Municipality of Lakeshore
Stormwater Master Plan – Phase 1

Final Report

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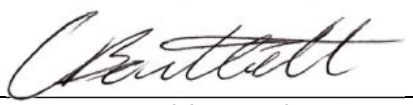
Prepared by 
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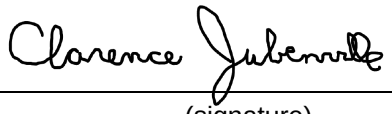
Reviewed by 
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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Abbreviations

AMC	Antecedent Moisture Conditions
BMP	Best Management Practice
CA	Conservation Authority
ECA	Environmental Compliance Approval
ERCA	Essex Region Conservation Authority
ESC	Erosion and Sediment Control
ETV	Environmental Technology Verification
GI	Green Infrastructure
ha	hectares
HGL	Hydraulic Grade Line
HWL	High Water Level
IDF	Intensity-Duration-Frequency
L/s	Litres per second
LID	Low Impact Development
LTVCA	Lower Thames Valley Conservation Authority
m	metres
m^3	cubic metres
m^3/s	cubic metres per second
mm	millimetres
MNRF	Ministry of Natural Resources and Forestry
MECP	Ministry of Environment, Conservation and Parks (formerly MOECC and MOE)
MOECC	Ministry of Environment and Climate Change
MTO	Ministry of Transportation Ontario
NRCS	National Resources Conservation Service
NWL	Normal Water Level
OGS	Oil/Grit Separator
RVC_T	Runoff Volume Control Target
SCS	Soil Conservation Service (now NRCS)
SWM	Stormwater Management
SWMF	Stormwater Management Facility
SWMP	Stormwater Management Practice
TSS	Total suspended solids
WQS	Water Quality Storm
WSEL	Water Surface Elevation

Glossary

1:5 year storm event (also referred to as 5-year storm	A storm event with a 1:5 year return period or 20% probability of occurrence in any given year.
Allowable release rate	A maximum specified flow rate at which development is allowed to discharge.
Antecedent moisture condition	The pre-storm soil moisture condition.
Backwater condition	A backflow condition or rise in water level which impacts conveyance capacity
Combined sewer	A combined sewer is a sewage collection system of pipes and tunnels designed to also collect surface runoff
Detention	The temporary storage of stormwater to control runoff discharge rates and promote settling of sediment.
Extended detention	A specified volume to be detained over a minimum 24-hour period for water quality purposes.
Freeboard	The depth measured from the water surface elevation to a specified reference point (e.g. manhole cover, building opening, pond bank)
Holistic approach	An approach that considers in the context of the overall watershed.
Hydraulic grade line	The surface or profile of water flowing in an open channel or a pipe flowing partially full. If a pipe is under pressure, the hydraulic grade line is that level water would rise to in a small, vertical tube connected to the pipe.
Hydrodynamics	The study of motion of liquids, and in particular, water. A hydrodynamic model is a tool able to describe or represent in some way the motion of water.
Hyetograph	A graphical representation of the distribution of rainfall over time.
Level of service	Level of service refers to the efficiency of the drainage system to capture and convey runoff away from the surface and buildings. In the context of drainage, level of service is described in terms of a return period.
Major	In the context of stormwater, major relates to a major storm event. For purposes of design, the major storm event is typically quantified as a 1:100 year storm event.
Minor	In the context of stormwater, minor relates to a minor storm event. For purposes of design, the minor storm event is typically specified for storm sewer sizing with a return period of 1:2 year or 1:5 year.
Obvert	Elevation at the highest point of the inner surface of a pipe (i.e. interior top of pipe)
Permanent pool	The body of water which remains in the stormwater management pond.

Private drainage system	A system of underground piping, sump pump, roof leaders, rear yard catch basins, sewage ejector pumps, etc. which convey stormwater and sewage flows from private property to the municipal sewer(s).
Receiver	The receiving drain, watercourse or sewer.
Retention	The permanent storage of stormwater to control runoff discharge rates and volume by promoting infiltration, evapotranspiration and re-use.
Return period	A return period, also known as a recurrence interval is an estimate of the likelihood of an event, such as an earthquake, flood or a river discharge flow to occur
Runoff	Surface water, from precipitation, that flow over the land surface.
Stormwater	Stormwater is the water from rain or melting snow that is not absorbed into the ground.
Subcatchment	An area of land where all surface runoff converges or is assigned to a single point along a drainage feature. e.g. a storm sewer manhole.
Watercourse	An open channel that conveys water to a larger watercourse or waterbody.
Watershed	An area of land that drains into a watercourse or waterbody

1.0 INTRODUCTION

The Municipality of Lakeshore (Town) retained Stantec Consulting Ltd. (Stantec) to complete a Municipal Class Environmental Assessment (Municipal Class EA) following Master Plan Approach 2 to develop a stormwater servicing strategy to address drainage concerns in the urban portion of the Town.

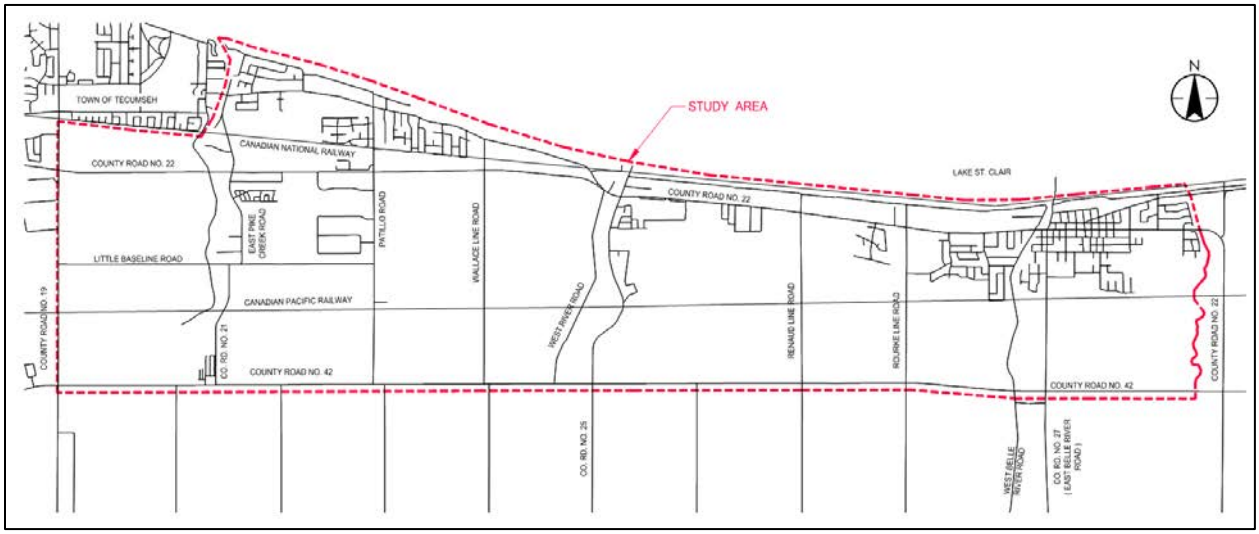
The Stormwater Master Plan (SMP) has been developed according to the Municipal Class EA Process (MCEA October 2000 as amended in 2007, 2011, and 2015) to identify necessary storm drainage system improvements to better service the existing community, and to provide a drainage servicing strategy to accommodate future growth and development within the Town.

1.1 BACKGROUND

The western end of the Municipality of Lakeshore and neighbouring north shore communities (Town of Tecumseh and City of Windsor) experienced two extreme rainfall events in September 2016 and August 2017. Both events resulted in thousands of flooded homes and inundated streets within the three communities, which prompted and prioritized the undertaking of this Stormwater Master Plan.

The SMP is being undertaken in two phases with Phase 1 addressing stormwater issues in the mostly urban areas of the northwest portion of the Town and Phase 2 addressing the remaining urbanized areas of the Town. The Phase 1 study area limits are County Road 42 to the south, Lake St. Clair to the north, County Road 19 (Manning Road) to the west and County Road 22 (near Duck Creek) to the east. The study area consists of approximately 2,300 hectares (ha) of developed land and 2,400 ha of agricultural lands. The study area limits are shown on the following figure.

Figure 1.1: Study Area



1.2 OBJECTIVES

The intent of this Master Plan is to identify and address public, review agency, and Indigenous community comments and concerns, and to ensure that all feasible alternatives and opportunities are fairly assessed and reviewed in a public forum before being finalized and carried forward for implementation. The scope of work being completed as part of this Master Plan includes:

- Background review and identification of key issues;
- Natural Environment Review;
- Technical review of existing drainage conditions and catchment areas;
- Identification and evaluation of alternatives based on a set of criteria that address key issues, as well as the social, natural, technical, and economic environmental factors;
- Public, Indigenous community, agency, and stakeholder consultation;
- Development of a SMP to outline drainage servicing improvements based on the preferred alternatives; and
- Preparation and Filing of a SMP document for public review of the recommended Schedule B projects.

The main objective of this SMP is to identify the causes of existing flooding and drainage issues within the Town, develop a strategy to implement stormwater management measures that protect public and private property from flooding, preserve receiving water systems, and minimize stormwater servicing costs.

1.3 REPORT OUTLINE

This SMP document provides the context in which the Municipal Class EA process was carried out and documents the rationale leading to the preferred SMP, and includes the following:

- Overview of the Municipal Class EA and Master Plan process;
- Consultation plan followed throughout the study, documenting all points of contact with the public, agencies, Indigenous communities, and other stakeholders;
- Identification and description of the problems and opportunities;
- Overview of applicable planning and policy documents;
- Comprehensive review and analysis of existing stormwater infrastructure to identify areas of need for infrastructure improvements;
- Overview of the existing natural, cultural, and social environment conditions;
- Identification, development, and evaluation of alternative solutions;
- Description of the preferred solutions making up the preferred SMP;
- Recommendations for prioritizing implementation of improvements based on level of service and risk to develop phasing and sustainable cost strategy;
- Recommendations for best management practices to develop inspection and maintenance programs for the Town's stormwater infrastructure assets; and
- Recommended mitigation and compensation measures based on the general scope of the proposed works.

2.0 MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT PROCESS

All municipalities in Ontario are subject to the provisions of the Environmental Assessment Act (EA Act). The Municipal Class EA process was developed by the Municipal Engineers Association to fulfill the requirements of the EA Act for municipal infrastructure projects. This planning process provides a consistent method of identifying and assessing potential environmental impacts and helps to ensure that project planning is undertaken in a manner that considers all aspects of the environment. Key components of the EA planning process include:

- Consultation with potentially interested parties early and throughout the process;
- Consideration for a reasonable range of alternative solutions;
- Systematic evaluation of alternatives;
- Clear and transparent documentation; and
- Traceable decision-making

The Municipal Class EA process and associated documentation serves as a public statement of the decision making process followed by municipalities for the planning and implementation of necessary infrastructure.

2.1 5-PHASE PLANNING PROCESS

Figure 2.1 illustrates the five-phase planning and design process outlined in the Municipal Class EA document. The corresponding phases are briefly described below:

Phase 1 — Identify the problem (deficiency) or opportunity, which may include public consultation to confirm/review the problem or opportunity.

Phase 2 — Identify a reasonable range of alternative solutions to address the problem or opportunity. This Phase also includes an inventory of the natural environment in order to identify potential mitigation measures, and to assist in the evaluation of alternatives in terms of the identified evaluation criteria. A preferred solution is chosen based on the results of the evaluation and taking into account input received from the public, review agencies, and Indigenous communities throughout the planning process. It is at this point that the appropriate Schedule (B or C) is chosen for the undertaking. If Schedule B is selected, the process and decisions are then documented within a Project File. Schedule C projects must proceed through the additional Phases 3 and 4.

Phase 3 — Examine the alternative methods for implementing the preferred solution, which typically involve design alternatives. More detailed inventory of the natural, social, economic, and technical environment is undertaken in order to assess the impacts of the alternative designs, in an attempt to minimize negative effects and maximize positive effects.

Phase 4 Document the Municipal Class EA process followed in an Environmental Study Report (ESR), which includes a summary of the rationale and the planning, design, and consultation process followed for the project and make the documentation available for consideration by the public, review agencies, and Indigenous communities for a minimum 30-day review period.

Phase 5 Complete contract drawings and documents, and proceed to construction and operation with monitoring to ensure adherence to environmental provisions and commitments.

2.2 TYPES OF PROJECTS

The Municipal Class EA document provides a framework by which projects are classified as Schedule "A", A+", "B", or "C". Classification of a project is based on a variety of factors including the potential impacts to the environment, general complexity of the project, and project costs. It is the responsibility of the proponent to identify the appropriate schedule for a given project, and to review the applicability of the chosen schedule at various stages throughout the project. Each schedule requires a different level of documentation and review to satisfy the Municipal Class EA requirements.

Schedule A projects are limited in scale, have minimal adverse environmental impacts, and do not require public notification or documentation.

Schedule A+ projects are limited in scale, have minimal adverse environmental impacts, and do not require documentation. However, the public is to be advised of the project prior to implementation.

Schedule B projects have the potential for some adverse environmental impacts. The proponent is required to undertake a screening process by completing Phases 1 and 2 of the Municipal Class EA process and carrying out mandatory consultation activities to ensure that the public, agencies Indigenous communities, and other stakeholders aware of the project and that their concerns are considered and/or addressed. These types of projects require that a Project File be prepared and filed for review.

Schedule C projects have the potential for significant environmental impacts and must proceed under the full planning and documentation procedures (i.e., Phases 1 through 4) of the Municipal Class EA document. An Environmental Study Report is to be prepared and filed on the public record for review by the public, agencies Indigenous communities, and other stakeholders.

2.3 MASTER PLAN APPROACH

This stormwater study is being undertaken in accordance with the Master Plan requirements outlined in the Municipal Class EA document. This approach was developed to recognize the benefits of considering a group of related projects, or an overall system – in this case stormwater management – prior to addressing individual projects or areas.

Master Plans are long-range plans undertaken to create a framework for future projects that form part of an integrated system. The projects identified within Master Plans are typically distributed geographically

throughout a broader area, and are intended to be implemented over a period of time, dependent on project triggers including required maintenance, available funding, etc.

The scope of Master Plans varies significantly, and the Municipal Class EA document offers four general approaches that address Master Plans of varying complexity. This SMP was developed following Approach 2, which involves the completion of a Master Plan document at the conclusion of Phases 1 and 2, fulfilling the requirements for Schedule B projects. This SMP provides the basis for projects identified as Schedule C undertakings. These types of projects would be subject to the completion of subsequent Phases 3 and 4 of the Municipal Class EA process.

2.4 PART II ORDERS

If significant outstanding issues concerning the Schedule B projects identified within this SMP have not been addressed and could be better addressed through an Individual EA process, any member of the public can ask for a higher level of assessment. This is known as a Part II Order request.

A Part II Order request can be made within the specified review period as outlined in the Notice of Study Completion. A Part II Order request is submitted only when issues cannot be resolved through the Municipal Class EA process, discussions with the proponent or with mediation. It should be noted that a Part II Order request should not be submitted to delay or stop the planning and implementation of a project.

As of July 1, 2018, a Part II Order Request Form must be submitted to request a Part II Order. To submit your Part II Order Request, you need to download and complete the download the Part II Order Request Form and include the following information:

- Name and address;
- Project name;
- Proponent name;
- Specific reasons why the request is being made – concerns and issues;
- Why a higher level of environmental assessment would address your concerns;
- Information about efforts to date to discuss and resolve concerns with the proponent;
- The outcome you are seeking from the minister; and
- Other matters relevant to the request.

The request must focus on potential environmental effects of the project or the MCEA process; not focus on decisions outside the MCEA process (e.g., land-use planning decisions made under the *Planning Act* or issues related to municipal decision-making about the process); and not raise issues unrelated to the project. Unless stated otherwise in the request, any personal information provided will become part of the public record and will be released, if requested, to any person.

The completed Part II Order Request Form must be submitted to the Minister of Environment, Conservation and Parks or delegate, with a copy of the form to the Director of Environmental Assessment and Permissions Branch and the Town Clerk:

Minister
Ministry of the Environment, Conservation and Parks
Floor 11, 77 Wellesley Street West
Toronto ON M7A 2T5
minister.mecp@ontario.ca

Director, Environmental Assessment and Permissions Branch
Ministry of the Environment, Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto ON M4V 1P5
enviropermissions@ontario.ca

The Minister has the following options for a decision on a Part II Order Request, and the Minister's decision is final:

1. Refer the matter to mediation before making a decision;
2. Deny the request and inform the proponent and requester;
3. Deny the request but impose conditions; or
4. Require the proponent to comply with the Part II Order and prepare a Terms of Reference and Individual Environmental Assessment.

If the request has been declined by the Minister, the proponent can implement the project subject to any conditions imposed. If the request has been granted, the proponent may be required to begin preparing Terms of Reference for an Individual EA, should they still wish to move ahead with the project.

3.0 CONSULTATION PLAN

Consultation with potentially affected persons is a vital part of the Municipal Class EA process, both in the collection of background information used to identify key issues, and in the development of the preferred solutions to best address all stakeholders' concerns while satisfying the Problem/Opportunity statement for the particular project. A contact list was developed for this study which included members of the public, review agencies, conservation authorities, Indigenous communities, and other stakeholders to which all study notifications were sent. The contact list was updated throughout the course of the study to include those that had expressed an interest in the study. A copy of the contact list is included in Appendix B.

The following table documents the various points of contact throughout the study and the means of dissemination. Copies of all study notifications are included in Appendix A.

Table 3.1 Stakeholder Consultation

Point of Contact	Date and method of dissemination
Flood Task Force Meeting	Meeting on July 16, 2018
Flood Task Force Meeting	Meeting on October 4, 2018
Notice of Commencement & PIC #1	Published in the Windsor Star, November 10, 2018 and November 17, 2018 Posted on the Town's website Mailed via Canada Post to all stakeholders identified on the project contact list on November 10, 2018
Public Information Centre #1, Atlas Tube Centre	November 27, 2018 (open house format)
Notice of PIC #2	Published in the Windsor Star, October 9, 2019 and October 16, 2019 Posted on the Town's website Mailed via Canada Post to all stakeholders identified on the project contact list on October 9, 2019
Public Information Centre #2, Atlas Tube Centre	October 23, 2019 (open house format)
Notice of Completion	Published in the Windsor Star, July 18, 2020 and July 25, 2020

3.1 INDIGENOUS CONSULTATION

A search was conducted using the Aboriginal Treaty Information System administered by Aboriginal Affairs and Northern Development to identify any active or closed land claims in and around the study area. Based on this information, proximity to the study area, known interests, and communication from the Ministry of Aboriginal Affairs, a list of eight (8) potentially interested Indigenous communities was compiled and included:

- Chippewas of the Thames;
- Oneida Nation of the Thames;
- Munsee-Delaware Nation;
- Delaware Nation (Moravian of the Thames);
- Bkejwanong Territory (Walpole Island);
- Caldwell First Nation;
- Chippewas of Kettle and Stony Point; and
- Aamjiwnaang First Nation.

All project notices were mailed directly to these communities, and follow-up telephone calls were made to verify that they had appropriate opportunities to review project information and provide comment. A table documenting all communication is included in Appendix B.

3.2 AGENCY CONSULTATION

Several government agencies identified as potentially having interest in the project were included in the study contact list and were provided relevant project documentation when requested. A summary of the comments, questions and/or concerns raised by agencies and how they were responded to by the study team is provided in Appendix B.

3.3 FLOOD TASK FORCE

The Flood Task Force (FTF) was established by Council in response to the two significant rainfall events of September 29, 2016 and August 28, 2017 that impacted the westerly portion of Lakeshore. The FTF is comprised of both Town Councilors and residents and its purpose is to communicate areas of concern with flooding that would allow the Town to better investigate aspects of existing drainage infrastructure, and resource allocation for planning and identifying opportunities for improving flood prevention conditions in the Town.

Members of the project team attended two FTF meetings to present an overview of the SMP and provide an update on the project status. The corresponding presentations are included in Appendix B.

3.4 PUBLIC INFORMATION CENTRES

Two Public Information Centres (PICs) were held during the course of the SWMP study. Each PIC was held in an open house format and members of the study team were in attendance to respond to questions and concerns raised by attendees.

All information presented at the PICs was made available on the Municipality of Lakeshore website. In addition, residents were encouraged to submit comments using the comment sheets provided. Copies of the completed comment forms are included in Appendix A. A copy of the information presented at each PIC is included in Appendix A. In addition, a summary of the questions/comments/concerns raised at/following the PIC and the associated response from the study team and/or how it was addressed as part of this SMP study is provided in Appendix B.

3.4.1 Public Information Centre 1

PIC 1 was held at the Atlas Tube Centre Lobby on November 27, 2018. The Notice of PIC was published in two consecutive editions of the Windsor Star newspaper. Information presented at the PIC included:

- Description of the study background and purpose;
- An overview of the Master Plan Municipal Class EA process;
- A summary of typical basement flooding causes;
- Description of the problems and opportunity;
- Potential private drainage system improvements to mitigate basement flooding;
- Potential private drainage system solutions to mitigate basement flooding; and
- Preliminary study recommendations.

3.4.2 Public Information Centre 2

PIC 2 was held at the Atlas Tube Centre Lobby on October 23, 2019. The Notice of PIC was published in two consecutive editions of the Windsor Star newspaper. In addition, attendees from PIC 1, review agencies, conservation authorities, Indigenous communities, and other stakeholders were directly mailed notices of PIC 2 (Appendix A). Information presented at the PIC included:

- An overview of the Master Plan Municipal Class EA process;
- The Problem and Opportunity Statement;
- General solution approach and the importance of both private drainage system improvements and public drainage system improvements;
- Potential private drainage system improvements to mitigate basement flooding;
- Key issues by catchment area and the public drainage system improvement alternatives considered for each catchment area;
- Evaluation criteria and summary of the evaluation process for each catchment area; and
- Recommended alternatives for each catchment area.

4.0 PROBLEM AND OPPORTUNITY STATEMENT

The first step in the Class EA process is to identify the problem or opportunity that has led to the undertaking of the Master Plan. The Problem and Opportunity statement for the Lakeshore Stormwater Master Plan - Phase 1 is as follows:

"The Municipality of Lakeshore experienced two extreme rainfall events in September 2016 and August 2017 that resulted in widespread residential flooding and inundated streets. These floods caused significant property damage in the form of basement flooding. While there are portions of the study area that are at risk due to shoreline and riverine flood hazards, the focus of this study is to evaluate and address flooding caused by severe storm events.

A comprehensive Stormwater Master Plan must be developed for the Town to identify necessary storm drainage system improvements to reduce flooding caused by severe rainfall events. The proposed servicing plan will identify both private and public drainage system improvements required to mitigate the possibility of basement flooding during extreme storms. The proposed SMP will contain the optimum solutions that balance the following responsibilities:

- *Provides adequate drainage servicing and stormwater treatment;*
- *Protects the natural environment;*
- *Reduces ancillary negative impacts on affected properties; and*
- *Minimizes stormwater servicing costs.*

Ultimately, the SMP will guide the Municipality of Lakeshore towards improved stormwater resiliency. Any other relevant responsibilities identified through the Class EA process will also be integrated into the proposed SMP."

5.0 EXISTING CONDITIONS

5.1 POLICY AND PLANNING REVIEW

A review was completed of relevant policy and planning documents and a summary is provided below.

5.1.1 Provincial Policy Statement (PPS) 2014

The Provincial Policy Statement (PPS) is a complimentary policy document to the *Planning Act* (2005), issued under Section 3 of the *Act*, and sets a policy foundation for regulating the development and use of land in Ontario. It provides direction on matters of provincial interest and supports the enhancement of the quality of life for all citizens of Ontario. Consistency with the PPS shall be considered during the development and evaluation of alternative solutions.

Three general principles are established in the PPS that are further elaborated on in a detailed set of policies that generally address the following matters:

- Building Strong Healthy Communities (PPS Section 1);
- Wise Use and Management of Resources (PPS Section 2);
- Protecting Public Health and Safety (PPS Section 3).

More specifically, the PPS recognizes that land use must be carefully managed to appropriately accommodate development for current and future needs. Appropriately managed development also helps to achieve efficient development patterns, which optimizes the use of land and the investment in public infrastructure, such as stormwater management systems. New development taking place in designated growth areas should occur adjacent to existing built-up areas to allow for the efficient use of land and public infrastructure, including the optimization of municipal drainage services. It is the job of Planning Authorities to direct development of new housing towards locations where appropriate levels of infrastructure exist or will be available to support current and projected needs.

As noted in Section 1.6.6.7 of the PPS, stormwater management services shall be planned to ensure that these systems are provided in a manner that:

- Minimizes, or, where possible, prevents increases in contaminant loads;
- Minimizes changes in water balance and erosion;
- Does not increase risks to human health and safety and property damage;
- Maximizes the extent and function of vegetative and pervious surfaces; and
- Promotes stormwater management best practices, including stormwater attenuation and re-use, and low impact development.

The preferred alternatives and supporting recommendations will meet the objectives of the PPS by planning for infrastructure that is appropriate to address projected needs, protects the natural environment, and protects public health and safety.

5.1.2 County of Essex Official Plan

The Municipality of Lakeshore is a lower-tier municipality within County of Essex. The Essex County Official Plan provides a broad policy framework related to land use planning direction and addresses issues of provincial and county wide interest, with which lower-tier municipal Official Plans must conform.

The current Official Plan outlines policies for Growth Management which recognizes the need to accommodate growth within each of its lower tier municipalities, estimating that by 2031, 18% of the County's estimated growth will occur in Lakeshore. As part of the Essex County Official Plan, a hierarchy was established to guide environmentally responsible growth, including avoiding conflict with natural features and hazards and the agricultural community.

According to the Official Plan, growth shall be directed to the designated settlement areas, with the majority of growth directed to Primary Settlement Areas, as these areas are expected to be fully serviced with municipal water and sewage services and stormwater management facilities. Primary Settlement Areas are also where investment in upgrading/expanding municipal sewage services or municipal water services is to be directed. These designated areas shall: demonstrate the potential to accommodate future growth through population projections; currently serve a community function; and demonstrate the potential to provide a level of service necessary to support future growth through a master servicing component of a Settlement Capability Report and/or completion of an Environmental Assessment.

The Essex County Official Plan states that local official plans shall encourage stormwater management practices that minimize stormwater volumes and contaminant loads. Further, future development within settlement areas is to proceed on the basis of full municipal services. Partial services may be permitted on an interim basis where proper justification is provided.

5.1.3 Municipality of Lakeshore Official Plan

The Municipality of Lakeshore Official Plan was adopted in November 2010, and outlines the various goals, objectives, and policies required to manage and direct physical change within Lakeshore.

5.1.3.1 Land Use

As illustrated on Schedule A of the Municipality of Lakeshore Official Plan (Appendix C), a large portion of the study area is designated Urban Area, which is where residential, commercial, non-industrial, and community related uses are directed within the Municipality of Lakeshore. Urban Areas support opportunities for redevelopment and intensification through a range of appropriate uses, considering existing building stock and the availability of suitable existing or planned infrastructure. More detailed land use schedules within the Official Plan further identify the specific land uses within these Urban Areas. These detailed schedules illustrate that the predominant land use within the study area is Residential, which permits a variety of residential dwelling types and requires sufficient watermain and sanitary sewer servicing in the area. Along the railway corridor, the adjacent lands are designated Employment and Mixed Use. Employment lands are characterized by a high visual profile and accessibility, and Mixed Use lands are characterized by a range of transit-supported commercial and residential uses. Designated Urban Reserve lands are present within the west portion of the study area are designated Urban Reserve. Schedule A

also identifies Primary and Mixed Use Nodes within the study area. These areas are envisaged for higher intensity, which can accommodate major concentrations of residential, commercial, and community service uses. These lands, in addition to the Urban Areas, are intended to accommodate the Municipality of Lakeshore's projected urban and employment growth, up to the year 2031.

The majority of the southern portion of the study area is designated Agricultural, consisting entirely of prime agricultural lands which the Municipality of Lakeshore intends to preserve and strengthen. Any Agriculture related commercial and/or industrial uses will only be permitted if water volume requirements and/or effluent volumes are minimal, and if appropriate water supply and sewage treatment servicing is provided. To support future agricultural-related commercial and industrial uses, sufficient watermain and sanitary sewer servicing will be required. Lands adjacent to the Belle and Puce Rivers are designated Waterfront Residential, consisting of the historic, predominately low density, residential dwellings that abut watercourses and, while the character of these areas is to be maintained, any development or site alteration is subject to the natural resource asset protection policies.

In addition to the specific land use designations, various lands within the study area are also designated Floodprone and are subject to Natural Heritage protection policies. Floodprone areas are generally located within 1 km of the Lake St. Clair shoreline and adjacent to the Belle River or Puce River. These designated areas are susceptible to periodic flooding and/or erosion hazards. Appropriate access and floodproofing is required for existing and future development, and all development activities within these areas are subject to prior approval from the appropriate Conservation Authority.

Designated areas within the study area, such as lands in close proximity to Significant Valley land or a Candidate Provincially Significant Wetlands, or lands that within the Inland Floodplain Development Control Area, are subject to Natural Heritage protection policies, including the completion of an Environmental Impact Assessment prior to any development or site alteration within or adjacent to these features.

5.1.3.2 Stormwater Management

Section 7.3.3 of the Municipality of Lakeshore Official Plan provides policy direction related to the Town's stormwater management system and encourages development planning to align with other infrastructure systems within the town. The Municipality of Lakeshore's flat topography and increased water run-off rate is recognized as part of the Town's Official Plan, as well as the need for inland drainage and pumping systems to properly drain its low-lying, below lake level lands.

To prevent negative impacts on existing land drainage characteristics, all new development within the Town requires a stormwater management plan. It is also the preference of the Town that all stormwater management facilities will be municipally owned, operated, and maintained, and that stormwater management requirements will be incorporated as a component of the development approvals process. The integration of natural vegetative features adjacent to and within new regional facilities will be encouraged, where appropriate, and the naturalization of the periphery of existing stormwater management facilities is encouraged.

The Town also recognizes that it may be necessary for some storm sewer oversizing and deepening to occur within designated Urban Areas and Employment Areas. In the case of natural watercourses,

modifications may only be undertaken if natural features can be integrated with optimal design to ensure that quality and quantity impacts are mitigated.

5.1.4 Municipality of Lakeshore Zoning By-Law

The Municipality of Lakeshore Zoning By-law establishes and regulates the use of land by implementing the policies of both the Town and County Official Plans. Schedule A of the Municipality of Lakeshore Zoning By-law indicates that the lands along the Lake St. Clair shoreline are identified as being within the Lake St. Clair Floodprone Areas and that lands along the inland watercourses in Belle River, Puce, and Pike Creek are identified as being within the Inland Floodplain Development Control Area (Appendix C). Development is restricted within these areas and permits from the applicable Conservation Authority must be issued, in consultation with the Town, prior to any part of any building or structure being erected. Regarding the inland floodplain development control area, construction or reconstruction within the floodway is prohibited. Lands within the floodplain area, but outside the floodway, may be used in accordance with the provisions of the underlying zone but all habitable space of buildings shall be floodproofed.

The Municipality of Lakeshore Zoning By-law defines storm drainage and stormwater management controls and/or systems as Municipal Services and Public Utilities but does not provide additional requirements for the specific placement of these facilities. The detailed design and implementation of improvements identified within this Master Plan will be required to comply with the policies of the Municipality of Lakeshore Zoning By-law, especially if located within either the Lake St. Clair Floodprone Area or the Inland Floodplain Development Control Area.

5.1.5 Municipality of Lakeshore Development Manual

The Municipality of Lakeshore Development Manual provides the standards and expectations for new development. Sections 4 and 5 of the Town's Development Manual contains specific engineering and construction guidelines related to the stormwater drainage system, as well as information on infrastructure easements. Design standards shall be followed during detailed design and implementation of improvements identified within this Master Plan.

5.1.6 Windsor/Essex Region Stormwater Management Standards Manual

The Windsor/Essex Region Stormwater Management Standards Manual (WERSMSM) outlines best practice stormwater management guidelines for the Windsor/Essex Region. The manual also identifies the need for better coordination of municipal and private drain design, as well as the requirements for proper implementation, construction, operation, and maintenance to support current and future stormwater needs.

The manual recognizes that the limited land gradient within Essex County causes many of the receiving watercourses and trunk sewers to flow near full during moderate rainfall events, with extreme events causing watercourse overflow, as seen within the Municipality of Lakeshore, and provides direction for drainage planning and design requirements within the Windsor/Essex Region.

The assessment of alternatives and implementation of projects recommended by this Master Plan, shall be consistent with the context and direction provided by the policies presented in this manual.

5.2 NATURAL ENVIRONMENT REVIEW

As part of the Municipal Class EA process, a Natural Environment Review (NER) was prepared to characterize the significance and sensitivity of the natural features in the study area, identify potential environmental effects and recommend appropriate measures to avoid or minimize potential negative impacts on the surrounding environment.

For the purposes of this Master Plan, the NER was prepared through a desktop review of available federal and provincial databases and is intended to provide a general framework for future projects. Prior to construction, field investigation may be required to confirm the presence of Species at Risk (SAR) or Significant Wildlife Habitat, and if proposed works may endanger SAR habitat or Significant Wildlife Habitat, a permit will be required under the Species at Risk Act/Endangered Species Act.

5.2.1 Methodology for Data Collection

The following references were used as primary data sources for this report:

- Natural Heritage Information Centre (NHIC) (Ministry of Natural Resources and Forestry, 2019);
- Background wildlife atlases (e.g., Breeding Bird Atlas, Ontario Reptile and Amphibian Atlas, Mammals of Ontario);
- Essex Region Conservation Authority Watershed Report Card;
- Essex Region Source Protection Area Updated Assessment Report;
- Land Information Ontario; and
- Geology Ontario.

5.2.2 Field Studies and Investigations

Fieldwork was not incorporated into the natural environment characterization. Species information may be sufficiently updated at the time of project implementation. Fieldwork should be planned and completed at the project onset through discussions with agency staff, subject to the extent of construction activity proposed.

5.2.3 Environmental Planning and Policy Documents

5.2.3.1 Provincial Policy Statement (2014)

The wise use and management of the natural environment is recognized as a crucial component of ensuring Ontario's long-term prosperity, environmental health and social well-being. Accordingly, the Provincial Policy Statement (PPS) provides direction for the long-term protection, restoration and improvement of the diversity and connectivity of natural features, the ecological function and biodiversity of natural systems, and the quality and quantity of water at a watershed scale.

Policy 2.1 of the PPS (2014) provides direction for the protection of the natural heritage features, while guidance in this regard is provided through the Natural Heritage Reference Manual (Ministry of Natural Resources, 2010). The natural heritage features to be considered in accordance with the PPS include:

- Significant wetlands (PSW) and significant coastal wetlands;
- Significant habitat of endangered and threatened species;
- Significant woodlands;
- Significant valleylands;
- Significant wildlife habitat;
- Significant areas of natural and scientific interest (ANSIs); and
- Fish habitat.

In southern Ontario, development and site alteration is not permitted in significant habitat of endangered and threatened species or fish habitat except in accordance with provincial and federal requirements. Development and site alteration may be permitted on lands adjacent to significant wetlands, coastal wetlands and the habitat of endangered and threatened species if it is demonstrated that there will be no negative impacts on the natural features or the ecological functions for which the area was identified.

Development is not permitted within, or on lands adjacent to, the other significant natural heritage features unless the ecological function of these lands has been evaluated and it has been demonstrated that no negative impacts on the natural heritage features or their ecological function will occur.

The assessment, selection and implementation of any preferred alternatives should be consistent with the context and direction provided by the policies in the PPS.

5.2.3.2 County of Essex Official Plan – Natural Environment Policies

The Essex County Official Plan (OP) was approved by the Minister of Municipal Affairs & Housing (MMAH) on April 28, 2014.

The Essex County OP includes the following goals:

- Protect and enhance the natural heritage system by increasing the amount of core natural area and natural buffers where possible, particularly through restoration efforts;
- Link wildlife habitat and natural heritage areas to each other, human settlements to other human settlements and people to nature; and
- Protect life and property by directing development away from natural and human-made hazards.

The OP states, "*The vision for lands designated "Natural Environment" and other areas with natural heritage features and lands adjacent to areas with significant natural heritage features is one which includes a strong commitment to protect, preserve and enhance those areas that exist within the County."*

Natural Environment features include the following:

- Provincially Significant Wetlands;
- Significant habitat of endangered or threatened species;
- Lands designated in local Official Plans for natural heritage protection; and

- Other high priority natural heritage features meeting 5 of the 11 criteria set out in the County of Essex Natural Heritage System Strategy.

Development and site alteration are not permitted on lands designated Natural Environment in the OP. Permitted uses are limited to passive recreational uses and activities that create or maintain infrastructure. The continuation of agricultural uses is permitted on lands within the Natural Environment designation.

Secondary priority Natural Environment features include woodlands and wildlife habitat. Species policies apply to these lands when subject to a development review of a Planning Act application. The County encourages local municipalities to undertake Candidate Natural Heritage Studies to identify provincial, regional and locally significant natural heritage features.

Opportunities for restoration to enhance the existing natural heritage system and create linkages among features are also identified in the Official Plan. Policy 3.4.5.a states that Secondary Plans shall evaluate opportunities to enhance and restore the natural heritage features in the area, including the establishment of linkages, establish buffers, and to set aside strategic areas for restoration and enhancement.

Schedule A-1 of the OP identifies components of the Natural Environment, comprised of significant terrestrial features (Schedule B1) and Provincially Significant Wetlands (Schedule B1, discussed below). Schedules have been included in Appendix C. There are approximately eleven natural environment features identified within the Study Area on Schedule A-1.

5.2.3.3 Municipality of Lakeshore Official Plan – Natural Environment Policies

The Municipality of Lakeshore Official Plan (Lakeshore OP) was adopted on November 22, 2010.

One of the six planning objectives is to ensure the Municipality of Lakeshore is naturally inviting and environmentally aware. Policies protecting the natural environment are included in Section 5.2 of the Lakeshore OP, which states that “the Town will work to conserve, restore and enhance Natural Heritage Features and functions, wherever possible.” The delineation of Natural Heritage Features is based on data provided by the MNRF, ERCA and Lower Thames Valley Conservation Authority (LTVCA).

Natural heritage policies in the Lakeshore OP are generally consistent with those in the Provincial Policy Statement and Essex County OP. Development and site alteration is not permitted within a provincially significant wetland or significant habitat of threatened or endangered species, or within fish habitat except in accordance with applicable legislation. In the Lakeshore OP however, existing protections for all other natural heritage features (i.e. significant wildlife habitat, significant woodland), including high quality examples of these features, are less stringent than those provided in the Essex County OP in that development or site alteration may be permitted subject to completion of an Environmental Impact Assessment.

With respect to creating and restoring habitat within the community, Policy 5.2.4.f) notes that the Town will encourage opportunities for creating new habitats, natural vegetation regeneration and for promoting environmental education and interpretation. The Town will also encourage the protection of species at risk.

Official Plan Schedule B2 identifies candidate PSWs and woodlands, and is discussed further below.

5.2.3.4 Species at Risk Act

The Species at Risk Act (SARA) is Federal legislation that identifies wildlife species considered to be at risk in Canada and designates them as threatened, endangered, extirpated or of special concern. Species at risk are identified and assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which is an independent committee of wildlife experts and scientists that makes recommendations to the federal government regarding the status of wildlife species in Canada.

The purpose of SARA is to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened.

The protection and conservation measures afforded by SARA apply to those species identified on Schedule 1 of the Act. Other species identified by COSEWIC as species at risk that required further assessment in accordance with current assessment criteria are identified on Schedule 2 (Endangered and Threatened) and Schedule 3 (Special Concern) of the Act. All listed (Schedule 1) aquatic species and migratory birds in Canada are protected by SARA. Remaining listed species (plants, mammals, reptiles, amphibians) are only protected where they occur on federal lands (i.e. National Parks, First Nations Reserves).

Any activity affecting a listed species or its critical habitat requires the prior issuance of a permit from the applicable agency, either Environment Canada or Fisheries and Oceans Canada (DFO). Permits may only be issued for scientific research relating to the conservation of the species, where activities are required to benefit a species or to enhance its chances of survival or for incidental impacts. Efforts to avoid, reduce, or minimize impacts must first be employed and activities will not be permitted if they would jeopardize the survival or recovery of the species.

5.2.3.5 Endangered Species Act

Similar to SARA, the Endangered Species Act (ESA) identifies wildlife species considered to be at risk in Ontario and designates them as threatened, endangered, extirpated or of special concern. Provincial species at risk are identified and assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) which is a committee of wildlife experts and scientists, as well as those who provide Aboriginal traditional knowledge, that classify species according to their degree of risk based on the best available scientific information, community knowledge and aboriginal traditional knowledge. When COSSARO classifies a species at risk, that classification applies throughout Ontario, unless otherwise noted.

The ESA (2007) replaces the original (1971) to provide broader protection for species at risk and their habitats, a stronger commitment to recovery of species, greater flexibility, increased fines and more effective enforcement, as well as greater accountability through government reporting requirements.

The ESA protects species at risk and their habitats by prohibiting anyone from killing, harming, harassing or possessing protected species, as well as prohibiting any damage or destruction to the habitat of species

identified on the Species At Risk in Ontario (SARO) list. All species on the SARO list are provided with general habitat protections under the Endangered Species Act, which protect areas that species depend on to carry out their life processes, such as reproduction, rearing, hibernation, migration, or feeding.

A species added to the SARO list is required to have a regulation approved by the Ministry of Environment, Conservation and Parks (MECP) within a set period of time to define species specific habitat requirements, which identifies specific boundaries, areas, or features of an area where the species lives, used to live or is believed to be capable of living. This 'regulated habitat' replaces the general habitat description once approved.

Any activity that may impact a protected species or its habitat requires the prior issuance of a permit from the MECP. Such permits may only be issued under certain circumstances, which are limited to activities required to protect human health and safety, activities that will assist in the protection or recovery of the species, activities that will result in an overall benefit to the species or activities that may provide significant social or economic benefit without jeopardizing the survival or recovery of the species in Ontario.

Recent changes to the ESA allow for specific infrastructure projects to proceed without the prior issuance of a permit. For these activities, the work must be registered and adhere to certain rules and guidelines. Consultation with the MECP is recommended prior to the works starting in order to ensure compliance with the ESA.

5.2.3.6 Essex Region Conservation Authority

Essex Region Conservation Authority (ERCA) is responsible for approval of development or site alteration within hazardous areas adjacent to shorelines, watercourses and wetlands within its jurisdiction. These areas are identified by boundaries on adjacent lands known as the "Regulation Limit", are detailed in *Ontario Regulation 158/06: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses,* and its accompanying mapping. The purposes of these regulations are to protect life and property from flooding, erosion and unstable slopes. Any proposed works within the Regulation Limits generally require the issuance of a permit from ERCA.

5.2.3.7 Summary of Policy Implications

This Master Plan process recognizes the objectives of the policies noted above and the requirements of the individual agencies. The corresponding opportunities and constraints established by these policies and supporting guidelines should be recognized and addressed throughout the planning process, as well as through implementation, including the identification of appropriate mitigation, restoration, and enhancement measures to offset potential negative impacts. The intent of this review is to demonstrate how the proposed project complies with the applicable policies noted above. As such, this approach is to recognize the objectives of the policies noted above and the requirements of the individual agencies charged with their implementation. This information will be considered during the establishment of the preferred alternative and identification of appropriate mitigation, restoration and, where feasible, enhancement opportunities.

5.2.4 Existing Natural Features and Functions

5.2.4.1 Climate

Environment Canada's Windsor Airport weather monitoring station is the closest station to the study area with documented long-term temperature, precipitation and other weather data, (Environment Canada Station Climate ID 6139525). This climate station meets the World Meteorological Organization (WMO) standards for temperature and precipitation. Climate averages for the period 1981-2010 are outlined in Table 5.1 below (Environment Canada, 2013).

Table 5.1 Windsor Airport Climate Averages (1981-2010)

Climate Station ID 6137362		Value	Month
Daily Average Temperature	**Highest Month**	23.0 ºC	July
	Lowest Month	-3.8 ºC	January
Average Monthly Precipitation	**Highest Month**	93.9 mm	September
	Lowest Month	62.1 mm	February
Total Annual Precipitation		934.6 mm	---

5.2.4.2 Topography and Physiography

The topography of the Study Area is generally flat with a gentle slope northwards towards Lake St. Clair. Ground elevation ranges between approximately 182 m Above Sea Level (ASL) at the southeastern boundary to approximately 175 m ASL at the shoreline. The topography is presented on Figure 5.3.

It is located within the St. Clair Clay Plains physiographic region of southern Ontario and is characterized by beveled till plains (Chapman and Putnam, 2007). Sand Plain deposits have been mapped along the shoreline. The physiography is presented on Figure 5.1.

5.2.4.3 Soils, Geology and Hydrogeology

Surficial geology mapping by the Ontario Geological Survey (OGS) (2010) is presented on Figure 5.2. The surficial geology of the Study Area consists chiefly of fine-textured glaciolacustrine deposits (Unit 8a) with some till (Unit 5d) along the southern boundary, and coarse-textured lacustrine deposits (Unit 14b) adjacent to the shoreline (OGS, 2010). Unit 8a consists of silt and clay with minor sand and gravel that is massive and well laminated. The till consists of clay to silt-textured deposits and Unit 14b is composed of littoral beach deposits consisting of sand and gravel with minor silt and clay. There are modern alluvial deposits (Unit 19) associated with Pike Creek, Puce River, and Belle River.

The shallow bedrock consists of Devonian-aged shales and limestones of the Hamilton Group and limestone of the Dundee Formation (OGS, 2011; Sun, 2018). According to MECP Water Well Records (WWR) and OGS geotechnical boreholes, bedrock is encountered at depths ranging between 30 m to 55 m below ground surface (BGS). The location of the MECP WWRs are presented on Figure 5.2.

A petroleum reservoir (Belle River Pool) has been mapped in the Study Area (OGSR, 2019). It is located adjacent to Lake St. Clair between Duck Creek and Belle River. No wells are shown within the Pool footprint. Petroleum reservoirs in the general area are hosted in the deeper bedrock of Ordovician-aged Black River Group limestones at approximately 950 m depth (OGSR, 2019). The Ordovician-aged deposits overlie crystalline Precambrian-aged rocks.

A review of the MECP WWR located within the Study Area indicated that water supply wells are chiefly used for livestock and domestic. The well depths ranged between 30 m BGS to 50 m BGS and are generally screened within the bedrock. Wells that are screened within the overburden, straddle either a sand, or a sand and gravel unit that lies directly over the bedrock.

There were no WWR of shallow water supply wells (< 30 m) screened in the overburden indicating that the shallow overburden does not yield high groundwater supply rates. This is consistent with the mapped deposits of clay and silt.

There are no areas of significant groundwater recharge and no highly vulnerable aquifers (MECP, 2019). There are also no wellhead protection areas as the area relies on surface water for domestic supply (MECP, 2019).

5.2.4.4 Watersheds

The Study Area is located in the Lake St. Clair Watershed and is subdivided into four subwatersheds:

- Pike Creek Subwatershed;
- Puce River Subwatershed;
- Belle River Subwatershed; and
- Duck Creek Subwatershed.

The largest of the subwatersheds is Belle River, covering an area of approximately 113 km^2. Pike Creek and Puce River each cover an area of approximately 90 km^2 and Duck Creek is the smallest at approximately 24 km^2 (ERCA, 2015). The watershed boundaries and watercourses are presented on Figure 5.4.

These watersheds have been impacted by agricultural activities that include loss of wetlands and headwater drainage features that have led to a reduction in flow during drier periods leading to impacts to available fish habitat. The loss of wetlands and headwater drainage features combined with altered flow regimes through agricultural drainage has also led to increased erosion during large storm events. Within these watersheds, water quality is generally poor due to sediment loading, urban runoff, low dissolved oxygen, high summer water temperatures, elevated bacteria levels and nutrient inputs (Hayman et al 2005).

5.2.4.5 Aquatic Species

All of the watercourses within the Study Area are managed as warmwater habitat with 46 fish species identified in the various watersheds. Table 5.2 provides a list of fish species known to occur in each of the watersheds, as determined through a review of the Land Information Ontario (LIO) database and work completed by Hayman et al (2005) for the Essex Region Fish Habitat Management Plan.

Table 5.2 Fish Species Known to Inhabit Watersheds within the Study Area

Common Name	Scientific Name	Pike Creek	Puce River	Belle River	Duck Creek
Black Bullhead	*Ameiurus melas*		X		
Black Crappie	*Pomoxis nigromaculatus*	X			X
Blackside Darter	*Percina maculata*	X		X	
Bluegill	*Lepomis macrochirus*	X	X	X	X
Bluntnose Minnow	*Pimephales notatus*	X		X	X
Brassy Minnow	*Hybognathus hankinsoni*		X		
Brook Stickleback	*Culaea inconstans*	X		X	X
Brown Bullhead	*Ameiurus nebulosus*		X	X	X
Central Mudminnow	*Umbra limi*	X	X	X	X
Channel Catfish	*Ictalurus punctatus*				X
Channel Darter	*Percina copelandi*	X			
Common Carp	*Cyprinus carpio*	X	X	X	X
Common Shiner	*Luxilus cornutus*			X	
Creek Chub	*Semotilus atromaculatus*	X	X	X	
Eastern Sand Darter	*Ammocrypta pellucida*			X	
Emerald Shiner	*Notropis atherinoides*	X	X	X	
Fathead Minnow	*Pimephales promelas*	X	X	X	X
Freshwater Drum	*Aplodinotus grunniens*		X		X
Ghost Shiner	*Notropis buchanani*				X
Gizzard Shad	*Dorosoma cepedianum*	X		X	X
Golden Shiner	*Notemigonus crysoleucas*	X	X	X	X
Goldfish	*Carassius auratus*	X	X	X	X
Grass Pickerel	*Esox americanus vermiculatus*				X
Green Sunfish	*Lepomis cyanellus*	X	X	X	X
Largemouth Bass	*Micropterus salmoides*	X	X	X	X
Logperch	*Percina caprodes*		X		
Mimic Shiner	*Notropis volucellus*			X	
Mooneye	*Hiodon tergisus*	X			
Mottled Sculpin	*Cottus bairdii*	X			
Northern Pike	*Esox lucius*	X	X	X	X
Pumpkinseed	*Lepomis gibbosus*	X	X	X	X
Quillback	*Carpiodes cyprinus*		X		
Redfin Shiner	*Lythrurus umbratilis*			X	
Rock Bass	*Ambloplites rupestris*	X	X	X	X
Round Goby	*Neogobius melanostomus*	X			

Common Name	Scientific Name	Pike Creek	Puce River	Belle River	Duck Creek
Silver Redhorse	*Moxostoma anisurum*			X	
Spotfin Shiner	*Cyprinella spiloptera*	X	X	X	X
Spottail Shiner	*Notropis hudsonius*		X	X	X
Spotted Sucker	*Minytrema melanops*			X	
Striped Shiner	*Luxilus chrysocephalus*	X			
Tadpole Madtom	*Noturus gyrinus*	X	X	X	
Trout-perch	*Percopsis omiscomaycus*			X	
White Bass	*Morone chrysops*				X
White Crappie	*Pomoxis annularis*	X	X	X	X
White Perch	*Morone americana*				X
White Sucker	*Catostomus commersonii*	X	X		
Yellow Bullhead	*Ameiurus natalis*			X	
Yellow Perch	*Perca flavescens*	X		X	

Most of the fish species identified within the watersheds are common to warmwater habitats throughout Ontario. Mottled Sculpin and Trout-perch are generally found in coldwater habitats and suggests that there are areas of colder temperatures in the Pike Creek and Belle River watersheds. Species such as Brook Stickleback, Creek Chub, and White Sucker are tolerant of degraded conditions such as those found in the Study Area (Holm et al, 2009; Scott and Crossman, 1998). Ghost Shiner, Mimic Shiner, and Silver Redhorse are fish species unique to the location of the Study Area within the Lake St. Clair drainage basin (Hayman et al, 2005).

Aquatic Species at Risk

A review of Fisheries and Oceans Canada's (DFO) Aquatic Species at Risk mapping indicates that there are seven aquatic species at risk recorded within the Study Area (DFO, 2019). The following table lists the species at risk identified on DFO mapping in each watershed within the Study Area. Locations are shown on Figure 5.5 and Figure 5.6.

Table 5.3 Aquatic Species at Risk found within the Study Area

Species Common Name	Species Scientific Name	S-Rank	Provincial Status	Federal Status
Pike Creek Watershed				
Channel Darter	*Percina copelandi*	S1	Special Concern	Threatened
Grass Pickerel	*Esox americanus vermiculatus*	S3	Special Concern	Special Concern
Belle River Watershed				
Spotted Sucker	Minytrema melanops	S2	Special Concern	Special Concern
Eastern Sand Darter	Ammocrypta pellucida	S2	Endangered	Threatened
Liliput	Toxolasma parvum	S1	Threatened	Endangered
Duck Creek Watershed				
Grass Pickerel	*Esox americanus vermiculatus*	S3	Special Concern	Special Concern
Lake St. Clair Shoreline				
Channel Darter	*Percina copelandi*	S1	Special Concern	Threatened
Eastern Sand Darter	*Ammocrypta pellucida*	S2	Endangered	Threatened
Northern Madtom	*Noturus stigmosus*	S1	Endangered	Endangered
Pugnose Shiner	*Notropis anogenus*	S2	Threatened	Threatened

Additional review of updated information and field investigations to determine the presence or absence of at-risk species and/or suitable habitat may be required prior to implementation of the recommended alternatives.

5.2.4.6 Water Quality

The ERCA 2018 Watershed Report Card grades surface water quality according to the *Guide to Developing Conservation Authority Watershed Report Cards* (Conservation Ontario, 2011). Three indicators are used to assess the surface water quality for each watershed:

- Bacteria (*E. coli*);
- Total phosphorus; and
- Benthic invertebrates.

Grades across the ERCA watersheds were mostly Ds, ranging from C to F. Decreases in surface water quality grades from the previous report card in 2012 were noted due to increased E. coli levels in some streams and the addition of new data (i.e., benthic invertebrate data) in others. These new data provided a

more detailed water quality assessment over those previously reported in 2012. Phosphorus sources remained constant; representative of land uses in the region.

ERCA attributes the increase in *E. coli* in some streams to the following potential causes:

- Rain event timing and intensity; and
- New or increased sources of *E. coli* (e.g., faulty septic systems, manure storage and application).

Results of the benthic invertebrate surveys identified assemblages that are tolerant to poor water quality conditions, contributing to the low score for this component of the overall surface water quality grade.

5.2.4.7 Vegetation Communities

Field investigations of vegetation communities have not been conducted for this NER, however the Ministry of Natural Resources and Forestry's Southern Ontario Land Resources Information System (SOLRIS) dataset provides a high-level overview of the types of vegetation communities that exist on the landscape.

The Study Area is primarily occupied by agricultural (tilled) lands followed by transportation infrastructure and built up areas. The SOLRIS data is shown on Figure 5.7 and summarized in the following table.

Table 5.4 SOLRIS Habitat Types Found within the Study Area

Class	Habitat Type	Area (ha)
90	Forest	1
93	Deciduous Forest	45
131	Treed Swamp	112
135	Thicket Swamp	6
160	Marsh	18
170	Open Water	88
192	Hedge Row	56
193	Tilled	2522
201	Transportation	388
202	Built Up Area – Pervious	326
203	Built Up Area – Impervious	964
250	Undifferentiated	225
	TOTAL	**4,752**

5.2.4.8 Plant Species

The Natural Heritage Information Centre (NHIC) maintains a publicly available database of critical flora and fauna previously observed within the study area. Since 1990, there have not been any observations of provincially protected species (Ministry of Natural Resources, 2019). Further studies to identify rare and/or locally significant species may be required on a site-specific basis.

5.2.4.9 Wildlife

The NHIC identifies two at–risk species in or near the study area since 1990 (Ministry of Natural Resources, 2019); Butler's Gartersnake and Blanding's Turtle. Eight additional species were identified based on background reviews of applicable wildlife atlases (Cadman, Sutherland, Beck, Lepage, & Couturier, 2007); (Dobbyn, 1994); (Ontario Nature, 2015). Further studies to identify rare and/or locally significant species may be required on a site-specific basis.

Table 5.5 Wildlife Species at Risk

Species Common Name	Species Scientific Name	S-Rank	Provincial Status	Federal Status	Source
BIRDS					
Bank Swallow	*Riparia riparia*	S4B	Threatened	Threatened	OBBA
Barn Swallow	*Hirundo rustica*	S4B	Threatened	Threatened	OBBA
Bobolink	*Dolichonyx oryzivorus*	S4B	Threatened	Threatened	OBBA
Chimney Swift	*Chaetura pelagica*	S4B	Threatened	Threatened	OBBA
Eastern Meadowlark	*Sturnella magna*	S4B	Threatened	Threatened	OBBA
REPTILES					
Blanding's Turtle	*Emydo idea blandingi*	S3	Threatened	Threatened	NHIC and ORAA
Butler's Gartersnake	*Thamnophis butleri*	S2	Endangered	Endangered	NHIC and ORAA
Eastern Foxsnake (Carolinian)	*Pantherophis gloydi*	S3	Endangered	Endangered	ORAA
MAMMALS					
Little Brown Myotis	*Myotis lucifugus*	S4	Endangered	Endangered	AMO
Northern Myotis	*Myotis septentrionalis*	S3	Endangered	Endangered	AMO

LIO mapping identified the presence of a portion of one Important Bird Area (IBA), Eastern Lake St. Clair Southwestern Ontario (ON012). This area is globally significant for congregatory species and waterfowl concentrations while nationally significant for congregatory species (BirdLife International, 2019).

5.2.4.10 Natural Hazard Features

Natural processes that have the potential to cause damage to property, personal injury or loss of life are regulated in Ontario under the Conservation Authorities Act. These hazards can include flooding, erosion, dynamic beaches and unstable slopes.

Ontario Regulation (O. Reg.) 158/06 outlines regulated areas within the jurisdiction of ERCA, based on:

- The 100-Year Flood Event Standard;
- Long term stable slopes;
- Dynamic beaches;
- Riverine meander belts;
- Wetlands;
- Other hazardous lands; and
- Additional setbacks from these features.

Approximately 35 percent of the study area is regulated by ERCA. Any development or site alteration proposed within regulated areas will require prior written approval from the Conservation Authority.

5.2.4.11 Significant Wetlands

The Ontario Wetland Evaluation System is used to identify Provincially Significant Wetlands (PSW). An evaluated wetland may be one contiguous unit or may be a series of smaller wetlands functioning as a whole. Evaluated wetlands that do not qualify as provincially significant may be designated as locally significant and may be protected through local planning and policy measures. Not all wetlands are evaluated, which are categorized as unevaluated wetlands.

Five Provincially Significant Wetlands (PSW) or unevaluated wetlands were identified in background LIO mapping, as shown on Figures 5.8, 5.9, and 5.10. This includes two PSWs in the Pike Creek subwatershed; the Russel Woods Swamp (ER25) and Pike Creek Wetlands (ER26). There are two PSWs in the Puce River subwatershed; Swanson Swamp (ER22) and Patillo Road Marsh. There is also a PSW adjacent to the Belle River called the Belle River Wetland Complex.

The County of Essex OP identifies nine PSWs within the Study Area on Schedule B1 (Appendix C).

The Lakeshore OP does not identify PSWs, but instead identifies two candidate PSWs within the Study Area on Schedule B.2 (Appendix C). These parcels were identified through a Natural Heritage Feature Inventory undertaken by ERCA and the Municipality of Lakeshore as displaying vegetative and soil characteristics consistent with PSWs, but have not been formally evaluated (i.e., using the Ontario Wetland Evaluation System). The Municipality of Lakeshore applies PSW policies to these features, until a formal evaluation and/or official plan amendment are implemented.

5.2.4.12 Significant Woodlands

The County of Essex OP identifies significant woodlands as any woodland greater than 2 ha in size, although smaller woodlands may be considered significant if stand age, composition, or quality that is uncommon in the region. Significant woodlands are not specifically mapped, although they are integrated into the Natural Environment layer on Schedule A1, Significant Terrestrial Feature layer on Schedule B1, and Environmental Feature Overlay on Schedule B2.

The Lakeshore Official Plan identifies woodlands on Schedule B.2 of its Official Plan, including approximately 35 within the Study Area (Appendix C). An assessment of significance is not provided.

LIO mapping does not identify any significant woodlands in the Study Area.

5.2.4.13 Invasive Species

Invasive species have far-reaching impacts on the natural environment and are one of the greatest threats to biodiversity. The Ontario Ministry of Natural Resources and Forestry (MNRF) define invasive species as: “harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health” (Ministry of Natural Resources and Forestry, 2012).

Consultation with First Nations communities during similar projects has identified concerns over the potential for common reed (*Phragmites australis* subsp. *australis*) to become established in the area of the project site once construction has been completed.

Common reed is an invasive perennial grass that creates monoculture stands that in most cases leads to a decrease in biodiversity and destruction of habitat for other species (Ontario Ministry of Natural Resources, 2011). It thrives in disturbed habitat and is often among the first species to colonize a new area. It is for this reason that it has been identified as a concern.

It is important to note that the invasive subspecies is similar to a native species (subspecies *americanaus*) and is imperative to correctly identify before implementing a management or removal plan.

5.2.4.14 Drinking Water Source Protection

Drinking Water Source Protection represents the first barrier in the protection of drinking water. Protecting surface and ground water from becoming contaminated or overused will ensure a sufficient supply of clean, safe drinking water. The Clean Water Act 2006 (CWA) is intended to protect existing and future sources of drinking water as part of the government’s overall commitment to protecting human health and the environment. The CWA sets out a framework for source protection planning on a watershed basis with Source Protection Areas established based on the watershed boundaries of Ontario’s 36 Conservation Authorities. The Essex Source Protection Area is one of 19 established across the province.

5.3 EXISTING DRAINAGE REVIEW

The existing drainage conditions within the study area were reviewed as follows:

- A minor system assessment was completed to evaluate the condition and capacities of the existing storm sewers and associated works;
- A major system assessment was completed to identify maximum surface ponding depths and their associated ponding limits during severe storm events;
- The existing SWM pond volumes were estimated to verify that they are constructed as designed and meet their corresponding treatment targets; and
- The existing drainage conditions in each catchment within the study area was characterized to identify key issues.

Generally, municipal drains within the study area were not included in the existing drainage conditions assessment because they are regulated under the Drainage Act and are not subject the Environmental Assessment Act process.

5.3.1 Minor Storm System Assessment

The minor system, typically a storm sewer, consists of drainage works that convey flows from the design minor storm event – typically a 2-year or 5-year return period. These systems offer quick and efficient drainage of urbanized areas to limit the inconvenience of stormwater ponding for most storm events. They are not designed to accommodate the runoff from infrequent events such as those experienced in September 2016 and August 2017. During less frequent events, the major storm system is needed to assist in conveying excess flows to a sufficient outlet. The major storm system is discussed in Section 5.3.2.

Minor systems within the Phase 1 study area discharge to the local receiving watercourses either by gravity or pumped outlets. The role of the pump station varies from system to system. In some cases, the pump is designed to convey the minor storm flows, and in others its purpose is to dewater the upstream minor system when the outlet is submerged below the downstream lake level. Many of the minor system outlets are equipped with flap gates to provide backflow prevention.

The minor system assessment was performed as follows:

1. An inventory of the existing pump stations was developed based on the available information provided by the Town; and
2. An evaluation of all Phase 1 study area storm sewers identified in the Town GIS was completed to identify portions of the minor system that present a risk of local flooding and to develop a replacement strategy.

5.3.1.1 Pumps

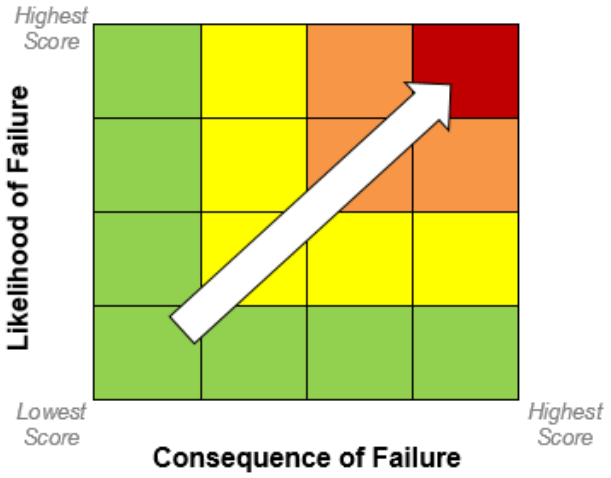
There is a total of 25 storm sewer pump stations and 16 municipal drain pump stations within the Phase 1 study area. A review of all storm sewer pump stations was completed. Several municipal drain pump stations that drain residential developments and storm sewers were also reviewed.

Information on pump operations, flow rates, and inlet and outlet pipes were collected and are summarized in Appendix D**.** Many municipal drain pump stations and a few storm sewer pump stations have data gaps or no available information at all on the pump details. A field inspection of several pump stations was completed, and some maintenance concerns were identified.

5.3.1.2 Storm Sewers

The Phase 1 study area includes approximately 112.2 kilometres of storm sewers and 1,135 storm manholes. A comprehensive review of the existing storm sewers was completed to assess the minor storm system and effectively prioritize storm sewer improvements. Stantec developed a scoring system to rate the pipe performance and condition that accounts for both its likelihood of failure (LOF) and consequence of failure (COF), as illustrated in Graph 5.1.

Graph 5.1: Minor System Scoring



Each pipe was assigned a score to assist in identifying portions of the system that are likely candidates for replacement. A brief summary of the minor system assessment is provided below and a detailed description of the corresponding scoring methodology is presented in Appendix E.

Likelihood of Failure

The likelihood of failure component of the minor system scoring includes structural and hydraulic capacity considerations. The structural condition of each pipe was predicted based on anticipated pipe deterioration as a function of the pipe age compared to its material and associated typical design life.

The hydraulic capacity of each pipe was evaluated using a PCSWMM model of the Phase 1 study area minor system. Peak design flows were compared with the calculated capacity of each pipe based on minimum pipe slopes to evaluate the available capacity of each pipe barrel. This comparison provides information regarding the pipe capacity that does not include downstream tailwater impacts. Additionally, calculated HGL elevations were used to estimate the surcharge depth in each pipe to assess the system performance with tailwater effects. Composite LOF scores were assigned to each pipe based on the results of these two approaches.

Consequence of Failure

The consequence of failure component of the minor system score includes risk considerations, which is based on overland flow routing availability and maximum depth of surface ponding. Greater importance was placed on areas where excessive surface ponding depths may occur. A more detailed description of the risk category and associated scoring is presented in Appendix E. Appendix F includes topographic

maps depicting overland flow routes, local spill elevations and ponding depths. Local spill elevations are based on topographic information which, in some instances, does not capture the shoreline protection along the lake and major watercourses. Scoring has assumed that improvements will be made to provide surface flow relief at the shoreline walls.

Overall Minor System Scoring

The overall minor system scoring is simply the sum of the LOF Score and the COF Score for each pipe. The overall scoring results are shown on the mapping presented in Appendix G.

Table 5.6 Sewer Prioritization Matrix Framework

Likelihood of Failure - Factors							
Likelihood Category	**Indicator**	**Weight (%)**	**LOF Score**				
			1	**2**	**3**	**4**	**5**
Structural	Age & Material	**60**	<20	20-40	40-60	60-80	>80
Capacity	Hydraulics	**40**	**vg** (3-4)	**g** (5-6)	**f** (7-8)	**p** (9-10)	**vp** (11-13)
Consequence of Failure - Factors							
Consequence Category	**Indicator**	**Weight (%)**	**COF Score**				
			1	**2**	**3**	**4**	**5**
Risk	Overland Relief	**100**	≤ 0.3	n/a	0.3-0.5	n/a	≥ 0.5

A detailed tabulated listing of each sewer section with scoring by category is included in Appendix E.

Table 5.7 Sewer Prioritization Overall Scoring

Total Score	Prioritization Grade
8-10	Very Poor
6-8	Poor
4-6	Fair
2-4	Good
0-2	Very Good

5.3.2 Major Storm System Assessment

The major system consists of drainage features that convey flows during major storm events that occur less frequently – typical major systems are designed to a 100-year return period. The major system usually consists of surface features such as roadways and overland swales that provide a pathway to safely convey runoff to the receiving outlet. The dual drainage concept is such that the minor system provides the convenient drainage for minor storm flows and the major system assists in conveying major storm flows in

excess of the minor system capacity. The major system always exists, regardless of whether or not it is planned for.

During major rainfall events, sewer systems become surcharged and water begins to pond on roads. Whether by design or not, once the ponded water rises enough, it will begin to flow overland until it can either find a spill point into a pond or waterbody, or it will sit and pond until storm sewer system capacity is available to drain the ponded water. If there is no overland flow route for the water to travel, ponded water can sit on roads and in yards for several hours.

In newer developments, finished grade elevations are typically set at least 0.4 m above the roadway based on a 13.1 metre distance (5.5 m boulevard + minimum 7.6 m setback) at a minimum 3% slope. With overland routing planned for at the design stage, the roadway grading is designed such that surface ponding depths do not exceed 0.3 m depth, which consequently ensures that surface water will be conveyed away from the homes before the surface ponding extent reaches the dwelling.

Past stormwater practices dealt with minor system drainage and did not adequately consider overland routing. Consequently, some homes have been constructed at finished grade elevations based on pre-development topography. As an example, many homes constructed along the shoreline between Old Tecumseh Road and the Canadian National Railway are notably lower than these raised right-of-ways. This has resulted in a lack of overland flow relief and make these homes highly vulnerable to encroachment from surface ponding.

Rather than attempt to evaluate the hydraulic capacity of the combined minor and major storm system throughout the study area, this SMP takes a simplified and more resilient approach to assess potential maximum ponding depths, irrespective of the standard 100-year design storm. Recall that the extreme events recently experienced were much more severe than the 100-year design event in localized drainage catchments within the study area. Evaluating maximum ponding depths for a prescribed synthetic storm event under both existing conditions and proposed improvement scenarios does not necessarily address the potential risk under extreme rainfall conditions. Moreover, a measured ponding depth of 0.34 m under existing conditions exceeds current standards and a proposed improvement could lower the same ponding depth to 0.29 m (within standard), yet what would the resulting reduced risk be? Being extremely difficult to quantify the reduced risk, it is reasonable to qualitatively assume that the 0.05 m decrease in ponding depth would likely have a negligible impact in most residential roadway surface ponding settings.

Appendix F includes maps showing spill points, overland flow routes and ponding depths. Depths were estimated at existing catchbasin lids and were divided into three subcategories:

- **Depth less than 0.3 m:** This is the preferred maximum surface ponding depth, consistent with both Town and ERCA design guidelines. The associated risk to public safety is low, as the guidance presented in River and Stream Systems: Flooding Hazard Limit (Stantec, 2002) suggests that this depth probably doesn't limit access by most passenger vehicles.
- **Depth between 0.3m and 0.5m:** These ponding depths present a moderate risk to public safety, as these ponding depths may limit access/egress by passenger vehicles. However, since the maximum ponding depths are calculated at the catchbasin lids, the corresponding ponding depths at the road crown would be shallower, and some roadways would still be passable for most vehicles through the centre of the roadway. Safe pedestrian access/egress is not anticipated to be

significantly impeded by these depths since water velocities in the ponded areas are likely negligible.

- **Depth greater than 0.5m:** This is an undesirable level of surface ponding (>0.5 m) and presents a more significant threat to public safety. This depth could make roadways inaccessible to passenger vehicles and some emergency vehicles, forcing road closures and causing traffic nuisances in the form of detours. There is a higher potential for damage due to surface flooding. However, safe pedestrian access/egress is not anticipated to be significantly impeded by these depths since water velocities in the ponded areas are likely negligible.

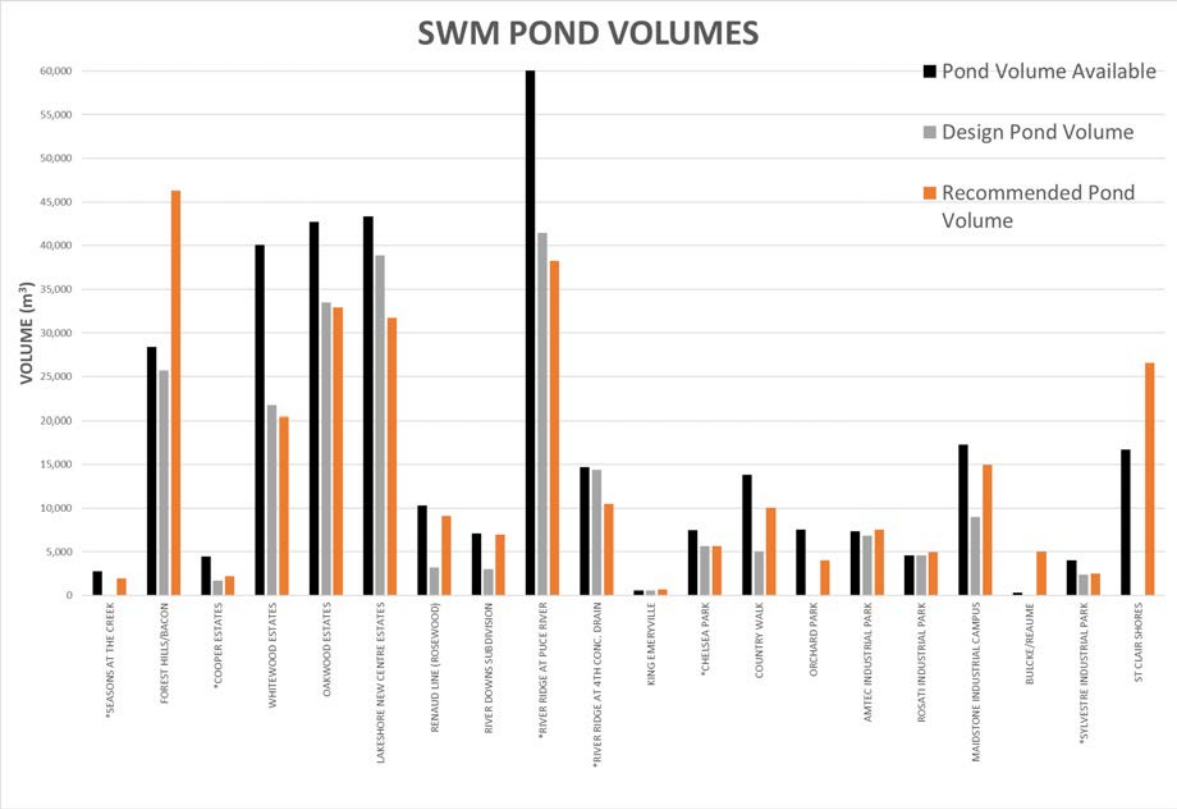
Recent extreme rainfall events have seemingly brought to light the general public's expectation that surface ponding is an indication of sub-standard infrastructure. This is a false and impractical expectation. Surface ponding will continue to occur and should be expected during major storm events. The goal is to mitigate risk – that is "real" risk to safety and property and not a temporary nuisance due to a flooded roadway.

As presented in Table 5.6, the ponding depths account for 50% of the overall scoring system used to evaluate the Town's storm sewer system. Beyond the overall scoring, areas within greater than 0.5m ponding depths were flagged and the potential flooding extents were mapped to identify homes vulnerable to damage caused directly by surface flooding. Areas that demonstrated the potential extent of surface flooding encroaching up to building footprints were identified as top priority for infrastructure improvements.

5.3.3 Stormwater Management Facilities

There is a total of 20 stormwater management ponds in the Phase 1 study area. A PCSWMM model was developed to evaluate whether each pond provides sufficient storage volume to accommodate the runoff from the 100-year design storm event. The pond outlets were represented in the model using the information presented in the available as-built drawings and stormwater management reports. The pond storage volumes used in the model were estimated using a digital elevation model (DEM) developed from the available LiDAR data. A comparison of the estimated storage volumes with the design volumes presented in the available stormwater reports showed different design volumes than what was available. A Chicago 100-year 4-hour storm distribution was used to calculate the available pond capacity under peak flow conditions. The SCS Type II 24-hour 108 mm design storm was also used to test the pond capacity with a greater volume.

The modelled outputs showed which ponds had enough storage to hold the water from the Chicago 100-year and SCS Type 2 108 mm storm.



5.3.4 Catchment Characterization

Stormwater catchments within the study area that are serviced by municipally owned infrastructure were delineated as shown on Figures 5.11 and 5.12. Areas serviced exclusively by municipal drains were not included in the evaluation since drainage improvements within these areas can be completed through the provisions of the Drainage Act and are not subject to review through the Class EA process. Stantec characterized the existing drainage servicing in each of the identified catchments based on the following information:

- The results of the minor system, major system, and existing SWM pond assessments;
- Reviews of available stormwater management reports, design drawings and engineer's reports; and
- Completion of site visits to evaluate existing system conditions and operations.

A brief summary of the drainage conditions for each evaluated catchment is summarized below.

5.3.4.1 Amy Croft Drive

Land uses within the Amy Croft Drive drainage area include mixed use with commercial and residential development. The catchment area is serviced by a network of storm sewers that discharge to Pike Creek at three separate outfalls. Runoff from most of the catchment is treated by the existing linear storage and

dry SWM pond located on the west side of West Pike Creek Road. A recent inspection of the facility's 600 mm diameter outlet pipe revealed that it is clear of vegetation, however the West Pike Creek Road culvert crossing to Pike Creek Drain is partly submerged and appears to be in poor condition.

Runoff from the southeast portion of the catchment discharges to Pike Creek without peak flow attenuation via the Elmstead Road Drain #8 and Elmstead Road Drain #9 outfalls. Elmstead Road Drain #9 is a 750 mm diameter HDPE pipe that receives runoff from the final phase of the St. Clair Shores' Subdivision (Selina Street) & Walk the Pike. An OGS unit provides water quality treatment to the runoff from a portion of the Elmstead Road #9 drainage area. A significant portion of Elmstead Road Drain #9 is located underneath a concrete driveway, which will likely result in significant restoration costs for future maintenance. Elmstead Road Drain #8 is a 750 mm CSP that conveys mostly rear yard drainage from the final phase of the St. Clair Shores Subdivision, County Rd 21 (West Pike Creek Rd), and roadside drainage. The drain passes between two residences and is located underneath a retaining wall, which makes access for future maintenance challenging.

Much of the western portion of the Amy Croft Drive catchment is currently undeveloped. A stormwater management strategy is required to control the runoff from this future commercial development. The proposed SWM strategy will likely incorporate linear detention ponds and parking lot storage to restrict the flows conveyed to the existing downstream dry SWM pond.

A significant number of both sanitary and storm related flooding complaints have been made to the Town by property owners in this catchment. The results of the major system review suggest that while the maximum ponding depths in the Amy Croft Drive drainage area are greater than 0.5 m, there appear to be few homes located within the maximum estimated ponding limits. The existing overland flow route that conveys major flows to Pike Creeks is located on private property. Hydrologic/hydraulic calculation results suggest that the maximum ponding depths during both the 2-year and 5-year design events are less than 0.3 m.

5.3.4.2 Croft Drive (Sylvestre Industrial Park)

Runoff from this industrial subdivision is collected by the existing storm sewer system along Croft Drive. Runoff from the western portion of the development is conveyed westward to the enclosed Webbwood Drain along East Pike Creek Road which ultimately outlets to Pike Creek. Runoff from the eastern portion of the development is conveyed to a SWM pond which has a pumped discharge to the enclosed portion of Webbwood Drain located south of the development. The pond was designed primarily as a quality control measure and the pump station's main purpose is to de-water the system during low flow and dry periods. When the water level in the eastern portion of the system rises above 176.41 m during major events, a manhole in the Croft Drive storm sewer allows stormwater to spill westward, bypassing the SWM pond.

A review of the major system topography suggests that the maximum calculated ponding depths on the local right-of-ways range from 0.3 m to 0.5 m, which is higher than the maximum target depth of 0.3 m. The area is highly vulnerable as the available topographic information suggests that there may not be adequate overland relief under an extreme rainfall event.

Detailed analysis of Croft Drive was completed following the Draft Master Plan. Existing building elevations were reviewed, and it was determined that buildings are set to have a minimum 0.3 m freeboard for the 100-year storm event. It was also determined that under the 100-year storm event, maximum road ponding reaches 0.40 m. Surface flooding encroaching up to buildings is not a significant concern for this development.

5.3.4.3 Ruggaber – Reaume

This catchment is comprised of single-family residential homes. Runoff from this area is collected and conveyed to Pike Creek by two separate storm sewer systems, one located on Little Baseline Road and the other located on Ruggaber Drive. The invert elevations of both outlets are higher than the local Pike Creek normal water level. Major flows are conveyed towards Pike Creek as shallow surface flow by the local right-of-ways, but overland flows from Ruggaber Drive are conveyed to Pike Creek across private property. The available topographic information suggests that the maximum local ponding depths are less than 0.3 m. There are no known formal stormwater management controls within this catchment.

5.3.4.4 Gammon

Stormwater from the Gammon residential subdivision and Centennial Park is collected by local storm sewers that discharge into the Maidstone Park Drain. The drain is dewatered by the Gammon Pump Station, which discharges to the Maidstone Park Pump Station and is released to the Puce River. A field inspection completed by Stantec in 2018 suggested that the Gammon Pump Station was not operating, and the Municipality of Lakeshore was notified.

Few flooding complaints have been received by the Town from property owners in this catchment. The results of the major system review suggest that while the maximum ponding depths are greater than 0.3 m, the homes in this drainage area appear to be higher than the maximum estimated ponding limits. The existing overland flow route that conveys major flows to Puce River is located on private property. There are no known formal stormwater management controls within this catchment.

5.3.4.5 Monarch Meadows

The Monarch Meadows catchment consists of existing residential development. Stormwater is collected and conveyed to the Monarch Pump Station by local storm sewers. The pump station discharges to the Puce River and the outlet includes a manhole flap gate chamber to reduce the possibility of water from the river flowing back into the storm drainage system.

The Municipality of Lakeshore has received both storm and sanitary flooding complaints from some properties within this catchment. The Town has also received reports from residents stating that their sump pumps run continuously.

A review of the major system suggests that overland flows generally flow towards Puce Road and spill into Puce River across privately-owned property. The local high point at the intersection of Monarch Meadows and Puce Rd. results in maximum ponding depths greater than 0.3 m. However, the available topographic

information suggests that the resulting surface ponding extents to not encroach into any existing building envelopes.

5.3.4.6 Chelsea Park

Runoff from both existing and proposed residential development within this catchment is collected by local storm sewers and treated by an existing SWM pond located south of Monarch Meadows Drive. The East Puce Road Drain Pump Station conveys stormwater from the SWM pond to the 1350 mm diameter Puce Drain, which discharges to the Puce River. Additionally, an outlet pipe equipped with backflow protection allows the pond to overflow into the Puce River via gravity if the pond level is greater than both the maximum design elevation and the water level in the receiving system.

Major flows from most of the catchment are generally conveyed westward to the Monarch Meadows Drive/Puce Road intersection, where overland flows spill across private property to the Puce River. Major flows from a small portion of the catchment are conveyed eastward to the neighboring King/Emeryville catchment and are discharged to the 4th Concession Drain. The maximum calculated ponding depths are greater than 0.5 m, though the available grading plans suggest that the resulting surface ponding extents do not encroach into homes.

The Municipality of Lakeshore has received stormwater flooding complaints from some properties within this catchment.

5.3.4.7 River Downs

Storm sewers in the River Downs residential subdivision discharge to a local SWM pond that provides all necessary stormwater treatment. The pond is designed to attenuate the peak discharges from all storm events to magnitudes less than or equal to the 2-year predevelopment peak. A review of the pond design suggests that the pond pipe outlet elevation is higher than the Puce River normal water level and the pond design volume is adequate to meet the design discharge criteria.

The available topographic information suggests that the maximum surface ponding depths in this catchment are less than 0.3 m, and there is an acceptable overland flow route that can convey major flows to the Puce River. The Municipality of Lakeshore has received a single stormwater related flooding report from this catchment.

5.3.4.8 Optimist

This catchment is comprised of mostly residential land with a portion of undeveloped land designated as mixed use. This area is serviced by a network of enclosed roadside drains that have two outlets that discharge into Belle River, including a gravity flow outlet at 153 West River Street, and a dewatering pump (CNR Pump). Both the design pumping rate and the presence of any backflow prevention measures are unknown. There are no known SWM controls in this catchment.

A review of the major system suggest that the maximum surface ponding depths are greater than 0.3 m but less than 0.5 m. Additionally, the overland flow routes from this catchment to Belle River are blocked by

the Belle River Flood Protection works. Existing topography suggests that maximum ponding limits are likely to encroach into the building envelopes of multiple homes. The Municipality of Lakeshore received a single stormwater related flooding report from this catchment prior to the 2016/2017 major events.

5.3.4.9 Notre Dame Pump

Land uses within this catchment include residential, mixed use and parks/open space. Both gravity storm sewers and enclosed roadside drains convey stormwater to the Notre Dame Pump Station, which discharges to Belle River. The pump station includes a 600 mm diameter steel outlet pipe equipped with a flap gate that allows the upstream system to drain to the river by gravity when it is sufficiently surcharged. The pump station is equipped with two pumps that dewater the system during low flows. Based on information provided by the Municipality of Lakeshore, the existing pump has sufficient capacity to convey the 5-year peak discharge.

The available topographic information suggests that the maximum surface ponding depths within the catchment are greater than 0.3 m and that the major flow route conveys overland flows westward across several private residential properties. Furthermore, the overland flow routes from this catchment to the Belle River are blocked by the Belle River Flood Protection Works.

5.3.4.10 Seasons at the Creek

Stormwater from this residential subdivision is conveyed to a local SWM pond by gravity storm sewers. The SWM pond is designed to provide water quality treatment. The pond discharges to Duck Creek via both a 1050 mm diameter overflow pipe equipped with a flap gate and a pump station that dewaters the pond below the design HWL of 174.25 m. The Municipality of Lakeshore has noted the following concerns with the pump station:

- The pump takes too long to draw the pond water level down;
- NWL is not always reached prior to the onset of the next storm event; and
- The capacity of the discharge pipe is too small and is causing excessive wear and tear on the pump.

The maximum estimated surface ponding depths in the subdivision are less than 0.3 m.

5.3.4.11 Belle River West

Most of this catchment drains to Belle River via existing gravity storm sewers with no stormwater treatment. The land use varies across the catchment, with majority of the storm sewers receiving flows from residential developments, though there are several parks and institutional buildings. The Municipality of Lakeshore has received storm flooding complaints from four homes within this catchment. Three reports were received in 2011 and the fourth was received in August 2017 for a St. Charles Street address.

The Cooper Estates Subdivision storm sewers outlet to a wet SWM pond designed to provide both water quality and quantity control. Water levels are maintained during low flow and dry periods by a dewatering pump. If the pond's capacity is reached, a ditch conveys overflows to a manhole flap gate chamber next to

the system's dewatering pump. The release rate to existing municipal trunk sewer on Belle River Road is controlled by a 300 mm diameter outlet pipe.

The First Street Pump Station provides an outlet to Belle River for drainage from Railway Avenue and Broadway Street between First Street and Seventh Street. Stormwater from the drainage area is conveyed by gravity to the pump station by local storm sewers. A 1200 mm diameter bypass storm sewer located on First Street between Railway Avenue and the VIA railway outlets directly to Belle River and is equipped with an inline Checkmate check valve to prevent backflow. During major storm events, when the hydraulic grade line in the storm sewers is higher than the river level, the check valve opens. The First Street Pump Station dewaters the storm sewer system during low flow and dry periods.

Major flows from the catchment are generally conveyed westward to Belle River as shallow surface flow. A review of the major system suggests that the maximum estimated ponding depths within the catchment are greater than 0.3 m.

Drainage system improvements for this area were previously identified in Belle River Storm System Review in the Community of Belle River (Dillon 2012).

5.3.4.12 Bacon/Forest Hill

Stormwater from the Forest Hill/Bacon drainage area is conveyed by gravity storm sewers that outlet to the local SWM pond. The pond has a pump to maintain the pond at normal water level. The pond was constructed to accommodate storage and drainage for the entire Forest Hills/ Bacon development. The area is not fully developed, with approximately 30 ha of undeveloped land. Currently the storm pond has enough capacity to service the developed area, however it is estimated that the current pond does not have adequate storage capacity to service the planned full buildout condition.

The Master Servicing Plan Final Report (March 1996) states that since the SWM facility is near the outlet (Lake St. Clair) for Duck Creek, peak flows from this catchment can be released before the Duck Creek peak streamflow reaches the SWM pond outlet. The report goes on to state that a variable speed pump station will be installed with the maximum outlet rate to Duck Creek of 2.5 m^3/s. The SWM Plan for Bacon Subdivision (August 1996) states the ultimate pump station capacity is 1 m^3/s, which was determined as proportional part of the total 2.5 m^3/s capacity proposed for the entire Master Servicing Plan area. When the pond was expanded in 2003 to accommodate the Forest Hills development, the permanent pump station was designed with a maximum outlet rate to Duck Creek of 1 m^3/s for the entire area, though no corresponding rationale was provided for this value. Therefore, a hydrologic assessment should be completed to evaluate whether the existing pond can accommodate the runoff from future development if the capacity of the existing pump station is increased to 2.5 m^3/s.

5.3.4.13 Terra Lou

Stormwater from the Terra Lou Estates Subdivision is conveyed by gravity storm sewers that outlet to Duck Creek. The outlet sewer is complete with a manhole flap gate chamber that reduces the possibility of backflows into the drainage system. A pumping station dewaters the system during low flow and dry periods.

Storm sewers provide drainage for a section of Notre Dame Street within the community of Belle River between Eleventh Street and Duck Creek. At the most downstream end of trunk sewer, there is a pump station that dewaters the system during low flow and dry periods. The Town completed CCTV inspection of the storm sewer system as part of the Notre Dame Street reconstruction project and no repairs are contemplated to be completed to the 900 mm diameter CSP outlet sewer at this time.

The Municipality of Lakeshore received nine flooding reports from this catchment, but whether five of these reports are storm or sanitary related is unknown. These events all occurred before 2011 and have no additional flooding complaints have been reported since. Residents upstream of the Terra Lou pump station have noted that sump pumps run constantly when the local storm sewers are not dewatered during dry periods.

A review of the major system suggests that the maximum estimated ponding depths are greater than 0.5 m at several locations. However, the available grading plans suggest that the local design finished floor elevations are higher than the maximum ponding elevations.

5.3.4.14 Russell Woods

This catchment area consists of existing residential lands and future residential development is planned east of Flanders Subdivision. The drainage infrastructure consists of storm sewers and both open and closed municipal drains that convey stormwater to the Russel Woods Pump Station. The pump station discharges to Pike Creek. The station has three duty pumps as well as an overflow pipe with a manual sluice gate. When lake levels are high, the sluice gate must be manually operated during major storm events to provide a gravity outlet. There is currently an issue with lake water seeping into the pump chamber. The adjacent shore wall is in poor condition and the Town has engaged a consultant to assess its condition.

The maximum estimated surface ponding depths in the Russell Woods catchment area are greater than 0.5 m. Homes located north of Old Tecumseh Road are not anticipated to be vulnerable to surface flooding, as the homes' finished floor elevations are significantly higher than typical road grades. While significant road ponding is possible under an extreme event, the risk of property damage appears to be relatively low.

Based on information provided by residents, the recent high lake levels have caused water from the boat ramp to enter East Pike Creek Road. The water is collected by the local storm sewer and is pumped into Lake St. Clair by the Russell Woods Pump Station. Efforts to contain the water at the boat ramp were ineffective.

The major system review suggests that some homes located south of Old Tecumseh Road in the Laurendale and Jordan subdivisions are likely vulnerable to surface flooding. The flooding extents that correspond with the maximum anticipated overland flow depth in this area encroach into several existing building envelopes.

The Town has received a significant number of both sanitary and storm related flooding reports from the Russell Woods catchment.

5.3.4.15 Lefaive Drain

This catchment area consists of existing residential lands and includes the Willowwood, Charron and Labbe residential subdivisions. Gravity storm sewers convey stormwater from this area to an enclosed municipal trunk sewer dewatered by the Lefaive Pump Station. In addition to the pump station, there are several gravity outlets that discharge to the Belle River. Based on information provided by Town staff, significant sediment accumulation has previously occurred in the Elmwood Avenue storm sewer. While the Town has not received flooding reports from this catchment, residents have complained of sump pumps that run constantly, even during dry periods.

The estimated surface ponding depths within this catchment area are greater than the maximum design ponding depth of 0.3 m and exceed the 0.5 m at some locations. Overland flows are conveyed eastward by the existing right-of-ways to the Lefaive Drain easement, which conveys major flows towards Belle River. However, overland flows from this catchment to the Belle River are blocked by the Belle River Flood Protection Works. The available topographic mapping suggests that some homes may be vulnerable to surface flooding, as the flooding extents associated with the maximum estimated major flow depth appear to encroach into some building envelopes.

5.3.4.16 Whitewood

Stormwater from the Whitewood Estates residential subdivision is conveyed by a system of gravity storm sewers that outlet to a local SWM pond. The SWM Pond has four inlets prone to sediment and debris accumulation. The pond outlet conveys stormwater to a pump station equipped with two pumps and an overflow opening that discharges to an outfall chamber. The system's outlet sewer is located in an easement and crosses West Belle River Road to outlet to Belle River. A review of the pond storage volumes suggests that the pond is adequately sized and the pond discharges are limited by the pump capacities.

Major flows from the Whitewood catchment are conveyed by the existing right-of-ways to the local SWM pond. The maximum estimated ponding depths are less than 0.3 m.

5.3.4.17 Brown's Creek Drain

The Brown's Creek Drain catchment is comprised of both existing and future residential development, agricultural lands, and park lands. Brown's Creek Drain is an enclosed municipal drain and receives flow from the Oakwood and Girard subdivisions. The drain discharges to Lake St. Clair. The Browns Creek Pump Station conveys stormwater to the lake when high lake levels prevent gravity discharge.

Stormwater from the Oakwood Subdivision is conveyed by a system of gravity storm sewers that outlets to a local wet SWM pond designed to provide both water quality and quantity treatment. The pond is dewatered by a pump station that discharges to Brown's Creek Drain. Under extreme events, an overflow pipe conveys flows from the pond directly to the drain. The future development is not included in the catchment area that is directed to the Oakwood SWM Pond.

Major flows from this catchment are collected by the open portion of Brown's Creek Drain. An overland flow route for a portion of the Oakwood Subdivision goes through a Town acquired easement before

crossing private properties and discharging to Brown's Creek Drain. The overland flow route that conveys flows from the remaining portion of the subdivision crosses an empty lot that will be developed in the future.

The maximum estimated surface ponding depths are greater than 0.3 m guideline at several locations and greater than 0.5 m at one location on Traditional Trail. The available topographic information suggests that the local major system spill elevations are lower than the ground elevations at the existing homes.

5.3.4.18 Lakeshore New Centre Estates

The catchment area consists of existing residential lands and future residential development is planned for the vacant lots located south of Oakwood Avenue. Stormwater from this drainage area is conveyed by gravity storm sewers to a local SWM pond. The pond discharges through a pumping station to an outlet manhole equipped with a flap gate which ultimately outlets to the enclosed Renaud Line Drain. Discharges from the pump station are restricted to the design release rate and the SWM pond is designed to provide sufficient storage to accommodate storms up to and including the 100-year design event. During severe storm events, overflows from the pond can flow via gravity through the outlet manhole when the pond levels are higher than the downstream hydraulic grade line.

Major flows from New Lakeshore Centre Estates travel eastward as shallow surface flow through the neighboring development and into Brown's Creek Drain. The maximum estimated ponding depths at the low points are greater than 0.3 m near the Pascal Avenue/Girard Drive intersection.

5.3.4.19 Bulcke/Reaume

The Bulcke/Reaume development is a 10.5 ha subdivision consisting of single-family residential homes. The development is serviced by storm sewers that outlet to a small stormwater management pond. The pond outlets to the 8th Concession Drain via four 375mm diameter pipes.

During the 100-year storm, the calculated post-development outflow rate exceeds the design target discharge and the pond does not have sufficient storage capacity to accommodate the 100-year design event. A review of the subdivision stormwater management report suggests that a portion of the SWM storage volume was to be provided by shallow roadside swales. However, these swales were subsequently filled in by homeowners.

The maximum estimated surface ponding depths in this catchment are greater than 0.3 m.

5.3.4.20 Hood Drain and Leffler Drain

The Leffler watershed consists of residential, industrial, and agricultural lands. The residential subdivisions include Orchard Park, Freed/Orman, Conway, Coco, LGR, PMRG, Russell Park Estates, and Americo Dean which all have their own storm sewer networks that outlet to either the Hood or Leffler Drains. The industrial areas, Maidstone Industrial Campus (Advance), Silver Creek Industrial Estates, Amtec Industrial Park, and Blanchard Drive, all have their own storm sewers that connect to the Leffler Drain. The Leffler Drain is an open drain along Patillo Road starting from County Road 42 running north. It becomes enclosed just south of Old Tecumseh Road and continues north towards a pump station that outlets to Lake St. Clair.

The Hood Drain is enclosed and runs west along Old Tecumseh Road to connect to the Leffler Drain. The pump station contains 3 duty pumps, an overflow weir with aluminum stoplogs, and an emergency discharge pump operated by tractor power take-off (PTO).

A site visit completed by Stantec revealed that the current pump operation settings do not correspond with the design settings. The pump start and stop elevations have been altered, which may affect the maximum observed upstream water levels during storm events.

The August 28-29, 2017 rainfall event was more severe than the local 100-year design storm. A Town employee observed that the Leffler Pump Station was surcharged, and the bypass channel was receiving flow. The Town removed a few stoplogs to increase the outflow. However, due to the high water levels, not all of the stoplogs could not be removed. During this storm, there were also complaints of significant road ponding and basement flooding in the residential developments.

An issue that was made evident during model calibration of the August 2017 storm event was the impact of trash/debris accumulation in the Leffler drainage system. This issue has been prominent for this watershed and trash grates have been installed to mitigate the impact along with frequent cleaning of the gates to manage the buildup. The flow monitoring data from the August 2017 event suggests that peak flows exceeded the capacity of the pump station, which was confirmed by Town staff observations of the gravity overflow being active (i.e. the wet well water levels exceeded the high lake levels). However, by comparing of the measured flow data and the simulated flows, it appears very likely that trash accumulated at the pump station grate during the extreme event to the point where inflow to the pump station was being partially impeded – to the extent that the third pump stopped operating many hours sooner than the model predicted.

Design work is underway for improvements to Patillo Road from County Road 22 to the Canadian Pacific Railway. The proposed work includes enclosure of the Leffler Drain within the project limits, which is expected to reduce the risk of obstructions caused by trash/debris.

The maximum estimated surface ponding depths in this catchment are greater than 0.5 m. It is anticipated that maximum surface ponding limits could encroach into existing homes north of VIA railway.

5.3.4.21 Country Walk & Dean Development

The Country Walk residential development consists of a storm sewer network that outlets to a dry pond. The pond outlets via a pumping station with a single pump. When the pond water level reaches the design HWL, overflows are conveyed by a 600 mm diameter overflow pipe and an emergency spillway. The pump station and the overflows outlet to a ditch which flows easterly into the Wallace Line Drain that carries the flows north to Lake St. Clair.

With regards to the pond's operation, the dry pond has a 975 mm diameter storm sewer that runs below the pond bottom to send low flows directly to the pump station. During major storm events, water surcharges the pipes and fills the pond. These pipes present a chronic maintenance issue since they are prone to sediment and debris accumulation.

This residential development is currently operating at less than a 2-year level of service. Residents have also expressed concern about frequent and prolonged roadway ponding. While the pond seemingly has ample capacity up to the top of bank elevation of approximately 177.2m, the apparent concern is that the roadway low points are at approximately 176.1m in some locations, and thus below the pond's potential high water level. Existing surface ponding occurs to depths greater than 0.5 m in some locations. Moreover, the development does not benefit from an overland flow route to direct surface flows to the pond and thus the roadway ponding depth and duration would be prolonged, as observed by residents. The pond high water level must draw down via the controlled pump discharge to allow the storm sewer to effectively drain the surface runoff. Maximum estimated surface ponding limits do not appear to encroach into the existing homes.

To the east of the Country Walk and Dean Development, there is undeveloped land that is planned for future development. Phase 1 of the Lakeshore Estates Subdivision is currently under construction and will be serviced by proposed storm sewers that will outlet to the recently enclosed Wallace Line Drain. On the east side of the Wallace Line Drain, there is approximately 8.2 hectares of land for future development.

The Wallace Line Drain Watershed Report (Stantec 2017) presents the stormwater management strategy for future development in the Wallace Line Drain service area. The report includes recommendations for future improvements to the Wallace Line Drain, including outlet improvements. These works will be completed in accordance with Drainage Act and are not evaluated in the SMP.

5.3.4.22 King Emeryville Subdivision

The King Emeryville Subdivision is approximately 6.1 hectares of single-family residential homes. The area is serviced by storm sewers that flow to a pumping station with two duty pumps and two overflow weirs. The pump station's main purpose is to dewater the storm sewer system during low flow and dry periods. The pump station outlets to a stormwater pond that discharges to the 4th Concession Drain. The pond is designed for quality control but also provides some quantity control due to the 600mm diameter outlet pipe that limits peak discharges. A 75 mm diameter outlet pipe drains the pond down to normal water level but is prone to blockage caused by debris accumulation.

5.3.4.23 River Ridge Development at Puce River

The River Ridge Puce development is a mixed residential development containing townhouses, semi-detached, and single-family homes. The development is serviced by storm sewers that convey flows to a stormwater management facility and pump station. The outlet for the development is the Puce River.

During minor storm events, stormwater is directed to the SWM pond for quality treatment prior to discharging to Puce River. Under most conditions, the SWM facility will discharge to Puce River by gravity through a manhole flap gate chamber. This is considered the normal operating conditions for this system. However, when the Puce River water levels are high, stormwater is directed to the pump station. The pond and storm sewers provide sufficient storage to accommodate the runoff from the 100-year storm event.

The River Ridge Puce Development includes approximately 40 hectares of currently undeveloped land. The existing pond is designed to accommodate the runoff from this future development. Proposed storm sewers will convey the runoff from the future development to the existing linear pond.

5.3.4.24 River Ridge Development at 4th Concession Drain

The River Ridge 4th Concession development is adjacent to the Puce development. The catchment area is 20.8 hectares of residential subdivision. The area is serviced by storm sewers that outlet to a storm pond. The storm pond then outlets to the 4th Concession Drain. Currently, only the 7.5 hectare high school at the south side of the design service area has been developed. The remaining portion of the development is currently under construction.

5.3.4.25 Renaud Line Development (Rosewood)

The Renaud Line development is 15.2 hectares of residential semi-detached homes and townhouses. The area is serviced by storm sewers that outlet to a linear pond. The linear pond is drained by a pump station with a single pump and overflow weirs that outlet to the Renaud Line Drain.

The north 7.5 hectares of this subdivision are currently undeveloped. The stormwater facility was sized to accommodate the runoff for the entire area once fully developed.

5.3.5 Catchment Screening

A catchment screening exercise was performed to develop an understanding of the key issues and to identify catchments where alternative solutions will be developed and evaluated in accordance with the environmental assessment process. Based on a review of the catchment descriptions presented above, the following key issues were identified:

- Major System Capacity – There are locations in the Study Area where the maximum calculated road surface ponding depths are greater than 0.5 m or buildings are likely vulnerable to flooding due to the capacity of the local major system. While both the Town and ERCA design standards cite 0.3 m as the maximum allowable road ponding depth, the 0.5 m ponding threshold was used to identify priority areas in the SMP for the following reasons:
  - The ponding depths identified in the major system assessment are conservative, as they are calculated based on ground elevations, whereas the Town and ERCA maximum ponding depths are associated with the 100-year design event;
  - The ponding depths identified in the major system assessment are conservative, as they are calculated based on catchbasin lid elevations. Thus, many roadways with ponding depths less than 0.5 m will likely remain accessible to passenger vehicles through the centre of the roadway;
  - Pedestrian access/egress is not anticipated to be significantly impeded by these depths since water velocities in the ponded areas are likely negligible; and
  - Using 0.3 m as the ponding threshold to identify priority areas would have resulted in an unmanageable number of areas carried forward for detailed evaluation. Furthermore, the additional areas would have presented very low risks to public safety and property.

Regardless of the calculated ponding depths, all areas where existing buildings may be vulnerable due to the capacity of the major system were identified as priorities for additional assessment.

- Infrastructure Location – Many locations in the Study Area have drainage components and overland flow routes located on lands that are not controlled by the Municipality of Lakeshore. This presents a challenge to the Town in accessing this infrastructure for inspection, maintenance and replacement. In the case of overland flow routes, it presents an additional flood risk, as private landowners could potentially obstruct the existing flow path; and
- SWM Pond Capacity – Some portions of the Study Area have existing SWM ponds that do not have sufficient capacity to accommodate the 100-year design event runoff from future planned development.

The status of these issues within each of the identified stormwater catchments is summarized in the following table. The table also identifies which catchments were evaluated in further detail through the EA process.

Table 5.8 Catchment Screening

Catchment	Surface Ponding > 0.5 m (Y/N)	Buildings Threatened by Surface Ponding (Y/N)	Infrastructure Poorly Located[1] (Y/N)	SWM Pond Size Insufficient to Service Future Development (Y/N)	Detailed Analysis Required (Y/N)
Amy Croft Drive	Y	N	Y	Y	**Y**
Croft Drive	Y	N	Y	N	**Y**
Ruggaber Reaume	N	N	N	N	**N**
Gammon	N	N	N	N	**N**
Monarch Meadows	N	N	N	N	**N**
Chelsea Park	Y	Y	N	N	**Y**
River Downs	N	N	N	N	**N**
Optimist	N	Y	Y	N	**Y**
Notre Dame Pump	N	Y	Y	N	**Y**
Seasons at the Creek	N	N	N	N	**Y**
Belle River West	N	Y	Y	N	**Y**
Bacon/Forest Hill	N	N	N	Y	**Y**
Terra Lou	Y	N	Y	N	**Y**
Russell Woods	Y	Y	Y	N	**Y**
Lefaive Drain	Y	Y	Y	N	**Y**
Whitewood	N	N	N	N	**N**
Brown's Creek Drain	Y	N	Y	N	**Y**
Lakeshore New Centre Estates	N	N	N	N	**N**
Bulcke Reaume	N	N	N	N	**N**
Leffler Drain	Y	Y	N	N	**Y**
Country Walk	Y	Y	N	N	**Y**
King Emeryville	N	N	N	N	**N**
River Ridge - Puce	N	N	N	N	**N**
River Ridge - 4th Concession	N	N	N	N	**N**
Rosewood	N	N	N	N	**N**

Notes:

1 Drainage infrastructure or major flow route located outside of municipal right-of-way or enforceable maintenance easement.

2 The surface ponding noted above are conservative since it is calculated based on ground elevations with overland spill points from the watershed. The above ponding depths are not based on the standard 100-year storm event

6.0 EVALUATION OF ALTERNATIVE SOLUTIONS

As part of the Class EA planning process, reasonable and feasible alternative solutions to the Phase 1 problem and opportunity statement are identified and described in Phase 2. The magnitude of the net positive and negative effects of each alternative solution are identified and evaluated. Based on this evaluation, a preliminary preferred option is selected and confirmed based on public, agency and First Nation community consultation.

6.1 PRIVATE DRAINAGE SOLUTIONS VS. PUBLIC DRAINAGE SOLUTIONS

Flooding damage can be a result of one or more of the following:

1. Lake flooding – high lake levels encroaches onto shoreline properties;
2. Riverine flooding – high river levels encroaches onto properties adjacent a watercourse;
3. Urban flooding – high surface flooding levels encroaches onto properties as a result of stormwater flows exceeding the capacity of the municipal stormwater system (typically sewers and roadways in urban development); and
4. Private property flooding – roof and groundwater flows exceeds the capacity of the private drainage system or the system fails.

While there are isolated areas within the study area that are at risk of lake, riverine and urban flooding, the majority of the property damage experienced from recent extreme rainfall events were caused by private property flooding (basement flooding). The exact cause of basement flooding at each individual home is difficult to identify and can be a result of one or many circumstances, such as:

- Private drainage systems can become surcharged – backfill areas surrounding foundation walls become saturated with water;
- Private drainage systems are potentially deficient (i.e. – cracked pipes, sump pump failure, tree roots, grading around the house, etc.);
- At low lying areas, water accumulates (ponds) can enter the sanitary sewer system through manhole covers or cleanouts.

The most effective way to address the problem involves a two-part solution:

Part 1 Maintain/Improve private drainage systems to ensure adequate drainage of surface, roof and groundwater around the home, supplemented with;

Part 2 Improvements to the Town's stormwater system to reduce the duration and frequency of sewer surcharging during intense rainfall events.

6.1.1 Solution Part 1 – Private Drainage

Private drainage maintenance and improvements are critical in reducing the risk of flooding and protecting the home. This solution is the first line of defense and can be implemented immediately. It is strongly recommended that the homeowner take an active role in implementing home improvements to reduce the risk of basement flooding.

The implementation of private drainage solutions is the responsibility of each property owner and involves works on private lands. While this SMP identifies potential improvements that can be considered by property owners to reduce their risk of basement flooding, developing individual solutions for affected properties is beyond the scope of the MCEA process. Further information regarding private drainage system improvements is presented in Section 7.1.

6.1.2 Solution Part 2 – Public Drainage

Improvements to the public drainage system will help to mitigate risk of flooding by alleviating stress on the private drainage system caused by sewer surcharging and prolonged surface ponding. However, public drainage system improvements are ultimately only a supporting measure that does not provide direct protection against basement flooding and should not be relied upon without implementing private drainage solutions.

Alternatives to improve the Municipality of Lakeshore public drainage system are evaluated in this SMP in accordance with the MCEA process.

6.2 STORMWATER DESIGN CRITERIA AND KEY OBJECTIVES

The following study objectives were developed to incorporate applicable design criteria (Municipality of Lakeshore Design Standards, Ministry of the Environment Stormwater Management Planning and Design Manual 2003) in order to identify the ideal outcome for each of the key issues previously noted specific to the existing public drainage systems. The objectives were used in the development of alternative solutions and the evaluation criteria discussed in Section 6.4, against which each alternative solution was evaluated.

- Roadway Ponding – The Master Plan should mitigate roadway ponding that threatens property or public safety. The Municipality of Lakeshore design standards state that maximum design ponding depths for the 100-year storm event are 300 mm on roadways and are used as a target in the SMP.
- Municipal Drains – Drainage servicing in much of Lakeshore is provided by Municipal Drains. There are several problems associated with these systems; they are typically constructed to address drainage concerns in rural or agricultural areas, and thus typically have insufficient capacity to convey peak discharges within developed areas. Additional complications include access for maintenance, and procuring funding for maintenance;
- Capacity – In accordance with the Winsor Essex stormwater design standards, all proposed minor storm drainage systems presented in the SMP should be designed to convey the peak runoff from 5-year design storm event and all proposed major storm drainage systems should be designed to convey the peak runoff from 100-year design storm event.

- Infrastructure Location – All proposed drainage infrastructure should be located in municipal right-of-ways or municipally controlled easements.

6.3 PUBLIC DRAINAGE SOLUTIONS BY CATCHMENT AREA

The following solution alternatives were developed to address the public drainage system key issues identified in each catchment.

6.3.1 Amy Croft Drive

The St. Clair Shores development is made up of residential and commercial lands. A large percentage of the commercial lands is currently undeveloped. Currently the storm pond has enough capacity to service the developed area, however it is estimated that the current pond does not have adequate storage capacity to service the planned full buildout condition.

The maximum ponding depth on West Pike Creek Road is greater than 0.5 m, which could present a significant hazard to motorists during severe storm events and could delay emergency vehicles forced to detour around the ponded area. Major flows from the low point must travel across private lands in order to reach Pike Creek.

The existing municipal drain and SWM pond outlets are likely in poor condition. Furthermore, the municipal drain outlets are poorly located to perform future maintenance. Elmstead Road Drain #8 is located under a private driveway and Elmstead Road Drain #9 is located under a retaining wall between two homes. Restoration costs following future replacement will be significant.

While widespread roadway ponding greater than 0.3 m deep in the residential area west of West Pike Creek Road was identified, the available grading plans suggest that the existing finished floor elevations are higher than the maximum ponding elevations. Furthermore, reprofiling the existing roadways to reduce the maximum surface ponding depths is not feasible, due to the significant anticipated impacts on road design, curbs, driveway entrances, streetlights, and sidewalks.

The following alternatives were developed to address the SWM servicing requirements for future development in the western portion of the drainage area, attempt to reduce the maximum ponding depths in the local right-of-ways, and to assert municipal control over the major flow route from the catchment to Pike Creek.

6.3.1.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. The existing storm sewer capacity issues are exacerbated with additional runoff from the proposed commercial development at the west end of the catchment area.

The maximum calculated ponding depths that may occur during severe storm events are deeper than 0.5 m, which is higher than the WERSMSM design guidelines. This includes surface ponding depths greater

than 0.5 m on West Pike Creek Road, which is an arterial road. However, the available topography suggests that no existing homes are located within the maximum estimated ponding limits.

The existing major system drains to Pike Creek via on overland flow route located on private property. Without a drainage easement, there is a risk that the property owner could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

6.3.1.2 Alternative 2 – Provide Upstream SWM Servicing

This alternative consists of providing upstream stormwater servicing in order to control the runoff from future commercial development. The additional flows are conveyed to a new stormwater management facility that provides quantity control and water quality treatment. Stormwater from the proposed pond is released at a restricted rate into the existing dry SWM pond.

Proposed improvements to the major system include regrading the east roadside ditch on West Pike Creek Road and securing a drainage easement on 160 West Pike Creek Road to secure an unobstructed overland flow route to Pike Creek. The proposed overland flow route alignment was selected because it is currently undeveloped vacant land located next to Pike Creek. The proposed drainage easement is graded to reduce the maximum ponding depths on West Pike Creek Road. The portions of the existing municipal drains located east of West Pike Creek Road are abandoned and a new proposed storm sewer is constructed in the proposed drainage easement to convey the minor flows to Pike Creek.

6.3.1.3 Alternative 3 – Increased Release Rate

In this alternative, at-source stormwater treatment is provided on the future developments and the existing SWM pond outlet is modified to maximize the peak discharge from the facility. The pond still provides water quality treatment from its design service area, but the peak discharges are allowed to enter Pike Creek with little peak flow attenuation during severe storm events. This reduces the required footprint of the proposed upstream SWM facility that treats the runoff form the future development lands. Significant impacts on the downstream Pike Creek water surface elevations are not anticipated because the peak flow from the Amy Croft catchment enters the creek before the peak streamflow occurs.

Additionally, proposed improvements to the major system include regrading the east roadside ditch on West Pike Creek Road and securing a drainage easement on 160 West Pike Creek Road to secure an unobstructed overland flow route to Pike Creek. The proposed overland flow route alignment is currently undeveloped vacant land. The proposed drainage easement is graded to reduce the maximum ponding depths on West Pike Creek Road. The portions of the existing municipal drains located east of West Pike Creek Road are abandoned and a new proposed storm sewer is constructed in the proposed drainage easement to convey the minor flows to Pike Creek.

6.3.2 Croft Drive

Alternatives for this catchment were developed to reduce the maximum ponding depths on the local right-of-ways, mitigate the flood risk at existing buildings, and to assert municipal control over the major flow route from the catchment to Pike Creek.

Modifying the East Pike Creek Road and Croft Drive Road profiles to reduce the major system spill elevation and acquiring a drainage easement on the west side of East Pike Creek Road were not considered feasible because of the significant associated costs and the impacts on the existing properties that front on East Pike Creek Road and Croft Drive.

6.3.2.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Ponding depths greater than WERSMSM design guidelines may occur during extreme storm events at low points in topography. During severe storm events, there is a risk that surface ponding could flood some existing buildings.

The existing major system drains to Pike Creek via on overland flow route located on private property. Without a drainage easement, there is a risk that the property owner could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

6.3.2.2 Alternative 2 – Major North Flow Diversion

This alternative involves major system improvements to reduce the maximum surface ponding depths and to mitigate the risk of flooding at existing buildings. The proposed improvements include a drainage easement located on the undeveloped lands located between 320 and 344 Croft Drive. The proposed drainage easement conveys major flows northward to the roadside ditch on County Road 22, which is deepened to accommodate the major flows from the Croft Drive catchment. Inlet improvements to the Webbwood Drain convey the major flows from the County Road 22 ditch westward across East Pike Creek Road. Additionally, the Croft Drive boulevard is regraded to reduce the local spill point and allow roadway ponding to travel as surface flow into the existing SWM pond.

6.3.2.3 Alternative 3 – Major South Flow Diversion

This alternative is similar to Alternative 2, but the proposed drainage easement is located on the south side of Croft Drive and provides an overland flow route directly to the Webbwood Drain. Inlet improvements will be required on Webbwood Drain to accommodate the overland flows, as the drain was recently enclosed. Additionally, the Croft Drive boulevard is regraded to reduce the local spill point and allow roadway ponding to travel as surface flow into the existing SWM pond.

6.3.3 Chelsea Park

Alternatives for this catchment were developed to reduce the maximum ponding depths on the local right-of-ways and to mitigate the flood risk to existing homes, and to assert municipal control over the major flow route from the catchment to the Puce River.

6.3.3.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. The maximum flood depth at the Regency

Crescent/Agency Road intersection is greater than 0.5 m, and there is a risk that the corresponding ponding limits could encroach into existing homes.

The existing major system drains to the Puce River via on overland flow route located on private property. Without a drainage easement, there is a risk that the property owner could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

6.3.3.2 Alternative 2 – Major System Improvements – Reprofile Regency Crescent

To reduce the maximum ponding depths, the Regency Crescent road profile east of the Regency Crescent/Agency Road intersection is reprofiled and the cross section is modified. To reduce impacts on existing driveways and utilities, the west curb line is lowered, and a portion of the road cross section is superelevated. This will reduce the local major system spill elevation and lower the maximum ponding depths.

Additionally, a drainage easement is obtained on the existing overland flow route from East Puce Road to the Puce River. The drainage easement will mitigate the risk of alterations or obstructions on the overland flow route that could cause deeper upstream ponding during severe storm events.

6.3.3.3 Alternative 3 – Major System Improvements – Reprofile Street Stub

In this alternative, the maximum ponding depths at the Regency Crescent/Agency Road intersection are reduced by constructing a major flow route from the ponding location to the existing SWM pond on the neighboring River Ridge 4th Concession future development. Future development agreements will include clauses stating that the proposed major system must be designed to accommodate the major flows from the Regency Crescent/Agency Road intersection low point.

Additionally, a drainage easement is obtained on the existing overland flow route from East Puce Road to the Puce River. The drainage easement will mitigate the risk of alterations or obstructions on the overland flow route that could cause deeper upstream ponding during severe storm events.

6.3.4 Optimist

The existing topography suggests that the maximum surface ponding depths are greater than WERSMSM design guidelines and that the maximum ponding limits likely encroach into the building envelopes of several homes. Furthermore, the downstream overland flow route from West River Street to the Belle River is located on private property and there is consequently a risk that it could be obstructed or altered.

Design solutions to mitigate flood risk in this catchment are limited because the existing ground elevations at the low points are lower than the recorded July 2019 Lake St. Clair water levels and the west streambank of the Belle River is fully developed. The existing Belle River Flood Protection works block major flow conveyance to the Belle River. The peak minor system discharges from this catchment to Belle River are likely restricted by the capacity of the existing CNR pump, for which there is no available information. Furthermore, the system is likely vulnerable to flooding if the CNR pump fails during a significant storm event.

6.3.4.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. The maximum flood depth in the Optimist Street right-of-way is greater than 0.3 m, and there is a risk that the corresponding ponding limits could encroach into existing homes.

The existing gravity outlet to the Belle River appears to be located on private property, and access for future maintenance or replacement may prove challenging. The existing major system drains to the Belle River via on overland flow route located on private property. Without a drainage easement, there is a risk that the property owner could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

6.3.4.2 Alternative 2 – New Pump Station

A new pump station is proposed to address the flood risks in this catchment. The proposed pump station is located at the existing CNR pump station site. The existing West River Street storm sewer is reconstructed to convey stormwater to the proposed pump station. The proposed pump station dewaters the minor system during high lake level conditions and reduces the maximum ponding depths and durations during severe storm events.

6.3.4.3 Alternative 3 – New Pump Station & Offline Dry SWM Pond

This option includes the new pump station described in Alternative 2 in addition to a proposed offline dry SWM pond located in the western portion of Optimist Park. The dry SWM pond provides flood storage to reduce ponding depths during severe storm events when the peak flows are greater than the capacity of the proposed pump station or in the event of pump failure.

The offline dry SWM pond is connected to the pump station by a proposed storm sewer located under the Optimist Park sports fields. The proposed pond will significantly disrupt park use during construction and, once complete, will disrupt park use following severe storm events. Experience during the recent Notre Dame Street roundabout construction suggests that the proposed SWM pond site likely has significant archeological potential.

6.3.5 Notre Dame Pump

The following alternatives were developed to reduce the maximum estimated flood depths, mitigate the risk of flooding existing homes, and to move the major flow route into municipal right-of-ways. The Belle River Flood Protection Works present a significant challenge in this area, since they block major flows from entering the Belle River. Lowering or modifying the flood protection works is not feasible, since this would increase the area's vulnerability to the riverine flood hazard.

6.3.5.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Major overland flows travel from Charron Street to West River Road across several private properties and travel from West River Road to the Belle River between two homes. Without drainage easements, there is a risk that the property owners could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

The maximum estimated flood depths are greater than 0.3 m and there is a potential risk that the corresponding ponding limits could encroach into existing homes.

6.3.5.2 Alternative 2 – Divert Major Flows to Proposed Optimist Park Dry SWM Pond

In this option, major flows are diverted from the local low points at the Charron Street and Trottier Street intersections with Notre Dame Street to a proposed dry SWM pond located in Optimist Park, as described in Optimist Catchment Alternative 3. This will not eliminate major flows from Charron Street travelling over private properties towards West Belle River Road. However, the peak flows and volumes within the existing overland flow route are reduced, as are the maximum estimated ponding depths.

A drainage easement located north of 251 West Belle River Road is proposed to convey the major flows from the West Belle River Road right-of-way to Belle River.

6.3.6 Seasons at the Creek

The Seasons at the Creek Subdivision SWM pond is designed to provide water quality treatment to the runoff from its design service area. Stormwater is discharged from the pond by a pump station designed to dewater the water quality storage volume and a bypass pipe that flows to Duck Creek via gravity when the pond water level is above 174.25 m. The long pond drawdown times and pump failures noted by the Town are caused by the recent high persistent Lake St. Clair water levels above 174.25 m that have prevented the pond from discharging by gravity. High lake levels force the pond to drain entirely via the pump station, which was not designed to dewater the entire facility.

The following alternatives were developed to address the long drawdown times at the Seasons at the Creek Subdivision SWM pond, the operation and maintenance concerns at the pond pumping station, and ownership of the existing overland flow route to Duck Creek, which is located on private property.

6.3.6.1 Alternative 1 – Do Nothing

Under this alternative, no SWM works are proposed. The long drawdown times in the existing SWM pond will continue, which may contribute to future pond overtopping if the pond is not adequately dewatered prior to a severe storm event. Furthermore, frequent pump maintenance may be required due to long pump run times. Hydraulic calculations performed based on the available pump information and the pump station record drawings suggest that the minimum pump discharge rate is approximately 4 L/s. The calculated drawdown time for the pump to lower the pond water level from 176.0 m to the NWL is approximately 10 days.

6.3.6.2 Alternative 2 – Pond Outlet Improvements

Based on information provided by ERCA, Seasons at the Creek can release at an unrestricted rate into Duck Creek due to its proximity to Lake St. Clair. Thus, the peak pond discharge rate can be increased without causing significant downstream flood impacts. Hydraulic calculations performed based on the available pump information and the pump station record drawings suggest that by replacing the existing 50 mm pump discharge pipe with a 100 mm pipe, the minimum pump discharge rate increases to approximately 18 L/s. As a result, the calculated drawdown time for the pump to lower the pond water level from 176.0 m to the NWL is reduced to approximately 2 days, which is consistent with typical pond designs. However, the water quality storage volume drawdown time is less than 24 hours, which is the minimum recommended by the MECP. An MECP ECA amendment will likely be required since the proposed improvements affect the existing pond operation.

6.3.6.3 Alternative 3 – Pump and Outlet Improvements

This alternative includes the pond outlet improvements described in Alternative 2, but also includes installation of an additional pump. The proposed pump station operates as follows:

- The existing pump dewaters the pond from the HWL to the top of the water quality storage volume at 174.25 m at a minimum discharge rate of 18 L/s; and
- The new pump dewaters the pond water quality storage volume and the pump is sized to meet the minimum MECP water quality detention time of 24 hours.

This alternative may require replacement of the existing pump station to accommodate the new pump and its associated controls. An MECP ECA amendment will likely be required since the proposed improvements affect the existing pond operation.

6.3.7 Belle River West

The existing topographic information suggests that the maximum estimated ponding depths within the catchment are greater than the maximum WERSMSM guideline value of 0.3 m and the maximum ponding limits likely encroach into some existing building envelopes. Also, the existing overland flow routes from this catchment to the Belle River are located on private properties. However, there are limited opportunities to mitigate surface ponding in this catchment since:

- This is a fully developed urban area with little vacant land available to accommodate potential SWM works; and
- The Belle River east streambank is fully developed, limiting access to the river to construct outlet works.

6.3.7.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Maximum ponding depths greater than WERSMSM design guidelines are possible during severe storm events and surface ponding may encroach

into existing buildings. Major flows travel to the Belle River across private properties. Without drainage easements, there is a risk that the property owners could alter or obstruct the overland routes, resulting in deeper upstream ponding depths during severe storm events.

6.3.7.2 Alternative 2 – Stormwater Storage

A proposed offline dry SWM pond located in Ladouceur-Lions Park provides flood storage to reduce ponding depths during severe storm events when the peak flows are greater than the capacity of the minor system. Storm sewer improvements are required to connect the proposed SWM pond to the existing minor system. The proposed pond will significantly disrupt park use during construction and, once complete, will disrupt park use following severe storm events.

The road profile at East River Street/Centre Street is modified to convey major flows to Belle River within the public road allowance.

6.3.7.3 Alternative 3 – New Pump Stations

This alternative includes the recommendations of the Belle River Storm System Review in the Community of Belle River (Dillon 2012), which propose replacing the existing First Street pump station and constructing a new pump station at the St. Charles Street storm sewer outlet. The proposed pump stations are designed to convey the 5-year peak discharges from each system to the Belle River and will provide an outlet under high lake level conditions.

The road profile at East River Street/Centre Street is modified to convey major flows to Belle River within the public road allowance.

6.3.8 Terra Lou

The following alternatives were developed to reduce the maximum estimated flood depths and verify that major flow routes are located in municipally controlled lands.

6.3.8.1 Alternative 1 – Do Nothing

Under this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Roadway ponding depths greater than WERSMSM design guidelines are possible during severe storm events.

Major flows travel to Duck Creek across a private property. Without drainage easements, there is a risk that the property owner could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

6.3.8.2 Alternative 2 – Overflow Pipe

A proposed overflow pipe with a high capacity inlet at Terra Lou Park provides major flow relief and reduces the maximum roadway ponding depths under low lake level conditions. The proposed overflow pipe

discharges to the existing Notre Dame Street outlet downstream of the existing pumping station. The proposed overflow pipe includes a flap gate to prevent backflow during high lake level conditions.

6.3.9 Bacon/Forest Hill

The following alternatives were developed to provide SWM servicing capacity to accommodate future development.

6.3.9.1 Alternative 1 – Do Nothing

Under this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. The additional runoff from future development will likely cause the existing Forest Hills/Bacon Subdivision pond to overtop during severe storm events.

6.3.9.2 Alternative 2 – Pond Expansion

This alternative includes expanding the existing Forest Hills/Bacon SWM pond to accommodate the runoff from future development. The pond has enough room to be expanded in area and, because it has a pumped outlet, it can be deepened to increase the design storage volume.

6.3.9.3 Alternative 3 – Increase Forest Hills SWM Pond Release Rate

This alternative consists of improvements to the Forest Hills pump station by means of either upgrading the pumps or constructing a gravity overflow.

6.3.10 Russell Woods

The following alternatives were developed to address the Russell Woods pump station operation concerns, reduce the maximum estimated flood depths, mitigate the risk of roadway ponding encroaching into existing homes located south of Old Tecumseh Road in the Laurendale and Jordan Subdivisions, and verify that major flow routes are located in municipally controlled lands.

6.3.10.1 Alternative 1 – Do Nothing

Under this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Ponding depths greater than WERSMSM design guidelines are possible during severe storm events and surface ponding may encroach into existing buildings. Since the sluice gate at the pump station is manually operated, there is a risk that it will not be in the correct position to provide a flow bypass during severe storm events.

Major flows travel to Lake St. Clair across a private property. Without drainage easements, there is a risk that the property owner could alter or obstruct the overland route, resulting in deeper upstream ponding depths during severe storm events.

6.3.10.2 Alternative 2 – Pump Station Improvements

The existing Russell Woods pump station includes a 900 mm diameter steel overflow pipe. The pipe is fitted with an Armco sluice gate mounted to a steel frame, which is manually operated and remains closed when the Lake St. Clair water levels are high. An automated sluice gate for the overflow pipe is proposed which would open the gate when the hydraulic head in the pump station wet well is higher than the lake water elevation. This provides an overflow during severe storm events, increasing the total release rate of the system without installing upgraded pumps.

The possibility of increasing the pump station overflow capacity by increasing the overflow pipe diameter was also considered, but preliminary evaluation results suggested this did not significantly affect the pump station peak discharges. Similarly, the possibility of increasing the pump station capacity by increasing the pump discharge pipe diameter was considered, but preliminary evaluation results suggested this did not significantly affect the pump station peak discharges.

Improvements to the Laurendale Subdivision pump station are proposed to mitigate surface flooding at the Laurendale and Jordan Subdivisions. By increasing the capacity of the existing pump station, both maximum ponding depths and durations are reduced.

Additionally, a drainage easement is proposed on the existing overland flow route from Elmgrove Drive to Lake St. Clair. The drainage easement will mitigate the risk of alterations or obstructions on the overland flow route that could cause deeper upstream ponding during severe storm events.

6.3.10.3 Alternative 3 – New Pump Station

In addition to the existing Russell Woods pump station and Laurendale Subdivision pump station improvements proposed in Alternative 2, this alternative also includes a new pump station that discharges to Pike Creek from East Pike Creek Road, south of the canal. The existing pipe that conveys flows under the canal will be decommissioned. The proposed pump station reduces the drainage area that contributes runoff to the Russell Woods pump station and mitigates the potential downstream impacts of the proposed Laurendale Subdivision pump station improvements.

6.3.11 Lefaive Drain

The Lefaive Drain is a closed municipal drain that provides the main outlet for most of this catchment. The drain is located near the rear property line of the homes on the north side of St. Pierre Street. The minor system assessment suggests that the Lefaivre Drain's overall score is poor. Furthermore, the major flow route from much of the catchment follows the drain alignment. Recent aerial photography suggests that obstructions such as sheds, fences and landscape features have been constructed within the major flow route. Given the drain's location, future access for maintenance or replacement will likely be problematic.

The following alternatives were developed to reduce the maximum estimated flood depths, mitigate the risk of flooding existing homes, and verify that significant drainage infrastructure is located in municipally controlled lands.

6.3.11.1 Alternative 1 – Do Nothing

In this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Major overland flows follow the Lefaivre Drain alignment through private backyards north of St. Pierre Street. The existing overland flow route is partly obstructed by fences and sheds.

The maximum ponding depths upstream of the overland flow route are deeper than 0.5 m and there is a risk that the maximum surface ponding limits could encroach into existing homes.

6.3.11.2 Alternative 2 – New St. Pierre Street Storm Sewer and Major Flow Route

In this alternative, the Lefaivre Drain is abandoned from Willowwood Drive to the downstream connection to Marie Street and replaced with a new storm sewer located on St. Pierre Street that conveys the minor flows to the existing Lefaivre Drain pump station. In conjunction with the new storm sewer construction, the St. Pierre Street profile is lowered to convey major flows from the upstream ponding areas towards West Belle River Road. Similar to the Notre Dame Pump catchment alternatives, the major flows are conveyed to the Belle River by a proposed drainage easement located north of 251 West Belle River Road. Modifying the St. Pierre Street profile will impact other infrastructure, including streetlights and fire hydrants, and will increase the driveway entrance slopes.

This alternative will reduce the maximum estimated surface ponding depths, reduce the possibility of flooding existing homes, and relocates a significant drainage infrastructure into the municipal right-of-way.

6.3.12 Brown's Creek Drain

The major system analysis suggests that the maximum ponding depths in this catchment exceed the WERSMSM design guideline values, but the corresponding estimated ponding limits do not encroach into existing homes. The following alternatives were developed to try and reduce the maximum surface ponding depths.

6.3.12.1 Alternative 1 – Do Nothing

Under this alternative, no stormwater works are completed. Therefore, no land acquisition is required, and no additional water quality or quantity controls are implemented. Ponding depths greater than WERSMSM design guidelines will likely occur during severe storm events.

6.3.12.2 Alternative 2 – Reprofile Girard Drive and Grandview Boulevard

In this alternative, the Girard Drive profile is lowered from Grandview Boulevard to the Girard SWM pond and the Grandview Boulevard profile is lowered from Girard Drive to Heritage Garden Crescent to reduce the maximum upstream surface ponding depths and convey major flows to the pond. Modifying the road profiles will impact other infrastructure, including streetlights and fire hydrants, and will increase the driveway entrance slopes.

6.3.13 Hood Drain and Leffler Drain

The results of detailed dual drainage modeling suggest that that the existing drainage system currently operates below a 2-year level of service and that the low-lying residential lands between the railway and Old Tecumseh Road can experience significant surface ponding before overland relief is achieved. Some of these lands have been identified as highly vulnerable given the potential for surface flooding encroaching up to the dwellings.

As part of the ongoing Patillo Road reconstruction, the upstream portions of the Leffler Drain will be enclosed. The effects of enclosing the drain on the downstream peak flows are mitigated by replacing the existing stop logs at the Leffler Drain pump station with an automatic sluice gate, as described in the Stantec memo dated June 25, 2019. The following alternatives were developed to improve the minor system performance, reduce frequency of ponding, lower the maximum estimated surface ponding depths, and reduce the number of properties that may be vulnerable to flooding during severe storm events.

6.3.13.1 Alternative 1 – Do Nothing

Under this alternative, no stormwater works are proposed. The existing developments will continue to experience prolonged road ponding during severe storm events. Surface ponding will occur during storm events less severe than the 2-year design event. The 100-year storm calculated surface ponding depths are deeper than 0.5 m at some locations and some homes are vulnerable to surface flooding.

6.3.13.2 Alternative 2 – Regional Pond at County Road 22

Alternative 2 involves creating a regional SWM pond at County Road 22 to attenuate the peak flows from the upstream portion of the catchment. The approximately 200,000 m^3 pond discharges to the Leffler Drain via a proposed pumping station designed to drain the pond over a 48-hour period.

This alternative significantly reduces the surface ponding durations in the existing downstream residential areas, though the maximum surface ponding depths may still be greater than 0.3 m. Surface ponding depths and durations in the upstream industrial areas are also reduced.

6.3.13.3 Alternative 3 – Leffler Drain Pump Station Pump Replacement

Alternative 3 consists of significant upgrades to the Leffler Drain pump station. All three pumps are upgraded to the maximum size that can be accommodated in the existing wet well, which increases the peak discharge rate to approximately 2.2 m^3/s per pump. The PTO emergency pump is also to be replaced with a permanent 2.2 m^3/s pump. This brings the total pump capacity to approximately 8.8 m^3/s, compared to the current 3.8 m^3/s capacity provided by the three existing duty pumps.

Increasing the pump station capacity allows the system to convey flows more quickly and significantly reduces ponding durations in the residential areas. However, the maximum surface ponding depths may still be greater than 0.3 m. This alternative also reduces the maximum ponding depths and durations in the upstream industrial areas. In fact, this alternative improves the system performance in the industrial areas more than Alternative 2.

6.3.13.4 Alternative 4 – Leffler Drain Pump Station PTO Pump Upgrade

Alternative 4 involves replacing the emergency PTO pump with a permanent 1.0 m^3/s pump to achieve a minor system service level equivalent to a 2-year storm event. This additional capacity will reduce the likelihood of surface ponding and storm sewer surcharging during the 2-year design storm event. While this alternative reduces the ponding durations during the 100-year storm event in the residential developments, the corresponding maximum surface ponding depths are likely greater than 0.3 m.

6.3.13.5 Alternative 5 – Magna SWM Pond Improvements

In this alternative, the existing Magna SWM pond is expanded to attenuate the peak flows from the upstream portion of the catchment. The pond volume is increased to a total volume of 65,000m^3 by increasing the pond footprint to approximately 21,000m^2, deepening the pond, and removing the low flow sewer underneath the pond. A proposed overflow weir provides additional discharge capacity to supplement the flows from the pond pump station during sever storm events and outlets back to the existing enclosed Leffler Drain. By attenuating the peak flows, the downstream minor system is able to achieve a level of service approximately equal to the 2-year design storm.

This alternative reduces the maximum ponding durations in the residential existing residential areas. However, the maximum ponding depths during the 100-year storm are still likely deeper than 0.3 m.

6.3.13.6 Additional Recommendations

The following measures are also included in Alternatives 2, 3, 4, and 5:

- Backup power at the Leffler Pump Station is provided to protect against significant flooding during power outages; and
- The existing open Leffler Drain between County Road 22 and Old Tecumseh Road is enclosed to reduce the possibility of obstructions caused by debris, improve conveyance and road safety along Patillo Road.

6.3.14 Country Walk & Dean Development

The following alternatives were developed to address the need for frequent sediment removal from the storm sewer located under the Country Walk dry SWM pond and the frequent deep surface ponding that occurs in the local right-of-ways.

6.3.14.1 Alternative 1 – Do Nothing

Under this alternative, no stormwater works are completed. Frequent and prolonged road ponding occurs during sever storm events and the minor system provides a level of service less than the 2-year event. The maximum estimated ponding depth on Quinlan Drive is deeper than 0.5 m during the 100-year storm event.

6.3.14.2 Alternative 2 – Pond Improvements

In this alternative, the existing storm sewer underneath the dry SWM pond is removed and the pond is deepened to the existing pipe inverts. Headwalls are provided at the new pond inlets and the outlet to the existing pump station. All pump station control settings remain unchanged, and the pond will continue to operate as a dry facility. This should eliminate the need for frequent sewer flushing while also lowering pond storage water levels and reducing roadway ponding frequency and duration.

While the development suffers from poor overland routing, the homes have been built to an adequate floodproofing elevation and surface flooding will spill towards the lake prior to encroaching onto the homes. This alternative significantly reduces the maximum estimated ponding durations on roadways. However, some localized ponding may still exceed depths of 0.5 m. During the 2-year design storm event, temporary ponding may still occur on the existing roadways.

6.4 EVALUATION METHODOLOGY

As part of Phase 2 of the Municipal Class EA process, the framework and criteria for evaluating the alternative solutions must be defined. The following sections describe the environmental components and evaluation criteria that were employed during the selection of preferred alternatives.

The environmental components outlined below represent a broad definition of the environment as described in the EA Act.

Table 6.1 Environmental Components

Environmental Component	Description
Social/Cultural	Component that evaluates potential effects on residents, neighbourhoods, businesses, community character, social cohesion, community features, and historical/archaeological and heritage components.
Natural Environment	Component having regard for protecting significant natural and physical elements of the environment (i.e. air, land, water, and biota), including natural heritage and environmental features and functions.
Technical	Component that considers technical suitability and other engineering aspects of the servicing options.
Economic/Financial	Component that addresses the potential effect on servicing costs.

A qualitative evaluation was used to consider the relative suitability of each servicing option and to identify significant advantages and disadvantages with respect to a specific set of evaluation criteria identified for each environmental component. The following criteria summarize in the following table were identified for this study.

Table 6.2 Evaluation Criteria

Environmental Component	Evaluation Criteria	Description
Social/ Cultural	Public Health and Safety	• Impacts to health and safety for each option and during construction
	Cultural Heritage Resources	• Disruption of site having significant archaeological, historical, or architectural value
	Aesthetics	• Visual appearance with or without mitigation
	Property Impacts/Acquisitions	• Potential acquisition of additional land for construction • Potential negotiation of drainage easements • Disruption to property both during and after construction
	Municipal Policy/Guidelines	• Conforms to provincial, county and municipal land use policies, and general guidelines
	Aboriginal Impacts	• Land Claims/Treaty Rights
Natural Environment	Erosion and Sedimentation Impacts	• Impacts and mitigation measures for erosion and sedimentation downstream
	Aquatic Habitats	• Reduction or deterioration of habitat • Effects of timing of construction on spawning periods • Changes in vegetation composition
	Terrestrial Habitats	• Reduction or deterioration of wildlife habitat

		• Effects on wildlife habitat related to food and shelter • Removal or disturbance of significant trees and/or ground flora • Changes in vegetation composition
	Migratory/Other Birds	• Reduction or deterioration of habitat • Effects of contamination on birds • Effects of timing of construction on nesting periods • Changes in vegetation composition
Technical	Compliance with Stormwater Design Targets	• Ministry of the Environment and Climate Change, municipal, and other design standards
	Effects on Local Ponding Depths	• Impacts to design ponding depths
	Effect on Groundwater Levels	• Potential impacts on groundwater levels, and opportunities for mitigating high groundwater levels
	Capacity (for Existing and Future Development)	• Capacity to accommodate runoff from existing and future development areas.
	Compliance with Applicable Floodplain Policies	• Potential impact of alternative on floodplain based on location of proposed works, potential for erosion, etc.
	Site Design Challenges	• Identifying any site design challenges and solutions
	Geotechnical Considerations	• Potential soil and/or groundwater impacts
	Consequences of System Failure	• Overall impacts/consequences if system fails
	Construction	• Implementation, noise/vibration/dust during construction, construction access
	Operation and Maintenance	• Adjacent property requirements • Vegetation establishment • Accessibility
	Approval and Regulatory Requirements	• Provincial & Municipal Requirements • Conservation Authority Requirements
	Initial Capital Costs	• Total Project Costs (design/construction)
Economic/ Financial	Property Acquisition Costs	• Costs associated with any required property acquisitions
	Operation and Maintenance Costs	• Costs associated with operation and maintenance

6.5 EVALUATION OF ALTERNATIVE SOLUTIONS

The alternatives for each catchment area were compared using the evaluation criteria listed in Table 6.2. A decision matrix was developed to document the potential impacts associated with each option and assist in selecting the preferred solution in coordination with Municipality of Lakeshore staff. The matrices are provided in the following tables.

7.0 PRIVATE AND PUBLIC DRAINAGE SOLUTIONS

As noted in Section 6, improvements to both private and public drainage works are necessary to reduce the risk of flood damage caused by severe storm events and improve system resiliency. The following sections describe potential private drainage improvements that property owners should consider to reduce their flood risk, public drainage improvements that the Town should implement to improve system performance.

7.1 PRIVATE DRAINAGE IMPROVEMENTS

Operation and maintenance of the private drainage system is the responsibility of the property owner. The following guidance may assist homeowners to reduce basement flood risk.

7.1.1 Ensure Proper Outflow from Home

How do we mitigate risk of basement flooding? Start from the inside out. When we start inside the basement, we correctly identify the sump pump system as the most critical piece of equipment to protect against wet basements. We say "system" because the conventional thought of a single sump pump is not going to keep basements dry all the time. Common sump pump failures include:

- Single pump can't keep up with inflow;
- Power outage;
- Pump burns out;
- Pump switches get hung up – pump doesn't turn on; or
- Pump clogs with sediment, mud, or debris.

While a basement might be dry for many years with no apparent problem, it only takes one extreme storm event to potentially overwhelm a single pump and result in flood damage. A robust sump pump system consists of multiple pumps - a primary pump to handle day-to-day flows, a secondary pump discharging at the surface to handle the infrequent heavy flow from an extreme rain event and a backup pump in the event of a power outage.

It should be recognized that a backup pump typically has limited capacity both in terms of the rate at which it can pump and the duration. Ironically, it is during high intensity storms where the power outage is more likely and when more (not less) pumping capacity is needed. While a backup pump offers some protection, it may not be enough on its own – particularly if the power outage is prolonged. A better protection would be to have a portable power generator ready to backup the primary and secondary pumps. Obviously, this only works if there is an alarm to signal the homeowner and, more importantly, that they are home. The best, but significantly more costly protection would be permanent power generator.

Moving outwards from the sump pump, the next component of the drainage system is the perimeter drain that typically wraps around the foundation walls and collects sump pump discharge flows as well as flows from connected roof leaders, as depicted in Figures 7.1 and 7.2 below.

If the perimeter drainage pipes are cracked or displaced, water from pump and roof will track back into the sump pit - resulting in recirculating flow and a pump that eventually "can't keep up" as it is pumping fruitlessly. For the sump pump to be effective, its discharge needs to be directed away from the home and away from the sump pit. To achieve this, the pump must discharge into a solid perimeter drain system and/or to a location at the surface which directs water away from the home.

Figure 7.1: Lot Level Servicing - Plan View

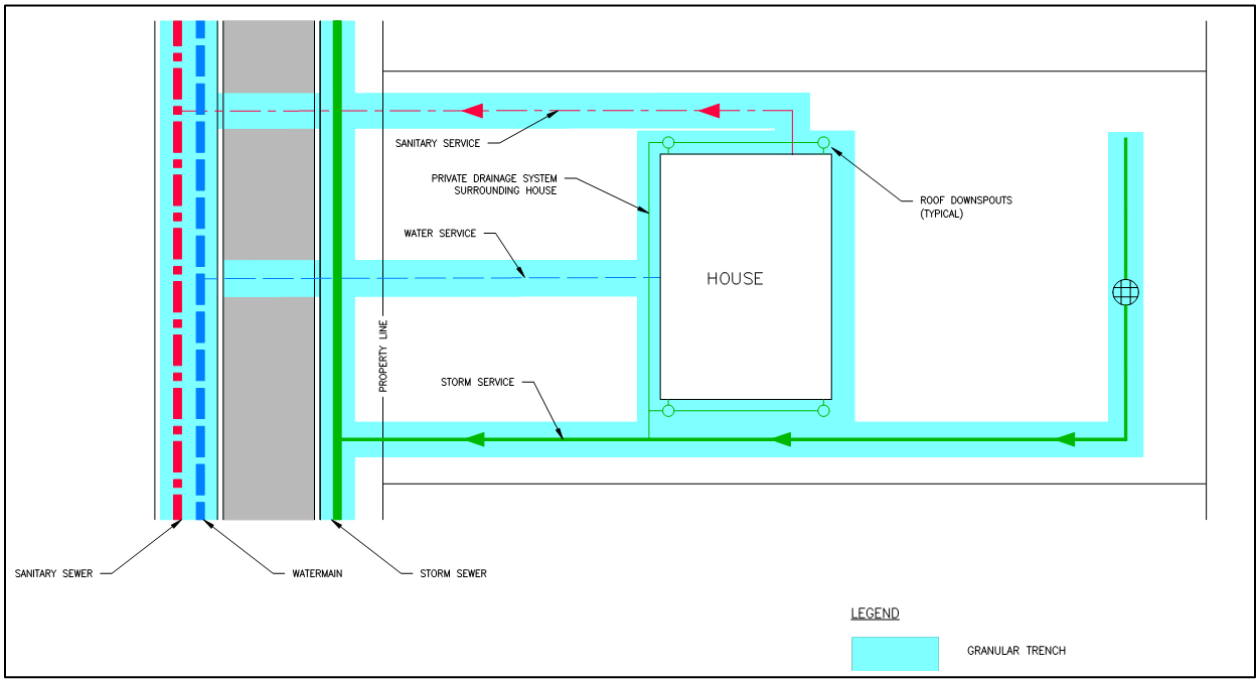
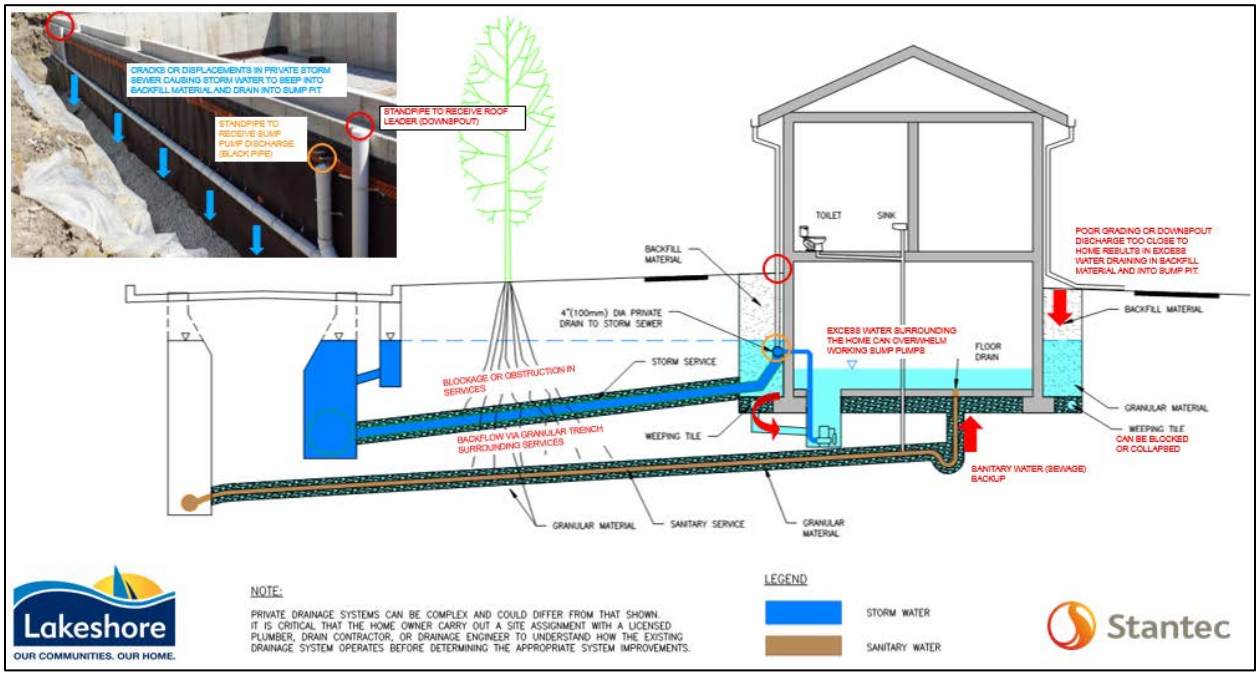


Figure 7.2: Unprotected Lot Level Servicing - Section View



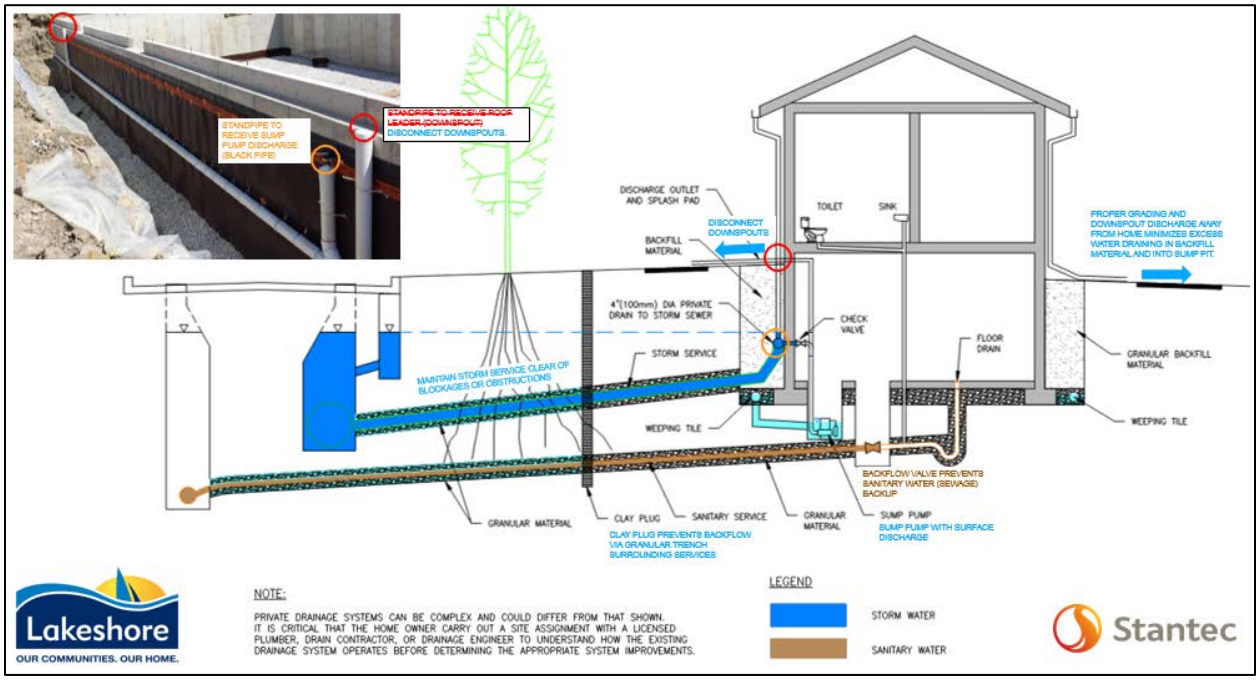
7.1.2 Minimize Inflow to Home

In addition to ensuring proper discharge of roof and perimeter drainage, it is also important to mitigate any excess flow from entering the private drainage system. During high lake level periods and/or intense rainfall events, water levels rise in sewer trenches. This condition can create a backwater condition – a condition where water in the stone/sand bedding of sewer and other utility trenches can easily travel back and fill stone bedding around the perimeter of the home. This phenomenon can significantly increase inflow to the sump pit and put excessive strain on the pump. A simple measure to mitigate this backflow condition is to install impervious plugs during home construction to cut off the potential backflow from trenches between main services at the roadway to the home. While this measure is a typical development standard, it has not always been either prescribed and/or properly implemented to mitigate backwater conditions.

When feasible, disconnection of the roof downspouts from the underground sewer system can significantly reduce the direct inflow of water to the private drainage system. However, care must be taken to direct roof water to the street and/or rear yard drainage inlet, and not on neighbouring property. In addition, clogged eavestroughs could result in roof water overtopping eaves and draining along walls or onto the backfill zone which drains more easily and quickly to the tile drainage.

As shown on Figure 7.3, backflow valves are critical to mitigate the potential for storm/sanitary water to enter the home via backflow from the sewer main.

Figure 7.3: Protected Lot Level Servicing - Section View



7.1.3 Maintenance and Inspection

Periodic maintenance and repairs to private drainage systems are important to verify that surface water and groundwater surrounding the home is directed away from the home and towards the roadway/storm sewer system. A short check list of critical items includes:

- Repair cracked pipes and basement walls;
- Maintain sump pump system;
- Clean roof eaves;
- Remove blockages caused by tree roots;
- Maintain sanitary backflow valves; and
- Address poor grading around the house.

The Municipality of Lakeshore currently provides the following assistance to assist homeowners maintain their private drainage services:

- Camera inspection for sanitary and storm sewers (free);
- Backflow valves (subsidy available);
- Sump pump overflow (subsidy available); and
- Downspout disconnection (subsidy available).

7.2 PUBLIC DRAINAGE IMPROVEMENTS

The preferred public drainage system improvements for each catchment area were selected based on the results of the alternative evaluation and were modified based on comments received from the public and other stakeholders after the Public Information Centre (a summary of the comments received and the resultant modifications can be found in Appendix B). The preferred alternatives for each catchment area are discussed below.

7.2.1 Amy Croft Drive

Preferred Alternative – Alternative 3

The proposed future developments will provide at-source stormwater treatment to provide water quality control and storage to attenuate the peak discharges from all design events up to and including the 100-year storm to the post-development 5-year peak. Future development agreements will include conditions citing these on-site SWM control requirements. A proposed stormwater management pond will provide additional peak flow control storage to mitigate the impacts of the proposed development runoff on the existing pond operating levels. The proposed pond will be designed to operate without increasing the downstream pond maximum design HWL.

The existing SWM pond outlet structure will be replaced with a larger diameter pipe to maximize the peak discharges from the facility. The existing pond still provides water quality treatment from its design service area, but the peak discharges are allowed to enter Pike Creek with little peak flow attenuation during severe storm events. Significant impacts on the downstream Pike Creek water surface elevations are not anticipated because the peak flow from the Amy Croft catchment enters the creek before the peak streamflow occurs.

Proposed improvements to the major system include regrading the east roadside ditch on West Pike Creek Road and securing a drainage easement on 160 West Pike Creek Road to establish an unobstructed overland flow route to Pike Creek. The proposed overland flow route alignment is currently undeveloped vacant land. The proposed drainage easement will be graded to reduce the maximum ponding depths on West Pike Creek Road. The portions of the existing municipal drains located east of West Pike Creek Road will be abandoned and a new proposed storm sewer is constructed in the proposed drainage easement to convey the minor flows to Pike Creek.

Both flap gates and clay plugs at all outfalls shall be installed to mitigate the effects of high downstream water levels on the system performance and to reduce seepage in the servicing trenches.

7.2.2 Croft Drive

Preferred Alternative – Alternative 3

A proposed drainage easement will be obtained south of Croft Drive to convey major flows from the Croft Drive right-of-way to Webbwood Drain. The proposed drainage easement will be graded to reduce the maximum ponding depth on Croft Drive to 300 mm. Inlet improvements at Webbwood Drain required to

accommodate the proposed surface flows will be completed in accordance with the provisions of the Drainage Act. Since the increase in peak flows directed to the Webbwood Drain is relatively small, significant downstream impacts are not anticipated. Regardless, a detailed hydraulic assessment should be completed to identify any necessary mitigation measures.

The Croft Drive boulevard will be regraded to lower the local spill elevation and allow roadway ponding to travel as surface flow into the existing SWM pond. No downstream impacts are anticipated since the pond discharges to Webbwood Drain via a pumped outlet.

7.2.3 Chelsea Park

Preferred Alternative – Alternative 3

The maximum ponding depths at the Regency Crescent/Agency Road intersection will be reduced to 300 mm by constructing a major flow route from the ponding location to the existing SWM pond on the neighboring River Ridge 4th Concession future development. Future development agreements will include clauses stating that the proposed major system must be designed to accommodate the major flows from the Regency Crescent/Agency Road intersection low point. No significant impacts on the downstream major flow route or SWM pond are anticipated since the associated flow increase is relatively small and only occurs during severe storm events.

Additionally, a drainage easement shall be obtained on the existing overland flow route from East Puce Road to the Puce River. The drainage easement will mitigate the risk of alterations or obstructions on the overland flow route that could cause deeper upstream ponding during severe storm events.

7.2.4 Optimist

Preferred Alternative – Alternative 2

The existing CNR pump station will be replaced with a new pump station designed to convey the 5-year peak discharge. The proposed pump station will be constructed with a gravity overflow and will include at least two pumps that will operate alternately. The proposed pump station will include necessary equipment to facilitate pump removal and replacement. Both flap gates and clay plugs shall be installed at the proposed outfall to mitigate the effects of high downstream water levels on the system performance and to reduce seepage.

The West River Street storm sewer will be reconstructed to convey the 5-year peak discharge to the proposed pump station. The existing storm sewer gravity outlets will be decommissioned. under proposed pump station dewaters the minor system during high lake level conditions and reduces the maximum ponding depths and durations during severe storm events.

7.2.5 Notre Dame Pump

Preferred Alternative – Alternative 1

No drainage improvements are proposed within this catchment since:

- The existing pumping station was recently improved to increase the maximum pumping rates;
- The drainage area that contributes runoff to the existing major flow route is relatively small and unlikely to generate sufficient runoff to threaten existing homes; and
- The maximum estimated road ponding depths are unlikely to present a significant safety risk.

7.2.6 Seasons at the Creek

Preferred Alternative – Alternative 2

The existing 50 mm pump discharge pipe will be replaced with a 100 mm diameter pipe to increase the peak discharges from the pumping station, reduce pump run times and pump maintenance. Furthermore, the pump station improvements shall include the installation of equipment to facilitate future pump replacement. An MECP ECA amendment is required since the proposed pump station improvements modify the approved pond outlet design and affect the existing pond operation.

A drainage easement located on the existing properties at the Summer Street low point shall be acquired to prevent obstruction and to provide future municipal access to the overland flow route that conveys the major flows to Duck Creek.

7.2.7 Belle River West

Preferred Alternative – Alternative 3

The existing First Street pumping station will be replaced with a new station that discharges to Belle River downstream of the railway bridge and a new pumping station will be constructed at the St. Charles Street storm sewer outlet. The proposed pump stations will be designed to convey the 5-year peak discharges from each system to the Belle River and will provide an outlet under high lake level conditions. The proposed pump stations will be constructed with gravity overflows and will include at least two pumps that will operate alternately. The proposed pump stations will include necessary equipment to facilitate pump removal and replacement. Both flap gates and clay plugs shall be installed at the proposed outfalls to mitigate the effects of high downstream water levels on the system performance and to reduce seepage. Gradual storm sewer replacements upstream of the proposed pump stations in accordance with the Town's infrastructure renewal program will improve peak flow conveyance.

The East River Street/Centre Street road profile will be modified to convey major flows to Belle River within the public road allowance.

7.2.8 Terra Lou

Preferred Alternative – Alternative 2

A proposed overflow pipe with a high capacity inlet will be constructed at Terra Lou Park to provide major flow relief and reduce the maximum roadway ponding depths on Terra Lou Drive under low lake level conditions. The proposed overflow pipe will be equipped with a flap gate and will discharge to the existing Notre Dame Street outlet downstream of the existing pumping station.

7.2.9 Bacon/Forest Hill

Preferred Alternative – Alternative 3

The Forest Hills pump station will be improved to increase the peak discharge rates to Duck Creek to 2.5 m^3/s. The proposed pump station improvements will include necessary equipment to facilitate pump removal and replacement. Both flap gates and clay plugs shall be installed at the pump station to mitigate the effects of high downstream water levels on the system performance and to reduce seepage.

7.2.10 Russell Woods

Preferred Alternative – Alternative 3

The proposed drainage improvements include:

- An automatic sluice gate at the Russell Woods pump station to provide a gravity outlet under high lake level conditions;
- Improvements at the Laurendale Subdivision pump station to increase the peak discharges; and
- A new pump station that discharges the flows from the East Pike Creek Drain to Pike creek.

The proposed pump station will be designed to convey the 5-year peak discharge. The proposed pump station will be constructed with a gravity overflow and will include at least two pumps that will operate alternately. The proposed pump station will include necessary equipment to facilitate pump removal and replacement. Both flap gates and clay plugs shall be installed at the proposed outfall to mitigate the effects of high downstream water levels on the system performance and to reduce seepage. Gradual storm sewer replacements upstream of the proposed pump station in accordance with the Town's infrastructure renewal program will improve peak flow conveyance.

Lake water encroaching into the East Pike Creek Road right-of-way from the private boat launch under high lake level conditions should continue to be managed using temporary measures. Since sand bags have not previously been effective, the town should consider other temporary measures such as aquadams.

7.2.11 Lefaive Drain

Preferred Alternative – Alternative 2

Lefaivre Drain will be abandoned in accordance with the provisions of the Drainage Act from Willowwood Drive to the downstream connection to Marie Street and replaced with a new storm sewer located on St. Pierre Street that conveys the minor flows to a new pump station. The proposed storm sewer will be designed to convey the 5-year peak discharge and St. Pierre Street will be reprofiled to reduce the local road ponding depths.

The proposed pump station will be constructed with a gravity overflow and will include at least two pumps that will operate alternately. The proposed pump station will convey the 5-year peak discharge and will include necessary equipment to facilitate pump removal and replacement. Both flap gates and clay plugs shall be installed at the proposed outfall to mitigate the effects of high downstream water levels on the system performance and to reduce seepage. The existing gravity outfalls to Belle River will be decommissioned.

7.2.12 Brown's Creek Drain

Preferred Alternative – Alternative 1

The alternative evaluation suggests that reducing the maximum ponding depth in this catchment will cause significant disturbance and has a significant cost. Since there are no significant safety issues associated with the maximum ponding depth and access to properties is unlikely to be significantly affected during severe storm events, no public drainage system improvements are proposed at this time.

The available topographic information suggests that major flow from Heritage Garden Crescent travel eastwards across the existing undeveloped lands to Brown's Creek Drain. Future development agreements shall include clauses stating that the proposed major system must be designed to accommodate these major flows.

7.2.13 Hood Drain and Leffler Drain

Preferred Alternative – Alternative 4

In addition to the proposed automatic sluice gate at the Leffler Drain pump station proposed as part of the Patillo Road improvements, a permanent motor will be installed at the emergency PTO pump and the Leffler Drain will be enclosed from the railway to the pump station. In accordance with previous guidance provided by ERCA, the proposed improvements must not raise the Leffler Drain 100-year water surface elevation. Furthermore, the proposed drain enclosure will require ERCA approval.

7.2.14 Country Walk & Dean Development

Preferred Alternative – Alternative 2

The existing storm sewer underneath the dry SWM pond will be removed and the pond will be deepened to the existing pipe inverts. Based on the hydraulic modelling completed for the downstream Wallace Line Drain, the existing pond overflow weir elevation can be reduced to approximately 176.5 m. An amendment to the existing pond Certificate of Approval will be required. The drainage system performance could likely be further improved by providing additional conveyance across the railway corridor.

7.3 ADDITIONAL PUBLIC DRAINAGE IMPROVEMENTS

7.3.1 Outfalls

Combined with recent extreme rainfall events, the St. Clair lake levels and corresponding levels in its tributary watercourses have been well above average in recent years. These high levels have exposed the problem of lake/river water seeping back into sewer stone trenches, ultimately transmitting a steady and sometimes substantial inflow of water to private drainage system via service connection trenches, discussed in Section 7.1.2. This phenomenon puts enormous strain on sump pump systems, particularly those homes that are lowest in the sewer network connected to the waterbody.

It is strongly recommended that all submerged outfalls be retrofitted to have backflow prevention and impervious plugs to cut-off water seepage via pervious trench backfill material. Where feasible, pumping should be incorporated into the outfall design to drain the sewer systems and trenches once stormwater flow subsides and the flap gate closes after a rainfall event.

A total of 48 outlet locations were identified and a cursory assessment was performed based on a review of record drawings. Comments can be referenced in Appendix H along with maps for outlet locations.

7.3.2 Outlet Improvements

Numerous locations along the shoreline and watercourses banks have implemented flood protection systems to protect from high water levels encroaching onto low lying property. However, this protection can inhibit the potential for overland surface flow relief during major rainfall events. The photograph to the right illustrates an example of this condition.

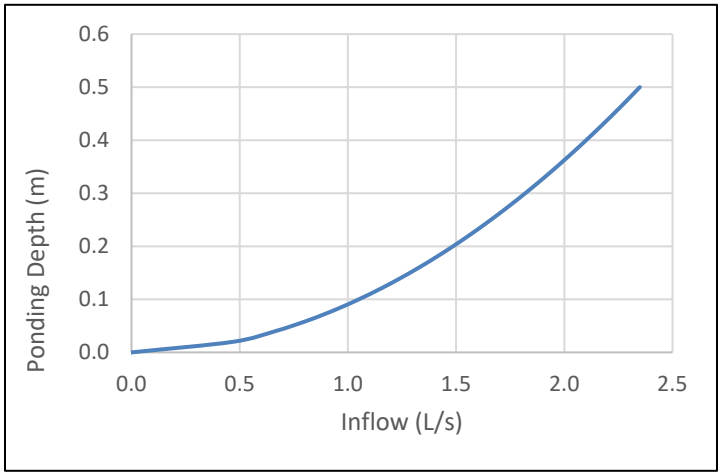
It is recommended that storm surge flap gates be installed at overland flow relief locations to provide both surface flow relief and high lake level protection.

7.3.3 Surface Inflow to Sanitary Sewer

During major storm events resulting in surface flooding, water can sometimes enter the sanitary sewer through manhole lift holes. This can be a significant source of inflow to the sanitary sewer. A typical 200mm dia. sanitary sewer has an approximate capacity of 18 litres per second (L/s). At an inflow rate of 1.8 L/s for one manhole, it would only take 10 manholes with 0.3 metres of ponding to use up the sewer capacity.

To mitigate this, the Town should continue installing RainGuards at all sanitary manholes located near low points.

Graph 7.1: Sanitary Manhole Inflow



8.0 CONCLUSION AND RECOMMENDATIONS

8.1 COSTS

An opinion of probable cost was prepared as an attempt to project what someone else will be willing to contract for in the future to do construction work which has not yet been defined and which is subject to changes in scope, design, and market conditions. The opinion of probable costs contained in this report were prepared in 2020 and are in 2020 dollars.

8.1.1 Level of Accuracy

Opinions of probable cost are typically provided throughout various stages of a project's life cycle. There are a number of classifications for estimates that identify typical minimum and maximum probable costs or levels of accuracy. These classifications vary widely by industry but all are based on the fact that the level of accuracy is directly proportional to the level of detail available at each stage of the project.

The level of accuracy increases as the project moves through the various stages from planning to preliminary design to final design. A wide range of accuracy would be expected at the planning stage of a project development because a number of details would be unknown. As the project moves closer to completion of final design, the estimate would become more accurate due to the increased level of detail available and the reduced number of unknowns.

The following table presents a summary of typical estimate classifications used throughout a project's development including a description of the project stage and range of accuracy.

Table 8.1 Classification of Cost Estimates

Class	Description	Level of Accuracy	Stage of Project Lifecycle
1	Conceptual Estimate	+50% to -30%	Screening of alternatives.
2	Study Estimate	+30% to -15%	Treatment system master plans.
3	Preliminary Estimate	+25% to -10%	Pre-design report.
4	Detailed Estimate	+15% to -5%	Completed plans and specifications.
5	Tender Estimate	+10% to -3%	This is the actual tender price and it can vary depending on the amount of contingency allowance consumed.

The opinions of probable cost in this study are estimated at the study stage (Class 1) and the corresponding level of accuracy could range from –30% to +50% from the opinion presented in the report.

8.1.2 Minor System Improvements

A cost analysis of the proposed minor system improvements was created to show estimates for sewers that have the lowest level of service. Using the scoring system from the 2-year design storm the sewers were divided into four coloured tiers. The green tiers in the scoring total categories have been aggregated for simplicity. Refer to Appendix E for maps showing results of sewer scoring.

Table 8.2 Sewer Prioritization Overall Scoring

Total Score	Prioritization Grade
8-10	Very Poor
6-8	Poor
4-6	Fair
2-4	Good
0-2	Very Good

All proposed storm sewers were sized to convey the estimated 5-year peak flow based on Manning's equation and assuming minimum grade. A cost estimate spreadsheet was then created using the new sewer sizes. The spreadsheet accounts for all material and construction costs associated with replacing the sewers and manholes. The following table shows the cost summarization for the tiers resulting from poor conditions.

Table 8.3 Sewer Prioritization Cost

Tier	Material & Construction Subtotal	Geotech Testing (0.5%)	Financing Legal (1%)	Miscellaneous (0.5%)	Engineering (15%)	Total Scenario Cost
Red	$395,707	$1,979	$3,957	$1,979	$59,356	$462,977
Orange	$7,923,086	$39,615	$79,231	$39,615	$1,188,463	$9,270,011
						$9,732,988

Note that the costs presented in Table 8.3 do not include HST.

8.1.3 Catchment Improvements

A cost analysis was performed for the preferred alternative in each catchment identified through this master plan. Two catchments will not have associated costs as the preferred alternative was to keep existing conditions with no improvements. These are Notre Dame Pump Station and Brown's Creek Drain. Further it is important to note that there were gaps in existing sewer and pump station data for some of these catchments. Therefore, Stantec does not guarantee the accuracy of this opinion of probable cost. The actual final cost of any identified project should be determined through the bidding and construction process, and subject to further refinement of design and determination of overall scope of work. These costs are intended to represent a preliminary cost assessment and items considered are included in the tables shown in Appendix I.

Table 8.4 Preliminary Opinion of Probable Costs for Preferred Solutions

Catchment	Projects	Cost
Amy Croft Drive	SWM Pond Retrofit, Storm Sewer Replacement, Major Flow Improvements, Municipal Drain Abandonment	$800,000
Croft Drive	Major Flow Improvements	$80,000
Chelsea Park	Major Flow Improvements	$100,000
Optimist	Pump Station Replacement, Storm Sewer Replacement	$1,400,000
Seasons at the Creek	Pump Station Improvements	$140,000
Belle River West	New Pump Stations, Major System Improvements	$4,100,000
Terra Lou	Major System Improvements	$120,000
Bacon/Forest Hill	Pump Station Improvements	$1,700,000
Russell Woods	Pump Station Improvements, New Pump Station	$2,700,000
Lefaive Drain	New Storm Sewer, Pump Station Replacement, Municipal Drain Abandonment	$8,000,000
Hood and Leffler Drain	Pump Station Improvements, Municipal Drain Enclosure	$14,000,000
Country Walk and Dean Development	SWM Pond Retrofit	$700,000
	TOTAL	$33,840,000

Note that the costs presented in Table 8.4 do not include HST.

8.1.4 Operation and Maintenance

The associated annual operation and maintenance (O&M) costs presented in the following table were developed for the proposed catchment improvements. The operation and maintenance costs include annualized costs for significant maintenance items and were calculated based on the following assumptions:

- All facilities are inspected by a qualified professional at least annually;
- All SWM ponds require sediment removal approximately every 10 years;
- All pumps are assumed to have a design service life of 20 years; and
- Costs do not include pump station electricity costs.

Additional details regarding the preliminary cost assessment assumptions are presented in Appendix I.

Table 8.5 Preliminary Opinion of Probable Annual O & M Costs for Preferred Solutions

Catchment	Estimated Annual O&M Cost ($)
Town Owned Facilities	
Amy Croft	$13,000
Croft Drive	$1,000
Chelsea Park	$0
Optimist	$10,000
Seasons at the Creek	$8,000
Belle River West	$16,000
Terra Lou	$1,000
Bacon/Forest Hill	$11,000
Lefaive Drain	$11,000
Country Walk	$13,000
Subtotal	**$84,000**
Municipal Drain Facilities[1]	
Russell Woods	$12,000
Hood and Leffler	$15,000
Subtotal	**$27,000**
TOTAL	**$111,000**

Notes:

[1] Operation and maintenance costs for Municipal Drains should be paid in accordance with the provisions of the Drainage Act.

Additionally, a cost analysis was completed to estimate the annual operation and maintenance costs for all Town-owned stormwater facilities. The information presented in the following table is provided to assist the Town in identifying future funding requirements to adequately manage its end-of-pipe stormwater assets. Note that the O&M costs associated with stormwater conveyance measures have not been estimated.

Table 8.6 Preliminary Opinion of Probable Annual O & M Costs for Town-Owned Facilities

Type of Facility	Quantity	Typical Annual O&M Cost ($)	Total Estimated O&M Cost ($)
Town-Owned SWM Ponds	21 [1]	$13,000	$273,000
Town-Owned Storm Pump Stations	26 [2]	$10,000	$260,000
		TOTAL	$533,000

Notes:

[1] Based on 20 existing Town-owned SWM ponds and 1 proposed SWM pond (Amy Croft)

[2] Based on 22 existing Town-owned storm pump stations, 3 proposed replacement pump stations (Optimist, Belle River West, and Lefaive) and 1 proposed new pump station (Belle River West)

8.2 INSPECTION AND MAINTENANCE

An Inspection and Maintenance Program is important to ensure that all aspects of a stormwater management system continue to work the way they were designed to. This includes sewer systems, stormwater management facilities (stormwater ponds), and pump stations. “One of the main reasons for SWMP failures and/or poor performance in the past was a lack of maintenance.” (Ontario, 2017) Outlined in this program, is a list of inspection and maintenance tasks that should be completed along with a frequency timeframe for each action.

8.2.1 Stormwater Management Facilities

Stormwater management ponds are a key part in a stormwater system. It is crucial that these ponds are sized correctly so that storm sewers can properly drain after a rainfall event and also allow a controlled release rate into the downstream waterway or drain. Over time, sediment, vegetation, erosion, debris, and litter can all have effects on the efficiency and size of these ponds.

8.2.2 Storm Sewers Systems

Storm sewers can often become clogged with silt or debris and litter. They also can occasionally become damaged including joints that come apart or pipe sections that collapse. Manhole inspection with the use of Zoom Cameras can be a simple first step in the inspection and maintenance of sewer systems.

Zoom Cameras can be lowered into each manhole to inspect and record the condition of the manhole and the sewers in the upstream and downstream directions. Completing this inspection can show which sewer sections require cleaning to remove debris and silt. It can also identify which sections may require further inspection through CCTV to investigate potential issues.

8.2.3 Pump Stations

Pump stations should be inspected and tested to ensure all pumps are operating correctly. It is also important to inspect overflows, backwater valves and flap gates and observe that storm sewer systems are dewatering properly. If sewer systems are not dewatering, inspection should be completed to find the source of the water and determine a solution.

8.2.4 Observed Maintenance Issues

The following is a list of maintenance issues that were observed through site visits or potential maintenance issues discovered. Note that this list only covers specific issues that have been observed. There potentially could be more maintenance issues that have not yet been discovered. It is recommended that the Town complete the entire Inspection and Maintenance schedule to identify more issues.

Table 8.7 Pump Station Maintenance Issues Observed

ID	Location	Issue
17	River Ridge Pump Station	Flap Gate has faulty seal. Due to high lake levels, water is leaking into the Junction Chamber and flowing through the 600 mm dia. connection pipe to the Pump Chamber causing the Pump Station to turn on more frequently, even during dry periods. This could reduce the life expectancy of the pumps. **The Town has purchased seal and replacement parts and is waiting for lake levels to drop so that the seal can be replaced. Pumps are being replaced.**
33	Monarch Meadows Pump Station	Pump is constantly cycling. Storm sewers are constantly full of water and do not drain. **The Town subsequently got the flap gate in good working order. Since then, the storm sewers have been pumped dry but outlet erosion and trench water protection are items that need to be resolved.**
34	Gammon Development Pump Station	Pump station not running. Town could not turn it on. Water in the storm system as high as the overflow pipe outlet. Town to contact an electrician for maintenance. **The Town has subsequently resolved these issues and the pump is working normally.**
40	Hood Drain and Leffler Pump Station	Through calibration efforts, it appeared that during the August 28, 2017 rainfall event, the third pump may not be turning on. **Upstream debris blockage likely prevented the third pump from turning on. The pump is working normally.**
41	Russell Woods Pump Station	The Town stated the shore walls surrounding the pump chamber is in poor condition and Landmark Engineering has been contacted to assess the condition. There is an issue with lake water seeping into the pump chamber. **Landmark Engineering reviewed the condition with the assistance of a diver. No concerns were identified through the field inspection.**

Table 8.8 Pond Maintenance Issues Observed

ID	Subdivision	Issue
3	Cooper Estates	Vegetation growth along bottom of drain restricts flow. Ditch inlet pipe partially blocked (Ø 750 mm). Low flow pipe (Ø 250 mm) should be inspected further as it is prone to sediment buildup / blockages.
4	Whitewood Estates	Vegetation growth along bottom of drain restricts flow. Storm sewer inlet / outlet pipes to pond sit in bowls that accumulate vegetation, sediment and debris restricting flow.
5	Oakwood Estates	Install flap gate on the over flow pipe (Ø 750 mm) to prevent backwater from a surcharged storm sewer along Rourke Line.
7	Renaud Line Development	Flap gate stuck open for the pond over flow channel.
9	River Ridge	Heavy vegetation growth along SWM ditch north side of CP tracks. This restricts flow and should be cleaned.
11	King Emeryville	A 2 by 4 wooden plank was found holding the flap gate open for the pond outlet pipe (Ø 600 mm). Clean low flow pipe (Ø 75 mm) as it appears to be plugged.
12	Chelsea Park	Pond inlet manhole was buried it should be located and brought to grade. Inlet and outlet pipes have over grown surrounding vegetation, which should be cleaned to improve flow. Re-grade 100-year overland flow route to easement.
13	Country Walk	Clear vegetation from dry pond and ensure submerged storm pipes below dry pond are cleaned.
15	Maidstone Industrial Campus	Check the submerged storm pipe (Ø 500 mm) below the pond bottom for sediment build up and clean if necessary. Flap gate stuck open on the pump station discharge pipe (Ø 300 mm).
18	Bulcke/Reaume Development	Rodent grate not installed on pond inlet pipe (Ø 750 mm).

8.3 PROJECT IMPLEMENTATION

8.3.1 Project Triggers

The implementation of improvements identified within the Master Plan should generally be triggered by the following:

- Infrastructure failure or works required immediately to address public health/safety risks;
- Infrastructure failure or works required immediately to address property risks;
- Projects required during development applications to allow development to proceed;
- Improvements that can be coordinated with required road maintenance;
- The availability of municipal funding; and/or
- The ability to secure Provincial and/or Federal level funding (i.e., future infrastructure funding programs, Gas Tax programs, etc.).

Based on these triggers, Stantec prioritized the proposed stormwater improvement projects. This list is intended only as preliminary guidance and should be reviewed and updated as system conditions change and as funding becomes available:

1. Amy Croft Drive – Major system improvements are proposed to mitigate the public safety hazard presented by ponding on West Pike Creek Road and the proposed SWM pond retrofit is proposed to provide drainage servicing for future development. There are active development applications in this area.
2. Country Walk and Dean Development – Proposed pond retrofit is proposed to mitigate safety concerns caused by widespread ponding greater than 0.5 m deep and potential property damage.
3. Russell Woods – Pump Station improvements at Russell Woods, proposed pump station, and Laurendale Subdivision pump station improvements help to mitigate safety concerns caused by widespread ponding greater than 0.5 m deep and potential property damage.
4. Hood and Leffler Drain – Pump station improvements and drain enclosure are proposed to mitigate safety concerns caused by widespread ponding greater than 0.5 m deep and potential property damage.
5. Croft Drive – Major system improvements to reduce the risk of property damage should proceed before a development application for affected lands is received by the Town.
6. Optimist –Proposed pump station and storm sewer improvements reduce the risk of property damage.
7. Belle River West – Proposed pump station and storm sewer improvements reduce the risk of property damage.
8. Lefaive Drain – Proposed storm sewer and pump station replacement are required to address aging infrastructure and to mitigate nuisance flooding. Since St. Pierre Street was recently repaved, storm sewer replacement should be delayed, if possible. An inspection of the Lefaive Drain should be completed to assess its condition and guide replacement timing.
9. Chelsea Park – Design for the proposed major system improvements to reduce nuisance flooding should be completed before a development application for the neighboring lands is received by the Town.
10. Seasons at the Creek – Proposed pump station improvements improve pond performance and reduce operation and maintenance requirements.
11. Terra Lou – Proposed major system improvements reduce nuisance flooding under low lake level conditions.
12. Bacon/Forest Hill – Proposed pump station improvements are required to provide drainage servicing for future development. Improvements should proceed once a development application is received by the Town.

Furthermore, the priority storm sewer replacements identified in Section 8.1.2 should be included in the annual infrastructure budget for the coming years until all vulnerable systems are addressed. The priority storm sewer replacements should be coordinated with other upcoming servicing and road projects planned by the Town. The storm sewer replacement timeline will depend on funding availability and the priority of concurrent projects. However, Stantec recommends that the Town develop a 10-year plan to complete the priority storm sewer replacements.

8.3.2 Drainage Easements

Some preferred alternatives require the negotiation of easements. Municipal Servicing Easements are required for storm sewers, stormwater management ponds, and channels, and will need to be negotiated in accordance with the provisions of the Town's Development Manual.

8.3.3 Permit Requirements

Environmental Compliance Approvals (ECAs) will be required from the Ministry of the Environment, Conservation and Parks (MECP) to the construction of any new storm sewers and related appurtenances or where replacement works require modification to sizing/capacity or modification to the drainage areas.

Section 28 permits will be required from ERCA for any modifications to existing outlets, or for the installation of new outlets within Conservation Authority regulated lands.

Permitting and/or Registration will be required for any activities that have the potential for disruption to habitat for Endangered or Threatened Species under the Endangered Species Act, through the Ministry of Natural Resources and Forestry.

8.3.4 Archeological Resources

Given the previously disturbed nature of the study area, the potential for significant archeological resources within the limits of the proposed individual projects is likely relatively low. Regardless, prior to implementation of each individual project, clearance of archaeological potential should be undertaken by a licensed archeologist.

8.3.5 Recommended Natural Environment Protection and Mitigation Measures

During the planning, design, and construction of recommended projects, the potential exists for adverse environmental impacts on the natural features and ecological functions identified within the study area. During the evaluation of servicing alternatives, potential environmental impacts were noted. Assuming appropriate mitigation measures are followed, these impacts will be preventable or minimal to the surrounding environment.

Table 8.8 summarizes typical recommended mitigation and enhancement measures, and suggested application to minimize and mitigate the potentially adverse environmental impacts associated with the Master Plan and any proposed projects where potential for habitat disturbance exists. This information should be used in further planning studies, preparing detailed designs, construction timing, agency approvals, and on-going monitoring to ensure that the natural environment features identified within this report are protected, maintained, and restored through the implementation of any identified projects.

Table 8.9 Potential Impact and Mitigation Measures

Potential Impact	Typical Recommended Mitigation and Enhancement Measures
Aquatic Habitat, Fisheries and Water Quality	
Direct loss, alteration, or disruption of fish habitat	• Restore vegetation and aquatic habitat (substrate) to pre-construction condition (or better), ensuring that any habitat features are restored or enhanced. • Any Harmful Alteration, Disruption or Destruction (HADD) of fish habitat that may result from the proposed drainage improvements will require prior authorization from DFO. A compensation plan will be required for review and approval and should be discussed with DFO. • Opportunities to enhance riparian vegetation through the planting of overhanging grasses, shrubs and trees will improve stream cover, reduce temperature impacts, and provide allochthonous inputs (food source for various fish species).
Increased turbidity and siltation in downstream areas resulting in "smothered" plants and animals due to the deposition of silt and increased turbidity of surface watercourses	• Ensure erosion control measures are installed and maintained throughout all phases of construction to protect exposed surfaces, control run-off and minimize the deposition of silt or suspended sediments within downstream habitats. • Worksite isolation and dewatering plans should be prepared to identify appropriate isolation methods, siltation controls and dewatering measures to be implemented. • Any pumped water resulting from dewatering activities should be discharged to settling areas or through filter media before entering the surface water bodies. • Utilize suitable backfill material along banks and footings. • Stage construction activity to minimize the frequency and duration of any in-water work, as much as feasible. • Re-vegetate all disturbed areas as soon as possible following disturbance to stabilize the area and minimize erosion potential. • Effective monitoring and reporting is required.
Impacts on species at risk	• Improve water quality enhanced erosion control. • Restore riparian vegetation cover through the planting of overhanging grasses, forbs and shrubs, to provide cover, shade and a source of food (insects). • Any work along or in the watercourse margins should be timed/scheduled to minimize impacts to fish and mussel species. A review of the particular activity may assist in negotiating the timing window.
Stress on fish communities	• Any fish that may occur within isolated work areas should be captured and released in accordance with appropriate MNRF protocols.
Terrestrial Habitat and Species	
Removal or disturbance of significant trees or ground flora	• Relocate or replant any significant species in a timely manner following construction. • Minimize tree removal during construction. • Stabilize all disturbed areas upon completion of any grading works through re-vegetation of the disturbed areas utilizing native plant species (ex. seed and mulch, compost mix, tree and shrub planting).

Potential Impact	Typical Recommended Mitigation and Enhancement Measures
Migratory Birds	• Avoidance of construction during the recommended May 1 to July 31 nesting period for southern Ontario. If construction is necessary, nest searches must be completed within three days of clearing.
Stress on biological communities	• Avoid construction impacts during sensitive wildlife periods, such as breeding seasons for various bird species.
Introduction of invasive species through disturbance and material removal	• Restore disturbed areas as soon as possible. • Use only native species for all re-vegetation work. • Monitoring plans should include invasive species. • All soils removed from the project site containing invasive species material to be dealt with in a manner to prevent spreading to a new area.
Interference with ecological corridors and linkages	• Minimize vegetation disturbance in grassland areas to ensure habitat protection.
Physical Impacts	
Slope Stability	• Minimize potential for increased flows to receiving areas with known erosion susceptibility to reduce slope stability issues through implementation of upstream quantity controls. • Where increase of flows may occur or where slope stability issues exist, implementation of slope stability measures to be incorporated in design.

8.3.6 Class EA Projects and Schedule

This Master Plan has been completed in accordance with Approach 2 under the MEA Class EA approach for Master Plans which satisfied Phase 1 and 2 of the planning process. Accordingly, this document provides information to support any future studies or investigations in relation to each of the preferred solutions identified within the Master Plan.

Projects identified as part of the Master Plan are outlined in Table 8.9, along with their respective Class EA schedule. In determining the proposed Class EA schedule for each project, recommendations are provided based on the anticipated magnitude of the preferred alternatives environmental impact, and input received by stakeholders as part of the consultation process. For drainage areas where development may occur and stormwater works are required on development lands (i.e., dry SWM pond, OGS) with no additional land acquisition or perceived impact on the environment, works are noted as Schedule A activities as the SWM facilities and related appurtenances will be addressed as part of the Planning Act.

Upon completion of the Master Plan and subject to the 30-day review period (assuming no Part II Orders or bump up requests), Schedule A, A+, and B projects are pre-approved and may proceed to design and construction subject to approval by Council. During subsequent design and construction, proposed alignments and locations of infrastructure may be refined as necessary, but within the general context of the project as defined in this Master Plan.

The Notice of Completion of this Master Plan is issued on the basis of the identification of the following projects and Class EA schedules.

Table 8.10 Identified Class EA Project and Schedule

Drainage Area	Projects	Class EA Schedule
Various Catchments	Storm Sewer Replacements	Schedule A
Amy Croft Drive	SWM Pond Retrofit, Storm Sewer Replacement, Major Flow Improvements, Municipal Drain Abandonment	Schedule B, Drainage Act
Croft Drive	Major Flow Improvements	Schedule B, Drainage Act
Chelsea Park	Major Flow Improvements	Schedule A
Optimist	Pump Station Replacement, Storm Sewer Replacement	Schedule B
Seasons at the Creek	Pump Station Improvements	Schedule A
Belle River West	New Pump Stations, Major System Improvements	Schedule B
Terra Lou	Major System Improvements	Schedule A
Bacon/Forest Hill	Pump Station Improvements	Schedule B
Russell Woods	Pump Station Improvements, New Pump Station	Drainage Act
Lefaive Drain	New Storm Sewer, Pump Station Replacement, Municipal Drain Abandonment	Schedule B, Drainage Act
Hood and Leffler Drain	Pump Station Improvements, Municipal Drain Enclosure	Drainage Act
Country Walk and Dean Development	SWM Pond Retrofit	Schedule A

8.3.7 Master Plan Filing Procedure and Notice of Completion

Due to the COVID-19 pandemic, an electronic copy of the draft Master Plan document was placed on public record for the mandatory 30 day review period on the Town's website following the publication of the Notice of Commencement (Windsor Star, July 18, 2020). Comments and/or concerns are to be submitted to the Municipality of Lakeshore and Stantec within the 30 day review period (ending August 21, 2020). Anyone who has outstanding concerns relating to Schedule B projects identified, within the 30 day review period may request the Minister of Environment to issue an order to comply with Part II of the EA Act if the concern cannot be addressed. The work undertaken in preparing this report represents the completion of the EA process for the Municipality of Lakeshore Stormwater Master Plan – Phase 1. Subject to approval of the recommendations identified herein, the Municipality of Lakeshore intends to proceed with design and implementation.

8.4 ADDITIONAL RECOMMENDATIONS

In addition to the public and private drainage system improvements proposed in Section 7, the following recommendations were developed to support future drainage system improvements in the Municipality of Lakeshore and increase drainage system resiliency under extreme rainfall events:

1. The Town should consider expanding its sanitary sewer inflow & infiltration reduction program to identify and mitigate significant wet weather flows. Furthermore, RainGuards should be installed at all sanitary manholes where there is a risk of inflow caused by roadway ponding;
2. All stormwater outfalls that are at risk of being submerged under high lake level conditions should be retrofitted with backflow prevention and impervious plugs. Where feasible, pumping should be considered to dewater submerged storm sewer systems;
3. An operation and maintenance schedule for all SWM facilities should be developed and implemented in accordance with all existing pond Certificates of Approval and Environmental Compliance Approvals;
4. A comprehensive storm sewer condition assessment and maintenance program that includes video inspection should be developed and implemented to confirm replacement priorities;
5. The Town should continue to support its camera inspection program of private infrastructure;
6. Opportunities to support continued education and subsidy programs to maintain and improve private drainage systems should be identified (educational videos, information on the Town website etc.);
7. Standard operating procedures for all existing pump stations should be developed;
8. Develop a plan to work with homeowners to reinstate the shallow roadside swales in the Bulcke/Reaume catchment area;
9. Standardized Lake St. Clair design water levels should be developed for new outfalls that account for the concurrent risk of a significant rainfall event occurring under high lake level conditions, in accordance with the WERSMSM;
10. Develop formal pump station design requirements that consider the risk of station failure, include provisions for backup pumps, and address the need for emergency power, where necessary;
11. Development of a comprehensive rain gauge network should be considered as funding opportunities become available. Data from the rain gauge network could be used to direct Town resources to potential problem areas during severe rainfall events. Furthermore, the recorded rain gauge data could be used to better understand, evaluate, and mitigate observed flooding; and
12. Development of a pump station remote monitoring network should be considered as funding opportunities become available. The network would provide Town staff with real-time information such as wet well levels and pump status. The monitoring information would be used during severe events to identify problems such as debris accumulation or pump failure, allowing staff to respond promptly and mitigate potential flooding.

9.0 REFERENCES

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