Municipality of Brighton

Stormwater Master Plan

Municipal Class Environmental Assessment Report

FINAL DRAFT

December 2018

MUNICIPALITY OF BRIGHTON

water ecology community

Emmons & Olivier Resources, Inc.

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December 10, 2018

Mr. Gary King
Interim Chief Administrative Officer
Municipality of Brighton
35 Alice Street
Brighton, ON K0K 1H0

Dear Mr. Kelly:

Regarding: Final Draft Brighton Stormwater Master Plan Class Environmental Assessment Report

EOR is pleased to submit the final draft of Brighton's Stormwater Master Plan Class Environmental Assessment for review by Indigenous communities, the public, and agencies.

We would like to thank the Municipality of Brighton for their assistance throughout the study and the valuable input we received from you, Lucas Kelly (Municipality of Brighton), Municipal staff, Janet Noyes (Lower Trent Conservation), Denise Marshall (Northumberland County), Indigenous communities, and interested members of the public.

We look forward to receiving comments on this draft by January 11, 2019.

Sincerely,
EOR Inc.

OSparrow

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Water Resources Engineer
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Issues and Revisions Registry

Identification	Date	Description of Issue and/or Revision
Draft Report	October 15, 2018	For Municipality, Lower Trent Conservation, and Northumberland County Review
Final Draft Report	December 10, 2018	For Indigenous Community, Public, and Agency Review

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The Brighton Urban Area is a growing community on the Lake Ontario shoreline where coldwater streams feed into the Provincially Significant Presqu'ile Bay Marsh. Many of the neighbourhoods in Brighton were historically developed with no infrastructure to treat or slow down stormwater as was typical at the time. More recent land development projects within the past 15 years have primarily utilized stormwater management ponds to treat and slow down runoff in line with standard practices. The background and baseline conditions for this Master Plan are detailed in Sections 1 and 2, respectively.

Currently, runoff from 17% of the built portion of the Brighton Urban Area is being treated by stormwater management facilities. Assessment of current stormwater management infrastructure in Brighton has identified deficiencies and gaps in terms of water quality and quantity control that need to be addressed to improve the performance and resiliency of the system into the future. In addition, the design standards for stormwater management in Ontario are rapidly evolving to use a broader suite of approaches that will enhance water quality and quantity control in the face of more extreme climate conditions. The deficiencies in the existing stormwater management system detailed in Section 3 are summarized as follows:

- Areas without any stormwater quality control
- Stormwater management infrastructure (e.g. ponds) requiring annual inspection and maintenance to restore approved water quality control
- Urban roadside ditches and culverts requiring regular inspection and maintenance to restore conveyance capacity
- Stormwater management infrastructure that is undersized to provide approved water quality control in the permanent pool and water quantity control with sufficient freeboard
- Lack of controls to prevent thermal pollution and protect water balance (i.e. sustain groundwater and its discharge to coldwater streams)
- Flood risk to roads and buildings in depressions on the landscape (e.g. road sags) and along the lakeshore where outlet capacity will be limited by high lake levels
- Storm sewers that are undersized to convey at least the 5-year rainfall event without surcharging or flooding
- Cumulative impacts of the above deficiencies on receiving waterbodies, such as observed warming and degraded habitat for fish and aquatic insects in Butler Creek

The Stormwater Master Plan outlines the long-term strategies, capital improvements, and maintenance programs needed to improve the capacity of the current stormwater management system, support future development and protect the natural heritage features unique to Brighton. The Stormwater Master Plan addresses the following stormwater management objectives in order to improve the stormwater management system:

A. Reduce Flood Risk & Increase Resiliency to Climate Change
B. Reduce Future Maintenance
C. Protect Streams, Wetlands, and Presqu'ile Bay from Stormwater Impacts
D. Improve Public Safety

The advantages and disadvantages of four alternative approaches were compared in Section 3.6 relative to their ability to address the objectives of the Stormwater Master Plan:

1. **Conventional Stormwater Management** (e.g. storm sewers and ponds)
2. **Treatment Train Stormwater Management** (i.e. emphasis on Low Impact Development and Green Infrastructure prior to reliance on storm sewers and ponds)
3. **Non-Structural Alternatives** (e.g. new stormwater design standards)
4. **Do Nothing**

The preferred alternatives for the Stormwater Master Plan are using a treatment train stormwater management approach (Alternative #2) as well as non-structural solutions (Alternative #3). Evaluation of alternative stormwater management practices for the subwatershed improvement projects were compared at a preliminary feasibility screening level based on constraints such as shallow groundwater.

The Stormwater Master Plan includes the following components described in Sections 5.1 to 5.6:

1. Maintenance Program
2. Infrastructure Retrofit Projects
3. Policies
4. Education & Outreach
5. Administration
6. Partnerships

The recommended implementation schedule for the Stormwater Master Plan provided in Section 5.7 includes estimated costs in order to facilitate budgeting, partnerships and grant applications over the next 10 years. Overall, the recommended schedule will maintain the municipality's existing stormwater management activities in Year 1 with additional efforts to start the Maintenance Program (including annual inspections), staff training, proactive incorporation of treatment train stormwater management improvements in Class EAs for road reconstruction projects, retaining securities through Development Agreements, and refusal to assume ownership of stormwater infrastructure that is non-compliant with MECP Environmental Compliance Approvals. The Municipality's *Development Charges Study* for 2019 will include the estimated cost of the recommended *Stormwater Use Fee Study* to be completed in Year 2 based on the recommended funding strategies outlined in Appendix G. The remaining recommendations of the Stormwater Master Plan will be phased in based on the assumption that the Stormwater User Fee will be initiated in Year 3 to provide $150,000 of funding and increased by the same amount each year until Year 6 once the total funding needed to support implementation of the Stormwater Master Plan is achieved. Reliance on the tax levy for stormwater services will be entirely replaced by the Stormwater User Fee by Year 6.

The timing of Municipal pond cleanouts and subwatershed improvement projects is recommended based on relative consequence and probability of failure of each pond or system (See Section 3). Private infrastructure improvements will be implemented by future development or recouped through development charges. Funding through the tax levy and Stormwater User Fee should be supplemented to the extent possible by securing grants, leveraging partnerships and adopting other funding strategies presented Appendix G. Projects should be implemented ahead of schedule if they become fully funded.

This Master Plan fulfills Phases 1 and 2 of the Class EA process for which consultation is a key part. The consultation conducted as part of this project is summarized in Section 4 and detailed in Appendix F. Considerations for implementation of the Master Plan are outlined in Section 5.8, such as EA Schedules, potential effects and mitigating measures, permits and approvals, and future studies. Many of the actions recommended in this Master Plan are considered Schedule A projects, such as maintenance of stormwater management infrastructure and installation of low impact development practices within road right-of-ways, which can proceed without further assessment under the EA process. The public will need to be notified prior to implementation of Schedule A+ projects, which would include water quality retrofits within existing easements or public property. Stormwater management facilities that require additional property are considered Schedule B projects, which will require a screening process and consultation to develop a design that addresses any outstanding concerns. Other projects that could have significant environmental effects, such as the subwatershed improvement projects that will mitigate flood risk, must proceed through the remaining phases of the Class EA process, including Phase 3 (Alternative Design Concepts for the Preferred Solution), Phase 4 (Environmental Study Report) and Phase 5 (Implementation).

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1. INTRODUCTION

1.1. Background

Stormwater is rain and melted snow that runs off streets, parking lots, and lawns. Natural areas soak up stormwater like a sponge, nourishing plants and replenishing streams, lakes, wetlands, and aquifers. Impervious surfaces such as pavement and roofs prevent precipitation from naturally soaking into the ground. Instead, the water runs quickly into storm drains, sewer systems, and drainage ditches. The Municipality of Brighton (the Municipality) initiated the Stormwater Master Plan Class Environmental Assessment (EA) for the Brighton Urban Area to assess current and future stormwater infrastructure needs as the community continues to grow. The Study Area is defined by the Brighton Urban Area perimeter shown in Figure 1, which is bounded, by Lake Ontario and Presqu'ile Provincial Park to the south.

Brighton's *Official Plan* (Municipality of Brighton 2014) outlines the Municipality's commitment to enhancing and preserving the environmental qualities that contribute to the attraction of Brighton, including the diversity and connectivity of natural features and long-term ecological function of natural heritage systems. An objective of the Official Plan is to protect, improve and restore the quality and quantity of surface and groundwater resources in Brighton. As the Municipality continues to grow, the Plan calls for new and re-development activities to mitigate impacts on downstream resources through stormwater management practices and maintaining or increasing pervious/vegetated surfaces in the urban areas as outlined in a "Master Drainage Plan" (i.e. a Stormwater Master Plan) for the Brighton Urban Area (Section 3.5.4). Brighton's Stormwater Master Plan addresses these objectives of the Official Plan by defining stormwater management policies for land development as well as Municipal programs and capital projects to improve stormwater management across the Brighton Urban Area. Despite its name, the Brighton Urban Area contains undeveloped areas that are identified for future growth in the Official Plan.

The *Investigation and Assessment of Stormwater Systems and Facilities* (GENIVAR 2009) evaluated the performance of storm sewers and stormwater management ponds in the Brighton Urban Area south of the railroad. The study recommended maintenance activities, capital improvements, policies, standards, and actions to improve stormwater infrastructure in Brighton. Survey, mapping, and modeling were recommended to address gaps in available information about storm sewer infrastructure and limitations to the analysis method. The study did not provide a recommended approach to funding the implementation of its recommendations. The limitations and recommendations of the assessment were driving factors behind initiating this master planning exercise, in addition to new considerations such as the need for a defined stormwater management maintenance program and the implications of extreme lake level fluctuations. Findings from the GENIVAR study were incorporated into this Stormwater Master Plan with appropriate updates using new information and analysis methods, as well as a larger study area encompassing the entire Brighton Urban Area.

Additional background reports and studies provided by the Municipality and Lower Trent Conservation (LTC) were reviewed to understand the design of stormwater management facilities in previous developments and past studies of drainage in Brighton. Stormwater management standards and best practices are rapidly changing in Ontario as well to support the resiliency of communities to climate change. The background reports reviewed as part of this study are summarized in Section 1.3. An overview of the regulatory setting regarding stormwater management is provided in Section 1.4.

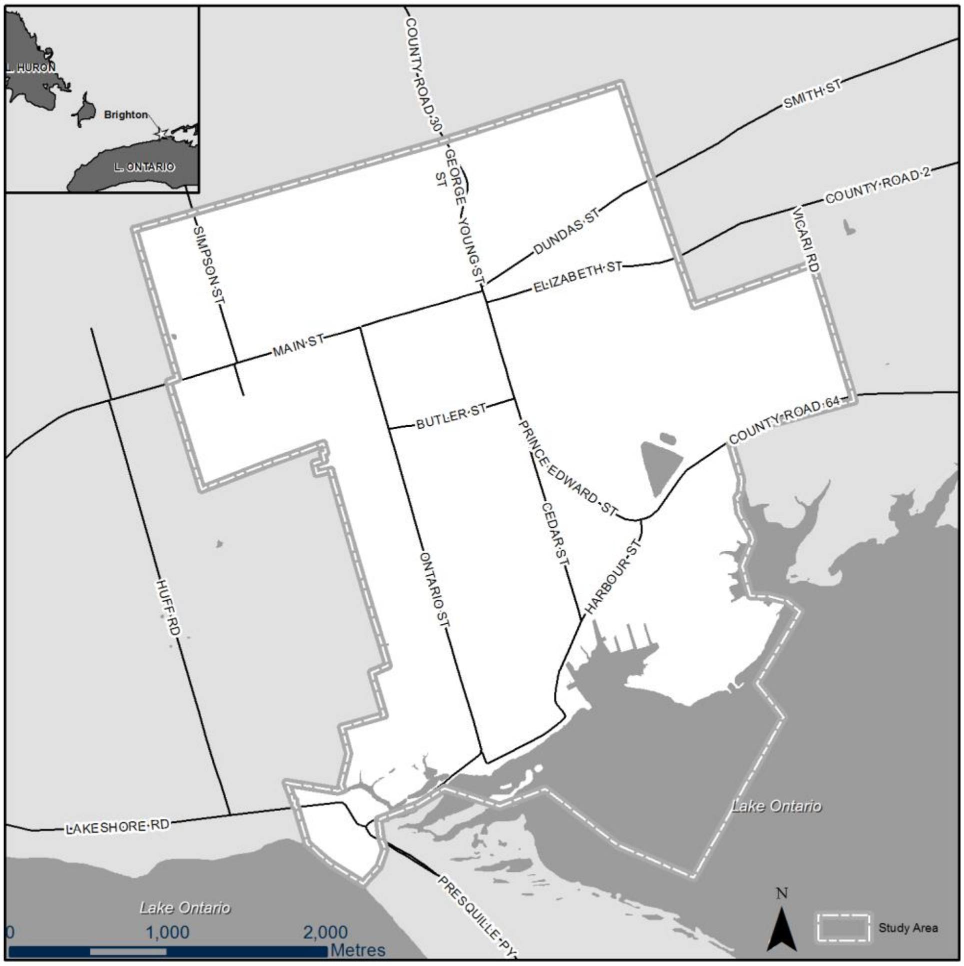

Figure 1. Study Area

1.2. Municipal Class Environmental Assessment Process

The Class Environmental Assessment (EA) streamlines the planning and approvals process for municipal projects that are:

- Recurring,
- Similar in nature,
- Usually limited in scale,
- Predictable range of environmental impacts, and
- Responsive to mitigation.

The Municipal Class Environmental Assessment outlines the 5-phase process to be followed to satisfy EA requirements:

- Phase 1: Problem or Opportunity
- Phase 2: Alternative Solutions
- Phase 3: Alternative Design Concepts for the Preferred Solution
- Phase 4: Environmental Study Report
- Phase 5: Implementation.

Projects subject to the Class EA process are classified into four possible “schedules”, depending on the degree of expected impacts.

- Schedule A projects are minor, operational and maintenance activities and are pre-approved without the need for further assessment.

- Schedule A+ projects are also pre-approved; however, the public is to be advised prior to project implementation.

- Schedule B projects require a screening of alternatives for their environmental impacts and fulfillment of Phases 1 and 2 of the planning process.

- Schedule C projects must satisfy all five phases of the Class EA planning process. These projects have the potential for greater environmental impacts. Provided no significant impacts are identified and no requests for a Part II Order or “bump-up” to an Individual EA are received, Schedule C projects are then approved and may proceed directly to implementation.

The Class EA defines master plans as:

> *“Long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system(s) or group of related projects in order to outline a framework for planning for subsequent projects and/or developments.”*

Master Plans are broad in scope and focus on the analysis of a system for the purpose of outlining a framework for the provision of future works and developments. Specific projects recommended in a Master Plan are part of a larger management system thus, implementation of specific projects may occur over an extended time frame.

A Master Plan must at least satisfy the requirements of Phases 1 and 2 of the Class EA process. The Master Plan must document public, Indigenous and agency consultation at each phase of the process and a reasonable range of alternative solutions must be identified and systematically evaluated. This Master Plan for the Municipality of Brighton fulfills Phases 1 and 2 of the Class EA process. Consultation is a key part of the Master Planning process. The consultation conducted as part of this project is summarized in Section 4 and detailed in Appendix F.

1.3. Reports and Studies

The background studies reviewed in preparing this plan are summarized below. Many other reports detailing the stormwater management plans of individual developments over the past 17 years were also reviewed to inform the storm sewer and pond assessments. The Municipality's Official Plan and other local regulations relating to stormwater management are summarized in Section 1.4.3.

Storm Drainage Study for Village of Brighton (Totten Sims Hubicki Associates 1979)

This study reviewed the existing minor drainage systems within the Town limits at a time when the majority of development had occurred north of the railroad other than some development near the lakeshore, such as the Village of Gosport. The study included a detailed inventory and evaluation of all culverts and storm sewer systems with records provided in tabular and map formats in the appendices. The comprehensive inventory of the storm sewer network identified 9.6 km of storm sewers in the study area with material conditions ranging from poor to good. The study found that 32% of the storm sewer system had deficient capacity to convey the 5-year rainfall event and that an additional 11.5 km of storm sewer would be necessary to service future development. The latter was the primary focus of the study since new storm sewers were needed in multiple areas to accommodate future growth. The report outlined estimated costs and recommended staging and implementation priorities that would largely be tied to street urbanization, road needs, future development, and available funds.

One particular issue area identified in the study was the significant amount of drainage to the Butler Creek Tributary crossing Grimes Street. The tributary daylighted from a storm sewer at Oliphant Street south of Elizabeth Street and had a history of flooding issues through to Grimes Street. As such, the contributing area was proposed to be significantly reduced by a diversion storm sewer along Singleton Street and Pinnacle Street that would swap the drainage area from Butler Creek to Arena Creek. The study did not evaluate the effect of the proposed diversion on the receiving watercourses, assuming "that the creek will be able to handle the extra volume" and recommending, "The watercourse should be inspected and improved where necessary to handle the increased flow".

Other notable expansions of the storm sewer system that were recommended in the study included the Ontario Street storm sewer systems north and south of the railroad, as well as the Cedar Street system that to this day also collects discharge from Raglan Street and Harbour Point Pond.

Butler Creek Flood Reduction Study for Town of Brighton (Totten Sims Hubicki Associates 1988)

On March 21 and 20, 1980, severe flooding damaged residential and commercial buildings as a result of a spring rainfall event that occurred when soils were frozen and the ground was mostly snow-free. The purpose of this study was to develop a comprehensive flood reduction program for Butler Creek from Proctor Park Conservation Area to Presqu'ile Bay such that flood risk was lowered to acceptable levels. Hydrologic analysis of Butler Creek was updated from previous studies (Totten Sims Hubicki Associates 1978) using OTTHYMO and up to date parameterization methodologies to represent fully developed conditions which, at the time, was expected to cover 8% of the watershed. In the absence of historical flow data for calibration, the sensitivity of the OTTHYMO results were tested and the design flows were found to be consistent with the results of the Watershed Classification Method, the Index Flood Method, and the Regional Regression Method. The new design flows were used to simulate flooding in a HEC-2 hydraulic model with a downstream boundary condition of the mean water level of the lake from the Cobourg Ontario Water Level Station (#13590). The hydraulic model results were then used to update the maps of the 100-year and Regional flood lines. After reviewing potential flood risks and mitigation options, the study outlined recommended flood mitigation approaches including physical improvements and consideration for applying the Two Zone Concept for future land use planning.

Southwest Master Drainage Study for Town of Brighton (Totten Sims Hubicki Associates 1991)

This study prepared a stormwater management strategy to protect downstream natural resources from the impacts of planned development on the west side of Ontario Street and South of Butler Street. This area drains to an unnamed creek system and ultimately to Presqu'ile Bay Marsh. A key consideration of this study was the overflow (i.e. spill) of Butler Creek into this system west of the Ontario Street crossing during the Regional Storm which had previously been assessed in the *Butler Creek Flood Reduction Study* (Totten Sims Hubicki Associates 1988). The *Southwest Master Drainage Study* recommended that a berm be built to contain the spill, although a two zone approach to development in the flood fringe of the spill was another option under consideration. The recommended stormwater management approach included a ditched minor system draining to a water quantity/quality pond designed to augment baseflows in the watercourse and maintain pre-development peak flows. In addition, setbacks from the existing wooded swamp and watercourses were recommended to protect existing riparian habitat and the springs feeding into the stream. Modelling in OTTHYMO was verified using Rational Method and Regional Flood Frequency analyses to estimate stormwater facility sizing and a HEC-2 model was used to assess the impacts of development on the regional floodplain and estimate the necessary size of a replacement culvert for the Raglan Street crossing of the creek. The flat terrain of the area limited feasibility of stormwater conveyance via storm sewers and as such ditch systems were recommended. The other alternative of directing all stormwater via a storm sewer directly to the Bay was prohibited in order to maintain high quality wetland habitats. Infiltration practices were deemed infeasible due to concerns regarding clogging and groundwater contamination.

Master Drainage Study for Northeast Brighton (Totten Sims Hubicki Associates 1993)

This study defined the stormwater management objectives for development of the rural lands north of Dundas Street between Pinnacle Street and Georgina Street, which are still undergoing development as part of the Tackaberry Ridge East Subdivision Phase 1. The study included assessment of fish, macroinvertebrates, and water quality in Arena Creek from Presqu'ile Bay Marsh up to the railroad that found conditions more reflective of a warmwater stream; however, background conditions of the main stem upstream of the industrial lands were not assessed as part of the study. A hydrologic model was developed using OTTHYMO.89 to assess pre and post-development flows to the Pinnacle Street storm sewer at Singleton Street to estimate the storage volume required to match pre-development peak flows. Rational Method and Regional Flood

Frequency analyses were also conducted. The study outlined a recommended stormwater management plan for controlling runoff in multiple stormwater detention ponds to protect downstream fisheries, infrastructure, and properties as the preferred method rather than others, such as a single pond or infiltration facilities. Recommended design parameters for the pond and swale were also provided, including details such as 2:1 side slopes for the north pond (i.e. Tackaberry Ridge Pond) to reduce its surface area, in addition to requirements for erosion and sediment control. Recommendations were also provided for operations and maintenance, including anticipated cleanout every 5 to 10 years and water quality monitoring to assess the performance of the pond after construction conducted by developers over a two or three year warranty period.

Fill and Flood line Mapping Study of Cold and Butler Creeks for LTC (Totten Sims Hubicki Associates 1978)

This study was not reviewed as part of developing Brighton's Stormwater Master Plan.

Investigation and Assessment of Stormwater Systems and Facilities (GENIVAR 2009)

An overview of this report is provided in Section 1.1.

Asset Management Plan for the Municipality of Brighton (Associated Engineering 2013)

The Municipality's Asset Management Plan (AMP) included an inventory of major storm sewer infrastructure to assess the current age, condition, and estimated service life of the storm sewer network. The AMP did not include all types of stormwater management infrastructure such as ponds. The AMP outlined desired levels of service and key performance indicators, such as no flooding on roads, and outlined the data about infrastructure that must be collected by Municipal staff to maintain an up-to-date understanding of performance on an ongoing basis, such as CCTV of storm sewers and completing a Road Needs Study every three years. The AMP also provided recommendations for storing the information in a database. The Municipality has used the findings and recommendations of this study to prioritize annual infrastructure replacement and rehabilitation projects. Recent replacement activities that were recommended in the AMP include underground infrastructure improvements to Young Street (from Main to the northern town limit), Terry Fox Drive, Orchard Crescent, and Dundas Street (from Young Street to Daniels Drive). Details regarding the next priorities subsequent to those were not provided in the AMP since the recommended cycle for AMP is to update the assessment and recommendations every five years. The AMP outlined that continued investment was required to continue financing storm sewer replacement from 2019 to 2028.

Road Needs Study for the Municipality of Brighton (The Greer Galloway Group Inc. 2013)

The Road Needs Study collected and inventoried information about the condition of the existing urban and rural road system in Brighton. The study noted that, "Accurate assessment of the existing road structure and drainage are the two most important factors that will ultimately determine the type and amount of effort needed to maintain and/or improve the system." The study's inventory was then used to develop a schedule of recommended road rehabilitation (i.e. resurfacing) and reconstruction projects, including estimated costs. The Municipality has used the findings and recommendations of this study to prioritize annual road reconstruction and resurfacing projects. While many of the high priority recommendations have been implemented, reconstruction of Sanford Street (Platt Street to Princess Street), Platt Street (Sanford Street to Main Street), Napier Street (Monck Street to Napolean Street), and Hope Street (Singleton Street to Lakeview Heights) remain to be implemented by 2023, after which a new Road Needs Study should be conducted to provide updated recommendations. Many of the immediate implementation recommendations in the study were for drainage improvements to ditches and culverts, whereas the longer term recommendations currently underway related to more comprehensive road reconstruction efforts.

1.4. Regulatory Setting

Stormwater management in Ontario is regulated by multiple pieces of legislation administered by each level of government, including federal, provincial, and municipal. Provincial legislation gives various levels of authority and power to municipal governments and conservation authorities to regulate the management of stormwater. This section outlines the regulations and policies that apply to stormwater management in Ontario that must be considered in the Municipality's Stormwater Master Plan.

1.4.1. Federal Legislation

There is currently no federal legislation that relates directly to stormwater, although the federal government has several pieces of legislation focused on its constitutional responsibility for protecting fisheries, wildlife, the environment, navigation, and public health.

Department of Fisheries and Oceans

The Department of Fisheries and Oceans (DFO) administers the *Fisheries Act* (RSC 1985, c F-14), which prohibits the release of deleterious substances into fish habitat, which is defined very broadly in the Act and can include roadside ditches and watercourses that are only intermittently wet. Proponents conduct a self-assessment to determine if DFO authorization is required.

Transport Canada

Transport Canada requires works that affect navigable waters, such as bridges and culverts, to obtain approval through the *Navigation Protection Act* (RSC 1985, c N-22), formerly named the *Navigable Waters Act*, if the affected waterway is included in the Act's List of Scheduled Waters. Although the majority of waterways in Canada are not included in the list, the public right to navigation exists for all navigable waters under Common Law. Proponents of work on navigable waterways not included in the List of Scheduled Waters can opt in and seek Transport Canada's approval, making the application subject to Transport Canada's compliance monitoring and enforcement regime.

Canadian Environmental Assessment Agency

The Canadian Environmental Assessment Agency administers the *Canadian Environmental Assessment Act* (CEAA) (SC 2012, c 19, s 52) to require federal departments, agencies, and crown corporations to conduct environmental assessment of projects proposed by the federal government. The major objective of the CEAA is to identify and assess potential environmental effects of federal projects so that effective mitigation measures can be developed through the prescribed planning process.

Environment and Climate Change Canada

Environment and Climate Change Canada administers several acts relevant to stormwater management. The *Canadian Environmental Protection Act* (CEPA) (SC 1999, c 33) contributes to sustainable development through pollution prevention and protecting the environment, human life and health from risks associated with toxic substances. CEPA relates to stormwater management by mandating emergency planning for industrial accidents and the guidelines for the Act include treatment of stormwater before runoff containing toxic substances reaches ecosystems. The *Canada Water Act* (RSC 1985, c C-11) facilitates federal-provincial agreements for the management of water resources through research, planning, and implementation of programs relating to the conservation, development, and utilization of water resources. For example, the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health was made pursuant to the *Canada Water Act* in order to carry out the Great Lakes Strategy. The *Species at Risk Act* (SC 2002, c 29) protects wildlife species at risk and develops recovery plans. The *Migratory Birds Convention Act* (SC 1994, c 22) to protect migratory songbirds and their nests from disturbance or destruction.

1.4.2. Provincial Legislation

Provincial legislation is administered by multiple ministries of the Ontario government and grants powers and obligations to other government actors, such as Conservation Authorities and municipalities, in matters relating to stormwater management.

Ministry of Municipal Affairs

The Ministry of Municipal Affairs (MMA) issues the Provincial Policy Statement (PPS) under Section 3 of the *Planning Act* (RSO 1990, c P-13). The *Planning Act* defines how land uses may be controlled by planning authorities, such as municipalities. Municipal Official Plans must be consistent with the PPS and applicable provincial plans. Section 2.2 of the PPS requires that planning authorities protect, improve or restore the quality and quantity of water. Planning authorities shall ensure that stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces. The PPS acknowledges that, in addition to approvals under the Planning Act, infrastructure may require approvals under other acts and provincial plans.

Ministry of Environment, Conservation and Parks

The Ministry of Environment, Conservation and Parks (MECP) administers multiple acts with relationships to stormwater management, as follows:

Ontario Water Resources Act, RSO 1990, c O-40	• Regulates stormwater works, including requirements of owners to conduct ongoing maintenance and monitoring.

	• Prohibits the discharge of any material that may impair surface or groundwater quality. • Requires erosion controls to protect downstream watercourses. • Regulates permits to take water in addition to well construction, operation and abandonment.
Environmental Protection Act, RSO 1990, c E-19	• Prohibits release of contaminants into the natural environments that may cause adverse effects and requires prompt reporting and clean-up of pollutant spills. • Requires projects to comply with conditions defined in provincial Environmental Compliance Approvals (previously Certificates of Approval).
Clean Water Act, SO 2006, c 22	• Requires local communities to reduce or eliminate significant existing or potential threats to their municipal drinking water sources through development and implementation of source protection plans and followed by ongoing monitoring and reporting.
Safe Drinking Water Act, SO 2002, c 32	• Requires municipal drinking water systems to obtain approval from the director of the MOECC in order to operate. Operators must be trained and certified to provincial standards. • Defines framework for testing with legally-binding drinking water contaminant standards.
Nutrient Management Act, SO 2002, c 4	• Defines standards for nutrient storage and application and a framework for best practices for nutrient management to reduce potential for surface water, groundwater, or other environmental contamination.
Environmental Assessment Act, RSO 1990, c E-18	• Requires an environmental assessment of any major public or private undertaking in order to determine the ecological, cultural, economic and social impact of the project. • Establishes a "Class Environmental Assessment" process for planning certain municipal projects, including road, water, and sewage and stormwater projects.
Water Opportunities Act, SO 2010, c 19	• Fosters innovative water, wastewater and stormwater technologies, services and practices in the private and public sectors. • Creates opportunities for economic development and clean-technology jobs in Ontario. • Aims to conserve and sustain water resources for present and future generations.
Great Lakes Protection Act, SO 2015, c 24	• Provides opportunities for individuals and communities to become involved in the protection and restoration of the ecological health of the Great Lakes-St. Lawrence River Basin.

The Ministry has also published key policy and guidance documents related to stormwater management practices and objectives. The Ministry of Environment and Energy published Water Management: Policies, Guidelines, Provincial Water Quality Objectives (PWQO) in 1994 (also referred to as the Blue Book) to assist in managing quality and quantity of surface and groundwater as required for approval under the *Ontario Water Resources Act* and the *Environmental Protection Act* (Ontario Ministry of Environment and Energy 1994).

The Stormwater Management Planning and Design Manual (Ministry of the Environment 2003) is a technical guide for planning, designing and reviewing stormwater management practices for approval under the *Ontario Water Resources Act*. The manual articulates development guidelines and criteria for water balance, water quality, water quantity, and erosion and sediment control. Some of the guidelines, such as the enhanced level control for water quality, are used as minimum standards for stormwater management facilities designed to comply with Environmental Compliance Approvals through the *Environmental Protection Act*.

The Ministry published an Interpretation Bulletin to clarify the expectations of the Ministry regarding stormwater management as defined in the provincial policies and guidance (MOECC 2015). The bulletin also announced that the Ministry would release an LID stormwater management guidance document which is still under development. Until then, the bulletin clarified the following regarding the application of and justification for Low Impact Development approach to stormwater management:

> "…the ministry's existing guidance emphasizes an approach to stormwater management that mimics a site's natural hydrology by controlling precipitation as close as possible to where it falls so water quality remains satisfactory for aquatic life and recreation and water quantity is managed to ensure a fair sharing among users, water conservation, and sustainability of the resource (p. 1 of letter)."
>
> "…the MOECC's current guidelines and policies support locally derived site-specific performance criteria based on watershed/subwatershed studies and source control measures such as low impact development (LID). This Bulletin is also intended to encourage stormwater management applications that emphasize low impact development techniques while the ministry undertakes the development of a low impact development stormwater management guidance document, targeted for completion in 2016 (p. 1 of letter)."
>
> "Low impact development stormwater management is relevant to all forms of development, including new development, redevelopment, infill, and retrofit development. Compact urban development and urban intensification helps to prevent sprawl and thus protect farmland, wetlands, and green spaces, and also provides for efficient use of land, water and energy resources and existing infrastructure. Employing LID facilities to the greatest extent possible, when undertaking intensifying urban development, will add to these benefits (p. 2 of bulletin)."
>
> "…it has been demonstrated that LID installations, when properly sited, designed and maintained, can meet all of the requirements and no end-of-pipe controls are required (p.4 of bulletin)."

Ministry of Natural Resources

The Ministry of Natural Resources and Forestry (MNRF) provides guidelines on protection of wetlands and management of Natural Hazards as they relate to river and stream systems. The MNRF also administers multiple acts with relationships to stormwater management, as follows:

Lakes and Rivers Improvement Act, RSO 1990, c L-3	• Regulates public and private use of Ontario's lakes and rivers, including construction, repair, and use of dams • Requires Water Management plans for waterpower facilities to ensure environmental, social and economic concerns are addressed. • Prohibits the discharge of substances into lakes and rivers that may impair water quality and/or quantity.
Public Lands Act, RSO 1990, c P-43	• Guides the use, management, sale and disposition of public lands and forests, including public land use planning and development.
Endangered Species Act, SO 2007, c 6	• Enacts the protection of Endangered, Threatened and Special Concern species (provincial) and their habitats. • Regulates activities which may affect these species. • Provides for development of Recovery Strategies.
Fish & Wildlife Conservation Act, SO 1997, c 41	• Enables the MNRF to manage fish and wildlife.

The Northern and Southern Manuals for the Ontario Wetland Evaluation System (OWES) (Ontario Ministry of Natural Resources 2014a; Ontario Ministry of Natural Resources 2014b) published by the MNRF are guidelines for evaluating the functions of wetlands. Wetlands evaluated through the OWES that meet certain criteria are identified as Provincially Significant Wetlands and have protection under the PPS. The Manuals specify that Municipalities can protect other wetlands that are significant on a local scale.

The Natural Hazards Policies applied under the PPS are administered by the MNRF according to the Technical Guide for River and Stream Systems. The policies and guidelines aim to reduce risk to public safety and property damage relating to flooding, erosion, and slope stability by directing development away from Natural Hazards. Relevant policies to the SMP include those requiring that hydraulic structures provide safe access and egress for emergency vehicles. Another policy is to mitigate offsite flood impact by providing flood control (post- to pre-development peak flow control), conveyance improvements, or securing permission from any impacted land owners.

Ministry of Transportation

The Ministry of Transportation (MTO) has a series of guidelines addressing drainage considerations in highway design and corridor management. In particular, hydraulic structures crossing watercourses must provide sufficient freeboard per the Highway Design Standards (Ontario Ministry of Transportation 2008).

Ministry of Agriculture, Food, and Rural Affairs

The Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) administers the *Drainage Act* (RSO 1990, c D-17) to regulate the creation of Mutual Agreement Drains between landowners and provide a democratic procedure for construction, improvement, and maintenance of drainage works for which grants are made available to municipalities.

Lower Trent Conservation

The *Conservation Authorities Act* (RSO 1990, c 27) grants conservation authorities the power to control the flow of surface waters to prevent flooding and to reduce adverse effects thereof (Laura L. Zizzo et al. 2014). Lower Trent Conservation provides input and review of land use planning to municipalities and developers in accordance with provincial, federal, and conservation authority policies and regulations. Territories that are not covered by a Conservation Authority in Ontario fall under the jurisdiction of the MNRF.

Any development within the regulated area will require a permit from the Lower Trent Conservation as follows:

Regulated Areas

Areas within Lower Trent Conservation Jurisdiction considered to be regulated by the Conservation Authority include, but are not limited to:

- All watercourses including streams, rivers and creeks and areas adjacent to watercourses
- Provincially Significant Wetlands plus 120 metres surrounding the wetland
- All non-provincially significant wetlands plus 30 metres surrounding the wetland
- In-land lakes and shorelines and areas adjacent to these lakes
- 15 metres landward of the most landward hazard of 100 year flood hazard, 100-year erosion hazard, or dynamic beach hazard on Lake Ontario shoreline
- Ravines, valleys, steep slopes and talus slopes and adjacent lands
- Meander belts on non-apparent valley systems and adjacent lands
- Hazardous lands including unstable soil and bedrock

Regulated Activities

The Regulation applies to development including, but not limited to:

- The construction, reconstruction, erection or placing of a structure of any kind
- The temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere
- Any alteration to a watercourse including culvert, bridge and boat launch installations
- Any site alteration and/or grading
- Alteration to a shoreline
- Interference in a wetland or adjacent lands

1.4.3. Municipal Regulation

Municipalities such as the Brighton are given authority by the provincial legislature through the *Municipal Act* (SO 2001, c 25) to enact By-Laws and provide services to the public, including stormwater management. Additional authorities regarding stormwater management are provided to municipalities through the *Planning Act* (RSO 1990, c P-13) and *Building Code Act* (SO 1992, c 23), such as the ability to require land owners to manage stormwater from their property and operate stormwater systems to be in compliance with the *Building Code Act* (Laura L. Zizzo et al. 2014). Overall, the *Planning Act* provides municipalities with the powers to establish municipal Official Plans, zoning By-Laws, and other land use planning tools, which include the ability to place conditions on development approvals. Provincial requirements for land use planning are discussed further in the previous section.

Given these authorities, municipalities are responsible for planning, designing, operating, and maintaining stormwater management infrastructure. The following sections outline the policies, By-Laws and guidelines developed by the Municipality related to stormwater management.

Policies

The Municipality's Official Plan defines how land in Brighton should be used. The Official Plan's policies recognize the importance of the Municipality's surface water and groundwater resources. The Plan identifies criteria for land development projects to address stormwater management concerns. The Plan's natural environment policies support the protection of natural heritage features and water resources. The Plan's policies apply to both public and private land development. Northumberland County also has an Official Plan that provides direction and a policy framework for managing growth and land use decisions.

By-Laws

Several of the Municipality's By-Laws relate to aspects of stormwater management, the most applicable of which are the Zoning By-Law. Section 34 of the *Planning Act* authorizes Municipal Councils to pass Zoning By-Laws that standardize the use of land in a community and specify the permitted type, use and locations of permitted buildings and structures. Zoning By-Laws also define lot sizes and dimensions, building heights and sizes, parking, and landscaped open space requirements. Zoning By-Laws implement land-use policies specified in the Official Plan and contain specific, legally enforceable requirements. In general, no person shall use any land, building, or structure within a Zone for a use that is not permitted within that Zone, unless a variance is approved by Council. The Municipality's current Zoning By-Law is applicable to all land and all buildings erected, altered, enlarged, or used within the Municipality.

The Municipality does not have Site Plan Control or Site Alteration By-laws, however there is a Fill By-law. The Fill By-law controls and regulates the dumping and moving of fill in Brighton. Staff will assess if a permit is required under this by-law prior to moving any large amounts of fill, removal of topsoil or altering grades. Section 3 outlines exemptions for activities such as residential landscaping and agricultural practices while Section 5 includes provisions for erosion and dust control.

Section 15.1 of the *Building Code Act* authorizes Municipal Councils to define the minimum standards for property maintenance in Property Standards By-Laws. Brighton's Property Standards By-Law includes specific standards relating to stormwater management in Section 2.3, as follows:

2.3.2 Stormwater shall be drained from the property so as to prevent excessive ponding or the entrance of water into a basement or cellar.
2.3.3 Exterior property areas shall be graded and maintained to prevent ponding of water creating an unsafe condition. Catch basins and swales shall be installed and maintained where necessary to facilitate drainage and so as not to impede natural flow of water.
2.3.4 All yards and exterior property areas shall be cultivated or protected with suitable ground cover to prevent erosion of the soil.
2.3.5 No roof drainage or sump pump shall be discharged onto sidewalks, stairs or neighbouring property or into a sanitary sewer.
2.3.6 No person shall change the grade of any property, by filling or excavation, which affects the natural stormwater drainage of the property or adjacent properties without the prior written approval of the Corporation.
2.3.7 No person shall install, alter, relay or repair a private stormwater or groundwater drain that discharges onto a neighbouring property or into a municipal storm sewer, creek or roadside drainage ditch without the prior written approval of the Corporation.

The Sewer Use By-Law regulates discharge and connections to the municipal stormwater management system. Section 2.0 of the By-Law prohibits the discharge of excessive pollutants into the stormwater management system, including storm sewer, drainage works, swale, pond, municipal or private sewer connection that could:

- Interfere with, obstruct, restrict, or damage stormwater management infrastructure
- Result in a hazard or adverse impact to any person, animal, property, or vegetation
- Contravene or result in the contravention of an Environmental Compliance Approval under the Environmental Protection Act or Ontario Water Resources Act with respect to storm sewer and or stormwater discharge
- Meet the By-Laws the appearance, pH, or temperature criteria in Section 3.1 (f)
- Contain high E.Coli levels or at least one of the other pollutants listed in Section 3.1(g)

Connections to the municipal storm sewer are regulated under Section 4 of the Sewer Use By-Law, including requirements regarding the following:

- appropriate lot level storm water management measures to reduce storm water quantity and improve storm water quality (4.13)
- new storm sewer connections needed for draining new impervious surfaces and providing groundwater drainage, the latter via sump pump or gravity flow foundation drain system, where feasible, which must be installed and maintained at the property owner's expense (4.14)
- roof water drainage, including prohibited connection of roof water leaders or down spouts to the sanitary sewer (4.15), mandatory disconnection (4.17), and specifications for areas without storm sewer service (4.16)

Guidelines

The Municipality's Engineering Design Guidelines (2018) provide minimum standards for storm sewer and foundation drain design, erosion control, submittal requirements, and checklists for subdivision design.

2. BASELINE CONDITIONS

This section summarizes the existing environment in the study area (Figure 1) relevant to stormwater management planning. The existing environment includes the physical, social, cultural, and natural environments of the Brighton Urban Area. The physical environment includes climate, topography, geology, soils and surface/groundwater. The social environment includes existing and proposed development and the built components of the environment that alter or manage the quantity and quality of stormwater. The cultural environment includes archaeological heritage features that retain the evidence of human activity. The natural environment includes terrestrial and aquatic habitats and species as well as environmentally significant or sensitive areas. Some components of the natural environment, such as trees and wetlands, also provide stormwater management related functions such as evapotranspiration.

2.1. Physical Environment

2.1.1. Climate and Precipitation

The temperate climate in Brighton is moderated by Lake Ontario. There is no local weather station in Brighton. The nearest operating weather station with a long record is Environment Canada's Station 6158875 (Trenton A) at the Canadian Forces Base with hourly records dating back to 1953. The temperature and precipitation climate normals from 1981 to 2010 are summarized in Table 1 and Table 2.

Table 1. Climate Normals for Temperature at Trenton A Station (1981 to 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Max. (°C)	-2	-0.7	4.2	11.9	18.4	23.6	26.3	25.3	20.9	13.8	7.4	1
Daily Mean (°C)	-6.8	-5.7	-0.7	6.6	12.7	18	20.7	19.7	15.3	8.6	3	-3.3
Daily Min. (°C)	-11.6	-10.6	-5.7	1.2	7	12.3	15.2	14	9.7	3.5	-1.4	-7.6

Source: (Environment Canada 2013 Sep 25)

Table 2. Climate Normals for Precipitation at Trenton A Station (1981 to 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)	34.2	29.2	41.1	72.2	79.4	78.3	69	72.2	90.1	83.3	86.9	50.4	786.3
Snowfall (cm)	44.8	34.6	23.8	5.6	0	0	0	0	0	0.3	10.4	36.5	156
Total Precipitation (mm)	68.1	56.5	62.3	77.3	79.4	78.3	69	72.2	90.1	83.6	95.5	79	911.4

Source: (Environment Canada 2013 Sep 25)

Climate change includes more frequent and intense storms that increase stormwater runoff. In some areas, the combination of climate and land use change may make existing stormwater issues (e.g. flooding) worse, while other areas may be less affected. Up to date rainfall datasets, such as the Ontario Ministry of Transportation's Intensity-Duration-Frequency (IDF) Curve Lookup Tool[1] and

[1] http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

the Ontario Climate Change Data Portal[2], are essential to planning and designing stormwater management infrastructure. The former was used to assess storm sewer capacity in the study area using the Brighton Urban Area hydrologic and hydraulic model developed for this Master Plan (See Appendix C). Stormwater-related adaptation strategies serve to provide additional capacity in the existing system so that it is more resilient under more intense or multi-day precipitation events, while also mitigating other impacts of climate change on downstream water bodies, such as increased air temperatures and evapotranspiration on coldwater streams.

2.1.2. Topography

The study area generally slopes to the south with relatively steep slopes found in the north and flatter slopes in the south (Figure 2). The topography of the study area was mapped using new LiDAR data from the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) acquired during flights in 2016 and 2017 with 50-centimeter resolution. This is a significant improvement over previous sources (e.g. 2 m resolution SCOOP in 2013, 2011 LiDAR by MNR limited to the lakeshore) and was used to map and assess stormwater infrastructure in the study area as detailed in Appendix C.

2.1.3. Geology & Surficial Soils

The overall structure of south central Ontario is primarily the result of the underlying Precambrian bedrock. The Precambrian land surface was slowly invaded by Paleozioic seas and marine and deltaic sediments were deposited, buried and lithified. During the Middle Ordovician period, carbonates of the Trenton Group were deposited and these limestones and shales form the uppermost bedrock formation in Northumberland County. No bedrock exposures are encountered within the study area. Glacial deposits cover the study area with the exception of some shoreline zones. The study area is within the south central Ontario bedrock geology division and the Iroquois Sand Plain physiographic region (Chapman and Putnam 1984).

As the Wisconsinan glaciation receded during the late Pleistocene Epoch, an ice lobe still occupied the St. Lawrence River valley and the lowlands along Lake Ontario were inundated by Lake Iroquois. Its old shorelines are identifiable north of Highway 2 in Brighton. The wave action along the two to three kilometre wide shoreline reworked the unconsolidated till deposits into a relatively smooth plain which has been overlain by more recent lacustrine deposits which are the parent material from which soils have developed (Chapman and Putnam 1984).

The soils in the study area vary considerably as shown in Figure 3, with textures including loams (e.g. clay loam, fine sandy loam, silty loam), sands (e.g. sand, gravelly sand), and muck. The dominant soil texture is sandy loam, which composes 43% of the study area (Hoffman and Acton 1974). These soil textures were used to assess stormwater infrastructure capacity in the study area as detailed in Appendix C.

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[2] http://www.ontarioccdp.ca/

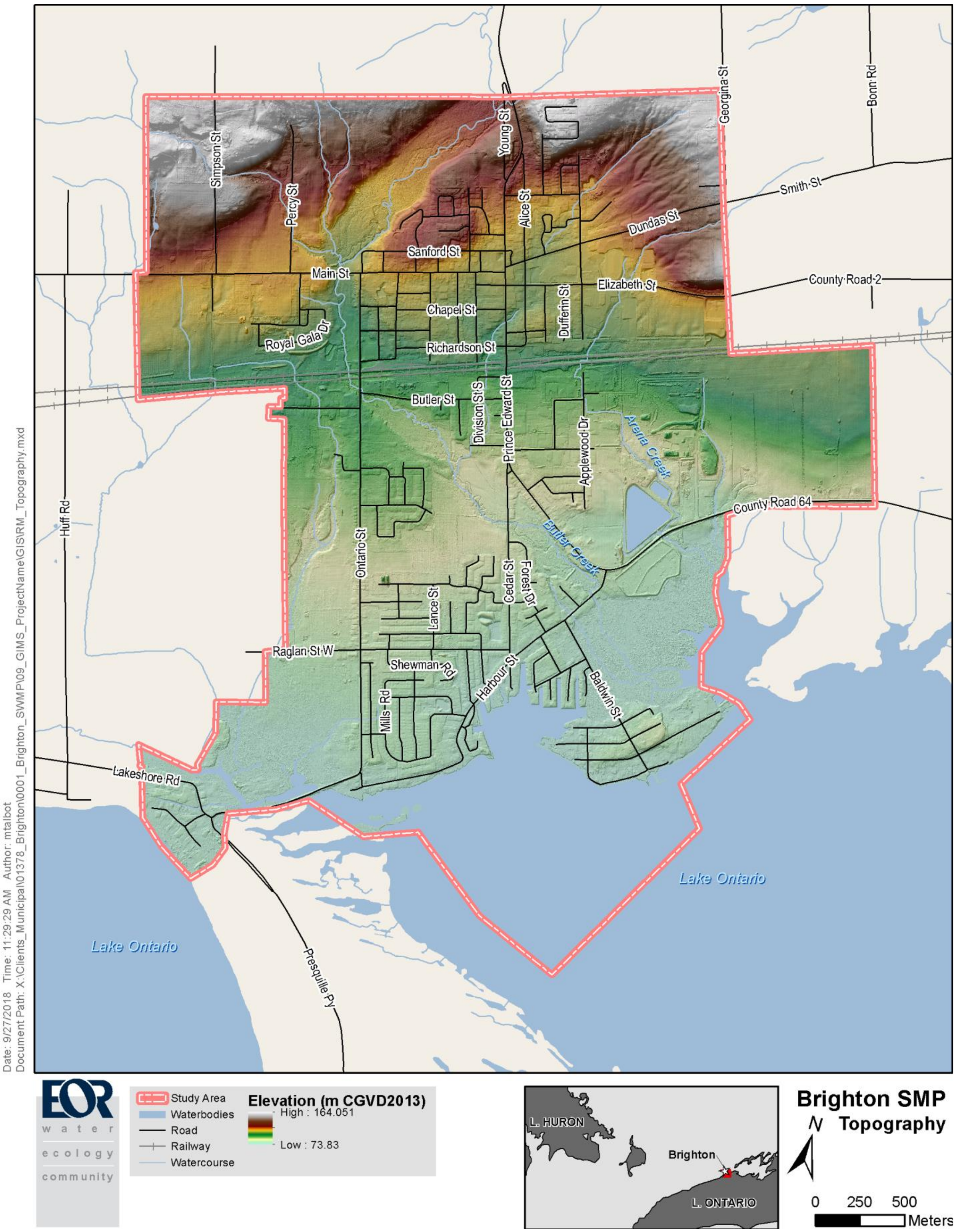


Figure 2. Topography [Source: Peterborough LiDAR, Package C (Airborne Imaging 2018)]

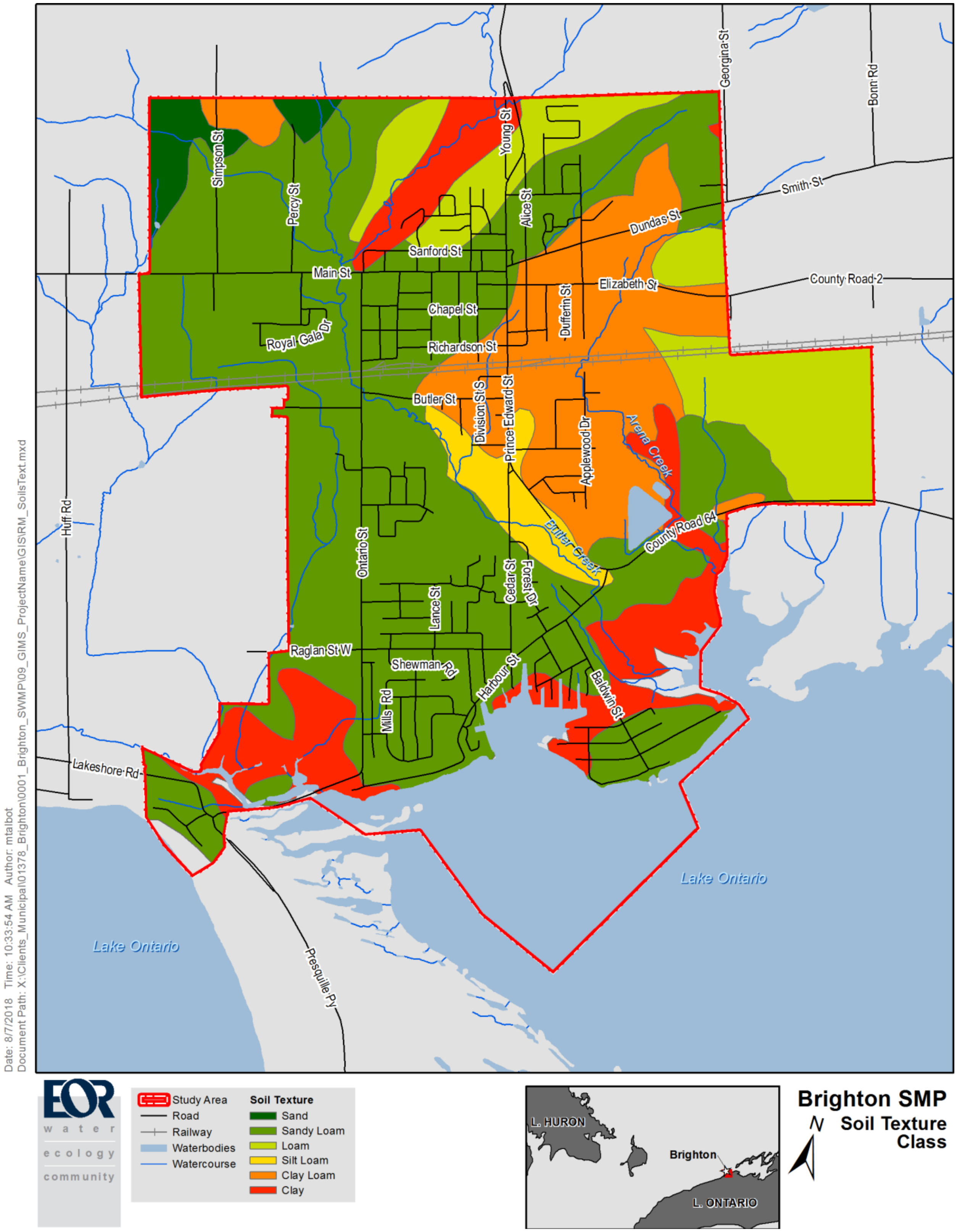


Figure 3. Soil Texture [Source: The Soils of Northumberland County (Hoffman and Acton 1974)]

2.1.4. Lake Ontario Water Level

The level of Lake Ontario varies throughout the year and from year-to-year. Extreme levels are expected to continue occurring in light of climate change, strong winds, and wave action (International Lake Ontario-St. Lawrence River Board 2018). Historic lake levels in nearby Cobourg, Ontario are shown in Figure 4, including the extreme high level that occurred in the spring of 2017. The historic lake levels also illustrate that the annual maximum water level is rising. Brighton developed a Flooding Response Policy outlined in Annex G of the Municipality's Emergency Response Plan based on lessons learned during the Spring of 2017 (Caddick, Rick 2018). The *Lake Ontario Shoreline Hazard Management Plan* is also being developed by Lower Trent Conservation in collaboration with other Conservation Authorities to assess and mitigate hazards along the lakeshore. In general, stormwater will back up the Municipality's stormwater management system in the southern portion of the study area when culverts, ditches, and storm sewers are submerged under extreme lake levels. The system will return to normal when lake levels recede, allowing the system to empty into the lake. The implications of extreme lake levels on stormwater infrastructure capacity was assessed in the study area as detailed in Appendix C.

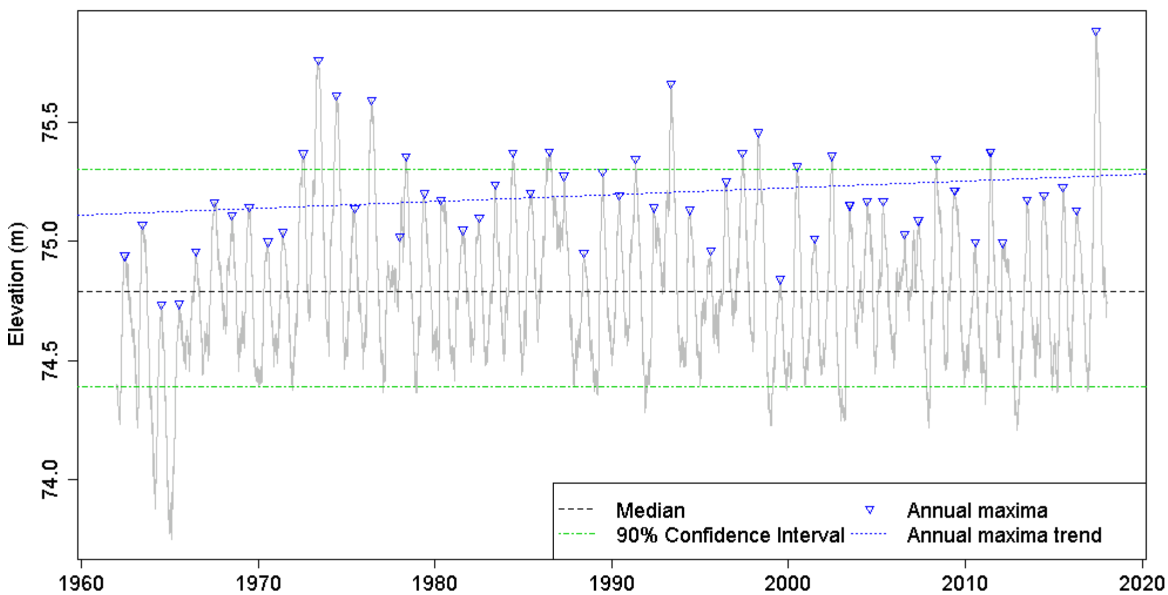


Figure 4. Historic Lake Levels at Cobourg, ON (1962-2017)

2.1.5. Groundwater

Background studies have indicated relatively high groundwater table at multiple locations around the study area, including low lands in the south and high lands in the north (Totten Sims Hubicki Associates 1991; Totten Sims Hubicki Associates 1993). There is insufficient breadth and detail in available geotechnical and hydrogeological information to estimate the seasonally high groundwater table across the study area and differentiate between interflow and the water table. Such determination is recommended on a site-by-site basis to inform the design of appropriate stormwater management practices implemented subsequent to this plan. Groundwater is relevant to stormwater management in multiple ways as summarized below for this study area:

- High groundwater levels in areas with flat topography makes it challenging to build deep stormwater facilities without intersecting the groundwater table which can increase the risk of groundwater contamination and decrease the efficiency of stormwater management facilities. This challenge can be addressed by using small and shallow stormwater facilities instead of central, deep facilities or lining facilities.
- Low permeability soils and shallow groundwater make it challenging to maintain the water balance of an area undergoing development. That is, maintaining how much rainfall previously percolated through the soils and replenished the aquifer where impervious surfaces are introduced that prevent infiltration. Water balance can also be maintained through stormwater landscaping and protecting native vegetation that will sustain some existing evapotranspiration. Another option is collecting and using stormwater for irrigation between rainfall events (referred to as "rainwater harvesting"). Lastly, better site design practices will also aid in maintaining water balance of development sites by reducing proposed impervious coverage and disconnecting impervious areas.
- Anecdotal evidence from property owners in the study area indicates that many houses have been built with basements at an elevation where the sump pump/foundation drainage systems are often active. Throughout the study area, foundation drainage systems outlet to either the surface (e.g. a rear yard swale) or directly to the municipal storm sewer per the current municipal design guidelines (Municipality of Brighton 2018). There is insufficient information to specify if foundation systems are draining the water table or interflow. Regardless, this configuration results in a constructed connection between subsurface and surface drainage and an added pressure on the existing municipal stormwater management system. Future developments can mitigate such issues by monitoring the groundwater table for multiple years and then designing the low floor elevations of the houses at least 0.5 m above the seasonally high groundwater table. Additional separation may be warranted in areas influenced by lake levels to provide a greater factor of safety. There are also approaches to improving structural lining and foundation drainage system design for such conditions, however outlining these other options are beyond the scope of this Plan.

2.1.6. Drinking Water

There are no municipal drinking water intake points or source water protection zones located within the study area (Trent Conservation Coalition 2018). Drinking water from sources outside of the study area are circulated throughout the study area via the municipal underground distribution pipe network.

2.2. Built and Social Environment

The social environment includes residential, business and community features in the Brighton Urban Area. As the built environment expands, there will be more demands on the stormwater management system. In addition, a functioning stormwater management system is required to support the growth of Brighton while protecting it from flood risk and nuisance drainage issues. Flooding generally occurs when the volume of stormwater cannot be contained or conveyed by the stormwater management system, in addition to flooding along shoreline areas when water levels area high.

Typical risks during flooding include impassable roads, delayed emergency response, utility damage, property damage, delayed re-occupancy, and injury or loss of life.

Essential community services within the study area include the fire station at Elizabeth Street and Oliphant Street as well as the Ontario Provincial Police Station on Dundas Street east of Terry Fox Drive. The entire Municipality is home to almost 11,000 residents, a quarter of which are over the age of 65 (Government of Canada 2012 Feb 8). Areas with elevated risk of flooding were identified using the storm sewer model and a depression analysis (Section 3.2). These exercises identified areas where the existing drainage system will not function under certain conditions (e.g. normal or high lake levels), as well as low-lying depressions without a sufficient outlet.

While this plan considers how lake levels affect the performance of the Municipality's stormwater management infrastructure, managing hazards along the lakeshore are beyond the scope of this plan. Lower Trent Conservation is currently developing the *Lake Ontario Shoreline Hazard Management Plan* in collaboration with other Conservation Authorities in order to assess and mitigate hazards along the lakeshore. Brighton's *Flooding Response Policy* is outlined in Annex G of the Municipality's *Emergency Response Plan* (Caddick, Rick 2018). Lower Trent Conservation manages other hazard lands such as floodplains along the creeks in the study area as well as areas with steep slopes.

2.2.1. Land Use

Development within the study area primarily consists of single family residential at low and medium densities, commercial, institutional, and industrial land uses, as shown in Figure 5. The study area also includes agricultural land uses such as pasture, apple orchards, and cropland that currently remain with the Brighton Urban Area boundary defined in the Official Plan. The land use designations used in this study are based on the Official Plan and were used in the hydrologic model developed as part of this study (See Appendix C).

Within the next decade, several areas are expected develop from natural or rural conditions into subdivisions, while other areas along Main Street in central Brighton are expected to be redeveloped into higher density land uses (Figure 6, Table 3). Other growth areas identified in Brighton's Official Plan are not expected to be developed within the next ten years, after which the Municipality should review and update the Stormwater Master Plan. The watershed boundaries are illustrated in Figure 7.

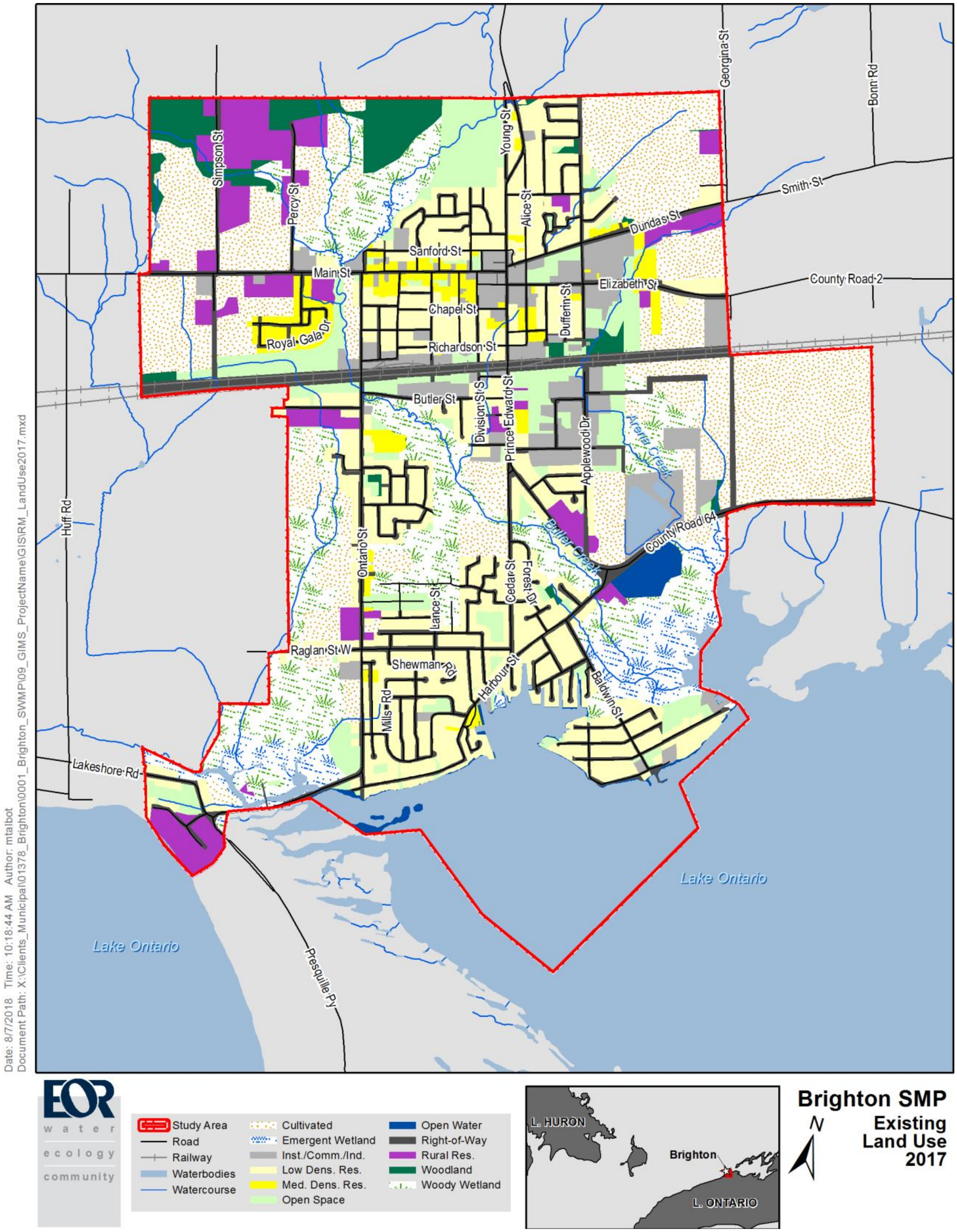


Figure 5. Existing Land Use

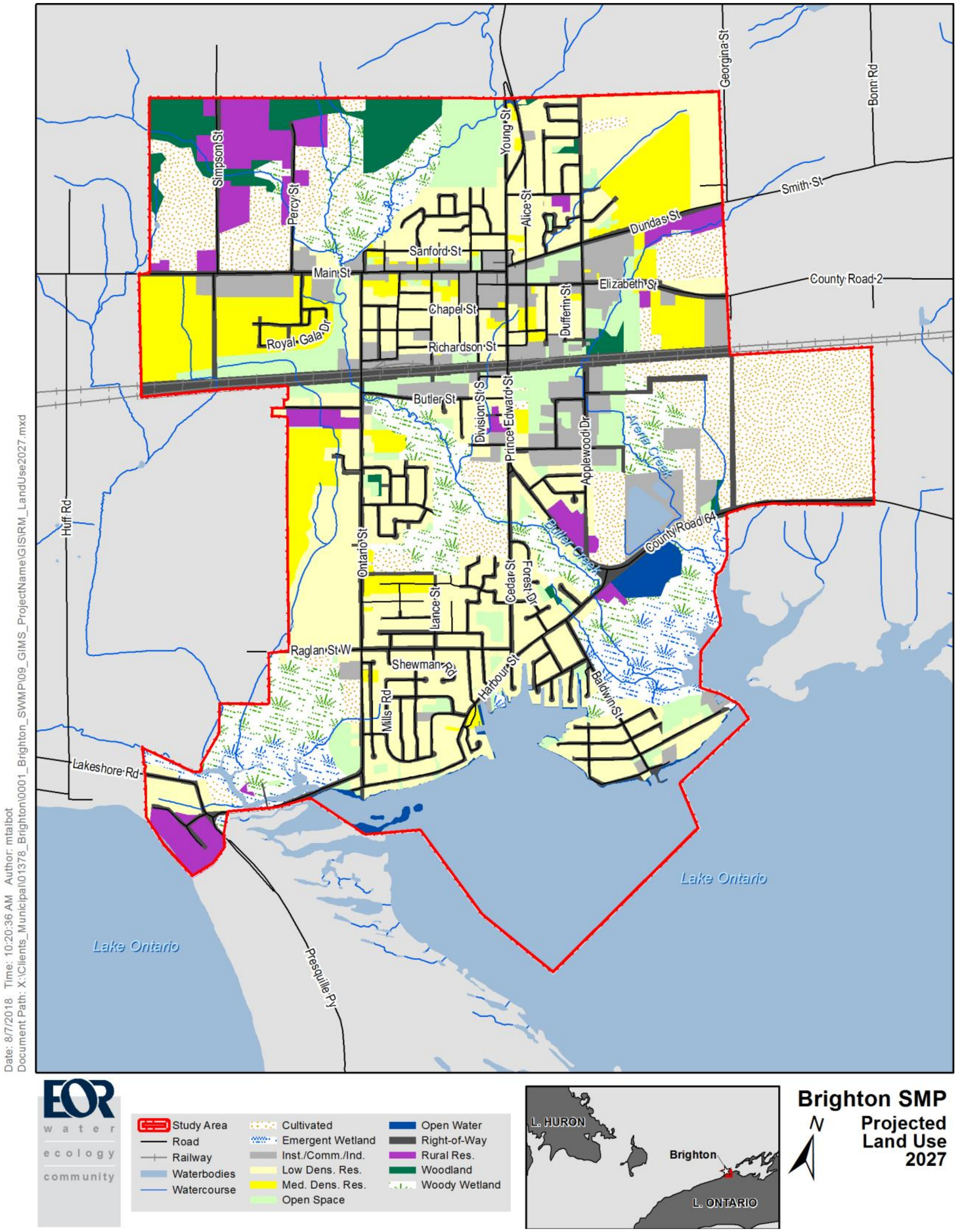


Figure 6. Future Land Use

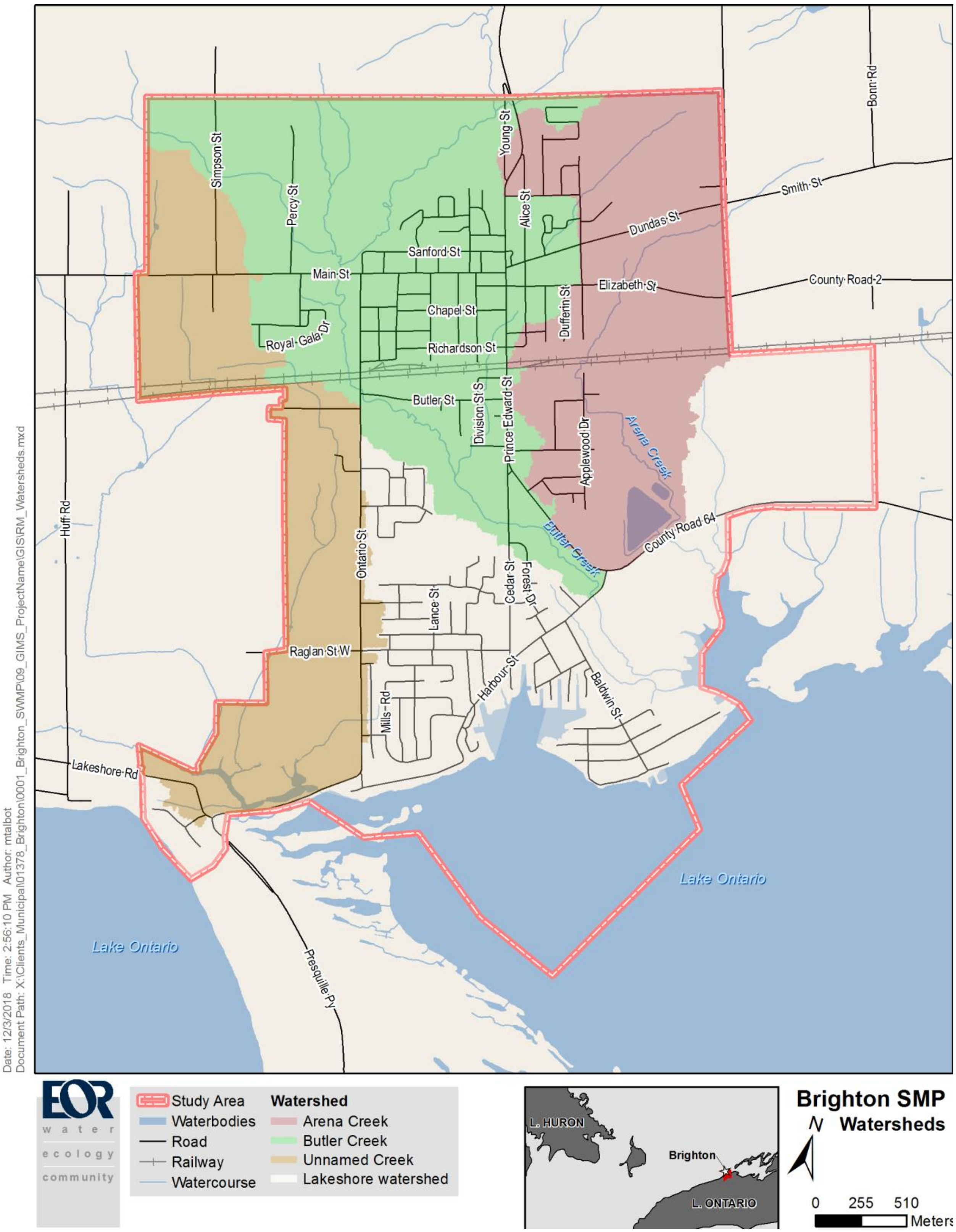


Figure 7. Watersheds

Table 3. Development in Study Area Watersheds

Watershed	Imperviousness*		Description of Future Development
	Existing	Future	
Butler Creek	4%	5%	• The medium density residential properties along Main Street between Ontario Street and Prince Edward Street are expected to be redeveloped into high density residential or commercial land uses. Runoff from this area drains directly to Butler Creek via three storm sewer networks.
Arena Creek	16%	23%	• The orchards north of Dundas Street between Pinnacle Street and Georgina Street will develop into single family residential land use, including the Tackaberry Ridge East Subdivision. Runoff from this area drains to Arena Creek via a constructed channel to a trunk storm sewer from Singleton Street to the railroad along Pinnacle Street. Stormwater management in this area was previously planned as part of the *Master Drainage Study for Northeast Brighton* (Totten Sims Hubicki Associates 1993) which allowed for a Normal Level of water quality treatment (70% TSS removal), however an Enhanced Level of treatment has since been required for facilities such as Tackaberry Ridge pond. • The farmland west of the No Frills on County Road 2/Elizabeth Street will develop into a mix of single family residential, commercial, and high density residential land uses. Runoff from this area drains to Arena Creek.
Unnamed West Tributaries	4%	8%	• The farmland located south of County Road 2, north of the railroad, east of Huff Road, and west of the western end of Royal Gala Drive will develop into single family residential land use, including the Applewood Meadows Subdivision. Runoff from this area drains directly into a tributary of the unnamed coldwater stream and unevaluated wetland complex at the southwest corner of the study area. • The woodlands, wetlands, and open space west of Ontario Street between Butler Street West and Raglan Street will develop into a single family residential subdivision. This area drains directly into a tributary of the unnamed coldwater stream and unevaluated wetland complex at the southwest corner of the study area.
Lakeshore	9%	10%	• The undeveloped land east of Ontario Street and north of Fox Den Drive will develop into single family residential land uses as part of the Hamilton Woods Subdivision. Runoff from this area currently drains into Harbour Point Pond and subsequently to Lake Ontario in Presqu'ile Bay. • The undeveloped land west of Lakeshore the intersection of Road and Presqu'ile Parkway will develop into Lakeside Landing, a single family residential subdivision. Runoff from this area drains directly into Lake Ontario.

*Imperviousness was estimated based on land uses (Figure 5 and Figure 6) and the typical imperviousness of each land use (Appendix C, Table 47).

2.2.2. Road and Trail Infrastructure

Public road and trail improvements are also expected within the next ten years that may increase impervious coverage and present opportunities for stormwater infrastructure improvements. The *Cycling Master Plan* (Northumberland County 2014) outlines the proposed upgrades and timing of cycling routes through the study area and will soon be updated to include new considerations from the County's *Transportation Master Plan* (WSP and MMM Group 2007). The Municipality has jurisdiction over all public roads in the study area except for County Road 64 from Elizabeth Street south to the Quinte West boundary. The Municipality manages a program of reconstructing and resurfacing roads as outlined in the *Roads Needs Study* (The Greer Galloway Group Inc. 2013) and replacing/rehabilitating infrastructure at the end of its expected lifespan based on the *Asset Management Plan* (Associated Engineering 2013). While many of the high priority recommendations have been implemented, the following road reconstruction projects remain and are expected to be implemented within the next ten years in the study area:

- County Road 64 (with underground infrastructure upgrades coordinated with Municipality)
- Sanford St (Platt St to Princess St)
- Platt St (Sanford St to Main St)
- Napier St (Monck St to Napolean St)
- Hope St (Singleton St to Lakeview Heights)

Separate from the Stormwater Master Plan, the Municipality will review the Road Needs Study and staff's knowledge to determine additional capital needs for road improvements in the next 10 years. Other roads with aging stormwater infrastructure include Cheer Drive, Kingsley Ave, North Drive, Chapel Street, and Grimes Street.

The Municipality currently uses road salt, not a sand-salt mix, to manage ice as part of winter maintenance operations.

2.2.3. Stormwater Management Infrastructure

This section introduces the current best practices for stormwater management in Ontario and inventories the infrastructure in the study area, which is mapped in Figure 17 (Appendix A).

Stormwater management involves controlling the quantity and quality of runoff resulting from rainfall and snowmelt. Both the quantity of runoff and the pollutants it carries dramatically increase as a result of urbanization if the appropriate stormwater management practices are not installed and maintained. A variety of problems can occur where there is insufficient stormwater management, including evident affects such as chronic flooding and erosion in addition to less obvious effects on water quality, stream stability, and the environment in general. Best practices in stormwater management are rapidly evolving in Ontario to mitigate these effects and to account for the additional pressures of continued growth and climate change. The Stormwater Master Plan includes recommendations for capital improvements (Section 5.2) and standards (Section 5.3) that are consistent with the province’s guidelines and policies, which are described as follows:

> “The environmental health of many watersheds continues to decline as urbanization increases. Conventional (pipe and pond) stormwater management practices that focus on controlling peak flow rate and removal of total suspended solids are not fully achieving the desired protection of the watershed ecosystem. This is due to increased volume of stormwater and resultant sustained flows from end-of-pipe stormwater management facilities and may be exacerbated by more intense storms resulting from climate change. Conventional management practices are not always effective at mitigating in-stream erosion or fully protecting water quality, fish and wildlife habitat, and other aquatic resources from stormwater runoff and contaminants that are not removed by settling… The ministry’s existing policies and guidance emphasize an approach to stormwater management that mimics a site's natural hydrology as the landscape is developed. The main tenet of this

> approach is to control precipitation as close as possible to where it falls by employing lot level and conveyance controls otherwise known as Low Impact Development (LID), often as part of a treatment train approach… Low Impact Development stormwater management is relevant to all forms of development, including new development, redevelopment, infill, and retrofit development… LID can be less costly than conventional stormwater management practices. A 2007 US EPA report summarizes 17 case studies of developments that include LID practices and concludes that applying LID techniques can reduce project costs and improve environmental performance (United States Environmental Protection Agency 2007)." (MOECC 2015)

Neighbourhoods established prior to the late 1990's in the study area were built without any stormwater management facilities and remain serviced by stormwater conveyance infrastructure, such as storm sewers, ditches, culverts, and overland flow pathways provided along roads. End-of-pipe facilities, such as wet ponds and oil-grit separators (OGSs) are now commonly used to control runoff from new developments. OGSs are structures installed underground that capture oil, floating debris, and sediment from urban runoff. Several other types of stormwater management facilities, such as a dry pond, constructed wetland, and subsurface storage, have also been constructed in the study area. Low Impact Development practices have not been constructed yet in Brighton.

Review of the current and historical inventories of the system demonstrates the shift in stormwater management practices used in Brighton, the rate at which the whole system is growing, and the age/condition of the system. The first comprehensive inventory of the storm sewer network conducted in 1979 identified 10 km of storm sewers with material conditions ranging from poor to good. The study found that 32% of the storm sewer system had deficient capacity and that an additional 11.5 km of storm sewer would be necessary to service future development (Totten Sims Hubicki Associates 1979). Since then, a partial inventory of the storm sewer network south of the railroad found 14 km of storm sewers, 30 manholes, and 299 inlets (GENIVAR 2009). Most recently, Brighton's *Asset Management Plan* identified 19 km of storm sewers, 100 manholes, and 87 catchbasins, which did not include all types of stormwater management infrastructure or capture the entire system. Almost half of the system was over 36 years old but was in very good condition overall (Associated Engineering 2013). The current inventory of stormwater management infrastructure presented in Table 4 was developed as part of this plan using available GIS data, previous studies, field investigations, and review of designs of street reconstruction and land development projects. Comparison of the historical and current inventories indicates that the municipal storm sewer system is currently growing at a rate of approximately 0.7 km and one pond per year. Expansion of the system is accelerating to accommodate growth of the community and new criteria for stormwater management, all of which results in additional infrastructure for the Municipality to maintain after assumption of ownership. The age of a piece of stormwater management infrastructure is a common indicator for its condition (e.g. poor or good) and is used to plan schedules of infrastructure upgrades or replacements in Asset Management Plans.

Table 4. Inventory of Municipal Stormwater Infrastructure

Type	Quantity	Purpose
Wet Ponds	6*	Slow down runoff and remove pollutants
Dry Ponds	1*	
Constructed Wetland	1	
Subsurface Infiltration/Storage	2	Maintain water balance, slow down runoff, and remove pollutants
Oil Grit Separators (Table 5)	6	Remove urban pollutants
Storm Sewer	36 km	Safely convey runoff away from roads and structures[2]
Manholes	243	
Inlets [1]	907	
Outfalls	37	
Culverts	5.8 km	
Ditches & Rear Yard Swales [3]	Unknown	
Roof Water Leader Connections	Unknown	
Foundation Drain Connections	Unknown	

[1] Includes catchbasins, double catchbasins, catchbasin manholes, and ditch inlets.

[2] The conveyance systems have been sized for minor and/or major events depending on their location.

[3] Includes constructed channel south and east of Tackaberry Ridge Pond.

*Tackaberry Ridge & Forest Hill (wet and dry) ponds have not yet been assumed by the Municipality.

Table 5. Inventory of Municipal Oil Grit Separators

ID #	Location	Manufacturer	Model	Size	Max Treatment Flow (L/s)
1	Singleton St & Thompson Cr	Imbrium	Stormceptor	STC 300	9
2	West of Rosslyn Dr	Imbrium	Stormceptor	STC 4000	50
3	North end of Forest Dr	Armtec	Downstream Defender	1800	227
4	West of Mill Pond Crt	Armtec	Downstream Defender	1800	227
5	Southeast of Dockside Ln	unknown	unknown	unknown	226
6	South of Edgewater Dr	unknown	unknown	unknown	226

Inspection of stormwater management infrastructure provides more specific information regarding the condition of infrastructure components based on observations of the material, capacity, invert, shape, scour, settlement, and erosion. The stormwater management ponds in the study area were inspected as part of this plan as detailed in Appendix B. In addition, the Municipality conducted CCTV inspections of several storm sewer segments in 2018, finding calcification requiring specific maintenance procedures and a rectangular concrete box with part of its bottom removed which requires ongoing monitoring. Most of the observations from the CCTV inspections identified common conditions found in systems in place for 10 to 15 years, such as the following:

- Cracked concrete, circumferential fracture at joint, and sewer broken at joint
- Displaced and open joints (small and large)
- Light encrustation
- Tap and fine roots in joint
- Sediment accumulation and debris blocking 5 to 60% of pipe diameter
- Deformed corrugated metal pipe from 5 to 35%

While this updated inventory has combined many sources of historical information into one database, several gaps remain regarding information about infrastructure in some areas (e.g. elevation of pipe, diameter of pipe) and certain types of infrastructure (e.g. culverts, roadside ditches, rear yard swales, drainage easements, linear trench drains, and connections to roof water leaders and foundation drains) which have not been comprehensively mapped. The Municipality's current standards specify that weeping tile foundation drains are to be connected to the storm sewer while roof water leaders shall not be connected, however a variety of foundation drainage outlet configurations to the surface have been used previously as well as direct connection of roof water leaders to the storm sewer system. Provincial guidance regarding foundation drainage includes the following:

> "In areas where the seasonally high water table is within 1 metre of the building foundation drains, sump pumps should not be utilized. This requirement is imposed to prevent excessive sump pump operation and to prevent a looped system whereby the sump pump discharges maintain the foundation drainage. Where the use of sump pumps is not feasible, a "third pipe" may be used to convey foundation drainage to the receiving water." (Ministry of the Environment 2003)

There is uncertainty regarding some of the historical information on stormwater management infrastructure in the study area due to factors such as use of local vertical datum and lack of as-built plans (i.e. infrastructure was built differently from the design). The gaps were addressed to the extent feasible within the scope of this plan using LiDAR, survey, CCTV inspection, and appropriate assumptions. Recommendations to address these gaps moving forward are outlined in Section 5, including better information management and survey of existing infrastructure targeted within the recommended implementation areas.

Portions of the study area draining to roadside ditch and culvert systems were not assessed and inventoried in detail as part of this study. Overall, general observations made during field work for this study, previous studies, and anecdotes from stakeholders indicate the following characterization of the roadside ditch drainage systems in the study area:

- This style of drainage system has been used in flat areas near the lake where storm sewers have been deemed infeasible due to slope or cover constraints.
- Numerous culverts have limited capacity due to sediment and debris accumulation.
- Property owners have installed private "culverts" to alleviate issues in the absence of a municipal storm sewer system, sometimes unsuccessfully.
- A combination of ditches, curb and gutter, and storm sewer have been used as some roads have been reconstructed. Although these reconstruction projects are intended to convert the typical cross section of the road from a rural cross section (i.e. roadside ditches) to an urban cross section (i.e. curb and gutter with storm sewer), the ditches have been left behind the curb line to capture lot drainage and direct to the storm sewer via ditch inlets.
- Backup of high lake levels into roadside ditches and culverts along the lakeshore was evident in the spring of 2017 and was managed to varying degree using sand bags to protect properties adjacent to the ditches.

There is no water quality monitoring data available for the study area's storm sewer system, however the findings of monitoring conducted in the receiving water bodies are summarized in Section 2.4.1. With only 17% of the urban area being treated by stormwater management facilities, it is expected that the pollutants commonly found in urban runoff are present in the Brighton Urban Area. Urban stormwater may contain elevated levels of suspended solids, nutrients, bacteria, heavy metals, oil and grease, pesticides, and sodium/chloride. Urban runoff can also alter temperature and dissolved oxygen. Pollutants are first introduced during construction by erosion and then, after an area is developed, the pollutants are washed off of impervious areas where they accumulate between rainfall events. Water quality in downstream resources is also degraded by altered flow regimes that is a combination of the rate, volume, and timing of flows into the watercourse/waterbody. As previously discussed, existing stormwater management facilities in the study area were designed to variable criteria, including enhanced level protection and peak flow matching. The sensitive aquatic habitats in the coldwater streams and in Presqu'ile Bay Marsh should be protected from stormwater impacts by requiring at least the Enhanced Protection as specified in the *Stormwater Management Planning & Design Manual* (Ministry of the Environment 2003) in addition to other criteria for temperature and wetland inundation mitigation.

Previous development in the lakeshore watershed has not controlled the rate of discharge to pre-development levels based on the justification that Lake Ontario is a free outfall. The high lake levels in the spring of 2017 and the trends in historic water level data (Figure 4) strongly indicate that more extreme lake levels are expected in the future. This will introduce a constraint to the system which will limit or prevent discharge via outlets to the lake. Managing the volume of rainfall and resulting runoff in the Lakeshore Watershed under high lake level conditions will be required to protect properties and roadways during these extreme conditions. The capacity of the stormwater management system to control water quality and quantity is assessed in Section 3.

2.3. Cultural Environment

Properties in the study area in Brighton's Municipal Register Index or designated under the Ontario Heritage Act are mapped in Figure 8. No National Historic Sites are located in the study area. The Ministry of Tourism, Culture and Sport checklist for EAs was used to screen for built heritage, cultural heritage landscapes and archaeological potential at the known potential project locations where ponds have insufficient water quality or quantity control capacity. The Illustrated Historical Atlas of the Counties of Northumberland and Durham, Ontario (H. Belden & Co. 1878) does not indicate that there were historic early Euro-Canadian settlements or transportation routes at the these pond locations. The screening checklist is used to determine if a Heritage Impact Assessment or Stage 1 Archaeological Assessment will be required in the future to inform the design of Schedule C projects implemented subsequent to this plan. All of the locations have recently been disturbed during construction of the ponds in the past 15 years. Several of the ponds are located adjacent to undisturbed woodlots and are within 300 metres of watercourses and waterbodies. The checklists indicate that archaeological assessment is not required for pond expansion unless projects extend into adjacent, undisturbed woodlots. All of the pond locations reviewed have low potential for built heritage or cultural heritage landscape and so Heritage Impact Assessments are not required. The completed checklists are included in Appendix E.

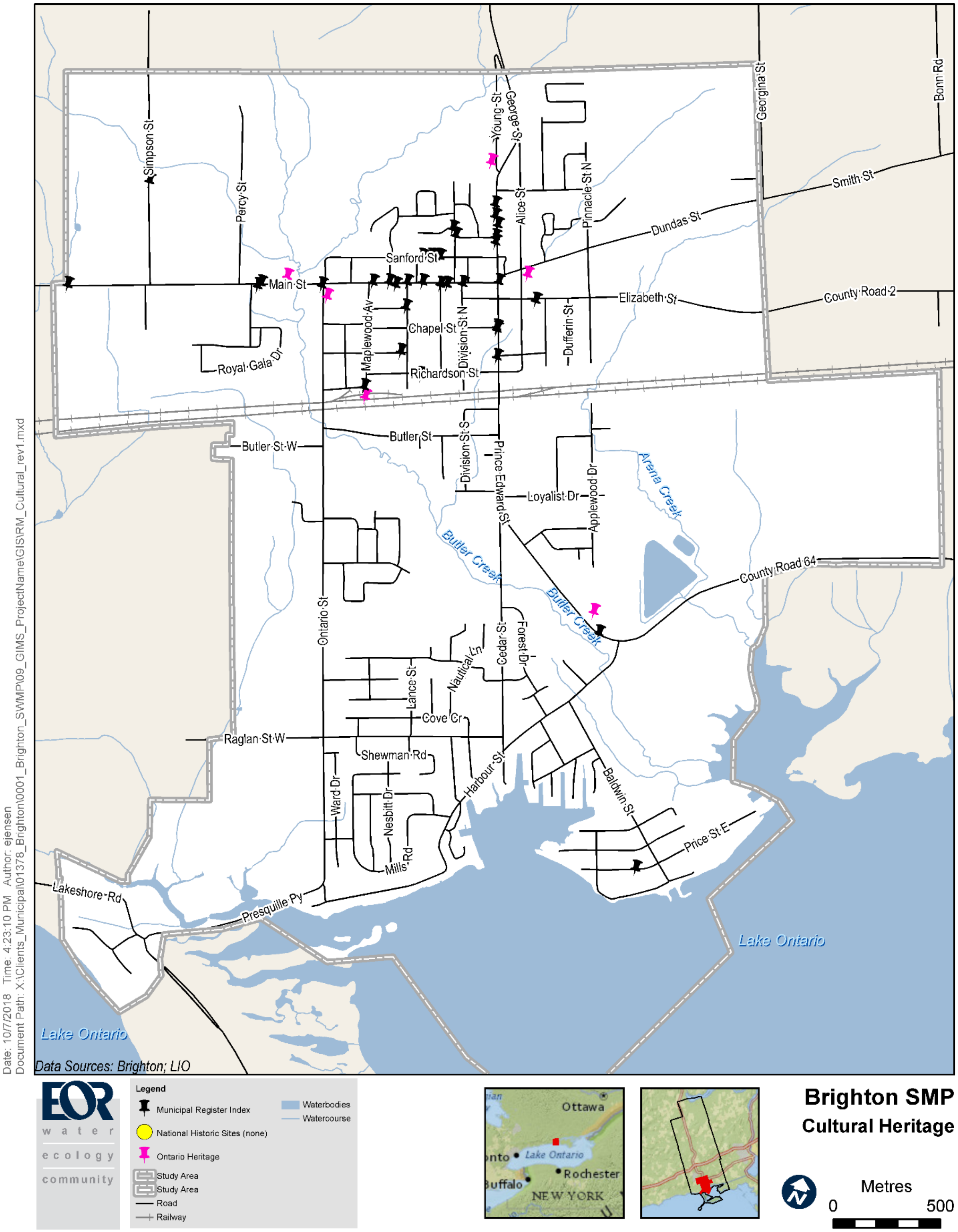


Figure 8. Cultural Heritage

2.4. Natural Environment

The study area includes multiple important natural heritage features shown in Figure 9, such as coldwater streams and wetlands, in addition to being close to many others around Presqu'ile Bay, such as Presqu'ile Provincial Park and connections to the Bay of Quinte via the Murray Canal. This section describes the natural heritage features within the study area.

2.4.1. Creeks & Watersheds

The three watercourses flowing through the study area are Butler Creek (also referred to as Proctor Creek), Arena Creek, and the unnamed tributaries on the west side of the study area. All three have coldwater thermal regimes (Prell 2018) that feed into the Provincially Significant Presqu'ile Bay Marsh. The watershed boundaries within the study area are delineated in Figure 17 (Appendix A).

There are no active long term monitoring stations for stream flow or water quality within the study area to assess the current condition of the thermal regime in the three creeks; however, the available background information is summarized below.

Butler Creek

The watershed of Butler Creek extends far north of the study area and encompasses much of the area within the Municipal boundary of Brighton. The total watershed area is approximately 26 km^2, most of which is rural, and the main channel of Butler Creek is over 8 km in length. The headwaters of the creek are located approximately 1 km north of Highway 401 and then the creek generally drains southwards towards the study area. The creek enters the study area at the center of the northern study area boundary at the County Road 30/George Street crossing. The creek continues to the southwest, where its floodplain and valley define the northern extent of development in the Brighton Urban Area. A tributary draining approximately 400 ha, including Cankerville Swamp, enters the northwest corner of the study area and joins Butler Creek at the Main Street crossing. Up to this point, the slope of the creek typically ranges from 1 to 1.5% and then shifts to a relatively mild and consistent slope of 0.8% downstream of Main Street (Totten Sims Hubicki Associates 1988). The creek continues south and then southeast through the residential, commercial and industrial developments in the center of the study area. A short tributary that begins at Oliphant Street south of Elizabeth Street joins the creek south of the west end of Grimes Street. A resident has reported recent erosion of the bank along this tributary at Grimes Street. The creek discharges into Presqu'ile Bay Marsh east of Mill Pond Court. Previous watershed management efforts along Butler Creek have focused on mitigating riverine flood risk that included the diversion of one of the tributaries into Arena Creek via a storm sewer on Pinnacle Street, which is discussed further below.

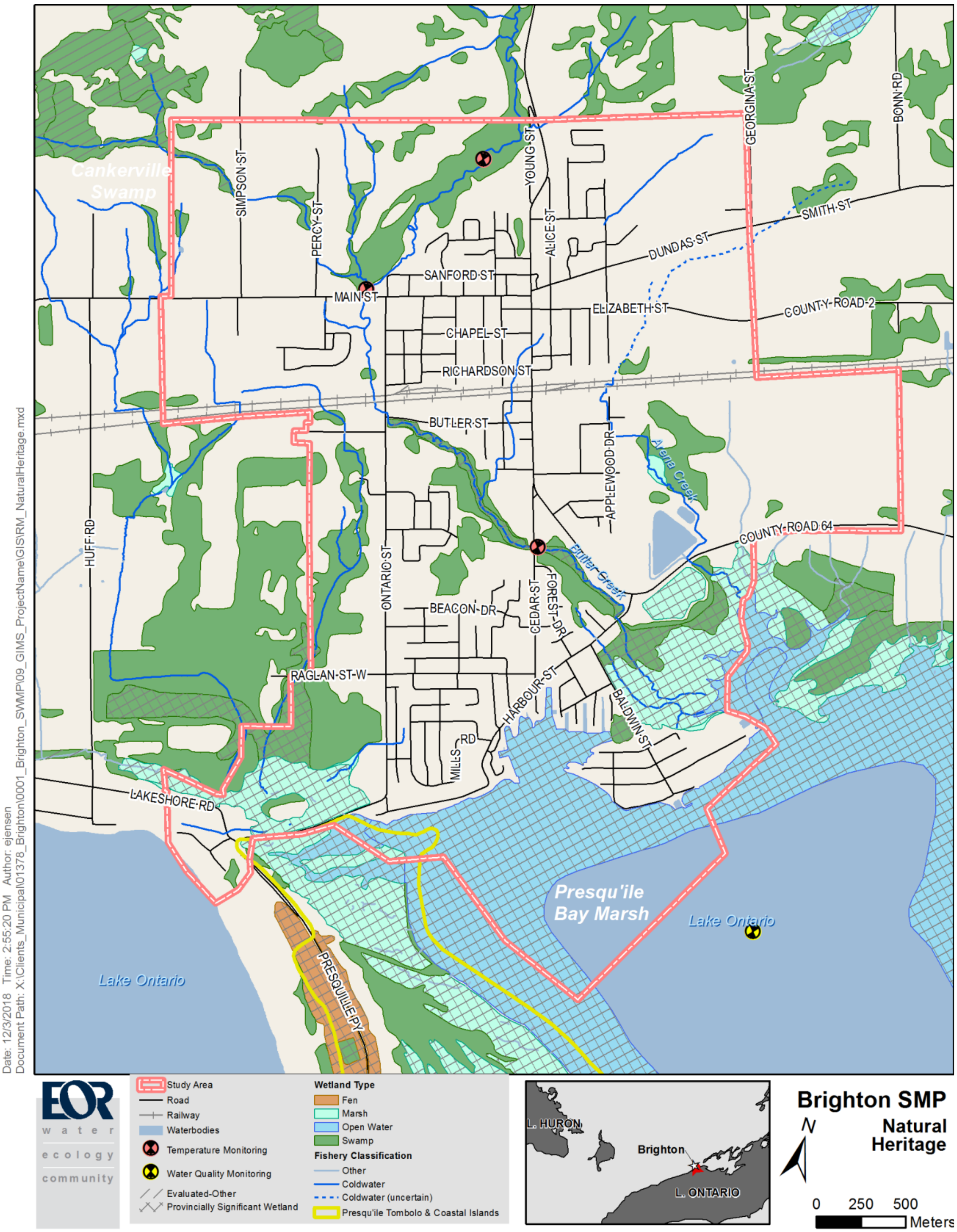


Figure 9. Natural Heritage

The Ministry of Natural Resources and Forestry (MNRF) has identified the following fish species present in Butler Creeks (Prell 2018), although detailed fish and macroinvertebrate survey records are not available:

- Brook trout
- Common shiner
- Creek chub
- Eastern blacknose dace
- Longnose dace
- Mottled sculpin Northern redbelly dace
- Rainbow trout
- White sucker

Lower Trent Conservation has monitored benthic macroinvertebrates (i.e. the bugs that live in the stream) in Butler Creek at Station BC02 near Cedar Street annually since 2014 using the Ontario Benthos Biomonitoring Network methodology (Jones and Craig 2004). Some benthic macroinvertebrates can tolerate high pollutant levels while others cannot. The number and diversity of macroinvertebrates found in the surveys each year is used an indicator of water quality and habitat impairment. The results of Lower Trent Conservation's benthic monitoring are summarized in Table 6 using the Hilsenhoff Biotic Index. The results of the 2018 surveys are not yet available. The benthic monitoring results indicate that water quality and habitat in Butler Creek has become substantially impaired in recent years.

Table 6. Benthic Macroinvertebrate Hilsenhoff Biotic Index of Butler Creek at Cedar Street (Station BC02)

Year	Score	Grade
2014	**5.14**	**C** *(Fairly substantial pollution likely)*
2015	**4.93**	**B** *(Some organic pollution probable)*
2016	**6.64**	**F** *(Very substantial pollution likely)*
2017	**6.77**	**F** *(Very substantial pollution likely)*

Source: (Comeau 2018)

Lower Trent Conservation has also operated three temperature monitoring stations along Butler Creek since 2012 at Cedar Street, Main Street, and Proctor Park as shown in Figure 9. The results of the annual thermal regime analysis performed using a simple method (Chu et al. 2009) are summarized in Table 7. The changes in thermal regimes each year generally indicates that the creek is warming as it flows through the Brighton Urban Area. Several years are missing data at each station due to loss of loggers.

Table 7. Thermal Regime Analysis of Butler Creek

Year	Station		
	BC01 at Proctor Park	**BC03** at Main Street	**BC02** at Cedar Street
2012	**Cool**	**Cool**	**Cool**
2013	**Cold-Cool**	**Cool-warm**	**Cool-warm**
2014	**n/a**	**Cool-warm**	**Cool**
2015	**Cool**	**n/a**	**Cool-warm**
2016	**Cool**	**n/a**	**Cool-warm**
2017	**Lost**	**n/a**	**Cool**
2018	**Cold-Cool**	**n/a**	**Lost**

Source: (Noyes 2018)

Other water quality and flow in Butler Creek has been inconsistently monitored within the study area. As such, there is inadequate data and analysis of water quality parameters in Butler Creek to identify all stressors (i.e. causes) of degradation indicated by the biotic index results, however thermal regime change may be one contributing factor. The Provincial Water Quality Monitoring Network historically included Station 06015100102 where Harbour Street crosses Butler Creek from 1964 to 1998. Stream flow in Butler Creek has also been monitored upstream of the study area since 2002 as part of the Water Survey Canada network (Station 02HD018). This historical data could provide a useful benchmark of flow and water quality in the creek relative to downstream conditions once several years of data is collected from the Lower Trent Conservation gauge recently installed at Harbour Street. The *Butler Creek Flood Reduction Study* noted that the uniform profile of Butler Creek indicated that the streambed was likely in an equilibrium state with minimal sedimentation and scouring (Totten Sims Hubicki Associates 1988).

Water quality in Butler Creek at Harbour Street (i.e. near its mouth to Presqu'ile Bay) was monitored three times in 2013 as part of the *Presqu'ile Bay Water Quality Study*, including parameters such as suspended solids and phosphorus. The average phosphorus level slightly exceeded the Provincial Water Quality Objective due to elevated concentration in the sample collected in May 2013 although the concentration was within standard range of 25 to 75 µg/L for oligo-mesotrophic streams (Dodds et al. 1998) like Butler Creek. Lower phosphorus levels were observed in the samples collected in August and September. A high concentration of suspended solids was observed in the May sample (46 mg/L) while concentrations lowered to 4.9 and 0.7 mg/L in August and September (Benoit 2016).

Water quality in Butler Creek was assessed as part of the MECP's investigation of the former Cooey Metal Products Limited property. Sampling locations included the main stem of Butler Creek at Harbour Street, northwest of Cedar Street and upstream of the confluence with the tributary from Grimes Street. The tributary was sampled at Grimes Street, near William Street, Division Street (north of Butler Street), and at Richardson Street. Overall, the monitoring findings indicates that major impacts to aquatic biota and benthic organisms are not expected in Butler Creek due to the Cooey Metals site. Normal phosphorus levels were observed at in the creek and soil samples indicate that legacy phosphorus is not an issue in the Butler Creek watershed. The report reviews other pollutant findings such as metals, PAHs, and PHCs from previous spills in Brighton and identifies that subsequent studies after three to five years should assess sediment and water quality conditions in the creek in addition to migration of the plume containing elevated levels of VOCs, PAHs, and metals (Clerk, Saloni 2014).

Arena Creek

Arena Creek originates from springs in the orchards and rural land northeast of the study area. The main stem of the creek enters the study area at its eastern boundary, south of Dundas Street, and then travels west and then southwest across Elizabeth Street and through King Edward Park. The northern tributary of Arena Creek located north of Dundas Street historically was a tributary to Butler Creek but was diverted via a storm sewer on Pinnacle Street from Singleton Street to the south end of the Pinnacle Street between 1979 and 1993. The diversion was recommended as part of the *Storm Drainage Study* to alleviate flooding issues farther downstream in the tributary between Oliphant Street and Grimes Street, as well as drainage issues in the residential area along Dundas

Street (Totten Sims Hubicki Associates 1979). Correspondence regarding the *Northeast Master Drainage Study* indicates that Lower Trent Conservation was not aware of the diversion (Totten Sims Hubicki Associates 1993) and the study noted that the impacts of increased runoff volume to the creek was not assessed (Totten Sims Hubicki Associates 1979). The diversion storm sewer continues to discharge to the main stem of Arena Creek south of Pinnacle Street and King Edward Park. Arena Creek then crosses the railroad and flows into Brighton's industrial park, passing the wastewater treatment plant lagoon before discharging into Presqu'ile Bay Marsh.

The Ministry of Natural Resources and Forestry (MNRF) has identified the following fish species present in Arena Creek (Prell 2018):

- Banded killfish
- Blackchin shiner
- Brook Stickleback
- Creek chub
- Fathead minnow
- Northern redbelly dace
- White sucker
- Yellow perch

Stream surveys conducted in the early 1990's as part of the *Northeast Master Drainage Study* included substrate mapping, water quality analysis, invertebrate sampling, and fish sampling from the mouth of Arena Creek up to the railroad crossing (hereafter referred to as the lower reach). The analysis found that dissolved oxygen was lowest downstream of the sewage lagoon and highest at the Pinnacle Street outfall. Overall, the macroinvertebrate survey indicated that all of the monitored stations had good stream habitat conditions except for the station below the sewage lagoon where nutrient rich water supported an excessive population of Cladocera. The study noted that the spring-fed headwaters (i.e. the main stem upstream of King Edward Park and the north tributary) could support coldwater biota that is consistent with the MNRF coldwater regime designation. However, the survey of the lower reach identified multiple conditions inconsistent with a coldwater regime, such as silt-covered streambed, low water levels, barriers to migration (e.g. culverts), and elevated water temperatures (e.g. 21°C at the railway and 23°C at the mouth) (Totten Sims Hubicki Associates 1993). While these findings illustrate that fish habitat in the lower reach was degraded, the survey extents did not assess conditions of the main stem of Arena Creek within or upstream of King Edward Park (i.e. the background levels or historical conditions in the less-developed upper reaches of the watershed were not assessed). The degradation observed in the lower reach of Arena Creek in the early 1990's was likely in part due to the swapped urban drainage area from Butler Creek into the Arena Creek watershed described at the beginning of this section. Lagoon effluent was diverted into the wetlands constructed on the southeast side of County Road 64 starting in 1997/1998. The constructed wetlands discharge directly into Presqu'ile Bay Marsh. A culvert blow-out northwest of the Applewood Drive and Sharp Road intersection in the industrial area (lower reach) occurred in 2017, which indicates altered flow regime.

Water quality in Arena Creek was assessed at King Edward Park, the industrial park, and northeast of the sewage lagoon as part of the MECP's investigation of the former Cooey Metal Products Limited property. Overall, the monitoring findings indicates that major impacts to aquatic biota and benthic organisms are not expected in Arena Creek due to the Cooey Metals site. Phosphorus levels in the creek at King Edward Park slightly exceeded the Provincial Water Quality Objective, however normal levels were observed at other locations in the creek and soil samples indicate that legacy phosphorus is not an issue in the Arena Creek watershed. The report reviews other pollutant findings such as metals, PAHs, and PHCs from previous spills in Brighton and identifies that subsequent studies after three to five years should assess sediment and water quality conditions in the creek in addition to migration of the plume containing elevated levels of VOCs, PAHs, and metals (Clerk, Saloni 2014).

West Tributaries

The unnamed watercourses on the west side of the study area are intermittent, spring-fed streams with a history of being channelized to improve drainage for agricultural use of the adjacent lands (Totten Sims Hubicki Associates 1991). The system is composed of four branches: the east branch that is located west of Ontario Street, the west branch that is located east of Huff Road, the southeast branch from Ontario Street (south of Raglan Street), and the southwest branch that extends west of the study area along the north side of Lakeshore Road. The southwest branch and its contributing area are located outside of the study area and are not described further in this plan. Both the east and west branches drain south through wooded and shrubby swamp into Presqu'ile Bay Marsh on the north side of Lakeshore Road and Presqu'ile Parkway. The creek drains around the south side of a former landfill shown by the open water channel through the marsh and then east to cross Presqu'ile Parkway and into the bay. The system was last assessed as part of the *Master Drainage Study of Southwest Brighton* which found no signs of erosion along the east tributary (Totten Sims Hubicki Associates 1991). There is no information on fish, macroinvertebrates, water quality, or flow regime in the west tributaries other than the MNRF coldwater thermal regime classification.

Presqu'ile Bay Marsh is a Provincially Significant Wetland (PSW) as discussed in detail later in this section. Swamp areas extend north beyond the PSW boundary and along the branches. The entire swamp has not been evaluated but the description of the swamp provided in the *Master Drainage Study of Southwest Brighton* indicates that the area may at least be locally significant. The study characterizes the west creek (both east and west tributaries) as being insignificant because of their intermittent flow regime. The significance of the unevaluated swamp and the role that the west tributaries play in sustaining the functions of both the swamp and Presqu'ile Bay Marsh were not assessed in the previous study (Totten Sims Hubicki Associates 1991). Perennial headwater streams are typically an important input to downstream water resources, be it wetlands, lakes, or larger creeks/rivers, due to their interaction with clean and cool groundwater. Although they may offer only intermittent aquatic habitat to fisheries, they often support unique communities of macroinvertebrates.

Lakeshore Watershed

The remaining land within the study area drains directly to Presqu'ile Bay and the western end of the study area drains directly to the lake (not the bay). Several short stream segments drain parts of this watershed, including one segment south of Mill Pond Court and others east of the Arena Creek watershed. An unevaluated swamp is located between the Roos and Harbour Point developments. There is no information available regarding these stream segments or the wetland. There have been no master drainage studies conducted for Lakeshore Watershed.

The Lakeshore Watershed discharges into Presqu'ile Bay. The MNRF provided information about the nearshore fish community in Presqu'ile Bay based on sampling in the summer of 2008 and 2015 following the nearshore community index netting program (NSCIN). The sampled habitat was characterized as shallow (2 to 2.5 m deep), soft bottomed (silt-sand), and highly vegetated (approximately 86% of the sampled areas had more than 25% vegetated cover). The fish community was found to be in good health with a catch dominated by sunfish species and largemouth bass in addition to brown bullhead (catfish). Other important species include walleye, northern pike, and yellow perch. The bay ranks relatively high when comparing important sport fish to other embayments along Lake Ontario. Presqu'ile Bay has a locally important recreational fishery year-round and receives some tournament angling pressure during events held in the Bay of Quinte via the connection along the Murray Canal. Due to the canal, Presqu'ile Bay may serve as an important stopover and rearing habitat for walleye in the Bay of Quinte. Recent tagging data indicates the canal is a migratory corridor potentially elevating Presqu'ile Bay from locally to regionally significant. There is also an active commercial fishery in Presqu'ile Bay with five licenses, two of which are active, for use of live capture gear (hoop nets) to primarily harvest sunfish species, rock bass, yellow perch, and northern pike. There is a small allowance for walleye harvest. American eel capture was recently permitted as part of a program to transport mature eels around the hydroelectric dams in the St. Lawrence River to mitigate turbine passage mortality issues through a partnership between MNRF, Ontario Power Generation, and local commercial fisheries. Overall, the commercial harvest from the Presqu'ile area is approximately 2% of the total commercial harvest for Lake Ontario.

In 2012, the Municipality of Brighton requested that the MECP implement a long-term water quality study of Presqu'ile Bay and subsequently develop a remedial action plan. The MECP addressed this request by monitoring water quality at twelve locations in the bay and contributing tributaries in 2013. The sampling plan was developed to identify potential factors contributing to perceived degraded water quality in the bay. Overall, the results indicate that conditions in Presqu'ile Bay were within the mesotrophic range, which means that the lake has an intermediate level of productivity, is often clear, and has medium levels of nutrients. Phosphorus levels generally fell below the interim PWQO guideline of 20 μg/L for avoiding nuisance algae, except for elevated levels at the WWTP constructed wetland outfall to Presqu'ile Bay Marsh, which were quickly dissipated through Presqu'ile Bay Marsh. The report details other water quality results regarding nitrate, chlorophyll, conductivity, temperature, and *E. coli* as well as assessment of phytoplankton, invasive species and retention time. Overall, the findings suggest that Presqu'ile Bay was not at risk of algal blooms likely due to frequent movement of water through the bay and mixing with the Murray Canal and Lake Ontario waters. Ongoing monitoring of the index station (Great Lakes Nearshore Water Quality Station 600012974 shown in Figure 9) was anticipated by the study to provide updates to this water quality assessment (Benoit 2016).

2.4.2. Wetlands

Wetlands occur between upland and aquatic environments where the water table is at or near the surface of the land or where the land is covered by up to 2 m of standing water. The single feature that most wetlands share is soil or substrate material that is periodically saturated or covered by water. This saturation creates physiological conditions requiring special adaptations by plants and animals for life in an oxygen-deprived (anaerobic) environment. As such, water saturation is the primary driver for the unique plant and animal life in wetlands.

Wetlands provide numerous benefits depending on the season and wetland type, including the following:

- **Floodwater storage and retention:**
  Snowmelt or stormwater is temporarily stored in wetlands and is slowly released over a longer period of time than the water entering the wetland.
- **Nutrient assimilation:**
  Wetland plants absorb nutrients during their growth and development, resulting in cleaner water leaving the wetland than came into it.
- **Sediment entrapment:**
  Sediments have time to settle out when the flow of water is slowed down, as previously described.
- **Groundwater recharge:**
  Some wetlands collect and retain surface water in ground water recharge areas.
- **Low flow augmentation:**
  A benefit of slowly releasing water from wetlands is that the steadier outflow can reduce the impacts of short-term droughts on downstream rivers and streams.
- **Shoreland anchoring and erosion control:**
  Wetland vegetation can reduce shoreline and bank erosion by anchoring the soil from the forces of wave action.
- **Fish and wildlife habitat:**
  Many species of fish and wildlife spend part or all of their life cycle in wetland habitats used for breeding, feeding, cover protection, or brood rearing.
- **Medicine chest:**
  The wealth of unique plant species found in wetlands supplies the “medicine chest” of Indigenous communities.
- **Aesthetics and recreation:**
  This includes scenic value in urban and suburban environments. Wetlands also provide a place for people to observe nature. Hunters, birders, and anglers are frequent users of wetlands.
- **Education:**
  Wetlands provide outdoor classrooms for learning.

Wetlands currently cover 316 ha (24%) of the study area as shown in Figure 9. Wetlands across Ontario are first mapped using remote-sensing data by the Ministry of Natural Resources and Forestry (MNRF). Two wetlands in the study area were evaluated through the Ontario Wetland Evaluation System (OWES): Presqu'ile Bay Marsh (a Provincially Significant Wetland described in Section 2.4.4) and Cankerville Swamp. The remaining wetlands in the study area have not been evaluated. The MNRF recommends that unevaluated wetlands be treated as Provincially Significant Wetland or should be evaluated by an OWES certified evaluator (Prell 2018). Municipalities can also protect wetlands based on their local significance.

Presqu'ile Bay Marsh is a Provincially Significant Wetland that extends across the entire shoreline of Presqu'ile Bay in the study area (Snider 2006). As more than two-thirds of coastal wetlands along the Great Lakes have been lost, the 970 ha Presqu'ile Bay Marsh PSW has great environmental value and presents an important opportunity for conservation initiatives. The Nature Conservancy of Canada and Ducks Unlimited Canada recently acquired land on the eastern side of the study area along the lakeshore to establish a protected refuge that encompasses part of Presqu'ile Bay Marsh.

The wetlands in the Brighton Urban Area include swamps, marshes, and open water marshes. The main differentiator between these wetland types in relation to stormwater management objectives is that swamps are wooded wetlands with mature trees or thickets (i.e. shrubs) (Ontario Ministry of Natural Resources 2014a). Swamps have a varying degree of sensitivity to stormwater impacts depending on the species of woody vegetation. The boundary of Presqu'ile Bay Marsh extends into the swamps along the unnamed creek tributaries on the west side of the study area and along Butler Creek. Some of these wooded swamps have representative tree species that are susceptible to water level fluctuations and extended periods of inundation during the growing season. Of the tree species noted in the wetland inventory (Snider 2006; Peterborough District Ministry of Natural Resources and Forestry 2018), white birch and white cedar are the most sensitive and were identified as dominant components of several plant communities in the wetland. Changes in water levels could cause dieback of these sensitive species providing conditions suitable for more tolerant species. Previous assessment of the unevaluated swamp west of Ontario Street and north of Presqu'ile Bay Marsh identified other species that are very susceptible to inundation, such as balsam fir and white pine (Totten Sims Hubicki Associates 1991). The marshes and wetlands with wild rice represented in the species assemblage (Snider 2006; Peterborough District Ministry of Natural Resources and Forestry 2018) may also be susceptible to water level fluctuations during the growing season. Wild rice may not perish from periodic inundation periods however it may not produce a rice crop during years of untimely or extended periods of flooding. Water levels in the marsh and open marsh areas are expected to largely be defined by the lake level, not stormwater runoff from the Brighton Urban Area. Several indicator species for susceptibility of marshes and swamps to stormwater impacts are outlined in Table 8. Previous drainage studies in the Brighton Urban Area have not considered the impacts of stormwater on downstream wetlands in terms of changes to inundation depth and duration.

Table 8. Species Indicating Susceptibility of Swamp and Marsh to Stormwater Impacts

Stormwater Susceptibility	Map Codes	Key Species	Notes
Annual	M1, W5	Wild Rice	Wild rice is annually susceptible to water level fluctuations meaning the plant may not perish but annual rice crops could be negatively affected if untimely water level fluctuations occur.
Marginal	S1, S2, S3, S5, S8, S9, S14, S20	White Birch	White birch is a component in many wetland vegetation communities. The birch are susceptible to die back if flooded but the overall community is not at high risk.
High	S12, S13	White Cedar	White Cedar are highly sensitive to frequent and extended inundation during the growing season.

Evaluation of the wetland west of Ontario Street is needed to confirm susceptibility to stormwater impacts and the local and regional value of the wetland in terms of hydrology, social value, and Indigenous values/cultural heritage following the procedures of the Ontario Wetland Evaluation System Southern Manual (Ontario Ministry of Natural Resources 2014a). The evaluator should assess for both Provincial and Local Significance to inform land use management decisions in accordance with Brighton's Official Plan which states, "The Municipality shall ensure [wetlands which have not been identified as Provincially Significant] are protected for the long term by maintaining, improving, or where possible, restoring these wetlands and their ecological and hydrological functions." The wetland evaluation should be circulated to the MNRF to check the potential for complexing with Presqu'ile Bay Marsh.

The wetlands in the study area are providing substantial runoff reduction and storage functions that are protecting existing and future land owners from flooding. Using the total footprint of wetlands within the study area (316 ha) and estimating the average active storage depth in the wetlands to be 300 mm, the wetlands provide approximately 948,000 m^3 of storage for stormwater and backwater from high lake levels. This estimated active storage depth does not include analysis of topography, soils, or vegetative cover and does not account for interception and sublimation which would reduce how much precipitation reaches the ground. Loss of these wetlands would result in loss of this function unless otherwise replaced by constructing stormwater management facilities with equivalent storage, while other values of the wetlands would be lost. Recent study of wetlands in Ontario have found that maintaining wetlands in their natural state can substantially reduce flood damage costs to buildings in rural and urban areas (Moudrak et al. 2017).

Wetland protection policies are also the jurisdiction of Lower Trent Conservation through the PPS and Ontario Regulation 163/06. For example, impacts of stormwater on wetlands can be mitigated by protecting buffer zones around the wetlands. Currently, such setbacks are defined and regulated by Lower Trent Conservation however additional setbacks could be defined and enforced by the Municipality through an amendment to the Official Plan and Zoning By-Law.

2.4.3. Terrestrial

Woodlands are located throughout the undeveloped portions of the study area and within areas identified as wetlands.

2.4.4. Designated Areas

Presqu'ile Bay Marsh is a Provincially Significant Wetland that extends across the entire shoreline of Presqu'ile Bay in the study area (Snider 2006). As more than two-thirds of coastal wetlands along the Great Lakes have been lost, the 970 ha Presqu'ile Bay Marsh PSW has great environmental value and presents an important opportunity for conservation initiatives. The Nature Conservancy of Canada and Ducks Unlimited Canada recently acquired land on the eastern side of the study area along the lakeshore to establish a protected refuge that encompasses part of Presqu'ile Bay Marsh.

The Presqu'ile Tombolo and Coastal Islands is a Candidate Life Science Provincial Area of Natural and Scientific Interest (ANSI) (Ontario Ministry of Natural Resources 2009) that intersects the southwest corner of the study area as shown in Figure 9. The Candidate ANSI extends to the southeast and includes the panne, backdunes, marsh (including the Fingers), Owen Point, and Gull and High Bluff islands (Usher 2000). Adjacent to the study area is Presqu'ile Provincial Park, which is situated along the tombolo, classified as a Natural Environment Park, and designated as an Important Bird Area (Ontario Ministry of Natural Resources 2009). The tombolo defines the western and southwestern shores of Presqu'ile Bay.

Other areas for environmental protection are specified in Brighton's Official Plan with other considerations such as flood line and shoreline hazards managed by Lower Trent Conservation.

2.4.5. Designated Species

The MNRF and Department of Fisheries and Oceans (DFO) have identified the following Species at Risk within 1 km of Study Area that are endangered (E), special concern (SC) or threatened (T):

Federal:

- Eastern Pondmussel (E)
- Bridle Shiner (SC)
- Grass Pickerel (SC)

Provincial:

- Gypsy Cuckoo Bumble Bee (E)
- King Rail (E)
- Piping Plover (E)
- Butternut (E)
- Canada Warbler (SC)
- Eastern Wood-pewee (SC)
- Grass Pickerel (SC)
- Northern Map Turtle (SC)
- Peregrine Falcon (SC)
- Snapping Turtle (SC)
- Yellow Rail (SC)
- Bank Swallow (T)
- Barn Swallow (T)
- Blanding's Turtle (T)
- Bobolink (T)
- Eastern Meadowlark (T)
- Least Bittern (T)

Habitat for the Eastern Pondmussel, Bridle Shiner, and Grass Pickerel has been identified along the lakeshore within the study area. Improving the quality of urban stormwater runoff will aid in addressing the threats to these three species (Boucher et al. 2011; Beauchamp et al. 2012; Fisheries and Oceans Canada 2018a).

3. IDENTIFICATION AND DESCRIPTION OF THE PROBLEM

Performance of the existing stormwater management system's quality and quantity controls, and the resulting implications for natural heritage features, are evaluated and discussed in this section. The system assessment is used to identify and prioritize specific deficiencies in the system such that strategic improvements may be implemented to increase the capacity and resiliency of the system to extreme weather events and high lake levels conditions. Current and future trends are discussed in relation to protecting downstream watercourses and waterbodies from stormwater impacts as the community continues to grow. The issues in the study area are summarized at the end of this section in a problem statement, which leads into the four objectives of the Stormwater Master Plan, and alternatives for addressing these objectives are evaluated.

3.1. Water Quality

Runoff from 83% of the developed portion of the study area currently discharges to the creeks, wetlands, and Presqu'ile Bay in the study area without water quality controls. The remainder of the study area has been developed with end-of-pipe facilities (e.g. ponds and oil-grit separators) to provide Enhanced Level protection as defined in the *Stormwater Management Planning & Design Manual* (Ministry of the Environment 2003). Stormwater management strategies in Brighton have not been designed to mitigate the temperature impacts of urban runoff. Instead, the primary focus in Brighton has been controlling sediment. Managing excess sediment in a stormwater management system is important because it will mitigate potential impacts to downstream natural heritage features and operational issues within the system. For example, sediment accumulation in pipes, ditches, and ponds can limit and eventually block drainage, resulting in increased flood risk. The effectiveness of sediment control on construction sites is reviewed in this section in addition to the treatment efficiency and maintenance needs in the existing stormwater management ponds.

3.1.1. Construction Activity and Erosion Control

Deficient erosion and sediment control practices were observed in 2018 and previously in 2008 as part of the *Investigation and Assessment of Stormwater Systems and Facilities* (GENIVAR, 2009). Deficiencies included inadequate placement of perimeter controls (e.g. silt fence) around areas of ground disturbance, improper inlet controls to prevent sediment from entering the storm sewer system, inadequate cleanout of catch basins, and inadequate street sweeping. Deposition of sediment was also found in culverts, catch basins, manholes, storm sewers, and ponds, decreasing the treatment efficiency of the system required to protect downstream natural areas from degradation. The negative impacts of excess sediment on fish and other aquatic biota include impaired respiratory functions, lower tolerance to disease, increased physiological stress, decreased reproductive success, and reduced vision (Newcombe and MacDonald 1991; Waters 1995). Inadequate erosion control measures on construction sites can result in increased maintenance cost of municipal infrastructure, increased risk of flooding due to limited capacity remaining in the system, and modified stability/instability of watercourses and channels.

The best practices in managing sediment focus first on preventing erosion and second on capturing sediment. Control measures are always most cost effective when sediment is captured close to the source, rather than allowing it to be transported to a central location in the system. The longer the transport length, the higher the chances for additional erosion and for the central location pond to become overwhelmed with sediments, as it has occurred in some instances in Brighton (See Section 3.1.2). The most cost effective way to capture sediments that escape local erosion control measures during construction is to use temporary sedimentation ponds for each phase of construction. These temporary ponds can be cleaned up at the end of the construction phase and transformed into permanent facilities, or eliminated altogether and use a downstream regional pond instead once construction is finished and soils are completely stabilized.

Erosion control is also required by the Ministry of Environment, Conservation and Parks through Environmental Compliance Approvals for stormwater management facilities. Water quality standards relating to the discharge of sediment-laden stormwater to water bodies are summarized in Table 9. As illustrated in Figure 10, significant changes in turbidity are apparent from visual inspection whereas minor changes such as those defined to protect aquatic life may require analysis of turbidity or the concentration of Total Suspended Solids (TSS).

Table 9. Turbidity and Sediment Standards

Source	Standard
Provincial Water Quality Objectives	Should not change the natural Secchi disc reading by more than 10%
Canada Water Quality Guidelines for Protection of Aquatic Life	Clear-flow (i) Short-term exposure: Max. increase of 8 NTUs from background levels (ii) Longer-term exposure: Max. increase of 2 NTUs from background levels High-Flow (i) Max. increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs (ii) Should not increase more than 10% of background levels when background is > 80 NTUs
Canada Water Quality Guidelines for Protection of Recreation	Turbidity ≤ 50 NTU
Minnesota Pollution Control Agency Standard for Coldwater Streams	TSS Concentration ≤ 15 mg/L (April to September)

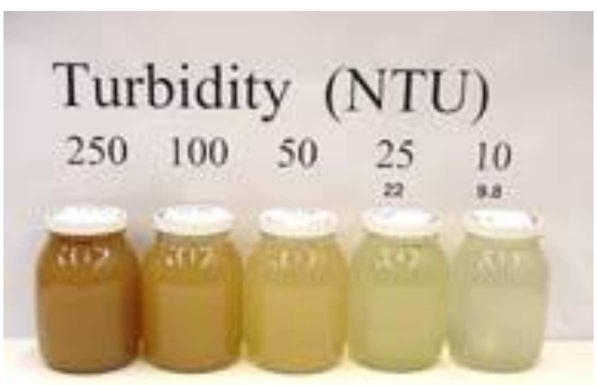


Figure 10. Appearance of High to Low Turbidity (SCCF RECON)

3.1.2. Stormwater Management Ponds

The stormwater management ponds were inspected to assess how well they are capturing sediment, determine if sediment cleanout is necessary, and to identify other maintenance needs, such as vegetation removal. This section summarizes the findings of the field inspections and sediment accumulation assessment detailed in Appendix B. Monitoring the flow and water quality treatment in the ponds was beyond the scope of this exercise. In addition, consistency with applicable design standards was not reviewed in detail. Other stormwater management facilities in Brighton, such as oil-grit separators and infiltration facilities were not inspected as part of this study.

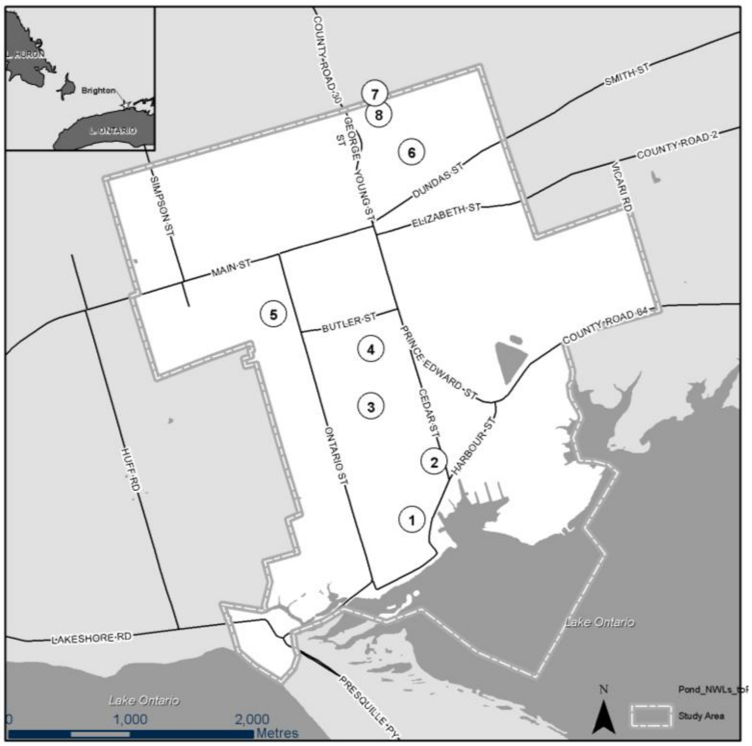


Figure 11. Pond Location Map

Sediment Accumulation Assessment

Bathymetric (i.e. under water) and topographic (i.e. land) surveys were conducted at each wet pond to estimate the volume of sediment accumulation and remaining capacity of the pond to capture sediment. The approach, analysis, and results of this sediment accumulation assessment of each pond are detailed in Appendix B and are summarized in Table 10. Overall, five of the seven wet ponds need to be cleaned out to comply with provincial standards and Environmental Compliance Approvals. Rapid sediment accumulation in some ponds may be partly attributed to the lack of erosion control on ongoing upstream land development projects. Drainage studies and stormwater management plans for previous developments have recommended use of the ponds as temporary sedimentation basins. Land development is ongoing in the contributing drainage areas of Ponds 1, 2, 5, 6, and 7. Accelerated sediment accumulation in Ponds 1, 3, and 4 may also be due to elevated water levels, lack of shoreline vegetation and the resulting shoreline erosion depositing sediment into the ponds.

Additional treatment capacity is necessary in or upstream of Ponds 2, 3, and 4 to achieve the required level of treatment considering all undeveloped and developed areas draining to those ponds. The Municipality has not yet assumed ownership of Ponds 6 and 7. Sediment accumulation in the eighth pond in the study area (a dry pond in the Forest Hill development) was identified only in the outlet structure and not in the main pond area and so sediment accumulation analysis was not necessary in the dry pond.

Table 10. Summary of Sediment Accumulation Assessment of Ponds

Pond Name and ID #	Type of Facility	Sediment Accumulation Rate (m^3/year)		Remaining Permanent Pool Storage (%)	Current Treatment Efficiency	Required Treatment Efficiency**
		Estimated*	Observed			
1 Brighton By the Bay	Wetland	11	38	12%	46%	70%
2 Harbour Point	Wet Pond	13	11	88%	69%	80%
3 Roos	Wet Pond	5.6	29	55%	66%	80%
4 Lucas	Wet Pond	5.1	11	64%	64%	80%
5 Orchard Gate	Wet Pond	9.3	52	78%	77%	80%
6 Tackaberry Ridge***	Wet Pond	4.1	213	14%	67%	80%
7 Forest Hill (Wet)***	Wet Pond	3.1	27	82%	84%	80%

* per MOECC SWMPD Manual at As-Built Efficiency

** ponds should be cleaned out once efficiency is reduced by 5% per MOECC SWMPD

*** pond has not been assumed by Municipality

Cleanout required

Field Inspections

All eight ponds were inspected in May of 2018 to identify routine and immediate repair needs. The detailed inspection reports on each pond are provided in Appendix B. Overall, the continued need for routine repairs has resulted in multiple other immediate repair needs. For example, debris accumulation on/in the pond outlets is common and typically requires annual or more frequent maintenance. However, debris left on pond outlet structures limits how quickly the pond's water level can return to its normal level after a rainfall event. Sustained abnormally high levels can result in die-off of shoreline vegetation that cannot survive under water and subsequent erosion of the shoreline once it is no longer stabilized by shoreline vegetation. Other issues were identified that should be monitored in future inspections, but do not currently require maintenance. The number of issues identified at each pond are summarized in Table 11 and the types of issues are summarized in Table 12.

Table 11. Number of Maintenance Issues Identified by Inspections of SWM Ponds

Pond Name and ID #	Type of Facility	Needs Monitoring	Routine Repair	Immediate Repair
1 Brighton By the Bay	Wetland	2	5	6
2 Harbour Point	Wet Pond	7	13	5
3 Roos	Wet Pond	4	11	8
4 Lucas	Wet Pond	9	13	2
5 Orchard Gate	Wet Pond	14	7	9
6 Tackaberry Ridge	Wet Pond	9	6	12
7 Forest Hill (Wet)	Wet Pond	11	12	3
8 Forest Hill (Dry)	Dry Pond	8	8	3

Table 12. Types of Maintenance Issues in Ponds

Pond Name and ID #	Type of Facility	Inlet / Outlet (s)				Shoreline / Side Slope					Water			Area Surrounding Pond					Complaints from Residents
		Sediment/ Debris Accumulation	Vegetation Growth	Bare Soil	Condition of Structures	Erosion	Soggy	Inadequate Vegetation	Woody Vegetation	Invasive Plants	Abnormally High Water Levels	Turbidity	Sediment Accumulation	Trash /Yard Waste	Encroachment in Pond Area	Excessive Mosquitos	Fence Repair	Construction Pollution Prevention	
1 Brighton By the Bay	Wetland	✓	✓		×	✓		✓			✓			✓	✓				
2 Harbour Point	Wet Pond	✓	✓	✓	×		×	✓		✓	✓		×	✓	✓				✓
3 Roos	Wet Pond	✓	✓	✓		✓	✓	✓	✓	×	✓		×		✓				✓
4 Lucas	Wet Pond	✓	✓		×	✓		✓	×	×	✓		×	✓		✓			✓
5 Orchard Gate	Wet Pond	✓	✓	✓	✓	×				✓	×	×	×	✓	×			✓	×
6 Tackaberry Ridge	Wet Pond	✓	×	✓	×	✓		✓	×	✓	✓		×	✓	×		✓	✓	×
7 Forest Hill (Wet)	Wet Pond	✓	×		✓	×	×	✓	×	✓			×	✓					
8 Forest Hill (Dry)	Dry Pond	✓	✓		✓			×	×		✓		✓	✓	✓				

✓ Repair needed
× Monitoring needed

Recommended Maintenance Actions

The issues identified in the sediment accumulation assessments, field inspections, and review of background information were compiled into Table 13, which provides a summary of the recommended maintenance actions for each pond. In some cases, multiple issues can be addressed by a single action (e.g. remove trash that was identified at multiple locations). There are also instances where issues needing immediate repair, such as elevated permanent pool levels, will be addressed by routine repair, such as removing debris from the outlet structure. Feasibility studies listed in the table should be included in subwatershed implementation projects conducted subsequent to this Stormwater Master Plan (See Section 3.3) while all other actions are recommended for implementation as part of the Municipality's maintenance program.

Table 13. Summary of Maintenance Actions Needed in Ponds

Pond Name and ID #	Type of Facility	Routine Repair Actions	Immediate Repair Actions, including Sediment Cleanout
1 Brighton By the Bay	Wetland	1. Remove woody vegetation, debris and sediment that is within and near the outlet riser. 2. Remove debris, sediment, and vegetation from the pond inlet. 3. Remove trash that is in and around the wetland. 4. Do not mow vegetation within 10 feet of the wetland's high water level shorter than 8 inches.	1. Clean out wetland and restore outlet capacity. 2. Restore grade, stabilize, and establish aquatic vegetation (not turf grass) on wetland shoreline (See Appendix I). Prevent future shoreline erosion through other routine maintenance, including improved mowing practices and outlet structure maintenance to prevent clogging / maintain outlet capacity. 3. Mitigate elevated permanent pool elevation through routine maintenance of sediment and debris at outlet. 4. Raise the upstream diversion weir per the Amended ECA and confirm other modifications have been implemented. 5. Implement monitoring, maintenance, and erosion control requirements of Amended ECA. 6. As part of the Subwatershed Implementation project for this area, conduct feasibility study to assess and address the effect of high lake levels on the wetland, the upstream drainage system, and uncontrolled systems draining to the same outfall location (i.e. near Marina Street and Harbour Street). The study should also assess the effectiveness of the wetland in capturing sediment, sediment accumulation in the marina, and solutions that could improve treatment efficiency while also addressing minor and major system conveyance deficiencies under normal and high lake level conditions. The study should consider modified grading of the pond to increase storage capacity and permanent pool depth.

Pond Name and ID #	Type of Facility	Routine Repair Actions	Immediate Repair Actions, including Sediment Cleanout
2 Harbour Point *	Wet Pond	1. Remove woody vegetation and debris that is on or near the pond outlet structure and the orifice into outlet structure that are limiting discharge from the pond and possibly causing elevated permanent pool levels. 2. Remove sediment accumulation within ditch inlet structure upstream of the pond as well as debris on and around the grate. 3. Remove trash that is in and around the pond. 4. Stabilize and establish vegetation on areas with bare soil marked on inspection report map in accordance with the landscape guidelines in Appendix I. 5. Do not mow vegetation within 10 feet of the pond's high water level shorter than 8 inches. 6. Monitor and manage common reed (See Appendix H).	1. Clean out pond and restore inlet and outlet capacity. 2. Remove yard waste, soil, and rock waste deposited around the pond. 3. Stabilize and establish aquatic vegetation (not turf grass) on the pond shoreline (See Appendix I). Prevent future shoreline erosion through other routine maintenance, including improved mowing practices and outlet structure maintenance to prevent clogging / maintain outlet capacity. Consider installing a skimmer structure around outlet orifice to collect debris while maintaining full flow capacity of the orifice. 4. Manage common reed at southwest corner of pond (See Appendix H). 5. Install signage around pond buffer to mitigate encroachment (see Appendix I). 6. As part of the Subwatershed Implementation project for this area, retrofit the pond or implement upstream stormwater controls to provide required permanent pool volume for water quality treatment at a minimum for the current conditions (i.e. the partially developed 57 ha with at least 80 m^3/ha of extended detention to account for upstream Roos Pond). 7. Future development will need to include retrofitting additional capacity into the pond or providing upstream controls.
3 Roos *	Wet Pond	1. Remove debris from outfall channel. 2. Remove woody vegetation, debris and sediment that is within and near the outlet riser. 3. Remove sediment accumulation at inlet outfall. 4. Remove yard waste from pond perimeter. 5. Stabilize and establish vegetation on eroded area next to pond inlet (See Appendix I). 6. Mow vegetation within 10 feet of the pond's high water level to prevent the establishment of woody vegetation, but do not mow shorter than 8 inches. 7. Remove woody growth from spillway.	1. Clean out pond. 2. Restore outlet capacity via the outlet pipe that is currently submerged/buried and in the downstream drainage ditch (i.e. outfall channel). 3. Restore grade, stabilize, and establish aquatic vegetation (See Appendix I) on pond's shoreline, banks, and spillway where erosion has occurred. Prevent future shoreline and bank erosion through other routine maintenance, including improved mowing practices and outlet structure maintenance to prevent clogging / maintain outlet capacity. 4. Install signage around pond buffer to mitigate encroachment (see Appendix I). 5. As part of the Subwatershed Implementation project for this area, retrofit the pond or implement upstream stormwater controls to treat the full contributing drainage area. Expanding the pond would require property acquisition south of the pond. Also conduct a feasibility study to assess if a retrofit is required to restore capacity of outlet pipe in the long term.
4 Lucas *	Wet Pond	1. Remove debris from the outfall channel. 2. Remove debris and sediment that is within, on and near outlet riser. 3. Remove sediment that has accumulated in the pond inlet pipes. 4. Remove sediment from the upstream end of the inlet pipe that conveys drainage from the rear yard swale. 5. Remove sediment from the Butler Street storm sewer that discharges to the rear yard swale north of the pond. 6. Remove trash that is in and around the pond. 7. Restore grade, stabilize, and establish aquatic vegetation on pond shoreline (See Appendix I). This will encourage a plant-dominated state that will assist with mosquito management. 8. Install bird and bat houses near the pond to encourage predation of mosquitoes. 9. Do not mow vegetation shorter than 8 inches within 10 feet of the pond's high water level.	1. Clean out pond, making sure to provide storage capacity in the permanent pool at least 1 m deep per the original design. 2. Restore outlet capacity to return permanent pool to normal lower levels. 3. Prevent future shoreline erosion through other routine maintenance, including improved mowing practices and outlet structure maintenance to prevent clogging / maintain outlet capacity. 4. As part of the Subwatershed Implementation project for this area, retrofit the pond or implement upstream stormwater controls to treat the full contributing drainage area and meet quantity control requirements. The Municipality owns the property east of pond which presents an opportunity for expansion, however the existing woodlands on the property would need to be assessed to identify and mitigate environmental and cultural heritage impacts.
5 Orchard Gate	Wet Pond	1. Remove silt fence materials and dead sod on west bank of Pond A. 2. Remove woody vegetation growth at outlet pipe headwalls. 3. Stabilize bare soil/eroding areas around the pond (See Appendix I). 4. Remove and monitor/manage common reed around shoreline (See Appendix H). 5. Do not mow vegetation shorter than 8 inches within 10 feet of the pond's high water level. 6. Remove trash that is in and around the pond.	1. Remove woody debris from the outfall channel between the pond and Butler Creek. 2. Restore spillway elevation (measured at the top of rip rap) and width to be consistent with the approved design. 3. Repair joint material of outlet pipe at upstream headwall and spalling. 4. Remove sediment accumulation from inlet pipe outfalls to Ponds A and B. 5. Repair joint material of the pipe between Ponds A and B at upstream and downstream ends. 6. Remedy insufficient erosion controls in contributing drainage area through stabilization and temporary vegetation cover on areas with open soils, perimeter controls around bare soils, inlet controls (silt fence material is unacceptable), street sweeping, and stable construction entrances 7. Future development will need to include retrofitting additional capacity into the pond or providing upstream controls.
6 Tackaberry Ridge	Wet Pond	1. Remove trash and debris from low flow outlet structure and in other areas around the pond. This should assist with restoring normal permanent pool levels that were elevated due to the partially blocked outlet. 2. Extend rip rap at south end of the forebay berm up the side slope of the pond. 3. Remove and monitor/manage common reed on eastern edge of the pond (See Appendix H).	1. Clean out pond and restore outlet capacity. 2. Install and maintain proper erosion prevention and sediment control measures in the area under construction that is impacting the pond and the stream channel, including stabilization and temporary vegetation cover on areas with open soils, perimeter controls around bare soils, inlet controls (silt fence material is unacceptable), street sweeping, and stable construction entrances. Practices should be replaced prior to failure, such as straw bales overtopping with sediment. 3. Stabilize open soil areas around the pond, such as along the edge of rip rap at south inlet and around the low flow outlet. 4. Repair joint material around the 300 mm diameter pipe at DICB8. 5. Close the fence at the south inlet and remove fence installation material.

Pond Name and ID #	Type of Facility	Routine Repair Actions	Immediate Repair Actions, including Sediment Cleanout
7 Forest Hill (Wet)	Wet Pond	1. Remove woody vegetation and debris from outfall channel, emergency spillway, ditch inlet at the northwest corner of the pond, and the pond inlet headwall. 2. Remove trash from the pond near the inlet. 3. Remove and monitor/manage common reed on western shoreline (See Appendix H). 4. Establish vegetation at the southwest corner of the pond at the top of the pond berm. 5. Stabilize the eroding pathway from Castle Ridge to the pond and remove rip rap from blocking CB inlet on pathway. 6. Remove silt fence west of pond after construction is finished.	1. Restore connection between the existing drainage swale west of the pond with the downstream channel towards Butler Creek which has been partially blocked by the placement of rip rap at the pond outlet outfall. 2. Repair joint material at pond inlet outfall headwall. 3. Remove sediment accumulation from pond inlet.
8 Forest Hill (Dry)	Dry Pond	1. Remove woody vegetation growth from the spillway, which is also near the outlet structure. 2. Remove debris and sediment from within and around the pond outlet structure. This should restore discharge capacity and prevent standing water in the pond. 3. Remove trash and yard waste around the pond. 4. Do not mow vegetation shorter than 8 inches within 10 feet of the pond's high water level. 5. Install signage (see Appendix I).	1. Repair displaced rip rap along the outfall channel using appropriately sized rip rap (i.e. larger than the rip rap that has been displaced). 2. Remove sediment that has accumulated in inlet pipe outfall and forebay area.

* Pond is currently undersized relative to contributing drainage area

"Cleanout" is defined as the removal of sediment and debris from the facility, inlet, outlet, and upstream drainage system to restore the original intended capacity of the facility. Cleanout must be accompanied by stabilization of the shoreline/banks with proper erosion control measures and plantings per the Landscaping Guidelines (Appendix I) to prevent bank erosion and to establish buffer vegetation.

See Appendix B for detailed notes and sketches of inspection findings and recommendations

Prioritization of cleanouts is recommended based on the risk matrix detailed in Table 11 and shown in Figure 12. The risk matrix considers both the relative size of the ponds (i.e. consequence of failure) and the extent to which the ponds fail to meet the required water quality treatment efficiency. The ponds are ranked based on a combined score of the two multiplied by each other. It is noted that Orchard Gate is also expected to become non-compliant by 2023 and so will be included in the implementation plan as the 6th priority cleanout within the 10-year implementation time frame of this plan. Routine maintenance of all ponds is recommended for implementation immediately by Municipal staff to reduce the risk of exacerbating existing issues in the ponds (e.g. blocked outlets elevating the normal water level). Other maintenance should be coordinated with cleanout priorities for cost efficiency and to reduce site disturbance.

Table 14. Comparative Risk of Sediment Accumulation in Ponds Needing Cleanout as of 2018

Pond Name	Constructed Permanent Pool Storage Volume (m^3)	Consequence of Failure Score	Current Treatment Efficiency	Required Treatment Efficiency	Extent of Failure Score	Combined Score	Priority Ranking
Brighton By the Bay	507	0.28	46%	70%	24%	0.07	3
Harbour Point	1841	1.00	69%	80%	11%	0.11	2
Roos	684	0.37	66%	80%	14%	0.05	4
Lucas	383	0.21	64%	80%	16%	0.03	5
Tackaberry Ridge	1740	0.95	67%	80%	13%	0.12	1

Note: Prioritization of other ponds cleanouts will be evaluated in the future as part of the Municipality's maintenance program.

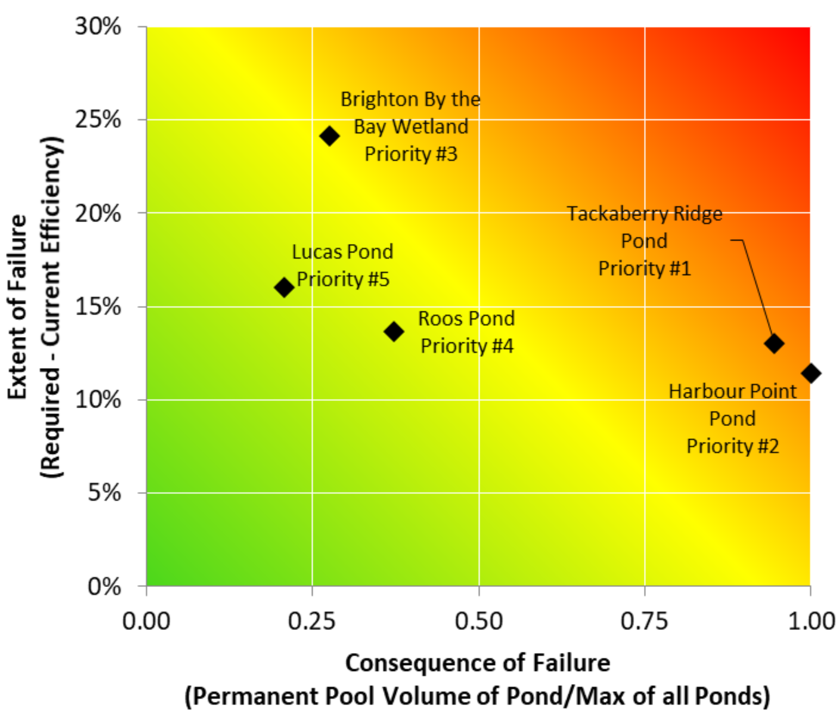


Figure 12. Risk Profile of Sediment Accumulation in Ponds (2018)

The cost of cleaning out each pond in Table 15 was estimated using an average cost of $168 per cubic meter of accumulated sediment. This average cost is from previous cleanout projects that included mobilization, storm sewer cleanout, and rehabilitation of outlet structures (Toronto and Region Conservation Authority and CH2M Canada 2016), converted to 2018 dollars assuming 3% inflation. The cost estimates do not include retrofit in or upstream of Harbour Point Pond, Roos Pond, or Lucas Pond to provide the additional treatment capacity necessary to achieve the required level of treatment considering all undeveloped and developed areas draining to those ponds. Municipal staff confirmed that sampling of Harbour Point Pond sediments in 2018 found pollutant concentrations within the allowable limits for beneficial reuse of the sediments on-site. These costs assume that similar pollutant levels will be found during sediment sampling in other ponds and so off-site disposal is not included. It is recommended that the Municipality require cleanouts prior to assumption of these ponds, where possible and otherwise fund the maintenance using the securities held for other ponds, consistent with the Municipality's Engineering Design Guidelines that specify the following:

> "The guarantee period for a stormwater management facility will be extended until 90% buildout of the development has been achieved and the facility has been cleaned out. In the case of a central facility with stormwater contributions from more than one development and the developments are building out at different rates, the Municipality of Brighton may elect to reserve the proportional cost to clean out the facility from the securities of the first Developer(s) and hold the funds to coordinate a final cleanout with the remaining Developers." (Municipality of Brighton 2018)

Table 15. Estimated Cost of Pond Cleanouts

Priority Ranking	Pond Name	Estimated Year of Cleanout [1]	Sediment Accumulation Volume [2] (m^3)	Cleanout Cost Estimate (2018 dollars)
1	Tackaberry Ridge	2019	1685	$283,200
2	Harbour Point	2020	235	$39,500
3	Brighton By the Bay	2021	506	$85,000
4	Roos	2022	419	$70,400
5	Lucas	2023	191	$32,100
6	Orchard Gate	2024	819	$137,600

[1] Indicates relative priority of pond cleanouts but earlier implementation is recommended wherever feasible.

[2] Volumes estimated using sediment accumulation curves (Appendix B) for year of cleanout. Volume will increase if the rate of sediment load to the pond increases or if the timing of cleanout is delayed.

The next steps for implementation of pond cleanouts/retrofits include the following which are detailed in applicable guidelines for pond maintenance (Toronto and Region Conservation Authority and CH2M Canada 2016) and should also follow the recommended landscaping guidelines in Appendix I to address vegetation, access, and safety objectives where possible:

- Sampling and analysis of sediment with respect to O.Reg. 347 Leachate Test and O.Reg. 153/04 Soil Standards
- Design of cleanouts/retrofits coordinated with other retrofit projects (See Section 3.2)
- Property acquisition (if required)
- Permits and approvals, including amended ECAs (if required)

3.2. Water Quantity

Water quantity refers to both the volume and rate of stormwater in the study area. Stormwater management previously focused on controlling the rate of stormwater runoff from land developments in order to meet capacity restrictions in downstream storm sewers and mitigate the risk of increased, erosive flows in downstream watercourses. The stormwater management ponds and underground storage facilities in Brighton were designed with this intent as well.

Across Ontario, the focus on managing the quantity of stormwater now also includes managing the volume of runoff from developed landscapes and conversely the volume of rainfall that is infiltrated to sustain groundwater resources. These considerations are referred to in the *Stormwater Management Planning & Design Manual* as maintaining the water balance (Ministry of the Environment 2003). Recent guidance from the province elaborated on the need for managing runoff volume as follows:

> "The environmental health of many watersheds continues to decline as urbanization increases. Conventional (pipe and pond) stormwater management practices that focus on controlling peak flow rate and removal of total suspended solids are not fully achieving the desired protection of the watershed ecosystem. This is due to increased volume of stormwater and resultant sustained flows from end-of-pipe stormwater management facilities and may be exacerbated by more intense storms resulting from climate change." (MOECC 2015)

The additional volume generated when land uses are converted, whether it be from forest to agriculture or agriculture to residential development, is significant. The increase in stormwater runoff carries increased loads of pollutants (i.e. nutrients, sediment and other pollutants). The pollutants either originate from the transition in land use (i.e. new impervious surfaces) or they result from the increased power of runoff, which makes it more efficient at washing off and picking up pollutants that would otherwise be trapped in the natural vegetation and porous soils. Many studies have documented the significant impacts increased runoff volume has on the stability of streams and rivers. Bank erosion impacts streams by adding more pollutants to the water (i.e. sediment and nutrients) and it makes the stream configuration less natural which results in loss of habitat. In addition, in-stream erosion can damage stream banks and nearby lands which can be an issue for buildings located near the resource. Increased runoff volumes also increases the likelihood of flooding, which threatens public safety and increases the potential for infrastructure damage, and as such managing runoff volumes will mitigate such risks.

Runoff from 17% of the developed portion of the study area is controlled by stormwater management facilities before they discharge to the creeks, wetlands, and Presqu'ile Bay in Brighton. These facilities include some that provide no quantity control (e.g. oil grit separators), rate control only (e.g. wet ponds), and both rate and volume control (e.g. infiltration system on Westview Drive). Roadside ditches and rear yard swales also provide rate and volume control throughout Brighton as well, although to varying degrees based on the separation from groundwater or lake levels and the installation of drain tiles along the swales. The remainder of the study area is drained by a storm sewer system. This underground pipe network has a fixed capacity based on the diameter and slope of each pipe segment, and some are further limited when inundated by high water levels at their outlet. Across Ontario, an added challenge related to managing the quantity of stormwater is that climate change is increasing the intensity and frequency of rainfall events, which is resulting in greater volumes of runoff needing to be managed by existing stormwater infrastructure.

The existing stormwater management system in Brighton was assessed to identify the follow types of deficiencies related to water quantity:

- Storm sewers that cannot convey the 2-year rainfall event
- Manholes and catchbasins that will surcharge during the 2-year rainfall event
- Depressions in the landscape with or without outlets
- Locations where the above deficiencies would be exacerbated by high lake levels

A storm sewer model was developed of the Brighton Urban Area to identify deficiencies in the storm sewer system and prioritize capital improvements. The inputs, assumptions, and results of the modeling are detailed in Appendix C. Overall, multiple deficiencies were identified throughout the storm sewer system during the 2-year rainfall event simulation. Storm sewer segments were prioritized for capital improvements based on the combination of flooding at junctions in the system as well as having limited capacity in the pipe during the 2-year, 5-year, and 10-year events, as detailed in Appendix C. The model was also used to assess the extended detention capacity of the stormwater management ponds. Only three of the seven wet ponds – Harbour Point, Forest Hill and Tackaberry Ridge – had sufficient capacity under existing conditions to contain all storms up to and including the 100-year event without overflowing. The other wet ponds – Brighton by the Bay, Roos Pond, Lucas Pond, and Orchard Gate Pond – had limited storage capacity which should be addressed prior to assumption of the ponds or otherwise rectified to the extent possible by retrofits at or upstream of the ponds. These findings underscore the importance of using hydrologic and hydraulic models to design stormwater management facilities and consider tailwater effects on system capacity, in addition to accounting for undeveloped areas in the contributing drainage areas to stormwater management facilities. The model was also used to identify areas in the storm sewer system where sediment accumulation is most likely due to slow velocities, which should aid in prioritizing storm sewer maintenance (see Figure 57 and Figure 58 in Appendix C). The Brighton Urban Area model is a valuable tool for the Municipality moving forward to plan, design, and review private development and public infrastructure projects. Several potential future applications of the model are outlined at the end of Appendix C.

A 50 cm resolution digital terrain model derived from LiDAR from Land Information Ontario was used to delineate depressions in the landscape where runoff may pond after a rainfall event. These depressions were used in the model discussed above, but were also used to identify 22 areas exhibiting high risk to roads or buildings (i.e. no outlet or limited outlet capacity) and 35 depressions identified as having medium risk to roads or buildings (i.e. had an outlet with at least 10-year event capacity). These areas are mapped in Figure 19 (Appendix A).

Overall, these assessments have demonstrated that the existing stormwater infrastructure in Brighton cannot sufficiently convey or control the rate and volume of runoff at multiple locations.

3.3. System Deficiencies and Subwatershed Improvement Projects

Multiple types of deficiencies and system conditions were identified and can be broadly categorized as water quality and water quantity related. Water quality deficiencies include storm sewer outfalls that have no or partial upstream treatment, as well as ponds with inadequate treatment efficiency due to sediment accumulation. An overall water quality deficiency is the lack of temperature and water balance control measures to protect coldwater streams in the study area. Water quantity deficiencies include areas where storm sewers, overland flow pathways, or ponds are too small to store and/or convey runoff. These deficiencies are exacerbated by high lake levels, future land use/development, topographically low areas, climate change, and aging infrastructure. Lake levels are particularly important along the lakeshore while aging infrastructure is particularly relevant to the northern part of the study area. A detailed map of the stormwater management system's deficiencies and conditions is provided in Figure 19 (Appendix A) and are described in Table 16.

Table 16. Types of Deficiencies Identified in the Stormwater Management System

Icon	Description of Deficiency
	Minor and Major Capacity Deficiencies • Yellow pipe segments have limited capacity that will result in more frequent runoff ponding above catchbasin grates, relative to other areas of the storm sewer system • Red pipe segments are shown in areas that do not have defined overland flow routes when pipe capacity is exceeded.
	Future Land Use - Expected development within next ten years • Black hatched areas have known capacity limitations in downstream infrastructure, such as a pond, lake outfall, ditch, or culvert
	Pond Deficiencies • Indicates if regular maintenance (light blue), cleanout and regular maintenance (yellow), and retrofit, cleanout and regular maintenance (pink), is recommended
	Depression Risk Level • Indicates the relative risk (blue, green, yellow and red dotted contours) of runoff ponding in depressions such as along roads, in rear yard swales, and along the lakeshore
	Outfall Treatment Level • Indicates if runoff to a storm sewer outfall is receiving full (green triangle), partial (yellow triangle), or no (red triangle) water quality treatment
	Lake Level Impacts • Purple dots indicate where water levels at catchbasins and in ditches are impacted by high lake level, in addition to ponds with red outlines

The map also identifies priority implementation areas shaded to show the upstream areas draining into the deficient components. These subwatersheds are highlighted based on the number of deficiencies identified within them and based on elevated risk due to conditions such as lake level or ongoing development as mentioned above. Identifying these areas does not negate the need to address deficiencies beyond them, but instead aims to demonstrate the presence of compounding issues that can be addressed by common, coordinated solutions. The issues in each subwatershed are described in Table 17 along with a recommended objectives and targets for water quality and quantity control. The proposed objectives are defined based on the following expected level of service:

- Stormwater management ponds should be large enough to contain the 100-year rainfall event while maintaining at least 0.2 m of freeboard.
- Storm sewers should not surcharge during the 5-year rainfall event under normal and high lake level conditions.
- Existing drainage towards known flooding areas should be retained, detained, or diverted to mitigate flood risk to downstream roads and buildings.
- New drainage should not be directed to areas with known flood risk.

Table 17. Issues and Recommended Objectives for Subwatershed Improvement Projects

ID	Name	Type of Existing Stormwater Infrastructure	Deficiencies/Conditions						Description	Proposed Quantity Control Objective	Proposed Quality Control Objective	Description of Quantity Control Results from Urban Area Model	Storage Target (m^3)	
													Quantity Control	Quality Control
1	Brighton by the Bay	Storm sewer & constructed wetland							The system's capacity will be limited when lake levels are high to the extent that overtopping of Brighton by the Bay Wetland and ponding of water in road sags is expected. Residents reported significant volumes of water are pumped by sumps in the homes around the neighbourhood and are discharged to their lawns but often overflow onto the roads. Slippery slime and ice develop along the consistent flow of sump discharge along the roads in summers and winters, respectively, creating a risk of falling accidents. Modeling indicates that the wetland will overtop during a 25-year event under high lake level conditions. The estimated as-built treatment efficiency of the wetland is 69% while the required efficiency is 70%.	Provide sufficient storage to prevent Brighton by the Bay wetland from overtopping during the 100-year rainfall event under high lake level conditions. Mitigate risk of falls due to sump drainage issues. **	Provide 70% TSS efficiency for the subwatershed.	Total volume of discharge through the spillway during the 100-year rainfall event with high lake level condition.	830	40
2	Marina at Harbour	Ditch & culvert							Roadside ditches and rear yard swales drain towards the lakeshore near Marina Drive. High lake levels will back up into this system, adjacent to residential properties, such that there is limited to no capacity for storing simultaneous rainfall and runoff from the subwatershed.	Provide sufficient storage to retain/detain the 90th percentile storm event (27 mm) runoff volume, mitigating risk to downstream properties. Do not direct any new runoff to this system	Capture and treat the 90th percentile event runoff volume.	Total runoff volume from the 27 mm rainfall event.	580	580
3	Harbour Point, Roos, and Hamilton Woods	Storm sewer, ditch, culvert & wet ponds							Land development will continue in the center of this subwatershed which already faces challenges of insufficient active storage in Roos Pond as well as deficient water quality treatment efficiency in Roos and Harbour Point Ponds. High lake level conditions will limit discharge from Harbour Point. Depressions in the developed and undeveloped areas present risks and opportunities, respectively. Modeling indicates that Roos pond will overtop during the 25-year event under current conditions. The estimated as-built treatment efficiencies of Harbour Point Pond and Roos Pond are 69% and 73%, respectively, while the required efficiency for both is 80%.	Provide sufficient storage such that Roos Pond can contain can contain the 100-year event with use of the EOF with sufficient freeboard*.** Quantity and quality capacity limitations in Harbour Point Pond are to be addressed by future development between Harbour Point and Roos Ponds by providing the necessary additional capacity such that this system is providing required water quality and quantity controls, with consideration for high lake level conditions and known flood risk of the Marina at Harbour subwatershed to the south. Major flows should not be directed into the Marina at Harbour subwatershed.	Capture and treat the 90th percentile event runoff volume from areas without stormwater controls (480 m^3) and provide 80% TSS efficiency in other areas controlled by the two ponds (2220 m^3).	Total volume of discharge through the spillway during the 100-year rainfall event and the storage volume above freeboard elevation*.	210	2530
4	Cedar at Harbour	Storm sewer, ditch, & culvert							The storm sewer system along Harbour Street from Cedar Street to Forest Drive is expected to flood during high lake level conditions during the 5-year and 10-year events with several surcharges also occurring in rear yard swale systems off of Forest Drive. The system has no water quality controls.	Provide sufficient storage such that the storm sewer system does not flood during the 5-year event.	Capture and treat the 90th percentile event runoff volume.	Total flooded volume at model nodes during the 5-year rainfall event.	100	850

5	Prince Edward	Storm sewer, ditch, & culvert							The limited overland flow pathways along Catherine Crescent and Kelley's Court are not accounted for in the storm sewer servicing the area. The system has no water quality controls.	Provide sufficient storage such that the storm sewer system does not flood during the 10-year event.	Capture and treat the 90th percentile storm. Mitigate thermal pollution to the extent feasible.	Total flooded volume at model nodes during the 10-year storm event.	30	910
6	Butler at Lucas	Storm sewer, ditch, culvert & wet pond							Lucas Pond provides insufficient water quality and quantity control. Modeling indicates it will overtop during the 5-year event. Depressions in the developed and undeveloped contributing areas present risks and opportunities, respectively. The estimated as-built treatment efficiency of the pond was 69% whereas the required efficiency is 80%.	Provide sufficient storage such that Lucas Pond can contain the 100-year event with use of the EOF with sufficient freeboard*.	Mitigate thermal pollution to the extent feasible.	Total volume of discharge through the spillway during the 100-year rainfall event and the storage volume above freeboard elevation*.	390	490
7	Orchard Gate	Storm sewer & wet pond							Orchard Gate Pond provides insufficient water quantity control and continued development is expected upstream. Modeling indicates it will overtop during the 100-year event. Depressions in the developed and undeveloped contributing areas present risks and opportunities, respectively.	Provide sufficient storage to prevent Orchard Gate Pond can contain the 100-year event with use of the EOF with sufficient freeboard*.	Mitigate thermal pollution to the extent feasible.	Total volume of discharge through the spillway during the 100-year rainfall event and the storage volume above freeboard elevation*.	500	0
8	Sanford and Cheer	Storm sewer, ditch, & culvert							Storm sewer segments along Sanford Street, Dorman Street, Cheer Drive, and Young Street have insufficient capacity to convey 5- and 10-year rainfall events. The configuration of the storm sewer from the Young Street and Dundas Street intersection is undocumented.	Provide sufficient storage such that the storm sewer does not flood during a 5-year rainfall event with consideration for potential constraints in the downstream system.	Capture and treat the 90th percentile event runoff volume. Mitigate thermal pollution to the extent feasible.	Total flooded volume at model nodes during the 5-year storm event.	70	950

Overarching Management Objective: *Improve temperature mitigation to the extent feasible on each project.*

*Freeboard elevation is defined as: The maximum high water level in the pond during the 100 year should be at least 0.2 m below the spillway elevation.

**Conduct feasibility study regarding maintenance issues at storm water management facilities per Table 13

90th percentile storm event depth for Brighton is 27 mm.

Deficiencies and Conditions Key:

 Minor and Major Capacity Deficiencies

 Future Land Use

 Pond Deficiencies

 Depression Risk Level

 Outfall Treatment Level

 Lake Level Impacts

The storage targets for each subwatershed are detailed in Table 18. The water quantity storage deficiencies are defined based on the proposed objectives and model results described in Table 17. Water quality storage deficiencies are a combination of two gaps in the system: (1) ponds that are too small to remove the required amount of TSS annually and (2) areas that have no stormwater management facilities to treat runoff. The pond deficiency was calculated as part of the sediment accumulation analysis detailed in Appendix B. The storage missing from untreated areas was defined based on the runoff volume from the 90th percentile event in Brighton, which is an event with a total rainfall depth of 27 mm. If these deficiencies are addressed by end-of-pipe facilities, such as wet ponds, the facilities will need to address the sum of both the water quality and quantity storage deficiencies since ponds use separate functions to treat and slow down runoff. If low impact development (LID) practices are used in the upland areas of the subwatersheds, only the larger of the two storage deficiencies will need to be addressed since LID practices often use the same functions (e.g. infiltration) to control the amount and quality of discharge.

Table 18. Summary of Storage Capacity Deficiencies and Alternative Targets

Subwatershed		Water Quantity Storage Deficiency (m^3)	Water Quality Storage Deficiency (m^3)			Alternative Storage Targets (m^3)	
			Undersized Ponds	Un-treated Areas	Total	End-of-pipe (1)	LID (2)
1	Brighton By the Bay	830	40	0	40	870	830
2	Marina at Harbour	580	n/a	580	580	1160	580
3	Harbour Point, Roos & Hamilton Woods	210	2220*	310	2530	2740	2530
4	Cedar at Harbour	100	n/a	850	850	950	850
5	Prince Edward	30	n/a	910	910	940	910
6	Butler at Lucas	390	490	0	490	880	490
7	Orchard Gate	500*	0	0	0	500	500
8	Sanford & Cheer	70	n/a	950	950	1020	950

Notes:

*To be addressed through future development, not Municipal retrofit projects.

(1) End of pipe facilities, such as ponds, typically use separate components to control quantity and quality of runoff via extended detention and permanent pools, respectively. If end-of pipe facilities are used, the sum of the quantity and quality targets would apply.

(2) Low impact development (LID) practices provide storage that controls both the quantity and quality of runoff simultaneously. If LID practices are used, the maximum of the quantity or quality targets would apply.

Prioritization of the subwatershed improvement projects is recommended based on the risk matrix detailed in Table 19and shown in Figure 13. The risk matrix considers the type of risk (i.e. consequence of failure) and the probability of failure in any year, both of which were informed by the modeling conducted as part of this project (See Appendix C and D). The subwatersheds are ranked based on a combined score of the two multiplied by each other. The probability of failure was calculated as the inverse of the return period at which failure is expected.

Table 19. Comparative Risk of Subwatershed Improvement Projects as of 2018

Subwatershed Name	Risk Type	Consequence of Failure Score	Return Period of Failure	Probability of Failure In Any Year	Combined Score	Priority Ranking
Brighton By the Bay	Buildings	1.00	25	4%	0.040	6
Marina at Harbour	Buildings	1.00	1	100%	1.000	1
Harbour Point, Roos & Hamilton Woods	Erosion	0.20	25	4%	0.008	7
Cedar at Harbour	Roads	0.50	5	20%	0.100	2
Prince Edward	Roads	0.50	5	20%	0.100	2
Butler at Lucas	Erosion	0.20	5	20%	0.040	5
Orchard Gate	Erosion	0.20	100	1%	0.002	8
Sanford and Cheer	Roads	0.50	5	20%	0.100	2

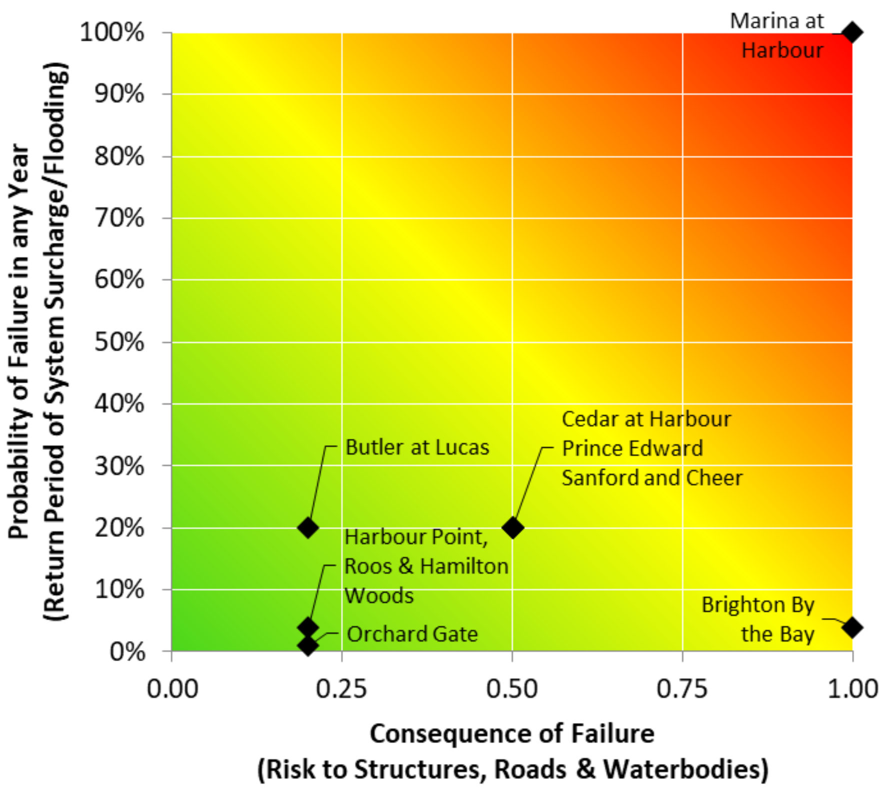


Figure 13. Risk Profile of Subwatershed Improvement Projects (2018)

Future development and public infrastructure improvements (e.g. road reconstruction projects, the storm sewer replacement program, and a new stormwater retrofit program) present opportunities to address the deficiencies that have been identified and prioritized. Section 5 outlines each component of the Stormwater Master Plan that is recommended to address these deficiencies over the next decade.

3.4. Cumulative Impacts to Receiving Water Resources

Without appropriate stormwater management, runoff from urban areas will degrade the quality of downstream natural heritage features due to changes in both the quantity and quality of stormwater. Higher levels of pollutants, increased flow velocities and erosion, alteration of riparian corridors, and sedimentation associated with stormwater runoff negatively affect the integrity of aquatic ecosystems. The most comprehensive study of urban runoff was the Nationwide Urban Runoff Program (NURP), conducted by the US Environmental Protection Agency between 1978 and 1983. The NURP study was conducted to examine the characteristics of urban runoff and similarities or differences between various urban land uses, the extent to which urban runoff is a significant contributor to water quality problems, and the performance characteristics and effectiveness of management practices to control pollution from urban runoff. Subsequent research by the Environmental Protection Agency determined that urban runoff is one of the leading causes of water quality impairment in receiving water bodies. Schueler (1994) also suggested a direct relationship between watershed imperviousness and stream health. The Schueler study found that stream health impacts tend to begin in watersheds with as little as 10 to 20 percent imperviousness. This study demonstrated that sensitive streams could exist relatively unaffected by urban stormwater with good levels of stream quality where impervious cover is less than 10 percent. However, some sensitive streams have been observed to experience water quality impacts as low as 5 percent imperviousness.

Schueler's relationship was used to compare the relative impacts of development on the study area watersheds in Table 20 in the absence of long term natural resource and biotic assessments. In the absence of monitoring record for the creeks in the Brighton Urban Area, the Schueler study was used to assess stream health. The current level of imperviousness in the watersheds through the Brighton Urban Area range from 4 to 16% and the Arena Creek watershed is expected to exceed 20% imperviousness within the next decade (See Table 20). Arena Creek is at an impacted level of imperviousness, which is consistent with recent culvert blow-outs experienced downstream of the railroad and will approach a non-supporting level within the next decade. Butler Creek is expected to stay within the sensitive classification level over the next decade, however the thermal regime of the creek is already showing evidence of warming throughout the urban area and benthic macroinvertebrate monitoring indicates that the creek is likely impaired due to very substantial pollution (See Section 2.4.1). The imperviousness of the west creek's watershed is expected to double within the next decade, rapidly approaching an impacted level. The lakeshore watershed includes the east side of the study area that will remain undeveloped.

Table 20. Existing and Future Imperviousness of Study Area Watersheds

Watershed	Imperviousness	
	Existing	Future
Butler Creek	4%	5%
Arena Creek	16%	23%
Unnamed West Creek	4%	8%
Lakeshore	9%	10%

Urban Stream Classification based on Imperviousness: (Schueler 1994)	Sensitive (0 – 10% Imperv.)	Impacted (11 – 25% Imperv.)	Non-Supporting (26-100% Imperv.)

Only 17% of the developed land in the study area is currently controlled by stormwater management practices. Land development without stormwater management controls will increase the stormwater runoff and pollutants by introducing impervious surfaces (e.g. pavement) and removing natural storage from the landscape (e.g. depressions, small wetlands). These changes will result in increased demands on the existing downstream stormwater management system as well as impacts on receiving water bodies. The next sections outline what quantity and quality parameters are being managed by the existing stormwater management facilities. The potential implications of current and future development on natural heritage features, and the necessary stormwater management objectives to mitigate impacts, are discussed at the end of this section.

3.4.1. Butler Creek

The majority of development in the Butler Creek watershed is located within the study area. The imperviousness of the watershed is expected to increase from 4% to 5% within the next decade. Four stormwater management ponds currently discharge to Butler Creek (Orchard Gate, Lucas, and Forest Hill Wet and Dry Ponds) which were designed to control rate of runoff and suspended solids (See Section 3.1.2 for evaluation). An infiltration chamber and oil-grit separator is also located at the end of Rosslyn Street and another oil-grit separator is located at the northern end of Forest Drive.

3.4.2. Arena Creek

The *Northeast Master Drainage Study* recommended a level of stormwater management appropriate for warmwater streams referred to as Normal Protection (70% TSS Removal). This level of treatment is inconsistent with today's best practices in water resource protection and stormwater management. The degradation observed in the lower reach of Arena Creek in the early 1990's was likely in part due to the swapped urban drainage area from Butler Creek into the Arena Creek watershed (See Section 2.4.1), however degradation of a coldwater stream does not negate the need to protect it from further impacts. Instead, reversal of its degradation is warranted moving forward, especially since it will help protect Presqu'ile Bay Marsh. As such, development in the Arena Creek watershed should provide Enhanced Protection (80% TSS Removal) in addition to thermal pollution and water balance controls. This will also aid in mitigating the impacts of the swapped drainage areas and increased runoff volume to the creek that likely led to other issues such as culvert blow-outs in the industrial area in the lower reach in 2017.

Development in the Arena Creek Watershed has included the construction of one private stormwater management pond south of the No Frills grocery store and another pond northeast of the intersection of Pinnacle Street and Singleton Street as part of the Tackaberry Ridge development. Part of this residential development is treated by an Oil-Grit Separator at Singleton Street and Thompson Crescent. This development is expected to continue eastward to the study area boundary within the next decade. As development continues, more care should be taken to protecting the function and value of the intermittent, albeit segmented, northern tributary of Arena Creek. The lower end of the tributary has been converted to a rip-rap channel (Figure 14a) with insufficient erosion control measures to protect it from sediment loads which have accumulated behind check dams along the stream as shown in Figure 14 (b). In addition, riparian vegetation has not been maintained and replaced to provide a buffer to the channel. This is contrary to the *Northeast Master Drainage Study* recommendation to retain buffer zone vegetation along the former stream segment for a minimum width of 15 m on either side of the channel. Future phases of the development should provide such a buffer and consider natural channel or bioswale design alternatives (See examples in Figure 15) that will maintain some ecological function along the watercourse that will continue to receive groundwater discharge via upstream seeps and drain tiles. Naturalized design will also enhance this feature as an amenity for residents of the future development and buffer landscaping will aid in deterring encroachment from adjacent property owners into the channel.

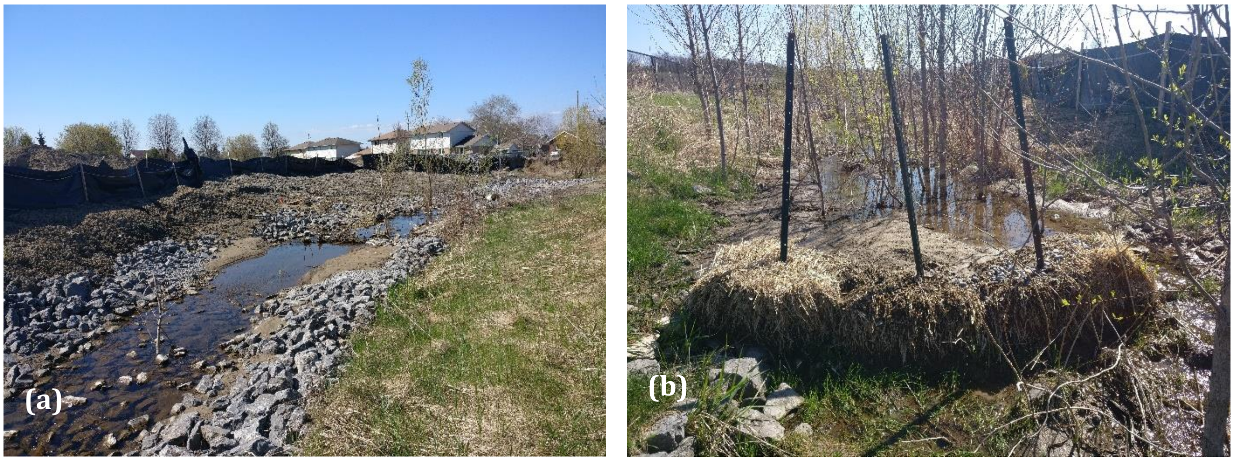


Figure 14. Rip-Rap Channel (a) and Sediment Accumulation Behind Check Dam (b) in Arena Creek North Tributary

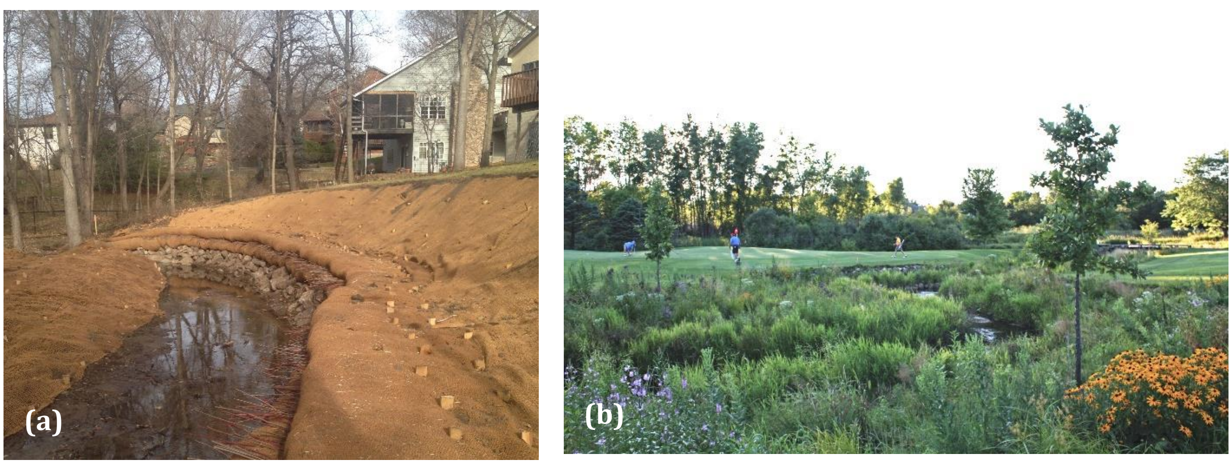


Figure 15. Examples of Natural Channels Under Construction with Erosion Control Blanket Protecting the Upper Stage (a) and After Establishment of Buffer Vegetation (b)

3.4.3. West Tributaries

There is minimal development in the watershed of the west tributaries but continuation of the Applewood Meadows development is expected within the next decade north of the west branch's railroad crossing. The eastern tributary receives runoff from development along Butler Street, Westview Drive, and Raglan Street on the west side of Ontario Street, and further development is anticipated in this area. Runoff from Westview Drive drains to an underground infiltration system before discharging to the east branch. In addition, a large pond constructed over 70 years ago with limestone shale lining is located just north of Raglan Street, online with the east tributary. A car salvage yard is located at the west end of Raglan Street. The Ontario Street storm sewer and ditch system south of Butler Street drains to the southeast branch that is separate from the two east and west branches but discharges to the main channel through Presqu'ile Bay Marsh north of Presqu'ile Parkway.

Perennial headwater streams are typically an important input to downstream water resources, be it wetlands, lakes, or larger creeks/rivers, due to their interaction with clean and cool groundwater. Although they may offer only intermittent aquatic habitat to fisheries, they often support unique communities of macroinvertebrates. As such, the west creek should receive the same Enhanced Level protection from stormwater impacts as the other coldwater streams throughout the study area, in addition to the volume, water balance, and thermal pollution controls that have already been discussed. In addition to stormwater controls upland of the creek, channelization of the creek is strongly discouraged due to potential adverse effects to the stream ecosystem and subsequent impacts to the downstream wetlands.

3.4.4. Lakeshore Watershed

The lakeshore watershed contains multiple separate drainage systems to the Lake or Presqu'ile Bay Marsh described as follows from east to west:

- The rural and semi-industrial area east of the Arena Creek watershed drains to several short tributaries southerly to the marsh and no development is anticipated.
- The Mill Pond Woods development includes Mill Pond Court and the developments on and around Forest Drive. Part of this development is treated by an oil grit separator while another outfall has no treatment prior to discharging to a small tributary to the marsh located west of Mill Pond Court.
- The residential areas south of Harbour Street along Baldwin, including Gosport, are fully developed and drain via roadside ditches and culverts to the Presqu'ile Bay.
- The storm sewer system at Harbour Street and Cedar Street service the majority of the lakeshore watershed, including discharge from Harbour Point Pond and also as far to the northwest as the development draining to Roos Pond. Continued development in this watershed is anticipated.
- The second largest system in the watershed is the Brighton by the Bay system which is almost completely developed and discharges to the marsh south of Harbour Street, between Walas Street and Marina Drive.
- Walas Street and Marina Drive drain to roadside ditches which ultimately discharge to the same location as the Brighton by the Bay outfall.
- Two OGSs treat runoff from the homes on Edgewater Drive and Dockside Lane.
- The rows of homes along the western end of Harbour Street drain by roadside ditches and culverts to the marsh.
- The Lakehurst Street area on the western edge of the study area drains directly to Lake Ontario (not to Presqu'ile Bay Marsh) and future development is planned.

3.4.5. Presqu'ile Bay Marsh

Stormwater from the Brighton Urban Area drains into Presqu'ile Bay Marsh via coldwater streams (Butler Creek, Arena Creek, and the unnamed west tributaries). Runoff from 83% of the developed portion of the study area is currently discharged to the creeks and bay without water quality or quantity controls. The remainder of the urban area has been developed with variable controls, including enhanced level protection and peak flow matching. Development in the lakeshore watershed has not controlled the rate of discharge to pre-development levels based on the justification that Lake Ontario is a free outfall. The sensitive aquatic habitats in Presqu'ile Bay Marsh should be protected from stormwater impacts by requiring at least the Enhanced Protection as specified in the *Stormwater Management Planning & Design Manual* (Ministry of the Environment 2003). Enhanced protection corresponds to the end-of-pipe storage volumes required for the long-term average removal of 80% of suspended solids. As Provincially Significant Wetlands have protection under the Provincial Policy Statement (PPS), appropriate measures should be taken in consultation with the Lower Trent Conservation to protect them, both from direct impacts of land development (i.e. wetland loss) and indirect impacts from stormwater runoff. The need for additional stormwater management criteria are discussed below with regards to mitigating the following potential stormwater impacts on wetlands:

- **Hydrology:** Modified inundation depth and duration of inundation with potential effects on wetland vegetation and associated habitat
- **Erosive flow:** Increased rate of discharge at outfalls to the wetlands with potential effects such as dislodging vegetation and eroding channels through the wetlands
- **Water quality:** Discharge of contaminants such as chemicals, sediment, hydrocarbons, and nutrients with potential effects on vegetation and wildlife
- **Plant community:** Transport of invasive species

There are many outfalls from the Brighton Urban Area stormwater system into Presqu'ile Bay Marsh. Each individual outfall presents a risk of erosive stormwater discharge dislodging vegetation and eroding channels through the marsh, with associated release of contaminants. The cumulative impact of the outfalls could also deliver a significant amount of urban contaminants from the watershed. Localized pollution was noted as a threat to the wetland during evaluation, in addition to observations of invasive species such as European frogbit, reed canary grass, Eurasian milfoil, Purple loosestrife, Common reed grass (Snider 2006; Peterborough District Ministry of Natural Resources and Forestry 2018). Common reed grass was found in several stormwater management ponds during inspections conducted in 2018. Managing water quality in the marsh is also important as it relates to protecting fish rearing habitat and Species at Risk, discussed Section 2.4.

3.4.6. Stormwater Management Objectives for Protecting Natural Heritage Features

New stormwater management standards in Brighton are required to protect valuable natural heritage features, make the community more resilient to extreme climate conditions, and align local standards with other Municipal policies (e.g. the Official Plan) and provincial guidelines. There are well-established best practices for protecting the sensitive aquatic habitats in coldwater streams through managing the volume, temperature, and pollutants of urban runoff. The coldwater creeks in the Brighton Urban Area should be protected from stormwater impacts by requiring at least the Enhanced Protection as specified in the *Stormwater Management Planning & Design Manual* (Ministry of the Environment 2003). Enhanced protection corresponds to the end-of-pipe storage volumes required for the long-term average removal of 80% of suspended solids. In addition, new stormwater management criteria are needed for mitigating thermal impacts, including mitigation for increased runoff volumes and modified water balance (i.e. decreased infiltration). Land development in coldwater watersheds introduce several threats to the health of coldwater ecosystems. Runoff from impervious surfaces and stormwater outflow from ponds are heated to higher temperatures than pre-development runoff. Development also increases the volume of runoff in comparison to pre-development conditions, further increasing the heat load to the receiving coldwater stream. Increased runoff volume also signifies a decrease in infiltration of water into the soil and into the groundwater. Groundwater baseflow sustains coldwater streams and so it is important to ensure adequate rainfall continues to percolate into the ground and replenish aquifers.

Favouring stormwater management strategies that reduce runoff volumes will also aide in mitigating flood risk and other quantity control deficiencies. Storing and reducing runoff volumes will be especially pertinent in the systems with downstream constraints, such as high lake levels, where deficiencies will need to be addressed first and foremost by providing storage for excess runoff volumes. Storing or reducing runoff volumes will need to be the primary focus in such areas because high lake levels will limit the effectiveness of other strategies such as increasing the conveyance capacity of the storm sewer system. Adding storage to the upland systems would also be advantageous in that it would also reduce peak flows and improve water quality, alleviating three types of deficiencies at once.

3.5. Problem Statement and Objectives

The Brighton Urban Area is a growing community on the Lake Ontario shoreline where coldwater streams feed into the Provincially Significant Presqu'ile Bay Marsh. Many of the neighbourhoods in Brighton were historically developed with no infrastructure to treat or slow down stormwater as was typical at the time. More recent land development projects within the past 15 years have primarily utilized stormwater management ponds to treat and slow down runoff in line with standard practices. Currently, runoff from 17% of the built portion of the Brighton Urban Area is being treated by stormwater management facilities. The assessment of current stormwater management infrastructure in Brighton has identified deficiencies and gaps that need to be addressed to ensure the performance and resiliency of the system into the future. In addition, the design standards for stormwater management in Ontario are rapidly evolving to use a broader suite of approaches that will enhance water quality and quantity control in the face of more extreme climate conditions. The Stormwater Master Plan outlines the long-term strategies, capital improvements, and maintenance programs needed to improve the capacity of the current stormwater management system, support future development and protect the natural heritage features unique to Brighton.

The Stormwater Master Plan addresses the following stormwater management objectives in order to improve Brighton's stormwater management system:

A. Reduce Flood Risk & Increase Resiliency to Climate Change

B. Reduce Future Maintenance

C. Protect Streams, Wetlands, & Presqu'ile Bay from Stormwater Impacts

D. Improve Public Safety

3.6. Evaluation of Alternatives

The alternative approaches to achieving the objectives of the Stormwater Master Plan include the following:

1. **Conventional Stormwater Management**
   Conventional stormwater management focuses on centralized detention of stormwater, which involves storing and then slowly releasing stormwater while settling suspended sediment and associated pollutants to the bottom of facilities. Detention is one approach to mitigating flood risk and improving resiliency to large rain events. Examples of conventional stormwater management facilities include wet ponds, dry ponds, constructed wetlands, detention chambers, and hydrodynamic separators (e.g. oil-grit separators).

2. **Treatment Train Stormwater Management**
   The treatment train approach uses multiple practices to manage the quantity and quality of stormwater runoff in order to achieve stormwater management objectives. A simple schematic of a treatment train is provided in **Error! Reference source not found.**. T reatment trains often also include pollution prevention, which are described in alternative #3 (Non-Structural Alternatives). Practices are selected to maximize control of pollutants while complying with constraints such as limited space, physical conditions and regulatory requirements. Source, conveyance, and site controls include Low Impact Development (LID) and Green Infrastructure (GI) strategies that work with nature to manage stormwater as close to its source as possible. In general, these practices are favored over alternative end-of-pipe facilities because they reduce both stormwater volumes and pollutant loading. They mimic natural processes to infiltrate, filter, evapotranspire, and reuse stormwater. Where source, conveyance, and site controls are insufficient or infeasible, traditional conveyance (e.g. storm sewers, ditches, culverts) and end-of-pipe facilities can be used as part of the treatment train approach. Additional processes can be included in end-of-pipe facilities to enhance their benefits, such as percolation trenches or rock cribs to cool discharge from the ponds.

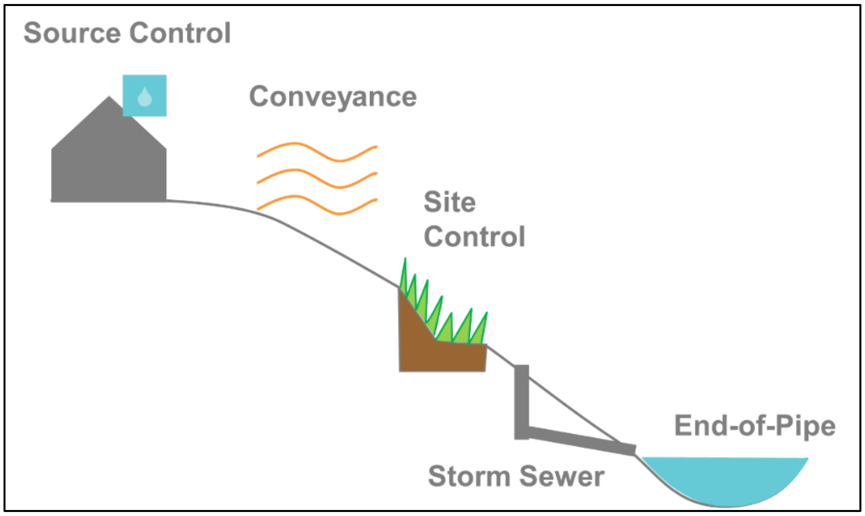


Figure 16. Treatment Train Components

The treatment train approach is consistent with current best practices in stormwater management to deliver cost-effective improvements that offer multiple benefits to the community. The increased use of Green Infrastructure to address issues related to water quality and flooding can also serve to increase community resilience to climate change and improve quality of life.

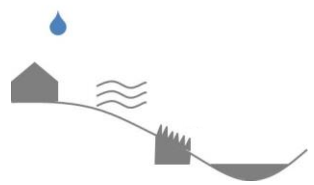
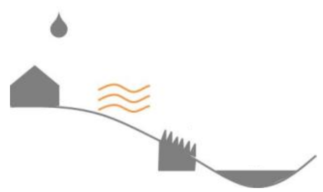
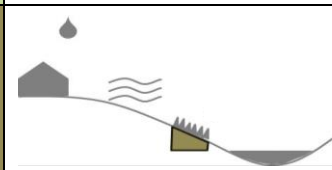
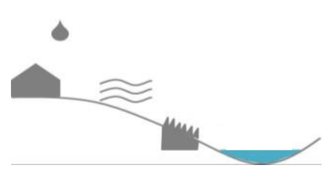
Examples of the many benefits and types of stormwater management practices included in the treatment train approach are provided in Table 21.

3. **Non-Structural Alternatives**
   Non-structural alternatives are policies and programs that aide in improving or preventing the need for stormwater management. Examples include stormwater design standards for private development, a program for maintaining stormwater management infrastructure, pollution prevention programs (e.g. street sweeping), public outreach/education, and bylaw enforcement.

4. **Do Nothing**
   This alternative consists of implementing no improvements or changes to solve the stormwater management deficiencies identified in the Brighton Urban Area. Development of the community would continue with the current methods used to manage stormwater.

The advantages and disadvantages of each alternative relative to the objectives of the Stormwater Master Plan are compared in Table 22. The preferred alternatives are using a treatment train approach (Alternative #2) as well as non-structural solutions (Alternative #3).

Table 21. Benefits of Stormwater Management Practices

	STORMWATER MANAGEMENT PRACTICES	LOCATION IN THE LANDSCAPE	HYDROLOGIC BENEFITS			SURFACE WATER POLLUTANT REMOVAL					
			INFILTRATION	EVAPO- TRANSPIRATION	RUNOFF VOLUME REDUCTION	TP	TN	TSS	Metals	TEMPERATURE	GROUNDWATER CONTAMINATION RISK
SOURCE CONTROL	Impervious Cover Reduction		✔	✔	40%	30-55%	64%	20-60%	40-80%	✔	
	Soil Amendments/ Decompaction		✔	✔	50-75%	50-75%	50-75%			✔	
	Pervious Pavements		✔		45-85%	30-80%	60-80%		90%	✔	💧
	Downspout / Impervious Disconnection		✔	✔	25-50%	25-50%	25-50%			✔	
	Rainwater Harvesting				40%	40%	40%	50-60%	40-50%		
	Stormwater Harvesting		✓	✔	20-75%	45-95%	45-95%	45-95%	45-95%		
	Green Roofs			✔	45-90%	highly variable	20-90%	70-90%	80%		
CONVEYANCE	Level Spreaders		✓	✓	50-75%	50-75%	50-75%				
	Filter Strips		✓	✓	25-75%	30-80%	35%	75-90%	80%		
	Storm Sewers*										
	Dry Swales (e.g. Enhanced Ditches)		✓	✓	10-60%	15-75%	55-75%	30-85%	20-70%		
SURFACE TREATMENT	Bioretention Devices (without under drain)		✔	✔	65-85%	90%	90%		30-99%	✓	💧
	Bioretention Devices (with underdrain)			✔	40-45%	55-65%	45-65%	85%	95%	✓	
	Tree Trenches		✔	✔	variable	75%	70%	85%	80%	✓	
	Infiltration Basins		✔	✔	50-90%	15-95%	60-95%	40-95%	40-95%	✓	💧
SUBSURFACE TREATMENT	Below-ground Recharge Systems		✔		85%	50-80%	40-70%	70-90%	70-90%		💧
END OF PIPE	Wet & Dry Ponds*			✓		40-70%	30-50%	60-80%	60-80%		
	Constructed Wetlands*		✓	✔		40-90%	40-90%	60-80%	40-90%		
	Detention Chambers*					30-70%	30-50%	50-80%	40-60%	✓	
	Hydrodynamic Separator (OGS)*					20-80%	20-50%	50-90%	40-60%		
	Cooling Rock Crib									✔	

Notes:

* Alternative #1: Conventional Stormwater Management includes storm sewers, ponds, constructed wetlands, detention chambers, and hydrodynamic separators.

Alternative #2: Treatment Train Stormwater Management includes all possible stormwater management practices, such as those listed above, with an emphasis on low impact development through source, conveyance, and surface treatment practices that address runoff close to its source.

✔ = Primary benefit of practice (with suitable soils)

✓ = Minor benefit of practice (with suitable soils)

Runoff and Pollutant Reductions: Reduction ranges represent variations in design and site conditions across multiple studies. As a result, comparisons between BMPs across different studies may not reflect true performance.

💧 = Pre-treatment or siting restrictions needed to address groundwater contamination risk

Table 22. Evaluation of Alternative Solutions to the Stormwater Master Plan Objectives

Alternative	Objectives Addressed	Advantages	Disadvantages
1) Conventional Stormwater Management		• Controls rate of runoff, sediment, and particulate phosphorus from contributing area. • Creates a focal point in some neighbourhoods for surrounding trail systems.	• Use of this approach alone is inconsistent with provincial guidelines. • Does note control runoff volume, restore water balance, or mitigate temperature impacts as is needed to protect Brighton's natural heritage features (See Section 3.4.6). Does not capture dissolved phosphorus. • Cumulative effect of this approach's reliance on rate control, not volume control, can overwhelm the capacity of downstream built and natural conveyance systems. Hydromodification degrades natural habitats directly (e.g. deeper baseflow in streams) and indirectly (e.g. erosion of streambanks). • The above cumulative effects may be exacerbated by climate change. • Not feasible in built areas with limited open space. • Substantial investment & planning of upstream drainage networks needed to safely convey runoff to the centralized/regional facilities.
2) Treatment Train Stormwater Management		• Controls runoff rate, runoff volume, water balance, sediment, nutrients, and temperature as is needed to protect Brighton's natural heritage features (See Section 3.4.6). • Reduces the amount of runoff and pollutants that need to be conveyed by storm sewers and ditches, or controlled by end-of-pipe facilities (e.g. ponds). As a result, there is a reduced demand for new conveyance and end-of-pipe facilities, saving infrastructure and land costs. Another benefit is that existing downstream components of the system will become more resilient to climate change and will need to be maintained less frequently. • Facilities can fit within the limited available space in built areas. • Low impact development and green infrastructure technologies offer additional benefits beyond the Plan's objectives, such as enhancing the livability of built environments.	• Low impact development and green infrastructure technologies have not yet been used in Brighton. Successful implementation will require capacity to design, construct and maintain such facilities.

Alternative	Objectives Addressed	Advantages	Disadvantages
3) Non-Structural Alternatives		• Introduces preventative measures that will maintain capacity of the stormwater system for quantity and quality control and, in managing minor maintenance needs, will reduce the need for frequent major maintenance, such as pond cleanouts. • Mitigates the potential impact of future growth on existing stormwater infrastructure, properties, and natural heritage features. • Addresses the municipality's obligation for wisely managing public infrastructure.	• Does not immediately address deficiencies in the system where there is no anticipated development.
4) Do Nothing	None	• Low up front cost.	• Does not address the Municipality's obligation for wisely managing public infrastructure. • Sustained or increased flood risk; reduced public safety. • Compounding maintenance issues will further reduce the community's resiliency to climate change. • Continued degradation of natural heritage features.

Evaluation of alternative stormwater management practices for the subwatershed improvement projects were compared at a preliminary feasibility screening level as summarized in Table 23. Practices were screened based on constraints such as shallow groundwater. Further assessment of each subwatershed will be needed subsequent to the development of this plan to design the most appropriate solutions for each project. The constraints have multiple implications for feasibility of specific stormwater management practices, such as the following:

1. **Shallow groundwater** limits the ability to infiltrate runoff when groundwater is within 1 m from the bottom of a stormwater management practice. As such, shallow groundwater negates the primary purpose (infiltration) of bioretention, below-ground recharge systems, infiltration basins and pervious pavements, and so the practices would not be cost effective. Shallow groundwater also presents the risk of directing contaminants from surface runoff into groundwater or vice versa.

2. **High lake level** limits the outlet capacity of drainage systems where they are partially or completely submerged by lake water. Increasing the size of inundated storm sewers would not effectively address flooding issues. Many hydrodynamic separators (e.g. Oil Grit Separators) are ineffective when downstream water backs up and flows backwards through the separator.

3. **Limited space** is a major limitation for practices that require a large footprint to be effective, such as wet ponds, dry ponds, and constructed wetlands.

4. **Lack of flat-roofed buildings** limits the ability to install green roofs. Green roofs retrofitted onto existing buildings also need to consider the capacity of the structure which is often limited and leads to a focus on extensive green roofs with shallow soil media and small plants.

5. **Clay soils** limit the rate at which surface runoff can infiltrate into the ground. Similar to shallow groundwater, this constraint can be managed by using underdrains in bioretention practices, however others such as pervious pavements and infiltration basins are not cost-effective relative to other options. Some alternatives will reduce runoff volumes even with this constraint, such as rainwater harvesting.

Table 23. Evaluation of Alternatives for Subwatershed Improvement Projects

SUBWATERSHED #:	1	2	3	4	5	6	7	8
CONSTRAINTS:	1, 2, 3, 4	1, 2, 3	1, 2	1, 2, 3	5	5		3
Impervious Cover Reduction	✓	✓	✓	✓	✓	✓	✓	✓
Soil Amendments/ Decompaction	✓	✓	✓	✓	✓	✓	✓	✓
Pervious Pavements	✘	✘	✘	✘	✘	✘	✓	✓
Downspout / Impervious Disconnection	✓	✓	✓	✓	✓	✓	✓	✓
Green Roofs	✘	✘	✘	✘	✘	✓	✘	✓
Level Spreaders	✓	✓	✓	✓	✓	✓	✓	✓
Filter Strips	✓	✓	✓	✓	✓	✓	✓	✓
Storm Sewers*	✘	✘	✘	✘	✓	✓	✓	✓
Dry Swales (e.g. Enhanced Ditches)	✓	✓	✓	✓	✓	✓	✓	✓
Bioretention Devices (without under drain)	✘	✘	✘	✘	✘	✘	✓	✓
Bioretention Devices (with underdrain)	✓	✓	✓	✓	✓	✓	✓	✓
Tree Trenches	✓	✓	✓	✓	✓	✓	✓	✓
Infiltration Basins	✘	✘	✘	✘	✘	✘	✓	✓
Below-ground Recharge Systems	✘	✘	✘	✘	✘	✘	✓	✓
Rainwater Harvesting	✓	✓	✓	✓	✓	✓	✓	✓
Stormwater Harvesting	✓	✓	✓	✓	✓	✓	✓	✓
Wet & Dry Ponds*	✓	✘	✓	✘	✓	✓	✓	✘
Constructed Wetlands*	✘	✘	✓	✘	✓	✓	✓	✘
Detention Chambers*	✓	✓	✓	✓	✓	✓	✓	✓
Hydrodynamic Separator*	✘	✘	✘	✘	✓	✓	✓	✓
Cooling Rock Crib	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

* Alternative #1: Conventional Stormwater Management includes storm sewers, ponds, constructed wetlands, detention chambers, and hydrodynamic separators.

Alternative #2: Treatment Train Stormwater Management includes all possible stormwater management practices, such as those listed above, with an emphasis on low impact development through source, conveyance, and surface treatment practices that address runoff close to its source.

✓ possible practice for preventing, retaining, or detaining runoff

✓ possible practice for achieving other stormwater objectives (e.g. mitigate thermal pollution)

✘ practice likely infeasible due to constraints:

(1) Potential shallow groundwater
(2) High lake levels limiting outlet capacity
(3) Limited space in the subwatershed
(4) No flat-roofed buildings
(5) Clay soils

4. PUBLIC, AGENCY, AND INDIGENOUS COMMUNITY CONSULTATION

4.1. Public Consultation Activities

The Municipal Class EA requires the proponent undertakes one mandatory point of contact while developing a Master Plan. The general public, residents, property owners, agencies, and other stakeholders were given the following opportunities for comment:

- Notice of Commencement
- Notice of Public Information Centre (PIC)
- PIC
- Notice of Completion

Public comments were welcomed throughout the EA process and the comments received are included in Appendix F.

4.1.1. Notice of Commencement

The Notice of Commencement was distributed to stakeholders, review agencies, and Indigenous communities on May 3, 2018 by direct email and letter mail. In addition, the notice was posted on the Municipality's project webpage and published in the local newspaper (The Brighton Independent) on May 3 and 10, 2018. The purpose of the notice was to inform the public, stakeholders, and Indigenous communities that a Class EA study had been initiated in the Municipality. The notice provided background information about the project. Furthermore, the contact information for the Municipality's project manager and EOR's Project Manager were made available to the public to engage any initial feedback on the project. A copy of the Notice of Commencement is provided in Appendix F. The public comments received after the Notice of Commencement are summarized in Table 24 along with the responses to each.

Table 24. Input Heard after Notice of Commencement

Comment	Response
How will existing ponds be modified to accommodate future development?	The Stormwater Master Plan includes assessment of how future development will affect existing infrastructure and evaluates and recommends solutions where needed to mitigate impacts of future development. See the assessments in Section 3 and the recommendations in Section 5.
Residents have commented on the need for more regular maintenance of stormwater management ponds and issues of high lake levels backing up into the residential areas near Harbour Street and Marina Drive.	These issues are assessed in the Stormwater Master Plan (See Section 3) and recommended solutions are outlined in Section 5.
Multiple residents have noted issues regarding groundwater flowing into their basements and the necessity of running sump pumps to keep basements dry.	Recommendations of the Stormwater Master Plan address issues in overland flow pathways, storm sewers, and ponds. Basement flooding issues are not within the scope of the Master Plan.
When and where will monthly status reports be made available?	Monthly status reports will be posted to the project webpage (https://www.brighton.ca/en/municipal-services/storm-water-masterplan.aspx) after they are presented to and discussed with Council.

4.1.2. Notice of Public Information Centre

The Notice of PIC was mailed directly to residents, stakeholders, and Indigenous communities on the mailing list on August 30, 2018. The notice was also published on the Municipality's project webpage and in the local newspaper The Brighton Independent on August 29 and September 6, 2018. The notice provided a project description, description of work completed to date, information regarding next steps, and a request for comments and input. Contact information for Municipality's project manager was also provided to encourage the submission of comments. A copy of the Notice of the PIC is provided in Appendix F.

4.1.3. Public Information Centre

The PIC for this project was held on September 13, 2018. It was attended by 17 people consisting of residents, one Municipal councillor, and the Mayor. The project team, including Olivia Sparrow, Anneliese Grieve, Mike Gregory, and the Municipal staff, were in attendance to answer questions from attendees. The following elements were presented at the PIC:

- Why does Brighton need a Stormwater Master Plan
- Overview of the Municipal Class EA Planning Process
- Background information about stormwater, the impacts of impervious surfaces, and how stormwater can be managed
- Characterization of the study area
- Summary and map of existing stormwater infrastructure in the study area
- Map of implementation areas to address deficiencies in existing storm sewers, ponds, and overland flow routes
- Solutions to address capacity deficiencies, including new infrastructure, policies, and programs
- Strategies to fund the Stormwater Master Plan
- Next steps

Copies of the display boards presented at the PIC are provided in Appendix F. Input heard at and after the meeting is summarized in Table 25 in addition responses.

Table 25. Input Heard at and after Public Information Centre

Comment	Response
Will there be a timeline for implementing the Stormwater Master Plan?	Yes, the plan includes a recommended timeline. See Section 5.7.
Concerns regarding sediment from storm sewers emptying into the Bay and implications for water quality and dredging frequency along docks.	The Stormwater Master Plan will include municipal projects and maintenance to improve the quality of stormwater as well as standards for land development to prevent sediment from getting into the storm sewer system.
When and where will monthly status reports be made available?	Monthly status reports will be posted to the project webpage (linked above) after they are presented to and discussed with Council.

Comment	Response
The roadside ditch and culvert system at Harbour Street and Marina Drive has insufficient capacity to manage high lake levels and runoff from the contributing drainage area. Surface drainage needs to be addressed for the area bounded by Cedar St to Marina Dr and Raglan St to Harbour St to mitigate capacity limitations, flood risk, and improve the quality of runoff before it reaches the Bay.	The Stormwater Master Plan includes this neighbourhood in one of the implementation subwatersheds that requires multiple improvements to better control and convey stormwater to mitigate flood risk at Harbour Street and Marina Drive (See Figure 19and Table 17). The Stormwater Master Plan report does not include design of the retrofits needed to address the issues in this subwatershed. The improvements will be designed as part of the implementation activities recommended in the Plan.
There are drainage issues in the areas near the southeast corner of Proctor Park, including parts of Young Street, North Drive, and Cheer Drive. Issues relate to aging and buried culverts along North Street, modified overland drainage pathways due to placement of fill, erosive flows, and future development. Installation of storm sewers, rain gardens, and/or improved ditches would help address these issues.	The Stormwater Master Plan includes this neighbourhood in one of the implementation subwatersheds that requires multiple improvements to better control and convey stormwater using a treatment train approach (See Figure 19and Table 17). Brighton's property standards By-law prohibits the alterations to property grading that affects drainage on adjacent properties except if given prior written approval from the Municipality.
The Plan should consider proper maintenance of creeks since they are part of the stormwater system. There is excessive bank erosion on the tributary to Butler Creek at the east end of Grimes Street that should be addressed by the Municipality.	The Stormwater Master Plan has identified the conditions of the creeks through the study area as they relate to stormwater management on Municipal land and areas under Municipal jurisdiction. The plan introduces new criteria for stormwater management retrofits and future development relevant to protecting creeks, including enhanced level sediment control, erosion control standards, temperature standards, and runoff volume standards. Lower Trent Conservation is responsible for managing risks associated with the creeks in the study area and can provide advice regarding plantings and other assistance with minimizing erosion. The Municipality is not proposing stream stabilization or restoration work as part of the Stormwater Master Plan.
The roadside ditch on north side of Main Street and east of Simpson Street does not completely drain south to the opposite side of Main Street.	The Stormwater Master Plan identified this area as a low risk depression relative to other depressions in the landscape throughout the study area (See Figure 19). The Plan recommends that areas like this be addressed as part of road improvement projects and that risk be mitigated to the extent possible by adjacent development which is anticipated to the south of this issue area.
The culvert crossing Percy Street on the north side of Main Street is blocked with debris and vegetation.	The Stormwater Master Plan includes a recommended maintenance plan for culverts and ditches (See Section 5.1), including annual inspections and ongoing preventative maintenance, such as cleaning out debris from ditches and culverts.
A developer in the community noted that the process of planning a land development has been challenging due to discovery of existing drainage issues upstream and downstream of subject properties.	The Stormwater Master Plan identified prioritized deficiencies in the stormwater management system in Figure 19. These deficiencies were identified through pond inspections and sediment accumulation assessments (Appendix B), development of the Brighton Urban Area Hydrologic and Hydraulic Model (See Appendix C), and the depression analysis (Appendix D). The prioritization of storm sewer capacity deficiencies are shown in Figure 45 and Figure 46, in addition to other useful maps in Appendix C developed using the model results.

Comment	Response
The Brighton by the Bay Homeowners Association (HOA) reported that sediment in Brighton by the Bay pond was removed in 2012 and has quickly accumulated again since. The contractor cleaning out the pond reportedly identified sediment accumulation in the storm sewer inlet from Mills Road. The HOA suggests that after completion of development of the lands draining to the pond, that all storm sewers and catchbasins be inspected and cleaned out prior to assumption and that on a regular basis maintained to extend the remediation cycles of the pond.	The Stormwater Master Plan identifies that cleanout of Brighton by the Bay pond is recommended. The Plan defines "Cleanout" as the removal of sediment and debris from the facility, inlet, outlet, and upstream drainage system to restore the original intended capacity of the facility. The maintenance procedures recommended in the Plan (See Section 5.1) include inspection and preventative maintenance, such as catchbasin cleaning, to extend the lifecycle of a pond between cleanouts. The Plan has provided a map of storm sewer pipes that are more likely to accumulate sediment to assist the Municipality in prioritizing inspections and cleanouts (See Figure 57 and Figure 58).
The Brighton by the Bay HOA noted that the pond water level will be raised to provide more capacity in the pond. The HOA suggested that a deeper water level (at least 4 feet) will inhibit the incursion of vegetation and will keep the pond functional, attractive and extend the remediation cycles of the pond.	The Stormwater Master Plan does not include design of pond retrofits, however the Plan does identify which ponds have insufficient capacity for managing quantity and/or quality of runoff and provides recommended next steps such as feasibility studies and design. The summary of maintenance needs for Brighton by the Bay Pond provided in Table 13 includes the recommendation that future feasibility assessments consider the option of increasing the depth of the permanent pool in the pond.
The Brighton by the Bay HOA reported significant volumes of water are pumped by sumps in the homes around the neighbourhood and are discharged to their lawns but often overflow onto the roads. Slippery slime and ice develop along the consistent flow of sump discharge on the roads in summers and winters, respectively, creating a risk of falling accidents. The HOA suggests that connecting the sump discharge more directly to the storm sewer system.	Recommendations of the Stormwater Master Plan address issues in overland flow pathways, storm sewers, and ponds. Basement flooding issues are not within the scope of the Master Plan. In terms of managing continuous streams of overland flow along the road, the Plan includes this neighbourhood as one of the implementation subwatersheds that require multiple improvements to better control and convey stormwater using a treatment train approach (Table 16), including the need to address fall risk along the road.

Comment	Response
The Brighton by the Bay HOA is aware that storage in the pond needed to be increased as part of the final phase of the Brighton by the Bay development, which is now underway. The HOA suggested that instead of raising the water level in the pond, the storage should be increased by deepening the pond. This is in addition to the other comment above related to deepening the pond for water quality purposes.	The final phase of the development was required to change a hydraulic control weir on Mills Road so that additional runoff would be directed to the pond instead of bypassing the pond by overtopping the weir. In this way, the final phase increased the amount of runoff being treated by the pond and its high water level, but did not change the normal water level that the pond returns to between rainfall events. The Stormwater Master Plan does not include the design of pond retrofits, however the Plan does identify which ponds have insufficient capacity for managing quantity and/or quality of runoff and provides recommended next steps such as feasibility studies and design. The summary of maintenance needs for Brighton by the Bay Pond provided in Table 13 includes the recommendation that future feasibility assessments consider the option of increasing the depth of the permanent pool in the pond.
The Brighton by the Bay HOA expressed interest in implementing stormwater retrofits upstream of the pond, such as in the private park managed by the HOA, to increase the resiliency of the pond.	The HOA and the Municipality are encouraged to discuss this partnership opportunity as part of achieving the objectives of the Stormwater Master Plan. Potential partners are identified in Section 5.6 of the Plan.
How many detention/retention ponds were assessed?	All eight stormwater management ponds were inspected and assessed in the Brighton Urban Area model. Sediment accumulation was assessed for the ponds that maintain a permanent pool.
Is Harbour Point Pond functioning as designed? If not, to what percentage is it functioning and how much has storage been reduced? What needs to be done to restore the pond to its intended design capacity and at what cost?	Harbour Point Pond is not functioning as designed. The current capacity and treatment efficiency of Harbour Point Pond is reported in Section 3.1.2 and Appendix B (Section B.4) of the Plan. The maintenance actions required in Harbour Point Pond are described in Table 13 and the estimated cost of cleanout is provided in Table 15.
Does the assessment of Harbour Point Pond account for drainage from Phase 2 of the Hamilton Woods development in its current configuration?	The assessment of Harbour Point Pond includes the current configuration of drainage infrastructure from Hamilton Woods Phase 2 to Harbour Point Pond. The scope of the modeling conducted in this Plan was focused on surface drainage and does not simulate groundwater discharge to surface water systems via French drains or foundation drains. However, Appendix C of the plan outlines multiple useful applications of the Brighton Urban Area model which could include adding groundwater/surface water interactions.
A resident was concerned about the feasibility of connecting the future storm sewer network from the Hamilton Woods development to Harbour Point Pond across Nautical Lane due to the width of the easement and depth of excavation necessary to install the pipe.	These types of considerations are reviewed by the Municipality and Lower Trent Conservation when drainage plans are submitted by the developer. Reviewing this concern is not within the scope of the Stormwater Master Plan.

Comment	Response
Will the work done in June and August of 2018 to Harbour Point Pond affect your assessment of Harbour Point Pond? The work involved spreading sediment that had been removed from the pond around the pond. Were the results of soil tests conducted in September 2018 shared with the consulting team for the Stormwater Master Plan?	The Stormwater Master Plan includes recommended procedures for maintaining stormwater management ponds (See Section 5.1) in accordance with applicable guidelines for pond maintenance (Toronto and Region Conservation Authority and CH2M Canada 2016). The Plan also provides specific maintenance recommendations for each pond based on the inspection and sediment accumulation assessment (See Section 3.1.2 and Appendix B.4). Municipal staff confirmed that sampling of Harbour Point Pond sediments in 2018 found pollutant concentrations within the allowable limits for beneficial reuse of the sediments on-site. The estimated cost for cleaning out the remainder of Harbour Point Pond assume that similar pollutant levels will be found during sediment sampling conducted prior to cleanout and that off-site disposal is not included. To clarify, the work done in June and August of 2018 in the pond did not include a cleanout of all sediment accumulation in the pond; it was focussed on vegetation maintenance, which resulted in sediment management.
What funding could help offset costs for all the ponds and for the Stormwater Master Plan?	Appendix G includes description of the alternative funding strategies for maintaining existing infrastructure and constructing new or retrofit infrastructure. Multiple grant opportunities are listed under Section G.2.4.1.
What vegetation do you recommend be planted around the ponds that will help keep Canada Geese and Swans away?	Vegetation taller than mowed grass is a major deterrent for geese. Establishing native vegetation and no-mow zones along the shorelines of ponds has multiple benefits in comparison to mowed turf grass, including the deterrence of geese and swans. In areas where geese populations are extremely large, temporary fenced exclosures are necessary for 1 to 2 years to establish the buffer. The Plan includes recommendations for native plantings around ponds in Appendix I.
What vegetation for stormwater management facilities is tolerant of road salt?	Recommended plants for stormwater management facilities is provided in Appendix I, although the plant list is not a comprehensive list of all possible species that could be appropriate. The success of plantings in facilities receiving road runoff is also influenced by the hydraulic design of the facilities and best practices include ensuring sufficient outlet such as a draintile to sustain flow through the soil media of rain gardens and tree trenches, preventing the accumulating of salt in the soils.
Will the plan provide proper maintenance procedures and record keeping as set out by the MOECC in 2003?	The Stormwater Master Plan includes recommended procedures for maintaining stormwater management ponds (See Section 5.1), including record keeping, in accordance with the *Stormwater Management Planning and Design Manual* (Ministry of the Environment 2003), Environmental Compliance Approvals, and applicable guidelines for pond maintenance (Toronto and Region Conservation Authority and CH2M Canada 2016).
The MOECC/MECP was working on updating the 2003 guidelines for detention ponds. Do you know if this was completed? If so, could you provide us with a copy of the updated manual?	The Ministry of Environment, Conservation and Parks is developing new guidance focussed on Low Impact Development, which will build off of the 2003 *Stormwater Management Planning and Design Manual*. The Low Impact Development Guidelines have not yet been published, however preliminary documents were released for comment in 2017 (https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTMwOTcz&statusId=MTk4NDg3) and presented at a conference in Toronto (https://trieca.com/app/uploads/2016/07/6-A-1-Chris-Denisch-John-Antoszek-2017-LID-Stormwater-Management-Guidance-Manual.pdf).

4.1.4. Notice of Completion

The Notice of Completion informs stakeholders of the completion of the Class EA and provides the location(s) where stakeholders can review the completed Project File. The notice also informs the public of the 30-day review period associated with the conclusion of the EA process. During this review period, concerned individuals have the right to raise and discuss issues prior to requesting a Part II Order before the project may proceed to implementation. A copy of the Notice of Completion will be provided in Appendix F in the final report.

4.2. Indigenous Community Consultation

This section provides an overview of the Indigenous community consultation process, issues raised to date, and how these issues have been addressed.

The MECP recommended on April 13, 2018 that the following Indigenous communities be consulted as part of this study:

- Alderville First Nation
- Curve Lake First Nation
- Mississaugas of Scugog Island First Nation
- Hiawatha First Nation
- Mohawks of the Bay of Quinte

The Notice of Commencement was distributed to each of these communities on May 3, 2018, addressed to the Chief and copied to the relevant consultation staff representative(s). In addition, each staff representative was contacted by phone and e-mail to follow up on the Notice of Commencement. The purpose of these contacts was to facilitate communication, inquire if additional information was required and seek feedback on any specific Indigenous values that should be considered during the Study.

Telephone conversations resulted with staff at two communities, Hiawatha First Nation and Mississaugas of Scugog Island First Nation, who identified the following issues and the corresponding responses:

- Requested a map of the Study Area to clarify the affected area. *Response: a map was provided.*
- Potential concern over quality of effluent from stormwater, based on previous experience with impacts to cold water fisheries from an unrelated road project in another municipality. *Response: Mitigating temperature and other water quality impacts of urban development are incorporated into the Plan's recommendations for policies for future development and strategies for municipal infrastructure retrofits.*
- Preference for avoidance over mitigation of impacts. *Response: The Stormwater Master Plan recommends the adoption of Low Impact Development strategies that focus on treating rainfall close to where it falls rather than the use of end-of-pipe facilities. The Plan also recommends new maintenance procedures that will prevent erosion and sediment transport rather than collecting sediment in centralized basins. The Plan also introduces new standards for stormwater management that will maintain water balance and runoff volumes, both of which will aid in preventing cumulative impacts to downstream resources.*
- Which Indigenous communities were being consulted and that the Study Area is within the Williams Treaty Nations' traditional territory. *Response: See discussion in this section.*

Information was provided during the call, or in a follow-up e-mail in response to these issues, as well as the responses outlined above. For the remaining communities, either no reply was received or a telephone conversation could not be arranged.

The Notice of Public Information Centre ("PIC") was distributed to each of the above communities on August 30, 2018, again addressed to the Chief and copied to the relevant consultation staff representative(s). As with the Notice of Commencement, each staff representative was contacted by phone and e-mail to follow up on the Notice. Telephone discussions took place with staff at Mississaugas of Scugog Island, Hiawatha and Alderville First Nations. The representatives generally did not anticipate concerns or attendance at the PIC, but wished to continue to receive information about the Study. No response was received from Mohawk of the Bay of Quinte. Curve Lake First Nation provided a written response to the Notice of PIC, including the following areas comments:

- Identified potential areas of concern, namely: "…possible environmental impact to our drinking water; endangerment to fish and wild game; impact on Aboriginal heritage and cultural values; and to endangered species; lands; savannahs, etc."
- Stated that the Study was considered a Special Consultation Framework project under the Curve Lake Consultation Protocol
- Suggested further communication with the Williams Treaty Claims Coordinator, representing all seven Williams Treaty Nations.
- Advised that Curve Lake has not completed detailed archaeological studies in the Brighton Urban Area.

These issues were addressed by the consultant during a telephone call with Curve Lake consultation staff representatives on September 27, 2018. The consultant explained that the focus of the Master Plan will be on improving the quality of urban runoff through a Low Impact Development approach to stormwater management. This addressed many of the environmental impact concerns. Providing recommendations in the Master Plan to conduct archaeological assessment in accordance with Curve Lake First Nation's Archaeological Protocol where necessary for projects implemented subsequent to the Master Plan also addressed their concerns regarding impacts to Aboriginal heritage and cultural values. Based on the call, staff confirmed the Study would not require a Special Consultation Framework and asked to be included on updates, including the final draft plan. A letter confirming the foregoing and additional project information was sent in response to the Curve Lake letter on September 28, 2018. No reply has been received as of the date of this report. Additionally, information about the project was shared by e-mail with the Williams Treaty First Nations Claims Coordinator on September 28, 2018, as requested in the Curve Lake letter. No reply has been received as of the date of this report.

All other Study notices will be distributed to the Indigenous communities recommended by MECP.

4.3. Agency Consultation

Multiple project meetings were held throughout the study with the Municipality's project manager and representatives from Lower Trent Conservation and Northumberland County to provide ongoing technical input to the project team. All notices were mailed directly to representatives at Lower Trent Conservation, Northumberland County, MECP, MNRF, and the Ministry of Tourism, Culture, and Sport (MTCS). The response from the MECP defined the Indigenous communities to be consulted as part of this plan as well as other requirements of a Municipal Class EA Master Plan and technical review. The MNRF provided screening of natural heritage features in or near the study area including wetlands, ANSIs, creeks, fisheries, and provincial Species at Risk. The Department of Fisheries and Oceans (DFO) confirmed the presence of habitat for federal Species at Risk. MTCS responded with guidance related to Aboriginal and Cultural Heritage, including use of MTCS checklists.

5. STORMWATER MASTER PLAN

The SMP includes recommendations for the Municipality to implement a maintenance program, retrofit projects, policies, education/outreach, and administration. Partnership with other agencies and property owners will aid in managing stormwater across the community. Each element of the Master Plan is described in this section. A recommended implementation schedule as well as other considerations are outlined at the end of this section.

5.1. Maintenance Program

All stormwater management systems require proper design, construction and maintenance to perform successfully. Historically, stormwater management systems were designed to transport stormwater runoff safely and efficiently from one location to another. Given that these systems were designed to transport or impound runoff from a relatively rare storm event (i.e. recurrence interval of 10, 25 to 100-years) they may experience maximum design conditions a few times in their lifetime. This resulted in lower maintenance requirements over the lifetime of the infrastructure.

However, in response to growing concerns over nonpoint source pollution, flooding and erosion, a new type of stormwater management system has evolved. Modern stormwater management system designs not only convey runoff but also manage runoff by deliberately modifying its flow rate, volume and water quality. Modern stormwater management systems thus address a wider range of concerns by utilizing a variety of techniques such as infiltration, extended dry or wet detention, sand filters, vegetated swales, and Green Infrastructure. Given the complexity of the issues stormwater systems are being designed to address, they have become more complex in nature. The new types of stormwater management facilities include smaller Low Impact Development practices that are design to capture small and frequent rainfall close to where it falls. These types of facilities will experience design conditions more often than end-of-pipe facilities designed for the larger, less frequent events across larger drainage areas.

As stormwater management becomes an increasingly important part of the Municipality's efforts to achieve clean water and a safe environment, so too does regular inspection and thorough stormwater system maintenance. While much of the inspection and maintenance roles and responsibilities for private development projects are addressed by the Municipality's By-Laws, there are operation and maintenance activities that the Municipality is responsible for performing. The statutory obligations and liabilities for Municipalities regarding stormwater management facilities are defined in the *Ontario Water Resources Act* (OWRA). The Municipality is required by the MECP to inspect, maintain, replace, and repair municipal stormwater management facilities and infrastructure in accordance with the Environmental Compliance Approvals (ECAs) issued for the facilities by the MECP that outline the operations, maintenance, inspection, monitoring, and reporting requirements for these facilities. A municipality may be convicted of an offence under the OWRA, and face fines of up to $500,000, if it fails to comply with its obligations under an ECA. Another municipal obligation defined in the OWRA is regarding the situation when a municipality is directed or ordered by a MECP Director to maintain, repair, or operate a SWMF in a specific manner. Depending on the facts, if the municipality fails to comply with an order, an external body may conduct the necessary work on the

SWMF, and the associated costs can be recovered directly from the municipality. Separate from the OWRA, Municipalities may also face liability under the common law tort of negligence in scenario that property is damaged subsequent to the Municipality failing to adequately maintain a stormwater management facility, however there is uncertainty because there have been no court decisions on these types of issues.

The following recommendations for the Municipality's stormwater maintenance program were developed based on the requirements in applicable ECAs as well as the Ministry of Infrastructure of Ontario's guidelines "BUILDING TOGETHER: Guide for Municipal Asset Management Plans" (2012). This is an annual recurring program for the Municipality to conduct inventory, monitoring, and inspections of stormwater management facilities, prioritize maintenance needs, implement preventative maintenance works, and develop/implement designs of corrective actions needed to restore the intended function of the facilities. As per Section 2 Baseline Conditions, many of Brighton's stormwater ponds are not functioning properly because of extreme sedimentation. If nothing is done, sedimentation will continue and could potentially block the pond outlets, leading to flooding of lower lying areas for which the Municipality can be held legally liable for property damages.

5.1.1. Inventory

Keeping an up-to-date detailed inventory of all municipal stormwater management assets is required to effectively manage and maintain assets. Many of the Municipality's stormwater assets have been mapped as part of this plan and were partially inventoried in past studies (GENIVAR 2009; Associated Engineering 2013). Gaps remain regarding the information about certain assets, such as the diameter of culverts. As Brighton continues to grow, new infrastructure will need to be added to the Municipality's database of stormwater management infrastructure. The database should be updated annually using as-built drawings submitted by developers and contractors.

Building from the current database, the stormwater assets to be inventoried including storm sewers, culverts, manholes, catchbasins, outfalls, ditches/channels with more than 1 m bottom width, ponds/constructed wetlands, infiltration facilities, oil-grit separators (OGSs), and LID/Green Infrastructure. All inventory information should follow the format outlined in the Ontario Structure Inspection Manual. Electronic data is preferred, but paper form would also be acceptable. At a minimum, the following information should be documented for each asset:

- Type and identification number of asset (e.g. pipe # A35, manhole # A35-1, pond #1, etc.)
- Material (e.g. CSP, RCP, PVC, etc.)
- Location
- Dimensions (incorporate picture in the database)
- Years of construction year and last inspection
- Probability of failure as defined on page 4-20 of the AMP (age ÷ expected life)
- Invert elevation and depth

- Consequence of failure using the following ranking system:
  - Storm Sewers & Culverts — < 450 mm = score of 1; 450 mm - 1050 mm = score of 2; 1,051 mm – 2,000 mm = score of 3; 2,001 mm – 3,000 mm = score of 4
  - Manholes & Catchbasins — ≤ 2 m deep = score of 1; > 2 m deep = score of 2
  - Ditches — 1 m – 2 m bottom width = score of 1; > 2 m bottom width = score of 2
  - Wet & Dry Ponds / Constructed Wetlands — < 4,000 m^3 = score of 3; 4,000 m^3 - 8,000 m^3 = score of 4; > 8,000 m^3 = score of 5
  - OGS, LID/BMPs & Skimmers — Score 1 to 5 depending upon the quality of the downstream resources impacted by failure or defective operation

5.1.2. Inspection

Annual inspection of municipal stormwater management facilities is required in accordance with the ECAs. A template inspection form is provided in Appendix H for use when inspecting the existing wet ponds, dry ponds, and constructed wetlands. Oil-grit separators must be inspected per the manufacturer's instructions. Future inspections may need to be tailored to other types of stormwater assets constructed in the future or based on specific conditions outlined in permits, operations plan, or found in previous inspections of a facility. Inspectors should assess the condition and performance of the assets using a consistent scale, such as the scale presented in Table 26. The recommended frequency and type of inspection activities for many types of stormwater assets are outlined in Appendix H (Table 55). As described throughout the table, inspection of all stormwater assets will offer multiple benefits such as identifying the need for preventative maintenance (e.g. cleaning out storm sewers) that will reduce the frequency of costly corrective actions (e.g. cleaning out the downstream pond). In addition, areas with known nuisance drainage issues should be inspected prior to major storm events to identify and clear any debris or blockages. If the Municipality implements the recommended maintenance schedule in this plan as well as enforcement of erosion and sediment control standards, the Municipality will not need to conduct detailed bathymetric survey within the next 10 to 30 years. However, sediment accumulation analysis will be needed more frequently if rapid sediment accumulation continues. Recommendations for assumption protocols and sediment control requirements for developers are outlined in Section 5.3 Policies to mitigate the cost to the Municipality in this situation.

Table 26. Grading Scale of Condition and Performance

Rating	Letter Grade	Description
5	A	Excellent: No noticeable defects.
4	B	Good: Minor deterioration.
3	C	Fair: Deterioration evident, function is affected.
2	D	Poor: Serious deterioration, function is reduced.
1	F	Critical: No longer functional, general or complete failure.

The Municipality currently assesses the need for ditch and culvert improvements as part of the Road Needs Studies, the last of which was conducted in 2013. It is recommended that these studies be conducted every five years to identify urgently needed ditch and culvert repairs, and every ten years for identifying major road reconstruction projects. Continuation of other inspection programs already in place, such as the CCTV inspections of storm sewers called for in the Municipality's *Asset Management Plan*, are also recommended.

5.1.3. Monitoring

Monitoring is required by the MECP to comply with the ECAs issued for specific stormwater management facilities, as summarized in Table 27. During construction of private developments and stormwater management facilities, enforcement of erosion and sediment control standards (See Section 5.3) is strongly recommended to reduce the Municipality's inspection and cleanout costs after assuming ownership.

Table 27. Monitoring Requirements per ECAs

Pond	Parameters	Protocol	Method	Frequency	Duration	Location
1 Brighton By the Bay (BBB)	TSS	See ECA #3016-A7FQ2G, Section 5.4	Grab	Three rainfall wet events* per year	Until two years after 90% of BBB Phase 8 homes are occupied	Pond outlet
6 Tackaberry Ridge	TSS, Phosphorus, & Temperature	See ECA #5510-AQGKHS, Section 6.3	Grab	Three rainfall wet events* per year	In perpetuity	Pond inlets & outlets
All	Temporary Sediment & Erosion Controls	**	**	Once every two (2) weeks & after each significant storm event***	Ongoing during construction in contributing drainage area	Drainage area to pond

* A wet event is defined as a minimum of 15 mm of rain in the previous 24 hours. Two of the events must occur between May and September.

** Best practice guidelines such as Erosion & Sediment Control Guideline for Urban Construction (Greater Golden Horseshoe Area Conservation Authorities, 2006)

*** a significant storm event is defined as a minimum of 25 mm of rain in any 24-hour period

Lower Trent Conservation also monitors stream flow, temperature and rainfall in the study area. Continued support of these activities is recommended as it will inform future review of the effectiveness of Brighton's stormwater management strategy.

5.1.4. Preventative Maintenance & Corrective Action

The inspections conducted as part of this study identified preventative maintenance and corrective actions needed in the existing stormwater management ponds (see Table 13). The next steps for implementation of pond cleanouts/retrofits include the following which are detailed in applicable guidelines for pond maintenance (Toronto and Region Conservation Authority and CH2M Canada 2016):

- Sampling and analysis of sediment with respect to O.Reg. 153/04 Soil Standards
- Design of cleanouts/retrofits coordinated with other retrofit projects (See Section 5.1.2)
- Property acquisition (if required)
- Permits and approvals, including amended ECAs (if required)

Moving forward, the Maintenance Program will include annual implementation of preventative maintenance and corrective actions as defined by the findings of annual inspections. Proper maintenance of stormwater assets will sustain the functions of stormwater assets for the expected useful life outlined in Table 28 based on asset management planning guidelines for cold climates similar to Brighton. A comprehensive list of the optimal frequency of preventative maintenance and corrective actions is outlined in Table 56 (Appendix H).

The Municipality and their contractors should follow best practices for managing invasive species in the ponds. Best practices for the management of common reed are outlined in Appendix H.

The Maintenance Program will also include remedial erosion and sediment control measures to mitigate issues identified at constructions sites in accordance with the ECAs of each facility.

Table 28. Expected Useful Life for Various Stormwater Assets When Properly Maintained

Stormwater Asset	Years
Gravity Pipes/Culverts (Concrete, Brick, Vitrified Clay, Ductile Iron)	100
Gravity Pipes (HDPE, PVC, Truss Pipe)	100
Gravity Pipes/Laterals/Culverts (Corrugated Metal)	50
Laterals (Concrete, Brick, Vitrified Clay, Ductile Iron)	50
Laterals (HDPE, PVC, Truss Pipe)	50
Pressurized Mains	100
Manholes (Brick and Concrete)	100
Catchbasins	50
Outfalls	75
Ditches/Open Channels (excluding standard, roadside grassed ditches)	100
Dry and Wet Ponds, including Constructed Wetlands (Basin/Outlet)	100/50
Infiltration Basins (Natural Soils)	50-100
Infiltration/Infiltration Basins (Engineered Soils, Drain tile)	50
Other LID/BMPs	30-100
OGS	50-100
Skimmers	30-75

5.1.5. Reporting & Record Keeping

Annual reporting will be a necessary step at the end of each year to summarize the findings of annual inspections, record the previous year's maintenance actions, and prioritize recommended maintenance actions for the next year. The annual maintenance report should be used to inform the annual budget of the subsequent year using the relative scoring of each facility's probability and consequence of failure to prioritize corrective actions (See Section 3.1.2). The MECP also requires annual performance reporting in addition to records of inspection and maintenance for the previous five years. The annual monitoring report should include the following:

- Summary of what was inspected and the findings
- Summary of erosion and sediment control inspections and remedial measures taken
- Performance assessment of Brighton by the Bay wetland (every 5 years) and Tackaberry Ridge Pond (every year) using monitoring results compared to intended design
- Summary of maintenance and cleanouts implemented
- Summary of prioritized maintenance action for following year
- Appendix for each asset with an ECA (e.g. ponds and OGSs) including the following details:
    - inspection record with date and findings
    - erosion control inspection records, including date, name of inspector, and remedial measures taken
    - maintenance and cleaning records with estimated quantity of material removed
    - detailed monitoring results (applicable only for Brighton by the Bay wetland and Tackaberry Ridge Pond)

The municipality should require contractors conducting maintenance activities to provide a summary report that includes the name of the stormwater asset, the date and results of maintenance/cleanout, and the quantity of material removed. These summary reports should be appended to the annual monitoring report.

5.1.6. Asset Management Planning

The Municipality's Asset Management Plan (AMP) includes an inventory and condition assessment of storm sewers, manholes, and catchbasins in addition to other water/wastewater assets. The AMP recommended performance indicators, data needed to assess level of service, and road segments requiring storm sewer replacement. The AMP included a forecast of the cost of replacing storm sewers according to their estimated service life. The following updates to the AMP are recommended to inform budgeting decisions and show the evidence of need that is required for securing certain Provincial and Federal funding for infrastructure replacement:

- Update the inventory a valuation of stormwater assets to include all other types of stormwater infrastructure (e.g. outfalls, culverts, ditches/channels, ponds, infiltration facilities, and OGSs) and the storm sewers, manholes, and catchbasins that were missing from / constructed since the previous AMP.
- Update the recommended operation and maintenance activities to include the inspection recommendations in Table 55 (Appendix H).
- Replace the diameter used in the risk matrix with the consequence of failure recommended in the "Inventory" section to provide scores for each type of stormwater asset.
- Include projected growth of stormwater assets.
- Consider that preventive maintenance and corrective actions can increase the asset's life and lower overall replacement costs.
- Track the following operational indicators to the performance indicators:

  - Percentage of Stormwater Network that is inspected annually by asset (e.g. percentage of ponds inspected annually).
  - Operating cost by stormwater asset (i.e. operating cost per km. of pipe or ditches, operating cost per culvert, operating cost per pond, etc.).
  - Number of customer requests received annually per stormwater asset.
  - Percentage of customer requests responded to within 24 hours per stormwater asset.
- As noted in the AMP, level of service (e.g. storm sewer capacity) is not considered in the AMP but may be another reason to replace or improve stormwater management infrastructure components. The comprehensive storm sewer model for the Brighton Urban Area should be used to input the target and existing level of service into the asset management database. Dual drainage features will need to be added to the model to assess storm sewer capacities for major storm events.

5.2. Infrastructure Retrofit Projects

Municipal capital improvement projects are recommended to address quantity and quality control deficiencies in the existing stormwater management system, including limitations in conveying, controlling, and treating stormwater. Eight high priority subwatershed improvement projects are described in Section 3.3 and illustrated in Figure 19 (Appendix A) in addition to other stand-alone deficiencies shown in the map. Implementation of improvements to address these deficiencies are recommended through the following municipal infrastructure programs:

1. **Road reconstruction projects** implemented based on the priorities of Brighton's *Road Needs Study* (The Greer Galloway Group Inc. 2013), which will be implemented as Municipal Class EA projects, will proactively incorporate stormwater management improvements using the treatment train approach.
2. **Storm sewer replacements** prioritized to manage aging infrastructure as outlined in Brighton's *Asset Management Plan* (Associated Engineering 2013) will include additional stormwater improvements where possible, which could also mitigate the need to increase storm sewer sizes.
3. A new program will be initiated to implement **subwatershed improvement projects** described in Section 3.3 and illustrated in Figure 19 (Appendix A). The projects will utilize the treatment train approach to address multiple issues in each subwatersheds mapped in Figure 19. These projects will proceed along the Class EA process to develop alternative design concepts for the preferred alternative (i.e. the treatment train approach). The next steps for implementing the subwatershed improvement projects include:
   - Additional data collection and analysis, including geotechnical, survey, utilities investigation.
   - Develop design concepts using the additional data and provide a detailed inventory of opportunities for source, conveyance and site control practices.
   - Evaluate design concepts using modeling relative to the proposed quantity and quality control objectives.
   - Consultation around specific objectives for quantity and quality control, as well as the alternative design concepts.

- Detailed design.
- Permits and approvals.
- Secure funding.
- Property acquisition, if necessary.

Other opportunities to address drainage deficiencies are included in this plan under partnerships with land owners and other agencies / stakeholders (Section 5.6). New policies are recommended in Section 5.3 that will require new and re-development projects to account for downstream deficiencies in their stormwater management plans.

5.3. Policies

Municipal policies provide a means to improve the stormwater management practices used to control increased stormwater runoff, pollutants, and modified water balance caused by private land development. Policies relevant to stormwater management in Brighton include the Engineering Design Guidelines and the Official Plan, the latter of which is reviewed and updated as necessary every five years. The minimum expectations for subdivision and site plan approval are defined in the Engineering Design Guidelines, including stormwater management (Section E Storm Drainage), sediment and erosion control (Section E 1), required submissions (Section A 2, 4, 5, 6, and 7), and assumption of infrastructure (Section A 8) (Municipality of Brighton 2018). The Official Plan defines overarching objectives of the Municipality with respect to protecting the environment and water (Section 2.4.12) and specific criteria for managing stormwater (Section 3.5). Recommended updates to the stormwater management and erosion control standards in the Engineering Design Guidelines are outlined in Table 29 to align them with the Official Plan and to address the stormwater management objectives of the Stormwater Master Plan. The purpose of these standards are to make fair and reasonable demands of developers to ensure that the interests of the residents of the new development and the Municipality as a whole are protected. The next amendment of the Official Plan should incorporate the findings and recommendations of the Stormwater Master Plan.

Table 29. Recommended Updates to Stormwater Management and Erosion Control Standards in Brighton

	Standard	Objectives
1	Control rate of runoff to pre-development levels.	
2	Control runoff volume to pre-development levels. Pre-development levels must include the storage provided by on-site wetlands.	
3	Control water balance to pre-development levels.	
4	Where the receiving watercourse is a coldwater stream, mitigate thermal impacts by infiltrating the runoff volume generated by a two-year, 24-hour storm event. The bottom of infiltration facilities must be at least 1 m above the seasonally high water table, bedrock or other impeding layer. If this infiltration standard is determined infeasible, site runoff must be non-erosive and routed through a subsurface system, flow spreader, cooling trench or other device that discharges water through or across the ground at a discharge temperature lower than the temperature of ambient soil. Other temperature mitigation measures may be considered towards achieving this standard, such as shoreline planting, shading with trees, and bottom draw outlets from ponds. Bottom draw outlets must have an invert 0.5 m above the bottom of the facility to prevent sediment from entering the pipe. Bottom draw outlets must discharge to an outfall designed to restore dissolved oxygen.	
5	Over-control runoff rate and volume to address constraints and flooding issues in the downstream system (See deficiencies in Figure 19, Figure 45, and Figure 46) and address objectives of the Subwatershed Improvement Projects (Table 17).	

6	Preserve existing water storage capacity in the 100-year floodplain of all waterbodies and wetlands.	
7	Post-development runoff should not significantly alter the depth and duration of inundation in wetlands.	
8	Do not unreasonably burden adjacent property owners with altered stormwater flows at a property boundary by changing land contours, diverting or obstructing surface or channel flow, or creating a basin outlet.	
9	Design stormwater management facility outlets to operate under free-flowing conditions, where possible. Otherwise, determine the return period water surface elevations of the receiving water body (e.g. Lake Ontario) and assess performance of the proposed stormwater management infrastructure under submerged outlet conditions.	
10	Design all stormwater management facilities in accordance with the most current *Stormwater Management Planning and Design Manual* (Ministry of the Environment 2003), *Low Impact Development Stormwater Management Planning and Design Guide* (Credit Valley Conservation and Toronto and Region Conservation 2010) and Lower Trent Conservation Authority requirements.	
11	Follow the Landscaping Guidelines outlined in Appendix I regarding plantings, maintenance access, public safety, signage, fencing, and mosquito management. Use of mild slopes (6:1) and a safety bench with emergent vegetation around the permanent pool is preferred to installing perimeter fencing around ponds.	
12	The preferred order of stormwater management practices is: (1) lot level and source controls, (2) transport and conveyance controls, and (3) end-of-pipe controls.	
13	Design stormwater infrastructure using the rainfall intensity-duration-frequency curve defined for the project site using MTO IDF Curve Lookup Tool and with rainfall intensities increased by 15% to account for climate change.	
14	Design the minor system to convey at least the 5-year event and the major system to convey the 100-year and Regional events.	
15	Foundation Drainage: • Design the lowest floor elevations of proposed buildings at least 0.5 m above the measured seasonally high groundwater table to minimize the flow from foundation drains into the municipal stormwater management system. • "In areas where the seasonally high water table is within 1 metre of the building foundation drains, sump pumps should not be utilized. This requirement is imposed to prevent excessive sump pump operation and to prevent a looped system whereby the sump pump discharges maintain the foundation drainage. Where the use of sump pumps is not feasible, a "third pipe" may be used to convey foundation drainage to the receiving water." (Ministry of the Environment 2003)	
16	Provide a minimum of Enhanced Level 1 water quality treatment for all land development projects in the study area, as is appropriate to protect the coldwater streams and Provincially Significant Wetlands.	
17	Design stormwater manholes and catchbasins with sumps (i.e. an invert that is below both the inlet and outlet pipes) to store sediment and debris.	
18	Prevent erosion and control sediment on all land-altering projects in accordance with the Erosion and Sediment Control Guideline for Urban Construction (Greater Golden Horseshoe Area Conservation Authorities 2006). Permanent Stormwater Management Ponds cannot be used as temporary sedimentation basins during construction.	
19	Conduct the necessary inspections and maintenance required by the Ministry of Environment, Conservation and Parks as defined in the Environmental Compliance Approval for each facility. Records demonstrating compliance with these requirements must be provided to the Municipality prior to assumption.	
20	Stormwater management and erosion control standards are applicable to all new and redevelopment projects.	
21	Provide a stand-alone operations and maintenance manual for each stormwater management facility, including a facility location map, a diagram of the facility components, inspection checklists, description of maintenance activities, and expected frequency of maintenance activities. Include recommended approach for removing sediment accumulation from the facility.	
22	Amend Section A 8.00 Acceptance of Services with the following: • "Applicable standards" include the conditions of the Environmental Compliance Approval for the facilities, the most current *Stormwater Management Planning and Design Manual* (Ministry of the Environment 2003), *Low Impact Development Stormwater Management Planning and Design Guide* (Credit Valley Conservation and Toronto and Region Conservation 2010), Lower Trent Conservation	

	Authority requirements, and the Municipality's Engineering Design Guidelines. Detailed assumption protocols for stormwater management facilities. • "Cleanout" is defined as the removal of sediment and debris from the facility, inlet, outlet, and upstream drainage system to restore the original intended capacity of the facility. Specify that cleanout must be accompanied by stabilization of the facility and plantings per the Landscaping Guidelines (Appendix I) to prevent bank erosion and establish buffer vegetation. • Extend the guarantee period for stormwater management facilities to 100% buildout or otherwise require over-excavation of the facility and release of security at 90% to accommodate potential sediment load from the remaining 10% build out. • Definition of the protocol in cases of sequential development phases serviced by the same stormwater management facility (see discussion below).	
23	"Better Site Design" approach is required in consultation with LTC staff and will be enforced by Municipality as part of the Fill By-Law. Better Site Design includes practices such as preservation of existing vegetation communities and reduction in standard road and driveway widths as a means to reduce runoff.	

Reduce Flood Risk & Increase Resiliency to Climate Change

Protect Streams, Wetlands, and Presqu'ile Bay from Stormwater Impacts

Reduce Future Maintenance

Improve Public Safety

Enforcement of the Municipality's standards is critical to achieving the goals and objectives of the Stormwater Master Plan. As noted in Section 5.1, it is recommended that the erosion and sediment control standards, including the conditions of Environmental Compliance Approvals, be enforced by Municipal inspections during construction. Enforcement of submittal requirements, such as submitting as-built sketches, will also aid the Municipality in maintaining an up-to-date database of public stormwater management infrastructure.

Detailed protocols for assuming ownership of stormwater management facilities should be developed and incorporated into the Engineering Design Guidelines. Protocols will need to consider the scenarios of sequential development in phases to provide a fair approach to developers while also providing sufficient securities to maintain the pond if needed. Cleanout should be required at the end of each phase of development. Options for phasing the securities and sizing of regional (i.e. shared) facilities include the following:

1. Require the 1st developer to oversize and stabilize the facility so that it will serve ultimate development conditions. Reduce the development charges to the 1st developer by the cost of oversizing the facility. Increase the development charges for the 2nd developer in the same amount that they were reduced for the 1st. This option provides the Municipality with financial protection and benefits the system and downstream water bodies through over-treating until the 2nd development comes in place.
2. Require the 1st developer to size and stabilize the facility for the 1st phase of development only. The 2nd developer would have to enlarge it to cover the combined needs of both developments. This approach requires more logistical coordination for easements and access but is manageable for both developers and the Municipality, especially if development charges are equitably defined.

Other policies may be required as part of implementing the funding strategy for the Stormwater Master Plan which will be determined through a feasibility study (See Appendix G).

5.4. Education & Outreach

"The Official Plan alone cannot guarantee the environmental health of the community. Private stewardship of land, incentive programs, community based actions, and public education will go even further in the proper management of the environment." (Municipality of Brighton 2014)

Individuals within the community can make a significant difference in the performance of stormwater infrastructure and the health of natural heritage areas through their everyday activities. Residents are already interested in improving stormwater management in Brighton. An effective education program will enhance public participation in stormwater management activities and increase public knowledge related to protecting water resources such as Presqu'ile Bay Marsh. Education and outreach programs are recommended to provide residents, businesses and institutions with a good understanding of stormwater management, in addition to providing the resources and incentives for becoming stewards of Brighton's watersheds. The programs will include:

- Property owner education regarding what they can do to improve stormwater management through information on the Municipality's webpage and newspaper, and workshops on stormwater management practices, such as rain gardens.
- Information about responsibilities relating to stormwater management in Brighton for property owners, the Municipality, Lower Trent Conservation, and the province. Guidelines[3] are specifically needed to outline the division of responsibilities between these stakeholders.
- Cost share program to offset the cost of property owners installing rain gardens, rain barrels and disconnecting roof water drains.
- Stormwater retrofit credit program for properties with extra stormwater management beyond the minimum applicable standards (See Section 5.5).

In addition to public education, developers, consultants and contractors should be encouraged to attend the latest training in stormwater management practices (LID) and erosion control. In addition, Municipal staff could facilitate workshops for local builders, developers, and contractors on topics such as lot grading requirements in Brighton.

5.5. Administration

Implementation of the SMP will rely on the organizational capacity and structure of the Municipality to carry-through on recommendations. Multiple departments have responsibilities related to stormwater management as outlined in Table 30. The Municipality also plays a role through its annual funding of Lower Trent Conservation and participation on the board, which is a responsibility of Councillors or another designated person.

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[3] Example of a similar guideline:
http://www.ecosuperior.org/upload/documents/es_drainage_book_final.pdf

Table 30. Municipal Stormwater Management Responsibilities

Department	Stormwater Management Responsibilities
Development & Capital Infrastructure	Oversee the renewal of municipal stormwater infrastructure through capital improvement projects. See the recommended strategy in Section 5.2. Update Stormwater Master Plan every five to ten years.
Public Works & Environment	Maintain municipal stormwater infrastructure, monitor water quality in Brighton by the Bay and Tackaberry ponds, sweep streets, update the Municipality's Asset Management Plan, and oversee GIS/Data Management (See Section 5.1). Update the Municipality's Engineering and Design Guidelines (See Section 5.3). Coordinate public education and outreach (See Section 5.4) and respond to reported drainage issues.
Planning, Building, By-law & Community Development	Manage land use planning and review development applications in accordance with the Official Plan and Zoning By-law. Review and update the Official Plan at least every five years. Enforce Municipal By-laws. See Section 5.3 for recommended stormwater management standards.
Parks and Recreation	Maintain municipal parks and landscaped areas, including tree pruning and grass cutting.
Finance	Oversee taxation and water/wastewater billing, including the recommended funding strategy for the SMP (See below and Appendix G). Coordinate financial strategy of the municipality, including asset management planning (Section 5.1.6).
Fire	Protect the community under emergencies, such as emergency response to extreme weather events.

Capacity development will also be necessary so that staff have the required expertise to implement the recommendations of the SMP. In some cases, partnerships have been recommended where local expertise is readily available. Municipal staff training may include Certified Inspector of Sediment and Erosion Control (CISEC), Low Impact Development design/construction and maintenance.

Information management is currently a shared responsibility across multiple departments that presents challenges in accessing and updating relevant historical or current information for municipal projects and plan review, amongst other tasks relating to stormwater management and other municipal services. It is recommended that the Municipality enlist a GIS management service to oversee the compilation and database updates moving forward. This is recommended for the stormwater management infrastructure database as part of this SMP but will also benefit other services as well in terms of making the considerable number of previous studies and reports invested in by the Municipality readily available to staff and consultants moving forward.

The Municipality will also need adequate funding to implement the SMP. Municipal stormwater management across Ontario has evolved beyond a basic capital construction and maintenance expense into an integrated water resource management challenge with overlapping responsibilities across departments and agencies. The Municipality is sensitive to the economic status of its residents and is mindful of the importance of a transparent and fair approach to financing stormwater management expenditures. In addition, cost-efficiencies need to be realized through partnerships with other agencies, securing supplemental funding, and implementing stormwater management improvement projects with other capital improvements (e.g. road reconstruction). The Municipality currently funds stormwater related services through allocation of a portion of the general tax fund (i.e. property taxes). In addition, the cost of stormwater management related to specific developments has been recovered through development charges since 2009. A detailed review and comparison of options for funding implementation of the Municipality's Stormwater Master Plan is provided in Appendix G. Eight funding options were evaluated based on the following:

- Municipality-wide applicability
- Meets entire revenue needs
- Fair & equitable allocation
- Dedicated funding source
- Effort to administrate
- Public accountability
- Environmental benefits
- Social benefits

The preferred alternative for funding a comprehensive stormwater program in Brighton is a variable rate stormwater user fee. No changes are recommended to other existing funding mechanisms that provide important revenue streams that reduce the overall cost of the user-supported stormwater program, such as development charges. It is therefore recommended that the Municipality of Brighton consider a variable rate stormwater user fee to replace the currently tax-supported portion of the Municipality's stormwater management program. A recommended implementation strategy the funding mechanism is detailed in Section G.3.4 which begins with a feasibility study to investigate, analyze, and formulate an appropriate rate structure and ultimately develop a recommended implementation strategy for Council to decide whether or not to proceed with the subsequent implementation steps. Public consultation to solicit feedback will be integral to the feasibility study.

5.6. Partnerships

The Municipality will actively seek out and leverage partnership opportunities with agencies and private land owners to implement stormwater improvement projects. Several agencies have responsibilities related to stormwater management (See Table 31). Examples of partnership opportunities are outlined in Table 32. Additional opportunities may be identified as the Municipality approaches potential partners and implements the SMP.

Table 31. External Stormwater Management Responsibilities

Agency	Stormwater Management Responsibilities
Lower Trent Conservation	Monitor and mitigate flooding and erosion risk along hazard lands, including floodplain and shoreline management*. Maintain Proctor Park Conservation Area. Monitor water quality, flow, and precipitation.
Northumberland County	Coordinating stormwater management as part of County road construction projects. Working and collaborating with all agencies on review and approvals for developments in the County.
Ministry of Environment, Conservation and Parks	Develop provincial standards for stormwater management and water quality criteria. Issue Environmental Compliance Approvals for stormwater management facilities.
Ministry of Natural Resources and Forestry	Identify wetland areas and develop guidelines for evaluating the significance of wetlands and management of natural hazards. Assess the thermal regime of watercourses. Identify and develop management plans for provincial species at risk.
Department of Fisheries and Oceans	Identify and develop management plans for federal species at risk.

* Responsibilities do not include local drainage, groundwater, or surface flooding outside of hazard lands.

Table 32. Partnership Opportunities

Partner	Opportunities	Overlapping Element
Northumberland County	Stormwater management improvements as part of County Road projects.	Infrastructure Retrofit Projects
Ministry of Environment, Conservation and Parks	Guest speaker at staff workshop regarding maintenance of stormwater management facilities.	Administration
Ministry of Natural Resources and Forestry	Guest speaker at Council meeting to share information about: - The role marshes and wetlands play in the hydrologic cycle, the functions and values they provide to watershed health and how they can be used to sustainably manage stormwater. - The unique species at risk in the Brighton Urban Area. - The coldwater streams in Brighton and strategies for protecting them from development impacts.	Education & Outreach
Department of Fisheries and Oceans	Guest speaker at Council meeting to share information about federal species at risk.	Education & Outreach
Great Lakes and St. Lawrence Cities Initiative	A binational coalition of U.S. and Canadian mayors and other local officials working to advance the protection and restoration of the Great Lakes and St. Lawrence River. This network of cities that are often similar in size, demographics, and geography will provide useful connections for information sharing and municipal partnerships.	Education & Outreach
Nature Conservancy of Canada and Ducks Unlimited Canada	NCC and DUC are developing a joint management plan for Brighton Wetland, located at the southeast corner of the study area and encompassing part of Presqu'ile Bay Marsh. Opportunities include stormwater retrofits to treat runoff from County Road 64 and the rural upland areas, as well as education and outreach regarding the wetland (e.g. signage, public access, presentation to Council).	Infrastructure Retrofit Projects, Education & Outreach
Property Owners (Residential, Commercial, Industrial, and Institutional) and Neighbourhood Associations	Stakeholders at the Public Information Centre expressed an interest in implementing improvements and are encouraged to implement source, conveyance, and site controls that will increase the overall capacity of the stormwater management system in slowing down and cleaning runoff.	Infrastructure Retrofit Projects

5.7. Implementation Schedule

The recommended implementation schedule for the Stormwater Master Plan includes estimated annual costs and recommended timing of implementing the elements of the Stormwater Master Plan described in Sections 5.1 to 5.6. This schedule was developed to facilitate budgeting, partnerships, and grant applications. The Municipality will need to periodically review and revise the Stormwater Master Plan so that it continues to reflect the needs and priorities of Brighton. The following considerations guided the development of this schedule in terms of prioritizing and funding the Stormwater Master Plan:

1. Continue implementing existing stormwater management activities in Years 1 and 2.
2. Begin the Maintenance Program and preparatory training for Municipal staff in Year 1. Address the staff capacity gap to provide oversight of implementing the Stormwater Master Plan as part of the Municipality's environmental services.
3. Beginning in Year 1, the Municipality will use new Development Agreements to retain securities for stormwater management infrastructure built as part of private developments, including extended guarantee periods for central facilities used for multiple phases of development. Stormwater infrastructure that is non-compliant with Environmental Compliance Approvals, development agreements or the objectives of the Stormwater Master Plan will not be assumed by the Municipality until issues are rectified.
4. Starting in Year 1, the Municipality will proactively incorporate treatment train stormwater management improvements into ongoing public infrastructure programs, such as the Class EAs for road reconstruction projects as well as the Municipality's storm sewer replacement program.
5. Phase in the remaining recommendations to match the annual funding in Years 3 to 10. This includes beginning the subwatershed improvement projects in Year 3 and addressing the funding gap for storm sewer replacement starting in Year 4.
6. Include the estimated cost of the *Stormwater User Fee Feasibility Study* ($120,000) in the *Development Charges Study* for 2019.
7. Conduct the *Stormwater User Fee Feasibility Study* in Year 2, building from the recommended funding strategies in Appendix G. A fully defined scope for the Feasibility Study is outlined in Appendix G.3.4.1. Develop and initiate the Stormwater User Fee by the beginning of Year 3. Incrementally increase the Stormwater User Fee in Years 3 to 6 by at most $150,000 in order to phase in its implementation and ultimately reach the total annual funding needed to support implementation of the Stormwater Master Plan by Year 6. The user fee is anticipated to provide between $450,000 to $525,000 annually to fund the implementation of the plan while tax funding will be decreased to $0 in Year 6.
8. Supplement funds from the existing tax levy in Years 1 to 2 and from the Stormwater User Fee during Years 3 to 10 when needed to fully fund implementation of the plan by securing grants, leveraging partnerships and adopting other funding strategies presented Appendix G.
9. Implement major projects in the prioritized order recommended in the plan such that costs are spread throughout Years 1 to 10. Implement projects ahead of schedule if they become fully funded.

Funding needs for the first two years are based on cost estimates provided by Municipal staff regarding existing programs and moderate increases of approximately $27,000 per year to begin the Maintenance Program and administrative costs, such as staff training. The Municipality currently spends approximately $110,500 annually on stormwater related tasks including staff time and minor repairs. Storm sewer replacement along road reconstruction projects is included under the Municipality's roads budget and will not be included in the SMP implementation plan. Ditching done by the municipality is currently only done in rural areas (outside of the study area) and those current expenditures are not included in the $110,500. The recommendations for annual investment in stormwater infrastructure outlined in the current Asset Management Plan (AMP) are not being implemented since there is an infrastructure funding gap. According to the current AMP, a budget of

$614,529 will be required for major capital investment in replacing aging stormwater infrastructure between 2019 and 2023, followed by $602,775 between 2024 and 2028 (Associated Engineering 2013), assuming 3% inflation to convert to 2018 dollars. The estimated cost of storm sewer replacement in the implementation schedule starts in Year 4 to close the funding gap for this program. Further increases may be necessary as new infrastructure is added to the AMP.

The implementation schedule does not include the following costs that apply to multiple service areas beyond stormwater management and/or are budgeted separately from urban stormwater services:

- Addressing staff capacity gaps for oversight of the Stormwater Master Plan implementation and data management (e.g. GIS technician).
- Development charges, which are periodically defined through *Development Charges Studies* based on the future residential and non-residential growth forecast and growth-related infrastructure needs and costs.
- Updates to the Municipality's *Asset Management Plan* for water, wastewater, and stormwater services.
- Road reconstruction, including associated stormwater infrastructure improvements, which is prioritized by the Municipality's *Road Needs Studies*.
- Street sweeping.
- Rural ditch and culvert improvements, which are implemented outside of the Brighton Urban Area (study area limits).
- Enforcement of the Municipality's Engineering Design Standards through development application review, which is covered by development charges.

Table 33. Implementation Schedule

Year:	1	2	3	4	5	6	7	8	9	10
Elements & Activities	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Maintenance	**$401,600**	**$164,000**	**$218,300**	**$212,400**	**$193,000**	**$290,900**	**$162,500**	**$172,100**	**$180,900**	**$206,400**
Inventory	$3,600	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200
Inspection	$15,100	$16,000	$17,000	$17,900	$18,800	$19,800	$20,600	$21,700	$22,500	$23,600
Monitoring	$15,100	$15,100	$15,100	$15,100	$15,100	$8,600	$8,200	$8,200	$8,200	$8,200
Preventative Maintenance	$48,300	$54,200	$60,200	$66,100	$72,100	$78,000	$84,100	$90,300	$96,400	$102,600
Corrective Action	$317,200	$75,200	$122,500	$109,800	$73,500	$181,000	$46,100	$48,400	$50,300	$52,800
Reporting	$2,300	$2,300	$2,300	$2,300	$12,300	$2,300	$2,300	$2,300	$2,300	$18,000
Infrastructure Retrofit Projects	**$-**	**$-**	**$122,400**	**$189,900**	**$338,300**	**$254,700**	**$535,400**	**$367,900**	**$426,300**	**$259,600**
Subwatershed Improvement Projects	$-	$-	$122,400	$66,900	$215,300	$133,700	$414,400	$246,900	$305,300	$138,600
Storm Sewer Replacement	$-	$-	$-	$123,000	$123,000	$121,000	$121,000	$121,000	$121,000	$121,000
Policies & Enforcement	**$15,000**	**$-**	**$-**	**$-**	**$3,000**	**$-**	**$-**	**$-**	**$-**	**$3,000**
Stormwater Management Standards	$5,000	$-	$-	$-	$1,000	$-	$-	$-	$-	$1,000
Erosion & Sediment Control Standards	$5,000	$-	$-	$-	$1,000	$-	$-	$-	$-	$1,000
Assumption Protocol	$5,000	$-	$-	$-	$1,000	$-	$-	$-	$-	$1,000
Education & Outreach	**$-**	**$3,000**	**$3,000**	**$3,000**	**$28,000**	**$28,000**	**$28,000**	**$28,000**	**$28,000**	**$28,000**
Property Owner Education	$-	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
Cost-Share Program	$-	$-	$-	$-	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000
Administration	**$5,900**	**$120,000**	**$5,000**	**$5,000**	**$25,000**	**$10,900**	**$5,000**	**$5,000**	**$5,000**	**$45,000**
Stormwater User Fee	$-	$120,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Staff Training	$5,900	$-	$-	$-	$-	$5,900	$-	$-	$-	$-
SMP Evaluation & Update	$-	$-	$-	$-	$20,000	$-	$-	$-	$-	$40,000
TOTAL	**$422,500**	**$287,000**	**$348,700**	**$410,300**	**$587,300**	**$584,500**	**$730,900**	**$573,000**	**$640,200**	**$542,000**

Table 34. Implementation Schedule by Estimated Funding Sources

Year:	1	2	3	4	5	6	7	8	9	10
Elements & Activities	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Development Charges or Implemented by Developers*	$284,200	$121,000	$1,000	$0	$0	$0	$500	$500	$0	$0
Grants, Partnerships, Other	$0	$1,500	$62,700	$34,950	$121,650	$80,850	$221,200	$137,450	$166,650	$83,300
Tax Levy *(Phased Out)*	$138,300	$164,500	$135,000	$75,350	$15,650	$0	$0	$0	$0	$0
Stormwater User Fee *(Phased In)*	$0	$0	$150,000	$300,000	$450,000	$503,650	$509,200	$435,050	$473,550	$458,700
TOTAL	**$422,500**	**$287,000**	**$348,700**	**$410,300**	**$587,300**	**$584,500**	**$730,900**	**$573,000**	**$640,200**	**$542,000**

*Includes pond cleanout, pond monitoring, and the Stormwater User Fee Feasibility Study

5.8. Implementation Considerations

5.8.1. EA Schedules

All projects implemented subsequent to this Master Plan will be reviewed to identify the appropriate Class EA Schedule requirements prior to any planning or design work being undertaken. In general, the schedules listed Table 35 will be considered for implementation of this Plan. Stormwater improvements implemented as part of road reconstruction projects will be done under the appropriate Class EA schedule determined for the overall project.

Table 35. Project Examples for EA Schedules

Schedule	Description	Project Examples
A	Projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. Projects are pre-approved and may proceed without following the Class EA.	• Ongoing preventative and corrective maintenance of stormwater infrastructure, including removal of sediment from ditches, roadside culverts, storm sewers, stormwater management ponds and constructed wetlands. • Replacement-in-kind of culverts and storm sewers due to material degradation/aging. • Establish new low impact development facilities for the purpose of stormwater quality control by retrofitting them into an existing road allowance where no additional property is required and where such facilities are not implemented as part of a road reconstruction project.
A+	Projects are pre-approved and may proceed without following the Class EA however, the public is to be advised prior to project implementation.	• Replace storm sewer catchbasins with the same structure/flow capacity but with the addition of a sump to capture additional sediment and debris. • Modify or improve a stormwater management pond or constructed wetland for the purpose of stormwater quality control, such as improving the outlet structure to prevent clogging (but not change its flow capacity). Improvements that address flood mitigation objectives are not appropriate for this Class EA schedule.
B	Projects have the potential for some adverse environmental effects through new, improved or minor expansions of existing facilities. The proponent is required to undertake a screening process involving mandatory contact with directly affected public and relevant review agencies to ensure that they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation.	• Construct a stormwater infiltration system for groundwater recharge. • Establish new stormwater management facilities where additional property is required.

Schedule	Description	Project Examples
C	Projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Class EA. Schedule C projects require that an Environmental Study Report be prepared and filed for review by the public and review agencies. Schedule C projects generally include the construction of new facilities and major expansions to existing facilities.	• Construct new or improve existing stormwater management facilities for the purpose of mitigating flood risk, such as the subwatershed improvement projects.

5.8.2. Potential Effects and Mitigation Measures

The measures to avoid, mitigate or negate the potential adverse effects associated with the activities included in the recommended maintenance program are outlined in Table 36. The maintenance program includes activities such as removing sediment from catchbasins, storm sewers, ditches, and ponds as well as addressing performance issues such as debris blocking pond outlet structures and erosion observed on pond banks and along ditches.

Table 36. Potential Effects and Mitigation Measures for Stormwater Infrastructure Maintenance

Feature	Potential Effect	Mitigation Measures
Cultural Environment		
Cultural / Built Heritage	No impacts are anticipated associated with restoring grading, beneficial use of soils on site and accessing the site with maintenance equipment because the facilities area already constructed and easements/public property provide relatively easy access.	Not applicable.
Social Environment		
Utilities and Servicing	Disturbance to utilities or other underground services causing temporary disruption of service and construction delays.	Utility locates must be obtained prior to cleanout of ditches and other surface drainage features.
Use of Adjacent Properties	Adjacent properties may be impacted by construction activities such as noise or dust.	Standard mitigation techniques will be used to minimize potential noise and dust. Comply with municipal noise by-law (i.e. hours of maintenance except under extraordinary circumstances). Maintenance activities will not have a long term negative impact on the usability of adjacent land.
Public Safety	Cleanout of ponds, ditches, and storm sewers can create hazards to the public including open pits during excavation and moving construction equipment.	The maintenance team will implement appropriate safety features to reduce hazards and risk to the public during maintenance activities. Such features include fences, signage and other means of deterring the public from entering the maintenance area. In addition, restoration after pond cleanouts can incorporate improved deterrents in the landscaping around the facility, such as the options outlined in Appendix I. Pond cleanout staging areas should be strategically located to reduce hazards and disruption to the public during maintenance.

Feature	Potential Effect	Mitigation Measures
Traffic Flow	Traffic flow may be negatively affected by maintenance activities and storage of equipment or materials within the right-of-way.	Implement appropriate traffic controls to mitigate traffic impacts. The number and frequency of disruptions in the same neighbourhoods could be limited by coordinating the schedule of different types of maintenance activities.
Property Access	Temporary disruption resulting from maintenance activities.	Stage and schedule maintenance activities to reduce disruption to residents and businesses. Notify the public of the planned schedule and locations of maintenance activities. Ensure access for emergency vehicles. Maintain pedestrian access to key locations to the extent possible (e.g. mail boxes, library, community centre, etc.).
Natural Environment		
Terrestrial Environment	Potential pollution or inhibition of plant growth/infiltration due to placement of sediment on or off-site.	Sediment quality should be analyzed to determine the appropriate disposal or beneficial use requirements. First, the O.Reg. 347 Leachate Test will establish if the sediment is hazardous waste. Second, the O.Reg. 153/04 Bulk Soil Analysis determines if sediment is suitable for beneficial reuse or if it should be landfilled. Sampling and analysis should follow applicable guidelines, such as the *Inspection and Maintenance Guide for SWM Ponds and Constructed Wetlands* (Toronto and Region Conservation Authority and CH2M Canada 2016). Sediments removed from pre-treatment structures of green infrastructure or low impact development practices (e.g. rain gardens) should never be placed into or around the practices as this will plug the practices and prevent infiltration.
	Damage to existing vegetation associated with grading and accessing the site with maintenance equipment. Removal of existing vegetation associated with maintenance activities.	Vegetation maintenance activities should be limited to managing new growth of woody vegetation at stormwater management facilities. Mowing can help native plants establish within the first few years after planting/seeding while also preventing the establishment of woody or invasive species. However, vegetation within 10 feet of the normal and high water level of ponding facilities should not be mowed shorter than 8 inches. These maintenance activities should not extend into previously undisturbed woodlots and this will avoid impacts to terrestrial species at risk. Protected vegetation areas should be clearly marked when equipment is needed, such as for pond cleanouts. In addition, the area disturbed during maintenance should be minimized to limit impacts to terrestrial habitat. Areas disturbed by maintenance activities will be restored following the recommended landscaping guidelines in Appendix I.

Feature	Potential Effect	Mitigation Measures
Aquatic Environment	Sediment discharge to downstream creeks, wetlands, or the bay associated with maintenance activities.	The area of ground disturbance during maintenance should be minimized as much as feasible and should be restored in accordance with the Landscaping Guidelines (Appendix I). Appropriate measures to prevent erosion and control sediment should be used. After the maintenance activity is complete, permanent erosion control measures should be implemented along with restoration. For example, sediment removal along ditches should be accompanied by an appropriate erosion control measure for concentrated flow paths (e.g. erosion control blanket) and seeded for restoring vegetation cover. Measures should be consistent with best practice guidelines such as *Erosion & Sediment Control Guideline for Urban Construction* (Greater Golden Horseshoe Area Conservation Authorities, 2006). Erosion and sediment control measures should be inspected after maintenance is complete to mitigate downstream impacts of sediment on stormwater infrastructure and receiving water bodies. The inspector should be a Certified Inspector of Erosion and Sediment Control (CISEC). The Municipality's maintenance program manager or contractor should review the inspection reports and determine if and what remedial measures are needed Appropriate isolation measures and dewatering techniques should be used wherever maintenance work is be done in or near a watercourse or wet pond to ensure that fish are not harmed or otherwise negatively impacted.

The measures to avoid, mitigate or negate the potential adverse effects associated with new/retrofit stormwater infrastructure implemented through the Stormwater Master Plan are outlined in Table 37.

Table 37. Potential Effects and Mitigation Measures for New or Retrofit Stormwater Infrastructure Projects

Feature	Potential Effect	Mitigation Measures
Cultural Environment		
Archaeological Resources	Disturbance to archaeological resources associated with grading / excavation activities.	All of the sites will require at least a Stage 1 Archaeological Assessment and/or a heritage impact assessment prior to implementation to ensure that built and cultural heritage landscapes or archaeological resources are not impacted. Archaeological assessments should follow the Curve Lake First Nation's Archaeological Protocol and other relevant protocols.
Cultural / Built Heritage	Impacts associated with grading and drainage works.	Design components of retrofit projects should preserve built heritage in Brighton, such as pedestrian sidewalks and trails, and include details such as similar surface treatments.
Social Environment		
Utilities and Servicing	Disturbance to utilities or other underground services causing temporary disruption of service and construction delays.	Utility locates must be obtained during the detailed design of the retrofit projects so that the design can be modified as necessary to avoid conflicts and arrange for relocates where necessary. In addition, storm sewer locations, size, material and elevations should be verified during the detailed design phase to avoid construction delays.

Feature	Potential Effect	Mitigation Measures
Use of Adjacent Properties	Adjacent properties may be impacted by construction.	Staging areas are to be located such that there are no impacts to the use or access of adjacent properties wherever feasible. Where needed, easements, land use agreements or the purchase of private property, will be obtained prior to construction. The retrofit projects will not have a long term negative impact on the usability of adjacent land.
Public Safety	Stormwater management wet ponds pose a drowning risk to anyone that enters the facility. Construction of retrofit projects can create hazards to public including open pits during excavation and moving construction equipment.	The detailed design of any new or retrofit above ground stormwater management facilities should include the appropriate safety features to reduce hazards and risk to the public. This can include fences, signage and other means of deterring the public from entering a facility, as outlined in Appendix I. Construction staging areas should be strategically located to reduce hazards and disruption to the public during construction.
Traffic Flow	Traffic flow may be negatively affected by construction and storage of equipment or materials within the right-of-way or other project sites in addition to accessing a site from a road.	Implement appropriate traffic controls to mitigate traffic impacts. Specific controls are to be developed during the detailed design of the retrofit projects. Repeated disruptions at the same location could be prevented by implementing stormwater retrofit projects during road reconstruction already scheduled and needed for other reasons (e.g. road surface condition, aging utilities needing replacement).
Property Access	Temporary disruption resulting from construction activities.	Stage and schedule construction activities to reduce disruption to residents and businesses. Notify adjacent landowners of construction scheduling. Ensure access for emergency vehicles. Maintain pedestrian access to key locations to the extent possible (e.g. mail boxes, library, community centre, etc.).
Noise, Dust and Air Quality	Temporary disruption resulting from construction activities.	Implement appropriate dust control measures during construction. Comply with municipal noise by-law (e.g. hours of construction except under extraordinary circumstances).
Natural Environment		
Groundwater	Risk of groundwater contamination from infiltration facilities.	The bottom of such facilities should be designed at least 1 m above the seasonally high groundwater table to limit the risk of groundwater contamination and ensure the facility functions properly. In areas with shallow groundwater, facilities should be lined to prevent such risks. The lining will prevent infiltration but the facility will still have benefits of storing, filtering, and slowing down runoff.
	Risk of introducing pathways for the Cooey metals contaminated groundwater plume to enter the environment.	Public infrastructure improvements planned south and east of the Cooey metals site, which is on the southeast corner of Prince Edward Street and the railway), down to Butler Creek or Arena Creek should be designed to minimize risk of excavating into the groundwater plume contaminated with PAHs, VOCs, and metals. Contact the MECP's Environmental Monitoring and Reporting Branch for the latest analysis of the plume migration. Minimize the depth of excavation to the extent possible and prevent groundwater discharge into stormwater management facilities using impermeable liner, and inflow into the stormwater piping system by protecting/insulating the pipe joints.

Feature	Potential Effect	Mitigation Measures
Terrestrial Environment	Damage to existing vegetation (e.g. tree roots) associated with proposed grading and drainage works. Removal of existing vegetation associated with grading and drainage works.	Several terrestrial species at risk were identified within 1 km of the Master Plan Study Area by the MNRF, including the Butternut tree. Clearing of vegetation, including brush and potentially trees, may be required at some retrofit project sites. Detailed vegetation surveys are to be taken to identify trees and significant vegetation that should be protected during construction. Determine whether any activities will require approval required under MNR Endangered Species Act (Species At Risk). Also undertake a vegetation health assessment by a qualified Arborist, including identification of Butternut trees. The design should be modified to avoid tree removal, which can be done by utilizing upstream low impact development and green infrastructure practices rather than expanding end-of-pipe facilities (e.g. ponds) into adjacent woodlots. Prepare a tree preservation plan prior to construction and conduct ongoing construction monitoring. Protected vegetation should be clearly marked during construction. The area disturbed during construction should be minimized to limit impacts to terrestrial habitat by using alternative construction techniques that limit the extent of excavation, if feasible. Construction sites should be restored to pre-construction conditions or better with compatible species. Restoration work in or around stormwater management facilities should follow the recommended landscaping guidelines in Appendix I.
Aquatic Environment	Sediment discharge to downstream creeks, wetlands, or the bay associated as a result of temporary construction activities.	The area of disturbance during construction should be minimized as much as feasible and should be restored in accordance with the Landscaping Guidelines (Appendix I) after construction. Appropriate measures will be needed to prevent erosion and control sediment during construction and are to be developed during the detailed design of the retrofit projects. Measures should be consistent with best practice guidelines such as *Erosion & Sediment Control Guideline for Urban Construction* (Greater Golden Horseshoe Area Conservation Authorities, 2006). Erosion and sediment control measures should be inspected and maintained during construction to mitigate downstream impacts on stormwater infrastructure and receiving water bodies (see below). The inspector should be a Certified Inspector of Erosion and Sediment Control (CISEC). At a minimum, inspections should be conducted at least once every two weeks and after each significant storm event. A significant storm event is at least 25 mm of rain within 24 hours. Inspections should continue during construction and records of the inspections should be kept by the contractor/Municipality. The project manager should determine if and where remedial measures are necessary. Appropriate isolation measures and dewatering techniques should be used wherever work is be done in or near a watercourse or wet pond to ensure that fish are not harmed or otherwise negatively impacted during construction. Direct effects are avoided since no projects are proposed directly within the creeks, wetlands, or bay.

Feature	Potential Effect	Mitigation Measures
	Long term impacts from urban stormwater runoff, such as warm discharge to coldwater streams.	Public projects should adhere to the design standards defined in Section 5.3 of the plan to mitigate the long term impacts of stormwater on receiving water bodies. Following these standards will require the selection of appropriate practices as well as appropriate design features. For example, some stormwater management practices such as stormwater management ponds may increase the temperature of discharge, however this impact can be mitigated through use of alternative stormwater management practices and/or alternative design of the pond outlet.

5.8.3. Permits and Approvals

All projects implemented subsequent to this Master Plan will be reviewed to identify the necessary permits and approvals prior to design and construction. No recommendations in this plan involve work within watercourses. All permits and approvals must be secured and obtained prior to tendering Municipal projects. In general, the following permits and approvals may be applicable to the activities recommended in the Stormwater Master Plan:

- New or amended Environmental Compliance Approvals for sewage works, MECP
- Environmental Compliance Approval for waste management (dependant on contaminant levels in pond sediment), MECP
- Permit to Take Water, MECP
- Letter of Concurrence for Stage 1 Archaeological Assessment, Ministry of Tourism, Culture and Sport
- Approval or letter of advice under the Endangered Species Act, MNRF
- License to Collect Fish for Scientific Purposes, issued under O.Reg. 664/98 for the collection, handling and deposition of fish if required to dewater a stormwater management facility, MNRF
- Regulation 163/06 (Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses) Permit, Lower Trent Conservation
- Road permit for work within County Road Right-of-Way, Northumberland County
- Approvals under the Planning Act (e.g. site plan approval, building permit), Municipality of Brighton
- Approvals and exemptions from applicable b-laws (e.g. Noise, Sewer Use), Municipality of Brighton

5.8.4. Future Studies

Several areas needing more detailed study beyond the scope of this Plan include the following:

- Salt management planning
- Sediment accumulation in marina and need for dredging
- Groundwater resource management and basement flooding
- Geomorphology, biota, and thermal regime of Butler, Arena, and West Creeks
- Evaluation of wetland west of Ontario Street per the OWES and circulation of the evaluation to the MNRF to check the potential for complexing with Presqu’ile Bay Marsh

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