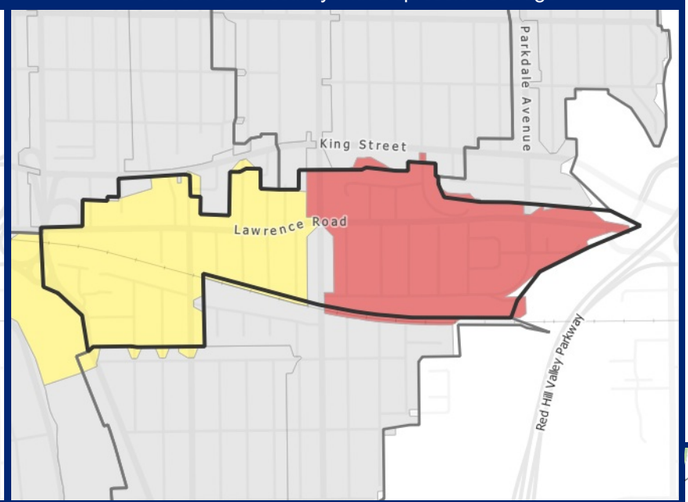
Pipe Condition and Age



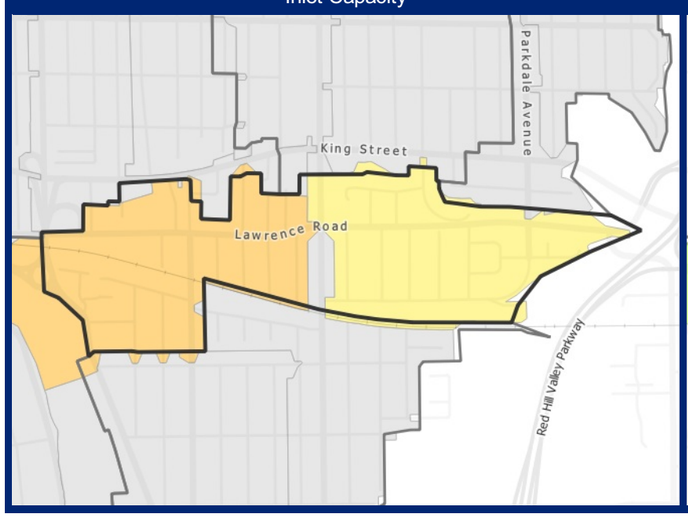
HGL to Basement Elevation of 1.8 m



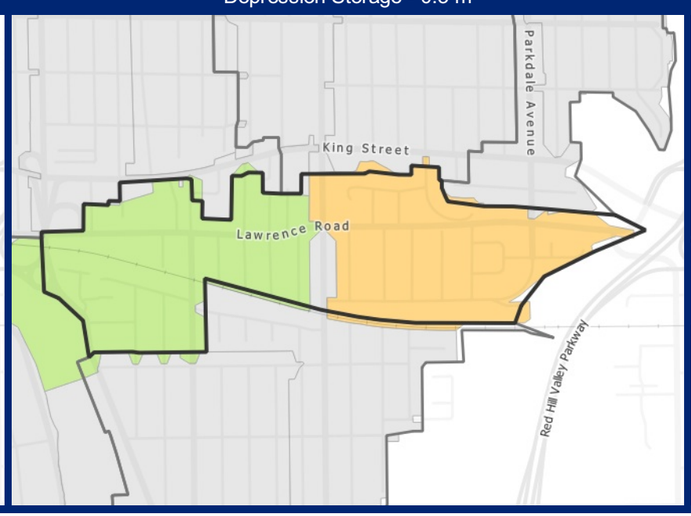
Overland Connectivity with Depression Storage



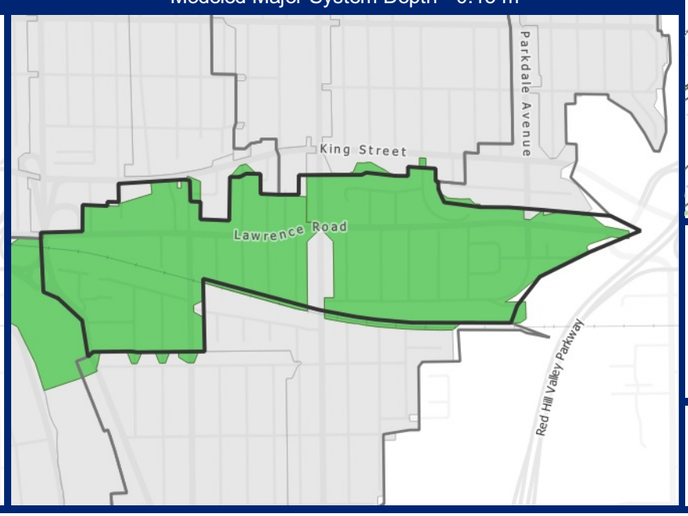
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

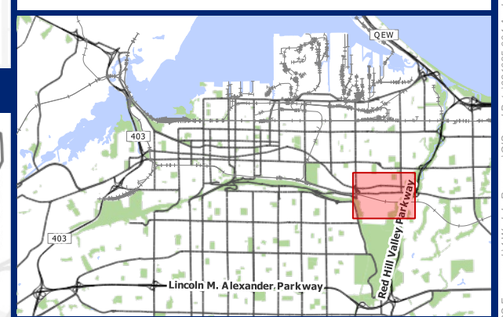


Figure 22 of 24

Lawrence CSO

Results Analysis

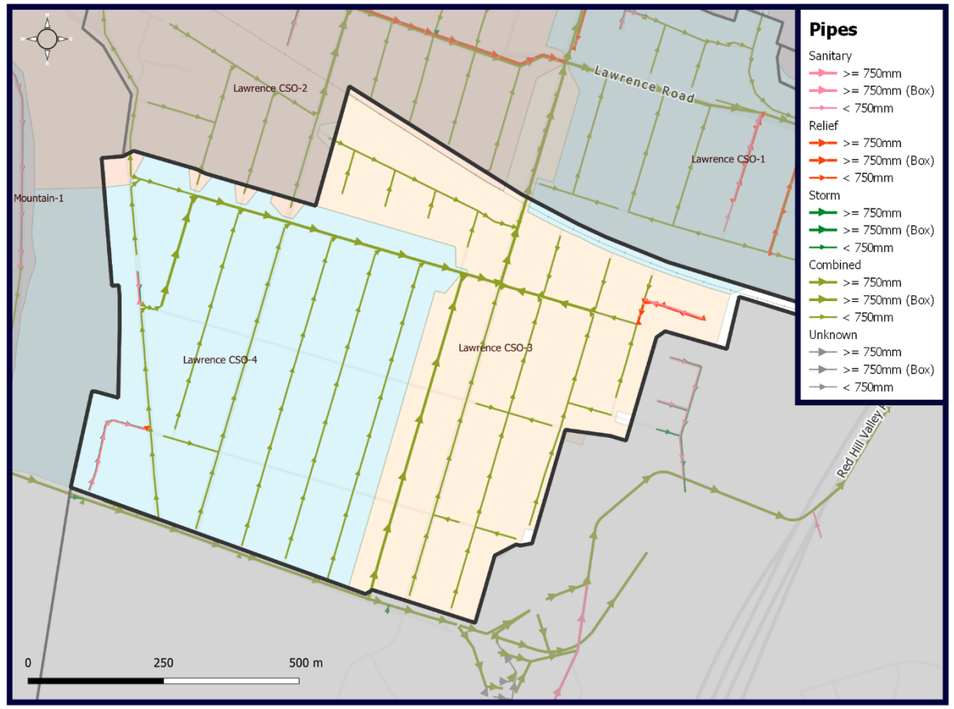
BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

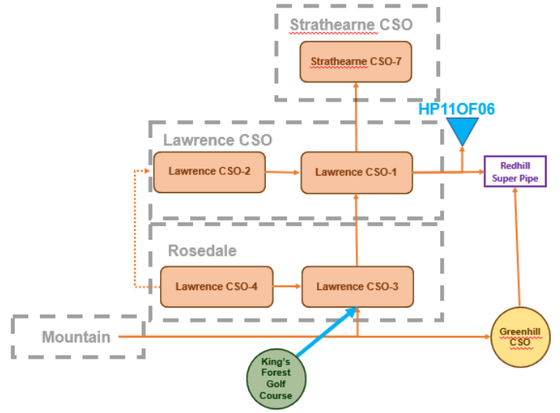
CSO Catchment Rosedale

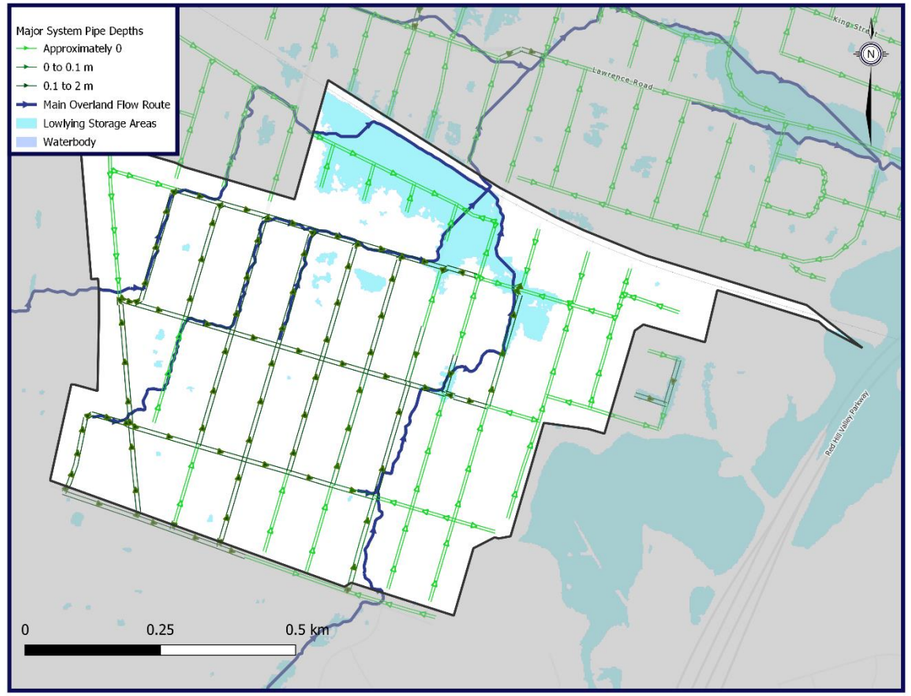
Catchment Summary

Overview	The Rosedale catchment is located in the eastern portion of the City's combined sewer system. The catchment is entirely located within the Rosedale neighbourhood and encompasses the southwestern and southeastern portions of the Rosedale nieghbourhood combined sewer system. Due to the proximity to the Lawrence CSO, the catchments have been labelled Lawrence CSO-3 and Lawrence CSO-4.	
Catchment Metrics	Area (ha)	77.7
	Total Length of Sewers (km)	10.1
	Length of Combined Sewers (km)	9.3
	Length of Sanitary Sewers (km)	0.4
	Length of Storm Sewers (km)	0.3
	Length of Relief Sewers (km)	0.2
	Storage Tanks (# and Name)	N/A



CSO Catchment Rosedale

Minor System Overview	• Trunk combined sewer connection into Lawrence CSO-3 from the Mountain catchment running down Greenhill Ave to the Greenhill CSO Tank • Lawrence CSO-4 drains into Lawrence CSO-3 via a trunk combined sewer on Montrow Ave • Lawrence CSO-3 drains into Lawrence CSO-1 via a trunk combined sewer along Cochrane Road crossing the rail tracks • Combined sewer flow split between Lawrence CSO-4 and Lawrence CSO-2 at Kimberly Dr and Montrose Ave	

Major System Overview	• Major system flows from Mountain along Greenhill Avenue contributes flows to Lawrence CSO-4 at Cortina Ave, Kimberly Dr, and Stewartdale Ave
	• Major system flows through Lawrence CSO-4 generally follow the overland flow paths to Montrose Ave.
	  ○ Overland flows at Dumbarton Dr and Kimberly Ave shown to flow down Cloverdale Avenue.
	  ○ Major system flows simulated to flow down Kimberly Dr and Rosedale Ave due to no major system connection to Cloverdale Ave.
	• External overland flow path from King's Forest Golf Club potentially contributing to Lawrence CSO-3 via Malta Dr.
	• External overland flow path from Mountain catchment potentially spilling down escarpment at Mountain Brow Blvd and Margate Ave. and contributing to overland flows through Lawrence CSO-4 along Ferndale Ave.
	  ○ Overland flow shown to cross into Lawrence CSO-2 along Cloverdale Ave before returning into Lawrence CSO-3 at the large ponded area on Dunkirk Dr.
	• Large ponded area on Dunkirk Dr upstream of the rail tracks crossing of Cochrane Rd.
	  ○ Area is depressed compared to rail and Cochrane Rd, no major system relief
	• No major system connection with significant flow depths crossing the tracks.
		

CSO Catchment Rosedale

Summary of Previous Studies	**Rosedale Neighbourhood SWM Facility at King's Forest Golf Course Stormwater Management Design Brief (WSP April 5, 2018)** • Four (4) historic watercourses convey runoff to existing DIs along south side of Greenhill Ave • DIs convey flows east through the 3000 mm x 3000 mm combined trunk sewer along Greenhill Ave • Rosedale Neighbourhood Study Update and Preliminary Design Memorandum (MMM Group, August 2014) is made reference to where several options were compared in terms of flooding reduction to address flooding issues in Rosedale neighbourhood. ○ Selected option includes a wide diversion channel with a berm to divert flows from the 4 DIs towards the east to the depression / low-lying area south of the pedestrian trail (asphalt driveway) and west of Whitehouse Road • Existing swale to be upsized for Regional Storm conveyance • Estimated 90% average flow reduction to the remaining DIs • Dry stormwater management facility to provide peak flow control for drainage area of 40.0 ha **Rosedale Neighbourhood SWM Facility at King's Forest Golf Course Drainage and Stormwater Management Report (WSP March 14, 2018)** • See summary for Design Brief **Rosedale Neighbourhood SWM Facility at King's Forest Golf Course ECA Application Report Drawings (WSP, undated)** • SWM Facility shown at southwest corner of Greenhill Ave and Malta Dr. • Major system flows shown to travel through SWM facility and down Greenhill Ave towards Greenhill CSO Tank **Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)** • Recommendation to continue with preferred alternative from Rosedale Flood Relief Study (copy not provided to Wood/GMBP)

Summary of Planned Works	• WSP study ongoing to provide dry SWM facility and conveyance ditch sized for Regional Storm Event to reduce major system flows from golf course
	  ○ MECP refused latest design based on outlet of pond re-entering combined system
	  ○ City intent to intercept external overland flows to provide major system relief to Rosedale Neighbourhood
	  ▪ Consider prioritizing separation on Greenhill Ave (or alternative route) to provide outlet for SWM Pond

Analysis Summary

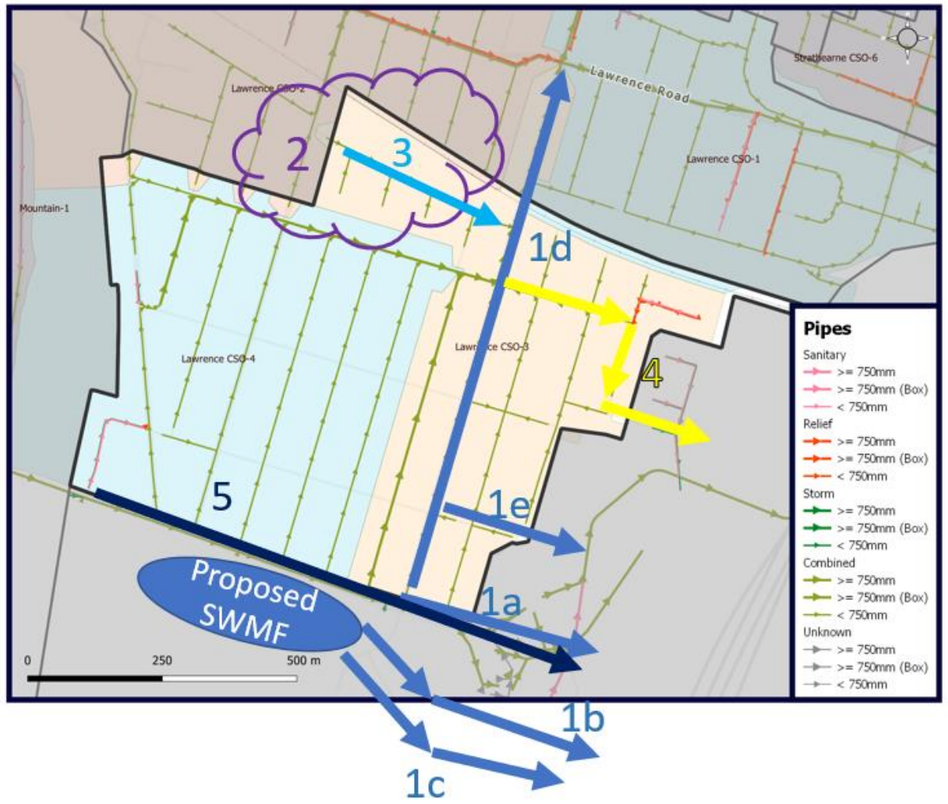
	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Lawrence CSO-4	1	1	5	2	5	1	4	1
Lawrence CSO-3	1	3	5	2	5	5	3	4

Sub Catchment Prioritization

	Catchment Priority	Data Uncertainty	Commentary
Lawrence CSO-4	Medium	Low	Lawrence CSOs - Railway influencing overland flow.
Lawrence CSO-3	High	Low	Lawrence CSOs - Railway influencing overland flow.

CSO Catchment Rosedale

Issues and Options

Summary of Key Issues	• Overland flow through golf course contributing to surcharged trunk sewer on Greenhill Ave
	  ○ Potential for overland flow to spill from escarpment into golf course or onto Greenhill Ave
	• Ponded area at rail tracks on Dunkirk Dr has no major system relief due to elevation relative to rail and surrounding roads
	  ○ Model results indicate no significant HGL issues during 100 year event on Dunkirk Dr
	• Alternatives with new infrastructure impacting Red Hill Creek subject to Joint Stewardship Board (Indigenous) consultation and completion of a comprehensive study of potential new storm sewer outfalls to Red Hill Creek
		

Summary of Potential Options	1. (RS-1) Separation sewer to provide outlet for SWM facility (Consider sizing any trunk sewers or relief sewers to convey Mountain flows, alternatives listed in order of feasibility in near term)
	  a. (RS-1a) Greenhill Ave through Softball Complex
	  b. (RS-1b) Across Whitehouse Rd and outlet via Greenhill Bowl Park Parking Lot
	  c. (RS-1c) Across Whitehouse Rd under golf course paved path
	  d. (RS-1d) Cochrane Rd to Lawrence Rd to Redhill Valley
	  e. (RS-1e) Cochrane Rd to Dumbarton Ave to Redhill Valley
	2. (RS-2) Increased inlet capacity on Dunkirk Dr
	3. (RS-3) Major system relief sewer from Dunkirk Dr
	4. (RS-4) New storm sewer to Red Hill via Montrose, Erin and Dundonald
	5. (RS-5) New storm sewer outfall for the Mountain	

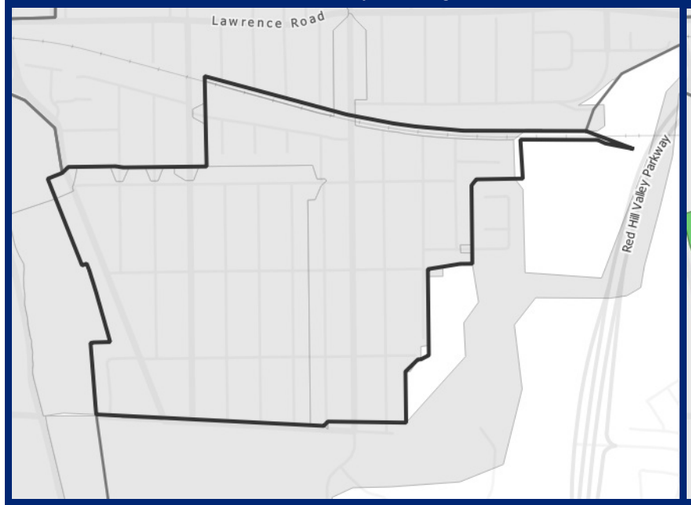
Option Evaluation

Option	Advantages	Disadvantages	System Benefit	Cost	Outcome	Priority and Timeline	Pre-Requisite Works
1a Kings Forest SWMR outlet through Greenhill and Park (RS-1a)	• Shortest path to Red Hill Valley • Provides outlet for proposed SWM Facility	• High chance for conflicting underground infrastructure (Greenhill CSO tank) • Disruption to City amenity		(Study ongoing through WSP) Screened out for costing	Further Study		

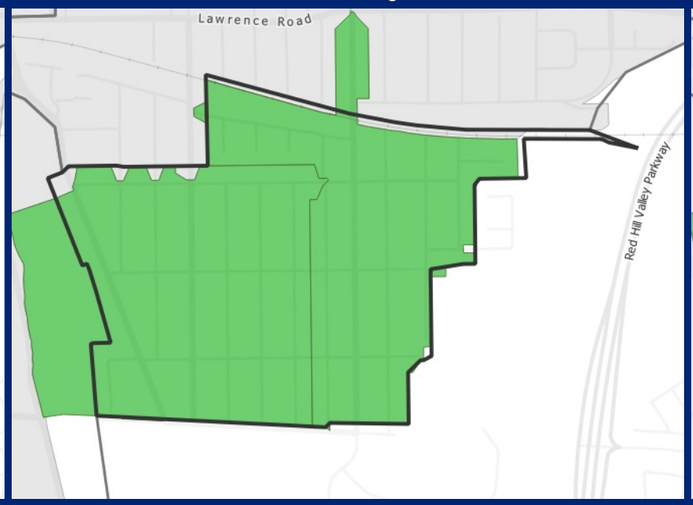
CSO Catchment Rosedale							
1b Kings Forest SWMF outlet through Whitehouse Road and Kings Forest Park (RS-1b)	• Next shortest path • Potentially avoids conflicting underground infrastructure • Potential to rehabilitated roadway as part of the same project • Provides outlet for proposed SWM Facility	• Potential conflict with hydro towers • Complexities with slope	System Wide Solution Moderate Benefit	$3.4M	Recommended	High Priority Short Term (3 – 5 Years)	STR-2
1c Kings Forest SWMF outlet through golf course path (RS-1c)	• Avoids hydro towers • Provides outlet for proposed SWM Facility	• Conflicts with golf course • Conflicts with trail			Screened out		
1d Kings Forest SWMF outlet via Cochrane Road (RS-1d)	• Potentially provides an outlet for other areas for separation	• Longest path to outlet • High cost			Screened out		
1e Kings Forest SWMF outlet via Dumbarton Ave (RS-1e)	• Potentially provides an outlet for other areas for separation	• Requires additional street construction • Drop sewer required into Red Hill Valley • Outlet would be on a meandering portion of creek, significant erosion protection may be required • Trail path conflict • Outlet requires going through treed valley section •			Screened out		
2 Increased Inlet Capacity on Dunkirk Dr (RS-2)	• Reduce major system flows on Dunkirk Dr	• No significant Hansen calls within area and no HGL issues noted • Potential to worsen combined sewer surcharging if insufficient capacity	Local Solution Low Benefit	150K	Further Study	Low Priority Long Term (10 – 20 Years)	None
3 Major System Relief Sewer from Dunkirk Dr (RS-3)	• Potential to provide 100 year capacity to protect homes on Dunkirk Dr	• No significant Hansen calls within area and no HGL issues noted • Sewer requires an outlet which would be much more involved	Local Solution Moderate Benefit	$1.5M	Further Study	Low Priority Long Term (10 – 20 Years)	None

CSO Catchment Rosedale							
4 New Storm Sewer to Red Hill via Montrose, Erin and Dundonald (RS-4)	• Would allow for potential separation of entire Rosedale community if appropriately sized and designed • Significant reduction in expected surcharge and volume and flows to combined sewer system	• High cost and complexity • Need for new outfall to Red Hill would impact valley and creek	System Wide Solution High Benefit	$13.4M	Recommended	High Priority Short Term (3 – 5 Years)	STR-2
5 New Storm Sewer Outfall for the Mountain (RS-5)	• Would allow for separation of a very large area on the mountain • Significant reduction in flows to the combined sewer system and Greenhill and Red Hill super pipe CSOs	• High cost and complexity • Cost does not include substantial cost associated with new drop structure from top of escarpment to Greenhill Ave • Need for separation would clearly require further study to evaluate cost-benefit	System Wide Solution High Benefit	$19.7M (not including drop structure)	Further Study	Low Priority Long Term (10 – 20 Years)	STR-2
Managed Sewer Separation (RS-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$12.8M	Recommended	Medium Priority Future Planning (20+ Years)	None

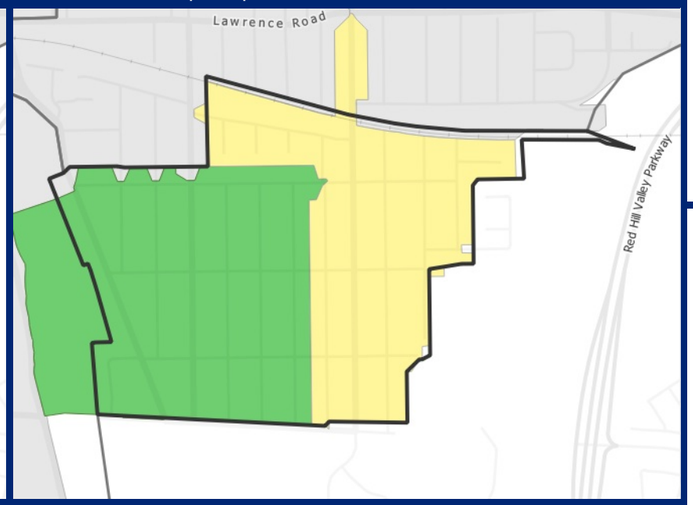
Overall Priority Ranking



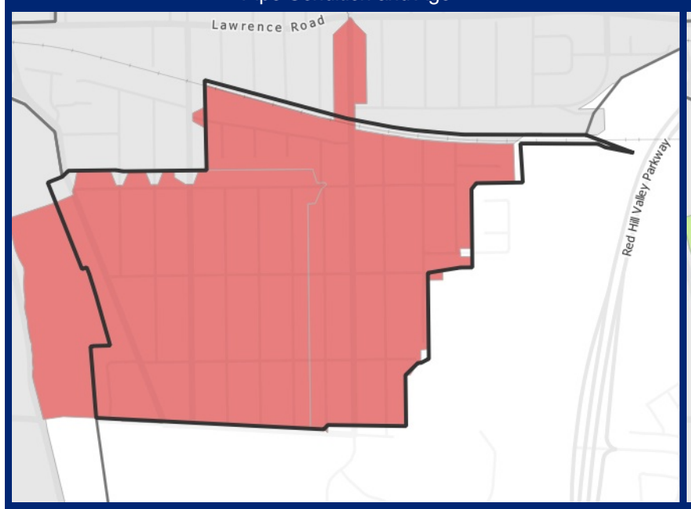
Hansen Flooding Calls



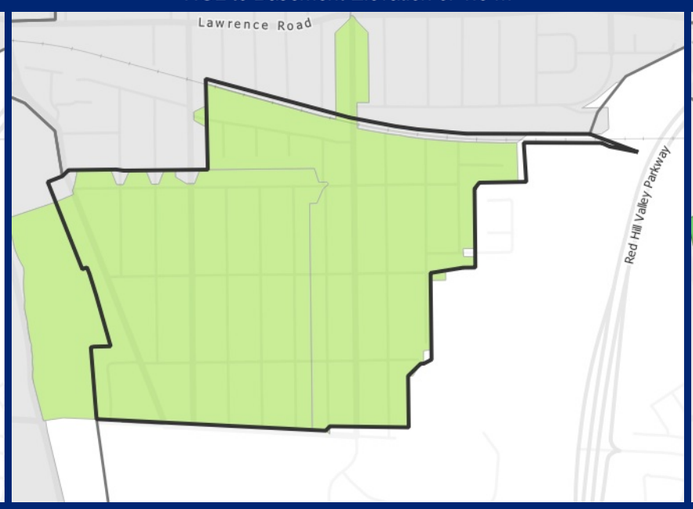
Pipe Depth for Residential Connections



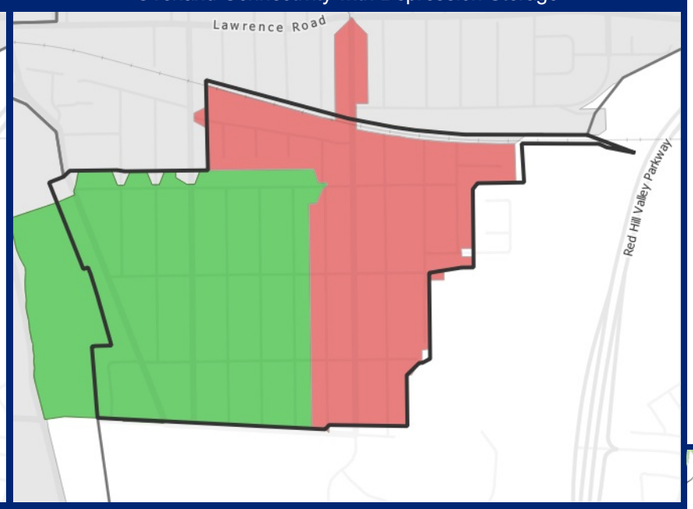
Pipe Condition and Age



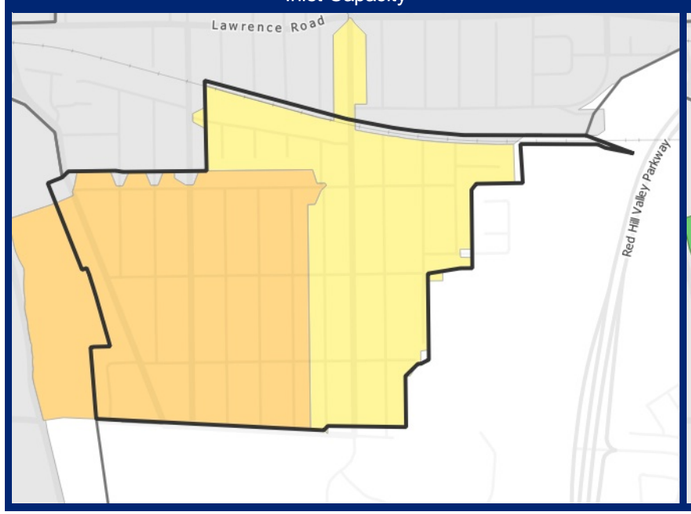
HGL to Basement Elevation of 1.8 m



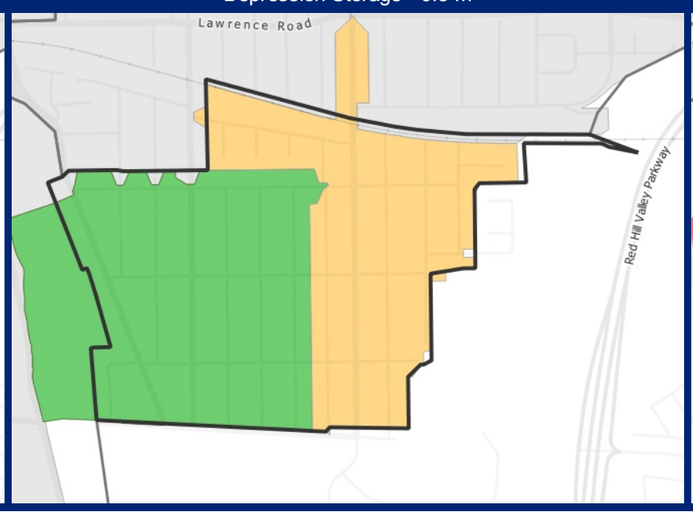
Overland Connectivity with Depression Storage



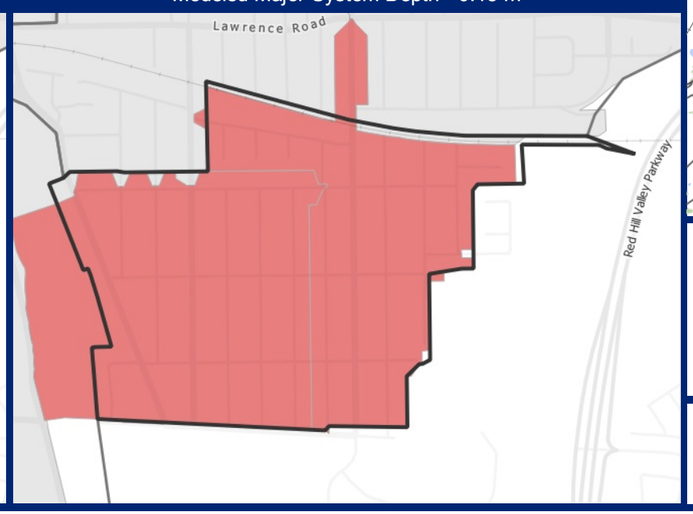
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

0 0.5 1 km

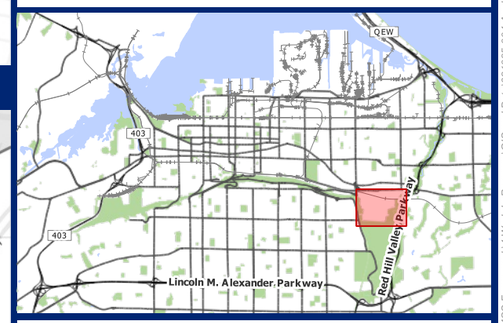


Figure 23 of 24

Rosedale

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

CSO Catchment Mountain

Catchment Summary

Overview

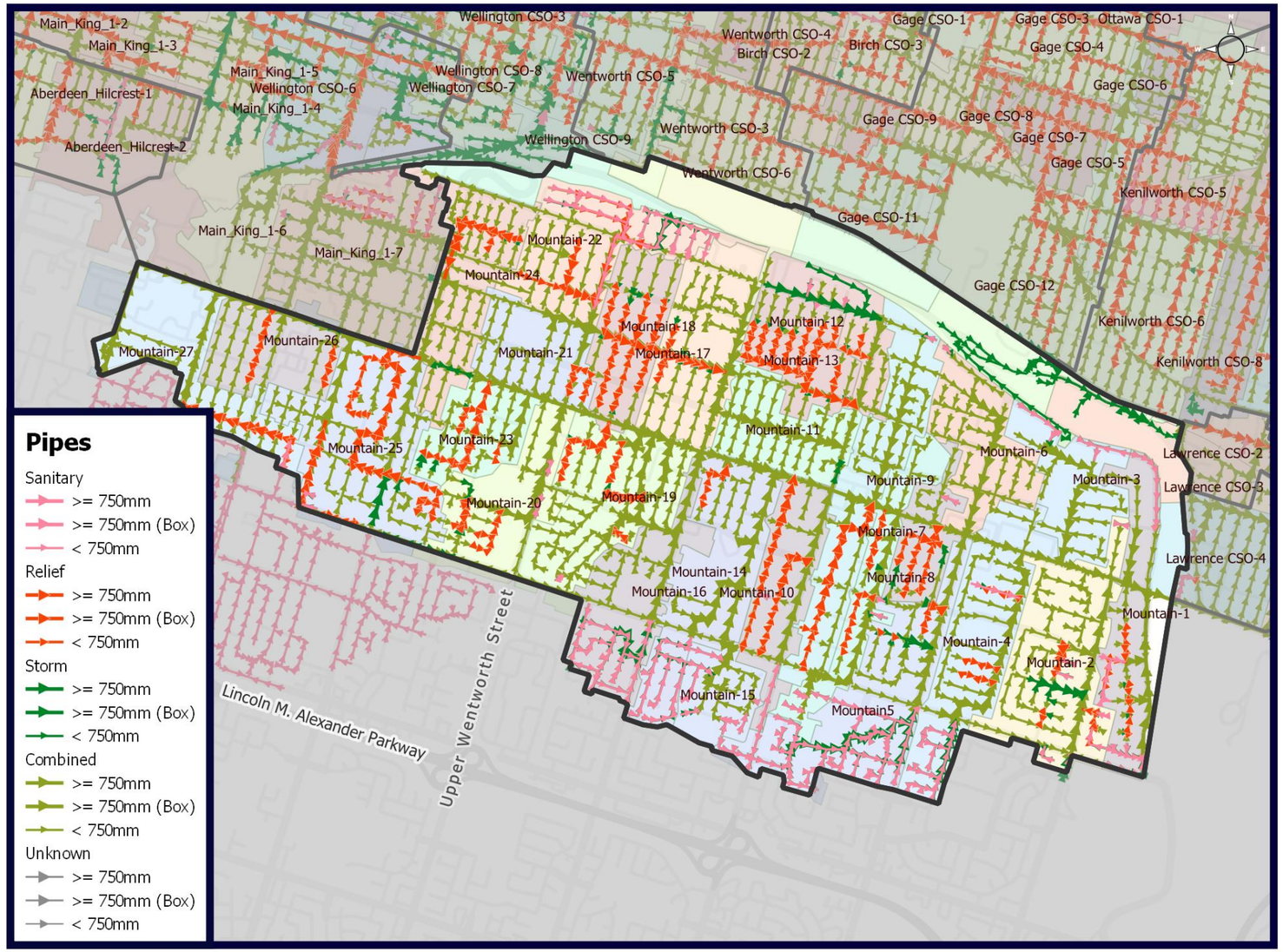
The Mountain CSO catchment is located in the southern portion of the City's combined sewer system. The catchment includes portions of the following boroughs of Hamilton:

- Huntington
- Sherwood
- Sunninghill
- Hampton Heights
- Berrisfield
- Raleigh
- Macassa
- Lawfield
- Thorner
- Burkholm
- Eastmount
- Inch Park
- Hill Park
- Balfour
- Centremount
- Southam
- Bonnington
- Mohawk
- Buchanan

The Mountain CSO catchments contains twenty seven (27) subcatchments.

Catchment Metrics

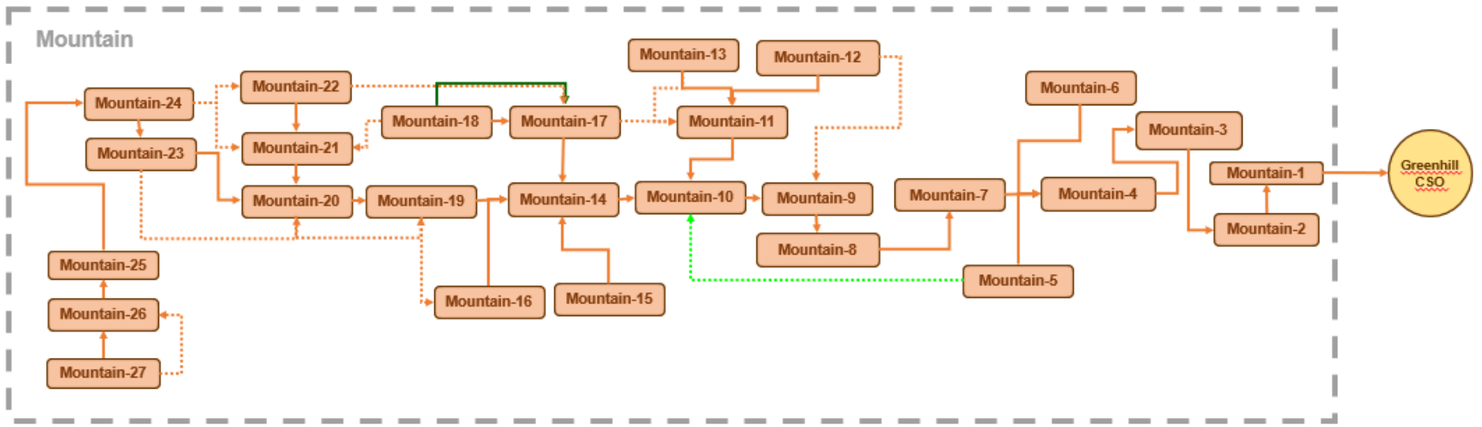
Area (ha)	1244.5
Total Length of Sewers (km)	217
Length of Combined Sewers (km)	146
Length of Sanitary Sewers (km)	21
Length of Storm Sewers (km)	24
Length of Relief Sewers (km)	26
Storage Tanks (# and Name)	Greenhill CSO (located in Rosedale Catchment)



CSO Catchment Mountain

Minor System Overview

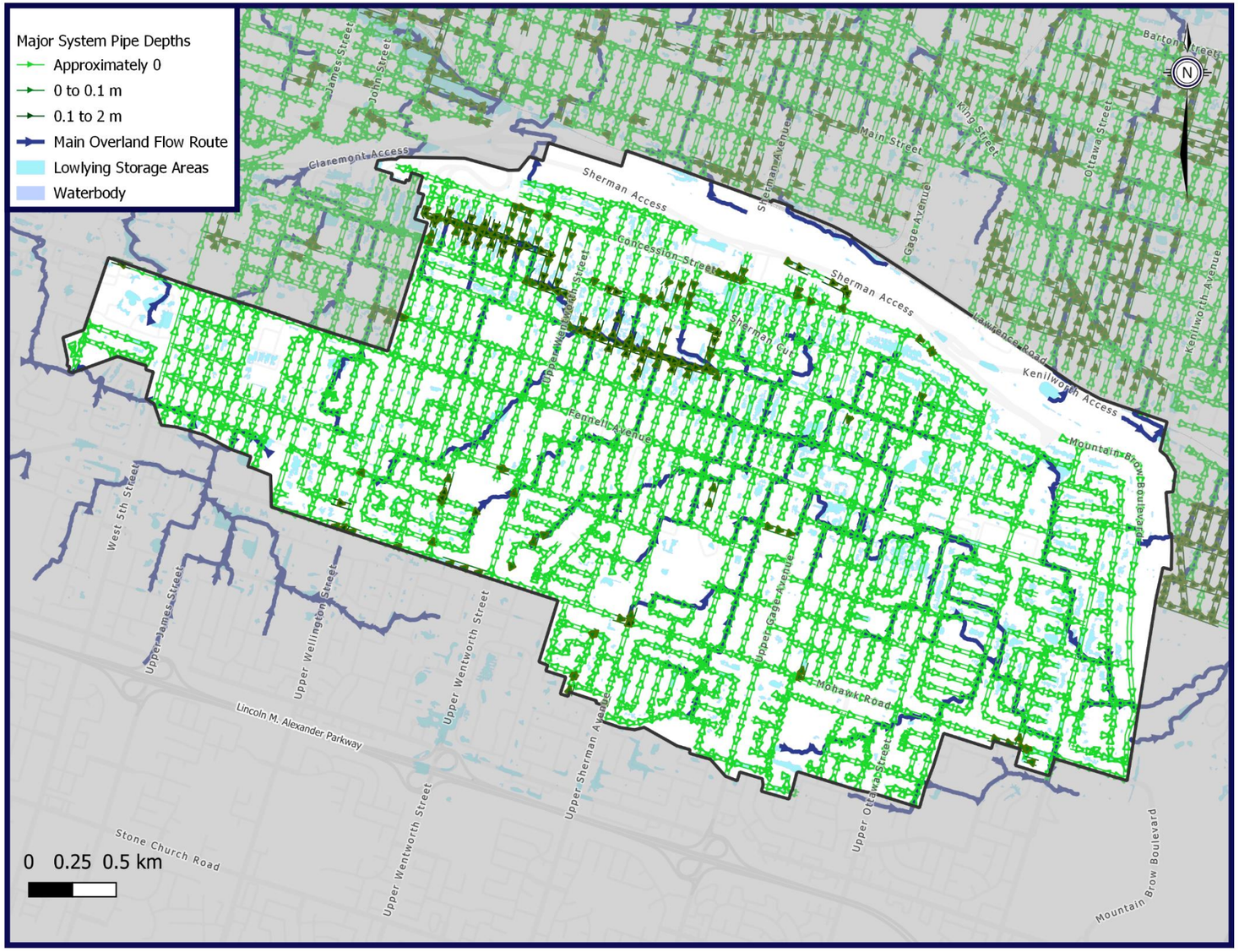
- Minor system generally conveys flows north/south to Fennel Ave East
- Fennel Ave East is the main trunk which conveys flows east to the Greenhill CSO tank
- Area south of Mohawk Rd East is mostly separated at the local scale, re-entering the combined system on Mohawk Rd East
- Area along escarpment and west of the Sheman Cut (north of catchment) is mostly separated at local scale, entering combined system at Concession St
- Queensdale Ave East between Mountain-22, Mountain-18 and Mountain-17 provides an east/west connection with trunk combined and relief sewers
    - Connects to Fennel Ave trunk sewer via Upper Wentworth St and Upper Sherman Ave
- Relief sewers have moderate coverage in the following catchments:
    - Mountain-22, Mountain-18, Mountain-13, Mountain-10, Mountain-7,
- The following catchments have moderate coverage of relief sewers south of Fennel Ave:
    - Mountain-9, Mountain-8, Mountain-7, Mountain-1



CSO Catchment Mountain

Major System Overview

- Overland flow path generally from northwest to southeast
- Major system flows generally drain from west to east
- Major system shows significant depths along major overland flow path starting in northwest of catchment:
  - Mountville Ave flowing east to East 18th St
  - South to Inverness Ave East, east to Upper Wentworth St
  - South to Queensdale Ave East, east to Upper Sherman Ave
    - Major system shows flow going north here, but overland flow path suggests the flow would go east and south to Brucedale
- Pocketed depressions throughout Mountain catchment, generally align with the overland flow path
- Overland flow path shows most of catchment draining overland to Mohawk Sports Park
- Overland flows from Mountain-3 and Mountain-1 shown to contribute to Kings Forest Golf Course



CSO Catchment Mountain

Summary of Previous Studies	**Flooding and Drainage Master Servicing Study – Final Report (Aquafor Beech, September 23, 2019)** • System storage (in-line / off-line) within existing combined sewer system **Rosedale Neighbourhood SWM Facility at King's Forest Golf Course Stormwater Management Design Brief (WSP April 5, 2018)** Potential for outlet of King's Forest SWMF to be a storm/relief sewer which could be sized to provide outlet for Mountain
Summary of Planned Works	• No known works at this time

Analysis Summary

	Historic Flooding	Sewer Configuration (Depth and Land use)	Sewer Age and Condition	Minor System Capacity (Modelling)	Major System Capacity (Modelling)	Major System Capacity (Topographic)	Inlet Capacity	Surface Depressions
Mountain-1	1	1	5	1	1	1	1	2
Mountain-2	3	3	3	2	1	3	2	3
Mountain-3	1	1	3	1	1	3	1	3
Mountain-4	3	1	5	3	1	2	2	2
Mountain5	1	1	5	5	1	1	2	1
Mountain-6	1	3	5	1	1	1	3	3
Mountain-7	1	1	1	1	1	5	3	5
Mountain-8	1	1	1	1	1	3	2	3
Mountain-9	1	1	5	2	1	3	2	3
Mountain-10	1	1	3	3	1	1	4	1
Mountain-11	1	1	3	2	1	4	3	4
Mountain-12	1	3	1	5	1	1	3	2
Mountain-13	1	3	3	2	1	2	3	3
Mountain-14	1	1	3	4	1	1	3	1

CSO Catchment Mountain								
Mountain-15	1	1	3	1	1	1	2	2
Mountain-16	1	1	3	5	1	1	3	1
Mountain-17	3	3	3	2	5	1	3	2
Mountain-18	1	3	1	1	5	1	3	2
Mountain-19	1	1	1	2	1	1	2	1
Mountain-20	1	3	5	2	3	1	1	1
Mountain-21	1	1	3	1	1	1	3	1
Mountain-22	1	3	1	5	5	3	2	3
Mountain-23	3	1	3	1	1	3	3	2
Mountain-24	1	3	1	2	5	1	2	2
Mountain-25	3	1	5	2	3	1	1	2
Mountain-26	1	1	5	1	1	1	1	1
Mountain-27	1	1	1	1	3	2	2	2

Sub Catchment Prioritization			
	Catchment Priority	Data Uncertainty	Commentary
Mountain-1	Low	Medium	
Mountain-2	Medium	Medium	
Mountain-3	Low	Medium	
Mountain-4	High	High	
Mountain5	High	Medium	
Mountain-6	Medium	Low	
Mountain-7	Medium	Medium	

CSO Catchment Mountain			
Mountain-8	Low	Medium	
Mountain-9	Medium	Medium	
Mountain-10	Low	Medium	
Mountain-11	Medium	Low	
Mountain-12	Medium	Medium	
Mountain-13	Low	Medium	
Mountain-14	Low	Medium	
Mountain-15	Low	High	
Mountain-16	Medium	Medium	
Mountain-17	High	Medium	
Mountain-18	Medium	Low	
Mountain-19	Low	High	
Mountain-20	Medium	Low	
Mountain-21	Low	Medium	
Mountain-22	High	Medium	
Mountain-23	Medium	High	
Mountain-24	Low	Low	
Mountain-25	Medium	Medium	
Mountain-26	Low	Medium	
Mountain-27	Low	Medium	

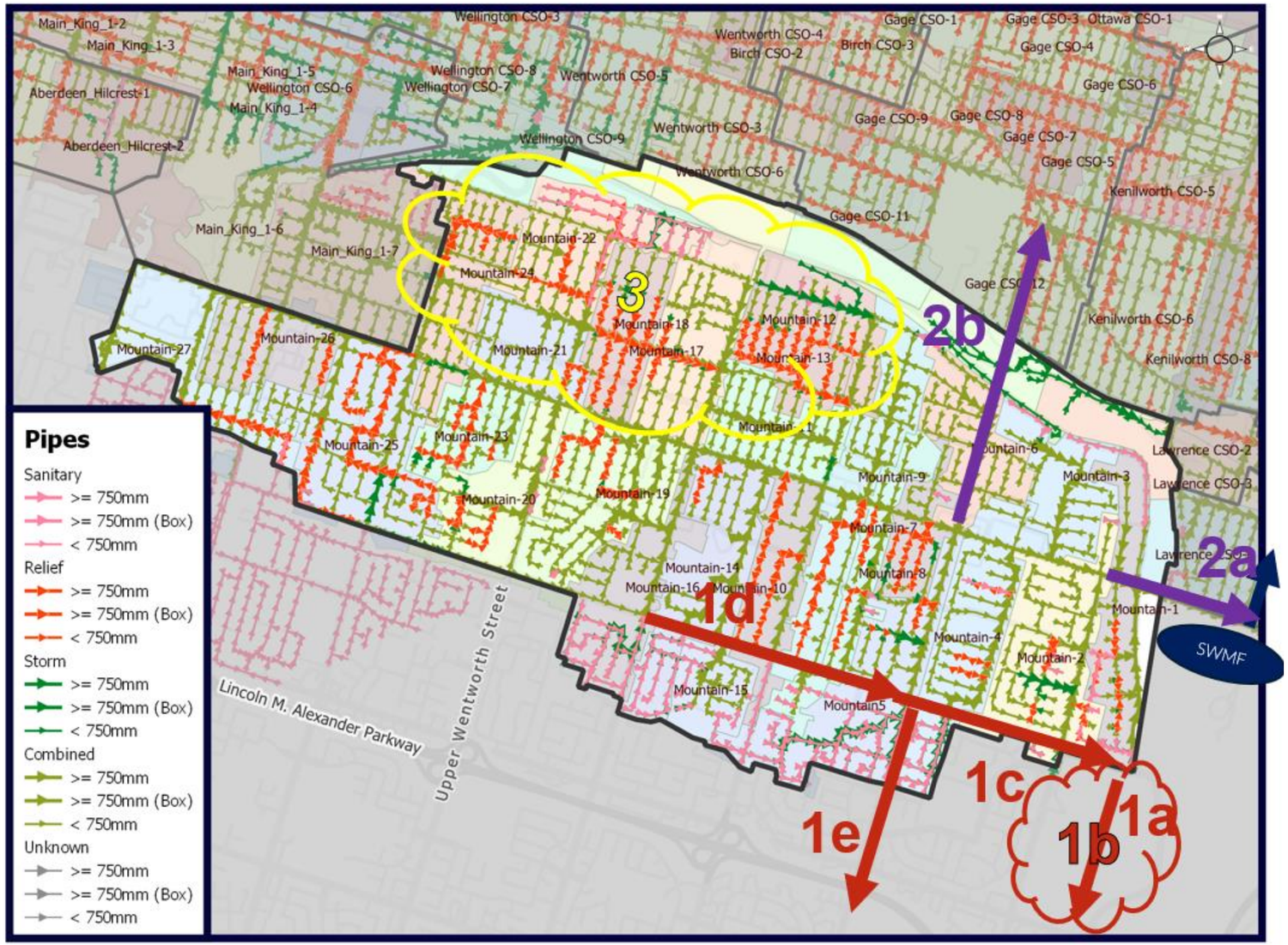
CSO Catchment Mountain		
Issues and Options		
Summary of Key Issues	• Combined sewers all conveyed to Fennel and outlet Greenhill Ave • One outlet for 1244 ha • No current opportunity to divert flows to lower city – no separated storm sewer outfalls at bottom of escarpment • Area around Upper Ottawa south of Mohawk priority area separated but many Hansen calls • Major system/Overland flow in northwest along Mountville, Inverness, Queensdale • Concession St to Mountain Park Ave showing HGL issues, minimal Hansen records • No other major issues (relatively low priority at catchment scale) • Any new potential outlets to RHV subject to consultation and agreement with indigenous communities	

CSO Catchment Mountain

Summary of Potential Options

1. Separate Mohawk from Upper Ottawa to RHV
   a. (MT-1a) New storm sewer to Buttermilk Falls via Mohawk Sports Park
   b. (MT-1b) Consider LID/Storage in Mohawk Sports Park
   c. (MT-1c) Separated Sewer on Mohawk Rd (Upper Ottawa to Mountain Brow)
   d. (MT-1d) Extend storm sewer on Mohawk Rd to Upper Sherman
   e. (MT-1e) Alternative Storm sewer trunk to Red Hill via Upper Ottawa
2. Separate Storm Outfall Study for Mountain catchment
   a. (MT-2a) Via Fennel Ave
   b. (MT-2b) Via High St
3. Major System Study north of Fennel Ave E (subcatchments 24, 22,18 and 17)
   a. Explore need for CSO/overland storage in parks and road right-of-way in this area (as per FDMSS)
   b. Flow monitoring to validate/calibrate modelling
   c. Local model update to determine benefits to downstream properties and Greenhill CSO

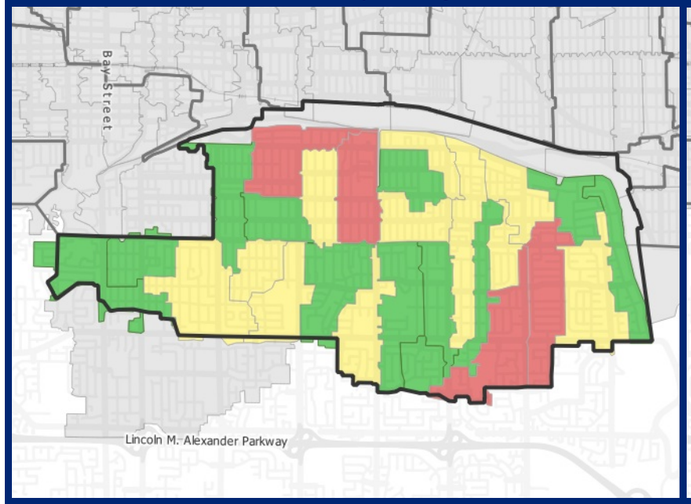
Storm sewer outfall impact study to Red Hill Valley with consultation with the Joint Stewardship Board to highlight the balance of CSOs versus new storm outfalls **(Further Study)**



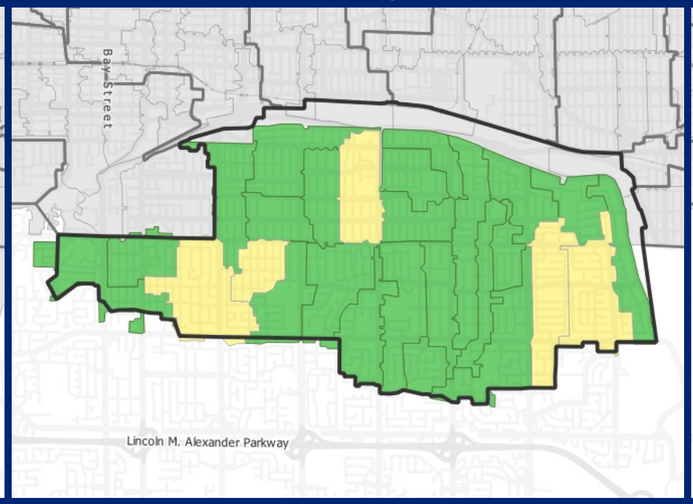
CSO Catchment Mountain							
Option Evaluation							
Option	**Advantages**	**Disadvantages**	**System Benefit**	**Cost**	**Outcome**	**Priority and Timeline**	**Pre-Requisite Works**
1. a) New storm sewer from Mohawk Road to Buttermilk Falls via Mohawk Sports Park (MT-1a)	• Provide outlet for majority of already largely separated local areas south of Mohawk Rd • Benefits not only areas south of Mohawk (reduced surcharging) but also areas north of Mohawk due to reduced combined sewer inflows	• Buttermilk Falls outlet needs further study and approval • High cost and likely long term implementation • Construction within City park lands would facilitate works	System Wide Solution Substantial Benefit	$13.4M	Recommended	Medium Priority Medium Term (5 – 10 Years)	STR-2 RS-OUT2
1. b) LID or Storage within Mohawk Sports Park to mitigate flow increases (MT-1b)	• Potential to offset impacts of additional flows to receiver and promote increased infiltration if feasible • Flexibility and ease of working in public area off the roadway	• Infiltration feasibility in area of high bedrock (escarpment) and need for rock excavation to be confirmed	System Wide Solution Moderate Benefit	$5.0M	Further Study	Medium Priority Medium Term (5 – 10 Years)	None
1. c) Separated storm sewer on Mohawk Road (Upper Ottawa to Mountain Brow) (MT-1c)	• Extension of same benefits outlined in 1a	• Need outlet to Red Hill first • Mohawk Road recently reconstructed, likely longer term time frame • High cost and timeframe, need for tunnelling vs open cut to be confirmed	System Wide Solution Substantial Benefit	$19.8M	Recommended	Low Priority Long Term (10 – 20 Years)	None
1. d) Extend storm sewer on Mohawk Road to Upper Sherman (MT-1d)	• Extension of same benefits outlined in 1a	• Similar issues to 1c	System Wide Solution Substantial Benefit	$14.9M	Recommended	Low Priority Long Term (10 – 20 Years)	None

CSO Catchment Mountain							
1. e) Storm sewer trunk to Red Hill via Upper Ottawa (MT-1e)	• Avoids an outfall to Buttermilk Falls, which may be more sensitive • Avoids work on Mohawk Road which was recently reconstructed	• Longer route on arterial roadway, would require tunnelling – costly • Potential impact to "juggernaut" trunk sewer	System Wide Solution Substantial Benefit		Screened Out		
2. a) Potential storm sewer trunk for Mountain via Fennell Ave (MT-2a)	• In line with the existing path of combined sewer trunk for the mountain • Allows for the potential future separation of some or all of the mountain area depending on sizing criteria • High potential benefit to surcharging and downstream CSO reduction	• Substantial cost and complexity • Additional cost for balance of trunk on Greenhill to RHC (Roseland) • Need requires further assessment depending on benefit to Mountain and downstream CSOs	System Wide Solution Substantial Benefit	$13.1M (including drop structure)	Further Study	Low Priority Long Term (10 – 20 Years)	STR-2
2. b) Potential storm sewer trunk for Mountain via High Street (MT-2b)	• Similar overall benefits to 2a • Avoids potential conflict with existing infrastructure along Fennell and drop along the escarpment	• High complexity of escarpment drop structure • Would require corresponding development of trunk sewer infrastructure downstream for long distance, likely not feasible or cost effective • Need requires further assessment depending on benefit to Mountain and downstream CSOs	System Wide Solution Substantial Benefit		Screened Out		
Managed Sewer Separation (MT-SWR)	• Removes storm flows from combined sewer system, reduced surcharging potential • Reduced CSO overflow potential • Reduced WWTP treatment volume	• Additional infrastructure (longer term O&M requirements) • Additional costs	System Wide Solution High Benefit	$26.7M	Recommended	Medium Priority Future Planning (20+ Years)	None

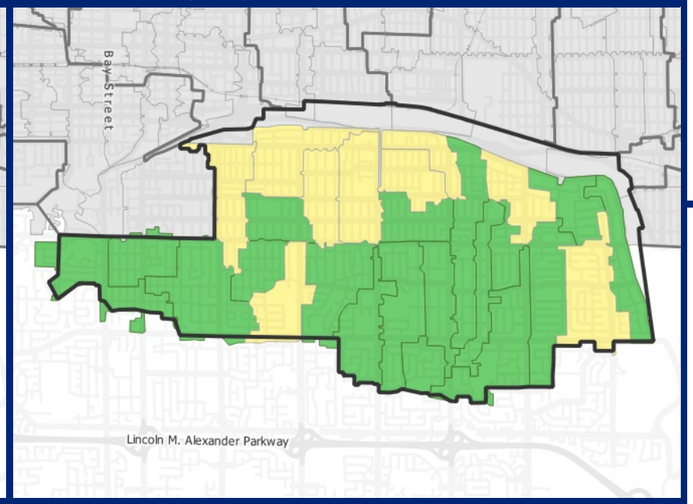
Overall Priority Ranking



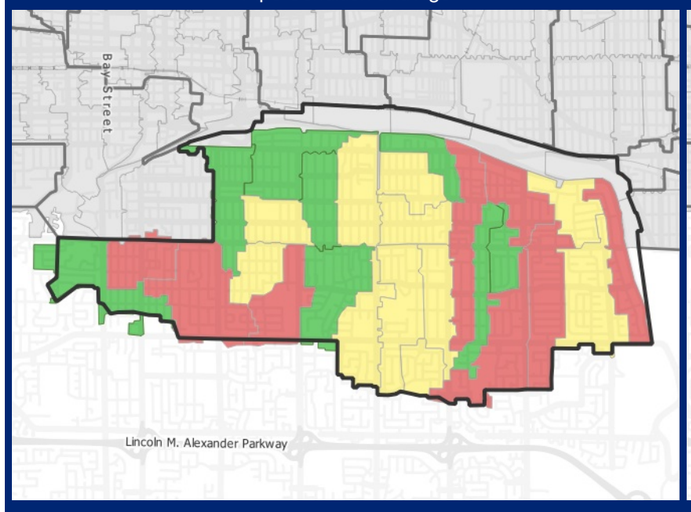
Hansen Flooding Calls



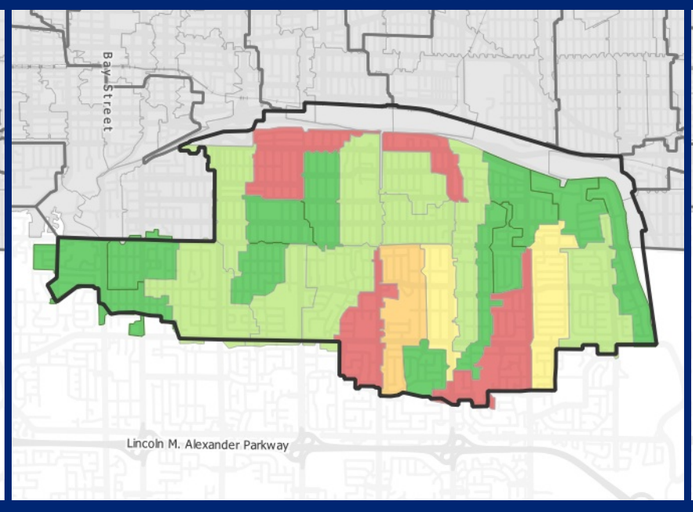
Pipe Depth for Residential Connections



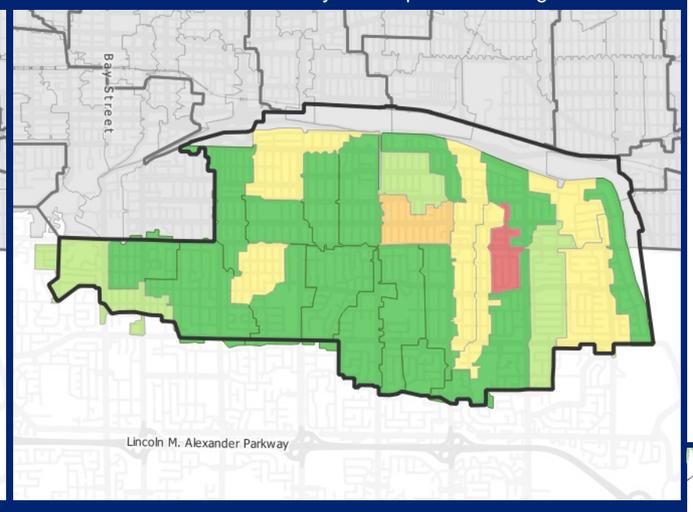
Pipe Condition and Age



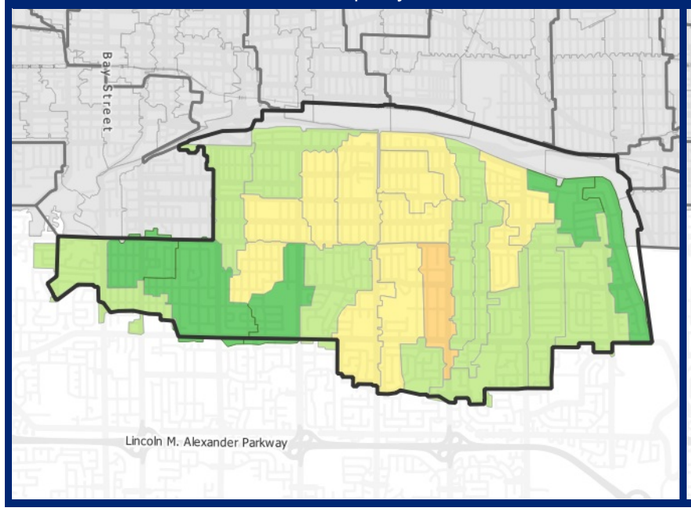
HGL to Basement Elevation of 1.8 m



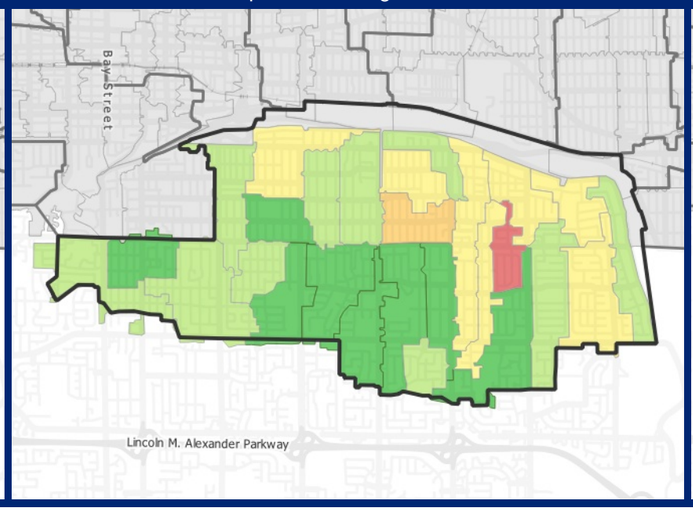
Overland Connectivity with Depression Storage



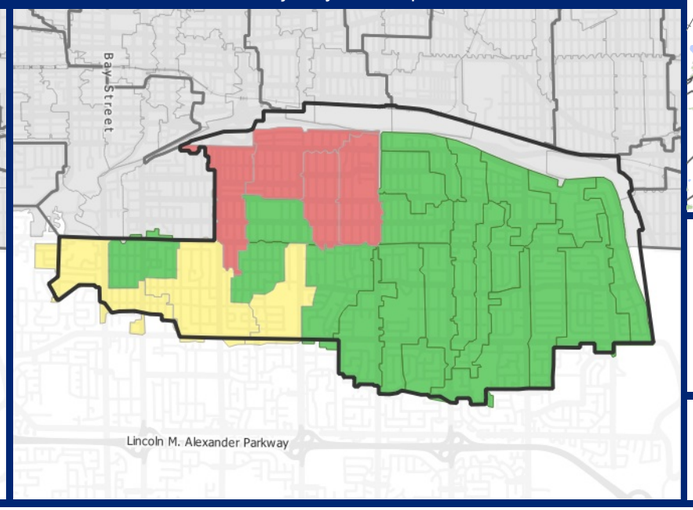
Inlet Capacity



Depression Storage - 0.3 m



Modeled Major System Depth - 0.15 m



Hamilton

Flooding and Drainage Master Servicing Study (FDMSS)

Priority

- 1 - Low
- 2 - Medium-Low
- 3 - Medium
- 4 - Medium-High
- 5 - High
- Other catchments
- Catchment Boundary
- Railways
- Highway/Parkway
- Arterial and Collector
- Local Streets
- Waterbody

N

0 0.5 1 km

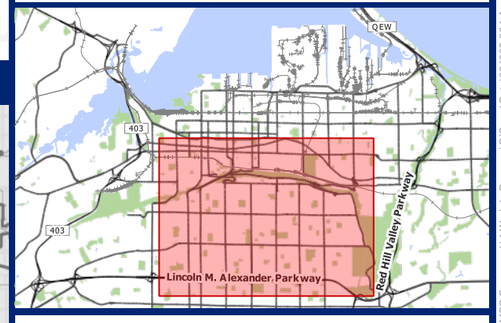


Figure 24 of 24

Mountain

Results Analysis

BluePlan ENGINEERING

September, 2021
621085-004
Projection EPSG:26917

Document Path: W:\Hamilton\621000\621085 Hamilton FDMSS Framework\4 Work In Progress\GIS and Data\621085-004-Analysis Results.qgz

APPENDIX B: SUMMARY OF RAINFALL EVENTS FOR HANSEN FILTERING

Rain Gauge Selection:

The City of Hamilton provided consulting team with shapefiles including the locations of the City's (and external monitoring contractors/consultants) rain gauges. Three (3) rain gauges were selected due to the high-level scope of the project and time constraints. The selection was based on relative coverage of the combined sewer system. The following rain gauges were used in the rainfall analysis:

Table B1: Rain gauge locations

Rain Gauge ID	Location	Dataset Timeframe
RG003	Dalewood School	2011 - 2021
RG007	Cathy Weaver School	2011 – 2021
RG032	Sackville Hill Centre	2011 – 2011

The data was processed to determine unique rainfall events based on a 24-hour inter-event time. **Table B2** provides a summary of the rainfall events for each rain gauge using the 24-hour inter-event time. Note, some events are observed across multiple rain gauges, while some events are only observed at a single rain gauge.

Event_No	Client_Name	PrecipitationStation_Name	StartOfRain	EndOfRain	Duration_ddhhmm	TotalPrecip_mm	Peak1hrIntensity_mm_hr
1	City of Hamilton	RG032	1/1/2011 1:25	1/1/2011 17:10	0:15:45	129.6	31.2
1	City of Hamilton	RG003	1/1/2011 7:30	1/1/2011 17:05	0:09:35	115.2	28.8
1	City of Hamilton	RG007	1/1/2011 7:35	1/1/2011 17:10	0:09:35	98.4	26.4
2	City of Hamilton	RG003	1/17/2011 14:45	1/18/2011 20:25	1:05:40	79.2	14.4
2	City of Hamilton	RG007	1/17/2011 14:55	1/18/2011 20:35	1:05:40	57.6	14.4
2	City of Hamilton	RG032	1/18/2011 9:40	1/18/2011 21:55	0:12:15	57.6	14.4
3	City of Hamilton	RG003	2/6/2011 11:35	2/7/2011 16:55	1:05:20	40.8	26.4
3	City of Hamilton	RG007	2/6/2011 11:40	2/6/2011 12:30	0:00:50	36	36
3	City of Hamilton	RG032	2/6/2011 12:50	2/7/2011 12:05	0:23:15	50.4	36
4	City of Hamilton	RG003	2/17/2011 7:30	2/19/2011 18:00	2:10:30	153.6	45.6
5	City of Hamilton	RG003	2/25/2011 12:45	2/25/2011 15:00	0:02:15	33.6	28.8
5	City of Hamilton	RG007	2/25/2011 13:05	2/25/2011 13:55	0:00:50	26.4	26.4
6	City of Hamilton	RG032	2/26/2011 17:35	2/28/2011 9:20	1:15:45	264	93.6
6	City of Hamilton	RG007	2/27/2011 10:00	2/28/2011 17:25	1:07:25	252	93.6
6	City of Hamilton	RG003	2/27/2011 11:05	2/28/2011 11:20	1:00:15	292.8	88.8
7	City of Hamilton	RG003	5/13/2011 20:30	5/18/2011 23:40	5:03:10	81.4	8.2
7	City of Hamilton	RG032	5/13/2011 20:30	5/19/2011 10:05	5:13:35	91	8.8
7	City of Hamilton	RG007	5/13/2011 20:35	5/16/2011 12:05	2:15:30	52.8	7.2
8	City of Hamilton	RG007	6/4/2011 10:25	6/5/2011 8:30	0:22:05	23.8	21.6
9	City of Hamilton	RG007	6/7/2011 4:15	6/8/2011 1:50	0:21:35	32.2	27.2
9	City of Hamilton	RG003	6/7/2011 4:55	6/8/2011 2:20	0:21:25	29.6	25
10	City of Hamilton	RG007	8/24/2011 21:20	8/25/2011 1:20	0:04:00	23.4	22.2
11	City of Hamilton	RG003	10/18/2011 13:55	10/21/2011 15:55	3:02:00	112.4	18.2
11	City of Hamilton	RG032	10/18/2011 23:30	10/21/2011 1:25	2:01:55	91.6	13.8
11	City of Hamilton	RG007	10/18/2011 23:35	10/21/2011 14:50	2:15:15	89.4	12.8
12	City of Hamilton	RG003	11/27/2011 9:10	12/2/2011 10:30	5:01:20	60	7.4
12	City of Hamilton	RG032	11/27/2011 9:15	11/30/2011 13:20	3:04:05	65.2	9.2
12	City of Hamilton	RG007	11/27/2011 9:25	11/30/2011 12:40	3:03:15	59	7.2
13	City of Hamilton	RG032	7/13/2012 13:35	7/13/2012 18:10	0:04:35	27.8	27.6
14	City of Hamilton	RG032	7/22/2012 15:50	7/22/2012 18:35	0:02:45	35	23.8
15	City of Hamilton	RG003	10/26/2012 15:35	11/1/2012 2:00	5:10:25	72.2	3.8
16	City of Hamilton	RG003	1/11/2013 4:10	1/14/2013 6:20	3:02:10	55	19.2
17	City of Hamilton	RG007	4/8/2013 14:55	4/12/2013 18:55	4:04:00	90.8	10.4
18	City of Hamilton	RG003	5/28/2013 4:45	5/29/2013 19:35	1:14:50	48.2	22
18	City of Hamilton	RG007	5/28/2013 5:00	5/30/2013 10:30	2:05:30	43.4	20.8
19	City of Hamilton	RG032	6/10/2013 6:45	6/14/2013 1:25	3:18:40	53.8	8.6
20	City of Hamilton	RG003	7/18/2013 23:55	7/20/2013 2:40	1:02:45	57.8	14.2
20	City of Hamilton	RG007	7/18/2013 23:55	7/20/2013 2:40	1:02:45	57.6	14.4
21	City of Hamilton	RG003	5/12/2014 21:20	5/16/2014 3:40	3:06:20	64.4	21
21	City of Hamilton	RG032	5/13/2014 1:10	5/16/2014 3:50	3:02:40	66.2	19.2
22	City of Hamilton	RG007	5/28/2014 5:00	5/30/2014 10:30	2:05:30	43.4	20.8
23	City of Hamilton	RG003	7/7/2014 2:55	7/8/2014 20:00	1:17:05	57.4	18.2
23	City of Hamilton	RG007	7/7/2014 3:10	7/8/2014 20:05	1:16:55	58	15.4
23	City of Hamilton	RG032	7/7/2014 3:10	7/9/2014 8:40	2:05:30	63.2	21.8
24	City of Hamilton	RG032	5/29/2015 23:30	5/31/2015 21:20	1:21:50	54.6	7.8
24	City of Hamilton	RG007	5/30/2015 15:05	6/1/2015 0:20	1:09:15	55.2	9.6
25	City of Hamilton	RG032	6/27/2015 8:55	6/29/2015 11:00	2:02:05	69.4	7
25	City of Hamilton	RG003	6/27/2015 9:30	6/29/2015 10:05	2:00:35	68	9.4
25	City of Hamilton	RG007	6/27/2015 9:35	6/29/2015 10:00	2:00:25	61.6	7.8
26	City of Hamilton	RG007	10/28/2015 2:15	10/29/2015 6:00	1:03:45	50.2	9.2
27	City of Hamilton	RG003	3/22/2016 18:30	3/25/2016 7:40	2:13:10	51.8	6
28	City of Hamilton	RG032	3/31/2016 1:00	4/7/2016 8:10	7:07:10	55	9.8
29	City of Hamilton	RG032	8/8/2016 17:25	8/17/2016 10:30	8:17:05	67.4	18
30	City of Hamilton	RG003	8/24/2016 23:35	8/26/2016 7:00	1:07:25	50	22.2
31	City of Hamilton	RG032	11/19/2016 10:20	11/20/2016 14:20	1:04:00	32.8	26.4
32	City of Hamilton	RG032	12/20/2016 11:00	12/21/2016 7:45	0:20:45	70	28.6
33	City of Hamilton	RG032	12/29/2016 10:00	1/6/2017 8:45	7:22:45	92	29.8
34	City of Hamilton	RG007	4/19/2017 8:15	4/20/2017 21:55	1:13:40	73.2	14
34	City of Hamilton	RG003	4/19/2017 10:20	4/21/2017 17:35	2:07:15	52.8	14.4
35	City of Hamilton	RG003	4/30/2017 4:40	5/2/2017 15:00	2:10:20	56.4	15.4
36	City of Hamilton	RG032	5/4/2017 11:05	5/7/2017 12:00	3:00:55	70	4.6
36	City of Hamilton	RG003	5/4/2017 11:20	5/7/2017 2:25	2:15:05	59.4	4.8
36	City of Hamilton	RG007	5/4/2017 11:35	5/7/2017 15:00	3:03:25	66.8	4.2
37	City of Hamilton	RG032	6/22/2017 10:10	7/13/2017 10:30	21:00:20	127.6	12.2
38	City of Hamilton	RG003	7/20/2017 9:35	7/20/2017 11:30	0:01:55	31.4	24.4
38	City of Hamilton	RG007	7/20/2017 9:35	7/20/2017 11:30	0:01:55	36.2	22.8
39	City of Hamilton	RG032	8/6/2017 11:20	8/22/2017 17:20	16:06:00	79.2	33.6
40	City of Hamilton	RG032	10/1/2017 0:00	10/12/2017 9:20	11:09:20	72.6	7.6
41	City of Hamilton	RG032	3/31/2018 16:25	4/5/2018 7:20	4:14:55	59	10.8
42	City of Hamilton	RG003	4/11/2018 13:35	4/15/2018 22:35	4:09:00	61.6	8
42	City of Hamilton	RG032	4/13/2018 17:50	4/16/2018 20:00	3:02:10	71.4	6.6
42	City of Hamilton	RG007	4/15/2018 10:20	4/17/2018 2:00	1:15:40	66	6
43	City of Hamilton	RG032	7/14/2018 6:30	8/31/2018 17:15	48:10:45	138.2	11.4
43	City of Hamilton	RG007	8/16/2018 10:40	8/18/2018 5:15	1:18:35	45.8	23
44	City of Hamilton	RG003	10/30/2018 22:25	11/2/2018 18:40	2:20:15	58.8	5.4
44	City of Hamilton	RG007	10/30/2018 22:35	11/3/2018 6:15	3:07:40	59.6	6.6
45	City of Hamilton	RG032	4/22/2019 12:05	5/1/2019 18:55	9:06:50	62.2	7
46	City of Hamilton	RG032	7/5/2019 17:45	7/7/2019 10:00	1:16:15	84.8	37.4
46	City of Hamilton	RG003	7/5/2019 17:50	7/6/2019 23:00	1:05:10	50.2	23.6
47	City of Hamilton	RG003	9/10/2019 20:55	9/12/2019 17:00	1:20:05	44.8	23.6
48	City of Hamilton	RG032	1/5/2020 13:25	1/12/2020 5:10	6:15:45	66.6	13.8
48	City of Hamilton	RG007	1/10/2020 1:45	1/12/2020 6:40	2:04:55	64.4	7.4
48	City of Hamilton	RG003	1/10/2020 5:40	1/12/2020 6:35	2:00:55	67.2	6.8
49	City of Hamilton	RG003	7/10/2020 18:40	7/11/2020 15:45	0:21:05	31.6	27.6
50	City of Hamilton	RG032	7/30/2020 3:35	8/31/2020 18:40	8:15:05	90.6	15
50	City of Hamilton	RG003	8/3/2020 16:10	8/5/2020 10:20	1:18:10	46.2	30.4

APPENDIX C: PROJECT COSTING AND CAPITAL PROGRAM

Project Costing Framework:

To begin, projects are defined as either a sewer project or a storage/LID project. For sewer projects, the project classification is determined as either a local sewer, a collector sewer, or a large trunk sewer. The size and associated unit cost are applied using the following relationship:

Table C1: Sewer size and unit rates based on classification

Sewer Classification	Average Sewer Size (related to classification) (mm)	Unit Cost ($/m)
Large Trunk	2400	$8,555
Trunk	1500	$5,077
Collector	900	$3,559
Local	450	$2,153

For non-sewer projects, the type of project and associated unit cost are determined from the following table:

Table C2: Non-sewer project classification and unit rates

LID BMP/ Storage Classification	Units	Unit Cost ($)
LID BMP (linear)	m	$600
Underground storage (road)	m^3	$1,000
Underground storage (boulevard/vegetation)	m^3	$750
Above-ground storage	m^3	$200
Superpipe	m	$10,000
Inlet Control Devices	m	$50
Additional Inlets (catchbasins)	#	$200
Re-Grading and Paving	m	$2,000

For sewer projects, the length is then determined through GIS mapping measurement to determine an overall installation cost. For non-sewer projects, the overall installation cost is determined though either storage requirement estimation or length of feature as measured in GIS mapping. If there are both sewer components and non-sewer components associated with a project option, these are added to create the total installation cost ❶.

The location of the project is then selected from the following subset of potential project locations:

- Boulevard/Open Space
- Local or Collector Road
- Arterial or Congested / High Value Area
- Arterial and Congested / High Value Area

This determines the required construction uplift cost ❷ to be applied to the installation cost utilizing the following relationship:

Table C3: Construction uplift relationship to project location

Installation Location / Road Type	Construction Uplift
Boulevard/Open Space	0%
Local or Collector Road	20%
Arterial or Congested / High-value Area	30%
Arterial and Congested / High-value Area	35%

The total base cost ❸ is determined as follows:

❶ + ❷ = ❸

An additional construction cost ❹ is applied to the base cost ❸ depending on project complexity / uncertainty. This accounts for costs not covered under the base construction cost or uplift, such as mobilization, traffic management, inspections, etc. The following table shows the relationship between project complexity and allowance as a percentage of the total base cost:

Table C4: Additional construction costs based on project complexity / uncertainty

Project Complexity / Uncertainty Contingency	Additional Construction Costs
Low	10%
Medium	15%
High	20%

The total construction cost ❺ then becomes:

❸ + ❹ = ❺

The cost for consulting, study, design, and contract administration ❻ is determined based on the total construction cost ❺ using the following relationship:

Table C5: Consultant study, design, contract administration costs based on total construction costs

Construction costs	Consultant Study/Design/CA
<$10M	15%
$10M - $50M	12%
$50M +	10%

The overall project contingency ❼ is also determined based on the project complexity / uncertainty using the following relationship:

Table C6: Project contingency based on project complexity / uncertainty

Project Complexity / Uncertainty Contingency	Project Contingency
Low	11.5%
Medium	18.0%
High	29.0%

The total project cost ❽ is then determined as:

❺ + ❻ + ❼ = ❽

Table C10 provides a summary of the costing calculations by project. **Table C11** provides a summary of the proposed study costs. **Table C12** provides a summary of the anticipated implementation schedule along with ties to applicable prerequisite studies for each project.

Managed Sewer Separation Costing Framework:

To begin, the CSO Catchment sewer separation costs and model system lengths from the Draft FDMSS (Aquafor Beech, 2019) are carried forward for reference. The approximate length of separation is estimated using the following formula, utilizing the Draft FDMSS (Aquafor Beech, 2019) existing conditions model:

$$Approximate\ Length\ of\ Separation\ (m) = SAN + COMB - STM - RLF$$

The unit cost of separation for each CSO Catchment was then calculated using the following relationship:

$$Unit\ Cost\ (\$/m) = CSO\ Catchment\ Separation\ Cost\ (\$)\ /\ Approximate\ Length\ of\ Separation\ (m)$$

The results of this extrapolation are presented in **Table C7**.

Table C7: Draft FDMSS (Aquafor Beech, 2019) estimated cost of separation by CSO Catchment with extrapolated approximate length of existing separation and unit cost of separation

CSO Catchment	Approximate Length of Separation (m)	Draft FDMSS Cost Estimate for Separation ($)	Unit Cost ($/m)
Aberdeen Hilcrest CSO	4,025	$ 9,500,000	$ 2,360
Ainslie Wood CSO	21,842	$ 18,111,000	$ 829
Bayfront CSO	17,113	$ 18,454,000	$ 1,078
Birch CSO	17,338	$ 12,847,000	$ 741
Churchill Park CSO	8,674	$ 15,042,000	$ 1,734
Dunn Woodward CSO	10,337	$ 20,505,000	$ 1,984
Eastwood Park CSO	5,278	$ 117,000	$ 22
Gage CSO	33,157	$ 57,323,000	$ 1,729
James CSO	5,390	$ 5,156,000	$ 957
Kenilworth CSO	27,628	$ 46,984,000	$ 1,701
Lawrence CSO	6,429	$ 18,722,000	$ 2,912
Rosedale CSO	9,192	$ 28,871,000	$ 3,141
Main-King-1 CSO	27,922	$ 35,475,000	$ 1,271
Main-King-2 CSO	3,854	$ 1,780,000	$ 462
McMaster CSO	5,865	$ -	$ -
Melvin CSO	5,822	$ 8,144,000	$ 1,399
Mountain CSO	117,545	$ 136,866,000	$ 1,164
Ottawa CSO	3,459	$ 5,477,000	$ 1,583
Parkdale CSO	8,748	$ 18,000,000	$ 2,057
Queenston CSO	2,669	$ 5,289,000	$ 1,982
Strathearne CSO	32,384	$ 28,871,000	$ 892
Wellington CSO	33,509	$ 187,056,000	$ 5,582
Wentworth CSO	27,866	$ 40,834,000	$ 1,465
Westdale CSO	14,713	$ 2,003,000	$ 136

The average unit cost calculated across all CSO Catchments presented in **Table C7** is **$ 1,549/m**. The extrapolated Draft FDMSS (Aquafor Beech, 2019) unit costs for each CSO Catchment were compared against the average unit cost calculated across all CSO Catchments. Outlier CSO Catchments (individual CSO Catchment extrapolated unit costs <60% or >200% of the average unit cost) were recalculated using the average unit cost of $1,549/m. The results of the updated CSO Catchment estimated costs for separation are provided in **Table C8**. Shaded rows indicated costing has been recalculated using the above methodology.

Table C8: Updated estimated cost of separation by CSO Catchment with extrapolated approximate length of existing separation and unit cost of separation

CSO Catchment	Approximate Length of Separation (m)	Draft FDMSS Cost Estimate for Separation ($)	Unit Cost ($/m)
Aberdeen Hilcrest CSO	4,025	$ 9,500,000	$ 2,360
Ainslie Wood CSO	21,842	$ 33,838,201	$ 1,549
Bayfront CSO	17,113	$ 18,454,000	$ 1,078
Birch CSO	17,338	$ 26,860,187	$ 1,549
Churchill Park CSO	8,674	$ 15,042,000	$ 1,734
Dunn Woodward CSO	10,337	$ 20,505,000	$ 1,984
Eastwood Park CSO	5,278	$ 8,176,734	$ 1,549
Gage CSO	33,157	$ 57,323,000	$ 1,729
James CSO	5,390	$ 5,156,000	$ 957
Kenilworth CSO	27,628	$ 46,984,000	$ 1,701
Lawrence CSO	6,429	$ 18,722,000	$ 2,912
Rosedale CSO	9,192	$ 14,239,616	$ 1,549
Main-King-1 CSO	27,922	$ 35,475,000	$ 1,271
Main-King-2 CSO	3,854	$ 5,970,323	$ 1,549
McMaster CSO	5,865	$ 9,085,793	$ 1,549
Melvin CSO	5,822	$ 8,144,000	$ 1,399
Mountain CSO	117,545	$ 136,866,000	$ 1,164
Ottawa CSO	3,459	$ 5,477,000	$ 1,583
Parkdale CSO	8,748	$ 18,000,000	$ 2,057
Queenston CSO	2,669	$ 5,289,000	$ 1,982
Strathearne CSO	32,384	$ 50,169,882	$ 1,549
Wellington CSO	33,509	$ 51,912,499	$ 1,549
Wentworth CSO	27,866	$ 40,834,000	$ 1,465
Westdale CSO	14,713	$ 22,793,910	$ 1,549

Table C8 presents the estimated cost of separation for each CSO Catchment; however, it does not account for the costs associated with the non-"Managed Sewer Separation" projects. The lengths of these projects will need to be subtracted from the approximate length of separation for each CSO Catchment, with an adjustment factor then applied to the estimated cost for separation using the following relationship:

$$Adjustment\ Factor\ =\ 1 - (Capital\ Project\ Length\ (m)\ /\ Approximate\ Length\ of\ Separation\ (m))$$

The total cost for "Managed Sewer Separation" is then calculated as:

$$Managed\ Sewer\ Separation\ Cost\ (\$)\ =\ Draft\ FDMSS\ Cost\ (\$)\ *\ Adjustment\ Factor$$

The results of this adjustment are presented in **Table C9**.

Table C9: "Managed Sewer Separation" costs

CSO Catchment	Approximate Length of Separation (m)	Draft FDMSS Cost Estimate for Separation ($)	Approximate Length of Framework Capital Projects (m)	Adjustment Factor	Managed Sewer Separation Cost ($)
Aberdeen Hilcrest CSO	4,025	$ 9,500,000	2,840	0.29	$ 2,797,548
Ainslie Wood CSO	21,842	$ 33,838,201	12,100	0.45	$ 15,093,622
Bayfront CSO	17,113	$ 18,454,000	-	-	$ 18,454,000
Birch CSO	17,338	$ 26,860,187	950	0.95	$ 25,388,265
Churchill Park CSO	8,674	$ 15,042,000	600	0.93	$ 14,001,558
Dunn Woodward CSO	10,337	$ 20,505,000	1,030	0.90	$ 18,461,899
Eastwood Park CSO	5,278	$ 8,176,734	-	-	$ 8,180,000
Gage CSO	33,157	$ 57,323,000	1,000	0.97	$ 55,594,143
James CSO	5,390	$ 5,156,000	-	-	$ 5,156,000
Kenilworth CSO	27,628	$ 46,984,000	2,975	0.89	$ 41,924,714
Lawrence CSO	6,429	$ 18,722,000	1,515	0.76	$ 14,310,276
Rosedale CSO	9,192	$ 14,239,616	570	0.94	$ 13,356,929
Main-King-1 CSO	27,922	$ 35,475,000	10,590	0.62	$ 22,020,351
Main-King-2 CSO	3,854	$ 5,970,323	-	-	$ 5,970,000
McMaster CSO	5,865	$ 9,085,793	-	-	$ 9,090,000
Melvin CSO	5,822	$ 8,144,000	115	0.98	$ 7,983,132
Mountain CSO[1]	117,545	$ 136,866,000	-	-	$ 7,650,000
Ottawa CSO	3,459	$ 5,477,000	450	0.87	$ 4,764,480
Parkdale CSO	8,748	$ 18,000,000	1,465	0.83	$ 14,985,767
Queenston CSO	2,669	$ 5,289,000	650	0.76	$ 4,000,885
Strathearne CSO	32,384	$ 50,169,882	3,400	0.90	$ 44,902,690
Wellington CSO	33,509	$ 51,912,499	4,810	0.86	$ 44,458,682
Wentworth CSO	27,866	$ 40,834,000	3,470	0.88	$ 35,749,144
Westdale CSO	14,713	$ 22,793,910	5,830	0.60	$ 13,759,684

Note 1: Mountain CSO Catchment "Managed Separation Costs" estimated only for area south of Mohawk Road

Table C10: Summary of Capital Program Costs

Catchment Projects				Sewer Costing					LID / Storage Costing			
CSO Catchment	**Catchment Priority**	**Option Number**	**Option Description**	**Sewer Classification**	**Sewer Size (related to classification) (mm)**	**Unit Cost ($)**	**Length (m)**	**Sewer Cost ($)**	**LID / Storage Classification**	**Unit Cost ($)**	**Length OR Volume (m OR m3)**	**LID Cost ($)**
		AW-1	Creek separation along Iona Ave	Large Trunk	2400	$ 8,555	1,440	$ 12,319,200		$ -		$ -
		AW-2	Sewer separation within Ainslie Wood south*	Local	450	$ 2,153	5,005	$ 10,775,765	LID (linear)	$ 600	5,005	$ 3,003,000
		AW-3a	Sewer separation within Ainslie Wood north with connection to McMaster catchment*	Local	450	$ 2,153	1,925	$ 4,144,525	LID (linear)	$ 600	1,925	$ 1,155,000
		AW-3b	Collector sewer for sewer separation within Ainslie Wood north	Collector	900	$ 3,559	760	$ 2,704,840	LID (linear)	$ 600	760	$ 456,000
		AW-4	Major system stormwater diversion to Alexander Park		-	$ -		$ -	Above-ground storage	$ 200	6,000	$ 1,200,000
		AW-OUT	Implementation of new outfall to Chedoke Creek		-	$ -		$ -		$ -		$ -
Ainslie Wood	**High**	AW-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		MCM-1	Upgrade of trunk sewer to outlet to accommodate Ainslie Wood sewer separation	Trunk	1500	$ 5,077	500	$ 2,538,500		$ -		$ -
		MCM-OUT	Implementation of new outfall to Cootes Paradise		-	$ -		$ -		$ -		$ -
McMaster	**Medium**	MCM-SWR	Complete managed sewer separation within catchment		-	$ -		$ -		$ -		$ -
		WD-1a	North end sewer separation*	Local	450	$ 2,153	1,687	$ 3,632,111	LID (linear)	$ 600	1,687	$ 1,012,200
		WD-1b	Collector sewer for north end sewer separation	Collector	900	$ 3,559	530	$ 1,886,270	LID (linear)	$ 600	530	$ 318,000
		WD-2	Dalewood Middle School underground storage		-	$ -		$ -		$ -		$ -
		WD-3	Westdale Secondary School Storage		-	$ -		$ -	Underground storage (boulevard/vegitation)	$ 750	10,000	$ 7,500,000
		WD-4a	South end sewer separation*	Local	450	$ 2,153	1,596	$ 3,436,188	LID (linear)	$ 600	1,596	$ 957,600
		WD-4b	Collector sewer for south end sewer separation	Collector	900	$ 3,559	610	$ 2,170,990	LID (linear)	$ 600	610	$ 366,000
		WD-5	Deepen local sewers during asset renewal**	Local	450	$ 2,153	0	$ -	LID (linear)	$ 600	0	$ -
		WD-OUT1	Implementation of new outfall to Cootes Paradise		-	$ -		$ -		$ -		$ -
		WD-OUT2	Implementation of new outfall to Chedoke Creek		-	$ -		$ -		$ -		$ -
Westdale	**High**	WD-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		CP-1	New proposed LID - FIX SHEET		-	$ -		$ -	Underground storage (boulevard/vegitation)	$ 750	2,000	$ 1,500,000
		CP-2	Superpipe storage		-	$ -		$ -	Superpipe	$ 10,000	600	$ 6,000,000
		CP-OUT	Implementation of new outfall to Chedoke Creek		-	$ -		$ -		$ -		$ -
Churchill Park	**High**	CP-SWR	Complete sewer separation		-	$ -		$ -		$ -		$ -
		MK1-1a	Hill St park storage		-	$ -		$ -	Above-ground storage	$ 200	1,800	$ 360,000
		MK1-1b	Upstream major system storage (Durand Park)		-	$ -		$ -	Above-ground storage	$ 200	900	$ 180,000
		MK1-2	Trunk sewer upgrades		-	$ -		$ -		$ -		$ -
		MK1-3	Bold St sewer separation	Local	450	$ 2,153	420	$ 904,260	LID (linear)	$ 600	420	$ 252,000
		MK1-4	Managed sewer separation within east end*	Local	450	$ 2,153	7,119	$ 15,327,207	LID (linear)	$ 600	7,119	$ 4,271,400
		MK1-5	Bold St stormwater diversion to Hamilton Amateur Athletic Association Grounds	Collector	900	$ 3,559	250	$ 889,750	Underground storage (boulevard/vegitation)	$ 750	6,000	$ 4,500,000
		MK1-OUT	New outfall to Chedoke Creek		-	$ -		$ -		$ -		$ -
Main-King 1	**High**	MK1-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		MK2-OUT	(Duplication of Main-King 1 Outfall)		-	$ -		$ -		$ -		$ -
Main-King 2	**Low**	MK2-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -
		AH-1a	Sewer separation within Aberdeen Hillcrest - 1*	Local	450	$ 1,507	1,420	$ 2,140,082	LID (linear)	$ 600	1,420	$ 852,000
		AH-1b	Trunk infrastructure for sewer separation within Aberdeen Hillcrest - 1	Trunk	1500	$ 5,077	860	$ 4,366,220	LID (linear)	$ 600	860	$ 516,000
		AH-2	Extension of storm sewer along Aberdeen Ave	Trunk	1500	$ 5,077	560	$ 2,843,120	LID (linear)	$ 600	560	$ 336,000
		AH-OUT	New outfall to Chedoke Creek		-	$ -		$ -		$ -		$ -
Aberdeen Hillcrest	**High**	AH-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		JM-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
James	**Low**	JM-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -
		EP-1	Eastwood Park LID		-	$ -		$ -		$ -		$ -
		EP-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
Eastwood Park	**Low**	EP-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -

Table C10: Summary of Capital Program Costs

Catchment Projects				Sewer Costing					LID / Storage Costing			
CSO Catchment	Catchment Priority	Option Number	Option Description	Sewer Classification	Sewer Size (related to classification) (mm)	Unit Cost ($)	Length (m)	Sewer Cost ($)	LID / Storage Classification	Unit Cost ($)	Length OR Volume (m OR m3)	LID Cost ($)
		BF-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
Bayfront	Low	BF-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -
		WL-1a	Managed sewer separation within existing separated areas	Local	450	$ 2,153	100	$ 215,300		$ -		$ -
		WL-1b	Trunk infrastructure for managed sewer separation within existing separated areas	Trunk	1500	$ 5,077	3,820	$ 19,394,140	LID (linear)	$ 600	3,820	$ 2,292,000
		WL-2	Relief sewer for surface depression	Collector	900	$ 3,559	320	$ 1,138,880		$ -		$ -
		WL-3	Wellington St relief sewer extension	Collector	900	$ 3,559	240	$ 854,160		$ -		$ -
		WL-4	Flow monitoring with potential relief sewer extension	Collector	900	$ 3,559	430	$ 1,530,370		$ -		$ -
		WL-5	Inlet control device implementation		-	$ -		$ -	Inlet Control Devices	$ 50	740	$ 37,000
		WL-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
Wellington	High	WL-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -
		WN-1	Separate northern sewer network*	Local	450	$ 2,153	2,240	$ 4,822,720	LID (linear)	$ 600	2,240	$ 1,344,000
		WN-2	Condition assessment and infrastructure renewal with upsizing**	Local	450	$ 2,153	0	$ -	LID (linear)	$ 600	0	$ -
		WN-3	East Ave N storm sewer	Local	450	$ 2,153	270	$ 581,310	LID (linear)	$ 600	270	$ 162,000
		WN-4a	Asset renewal with managed sewer separation**	Local	450	$ 2,153	0	$ -	LID (linear)	$ 600	0	$ -
		WN-4b	Trunk infrastructure for asset renewal with managed sewer separation**	Trunk	1500	$ 5,077	0	$ -	LID (linear)	$ 600	0	$ -
		WN-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
Wentworth	Medium	WN-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		BR-1	Storm disconnection from relief with upstream overland interception	Lump Sum (LS)	-	-	-	$ 100,000	Additional Inlets	$ 200	10	$ 2,000
		BR-2	Extend relief sewer within Birch to outfall with storm conversion	Large Trunk	2400	$ 8,555	950	$ 8,127,250		$ -		$ -
		BR-3	Construct lift station for underpass flooding	Lump Sum (LS)	-	-	-	$ 5,000,000		$ -		$ -
		BR-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
Birch	Medium	BR-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -
		GG-1	Implement localized recommendations of LEEDS report	Local	450	$ 2,153	1,000	$ 2,153,000	LID (linear)	$ 600	1,000	$ 600,000
		GG-OUT	New outfall to Hamilton Harbour		-	$ -		$ -		$ -		$ -
Gage	High	GG-SWR	Managed sewer separation		-	$ -		$ -		$ -		$ -
		OT-1	ICDs along Dalkeith Ave and Craigmiller Ave	Local	450	$ 2,153	0	$ -	Inlet Control Devices	$ 50	520	$ 26,000
		OT-2a	Complete separation along Grenfell Street (Bayfield to Kenilworth) to existing storm sewer	Collector	900	$ 3,559	450	$ 1,601,550	LID (linear)	$ 600	450	$ 270,000
Ottawa	Medium	OT-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		KN-1	Separation on Edgemont (Lawrence to Main)	Local	450	$ 2,153	600	$ 1,291,800	LID (linear)	$ 600	600	$ 360,000
				Collector	900	$ 3,559	360	$ 1,281,240	LID (linear)	$ 600	360	$ 216,000
		KN-2	Relief Sewer on Kenilworth (Central to Main)	Collector	900	$ 3,559	380	$ 1,352,420	LID (linear)	$ 600	380	$ 228,000
		KN-2a	Sewer Separation on Crosthwaite Street (Central to Main)	Local	450	$ 2,153	380	$ 818,140	LID (linear)	$ 600	380	$ 228,000
		KN-2b	Sewer Separation on Main Street (Kenilworth to Garside)	Collector	900	$ 3,559	160	$ 569,440	LID (linear)	$ 600	160	$ 96,000
		KN-2c	Storm Sewer diversion on Maple Ave	Local	450	$ 2,153	160	$ 344,480	LID (linear)	$ 600	160	$ 96,000
		KN-3	Relief Sewers on Hope and Allan	Local	450	$ 2,153	390	$ 839,670	LID (linear)	$ 600	390	$ 234,000
		KN-4	Overflow connection at Harmony and Britannia	Collector	900	$ 3,559	90	$ 320,310	LID (linear)	$ 600	90	$ 54,000
		KN-4a	Complete sewer separation on Barton (Harmony to Kenilworth)	Trunk	1500	$ 5,077	175	$ 888,475	LID (linear)	$ 600	175	$ 105,000
		KN-5	ICDs on Cope Street from Main to Britannia	Local	450	$ 2,153	0	$ -	Inlet Control Devices	$ 50	660	$ 33,000
		KN-5a	Additional ICDs on adjacent streets (Garside, Cameron, Barons)	Local	450	$ 2,153	0	$ -	Inlet Control Devices	$ 50	2,710	$ 135,500
		KN-6	Sewer Separation on Ellis Ave	Local	450	$ 2,153	370	$ 796,610	LID (linear)	$ 600	370	$ 222,000
		KN-6a	Storage in RT Steel Park	Local	450	$ 2,153	0	$ -	Underground storage (boulevard/vegitation)	$ 750	500	$ 375,000
		KN-7a	Trunk storm sewer on waterworks corridor	Large Trunk	2400	$ 8,555	1,900	$ 16,254,500	LID (linear)	$ 600	1,900	$ 1,140,000
		KN-OUT	(Duplication of Strathearne Outfall)		-	$ -		$ -		$ -		$ -
Kenilworth	Medium	KN-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		ST-1	Trunk storm sewer on Strathearne Ave	Large Trunk	2400	$ 8,555	1,970	$ 16,853,350	LID (linear)	$ 600	0	$ -
		ST-1b	Separation on Barton (Walter to Strathearne)	Large Trunk	2400	$ 8,555	285	$ 2,438,175	LID (linear)	$ 600	285	$ 171,000
		ST-1c	Separation on Vansitmart (Weir to Strathearne)	Local	450	$ 2,153	275	$ 592,075	LID (linear)	$ 600	275	$ 165,000
		ST-2a	Parkdale Park Storage	Local	450	$ 2,153	0	$ -	Above-ground storage	$ 200	4,500	$ 900,000
		ST-2b	Viscount Montgomery PS Storage	Local	450	$ 2,153	0	$ -	Above-ground storage	$ 200	2,100	$ 420,000
		ST-2c	Montgomery Park Storage	Local	450	$ 2,153	0	$ -	Above-ground storage	$ 200	7,500	$ 1,500,000
		ST-2d	Mahoney Park Storage	Local	450	$ 2,153	0	$ -	Above-ground storage	$ 200	9,600	$ 1,920,000
		ST-2e	Fairfield Park Storage	Local	450	$ 2,153	0	$ -	Above-ground storage	$ 200	1,350	$ 270,000
		ST-3	Relief sewers on Queenston and Walter	Collector	900	$ 3,559	190	$ 676,210	LID (linear)	$ 600	190	$ 114,000
				Collector	900	$ 3,559	200	$ 711,800	LID (linear)	$ 600	200	$ 120,000
				Trunk	1500	$ 5,077	210	$ 1,066,170	LID (linear)	$ 600	210	$ 126,000
		ST-4	Maintain culverts over rail line at Division, Cope, Tragina and Weir	Local	450	$ 2,153	410	$ 882,730	LID (linear)	$ 600	0	$ -
		ST-5	Additional inlets along south side of railway - Weir to Strathearne	Local	450	$ 2,153	0	$ -	Additional Inlets	$ 200	235	$ 47,000
		ST-6	Relief sewer on Britannia from Weir to Strathearne	Collector	900	$ 3,559	270	$ 960,930	LID (linear)	$ 600	270	$ 162,000
		ST-OUT	Storm Sewer Outfall to Harbour via Strathearne		-	$ -		$ -		$ -		$ -
Strathearne	High	ST-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -

Table C10: Summary of Capital Program Costs

Catchment Projects				Sewer Costing					LID / Storage Costing			
CSO Catchment	Catchment Priority	Option Number	Option Description	Sewer Classification	Sewer Size (related to classification) (mm)	Unit Cost ($)	Length (m)	Sewer Cost ($)	LID / Storage Classification	Unit Cost ($)	Length OR Volume (m OR m3)	LID Cost ($)
		PK-1	Relief sewers on Mahony and Adeline	Local	450	$ 2,153	380	$ 818,140	LID (linear)	$ 600	380	$ 228,000
		PK-2	Relief sewers on Mead Avenue	Local	450	$ 2,153	455	$ 979,615	LID (linear)	$ 600	455	$ 273,000
		PK-2a	Connection from Mead Avenue to Dunn Ave	Local	450	$ 2,153	180	$ 387,540	LID (linear)	$ 600	180	$ 108,000
		PK-3	Relief sewer or separation on Brighton Ave	Local	450	$ 2,153	450	$ 968,850	LID (linear)	$ 600	450	$ 270,000
Parkdale	High	PK-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		DW-2	New Storm sewer along Brampton Street to Red Hill	Collector	900	$ 3,559	680	$ 2,420,120	LID (linear)	$ 600	680	$ 408,000
		DW-3	ICDs on Rennie Street	Local	450	$ 2,153	0	$ -	Inlet Control Devices	$ 50	801	$ 40,050
		DW-3a	Relief sewer/upgrade on Rennie Street	Collector	900	$ 3,559	325	$ 1,156,675	LID (linear)	$ 600	325	$ 195,000
		DW-4	Separation sewer on Woodward and Glow	Collector	900	$ 3,559	350	$ 1,245,650	LID (linear)	$ 600	350	$ 210,000
				Trunk	1500	$ 5,077	1,000	$ 5,077,000	LID (linear)	$ 600	1,000	$ 600,000
		DW-OUT	Implementation of new outfall to Red Hill via Brampton Street		-	$ -		$ -		$ -		$ -
Dunn-Woodward	Medium	DW-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		ML-1	ICDs along Melvin from Adair to Talbot	Local	450	$ 2,153	0	$ -	Inlet Control Devices	$ 50	945	$ 47,250
		ML-2	ICDS along Glengrove and Armstrong	Local	450	$ 2,153	0	$ -	Inlet Control Devices	$ 50	740	$ 37,000
		ML-3a	Storm sewer along Melvin to Red Hill	Trunk	1500	$ 5,077	115	$ 583,855	LID (linear)	$ 600	115	$ 69,000
		ML-OUT	Implementation of new outfall to Red Hill via Melvin Ave		-	$ -		$ -		$ -		$ -
Melvin	Low	ML-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		QN-1	Relief sewer on Central Ave from Glencarry to Parkdale	Local	450	$ 2,153	90	$ 193,770	LID (linear)	$ 600	90	$ 54,000
		QN-2	Relief sewers or separation on Beland Street	Local	450	$ 2,153	560	$ 1,205,680	LID (linear)	$ 600	560	$ 336,000
		QN-OUT	Implementation of new outfall at Queenston (separation of existing)		-	$ -		$ -		$ -		$ -
Queenston	Medium	QN-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		LW-1	Regrading of Glenholme Avenue	Local	450	$ 2,153	0	$ -	Re-Grading and Paving	$ 2,000	315	$ 630,000
		LW-2	Storm trunk on Lawrence Road from Bettina to Red Hill	Large Trunk	2400	$ 8,555	640	$ 5,475,200	LID (linear)	$ 600	640	$ 384,000
		LW-2a	Storm trunk on Lawrence from Cochrane to Bettina	Large Trunk	2400	$ 8,555	375	$ 3,208,125	LID (linear)	$ 600	375	$ 225,000
		LW-2b	Storm trunk on Cochrane to pick up depressed area on Dunkirk	Trunk	1500	$ 5,077	320	$ 1,624,640	LID (linear)	$ 600	320	$ 192,000
		LW-3	Sewer separation on Glenholme Avenue	Local	450	$ 2,153	180	$ 387,540	LID (linear)	$ 600	180	$ 108,000
		LW-OUT	Implementation of new outfall at Lawrence		-	$ -		$ -		$ -		$ -
Lawrence	Medium	LW-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		RS-1b	Kings Forest SWMF outlet via Whitehouse Road and Kings Forest Park	Local	450	$ 2,153	620	$ 1,334,860	LID (linear)	$ 600	620	$ 372,000
		RS-2	Increased inlet capacity on Dunkirk	Local	450	$ 2,153	0	$ -	Additional Inlets	$ 200	405	$ 81,000
		RS-3	Major system relief sewer on Dunkirk	Local	450	$ 2,153	0	$ -	Re-Grading and Paving	$ 2,000	405	$ 810,000
		RS-4	New storm sewer to Red Hill via Montrose, Erin and Dundonald	Large Trunk	2400	$ 8,555	570	$ 4,876,350	LID (linear)	$ 600	570	$ 342,000
		RS-5	New storm sewer outfall for the Mountain	Large Trunk	2400	$ 8,555	1,030	$ 8,811,650	LID (linear)	$ 600	1,030	$ 618,000
		RS-OUT1	Implementation of new outfall to Red Hill via Dundonald		-	$ -		$ -		$ -		$ -
		RS-OUT2	Implementation of new outfall to Red Hill via Greenhill		-	$ -		$ -		$ -		$ -
Rosedale	High	RW-SWR	Balance of sewer separation		-	$ -		$ -		$ -		$ -
		MT-1a	New storm sewer from Mohawk Road to Buttermilk Falls via Mohawk Sports Park	Large Trunk	2400	$ 8,555	800	$ 6,844,000	LID (linear)	$ 600	0	$ -
		MT-1b	LID or Storage within Mohawk Sports Park to mitigate flow increases	Large Trunk	2400	$ 8,555	0	$ -	Underground storage (boulevard/vegitation)	$ 750	4,000	$ 3,000,000
		MT-1c	Separated storm sewer on Mohawk Road (Upper Ottawa to Mountain Brow)	Trunk	1500	$ 5,077	925	$ 4,696,225	LID (linear)	$ 600	925	$ 555,000
				Large Trunk	2400	$ 8,555	425	$ 3,635,875	LID (linear)	$ 600	425	$ 255,000
		MT-1d	Extend storm sewer on Mohawk Road to Upper Sherman	Local	450	$ 2,153	465	$ 1,001,145	LID (linear)	$ 600	465	$ 279,000
				Collector	900	$ 3,559	510	$ 1,815,090	LID (linear)	$ 600	510	$ 306,000
				Trunk	1500	$ 5,077	615	$ 3,122,355	LID (linear)	$ 600	615	$ 369,000
		MT-2a	Potential storm sewer trunk for Mountain via Fennell Ave	Large Trunk	2400	$ 8,555	150	$ 1,283,250	LID (linear)	$ 600	0	$ -
		MT-OUT1	Implementation of new outfall to Red Hill via Buttermilk Falls		-	$ -		$ -		$ -		$ -
		MT-OUT2	Implementation of new outfall to Red Hill via Greenhill		-	$ -		$ -		$ -		$ -
		MT-SWR	Balance of sewer separation (area south of Mohawk Road only)	Local	450	$ 2,153	1,525	$ 3,283,325	LID (linear)	$ 600	1,525	$ 915,000
Mountain	Medium			Collector	900	$ 3,559	365	$ 1,299,035	LID (linear)	$ 600	365	$ 219,000

* - Sewer separation calculated by taking 70% of combined sewer lengths for specific project areas (to account for approx 30% being upstream lengths not necessary for storm implementation when utilizing sanitary linework/lengths)
** - Capital costing not provided as option implemented during asset renewal
*** - Indicates that the Draft FDMSS sewer separation cost has been adjusted per Appendix C "Managed Sewer Separation Costing"

LID (linear)	$ 29,890,200

Table C10: Summary of Capital Program Costs

Catchment Projects				Contingency / Costing Summary														
CSO Catchment	Catchment Priority	Option Number	Option Description	Project Subtotal ($)	Installation Location / Road Type	Construction Uplift (% of subtotal)	Uplift Cost ($)	Subtotal ($)	Project Complexity	Additional Construction Cost Allowance (%)	Additional Construction Cost ($)	Total Construction Cost ($)	Consulting Engineering Fees (%)	Project Contingency (%)	Adjusted Draft FDMSS (Aquafor Beech, 2019) Separation Cost[1] ($)	Managed Sewer Separation Adjustment Factor	Total ($)	Managed Sewer Separation Cost Comment
		AW-1	Creek separation along Iona Ave	$ 12,319,200	Local or Collector Road	20%	$ 2,463,840	$ 14,783,040	Low	20%	$ 2,956,608	$ 17,739,648	-	12%			$ 19,780,000	
		AW-2	Sewer separation within Ainslie Wood south*	$ 13,778,765	Local or Collector Road	20%	$ 2,755,753	$ 16,534,518	Low	20%	$ 3,306,904	$ 19,841,422	-	12%			$ 22,120,000	
		AW-3a	Sewer separation within Ainslie Wood north with connection to McMaster catchment*	$ 5,299,525	Local or Collector Road	20%	$ 1,059,905	$ 6,359,430	Low	20%	$ 1,271,886	$ 7,631,316	15%	12%			$ 9,650,000	
		AW-3b	Collector sewer for sewer separation within Ainslie Wood north	$ 3,160,840	Local or Collector Road	20%	$ 632,168	$ 3,793,008	Low	20%	$ 758,602	$ 4,551,610	15%	12%			$ 5,760,000	
		AW-4	Major system stormwater diversion to Alexander Park	$ 1,200,000	Boulevard/Open Space	0%	$ -	$ 1,200,000	Low	20%	$ 240,000	$ 1,440,000	15%	12%			$ 1,820,000	
		AW-OUT	Implementation of new outfall to Chedoke Creek	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
Ainslie Wood	**High**	AW-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 33,840,000 ***	0.45	$ 15,093,622	$33,840,00 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Ainslie Wood anticipated to complete 65% of CSO Catchment separation.
		MCM-1	Upgrade of trunk sewer to outlet to accommodate Ainslie Wood sewer separation	$ 2,538,500	Boulevard/Open Space	0%	$ -	$ 2,538,500	Medium	25%	$ 634,625	$ 3,173,125	15%	18%			$ 4,220,000	
		MCM-OUT	Implementation of new outfall to Cootes Paradise	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
McMaster	**Medium**	MCM-SWR	Complete managed sewer separation within catchment	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 9,090,000 ***	1.00	$ 9,090,000	$9,090,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for McMaster anticipated to complete 0% of CSO Catchment separation.
		WD-1a	North end sewer separation*	$ 4,644,311	Local or Collector Road	20%	$ 928,862	$ 5,573,173	Low	20%	$ 1,114,635	$ 6,687,808	15%	12%			$ 8,460,000	
		WD-1b	Collector sewer for north end sewer separation	$ 2,204,270	Local or Collector Road	20%	$ 440,854	$ 2,645,124	Low	20%	$ 529,025	$ 3,174,149	15%	12%			$ 4,020,000	
		WD-2	Dalewood Middle School underground storage	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ -	
		WD-3	Westdale Secondary School Storage	$ 7,500,000	Boulevard/Open Space	0%	$ -	$ 7,500,000	Medium	25%	$ 1,875,000	$ 9,375,000	15%	18%			$ 12,470,000	
		WD-4a	South end sewer separation*	$ 4,393,788	Local or Collector Road	20%	$ 878,758	$ 5,272,546	Low	20%	$ 1,054,509	$ 6,327,055	15%	12%			$ 8,000,000	
		WD-4b	Collector sewer for south end sewer separation	$ 2,536,990	Arterial or Congested / High-value Area	30%	$ 761,097	$ 3,298,087	Low	20%	$ 659,617	$ 3,957,704	15%	12%			$ 5,010,000	
		WD-5	Deepen local sewers during asset renewal**	$ -	Local or Collector Road	20%	$ -	$ -	Low	20%	$ -	$ -	-	12%			$ -	
		WD-OUT1	Implementation of new outfall to Cootes Paradise	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		WD-OUT2	Implementation of new outfall to Chedoke Creek	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
Westdale	**High**	WD-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 22,790,000 ***	0.60	$ 13,759,684	$22,790,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Westdale anticipated to complete 40% of CSO Catchment separation.
		CP-1	New proposed LID - FIX SHEET	$ 1,500,000	Boulevard/Open Space	0%	$ -	$ 1,500,000	Medium	25%	$ 375,000	$ 1,875,000	15%	18%			$ 2,490,000	
		CP-2	Superpipe storage	$ 6,000,000	Local or Collector Road	20%	$ 1,200,000	$ 7,200,000	Low	20%	$ 1,440,000	$ 8,640,000	15%	12%			$ 10,930,000	
		CP-OUT	Implementation of new outfall to Chedoke Creek	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
Churchill Park	**High**	CP-SWR	Complete sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 15,042,000	0.93	$ 14,001,558	$15,042,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Churchill Park anticipated to complete 7% of CSO Catchment separation.
		MK1-1a	Hill St park storage	$ 360,000	Boulevard/Open Space	0%	$ -	$ 360,000	High	30%	$ 108,000	$ 468,000	15%	29%			$ 670,000	
		MK1-1b	Upstream major system storage (Durand Park)	$ 180,000	Boulevard/Open Space	0%	$ -	$ 180,000	Low	20%	$ 36,000	$ 216,000	15%	12%			$ 270,000	
		MK1-2	Trunk sewer upgrades	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ -	
		MK1-3	Bold St sewer separation	$ 1,156,260	Local or Collector Road	20%	$ 231,252	$ 1,387,512	Low	20%	$ 277,502	$ 1,665,014	15%	12%			$ 2,110,000	
		MK1-4	Managed sewer separation within east end*	$ 19,598,607	Local or Collector Road	20%	$ 3,919,721	$ 23,518,328	Low	20%	$ 4,703,666	$ 28,221,994	-	12%			$ 31,470,000	
		MK1-5	Bold St stormwater diversion to Hamilton Amateur Athletic Association Grounds	$ 5,389,750	Local or Collector Road	20%	$ 1,077,950	$ 6,467,700	High	30%	$ 1,940,310	$ 8,408,010	15%	29%			$ 12,110,000	
		MK1-OUT	New outfall to Chedoke Creek	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
Main-King 1	**High**	MK1-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 35,475,000	0.62	$ 22,020,351	Proposed capital project works for Main-King 1 anticipated to complete 38% of CSO Catchment separation.
		MK2-OUT	(Duplication of Main-King 1 Outfall)	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ -	
Main-King 2	**Low**	MK2-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 5,970,000 ***	1.00	$ 5,970,000	$5,970,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Main-King 2 anticipated to complete 0% of CSO Catchment separation.
		AH-1a	Sewer separation within Aberdeen Hillcrest - 1*	$ 2,992,082	Local or Collector Road	20%	$ 598,416	$ 3,590,498	Low	20%	$ 718,100	$ 4,308,598	15%	12%			$ 5,450,000	
		AH-1b	Trunk infrastructure for sewer separation within Aberdeen Hillcrest - 1	$ 4,882,220	Arterial or Congested / High-value Area	30%	$ 1,464,666	$ 6,346,886	Low	20%	$ 1,269,377	$ 7,616,263	15%	12%			$ 9,630,000	
		AH-2	Extension of storm sewer along Aberdeen Ave	$ 3,179,120	Arterial or Congested / High-value Area	30%	$ 953,736	$ 4,132,856	Medium	25%	$ 1,033,214	$ 5,166,070	15%	18%			$ 6,870,000	
		AH-OUT	New outfall to Chedoke Creek	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
Aberdeen Hillcrest	**High**	AH-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 9,500,000	0.29	$ 2,797,548	Proposed capital project works for Aberdeen Hillcrest anticipated to complete 71% of CSO Catchment separation.
		JM-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
James	**Low**	JM-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 5,156,000	1.00	$ 5,156,000	Proposed capital project works for James anticipated to complete 0% of CSO Catchment separation.
		EP-1	Eastwood Park LID	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ -	
		EP-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
Eastwood Park	**Low**	EP-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 8,180,000 ***	1.00	$ 8,180,000	$8,180,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Eastwood Park anticipated to complete 0% of CSO Catchment separation.

Table C10: Summary of Capital Program Costs

Catchment Projects				Contingency / Costing Summary														
CSO Catchment	Catchment Priority	Option Number	Option Description	Project Subtotal ($)	Installation Location / Road Type	Construction Uplift (% of subtotal)	Uplift Cost ($)	Subtotal ($)	Project Complexity	Additional Construction Cost Allowance (%)	Additional Construction Cost ($)	Total Construction Cost ($)	Consulting Engineering Fees (%)	Project Contingency (%)	Adjusted Draft FDMSS (Aquafor Beech, 2019) Separation Cost[1] ($)	Managed Sewer Separation Adjustment Factor	Total ($)	Managed Sewer Separation Cost Comment
Bayfront	Low	BF-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
		BF-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 18,454,000	1.00	$ 18,454,000	Proposed capital project works for Bayfront anticipated to complete 0% of CSO Catchment separation.
Wellington	High	WL-1a	Managed sewer separation within existing separated areas	$ 215,300	Local or Collector Road	20%	$ 43,060	$ 258,360	Low	20%	$ 51,672	$ 310,032	15%	12%			$ 390,000	
		WL-1b	Trunk infrastructure for managed sewer separation within existing separated areas	$ 21,686,140	Arterial or Congested / High-value Area	30%	$ 6,505,842	$ 28,191,982	High	30%	$ 8,457,595	$ 36,649,577	-	29%			$ 47,280,000	
		WL-2	Relief sewer for surface depression	$ 1,138,880	Local or Collector Road	20%	$ 227,776	$ 1,366,656	Low	20%	$ 273,331	$ 1,639,987	15%	12%			$ 2,070,000	
		WL-3	Wellington St relief sewer extension	$ 854,160	Arterial or Congested / High-value Area	30%	$ 256,248	$ 1,110,408	High	30%	$ 333,122	$ 1,443,530	15%	29%			$ 2,080,000	
		WL-4	Flow monitoring with potential relief sewer extension	$ 1,530,370	Arterial or Congested / High-value Area	30%	$ 459,111	$ 1,989,481	High	30%	$ 596,844	$ 2,586,325	15%	29%			$ 3,720,000	
		WL-5	Inlet control device implementation	$ 37,000	Arterial and Congested / High-value Area	35%	$ 12,950	$ 49,950	Low	20%	$ 9,990	$ 59,940	15%	12%			$ 80,000	
		WL-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
		WL-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 51,910,000 ***	0.86	$ 44,458,682	$51,910,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Wellington anticipated to complete 14% of CSO Catchment separation.
Wentworth	Medium	WN-1	Separate northern sewer network*	$ 6,166,720	Local or Collector Road	20%	$ 1,233,344	$ 7,400,064	Low	20%	$ 1,480,013	$ 8,880,077	15%	12%			$ 11,230,000	
		WN-2	Condition assessment and infrastructure renewal with upsizing**	$ -	Local or Collector Road	20%	$ -	$ -	Low	20%	$ -	$ -	-	12%			$ -	
		WN-3	East Ave N storm sewer	$ 743,310	Local or Collector Road	20%	$ 148,662	$ 891,972	Low	20%	$ 178,394	$ 1,070,366	15%	12%			$ 1,350,000	
		WN-4a	Asset renewal with managed sewer separation**	$ -	Local or Collector Road	20%	$ -	$ -	Low	20%	$ -	$ -	-	12%			$ -	
		WN-4b	Trunk infrastructure for asset renewal with managed sewer separation**	$ -	Arterial and Congested / High-value Area	35%	$ -	$ -	High	30%	$ -	$ -	-	29%			$ -	
		WN-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
		WN-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 40,834,000	0.88	$ 35,749,144	Proposed capital project works for Wentworth anticipated to complete 12% of CSO Catchment separation.
Birch	Medium	BR-1	Storm disconnection from relief with upstream overland interception	$ 102,000	Arterial and Congested / High-value Area	35%	$ 35,700	$ 137,700	Low	20%	$ 27,540	$ 165,240	15%	12%			$ 210,000	
		BR-2	Extend relief sewer within Birch to outfall with storm conversion	$ 8,127,250	Arterial and Congested / High-value Area	35%	$ 2,844,538	$ 10,971,788	High	30%	$ 3,291,536	$ 14,263,324	-	29%			$ 18,400,000	
		BR-3	Construct lift station for underpass flooding	$ 5,000,000	Arterial and Congested / High-value Area	35%	$ 1,750,000	$ 6,750,000	High	30%	$ 2,025,000	$ 8,775,000	15%	29%			$ 12,640,000	
		BR-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
		BR-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 26,860,000	0.95	$ 25,388,265	Proposed capital project works for Birch anticipated to complete 5% of CSO Catchment separation.
Gage	High	GG-1	Implement localized recommendations of LEEDS report	$ 2,753,000	Local or Collector Road	20%	$ 550,600	$ 3,303,600	Low	20%	$ 660,720	$ 3,964,320	15%	12%			$ 5,010,000	
		GG-OUT	New outfall to Hamilton Harbour	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
		GG-SWR	Managed sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 57,323,000	0.97	$ 55,594,143	Proposed capital project works for Gage anticipated to complete 3% of CSO Catchment separation.
Ottawa	Medium	OT-1	ICDs along Dalkeith Ave and Craigmiller Ave	$ 26,000	Local or Collector Road	20%	$ 5,200	$ 31,200	Low	20%	$ 6,240	$ 37,440	15%	12%			$ 50,000	
		OT-2a	Complete separation along Grenfell Street (Bayfield to Kenilworth) to existing storm sewer	$ 1,871,550	Local or Collector Road	20%	$ 374,310	$ 2,245,860	Low	20%	$ 449,172	$ 2,695,032	15%	12%			$ 3,410,000	
		OT-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 5,477,000	0.87	$ 4,764,480	Proposed capital project works for Ottawa anticipated to complete 13% of CSO Catchment separation.
Kenilworth	Medium	KN-1	Separation on Edgemont (Lawrence to Main)	$ 1,651,800	Local or Collector Road	20%	$ 330,360	$ 1,982,160	Low	20%	$ 396,432	$ 2,378,592	15%	12%			$ 3,010,000	
				$ 1,497,240	Local or Collector Road	20%	$ 299,448	$ 1,796,688	Low	20%	$ 359,338	$ 2,156,026	15%	12%			$ 2,730,000	
		KN-2	Relief Sewer on Kenilworth (Central to Main)	$ 1,580,420	Arterial or Congested / High-value Area	30%	$ 474,126	$ 2,054,546	Medium	25%	$ 513,637	$ 2,568,183	15%	18%			$ 3,420,000	
		KN-2a	Sewer Separation on Crosthwaite Street (Central to Main)	$ 1,046,140	Local or Collector Road	20%	$ 209,228	$ 1,255,368	Low	20%	$ 251,074	$ 1,506,442	15%	12%			$ 1,910,000	
		KN-2b	Sewer Separation on Main Street (Kenilworth to Garside)	$ 665,440	Arterial and Congested / High-value Area	35%	$ 232,904	$ 898,344	Medium	25%	$ 224,586	$ 1,122,930	15%	18%			$ 1,490,000	
		KN-2c	Storm Sewer diversion on Maple Ave	$ 440,480	Local or Collector Road	20%	$ 88,096	$ 528,576	Low	20%	$ 105,715	$ 634,291	15%	12%			$ 800,000	
		KN-3	Relief Sewers on Hope and Allan	$ 1,073,670	Local or Collector Road	20%	$ 214,734	$ 1,288,404	Low	20%	$ 257,681	$ 1,546,085	15%	12%			$ 1,960,000	
		KN-4	Overflow connection at Harmony and Britannia	$ 374,310	Local or Collector Road	20%	$ 74,862	$ 449,172	Low	20%	$ 89,834	$ 539,006	15%	12%			$ 680,000	
		KN-4a	Complete sewer separation on Barton (Harmony to Kenilworth)	$ 993,475	Arterial or Congested / High-value Area	30%	$ 298,043	$ 1,291,518	Medium	25%	$ 322,879	$ 1,614,397	15%	18%			$ 2,150,000	
		KN-5	ICDs on Cope Street from Main to Britannia	$ 33,000	Local or Collector Road	20%	$ 6,600	$ 39,600	Low	20%	$ 7,920	$ 47,520	15%	12%			$ 60,000	
		KN-5a	Additional ICDs on adjacent streets (Garside, Cameron, Barons)	$ 135,500	Local or Collector Road	20%	$ 27,100	$ 162,600	Low	20%	$ 32,520	$ 195,120	15%	12%			$ 250,000	
		KN-6	Sewer Separation on Ellis Ave	$ 1,018,610	Local or Collector Road	20%	$ 203,722	$ 1,222,332	Low	20%	$ 244,466	$ 1,466,798	15%	12%			$ 1,860,000	
		KN-6a	Storage in RT Steel Park	$ 375,000	Boulevard/Open Space	0%	$ -	$ 375,000	Medium	25%	$ 93,750	$ 468,750	15%	18%			$ 620,000	
		KN-7a	Trunk storm sewer on waterworks corridor	$ 17,394,500	Boulevard/Open Space	0%	$ -	$ 17,394,500	High	30%	$ 5,218,350	$ 22,612,850	-	29%			$ 29,170,000	
		KN-OUT	(Duplication of Strathearne Outfall)	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ -	
		KN-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 46,984,000	0.89	$ 41,924,714	Proposed capital project works for Kenilworth anticipated to complete 11% of CSO Catchment separation.
Strathearne	High	ST-1	Trunk storm sewer on Strathearne Ave	$ 16,853,350	Arterial or Congested / High-value Area	30%	$ 5,056,005	$ 21,909,355	High	30%	$ 6,572,807	$ 28,482,162	-	29%			$ 36,740,000	
		ST-1b	Separation on Barton (Walter to Strathearne)	$ 2,609,175	Arterial or Congested / High-value Area	30%	$ 782,753	$ 3,391,928	Medium	25%	$ 847,982	$ 4,239,909	15%	18%			$ 5,640,000	
		ST-1c	Separation on Vansitmart (Weir to Strathearne)	$ 757,075	Local or Collector Road	20%	$ 151,415	$ 908,490	Low	20%	$ 181,698	$ 1,090,188	15%	12%			$ 1,380,000	
		ST-2a	Parkdale Park Storage	$ 900,000	Boulevard/Open Space	0%	$ -	$ 900,000	Low	20%	$ 180,000	$ 1,080,000	15%	12%			$ 1,370,000	
		ST-2b	Viscount Montgomery PS Storage	$ 420,000	Boulevard/Open Space	0%	$ -	$ 420,000	Low	20%	$ 84,000	$ 504,000	15%	12%			$ 640,000	
		ST-2c	Montgomery Park Storage	$ 1,500,000	Boulevard/Open Space	0%	$ -	$ 1,500,000	Low	20%	$ 300,000	$ 1,800,000	15%	12%			$ 2,280,000	
		ST-2d	Mahoney Park Storage	$ 1,920,000	Boulevard/Open Space	0%	$ -	$ 1,920,000	Low	20%	$ 384,000	$ 2,304,000	15%	12%			$ 2,910,000	
		ST-2e	Fairfield Park Storage	$ 270,000	Boulevard/Open Space	0%	$ -	$ 270,000	Low	20%	$ 54,000	$ 324,000	15%	12%			$ 410,000	
		ST-3	Relief sewers on Queenston and Walter	$ 790,210	Arterial or Congested / High-value Area	30%	$ 237,063	$ 1,027,273	Medium	25%	$ 256,818	$ 1,284,091	15%	18%			$ 1,710,000	
				$ 831,800	Local or Collector Road	20%	$ 166,360	$ 998,160	Low	20%	$ 199,632	$ 1,197,792	15%	12%			$ 1,520,000	
				$ 1,192,170	Local or Collector Road	20%	$ 238,434	$ 1,430,604	Low	20%	$ 286,121	$ 1,716,725	15%	12%			$ 2,170,000	
		ST-4	Maintain culverts over rail line at Division, Cope, Tragina and Weir	$ 882,730	Boulevard/Open Space	0%	$ -	$ 882,730	High	30%	$ 264,819	$ 1,147,549	15%	29%			$ 1,650,000	
		ST-5	Additional inlets along south side of railway - Weir to Strathearne	$ 47,000	Local or Collector Road	20%	$ 9,400	$ 56,400	Low	20%	$ 11,280	$ 67,680	15%	12%			$ 90,000	
		ST-6	Relief sewer on Britannia from Weir to Strathearne	$ 1,122,930	Local or Collector Road	20%	$ 224,586	$ 1,347,516	Low	20%	$ 269,503	$ 1,617,019	15%	12%			$ 2,050,000	
		ST-OUT	Storm Sewer Outfall to Harbour via Strathearne	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 1,000,000	
		ST-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 50,170,000 ***	0.90	$ 44,902,690	$50,170,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Strathearne anticipated to complete 10% of CSO Catchment separation.

Table C10: Summary of Capital Program Costs

Catchment Projects				Contingency / Costing Summary														
CSO Catchment	Catchment Priority	Option Number	Option Description	Project Subtotal ($)	Installation Location / Road Type	Construction Uplift (% of subtotal)	Uplift Cost ($)	Subtotal ($)	Project Complexity	Additional Construction Cost Allowance (%)	Additional Construction Cost ($)	Total Construction Cost ($)	Consulting Engineering Fees (%)	Project Contingency (%)	Adjusted Draft FDMSS (Aquafor Beech, 2019) Separation Cost[1] ($)	Managed Sewer Separation Adjustment Factor	Total ($)	Managed Sewer Separation Cost Comment
Parkdale	High	PK-1	Relief sewers on Mahony and Adeline	$ 1,046,140	Local or Collector Road	20%	$ 209,228	$ 1,255,368	Low	20%	$ 251,074	$ 1,506,442	15%	12%			$ 1,910,000	
		PK-2	Relief sewers on Mead Avenue	$ 1,252,615	Local or Collector Road	20%	$ 250,523	$ 1,503,138	Low	20%	$ 300,628	$ 1,803,766	15%	12%			$ 2,280,000	
		PK-2a	Connection from Mead Avenue to Dunn Ave	$ 495,540	Local or Collector Road	20%	$ 99,108	$ 594,648	Low	20%	$ 118,930	$ 713,578	15%	12%			$ 900,000	
		PK-3	Relief sewer or separation on Brighton Ave	$ 1,238,850	Local or Collector Road	20%	$ 247,770	$ 1,486,620	Low	20%	$ 297,324	$ 1,783,944	15%	12%			$ 2,260,000	
		PK-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 18,000,000	0.83	$ 14,985,767	Proposed capital project works for Parkdale anticipated to complete 17% of CSO Catchment separation.
Dunn-Woodward	Medium	DW-2	New Storm sewer along Brampton Street to Red Hill	$ 2,828,120	Local or Collector Road	20%	$ 565,624	$ 3,393,744	Low	20%	$ 678,749	$ 4,072,493	15%	12%			$ 5,150,000	
		DW-3	ICDs on Rennie Street	$ 40,050	Local or Collector Road	20%	$ 8,010	$ 48,060	Medium	25%	$ 12,015	$ 60,075	15%	18%			$ 80,000	
		DW-3a	Relief sewer/upgrade on Rennie Street	$ 1,351,675	Local or Collector Road	20%	$ 270,335	$ 1,622,010	Medium	25%	$ 405,503	$ 2,027,513	15%	18%			$ 2,700,000	
		DW-4	Separation sewer on Woodward and Glow	$ 1,455,650	Arterial or Congested / High-value Area	30%	$ 436,695	$ 1,892,345	Medium	25%	$ 473,086	$ 2,365,431	15%	18%			$ 3,150,000	
				$ 5,677,000	Arterial or Congested / High-value Area	30%	$ 1,703,100	$ 7,380,100	Medium	25%	$ 1,845,025	$ 9,225,125	15%	18%			$ 12,270,000	
		DW-OUT	Implementation of new outfall to Red Hill via Brampton Street	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		DW-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 20,505,000	0.90	$ 18,461,899	Proposed capital project works for Dunn-Woodward anticipated to complete 10% of CSO Catchment separation.
Melvin	Low	ML-1	ICDs along Melvin from Adair to Talbot	$ 47,250	Local or Collector Road	20%	$ 9,450	$ 56,700	Medium	25%	$ 14,175	$ 70,875	15%	18%			$ 90,000	
		ML-2	ICDS along Glengrove and Armstrong	$ 37,000	Local or Collector Road	20%	$ 7,400	$ 44,400	Low	20%	$ 8,880	$ 53,280	15%	12%			$ 70,000	
		ML-3a	Storm sewer along Melvin to Red Hill	$ 652,855	Local or Collector Road	20%	$ 130,571	$ 783,426	High	30%	$ 235,028	$ 1,018,454	15%	29%			$ 1,470,000	
		ML-OUT	Implementation of new outfall to Red Hill via Melvin Ave	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		ML-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 8,144,000	0.98	$ 7,983,132	Proposed capital project works for Melvin anticipated to complete 2% of CSO Catchment separation.
Queenston	Medium	QN-1	Relief sewer on Central Ave from Glencarry to Parkdale	$ 247,770	Local or Collector Road	20%	$ 49,554	$ 297,324	Medium	25%	$ 74,331	$ 371,655	15%	18%			$ 490,000	
		QN-2	Relief sewers or separation on Beland Street	$ 1,541,680	Local or Collector Road	20%	$ 308,336	$ 1,850,016	Low	20%	$ 370,003	$ 2,220,019	15%	12%			$ 2,810,000	
		QN-OUT	Implementation of new outfall at Queenston (separation of existing)	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		QN-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 5,289,000	0.76	$ 4,000,885	Proposed capital project works for Queenston anticipated to complete 24% of CSO Catchment separation.
Lawrence	Medium	LW-1	Regrading of Glenholme Avenue	$ 630,000	Local or Collector Road	20%	$ 126,000	$ 756,000	Low	20%	$ 151,200	$ 907,200	15%	12%			$ 1,150,000	
		LW-2	Storm trunk on Lawrence Road from Bettina to Red Hill	$ 5,859,200	Arterial or Congested / High-value Area	30%	$ 1,757,760	$ 7,616,960	Medium	25%	$ 1,904,240	$ 9,521,200	15%	18%			$ 12,660,000	
		LW-2a	Storm trunk on Lawrence from Cochrane to Bettina	$ 3,433,125	Arterial or Congested / High-value Area	30%	$ 1,029,938	$ 4,463,063	Medium	25%	$ 1,115,766	$ 5,578,828	15%	18%			$ 7,420,000	
		LW-2b	Storm trunk on Cochrane to pick up depressed area on Dunkirk	$ 1,816,640	Local or Collector Road	20%	$ 363,328	$ 2,179,968	Medium	25%	$ 544,992	$ 2,724,960	15%	18%			$ 3,620,000	
		LW-3	Sewer separation on Glenholme Avenue	$ 495,540	Local or Collector Road	20%	$ 99,108	$ 594,648	Low	20%	$ 118,930	$ 713,578	15%	12%			$ 900,000	
		LW-OUT	Implementation of new outfall at Lawrence	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		LW-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 18,722,000	0.76	$ 14,310,276	Proposed capital project works for Lawrence anticipated to complete 24% of CSO Catchment separation.
Rosedale	High	RS-1b	Kings Forest SWMF outlet via Whitehouse Road and Kings Forest Park	$ 1,706,860	Local or Collector Road	20%	$ 341,372	$ 2,048,232	Medium	25%	$ 512,058	$ 2,560,290	15%	18%			$ 3,410,000	
		RS-2	Increased inlet capacity on Dunkirk	$ 81,000	Local or Collector Road	20%	$ 16,200	$ 97,200	Low	20%	$ 19,440	$ 116,640	15%	12%			$ 150,000	
		RS-3	Major system relief sewer on Dunkirk	$ 810,000	Local or Collector Road	20%	$ 162,000	$ 972,000	Low	20%	$ 194,400	$ 1,166,400	15%	12%			$ 1,480,000	
		RS-4	New storm sewer to Red Hill via Montrose, Erin and Dundonald	$ 5,218,350	Local or Collector Road	20%	$ 1,043,670	$ 6,262,020	Medium	25%	$ 1,565,505	$ 7,827,525	15%	18%			$ 10,410,000	
		RS-5	New storm sewer outfall for the Mountain	$ 9,429,650	Local or Collector Road	20%	$ 1,885,930	$ 11,315,580	Medium	25%	$ 2,828,895	$ 14,144,475	-	18%			$ 16,690,000	
		RS-OUT1	Implementation of new outfall to Red Hill via Dundonald	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		RS-OUT2	Implementation of new outfall to Red Hill via Greenhill	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		RW-SWR	Balance of sewer separation	$ -		-	$ -	$ -		-	$ -	$ -	-	-	$ 14,240,000 ***	0.94	$ 13,356,929	$14,240,000 is the adjusted Draft FDMSS cost separation per the details outlined in Appendix C. Proposed capital project works for Rosedale anticipated to complete 6% of CSO Catchment separation.
Mountain	Medium	MT-1a	New storm sewer from Mohawk Road to Buttermilk Falls via Mohawk Sports Park	$ 6,844,000	Boulevard/Open Space	0%	$ -	$ 6,844,000	Low	20%	$ 1,368,800	$ 8,212,800	15%	12%			$ 10,390,000	
		MT-1b	LID or Storage within Mohawk Sports Park to mitigate flow increases	$ 3,000,000	Boulevard/Open Space	0%	$ -	$ 3,000,000	Medium	25%	$ 750,000	$ 3,750,000	15%	18%			$ 4,990,000	
		MT-1c	Separated storm sewer on Mohawk Road (Upper Ottawa to Mountain Brow)	$ 5,251,225	Arterial or Congested / High-value Area	30%	$ 1,575,368	$ 6,826,593	Medium	25%	$ 1,706,648	$ 8,533,241	15%	18%			$ 11,350,000	
				$ 3,890,875	Arterial or Congested / High-value Area	30%	$ 1,167,263	$ 5,058,138	Medium	25%	$ 1,264,534	$ 6,322,672	15%	18%			$ 8,410,000	
		MT-1d	Extend storm sewer on Mohawk Road to Upper Sherman	$ 1,280,145	Arterial or Congested / High-value Area	30%	$ 384,044	$ 1,664,189	Medium	25%	$ 416,047	$ 2,080,236	15%	18%			$ 2,770,000	
				$ 2,121,090	Arterial or Congested / High-value Area	30%	$ 636,327	$ 2,757,417	Medium	25%	$ 689,354	$ 3,446,771	15%	18%			$ 4,580,000	
				$ 3,491,355	Arterial or Congested / High-value Area	30%	$ 1,047,407	$ 4,538,762	Medium	25%	$ 1,134,690	$ 5,673,452	15%	18%			$ 7,550,000	
		MT-2a	Potential storm sewer trunk for Mountain via Fennell Ave	$ 1,283,250	Arterial or Congested / High-value Area	30%	$ 384,975	$ 1,668,225	High	30%	$ 500,468	$ 2,168,693	15%	29%			$ 3,120,000	
		MT-OUT1	Implementation of new outfall to Red Hill via Buttermilk Falls	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 3,000,000	
		MT-OUT2	Implementation of new outfall to Red Hill via Greenhill	$ -		-	$ -	$ -		-	$ -	$ -	-	-			$ 10,000,000	
		MT-SWR	Balance of sewer separation (area south of Mohawk Road only)	$ 4,198,325	Local or Collector Road	20%	$ 839,665	$ 5,037,990	Low	20%	$ 1,007,598	$ 6,045,588	15%	12%			$ 7,650,000	
				$ 1,518,035	Local or Collector Road	20%	$ 303,607	$ 1,821,642	Low	20%	$ 364,328	$ 2,185,970	15%	12%			$ 2,770,000	

* - Sewer separation calculated by taking 70% of combined sewer lengths for specific project areas (to account for approx 30% being upstream lengths not necessary for storm implementation when utilizing sanitary linework/lengths)
** - Capital costing not provided as option implemented during asset renewal
*** - Indicates that the Draft FDMSS sewer separation cost has been adjusted per Appendix C "Managed Sewer Separation Costing"

Table C11: Summary of Proposed Study Costs

Study/Report ID	Study/Report Name	Study Scope	Study Cost	Need	Study Timeline
STR-1	West End Sewer Separation Study and New Outfall EA (Chedoke and Cootes Paradise)	West End catchments	$500,000	Immediate	0-3 years
STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$1,000,000	Short Term	3-5 years
STR-3	Hamilton Harbour Sewer Separation Study and New Outfall EA	Lower City catchments	$1,000,000	Short Term	3-5 years
STR-4	Scoped Capacity Assessment of North Mountain Area	Mountain	$200,000	Medium Term	5-10 years
STR-5	Interceptor Feasibility Study and EA	Entire City	$500,000	Medium Term	5-10 years
STR-6	Iona Creek Sewer Separation EA	Ainslie Wood	$250,000	Immediate	0-3 years
STR-7	3D visual pipe model SUE	Central/Downtown Core	$250,000	Short Term	3-5 years
STR-8	All-Pipes Model Update	Entire City	$1,000,000	Immediate	0-3 years
STR-9	Stormwater and LID Policy Update	Entire City	$100,000	Immediate	0-3 years
STR-10	Stormwater User Rate Study	Entire City	$500,000	Immediate	0-3 years
		Total	$5,300,000		

Table C12: Summary of Implementation Schedule, Associated Costs, and Relevant Prerequesite Studies

Catchment Projects				Implementation							Prerequisite Studies				
CSO Catchment	Catchment Priority	Option Number	Option Description	Outcome	Option Cost	Separation Balance Cost	Priority	Priority Rationale	Need	Option Timeline	Study ID	Study	Scope	Study Cost	Study Timeline
											STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		AW-1	Creek separation along Iona Ave	Recommended	$ 19,780,000		High	Existing capital program allocation	Immediate	0 - 3 years	STR-6	Iona Creek Sewer Separation EA	Ainslie Wood	$ 250,000	0-3 years
		AW-2	Sewer separation within Ainslie Wood south	Recommended	$ 22,120,000		Medium	Moderate number of Hansen calls	Medium Term	5 - 10 years		-	-	-	-
		AW-3a	Sewer separation within Ainslie Wood north with connection to McMaster catchment	Recommended	$ 9,650,000		Medium	Moderate number of Hansen calls	Medium Term	5 - 10 years		-	-	-	-
		AW-3b	Collector sewer for sewer separation within Ainslie Wood north	Recommended	$ 5,760,000		Medium	Moderate number of Hansen calls	Medium Term	5 - 10 years		-	-	-	-
		AW-4	Major system stormwater diversion to Alexander Park	Further Study	$ 1,820,000		Medium	Requires conveyance of disconnected major system flows	Short Term	3 - 5 years		-	-	-	-
		AW-OUT	Implementation of new outfall to Chedoke Creek	Recommended	$ -	$ 3,000,000	High		Short Term	3 - 5 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
Ainslie Wood	High	AW-SWR	Balance of sewer separation	Recommended	$ -	$ 15,094,000	Medium		Future planning	20+ years		-	-	-	-
		MCM-1	Upgrade of trunk sewer to outlet to accommodate Ainslie Wood sewer separation	Further Study	$ 4,220,000		Medium	Required as prerequesite or in tandem with Ainslie Wood northern sewer separation.	Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		MCM-OUT	Implementation of new outfall to Cootes Paradise	Recommended	$ -	$ 3,000,000	Medium		Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
McMaster	Medium	MCM-SWR	Complete managed sewer separation within catchment	Recommended	$ -	$ 9,090,000	Low		Future planning	20+ years		-	-	-	-
		WD-1a	North end sewer separation	Further Study	$ 8,460,000		High	Significant number of Hansen flooding calls in subject area. Existing relief outfall requires investigation for reuse	Short Term	3 - 5 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		WD-1b	North end sewer separation	Further Study	$ 4,020,000		High	Significant number of Hansen flooding calls in subject area. Existing relief outfall requires investigation for reuse	Short Term	3 - 5 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		WD-2	Dalewood Middle School underground storage	Screened Out	$ -		-	Existing flow direction not suitable for conveyance to Dalewood	-	-		-	-	-	-
		WD-3	Westdale Secondary School Storage	Further Study	$ 12,470,000		Medium	Further study required to determine if storage mitigates flooding.	Medium Term	5 - 10 years		-	-	-	-
		WD-4a	South end sewer separation	Further Study	$ 8,000,000		High	Significant number of Hansen flooding calls in subject area. Requires new outfall	Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		WD-4b	South end sewer separation	Further Study	$ 5,010,000		High	Significant number of Hansen flooding calls in subject area. Requires new outfall	Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		WD-5	Deepen local sewers during asset renewal	Recommended	$ -		Medium	Significant aging infrastructure in catchment, potential upcoming renewal	Medium Term	5 - 10 years		-	-	-	-
		WD-OUT1	Implementation of new outfall to Cootes Paradise	Further Study	$ -	$ 3,000,000	High	Project in tandem with north end sewer separation	Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
		WD-OUT2	Implementation of new outfall to Chedoke Creek	Further Study	$ -	$ 3,000,000	High	Project in tandem with south end sewer separation	Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
Westdale	High	WD-SWR	Balance of sewer separation	Recommended	$ -	$ 13,760,000	High		Future planning	20+ years		-	-	-	-
		CP-1	New proposed LID	Recommended	$ 2,490,000		Medium	Hansen flooding calls align with depression storage in this area	Medium Term	5 - 10 years		-	-	-	-
		CP-2	Superpipe storage	Further Study	$ 10,930,000		Medium	Hansen flooding calls align with depression storage in this area	Medium Term	5 - 10 years		-	-	-	-
		CP-OUT	Implementation of new outfall to Chedoke Creek	Recommended	$ -	$ 3,000,000	High		Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
Churchill Park	High	CP-SWR	Complete sewer separation	Recommended	$ -	$ 14,002,000	High	Significant number of Hansen flooding calls in area	Medium Term	5 - 10 years		-	-	-	-
		MK1-1a	Hill St park storage	Further Study	$ 670,000		High	Potential alternative to mitigate Bold St flooding	Short Term	3 - 5 years		-	-	-	-
		MK1-1b	Upstream major system storage (Durand Park)	Further Study	$ 270,000		High	Potential alternative to mitigate Bold St flooding	Short Term	3 - 5 years		-	-	-	-
		MK1-2	Trunk sewer upgrades	Screened Out	$ -		-		-	-		-	-	-	-
		MK1-3	Bold St sewer separation	Further Study	$ 2,110,000		High	Potential alternative to mitigate Bold St flooding	Short Term	3 - 5 years		-	-	-	-
		MK1-4	Managed sewer separation within east end	Further Study	$ 31,470,000		Medium		Long Term	10 - 20 years		-	-	-	-
		MK1-5	Bold St stormwater diversion to Hamilton Amateur Athletic Association Grounds	Further Study	$ 12,110,000		High	Potential alternative to mitigate Bold St flooding	Short Term	3 - 5 years		-	-	-	-
		MK1-OUT	New outfall to Chedoke Creek	Recommended	$ -	$ 3,000,000	Medium		Long Term	10 - 20 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
Main-King 1	High	MK1-SWR	Balance of sewer separation	Recommended	$ -	$ 22,020,000	Medium		Future planning	20+ years		-	-	-	-
		MK2-OUT	(Duplication of Main-King 1 Outfall)	Recommended	$ -	$ -	Low		Future planning	20+ years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
Main-King 2	Low	MK2-SWR	Managed sewer separation	Recommended	$ -	$ 5,970,000	Low		Future planning	20+ years		-	-	-	-
		AH-1a	Sewer separation within Aberdeen Hillcrest - 1	Recommended	$ 5,450,000		High	Per XCG Report recommendations and costing, including new outfall.	Short Term	3 - 5 years		-	-	-	-
		AH-1b	Sewer separation within Aberdeen Hillcrest - 1	Recommended	$ 9,630,000		High	Per XCG Report recommendations and costing, including new outfall.	Short Term	3 - 5 years		-	-	-	-
		AH-2	Extension of storm sewer along Aberdeen Ave	Further Study	$ 6,870,000		Medium	Support future sewer separation.	Medium Term	5 - 10 years		-	-	-	-
		AH-OUT	New outfall to Chedoke Creek	Recommended	$ -	$ 3,000,000	Medium	Limited Hansen flooding with relatively appropriate HGL results.	Medium Term	5 - 10 years	STR-1	West End Sewer Separation Study and New Outfall EA (C	West End catchments	$ 500,000	0-3 years
Aberdeen Hillcrest	High	AH-SWR	Balance of sewer separation	Recommended	$ -	$ 2,798,000	Medium		Future planning	20+ years		-	-	-	-
		JM-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	Low		Future planning	20+ years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
James	Low	JM-SWR	Managed sewer separation	Recommended	$ -	$ 5,156,000	Low		Future planning	20+ years		-	-	-	-
		EP-1	Eastwood Park LID	Screened Out	$ -		-		-	-		-	-	-	-
		EP-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	Low		Future planning	20+ years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Eastwood Park	Low	EP-SWR	Managed sewer separation	Recommended	$ -	$ 8,180,000	Low		Future planning	20+ years		-	-	-	-
		BF-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	Low		Future planning	20+ years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Bayfront	Low	BF-SWR	Managed sewer separation	Recommended	$ -	$ 18,454,000	Low		Future planning	20+ years		-	-	-	-
		WL-1a	Managed sewer separation within existing separated areas	Recommended	$ 390,000		High		Long Term	10 - 20 years		-	-	-	-
		WL-1b	Trunk infrastructure for managed sewer separation within existing separated areas	Recommended	$ 47,280,000		High		Long Term	10 - 20 years		-	-	-	-
		WL-2	Relief sewer for surface depression	Further Study	$ 2,070,000		Low		Medium Term	5 - 10 years		-	-	-	-
		WL-3	Wellington St relief sewer extension	Further Study	$ 2,080,000		Medium		Medium Term	5 - 10 years		-	-	-	-
		WL-4	Flow monitoring with potential relief sewer extension	Recommended	$ 3,720,000		Medium		Medium Term	5 - 10 years		-	-	-	-
		WL-5	Inlet control device implementation	Further Study	$ 80,000		Medium		Medium Term	5 - 10 years		-	-	-	-
		WL-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	High		Long Term	10 - 20 years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Wellington	High	WL-SWR	Managed sewer separation	Recommended	$ -	$ 44,459,000	High		Future planning	20+ years		-	-	-	-
		WN-1	Separate northern sewer network	Recommended	$ 11,230,000		High	Large number of Hansen calls	Medium Term	5 - 10 years		-	-	-	-
		WN-2	Condition assessment and infrastructure renewal with upsizing	Recommended	$ -		High	High percentage of poor condition infrastructure in area	Short Term	3 - 5 years		-	-	-	-
		WN-3	East Ave N storm sewer	Further Study	$ 1,350,000		High	Small project for connectivity. Benefit to be determined through study	Medium Term	5 - 10 years		-	-	-	-
		WN-4a	Assete renewal with managed sewer separation	Recommended	$ -		Medium		Long Term	10 - 20 years		-	-	-	-
		WN-4b	Assete renewal with managed sewer separation	Recommended	$ -		Medium		Long Term	10 - 20 years		-	-	-	-
		WN-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	Medium		Long Term	10 - 20 years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Wentworth	Medium	WN-SWR	Balance of sewer separation	Recommended	$ -	$ 35,749,000	Medium		Future Planning	20+ years		-	-	-	-

Table C12: Summary of Implementation Schedule, Associated Costs, and Relevant Prerequesite Studies

Catchment Projects				Implementation							Prerequisite Studies				
CSO Catchment	Catchment Priority	Option Number	Option Description	Outcome	Option Cost	Separation Balance Cost	Priority	Priority Rationale	Need	Option Timeline	Study ID	Study	Scope	Study Cost	Study Timeline
		BR-1	Storm disconnection from relief with upstream overland interception	Recommended	$ 210,000		High	Localized recommendation flagged in LEEDS report	Short Term	3 - 5 years		-	-	-	-
		BR-2	Extend relief sewer within Birch to outfall with storm conversion	Further Study	$ 18,400,000		Medium	Allows further sewer separation in catchment	Long Term	10 - 20 years		-	-	-	-
		BR-3	Construct lift station for underpass flooding	Further Study	$ 12,640,000		Medium	Requires further study to confirm if required	Long Term	10 - 20 years		-	-	-	-
		BR-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	Medium		Long Term	10 - 20 years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Birch	Medium	BR-SWR	Managed sewer separation	Recommended	$ -	$ 25,388,000	Medium		Future Planning	20+ years		-	-	-	-
		GG-1	Implement localized recommendations of LEEDS report	Recommended	$ 5,010,000		High	Localized solutions for high number of Hansen calls	Short Term	3 - 5 years		-	-	-	-
		GG-OUT	New outfall to Hamilton Harbour	Recommended	$ -	$ 1,000,000	High		Medium Term	5 - 10 years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Gage	High	GG-SWR	Managed sewer separation	Recommended	$ -	$ 55,594,000	High		Future Planning	20+ years		-	-	-	-
		OT-1	ICDs along Dalkeith Ave and Craigmiller Ave	Recommended	$ 50,000		Medium	Cost-Benefit of ICDs, low hansen calls	Immediate	0 - 3 years		-	-	-	-
		OT-2a	Complete separation along Grenfell Street (Bayfield to Kenilworth) to existing storm sewer	Recommended	$ 3,410,000		Medium	Will allow future separation of area	Short Term	3 - 5 years		-	-	-	-
Ottawa	Medium	OT-SWR	Balance of sewer separation	Recommended	$ -	$ 2,067,000	Medium		Future Planning	20+ years		-	-	-	-
		KN-1	Separation on Edgemont (Lawrence to Main)	Recommended	$ 5,740,000		Medium	More involved reconstruction, 5 hansen calls	Medium Term	5 - 10 years		-	-	-	-
		KN-2	Relief Sewer on Kenilworth (Central to Main)	Recommended	$ 3,420,000		Low	Not as critical as other area upgrades	Long Term	10 - 20 years		-	-	-	-
		KN-2a	Sewer Separation on Crosthwaite Street (Central to Main)	Recommended	$ 1,910,000		Medium	Higher relative number of hansen records	Short Term	3 - 5 years		-	-	-	-
		KN-2b	Sewer Separation on Main Street (Kenilworth to Garside)	Recommended	$ 1,490,000		Medium	Allows separation of other areas	Short Term	3 - 5 years		-	-	-	-
		KN-2c	Storm Sewer diversion on Maple Ave	Further Study	$ 800,000		Low	May not be necessary if doing other works	Long Term	10 - 20 years		-	-	-	-
		KN-3	Relief Sewers on Hope and Allan	Recommended	$ 1,960,000		Medium	Localized benefit	Medium Term	5 - 10 years		-	-	-	-
		KN-4	Overflow connection at Harmony and Britannia	Further Study	$ 680,000		Low	Need to confirm still needed	Long Term	10 - 20 years		-	-	-	-
		KN-4a	Complete sewer separation on Barton (Harmony to Kenilworth)	Recommended	$ 2,150,000		High	Key link for separation	Short Term	3 - 5 years		-	-	-	-
		KN-5	ICDs on Cope Street from Main to Britannia	Recommended	$ 60,000		High	Cost-Benefit of ICDs, high Hansen calls	Immediate	0 - 3 years		-	-	-	-
		KN-5a	Additional ICDs on adjacent streets (Garside, Cameron, Barons)	Recommended	$ 250,000		High	Cost-Benefit of ICDs, high Hansen calls	Immediate	0 - 3 years		-	-	-	-
		KN-6	Sewer Separation on Ellis Ave	Further Study	$ 1,860,000		Medium	More localized benefit	Medium Term	5 - 10 years		-	-	-	-
		KN-6a	Storage in RT Steel Park	Further Study	$ 620,000		Medium	Consider in conjunction with sewer works	Medium Term	5 - 10 years		-	-	-	-
		KN-7	(Duplication of Strathearne Option 1)	Further Study	$ -					-		-	-	-	-
		KN-7a	Trunk storm sewer on waterworks corridor	Further Study	$ 29,170,000		Low	Would need strathearne trunk to be in place	Long Term	10 - 20 years		-	-	-	-
		KN-OUT	(Duplication of Strathearne Outfall)	Recommended	$ -	$ -				-		-	-	-	-
Kenilworth	Medium	KN-SWR	Balance of sewer separation	Recommended	$ -	$ 26,664,000	Medium		Future Planning	20+ years		-	-	-	-
		ST-1	Trunk storm sewer on Strathearne Ave	Recommended	$ 36,740,000		High	Key to whole area, but will take time	Short Term	3 - 5 years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
		ST-1b	Separation on Barton (Walter to Strathearne)	Recommended	$ 5,640,000		Medium	Important link after strathearne	Medium Term	5 - 10 years		-	-	-	-
		ST-1c	Separation on Vansitmart (Weir to Strathearne)	Further Study	$ 1,380,000		Medium	Important link after strathearne	Medium Term	5 - 10 years		-	-	-	-
		ST-2a	Parkdale Park Storage	Further Study	$ 1,370,000		Low	Requires further study to assess benefit	Long Term	10 - 20 years		-	-	-	-
		ST-2b	Viscount Montgomery PS Storage	Further Study	$ 640,000		Low	Requires further study to assess benefit	Long Term	10 - 20 years		-	-	-	-
		ST-2c	Montgomery Park Storage	Further Study	$ 2,280,000		Low	Requires further study to assess benefit	Long Term	10 - 20 years		-	-	-	-
		ST-2d	Mahoney Park Storage	Further Study	$ 2,910,000		Low	Requires further study to assess benefit	Long Term	10 - 20 years		-	-	-	-
		ST-2e	Fairfield Park Storage	Further Study	$ 410,000		Low	Requires further study to assess benefit	Long Term	10 - 20 years		-	-	-	-
		ST-3	Relief sewers on Queenston and Walter	Recommended	$ 5,400,000		Medium	Overall separation benefit to several areas	Medium Term	5 - 10 years		-	-	-	-
		ST-4	Maintain culverts over rail line at Division, Cope, Tragina and Weir	Recommended	$ 1,650,000		Medium	Importance for drainage, low Hansen though	Short Term	3 - 5 years		-	-	-	-
		ST-5	Additional inlets along south side of railway - Weir to Strathearne	Recommended	$ 90,000		Medium	Relatively easy fix to do	Short Term	3 - 5 years		-	-	-	-
		ST-6	Relief sewer on Britannia from Weir to Strathearne	Further Study	$ 2,050,000		Low	Further assessment, likely beneficial	Long Term	10 - 20 years		-	-	-	-
		ST-OUT	Storm Sewer Outfall to Harbour via Strathearne	Recommended	$ -	$ 1,000,000	High	Consider in conjunction with trunk	Short Term	3 - 5 years	STR-3	Hamilton Harbour Sewer Separation Study and New Out	Lower City catchments	$ 1,000,000	3-5 years
Strathearne	High	ST-SWR	Balance of sewer separation	Recommended	$ -	$ 35,700,000	High		Future Planning	20+ years		-	-	-	-
		PK-1	Relief sewers on Mahony and Adeline	Recommended	$ 1,910,000		Low	High priority area but low hansen	Long Term	10 - 20 years		-	-	-	-
		PK-2	Relief sewers on Mead Avenue	Further Study	$ 2,280,000		Medium	Needs Dunn connection to go first	Medium Term	5 - 10 years		-	-	-	-
		PK-2a	Connection from Mead Avenue to Dunn Ave	Further Study	$ 900,000		Medium	Allows separation on Mead	Medium Term	5 - 10 years		-	-	-	-
		PK-2b	Separated outlet via Brampton Street	Screened Out	$ -					-		-	-	-	-
		PK-3	Relief sewer or separation on Brighton Ave	Recommended	$ 2,260,000		Medium	HGL issues and hansen calls, outlet TBC	Medium Term	5 - 10 years		-	-	-	-
Parkdale	High	PK-SWR	Balance of sewer separation	Recommended	$ -	$ 10,650,000	High		Future Planning	20+ years		-	-	-	-
		DW-1	(Duplication of Parkdale Option 3)	Recommended	$ -					-		-	-	-	-
		DW-2	New Storm sewer along Brampton Street to Red Hill	Recommended	$ 5,150,000		High	Allows separation of other areas	Short Term	3 - 5 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		DW-3	ICDs on Rennie Street	Recommended	$ 80,000		Medium	Cost-Benefit of ICDs, low hansen calls	Immediate	0 - 3 years		-	-	-	-
		DW-3a	Relief sewer/upgrade on Rennie Street	Further Study	$ 2,700,000		Low	Further study required	Long Term	10 - 20 years		-	-	-	-
		DW-4	Separation sewer on Woodward and Glow	Further Study	$ 15,420,000		Medium	Important link, but just reconstructed	Long Term	10 - 20 years		-	-	-	-
		DW-OUT	Implementation of new outfall to Red Hill via Brampton Street	Recommended	$ -	$ 3,000,000	High	Consider in conjunction with Brampton Street	Short Term	3 - 5 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
Dunn-Woodward	Medium	DW-SWR	Balance of sewer separation	Recommended	$ -	$ 12,655,000	Medium		Future Planning	20+ years		-	-	-	-
		ML-1	ICDs along Melvin from Adair to Talbot	Recommended	$ 90,000		High	Cost-Benefit of ICDs, high Hansen calls	Immediate	0 - 3 years		-	-	-	-
		ML-2	ICDS along Glengrove and Armstrong	Recommended	$ 70,000		High	Cost-Benefit of ICDs, flood history	Immediate	0 - 3 years		-	-	-	-
		ML-3	Storm sewer connection to proposed trunk on Woodward	Screened Out	$ -					-		-	-	-	-
		ML-3a	Storm sewer along Melvin to Red Hill	Further Study	$ 1,470,000		Medium	Infrastructure already partially in place	Medium Term	5 - 10 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		ML-OUT	Implementation of new outfall to Red Hill via Melvin Ave	Further Study	$ -	$ 3,000,000	Medium	Consider in conjunction with Melvin	Medium Term	5 - 10 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
Melvin	Low	ML-SWR	Balance of sewer separation	Recommended	$ -	$ 8,144,000	Low		Future Planning	20+ years		-	-	-	-
		QN-1	Relief sewer on Central Ave from Glencarry to Parkdale	Recommended	$ 490,000		High	Relatively easy fix to do	Short Term	3 - 5 years		-	-	-	-
		QN-2	Relief sewers or separation on Beland Street	Recommended	$ 2,810,000		Low	Minimal hansen calls	Long Term	10 - 20 years		-	-	-	-
		QN-OUT	Implementation of new outfall at Queenston (separation of existing)	Further Study	$ -	$ 3,000,000	Medium	Further study, but trunk on Queenston is there	Medium Term	5 - 10 years		-	-	-	-
Queenston	Medium	QN-SWR	Balance of sewer separation	Recommended	$ -	$ 1,989,000	Medium		Future Planning	20+ years		-	-	-	-
		LW-1	Regrading of Glenholme Avenue	Recommended	$ 1,150,000		Low	Localized benefit only, grading constraints	Long Term	10 - 20 years		-	-	-	-
		LW-2	Storm trunk on Lawrence Road from Bettina to Red Hill	Recommended	$ 12,660,000		Medium	Key to whole area	Medium Term	5 - 10 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		LW-2a	Storm trunk on Lawrence from Cochrane to Bettina	Recommended	$ 7,420,000		Medium	Consider in conjunction with 2	Medium Term	5 - 10 years		-	-	-	-
		LW-2b	Storm trunk on Cochrane to pick up depressed area on Dunkirk	Further Study	$ 3,620,000		Low	Longer term once Lawrence trunk is in	Long Term	10 - 20 years		-	-	-	-
		LW-3	Sewer separation on Glenholme Avenue	Recommended	$ 900,000		Low	Localized benefit	Long Term	10 - 20 years		-	-	-	-
		LW-OUT	Implementation of new outfall at Lawrence	Further Study	$ -	$ 3,000,000	Medium	Consider in conjunction with 2 and 2a	Medium Term	5 - 10 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
Lawrence	Medium	LW-SWR	Balance of sewer separation	Recommended	$ -	$ 17,822,000	Medium		Future Planning	20+ years		-	-	-	-
		RS-1a	Kings Forest SWMF outlet via Greenhill and Park (not costed -1b costed only)	Further Study	$ -					-		-	-	-	-
		RS-1b	Kings Forest SWMF outlet via Whitehouse Road and Kings Forest Park	Recommended	$ 3,410,000		High	Separate study underway	Short Term	3 - 5 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		RS-1c	Kings Forest SWMF outlet via golf course path	Screened Out	$ -					-		-	-	-	-
		RS-1d	Kings Forest SWMF outlet via Cochrane Road	Screened Out	$ -					-		-	-	-	-
		RS-1e	Kings Forest SWMF outlet via Dumbarton Ave	Screened Out	$ -					-		-	-	-	-
		RS-2	Increased inlet capacity on Dunkirk	Further Study	$ 150,000		Low	Needs an outlet first	Long Term	10 - 20 years		-	-	-	-
		RS-3	Major system relief sewer on Dunkirk	Further Study	$ 1,480,000		Low	Needs an outlet first	Long Term	10 - 20 years		-	-	-	-
		RS-4	New storm sewer to Red Hill via Montrose, Erin and Dundonald	Recommended	$ 10,410,000		High	Critical piece for area	Short Term	3 - 5 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		RS-5	New storm sewer outfall for the Mountain	Further Study	$ 16,690,000		Low	Longer term item	Long Term	10 - 20 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		RS-OUT1	Implementation of new outfall to Red Hill via Dundonald	Recommended	$ -	$ 3,000,000	High	Consider in conjunction with 4	Short Term	3 - 5 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		RS-OUT2	Implementation of new outfall to Red Hill via Greenhill	Further Study	$ -	$ 3,000,000	Low	Longer term item in combination with 5	Long Term	10 - 20 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
Rosedale	High	RW-SWR	Balance of sewer separation	Recommended	$ -	$ 12,760,000	High		Future Planning	20+ years		-	-	-	-

Table C12: Summary of Implementation Schedule, Associated Costs, and Relevant Prerequesite Studies

Catchment Projects				Implementation							Prerequisite Studies				
CSO Catchment	Catchment Priority	Option Number	Option Description	Outcome	Option Cost	Separation Balance Cost	Priority	Priority Rationale	Need	Option Timeline	Study ID	Study	Scope	Study Cost	Study Timeline
Mountain	Medium	MT-1a	New storm sewer from Mohawk Road to Buttermilk Falls via Mohawk Sports Park	Recommended	$ 10,390,000		Medium	First piece needed for upstream separation	Medium Term	5 - 10 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		MT-1b	LID or Storage within Mohawk Sports Park to mitigate flow increases	Further Study	$ 4,990,000		Medium	Consider in conjunction with 1a	Medium Term	5 - 10 years		-	-	-	-
		MT-1c	Separated storm sewer on Mohawk Road (Upper Ottawa to Mountain Brow)	Recommended	$ 19,760,000		Low	Need outlet first	Long Term	10 - 20 years		-	-	-	-
		MT-1d	Extend storm sewer on Mohawk Road to Upper Sherman	Recommended	$ 14,900,000		Low	Need outlet first	Long Term	10 - 20 years		-	-	-	-
		MT-1e	Storm sewer trunk to Red Hill via Upper Ottawa	Screened Out	$ -					-		-	-	-	-
		MT-2a	Potential storm sewer trunk for Mountain via Fennell Ave	Further Study	$ 3,120,000		Low	Longer term item	Long Term	10 - 20 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		MT-2b	Potential storm sewer trunk for Mountain via High Street	Screened Out	$ -					-		-	-	-	-
		MT-OUT1	Implementation of new outfall to Red Hill via Buttermilk Falls	Recommended	$ -	$ 3,000,000	Medium	Consider in conjunction with 1a and 1b	Medium Term	5 - 10 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		MT-OUT2	Implementation of new outfall to Red Hill via Greenhill	Further Study	$ -	$ 10,000,000	Low	Longer term item	Long Term	10 - 20 years	STR-2	Red Hill Sewer Separation Study and New Outfall EA	Red Hill catchments	$ 1,000,000	3-5 years
		MT-SWR	Balance of sewer separation (area south of Mohawk Road only)	Recommended	$ -	$ 10,420,000	Low		Future Planning	20+ years	STR-4	Scoped Capacity Assessment of North Mountain Area	Mountain	$ 200,000	5-10 years