City of Mississauga

Port Credit Storm Drainage Master Plan

Final Report

July 22, 2024

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City of Mississauga

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1 INTRODUCTION

The City of Mississauga (City) is preparing a Storm Drainage Master Plan (SDMP) for the Port Credit community, which is located within the southern central limits of the City and is home to approximately 12,520 residents (ref. 2011 mid-year forecast, Stats Canada). The SDMP is to provide detailed study and analysis of the local Port Credit drainage system, in alignment with the City-wide Stormwater Master Plan (SMP), which is currently under way.

The Port Credit area is largely understood to be the area south of the CNR tracks to Lake Ontario, between the residential bounds of Shawnmarr Road (to the West) and extends beyond Hurontario Street towards Seneca Avenue (to the East). The approximate limits for the Port Credit focus study area are presented in the attached **Drawing 1**, which defines the primary study limits as Shawnmarr Road (to the West) and Hurontario Street (to the East). In addition to the preceding, in order to account for external drainage areas, a secondary study area has been noted as including the area between Hurontario Street and Briarwood Avenue; this area would not be expected to receive the same level of study and focus, however.

The subject areas encompass approximately 1.9 km^2 (190 ha +\-), and is subject to on-going infill / intensification pressures, including the expected re-development of a large property known as “West Village” (ref. Drawing 1, west of Mississauga Road and south of Lakeshore Road). These proposed re-developments are a key consideration and underpinning rationale of the current study.

One of the foundational steps for the City to determine its infrastructure needs, relates to detailed local dual drainage (major / minor) analytical modelling of its existing urbanized areas; this study will help to identify and establish a comprehensive program for the City’s drainage infrastructure. Specifically, preferred alternatives for managing storm drainage within the Port Credit study area will be established, along with the process and prioritization for implementation.

Port Credit’s SDMP is being prepared using the Municipal Engineers Association (MEA) Class Environmental Assessment (Class EA) procedures. It is proposed that the Master Plan adopt Approach # 2 as outlined in the 2000 MEA Documentation (including the 2007, 2011 and 2015 Updates), which will address Phases 1 and 2 of the Class EA process. Subsequent Schedule B projects could thereby proceed directly to the *Notice of Completion* and then to the detailed design and implementation stages.

The SDMP is proposed to have several key deliverables as follows:

— Priority-based Stormwater Management Program
— Local (area-specific) Stormwater Management Policy recommendations

The process to achieve these outcomes is fully integrated and consultatively developed, incorporating input from multiple agencies, key interest groups, and the Public. It is anticipated that numerous management alternatives will need to be assessed / considered to address the legacy of problems facing the Port Credit community; some of these relevant problems include:

— Undersized infrastructure
— Intensifying land uses with respect to coverage
— Lack of historical stormwater management for flood control
— Erosion prone receivers
— High lake levels
— Requirement to maintain emergency routes

It is understood through discussions with City staff that water quality management, though an important overall component of stormwater management, is not to be assessed as part of the current study. In addition, an overall implementation strategy for recommended infrastructure works will be addressed by the City and others, separate from the current study.

The Port Credit SDMP involves multiple steps, generally outlined as follows:

— Data collection and Background Information Review
— Detailed Dual Drainage Modelling and Analytical Assessment
— Infrastructure Needs Assessment and Preferred SWM Strategy

The objective of this study is to help formalize the understanding of the stormwater issues and systematically and consultatively develop a Master Plan to address the City's flooding and quantity control problems within the Port Credit study area. A key aspect will be to develop focused and action-oriented recommendations, which can be translated into an effective capital program by City staff.

WSP E&I Canada Limited (formerly Wood Environment & Infrastructure Solutions Canada Limited) has been retained by the City to complete the study.

The current summary report has compiled the work completed in previous milestone technical memoranda. This includes:

— Technical Memorandum # 1 (Study Area Characterization)
— Technical Memorandum # 2 (Model Build Out and Performance Assessment)
— Technical Memorandum # 3 (Alternative Evaluation).

The current report is intended to provide a comprehensive summary of the entirety of the project including the analyses completed, recommended solutions, and consultation and engagement completed in support of the study.

2 STUDY AREA CHARACTERIZATION

2.1 Background Information

2.1.1 Overview

Background information for the Port Credit area has been provided over the course of the study by the City and the Credit Valley Conservation Authority (CVC) in various forms, such as base mapping data, modelling, record drawings and Official Plan schedules, specific to the Port Credit community. The information provided includes the following:

Mapping Data:

- Buildings
- Character Areas
- Contours (0.5 m and 1 m)
- Mississauga Official Plan Areas (2010)
- Property Parcels
- Railways
- Road Curbs
- Spot Heights
- Storm Sewer Nodes
- Storm Sewer Mains
- Storm Sewer Laterals
- Aerial Photography (2019)
- Digital Elevation Model (DEM) (1 m)
- CCTV Inspection Mapping / Data Logs (completed August 2019, by Dambro Environmental Inc.)
- Environmental Mapping Data, CVC (ref. Section 2.1.3)

Drawings:

- Record Drawings ("C-series" drawings) for the study area which contain both plan and profile data for the storm sewer system

Reports:

- Report on Storm Water Outlets in Port Credit for the City of Mississauga, James F. MacLaren Limited, August 1975.
- Helene Street Outfall Structure Design Review Report, Fenco Consultants Ltd, May 1978.
- Port Credit Flooding Study, Gore & Storrie Limited, July 1984.
- Mississauga Official Plan – Port Credit Local Area Plan, City of Mississauga, November 2019. Included as Appendices:

  - Port Credit Built Form Guide, City of Mississauga, October 2019
  - Lakeshore Road Transportation Review – Executive Summary, HDR & iTRANS, December 2010
- West Village (Port Credit) – Stormwater Management Design Brief, Urbantech, May 2021

Modelling:

- West Village Development Community PCSWMM Models, Urbantech, May 2021
- Hydraulic Models (HEC-RAS) and Floodplain Mapping for the following systems:
  - Credit River at Lake Ontario, Golder Associates, March 2005
  - Tecumseh Creek, CVC, October 2020

Based on discussions with City staff (January 14, 2020) there is no information related to known areas of urban flooding or areas where pro-active maintenance has been typically undertaken in the past, prior to storm events. As a result, the current background review has primarily relied upon base mapping, drawings and planning documents provided by the City. These sources have been reviewed for completeness, relevance and usability for the current assessment and are discussed further in the following sections.

2.1.2 Planning Context

2.1.2.1 Overview and History

In a historical context, Port Credit has a long history of habitation; archaeological evidence suggests the first native settlers, known as the Mississaugas, established at the mouth of the Credit River by the 1700's, indicating over 300 years of established communities within the area. The first organized planning occurred in 1834 with a town developed on the west of the Credit River, this area now forms part of the Old Port Credit Village Heritage Conservation District.

Other historical land uses within Port Credit Village include a port (now a marina and charter fishing center), an oil refinery (now being redeveloped into Port Credit "West Village" mixed use neighborhood), the St. Lawrence Starch Works (redeveloped into a mixed-use neighborhood), and a local landfill servicing the old Town of Port Credit (capped and developed for municipal facilities including a library). Over time, the development of these lands along the Lake Ontario shoreline has required the addition of fill for the construction of both the Port Credit Harbour Marina and J.C. Saddington Park, located to the west of the mouth of the Credit River.

The current land use forms within Port Credit include stable residential neighborhoods varying in density and a commercial corridor which includes commercial, industrial, recreational and community uses. Existing development form is evident on **Drawing 1**; the approved Official Plan Use is presented in **Drawing 2**. The following can be noted with respect to land use:

- The existing residential land uses consist of a combination of dwelling types and forms, with the high-density area being centrally located near the Port Credit GO transit station. Along Lakeshore Road (east and west) and the harbour, there is both medium and high-density development. Along the east and west outskirts of Port Credit, there are low density areas characterized by tree-lined streets.
- Port Credit community uses include schools, library, arena, swimming pool and meeting spaces. The majority of these uses are concentrated centrally within the community.
- One of the unique elements of the Port Credit community is the waterfront area along both Lake Ontario and the Credit River. The waterfront is integral to the character of the area and provides the culturally and recreationally significant open space / waterfront park system.
- Cultural and heritage resources include heritage buildings, the Old Port Credit Village Conservation District (located south of Lakeshore Road, to the west of the Credit River), and cultural landscapes including: Port Credit Harbour, Port Credit Pier, the CN Bridge over the Credit River, Credit River Corridor and the Mississauga Road Scenic Route.
- The Credit River is considered a warmwater fish habitat but is also a migratory route for coldwater species. The valley lands are a component of an important ecological corridor that extends north throughout the City. The shoreline provides unique ecological functions and habitat, as well as an ecological corridor.

The Port Credit community has significant cultural, social, economic, and environmental value for not only the local community, but neighbouring areas and the City as a whole. Future development within the Port Credit area must adhere to policies and guidelines outlined in the Mississauga Official Plan (MOP) to ensure the character and planned function of the community is maintained.

2.1.2.2 Mississauga Official Plan (MOP)

The Mississauga Official Plan (MOP) provides a policy framework to protect, enhance, restore, and expand the Natural Heritage System, to direct growth to where it will benefit the urban form, support a strong public transportation system, and address the long-term sustainability of the City.

The MOP outlines City-wide policies regarding sustainable development, which include specific guidance for stormwater management and drainage (ref. Chapter 6 – Value the Environment, MOP). Direct relevant excerpts from this document are as follows:

6.4.2 Stormwater and Drainage

- "**6.4.2.1** Mississauga will use a water balance approach in the management of stormwater by encouraging and supporting measures and activities that reduce stormwater runoff, improve water quality, promote evapotranspiration and infiltration, and reduce erosion using ***stormwater best management practices***."
- "**6.4.2.2** Mississauga will require that development applications be supported by stormwater best management practices in accordance with relevant plans, studies, development standards and policies. Additional measures may be specified by the City based on known concerns related to storm sewer capacity, pollution prevention, flood risk and erosion, and protection of the city's Natural Heritage System, including its ecological function. ***Stormwater best management practices*** must be approved by the city, appropriate conservation authority and Provincial Government, where applicable."
- "**6.4.2.3** The location and design of surface drainage and stormwater management facilities will respect the Natural Heritage System and will include naturalization to the satisfaction of the City and the appropriate conservation authority."
- "**6.4.2.4** Surface drainage and stormwater management facilities will be installed for the safety of residents and to protect infrastructure and property."
- "**6.4.2.5** The design of storm drainage and stormwater management facilities will consider interim and ultimate development conditions."
- "**6.4.2.6** The design of stormwater management facilities and ***surface drainage facilities*** must conform to City standards, policies, and guidelines. A buffer may be required as determined by the City."
- "**6.4.2.7** At-source controls should be provided to reduce the need for new stormwater infrastructure. All efforts to this effect should be guided by the appropriate environmental agencies, according to all Provincial Government, Regional Government and municipal policies, guidelines, and regulations."
- "**6.4.2.8** Protective measures should be developed and implemented, in consultation with the appropriate conservation authority and Provincial Government, for significant ***ground water recharge*** and discharge areas, where appropriate."
- "**6.4.2.9** The design of storm drainage and stormwater management facilities will enhance the natural and visual landscape and ecological functions and provide recreational opportunities, if appropriate."

These policies demonstrate the goal for City-wide sustainable development and the protection of natural resources through application of best management practices, to promote source control of water quantity, quality, and offsite erosion. The policies outlined in the MOP and other relevant City codes / guidelines relating to stormwater management and building / development will be further reviewed as part of the assessment of potential mitigation options for future development.

2.1.2.3 Port Credit Local Area Plan (LAP)

As part of the MOP, several Local Area Plans (LAPs) were developed for unique aspects particular to specific areas within the City, which require further and specified planning guidance; this includes the Port Credit lands in south central Mississauga. The Port Credit LAP must be read in conjunction with the principal document (MOP) and provides policies and/or schedules specific to the lakefront community in order to maintain the character and planned function.

The Port Credit LAP outlines policies and schedules pertaining to development within the Port Credit area based upon the community concept. A summary of these components is as follows:

- **Green System:** Key features consisting of an open space network including the Credit River and the Lake Ontario shoreline. These contribute to the environmental, social, and economic health of the Port Credit community.
- **Community Node:** Focus area for the surrounding neighborhoods which includes a mixture of uses of compact urban form and appropriate density. To ensure a balanced land use plan, residential development / intensification needs to be accompanied by additional employment uses for a balanced and complete community. Future development within this area also needs to consider the GO Station, identified as a Major Transit Station Area, and future plans for the Hurontario Light Rail Transit (LRT) system and route station.
- **Neighborhoods:** These areas are primarily residential, with some commercial and employment uses along Lakeshore Road and the railway. Policies in the LAP and associated documents provide direction for appropriate development in built form and scale of proposed buildings, to ensure that the character of the neighborhood area is maintained.
- **Corridors:** Port Credit is serviced through two primary arterial roads, Lakeshore Road (east and west) which is identified as a corridor, and Hurontario Street which is identified as an intensification corridor. Lakeshore Road is the only east-west road that crosses the Credit River south of the QEW, serving both community and regional travel. These arterial roads play a crucial role in connecting the neighborhoods both within Port Credit and to surrounding communities.

The Port Credit LAP includes lands identified in the City structure as a Community Node, and Neighborhood Character areas; these areas have then been further divided into precincts which recognize different attributes and therefore contain different policy directions (ref. Port Credit Map included in **Appendix A**).

- The Community Node is comprised of the following precincts:
  - Central Residential Area
  - Mainstreet Node
  - Harbour Mixed-Use
  - Riverside
- The Neighborhood Character Areas are comprised of the following precincts:
  - Old Port Credit Village Heritage Conservation District
  - West Village
  - North Residential Neighborhood
  - South Residential Neighborhood
  - Mainstreet Neighborhood

2.1.2.4 Port Credit Built Form Guide

The Port Credit Built Form Guide (the Guide) was developed in accordance with the MOP and the Port Credit LAP; this guide is intended to assist in understanding and implementing the Desirable Urban Form policies outlined in the City plans. The guide ensures development is appropriate for Port Credit and reflects the unique characteristics of the area.

The built form guidelines outlined in the Guide are specific to the character areas and community node precincts in order to provide detailed guidance for urban development. The types of guidelines / policies outlined in the Guide include some of the following design components:

- Building Heights
- Building Distance / Distribution
- Frontage
- Material / Architectural Design
- Building Orientation
- Skyline
- Site Size
- Microclimate (Shadow / Wind)
- Landscape / Streetscape
- Parking, Loading and Service Areas

The focus of the Guide primarily revolves around the potential development in the community node, which incorporates mixed use land such as high and medium density residential, as well as commercial and employment uses. These policies will be reviewed in further detail as part of the future model scenarios in order to determine the attributes of future land use conditions for the community.

2.1.2.5 Port Credit Growth Areas

As identified in the MOP, the Port Credit Community Node and Hurontario Street are designated as intensification corridors (ref. Schedule 2 – Intensification Areas, MOP, attached in **Appendix A**). The Port Credit LAP states that the existing gross density of the Community Node is 115 residents and jobs combined per hectare; therefore, Port Credit is within the targeted range for Community Nodes, which is between 100 and 200 per hectare.

The current population to employment ratio is 3.2:1, which does not meet the target range of 2:1 to 1:2 for Community Nodes. Therefore, through the expected infill and redevelopment on lands designated as mixed use within the Community Node, the focus should be to create a more complete community and in particular, increase opportunities for employment.

In addition to the need for increased employment lands, special consideration is required for the current and future transportation needs of the area. The existing Port Credit GO Transit station is identified as a Gateway Mobility Hub in the Regional Transportation Plan prepared by Metrolinx (ref. The Big Move: Transforming Transportation in the Greater Toronto and Hamilton Area, Metrolinx, November 2008), and as a Major Transit Station in the MOP. In the future, this area is planned to have connections to high order transit lines serving Hurontario Street and Lakeshore Road East, which includes the proposed LRT line along Hurontario Street.

In terms of the neighborhood character areas on either side of the Community Node, these are stable areas, primarily residential in nature and are not expected to experience significant change. Intensification is expected to occur through modest infilling or redevelopment within existing low density residential lands, along Lakeshore Road Corridor (generally half a block north and south of Lakeshore Road), commercial plazas and the Port Credit West Village Precinct. Intensification should be sensitive to the existing character of the residential areas and the planned context of the Lakeshore Road Corridor, as outlined in the Port Credit LAP and associated Built Form Guide.

2.1.3 Desktop Environmental Inventory

2.1.3.1 Watersheds and Watercourses

The community of Port Credit is situated along the Lake Ontario shoreline at the downstream extent of two subwatersheds which are part of the Credit River Watershed, under the jurisdiction of the Credit Valley Conservation Authority (CVC); these include the Norval to Port Credit Subwatershed and Tecumseh Creek Subwatershed systems, both of which are conveyed within the study area limits. Subwatershed boundaries and other environmental data have been provided by CVC for reference in the current study; the subwatershed boundaries within the Port Credit study area have been presented on **Drawing 1**, along with the current regulated area limit and other environmental areas of interest.

The majority of the study area is located within the Norval to Port Credit Subwatershed, including all the study lands east of the Credit River, as well as a portion to the west. The north-western limits of the study area drain towards Tecumseh Creek, which ultimately flows through the Rhododendron Gardens park, prior to discharging to Lake Ontario. A significant portion of the study area also drains directly to Lake Ontario, bypassing the Credit River and Tecumseh Creek receivers; these areas are primarily south of Lakeshore Road, however there are local storm sewer systems which also collect and convey drainage from north of Lakeshore Road.

North of the study area limits to the east of the Credit River, there are two urban creek systems, namely Kenollie Creek and Mary Fix Creek, which collect and convey drainage throughout the residential lands north of the CNR. Both watercourses outlet to the Credit River via an engineered channel located on the north side of the railway tracks at Hurontario Street, west of Stavebank Road just upstream of the Port Credit GO Station.

CVC has recently completed a separate 1D / 2D hydraulic modelling study of spill areas and updated floodplain mapping for Mary Fix Creek (ref. Wood, Technical Memorandum: Spill Area 1 – Hurontario Street, March 2020). This study included a review of an identified spill area located along Hurontario Street, at Inglewood Drive just upstream of the Port Credit GO Station.

The results and conclusions from this study will be reviewed and included as appropriate in subsequent study components, as they can provide further insight into additional / external overland flooding during major storm events. These contributing spills may impact Port Credit’s storm sewer performance and depth of flooding and has the potential to influence proposed mitigation options.

CVC has also previously proposed a hydraulic modelling and floodplain mapping update study for Kenollie Creek; the status of this study and its potential impact on the current study area is currently unknown.

2.1.3.2 Environmental Inventory

In support of the current study for the Port Credit Community, CVC has provided the following environmental data and mapping for background review:

- Aquatic Habitat & Fish Community (Watercourses & Waterbodies)
- Natural Heritage Systems (NHS)
- Ecological Land Classification (ELC)
- Environmentally Significant Area (ESA)
- Significant Wildlife Habitat (SWH)
- Valleylands, Wetlands and Woodlands

Through review of the provided mapping, it is further understood that the Port Credit community is primarily an urban landscape, with the majority of existing natural systems being located within the bounds of protected natural areas under CVC regulation, such as the open space parks along the waterfront (ref. **Drawing 1**). The protected lands include some established high functioning valleylands along the banks of the Credit River which are denoted as environmentally significant areas (ESAs), woodland / treed areas within local parks (i.e., along Tecumseh Creek), and over 5 km (+/-) of shoreline within the study area limits (Lake Ontario and Credit River), which are designated as either Greenlands or Public Open Space land uses.

As outlined in a previous section, the majority of the Port Credit study area is located within the Credit River watershed. The Credit River Watershed extends across 871 km^2 of land from the Port Credit Community, up to the headwaters in the Town of Orangeville, flowing approximately 100 km through nine area municipalities. The land use within the basin is primarily urban and agricultural uses, with areas of forest, pasture, wetlands, and water bodies. With major urban centers such as Orangeville, Georgetown, Brampton, and Mississauga encompassing approximately 20% of the watershed, increasing urban development threatens the health and quality of the watershed ecosystems.

The Credit River is a well-known fishery system which is identified as a high functioning habitat, designated as an esturine fish community, with opportunities to fish for salmonines, namely brook trout, brown trout, as well as rainbow trout, chinook salmon, and coho salmon which are known to be in the lower watershed. The southern portion of the Credit River is identified as an ecologically significant estuary at the river mouth with Lake Ontario. Additionally, just north of the Port Credit community, the Credit River contains a Provincially significant wetland complex / Credit River Marshes which is identified in the Provincial Greenlands Plan as an external connection.

In order to protect these and other species within the Credit River, the Credit River Fisheries Management Plan was developed in 2002, through a public process by the Ministry of Natural Resources (MNR) in co-operation with CVC. The resulting management strategies from this plan include some of the following:

- Water Quantity / Water Budget
- Water Quality / Erosion Control

- Physical Habitat
- Angling Opportunities
- Enforcement
- Awareness
- Species Mix & Partitioning

In terms of the western limits of the Port Credit study area, these lands contribute to the Tecumseh Creek system, which discharges and flows throughout the Rhododendron Park south of Lakeshore Road, prior to the outlet at Lake Ontario. Tecumseh Creek, south of Lakeshore Road, is identified as a small warmwater fish community, with the surrounding lands identified as supporting woodlands and valleylands within the area.

In addition to land cover and aquatic habitat, the southern limits of the Port Credit study area are identified as Significant Wildlife Habitat (SWH) through the designation of Important Bird Areas (IBA) for migratory waterfowl, given the nearshore areas along the Lake Ontario shoreline. There are also certain areas designated as SWH for land bird stop over; however, these areas are primarily located within the woodland and/or CVC regulation areas, with the exception of the West Village development area, which meets the SWH criteria under the undeveloped / arid land conditions.

As outlined in the Port Credit LAP, the Green Systems areas of Port Credit are a valued part of the community atmosphere and are therefore protected / regulated for any development through CVC regulations and relevant City policies as appropriate.

2.1.4 Review of Data Sources

As previously outlined, a variety of base mapping and record information has been provided by the City as a basis for background review and subsequent model development. Each of these data sources has been summarized and the use / importance for the current study has been outlined in the following.

- **Buildings:** Building outlines are used in the model development to determine the existing building footprint area and the hard-impervious coverage under existing conditions. Building footprints can also be used to calculate related parameters, such as the associated amenity area (paved surfaces), such as patios, driveways, and other hardscaped areas. This information is crucial in determining the impervious coverage under existing conditions, as well as future land use conditions.
- **Property Parcels:** Property parcel limits identify lot sizes and land ownership, which is used in conjunction with building data to determine typical lot coverage based upon land use type, which can be applied in model development.
- **Contours (0.5 and 1 m):** Elevation contour topography data are used to review the existing topography and aid in determining the overland drainage divides and subcatchment delineation of contributing drainage areas for the storm sewer system.

- **Digital Elevation Model (DEM) (1 m):** The digital elevation model (DEM) provided by the City has a horizontal resolution of 1 m. These data have been used as a primary source for subcatchment delineation, major system drainage patterns and identification of low points / sags. The DEM is also used as a gap filling measure by spot elevation extraction for manhole rim elevation data as part of the major system model development.
- **Aerial Photography (2019):** Aerial photography from 2019 has been used to confirm the existing land use, building sizes, lot coverages and land covers. The aerials for the study area were initially provided in two separate images (as part of separate data requests), however there was a gap between both images. Therefore, the City subsequently provided a single aerial image to be used in future analysis and figure preparation for subsequent study tasks.
- **Mississauga Official Plan (MOP) Land Use (2010):** Land use mapping is used in conjunction with aerial photography to identify areas where development has taken place according to the MOP, as well as areas where future land development is expected based upon the MOP land use designation. This information will prove to be essential for future land use conditions and model development.
- **Road Curbs:** Roadway curb lines allow for the development of hydraulic transects representing the major system conveyance along both major and minor roadways, as well as help identify the limits of the road rights-of-way.
- **Storm Sewer Data (Nodes, Mains, Laterals):** The storm sewer mapping data serve as the basis for the dual drainage hydraulic model development, due to their georeferenced properties for accurate locations and details regarding pipe sizes, materials, and inlet capacity (catch-basins, etc.). This source of data has been discussed further in subsequent sections.
- **Record Drawings (C-plans):** Storm sewer record drawings have been provided for the study area and have been reviewed in conjunction with the storm sewer mapping for gap filling / validation of invert elevation and system components.
- **CCTV Inspection Mapping / Data Logs:** Closed Circuit Television (CCTV) inspections were completed for the Port Credit study area in August 2019 by others; this data has been used to flag / identify major findings and/or issues which pertain to the storm sewer system overall function and performance.

2.2 Review of Storm Sewer Infrastructure

2.2.1 Previous Studies

As noted in **Section 2.1.1**, a number of studies were completed for the Port Credit area between 1975 and 1984. Although these reports are some 40 - 50 years old, they do provide some useful background on previous infrastructure works and recommendations.

Report on Storm Water Outlets in Port Credit (James F. MacLaren Limited, August 1975)

- This study extended from Broadview Avenue \ Ben Machree Drive to the west to Briarwood Avenue \ Wenonah Drive to the east, south of the CNR.
- A total of 15 outfalls to Lake Ontario and seven outfalls to the Credit River were identified and assessed.
- Existing outfalls in the area of Helene Street were noted to have inverts below or near common Lake Ontario water levels and thus were frequently plugged with sediment and material from the Lake.
- For the area around Helene Street, a new storm sewer extended parallel to the breakwater was proposed to collect flow from the Helene Street outfall as well as storm drainage from Hurontario and the CNR spur line (i.e. outfalls 5, 16 and 17; refer to **Figure 2.1**).
- Specific storm sewer upgrades were proposed based on the modelling results for a series of different storm events and roof drain connectivity scenarios. The recommended upgrades for the 10-year storm event (with roofs connected) is replicated in **Figure 2.1**.
  - The section of storm sewer along Hurontario immediately south of the CNR is recommended as a 21” (525 mm) diameter (currently 450 mm diameter).
  - Upgrades to 18” (450 mm) diameter storm sewers is noted along Stavebank Road (note that the current pipes range in size from 300 to 375 mm in diameter).
  - Along Broadview and Lakeshore, upgrades between 18” to 24” (450 to 600 mm) diameter pipes are noted (current pipes 375 to 525 mm in diameter).
- Of relevance to the current study, the study pre-dates the construction of a new relief storm sewer on Lakeshore Road (Highway No. 2) between Helene Street and the Credit River).

Helene Street Outfall Structure Design Review Report (Fenco Consultants Ltd, May 1978)

- This study was a follow-up to the 1975 MacLaren report, specifically focused on the recommended works at Helene Street.
- As noted, the recommended solution involved connecting four separate existing storm sewers (outlets 5, 6, 16, and 17 from **Figure 2.1**) into a new chamber and storm sewer outfall to Lake Ontario. A 6’ (1800 mm) diameter pipe was proposed.
- Several alternatives were considered, the preferred approach was an above ground outfall extending 350 feet (107 m +\-) into the Lake. A concrete encased pipe contained between steel sheet pile walls was originally considered, however lower cost alternatives using rock fill instead of concrete encasement were noted.

Port Credit Flooding Study (Gore & Storrie Limited, July 1984)

- The study was undertaken in response to a major rainfall event on June 29, 1982, which had a total rainfall of approximately 50 mm over 8 hours. It caused extensive basement flooding, and flooded two sanitary pumping stations, and emergency pumping was required from the sanitary system in several locations.
- The work was completed for the Region of Peel and was focused primarily on sanitary system works.
- Leakage testing was undertaken and demonstrated that there was considerable leakage of the storm sewers above the springline. It was noted that this could result in more surface ponding and possible additional direct inflow into sanitary sewer manholes.
- The report notes that the storm sewer system is adequate for a 2-year storm, but the cost of providing sewers to accommodate a 10-year storm could not be justified.
- A separate section of the report discusses outfalls and overflow pipes. It notes that the Helene Street outfall (48” = 1200 mm) was completely blocked by debris and sediment, and that an overflow “has been broken into the pipe from which flow runs through a large ditch to the lake”.
- The report further notes that the construction of the 66” (1650 mm) diameter storm sewer on Lakeshore Road has diverted flows from north of Lakeshore Road to the new outlet to the Credit River. It is therefore noted that the reduced drainage area to the Helene Street outfall only requires a pipe of 27” (675 mm) in diameter. Breakwalls or wave protection were noted as likely required.

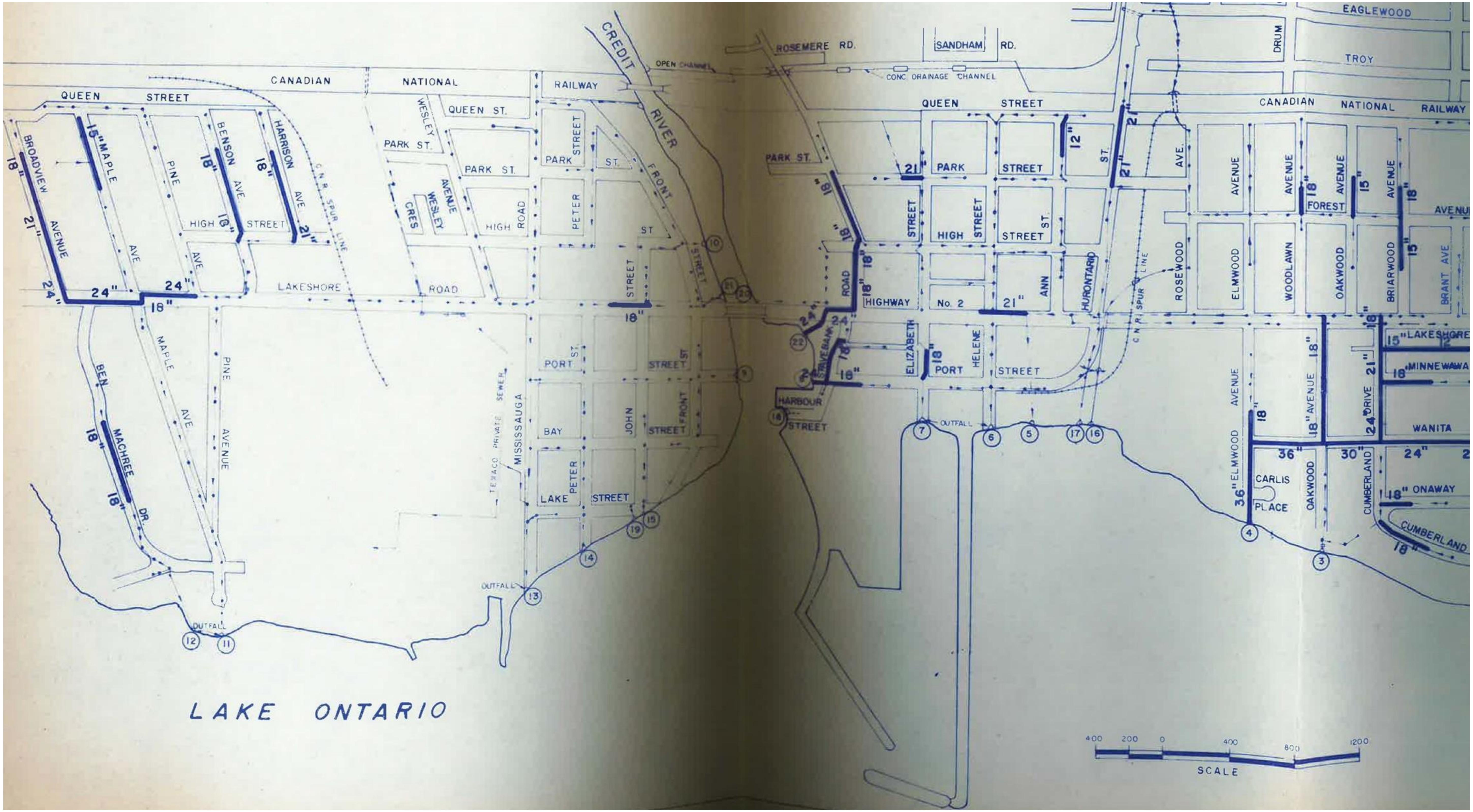

Figure 2.1: Proposed Relief Sewers (James F. MacLaren, 1975)

2.2.2 Storm Sewer Data Summary

It is understood that the City's available mapping of the existing storm sewer systems is limited to locations and pipe sizes only (Microstation™), with no unique identifiers for maintenance holes, storm sewers or pipe invert elevations.

As a result, record drawings ("C-plans") have been reviewed for the study area, in conjunction with the Microstation™ drawing files for overall completeness and initial database development for storm sewer elevations. Additional drawings have been requested and provided by the City, for areas where information and drawings were either missing, or for additional external areas which contribute to the Port Credit storm sewer network.

Based on this review of storm sewer infrastructure, a secondary area east of Hurontario Street has been included as part of the drainage assessment (given that it contributes to the Lakeshore Road trunk sewer) as indicated on **Drawing 1** and subsequent drawings.

As part of additional data requests, the City provided a geodatabase containing base mapping data, including shapefiles for the City's storm sewer network (nodes, mains and laterals). Through review of the mapping, it has been determined that the GIS storm sewer data contain pipe invert elevations associated with the storm sewer main, identifying both upstream and downstream invert elevations. Additionally, the storm sewer nodes and storm sewer mains shapefiles contain unique identifiers (IDs) which further correspond to the closed-circuit television (CCTV) inspection data.

Based upon this information, the GIS data provided by the City have been considered to be the best source of information for storm sewer model development. The storm sewer system data have been presented in a Storm Sewer Summary Plan (ref. **Drawing 3**) in order to summarize the main components of the system and identify any remaining data gaps.

The storm sewer system within the Port Credit study area consists of the following elements:

- 17,500 m (+/-) of storm sewer pipes – approximately 40% are trunk sewers (600 mm diameter or greater)
- Storm Nodes including:
  - Manholes (MH) = 159
  - Manhole Catch Basins (MHCB) = 204
  - Catch Basins (CB) = 435
  - Double Catch Basins (DCB) = 20

— Eighteen known storm sewer outfalls, identifying independent sewersheds, of which:
  – Nine outlet along the east / west sides of the Credit River
  – Six outlet south directly into Lake Ontario
  – One outlet south to Tecumseh Creek
  – Two local outlets – Memorial Park (ultimately draining towards the Credit River) & "West Village" lands (ultimately draining towards Lake Ontario)

The drainage areas to each of the known storm sewer outfalls have been delineated from available contour and DEM data. Naming convention prefixes include:

— CR: Credit River
— L: Local
— LO: Lake Ontario
— TC: Tecumseh Creek
— WV: West Village

Subcatchment suffixes further differentiate between the west (W) and east (E) sides of the Credit River. The resulting preliminary drainage areas to each outlet are presented on **Drawing 4** and are summarized in **Table 2.1**.

Table 2.1: Storm Sewer Drainage Boundaries / Independent Sewersheds

Receiver	Outlet Name	City Outfall ID	Drainage Area (ha)	% of Study Area	Included in Modelling
Credit River - East	CR_E1	68604	1.3	0.6%	Y
	CR_E2	68603	54.8	24.6%	Y
	CR_E3	68624	2.0	0.9%	Y
	CR_E4	68602	1.0	0.4%	N
Credit River - West	CR_W1	43580	2.6	1.2%	Y
	CR_W2	44086	3.5	1.6%	Y
	CR_W3	44088	3.1	1.4%	Y
	CR_W4	44087	14.2	6.4%	Y
	CR_W5	45464	3.3	1.5%	Y
Local Outlet	L1[1]	68614	0.7	0.3%	N
	WV1	68986	26.6	11.9%	N[2]
Lake Ontario - East	LO_E1	68601	0.7	0.3%	Y
	LO_E2 / LO_E3	67578 67579	3.4	1.5%	Y
	LO_W1	67600	5.3	2.4%	Y

Receiver	Outlet Name	City Outfall ID	Drainage Area (ha)	% of Study Area	Included in Modelling
Lake Ontario - West	LO_W2	67601	29.2	13.1%	Y
	LO_W3	43579	15.6	7.0%	Y
Tecumseh Creek	TC1	76566	15.4	6.9%	Y
Credit River	External Area (Not to STM Sewer)		12.5	5.6%	N
Lake Ontario			19.6	8.8%	N
Tecumseh Creek			8.6	3.8%	N

Note: [1] This outlet is located approx. 120 m (+/-) from the Credit River (East) shoreline – as such, it is assumed to be a local outlet, which collects local / independent drainage from the Port Credit Arena and is assumed to discharge through Memorial Park and ultimately contribute to the Credit River (included in Credit River total).
[2] West Village lands are accounted for in the current modelling but have been modelled explicitly by others.

The drainage boundaries demonstrate that of the 18 storm sewer outfalls, there are only six outfalls which collect and convey flows from drainage areas of 5 ha or greater. The largest sewersheds outlet along the east and west sides of the Credit River, and along the western Lake Ontario shoreline. The largest sewershed is CR_E2, which drains the majority of the lands on the east of the Credit River, and represents approximately 25% of the total study area.

Two areas are indicated as having crossing storm sewer infrastructure from separate outlets, which collect and convey drainage from the same general areas. These areas include networks in the Lake Ontario East (LO_E2 and LO_E3) as well as the Lake Ontario West / Credit River West areas (CR_W4 and LO_W3). These areas have been reviewed in further detail as part of subsequent model building tasks, to determine the appropriate modelling methodology to represent the independent systems.

Two areas have been identified as local outlets, as they appear to collect and discharge drainage via sewershed outlets and not directly to receiving watercourses. This includes the West Village lands (WV1), which would ultimately contribute to Lake Ontario, and the Memorial Park lands (L1) which collects drainage from the Port Credit Arena property via a 300 mm pipe, and appears to discharge directly into the park lands, which ultimately contributes to the Credit River (east). The area denoted as CR_E4 also appears to drain a small portion of land associated with a commercial unit (restaurant) and associated parking, discharging directly to the Credit River via a 300 mm pipe.

Due to the network size and the minimal storm sewer infrastructure associated with the L1 and CR_E4 networks, these minor networks have been excluded from the dual drainage modelling, placing the focus of the modelling efforts on the larger networks throughout the study area. The West Village lands (now known as Brightwater) have required additional review and inclusion in the modelling based upon separate design and study completed in support of the development; further details regarding the approach and modelling methodology are provided in **Section 3**.

Additionally, approximately 18% of the study area drains uncontrolled to the various receivers, representing external drainage areas which are not collected / conveyed through traditional storm sewers. These areas are primarily along the shorelines and protected park lands. These areas have been reviewed further in reference to potential overflow pathways, and similar to the smaller independent networks (L1 and CR_E4), these external lands have also been excluded from the current modelling.

With respect to the western portion of the study area contributing to Tecumseh Creek, it should be noted that the storm sewer system in this area is unique in that the sewer along Shawnmarr Road is a concrete box pipe (3 m span x 1 m rise). This pipe drains the Tecumseh Creek through an inlet north of the CNR and conveys the watercourse underground along the length of Shawnmarr Road, and outlets south of Lakeshore Road in the Rhododendron Gardens Park, which then conveys Tecumseh Creek as an open watercourse to Lake Ontario. This portion of the study area is therefore considered to be more of an enclosed watercourse, as opposed to a traditional storm sewer system. The existing storm sewer system contributing to the enclosed Tecumseh Creek includes approximately 240 m of storm sewer along Queen Street West.

The analyses for this area have required additional discussion with City staff to determine the preferred modelling approach. Through discussions with the City, it was determined that the focus of the current modelling is to assess the performance of the local contributing municipal storm sewers within the neighborhood, as opposed to discretely modelling the upstream portion of the Tecumseh Creek subwatershed beyond the study area limits. It should also be noted that a large portion of the Shawnmarr neighborhood consists of private townhouse developments, which have their own private storm servicing prior to connection to the enclosed Tecumseh Creek conduit. Further discussion regarding the modelling methodology applied in this area is provided in **Section 3.2**.

For the remainder of the study area, the majority of the storm sewer data included both upstream and downstream invert elevations; however, there are certain areas where no invert elevations were available in the GIS database (ref. **Drawing 3**). These areas have been further reviewed against other available data sources in order to gap fill accordingly, which has been summarized in the following section.

2.2.3 Data Gap Analysis

2.2.3.1 Data Gap Summary

As outlined on **Drawing 3**, there are several segments of the storm sewer shapefile which did not contain invert elevations. Additionally, the GIS data provided did not contain any MH rim elevations, which is a vital data item for the dual drainage component of model development (invert of the overland flow (roadway) system is assumed to be equal to the MH rim elevations). The missing information has been extracted from the City provided C-plan record drawings (where available); this included stated invert or rim elevations or estimating from the scaled profile of the sewer system. Given the vintage of the drawings, the elevations have been converted from Imperial to Metric units as required.

Some of the available C-plan drawings only contained plan views of the sewer system and did not provide a scaled profile view or stated elevations; these areas have been identified as data gaps for which topographic survey may be required for confirmation. Additionally, these areas have also been reviewed against the CCTV investigation data to confirm presence / absence, such as where the line could not be located, could not be accessed, or was not included in the investigation.

The remaining data gaps of most importance to the current study and the process to address the gaps include the following (refer to **Drawing 3** for locations):

Data Gap # 1: 1650 mm Trunk Sewer at Hurontario Street and Lakeshore Road:

— The GIS data indicate a 1650 mm trunk sewer, 36 m (+/-) in length entering the Lakeshore Road East trunk sewer from the # 1 Hurontario Street property, with no other upstream connection. It was assumed based on the C-plan drawing (ref. C46450), that this GIS feature represents remnant infrastructure whose function has since been replaced by the 1200 mm sewer to the east, which connects the drainage from Rosewood Avenue to the trunk sewer along Lakeshore Road East; this assumption was confirmed through review of subsequent design drawings.

Data Gap # 2: Port Credit Library – Parking Lot:

— The 450 mm diameter storm sewer (approximately 130 m (+/-) in length), collecting drainage from the Port Credit Library parking lot did not contain invert elevations at two MHs and the outlet at the Credit River; these locations were successfully surveyed as part of the topographic survey (ref. Section 2.2.3.2).

Data Gap # 3: J.C. Saddington Park:

- The 450 mm diameter storm sewer on the western side, passing through the north end of J.C. Saddington Park, which connects the sewer network on Peter Street South to the network along Mississauga Road South, as well as the 1050 mm diameter outlet pipe to Lake Ontario do not have invert information, and could not be located during the CCTV investigation. These locations were successfully surveyed as part of the topographic survey and/or resolved through additional drawings / data provided by the City (ref. Section 2.2.3.2).
- The 450 mm diameter storm sewer on the eastern side of the park, which conveys drainage from John Street South and Lake Street out to the Credit River, does not have any invert information nor could be located through CCTV. This location was partially surveyed as part of the topographic survey and has been assumed to outlet as indicated in the GIS files (ref. Section 2.2.3.2).

Data Gap # 4: “West Village” Development Lands:

- There are several storm sewers shown on the West Village development lands, which range from 900 mm to 1200 mm in diameter. The GIS data show connections to the storm sewer along Mississauga Road South, near the aforementioned J.C. Saddington Park, as well as a connection across Lakeshore Road West in the Credit Landing commercial property. This area was investigated by City staff which found that the infrastructure depicted in the GIS files no longer has status and will be replaced by the infrastructure proposed as part of the West Village development.
- City staff has provided additional information related to the proposed West Village development community called Brightwater. This includes proposed storm sewer infrastructure internal to the development, which discharges to the storm sewer network on Mississauga Road, south of Lakeshore Road, and ultimately outlets to Lake Ontario (ref. LO_W2). As part of this proposed development, the storm sewer along Mississauga Road is proposed to be upgraded; further details regarding the development area and impacts to infrastructure are provided in **Section 3**.

In addition to the invert elevation gap filling, MH rim elevations have been sourced from available C-plan drawings, if elevations or road profiles are available on the provided drawings. In cases where rim elevations could not be sourced from the available drawings, these elevations have been extracted from the DEM at the MH location. The rim elevations have been reviewed for discrepancies which potentially warranted topographic survey for confirmations, these areas have been discussed in the subsequent section.

2.2.3.2 Topographic Survey / Site Visits

A topographic survey was conducted by WSP staff the week of June 29, 2020. The topographic survey was initially completed based on the CGVD28 (1978 adjustment) datum. The City of Mississauga standard is the unadjusted CGVD28 datum. As such, a correction factor for the surveyed elevations is required in order to be incorporated into the future model building and City data set. As part of the survey work conducted by WSP, four of the City's benchmark locations have been surveyed to determine the appropriate correction factor required; the results of this comparison are presented in **Table 2.2**.

Table 2.2: Topographic Survey – Benchmark Elevation Comparison for City Offsets

Benchmark ID	Latitude	Longitude	WSP Survey Elevation (m, 1978 Datum)	City Elevation (m, 1928 Datum)	Difference
BM429	N43° 32' 59.94"	W79° 35' 26.64"	83.118	83.311	-0.193
BM45	N43° 33' 00.71"	W79° 35' 36.69"	81.327	81.506	-0.179
BM731	N43° 32' 51.95"	W79° 35' 17.61"	81.412	81.580	-0.168
BM732	N43° 33' 11.08"	W79° 34' 54.67"	77.976	78.128	-0.152
				Average Difference	**-0.173**

Based on these data, the surveyed elevations are on average of 0.17 m (+/-) lower than the City's reported elevations. Therefore, a correction factor of +0.17 m has been applied to all surveyed elevations prior to any further data comparisons.

As discussed, the locations identified for topographic survey included seven MHs and three storm sewer outlets (at Lake Ontario and the Credit River), located within J.C. Saddington Park and the Port Credit Library parking lot. These areas have been selected, as they have minimal elevation data either from GIS data, available C-plan drawings or could not be confirmed through the CCTV survey information. The topographic survey conducted by WSP (completed the week of June 29, 2020) found the following:

Data Gap # 2: Port Credit Library Parking Lot:

— The survey investigation was successful in locating and measuring the MHs and the obvert of the outlet at the Credit River.

Data Gap # 3: J.C. Saddington Park:

- The western 450 mm diameter storm sewer connecting the CB at the southern end of Peter Street South to the 1050 mm diameter storm sewer along Mississauga Road West was not found during the survey. The CB on Peter Street South was found to have a north and a south connection, as opposed to a pipe exiting west. The central MH located along the midpoint of the 450 mm diameter storm sewer was also not found. The point of entry for the 450 mm diameter storm sewer into the 1050 mm diameter storm sewer is classified as a "NODEM" in the GIS files, therefore it is assumed that this connection (if it exists) does not have above ground access. The obvert of the outlet at Lake Ontario was successfully surveyed.
  - It should be noted that an additional site visit was conducted by WSP staff on July 17, 2020, to further confirm the infrastructure (or lack thereof) in this area. The site visit confirmed that the MH and connection to the 1050 mm diameter storm sewer were not visible above ground; the mapped location of the MH appears to be in close vicinity to an existing City building on high ground (approximately 2 m higher than the parking lot), from the neighboring City buildings it appears this area may be a source of other servicing, although it is not clear based upon the record drawings provided for this area.
  - Through review of subsequent information provided by the City in reference to the Park and West Village development (to the west of the Park), this connection has been confirmed and has been included in the modelling as depicted in the GIS files.
- The MH on John Street South connecting to the storm sewer on Lake Street was not found during survey. The CB on Lake Street was successfully surveyed, and a pipe exiting east was noted, confirming the drawing information. As part of the CCTV, the pipe from this CB to the MH was not located, so the connection between these two points is unconfirmed. The CCTV was able to enter the upstream MH on John Street, but the survey was abandoned due to rocks / obstructions. The outlet at the Credit River was also not found during survey.
  - During the site visit, WSP staff could not locate the outlet along the river, or the MH on John Street South. It was noted that there were slight differences in the road paving on John Street South, indicating a possibility that the MH may have been paved over (although this cannot be definitively confirmed). The outlet along the river may be difficult to locate, as the shoreline is lined with armour stone, and there is a steep boardwalk making it difficult to inspect along the shoreline. This area has been assumed to be connected and outlet at the location along the river as depicted in the GIS files.

In addition to the areas with missing information, there were a total of 40 MHs / CBs identified for topographic survey, for which the rim elevation was to be confirmed. These locations were selected where a large discrepancy (i.e. >0.30 m +/-) between the rim elevations noted in the available C-plans and the elevations extracted from the City provided DEM was indicated. Surveying of these locations allows for the data sources to be confirmed, and whether any additional correction factors would be required. From review of the surveyed locations, the corrected surveyed elevations on average were found to be within 0.05 m (+/-) in comparison to the C-plan elevations. This demonstrates a strong degree of confidence with respect to the surveyed elevations, which have been carried forward as the primary source of rim elevation.

It should also be noted that as part of previous data analysis, there were discrepancies found with respect to the DEM data and the other sources of elevation data (survey and C-plans), indicating a potential discrepancy with the vertical datum applied (ref. Technical Memorandum # 1). Through subsequent model building, it was found that the initial DEM provided by the City was also generating errors during the elevation processing as part of the PCSWMM model development. The City subsequently re-issued the DEM in a refined GIS compatible format, which was then further reviewed for consistency amongst other data sources provided and collected through the course of the study. Through review of the corrected survey data, record drawings and comparison to the initial DEM, the revised DEM provided by the City was confirmed to be in the City's 1928 vertical datum and provided refined data quality to resolve the issues experienced with the model building tools.

The purpose of the additional site visit conducted by WSP staff on July 17, 2020, was to confirm the missing infrastructure from the topographic survey, as well as conduct spot depth measurements within select sewersheds. A high-level comparison of C-plan drawing inverts and the elevations within the GIS data has been completed, and some discrepancies were found in the western part of the study area, primarily in existing residential areas (Broadview Avenue, Maple Avenue, Pine Avenue). In these cases, the elevations determined through site visits have been used to adjust the rim elevation as required.

2.2.4 Closed Circuit Television (CCTV) Review

City wide infrastructure operations & maintenance (O & M) and asset management programs include inspections of City owned infrastructure. This allows for the completion of condition assessments and identification of critical issues to inform scheduling and budgets of both maintenance and capital improvement projects. For buried infrastructure such as storm sewers, a typical method for inspections includes camera-based investigations, such as closed-circuit television (CCTV).

As outlined previously, CCTV inspections were completed in August 2019, by Dambro Environmental Inc., for the storm sewer system in the Port Credit area. This inspection and associated reports included summary of maintenance issues such as deposits, debris, cracks, damage, obstructions, as well as identification of unknown system components, such as unmapped taps / connections into the system and other elements, such as undocumented pipe material changes. The outcomes for this inspection resulted in O & M ratings and likelihood of failure, which can provide further insight into the maintenance needs of the system.

Based upon the mapping and CCTV investigation reports provided by the City, over 50% of the storm sewers within the current study area were attempted as part of the inspection. Those that were excluded were sewers along major roadways such as Lakeshore Road and Hurontario Street (likely due to safety concerns), as well as private infrastructure within the "West Village" development lands, and the external areas to the east of Hurontario Street and the Tecumseh Creek box culvert along Shawnmarr Road. The CCTV investigation focused upon the neighborhood and community node areas of Port Credit.

It should be noted that of the areas for which CCTV was attempted, there are several areas which were unsuccessful due to issues with access and/or not being able to locate the line. These instances have not been reviewed / summarized, as the focus of the current summary is for any issues found in the field during completed CCTV inspection.

For the purpose of this study, the CCTV data have been reviewed to identify major findings which could influence the existing performance of the system and exacerbate local flooding issues. The major findings included in this summary are as follows:

- **Unmapped Taps:** These indicate external connections (i.e., private connections such as basements, etc.) which could be prone to flooding under backwater conditions.
- **Major Issues:** These are noted if they resulted in an abandoned survey attempt, or if deemed more excessive than typical maintenance needs, including:
  - Maintenance: Debris, Deposits, Damage
  - Obstructions (i.e., external pipe / chamber)
  - Line Under Water (i.e., submerged on a dry weather day)

The major findings from the CCTV investigation have been summarized on **Drawing 5** as well as in **Table 2.3**.

Of the completed CCTV investigations, there were over 30 pipe segments found to have unmapped taps indicating external connections; these occurrences are scattered throughout the study area and have been considered for the performance evaluation of the system and impacts to the local area. These connections may represent residential foundation drain connections and may require further review with the City of Mississauga for further information.

Maintenance issues such as local debris, deposits and minor damage are expected in buried infrastructure, especially within a system of this vintage; however, over 20 pipe segments were found to have more significant maintenance issues, some of which resulted in abandoned survey (unable to pass). Issues of this magnitude can reduce flow conveyance and cause additional backup within the system during a storm event.

Table 2.3: Major Findings from Port Credit CCTV Investigation

CCTV Investigation Finding	Results
Study Area – CCTV Attempted (# of pipe segments / m of sewer)	225 / 9,750 m
Study Area – CCTV Not Attempted (# of pipe segments / m of sewer)	141 / 7,725 m
Unmapped Taps (# of pipes)	33 (+/-)
Debris (# of pipes)	6 (+/-)
Deposits (# of pipes)	9 (+/-)
Damage (# of pipes)	8 (+/-)
Obstructions (# of pipes)	27 (+/-)
Line Under Water (# of pipes)	15 (+/-)

In addition to general maintenance findings, over 25 pipe segments were found to have significant obstructions which prevented the CCTV from continuing along the pipe; the type of obstructions identified included external / intruding pipes, excessive debris, or unknown obstructions. Similar to the other maintenance issues noted, obstructions can significantly reduce the conveyance capacity of the system and result in lowered performance and increased risk of flooding.

Most notably, 15 pipe segments were found to be submerged / under significant water depth during the time of the inspection. Given that the inspections were completed under dry weather conditions, it would not be expected for the lines to be submerged. This suggests significant backwater influence from the Credit River and Lake Ontario, which has been noted to have high lake levels since 2017, causing approximately 600 m (+/) of sewer length to be submerged under dry conditions; these findings have been taken into consideration for model development and performance analysis.

2.2.5 Major System Flow Route Analysis

Historically, severe storm events often cause significant problems related to the performance of the major (overland) system. This is particularly prevalent in areas which pre-date modern major / minor system design principles, which constitutes the majority of the subject study area in Port Credit. A surface storage analysis based upon the local terrain can provide further insight into the overland drainage patterns and helps identify potential sag areas prone to ponding, which are often most impacted by blockages in the catch basin inlets, therefore reducing storm sewer capacity and increasing roadway flooding.

A GIS-based depression storage assessment has been completed, using the secondary DEM provided by the City, to define low points on the landscape, in order to identify both potential problem areas and specific locations for future focused analysis and remediation. A depression has been identified if elevation points surrounded / encircled another elevation point with at least a 0.30 m decrease in elevation from the outer points, and a minimum ponded area of 25 m^2. The results of this assessment have been summarized on **Drawing 6** which demonstrates areas of higher depression storage, at a depth greater than 0.30 m.

There are several zones within the study area which demonstrate larger depression storage capacity and potential for ponding, including those within both private and public property. Based on the mapping (ref. **Drawing 6**), the largest surficial depression areas include those within the following areas:

- Shawnmarr Road approaching Lakeshore Road
- The mixed-use parcel west of the Credit Landing Shopping Centre (undeveloped conditions)
- The south-eastern parking lot of J.C. Saddington Park and Lake Street
- Harbourfront / marina parking lot
- Community Node area – ranging from Park Street north of Lakeshore, extending east towards Port Street south of Lakeshore
- Sags beneath CNR crossings – Mississauga Road and Hurontario Street
- Eaglewood Blvd to Troy Street, north of the railway

These locations represent potential problem areas which may require additional analyses, such as 2-Dimensional modelling, to further assess the performance and flood risk throughout the noted overland storage zones. This need has been reviewed as part of subsequent project tasks with respect to the hydrologic / hydraulic modelling.

3 EXISTING CONDITIONS CHARACTERIZATION

3.1 Model Selection

The integrated hydrologic-hydraulic model selected for use in this study is PCSWMM. PCSWMM is a graphical user interface which applies the US EPA-SWMM model. PCSWMM has been selected based on previous application in the City of Mississauga and adjacent Southern Ontario municipalities for similar assessments, the robustness of the tool, support through the U.S. Environmental Protection Agency (including the ability to open any models generated through the EPA-SWMM freeware), as well as pre- and post-processing enhancements, including powerful GIS tools.

3.2 Hydrologic Model Development

3.2.1 Drainage Boundary Delineation

3.2.1.1 Sewershed Delineation

The preliminary drainage boundaries for each of the storm sewersheds within the Port Credit study were initially delineated based upon available 1 m contours and the storm sewer mapping provided by the City. As part of subsequent model building steps, these boundaries have been refined and updated to reflect the DEM data provided for use in this study. Subcatchments have been delineated using the Watershed Delineation Tool (WDT) provided in PCSWMM, which processes the topography data at a user defined threshold for target drainage area size; this has been set to a target of approximately 0.5 hectares per subcatchment, which generates a resolute level of detail, particularly for the current master plan level of study.

The resulting subcatchments have been further reviewed and refined based upon contour data, aerial mapping, parcel data and storm sewer infrastructure mapping to ensure appropriate delineation within the respective sewershed and ultimately routing to outlets. The summary statistics for the hydrologic delineation within each network is provided in **Table 3.1**.

Table 3.1: Hydrologic Model Network Summary

Network ID	Total Drainage Area (ha)	No. of Subcatchments (#)	Average Size of Subcatchments (ha)
CR_E1	1.3	4	0.32
CR_E2	54.8	168	0.33
CR_E3	2.0	11	0.18
CR_W1	2.6	9	0.29
CR_W2	3.5	15	0.23
CR_W3	3.1	14	0.22
CR_W4	14.2	30	0.47
CR_W5	3.3	10	0.33
LO_E1	0.7	2	0.34
LO_E2/3	3.4	15	0.23
LO_W1	5.3	12	0.44
LO_W2	29.5	83	0.35
LO_W3	15.2	52	0.30
TC1	15.1	23	0.69
Total Model	**154.0**	**448**	**0.34**

As noted in **Section 2.2.1**, the TC1 network contributing to the enclosed Tecumseh Creek culvert is unique in that the majority of the contributing lands are private townhouse developments, which are assumed to have separate and internal private servicing for the conveyance and collection of stormwater runoff. Record drawings provided for a segment of Shawnmarr Road demonstrate a number of servicing connections from the private parcels on the west and east sides of Shawnmarr Road; these mapped connections have been used to support the delineation of the subcatchments in this area, and discharge to the enclosed 3 m wide x 1 m high box culvert. The minor / major system split in this area is based solely on the connecting conduit capacity, due to the lack of information regarding internal servicing and major flow pathways.

3.2.1.2 Brightwater Community

As indicated in previous sections, the Brightwater Community is proposed within the West Village development lands located west of Mississauga Road and south of Lakeshore Road. Background information was provided by the City regarding the proposed Brightwater Community including a Stormwater Management Design Brief (ref. Urbantech, May 2021) and associated PCSWMM models to assess site drainage and confirm the proposed SWM design. Given the substantial development application and its influence on the current Port Credit SDMP, special consideration has been required to incorporate this area into the current modelling efforts.

Through review of the Brightwater Community SWM Brief, the Brightwater Community lands consist of 29.1 hectares of land, which were formerly used by Imperial Oil for refinery and other industrial uses (including a brickworks facility); therefore, the site is currently undergoing active environmental remediation prior to development. Under existing conditions, the undeveloped lands drain generally from north to south towards Lake Ontario.

The proposed land use for the proposed development includes several public rights-of-way (ROW) and private site plan development blocks consisting of mixed use, high density residential, commercial, and parks / open space areas. The proposed development lands are to drain towards two separate outlets, denoted as the west and east outfalls. The west outfall is proposed to be a new outfall location to Lake Ontario and is to provide an outlet for approximately 16.2 ha of the subject lands. These lands would therefore remain independent of the existing storm sewer network and would consist of new internal site servicing and sewer designs.

The east outfall drainage is proposed to consist of approximately 12.6 ha of the subject lands, and discharge into the existing storm sewer system along Mississauga Road, which currently collects drainage from external lands including Port Street, Bay Street, Lake Street, Peter Street, and lands to the North of Lakeshore Road. The existing storm sewer along Mississauga Road consists of pipe sizes ranging from 900 mm up to 1050 mm in diameter, which ultimately outlets to Lake Ontario via an existing headwall; this outfall and associated network is referred to as LO_W3 in the current Port Credit SDMP.

The existing conditions assessment completed by Urbantech found that this storm sewer system is currently over capacity during the 10-year storm event, which is the City of Mississauga's minor system design criteria. This suggests that the existing storm sewer system is currently undersized for the contributing drainage area. As such, Urbantech has proposed infrastructure upgrades along Mississauga Road south of Lakeshore Road consisting of box culvert sections ranging from 1800 mm W x 900 mm H up to 3600 mm W x 1200 mm H at the outlet, to accommodate all additional drainage from the subject lands and improve the capacity with respect to the external drainage areas.

With respect to SWM measures associated with the proposed development, Urbantech has outlined that the subject area does not require quantity control given the proximity to Lake Ontario. However, to limit the size of infrastructure required within the public ROWs, the site plan areas are proposed to provide quantity control of the 100-year event through on-site controls (i.e., cisterns / storage tanks, and/or Low Impact Development (LID) Best Management Practices (BMPs)) and discharge into the storm sewer at the specified release rate (i.e. 10-year flow or lower). The detailed design of these controls is to be finalized as part of the individual site plans for each block; however, the quantity control aspect was included as part of the public ROW storm sewer design in the supplied modelling. Water quality control, erosion control and water balance measures are also required for the private site plan areas and are to be designed as part of the subsequent site plan development applications.

Water quality control measures have been designed for the public ROW areas in the form of 53 bioretention facilities designed to treat 27 mm of runoff, in accordance with the applicable design requirements. These bioretention facilities are proposed to be designed with an impermeable liner, as a result of poor soil conditions limiting the ability for infiltration; these features have therefore not been credited as part of the storm sewer design. Quantity control explicit to the public ROW drainage areas has not been required.

Given the complexity of the proposed development area representing a significant change in land use, as well as the various on-site controls proposed and designed by others, this development has been incorporated separately, through the importation of outflow hydrographs from Urbantech's modelling into WSP's dual drainage model developed for the Port Credit SDMP. The infrastructure upgrades proposed along Mississauga Road have been applied in the current Port Credit PCSWMM model, with the assumption that these upgrades have been approved by City staff and will likely be constructed imminently as part of the development works (thus it has been concluded that there is no value in assessing the existing City storm sewer in this area). The Brightwater Community PCSWMM models developed by Urbantech have been simulated for the design storm events identified for the SDMP to develop the site outflow hydrographs (ref. **Section 3.4**).

The resulting flows from the Brightwater PCSWMM models specific to the east outfall area have been extracted for all simulated storm events, and assigned to the appropriate inlet node (i.e., storm sewer manhole and/or tie for minor flow or any major flow from the Brightwater ROW contributing to the major / minor system on Mississauga Road) of the current Port Credit PCSWMM model. Given that the west outfall is a newly proposed outlet to Lake Ontario and is independent of any existing City infrastructure, this drainage area has not been incorporated into the current model, under the assumption that all site plans are to be controlled and discharge to the new storm sewer system and west outfall. This methodology allows for the inclusion of both the minor / major inflows to the Mississauga Road storm sewer network (LO_W3) from the lands contributing to the east outfall, while minimizing the duplication of effort for modelling the

Brightwater Community lands, which have been assessed by others through separate study.

3.2.2 Subcatchment Parameterization

The subcatchments delineated for each sewershed (refer to **Drawing 7**) have been parameterized based upon the provided background information including the DEM, aerial mapping, direct measurements, soil reports, etc. Further description of the methodology for hydrologic parameterization of existing conditions is provided in the following subsections.

3.2.2.1 Imperviousness

The impervious coverage for each of the subcatchments has been established through review of the existing land uses present within the study area. Through review of the MOP mapping, the Port Credit community land use is largely consistent with the planned OP, with areas of residential, mixed use and commercial land uses. The MOP mapping layer (shown as received on **Drawing 2**) has been reviewed and refined in certain areas to represent further detail including areas such as large parking lots for parks / recreation, schools, etc., which are important considerations for hydrologic parameterization.

The impervious coverage of the resulting land use designations has been assessed by reviewing aerial imagery and measuring the impervious coverage (i.e., buildings, driveways, patios, parking lots, etc.) on a select number of parcels, to determine an average imperviousness per land use type. The resulting imperviousness of the existing land uses within the Port Credit study area are summarized in **Table 3.2**.

Table 3.2: Impervious Coverage for Port Credit Land Uses

Land Use Category	Imperviousness (%)
Commercial	90
Greenlands	5
Mixed Use	90
Open Space	5
Parking	95
Rail	60
Res High Density	65
Res Low Density I	45
Res Low Density II	45
Res Medium Density	55
Road	70

These average impervious coverages have been used in conjunction with the existing land use mapping to determine the subcatchment imperviousness through areal weighting. The resulting subcatchment imperviousness ranges from 6% up to 95%, with the average imperviousness being approximately 63%.

3.2.2.2 Flow Length and Slope

The overland flow length, as defined in the EPA SWMM 5 manual, represents the length of the sheet flow path (shallow flow). For larger subcatchments, this parameter typically becomes a calibration factor, however for smaller catchments the modelling is generally insensitive. The subcatchment slope represents the average gradient across the subcatchment surface.

For the Port Credit SDMP, flow length and slope were initially determined through the WDT process using the DEM provided for this study. The resulting flow length automatically calculated for each subcatchment has then been reviewed and refined to ensure reasonableness based upon the average length for sheet flow, before entering the urban storm sewer collection system. For example, sheet flow in residential areas has been typically assumed to occur lengthwise across the parcel, such as from the roof line to the roadway, assuming lots are graded to drain towards the roadway. This may not be represented in the automatically generated flow lengths and has therefore been spot checked to represent the urbanized site grading, and shorter flow paths prior to being intercepted by the urban collection system in the roadway.

Slope for each subcatchment has been initially determined automatically using the DEM, these values have been further reviewed / refined to ensure accuracy and reasonableness with respect to the flow path, and to simplify the ranges to avoid excessively large or small slope values. On average, the slope of the subcatchments range from 0.5% to 10%, with an average of 1.7% across the study area, which is consistent with urbanized lands.

3.2.2.3 Manning's Roughness Coefficients

Manning's roughness coefficients represent the type of surface for the subcatchment, and the associated friction applied to the flow across the subcatchment surface. Manning's roughness coefficients have been determined for the pervious and impervious portions of each subcatchment. Consistent with previous studies and literature recommended values, a value of 0.013 has been assigned to the impervious segment of each subcatchment and a value of 0.25 has been assigned to the pervious segment of each subcatchment.

3.2.2.4 Depression Storage

Depression storage represents the depth of rainfall which would be captured and detained in surface depressions within the subcatchment. Depression Storage values have been assigned to the impervious and pervious segments of each subcatchment. One mm of depression storage has been assigned to impervious segments of subcatchments, while 5 mm of depression storage has been assigned to pervious segments of subcatchments based on standard conventions applied on other similar studies.

3.2.2.5 Soil Parameters

The infiltration methodology selected for the model development and simulation is the United States Soil Conservation Service (SCS) Curve Number method; this method determines the infiltration potential of the pervious lands based upon the hydrologic soil type, land cover and condition. Traditionally, soil mapping would be used to determine the soil types present within the study area and utilize an areal weighting approach for the subcatchments; however, given the urban nature of the Port Credit study area, open-source soil mapping (i.e., Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Soil Survey) does not have mapping available for built up areas.

As such, the City has provided a number of geotechnical investigations completed throughout the study area to assist in determining the native soil conditions. The borehole data have been reviewed from the various sources, and the information has allowed for the characterization of the study area into four general zones; these are generally separated by the Credit River (West and East), and Lakeshore Road (North and South). The findings from the geotechnical investigations found the native soils are largely heterogenous with occurrences of sandy loam, sandy silt, clayey silt, clay till, etc.

Through review of the borehole records within each approximate zone, the predominant hydrologic soil groups were found to be Hydrologic Soil Group B (i.e., Silt Loam) in Zone 1 and 3, north of Lakeshore Road, and Hydrologic Soil Group C (i.e., Sandy Clay Loam) in Zone 2 and 4, south of Lakeshore Road. A visual representation of the area zones is presented in **Figure 3.1**.

Figure 3.1: Soil Zones within the Study Area

The Curve Numbers (CN) have been sourced from Table 2-2a in the Urban Hydrology for Small Watersheds (ref. TR-55), which summarizes the various CN for urban areas. Based upon the soil groups B and C, and assuming the pervious lands are in good condition (grass cover > 75%), the resulting CN for areas north of Lakeshore Road (Zones 1 and 3) and south of Lakeshore Road (Zones 2 and 4) are assumed to be 61 and 74 respectively. It should also be noted that the models developed for the Brightwater Community (located south of Lakeshore in Zone 4), also applied a CN value of 74, which is consistent with the current findings.

3.3 Hydraulic Model Development

3.3.1 Minor System (Storm Sewers)

The GIS data for the storm sewer network (nodes and mains) provided by the City have been used to create a base hydraulic model in PCSWMM for the primary hydraulic elements, including all storm sewer conduits and junctions. The invert and rim elevations have been assigned as provided in the GIS shapefile and/or gap filled through C-plans and/or survey, as outlined in the previous sections.

As noted in **Section 3.2.1.2**, the Brightwater Community development has included infrastructure upgrades along Mississauga Road, south of Lakeshore Road to the outlet at Lake Ontario. These proposed upgrades from circular pipes to larger box culvert pipes have been incorporated into the existing conditions hydraulic model, to represent the improvements expected to be carried forward imminently by the approved development.

The vast majority of the storm sewer system consists of concrete pipes, with few occurrences of corrugated metal pipes, based upon the GIS data provided by the City. Concrete pipes have been assigned a Manning's Roughness Coefficient of 0.013, and corrugated metal pipes have been assigned a Coefficient of 0.024. The losses associated with the inlet / outlet treatment of the pipes (i.e., pipe bends at manholes) have not been accounted for in the current assessment, which is considered to be appropriate for the current scope of the modelling effort.

The boundary conditions for each of the hydraulic networks have been evaluated by comparing the impact of applying a normal depth boundary condition (i.e., based on conduit slope) as compared to applying the 100-year Lake Ontario water level, which is 76.0 m based upon CVC's December 2020 publication (ref. Addendum to CVC's Lake Ontario Shoreline Hazards Report (Shoreplan, 2005), December 24, 2020). It was found that while applying the 100-year Lake Ontario level boundary condition would be slightly more conservative for the storm sewer segments immediately upstream of the outfalls, it generated oscillations and instabilities in the modelling results near the outlet. When comparing the results between the normal and high lake level conditions, the differences were largely found to be within the downstream segments of the sewer system and had minimal impact further upstream.

For this analysis, the normal depth boundary condition has been applied for the model simulations to limit any model instability. However, it is noted that backwater conditions from Lake Ontario and/or the Credit River may be a concern in certain areas, therefore any implications should be taken into consideration when evaluating opportunities for improvements.

3.3.2 Major System (Roadways)

The PCSWMM software provides the dual drainage feature for the interconnected modelling of both the minor system (subsurface) and major system (surface). PCSWMM can automatically generate the major system pathways using the Dual Drainage Creator tool, which uses the defined minor system nodes (manholes) and generates a mirrored conveyance system based upon the rim elevation of the manholes acting as the inverts of the major system (road profile).

The major system conduits in the model have been established based on the various road rights-of-way (ROW) sections within the Port Credit study area. The ROW cross-sections are largely comprised of urban cross-sections with curb and gutters, as well as select areas consisting of rural cross-sections with roadside ditches. Routing elements representing the urban cross-sections have been developed based upon aerial imagery, parcel mapping and standard ROW cross-sections for two different urban categories, including residential roadways (i.e., two lanes, majority of the study area) or major roadways (i.e., four lanes, such as Lakeshore Road and Hurontario Street). For rurally serviced sections in certain residential neighborhoods, ditch cross-sections have been characterized through measurements of the DEM and confirmation via field data and/or Google Street View™ programs. Rural sections have been incorporated into the modelling as two laned roadways, with roadside ditches along both sides of the ROW (average ditch depth of 0.30 m).

Both the urban and rural cross-sections have also applied an additional 2% cross-fall for the portion of the cross-section beyond the ROW, providing the opportunity to quantify if flow extends beyond the ROW limits which supports the assessment of level of service. The maximum allowable depth within the urban ROW has been established as 0.25 m, with the transect extended beyond the ROW to a maximum allowable depth of 0.35 m. The rural sections have a maximum allowable depth within the rural ROW of 0.37 m, and extending beyond the ROW to a maximum allowable depth of 0.42 m.

The major system pathways have been reviewed and refined to represent any additional pathways (i.e., rear-yard swales, roadway connections not indicated by the initial dual drainage tool for the minor system) and connections such as inter-network spills occurring during high flow and/or backwater conditions. This allows for the major system portion of the model to be fully connected and can further identify areas where conveyance capacity is insufficient. Boundary conditions for the major system conduits have also been set to normal depth, which is consistent with the interconnected minor system.

3.3.3 Linkages (Inlets)

The PCSWMM model has been developed such that the runoff generated from each subcatchment is initially conveyed to the major system components and then routed to the minor system through orifices representing catchbasins (single and double) and maintenance hole lids.

The orifices have been modelled as square bottom draw openings, which have been sized based upon the measurements of the open area depicted on the respective Ontario Provincial Standard Drawings for catchbasin grates (i.e., standard single catch basin opening size of 0.125 m^2, modelled as 0.35 m x 0.35 m opening). The number and type of catch basins within each sewer network have been established, and an equivalent opening size has been applied to each storm sewer node (manhole) representing the inlet capacity of the upstream and/or surrounding inlets.

It should be noted that there are some drainage areas which have been directly connected to the minor system through subcatchment routing as opposed to inlet controls. Areas where this methodology has been applied are private parcels assumed to have internal and private servicing, for which there is no public information. An example of a residential area with this assumption includes the townhouse developments along Shawnmarr Road (network TC1), and mixed-use / commercial examples include the Credit Landing Shopping Centre (network CR_W4), and the 70 Port Street E plaza (network LO_E2/E3). Through aerial imagery, these properties have been identified to have on-site inlet controls (catch basins, inlet grates at intersections, etc.) which suggest internal stormwater servicing, ultimately contributing to the City infrastructure located in the ROW. Due to the lack of information regarding the internal servicing on private properties, stormwater runoff from these areas has been conservatively assumed to be captured on-site and has been routed directly to the minor system.

3.4 Model Performance Analysis

3.4.1 Modelling Approach

The design storm events being used for simulation have been based upon the existing IDF parameters per Section 8 in the City's Development Requirements Manual (effective November 2020). There are a variety of storm durations and distributions that can be applied when completing design storm assessments; the choice typically depends on the modelling platform, legacy modelling, and the study purpose (i.e. investigative versus design). For studies such as the Port Credit SDMP, the most conservative event would be preferred to evaluate the system performance under the most significant events.

As indicated in the City standards, the Chicago distribution is recommended for determining hydrographs in urban areas, whereas the SCS method should be used for undeveloped watersheds and for checking detention storages for quantity control. Therefore, the PCSWMM model has been simulated for the 24 hour 100-year event, applying both the Chicago and SCS distributions to determine the more conservative event. Based upon review of the system results (ref. **Appendix B**), the Chicago distribution (10 min time step, and time to peak of r = 0.35) produced a higher peak flow (as a result of higher maximum intensity) and has therefore been applied for the remaining design storms, including the 2-, 5-, 10-, 25- and 50-year events.

3.4.2 Model Validation

The existing conditions PCSWMM model has simulated the 100-year design storm event and the subcatchment peak runoff results have been reported on a unitary basis (per area), in order to compare the results to other similar hydrologic modelling studies, from both rural and urban drainage areas, for various sizes of subcatchment area. The unitary results have been summarized for each of the 14 networks and have been compared to unitary modelling results completed using both PCSWMM and XPSWMM, for urban study areas with a similar subcatchment resolution to that applied in the Port Credit modelling (i.e., less than 10 ha). This comparison of 100-year unitary flows is demonstrated on **Figure 3.2**.

The resulting average unitary flows produced by the Port Credit PCSWMM model range from 0.30 to 0.45 $m^3/s/ha$ on a network basis, and an average model unitary flow of 0.37 $m^3/s/ha$. Based upon WSP's experience, these results are generally consistent with those found in other similar urban hydrologic modelling studies. The Port Credit PCSWMM results are within the higher range of the comparison, however this can be expected given the high imperviousness of certain networks.

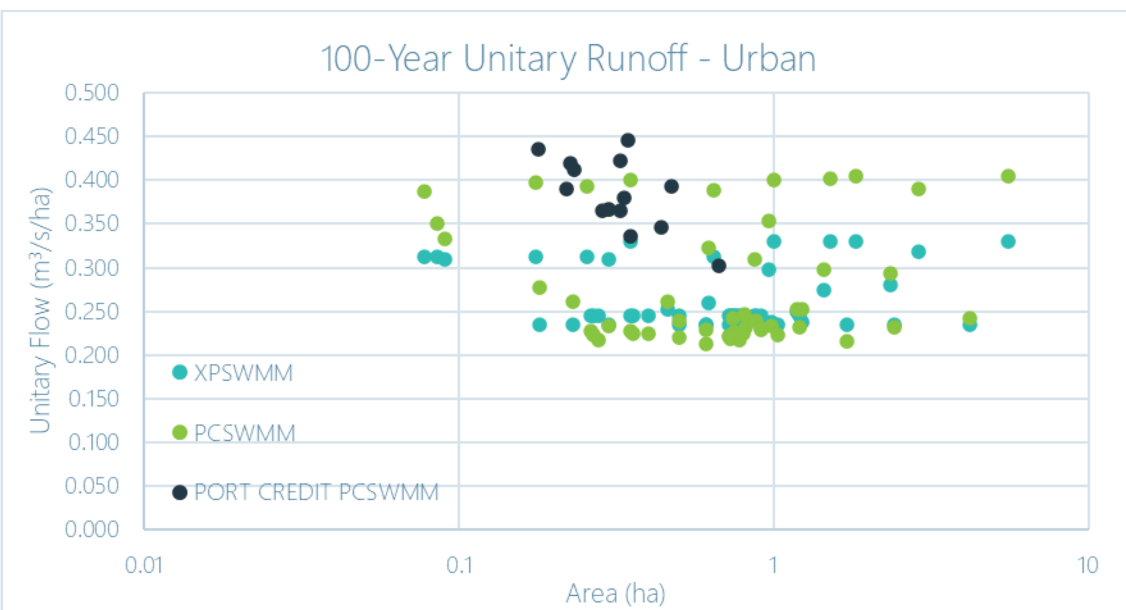

Figure 3.2: 100-year Unitary Runoff Urban Area Validation

3.4.3 Performance Results

The validated PCSWMM model has been assessed to identify system performance and associated capacity constraints along the major and minor systems under existing conditions. Performance of the minor system has been evaluated using the 10-year design storm and the performance of the major system has been evaluated under the 100-year design storm, in accordance with the City’s current design standards. As outlined in **Section 3.4.1**, the synthetic design storms have been generated using the Chicago distribution with a 24-hour duration, using the Intensity-Duration-Frequency relationships provided in City’s Development Requirements Manual (November 2020), which have been derived from the Pearson International Airport rainfall data. The precipitation depth totals for the City’s current 10-year and 100-year 24-hour design storm events are presented in **Table 3.3**. The following sections discuss the results of the analyses.

Table 3.3: City of Mississauga 24-Hour Design Storm Event Precipitation Depths

Design Storm Event Return Period	Total Precipitation Depth (mm)
10-year (Minor System)	83.2
100-year (Major System)	119.4

3.4.3.1 Minor System Results

The validated PCSWMM hydrologic model has been used to assess the performance of the minor system, comprised of existing storm sewers within the urban rights-of-way in the Port Credit study area. The performance of the storm sewer network has been established based upon two categories for performance, including the hydraulic gradeline (HGL) within the minor system, as well as the operating pipe depth capacity during the simulated events. A visual representation of the HGL performance is presented in **Figure 3.3**, and further details are provided below for each performance category.

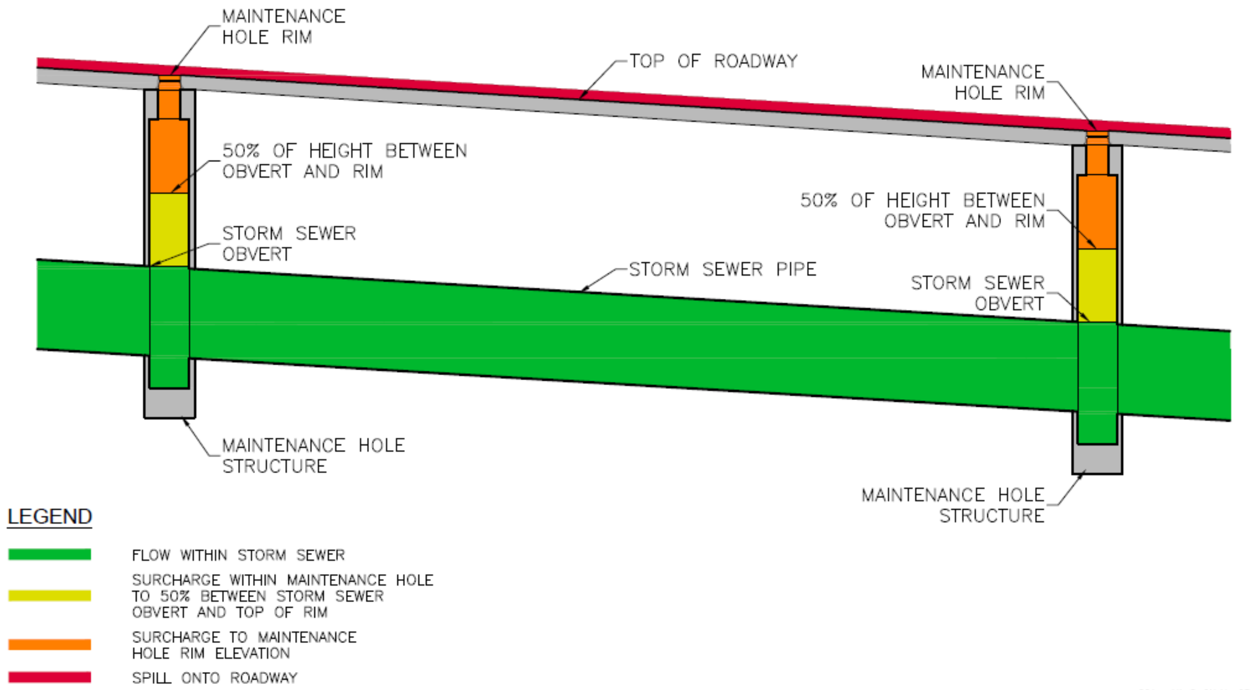

Figure 3.3: Minor System Performance Criteria (HGL)

Hydraulic Gradeline (HGL)

— **Grade A**: Hydraulic gradeline at or below pipe obvert.

— **Grade B:** Hydraulic gradeline above pipe obvert, but below 50% of the height between the obvert and the top of the manhole.

— **Grade C:** Hydraulic gradeline above 50% of the height between the obvert and the top of the manhole, but below the top of the manhole.

— **Grade D:** Hydraulic gradeline above the top of the manhole.

Hydraulic Capacity

— Pipe operating at less than capacity during simulated event.

— Pipe operating at capacity during simulated event.

The benefit of identifying if the HGL is above or below the 50% height of the manhole, is in reference to external connections such as foundation drains or other private connections, which may be impacted by the potential backup of water during high flow storm events. While information regarding private connections is not readily available for the Port Credit community, it can be inferred through the results of the CCTV and/or as part of future studies to identify areas where this condition might be sensitive.

The length of storm sewer within each performance category for both HGL and capacity has been summarized for each sewershed network and has been reported both in terms of length and percentage of the system within each performance category. The results for the HGL and Flow Capacity assessment of the 10-year storm have been presented in **Table 3.4** and **Table 3.5** and have also been visually represented on **Drawing 8** and **Drawing 9**. Results for additional storm event simulations can be found in **Appendix C**.

Table 3.4: Existing Conditions Minor System Performance – Hydraulic Gradeline – 10-year Storm

Network	Minor System Length (m)	HGL Performance (m)				HGL Performance (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	82	132	0	0	38%	62%	0%	0%
CR_E2	6,481	1,535	1,254	1,677	2,014	24%	19%	26%	31%
CR_E3	346	145	0	110	91	42%	0%	32%	26%
CR_W1	300	0	0	213	87	0%	0%	71%	29%
CR_W2	434	0	146	62	226	0%	34%	14%	52%
CR_W3	430	173	256	0	0	40%	60%	0%	0%
CR_W4	1394	164	255	898	77	12%	18%	64%	6%
CR_W5	413	243	118	53	0	59%	28%	13%	0%
LO_E1	126	63	0	64	0	50%	0%	50%	0%
LO_E2	179	179	0	0	0	100%	0%	0%	0%
LO_E3	454	454	0	0	0	100%	0%	0%	0%
LO_W1	106	0	0	106	0	0%	0%	100%	0%
LO_W2	3,437	206	321	1,226	1,684	6%	9%	36%	49%
LO_W3	2,278	860	337	466	615	38%	15%	20%	27%
TC1	905	905	0	0	0	100%	0%	0%	0%
Total	**17,496**	**5,008**	**2,819**	**4,875**	**4,794**	**29%**	**16%**	**28%**	**27%**

Table 3.5: Existing Conditions Minor System Performance – Pipe Capacity – 10-year Storm

Network	Minor System Length (m)	Capacity Performance (m)			Capacity Performance (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	123	91	0%	57%	43%
CR_E2	6,481	584	1,759	4,138	9%	27%	64%
CR_E3	346	50	94	201	15%	27%	58%
CR_W1	300	0	0	300	0%	0%	100%
CR_W2	434	16	130	288	4%	30%	66%
CR_W3	430	51	287	91	12%	67%	21%
CR_W4	1,394	156	149	1,089	11%	11%	78%
CR_W5	413	62	323	29	15%	78%	7%
LO_E1	126	0	63	64	0%	50%	50%
LO_E2	179	102	77	0	57%	43%	0%
LO_E3	454	438	16	0	96%	4%	0%
LO_W1	106	0	0	106	0%	0%	100%
LO_W2	3,437	156	459	2,822	5%	13%	82%
LO_W3	2,278	445	717	1,117	20%	31%	49%
TC1	905	814	90	0	90%	10%	0%
Total	**17,496**	**2,875**	**4,287**	**10,335**	**16%**	**25%**	**59%**

The results in **Table 3.4** demonstrate that six of the networks have over 20% of the sewer network operating at a performance category D (HGL above manhole rim), which includes the three largest sewershed pipe networks (CR_E2, LO_W2 and LO_W3). The total simulated study area performance indicates that 27% of the storm sewer infrastructure has an HGL that would exceed the manhole rim and reach road elevation, whereas the remaining 73% of the network is contained within the storm sewer infrastructure.

The results in **Table 3.5** demonstrate that a vast majority of the networks are at full capacity during the 10-year storm event, with 59% of the total study area operating at full capacity. This includes eight out of the 14 networks operating with over 50% of the storm sewer network at full capacity. These results indicate deficient conveyance capacity and would have a higher susceptibility to high levels of surcharge and/or surcharging above the rim elevation during the 10-year design event. These results will be used as baseline characterization and comparison points for both intensification and climate change scenarios, to evaluate the need for mitigation options within the Port Credit study area.

3.4.3.2 Major System Results

The validated PCSWMM hydrologic model has been used to assess the performance of the existing major system, which encompasses primarily urban road sections, with some ditched / hybrid road sections within the study area. The hydraulic gradeline generated for the 100-year synthetic design storm has been used to determine the total length of road rights-of-way in each network for which the hydraulic gradeline would fall into the following performance categories:

Grade A: 100 Year flow contained within the top of curb / top of ditch

— Water Depth = <0.15 m (urban) or <0.30 m (ditch)

Grade B: 100 Year flow above top of curb / top of ditch but contained within rights-of-way

— Water Depth = between 0.15 and 0.25 m (urban) or 0.30 m and 0.37 m (ditch)

Grade C: 100 Year flow exceeds the rights-of-way

— Water Depth = >0.25 m (urban) or >0.37 m (ditch)

It should be noted that the resulting depth within an overland flow conduit is based upon an average of the two connecting nodes upstream and downstream. As a result, the resulting performance grade may not fully represent the conditions on either end of the pipe (i.e., high point versus a sag point, may generate an average performance); however, the average provides a strong indication of the areas which warrant additional review for capacity improvements.

The total length and percentage of rights-of-way within each network, which falls into each of the above performance categories, is summarized in **Table 3.6**. The grand total in each table represents the total length of the storm sewers for each network and the percentage of the storm sewers in the study area respectfully. The curbed and ditched performance results are depicted graphically in **Drawing 10**. Results for additional storm event simulations can be found in **Appendix C**.

The results in **Table 3.6** demonstrate that 80% of the major system pathways would contain flow within the curb / ditch, 16% of the major system being higher flow depth but contained within the rights-of-way, and only select networks demonstrating flow exceeding the rights-of-way under the 100-year event. In review of the topography and depression storage analysis (ref. **Section 2.2.4**), the areas with poor major system performance are generally aligned with the areas identified to have greater than 300 mm depression storage (ref. **Drawing 10**). These areas are essentially low points in the major system which are expected to receive excess / bypass flow from contributing areas and results in ponding within the rights-of-way. These results will be used as baseline characterization and comparison points to both intensification and climate change scenarios, to evaluate the need for mitigation options within the Port Credit study area.

Table 3.6: Existing Conditions Major System Performance – Hydraulic Gradeline – 10-year Storm

Network	Major System Length (m)	Performance (m)			Performance (%)		
		A	B	C	A	B	C
CR_E1	123	41	38	44	33%	31%	36%
CR_E2	6,518	4,937	1,243	338	76%	19%	5%
CR_E3	318	253	66	0	79%	21%	0%
CR_W1	233	233	0	0	100%	0%	0%
CR_W2	383	327	56	0	85%	15%	0%
CR_W3	406	406	0	0	100%	0%	0%
CR_W4	1,255	1,033	222	0	82%	18%	0%
CR_W5	240	229	11	0	95%	5%	0%
LO_E1	62	62	0	0	100%	0%	0%
LO_E2/3	499	419	80	0	84%	16%	0%
LO_W1	419	139	225	55	33%	54%	13%
LO_W2	3,467	2,852	505	110	82%	15%	3%
LO_W3	2,155	1,952	157	46	91%	7%	2%
TC1	848	732	116	0	86%	14%	0%
Total	**16,927**	**13,615**	**2,719**	**593**	**80%**	**16%**	**4%**

Note: LO_E2 & LO_E3 are reported as a single network due to their overlapping infrastructure and shared major system pathways.

4 ADDITIONAL SYSTEM CHARACTERIZATION SCENARIOS

4.1 Intensification

4.1.1 Methodology

As part of the SDMP, land use intensification stress-testing has been completed to evaluate the response and performance of the existing storm sewer infrastructure and major system under future intensified land use conditions. The Port Credit study area is predominantly built out / urbanized under existing conditions (apart from the Brightwater Community, credited in the existing conditions scenario). Therefore, it is expected that the type of future development within the Port Credit community will consist of residential intensification on a lot-level basis, maintaining the existing zoned land uses in the community core.

Through discussions with City staff, it has been determined that the focus of the intensification revolves around the low-density residential zones (both category I and category II), given that these present the largest opportunity for re-builds and increased impervious coverage throughout the study area. The low-density residential areas are present throughout the study area, often bounding the mixed-use corridor both north and south of Lakeshore Road. These areas represent approximately 23% of the total modelled drainage area and are often the oldest neighbourhoods with aging infrastructure.

Mixed-use and/or commercial areas are expected to be generally maintained within their current designations and minimal change in the already high impervious coverage is expected. Medium / high density residential areas currently contain private developments (i.e., townhouses, apartments, condos, etc.) and are not anticipated to see the same magnitude of change as those within the lower density and older neighbourhoods.

To incorporate the expected change in imperviousness as a result of infill / intensification, an evaluation of the existing lot / building coverage has been completed based upon the parcel mapping and building footprint layers provided by the City. The threshold for determining intensification potential is the “as-of-right” condition, for which the City Zoning By-Law stipulates the maximum building footprint cannot exceed 40% of the parcel area for detached dwellings within the Port Credit community (ref. R7 and R15 Zones).

Based upon a GIS analysis of the low-density residential areas, approximately 88% of the lots within this designation have less than the 40% maximum building footprint, indicating a considerable potential for intensification across the study area. The average building footprint under existing conditions was found to be approximately 28% of the parcel area.

To quantify the potential increase in imperviousness associated with the building footprint, all properties identified for potential intensification (i.e. existing building less than 40%) had their future building footprint assigned to the maximum 40%. This resulted in an average building footprint of approximately 40% of the total lot area, assuming all parcels were re-developed simultaneously (100% uptake), representing the most conservative condition.

The building footprint coverage however does not account for the changes in impervious coverage associated with amenity areas such as driveways, patios, walkways, pools etc., which are also known to increase as part of infill / intensification. Through WSP's prior project experience in other similar residential areas, amenity area coverage can generally be assumed as a function of the building footprint (i.e., bigger house, more amenity areas). While this may not always be the case, it is considered reasonable for the current assessment. Through studies completed in other municipalities, amenity areas have been found to be approximately 90% of the building footprint. For the current "as-of-right" scenario, this would represent an additional 36% of the lot area being dedicated to impervious amenity coverage, generating an approximate total impervious coverage of over 76% on a lot scale. This 90% relationship between amenity areas and building footprint has been applied to determine the potential change in total impervious coverage.

Based upon the foregoing analysis, the total impervious coverage (building and amenity area) has been determined to increase by approximately 45% from existing conditions under 100% uptake conditions. This approach to intensification has been discussed with City staff, through which it was decided that a 50% uptake scenario would provide a more realistic condition for future planning purposes.

The low-density residential areas under existing conditions have applied an impervious coverage of approximately 45% through review of aerial mapping and lot measurements. Applying the 50% uptake methodology, the approximate increase in impervious coverage would be approximately 22.5%, generating a future conditions impervious coverage of approximately 55%. This is consistent with that of the medium density residential (set to 55%), which represents the impact of infill / intensification shifting low-density residential areas into higher density categories.

The future conditions model has been updated to reflect this increase in impervious coverage by assuming 55% imperviousness for future low-density residential and updating the subcatchment impervious coverage through a similar areal weighting exercise, as completed for existing conditions. It should be noted that while it is understood that intensification can occur more in certain areas and less in others, the expected locations for intensification are unknown at this time; therefore, the average spread of intensification across the study area is considered reasonable for the current assessment to provide an indication of relative sensitivity. No other changes have been applied to the model, so the performance results are solely representing the influence of infill / intensification on the existing storm sewer and major systems based on the preceding assumptions.

4.1.2 Performance Results

4.1.2.1 Minor System Results

The future intensification scenario PCSWMM hydrologic model has been applied to assess the performance of the minor system and compare against existing conditions (ref. **Section 3.4**). Consistent with the existing conditions results, the performance of the storm sewer network has been established based upon two categories for performance, including the hydraulic gradeline (HGL) within the minor system, as well as the pipe capacity during the simulated events; details for both performance categories are repeated below for reference.

Hydraulic Gradeline (HGL)

- **Grade A:** Hydraulic gradeline at or below pipe obvert.
- **Grade B:** Hydraulic gradeline above pipe obvert, but below 50% of the height between the obvert and the top of the manhole.
- **Grade C:** Hydraulic gradeline above 50% of the height between the obvert and the top of the manhole, but below the top of the manhole.
- **Grade D:** Hydraulic gradeline above the top of the manhole.

Hydraulic Capacity

- Pipe operating at less than capacity during simulated event.
- Pipe operating at capacity during simulated event.

The length of storm sewer within each performance category for both HGL and capacity have been summarized for each sewershed network and have been reported both in terms of length and percentage of the system within each performance category. This has been completed both in terms of future intensification performance, as well as a comparison to existing conditions demonstrating the changes in result categories. The results for the HGL assessment of the 10-year storm have been presented in **Table 4.1** and **Table 4.2**, and the results of the capacity assessment have been presented in **Table 4.3** and **Table 4.4**.. These results have also been visually represented on **Drawing 11** and **Drawing 12**. Results for additional storm event simulations can be found in **Appendix D**.

The results demonstrate that under future intensification conditions, the largest changes observed are within the HGL performance categories of B and C, which is based upon the surcharge depth within the manhole. Minimal increases in the surcharge depth above the manhole rim are observed, with the exception of network LO_W1, which under future intensification conditions would operate at a performance grade D. The pipe capacity results are largely consistent with existing conditions, with approximately 60% of the sewers operating at full capacity under the 10-year event. These results support the characterization of the existing storm sewer network and demonstrates the localized minor sensitivity to intensification in certain networks, predominately within the drainage areas consisting of largely low-density residential.

Table 4.1: Intensification Conditions Minor System Performance – Hydraulic Gradeline – 10 year-Storm

Network	Minor System Length (m)	HGL Performance (m)				HGL Performance (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	82	132	0	0	38%	62%	0%	0%
CR_E2	6,481	1,605	984	1,942	1,949	25%	15%	30%	30%
CR_E3	346	145	0	110	91	42%	0%	32%	26%
CR_W1	300	0	0	213	87	0%	0%	71%	29%
CR_W2	434	0	146	62	226	0%	34%	14%	52%
CR_W3	430	173	256	0	0	40%	60%	0%	0%
CR_W4	1,394	164	255	898	77	12%	18%	64%	6%
CR_W5	413	243	118	53	0	59%	28%	13%	0%
LO_E1	126	63	0	64	0	50%	0%	50%	0%
LO_E2	179	179	0	0	0	100%	0%	0%	0%
LO_E3	454	454	0	0	0	100%	0%	0%	0%
LO_W1	106	0	0	0	106	0%	0%	0%	100%
LO_W2	3,437	206	306	1,367	1,558	6%	9%	40%	45%
LO_W3	2,278	860	234	569	615	38%	10%	25%	27%
TC1	905	905	0	0	0	100%	0%	0%	0%
Total	**17,496**	**5,078**	**2,431**	**5,277**	**4,710**	**29%**	**14%**	**30%**	**27%**

Table 4.2: Intensification Conditions vs. Existing Conditions Minor System Performance – Hydraulic Gradeline – 10-year Storm

Network	Minor System Length (m)	Change in HGL (m)				Change in HGL (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	0	0	0	0	0%	0%	0%	0%
CR_E2	6,481	70	-270	264	-65	5%[1]	-21%	16%	-3%
CR_E3	346	0	0	0	0	0%	0%	0%	0%
CR_W1	300	0	0	0	0	0%	0%	0%	0%
CR_W2	434	0	0	0	0	0%	0%	0%	0%
CR_W3	430	0	0	0	0	0%	0%	0%	0%
CR_W4	1,394	0	0	0	0	0%	0%	0%	0%
CR_W5	413	0	0	0	0	0%	0%	0%	0%
LO_E1	126	0	0	0	0	0%	0%	0%	0%
LO_E2	179	0	0	0	0	0%	0%	0%	0%
LO_E3	454	0	0	0	0	0%	0%	0%	0%
LO_W1	106	0	0	-106	106	0%	0%	-100%	100%
LO_W2	3,437	0	-15	141	-126	0%	-5%	11%	-7%
LO_W3	2,278	0	-103	103	0	0%	-31%	22%	0%
TC1	905	0	0	0	0	0%	0%	0%	0%
Total Change (+/-)		**70**	**-388**	**402**	**-84**	**1%**	**-14%**	**8%**	**-2%**

Note: [1] This increase in performance to an un-surcharged condition is located in a single pipe segment at the downstream end of CR_E2. The difference in WSE results between existing and intensification conditions is within 10 cm (+/-), shifting the performance category accordingly. The performance of both the upstream and downstream pipe segments remains the same under both land use conditions.

Table 4.3: Intensification Conditions Minor System Performance – Pipe Capacity – 10-year Storm

Network	Minor System Length (m)	Capacity Performance (m)			Capacity Performance (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	123	91	0%	57%	43%
CR_E2	6,481	584	1795	4,101	9%	28%	63%
CR_E3	346	50	94	201	15%	27%	58%
CR_W1	300	0	0	300	0%	0%	100%
CR_W2	434	16	130	288	4%	30%	66%
CR_W3	430	51	287	91	12%	67%	21%
CR_W4	1,394	156	149	1,089	11%	11%	78%
CR_W5	413	62	323	29	15%	78%	7%
LO_E1	126	0	63	64	0%	50%	50%
LO_E2	179	102	77	0	57%	43%	0%
LO_E3	454	438	16	0	96%	4%	0%
LO_W1	106	0	0	106	0%	0%	100%
LO_W2	3,437	156	300	2,981	5%	9%	87%
LO_W3	2,278	445	717	1,117	20%	31%	49%
TC1	905	814	90	0	90%	10%	0%
Total	**17,496**	**2,875**	**4,165**	**10,457**	**16%**	**24%**	**60%**

Table 4.4: Intensification Conditions vs. Existing Conditions Minor System Performance – Pipe Capacity – 10-year Storm

Network	Minor System Length (m)	Change in Capacity (m)			Change in Capacity (%)		
		<0.5	**0.5 - 1**	**= 1**	**<0.5**	**0.5 - 1**	**= 1**
CR_E1	214	0	0	0	0%	0%	0%
CR_E2	6481	0	36	-36	0%	2%	-1%
CR_E3	346	0	0	0	0%	0%	0%
CR_W1	300	0	0	0	0%	0%	0%
CR_W2	434	0	0	0	0%	0%	0%
CR_W3	430	0	0	0	0%	0%	0%
CR_W4	1394	0	0	0	0%	0%	0%
CR_W5	413	0	0	0	0%	0%	0%
LO_E1	126	0	0	0	0%	0%	0%
LO_E2	179	0	0	0	0%	0%	0%
LO_E3	454	0	0	0	0%	0%	0%
LO_W1	106	0	0	0	0%	0%	0%
LO_W2	3437	0	-158	158	0%	-35%	6%
LO_W3	2278	0	0	0	0%	0%	0%
TC1	905	0	0	0	0%	0%	0%
Total Change (+/-)		**0**	**-122**	**122**	**0%**	**-3%**	**1%**

4.1.2.2 Major System Results

The future intensification scenario PCSWMM hydrologic model has been used to assess the performance of the existing major system and compare against existing conditions (ref. **Section 3.4**). Consistent with the methodology for existing conditions, the hydraulic gradeline generated for the 100-year synthetic design storm under intensification conditions has been used to determine the total length of road rights-of-way in each network for which the hydraulic gradeline would fall into the following performance categories:

Grade A: 100 Year flow contained within the top of curb / top of ditch

— Water Depth = <0.15 m (urban) or <0.30 m (ditch)

Grade B: 100 Year flow above top of curb / top of ditch but contained within rights-of-way

— Water Depth = between 0.15 and 0.25 m (urban) or 0.30 m and 0.37 m (ditch)

Grade C: 100 Year flow exceeds the rights-of-way.

— Water Depth = >0.25 m (urban) or >0.37 m (ditch)

The total length and percentage of rights-of-way within each network, which falls into each of the above performance categories, is summarized in **Table 4.5**, with a comparison to existing conditions demonstrated in **Table 4.6** The grand total in each table represents the total length of the storm sewers for each network and the percentage of the storm sewers in the focus area respectfully. The curbed and ditched performance results are depicted graphically in **Drawing 13**. Results for additional storm event simulations can be found in **Appendix D**.

Table 4.5: Intensification Conditions Major System Performance – Hydraulic Gradeline – 100-year Storm

Network	Major System Length (m)	Performance (m)			Performance (%)		
		A	B	C	A	B	C
CR_E1	123	41	38	44	33%	31%	36%
CR_E2	6,518	4,838	1,342	338	74%	21%	5%
CR_E3	318	253	66	0	79%	21%	0%
CR_W1	233	203	30	0	87%	13%	0%
CR_W2	383	327	56	0	85%	15%	0%
CR_W3	406	406	0	0	100%	0%	0%
CR_W4	1,255	1,033	222	0	82%	18%	0%
CR_W5	240	229	11	0	95%	5%	0%
LO_E1	62	62	0	0	100%	0%	0%
LO_E2/3	499	419	80	0	84%	16%	0%
LO_W1	419	139	225	55	33%	54%	13%
LO_W2	3,467	2,383	923	160	69%	27%	5%
LO_W3	2,155	1,922	187	46	89%	9%	2%
TC1	848	732	116	0	86%	14%	0%
Total	**16,927**	**12,987**	**3,296**	**643**	**77%**	**19%**	**4%**

Table 4.6: Intensification Conditions vs. Existing Conditions Major System Performance – Hydraulics Gradeline – 100-year Storm

Network	Major System Length (m)	Change in Major HGL (m)			Change in Major HGL (%)		
		A	B	C	A	B	C
CR_E1	123	0	0	0	0%	0%	0%
CR_E2	6,518	-99	99	0	-2%	8%	0%
CR_E3	318	0	0	0	0%	0%	0%
CR_W1	233	-30	30	0	-13%	0%	0%
CR_W2	383	0	0	0	0%	0%	0%
CR_W3	406	0	0	0	0%	0%	0%
CR_W4	1,255	0	0	0	0%	0%	0%
CR_W5	240	0	0	0	0%	0%	0%
LO_E1	62	0	0	0	0%	0%	0%
LO_E2/3	499	0	0	0	0%	0%	0%
LO_W1	419	0	0	0	0%	0%	0%
LO_W2	3,467	-469	418	51	-16%	83%	46%
LO_W3	2,155	-30	30	0	-2%	19%	0%
TC1	848	0	0	0	0%	0%	0%
Total Change (+/-)		**-628**	**577**	**51**	**-5%**	**21%**	**9%**

The results of the future intensification analysis demonstrate that there is a 21% increase in major system pathways exceeding the curb / ditch limits, while remaining within the respective road rights-of-way. The network LO_W2, which is exclusively low-density residential beyond the Lakeshore Road corridor, exhibits an increase in flow exceeding the rights-of-way, demonstrating insufficient capacity as a result of intensification. This assessment demonstrates the sensitivities with respect to major system conveyance capacity and identifying the areas susceptible to decreases in performance as a result of low-density residential infill / intensification.

4.2 Climate Change Analysis

4.2.1 Climate Change Rainfall Datasets

The Climate Change analysis has been undertaken based upon the input received from the Region of Peel and Climate Risk Institute, through an information sharing meeting conducted on July 9, 2021. The input received from this meeting suggested that the preferred method would be to apply climate change adjustments to the IDF curves to generate climate change influenced design storms. The preferred tool was indicated to be the University of Western's IDF_CC Tool, as the methodology behind this tool incorporates climate modelling projections, as opposed to historical analyses alone. The emissions scenarios were also noted for review; however, it was indicated that RCP 4.5 and RCP 8.5 are the most common scenarios, with RCP 8.5 representing the most conservative (i.e., worst case).

As such, the IDF_CC Tool has been applied for the current study to assess a variety of different climate change storm scenarios and identify the most appropriate source to be applied for the Port Credit study area. The IDF_CC Tool is capable of generating climate change influenced IDF curves based upon two types of rainfall sources, these include “Gauged Locations” based upon Environment and Climate Change Canada rainfall monitoring stations, as well as “Ungauged Locations” which are interpolated at the selected location based upon available gridded datasets. This provides additional flexibility for modelling decisions depending upon the location of the study area (proximity to real rain gauge locations), and the desired conservativeness for the future climate change rainfall projection offering two options. For the climate change analysis of the Port Credit study area, a comparison between the gauged location and ungauged location resultant rainfall has been completed to support the choice between the two options.

The City of Mississauga’s current IDF parameters are noted to be based upon statistical analyses for the Environment Canada rainfall station located at Toronto International Airport (Pearson), therefore the Pearson Airport has been selected as the “Gauged Location” for use in the IDF_CC Tool. The “Ungauged Location” has been selected to be inside the downtown corridor in the Port Credit community, along Lakeshore Road, west of Hurontario Street (ref. **Figure 4.1**). This provides an opportunity to apply interpolated rainfall data closer to the study area boundaries, given that Pearson Airport is approximately 21.5 km away from the Port Credit community.

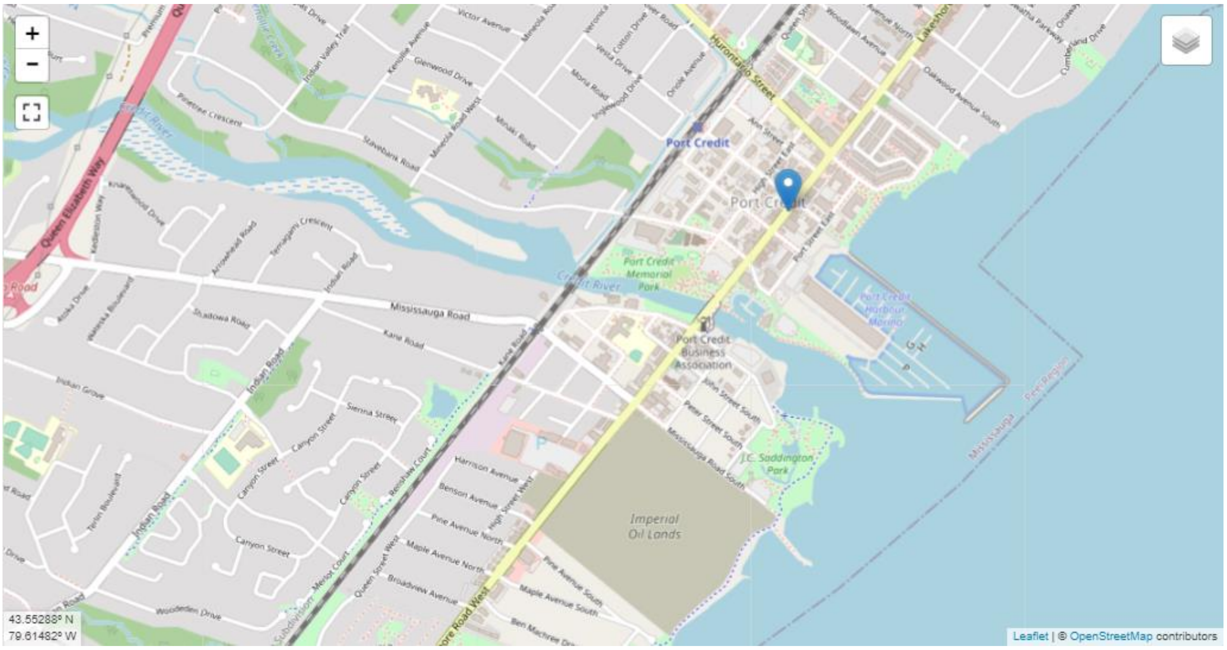

Figure 4.1: Ungauged Station in Downtown Port Credit (IDF_CC Tool)

Based upon the two location options, the IDF_CC Tool has been used to analyze historical rainfall data available through the tool and apply a climate change projection scenario for a 30-year period from the years 2070 - 2100, representing the "2080s" decade scenario. Several global climate models (GCMs) are available through the IDF_CC Tool, however the most recent Coupled Model Intercomparison Project (CMIP6) has been used given the substantial expansion in GCMs beyond previous versions. An "ensemble" approach has been applied to incorporate data / findings from all available GCMs to apply projections to the rainfall data for the select time period; this allows for the projected rainfall scenarios to incorporate predictions from multiple GCMs to avoid reliance on a single GCM.

It should be noted that as part of the recent CMIP6, the assessment of varying emissions scenarios has changed from solely Representative Concentration Pathways (RCPs), which are based upon three varying levels of greenhouse gas emissions, to Shared Socioeconomic Pathways (SSPs), which consider five different scenarios incorporating aspects of climate change policy and mitigation opportunities to achieve targets set as part of the RCPs (ref. Computerized IDF CC Tool for the Development of Intensity-Duration-Frequency Curves under a Changing Climate: (idf-cc-uwo.ca)). Based upon the guidance from Region of Peel and Climate Risk Institute (ref. Meeting on July 9, 2021), the SSP 2-4.5 (RCP 4.5) and SSP 5-8.5 (RCP 8.5) have been used in the current study as the selected future climate projects.

The IDF_CC Tool has been used to generate IDF curves under future climate change conditions for both the "Gauged" (Pearson Airport) and "Ungauged" (Downtown Port Credit) for the 2080s time period, under both SSP 2-4.5 and SSP 5-8.5 emissions scenarios. The resultant total precipitation amounts for different return periods are presented in **Table 4.7** and **Table 4.8**, for the Gauged location, and **Table 4.9** and **Table 4.10** for the Ungauged results respectively.

Table 4.7: Gauged Location (Toronto Intl Airport) – Climate Change Adjusted IDF Curve – SSCP 2-4.5

Toronto Intl. Airport: SSCP 2-4.5 – Rainfall Depths (mm)							
T (years)	**2-yr**	**5-yr**	**10-yr**	**20-yr**	**25-yr**	**50-yr**	**100-yr**
5 min	9.63	12.73	14.76	16.83	17.46	19.36	21.41
10 min	14.22	18.85	21.74	24.56	25.45	28.12	30.4
15 min	17.62	23.51	27.08	30.59	31.63	34.71	37.7
30 min	23.14	31.47	36.62	41.69	43.31	47.34	51.12
1 h	26.51	36.4	43.12	49.68	52.17	57.83	65.17
2 h	30.1	41.89	50.65	60.56	63.54	73.36	84.82
6 h	38.29	52.64	64.52	78.97	83.65	100.27	121.81
12 h	44.02	58.3	70.91	87.08	92.67	113.33	144.21
24 h	50.14	65.85	79.57	97.21	103.25	125.43	158.29

Table 4.8: Gauged Location (Toronto Intl Airport) – Climate Change Adjusted IDF Curve – SSCP 5-8.5

Toronto Intl. Airport: SSCP 5-8.5 – Rainfall Depths (mm)							
T (years)	**2-yr**	**5-yr**	**10-yr**	**20-yr**	**25-yr**	**50-yr**	**100-yr**
5 min	10.06	13.42	15.69	17.8	18.41	20.36	22.55
10 min	14.82	19.91	23.15	26.06	26.84	29.32	32.11
15 min	18.34	24.85	28.86	32.44	33.4	36.23	39.47
30 min	24.12	33.22	39.01	44.26	45.64	50.2	55.23
1 h	27.78	38.48	45.85	52.83	54.92	61.86	69.6
2 h	31.64	44.24	53.61	63.11	66.21	77.02	89.31
6 h	40.42	55.96	68.15	82.16	87.15	106.31	126.11
12 h	46.56	62.13	74.91	91.09	96.99	118.73	143.44
24 h	53.07	70.14	84.1	101.65	108.04	131.75	157.97

Table 4.9: Ungauged Location (Port Credit) – Climate Change Adjusted IDF Curve – SSCP 2-4.5

Downtown Port Credit: SSCP 2-4.5 – Rainfall Depths (mm)							
T (years)	**2-yr**	**5-yr**	**10-yr**	**20-yr**	**25-yr**	**50-yr**	**100-yr**
5 min	9.91	12.9	14.97	16.7	17.09	18.74	20.3
10 min	14.12	18.7	22.08	25.1	25.87	28.98	32.17
15 min	16.95	22.51	26.67	30.34	31.37	35.22	39.12
30 min	21.93	29.76	35.61	40.83	42.2	47.49	52.73
1 h	26.23	37.45	47.12	57.44	60.46	73.02	87.84
2 h	31.58	45.75	58.19	71.55	75.56	91.74	110.51
6 h	41.16	59.32	76.08	95.07	100.84	125.08	154.55
12 h	47.11	65.48	82.15	100.61	106.13	129.44	157.57
24 h	54.16	74.1	91.27	109.2	114.44	135.93	160.68

Table 4.10: Ungauged Location (Port Credit) – Climate Change Adjusted IDF Curved – SSCP 5-8.5

Downtown Port Credit: SSCP 5-8.5 – Rainfall Depths (mm)							
T (years)	**2-yr**	**5-yr**	**10-yr**	**20-yr**	**25-yr**	**50-yr**	**100-yr**
5 min	10.61	14.02	16.02	18.1	18.59	20	21.82
10 min	15.12	20.33	23.63	27.21	28.13	30.94	34.57
15 min	18.14	24.47	28.54	32.87	34.12	37.61	42.04
30 min	23.47	32.35	38.11	44.25	45.89	50.7	56.67
1 h	28.08	40.71	50.42	62.24	65.75	77.96	94.39
2 h	33.8	49.73	62.28	77.54	82.17	97.95	118.75
6 h	44.05	64.48	81.42	103.03	109.67	133.55	166.08
12 h	50.42	71.18	87.91	109.03	115.42	138.2	169.33
24 h	57.97	80.55	97.68	118.34	124.46	145.13	172.66

The resulting rainfall depths per return period presented in **Table 4.7** to **Table** 4.10 have been used to generate climate change adjusted IDF curves and design storm events for the 10-year (minor system LOS) and 100-year (major system LOS) return periods, using PCSWMM's IDF tool. A 24-hour Chicago distribution has been applied to maintain consistency with the design storms applied under existing climate conditions. The resulting total rainfall depths for each simulated design storm are summarized in **Table** 4.11.

Table 4.11: Total Rainfall Depth Comparison (mm) – 24-Hour Chicago Distribution

Design Storm Event	City IDF (Current)	Gauged Location (Pearson Airport)		Ungauged Location (in Port Credit)	
		SSP 2-4.5	SSP 5-8.5	SSP 2-4.5	SSP 5-8.5
10-year (Minor System)	83.2	80.0	84.4	94.6	102.2
100-year (Major System)	119.4	170.0	168.3	175.8	188.1

Based upon the simulated rainfall depths in **Table 4.11**, the Gauged Location (Pearson Airport) demonstrates a smaller total rainfall amount under SSP 2-4.5 climate change conditions than the City's current IDF for the 10-year event, which is an unexpected result. This suggests that the amount of historical data available for the Pearson Airport used as the basis for the projection simulation may be different than the historical data used by the City at the time of writing the design manual / current IDF parameters, as well as potential differences in statistical analyses applied for the IDF parameter interpolation. The 100-year projected rainfall amounts at the Gauged Location demonstrate a significant increase above the current IDF, which is aligned with expectations for future climate change rainfall patterns. It should also be noted that the SSP 5-8.5 scenario for the Pearson Airport is slightly lower than the SSP 2-4.5 scenario, which again is an unexpected result, however, is likely due to the assumptions made as part of the socioeconomic considerations for the future projections.

In comparison, the rainfall projections from the Ungauged Location (set in Downtown Port Credit) are higher than those resulting from the Pearson Airport rain gauge and demonstrate a consistent increase above the City's current IDF for both the 10-year and 100-year event and support the SSP 5-8.5 scenario being the most conservative (i.e., worst case). Given that these design storms represent a more conservative rainfall projection and are more local to the study area, it is recommended that the Ungauged Location be used as the climate change rainfall dataset for the Port Credit study.

4.2.2 Performance Results

4.2.2.1 Minor System Results

The existing conditions land use scenario PCSWMM hydrologic model has been simulated with the climate change rainfall data set (Ungauged Location) to assess the performance of the minor system under both the SSP 2-4.5 and SSP 5-8.5 scenarios and compare against existing climate conditions (ref. **Section 3.4**). Consistent with the existing conditions and intensification results, the performance of the storm sewer network has been established based upon two categories for performance, including the hydraulic gradeline (HGL) within the minor system, as well as the pipe capacity during the simulated events; details for both performance categories are repeated below for reference.

Hydraulic Gradeline (HGL)

- **Grade A*:*** Hydraulic gradeline at or below pipe obvert.
- **Grade B:** Hydraulic gradeline above pipe obvert, but below 50% of the height between the obvert and the top of the manhole.
- **Grade C:** Hydraulic gradeline above 50% of the height between the obvert and the top of the manhole, but below the top of the manhole.
- **Grade D:** Hydraulic gradeline above the top of the manhole.

Hydraulic Capacity

- Pipe operating at less than capacity during simulated event.
- Pipe operating at capacity during simulated event.

The length of storm sewer within each performance category for both HGL and capacity have been summarized for each sewershed network and have been reported both in terms of length and percentage of the system within each performance category. This has been completed both in terms of future climate change performance, as well as a comparison to existing conditions demonstrating the changes in result categories. The results for the HGL assessment of the 10-year storm SSP 2-4.5 scenario have been presented in **Table 4.12** and **Table 4.13**, and the results of the capacity assessment have been presented in **Table 4.14** and **Table 4.15**. These results have also been visually represented on Figures presented in **Appendix E**.

Table 4.12: Climate Change Conditions Minor System Performance – Hydraulic Gradeline – 10-year Storm (SSP 2-4.5)

Network	Minor System Length (m)	HGL Performance (m of sewer)				HGL Performance (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	82	132	0	0	38%	62%	0%	0%
CR_E2	6,481	1196	1229	2046	2010	19%	19%	32%	31%
CR_E3	346	99	46	110	91	28%	13%	32%	26%
CR_W1	300	0	0	213	87	0%	0%	71%	29%
CR_W2	434	0	60	148	226	0%	14%	34%	52%
CR_W3	430	85	284	61	0	20%	66%	14%	0%
CR_W4	1,394	164	187	770	273	12%	13%	55%	20%
CR_W5	413	183	60	170	0	44%	14%	41%	0%
LO_E1	126	63	0	64	0	50%	0%	50%	0%
LO_E2	179	179	0	0	0	100%	0%	0%	0%
LO_E3	454	454	0	0	0	100%	0%	0%	0%
LO_W1	106	0	0	0	106	0%	0%	0%	100%
LO_W2	3,437	206	153	1445	1633	6%	4%	42%	48%
LO_W3	2,278	784	159	721	615	34%	7%	32%	27%
TC1	905	905	0	0	0	100%	0%	0%	0%
Total	**17,496**	**4398**	**2310**	**5747**	**5041**	**25%**	**13%**	**33%**	**29%**

Table 4.13: Climate Change Conditions vs. Existing Conditions Minor System Performance – Hydraulic Gradeline – 10-year Storm (SSP 2-4.5)

Network	Minor System Length (m)	Change in HGL (m of sewer)				Change in HGL (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	0	0	0	0	0%	0%	-	-
CR_E2	6,481	-339	-25	+369	-4	-22%	-2%	+22%	0%
CR_E3	346	-46	+46	0	0	-32%	-	0%	0%
CR_W1	300	0	0	0	0	-	-	0%	0%
CR_W2	434	0	-86	+86	0	-	-59%	+138 %	0%
CR_W3	430	-89	+28	+61	0	-51%	+11%	-	-
CR_W4	1,394	0	-68	-128	+196	0%	-27%	-14%	+253 %
CR_W5	413	-60	-58	+118	0	-25%	-49%	+224 %	-
LO_E1	126	0	0	0	0	0%	-	0%	-
LO_E2	179	0	0	0	0	0%	-	-	-
LO_E3	454	0	0	0	0	0%	-	-	-
LO_W1	106	0	0	-106	+106	-	-	-100%	-
LO_W2	3,437	0	-168	+219	-51	0%	-52%	+18%	-3%
LO_W3	2,278	-76	-179	+255	0	-9%	-53%	+55%	0%
TC1	905	0	0	0	0	0%	-	-	-
Total Change (+/-)		**-610**	**-509**	**+872**	**+247**	**-12%**	**-18%**	**+18%**	**+5%**

Table 4.14: Climate Change Conditions Minor System Performance – Pipe Capacity – 10-year Storm (SSP 2-4.5)

Network	Minor System Length (m)	Capacity Performance (m of sewer)			Capacity Performance (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	123	91	0%	57%	43%
CR_E2	6,481	471	1486	4524	7%	23%	70%
CR_E3	346	50	67	229	15%	19%	66%
CR_W1	300	0	0	300	0%	0%	100%
CR_W2	434	16	130	288	4%	30%	66%
CR_W3	430	49	195	186	11%	45%	43%
CR_W4	1,394	156	149	1089	11%	11%	78%
CR_W5	413	11	341	61	3%	83%	15%
LO_E1	126	0	63	64	0%	50%	50%
LO_E2	179	51	128	0	28%	72%	0%
LO_E3	454	382	73	0	84%	16%	0%
LO_W1	106	0	0	106	0%	0%	100%
LO_W2	3,437	78	378	2981	2%	11%	87%
LO_W3	2,278	436	560	1282	19%	25%	56%
TC1	905	814	90	0	90%	10%	0%
Total	**17,496**	**2514**	**3783**	**11200**	**14%**	**22%**	**64%**

Table 4.15: Climate Change Conditions vs. Existing Conditions Minor System Performance – Pipe Capacity – 10-year Storm (SSP 2-4.5)

Network	Minor System Length (m)	Change in Capacity (m of sewer)			Change in Capacity (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	0	0	-	0%	0%
CR_E2	6481	-113	-273	+386	-19%	-16%	+9%
CR_E3	346	0	-28	+28	0%	-29%	+14%
CR_W1	300	0	0	0	-	-	0%
CR_W2	434	0	0	0	0%	0%	0%
CR_W3	430	-3	-92	+95	-5%	-32%	+104%
CR_W4	1394	0	0	0	0%	0%	0%
CR_W5	413	-51	+19	+32	-82%	6%	+113%
LO_E1	126	0	0	0	-	0%	0%
LO_E2	179	-51	+51	0	-50%	+67%	-
LO_E3	454	-57	+57	0	-13%	+352%	-
LO_W1	106	0	0	0	-	-	0%
LO_W2	3437	-78	-81	+158	-50%	-18%	+6%
LO_W3	2278	-8	-157	+166	-2%	-22%	+15%
TC1	905	0	0	0	0%	0%	-
Total Change (+/-)		**-361**	**-504**	**865**	**-13%**	**-12%**	**+8%**

The results demonstrate that under future SSP 2-4.5 climate change conditions, worsened HGL performance is anticipated across the majority of the study area, with the largest impacts observed in the larger networks (i.e., more drainage area contributing higher runoff from storm event). The results demonstrate a similar trend to that of existing conditions, with an increased number of sewers being surcharged within the manhole and above ground conditions; approximately 75% of the storm sewer system is operating at a surcharged condition, with close to 30% of the sewer indicating HGL elevations above the manhole elevation (surcharging to the roadway). The pipe capacity results exhibit similar trends, with an increase up to 64% of the sewers operating at full capacity under the 10-year event. These results support the understanding that under future climate change conditions, larger storm events will increase pressure on existing storm sewer infrastructure, suggesting the need for improved capacity and performance measures.

The results for the HGL assessment of the 10-year storm SSP 5-8.5 scenario have been presented in **Table 4.16** and **Table 4.17**, and the results of the capacity assessment have been presented in **Table 4.18** and **Table 4.19**. These results have also been visually represented on Figures presented in **Appendix E**.

Table 4.16: Climate Change Condition Minor System Performance – Hydraulic Gradeline – 10-year Storm (SSP 5-8.5)

Network	Minor System Length (m)	HGL Performance (m of sewer)				HGL Performance (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	82	0	132	0	38%	0%	62%	0%
CR_E2	6,481	980	1418	1606	2477	15%	22%	25%	38%
CR_E3	346	99	46	110	91	28%	13%	32%	26%
CR_W1	300	0	0	213	87	0%	0%	71%	29%
CR_W2	434	0	60	148	226	0%	14%	34%	52%
CR_W3	430	49	148	233	0	11%	34%	54%	0%
CR_W4	1,394	164	187	770	273	12%	13%	55%	20%
CR_W5	413	183	60	170	0	44%	14%	41%	0%
LO_E1	126	63	0	64	0	50%	0%	50%	0%
LO_E2	179	179	0	0	0	100%	0%	0%	0%
LO_E3	454	454	0	0	0	100%	0%	0%	0%
LO_W1	106	0	0	0	106	0%	0%	0%	100%
LO_W2	3,437	206	153	1210	1868	6%	4%	35%	54%
LO_W3	2,278	749	118	737	675	33%	5%	32%	30%
TC1	905	814	90	0	0	90%	10%	0%	0%
Total	**17,496**	**4020**	**2281**	**5393**	**5803**	**23%**	**13%**	**31%**	**33%**

Table 4.17: Climate Change Conditions vs. Existing Conditions Minor System Performance – Hydraulic Gradeline – 10-year Storm (SSP 5-8.5)

Network	Minor System Length (m)	Change in HGL (m of sewer)				Change in HGL (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	0	-132	+132	0	0%	+100 %	-	-
CR_E2	6,481	-556	+164	-72	+463	-36%	+13%	-4%	+23%
CR_E3	346	-46	+46	0	0	-32%	-	0%	0%
CR_W1	300	0	0	0	0	-	-	0%	0%
CR_W2	434	0	-86	+86	0	-	-59%	+138 %	0%
CR_W3	430	-125	-108	+233	0	-72%	-42%	-	-
CR_W4	1,394	0	-68	-128	+196	0%	-27%	-14%	+253 %
CR_W5	413	-60	-58	+118	0	-25%	-49%	+224 %	-
LO_E1	126	0	0	0	0	0%	-	0%	-
LO_E2	179	0	0	0	0	0%	-	-	-
LO_E3	454	0	0	0	0	0%	-	-	-
LO_W1	106	0	0	-106	+106	-	-	-100%	-
LO_W2	3,437	0	-168	-16	+184	0%	-52%	-1%	+11%
LO_W3	2,278	-111	-219	+271	+60	-13%	-65%	+58%	+10%
TC1	905	-90	+90	0	0	-10%	-	-	-
Total Change (+/-)		**-988**	**-539**	**+518**	**+1009**	**-20%**	**-19%**	**+11%**	**+21%**

Table 4.18: Climate Change Conditions Minor System Performance – Pipe Capacity – 10-year Storm (SSP 5-8.5)

Network	Minor System Length (m)	Capacity Performance (m of sewer)			Capacity Performance (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	123	91	0%	57%	43%
CR_E2	6,481	368	1326	4787	6%	20%	74%
CR_E3	346	50	67	229	15%	19%	66%
CR_W1	300	0	0	300	0%	0%	100%
CR_W2	434	0	107	326	0%	25%	75%
CR_W3	430	0	121	309	0%	28%	72%
CR_W4	1,394	156	149	1089	11%	11%	78%
CR_W5	413	11	341	61	3%	83%	15%
LO_E1	126	0	63	64	0%	50%	50%
LO_E2	179	51	128	0	28%	72%	0%
LO_E3	454	382	73	0	84%	16%	0%
LO_W1	106	0	0	106	0%	0%	100%
LO_W2	3,437	0	456	2981	0%	13%	87%
LO_W3	2,278	267	729	1282	12%	32%	56%
TC1	905	814	90	0	90%	10%	0%
Total	**17,496**	**2098**	**3773**	**11625**	**12%**	**22%**	**66%**

Table 4.19: Climate Change Conditions vs. Existing Conditions Minor System Performance – Pipe Capacity – 10-year Storm (SSP 5-8.5)

Network	Minor System Length (m)	Change in Capacity (m of sewer)			Change in Capacity (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	0	0	-	0%	0%
CR_E2	6481	-216	-433	+650	-37%	-25%	+16%
CR_E3	346	0	-28	+28	0%	-29%	+14%
CR_W1	300	0	0	0	-	-	0%
CR_W2	434	-16	-22	+39	-100%	-17%	+13%
CR_W3	430	-51	-167	+218	-100%	-58%	+240%
CR_W4	1394	0	0	0	0%	0%	0%
CR_W5	413	-51	+19	+32	-82%	+6%	+113%
LO_E1	126	0	0	0	-	0%	0%
LO_E2	179	-51	+51	0	-50%	+67%	-
LO_E3	454	-57	+57	0	-13%	+352%	-
LO_W1	106	0	0	0	-	-	0%
LO_W2	3437	-156	-3	+158	-100%	-1%	+6%
LO_W3	2278	-178	+12	+166	-40%	+2%	+15%
TC1	905	0	0	0	0%	0%	-
Total Change (+/-)		**-776**	**-514**	**+1290**	**-27%**	**-12%**	**+12%**

The results under the SSP 5-8.5 future climate change condition scenario demonstrate a similar trend to that of the SSP 2-4.5, whereby decreased performances are observed across the study area, generating higher HGL elevations throughout the networks, and increased number of sewer segments operating at full capacity. The majority of differences are observed in the larger drainage networks (i.e., greater than 400 m length of sewers), given the larger drainage area associated with the hydraulic networks.

It should be noted that while peak flow and resulting depths are impacted by the future climate change rainfall across all networks, the impacts may not be large enough to result in a visible change in the reported performance categories (i.e., some networks (such as LO_W1) exhibit no change). For example, the HGL result at a manhole may increase by +0.10 m under a future climate change storm event, however this increase may not result in a change from category “B” to category “C”, based upon the thresholds applied for each performance category and therefore might not demonstrate an observed change when compared to existing conditions.

Based upon the minor system performance results under both the SSP 2-4.5 and SSP 5-8.5 scenarios, the networks experiencing the largest simulated magnitude of change in minor system performance (HGL and Capacity) include networks CR_E2, CR_W2, CR_W4, CR_W5, LO_W2 and LO_W3 (all greater than 400 m in length). The results of this analysis have been taken into consideration when evaluating potential mitigation measures to improve minor system performance and reduce flood risks under future climate change rainfall.

4.2.2.2 Major System Results

The existing conditions land use scenario PCSWMM hydrologic model has been simulated with the climate change rainfall data set (Ungauged Location) to assess the performance of the existing major system under both the SSP 2-4.5 and SSP 5-8.5 scenarios and compare against existing conditions (ref. **Section 3.4**). Consistent with the methodology for existing conditions and intensification conditions, the hydraulic gradeline generated for the 100-year synthetic design storm under future climate conditions has been used to determine the total length of road rights-of-way in each network for which the hydraulic gradeline would fall into the following performance categories:

Grade A: 100 Year flow contained within the top of curb / top of ditch

— Water Depth = <0.15 m (urban) or <0.30 m (ditch)

Grade B: 100 Year flow above top of curb / top of ditch but contained within rights-of-way

— Water Depth = between 0.15 and 0.25 m (urban) or 0.30 m and 0.37 m (ditch)

Grade C: 100 Year flow exceeds the rights-of-way

— Water Depth = >0.25 m (urban) or >0.37 m (ditch)

The total length and percentage of rights-of-way within each network, which falls into each of the above performance categories, is summarized in **Table 4.20,** with a comparison to existing conditions demonstrated in **Table 4.21** for SSP 2-4.5 conditions, and **Table 4.22** and **Table 4.23** for SSP 5-8.5 conditions. The grand total in each table represents the total length of the road sections for each network and the percentage of the roadway in the focus network respectfully. The curbed and ditched performance results are depicted graphically in Figures which can be found in **Appendix E**.

Table 4.20: Climate Change Conditions Major System Performance – Hydraulic Gradeline – 100-year Storm (SSP 2-4.5)

Network	Major System Length (m)	Performance (m of road)			Performance (%)		
		A	B	C	A	B	C
CR_E1	123	0	79	44	0%	64%	36%
CR_E2	6,518	3,893	1,694	931	60%	26%	14%
CR_E3	318	228	90	0	72%	28%	0%
CR_W1	233	203	30	0	87%	13%	0%
CR_W2	383	327	56	0	85%	15%	0%
CR_W3	406	346	61	0	85%	15%	0%
CR_W4	1,255	887	343	26	71%	27%	2%
CR_W5	240	210	19	11	88%	8%	5%
LO_E1	62	62	0	0	100%	0%	0%
LO_E2/3	499	419	80	0	84%	16%	0%
LO_W1	419	137	179	103	33%	43%	25%
LO_W2	3,467	1,743	1,427	297	50%	41%	9%
LO_W3	2,155	1,793	209	154	83%	10%	7%
TC1	848	732	116	0	86%	14%	0%
Total	**16,927**	**10,979**	**4,382**	**1,566**	**65%**	**26%**	**9%**

Table 4.21: Climate Change Conditions vs Existing Conditions Major System Performance – Hydraulic Gradeline – 10—year Storm (SSP 2-4.5)

Network	Major System Length (m)	Change in Major HGL (m of road)			Change in Major HGL (%)		
		A	B	C	A	B	C
CR_E1	123	-41	+41	0	-100%	+108%	0%
CR_E2	6,518	-1,044	+450	+593	-21%	+36%	+176%
CR_E3	318	-24	+24	0	-10%	+37%	-
CR_W1	233	-30	+30	0	-13%	-	-
CR_W2	383	0	0	0	0%	0%	-
CR_W3	406	-61	+61	0	-15%	-	-
CR_W4	1,255	-146	+121	+26	-14%	+54%	-
CR_W5	240	-19	8	+11	-8%	+75%	-
LO_E1	62	0	0	0	0%	-	-
LO_E2/3	499	0	0	0	0%	0%	-
LO_W1	419	-2	-46	+48	-2%	-20%	+86%
LO_W2	3,467	-1,109	+922	+188	-39%	+183%	+171%
LO_W3	2,155	-159	+52	+107	-8%	+33%	+233%
TC1	848	0	0	0	0%	0%	-
Total Change (+/-)		**-2,636**	**+1,663**	**+973**	**-19%**	**+61%**	**+164%**

Table 4.22: Climate Change Conditions Major System Performance – Hydraulic Gradeline – 100-year Storm (SSP 5-8.5)

Network	Major System Length (m)	Performance (m of road)			Performance (%)		
		A	B	C	A	B	C
CR_E1	123	0	79	44	0%	64%	36%
CR_E2	6,518	3660	1821	1037	56%	28%	16%
CR_E3	318	228	90	0	72%	28%	0%
CR_W1	233	111	92	30	48%	39%	13%
CR_W2	383	327	56	0	85%	15%	0%
CR_W3	406	346	61	0	85%	15%	0%
CR_W4	1,255	872	320	64	69%	25%	5%
CR_W5	240	210	19	11	88%	8%	5%
LO_E1	62	62	0	0	100%	0%	0%
LO_E2/3	499	419	80	0	84%	16%	0%
LO_W1	419	88	225	105	21%	54%	25%
LO_W2	3,467	1732	1437	297	50%	41%	9%
LO_W3	2,155	1720	281	154	80%	13%	7%
TC1	848	732	116	0	86%	14%	0%
Total	**16,927**	**10507**	**4677**	**1742**	**62%**	**28%**	**10%**

Table 4.23: Climate Change Conditions vs Existing Conditions Major System Performance – Hydraulic Gradeline – 100-year Storm (SSP 5-8.5)

Network	Major System Length (m)	Change in Major HGL (m of road)			Change in Major HGL (%)		
		A	B	C	A	B	C
CR_E1	123	-41	+41	0	-100%	+108%	0%
CR_E2	6,518	-1277	+578	+700	-26%	+46%	+207%
CR_E3	318	-24	+24	0	-10%	+37%	-
CR_W1	233	-122	+92	+30	-52%	-	-
CR_W2	383	0	0	0	0%	0%	-
CR_W3	406	-61	+61	0	-15%	-	-
CR_W4	1,255	-161	+97	+64	-16%	+44%	-
CR_W5	240	-19	+8	+11	-8%	+75%	-
LO_E1	62	0	0	0	0%	-	-
LO_E2/3	499	0	0	0	0%	0%	-
LO_W1	419	-50	0	+50	-36%	0%	+90%
LO_W2	3,467	-1,120	+933	+188	-39%	+185%	+171%
LO_W3	2,155	-231	+124	+107	-12%	+79%	+233%
TC1	848	0	0	0	0%	0%	-
Total Change (+/-)		**-3,108**	**+1,958**	**+1,149**	**-23%**	**+72%**	**+194%**

The results of the future climate change analysis demonstrate that there is approximately a 60% to 72% increase in major system pathways exceeding the curb / ditch limits, as well as approximately 10% of the major system across the study area exceeding the rights-of-way limits (representing a 164% to 194% increase in this category) under the future climate change rainfall projections.

The networks of CR_E2, LO_W1, LO_W2 and LO_W3, exhibit the largest increase in flow exceeding the rights-of-way, demonstrating worsened / insufficient capacity as a result of climate change rainfall analysis. Other networks such as CR_E1, CR_W1, CR_W4 and CR_W5 also experience flow beyond the rights-of-way under future climate change conditions, however to a lesser extent than other networks (less than 100 m of major system length exceeding rights-of-way within this category).

The largest impacts are typically observed in the largest drainage networks, demonstrating the significance of drainage area with respect to increased runoff; this is consistent with the findings as part of the minor system performance. The results of this analysis have been taken into consideration when evaluating potential areas in need of mitigation, in order to improve both major and minor system performance and reduce flood risks under the impacts of climate change.

5 ALTERNATIVE EVALUATION

5.1 Long-List of Alternatives

As an initial step in the alternative assessment process, a long-list of potential mitigation alternatives has been developed, based on the characterization and background presented in **Section 2**, and the modelling results in **Sections 3** and **4**. Alternatives have been divided into common types of works.

Storm Sewer and Inlet Capacity Modifications

- Increase size of affected storm sewers or supplement capacity
- Storm Sewer Diversions
- Roof leader / foundation drain disconnection, where connected
- Inlet capacity modifications
  - Increases in areas with deficient major system, where sufficient minor system capacity can be provided
  - Decreases in areas where minor system is constrained and temporary surface ponding can be accommodated

Major System and Grading

- Modify grading on private property to mitigate surface flow extending onto private properties
- Modify grading within road rights-of-way to mitigate surface flow extending onto private properties

Infiltration, Storage, and Quantity Control

- Low Impact Development Best Management Practices (LID BMPs) for public and private realm to promote at-source infiltration
- Implement super pipes to provide on-line stormwater quantity control
- Implement on-site stormwater management for individual private properties
- Implement off-line storage areas within available public spaces
  - Surface-based (in conjunction with inlet capacity restrictions)
  - Sub-surface (i.e., chambers or tanks)

Combinations

In addition to the preceding, the “do nothing” alternative must be carried forward for evaluation.

Based on a pre-screening of options on the basis of technical feasibility and utility, the following options have been screened out:

Roof Leader \ Foundation Drain Disconnections

- Given the highly urbanized nature of the majority of the study area, roof leader and foundation drain disconnection is likely not technically feasible as there are no appropriate pervious areas to discharge these flows to.
- For less urbanized areas (local detached residential areas) roof leaders and foundation drains would already be expected to be disconnected as per typical City requirements; it is also atypical to provide storm sewer lateral connections in such areas.
- Enforcement of roof leader and foundation drain disconnections can also be challenging, for the few locations that are not constrained by the above-noted factors. As such, this option is considered likely infeasible.

Surface grading modifications

- Private property grading is considered to be challenging given the need for agreement from private landowners (which may not be forthcoming) and also compensation measures. There are also considered to be limited adjustments that can be made given the highly urbanized nature of the study area and the need to meet existing grades at roadways. Therefore, this alternative is considered generally infeasible.
- Grading modifications within the roadway rights-of-way may be feasible to a limited degree in localized areas but is generally constrained by the need to meet adjacent grades at property boundaries and adjacent streets and rights-of-way. As noted, the highly urbanized nature of the study area makes this option infeasible for wide-scale application.

Quantity control storage (super pipes and off-line storage areas – surface and sub-surface)

- In general, quantity control is considered to be of limited value for the study area given the proximity of open water receivers (i.e., the Credit River and Lake Ontario) and the associated length of existing storm sewers.
- Available space for quantity control measures is similarly a challenge. Superpipes require a large degree of space within the road rights-of-way section and can lead to utility conflicts. Off-line storage areas also require sufficient available public space. Within the Port Credit areas, larger public spaces are typically located along the

shoreline (of either the Credit River or Lake Ontario), at which point quantity control measures would not be required as noted previously.

- Given the preceding, inlet capacity restrictions (i.e. surface ponding) is also not considered a technically appropriate solution.
- Based on the preceding, conveyance improvements are considered a more technically feasible approach than quantity control storage measures.

City staff have noted (ref. meeting of October 12, 2022) that while on-site quantity controls would not apply to single family homes (not subject to the site plan approval process), the City has typically required over-control of stormwater peak flows to the limit of the available storm sewer capacity for other types of development which are subject to the site plan approval process. As such, it is considered that specific recommendations for on-site control are not required as part of the current Class EA, as they are already accounted for in standard City practices and guidelines.

Based on the preceding the primary short-listed measures for further evaluation relate to storm sewer upgrades (both to address minor system capacity deficiencies and potentially reduce major system drainage issues) and related storm sewer diversions, where feasible. Inlet capacity upgrades should be considered in conjunction with the preceding, as part of the constructed dual drainage modelling.

Low Impact Development Best Management Practices (LID BMPs) are also considered to be a potentially beneficial alternative to address remaining deficiencies which cannot be addressed by storm sewer upgrades, particularly in areas with deficient major system issues which are not likely to be addressed through major system grading modifications. This alternative has not been assessed through the developed modelling given that LID BMPs are typically targeted for smaller, more frequent storm events (as compared to the storm sewer design basis of a 1 in 10-year storm event).

5.2 Technical Assessment of Storm Sewer Works

5.2.1 Technical Evaluation

5.2.1.1 Baseline Conditions

The existing conditions hydrologic \ hydraulic model (PCSWMM) described in **Section 3** has been applied to undertake a technical evaluation of the storm sewer system upgrades necessary to achieve a consistent Level of Service (LOS) for the Port Credit area. As per previous analyses, storm sewers have been assessed for the City standard 1 in 10-year storm event (such that the peak simulated water level is below the pipe obvert – unsurcharged flow).

An iterative approach has been undertaken to confirm required conveyance system upgrades. Where warranted, minor adjustments in storm sewer inverts have been considered to better optimize storm sewer performance. A summary of the resulting storm sewer upgrades are presented in **Drawing 14**. For clarity, pipe size upgrades have been categorized based on the relative degree of upgrade, on the basis of number of standard circular pipe size categories required to be increased.

Overall, the assessment has identified a total of 197 sections of storm sewer (of the 381 within the study area; or 52%) for which a capacity upgrade is recommended. Of the recommended upgrades:

- 77 (39%) are for 1 standard pipe size
- 56 (28%) are for 2 standard pipe sizes
- 31 (16%) are for 3 standard pipe sizes
- 19 (10%) are for 4 standard pipe sizes
- 14 (7%) are for 5 or more standard pipe sizes

The resulting modelling has been assessed using the same performance metrics as presented in **Sections 3** and **4** of the report. For reference, this assessment has considered the following metrics for the minor system:

Hydraulic Gradeline (HGL)

- **Grade A:** Hydraulic gradeline at or below pipe obvert.
- **Grade B**: Hydraulic gradeline above pipe obvert, but below 50% of the height between the obvert and the top of the manhole.
- **Grade C:** Hydraulic gradeline above 50% of the height between the obvert and the top of the manhole, but below the top of the manhole.
- **Grade D:** Hydraulic gradeline above the top of the manhole.

Hydraulic Capacity

- Pipe operating at less than capacity during simulated event.
- Pipe operating at capacity during simulated event.

The results for the HGL assessment are presented in **Table 5.1** and the resulting difference to the existing conditions results are presented in **Table 5.2**. The results for the hydraulic capacity assessment are presented in **Table 5.3** and the resulting difference to the existing conditions results are presented in **Table 5.4.**

Table 5.1: Pipe Upgrade Scenario – Minor System Performance – Hydraulic Gradeline 10-year Storm (Existing IDF)

Network	Minor System Length (m)	HGL Performance (m of sewer)				HGL Performance (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	214	0	0	0	100%	0%	0%	0%
CR_E2	6,481	6,265	216	0	0	100%	3%	5%	0%
CR_E3	346	346	0	0	0	88%	12%	0%	0%
CR_W1	300	300	0	0	0	100%	0%	0%	0%
CR_W2	434	279	155	0	0	64%	36%	0%	0%
CR_W3	430	430	0	0	0	100%	0%	0%	0%
CR_W4	1,394	1,394	0	0	0	100%	0%	0%	0%
CR_W5	413	413	0	0	0	100%	0%	0%	0%
LO_E1	126	63	64	0	0	50%	50%	0%	0%
LO_E2	179	179	0	0	0	100%	0%	0%	0%
LO_E3	454	454	0	0	0	100%	0%	0%	0%
LO_W1	106	106	0	0	0	100%	0%	0%	0%
LO_W2	3,437	3,365	72	0	0	98%	2%	0%	0%
LO_W3	2,278	2,241	38	0	0	98%	2%	0%	0%
TC1	905	905	0	0	0	100%	0%	0%	0%
Total	**17,496**	**16,952**	**544**	**0**	**0**	**97%**	**3%**	**2%**	**0%**

Table 5.2: Pipe Upgrade Scenario vs. Existing Conditions Minor System Performance Hydraulic Gradeline – 10-year Storm (Existing Conditions)

Network	Minor System Length (m)	Change in HGL (m of sewer)				Change in HGL (%)			
		A	B	C	D	A	B	C	D
CR_E1	214	+132	-132	0	0	+161%	-100%	0%	0%
CR_E2	6,481	+4,730	-1,038	-1,677	-2,014	+308%	-83%	-100%	-100%
CR_E3	346	+201	0	-110	-91	+139%	0%	-100%	-100%
CR_W1	300	+300	0	-213	-87	>200%	0%	-100%	-100%
CR_W2	434	+279	+9	-62	-226	>200%	+6%	-100%	-100%
CR_W3	430	+256	-256	0	0	+148%	-100%	0%	0%
CR_W4	1,394	+1,230	-255	-898	-77	>200%	-100%	-100%	-100%
CR_W5	413	+170	-118	-53	0	+70%	-100%	-100%	0%
LO_E1	126	0	64	-64	0	0%	>200%	-100%	0%
LO_E2	179	0	0	0	0	0%	0%	0%	0%
LO_E3	454	0	0	0	0	0%	0%	0%	0%
LO_W1	106	+106	0	-106	0	>200%	0%	-100%	0%
LO_W2	3,437	+3,159	-249	-1,226	-1,684	>200%	-100%	-100%	-100%
LO_W3	2,278	+1,380	-299	-466	-615	+161%	-89%	-100%	-100%
TC1	905	0	0	0	0	0%	0%	0%	0%
Total Change (+/-)		**+11,944**	**-2,275**	**-4,875**	**-4,794**	**+239%**	**-81%**	**-100%**	**-100%**

Table 5.3: Pipe Upgrade Scenario – Minor system Performance – Pipe Capacity 10-year Storm (Existing IDF)

Network	Minor System Length (m)	Capacity Performance (m of sewer)			Capacity Performance (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	214	0	0%	100%	0%
CR_E2	6,481	683	5,798	0	11%	89%	0%
CR_E3	346	50	296	0	15%	85%	0%
CR_W1	300	0	300	0	0%	100%	0%
CR_W2	434	16	417	0	4%	96%	0%
CR_W3	430	86	344	0	20%	80%	0%
CR_W4	1,394	156	1,238	0	11%	89%	0%
CR_W5	413	96	317	0	23%	77%	0%
LO_E1	126	0	126	0	0%	100%	0%
LO_E2	179	144	35	0	81%	19%	0%
LO_E3	454	432	23	0	95%	5%	0%
LO_W1	106	0	106	0	0%	100%	0%
LO_W2	3,437	106	3,331	0	3%	97%	0%
LO_W3	2,278	374	1,904	0	16%	84%	0%
TC1	905	814	90	0	90%	10%	0%
Total	***17,496***	***2,957***	***14,540***	***0***	***17%***	***83%***	***0%***

Table 5.4: Pipe Upgrade Scenario vs. Existing Conditions Minor System Performance Pipe Capacity – 10-year Storm (Existing IDF)

Network	Minor System Length (m)	Change in Capacity (m of sewer)			Change in Capacity (%)		
		<0.5	0.5 - 1	= 1	<0.5	0.5 - 1	= 1
CR_E1	214	0	+91	-91	0%	+74%	-100%
CR_E2	6481	+98	+4,039	-4,138	+17%	+230%	-100%
CR_E3	346	0	+201	-201	0%	+214%	-100%
CR_W1	300	0	+300	-300	0%	0%	-100%
CR_W2	434	0	+288	-288	0%	+222%	-100%
CR_W3	430	+34	+57	-91	+67%	20%	-100%
CR_W4	1394	0	+1,089	-1,089	0%	>200%	-100%
CR_W5	413	+34	-6	-29	+56%	-2%	-100%
LO_E1	126	0	+64	-64	0%	+102%	-100%
LO_E2	179	+42	-42	0	+41%	-55%	0%
LO_E3	454	-7	+7	0	-2%	+41%	0%
LO_W1	106	0	+106	-106	0%	0%	-100%
LO_W2	3437	-50	+2,873	-2,822	-32%	>200%	-100%
LO_W3	2278	-71	+1,187	-1,117	-16%	+165%	-100%
TC1	905	0	0	0	0%	0%	0%
Total Change (+/-)		**+82**	**+10,253**	**-10,335**	**+3%**	**+239%**	**-100%**

As per **Table 5.1**, with the proposed storm sewer upgrades in place, the majority of the results are in Category A (i.e., unsurcharged). A smaller percentage are indicated as being in Category B (i.e., between pipe obvert and 50% of surface height); these results appear attributable to areas where the simulated HGL is just above the pipe obvert, or where it is indicated as such for a very short period of time based on the hydraulic routing time step. The results are further confirmed by the pipe capacity analysis as presented in **Table 5.3,** which indicates that the majority of the pipes are now in the 0.5 - 1.0 ratio, and zero pipes are now indicated as having a flow capacity greater than 1.0 (i.e. greater than theoretical flow capacity). The results confirm what would be expected, namely that the pipe upgrade scenario results in the intended outcome of all pipes meeting the 10-year LOS.

As part of the proposed analysis, it has been noted that capacity upgrades are recommended along the large trunk sewer (1650 to 1950 mm diameter) on Lakeshore Road from Hurontario Street westerly to the outfall to the Credit River. Recommended upgraded pipe sizes range between 1800 and 2400 mm in diameter. Clearly, this would be a costly storm sewer upgrade project to undertake. As a potential alternative, it has been noted that there is a trunk storm sewer (1200 mm diameter) on Helene Street which appears to be under-utilized. Based on a preliminary assessment, a storm sewer overflow to this system is feasible, however would not become active until the trunk storm sewer on Lakeshore Road becomes near full. However, using a 900 mm diameter diversion \ overflow pipe, approximately 1.0 m^3/s of flow could be diverted away from Lakeshore to Helene. The existing trunk storm sewer on Lakeshore Road would remain slightly surcharged (and the storm sewer on Helene Street would still not be fully utilized), however it would improve capacity and reduce the requirement for a costly trunk storm sewer upgrade. This alternative would require further review through detailed survey of pipe inverts in this area, (and other potential utility conflicts) and also confirmation that the Helene Street storm outfall is in good condition.

As previously described, there are significant downstream sections of storm sewer that are currently impacted by high water levels in the Credit River \ Lake Ontario. The most effective solution is to raise the outlet inverts, however physical constraints make this largely infeasible. During detailed design, the potential to raise pipes should be considered. Currently, there is insufficient information to fully assess the physical constraints. Enlarging pipes impacted by significant backwater is not economically effective as large increases in pipe size have marginal impacts on water levels. As described previously in **Section 3.3.1**, the current hydraulic modelling assumes a normal boundary condition at all outfalls. As noted in that section, based on a scoped assessment (and WSP's previous experience) tailwater levels generally only affect the immediate area at the outfall. Further upstream, the head differential caused by the stormwater inflows are sufficient to maintain pipes in unsurcharged conditions. However, this may warrant a further scoped assessment.

In addition, the City of Mississauga has expressed an interest in further validating the modelling results against the Rational Method, which is typically used for the design of smaller storm sewers as it is simpler, and generally conservative (generates higher peak flows). This approach could be implemented by converting the subcatchment imperviousness into Runoff Coefficients and testing selected areas.

While the focus of the preceding has been upon minor system performance, it is expected that the proposed storm sewer upgrades would have some benefit on the expected overland flow performance for the 100-year storm event.

Consistent with the methodology for previous modelling scenarios, the hydraulic gradeline generated for the 100-year synthetic design storm (existing IDF) has been used to determine the total length of road rights-of-way in each network for which the hydraulic gradeline would fall into the following performance categories:

Grade A: 100 Year flow contained within the top of curb / top of ditch

— Water Depth = <0.15 m (urban) or <0.30 m (ditch)

Grade B: 100 Year flow above top of curb / top of ditch but contained within rights-of-way

— Water Depth = between 0.15 and 0.25 m (urban) or 0.30 m and 0.37 m (ditch)

Grade C: 100 Year flow exceeds the rights-of-way

— Water Depth = >0.25 m (urban) or >0.37 m (ditch)

The total length and percentage of rights-of-way within each network, which falls into each of the above performance categories, is summarized in **Table 5.5**, with a comparison to existing conditions presented in **Table 5.6**.

As evident, the proposed storm sewer upgrades would also benefit the 100-year overland flow performance. There is a clear increase in major system segments within Grade A (below curb) and decreases in Grades B and C (above curb or outside of ROW). As per **Table 5.5**, the majority (91%) would now be in Grade A, with only 8% in Grade B (still within the ROW) and only one segment in LO_W1 indicated as Grade C. There are two areas where additional inlet capacity is required to eliminate the major system Grade C deficiencies. These areas are indicated on **Drawing 14**.

Table 5.5: Pipe Upgrade Scenario Major System Performance – Hydraulic Gradeline 100-year Storm (Existing IDF)

Network	Major System Length (m)	Performance (m of road)			Performance (%)		
		A	B	C	A	B	C
CR_E1	123	79	44	0	64%	36%	0%
CR_E2	6,518	5,919	598	0	91%	9%	0%
CR_E3	318	318	0	0	100%	0%	0%
CR_W1	233	233	0	0	100%	0%	0%
CR_W2	383	327	56	0	85%	15%	0%
CR_W3	406	406	0	0	100%	0%	0%
CR_W4	1,255	1,098	157	0	87%	13%	0%
CR_W5	240	229	11	0	95%	5%	0%
LO_E1	62	62	0	0	100%	0%	0%
LO_E2/3	499	419	80	0	84%	16%	0%
LO_W1	419	208	191	20	50%	46%	5%
LO_W2	3,467	3,289	178	0	95%	5%	0%
LO_W3	2,155	2,046	109	0	95%	5%	0%
TC1	848	848	0	0	100%	0%	0%
Total	**16,927**	**15,414**	**1,430**	**83**	**91%**	**8%**	**<1%**

Table 5.6: Pipe Upgrade Scenario vs Existing Conditions Major System Performance – Hydraulic Gradeline – 100-year Storm (Existing IDF)

Network	Major System Length (m)	Change in Major HGL (m of road)			Change in Major HGL (%)		
		A	B	C	A	B	C
CR_E1	123	+38	+6	-44	+92%	+16%	-100%
CR_E2	6,518	+982	-645	-338	+20%	-52%	-100%
CR_E3	318	+66	-66	0	+26%	-100%	0%
CR_W1	233	0	0	0	0%	0%	0%
CR_W2	383	0	0	0	0%	0%	0%
CR_W3	406	0	0	0	0%	0%	0%
CR_W4	1,255	+65	-65	0	6%	-29%	0%
CR_W5	240	0	0	0	0%	0%	0%
LO_E1	62	0	0	0	0%	0%	0%
LO_E2/3	499	0	0	0	0%	0%	0%
LO_W1	419	+69	-33	-36	+50%	-15%	-64%
LO_W2	3,467	+436	-327	-110	+15%	-65%	-100%
LO_W3	2,155	+94	-48	-46	+5%	-30%	-100%
TC1	848	+116	-116	0	+16%	-100%	0%
Total Change (+/-)		**+1,799**	**+1,799**	**-1,289**	**-510**	**+14%**	**-48%**

Based on the preceding, there remains only residual major system drainage issues, which likely do not warrant substantial further remedial measures. Low Impact Development Best Management Practices (LID BMPs) may be an effective measure to promote additional infiltration and drainage of sag points; this is reviewed further in a subsequent section.

5.2.1.2 Future Conditions

To assess infrastructure sensitivity to climate change altered rainfall and future land use intensification, a scoped modelling review has been completed in PCSWMM. The SSP 5-8.5 climate change scenario is expected to yield the most conservative results and has been used for this analysis. For each scenario, the storm sewers have been sized for the 1 in 10-year storm event (climate change adjusted rainfall) such that the peak simulated water level is below the pipe obvert (unsurcharged flow) consistent with the approach applied under existing conditions. To demonstrate the impact of potential future conditions on the extent of required upgrades, the number and magnitude of upgrades under each scenario are summarized in **Table 5.7**.

Table 5.7: Quantification of Pipe Upgrades (Number of Sections) to Meet Design Standard Under Potential Future Design Scenarios

Recommended Upgrade	Existing Scenario	Climate Change Scenario		Future Land Use Plus Climate Change	
	Upgrades	Upgrades	Difference	Upgrades	Difference
1 standard pipe size	77	64	-13	77	0
2 standard pipe sizes	56	62	+6	128	+72
3 standard pipe sizes	31	46	+15	46	+15
4 standard pipe sizes	19	28	+9	21	+2
5+ standard pipe sizes	14	14	0	27	+13
Total upgrade sections	**197**	**214**	**+17**	**299**	**+102**

The results presented in **Table 5.7** indicate that based on climate change impacts alone, the difference in required storm sewer upgrades is minor. An additional 17 sections of storm sewer would require upgrades (increase of 9% as compared to existing condition upgrades). In addition, the balance of required upgrades would increase, with a greater number in the 2 to 4 pipe standard pipe size upgrades as compared to the existing conditions upgrade scenario.

A greater number of upgrades are noted under the combined future land use (infill / intensification) and climate change scenario. An additional 102 pipe segments would require upgrades (increase of 52% as compared to existing condition upgrades). The results also indicate a shift in the degree of upgrade required, with the majority occurring in the two standard pipe sizes category (72 of the 102 pipe segments).

It considered that these impacts could potentially be better mitigated by on-site quantity controls as per City Stormwater Management requirements, however these requirements would only apply to sites subject to the Site Plan Control process, and thus excludes single family homes. As discussed in **Section 4.1.1**., these areas represent the majority of the expected intensification and as such any quantity controls would likely have to be municipally led within the roadway rights-of-way. Conveyance upgrades may therefore be a preferable approach, given the proximity to outlets (Credit River and Lake Ontario) and previously identified infrastructure deficiencies.

5.2.2 Cost Estimate

5.2.2.1 Baseline Conditions

To support further evaluation of alternatives, the financial implications (capital construction costs) are required. As such, preliminary construction cost estimates for the recommended storm sewer upgrades have been prepared. Further details are provided in **Appendix F**.

It is noted that it is unlikely the works would be completed on a "pipe by pipe" basis but would rather be completed in common sections. To this end, the recommended upgrades presented on **Drawing 14** have been divided into expected common scope \ tender areas. The following limits have been considered:

Project # 1

- Helene Street (Queen Street to Lakeshore Road, including potential overflow to Helene trunk sewer south of Lakeshore Road)
- High Street (Stavebank Road to Ann Street)
- Elizabeth Street (Park Street to High Street; could also include High Street to Lakeshore Road and Park Street to Queen Street for continuity)
- Stavebank Road (CNR to High Street)
- Consider also including Park Street (Stavebank Road to Ann Street) for continuity

Project # 2

- Ben Machrree Drive to Lake Ontario
- Maple Avenue South (Lakeshore Road to Lake Ontario)
- Pine Avenue South (Lakeshore Road to Maple Avenue South)
- Consider including Lakeshore Road (Broadview Avenue to Benson Avenue)

Project # 3

— Rosewood Avenue (CNR to Lakeshore Road, including potential re-alignment along south limits of Rosewood Avenue)
— Lakeshore Road (Rosewood Avenue to Helene Street)
— Forest Avenue (Briarwood Avenue to Rosewood Avenue)

None of the identified areas are understood to be included within the City's immediate capital planning (i.e. 2024) for road rehabilitation or reconstruction.

The preceding also excludes streets where only nominal conveyance upgrades have been proposed (i.e., generally one standard pipe size). In these areas, it is suggested that pipe upgrades would occur as part of longer-term capital planning and road and sewer reconstruction work based on end-of-life considerations. These areas have therefore not been included as part of the costing.

Preliminary construction costing for the three identified projects is provided in **Table 5.8**. Detailed costing information is provided in **Appendix F** (refer to Tables F1 to F3).

Table 5.8: Preliminary Construction Cost Estimate for Infrastructure Upgrade Projects

Project	Length (km)	Construction Costs	Engineering and Design Fees (15%)	Contingency (15%)	Total with Design and Contingency
# 1 (Helene and High Street)	1.4	$5,070,000	$510,000	$770,000	$6,350,000
# 2 (Maple and Pine Avenue)	1.2	$5,910,000	$600,000	$890,000	$7,400,000
# 3 (Forest and Rosewood Avenue)	1.1	$6,290,000	$630,000	$950,000	$7,870,000
TOTAL	**3.7**	**$17,270,000**	**$1,740,000**	**$2,610,000**	**$21,620,000**

Based on the information provided in **Table 5.8**, a total capital cost of $21,620,000 would be expected for the design and construction of the three projects, including contingency. Costing assumptions are outlined in **Appendix F**. As noted this does not include costs for rehabilitation of Region of Peel infrastructure (water and sanitary). Depending on budgeting timelines, additional amounts to account for inflation and construction cost escalation should be included as well.

5.2.2.2 Future Conditions

As noted in **Section 5.2.1.2**, there are additional infrastructure upgrades required if the impacts of climate change adjusted rainfall and future intensification are considered. The simulated impacts of climate change adjusted rainfall are more nominal than those from future intensification, which are likely to occur primarily due to single family home re-builds, which are not subject to the Site Plan Control process and thus to City requirements for on-site stormwater management and quantity control.

No costing of these additional conveyance upgrades has been included as part of the current summary; further discussion with City staff is required as to whether these additional costs should be considered as part of the recommended works or deferred to evaluation as part of the subsequent detailed design phase.

5.3 Low Impact Development Best Management Practices

As noted previously, a number of depressed areas have been identified within the study area. Although the proposed minor system (storm sewer) upgrades will be largely effective in addressing major system drainage deficiencies, the scoped application of Low Impact Development Best Management Practices (LID BMPs) would also be beneficial in reducing nuisance ponding and promoting infiltration or filtration at source. There would also be stormwater quality benefits, however this has not been assessed as part of the current study based on the scope.

As indicated in previous sections, the study area is split between hydrologic soil group B (i.e., Silt Loam) to the north of Lakeshore Road and hydrologic soil group C (i.e., Sandy Clay Loam) south of Lakeshore Road. Because of lesser infiltration capacity and higher potential for groundwater interference / groundwater contamination closer to Lake Ontario, no infiltrating LIDs are currently recommended south of Lakeshore Road. However, this could be re-visited on a site-by-site basis subject to additional detailed information.

Areas near Lake Ontario, where maintenance hole rim elevations are less than approximately 78 m have also been screened as non-infiltrating LIDs due to expected groundwater impacts.

Arterial and collector roadways are also typically not recommended for infiltration LID BMPs due to the expected higher use of road salting, and higher potential for contamination. As such, Lakeshore Road, Hurontario Street, and Mississauga Road are recommended for non-infiltrative LID BMPs.

Underdrains would be recommended for non-infiltrative / filtrative LID BMPs. These types of LID BMPs would provide additional storage for surface inflows, reduce nuisance ponding, and delay peak flows.

Drawing 15 provides an overview of preliminary recommended LID BMPs for the Port Credit area. The three types of LID BMPs are as follows:

- **Linear LID BMPs:** (Applied in roadway ROW). Depending on site constraints, these could include infiltration trenches / exfiltration pipes, bioretention, tree planter units, and dry swales.
- **Lot Level LID BMPs:** (Applied in residential areas with significant ponding). Soakaway pits are generally recommended, given potential resident complaints about ponding water / drainage issues. Bioretention areas could be considered but may be more challenging to maintain.
- **Centralized LID BMPs:** (Applied in larger parking areas, parks). Infiltration chambers / underground storage would generally be recommended.

The preceding would be subject to additional site-specific investigations and detailed design as noted previously to confirm feasibility. In addition, the proposed measures should not be considered as exhaustive. Road reconstruction projects or other development works within the study area should be considered as an opportunity to implement LID BMP measures, consistent with other City directives and policies, including the City's Stormwater Master Plan (Build Beautiful).

Costing for LID BMPs has not been provided as part of the current assessment, given the potential range of locations and types of LID BMPs to be considered; further review with City staff is warranted.

5.4 Overall Evaluation

As per the Class Environmental Assessment process, alternatives should be evaluated against a fulsome suite of factors beyond just technical considerations. A broad description of the type of impacts and issues under consideration includes:

1. **Functionality:** How effective the alternative may be in addressing identified drainage system issues, and the ease or complexity associated with the construction and long-term operation of the alternative.

2 **Social Environment:** Impacts / issues relating to the interaction of the community / neighbourhood with the implementation of the proposed alternative. How effective the proposed alternative is at reducing risk and increasing public safety; impacts to public (recreational) spaces as well as private property, including short-term construction impacts to the area.

3 **Economic Environment:** Immediate (capital) costs and future long-term (operations and maintenance) costs and overall cost-benefit of the alternative.

4 **Cultural Environment:** Impacts / issues related to potential archaeological and cultural heritage resources. It should be noted that as the current study did not include specific assessments for these areas, the screening has been more generalized based on limited available data or typical areas of concern from WSP's previous experience.

5 **Natural Environment:** Potential environmental impacts or benefits that alternatives may have on the local area, including both terrestrial and aquatic features.

6 **Climate Change:** Evaluation of how the alternative may contribute to overall climate change impacts (i.e., greenhouse gas emissions) and also how resilient \ adaptive the works are to future changing climatic conditions.

A number of sub-evaluation factors have been considered for each of the primary evaluation factors noted above. These criteria are presented in **Table 5.9** along with a description of what is considered. In addition, criteria weighting have been proposed to reflect the relative importance of each evaluation factor. Initial evaluation weightings were reviewed with City staff at a meeting on October 12, 2022. The values presented in **Table 5.9** reflect City input.

Table 5.9: Summary of Alternative Evaluation Criteria

Evaluation Category	Criteria Weight	Evaluation Criteria	Criteria Description
Functionality	15%	Effectiveness	Overall effectiveness to improve drainage system performance
	5%	Implementation	Complexity or ease of construction
	5%	Maintenance	Complexity or ease of longer-term operations and maintenance
	5%	Utilities	Potential effects on public and private infrastructure (utilities)
Social Environment	5%	Public Safety	Potential for improved public safety
	5%	Recreational Uses	Potential impacts to public's use of area for recreational purposes (trails and parks)
	5%	Private Property Impacts	Potential impact to adjacent private properties (business and residential) or land needs for the works
	5%	Construction Effects	Potential impacts during construction (noise, air quality, dust, etcetera)
Economic Environment	5%	Construction Cost	Capital cost for construction
	5%	Maintenance Cost	Long-term operations and maintenance costs
Cultural Environment	5%	Archaeological Resources	Potential impacts on identified archaeological resources
	5%	Heritage Resources	Potential effects on built heritage resources and cultural heritage
Natural Environment	5%	Terrestrial Ecosystem	Potential effects on terrestrial ecosystem
	5%	Aquatic Ecosystem	Potential effects on aquatic ecosystem
Climate Change	10%	Climate Change Mitigation	Expected production of greenhouse gas emissions and impacts on carbon sinks (i.e. trees)
	10%	Climate Change Adaptation	Resilience or vulnerability to changing climatic conditions

The criteria presented in **Table 5.9** have been applied to each of the primary alternatives, namely the three infrastructure (storm sewer) reconstruction projects. Note that in this case due to the previous screening of alternatives on the basis of technical effectiveness and given that each of the three projects are stand-alone, the alternatives have been compared to the "Do Nothing" alternative only.

Scores have been developed for each from 0 to 10. For some criteria, such as functional or economic considerations, 0 would represent the worst case (i.e., no improvement, highest cost), while 10 would represent the best case (i.e., complete improvement, lowest cost). For certain other criteria where the evaluation may be negative, neutral, or positive, a similar approach would apply, however 0 to 4 would represent negative outcomes, 5 would represent a neutral outcome, and 6 to 10 would represent positive outcomes.

The technical effectiveness and capital costing have been assessed based on the results in the preceding sections. Other criteria have been assessed qualitatively. Estimated scores for each alternative are presented in **Appendix F** (Table F4). The scores for each category have been adjusted based on the criteria weighting previously noted. The most preferred alternative would therefore have the highest overall score. A summary of the resultant scores is presented in **Table 5.10**.

Table 5.10: Evaluation Scoring Summary

Project	Alternative	Weighted Score (of 10)
# 1 (Helene and High Street)	Do Nothing	4.3
	As proposed	6.1
# 2 (Maple and Pine Avenue)	Do Nothing	4.3
	As proposed	6.1
# 3 (Forest and Rosewood Avenue)	Do Nothing	4.3
	As proposed	6.1

As evident from **Table 5.10**, the proposed construction works have a higher score for each of the three proposed projects as compared to the do-nothing option. As such, each are recommended for implementation.

5.5 Prioritization

In general, it is considered that the numbering \ sequencing of the projects also reflects the relative prioritization. Project # 1 includes works in the area of Helene and High Street, which is already a highly urbanized area, but is understood to be an area currently subject to high infill / intensification and re-development pressures. As such, the proposed works would ensure a consistent level of service (LOS) for these areas and support associated development. As noted previously, the proposed storm sewer upgrades would also help address identified surface ponding issues, particularly if combined with the proposed LID BMP works.

Project # 2 is also located in an area of re-development and infill and intensification (single family detached residential). As such, ensuring a consistent level of service (LOS) for this area would also be important. The recommended works may require further upgrading to account for the additional impervious area associated with intensification, given that single family homes would not be subject to typical City requirements for on-site stormwater management (i.e., not subject to Site Plan Control).

Project # 3 is the lowest priority of the three projects. The works are located within a secondary study area (outside of the primary study area) and are understood from City staff to have a reduced pressure with respect to infill / intensification. Depression storage and overland flow deficiencies in this area are also correspondingly less than adjacent areas.

Based on information provided by City staff, only two streets in the area were tentatively scheduled for road rehabilitation in 2024 (Front Street South and Port Street West). These works are also understood to likely involve road re-surfacing only (i.e., not full depth reconstruction including storm sewers). Neither of these areas would align with the high priority projects noted.

In addition to the preceding, a number of deficiencies were noted as part of the supplied CCTV information (refer to **Drawing 5**). It is expected that these works would be addressed as part of the City’s ongoing operations and maintenance works. Priority should be given to areas with obstructions (flushing to be considered first, and then the area should be re-evaluated) and areas with identified damage. This includes storm sewers along Harrison Avenue and Wesley Avenue in particular.

6 CONSULTATION AND ENGAGEMENT

Engagement has been undertaken to inform the public about the different tasks of the Municipal Class EA Study. Formal consultation was initiated with the Notice of Commencement publication on July 25, 2022. A key component of this Study is to consult with regulatory agencies, the public, interested stakeholders and Indigenous Peoples & Nations whose Traditional Territory the Study is located in. The project materials for consultation and engagement are documented in **Appendix G**.

6.1 Communication and Engagement Activities

To provide an opportunity for feedback for stakeholders and members of the public, engagement and comment were provided in a diverse set of engagement methods, including:

— Online engagement on the Project website (https://www.mississauga.ca/projects-and-strategies/environmental-assessments/port-credit-storm-drainage-master-plan/), where participants could learn more about the project and provide feedback via email or comment form
— Notifications and email updates
— Correspondence with conservation authorities
— Consultation with members of the City Project Team
— Meeting with stakeholders as part of the Technical Advisory Committee
— Notifications to, and discussions with, Property Owners
— Notifications to Indigenous Nations
— Two virtual Public Information Centres (PICs) in 2022 and 2024

6.1.1 Public Information Centres

Two virtual Public Information Centres (PICs) were held throughout the Municipal Class EA Study engagement process. Notification was issued in advance to area residents and the public. The first PIC was held from July 26, 2022 to August 16, 2022 to provide information regarding Task 1: Study Area Characterization and Task 2: Analysis & Assessment of Stormwater Management System. The second PIC was held from March 20, 2024 to April 10, 2024 and provided an overview of Task 1 and Task 2, as well as further detail regarding Task 3: Evaluation of Alternatives, and Task 4: Preferred Stormwater Management Strategy. Both virtual PICs were completed in a video format with narration to provide detailed information and explanation regarding the tasks within the Study process. The presentation panels and video scripts for both PICs is provided in **Appendix G**.

The virtual PICs were posted on the Project website. One (1) phone call was received from the Port Credit resident's association after the first PIC and there were no comments or questions received during the second PIC. After the completion of the Final Report, the Notice of Completion is to be released and the public will have an additional opportunity to comment on the Study during the 30-Day Public Review Period.

A summary of the engagement material for the Public Information Centres is provided in **Appendix G**.

6.1.2 Technical Advisory Committee

A Technical Advisory Committee (TAC) was established for the Project, comprised of the Region of Peel and Credit Valley Conservation (CVC). Members of the TAC offered feedback on Project materials, interacted on policy and program issues, and identified partnership opportunities for future stormwater management Actions. All stakeholder meetings were held virtually.

6.1.2.1 TAC Meeting # 1

TAC Meeting #1 was held on May 5, 2022 to provide an overview of, and receive feedback on the following:

- Study schedule
- Responsibilities of members of the TAC
- Overview of Task 1 and Task 2

Stakeholders provided feedback and comments on the materials shared and identified methodology considerations for the technical components of the Study.

Presentation Slides, Meeting Minutes and stakeholder feedback is provided in **Appendix G**.

6.1.2.2 TAC MEETING # 2

TAC Meeting #2 was held on March 6, 2023 to provide an overview of, and receive feedback on the following:

- Update on project schedule and tasks
- Public Information Centre #1
- Preferred solution of providing upgrades in three separate areas ("projects")

— LID BMP installation

Stakeholders provided feedback on the materials shared, identified timelines for implementation, and provided suggestions for the next Public Information Centre.

Presentation Slides, Meeting Minutes and stakeholder feedback is provided in **Appendix G.**

6.1.3 Project Progress Meetings

Project Progress Meetings were held with a variety of stakeholders to provide strategic direction throughout the Project, review Project materials including information to be shared externally for consultation, and to discuss key City policies and initiatives. Project Progress Meetings were held six times throughout the project process. **Table** 6.1 provides a summary of the Project Progress Meetings.

Table 6.1: Summary of Project Progress Meetings

Date	Attendees	Matters Discussed
December 2, 2020	City, WSP	- Overview of Port Credit community - Consultation and engagement - Technical Memorandum # 1 - Synergy with capital planning and construction activities
February 10, 2021	City, Region of Peel, WSP	- Overview of Study - Region of Peel I/I Reduction Program - Level of service enhancements for Port Credit - Consultation and engagement
June 15, 2021	City, WSP	- Infill and intensification within Port Credit - Climate change impacts
July 9, 2021	City, Region of Peel, Climate Risk Institute, WSP	- Overview of Study progress - Region of Peel Climate Change Studies (past and on-going) - Recommendations for climate change tools and data sets for the Study
October 12, 2022	City, WSP	- Alternative assessment review, including LID BMPs - Study progress and schedule - Consultation and engagement
January 12, 2023	City, WSP	- Discussion of preliminary preferred solution - Consultation and engagement

Meeting Minutes from the progress meeting are provided in **Appendix G**.

6.2 Indigenous Consultation

The following Indigenous Peoples & Nations were engaged as part of the Project process, based on WSP's experience working with Indigenous Peoples & Nations within Mississauga previously, and through consultation with the City's Manager of Heritage Planning and Indigenous Relations:

- Haudenosaunee Confederacy Chiefs Council (HCCC) represented by Haudenosaunee Development Institute (HDI)
- Six Nations of the Grand River (SNGR)
- Mississaugas of the Credit First Nation (MCFN)
- Huron-Wendat First Nation (HWN)

Given that the City was concurrently undertaking the City of Missisauga Build Beautiful Stormwater Master Plan, which is closely related to the Port Credit Storm Drainage Master Plan, and since WSP was the consultation lead supporting the City on this related Action, a joint Project Summary and Letter, describing both the Build Beautiful SWMP and Port Credit Environmental Assessment (EA), was provided to the Indigenous Nations in order to highlight their interconnectedness and be respectful and reduce review time of Indigenous Nations' staff. Engagement and correspondence with Indigenous Peoples & Nations is summarized in the subsections below. Consultation with each Indigenous Nation is documented in **Appendix G**.

6.2.1 Haudenosaunee Development Institute (HDI) on behalf of Haudenosaunee Confederacy Chiefs Council (HCCC)

The following engagement activities were undertaken with the Haudenosaunee Development Institute (HDI) on behalf of Haudenosaunee Confederacy Chiefs Council (HCCC):

- An email was sent to HDI on May 7, 2021, which provided an Introductory Letter and Project Summaries for the Port Credit Storm Drainage Master Plan Build Beautiful SWMP, as these projects are directly related, therefore together provide additional context and support streamlining the review process.
- A phone call discussion took place on July 27, 2022, between the City and HDI following up on the May 7, 2021, e-mail for any feedback. Given the passage of time, due to the pandemic and other important issues taking place within the Indigenous community, a follow-up email was sent on July 27, 2022, including the Introductory Letter and Project Summaries for further consideration and feedback from HDI.

- A follow-up phone call was made on August 25, 2022, for closure, after which no written or verbal correspondence was received. Having not received any feedback, a closure e-mail was issued on November 3, 2022. This e-mail included a soft copy of the HDI Agreement.
- A hard copy of the above-noted Agreement was issued to HDI along with a cheque for the review fee of $3,000.

6.2.2 Huron-Wendat Nation (HWN)

The following engagement activities were undertaken with the Huron-Wendat Nation (HWN):

- An email was sent to HWN on May 7, 2021, which provided an Introductory Letter and Project Summaries for the Port Credit Storm Drainage Master Plan and Build Beautiful SWMP, as these projects are directly related, therefore together provide additional context and support streamlining the review process.
- A phone call attempt was made on July 25, 2022, from the City to HWN following up on the May 7, 2021, e-mail for any feedback. Given the passage of time, due to the pandemic and other important issues taking place within the Indigenous community, a follow-up email was sent on July 25, 2022, including the Introductory Letter and Project Summaries for further consideration and feedback from HWN.
- A follow-up phone call was made on August 25, 2022, for closure, after which no written or verbal correspondence was received. Having not received any feedback, a closure e-mail was issued on November 3, 2022.

6.2.3 Mississaugas of the Credit First Nation (MCFN)

The following engagement activities were undertaken with the Mississaugas of the Credit First Nation (MCFN):

- An email was sent to MCFN on May 7, 2021, which provided an Introductory Letter and Project Summaries for the Port Credit Storm Drainage Master Plan and Build Beautiful SWMP, as these projects are directly related, therefore together provide additional context and support streamlining the review process.
- A phone call discussion took place on July 25, 2022, date between the City and MCFN following up on the May 7, 2021, e-mail for any feedback. Given the passage of time, due to the pandemic and other important issues taking place within the Indigenous community a follow-up email was sent on July 25, 2022, including the Introductory Letter and Project Summaries for further consideration and feedback from MCFN.

- MCFN responded via email on July 26, 2022, identifying that they have no comments or concerns regarding the Stormwater Master Plan and Port Credit Storm Drainage Master Plan, and requested they be informed if any new information arises about the projects.

6.2.4 Six Nations of the Grand River (SNGR)

The following engagement activities were undertaken with the Six Nations of the Grand River (SNGR):

- An email was sent to SNGR on May 7, 2021, which provided an Introductory Letter and Project Summaries for the Port Credit Storm Drainage Master Plan and Build Beautiful SWMP, as these projects are directly related, therefore together provide additional context and support streamlining the review process.
- A phone call discussion took place on July 25, 2022, date between the City and SNGR following up on the May 7, 2021, e-mail for any feedback. Given the passage of time, due to the pandemic and other important issues taking place within the Indigenous community, a follow-up email was sent on July 27, 2022, including the Introductory Letter and Project Summaries for further consideration and feedback from SNGR.
- A follow-up phone call was made on August 25, 2022, for closure. In response to this call, the City had a phone conversation on August 26, 2022 with a SNGR archaeologist that confirmed there were no comments on the matter.

7 SUMMARY AND CONCLUSIONS

A dual drainage (minor and major system) hydrologic and hydraulic model has been developed for the Port Credit study area using PCSWMM. This model has been built premised on the data and findings from the completed background review.

The modelling has been used to assess the simulated capacity of the drainage systems within the Port Credit community, including the minor (storm sewer) and major (overland flow – roadway) systems, under the City's specified design events, namely the 10 and 100-year storms respectively. The simulated results indicate that only between 29 and 41% of the storm sewer system would meet the City standards, depending on the evaluation metric applied. The balance of the storm sewers indicates varying degrees of surcharging, between limited impacts (peak water level slightly greater than top of pipe) to greater impacts (peak water level for storm sewer system above ground level). The preceding are overall average results for the study areas as a whole, whereas certain networks indicate worse performance than average and may therefore be target areas for future remedial works.

The results for the major system indicate that 16% of roadway sections would exceed the primary conveyance (i.e., ditch or curb) but remain within the road rights-of-way; overall only 4% of simulated conduits indicate exceedance of flow beyond the rights-of-way (municipal property) limits. Notwithstanding, several specific drainage system networks indicate much worse performance than the average, network LO_W1 and CR_E1 in particular. Many of the poorly performing major system areas coincide with areas with identified overland flow constraints (i.e., high surface depression storage) which is logical and consistent with expectations.

In addition to the preceding, an assessment of the potential impacts of future intensification, through assumed limited re-development of existing low-density residential areas, has been undertaken. The findings indicate some sensitivity to potential changes, particularly in specific areas with high concentrations of existing low-density residential land use.

Based on direction from the Region of Peel and others, a scoped climate change analysis has been undertaken using predicted climate change adjusted rainfall intensity-duration-frequency (IDF) datasets, using the recommended IDF_CC tool by the University of Western. Two different emission scenarios have been assessed, including the SSP 2-4.5 and SSP 5-8.5, to assess the range of climate change impacts using the ungauged location in Downtown Port Credit. The climate change analysis has demonstrated that under future climate change rainfall conditions, both the minor system and major system experience worsened performance, indicating additional surcharging and spills beyond the rights-of-way. The largest impacts in performance are observed within the largest drainage networks (>400 m length of storm sewer), given the significant drainage area contributing to these systems.

An alternative evaluation process has been undertaken to identified preferred measures to address identified drainage system capacity restrictions. A long-list of alternatives has been pre-screened on the basis of technical feasibility. Based on the constrained nature of the study area, the generally preferred approach involves storm sewer upgrades, in conjunction with inlet capacity upgrades as required. Three reconstruction projects have been identified and screened using the Class EA evaluation process. Opportunities for local Low Impact Development Best Management Practices (LID BMPs) have also been identified and recommended.