DILLON CONSULTING

TOWN OF KENTVILLE ENGINEERING AND PUBLIC WORKS

Stormwater Management Master Plan

April 2025 - 24-8977

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April 4, 2025

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Attention: Dave Bell, P.Eng.
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Stormwater Management Master Plan – Final Design Submission

Dillon Consulting Limited is pleased to provide the Town of Kentville with the attached Stormwater Management Master Plan and hydrologic/hydraulic assessment report for the Town of Kentville. This study was undertaken to evaluate the existing drainage system within the community, identify drainage issues and vulnerabilities, and recommend improvement opportunities to mitigate flood risks and enhance community resilience. The report details the study's methodology, findings, and recommendations related to:

- Assessment of existing drainage infrastructure and hydraulic constrictions;
- Hydrologic and hydraulic modeling of current and future development scenarios;
- Identification of flood-vulnerable areas and potential mitigation measures; and
- Conceptual design and cost estimates for recommended drainage improvements.

We trust that this report will serve as a valuable resource for the Town of Kentville in prioritizing and implementing stormwater infrastructure upgrades, safeguarding the community from future flooding events, and supporting sustainable development initiatives.

Please feel free to contact the undersigned should you have any questions or comments regarding the contents of this report or require further information.

Sincerely,

DILLON CONSULTING LIMITED

Jeff Melanson, P.Eng.
Project Manager

Emily Colborne, P.Eng.
Water Resources Engineer

JAM:EMC:llc

Our file: 24-8977

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Executive Summary

Dillon Consulting Limited was retained to provide the Town of Kentville a Stormwater Management Master Plan to evaluate the existing stormwater system, identify potential drainage challenges, and recommend improvement opportunities as part of a 10-year capital plan. The objective of this study is to develop a clearer understanding of the drainage challenges within the community to protect community members from flooding, mitigate damage to infrastructure and property, and manage stormwater runoff effectively. Using a well-established approach and numerical modeling tools, Dillon investigated the existing infrastructure's performance and proposed practical solutions to address drainage challenges.

The community has faced recurring challenges with stormwater management and flooding, impacting critical infrastructure and housing. The existing drainage infrastructure's capacity and effectiveness were a key focus of this assessment. To understand the existing level of flood risk within the Town, a series of site visits were completed in the summer and fall of 2024. These site visits included a site walkthrough with community members, topographical survey, and a visual inspection of drainage infrastructure.

Informed by field observations, community input, and the results of PCSWMM simulations, four (4) primary areas of concern were identified:

- **Area 1: West Kentville Residential Area** (McDougall Heights, Park Street, and connecting subdivisions) is subject to frequent flooding due to high stream flow, undersized culverts, and sediment buildup.
- **Area 2: West Main and Harvest Moon Trail Area** experiences flooding and sediment deposition, with stormwater infrastructure including overland flow, natural drainage channels, and underground stormwater pipes.
- **Area 3: Residential Area South of Park Street** (Condon, Miller, and Dennison Avenues) faces flood risks from natural drainage channels, steep terrain, and sediment buildup.
- **Area 4: Mill Brook Area** (Crescent Avenue and the residential properties) is vulnerable to riverine flooding, with a history of the brook overtopping its banks.

To mitigate flooding in these areas, a range of conceptual drainage improvement options were developed, including upgrades to existing stormwater infrastructure and attenuation facilities. These upgrades were evaluated considering future development conditions in consultation with the Town. Rough order of magnitude construction costs for potential upgrades have also been prepared to support budgetary planning.

1.0 Introduction

Dillon Consulting Limited (Dillon) was retained by the Town of Kentville (Town) to provide a Stormwater Management Master Plan to evaluate the existing stormwater system, identify potential drainage challenges, and recommend improvement opportunities as part of a 10-year capital plan. The objective of this study is to develop a deeper understanding of drainage patterns within the Town to inform the identification of potential infrastructure upgrades and enhancements. These improvements are intended to mitigate community risk to stormwater flooding, minimize infrastructure and property damage, and manage stormwater runoff effectively under current and projected future conditions. It is important to highlight that this study has been completed at the community scale and is focused on municipal stormwater infrastructure and is not intended to address individual lot level drainage challenges.

Using a combination of existing information, field observations, and numerical modeling tools, Dillon assessed the performance of existing infrastructure and proposed practical solutions to address drainage challenges. This involved gathering background information on the Town's drainage history, collecting information on the existing infrastructure, and developing a hydrologic/hydraulic model to simulate rainfall events and assess the systems conveyance capacity under various conditions. By incorporating community input and the implementation of advanced modeling tools, the study will provide the Town with a comprehensive understanding of its drainage challenges. This information was used to inform recommendations for mitigating flooding and implementing sustainable and effective stormwater management systems.

2.0 Background

2.1 Site Background

The Town of Kentville is centrally located within the Annapolis Valley region of Nova Scotia and encompasses a geographical area of approximately 18 km^2, shown in **Figure 2-1**. The Town has a population of 6,630 residents as of 2021 (Statistics Canada, 2023) and is actively growing. The Town's topography is characterized by rolling hills and valleys that can be attributed to the historical influences of glaciers and the erosive processes of the Cornwallis River, also referred to as Jijuktu'kwejk. Several soil formations can be found within the Town's borders however, the predominant underlying soil type is a sandy loam with a moderately to rapidly drained drainage class.

The Town is situated along the tidally influenced Cornwallis River, a meandering river originating in the North Mountain and flowing through the Annapolis Valley before discharging into the Minas Basin of the Bay of Fundy. Due to the large tidal range of the Bay of Fundy, the lower 15 km of the Cornwallis River are tidally influenced, extending up to 5 km west of the Town. The Town's proximity to the Cornwallis River increases its vulnerability to riverine and coastal flooding and storm surges. While previous studies have estimated that lands below the nine-metre contour are susceptible to flooding, more recent studies have estimated the risk of flooding to extend to even higher elevations (East Kentville Flood Assessment, 2015).

Stormwater management is a growing concern in the Town. Several recent high-intensity rainfall events have overwhelmed the Town's drainage systems, impacting critical infrastructure and residential housing, with an example of the stormwater infrastructure at the intersection of West Main Street and the Harvest Moon Trail ditch network being overwhelmed during high intensity rainfall on July 11th, 2024, shown in **Figure 2-2**. Stormwater flooding and sediment deposition on private properties and within the stormwater infrastructure have presented ongoing challenges for the municipality. Erosion along natural drainage channels leads to sediment deposition downstream, clogging culverts that connect these channels to the stormwater network. This results in significant sediment, bank material, and debris being deposited on adjacent and downstream properties, with an example of this occurring at a property located on Condon Avenue after a heavy rain in 2019 shown in **Figure 2-3.**

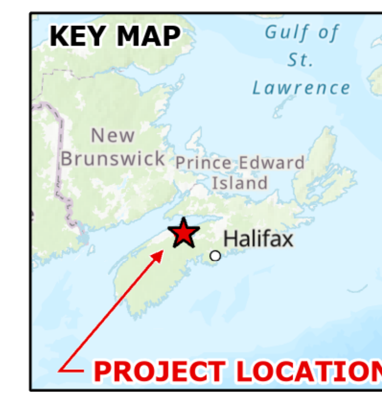
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

PROJECT LOCATION

FIGURE #2-1

Town of Kentville
Waterbody
Watercourse
Highway
Major Road
Local Road



SCALE 1:25,000

0 0.5 1 Kilometers

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova

MAP CREATED BY: JA
MAP CHECKED BY: EC
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

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PROJECT: 24-8977
STATUS: DRAFT
DATE: 2025-02-24

FILE LOCATION: K:\GIS\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan.aprx; LAYOUT: F01 Site Location

Figure 2-2: Culvert Located at Intersection of West Main Street and Harvest Moon Trail Ditch on July 11, 2024 (Photo Provided by Kentville Resident)

Figure 2-3: Deposited Sediment Covering Yard of a Private Residence on Condon Avenue After a Heavy Rain in 2019 (Photo Provided by Resident of Condon Avenue)

2.2 Study Scope and Objectives

To address the ongoing drainage issues and support planning for future development, the Town has requested the development of a comprehensive stormwater management master plan to evaluate the current stormwater management system and to develop a range of potential drainage improvement options based on future climate, future land use, and infrastructure conditions. Climate change and the complex relationship with the Cornwallis River's tailwater influences further exacerbate the Town's vulnerability to coastal flooding, storm surges, and drainage overflows. These influences necessitate a proactive and adaptive stormwater management strategy. It is understood that this Stormwater Management Master Plan shall address the Town's current needs, as well as anticipate future challenges, supporting the long-term resilience and sustainability of Town's infrastructure.

3.0 Data Collection

The existing drainage infrastructure within the Town primarily consists of a subsurface storm sewer system, natural channels, roadside ditches, and culverts that drain towards the Cornwallis River. A comprehensive understanding of the existing drainage infrastructure is a fundamental component of a drainage assessment. The following sections outline the background information reviewed, and field data collected to support this study.

3.1 Review of Existing Data

As part of the background information review process, Dillon reviewed several relevant documents supplied by the Town. This included various forms of documentation such as previous flood risk assessments, construction plans, and town zoning maps. All background information was reviewed to assist with the development of the proposed comprehensive stormwater management master drainage plan. A summary of the background information reviewed is summarized below.

Condon Avenue Storm System Upgrades Drawing Set (2024)

The Condon Avenue Storm System Upgrades drawing outlined plan and profile views of the stormwater sewer and its associated components, including dimensions, elevations, and grading information for the upgraded system.

Donald E. Hiltz Connector Road Drawing Set (Issued for Tender) (2025)

The Donald E. Hiltz Connector Road is being constructed near the south side of the Town's boundary to connect the Kentville Business Park and Prospect Avenue. This drawing set outlined plan and profile views of the proposed roadway and its associated culverts, ditching, and drainage components, including dimensions, elevations, and grading information for culverts and piping. Drainage components included in the drawing set included stormwater ponds, vegetated swales, in ditch-detention areas, and riprap basins at culvert outlets.

East Kentville Flood Assessment – Final Report for the Town of Kentville (2015)

The East Kentville Flood Assessment, completed in 2015, was conducted to assess and identify flood vulnerable areas in East Kentville along the Cornwallis River and Mill Brook. A hydrologic/hydraulic model and assessment was completed and resulted in flood plain maps being produced displaying the 1 in 20 and 1 in 100-year storm flood extents. Following the identification of areas with a risk of flooding, the report continued by outlining several potential flood protection measures at a conceptual level. These included recommendations such as upgrading bridges or structures that restrict flow, increasing upstream storage, protecting properties with structures, and other lot level methods such as regrading, sump pumps, or foundation drains.

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Gaspereau Primary Watershed Flood Line Mapping – Final Report for the Town of Kentville (2023)

Dillon Consulting Limited was retained by the Town of Kentville to prepare flood line maps for the Gaspereau Primary Watershed, adhering to the technical guidance outlined in the Draft Nova Scotia Municipal Flood Line Mapping Documentation (2022 ed.). The project involved establishing regulatory floodplain limits along various river systems, including the Cornwallis River, and the adjacent coastline. This was achieved through a combination of comprehensive field monitoring, hydrologic and hydraulic modeling, and advanced estuarine and coastal flood mapping techniques. The resulting floodplain maps will guide future development within the watershed.

Geographic Information System (GIS) Data on Existing Infrastructure (2024)

Dillon was supplied with a GIS package containing the known compiled stormwater structure information by the Town. Included in the GIS information were data regarding invert and obvert elevations, structure types and sizes, pipe construction material, pipe lengths, and manhole locations. It is worth noting that the information contained within the GIS package was limited and most points did not include any relevant information such as elevations, sizing, or details regarding pipe connections.

Kentville Stormwater Management Report – DRAFT Report (Undated)

Following the previous Flood Assessment (2015), further investigation into the Town's stormwater drainage system occurred. The report identified nine major drainage systems and delineated a total of 138 sub-watersheds in the study area. The study utilized PCSWMM to complete a hydraulic and hydrologic assessment of the drainage area and used this to size the system to convey the 1 in 5, 1 in 10, and 1 in 100-year return period flows without pipe surcharging. The report continues by describing some recommendations to improve future stormwater management systems through planning for the inclusion of low impact development (LID) features and typical best management practices for stormwater in forested and urban areas.

North Kentville Stormwater Management Plan – Draft Report (2016)

In response to historical stormwater drainage issues occurring in several parts of North Kentville, specifically from Mee Road towards Governor Court and Rosedale Avenue and down to Chipman's corner, CBCL completed a two-dimensional modelling of the area to assess the drainage network and find the cause of the flooding and propose solutions to alleviate it. The hydrologic and hydraulic assessment resulted in significant flooding expected to occur even with more minor storms such as the 1 in 5-year storm. The flooding was deemed to be due to the natural systems floodplain and can only be partially alleviated through methods such as upgrading the current infrastructure or implementing LID and BMP features.

Town of Kentville March 2003 – Storm Water Study (2003)

Study of storm water drainage for the Main Street West area of Kentville with emphasis on major floods experienced earlier that year. Evidence of March 2003 flood event showed water elevations and flooding in some areas up to the 9-metre mark. The report continued by identifying that the Cornwallis River was higher than normal at the time of the extreme storm event and the flooding experienced was due to the elevated riverine water levels and not caused by Kentville's storm water system.

Town of Kentville Land Use Bylaw Map (Town of Kentville, 2020)

A copy of the land use bylaw zoning map resulting from the July 20, 2020, amendments. This zoning map was used to determine the approximate location and extent of future development scenarios in the hydraulic/hydrologic model.

3.2 Community Supplied Information and Photographs

During the study, members of the community supplied Dillon with photos and information pertaining to previous flood events within the Town. These included photographs from multiple floods events spanning from 2003 to 2024, descriptions and timelines of previous flood events, and the locations of areas prone to flooding during high intensity rain events. The use of an online OneDrive folder was implemented to allow the continual addition of new information from the community as the project was underway.

In addition to this, Dillon participated in a Town held public engagement session on November 20th, 2024. In this engagement session, residents shared their personal experiences and concerns regarding stormwater management within the Town. A summary of the concerns raised during the public engagement session can be found in **Section 3.6**.

3.3 Municipal Assets

Geographical information system (GIS) files of known stormwater piping locations and information was supplied to Dillon by the Town. This information included location and size for a subset of drainage infrastructure in the Town (i.e. catch basin leads, stormwater drainage grates, and piping systems).

Further, the following is a list of municipal assets that are owned and managed by the Town. It is noteworthy that the Town operates and maintains the following infrastructure:

- A water system comprised of 7 municipal water wells, 2 treatment facilities, 4 storage towers and associated transmission and distribution mains, servicing approximately 3600 residential and commercial customers;
- A wastewater collection system including 13 sewage lift stations;
- A sidewalk network made up of approximately 35 km of asphalt and concrete sidewalks;
- A road network made up of approximately 60 km of local, collector and atrial streets;
- The Centennial Arena, Public Works Building, Townhall, and other municipal buildings; and
- Numerous parks & playgrounds throughout the Town.

3.4 Historical Flooding

Flooding has been an ongoing concern in the Town, causing significant damage to residential properties. Historical Flood Events information available through Natural Resources Canada (NRCan) has reports of historical flooding in the Kentville area dating back to the early 1880's. Flooding attributed to spring freshet, heavy rainfall, and coastal storms have all been reported throughout the years (NRCan, 2024). During interviews and conversations with the public, several residents spoke of previous flood events inundating basements with up to 1.8 m (6 ft) of water and lawns and driveways covered with debris and sediment as flood waters receded.

Despite the presence of flood protection dykes, riverine and coastal flooding remains a concern. The combined effects of high tides and high intensity rainfalls have previously resulted in the river overtopping its banks, impacting adjacent properties and low-lying areas. High water levels in the Cornwallis River also result in some gravity fed stormwater sewer network outlets to be submerged, reducing the hydraulic conveyance capacity of the overall stormwater management system. While high water levels can exacerbate stormwater management issues, localized flooding of stormwater infrastructure has been typically associated with high intensity rainfall events. The following sections summarize two of the most significant recent flood events related to stormwater.

March 30, 2003

On March 30 and 31, 2003, the Town and surrounding area received 70 mm of precipitation in 36 hours. This rainfall, combined with rising temperatures and rapid snow melt, resulted in the Cornwallis River overtopping its banks. Further, high tidal conditions resulted in an increase in water levels to or near the 9 m elevation (Hiltz and Seamone, 2003). These high-water levels imposed a high tailwater condition on the Town's storm sewers, resulting in a lack of local drainage capacity. Further, the high tail water conditions resulted in Mill Brook overtopping its bank and flooding properties located along Brook Avenue, shown in **Figure 3-1**.

Figure 3-1: Mill Brook Overtopping its Banks March 30, 2003 (Saltwire Network, 2003)

July 11, 2024

On July 11, 2024, the Town and surrounding region experienced a high intensity storm (approximately 90 mm of precipitation in 8 hours), prompting flash flood warnings being issued for Digby, Annapolis, Kings and Hants counties. Within the Town, the heavy rain led to flash flooding around Condon Avenue, with water overflowing onto Park Street and inundating the nearby ballfields in Memorial Park, shown in **Figure 3-2**. Localized flooding is largely attributed to the volume of runoff overwhelming the Town's stormwater infrastructure and overtopping onto the roadway and adjacent properties. Moreover, limited outlet capacity caused stormwater to accumulate and subsequently back up the ditching system adjacent to Memorial Park. As the water exceeded the ditch's storage capacity, several residents along West Main Street reported flooding in their backyards due to overflow.

Figure 3-2: Flood Water in Memorial Park on July 11, 2024 (Jason Mallory, SaltWire)

As flood waters receded, properties and portions of Condon Avenue were covered with sediment and debris indicative of severe erosion within the upstream natural channels, as shown in **Figure 3-3**.

Figure 3-3: Sediment and Bank Material Deposited on Condon Avenue Following the July 11, 2024, Rainfall Event (Photo Provided by a Resident of Condon Avenue)

3.5 Site Reconnaissance and Survey

Site visits were conducted on November 4 through 8, 2024, and November 18 through 20, 2024, to gather information on the existing drainage network within the assessment area. During these visits, Dillon personnel completed topographic surveys of natural drainage channels and roadside ditches, a visual inspection of drainage infrastructure, as well as subsurface surveys of culvert crossings and catch basins where accessible. The purpose of these surveys was to gather data on existing infrastructure and the expected drainage path of stormwater, including invert elevations, sizes, and construction material, to develop a greater understanding of the Town's drainage system.

A targeted survey approach was adopted to manage project costs, prioritize areas lacking existing data, and areas identified as potentially contributing to flood risk within the community. All surveys were completed using a high-accuracy GPS unit (approximately ±8 mm H and ±15 mm V) to collect precise and reliable data collection. A map of the survey points collected by Dillon Staff during the field programme are presented in **Figure A-1** in **Appendix A**.

During the course of the site visit, precipitation was recorded in the Town and catch basins and stormwater pipes were observed actively storing and conveying flow downstream. Debris and sediment accumulation was noted within many pipes and catch basins accessed during the site visits, as shown in **Figure 3-4**. Sediment and debris accumulation can result in infrastructure operating at reduced capacity through a loss of conveyance capacity, ultimately affecting the overall efficacy of the drainage system. Only grate rim elevations were recorded at targeted survey locations where debris restricting access was present.

Figure 3-4: Reduced Capacity Catch Basin on Main Street (November 6, 2024)

During data collection, residents identified several problem drainage areas, including Memorial Park, Condon Avenue, The Gorge Trail, and Mitchell Avenue. A key concern was erosion depositing sediment into storm systems, leading to culvert blockages and stormwater backups. Residents on Condon Avenue have installed sandbags and jersey barrier defenses (**Figure 3-5**) to protect their properties from increased flooding.

Figure 3-5: Flood Protection Measures at a Residence on Condon Avenue (September 27, 2024)

3.6 Public Engagement

On November 20, 2024, the Town held a public engagement session to discuss the ongoing stormwater management challenges. This session served as a platform to inform the community about the scope of Dillon's work regarding the stormwater drainage assessment, identify areas that may require further assessment, and gather a greater understanding of the history of drainage issues affecting the Town. Residents actively participated in this session, sharing their experiences and concerns regarding flooding, infrastructure limitations, and the impact of new development. The feedback received highlighted several areas of heightened flood risk within the Town.

Input gathered from the public engagement session was used to inform Dillon's development of the Town's stormwater management strategy. Concerns raised during the session provided site-specific information relevant to the hydraulic assessment, infrastructure upgrades, and the development of regulations prioritizing stormwater control. Incorporating the community's feedback into the stormwater drainage assessment enabled the identification of effective solutions for mitigating current flood risk and preparing Town staff to manage potential future stormwater challenges. The following sections provide a summary of the concerns raised during the public engagement session.

Concerns Regarding Proposed Upstream Development

Residents expressed concerns about the increasing density of development and the potential impact on the existing stormwater infrastructure. Specifically, many residents were concerned with the impact of high-density development projects in the southern portion of the Town on runoff volumes and the capacity of the current drainage system to convey these increased flows was a recurring theme.

During the early construction of the Donald E. Hilts Connector Road, several new culverts were installed along its length to direct stormflow. Since the construction of these culverts, residents of downstream areas, specifically Condon Avenue and Park Street, have reported increased flooding and sediment loading. Some residents who have walked along the drainage paths of the culverts have reported seeing signs of significant erosion.

Concerns Regarding Conveyance Capacities

Inadequate infrastructure maintenance and the need for conveyance capacity upgrades emerged as significant concerns. Residents reported instances of blocked culverts, areas with undersized piping, insufficient or undersized drainage channels, and the lack of sufficient upstream storage, such as holding ponds, in areas prone to flooding. Residential areas in the southern portion of the Town, such as MacDougall Heights, Condon Avenue, and West Main Street, were specifically identified as experiencing recurring flooding problems associated with stormwater drainage. The lack of adequate stormwater control measures in these areas has led to property damage, disruptions to daily life, and concerns about future development and the impact it would have on the Town's residents.

Concerns Regarding Erosion and Flooding Near Mill Brook

Erosion along Mill Brook was also identified as a major concern. Mill Brook converges with the Cornwallis River southeast of Miner's Marsh and features several residential areas along its lower reaches, including Crescent Avenue, Brook Avenue, and Willow Lane. In recent years, residents have noted changes in the brook's channel and the deterioration of retaining walls along its banks, contributing to flooding and property damage for several nearby properties.

The need for a comprehensive assessment of Mill Brook's capacity to handle both the existing and future runoff was highlighted. These concerns stem from the perceived impact of recent residential development in the area. The effectiveness of the retaining walls along Main Street in mitigating flooding was also questioned, suggesting the need for a more thorough evaluation of their structural integrity and functionality in reducing localized flooding.

3.6.2 Community Supplied Information

In addition to the public engagement event held by the Town, residents were encouraged to share their personal experiences with stormwater management challenges within the community with Dillon. This was facilitated by members of the Town who set up a OneDrive folder containing the compiled information provided by residents. Information was provided by over 15 residents and includes photographs, videos, email exchanges, and notes regarding stormwater challenges experienced by the public.

Several residents spoke directly to Dillon staff members during the data collection phase and through interviews conducted after the public engagement session. Residents interviewed included residents of Park Street, West Main Street, Condon Avenue, and Crescent Avenue. The resident interviews resulted in the identification of several key concerns regarding current infrastructure, the effects of increased development, and erosion of natural channels. The concerns expressed by the community in the interviews included:

- **Severe and Recurring Flooding**: Residents on West Main and Condon Avenue experience frequent and significant flooding with water depths reaching several feet causing substantial property damage, including flooded basements and damage to foundations. In the case of Condon Avenue, residents have reported to have incurred significant mitigation and cleanup costs to protect their properties.
- **Stormwater Infrastructure Deficiencies:** Residents identified several areas where they have witnessed stormwater management challenges occurring. Culverts, particularly those along the Harvest Moon Trail and Condon Avenue, are prone to blockage due to debris. Residents also believed that the current infrastructure is undersized including the pumping station which assists in draining the West Main ditching system. The pump's activation timing was also of concern as it was reported that is previous flood events the pumps have been noted to turn on hours after flooding begins.
- **Increased Runoff from Development:** Uphill development, including deforestation and paving, on the south side of the Town has caused major issues with downstream receiving bodies. Residents expressed concern that the development has led to increases in the volume and velocity of runoff that are not appropriately addressed.
- **Sediment and Erosion Issues:** Erosion control measures are insufficient, leading to excessive sediment buildup in culverts, ditches, and on properties. This sediment further restricts drainage capacity and contributes to the flooding.
- **General Recommendations**: Residents suggested the inclusion of recommendations for maintenance and a culvert cleaning program, implementation of strict stormwater management policies for developers, video inspections of stormwater networks, and improving communication and emergency planning regarding stormwater flooding risk.

3.7 Future Drainage Conditions

As with many communities in Atlantic Canada, the Town is currently faced with an increased demand for additional housing. Increased development generally correlates with an increase in impervious surfaces such as buildings, roads, or parking lots. This creates challenges for managing stormwater as the available area allowing the infiltration of rainwater is reduced. With decreased infiltration, runoff has a greater potential to carry pollutants and sediment into the stormwater management system and local water bodies. Without adequate storage or conveyance capacity to accommodate increased runoff rates/volumes, there is an increased risk of flooding in and around these areas as well as down gradient of the development.

Potential future development areas were identified in consultation with the Town and through use of the 2020 Kentville Land Use Zoning Map (**Figure C-1** in **Appendix C**). Through these discussions, it is understood that the subdivisions in the south-western portion of the town, the MacDougall Heights, Glenwood, and Palmeter subdivisions, are anticipated to see significant development as the need for additional housing rises. Further, it is understood that future development is planned in the vicinity of the eastern portion of the Kentville Business Park.

4.0 Areas of Concern

Areas of concern were identified through a combination of information received during the public engagement session and resident interviews, a comprehensive review of background information, and observations made during site visits. Key concerns raised by the public included perceived increases in runoff attributed to recent residential development, inadequate drainage capacity, and erosion. Based on this information four (4) primary areas of concern were identified in the town; these areas are discussed below and outlined in **Figure 4-1**.

4.1 Area 1: West Kentville Residential Area

This area includes, but is not limited to, the McDougall Heights subdivision, Park Street between Acadia Drive and Palmeter Avenue, and the subdivisions connecting to Duncan Avenue and Palmeter Avenue. This area also includes an unnamed watercourse that originates in the hills south of Park Street and flows between Duncan and Palmeter Avenue before crossing Park Street at Gary Pearl Drive. This area faces significant flooding concerns due to a variety of factors, as highlighted in **Section 3.4**. Frequent flooding results from high stream flow in the unnamed watercourse, which is understood to be conveyed by a 900 mm diameter inlet leading to twin timber box culverts of unknown age and condition. Furthermore, the steep terrain surrounding the area leads to erosion, resulting in substantial sediment buildup within the stormwater system. A visual assessment of the timber box culvert connection revealed that the culvert is primarily buried or filled with debris and sediment, greatly reducing its conveyance capacity. Due to the buried nature of the structure, staff were unable to determine the size of the timber box culverts. Compounding these issues is the sediment buildup within the stormwater system, reducing hydraulic capacity and ultimately contributing to overall flood risk in the area.

4.2 Area 2: West Main and Harvest Moon Trail Area

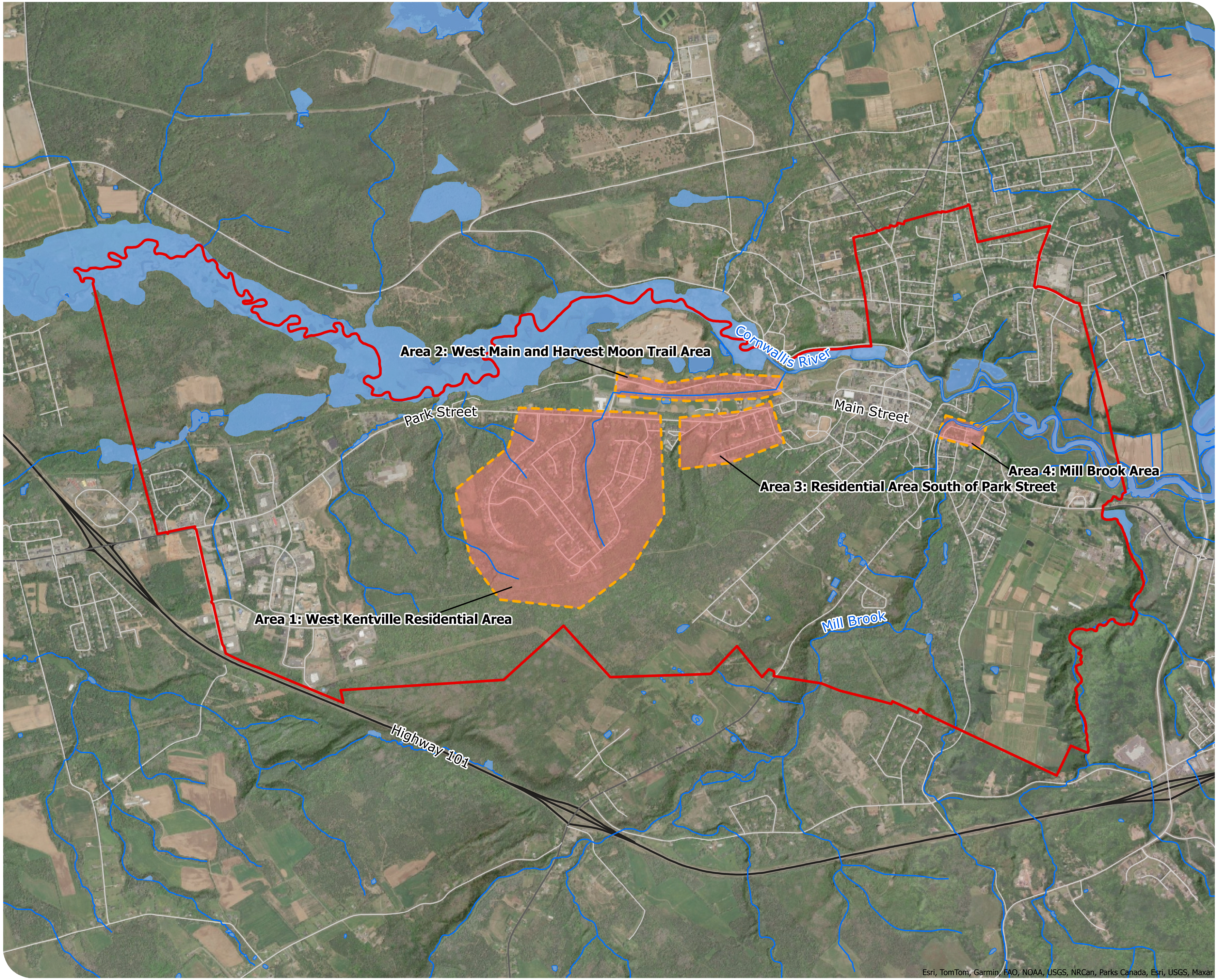
West Main Street was highlighted during public engagement, and evidence of flooding and sediment deposition were observed during site visits. This area includes the residential areas on West Main Street, the Harvest Moon Trail, and Memorial Park (PID 55247480). Stormwater infrastructure in this area includes overland flow, natural drainage channels, and a network of underground stormwater pipes. This area includes two large drainage channels that travel the length of the Harvest Moon Trail. Drainage channels are present on both the north and south sides of the Harvest Moon Trail, directing much of the stormwater infrastructure from the southwestern portion of the Town to the detention area at the intersection of the trail and West Main Street.

4.3 Area 3: Residential Area South of Park Street

This area, encompassing the residential areas south of Park Street from Gladys Porter Drive to Glenview Avenue, including Condon, Miller, and Dennison Avenue, faces significant flood risks due to a combination of natural and infrastructure based challenges. The presence of several natural drainage channels, coupled with the area's steep terrain, contributes to rapid runoff and increased erosion. This erosion leads to substantial sediment buildup within the buried stormwater infrastructure, restricting hydraulic capacity.

4.4 Area 4: Mill Brook Area

The Mill Brook area includes residential properties situated between Crescent Avenue and Main Street. Stormwater infrastructure consists of a storm sewer network within the roadway, curbs and gutter, and overland flow, ultimately discharging to Mill Brook. Due to low elevations in this area, riverine flooding is a major concern and historical flood reports indicate that the brook has overtopped its banks and impacted properties along Brook Avenue and Crescent Avenue during high flow events. A flood protection berm has previously been constructed on a portion of the banks of Mill Brook, however flooding is still prevalent due to tailwater influences from the Cornwallis River.



TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

AREAS OF CONCERN

FIGURE #4-1

- Town of Kentville
- Area of Concern
- Waterbody
- Watercourse
- Highway
- Major Road
- Local Road

SCALE 1:25,000

0 0.5 1 Kilometers

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova

MAP CREATED BY: JA/CHM
MAP CHECKED BY: EC
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

DILLON CONSULTING

PROJECT: 24-8977
STATUS: DRAFT
DATE: 2025-04-03

FILE LOCATION: K:\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan (CHM).aprx; LAYOUT: F4-1 Areas of Concern

5.0 Model Development

To assess the drainage system performance within the study area, a hydrologic/hydraulic model was developed using the latest version of PCSWMM Professional by the Computational Hydraulic Institutes (CHI). This advanced software was chosen for its ability to integrate both hydrologic and hydraulic simulations including dynamic wave unsteady state modelling capabilities, enabling a comprehensive analysis of existing and projected future conditions. This allows for the simultaneous simulations of rainfall-runoff relationship, flood routing, and accounts for storage and backwater effects within the system.

A targeted modelling approach was used to model the areas of concern identified in **Section 4.0**. By focusing on smaller, well-defined areas of concern, higher resolution simulations can be completed and used to develop site specific mitigation measures. This approach facilitates a comprehensive understanding of the drainage system, enabling the identification of specific locations where infrastructure upgrades or flood mitigation measures would be most effective. The model was then used to evaluate the effectiveness of the proposed mitigation measures to inform cost estimates and the prioritization of improvements.

The following sections detail the model's configuration, including the specific inputs and parameters used to conduct the numerical simulation.

5.1 Hydrologic Model Development

Surface runoff or stormwater runoff occurs when rainfall intensity surpasses the soil's infiltration capacity. The volume of runoff generated is influenced by several factors, including rainfall intensity and duration, storm extent, and watershed characteristics such as topography, slope, soil type, and land cover.

Hydrologic modeling plays a crucial role in understanding and predicting the behavior of surface runoff. By simulating rainfall-runoff processes, infiltration, and flow routing, these models provide valuable insights into the complex interactions within a watershed. Hydraulic modelling follows hydrologic modelling as it uses the determined surface runoff relationships to assess the conveyance of water through the pipes and channels constituting the Town’s stormwater management systems.

5.1.1 Catchment Parameters

Catchment Delineation

Catchment delineation was initially completed using the existing Nova Scotia digital elevation model (DEM) data (obtained from GeoNova) for the general study area. The initial coarse catchment delineations were further refined based the topographic data collected by Dillon along with the observations made during the site visits. The study area was subdivided into 113 subcatchments, with the delineation of subcatchments presented in **Figure B-1** in **Appendix B**.

Infiltration Parameters

To simulate infiltration and the resulting runoff within the study area, the Green-Ampt infiltration method was used. This method estimates infiltration rates based on the soil's hydraulic conductivity, suction head, and initial soil moisture content. Compared to simpler methods, the Green-Ampt method allows for a more dynamic representation of infiltration by accounting for temporal changes in soil moisture, a crucial factor in scenarios with varying rainfall intensities and durations. Based on the classification of the soil, representative values for hydraulic conductivity, moisture content, and wetting front suction head were derived from soil surveys and related literature.

Based on the Canadian Soil Information Service (CanSIS), several types of soils are present within the Town boundaries. The primary soil formations in the Town include the Morristown, Nictaux, Berwick, and Cornwallis formations. The classification of these soils range from sandy to loamy soils with the predominant soil type being a sandy loam. Soils north of the Cornwallis River feature a higher sand content than those in the southern portion of the Town which are predominantly loam to sandy loam soils (CanSIS, 2024). These soil formations are separated by the poorly drained Castley formation which encompasses the Cornwallis River. A map displaying the soil formations present within the Town is seen in **Figure 5-1.**

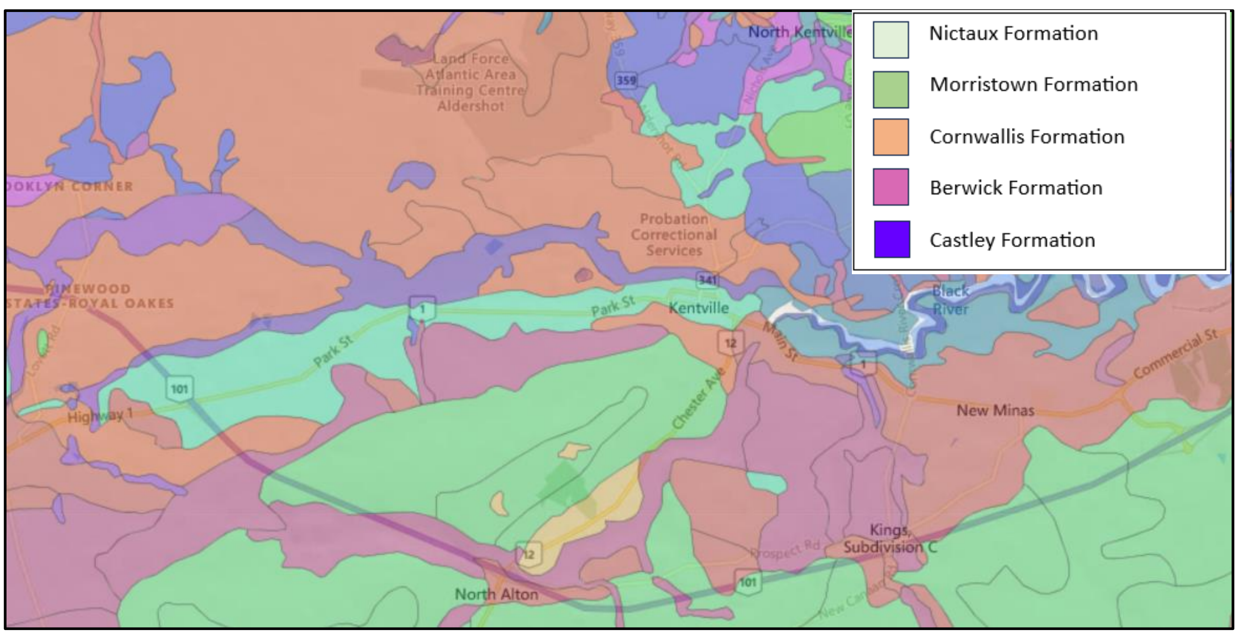


Figure 5-1: Map of Soil Formations Present in the Kentville Region (Nova Scotia Soils Series Map, 2024)

The parameters used in the targeted models consisted of those previously derived from the calibrated and validated Cornwallis River model (Dillon, 2023). Using Green-Ampt soil parameters from an existing calibrated and validated model offers greater confidence than using assumed values, as these values have been empirically derived from observed data, reflecting site-specific conditions, and integrated effects of various factors influencing infiltration. This leads to reduced uncertainty, improved model performance, and more reliable predictions of infiltration and runoff. A comprehensive summary of the infiltration parameters for each sub-catchment is provided in **Appendix B.**

Impervious Areas

Impervious areas are defined as having limited infiltration capacity and encompasses surfaces such as roads, parking lots, buildings, and similar structures. These areas were defined using distinct approaches for existing and proposed conditions.

Existing impervious areas were identified through analysis of high-resolution aerial imagery and observations made during the site visits as described in **Section 3.5**. Using GIS software, impervious areas within each sub catchment were carefully delineated and calculated based on typical minimum impervious percentage associated with specific land uses, presented in **Appendix C**. Impervious areas for each sub catchment were calculated using a weighted average of the impervious percentages associated with the identified land uses present.

For future development conditions, Dillon conducted an assessment of the projected extent of development in the next 25 years, discussed further in **Section 5.3**, and consulted with the Town to identify the potential development zones. In accordance with Section 4.3 of the Town of Kentville Subdivision Bylaws (2002), the analysis considered at least a 20-year projected development scenario. This information was used to adjust the percentage of imperviousness within affected sub-catchments, reflecting the projected increase in such surfaces.

5.1.2 Meteorological Inputs

Data regarding typical rainfall volume and intensity is required to assess the conveyance, storage and release of stormwater within the Town. Storm events are often simulated using synthetic storms, or design storms, constructed for a specific return period with greater return periods corresponding to higher rainfall volumes.

This study used rainfall data from Environment and Climate Change Canada's Kentville CDA CS Climate Station (#8202800). This station provides a robust dataset with nearly 109 years of climate observations. Due to its proximity to the site and extensive period of record, this station was used to estimate high-intensity rainfall for the assessment area. Historical rainfall intensity-duration-frequency (IDF) statistics from this station were analyzed to determine rainfall depths for 24-hour storm events of varying return periods, presented in **Table 5-1**.

Future rainfall depths, incorporating potential climate change impacts, were estimated using the Canadian Water Network's IDF Climate Change Computerized Tool (IDFCC, 2015). This tool employs the shared socioeconomic pathway (SSP) approach to estimate the impacts of climate change on future climate scenarios. Although the tool offers multiple severity scenarios, SSP5.85 assumes a high climate change severity with radiative forcing peaking at 8.5 W/m^2 by 2100 and imposes the most severe climate change impact projections. **Table 5-1** provides a comparison of historical and projected future rainfall depths for the Kentville CDA CS climate station.

Table 5-1: Summary of Historical and Projected Future Rainfall Depths for Kentville CDA CS (#8202810)

Return Period	Historical 24-Hour Rainfall Depths (mm)	Estimated Future Climate Change Rainfall Depth[1] (mm)	Percent Difference
100	123.58	142.39	15.2%
50	113.06	129.71	14.7%
25	102.47	116.94	14.1%
10	88.88	101.57	14.3%
5	78.72	88.49	12.4%
2	61.25	68.59	12%

[1]Assumes High Emissions Scenario – SSP5.85 and 2050s time horizon

Based on the historical and projected future rainfall data presented above, 24-hour rainfall depths are expected to increase by approximately 12% to 15% for the 2050s time horizon under projected climate change conditions.

Design hyetographs for historical and future rainfall events were generated using the Soil Conservation Service (SCS) Type III distribution. The SCS Type III distribution was chosen for its simplicity, ease of use, and the applicability to a wide range of storm durations, enabling the creation of rainfall time series from regional IDF statistics. These synthetic rainfall events were used as inputs into the PCSWMM model to evaluate infrastructure performance under current and future climate scenarios. The 24-hour rainfall distribution for the 100-year SCS Type III historical design storm event is shown in **Figure 5-2**.

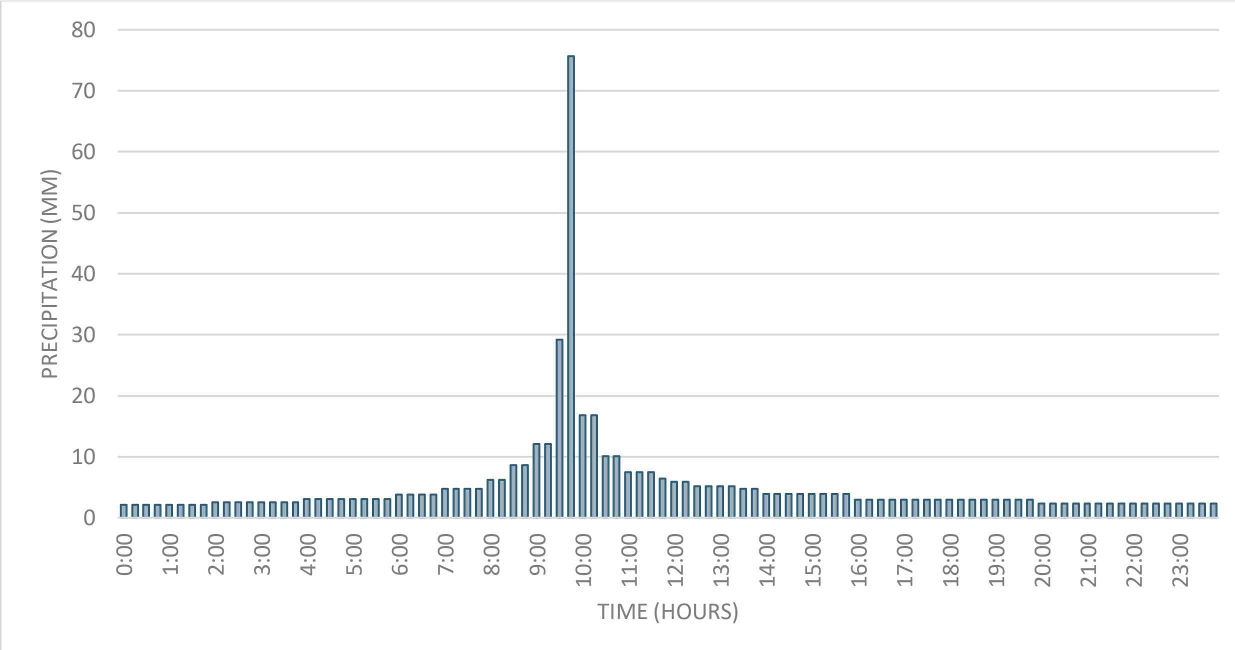


Figure 5-2: Simulated SCS 100-Year 24-Hour Rainfall Distribution for Kentville CDA CS

5.2 Hydraulic Model Development

A hydrologic/hydraulic model was developed using PCSWMM to simulate the performance of the existing drainage network within the study area. The model was used to assess the response of the existing drainage network to two historical rainfall events and two future rainfall events that incorporate climate change projections.

The model was informed by GIS information provided by the Town and the data collected during site visits discussed in **Section 3.5**. For this analysis, the model assumed ideal operating conditions for the drainage network, with culverts considered clear of debris.

A targeted survey approach was adopted to manage project costs, prioritize areas lacking existing data, and areas identified as potentially contributing to flood risk within the community. While these surveys captured essential data for model development, certain assumptions were necessary to complete the model, including:

- Where pipes and manholes included in the supplied GIS package had limited to no data regarding construction material, inverts, or structure sizes, assumptions regarding the material and size of the structure were estimated from upstream connections. If the upstream nodes contained a known size or material, it was assumed to continue to downstream connections;
- Where invert, obvert, and rim elevations were lacking, rim elevations were assumed from the DEM and inverts and obverts were assumed based on the available grade downstream with efforts to limit the grades to under 5% where capable;

- Where downstream pipe connections were unknown, it was assumed the piping were the same size and material as those upstream of it;
- Where pipes with no known or accessible downstream connections were included in the GIS files or identified in surveys, an assumed connection using the same size and material as the upstream connection was made to the assumed downstream connection point; and
- Watercourse cross-sections not surveyed with high-resolution GPS were estimated from LiDAR.

Additionally, assumptions regarding Manning's roughness coefficients (n) for specific pipe materials are included in **Table C-2** in **Appendix C**.

5.2.1.1 Downstream Boundary Conditions

Stormwater within the study site is assumed to discharge to the Cornwallis River and water levels of the receiving watercourse are of particular interest and importance during modelling efforts. Leveraging Dillon's prior experience from the Gaspereau Primary Watershed MFLM initiative, the downstream boundary conditions of the Cornwallis River were estimated using the same model employed to determine provincial flood extent water elevations.

To account for the possibility of extreme rainfall or snow melt events to coincide with elevated water levels in the Cornwallis River, a 20-year return period freshwater flow was selected in conjunction with the higher high water large tide (HHWLT) tidal condition. While extreme coastal sea levels are important for the design of future coastal flood protection, pairing extreme rainfall/snowmelt events with equally extreme tidal conditions is impractical due to the statistically remote probability of these events coinciding. The 20-year return period freshwater flow combined with the HHWLT under climate change scenario produced estimated water surface elevations of 8.61 m (CGVD2013) in the vicinity of the Town.

By adopting these higher provincial flood extents, the hydraulic model is expected to reflect realistic extreme flood conditions, capturing tailwater influences on water levels, flow paths, and floodplain extents.

5.3 Future Conditions

When effectively implemented, stormwater management practices should control runoff peak flows to pre-development levels. In areas where development is expected, stormwater drainage is assumed to connect to existing storm sewers or follow the existing grade.

In summary, development in the Town is projected to increase by 26% by 2050. To translate the anticipated increase in development into changes in impervious percentages, the location and extent of development within the modelled catchments was estimated. In the Memorial Park Area model, changes to imperviousness representing an increase in development area were applied to the sub catchments encompassing the subdivisions South of Park Street as residential areas in this portion are anticipated to experience continual growth as demands for housing increase. The existing imperviousness values were increased by 20% in these areas to account for the residential growth. **Table 5-2** summarizes the changes in imperviousness for each sub-catchment between existing and future conditions. No increases in impervious percentages are anticipated for sub catchments within the Mill Brook Area. The methods used to estimate the extent of development expected by 2050 are described in the following sections.

Table 5-2: Imperviousness Increase Estimated for Future Development Conditions

Catchment ID	Imperviousness (%) – Existing Conditions	Imperviousness (%) – Future Development Conditions
S4_18	10	30
S4_20	10	30
S3_11	5	25
S3	15	35
S8	12	32
S4_30	10	30
S3_9	5	25
S1_1	10	30
S1_12	10	30
S1_48	10	30
S1_23	10	30
S2	10	30
S1_29	64	75

5.3.1 Estimation of Changes to Kentville Development Area

Projected growth of urban lands within the Town over the next 25 years, was estimated based on the best available information including:

- base population and employment information, with labour force used as a proxy for employment, from the 2021 Census;
- population forecast completed by Kings County to 2050;
- long-range population forecasts updated for Nova Scotia by Statistics Canada (2025); and
- typical patterns and densities of development for residential and employment.

The area is strictly defined by the boundaries of the Town of Kentville and does not include the larger Census Agglomeration Area or Kings County. Details of the estimate including approach and key inputs are outlined below.

5.3.1.1 Residential Land Use Forecast

Kings County and Kentville Population Forecast to 2050

Kings County published a national population projection to 2050 using high growth, low growth, and decline scenarios. The high growth scenario was utilized to support changes in impermeable areas, which estimated growth to 89,315 and was crosschecked with 2025 provincial population forecasts for Nova Scotia by Statistics Canada for validation purposes (Statistics Canada, 2025).

As of the 2021 census, Kentville has a population of 6,630 residents and comprises of 9% of the County's population and has since the 2001 census (Statistics Canada, 2001). This percentage was assumed to remain constant throughout the lifespan of the population forecast.

This report uses the "total" census population data, which accounts for undercounting and overcounting. This is also called a "net under coverage," and it indicates how enumerations in census data can be higher or lower than the actual population (Statistics Canada 2021). Kentville's share of the 2021 census population was divided by the high growth scenario (89,315), arriving at a 2050 projection of 8,318 residents.

Growth Scenario Assumptions

The population projections for the Town are based on several key assumptions that reflect both historical trends and potential future developments. Historically, Kings County has experienced an annual growth rate of approximately 1% per year, a figure derived from census data spanning from 1921 to the present and was consistent with the growth observed from the 1970s through the 1990s (Kings County 2012; Statistics Canada 2025).

Assumptions are consistent with periodic updates made by Statistics Canada to reflect recent developments in Canadian demographics, including changes in immigration targets and the effects of the COVID-19 pandemic (Statistics Canada 2025). Local assumptions for the Town were based on national growth trends, along population growth trends over the past 25 years, which has showed an annual population growth rate of approximately 0.7%.

Projected Dwelling Growth, Mix, and Densities

Arriving at a projection for the growth in housing units involves dividing the 2050 projected Kentville population (8,318) by the average number of persons per household according to Statistics Canada (2.2). Following these steps leads to a projected number of 3,781 total households in the Town by 2050. With 2,956 households in Kentville in 2021, the estimated growth number of households by 2050 is 825.

Historical census data, available to the year 2006, was used to estimate dwelling type breakdowns. Historical dwelling breakdowns were assessed in addition to current planning initiatives and demographic changes that are influencing reductions in single detached dwellings (projected at 60% by 2050) in favour of townhouses/ row housing (15%), and apartments (25%).

Dwelling types were paired by an assumed unit per hectare for density: Single/semi-detached at 20 units per hectare, townhouses/row housing at 50 units per hectare, and apartments at 80 units per hectare. The dwelling and density measurements were summed to arrive at a sub-total of 25 ha. This figure was doubled to account for community area lands, for a total residential land need of 50 ha.

5.3.1.2 Employment Land Use and Total Forecast

Preparing a forecast for the Town employment comes with challenges as a forecasted time horizon of 25 years includes inevitable periods of growth and decline. Information on jobs, employment land, and non-residential space is constantly improving, though data sources are not always consistent or complete. As a result, employment growth is less predictable than population growth, and subject to a greater number of assumptions.

This employment forecast uses the labour force as a proxy for total employment. The projected population for the Town (8,318) was used to find the projected labour force for 2050. The labour force is assumed to be 47% of the total population growth (1,498), resulting in a forecasted labour force growth of 704.

Growth in Employment Lands and Employment Density

The labour force was then divided into three employment type categories: Population Related Employment, Major Office Employment, and Industrial/Business Park Employment. Population Related Employment is estimated at 1 job per 5 persons. Major office employment was assumed to make up 10% of jobs in the Kentville, given as the Town of a smaller commercial centre of a primarily rural area. The remainder of employment is assumed to fall into Industrial and Business Park Employment (45%). A net density of 25 jobs per unit was applied to industrial employment to estimate land needs, with Population Related Employment and Major Office Employment already accounted for. Population Related Employment is accounted for in residential growth projections and is built out as part of neighbourhood growth. Major office employment accounts for a percentage of employment that does not require a unique density measurement.

The net new industrial land required was 13 ha. Note that we have not adjusted for major office employment or population related employment, with the former likely to be minimal in the Town's largely rural context, and the later taking place as part of the planning process for population growth. A gross adjustment of 75% was added to account for community uses (libraries, parks, walkways, and storm infrastructure). The gross land required for employment was determined to be 18 ha

5.3.1.3 Total Projected Residential and Employment Land Use Needs

Combined with the required Residential Land Area (50 ha), the Total New Development Area in the Town for 2050 was determined to be 68 ha and the current development area within the Town is assumed to be 260.23 hectares for a 26% change in development area from 2024 to 2050.

6.0 Model Results

The following subsections present the results of hydrologic/hydraulic modeling for both existing and projected future conditions. The analysis considered the 1:5-year 24-hour and 1:100-year 24-hour rainfall events with a semidiurnal tidal downstream boundary condition. Further, the system performance was assessed for the 1:5-year 24-hour and 1:100-year 24-hour climate change event with a 50-year projection.

It is important to establish clear criteria for evaluating the drainage system's performance. The level of service (LOS) is defined by how the system functions for various events. For example, a closed system is designed to convey flow within the system for the 1:5-year event and have minimal surcharging (i.e. 0.3 m of ponding in the roadway) for the 1:100-year event. For open channels, the LOS is defined as the rainfall event that causes overtopping of the ditch banks. A detailed examination of the simulation results and flood-prone areas is provided in the following sections.

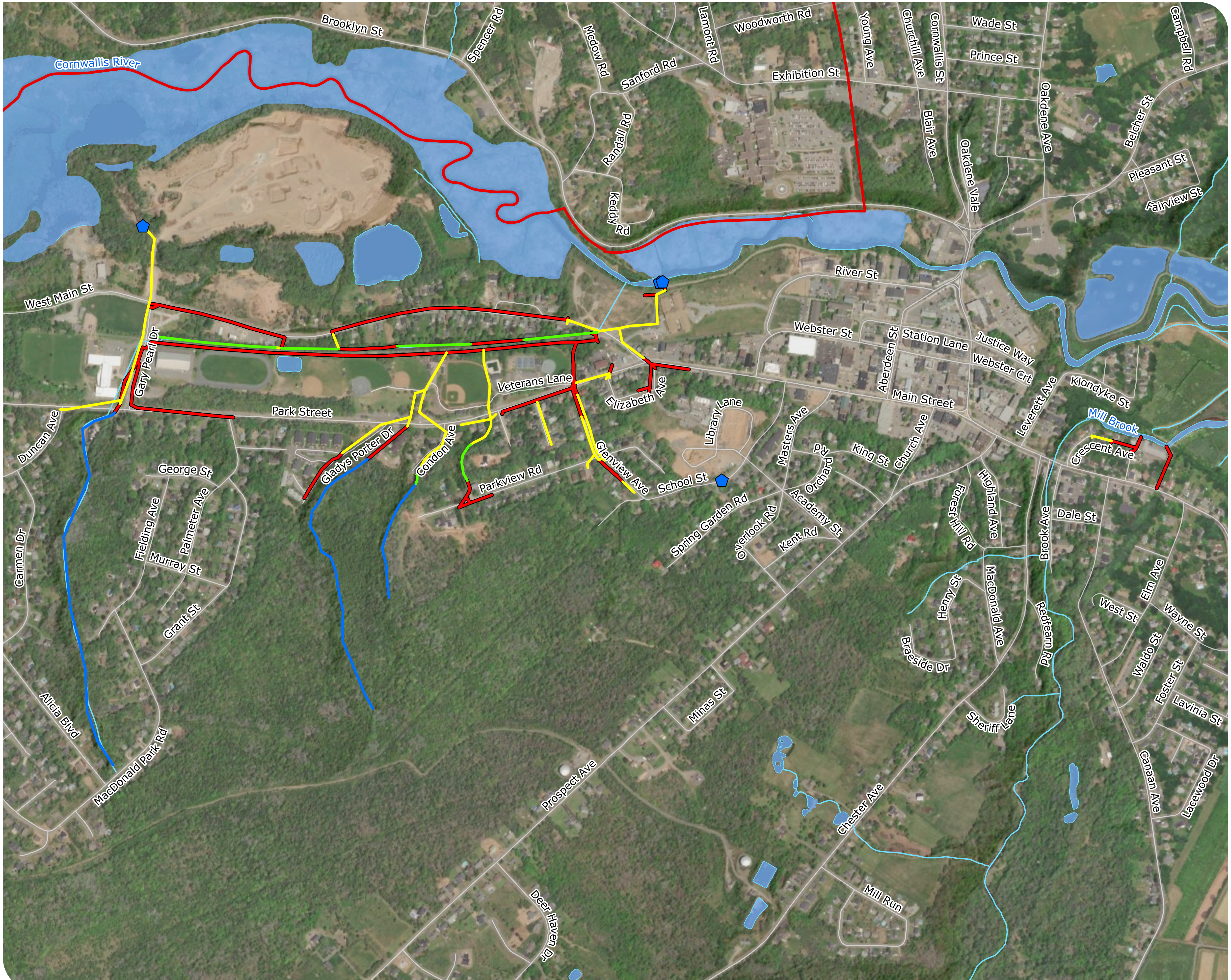
A summary of simulation results and flood-prone areas is provided in the following sections.

6.1 Existing Conditions

An assessment of existing drainage conditions was completed for the areas of concern using the targeted PCSWMM models. The models suggest there are several locations prone to flooding within the study area. These areas are highlighted in **Figure 6-1** and discussed further below.

In general, the existing drainage system generally have inadequate capacity to convey the 1:5-year event, resulting in frequent flooding of the Harvest Moon Trail ditch network and adjacent properties. Undersized culverts and pipes, and high-water levels in the Cornwallis River further restrict flow, leading to surcharging and roadway overflows. Further, high velocity flows carrying sediment and debris have historically been deposited within the stormwater network, exacerbating problems associated with pipe capacity. The resulting flooding poses several hazards to residents and commuters, as it can compromise road safety and lead to property damage. A summary of simulated peak water levels at high-risk areas (i.e. flood-prone areas) is presented in **Table 6-1**; see **Figure D-1** in **Appendix D** for the locations of the highlighted areas.

It is noteworthy that water levels exceeding 0.3 m above the roadway elevation are assumed to negatively impact adjacent properties, and these levels will overtop the curb and encroach on private property. Locations where this is present are highlighted in red in **Table 6-1**.



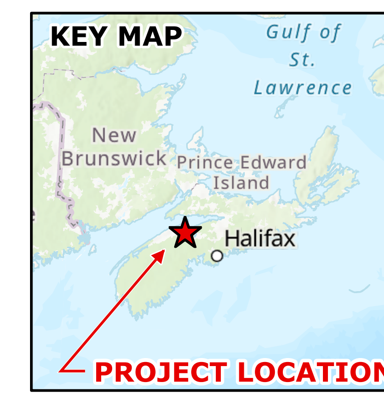
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

FLOOD PRONE LOCATIONS (1:100-YEAR EVENT) - EXISTING CONDITIONS

FIGURE #6-1

- Town of Kentville
- Outfalls
- Roadside Ditch
- Stream/ River
- Stormwater Pipe
- Flooded
- Watercourse
- Waterbody
- Local Road



SCALE 1:9,000

0 150 300 Meters

N E S W

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova, Dillon

MAP CREATED BY: JA/RR
MAP CHECKED BY: EC
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

DILLON CONSULTING

PROJECT: 24-8977
STATUS: DRAFT
DATE: 2025-04-04

FILE LOCATION: K:\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan.aprx; LAYOUT: F6-1 Flood Prone Locations Existing

Table 6-1: Simulated Peak Water Levels - Existing Conditions

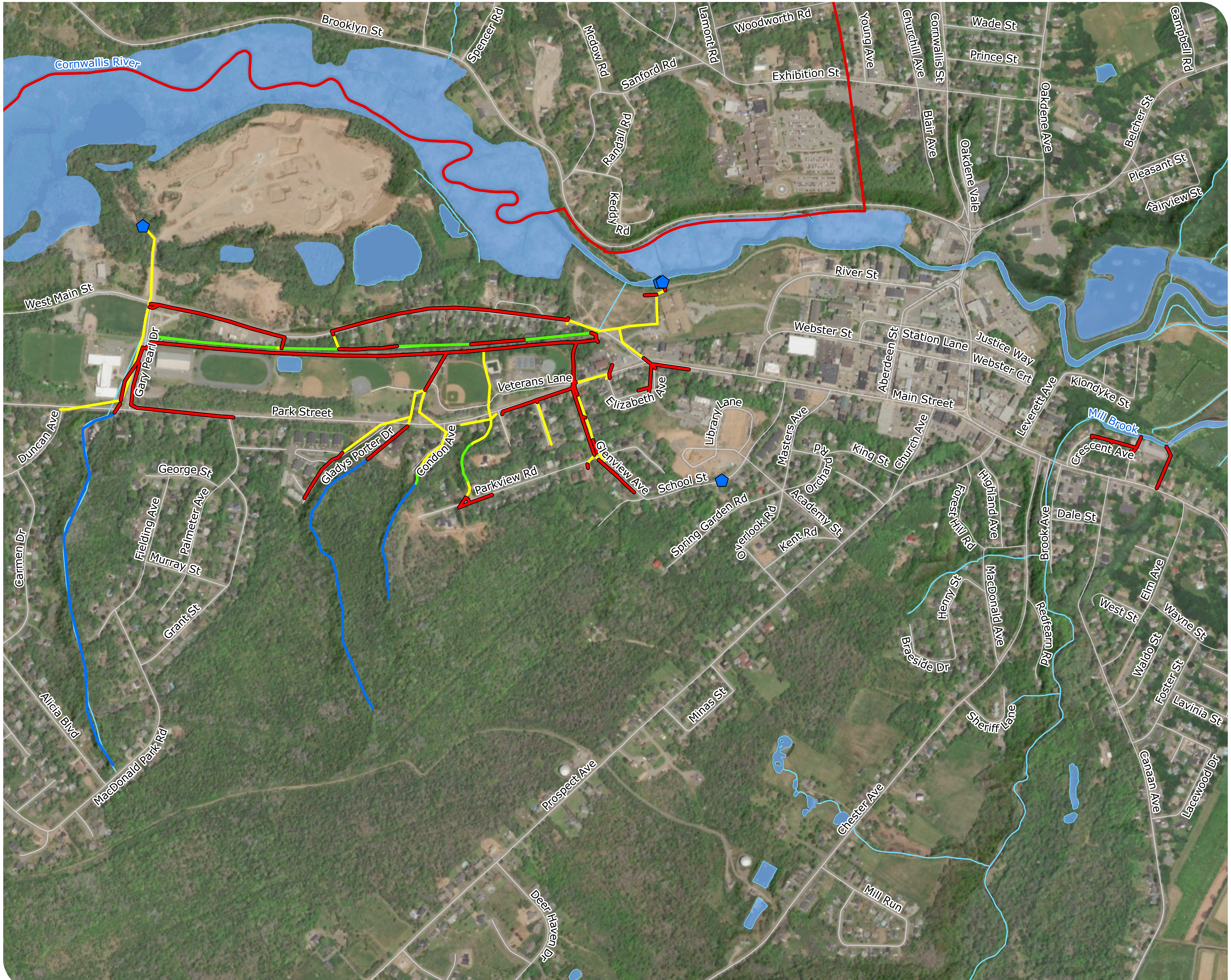
Location	Roadway/Bank Elevation (m)	5-year Peak Water Level (m)	100-year Peak Water Level (m)
Area 1: West Kentville Residential Area			
Park Street at Mitchell Brook (J20)	18.10	16.50	16.89
Mitchell Brook (J28)	18.10	17.36	17.49
Gary Pearl Drive at Park Street (J147)	14.70	14.98	>15.0
Park Street at Glenview Ave (J1037)	8.90	8.80	>9.2
Area 2: West Main and Harvest Moon Trail Area			
W. Main Ditch Upstream (J1032)	10.8	>11.1	>11.1
W. Main Ditch (J496)	10.0	>10.3	>10.3
W. Main Ditch (J251)	9.5	>9.8	>9.8
W. Main Ditch Downstream (J1110)	8.8	>9.1	>9.1
W. Main Street downstream of Gary Pearl Drive (J130)	9.63	>9.93	>9.93
W.t Main Street downstream of Gary Pearl Drive (J129)	9.97	10.26	>10.27
W. Main Street inlet – 750 mm Culvert (J936)	8.20	8.36	>8.50
W. Main Street downstream of Gary Pearl Drive (J131)	9.94	10.21	>10.24
Gary Pearl Drive at W. Main Ditch (J362)	12.69	12.85	12.85
Area 3: Residential Area South of Park Street			
Park Street at Gladys Porter Drive (J9)	21.49	21.02	21.65
Park Street and Dennison Ave (J504)	11.34	11.49	>11.64
Main Street and Elizabeth Avenue (J864)	8.95	>9.25	>9.25
Park Street at Glenview Avenue (J1036)	10.84	10.41	10.99
Area 4: Mill Brook Area			
Crescent Ave Downstream(J550)	7.26	>7.56	>7.56
Crescent Ave Upstream (North) (J551)	7.24	7.44	>7.54
Crescent Ave Upstream (West) (J553)	7.99	7.57	>8.15
Inlet at Main Street (J855)	7.50	>7.80	>7.80

The PCSWMM model has been used to simulate water surface elevation and identify locations where peak water levels exceed 0.3 m above road grade. Above this level, the area is considered flooded and upgrades are recommended. It can be seen in **Table 6-1** that simulated water elevations for the 5 and 100-year events are expected to exceed this flood threshold and are denoted in red. These model results suggest that upgrades are required in all 4 of the high risk flood areas considered.

6.2 Future Development Conditions

Future development within the study area, primarily residential expansion south of Memorial Park and near Fairweather Lane, was projected based on discussions with the Town and development projections, as discussed in **Section 3.7**. An estimated 25-acres of residential land use is projected to be added around the Donald E. Hiltz connector Road, which would result in an increase of impervious surfaces and, without proper mitigation measures, could lead to further drainage and erosion issues.

To assess the impact of this development on the drainage network, the hydraulic model was updated to reflect increased impervious areas within affected sub-catchments. As a conservative approach, it is assumed that the new development areas will drain to the existing stormwater outlet at West Main Street through existing stormwater system. Water levels in the flood-prone areas for the future scenario are shown in **Table 6-2** and are illustrated in **Figure 6-2**. It is noteworthy that water levels above 0.3 m are assumed to negatively impact adjacent properties, and these levels will overtop the curb. Locations where this is present are highlighted in red in **Table 6-2**.



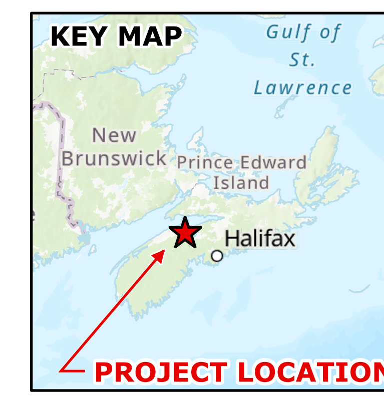
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

FLOOD PRONE LOCATIONS (1:100-YEAR EVENT) - FUTURE DEVELOPMENT CONDITIONS

FIGURE #6-2

- Town of Kentville
- Outfalls
- Roadside Ditch
- Stream/ River
- Stormwater Pipe
- Flooded
- Watercourse
- Waterbody
- Local Road



SCALE 1:9,000

0 150 300 Meters

MAP DRAWING INFORMATION:
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DILLON CONSULTING

PROJECT: 24-8977
STATUS: DRAFT
DATE: 2025-04-04

Table 6-2: Simulated Peak Water Levels – Future Climate Conditions

Location	Roadway/Bank Elevation (m)	5-year Peak Water Level (m)	100-year Peak Water Level (m)
Area 1: West Kentville Residential Area			
Park Street at Mitchell Brook (J20)	18.10	16.50	16.89
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Park Street at Glenview Ave (J1037)	8.90	9.05	>9.2
Area 2: West Main and Harvest Moon Trail Area			
W. Main Ditch Upstream (J1032)	10.8	>11.1	>11.1
W. Main Ditch (J496)	10.0	>10.3	>10.3
W. Main Ditch (J251)	9.5	>9.8	>9.8
W. Main Ditch Downstream (J1110)	8.8	>9.1	>9.1
W. Main Street downstream of Gary Pearl Drive (J130)	9.63	>9.93	>9.93
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W. Main Street downstream of Gary Pearl Drive (J131)	9.94	10.21	>10.24
Gary Pearl Drive at W. Main Ditch (J362)	12.69	12.85	12.85
Area 3: Residential Area South of Park Street			
Park Street at Gladys Porter Drive (J9)	21.49	21.02	21.65
Park Street and Dennison Ave (J504)	11.34	11.49	>11.64
Main Street and Elizabeth Avenue (J864)	8.95	>9.25	>9.25
Park Street at Glenview Avenue (J1036)	10.84	10.55	>11.04
Area 4: Mill Brook Area			
Crescent Ave Downstream(J550)	7.26	>7.56	>7.56
Crescent Ave Upstream (North) (J551)	7.24	7.44	>7.54
Crescent Ave Upstream (West) (J553)	7.51	7.57	7.61
Inlet at Main Street (J855)	7.50	>7.80	>7.80

It can be seen in **Table 6-2** that the in some areas are expected to be higher under projected future conditions compared to existing. These areas include Crescent Avenue, Park Street and Gary Pearl Drive. It is noteworthy that the proposed development in the southern area of the Town may negatively impact Glenview Avenue and the Harvest Moon Trail ditch system; stormwater management measures are recommended in this area to mitigate future flooding. Further, the development may also increase velocities within the natural drainage channels along the steep hillsides located south of the residential areas may worsen existing erosion challenges.

7.0 Preliminary Drainage Improvement Options

Informed by field observations, community input, and the results of PCSWMM simulations, a set of conceptual drainage improvement options were developed. These upgrades were assessed considering projected future conditions. It is noteworthy that the improvements presented are conceptual in nature; further survey and analysis should be completed to support design, construction and implementation.

To enhance community resilience against flooding and understand next steps, stormwater improvement upgrades have been divided into four key categories:

1. **Erosion and Sediment Control**: This involves the implementation of erosion and sediment control mechanisms for the natural drainage channels present in the southern portion of the Town to limit the extent of sediment and debris entering the drainage system. These improvements are vital for protecting the homes and roadways downstream of the natural drainage channels where flooding has been documented to disrupt traffic flow, damage private properties, and disrupt community life.
2. **Stormwater Infrastructure Improvements**: This involves replacing aging or undersized culverts, and stabilizing ditch banks to ensure effective drainage. These improvements are vital for protecting homes and roadways in residential areas, as well as safeguarding main streets where flooding can disrupt traffic flow, businesses, and community life.
3. **Increasing Available Stormwater Storage**: When high tailwater conditions are present, the outlet capacity of gravity fed systems are limited or negligible. To address this, it is recommended that stormwater storage be increased at Memorial Park. Increasing the storage capacity of the system in Memorial Park would limit the documented flooding of nearby residential properties during high intensity events.
4. **Implementation of a Regular Maintenance Program:** With steep slopes, high velocities, and mobile material, the risk of sediment entering the stormwater network and limiting conveyance capacity is ever prevalent. In efforts to limit reductions to the conveyance capacity of the system due to sediment loading, a regular maintenance program should be implemented.

7.1 Area 1: West Kentville Residential Area

Erosion and Sediment Control

Due to the significant erosion present in the Town, specifically at the unnamed watercourse between the Palmeter and MacDougall Heights subdivisions, channel bank restoration is recommended. The unnamed watercourse is approximately 1 km in length between the Donald E. Hiltz connector road and Park Street; for this assessment, it was recommended bank restoration would be required along the entirety of the watercourse. To estimate the full scope of restoration work, further surveys are necessary. Given the high canopy coverage, establishing vegetation for bank stabilization may be challenging, therefore, riprap lining is suggested as a potential stabilization solution.

To mitigate sediment deposition, it is recommended to implement riprap sediment traps at regular intervals along the watercourse. These sediment traps would be placed at regular intervals along the channels. Riprap sizing, riprap basin spacing, and flow attenuation performance will be required as part of future design work.

Stormwater Infrastructure Upgrades

Upgrading the existing stormwater infrastructure is recommended to mitigate surcharging and flooding in the roadways. In efforts to limit the amount of stormwater directed towards the Harvest Moon trail ditch, it is recommended the existing watercourse diversion be upsized and include connections to the nearby Duncan Avenue and Palmeter Subdivisions. It is recommended the connections between the subdivisions and the diversion under Park Street be increased to 600 mm and 750 mm diameter pipes; this increase in pipe size would improve conveyance capacity and reduce surcharging and flooding within the roadways. Further, increasing the capacity of the culvert under Park Street conveying flow from the watercourse to the previously completed diversion is recommended.

The existing twin box culvert conveying flow from the unnamed watercourse to an outlet northeast of the Town of Kentville Public Works building should also be assessed to confirm structural condition and dimensions. Pending the outcome of this assessment, it is estimated that an 1800 mm diameter pipe will adequately convey the projected 100-year climate change storm event flows from both the watercourse and nearby subdivisions. Other pipe geometries and arrangements may also be considered as part of future design work.

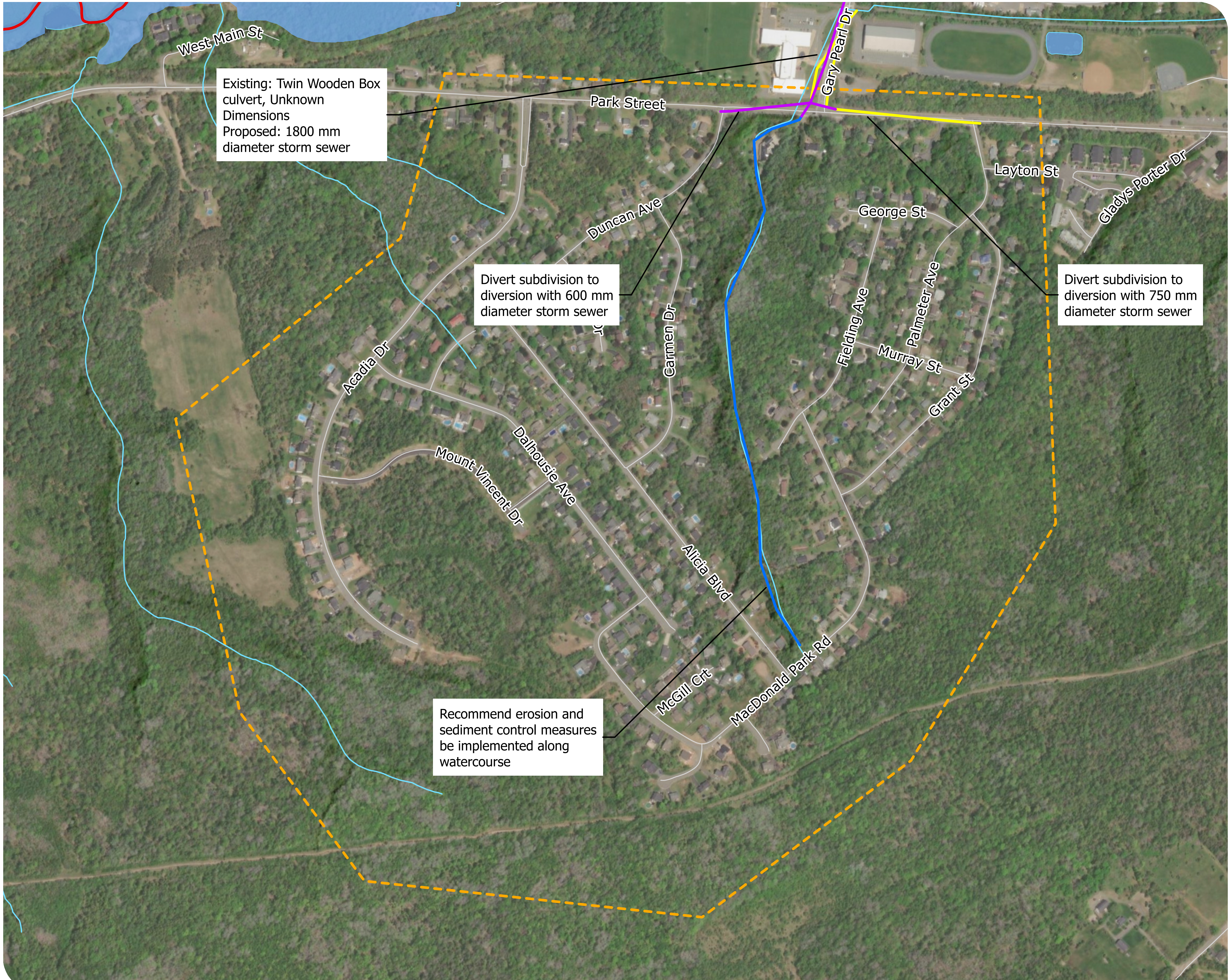
The cost estimate for the upgrades recommended are presented in **Table 7-1**. A summary of the proposed infrastructure upgrades and flood mitigation measures for Area 1 are presented in **Figure 7-1**.

Table 7-1: Order of Magnitude Cost Estimate (Area 1)

Recommended Updates	Order of Magnitude Cost Estimate
Erosion and Sediment Control	$100,000
Stormwater Infrastructure Upgrades	$1,570,000
Total	**$1,670,000**

Donald E. Hiltz Connector Road

In the Donald E. Hiltz Connector Road tender drawing package provided by the Town, there are several proposed erosion and stormwater control structures throughout the proposed development including stormwater management ponds, ditch detention areas, energy dissipation aprons/basins, as well as vegetated swales. While Dillon was not involved in the development of these design solutions, they have the potential to reduce peak flow and erosion downstream. Particular attention should be given to the culvert sizes and invert elevations during construction to ensure that flow attenuation is provided and storage areas are engaged during high flow events.



TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

PROPOSED UPGRADES AREA OF CONCERN 1: WEST KENTVILLE RESIDENTIAL AREA

FIGURE #7-1

- Town of Kentville
- Area of Concern
- Stream/ River
- Stormwater Pipe
- Proposed Upgarde Location
- Watercourse
- Local Road
- Waterbody

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova

MAP CREATED BY: JA/RR
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PROJECT: 24-8977
STATUS: DRAFT
DATE: 2025-04-04

FILE LOCATION: K:\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan.aprx; LAYOUT: F4-1 Areas of Concern_1_WestKentville

7.2 Area 2: West Main and Harvest Moon Trail Area

With the Harvest Moon Trail ditch system proving inadequate to store and convey larger rainfall events, additional storage is recommended. With steep slopes along the hills south of Memorial Park, upstream options are limited. For this reason, storage options were mainly considered in the vicinity of Memorial Park where more grade and area are available.

Additional Storage Capacity

Increasing in-line flood storage along the Harvest Moon Trail ditch system will partially mitigate flooding in the Memorial Park area. For instance, introducing approximately 900 m^3 of storage in the downstream portion of the ditch will mitigate flooding for the 1:5-year event. However, for the system to safely manage the 1:100-year event, the required storage exceeds 6000 m^3, which is expected to exceed the practical limits of available storage in the area. Therefore above ground storage solutions are not considered a viable option in this area.

For this reason, an investigation into the feasibility of underground storage (e.g. Stormtech Underground Storage Chamber) was completed. Potential locations include beneath one or more of the five baseball fields or one of the Memorial Park parking lots. Based on the available area for underground storage (approximately 6000 m^2), it is estimated that a storage capacity of approximately 6400 m^3 would yield considerable benefit for the area for the 1:100-year event. It is noteworthy that the feasibility of this option would require a comprehensive review of seasonal groundwater elevations, as high groundwater can reduce available storage. It's possible that additional storage volumes may be available depending on depth to groundwater and other factors.

It is important to highlight that underground stormwater systems require ongoing maintenance to support continued performance and structural longevity. The accumulation of sediment and debris necessitates periodic flushing and cleaning to maintain design volume capacities and prevent system blockages. For this reason, it is essential that the implementation of an underground stormwater system is paired with proper sediment and erosion control practices. While service life is dependent on material selection, installation quality, and environmental exposure, consistent maintenance is critical for extending the operational lifespan of underground stormwater infrastructure. A review of the feasibility of incorporating a stormwater management pond within the vacant lot (PID 55251433) is recommended. For assessment and costing purposes, the total lot area (12,000 m^2) was assumed to be available for use. The inclusion of this additional storage would provide storage during heavy rainfall events (i.e. 1:100-year event) and during high tide, when water levels in the Cornwallis River are elevated. The total estimated available storage in this area is approximately 14,000m^3.

Stormwater Infrastructure Upgrades

Several culvert upgrades are recommended in this area. The culverts in the Harvest Moon Trail ditch at the trail intersection by the existing stormwater management pond and Ultramar Energy Property are recommended to be increased to (at a minimum) 900 mm diameter culverts to improve conveyance capacity and limit backing up in the ditch. It is also recommended that the culvert connecting the south ditch to the north ditch at the Harvest Moon Trail's intersection at West Main Street be increased to a 1500 mm diameter pipe. Further, the outlet from the system is recommended to be increased to a 1500 mm diameter pipe; this increase will be required from the outlet of the ditch system to its ultimate outlet at the Cornwallis River. These upgrade recommendations will convey the 1:5-year flow in the system with no flooding.

The cost estimate for the upgrades recommended are presented in **Table 7-2**. A summary of the proposed infrastructure upgrades and flood mitigation measures for Area 2 are presented in **Figure 7-2.**

Table 7-2: Order of Magnitude Cost Estimate (Area 2)

Preliminary Drainage Improvement Options	Order of Magnitude Cost Estimate
Empty Lot – Storage Pond	$1,200,000
Underground Storage – Memorial Park	$4,750,000
Stormwater Infrastructure Upgrades	$2,100,000
Total	**$8,050,000**

7.3 Area 3: Residential Area South of Park Street

Additional Storage Capacity

To mitigate localized flooding, reduce sediment accumulation, and attenuate flows entering the stormwater network, the construction of a stormwater management pond above Condon Avenue was considered. An investigation into the feasibility of such a pond suggested limited areas with suitable grades. To mitigate flooding for a 1:100-year event, a storage capacity in the order of 1500 m^3 is required.

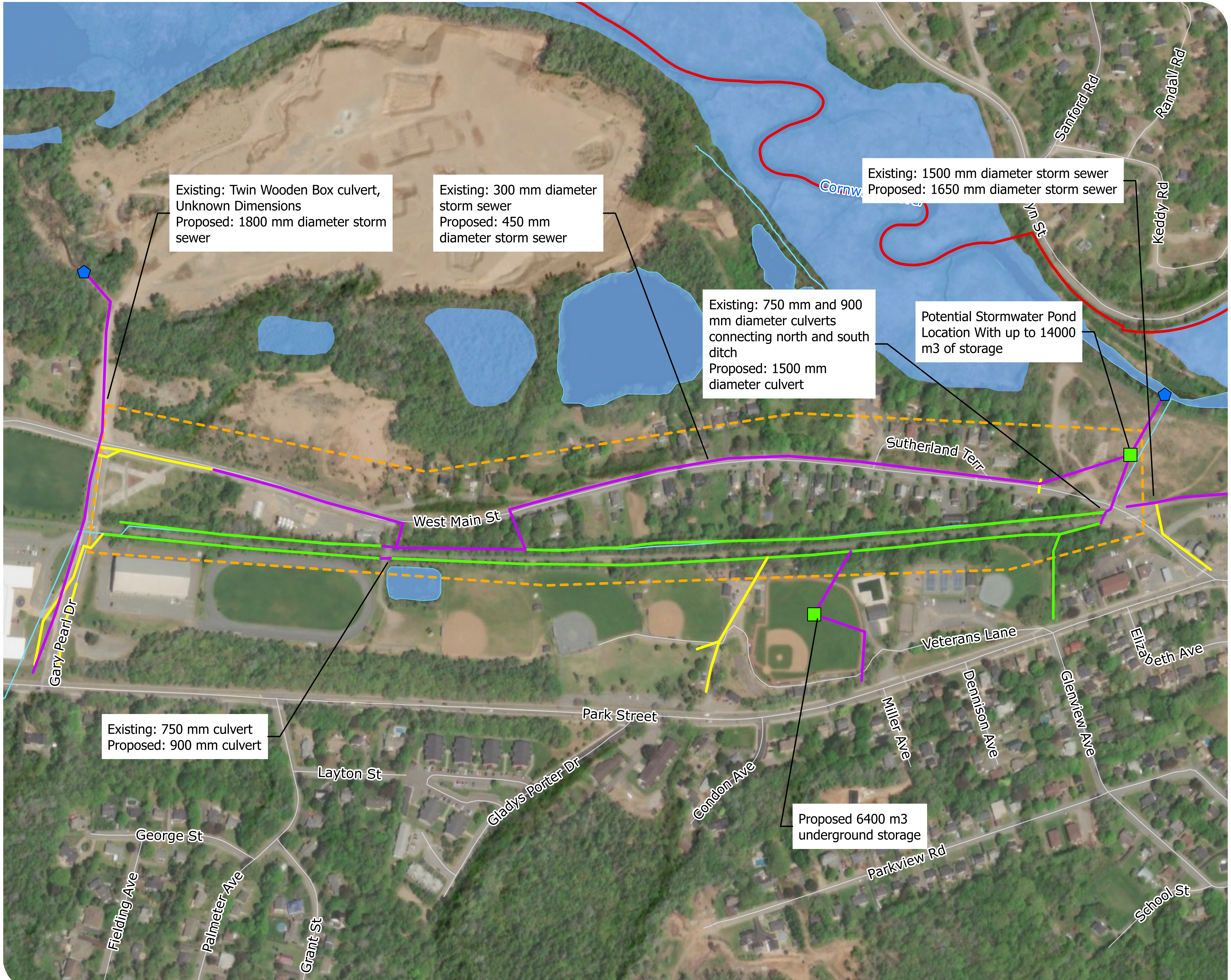
Stormwater Infrastructure Upgrades

Further, it is recommended that existing stormwater infrastructure be upgraded on Dennison Avenue, and Park Street between Miller Drive and Glenview Avenue. The upgraded pipes will range from 450 mm to 600 mm. Upgrades in this area will allow the conveyance of 1:5-year flows to remain within the pipe network, and minimal surcharging (i.e. less than 0.3 m of flow within the roadway) during the 1:100-year event.

The cost estimate for the upgrades recommended are presented in **Table 7-3**. A summary of the proposed infrastructure upgrades and flood mitigation measures for Area 3 are presented in **Figure 7-3.**

Table 7-3: Order of Magnitude Cost Estimate (Area 3)

Recommended Updates	Order of Magnitude Cost Estimate
Storage Pond	$130,000
Stormwater infrastructure upgrades	$1,200,000
Total	**$1,330,000**



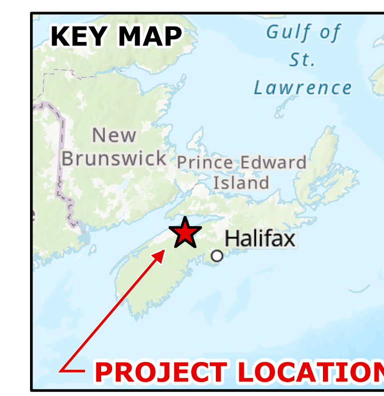
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

PROPOSED UPGRADES AREA OF CONCERN 2: WEST MAIN AND HARVEST MOON TRAIL AREA

FIGURE #7-2

- Town of Kentville
- Area of Concern
- Proposed Storage Location
- Outfalls
- Roadside Ditch
- Stormwater Pipe
- Proposed Upgrade Location
- Watercourse
- Waterbody
- Local Road



SCALE 1:4,000

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MAP DRAWING INFORMATION:
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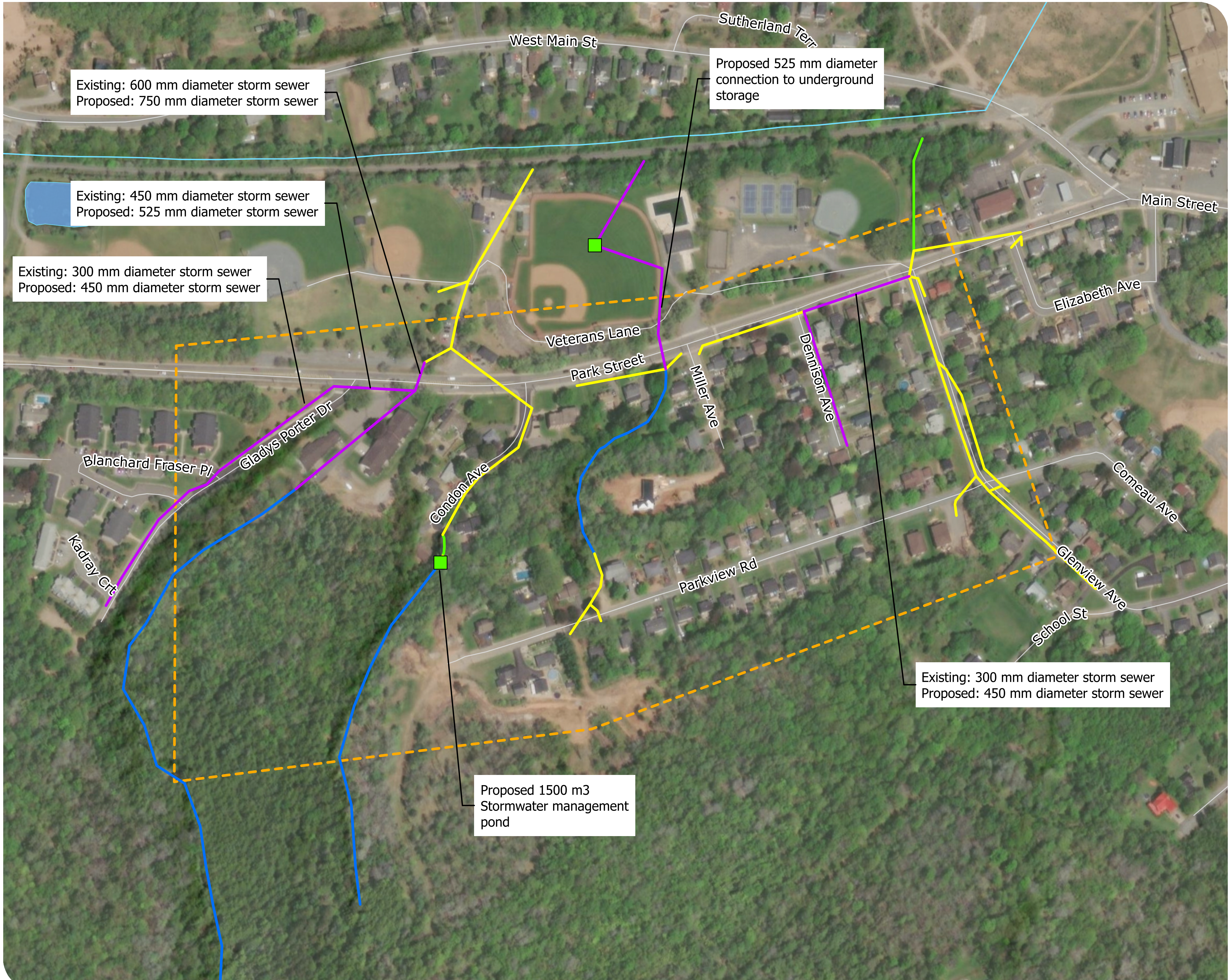


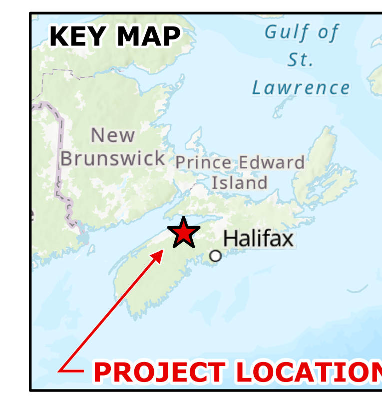
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

PROPOSED UPGRADES AREA OF CONCERN 3 : RESIDENTIAL AREA SOUTH OF PARK STREET

FIGURE #7-3

- Town of Kentville
- Area of Concern
- Proposed Storage Location
- Stream/ River
- Roadside Ditch
- Stormwater Pipe
- Proposed Upgrade Location
- Watercourse
- Waterbody
- Local Road



SCALE 1:3,000

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MAP DRAWING INFORMATION:
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PROJECT: 24-8977
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FILE LOCATION: K:\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan.aprx; LAYOUT: F4-1 Areas of Concern_3_SouthOfParkSt

7.4 Area 4: Mill Brook Area

Flooding in the Mill Brook area is primarily attributed to the backing up of the Cornwallis River. The hydraulic model indicates that the existing residential pipe network is only adequately sized for events smaller than a 5-year return period. During larger rainfall events (i.e. 1:100-year events), the high-water levels in Mill Brook limit the drainage capacity of the residential pipes, resulting in flooding.

Flood Protection Berms

From historical flood reports and the results of the Gaspereau watershed flood extent mapping (Dillon, 2023) that assessment suggests elevated water-levels upstream of the Main Street bridge compared to the downstream elevations. This suggests that the bridge imposes a hydraulic restriction during high flow events, causing water to surcharge along Mill Brook and may increases flood risk for properties adjacent to the brook. It is recommended that a detailed hydraulic analysis of the bridge in partnership with Nova Scotia Department of Public Works (NSDPW) be undertaken to assess hydraulic capacity and associated upgrade requirements, if required.

To improve flood protection along the northern portion of Mill Brook, upgrading the existing earthen berms is recommended. It is understood that the current berm extends 100 meters along Mill Brook's banks with heights varying between 9 m and 7.2 m (CGVD2013). To enhance protection, it is recommended the flood protection berm be extended 350 m downstream to a height of 9 m. This elevation has been estimated for existing conditions and does not account for potential future bridge upgrades.

Stormwater Infrastructure Upgrades

Further, upgrading the existing stormwater infrastructure from 300 mm diameter pipes to 600 mm diameter pipes along Crescent Avenue will convey runoff from the 1:5-year event without flooding in the roadway.

The cost estimate for the upgrades recommended are presented in **Table 7-4**. Cost estimates associated with the bridge have not been included as this is expected to be the responsibility of NSDPW. A summary of the proposed infrastructure upgrades and flood mitigation measures for Area 4 are presented in **Figure 7-4.**

Table 7-4: Order of Magnitude Cost Estimate (Area 4)

Description of Upgrades	Order of Magnitude Cost Estimate
Extend and Raise Existing Berm	$350,000
Upgrade Existing Stormwater Infrastructure	$460,000
Total	**$810,000**

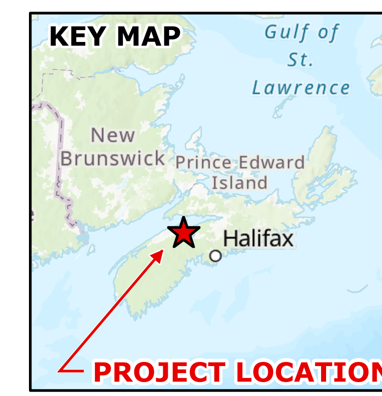
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

PROPOSED UPGRADES AREA OF CONCERN 4: MILL BROOK AREA

FIGURE #7-4

- Town of Kentville
- Area of Concern
- Outfalls
- Proposed Upgrade Location
- Earthen Berm
- Watercourse
- Waterbody
- Local Road



SCALE 1:2,000

0 30 60 Meters

MAP DRAWING INFORMATION:
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MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

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7.5 Drainage Improvement Results

Incorporating the proposed drainage upgrades, which include expanded culvert capacities, the creation of strategically placed retention ponds, and enhanced storm sewer infrastructure, is projected to significantly mitigate flooding during 1:5-year rainfall events. By increasing the system's capacity to safely convey peak flow rates and providing temporary storage for excess runoff, these improvements are expected to reduce flood risk within the high risk areas.

Table 7-5 presents the water level results for the hydraulic model and demonstrates the impact of the proposed drainage upgrades.

Table 7-5: Simulated Peak Water Levels – Drainage Upgrades

Location	Roadway/Bank Elevation (m)	5-year Peak Water Level (m)	100-year Peak Water Level (m)
Area 1: West Kentville Residential Area			
Park Street at Mitchell Brook (J20)	18.10	16.5	17.02
Mitchell Brook (J28)	18.10	17.34	17.46
Gary Pearl Drive at Park Street (J147)	14.70	13.69	13.76
Park Street at Glenview Ave (J1037)	8.90	8.81	8.84
Area 2: West Main and Harvest Moon Trail Area			
W. Main Ditch Upstream (J1032)	10.8	10.8	10.99
W. Main Ditch (J496)	10.0	9.44	9.71
W. Main Ditch (J251)	9.5	9.23	9.52
W. Main Ditch Downstream (J1110)	8.8	8.63	9.01
W. Main Street downstream of Gary Pearl Drive (J130)	9.63	9.18	>9.93
W.t Main Street downstream of Gary Pearl Drive (J129)	9.97	9.36	10.06
W. Main Street inlet – 750 mm Culvert (J936)	8.63	7.87	8.8
W. Main Street downstream of Gary Pearl Drive (J131)	9.94	8.88	9.95
Gary Pearl Drive at W. Main Ditch (J362)	12.69	11.04	11.17
Area 3: Residential Area South of Park Street			
Park Street at Gladys Porter Drive (J9)	21.65	21	21.8
Park Street and Dennison Ave (J504)	11.34	10.77	11.19
Main Street and Elizabeth Avenue (J864)	8.95	7.74	9
Park Street at Glenview Avenue (J1036)	10.84	10.23	10.85
Area 4: Mill Brook Area			
Crescent Ave Downstream(J550)	7.60	7.55	7.56
Crescent Ave Upstream (North) (J551)	7.60	7.55	7.54
Crescent Ave Upstream (West) (J553)	7.60	7.55	7.61
Inlet at Main Street (J855)	7.50	7.55	7.57

Best Practices for Stormwater Management

This section presents several additional stormwater best practices that can be considered by the Town. These recommendations focus on non-structural approaches to improving drainage within the community. This includes revisiting existing stormwater guidance, community scale stream restoration initiatives, and incorporating low impact design approaches for stormwater. A summary of these approaches is provided below.

7.5.1 Enhance Existing Stormwater Design Guidelines

The growing demand for housing and associated development pressures are expected to further exacerbate drainage challenges if appropriate SWM controls are not applied. To better prepare for these challenges, it is recommended that the Town review and enhance its existing stormwater design guidelines. Enhanced guidelines would further strengthen and promote the following key benefits:

- **Efficient Drainage and Flood Mitigation:** Clear criteria for sizing and designing drainage infrastructure ensure systems can handle large storm events, minimizing flood risk and property damage through pre/post peak runoff management. This protects residents, businesses, and reduces the financial burden of flood recovery. This should also be combined with a robust review process at both the design and post-construction phase of development projects to confirm that pre/post peak flow balances are achieved.
- **Water Quality Protection:** Well-designed guidelines promote the use of best management practices (BMPs) such as bioretention areas, vegetated swales, and permeable pavements. These BMPs have the potential to reduce sediment in stormwater runoff, protecting aquatic ecosystems and limiting downstream sediment accumulation.
- **Environmental Sustainability:** Green infrastructure solutions like rain gardens and vegetated swales improve the appearance of neighborhoods while providing the potential for wildlife habitat. Promoting infiltration and reducing runoff helps replenish groundwater supplies and supports healthy ecosystems.

To achieve these benefits, the Town should revise its existing storm sewer guidelines to be more prescriptive, providing developers and designers with the tools to support low impact development for stormwater.

7.5.2 Community Led Erosion and Sediment Control Measures

To protect water quality, reduce maintenance costs, and support the long-term sustainability of development projects, community groups can take the lead in implementing effective erosion and sediment control measures. Uncontrolled erosion increases sediment loads in stormwater systems and receiving waters, degrading water quality, harming aquatic habitats, and necessitating costly maintenance. These initiatives can be low cost and not require the use of heavy equipment and contractors. The following sections provide a few examples of community scale improvements that could be considered in the future.

Channel Bank Restoration

Community groups can also play a vital role in restoring degraded channel banks, which contribute significantly to sediment loading and erosion, see **Figure 7-5** for an example. Restoration efforts can include:

- **Regrading:** Reshaping slopes to a more stable angle;
- **Stabilization:** Using natural materials like live stakes, brush layering, or coir logs to reinforce banks; and
- **Revegetation:** Planting native vegetation to stabilize banks and filter runoff (See **Figure 7-6**).

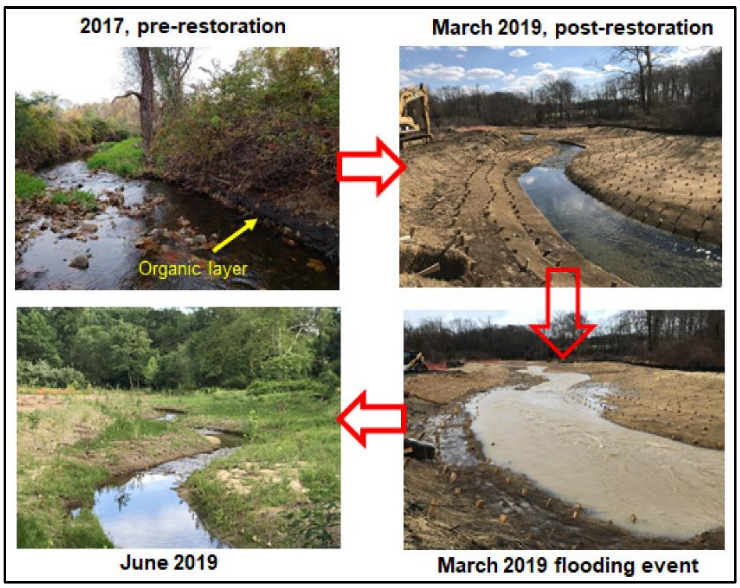

Figure 7-5: Example of Channel Bank Restoration at Gramies Run, Maryland (Mattern et., 2020)

Figure 7-6: Example of Community Led Revegetation Project

Revegetation and bank stabilization offers numerous benefits for channel bank stabilization and overall watershed health. By establishing a robust plant community along waterways, the root systems effectively bind soil particles, increasing the bank's resistance to erosion. The presence of vegetation also increases surface roughness, which slows water flow and reduces sediment transport, further protecting the integrity of the channel. Additionally, plants act as natural filters, removing pollutants from runoff and improving water quality. Finally, revegetation, particularly with native species, enhances the ecological health of the riparian area by providing valuable habitat and increasing biodiversity.

By implementing these measures, community groups can play an important role in protecting water resources and promoting the sustainability of development projects, all while avoiding the need for large equipment and contractors.

7.5.3 Low Impact Development Strategies

Enhanced Vegetated Swales (Roadside Ditch Upgrades)

Enhanced vegetated swales, also called grass swales, are low slope vegetated open channels designed to attenuate, treat, and convey stormwater runoff. Enhanced vegetated swales are often sited next to roadways as an alternative for simple ditching. Vegetated swales allow for conveyance of stormwater during intense rainfall events and have the potential to contribute to treatment of surface runoff contaminants and reduce runoff velocity through infiltration. Swales may be used in conjunction with other stormwater and erosion control measures such as check dams or level spreaders to achieve treatment and attenuation goals (TRCA, nd). Plan and profile views of a typical grass swale layout are shown in **Figure 7-7** and **Figure 7-8**, respectively.

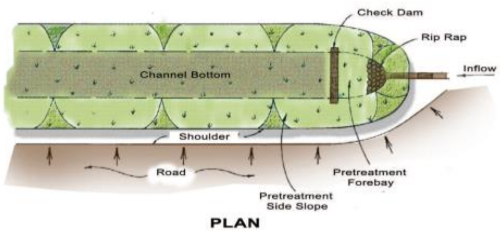

Figure 7-7: Enhanced Grass Swale Layout, Plan View (TRCA, nd)

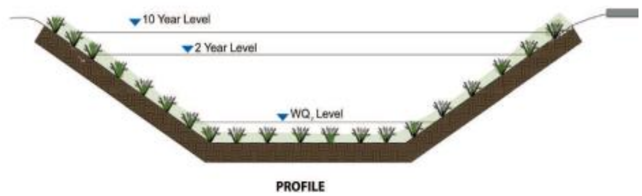

Figure 7-8: Enhanced Grass Swale Layout, Profile View (TRCA, nd)

The infiltration capacity of underlying soils, and depth to groundwater, play an important role in determining whether infiltration can reduce peak runoff volumes. Test pitting and infiltration testing of underlying soils prior to construction of a vegetated swale can assist in determining site suitability.

Figure 7-9: Double Ring Infiltrometer (Wikipedia, 2018)

Over time, the permeability of the soil media can decrease significantly due to the accumulation of fines in the overlying topsoil and vegetation. A simple test can be used to measure infiltration capacity in a vegetated soil media. A double ringed infiltrometer (**Figure 7-9**) provides a simple and effective means to estimate infiltration rate. This approach can be used in estimating in-situ infiltration rates for new swale/basin construction, or to evaluate infiltration rate of existing vegetated surfaces. For areas found to have poor infiltration capacity, the overlying soils may be removed and replaced with well-draining topsoil or specially engineered soil amendments, and re-vegetated; however, adequate underdrainage should be confirmed prior to construction.

Engineered/Natural Wetlands

Wetland enhancement or wetland creation for stormwater treatment is an effective tool to filter stormwater runoff and can provide high removal efficiencies for stormwater pollutants (i.e., TSS, metals and hydrocarbons) and can be used to filter reduce stormwater runoff peak discharge rates (velocity/flow). A conceptual sketch of wetland creation along a watercourse is depicted below in **Figure 7-10**.

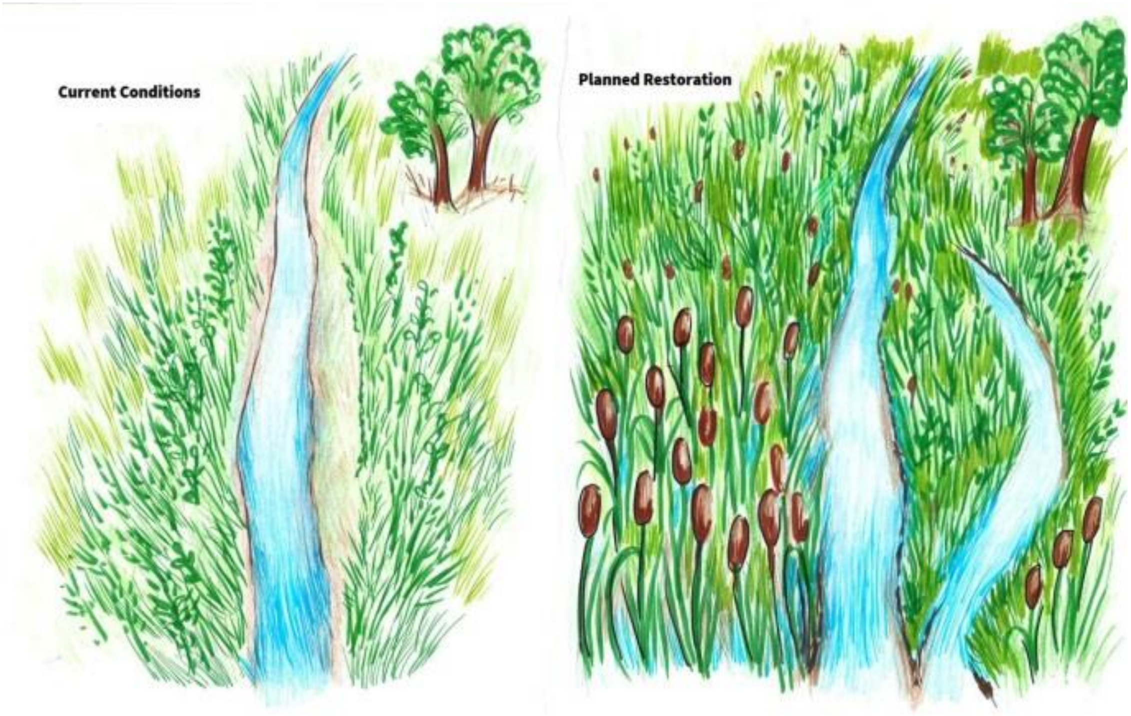

Figure 7-10: Conceptual Sketch of Wetland Upgrades

Engineered wetlands should be inspected twice per year (every 6 months). At time of inspection, undesirable plant species should be pulled out, dead (not dormant) vegetation removed, and pipes, grates, and screens cleaned. Fertilization may also be required to initiate or sustain vegetation growth. Depending on pollutant loading and removal efficiency, gravel within the engineered wetland may also need to be cleaned and/or replaced if it becomes clogged and the wetland is no longer performing effectively (Taylor, Yahner, Jones, Ogden, & Dunn, 1998).

Rain Gardens/Bioretention Cells

Bioretention cells, often also referred to as Rain Gardens, are designed to temporarily store, treat, and infiltrate stormwater runoff. Bioretention cells vary significantly in size depending on the application but are particularly suited to natural depression areas and vegetated strips in paved areas to slow runoff velocities, and also help settle out sediment, support contaminant and pollutant removal, and encourage infiltration into native soils (TRCA, nd). A sample drawing of a bioretention cell is shown in **Figure 7-11**.

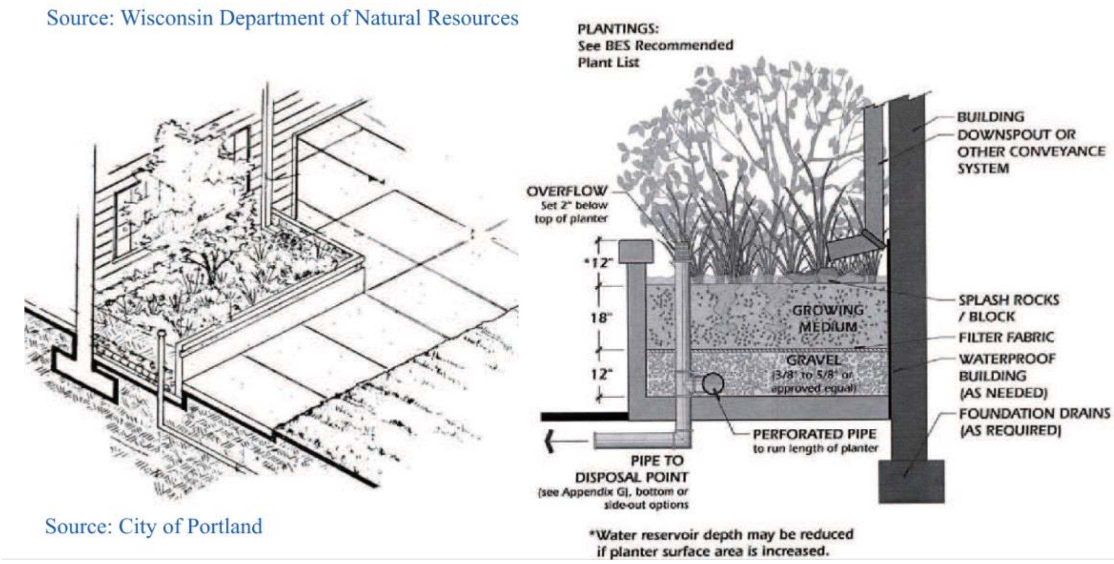

Figure 7-11: Conceptual Sketch of Bioretention Cell Components (TRCA, nd)

Permeable Pavements

Permeable Pavements are an alternative to traditional pavement surfaces such as asphalt and concrete. Permeable pavement systems allow stormwater to infiltrate from the paved surface, rather than generating runoff. Permeable pavements help reduce the negative impacts often associated with paved areas, such as increased runoff velocity and water temperatures (TRCA, 2015).

Figure 7-12: Installed Permeable Pavers in Winter (TRCA, 2015)

Permeable pavements are available in four general types: permeable interlocking pavers (as shown in **Figure 7-12**), permeable interlocking grids, pervious concrete and pervious asphalts. Permeable pavements are often better suited to new development projects but may also be appropriate for deep retrofits of existing parking areas on the Base. These systems are best suited to low-to-medium vehicle traffic areas including parking lots, plazas, walkways, and driveways (TRCA, 2015).

As with green roofs, a formal consideration for the installation of permeable pavements should be implemented as part of the planning process for new developments as well as for deep retrofit projects.

8.0 Conclusion

The Town of Kentville Stormwater Management Master Plan and hydrologic/hydraulic assessment evaluated the existing stormwater system, identified key vulnerabilities and hydraulic constrictions, and provided a set of prioritized recommendations for improvements. By utilizing hydrologic and hydraulic modeling, incorporating community input, and considering future development scenarios, this study has equipped the Town with the necessary tools to make informed decisions regarding stormwater infrastructure upgrades.

The implementation of the recommended improvements will enhance community resilience to flooding, protect infrastructure and property, limit the mobilization and deposition of sediment within the stormwater system, and promote sustainable development. This includes increasing ditch capacities, bank restoration of natural channels, implementing flow attenuation measures, introducing increased storage, and increasing conveyance capacity of undersized pipes and culverts. Additionally, community-wide measures include the enhancement of the existing maintenance program, implementing Low Impact Development (LID) strategies, such as enhanced vegetated swales, wetlands, rain gardens, and permeable pavements in new developments, to improve stormwater quality and reduce runoff.

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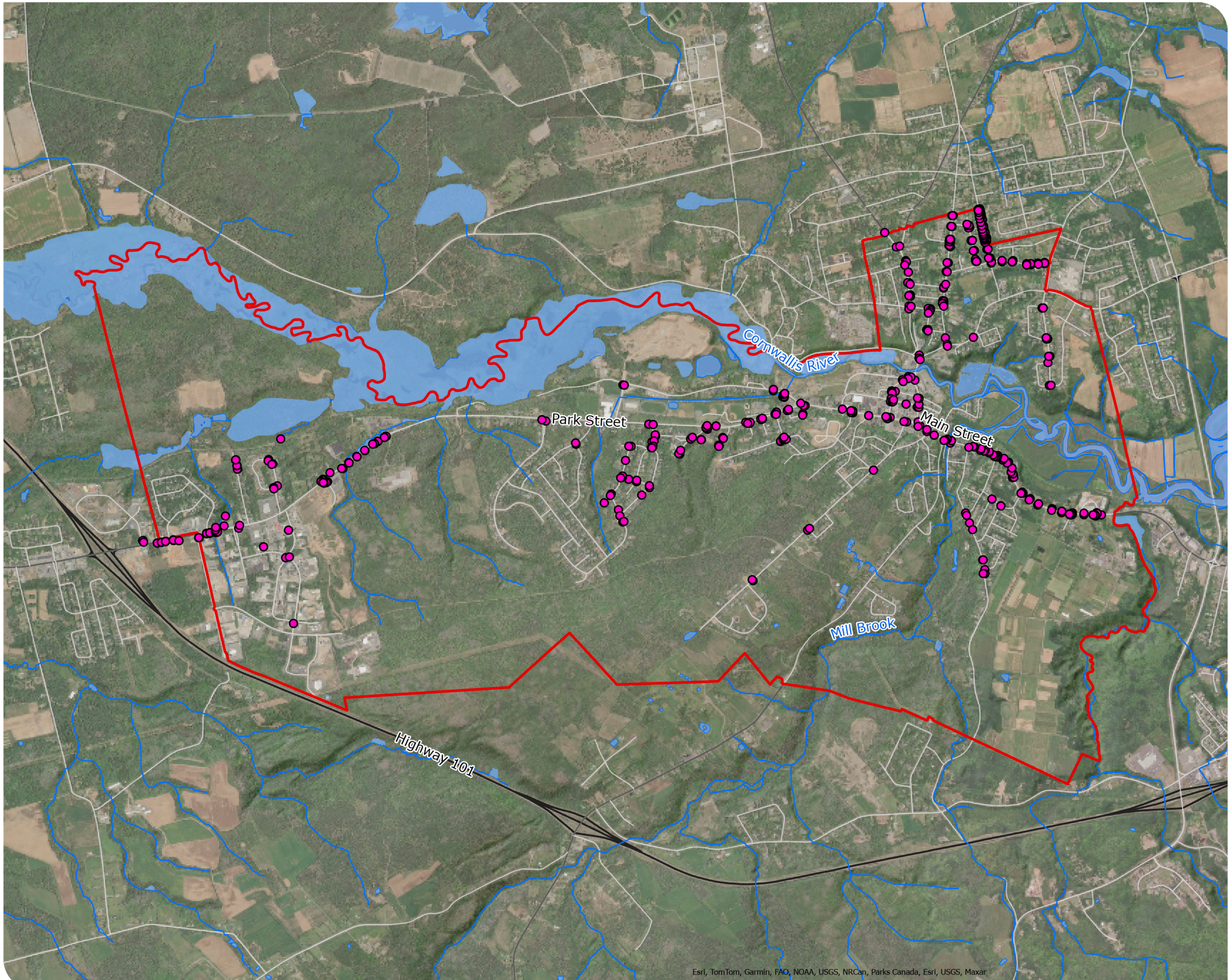
Appendix A

Field Data Collection Survey Points



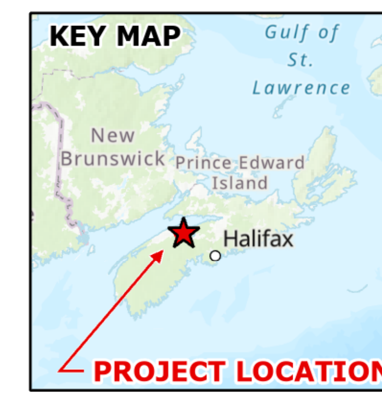
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

SURVEYED LOCATIONS

FIGURE #A-1

- Surveyed Location
- Town of Kentville
- Waterbody
- Watercourse
- Highway
- Major Road
- Local Road



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MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova

MAP CREATED BY: JA
MAP CHECKED BY: EC
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

DILLON CONSULTING

PROJECT: 24-8977
STATUS: DRAFT
DATE: 2025-02-24

FILE LOCATION: K:\GIS\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan.aprx; LAYOUT: F03 Surveyed Locations

Appendix B

Catchment Parameters

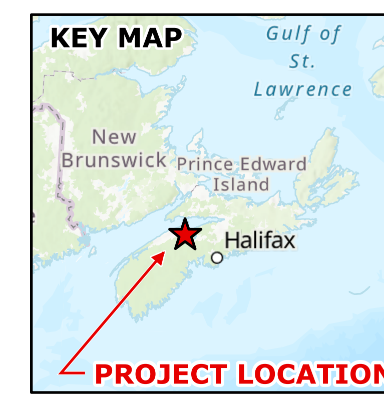
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

DELINEATED SUBCATCHMENTS USED IN MODELLING

FIGURE #B-1

- Town of Kentville
- Subcatchments
- Watercourse
- Waterbody
- Local Road



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N E S W

MAP DRAWING INFORMATION:
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MAP CHECKED BY: EC
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DILLON CONSULTING

PROJECT: 24-8977
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FILE LOCATION: K:\2024\248977\Product\Client\Town of Kentville Stormwater Management Plan\Town of Kentville Stormwater Management Plan.aprx; LAYOUT: FB-1 DelineatedSubcatchmentsInModelling

PCSWMM Catchment Parameters (Memorial Park Area) – Existing Conditions

Name	Area (ha)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
S1	8.246	346	9	47.085	0.012	0.25	183.96	7.24	0.15
S1_1	4.3443	480	10	5	0.012	0.4	183.96	7.24	0.15
S1_10	2.2804	240	12	30	0.012	0.25	183.96	7.24	0.15
S1_11	0.6272	76	5	20	0.012	0.25	183.96	7.24	0.15
S1_12	5.3714	640	11	5	0.012	0.4	183.96	7.24	0.15
S1_13	0.1432	61	3	15	0.012	0.25	183.96	7.24	0.15
S1_14	1.4248	197	1	20	0.012	0.25	183.96	7.24	0.15
S1_15	3.1998	250	9	20	0.012	0.25	183.96	7.24	0.15
S1_16	0.8879	144	1	20	0.012	0.25	183.96	7.24	0.15
S1_17	0.0912	75	1	20	0.012	0.25	183.96	7.24	0.15
S1_18	0.7502	140	1	20	0.012	0.25	183.96	7.24	0.15
S1_19	0.3051	20	5	60	0.012	0.25	183.96	7.24	0.15
S1_2	0.3271	135	12	25	0.012	0.25	183.96	7.24	0.15
S1_20	0.6701	240	12	30	0.012	0.25	183.96	7.24	0.15
S1_21	0.3740	101	2	15	0.012	0.25	183.96	7.24	0.15
S1_22	0.0561	39	5	40	0.012	0.25	183.96	7.24	0.15
S1_23	4.2085	615	11	5	0.012	0.4	183.96	7.24	0.15
S1_24	5.0480	350	6	30	0.012	0.25	183.96	7.24	0.15
S1_25	2.6426	215	10	20	0.012	0.25	183.96	7.24	0.15
S1_26	0.1853	40	12	70	0.012	0.25	183.96	7.24	0.15
S1_27	0.4637	56	8	20	0.012	0.25	183.96	7.24	0.15
S1_28	0.6828	95	15	20	0.012	0.25	183.96	7.24	0.15
S1_3	1.4783	165	25	20	0.012	0.25	183.96	7.24	0.15
S1_30	0.8403	91	9	85	0.012	0.25	183.96	7.24	0.15

Name	Area (ha)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
S1_31	0.1142	80	6	60	0.012	0.25	183.96	7.24	0.15
S1_32	0.3181	85	8	50	0.012	0.25	183.96	7.24	0.15
S1_33	1.2219	165	5	60	0.012	0.25	183.96	7.24	0.15
S1_34	1.1130	93	17	36	0.012	0.25	183.96	7.24	0.15
S1_35	0.2386	91	16	50	0.012	0.25	183.96	7.24	0.15
S1_37	0.5905	92	5	40	0.012	0.25	183.96	7.24	0.15
S1_38	0.0747	91	2	72	0.012	0.25	183.96	7.24	0.15
S1_39	0.7663	190	13	30	0.012	0.25	183.96	7.24	0.15
S1_4	0.9840	141	9	25	0.012	0.25	183.96	7.24	0.15
S1_41	0.0890	39	5	15	0.012	0.25	183.96	7.24	0.15
S1_42	0.4964	110	8	40	0.012	0.25	183.96	7.24	0.15
S1_43	0.2625	92	3	20	0.012	0.25	183.96	7.24	0.15
S1_44	1.0278	141	1	20	0.012	0.25	183.96	7.24	0.15
S1_45	0.6035	91	2	75	0.012	0.25	183.96	7.24	0.15
S1_46	0.4685	165	13	15	0.012	0.25	183.96	7.24	0.15
S1_47	0.7395	180	13	15	0.012	0.25	183.96	7.24	0.15
S1_48	2.7319	550	13	5	0.012	0.4	183.96	7.24	0.15
S1_49	1.4559	300	10	40	0.012	0.25	183.96	7.24	0.15
S1_5	0.0615	92	3	65	0.012	0.25	183.96	7.24	0.15
S1_51	0.2570	80	1	40	0.012	0.25	183.96	7.24	0.15
S1_52	0.1402	20	5	60	0.012	0.25	183.96	7.24	0.15
S1_54	0.9137	190	13	25	0.012	0.25	183.96	7.24	0.15
S1_55	0.7131	190	13	25	0.012	0.25	183.96	7.24	0.15
S1_56	0.3202	80	1	40	0.012	0.25	183.96	7.24	0.15
S1_6	0.4294	86	9	60	0.012	0.25	183.96	7.24	0.15

Name	Area (ha)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
S1_7	0.2496	140	9	75	0.012	0.25	183.96	7.24	0.15
S1_8	0.1895	61	3	10	0.012	0.25	183.96	7.24	0.15
S1_9	0.6615	85	21	10	0.012	0.25	183.96	7.24	0.15
S2	10.4232	636	13	5	0.012	0.4	183.96	7.24	0.15
S3	9.2298	425	12	15	0.012	0.4	183.96	7.24	0.15
S3_1	2.1491	191	7	20	0.012	0.25	183.96	7.24	0.15
S3_10	0.4761	100	5	8	0.012	0.25	183.96	7.24	0.15
S3_11	7.1248	300	11	5	0.012	0.4	183.96	7.24	0.15
S3_13	0.5674	98	3	72	0.012	0.25	183.96	7.24	0.15
S3_14	1.3834	100	11	5	0.012	0.25	183.96	7.24	0.15
S3_15	2.2349	175	11	5	0.012	0.25	183.96	7.24	0.15
S3_2	0.1012	65	2	5	0.012	0.25	183.96	7.24	0.15
S3_3	0.5464	96	2	15	0.012	0.25	183.96	7.24	0.15
S3_5	0.4165	63	2	45	0.012	0.25	183.96	7.24	0.15
S3_6	1.2958	140	1	80	0.012	0.25	183.96	7.24	0.15
S3_7	0.2849	150	1	80	0.012	0.25	183.96	7.24	0.15
S3_8	2.8845	200	5	20	0.012	0.25	183.96	7.24	0.15
S3_9	9.8526	400	11	5	0.012	0.4	183.96	7.24	0.15
S4	0.5994	102	1	20	0.012	0.25	183.96	7.24	0.15
S4_1	0.0768	235	1	50	0.012	0.25	183.96	7.24	0.15
S4_10	0.4007	132	10	52	0.012	0.25	183.96	7.24	0.15
S4_11	1.0818	163	7	60	0.012	0.25	183.96	7.24	0.15
S4_12	1.3442	125	13	10	0.012	0.4	183.96	7.24	0.15
S4_13	0.1174	205	1	75	0.012	0.25	183.96	7.24	0.15
S4_14	0.3968	266	20	20	0.012	0.25	183.96	7.24	0.15

Name	Area (ha)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
S4_15	0.3844	190	0	60	0.012	0.25	183.96	7.24	0.15
S4_16	0.2322	235	1	50	0.012	0.25	183.96	7.24	0.15
S4_17	0.6836	266	20	25	0.012	0.25	183.96	7.24	0.15
S4_18	22.1682	575	12	10	0.012	0.4	183.96	7.24	0.15
S4_19	0.1223	205	1	75	0.012	0.25	183.96	7.24	0.15
S4_2	0.1114	205	1	70	0.012	0.25	183.96	7.24	0.15
S4_20	16.8718	600	13	10	0.012	0.4	183.96	7.24	0.15
S4_21	2.2996	175	12	15	0.012	0.4	183.96	7.24	0.15
S4_26	3.2260	200	12	15	0.012	0.4	183.96	7.24	0.15
S4_27	2.6422	200	12	15	0.012	0.4	183.96	7.24	0.15
S4_28	1.2456	100	13	10	0.012	0.4	183.96	7.24	0.15
S4_29	1.5411	200	12	15	0.012	0.4	183.96	7.24	0.15
S4_3	0.7679	185	13	40	0.012	0.25	183.96	7.24	0.15
S4_30	7.1648	315	13	10	0.012	0.4	183.96	7.24	0.15
S4_31	2.5292	175	13	10	0.012	0.4	183.96	7.24	0.15
S4_32	2.3797	150	13	10	0.012	0.4	183.96	7.24	0.15
S4_34	1.2119	100	13	10	0.012	0.4	183.96	7.24	0.15
S4_35	2.1799	315	12	35	0.012	0.4	183.96	7.24	0.15
S4_36	4.3286	340	12	35	0.012	0.4	183.96	7.24	0.15
S4_39	1.2542	197	12	42	0.012	0.25	183.96	7.24	0.15
S4_4	1.3508	235	6	20	0.012	0.25	183.96	7.24	0.15
S4_5	2.5652	200	12	15	0.012	0.4	183.96	7.24	0.15
S4_7	0.3479	63	7	50	0.012	0.25	183.96	7.24	0.15
S4_8	0.6670	67	4	75	0.012	0.25	183.96	7.24	0.15
S4_9	2.1517	175	12	15	0.012	0.4	183.96	7.24	0.15

Name	Area (ha)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
S5	5.2735	375	12	15	0.012	0.4	183.96	7.24	0.15
S6	1.1563	151	5	15	0.012	0.25	183.96	7.24	0.15
S6_2	5.5399	150	8	50	0.012	0.25	183.96	7.24	0.15
S7	1.6534	180	13	15	0.012	0.4	183.96	7.24	0.15
S8	15.6972	566	10	8	0.012	0.4	183.96	7.24	0.15
S9	0.3295	56	3	69.313	0.012	0.25	183.96	7.24	0.15
S9_1	0.6029	125	11	28.486	0.012	0.25	183.96	7.24	0.15
S9_2	1.0579	125	11	28.486	0.012	0.25	183.96	7.24	0.15
S9_4	0.0479	65	2	60	0.012	0.25	183.96	7.24	0.15
S9_5	0.2080	65	2	60	0.012	0.25	183.96	7.24	0.15

Appendix C

Model Development and Results

Minimum Imperviousness Percentages by Land Use Type (Windsor/Essex Region Stormwater Manual, 2024)

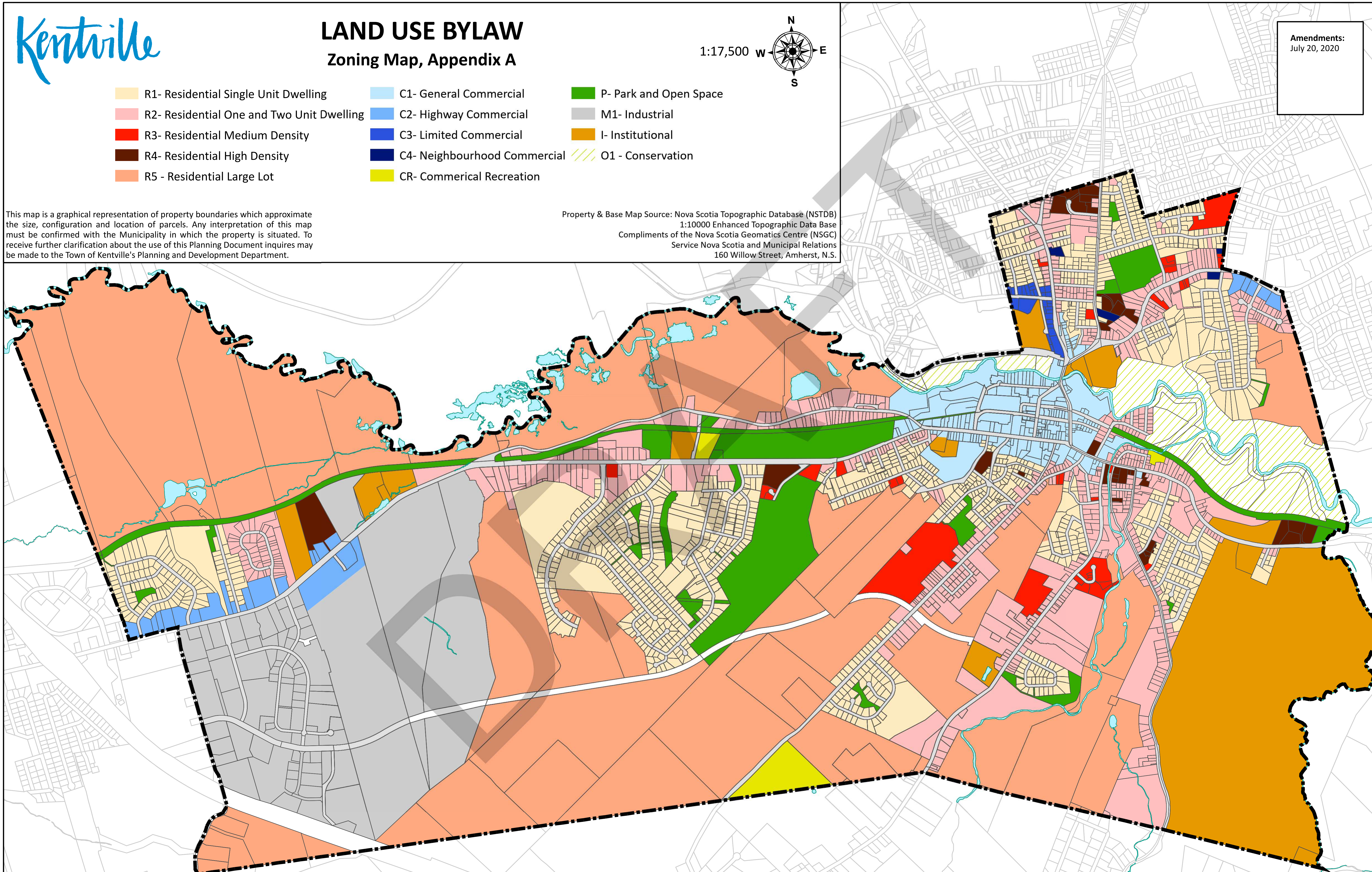
Land Use	Impervious Ratio
Residential – Single Family	60%
Residential – Single Family (lot size of 500 m^2 or less)	70%
Resedential – Semi-detached	70%
Residential – Townhouse / Row Housing	80%
Industrial / Commercial	90%
Wet Ponds	100%

Manning's Roughness Coefficients Used for Pipes and Overland Flow

Pipe Material	Manning's Roughness Coefficient (n)
Corrugated Metal	0.025
Concrete	0.014
High Density Polyethylene (HDPE)	0.012
PVC	0.011
Overland Flow – Wooded Areas	0.4
Overland Flow – Cultivated Land	0.1

LAND USE BYLAW

Zoning Map, Appendix A



Appendix D

Flooded Locations

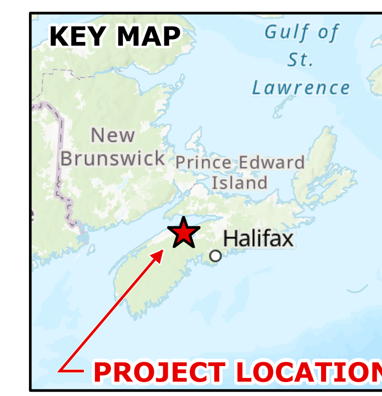
TOWN OF KENTVILLE

STORMWATER MANAGEMENT PLAN

FLOODED LOCATIONS

FIGURE #D-1

- Flood Junctions
- Town of Kentville
- Waterbody
- Watercourse
- Local Road



SCALE 1:8,700

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MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova

MAP CREATED BY: CHM
MAP CHECKED BY: EC
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

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PROJECT: 24-8977
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