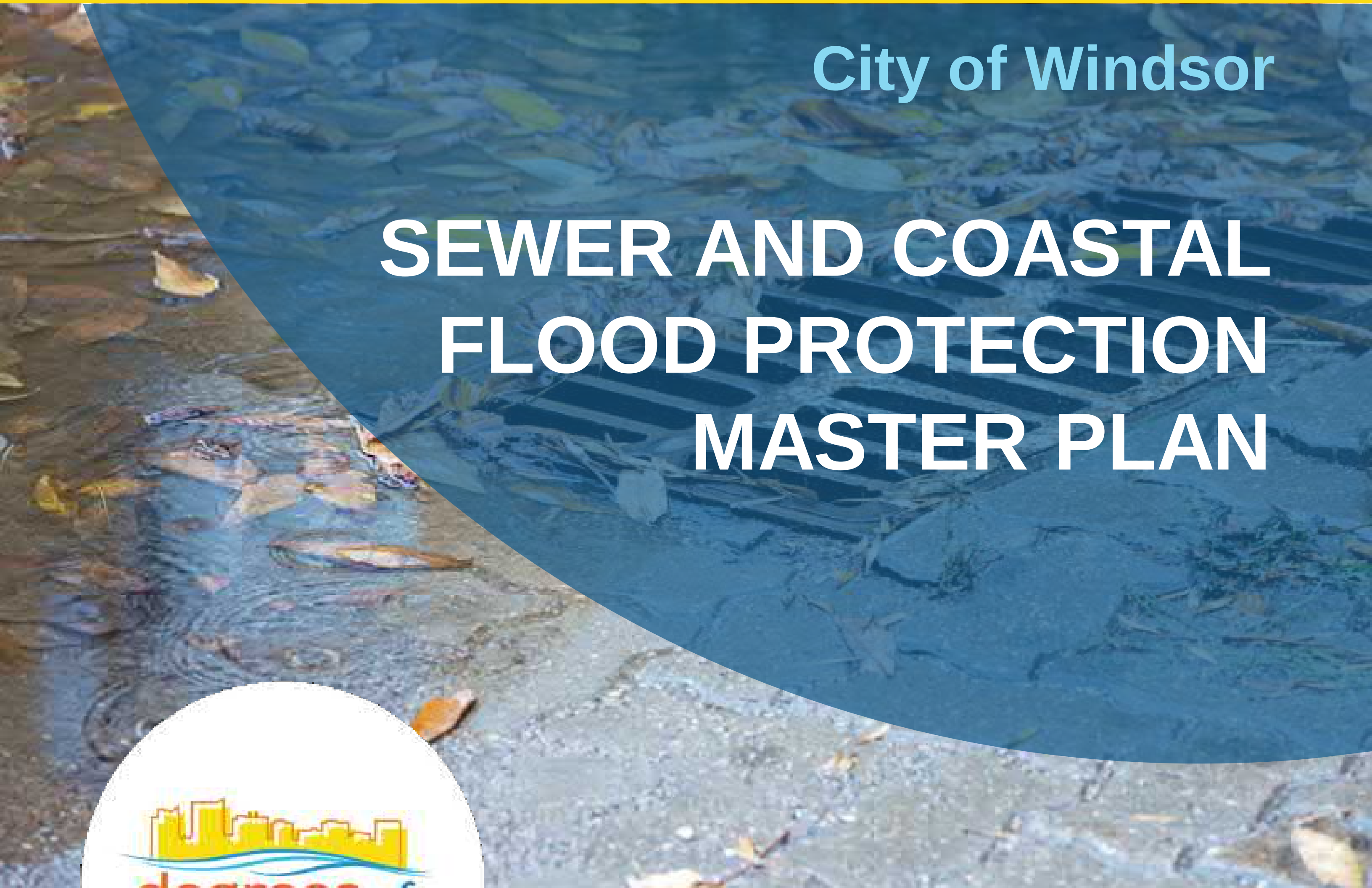


City of Windsor

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Master Plan Report

Project No. 17-6638

November 2020

PREPARED BY:

DILLON CONSULTING LIMITED AND AQUAFOR BEECH LIMITED

Laura Herlehy, P. Eng
Project Engineer - Dillon Consulting Limited

Chris Patten, P. Eng
Project Engineer - Dillon Consulting Limited

Samir Dhanvantari, P. Eng.
Water Resources Engineer – Aquafor Beech Limited

Karla Kolli
Environmental Planner - Dillon Consulting Limited

CHECKED BY:

DILLON CONSULTING LIMITED

Ian Wilson, P. Eng
Water Resources Engineer - Dillon Consulting (City of Windsor)

AQUAFOR BEECH LIMITED

Dave Maunder, P. Eng
Project Manager – Aquafor Beech Limited

Flavio Forest, P. Eng,
Project Manager - Dillon Consulting

Identification	Date	Description of issue and/or revision
Final Report – Public Review	11/20/2020	

Preface

In October 2017, Mayor Dilkens presented an 8-Point Plan to address flooding in Windsor. An important facet of the Mayor's 8-point plan was to expedite completion of the City's Sewer Master Plan. Work began on the Sewer and Coastal Flood Protection Master Plan in the spring of 2018 and was recently endorsed by City Council in July of 2020.

Development of the Sewer and Coastal Flood Protection Master Plan consisted of a comprehensive study with the objective to understand the causes and locations of basement, surface and coastal flooding. The project that lasted over two years had numerous consultants and professional staff overseeing its development. The public was consulted throughout the process and included: 2 Public Information Centres with over 250 attendees, 15 meetings with applicable property owners and agency groups, 590 resident interactions at pop-up events, 7,100 visits to the City's "Weathering the Storm" website (weatheringthestorm.ca); distribution of 3 newsletters and completion of the "Partners for Action" survey by 306 residents.

The development and endorsement of the Sewer and Coastal Flood Protection Master Plan represents a momentous achievement in the City's ongoing efforts to reduce flooding in the City of Windsor. For Administration, City Council, and residents in the City of Windsor, the Sewer and Coastal Flood Protection Master Plan provides an achievable blueprint that identifies and prioritizes improvements to City infrastructure (public property) as well as identifies actions homeowners can take to reduce their risk of flooding (private property).

The recommendations contained in the Sewer and Coastal Flood Protection Master Plan provide a roadmap to follow over the next 50 years or more. The plan consists of a mix of both short-term and long-term solutions that will serve to reduce the impact and risk of flooding. In total, there are approximately $5 billion dollars worth of solutions identified in the plan. While the cost may seem overwhelming and unattainable, it is important to recognize that these improvements are not intended to be completed overnight but rather to be undertaken over many years within approved capital budgets while leveraging funding support from upper levels of government. In the future, having the Sewer and Coastal Flood Protection Master Plan will allow the City to quickly rank and bundle qualifying projects together and be ready to apply for any announced infrastructure programs.

The devastating impacts of climate change are being experienced more frequently in our community and around the world. However, each component of the plan – once completed – will further reduce the risk of flooding within the City of Windsor. The Sewer and Coastal Flood Protection Master Plan will guide the decision making of this and future generations of City Administration and City Councillors as they look to continue to mitigate the impact of climate change and to reduce the risk of basement, surface and coastal flooding within the City of Windsor.

MARK WINTERTON P.ENG
City Engineer and Corporate Leader for Environmental, Transportation and Transit
Corporation of the City of Windsor

Table of Contents

FIGURES

TABLES

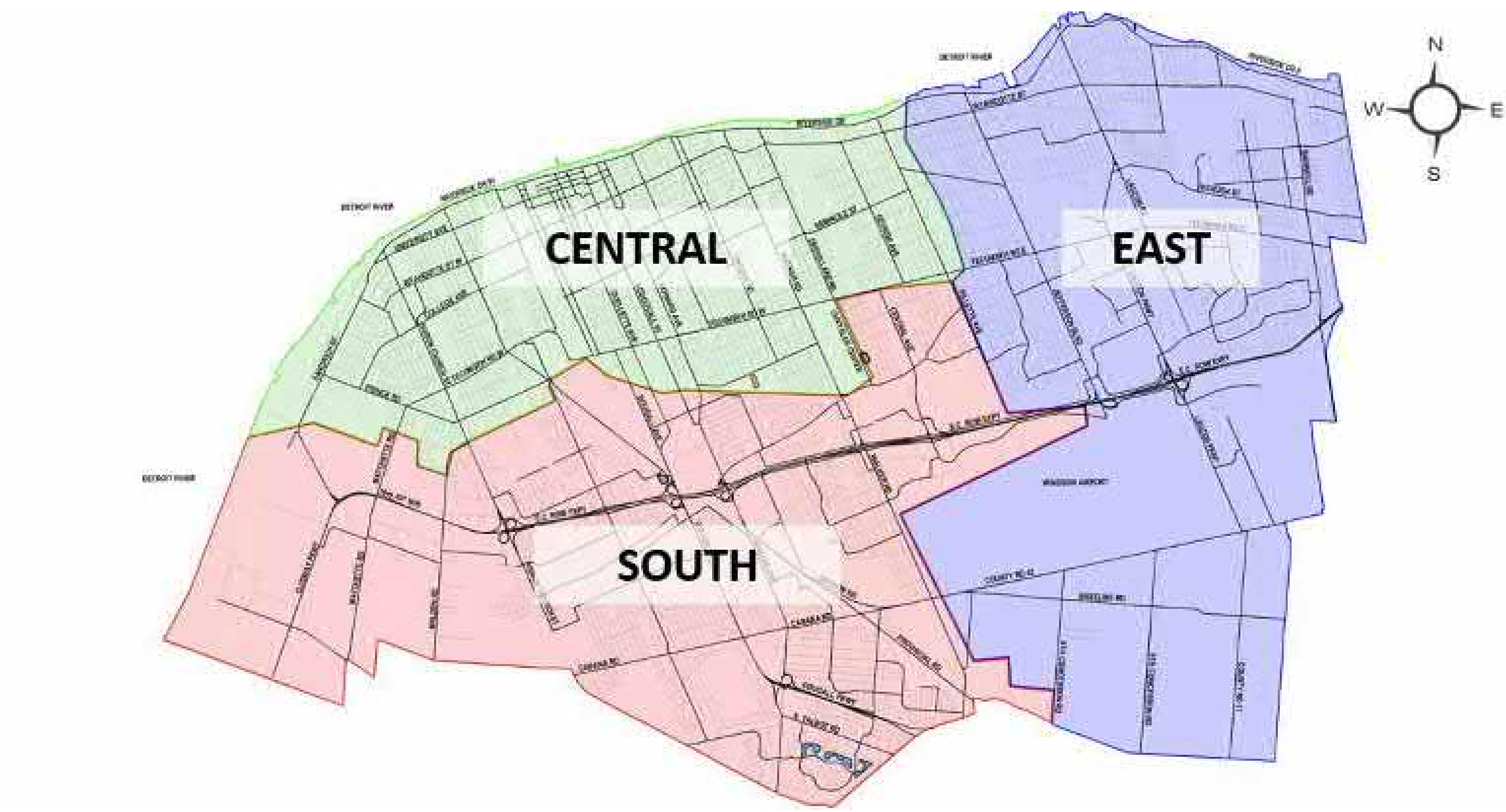
APPENDICES

Sewer and Coastal Flood Protection Master Plan

The City of Windsor has experienced several significant storm events in recent years that have resulted in widespread basement and surface flooding throughout the City. In addition to these events, current high Lake St. Clair and Detroit River Water Levels are putting strain on the municipal sewer system and posing risks to property owners in coastal and low lying areas. The City has undertaken this master plan to understand the causes of flooding, identify and evaluate solutions, complete high level design and cost estimates for proposed infrastructure improvements, and to provide an implementation strategy for the recommended solutions.

This Sewer and Coastal Flood Protection master plan follows the Municipal Class Environmental Assessment process which provides the framework for the public to have an active role in the development of the solutions.

This executive summary document is intended to provide a summary of the findings and final recommendations of the City's master plan. Further details will be available in the Master Plan Environmental Assessment report and appendices.



Report Overview

Book 1	• Master Plan Report • Acronyms, Abbreviations, Definitions • Appendix A - Background Literature Review
Book 2	• Appendix B – Stakeholder Consultation Summary Report and Consultation Documentation
Book 3	• Appendix C – Short Term Solution Recommendation Report • Appendix D – Technical Volume 1: Sewer Model Development and Existing Conditions • Appendix E – Technical Volume 2: Flood Reduction Solutions Alternative Development
Book 4	• Appendix F – Technical Volume 3: Functional Design, Estimated Cost and Implementation • Appendix G –Evaluation Matrices and Potential Effects and Proposed Mitigation Summary
Book 5	• Appendix H – Natural Environment Assessment • Appendix I – Archaeological Assessment Stage 1 Report • Appendix J – Geotechnical Desktop Review

Master Plan Objectives

Master Plan Section 1.0

- Understand the causes of basement, surface, and coastal flooding.
- Identify areas vulnerable to basement, surface, and coastal flooding.
- Identify and evaluate short-term and long-term solutions to reduce the risks and impacts of this flooding.
- Identify improvements to City infrastructure.
- Identify actions homeowners can take to reduce their risk of flooding and reduce strain on the City's system.
- Develop preliminary designs and cost estimates for the recommended infrastructure improvements.
- Recommend an implementation strategy.

Community Engagement

Appendix B

To keep the community informed of this study and to obtain valuable feedback regarding the study's recommendations, an enhanced level public engagement was implemented. The master plan's engagement plan included;

- Several popup events
- Public information centres
- Flooding Survey for residents
- Project website (weatheringthestorm.ca)
- A Stakeholder Advisory Committee (SAC)
- Engagement with regulative agencies, first nations and adjacent municipalities.

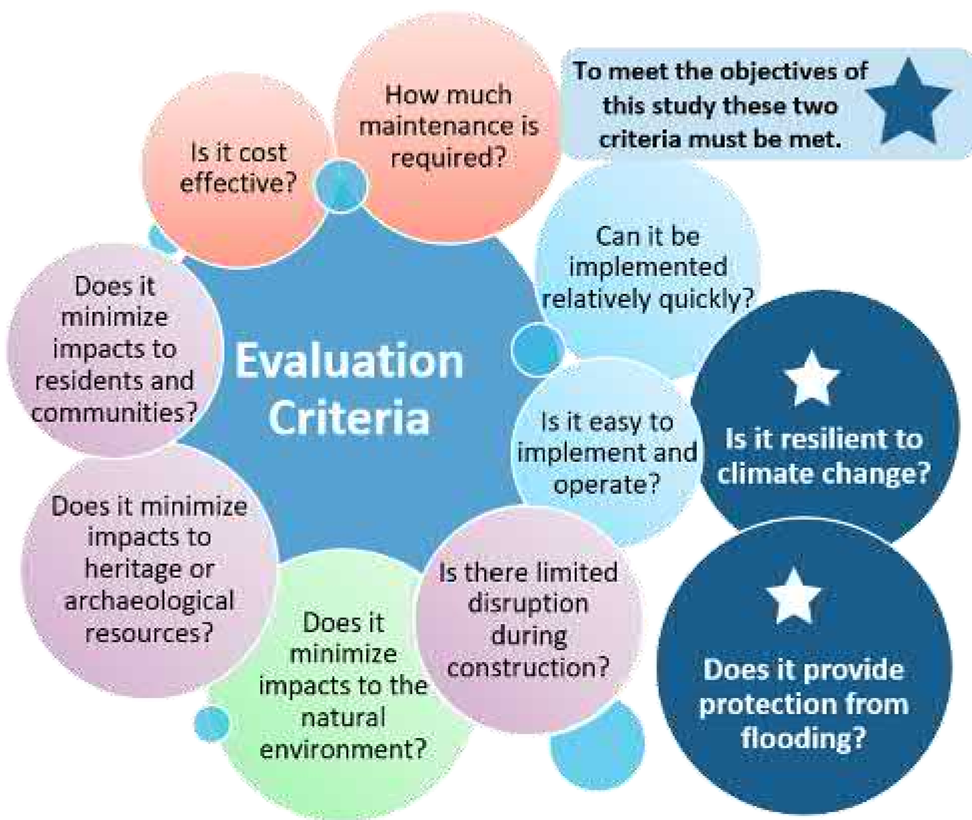
Evaluation of Alternative Solutions

Using the City-Wide Sewer Computational Model, various alternative solutions were developed to meet the established level of service.

Alternative solutions were evaluated following the Municipal Class Environmental Assessment process, comparing each solution based on a number of evaluation criteria.

The recommended solutions summarized in this document represent the preferred solution determined through this process.

**Master Plan Section 6.0
And Appendix G**



Problem Identification

Appendix E

A number of key principles were considered in the identification of problem areas and mitigation of flood risk:

- More stringent design criteria should be used to mitigate flooding for vulnerable areas;
- Solutions recognize that residents and property owners play an integral part in achieving the goals of this initiative, and
- Solutions cannot rely on only one level of intervention and need to include all components of the drainage system.

Level of Service is a benchmark used to determine where problem areas exist and determine where improvements are needed to mitigate the risks of flooding.

Level of Service

Level of Service: 1:100 Year Storm (85 mm over 4 hours):

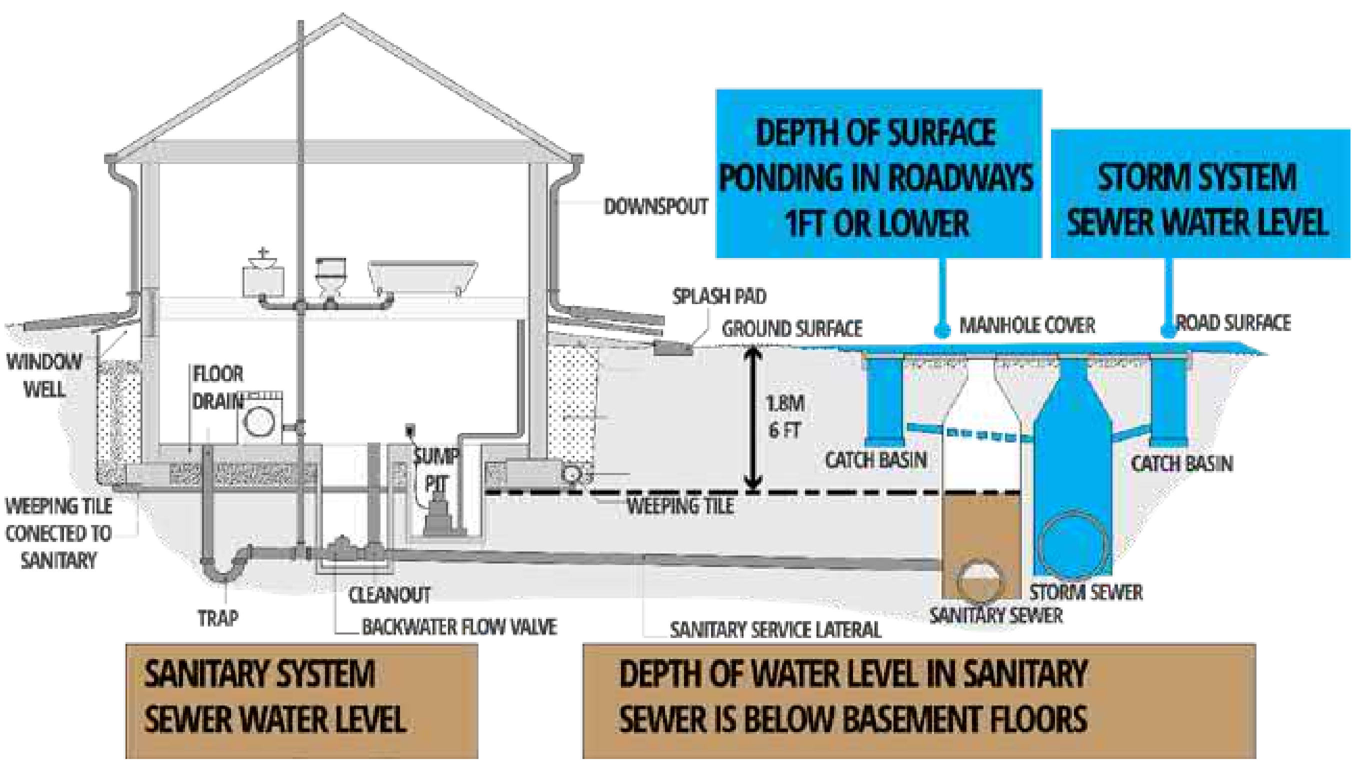
Sanitary System: Sewer surcharge below typical basement floor level (1.8 m (6.0 ft) below ground).

Storm System: Limit surface (roadway) ponding to less than 30 cm (1 ft).

Coastal Flood Protection Infrastructure: Protect lower-lying inland areas from impacts of high lake levels based on projected high lake level elevation (176.50 m).

Enhanced Level of Service: "Climate Change" Storm (120 mm over 4 hours):

More severe storm criteria were used for **major roadways** and **vulnerable areas**.
Vulnerable areas include schools, hospitals, long term care centres, emergency services, evacuation centres.



Recommended Solutions

Appendix E

Flooding solutions are made up of a combination of various levels of improvement. Each level represents a part of the City's drainage system, these include:

Increase Downstream Outlet Capacity
(Increased treatment capacity or larger outlets to receiving water bodies)

Source Control and Private Property Measures

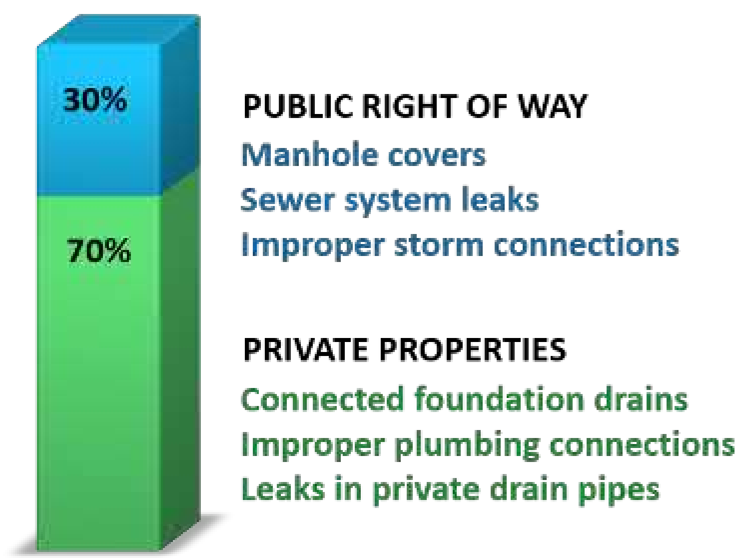
Coastal Flood Protection
(Overland flood barriers and backflow prevention)

Improve Sewer System Conveyance and Storage Capacity
(Large sewer pipes and storage facilities)

Key Assumptions:

1. The effectiveness of **solutions rely on a partnering approach** between private property owners and the City. **Integration of private property measures and public infrastructure upgrades** are required to reduce the risk and impacts of flooding.
2. Solutions will **reduce, but not completely eliminate flooding risks**.
3. The infrastructure improvements are expected to require an **extended period of time to implement** due to the scope and costs. The City will incorporate these improvements into their asset management plan and implement projects in conjunction with other initiatives.
4. The City will need to enhance their current operation and maintenance programs for a new and larger infrastructure.
5. Recommended solutions do not eliminate the need for property owners to implement property protection measures and plumbing improvements.

Sources of Inflow and Infiltration into the Sanitary System



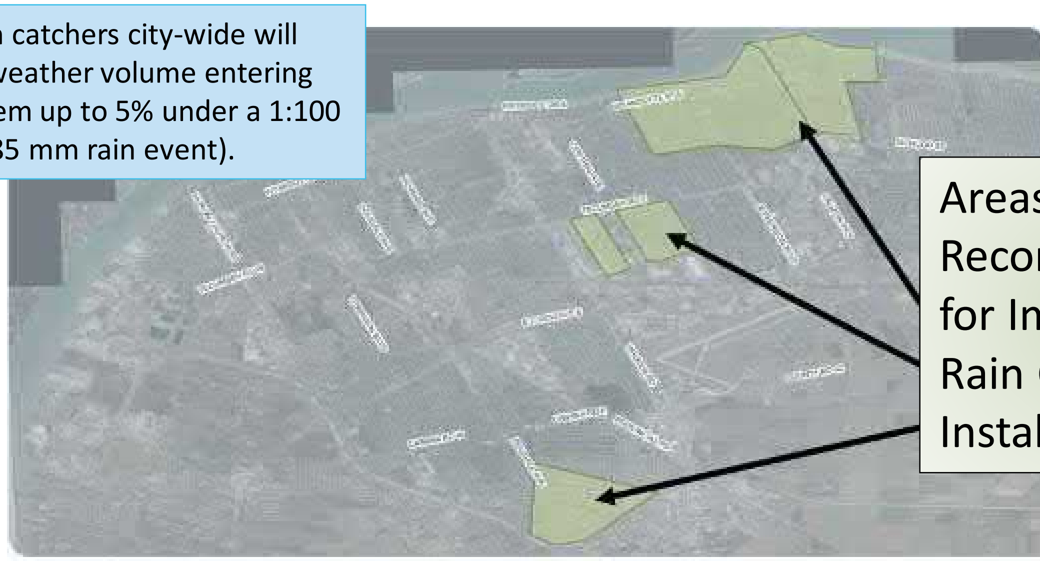
Source Control: City Projects

- ✓ Pilot Projects to measure the benefit of Downspout Disconnection, Foundation Disconnection and Low Impact Development (LID) Measures.
  - ✓ Confirm the criteria and assumptions used in the development of these solutions are valid and that measurable reductions in inflow are observed.
- ✓ Updating and implementing new City by-laws:
  - ✓ City-Wide Downspout Disconnection By-Law (By-law 26-2008)
  - ✓ Foundation Drain Disconnection By-Law
- ✓ Updating the City's Development Standards to reflect a new flood mitigation criteria.
  - ✓ Revise a new sewer design criteria and mechanisms to control excess inflow.
  - ✓ Developers must demonstrate that new builds will not impact downstream areas.
  - ✓ Mandatory sewage ejector pumps for new development.
  - ✓ Develop Standards for the implementation of LIDs.
- ✓ Enhanced Educational Program
  - ✓ Homeowner and Contractor Information Sessions.
  - ✓ Develop and Distribute Education Materials and Guidelines.
  - ✓ Continue Project Website: Weatheringthestorm.ca.
- ✓ Implementing Low Impact Development (LIDs) measures, such as:
  - ✓ Exfiltration trenches (Example: Matthew Brady Construction).
  - ✓ Bioswales, Rain Gardens and Stormwater Retention Features.
  - ✓ Permeable Pavements (Example: Tranby Park Parking Lot).
- ✓ Installing rain catchers on manholes in high priority areas and eventually all manholes.
- ✓ Placement of Backflow Prevention Devices, to:
  - ✓ Protect the City's Sewer System from high river levels.
  - ✓ Place at storm and sanitary sewer system interconnections.

Appendix C

Manhole Rain Catcher

Installing rain catchers city-wide will reduce wet weather volume entering sanitary system up to 5% under a 1:100 year storm (85 mm rain event).



Areas Recommended for Immediate Rain Catcher Installation

Source Control:
Private Property Improvements

In order to meet the level of service and to mitigate the risks of flooding property owners will need to take an active role to mitigate their property's strain on the municipal system.

Basement Flooding Solution

- ✓ **Foundation Drain Disconnection**
- ✓ Correct Improper Connections
- ✓ Backflow Prevention Valves

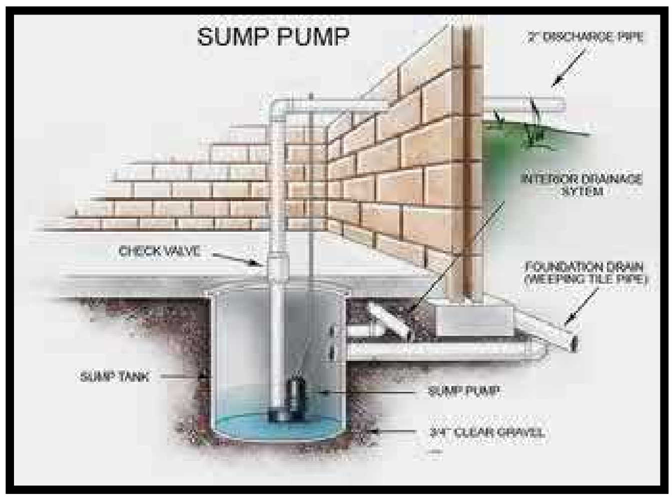
Surface Flooding Solution

- ✓ **Downspout Disconnection**
- ✓ Improve Lot Grading
- ✓ Low Impact Development (LID) measures, such as:
  - ✓ Rain Barrels and Rain Gardens
  - ✓ Seal window wells
  - ✓ Permeable pavements

These measures are **key** components of the overall recommended solution strategy. The City will need to partner with property owners to meet flood reduction goals.

Appendix E

Private property measures and property owner cooperation are an integral part of the comprehensive recommended solutions. Foundation drain disconnection and downspout disconnection will have a benefit to the City's system if implemented City-wide.



Is it recommended that the City move forward with the following:

- Implement necessary By-Law to provide the framework for a City Wide policy.
- Coordinate with neighbouring municipalities to implement source control measures (Town of Tecumseh and Town of LaSalle).
- Complete Pilot Projects, whereby the City shall implement this bylaw in an isolated area, which will be monitored and assessed to confirm the benefit of these measures.
- Implement a subsidy program.
- Develop a program to inspect and enforce compliance with the new by-law.
- Develop an Approved Contractor List for residents.

Sewer System Conveyance and Storage Improvements

Basement Flooding Solutions

- ✓ Enhanced sewer separation strategy for combined sewer areas (Downtown/Central Area and Fontainebleu Area).
- ✓ Construction of large sanitary trunk sewers to provide underground storage and improve flow conveyance:
  - 47 km of sanitary sewer upgrades in East Windsor area.
  - 8 km of sanitary sewer upgrades in South Windsor area.

Appendix E and F

Surface Flooding Solutions

- ✓ Large storm trunk sewers to provide underground storage and improve flow conveyance:
  - 40 km in East Windsor area and 9 km in South Windsor area.
  - 17 km of trunk storm sewer in Central Windsor area.
- ✓ 3 New and 4 Upgraded stormwater management (SWM) ponds:
  - Little River Golf Course New SWM Pond.
  - Dougall Ave. and Howard Ave. SWM Ponds.
  - Modifications to ponds serving Southwood Lakes
  - Increase size of the Central Ave. SWM Pond.
- ✓ Underground storage systems under parks, parking lots, and commercial properties.
- ✓ Construction of Low impact development (LID) measures:
  - Tranby Park Permeable Parking Lot, Matthew Brady Exfiltration Trenches.

Downstream Outlet Capacity Improvements

Basement Flooding Solutions

- ✓ Little River Pollution Control Plant:
  - Future plant expansion to provide service for population growth and to provide some wet weather treatment capacity.
  - In the interim, improve the existing bypass outlet at the treatment plant (Pontiac Pumping Station improvements).
- ✓ Lou Romano Water Reclamation Plant:
  - Construct a Retention Treatment Basin Facility and Sandwich Street Combined Relief Trunk Sewer.
    (Combined Sewer Overflow Control in the Riverfront Area, West of Caron Avenue, Class EA).

Appendix E and F

Surface Flooding Solutions

- ✓ Improved or construct a new storm sewer outlets to the Detroit River.
  - Detroit St., Bruce Ave., Cameron St., Albert Rd., Marentette Ave.
- ✓ New or improved stormwater pumping station (PS) capacities including emergency back-up power.
  - New St. Rose Ave. PS (St. Rose Park) –Improved outlet capacity and provide flood relief to drainage area.
  - Improve St. Paul PS – Pumping Station Expansion to provide relief to drainage area.
  - East Marsh PS – Maintain current capacity for a reduced drainage area.
  - Improve Ford Blvd. PS (Reaume Park) – Upsize pumps to improve resiliency of the drainage area.
  - Improve Drouillard PS (Cadillac Park) – Replace existing pumping station with a new pumping station to improve flooding along Drouillard Rd.
  - Improve Lakeview PS (South Rendezvous Park) - Replace existing pumping station with a new pumping station to improve the Blue Heron Pond outlet.
  - New Pump Station at Chappell Ave. – Required to drain the storm system after rain events.

Coastal Flood Protection

The purpose of Coastal Flood Protection:

- ✓ Protect in-land areas from high lake/river levels.
- ✓ Protect low lying residents, who live North of Riverside Dr., from overland surface flooding on Riverside Dr.
- ✓ Mitigate inflow of lake/river water into the municipal storm sewer system.
- ✓ Utilize existing private property grades to meet minimum protection levels.
- ✓ Prevent backflow of high lake levels into the sanitary and storm sewers systems.

Appendix E and F

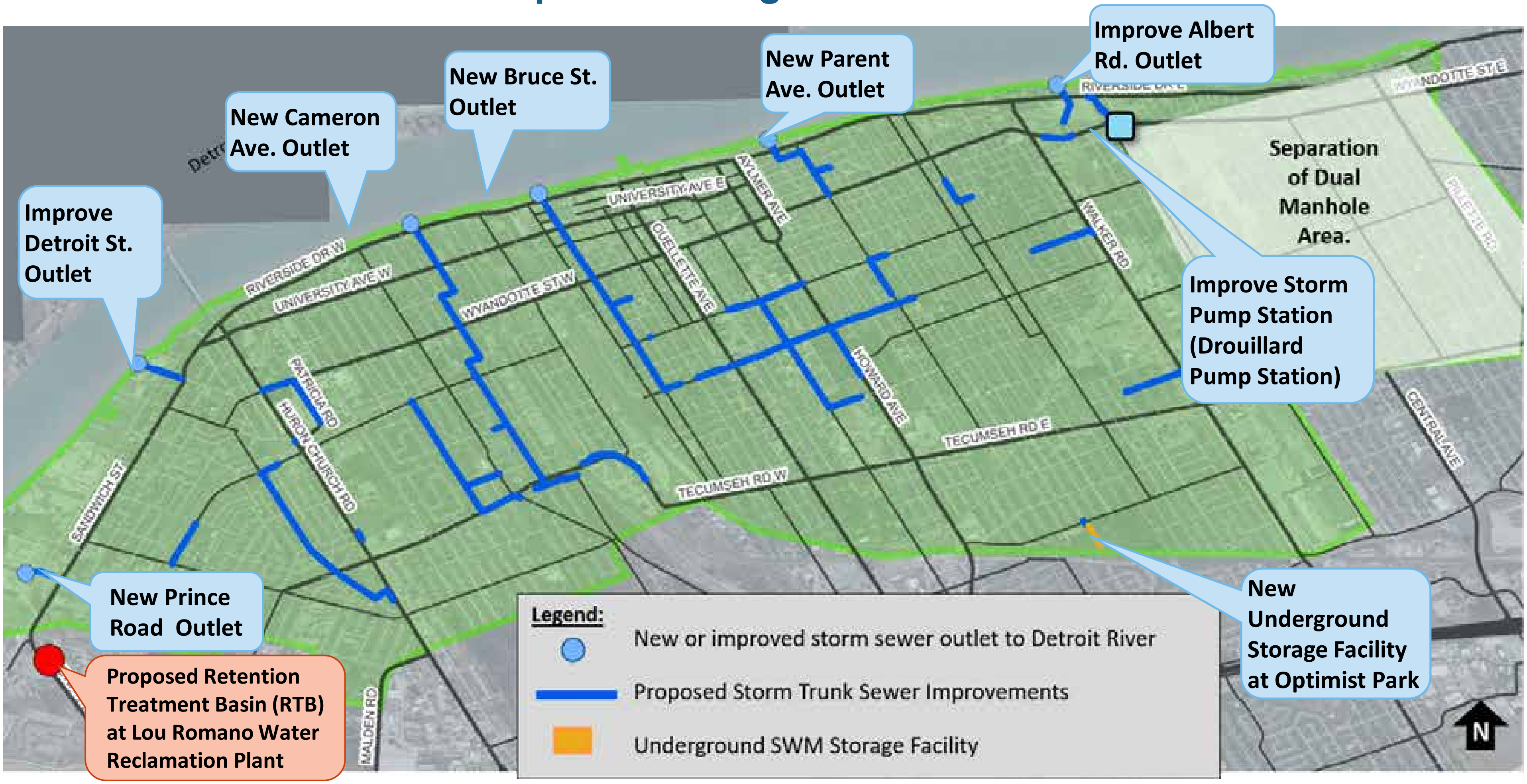
The recommended landform barrier will be an earth berm built to an elevation of **176.50,** located along the North or South boulevard of Riverside Drive East. Construction of the berm will require:

- Acquisition of property or an easement along the Riverside Drive East right of way.
- Where properties are **above** the established protection elevation, the earth berm will not be required. The City will work with these property owners to incorporate lot elevation as part of the property's legal status.
- Maintenance of acceptable driveway grades for vehicle and barrier free access.
- Storm sewers and catch basins to capture local drainage north of the berm.
- In Area 1: Riverside Drive East, Ford Blvd. to St. Rose. Ave., berm construction will be integrated into the reconstruction of Riverside Drive (Vista Phase 2A Construction Limits).
- In Area 2: Riverside Drive East, St. Rose Ave. to Riverdale Ave., much of the berm construction has been completed as part of the recent Riverside Vista Phase 1 construction.
- In Area 3: East Riverside Area, Riverdale Ave. to East City limits (Ganatchio Trail), construction will require infill where the existing berm or intersection streets do not meet minimum protection grades.

Two flood protection elevation scenarios have been elevated based on the existing regulatory flood protection levels and recent climate change projections.

Based on the environmental assessment, the barrier elevation of 176.50 was found to be preferred. The landform barrier elevation of 176.80 would have significant impacts on private property would require extensive surface area to construct.

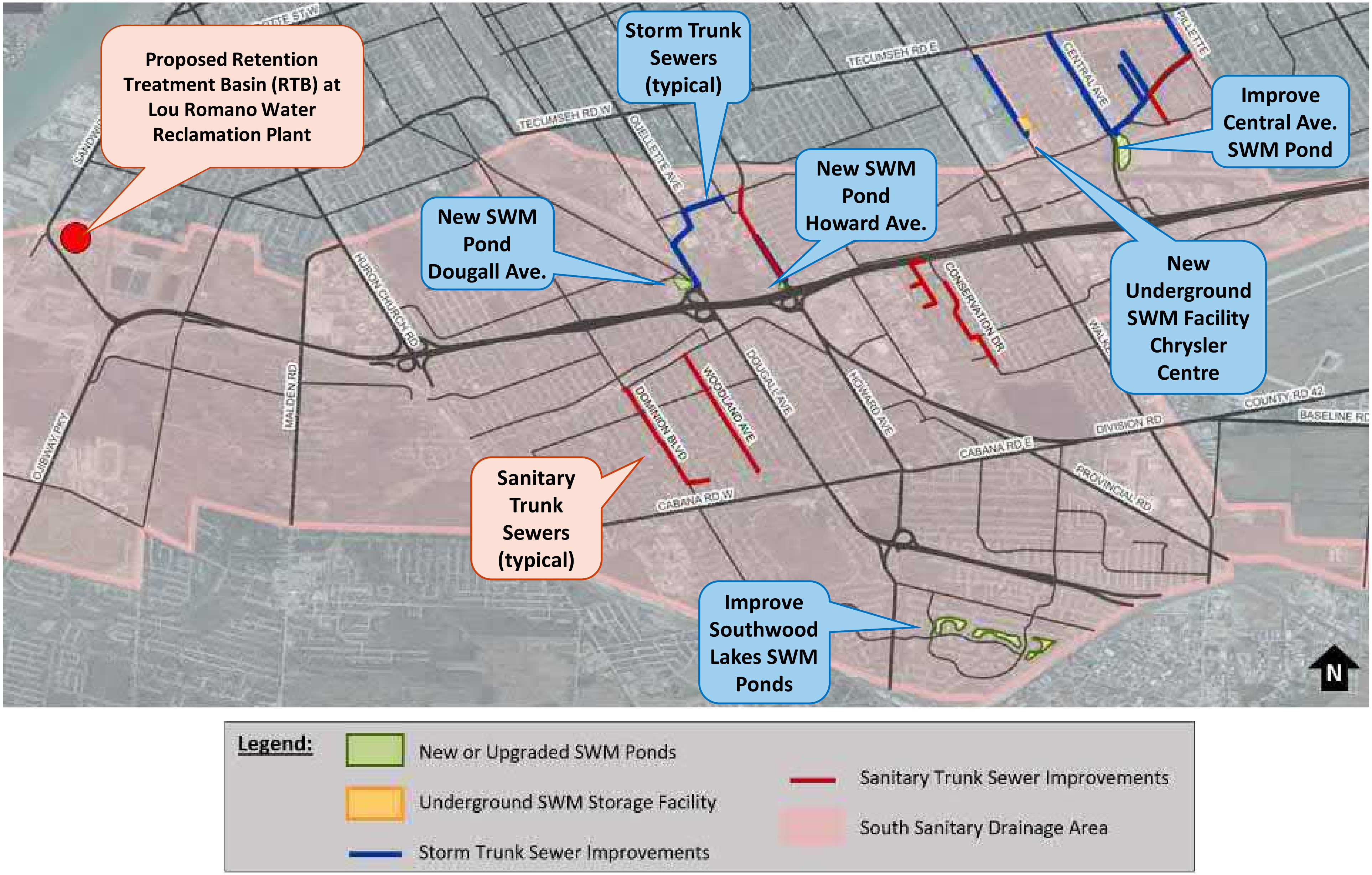
Recommended Infrastructure Projects
Central Windsor Area – Sewer Separation Program



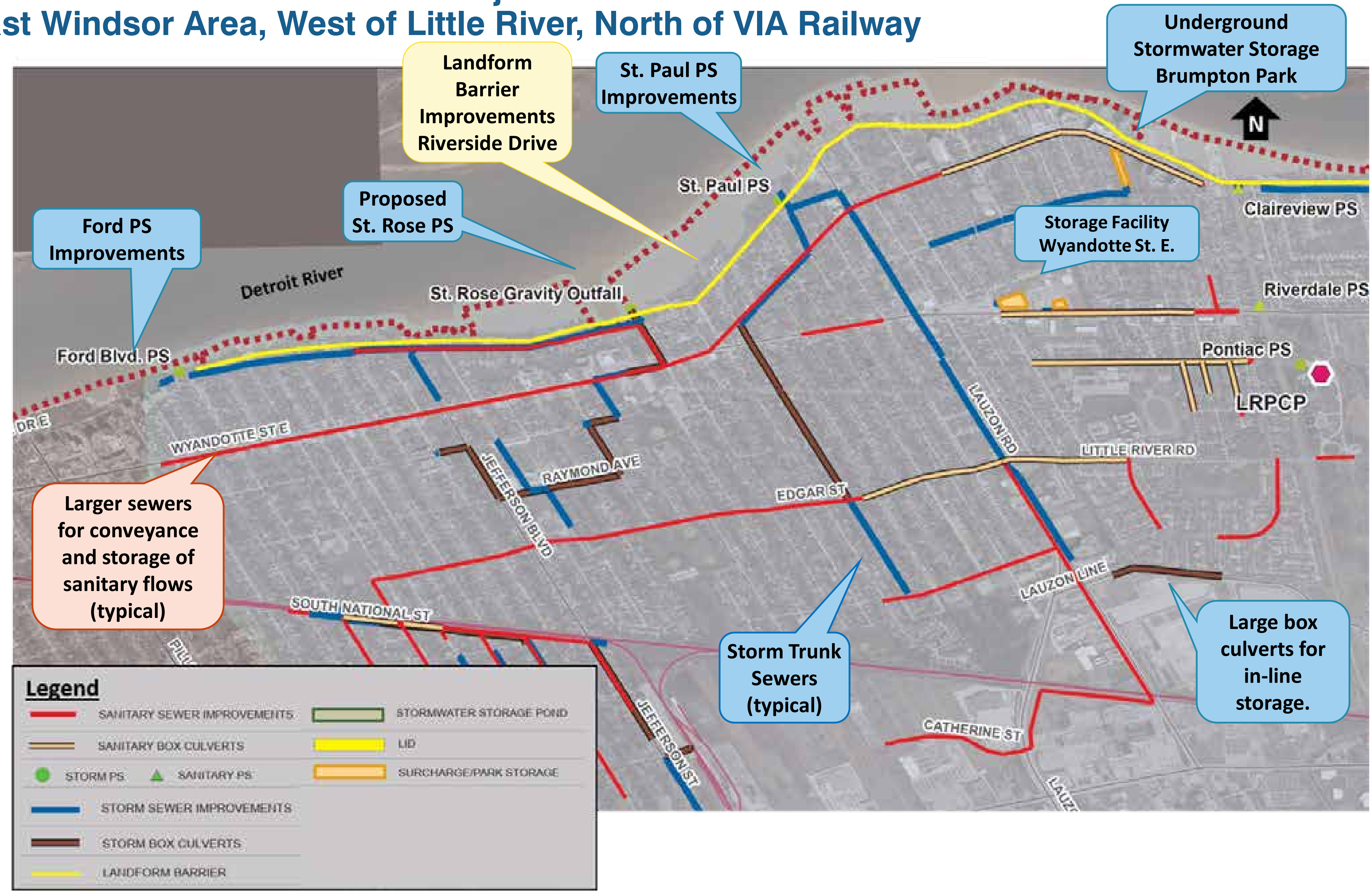
These improvements include the construction of 4 new storm sewer outlets and improvement to 2 existing outlets. This solution requires the direction of both municipal and private property drainage, such as drainage from roofs, front and rear yards and alleys, to the storm sewer system and out of the combined sewage system.

In addition, a Retention Treatment Basin (RTB) is proposed at the Lou Romano water reclamation plant, which will reduce the frequency of CSOs and better manage wet weather inflow at the treatment plant.

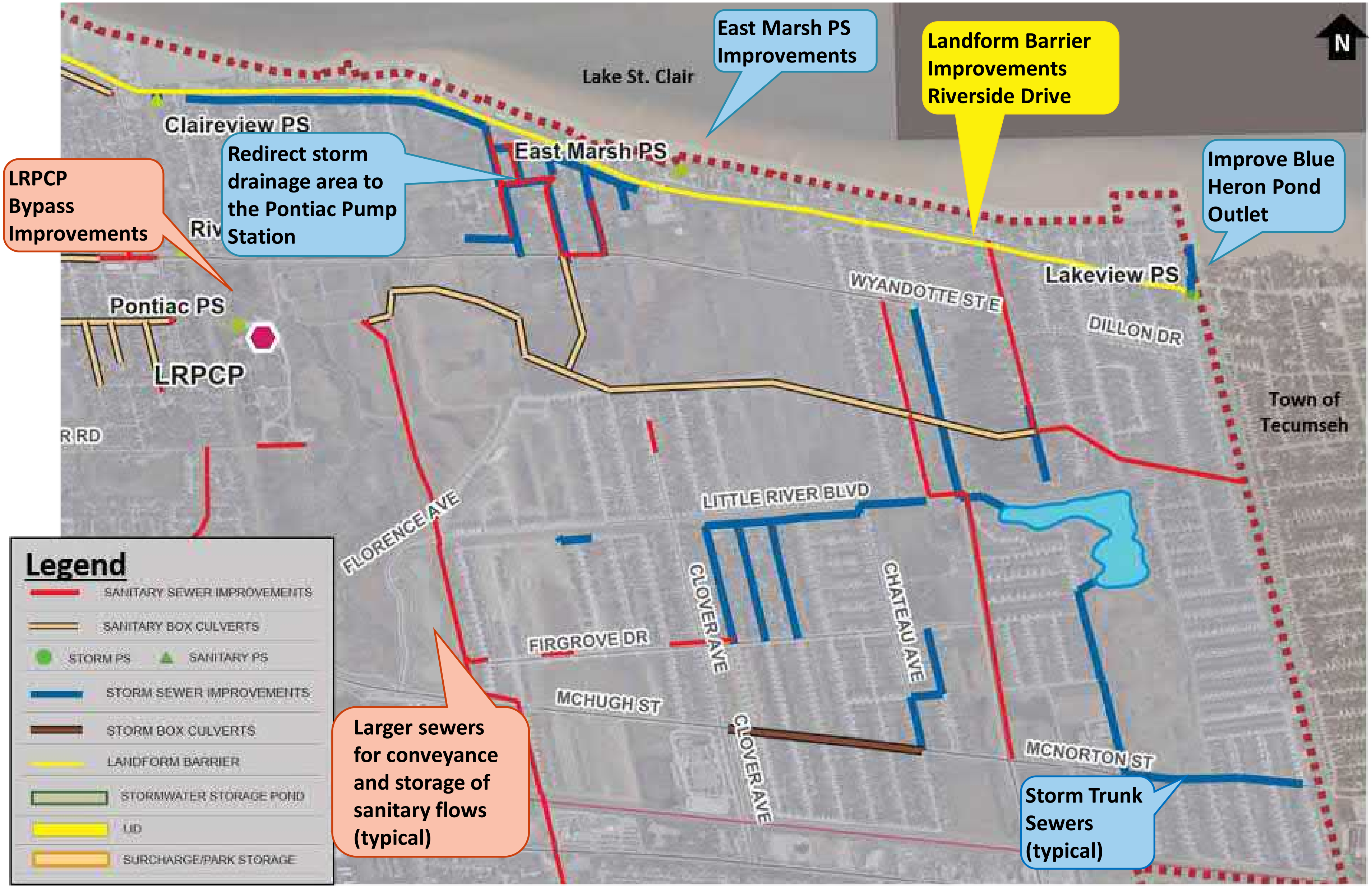
Recommended Infrastructure Projects South Windsor Area



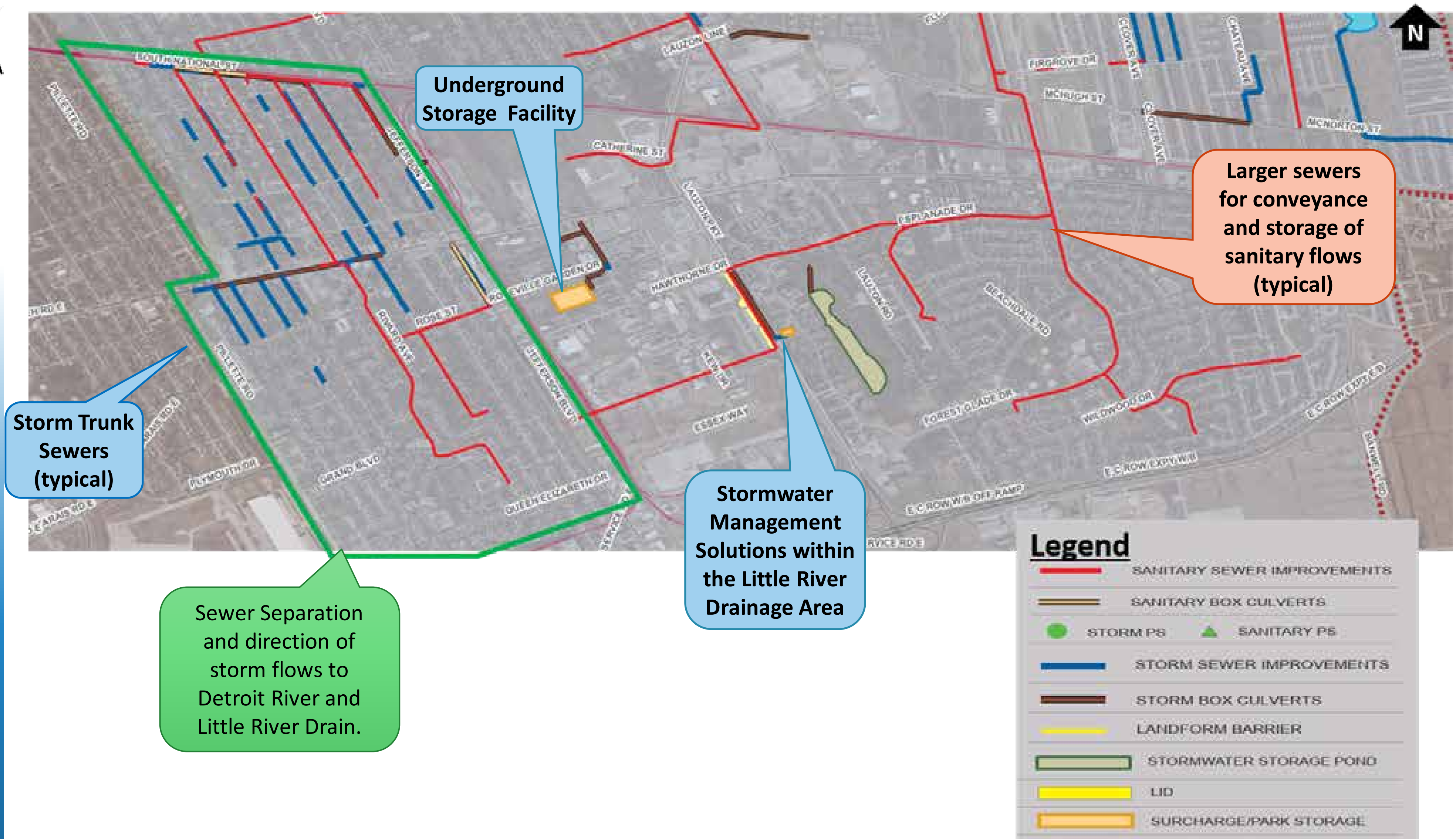
Recommended Infrastructure Projects
East Windsor Area, West of Little River, North of VIA Railway



Recommended Infrastructure Projects
East Windsor Area – East of Little River, North of Via Railway



Recommended Infrastructure Projects
East Windsor Area - South of VIA RAIL



Estimated Construction Costs

Source Control Measures and Private and Public Improvements

Solution Component	Sub-Total Costs
Private Property Programs:	**-**
City-wide Foundation Drain Program	**$950M**
City-wide Downspout Disconnection Program	**$50M**
Public Infrastructure Improvements	**-**
Sanitary Manhole Sealing Program	**$0.5M**
Sewer Backflow Prevention Device Program Allowance	**$8M**
Sub-Total	**$1,009M**

Sewer System and Downstream Improvements

Solution Component	Sub-Total Costs
Conveyance and Storage	
Sanitary System Improvements	**$3,040M**
Storm System Improvements	**$883M**
Coastal Flood Protection	
Barrier Landform and Sewer Backflow Protection	**$9M**
Outlet Capacity	
LRWRP - Retention Treatment Basin	**$70M**
LRPCP - Improved Bypass	**$5M**
New or Upgraded Stormwater Pumping Stations	**$40M**
Grand Total	**$4,047M**

Appendix F

Costs Are in Million of Dollars.

Total Summary of Construction Costs

Recommended Solutions	Central Windsor	South Windsor	East Windsor	Total Costs
Grand Total	$3,475M	$429M	$1,158M2	**$5,056M**

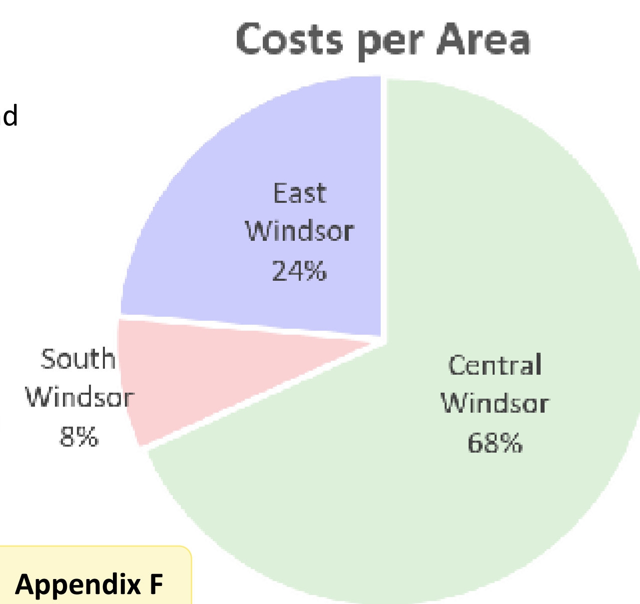
Improvements require significant investment however it is important to recognize these improvements are meant to be implemented over the next 50+ years.

Improvements will be integrated into the City's Capital Works program and asset management plan.

As new infrastructure is implemented necessary operation and maintenance costs should be incorporated into the City's Annual Capital Works budget.

Estimated Construction Cost Assumptions

- These high level budgetary costs shall be used for capital works planning however they are not based on detailed design of proposed infrastructure.
- Cost estimates are based on 2020 construction prices and exclude applicable taxes.
- Construction cost estimates are Class D Estimates and a +30% contingency has been added.
- An allowance of 20% has been included for engineering including design and site construction observation.
- Landform barrier estimates assume that the flood protection will be provided with an earth berm only. Flood protection measure estimates do not include costs for walls, partial walls or mechanical gate structures.
- Construction costs includes full road reconstruction of ensure City.
- Storm sewer improvements includes an allowance to implement Low Impact Development (LID) measures. The type of LID suitable for each project will need to be evaluated on a site by site basis.
- Construction costs exclude
  - Utility relocation.
  - Land acquisition, land appraisal, legal costs, and expropriation costs.
  - Additional studies or additional site environmental assessments.
  - Demolition of existing buildings.
  - Fees associated with agency reviews, permits, and approvals.
  - Costs for annualized maintenance of identified improvements has not been included in the construction cost estimates.
  - Phasing and staging works have not been included.



Appendix F

Implementation

To assist City administration in planning and scheduling recommended solutions, projects have been assigned a priority level based on various criteria. Projects that are already funded or are required to facilitate source control or private property improvements are considered immediate. The remaining projects were ranked (High, Medium and Low), using a ranking system developed to score projects based on the below criteria.

- **Condition of Existing Sewers**
- **Flood Reduction Effectiveness**
- **Emergency Access**
- **Cost Efficiency**
- **Reduction of Combined Sewer Overflows (CSOs)**
- **Access to Vulnerable Areas**

It is recommended that the City continuously review and re-evaluate the prioritization list, especially as it relates to future climate change projections, and how the list overlaps with other road/capital projects or maintenance programs.

It is important to note that public infrastructure improvements are only one part of the comprehensive solution to mitigate flooding and that the implementation of private property source control and protection measures are critical in achieving the established level of service. Continuous sewer system monitoring and modelling analysis will be required to confirm that the anticipated the benefit is achieved.

As projects and source control measures are implemented, the risk of flooding will be reduced.

Upcoming Programs and Construction Projects (0-8 years)

- ✓ Completion of various ongoing programs (Inflow and Infiltration reduction program, basement subsidy programs, etc.).
- ✓ Sealing manhole covers in low lying areas.
- ✓ Determining how to fund stormwater projects (Stormwater Financing Study).
- ✓ Prepare and facilitate an Enhanced Educational Program to educate the community on measures residents can do in their home.
- ✓ Updating the City's Development Standards Manual.
- ✓ Implementing Pilot Projects, Sewer Monitoring and Evaluation of Solutions to test the benefit of recommended source control measures.
- ✓ Storm Sewer System Improvement in Riverside Area funded by Disaster Mitigation and Adaptation Fund (DMAF), see below.

Disaster Mitigation and Adaptation Fund - Round 1

- Little River Pollution Control Plant Overflow Improvements.
- St. Paul and East Marsh Pumping Station Improvements.
- Brumpton Park Stormwater Management Improvements.
- Riverside Vista Reconstruction -Phase 2A: Large storm trunk sewer and landform barrier (2020-2024).
- Storm sewer improvements along Belleperche Place, Cedarview St., Matthew Brady Blvd., Belle Isle View Blvd., Eastlawn Ave. and within the East Marsh Drainage Areas.

The following projects have also been identified as 'immediate' because they must be constructed in conjunction with the DMAF funded projects listed above.

- St. Rose Ave. and Ford Blvd. Pumping Station Improvements.
- St. Rose Ave. Storm and Sanitary Trunk Sewers.
- Sanitary Trunk Sewer along Riverside Vista Phase 2A project limits.

Appendix F

Basement Flooding

Project Prioritization Central/Combined Area

Priority	Trunk Storm Sewer Improvement and Enhanced Sewer Separation
Immediate Priority (0 – 10 Years)	Lou Romano Water Reclamation Plant Retention Treatment Basin and Sandwich St. Sanitary Sewer Prince Road Storm Trunk Sewer Outlet and Pump Station at Chappelle Ave.
High	Cameron Ave. Trunk Sewers Wellington Ave. Trunk Sewers
Medium	McDougall Ave. Trunk Sewers Lincoln Ave. Trunk Sewers Parent Ave. Outlet and Trunk Sewers Bruce St. Outlet and Trunk Sewers Detroit St. Outlet and Trunk Sewers
Low	Huron Church Trunk Sewers Trunk Sewers Albert Rd. Outlet and Trunk Sewers Dual Manhole Area Separation Askin Ave. Sewer Separation Felix Ave. Trunk Sewers Prince Road Sewer Separation

Appendix F

Basement Flooding

East and South Area

Priority	Basement Flooding Solutions
Immediate Priority Projects (0 – 10 Years)	• Little River Pollution Control Plant Overflow Improvements Riverside Drive Sanitary Trunk Sewer - Ford Blvd. To St. Rose Blvd. • Sanitary Sewer Improvements along Riverside Drive E. and St. Rose Ave.
High	**East Windsor Area 1: Martinique Inlet Sanitary Sewer Infrastructure** Riverside Dr. E., St. Rose Ave., Ganatchio Trail, Clairview Ave.
Medium	**South Windsor Area: Sanitary Sewer Infrastructure** (Howard Ave., Dominion Blvd., Roselawn Dr., Woodland Ave., Parkwood Ave., Sydney Ave., Malcolm Ave., Foster Ave., Calderwood Ave., EC Row Ave. E, Conservation Dr., Grand Marais Rd. E., Tourangeau Rd.) **East Windsor Area 2: Wyandotte Inlet Sanitary Sewer Infrastructure** (Wyandotte St. E., Carling Cres.) **East Windsor Area 4: Edgar Inlet Sanitary Sewer Infrastructure** (Edgar St., Tranby Ave., Little River Rd., Little River Acres Dr., Catherine St., Lauzon Pkwy., Lauzon Rd., South National St., Jefferson St., Balfour Blvd., Glendale Ave., Ferndale Ave., Ford Blvd., Tecumseh Rd. E., Rivard Ave., Grandview St., Courtland Cres., Coronation School Yard/Pikes Park/WECHC, Rose St., Jos St. Louis Ave.) **East Windsor Area 3: Jerome Inlet Sanitary Sewer Infrastructure** (Jerome St., Westchester Dr., Rholaine Dr., Greendale Dr., Thompson Park)
Low	**Sanitary Sewer Infrastructure East Area 5:** **East/South Inlet via Aspenshore and Beverly Glen** (East Riverside, Forest Glade and Sandwich South)

Appendix F

Surface Flooding

Project Prioritization

Priority	Road Surface Flooding Solutions
Immediate Projects (0-10 Years)	• Dorchester Rd. • Totten St. • Felix Ave. • Ellis St. and Giles Blvd. -McDougall Ave. to Howard Ave. • Prince Rd. Storm Outlet at Chappell Ave. • Lauzon Parkway
High	• Dougall Ave. at the CN Rail Crossing and Eugenie St. E. • Howard Ave. at EC Row Expressway • Tecumseh Rd. W. at Crawford Ave.
Medium	• McNorton St., East of Banwell Ave. • Roseville School and Rose-Ville Garden Dr. • Giles Blvd./McDougall Ave./Erie St. • Mc Hugh St., East of Lauzon Rd. • Banwell Ave. • Jefferson Blvd. and Raymond Ave. • Huron Church Rd. • Parent Ave. • Lauzon Rd. • Jefferson Blvd. and South National St. • Ypres Ave.
Low	• Chrysler Centre • Mc Hugh St., West of Banwell Ave. • Wyandotte St. East at Watson Ave. • College Ave. • Drouillard Rd. • Walker Rd. • Patricia Rd. • Lincoln Rd. • Ontario St.

Appendix F

Surface Flooding

Project Prioritization

Priority	Regional Surface Flooding Solutions
Immediate	• DMAF Round 1 Projects and related projects (St. Rose Pump Station, St. Rose Sewer, etc.)
High	• Storm Problem Areas 1 and 2 – Riverside - Ford Blvd to Lauzon Road • Storm Problem Area 3 and 4 - Fontainebleau and Lauzon Parkway
Medium	• Storm Problem Area 7 - Central/Pillette/Grand Marais • Storm Problem Area 8 - Southwood Lakes
Low	• Storm Problem Area 5 - Blue Heron Pond • Storm Problem Area 6 - Pontiac and East Marsh Drainage Area

Priority	Coastal Flood Protection (Landform Barrier/Backflow Prevention Solutions
Immediate	• Area 1: Riverside Dr. E., Ford Blvd. to St. Rose. Ave. (Riverside Vista Ph. 2A).
High	• Area 2: Riverside Dr. E., St. Rose Ave. to Riverdale Ave. • Area 3: East Riverside Area, Riverdale Ave. - East City limits (Ganatchio Trail)

Appendix F

Class EA Project Schedules

This master plan will satisfy the EA requirements for **Schedule B** projects. The following is a general description of Schedule B and C projects that have been identified among the preferred solutions:

Schedule B Projects:

- New and Improved Stormwater Pumping Stations;
- New Stormwater Management Ponds and Underground Storage Facilities on Private Property;
- New Low Impact Development (LID) Measures on Private Property;
- New Sanitary/Storm Trunk Sewers and Box Culverts Requiring Additional Property;
- New Storm Sewers including Upgrades to Existing Outlets to the Detroit River; and
- Barrier Landform Improvements on Riverside Drive that Require Additional Property.

Schedule C Projects:

- New Stormwater Pumping Stations;
- New Trunk Storm Sewers that require new outlets to the Detroit River;
- Improvements to the Little River Pollution Control Plant wastewater treatment facility, including:
    - Improvements to the existing bypass at the Pontiac pumping station;
    - Interim measures to optimize the operation of the Little River Pollution Control Plant for existing wet weather flows; and
    - Future treatment plant expansion to meet the ultimate development needs.

The project schedules for each recommended solution are noted in the Master Plan and will be identified in the Notice of Completion. Prior to implementing any Schedule C project, additional consultation and investigation, which will fulfill Phases 3 and 4 of the Municipal Cass EA, will need to be completed and provided for public review.

During the Review Period (45 Days), any person who has significant concerns about the project may provide written comments to our project team or the Ministry of Environment Conservation and Parks (MECP). Requests should specify what kind of order is being requested, how an order may prevent, mitigate or remedy potential adverse impacts, and any information in support of the statements in the request.

Conclusions

- ✓ Recommendations to mitigate risk of basement, surface and coastal flooding have been developed based on the established level of service.
- ✓ The total cost of recommendation solutions will be $5.0 Billion Dollars, which will be integrated into the City's capitals works program.
- ✓ The ultimate solution recommendations will need to be integrated into the City's asset management program.
- ✓ City will need to enhance their current operation and maintenance programs for new and larger infrastructure. Flooding solutions are based on a **partnering approach** between private property owners and the City.
- ✓ Flooding solutions will require an **extended period of time** to be fully implemented due to their scope and costs.
- ✓ Flooding solutions will **reduce**, but not completely eliminate flooding risks.

Master Plan Section 8.0

1.0 Introduction

1.1 Project Background

In the past decade, the City of Windsor has experienced significant rainfall events with prevalent surface and basement flooding. These significant rainfall events included: June 4, 5 and 6, 2010; November 29 and 30, 2011, August 11, 2014, September 28, 2016, and August 27 and 28, 2017. The City received basement flooding reports totalling over 2,200, 2,800 and 6,000, for the three most severe events: 2010, 2016 and 2017 rainfall event, respectively (see **Figure 1-1** illustrating 2017 flooding). The August 28 and 29 2017, event recorded rainfall that exceeded a 1:100 year storm event and the September 28, 2016 storm event was just under a 1:50 year occurrence. The June 2010 rainfall event was estimated to be between a 1:50 and 1:100 year occurrence.

Figure 1-1: Mayor's 8-Point Plan

Throughout this report, reference will be made to the return period (occurrence probability) for various storm events (1:5, 1:25, 1:100 etc.). A 1:100 year storm event, refers to an event that has 1% chance of happening in any given year. For the purposes of this study, a 1:100 year refers to an 85 mm rainfall event that occurs within a 4 hour period. Less severe storms, such as 1:50 year (2% chance) or 1:5 year (20% chance) events, are less intense and have less rainfall volumes associated with them, with the later event being more common and likely to occur. More description of these events are included in Technical Volume 1 and 2 (Appendices C & D).

Climate change has increased the likelihood of extreme weather events, meaning that precipitation storm events will continue to become more frequent, more intense and more unpredictable in the future. The Windsor Climate Change Adaptation Plan (2020) describes that more intense precipitation events are expected, with the potential for the 1:10 year and 1:100 year storm rainfall intensities to increase up to 25% and 40%, respectively.

Throughout this master plan, consideration for increases in storm event intensities due to Climate Change, are used to apply higher service levels to vulnerable areas and to assess the resiliency of the proposed solutions.

Following the August 29th, 2017 rainfall event, the Mayor developed an 8-point plan to begin addressing flooding in the City, with Council resolution CR660/2017 on November 6, 2017. This resolution included expediting the completion of this MP.

In addition to surface and basement flooding that has occurred during historical rain events, the City has also experienced flooding due to high water levels in Lake St. Clair and Detroit River. In June 2019, water levels in these watercourses reached record maximum recorded water levels which caused backup into the storm sewer system and flooding of coastal low lying areas.

In order to complete the Sewer and Coastal Flood Protection Master Plan (MP) project, an engineering and planning team was assembled with Dillon Consulting Limited (Dillon), as lead consulting firm, partnered with Aquafor Beech Limited (Aquafor) and AMG Environmental Inc. (AMG).

A Technical Advisory Committee (TAC) was established at the beginning of the project to provide input during key stages of the development of the MP. The TAC was comprised of City of Windsor staff, the Essex Region Conservation Authority (ERCA), Aquafor and Dillon. The role of the TAC was to review technical findings of the sewer model analysis, assist in the identification of problem areas, provide feedback on solutions, develop evaluation criteria, review public comments, and provide input on the implementation plan.

A Stakeholder Advisory Committee (SAC) was formed to provide diverse perspectives throughout the duration of the project. The SAC was comprised of local businesses, community organizations, environmental organizations, emergency providers, research organizations, insurance providers, and local residents. While the SAC was not a decision-making body, it provided insight, advice, and feedback on the development of the MP Project Purpose and Approach

The City has experienced basement, stormwater, and coastal flooding resulting in property damage, emergency access issues and disruption to community life i.e. a cascading hazard[1]. During significant storm events the City's municipal infrastructure (sewers, roadways and open drains) may be overwhelmed creating the potential for extensive surface flooding and backflow into basements. The purpose of undertaking this MP was to identify specific problems and explore achievable measures to reduce the cascading risks and impacts of flooding; with the aim of building a partnership between property owners and the City to address the issues and reduce risks and impacts on the sustainability of Windsor's environment, social and economic well-being. For the purposes of this MP property owners is general term that refers to those who own, operate or maintain properties within Windsor's municipal boundaries, excluding the City's right-of-way.

As part of the MP, the City considered:

- **Shorter-term solutions** which can be implemented relatively quickly (e.g. 0-10 years) and do not need significant capital investment. Generally, these include measures that reduce the amount of rain or lake water getting into sewers; and,
- **Longer-term solutions** to improve the sewer systems by increasing the conveyance of flow, providing temporary storage capacity and/or improving the corresponding system outlets. Generally, these solutions will require a longer period of time to implement (e.g. more than 10 years) and may involve significant capital investment.

In order to meet the established flood mitigation measures, a comprehensive plan that includes both shorter-term and longer-term solutions is required. The City will also work

[1] FEMA (2019) definition, "cascading events are events that occur as a direct or indirect result of an initial event. For example, if a flash flood disrupts electricity to an area and, as a result of the electrical failure, a serious traffic accident involving a hazardous materials spill occurs, the traffic accident is a cascading event. If, as a result of the hazardous materials spill, a neighborhood must be evacuated and a local stream is contaminated, these are also cascading events. Taken together, the effect of cascading events can be crippling to a community."

in full cooperation with private property owners (residential, commercial, institutional and industrial) in order to mitigate stress on the City's system.

The project included setting standards for sewer operation and maintenance, identifying actions homeowners can take to reduce their risk of flooding, confirming the cost for improvements, and identifying a plan and schedule for implementing improvements.

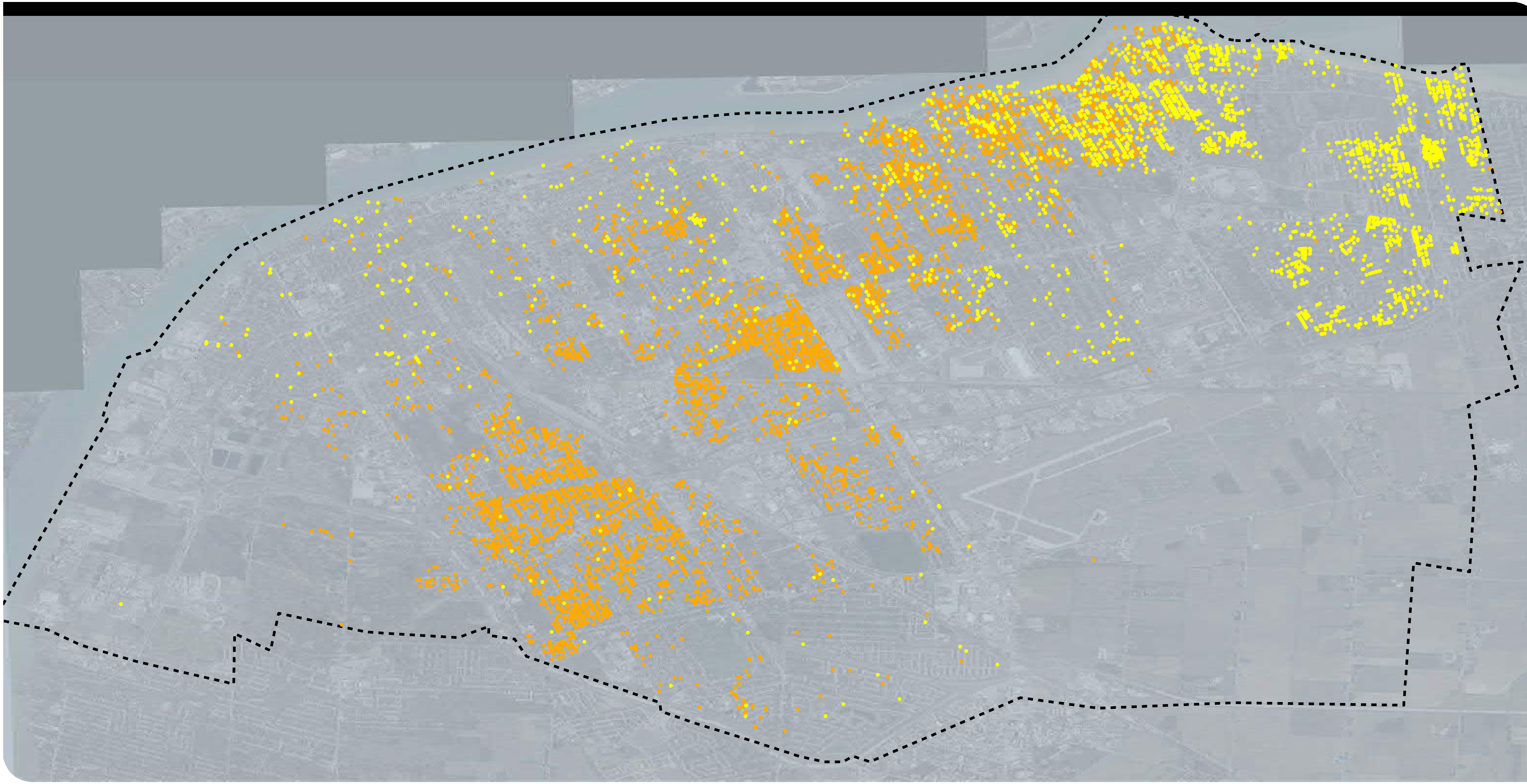
The following flow diagram provides an overview of the MP Study Process:

Figure 1-2: Flow Diagram - Master Plan Study Process

Figure 1-3 illustrates the scale of basement flooding calls received by the City of Windsor as a result of the September 28th, 2016 and the August 28th and 29th, 2017 storm events.

In addition to the flooding reported during the 2016 and 2017 years, historical data examined also included all basement flooding reports recorded by the City in the last two decades. A key task of the MP was to address the known issues as outlined in the following **Table 1-1**.

Page is intentionally blank



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Flooding Calls Received

Figure 1-3

Flooding Calls 2016

Flooding Calls 2017

Study Area

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

0 0.5 1 2 km

SCALE 1:60,000

PROJECT: 17-6638

STATUS: FINAL

DATE: 10/22/20

Page is intentionally blank.

Table 1-1: Summary of Problems and Opportunities

Issue (Problem)	Problem/Opportunity Description
Capacity – Exceedances of flow capacity in storm, sanitary, and combined sewers due to excess rainwater entering the municipal drainage system	Sewers have been historically designed to provide drainage for more frequent rain events and has included allowances for *inflow and infiltration*. The City has experienced higher intensity rain events accompanied by significant excess inflow and infiltration. The existing systems are overwhelmed during these *wet weather flow* conditions; often leading to flooding damages and economic losses. There is opportunity to make improvements to reduce the volume of excess rainwater entering the system and to improve conveyance of flows during these severe rain events.
Public Health – Issues of nuisance, potential health risks, and environmental degradation from flooding conditions.	The inability of the sanitary sewer system to handle excessive extraneous flows can result in backup of raw sewage into basements and by-passing of partially treated sewage flow to open bodies of water (surface water).
Overland Flow – Issues of surface water directed towards habitable structures.	Rainwater or high lake/river levels can cause flooding within roadways which can impact structures. Also low lying areas or poor lot grading can lead to rainwater being directed to habitable structures.

Issue (Problem)	Problem/Opportunity Description
Transportation Access – Issues of limiting access due to coastal flooding and stormwater ponding, impacting roads.	Under extreme wet-weather events and high lake/river levels, the depth of stormwater flooding along roadways beyond normal conditions (0.3 metres (1.0 foot)) is capable of stopping/altering road traffic patterns and potentially damaging vehicles. This condition could potentially affect emergency vehicles response times, and community safety.
Future Development Capacity – Limited sewer capacity reduces opportunities for new development	New development results in additional stormwater and sewage discharge to the City's sewer system. This discharge has the potential to impact the existing sewers system. There is opportunity to incorporate new development servicing needs in the development of solutions. Also, this plan will outline design criteria and private property construction parameters for new development to mitigate risk of flooding within those developments as well as the existing development surrounding those sites.

This MP was completed in accordance with Master Plan Approach No. 2 of the Municipal Class Environmental Assessment (MCEA) process and is intended to satisfy the environmental assessment (EA) requirements for Schedule B projects. The MCEA process includes a recognized framework for engaging the public and agencies in considering alternative solutions to reduce the risk of flooding.

1.2 Project Objectives

The objectives of this study are to mitigate risk of basement, surface and coastal flooding and more specifically address the five (5) key issues as outlined in **Table 1.1** above. The objectives included:

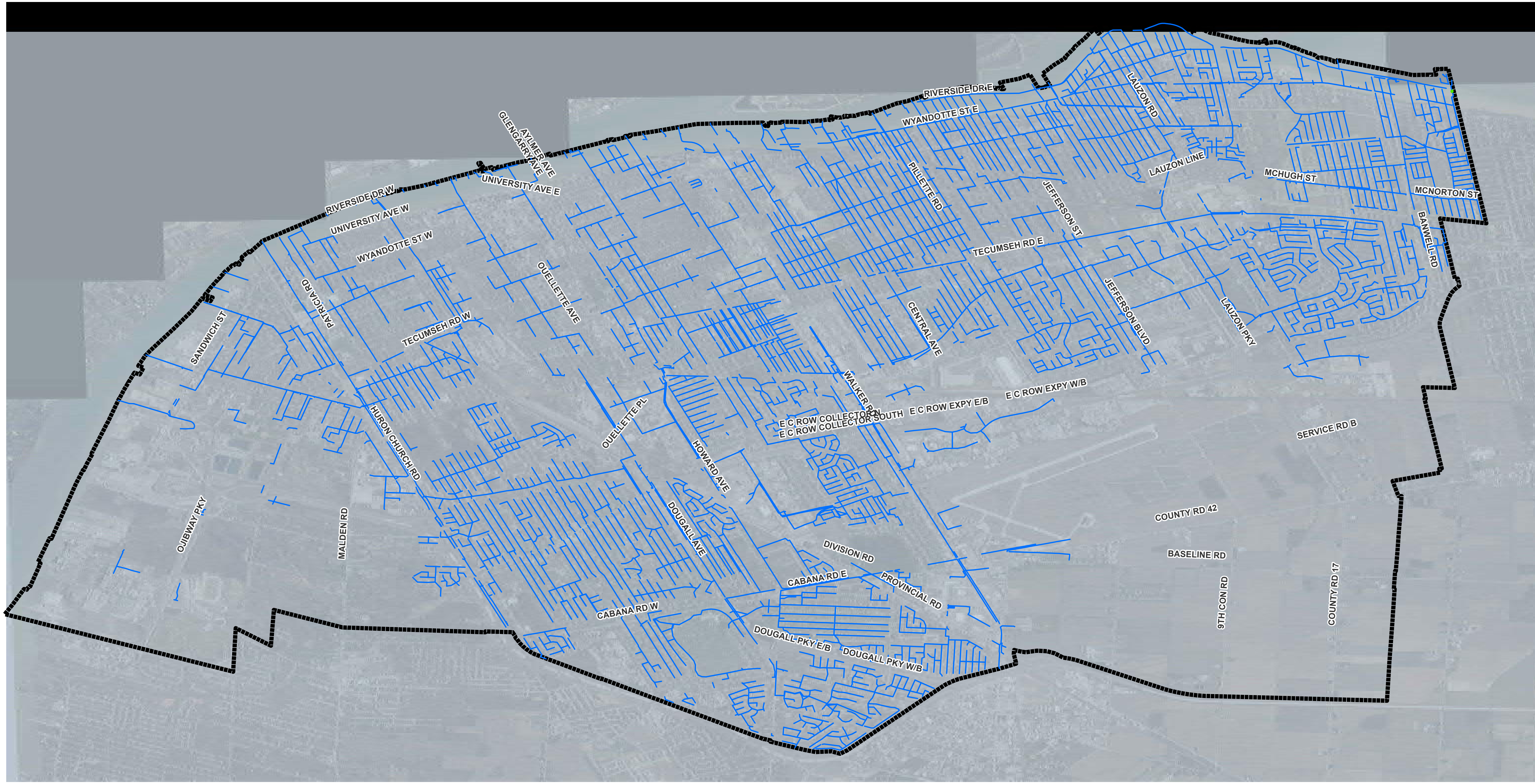
- **Document and characterize existing drainage and sewer conditions** within the City of Windsor, including the completion and analysis of a City-wide computational sewer model;
- **Complete a comprehensive public and agency engagement program** following the Municipal Class Environmental Assessment Master Planning process, including confirmation of flooding findings and obtaining feedback on solution alternatives;
- **Identify problem areas** where public and private property are at risk of basement, surface and/or coastal flooding;
- Develop recommended actions for short-term solutions to address basement and surface flooding.
- Develop in coordination with the City, Stakeholders, MECP, and the Essex Region Conservation Authority (ERCA), **a framework for guidelines and criteria to guide the solutions** developed as part of this project;
- Design and model alternative solutions for each problem area;
- **Complete a comparative evaluation of alternative solutions** using evaluation criteria developed with various project stakeholders;
- **Complete a desktop environmental inventory** as part of the evaluation of the alternative solutions and identification of mitigation strategies for the preferred solutions;
- **Complete budgetary project cost estimates** to develop a long-term capital improvement program, including a recommended implementation strategy for City Council's consideration; and,
- **Develop an implementation strategy** that assigns priority to projects and helps guide City administration to implement recommendations.

1.3 Study Area Context

In order to obtain a comprehensive understanding of flooding issues, the whole City of Windsor needed to be considered through the context of municipal policy and operations. The Study Area boundary of the MP was; therefore, set as the municipal boundary for the City of Windsor, Ontario, see **Figure 1-4** for the boundary limits.

As shown in **Figure 1-4**: City of Windsor and Surrounding Area are two adjacent communities surrounding the City of Windsor that also struggle with the similar flooding issues, the Town of LaSalle and the Town of Tecumseh, which run along east and south boundaries of the City. Lake St. Clair and the Detroit River border the north and west sides of the City of Windsor and act as the receiving waterbodies for the city stormwater sewer system. **Figure 1-5-1 and Figure 1-5-2** also illustrates the existing sewer system for the City of Windsor, refer to Section 5.4 for a description of the existing sewer system.

Figure 1-4: City of Windsor and Surrounding Area



CITY OF WINDSOR
SEWER AND COASTAL FLOOD
PROTECTION MASTER PLAN

City of Windsor Sewer System -
Storm Sewers

Figure 1-5

THE CITY OF WINDSOR

STUDY AREA

STORM SEWER

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

0 0.5 1 2 km
SCALE 1:60,000

N E S W

DUAL MANHOLE AREA

COMBINED SEWER AREA

PROJECT: 17-6638
STATUS: FINAL
DATE: 10/22/20

Page is intentionally blank.

CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

City of Windsor Sewer System - Sanitary Sewers

Figure 1-5

THE CITY OF WINDSOR

STUDY AREA

COMBINED SEWER

SANITARY SEWER

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

0 0.5 1 2 km
SCALE 1:60,000

N W E S

DUAL MANHOLE AREA

COMBINED SEWER AREA

PROJECT: 17-6638 STATUS: FINAL DATE: 10/22/20

Page is intentionally blank.

1.4 Report Structure

This report consists of the following sections:

- **Section 1** presents an introduction to the plan, some background, the purpose and approach, the objectives, and a description of the Study Area;
- **Section 2** describes the flooding context, including stormwater management context and historical flooding;
- **Section 3** presents the EA process;
- **Section 4** describes the stakeholder engagement employed, including approach and objectives, engagement activities, and a summary of the feedback and how it mattered;
- **Section 5** provides a description of the existing environment, which includes: natural environment, socio-economic environment, infrastructure, and climate change;
- **Section 6** outlines the solutions considered to address flooding in the City;
- **Section 7** outlines the potential effects and mitigation, practical tools for implementation, and costs; and,
- **Section 8** provides an overview of the recommendations and how each of the Mayor's 8-Point Plan and the Project Objectives, were addressed.

In addition, the appendices provide detailed information to support the main report, and include:

A Background Literature Review Summary Report;

B Consultation Summary Report;

C Short-Term Recommended Solutions;

D Technical Report #1 – Sewer Model Development;

E Technical Report #2 – Flood Reduction Solution Alternatives Development;

F Technical Report #3 – Functional Design, Costs and Implementation;

G Evaluation Matrices and Potential Effects and Mitigation;

H Natural Environment Report;

I Archaeological Assessment Report; and

J Geotechnical Report.

Technical and engineering work development of the solutions developed as part of this plan area summarized in the Short-term Recommended solutions report and three volumes of the technical reports which are described as follows:

Short-Term Recommended Solutions Report includes:

- Benchmark review of measures being taken by other municipalities;
- Summary or recommended short term measure, including updates to municipal polices, subsidy programs and collaborative improvements; and,
- Detailed recommendations for first round of short-term solution measures.

Technical Report Volume I includes:

- Identification of new sewer and drainage data collected in 2018;
- Summary of data used from the Flow Monitoring and Hydraulic Modeling of the Sewer System report (Dillon & Aquafor, 2016);
- Process and methodology for expanding the existing City-wide sewer model, including calibration; and,
- Identification of existing baseline sewer and overland drainage conditions within the City, including characterization of rain-derived inflow and infiltration (RDII).

Technical Report Volume II includes:

- Identification of level of service criteria for basement and surface flooding solutions, including development, discussion with the technical committee and comparisons to other municipalities;
- Delineation of existing level of service for basement and surface flooding;
- An overview of the development process for basement and surface flooding solutions, including source control programs, conveyance/storage measures, and end of pipe (outlet) improvements. A summary of alternatives solutions considered;
- A background review of coastal flooding risk and level of service criteria. A summary of the development process for coastal flooding solutions; and,
- Summary of pilot project programs required to assess the benefit of source control solution measures.

Technical Report Volume III includes:

- For the preferred solutions, a summary of the preliminary functional design process and recommendations for the proposed storm and sanitary sewer improvements;
- For the preferred coastal flooding solutions a summary of the functional design process and recommendations;
- A summary of the assumptions and methodology in developing unit prices and cost estimates for the preferred solutions; and,
- The development process for the flooding solution recommended implementation plan. The plan assigns priority to projects based on multiple metrics identified.

2.0 The Flooding Context

Ontario's current approach to managing risk associated with flooding is based on five key elements, namely: Prevention, mitigation, preparedness, response and recovery. A series of provincial government Acts, Regulations, policies and technical guides are used to achieve progress towards minimizing the risk. By minimizing risk of flooding, the end goals are being worked towards to save lives, save money; protect property, public health and the environment; maintain a community's economic stability, protection of critical infrastructure, and reduce the disruption associated with flooding emergencies.

2.1 Municipal Benchmark Review

A benchmark review was conducted to examine the various geographical contexts that the City of Windsor may be influenced by and/or influence, namely: local, regional, national, and global frameworks with respect to flood control/response.

A benchmark review was undertaken to garner potential specific source control and short-term measures from other Ontario municipalities that could be applied in the City of Windsor. Numerous options for flood management were identified as viable for use by the City. Findings of this background review where used to develop a list of short-term solutions that are recommended to be implemented as part of the comprehensive solutions to mitigate flood risk. A summary report of recommended remediation measures is included as **Appendix C - Short-Term Recommended Solutions** and **Section 6.6** below provides a summary of how those solutions are implemented in the holistic strategy to mitigate flood risk.

2.2 Local Context

In November 2016, the Phase 1 Flow Monitoring and Hydraulic Modeling of the Sewer System report (Dillon Consulting Limited & Aquafor Beech Limited) was completed. This report summarizes the methodology and findings for the development of a City-wide calibrated model, including the sanitary, storm and combined sewer systems. The recommended next steps from this project (November 2016) was the development of Phase 2 of the MP to address basement flooding. Further, the project deliverables from the November 2016 report served as the basis to identify and implement comprehensive sewer system improvements.

Adjoining communities of the Towns of LaSalle, Tecumseh, and Lakeshore have each had their own flood hazard issues as documented in public forums.

The Town of LaSalle situated along the Detroit River adjacent to the City of Windsor, has similarly experienced surface and basement flooding which fluctuates as a result of wind shifts and changing water levels in the Detroit River, causing disruption of transportation routes and community services. The City has developed mapping to identify at risk areas and implemented an emergency alert system.

The Town of Tecumseh situated on the shoreline of Lake St. Clair adjacent to the City of Windsor has also experienced flooding as a direct result of lake levels, high wind, and extreme precipitation events with some events resulting in sanitary surcharging into basements. The Town has an Emergency Notification System where residents can sign-up to receive electronic alerts; they provide sandbags and sand free of charge to residents along the lakeshore; they have conducted topographical surveys of the shoreline to determine critical areas for protection; they have shored up pumping stations and cleared drainage channels; they have hosted information sessions regarding flood preparedness and evacuation; and are developing a Flood Emergency Response Plan.

The Town of Lakeshore also along the Lake St. Clair shoreline and adjacent to the Town of Tecumseh, has experienced the same problems and have taken the following steps: provided subsidies to residents for the connection of backwater prevention valves, for sump pump overflow, and for downspout disconnection; offered free camera inspections of private sanitary/storm sewers.

2.3 Regional & Provincial Context

The Ministry of Natural Resources and Forestry (MNRF), Ministry of Environment, Conservation and Park (MECP), the Essex Region Conservation Authority (ERCA), and the City of Windsor all have legislated responsibilities to manage and respond to flooding. Conservation authorities and other government ministries monitor conditions and provide support in the preparation of adequate response and recovery actions. The Ministry of Municipal Affairs and Housing (MMAH) coordinates disaster financial assistance programs for some uninsurable losses for eligible groups, and liaises with the Government of Canada for federal funding when appropriate.

The ERCA is responsible for monitoring: stream flow, lake and river levels, and ice conditions within its watershed[2]. They also assess soil saturation levels, and provide flood warnings to municipalities and agencies as required. The ERCA prepare flood contingency plans and assist municipalities during the emergency response process. They access weather information at both the local and international levels to allow timely alerts to be issued. The ERCA are working with municipal partners to coordinate a Regional Climate Strategy.

A climate change consortium held at the University of Windsor on December 5, 2018 produced a report that lists a few of the top challenges in dealing with climate change that are relevant to this MP: the ageing infrastructure of communities being inadequate to deal with the extreme precipitation and flooding events, as well as, constraints to new development projects because of inadequate drainage; and vague policies, legislation and lack of enforcement.

2.4 National Context

Emergency management in Canada uses an all-hazards approach, including cascading events, to address hazards and disasters. As climate change will continue to increase the frequency and intensity of extreme weather events, including heavy rainfalls and related flooding, the increasing strain on community emergency management capacities and budgets is highly likely. Although most hazard events are local in nature and are managed by municipalities, some events could transcend geographic boundaries posing greater challenges for emergency response providers[3]. The Emergency Management Framework for Canada report was written to provide guidance and to strengthen the manner in which governments and partners assess risks and work together to prevent/mitigate, prepare for, respond to, and recover from hazards. To ensure the most effective use of emergency

[2] Under the CA Act, the ERCA has authority "to study and investigate the watershed and to determine programs and services whereby the natural resources of the watershed may be conserved, restored, developed and managed", "to control the flow of surface waters in order to prevent floods or pollution or to reduce the adverse effects thereof", "to cause research to be done", and "to erect works and structures and create reservoirs by the construction of dams or otherwise"; to name a few of their relevant powers.

[3] Federal/Provincial Emergency Management Partners. Building Resiliency Together: An Emergency Management Framework for Canada. Third Edition. May 2017.

management resources and execution of response activities, a concerted effort is required to be able to coordinate, collaborate, and integrate the execution of activities.

The Provincial Policy Statements set out direction for municipalities to restrict development and site alteration in areas prone to erosion and flooding hazards. In 2014, $200 million over five years was earmarked to establish the National Disaster Mitigation Program (NDMP), designed to address rising flood risk and cost, through local small-scale structural and non-structural mitigation projects[4].

The City has received $32.1 million from the Federal Government's Disaster Mitigation and Adaptation Fund. This is to assist with the construction of $90 Million dollars of infrastructure recommended through the St. Paul and Pontiac Pump Station and St. Rose Storm Drainage Areas study (Dillon, 2018). Those recommendations have been incorporated and refined in this MP. The City has applied for an additional $27 million (July 2020) to provide assistance for an additional $80 million dollars of related infrastructure projects. More details on this funding and associated construction work and timelines can be found in Section 7.4 Implementation Plan.

To continue to evolve more resilient systems for communities, changes will be necessary to policies at all level of governance, as well as changes to: programs, standards, and activities that must adapt to the changing hazards.

2.5 International Context

The Detroit River as a unique international waterway flows through a metropolitan region of over 5 million people, including the City of Windsor, mutually dependent on its watershed that traverses political boundaries[5]. As a highly urbanized and industrialized area, the Detroit River requires collaboration among countries, government agencies, community organizations, businesses, and individuals respond to challenges such as significant storm events and flooding. A Management Strategy was developed as part of the process of designating the Detroit River as a Canadian Heritage River, and it serves to provide a framework for the community to carry out joint efforts with other communities adjoining the Detroit River, as required.

[4] Emergency Management Ontario. HIRA Report Section B: Environmental – Flood. 2019
[5] ERCA. The Detroit River Management Strategy Committee 2001: The Detroit River as a Canadian Heritage River, 2001.

The City of Detroit, Michigan located on the other side of the Detroit River from Windsor, has similarly experienced surface and basement flooding. The Detroit Free Press reported on historic water levels during spring 2019. To prevent future flooding, the Detroit Water and Sewerage Department have been assessing problem areas, cleaning drains and building sand barriers to mitigate future floods and ease the impact on the underground stormwater pumping systems. In 2019, an emergency order was issued by the City of Detroit, granting permission for City workers to enter private property in order to install sandbags, with a $500 fine for residents removing sandbags and/or 90 days in jail[6]. The U.S. Army Corp of Engineers Detroit District maintain their own records of water levels on the Great Lakes, and diligently monitors potential inland river flooding and potential flooding on connecting channels due to ice jams. They provide advance notification to U.S. emergency managers in regard to forecasted weather events and ice conditions that could potentially cause flooding.

2.6 Historical Flooding in Windsor

Over the past ten years, the City of Windsor has experienced significant rainfall events, which have led to both localized and wide-spread surface and basement flooding within the study area, including June 4th, 5th and 6th 2010, November 29th and 30th, 2011, August 11th, 2014; September 28th, 2016; and August 28th and August 29th, 2017. The City received over 2200, 2800, and 6000 total reports of basement flooding from the three most sever events: 2010, 2016 and 2017 rainfall events. The most prominent event was the September 28, 2016 storm where the City's east-side received nearly 100 mm of rainfall over 24 hours causing significant surface and basement flooding. The rainfall amount recorded at the Little River PCP/Pontiac Pump Station rain gauge confirms that the area around the Pontiac Pump Station experienced the worst of the storm, indicating that precipitation from these events are not uniformly distributed over the whole City. Rainfall totals from numerous gauging stations had 24-hour precipitation total depths greater than a 1:100 year event for the August 28th, 2017 event and just under a 1:50 year event for the September 28th, 2016 event. The June 2010 rainfall event was estimated to be between a 1-in-50 year and 1-in-100 year event.

The significant storm event occurred in the Windsor area in August 2017, saw intense precipitation over 28 hours. A maximum measured rainfall amount of 219 mm was

---

[6] Detroit Free Press. July 10, 2019.

recorded at the southwest area Huron Estates Pump Station and 189 mm at the Howard Grade Separation Pump Station. The rain gauge measurements within and around the City recorded 89 mm, 105mm and 149 mm at the Little River PCP/Pontiac Pump Station, Twin Oaks Pump Station and Drouillard Pump Station rain gauges respectively. East Windsor, although not as severely hit as in the previous year, still sustained significant surface flooding along Riverside Dr. E. and Wyandotte St. An estimated 60% of the rainfall during this storm occurred within a three-and-a-half-hour time frame, which most likely caused the majority of the surface flooding. It was estimated that the August 2017 event was approximately 30% greater than the 1-in-100 year occurrence.

As a result of the August 2016 storm, a public questionnaire was made available for residents to reporting flooding as a results of the storm, 90% of homeowners who responded, observed water backing up through basement floor drains, shower tubs, toilets, sinks or laundry. These flooding records were provided by the City of Windsor to review the areas with high flood vulnerability. The data was analyzed and mapped to correlate areas of frequent flooding over multiple years. The flooding record data was used to assist with the development of the computational sewer model and provide better understanding of where flood mitigation measures should be taken.

For a map of basements flooding throughout the City limits based on the historical data for 2016 and 2017 refer to the Technical Volume 1 report. **Table 2-1** below summarizes total rainfall volume and storm duration for the 2016 and 2017 flood events to provide context.

Table 2-1: Summary of Flood Events 2016 & 2017

Event Date	Maximum Total Rainfall Accumulation (mm)	Approximate Storm Duration (hrs)
September 28, 2016	100	37
August 28 & 29, 2017	212	29

It is noted that the accumulated rainfall amounts identified above do not reflect the rainfall amounts that may have impacted each part of the Study Areas. The amounts represent the maximum rainfall accumulation recorded at the most severely hit rain gauges in the City's network.

In addition to historical flooding from rain events, the City has also experienced historical flooding from high lake and river levels which cause erosion and property damage. Significant flooding events occurred in the early 1950's, 1973, 1986 and 1998 (East Riverside Flood Risk Assessment, Landmark 2019). The lake levels have been rising since 2013 with record high lake levels being reached by the summer of 2019.

2.7 Coordination with Other Studies

In addition to this MP, there are a number of related studies currently underway that also address improvements and flood mitigation within the City. The MP technical team has worked closely with City administration and other consultants, to ensure that findings and recommendations developed through this study are consistent with other studies. The table which follows, is a summary of the other studies that have been recently completed or are underway and how they have been integrated into this study. A more complete list of historical reports that have been reviewed and integrated into this study's analysis is available in **Appendix A: Literature Review**.

Table 2-2: Related Study Summary

Study Title	Consultant Author	Coordination with this Master Plan
Flow Monitoring and Hydraulic modelling of Sewer System (2016)	Dillon Consulting Limited	This report summarizes the first Phase of this MP report. In 2016, the City's sewer model was first developed for the major sewers in the City. This master plan's sewer model is a refinement to the previous 2016 model.

Study Title	Consultant Author	Coordination with this Master Plan
East Riverside Flood Risk Assessment (2019)	Landmark Engineering	Recommendation from this report were considered in the development of the proposed coastal flood protection alternatives. Findings from the East Riverside study were further refined and used as a basis for the recommended landform barrier and backflow prevention design.
Combined Sewer Overflow (CSO) in the Riverfront Area West of Caron Ave. Environmental Assessment (Ongoing)	Stantec Consulting Limited	The proposed LRWRP RTB (Retention Treatment Basin) and Sandwich St. Trunk Sewer upstream of the LRWRP have been incorporated into the City's sewer model. The operation and added capacity of the RTB has been confirmed through the overall City model. The proposed LRWRP RTB is an essential part of the comprehensive basement flood mitigation recommendations for the South Windsor Area and an essential part of the CSO management strategy for Central Windsor.

Study Title	Consultant Author	Coordination with this Master Plan
Sandwich South Secondary Plan Area Master Servicing Plan (Ongoing)	Dillon Consulting Limited	Servicing capacity needed for the developable lands within this area have been added to the City's sewer model to confirm that proposed sanitary trunk infrastructure incorporates the necessary provision for future development.
Little River Flood Plain Mapping (Ongoing)	Dillon Consulting Limited	Recommendations of this MP, including the proposed modifications of the Little River Pollution Control Plant Bypass and corresponding outlet will be assessed through the floodplain assessment study.
Stormwater Financing Study (Ongoing)	Wood	Recommendations of the MP have been communicated to the financing study team to assist with the development of their study recommendations.
Campbell/University Combined Sewer Separation and Stormwater Management Strategy	Stantec Consulting Limited	Preliminary results of the Campbell/ University study have been reviewed. This MP has established a new level of service and sewer separation strategy; therefore, infrastructure recommendations outlined in the Campbell/University are no longer valid.

Study Title	Consultant Author	Coordination with this Master Plan
Grand Marais Drain Hydraulics and Hydrology Models (March 2019)	Landmark Engineering	The open drain model developed for this study was used to assess the impact of the MP recommended solutions on the Grand Marais Drain.

3.0 The Environmental Assessment Process

3.1 Master Plans and the Class EA Process

MPs are long-range plans that take a system wide approach that is intended to identify interconnected issues and related infrastructure projects to address system needs. The MP, using environmental assessment principles, examines the existing infrastructure system or group of community projects, in order to come up with a broad framework and long term plan to make infrastructure improvements. Considering a full system and developing an overall plan is efficient, thorough and provides tangible benefits to the community. The final MP identifies a full list of projects to be undertaken over time.

Specific projects identified within a Master Plan must fulfill all the requirements of the MCEA. At a minimum, MPs must address at least the first two phases of the Class EA process, namely: identification of the deficiencies or opportunities, and identification of alternative solutions to address them. In addition, the MP process requires consultation at key points. Refer to the MCEA flow chart (**Figure 3-1**) below for a description of each phase of the MCEA process and the mandatory consultation points.

MPs are typically reviewed and updated approximately every five years to address changing needs, and to take advantage of new approaches and technologies.

Changes proposed to the MCEA (2000, as amended) were posted on the Environmental Registry by the provincial government in July 2020[7], and include the following:

- Exemption of twenty-eight project types that are considered to be low impact, where there is duplication with other processes, or where the project types would be needed in cases of emergency;
- Upgrading or downgrading assessment requirements for projects (e.g. shifting project schedules);
- Removing cost thresholds for road projects; and
- Clarifying and modernizing current process requirements.

The public commenting period on proposed the MCEA amendments ended August 22, 2020 at which time the MECP began their review to consider all comments received

[7] https://www.ontario.ca/page/class-ea-municipal-infrastructure-projects, accessed November 16, 2020.

during the comment period. Once approved, the amended MCEA will replace the existing version.

The Covid-19 Economic Recovery Act, 2020 also resulted in amendments to the Environmental Assessment Act. Specifically, as a result of amendments, Part II Order requests are now limited to potential adverse impacts of projects on constitutionally protected Aboriginal or treaty rights. This change is currently in effect.[8]

[8] https://ero.ontario.ca/notice/019-2051, accessed November 16, 2020

Page is intentionally blank

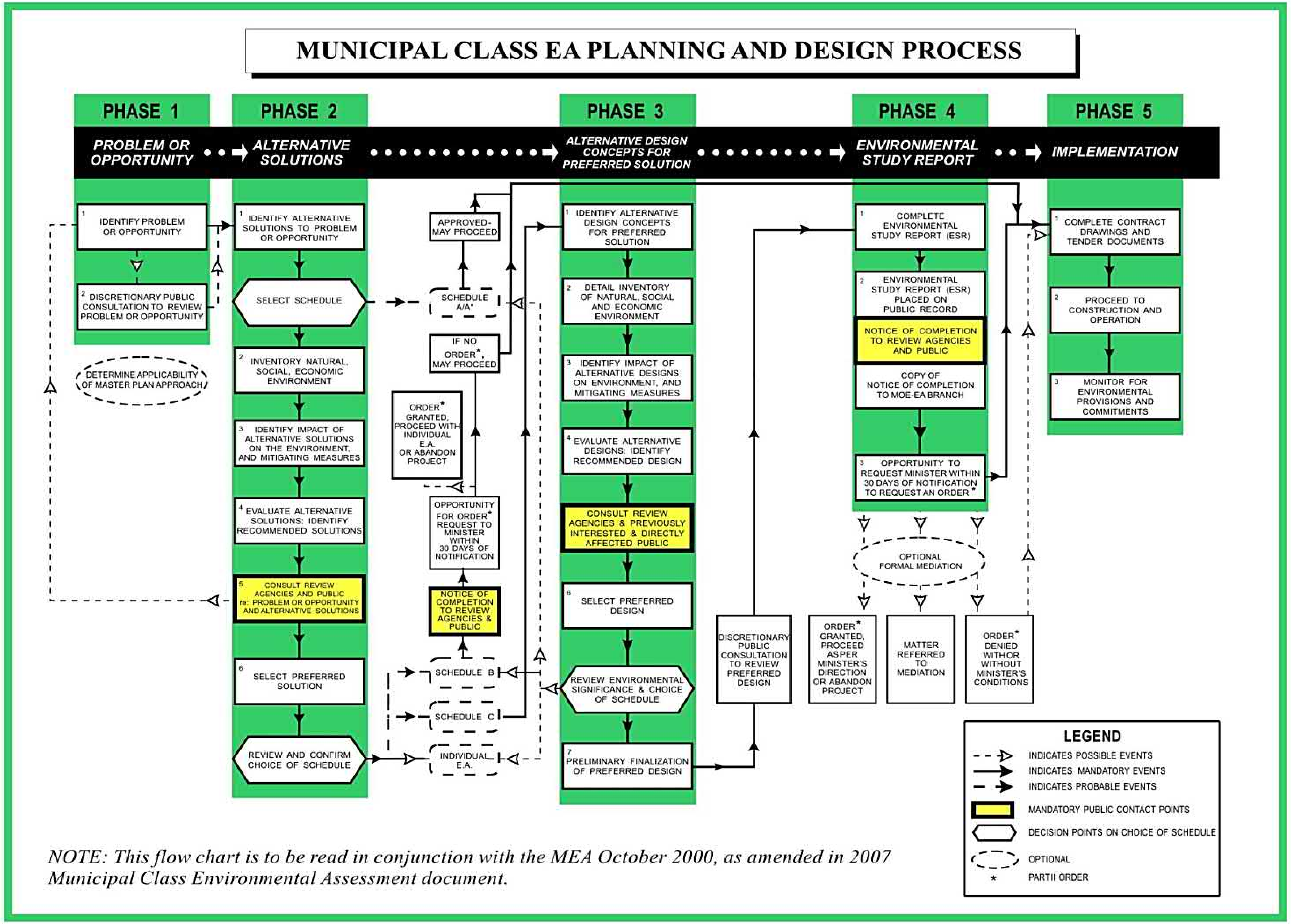


Figure 3-1: Municipal Class EA Process Schematic

Page is intentionally blank.

3.2 Approval of Projects Identified within the Master Plan

Under the MCEA process, projects are identified within different categories depending on their complexity and potential for effects on the surrounding environment. **Table 3.1** provides a summary of the different project categories. There are different approaches to completing Master Plans and for this MP, the City has chosen to follow Approach #2 which means that the Master Plan will complete the full Class EA requirements for all projects identified as Schedule B project.

This Master Plan is being completed following Approach #2 in the MECA (2000, as amended). As such, following the posting of a notice of completion and approval by the MECP, projects identified as Schedule A, A+ and B will be approved for implementation and construction. Others (Schedule C projects) may require additional public notice and/or further study, as they are identified to potentially have significant environmental effect, to implementation. The following table provides a summary of the different project categories:

Table 3-1: Municipal Class EA Project Categories

Project Schedule (Category)	Description
Schedule A	Project limited in scale, has minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects are pre-approved and may proceed to implementation. These include normal or emergency operation and maintenance activities.
Schedule A+	These projects are the same as Schedule A, these projects are expected to have minimal adverse environmental effects, except they require public notification prior to implementation. Advising the community members is a means to inform those in the area where the work is to be undertaken. Notification is determined by the municipality, and can be one of these: a notice to adjacent neighbours, a notice posted at the site, a report to council, or a list of projects posted on the municipality's website, as examples.

Project Schedule (Category)	Description
Schedule B	Projects have the potential for some adverse environmental effects. The municipality is required to undertake Phases 1 and 2 of the MCEA and complete screening process involving mandatory contact with those directly affected and relevant review agencies to ensure that they are aware of the project, and that their concerns are considered. These projects include improvements and minor expansions to existing infrastructure/facilities.
Schedule C	Projects have the potential for significant environmental effects. The municipality is required to conduct full planning and documentation procedures, including an Environmental Study Report that is reviewed by community members and review agencies. These projects include construction of new infrastructure/facilities and major expansions to existing infrastructure/facilities.

3.3 Identification of Deficiency / Opportunity Overview

In the City of Windsor, overland surface flooding, sewage system back-ups, and flooding due to high lake/river levels, have resulted environmental, social, economic, and technical (sewers and other sewage system infrastructure) challenges in the community; with a trend of increasing frequency of the following conditions:

- High intensity, short duration or long duration rainfall events that produce high runoff and infiltration;
- Saturated or frozen ground conditions that result in increased runoff;
- Snow melt, including ice blockage that may limit overland drainage;
- Excess rainwater inflow into the sanitary system due to improper private property drainage connections;
- Shoreline flooding from high lake and river levels; and,
- Reduced outlet capacity due to high lake and river levels.

Specific deficiencies and opportunities for improvement have been identified through this MP and are documented in Section 6.3.

3.3.1 Solution Alternative Development

Through the benchmark review and greater understanding of the City's drainage system and the causes of basement, surface and coastal flooding it is understood that the solutions to mitigate flood risk will need to include improvements and mitigation measures within all levels of the City's drainage systems. To provide more immediate relief to the existing system, solutions must include both short-term and longer-term solutions. For the purposes of this study, the definition of short-term and long-term solutions area as follows:

- **Short Term Solutions** are those that can be taken immediately to reduce strain on sewer systems and to protect private property, such as:
    - Source Control Measures to reduce inflow of excess rainwater entering the municipal system; and,
    - Private Property Protection Measures which help prevent property damage by protecting against sewer backup or overland flooding.
- **Long Term Solutions** include infrastructure improvements that require significant investment, planning and engineering and will need to be integrated into the City's asset management program.

The City shall use a balance of tools to mitigate flooding so that solutions are resilient and do not rely on only one type of intervention. Four (4) levels of intervention were used in the development of solutions alternatives and are summarized below and in **Figure 3.2** below. Solutions are comprised of infrastructure improvements and measures under each level. All levels shall be used jointly to meet the goals outlined in this study and to meet the established level of service. As improvements are undertaken the system will observe an incremental level of benefit. Only after all level of improvement are completed will the sewer system level of service be met.

4 Levels of Solutions

Source Control:

Includes measures to reduce or slow the volume of rainwater getting into the sewer system. Measures must be taken both in the private property areas and within the City's public right-of-way; therefore, relying on a partnership between the City and property owners.

Sewer System Conveyance and Storage Capacity:

To improve the movement of flows within the City's system, larger sewers are proposed to help the system drain faster. This also includes storing flows temporarily, especially where there are downstream restrictions such as limited receiving watercourse capacity.

Increase Downstream Outlet Capacity:

Includes measures to increase the capacity of the storms, sanitary and combine sewer system outlets, including outlets to watercourses or increasing treatment capacity, where possible.

Coastal Flood Protection:

Incorporates measures to reduce risk of coastal flooding to low lying areas and to reduce backflow of river/lake water into the City's system.

Figure 3-2: Comprehensive Flood Mitigation Solution Toolbox

Specific solutions considered, the evaluation of alternatives and the preferred solutions are detailed in Sections 6.7 of this MP.

4.0 Stakeholder Engagement

4.1 Communication and Engagement Overview

The overall objective of communicating and engaging with specific stakeholders and the broader public was to create a MP that takes various perspectives into account, is understood and supported by the community and can be endorsed by City staff and Council. The following represents the overarching objectives of the MP communication and engagement program and reflections on whether the project was successful at achieving each objective:

Table 4-1: Summary of Public Engagement Objectives

Engagement and Communication Objectives	Reflections on What Was Achieved
Increase awareness of flood management activities and how the public can assist in managing flooding.	Increasing awareness around the project has been a central objective to the engagement and consultation program. The team took a multi-pronged approach to advertisements, notifications and providing updates that included emailing a project list, regular website updates, publishing newsletters, developing educational videos, and promoting events where members of the public could speak with project team members.
Obtain input on MP development.	Members of the public had several opportunities to provide input based on their experiences, preferences and expertise through the project website, at Public Information Centres and Pop-Up events, emailing directly to the project team, and/or other online opportunities, including an interactive map as well as a survey. A number of community members also actively participated in a project Stakeholder Advisory Committee to provide in-depth insights on public communications, key decisions and evaluation criteria.

Engagement and Communication Objectives	Reflections on What Was Achieved
<u>Be transparent and timely</u> and show how the input received was used.	While much of this project involved highly-technical information, the Stakeholder Advisory Committee provided an excellent sounding board assisting in making the information clear and easy to understand for the public and providing advice on community priorities. Project communications demonstrated the current system conditions and provided explanation on why flooding is a City Wide issues. Detailed maps of existing flooding hot spots and confirmed flooding calls has been used to help build solutions that are not one-size fits all.

Table 4-2 summarizes the overall consultation program tactics and timing in relation to the key technical work steps noting that website updates were maintained throughout the project.

Table 4-2: Summary of Consultation Program

Technical Phases and Timing	Communication and Consultation Tactics
Phase 1: Existing Conditions/Define Problem & Opportunity (January 2018 to June 2018)	Newsletters #1 and #2 Notice of Commencement Advertisement in the City's Activity Guide Partners for Action Survey Climate Change Brochure Pop up event #1- Windsor Earth Day Stakeholder Advisory Committee Meetings (1) Public Information Centre #1 Mayor Dilkens Windsor MP Introduction Video Social media promotion around web site launch and events

Technical Phases and Timing	Communication and Consultation Tactics
Phase 2: Develop Long Term Alternative Solutions & Implement Short Term Solutions (July 2018 to December 2018)	Pop up event #2 Stakeholder Advisory Committee Meetings (1)
Phase 3: Evaluate Long Term Solutions (January 2019 to February 2020)	Newsletter #3 First Nations Communication Via Update Letter Pop up event # 3- Windsor Home and Garden Show Pop up event # 4- Windsor Earth Day Event Pop up event # 5- Little River Pollution Control Plant Public Tour Pop up event # 6- Windsor Open Streets Stakeholder Advisory Committee Meetings (4) Property Owner Consultation Sessions and one-on-one meetings Newspaper article "Homeowners encouraged to provide feedback as city moves to finalize sewer master plan" published in the Windsor Star on February 4, 2020 inviting people to PIC #2 Ads in the City of Windsor Activity Guide (Summer and Fall 2018, Fall 2019) Public Information Centre #2 Educational Videos (3) City Engineer MP Update Video Attendance at the Ward 6 Town Hall Meeting – November 7, 2019 Social media promotion around events

Technical Phases and Timing	Communication and Consultation Tactics
Phase 4: Confirm preferred Long Term Strategy/ Document MP (February 2020 to November 2020)	Stakeholder Advisory Committee Meetings (1) Property Owner Meetings Newspaper article “'This is huge.' Windsor approves multi-generational $4.9B sewer plan” published in the Windsor Star on July 27, 2020 to report on council endorsement of the MP conclusions Final Recommendations Presentation To Council – July 27, 2020 Final MP Presented to Council – November 23, 2020 Notice of Completion - December 2nd and 5th, 2020

Throughout the project duration, communication also included continued update to the project website (weatheringthestorm.ca), continued individual engagement through the project email (info@weatheringthestorm.ca).

Detailed information on the engagement program, materials and input received can be found in **Appendix B Stakeholder Consultation Summary**.

4.2 Public Consultation

In addition to viewing information on the project website, the public had a number of opportunities to get informed and involved at public information centres which included displays of technical information and pop-ups which provided opportunity for those attending local events to learn about the MP project. The event are summarized in **Table 4-3**.

Table 4-3: Summary of Public Consultation

	Event and Date	Focus of Discussion	Attendees
PIC # 1	June 12th, 2018 from 5:00 – 8:00 pm at Tecumseh Mall	The purpose of this round of PICs was to present information on the causes and factors being considered to address flooding; the preliminary model results identifying the problems in the sewer and overland drainage systems; short-term solution alternatives, including existing City subsidy programs and alternatives; and next steps. This round also obtained input on what issues should be taken into consideration in evaluating short-term and long-term solutions. Comments received from the public can be found in **Appendix B**.	27 people/families
PIC # 1	June 13th, 2018 from 3:00 – 5:00 pm and 6:00 – 8:00 pm at Fogolar Furlan Club	See June 12th, 2018	11 people/ families
PIC # 1	June 14th, 2018 from 5:00 – 8:00 pm at Roseland Golf and Curling Club	See June 12th, 2018	15 people/ families

	Event and Date	Focus of Discussion	Attendees
PIC # 2	February 4th, 2020 from 5:00 – 8:00pm at Roseland Golf and Curling Club	The second round of PICs took place in February 2020. The focus was on receiving input on the evaluation of alternative solutions, the preliminary preferred solutions and proposed implementation plan. The PIC event included interactive display panels, feedback forms and opportunities for members of the public to ask questions to members of the project team. Comments received from the public can be found in **Appendix B**.	42 people/ families
PIC # 2	February 5th, 2020 from 3:00 – 8:00pm at WFCU Centre	See February 4th, 2020	142 people/ families
PIC # 2	February 6th, 2020 from 5:00 – 8:00pm at Windsor International Aquatic and Training Centre	See February 4th, 2020	30 people/ families
Pop-up Events	Earth Day at Malden Park – April 22, 2018	Introduction to the MP Project	Over 100 people
Pop-up Events	Windsor Open Streets – September 23, 2018	Introduction to the MP Project	Over 140 people
Pop-up Events	Windsor Home & Garden Show – April 12-14, 2019	Introduction to the MP Project	Over 200 people
Pop-up Events	Earth Day at Malden Park – April 28, 2019	Introduction to the MP Project	Over 120 people

	Event and Date	Focus of Discussion	Attendees
Pop-up Events	Windsor Open Streets – September 22, 2019	Introduction to the MP Project	Over 30 people

4.3 Property Owner Consultation

Meetings were held with property owners who would be affected by the location of recommended solutions, including pumping stations, stormwater management ponds, underground storage facilitates and the proposed berm alongside Riverside Dr.

- Riverside Dr. Landform Barrier Property Owner Meeting (Oct. 30, 2019)
- St. Rose Pump Station Property Owner Meetings (Nov. 5, 2019)
- Ford Blvd. Pump Station Property Owner Meetings (Nov. 6, 2019)
- FCA - Fiat Chrysler Automobiles - Windsor Assembly Plant (Jan. 15, 2020)
- Ford Motor Company – Windsor Engine Plant (Feb. 3, 2020)
- Greater Essex School Board (Feb. 5, 2020)
- Rosati Group (May 19, 2020)

In addition to the meetings listed above, several site meetings with residents or neighbour groups to discuss issues or solutions specific to those areas were held throughout the project. Refer to detailed summary of property owner meetings in **Appendix B**.

4.4 Indigenous Communities Consultation

Consultation with Indigenous Communities is an important part of conducting an EA. Engagement with First Nations and Métis provides an Ave. to understand their perspectives regarding the Project. Waste Connections can then incorporate their issues and concerns into the EA and work with Indigenous Communities to find ways to avoid or mitigate issues.

The Indigenous Communities contacted as part of the MP include:

- Aamjiwnaang First Nation;
- Bkejwanong Territory (Walpole Island First Nation);
- Chippewas of Kettle and Stone Point First Nation;
- Chippewas of the Thames First Nation;
- Caldwell First Nation; and

- Oneida Nation of the Thames (ONYOTA'A:KA).

There were four points of contact with these Indigenous Communities:

- March 21, 2018 – Cover Letter and Notice of Commencement letters were sent to each of the Indigenous Communities.
- May 14, 2019 – Project Update and Newsletter #2 was emailed to the entire project contact list which included the Indigenous Communities.
- August 28, 2019 – Project Update was mailed and emailed to each of the Indigenous Communities.
- January 24, 2020 – Project Update and Notice of Public Information Centre was emailed to the entire project contact list which included the Indigenous Communities.

The following group requested to continue to be informed about this project:

- Chippewas of the Thames First Nation (letter dated August 28th, 2019);

As the remaining groups had not responded to the above notifications. Calls were made to all Indigenous Communities in November 2020 to identify whether there were any concerns regarding the project and offering and opportunity to meet to discuss. To date, Walpole Island First Nation has indicated an interest to meet to discuss the project.

4.5 Agency and Municipal Consultation

Liaison and information exchange occurred with key agencies and neighbouring municipalities as follows:

- Between June 2019 and October 2019, the City and Project team has several meetings with the Ministry of Environment, Conservation and Parks (MECP) Environmental Approval and Local branch representatives to review and obtain feedback on the range of alternative solutions developed to reduce flooding risks and to discuss methods to reduce the frequency of combined sewer overflows (CSOs) and manage wet weather flow at the City's two treatment plants.
- Throughout the duration of this project ERCA has been actively involved in the establishment of level of service and development of alternatives for the reduction of flooding specifically for surface and coastal flood protection. ERCA has been integral in the technical development of this project participating in many of the

Technical Steering Committee workshops; as well as the public and property owner meetings.

- The project team has consulted the City's medical, fire and police agencies to provide information on the findings of the MP, confirm findings are consistent with observations of agency members and to confirm that level of service criteria for flood mitigation is sufficient to provide those services the ability to perform their duties for major storm events.
- The Project team met with the Town of Tecumseh (Tecumseh), July 23, 2020, to review recommendations of this mater plan, specifically solutions that are adjacent or related to the shared sanitary sewer system.
- The Project team met with the Town of LaSalle together with ERCA on May 8, 2020 to discuss potential changes to the Grand Marais drain as a result of recommendations of this MP, specifically the potential changes to the flows at the City of Windsor/Town of LaSalle boundary.
- The Town of LaSalle (LaSalle) responded to the Notice of commencement on April 5, 2018 noting interest in this MP and requesting that solutions developed within the upper reaches of the Turkey Creek and River Canard watersheds do not negatively impact those drainage systems. The upper reaches of those watercourses correspond to the South Windsor are defined in this MP study. This request was incorporated into the solution development strategy for this MP under the guidance of ERCA. In April 2020, the MP team provided the Town of LaSalle an Outlet Capacity Assessment report that demonstrated that the MP solutions do not negatively impact the watercourses listed above. MP solution development methodology was presented to the Town of LaSalle on May 8, 2020 via a virtual meeting. The Town of LaSalle has expressed several concerns related to the completion of this outlet assessment, the development of the MP solutions and the condition of the existing drainage watercourses listed above. The concerns of the Town are understood and the City of Windsor and MP team is in agreement that the Town concerns related to the existing drainage conditions need to be assessed. Most notably the Town has requested that a regional study be completed that assesses these drains prior to implementing any solutions within the upper reaches of the associated with those watercourses. Assessment of these watercourses was not included in the scope of this MP but a separate study will be initiated by ERCA and with the cooperation of the Town of LaSalle, Town of

Tecumseh and the City of Windsor. A detailed summary of the consultation related to this item is provided in **Appendix B**.

- On March 25, 2020, a meeting was held with the Source Protection branch of ERCA to provide an overview of the solutions developed and the potential impacts and changes to the downstream receiving watercourses. The Source Water protection representatives provided the project team an overview of the necessary policies and risk management guidelines that are applicable to this MP's recommendations. More information is provided below is Section 7.1 Effects and Mitigation.

4.6 Project Committees

Over 17 meetings were held with the Technical Advisory Committee (TAC) formed to provide regular input and guidance to the project team during the duration of the project. The technical steering committee consisted of representatives from the following City departments:

- Engineering
- Pollution Control
- Recreation & Culture
- Infrastructure & Geomatics
- Finance
- Public Works Operations
- Legal Services
- Fire & Rescue Services
- Planning & Building Services

The TAC was involved in discussion on the modelling results, problem areas, potential solutions, criteria and evaluation methodology, cost and assumptions and a review of public comments.

A Stakeholder advisory committee (SAC) was also formed for this project. The SAC was made up of sixteen (16) people representing community interests, environmental interests, academic interests, and citizens at large. The specific organizations invited to participate and notes of the meetings are included in **Appendix B**.

At each meeting, SAC members contributed thoughtful questions, raised concerns and suggested ways to improve our approach, communications and evaluation criteria. The SAC generously donated several hours of their time over the course of two years to review materials, attend meetings and promote project events within their networks. Their contributions were essential in ensuring the MP would consider and meet the various local needs.

4.7 What We Heard

Through engagement, we learned that residents of Windsor have experienced a range of impacts from recent flooding events. These impacts include repair costs for home and belongings; stress; damage to sentimental items; and other financial costs. The Windsor MP engagement program has tried to understand the flooding experience of Windsor residents in developing the measures that will be taken to mitigate the impacts of future flooding events.

While the impacts of flooding vary among Windsor residents, so do the actions residents are taking. Some residents are proactively installing mechanisms to mitigate the potential for flooding damage in the future; other residents do not believe it is their responsibility to prevent flooding; and some residents are growing frustrated with the City suggesting they are not doing enough to address flooding which is believed to be caused by aging or inadequate infrastructure.

Windsorites use different methods for obtaining flooding information, sharing their experiences and addressing their damage. Through this project we tested some methods of distributing flood related information and obtained an understanding of the type of information that would be valuable to residents moving forward.

The following summarizes some of the recurring themes heard from participants:

- Public education is considered an important element of this project and its ongoing implementation. This could include sharing success stories and being transparent to continue to build community trust. More use of social media was suggested as a way to reach members of the community with information along with the city website.
    - The City will continue to incorporate communication and educating throughout moving forward.
- There is recognition that the proposed landform barrier along Riverside Dr. E. provides protection for the storm sewer system and the larger community; however, property owners along Riverside Dr. have concerns about direct impacts from berm construction.

  - During detailed design, the City will work with property owners on a property-by-property basis to minimize the impacts of berm construction and where properties are above the flood protection elevation the City will work with owners to assign legal status to property grades in lieu of a separate barrier structure.
- Residents along the River/Lake Shoreline, north of Riverside Dr. E., are concerned that the flood protection measures will not provide coastal flood protection for their properties leaving their properties vulnerable.
  - The City has acknowledged the coastal flood risk that exists along the existing shoreline and has notified residents and have developed an emergency preparedness plan for these properties. Due to several factors listed in Section 6.7.1.11.4 of this report, a City-owned and operated structure or protection measure cannot be placed along the shoreline. Additional coordination with property owners and flood risk mitigation will be included in other City programs.
- Development of the surface flooding solutions identified the need for a new pump station within the park north of the St. Rose Ave. and Riverside Dr. E. intersection. Local residents have expressed opposition and concern about this pump station as it would impact valuable park lands, impede views of the River, and have environmental and social environmental impacts.
  - Through this evaluation and functional design process, alternative locations for this pump station where reviewed. The project team reassessed the need for this pump station and was able to reduce the size of the St. Rose Pump Station from 18 m^3/s Capacity (Nov. 6th, 2019 solution presentation) to 13.5 m^3/s which reduced the pump station footprint. It has been determined that his project will be completed as a Schedule C project, which will require additional consultation and site assessment to be completed prior to obtaining construction approvals. The City will liaise with the adjacent community prior to and during detailed design to help the City develop a site layout and aesthetic that fits the character of the neighbourhood for a responsible budget. Refer to Section 6.7.1.7.3 below for more information on the site selection for this PS.

- Residents are prepared to install short-term solutions to their properties; however, they are also keen to learn what the City will be doing for long-term solutions and how much this costs.
  - The MP clearly lays out both the short and long term solutions and the approximate cost and timing to implement.
- Interest in the City taking a holistic approach that considers the implications of climate change (intensity and frequency of storms).
  - The MP modelling and recommended solutions are based on ensuring resiliency given the more intense and frequent storms expected with climate change.
- General support for the use of low-impact development measures (LIDs) and green infrastructure as much as possible to meet the level of service and to offset the need for most costly conventional infrastructure (ie. Sewers, underground storage).
  - In this MP, the use of LIDs is encouraged and it is recommended that the City assess the suitability and feasibility of LIDs as part of every construction project moving forward. For private property areas, the City will incorporate education on how property owners can implement LIDs on their properties and methods of incentivising these measures are being explored as part of the City's Stormwater Financing Study.
- Residents want the City to be transparent and forthcoming with information regarding flood risk and to be proactive by implementation measures to protect residents and reduce flooding risk. the have 'tough conversations' suggesting that terms of mandatory requirements of some short term solutions (examp disconnected downspout) or that some properties are included/excluded from additional considerations (e.g. in reference to the berm and/or break wall).
  - The City has included a number of short term recommendations that involve mandatory requirements and the associated tough conversations.
- Solutions related to coastal flooding should be implemented immediately as the river and lake levels area currently at record high elevations and are projected to rise.
  - Coastal flood protection measures have been assigned a high priority as part of the project implementation plan. In addition, the City is actively looking for external funding sources to be able to move forward with this type of projects. .

- Residents expressed belief that flooding in the City is a result of inadequate infrastructure and management practices. Residents also have been positive about seeing action being taken to address flooding.
    - There are many underlying causes of flooding both on the private and public infrastructure. Municipal infrastructure has historically been constructed according to the standards and technology of the time of implementation. The MP identifies the problems and puts forward solutions. Ongoing maintenance and upkeep are required for all recommended infrastructure.
- Some residents expressed appreciation for the options available to protect their properties (e.g. basement flooding subsidy program). There were also residents who had installed systems to protect their basement that did not work in recent floods.
    - The City realizes that a variety of solutions are required and must be implemented together to address flooding. The MP is based on collaboration between the City and its residents to address flooding.
    - It is recommended that the City provide education to residents to be able to implement and maintain private property projection and source control measures.

5.0 Existing Conditions

5.1 Natural Environment

The balance between human activities and natural features and how they both function, is the key to a healthy and sustainable community. In order to achieve this balance, a community must manage its development activities while also attempting to enhance its natural environment. The City of Windsor's Official Plan designates land as Natural Heritage for areas that are deemed environmentally significant or sensitive, including areas of natural and scientific interest (ANSI) that have been provincially designated. Other areas are designated as Environmental Policy Area (EPA) where the environment may be able to tolerate development activities. Sensitivity to Species at Risk within these designated areas is also required when considering any community infrastructure projects. Flood reduction solutions will need to take into consideration and be sensitive to the natural environmental features in the vicinity of proposed projects.

5.1.1 Environmental Master Plan (City of Windsor)

The Environmental Master Plan completed in January 2017, provides a 20-year vision, intrinsically linked with the City's Strategic Vision, which endeavours to make the City greener, cleaner, healthier and more sustainable. A key component of this updated plan is the consideration of climate change and its impacts on the community's residents in an effort to deal with the challenges posed by more extreme and unpredictable weather events. A comprehensive and integrated approach as important in refining policies, strategies, and actions (short-term and long-term) to promote a healthy, safe and sustainable City. Initiatives proposed include:

- Improvement in Air Quality;
- Improvement in Water Quality;
- Responsible Land Use;
- Increased Efficiency of Resources; and,
- Promotion of Environmental Awareness.

The Environmental MP, recommends the development of a management plan which includes buffer zones and wetland protection, which will naturally provide flood control to reduce flooding risk for residents.

5.1.2 Detroit River Management Strategy (Essex Region Conservation Authority)

The Detroit River, located on the west and north side of the City, was nominated in 1999 as part of the Canadian Heritage River System (CHRS) because of its human heritage and recreational values associated with this unique international waterway that flow through an area inhabited by more than five million people. It is the first river on the continent to receive both Canadian and American heritage river status; designated as an American Heritage River in 1998. As a result of the designation, a management strategy was developed, consisting of five strategic directions for the Detroit River and its watershed:

Strategic Directions

A series of strategic directions for the management of the Detroit River as a Canadian Heritage River follow this goal, and are as follows:

I. Promote the continued importance of the Detroit River's values, and stimulate further community interest in these values by providing increased opportunities for participation in Detroit River related actions.
II. Recognize and support present and future actions undertaken by the local and international community to conserve, interpret, enhance and appreciate the human heritage, natural heritage and recreational values of the Detroit River and its watershed.
III. Support and stimulate further local and international environmental clean-up and enhancement efforts for the Detroit River and its watershed.
IV. Develop partnerships for planning and undertaking integrated local and international river-related actions.
V. Encourage and support policies and legislation which respect and protect the human heritage, recreational and natural heritage values of the Detroit River and its watershed.

Under III, actions listed include:

- Expand implementation of water quality remediation work plans;
- Continue habitat restoration projects;
- Coordinate and expand water-wide water quality monitoring;
- Recognize and support environmental clean-up efforts undertaken;
- Protect natural features through municipal planning documents and other policies;
- Encourage greater public involvement in environmental clean-up activities; and

- Coordinate and expand watershed-wide air quality monitoring and remediation programs.

Strategic direction number IV regarding developing partnerships indicates a willingness to work with the City to achieve remedial measures for flood control in order to improve the surface water environment.

5.1.3 Soils and Topography

Soil type and ground elevations can significantly impact the volume and rate of runoff produced from a rain event. Hard, impervious surface (like pavement) results in more runoff than more pervious surfaces (like grass and soil). The amount of water that can soak into the ground (i.e. infiltration capacity) varies based on the type of soils. The moisture conditions already in the soil also affects the amount of water that can soak into the ground, affecting the volume and rate of runoff. Geo-spatial data from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) identifies the majority of Windsor as having heavy clay soils that have slow to very slow infiltration rates.

Areas of south and western portions of the study area have sections of moderate to high infiltration rates characteristic of sandy soils.

The City of Windsor's relatively flat topography lies within the watersheds of Little River, Turkey Creek, River Canard and Detroit River. The central portion of the City is only 15 m (about 50 ft) higher than lands to the east and west. Stormwater runoff from higher elevation areas can generally be managed by gravity flow. Technical Volume 1 Report includes heat map showing the ground elevations across the study area.

Where recommended solution sites have been identified, a desktop review of historical geotechnical records, by Golder Associates Ltd. have been completed to identify the soil conditions and additional measures required to facilitate construction (refer to **Appendix J).**

5.1.4 Terrestrial Resources

This MP generally focuses on improvements related to underground infrastructure within existing development areas. Where solution alternatives were proposed outside to the City's ROW, in vacant land parcels or within parks, terrestrial resource assessments were completed. Based on the solution alternatives developed for this MP, a total of 31 sites were reviewed. Only sites associated with preferred solutions will have impacts associated with this studies recommendations. The purpose of this review is to assist with the evaluation of alternatives as it relates to terrestrial resource impacts.

A detailed report summarizing the findings and field assessments completed for applicable sites is included in **Appendix H: Natural Environment Baseline Conditions of Project Locations**.

Prior to conducting field investigations, a background information review was completed of existing published data, information available from public agencies, and web-based mapping. Field investigations were conducted on November 20 and 29, 2019 by a Dillon biologist to document existing natural features, including potential areas of significant wildlife habitat (SWH), species at risk (SAR) occurrences, and SAR habitat suitability. Refer to **sub-Appendix H-2, Memo-Natural Environment Baseline Conditions**, for a detailed account.

The purpose of the field investigation was to complete a high-level Ecological Land Classification (ELC) reconnaissance of the identified sites with the objective of confirming the presence of features identified from the background information review, as well as identifying any additional features by visual assessment of the land and natural heritage features.

Within the solution study areas identified, three natural ELC communities were identified (Me, FOD, OA), and six cultural communities were observed (OAG, TAGM5, CVR, CVI, CVC, and CGL), where Me=meadow, FOD=deciduous forest, OA=open water, OAG=open agriculture, TAGM5=fencerow, CVR=residential, CVI=transportation/utilities, CVC=commercial/institutional, and CGL=green land.

Three areas of woodlands as mapped by the MNRF, are located: along Old Little River at the Little River PCP, along Little River at the Little River Golf Course, and a scattering of trees at the St. Paul PS.

The potential exists to provide significant wildlife habitat for the following:

- Bat maternity colonies (FOD);
- Turtle wintering areas (OA);
- Reptile hibernaculum (ME, TAGM5, and FOD); and,
- Amphibian breeding (Woodland, FOD, Wetlands, OA).

Study Area locations are generally urban in nature, dominated by: greenspace, residential, commercial, and institutional lands and as a result, are regularly disturbed. Although the potential to impact SAR and/or their habitat has been determined to be low for the relatively small areas identified, in locations where project activities have the potential to do so, species-specific surveys will be required to confirm the presence/absence of species and/or their habitat during the detailed design phase. Potential impacts can be avoided through appropriate mitigation measures and best practices (e.g. timing windows), and/or through the issuance of an MECP Letter to Proponent.

5.1.5 Aquatic Resources

The City's sewer systems have multiple outlet points to existing watercourses as well as stormwater management ponds. Where solution alternatives are proposed adjacent or within existing aquatic environments, the potential impact of those locations where reviewed in more detail. Only sites associated with preferred solutions will have impacts associated with this studies recommendations. The purpose of this review is to assist with the evaluation of alternatives as it relates to aquatic resource impacts.

A detailed report summarizing the findings and field assessments completed for applicable sites is included in **Appendix H Natural Environment Baseline Conditions of Project Locations**.

Field investigations were conducted on November 20 and 29, 2019 by a Dillon biologist to document existing channel form, presence/absence of flow, substrate type, channel dimensions, riparian vegetation, and whether the system had the potential to support fish habitat. Fish community sampling was not completed.

Given the potential for impacts, including Harmful Alteration, Disruption or Destruction (HADD) of habitat used by fish, as defined by the *Fisheries Act,* a "Request for Review" shall be submitted to the DFO to determine if a Fisheries Act Authorization application is required prior to implementing each individual project. Preliminary design drawings will form part of the submission package.

5.1.6 Receiving Water Capacity and Rainfall

Figure 5-1 illustrates the main receiving watercourses and waterbodies for overland flow, which influenced the range of flood relief solutions available, and consists of the following sub-watershed areas:

- Little River;
- Grand Marais Drain;
- Lennon Drain;
- Cahill Drain; and,
- Detroit River.

A network of 14 rain gauges that collect a continuous record of rainfall volumes is maintained by the City. An additional two rain gauges were added to the sewer model monitoring program in 2018. The rainfall records were used to help characterize and understand the City's drainage network. (Refer to Technical Volume 1 Report for more detail)

The Little River extends 12 km, draining approximately 6500 ha of land area. This drain serves much of the East Windsor sewershed area, including portion of the Town of Tecumseh. This drain discharges directly to Lake St. Clair at its convergence with the Detroit River.

The Grand Marais Drain, which is part of the Turkey Creek Drainage area. This drain serve much of the South Windsor sewershed area.

The Lennon Drain, originating east of Dougall Ave., flows west & south through southern Windsor, including the Roseland Golf Club and St. Clair College sites, ending at the Lennon Drain siphon, constructed as part of the Herb Gray Pkwy., with flow continuing into the Cahill Drain.

The Cahill Drain, originates at Howard Ave. and Cousineau Rd. in the City of Windsor. It drains west along Cousineau Rd. and the Herb Gray Pkwy. (HGP), entering the Town of LaSalle as it crosses the HGP. This drain extends, westerly along Villa Maria Blvd., through vacant lands, crossing Malden Rd., just south of Normandy St. and drains to Turkey Creek. The Cahill drain receives flow from the Lennon Drain and smaller branch drains. A spill over exists within in the Town of LaSalle, that directs flow southerly to the West Branch of the Cahill drain, to River Canard.

The Detroit River, is the receiving body for all of the abovementioned surface drainage areas. The river flows approximately 45 km south, forming part of the border between Canada and the U.S. It is narrow, being 0.8 to 4.0 km wide; and is 16 m deep in the deepest section of the river.

Page is intentionally blank

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Receiving Watercourses & Waterbodies

Figure 5-1

THE CITY OF WINDSOR

OTHER WATERCOURSES AND DRAINS

MAJOR WATERCOURSE OR DRAIN

STUDY AREA

DILLON CONSULTING

Aquafor Beech Limited

MAP DRAWING INFORMATION:
DATA PROVIDED BY CITY OF WINDSOR

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

0 0.5 1 2 km

SCALE 1:60,000

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: 10/22/20

Page is intentionally blank.

5.2 Cultural Environment

As a City rich in cultural resources, and situated along the Detroit River, Windsor is an area of high historical significance. Increasing development pressures encouraged the community to commission the development of an Archaeological Master Plan (2005) and a Cultural Heritage Master Plan (2010) in order to better understand the extent and complexity of its heritage.

The Detroit River, for which the City of Windsor is nestled along a portion of its shore, is one of a series of Canada's forty Heritage Rivers that are recognized nationally for their outstanding natural, cultural, and recreational heritage. It is part of a network of waterways that are cared for by passionate river stewards, including representatives from various government agencies, Indigenous Communities and Groups, local communities, conservation authorities and local citizens. The Canadian Heritage Rivers System recognizes that healthy rivers are essential to life on earth, and that effective and holistic river management helps to ensure that rivers continue to provide a full range of ecological and social benefits for future generations. To that end, the Ontario Ministry of Tourism, Culture and Sports' (OMTCS) checklist, flags any parcel of land that is in the Canadian River System Watershed as requiring cultural assessment, as well as any buildings which are determined to be more than 40 years old with the potential to have cultural heritage value or features.

5.2.1 Cultural Heritage Master Plan (Windsor) 2010

The City of Windsor has committed to recognizing, conserving and enhancing its cultural heritage resources with the City of Windsor's Cultural Heritage MP. The City's Official Plan sets the goals for heritage planning, which are to identify, recognize, protect, enhance and properly manage the City's cultural heritage resources. These resources include buildings, structures, archaeological and historic sites, landscapes and landmarks, either individually or in groups, which are considered to be of significant architectural and/or historic value. To that end, the City of Windsor maintains an online Cultural Heritage Register (July 2019) of the community's physical cultural assets and resources.

5.2.2 Cultural Heritage Sites

In general, heritage buildings are features that are not likely to be affected by underground sewer infrastructure that makes up most of the recommendations of this

MP. Improvements such as pumping stations, ponds, underground stormwater facilities or other improvements outside of the road right of way may present potential impact. **Table 5-1** below lists the five properties that were identified from the City's Cultural Heritage Register, as those locations that may be potentially impacted by the preferred alternatives of this MP. These five sites have been identified as having cultural heritage value or interest (CHVI) by the City, but are not registered under the Ontario Heritage Act. Each of these 5 properties are in the same general area, north of Riverside Dr. E., west of St. Rose Ave. They are within the construction impact zones of the coastal flooding landform barrier (BERM-1-2) and the storm and sanitary trunk sewers proposed along Riverside Dr. E. (STM-E1-1 and SAN-E-2).

Table 5-1: Properties Identified as Having Cultural Heritage Value or Interest

Location	Year Built/ Established	Reason for Consideration	Name of Site
5840 Riverside Dr. E	1929	English Cottage	House
5860 Riverside Dr. E	1925	Vernacular	House
5880 Riverside Dr. E	1946	Colonial Revival	Clifford Hatch-John McCabe House
Lot E, 5880 Riverside Dr E	1913	Private Riverfront Park	Esdras Place Park
5970 Riverside Dr. E	1960	Architect- Harold C. Beckett	Gelling House

A property specific Heritage Impact Assessment (HIA) is required prior to any change to the environment for these properties. A cultural heritage resource assessment of the cultural heritage landscapes will also need to be completed in the vicinity of these sites, which should include an evaluation of each resource based on the criteria set out in Ontario Regulation 9/06.

Consideration of construction activities should be suitably planned on a site by site basis, to avoid impacts to these identified cultural heritage resources. As required by the MHSTC, should construction activities occur in close proximity to identified resources, the impacts of vibrations should be determined through an engineering assessment and any resulting mitigation measures should be implemented prior to construction as needed.

5.2.3 Archaeological Master Plan (Windsor) 2005

In 2005, the City completed an Archaeological Master Plan. The major recommendations of the plan identified the areas of archaeological potential, the recovery of human remains, the maintenance of the City's archaeological database, restrictions on access to sensitive archaeological data, and the disposition of archaeological artifacts. In keeping with the Archaeological Master Plan and the City's Official Plan, Section 9 – Heritage Conservation, Stage 1 Archaeological Assessments were completed for project sites that will be impacted by to Schedule B or C projects. See **Figure 5-2** for the City's Archaeological MP – Archaeological Potential Map. For A or A+ project, the City shall follow the most current Archaeological and Cultural Heritage conservation policy at the time of implementation to identify and protect existing resources.

5.2.4 Stage 1 Archaeological Assessment Summary

The following section provides an overview of the existing condition assessments completed for applicable sites, refer to Section 6.0 for details regarding the propose infrastructure related to each of the solution alternatives.

Initial screening was conducted by Dillon Consulting Limited as part of this MP for sites identified as possible solutions. Ten out of the 33 sites (plus 3 berm segments) were cleared during the desktop review, with the remaining 23 sites (plus the berm segments) requiring further study as part of a Stage 1 Archaeological Assessment conducted by Fisher Archaeological Consultants[9](**Appendix I**), which are listed in the table below.

[9] Note: FAC Stage 1 Archaeological Assessment submitted to MHSTCI on August 21, 2020.

Table 5-2: Stage 1 Archaeological Assessment Sites

Sewershed	Sub-Sewershed Drainage Area	Alternative Code	Alternative Sub-Drainage Area & Proposed Project
Central	Detroit River	STM-C1	Prince Rd. Trunk Sewer – new storm sewer outfall.
Central	Detroit River	STM-C2	Detroit St. Trunk Sewer – upgrade to existing storm sewer outfall.
Central	Detroit River	STM-C3	Cameron Ave. Trunk Sewer – new storm sewer outfall.
Central	Detroit River	STM-C4	Bruce St. Trunk Sewer - new storm sewer outfall.
Central	Detroit River	STM-C5	Parent Ave. (Marentette Ave.) Trunk Sewer – new storm sewer outfall.
Central	Detroit River	STM-C6	New underground stormwater storage facility at Optimist Park. (Ypres Ave.)
Central	Detroit River	STM-C7	Albert Rd. Trunk Sewer - upgrade to an existing storm sewer outfall.
Central	Detroit River	STM-C8	Drouillard Pump Station – new build.
South	Grand Marais Drain	ROAD-S1	Dougall Ave. and Northwood St. – agricultural stormwater management pond (SWM Pond).
South	Grand Marais Drain	ROAD-S2	2929 Howard Ave. – new SWM pond.
South	Grand Marais Drain	ROAD-S3	2459 Chrysler Centre – Underground SWM Facility.
South	Grand Marais Drain	STM-S7	Central Ave. – SWM Pond Expansion
East	Detroit River/ Riverside	PS-E1-ROSE	New St. Rose Pump Station

Sewershed	Sub-Sewershed Drainage Area	Alternative Code	Alternative Sub-Drainage Area & Proposed Project
East	Detroit River/ Riverside	PS-E1-FORD	Ford Blvd PS Improvements
East	Detroit River/ Riverside	PS-E1-STPAUL	Expansion of St. Paul Pump Station
East	Blue Heron	STM-E5	Lakeview PS Improvements & Blue Heron Pond Outlet
East	Little River	ROAD-E4	*Lauzon Pkwy.* – Surface Retention Swales, west of Lauzon Pkwy. *Little River Golf Course* - New Stormwater Management Facility *Meadowbrook Park* - New Underground Storage Facility
East	Little River	ROAD-E11	New stormwater management facility within Roseville Public School Park and Roseville Garden Dr. In-Line Storage Sewer
East	Little River	STM-E6 (SAN-E2)	Improvements at Pontiac Pump Station (LRPCP ByPass) New Underground Stormwater Management Facility Brumpton Park
East	Little River	ROAD-E9	Wyandotte St. East, east of Watson Ave. Commercial land new storm water management facility
East	Landform Barriers	BERM-E1	Riverside Dr. E - East of Villaire Ave, within 5656 Riverside Dr. E. to just west of 5680 Riverside Dr. E., on the north side of the road.

Sewershed	Sub-Sewershed Drainage Area	Alternative Code	Alternative Sub-Drainage Area & Proposed Project
East	Landform Barriers	BERM-E2	Riverside Dr. E.- eastern edge of St. Rose PS on western boundaries of 7010 and 7007 Riverside Dr. E., and continues eastwards, to Little River Drain.
East	Landform Barriers	BERM-E3	Little River Drain along the Ganatchio Trail eastwards on the south side of road to the East Limits of the City of Windsor.

The following sub-sections provide a brief of each of the major findings for each of the entries in **Table 5-2** above, refer to the **Appendix I** for more detailed description and figures for each site area.

5.2.4.1 Central Sewershed

5.2.4.1.1 STM-C1 (Prince Rd. Trunk Sewer Outlet)

A small area within this study area retains high potential for buried archaeological deposits due to its proximity to the River, raised elevation, and location abutting the early Sandwich St. Stage 2 Archaeological Assessment is recommended due to the high potential for the presence of archaeological resources, including burials.

5.2.4.1.2 STM-C2 (Detroit St. Trunk Sewer Outlet)

A portion within the Detroit St. Study Area retains high potential for buried archaeological deposits due to the potential presence of original soils buried beneath fill material on the original shoreline bank, depending on the depth of modern disturbance. Stage 2 Archaeological Assessment is recommended due to the high potential for the presence of archaeological resources.

5.2.4.1.3 STM-C3 (Cameron Ave. Trunk Sewer Outlet)

Undisturbed portions of the Cameron Ave. Study Area retain high potential for Indigenous archaeological material based on its location on the Detroit River shoreline, and also a high potential for 19th century Euro-Canadian and early industrial archaeological resources such as the first railway station. Apart from the known disturbance from the railway tunnel construction, Stage 2 Archaeological Assessment is recommended over the remainder of the Study Area in order to rule out other extensive disturbances from landscaping and utilities and proceed accordingly.

5.2.4.1.4 STM-C4 (Bruce Ave. Trunk Sewer Outlet)

All archaeological potential has been removed due to: The initial infilling and construction of the government docks in the early 1900s; the construction of the Holiday Inn and Odeon Theatre and associated infilling and land alterations in the late 1900s; and the demolition of the Holiday Inn and re-landscaping of the area into a park. No archaeological potential remains in this Study Area. No further work is recommended for this location.

5.2.4.1.5 STM-C5 (Langlois Ave. Storm Sewer Outfall)

Based on background research, the area has high potential for both Indigenous and Euro-Canadian archaeological resources, and high potential for Indigenous burials. There is also the potential presence for structural remains from the 1st century Verhoeff Wharf. The extent of disturbance from the construction of the roundhouse and other rail yard associated activities and from other activities is unknown. Stage 2 Archaeological Assessment is recommended.

5.2.4.1.6 STM-C6 (Optimist Park Underground Stormwater Storage Facility)

This study area has no archaeological sites registered within 300 m; therefore, has low potential for Indigenous archaeological resources. In addition, there is no expectation of historic Euro-Canadian material related to the first generation of settlers within the Study Area. As a result, no further archaeological work is recommended for the Optimist Park Study Area.

5.2.4.1.7 STM-C7 (Albert Rd. Trunk Sewer Outlet)

The background research and property inspection showed that this study area is completely within the bounds of a previous Stage 1 Background Study Report (MHCI Dec 2006); that report concluded that there was low potential for archaeological resources due to extensive disturbance. Fisher reviewed the background information and concurs with this previous report. No further archaeological work is recommended for the Albert Rd. Study Area.

5.2.4.1.8 STM-C8 (Drouillard Rd. Pump Station Site)

The majority of this study area is considered to have low potential due to extensive modern disturbance from the Underpass construction and subsequent demolition of the houses and institutional structures, utilities and a graded, sloped parking lot. The remainder of the study area, including the footprints of the small garden sheds or backyard structures, is considered to retain high archaeological potential as the degree of disturbance to these areas cannot be confirmed at this level of study; therefore, a Stage 2 Archaeological Assessment is recommended

5.2.4.2 South Sewershed

Four (4) solutions were proposed for the Grand Marais Drain sub-drainage area, which as previously mentioned is part of the Turkey Creek Drainage Area.

5.2.4.2.1 ROAD-S1 (Dougall Ave. Underpass / Northwood St.)

This Study Area, consisting of an isolated open field, has no archaeological potential. The background research conducted by Fisher Archaeological for the area of the proposed stormwater management pond (SWM Pond) at Dougall Underpass/Northwood St., concurs with a previous investigation[10] that this Study Area has no archaeological criteria that would trigger the requirement of an archaeological assessment. Therefore, this Study Area has low potential. No further archaeological work is recommended for the Dougall Ave. Underpass/Northwood St. MP Study Area.

5.2.4.2.2 ROAD-S2 (2929 Howard Ave. – SWM Pond)

This potential area consists of a triangular-shaped commercial land use measuring approximately 0.5 ha, with paved driveway and parking area, one structure, grass boulevard and a steep bank on the south side up to the overpass. The extensive modern disturbance renders this area with no archaeological potential. There are no registered archaeological sites within one km. No further archaeological work is recommended for 2929 Howard Ave. MP Study Area.

[10] CRM Group et al. 2005

5.2.4.2.3 ROAD-S3 (2459 Chrysler Ave. - stormwater management facility (SMF))

This proposed area consists of approximately 2.5 ha, rectangular-shaped parking lot for the Chrysler industrial plant, privately-owned, with a narrow grassed edge on the eastern side. There is one registered archaeological site at the one km limit of this area which was not recommended for further work. The land is heavily modified in the vicinity of this area and does not appear to retain its natural topography, with development taking place post-2000; therefore, is deemed to have no archaeological potential. No further archaeological work is recommended for 2459 Chrysler Ave. SMF Study Area.

5.2.4.2.4 STM-S7 (Central Ave. – SWM Pond)

This potential site is located off the southeast corner of the intersection of Central Ave. and Plymouth Dr., and is currently composed of a series of small interconnected ponds. In addition, a portion of 4001 Plymouth Dr. adjacent to the ponds are also examined as part of the proposed area. The topography consists of steep banks down to the pond system from surrounding land uses. There are no registered archaeological sites within one km. As this former agricultural area has been heavily modified by industrial expansion, no archaeological potential remains, and no further archaeological work is recommended for the Central Ave. MP Study Area.

5.2.4.3 East Sewershed

5.2.4.3.1 PS-E-ROSE (New St. Rose Pump Station / Improvements to Existing Pump Station)

The total Study Area measuring approximately 0.7 ha, located on the north side of Riverside Dr. East opposite St. Rose Ave., in St. Rose Beach Park, has about 0.3 ha under water in the Detroit River. Of the remaining 0.4 ha of land, further archaeological work is only recommended for a small strip of land along the roadway that still retains high potential for archaeological resources. The area having low archaeological potential will not require further archaeological work. A Stage 2 Archaeological Assessment is recommended for the small are along the south park boundary.

5.2.4.3.2 PS-E-FORD (Modification of Ford Pump Station, Reaume Park)

The majority of this Study Area retains high archaeological potential and will require further archaeological work. The study area is situated in the east end of Resume-Coventry Park, at 5270 Riverside Dr. East, and is bounded on the east by a residential lot, on the north by the Detroit River, on the south by Riverside Dr. East, and on the west by the rest of the park. The historic mapping and photos indicate that the shore has been infilled to some extent, while it appears that not much other disturbance has occurred in the remainder of the Study Area. The majority of this Study Area retains high archaeological potential and will require further archaeological work. A Stage 2 Archaeological Assessment is recommended for any potential work within the red areas shown in the associated figure in **Appendix I**. The recommended pump station improvements can be completed within the existing pump station wet well; however, the construction of an emergency power generator or monitoring/control panel may will require a Stage 2 assessment.

5.2.4.3.3 PS-E-STPAUL (Expansion of St. Paul Pump Station)

The Study Area, measuring approximately 0.84 ha less 0.13 ha in water, includes the current St. Paul Pump Station, the lawn to the south and east. Most of this Study Area has no archaeological potential as air photos and mapping indicate this area has been altered and infilled. Based on the shoreline configurations, and the history of land use in the Study Area, there is only a small section of the Study Area that could retain archaeological potential as the original shoreline, located in the eastern section adjacent to Riverside Dr. East and is recommended for Stage 2 Assessment. The remainder of the Study Area has low potential and no further work is recommended.

5.2.4.3.4 STM-E5 (Upgrade Lakeview PS & Blue Heron Pond Outlet)

Located on the border between the City of Windsor and the Town of Tecumseh, measuring approximately 0.5 ha in size. The Ganatchio Trail crosses this Study Area. Based on the background information and aerial photos, the northern section that includes the footprint of Riverside Dr. East, does not retain any archaeological potential as it has been infilled and extensively disturbed, and no further work is required in that area. The southern section retains high archaeological potential in those areas that have not been extensively disturbed and will require further archaeological work. A Stage 2 Archaeological Assessment is recommended for areas shown in in **Appendix I**.

5.2.4.3.5 STM-E6 (Storm Area 6, Upgrade Pontiac PS/Brumpton Park Underground SWM)

Upgrade Pontiac PS (STM-E6): This Study Area is trapezoidal in shape and measures approximately 0.75 ha. This alternative consists of the ground of the Pontiac Pump

Station, a land area between the Little River and the 'Old' Little River. There is one registered archaeological site within one km. The archaeological potential for both Indigenous and Euro-Canadian sites is high based on the proximity to the watercourse. Although no photographic evidence could be located to verify extensive disturbances, certain sections may still retain archaeological potential and will require further investigation. A Stage 2 Archaeological Assessment is recommended for portions of this site

Brumpton Park SMF (STM-E6): As part of the Pontiac Pump Station Sub-Watershed, this alternative consists of the whole of Brumpton Park, covering an area roughly 2 ha. There is one registered archaeological site more than one km away. The Study Area has remained parkland with seemingly minimal impacts; therefore, the majority of the area will require further archaeological work. A Stage 2 Archaeological Assessment is recommended.

5.2.4.3.6 ROAD-E4 (Lauzon Pkwy. Storm Sewer Improvements, Surface Storage Swales, Meadowbrook Park Underground SWM, Little River Golf Course SWM Pond

Lauzon Pkwy. Surface Storage Swales

This Study Area measures approximately 4 ha, situated on the west side of Lauzon Pkwy. between Hawthorne Dr. and Cantelon Dr. The background research indicates variability with respect to archaeological potential across this area. The northern half has been extensively disturbed; therefore, has low potential, while the southern half has both high and low potential areas of archaeological resources. A Stage 2 Archaeological Assessment is recommended.

Meadowbrook Park

The Study Area for this alternative does not cover the park in its entirety, rather it excludes a small strip across both the northern and southern borders. Based on background research, the northern section has low potential for archaeology. The southern section is deemed to have high archaeological potential due to the unknown level of disturbance. A Stage 2 Archaeological Assessment is recommended.

Little River Golf Course

This study Area encompasses nearly the entire Little River Golf Course lands. The area would have originally had high archaeological potential due to its proximity to the Little

River; however, based on background review, there is a mixture of high potential and low potential based on level of disturbance. A Stage 2 Archaeological Assessment is recommended.

5.2.4.3.7 ROAD-E9 (Commercial Land SMF)

The Study Area measures approximately 3 ha in an irregular shaped parcel consisting of a shopping plaza with vacant commercial land. The western section has been disturbed to a large extent from previous construction and earth movement. The areas retaining high potential for archaeology such as the grassed area in the southeast portion, are recommended for further investigation; therefore, a Stage 2 Archaeological Assessment is recommended.

5.2.4.3.8 ROAD-E11 (Roseville SMF)

The Study Area measures nearly 4 ha and consists of the Roseville Park and Public School grounds, located opposite Thornberry Crescent on its north side. Both the park and school lands have low archaeological potential, based on background research. No further archaeological work is recommended.

5.2.4.3.9 Riverside Dr. Flood Protection Landform Barriers

Three landform barrier areas were investigated by Fisher Archaeological with a Stage 1 Assessment, namely BERM-E1, BERM-E2, and BERM-E3. As a flood management feature, it is proposed to upgrade some existing ones, and to construct new ones. The overall area of all berms extend from Ford Blvd. to the Town of Tecumseh border, running parallel to the Detroit River and Riverside Dr. E., through the East Sewershed area to the City limits.

BERM-E1

This study area begins east of Villaire Ave., extending on the north side of Riverside Dr. East, to the end which is located between 6867 and 7010 Riverside Dr. East. This area is located within a known pre-1800 Euro-Canadian settlement and within 100 metres of a historic roadway, with known small watercourses that have been infilled or diverted underground. BERM-E1 Study Area is considered to have variable potential for archaeological resources. **Appendix I** figures denote areas with higher potential in red, which are recommended for Stage 2 Archaeological Assessment.

BERM-E2

This study area begins at the eastern edge of the St. Rose Pump Station, extending eastwards, and passing the St. Paul Pump Station area. Previous studies completed indicate a moderate potential for both Indigenous and historic Euro-Canadian archaeological resources and require further study, as it is within an area of pre-1800 Euro-Canadian settlement and parts are within 50 m of the Windsor & Amherstburg Railway. This Study Area has been heavily urbanized, but originally contained two watercourses. The east end has low potential due to modern disturbances. BERM-F2 Study Area is considered to have variable potential for archaeological resources. **Appendix I** figures denote denotes those areas with higher potential in red, which are recommended for Stage 2 Archaeological Assessment.

BERM-E3

This study area begins at the Brumpton Park area and follows the Ganatchio Trail eastwards on the south side of Riverside Dr. East. Previous studies indicate a high potential for archaeological resources in the block area of Martinique Dr., Menard St., and Flora Ave. Shovel test pitting identified extensive fill deposits. Nothing of heritage value or significance was identified. This study area is located within a known area of pre-1800 Euro-Canadian settlement and within 50 m of the Windsor & Amherstburg Railway. Similar to BERM-E2, BERM-E3 has been heavily urbanized, with extensive infilling to former marsh areas and four watercourses. **Appendix I** figures denotes those areas with higher potential in red, which are recommended for Stage 2 Archaeological Assessment.

5.2.5 Stage 2 Archaeological Assessment

Fisher Archaeological Consultants Inc. have identified no archaeological studies required for the South Sewershed. **Table 5-3** lists only the sites requiring further study on portions of lands as indicated in the archaeological study. **Figure 5-3** illustrates the location (orange and violet circles and lines) of study areas requiring a stage 2 Archaeological Assessment.

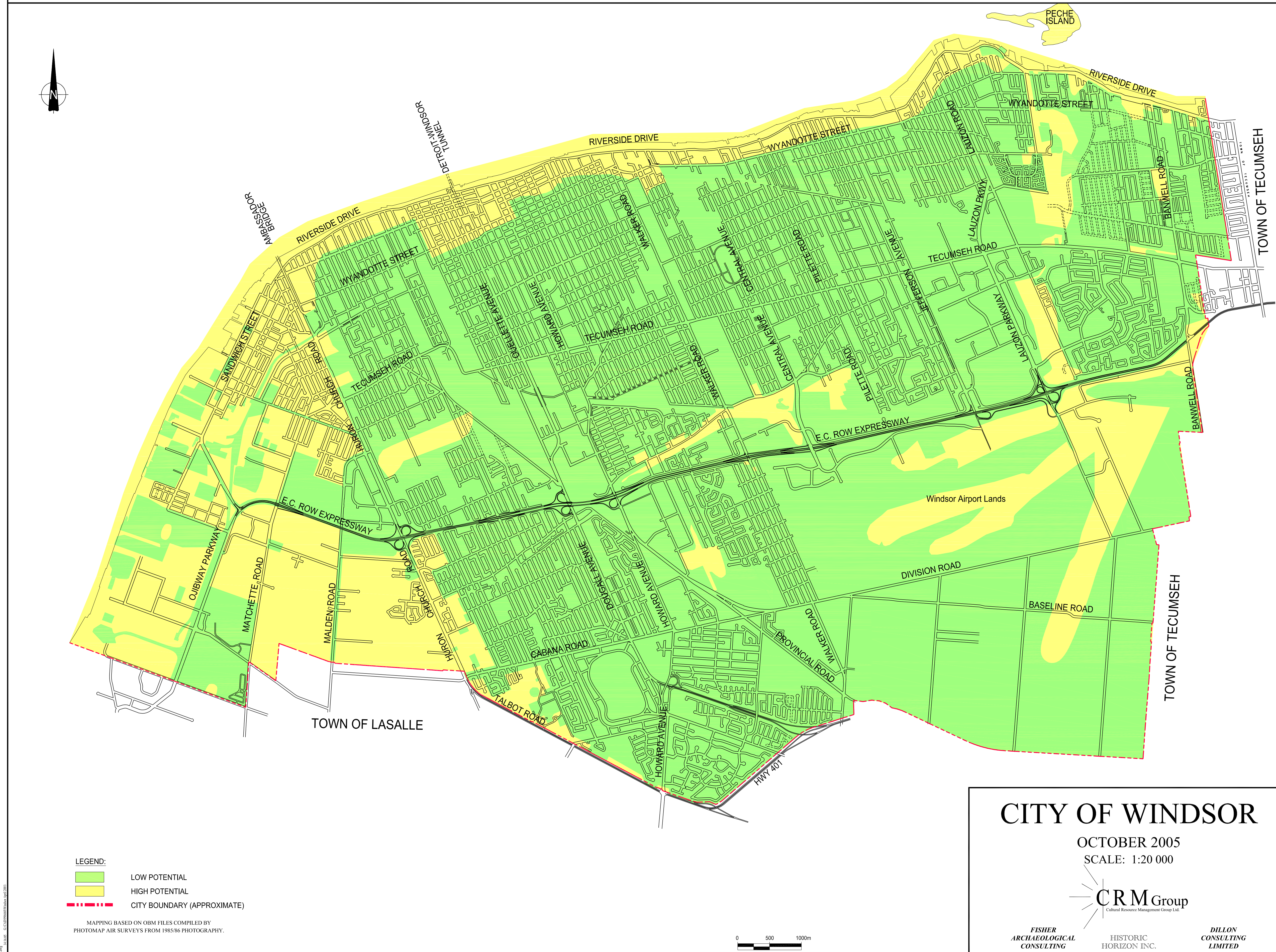
Table 5-3: Sites Requiring Stage 2 Archaeological Assessment

Sewershed	**Sub-Sewershed Drainage Area**	**Alternative Code**	**Alternative** Sub-Drainage Area & Proposed Project
Central	Detroit River	STM-C1	Prince Rd. Sewer – new storm sewer outfall.
Central	Detroit River	STM-C2	Detroit St Sewer – upgrade to storm sewer outfall.
Central	Detroit River	STM-C3	Portion of study area for Cameron Ave. Trunk Sewer – new storm sewer outfall.
Central	Detroit River	STM-C5	Storm sewer outfall at Marentette Ave.
Central	Detroit River	STM-C8	Drouillard Pump Station – new build.
East	Detroit River/ Riverside	PS-E-ROSE	New St. Rose Pump Station
East	Detroit River/ Riverside	PS-E-FORD	New St. Rose Pump Station / Improvements to Ford PS
East	Detroit River/ Riverside	PS-E-STPAUL	Expansion of St. Paul Pump Station
East	Blue Heron	STM-E5	Upgrade Lakeview PS & Blue Heron Pond Outlet

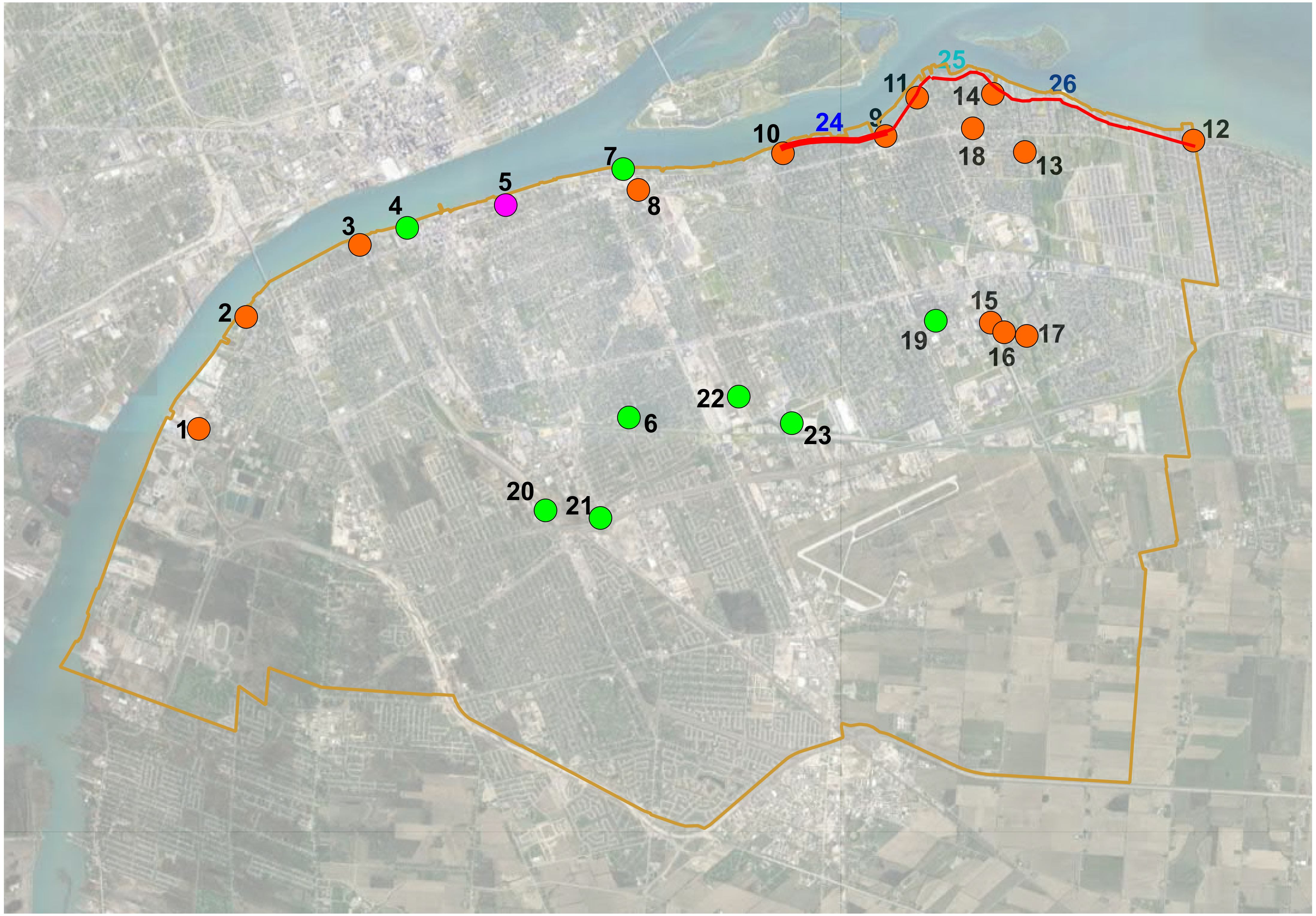
Sewershed	**Sub-Sewershed Drainage Area**	**Alternative Code**	**Alternative** Sub-Drainage Area & Proposed Project
East	Little River	ROAD-E4	Lauzon Pkwy. – Surface Retention Swales, west boulevard. Little River Golf Course - New Stormwater Management Facility Meadowbrook Park - New Underground Storage Facility
East	Pontiac Pump Station	STM-E6	Pontiac PS upgrade Brumpton Park New SMF
East	Pontiac Pump Station	ROAD-E9	Commercial land new storm water management facility
East	Landform Barriers	BERM-E1	BERM-E1 Study Area is considered to have variable potential for archaeological resources
East	Landform Barriers	BERM-E2	Previous studies completed indicate a moderate potential for both Indigenous and historic Euro-Canadian archaeological resources
East	Landform Barriers	BERM-E3	Previous studies indicate a high potential for archaeological resources in the block area of Martinique Dr., Menard St., and Flora Ave.

Page is intentionally blank.

Figure 5-2: Windsor Archaeological Master Plan - Heritage Conservation Areas



Page is intentionally blank.



Satellite Imagery: Google Earth 2017

N

Scale
0 2.5 km

Study Area Key

Central Windsor

1 Prince Rd New Outfall STM-C1

2 Detroit St Outfall Upgrade STM-C2

3 Cameron Ave New Outfall STM-C3

4 Bruce Ave New Outfall STM-C5a (STM-C4)

5 Marentette Ave New Outfall STM-C5b (STM-C4)

6 Optimist Park New Storage STM-C6

7 Albert Rd New Outfall STM-C7

8 Drouillard Underpass New Pump Station STM-C8

South Windsor

20 Dougall Underpass SMP, ROAD-S1

21 2929 Howard Avenue SMP, ROAD-S2

22 2459 Chrysler Centre SMF, ROAD-S3

23 Central Avenue SMP Expansion STM-S7

East Windsor

9 New St. Rose PS PS-E-ROSE

10 Ford PS Upgrades PS-E-FORD

11 St. Paul PS Expansion PS-E-STPAUL

12 Blue Heron/Lakeview PS Upgrades STM-E5

13 Pontiac PS Upgrades STM-E6

14 Brumpton Park, SMF STM-E6

15 LID Swales, Lauzon Parkway ROAD-E4

16 Lauzon Parkway, Meadowbrook Park, SMF ROAD-E4

17 Lauzon Parkway, Little River Golf Course, SMP ROAD-E4

18 Commercial Wyandotte at Watson, SMF ROAD-E9

19 Roseville School & Park, SMF ROAD-E11

Riverside Landform Barriers

24 BERM-E1 & Riverside Vista

25 BERM-E2

26 BERM-E3

FAC
Date: 9/07/20
Designer:RM

KEY

City of Windsor Boundary

Landform Barriers (BERMS E-1, E-2, E-3) & Riverside Vista Stage 2 Archaeological Assessment Recommended for Portions of the Berm Study Areas 24, 25, 26

Sewershed Solution Areas, Recommendations Key

No Further Work Recommended

Stage 2 Recommended for Part of the Study Area

Stage 2 Recommended for All of the Study Area

CITY OF WINDSOR
SEWER & COASTAL FLOOD PROTECTION MASTER PLAN
Archaeological Stage 1 Assessment: Background Study
Windsor Archaeological Master Plan - Heritage Conservation Areas
Figure 5-2

Page is intentionally blank.

5.3 Socio-Economic Environment

The team spoke with the City's Planning Development Department to garner an understanding of existing conditions and future development areas anticipated in the City. To complement the information attained, a City-wide background review was also undertaken. The following sub-sections outline the findings of the inventory, including existing population statistics, economic conditions of the community, and land use information pertaining to flooding.

5.3.1 Population Statistics

Population data for the City of Windsor was based on the Statistics Canada 2011 Census which was provided and adapted by the City of Windsor Planning Department is used to determine estimate population data within each stormwater sub-catchment area. The Land Use map is included as **Figure 5-4.**

Between 2011 and 2016 Census periods, the City's population grew by 3%, from 210,891 to 217,188. The average age of residents was 40.2 years of age with the dominant age range being 45 to 49 years of age and 77% of households that include children.

5.3.2 Economic Setting

The City of Windsor's economy consists of mostly manufacturing, mining, and tourism, education and government services. The city is a major automobile manufacturing hub that includes the FCA Canada minivan assembly plant, two Ford Motor Company engine plants, and several tool and die automotive parts manufacturers. The Windsor Salt Mine employs approximately 250 people, producing road and mining salt. The experienced labour force in Windsor totals 101,875 in 2016[11] and an employment rate of 51.8%. Unemployment rate for the community in 2016 was listed at 9.2 percent.

Tourism in the City includes a casino that is one of the largest employers and is the largest in Canada. The city's extensive river and lakefront park system attract visitors from outside the region as well. Other sectors represented in the city include: pharmaceutical, alternative energy, insurance, software, and internet. The Great Lakes Regional office of the International Joint Commission (IJC) is located in the City of Windsor.

---

[11] Statistics Canada. 2016 Census – City of Windsor.

5.3.3 Land Use

The City of Windsor encompasses approximately 150 square kilometres, situated on the south bank of the Detroit River and Lake St. Clair. The city is located within Essex County and is the southernmost city in Canada directly across from Detroit, Michigan. With a population in 2016 of 287,069 Windsor is the seventh most populated city in Ontario; with the international crossing at the Ambassador Bridge as the busiest commercial crossing between Canada and the U.S. Windsor is the western terminating point of both Highway 401 and Via Rail's railway corridor.

The Official Plan Land Use map as well as Zoning By-Law 8600 were provided by the City of Windsor Planning Department to determine initial land uses throughout the City with respect to understanding flooding impacts. The zoning maps, respective By-Laws and 2013 aerial imaging were referenced to identify and confirm each land use category for existing and future land uses summarized below with their representative zoning district in order to better understand the imperious nature of the community.

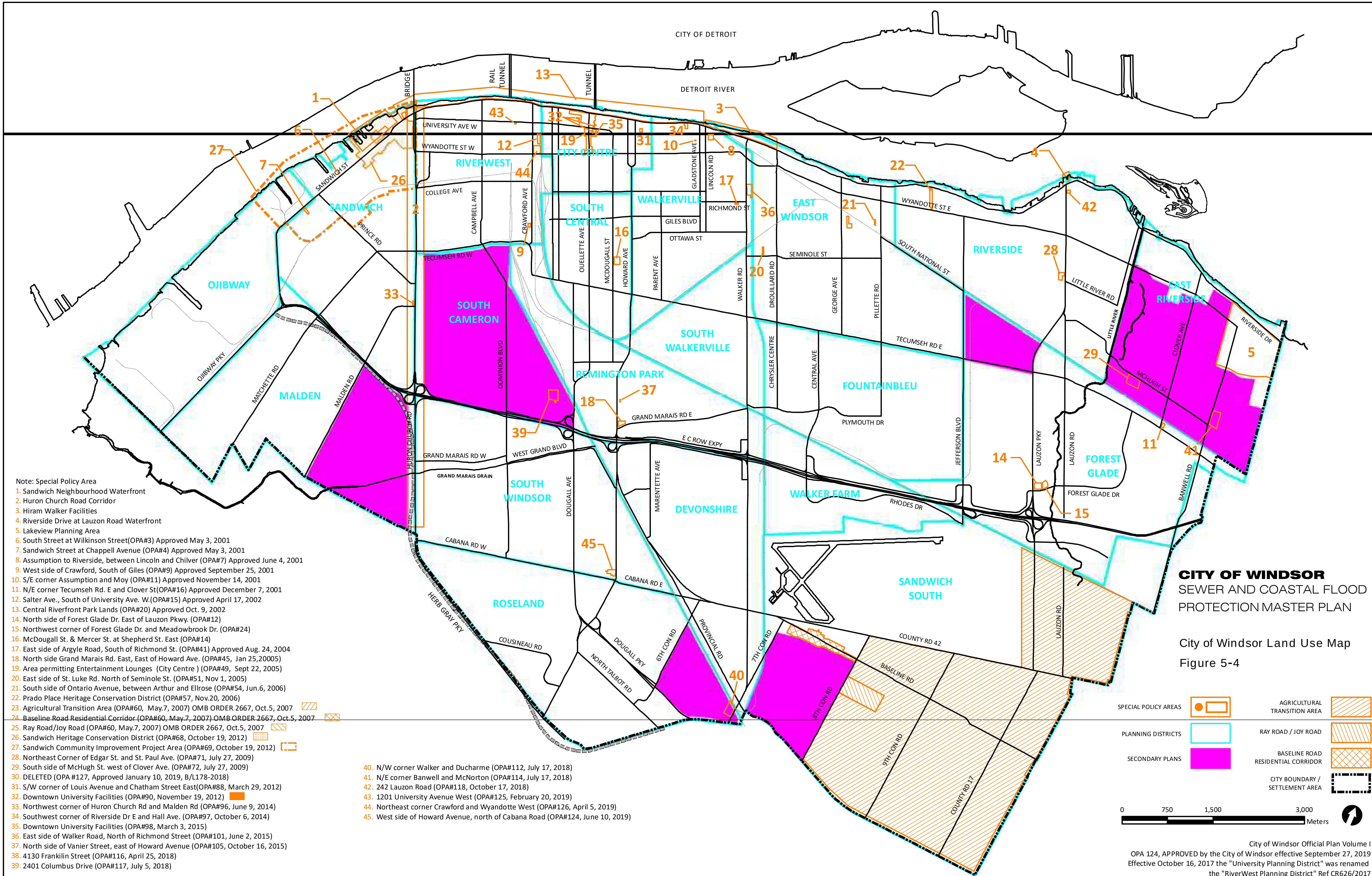
Table 5-4: City of Windsor Land Use Designations

Zoning	Associated Zoning Districts	Description
Low Density Residential	RD1.1 – RD1.7	Single Unit
Medium Density Residential	RD2.1 – RD2.6	Single Unit, Duplex, Semi-Detached
High Density Residential	RD3.1 – RD3.15	Multiple Dwellings, Townhomes, Residential Care Facility
Institutional	ID1.1 – ID1.6	Church, School, Day Nursery
Commercial	CD1.1 – CD4.6	General/Highway Commercial, Neighbourhood Convenience, Restaurant, Grocery, Gas Bar, Auto Sales, Hotel
Light Industrial	MD1.1 – MD1.8	Light Manufacturing Districts, Business Park, Transportation/Shipping, Railway

Zoning	Associated Zoning Districts	Description
Heavy Industrial	MD2.1 – MD2.8	Heavy Manufacturing, Aggregate Industrial, Automotive Assembly
Parkland	GD1.1 – GD1.3	Green Districts, Public Park, Golf Course, Cemetery

For wastewater flow contributions, the population within each sub-catchment area was estimated based on the above zoning definitions and population census data. Illustrations of the distinctive land uses are provided in the Phase 1 Study.

Page is intentionally blank.


CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN
City of Windsor Land Use Map
Figure 5-4
CITY OF DETROIT
DETROIT RIVER
RIVERWEST
CITY CENTRE
SANDWICH
SOUTH CENTRAL
WALKERVILLE
EAST WINDSOR
RIVERSIDE
EAST RIVERSIDE
OJIBWAY
SOUTH CAMERON
SOUTH WALKERVILLE
MALDEN
REMINGTON PARK
FOUNTAINBLEU
FOREST GLADE
SOUTH WINDSOR
DEVONSHIRE
WALKER FARM
SANDWICH SOUTH
ROSELAND
Note: Special Policy Area
1. Sandwich Neighbourhood Waterfront
2. Huron Church Road Corridor
3. Hiram Walker Facilities
4. Riverside Drive at Lauzon Road Waterfront
5. Lakeview Planning Area
6. South Street at Wilkinson Street(OPA#3) Approved May 3, 2001
7. Sandwich Street at Chappell Avenue (OPA#4) Approved May 3, 2001
8. Assumption to Riverside, between Lincoln and Chilver (OPA#7) Approved June 4, 2001
9. West side of Crawford, South of Giles (OPA#9) Approved September 25, 2001
10. S/E corner Assumption and Moy (OPA#11) Approved November 14, 2001
11. N/E corner Tecumseh Rd. E and Clover St(OPA#16) Approved December 7, 2001
12. Salter Ave., South of University Ave. W.(OPA#15) Approved April 17, 2002
13. Central Riverfront Park Lands (OPA#20) Approved Oct. 9, 2002
14. North side of Forest Glade Dr. East of Lauzon Pkwy. (OPA#12)
15. Northwest corner of Forest Glade Dr. and Meadowbrook Dr. (OPA#24)
16. McDougall St. & Mercer St. at Shepherd St. East (OPA#14)
17. East side of Argyle Road, South of Richmond St. (OPA#41) Approved Aug. 24, 2004
18. North side Grand Marais Rd. East, East of Howard Ave. (OPA#45, Jan 25,20005)
19. Area permitting Entertainment Lounges (City Centre) (OPA#49, Sept 22, 2005)
20. East side of St. Luke Rd. North of Seminole St. (OPA#51, Nov 1, 2005)
21. South side of Ontario Avenue, between Arthur and Ellrose (OPA#54, Jun.6, 2006)
22. Prado Place Heritage Conservation District (OPA#57, Nov.20, 2006)
23. Agricultural Transition Area (OPA#60, May.7, 2007) OMB ORDER 2667, Oct.5, 2007
24. Baseline Road Residential Corridor (OPA#60, May.7, 2007) OMB ORDER 2667, Oct.5, 2007
25. Ray Road/Joy Road (OPA#60, May.7, 2007) OMB ORDER 2667, Oct.5, 2007
26. Sandwich Heritage Conservation District (OPA#68, October 19, 2012)
27. Sandwich Community Improvement Project Area (OPA#69, October 19, 2012)
28. Northeast Corner of Edgar St. and St. Paul Ave. (OPA#71, July 27, 2009)
29. South side of McHugh St. west of Clover Ave. (OPA#72, July 27, 2009)
30. DELETED (OPA #127, Approved January 10, 2019, B/L178-2018)
31. S/W corner of Louis Avenue and Chatham Street East(OPA#88, March 29, 2012)
32. Downtown University Facilities (OPA#90, November 19, 2012)
33. Northwest corner of Huron Church Rd and Malden Rd (OPA#96, June 9, 2014)
34. Southwest corner of Riverside Dr E and Hall Ave. (OPA#97, October 6, 2014)
35. Downtown University Facilities (OPA#98, March 3, 2015)
36. East side of Walker Road, North of Richmond Street (OPA#101, June 2, 2015)
37. North side of Vanier Street, east of Howard Avenue (OPA#105, October 16, 2015)
38. 4130 Frankilin Street (OPA#116, April 25, 2018)
39. 2401 Columbus Drive (OPA#117, July 5, 2018)
40. N/W corner Walker and Ducharme (OPA#112, July 17, 2018)
41. N/E corner Banwell and McNorton (OPA#114, July 17, 2018)
42. 242 Lauzon Road (OPA#118, October 17, 2018)
43. 1201 University Avenue West (OPA#125, February 20, 2019)
44. Northeast corner Crawford and Wyandotte West (OPA#126, April 5, 2019)
45. West side of Howard Avenue, north of Cabana Road (OPA#124, June 10, 2019)
SPECIAL POLICY AREAS
PLANNING DISTRICTS
SECONDARY PLANS
AGRICULTURAL TRANSITION AREA
RAY ROAD / JOY ROAD
BASELINE ROAD RESIDENTIAL CORRIDOR
CITY BOUNDARY / SETTLEMENT AREA
0 750 1,500 3,000 Meters
City of Windsor Official Plan Volume I
OPA 124, APPROVED by the City of Windsor effective September 27, 2019
Effective October 16, 2017 the "University Planning District" was renamed
the "RiverWest Planning District" Ref CR626/2017

Page is intentionally blank.

5.4 Existing City of Windsor Infrastructure

Three types of drainage systems exist with the City of Windsor; sanitary, storm and combined sewer systems. For the purposes of this study, the City has been separated into three sewershed areas, Central, South and East, each of these three systems having a unique combination of sewer types. Refer to for an illustration of the three existing Sewershed Districts.

5.4.1 Sewer Definitions

Sanitary Sewers:

The sanitary sewer systems conveys domestic sewage via local service connections from residential, commercial, industrial, institutional and other land uses to a wastewater treatment plant where it is filtered, treated and discharged. Within the City of Windsor, the two major sanitary outlets are as follows:

- Lou Romano Water Reclamation Plant; and
- Little River Pollution Control Plant.

Storm Sewers:

Storm sewers collect and convey rainwater to open watercourses such as the Detroit River. Rainwater enters the storm system at various sources, including catchbasins and private storm connections (drainage from foundation drains, rear yard catchbasins and roof downspouts). Storm sewers typical drain via gravity; however, pumping stations are used to overcome issues related to grade cover, conflicts with other infrastructure or water levels at outlets to receiving watercourses.

Combined Sewers:

Combined sewers convey stormwater runoff, sanitary sewage, and industrial wastewater in a single pipe. Under dry-weather conditions, all flows are conveyed to the downstream treatment plant. Under wet weather conditions, stormwater runoff sometimes exceeds the combined sewer's capacity, resulting in overflow to the Detroit River or other waterways.

5.4.1.1 Central Windsor Sewershed Characteristics

The Central Windsor lands are currently serviced or proposed to be serviced by the northern combined sewer trunk outletting to the Lou Romano Water Reclamation Plan (LRWRP). This includes Central Downtown Area, West Windsor and Walkerville. The existing drainage in this service area is primarily combined with several small pockets of separated systems. The stormwater drainage for this area is mostly conveyed to the Detroit River, with the exception of some southern lands which drain to the Grand Marais Drain.

The City of Windsor has historically provided for the continued separation of combined sewers as outlined in the community's Infrastructure Management Plan. These measures were to prevent backup of domestic sewage from existing overtaxed sewers or where needed, to reduce the demand on the pollution control plants. Soft separation of combined sewers is completed when roadways are reconstructed. In spite of this, there remains areas of combined sewer in the City and a need for an enhanced level of sewer separation that includes removal of all surface and roof (downspout) drainage to the sewer system, as well as removal of building foundation drainage (weeping tile) from the sewer system. See **Figure 5-6** for an illustration of the areas with combined and partially combined sewers in the Central Sewershed. Less than 20% of the lands are serviced by fully separated storm and sanitary sewer systems in Central Sewershed. There remains an estimated 300 km of combined sewers remaining to separate in the Central Sewershed.

In addition, there is a dual manhole system consisting of two pipes in parallel, one for stormwater conveyance, and the second lower pipe for conveyance of sanitary sewage. Under wet weather conditions, flows can mix between the two pipes of the dual manhole system. Replacing these sewers can also work to reduce the demand on the pollution control plants. See **Figure 5-5** for an illustration of the Dual Manhole Standard Drawing. There remains an estimated 73 kilometres of dual manhole sewers yet to be replaced in the Central Sewershed. Both the combined and dual manhole sewer systems are designed to convey stormwater but under heavy rainfall conditions, there is potential for the water levels in the sewers to surcharge. This increases the risk of basement flooding in properties without back flow preventers or similar protection measures.

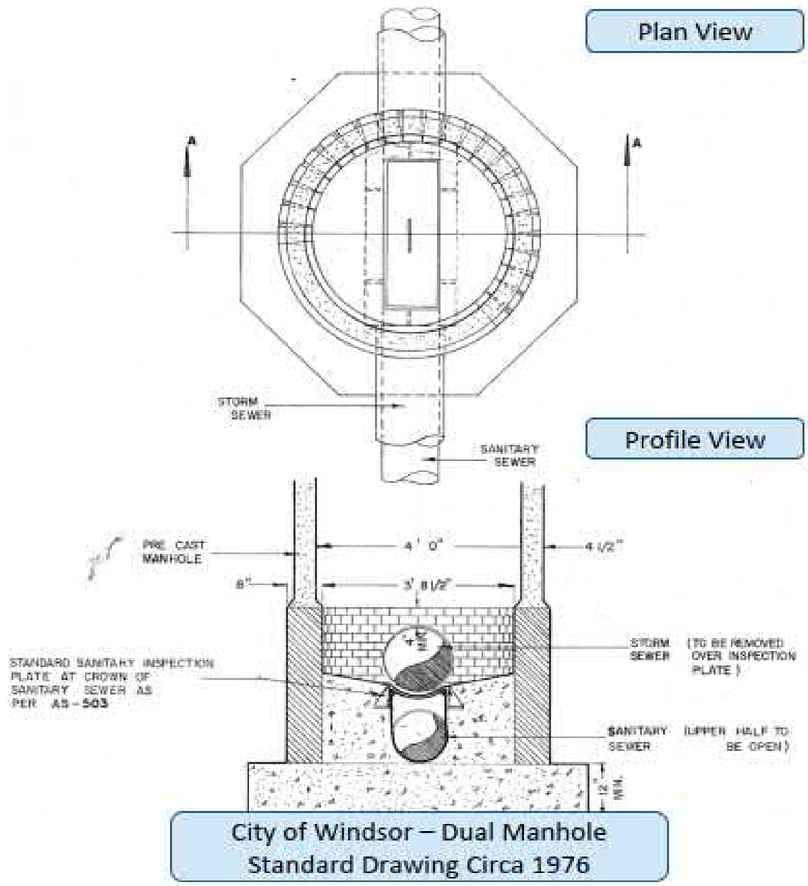


Figure 5-5: Dual Manhole Standard Drawing

An existing combined sewer overflow (CSO) management strategy was developed in coordination with the MECP, and includes limiting the overflows to the Detroit River and providing water quality treatment for overflows using Retention Treatment Basin (RTB) facilities.

The existing storm sewers system is serviced via outlets to the Detroit River. These outlets drain to the Detroit River by gravity with low risk of backflow of river into the system due to the grade difference between the inland areas and the Detroit River.

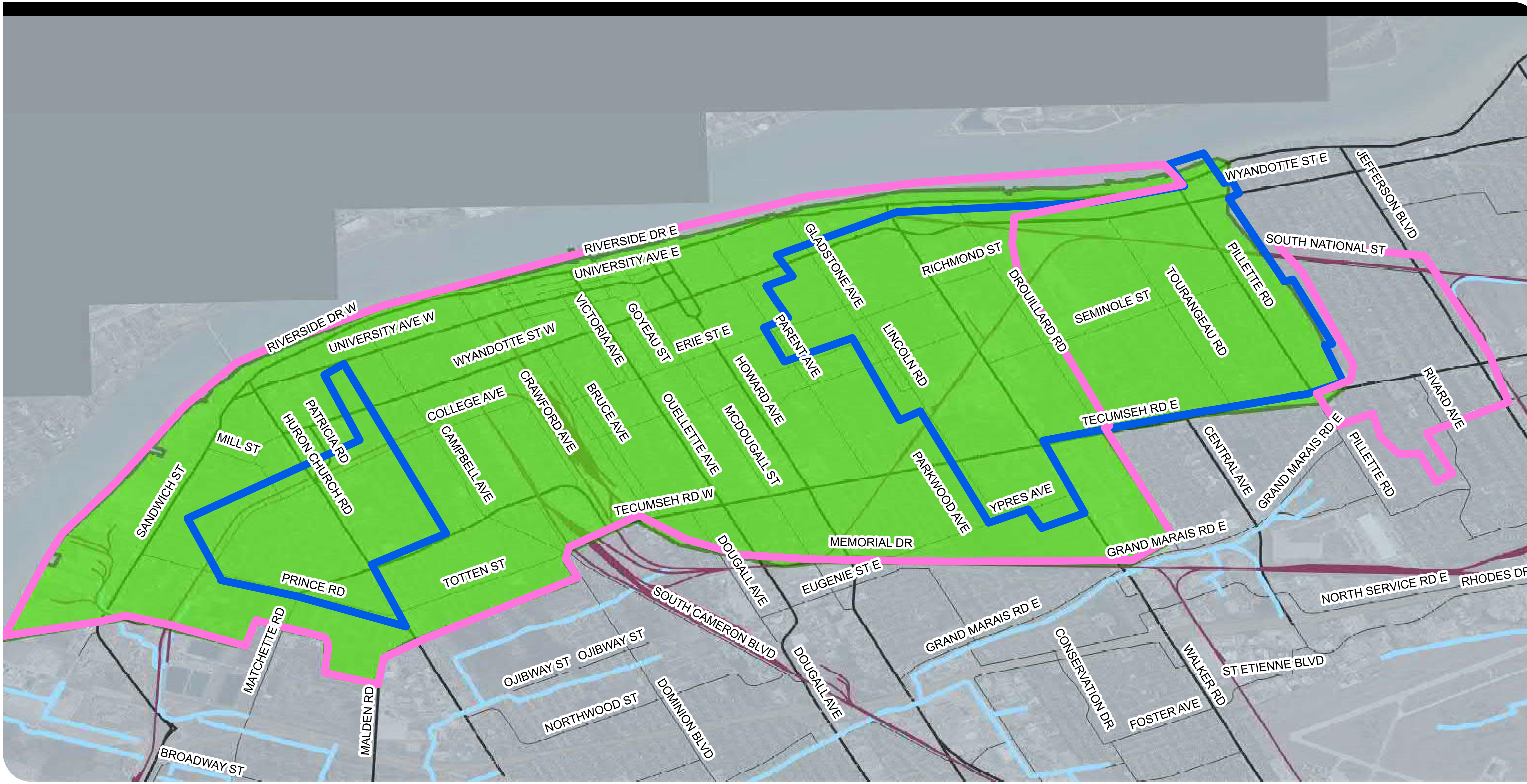
5.4.1.2 South Windsor Sewershed Characteristics

South Windsor is serviced by a separated sewer system consisting of both sanitary and storm sewers. The sanitary sewers convey sewage flows to the LRWRP and the storm sewers generally drain via storm sewer or open ditch to the Grand Marais, Cahill, Lennon or Wolfe municipal drains.

5.4.1.3 East Windsor Sewershed Characteristics

East Windsor is mostly serviced by a separated sewers system of storm and sanitary sewers. The sanitary sewer conveys sewage flows to the LRPCP. There is an area of east Windsor, bounded by Jefferson and Pillette Ave., south of South National St. that has combined sewers, which conveys both sewage flows and road drainage to the LRPCP.

The storm system generally discharges storm sewer drainage to the Little River Drain of directly to the Detroit River/Lake St. Clair. Many of the storm sewers servicing the East Windsor sewershed area discharge to the Detroit River, via pumping stations due to the grade differential between the lake/river water levels and the storms system and to also to prevent water from backing up into the sewer system by providing a disconnect between the storm sewers system and the lake/river.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Areas of Combined or Partially Combined Stormwater Sewers

Figure 5-6

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
COMBINED SEWER SYSTEM AREA
CENTRAL WINDSOR AREA
DUAL MANHOLE SEWER SYSTEM AREA

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY:IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:40,000

N E S W

PROJECT: 17-6638
STATUS: FINAL
DATE: October 2020

Page is intentionally blank.

5.4.2 Flood Protection Infrastructure

Lake St. Clair and the Detroit River flank the north and west boundaries of the City. Historically the City has implemented retaining walls and earth barriers to protect against erosion and inland flooding. For the context of this study, focus was given to the flood protection infrastructure in the Riverside areas, between Ford Blvd. and the east City limits, where inland topography is low and vulnerable to impacts of high lake/river water levels. Historically, this area has been protected by earth berms constructed in the 1980's along the south side of Riverside Blvd. A detailed description and background of the existing flood protection is included in the East Riverside Flood Risk Assessment study completed by Landmark Engineering (2019). Over time, the condition of the existing earth berm has been compromised due to the construction of cross streets and other site modifications.

5.4.3 Overview of Sewer Model Development

As the basis for the development of solutions, a computation model was developed. The model is calibrated using in sewer or drain flow monitoring, precipitation data collected throughout the City over many years, flooding call data, and observations from stakeholders and City administration.

The following flowchart (**Figure 5-7**) illustrates the process in the development of the Baseline Sewer Model.

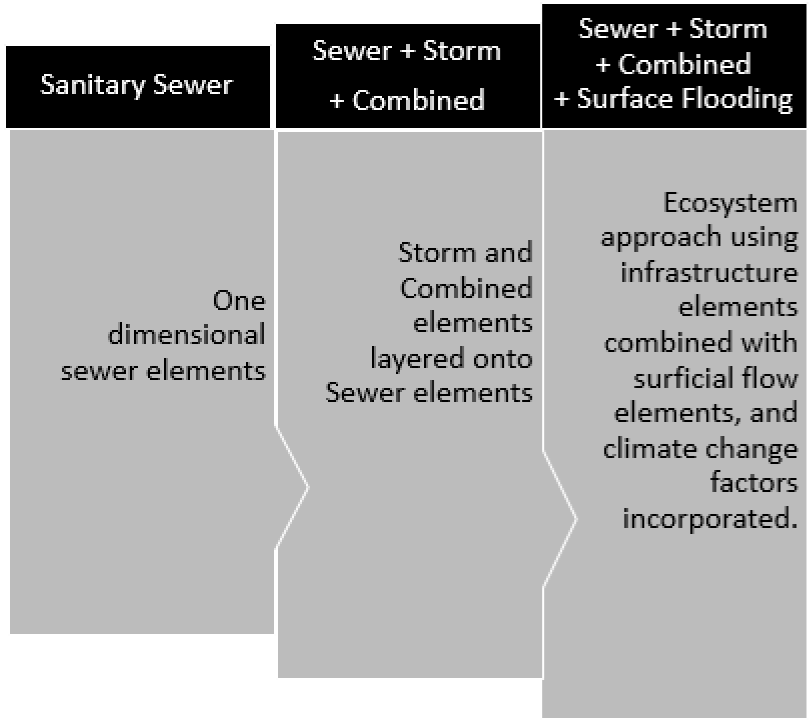


Figure 5-7: Flowchart of Model Development

The system was gauged using the one dimensional sewer elements from the model comparing the depth of the sewer hydraulic grade line (HGL) to the ground surface. Typically, the depth of a residential basement, from ground surface to basement floor is 1.8 m (6 feet). Where sanitary sewer and combined sewer HGLs are below typical basement floor elevations, it is assumed that basement flooding is unlikely to occur. Depth of the HGL was measured at each municipal sanitary manhole (node). Any nodes where the HGL was less than 1.8 m below the ground surface were considered surcharged for the design storms. It should be noted that homes are typically built higher then adjacent roadways and boulevards.

Properties, such as commercial, industrial or institutional buildings may have lower basement floor depths; however, for the purpose of this MP, it is assumed that those facilities have or may be equipped with plumbing features or mitigation measures to mitigate municipal backflow into their systems.

Water levels at sewer system outlets, such as ditches, drains, watercourses or rivers, directly impact the hydraulics of the City's sewer systems. It was essential to consider these open bodies of water to establish appropriate outlet condition parameters.

The following approach and assumptions were used to establish outlet conditions parameters for the purpose of this assessment and the development of recommended solutions.

For storm events, less than the 1:100 year occurrence:

- A normal outfall boundary condition was applied. Under these conditions the water level at the outfall is estimated without any additional restriction of flow or water causing a backup; and
- This approach was selected to represent the average or lower water levels expected under these less severe events.

For storm events, including design storms equal to or exceeding the 1:100 year occurrence:

- Constant fixed high water level conditions were used at outfalls and were obtained from other recent studies and modelling exercises (176.45 Existing ERCA 1:100 Year Event High Water Level); and
- This approach was selected to represent high water level conditions that could occur under a 1:100 year storm, although these conditions could be mutually independent.

After expanding the baseline sewer model, re-calibration was required to ensure the software tool provided a reasonable representation of sewer and surface flooding conditions. This calibration focused on representation of basement and surface flooding with an emphasis on the sanitary sewers wet-weather response inflow and infiltration. To represent surface flooding conditions a two-dimensional mesh was implemented to account for overland drainage system in the City.

The major system calibration was completed using records of observed flooding from the August 28, 2017 and September 28, 2016 storm events. These records were compiled with the help of City staff, both photos and descriptions of flooding were provided. The calibration process for the major system differed from the process for the sewer system calibration, as exact details or numbers for surface flooding were not recorded. Areas with observed significant surface flooding were documented and compared with the model estimates of surface flooding, model parameters, including the percent impervious and dimension; which were adjusted to increase flooding potential until a reasonable representation was developed.

The calibration and validation results indicated the following:

- The modelled sanitary sewer wet weather response was found to have a good to moderate match for storm events similar to or more intense than the 1:2 year occurrence, and further for the larger sanitary sewer service areas under extreme wet weather events, matches were good.
- The modelled storm sewer estimates were found to have a good to moderate match for storm events similar too or more intense than the 1:2 year occurrence.
- The modelled combined sewer estimates were found to have a good to moderate match for storm events less intense than the 1:2 year up to a 1:10 year occurrence.
- Major system (surface drainage) calibration was completed using observed records of surface flooding.

The resulting model is considered a reasonable baseline representation of the City of Windsor's storm, sanitary and combined sewer systems for storm events similar to or more intense than the 1:2 occurrence. Therefore, the baseline conditions model is an appropriate tool to evaluate existing flooding conditions and to develop, review and compare solutions to alleviate future surface and basement flooding.

5.4.3.1 Review of Documentation Pertinent to Model Development

A review was completed that compiled information from over 110 available City background reports related to existing sewers and drainage conditions. See **Appendix A** for a summary report of the review conducted of the City of Windsor's documentation of sewer and drainage conditions. The purpose of this review was to update and incorporate necessary information into the sewer model and to understand measures and analysis the City has completed.

The reports that were reviewed are organized by stormwater watersheds and the Little River/Lou Romano sanitary drainage areas. The summaries of the select studies are organized by the City's major storm and sanitary service areas.

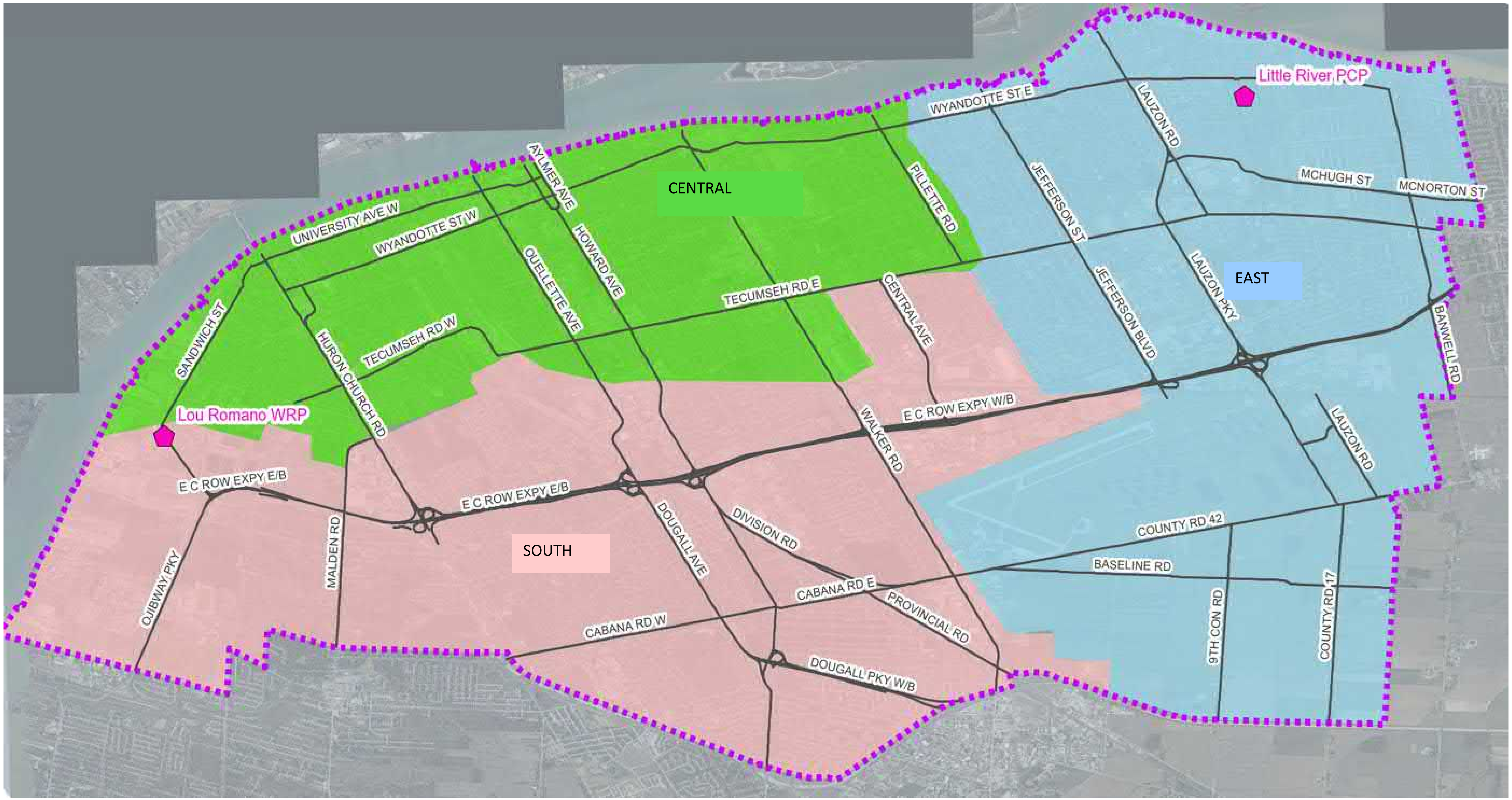


Figure 5-8: Major Sewershed Districts

Page is intentionally blank.

5.4.4 Overview of Primary Roadway System

In the review and identification of problem areas, the need to identify surface flooding along major roadways is imperative. Not only at their local safety and property damage risks associated with local flooding but major roadways within the City act provide major connection of residents are more notably for emergency services. Road classification was used to determine which roadway flooding areas were go be addressed through this MP.

The pertinent primary roadway network classifications within the City of Windsor as documented in the City of Windsor Official Plan[12] under Chapter 7 and include:

- Class I & II Arterial Roads (County Roads)
- Class I & II Collector Roads

Cycling facilities may be permitted on any of these roadway categories.

Class I Arterial Roads are controlled access highways designed to carry high volumes of passenger and commercial traffic for intra-city travel at moderate speeds. They have a minimum right-of-way width of 46 metres, with no direct property access or on-street parking.

Class II Arterial Roads are designed to carry high volumes of passenger and commercial traffic for intra-city travel at moderate speeds. Right-of-ways are to be no more than 42 metres. Direct property access is discouraged but on-street parking is permitted.

Class I Collector Roads are designed to carry moderate volumes of traffic with right-of-way no more than 28 metres wide. Direct property access permitted with some controls.

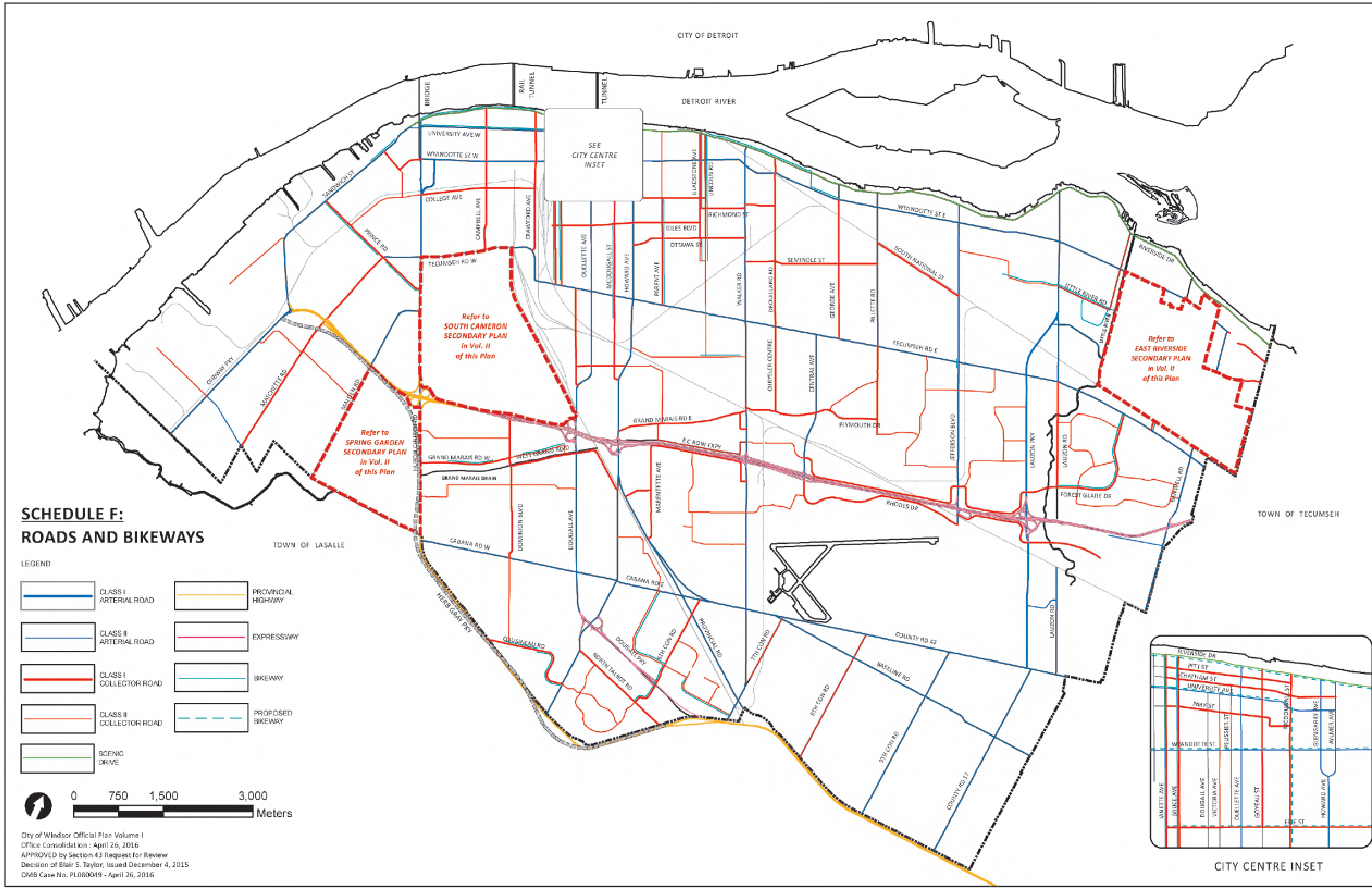
Class II Collector Roads: Class II Collector Roads are designed for moderate volumes of traffic. Right-of-ways are to be no more than 26 m, with direct property access permitted with some controls.

Right-of-way widths listed above are recommended but do not always reflect the width of existing road allowances. Many collector roadways have ROW widths of 20 m or less.

The remaining streets are scenic or local roads, designed to carry low to moderate volumes of traffic. Right-of-ways width are a minimum of 24 metres with direct property

[12] City of Windsor, Official Plan, Volume I, Infrastructure.

access permitted. On–street parking is permitted on local roads, but not on scenic roads such as Riverside Dr.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

CITY OF WINDSOR ROADWAY CLASSIFICATION SCHEDULE

FIGURE 5-9

THE CITY OF WINDSOR

DILLON CONSULTING

Aquafor Beech Limited

MAP DRAWING INFORMATION:
DATA PROVIDED BY CITY OF WINDSOR OFFICIAL PLAN (2006)

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SEE SCALE BAR IN FIGURE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

5.5 Climate Change

Climate change is the shift in weather patterns associated with an increase in global average temperatures. In Windsor, climate change appears to be increasing the rainfall intensities and volume, with corresponding severity in flooding. Though these climate change shifts may not be well-defined, the MP will look at ways to make drainage infrastructure resilient to potential changes in more frequent and significant storm events. Estimating potential changes in the future conditions is not an exact science; however, practitioners need to incorporate both current and reliable information related to climate change predictions.

To accommodate potential weather pattern changes due to climate change, a “stress test” design storm was applied to assess climate change risk across the study area for surface conveyance (overland flow) and storage infrastructure, and further to help develop a realistic level of service as discussed in Section 6.1. Further detail on how climate change considerations were integrated into the development of solution alternatives, Refer to **Appendix E- Technical Volume 2 Report**.

6.0 Addressing the Issues – Solutions

The following sections provide a summary of the methodology used to develop solutions to mitigate flooding and summarizes the environmental assessment completed to determine which solutions are recommended for implementation.

6.1 Methodology

This study has used a unique approach to develop solutions and infrastructure improvements. The level of service, design assumptions and recommended improvements have been established to provide an enhanced service level that strives to meet a higher standard of care than what is currently mandated through municipal and provincial standards and regulation. The development of the design standards, service levels, and criteria were developed in conjunction with stakeholder consultation, working with the TAC and SAC, and approved by the City.

Three principals were considered during the identification of problem areas and the development of solutions to mitigate basement, surface and coastal flooding.

Adaptive Approach

More stringent design criteria is used to mitigate flooding for vulnerable areas.

Through public engagement and discussions with stakeholders, including the project's SAC and TAC, the project team heard that solutions should not be "one size fits all". Vulnerable areas (flood protection, sensitive populations, and emergency response) should be assigned more stringent flood mitigation criteria.

Cooperative Approach

Solutions recognize that residents and property owners play an integral part in achieving the goals of this study

Practical solutions to mitigate flooding and reduce strain on the City's sewer and overland drainage systems required the municipality to partner with private property owners in reducing the amount of inflow and infiltration that gets into the sewer system. Based on other studies more than 70% of excess rainwater entering the sanitary sewage system is contributed by private property from direct connection of foundation drains, illegal cross connections and leaks from damaged private drain connections. Private property mitigation measures need to be applied City Wide to provide measurable benefit to the City's system. These measurements must be accompanied by protection measures that provide immediate flood reduction benefits for private properties.

Balanced Approach

Solutions do not rely on only one level of intervention. Improvements are recommended along all parts of the drainage system, including the inlets and outlets. Each infrastructure project identified shall be accompanied by source control measure both in the public right-of-way and within private property areas.

6.2 Level of Service (LOS) Criteria

As part of this MP, Level of Service criteria was established to identify specific problem areas that are vulnerable to flooding and to develop achievable measures to reduce the risks and impacts of flooding by identifying and evaluating both shorter-term and longer-term solutions. These targets have been applied to both existing and future development (Greenfield and infill/intensification) conditions.

Two design storm events are being used as the basis for applying this level of service. The 1:100 Year event is applied more broadly to all sewer systems within the City. Refer to **Table 6-1** below for details. Both events are based on 4-hour Chicago Storm distribution which represents a high intensity thunderstorm event and is recommended as the design storm type to assess conveyance capacity of urban systems.

Table 6-1: Summary of Design Storm Events

Design Storm Event	Duration (Hours)	Total Volume (mm)	Peak Intensity (mm/hr)
1:100 Year	4	81.6	144.7
Climate Change Stress Test	4	114.2	202.6

The Climate Change Stress Test storm is used to follow an adaptive approach where high level of services is applied to more vulnerable areas. This storm is based on the "Urban Stress Test" storm defined in the Regional Stormwater Management Standards Manual (2018) which has been developed to test the resiliency of the storm drainage system under higher volume (40%) storm conditions. For this study and in coordination with ERCA, it was recommended that in addition to a 40% added volume factor that the rainfall intensity also be increased by a factor of 40% to provide an even higher level of resiliency.

The established level of service was used to identify problem areas and size all infrastructure alternatives for both short and long-term proposed solutions are detailed in the following table:

Table 6-2: Level of Service (LOS) Criteria

LOS Criteria	Objective
Basement Flood Risk Reduction Criteria – Sanitary Drainage System	-
Sewer hydraulic grade line (HGL) is more than 1.8 m (6.0 ft) below existing grades, for 1:100-year storm event for wet weather flow. The depth of 1.8 m (6 ft) represents the typical residential basement depth.	Reduce risk of basement sewage flooding for storm events, up to and including the 1:100-year storm event.
Surface Flood Risk Reduction Criteria – Storm Drainage System	**-**
Less than 30 cm (1 ft) of surface flooding in the Right-of-Way (ROW), where feasible for 1:100-year storm event for major overland drainage system. *	Standard criteria for access and risks of property damage.
Less than 30 cm of surface flooding in the ROW for arterial and collector roads, where feasible for a Climate Change storm event for major overland drainage system.*	Provide enhanced/variable level of service where there is a higher consequence of surface flooding.

LOS Criteria	Objective
Basement and Surface Flood Risk Reduction Criteria - Combined Sewer Drainage	**-**
Complete enhanced sewer separation using the below criteria:	-
Sewer hydraulic grade line (HGL) is more than 1.8 m (6.0 ft) below existing grades, for 1:100-year storm event for wet weather flow. The depth of 1.8 m (6 ft) represents the typical residential basement depth.*	Reduce risk of basement sewage flooding for storm events, up to and including the 1:100-year storm event.
Less than 30 cm of surface flooding in the Right-of-Way (ROW), where feasible for 1:100-year storm event for the major overland drainage system. *	Standard criteria for access and risks of property damage.
Less than 30 cm of surface flooding in the ROW for arterial and collector roads, where feasible for a Climate Change storm event for major overland drainage system.*	Provide enhanced/variable level of service where there is a higher consequence of surface flooding.
Criteria – Coastal Flood Protection	**-**
Provide coastal flood protection where inland areas are lower than the established flood protection elevation 176.45 meters above sea level (masl) (ERCA Regulatory High Water Level). Flood Protection shall be constructed to a minimum established elevation. (Note: protection level was determined through a comparative evaluation as part of this MP and is detailed further in 6.7).	Mitigate risk of inland surface flooding in low lying areas due to high lake/river water levels.

Note: * - The level of service denoted for surface flooding risk reduction were applied to the entire study area to determine where this criteria was not met and better define the scope of this MP. The solutions developed for this City-wide MP focuses on reducing surface flood risk within greater Regional Problem areas and/or major roadway segments. There may be localized areas where this level of service is not met, these areas will need to be reviewed and addressed through other initiatives.

The use of 1.8 m (6.0 ft) to represent basement flood depths is based on typical basement depths and is consistent with assumptions used for typical sanitary sewer design practice. For the purposes of this assessment 1.8 m is measured from the ground surface (top of sanitary manholes covers) to the sewer water level elevation (HGL). Typically, the ground elevation at homes is higher than the manhole cover elevations so this measurement is considered acceptable.

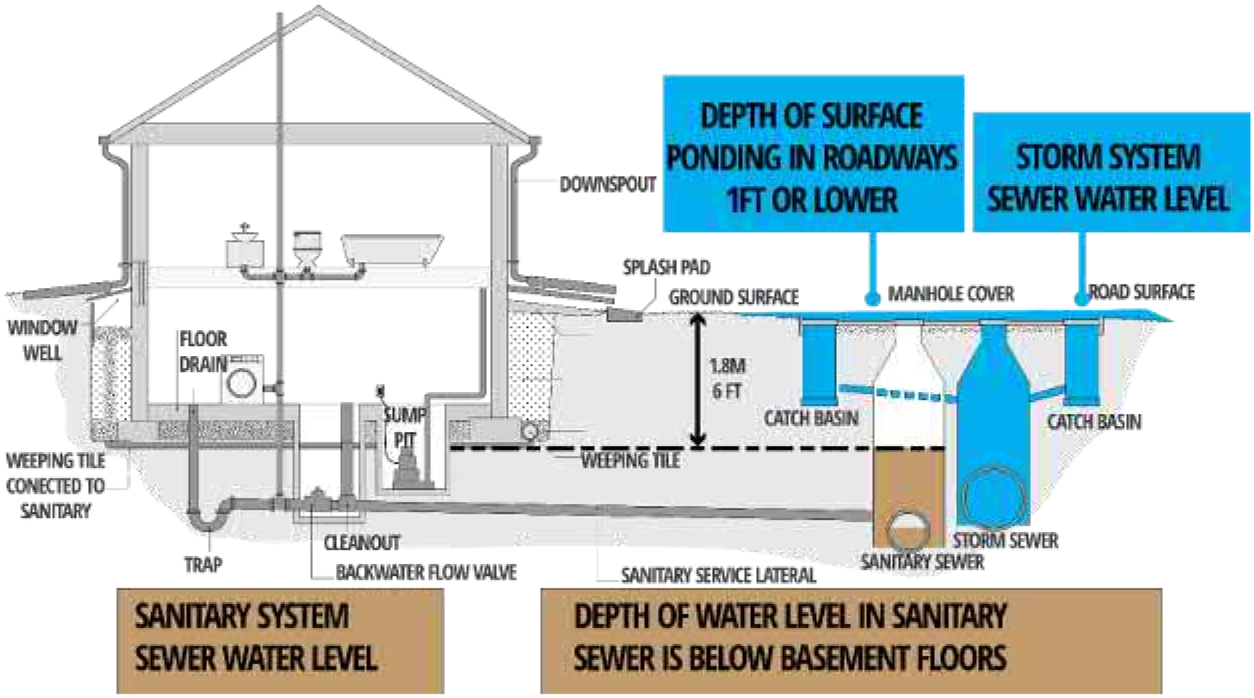
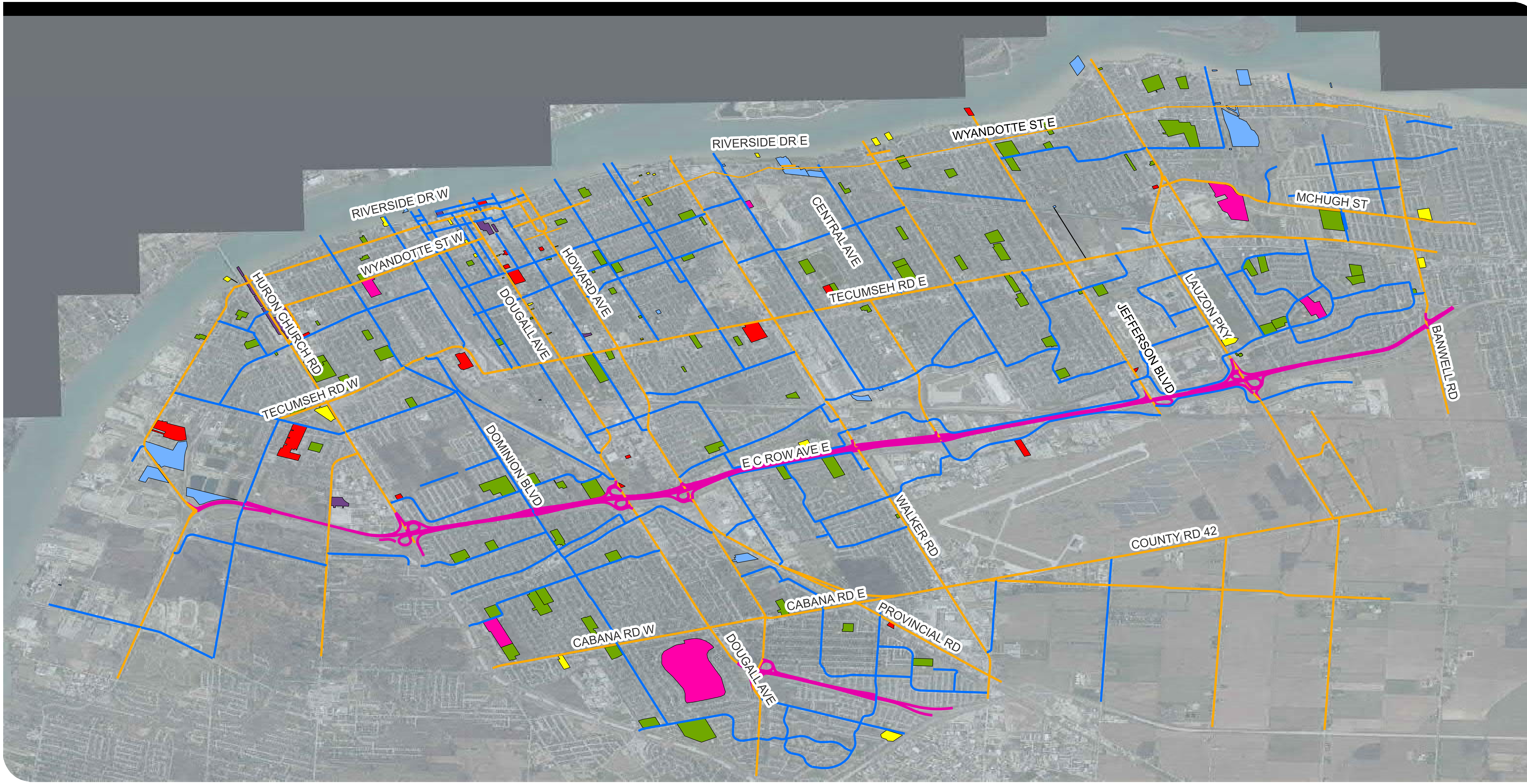


Figure 6-1: Residential Level of Service Schematic

As identified earlier, solutions developed follow an 'Adaptive approach' which provides an added cushion of resiliency to enhance the level of service for drainage improvements in those areas identified as higher risk, more sensitive or more vulnerable, namely:

- Hospitals;
- Emergency services (including the 911 Call Centre on Rhodes Dr.);
- Schools;
- Day-cares;
- Nursing homes;
- Long-term care facilities;
- City Shelters; and,
- Major roads (i.e. collector, arterial, and freeways).



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

City of Windsor - Vulnerable Areas

Figure 6-2

VACANT LAND	TRANSPORTATION	CLASS 1&2 ARTERIALS
RESIDENTIAL DEVELOPMENT LAND	WATER TREATMENT/FILTRATION/WATER TOWERS/PUMP STATIONS	CLASS 1&2 COLLECTORS
EMERGENCY SHELTER CENTRES	EMERGENCY SHELTER CENTRES	EXPRESSWAY

MAP DRAWING INFORMATION:
DATA PROVIDED BY CITY OF WINDSOR

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:60,000

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

Determination of applicable properties that are considered vulnerable (see **Figure 6-2**) were determined in coordination with City administration, the stakeholder advisory committee and emergency service (Windsor Police Services, Windsor Fire Department and Essex Windsor Emergency Management Services).

An adaptive approach entails consideration of a flexible and a sustainable suite of solutions that accounts for a reasonable degree of uncertainty due to climate change, with flood risk mitigation, and level of service strategies City-wide.

The following assumptions and considerations have been made in the development of solution alternatives:

Basement Flood Risk Reduction Solution Assumptions - Sanitary/Combined Sewer System

- Solutions shall reduce the flood risk (reduce the simulated HGL below established acceptable depths) for a minimum of 90% of the respective drainage area. From a cost and feasibility perspective reducing the flood risk level for 100% of the areas would not be cost effective. It should be noted that private property protection is still encouraged for all private properties.
    - (For Example: In South Windsor, under existing conditions, only 37% of the drainage area meets the LoS. The South Windsor sanitary infrastructure solutions recommended as part of this study, improvements reduces the HGL. Under ultimate conditions more than 90% of the drainage area meets the LoS).
- LoS is considered met once all solution components pertaining to each areas has been implemented. For instance, sanitary sewers improvements along a segment of roadway will only provide an incremental reduction of basement flooding and that downstream improvements, such as treatment plant improvements, and source control solutions, such as foundation drain disconnection, must also be completed to meet the LoS.
- Solution that is recommended through this study will not eliminate the risk of basement flooding; however, the risk of basement flooding should be much less once all improvements have been implemented. These improvement do not replace private property protection measures and all property owners are recommended to implement solutions to their internal plumbing systems.
- Future development servicing needs have been incorporated into the overall solution strategy for these areas. Development of Secondary Plan Areas (per the

City's Official Plan) and individual site developments under Site Plan Approval have been incorporated into the ultimate conditions analysis, refer to the **Appendix E- Technical Volume 2 report**.

- In order to limit combined sewer overflows to the Detroit River, there is a requirement to also meet the MECP's Procedure F-5-5[13] criteria. The City's strategy to meet the MECP's Procedure F-5-5 criteria were developed separately in other studies;
- Eliminate combined sewer overflows (CSOs) in dry weather periods, except in emergency conditions;
- Capture and treat, to a minimum level of primary treatment or period (April to October) during an average year;
- Apply additional controls for swimming and bathing beaches affected by CSOs:
  - There should be no violation of the body contact recreational water quality at swimming and bathing beaches for at least 95% of the four-month season (June to Sept) in an average year; and
  - Controlling to not more than two overflow events/season (June 1 to Sept 30) for an average year in a combined sewer system with the combined total duration of the CSOs at any single CSO location being less than 48 hours.

Surface Flood Risk Reduction Solution Assumptions – Storm Sewer System

- Solutions for Regional Flood Risk Areas (areas are defined in later sections of this report) shall reduce the surface flood risk (reduce roadway surface flooding to below 0.3 m (1ft))) for a minimum of 90% of the respective drainage area. From a feasibility perspective, it is impractical to reduce surface flooding for 100% of the drainage area and the sewer model used to support this study is high level and outputs may be too coarse to address local low lying areas which will need to be identified and addressed during reconstruction or maintenance works. Generally, where surface flooding depth is reduced to below 0.3 m, the risk of surface flooding along adjacent properties is also reduced.
- Surface flood mitigation measures were not developed for areas where surface flooding is greater than 0.3 m in private property non-residential lands. It is assumed that private property owners are required to mitigate local property

[13] Procedure F-5-5 is a MECP supporting document for Guideline F-5 "Levels of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters".

flooding independently. Recommendations of this study may benefit those areas; however, it is not the intent of this study. New development within greenfield or brownfield sites will need to provide onsite stormwater management based on provided boundary conditions which will be based on will meeting the LoS established through this study.

- Areas where surface flooding has been identified along Arterial and Class II Collector roadways, a maximum of 20 m of surface flooding above 0.3 m (1ft) has been deemed acceptable. The high level nature of this study and the sewer model cannot evaluate flooding beyond this level. The City will need to review surface flooding risk on a road by road basis through their regular roadway reconstruction and maintenance program.
- Per ERCA requirements storm systems must provide sufficient drainage to maintain a minimum of one dry drivable lane to provide emergency access during 1:100 year events. The City's MP sewer model used LIDAR elevation mapping to assess flooding areas and develop solution alternatives. For this large, City-wide model to <u>efficiently run, a significantly coarser elevation data set was used; therefore,</u> it does not provide sufficient level of detail to confirm if a minimum one lane is dry. For the purpose of this study, it is assumed that where surface flooding within roadways are less than 0.3 m under a Climate Change Storm, that this criteria is met. During detailed design of recommended improvements, the designer shall confirm that storm sewer improvements will provide adequate ingress/egress.
- Solutions recommended through this study will not eliminate risks associated with surface flooding as storm events and system hydraulics, including outlet conditions are variable and unpredictable. Solutions have been developed will reduce surface flood risks, provide improved drainage to allow emergency access on major roadways and reduce impact to private property.

Coastal Flood Protection Assumptions

- Protection measures for the low-lying areas of the City include two main components:
    - Landform barrier to prevent spilling and overtopping of lake/river waters into low lying areas; and
    - Backflow prevention devices that prevent the backflow of lake/river water into the existing underground sewer systems.

It is assumed that where the landform barrier is constructed to the established protection level in conjunction with underground backflow prevention that the LoS is met. Risk assessments for the flood protection measure elevations chosen are being reviewed via a coastal flood modelling assessment. The established flood protection shall be assessed regularly as lake/river high water levels fluctuate.

6.3 Problem Area Identification

Using the level of service criteria listed above, areas within the City that are vulnerable to the various types of flooding where identified. The problem area maps include herein are based on the existing conditions sewer model and corresponding hydraulic grade line under various storm conditions. When using the model, design storm events are applied to the entire city whereas during actual storm events rainfall typically has uneven intensity, where often only portions of the City may be impacted.

6.3.1 Basement Flood Risk Areas

Figure 6-3 shows areas that do not meet the established level of service for 1:5 Year, 1:25 Year and 1:100 Year storm events.

Under a less severe, 1:5 year rain event (50 mm rainfall over 4 hours), the map shows that most of the Central Windsor Area is at risk of basement flooding. This can be attributed to the nature of the combined sewer system, which conveys both sanitary and storm flows. During, the 2016 and 2017 rain events, basement flooding was not as prevalent this area as most of the rainfall was concentrated in the south or east portions of the City. Based on the results of the model simulation and the known frequency of combined sewer overflows that occur during major rain event, it can be concluded that continuing sewer separation in the combined areas is necessary. In the East Windsor, areas that are at higher risk of basement flooding include the Riverside Area, between Pillette Rd. and St. Rose Ave., and the Fountainbleu area, south of Tecumseh Rd. E., east of Pillette Rd. and Jefferson St. . The Fountainbleu area is also comprised of several combined sewers and separated sewers interconnections which contribute to the basement cflood risk. The South Windsor area has the least basement flooding risk of the three service areas for storm events. Under a more intense, 1:25 year storm (67 mm rainfall over 4 hours) the basement flood risk incrementally increases throughout the City and most of the City is considered at risk during this larger event.

Under the highest design rain event (1:100 year event, 85 mm over 4 hours) approximately 80% of the existing City system does not meet the established level of services. This is consistent with the known widespread basement flooding that was experienced during the previous 2016 and 2017 events.

6.3.2 Surface Flood Risk Areas

The level of service is not met where the surface flood depths reach depths greater than 0.3 m (1ft) within municipal road allowances. **Figure 6-4** shows the surface flooding during a 1:100 year storm (85 mm rainfall over 4 hours). Areas highlighted in red do not meet the LoS; however, it should be noted that the red areas have been enlarged to better demonstrate problem areas and do not reflect the exact area of excessive flooding.

Page is intentionally blank

CITY OF WINDSOR
SEWER MASTER PLAN

Surface Flooding Regional Problem Areas: 1:100 Year Storm

FIGURE 6-3

HIGH POTENTIAL RISK OF BASEMENT FLOODING UNDER 1:5 YEAR STORM
HIGH POTENTIAL RISK OF BASEMENT FLOODING UNDER 1:25 YEAR STORM
HIGH POTENTIAL RISK OF BASEMENT FLOODING UNDER 1:100 YEAR STORM

MAP DRAWING INFORMATION:
DATA PROVIDED BY CITY OF WINDSOR

MAP CREATED BY: IDW
MAP CHECKED BY: FF
MAP PROJECTION: NAD 1983 UTM Zone 17N

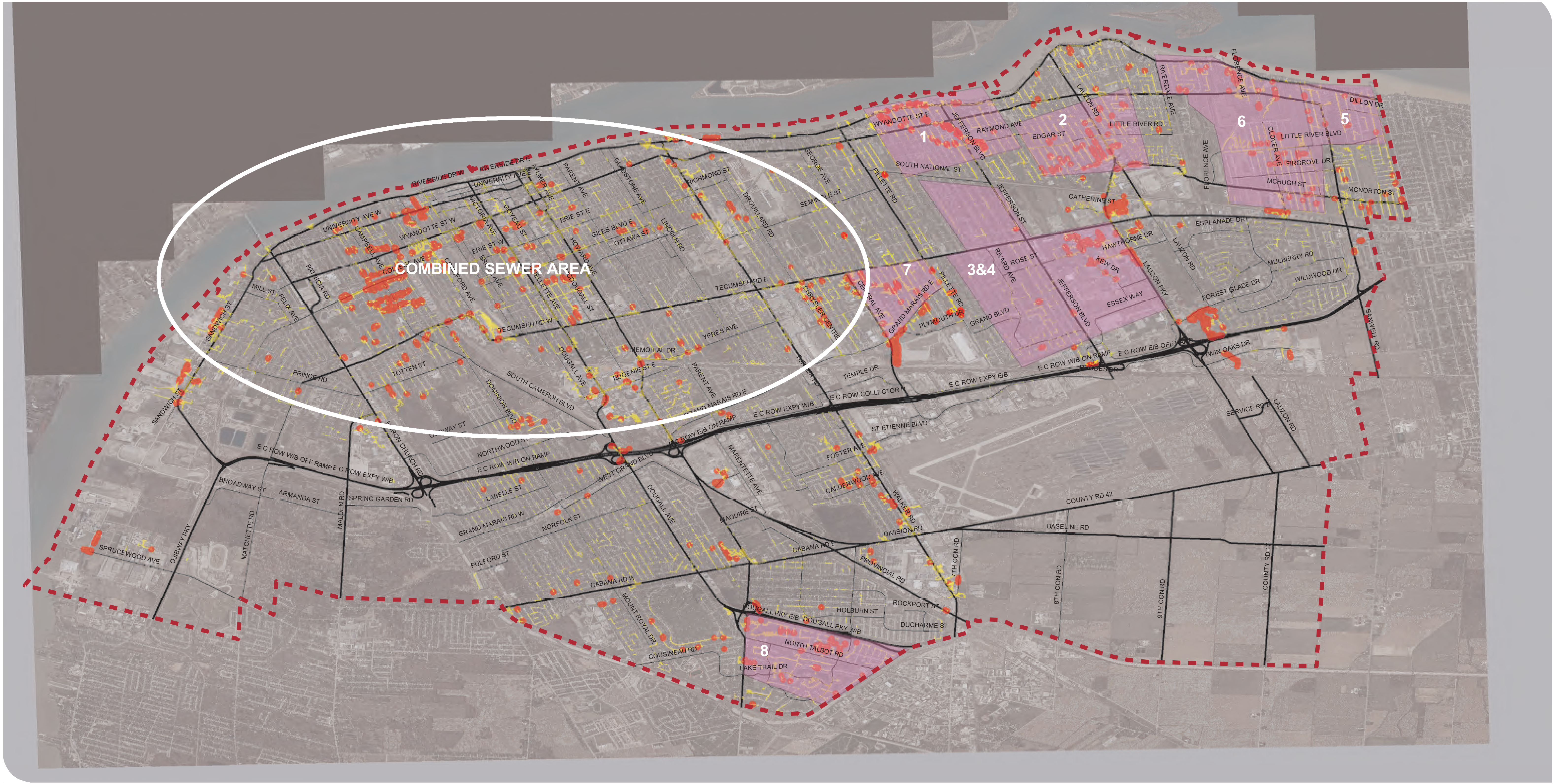
0 0.5 1 2 km
SCALE 1:60,000

2

FILE LOCATION: \\dillon.ca\DILLON_DFS\Windsor\Windsor CAD\CAD\GIS\17-6638 Sewer and Overland Drainage MP\GIS\Technical Volume I Report\Figures

PROJECT: 17-6638 STATUS: DRAFT DATE: 12/12/18

Page is intentionally blank.



EXPRESSWAY AND ARTERIAL ROADS	STUDY AREA	SURFACE FLOODING DEPTH LESS THAN 0.30 m (1.0 ft)
CLASS 1 AND 2 COLLECTOR ROADS	REGIONAL SURFACE FLOODING AREA	SURFACE FLOODING DEPTH MORE THAN 0.30 m (1.0 ft)

Surface Flooding Regional Problem Areas: 1:100 Year Storm

Figure 6-4.1

THE CITY OF WINDSOR

DILLON CONSULTING

Aquafor Beech

MAP DRAWING INFORMATION:
PROBLEM AREA DATA PROVIDED BY CITY OF WINDSOR

MAP CREATED BY: SD
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:60,000

N E S W

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

This problem area map was reviewed in detail with the City's administration staff to confirm that identified problem areas are consistent with observed and reported surface flooding. Based on this map, "Regional Areas" where widespread flooding is observed across many streets within a local neighbour have been identified.

The 8 regional areas have been identified below and are highlighted in **Figure 6-4** above.

- Regional Area 1&2 - Riverside Area along Riverside Dr. East (St. Rose Ave. Trunk, Ford Blvd. Trunk and St. Paul Trunk Sewer drainage areas);
- Regional Area 3&4 – Jefferson St. /Lauzon Ave. Area south of Tecumseh Rd.;
- Regional Area 5 - Blue Heron Pond Drainage Area;
- Regional Area 6 – East Riverside (Pontiac and East Marsh Pump Station Drainage Areas);
- Regional Area 7 – Central Ave./Pillette Rd.(Upper extent of Grand Marais Drain Drainage Area); and
- Regional Area 8 – Southwood Lakes.

Surface flooding observed within the Central Windsor area has not been included in process. As part of the combined area, necessary large storm trunk sewers to provide the backbone for the ongoing separation program will address most of the surface flooding in this area. Through the sewer model, surface flooding solutions have been developed and sized assuming that that program is undertaken.

To address emergency access issues, roadway surface flooding areas have been identified based on various levels of risk. A decision making flow chart (**Figure 6-5** below) was developed to focus the solutions in areas that need to be prioritized.

Roadway flooding solutions have be developed for road segments that pose ingress/egress issues for vulnerable land uses as defined previously. Also it has been identified that during major rain events, major arterial roadways must be travelable so that EMS, Police and Fire services are able to address calls and to provide access to health care facilities. Many arterial roadways in Windsor are the sole connection point for north-south travel due to the location of Railways and the E.C Row Expressway. If these access points are not passable, considerable excess time is required to find alternative routes. Road surface flooding solutions were also focussed on road segments where greater than 20 m of flooding above 0.3 m deep is observed.

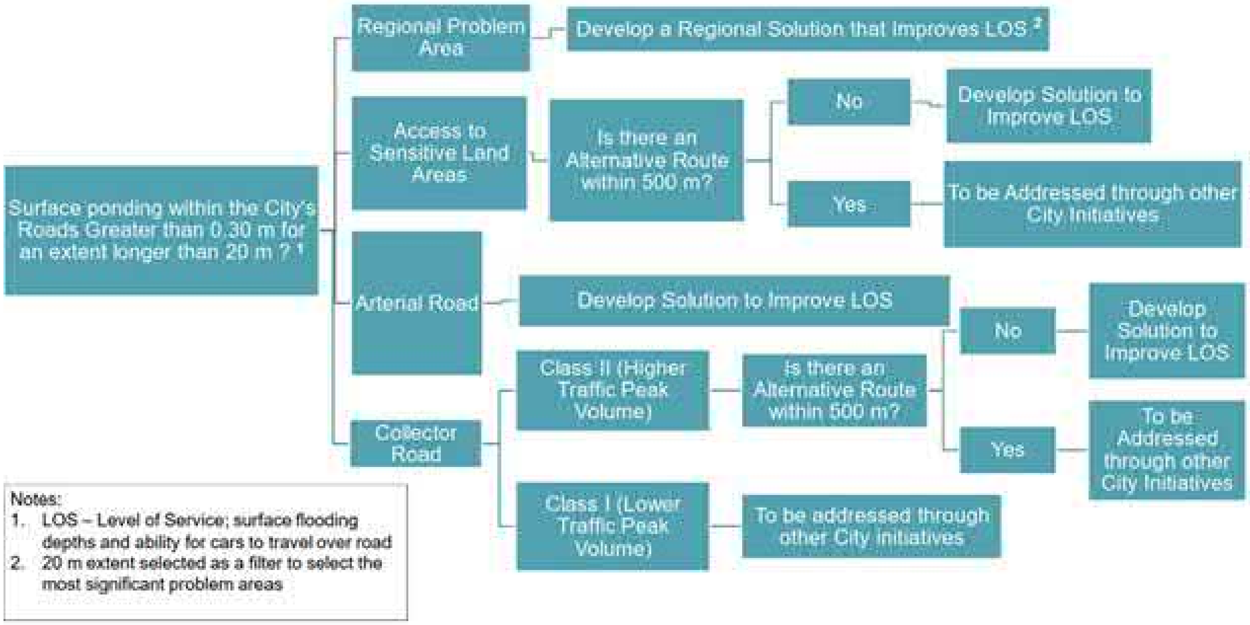


Figure 6-5: Flow Chart – Decision-Making Process - Surface Flooding Solutions

6.3.3 Coastal Flood Risk Areas

Coastal flood risk areas are defined as those areas that are risk of flooding due to overtopping of the existing shoreline from high lake/river level conditions. There are two areas identified as coastal flood risk areas:

- Riverside Area between Ford Blvd. and the East City Limits; and,
- West Windsor area between the Ambassador Bridge and McKee Creek.

The very west end of the City, west of Russell St. is located adjacent to the Detroit Area, there are some areas that are below the identified high water level elevation. Potential need for flood protection measures at this location are not being developed as part of this study. The City will be completing a separate assessment of the risks and evaluate the need for coastal flood protection measures. The area under the flood protection elevation is included in **Figure 6-6**.

Through several previous studies, including the East Riverside Flood Risk Assessment (ERFRA), the Riverside Dr. E and East Riverside areas have been identified a high risk for coastal flooding. The ERFRA study looked more closely at this area, using the available LIDAR topographic information to map out areas below critical HWL elevations. This study included a detailed evaluation of the existing coastal flood protection measures so identify where gaps are present.

Level of service for coastal flood protection measures is based on the elevation of the proposed infrastructure measure Generally, the higher the landform barrier the lower the risk of overtopping. In conjunction with surface flooding barriers coastal flood protection must also be applied to the underground sewer system to prevent the flow of waters inland. Using historical data and projections of future climate patterns, estimated HWL elevations under various scenarios were determined. The elevation of the proposed landform barrier will dictate the footprint and associated land impacts that will result. This MP has reviewed various level of service options for the landform barrier through findings and recommendations that have been outlined In the ERFRA report and consultation with ERCA.

Page is intentionally blank.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Flood Protection Elevations

Figure 6-6

ELEVATION (m)

<VALUE>

- 176.30 OR MORE
- 176.00 - 176.30
- 176 OR LESS
- Residential Lots

MAP DRAWING INFORMATION:
DATA PROVIDED BY CITY OF WINDSOR

MAP CREATED BY: IDW
MAP CHECKED BY: FF
MAP PROJECTION: NAD 1983 UTM Zone 17N

FILE LOCATION: \\dillon.ca\DILLON_DFS\Windsor\Windsor CAD\CAD\GIS\17-6638 Sewer and Overland Drainage MP\GIS\Technical Volume I Report\Figures

SCALE: VARIOUS

N
W
E
S

DILLON CONSULTING

PROJECT: 17-6638 STATUS: FINAL DATE: 03/06/20

Page is intentionally blank.

6.4 General Solution Assumptions

There are assumptions to consider while deliberating the preferred alternatives for relieving the problem areas of surface and basement flooding issues. The following are assumptions for each Sewershed in the City of Windsor.

6.4.1 Central Windsor Sewershed (Combined Sewer System)

- Assume increased sewage treatment capacity at the Lou Romano Water Reclamation Plant, with construction of a new retention treatment basin (RTB). This RTB is recommended through the separation CSO Reduction EA being completed;
- Assume an area-wide downspout disconnection has been implemented;
- Residential rear yard and alley drainage directed to storm sewers;
- Disconnection of all existing residential foundation drainage (homes older than 1980) from the sanitary sewer system is recommended for this area; however, due to the urban nature of this area and older homes the reduction of inflow has not been accounted for in the sizing of proposed infrastructure;
- Larger buildings (commercial, apartments, etc.) may have roof drainage directed to the combined sewer. Upon redevelopment and through the City's permit process, the City will require these properties to separate internal plumbing fixtures to remove storm drainage from sanitary flows;
- To accomplish complete 'Enhanced' separation, each roadway will require new local storm sewer that is sized to accommodate drainage from both public and private property areas;
- Consideration for 1:100 year Detroit River high water level conditions; and
- Water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches. To be confirmed later in the design phase.

6.4.2 South Windsor Sewershed

- Assume increased sewage treatment capacity at the Lou Romano Water Reclamation Plant, with construction of a new retention treatment basin (RTB);
- Disconnection of all existing residential (homes older than 1980) foundation drainage from the sanitary sewer system;

- All residents properties will have roof drains disconnected from the storm sewer system and discharges to ground surface;
- Reduction of inflow into the sanitary system following sealing of manhole lids with rain catchers and continued repair and sealing of existing leaky sewer pipes and manhole structures.
- Solutions would not increase the peak flow of stormwater runoff entering existing municipal drains, including the Grand Marais Drain and Cahill Drain; and
- Water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches. To be confirmed later in the design phase.

6.4.3 East Windsor Sewershed

- Disconnection of all existing residential foundation drainage from the sanitary system;
- All residential properties will have roof drains disconnected;
- Reduced inflow into the sanitary system following sealing of manhole lids using rain catchers and continued repair and sealing of leaky sewer pipes and manholes;
- Allowances for full future development sanitary sewage flows from both Windsor vacant areas and Tecumseh were included in the assessment of alternatives.
- Assumes that enhanced sewer separation in Regional Area 3;
- Allowances for full future development's impact on stormwater runoff was considered in assessing alternatives;
- Consideration for 1:100 year Detroit River high water level conditions;
- No increase in stormwater peak flow entering the Little River Watercourse;
- Where stormwater pump stations improvements are recommended to provide surface flood relief, the new or improved pumping station capacity is based on providing a 1:100 year storm level of service. In some cases, pumping station improvements were recommended to improve system or stormwater pond drawdown times; and
- Water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches. To be confirmed later in the design phase.

6.5 Comparative Evaluation Process

For each of the problem areas within each Sewershed and drainage area alternatives were identified and comparatively evaluated to identify a preferred improvement. Short-term source control solutions, summarized in Section 6.6, were all considered to be fundamental solutions that are required to meet the objectives of this study; therefore, were carried forward. Longer-term alternative solutions were evaluated against a set of comparative evaluation criteria in order to enable determination of a recommended solution for each problem area.

At the outset of the MP, it was determined that a community-led approach to developing the strategy to reduce basement and surface flooding was needed. Input was received from the public, members of the SAC, TAC and other key stakeholders on what issues needed to be considered when making decisions on infrastructure solutions. These issues were used to determine objectives for the project and the evaluation criteria to select the preferred alternatives for each flooding problem area. This is a holistic, multi-disciplinary approach to completing the evaluation. It reflects a desire to develop a sustainable strategy for reducing flooding impacts by evaluating the alternatives against integrated environmental, social and economic objectives.

Table 6-3 below shows the evaluation criteria developed for the project.

Table 6-3: Evaluation Criteria

Objective	Evaluation Criteria	Rationale
Reduce Potential for Flooding	Extent of basement flood reduction realized by alternative. Extent of surface flood reduction realized by alternative.	Reducing the potential for damage in homes (generally basements) and reducing undesirable surface flooding (i.e. roadway flood depths greater than 30 cm (1 ft)).
Provides Enhanced Level of Service for Vulnerable Areas	Consideration to provide an enhanced level of service for major roadways and vulnerable land uses such as hospitals, long term care centers, etc.	Provide additional protection to areas or infrastructure that provide service to sensitive populations. Consider safety of residents and maintain emergency services.

Objective	Evaluation Criteria	Rationale
Accommodates Land Use Changes	Flexibility of alternative to accommodate changes in land use throughout the applicable drainage area.	Allows new development to progress by meeting minimum ingress/egress requirements. Considers infill of vacant areas such as secondary plan areas and areas currently under development reviews.
Flexibility to Adjust to Climate Change	Flexibility of alternative to adjust to climate change.	Being forward looking and resilient considering climate change.
Water Quality	Ability to maintain or improve water quality.	Solutions should meet environmental standards and minimize impact to watercourses.
Cost Effective	Relative capital cost. Relative operation and maintenance costs.	Considering affordability for homeowners and tax payers.
Ease of Implementation	Level of installation and operational complexity for homeowner or City (including consideration of space requirements, construction requirements, etc.).	Reducing homeowner and City challenges and barriers to flood reduction measures.
Timely Implementation	Length of time required for implementation.	Solution can be implemented in a timely manner to avoid further risk of flooding.
Ease of Maintenance	Anticipated extent of maintenance required.	Providing solutions that are relatively easy to maintain.

Objective	Evaluation Criteria	Rationale
Tailored	Consideration for provided enhanced level of service for sensitive land uses.	Identifying solutions that consider the needs of specific areas. Provide additional protection to areas or infrastructure to consider safety of sensitive pollutions and maintain emergency services.
Collaborative	Commitment from stakeholders.	Working collaboratively with residents, businesses, other municipalities and the City to find effective solutions.
Minimize Impacts	Minimize disruption to public infrastructure during construction/operation. Minimize disruption to homeowners/private property during construction/operation. Minimize disruption to aquatic systems.	Identifying solutions that can be implemented with minimal disruption to neighbours and the environment.

Each alternative was assessed against the criteria and the alternative(s) that best met these criteria was identified as the preferred solution for addressing that problem area. Opportunities to mitigate negative impacts were considered in the development and refinement of the alternatives strategies, so that "optimized" alternatives were evaluated.

6.6 Short-Term Solutions: Source Control and Private Property Measures

Various source control alternatives that were determined to meet the flood mitigaton criteria and be feasible for the City of Windsor, were presented to the community at various public venues for their review and comments. These solutions will be carried forward and were not evaluated using the comparative evaluation matrix as they are not considered Municipal Class Schedule B or Schedule C projects. Following positive feedback for the implementation of the alternatives presented, the first steps were determined in order to begin making positive changes.

Source Control solutions are City-wide improvements that can be implemented easily with low capital costs, and consist of measures that can reduce the amount of water going into the City's drainage systems, including partnering with homeowners to protect against the impacts of flooding.

Many of the infrastructure improvements recommended in this study will require significant funding and time to implement; therefore, the City should take advantage of opportunities to implement short-term solutions which will begin to relieve the City's system and provide protection to private properties.

A review of methods used by other municipalities was undertaken, and considered during the development of a short-term solution plan, this comparative review is included in **Appendix C - Short-Term Solution Recommended Report**.

A description of each of recommended source control alternative is provided in Table 6.3 under three distinct headings.

- Municipal Policies
- Subsidy Programs
- Collaborative Improvements

Details on how these recommendations were incorporated into the ultimate condition model is detailed in **Appendix D - Technical Volume 2 Report** and **Appendix C - Short-Term Solution Recommended Report**. Short term solutions that where integrated into the sewer model are integral components of the long-term infrastructure improvements are described below as Key Considerations. The established level of service will not be met if the highlighted short-term solutions are not fully implemented.

Table 6-4: Short-Term Solution Recommendations

Recommendation	Description
Municipal Policies	-
Mandatory Use of Sewage Ejector Pumps	For all new developments and re-development with basements and below-grade living spaces.
Mandatory Foundation Drain	Develop policies to mandate the disconnection of foundation drain disconnection for properties older than 1980 in East and South Windsor and applicable areas of the Central Windsor area. Include this item in the basement flood protection subsidy program. Develop, implement and enforce a By-law for the disconnection of foundation drains for all older existing development. ***Key Consideration:*** Solutions developed for the South and East Windsor Areas rely on the benefit that foundation drain will have on the sanitary sewer systems. Infrastructure improvements have been sized assuming that the City is successful in implementing a mandatory foundation drain disconnection program.
Mandatory Downspout Disconnection	Update and enforce the existing municipal By-law (By-law 26-2008) for new and existing development. ***Key Consideration:*** Solutions developed for the Central Windsor sewershed area and Regional Area 8 - Southwood Lakes area rely on the benefit that downspout disconnection will have on the storm sewer system. Infrastructure improvements have been sized assuming that full downspout disconnection objectives area are completed. For more rational on why these areas where identified as critical can be found in **Appendix E: Technical Volume 2 report**.

Recommendation	Description
Stormwater Surcharges and Green Infrastructure Credits	Stormwater Financing Study will form the basis of a future policy.
Sanitary Rain Catchers and Maintenance Hole Sealing	Retrofit existing sanitary sewer manholes with rain catchers to reduce inflow of rainwater into the sanitary system. Sanitary manholes that introduce the highest level of rainwater inflow into the sanitary system have identified and in included in **Appendix C** and is recommended the City proceed with sealing these manholes in the next couple of years. ***Key Consideration:*** Basement flood mitigation infrastructure improvements assume that rain catchers will be retrofitted within all new and existing sanitary manholes City Wide.
Infrastructure Maintenance and Assessment	Continue improvement to the sanitary system to reduce inflows from damaged sewers. Expand the existing operation and maintenance program to include new infrastructure.
Design Standards	Update the City's Development Manual to reflect new flood mitigation criteria: • Revise new sewer design criteria and mechanisms to control excess inflow. • Developers must demonstrate that new builds will not impact downstream areas. • Mandatory sewage ejector pumps for new development. • Develop Standards for the implementation of LIDs.

Recommendation	Description
Sewer Network Backflow Prevention Devices	To protect storm sewer system outlets from high water level conditions in Detroit River or Lake St. Clair; and To protect sanitary sewer systems from surcharging from high water level condition via overflows to the storm sewer system. ***Key Consideration:*** Locations where permanent backflow prevention devices are required are detailed in **Appendix C**. Where backflow prevention devices are required in low lying areas where coastal flood risk exist, locations of required devices are detailed in **Appendix F**: Technical Volume 3.
Subsidy Programs	-
Basement Flooding Protection Subsidy	Basement Flooding Protection (BFP) subsidy program for additional measures.
Mandatory Foundation Drain Disconnection Subsidy	Consider providing subsidy program, paid for by the City, to provide an allowance to cover the full cost of disconnection, similar to the City's BFP subsidy.
Downspout Disconnection	Continued Downspout Disconnection Program that provides this service free of charge.
Collaborative Improvements	-
Enhanced Educational Program	Develop a comprehensive education program to include homeowner and contractor Information Sessions, develop and distribute education materials and have information available on the City's website.
Green Infrastructure/Stormwater Surcharges	The is completing a Storm Financing Study that that will recommend implementing a storm system sewer surcharge to fund storm system improvements.

Recommendation	Description
Lot Grading	Homeowners shall assess and improve lot grading where possible to mitigate flooding.
Other Household Management Strategies	Homeowners have an interest in being actively involved in the implementation of mitigation measures to protect their home.

Measures to provide source control or provide protection to Industrial, Commerical and/or Institutional (ICI) properties were not investigated through this study; therefore, not included in total costs included in this study. The City is developing methods to encourage ICI properties to reduce their impact on the City's sewer system through the Stormwater Financing Study that is currently underway.

6.7 Flood Reduction Solutions

Longer-term solutions to mitigate risk of flooding are comprised of a balance of 4 levels of improvements:

- Source control;
- Increase the conveyance and storage capacity;
- Increase downstream capacity; and/or
- Protect the coastline from flooding.

These four methods can be further expounded upon.

Measures to reduce the amount of rainwater entering the system can be completed on the private property and within the City's ROW. Private property measures have been applied as described in Section 6.4 General Assumptions above. Public infrastructure measures such as sanitary manhole rain catchers and sewer sealing/repair will also reduce inflow into the sanitary system. Implementation of these measures have been applied as a baseline condition and it is assumed that all solution alternatives will include these measures.

Increasing the conveyance and storage capacity results in improving the movement and storage of flow within the existing infrastructure, such as: increasing trunk sewer sizes, separating combined sewers, construction of underground facilities to store rainwater, and implementing low impact development practices (LIDs) within the municipal right-of-way.

Increasing downstream capacity entails expanding the amount of flows that can be accommodated by downstream infrastructure of the sanitary and storm sewer systems, through treatment plant improvements, pump station improvements, and the addition of retention treatment basins.

Protecting the coastline from flooding involves the construction of strategically located berms, at a height and length sufficient to protect private property and community resources from surface flooding from most storm events.

6.7.1 Longer-Term Alternatives (Future Conditions) and Comparative Evaluations

6.7.1.1 Central Sewershed – Overall Basement Flooding Risk Reduction Strategy (SAN-C1)

The combined Central Windsor area is considered a high risk area for basement flooding as noted in Section 6.3 above. Several studies have been completed historically to provide a strategy for the separation of the combined system and the reduction of CSO occurrences. These strategies and recommendations have been partly implemented to date. The approach of this MP was to understand the existing system condition and determine what solutions will reduce the risk of basement flooding.

This MP investigated the potential basement flood risk reduction benefits in the Central Windsor Area under an ultimate condition scenario, where both the existing practice of soft-separation was completed throughout the entire service area and the existing CSO management strategy was fully implemented with the addition of the second RTB. This scenario is considered the “Do Nothing” (SAN-C1-2) alternative.

It was determined that continuing the current soft separation and CSO management strategy would not meet the objectives of mitigating basement flooding. Rather, an enhanced level of sewer separation alternative was deemed necessary to meet the basement flooding mitigation objectives, reduce impacts to the environment, and provide a framework for the sewer systems to become more resilient to climate changes.

The enhanced level of sewer separation initiative for the Central Sewershed includes:

- Removal of all surface and roof (downspout) drainage from the combined sewer systems and redirection to new storm sewers;

- Removal of building foundation drainage from combined and dual sewer systems, where feasible and discharging to the ground surface or storm sewer;
- Direction of all rear lot and alley surface drainage to a new storm system;
- Replacement of dual and combined sewers with new separated sewers; and
- Construction of storm sewer infrastructure to accommodate stormwater.

Figure 6-7 illustrates an overall view of the proposed new separated storm trunk sewers required to provide a framework for the enhanced separation of the entire Central Windsor area. The following **Section 6.7.1.2** provides a detailed summary of all the storm sewer improvements required for basement flood mitigation and surface flooding mitigation.

To meet the basement flooding risk reduction objective, construction of storm sewer infrastructure is required to accommodate re-directed surface drainage. Also, existing and new storm sewers for which the stormwater will be redirected to will need to be sized to meet the surface flooding mitigation objectives (level of service). Storm sewers will need to be sized such that surface flooding within the municipal ROW should be less than 30 cm (1.0 ft) under the 1:100 year storm and, along major roadways or adjacent to sensitive land uses, surface flooding should be less than 30 cm under the climate change storm (1:100 year storm + 40% Factor).

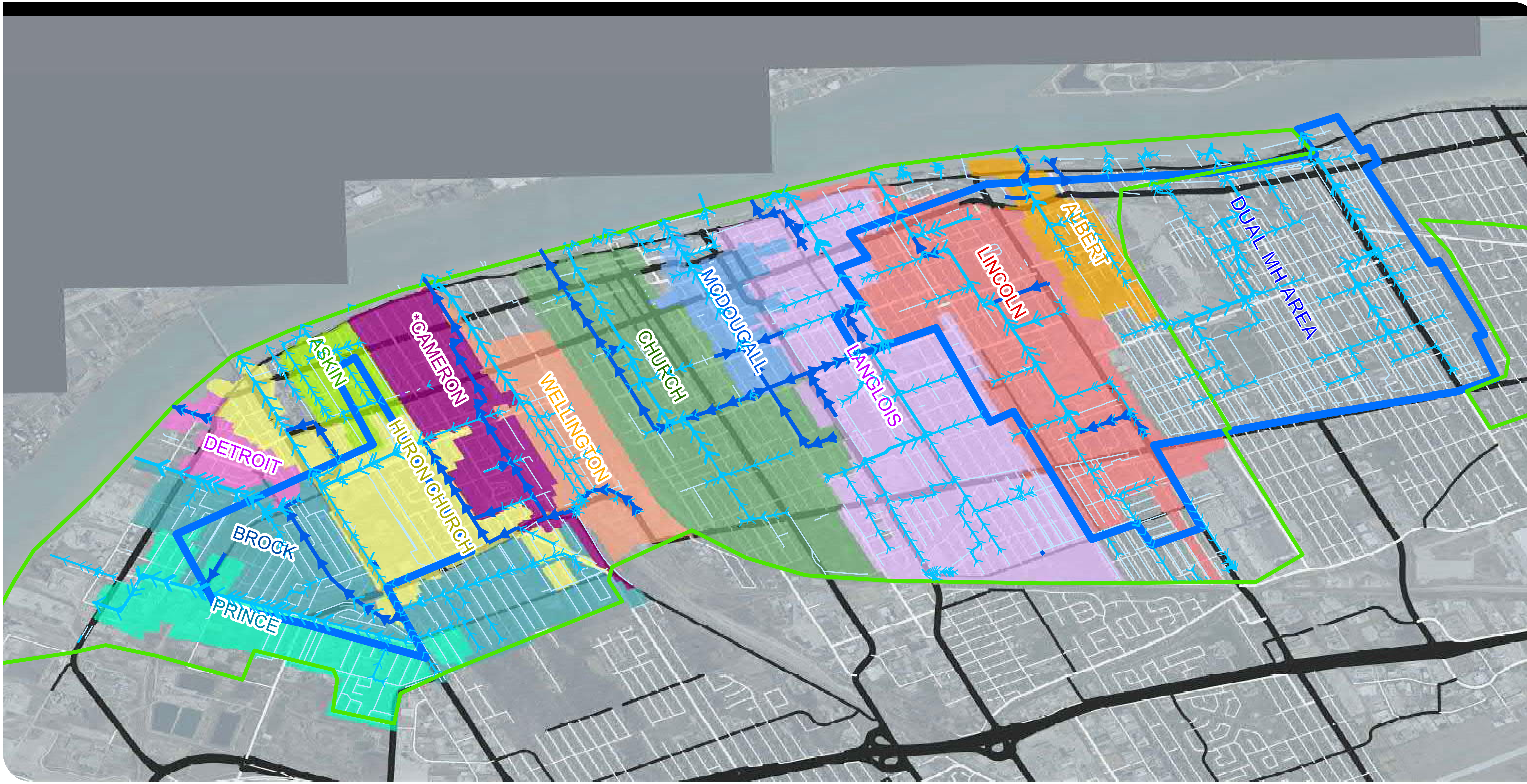
The separation of combined sewers will occur in conjunction with sewer and road rehabilitation projects. Over time, overflow volumes and flows will gradually be reduced in the sanitary sewer system as improvements are constructed. To accomplish the longer term goal of complete separation for the City of Windsor, each roadway in the Central Sewershed will require new storm sewers.

For the purposes of the comparative evaluations included in this section, the use of a " ✓ " denotes that the alternative is more favourable in comparison with other alternatives.

Table 6-5: Central Windsor Basement Flood Reduction Alternatives (SAN-C1)

Evaluation Criteria	Alternative 1 Complete Enhanced Sewer Separation of Combined Sewer and Dual Manhole Systems (SAN-C-1)	Continued Soft Separation Do Nothing (SAN-C-2)
Meets Flood Mitigation Objectives	✓	-
Flexibility to Adjust to Climate Change	✓	-
Complexity of Installation & Operation	-	Does not meet flood mitigation measures.
Water Quality	✓	Does not meet flood mitigation measures.
Length of Time Required for Implementation	-	Does not meet flood mitigation measures.
Anticipated Extent of Maintenance Required	-	Does not meet flood mitigation measures.
Disruption during Construction	-	Does not meet flood mitigation measures.
Permanent Changes to the Urban Community	✓	Does not meet flood mitigation measures.
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	Does not meet flood mitigation measures.
Impacts to the Natural Environment	✓	Does not meet flood mitigation measures.
Relative Capital Cost	-	Does not meet flood mitigation measures.
-	PREFERRED	-

Alternative SAN-C-2 was not found to meet the basement flood risk mitigation objective; therefore, alternative SAN-C-1 is considered preferred. Generally, both alternatives have similar impacts, as they both will require full reconstruction of the municipal ROW and construction of a new sanitary and storm sewers. It is anticipated that SAC-C-1 will have larger storm sewers and new connections to existing rear alley drainage systems.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Central Sewershed - Proposed New Separated Storm Sewers and New Outfalls (SAN-C1)

Figure 6-7

THE CITY OF WINDSOR

DUAL MAINTENANCE HOLE AREA
EXISTING STORM SEWER 900mm OR GREATER
PROPOSED STORM SEWER
COMBINED AREA
PRINCE DRAINAGE AREA
BROCK DRAINAGE AREA
PRINCE DRAINAGE AREA
HURON CHURCH DRAINAGE AREA
ASKIN DRAINAGE AREA
CAMERON DRAINAGE AREA
WELLINGTON DRAINAGE AREA
CHURCH DRAINAGE AREA
MCDOUGALL DRAINAGE AREA
LANGLOIS DRAINAGE AREA
LINCOLN DRAINAGE AREA
ALBERT DRAINAGE AREA

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:35,000

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2 Central Sewershed – Overall Surface Flooding Risk Reduction Strategy

In Central Windsor, the solutions described below are grouped based on their shared drainage area.

6.7.1.2.1 Prince Rd. Drainage Area Improvements

Prince Rd. Trunk Storm Sewer Outfall at Chappell Ave. (STM-C1) and College Ave. Storm Sewer (STM-C9)

Improvements include the construction of a new outlet for the existing separated storm system serving the Prince Rd. drainage area, via installation of approximately 200 m of new storm sewer **(STM-C1)** west of the intersection of Chappell Ave. and Sandwich St., to a new outfall to the McKee Creek. This outlet will provide a 1:100 year level of service for the full enhanced separation of this drainage area. The elevation of the new storm sewer is below lake levels at this location; therefore, a dewatering pump station will also be required to drawdown the storm system after a rain event. Much of the existing Prince Rd. drainage area has been separated through the City's ongoing soft separation program and the construction of this outlet will be the final stage of that project.

In addition to this outlet, construction of approximately 400 m of new storm sewers **(STM-C9),** along College Ave., a Class I Collector roadway, is proposed.

Refer to **Figure 6-8** for an illustration of the location, and **Table 6-6** for a comparative evaluation of the Prince Trunk Storm Sewer Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-6: Prince Trunk Storm Sewer and Outfall (STM-C1) Alternative

Evaluation Criteria	Alternative 1 New Outlet and Dewatering Pump Station	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-

Evaluation Criteria	Alternative 1 New Outlet and Dewatering Pump Station	Do Nothing Alternative
Impacts to Water Quality	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: New stormwater system and outlet will meet the basement and surface flood reduction level of service for a 1:100 year storm will provide resilience for potential impacts of climate change.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of this infrastructure for the service life of the pipe material.

Disruption during Construction: Temporary road closures in the vicinity of the construction corridors will be kept to a minimum to maintain traffic flow.

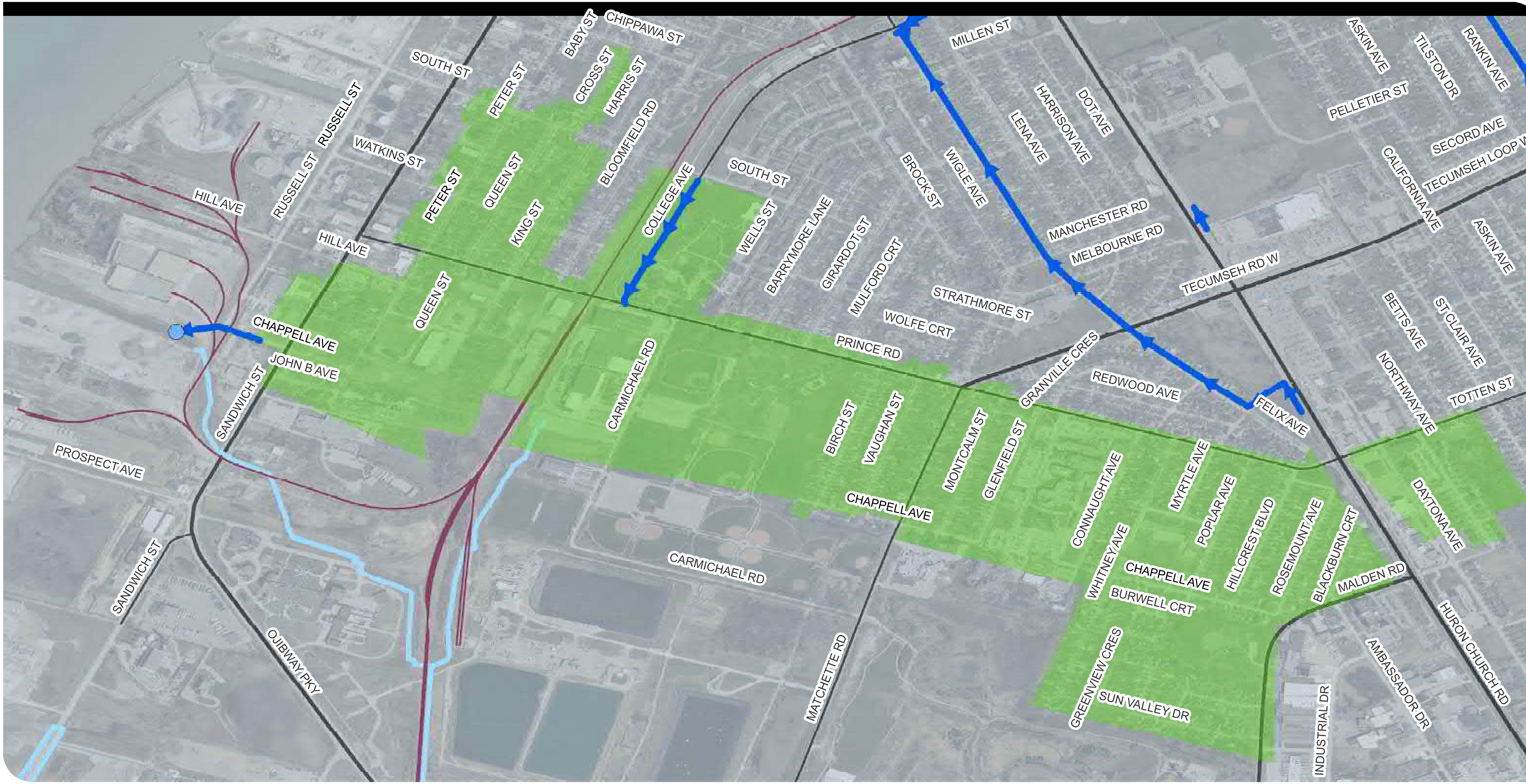
Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding. Property acquisition is required to construct this storm sewer outlet and dewatering pump station.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: The areas of storm sewer installation are already disturbed by urban activities, and the disturbance to the McKee Creek shoreline for the outfall installation will be performed during dry weather conditions to minimize any impacts to the creek bank, as well as outside of breeding season for species at risk present. There are no impacts anticipated to recreation or use of the waterway as a result of construction activity. Implementing enhanced sewer separation and associated storm sewer systems will reduce frequency of CSOs to the Detroit River.

The 'Do Nothing' alternative does not meet surface and basement flooding objectives of this study nor does it provide resiliency to account for climate change, future development or vulnerable lands uses. Alternative 1 is preferred as it is required to complete the City's continued sewer separation for the Price Road drainage area. The Prince Storm Trunk Sewers/Outfall is a Schedule 'C' level project and the College Ave. Storm Sewer is a Schedule 'A+" project.

Page is intentionally blank.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative - Prince Trunk Storm Sewer Outlet (STM-C1, STM-C9)

Figure 6-8

THE CITY OF WINDSOR

EXPRESSWAY AND ARTERIAL ROADS

CLASS 1 AND 2 COLLECTOR ROADS

RAILWAY

MUNICIPAL DRAINS

PRINCE ROAD PROPOSED DRAINAGE AREA

PROPOSED NEW OR UPGRADED STORM SEWERS

PROPOSED NEW STORM SEWER OUTFALL

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:10,500

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.2 **Felix Ave. Trunk Storm Sewer (STM-C10)**

This alternative requires trunk storm sewer construction of approximately 1600 m of new storm sewers along Felix Ave. ranging in size from 1200 mm diameter to 1800 mm x 1800 mm box culverts. Construction works starting just south of the intersection of Huron Church Rd. and Dorchester Rd., heading westerly along Dorchester Rd. and Felix Ave., connecting to the existing trunk sewer at College Ave. See **Figure 6-10** for an illustration of the location. This is a Schedule A+ project.

6.7.1.2.3 **Detroit St. Trunk Storm Sewer and Outfall (STM-C2)**

This alternative requires improvement to on the existing storm sewer outlet at Detroit St. to accommodate additional storm flows generated from the enhanced sewer separation program. This alternative include installation of approximately 300 m of storm sewer along Detroit St. to a new enlarged outfall at the Detroit River, within an existing easement. See **Figure 6-10** for an illustration of the location, and **Table 6-7** for a comparative evaluation of the Detroit St. Trunk Storm Sewer Alternative to the Do Nothing alternative.

Table 6-7: Detroit St. Storm Sewer/Outfall (STM-C2) Alternative

Evaluation Criteria	Alternative 1 Install Detroit St. Storm Sewer Pipeline/Replace Outfall	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Water Quality	✓	-

Evaluation Criteria	Alternative 1 Install Detroit St. Storm Sewer Pipeline/Replace Outfall	Do Nothing Alternative
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓
Impacts to the Natural Environment	-	✓
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage roadway surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Alternative 1 achieves this objective.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a standard installation and operation.

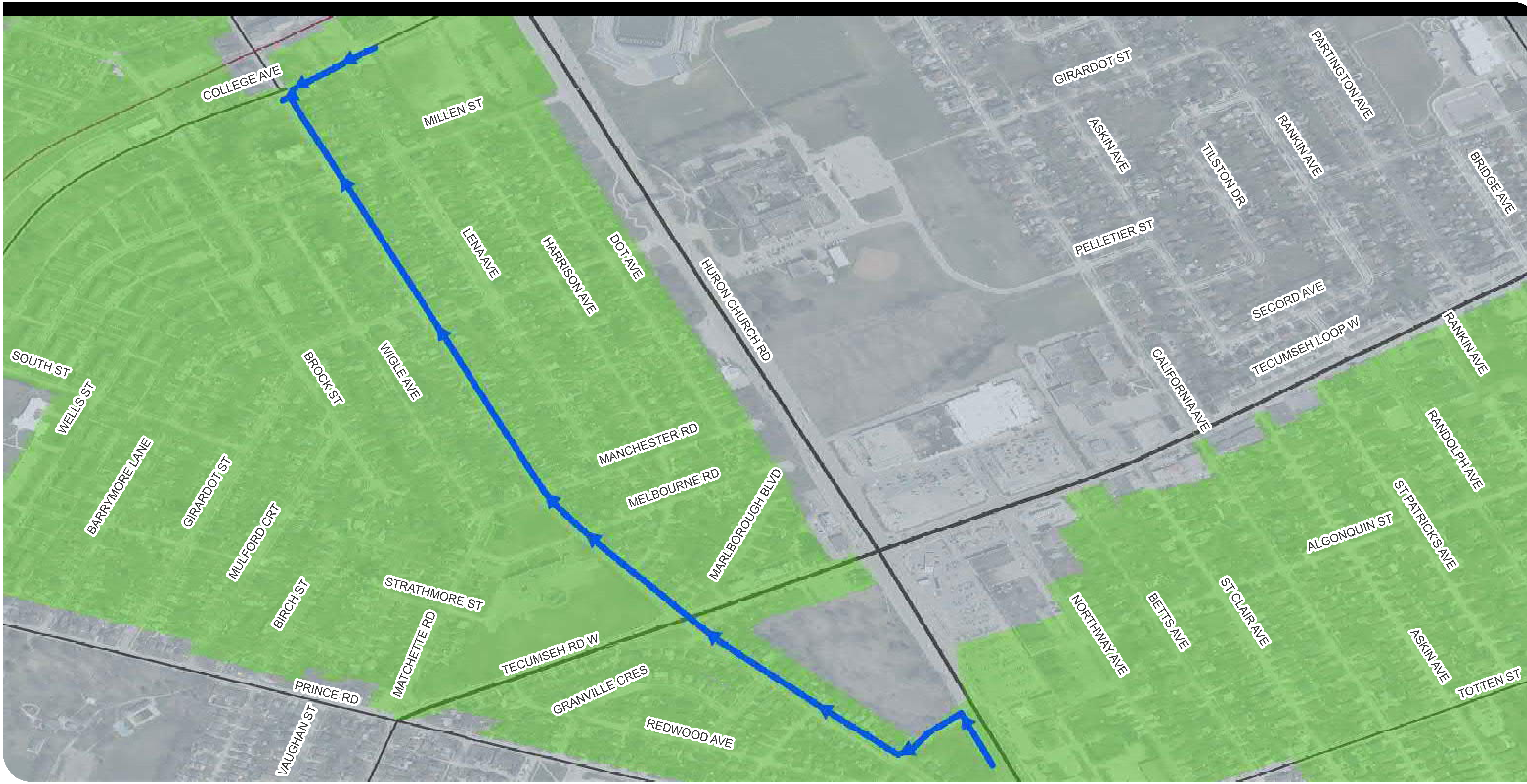
Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface and basement flooding

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and offer mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: This outlet is not anticipated to have impacts to the natural environment. This outlet is not anticipated to have impacts to the natural environment. Implementing enhanced sewer separation and associated storm sewer systems will reduce frequency of CSOs to the Detroit River.

The 'Do Nothing' alternative does not improve the surface and basement flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with construction of the total 300 m of storm sewer conduit and outfall installation to alleviate current basement and surface flooding risk and prevent future flooding. This sewer will replace an existing storm sewer outfall at the Detroit River and within the same sewer alignment; therefore, impacts to the urban community is considered minimal. The Detroit St. Storm Sewer Outfall Improvements is anticipated to be a Schedule 'B' level project.

Page is intentionally blank.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative-Felix Ave. Storm Sewer (STM-C10)

Figure 6-9

THE CITY OF WINDSOR

EXPRESSWAY AND ARTERIAL ROADS

CLASS 1 AND 2 COLLECTOR ROADS

RAILWAY

MUNICIPAL DRAINS

BROCK ROAD PROPOSED DRAINAGE AREA

PROPOSED NEW OR UPGRADED STORM SEWERS

PROPOSED NEW STORM SEWER OUTFALL

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:6,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative - Detroit St. Trunk Storm Sewer (STM-C2)

Figure 6-10

THE CITY OF WINDSOR

EXPRESSWAY AND ARTERIAL ROADS

CLASS 1 AND 2 COLLECTOR ROADS

RAILWAY

MUNICIPAL DRAINS

DETROIT STREET PROPOSED DRAINAGE AREA

PROPOSED NEW OR UPGRADED STORM SEWERS

PROPOSED NEW STORM SEWER OUTFALL

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:6,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.4 Partington Ave. Trunk Storm Sewer (STM-C11)

This solution requires storm sewer system improvements to facilitate the enhanced separation of sewers in the Huron Church Rd. drainage area. This alternative includes the installation of approximately 1,300 m of new storm sewers along Tecumseh Rd. W. and Partington Ave. starting just south of the intersection of Tecumseh Rd. W. (Class I Arterial Roadway), and Dominion Blvd. extending in a westerly direction along Tecumseh Rd. W., and northwards along Partington Ave.; and terminating at a connection to the existing College Ave. Storm Sewer Trunk. Refer to **Figure 6-11** for an illustration of the location. This project is anticipated to be a Schedule 'A' level project.

6.7.1.2.5 Patricia Ave. Trunk Storm Sewer (STM-C12)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor) in the area east of Huron Church Rd. and north of College Ave. This alternative includes the construction of 650 m of storm sewer northwards along Patricia Rd., and westwards along Wyandotte St. W. (Class I Arterial Roadway); connecting to the existing Huron Church Rd. storm sewer trunk. Refer to **Figure 6-11** for an illustration of the location. This project is anticipated to be a Schedule 'A' level project.

6.7.1.2.6 Huron Church Rd. Trunk Storm Sewer (STM-C13)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor) in the area east of Huron Church Rd. and north of Tecumseh Rd. W. This solution includes the construction of approximately 70 m of 3000 mm diameter storage sewers. Refer to **Figure 6-11** for an illustration of the location. This project is anticipated to be a Schedule 'A' level project.

Page is intentionally blank.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative - Huron Church Trunk Storm Sewer (STM-C11, STM-C12, STM-C13)

Figure 6-11

EXPRESSWAY AND ARTERIAL ROADS	RAILWAY	HURON CHURCH ROAD PROPOSED DRAINAGE AREA
CLASS 1 AND 2 COLLECTOR ROADS	MUNICIPAL DRAINS	PROPOSED NEW OR UPGRADED STORM SEWERS
		PROPOSED NEW STORM SEWER OUTFALL

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:13,000

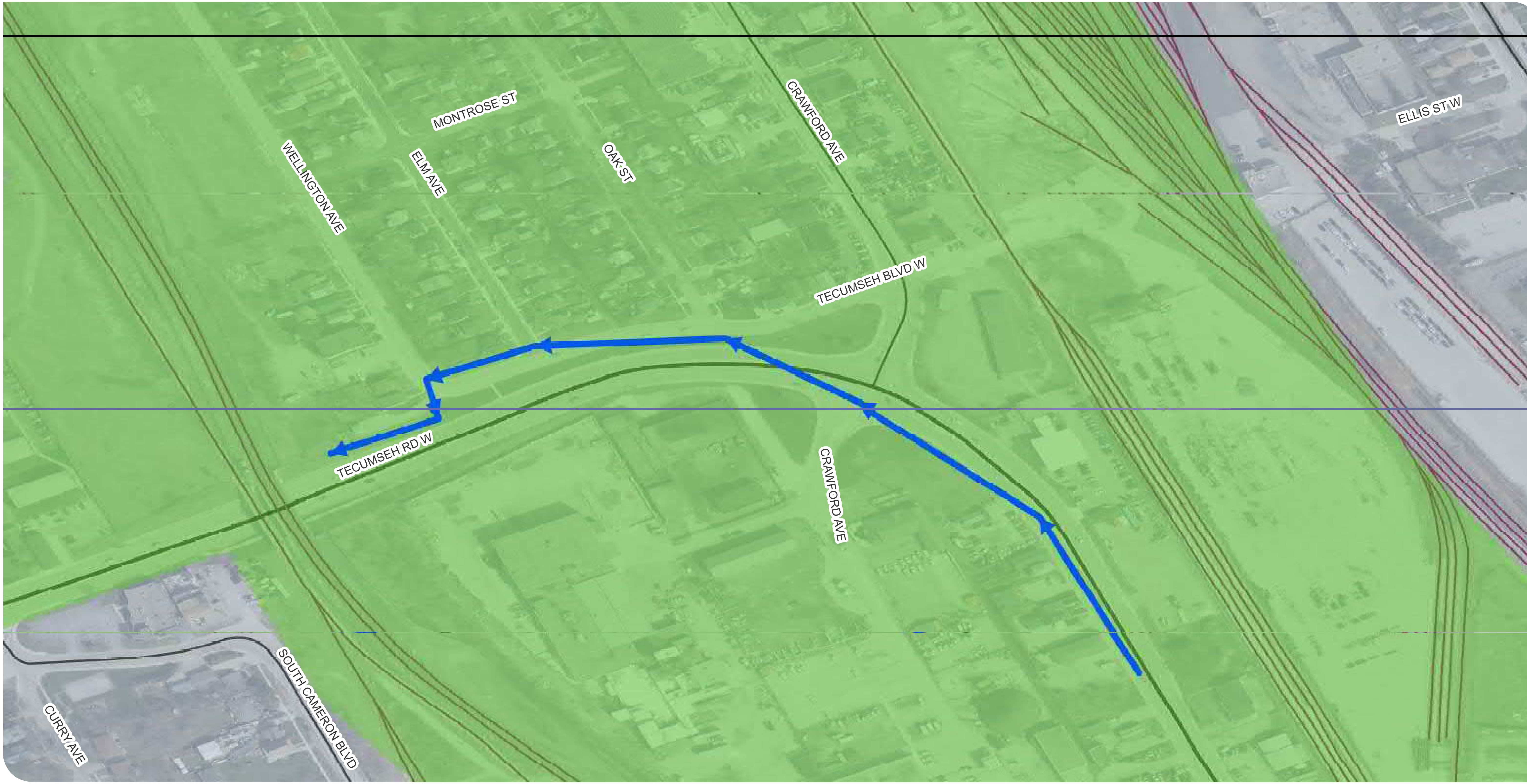
PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.7 Tecumseh Rd. W. Trunk Storm Sewer (STM-C14)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor) on Tecumseh Rd. (Class I Arterial). This alternative includes: Installation of approximately 600 m of new storm sewers westwards along Tecumseh Rd. W., south on Wellington Ave. and west along Tecumseh Rd. W., to connect with the existing trunk storm sewer at the railway right-of-way. See **Figure 6-8** for an illustration of the location. This is a Schedule A+ project.

Page is intentionally blank.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative - Tecumseh Trunk Storm Sewer (STM-C14)

Figure 6-12

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
WELLINGTON AVE PROPOSED DRAINAGE AREA
PROPOSED NEW OR UPGRADED STORM SEWERS
PROPOSED NEW STORM SEWER OUTFALL

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:2,500

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.8 Cameron Ave. Trunk Storm Sewer and Outfall (STM-C3)

This solution provides a framework to accommodate the additional storm sewer flows that will require outlet to the Detroit River, as part of the enhanced sewer separation program. This alternative includes: Installation of approximately 2,700 m of new storm sewers on Tecumseh Rd. W. (Class I Arterial), Curry Ave., Rooney St., McKay Ave., Martindale St., and northwards along Cameron Ave. to connect to a new outfall at the Detroit River.

Refer to **Figure 6-13** for an illustration of the location, and **Table 6-8** for a comparative evaluation of the Cameron Trunk Storm Sewer Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-8: Cameron Trunk Storm Sewer/Outfall Alternative (STM-C3)

Evaluation Criteria	Alternative 1 Install Cameron Trunk Storm Sewer Pipeline/Outfall	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Water Quality	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓

Evaluation Criteria	Alternative 1 Install Cameron Trunk Storm Sewer Pipeline/Outfall	Do Nothing Alternative
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	✓
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: New stormwater system and outlet will meet the basement and surface flood reduction level of service for a 1:100 year storm will provide resilience for potential impacts of climate change.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of this infrastructure for the service life of the pipe material.

Disruption during Construction: Temporary road closures in the vicinity of the construction corridors will be kept to a minimum to maintain traffic flow along Tecumseh Rd. West (Class I Arterial), Curry Ave., Rooney St., McKay Ave., Martindale St., and Cameron Ave. Temporary closure of park areas will be required during construction.

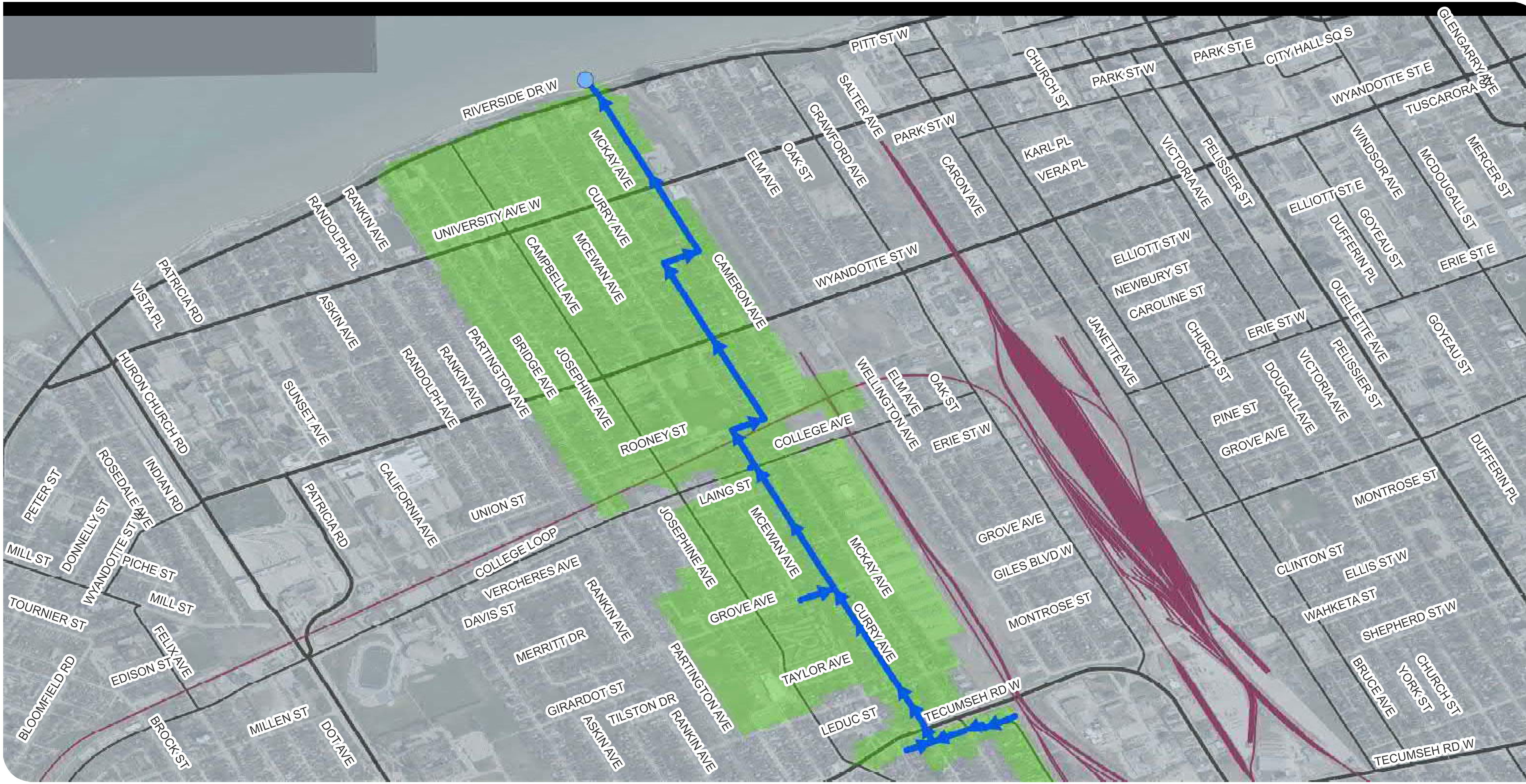
Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhoods for the community’s future by reducing the risk of surface flooding.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. The completion of a Stage 2 Archaeological Assessment is not required for this site.

Impacts to the Natural Environment: The areas of storm sewer installation are already disturbed by urban activities, and the disturbance to the Detroit River shoreline for the outfall installation will be performed during dry weather conditions to minimize any impacts to the riverbank, as well as outside of breeding season for species at risk present. There are no impacts anticipated to recreation or use of the waterway as a result of construction activity. This outlet is not anticipated to have impacts to the natural environment. Implementing enhanced sewer separation and associated storm sewer systems will reduce frequency of CSOs to the Detroit River.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with construction of the total 2,700 m of storm sewer pipeline and outfall installation, to alleviate current surface flooding issues and prevent future flooding. The Cameron Storm Trunk Sewers/Outfall is anticipated to be a Schedule 'C' level project.

Page is intentionally blank.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative - Cameron Trunk Storm Sewer (STM-C3)

Figure 6-13

EXPRESSWAY AND ARTERIAL ROADS

CLASS 1 AND 2 COLLECTOR ROADS

RAILWAY

MUNICIPAL DRAINS

CAMERON AVE PROPOSED DRAINAGE AREA

PROPOSED NEW OR UPGRADED STORM SEWERS

PROPOSED NEW STORM SEWER OUTFALL

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:12,500

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.9 Bruce Ave. Trunk Storm Sewer and Outfall (STM-C4)

This solution requires improvement to provide a framework to accommodate the additional storm sewer flows that will require outlet as part of the enhanced sewer separation program in the Bruce Ave. drainage Area. This alternative includes the installation of approximately 2,000 m of new storm sewers north along Bruce Ave. to connect to a new outfall at the Detroit River.

See **Figure 6-14** for an illustration of the location, and **Table 6-9** for a comparative evaluation of the Bruce Ave. Trunk Storm Sewer Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-9: Bruce Ave. Trunk Storm Sewer/Outfall (STM-C4) Alternative

Evaluation Criteria	Alternative 1 Install Bruce Ave Trunk Storm Sewer Pipelines	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Water Quality	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓

Evaluation Criteria	Alternative 1 Install Bruce Ave Trunk Storm Sewer Pipelines	Do Nothing Alternative
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: Larger sewer infrastructure sized to meet the basement flood reduction level of service for a 1:100 year storm will provide resilience for potential impacts of climate change.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of this infrastructure for the service life of the pipe material.

Disruption during Construction: Temporary closures in the vicinity of the construction sites will be kept to a minimum to maintain traffic flow. Temporary closure of park areas will be required during construction.

Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding.

I**mpacts to Archaeological, Built Heritage, & Cultural Heritage:** The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: The areas of storm sewer installation are already disturbed by urban activities, and the disturbance to the Detroit River shoreline for the outfall installation will be performed during dry weather conditions to minimize any impacts to the riverbank, as well as outside of breeding season for species at risk present. There are no impacts anticipated to recreation or use of the waterway as a result of construction activity.

The 'Do Nothing' alternative does not improve the existing basement and surface flooding risk, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with construction of these storm sewer and outfall improvements to alleviate current surface flooding issues and prevent future flooding. The Bruce St. Storm Trunk Sewers/Outfall is anticipated to be a Schedule 'C' level project.

6.7.1.2.10 Parent Ave. Trunk Storm Sewer and Marentette Ave. Outfall (STM-C5)

This solution provides a framework to accommodate the additional storm sewer flows that will require outlet as part of the enhanced sewer separation program within the Langlois Ave. drainage area. This alternative includes the installation of 800 m of new storm sewers along the connecting portion of Assumption St. to Parent Ave., north along Parent Ave. (from Wyandotte St. East), westerly on Chatham St. East, and north along Marentette Ave.; to a new outfall at the Detroit River to connect to a new outfall at the Detroit River.

See **Figure 6-14** for an illustration of the location, and **Table 6-10** for a comparative evaluation of the Parent Ave. Trunk Storm Sewer Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-10: Parent Ave. Trunk Storm Sewer and Marentette Ave. Outfall (STM-C5) Alternative

Evaluation Criteria	Alternative 1 Install Marentette Ave Trunk Storm Sewer Pipelines	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Water Quality	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	✓
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), the installation of storm sewer infrastructure is vital towards achieving this objective.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of this infrastructure for the service life of the pipe material.

Disruption during Construction: Temporary road closures in the vicinity of the construction sites will be kept to a minimum to maintain traffic flow along. Temporary closure of park areas will be required during construction.

Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity. If, upon completion of a Stage 2 archaeological assessments show the presence of archaeological resources, consideration to relocate the outfall along the waterfront should be given.

Impacts to the Natural Environment: The areas of storm sewer installation are already disturbed by urban activities, and the disturbance to the Detroit River shoreline for the outfall installation will be performed during dry weather conditions to minimize any impacts to the riverbank, as well as outside of breeding season for species at risk present. There are no impacts anticipated to recreation or use of the waterway as a result of construction activity.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with construction of these storm sewer and outfall improvements to alleviate current surface flooding issues and prevent future flooding. This project is anticipated to be a Schedule 'C' level project.

6.7.1.2.11 Giles Ave. Interconnection Trunk Storm Sewer (STM-C15)

Giles Ave. Interconnection Trunk Storm Sewer (STM-C15) is required to manage risk of surface flooding on roadways. These improvements include the interconnect to the existing stormwater management system, installation of approximately 1,500 m of new storm sewers westward along Giles Ave., Shepherd St. , McDougall St. , Erie St. Howard Ave. Refer to **Figure 6-14** below for locations of proposed improvements. This project is anticipated to be a Schedule 'A+' level project.

6.7.1.2.12 Parent Ave. Trunk Storm Sewer (STM-C16)

Parent Ave. Trunk Storm Sewer (STM-C16) is required to manage surface flooding on roadways. These improvements the installation of 450 m of new storm sewers northerly along Parent Ave. (north of Giles Blvd. E.) and easterly for a portion of Erie St. Refer to **Figure 6-14** below for locations of proposed improvements. This project is anticipated to be a Schedule 'A+' level project.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative – Bruce Ave, Marentette Ave. Outlet (Langlois Drainage Area) and Giles Blvd E Trunk Storm Sewers (STM-C4, STM-C5, STM-C15, STM-16)

Figure 6-14

EXPRESSWAY AND ARTERIAL ROADS

CLASS 1 AND 2 COLLECTOR ROADS

RAILWAY

MUNICIPAL DRAINS

CHURCH-MCDOUGALL-LANGLOIS PROPOSED DRAINAGE AREA

PROPOSED NEW OR UPGRADED STORM SEWERS

PROPOSED NEW STORM SEWER OUTFALL

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:12,500

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.13 Lincoln Rd. Trunk Storm Sewer (STM-C17)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor). This alternative includes installation of approximately 300 m of new storm sewers along Lincoln Rd. between Niagara St. and Cataraqui St. This project is anticipated to be a Schedule ‘A+’ level project.

6.7.1.2.14 Ontario St. Trunk Storm Sewer (STM-C18)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor). This alternative includes installation of approximately 440 m of new storm sewers along Ontario St. This project is anticipated to be a Schedule ‘A+’ level project.

6.7.1.2.15 Walker Rd. Trunk Storm Sewer (STM-C19)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor. This alternative includes installation of approximately 640 m of new storm sewers northwards along Walker Rd. south from the Tecumseh Rd. W. intersection, and westwards along a portion of Mohawk St. This project is anticipated to be a Schedule ‘A+’ level project.

Refer to **Figure 6-15** for a map of improvements noted above (STM-C17, STM-C18, STM-C19).

Page is intentionally blank.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative–Lincoln Rd, Ontario St & Walker Rd Trunk Storm Sewer (STM-C17, STM-C18, STM-C19)

Figure 6-15

THE CITY OF WINDSOR

EXPRESSWAY AND ARTERIAL ROADS

CLASS 1 AND 2 COLLECTOR ROADS

RAILWAY

LINCOLN ROAD PROPOSED DRAINAGE AREA

PROPOSED NEW OR UPGRADED STORM SEWERS

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE : 1:10,000

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.16 Ypres Ave. Surface Flooding Risk Reduction Measure (STM-C6)

This solution requires improvement to manage surface flooding risk for major roadways, under the Climate Change Storm (1:100 year storm + 40% factor) in the area of Ypres Ave. The two alternatives evaluated to improve current conditions are:

- **Alternative 1** – Installation of new underground stormwater storage under the existing gravel parking lot area at Optimist Park on Ypres Ave, east of Forest St.
- **Alternative 2** – Use of the existing wooded area at the east end of Optimist Park. During major rain events, the sewer system could surcharge into the naturally low lying area and be stored temporary prior to draining back to the municipal storm sewers.

See **Figure 6-16** for an illustration of the location, and **Table 6-11** for a comparative evaluation of the Ypres Ave. surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-11: Ypres Ave. Surface Flooding Risk Reduction (STM-C6) Alternatives

Evaluation Criteria	Alternative 1 Install New Underground SWM facility Parking Lot	Alternative 2 Surface surcharge storage using the Optimist Park wood lot area.	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Water Quality	✓	✓	-

Evaluation Criteria	Alternative 1 Install New Underground SWM facility Parking Lot	Alternative 2 Surface surcharge storage using the Optimist Park wood lot area.	Do Nothing Alternative
Complexity of Installation & Operation	-	-	✓
Anticipated Extent of Maintenance Required	-	-	✓
Length of Time Required for Implementation	-	-	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	✓	-	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	-	✓
Impacts to the Natural Environment	✓	-	-
Relative Capital Cost	-	-	✓
-	PREFERRED	-	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Both alternatives achieve this.

Complexity of Installation & Operation: Initial pre-design investigation has determined these alternatives to be relatively standard installation and operation for both alternative 1 – parking lot sub-surface stormwater storage, and alternative 2 – surface storage in woodlot.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of these types of stormwater management measures.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along Ypres and Gladstone Ave. (Class I Collector) for each of the two alternatives. For alternative 2, closure of the woodlot during construction would disrupt community access for an extended period of time. Alternative 1 construction could potentially occur during a period when park use is less, such as during colder weather to minimize disruption to access and recreational use for residents.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding for both alternatives.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity for both alternatives. Alternative 1 will alter the parking lot temporarily during construction, whereas alternative 2 will require permanent changes to the understorey of the woodlot which alters the cultural heritage value of the woodlot in a negative manner, as the aesthetic and recreational experience will be changed by the loss of flora and fauna as a result of construction activity. A stage 2 assessment is not required for this study area. Alternative 1 is preferred for this criteria.

Impacts to the Natural Environment: For alternative 1, the parking lot area is already disturbed by urban activities. For alternative 2, disturbance of the woodlot understorey would significantly impact flora and fauna in a negative manner. Alternative 1 is preferred in this instance.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk, including during more severe climate change storms. The preferred alternative is alternative 1, as there are potentially less negative impacts, although more costly than the other alternatives, it preserves the woodlot and has the least disruption in working to alleviate current surface flooding issues and prevent future flooding. The

Ypres Surface Flooding Risk Reduction at the parking lot of Optimist Park is anticipated to be a Schedule 'B' level project.

YPRES ALTERNATIVE 1 (PREFERRED)	YPRES ALTERNATIVE 2
UNDERGROUND STORAGE AT OPTIMIST PARK, PARKING LOT.	SURFACE STORAGE AT OPTIMIST PARK, WOOD LOT.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

CENTRAL WINDSOR - YPRES AVE FLOOD RISK REDUCTION ALTERNATIVES (STM-C6)

FIGURE 6-16

EXPRESSWAY AND ARTERIAL ROADS	RAILWAY	UNDERGOUND STORAGE
CLASS 1 AND 2 COLLECTOR ROADS	PROPOSED NEW OR UPGRADED STORM SEWERS	SURFACE STORAGE IN WOODLOT

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:3,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.17 Albert Trunk Storm Sewer/Outfall and Wyandotte St. E. Sewer (STM-C7.1)

This solution requires improvement to provide added capacity to the existing storm system to accommodate future enhanced sewer separation. This alternative includes the installation of approximately 350 m of new storm sewers located south of the railway tracks north of St. Luke Rd. and along Albert Rd., to connect with a new outfall at the Detroit River. In addition, to mitigate surface flooding on Wyandotte St. E., for a Climate Change storm, it is recommended that a 200 m storm sewer be constructed between Walker Rd. and St. Luke St.

Refer to **Figure 6-17** for an illustration of the location, and **Table 6-12** for a comparative evaluation of the Albert Trunk Storm Sewer Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-12: Albert Trunk Storm Sewer/Outfall (STM-C7) Alternative

Evaluation Criteria	Alternative 1 Install Albert Trunk Storm Sewer	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Water Quality	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓

Evaluation Criteria	Alternative 1 Install Albert Trunk Storm Sewer	Do Nothing Alternative
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Alternative 1 achieves this objective.

Anticipated Extent of Maintenance Required: Upon completion of installation of Alternative 1, standard maintenance practices are anticipated to enable the sustainability of this infrastructure for the service life of the pipe material.

Disruption during Construction: Temporary road closures in the vicinity of the construction corridors will be kept to a minimum to maintain traffic flow along Wyandotte St. East (Class I Arterial) and along Albert Rd.

Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding. Property acquisition for an easement will be required for this alternative.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. A stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: The areas of storm sewer installation are already disturbed by urban activities, and the disturbance to the riverbank of the Detroit River for the outfall installation will be performed during dry weather conditions to minimize any impacts to the riverbank, as well as outside of breeding season for species at risk present. During construction there are not anticipated to be any impacts to recreation or use of the Detroit River.

The ‘Do Nothing’ alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with construction of the total 550 m of storm sewer and outfall installation to alleviate current surface flooding issues and prevent future flooding. The Albert Storm Trunk Sewers/Outfall is anticipated to be a Schedule ‘B’ level project.

6.7.1.2.18 Wyandotte St. E. Storm Sewer at St. Luke Rd. (STM-C7.2)

Albert Trunk Storm Sewer/Outfall (STM-C7) requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor) on Wyandotte St. East, a Class I Arterial roadway in the City. This alternative includes the installation of approximately 350 m of new storm sewers located south of the railway tracks north of St. Luke Rd. and along Albert Rd., to connect with a new outfall at the Detroit River.

Refer to **Figure 6-17** for an illustration of the location.

Page is intentionally blank

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Alternative - Albert Trunk Storm Sewer Outlet and Wyandotte St. E. Storm Sewer (STM-C7)

Figure 6-17

EXPRESSWAY AND ARTERIAL ROADS	RAILWAY
CLASS 1 AND 2 COLLECTOR ROADS	ALBERT ROAD PROPOSED DRAINAGE AREA
PROPOSED NEW OR UPGRADED STORM SEWERS	PROPOSED NEW STORM SEWER OUTFALL

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE : 1:8,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.2.19 Drouillard Rd. Surface Flooding Risk Reduction Measure (STM-C8)

This solution requires improvement to manage surface flooding risk for the Drouillard Rd./ Wyandotte St. E. intersection (Class II Arterial) under the Climate Change Storm (1:100 year storm + 40% factor). It is assumed that water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches for both alternatives, which would be confirmed later in the design phase of the preferred alternative. The two different alternatives possible to improve current conditions are:

- **Alternative 1** – New pump station and upgraded sewers. This alternative includes upgrading the underpass' pump station to a capacity of approximately 1,200 L/s coupled with upgraded 270 m of storm sewers, 825 mm in diameter connecting to an existing 900 mm diameter sewer that outlets to the Detroit River.
- **Alternative 2-** Maintain existing pump station with new underground storage. This alternative includes maintaining the existing pump station but providing additional 2,200 m^3 of upstream underground storage beneath the underpass. Underground storage is proposed as two large box culverts that will require most of the existing underpass to construct.

See **Figure 6-18** for an illustration of the location, and **Table 6-13** for a comparative evaluation of the Drouillard surface flooding risk reduction alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-13: Drouillard Rd. Surface Flooding Risk Reduction (STM-C8) Alternatives

Evaluation Criteria	Alternative 1 Install New Pump Station & Upgraded Storm Sewers	Alternative 2 Install New Under-ground Storage at Existing Pump Station & Upgrades	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Water Quality	✓	✓	-
Complexity of Installation & Operation	✓	-	✓
Anticipated Extent of Maintenance Required	-	-	✓
Length of Time Required for Implementation	-	-	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	-	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	-	✓
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	-	-	✓
-	PREFERRED	-	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Both alternatives achieve the objective of reducing surface flooding to less than 30 cm in the Drouillard Rd./Wyandotte St. East underpass, and both meet the objective of reducing surface flooding during more severe climate change storms.

Complexity of Installation & Operation: Initial pre-design investigation has determined that Alternative 1 would require less construction within the underpass but more construction along Drouillard Rd. and within Cadillac Park. Alternative 1 would be relatively easier to implement than Alternative 2 as requires the construction of twin large box culverts.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of these types of stormwater management measures.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along Drouillard Rd. and Wyandotte St. East for each of the two alternatives. For alternative 2 is anticipated to require more construction and may potentially require more frequency temporary road closures than alternative 1. Both alternatives could potentially schedule construction to occur during a period when park use is less, such as during colder weather to minimize disruption to access and recreational use for residents.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding for both alternatives.

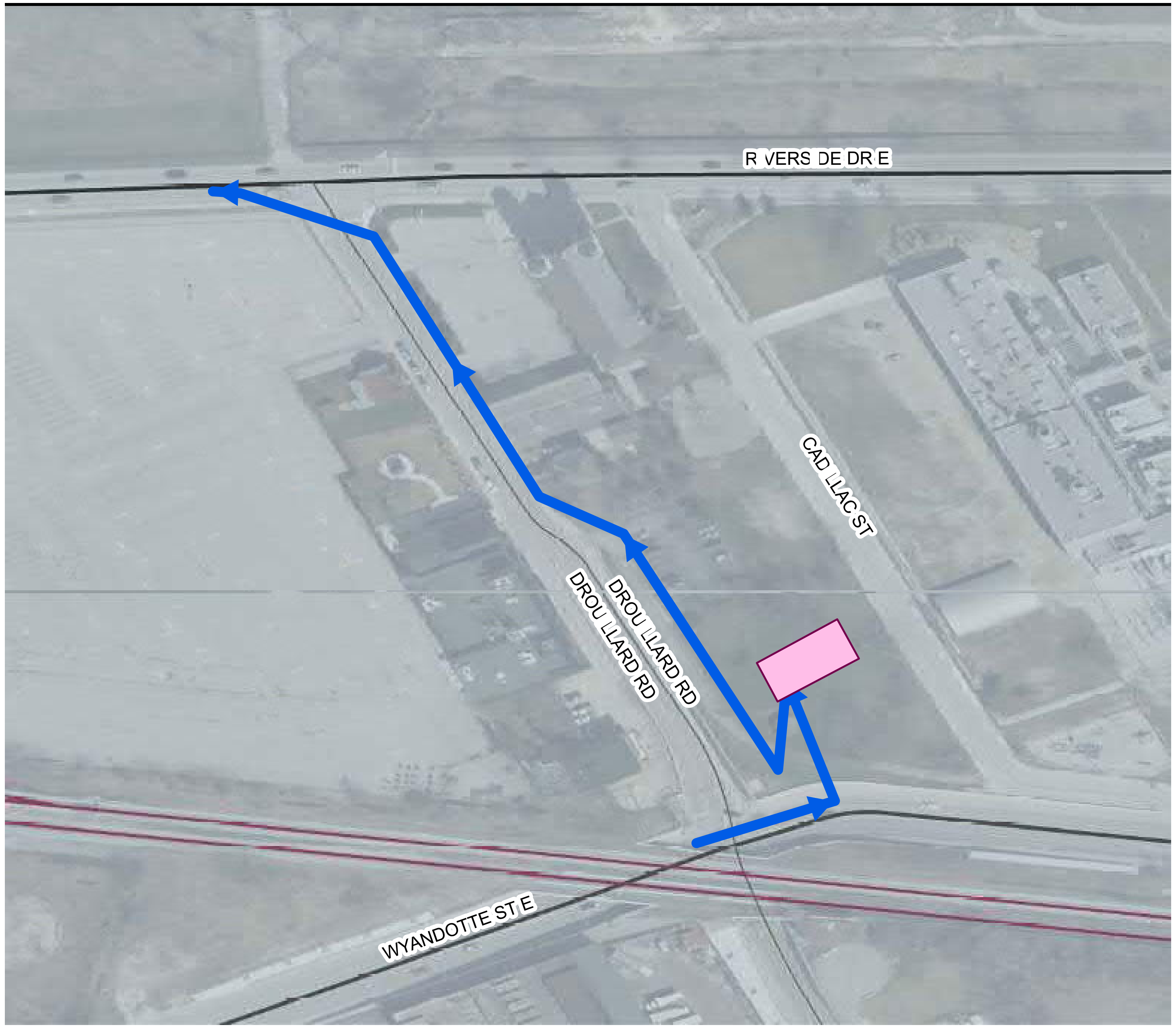
Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity for both alternatives. The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

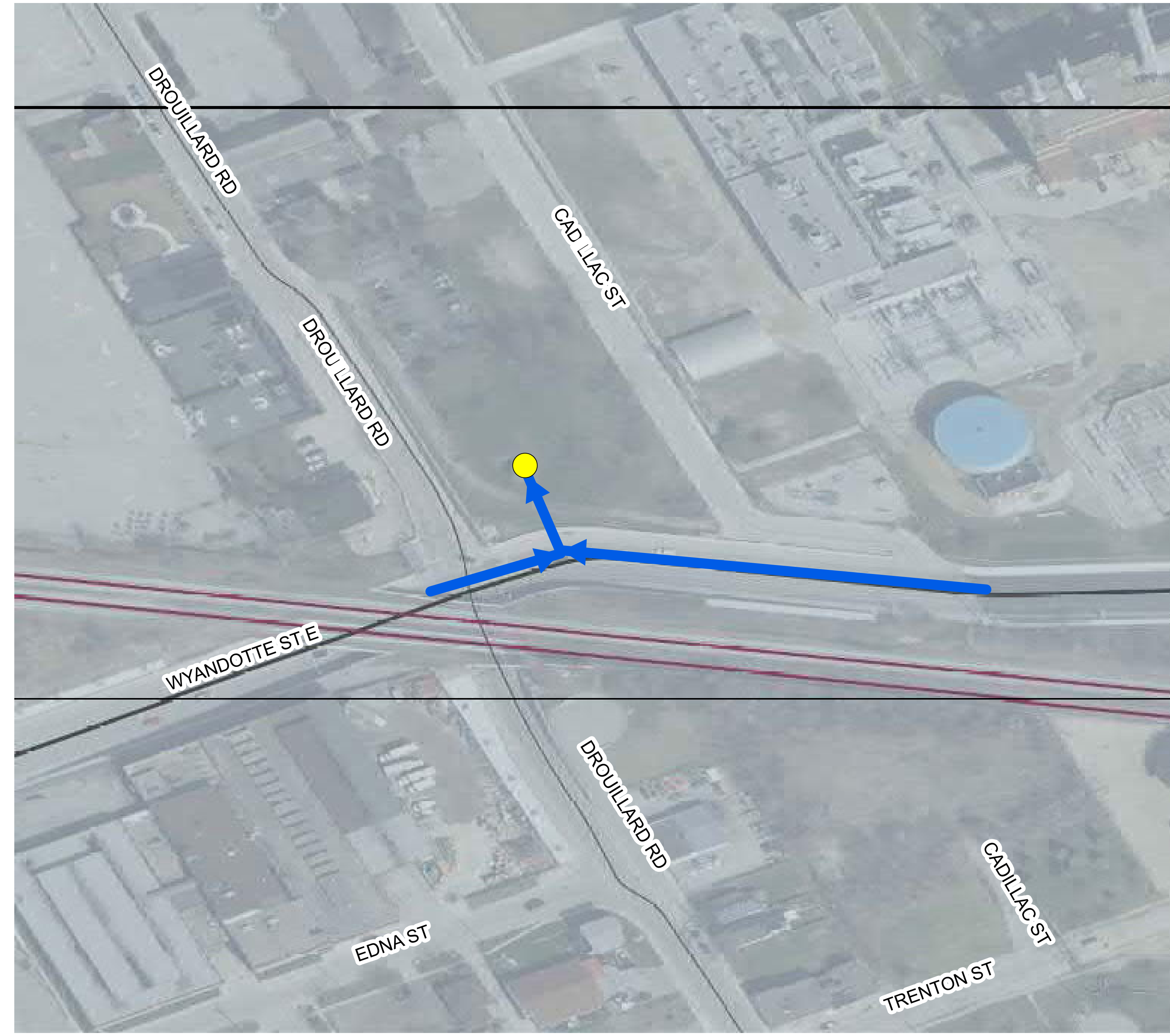
Impacts to the Natural Environment: For both alternatives, the proposed construction areas are already disturbed by urban activities.

Relative Capital Cost: The cost for Alternative 2 is more expensive than alternative 1, as it requires more construction effort to install a stormwater storage system underground and within the underpass. For this criteria, alternative 1 is preferred.

The ‘Do Nothing’ alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk, including during more severe climate change storms. The preferred alternative is alternative 1, as it is less costly than the other alternatives, and consists of less construction within the underpass and less disruption in order to alleviate current surface flooding issues and prevent future flooding. The Drouillard Rd. Surface Flooding Risk Reduction is anticipated to be a Schedule ‘B’ level project.

DROUILLARD ALTERNATIVE 1 (PREFERRED)	DROUILLARD ALTERNATIVE 2
New Pump Station and Upgraded Sewers on Drouillard Road and Wyandotte St.E.	Existing Pump Station with Underground Storage on Wyandotte St. E.





CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Drouillard Surface Flooding Risk Reduction (STM-C8) Alternatives

Figure 6-18

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
PROPOSED NEW OR UPGRADED STORM SEWERS
NEW PUMPSTATION LOCATION/FOOTPRINT
EXISITNG PUMP STATION

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE : 1:2000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.3 South Sewershed – Overall Basement Flooding Risk Reduction Strategy (SAN-S)

The basement flooding issues of the South Sewershed differ from those in the Central area, basement flooding is generally caused by excess rainwater entering the sanitary sewers system due to inflow sources (foundation drains, illegal connections) and infiltration (cracks and leaks within the private and public sewers system). The objective for basement flood risk reduction under a 1:100 year storm is to reduce water levels in the sanitary sewer system in the South Sewershed such that 10% or less of the sewers surcharge to levels that could result in basement flooding.

Two basement flood risk alternatives (see **Figure 6-14**) were established to achieve this for the South Sewershed, namely:

- **Alternative 1 - Targeted Sub-Trunk Stormwater Storage** consisting of new sanitary trunk sewers (750 to 900 mm diameter) on Dominion Blvd., Woodland Ave., Parkwood Ave., Conservation Dr., Tourangeau Rd., as well as Howard Ave. (Class 1 Arterial), and Grand Marais Rd. E. (Class 1 Collector); or
- **Alternative 2 - Decentralized Upstream Stormwater Storage** consisting of new sanitary sewers (600 to 750 mm diameter) along numerous local roadways.

It was determined that both alternatives meet the objective of mitigating basement flooding and achieving similar flood resiliency for severe climate change storm events, whereas the Do Nothing alternative does not meet the objective. As part of the pre-design phase, SAN-S-1 was determined to be less expensive and require significantly less construction than SAN-S-2, SAN-S-1 is preferred.

The assumptions for the South Sewershed includes:

- Increased sewage treatment capacity at the Lou Romano Water Reclamation Plant, with construction of a new retention treatment basin (RTB) (this RTB was recommended as part the City's CSO Reduction Environmental Assessment (Stantec, 2019));
- Disconnection of all existing residential foundation drainage from the sanitary sewer system;
- Reduced inflow into the sanitary sewer system following sealing of manhole lids and continued repair and sealing of existing leaky sewer pipes and manhole structures; and

- No changes to the sanitary flow allowances from the Town of LaSalle inflow points.

See **Figure 6-19** for an illustration of the sanitary sewer alternatives described, and **Table 6-14** for a comparative evaluation of the South Windsor basement flooding risk reduction alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-14: South Windsor Basement Flooding Risk Reduction Alternatives (SAN-S)

Evaluation Criteria	Alternative 1 Targeted Sub-trunk Storage	Alternative 2 Decentralized Upstream Storage	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Water Quality	✓	✓	Does not meet the flood mitigation objectives.
Complexity of Installation & Operation	✓	-	Does not meet the flood mitigation objectives
Anticipated Extent of Maintenance Required	✓	-	Does not meet the flood mitigation objectives
Length of Time Required for Implementation	✓	-	Does not meet the flood mitigation objectives

Evaluation Criteria	Alternative 1 Targeted Sub-trunk Storage	Alternative 2 Decentralized Upstream Storage	Do Nothing Alternative
Disruption during Construction	✓	-	Does not meet the flood mitigation objectives
Permanent Changes to the Urban Community	✓	✓	Does not meet the flood mitigation objectives
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	Does not meet the flood mitigation objectives
Impacts to the Natural Environment	✓	✓	Does not meet the flood mitigation objectives
Relative Capital Cost	✓	-	Does not meet the flood mitigation objectives
-	PREFERRED	-	-

Flexibility to Adjust to Climate Change: Larger sewer infrastructure sized to meet the basement flood reduction level of service for a 1:100 year storm will provide resilience for potential impacts of climate change.

Complexity of Installation & Operation: Alternative 2 would require significantly more construction. Private property measures to meet flood mitigation level of service for both alternatives are the same (area wide foundation drain disconnection).

Anticipated Extent of Maintenance Required: Alternative 1 has a comparatively lower quantity of large trunk sanitary sewers which requires a relatively lower level of operation and maintenance.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow. For alternative 2 is anticipated to require more construction and may potentially require more frequency temporary road closures than alternative 1.

Permanent Changes to the Urban Community: The installation of basement flood mitigation measures in this area will benefit the urban community by minimizing property damage associated with sewer backups. This is applicable to both alternatives.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: For both alternatives, the installation of sanitary sewers are proposed within the City's right-of-way. A Stage 2 assessment is not required for this study area.

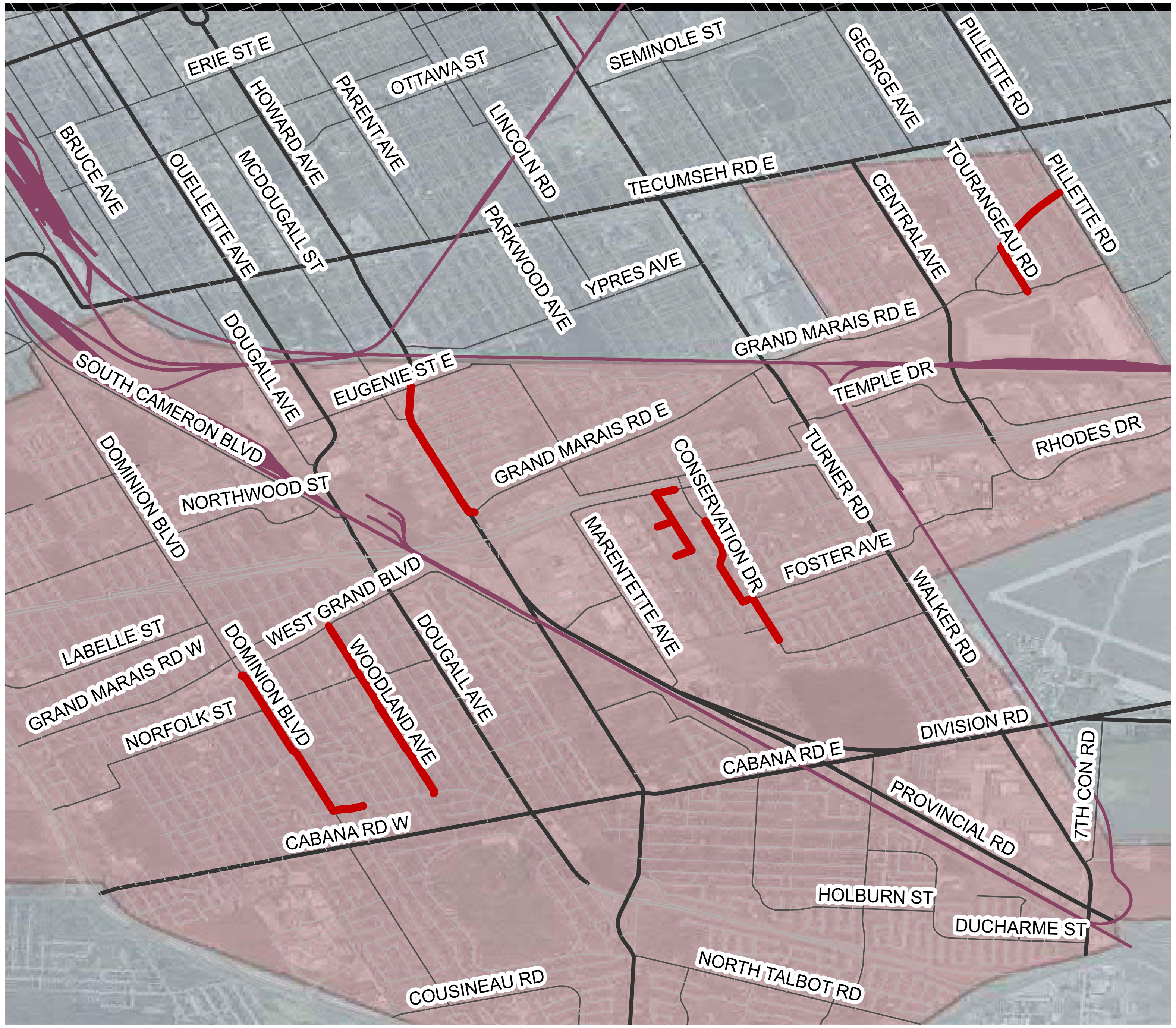
Impacts to the Natural Environment: For both alternatives, the proposed construction areas are already disturbed by urban activities.

Relative Capital Cost: The cost for Alternative 2 is more expensive than Alternative 1, as it requires more construction effort to install a larger quantity of sanitary sewers underground and within the underpass.

The 'Do Nothing' alternative does not meet the flood mitigation objectives of this study; therefore, is not a viable solution. Both alternatives 1 and 2 meet the objective of reducing basement flooding risk under a 1:100 year event. The preferred alternative is alternative 1, as it is less costly than the other alternatives, and consists of less construction. This is anticipated to be a Schedule 'A+' level project.

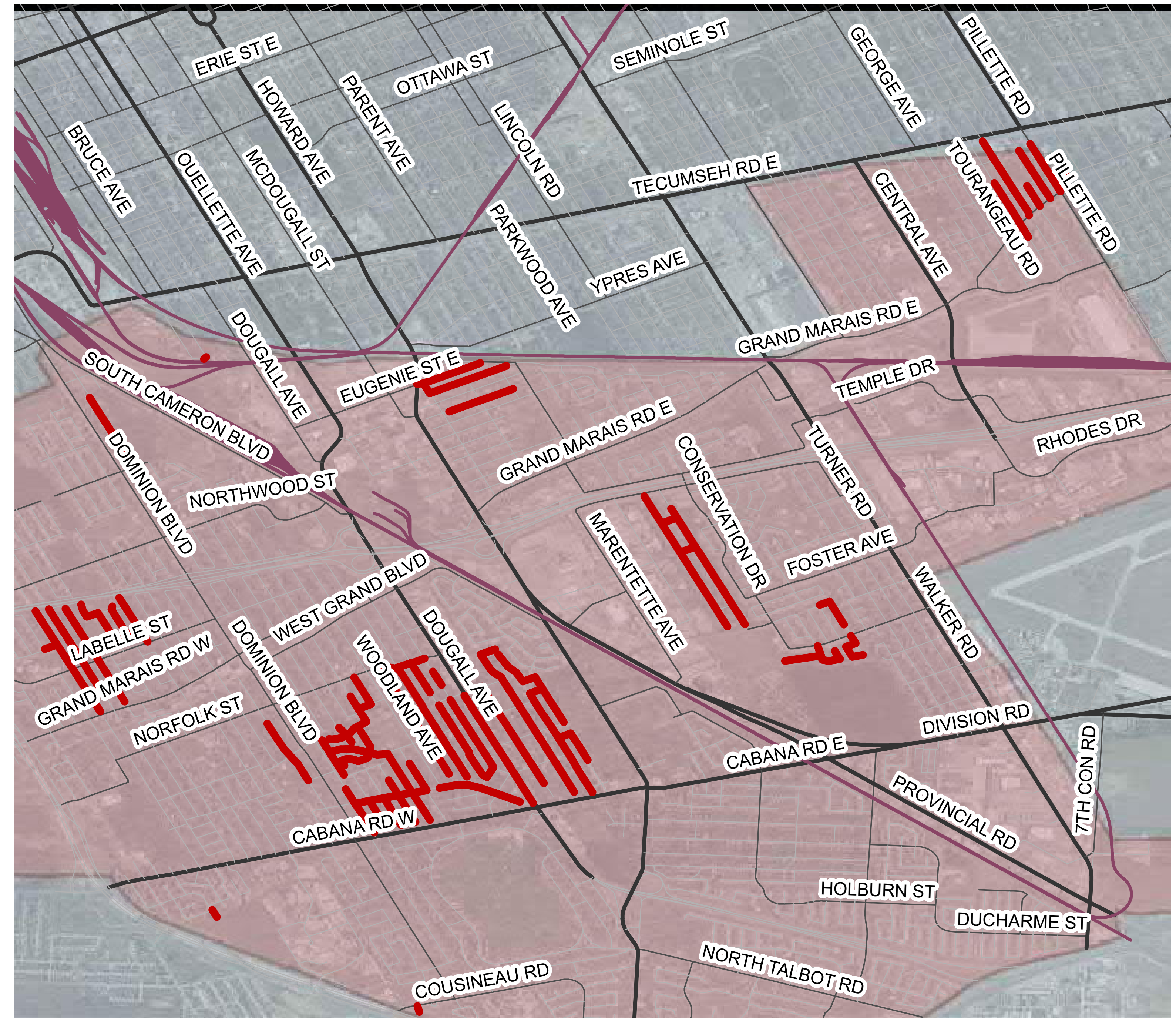
SOUTH WINDSOR BASEMENT FLOODING ALTERNATIVE 1 (PREFERRED)

Targeted Sub-Trunk Storage:
Proposed trunk sanitary sewers (750 to 900 mm diameter) on Dominion Blvd., Woodland Ave., Howard Ave., Parkwood Ave., Conservation Dr., Grand Marias Rd. E, and Tourangeau Rd.
Construction on approximately 8 km of sanitary sewer.



SOUTH WINDSOR BASEMENT FLOODING ALTERNATIVE 2

Decentralized Upstream Storage:
Proposed 26 km of sanitary sewers on multiple streets.
Proposed sewer diameters range from 600 to 750 mm.



EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
SANITARY SEWER IMPROVEMENTS
SOUTH WINDSOR SANITARY SEWER DRAINAGE AREA

CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

South Sewershed - Proposed Basement Flooding Alternatives (SAN-S)
Figure 6-19

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:46,000

ROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.4 South Sewershed – Surface Flood Reduction Solutions – Grand Marais Drain Sub-Drainage Area

6.7.1.4.1 Dougall Surface Flooding Risk Reduction Measure (ROAD-S1)

This solution requires improvement to manage surface flooding risk for major roadways, under the Climate Change Storm (1:100 year storm + 40% factor) in the area of Eugenie St. , west of McDougall St, and Dougall Ave., north of the railway underpass. It is assumed that water quality treatment may be provided by low impact development (LID) for both alternatives, which would be confirmed later in the design phase of the preferred alternative. The two different alternatives possible to improve current conditions are:

- **Alternative 1** – Installation of approximately 1,500 m of new trunk storm sewer from Eugenie St. to a new SWM Pond (14,000 m^3 capacity) on a vacant privately-owned parcel of land located south of Northwood St. at Dougall Ave. (Class 1 Arterial).
- **Alternative 2** – Installation of approximately 2,000 m of new trunk storm sewer from Eugenie St. to two new SWM Ponds (each with 7,500 m^3 capacity) within two separate publicly-owned parcels of land, located west of Dougall Ave. (Class 1 Arterial) within the EC Row Expressway ramp loops.

See **Figure 6-20** for an illustration of the location, and **Table 6-15** for a comparative evaluation of the Dougall Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-15: Dougall Surface Flooding Risk Reduction (ROAD-S1) Alternatives

Evaluation Criteria	Alternative 1 Install New Trunk Sewer and SWM Pond on Vacant Parcel	Alternative 2 Install Trunk Sewer to Two New SWM Ponds on Public Land Parcels	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Water Quality	✓	✓	-
Complexity of Installation & Operation	✓	-	✓
Anticipated Extent of Maintenance Required	✓	-	✓
Length of Time Required for Implementation	-	-	✓
Disruption during Construction	✓	-	✓
Permanent Changes to the Urban Community	✓	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	-
Impacts to the Natural Environment	✓	✓	-

Evaluation Criteria	Alternative 1 Install New Trunk Sewer and SWM Pond on Vacant Parcel	Alternative 2 Install Trunk Sewer to Two New SWM Ponds on Public Land Parcels	Do Nothing Alternative
Relative Capital Cost	✓	-	✓
-	PREFERRED	-	

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Both alternatives achieve this.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be relatively standard installation and operation, and alternative 2 to be more complex because of the limited space and traffic movement around the two parcels proposed for the SWM Ponds, which would require a significant amount of night time work to keep the roadways open during daylight hours. Alternative 2 also requires retention walls and road safety barriers to account for changes in grade between the road and the SWM Pond.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of these types of stormwater management measures.

Length of Time Required for Implementation: Alternative 1 requires property acquisition which may delay the project. Initial pre-design investigation has determined alternative 2 to be more complex due to the presence of traffic all around the two potential SWM Pond areas requiring more time, approximately 10-12 months, as opposed to the 6-8 months required for alternative 1.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along Dougall Ave. (Class I Arterial) for each of the two alternatives, although more temporary closures are anticipated for alternative 2 as there is vehicular movement all around each of the two proposed SWM Ponds.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding for both alternatives. Alternative 1 can be a feature that is integrated into the newly constructed pedestrian underpass under the existing CN rail line.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers and SWM Pond(s) in this area will positively impact these features by reducing the risk of surface flooding in the vicinity for both alternatives. Alternative 1 will alter the vacant lot, whereas alternative 2 will be two smaller SWM Ponds within previously disturbed parcels of land. A stage 2 assessment is not required for this study area. Alternative 1 is preferred for this criteria.

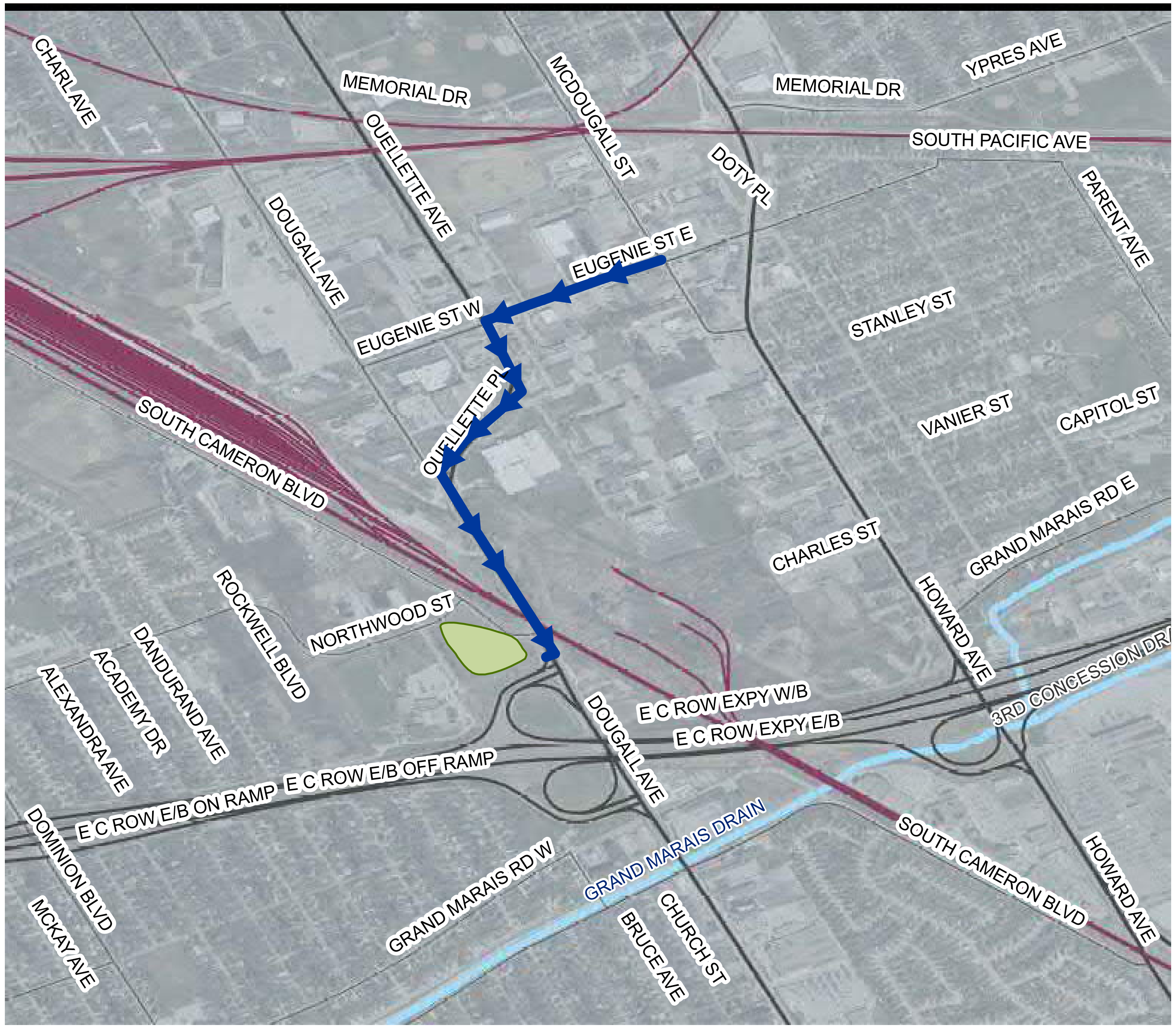
Impacts to the Natural Environment: For alternative 1, the vacant lot area is currently used for agricultural use. For alternative 2, the land parcels have already been disturbed by urban activities; however, the extensive tree plantings in these green spaces would be lost. Alternative 1 is preferred in this instance.

Relative Capital Cost: The cost for Alternative 2 is more expensive as it requires more construction effort, including retaining walls and secondary inlet/outlet infrastructure. Alternative 1 is less costly to implement than Alternative 2 as it would direct additional stormwater runoff to a vacant lot which is more readily accessible for construction purposes. For this criteria, alternative 1 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk, including during more severe climate change storms, while not increasing the flow of stormwater runoff entering the Grand Marais Drain. The preferred alternative is alternative 1, as there are potentially less negative impacts, and is least costly. The Dougall Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level project.

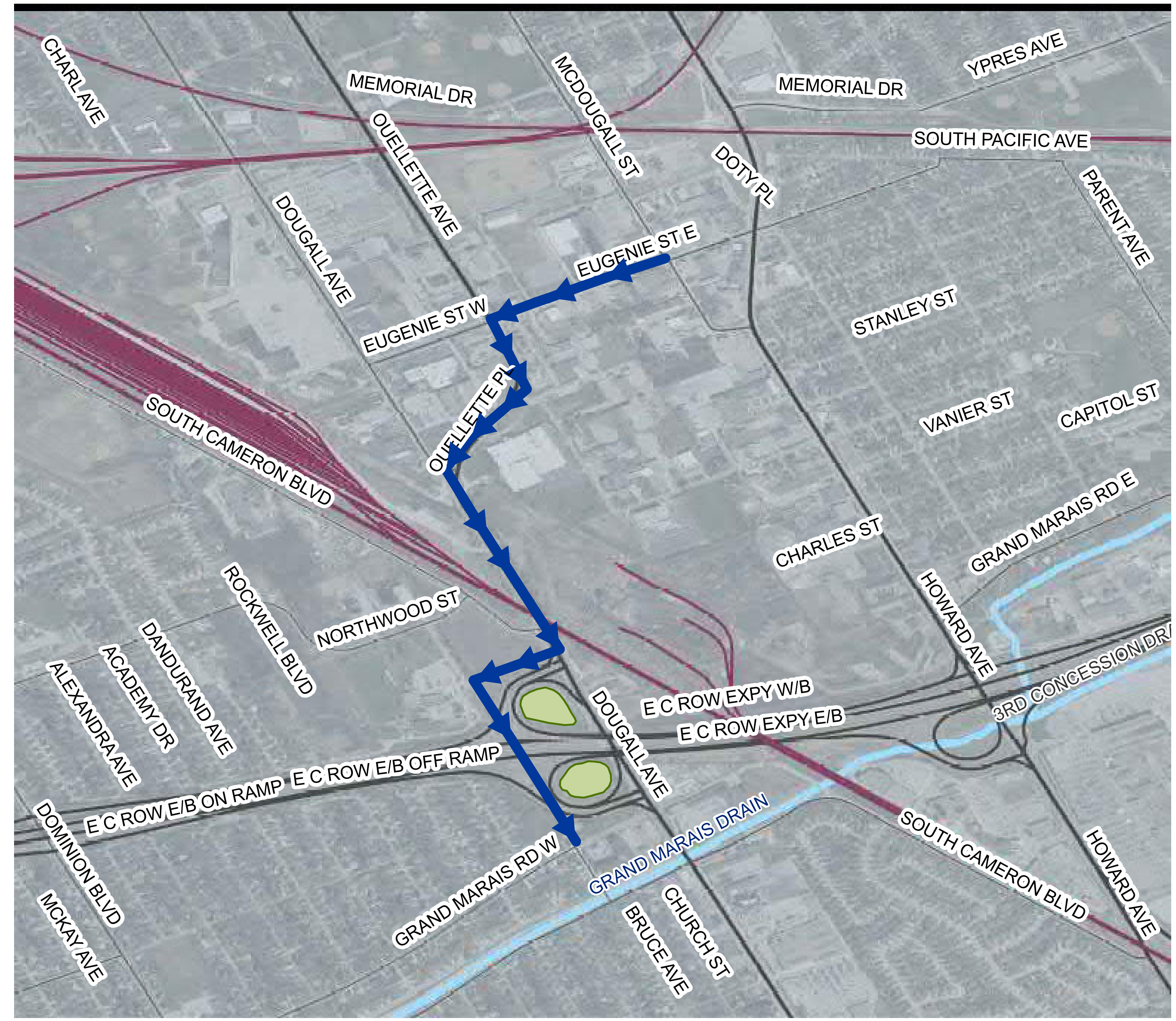
DOUGALL AVE. ALTERNATIVE 1 (PREFERRED)

Proposed trunk storm sewer from Eugenie Street to proposed stormwater management pond within vacant property south of Northwood St.



DOUGALL AVE. ALTERNATIVE 2

Proposed trunk storm sewer from Eugenie Street to two proposed stormwater ponds within EC ROW ON/OFF ramp areas.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Dougall Surface Flooding Risk Reduction (ROAD-S1) Alternatives

Figure 6-20

THE CITY OF WINDSOR

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
STORMWATER STORAGE POND

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: GCS NORTH AMERICAN 1983

SCALE : 1:14,500

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.4.2 Howard Surface Flooding Risk Reduction Measure (ROAD-S2)

Howard Surface Flooding Risk Reduction Measure (ROAD-S2) requires improvement to manage surface flooding risk for major roadways, under the Climate Change Storm (1:100 year storm + 40% Factor) in the area of Howard Ave. (Class 1 Arterial), north of the E.C Row underpass. It is assumed that water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches for both alternatives, which would be confirmed later in the design phase of the preferred alternative. The two different alternatives determined to improve current conditions are:

- **Alternative 1** – Installation of approximately 2,000 m of new trunk storm sewer along Howard Ave. to a new SWM Pond (5,000 m^3 capacity) on a vacant privately-owned parcel of land located within an existing residential area.
- **Alternative 2** – Installation of approximately 2,000 m of new trunk storm sewer along Howard Ave. to a new SWM Pond (3,500 m^3 capacity) on a privately-owned parcel of land located within an existing commercial area.

See **Figure 6-21** for an illustration of the location, and **Table 6-16** for a comparative evaluation of the Howard Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-16: Howard Surface Flooding Risk Reduction (ROAD-S2) Alternatives

Evaluation Criteria	Alternative 1 Install New Trunk Sewer and SWM Pond on Residential Land Parcel	Alternative 2 Install New Trunk Sewer and SWM Pond on Commercial Land Parcel	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-

Evaluation Criteria	Alternative 1 Install New Trunk Sewer and SWM Pond on Residential Land Parcel	Alternative 2 Install New Trunk Sewer and SWM Pond on Commercial Land Parcel	Do Nothing Alternative
Flexibility to Adjust to Climate Change	✓	✓	-
Complexity of Installation & Operation	-	✓	✓
Anticipated Extent of Maintenance Required	✓	✓	-
Length of Time Required for Implementation	✓	✓	-
Disruption during Construction	-	✓	✓
Permanent Changes to the Urban Community	✓	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	-
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	-	✓	-
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Both alternatives achieve this.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be relatively standard installation and operation, and alternative 2 to be more complex because of the limited space and traffic movement all around the two parcels proposed for the SWM Ponds, which would require a significant amount of night time work to keep the roadways open during daylight hours.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to enable the sustainability of these types of stormwater management measures.

Length of Time Required for Implementation: Alternative 1 requires property acquisition which may delay the project. Initial pre-design investigation has determined alternative 2 to be more complex due to the presence of traffic all around the two potential SWM Pond areas requiring more time, approximately 10-12 months, as opposed to the 6-8 months required for alternative 1.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along Dougall Ave. (Class I Arterial) for each of the two alternatives, although more temporary closures are anticipated for alternative 2 as there is vehicular movement all around each of the two proposed SWM Ponds.

Permanent Changes to the Urban Community: Alternative 1 would require significant impact to the urban committee as it requires the acquisition, demolition and displacement of approx. 7 homes north of Charles St. in comparison to the impacts to the commercial office located Alternative 2 private property area. The installation of stormwater management measures in this area will positively change the neighbourhood for the community’s future by reducing the risk of surface flooding for both alternatives.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers and SWM Pond(s) in this area will positively impact these features by reducing the risk of surface flooding in the vicinity for both alternatives. A stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: For both alternatives the land parcels have already been disturbed by urban activities; however, for Alternative 1, the extensive tree plantings in these green spaces would be lost. Alternative 2 is preferred in this instance.

Relative Capital Cost: The cost for Alternative 1 is more expensive as it requires demo and acquisition of a large quantity of land parcels. The SWM Pond is also relatively larger in size. For this criteria, Alternative 2 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk, including during more severe climate change storms, while not increasing the flow of stormwater runoff entering the Grand Marais Drain. The preferred alternative is alternative 1, as there are potentially less negative impacts, and is least costly. The Dougall Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level project.

HOWARD AVE. ALTERNATIVE	HOWARD AVE. ALTERNATIVE 2 (PREFERRED)
New trunk sewers on Howard Ave. to new stormwater pond within existing residential area.	New trunk sewers on Howard Ave. to new stormwater pond within exisitng commercial property.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Howard Surface Flooding Risk Reduction (ROAD-S2) Alternatives

Figure 6-21

EXPRESSWAY AND ARTERIAL ROADS	RAILWAY	STORM SEWER IMPROVEMENTS
CLASS 1 AND 2 COLLECTOR ROADS	MUNICIPAL DRAINS	STORMWATER STORAGE POND

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE : 1:5,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.4.3 Chrysler Centre Surface Flooding Risk Reduction Measure (ROAD-S3)

Chrysler Centre Surface Flooding Risk Reduction Measure (ROAD-S3) requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor) in the area of the Chrysler Centre to reduce surface flooding to less than 0.3 m on Chrysler Centre. It is assumed that water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches for both alternatives, which would be confirmed later in the design phase of the preferred alternative. The two different alternatives determined to improve current conditions are:

- **Alternative 1** – Installation of approximately 600 m of new trunk storm sewer along Chrysler Centre to two new underground stormwater management facilities (USMF) (400 m^3 and 5,000 m^3 capacity, respectively) within privately owned parking lot areas located adjacent to an existing residential area.
- **Alternative 2** – Installation of approximately 600 m of new trunk storm sewer along Chrysler Centre to a new stormwater management facility (USMF) (5,500 m^3 capacity) within a privately-owned parking lot area located adjacent to an existing residential area.

See **Figure 6-22** for an illustration of the location, and **Table 6-17** for a comparative evaluation of the Chrysler Centre Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-17: Chrysler Centre Surface Flooding Risk Reduction (ROAD-S3) Alternatives

Evaluation Criteria	Alternative 1 Install New Sewer and Two USMF	Alternative 2 Install New Sewer and One USMF	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-

Evaluation Criteria	Alternative 1 Install New Sewer and Two USMF	Alternative 2 Install New Sewer and One USMF	Do Nothing Alternative
Flexibility to Adjust to Climate Change	✓	✓	-
Complexity of Installation & Operation	✓	✓	✓
Anticipated Extent of Maintenance Required	-	✓	-
Length of Time Required for Implementation	-	✓	-
Disruption during Construction	-	✓	✓
Permanent Changes to the Urban Community	✓	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	-
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	-	✓	-
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor), the installation of storm sewer infrastructure is vital towards achieving this objective. Both alternatives achieve this.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 2 with only one underground stormwater storage tank to be a simpler installation and operation than Alternative 2.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 2, a single underground stormwater storage tank, as opposed to two of Alternative 1.

Length of Time Required for Implementation: Both alternatives require acquisition of an easement over the project site(s). Initial pre-design investigation has determined alternative 2 to be less time-consuming to install one USMF than two.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along Chrysler Centre (Class I Collector) for each of the two alternatives.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding for both alternatives.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers and stormwater management facilitates in this area will positively impact these features by reducing the risk of surface flooding in the vicinity for both alternatives. A Stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: Land parcels for both alternatives have already been disturbed by urban activities.

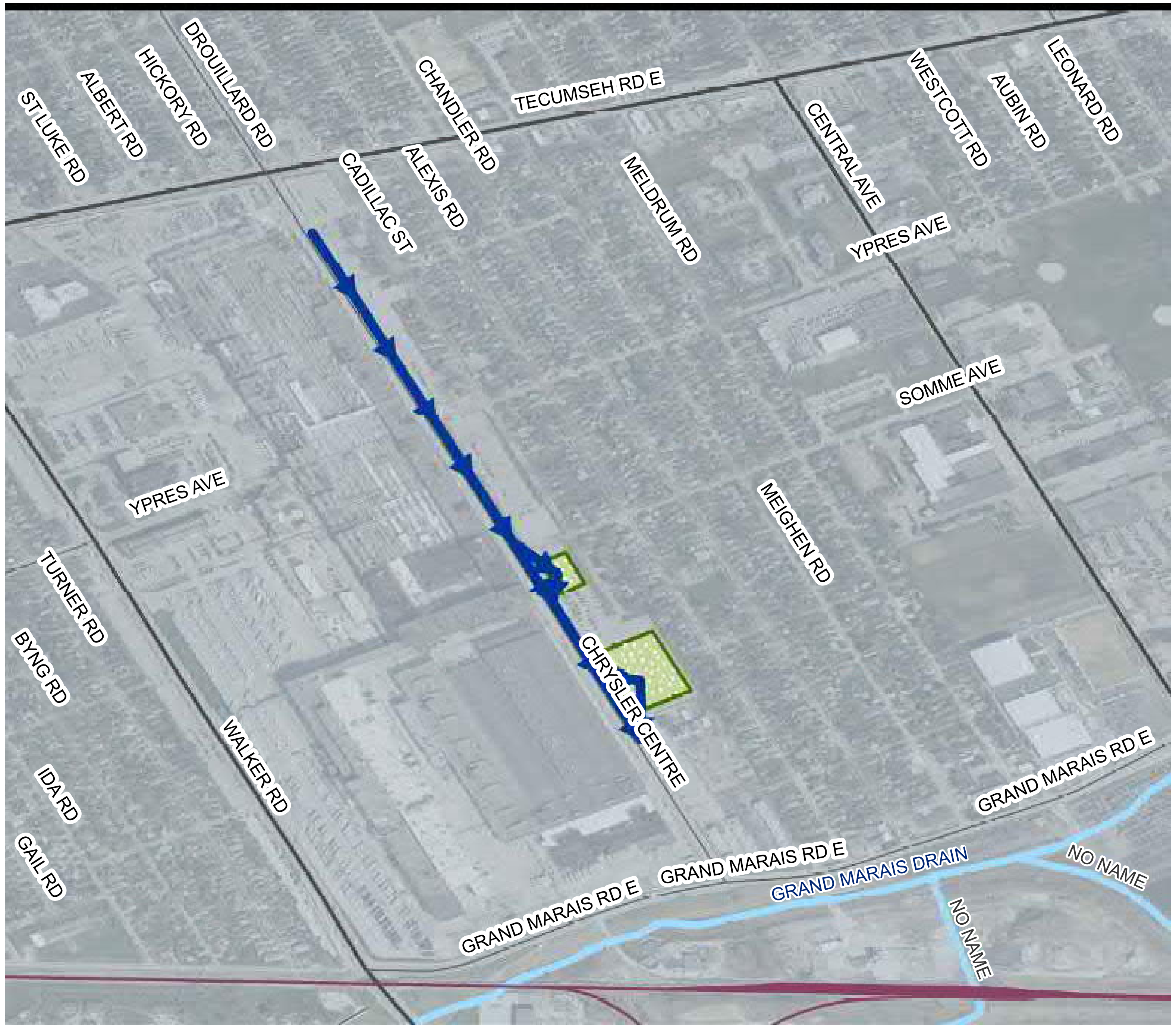
Relative Capital Cost: The cost for Alternative 1 is more expensive as it requires two construction sites and underground tanks than Alternative 2. Alternative 2 is less costly to implement with only one underground storage unit than Alternative 1. For this criteria, alternative 2 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk, including during more severe climate change storms, while not increasing the flow of stormwater runoff entering the Grand Marais Drain. The preferred alternative is alternative 2, as there are potentially less negative impacts, and is least costly. The Chrysler Centre Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level project.

Page is intentionally blank.

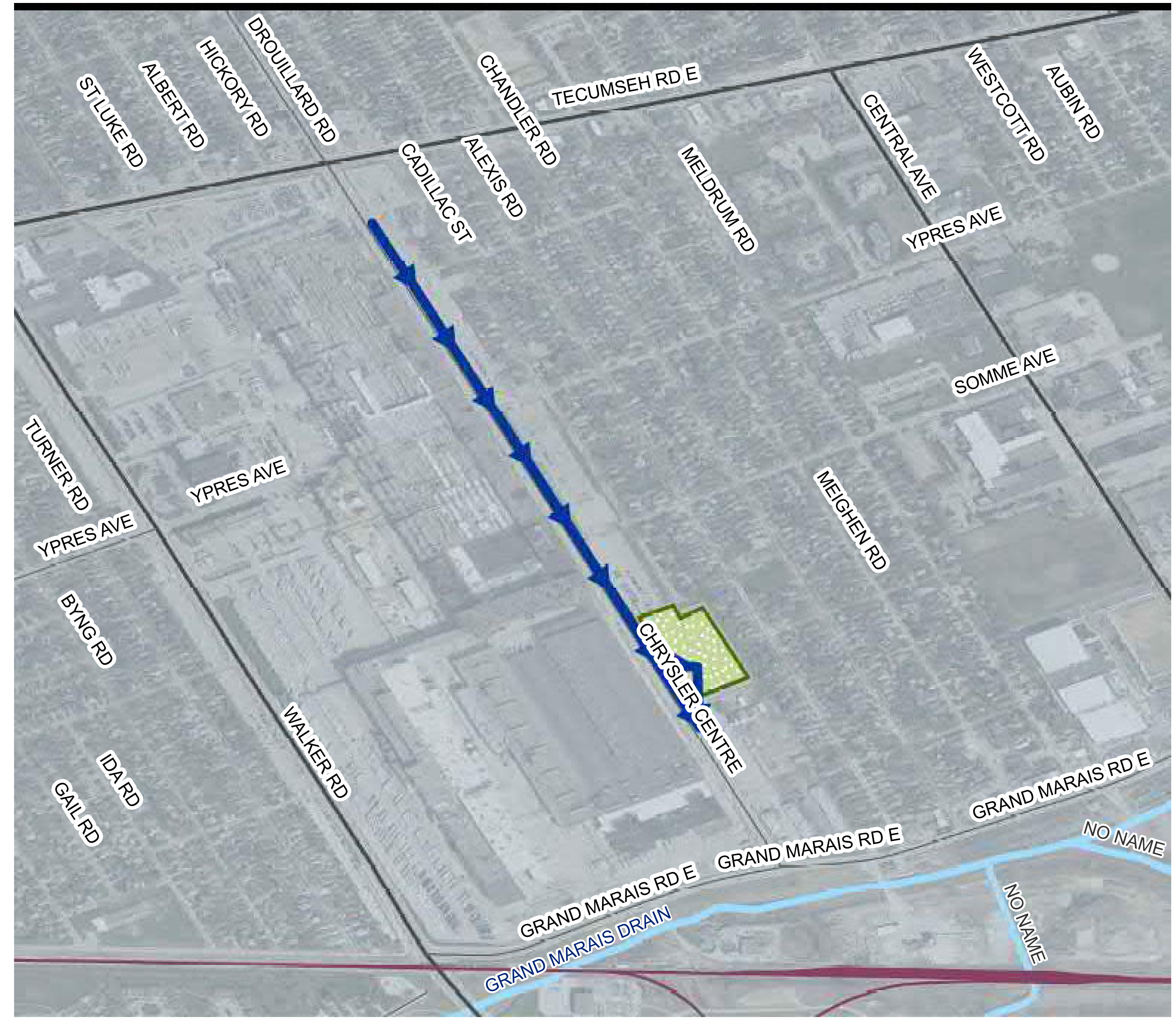
CHRYSLER CENTRE ALTERNATIVE 1

Proposed storm sewer on Chrysler Centre from Tecumseh Road to two proposed underground stormwater management facilities within privately owned parking lot area.



CHRYSLER CENTRE ALTERNATIVE 2 (PREFERRED)

Proposed storm sewer on Chrysler Centre from Tecumseh Road to one proposed underground stormwater management facility within privately owned parking lot area.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Chrysler Centre Surface Flooding Risk Reduction (ROAD-S3) Alternatives

Figure 6-22

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
UNDERGROUND STORMWATER STORAGE

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: GCS NORTH AMERICAN 1983

SCALE : 1:10,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.4.4 Central, Pillette and Regional Area 7 Surface Flooding Risk Reduction Measure (STM-S7)

Central, Pillette and Regional Area 7 Surface Flooding Risk Reduction Measure (STM-S7) requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor) to reduce surface flooding on Pillette Rd. and Central Ave. (both Class II Arterials) to less than 30 cm and to reduce surface flooding on local roadways in this area for a 1:100 year storm. It is assumed that the alternatives not increase the peak flow of stormwater runoff entering the Grand Marais Drain, and that water quality treatment may be provided by low impact development (LID) measures such as exfiltration trenches for both alternatives, which would be confirmed later in the design phase of the preferred alternative. The two different alternatives determined to improve current conditions are:

- **Alternative 1** – Installation of approximately 3,800 m of new storm sewers along Pillette Rd. and Central Ave. (Class I Arterials); Somme Ave., Bernard Rd., and Tourangeau Rd., to a new underground stormwater management facility (USMF) (approximately 23,000 m^3 capacity) within McDonald Park.
- **Alternative 2** – Installation of approximately 4,700 m of new storm sewers along Pillette Rd. and Central Ave. (Class II Arterials); Somme Ave., Grand Marais Rd. East (Class I Collector); Tourangeau Rd., and Bernard Rd., to a new stormwater management facility (USMF) (approximately 23,000 m^3 capacity) within a privately-owned vacant land parcel located north of the YMCA.
- **Alternative 3** – New storm sewers and expansion of the existing Central Ave. stormwater management pond. This upgrade to the storm system would create split drainage where the lands that currently drain via storm sewers under Grand Marais Rd. E would maintain that outfall and have drainage being conveyed to the expanded Central Ave. pond. This alternative includes approximately 4,600 m of upgraded storm sewers ranging in size from 525 mm to 1800 mm diameter and an expanded pond total volume of approximately 106,000 m^3 at elevation 185.70 m and 82,000 m^3 at elevation 185.10 m.

See **Figure 6-23** for an illustration of the locations, and **Table 6-18** for a comparative evaluation of the Central Ave., Pillette Rd. and Regional Area 7 Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-18: Central, Pillette and Regional Area 7 Surface Flooding Risk Reduction (STM-S7) Alternatives

Evaluation Criteria	Alternative 1 Install New SWM Pond – McDonald Park	Alternative 2 Install New SWM Pond on Private Land	Alternative 3 Expand Existing Central SWM Pond	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	✓	-
Accommodates Land Use Changes	✓	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	✓	-
Complexity of Installation & Operation	-	-	✓	✓
Anticipated Extent of Maintenance Required	✓	✓	✓	-
Length of Time Required for Implementation	-	✓	✓	-
Disruption during Construction	-	-	✓	✓
Permanent Changes to the Urban Community	-	-	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	✓	-
Impacts to the Natural Environment	✓	✓	✓	-

Evaluation Criteria	Alternative 1 Install New SWM Pond – McDonald Park	Alternative 2 Install New SWM Pond on Private Land	Alternative 3 Expand Existing Central SWM Pond	Do Nothing Alternative
Relative Capital Cost		✓	✓	-
-	-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% Factor), the installation of storm sewer infrastructure is vital towards achieving this objective. All three alternatives achieve this.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 3 with an expansion to an existing SWM Pond to be a simpler installation and operation than Alternatives 1 or 2.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 3, an existing SWM Pond, as opposed to Alternatives 1 or 2.

Length of Time Required for Implementation: Both Alternatives 1 and 2 requires acquisition of property to construct an USMF. Alternative 3 requires acquisition of property, east of the SWM Pond; however, this property is current under development review and there is opportunity to configure the pond expansion to accommodate the adjacent development. Initial pre-design investigation has determined Alternative 3 to be least time-consuming to install as the pond expansion is relative faster to construct and the property acquisition will be relatively faster as discussion with adjacent property owners are already underway.

Disruption during Construction: For Alternatives 1 and 2, temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow. Alternative 3 is determined to be the least disruptive as it is a straightforward expansion of an existing City owned and operated SWM Pond, requiring less time to construct.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding for all alternatives. Alternatives 1 and 2 will require changes in land use to a passive use. Alternative 3 is determined to be the preferred alternative for this particular criteria.

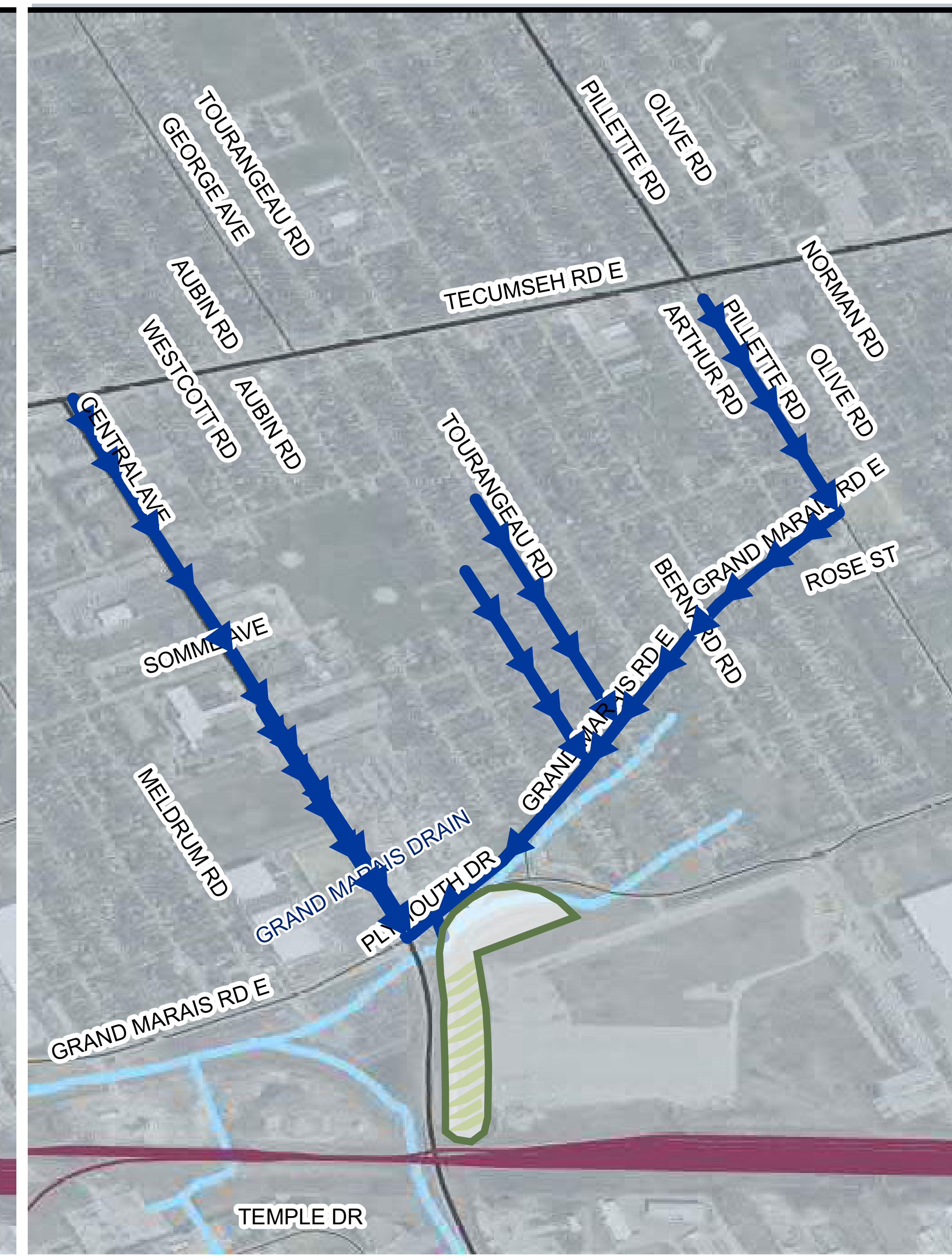
Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers and SWM Pond(s) in this area will positively impact these features by reducing the risk of surface flooding in the vicinity for all alternatives. A stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: Land parcels for all alternatives have already been disturbed by urban activities. Archaeological assessments are not required for these three alternatives. The location of the pond shown for Alternative 3 has been developed to mitigate an impact to the existing vegetation on the west side of the pond bank. The expanded pond design shall incorporate provisions to mitigate water fowl habitat due to the proximity to the Windsor Airport.

Relative Capital Cost: The cost for Alternative 1 and 2 are more expensive than 3 as they require construction of a new underground storage at McDonald Park. Alternative 3 is the least costly to implement with the least amount of infrastructure to construct and maintain, and requiring less time to construct. For this criteria, Alternative 3 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Alternatives 1, 2, and 3 meet the objective of reducing surface flooding risk, including during more severe climate change storms, while not increasing the flow of stormwater runoff entering the Grand Marais Drain. The preferred alternative is alternative 3, as there are potentially less negative impacts, and is least costly. The Pillette and Regional Area 7 Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level project.

CENTRAL, PILLETTE AND REGIONAL AREA 7 ALTERNATIVE 1	CENTRAL, PILLETTE AND REGIONAL AREA 7 ALTERNATIVE 2	CENTRAL, PILLETTE AND REGIONAL AREA 7 ALTERNATIVE 3 (PREFERRED)
Proposed storm sewers and underground stormwater management facility within McDonald Park, including LIDs along all sewers.	Proposed storm sewers to proposed underground or surface stormwater management facility within vacant land north of YMCA, including LIDs along all sewers.	Proposed storm sewers to expanded Central Ave. stormwater pond.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Central, Pillette and Regional Area 7 Surface Flooding Risk Reduction (STM-S7) Alternatives

Figure 6-23

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
UNDERGROUND STORMWATER STORAGE
STORMWATER POND IMPROVEMENT EXPANSION

Note: The existing private pond reconfiguration and additional property acquisition will be required for the new central pond configuration.

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: GCS NORTH AMERICAN 1983

SCALE : 1:15,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.5 South Sewershed – Surface Flood Reduction Solutions - Cahill Drain Sub-Drainage Area

6.7.1.5.1 Regional Area 8 Surface Flooding Risk Reduction Measure (STM-S8)

Regional Area 8 Surface Flooding Risk Reduction Measure (STM-S8) requires improvement to manage surface flooding under a 1:100 year storm in the Regional Area 8 to reduce surface flooding to less than 30 m. The two different alternatives determined to improve current conditions are:

- **Alternative 1** – Installation of approximately 13 km of low impact development (LID) measures (such as exfiltration trenches along storm sewers) in Regional Area 8.
- **Alternative 2** – Lower the normal water levels in the existing SWM Ponds by excavating to lower the pond bottom elevation which includes the reconstruction of storm sewers interconnecting these SWM Ponds.

See **Figure 6-24** for an illustration of the location, and **Table 6-19** for a comparative evaluation of the Regional Area 8 Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-19: Regional Area 8 Surface Flooding Risk Reduction (STM-S8) Alternatives

Evaluation Criteria	Alternative 1 Install LIDs and Downspout Disconnections	Alternative 2 Lower SWM Pond Water Level and Downspout Disconnections	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-

Evaluation Criteria	Alternative 1 Install LIDs and Downspout Disconnections	Alternative 2 Lower SWM Pond Water Level and Downspout Disconnections	Do Nothing Alternative
Complexity of Installation & Operation	✓	✓	✓
Anticipated Extent of Maintenance Required	-	✓	-
Length of Time Required for Implementation	-	✓	-
Disruption during Construction	-	✓	✓
Permanent Changes to the Urban Community	✓	-	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	-
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	-	✓	-
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding (1:100 year storm), the disconnection of downspouts (currently 50% complete) in the Regional Area 8 is vital towards achieving this objective. Both alternatives achieve this. The lowering of water levels in the existing SWM Ponds (Alternative 2), as well as installation of LIDs (Alternative 1) would also enhance the ability to manage stormwater, providing resiliency for climate change compared to existing conditions.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 2 is determined to be a simpler installation and operation than Alternative 1, as lowering the water levels of existing SWM Ponds is less complex than installing LIDs along 13 km of storm sewers, including road reconstruction.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 2 on existing SWM Ponds, as opposed to Alternative 1 with 13 km of new LIDs which would require flushing and video of sewers.

Length of Time Required for Implementation: Initial pre-design investigation has determined Alternative 2 to be less time-consuming to install than Alternative 1.

Disruption during Construction: No road closures are anticipated to be required for Alternative 2; therefore,is preferred for this criteria.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will lower the normal water level of the SWM Ponds, keeping the water line further away from existing residential property that back onto these SWM Ponds during typical conditions. Modification to these features may not be acceptable to property owners immediately adjacent to the SWM Ponds.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of LIDs along existing storm sewers and disconnection of the remaining downspouts in this area will positively impact these features by reducing the risk of surface flooding for both Alternatives 1 and 2. A stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities.

Relative Capital Cost: The cost for Alternative 1 is more expensive as it requires installation of LIDs along 13 km of storm sewers. Alternative 2 is less costly to implement with only the lowering of normal water levels in existing SWM Ponds. For this criteria, alternative 2 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk, including during more severe climate change storms, while not increasing the flow of stormwater runoff entering the Cahill Drain. The preferred alternative is Alternative 2, as there are potentially less negative impacts, is quicker to implement and is least costly. The Regional Area 8 Surface Flooding Risk Reduction is anticipated to be a Schedule 'A+' level project.

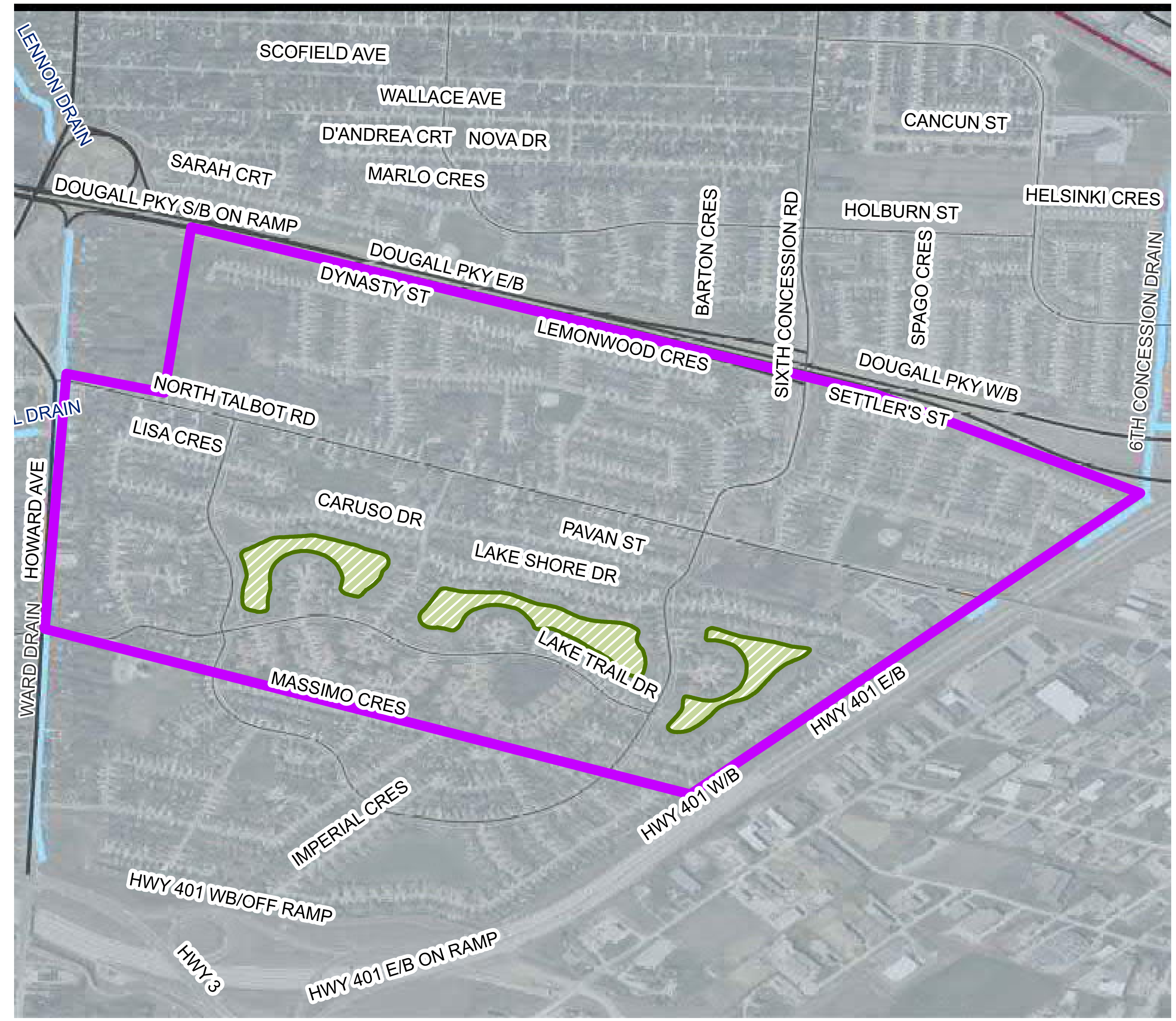
Page is intentionally blank.

REGIONAL AREA 8 ALTERNATIVE 1

Low impact development (LID) measures (exfiltration trenches along stormsewers) and mandatory downspout disconnection.

REGIONAL AREA 8 ALTERNATIVE 2 (PREFERRED)

Lower pond normal water levels and mandatory downspout disconnection.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Regional Area 8 Surface Flooding Risk Reduction (STM-S8) Alternatives

Figure 6-24

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
UNDERGROUND STORMWATER STORAGE
EXISTING STORMWATER POND IMPROVEMENTS

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE : 1:14,000

PROJECT: 17-6638 STATUS: FINAL DATE: October 2020

Page is intentionally blank.

6.7.1.6 East Sewershed – Overall Basement Flooding Risk Reduction Strategy (SAN-E2)

The objective for the basement flooding solutions is to reduce the HGL within the sanitary sewer to meet the level of service which requires the HGL to be 1.8 m below existing grade for a 1:100 year storm. Solutions developed must reduce the HGL so that 10% or less of the sewers surcharge to levels that could result in basement flooding.

Two stormwater storage alternatives (**Figure 6-25**) were established to achieve this for the East Sewershed, namely:

- **Alternative 1 -** consisting of improving conveyance and storage capacity by constructing approximately 44 km m of new sanitary sewers (450 mm to 2,700 mm diameter) and box culverts (2.4 m by 4.2 m), a new underground storage system at McHugh Park and maintaining the current capacity of the Little River Pollution Control Plant; or
- **Alternative 2 -** consisting of increasing the capacity of the Little River Pollution Control Plant (LRPCP) and constructing approximately 47 km of new sanitary sewers (450 mm to 2,700 mm diameter) and box culverts (2.4 m by 4.2 m).

Under ultimate conditions, the LRPCP plant will be expanded to provide treatment capacity for the expanded developed areas within the East Windsor area. The LRPCP currently does not have the capacity to treat the significant increase of wet weather flows that are conveyed to the plant during major rain events. Expansion of the treatment plant is dependent on daily average population sewage demands and cannot be undertaken to provide intermittent treatment of flows during rain events; therefore, expansion of the plant for the treatment of diluted storm event flows is not warranted. To provide relief to the sanitary system during wet weather events and to mitigate the risk of sanitary system backup it is recommended that improvements to the plant's existing bypass be undertaken. This includes the expansion of the pumping capacity at the Pontiac Pump station via a separate wet well and pump system. Pump station improvements are explained more under **Section 6.7.1.7.1** for STM-E6 below. **Appendix E- Technical Volume 2 report** details the findings related to the wet weather sanitary system assessment in more detail.

It was determined that both alternatives meet the objective of mitigating basement flooding and achieving similar flood resiliency for a 1:100 year storm events, whereas a

Do Nothing alternative does not meet the objective. As part of the pre-design phase, Alternative 2 was determined to be less expensive and provide more resiliency of basement flooding protection than Alternative 1, as well as not impacting McHugh Park. Alternative 2 is preferred over Alternative 1 for Basement Flooding Risk Reduction.

The assumptions for the East Sewershed includes:

- Disconnection of all existing residential foundation drainage from the sanitary system and separation of remaining combined sewers;
- Reduced inflow into the sanitary system following sealing of manhole lids and continued repair and sealing of leaky sewer pipes and manholes; and
- Allowances for sanitary sewage flows from future development in both Windsor and Tecumseh were included in the assessment of alternatives.

See **Figure 6-25** for an illustration of the basement flooding locations as described above, and **Table 6-20** for a comparative evaluation of the South Windsor basement flooding risk reduction alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-20: East Windsor Basement Flooding Risk Reduction Alternatives (SAN-E)

Evaluation Criteria	Alternative 1 McHugh Park Underground Storage and Sanitary Sewers	Alternative 2 LRPCP Interim Improvements and Sanitary Sewers	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	-	✓	-
Water Quality	✓	-	-
Complexity of Installation & Operation	-	✓	✓

Evaluation Criteria	Alternative 1 McHugh Park Underground Storage and Sanitary Sewers	Alternative 2 LRPCP Interim Improvements and Sanitary Sewers	Do Nothing Alternative
Anticipated Extent of Maintenance Required	-	✓	✓
Length of Time Required for Implementation	-	-	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	✓	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-	✓
Impacts to the Natural Environment	✓	-	-
Relative Capital Cost	-	✓	✓
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: Alternative 2 includes the more immediate improvement the existing bypass at the LRPCP. This option is also more resilient to storm events greater than 1:100 year events as the bypass will be able to continuous relieve the system throughout the duration of a storm whereas the McHugh Underground facility will not provide additional relief once full. Also, the underground storage unit leaves the system susceptible to back to back storms if the storage unit does not fully drain between storms.

Complexity of Installation & Operation: Alternative 1 has higher comparative construction complexity and operation and is more costly in comparison with the improved LRPCP bypass. Private property measures to meet flood mitigation level of service for both alternatives are the same (area wide foundation drain disconnection).

Water Quality: Alternative 2 requires the continued use of the existing CSO at the LRPCP; however, the frequency of CSOs will be than "Do Nothing" Alternative Opportunities to optimize the plant's treatment capacity should be considered.

Anticipated Extent of Maintenance Required: Alternative 1 requires comparatively more operation and maintenance to operate the underground storage within McHugh Park.

Permanent Changes to the Urban Community: The installation of basement flood mitigation measures in this area will benefit the urban community by minimizing property damage associated with sewer backups. This is applicable to both alternatives.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: For both alternatives, the installation of sanitary sewers are proposed within the City's existing right-of-way. A Stage 2, assessment is required for the LRPCP bypass improvement site (Pontiac PS).

Impacts to the Natural Environment: For both alternatives, the proposed construction areas are already disturbed by urban activities. Alternative 1 will have most benefit to the natural environment due to the greatest reduction to CSO occurrences.

Relative Capital Cost: Alternative 2 is more expensive than alternative 1, as it requires the construction of a large underground storage unit within McHugh Park.

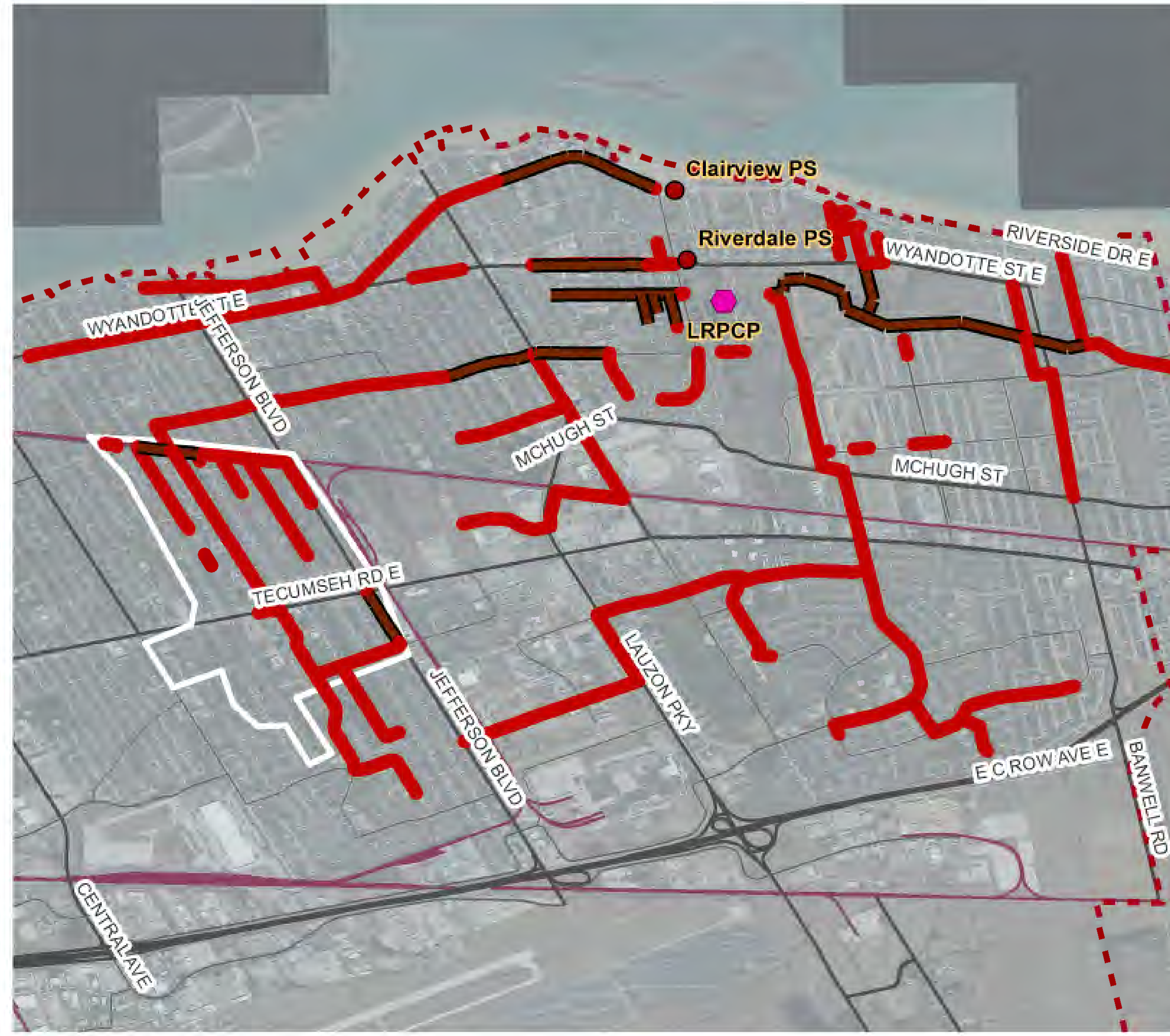
The 'Do Nothing' alternative does not improve the basement flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing basement flooding risk under a 1:100 year event. The preferred alternative is alternative 1, as it is less costly and more resilient to impacts of climate change.

EAST WINDSOR BASEMENT FLOODING ALTERNATIVE 1 (SAN-E1)

McHugh Park Under Ground Storage and Maintaining Existing Treatment Plant Pumping Capacity (2.6 m3/s):
New sanitary sewers (300mm - 2700mm diameter) and in-line storage box culverts (3600mX1800m to 4200mmX 2700mm) to improve conveyance and a new under ground sanitary storage system at McHugh Park.
Construction includes approximately 45,6 km of new sewers.

EAST WINDSOR BASEMENT FLOODING ALTERNATIVE 2 (SAN-E2 PREFERRED)

Expanded Treatment Plant Pumping Capacity (5.2 m3/s):
New sanitary sewers (300mm - 3000mm diameter) and in-line storage (3600mmX1800mm to 4200mmX 2700mm box culverts) to improve sanitary system conveyance and upstream storage.capacity.
Construction includes approximately 45,6 km of new infrastructure.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

East Sewershed - Proposed Basement Flooding (SAN-E2) Alternatives
Figure 6-25

SANITARY PUMP STATION (PS)
WASTEWATER TREATMENT PLANT (WTP)
EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
SANITARY SEWER IMPROVEMENTS
SANITARY BOX CULVERTS
UNDERGROUND SANITARY STORAGE
EXISTING COMBINED SEWER AREA TO BE SEPERATED

MAP CREATED BY: SD
MAP CHECKED BY: DEM / LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7 East Sewershed – Detroit River/Riverside Sub-Drainage Area

6.7.1.7.1 Regional Areas 1 & 2 Surface Flooding Risk Reduction Measure (STM-E1)

This solution requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor) on Jefferson Blvd. (Class II Arterial) and Riverside Dr. East (Scenic Dr.), as well as reduce surface flooding in the Regional Areas 1 & 2 to less than 30 cm. The assumption is that Low Impact Development (LID) measures such as exfiltration trenches will be employed along with the preferred alternative, and that the capacity of the pumping stations are based on providing a 1:100 year storm level of service.

The two different alternatives determined to improve current conditions are:

- **Alternative 1** - Improve St. Rose, St. Paul, and Ford outlets, while maintaining the existing Ford drainage area. This alternative carries over the general recommendations from the St. Paul/Pontiac Study (Dillon 2018) that includes conveyance improvements and in-line storage along Riverside Dr. E., conveyance improvement and inline storage from Esdras Ave. to St. Rose Ave., a trunk sewer and box culvert along Belleperche Ave., and the St. Rose Ave. trunk sewer and box culvert. Further this alternative includes upgrades to the Ford PS (pump replacement), a new 6.5 m^3/s PS at St. Rose Beach, and an upgraded PS at St. Paul Ave with a peak capacity of 18 m^3/s.
- **Alternative 2** - Improve St. Rose, St. Paul, and Ford outlets, while modifying the Ford drainage area. This alternative includes conveyance improvements along Riverside Dr. E. and expanding the St. Rose drainage area, as well as a net reduction of the drainage area to the Ford Blvd pump station. This reduction includes relocating drainage areas north of South National St. to the St. Rose Ave. outfall and collecting more drainage area south of South National St. (i.e., part of the existing combined sewershed area). A new PS is proposed at St. Rose outfall (peak capacity of 13.5 m^3/s) and upgrades are proposed at St. Paul PS (peak capacity of 18.2 m^3/s) and at the Ford PS (pump replacement similar to Alternative 1)).

See **Figure 6-26** for an illustration of the location, and **Table 6-21** for a comparative evaluation of the Regional Areas 1 & 2 Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-21: Regional Areas 1 & 2 Surface Flooding Risk Reduction (STM-E1) Alternatives

Evaluation Criteria	Alternative 1 Improve Pumping Stations (St. Rose, St. Paul, & Ford)	Alternative 2 Improve St. Rose and St Paul PS, & Modify Ford Sub-Drainage Area	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Complexity of Installation & Operation	✓	-	✓
Anticipated Extent of Maintenance Required	-	✓	-
Length of Time Required for Implementation	✓	-	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	-	-	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	-	✓
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	✓	-	✓
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), and reduce surface flooding (1:100 year storm) in the Regional Areas 1 & 2 to less than 30 cm, improvements to storm sewers and pumping stations are vital towards achieving this objective. Alternative 2 achieving full conveyance of overland flow to the St. Rose Outfall whereas Alternative 1 achieves only partial conveyance to the outfall.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a simpler installation and operation than Alternative 2, as Alternative 1 requires less work on Riverside Dr. For this particular criteria, Alternative 1 is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 2 as opposed to Alternative 1.

Length of Time Required for Implementation: Initial pre-design investigation has determined Alternative 1 to be less time-consuming to install than Alternative 2 which requires more extensive work along Riverside Dr. For this particular criteria, Alternative 1 is preferred.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along roadways. Less road closures are anticipated to be required for Alternative 2 as there is less work on Riverside Dr. East (Scenic Dr.); therefore, is preferred for this criteria.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding for both Alternatives 1 and 2.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of surface flooding for both Alternatives 1 and 2. A Stage 2 Archaeological assessments are required for the pump station improvements.

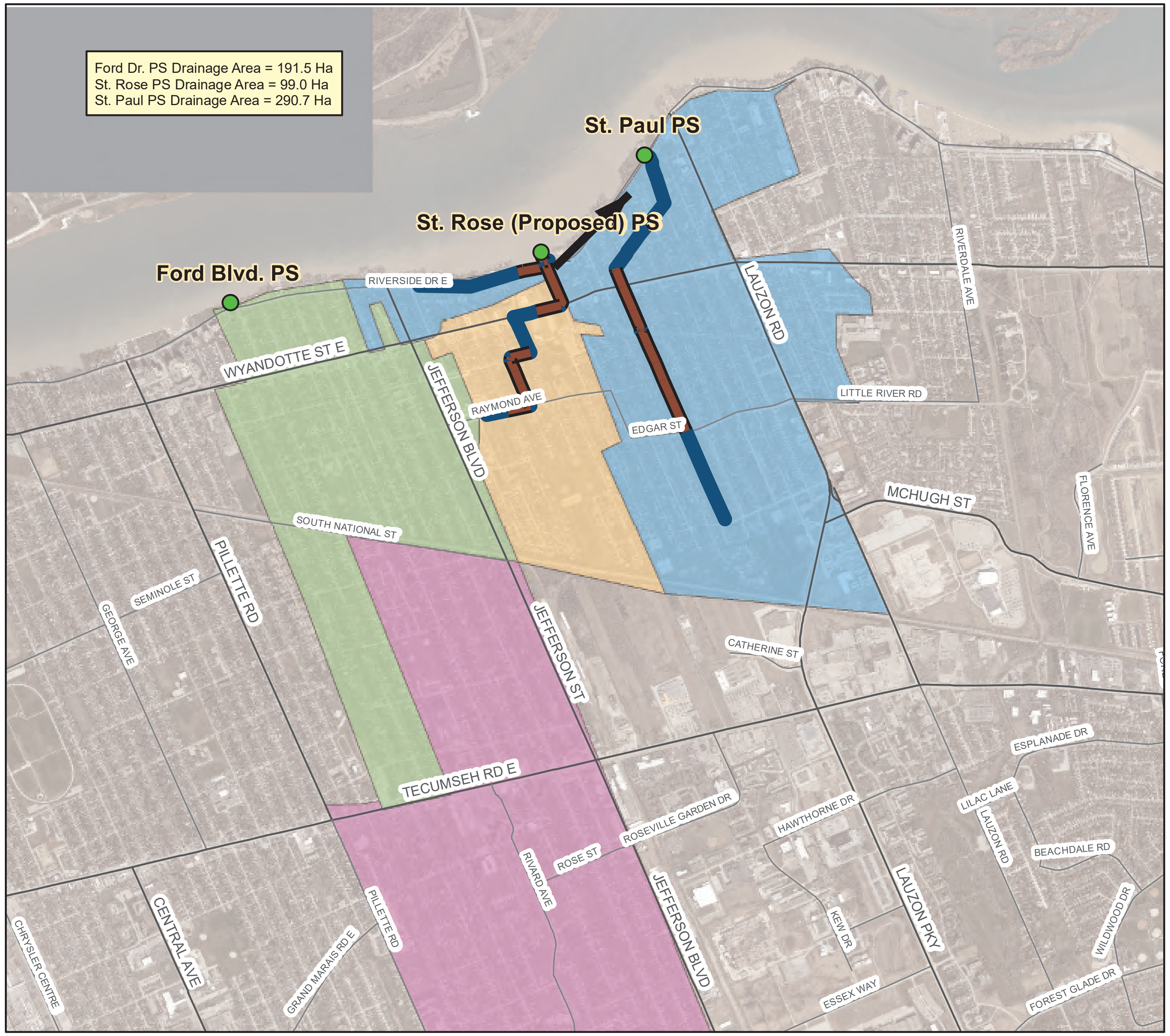
Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities.

Relative Capital Cost: The cost for Alternative 2 is less expensive as it requires a smaller improvement to the pumping stations than Alternative 1. For this criteria, alternative 2 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Both alternatives 1 and 2 meet the objective of reducing surface flooding risk. The preferred alternative is Alternative 2, as there are potentially less negative impacts, is least costly to implement, and also achieves full conveyance of overland flow to the St. Rose Outfall. The Regional Areas 1 & 2 Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level for the stormwater sewer projects, Schedule Level 'B' for the St. Paul Pump Station upgrades and Schedule Level 'C' for the St. Rose Pump Station upgrades.

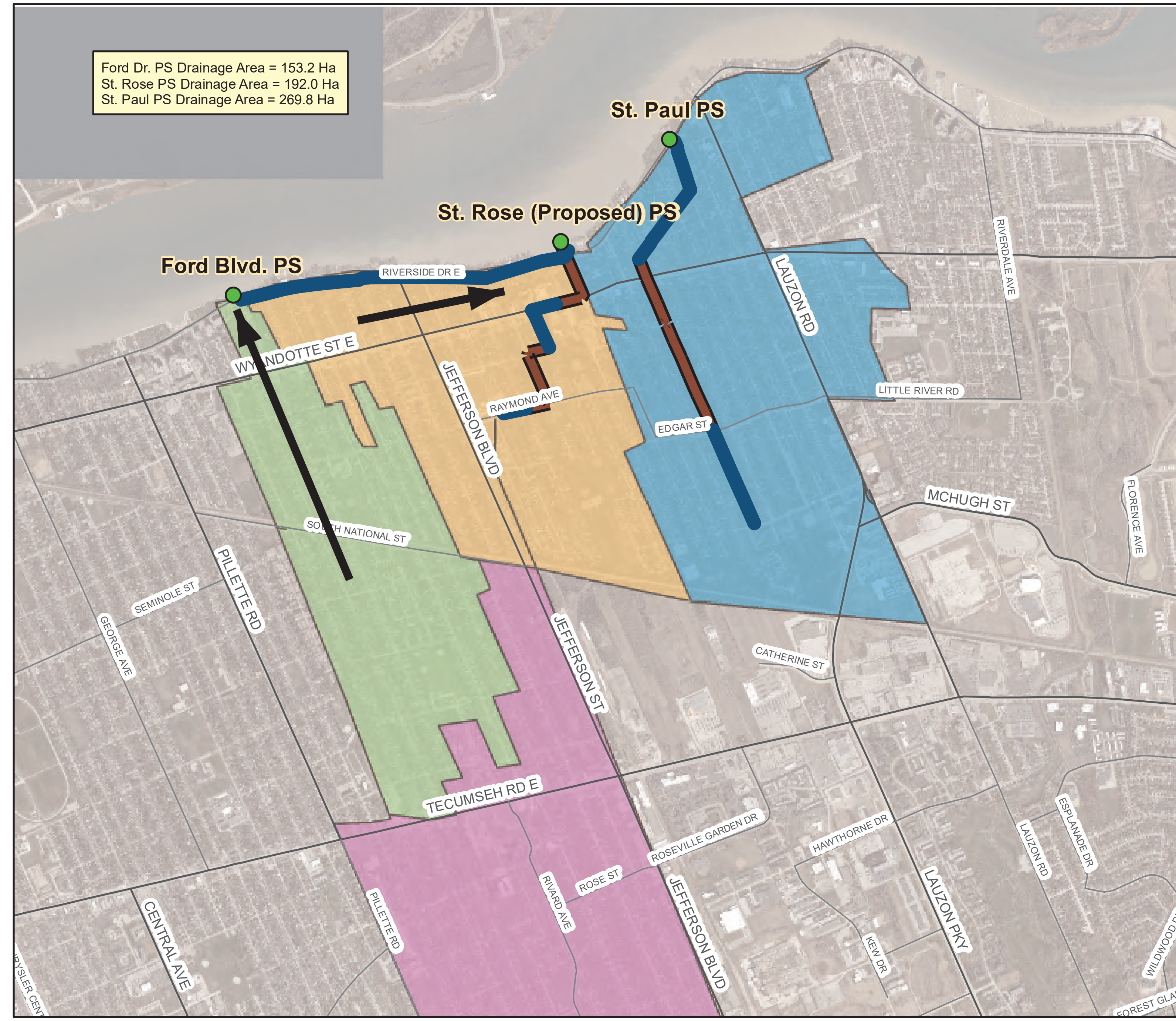
REGIONAL AREAS 1&2 ALTERNATIVE 1 - STM-E1-1

Pump Station Upgrades at St. Paul Ave. and Ford Blvd. and New Pump Station at St. Rose Ave.
2.6 km of New Storm Sewers (525mm - 2700mm); and 1.9 km of box culverts (1.8mX0.9m to 3.05mX1.83m); and Existing drainage areas manitained.



REGIONAL AREAS 1&2 ALTERNATIVE 2 - STM-E1-2(PREFERRED)

Pump Station Upgrades at St. Paul Ave. and Ford Blvd. and New Pump Station at St. Rose Ave.
3.7 km of New Storm Sewers (525mm - 2700mm) and 1.9 km of box culverts (1.8mX0.9m to 3.05mX1.83m); and Modified drainage areas.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

East Sewershed - Proposed Surface Flooding (STM-E1) Alternatives

Figure 6-26

STORM PUMP STATION (PS)
EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
STORM SEWER IMPROVEMENTS
BOX CULVERTS
ST. PAUL DRAINAGE AREA
ST. ROSE GRAVITY OUTFALL DRAINAGE AREA
FORD BLVD. PS DRAINAGE AREA
COMBINED SEWER DRAINAGE AREA

MAP CREATED BY: SD
MAP CHECKED BY: DM/LH
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7.2 Regional Areas 1 & 2 – St. Paul Pump Station - Surface Flooding Risk Reduction Measure (PS-E1-STPAUL)

This particular alternative requires a future expansion of the St. Paul Pump Station at the Detroit River as part of the long-term comprehensive preferred solution alternative for Regional Areas 1 and 2 (STM-E1) in order to provide a 1:100 year storm level of service and mitigation of surface flooding during a Climate Change Storm Event (1:100 year storm + 40% factor). This project t includes:

- Expansion works at the St. Paul PS east of the existing pump station
- New outfall at the Detroit River from the proposed expansion;
- Expansion of electrical systems within the existing system;
- Installation of a backup power generator to accommodate the additional electrical loading; and
- Construction of a storm trunk sewer along Belleperche Pl., Clairview Ave., and within the existing Kiwanis Park, discharging to the PS inlet sewer, north of Riverside Dr. E.

See **Figure 6-27** for an illustration of the PS location, and **Table 6-22** for a comparative evaluation of Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-22: Regional Areas 1 & 2 – St. Paul Pump Station - Surface Flooding Risk Reduction (PS-E1-STPAUL / PS-E1 & PS-E2) Alternatives

Evaluation Criteria	Alternative 1 Expand St. Paul Pump Station	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	-
Flexibility to Adjust to Climate Change	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	-	✓

Evaluation Criteria	Alternative 1 Expand St. Paul Pump Station	Do Nothing Alternative
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	✓
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	✓
-	PREFERRED	-

The ‘Do Nothing’ alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Alternative 1 meets the objectives. The preferred alternative is Alternative 1, as there are potentially less negative impacts overall. The Regional Areas 1 & 2 – St. Paul Pump Station Surface Flooding Risk Reduction is anticipated to be a Schedule ‘B’ level for the proposed expansion project.

CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION
MASTER PLAN

Regional Areas 1 & 2 – St. Paul Pump Station Expansion - Surface Flooding Risk Reduction (PS-E1-STPAUL) Alternatives

Figure 6-27:

THE CITY OF WINDSOR

—— PROPERTY LINE

DILLON CONSULTING

Aquafor Beech Limited

CREATED BY: JTB
CHECKED BY: LMH

N W E S

FILE LOCATION:
[illegible]
February 10, 2020 11:51 AM

PROJECT: 17-6638 STATUS: DRAFT DATE: February 2020

Page is intentionally blank.

6.7.1.7.3 Regional Areas 1 & 2 – Ford Blvd. Pump Station Surface Flooding Risk Reduction Measure (PS- E1-FORD)

This solutions is required to manage surface flooding under the 1:100 Year Storm within the Regional Area 1&2 and to reduce surface flooding on major roadways under the Climate Change Storm (1:100 year storm + 40% factor) as part of this area's comprehensive surface flood reduction preferred solution (STM-E1).

Through the evaluation of alternatives, the need to improve the resilience existing Ford Blvd. outlet has been identified. Currently, the storm sewer outlet for the Ford Blvd. storm drainage area is equipped with a dewatering pump station that drains the system after rain events. To reduce risks of surface flooding that may result due to potential back to back rain events, the opportunity to reduce the time required to relieve the storm sewer system has been identified.

To improve this outlet the following improvements are recommended:

- Replace pumps within the existing wet well structure with larger pumps to improve the system draw down time as much as possible;
- Install monitoring and control equipment to allow the City to track and control the operation of this pump station. Information can be used to optimize the operation of this pump station; and
- Assess the need and applicability for an emergency backup power generator.

See **Figure 6-28** for an illustration of the PS location.

Page is intentionally blank.

CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Regional Areas 1 & 2 – Ford Blvd. Pump Station Upgrades - Surface Flooding Risk Reduction (PS-E1-FORD) Alternatives

Figure 6-28

THE CITY OF WINDSOR

PROPERTY LINE
EXISTING PUMP STATION
EXISTING STORM SEWER

DILLON CONSULTING
Aquafor Beech Limited

CREATED BY: JTB
CHECKED BY: LMH

N E S W

FILE LOCATION:
C:\PROJECTWISE\WORKING
DIRECTOR [illegible] SITE-CON.DWG
February [illegible] 2020 [illegible] AM

PROJECT: 17-6636 | STATUS: DRAFT | DATE: February 2020

Page is intentionally blank.

6.7.1.7.4 Regional Areas 1 & 2 – St. Rose Pump Station New Build Surface Flooding Risk Reduction Measure (PS-E1-ROSE)

This problem area requires storms sewer system improvements to manage surface flooding within Regional Areas 1 & 2, under the 1:100 year storm, and to reduce surface flooding on major roadways under the Climate Change storm (1:100 year storm + 40% factor). Description of the comprehensive solution for this areas is described in the MP report.

Regarding the St. Rose Pump Station alternatives, it is assumed that:

- The pumping capacity of the proposed pumping station is based on providing a 1:100 year storm level of service area-wide within the Regional Areas 1 &2 (Area between Riverside Dr. and the Via Rail ROW and between Ford Blvd and east of Lauzon Rd.). This includes added resilience (enhanced level of service) for major roadways (Riverside Dr. E., Lauzon Rd., and Jefferson Blvd.) to mitigate surface flooding during a Climate Change Storm Event;
- The functional design of the pumping station and site features determined to be preferred, will be refined through the next step in the MP process (Schedule C) with additional input received from stakeholders and additional site assessments; and
- The City will provide opportunity for further consultation during the detailed design phase of this essential long-term component of the Windsor MP.

From the numerous options explored in the pre-design phase, the four (4) viable pumping station location alternatives were evaluated as described below:

- **Alternative 1** – Construct the St. Rose Ave. Pumping Station in the St. Rose Ave. Park greenspace on the north side of Riverside Dr. E., within the existing sheet pile/break wall area of the park. This alternative is the closest to the existing outfall and does not require displacement of any existing residences.
- **Alternative 2** – Construct the St. Rose Ave. Pumping Station to the south of Riverside Dr. and east of St. Rose Ave. This alternative requires permanent displacement of two residential buildings.
- **Alternative 3** – Construct the St. Rose Ave. Pumping Station to the south of Riverside Dr. and west of St. Rose Ave. This alternative requires permanent displacement of three residential buildings.

- **Alternative 4** – Construct the St. Rose Ave. Pumping Station, at the northwest corner of the St. Rose Ave./Wyandotte St. East intersection. This alternative requires permanent displacement of one commercial building, one residential building, and will require property from the adjacent property (acquire a portion of the existing parking area).

Each site is located in the vicinity of the existing St. Rose Ave. storm box culvert that provides the primary drainage outlet for the entire St. Rose Ave. drainage area (195 Ha). Alternatives were chosen based on their proximity to the outlet and the receiving water course. Alternative locations refer to more general areas where the pumping station could be located. The City may be able to fine tune the location of the pumping station based on further discussion and negotiation with property owners. For instance, there may be property owners along St. Rose Ave. or Riverside Dr., east of St. Rose Ave. that may be more open to selling and the homes may be less costly for the City to acquire.

For the purpose of this comparative evaluation, the four alternative pumping station locations are as listed above and shown in **Figure 6-29.** Exact property limits and impacted properties are subject to refinement based on detailed design of the proposed pumping station. This figure shows the footprint required to construct the proposed pumping station based on the functional design of the 13.5 m^3/s pumping station. The functional design includes provisions for maintenance access, an electrical/control building and an on-site emergency power generator.

Common features and considerations of all four of these alternatives include:

- New pumping station wet well structure to house 3 large sized pumps and 2 smaller duty pumps to provide a storm sewer outlet for the St. Rose Ave. and Riverside Dr. E. drainage area. The firm capacity of the pumping station (all pumps running) will be 13.5 m3/s. The dimensions of the wet well are a function of the depth of the inlet sewers, on-site soil conditions, and the size and operation of the pumps;
- Building structure to house the electrical systems and controls is required;
- A back-up power generator is recommended to provide standby power. Size and location of the generator shall be confirmed prior to detailed design to determine an appropriate power rating and size that would adequately mitigate risk associated with power outages. The generator will be placed and constructed to

mitigate impacts of noise from surrounding properties as required by applicable regulations;
- To provide power, an on-site power transformer will be required. Power source will need to be reviewed with EnWin prior to detailed design;
- Vehicular access points from the City's right-of-way to provide access for periodic maintenance of the site and pumps; and
- Landscaping amenities to improve the esthetic of the facility but also to provide site features that will add value to the property and be beneficial to the community. Local residents will be involved in the design process to assist in the development in a design that will fit the neighbourhood.

A detailed comparison of the St. Rose Ave. Pumping Station Location Alternatives to the Do Nothing alternative is included in **Appendix G**. **Table 6-23** below provides a high level comparison of the St. Rose Ave. Pumping Station Location Alternatives and is followed by additional commentary on the section of the preferred alternative.

Table 6-23: St. Rose Pumping Station Expansion/Upgrade Surface Flooding Risk Reduction (PS-E1-ROSE) Alternatives

Evaluation Criteria	Alternative 1 St. Rose Ave. Park	Alternative 2 SE Corner of St. Rose Ave./Riverside DR. E.	Alternative 3 SW Corner of St. Rose Ave./Riverside DR. E.	Alternative 4 NE Corner of St. Rose Ave./Riverside DR. E.
Meets Flood Mitigation Objectives	✓	✓	✓	✓
Flexibility to Adjust to Climate Change	✓	✓	✓	✓
Coastal Flood Risk	-	-	-	✓
Water Quality	✓	✓	✓	✓
Complexity of Installation & Operation	✓	-	-	-
Anticipated Extent of Maintenance Required	✓	-	-	-
Length of Time Required for Implementation	✓	-	-	-
Disruption during Construction	✓	-	-	-
Permanent Changes to the Urban Community Noise/Vibration Impacts	-	-	-	✓

Evaluation Criteria	Alternative 1 St. Rose Ave. Park	Alternative 2 SE Corner of St. Rose Ave./Riverside DR. E.	Alternative 3 SW Corner of St. Rose Ave./Riverside DR. E.	Alternative 4 NE Corner of St. Rose Ave./Riverside DR. E.
Permanent Changes to the Urban Community Displacement of Existing Residents/Businesses	✓	-	-	-
Permanent Changes to the Urban Community Disruption to Greenspaces/Parks	-	✓	✓	✓
Permanent Changes to the Urban Community Disruption to Waterfront/Views	-	✓	✓	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	-	-	✓
Impacts to the Natural Environment	✓	✓	✓	✓
Relative Capital Cost	✓	-	-	-
Preferred:	**PREFERRED**	-	-	-

Flexibility to Adjust to Climate Change: Many of the solutions developed through this study are recommended to help mitigate the impacts of climate change; however, in this case, the pumping station and outlet will also be susceptible to impacts related to high river levels that may result in climate change. To mitigate risks to the pumping station outlet sewers, the outlet sewer must be equipped with a gate which must be built above the projected Climate Change instantaneous high water level (177.10), to prevent river water from backing into the wet well. Back up of the river into the wet well will cause recirculation the river water and it will impact the capacity of the storm outlet. Refer to **Appendix E Technical Volume 2 report** for more details for more information on the projected water levels.

For Alternative 1, the outlet chamber is proposed to be elevated to incorporate the outlet gate directly into the pumping station, which requires the height of the pumping station to be 1.7 metres above existing grade (top of pumping station 178.00, finished grade 176.30).

For Alternatives 2, 3 and 4, to avoid conflict with other storm and sanitary sewers at the St. Rose Ave. and Riverside Dr. E. intersection, the pumping station outlet forcemain needs to be sufficiently deep (invert elevation at approximately 6.0 m depth). An outlet chamber equipped with backflow prevention gate will be required to protect the deep outlet forcemain and to provide spillover of outlet flows into the shallower river outlet pipe. This chamber would be in an approximately 6.0 m wide by 6.0 m long structure at a 1.7 m height to protect from instantaneous high river levels.

In addition, for all sites, to mitigate risks of high river levels on on-site electrical equipment, generators, electrical buildings and transformers will need to be built higher and be equipped with flood protection barriers/walls. Refer to **Appendix E Technical Volume 2** report for more details for more information on the projected water levels.

Complexity of Installation & Operation:

Each site will have challenges related to the construction of the large pumping station and storm sewer culvert. There are a number of factors that have been considered as part of the Ease of Implementation criteria. To provide the City better understanding of the comparative construction complexities that are associated with each alternative, a more detailed breakdown has been included in **Appendix E**. To confirm the feasibility of

Alternative 4, a schematic cross section of St. Rose Ave. is included in **Appendix E** showing the potential alignment of the 3 large trunk sewers required along St. Rose Ave. (Two deep large storm box culverts and one large sanitary sewer trunks sewer). It is anticipated that the pole line, gas main and other telecommunication utilities would need to be relocated outside to the existing 20 m right-of-way to facilitate construction of the storm sewer, sanitary sewer and watermain.

Due the added complexity of construction, two large storm sewers along St. Rose Ave. for Alternative 4, this option would be the least preferred from a constructability perspective.

Anticipated Extent of Maintenance Required: Standard maintenance practices required for the proposed pumping station is anticipated to be similar for all four alternatives. For all alternatives, the pumping station forcemain will need to be ”watertight” to mitigate back-up of flows within the lower lying area during major rain events. Due to the length of the pumping station forcemain required for Alternative 4, sealed and lockable access points are required. Due to the length of the enclosed forcemain outlet, risks associated with sewer back-up is more significant. Any maintenance on the forcemain would require the pumping station to be shut down. There is no opportunity to construct an additional back-up forcemain due to space limitations in the St. Rose Ave. right-of-way. Based on the extent of equipment and culverts required, Alternative 1 is most preferred.

Length of Time Required for Implementation: Alternatives 2, 3 and 4 require acquisition of private property and demolition of structures which would delay implementation. Risk associated with property acquisitions, including the potential need to expropriate could add additional time and costs to the project. Alternative 4 be most time-consuming to implement due to the extent of reconstruction and underground infrastructure required along St. Rose Ave.

Disruption during Construction: For all alternatives, temporary road closure of Riverside Dr. E. and St. Rose Ave. will be required. Alternative 4 will require the most disruption to residents due to the depth and size of the two proposed culverts required within the St. Rose Ave. right-of-way. Extensive advance utility relocation will be required. Potential need to provide temporary sanitary flow pumping, interim on-grade water distribution or other measures will be required to maintain servicing during construction. Access to driveways and emergency access during construction will also be limited. Alternative 1 is determined to be the least disruptive as it is on vacant land, requiring less time to construct.

Permanent Changes to the Urban Community: For the purpose of this pumping station location evaluation, this criteria has been separated into three distinct components:

- Noise/Vibration Impacts
- Displacement of Existing Residents/Businesses
- Disruption to Greenspaces/Parks
- Disruption to Waterfront/View

Noise and vibration impacts to the local environment are not expected to be significant. As part of the detailed design of the pumping station, necessary noise abatement measures such as noise enclosures and landscape/fence buffers will be incorporated into the design. Minimal vibration impacts are expected as the wet well and generator foundation structures will be designed adequately to mitigate vibration of equipment/structures. Alternative 4 is considered most preferred as it is furthest from adjacent property owners and located within a Commercial zoned area.

Alternatives 2, 3 and 4 all require the purchase of existing properties to accommodate the proposed pumping station, equipment and access areas. For the purposes of this comparative evaluation, properties impacted by each alternative is shown in **Figure 6-29.** The locations shown are subject to refinement upon further property owner consultation, which will be required under the Schedule C Class Environmental Assessment Process. The need for the relocation of existing residents/property owners is considered a significant negative impact to those local property owners. Up to 2-3 homes could need to be purchased to accommodate the pumping station which would require the displacement of up to 3 families. Alternative 4, would have less impact to residents and would require the relocation of an established business and 1 property owner.

Alternative 1 will result in the greatest permanent change to the local urban community due to the greater impact to the St. Rose Ave. Park land. Within the City, and especially in the Riverside Area, waterfront access is limited and is only available through the presence of City owned park lands. Placing the pumping station within the St. Rose Ave. Park (Alternative 1) will limit the use of most of the east portion of the Beach (east of the pier/walkway). Alternatives 2, 3, and 4 will require the installation of an outlet chamber within the park which will have less impact to the park land use. The detailed design of the pumps station/outlet chamber will consider additional features that will provide value to the local community, examples include (additional seating, plantings, look-out feature, etc.).

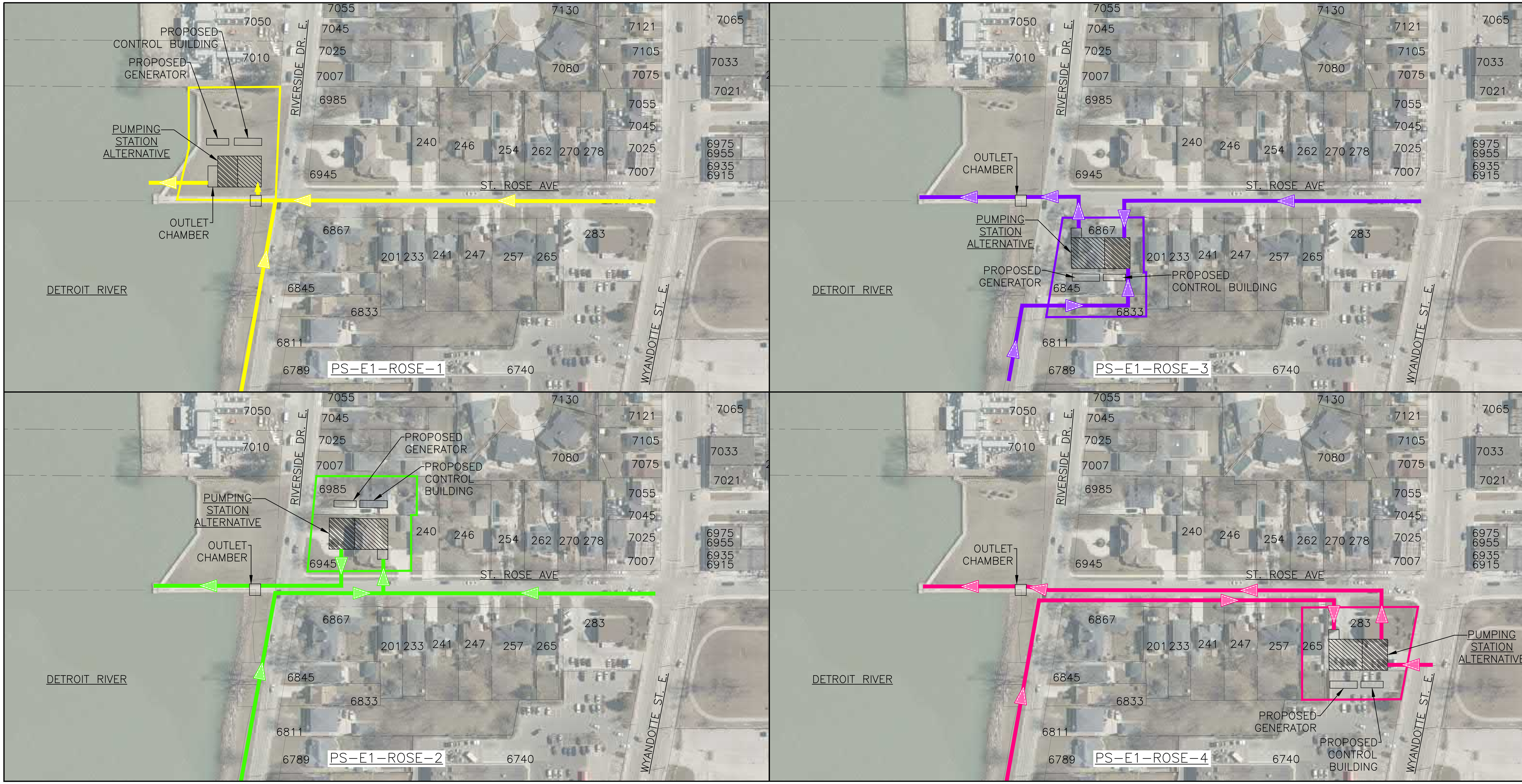
In addition to the significant change to the park use, the existing waterfront view will be compromised. The existing waterfront and Detroit River views are valuable to adjacent homeowners as well as the local community. The placement of this pumping station will have impacts to those that live adjacent or across from the park as it will partially impact the existing view of the river and Detroit city skyline. Alternative 2, 3, and 4 is preferred with respect to the impacts to waterfront view and park impacts as Alternative 1 will have the most permanent impact.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: Alternative 1 would have the most impact on the local cultural heritage by impacting the existing waterfront access and riverfront view, while Alternatives 2, 3 and 4 would have less of an impact as the proposed structure would be located away from the shoreline. There are no heritage classified or designated properties in the vicinity of the proposed pumping station site; therefore, minimal impacts from each of the alternatives is expected. The architecture of the proposed pumping station site should be designed such that it fits into the esthetic of the local neighbourhood. A Stage 2 archaeological assessment is required for Alternative 1, 2 and 3 in the area along the existing property line along the City's Riverside Dr. E. right-of-way. Alternative 4 will have the least, archaeological, built heritage and cultural heritage impact.

Impacts to the Natural Environment: Each of the 4 alternative sites are urban, landscaped properties that lack the potential for terrestrial habitats. All sites required the construction of a large outlet culvert in the vicinity of the existing outlet sewer. As noted in the St. Rose Ave. Pumping Station Preferred Location - Natural Environment Review document (August 2020) (**Appendix H** of the MP), the Detroit River has potential for aquatic habitat; therefore, measures to mitigate impacts to aquatic species and their habitat will need to be implemented prior and during construction. Each solution requires a similar quantity of in-water works. Alternative 1 will require additional sedimentation and erosion control measures due to the proximity of the wet well to the existing shoreline.

Relative Capital Cost: For the purposes of this evaluation a more detailed cost comparison was completed to evaluate the cost difference between the identified alternatives. For the purpose of this assessment, the cost comparison between Alternative 1 and Alternative 4 was completed to help understand the approximate order of magnitude cost difference. Alternative 1 is estimated to be approximately 15%-20% less costly than Alternative 4 based on the cost of the proposed pumping station, required additional upstream and downstream storm sewers and outlet. This cost comparison does not include considerations for cost differences resulting in the acquisition of private property, or any costs for relocating residents or businesses. Cost for park land is less than the cost to acquire residential/commercial property; therefore, the estimated cost difference is estimated to be greater than 20%. It is recommended that the City consult their Legal and Property Departments to confirm estimated costs. It is estimated that Alternative 2 and 3 will be more costly than Alternative 1 and less costly than Alternative 4.

To summarize, the project team reviewed and completed a detailed comparative evaluation of 4 alternative pumping station locations for the required St. Rose Ave. storm sewer outlet pumping station. Alternative 1 – St. Rose Beach is determined as preferred, based on the balance of criteria related to displacement of residents/property owners, constructability, and cost versus impacts to the park community feature and waterfront views. The results of the comparative evaluation does not show that Alternative 1 is significantly more preferred than Alternative 4. The project is also classified as a Schedule C project based on the current Municipal Class Environmental Assessment (MCEA) process; therefore, this solution will require additional investigation and consultation with property owners, including consultation with those who own property along St. Rose Ave. and at the Wyandotte St. E./St. Rose Ave. intersection.
A latest conceptual site layout of the St. Rose Pumping Station is included in **Appendix F – Technical Volume 3**.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Regional Areas 1 & 2 – St. Rose Ave. Pump Station Upgrades - Surface Flooding Risk Reduction (PS-E1-ROSE) Alternatives

Figure 6-29

PS–E1–ROSE–1 (Preferred Alternative)		HIGHER PORTION OF PUMP STATION	
PS–E1–ROSE–2		LOWER PORTION OF PUMP STATION	
PS–E1–ROSE–3		PROPERTY LINE	
PS–E1–ROSE–4			

NOTE:
Alternative site plan configurations are based on preliminary site plans and should be used for reference only. The more refined conceptual design of the preferred alternative St. Rose Pump Station is included in the Technical Volume 3 report.

DILLON CONSULTING

Aquafor Beech Limited

MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM ZONE 17N

0m 5m 10m 20m

PROJECT: 17-6638 STATUS: FINAL DATE: November 2020

THE CITY OF WINDSOR

Page is intentionally blank.

6.7.1.7.5 Regional Areas 3 & 4 Surface Flooding Risk Reduction Measure (STM-E3)

This solution is required to manage surface flooding under the 1:100 Year Storm within the Regional Area 3&4 and to reduce surface flooding on major roadways under the Climate Change Storm (1:100 year storm + 40% factor). These improvements are also necessary to separate this combined sewer area to reduce the volume of stormwater entering the sanitary system which will also reduce basement flood risks in this area. Regional areas 3 and 4 are generally between Jefferson Blvd., South National St., Pillette Rd., and the E.C.Row Expressway. The roadways within these regional areas are primarily local roads. This existing combined and partially separated sewer system drains both northerly to the Detroit River and easterly towards the Little River watercourse. The assumption is that Low Impact Development (LID) measures such as exfiltration trenches will be employed along with the preferred alternative, and that the capacity of the pumping stations are based on providing a 1:100 year storm level of service. Two flood risk reduction alternatives were developed as outlined below:

- **Alternative 1 -** Continued soft separation and maintaining current drainage areas. This alternative does not meet the flood risk reduction objectives.
- **Alternative 2 -** Complete sewer separation of the combined sewer systems and new stormwater drainage areas. This alternative includes removing stormwater from the Little River PCP via a new storm sewer system to the Detroit River and the Little River Watercourse. The proposed new or upgraded storm sewer system reduces surface flooding risk in regional area 3.

The key elements for alternative STM-E3-2 include infrastructure to convey flows while satisfying the 1:100 year event, providing infrastructure on Jefferson Blvd and South National St and diverting outflow of approximately 30 ha of area from Little River to the Detroit River via the Ford Blvd. trunk sewer.

See **Figure 6-30** for an illustration of the location, and **Table 6-24** for a comparative evaluation of the Regional Areas 3 & 2 Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-24: Regional Areas 3 & 4 Surface Flooding Risk Reduction (STM-E3) Alternatives

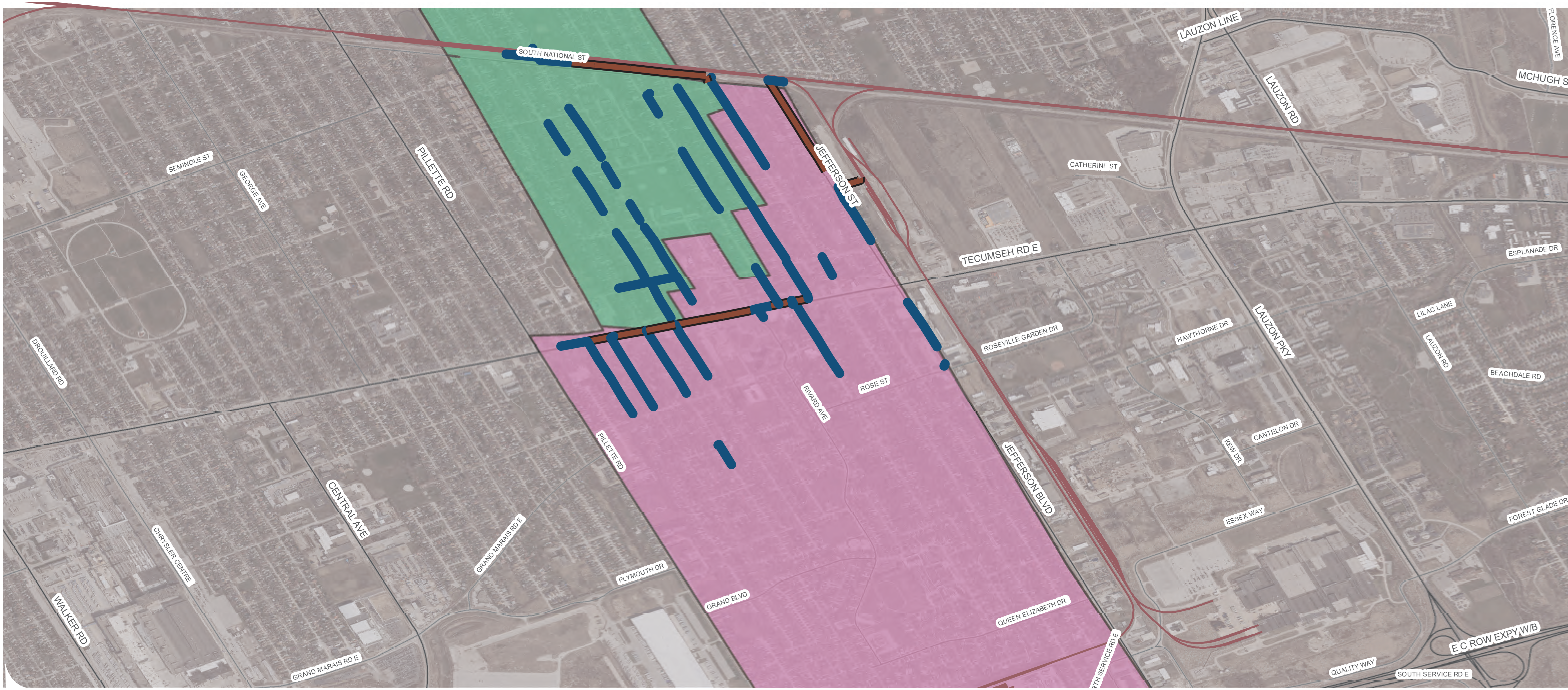
Evaluation Criteria	Alternative 1 Continued soft separation and maintaining current drainage areas. (Do Nothing)	Alternative 2 Complete sewer separation of the combined sewer systems and new stormwater drainage areas.
Meets Flood Mitigation Objectives	-	✓
Provides Enhanced Level of Service for Vulnerable Areas	-	✓
Accommodates Land Use Changes	-	✓
Flexibility to Adjust to Climate Change	-	✓
Complexity of Installation & Operation	✓	-
Water Quality	-	✓
Anticipated Extent of Maintenance Required	✓	-
Length of Time Required for Implementation	✓	-
Disruption during Construction	✓	-
Permanent Changes to the Urban Community	-	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓
Impacts to the Natural Environment	-	✓
Relative Capital Cost	✓	-
-	-	PREFERRED

The 'Do Nothing' (Alternative 1) does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The preferred alternative is Alternative 2, as this alternative will provide improved level of service, reduce impacts of stormwater getting into the sanitary system and will mitigate water quality impacts associated with CSOs (combined sewer overflows) to the downstream watercourses.

Page is intentionally blank

REGIONAL AREAS 3&4 FLOOD RISK REDUCTION ALTERNATIVE (STM-E3)

Complete seperation of combined sewage flows into seperated storm and sanitary sewer systems. New storm sewers (ranging from 450mm - 1650mm diameter to 1800mm X 3000mm box culverts). Reduction of drainage area to Little River and re-direction to the Detroit River via the Ford Blvd storm sewer. Construction includes approximately 9.5 km of new storm sewers.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Regional Areas 3 & 4 Surface Flooding Risk Reduction (STM-E3) Alternatives

Figure 6-30

RAILWAY
EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 & 2 COLLECTOR ROADS
STORM SEWER IMPROVEMENTS
BOX CULVERTS
FORD DR. PS DRAINAGE AREA
COMBINED SEWER DRAINAGE AREA

MAP CREATED BY: SD
MAP CHECKED BY: IW / DM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), and reduce surface flooding (1:100 year storm) in the Regional Area 3, to less than 30 cm, the improvements to storm sewers and the sub-drainage area are vital towards achieving this objective. Alternative 2 achieves this objective whereas Alternative 1 does not meet the flood mitigation objective.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of surface flooding for Alternative 2 only. A Stage 2 archaeological assessment is not required for this study area.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities. Alternative 1 results in further flooding risk and CSO occurrences to the natural environment.

Relative Capital Cost: Alternative 1 is less costly.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Similarly, Alternative 1 does not meet the flood mitigation objective for current or future risk. Alternative 2 meets the objective of reducing surface flooding risk. The preferred alternative is Alternative 2, as there are potentially less negative impacts, and ultimately is the least costly to implement. The Regional Area 3 Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level for the stormwater sewer project.

Proposed storm sewer infrastructure solutions have also been sized to reduce surface flooding within the major roadways (South National St. and Tecumseh Rd. E.) to below 30 cm for Climate Change Event. These improvements are listed under project code **ROAD-E3.** The storm sewer infrastructure project to mitigate roadway flooding which includes construction of storm sewer along South National St. and Tecumseh Rd. E. Anticipated to be a Schedule 'B' level project.

6.7.1.7.6 Lauzon Rd. Surface Flooding Risk Reduction Measure (ROAD-E5)

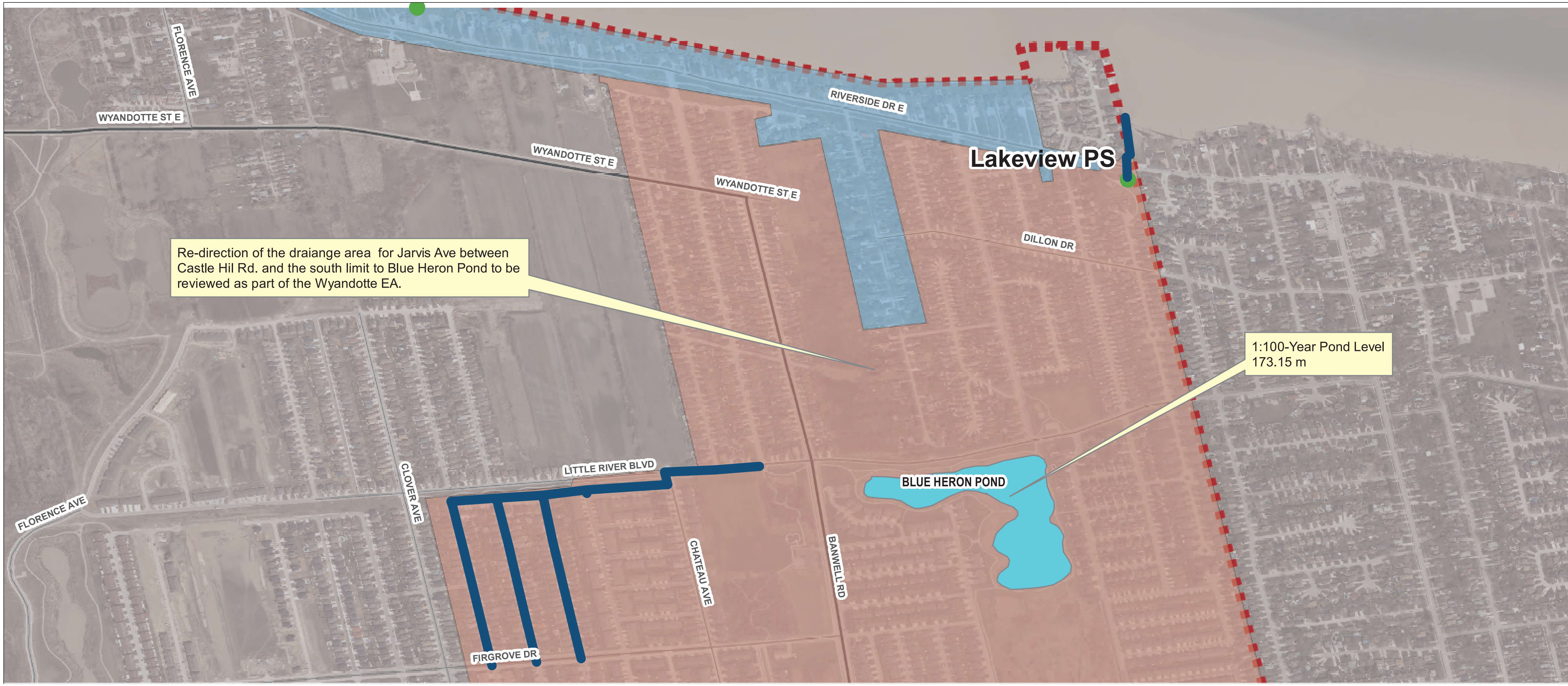
This solution requires improvement to manage surface flooding on Lauzon Rd., a Class II Arterial roadway, under a Climate Change Storm (1:100 year storm + 40% factor). This alternative includes: Installation of approximately 2,000 m of new storm sewers (2,400 mm diameter) along Lauzon Rd., accompanied by low impact development infiltration measures (LID) along Lauzon Rd. between Tranby Ave. and Cecile St. .

Three assumptions include:

- Improvements for the St. Paul drainage (see Section 6.7.1.7 above); and
- Low Impact Development (LID) measures such as exfiltration trenches will be employed along with the preferred alternative, and will be confirmed later in the design stage.
- Refer to **Figure 6-31** for an illustration of the location.

REGIONAL AREA 5 SURFACE FLOODING ALTERNATIVES (STM-E5)

Upgrade of Lakeview Pump Station and construction of approximately 160 m of sewer from Lakeview PS to outfall, approximately 640 m of new storm sewer south of and within Little River Blvd., and approximately 1.2 km of storm sewer upgrades between Firgrove Dr. and Little River Rd.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

STORM PS	EXPRESSWAY AND ARTERIAL ROADS	STORM SEWER IMPROVEMENTS
	LASS 1 AND 2 COLLECTOR ROADS	STORM BOX CULVERTS
STUDY AREA	RAILWAY	
EAST MARSH DRAINAGE AREA	LAKEVIEW DRAINAGE AREA	

THE CITY OF WINDSOR

DILLON CONSULTING

Aquafor Beech

MAP CREATED BY: SD
MAP CHECKED BY: DM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7.7 Roseville Garden Surface Flooding Risk Reduction Measure (ROAD-E11)

Roseville Garden Surface Flooding Risk Reduction Measure (ROAD-E11) requires improvement to manage surface flooding to less than 30 cm on Roseville Garden Dr., Hawthorne Dr. and Kew Dr., under a Climate Change Storm (1:100 year storm + 40% factor). This alternative includes: Installation of approximately 700 m of new storm sewers/box culverts along the aforementioned roadways, accompanied by low impact development infiltration measures (LIDs) and an underground stormwater storage facility (approximately 31,000 m^3) under Roseville Park and Roseville Public School's green space.

Assumptions for this alternative includes:

- No increase in stormwater peak flow entering the Little River; and
- Low Impact Development (LID) measures such as exfiltration trenches may be employed, and will be confirmed later in the design stage.

Refer to **Figure 6-32** for an illustration of the location, and **Table 6-25** for a comparative evaluation of the Roseville Garden Surface Flooding Risk Reduction Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-25: Roseville Garden Surface Flooding Risk Reduction (ROAD-E11) Alternative

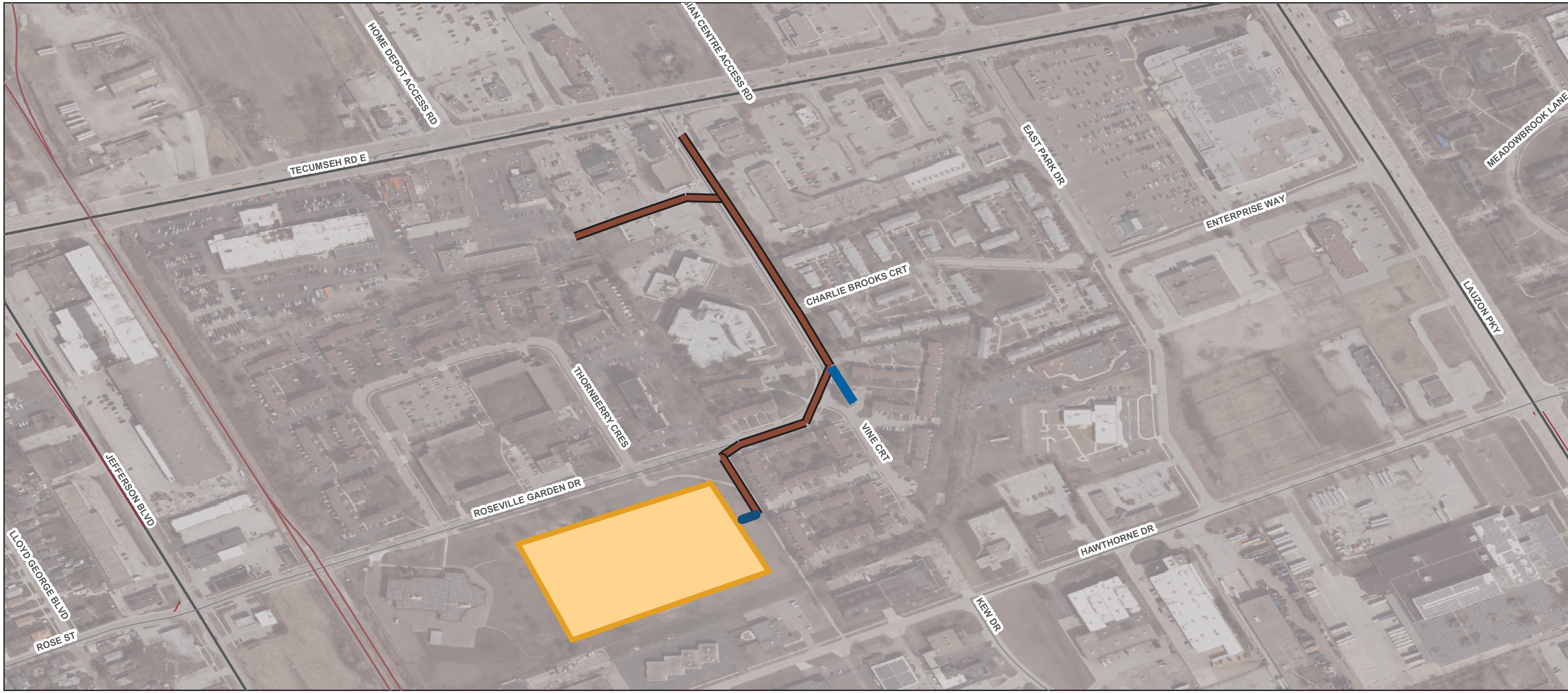
Evaluation Criteria	Alternative 1 Install Underground Storage Facility	Do Nothing Alternative (Maintain Current Stormwater Management System)
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Water Quality	✓	-
Complexity of Installation & Operation	-	✓

Evaluation Criteria	Alternative 1 Install Underground Storage Facility	Do Nothing Alternative (Maintain Current Stormwater Management System)
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	✓	-
Relative Capital Cost	-	-
-	PREFERRED	-

The ‘Do Nothing’ alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with the proposed stormwater management measures to alleviate current surface flooding issues and prevent future flooding. The Roseville Garden Surface Flooding Risk Reduction Alternative is anticipated to be a Schedule ‘B’ level project.

ROSEVILLE GARDEN FLOOD RISK REDUCTION ALTERNATIVE (ROAD-E11)

25,000 m3 of offline underground surcharge storage in Roseville Park and Roseville Public School property along with upstream sewer upgrades and LID uptake.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Roseville Garden Surface Flooding Risk Reduction (ROAD-E11) Alternatives
Figure 6-32

EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
STUDY AREA
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
STORM BOX CULVERTS
SURCHARGE/PARK STORAGE

DILLON CONSULTING
Aquafor Beech Limited

MAP CREATED BY: SD
MAP CHECKED BY: DEM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638
STATUS: FINAL
DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7.8 Banwell, McHugh, & McNorton Surface Flooding Risk Reduction Measure (ROAD-E10, E7, E8)

Banwell, McHugh, & McNorton Surface Flooding Risk Reduction Measure (E10, E7, E8) requires improvement to manage surface flooding to less than 30 cm on Banwell Rd., McHugh St. , and McNorton St. , under a Climate Change Storm (1:100 year storm + 40% factor).

Assumptions for this alternative includes:

- Low Impact Development (LID) measures such as exfiltration trenches may be employed, and will be confirmed later in the design stage.

This project is anticipated to be a Schedule ‘A+’ level project. Refer to **Figure 6-33** for an illustration of these project locations.

Page is intentionally blank.

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

STORM PS	EXPRESSWAY AND ARTERIAL ROADS	STORM SEWER IMPROVEMENTS
	CLASS 1 AND 2 COLLECTOR ROADS	STORM BOX CULVERTS
STUDY AREA	RAILWAY	MUNICIPAL DRAINS

DILLON CONSULTING

Aquafor Beech

MAP CREATED BY: SD
MAP CHECKED BY: DEM / LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7.9 McHugh at Darfield Surface Flooding Risk Reduction Measure (ROAD-E8)

McHugh at Darfield Surface Flooding Risk Reduction Measure (ROAD-E8) requires improvement to manage surface flooding to less than 30 cm on McHugh St. (secondary: from Lauzon eastward to Darfield Dr.), under a Climate Change Storm (1:100 year storm + 40% factor); preserving one passable driving lane under peak ponding conditions. It is assumed that there will be no increase in stormwater peak flow entering the Little River watercourse, and that water quality treatment may be provided by Low Impact Development (LID) measures such as exfiltration trenches; to be confirmed later in the detailed design stage.

The alternatives for the McHugh at Darfield Surface Flooding Risk Reduction Measure include:

- **Alternative 1** – Installation of new box culverts and regrading of approximately 350 m of McHugh St.; and,
- **Alternative 2** - Construction of new storm sewers and a surface SWM Pond, and regrading of approximately 350 m of McHugh St. .

See **Figure 6-34** for an illustration of the location, and **Table 6-26** for a comparative evaluation of the McHugh St. at Darfield Dr. surface flooding risk reduction alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-26: McHugh St. at Darfield Dr. Surface Flooding Risk Reduction Measure (ROAD-E8) Alternative

Evaluation Criteria	Alternative 1 New Box Culvert Storage & Conveyance & Regrading of 350m of Road	Alternative 2 Upgrade Conveyance & Overflow to SWM Pond	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-
Accommodates Land Use Changes	✓	✓	-

Evaluation Criteria	Alternative 1 New Box Culvert Storage & Conveyance & Regrading of 350m of Road	Alternative 2 Upgrade Conveyance & Overflow to SWM Pond	Do Nothing Alternative
Flexibility to Adjust to Climate Change	✓	✓	-
Complexity of Installation & Operation	-	-	✓
Anticipated Extent of Maintenance Required	-	-	✓
Water Quality	✓	✓	-
Length of Time Required for Implementation	-	-	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	✓	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-	✓
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	✓	-	✓
-	PREFERRED	-	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding to less than 30 m on McHugh St. under the Climate Change Storm (1:100 year storm + 40% factor), stormwater management measures are vital towards achieving this objective. Both Alternatives 1 & 2 achieve this objective. The Do Nothing Alternatives does not achieve the objective.

Complexity of Installation & Operation: Initial pre-design investigation has determined alternative 1 and the Do Nothing to be the simplest alternatives. Alternative 2 is a more complex installation, and a property acquisition is necessary for the SWM Pond and the construction will require disruption to resident along McHugh St.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated for Alternatives similar to what is required under Do Nothing conditions. Under Alternative 2 additional maintenance of a standalone SWM pond would be required.

Disruption during Construction: Temporary road closures within the construction corridor will be kept to a minimum to maintain traffic flow along McHugh St.; however, the length of time required for construction will result in numerous disruptions for Alternative 2. For this criteria, Alternative 1 and the Do Nothing Alternative are preferred.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding with both Alternatives 1 & 2. Alternative 2 requires the need for additional private property within the developable lands, south Hugh St. This solution would impact current development being implemented on this site.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of stormwater management measures of both Alternatives 1 & 2 in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. A Stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: The area of proposed construction has already disturbed by urban activities.

Relative Capital Cost: The cost of the proposed stormwater management measures proposed as Alternative 2 is considered moderate, and Alternative 1 is determined to be less costly than Alternative 2. Alternative 1 is preferred for this criteria.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Alternatives 1 & 2 achieve the objective of meeting the surface flooding risk reduction objectives, including more severe climate change storms – preserving one passable driving lane under peak ponding conditions. The preferred choice is to proceed with Alternative 1 to alleviate current surface flooding issues and prevent future flooding. The McHugh St. at Darfield Dr. Surface Flooding Risk Reduction Measure is anticipated to be a Schedule ‘A+’ level project.

MCHUGH ST (LAUZON LINE TO DARFIELD DR) - ROAD-E6 ALT 1 (PREFERRED)

Box culverts (3600 mm X 1800 mm to 4600 mm X 1800 mm) and re-grading of approx.350 m of McHugh St.

MCHUGH ST (LAUZON LINE TO DARFIELD DR) - ROAD-E6 ALT 2

Upgrade sewers with overflow to SWM pond on developable lands

CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

McHugh at Darfield Surface Flooding Risk Reduction (ROAD-E6) Alternatives

Figure 6-34

STORM PS
EXPRESSWAY AND ARTERIAL ROADS
STORM SEWER IMPROVEMENTS
STORMWATER STORAGE POND
CLASS 1 AND 2 COLLECTOR ROADS
STORM BOX CULVERTS
STUDY AREA
RAILWAY
MUNICIPAL DRAINS

MAP CREATED BY: SD
MAP CHECKED BY: DEM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7.10 Jefferson Surface Flooding Risk Reduction Measure (ROAD-E2)

This solution requires improvement to manage surface flooding to less than 30 cm under the Climate Change Storm (1:100 year storm + 40% factor) on Jefferson Blvd. (Class I Arterial).

The assumptions for the Jefferson Blvd. Alternatives include:

- That improvements for the St. Rose drainage system, including a new pump station and trunk sewers are constructed; and
- Low Impact Development (LID) measures such as exfiltration trenches may be employed along with the preferred alternative.

The two different alternatives determined to improve current conditions for Jefferson Blvd. are:

- **Alternative 1** – Installation of new storm sewers along Jefferson Blvd. and Ontario St., an underground stormwater storage facility on the Dr. David Suzuki School grounds and a surface storage swale along the south property boundary of the Dr. David Suzuki School grounds.
- **Alternative 2** – Installation of new storm sewers and box culverts along Jefferson Blvd., Ontario St. and Raymond Ave.

See **Figure 6-35** for an illustration of the location, and **Table 6-27** for a comparative evaluation of the Jefferson Surface Flooding Risk Reduction Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-27: Jefferson Blvd Surface Flooding Risk Reduction (ROAD-E2) Alternatives

Evaluation Criteria	Alternative 1 New Storm Sewers & Underground Storage at David Suzuki School	Alternative 2 New Storm Sewers & Box Culverts	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	✓	-

Evaluation Criteria	**Alternative 1 New Storm Sewers & Underground Storage at David Suzuki School**	**Alternative 2 New Storm Sewers & Box Culverts**	**Do Nothing Alternative**
Accommodates Land Use Changes	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Complexity of Installation & Operation	-	✓	✓
Anticipated Extent of Maintenance Required	-	✓	✓
Length of Time Required for Implementation	✓	-	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	✓	✓	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	✓	✓
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	-	✓	✓
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding to less than 30 cm under the Climate Change Storm (1:100 year storm + 40% factor), the improvements to storm sewers in the sub-drainage area are vital towards achieving this objective. Both alternatives achieve this objective.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a more complex installation and operation than Alternative 2, as

Alternative 1 requires an underground stormwater storage facility. For this particular criteria, Alternative 2 is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 2 as opposed to Alternative 1.

Disruption during Construction: Temporary road closure in the vicinity of the construction corridor will be kept to a minimum to maintain traffic flow along Jefferson Blvd., Ontario St. and Raymond Ave. for both alternatives.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding for both alternatives.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of surface flooding for both alternatives. A stage 2 assessment is not required for this study area.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities.

Relative Capital Cost: Both alternatives require construction of new storm sewers on Jefferson Blvd.; however, Alternative 1 also requires underground stormwater storage facility at the Dr. David Suzuki School whereas Alternative 2 does not. For this criteria, alternative 2 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The preferred alternative is Alternative 2, as there are potentially less negative impacts, and ultimately is the least costly to implement. The Jefferson Blvd. Surface Flooding Risk Reduction is anticipated to be a Schedule 'A+' level for the stormwater sewer project.

Page is intentionally blank.

JEFFERSON BLVD & RAYMOND AVE - ALTERNATIVE 1 (ROAD-E2-1)

Underground SWM facility on David Suzuki Public School property
In-line storage / box culverts and conveyance in roadway

JEFFERSON BLVD & RAYMOND AVE - ALTERNATIVE 2 (ROAD-E2-2 - PREFERRED)

Sewer upgrade through David Suzuki Public School property;
Sewer upgrade on Raymond Ave.;
Garden Crt Dr. sewer re-directed from Jefferson Blvd. to the proposed St. Rose trunk (STM-E1) via Raymond Ave.;
In-line storage / box culverts upgrade of Jefferson Blvd. trunk sewer.

CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Jefferson Blvd Surface Flooding Risk Reduction (ROAD-E2) Alternatives
Figure 6-35

STORM PS	EXPRESSWAY AND ARTERIAL ROADS	STORM SEWER IMPROVEMENTS	SURCHARGE/PARK STORAGE
	CLASS 1 AND 2 COLLECTOR ROADS	STORM BOX CULVERTS	
STUDY AREA	RAILWAY	MUNICIPAL DRAINS	

MAP CREATED BY: SD
MAP CHECKED BY: DM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.7.11 Regional Area 3 Surface Flooding Risk Reduction Measure (ROAD-E3)

Regional Area 3 Surface Flooding Risk Reduction Measure (ROAD-E3) requires improvement to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor) on South National St. (Class I Collector), Jefferson Blvd. (Class I Arterial), and Tecumseh Rd. E. (Class I Arterial), as well as reduce surface flooding in Regional Area 3, to less than 0.30m.

These storm sewer improvements are included in the comprehensive solution to mitigate surface flooding within the Regional Flood Risk Areas 3 and 4.

6.7.1.8 East Sewershed – Little River Sub-Drainage Area

6.7.1.8.1 Lauzon Pkwy. Surface Flooding Risk Reduction Measure (ROAD-E4)

This solution requires improvement to manage surface flooding to less than 30 cm on Lauzon Pkwy. (Class I Arterial), Hawthorn Dr. (secondary) and Jefferson Blvd. (Class II Arterial), under a Climate Change Storm (1:100 year storm + 40% factor). It is assumed that there will be no increase in stormwater peak flow entering the Little River watercourse.

The alternatives for the Lauzon Pkwy. Alternative include:

- **Alternative 1** – New underground in-line storage tank under Lauzon Pkwy. (845 m box culvert) with 10,000 m3 (underground storage facility in Meadowbrook Park along with 20,000m3 SWM facility in the Little River Golf Course Lands.
- **Alternative 2** - New underground in-line storage tank under Lauzon Pkwy. (845 m box culvert) with 5,000 m3 underground storage facility in Meadowbrook Park along with 20,00m3 SWM facility in the Little River Golf Course Lands. This alternative also incorporates 300 m of road-regrading on Lauzon Pkwy. and the implementation of swales along 500 m of open private property along the west side of Lauzon Pkwy. from Cantelon Dr. to Hawthorne Dr.

See **Figure 6-36** for an illustration of the location, and **Table 6-28** for a comparative evaluation of the Lauzon Pkwy. surface flooding risk reduction alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-28: Lauzon Pkwy. Surface Flooding Risk Reduction Measure (ROAD -E4) Alternative

Evaluation Criteria	Alternative 1 Change the Drainage Area to the Little River Golf Course SWM Pond	Alternative 2 Install Culverts, Underground Storage, Golf Course SWM Pond, New Sewers & LID Swales	Do Nothing Alternative (Maintain Current Drainage Systems)
Meets Flood Mitigation Objectives	-	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	-	✓	-
Accommodates Land Use Changes	-	✓	-
Flexibility to Adjust to Climate Change	-	✓	-
Complexity of Installation & Operation	-	-	✓
Anticipated Extent of Maintenance Required	-	-	✓
Water Quality	-	✓	-
Length of Time Required for Implementation	-	✓	✓
Disruption during Construction	-	-	✓
Permanent Changes to the Urban Community	-	-	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	-	✓
Impacts to the Natural Environment	-	✓	-
Relative Capital Cost	✓	-	✓
-	-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), the proposed storm management measures are vital towards achieving this objective. Alternative 2 achieves this objective. Alternative 1 and the Do Nothing Alternatives do not achieve the objective.

Complexity of Installation & Operation: Initial pre-design investigation has determined alternative 1 and the Do Nothing to be the simplest alternatives. Alternative 2 is a more complex installation, as the length and extent of construction will require disruption to residents, living, working, and travelling along the Lauzon Pkwy. (Class I Arterial).

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated for Alternative 2 that will enable the sustainability of this infrastructure for the service life of the new system. Alternative 1 and the Do Nothing alternatives will require increasing amounts of maintenance as the system is overwhelmed with Climate Change Storm Events.

Disruption during Construction: Temporary road closures within the construction corridor will be kept to a minimum to maintain traffic flow along the Lauzon Pkwy. (Class I Arterial); however, the length of time required for construction will result in numerous disruptions.

Permanent Changes to the Urban Community: The installation of stormwater management measures in this area will positively change the neighbourhoods for the community's future by reducing the risk of surface flooding with Alternative 2.

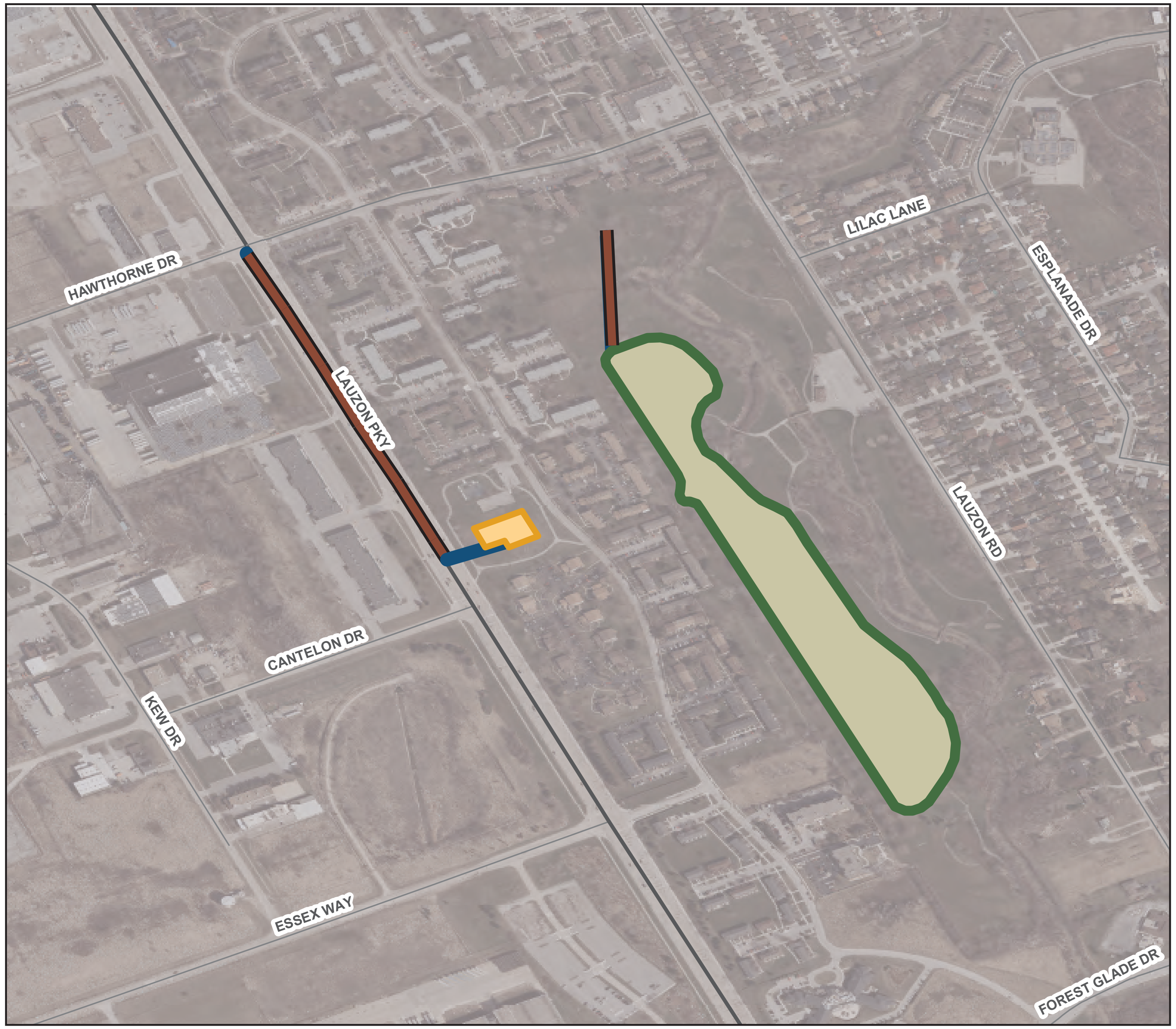
Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of stormwater management measures of Alternative 2 in this area will positively impact these features by reducing the risk of surface flooding in the vicinity. The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: The area of trunk storm sewer installation has already disturbed by urban activities. Both Alternative 1 and Alternative 2 require impacts to existing trees within the existing Little River Golf Course. Also, Alternative 1 will require the removal or protection of existing trees along the west side of Lauzon Rd.

The ‘Do Nothing’ alternative and Alternative 1 do not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with Alternative 2 to alleviate current surface flooding issues and prevent future flooding. The Lauzon Pkwy. Surface Flooding Risk Reduction Measure is anticipated to be a Schedule ‘B’ level project.

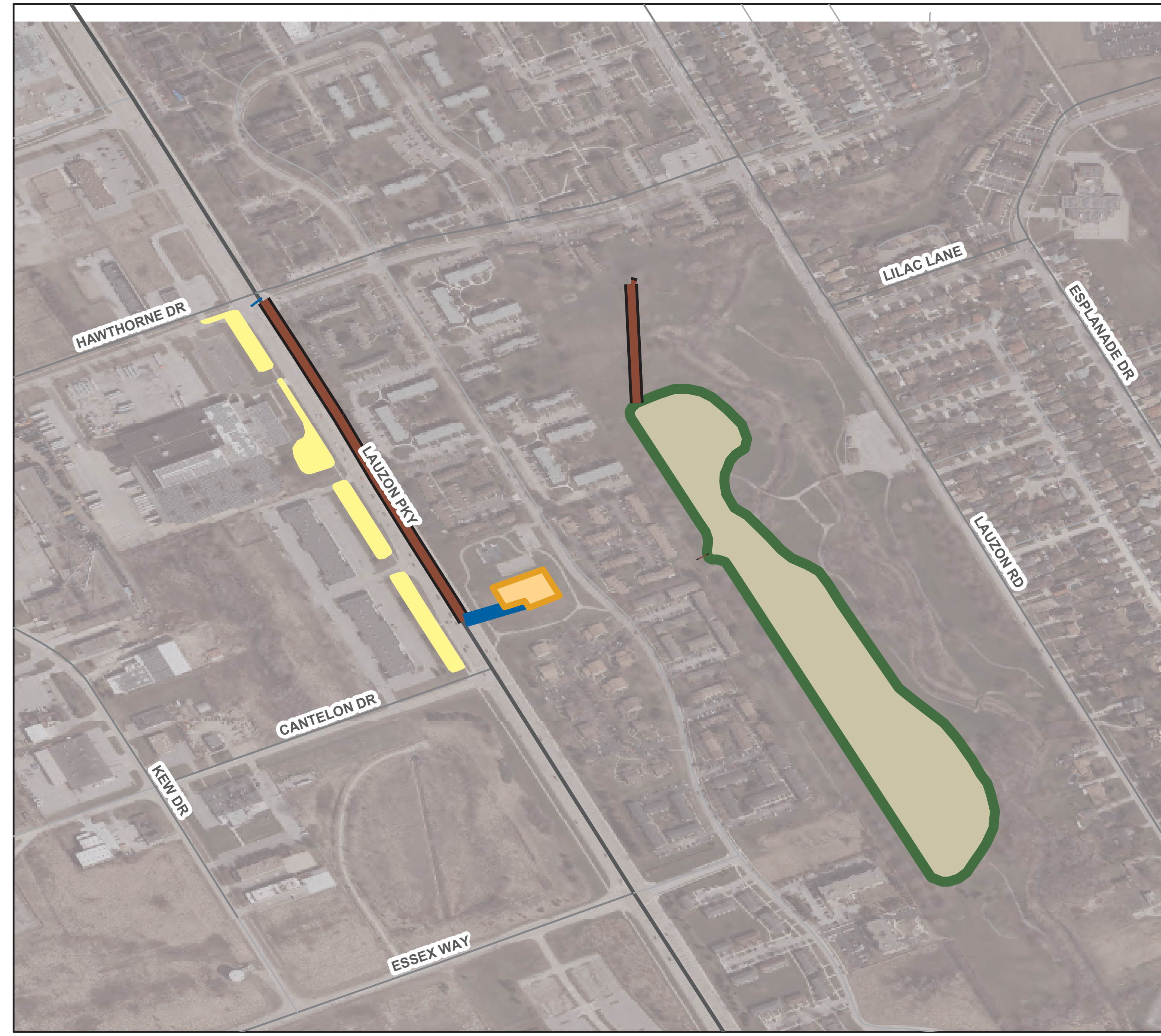
LAUZON PKWY / HAWTHORNE DR / LITTLE RIVER GOLF COURSE - ALT 1

Upgrade storm sewer on Lauzon Pkwy to twin box culvert with underground surcharge storage in Meadowbrook Park.
New SWM pond in golf course lands to control flows to Little River.



LAUZON PKWY / HAWTHORNE DR / LITTLE RIVER GOLF COURSE - ALT 2 (PREFERRED)

Upgrade storm sewer on Lauzon Pkwy to box culvert with underground surcharge storage in Meadowbrook Park.
500 m of LID on commercial properties and re-grading of 250 m of Lauzon Pkwy.
New SWM pond in golf course lands to control flows to Little River.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Lauzon Parkway Surface Flooding Risk Reduction (ROAD-E4) Alternatives

Figure 6-36

STORM PS
STUDY AREA
EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
STORM BOX CULVERTS
STORMWATER STORAGE POND
LID
SURCHARGE/PARK STORAGE

MAP CREATED BY: SD
MAP CHECKED BY: DEM / LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.9 East Sewershed – Blue Heron/Lakeview Pump Station Sub-Drainage Area

6.7.1.9.1 Regional Area 5 Surface Flooding Risk Reduction Measure (STM-E5)

This solution requires improvement to increase the resiliency for the Blue Heron pond stormwater system to potential back to back climate change storm events.

The assumptions for the Regional Area 5 sub-drainage area include:

- Consideration for the 1:100 year Detroit River high water level conditions;
- Allowances for full future development impact on stormwater runoff in assessing alternatives; and
- Low Impact Development (LID) measures such as exfiltration trenches may be employed along with the preferred alternative.

The two different alternatives determined to improve current conditions in Regional Area 5 are:

- **Alternative 1** – Upgrade storm sewers, forcemain and improve Lakeview pump station. This alternative includes upsizing the PS outlet sewer from a 350 mm diameter to 600 mm diameter and adjusting the on/off levels to improve the operation of the pump station. Also sewer upgrades are recommended on Morningstar Ave., Venetian Ave. and Katella Ave.
- **Alternative 2 "Do Nothing"** – Maintain the existing Lakeview Pump Station and SWM Pond operation as is.

See **Figure 6-37** for an illustration of the location, and **Table 6-29** for a comparative evaluation of the Regional Area 5 Surface Flooding Risk Reduction Alternative 2 to the Do Nothing Alternative 1, followed by a brief for each of the evaluation criteria.

Table 6-29: Regional Area 5 Surface Flooding Risk Reduction (STM-E5) Alternatives

Evaluation Criteria	Alternative 1 Upgrade Lakeview Pump Station and Outlet	Do Nothing Alternative 2 (Maintain Lakeview PS)
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-
Complexity of Installation & Operation	-	✓
Anticipated Extent of Maintenance Required	✓	-
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	✓	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	✓	-
Relative Capital Cost	✓	-
-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), and reduce surface flooding (1:100 year storm) in the Regional Area 5, to less than 30 cm, the upgrades to the Lakeview Pump Station and outlet are vital towards achieving this objective. Alternative

1 achieves this objective whereas Alternative 2 does not meet the flood mitigation objective.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a complex installation and operation than Alternative 2 Do Nothing. For this particular criteria, Alternative 2 is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 1 as opposed to Alternative 2.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along roadways. Alternative 1 will require numerous periods of disruptions, whereas Alternative 2 requires none.

Permanent Changes to the Urban Community: The upgrades to the Lakeview Pump Station and outlet of Alternative 1 in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of surface flooding for Alternative 1. A Stage 2 Archaeological Assessment is recommended for portions of the Pontiac PS bypass expansion site.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities. Alternative 2 results in higher frequency of CSOs during major rain events

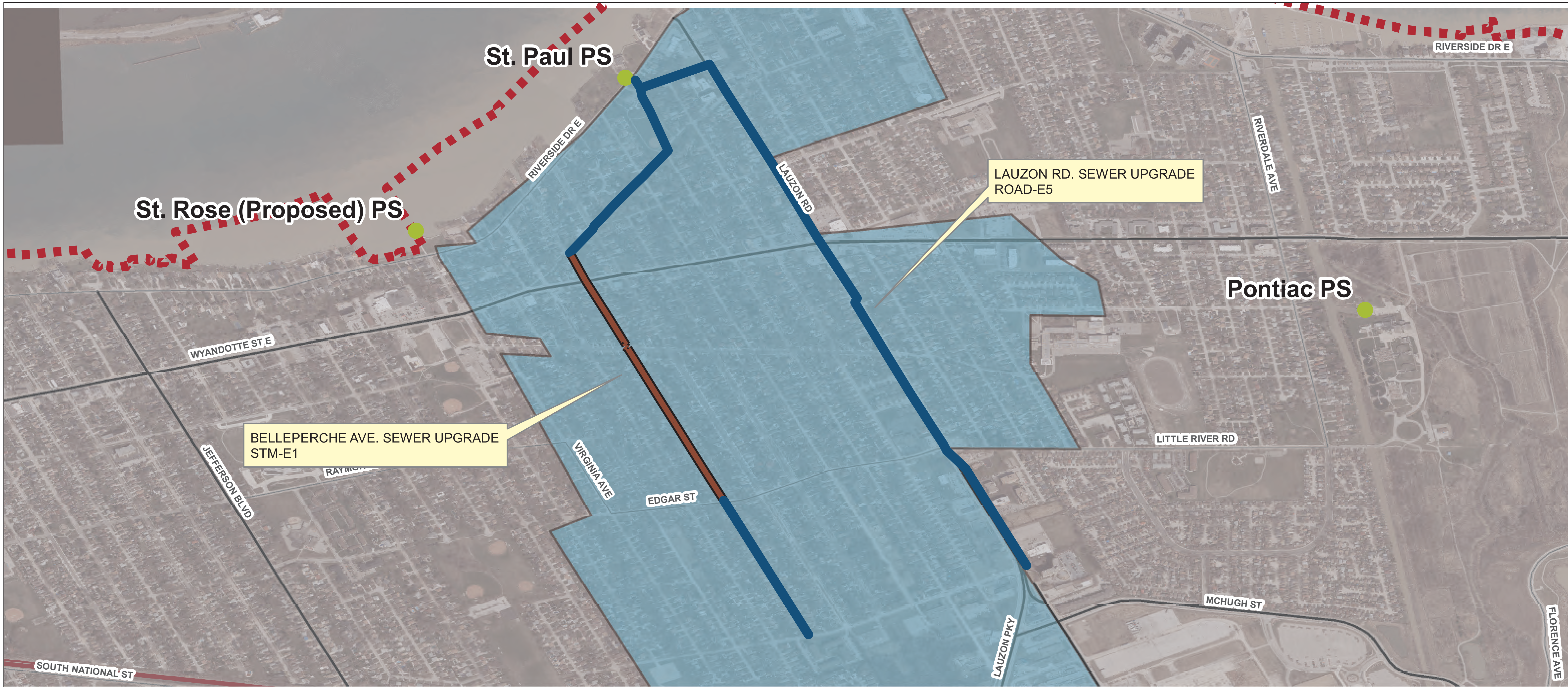
Relative Capital Cost: Alternative 1 is preferred.

Alternative 2 'Do Nothing' does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Alternative 1 meets the objective of reducing surface flooding risk. The preferred alternative is Alternative 1, as there are potentially less negative impacts. The Regional Area 5 Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level for the upgrades to the Lakeview Pump Station and Outlet.

Page is intentionally blank.

ST. PAUL PUMPING STATION DRAINAGE AREA RISK REDUCTION ALTERNATIVE: BELLEPERCHE AVE. (STM-E2) AND LAUZON RD. (ROAD-E5)

Sewer upgrades on Lauzon Rd. (2 km of new 2400 mm diameter sewer and deeper sewer near the St. Paul PS) together with Regional Area 2 Flood Risk Reduciton Preferred Alternative on Belleperche Ave.



STORM PS
EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
STUDY AREA
RAILWAY
MUNICIPAL DRAINS
STORM SEWER IMPROVEMENTS
STORM BOX CULVERTS

CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Regional Area 5 Surface Flooding Risk Reduction (STM-E5) Alternative
Figure 6-37

THE CITY OF WINDSOR

DILLON CONSULTING

Aquafor Beech

MAP CREATED BY: SD
MAP CHECKED BY: LMH / DEM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOTTO SCALE

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.10 East Sewershed – Pontiac Pump Station Sub-Drainage Area

6.7.1.10.1 Regional Area 6 Surface Flooding Risk Reduction Measure (STM-E6)

This solution requires improvement to reduce surface flooding risk in Regional Area 6, to less than 30 cm, and reduce the drainage area going to the East Marsh Pump Station to protect areas against high water levels and surface flooding along Riverside Dr.

The assumptions for the Regional Area 6 sub-drainage area include:

- Consideration for the 1:100 year Detroit River high water level conditions;
- No increase in stormwater peak flow entering the Little River;
- Allowances for full future development impact on stormwater runoff in assessing alternatives; and
- Low Impact Development (LID) measures such as exfiltration trenches may be employed along with the preferred alternative.

The two different alternatives determined to improve current conditions in Regional Area 6 are:

- **Alternative 1 "Do Nothing"** – Maintain the existing Drainage Area.
- **Alternative 2** – Installation of a new underground stormwater management facility (USMF) within Brumpton Park, and approximately 680 m of new storm sewer along Cedarview St., as well as reducing the risk of inland coastal flooding by redirecting stormwater drainage south of the Ganatchio Trail berm, from the East Marsh Pump Station system to the Pontiac Pump Station System. East Marsh pump station improvements, including replacing existing pumps with new pumps and installing backup power generators.

See **Figure 6-38** for an illustration of the location, and **Table 6-30** for a comparative evaluation of the Regional Area 6 Surface Flooding Risk Reduction Alternative 2 to the Do Nothing Alternative 1, followed by a brief for each of the evaluation criteria.

Table 6-30: Regional Area 6 Surface Flooding Risk Reduction (STM-E6) Alternatives

Evaluation Criteria	Do Nothing Alternative 1 (Maintain Current Drainage Areas)	Alternative 2 Storm Sewer Improvements, USMF, and East Marsh Area Modifications
Meets Flood Mitigation Objectives	-	✓
Provides Enhanced Level of Service for Vulnerable Areas	-	✓
Accommodates Land Use Changes	-	✓
Flexibility to Adjust to Climate Change	-	✓
Complexity of Installation & Operation	✓	-
Anticipated Extent of Maintenance Required	✓	-
Length of Time Required for Implementation	✓	-
Disruption during Construction	✓	-
Permanent Changes to the Urban Community	-	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	-	✓
Relative Capital Cost	✓	-
-	-	PREFERRED

Flexibility to Adjust to Climate Change: In order to reduce surface flooding (1:100 year storm) in the Regional Area 6, to less than 30 cm, the installation of underground storage within Brumpton Park and improvements to storm sewers and the sub-drainage area are vital towards achieving this objective. Alternative 2 achieves this objective whereas Alternative 1 does not meet the flood mitigation objective.

Complexity of Installation & Operation: Alternative 1 requires no installation than Alternative 2. For this particular criteria, Alternative 1 is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be simpler with Alternative 2 as opposed to Alternative 1 Do Nothing which would continue to be impacted by surface flooding, requiring higher levels of maintenance.

Disruption during Construction: Alternative 2 will require temporary road closure in the vicinity of the construction areas, which will be kept to a minimum to maintain traffic flow along roadways. Alternative 1 Do Nothing does not create any disruption.

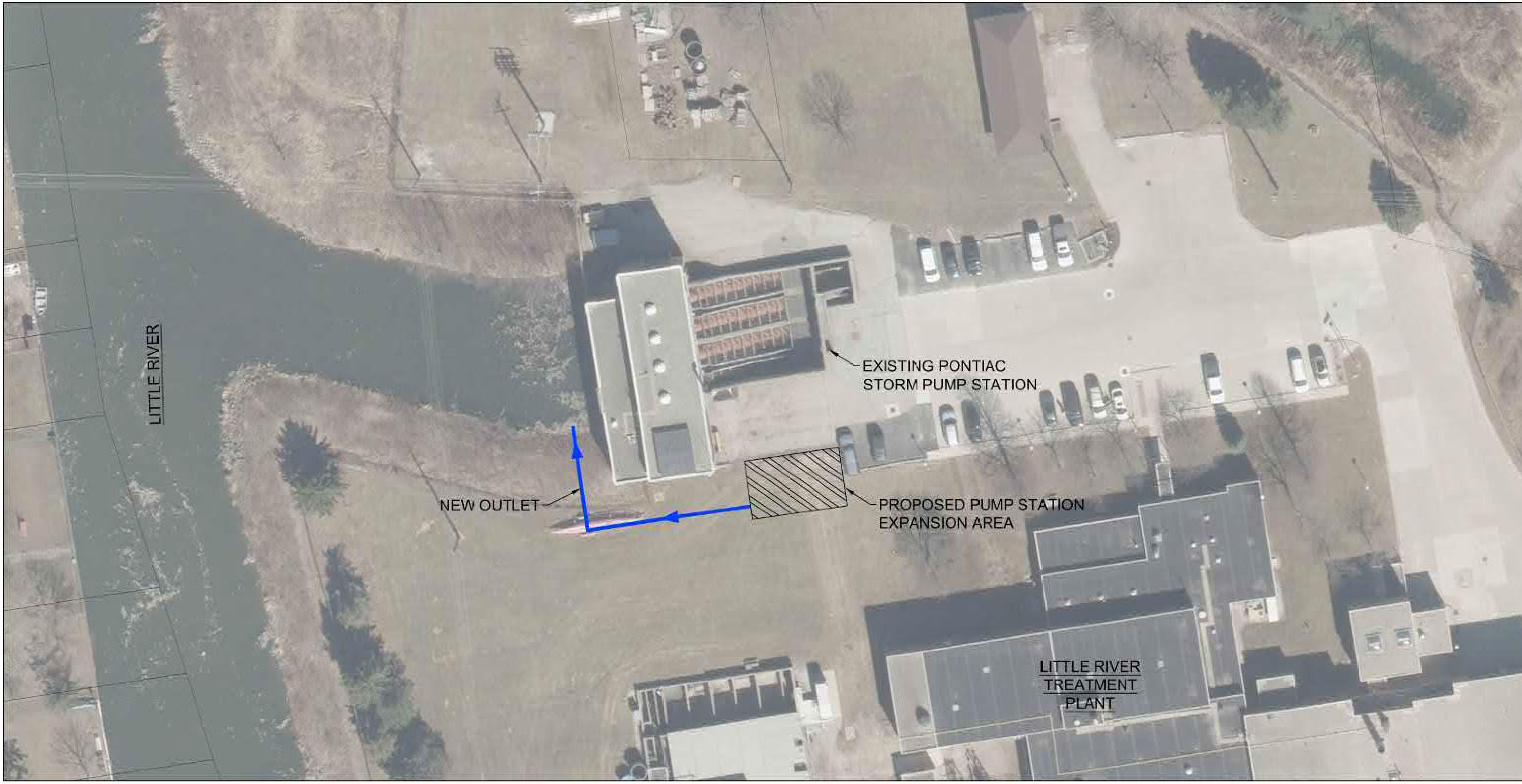
Permanent Changes to the Urban Community: The installation of stormwater management measures of Alternative 2 in this area will positively change the neighbourhood for the community’s future by reducing the risk of surface flooding, compared to the Do Nothing scenario.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of surface flooding for Alternative 2; however, proposed installations may impact in-situ archaeological resources; therefore, the completion of a Stage 2 Archaeological Assessment will be required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities. Alternative 1 results in further flooding risk to the natural environment, as the objective is not addressed.

Relative Capital Cost: Alternative 2 is preferred.

Alternative 1 ‘Do Nothing’ does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Alternative 2 meets the objective of reducing surface flooding risk. The preferred alternative is Alternative 2, as there are potentially less negative impacts. The Regional Area 6 Surface Flooding Risk Reduction including the East Marsh Pump Station Improvement and the construction of storm sewers to direct flows to the Pontiac PS is anticipated to be a Schedule ‘B’ level. The construction of the Brumpton Park USMF and Cedarview Dr storm sewer is anticipated to be aSchedule ‘B’ level project.



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Regional Area 6 Surface Flooding Risk Reduction Pontiac PS (SAN-E2 / STM-E6) Alternatives

Figure 6-38

PROPERTY LINE
PROPOSED PUMP STATION
NEW STORM OUTLET

THE CITY OF WINDSOR

DILLON CONSULTING

Aquafor Beech Limited

CREATED BY: JTB
CHECKED BY: LMH

FILE LOCATION:
C:\PROJECTWISE\WORKING
February 10, 2020 10:53 AM

PROJECT: 17-6638 STATUS: DRAFT DATE: February 2020

Page is intentionally blank.

6.7.1.10.2 Wyandotte at Watson Surface Flooding Risk Reduction Measure (ROAD-E9)

This solutions requires improvement to manage surface flooding to less than 30 cm under the Climate Change Storm (1:100 year storm + 40% factor) on Wyandotte St. East, a Class I Arterial roadway.

This alternative consists of: the proposed construction of two stormwater surcharge features (either underground or open SWM Pond), which will require the acquisition of property along the north side of Wyandotte St. East. This alternative utilizes the existing storm sewer infrastructure and allows space within the roadway corridor for recommended sanitary sewer improvements.

Assumptions for this alternative includes:

- Construction of the improvements for the St. Paul drainage system, including the proposed new pump station and trunk sewers are completed; and
- Low Impact Development (LID) measures such as exfiltration trenches may be employed along with the preferred alternative.

Refer to **Figure 6-39** for an illustration of the location, and **Table 6-31** for a comparative evaluation of the Wyandotte at Watson Surface Flooding Risk Reduction Measure Alternative to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-31: Wyandotte at Watson Surface Flooding Risk Reduction Measure (ROAD-E9) Alternative

Evaluation Criteria	Alternative 1 Construct Two Stormwater Storage Facilities	Do Nothing Alternative (Maintain Current System)
Meets Flood Mitigation Objectives	✓	-
Provides Enhanced Level of Service for Vulnerable Areas	✓	-
Accommodates Land Use Changes	✓	-
Flexibility to Adjust to Climate Change	✓	-

Evaluation Criteria	Alternative 1 Construct Two Stormwater Storage Facilities	Do Nothing Alternative (Maintain Current System)
Complexity of Installation & Operation	-	✓
Water Quality	✓	-
Anticipated Extent of Maintenance Required	-	✓
Length of Time Required for Implementation	-	✓
Disruption during Construction	-	✓
Permanent Changes to the Urban Community	-	✓
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-
Impacts to the Natural Environment	✓	✓
Relative Capital Cost	-	✓
-	PREFERRED	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), storm sewer infrastructure is vital towards achieving this objective. Alternative 1 achieves the objective.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a more complex installation and operation because of the double stormwater surcharge features.

Anticipated Extent of Maintenance Required: Upon completion of installation of Alternative 1, standard maintenance practices are anticipated to enable the sustainability of this infrastructure for the service life of the pipe material.

Length of Time Required for Implementation: Initial pre-design investigation has determined this Alternative 1 to be a more complex installation with a longer period of time required for acquisition of land parcels, detailed design, construction, and commissioning.

Disruption during Construction: Temporary road closures in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow; however, the length of time required for construction activity will lead to intermittent disruptions.

Permanent Changes to the Urban Community: The installation of storm sewers in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding. Property acquisition will be required for this alternative.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The installation of storm sewers in this area will positively impact these features by reducing the risk of surface flooding in the vicinity; however, the areas required for the proposed two storm water surcharge facilities.

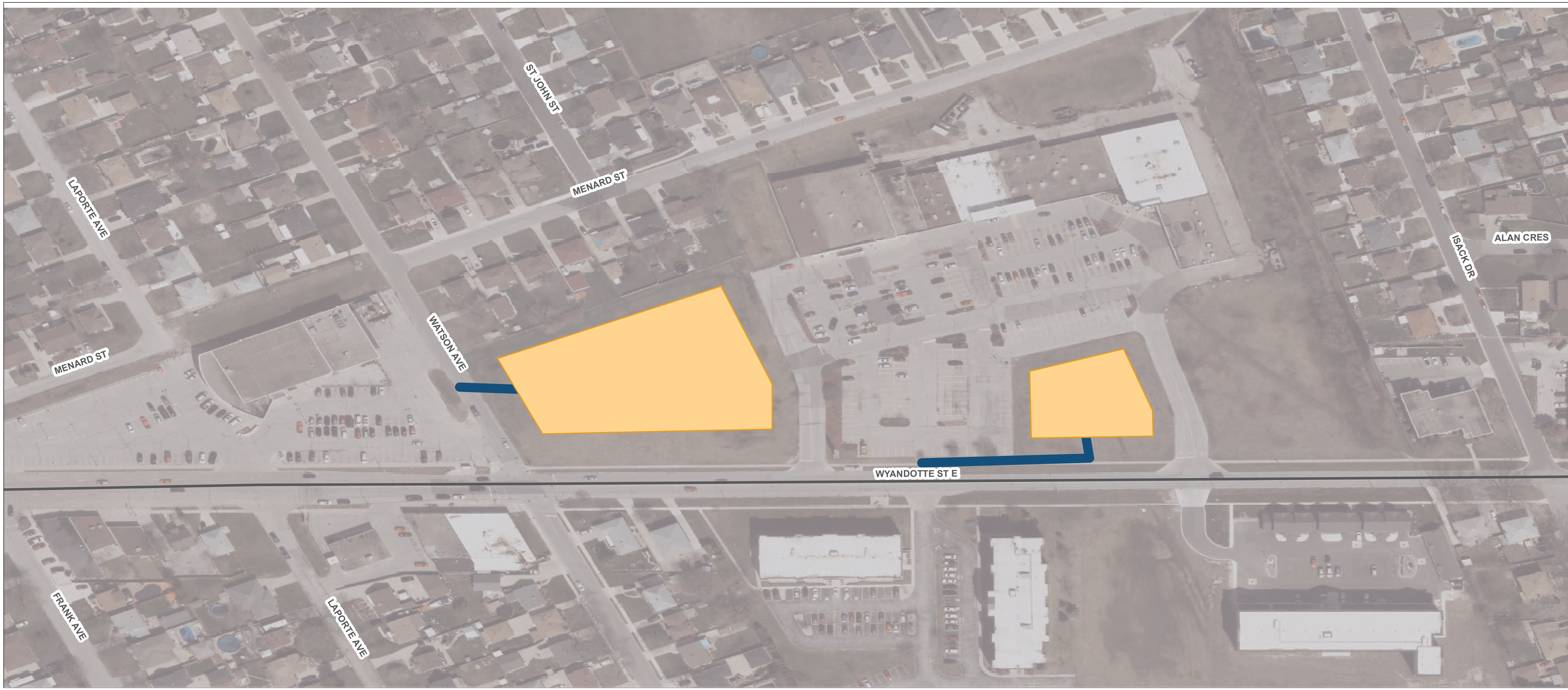
Impacts to the Natural Environment: The areas of storm sewer installation are already disturbed by urban activities.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The only alternative possible and preferred, is to proceed with the proposed construction of the two stormwater management facilities to alleviate current surface flooding issues and prevent future flooding. The Wyandotte St. E. at Watson Ave. Surface Flooding Risk Reduction Alternative is anticipated to be a Schedule 'B' level project.

Page is intentionally blank.

WYANDOTTE ST E AT WATSON AVE (ROAD-E9)

Underground surcharge storage within vacant commercially-zoned land and fronting commercial property on north side of Wyandotte St. E (Riverside Plaza)



CITY OF WINDSOR
SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Wyandotte at Watson Surface Flooding Risk Reduction (ROAD-E9) Alternative

Figure 6-39

THE CITY OF WINDSOR

STORM PS	EXPRESSWAY AND ARTERIAL ROADS	STORM SEWER IMPROVEMENTS	SURCHARGE/PARK STORAGE
	CLASS 1 AND 2 COLLECTOR ROADS	STORM BOX CULVERTS	
STUDY AREA	RAILWAY	MUNICIPAL DRAINS	

DILLON CONSULTING

Aquafor Beech

MAP CREATED BY: SD
MAP CHECKED BY: DM
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

N W E S

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

6.7.1.11 Coastal Flood Protection Solutions

To mitigate risk of coastal flood due to high lake or river water levels (HWL) the use of a landform barrier (i.e. berms) has been recommended through previous studies (East Riverside Flood Risk Assessment (2019) (ERFRA)). More details pertaining to findings and integration of the ERFRA report into this study is included in **Appendix E-Technical Report Volume 2**.

The Riverside Dr. E. and East Riverside Area have been broken down into three sections, as shown in **Figure 6-40**. Each with unique characteristics and extent of existing coastal flood protection measures.

Figure 6-40: Riverside Dr. E. and East Riverside Coastal Flood Protection Area Map

The following section summarizes the alternatives that were evaluated as part to this study.

6.7.1.11.1 Area 1 (BERM-E1) - Ford Blvd to St. Rose Ave - Riverside Vista 2A Boundaries

This solution requires improvement to provide costal flood protection to the Riverside Dr. East area between Ford Blvd. and St. Rose Ave.

The three different alternatives determined to improve current conditions in Area 1 are:

Alternative 1 – Landform Barrier at Flood Protection Elevation 176.45, South of Riverside Dr. E.

Alternative 2 – Landform Barrier at Flood Protection Elevation 176.45, North of Riverside Dr. E.

Alternative 3 – Landform Barrier at Flood Protection Elevation 176.80, North of Riverside Dr. E.

See **Figure 6-41** for an illustration of the typical cross section of Alternative 1, and **Table 6-32** for a comparative evaluation of the Area 1 Coastal Flood Protection Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-32: Area 1 Coastal Flood Risk (BERM-E1) Alternatives

Evaluation Criteria	Alternative 1 176.45 South Side	Alternative 2 176.45 North Side	Alternative 3 176.80 North Side	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	✓	-
Flexibility to Adjust to Climate Change	-	-	✓	-
Protects Inland Drainage Systems	-	✓	✓	-
Complexity of Installation & Operation	-	-	-	✓
Anticipated Extent of Maintenance Required	✓	✓	✓	-
Length of Time Required for Implementation	-	-	-	✓
Disruption during Construction	✓	✓	-	✓
Permanent Changes to the Urban Community	✓	✓	✓	-

Evaluation Criteria	Alternative 1 176.45 South Side	Alternative 2 176.45 North Side	Alternative 3 176.80 North Side	Do Nothing Alternative
Impacts to Archaeological, Built Heritage, & Cultural Heritage	-	-	-	✓
Impacts to the Natural Environment	-	-	-	✓
Relative Capital Cost	✓	✓	-	✓
-	-	PREFERRED	-	-

The minimum flood protection elevation of 176.45 is based on the recommendations of the ERFRA (Landmark 2019). For the purposes of the functional design and implementation of these coastal flood protection measures, the top of berm elevation of 176.50 was used and is reflected in the functional design figures.

Flexibility to Adjust to Climate Changes: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), and reduce surface flooding (1:100 year storm) in Area 1 to less than 30 cm, the improvements to landform barriers in area 1 (BERM-E1) are vital towards achieving this objective. Alternative 3 achieves this objective better than the other two alternatives.

Protects Inland Drainage Systems: Both Alternatives 2 and 3 provide protection to a portion of the local storm drainage system.

Complexity of Installation & Operation: Initial pre-design investigation has determined that all three Alternatives require a complex level of installation of operation. For this particular criteria, the Do Nothing Alternative is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be similar for all three alternatives.

Length of Time Required for Implementation: Initial pre-design investigation has determined Alternative 2 and 3 would require more extensive work.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along roadways. Alternatives will require varying periods of disruptions with Alternative 1 having the least amount of disruption.

Permanent Changes to the Urban Community: The installation of coastal flood management by landform barriers in this area will positively change the neighbourhood for the community's future by reducing the risk of surface flooding. Alternative 1 provides some benefit to permit development of lands to the south, as well as Alternative 2 which provides minimal benefit in this regard. Alternative 3 provides the most benefit to permit future development.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of surface flooding for Alternative 2 only. The completion of a Stage 2 Archaeological Assessment is required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities. Alternative 1 results in further flooding risk to the natural environment, as the objective is not addressed using the continued soft separation of combined sewers in Regional Area 3.

Relative Capital Cost: Alternative 1 is preferred.

The 'Do Nothing' alternative does not improve the coastal flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Similarly, Alternatives 1, 2 and 3 meet the objective of reducing coastal flooding risk. The preferred alternative is Alternative 1, as there are potentially less negative impacts, and ultimately is the least costly to implement. The Area 1 Coastal Flooding Risk Reduction is anticipated to be a Schedule 'B' level for the BERM-E1 project.

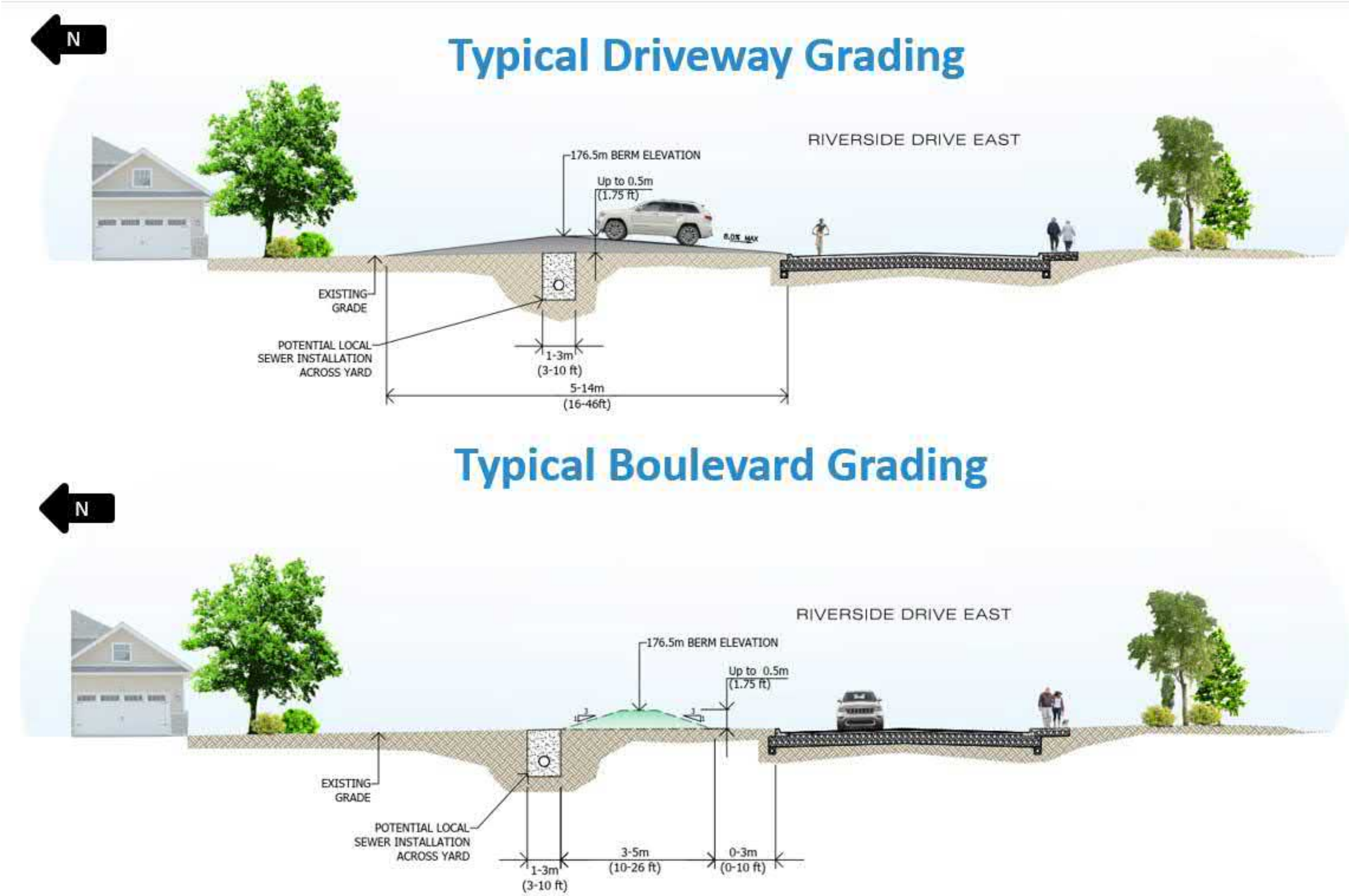


Figure 6-41: Typical Cross Section for the Alternative 1 Landform Barrier in Area 1 (BERM-E1)

6.7.1.11.2 Area 2 (BERM-E2) - St. Rose Ave to Riverdale Ave.

This solution requires improvement to provide costal flood protection to the Riverside Dr. East area between St. Rose Ave. and Riverdale Ave.

The two different alternatives determined to improve current conditions in Regional Area 2 are:

Alternative 1 – Landform Barrier at Flood Protection Elevation 176.45, Along Riverside Dr. E.
Alternative 2 – Landform Barrier at Flood Protection Elevation 176.80, Along Riverside Dr. E.

See **Figure 6-42** for an illustration of the typical cross section of Alternative 1, and **Table 6-33** for a comparative evaluation of the Area 1 Coastal Flood Protection Alternatives to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-33: Area 2 Coastal Flood Risk (BERM-E2) Alternatives

Evaluation Criteria	Alternative 1 176.45 South Side	Alternative 2 176.80 South Side	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Flexibility to Adjust to Climate Change	✓	✓	-
Protects Inland Drainage Systems	✓	✓	-
Complexity of Installation & Operation	✓	-	✓
Anticipated Extent of Maintenance Required	✓	✓	✓
Length of Time Required for Implementation	✓	-	✓
Disruption during Construction	✓	-	✓
Permanent Changes to the Urban Community	✓	-	-
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-	-

Evaluation Criteria	Alternative 1 176.45 South Side	Alternative 2 176.80 South Side	Do Nothing Alternative
Impacts to the Natural Environment	✓	-	-
Relative Capital Cost	✓	-	✓
-	PREFERRED	-	-

Flexibility to Adjust to Climate Change: In order to manage surface flooding under the Climate Change Storm (1:100 year storm + 40% factor), and reduce coastal flooding (1:100 year storm) in the Area 2 to less than 30 cm, the improvements to the landform barriers in Area 2 (BERM-E2) are vital towards achieving this objective. Both alternatives achieve this objective whereas the Do Nothing Alternative does not meet the flood mitigation objective.

Protects Inland Drainage Systems: Both Alternatives 1 and 2 provide high level of protection to a portion of the local storm drainage system.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a simpler installation and operation than Alternative 2, as Alternative 1 requires less work. For this particular criteria, Alternative 1 is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to similar for both alternatives.

Length of Time Required for Implementation: Initial pre-design investigation has determined Alternative 1 to be the least time-consuming to install.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along roadways. Alternative 1 will cause less disruption than Alternative 2.

Permanent Changes to the Urban Community: The installation of landform barriers of Alternative 2 in this area will provide the most benefit to permit development of lands to the south by reducing the risk of coastal flooding.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of coastal flooding for Alternative 1. In order to confirm the absence of resources, the completion of a Stage 2 Archaeological Assessment will be required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities.

Relative Capital Cost: Alternative 1 is preferred.

The 'Do Nothing' alternative does not improve the surface flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. Similarly, Alternative 1 does not meet the flood mitigation objective for current or future risk. Alternative 2 meets the objective of reducing surface flooding risk. The preferred alternative is Alternative 2, as there are potentially less negative impacts, and ultimately is the least costly to implement. The Regional Area 3 Surface Flooding Risk Reduction is anticipated to be a Schedule 'B' level for the stormwater sewer project.

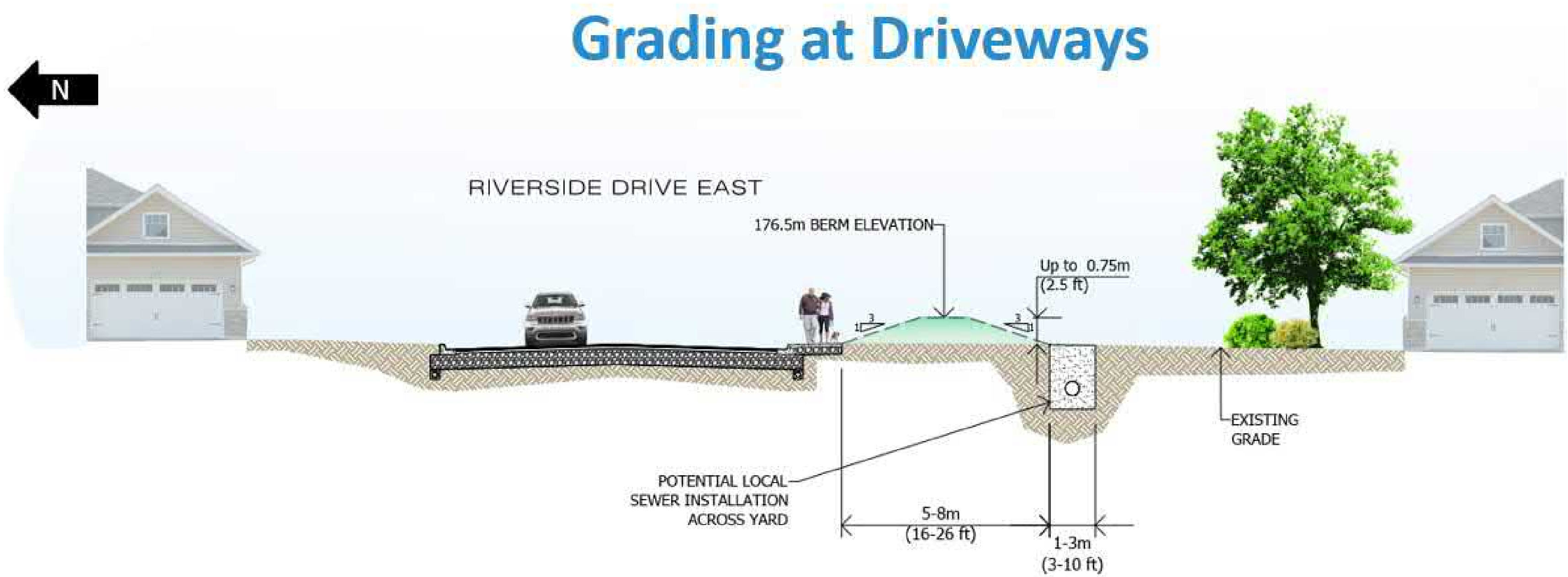


Figure 6-42: Typical Cross Section for the Alternative 1 Landform Barrier in Area 2 (BERM-2)

6.7.1.11.3 Area 3 (BERM-E3) - Riverdale Ave. to East City Limits

This solution requires improvement to provide coastal flood protection to the Riverside Dr. East area between St. Rose Ave. and Riverdale Ave.

The two different alternatives determined to improve current conditions in Regional Area 2 are:

Alternative 1 – Landform Barrier at Flood Protection Elevation 176.45, Along Ganatchio Trail
Alternative 2 – Landform Barrier at Flood Protection Elevation 176.80, Along Ganatchio Trail

See **Figure 6-43** for an illustration of the typical cross section of Alternative 1, and **Table 6-34** for a comparative evaluation of the Area 3 Coastal Flood Protection Alternatives (BERM-E3) to the Do Nothing alternative, followed by a brief for each of the evaluation criteria.

Table 6-34: Area 3 Coastal Flood Risk Alternatives (BERM-E3)

Evaluation Criteria	Alternative 1 176.45 Ganatchio Trail Infill	Alternative 2 176.80 Ganatchio Trail Infill	Do Nothing Alternative
Meets Flood Mitigation Objectives	✓	✓	-
Flexibility to Adjust to Climate Change	-	✓	-
Protects Inland Drainage Systems	-	✓	-
Complexity of Installation & Operation	✓	-	✓
Anticipated Extent of Maintenance Required	-	-	-
Length of Time Required for Implementation	✓	-	-
Disruption during Construction	✓	-	✓
Permanent Changes to the Urban Community	-	✓	-

Evaluation Criteria	Alternative 1 176.45 Ganatchio Trail Infill	Alternative 2 176.80 Ganatchio Trail Infill	Do Nothing Alternative
Impacts to Archaeological, Built Heritage, & Cultural Heritage	✓	-	✓
Impacts to the Natural Environment	✓	✓	-
Relative Capital Cost	✓	-	-
-	PREFERRED	-	-

Flexibility to Adjust to Climate Change: In order to manage coastal flooding under the Climate Change Storm (1:100 year storm + 40% factor), and reduce surface flooding (1:100 year storm) in Area 3 (BERM-E3), to less than 30 cm, the improvements to landform barriers are vital towards achieving this objective. Alternative 2 achieves this objective better than Alternative 1.

Protects Inland Drainage Systems: Both Alternatives 1 and 2 provide protection to a portion of the local storm drainage system.

Complexity of Installation & Operation: Initial pre-design investigation has determined Alternative 1 to be a simpler installation and operation than Alternative 2, as Alternative 1 requires less work. For this particular criteria, Alternative 1 is preferred.

Anticipated Extent of Maintenance Required: Upon completion of installation, standard maintenance practices are anticipated to be similar for all alternatives.

Length of Time Required for Implementation: Initial pre-design investigation has determined both Alternatives to be time-consuming to install. Alternative 2 requires more time for construction than Alternative 1, as Alternative 1 requires a lower level of construction.

Disruption during Construction: Temporary road closure in the vicinity of the construction areas will be kept to a minimum to maintain traffic flow along roadways. Alternative 1 has the smaller construction footprint and lowest degree of disruptions.

Permanent Changes to the Urban Community: The installation of landform barriers in this area will positively change the neighbourhood for the community's future by reducing the risk of coastal flooding. Alternative 2 provides the most benefit to permit development of lands to the south.

Impacts to Archaeological, Built Heritage, & Cultural Heritage: The proposed improvements in this area will positively impact these features by reducing the risk of coastal flooding for Alternative 1. In order to confirm the absence of resources, the completion of a Stage 2 Archaeological Assessment will be required prior to construction in order to identify and determine suitable mitigation measures for specific resources that may potentially be impacted by flooding and construction activity.

Impacts to the Natural Environment: Land areas for both alternatives 1 and 2 have already been disturbed by urban activities. Alternative 1 results in less coastal flooding risk to the natural environment.

Relative Capital Cost: alternative 1 is preferred.

The 'Do Nothing' alternative does not improve the coastal flooding issue, and over time, climate changes will increase the negative effects i.e. impacts, disruption and increased costs to the community. The Area 3 Coastal Flooding Risk Reduction (BERM-E3) is anticipated to be a Schedule 'B' level project.

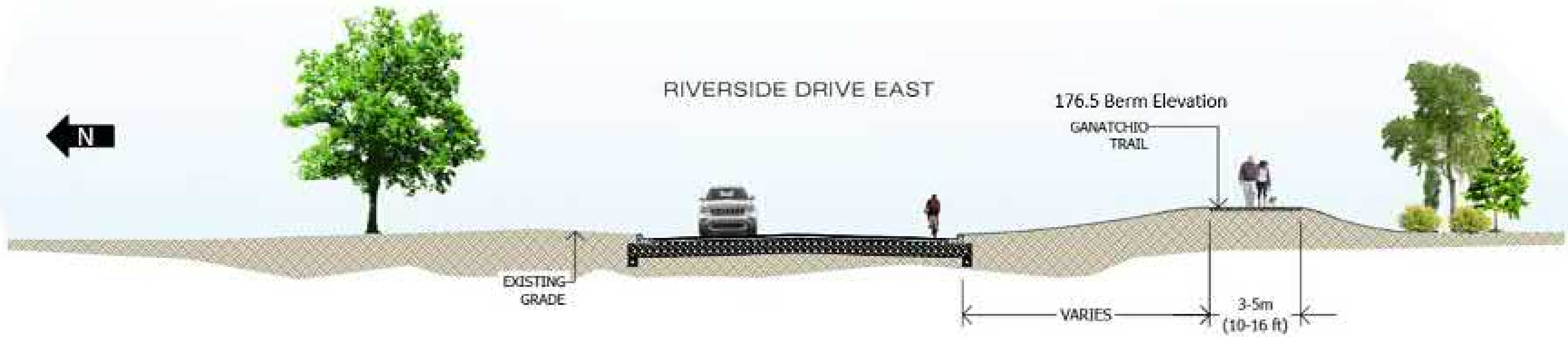


Figure 6-43: Typical Cross Section for the Alternative 1 Landform Barrier in Area 1 (BERM-3)

6.7.1.11.4 Consideration for Flood Protection along the Lake/River Shoreline

The solutions listed above do not include the consideration to place flood protection measures along the existing Lake St. Clair or Detroit River Shoreline. The option to provide flood protection along the north shoreline in the rear of private properties was reviewed with the TAC and the SAC; however, due to the following constraints these options were not feasible.

- Inspection & Maintenance
    - The City must have full access for regular inspection and maintenance of the any flood protection infrastructure. Structures will need to be constructed within established easements or right-of-way.
- Size/Height
    - Where flood protection measures are constructed at the lake/river water line the structure must be 0.3 m (1 ft) to 1.0 m (3.3 ft) higher than then protection measure proposed along Riverside Dr. This increase in flood protection height is required to account for wind and wave factors.
- Management & Jurisdiction
    - The City must be able to maintain access and legal status of the flood protection features to mitigate risks of damage or modifications to the structure which would leave the in-land areas vulnerable.
- Impacts
    - Would impact private property amenities such as pools, docks, boat slips and structures. Higher barrier would require property acquisition and removal of structures.

6.7.2 Overview of Recommended Longer-Term Solutions

Tables 6-35, **6-36**, **6-37**, and **6-38** below summarize the projects identified in the section above that together with the short term solutions form the long term strategy for managing drainage and flooding in the City. The tables also highlight the MECA schedule for each of the projects individual projects. As noted in Section 3.2, there are four schedules of projects each with different Class EA requirements as follows:

- Projects noted as Schedule A projects require no further study and can proceed directly to implementation/construction.

- Projects noted as Schedule A+ project require notification of project neighbours prior to implementation/construction.
- Projects noted as Schedule B projects have completed the MCEA requirements through this MP and subject to comments received during the review of this MP can proceed directly to implementation/construction.
- Projects noted as Schedule C projects have completed phases 1 and 2 of the MCEA process. Using the work in the MP as a base, Phases 3 & 4 of the MCEA process must be completed prior to implementation/construction.

Page is intentionally blank.

Table 6-35: Summary of Preferred Alternatives - Central Sewershed Drainage Area

Project No.	Sub-Drainage Area	Project Code	Project Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
1	Central	SAN-C	Central Windsor Sanitary Sewer System Solutions	Enhanced separation of the existing combined sewer system requiring the construction of a separated storm system to capture storm flows from the Municipal ROW, Private Property (Downspouts, Front and Rear Yards) and Rear Alleyways.	A+
2	Prince Road	STM-C1	Prince Trunk Storm Sewer Outfall including Drainage Area Sewer Separation	Installation of approx. 200 m of storm sewers to a new outfall at McKee Creek including a dewatering pump station.	C
3	Prince Road	STM-C9	College Ave. Storm Sewer	Installation of approx. 400 m of storm sewers and LIDs along College Ave. to connect with existing Prince Rd. trunk sewer on Prince Rd.	A+
4	Brock Street	STM-C10	Felix Ave. Storm Sewer including Drainage Area Sewer Separation	Installation of approx. 1,600 m of storm sewers along Felix Ave., connecting to existing main at College Ave.	A+
5	Detroit Street	STM-C2	Detroit Street Trunk Storm Sewer and Outfall Drainage Area Sewer Separation	Installation of approx. 300 m of storm sewer along Detroit Street, from Sandwich St. to an improved outfall at the Detroit River.	C (outfall)
6	Huron Church Rd.	STM-C11	Partington Ave. Trunk Storm Sewer including Drainage Area Sewer Separation	Installation of approx. 1,300 m of storm sewer along Tecumseh Rd. W and Partington Ave. to existing main at College Ave. including Drainage Area Sewer Separation.	A+
7	Huron Church Rd.	STM-C12	Patricia Trunk Storm Sewer	Installation of approx. 650 m of storm sewer along Patricia Rd. and Wyandotte St. W to existing main at Huron Church Rd.	A+
8	Huron Church Rd.	STM-C13	Huron Church Rd. Trunk Storm Sewer	Installation of approx. 70 m of storm sewer along Huron Church Rd. just north of the intersection with Tecumseh Rd. E.	A+
9	Askin Rd.	STM-C20	Askin Drainage Area Sewer Separation	Enhanced sewer separation of the entire drainage area.	A+
10	Wellington Avenue	STM-C14	Wellington Trunk Storm Sewer including Drainage Area Sewer Separation	Installation of approx. 600 m of storm sewer along Tecumseh Blvd. W. awford Ave.	A+

Project No.	Sub-Drainage Area	Project Code	Project Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
11	Cameron Avenue	STM-C3	Cameron Trunk Storm Sewer/ Outfall including Drainage Area Sewer Separation.	Installation of approx. 2,700 m of storm sewer along Tecumseh Rd. W., Curry Ave., Rooney St., McKay Ave., Martindale St., and Cameron Ave. to new outfall to the Detroit River, including Drainage Area Sewer Separation.	A+ and C (outfall)
12	Church Ave.	STM-C4	Bruce Ave. Trunk Storm Sewer/ Outfall including Drainage Area Sewer Separation	Installation of approx. 2,000 m of storm sewer along Bruce Ave. to connect to new outfall at Detroit River and Drainage Area Sewer Separation.	A+ and C (outfall)
13	McDougall Ave.	STM-C22	Drainage Area Sewer Separation	Enhanced sewer separation of the entire drainage area.	A+
14	Langlois Ae.	STM-C5	Parent Ave. Storm Sewer/ Marentette Ave. Outfall including Drainage Area Sewer Separation	Installation of approx. 800 m of storm sewers along Assumption St., Parent Ave., Chatham St., Marentette Ave., to new outfall at Detroit River and Drainage Area Sewer Separation.	A+ and C (outfall)
15	Church Ave./ McDougall Ave./ Langlois Ave.	STM-C15	Giles Ave. Storm Sewer Interconnection	Installation of approx. 1,500 m of storm sewers along Shepherd St., McDougall St., Giles Blvd. E., and Erie St.	A+
16	Parent Ave.	STM-C16	Parent Ave. Storm Sewer at Erie St. E.	Installation of 450 m of new storm sewers along Parent Ave. south of Erie St. E.	A+
17	Lincoln Ave.	STM-C23	Drainage Area Sewer Separation	Enhanced sewer separation of the entire drainage area.	A+
18	Lincoln Ave.	STM-C17	Lincoln Trunk Storm Sewer	Installation of approx. 300 m of storm sewer along Lincoln Rd.	A+
19	Lincoln Ave.	STM-C18	Ontario St. Storm Sewer	Installation of approx. 440 m of storm sewer along Ontario St.	A+
20	Lincoln Ave.	STM-C19	Walker Rd. Storm Sewer	Installation of approx. 640 m of storm sewer along Walker Rd. and a portion of Mohawk St	A+
21	Ypres Avenue.	STM-C6	Ypres Ave. Stormwater Management Facility	Installation of an underground stormwater storage facility under existing a parking lot within Optimist Park on Ypres Ave.	B
22	Albert Road	STM-C7.1	Albert Trunk Storm Sewer/Outfall	Installation of approx. 350 m of storm sewer along Albert Rd. to connect to an improved outfall to the Detroit River and Drainage Area Sewer Separation.	B

Project No.	**Sub-Drainage Area**	**Project Code**	**Project Name**	**Description**	**Proposed Class EA Schedule Level (A, A+ ,B , C)**
23	Albert Road	STM-C7.2	Wyandotte St. E. Storm Sewer	Installation of approx. 200 m of storm culverts along Wyandotte St. E. to provide stormwater storage capacity.	A+
24	Drouillard Road	STM-C8	Drouillard PS Improvements	Installation of approx. 270 m of storm sewer along Drouillard Rd. between Riverside Dr. E. and Wyandotte St. E. Construction of a new pump station within Cadillac Park and decommissioning of the existing pump station.	B
25	Dual Manhole Area	STM-C21	Separation of the Dual Manhole Drainage Area	Replaced the existing dual storm and sanitary system with a new fully separated system.	A+

Table 6-36: Summary of Preferred Alternatives – South Sewershed Drainage Area

Project Number	Sub-Drainage Area	Project Code	Project Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
1	Lou Romano WRP	SAN-S	South Windsor Basement Flood Risk Reduction Sanitary Sewer Improvements	Installation of upgraded sewer pipes ranging in size between 750 mm and 900 mm diameter for approximately 8 km on Dominion Blvd, Woodland Ave, Howard Ave, Pkwy. Ave, Conservation Dr, Grand Marais Rd E, and Tourangeau Rd.	A+
2	Grand Marais Drain	ROAD-S1	Dougall Ave. Stormwater Management Pond and Storm Sewer Improvements	Installation of approx. 1,400 m of storm sewers on Eugenie St. E., between McDougall St. and Dougall Ave., and along Dougall Ave., from Eugenie St. E. to a proposed SWM Pond, south of South Cameron Blvd. providing approx. 14,000 m^3 storage volume within private property.	B
3	Grand Marais Drain	ROAD-S2	Howard Ave. Stormwater Management Pond and Storm Sewer Improvements	Installation of approx. 1,200 m of storm sewer on Howard Ave. between Edinborough St. and E.C ROW Expressway to a proposed SWM Pond providing approx. 3,500 m3 storage volume within private property.	B
4	Grand Marais Drain	ROAD-S3	Chrysler Centre Underground Stormwater Management Facility and Storm Sewer Improvements	Installation of approx. 600 m of storm sewer along Chrysler Centre between Tecumseh Rd. E. and Grand Marais Rd. E. to a proposed underground stormwater management facility within private property, providing approx. 11,000 m3.	B
5	Grand Marais Drain	STM-S7	Regional Area 7 (Central Ave. and Pillette Rd.) Stormwater Management Pond and Storm Sewer Improvements	Installation of approx. 1,200 m of storm sewer along Pillette Rd., Central Ave., Grand Marais Rd. E. Tourangeau Rd., and Bernard Rd., to the existing Central Ave. SWM Pond. This includes the expansion of the Central Ave. pond within private property areas.	B
6	Cahill Drain	STM-S8	Regional Area 8 Surface Flooding Risk Reduction	Lowering the normal water levels in Lake Laguna, Lake Grande, and Lake Como coupled with complete downspout disconnection of all properties within the drainage area.	A+

Table 6-37: Summary of Preferred Alternatives - East Sewershed Drainage Area

Project No.	Sub-Drainage Area	Project Code	Project Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
1	East	SAN-E	East Windsor Basement Flood Risk Reduction Sanitary Sewer Improvements and LRPCP Improved Bypass	Improve conveyance and storage capacity of the East Windsor sanitary system by constructing approximately 47 km of new sanitary sewers (450 mm to 2,700 mm diameter) and box culverts (2.4 m by 4.2 m). Area-wide source control measures such as foundation drain disconnection are also required for this solution. Construction of a pump station adjacent to the existing Pontiac Pump Station to improve the wet weather bypass at the Little River Pollution Control Plant.	A+ (sanitary sewers) C (LRPCP Bypass)
2	Detroit River	STM-E1	Regional Areas 1 & 2 (Riverside Area) -St. Paul. Drainage Area Storm Sewer and Pump Station Improvements	Installation of storm trunk sewers on Belleperche Pl., Clairview Ave., and a proposed easement through Kiwanis Park.	B
3	Detroit River	STM-E1	Regional Areas 1 & 2 (Riverside Area) - St. Rose Ave. Drainage Area Storm Sewer and Pump Station Improvements	Installation of storm trunk sewers along Riverside Dr. E., St. Rose Ave., Wyandotte St. E., Janisse Dr., Ontario St., and St. Mary's Blvd.	B
4	Detroit River	PS-E1-PAUL	St. Paul PS Improvements	Expansion eastwards of the existing PS, new outfall at the Detroit River from the expansion, and backup generators.	B
5	Detroit River	PS-E1-ROSE	St. Rose Ave. PS Improvements	Construction of a new 13.5 m^3/s PS within the St. Rose Park lands including a new outfall and a backup power generator.	C
6	Detroit River	PS-E1-FORD	Ford Blvd. PS Upgrades	Upgrade capacity of the existing PS within the existing wet well, include controls, monitoring equipment and backup power generator.	A+
7	Little River/ Detroit River	STM-E3	Regional Areas 3 & 4 (East Windsor/ Fountainbleu Area) - Storm Sewer Improvements	Separation of sewers in the Regional Areas 3 and 4 (between Pillette Rd., and Jefferson Blvd., south of South National St., and north of the E.C.ROW Expressway). This includes the installation of approximately 9,500 m of large trunk storm sewers and culverts.	B
8	Little River	ROAD-E4	Lauzon Parkway Storm Sewer Improvements Underground	Installation of large storm culverts on Lauzon Pkwy. including the grading improvements within the municipal right-of-way.	B

Project No.	Sub-Drainage Area	Project Code	Project Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
9	Little River	ROAD-E4	Lauzon Parkway Surface Storage Swales	Installation of 500 m of surface storage swale located within private property are, west of Lauzon Pkwy., between Cantelon Dr. and Hawthorne Dr.	B
10	Little River	ROAD-E4	Meadowbrook Park Underground Stormwater Management Facility	Installation of an underground stormwater management facility within the park lands, west of Meadowbrook Lane.	B
11	Little River	ROAD-E4	Little River Golf Course Stormwater Management Pond	Installation of stormwater management pond within the Little River Golf Course.	B
12	Little River	ROAD-E11	Roseville Garden Underground Stormwater Management Facility and Storm Sewer Improvements	Installation of approx. 700 m of storm sewers and culverts along Roseville Garden Dr., as well as an underground stormwater storage facility under Roseville Park and Roseville Public School's green space.	B
13	Blue Heron/Lakeview PS	ROAD-E10	Banwell Surface Flooding Risk Reduction	Installation of approx. 1,800 m of storm sewers and 500 m of box culvert along Banwell Rd.	A+
14	Blue Heron/Lakeview PS	ROAD-E7	McHugh Surface Flooding Risk Reduction	Installation of approx. 530 m of storm sewers and 530 m of box culvert along McHugh St.	A+
15	Blue Heron/Lakeview PS	ROAD-E8	McNorton Surface Flooding Risk Reduction	Installation of approx. 600 m of storm sewers and 600 m of box culvert along McNorton St.	A+
16	Little River	ROAD-E6	McHugh St. Storm Sewer at Darfield Dr.	Installation of 500 m of new box culverts and regrading of 350 m of McHugh St.	A+
17	Blue Heron/Lakeview PS	STM-E5	Regional Area 5 (Blue Heron Pond Area) PS and Storm Sewer Outlet Improvements	Improve the Lakeview pump station at South Rendezvous Park and upgrade the existing outlet to Lake St. Clair.	B
18	Blue Heron/Lakeview PS	STM-E5	Regional Area 5 (Blue Heron Pond) Storm Sewer Improvements	Installation of storm sewer improvements on Morningstar Ave., Venetian Ave. and Katella Ave.	A+
19	Pontiac PS	STM-E6	Regional Area 6 Surface Flooding Risk Reduction	Installation of a storm sewer along Cedarview Dr., and new stormwater pond in Brumpton Park.	B

Project No.	Sub-Drainage Area	Project Code	Project Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
20	Pontiac PS	STM-E6	Regional Area 6 Surface Flooding Risk Reduction	New storm sewers required to redirect drainage south of Ganatchio Trail Berm from East Marsh PS to Pontiac PS in conjunction with East Marsh PS improvements which include upgraded s (no change in capacity) and installation of backup generators.	B
21	Pontiac PS	ROAD-E9	Wyandotte at Watson Underground Storage Facility	Construction of two stormwater surcharge features (either pond or underground), requiring property acquisition.	C
22	Detroit River	ROAD-E2	Jefferson Blvd. and Raymond Ave. Storm Sewer	Installation of approx. 1,100 m of storm sewers along Jefferson Blvd., Raymond Ave. and within David Suzuki Easement.	A+

Note: All storm sewer improvements recommended within the East Windsor area include the implementation of LIDs. The type and suitability of LIDs shall be reviewed prior to detailed design for all of these solutions.

Table 6-38: Summary of Preferred Alternatives – Riverside Dr. E. Landform Barrier

Sub-Drainage Area	Alternative Code	Area	Alternative Name	Description	Proposed Class EA Schedule Level (A, A+ ,B , C)
Riverside Dr. E. and East Riverside Coastal Flooding Risk Area	BERM-E1	Area 1	Area 1 Riverside Dr. E. (Ford Blvd to St. Rose Ave) – Landform Barrier and Backflow Prevention	Construct a landform barrier (earth berm) within applicable low lying private property areas along the north Riverside Dr. E. boulevard. Construction of a storm sewer to provide local storm sewer drainage. Installation of backflow prevention devices within the storm sewers system.	B
Riverside Dr. E. and East Riverside Coastal Flooding Risk Area	BERM-E2	Area 2	Area 2 Riverside Dr. E. (St. Rose to Riverdale Ave) – Landform Barrier and Backflow Prevention	Construct a landform barrier (earth berm) within applicable low lying private property areas along the north of Riverside Dr. E. boulevard, between St. Rose Ave. and Frank Ave., and south of Riverside Dr. E. between Frank Ave. and Riverdale Ave. Installation of backflow prevention devices within the storm sewers system.	B
Riverside Dr. E. and East Riverside Coastal Flooding Risk Area	BERM-E3	Area 3	Area 3 Riverside Dr. E. (Riverdale Ave. to East City Limits) – Landform Barrier and Backflow Prevention	The build-up of the existing landform barrier (earth berm) (Ganatchio Trail) along the south boulevard of Riverside Dr. E. between Riverdale Ave. and the east City Limits. Installation of backflow prevention devices within the storm sewers system.	B

6.8 Functional Design

During detailed design of the functional design solutions outlined within this study, it is recommended that the following design considerations be included:

- All applicable storm system improvement projects within the Turkey Creek and Little River watersheds shall be re-evaluated once the findings and recommendations of the Turkey Creek Watershed Study (Study to be initiated) and the Little River Floodplain Mapping study (Dillon, Ongoing) are finalized. Prior to detailed design, outlet conditions shall be confirmed and necessary mitigation measures required to confirm solutions do not have downstream impacts to these exiting watercourses shall be incorporated;
- Further geotechnical assessments;
- Erosion and coastal assessment surrounding areas of pump station and outlet improvements;
- Erosion and sediment control plans;
- Water management plan during construction of in-water works at pump station outfalls;
- Further archaeological investigation, as required, for submission to the Ministry of Tourism, Culture and Sport (MTCS);
- Additional natural environment investigations, if required in support of permits/approvals from MECP;
- Potential requirements for water quality control for any of the recommended solutions involving upgrades to the storm sewer infrastructure where roadways are being reconstructed from semi-urban cross sections to fully urban roadway cross sections as directed by the MECP during the Environmental Compliance Process;
- Obtain permits from appropriate agencies as required; and
- Use of Low Impact Development techniques.

6.9 Ultimate Condition Results

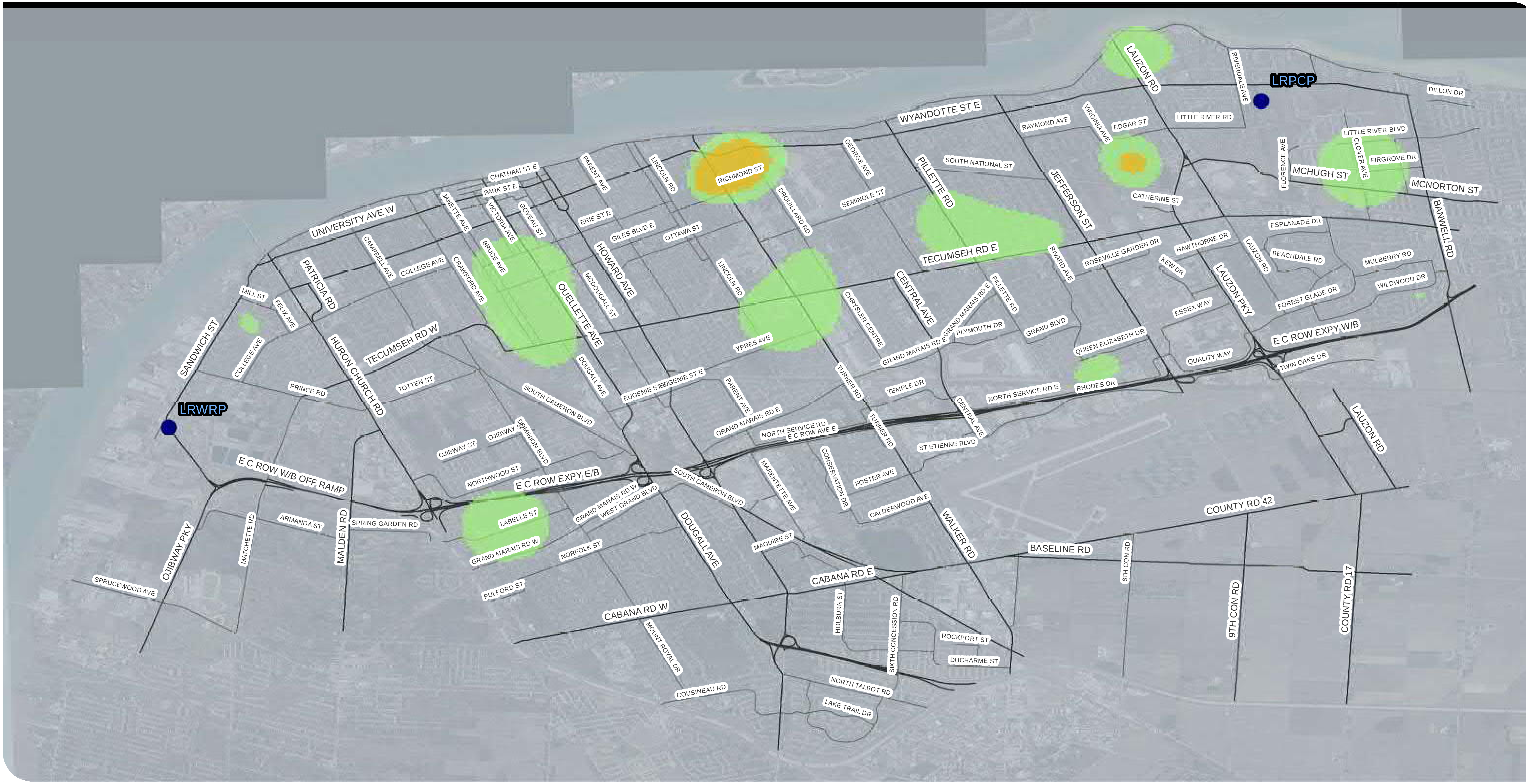
Using the sewer model, the HGL conditions under ultimate conditions was assessed to demonstration benefit of these short-term and long-term public and private solutions will have on the risk of flooding. Ultimate conditions assumes the following:

- All private property and public infrastructure improvements are implemented;

- Over time as developments were constructed that developments met the flood mitigation design standards and best management practices included in this report;
- Operation and maintenance practices have been maintained; and
- Lake St. Clair and Detroit River high water levels have not exceeded the HWL of 176.45 meters above sea level (masl).

The HGL depth for the entire City has been mapped to highlight areas at risk of basement flooding under ultimate conditions (see **Figure 6-43**). This map shows lowering of the HGL city wide for all storm events (1:5 year, 1:25 and 1:100 year), which represents an overall reduction to basement flooding risks.

Surface flooding depths have also reduced significantly under ultimate conditions. **Figure 6-45** shows the surface flooding depths during a 1:100 year storm (85 mm rainfall over 4 hours) where the red areas represent areas where the flooding is more than 0.3 m (1 ft) in depth. **Figure 6-46** shows the surface flood risk areas under a climate Change Storm (120 mm rainfall over 4 hours). For local roads and areas where surface flooding is greater than 0.3 m (1ft) under ultimate conditions should be looked at when the City completes restoration of sewer work in the area. Local flood mitigation measures and emergency access conditions need to be reviewed and minimum ERCA and City standards shall be met.



CITY OF WINDSOR
SEWER MASTER PLAN

Basement Flood Risk – Ultimate Conditions
Figure 6-44

HIGH POTENTIAL RISK OF BASEMENT FLOODING UNDER 1:5 YEAR STORM
HIGH POTENTIAL RISK OF BASEMENT FLOODING UNDER 1:25 YEAR STORM
HIGH POTENTIAL RISK OF BASEMENT FLOODING UNDER 1:100 YEAR STORM

THE CITY OF WINDSOR

DILLON CONSULTING

Aquafor Beech

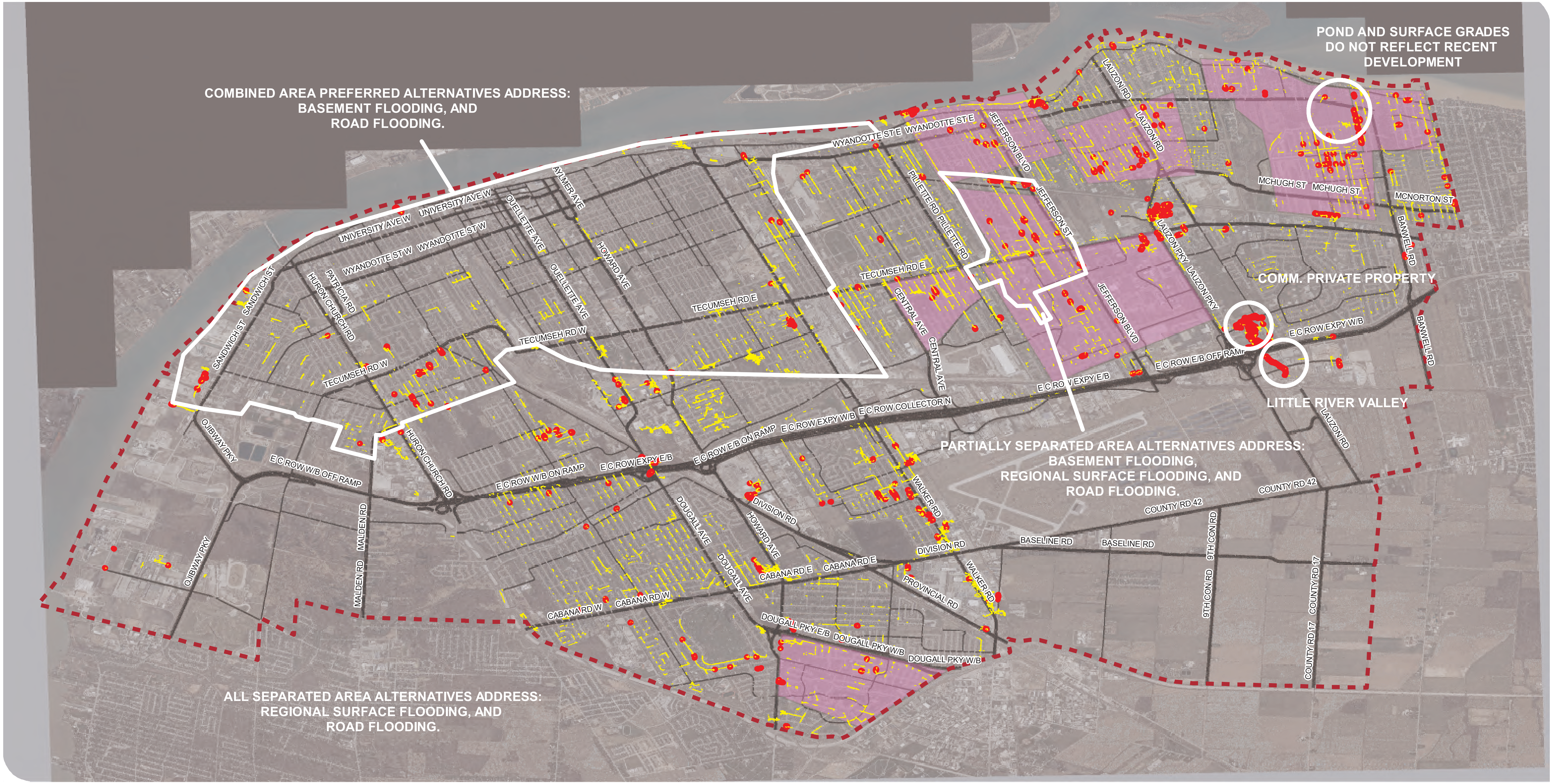
MAP CREATED BY: IDW
MAP CHECKED BY: LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:60,000

2

PROJECT: 17-6638 STATUS: FINAL DATE: November 2020

Page is intentionally blank.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Surface Flood Risk – Ultimate Conditions – 1:100 Year Storm

FIGURE 6-45

EXPRESSWAY AND ARTERIAL ROADS	CLASS 1 AND 2 COLLECTOR ROADS
STUDY AREA	REGIONAL SURFACE FLOODING AREA
SURFACE FLOODING DEPTH LESS THAN 0.30 m (1.0 ft)	SURFACE FLOODING DEPTH MORE THAN 0.30 m (1.0 ft)

NOTES:

Red areas are exaggerated to primarily show surface flooding at low points in roadways, ditches, parking lots, and existing open space and lands under development

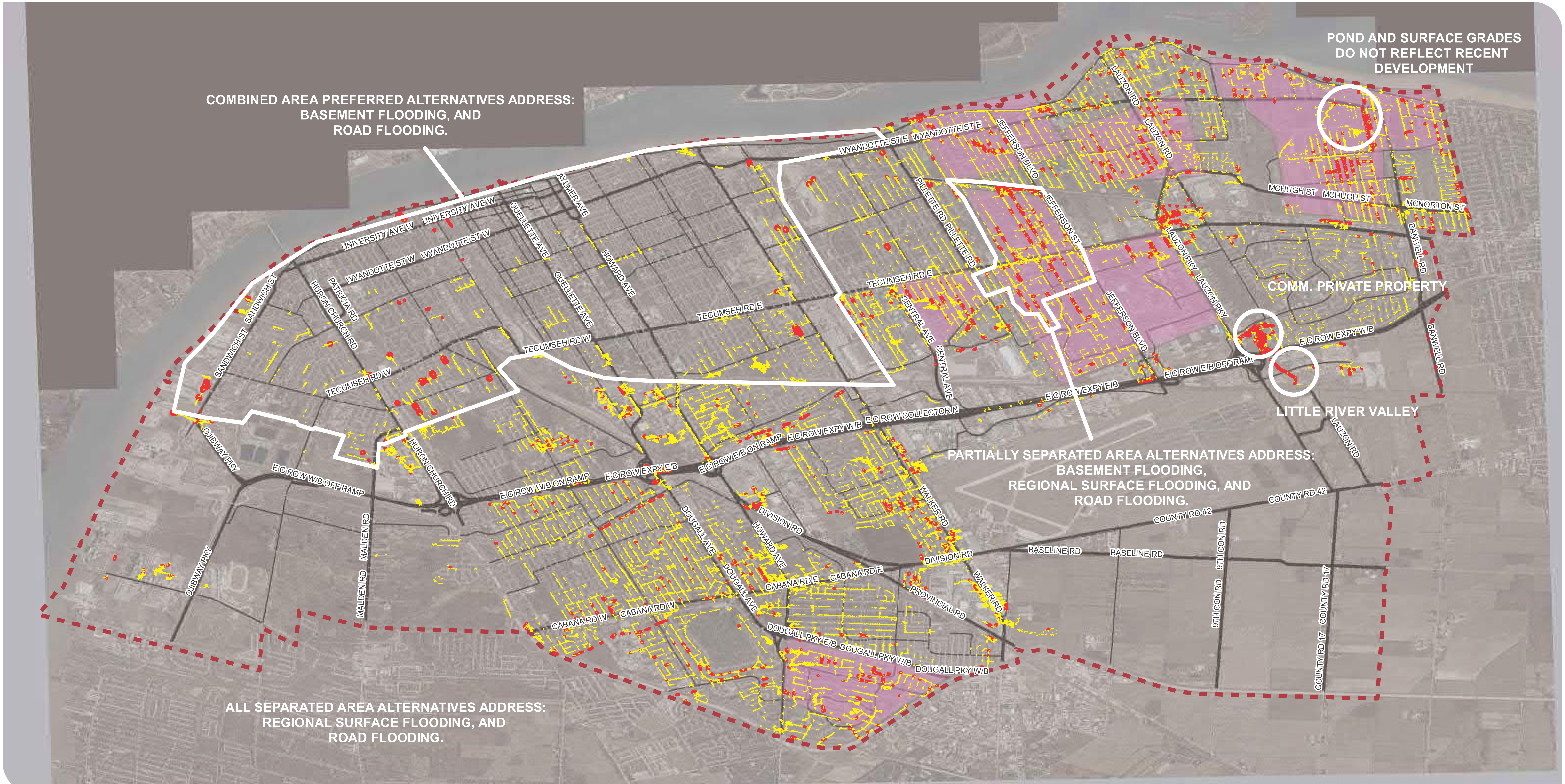
MAP DRAWING INFORMATION:
PROBLEM AREAS BASED ON DATA PROVIDED BY CITY OF WINDSOR

MAP CREATED BY: SD/IDW
MAP CHECKED BY: DEM/LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:60,000

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.



CITY OF WINDSOR

SEWER AND COASTAL FLOOD PROTECTION MASTER PLAN

Surface Flood Risk – Ultimate Conditions – Climate Change Storm

FIGURE 6-46

EXPRESSWAY AND ARTERIAL ROADS	CLASS 1 AND 2 COLLECTOR ROADS
STUDY AREA	REGIONAL SURFACE FLOODING AREA
SURFACE FLOODING DEPTH LESS THAN 0.30 m (1.0 ft)	SURFACE FLOODING DEPTH MORE THAN 0.30 m (1.0 ft)

NOTES:

Red areas have been exaggerated to primarily show surface flooding at low points in roadways, ditches, parking lots, and existing open space and lands under development

MAP DRAWING INFORMATION:
PROBLEM AREAS BASED ON DATA PROVIDED BY THE CITY OF WINDSOR

MAP CREATED BY: SD
MAP CHECKED BY: DEM/LMH
MAP PROJECTION: NAD 1983 UTM Zone 17N

SCALE 1:60,000

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

7.0 Implementation Considerations

7.1 Effects and Mitigation

Overall implementation of the recommended infrastructure improvements will result in an improvement over existing conditions and a reduction in surface and basement flooding. However, implementation of some of the recommended improvements will involve construction which, depending on the location and nature of the improvement, can result in permanent changes to some existing conditions and/or temporary construction impacts.

The City of Windsor is committed to implementing mitigation where appropriate and practical, in order to reduce negative effects associated with the recommended solutions. **Table 7-1** highlights the potential effects that could occur as a result of implementing the suite of recommended solutions, and the mitigation that is proposed. The specific potential effects and proposed mitigation identified for the 24 Schedule B projects which have been recommended in this MP is included in **Appendix G**. It is noted that recommended improvements identified as Schedule C projects will undergo further study and additional potential effects and proposed mitigation may be identified.

An environmental monitoring program will be established with the following objectives in mind:

- To assess water quality prior to discharge to the municipal drains or flood control facilities;
- To provide an early indication of any potential impairment or adverse effects on the on-site and off-site environments; and,
- To trigger and monitor the implementation of contingency measures as required.

7.1.1 Potential Natural Environment Impacts and Proposed Mitigation

Many of the recommended improvements for this project involve subsurface infrastructure. These improvements could involve temporary construction impacts. These improvements are typically within existing rights-of-way and while there could be temporary construction impacts, permanent displacement of natural features is not anticipated. Recommended infrastructure such as pumping stations, underground stormwater storage facilities, stormwater ponds, new outlets and the landform barrier for coastal flooding protection could displace natural features depending on their locations.

In consultation with the MNRF, comprehensive field investigations were completed within the Study Areas in order to document the existing natural environment conditions. Once the existing natural environment conditions and the preferred alternatives were known, potential biological effects were assessed for the construction and operational phases based on the preferred alternatives. **Appendix H** includes the results of the natural environmental assessment.

7.1.1.1 Terrestrial

Records of natural heritage features and species occurrences were identified for the Project Locations during the background review. Based on field investigations conducted on November 20, 29, 2019, January 28, 29, March 6, and 10, 2020, several of these features were confirmed to be present within the Project Locations. In general, the Project Locations contain a mix of cultural and natural Ecological Land Classification communities, with the latter consisting of relatively small areas within some Project Locations. There is potential for the Project Locations to provide wildlife habitat, including habitat for 31 Species of Conservation Concern, 18 SAR, and 6 candidate Significant Wildlife Habitats. However, considering the current land uses within and adjacent to the Project Locations (i.e. predominately Green Lands, Residential, and Commercial and Institutional lands), as well as the proposed works, the results of the background review and field investigations suggest that the proposed activities have a low likelihood of impacting terrestrial SAR and/or SAR habitat.

The landform barrier that is parallel to Riverside Dr. E., will require select, landscape trees to be removed. While no SAR and/or SAR habitat is expected to be negatively impacted, we recommend a qualified biologist conduct a wildlife sweep of this area at least 48 hours prior to the proposed works to ensure no nesting wildlife, SAR, and/or SAR habitat will be negatively impacted.

Depending on the specific proposed project and its potential implications it is recommended that the City consulted with MECP to confirm whether additional field investigations are required and/or whether permitting and approvals under the ESA will be required in support of the Project.

7.1.1.2 Aquatic

Some of the recommended projects involve construction of new outfalls which could require construction within watercourses with potential impact on aquatic habitat. Other projects could be in proximity to waterbodies requiring effort to minimize potential for erosion and sediment entering the watercourse or water quality concerns associated with construction.

There are five watercourse/waterbody features associated with the Project Locations, including the Detroit River, Lake St. Clair, McKee Creek, Little River, Central Pond/Grand Marais Drain and Southwood Lakes SWM Ponds. The Detroit River, Lake St Clair, McKee Creek and Little River sites provide suitable conditions to support direct fish habitat, while the Central Pond and Southwood Lakes sites are associated with SWM ponds that do not appear to be directly connected to fish habitat. There is potential for Significant Wildlife Habitat, Species of Conservation Concern and Species at risk within the Detroit River, Little River and Lake St. Clair, including the Northern Madtom and Eastern Sand Darter, protected by the Species at Risk Act (SARA).

The majority of potential impacts can generally be avoided through mitigation measures including, but not limited to, adherence to in-water timing windows for construction, site isolation and erosion and sediment controls. It is recommended that site specific data requests be submitted to DFO and if deemed necessary further field investigations be completed during detailed design to assist in confirming if significant habitat is present. Furthermore given the potential impacts of the of some of the individual projects to aquatic SAR and the potential for Harmful Alteration, Disruption or Destruction (HADD) of fish habitat, as defined by the Fisheries Act, it is anticipated that a “Request for Review” will need to be submitted to DFO for several Project Locations to determine if Fisheries Act Authorizations (or SARA permit applications) are required to be submitted. Preliminary design drawings would need to form part of the submission packages.

7.1.2 Potential Socio-Cultural Environment Impacts and Proposed Mitigation

Archaeology

A Stage 1 Background Study for the WSMP reviewed, in detail, proposed solutions in the Central Windsor Sewershed, East Windsor Sewershed, South Windsor Sewershed, and the Riverside Dr. Vista Phase 2A and Riverside Landform Barrier. Based on this work, a

Stage 2 Archaeological Assessment has been recommended for many of the recommended projects. Specific information and recommendations for each of the project locations is included in **Appendix I**. Where a Stage 2 Archaeological Assessment is identified as required, this work must be completed prior to construction and clearance provided by the Ministry of Heritage, Sport, Tourism and Culture Industries. Should any archaeological resources be discovered during construction for any of the recommended projects work will stop immediately and the appropriate authorities will be contacted.

Residents & Community

Residents and business owners will experience the positive impact of reduced surface and basement flooding over time as the MP projects are implemented. Despite this overall benefit, neighbours of recommended projects could experience temporary disruption impacts associated with construction such as noise, dust and traffic/access disruption. The City will work with local residents and businesses as it does with all construction projects to minimize disruptions where possible. This will include adhering to the City of Windsor noise by-law; providing notice in advance of construction, particularly if there could be impacts to driveways and access; and providing a contact information for members of the community to register complaints. Recommended projects that are within road rights of way could also have an impact on traffic flow. The City will schedule construction to minimize traffic impacts where possible and will use appropriate traffic management procedures and signage.

The implementation of some projects such as the pumping stations and stormwater facilities could result in changes to the landscape, waterfront recreational opportunities and scenic views. To minimize impacts for the pumping stations in particular, the City will liaise with the local community during detailed design to provide opportunity for community input on the aesthetics of the building and associated landscaping to integrate the facilities into the existing character of the area to the extent possible. This will be particularly important for the waterfront facilities recognizing the importance of the waterfront as a visual and recreational resource in the community. Noise and vibration could also be a concern for those who live in the immediate vicinity of the proposed pumping stations. The MECP establishes noise limits for facilities, such as pumping stations, and during detailed design the City will complete necessary studies and design work to ensure that the pumping stations are within these limits and do not result in vibration effects for neighbouring properties. As noted, for projects identified as a

Schedule C project, such as the St. Rose Pumping Station (PS-E1-ROSE), further work is required including additional consideration for potential effects and the development of site specific mitigation measures which will consider the feedback received from the public.

Some of the recommended projects, particularly the stormwater ponds and landform barrier will require property purchase or easements. During the development of the MP, the City has reached out to many of the property owners who may be directly affected by one of the projects. Liaison with property owners will continue during the detailed design of individual projects and the City will work to come to an amicable property purchase or easement agreement based on fair market value.

Some of the recommended projects will also be located in existing park space. The City will minimize the impact on parks through design to the extent possible. For surface facilities, landscaping will be put in place to help compensate for the impact of removing available park space. Construction of improvements under parks will result in temporary disturbance for park users. Construction timing will be reduced to the extent possible to minimize the length of the disturbance and park features will be restored upon completion of construction.

Table 7-1: Potential Effect and Mitigation Measures

Potential Effects	Mitigation
Terrestrial Environment	-
Some improvements may require the removal of a small amount of habitat.	The recommended solutions are located to minimize habitat disruption.
No removal of species-at-risk is anticipated as a result of the proposed improvements.	The City will consulted with MECP as necessary to confirm whether additional field investigations are required and/or whether permitting and approvals under the ESA will be required in support of the Project.

Potential Effects	Mitigation
Some tree removal may be required	Tree removal will be minimized. Trees in the vicinity of construction areas will be protected and any trees that require removal will be replaced.
Tree removal associated with the landform barrier has the potential to impact individual SAR bats and impact nesting wildlife.	A wildlife sweep of this area at least 48 hours prior to the proposed works to ensure no nesting wildlife, SAR, and/or SAR habitat will be negatively impacted.
Aquatic Environment	-
Improvements that involve changes to existing outfalls or the construction of new outfalls could require in-water work.	Any in-water works will occur between July 1 & March 14 of any given year to protect sensitive life stages/process of resident fish. Staging of construction equipment, stockpiling of materials and refueling will take place away from watercourses.
Any construction within the Detroit River, Little River and Lake St. Clair has potential to impact Significant Wildlife Habitat, Species of Conservation Concern and Species at Risk.	The City will liaise with DFO to confirm if further field investigations are needed. The City will submit a "Request for Review" for specific projects as required to determine if Fisheries Act Authorizations (or SARA permit applications) are required to be submitted.
Other construction could be in proximity to watercourses.	The City will use erosion and sediment control measures appropriate to the construction such as silt fencing to reduce impacts of sediment in watercourses.

Potential Effects	Mitigation
Socio-Cultural Environment	-
Archaeological potential - Some cases the areas were identified as having some potential for archaeological resources.	Stage 2 assessments will be completed prior to construction where required. Should archaeological resources be discovered during construction, work will stop immediately and appropriate contacts will be made, including notifications to First Nations.
Built heritage – There are no anticipated effects on built heritage for any of the recommended solutions.	No mitigation necessary.
Construction related noise and dust – Construction can result in temporary noise and dust impacts that could be experienced by neighbours.	The City will adhere to noise by-laws, dust reduction measures will be implemented, and the City will notify neighbours of construction and provide a contact for any complaints.
Traffic – Construction within road rights-of-way has the potential to impact traffic.	The City will schedule construction to minimize traffic impacts where feasible. Appropriate traffic management procedures and signage will be put in place. Traffic detours will be implemented and emergency access will be maintained.
Property requirements – Construction of the landform barrier and some stormwater facilities will require property.	The City will continue to reduce property requirements during detailed design where possible and will purchase or negotiate easements for any property required at fair market value.

Potential Effects	Mitigation
Visual impact – Most of the recommended solutions will be constructed below the surface (e.g. new sewer pipes) or are anticipated to have minimal visual impact (e.g. SWM Ponds, sewers). The exception to this is the proposed pumping stations which will be constructed above grade.	The City will consult with neighbours during detailed design of the pumping stations to obtain community input on aesthetics.
Waterfront recreation – Recommended improvements that will add infrastructure along the waterfront have the potential to impact the communities use and enjoyment of the waterfront.	The City will reduce the size of any new above ground facilities to the extent possible and consultation with neighbours and the community will assist in developing an appropriate building and landscape aesthetic.
Park impacts – Some projects will be placed in parks. This could result in temporary disruption to park use during construction and displacement of park space for above ground facilities.	The City will keep construction periods as short as possible and park features will be restored after construction. Additional landscaping will be provided for above ground facilities in parks to compensate for the removal of park space.
Operational Noise – The operation of a pumping station has some potential to result in noise and vibration.	The City will design pump stations to meet MECP noise criteria and to minimize any potential for vibration impacts on neighbouring properties.

7.1.3 Source Water Protection

Necessary design considerations and risk assessments must be completed to mitigate impacts to source water resources in and around the recommended project areas. Due to the location of drinking water intakes along the Detroit River, Vulnerable Areas (Intake Protection Zones (IPZ)) are required to be protected to mitigate contamination risks to source water. The most current map of vulnerable areas can be found on the ERCA website at https://essexregionconservation.ca/. Many recommendations of this study are located within these the IPZ and Event based Areas (EBA) of the A.H Weeks's Water Treatment Plant.

In order to protect source water, projects must consider and follow polices described in the Essex Region Source Protection Plan (SPP), May 2019. **Table 7-2** below describes polices that are applicable to recommendations of this MP and how Polices shall be addressed when solutions are implemented.

Table 7-2: Essex Region Source Protection Plan (SPP) Implementation Considerations

Policy	Source Water Vulnerable Area	Threat	Measure	Policy Requirements	MP Implementation Considerations
1	Windsor IPZ-1	CSO	Prohibit	The City is prohibited to construct any new combined sewers within the IPZ-1 and IPZ-2 areas.	This study recommends the separation of existing combined sewers; therefore, meeting this requirement is not a concern.
4	Windsor IPZ-2	Stormwater discharge	Manage	All ECAs for stormwater management facilities within the IPZ-1 and IPZ-2 areas must adequately manage SWM to protect drinking water, including consideration of the MEPC 2003 SWMPD Manual.	As new stormwater facilities are designed, necessary design parameters and SWM management considerations will be met. All facilities will require approval through the MECP's Environment Compliance Approval Process.

Policy	Source Water Vulnerable Area	Threat	Measure	Policy Requirements	MP Implementation Considerations
5&6	Windsor IPZ-2	Industrial effluent	Prohibit/ Manage	Effluent from industrial uses shall be managed.	This requirements is not applicable to solutions recommended through this MP.
7	Windsor IPZ-2	Wastewater Bypass	Manage	Wastewater bypass within vulnerable zones must be managed according to policy requirements.	This policy is applicable to the recommendation to improve the existing bypass at the LRPCP. As required, necessary mitigation measures may be required. Approvals will be required for any alterations at this outlet.
12	Windsor IPZ-2	Application of untreated septage to land.	Prohibit	Activity shall not occur within vulnerable areas.	This policy is not applicable to recommendations of this MP.
31	Event Based Area	Handling and Storage of Fuel	Manage	Spill mitigation measures shall be applied for any fuel stored on site.	This is applicable to sites that have back up power generators. Design of fuel tank storage areas shall follow requirements of this policy.

Policy	Source Water Vulnerable Area	Threat	Measure	Policy Requirements	MP Implementation Considerations
34-37	Windsor IPZ-2	Sewage effluent	Specify Action	Any sources of sewage effluent discharge to vulnerable areas such as Combined Sewer Overflows (CSOs) or treatment plant bypasses. Solutions must consider how the proposed works either help the City of Windsor implement these policies or demonstration that they do not impede the City from implementing these policies.	Most recommendations of this MP will assist with meeting necessary policies by reducing risk of CSO and bypass events. Measures that are recommended in this report include sewer separation, I&I reduction for the combined/sanitary systems, and inline storage to temporary detain excess effluent. The following must be satisfied for all designs: • -All requirements of the OWRA (Ontario water resource Act) must be met and necessary MECP approvals must be obtained. • -Necessary testing and monitoring programs must be in place. • -Upstream system measures to manage

Policy	Source Water Vulnerable Area	Threat	Measure	Policy Requirements	MP Implementation Considerations
					CSOs or bypasses shall be implemented to reduce the volume and frequency of bypasses. Measures are a critical element for the recommended basement flood mitigation strategy laid out in this MP.

7.2 Private Property Easement / Property Acquisition

There are a number of solutions recommended in this MP that require the acquisition of property or an easement to accommodate new infrastructure. These locations have been identified and through the consultation process, additional notifications have been forwarded to property owners via notification letter. Mailed notices identified the potential for impact to property and included an offer to hold individual meetings with the project team. **Table 7-3** includes a list of private properties impacted and the description of outreach or discussions.

Table 7-3: Private Property Easement/Acquisition Consultation

Solution Code	Solutions Name	Property Acquisition Description	Consultation with Property Owner
STM-C1	Prince Rd. Storm sewer outlet at Chappelle St.	Require easement for storm sewer outlet to McKee Creek.	The City has contacted the property owner separate from this study. Notification letter sent Dec. 24, 2020. PIC Notification Letter sent Jan. 23, 2020.
ROAD-S1	Dougall Ave. Storm Sewer and SWM Pond Improvements	Property acquisition required for new surcharge surface SWM Pond on vacant land.	Notification letter sent Dec. 24, 2020. PIC Notification Letter sent Jan. 23, 2020.
ROAD-S2	Howard Ave. Storm Sewer and SWM Pond Improvements	New surcharge surface SWM Pond requiring property acquisition and demo of existing building.	Notification letter sent Dec. 24, 2020. PIC Notification Letter sent Jan. 23, 2020.

Solution Code	Solutions Name	Property Acquisition Description	Consultation with Property Owner
ROAD-S3	Chrysler Centre Storm Sewer and Underground Storage	Easement required within FAC Canada Parking Lot.	Notification letters sent Dec. 24, 2019. Meeting held Jan. 15, 2020.
STM-S7	Central Ave. SWM Pond Improvements	Expand the existing Central Ave. SWM Pond.	Ongoing coordination with property owner, including meeting May 19, 2020.
ROAD-E4	Lauzon Rd. LID Swales	Easement required for LID swales along the W side of Lauzon Pkwy.	Notification letters sent Dec. 24, 2019. Meeting held Jan. 15, 2020.
ROAD-E9	Wyandotte St. E. at Watson Ave. Underground Storage	Easement or property acquisition required to accommodate underground storage facility.	Notification letters sent Dec. 24, 2019. Meeting held Jan. 15, 2020.
ROAD-E11	Roseville Gardens Storm Sewer and Underground Storage	Easement required to accommodate underground storage facility within Roseville School Property.	Notification letters sent Dec. 24, 2019. Meeting held Feb. 5, 2020.

Solution Code	Solutions Name	Property Acquisition Description	Consultation with Property Owner
BERM-1/2/3	Riverside Dr. Landform Barrier (All areas)	Easement required for the landform barrier along Riverside Dr.	Notification Letter sent Oct. 16, 2019. Property owner open house meeting held on Oct. 30, 2019. PIC Letter sent Jan. 23, 2020.
BERM-2	Riverside Dr. Landform Barrier (Area 2)	Property acquisition required for the landform barrier along south side of Riverside Dr.	Notification Letter sent Oct.16, 2019. Meeting held Feb. 24, 2020. PIC Letter sent Jan. 23, 2020.
BERM-2	Riverside Dr. Landform Barrier (Area 2)	Property acquisition required for the landform barrier along south side of Riverside Dr.	Notification Letter sent Oct. 16, 2019. Meeting held Feb. 6, 2020. PIC Letter sent Jan. 23, 2020.

Note: Property owner information has been omitted in this table.

Records of consultation with property owner (Notification Letters, meeting minutes, and presentations) are included in **Appendix B**. Though detailed design of the storm and sanitary sewer infrastructure in coordination with full road reconstruction works, there may instances where easements or property acquisition is required to accommodate all proposed infrastructure within the Municipal ROW. These property needs will be reviewed prior to implementation and the City will liaise with impacted property owners at that time.

7.3 Park Land Impacts

Several projects are recommended to be completed in park designated lands. The direct impact to each park spaces varies as described in **Table 7-4**:

Table 7-4: Summary of Impacted City Owned Parks

Solution Code	Solutions Name	Park	Description of Park Impacts
STM-C3	Cameron Ave Trunk Sewer	Riverfront Park	New storm sewer to be constructed below park. Removal, reinstatement and restoration of park required to accommodate these works.
STM-C4	Bruce Ave Trunk Sewer	Riverfront Park	New storm sewer to be constructed below park. Removal, reinstatement and restoration of park required to accommodate these works.
STM-C5	Parent Ave. Trunk Sewer	Riverfront Park	New storm sewer to be constructed below park. Removal, reinstatement and restoration of park required to accommodate these works.
STM-C6	Ypres Ave Underground Stormwater Management Facility	Optimist Park	New facility to be constructed under the existing asphalt parking lot. Removal and restoration of parking lot required to accommodate these works.
STM-C8	Drouillard Rd Storm Pump Station	Cadillac Park	New Pump station foot print will impact the use of this park. Mitigation measures will need to be developed during the detailed design phase.

Solution Code	Solutions Name	Park	Description of Park Impacts
STM-E1	Regional Areas 1&2 Storm Sewer System Improvements	Kiwanis Park	New Belleperche Pl. trunk sewer will bisect existing park. This work will require the removal and reinstatement of existing park features.
STM-E1 PS-E-ROSE	St Rose Storm Pump Station	St. Rose Park	New Pump station foot print will impact the use of this park. Mitigation measures will need to be developed during the detailed design phase.
STM-E1 PS-E-PAUL	St Paul Storm Pump Station	St. Paul Park	New Pump station foot print will impact the use of this park. Mitigation measures will need to be developed during the detailed design phase.
STM-E1	Ford Blvd Storm Pump Station	Reaume Park	New Pump station foot print will impact the use of this park. Mitigation measures will need to be developed during the detailed design phase. Effects to park space is limited.
STM-E5	Regional Area 5 Surface Flooding Risk Reduction – Lakeview Park Pump Station Improvements	Lakeview Park	New Pump station foot print will impact the use of this park. Mitigation measures will need to be developed during the detailed design phase.
STM-E6	Regional Area 6 Surface Flooding Risk Reduction – Brumpton Park Underground SMF	Brumpton Park	New undergrounds facility to be constructed under the existing grassed area. Removal and restoration of grassed field areas are required to accommodate these works.

Solution Code	Solutions Name	Park	Description of Park Impacts
ROAD-E5	Lauzon Pkwy. Surface Flooding Risk Reduction – Little River SWM Pond	Little River Golf Course	Construction of the SWM Pond will require the use of most of the Little River Golf Course Lands. Use for golf will no longer be possible; however, amenities to provide community benefit to this park can be incorporated into the design.
ROAD-E5	Lauzon Pkwy. Surface Flooding Risk Reduction - Meadowbrook Park Underground Stormwater management Facility	Meadowbroo k Park	New undergrounds facility to be constructed under the existing grassed area. Removal and restoration of grassed field areas are required to accommodate these works.

City Parks and Facilities Operations department shall be involved at the onsite of each of these projects and shall be provided the following:

- Detailed description of infrastructure planned and the respective affected area;
- Provide timeline for proposed improvements;
- Allocate costs to replace existing affected park amenities and provide additional amenities;
- Coordinate changes to the park into the Parks MP or other planning documents; and
- Include long term maintenance cost for parks as it relates to any new infrastructure.

7.4 Costing

Budgetary cost estimates where completed for recommendations of this study as described in the following sections.

7.4.1 Source Control and Private Property Solution Costs

Table 7-5 below summarizes the estimated costs for the recommended source control and private property flood mitigation measures that have been recommended through this study.

Table 7-5: Private Property Source Control Estimated Program Costs

Solution Component	Central Windsor	South Windsor	East Windsor	Estimated Cost (in Millions of Dollars)
Private Property Subsidy Programs:	-	-	-	-
City-wide Foundation Drain and Enhanced Private Property Improvement Program	$480M	$220M	$250M	$950M
City-wide Downspout Disconnection Program	$15M	$21M	$14M	$50M
Sub-Total	**$495M**	**$241M**	**$264M**	**$1,000M**

For foundation drain disconnection and downspout disconnection (private property measures), it is assumed that the City will develop mandatory programs requiring residents to complete these measures in keeping with the findings of this study. Costs assume that the City will provide financial assistance to property owners via subsidy programs, similar to the existing Basement Flood Protection Subsidy and Free Downspout Disconnection programs. Measures to provide source control or provide protection to Commercial, Institutional and/or Industrial properties were not investigated through this study; therefore, not included in these costs.

Table 7-6: Municipal Right-of-Way Source Control Estimated Costs

Solution Component	Central Windsor	South Windsor	East Windsor	Estimated Cost (in Millions of Dollars)
Public Infrastructure Improvements	-	-	-	-
Sanitary Manhole Sealing Program	N/A	$0.1M	$0.4M	$0.5M
Backflow Prevention Device Program Allowance	$4M	N/A	$4M	$8M
Sub-Total	**$4M**	**$0.1M**	**$4.4M**	**$8.5M**

The manhole sealing program cost represents the cost to complete the first round of manhole rain catcher retrofits for 733 manholes based on the recommendations of the Short-Term Solutions Recommendation Report, **Appendix C**. The balance of sanitary manholes may be sealed upon completion of road and sewer improvement works.

An allowance for the installation of backflow prevention devices within the Central and East Areas has been allotted to cover the cost for the installation of these devices at locations where high lake/river water levels can back up into the City's sewer system and where interconnections between the sanitary/combined sewer and storm sewer exist.

Additional short-term solutions such as the recommended Enhanced Educational Program and City Development Standards Update shall be developed by City administration and are not included in the project costs summarise in this report.

7.4.2 Sewer System Conveyance, Storage and Downstream Improvements

The recommended flooding infrastructure improvements outlined within this document have been designed to a level satisfying Approach 2 of the Master Planning process, in which all recommended flooding solutions are completed to a functional level of detail. The recommended solutions include pump station improvements, sanitary and storm sewer infrastructure improvements, outlet upgrades, localized storage solutions and treatment plant improvements. Cost estimates for all the proposed programs and infrastructure upgrades have been developed and are detailed in Technical Volume 3 report, **Appendix F**. The report includes a detailed list of costs per project, cost assumptions, estimation methodology and detailed itemized costs estimates summaries for each project.

The cost assumptions for all recommended improvements for each of the service area include the following:

- Construction cost estimates, including labour are based on 2020 unit prices and the accuracy of each estimate is +/- 10% and dependent on the timing of implementation;
- Construction cost estimates are Class D Estimates and a +30% contingency has been added;
- An allowance of 20% has been included for engineering, including design and site construction observation;
- Construction costs include full road reconstruction of the municipal right-of-way;
- Storm sewer improvements includes an allowance to implement Low Impact Development (LID) measures; and
- Construction costs exclude land acquisition, land appraisal, legal costs, and expropriation costs.

The following tables summarized the estimated costs per Sewershed area.

Table 7-7: Total Estimated Cost Summary for In-Line Sewers and Storage Facilities

Solution Component	Central Windsor	South Windsor	East Windsor	Estimated Cost (Millions of Dollars)
Basement Flooding Solutions - Sanitary System Improvements	$2,552M	$30M	$459M	$3,041M
Surface Flooding Solutions - Storm System Improvements	$352M	$158M	$373M	$883M
Sub-Total In-Line Sewer Improvements	**$2,904M**	**$188M**	**$832M**	**$3,924M**

Table 7-8: Total Estimated Cost Summary for Downstream Infrastructure Improvements

Solution Component	Estimated Cost (Millions of Dollars)
Lou Romano Water Reclamation Plant - Retention Treatment Basin (RTB)	$70.0M
Little River Pollution Control Plant - Improved Bypass at the Pontiac Pump Station	$5.1M
New or Upgraded Stormwater Pumping Stations	$43.5M
Sub-Total Downstream Improvements	**$115.5M**

Costs above does not include costs for the future expansion of the LRPCP. The timeframe and capacity of the LRPCP expansion shall be confirmed during future studies.

7.4.3 Coastal Flood Protection Improvements Costs

The following table summarizes the costs estimated for the landform barrier based on the Functional Design completed for the Coastal Flood Protection measures proposed along Riverside Dr. E.

Table 7-9: Landform Barrier Estimated Cost Summary

Area	Project Code	Project Description	Estimated Cost (Millions of Dollars)
Riverside Area 1	BERM-1-2	Riverside Dr. E.(Ford Blvd to St Rose Ave)	$3.9M
Riverside Area 1	BERM-2-1	Riverside Dr. E. (St Rose to Riverdale Ave)	$2.6M
Riverside Area 1	BERM-3-1	Riverside Dr. E. (Riverdale to East City Limits)	$2.9M
Sub-Total Coastal Flood Risk Mitigation	-	-	**$9.4M**

The following was assumed in the development of the above costs:

- Landform barrier estimates assume that the flood protection will be provided with an earth berm only.
- Costs for walls, partial walls or mechanical gate structures are excluded from this total.
- Costs for property acquisition, legal fees, and additional environmental site assessments are not included in the above costs.

7.4.4 Summary of Total Infrastructure Costs

The below **Table 7-10** Summarizes the total cost of the recommendations of this MP.

Table 7-10: Total Infrastructure Cost Summary

Solution Component	Total Estimated Cost (Millions of Dollars)
Source Control and Private Property Protection Measures	-
City-wide Foundation Drain and Enhanced Private Property Improvement Program	$950M
City-wide Downspout Disconnection Program	$50M
Sanitary Manhole Sealing Program	$0.5M
Backflow Prevention Device Program Allowance	$8M
Conveyance and Storage System Infrastructure Improvements:	-
Basement Flooding Solutions - Sanitary System Improvements	$3,041M
Surface Flooding Solutions - Storm System Improvements	$883M
Downstream Outlet Improvements:	-
Lou Romano Water Reclamation Plant - Retention Treatment Basin (RTB)	$70.0M
Little River Pollution Control Plant - Improved Bypass at the Pontiac Pump Station	$5.1M

Solution Component	Total Estimated Cost (Millions of Dollars)
New or Upgraded Stormwater Pumping Stations	$43.5M
Coastal Flood Protection Measures:	-
Landform Barrier and Backflow Prevention	$9.3M
Sub-Total	**$5,060.4M**

7.5 Implementation Plan and Project Prioritization

The City is now tasked with implementing the recommended solutions developed in this MP. To assist City administration with the planning and scheduling of long-term recommended projects, a prioritization list was developed. Due the scale and scope of the projects resulting from this MP, it is anticipated that implementation of the full MP will take more than 50 years; therefore, it is imperative to highlight projects that are higher priority; therefore, should be undertaken first. The acquisition of all necessary permits and meeting legislated requirements, is needed prior to construction.

Projects have been assigned High, Medium and Low priority level, based on a ranking matrix that used various criteria to comparatively evaluate projects that address the same type of flooding. As noted in the **Table 7-11**, for each criterion project would receive points based on how well they were able to address the criteria. For example, projects that are recommended to mitigate risk of surface flooding along roadways were ranked based on how each project scored on a number of prioritization ranking criteria for the type of flooding. Below is a list of the criteria that was applied using the methodology on how each were used for comparison. Projects that have already received funding through the City's capital works plan or through external funding resources have been identified as immediate solutions and were not included in this ranking. These immediate projects are listed in **Section 7.5.2** below.

Table 7-11: Priority Rating Criteria and Weighting

Prioritization Criteria	Methodology	Weighting
Level of Basement Flooding Risk	High priority is assigned to areas that have higher risk of basement flooding based on sewer model analysis. Higher priority will be assigned to areas that have a greater risk due to higher hydraulic grade line during a 1:5 year event.	x2
Reduction of wet weather flow to the Treatment Plant.	Priority is given to those solutions that reduce the volume and frequency of Combined Sewer Overflows (CSOs)	x2
Emergency Access for Vulnerable Areas	High priority is assigned to solutions that address surface flooding along roadways that are immediately adjacent to vulnerable land use sites, where alternative access routes are not available.	x2
Emergency Access for Major Roadways	High priority is assigned to solutions that address surface flooding along major arterial roadways that provide critical connections within the City's road network.	x2
Average Condition of combined sewers	High priority is assigned to solutions that coincide with the sewer life cycle replacement.	x1
Cost Effectiveness	Higher priority will be assigned to solutions that have the least cost per unit of benefit.	x1

The above listed criteria and weighting factors were developed and reviewed with the Technical Steering Committee and the SAC (Stakeholder Advisory Committee). Solutions that have also been assigned a double weighting “x2” represents the most significant criteria. Higher weighting was applied to criteria that related most directly with efficiency to mitigate flooding, water quality and emergency access.

It is recommended that the City continuously review and reevaluate the prioritization lists, summarized in the sub-sections below, especially as it relates to future climate change projections, and how identified solutions overlap with other capital projects or maintenance programs. As these projects would be constructed over a period of decades, the City will be seeking individual project approvals and permits, or where feasible, to bundle projects that are within the same construction period and area.

It is important to note that public infrastructure improvements are only one part of the comprehensive solution to mitigate flooding. Implementation of source control and private property protection measures are critical in achieving the established level of service. Continuous sewer system monitoring and modelling analysis will be required to confirm that the anticipated benefit is achieved; therefore; source control measures and associated monitoring programs are considered immediate solutions.

7.5.1 Project Prioritization Summaries

Table 7-12: Combined Sewer System - Central Windsor Sewershed Area

Priority Group	Drainage Area	Project Code	Project Description
High Priority	-	-	-
1	Cameron	STM-C3	Cameron St. Sewer and Drainage Area Enhanced Sewer Separation
2	Prince Rd.	STM-C1	Chappelle St. Outlet and Prince Rd. Drainage Area Enhanced Sewer Separation
Medium Priority	-	-	-
3	Wellington Ave.	N/A	Drainage Area Enhanced Sewer Separation
3	McDougall Ave.	N/A	Drainage Area Enhanced Sewer Separation
3	Langlois Ave.	STM-C5	Parent Ave. Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation
3	Lincoln Rd.	STM-C16	Lincoln Rd. Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation
4	Bruce Ave.	STM-C4	Bruce Ave. Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation

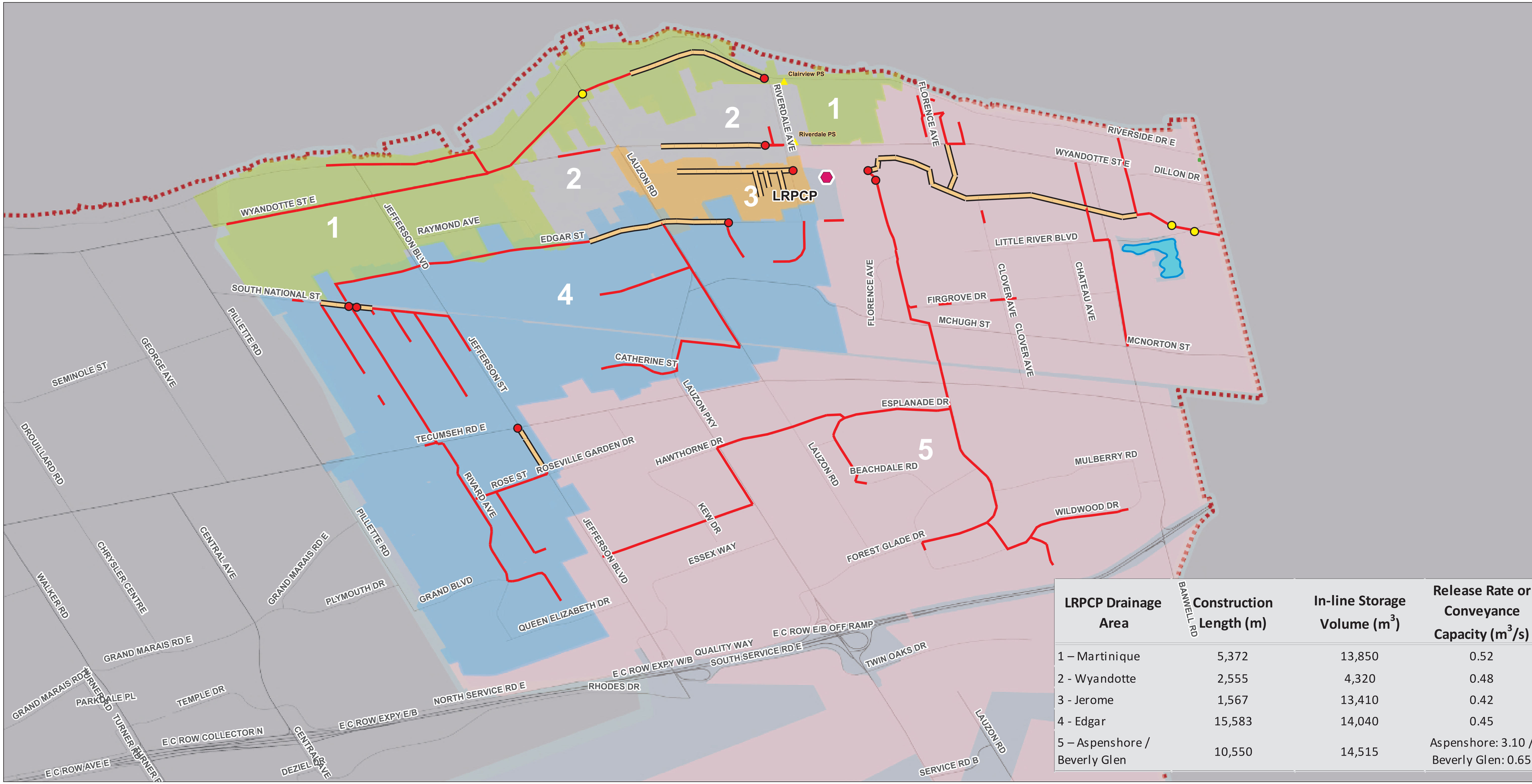
Priority Group	Drainage Area	Project Code	Project Description
4	Detroit St.	STM-C2	Detroit St. Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation
5	Partington Ave.	STM-C11	Partington Ave. Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation
Low Priority	-	-	-
6	Albert Rd.	STM-C7	Albert St. Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation
7	Dual MH Area, East of Albert	N/A	Drainage Area Enhanced Sewer Separation
7	Askin Ave.	N/A	Drainage Area Enhanced Sewer Separation
7	Felix Ave.	STM-C10	Felix Storm Trunk Sewer and Drainage Area Enhanced Sewer Separation

Table 7-13: Basement Flood Reduction Solutions - Separated System Prioritization

Priority Group	Area	Project Code	Project
High Priority	-	-	-
1	East	SAN-E-2	LRPCP Drainage Area 1 (Martinique Inlet)
Medium Priority	-	-	-
2	South	SAN-S-2	LRWRP Drainage Area 6 South Windsor
2	East	SAN-E-2	LRPCP Drainage Area 2 (Wyandotte Inlet)
2	East	SAN-E-2	LRPCP Drainage Area 4 (Edgar Inlet)
3	East	SAN-E-2	LRPCP Drainage Area 3 (Jerome Inlet)

Priority Group	Area	Project Code	Project
Low Priority	**-**	**-**	**-**
4	East	SAN-E-2	LRPCP Drainage Area 5 (East/South Inlet via Aspenshore and Beverly Glen)

Note: Refer to **Figure 7-1** for a map showing the drainage areas associated with the LRPCP, including associated numbering.



LRPCP Drainage Area	Construction Length (m)	In-line Storage Volume (m^3)	Release Rate or Conveyance Capacity (m^3/s)
1 – Martinique	5,372	13,850	0.52
2 - Wyandotte	2,555	4,320	0.48
3 - Jerome	1,567	13,410	0.42
4 - Edgar	15,583	14,040	0.45
5 – Aspenshore / Beverly Glen	10,550	14,515	Aspenshore: 3.10 / Beverly Glen: 0.65

CITY OF WINDSOR
SEWER AND COASTAL FLOODING PROTECTION MASTER PLAN

LRPCP Drainage Area Map

FIGURE 7-1

SEWAGE TREATMENT PLANT
EXPRESSWAY AND ARTERIAL ROADS
CLASS 1 AND 2 COLLECTOR ROADS
RAILWAY
STUDY AREA
TYPICAL DESIGN DETAIL #1
TYPICAL DESIGN DETAIL #3
SANITARY SEWER IMPROVEMENTS
SANITARY BOX CULVERTS
SANITARY PS

MAP CREATED BY: TBD
MAP CHECKED BY: TBD
MAP PROJECTION: NAD 1983 UTM Zone 17N

NOT TO SCALE

DUAL MANHOLE AREA
COMBINED SEWER AREA

PROJECT: 17-6638 STATUS: FINAL DATE: NOVEMBER 2020

Page is intentionally blank.

Table 7-14: Surface Flood Reduction Solutions - Regional Area Prioritization

Priority Group	Area	Project Code	Project
High Priority	-	-	-
1	East	STM-E1-2	Storm Problem Areas 1 and 2 (Riverside)
2	East	STM-E3-2	Storm Problem Area 3/4 (Fountainbleu and Lauzon)
Medium Priority	-	-	-
3	South	STM-S7-3	Storm Problem Area 7 Central/Pillette/ Grand Marais
4	South	STM-S8-2	Storm Problem Area 8 Southwood Lakes
Low Priority	-	-	-
5	East	STM-E5-1	Storm Problem Area 5 (Blue Heron SWM Pond)
6	East	STM-E6-2	Storm Problem Area 6 (Pontiac and East Marsh Drainage Area)

Table 7-15: Surface Flood Reduction Solutions - Major Road Prioritization

Priority Group	Area	Project Code	Project
High Priority - Long-Term Solutions	-	-	-
1	South	ROAD-S1-1	Dougall Pkwy. and Eugenie St. East
1	South	ROAD-S2-2	Howard Ave.
1	Central	STM-C14	Tecumseh Rd. W.
Medium Priority - Long-Term Solutions	-	-	-
2	East	ROAD-E8	Mc Norton, East of Banwell
2	East	ROAD-E11	Roseville School
2	Central	STM-C15	Giles Blvd.
3	East	ROAD-E6-3	Mc Hugh, East of Lauzon
3	East	ROAD-E2	Jefferson Blvd.
3	East	ROAD-E3 (STM-E3)	Jefferson Blvd. and South National
3	East	ROAD-E4-3	Lauzon Pkwy.
3	East	ROAD-E10	Banwell Ave.
3	Central	STM-C13	Huron Church Rd.
4	Central	STM-C16	Parent Ave.
4	East	ROAD-E5	Lauzon Rd.
4	Central	STM-C6	Ypres Ave.
Low Priority - Long-Term Solutions			
5	South	ROAD-S3-2	Chrysler Centre
5	East	ROAD-E7	Mc Hugh, West of Banwell Rd.
5	East	ROAD-E9-2	Wyandotte St. East at Watson St.
5	Central	STM-C8	Drouillard Rd.

Priority Group	Area	Project Code	Project
6	Central	STM-C9	College Ave.
6	Central	STM-C12	Patricia Rd.
6	Central	STM-C17	Lincoln Rd.
6	Central	STM-C18	Ontario St.
6	Central	STM-C19	Walker Rd.

Table 7-16: Coastal Flood Protection Solutions

Priority Group	Project Code	Project
High Priority - Long-Term Solutions	-	-
1	BERM-1-2	Area 1: Riverside Dr. E. East, Ford Blvd. to St. Rose. Ave. (To be constructed as part of the Riverside Vista Phase 2A Project)
2	BERM-2-1	Area 2: Riverside Dr. E. East, St. Rose Ave. to Riverdale Ave. and Backflow Prevention Measures.
3	BERM-3-1	Area 3: East Riverside Area, Riverdale Ave. to East City limits (Ganatchio Trail) and Backflow Prevention Measures.

7.5.2 Immediate Projects

The short-term solutions that have been identified are all recommended to be undertaken as soon as the City has the funds and staff available to complete. Also many of these recommendations can be integrated into many of City’s existing programs.

For long-term solutions, there are a number of solutions that are already planned to be completed as part of the City’s capital works sewer priorities or that have received or is pending funding from federal funding. Below is a summary of those projects and their current status.

Table 7-17: Immediate Project List

Project	Construction Timeline	Project Type/Source of Funding	System	Comments
Immediate Public Infrastructure Source Control Solutions:	-	-	-	-
Rain Catcher Installation - First Priority (1500 manholes)	2020	City Capital Works	Sanitary System	The remaining rain catchers shall be installed during identified road/sewer construction works, regular sewer maintenance and other regular annual program.
Monitoring Program for LID, Downspout and Foundation Drain Disconnection	2020-2021	City Capital Works	Storm/Sanitary	-
Pilot Projects - Downspout Disconnection, Foundation Drain Disconnection, and LID Measures	Ongoing	City Capital Works	Storm System	Pilot projects and monitoring to measure benefit of LIDs will be incorporated into the projects listed below that are being completed as part of the DMAF solutions.

Project	Construction Timeline	Project Type/Source of Funding	System	Comments
Immediate Infrastructure Projects:	-	-	-	-
Tranby Park Stormwater Improvements	Underway	DMAF	Storm System	-
Matthew Brady Phase 2	2019	DMAF	Storm System	-
Belle Isle View Phase 1	2019	DMAF	Storm System	-
Belle Isle View Phase 2	2020	DMAF	Storm System	-
Eastlawn Ave.	2021	DMAF	Storm System	-
East Marsh Pump Station Drainage Area - Menard, John M, Florence Reconstruction	2022	DMAF	Storm System	-
Riverside Dr. - Vista Phase 2A:	-	-	-	-
Storm Trunk Sewer Improvements	2023-2024	DMAF	Storm System	-
Sanitary Trunk Sewer Improvements	2022	DMAF	Sanitary System	-
Landform Barrier - Area 1	2022	DMAF	Coastal Flooding	-

Project	Construction Timeline	Project Type/Source of Funding	System	Comments
Matthew Brady Phase 3 Reconstruction	2022	DMAF	Storm System	-
East Marsh Pump Station Drainage Area - Clover Reconstruction	2023	DMAF	Storm System	-
East Marsh Pump Station Drainage Area - Elinor and Clairview Reconstruction	2024	DMAF	Storm System	-
St. Rose Ave. Pump Station Improvements	TBD	City Capital Works	Storm System	Timing to be confirmed based on available funding.
St. Rose Ave. storm and sanitary trunk storm sewers, between Riverside Dr. and Wyandotte St. E.	TBD	City Capital Works	Storm/Sanitary System	Timing to be confirmed based on available funding.
Little River Pollution Control Plant Overflow Improvements	2023	DMAF	Sanitary System	-
St. Paul Pump Station Improvements	2024	DMAF	Storm System	-
Cedarview Sewer Improvements	2024	DMAF	Storm System	-

Project	Construction Timeline	Project Type/Source of Funding	System	Comments
Brumpton Park Improvements	2027	DMAF	Storm System	-
Ford Pump Station Improvements	TBD	City Capital Works	Storm System	Timing to be confirmed based on available funding.
Belleperche Storm Trunk Sewer	2023-2025	DMAF	Storm System	-
East Marsh Pump Station Upgrades	2025	DMAF-1	Storm System	-
Lauzon Rd. Reconstruction	TBD	City Capital Works	Storm System	City to provide approximate timing. The City shall identify any other road reconstruction projects that may also overlap with recommended solutions.
Prince Rd. Storm Relief System - Chappell Ave. - West of Sandwich St. to McKee Creek (Detroit River Outlet)	TBD	City Capital Works	Combined System	This project has been identified as a Schedule C project; therefore, will require additional consultation and field assessments prior to construction.

Project	Construction Timeline	Project Type/Source of Funding	System	Comments
Dorchester Rd. - Prince Rd. to Huron Church Rd. Sewer Separation Improvements.	2024	City Capital Works	Combined System	Note: Projects listed on the City's sewer priority list that are not included in the current City Capital Work's Budget were excluded in this list and will be included in the High, Medium or Low categories.
Totten St. - Betts Ave. to East of Partington Rd. Sewer Separation Improvements	2026+	City Capital Works	Combined System	See above
Felix/Marlborough Sewer Separation Improvements	2025	City Capital Works	Combined System	See above
Ellis St. and Giles Blvd. - McDougall Ave. to Howard Ave. Sewer Separation Improvements	2026+	City Capital Works	Combined System	See above

As the City implements recommended projects, time and cost allowances should be included for pre-design studies or site assessments that may be required in advance of detailed design. These include, but are not limited to:

- Noise and Air Approvals;
- Source Water Protection Permits;
- Cultural Heritage Site Assessments;
- Terrestrial and Aquatic Natural Environment Assessments;

- Stage 2 Archaeological Assessments;
- Department of Fisheries and Oceans Pre-Assessment (DFO); and
- Environmental Compliance Approvals.

Schedule and cost allowances will also be required for necessary easement or property acquisition, a list of projects that require property are listed in Section 8.2.

8.0 Conclusions

The completed MP provides a well thought out suite of various recommended programs and projects that together will significantly reduce the City's vulnerability to flooding. As has been noted in the MP, climate change, more severe storms and high water levels are a significant concern in Windsor. This MP provides a guidebook to adapt to climate change by improving the resiliency of the City's infrastructure.

The complete MP package is large - totalling approximately $5 billion dollars, and will take a long time to fully implement - more than 50 years. Implementing the MP will require a partnership with the City and private property owners, each doing their part to reduce the effects of storm events and high water levels on the community. The short term solutions are focused on private property requiring homeowners to participate in subsidy programs and make improvements on their property to reduce the potential for water to enter basements and to reduce their contribution to sewer surcharge. The long term solutions are focused on capital infrastructure improvements requiring the City to fund and construct new sewers, stormwater ponds, underground storage facilities and pumping stations to manage rainwater, and a landform barrier to protect the community and storm system from higher water levels in the Detroit River and reduce spillover of overland flows to low lying residents north of Riverside Dr.

The recommended projects included in this MP were identified through the MCEA process which involves identifying problem areas, considering alternatives solutions, evaluating solutions using a set of criteria, and identifying solutions preferred for each problem area. The recommended solutions or projects were prioritized to develop an implementation plan. This MP document will serve as a resource that can be updated regularly to support implementation of the recommended projects. The full list of recommended programs and projects is included in Section 6.6 (short-term solutions) and Section 7.7.2 (list of long-term solutions).

8.1 Overview of MCEA Schedules

The Municipal Class Environmental Assessment (MCEA) process needs to be followed in order to meet the requirements of the *Environmental Assessment Act* (EA Act) to promote environmentally responsible decision-making, and ensure that interested persons have the opportunity of commenting on projects that may affect them. As a self-assessment process that is not legally required, but advised, MCEA allows the flexibility to plan and implement a range of projects without receiving EA approval for each project. It is a Municipality's tool for dealing with infrastructure projects, categorized according to their significance of environmental effects on the surrounding environment; broadly defined to include the natural, cultural, social, economic, and built environments.

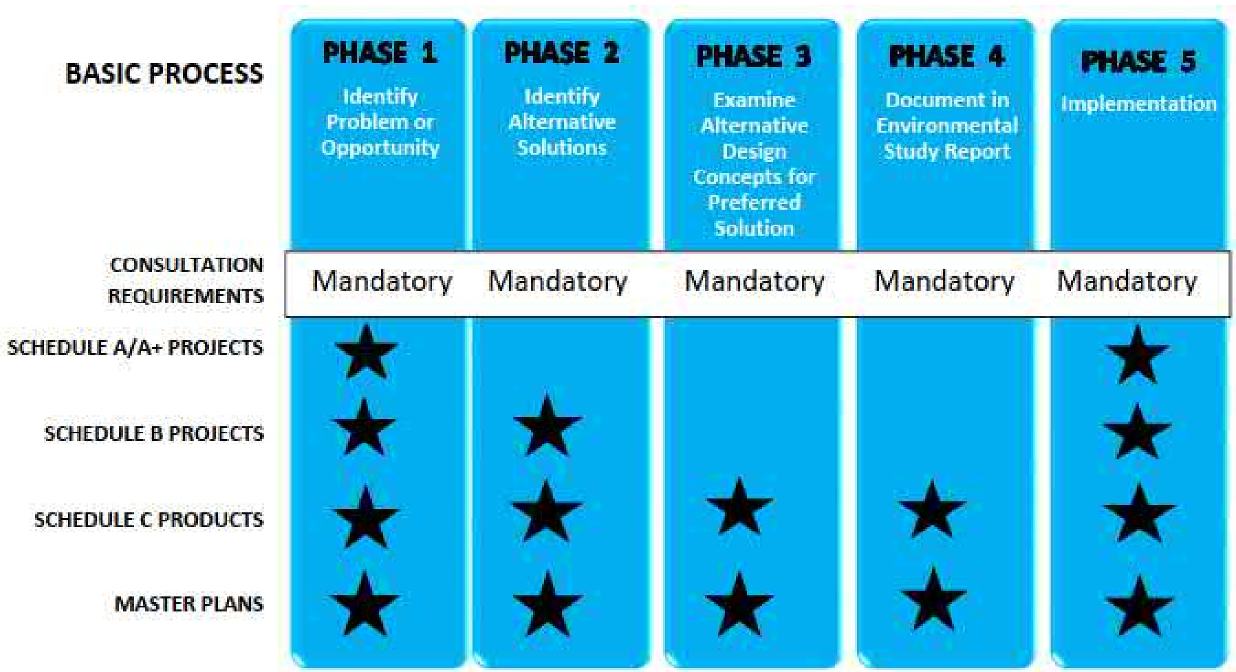


Figure 8-1: Municipal Class EA Overview of Project Schedule Levels

Key features of the MCEA's process is illustrated in the following figure:

> For some recommended projects, approvals under other legislation may be required (federal, provincial or municipal). For some of these projects, integration or coordination of the MCEA with other legislation or planning processes may be appropriate. This would avoid duplicating similar planning processes and address consultation and information requirements for both.

8.1.1 MCEA Proposed Revisions

Changes proposed in the next Municipal Class Environmental Assessment (MCEA) standard document with respect to Master Plans (MP) as posted on the Environmental Registry by the provincial government in July 2020, provide some indication of the potential effect on future projects. A brief listing of some of these proposed changes that may or may not affect the implementation of recommended projects of this particular MP include the following:

- No lapse of time limit on a MP; however, each Schedule ‘B’ or Schedule ‘C’ project must have current information (supporting data);
- MPs must be sent to the local MECP regional office for the purpose of tracking the completion of projects included in the MP;
- A notice of completion of the MP and each project must be submitted to the MECP;
- Schedule ‘A’ and ‘A+’ projects will be exempt from EA requirements;
- LID features will be added as Schedule ‘A+’;
- New SWM Ponds, outfalls, or tanks with no property acquisition shifts from Schedule ‘A’ to ‘A+’;
- New SWM Ponds, outfalls, or tanks requiring property acquisition will automatically be Schedule ‘B’;
- Construction/increase in capacity of wastewater pumping stations (PS) on an existing site will shift from Schedule ‘A’ or ‘B’ to Schedule ‘A+’;
- Expansion, refurbishment, or upgrade of sewage treatment plants (STP), including outfalls will shift from Schedule ‘B’ to ‘A+’ for up to 50% increase in capacity (permitted once in a 20-year time period);
- Water and wastewater infrastructure that will cross a watercourse using Trenchless Technology or to be supported from an existing bridge for water crossings, shifts from Schedule ‘B’ to ‘A+’;
- Any Schedule ‘B’ or ‘C’ work that is required to be completed due to an emergency situation, changes to Schedule ‘A+’ (with notification to the MECP director);
- A Record of Consultation will be required as part of an Environmental Study Report (SR);
- Construction of projects must commence within ten (10) years of the Notice of Completion filing of the MP; and
- The review of the draft MP report and the ESR by the government must be allotted one month for completion.

The revisions that are proposed are seen as practical changes that would ensure environmental protection while reducing delays and cost to communities, and eliminating duplication on projects. The overall effect of the major proposed amendments include:

exempting 28 project types that are considered to be low impact (e.g. modifications to traffic signals), where there is duplication with other processes, or the project types would be needed in cases of emergency; upgrading or downgrading assessment requirements for projects (e.g. shifting project schedules); removing cost thresholds for road projects; clarifying and modernizing current process requirements (e.g. removing the requirement to publish project notices in newspapers); and updating the requirements for transit projects to be more consistent with O. Reg. 231/08: Transit Projects and Metrolinx Undertakings under the Act and proposing additional exemptions.

The public commenting period ends August 22, 2020 at which time the MECP will review and consider all comments received during the comment period. Once approved, the amended Class EA will replace the existing 2015 version.

8.2 Mayor's 8-Point Plan Progress

The Mayor's 8-point plan to begin addressing flooding in the City began in November 2017. Since that time, there has been significant progress made on each of the Mayor's 8 Points Plan up to July 2020 as summarized below:

Point #1 - **Developing policies in conjunction with the Town of Tecumseh**: Annual meetings are held with the Towns of Tecumseh and Lakeshore in order to discuss future development in light of sewer system and coastal flooding issues, with a view of developing comprehensive development policies beneficial to each community.

Point #2 - **Basement Flooding Protection Subsidy**: To date (November 2020), 7,316 subsidy payments totalling $15,783,000 have been issued to subsidy applicants since the program's inception, for the purchase and installation of backflow valves and sump pumps.

Point #3 - **Disconnection of Weeping Tiles**: As part of the MP, priority areas for an initial pilot program have been identified, for the consideration of adding weeping tile disconnection to the existing subsidy program.

Point #4 - **Sewage Ejector Pumps**: As part of the MP, a policy requiring that new developments and new construction with basements be constructed with sewage ejector pumps as a means of reducing the risk of basement flooding is being recommended.

Point #5 – **Mandatory Downspout Disconnection**: A Council recommendation was passed to authorize City Administration to proceed with developing a mandatory downspout disconnection pilot program.

Point #6 – **Expedite Riverside Vista Project, Phase 2A**: Riverside Vista Project, Phase 2A, from Ford Blvd. to St. Rose Ave. is currently in the design phase. The City has been awarded grant funding in 2020 through the first Disaster Mitigation and Adaptation Fund (DMAF) for the trunk storm sewer work.

Point #7 & #8 – **Funding & MP**: To fully implement the recommendations contained in the MP is expensive. This MP provides a practical outline of recommendations using cost/benefit analysis that is achievable over time. As the recommended short-term and long-term solutions are implemented, incremental benefits to the system will be achieved and the risk of costly basement, surface and coastal flooding will be reduced. The next section outlines how the completion of the MP addressed initial objectives.

8.3 Master Plan Objectives/Problems (How Addressed)

The purpose of undertaking a MP was to identify specific problems and explore achievable measures to reduce the cascading risks and impacts of flooding by identifying and evaluating short-term and long-term solutions; with the aim of building a partnership between property owners and the City to address the issues identified in order to reduce risks and impacts on the sustainability of Windsor's environmental, social and economic well-being. Each of the following objectives were met:

- **Documented and characterized existing drainage and sewer conditions** within the City of Windsor focusing on factors that contributed to basement and surface flooding;
- Expanded the existing City-wide sewer model, including:
  - Development of surface/overland flow conveyance and storage with two-dimensional modelling using the City's LiDAR information; and
  - Incorporation of additional storm, sanitary and combined sewers to represent a greater portion of the existing sewer systems.
- **Collected additional flow monitoring and precipitation data** to further calibrate and confirm the validity of the City model;
- **Calibrated the expanded model** with flow monitoring data and flooding records from past wet weather events;
- **Completed model simulations assessing the problems,** including sewer hydraulic conveyance, surface ponding, and sanitary sewer wet-weather inflow and infiltration; and
- Developed recommended actions for short-term solutions to address basement and surface flooding.
- **Completed a comprehensive public and agency engagement program** following the Municipal Class Environmental Assessment Master Planning process, including collecting technical and non-technical stakeholders input;
- **Developed a framework for guidelines and criteria to guide the solutions** in coordination with the City, the MECP, and the Essex Region Conservation Authority (ERCA);
- Designed and modelled alternative solutions at a functional design level of detail;
- **Completed a desktop environmental inventory** as part of the evaluation of the alternative solutions and identification of mitigation strategies for the preferred solutions; and
- **Completed budgetary project cost estimates** to develop a long-term capital improvement program, including a recommended implementation strategy for City Council's consideration.

Table 8-1 summarizes how each of the identified problems and opportunities were addressed.

Table 8-1: Problems and Opportunities / How Addressed

Issue (Problem)	Opportunity	How Issue Was Addressed
Capacity - Issues of exceedances of flow capacity in storm, sanitary, and combined sewers.	The existing systems are not capable of providing an adequate level of service during wet weather flow conditions; leading to potential flooding damages and economic losses.	Sewer modelling identified deficiencies which can be addressed with future upgrading, replacing, or augmenting of the existing system within each Sewershed.
Public Health – Issues of nuisance, potential health risks, and environmental degradation.	The inability of the sanitary sewer system to handle excessive extraneous flows that result in backup of raw sewage into basements and by-passing of partially treated sewage flow to open bodies of water (surface water).	As the numerous short-term and long-term solutions are implemented, benefits to the system will be achieved and the potential health risks, environmental effects and nuisance issues will be reduced.
Overland Flow – Issues of surface water directed towards habitable structures.	Low or poor lot grading can lead to what otherwise would be considered normal roadway ponding; or excess ponding beyond normal conditions; being directed to habitable structures.	Modelling of surface ponding and flooding identified specific areas to focus stormwater management upgrades and installations. As the solutions are implemented, there will be less issues resulting from overland flow.

Issue (Problem)	Opportunity	How Issue Was Addressed
Transportation Access – Issues of limiting access due to stormwater ponding.	Under extreme wet-weather events, the depth of stormwater ponding in roads beyond normal conditions is capable of stopping/altering road traffic patterns and potentially damaging vehicles. May potentially affect emergency vehicles response times, and community safety.	An inventory of sensitive land uses identified specific locations to focus remedies in an effort to reduce impacts to emergency response and community safety. As the stormwater management upgrades and installation solutions are implemented, there will be less transportation access issues resulting from stormwater ponding.
Future Development Capacity – Issues of understanding sewer capacity for new development	Need to confirm the quantitative effect of mitigation measures in order to confirm sewer capacity to accommodate additional loading on the existing sewage and stormwater drainage systems.	Modelling efforts have resulted in a clearer understanding of future infrastructure capacity on a City-wide basis, and identified policy changes that will be required for a sustainable community growth plan.

The provision of City infrastructure such as sewerage and stormwater management works and utilities, allows all land uses to serve their intended function[14]. An adequate and regularly maintained/upgraded servicing network allows for a sustainable, efficient and effective municipal infrastructure system. Delivered in a cost-effective manner, it is poised to accommodate the future needs of the City of Windsor, while taking into account climate change projections.

[14] City of Windsor, Official Plan, Volume I, Infrastructure, Section 7.3

8.4 Next Steps

The following studies, design and approval requirements will influence the schedule for implementation of the solutions outlined in this report:

- Potential refinement of the recommended solutions based on any future developments (greenfield or infill) not assessed within this study that could impact the design of each solution;
- Detailed design of all recommended improvements;
- Necessary site assessments, approvals and permits to satisfy regulatory and best management practices; and
- Essex Region Conservation Authority and municipal permitting and approvals.

The City will need to review the need to complete a detailed formal review and/or update of the MP every 5 years. Potential changes which may trigger the need for a detailed review are as follows:

- Major changes to original assumptions;
- Major changes to components of the MP;
- Significant new environmental effects; and
- Major changes in proposed timing of projects within the MP.

9.0 References

Emergency Management Ontario, Hazard Identification Report 2019, Section B: Environmental Hazards, website: https://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/HIRA/Report/SectionB.html

Essex Region Conservation Authority. The Detroit River Management Strategy Committee 2001: The Detroit River as a Canadian Heritage River. For the Canadian Heritage Rivers Board. June 2001.

Essex Region Conservation Authority website: https://essexregionconservation.ca/watershed-health/flood-forecasting/

Essex Region Conservation Authority. The Essex Region Source Protection Plan (SPP). May 2019.

Evans, Cheryl and Dr. Blair Feltmate, Intact Centre on Climate Adaptation. Water on the Rise: Protecting Canadian Homes from the Growing Threat of Flooding. University of Waterloo. April 2019.

Federal/Provincial Emergency Management Partners. Building Resiliency Together: An Emergency Management Framework for Canada. Third Edition. May 2017.

Government of Canada, Public Safety Canada. Federal Emergency Response Plan. January 2011.

Green Communities Canada. Ready Set Rain. April 2019.

Ontario Climate Consortium. Establishing a Climate Collaborative for Essex Region: Post-Workshop Summary Report. January 2019.

Perry, Dajheonna, Detroit Free Press. City of Detroit issues emergency order to fend off severe flooding, July 10, 2019.

Public Safety Canada website: https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgtn/pltfrm-dsstr-rsk-rdctn/snd-frmwrk-en.aspx

Standards Council of Canada/CSA Group. Guideline on basement flood protection and risk reduction. Z800-18 August 2018.

U.S. Army Corp of Engineers Detroit District website: https://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Great-Lakes-Information.aspx#ICG_ETH_22307

City of Windsor, Corporate Climate Action Plan, March 6, 2017 (Draft), Garforth International IIc.

CITY OF WINDSOR

Acronyms, Abbreviations, Definitions

Sewer and Coastal Flood Protection Master Plan

November 2020 – 17-6638

Acronyms, Abbreviations, Definitions

An abbreviation and an acronym are both shortened versions of something else. Both can often be represented as a series of letters. Many people are unable to tell the difference between an abbreviation and an acronym.

Acronyms and Abbreviations

AD	Above Datum
Alt.	Alternative
Aquafor	Aquafor Beech Limited
CB	Catch basin
CSO	Combined Sewer Overflow
City	City of Windsor
Dillon	Dillon Consulting Limited
DWF	Dry Weather Flow
EA	Environmental Assessment
ERCA	Essex Region Conservation Authority
FM	Flow Monitor
GIS	Geographical Information Systems
HGL	Hydraulic Gradeline
I&I	Inflow & Infiltration
ICM	Integrated Catchment Modelling software
LID	Low Impact Development
LOS	Level of Service
LRPCP	Little River Pollution Control Plant
LRWRP	Lou Romano Water Reclamation Plant
MCEA	Municipal Class Environmental Assessment
MECP	Ministry of Environment, Conservation and Parks
MH	Maintenance Hole
PCP	Pollution Control Plant
PS	Pumping Station
RDII	Rainfall-derived Inflow & Infiltration
ROW	Right-of-way
SMP	Sewer and Coastal Flood Protection Master Plan

SWM	Stormwater Management
WRP	Water Reclamation Plant
WWF	Wet Weather Flow

Definitions

Term	Description
Calibration	Calibration of sewer and drainage software models is a procedure used to improve the ability of the software tool to better represent real-life conditions. This process commonly involves altering model input parameters within an acceptable range until a reasonable match between model estimates and observed conditions are achieved.
Climate Change	Climate change is the shift in weather patterns associated with an increase in global average temperatures.
Combined Sewer	A combined sewer system collects stormwater runoff, domestic sanitary sewage, and industrial wastewater into a single pipe. Under dry-weather conditions, it transports all of the wastewater it collects to a sewage treatment plant. Under wet-weather conditions, the additional stormwater runoff can sometimes exceed the capacity of the combined sewers, resulting in overflows directly to nearby streams, rivers, and other water bodies.
Design Storm Event	A representative rainfall event that does not necessarily match a real or actual rainfall, but is used to assess sewer and drainage system performance. The design storm event corresponds to a certain return period frequency (e.g. 1:5 year, 1:100 year).

Term	Description
Diurnal Flow Pattern	The daily dry weather flow pattern observed in sanitary and combined sewers derived from domestic wastewater use and non-rainfall derived groundwater infiltration. The patterns of water usage and consequently the dry weather hydrograph are often similar during weekdays periods and weekend periods.
Drainage Area	The total surface area upstream of a point where stormwater runoff not absorbed into the ground is conveyed to the same point.
Dry Weather Flow	Wastewater flow in a sewer system during periods of dry weather (without precipitation) with minimum infiltration.
Extraneous Flow	Unintended clean stormwater or groundwater that gets into the sanitary sewer system, also commonly referred to as "inflow and infiltration (I&I)".
Hydrograph	A graph showing the rate of flow (discharge) versus time past at specific point in a channel or conduit carrying flow. The rate of flow is expressed in cubic meters per second (m3/s) or litres per second (L/s).
Hydraulic Gradeline (HGL)	The surface or profile of water flowing in an open channel, on the ground surface, or a sewer pipe flowing partially full. If a sewer is under pressure, the HGL is that level water would rise to in a small, vertical tube connected to the pipe.
Impervious Area	Mainly artificial surfaces, such as pavements (roads, sidewalks, driveways and parking lots) and rooftops, over which stormwater is forced to travel across until it finds a place it can be collected and conveyed by a storm drainage system. Impervious surfaces allow for no to very limited infiltration.

Term	Description
Inflow & Infiltration (I&I)	**See extraneous flow**. This could include unintended clean water entering the sewer under both dry weather (i.e. groundwater infiltration) or from wet-weather (rainfall derived conditions). The inflow component generally includes quicker moving water sources such as improper cross-connections with the storm sewer system or from surface drainage through maintenance hole lids. The infiltration component generally includes slower moving water sources such as groundwater entering through cracks, unsealed pipe joints and other defects in the underground pipe network. Some sources of I&I such as foundation drain connections may exhibit hydrograph characteristics of both the quicker inflow and slower infiltration.
Initial Abstraction	The volume [mm] representing the initial loss caused by phenomena such as surface ponding, wetting, interception and evaporation that must be filled prior to the occurrence of surface water runoff from a rainfall event.
Long-term Solutions	Solutions to improve the sewer systems by reducing inflow at the sources, increasing conveyance capacity and/or identifying temporary storage measures. These measures often involve heavy construction to update or install solutions.
Master Plan	Master Plans are long range plans that integrate infrastructure requirements for existing and future land uses with environmental planning principles. This study is being completed to meet the requirements of the Municipal Class Environmental Assessment (EA), Master Plan Process (Approach No. 2).

Term	Description
Major System	Overland conveyance system for rainfall runoff typically defined by the road right-of-way.
Minor System	Conveyance system for stormwater drainage (i.e. storm sewer system).
Model Node	A model node represents a physical structure or location in the drainage system. This includes MH, storage tanks, and ponds.
Outfall Level	The water level at location where water leaves the model drainage system.
Peak Flow	Maximum rate of flow.
Previous Area	Land surface representing permeable surfaces that allow the infiltration of rainfall into the ground. These areas include lawns, gardens, and forests.
Primary Treatment	Removal of debris from sewage, to protect equipment and downstream processes.
Rainfall Depth	Total amount of rainfall [mm] for a given time period as measured from a rain gauge. May also be called precipitation depth.
Rainfall Intensity	The ratio of the rainfall depth falling during a given period to the duration of the period typically expressed as mm per hour [mm/hr]. May also be called precipitation intensity.
Rainfall-derived Inflow In Infiltration (RDII)	Inflow & Infiltration (I&I) that results directly from a rainfall event where the associated rainfall water enters the sanitary sewer system. This I&I is observed both during and after a rainfall event.
Rated Average Day Capacity	

Term	Description
Return Period	An estimate commonly based on records of past observation for how likely an event, such as rainfall or flood is to occur in any given year. For example a 1:100 year storm event has a 1 in 100 chance (or a 1%) of occurring in any given year.
Sanitary Sewer	A network of pipes that convey liquid and solid waste (wastewater) from domestic or industrial establishments (sewage) to the City’s wastewater facilities for treatment before being discharged to the Detroit River.
Service Area	The total surface area upstream of a point contributing flow that is conveyed to that point. This could include storm sewer, sanitary sewer or combined sewer systems’ areas.
Sewer and Costal Flood Protection Master Plan	See extraneous flow. Refers to the Master Planning work being completed as part of this project. May also be identified as the Sewer Master Plan.
Sewershed	An analogy to a natural watershed representing urban drainage determined by the sewer system service area and associated conveyance structures / devices.
Short-term Solutions	Solutions that can reduce the amount of water entering the City’s drainage systems, including partnering with homeowners to protect against the impacts of flooding.
Storm Sewer	A network of pipes that convey stormwater runoff from lower intensity rainfall events to receiving watercourses. Storm sewers are also known as the "minor" component of the storm drainage system, and function in combination with the “major” overland drainage system during more significant storm events.
Subcatchment	A defined land area used to model rainfall runoff. Each subcatchment generates a hydrograph that is typically routed to downstream watercourse, waterbody or other conveyance structure.

Term	Description
Validation	Validation of sewer and drainage software models is a process following model calibration and is completed as a check or confirmation of the model's validity to represent real life conditions.
Wet Weather Flow	The rate of wastewater flowing during dry weather combined with stormwater from surface runoff due to precipitation introduced into a combined sewer system, and dry weather flow combined with infiltraton & inflow in a separated sewer. For separate storm sewers, only wet weather flow is conveyed through the system.

Appendix A

Background Document Literature Review

Appendix B

Stakeholder Consultation Summary Report

Appendix C

Short-Term Solution Recommendation Report

Appendix D

Technical Volume 1 Report: Sewer Model Development and Existing Conditions

Appendix E

Technical Volume 2 Report: Flood Reduction Solution Alternative Development

Appendix F

Technical Volume 3 Report: Functional Design, Estimated Costs and Implementation

Appendix G

Evaluation Matrices and Potential Effects and Proposed Mitigation Summary

Appendix H

Natural Environment

Appendix I

Archaeological Assessment - Stage 1

Appendix J

Geotechnical Desktop Review Study