

INVESTIGATION OF CHRONIC BASEMENT FLOODING



EASTERN BEACHES (AREA 32)



FINALPROJECT FILE

MAY, 2012



MA-09-303-00-MA

May 31, 2012

Mr. Philip Cheung, P. Eng.
Senior Engineer
Water Infrastructure Management
Sewer Asset Planning
City of Toronto
Metro Hall, 18th Floor
55 John Street
Toronto, ON M5B 3C6

**Re: Eastern Beaches Basement Flooding Investigation (Area 32)
Final Project File**

Dear Mr. Cheung:

We are pleased to submit ten (10) copies of the above-referenced submission. The Project File has been structured to fulfill the requirements of Schedule 'B' of the Municipal Class Environmental Assessment (EA) process.

The main body of the report presents the key aspects and findings of the study. Further details are included in the appendices and attachments provided in the Project File.

Yours truly,
GENIVAR Inc.

Adel Ashamalla, P.Eng.
Project Manager

Executive Summary

ES-1 Introduction and Background

The City of Toronto has embarked on this project to investigate basement flooding in the Eastern Beaches as one of its next steps in a program to provide a comprehensive solution to basement flooding across the City. Periodically, the City has experienced both surface and basement flooding in response to relatively infrequent rainfall events. In the case of the Eastern Beaches, in June and July 2008, the area experienced a series of storm events in which basements in many residential homes were flooded and streets in low lying areas were inundated with floodwater. For this study area, the City received close to 300 basement flooding complaints.

In 2006, the City of Toronto Works Committee approved a work plan to develop flood mitigation plans for 31 chronic basement flooding areas throughout the City. These areas experienced severe basement flooding during the large rainfall events which occurred on August 19, 2005 and May 12, 2000. Since the Eastern Beaches area was mainly flooded in 2008, this study area was added later to the 31 chronic basement flooding areas previously identified in the council approved work plan. Hence, the Eastern Beaches area under investigation as part of this undertaking is referenced as "Basement Flooding Area 32".

ES-1 Description of Study Area

The Eastern Beaches study area is approximately bounded by the Don River to the west, Victoria Park to the east, south of Milverton Boulevard to the north and the Lakeshore Blvd East/Lake Ontario shoreline to the south. The total area, as shown in Figure 2.1, is approximately 2,340 ha.

The study area is serviced mainly by combined sewers, with separate storm and sanitary sewer systems in a few pocket areas. Most of the areas have road storm sewers, collecting surface storm flows through catchbasins while building flows including connected roof downspouts are still draining to the combined sewer. There are still some streets where road sewer separation has not been implemented and only combined sewers exist, which collects both house flow and surface storm flow.

Within the area, there are 3,280 storm pipe segments, 392 storm pipes with combined sewer overflow (CSO) contributions, 673 sanitary pipes and 4,117 combined sewer pipe segments. The sewer system also includes 64 outfalls (both to Don River and Lake Ontario), 75 control gates, 200 weirs, 28 orifices, 6 pumping stations and 20 inverted siphons. Five sanitary trunk sewer interceptors serve the study area, which are: Queen Street East Sanitary Trunk Sewer (STS), Lake Front Interceptor (LFI), Mid-Toronto Interceptor (MTI), High Level Interceptor (HLI) and Low Level Interceptor (LLI). All five interceptors ultimately discharge the wastewater to the Ashbridges Bay Wastewater Treatment Plant. Land use in the study area consists mainly of high density single and multiple family dwellings, mixed with commercial and office buildings.

ES-1 Scope of Study

The study has been carried out to assess the existing sanitary/combined sewer system as well as the major and minor stormwater drainage systems to identify the causes, mechanisms and impacts of basement flooding and to develop comprehensive flooding remediation plans that best meet the target level of service criteria of the City established in the 2006 work plan. To achieve this scope, the study included the undertaking of the following tasks:

- The Municipal Class Environment Assessment (EA) project Schedule B activities;
- Comprehensive review of background data and available information to confirm existing field conditions, supplemented as-required with additional field investigations;
- Extensive field investigation including field survey to identify roof downspout disconnections, low lying areas, reverse slope driveways, catchbasin locations and type in addition to inspection of control structures, silted outfalls, CCTV inspection and fog testing, as required;
- Flow monitoring program to measure flow in combined, sanitary and storm sewers at several locations;
- Identification and prioritization of the causes of basement flooding and surface flooding;
- Summary of the mechanisms by which water enters the basements, including interaction of the storm, combined and groundwater systems;
- Confirmation and identification of potential basement flooding and surface flooding;
- Summary of the mechanisms by which water enters the basements, including interaction of the storm, combined and groundwater systems;
- Confirmation and identification of potential basement flooding areas in Study Area 32;
- Identification of extent of potential surface flooding;
- Development of a GIS-based topographical model to help define the major system surface drainage patterns and identify and quantify low lying or other problematic areas;
- Development of stormwater and sanitary/combined system hydrologic and hydraulic model for Study Area 32 including assessment of the dual drainage system;
- Evaluation of various flood remediation measures and development of comprehensive cost effective flood remediation plans to achieve the targeted level of service for Study Area 32; and
- Provision of feasible conceptual design details of the proposed works recommended in the preferred alternative.

ES-2 Conclusions

The following conclusions were drawn from the completion of this study.

- The flow monitoring was useful in the calibration/validation of the model for the in-sewer sanitary/combined and storm sewer conditions but the storm events recorded were not severe enough to calibrate the model for overland (major system) conditions.
- The calibration/validation of the model showed good agreement with recorded flow data in terms of peak flows and volume of runoff. The calibration model was also successfully validated using the historic storm event of July 8, 2008.
- Ground water table is between 0-5 m below ground surface over much of the study area. Sewer infrastructure was found therefore to be below the water table in a sizable portion of the study area. In particular, most sewers within 1500 m of Lake Ontario were found to be below the ground water table. As a result of the hydrogeological analysis and the monitoring program, it is possible that groundwater infiltration would have been rapid

enough in some areas with shallow ground water levels and contributed to basement flooding.

- Past and present field investigations confirm that the existing outfalls along the Eastern Beaches are subjected to heavy siltation and partial or complete blockage by sediments. These sediments enter pipes by different mechanisms and have several sources including:
 - Sediments carried by sewer flows;
 - Sediments carried by along shore currents and waves from the open lake; and
 - Sediments carried by shoaling waves and wave-generated currents at the shoreline which vary with wind direction and wave height.
- The beach is in dynamic equilibrium at different time-scales, being re-shaped during each wave event to achieve a stable slope, with crescents between the hard points formed by the outfalls. Any proposed control structure or other measures need to preserve the beach amenity while also improving the performance of the outfalls and related sewer systems. Existing designs and conventional outfall designs are not working effectively due to a number of factors. While the need for some outfalls can be eliminated by re-routing sewer flows, the remaining outfalls must function better.
- The causes of flooding which occurred during the July 8, 2008 storm event can be generally attributed to the following:
 - Surcharge of the combined sewer caused by excessive stormwater volume entering through:
 - Perforated manhole covers;
 - Regular covers of manholes in low lying areas;
 - Connected house roof downspouts; and
 - Connected catchbasins in streets with no road storm sewers.
 - Back-up from outfalls to the Lake due to high Lake level or accumulation of sediment in the outflow conduits, resulting in street flooding.
 - Back-up from the interceptors due to high water level at the pumping station wet well at the Ashbridges Bay treatment plant.
 - High water level at the Kenilworth tank resulting in closure of the upstream flap gates to the contributing sewers to the tank.
 - Reverse sloped driveways due to surface flooding problems.
 - Surcharge of the storm sewer system, which may result in increasing the flow to the combined sewer system through potential interconnections between the two systems.
 - High ground water table, within basement elevation.
 - Accumulation of surface runoff in low-lying areas.
 - High overland flow depth above street right-of-way elevation.

- Sewer flows exceeding the design capacity of the sewer systems.
- Undersized storm sewers or undersized catchbasins resulting in high overland flow.
- Blocked/broken combined/sanitary sewers and manholes.
- Blocked catchbasins.
- The majority of the basement flooding has been caused by the combined sewer system with less flooding arising from the storm sewers.
- Source control measures alone were found not to significantly reduce basement flooding. Therefore, preferred remedial measures consist of a combination of source control measures and remedial measures applicable to the sewer systems.
- With the implementation of the preferred remedial measures and under the considered level of service, the combined/sanitary sewer system will not be surcharged. Storm sewer surcharge will occur for areas where it is not feasible to maintain the maximum HGL at no surcharge level and overland flow depth will be maintained within the street pavement.
- Reported basement flooding in scattered homes are not caused by the combined or the storm drainage system but rather by local condition at the lot level. Flooding may be a result of poor lot grading, cracked basement walls, entry of storm water through windows/doors, blocked or broken house drains, cross connection between the sanitary and storm drains, improper installation or operation of the back flow preventer valve, etc. Homeowners should disconnect roof downspouts where feasible and employ applicable measures supported by the Basement Flooding Protection Subsidy Program.
- The Schedule 'B' Class EA process has been fulfilled through the two Public Information Centres, agency consultation and the submission of this project file document.

ES-3 Recommendations

The following recommendations are made with respect to this study:

- City to proceed with short term interim remedial measures. These measures could be implemented without requiring additional investigation or detailed design and specification/tendering procedures. These measures will provide interim improvements to the combined and storm drainage systems resulting in reduction of the risk of basement and surface flooding. Details related the interim remedial measures are provided in Appendix D, and consist of:
 - Local remedial measures at Minto Street, Kingswood Road, Lee Avenue, Waverley Road, Woodbine Avenue, Kerr Road/Highfield Road, and Leslie Street.
 - Sediment removal from the five active storm outfalls and the ten outfalls with flat upstream sewers inspected during the course of the study.
 - Maintenance and repair of sewers identified in the 2009 and 2010 CCTV inspection.
 - Replacement of porous manhole covers on the combined sewer system with solid covers.

- Sealing of combined/sanitary manhole covers in low lying areas.
- Additional inflow/infiltration study is recommended particularly in the areas with high ground water levels where sewers intersect the ground water table to determine locations where ground water seepage could be a factor to sewer surcharge and basement flooding.
- Reconfiguring the outfall structures for the five active outfalls to the lake, namely, Lee Avenue, MacLean Avenue, Waverley Road, Kenilworth Avenue and Nursewood Road outfalls. It is, however, recommended to start with the Kenilworth Outfall Structure, as a pilot project and implement the following:
 - Advance the GENIVAR's conceptual design for a self-silting and scour control outfall structure as presented in T.M. #8, Attachment 5, to preliminary design;
 - Refine the design using 3D computer model and/or laboratory scale model;
 - This shall be accompanied by a joint probability analysis for Lake Ontario water levels and rainfall-runoff storm events. Also more detailed current measurements and numerical analysis should be considered to understand and quantify the near-shore sediment transport characteristics due to currents and or waves.
 - After monitoring the re-configured structure at Kenilworth Avenue outfall for 1-2 years, implementation of re-configuring the other outfall structures should proceed.
- City to continue promoting the Basement Flooding Protection Subsidy Program. Implementation of the measures included in this program will provide protection to most houses and will enhance the performance and level of protection provided by the remedial measures in the preferred alternative.
- City to proceed to detailed design and construction of preferred long term remediation measures, total estimated cost of \$38.7 million, excluding applicable taxes. They include: upgrading the capacity of the combined and storm sewer systems, separation of the combined sewer system into storm and sanitary sewers at select streets, installation of additional catchbasins at locations with excessive surface ponding, reconfiguration of storm sewer outfalls to reduce sediment blockage, and construction of underground relief sewers at certain locations. This work should be conducted in accordance with available funding from the capital budget and sequencing with other basement flooding protection projects.

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Appendices

Appendix A	Public Consultation
Appendix B	Agency Consultation
Appendix C	Conceptual Design and Preferred Alternative
Appendix D	Interim Remedial Measures

Attachments (Under Separate Cover)

Attachment 1	Technical Memorandum #1 – Field Investigation Technical Memorandum #2 – CCTV Inspection of Combined and Sanitary Sewers Technical Memorandum #3 – Fog Testing Results
Attachment 2	Technical Memorandum # 4 – Flow and Rainfall Monitoring Program
Attachment 3	Technical Memorandum #5 – Preliminary Assessment Report
Attachment 4	Technical Memorandums #6 & 7 – Model Calibration and Assessment of the Sanitary/Combined Sewer System and Storm Drainage System
Attachment 5	Technical Memorandum #8 – Investigation of Shoreline Storm Outfall and Control Structures
Attachment 6	Technical Memorandum #9- Alternative Analysis and Preferred Solution

1. Introduction

The City of Toronto has embarked on this project to investigate basement flooding in the Eastern Beaches as one of its next steps in a program to provide a comprehensive solution to basement flooding across the City. Periodically, the City has experienced both surface and basement flooding in response to relatively infrequent rainfall events. In the case of the Eastern Beaches, in June and July 2008, the area experienced a series of storm events in which basements in many residential homes were flooded and streets in low lying areas were inundated with floodwater. For this study area, the City received close to 300 basement flooding complaints.

In 2006, the City of Toronto Works Committee approved a work plan to develop flood mitigation plans for 31 chronic basement flooding areas throughout the City. These areas experienced severe basement flooding during the large rainfall events which occurred on August 19, 2005 and previously during other storm events which occurred on July 26, 2002, May 12, 2000 and August 26, 1986. Since the Eastern Beaches area was mainly flooded in 2008, this study area was added later to the 31 chronic basement flooding areas previously identified in the council approved work plan. Hence, the Eastern Beaches area under investigation as part of this undertaking is referenced as "Basement Flooding Area #32".

Historically, the former cities making up Metropolitan Toronto adopted a variety of measures to address basement flooding issues. These measures were only partially successful as they failed to address the impact of surface drainage entering the sanitary system through various avenues.

Accordingly, following the 2006 Council approved Work Plan, the City has adopted a new approach providing comprehensive basement flooding relief through an integrated strategy. The new strategy brings together reduction of surface flooding and storm sewer surcharge with a range of solutions for the sanitary/combined system.

The key elements of the new strategy include:

- Integrated modelling using the full capabilities of the InfoWorks CS model for linked analysis of surface stormwater flow, groundwater and resulting pipe flow in storm and sanitary sewers;
- Application of sophisticated visualization tools to aid in understanding the relationships of topography and surface features to flooding location and depth; and
- Detailed evaluation and monitoring of the study area to establish the sources of I/I and the nature of storm-sanitary linkages and to provide calibration data for the InfoWorks CS model.

This study has the main objective of assessing the existing sanitary/combined sewer and stormwater drainage systems to identify the causes, mechanisms and impacts of basement flooding and to develop comprehensive flooding remediation plans that best meet the target level of service criteria of the City.

The study has been undertaken according to the Municipal Class Environmental Assessment, Schedule B as described in Section 3.

2. Study Overview

2.1 Description of Study Area

The Eastern Beaches study area is approximately bounded by the Don River to the west, Victoria Park to the east, south of Milverton Boulevard to the north and the Lakeshore Blvd East/Lake Ontario shoreline to the south. The total area, as shown in Figure 2.1, is approximately 2,340 ha.

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There are two existing storage facilities, the Maclean Avenue Tank and the Kenilworth Avenue Tank, and one proposed storage facility, the Eastern Beaches Phase III Water Quality culvert controlling all outfalls to the beaches area east of the Maclean Avenue Tank. There are also six storage facilities under construction, controlling the outfalls to the Coatsworth Cut. All of the above facilities are designed to improve water quality to the Lake Front, in accordance with MOE guidelines.

2.2 Scope of Study

The study has been carried out to assess the existing sanitary/combined sewer system as well as the major and minor stormwater drainage systems to identify the causes, mechanisms and impacts of basement flooding and to develop comprehensive flooding remediation plans that best meet the target level of service criteria of the City. To achieve this scope, the study included the undertaking of the following tasks:

- The Municipal Class Environment Assessment (EA) project Schedule B activities;
- Comprehensive review of background data and available information to confirm existing field conditions, supplemented as-required with additional field investigations;
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- Flow monitoring program to measure flow in combined, sanitary and storm sewers at several locations;
- Identification and prioritization of the causes of basement flooding and surface flooding;
- Summary of the mechanisms by which water enters the basements, including interaction of the storm, combined and groundwater systems;
- Confirmation and identification of potential basement flooding and surface flooding;
- Summary of the mechanisms by which water enters the basements, including interaction of the storm, combined and groundwater systems;
- Confirmation and identification of potential basement flooding areas in Study Area 32;
- Identification of extent of potential surface flooding;
- Development of a GIS-based topographical model to help define the major system surface drainage patterns and identify and quantify low lying or other problematic areas;
- Development of stormwater and sanitary/combined system hydrologic and hydraulic model for Study Area 32 including assessment of the dual drainage system;
- Evaluation of various flood remediation measures and development of comprehensive cost effective flood remediation plans to achieve the targeted level of service for Study Area 32; and
- Provision of feasible conceptual design details of the proposed works recommended in the preferred alternative.

2.3 Problem Identification

Historically, basement and surface flooding in the Eastern Beaches study area have been reported during the June and July 2008 heavy rainfall events. The heaviest rainfall events occurred on July 8, 2008, during which the total rainfall depth was over 40 mm and over 200 basement flooding incidents were reported. In addition, streets in low lying areas were inundated with flood water. Other events that occurred on June 23, July 19 and July 22, 2008 also resulted in over an additional 50 basement flooding reports. The majority of the flooding reports were along Queen Street, Eastern Avenue, Pape Avenue, Logan Avenue, Carlaw Avenue and Minto Street. Severe street flooding also occurred on Kerr Road, Kippendavie Avenue, Kew Beach Avenue, and Lakeshore Boulevard west to Woodbine Avenue.

Figure 2.2 shows the location of the reported basement flooding during the July 2008 storm. Basement floodings reported during the previous August 19, 2005 storm event, which caused severe flooding throughout the City, are also shown in Figure 2.2 for comparison. A review of this figure shows that the August 19, 2005 storm event caused a few scattered basement flooding incidents within the Eastern Beaches area, and hence the reason this area was not considered originally within the 31 chronic basement flooding areas.

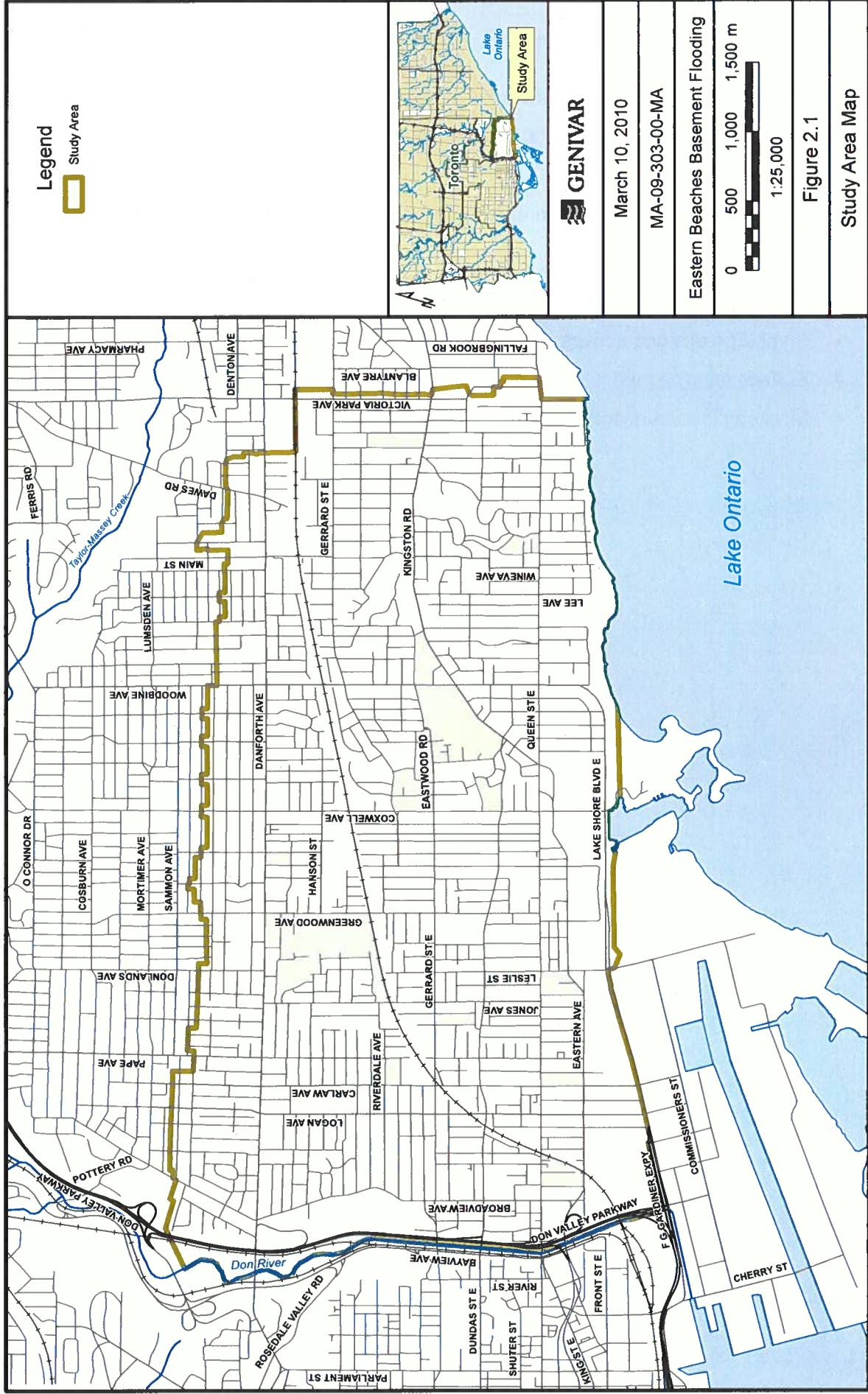
Basement flooding records indicate reported evidence of basement flooding mainly include:

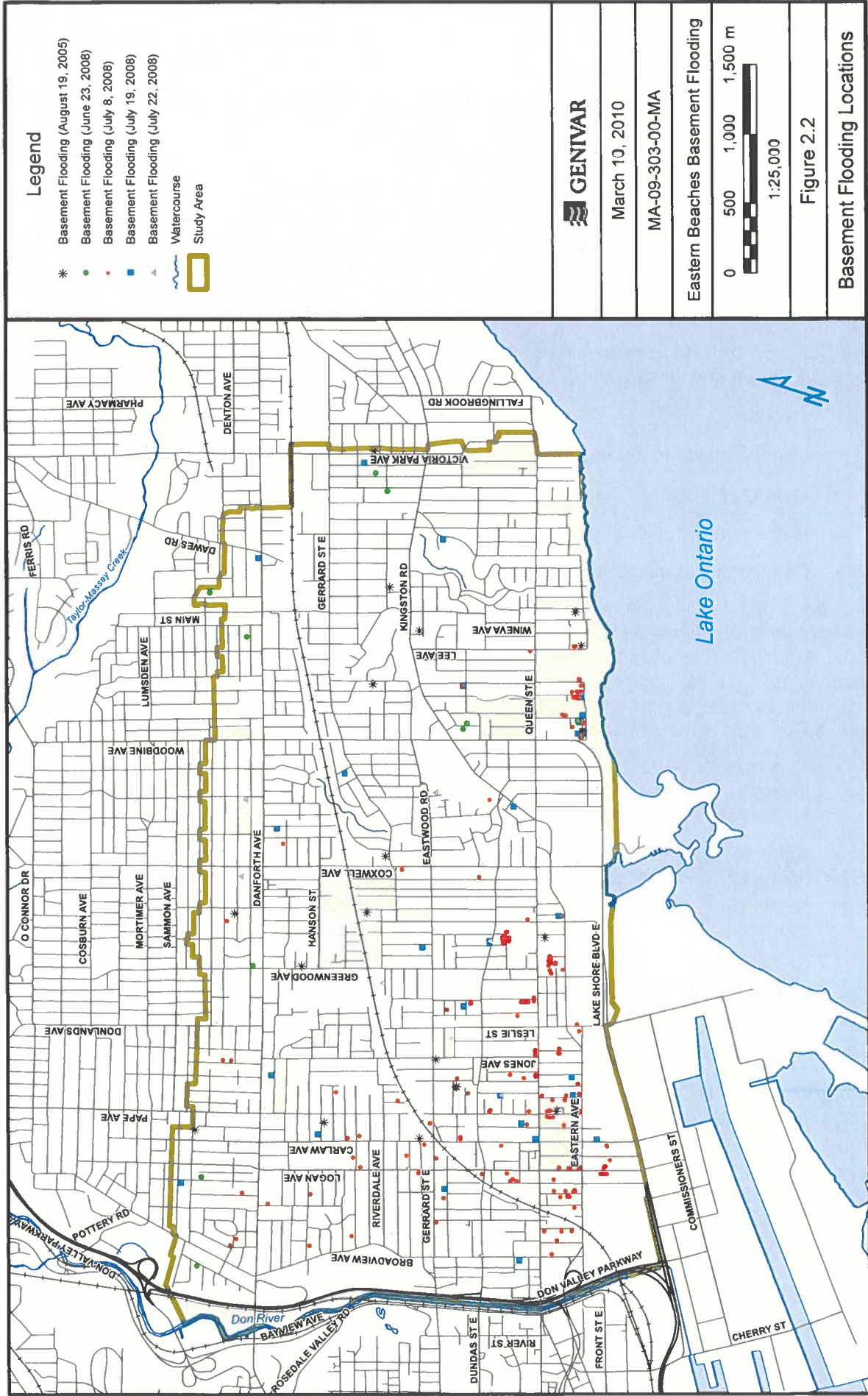
- Water backed up from floor drains;
- Overloaded sanitary/combined sewers and storm sewers;
- Potential overloading of the main interceptors to the Ashbridges Bay Treatment Plant;

- Leakage through cracks in basement walls;
- Flood water from windows and/or doors; and
- Heaved basement floors.

In addition, previous investigations in other areas indicate some possible causes of the flooding can be attributed to:

- Surcharge of sanitary/combined sewers caused by excessive infiltration/inflow (I/I); and surface storm water entering the sewer;
- Surcharge of storm sewers;
- Surface flooding; and
- Blockage in sewers and street catchbasins.





3. The Environmental Assessment Process

3.1 The Environmental Assessment

This study is being conducted in accordance with the requirements of the Municipal Class Environmental Assessment (EA) process. The Class EA planning process allows for the integration of sound engineering judgement, prudent long-term planning, and protection of all aspects of the environment (natural, social, economic and cultural). This includes consultation with the public and affected agencies to obtain comments and input, ensure regulatory compliance, and ultimately achieve acceptance of the preferred alternative.

The Class EA process was developed as a method of planning municipal infrastructure projects (including water and wastewater projects), which display the following common characteristics:

- Recurring;
- Usually similar in nature;
- Generally limited in scale;
- Have a predictable range of environmental effects; and
- Responsive to mitigating measures.

The requirements for undertaking a Class EA are described in the document *Municipal Class Environmental Assessment*, June 2000, Municipal Engineers Association (MEA) as amended in 2007. A Class EA applies to a group of projects that are permitted under the Environmental Assessment Act as long as they follow the approved planning process. The specific requirements depend on the type and complexity of the project as well as the significance of potential environmental impacts. The following three types of projects are identified:

- *Schedule 'A'* Projects are limited in scale and have minimal adverse environmental impacts. This type of project is pre-approved and may proceed to construction without further following the Class EA process.
- *Schedule 'B'* Projects have the potential for some adverse environmental impacts and are approved provided they are "screened" by the public and government review agencies. This type of project requires the completion of Phases 1 and 2 of the planning process.
- *Schedule 'C'* Projects are more complex and have the potential for significant environmental impacts. These projects generally include the construction of new facilities and major expansion to existing facilities. This type of project requires the completion of Phases 1, 2 and 3 of the Class EA process and the preparation of an Environmental Study Report (ESR) in Phase 4.

Throughout the EA planning process, agreements made or commitments given by the proponent to affected agencies or the public must be followed through and implemented. If an affected agency or the public has a concern that cannot be resolved by discussion and negotiation with the proponent, they can make a request to the Ministry of the Environment for a proponent to comply with Part II of the EA Act. Through issuance of a Part II Order, Schedule 'B' and Schedule 'C' projects may be elevated to an individual EA, requiring the proponent to comply with Part II of the EA Act. Schedule 'B' projects could also be elevated to a Schedule 'C'.

The residents in Study Area 32 have experienced basement flooding during wet weather conditions. This project assesses the existing major and minor stormwater systems as well as the sanitary/combined sewer system to identify the causes, mechanisms and impacts of basement flooding and to develop comprehensive flooding remediation plans that best meet the target level of the service criteria of the City. It is anticipated that all of the sewer system remediation work will be constructed within existing road allowances. Accordingly, it has been determined that this project will follow the Schedule 'B' process.

As a Schedule 'B' project, the following two phases of the Class EA process are required as shown in Figure 3.1.

- Phase 1: Identifying the problem or need for the project; and
- Phase 2: A thorough evaluation of the planning options or alternative solutions to the problem.

The Schedule 'B' Class EA concludes with the Notice of Completion and filing of the Class EA Project File for a minimum 30-day public review period.

The focus of Phase 2 of the EA Process is to develop and evaluate alternative flood remedial measures within the defined study area. Phase 2 work involved.

- Preparation of an Environmental Inventory;
- Development of Study Alternatives;
- Sizing of Alternatives;
- Establishment of Evaluation Criteria and Scoring System;
- Evaluation of Alternatives;
- Public Consultation; and
- Selection of the Preferred Solutions.

These steps are documented in the following sections of this Project File. This report documents Phase 1 and 2 of the Class EA study to fulfill the requirements for this Class EA Schedule 'B' project. The Project File will be available for the mandatory 30-day public review by the public and agencies.

3.2 Public Consultation

A comprehensive public consultation program was conducted for the study with the following components:

- **Mailing Lists** – A mailing list was created for the study. It included all review agency contacts as well as local interest groups and ratepayer associations residing within the study area. In addition, all members of the public who requested to be added via telephone, email or comment sheet were included. All persons on the mailing list were sent notices prior to each of the public open house events.
- **Public Open Houses** – Two open house events were held throughout the course of the study with each event held at two separate venues within the study area. They consisted of a drop-in centre with display panels and provided an opportunity for the public to speak with City staff. Handouts consisting of key display panels along with comment forms were made available.

- **Newspaper Advertisements** – Newspaper advertisements were placed in the Beach Mirror and East York Mirror newspapers to announce the commencement of the Class EA Study and prior to each open house event. The first round of advertisements was issued for the Notice of Study Commencement on November 20 and November 27, 2009. A second notice was issued for two consecutive issues in late September 2010 in advance of the first Open House, followed by advertisements for two consecutive issues in June 2011 announcing the second Open House. The advertisements invited the public to attend the event and identified ways to obtain more information.
- **Direct Mail** – Approximately two weeks prior to each point of public contact, flyers were mailed to area residents and businesses within the study boundaries using Canada Post. Notification letters were also mailed to local ratepayer groups and external agencies.
- **Project Website** – At the onset of the study, a website was launched by the City to provide the public with additional means of obtaining information about the project. The project website was advertised in the Notice of Study Commencement and in the Public Open House notices. The website was updated throughout the study with materials from the Open Houses. The website address for the study is http://www.toronto.ca/involved/projects/basement_floodings/sa_32.htm.

Copies of all public consultation related materials and correspondence can be found in Appendix A.

3.2.1 Public Notification

A Notice of Study Commencement was advertised in the November 20 and November 27, 2009 editions of newspaper. The notice was mailed to all residents and business owners within the boundaries of the study area loosely bounded by Don River (W), Danforth Avenue (N), Victoria Park Avenue (E) and Lakeshore Blvd (S). Flyers were also distributed to the local Business Improvement Associations and Ratepayer Associations within the affected Wards. The notice introduced the study, explained the objectives and the Municipal Class EA process and identified means of providing input.

In late September 2010, a public notice, advertising the first Public Open House was again distributed door-to-door via Canada Post to all homeowners and businesses within the study area. The local ratepayer associations were once again notified as well as those individuals who had requested to be added to the study mailing list. Advertisements for the event appeared in September 2009 in the Beach Mirror and East York Mirror newspapers.

In late June 2011, a third public notice was created and mailed to all residents, businesses and local interest groups both in the study area and those on the project mailing list. The notice explained details of the second Public Open House and announced that recommendations for the neighbourhood were to be presented. Advertisements for the second Public Open House appeared in the June 2011 editions of the Beach Mirror and East York Mirror newspapers.

3.2.2 Public Open House #1

Public Open House #1 was held on September 29, 2010 from 7:00 p.m. to 9:00 p.m. at Jimmie Simpson Community Centre at 870 Queen Street East and on September 30, 2010 from 7:00 p.m. to 9:00 p.m. at Mennonite New Life Centre of Toronto at 1774 Queen Street East. The purpose of the meeting was to:

- Introduce and provide background information on the study;

- Explain the Municipal Class Environmental Assessment Process;
- Present the causes of basement and surface flooding;
- Identify the potential solutions; and
- Outline the next steps in the study.

The format of the meeting included a public information centre with display panels. City staff and consultants were available to speak one-on-one with the public and answer questions. A presentation was also played on a continuous loop throughout the course of the evening. The presentation entitled, "Home Drainage & Causes of Basement Flooding", was used to help educate the public on how homes are connected to the City's sewer system and an explanation of what are the typical causes of basement flooding.

Staff was also on hand to speak about the city programs available to homeowners to help lower their risk of basement flooding. Staff provided information and details on both the Basement Flooding Protection Subsidy Program and Blocked Sewer Connections Program.

A comment sheet requesting input on the study was provided to participants along with a postage paid envelope. Participants were asked to submit their comments to the City within a two-week period following the Open House. 49 members of the public signed in at the meeting. Eleven (11) comment sheets were returned.

The following material was made available to the public as handouts:

- Basement Flooding Background;
- Frequently Asked Questions Sheet;
- Basement Flooding Protection Subsidy Program Brochure;
- Glossary of Terms;
- Quick Tips to Homeowners to help prevent flooding; and
- Comment sheet and postage-paid envelope.

3.2.3 Public Open House #2

The second Public Open House was held on June 13, 2011 from 6:30 to 8:30 p.m. at Jimmie Simpson Community Centre at 870 Queen Street East and on June 6, 2011 from 6:30 p.m. to 8:30 p.m. at Mennonite New Life Centre of Toronto at 1774 Queen Street East. The purpose of the meeting was to:

- Present the results of the evaluation of alternatives;
- Present the recommended solutions within Study Area 32; and
- Outline the next steps and timelines of the study process.

The format of the meeting was a public information centre with display panels. Similar to the previous open house, a presentation titled "Understanding Drainage and Proposed Remediation Measures" was played on a continuous loop. The presentation provided examples and explanations on a wide range of possible alternatives and information on how each would potentially impact residents.

The following material was made available to the public as handouts:

- Basement Flooding Protection Subsidy Program Brochure;
- Basement Flooding Fact Sheet;
- Frequently Asked Questions Sheet;
- Glossary of Terms;
- Grease Fact Sheet;
- Around the house water care tips brochure; and
- Comment sheet and postage-paid envelope.

Similar to the first Public Open House, staff from Toronto Water, Business Operations Management were in attendance to provide information and details on the City's Basement Flooding Protection Subsidy Program.

All information, including the display boards were posted on the project website. The comment sheet, which was provided to attendees, requested input on the recommended solution(s), whether there were any additional options the study team had not considered and any potential impacts the proposed alternatives may have on the community. Comments were requested within a two week period following the event. Eighty five (85) members of the public signed in at the two meetings. Fifteen (15) comment sheets were submitted to the City.

3.2.4 Councillor Briefings

The study area covers four City Wards; namely, Ward 30 (Councillor Paula Fletcher, Toronto-Danforth) and Ward 32 (Councillor Mary-Margaret McMahon, Beaches-East York) and portions of Ward 29 (Councillor Mary Fragedakis, Toronto Danforth), and Ward 31 (Councillor Janet Davis, Beaches East York). The Councillors for each Ward were notified of the study and their offices invited to attend each of the Public Open House events. Both Councillors were offered briefings prior to the second Public Open House. Staff from Toronto Water met with Councillor Paula Fletcher (Ward 30) on June 7, 2011 and with Councillor Mary-Margaret McMahon (Ward 32) on June 10, 2011 to outline the recommendations for their Wards.

3.2.5 Website

All background information related to the study, meeting material, project updates and staff contact information were posted on the project website at: http://www.toronto.ca/involved/projects/basement_floodings/sa_32.htm. The website was regularly updated as the study progressed.

3.3 Agency Consultation

The Notice of the Study Commencement was distributed in November 2009 to all relevant government agencies to inform them of the nature and scope of the project. In addition to the notice, a Fax Back form was also distributed to these groups requesting any input/feedback they may have that was of relevance to this study.

Notices were also sent in September 2009 and June 2011 inviting these groups to attend the Public Open Houses.

Response letters were received from the Ministry of the Environment, November 25, 2009.

Copies of all agency correspondence can be found in Appendix B.

3.4 First Nations Consultation

Letters were also issued to the following aboriginal contacts to notify them of the project upon its initiation:

- Indian and North Affairs Canada;
- Ontario Secretariat for Aboriginal Affairs;
- Mississauga's of the New Credit First Nation; and
- Notices were also sent in September 2009 and June 2011 inviting these groups to attend the Public Information Centres.

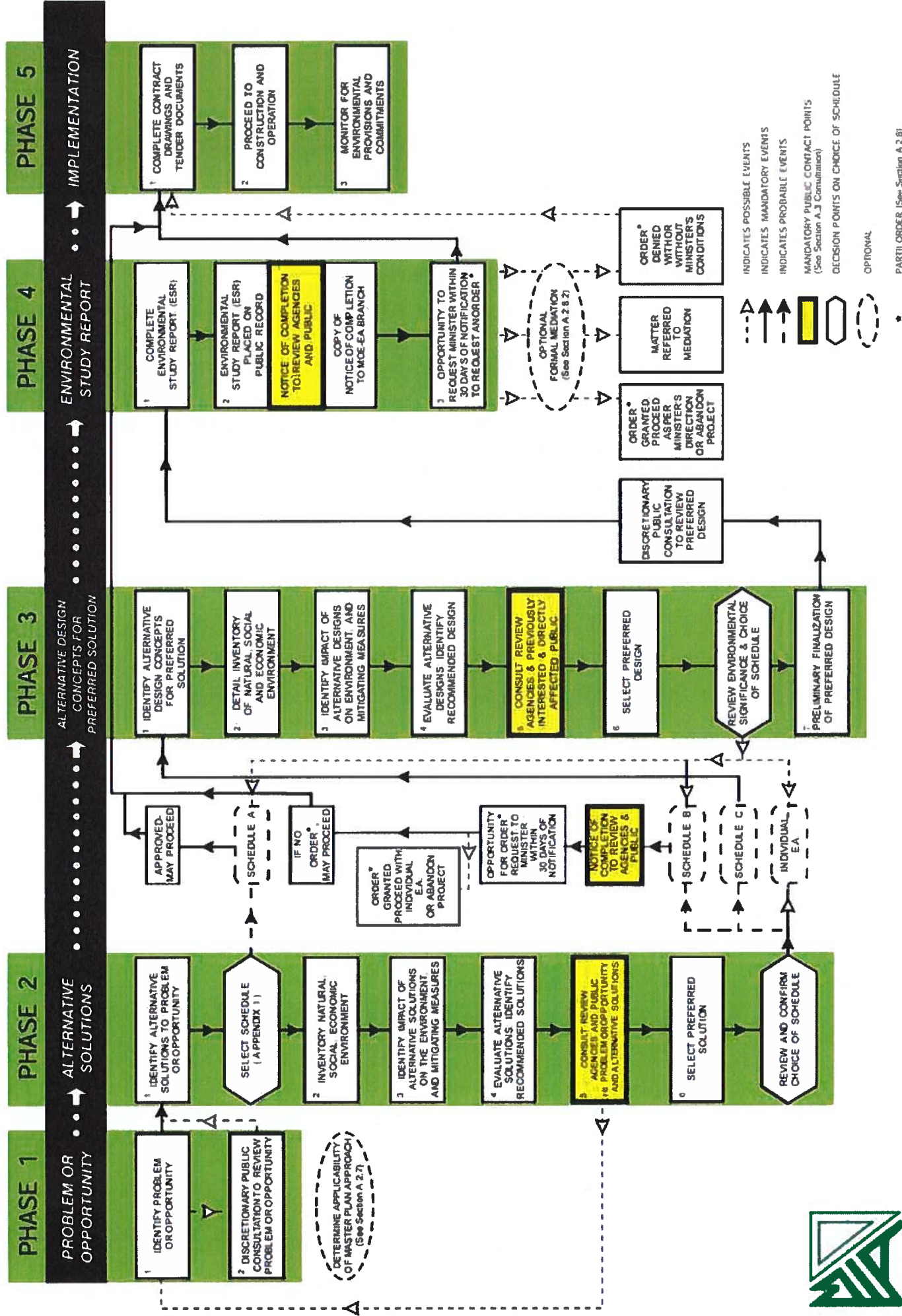
3.5 Notice of Completion

The filing of this Project File and the issuance of the Notice of Completion fulfill the requirements for Schedule 'B' projects under the Class EA process. Subject to comments received and the receipt of the necessary approvals, the City of Toronto intends to continue with the detailed design and construction of the flood remediation measures to alleviate basement and surface flooding in Study Area 32.

FIGURE 3.1

MUNICIPAL CLASS EA PLANNING AND DESIGN PROCESS

NOTE: This flow chart is to be read in conjunction with Part A of the Municipal Class EA



4. Existing Conditions

4.1 Site Conditions

The study area is bounded by the Don River to the west, Victoria Park Avenue to the east, Milverton Boulevard to the north and the Lake Shore Blvd. East/Lake Ontario shoreline to the south. The total area is approximately 2,340 ha. Land use consists mainly of single and multiple family dwellings, mixed with commercial, institutional and office buildings.

The study area drains towards the south, to the shoreline of Lake Ontario, except for a small area which drains to the Don River on the west side. Some low lying areas exist which do not provide positive drainage and resulting in accumulation of surface storm flow. Ground surface elevation range from over 120 m in the north to 75 m in the south along the shoreline. Groundwater flow direction is regionally towards the south, across most of the area, while flow along the western edge is towards Don River. The ground water depth is generally less than 5 m (between 0 and 5 m) below ground surface across most of the area, particularly in the south and central areas.

4.2 Sanitary/Combined Sewer and Storm Drainage Systems

The study area is serviced mainly by combined sewers, with separate storm and sanitary sewer systems in a few pocket areas. Most of the areas have road storm sewers, collecting surface storm flows through catchbasins while building flows including connected roof downspouts and foundation drains are still draining to the combined sewer. There are still some streets where road sewer separation has not been implemented and only combined sewer exists, which collects house flow and surface storm flow. Six sanitary trunk sewer interceptors are present in the study area, which are: Queen Street East Sanitary Trunk Sewer (STS), Lake Front Interceptor (LFI), Mid-Toronto Interceptor (MTI), High Level Interceptor (HLI) and Low Level Interceptor (LLI). The Coxwell Sanitary Sewer flows through the study area, but its catchment area is located outside the study area. Both the Queen Street East STS and the LFI drain only areas within the study area, while the MTI, HLI and LLI drain, in addition to parts of the study area, the entire Toronto District West of the Don River. The study area is also drained by 64 outfalls, both to the Don River and Lake Ontario. Some outfalls discharge only stormwater, while others receive CSO from the combined sewer system. The characteristics of the sanitary/combined sewer system, the storm sewer system and the overland flow system are explained in Section 6.

4.3 Socio-Economic Environment

4.3.1 Land Use Classification

The predominant land use in the study area is residential representing approximately 65.1% of the service area, which consists of 56.4% single family and 8.7% multilevel family residential developments. Approximately 23.4% of the service area is made up of industrial, commercial and institutional lands (ICI). An area of approximately 2.9% is classified as unknown land use which includes the vacant lands and the new developments in the study area. The remainder of the area is open space including the roadway and parks area.

Figure 4.1 presents the land use classification for Area 32. Table 4.1 presents a summary of the land use classification. The land use has been processed based on the sanitary/combined service boundary defined for the study area. Population information based on 2001 census data is also provided in Table 4.1. The total contributing population in the study area is 121,750.

Table 4.1 Land Use Classification and Population

Land Use Classification		Land Use Area (Ha)	Percentage of Total (%)	Population
Residential	Single Family	760.1	56.4%	95,640
	Multi Level Families	117.2	8.7%	25,709
Industrial/ Commercial/ Institutional	Industrial	107.0	7.9%	13
	Commercial	66.9	5.0%	336
	Institutional	142.3	10.5%	52
Open Area	Open Area	116.0	8.6%	0
Land Use to be Verified	Vacant lands, new developments, etc.	39.3	2.9%	0
Total		1,349	100%	121,750

4.3.2 Lake Shoreline and Beaches

The study area is bounded in the south by Lake Shore and the Eastern Beaches area. The Beaches area, consisting of Woodbine Beach, Beaches Park Beach, Kew Beach and Balmy Beach, are quite popular bathing beaches. The boardwalk bisects the Beaches area from west to east, and most of the area north of the boardwalk consists of a grassed park area with shade trees. A sand beach area lies south of the boardwalk. Erosion has been an on-going problem along the beach front resulting in a gradual loss of beach area. The Lake bottom in the study area is sandy and is considered to be a harsh environment for fish habitat. There are no significant natural features in the area.

4.4 Physical and Natural Environment

4.4.1 Topography, Physiology and Geology

The site is located in the Iroquois Sand Plain physiographic region (Chapman and Putnam, 1984). The Lake Iroquois Sand Plain marks the former existence of glacial Lake Iroquois. The lake plain consists of sandy lacustrine deposits. Clay deposits were observed in the Don Valley and some ravines (Chapman and Putnam, 1984). Glacial Lake Iroquois formed barrier beaches of different sizes across the Don River. Having been a source of sand and gravel in the past, the deposits have since been used for development. The beach gravel was excavated for construction, the sand plains were used as a housing site, and the flat lake plain containing shallow bedrock were used for industrial areas (Chapman and Putnam, 1984).

Topography across the site generally slopes downward from north to south as shown in Figure 4.2. The ground surface elevation ranges from approximately 110 m above sea level (masl) to 140 masl along Danforth Avenue to approximately 75 masl to 90 masl along Lakeshore Boulevard East. Several gullies of former watercourses are present within the site, indicating past drainage patterns.

The surficial geology of the site consists mainly of foreshore-basinal sands and silts deposited as part of the Don River delta. Coarser grained sands associated with littoral foreshore deposits (Baymouth Bar) cross the northeastern portion of the study area. Remnant undifferentiated older till and stratified sediment consisting of sandy till is present across the center of Area 32. To the west, the Don River Valley contains modern alluvial deposits, which consist of sand, silt, clay, gravel and organic remains (i.e. peat). Shale bedrock was encountered at elevation 50 masl to 75 masl. More details on the surficial and overburden geology of the study area is provided in Technical Memorandum (T.M.) #3, Attachment 1.

4.4.2 Hydrogeology and Groundwater Levels

Three primary overburden aquifer systems are identified in the area as the Upper, Middle, and Lower Aquifers (Howard et al., 1997; Eyles et al., 1996). Aquifers are developed in relatively coarse-grained outwash and lacustrine deposits and are confined by aquitards of fine-grained till deposits. Groundwater flow is generally from north to south in the Upper Aquifer and northwest to southeast in the deeper aquifers. Oak Ridges Moraine acts as the major recharge zone as well as forms the groundwater divide in the area, separating the Lake Ontario and Lake Simcoe basins (Howard et al., 1997). Flow in the Middle and Lower Aquifers are influenced by the discharge areas on the Scarborough Bluffs and in the major river valleys, Rouge River, Little Rouge Creek, and Highland Creek to the north.

Groundwater recharge values for the Lake sands in the urban study area were estimated to be 108 mm/yr. For the sandy till areas in within the study area, recharge was estimated at 54 mm/yr. Based on these values it is likely that the majority of precipitation in the study area is lost as runoff or evapotranspiration.

Groundwater levels across the study area were interpolated from the City of Toronto Borehole Database. Groundwater elevations range from over 120 masl in the northeast to 70 masl near the lakeshore and the Don River Valley. The groundwater flow direction is towards Lake Ontario across most of the area, while flow along the western edge is towards Don River.

Similarly, the depth to groundwater below ground surface (bgs) was interpolated based on City of Toronto borehole data. The groundwater depth is generally less than 5 mbgs across most of the area, particularly in the south and central areas. This coincides with the occurrence of majority of the basement flooding events. An area North of Kingston Road, between Woodbine Avenue and Victoria Park Avenue (Upper Beaches) contains deeper groundwater levels between 5 to 10 mbgs. At the south end of the Don River groundwater depth ranges from 0 to 5 mbgs. North of Gerrard Street East, the depth to groundwater increases to depths of up to 20 mbgs. Similarly, there are four locations in the southwest and central area of the site where groundwater depth also lies within this range. However, the majority of the basement flooding events corresponds to a groundwater table reading of less than 5 mbgs.

The sanitary sewer and storm sewer system maps were compared to the location of the groundwater table to provide an overall trend on the storm and wastewater flows. The comparison shows that the infrastructure is below the water table over a significant portion of the study area, particularly where the groundwater level was less than 5 mbgs. This area coincides with majority of the basement flooding events. In areas where the sewer infrastructure is above the groundwater table, groundwater levels tend to be 5 – 10 mbgs. Generally, groundwater seepage may be a contributing factor toward basement flooding in areas where the sewer infrastructure is located below the groundwater table. More details and maps are provided in T.M. #3, Attachment 1.

4.4.3 Vegetation

Most of the streets within the study area are lined with a variety of established trees and vegetation due to the mature nature of the area. These features assist in providing various levels of canopies over the area which helps to provide shade and also intercept some of the rainfall.

The most significant and abundant vegetated area within the sewershed boundary is contained within the Glen Stewart Ravine which is located on the east side of Glen Manor Road and extends from approximately Queen Street East to Kingston Road. In May 2008, Schoellen &

Company Inc. prepared a draft report for the City of Toronto entitled, "Glen Stewart Ravine Management Plan".

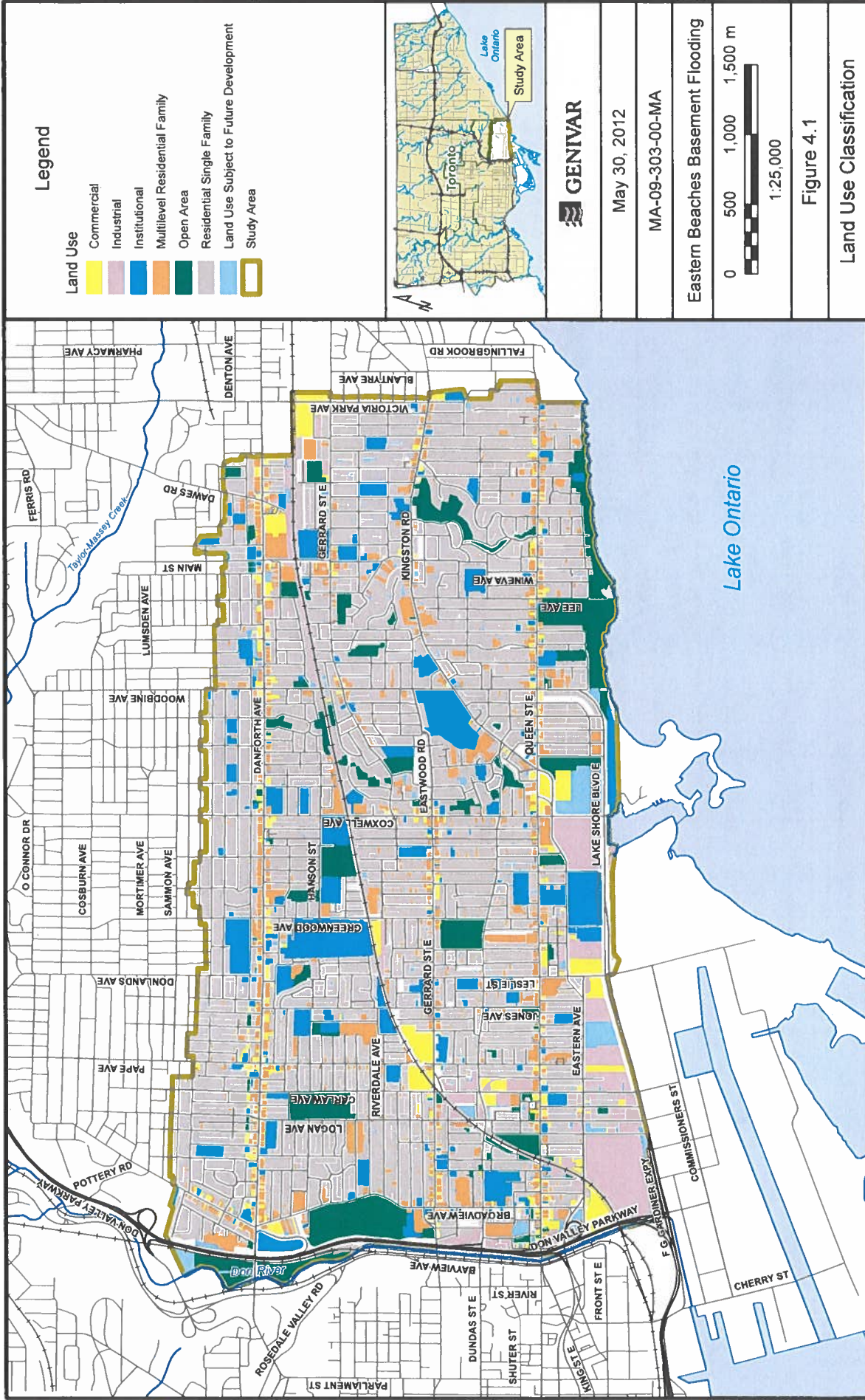
The vegetation information inventoried in the Schoellen report has been used for this section. The report documents that the Glen Stewart Ravine is situated within the Deciduous Forest Region and is dominated by Red Oak with Sugar Maple, Beech and White Oak associations. Many of the trees are estimated to be 100 to 150 years old. A small area of Hemlock Sugar Maple mixed forest also inhabits the south part of the ravine. The floodplain is variable, consisting of cultural meadow, small patches of open marsh, cultural woodland and lowland forest that is comprised of a high percentage of non-native trees. Some parts of the floodplain are maintained as wetland by seepage. Species in these areas are comprised of forbs, wetland grass species and ephemeral wildflowers.

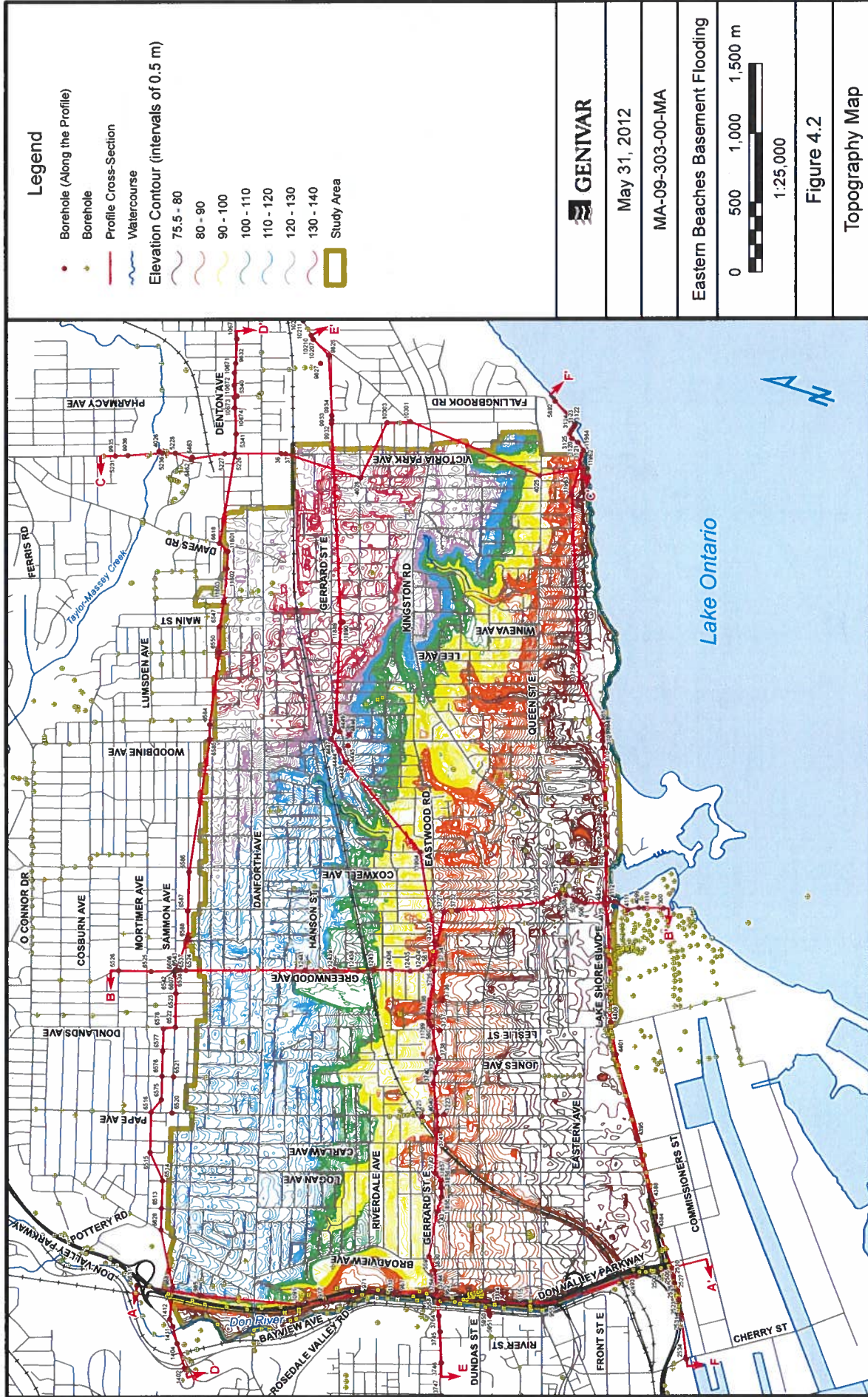
According to the report, much of the ravine's canopy and sub-canopy layers of vegetation are deemed to be in fairly good condition. However, there are signs that the herbaceous layer is being threatened by invasive species and some area affected by soil erosion.

4.4.4 Natural Heritage and Archaeological Potential

Archaeological assessment background research could be required in some studies to identify if there are archaeological sites or archaeological potential within the area. The impact, if any, of any development or landscape alteration on such sites could therefore be determined and avoided. For the current study, it was considered that there is no need to carry Archaeological Assessment because of the following:

- The area is well developed and development took place between the year 1880 and the year 2000.
- All elements of the preferred alternative are located in the street R.O.W. They consist of either pipe twinning at the same elevation as the existing pipe, pipe replacement with a larger diameter pipe or shallow pipes used for overland flow conveyance. No proposed elements are located in open area or parkland not disturbed before.





5. File and Field Data Collection

5.1 File Data Collection and Review

Two data groups were identified as Group 1 and Group 2. Group 1 data included physical information about the service areas and sewer systems. Group 2 data consist of historical information related to development practices, system configuration, topography, hydrogeology, operation and maintenance and basement flooding reports. A summary of the data collected and reviewed is given below, and more details are provided in T.M. #5, Attachment 3.

5.1.1 Group 1 Data

Group 1 data were provided by the City and include the basic physical information about the area and the sewer systems, as follows:

Land Use Classification

The predominant land use within the study area is residential, with some industrial along Lake Shore Blvd., commercial along Queen Street, Gerrard Street and Danforth Avenue, and scattered institutional development with the largest along Lake Shore Blvd., Kingston Road and Greenwood Avenue. Open areas exist mainly along the Lake Shore, Don River and Glen Manor Drive. More details about land use classification is given in Section 4.3.1.

Population

Population based on 2001 census data, and 2006 census data were collected. The 2001 census data is associated with each address point, while the 2006 census data is based on parcels enclosed within polygon boundaries in the study area. The servicing population is used to calculate the dry weather flow and is determined based on the addresses enclosed within the contributing area. It was determined that using the actual population at the addresses enclosed within the sub-catchment area, as given in the 2001 data, would better reflect the contributing population rather than using the population density within the sub-catchment area as calculated from the 2006 data to estimate the servicing population. Using the 2001 data is also supported by the fact that there is insignificant difference between the total population in the 2001 data and the 2006 data within the study area.

Water Consumption/Billing Records

The water consumption data is used to establish a Theoretical Wastewater Production Rate (TWPR), based on the assumption that approximately 85% of water consumed is returned to the sanitary/combined collection system. The TWPR calculated for the study area using the water consumption data, as provided by the City for the year 2004, yielded an average value of 378 Litres per capita per day (Lpcd) for the single family residential developments, compared to the City-wide value of 272 Lpcd, based on 2001 records. The difference could be in part attributed to the different record years used which will have an impact on the water consumption and an assumption that 85% of the consumption returns to the sewer.

Sewer Network Database in ARC GIS Format

The physical system database for the combined, sanitary and storm sewer systems was provided by the City. This defines the collection system networks including pipe, manhole, catchbasin physical characteristics and other information on special appurtenances such as weirs, orifices, sluice gates, flapgates, siphons and pumps. All of these structures were incorporated in the hydraulic model. Data gaps in the database were filled either by interpreting

available information (topographic maps, aerial photos, etc.), or by field observation, surveys, etc.

Aerial/Ortho Photography

Aerial photography is used to assess actual land use and identify changes in the area that have a potential impact on the study. It is also used to identify roof areas, paved and grass areas within each sub-catchment area in the model.

Topographical Information

The City provided the digital elevation model (DEM) which is based on 3 m grid point spacing with 16-bit pixel depth derived from 1:10,000 aerial ortho - photography. It was determined that this DEM does not have the sufficient resolution to define major drainage features. Therefore, another DEM was developed based on topographical maps with intervals at 0.5 m and consist of 1-m grid point spacing. The data were used to determine surface ponding areas, surface flow path throughout the area and surface drainage area boundaries.

5.1.2 Group 2 Data

The following presents a summary of Group 2 data compiled, reviewed and used in the analysis:

Previous and Present Studies

Reports of all previous studies carried out in the last two decades, and current studies were collected and reviewed. These studies are for water quality control facilities and sewer outfall improvements. A complete list of the reference document is provided in T.M. #5, Attachment 3.

Historical Basement Flooding

Figure 5.1 shows the locations of basement flooding reported to the City for 6 different events. The events include May 12, 2000, July 19, 2007, June 23, 2008, July 8, 2008, July 19, 2008, and July 22, 2008. Out of approximately 38,000 properties in Area 32, there were 285 reported basements flooded during the above mentioned events as provided in the Hansen Records and site visits in review with residents. Some of the streets that have experienced flooding include Lee Avenue, Kew Beach Avenue, Kerr Road, Highfield Road and Minto Place.

The Basement Flooding Reports known as Hansen Records were provided by the City in a condensed spreadsheet. The collection of this information provided valuable information on historic flooding events. There are 186 entries in the spreadsheets. The cause of flooding in many reports was "blockage in the sewer service line", which was removed by the City O&M personnel. Other observations which could be gathered from the Hansen Records include:

- The main problem description was either related to the sewer line (backup or blockage) or to the sewer service line (blockage). Very few are related to maintenance hole damage or maintenance hole overflowing (i.e Woodbine Avenue and Kew Beach Avenue).
- Water entered the basement through the floor drain in most of the reports. Very few indicate cracks in the wall, or water entered from the windows (e.g. Pape Avenue).
- The type of water flooding the basement is shown only in a very few reports. This is given as either storm, sanitary or combined.
- In very few reports, the depth of water in the basement as claimed by the resident was reported.

Most of the other information listed in the report were not filled, including depth of basement and information related to surface flooding and surface drainage conditions.

Historical Operation / Maintenance Records

Toronto District staff were interviewed to review the City's operations and maintenance program. District staff indicated the following programs:

- Catchbasin cleaning/street sweeping is carried out by the Transportation Services department at regular intervals through the year. They are responsible for clearing debris from catchbasin inlets.
- Catchbasin sumps are cleaned out on a yearly cycle for main roads (arterial and collector), and a 2 year cycle for residential roads throughout the City.
- Storm and sanitary maintenance holes are inspected on a continuous basis, but largely driven by complaint or City staff knowledge of the system.
- City staff knowledge of the local collection systems leads to more frequent inspection of problem locations (i.e. deposition).
- Sanitary sewer flushing is done on a 5 year cycle. During this cycle, manholes are inspected which includes an assessment of brick work, steps and clearing of debris if found.
- Historical operations and maintenance records are maintained in Hansen database system.
- CCTV work is undertaken in association with special studies for the City, in advance of road re-surfacing, or other utility work where a sanitary pipe is located.
- Storm sewer inspections are largely driven by complaint or City staff knowledge of the system.
- Maintenance on water courses and storm outfalls is carried out once a year or more frequently if needed (i.e. after a significant rainfall event) by Parks staff.
- Stormwater management facilities are checked after most rainfall events to ensure that inlet/outlet structures are clear of debris and are functioning properly.

The City has recently concentrated its sewer inspection and cleaning program in areas identified with "clusters" hardest hit with basement flooding to ensure the sewers are cleaned of debris, fat and grease accumulation. An enhanced level of service has been implemented including increased frequency of inspection and cleaning of road catchbasins, and weekly inspection of the storm outlet structures located along the Eastern Beaches.

CCTV Records

Ongoing CCTV inspections are being conducted by Toronto Water's Infrastructure Asset Management and District Operations for local trunk sewers to identify deficiencies. The sewers are then cleaned and flushed by District Operations as required. Deficient pipes are identified and posted in the next capital budget for repair, relining, root intrusion removal or replacement.

Recently, CCTV inspection of areas experiencing flooding and cleaning of the Lake Front Interceptor have been completed.

The available CCTV records for Area 32 for the storm and sanitary/combined sewer systems are shown in T.M. #5, Attachment 3.

Smoke-test / Dye-test Results

Historically Smoke/Dye testing has been undertaken by the City to address operation and maintenance issues as required. This investigation technique has been used in response to basement flooding events in the area and in support of engineering reports prepared by staff or consultants on behalf of the City. This investigative technique is also used by the City to identify cross connections if one is suspected. There is no program of routine smoke and dye testing and historical records are not readily available. Where the testing is done by a consulting firm, the information is available through the study reports.

Geotechnical Reports for Groundwater and Soil Conditions

Hydrogeological information is useful in defining the influence of groundwater on the sanitary/combined and storm sewer systems in the form of groundwater infiltration. The ground water level information available from borehole records supplied by the City has been assessed to identify areas where ground water levels may affect the sewer systems. T.M. # 3, Attachment 1, provides a detailed desktop hydrogeological review for the study area.

The overburden geology of the site was further examined by plotting borehole data from the City of Toronto's Borehole Database. Six conceptual cross-sections were developed across Area 32.

As indicated in the cross-sections, the upper overburden geology across the study area consists of the following units:

- Sand (Unit 1) – This unit is found at ground surface in the north-eastern portion of the study area.
- Silty Sand to Sand and Silt (Unit 2) – This unit is up to 15 m thick and is generally found at ground surface across most of the site. It is also located in the Don River Valley.
- Sandy Silt Till (Unit 3) – This unit is generally found near ground surface beneath units 1 and 2. It is occasionally located at depth.
- Silty Clay / Clayey Silt / Till (Unit 4) – Like unit 3, this unit is generally found beneath units 1 and 2. However, in the north-western portion of the study area, it is found at ground surface, and at depth in some locations.
- Peat (Unit 5) – This material is generally found near ground surface in the Don River Valley and near the lakeshore.

Shale bedrock was encountered at elevations 50 meters above sea level (masl) to 75 masl. The overburden geology as interpreted by the six-cross sections was generally consistent with the surficial geology as mapped by the OGS (2003).

It is interpreted that the sand and silty sand present at ground surface in Area 32 (Units 1 and 2) are likely associated with littoral and foreshore basinal deposits from the former glacial Lake Iroquois. These deposits were also associated with recent alluvial deposits in the Don River Valley. Halton Till varies texturally from sandy silt to clayey silt till interbedded with silt, clay, and gravel, which is consistent with what was observed. Units 3 and 4 are fine grained, and are likely associated with the Halton Till. Peat is generally formed in swampy regions, which is consistent with where these units were identified (Don River Valley, near the lakeshore).

Groundwater elevations range from over 120 meters above sea level (masl) in the northeast to 70 masl near the lakeshore and the Don River Valley. The groundwater flow direction is towards Lake Ontario across most of the area, while flow along the western edge is towards Don River.

The groundwater depth is generally less than 5 meters (between 0 and 5 m) below ground surface across most of Area 32, particularly in the south and central areas. This coincides with the occurrence of majority of the basement flooding events. An area North of Kingston Road, between Woodbine Avenue and Victoria Park Avenue (*Upper Beaches*) contains deeper groundwater levels between 5 to 10 mbgl. Groundwater levels on some of these plots may not necessarily correspond with the shallower aquifer, but may be representative of the deeper system. At the south end of the Don River groundwater depth ranges from 0 to 5 mbgl. North of Gerrard Street East the depth to groundwater increases to depths of up to 20 mbgl. Similarly, there are four locations in the southwest and central area of the site where groundwater depth also lies within this range. However, the majority of the basement flooding events corresponds to a groundwater table reading of less than 5 mbgl. While this may indicate that groundwater is the main source of inflow/infiltration in the sewer system, street flooding and sewer capacity were among the main evident reasons for flooding confirmed by field observation and the Hansen Complaint record.

Improvement Works Done in the Sewer System

The study area has not undergone major improvements in the sewer system in recent years. The most significant however, has been the road sewer separation program that started in the 1950s and resulted in partial separation in most of the study area. Recent and future developments like the Woodbine Race Tracks are being built with separate storm and sanitary sewer systems.

Another City program that has been implemented in this area is the Downspout Disconnection Program. This program, however, has not been implemented globally but rather it has been left to resident's discretion to disconnect their home downspouts from the sewer system. Disconnection of the downspouts provides a relief to the combined sewer reducing the probabilities of basement flooding.

Also, since the 1980s several storage facilities have been constructed in the Eastern Beaches area for stormwater relief and combined sewer overflow storage. These include oversized sanitary sewers at Kippendavie Avenue and Kew Beach Avenue, Waverley Road, Kenilworth Avenue stormwater storage tank and Maclean Avenue stormwater/CSO storage tank which were constructed to improve water quality in the beaches. Also, in-line storage tanks have been recently constructed as part of the Coatsworth Cut Wet Weather Flow control plan. The proposed box culvert intercepting the four (4) storm outfalls and connecting it to the Maclean Avenue Tank is scheduled for construction.

New Development and/or Re-development in the Study Area

The Eastern Beaches area is a well established area in Toronto and therefore very few significant developments have taken place in recent years. All future and recent development will be required to be serviced by separate sewer systems.

5.2 Field Investigation

5.2.1 Field Survey

The field survey comprised of a walkthrough of the neighbourhoods in the entire study area and making observations and compiling statistics on the following:

- Roof downspout connections;
- Low lying points where potential surface ponding may occur; and

- Reverse-sloped driveways.

Based on the available sources of information, the connected and partially connected downspouts were assumed to be connected mainly to the combined sewer system unless otherwise indicated by the other sources of information such as District staff.

The results of the survey which was undertaken during the fall of 2009, shows that out of the 41,049 units within the study area, there are 19,288 units (47%) with disconnected downspouts, while there are 9,386 units (23%) with connected downspouts. The balance either has no downspouts or units that are not residential such as institutional, commercial, industrial, parks, parking lots etc. Details of the method used and the results of the roof downspout connection survey are given in T.M. #1, Attachment 1.

From the field survey, low lying areas were also identified as well as low points in the road surface where there may be potential for ponding. Direction of flow for the overland flow system was indicated as best as possible. This was all confirmed with the Digital Elevation Model (DEM) as shown in detail in T.M. #1, Attachment 1.

The results of the survey show that many of the low points are located in the lower elevation below 90 m and where there are major transportation routes (i.e. railways, highways, etc.) crossing the roads.

As entrance to the individual lots was not included in the scope of work, a detailed assessment of the lot grading was not possible. It was observed that the lot grading has been slightly modified in many lots within the study area due to landscaping. However, there were no lot features observed that could be identified as contributing to basement flooding issues.

The locations of reverse-sloped driveways were also recorded during the roof downspout survey. This information was plotted onto the maps of the area and the locations of properties with reverse-sloped driveways in Area 32 are given in T.M. #1, Attachment 1.

The results of the survey show that the reversed-sloped driveways are scattered throughout the study area. However, some pockets of reverse-sloped driveway do occur such as north and south the CN railway corridor between Coxwell Avenue and Woodbine Avenue area bounded by CN rail, Don Valley Parkway and Gerrard Street East; and area bounded by Eastern Avenue / Kingston Road, Coxwell Avenue and Gerrard Street East / Eastwood Road.

Out of the 37,310 residential units observed, only 699 units (1.9%) have reverse-sloped driveways.

5.2.2 Catchbasin Survey

A survey of over 9,000 catchbasins (CBs) was undertaken to confirm the database provided by the City for modelling purposes. A GPS unit was employed to carry out the survey of the CBs in the streets throughout the study area.

Each CB was referenced with respect to northing and easting and with the vertical elevation tied in to the Geodetic Survey of Canada (GSC) datum. The results of the CBs survey are identified as follows; CBs that are shown in the City's database but do not exist in the field; CBs that were not accessible for measurements (e.g. vehicles in the way) and CBs not in the database but were found during the survey. Overall, the CBs that were surveyed showed close agreement with those in the database.

Type of catchbasins was also surveyed and the results show that approximately 95% of the catchbasins found in the study area are of the fish bone type with less than 5% being of the parallel and curb inlet type.

As part of the catchbasin survey, the streets where road sewer separation has taken place were also surveyed in order to determine whether the CB/MH covers in the combined sewer had been replaced with solid manhole covers. The results of the survey show that a significant number of manhole covers in the combined sewer system in the road storm sewer separation areas have not been replaced with solid cover and overland flow can still enter the combined sewer through the perforated cover. It is therefore recommended to replace these covers to eliminate overland flow entering the combined sewer and direct it to the storm sewer, as it was originally anticipated when the road storm sewer was constructed. This overland flow could be a significant contributor to the I/I in the combined sewer system and eliminating it will relieve the sewer system and reduce wet weather flow to the treatment plant.

5.2.3 Inspection of Flow / Overflow Control Structures

The purpose for the inspection of the 30 flow/overflow control structures was to check the information on database provided by the City so that accurate information could be used in the modelling of the various sewers where these structures are located. Information collected included measurements of weirs, orifices, sewers, and other physical components, depth of flow and depth of different structures from surface, conditions of structures (debris, sediment levels, etc.) and photographs were undertaken in order to confirm their present settings for modelling purposes. The location of these structures and the results of the survey at each structure are given in T.M. #1, Attachment 1.

Structures located on Queen Street and Coady Avenue and Queen Street and Alton Avenue were flooded and therefore the survey was not conducted. Also, three (3) structures could not be located since they appear to be near street car tracks and may have been paved over. The results of this survey were used to check and correct the information in the data base.

5.2.4 Inspection of Storm Outfalls

Marine investigation of 14 storm outfalls to the lake shore was conducted by Galcon Marine Ltd. in November 2009. The purpose of this investigation was to determine the condition of the outfalls and the amount of sediment accumulated in the vicinity of the outfall mouth to assess the impacts they may have in the basement flooding that has been experienced in the Eastern Beaches. The inspection determined that five (5) outfalls are inactive and they have been blocked due to the construction of the Maclean Avenue and Kenilworth Avenue existing control tanks. Three (3) more are proposed to be blocked in the future as a result of the construction of the proposed storm water control box culvert. The depth and extent of sediment at the outfalls and inside the conduits were identified, and hence, the recommended action was given. This is all shown in Table 5.1 and Figure 5.2. More details for each outfall are given in T.M. #1, Attachment 1.

Table 5.1 Summary of Inspection Condition for Eastern Beaches Storm Outfalls

Eastern Beaches Storm Outfalls	Outfalls Inspection Condition	Recommendations
1. Neville Park	Depth of sediment at the mouth of outfall was 30 mm; 5 m into the outfall it was 220 mm and at the upstream MH (40 m from the outlet) there was little or no sediment	Outfall will be flushed as part of the Eastern Beaches Storm Sewer Control at Maclean Ave. project.

Eastern Beaches Storm Outfalls	Outfalls Inspection Condition	Recommendations
2. Nursewood	- Small pile of sediment approx. 120 mm deep exists outside outfall. - Inside the outfall, sediment at 40 mm depth at the outlet, increases to 270 mm about 15 m in and decreases to 120 mm at the MH, a distance of approx. 33.4 m. 30 mm river run stones also found in the MH.	Outfall will be flushed as part of the Eastern Beaches Storm Sewer Control at Maclean Ave. project. Outfall will be plugged at box culvert.
3. Silver Birch	- Lake end of outfall is completely full of river run stones, hence diver could not enter the pipe. - The upstream MH, approx. 34 m from the outlet, was surcharged.	Outfall will be flushed as part of the Eastern Beaches Storm Sewer Control at Maclean Ave. project. Outfall will be plugged at box culvert
4. Willow	No sediment visible in the outfall since there is a 1.53 m difference in elevation between the invert of the outfall and lake bottom.	Outfall to be plugged as part of the Eastern Beaches Storm Sewer Control at Maclean Ave. project. No flushing is required.
5. Balsam	This outfall is plugged with concrete. Upstream MH could not be located.	No action required - INACTIVE
6. Maclean	- Sediment depth near the outlet is approximately 150 mm. - Sediment depth at approx. 20 m from outlet is about 65 mm - Within 35 m to 43 m from the outlet, sediment depth varies from light dusting to less than 10 mm. - The walls of the outfall are covered with zebra mussels which are approx. 12 mm thick.	Clean up of outfall required. Medium priority.
7. Glen Manor	This outfall is plugged with concrete. Upstream MH could not be located.	No action required - INACTIVE
8. Leuty	This outfall is plugged with concrete. Upstream MH could not be located.	No action required - INACTIVE
9. Lee	- At the entrance to the outfall, the depth of sediment was 600 mm. Hence the diver was not able to enter. - Underneath the grate, the sediment ranged from 400 to 600 mm.	Clean up of outfall recommended. High priority.
10. Waverley	- Outfall is completely blocked at the outlet. - Outfall is full of river run stones and concrete pieces from above the pipe.	Clean up of outfall recommended. High priority.
11. Kenilworth	- At opening under the grates, the depth of sediment is 280 mm. - Relief holes at the bottom of the grates are completely blocked with sediment. - Sediment depth ranges from 210 mm to 230 m at a distance from 5 m to 10 m. - Beyond the 10 m, sediment was not found. - The tunnel part of the outfall had some pieces of concrete missing as well as some exposed rebars on the walls and roof.	Clean up of outfall recommended. Low priority.

Eastern Beaches Storm Outfalls	Outfalls Inspection Condition	Recommendations
12. Kippendavie	- MH near the outfall had little to sediment. - Of 3 pipes connecting to the MH, the east pipe had 25 to 100 mm depth of sediment near its mouth.	No action required - INACTIVE
13. Woodbine Ave	- MH near the outfall had little to no sediment. - Of 3 pipes connecting to the MH, the north pipe had 150 mm depth of sediment near its mouth consisting of mostly leaves and plant material.	No action required - INACTIVE
14. Keating Channel	Outfall and MH could not be located.	No action required.

5.2.5 Inspection of Submerged, Silted Lake Outfalls

Investigation of ten (10) storm sewer outfalls with combined sewer overflows was performed by D.M. Robichaud Associates Ltd. in November 2009. Six (6) outfalls to the Coatsworth Cut and four (4) to the Keating Channel were inspected. The purpose of this investigation was to carry out a CCTV inspection from dry upstream manholes to determine the extent of the backwater from the lake and also to determine the accumulation of sediment in the pipes.

Once the CCTV inspection was initiated, it was found out that there was extensive depth of sediments along all the lake outfalls. The depth of sediment varied from little to no sediment to over a meter at some manhole, with the water in the sewers flowing above the sediment. The CCTV inspection was not possible due to the CCTV camera getting covered with mud/debris as it scraped along the top layer of the sediment. Instead of CCTV inspection, each MH was opened and the depth of sediment, water depth, and other visible conditions were recorded and photographs taken. Knowing the depth of sediment at the surveyed manhole and the sewer dimensions between the manholes, the total accumulated sediment in each outfall was estimated.

The results are provided in Table 5.2 and Figure 5.3 with more details provided in T.M. #1, Attachment 1.

Table 5.2 Summary of Submerged, Silted Lake Outfall Investigation (sediment measurements taken during the week of October 26, 2009)

Outfall	Manhole ID	Sediment Depth (m)	Sewer Diameter (mm)	Sewer Length (m)
TH- 4(2)	3522017759	No sediment		
	3484617871	0.56	1350x1650 ~ 2100X1350	395
	To outfall		2500x1800	428
TH-4(1)	3542817905	No sediment		
	3484517870	0.56	1650 ~ 2100x1350	742
	To outfall		2500x1800	428
TH-3(1)	3541518206	No sediment		
	3470618416	0.67	2700	776
	To outfall		2500x1500	72

Outfall	Manhole ID	Sediment Depth (m)	Sewer Diameter (mm)	Sewer Length (m)
TH-3(2)	3552518539	No sediment		
	3472518390	0.67	1600 ~ 1500x1200	1162
	To outfall		2500x2500	107
E-13	3593019203	No sediment		
	3554319301	1.03	300 ~ 975	307
	3563219305	1.11	975	3
	3555419328	0.34	1350	82
	3547619355	0.52	1350	82
	To outfall		2700x2100	119
E-14	3615319552	No sediment		
	3595719626	0.29	300 ~2400x1800	213
	3558519719	0.47	2100	386
	To outfall			
E-11(1)	3615319552	No sediment		
	3564719809	0.12	2400x1800 ~ 2600x1800	647
	3561219779	0.21	2700x2200	58
	To outfall		3350x2350	60
E-11(1)	3633519963	No sediment		
	3566019819A	0.14	600x900 ~ 2600x1800	830
	3559919778	0.15	2700x2200	74
	To outfall		3350x2350	59
E-12(1)	3606419273	No sediment	2100	627
	To outfall			
E-12(2)	3618019316	No sediment	2100	822
	To outfall			

5.2.6 CCTV Inspection and Fog Testing

CCTV inspection for seven (7) sewer sections and Fog testing in eight (8) areas were conducted by D.M. Robichaud Associates Ltd. as part of the study. The purpose of the inspection was to determine sewer system condition and service connections in areas subjected previously to basement flooding. The results showed system deficiencies in some areas:

- Sediment accumulation, encrustation and blockage in sewer sections;
- Cracks and broken parts in sewer sections;
- Blocked catchbasins which could be contributing to surface or basement flooding; and
- Interconnection between the storm and sanitary/combined system.

Detail results of the CCTV inspection and Fog testing are provided in T.M. #2, Attachment 1.

5.3 Flow Monitoring Program

The flow monitoring program was carried out in two periods with the first one carried out from mid-October 2009 to mid-December 2009 and the second from the beginning of April 2010 to the end of October 2010. Fifteen flow monitors and two rainfall gages were installed during the monitoring period. Out of the fifteen (15) flow monitoring stations, nine (9) were in combined sewers, two (2) in sanitary sewers and four (4) in storm sewers. The flow and level monitoring stations were strategically located throughout the area to establish representative depiction of the combined, sanitary and storm sewer usage across different physical characteristics and land uses over time. In Stage 2 monitoring, some stations were located at different locations to optimize the benefits of the program. The location of the flow monitors and type of flow monitored at each location is given in Tables 5.3 and 5.4 and Figures 5.4 and 5.5, respectively, for Phase 1 and Phase 2 monitoring program.

The objectives of the combined, sanitary and storm sewer flow monitoring program were to collect dry and wet-weather flow in the existing storm and sanitary/combined sewers in order to:

- Quantify the flow generation parameters from the tributary areas;
- Analyse combined, sanitary and storm flow monitoring data; and
- Calibrate a hydrologic and hydraulic model to allow for the effective analysis of the causes of Chronic Basement Flooding in Sewardshed Area 32 and the subsequent simulation of remedial measures.

As a result of the flow monitoring, dry-weather sanitary sewer flow patterns were established. Using the available population and land use data, (from the 2001 Census), it was possible to quantify population derived dry-weather flow (i.e. wastewater/sewage) as well as other sources of dry weather flow (groundwater infiltration) in the study area. This was necessary to evaluate the dry-weather conditions in the sewer, the average and peak dry-weather flow per capita, and the daily variability in sanitary flows.

Wet-weather flow data was monitored for the combined and sanitary sewer systems, to monitor the response of the system to rainfall (direct surface flow and infiltration and inflow). Specifically, infiltration and inflow (I/I) represents the flow additional to dry-weather flow that is caused by rainfall entering the sanitary sewer system through manhole covers, cracked or leaky pipes, and illegal connections. In addition, roof flow and surface runoff represents a major contributor to the combined sewer system during wet weather conditions. It was necessary to quantify stormwater flows to determine if wet-weather sanitary flows are partly responsible for basement flooding.

In addition to assessing dry-weather and wet-weather flows, the monitoring results were used to calibrate the hydrologic/hydraulic model. The calibrated model was used to evaluate the response of the sanitary system to observed and design rainfall events. Further details are provided in Section 6.

Similar to the sanitary/combined sewer monitoring program, storm sewer monitoring stations measured the response of the storm sewer system to rainfall. The observed data were used to calibrate and validate the model for the storm sewer system. In the storm sewer monitoring only the minor system (sewer) flows were monitored. The major system flows from overland and roads were not monitored.

The details of the flow monitoring program and the results obtained are provided in T.M. #4, Attachment 2.

Table 5.3 Location of Flow Monitors (Phase 1)

Station No.	System Type	Manhole No.	Location
1	Combined	3762921041	at Main St and Lyall Ave
2	Combined	3708416146	on Royal Drive, South of Danforth (exit to DVP)
3	Combined	3617816438	Langley St Easement, flow towards DVP
4	Combined	3640218034	at Jones Ave, North of Gerrard St E
5	Combined	3654818659	at Greenwood Ave, South of Gerrard St E
6	Combined	3602020708	at end of Kippendavie, South of Kew Beach Ave
7	Storm	3598220804	East of Kippendavie Ave
8	Storm	3598220804	West of Kenilworth Ave
9	Storm	3661722511	Nursewood Ave
10	Storm	3539818489	on Mosley St, between Eastern and Leslie
11	Sanitary	3541918555	at Mosley St, West of Leslie St
12	Sanitary	3613819044	on Highfield Rd, at Kerr Rd.
13	Combined	3660622165	Silver Birch Rd
14	Combined	3635517623	at Pape Ave, South of CNR Fenceline
15	Combined	3616417474	at Carlaw Ave, South of Gerrard St E

Table 5.4 Location of Flow Monitors (Phase 2)

Station No.	System Type	Manhole No.	Location
1	Combined	3762921041	Main Street, South of Lyall Street
2	Combined	3736616925	Logan Avenue, North of Danforth Avenue
3	Combined	3647016595	Broadview Avenue, South of Bain Avenue
4	Combined	3647318009	Jones Avenue, North of Gerrard Street East
5	Combined	3655318658	Greenwood Avenue, South of Gerrard Street East
6	Combined	3596519583	Eastern Avenue, West of Coxwell Avenue
7	Storm	3598220804	70 Kew Beach Avenue (off of bike path)
8	Storm	3598220804	71 Kew Beach Avenue (off of bike path)
9	Storm	3661722511	South end of Nursewood Road (on beach)
10	Storm	3622918092	Jones Avenue at Sprout Avenue
11	Combined	3554617773	Boston Avenue, North of Queen Street East
12	Sanitary	3613819044	Highfield Road, North of Kerr Road
13	Combined	3660622165	Glenfern Avenue, East of Silver Birch Avenue
14	Combined	3661917543	Pape Avenue, North of Riverdale Avenue
15	Combined	3630217434	Carlaw Avenue, North of Simpson Avenue



Legend

- Basement Flooding (May 2000)
- Basement Flooding (July 19, 2007)
- Basement Flooding (June 23, 2008)
- Basement Flooding (July 8, 2008)
- Basement Flooding (July 19, 2008)
- Basement Flooding (July 22, 2008)
- Watercourse
- Study Area



March 10, 2010

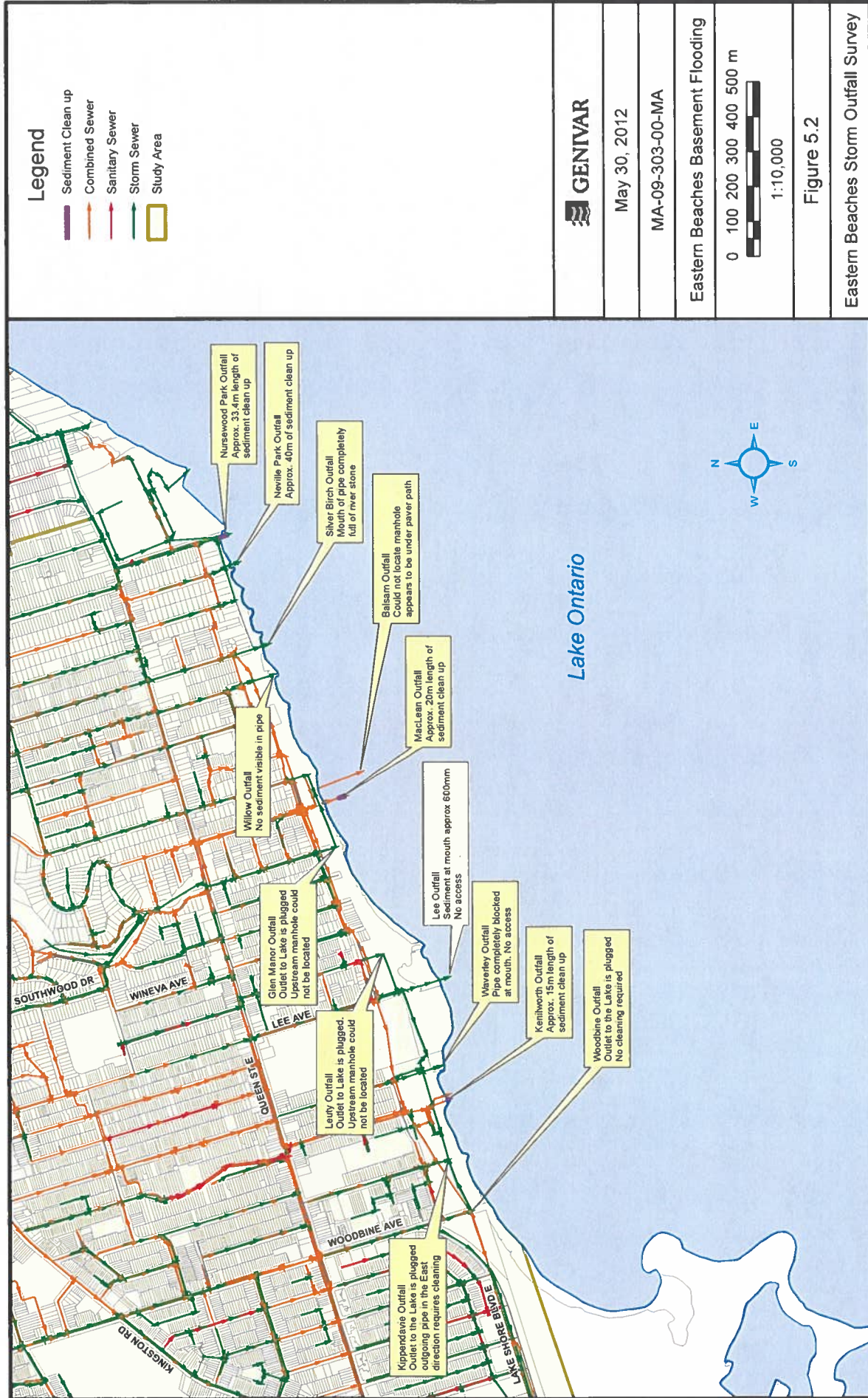
MA-09-303-00-MA

Eastern Beaches Basement Flooding



Figure 5.1

Basement Flooding Locations



Legend

- Sediment Clean up
- Combined Sewer
- Sanitary Sewer
- Storm Sewer
- Study Area

GENIVAR

May 30, 2012

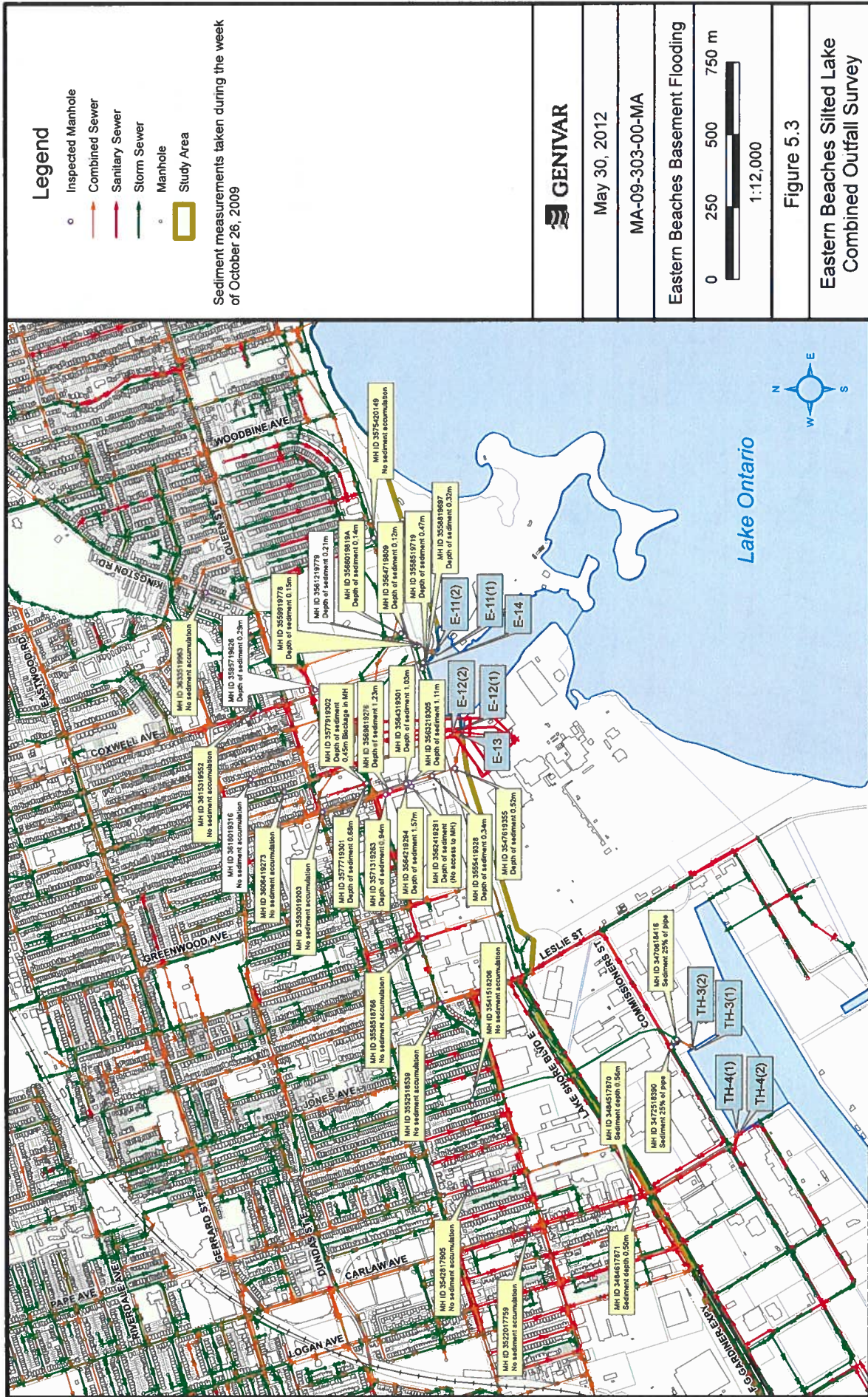
MA-09-303-00-MA

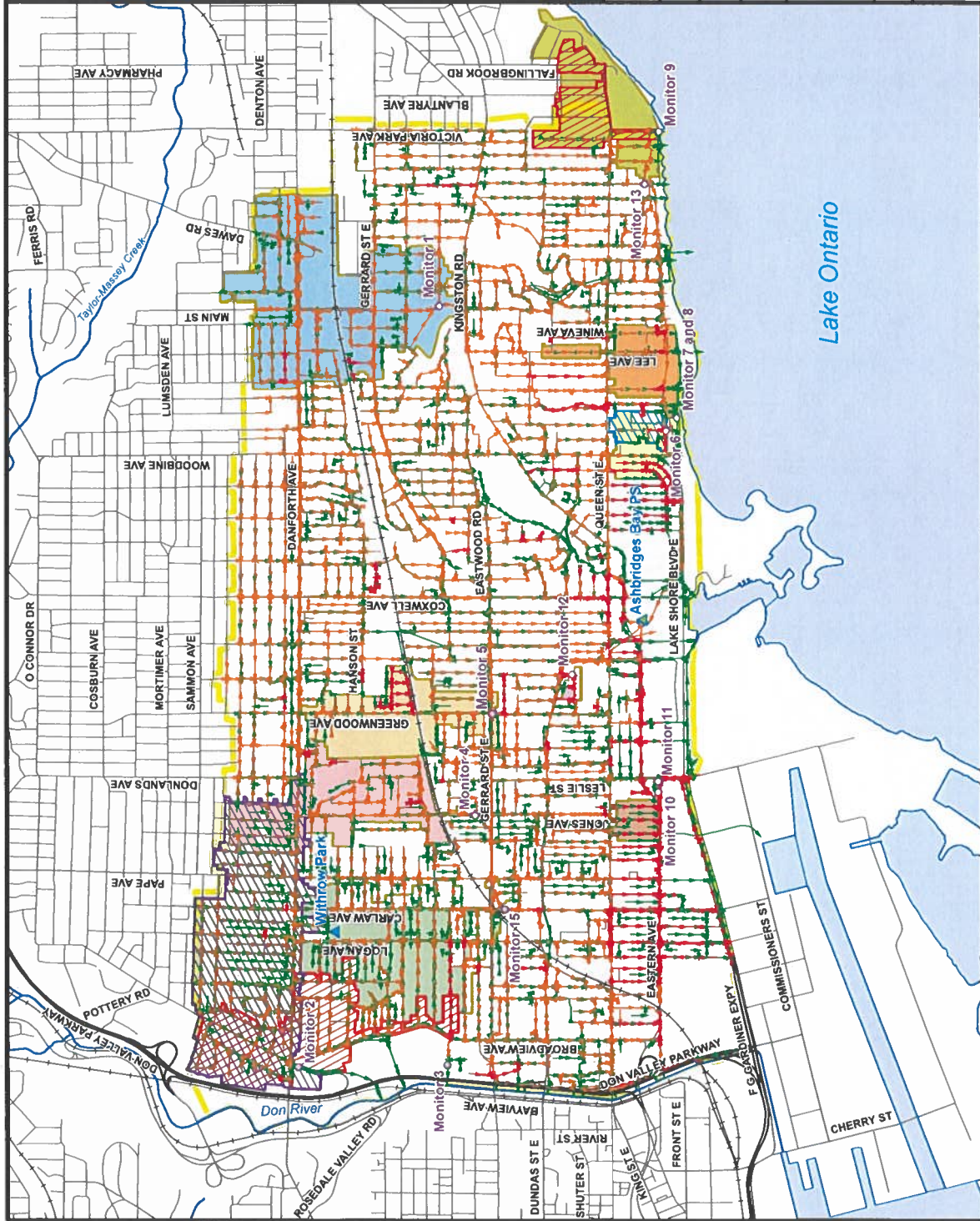
Eastern Beaches Basement Flooding

0 100 200 300 400 500 m
1:10,000

Figure 5.2

Eastern Beaches Storm Outfall Survey





Legend

- Flow Monitor (Phase 1)
- Existing Rain Gauge
- Proposed Rain Gauge
- Sanitary Sewer
- Combined Sewer
- Storm Sewer
- Study Area
- Station 1 Combined Sewershed
- Station 2 Combined Sewershed
- Station 3 Combined Sewershed
- Station 4 Combined Sewershed
- Station 5 Combined Sewershed
- Station 6 Combined Sewershed
- Station 7 Storm Sewershed
- Station 8 Storm Sewershed
- Station 9 Storm Sewershed
- Station 10 Storm Sewershed
- Station 11 Sanitary Sewershed
- Station 12 Sanitary Sewershed
- Station 13 Combined Sewershed
- Station 15 Combined Sewershed



May 31, 2012

Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

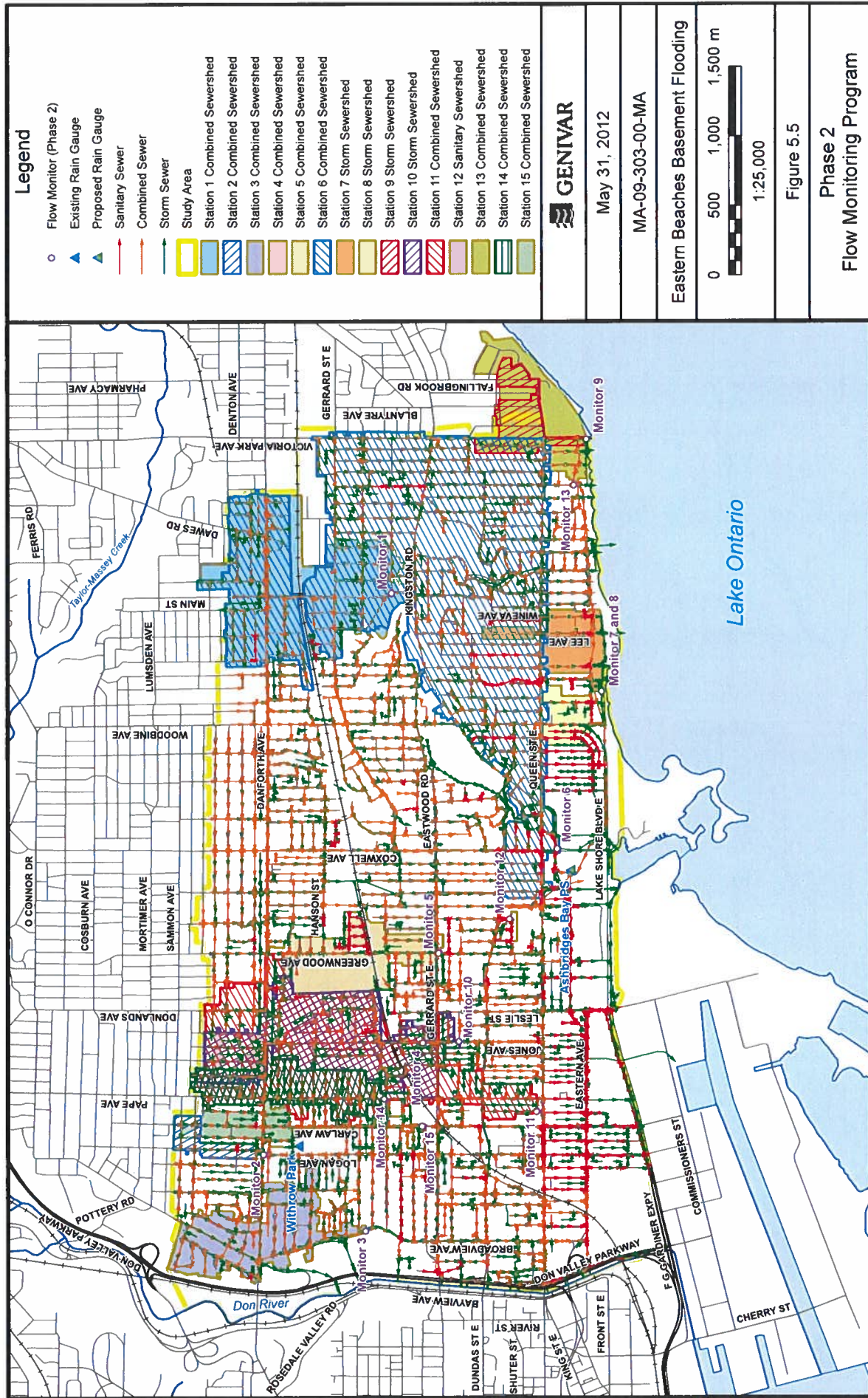
0 500 1,000 1,500 m

1:25,000

Figure 5.4

Phase 1

Flow Monitoring Program



6. Assessment of Existing Systems

6.1 General

The drainage systems in the study area were analysed to assess their capacities and identify problem areas and causes of flooding. In addition to the analysis of all collected data and information as explained in the previous section, a detailed hydrologic/hydraulic computer model of all the systems was used for the assessment. The model used is based on InfoWorks CS Version 9.5 by Wallingford Software Inc., and includes all sanitary/combined and storm networks. The objectives of the systems assessment and computer model application are:

- To define the primary causes(s) of basement flooding;
- To define the magnitude and extent of the surcharging in the collection systems as well as to determine surface flooding depths;
- To aid in the development and evaluation of alternatives based on the City's target level of service/performance; and
- To integrate the sanitary/combined and storm drainage systems modelling to identify potential flooding interactions in the study area.

6.2 Description of Existing Systems

6.2.1 Sanitary/Combined Sewer System

The study area consists of an extensive sanitary/combined sewer system which generally flows from north to south. Although the City has in the past undertaken an extensive road sewer separation program, there are still extensive areas which have combined sewers consisting of only one pipe to convey the sanitary and storm flows. There are approximately 4,117 combined sewer pipes (MH to MH) and 673 sanitary sewer pipes. The locations of the sanitary and combined sewers are shown in Figure 6.1.

The dry and wet weather flows from the sanitary/combined sewer system are intercepted by three (3) interceptors west of the Ashbridge Bay Wastewater Treatment Plant and one (1) trunk sewer and one (1) interceptor from the eastern side. These consist of the Mid-Toronto Interceptor (MTI), High Level Interceptor (HLI) and Low Level Interceptor (LLI) from the west and the Queen Street Sanitary Trunk Sewer (Queen St STS) and Lake Front Interceptor (LFI) from the east. The interceptors, all draining to the Ashbridges Bay Treatment Plant, are operated by several inter-connections and a network of control chambers equipped with fixed weirs or motorized gates. Once the capacities of the interceptors are exceeded during wet weather flow events, the overflows are discharged to the lake via several outfalls.

The system contains 75 gates, over 200 weirs, 28 orifices and 20 inverted siphons. The sewer system drains, storm flows and combined sewer overflows through 64 outfall structures to the Don River and the Lake.

6.2.2 Storm Sewer System

The storm sewer system generally drains from north to south towards the Lake. Except for a few pockets where full storm sewer separation exists due to new developments (e.g. Woodbine Avenue and Queen Street East area, Jones Avenue north of Railway track, Carlaw Avenue and Lake Shore Boulevard), most of the study area consists of partial road sewer separation. As shown in Figure 6.2, there are approximately 3,280 storm pipes and 392 storm sewer pipes with CSO.

In the combined sewer area, the road storm sewers receive storm flow only from the surface through catchbasins. House flows from roofs and foundation drain typically drain to the combined sewer. There are approximately 9,000 catchbasins within the study area. In areas where road sewer separation has been applied and in separate sewer system areas, catchbasins are connected to the storm sewer. In other areas, where no storm sewer exists, catchbasins are connected to the combined sewer. Areas with no storm sewers could be observed in Figure 6.2.

6.2.3 Overland Flow System

The storm drainage system includes a minor (storm sewer) and major (overland) flow system. The overland flow system within the study area typically consists of streets with flows constrained by the curb along both sides of the street. The street carries the flows from the surrounding lots in between catchbasins, and flows exceeding the capacity of the catchbasins.

The DEM with break lines was used to delineate the overland drainage system features such as surface drainage flow path and direction, surface ponding areas, and drainage area boundaries. This information was supplemented with field investigation during the roof downspout disconnection and catchbasin survey. Figure 6.3 shows the overland flow path.

It should be mentioned that at the time of development in the study area, no consideration was given to the dual drainage system concepts. The storm drainage system was not designed for a major storm event, say 100-year design storm event, and checked for flows exceeding the capacity of the minor system to be conveyed by the major overland flow system to a safe outlet without causing flooding problems.

6.3 Model Development

A detailed model for all drainage networks, sanitary/combined sewer system, storm sewer system and overland flow system was developed. A single model was required in order to consider the interaction between the sanitary/combined sewer system and the storm sewer system through hundreds of diversion structures connecting the two systems and the interaction between the combined and storm sewer systems and the overland flow through catchbasin inlet capacity limitation.

6.3.1 Sanitary/Combined Sewer System Model Setting

The sanitary/combined sewer model used the following settings:

- RTK method;
- DWF calculated based on population from the data base and per capita rate from the monitoring data;
- DWF calculated in ICI areas based on L/ha/d calculated from the monitoring data; and
- Water record checked, particularly for high water usage areas and ICI areas.

The baseline sanitary/combined sewer system information was received in a shape file database format, input into the InfoWorks CS computer model and subjected to a thorough data gap analysis and checking. Data gaps and checks were filled through review of the City's plan and profile drawings, and through a series of inference assumptions based on surrounding infrastructure and engineering judgement. Where sufficient uncertainty remained, confirmation with City staff or a site visit and field investigation was undertaken.

Sub-catchment areas were discretized on a manhole to manhole basis. The commercial, institutional and high-density residential areas were typically broken out into separate sub-catchments to allow more flexibility in the application/treatment of average flows, diurnal patterns and connectivity of foundation drains and roofs.

To generate the wastewater flow from the area, land use and population data were utilized within each subcatchment. Land use information, in the form of a shape file, was provided for all of the development blocks within the Study Area. Land use was classified into four categories: Residential Single Family, Multilevel Residential, Commercial/Industrial and Institutional, and Open Space. In addition to shape files, aerial photos were used for defining the unknown land use types.

The flow generated for each subcatchment was based on the distribution of land use within each area as generated in ArcGIS. To deal with subcatchments where there is a mixture of land uses, proportional amounts of each land use were applied to each subcatchment.

Hourly diurnal dry weather flow (DWF) patterns for both weekdays and weekends were extracted from the sanitary/combined flow monitoring data and were input alongside the average per capita flow rate in the Waste Water Group in InfoWorks CS for each monitoring site. Areas outside of the flow monitoring catchments were assigned a wastewater profile of the monitoring area that displayed similar land use, density and population characteristics. For dry weather groundwater infiltration (GWI), the monitoring value was input as a constant base flow.

The RTK unit hydrograph method was utilized to calculate inflow and infiltration (I/I) into the sanitary/combined sewers during wet weather events. The RTK method generates a hydrograph based on precipitation data and catchment area. The total I/I into the sanitary/combined sewer system is determined by combining triangular unit hydrographs from three components of flow:

- Rapid inflow (short-term response);
- Moderate infiltration (medium-term response); and
- Slow infiltration (long-term response).

The following three parameters describe the shape and volume of runoff that enters the sanitary/combined sewer:

- "R" is the fraction of precipitation that becomes direct inflow;
- "T" is the time to peak of the hydrograph; and
- "K" is the ratio of the recession time to time to peak.

"R" can be equated to the area under the unit hydrograph curve and represents I/I volume per unit area as a fraction of precipitation.

The InfoWorks CS model allows for the direct input of RTK parameters.

6.3.2 Storm Drainage Sewer System Model Setting

The storm sewer model was assembled using the database provided by the City and considering every manhole as a node. The area of each sub-catchment draining to a node was delineated using the parcel boundary layer. The distribution between pervious, impervious and roof areas in each sub-catchment was calculated from the aerial photography using ArcGIS. The directly connected roof area to the sewer system was calculated based on the information

obtained during field survey. Roof downspouts directed into the ground were considered to be connected to the storm sewer system or the combined sewer, if there is no storm sewer in the street. The number and location of catchbasins in the database and the type of catchbasin cover were input to the model based on information obtained from the field survey.

Flows from the roof area draining directly to the sewer, was restricted to the capacity of the roof gutter/downspout, considered to be 3 L/s for every 70 m² of roof area. Flows above this limit were considered to spill from the roof and run over the surface, to the catchbasin.

Catchbasin capacity was considered in the model as a head discharge relationship and limited to 46.7 L/s. Catchbasins with inlet control device were modeled using a special curve with limited capacity of 20 L/s.

In the storm model settings, every catchment area was divided into three (3) sub-catchments as follows:

- Sub-catchment 2 – was established for the two runoff surfaces, impervious surface (street pavement, sidewalk, driveways, and parking lots) and pervious surface.
- Sub-catchment 3 – was established for roof areas connected directly to the combined/storm sewer.
- Sub-catchment 4 – was established for disconnected roof areas.

In this approach, sub-catchment 2 and 4 were connected to the storm sewer through the gully (catchbasin) or the combined sewer, if there is no storm sewer, while sub-catchment 3 was connected to the combined/storm sewer. The model parameters for the sub-catchments are shown in Table 6.1.

Table 6.1 Model Setting and Parameters

Parameter	Subcatchment 2 Impervious Surface To Surface (Gully)	Subcatchment 2 Pervious Surface To Surface (Gully)	Subcatchment 4 Roof Disconnected To Surface (Gully)	Subcatchment 3 Roof Connected To Sewer
Manning's n	0.013	0.41	0.3	0.013
Depression Storage (mm)	1.88	5	3.75	1.0

It should be noted that in the modelling, the SWMM routine and Horton Method were used to model the infiltration. The runoff coefficient was not used hence the C-value always remained 1.0. Furthermore, flat roofs in the ICI areas were modeled using the same method and parameters as house roofs.

During the model calibration and validation process, the following parameters were adjusted to obtain good correlation with observed flow monitoring data:

- Subcatchment width (dimension);
- Depression storage (1.0 mm – 5.0 mm); and
- Manning's coefficient (0.013 - 0.41).

In some instances where reasonable calibration results could not be achieved by adjusting the above parameters within acceptable limits, the runoff coefficient or the ratio of pervious surface area to impervious surface area was used, as explained later.

6.3.3 Overland Flow System Model Setting

Surface area characteristics were considered for every sub-catchment which was delineated manhole to manhole. The overland runoff system was then added as an additional link between nodes as represented by the street cross sections. The overland flow system typically consisted of streets with flows constrained by the curb along both sides of the street. The streets were modelled as wide shallow open channels to reflect the appropriate geometry, cross section and channel roughness. The overland channel invert levels were set at the manhole cover levels such that flows into the overland channels can occur when there is flooding out of the manholes on the minor drainage system or when the flow is restricted into the minor system at the catchbasin based on the catchbasin inlet capture capacity. DEM was used for identifying low lying areas, areas of spillage from the street, etc.

Two street cross sections were considered for modelling purposes. One cross section represents a typical local street with a pavement width of 9.1 m and total Right-of-Way (ROW) width of 20.6 m while the second represents a typical collector street cross section with a pavement width of 14.6 m and total ROW width of 26.1 m.

6.4 Model Calibration/Validation

6.4.1 Dry Weather Calibration/Validation

The dry weather flow pattern in the combined and sanitary sewer system was used to calibrate the model. Dry weather flow (DWF) measurements at 10 monitoring stations in the sanitary/combined sewer system from Phase 1 monitoring program was used. These data were complimented by some data from Phase 2 monitoring, specifically the data during April 2010. To calibrate the model, DWF generation rates were calculated for Residential areas and Industrial, Commercial and Institutional (ICI) areas for the monitored combined and sanitary sewer catchments.

Parameters calculated from the model calibration are summarized in Table 6.2, and the results are given in T.M. #6 & 7, Attachment 4. It should be mentioned that, the results are generally within the 5% accuracy for both total volume and peak flow.

Table 6.2 Dry Weather Flow Rates

Station	Area ha	Population	GW L/ha/day	GW L/s/ha	PDWF L/cap/day
Combined Station 1	115.2	7665	9258	0.107	250
Combined Station 2*	12.6	982	4009	0.046	270
Combined Station 3*	69.8	5586	8638	0.1	240
Combined Station 4	61	3927	6587	0.076	195
Combined Station 5	45.9	2942	3610	0.042	140
Combined Station 6*	381.1	20187	6217	0.072	240
Combined Station 11*	57.7	4427	6229	0.072	270
Sanitary Station 12	2.4	218	8839	0.102	80
Combined Station 13	89.4	3189	8183	0.095	175
Combined Station 14*	42.1	3633	3487	0.04	80
Combined Station 15*	39.3	2898	2547	0.029	160

*From Phase 2 Monitoring Program

For the non-monitored areas, an average value of 250 L/c/d for the residential areas was applied in the model.

6.4.2 Wet Weather Flow Calibration/Validation

Model calibration is achieved by changing model parameters to produce results matching the measurements within a reasonable accuracy. Model verification tests the calibrated model performance using measurements different than the calibration period to ensure the repeatability of the model results. The model was calibrated therefore by matching as best as possible the modeled flows to the monitored flows. As was mentioned, during Phase 1 Monitoring Program, only two rainfall events could be used for this process, which occurred on December 2, 2009 and December 9, 2009.

The December 9, 2009 storm event was originally used for calibration and the December 2, 2009 storm event was used for validation. Each of the two events have a total rainfall depth of 15 mm – 27 mm over a 12-hour period and maximum intensity of 5.2 mm/hr – 7.5 mm/hr. This calibration/validation process resulted in good agreement with the observed peak flow and total flow volume compared with model simulated values within a 0-10% difference. When trying to validate the model using the July 8, 2008 storm event, it was found that the model setting and calibrated parameters are not valid for storm events larger than those used for the calibration. To validate the model different parameters had to be used. During the Phase 2 flow monitoring program on June 26-27, 2010, however, another significant storm event occurred. This event produced a depth of 59 mm of rainfall and a maximum intensity of 120 mm/hr and generated scattered pockets of flooding. Upon consultation with the City, it was decided to use this storm event and in an attempt to re-calibrate the model for heavy storm events. The reason was to obtain confidence in the results of model simulation under heavy storm events, much larger than the events that occurred in Phase 1 Monitoring Program and used in the first calibration.

As was considered before, data from all rainfall gauges within the study area were used in re-calibrating the model. The following parameters were adjusted to achieve a reasonable agreement between the measured flows and the model simulated flows:

- The RTK values, mainly the values of R1, T1 and K1;
- Depression storage for roof, paved and unpaved surfaces;
- The dimension, width of the sub-catchment; and
- Surface imperviousness presented in the estimated size of the paved versus unpaved surface areas on the sub-catchment.

The results of the model re-calibration at the monitored locations are given in Technical Memo #6 & #7, Attachment 4. Table 6.3 shows the final parameters used for this calibration using the June 26-27, 2010 storm event.

The model re-calibration results show that the observed peak flow and total volume compared with model simulated values are within 10% for most monitored locations. Some results, however, show higher difference values, which could be attributed to meter accuracy, rainfall variation over the entire monitored area, or field conditions resulting in reducing the sewer flow, e.g., blockage of catchbasin, broken or leaking pipes, manhole etc. It should be mentioned, however, that the simulated flows are generally higher than measurements in these monitored locations, which provides confidence that the model results are on the conservative side.

6.4.3 Model Validation Using Historical Events

The re-calibrated model was used to simulate the historic storm event of July 8, 2008, as a model validation exercise.

The locations of the reported basement flooding for the July 8, 2008 storm event is shown in Figure 6.4a and represented with a blue outer circle and a blue inner circle. The key areas flooding in July 2008 include the following nine (9) cluster areas:

- Kew Beach area consisting of Lee Avenue, Waverley Road, Kippendavie Avenue, Kew Beach Avenue and Kennilworth Avenue;
- Kerr Road / Highfield Road;
- Minto Street;
- Alton Avenue and Leslie Street, north of Lake Shore Boulevard;
- Queen Street East, Winnifred Avenue and Pape Avenue (south & north at Queen St.);
- Logan Avenue, Empire Avenue, Carlaw Avenue and Saulter Street;
- First Street;
- Player Boulevard; and
- Kingswood Road.

The results of the model validation using the re-calibrated parameters as shown in Table 6.3 for the sanitary/combined sewer system are also shown in Figure 6.4a for the July 8, 2008 storm event.

The results of the model for the storm event are shown in terms of the hydraulic grade line (HGL) in the sewer system.

The HGL in the sewer system is defined at the nodes in three categories as follows:

- The pipe is not surcharged (i.e. water level is below the crown of pipe) or the pipe is surcharged and the hydraulic grade line (HGL) is below 1.8 m from the surface;
- If the pipe is surcharged, the HGL is between 1.8 m below surface and surface elevation; and
- HGL is above the surface elevation.

Table 6.3 RTK Parameters for Model Calibration

Monitoring Station No.	Type	Width ¹	Imp. ²	R1	T1 (hours)	K1	R2	T2 (hours)	K2	R3	T3 (hours)	K3
1	Combined	0.3	0.7	0.01	1	2	0.003	6	2	0.001	12	2
2	Combined	0.5	0.75	0.012	1	2	0.003	6	2	0.001	12	2
3	Combined	0.3	0.7	0.004	1	2	0.003	6	2	0.001	12	2
4	Combined	0.5	0.75	0.008	1	2	0.003	6	2	0.001	12	2
5	Combined	0.3	0.7	0.003	1	2	0.003	6	2	0.001	12	2
6	Combined	0.5	0.75	0.012	1	2	0.003	6	2	0.001	12	2
7	Storm	1.0	1.0	0.012	1	2	0.003	6	2	0.001	12	2
8	Storm	1.0	1.2	0.012	1	2	0.003	6	2	0.001	12	2
9	Storm	0.5	0.75	0.012	1	2	0.003	6	2	0.001	12	2
10	Storm	1.0	1.25	0.012	1	2	0.003	6	2	0.001	12	2
11	Combined	1.0	1.25	0.03	1	2	0.003	6	2	0.001	12	2
12	Sanitary	0.5	2.0	0.006	1	2	0.003	6	2	0.001	12	2
13	Combined	1.0	0.02	0.02	1	2	0.003	6	2	0.001	12	2
14	Combined	0.5	0.75	0.004	1	2	0.003	6	2	0.001	12	2
15	Combined	0.3	0.7	0.004	1	2	0.003	6	2	0.001	12	2

¹ Adjusted factor to the default value of the dimension (width of sub-catchment)

² Adjusted factor to the estimated surface imperviousness

It was noticed that several sewers have their crown elevations higher than 1.8 m below surface elevation, hence it is expected that no foundation drains or basement floor drains could be connected to those sewers.

To assist in the analysis and identify the reason for surcharge and bottlenecks in the sewer, the surcharge state in the sewer is also defined in the same drawings in three categories as follows:

- The pipe is not surcharged;
- The pipe is surcharged and the slope of the HGL is flatter than the pipe slope, i.e. surcharge is due to back up as a result of over loaded downstream pipe; and
- The pipe is surcharged and the slope of the HGL is steeper than the pipe slope, i.e., the pipe is overloaded and flow exceeds its capacity.

Reference to Figure 6.4a demonstrates that the model replicates well the flooding that occurred in July 2008, particularly in the cluster areas identified above and areas where the slope of the hydraulic grade line (red) is above the slope of the pipe.

The model was also validated for the storm sewers for the same storm event. The results of the validated model for the storm sewers and overland flow system are shown in Figures 6.4b and 6.4c, respectively.

The results of the water level in the overland flow system for the storm event is shown in three different categories:

- From surface to 150 mm above surface the results indicate that the flow is contained in the street pavement;
- From 150 mm to 300 mm above surface the results indicate the water is above pavement but contained within the street right-of-way; and
- More than 300 mm above surface the results indicate potential surface flooding of private properties, and hence potential basement flooding from surface runoff.

Reference to Figure 6.4b demonstrates that most of the storm sewer surcharging occurred immediately north and south of Queen Street East, west of Coxwell Avenue, where extensive flooding was reported. In other areas such as between Gerrard Avenue East and Danforth Street East, west of Jones Avenue, flooding was reported but the storm sewers and sanitary/combined sewers were generally not surcharged. In this area and other areas with similar conditions, the basement flooding could be attributed to local blockage of the laterals, local grading problems, cracks in the basement walls, etc., but not due to the City's sewer system.

Reference to Figure 6.4c of the July 2008 storm event shows that except for a few pockets (red dots) where depth of overland flow in the streets exceeded 0.30 m, most of the flow depths were less than 0.15 m. Hence, overland flow from this event was not a major contributor to basement flooding.

Based on the model validation using the historical storm event of July 8, 2008 for the sanitary/combined sewer system, and storm sewer and overland flow system, it can be concluded that the model replicates fairly well the results of the observed basement flooding. Hence, there is confidence that the model will be capable of generating reliable results in the assessment of the alternative remedial measures.

6.5 Assessment of Existing Systems

6.5.1 Sanitary/Combined Sewer System

6.5.1.1 Design Storm Events

A review of the sanitary/combined sewer system shows that there are pockets of shallow pipes as shown in Figure 6.5. Most of these shallow pipes are located between Queen Street East and Gerrard Ave East but also scattered throughout the study area. The shallow pipes indicate that in these areas houses that exist do not likely have basements or in some areas these could be industrial/institutional areas.

The calibrated/validated model was subsequently used to simulate the 2-year, 5-year, 25-year and 100-year storm events for the sanitary/combined sewer system under existing conditions. The results of these simulations are shown in Figures 6.6a, 6.6b, 6.6c and 6.6d for the 2-year, 5-year, 25-year and 100-year storm events, respectively.

Based on the results of the analysis in terms of water level in the sewer system, the potential of basement flooding was considered if surcharge level in the sanitary/combined sewer is higher than 1.8 m below the surface elevation, which coincides with the assumed basement elevation for homes with direct basement connections to the sanitary/combined sewer.

Some of the sewers where water level is shown to be above basement elevation (in yellow dots) are shallow sewers and the water level could be within the sewer and the sewer is not surcharged (e.g Queen Street, Jones Avenue, Glen Manor Drive, etc.). Manholes with shallow sewers are identified in the drawings.

Under the 2-year event, there are a few scattered areas where the sanitary/combined sewer system is surcharged. Most notably, surcharging occurs north of Queen Street East between Carlaw Ave and Greenwood Ave with minor occurrences throughout the study area.

Under the 5-year event, surcharging of the system is predominant with more occurrences in the older part of the City between Queen Street East and Danforth Ave, west of Coxwell Ave. It is also evident that sewer surcharge under the 5-year design storm event is mostly in streets where no storm sewer exist, and the combined sewer is draining surface storm flows. Examples of this situation are sections in Kingston Road and Gerrard St. East. Under the 25-year event, the sanitary/combined sewers within the study area, including those under the 2- and 5-year event will be surcharged as the system was not designed to carry the flows generated under this event. As expected, under the 100-year event most of the sanitary/combined sewers within the study area will be surcharged as the system was not designed to carry the flows generated under this extreme event.

6.5.1.2 Existing Level of Service

Based on the simulation results in the above section, it has been determined that the level of service for the sanitary/combined sewer system is the 2-year storm event as there is minimal surcharging under this event. This is consistent with other older sanitary/combined sewer systems in the City.

6.5.1.3 Capacity of the Interceptors and Impact of Water Level at the ABTP

The capacity of the sanitary flow interceptors were evaluated under the design storm events including the 100-year event. The Low Level Interceptor (LLI), High Level Interceptor (HLI) and Mid Toronto Interceptor (MTI) drain the entire former municipality of Toronto, and hence their catchment areas extend much beyond the boundary of the study area. The flow hydrographs for

these interceptors at the western boundary of the study area for the different storm events were therefore included in the model.

The results of this analysis, assuming free flow conditions at the Ashbridges Bay Treatment Plant (ABTP) Pumping Station show that the capacity of the MTI and the HLI is adequate to convey the 100 year design storm flows without surcharge problems. The flow in the LLI exceeds its capacity under this storm condition and the interceptor is backing up in some local sewers. It is clear, however, that the back-up does not result in the water level being above basement elevation.

In some areas, the local sewers are surcharged above basement elevation because of high loading ratio within these sewers. When the local sewers are relieved, the back-up from the LLI does not result in water levels being higher than basement elevation.

The Lake Front Interceptor (LFI) is surcharged under the 100-year design storm condition, due to its flatness and limited capacity in many sections. The surcharge level backs up in many local sewers to above basement elevation, and even reaches the surface in one section. Reduction of storm flows entering the sewer and/or increasing the capacity of the sewer at many sections will be required to alleviate this surcharge and limit the HGL to below basement elevation. Under the 5-year design storm condition, the interceptor is not surcharged except in few areas. Measures to reduce storm flows getting into the interceptor or increase the capacity of the interceptor should be considered.

The Queen Street Sanitary Trunk Sewer (Queen St. STS) is restricted before it is connected to the LLI and enters the ABTP pumping station building. The interceptor overflows at that location to a sewer which drains to the Coatsworth Cut. The HGL is backing up from this diversion point and the water level in some connecting local sewers under the 100-year design storm is above basement elevation. Also, in upstream sections of the interceptors, the loading ratio is over 1.6 which results in the surcharge level rising above the surface in some locations.

The HLI and the LLI drain to the M-Building pumping station of the Ashbridges Bay Treatment Plant (ABTP). The LFI and the Queen St. STS connect with the LLI before it enters the M-Building. The LFI and Queen St. STS drain the area east of the treatment plant. The MTI drains to the T-Building pumping station.

To analyse the impact of the water level at the ABTP pumping station, model simulations were carried out with free flow conditions for the interceptors and for fixed water level at the outlet. The water level considered for the LLI, HLI, LFI and Queen Street STS is 72.0 m, since these are discharged to the M-Building pumping station. This elevation was considered since it is the highest operating level during normal operation. For the MTI, which discharges to the T-Building pumping station, the considered water level at the P.S. was 64.0 m.

The results show that water level in the MTI, HLI and LLI will not be impacted by the above operating water level at the ABTP pumping station, up to the 100-year design level.

The water level at the P.S. will be backed up into the LFI resulting in surcharging the interceptor at its outlet. This surcharged level, although it will be reduced upstream, will still have an impact up to Lee Avenue, where the surcharge depth will be higher by 0.29 m compared to the free flow condition at the ABTP P.S.

This increase in the surcharge level, however, does not increase the requirement for remediation, since under the 100-year design flow, the LFI is surcharged to above the basement elevation considering free outfall is assumed at the outlet. Comparing the results of simulation

with free outfall condition and with a water level of 72.0 m at the outlet, however, the areas requiring remediation are the same for both conditions.

For the Queen Street STS, considering water level of 72.0 m at the outlet, the surcharge level will be increased in the reduced size section at the outlet, compared with free outfall conditions. This increase however will be reduced to less than 30 mm at the diversion chamber and in the upstream sections.

It should be concluded that by limiting the water level at the treatment plant P.S. to 72.0 m at the M-Building and to 64.0 m at the T-Building, the potential of basement flooding in the contributing areas will not increase up to the 100-year design storm level as a result of water level backing up from the P.S. to the interceptors. Higher water levels at the pumping station than the above levels may result in increasing the potential of basement flooding in the contributing areas.

6.5.2 Storm Drainage System

6.5.2.1 Design Storm Events

The calibrated/validated model was subsequently used to simulate the 2-year, 5-year, 25-year and 100-year storm events for the storm sewer and overland flow system under existing conditions. The storm sewer simulation results are shown in Figures 6.7a, 6.7b, 6.7c and 6.7d for the 2-year, 5-year, 25-year and 100-year storm events, respectively. The overland flow simulation results are shown in Figures 6.8a, 6.8b, 6.8c and 6.8d for the 2-year, 5-year, 25-year and 100-year storm events, respectively.

Based on the results of the analysis in terms of water level in the sewer system and in the overland flow system, the potential of basement flooding was considered if:

- Surface water level is above the surface elevation (gutter elevation) by more than 300 mm. (150 mm for houses with reverse slope driveways)
- Surcharge level in the storm sewer is higher than 1.8 m below the surface elevation, which coincides with the assumed basement elevation for homes with direct basement connections to the storm sewer.

As shown in Figure 6.7a, under the 2-year event, the primary location for the surcharging of the storm sewer is south of Queen Street East, west of Coxwell Ave. Scattered pockets of storm sewer surcharging occur towards the southeast part of the study. However, as indicated in Figure 6.8a, most of the overland flow under this storm event is less than 0.15 m with some isolated spots where it is higher.

Under the 5-year event, Figure 6.7b shows that surcharging of the storm sewer system is widespread including the area surcharged under the 2-year event and other scattered pockets throughout the study area. However under this event, Figure 6.8b shows that the overland flow has a few scattered location where the depth of flow will be greater than 0.15 m but overall it provides fairly minor contribution towards basement flooding.

Under the 25-year event, Figure 6.7c shows that surcharging of the storm sewer system is more widespread including the area surcharged under the 2- and 5-year events and other scattered pockets throughout the study area. However under this event, Figure 6.8c shows that the overland flow has a few scattered location where the depth of flow will be greater than 0.30 m but overall it provides minor contribution towards basement flooding.

As expected, under the 100-year event most of the storm sewer system will be surcharged, as shown in Figure 6.7d. However, there are some storm sewer pockets towards the east end of

the study area and north of Danforth Ave East which will not be surcharged under this storm event. In these areas, it is likely that the overland flow system will be carrying most of the flow due to steep slopes and/or due to lack of catchbasins to intercept the flow. Reference to Figure 6.8d demonstrates that under the 100-year storm event, there are many areas where the depth of overland flow exceeds 0.30 m. Figure 6.8d shows that most of this condition occurs throughout the study area.

6.5.2.2 Existing Level of Service

Based on the simulation results in the above section, it has been determined that the level of service for the storm sewer system is the 2-year storm event, although some surcharging occurs in the storm sewer south of Queen Street East, west of Coxwell Ave, and scattered pockets of storm sewer surcharging towards the southeast part of the study.

6.5.2.3 Impact of Lake Water Level and Sedimentation in the Outfalls

A simulation was carried out for the 100-year design storm and considering Lake water level at the 5-year return period level, which is 75.2 m. The results were compared with the results of similar simulation but with free outfalls, i.e., no water level at the outfalls. Comparing the water levels in the sewer system under the two conditions shows that there is no difference away from the shoreline and in the developed areas. The main reasons are:-

- Outfalls to the beach area are controlled by the two detention tanks, Maclean Avenue tank and Kenilworth Avenue tank. There are four storm outlets east of Maclean Avenue tank and the sewers drop before discharging to the Lake.
- The ten outfalls to the Coatsworth Cut and the Turning Basins, are not impacted by the Lake water level, since they are all exposed at elevation 75.2 m, i.e., with the invert of the sewer higher than this elevation.

The impact of sediment accumulation at the outfall and in flat sections of the sewer was also investigated. Fourteen storm outfalls to the Lake were inspected and sediment accumulation was observed in seven outfalls. Also, ten outfalls to the Coatsworth Cut and the Turning Basin with flat upstream sewers were inspected. The inspection showed sediment accumulation for several hundred metres in the flat sewers upstream of the outfall.

Although the impact of sediment accumulation in the sewer was not considered in the model, sediment accumulation at the outfall and in flat sewer sections upstream of the outfall definitely reduces the capacity of the outfall and results in higher water level. This may increase the potential of basement flooding, especially under heavy storm conditions and/or high Lake water levels. Regular maintenance for areas subject to sediment accumulation will reduce basement flooding potential and hence form part of the recommendation of this study.

In addition, studies were carried out to investigate the causes and solution to the accumulation of sediment problems at the Lake outfall structures. Detailed studies were carried out for each one of the five active outfalls to the Lake. The impact of Lake water level, wind, current and wave action were studied and solution alternatives were provided for each outfall structure. The recommended solutions included reconfiguring the outfall structure to a newly developed innovative design for a self-silting and scour control outfall structure from the Eastern Beaches partially submerged outfalls. The recommendations are discussed in the following sections, and more details on the studies, findings and recommendation are provided in Attachment 5, T.M. #8.

6.5.2.4 Impact of Kenilworth Avenue Tank in the Connected Sewers

The impact of back-up in the sewer system from the Kenilworth Avenue tank on basement flooding was investigated. To avoid the tank backing up in the existing sewer system, flap gates were installed at three of the incoming storm sewers at Lee Avenue, Waverly Road and on the laneway north of Kew Beach Avenue. The flap gates are closed if the water level backing up from the tank at the downstream side is higher than the water level in the upstream side. During storm events, water level may rise in the tank up to the weir elevation and then overflow from the tank to the Lake. This could happen on the average once a year, since the tank is designed to treat the average year flow. The weir in the tank is set up currently at 75.4 m, with the possibility of raising it up to 75.6 m, depending on the Lake water level.

Under heavy storm events, the water level in the sewers will rise, and it has to be always higher than the tank back-up water level at the flap gate, in order for the gate to stay open. The results of the 100-year design storm simulation show that water level in the three connected sewers was up to the surface. Results of simulation of the July 8, 2008 event also show high surcharge levels in all sewers connecting to the tank. Tank water level backing up in the storm sewers was then identified as one of the causes of flooding under heavy storm events.

6.6 Problem Identification

6.6.1 Summary of Sanitary/Combined and Storm Drainage Systems

The combined sewer system has the capacity in most parts within the study area to convey the 2-year design storm without surcharge. It has been noticed, however, that most of the weirs allowing overflow from the combined sewers to the storm sewer/CSO system, are flowing and allowing overflow under the 2-year condition. This situation allows CSO discharges to the Don River and the Lake to occur on a more regular, frequent basis than the 2-year design frequency. In many areas, where road storm sewer separation has not been carried out and only one combined sewer exists in the street, the combined sewer does not have adequate capacity to convey the 2-year design storm without surcharge.

Under storm events larger than the 2-year design event, the combined sewer system is surcharged, and in many areas the surcharge level is up to the surface considering the 100-year design storm event. It is expected that if the surcharge level is above 1.8 m below the surface, the flow in the sewer could back-up to the house basements.

To eliminate such surcharge in the combined sewer system, the first step to be considered is to reduce as much as possible the storm water entering the system. This could be achieved by many means including roof downspout disconnection, blocking perforated manhole covers and sealing regular covers in low lying areas, constructing road storm sewer in street with only one combined sewer, and repairing sewer segments to reduce I/I, where CCTV and fog testing show deficiencies.

The storm sewers within the study area are basically constructed to collect surface flow and relieve the existing combined sewer system. Not all streets have storm sewers and in some areas only a combined sewer exists and is collecting surface flow through catchbasins and house sanitary, roof and foundation drain flow.

Generally, road storm sewers do not have house connection. Buildings have only one drain collecting sanitary and storm flow (from roof and foundation drain) which is connected to the combined sewer in the street. New developments have also one drain for sanitary flow connected to the sanitary sewer, while roof downspouts drain to the surface and foundation drains discharge to the surface through sump pump.

Storm sewers were designed for the 2-year design storm and generally have the capacity to convey flows up to this level. Under heavy storm events, storm sewers surcharge, and the surcharge level could be up to the surface, especially considering the 100-year design event. At the time the area was developed and sewer systems were installed, there was no consideration for the major drainage system or for conveying intense storm events higher than the capacity of the sewers. The streets were not designed with the intention of conveying flows from heavy storm events to a safe outlet without causing surface flooding problems to the adjacent properties.

As is expected, many storm sewers are surcharged under the 5-year design storm with the flow exceeding their capacity. The surcharge level is up to the surface under the 100-year design storm in many areas. This is expected since storm sewers are designed for the 2-5 year design storm and at the time of construction there was no consideration of limiting the inlet capacity to the sewer capacity, nor consideration for the major drainage system.

6.6.2 Model Assumptions and Application

There are some inherent limitations with the use and application of the validated storm and sanitary/combined model for Area 32. The best possible information available at the time was used to create, calibrate and validate the model; however, assumptions had to be made to fill the data gaps. The following section discusses the model limitations:

- Although field investigations were completed to help identify the connectivity of the house connections, (i.e. roof leaders, foundation drains, etc.), the connectivity of individual house connections could not be confirmed with 100% certainty. Therefore, assumptions normally on the conservative side were made for implementation in the model.
- In the overland system, there may be small pockets of depression storage that may not have been visible from the DEM data; therefore, they have not been accounted for in the model. In reality, these small depressions would reduce the peak and increase the travel time of the hydrographs.
- The sewer system has 200 weirs basically to divert flow from the combined sewer system to the storm/CSO sewers. The elevation of some of the weirs was field checked in 32 chambers, but not every weir could be checked. During the calibration/validation and analysis of existing system, some inconsistencies in the weir information were found and corrected, e.g. weir in the wrong pipe, weir elevation lower than pipe invert elevation etc. Because of the size of the model however, some of the inconsistencies/errors in the data base may not have been discovered, if it was not evident from the simulations. The system has also orifices, of which not all of them were field checked for sizes, elevation and locations. However, it is believed that such inconsistencies/errors if still exist, do not have significant impact on the accuracy of the model results and recommendations.
- The DEM was provided by the City based on a 3 m x 3 m grid. GENIVAR developed a new DEM based on the contour lines provided by the City and a 1 m x 1 m grid. The more detailed DEM was compared with the surface elevation provided in the data base at the manholes. The results show discrepancies in many areas. Since the DEM was not proven to be accurate in all areas, it was decided to evaluate individually each area with discrepancy. Evaluation at many areas having historical flooding problems, based on limited review of all available information and on field observation resulted in adjusting the surface elevation in the data base in some areas. Due to time limitations, this

evaluation could not be carried out at all nodes in the model (approximately 8813 nodes).

- Stormwater contribution to the combined sewer system through perforated manhole covers, and regular manhole covers located in low lying areas was not considered explicitly in the model. During the calibration/validation process of the monitoring data, this contribution was not considered since none of the monitored rainfall events produced overland flow depth up to the manhole surface elevation. For major storm events, the assessment shows that this could be a major contributing factor to the surcharge in the combined sewers during major events. Since remediation measures should consider sealing of all manhole covers contributing storm flows to the combined sewers, the existing model does provide appropriate simulation for the sewer system after applying these proposed remedial measures.
- The model shows instability in some areas under heavy storm conditions. Many of these occur at control structures (weirs, orifices, gates), still some instability occur when the surcharge level in the sewer exceeds the surface elevation and there is high flow and water depth in the overland flow system. The instability is shown at one node, but just one or two nodes both upstream and downstream, the model adjusts itself to provide stable computations and proper results. The instability could not therefore be noticed unless reviewing the profile and the HGL of the impacted sewer. It should be mentioned however, that such instability at few locations does not affect the overall model accuracy and the model results, overall, should be reliable.
- If the surcharge level of the sewer exceeds surface elevation, the model will allow the flow to get to the surface through the gully (catchbasin). Although the model will maintain the continuity (the flow volume balance), calculated water depths will not be reliable anymore. It should be considered that model results under this condition only gives an indication of problem area and the requirement for relief or remediation. After remediation is provided and surcharge level in the sewer is controlled at least to below surface elevation, the model results are no longer affected by this model limitation.

6.6.3 Identification of Problem Areas

Flooding problem areas were identified based on the reported basement flooding during the historic storm events of July 8 to 22, 2008, May 17, 2006 and August 19, 2005.

It should be mentioned that the May 17, 2006 and the August 19, 2005 storm events resulted in scattered basement flooding reports, while the July 8, 2008 storm resulted in flood reports clustered in many areas resulting in a total of 202 complaints. Streets with more than two basement flooding reports were considered as problem areas, since potential cause of flooding in these streets would be sewer back-up or overland flow rather than a local cause. Nine cluster areas as shown in Figure 6.9 were subsequently identified by the City, with the following streets identified with flooding problems in every cluster area.

- | | |
|----------------|--|
| Cluster Area 1 | Includes Lee Avenue, Waverly Road, Kippendavie Avenue, Kew Beach Avenue, Kenilworth Avenue |
| Cluster Area 2 | Kerr Road/Highfield Road |
| Cluster Area 3 | Minto Street |
| Cluster Area 4 | Alton Avenue and Leslie Street |

Cluster Area 5 Queen Street E., Winifred Avenue and Pape Avenue

Cluster Area 6 Logan Avenue, Empire Avenue, Carlaw Avenue and Saulter Street

Cluster Area 7 First Avenue

Cluster Area 8 Player Blvd

Cluster Area 9 Kingswood Road

6.6.4 Factors Contributing to Flooding

6.6.4.1 General

The causes of flooding for the combined sewer system in Study Area 32 can be generally attributed to the following:

- Surcharge of the combined sewer caused by excessive stormwater volume entering through:
 - Perforated manhole covers
 - Regular covers of manholes in low lying areas
 - Connected house roof downspouts
 - Connected catchbasins in streets with no road storm sewers
- Surcharge of the storm sewer system, which may result in increasing the flow to the combined sewer system through potential interaction between the two systems.
- High ground water table, within basement elevation.
- Accumulation of surface runoff in low-lying areas.
- Backup from outfall to the Lake due to high Lake level or accumulation of sediment in the outflow conduit.
- Back-up from the interceptors due to higher water level than allowed at the pumping station wet well of the treatment plant.
- High water level at the Kenilworth tank resulting in closure of the upstream flap gates to the contributing sewers to the tank.
- Reverse sloped driveways due to surface flooding problems.
- High overland flow depth above street right-of-way elevation.
- Undersized storm sewer or insufficient catchbasins resulting in high overland flow.
- Blocked/broken sanitary/combined sewers and manholes.
- Blocked catchbasins with debris and leaves.

To determine the primary and most possible causes of basement flooding in every flooding problem area, several sources of available information were reviewed, including:

- Field investigation and site observation.

- Surface elevation contours as shown in the Digital Elevation Model (DEM) drawing.
- Groundwater elevations in relation to sewer invert elevation.
- Houses with reverse-sloped driveways.
- Results of the model for the historic storm event of July 8, 2008.
- Review of the basement flooding reports provided in the Hansen data base.

By analyzing the above information, it was possible to identify the most probable cause of flooding in each flooding problem area. The results are explained below.

Basement flooding in scattered properties could be attributed to one or more of the following local conditions:

- Poor lot grading.
- Structural problems in the private drains.
- Blockage in the house connection.
- Cracks in the basement walls or floor resulting in storm water leakage.
- Improper installation or operation of backflow preventer valves.

Specific causes of basement flooding for each cluster area are provided below. It should be noted that the causes are based on the historic flooding that occurred on July 8, 2008, and more causes may be applicable under the 100-year design storm event identified as criteria for basement flooding protection.

6.6.4.2 Area Specific Factors Contributing to Flooding

CLUSTER 1 – LEE AVENUE

Causes of Flooding

- Accumulation of sediment and debris at the lake outfall.
- Accumulation of surface flow in low lying areas.
- Overland flow flooding due to lack of overland flow route with adequate capacity.
- Reverse slope driveways.
- Back-up in the storm sewer system resulting from high water level in Kenilworth Tank.

CLUSTER 1 – WAVERLEY ROAD

Causes of Flooding

- Accumulation of sediment and debris at the lake outfall.
- Overloaded combined sewer due to high storm flows from connected roof downspouts.
- High water level at the ABPS (M Bldg.) wet well causing back-up in the interceptors and local sanitary/combined sewers including the sanitary storage pipe.
- Higher groundwater table than basement elevation.

- Overland flow ponding.
- Back-up in the storm sewer system resulting from high water level in Kenilworth Tank.

CLUSTER 1 – KIPPENDAVIE AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from perforated manholes, low lying manholes, connected roof downspouts and sewer below ground water table.
- High water level at the ABPS wet well causing back-up in the interceptors and local sanitary/combined sewers including the sanitary storage pipes.
- Higher groundwater table than basement elevation.
- Accumulation of surface flow in low lying areas.
- Back-up in the storm sewer system resulting from high water level in Kenilworth Tank.

CLUSTER 1 – KEW BEACH AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from sewer receiving surface flow in streets with no storm sewers.
- High water level at the ABPS wet well causing back-up in the interceptors and local sanitary/combined sewers.
- Reverse slope driveways.
- High accumulated overland flow between Woodbine Ave., Keppendavie Ave., Kenilworth Ave. and Waverley Road.
- Back-up in the Woodbine storm sewer resulting from water level in Kenilworth Tank, which floods the surface in Woodbine Ave and spills into Kew Beach Ave.

CLUSTER 1 – KENILWORTH AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts.
- High water level at the ABPS wet well causing back up in the interceptors and local sanitary/combined sewers.

CLUSTER 2 – KERR ROAD/HIGHFIELD ROAD

Causes of Flooding

- Overloaded sanitary sewer due to potentially connected roof downspouts, low lying manholes, and sewer below ground water table.
- Interconnections between the sanitary and storm sewers.
- Accumulation of surface flow in low lying areas.
- Lack of standby power at the Highfield Road Pumping Station.

CLUSTER 3 – MINTO STREET

Causes of Flooding

- Overloaded combined sewer due to high storm flows from high ground water table and sewer receiving surface flow in streets with no storm sewers.
- High water level at the ABPS wet well causing back-up in the interceptors and local sanitary/combined sewers.
- Infiltration in a sewer from TTC, assumed to be blocked and directed to the Eastern Avenue Sewer but still some infiltration contributes to the combined sewer at Minto St.

CLUSTER 4 – ALTON AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and sewer receiving surface flow in streets with no storm sewers.
- High water level at the ABPS wet well causing back-up in the interceptors and local sanitary/combined sewers.
- Higher groundwater table than basement elevation.
- Accumulation of surface flow in low lying areas.

CLUSTER 4 – LESLIE STREET

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and sewer below ground water table.
- High water level at the ABPS wet well causing backup in the interceptors and local sanitary/combined sewers.
- Higher groundwater table than basement elevation.
- Accumulation of surface flow in low lying areas.

CLUSTER 5 – QUEEN STREET EAST

Causes of Flooding

- Overloaded combined sewer due to high storm flows from perforated manholes, connected roof downspouts and sewer below groundwater table.

CLUSTER 5 – WINNIFRED AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows including surface flow entering the combined sewer in streets with no storm sewers.

CLUSTER 5 – PAPE AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and the sewer receiving surface flow in streets with no storm sewers.

CLUSTER 6 – LOGAN AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from sewer below groundwater table, and the sewer receiving surface flow in streets with no storm sewers.
- Accumulation of surface flow in low lying areas.

CLUSTER 6 – EMPIRE AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and the sewer receiving surface flow in streets with no storm sewers.
- Accumulation of surface flow in low lying areas.

CLUSTER 6 – CARLAW AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from sewer below groundwater table.
- Accumulation of surface flow in low lying areas.

CLUSTER 6 – SAULTER STREET

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts, sewer below ground water table and the sewer receiving surface flow in streets with no storm sewers.
- Accumulation of surface flow in low lying areas.

CLUSTER 7 – FIRST AVENUE

Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and sewer below groundwater table.

CLUSTER 8 – PLAYER BLVD.

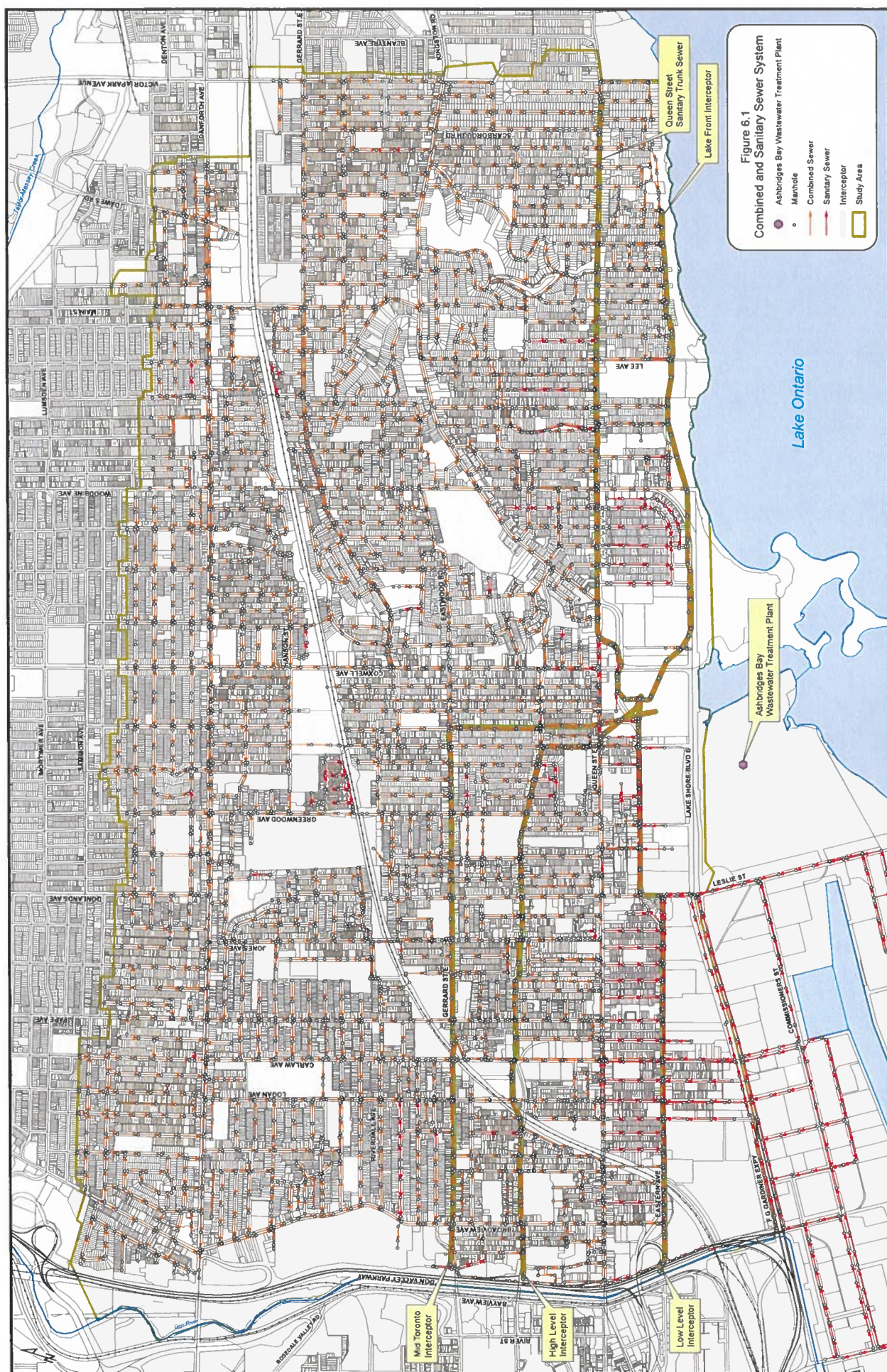
Causes of Flooding

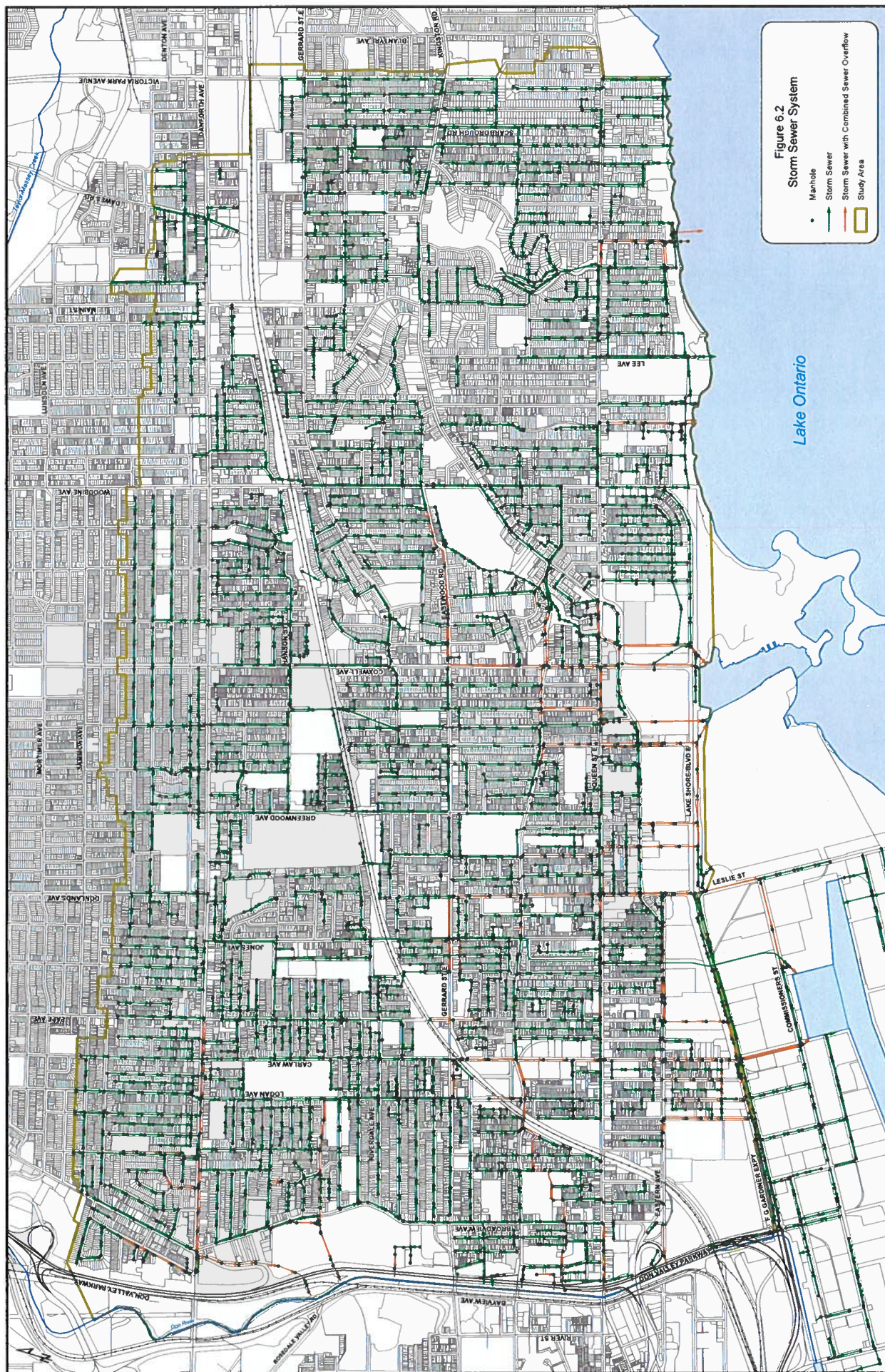
- Overloaded combined sewer due to high storm flows from perforated manholes and connected roof downspouts.
- High infiltration due to sewer being lower than groundwater table.

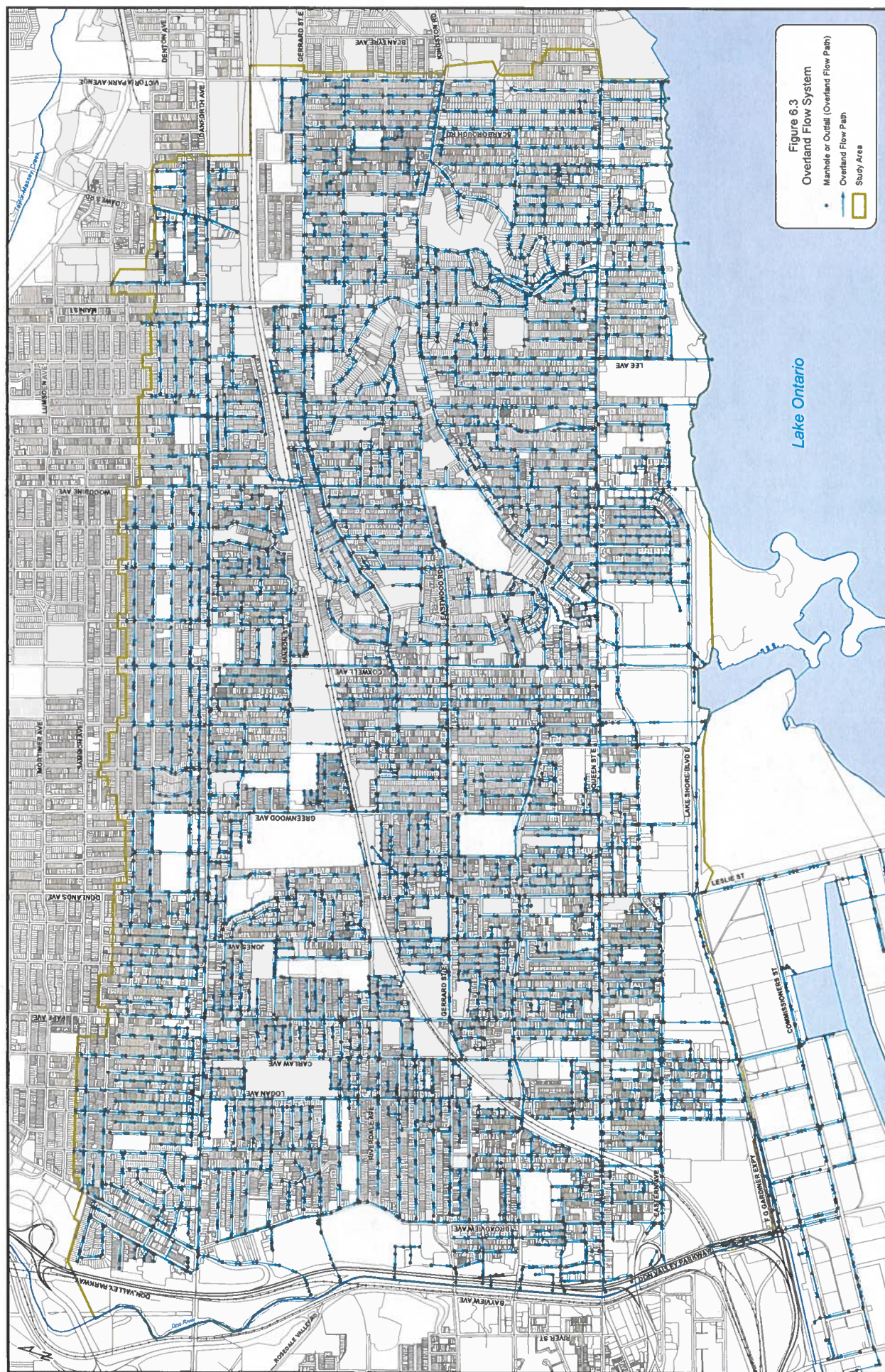
CLUSTER 9 – KINGSWOOD ROAD

Causes of Flooding

- Combined sewer is overloaded due to sewer receiving surface flow, i.e., no storm sewer in the street.
- Flooded homes are located at lower elevation than the street.
- Sewer is flat in one area resulting in inadequate capacity.







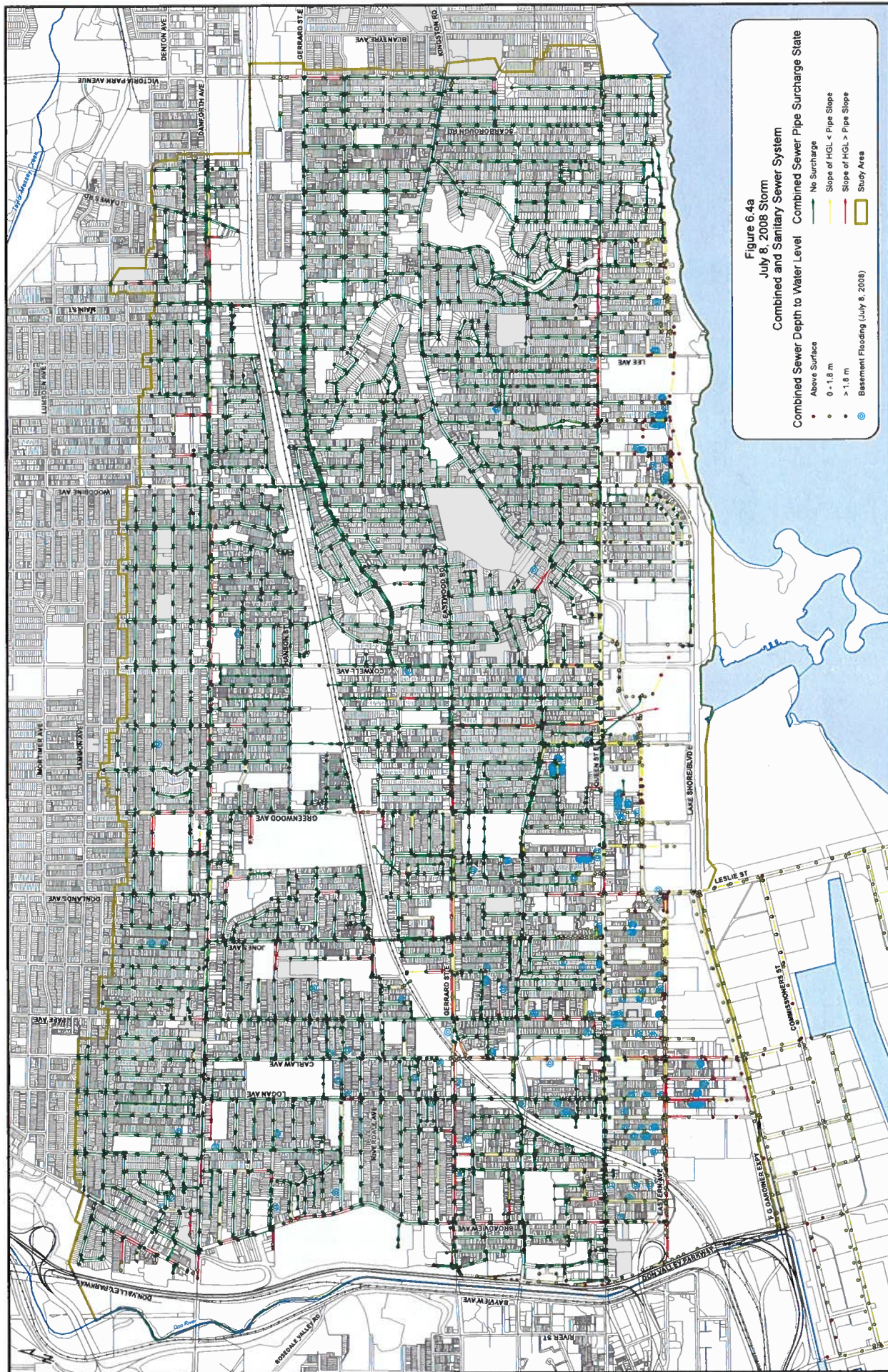
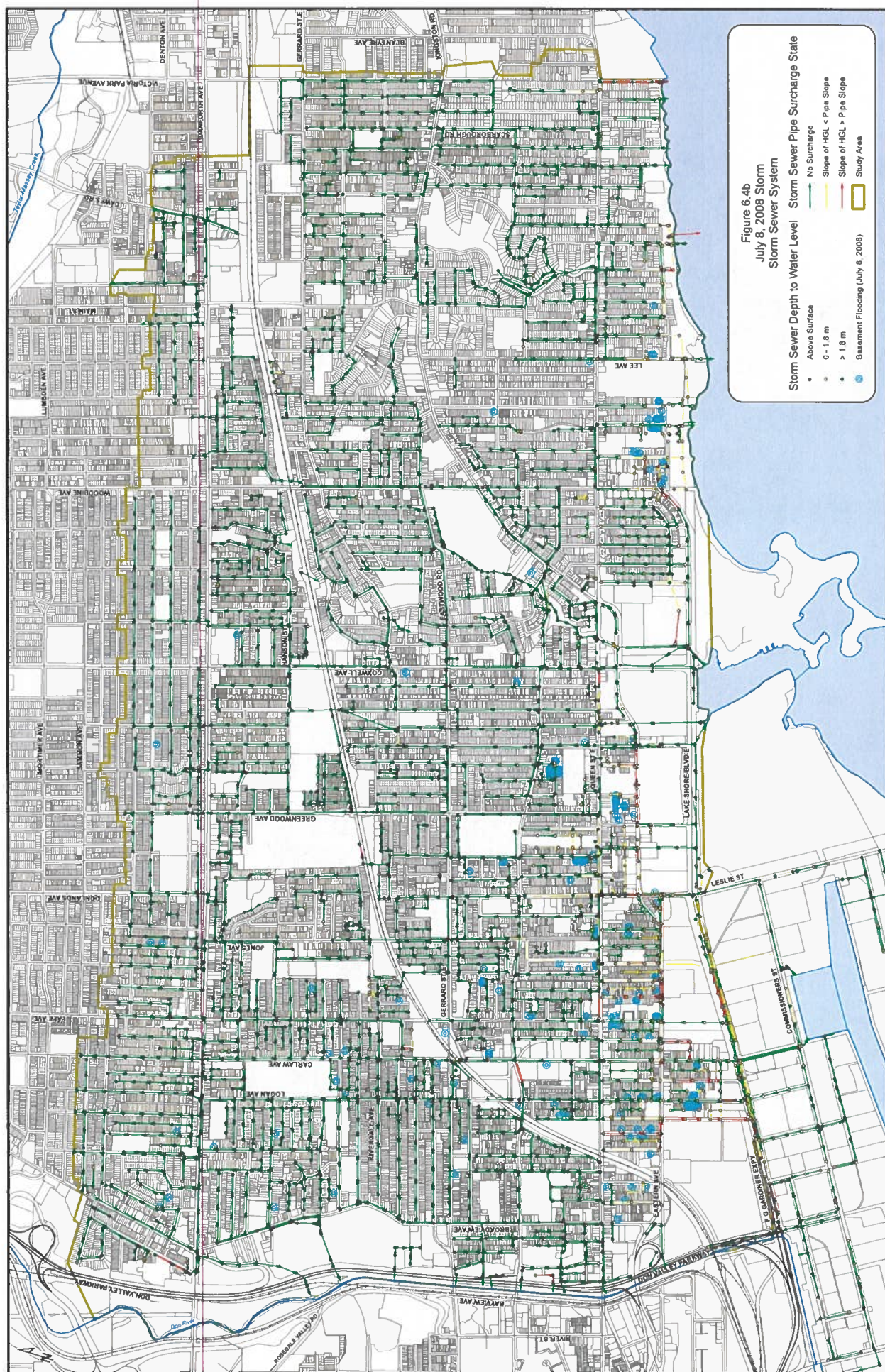
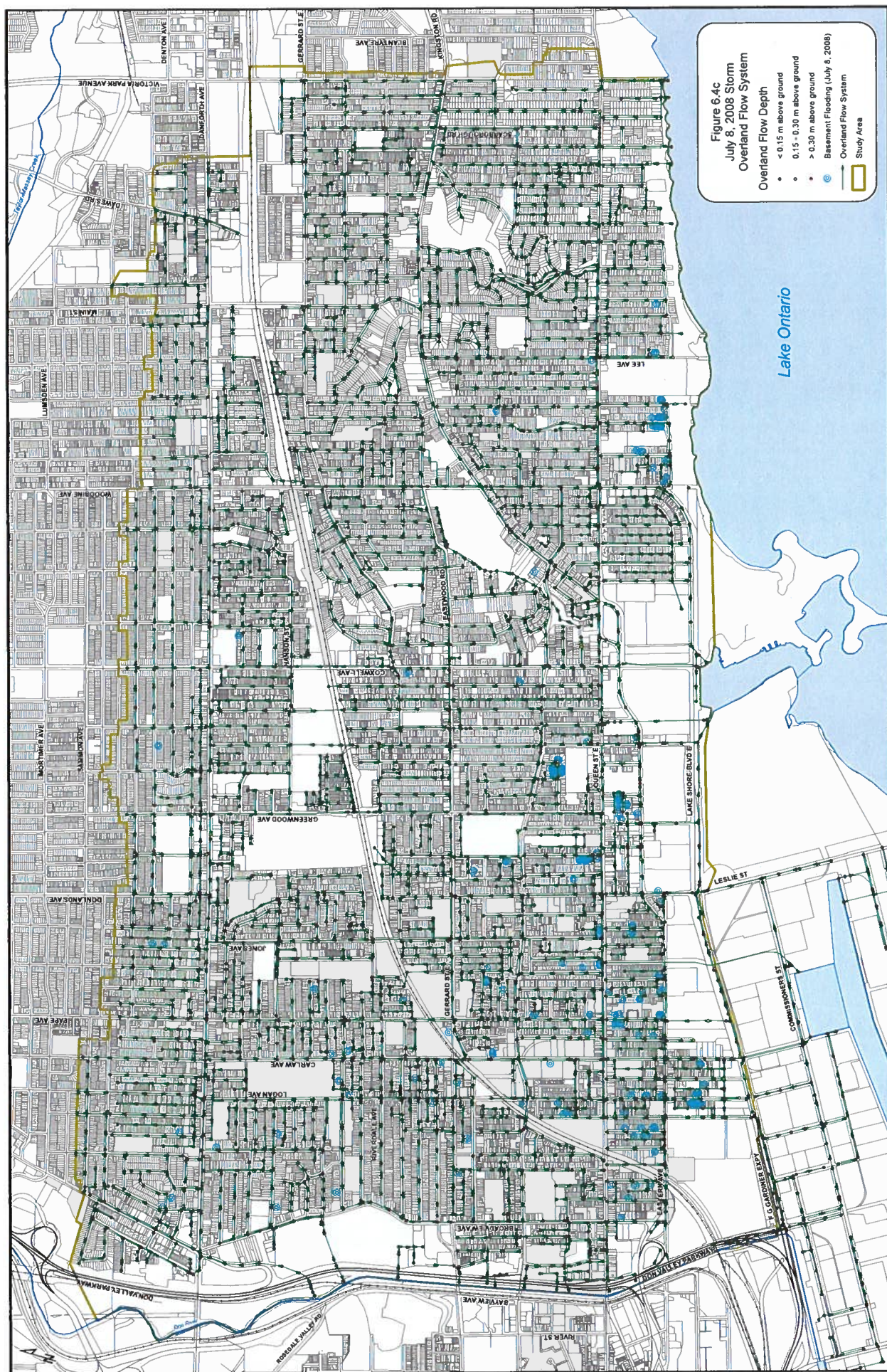
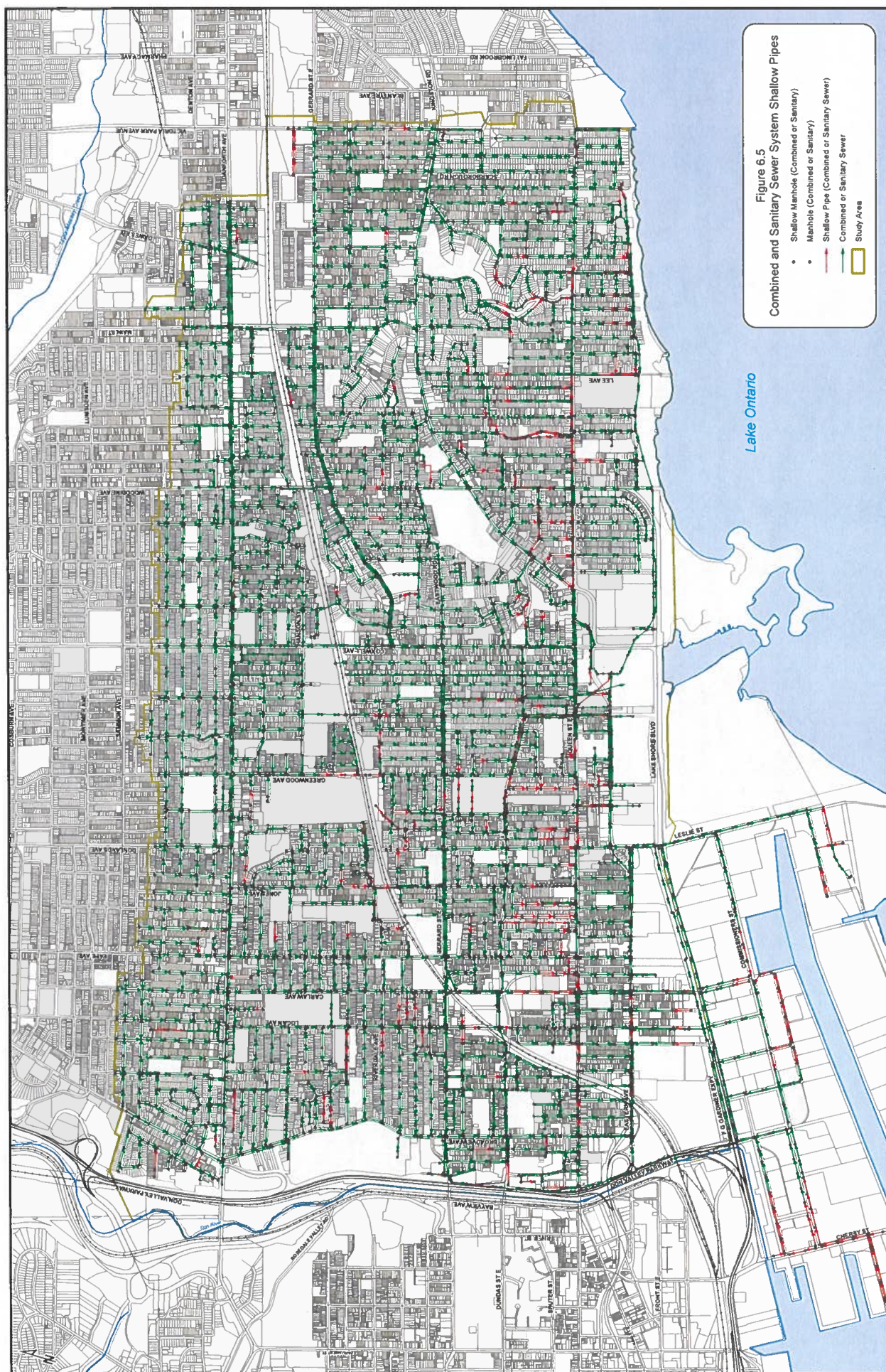


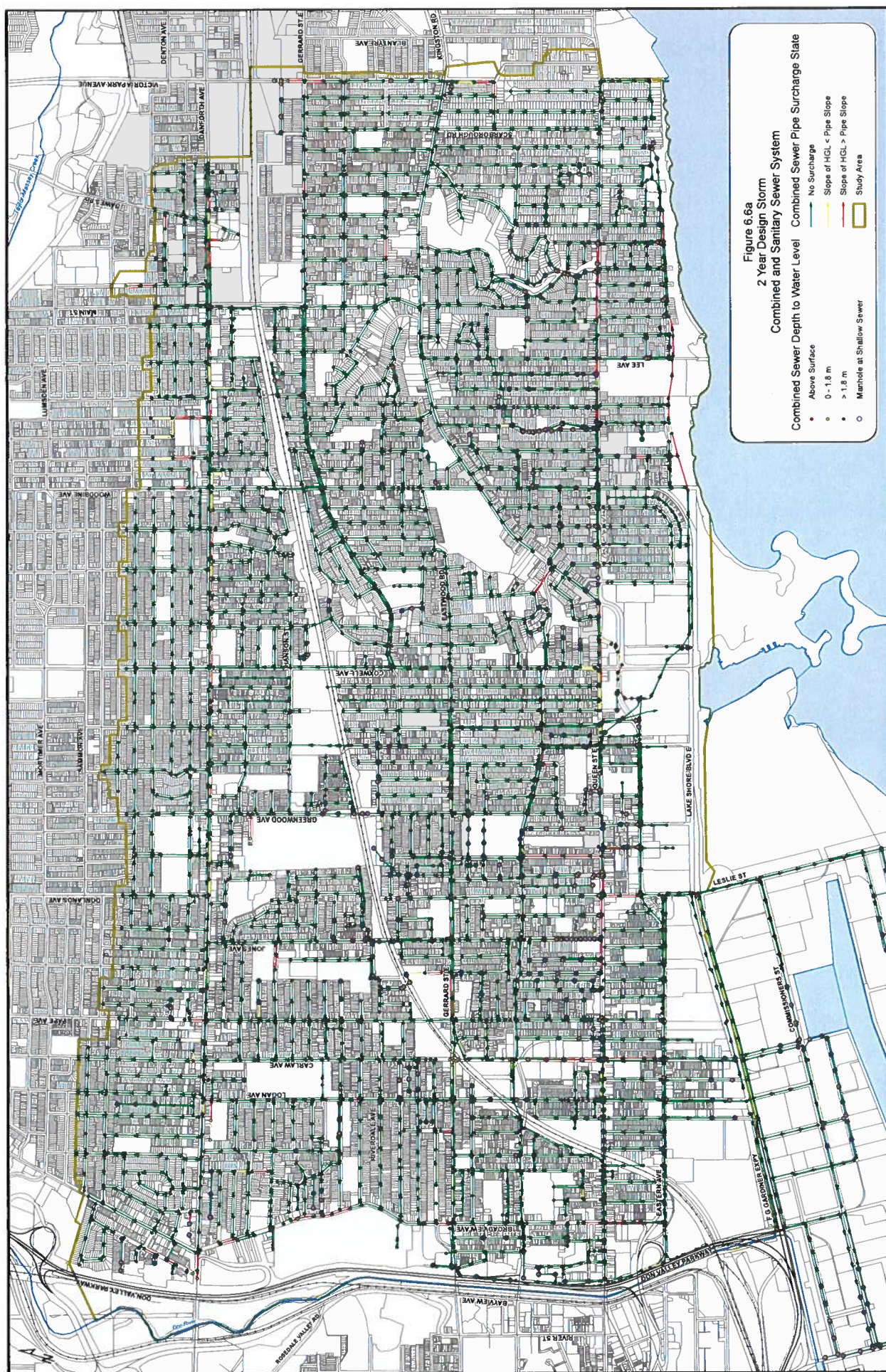
Figure 6.4a
 July 8, 2008 Storm
 Combined and Sanitary Sewer System
 Combined Sewer Depth to Water Level Combined Sewer Pipe Surcharge State

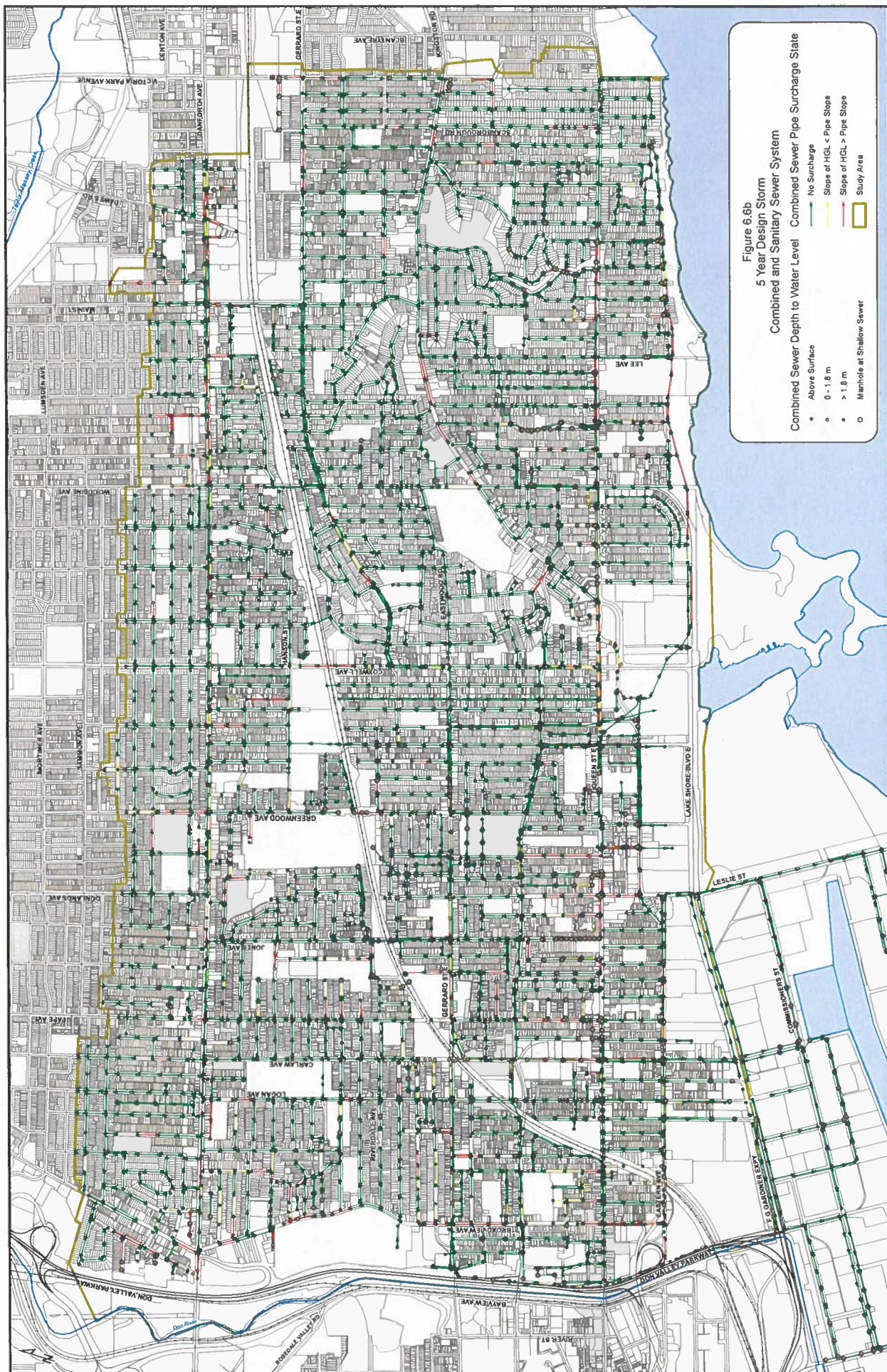
- No Surcharge
- Slope of HCL < Pipe Slope
- Slope of HCL > Pipe Slope
- Above Surface
- 0 - 1.8 m
- > 1.8 m
- Basement Flooding (July 8, 2008)
- Study Area

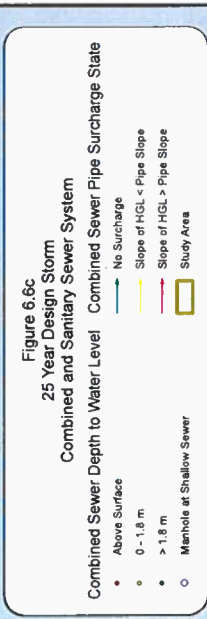


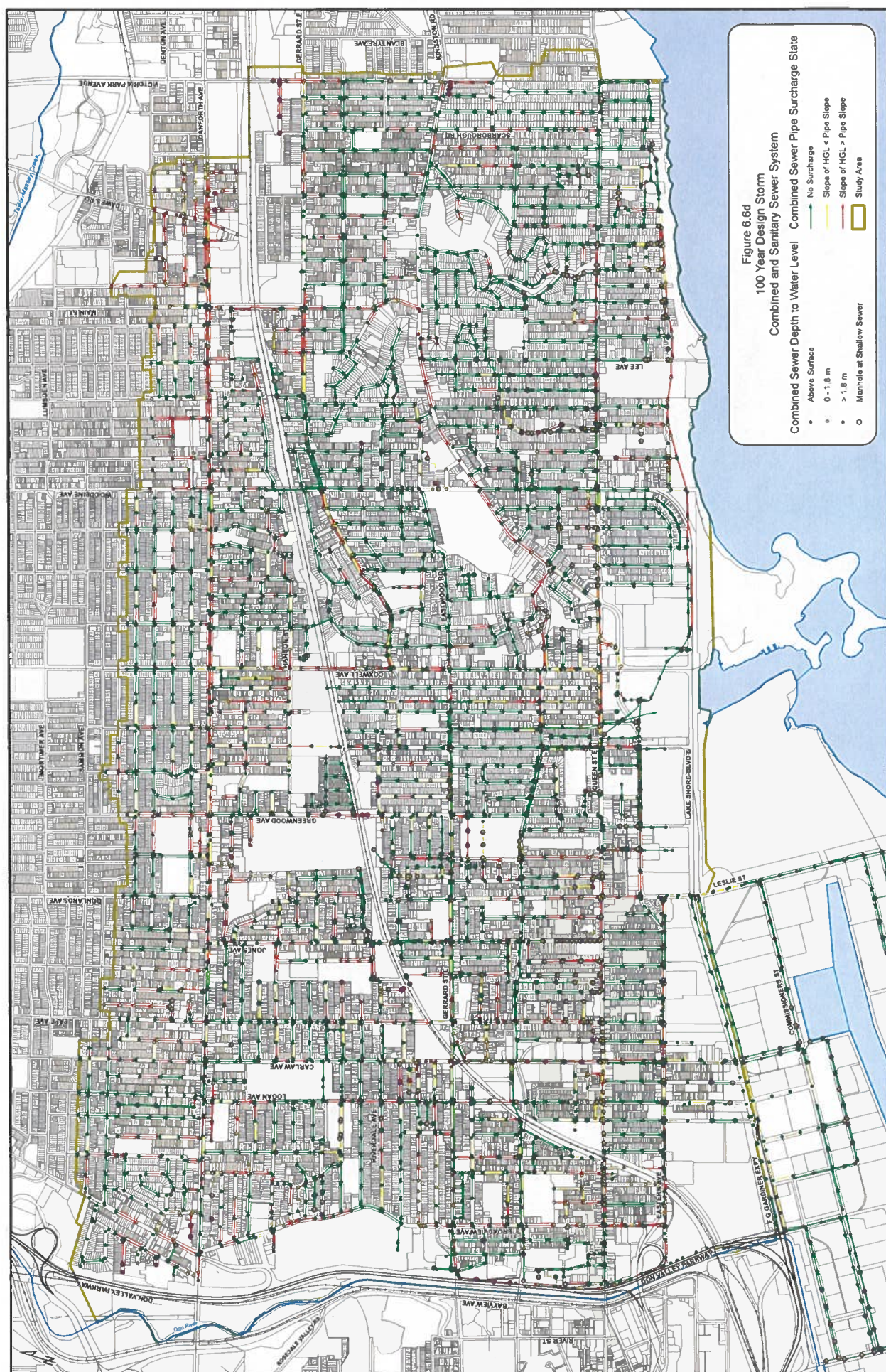


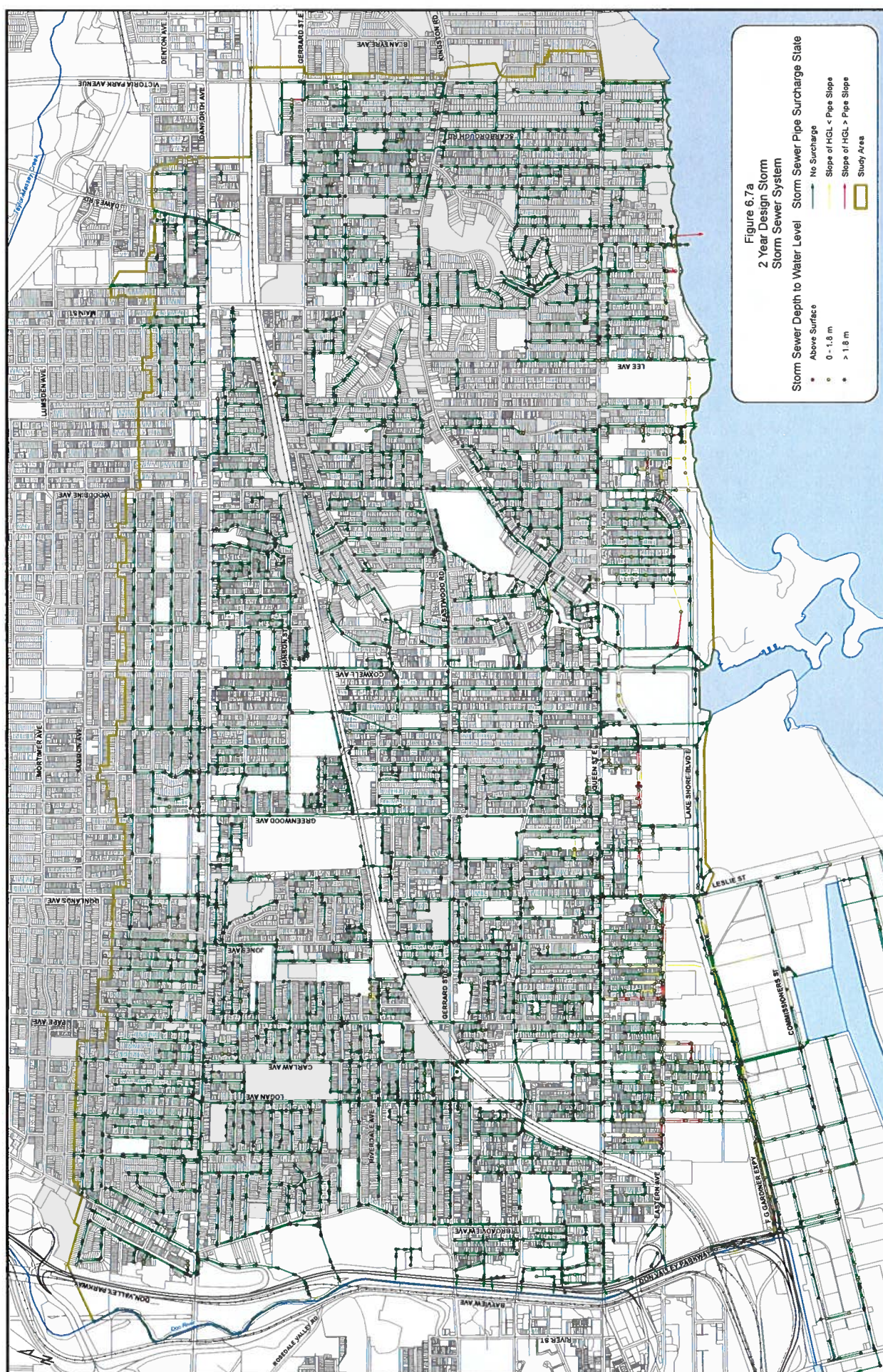


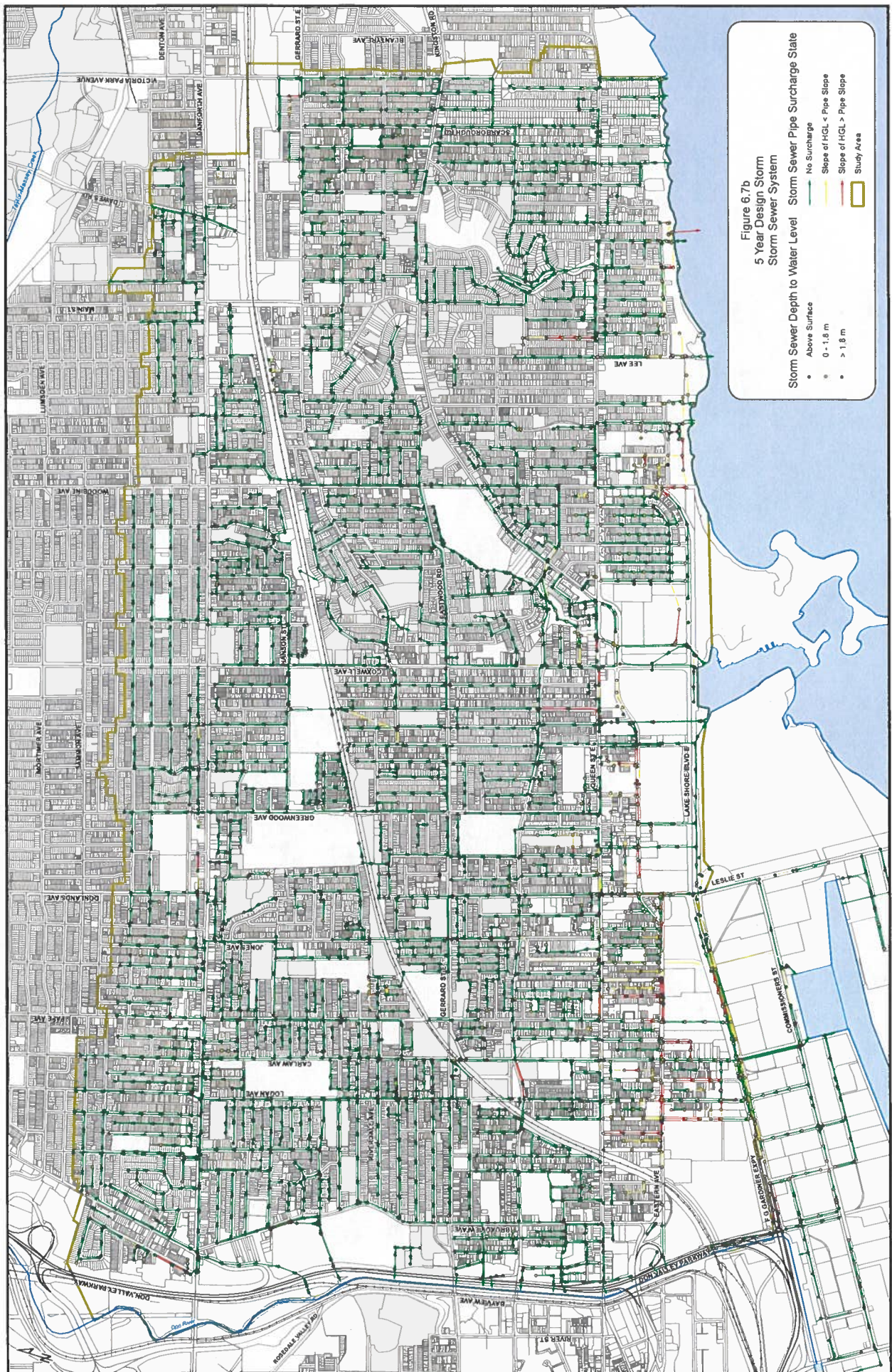


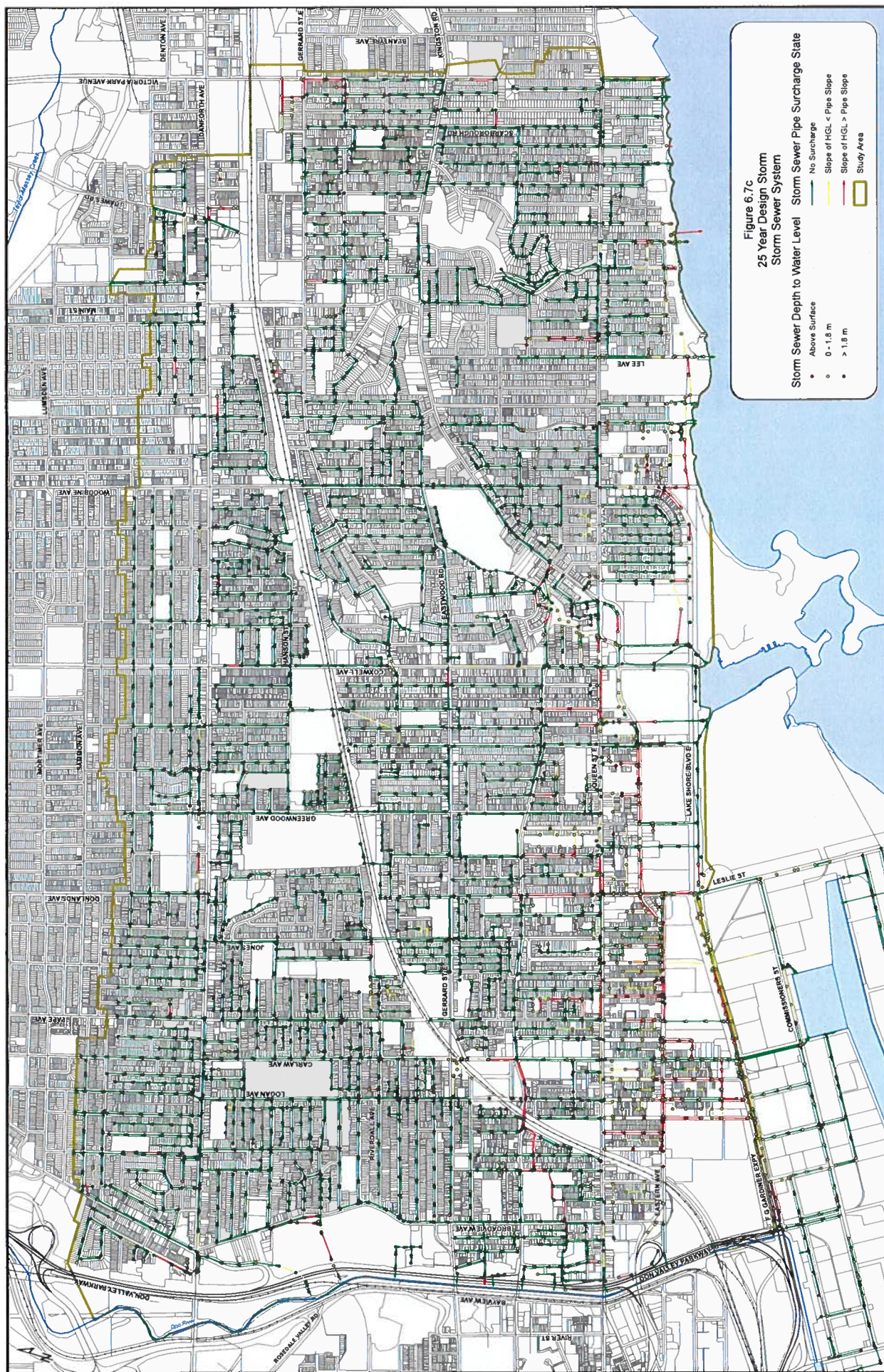


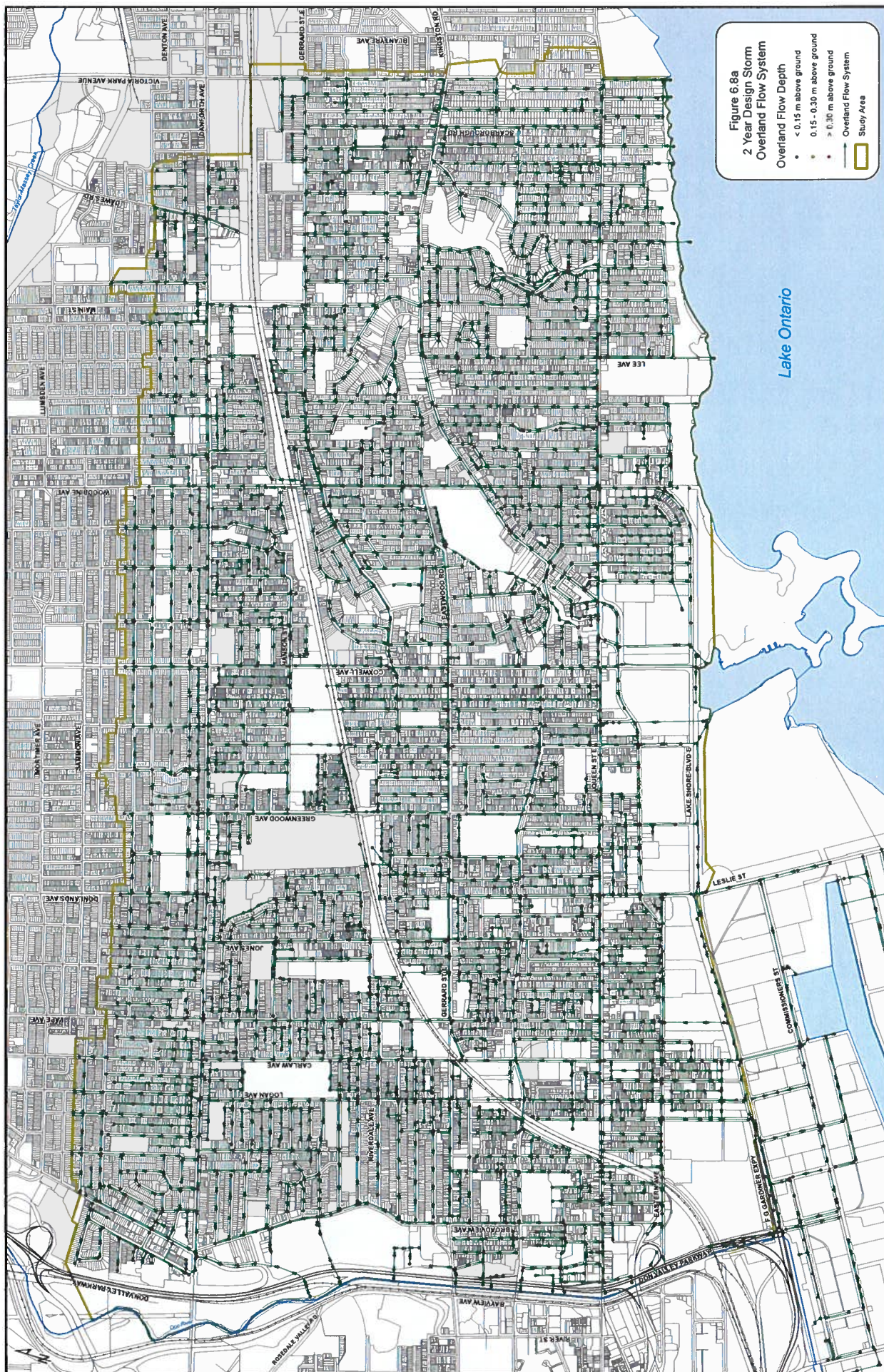


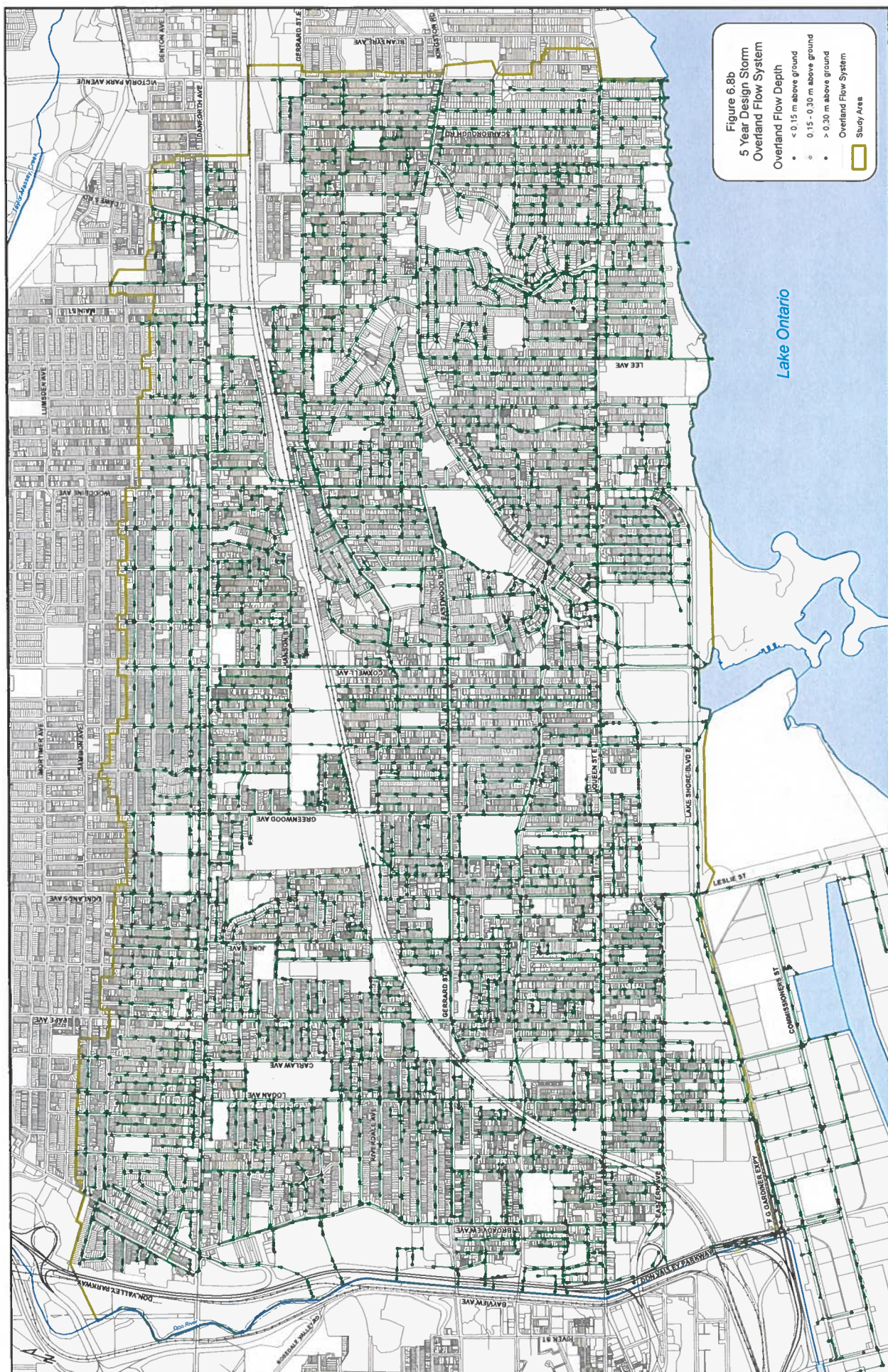


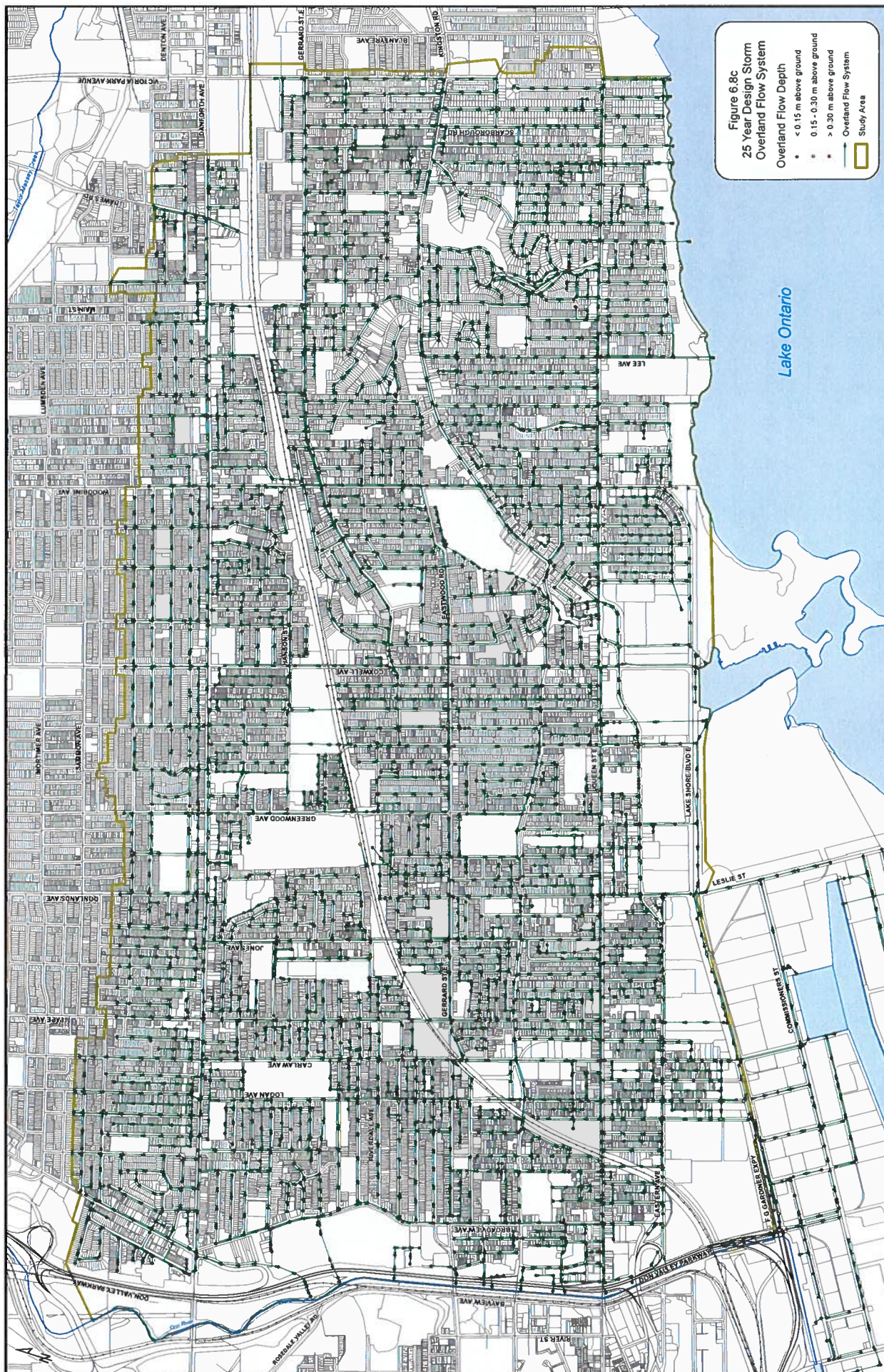


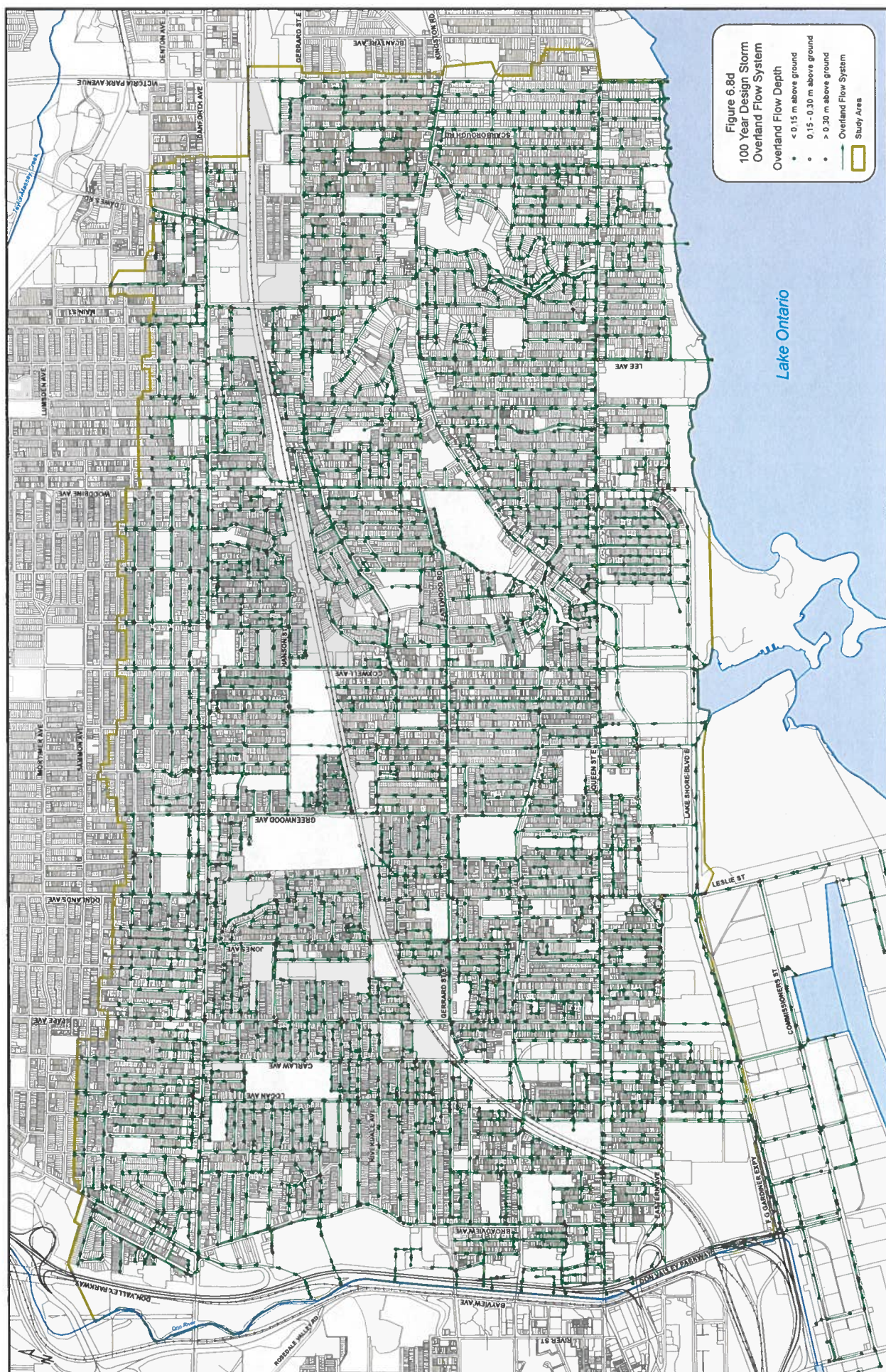




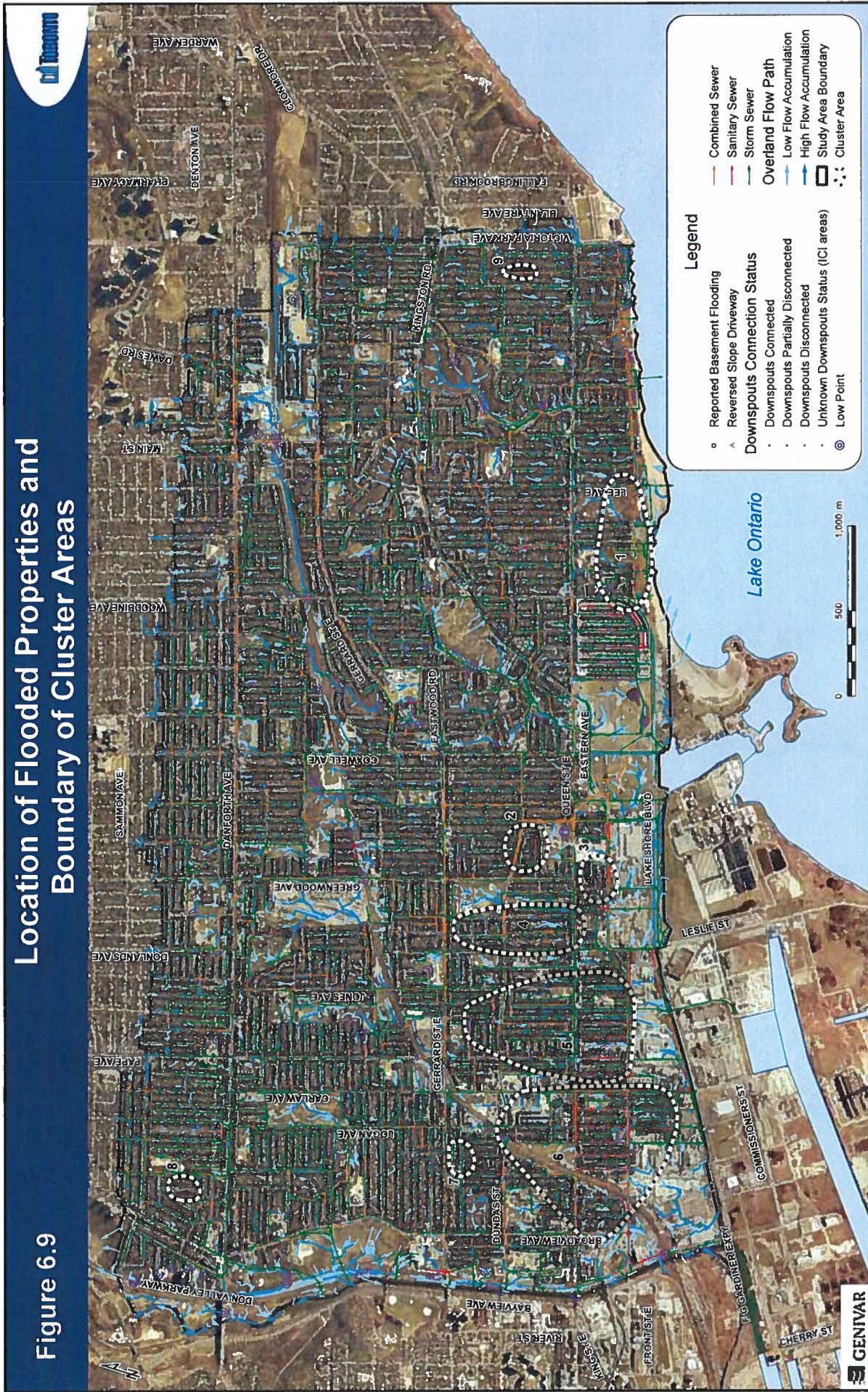








Location of Flooded Properties and Boundary of Cluster Areas



7. Development and Analysis of Alternative Remedial Measures

7.1 Development and Screening of Alternative Remedial Measures

To minimize basement flooding occurrences and control wet weather flows, several remedial measures are considered and evaluated. The measures are divided into four categories:

1. Source control measures.
2. Local measures.
3. Remedial measures applicable to the sanitary/combined sewer systems.
4. Remedial measures applicable to the storm drainage systems.

Table 7.1 lists the remedial measures and describes the advantages, disadvantages and applicability of each. This table is used as a screening method from which a short list of remedial measures is considered in the development of alternatives and the measures are subjected to quantitative assessment of their effectiveness. The short list of the remedial measures is:

- **Source Control Measures** - The major source control measure which will be carried further in the alternatives is the roof downspout disconnection. In the past, the City encouraged residents on a voluntary basis to disconnect downspouts and re-direct runoff towards grass area and/or to rain barrels. To move forward this program to a higher disconnection level, the City recently adopted a mandatory disconnection program aimed at obtaining at least 75% roof downspout disconnection, City wide. Therefore, a 75% roof downspout disconnection of all house roofs will be considered for all alternatives as a base remedial measure to reduce basement flooding. Other source control measures are encouraged by the City as voluntary initiatives that promote storm runoff control at source.
- **Local Remedial Measures** - These measures, if properly implemented, provide the highest level of protection for individual properties. They are highly recommended specially for isolated cases of basement flooding. These measures will not be included in the quantitative assessment nor the costing of alternatives but will be recommended for implementation in all alternatives specially for isolated houses where reported basement flooding is not related to City's sanitary/combined or storm system issues. Implementation of these measures will definitely enhance the preferred solution and provide additional level of protection.
- **Sanitary/Combined System Remedial Measures** - These measures are based on either reducing/eliminating storm water flows from entering the sanitary/combined system, or controlling the flow within the system. All measures will be evaluated for feasibility of application to the study area and for consideration in developing the alternatives.
- **Storm System Remedial Measures** - All measures listed in Table 7.1 will be considered and evaluated for feasibility of application in the study area and for further consideration in developing the alternatives.

Table 7.1 Screening of Alternative Remedial Measures

Control Type	Control Measure	Advantage	Disadvantage	Applicability	Considered in Alternative
Source Control	Roof leader disconnection	Divert roof runoff from storm and sanitary/combined sewers thereby reducing the peak flows and volume of runoff.	May temporarily limit property use (i.e., ponding in yards). Potential increase in overland flow. May require grade change.	Applicable in areas where overland flow does not cause a problem. To be assessed on an individual property basis.	All Alternatives.
	Soak away pits	Effective in reducing stormwater volume entering the sewer by redirecting roof drainage.	Implementation costs for retrofit would be considerably high due to disruption, damage and restoration of property.	Difficult to implement in already developed areas on public property. Not enforceable on private property.	
	Porous pavement	Reduces stormwater runoff through infiltration.	Requires the initiative/co-operation of private property owners. Low efficiency/cost ratio (will require financial incentive).	Applicable to any impervious surface.	
	Inlet control device in large paved areas (i.e., parking lots)	Highly effective in reducing peak flow rates to the sewer by temporarily retaining runoff on paved area.	Ponding can occur for larger storm events temporarily limiting the use of the affected area. Potential for increased frequency of overland flow.	Most effective on flat surfaces. Application may be restricted due to non-existing and/or inadequate overland flow capacity. Applicable for new developments.	

Table 7.1 Screening of Alternative Remedial Measures

Control Type	Control Measure	Advantage	Disadvantage	Applicability	Considered in Alternative
Local Remedial Measures	Backflow prevention with or without sump pump	Effective solution for individual properties to prevent basement flooding due to sewer surcharge.	Required installation in basement to reduce costs and sporadic maintenance by home owner (may require financial assistance to the homeowner from the City).	May be applied anywhere.	
	Sump pump for foundation drains	Disconnection of drains from sewer prevents hydrostatic pressure due to sewer surcharge. Reduces I/I in cases of drain connections to sanitary sewer.	Required installation in basement to reduce costs and sporadic maintenance by home owner (may require financial assistance to the homeowner from the City).	May be applied anywhere.	
	Lot regrading	Effective in reducing local flooding and high I/I to foundation drains.	Potential increase in overland flow and potential flooding to adjacent properties.	Applicable in areas where overland flow does not cause a problem. To be assessed on an individual property basis.	
	Rain barrel	Reduces storm runoff by promoting re-use of roof runoff, thus reduces municipal water consumption.	Requires co-operation of home owner (may require financial assistance).	Where space for barrel exists. May be used even where basement flooding has not occurred.	
Sanitary / Combined Systems	Replacing porous manhole covers with solid covers	Very low cost measure effectively reducing I/I in combined sewers.	None.	At all streets where storm sewer exist.	All Alternatives.

Table 7.1 Screening of Alternative Remedial Measures

Control Type	Control Measure	Advantage	Disadvantage	Applicability	Considered in Alternative
	Road sewer separation	Reduce storm water flows in the sewer system by diverting surface runoff to road storm sewer.	Requires an outlet to the new storm sewer.	In all streets without storm sewers, i.e., having only one combined sewer.	A-1
	Complete sewer separation	Significantly reduce storm water flows to the combined system by diverting surface runoff and storm flows from homes (roofs and foundation drains) to new storm sewer.	Very costly since it requires applying flow separation at the house level and constructing new storm drain from every house to the storm sewer at the street. Also involves greater community disruption (tearing up greater number of streets, more traffic disruption).	Could be applied to the entire combined sewer area.	
	Sealing sanitary sewer manhole covers	Low cost measure effectively reducing I/I in sanitary sewers.	Reduces self-ventilation of sewer system. Must be avoided at high points of system.	Primarily at low points of system or where frequent road flooding occurs.	All Alternatives.
	Pipe & manhole covers	Maintenance measure reducing I/I into sanitary sewer thus reducing need for construction.	None.	Should be focused where high I/I is evident.	All Alternatives.
	System storage (in-line/off-line sewers)	Allows some flexibility regarding location of construction. Construction generally	Requires favourable conditions of existing sewer for optimal operation and minimal	Anywhere other utilities do not impose constraints and hydraulic conditions	A-3

Table 7.1 Screening of Alternative Remedial Measures

Control Type	Control Measure	Advantage	Disadvantage	Applicability	Considered in Alternative
		less extensive than sewer replacement. Less O&M requirements than underground storage tank. Does not require open space for implementation.	maintenance.	allow implementation.	
	Pipe upgrade (pipe replacement/twinning)	Provides reduction/elimination of sewer surcharge and provides capacity for future growth.	Very disruptive construction due to length of upgrades.	Anywhere other utilities do not impose constraints.	A-1, A-2
	Underground storage tank	Extension of construction; more compact and thus potentially less disruptive during construction than other alternatives for storage of flow capacity increases.	Requires open space for construction at a hydraulically effective location. Interferes with recreational land use during construction. Adds noticeably to O&M costs of system.	Applicable where and if open space (parkland, school yard, etc) is available.	A-3
	Internal diversion (diversion of flow from overloaded sewer to other parts of the existing system with adequate capacity).	Balances flow in existing systems with minimal construction.	Reduces/eliminates spare capacity in other parts of system to accommodate more intensive storms.	Where system loadings vary substantially between areas and if receiving system can accommodate influx.	A-4
	Operations and Maintenance (i.e. sewer flushing)	Reduce I/I into sanitary sewer. Prevent potential bottlenecks from grease/sediment	None.	Everywhere, particularly where basement flooding has	All Alternatives.

Table 7.1 Screening of Alternative Remedial Measures

Control Type	Control Measure	Advantage	Disadvantage	Applicability	Considered in Alternative
Storm Systems		build-up.		occurred.	
	Increase inlet capacity by adding catchbasins.	Effective in rapidly conveying runoff from ground into storm sewer system where additional capacity exists.	High capital costs and potential construction constraints.	Applied where the sewer system has extra capacity and overland flow causes flooding. Reduce overland flow depth.	A-1 B-2
	Inlet control devices	Effective in controlling the stormwater entering the storm system where sewer capacity does not exist.	Water ponding will occur in open areas.	Applied in situations where sewer surcharge causes basement flooding and overland flow is not a problem as the major drainage system has adequate outlet capacity and there are no sags in the street.	A-1
	System storage (in-line/off-line sewers)	Effective in regulating/moderating peak flows at locations where the capacity of a sewer is inadequate.	Costs can vary significantly depending on sewer depth and the presence of bedrock. Land/space requirements can limit the application of the in-line/off-line storage.	Applied in situations where head and space in the street are available. Most effective if the downstream sewer system does not have adequate capacity to convey the peak flow.	A-3 B-3
	Storm relief sewers/pipe upgrades	Effective in preventing surcharge of existing storm sewer system.	High capital cost due to construction constraints.	Applied in situations where storm sewer is undersized.	A-2

Table 7.1 Screening of Alternative Remedial Measures

Control Type	Control Measure	Advantage	Disadvantage	Applicability	Considered in Alternative
	Provide SWM facilities	Effective in controlling stormwater peak flows by temporarily storing runoff and releasing at a controlled rate.	The footprints of SWM facilities occupy a significant amount of space.	Applied where open space is available.	A-3 B-4
	Overland flow diversion and outlets	Effective inflow of runoff into the storm sewer by re-directing runoff into grass areas or overland routes with adequate capacity.	Difficult to implement in urbanized areas due to non-availability of open /grassed areas.	Applied in situations where overland flow routes or natural channels are available.	B-1
	Internal diversion	Balances flow in existing systems with minimal construction.	Reduces/eliminates spare capacity in other parts of system to accommodate more intensive storms.	Where system loadings vary substantially between areas and if receiving system can accommodate influx.	A-4
	Operations and Maintenance (i.e. sewer flushing)	Prevent exfiltration from system. Prevent potential bottlenecks from sediment build-up.	None.	Everywhere, particularly where basement flooding has occurred.	All Alternatives.

7.2 Level of Protection

The City identified the level of service criteria to be targeted in developing and sizing remediation alternatives to alleviate basement and surface flooding. The criteria for the storm and sanitary sewer system was established for the original 31 chronic basement flooding areas as identified in the Work Plan and approved by City Council in April 2006. The current study area, Area 32 which was added later, has a combined sewer system. In discussions with the City, it was agreed to modify the original criteria (storm and sanitary sewer system) as described below in order to match the characteristics of the combined sewer system:

- **Combined Sewer System:** The maximum hydraulic grade line in the combined system shall be maintained at an elevation at least 1.8 m below the ground elevation (considered to be the basement elevation) under the City's 100-year design storm event.
- **Storm Drainage System:** The major storm flows are to be maintained within the road allowance and no higher than 150 mm for local roads (or 100 mm for collectors and industrial roads) above the crown of the road during the City's 100-year design storm event. As a second priority, the maximum Hydraulic Grade Line (HGL) of the storm sewer system shall be maintained to below basement elevation if economically feasible in the local streets. The reason for considering this as a second priority is that because the storm sewer system consists of road storm sewers, collecting only surface flow with no house connection. High water level in the road storm sewer may only contribute to the Inflow/Infiltration (I/I) to the combined sewer through illegal cross-connections if any, but will not affect the local house drainage system.

In the streets where houses with reverse slope driveways are located, maximum overland flow was maintained to below 150 mm above gutter elevation, i.e., to top at curb elevation.

7.3 Development of Study Alternatives

To alleviate the basement flooding problems, alternatives have been developed and evaluated. The alternatives are based on the short listed remedial measures presented in Table 7.1 and are explained in the following section. A "Do Nothing" alternative normally included in a Municipal Class Environment Assessment process was not considered here since it will not meet the objective of eliminating the basement flooding problem based on the City's level of protection criteria.

In developing and evaluating the alternatives, the following concepts need to be considered in relieving the combined and storm sewer systems and alleviating flooding problems:

- Reduce stormwater entering the combined sewer system as much as feasible.
- Minimize any increase in flow to the treatment plant.
- Minimize increase of flow to the lake under heavy storm events and maintain outflow/overflow to the lake to the existing level for storms up to the 2-year design storm.
- Limit the flow entering the sewer systems to the capacity of the sewers and utilize the street, as part of the major drainage system, to convey surface flow without excessive ponding/flooding.

The developed study alternatives are explained below:

Measures Applied in the Entire Area and Included in all Alternatives:

The following measures were considered for implementation with all alternatives. These measures need to be considered since they are either required by municipal by-laws or part of regular operation/maintenance programs:

- Disconnections of roof leader downspouts. Municipal by-law requires home owners in the City of Toronto to disconnect roof leader downspouts from the sewer and discharge roof flow to the surface. For the combined sewer area the deadline for the disconnection was November 20, 2011. Since there are constraints in some properties which could prevent roof downspout discharge to the surface, it is assumed that the roof disconnection could not be achieved for 25% of the properties on the average. Roof downspout disconnection was, therefore, considered to be increased from the existing level to 75% of all properties in the area.
- Replacing perforated combined sewer manhole covers in partially separated areas, where road storm sewer exists. Replacing these covers was supposed to be completed at the time when road storm sewer was installed and surface storm flow through catchbasins was connected to the storm sewer.
- Sealing combined and sanitary sewer manhole covers in low lying areas, to prevent surface ponded storm flow from entering the sewer system.
- Sewer repair areas identified by recent CCTV inspection and Fog testing carried out in 2009-2011.
- Encouraging home owners to apply for the Basement Flooding Protection Program, which provides local protection, backing up measures in the sewer system implemented by the City.

By implementing the above measures, storm flow entering the sewer system will be reduced and this may result in eliminating potential flooding problems in some areas. Additional remedial measure alternatives as explained below were developed to be applied to other areas. It should be noted that not every alternative was applied to all cluster areas, but only alternatives which are applicable were considered. In some cluster areas, only one alternative was found to be feasibly applicable, hence was selected as the preferred alternative. All alternatives consider the implementation of the above measures which are to be considered for the entire study area.

A. Alternatives for Sewer System

Alternative A-1

- Apply inlet control devices (ICD) in street catchbasins to limit surface storm flow entering the combined/storm sewer. Inlet device considered is the orifice plate limiting the flow to 20 L/s per catchbasin.
- In areas where no storm sewer exists, construct road storm sewer and direct all surface flow to the new storm sewer.
- After diverting surface flow from combined sewer, if the sewer is still surcharged to above basement elevation upgrade the sewer, provide subsurface storage or divert flow to a CSO sewer.

Alternative A-2

- Increase the capacity of the combined sewer system by upgrading the sewers to lower surcharge elevation to below basement elevation.
- Increase the capacity of the road storm sewers to avoid surcharging the sewer to the surface.

Alternative A-3

- Provide subsurface storage (in-line or off-line) for the combined or storm sewer in which flow is stored and released at slower rate to meet the capacity of the downstream pipe.
- Provide surface storage for storm flows in parks and open areas, if an open area is available at the right location and with the right elevation which allows positive flow from the sewer system to the pond.

Alternative A-4

- Divert flow from the combined sewer to CSO sewer to reduce surcharge level and back up in the sanitary/combined system.
- Divert flow from overloaded sewer to other parts of the sewer system which has adequate capacity.

B. Alternatives for Overland Flow System

Alternative B-1

- Regrade short street sections to eliminate low spot ponding areas and divert overland flow away from flooded area.
- Provide additional inlets to the storm sewer if the sewer has adequate capacity.

Alternative B-2

- Collect overland flow in a shallow pipe and convey to existing outlet.

Alternative B-3

- Collect overland flow in a shallow storage pipe/tank and release at slower rate to existing sewer system.

Alternative B-4

- Provide surface storage in parks and open areas, if a green area is available at the required location.

7.4 Sizing of Alternatives

After implementing the general measures to the entire study area as explained in the previous section, remedial measures alternatives were applied to the different system elements to reduce water levels according to the level of service criteria. The alternatives were applied first to the cluster areas, and afterwards to areas outside of the cluster areas. It should be noted that the cluster areas, and causes of flooding in each were identified based on historic flooding reports, basically from the July 8, 2008 storm event. Remediation requirements and the sizing of the remedial measures are applied to areas and system elements flooded under the 100-year design storm. The sizing is based on the level of protection criteria as explained in Section 7.2.

There are therefore remedial measures applied to areas outside of the cluster areas, which were not previously subject to basement or surface flooding.

7.4.1 Cluster Area 1

Lee Avenue

Sewer System

Alternative A-2

- Increase the length of the weir in Kenilworth tank.
- Upgrade the storm sewer upstream of the flap gate from 675mm to 1050mm, length of 128m and relocate the flap gate.

Alternative A-4

- Provide by-pass from the storm sewer upstream of the flap gate to the outfall, 600mm diameter, length of 71 m.

Overland Flow System

Alternative B-2

- Provide curb inlets at the south street corner and connect by 300mm lead to the ditch inlet in the park.
- Provide new catchbasin in front of the house with reverse slope driveway.
- Twin the storm sewer in the park, 600mm diameter, length of 83m.

Alternative B-4

- Provide curb cut, lower the ditch inlet by excavating in the park, or divert the flow to the lake through a 5 m wide channel, which requires 2 m excavation.

Waverley Road

Sewer System

Alternative A-2

- Increase the length of the weir in Kenilworth tank.
- Upgrade the storm sewer upstream of the flap gate from 375mm to 900mm, length of 144m and relocate the flap gate.

Alternative A-4

- Provide by-pass from the storm sewer upstream of the flap gate to the outfall, 600mm diameter, length of 53 m.

Overland Flow System

Alternative B-2

- Provide curb inlets at the south street corner and connect by 300mm lead to the ditch inlet in the park.

- Twin the storm sewer in the park, 600mm diameter for a length of 102 m.

Alternative B-4

- Provide curb cut, lower the ditch inlet by excavating in the park, or divert the flow to the lake through a 5 m wide channel, which requires 2 m excavation.

Kenilworth Avenue

Sewer System

Alternative A-2

- Increase the length of the weir in Kenilworth tank.

Alternative A-4

- Provide by-pass from the storm sewer upstream south of Kew Beach Avenue to the outfall, 600mm diameter, length of 81 m.

Woodbine Avenue

Sewer System

Alternative A-2

- Upgrade the storm sewer along Woodbine Avenue all the way to Kenilworth tank from 450mm-800mm to 750mm-1200mm, total length 711 m.

Alternative A-3

- Provide flap gate in the storm sewer along the park upstream of the tank. Provide by-pass from upstream of the flap gate to the proposed shallow sewer from Kew Beach Avenue, 750mm diameter, length of 3 m.
- Divert the existing 525mm storm sewer servicing the Greenwood Development from the Woodbine Avenue storm sewer to the Lake Shore Blvd. storm sewer. Provide a new storm sewer 525mm diameter, length of 51 m.
- Upgrade the Woodbine Avenue storm sewer from the park for 152 m northward from 600mm to 900mm.
- Upgrade the Lake Shore Blvd. storm sewer from 300mm - 825mm to 900mm for a length of 478 m.

Overland Flow System

Alternative B-4

- Extend the median 80 m northward to direct the overland flow to Lake Shore Blvd., instead of Woodbine Avenue.
- Provide catchbasin in the low area on the east side of the street, and double catchbasins at the median on the east side at the turn to Lake Shore Blvd.

Kippendavie Avenue

Sewer System

Alternative A-1

- Upgrade the combined sewer from 300mm to 450mm for a length of 225 m.
- Upgrade the storm sewer in Buller Avenue from 300mm to 450mm for a length of 48 m.

Alternative A-2

- Parallel the combined sewer by constructing another 300mm sewer.
- Parallel the storm sewer by constructing a 375mm sewer along Puller Lane and Kippendavie Avenue.

Kew Beach Avenue

Overland Flow System

Alternative B-2

- Collect overland flow along Kew Beach Avenue in a shallow sewer 900mm diameter which extends to Kenilworth Avenue outfall, total length of 380 m.

Alternative B-3

- Provide storage in shallow culvert 900mm x 4000mm and drain through 250mm pipe to the existing storm sewer along the beach to Kenilworth tank.

Alternative B-4

- Provide 10 m wide swale along the park area to the beach. Due to the high elevation at the park, excavation of up to 1.0 m will be required to provide positive slope to the beach area.

7.4.2 Cluster Area 2

Kerr Road/Highfield Road

Sewer System

Alternative A-1

- Block all interconnections between storm sewers and sanitary sewers.
- Add standby power at the Highfield sanitary pumping station.
- Upgrade the storm sewer along Kerr Road from 375mm diameter to 525mm diameter for 79 m. Add two catchbasins at the low area in the corner of Kerr Road and Highfield Road.

Overland Flow System

Alternative B-1

- Regrade the southeast corner of the Dundas Street/Highfield Road intersection to redirect overland flow along Dundas Street towards the west instead of south.

7.4.3 Cluster Area 3

Minto Street

Sewer System

Alternative A-1

- Provide new storm sewer along Minto Street west to east 375mm diameter, length of 79 m and connect to the existing sewer.
- Upgrade existing storm sewer along Minto Street north to south from 375mm to 600mm diameter, length of 89 m.
- Upgrade existing storm sewer along Eastern Avenue east of Minto Street from 300mm to 600mm diameter for a length of 87 m, and from 375mm to 1050mm diameter for a length of 65 m and west of Minto Street from 600mm – 675mm to 1050mm diameter for a length of 135 m. (total length of 1050mm diameter sewer is 200 m).
- Block the abandoned sewer from the TTC Russell Yard which drains to the Minto Street combined sewer. Blockage should be at the TTC property line.

Alternative A-2

- Upgrade the combined sewer along Minto Street to the interceptor at Eastern Avenue, from 300mm to 600mm for a length of 175 m.
- Upgrade the storm sewer along Eastern Avenue from 375mm - 600mm to 600mm - 750mm for a length of 223 m.

7.4.4 Cluster Area 4

Alton Street

Sewer System

Alternative A-1

- Upgrade the combined sewer along Alton Street (60 m), Queen Street East (39 m) and Liang Avenue (183 m) from 500mm diameter to 750mm diameter for a total length of 282 m.

Leslie Street

Overland Flow System

Alternative B-1

- Add two double catchbasins, one in the northeast side and the other in the northwest side at the intersection of Lake Shore Blvd. East and Leslie Street. Additional catch basins will intercept overland flow from Lake Shore Blvd. before it spills northward along Leslie Street.
- Provide double catchbasins at the low point on the west side of Leslie Street south of Lake Shore Blvd. at the driveway to the commercial site.

7.4.5 Cluster Area 5

Queen Street East

Sewer System

Alternative A-1

- Upgrade the combined sewer along Queen Street between Brooklyn Avenue and Jones Avenue from 300mm to 450mm diameter, length of 253 m and between Jones Avenue and Leslie Street from 375mm to 750mm, length of 210 m and along Leslie Street from 450mm to 750mm diameter, length of 21 m, and from 450mm to 900mm diameter, length of 171 m.
- Upgrade the combined sewer along Coady Avenue from 300mm to 450mm diameter, for a length of 92 m, and from 375mm to 600mm diameter, for a length of 191 m.

Alternative A-2

- Upgrade the combined sewer along Queen Street between Brooklyn Avenue and Leslie Street, from 300mm-375mm to 900mm diameter for a length of 463 m and along Leslie Street from 450mm to 900mm diameter for a length of 192 m.
- Upgrade the combined sewer along Coady Avenue from 300mm to 600mm diameter for a length of 92 m, and from 375mm to 750mm for a length of 191 m.

Winnifred Avenue

Alternative A-1

- Upgrade the storm sewer at Eastern Avenue between Caroline Avenue and Winnifred Avenue from 450mm to 750mm diameter for a length of 83 m and from Winnifred Avenue to Pape Avenue from 750mm to 900mm diameter for a length of 124 m.
- Upgrade the storm sewer at Eastern Avenue between Winnifred Avenue and Caroline Avenue flowing eastward from 450mm to 750mm diameter for a length of 76 m.
- Upgrade the storm sewer along Pape Avenue south of Eastern Avenue from 1050mm to 1200mm diameter for a length of 324 m.
- Upgrade the storm sewer at Winnifred Avenue north of Eastern Avenue from 375mm to 450mm diameter for a length of 139 m and from 375mm to 600mm diameter for a length of 84 m.

Pape Avenue

Alternative A-1

- Provide new storm sewer along Pape Avenue north of Dundas Street consisting of 525mm diameter for a length of 173 m.
- Provide new storm sewer along Pape Avenue south of Dundas Street, consisting of 450mm diameter for a length of 162 m.

Alternative A-2

- Upgrade the existing combined sewer along Pape Avenue from South of Austin Avenue to Brighton Avenue from 600x900mm eggshaped to 1200mm diameter for a total length of 335 m.

Eastern Avenue (West of Heward Avenue)

Alternative A-1

- a. Upgrade the storm sewer along Eastern Avenue west of Heward Avenue from 375mm to 600mm diameter, for a length of 83 m.

Eastern Avenue (West of Larchmount Avenue)

Alternative A-1

- a. Upgrade the storm sewer along Eastern Avenue west of Larchmount Avenue from 450mm to 750mm diameter, for a length of 429 m.

7.4.6 Cluster Area 6

Logan Avenue

Alternative A-4

- Plug the connections of the combined sewers on Logan Avenue, Booth Avenue and Morse Street north of Queen Street to the sewers south of Queen Street.

Carlaw Avenue

Alternative A-1

- Upgrade combined sewer along Carlaw Avenue north of Queen Street from 600mm x 900mm egg shape to 1050mm diameter for a total length of 366 m.
- Upgrade combined sewer along Gerrard Street East, between Boston Avenue and Carlaw Avenue from 300mm to 600mm diameter for a length of 106 m.

Saulter Street

Alternative A-1

- Provide a new storm sewer along Saulter Street north of Eastern Avenue and along Eastern Avenue, west of Saulter Street. The sewer is 450mm diameter for a length of 380 m, then 600mm along Eastern Avenue westward for a length of 106 m.

Empire Avenue

Alternative A-1

- Upgrade the storm sewer along Empire Avenue north of Eastern Avenue from 300mm to 450mm diameter, for a length of 187 m.

7.4.7 Cluster Area 7

First Avenue

- By implementing inlet control measures in street catchbasins and the general remedial measures to be applied in the entire area, as explained in Section 7.3 above, surcharge level in the combined sewer will be reduced to below basement elevation. No additional measures are therefore considered.

7.4.8 Cluster Area 8

Player Blvd.

- As explained in Cluster 7, by implementing inlet control measures in street catchbasins and the general remedial measures to be applied in the entire area, as explained in Section 7.3 above, surcharge level in the combined sewer will be reduced to below basement elevation. No additional measures are therefore considered.

7.4.9 Cluster Area 9

Kingswood Road

Alternative A-1

- Provide new storm sewer along Kingswood Road from Brackin Avenue to EdVans Lane, 375mm diameter, for a length of 426 m.
- Provide new storm sewer along Queen Street East from Kingswood Road to Neville Park Blvd., and south along Neville Park Blvd. south, 600mm diameter, for 169 m.
- Upgrade existing storm sewer along Neville Park Blvd. from 300mm diameter to 600mm diameter for a length of 176 m.

7.4.10 Interceptors

As discussed previously, only two interceptors require remediation since they surcharge to elevations above basement elevation in some areas, under the 100-year design storm event. The two interceptors are the Queen Street Sanitary Trunk Sewer (QSSTS) and the Lake Front Interceptor (LFI). The following describes remedial measure alternatives that have been developed for them.

Queen Street STS

Alternative A-2

- Upgrade the downstream section of the sewer from 600mm - 675mm diameter to 2100mm diameter for a length of 269 m that will allow more flow to the treatment plant, especially for storm events less frequent than the 2-year design storm.

Alternative A-4

- Lower the overflow weir elevation in the manhole east of Coxwell Avenue from 75.79 m to 75.44 m. That will allow higher overflow volume to the Ashbridges Bay for storm events less frequent than the 2-year design storm. With the proposed modified weir elevation of 75.44 m, there will still be no overflow from the interceptor for events up to the 2-year design storm event.

Lake Front Interceptor (LFI)

Alternative A-2

- Parallel the sewer in two areas by providing new sewer and connect to the existing sewer as follows:
 1. From east of Waverley Road to east of Coxwell Avenue, 900mm diameter for a length of 1214 m.
 2. From Maclean Avenue to Lee Avenue, 600mm diameter, for a length of 565 m.

Alternative A-3

- Provide offline storage conduit 900mm x 4000mm for a length of 100 m in the area of Alfresco Lawn which drains back to the interceptor through 200mm orifice.

Alternative A-4

- Divert the flow to Queen Street STS from two sewers draining areas north of Queen Street and currently draining into the LFI. The two sewers are 300mm diameter sewer, for a length of 7 m from Queen Street and 300mm sewer, for a length of 4 m from Kenilworth Avenue.

7.4.11 Other Areas

The analysis of the combined sewer and storm drainage systems show areas outside the cluster areas subject to potential flooding problems under the 100-year design storm event. This is expected since the cluster areas are based on flooding that occurred from the July 8, 2008 storm event, which has a return period of only 10-25 year. To satisfy the City's basement flooding protection criteria, alternative remedial measures have been developed and analysed for these other areas. The objective of the remedial measures is to minimize potential flooding to the extent physically feasible without having to upgrade and replace the entire sewerage systems in the study area.

Victoria Park Avenue

Alternative A-1

- Upgrade the combined sewer along Victoria Park Avenue from Musgrave Street to Swanwick Avenue from 300mm – 450mm diameter to 600mm diameter for a total length of 328 m.

Danforth Avenue / Luttrell Avenue

Alternative A-1

- Upgrade the combined sewer along Luttrell Avenue south of Danforth Avenue from 300mm to 450mm diameter, for a length of 72 m and from 300mm to 600mm diameter for a length of 72 m, and along Danforth Avenue west of Luttrell Avenue from 375mm to 600mm diameter for a length of 97 m.

Glen Manor Drive

Alternative A-1

- Provide new storm sewer along Glen Manor Drive from south of Beauford Road north of intersection to south of Beauford Road south intersection with Glen Manor Drive East. The proposed sewer is 375mm diameter, for a length of 162 m.

Kingston Road

Alternative A-1

- Upgrade the combined sewer along Kingston Road from Lee Avenue to Elmer Avenue from 900 x 1200mm basket handle to 1200mm diameter, for a length of 467 m, and from Columbine Avenue to Edgewood Avenue from 1050 x 1350mm - 1829 x 2080mm basket handle to 1800mm diameter, for a length of 231 m.

- Provide new storm sewer along Main Street from Gerrard Street East to Kingston Road, 450mm diameter for a length of 604 m, and along Kingston Road from Main Street to Woodbine Avenue, 450mm diameter for a length of 375 m, and 600mm diameter for a length of 433 m and 900mm diameter for a length of 170 m.
- Upgrade the storm sewer along Kingston Road from Woodbine Avenue to Columbine Avenue from 600mm - 675mm to 1050mm diameter for a length of 283 m and from 600mm to 900mm diameter for a length of 248 m.

Hambley Avenue

Alternative A-1

- Upgrade the storm sewer along Hambley Avenue north of Queen Street East from 300mm to 450mm diameter for a length of 163 m.

Rainsford Road

Alternative A-1

- Upgrade the combined sewer along Rainsford Road north of Queen Street East from 300mm to 600mm diameter for a length of 24 m.

Elmer Avenue

Alternative A-1

- Upgrade the storm sewer along Elmer Avenue north of Queen Street East from 300mm to 450mm diameter for a length of 102 m.

Queen Street East (Between Lee Avenue and Woodbine Avenue)

Alternative A-1

- Upgrade the combined sewer on the south side from 300mm to 600mm diameter for a length of 196 m.
- Upgrade the combined sewer on the north side from 375mm to 600mm diameter for a length of 162 m.

Alternative A-4

- Interconnect the 300mm local combined sewer along Queen Street, south side to the Queen Street Sanitary Trunk Sewer (QSSTS) at two locations, Whieler Avenue and Bellefair Avenue by two 450mm diameter, 4 m sewer connections. Interconnect the 350mm local combined sewer along Queen Street, north side to the QSSTS at Bellefair Avenue by 375mm diameter, 4 m sewer connection.

Queen Street East (Between Kingston Road and Greenwood Avenue)

Alternative A-1

- Upgrade combined sewer along Queen Street East, east and west of Coxwell Avenue from 375mm to 600mm diameter for a length of 232 m.

- Upgrade storm sewer along Queen Street East, from west of Woodward Avenue to Coxwell Avenue from 450mm to 600mm diameter for a length of 55 m and from 600mm to 900mm for a length of 215 m.

Rhodes Avenue

Alternative A-1

- Provide new storm sewer along Rhodes Avenue from Dundas Street to Queen Street East, 375mm diameter, length of 275 m.

Craven Road

Alternative A-1

- Provide new storm sewers along Craven Road as follows:
 1. From Fairlord Avenue to Gerrard Street East, 375mm diameter, for 243 m.
 2. From Gerrard Street East to Dundas Street East, 450mm diameter, for 443 m.
 3. From Dundas Street East to Queen Street East, 375mm diameter, for 273 m.

Eastern Avenue (West of Woodfield Road)

Alternative A-1

- Upgrade storm sewer west of Woodfield Road from 300mm to 600mm diameter for a length of 97 m.

Ivy Avenue

Alternative A-1

- Provide new storm sewer along Ivy Avenue east of Prust Avenue, 375mm diameter, for a length of 144 m.

Ravina Cres./Earl Grey Road/Shudell Avenue

Alternative A-1

- Provide new storm sewer along Ravina Cres., from Jones Avenue to Earl Grey Road, then along Earl Grey Road to Shudell Avenue, then along Shudell Avenue eastward to Condor Avenue. The storm sewer starts at 375mm diameter for a length of 487 m and 600mm diameter for a length of 165 m.

Hunter Street

Alternative A-1

- Provide new storm sewer along Hunter Street from Jones Avenue eastward, 375mm diameter, for a length of 194 m.

First Avenue

Alternative A-1

- Provide new storm sewer along First Avenue from Thackeray Street to Logan Avenue, 375mm diameter, for a length of 88 m.

Jones Avenue

Alternative A-1

- Provide new storm sewer along Jones Avenue from Dundas Street East to Queen Street East, 300mm diameter for a length of 195 m and 450mm diameter for a length of 198 m.

Morse Street

Alternative A-1

- Upgrade the storm sewer along Morse Street south of Eastern Avenue from 450mm to 750mm diameter for a length of 233 m.

Booth Avenue

Alternative A-1

- Upgrade the storm sewer along Booth Avenue south of Eastern Avenue from 450mm to 900mm diameter for a length of 190 m.

Kenilworth Avenue

- Provide 1 double catchbasin at low point on Kenilworth Avenue, N of Queen Street.

Corley Avenue/Woodbine Avenue

- Provide 2 double catchbasins at the intersection of Corley Avenue and Woodbine Avenue.

8. Evaluation of Alternatives

8.1 Evaluation Criteria and Scoring Systems

To evaluate the different alternatives, comparative criteria was established and applied for each sub area. The criteria are based on four categories: natural environment, social environment, technical considerations and cost considerations. The measure for evaluating each criterion has been established, as presented in Table 8.1.

Scoring of the evaluation was conducted in a comparative basis for three categories:

- No or positive impact, relatively low cost Score 3
- Neutral impact, relatively medium cost Score 2
- Negative impact, relatively high cost Score 1

The score has been applied to each alternative for every criterion and the total score for each alternative is calculated. The alternative with the highest score has been selected as the preferred alternative.

8.2 Evaluation of Alternatives

Based on the above method, alternatives for the sewer system and overland flow systems were evaluated and scored. The results of this evaluation are presented in Table 8.2. An explanation for the given scoring for each alternative is given below, and the preferred alternative was selected for each area. As indicated before and shown in the previous section, not all alternatives were applicable in every area. For most areas, only Alternatives A-1 and A-2 were considered, and in some areas only one alternative was considered, hence selected.

Evaluation and scoring of alternatives under each criteria is explained below:

Natural Environment, Terrestrial System

Alternatives A-1, A-2, A-4 do not impact on the terrestrial system, hence scored 3. Alternative A-3, surface storage may impact on existing trees, hence scored 2. Alternatives B-1, B-2 and B-3 do not impact on the terrestrial system, since work is basically carried out in the street, scored 3. Alternative B-4 being in the park area, will affect existing trees, hence scored 2.

Natural Environment, Aquatic System

All alternatives, except alternatives A-2 and B-2, have no significant increase in the flow discharged to the receiving water bodies, hence will have no impact on the aquatic system, and scored 3. Alternatives A-2 and B-2 may result in some increase in the flow discharged to the lake and Don River, and hence may have some impact on the aquatic system. Alternatives A-2 and B-2 scored 2.

Social Environment, Community Impact

Alternative A-2 has relatively large impact on the community since it involves digging in every street to replace or construct new pipe, therefore it scored 1. Alternatives A-1 and A-3 as well as, Alternatives B-3 and B-4, involve either construction in many streets or construction in open areas and parks, and therefore, expected to provide some impact on the community. These alternatives scored 2. On the other hand, Alternatives A-4, B-1 and B-2 are expected to provide the least impact compared to the other alternatives, and therefore scored 3.

Social Environment, Land Use Compatibility

Alternatives A-1, A-2, A-3, B-1 and B-2 involve construction basically within the street ROW, and therefore provide good compatibility with existing land use, and scored 3. Other alternatives, namely A-4, B-3 and B-4 involve either sub-surface or surface storage facilities which are constructed in parks or other open areas used for other purposes. These alternatives were therefore scored 2 because of their potential impact on other land uses.

Technical Considerations, Effectiveness of Control Measures

All alternatives except Alternatives A-3 and B-1 are not dependent on operation or maintenance requirement hence considered more effective and reliable in controlling flooding, than the other alternatives, and scored 3. Alternative A-3 requires regular maintenance and possibly operational needs to ensure its effectiveness. Alternative B-1 involves diversion of surface flow either overland or to the sewer through inlets/catchbasins, and its effectiveness depends on the reliability and regular maintenance of the diversion structure. Both alternatives scored 2.

Technical Considerations, Feasibility of the Control Measures

Alternatives A-2, A-4 and B-1 are the most feasible since they depend on utilizing the existing drainage system either by using available capacities in some areas or increasing its capacities in some areas or increasing its capacities in other areas. These alternatives scored 3. Alternatives A-1, A-3, B-2, B-3 are less feasible since they depend on additional remediation elements like inlet control devices, storage or conveyance elements, hence scored 2. Alternative B-4 requires open space or park area which should have consideration to availability of space, accessibility, ease of construction etc., hence scored 1.

Technical Considerations, Downstream Impacts

Alternatives A-1, A-3, B-3 and B-4 will result in reduction of the peak flow to the downstream receiving system, i.e., treatment plant and lake/rivers, and they scored 3. While Alternatives A-4, B-1 and B-2 will not result in changing the downstream peak flow, they scored 2. Alternative A-2 will result in increasing the downstream peak since it is based on increasing the capacity of the conveyance system. This alternative scored 1.

Cost Considerations, Capital Cost

By comparing the expected capital costs of the different alternatives, Alternative A-2 was found to be the most expensive among the sewer system alternatives and hence scored 1, while Alternative A-4 is the least expensive and scored 3, and Alternatives A-1 and A-3 are in between and scored 2. Among the overland flow system alternatives, Alternative B-2 and B-3 are the most expensive and scored 1, followed by Alternative B-4 and scored 2, and then Alternative B-1 which is the least expensive and scored 3.

Cost Considerations, O & M Cost

Alternatives A-2 and A-4 do not require additional O & M requirements and they scored 3. In Alternative A-3, the storage elements will need additional O & M efforts and scored 1, while Alternative A-1 will require more regular maintenance because of the ICDs and scored 2. For the overland flow alternatives, Alternatives B-1 and B-2 require no additional O & M and scored 3, while Alternatives B-3 and B-4 will involve additional maintenance and potentially operational requirements, if pumping is involved and hence scored 2.

Table 8.1 Evaluation Criteria

Comparative Criteria	Description	Measures for Evaluating
Natural Environment Criteria		
Terrestrial System	Potential to impact terrestrial habitats or systems, including terrestrial features / functions (ANSIs, ESAs), unique vegetation species, mature trees, existing park / open spaces linkages or wildlife.	- Alternative does not impact terrestrial system – score 3 - Alternative has comparatively small impact on terrestrial system – score 2 - Alternative has comparatively large impact on terrestrial system – score 1
Aquatic System	Potential to impact aquatic habitats or systems, including possible impacts on aquatic life, features / functions.	- Alternative does not impact aquatic system – score 3 - Alternative has comparatively small impact on aquatic system – score 2 - Alternative has comparatively large impact on aquatic system – score 1
Social Environment		
Community Impact	Potential to impact the community in terms of access to the site, visibility, road access, construction of mitigation measure in valley lands/ parks, possible noise / odour / light, potential risk in terms of proximity to open water which may provide breeding grounds for mosquitoes with West Nile Virus, short-term construction impact, etc.	- Alternative does not impact community – score 3 - Alternative has comparatively small impact on community – score 2 - Alternative has comparatively large impact on community – score 1
Land Use Compatibility	The extent to which the control measure blends in with the existing land uses in the area in terms of minimizing impacts related to visibility, noise, air emissions, traffic congestions and regulatory requirements.	- Alternative demonstrates good compatibility in blending in with existing land uses – score 3 - Alternative demonstrates fair compatibility in blending in with existing land uses – score 2 - Alternative demonstrates poor compatibility in blending in with existing land uses – score 1
Technical Considerations		
Effectiveness of Control Measure	Effectiveness of the alternative in the reduction of basement flooding from both combined and storm sewer systems in the cluster area based on the design criteria considered.	- Alternative is effective in achieving stated requirements – score 3 - Alternative is slightly effective in achieving stated requirements – score 2

Table 8.1 Evaluation Criteria

Comparative Criteria	Description	Measures for Evaluating
Feasibility of Control Measure	The extent to which the alternative is feasible in terms of availability of space, accessibility, ease of construction, cost-effectiveness, life cycle (durability), construction requirements and minimizing impacts such as upstream flooding.	- Alternative has minimal or no effectiveness in achieving stated requirements – score 1 - Alternative is feasible in terms of stated considerations – score 3 - Alternative is partially feasible in terms of stated considerations – score 2 - Alternative is not feasible in terms of stated considerations – score 1
Downstream Impacts on Downstream Trunk Sewers / Treatment Facilities / Receiving Water	The impacts of the alternative in increasing the peak flow rate and total flow in the downstream receiving water system.	- Alternative does not have an impact in increasing the peak flow and total flow downstream – score 3 - Alternative has comparatively minor impact in increasing the peak flow and total flow downstream – score 2 - Alternative has significant impact in increasing the peak flow and total flow downstream – score 1
Cost Considerations		
Capital Cost	The capital cost associated with the construction of the alternative including labour, material and equipment and possibly property acquisition.	- Capital cost of Alternative is low compared to other alternatives – score 3 - Capital cost of alternative is medium compared to other alternatives – score 2 - Capital cost of alternative is high compared to other alternatives – score 1
Operation & Maintenance (O&M) Cost	Post-construction operation and maintenance activities associated with various mitigation measures including regulation inspection, grass cutting / weed control, performance monitoring, sediment/trash removal and energy requirements from pumping, lights, flushing and other operational requirements.	- O & M cost of alternative is low compared to other alternatives – score 3 - O & M cost of alternative is medium compared to other alternatives – score 2 - O & M cost of alternative is high compared to other alternatives – score 1

8.3 Conclusions

The results of the evaluation show that for the sewer system alternatives, Alternative A-4 scored the highest and hence, was selected in the areas where it was applicable. In many areas Alternatives A-1 and A-2 are the only applicable among the four alternatives. Alternative A-1 was selected in these areas since it scored higher than Alternative A-2. Alternative A-1 is based on controlling the storm flow to the combined sewer system by applying ICDs and constructing road storm sewers. It also considers controlling the flow to the storm sewer system and directing more flow to the overland flow system. Alternative A-1 has the advantages of reducing the storm flow to the treatment plant, resulting in fewer disturbances to the community and less costly, compared to Alternative A-2.

For the overland flow system, Alternative B-1 scored the highest and hence was selected wherever it was applicable. Comparing Alternatives B-2 and B-3, Alternative B-2 scored slightly higher, and was selected where the two alternatives are applicable. Alternative B-4 is the lowest scored, and was not selected in any area.

Table 8.2 Evaluation of Alternatives

System	Alternatives	Description	Comparative Criteria Scoring								Total Score
			Natural Environment Criteria		Social Environment Criteria		Technical Considerations		Cost Considerations		
											Total
			Terrestrial System	Aquatic System	Community Impact	Land Use Compatibility	Effectiveness of Control Measures	Feasibility of Control Measures	Downstream Impacts	Capital Cost	
Sewer System	Alternative A-1	Apply inlet control devices (ICD) in street catchbasins to limit the flow in the combined / storm sewer. Construct road storm sewer. Provide subsurface storage or divert flow to a CSO sewer.	3	3	2	3	3	2	3	2	23
	Alternative A-2	Increase the capacity of the combined sewers. Increase the capacity of the road storm sewers.	3	2	1	3	3	3	1	3	20
	Alternative A-3	Provide subsurface storage (in-line or off-line) for the combined or storm sewer. Provide surface storage for storm flows in parks and open areas.	2	3	2	2	2	2	3	2	1

Table 8.2 Evaluation of Alternatives

System	Alternatives	Description	Comparative Criteria Scoring								Total Score		
			Natural Environment Criteria		Social Environment Criteria		Technical Considerations			Cost Considerations			
			Terrestrial System	Aquatic System	Community Impact	Land Use Compatibility	Effectiveness of Control Measures	Feasibility of Control Measures	Downstream Impacts	Capital Cost		O & M Cost	
Overland Flow System	Alternative A-4	Divert flow from the combined sewer to CSO sewer. Divert flow from overloaded sewer to other parts of the sewer system.	3	3	3	3	3	3	2	3	3	26	
	Alternative B-1	Regrade short street sections and divert overland flow. Provide additional inlets to the storm sewer.	3	3	3	3	2	3	2	3	3	25	
	Alternative B-2	Collect overland flow in a shallow pipe and convey to existing outlet.	3	2	3	3	3	3	2	2	1	3	22
	Alternative B-3	Collect overland flow in a shallow storage pipe/tank and release to existing sewer system.	3	3	2	2	3	3	2	3	1	2	21
	Alternative B-4	Provide surface storage in parks and open areas.	1	3	2	2	3	3	1	3	2	2	19

9. Preferred Alternatives

9.1 General Remedial Measures

Based on the evaluation of the alternatives discussed in the previous section, the highest score alternative among the applicable alternatives was selected as the preferred alternative in each area. The remedial measures included in the preferred alternative are listed and explained in the following sections. Figures 9.1 to 9.4 show all the remedial measures in the preferred alternative. More details are provided in the conceptual design of the remedial measures included in a separate volume in Appendix C. The conceptual design volume provides the following:

- Plan and profile for every upgraded or new sewer element.
- Plan and profile for overland flow relief measures.
- Maps showing sanitary manholes with perforated cover, to be replaced with solid cover.
- Maps showing sanitary manholes recommended for cover sealing.
- Maps showing all catchbasins where inlet control is recommended.

Please note the following which is applicable to all areas:

- The implementation of source control at lot level should be encouraged for the entire study area. In addition to the advantage of reducing the flow to the sewer system, these measures will help in solving local basement flooding problems.
- The option of sewer replacement with a larger pipe versus sewer twinning by adding a new relief sewer could be compared in detail during the detail design phase. Sewer replacement was considered in this study although it could be more expensive than sewer twinning because of the following reasons:
 - Increasing the capacity of existing combined sewer is more acceptable as a measure to eliminate basement flooding instead of building a new combined sewer.
 - The sewer system is quite old, over 100 years in many areas, and replacing existing sewers is required for structural purposes.
 - Most of the streets have more than one sewer in addition to other services and utilities with no available space for additional sewers. Constructing a new sewer in the street could be quite costly considering the requirements of re-location of existing services and utilities.
- When a new storm sewer is recommended, basically in streets where no storm sewer exists, it is required that all catchbasins in the area be disconnected from the existing combined sewers and connected to the new storm sewer.

The following remedial measures are applied for the entire study area, and therefore, they are not mentioned again in the details given below for each cluster area.

- House roof downspout disconnection of at least 75% of all the roofs in every area i.e., if in any street the disconnection level is less than 75%, it is considered to be increased to 75% in the ultimate condition. The 75% disconnection rate was considered since it is

realized that downspout disconnection in some areas may result in local surface flooding and ponding because of unfavourable lot grading or inadequate distance between houses. Achieving, however, higher disconnection rate is beneficial and will increase the level of protection against basement flooding. It is assumed that the disconnected downspout will discharge to a grass area sloping away from the house wall as much as practical to encourage storm water infiltration to the ground before it reaches the catchbasin.

- The preferred alternative is generally based on reducing storm water entering the sewer systems as much as feasible. This is achieved in the study area by applying the following measures:
 - Replacing the perforated manhole covers in the combined sewers by regular solid covers.
 - Sealing manhole covers in the sanitary/combined sewer system in low lying areas where storm water ponding could occur. Sealing of these covers will result in eliminating a significant source of storm water inflow into the sanitary/combined sewer system during wet weather conditions.
 - Installing inlet control device (ICD) inside the catchbasins to control the storm flow entering the sewer. ICDs were not considered where a new storm sewer is proposed or where the existing or recommended upgraded storm sewer has adequate capacity. ICDs were also not considered in low lying areas or where it may result in surface flooding problems, which could not be solved by applicable overland flow alternative. The ICD will limit the flow to the sewer to a maximum of 20 L/s per catchbasin.

9.1.1 Cluster Area 1

1-1 - Lee Avenue

- a. Provide by-pass from the storm sewer upstream of the flap gate to the outfall, 600mm diameter, length of 71 m, and relocate the flap gate.
- b. Provide a new storm sewer in the park paralleling the existing sewer. The new sewer is 600mm diameter, length of 83 m.
- c. Provide four double catchbasins with curb inlets at the south street corner and connect by 300mm lead to the existing ditch inlet in the park, and by a 450mm diameter pipe to the new 600mm sewer.
- d. Provide new catchbasin in front of the house with reverse slope driveway and connect to the existing storm sewer in the street.

1-2 - Waverley Road

- a. Provide by-pass from the storm sewer upstream of the flap gate to the outfall, 600mm diameter, length of 53 m, and relocate the flap gate.
- b. Provide a new storm sewer in the park paralleling the existing sewer. The new sewer is 600mm diameter, length of 102 m.
- c. Provide two double catchbasins with curb inlets at the south street corner and connect by 300mm lead to the existing ditch inlet in the park, and by a 450mm diameter pipe to the new 600mm sewer.

1-3 - Kenilworth Avenue

- a. Provide by-pass from the storm sewer upstream of Kew Beach Avenue to the outfall, 600mm diameter, length of 81 m.

1-4 - Woodbine Avenue

- a. Provide flap gate in the storm sewer along the park upstream of the Kenilworth tank. Provide by-pass from upstream of the flap gate to the proposed shallow sewer along Kew Beach Avenue. The by-pass is 750mm diameter, length of 3 m.
- b. Divert the existing 525mm diameter storm sewer servicing the Greenwood Development from the Woodbine Avenue storm sewer to the Lake Shore Blvd. storm sewer. Provide a new storm sewer 525mm diameter, length of 51 m.
- c. Upgrade Lake Shore Blvd. storm sewer from 300mm – 825mm diameter sewer to 900mm diameter for a length of 478 m.
- d. Upgrade the Woodbine Avenue storm sewer from the Park northward, from 600mm diameter to 900mm diameter for a length of 152 m.
- e. Extend the median northward for 80 m to direct overland flow from the north towards Lake Shore Blvd. instead of Woodbine Avenue.
- f. Provide catchbasin in the low area on the east side of the street and double catchbasins at the median, on the east side at the location where it turns to Lake Shore Blvd. and connect to the Woodbine Avenue storm sewer.

1-5 - Kippendavie Avenue

- a. Upgrade the combined sewer from 300mm to 450mm diameter for a length of 225 m.
- b. Upgrade the storm sewer in Buller Avenue from 300mm to 450mm diameter for a length of 48 m.

1-6 – Kew Beach Avenue

- a. Collect overland flow along Kew Beach Avenue in a shallow sewer, 900mm diameter which extends from Kew Beach Avenue to Kenilworth Avenue outfall, for a total length of 380 m.

9.1.2 Cluster Area 2

2-1 - Kerr Road/Highfield Road

- a. Add standby power at the Highfield Sanitary Pumping Station.
- b. Block all interconnections between the storm sewer system and the sanitary sewers, as shown in the fog testing.
- c. Upgrade the storm sewer along Kerr Road from 375mm diameter to 525mm diameter for a length of 79 m. Add two catchbasins at the low area in the corner of Kerr Road and Highfield Road.
- d. Regrade the southeast corner of the Highfield Road/Dundas Street intersection to redirect overland flow along Dundas Street towards the west instead of the south.

9.1.3 Cluster Area 3

3-1 - Minto Street

- a. Provide new storm sewer along Minto Street west to east, 375mm diameter, length of 79 m and connect to existing storm sewer.
- b. Upgrade existing storm sewer along Minto Street north to south from 375mm to 600mm diameter for a length of 89 m.
- c. Upgrade existing storm sewer along Eastern Avenue east of Minto Street from 300mm to 600mm diameter for a length of 87 m, and from 375mm to 1050mm diameter for a length of 65 m and west of Minto Street from 600mm – 675mm to 1050mm diameter for a length of 135 m. (total length of 1050mm diameter sewer is 200 m).
- d. Block the abundant sewer from the TTC Russell Yard which drains to Minto Street combined sewer. Blockage should be at the TTC yard property line.

9.1.4 Cluster Area 4

4-1 - Alton Street

- a. Upgrade the combined sewer from 500mm to 750mm diameter for the following length: 60 m along Alton Street, 39 m along Queen Street East and 183 m along Liang Avenue. Total length is 282 m.

4-2 - Leslie Street

- a. Add two double catchbasins at the intersection of Lake Shore Blvd. East and Leslie Street, one in the north east side and the other in the north west side.
- b. Provide double catchbasin at the low point on the west side south of Lake Shore Blvd. East at the driveway of the commercial site.

9.1.5 Cluster Area 5

5-1 - Queen Street East

- a. Upgrade the combined sewer along Queen Street as follows:
 - Between Brooklyn Avenue and Jones Avenue from 300mm to 450mm diameter, length of 253 m.
 - Between Jones Avenue and Leslie Street from 375mm to 750mm diameter, length of 210 m.
 - Along Leslie Street from 450mm to 750mm diameter, length of 21 m and from 450mm to 900mm diameter, length of 171 m.
- b. Upgrade the combined sewer along Coady Avenue from 300mm to 450mm diameter, length of 92 m, and from 375mm to 600mm diameter, length of 191 m.

5-2 - Winnifred Avenue

- a. Upgrade the storm sewer in Winnifred Avenue from 375mm to 450mm diameter for length of 139 m and from 375mm to 600mm diameter for a length of 84 m.
- b. From Winnifred Avenue to Caroline Avenue (flowing eastward) from 450mm to 750mm diameter for a length of 76 m.

- c. Upgrade the storm sewers in Eastern Avenue as follows:
 - From Caroline Avenue to Winnifred Avenue (flowing westward) from 450mm to 750mm diameter for a length of 83 m.
 - From Winnifred Avenue to Pape Avenue (flowing westward) from 750mm to 900mm diameter for a length of 124 m.
- d. Upgrade the storm sewer along Pape Avenue south of Eastern Avenue from 1050mm to 1200mm diameter for a length of 324 m.
- e. Remove the weir at Winnifred Avenue storm sewer north of Eastern Avenue and upgrade pipe from 375mm to 600mm diameter for a length of 13 m.
- f. Remove orifice and flap valve in the storm pipe in Caroline Avenue north of Eastern Avenue and connect to the Eastern Avenue sewer by 450mm diameter pipe, for a length of 10 m.

5-3 - Pape Avenue

- a. Provide new storm sewer along Pape Avenue north of Dundas Street, 525mm diameter for a length of 173 m and connect to existing storm sewer at Dundas Street.
- b. Provide new storm sewer along Pape Avenue south of Dundas Street, 450mm diameter for a length of 162 m and connect to existing storm sewer at Pape Avenue.

5-4 – Eastern Avenue (West of Heward Avenue)

- a. Upgrade the storm sewer along Eastern Avenue west of Heward Avenue from 375mm to 600mm diameter, for a length of 83 m.

5-5 – Eastern Avenue (West of Larchmount Avenue)

- a. Upgrade the storm sewer along Eastern Avenue west of Larchmount Avenue from 450mm to 750mm diameter, for a length of 429 m.

9.1.6 Cluster Area 6

6-1 - Logan Avenue

- a. Plug the connection of the combined sewer along Logan Avenue from north of Queen Street to the sewer south of Queen Street. This measure will ensure that the sewer along Logan Avenue south of Queen Street is not receiving surface storm flow, and hence considered as sanitary sewer.
- b. Plug the same connection of the combined sewers at Booth Avenue and Morse Street north of Queen Street to the sewers south of Queen Street.

6-2 - Carlaw Avenue

- a. Upgrade combined sewer along Carlaw Avenue north of Queen Street from 600mm x 900mm to 1050mm diameter for a length of 366 m.
- b. Upgrade combined sewer along Gerrard Street between Boston Avenue and Carlaw Avenue from 300mm to 600mm diameter for a length of 106 m.

6-3 - Saulter Street

- a. Provide new storm sewer along Saulter Street north of Eastern Avenue, 450mm diameter for 380 m length, and along Eastern Avenue from Saulter Street to Broadview Avenue, 600mm diameter for 106 m length.

6-4 - Empire Avenue

- a. Upgrade the storm sewer along Empire Avenue north of Eastern Avenue from 300mm to 450mm diameter, for a length of 187 m.

9.1.7 Cluster Area 7

7-1 - First Avenue

- a. Apply inlet control devices along First Avenue and West Avenue. In addition to the other general remedial measures applied to the entire study area, there is no need for additional remedial measures.

9.1.8 Cluster Area 8

8-1 - Player Blvd

- a. Apply inlet control devices along Player Blvd. In addition to the other general remedial measures applied to the entire study area, there is no need for additional remedial measures.

9.1.9 Cluster Area 9

9-1 - Kingswood Road

- a. Provide new storm sewer along Kingswood road from Bracken Avenue to north of Queen Street, 375mm diameter, length of 426 m.
- b. Provide new storm sewer along Queen Street East from Kingswood Road to Neville Park Blvd., and south along Neville Park Blvd., 600mm diameter, length of 169 m.
- c. Upgrade existing sewer along Neville Park Blvd. from 300mm to 600mm diameter for a length of 176 m.

9.1.10 Interceptors

10-1 – Queen Street STS

- a. Lower the weir elevation in the manhole east of Coxwell Avenue from 75.79 m to 75.44 m. that will reduce the surcharge elevation in the Queen Street STS and the connected sewers upstream of the weir to below basement elevation. The proposed weir elevation of 75.44 m, will still not allow overflow from the STS for events up to and including the 2-year design storm event.

10-2 – Lake Front Interceptor (LFI)

- a. Divert two sewers at Queen Street to the Queen Street STS. These are 300mm sewer, length of 7 m from Queen Street and 300mm sewer, length of 4 m from Kenilworth Avenue, which are draining areas north of Queen Street and currently draining southward to Lake Front Interceptor.

9.1.11 Other Areas

11-1 - Victoria Park Avenue

- a. Upgrade the combined sewer along Victoria Park Avenue from Musgrave Street to Swanwick Avenue from 300mm – 450mm diameter to 600mm diameter for a total length of 328 m.

11-2 - Danforth Avenue / Luttrell Avenue

- a. Upgrade the combined sewer along Luttrell Avenue south of Danforth Avenue from 300mm to 450mm diameter, for a length of 72 m and from 300mm to 600mm diameter for a length of 72 m, and along Danforth Avenue west of Luttrell Avenue from 375mm to 600mm diameter for 97 m.

11-3 - Glen Manor Drive

- a. Provide new storm sewer along Glen Manor Drive from south of Beauford Road north intersection to south of Beauford Road south intersection with Glen Manor Drive East. The proposed sewer is 375mm diameter, for a length of 162 m.

11-4 - Kingston Road

- a. Upgrade the combined sewer along Kingston Road from Lee Avenue to Elmer Avenue from 900 x 1200mm basket handle to 1200mm diameter, for a length of 467 m, and from Columbine Avenue to Edgewood Avenue from 1050mm x 1350mm - 1829 x 2080mm basket handle to 1800mm diameter, for a length of 231 m.
- b. Provide new storm sewer along Main Street from Gerrard Street East to Kingston Road 450mm diameter for a length of 604 m, and along Kingston Road from Main Street to Woodbine Avenue, 450mm diameter for a length of 375 m, and 600mm diameter for a length of 433 m and 1050mm diameter for a length of 170 m.
- c. Upgrade the storm sewer along Kingston Road from Woodbine Avenue to Columbine Avenue from 600mm – 675mm to 1050mm diameter for a length of 283 m and from 600 mm to 900 mm diameter for a length of 248 m.

11-5 - Hambley Avenue

- a. Upgrade the storm sewer along Hambley Avenue north of Queen Street from 300mm to 450mm diameter for a length of 163 m.

11-6 - Rainsford Road

- a. Upgrade the combined sewer along Rainsford Road north of Queen Street East from 300mm to 600mm for a length of 24 m.

11-7 - Elmer Avenue

- a. Upgrade the storm sewer along Elmer Avenue north of Queen Street East from 300mm to 450mm diameter for 102 m length.

11-8 - Queen Street East (Between Lee Avenue and Woodbine Avenue)

- a. Interconnect the 300mm local combined sewer along Queen Street, south side to the Queen Street Sanitary Trunk Sewer (QSSTS) at two locations, Whieler Avenue and Bellefair Avenue by two 450mm diameter, length of 4 m sewer connections. Interconnect the 350mm local combined sewer along Queen Street, north side to the QSSTS at Bellefair Avenue by 375mm diameter, length of 4 m sewer connection.

11-9 - Queen Street East (Between Kingston Road and Greenwood Avenue)

- a. Upgrade combined sewer along Queen Street, east and west of Coxwell Avenue from 375mm to 600mm diameter for a length of 232 m.
- b. Upgrade storm sewer along Queen Street East from west of Woodward Avenue to Coxwell Avenue from 450mm to 600mm diameter for a length of 55 m and from 600mm to 900mm diameter for a length of 215 m.

11-10 - Rhodes Avenue

- a. Provide new storm sewer along Rhodes Avenue from Dundas Street to Queen Street East, 375mm diameter, length of 275 m.

11-11 - Craven Road

- a. Provide new storm sewers along Craven Road as follows:
 - From Fairlord Avenue to Gerrard Street East, 375mm diameter, length of 243 m.
 - From Gerrard Street East to Dundas Street East, 450mm diameter, length of 443 m.
 - From Dundas Street East to Queen Street East, 375mm diameter, length of 273 m.

11-12 - Eastern Avenue (West of Woodfield Road)

- a. Upgrade storm sewer west of Woodfield Road from 300mm to 600mm diameter for a length of 97 m.

11-13 - Ivy Avenue

- a. Provide new storm sewer along Ivy Avenue east of Prust Avenue, 375mm diameter, for a length of 144 m.

11-14 - Ravina Crescent/Earl Grey Road/Shudell Avenue

- a. Provide new storm sewer along Ravina Cres., from Jones Avenue to Earl Grey Road then along Earl Grey Road to Shudell Avenue, then along Shudell Avenue eastward to Condor Avenue. The storm sewer starts at 375mm diameter for a length of 487 m, and 600mm diameter for a length of 165 m.

11-15 - Hunter Street

- a. Provide new storm sewer along Hunter Street from Jones Avenue eastward, 375mm diameter, length of 194 m.

11-16 - First Avenue

- a. Provide new storm sewer along First Avenue from Thackeray Street to Logan Avenue, 375mm diameter, length of 88 m.

11-17 - Jones Avenue

- a. Provide new storm sewer along Jones Avenue from Dundas Street East to Queen Street East, 300mm diameter for a length of 195 m and 450mm diameter for a length of 198 m.

11-18 - Morse Street

- a. Upgrade the storm sewer along Morse Street south of Eastern Avenue from 450mm to 750mm diameter for a length of 233 m.

11-19 - Booth Avenue

- a. Upgrade the storm sewer along Booth Avenue south of Eastern Avenue from 450mm to 900mm diameter for a length of 190 m.

11-20 - Kenilworth Avenue

- a. Provide 1 double catchbasin at low point on Kenilworth Avenue, N of Queen Street.

11-21 - Corley Avenue/Woodbine Avenue

- a. Provide 2 double catchbasins at the intersection of Corley Avenue and Woodbine Avenue.

9.2 Effectiveness of the Preferred Alternative

9.2.1 Achieving Level of Protection Criteria

The effectiveness of the preferred alternatives in relieving basement flooding problems under the target level of service was determined using the computer model. The final recommended sizes of the remedial measures were included in the model, and simulations were carried out under the design storm conditions identified for the considered level of service. Figures 9.5, 9.6 and 9.7 depict the model results of the combined sewer system, storm sewer system and overland flow system, respectively, with the preferred alternative under the design storm conditions.

- By analysing the results of the combined sewer system as shown in Figure 9.5 and comparing to the existing condition, the preferred alternative theoretically reduces many basement flooding locations, which are represented by dot colours changing from non-green to green. Under the preferred alternative in local residential areas, there are no non-green dots indicating high water level in the sewer above expected basement elevation.
- The yellow dots in the local residential areas shown in Figure 9.5 are due to the shallow depth of the pipes and not due to the pipe surcharge. It is assumed that no basements have any connection to these shallow pipes.
- Figure 9.5 shows few pipe segments in yellow dots meaning that water level could be above basement elevation e.g., Gerrard Street and Carlaw Avenue, Eastern Avenue south of Queen Street, and Broadview Avenue between Tennis Cr. and Millbrook Cr. In these locations however, there are no residential units connected to the sewer. The buildings connected to the sewers in these locations are either high rise residential or ICI building and no previous flooding complaints were received from these locations. As is common practice, these buildings may be equipped with sump pumps to handle foundation drainage.
- The results of the storm sewer system shown in Figure 9.6, show no red dots and no surcharge level in the storm sewer up to the surface. There are however, some yellow dots indicating surcharge level above basement elevations. It should be considered however, that there are no house connections to the storm sewers within the study area. In partially separated areas, house connections are to the combined sewers, and in fully

separated areas roof downspouts discharge to the surface and foundation drains either connected to the sanitary sewer or pumped to the surface through sump pumps.

- Overland flow depth as shown in Figure 9.7 is maintained within the street right-of-way, i.e., not higher than 300mm above the gutter level, except in front of houses with reverse slope driveways where not higher than 150mm was considered. At a few locations the model results show water depth slightly higher than 300mm above the gutter level for short distances. These locations are located along:
 - Eastern Avenue west of Laing Street
 - North of Lake Shore Blvd., between Booth Avenue and Logan Avenue
 - Laneway north of Gerrard Street, west of Victoria Park Avenue
 - Crown Road at Glen Manor Drive
- By reviewing each individual site, it was found that properties facing these locations are sloping upward from the street ROW and at higher ground from potential flood water level. In addition no properties in these areas have previously reported basement flooding. It should also be noted that this high water depth potentially occurs during the 100 year design storm conditions for a short period of time, less than 10 minutes, and subsides quickly afterward.

9.2.2 Impact on the Overflow to the Lake

Overflow to the Lake from the study area sewer system occurs along the shoreline between Victoria Park Avenue and the Coatsworth Cut, and to the Coatsworth Cut and Turning Basin. All outfalls to the shoreline are controlled either by existing or proposed control facilities. The impact of the preferred scheme on the outfalls from these facilities is discussed in Section 9.2.4, while the impact on the Coatsworth Cut and Turning Basin overflows is discussed in this section. There are ten outfall structures from the study area, six to Coatsworth Cut and four to the Turning Basin.

All of these outfalls contain CSO discharges. The total discharges in these outfall structures after implementing the preferred remedial measures were compared to the discharges under existing conditions. Model results for the 2 year and 100 year design storms are given in Table 9.1.

Table 9.1 shows that discharges to the Lake will be generally reduced after implementing the recommended remedial measures, as shown in all outfall structures. The degree of reduction depends on the amount of CSO included in the outfall discharges compared to the amount of storm water. As was mentioned earlier, one of the concepts considered in the recommended remedial measures is to reduce the storm flow entering the combined sewer system. Although some of the storm flows diverted from the combined sewer system by roof downspout disconnection is infiltrated to the ground water, still stormwater to the storm sewer will be increased and may result in some increase in storm sewer discharges to the Lake. However, as shown in Table 9.1, the total discharges to the Lake from all outfall structures are expected to be reduced after implementation of the preferred remedial measures.

Table 9.1 Simulated Discharges to the Lake

Outfall	2-Year Design Storm		100-Year Design Storm	
	Existing (m ³ /s)	After Remediation (m ³ /s)	Existing (m ³ /s)	After Remediation (m ³ /s)
TH – 4 (1)	1.60	1.25	5.23	4.17
TH – 4 (2)	1.92	1.47	5.39	4.42
TH – 3 (1)	0.80	0.51	4.75	3.62
TH – 3 (2)	0.71	0.48	6.12	5.49
E – 13	2.00	1.54	5.93	4.94
E – 14	0.076	0.075	4.20	4.03
E – 11 (1)	5.41	4.25	14.53	13.56
E – 11 (2)	4.88	3.60	13.24	11.96
E – 12 (1)	2.95	2.22	8.79	8.30
E – 12 (2)	2.64	1.98	8.46	7.97

9.2.3 Impact on the Treatment Plant

The study area drains to the Ashbridges Bay Wastewater Treatment Plant through five major interceptors. The western part of area, west of Ashbridges Bay drains to the High Level Interceptor (HLI), Low Level Interceptor (LLI) and the Mid-Toronto Interceptor (MTI). The eastern part of the area drains to the Queen Street STS and the Lake Front Interceptor (LFI). One of the concepts in which the general remedial measures and the preferred alternative is based on, is to reduce the stormwater entering the combined sewer system. This results in reducing the flow in the interceptors and, hence the flow to the treatment plant. Table 9.2 shows the flow in the five interceptors draining to the Treatment Plant under existing condition and after remediation. The table is based on the model simulation under the 2 year and 100 year design storm conditions.

As was indicated before, flow hydrographs at the study area boundary for the HLI, LLI, and MTI were estimated using available data from another study. Table 9.2 shows that the flow to the treatment plant will be reduced after implementing the recommended remedial measures. This reduction is noticeable under the 2-year and the 100-year design storms even for the HLI, LLI and MTI, although most of their contributing areas are outside of the Eastern Beaches study area, where remedial measures are recommended. Some reduction to the flow from the Queen Street STS could also be expected even after diverting flows from LFI to it, and lowering the overflow weir elevation to reduce the 100-year water level. The largest reduction is observed in the LFI, which is the result of diverting flows from it and reducing storm water entering its contributing sewers.

Table 9.2 Simulated Flows to the Ashbridges Bay Treatment Plant

Interceptor	2-Year Design Storm		100-Year Design Storm	
	Existing (m ³ /s)	After Remediation (m ³ /s)	Existing (m ³ /s)	After Remediation (m ³ /s)
H.L.I.	6.75	6.32	8.44	7.64
L.L.I.	2.65	2.52	3.56	3.37
M.T.I.	13.52	13.17	15.18	14.66
Queen St. STS	1.02	0.97	1.19	1.14
L.F.I.	0.83	0.55	1.31	0.85

9.2.4 Impact on Existing and Proposed Water Quality Control Facilities

The existing and proposed water quality control facilities within the study area are identified below.

Three facilities controlling the flow to the Balmy/Kew Beach area are:

- i. Existing Kenilworth Avenue Tank
- ii. Existing Maclean Avenue Tank
- iii. Proposed Water Quality Control Box Culvert (controlling four storm outfalls east of Maclean Avenue Tank)

Six facilities controlling the flow to Coatsworth Cut, either under construction or where construction will start soon are:

- i. Queen Street East storage (SS1)
- ii. Woodfield Road storage (SS2)
- iii. Dundas Street East/Highfield Road storage (SS3)
- iv. Kent Road storage (SS4)
- v. Ashdale Avenue storage (SS5)
- vi. Edgewood Avenue storage (SS6)

All of the above facilities are designed for pollution control to the Lake according to M.O.E. Procedure F.5.5. The design is based therefore in controlling the flow up to one overflow per year, on the average. The assessment of the impact of the proposed remedial measures in this study on the performance of these control facilities has been carried out considering the 2 year design storm model simulation. Table 9.3 shows the comparison of the inflows to the facilities, in terms of peak and total volume, under existing system conditions and after the implementation of all recommended remedial measures. It is clear that generally the inflow to the control facilities will be reduced, up to the 2 year design storm event. The exception to that is the inflow to the proposed storm water control culvert, where the inflows will be slightly increased. This is because this facility controls only storm water outfalls. However, because this culvert will be connected to the Maclean Avenue Tank, the combined inflows to both facilities, as shown in Table 9.3, will still be reduced in peak and volume after the implementation of the recommended

remedial measures. In addition, it should be mentioned that in the final design of the proposed culvert, the size required to achieve the required control was increased from 1.5 x 5m to 2 x 5m to meet operational and maintenance needs.

It should be mentioned that the recommended remedial measures are designed for the 100 year design storm event, and are based on the concept of reducing the storm flow entering the combined sewers. Reduction of flows to all control facilities is therefore expected. Such reduction will result in the control facility providing more control, less frequent over flow events and better performance than what was considered in the design.

Table 9.3 Simulated Inflows to the Water Quality Control Structures for the 2-year Design Storm

Control Facility	Existing		With Remediation	
	Peak (m ³ /s)	Volume (m ³ /s)	Peak (m ³ /s)	Volume m ³
Kenilworth Ave. Tank	1.04	3666	0.87	3258
Maclean Ave. Tank	6.23	14448	4.88	13591
Proposed Box Culvert along the shoreline	1.86	6855	1.94	7499
Combined inflow Maclean Ave. Tank & Box Culvert	8.09	21,303	6.82	21,090
Queen St. Storage (SS1)	0.162	1704	0.140	1476
Woodfield Rd storage (SS2)	0.089	117	0.056	94
Dundas St. E./Highfield Rd. (SS3)	0.278	379	0.183	305
Kent Rd storage (SS4)	0.050	90	0.034	69
Ashdale Ave. Storage (SS5)	0.035	76	0.03	70
Edgewood Ave. storage (SS6)	0.529	1374	0.322	1022

9.3 Mitigation of Potential Impact and Agency Concerns

The potential environmental impacts associated with the preferred alternative are related to the construction and implementation of the remedial measures. Most of these impacts will be basically in effect during the construction period. These impacts, their potential sources and mitigation, are identified in the following sections.

9.3.1 Traffic

Potential concern includes local traffic disruption during construction due to closed roads or blockage of driveways. The following mitigating measures are proposed:

- Consultation will be held with the City's Transportation Department to determine which lane(s) of traffic will be maintained or detour utilized to ensure a constant flow of traffic during construction.

- Homeowners will be notified if temporary blockage to their driveway during construction has to be considered, which will be kept to a minimum. Where possible, alternative short term parking will be provided.

9.3.2 Noise and Vibration

The potential source of noise and vibration are truck traffic and construction activities. The following mitigating measures are proposed to reduce these impacts:

- Minimize construction truck traffic in local residential streets by using primary routes.
- The City's anti-noise by-law will be enforced for all construction activities.
- Hours of operation during construction activities will be restricted to the hours between 7:00 a.m. and 7:00 p.m.
- Pre-construction survey will be undertaken for houses which may be affected by soil vibration during construction activities.
- Where rock excavation is required, blasting will not be permitted.

9.3.3 Sedimentation

Potential sources for sedimentation related to construction activities include sediments disturbed and deposited by construction vehicles and blowing sand and dust. The following mitigating measures are proposed:

- Sediment traps will be placed to deal with storm runoff during construction.
- Tire washing facilities will be provided for vehicles exiting the sites.
- A silt fence will be installed along the perimeters of the construction sites where appropriate to capture blowing sand and dust. Watering should be also considered.
- Exposed excavated material will be covered to prevent erosion by rain/wind.
- Catchbasins will be covered by filter fabric during construction to prevent migration of sediments to receiving watercourses.

9.3.4 Trees

The removal of existing trees is a potential concern. The proposed mitigation includes the following:

- Mature trees will be avoided to eliminate the need for their removal.
- Small trees, if removed, will be replaced or replanted. The replaced trees will be in accordance with City's requirements.
- Root pruning, if required, will be done in accordance with City Parks Department Standards.

9.3.5 Restoration

All sites/areas disturbed by construction will be restored. The proposed mitigating measures include the following;

- Disturbed sidewalks, road and parking areas will be restored to their existing conditions after construction.
- Removed small trees will be replanted or replaced.
- Disturbed park areas or private properties will be restored to their existing conditions or better.

9.4 Cost Estimate and Sequence of Implementation

9.4.1 Unit Cost Estimate

To estimate the capital cost of the recommended remedial measures on a preliminary basis, unit cost estimates were first established. The unit costs are based on the following sources and represent the entire tender price:

- Recent contracts tendered in the City of Toronto, in the last three years.
- Recent contracts tendered in other Ontario municipalities.
- Cost estimating data previously prepared for the City of Toronto and for York Region by the Consultant Team.
- Consideration to the increase in sewer tender pricing occurred in the last two years.

9.4.2 Total Preliminary Cost Estimate

Preliminary capital costs were estimated for every remedial measure in the preferred alternative. For sewer construction, the cost is based on the size, depth and length of sewer.

Table 9.4 provides the preliminary capital costs for the preferred alternative per cluster area. For Cluster 7, First Avenue and Cluster 8, Player Boulevard, the cost for recommended inlet control devices are included under this item recommended for the entire study area. These costs do not include land acquisition/easements or applicable taxes. The total estimated cost for all measures in the preferred alternative is \$ 38.7 million.

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (mm)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
1-1	a	storm	Lee Ave - by pass	71	71		new	CIRC	600	75.4	74.57	\$ 1,516	\$ 107,636	\$107,636
1-1	b	storm	Lee Ave - new storm sewer in park	12.3			new	CIRC	600	75.48	75.4	\$ 1,516	\$ 18,647	
1-1	b	storm	Lee Ave - new storm sewer in park	62.2			new	CIRC	600	75	74.97	\$ 1,516	\$ 94,295	
1-1	b	storm	Lee Ave - new storm sewer in park	8	82.5		new	CIRC	600	74.97	74.94	\$ 1,516	\$ 12,128	\$125,070
1-2	a	storm	Waverley Rd - by pass	52.1	52.1		new	CIRC	450	75.4	74.564	\$ 1,195	\$ 62,260	\$62,260
1-2	b	storm	Waverley Rd - new storm sewer in park	24.4			new	CIRC	600	74.99	74.98	\$ 1,516	\$ 36,990	
1-2	b	storm	Waverley Rd - new storm sewer in park	64.9			new	CIRC	600	74.98	74.93	\$ 1,516	\$ 98,388	
1-2	b	storm	Waverley Rd - new storm sewer in park	11.9	101.2		new	CIRC	600	74.9	74.69	\$ 1,516	\$ 18,040	\$153,419
1-3	a	storm	Kenilworth Ave - by pass	80.4	80.4		new	CIRC	600	75.4	74.406	\$ 1,516	\$ 121,886	\$121,886
1-4	a	storm	New storm sewer connection to shallow overland sewer	2.9	2.9		new	CIRC	750	73.55	74.411	\$ 1,894	\$ 5,493	\$5,493
1-4	b	storm	New storm sewer diversion to Lakeshore Blvd sewer	50.7	50.7		new	CIRC	525	75.346	75.182	\$ 1,313	\$ 66,569	\$66,569
1-4	c	storm	Lakeshore Blvd storm sewer	35.9		300	upgrade	CIRC	900	75.182	75.067	\$ 2,233	\$ 80,165	
1-4	c	storm	Lakeshore Blvd storm sewer	85.9		450	upgrade	CIRC	900	75.066	74.862	\$ 2,233	\$ 191,815	
1-4	c	storm	Lakeshore Blvd storm sewer	91.7		600	upgrade	CIRC	900	74.862	74.734	\$ 2,233	\$ 204,766	
1-4	c	storm	Lakeshore Blvd storm sewer	76.4		675	upgrade	CIRC	900	74.734	74.728	\$ 2,233	\$ 170,601	
1-4	c	storm	Lakeshore Blvd storm sewer	95.7		750	upgrade	CIRC	900	74.661	74.566	\$ 2,233	\$ 213,698	
1-4	c	storm	Lakeshore Blvd storm sewer	91.7	477.3	825	upgrade	CIRC	900	74.493	74.356	\$ 2,233	\$ 204,766	\$1,065,811
1-4	d	storm	Woodbine Ave storm sewer	30		600	upgrade	CIRC	900	74.987	74.912	\$ 2,233	\$ 66,990	
1-4	d	storm	Woodbine Ave storm sewer	61.2		600	upgrade	CIRC	900	74.912	74.758	\$ 2,233	\$ 136,660	
1-4	d	storm	Woodbine Ave storm sewer	60.6	151.8	600	upgrade	CIRC	900	74.758	74.473	\$ 2,233	\$ 135,320	\$338,969
1-5	a	combined	Kippendavie Ave combined sewer	83.5		300	upgrade	CIRC	450	73.844	73.527	\$ 1,195	\$ 99,783	
1-5	a	combined	Kippendavie Ave combined sewer	100.6		300	upgrade	CIRC	450	73.527	72.94	\$ 1,195	\$ 120,217	
1-5	a	combined	Kippendavie Ave combined sewer	10.6		300	upgrade	CIRC	450	72.93	72.92	\$ 1,195	\$ 12,667	
1-5	a	combined	Kippendavie Ave combined sewer	30.3	225	300	upgrade	CIRC	450	72.905	72.616	\$ 1,195	\$ 36,209	\$268,875
1-5	b	storm	Buller Ave storm sewer	38.8		300	upgrade	CIRC	450	75.3	75.103	\$ 1,195	\$ 46,366	
1-5	b	storm	Buller Ave storm sewer	8.7	47.5	300	upgrade	CIRC	450	75.1	75.07	\$ 1,195	\$ 10,397	\$56,763
1-6	a	storm	Kewbeach Ave - new shallow storm sewer	99.9			new	CIRC	900	74.85	74.65	\$ 2,233	\$ 223,077	
1-6	a	storm	Kewbeach Ave - new shallow storm sewer	119.5			new	CIRC	900	74.65	74.411	\$ 2,233	\$ 266,844	
1-6	a	storm	Kewbeach Ave - new shallow storm sewer	160	379.4		new	CIRC	900	74.411	74.406	\$ 2,233	\$ 357,280	\$847,200
2-1	a	storm	Kerr Rd storm sewer	63.9		375	upgrade	CIRC	525	76.386	75.731	\$ 1,313	\$ 83,901	
2-1	a	storm	Kerr Rd storm sewer	15	78.9	375	upgrade	CIRC	525	75.731	75.551	\$ 1,313	\$ 19,695	\$103,596
3-1	a	storm	Minto St - new storm sewer West to East	79	79		new	CIRC	375	75.245	75.087	\$ 1,100	\$ 86,900	\$86,900
3-1	b	storm	Minto St N of Eastern Ave storm sewer	77.6		375	upgrade	CIRC	600	75.087	74.686	\$ 1,516	\$ 117,642	
3-1	b	storm	Minto St N of Eastern Ave storm sewer	10.8	88.4	375	upgrade	CIRC	600	74.686	74.635	\$ 1,516	\$ 16,373	\$134,014

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (m)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
3-1	c	storm	Eastern Ave E of Minto St storm sewer	69.8		300	upgrade	CIRC	600	75.679	74.89	\$ 1,516	\$ 105,817	
3-1	c	storm	Eastern Ave E of Minto St storm sewer	16.5	86.3	300	upgrade	CIRC	600	74.89	74.7	\$ 1,516	\$ 25,014	\$130,831
3-1	c	storm	Eastern Ave E of Minto St storm sewer	17.3		375	upgrade	CIRC	1050	74.7	74.683	\$ 3,375	\$ 58,388	
3-1	c	storm	Eastern Ave E of Minto St storm sewer	47.6	64.9	375	upgrade	CIRC	1050	74.683	74.635	\$ 3,375	\$ 160,650	\$219,038
3-1	c	storm	Eastern Ave W of Minto St storm sewer	40.7		600	upgrade	CIRC	1050	74.635	74.594	\$ 3,375	\$ 137,363	
3-1	c	storm	Eastern Ave W of Minto St storm sewer	93.8	134.5	675	upgrade	CIRC	1050	74.594	74.5	\$ 3,375	\$ 316,575	\$453,938
4-1	a	combined	Alton Ave N of Queen St E combined sewer	60		500	upgrade	CIRC	750	74.341	74.219	\$ 1,894	\$ 113,640	
4-1	a	combined	Queen St E W of Liang St combined sewer	38.9		500	upgrade	CIRC	750	74.207	74.109	\$ 1,894	\$ 73,677	
4-1	a	combined	Liang St S of Queen St E combined sewer	101.5		500	upgrade	CIRC	750	74.109	73.856	\$ 1,894	\$ 192,241	
4-1	a	combined	Liang St S of Queen St E combined sewer	80.9	281.3	500	upgrade	CIRC	750	73.826	73.621	\$ 1,894	\$ 153,225	\$532,782
4-2	a		Provide 2 double catchbasins at the intersection of Lake Shore Blvd East and Leslie Street Provide 1 double catchbasin at low point on west side of Lake Shore Blvd East at driveway	3 units								\$ 5,000	\$ 15,000	\$15,000
5-1	a	combined	Queen St E between Brooklyn Ave and Bertmount Ave combined sewer	78.9		300	upgrade	CIRC	450	74.597	74.28	\$ 1,195	\$ 94,286	
5-1	a	combined	Queen St E between Bertmount Ave and Coady Ave combined sewer	68.3		300	upgrade	CIRC	450	74.28	74.085	\$ 1,195	\$ 81,619	
5-1	a	combined	Queen St E between Coady Ave and Jones Ave combined sewer	105.5	252.7	300	upgrade	CIRC	450	74.085	73.356	\$ 1,195	\$ 126,073	\$301,977
5-1	a	combined	Queen St E between Jones Ave and Curzon St combined sewer	120.1		375	upgrade	CIRC	750	73.356	72.896	\$ 1,894	\$ 227,469	
5-1	a	combined	Queen St E between Curzon St and Leslie St combined sewer	90.2	210.3	375	upgrade	CIRC	750	72.896	72.591	\$ 1,894	\$ 170,839	\$398,308
5-1	a	combined	Leslie St S of Queen St E combined sewer	20.6	20.6	450	upgrade	CIRC	750	72.591	72.484	\$ 1,894	\$ 39,016	\$39,016
5-1	a	combined	Leslie St S of Queen St E combined sewer	62.5		450	upgrade	CIRC	900	72.478	72.25	\$ 2,233	\$ 139,563	
5-1	a	combined	Leslie St S of Queen St E combined sewer	92.3		450	upgrade	CIRC	900	72.25	72.027	\$ 2,233	\$ 206,106	
5-1	a	combined	Leslie St S of Queen St E combined sewer	16.2	171	450	upgrade	CIRC	900	72.027	71.692	\$ 2,233	\$ 36,175	\$381,843
5-1	b	combined	Coady Ave N of Queen St E combined sewer	91.4	91.4	300	upgrade	CIRC	450	77.526	77.133	\$ 1,195	\$ 109,223	\$109,223
5-1	b	combined	Coady Ave N of Queen St E combined sewer	93.5		375	upgrade	CIRC	600	76.764	76.362	\$ 1,516	\$ 141,746	
5-1	b	combined	Coady Ave N of Queen St E combined sewer	75		375	upgrade	CIRC	600	76.362	76.042	\$ 1,516	\$ 113,700	

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (m)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
5-1	b	combined	Coady Ave N of Queen St E combined sewer	22.4	190.9	375	upgrade	CIRC	600	76.042	75.947	\$ 1,516	\$ 33,958	\$289,404
5-2	a	storm	Winnifred Ave N of Eastern Ave storm sewer	60.6		375	upgrade	CIRC	450	75.904	75.874	\$ 1,195	\$ 72,417	
5-2	a	storm	Winnifred Ave N of Eastern Ave storm sewer	77.9	138.5	375	upgrade	CIRC	450	75.871	75.746	\$ 1,195	\$ 93,091	\$165,508
5-2	a	storm	Winnifred Ave N of Eastern Ave storm sewer	84.1	84.1	375	upgrade	CIRC	600	75.746	75.529	\$ 1,516	\$ 127,496	\$127,496
5-2	b	storm	Eastern Ave between Winnifred Ave and Caroline Ave storm sewer	75.4	75.4	450	upgrade	CIRC	750	75.44	75.33	\$ 1,894	\$ 142,808	\$142,808
5-2	c	storm	Eastern Ave between Caroline Ave and Winnifred Ave storm sewer	82.3	82.3	450	upgrade	CIRC	750	75.121	74.959	\$ 1,894	\$ 155,876	\$155,876
5-2	c	storm	Eastern Ave between Winnifred Ave and Pape Ave storm sewer	123.9	123.9	750	upgrade	CIRC	900	74.959	74.697	\$ 2,233	\$ 276,669	\$276,669
5-2	d	storm	Pape Ave S of Eastern Ave storm sewer	7		1067	upgrade	CIRC	1200	74.647	74.596	\$ 3,060	\$ 21,420	
5-2	d	storm	Pape Ave S of Eastern Ave storm sewer	107.3		1050	upgrade	CIRC	1200	74.596	74.545	\$ 3,060	\$ 328,338	
5-2	d	storm	Pape Ave S of Eastern Ave storm sewer	101.8		1050	upgrade	CIRC	1200	74.545	74.438	\$ 3,060	\$ 311,508	
5-2	d	storm	Pape Ave S of Eastern Ave storm sewer	89.6		1050	upgrade	CIRC	1200	74.438	74.392	\$ 3,060	\$ 274,176	
5-2	d	storm	Pape Ave S of Eastern Ave storm sewer	17.4	323.1	1050	upgrade	CIRC	1200	74.392	74.383	\$ 3,060	\$ 53,244	\$988,686
5-2	e	storm	Remove weir and change pipe Winnifred Ave N of Eastern Ave	12.5	12.5	375	upgrade	CIRC	600	75.553	75.44	\$ 1,516	\$ 18,950	\$18,950
5-2	f	storm	Remove orifice and flap valve and change pipe Caroline Ave N of Eastern Ave	9.1	9.1	450	upgrade	CIRC	450	75.33	75.121	\$ 1,195	\$ 10,875	\$10,875
5-3	a	storm	New storm sewer Pape Ave N of Dundas St E	24.2			new	CIRC	525	81.305	81.184	\$ 1,313	\$ 31,775	
5-3	a	storm	New storm sewer Pape Ave N of Dundas St E	28.3			new	CIRC	525	81.184	81.042	\$ 1,313	\$ 37,158	
5-3	a	storm	New storm sewer Pape Ave N of Dundas St E	39.1			new	CIRC	525	81.042	80.846	\$ 1,313	\$ 51,338	
5-3	a	storm	New storm sewer Pape Ave N of Dundas St E	57.6			new	CIRC	525	80.846	80.558	\$ 1,313	\$ 75,629	
5-3	a	storm	New storm sewer Pape Ave N of Dundas St E	22.9	172.1		new	CIRC	525	80.558	80.443	\$ 1,313	\$ 30,068	\$225,967
5-3	b	storm	New storm sewer Pape Ave N of Dundas St E	57.8			new	CIRC	450	79.595	79.133	\$ 1,195	\$ 69,071	
5-3	b	storm	New storm sewer Pape Ave N of Dundas St E	104.1	161.9		new	CIRC	450	79.133	78.3	\$ 1,195	\$ 124,400	\$193,471
5-4	a	storm	Eastern Ave W of Heward Ave storm sewer	33.7		375	upgrade	CIRC	600	75.694	75.569	\$ 1,516	\$ 51,089	
5-4	a	storm	Eastern Ave W of Heward Ave storm sewer	42.5		375	upgrade	CIRC	600	75.569	75.412	\$ 1,516	\$ 64,430	
5-4	a	storm	Eastern Ave W of Heward Ave storm sewer	6.1	82.3	375	upgrade	CIRC	600	75.367	75.349	\$ 1,516	\$ 9,248	\$124,767
5-5	a	storm	Eastern Ave W of Larchmount Ave storm sewer	99.3		450	upgrade	CIRC	750	75.231	74.983	\$ 1,894	\$ 188,074	
5-5	a	storm	Eastern Ave W of Larchmount Ave storm sewer	140.5		450	upgrade	CIRC	750	74.983	74.632	\$ 1,894	\$ 266,107	

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (mm)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
5-5	a	storm sewer	Eastern Ave W of Larchmount Ave storm sewer	129.5		450	upgrade	CIRC	750	74.632	74.308	\$ 1,894	\$ 245,273	
5-5	a	storm sewer	Eastern Ave W of Larchmount Ave storm sewer	59.4	428.7	450	upgrade	CIRC	750	74.308	74.17	\$ 1,894	\$ 112,504	\$811,958
6-1	a		Plug connection of combined sewer along Logan Ave from north of Queen Street to south Plug connection of combined sewer along Booth Ave from north of Queen Street to south Plug connection of combined sewer along Morse Street from north of Queen Street to south	3 units								\$ 5,000	\$ 15,000	\$15,000
6-2	a	combined sewer	Carlaw Ave N of Queen St E combined sewer	91.9		600x900 egg	upgrade	CIRC	1050	77.928	77.7	\$ 3,375	\$ 310,163	
6-2	a	combined sewer	Carlaw Ave N of Queen St E combined sewer	90.6		600x900 egg	upgrade	CIRC	1050	77.7	77.471	\$ 3,375	\$ 305,775	
6-2	a	combined sewer	Carlaw Ave N of Queen St E combined sewer	92		600x900 egg	upgrade	CIRC	1050	77.471	77.166	\$ 3,375	\$ 310,500	
6-2	a	combined sewer	Carlaw Ave N of Queen St E combined sewer	91.4	365.9	600x900 egg	upgrade	CIRC	1050	77.166	76.91	\$ 3,375	\$ 308,475	\$1,234,913
6-2	b	combined sewer	Gerrard St E E of Carlaw Ave combined sewer	86.1		300	upgrade	CIRC	600	83.722	81.589	\$ 1,516	\$ 130,528	
6-2	b	combined sewer	Gerrard St E E of Carlaw Ave combined sewer	19.9	106	300	upgrade	CIRC	600	81.589	80.665	\$ 1,516	\$ 30,168	\$160,696
6-3	a	storm Ave	New storm sewer Saulter St N of Eastern Ave	123.4			new	CIRC	450	77.376	76.759	\$ 1,195	\$ 147,463	
6-3	a	storm Ave	New storm sewer Saulter St N of Eastern Ave	74.6			new	CIRC	450	76.759	76.386	\$ 1,195	\$ 89,147	
6-3	a	storm Ave	New storm sewer Saulter St N of Eastern Ave	45.9			new	CIRC	450	76.386	76.04	\$ 1,195	\$ 54,851	
6-3	a	storm Ave	New storm sewer Saulter St N of Eastern Ave	63.4			new	CIRC	450	76.04	75.55	\$ 1,195	\$ 75,763	
6-3	a	storm Ave	New storm sewer Eastern Ave W of Saulter St	72.1	379.4		new	CIRC	450	75.55	75	\$ 1,195	\$ 86,160	\$453,383
6-3	a	storm Ave	New storm sewer Eastern Ave W of Saulter St	105.9	105.9		new	CIRC	600	75	74.49	\$ 1,516	\$ 160,544	\$160,544
6-4	a	storm	Empire Ave N of Eastern Ave storm sewer	101.9		300	upgrade	CIRC	450	76.962	76.426	\$ 1,195	\$ 121,771	
6-4	a	storm	Empire Ave N of Eastern Ave storm sewer	85	186.9	300	upgrade	CIRC	450	76.426	75.971	\$ 1,195	\$ 101,575	\$223,346
9-1	a	storm	New storm sewer Kingswood Rd	72.9			new	CIRC	375	122.094	119.366	\$ 1,100	\$ 80,190	
9-1	a	storm	New storm sewer Kingswood Rd	69.6			new	CIRC	375	119.366	116.921	\$ 1,100	\$ 76,560	
9-1	a	storm	New storm sewer Kingswood Rd	106.7			new	CIRC	375	116.921	112.678	\$ 1,100	\$ 117,370	
9-1	a	storm	New storm sewer Kingswood Rd	92.2			new	CIRC	375	112.678	106.308	\$ 1,100	\$ 101,420	
9-1	a	storm	New storm sewer Kingswood Rd	48.1			new	CIRC	375	106.308	99.929	\$ 1,100	\$ 52,910	
9-1	a	storm	New storm sewer Kingswood Rd	35.7	425.2		new	CIRC	375	99.929	95.81	\$ 1,100	\$ 39,270	\$467,720

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (mm)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
9-1	b	storm	New storm sewer Queen St E of Kingswood Rd	63.1			new	CIRC	600	90.97	89.05	\$ 1,516	\$ 95,660	
9-1	b	storm	New storm sewer Neville Park Blvd S of Queen St E	105.3	168.4		new	CIRC	600	89.04	85.832	\$ 1,516	\$ 159,635	\$255,294
9-1	c	storm	Neville Park Blvd storm sewer	88.4		300	upgrade	CIRC	600	85.832	83.171	\$ 1,516	\$ 134,014	
9-1	c	storm	Neville Park Blvd storm sewer	87.3	175.7	300	upgrade	CIRC	600	83.14	80.51	\$ 1,516	\$ 132,347	\$286,361
10-1	a		Lower weir elevation in manhole east of Coxwell Ave from 75.79 m to 75.44 m										\$ 10,000	\$10,000
10-2	a		Divert sewer at Queen Street to Queen Street STS											
			Divert sewer from Kenilworth Ave to Queen Street STS										\$ 10,000	\$10,000
11-1	a	combined	Victoria Park Ave/Musgrave St combined sewer	33.1		300	upgrade	CIRC	600	125.992	125.788	\$ 1,516	\$ 50,180	
11-1	a	combined	Victoria Park Ave combined sewer	91.9		375	upgrade	CIRC	600	125.712	125.346	\$ 1,516	\$ 139,320	
11-1	a	combined	Victoria Park Ave combined sewer	96.3		375	upgrade	CIRC	600	125.346	125.059	\$ 1,516	\$ 145,991	
11-1	a	combined	Victoria Park Ave combined sewer	92.4		450	upgrade	CIRC	600	125.059	124.849	\$ 1,516	\$ 140,078	
11-1	a	combined	Victoria Park Ave/Swanwick Ave combined sewer	14.3	328	450	upgrade	CIRC	600	124.849	124.745	\$ 1,516	\$ 21,679	\$497,248
11-2	a	combined	Luttrell Ave S of Danforth Ave combined sewer	71.4	71.4	300	upgrade	CIRC	450	125.818	125.239	\$ 1,195	\$ 85,323	\$85,323
11-2	a	combined	Luttrell Ave S of Danforth Ave combined sewer	9.9		300	upgrade	CIRC	600	125.239	125.137	\$ 1,516	\$ 15,008	
11-2	a	combined	Luttrell Ave S of Danforth Ave combined sewer	40		300	upgrade	CIRC	600	125.137	124.724	\$ 1,516	\$ 60,640	
11-2	a	combined	Luttrell Ave S of Danforth Ave combined sewer	21.9	71.8	300	upgrade	CIRC	600	124.724	124.663	\$ 1,516	\$ 33,200	\$108,849
11-2	a	combined	Danforth Ave W of Luttrell Ave combined sewer	97	97	375	upgrade	CIRC	600	124.389	123.941	\$ 1,516	\$ 147,052	\$147,052
11-3	a	storm	New storm sewer Glen Manor Dr	52.1			new	CIRC	375	97.298	94.579	\$ 1,100	\$ 57,310	
11-3	a	storm	New storm sewer Glen Manor Dr	61.2			new	CIRC	375	94.156	93.811	\$ 1,100	\$ 67,320	
11-3	a	storm	New storm sewer Glen Manor Dr E	48.7	162		new	CIRC	375	93.811	88.026	\$ 1,100	\$ 53,570	\$178,200
11-4	a	combined	Kingston Rd/Lee Ave combined sewer	130.3		900x1200 basket handle	upgrade	CIRC	1200	112.48	107.661	\$ 3,060	\$ 398,718	
11-4	a	combined	Kingston Rd combined sewer	121.8		900x1200 basket handle	upgrade	CIRC	1200	107.661	102.776	\$ 3,060	\$ 372,708	
11-4	a	combined	Kingston Rd combined sewer	104.9		900x1200 basket handle	upgrade	CIRC	1200	102.776	96.597	\$ 3,060	\$ 320,994	
11-4	a	combined	Kingston Rd/Eimer Ave combined sewer	109.4	466.4	900x1200 basket handle	upgrade	CIRC	1200	96.597	92.681	\$ 3,060	\$ 334,764	\$1,427,184

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (m)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
11-4	a	combined	Kingston Rd/Columbine Ave combined sewer	98.8		1050x1350 basket handle	upgrade	CIRC	1800	85.853	81.75	\$ 6,083	\$ 601,000	
11-4	a	combined	Kingston Rd combined sewer	101.9	200.7	1200x1500 basket handle	upgrade	CIRC	1800	81.732	79.623	\$ 6,083	\$ 619,858	\$1,220,858
11-4	b	storm	New storm sewer Main St/Gerrard St	101.6			new	CIRC	450	120.445	120.179	\$ 1,195	\$ 121,412	
11-4	b	storm	New storm sewer Main St	168.6			new	CIRC	450	120.179	119.695	\$ 1,195	\$ 201,477	
11-4	b	storm	New storm sewer Main St	77.7			new	CIRC	450	119.695	119.472	\$ 1,195	\$ 92,852	
11-4	b	storm	New storm sewer Main St	13.7			new	CIRC	450	119.472	119.433	\$ 1,195	\$ 16,372	
11-4	b	storm	New storm sewer Main St	70.3			new	CIRC	450	119.433	119.29	\$ 1,195	\$ 84,009	
11-4	b	storm	New storm sewer Main St	53.1			new	CIRC	450	119.29	119.107	\$ 1,195	\$ 63,455	
11-4	b	storm	New storm sewer Main St/Kingston Rd	118.9	603.9		new	CIRC	450	119.107	118.698	\$ 1,195	\$ 142,086	\$721,661
11-4	b	storm	New storm sewer Kingston Rd/Main St	125.2			new	CIRC	450	118.698	116.571	\$ 1,195	\$ 149,614	
11-4	b	storm	New storm sewer Kingston Rd	119.2			new	CIRC	450	116.571	112.48	\$ 1,195	\$ 142,444	
11-4	b	storm	New storm sewer Kingston Rd	130.2	374.6		new	CIRC	450	112.48	107.661	\$ 1,195	\$ 155,589	\$447,647
11-4	b	storm	New storm sewer Kingston Rd	121.7			new	CIRC	600	107.661	102.776	\$ 1,516	\$ 184,497	
11-4	b	storm	New storm sewer Kingston Rd	105.3			new	CIRC	600	102.776	96.597	\$ 1,516	\$ 159,635	
11-4	b	storm	New storm sewer Kingston Rd	108.5			new	CIRC	600	96.597	92.681	\$ 1,516	\$ 164,486	
11-4	b	storm	New storm sewer Kingston Rd	97.7	433.2		new	CIRC	600	92.681	90.136	\$ 1,516	\$ 148,113	\$656,731
11-4	b	storm	New storm sewer Kingston Rd	87.7			new	CIRC	1050	90.136	89.873	\$ 3,375	\$ 295,988	
11-4	b	storm	New storm sewer Kingston Rd/Woodbine Ave	81.4	169.1		new	CIRC	1050	89.873	89.629	\$ 3,375	\$ 274,725	\$570,713
11-4	c	storm	Kingston Rd/Woodbine Ave storm sewer	81.9		600	upgrade	CIRC	1050	89.629	89.349	\$ 3,375	\$ 276,413	
11-4	c	storm	Kingston Rd storm sewer	80.8		600	upgrade	CIRC	1050	89.349	89.026	\$ 3,375	\$ 272,700	
11-4	c	storm	Kingston Rd storm sewer	77.8		675	upgrade	CIRC	1050	88.95	88.721	\$ 3,375	\$ 262,575	
11-4	c	storm	Kingston Rd storm sewer	26.1		675	upgrade	CIRC	1050	88.718	88.627	\$ 3,375	\$ 88,088	
11-4	c	storm	Kingston Rd/Bailey Lane storm sewer	15.9	282.5	675	upgrade	CIRC	1050	88.627	88.572	\$ 3,375	\$ 53,663	\$953,438
11-4	c	storm	Kingston Rd/Bailey Lane storm sewer	41.7		600	upgrade	CIRC	900	88.554	87.987	\$ 2,233	\$ 93,116	
11-4	c	storm	Kingston Rd storm sewer	92.1		600	upgrade	CIRC	900	87.935	84.088	\$ 2,233	\$ 205,659	
11-4	c	storm	Kingston Rd/Dundas St E storm sewer	113.5	247.3	600	upgrade	CIRC	900	84.036	80.4	\$ 2,233	\$ 253,446	\$552,221
11-5	a	storm	Hamby Ave N of Queen St E storm sewer	72.8		300	upgrade	CIRC	450	89.535	86.908	\$ 1,195	\$ 86,996	
11-5	a	storm	Hamby Ave N of Queen St E storm sewer	15.7		300	upgrade	CIRC	450	86.908	86.128	\$ 1,195	\$ 18,762	
11-5	a	storm	Hamby Ave N of Queen St E storm sewer	74.4	162.9	300	upgrade	CIRC	450	86.128	82.435	\$ 1,195	\$ 88,908	\$194,666
11-6	a	combined	Rainsford Rd N of Queen St E storm sewer	23.3	23.3	300	upgrade	CIRC	600	77.963	77.785	\$ 1,516	\$ 35,323	\$35,323
11-7	a	storm	Elmer Ave N of Queen St E storm sewer	101.1	101.1	300	upgrade	CIRC	450	80.824	77.776	\$ 1,195	\$ 120,815	\$120,815
11-8	a	combined	New combined sewer connection to Queen St E Interceptor	4	4		new	CIRC	450	79.751	79.64	\$ 1,516	\$ 6,064	\$6,064
11-8	a	combined	New combined sewer connection to Queen St E Interceptor	4.1	4.1		new	CIRC	450	79.981	79.971	\$ 1,516	\$ 6,216	\$6,216

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (mm)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
11-8	a	combined	New combined sewer connection to Queen St E Interceptor	4	4		new	CIRC	375	79.35	79.296	\$ 1,100	\$ 4,400	\$4,400
11-9	a	combined	Queen St E W of Coxwell Ave combined sewer	73.5		381	upgrade	CIRC	600	75.337	74.962	\$ 1,516	\$ 111,426	
11-9	a	combined	Queen St E and Coxwell Ave combined sewer	16.1		381	upgrade	CIRC	600	74.962	74.88	\$ 1,516	\$ 24,408	
11-9	a	combined	Queen St E E of Coxwell Ave combined sewer	141.7	231.3	375	upgrade	CIRC	600	74.88	74.042	\$ 1,516	\$ 214,817	\$350,651
11-9	b	storm	Queen St E E of Woodward Ave storm sewer	54.1	54.1	450	upgrade	CIRC	600	76.631	76.557	\$ 1,516	\$ 82,016	\$82,016
11-9	b	storm	Queen St E E of Woodward Ave storm sewer	54		600	upgrade	CIRC	900	76.404	76.298	\$ 2,233	\$ 120,582	
11-9	b	storm	Queen St E E of Woodward Ave storm sewer	68.6		600	upgrade	CIRC	900	76.298	76.099	\$ 2,233	\$ 153,184	
11-9	b	storm	Queen St E E of Woodward Ave storm sewer	80.8		600	upgrade	CIRC	900	76.099	75.895	\$ 2,233	\$ 180,426	
11-9	b	storm	Queen St E E of Woodward Ave storm sewer	10.7	214.1	600	upgrade	CIRC	900	75.895	75.867	\$ 2,233	\$ 23,893	\$478,085
11-10	a	storm	New storm sewer Rhodes Ave S of Dundas St E	93.4			new	CIRC	375	78.242	77.559	\$ 1,100	\$ 102,740	
11-10	a	storm	New storm sewer Rhodes Ave S of Dundas St E	90.2			new	CIRC	375	77.511	77.078	\$ 1,100	\$ 99,220	
11-10	a	storm	New storm sewer Rhodes Ave S of Dundas St E	56.4			new	CIRC	375	77.072	76.781	\$ 1,100	\$ 62,040	
11-10	a	storm	New storm sewer Rhodes Ave S of Dundas St E	34.3	274.3		new	CIRC	375	76.781	76.615	\$ 1,100	\$ 37,730	\$301,730
11-11	a	storm	New storm sewer Craven Rd N of Gerrard St E	80.6			new	CIRC	375	91.001	90.864	\$ 1,100	\$ 88,660	
11-11	a	storm	New storm sewer Craven Rd N of Gerrard St E	85.5			new	CIRC	375	89.95	88.898	\$ 1,100	\$ 94,050	
11-11	a	storm	New storm sewer Craven Rd N of Gerrard St E	76	242.1		new	CIRC	375	88.898	85.062	\$ 1,100	\$ 83,600	\$266,310
11-11	b	storm	New storm sewer Craven Rd S of Gerrard St E	89.8			new	CIRC	450	86.719	84.896	\$ 1,516	\$ 136,137	
11-11	b	storm	New storm sewer Craven Rd S of Gerrard St E	91.6			new	CIRC	450	84.801	83.174	\$ 1,516	\$ 138,866	
11-11	b	storm	New storm sewer Craven Rd S of Gerrard St E	92.1			new	CIRC	450	83.174	81.458	\$ 1,516	\$ 139,624	
11-11	b	storm	New storm sewer Craven Rd S of Gerrard St E	89.5			new	CIRC	450	81.458	79.836	\$ 1,516	\$ 135,682	
11-11	b	storm	New storm sewer Craven Rd S of Gerrard St E	79.8	442.8		new	CIRC	450	79.824	79.675	\$ 1,516	\$ 120,977	\$671,285
11-11	c	storm	New storm sewer Craven Rd S of Dundas St E	88.2			new	CIRC	375	78.556	77.791	\$ 1,100	\$ 97,020	
11-11	c	storm	New storm sewer Craven Rd S of Dundas St E	92			new	CIRC	375	77.791	76.999	\$ 1,100	\$ 101,200	
11-11	c	storm	New storm sewer Craven Rd S of Dundas St E	91.9	272.1		new	CIRC	375	76.941	76.621	\$ 1,100	\$ 101,090	\$299,310
11-12	a	storm	Eastern Ave W of Woodfield Rd storm sewer	85.8		300	upgrade	CIRC	600	74.99	74.605	\$ 1,516	\$ 130,073	

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No.	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (mm)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
11-12	a	storm	Eastern Ave W of Woodfield Rd storm sewer	10.7	96.5	300	upgrade	CIRC	600	74.605	74.557	\$ 1,516	\$ 16,221	\$146,294
11-13	a	storm	New storm sewer Ivy Ave E of Prust Ave storm sewer	74.3			new	CIRC	375	92.406	88.901	\$ 1,100	\$ 81,730	
11-13	a	storm	New storm sewer Ivy Ave E of Prust Ave storm sewer	46.6			new	CIRC	375	87.773	87.305	\$ 1,100	\$ 51,260	
11-13	a	storm	New storm sewer Ivy Ave E of Prust Ave storm sewer	22.8	143.7		new	CIRC	375	87.305	85.09	\$ 1,100	\$ 25,080	\$158,070
11-14	a	storm	New storm sewer Ravina Cres N of Earl Grey Rd	39.3			new	CIRC	375	111.121	110.92	\$ 1,100	\$ 43,230	
11-14	a	storm	New storm sewer Ravina Cres N of Earl Grey Rd	29.1			new	CIRC	375	110.92	110.77	\$ 1,100	\$ 32,010	
11-14	a	storm	New storm sewer Ravina Cres N of Earl Grey Rd	56.5			new	CIRC	375	110.77	110.6	\$ 1,100	\$ 64,350	
11-14	a	storm	New storm sewer Earl Grey Rd N of Baird Ave	36			new	CIRC	375	110.6	110.493	\$ 1,100	\$ 39,600	
11-14	a	storm	New storm sewer Earl Grey Rd N of Baird Ave	67.3			new	CIRC	375	110.493	109.841	\$ 1,100	\$ 74,030	
11-14	a	storm	New storm sewer Earl Grey Rd N of Baird Ave	62.7			new	CIRC	375	109.841	109.17	\$ 1,100	\$ 68,970	
11-14	a	storm	New storm sewer Earl Grey Rd at Baird Ave	18.3			new	CIRC	375	109.17	108.561	\$ 1,100	\$ 20,130	
11-14	a	storm	New storm sewer Earl Grey Rd N of Shudell Ave	87.9			new	CIRC	375	108.561	107.677	\$ 1,100	\$ 96,690	
11-14	a	storm	New storm sewer Earl Grey Rd N of Shudell Ave	87.7	486.8		new	CIRC	375	107.027	106.345	\$ 1,100	\$ 96,470	\$535,480
11-14	a	storm	New storm sewer Shudell Ave E of Earl Grey Rd	164.9	164.9		new	CIRC	600	106.345	106.04	\$ 1,516	\$ 249,988	\$249,988
11-15	a	storm	New storm sewer Hunter St E of Jones Ave	95.1			new	CIRC	375	105.68	105.055	\$ 1,100	\$ 104,610	
11-15	a	storm	New storm sewer Hunter St E of Jones Ave	85.5			new	CIRC	375	104.522	103.861	\$ 1,100	\$ 94,050	
11-15	a	storm	New storm sewer Hunter St E of Jones Ave	13.2	193.8		new	CIRC	375	102.465	100.59	\$ 1,100	\$ 14,520	\$213,180
11-16	a	storm	New storm sewer First Ave E of Logan Ave	87.3	87.3		new	CIRC	375	83.997	82.397	\$ 1,100	\$ 96,030	\$96,030
11-17	a	storm	New storm sewer Jones Ave S of Dundas St E	104.7			new	CIRC	300	77.108	76.139	\$ 981	\$ 102,711	
11-17	a	storm	New storm sewer Jones Ave S of Dundas St E	89.4	194.1		new	CIRC	300	76.08	75.667	\$ 981	\$ 87,701	\$190,412
11-17	a	storm	New storm sewer Jones Ave S of Dundas St E	98.2			new	CIRC	450	75.667	75.212	\$ 1,516	\$ 148,871	
11-17	a	storm	New storm sewer Jones Ave S of Dundas St E	70.9			new	CIRC	450	75.212	74.82	\$ 1,516	\$ 107,484	
11-17	a	storm	New storm sewer Jones Ave S of Dundas St E	28.5	197.6		new	CIRC	450	74.82	74.249	\$ 1,516	\$ 43,206	\$299,562
11-18	a	storm	Morse St S of Eastern Ave	92.1		450	upgrade	CIRC	750	75.49	75.301	\$ 1,894	\$ 174,437	
11-18	a	storm	Morse St S of Eastern Ave	92.7		450	upgrade	CIRC	750	75.301	74.978	\$ 1,894	\$ 175,574	
11-18	a	storm	Morse St S of Eastern Ave	47.6	232.4	450	upgrade	CIRC	750	74.978	74.795	\$ 1,894	\$ 90,154	\$440,166

Table 9.4 Preliminary Estimated Capital Cost

Cluster	No	System	Location	Length (m)	Total Length (m)	Existing Sewer Diameter (mm)	Sewer Status	Shape	Proposed Sewer Diameter (m)	Upstream Invert (m)	Downstream Invert (m)	Unit Cost	Cost	Cost per Measure
11-19	a	storm	Booth Ave S of Eastern Ave	114.3		450	upgrade	CIRC	900	75.377	75.091	\$ 2,233	\$ 255,232	
11-19	a	storm	Booth Ave S of Eastern Ave	75.6	189.9	450	upgrade	CIRC	900	75.091	74.902	\$ 2,233	\$ 168,815	\$424,047
11-20	a	storm	Provide 1 double catchbasin at low point on Kenilworth Avenue, N of Queen Street	1 unit								\$...5000	\$ 5,000	\$5,000
11-21	a	storm	Provide 2 double catchbasins at the intersection of Corley Ave and Woodbine Avenue	2 units								\$...5000	\$ 10,000	\$10,000
			Replacement of Perforated Manhole Covers	893 units								\$...500	\$ 446,500	\$446,500
			Sealing of Combined and Sanitary Manholes Covers	105 units								\$...500	\$ 52,500	\$52,500
			Installation of Inlet Control Devices	2090 units								\$...500	\$ 1,045,000	\$1,045,000
TOTAL COST														\$27,612,327
40% Contingency and Engineering Allowance														\$11,044,931
TOTAL COST including 40% Contingency and Engineering Allowance														\$38,657,258

9.4.3 Sequence of Implementation

In staging the implementation of the remedial measures, the following could be considered:

- Implementation of roof downspout disconnection should have high priority since this will significantly reduce potential basement flooding in many areas under the level of protection criteria. It should be reiterated that our analysis assumes 75% of the connected roofs to be disconnected. Achieving higher percentage of disconnection will be very beneficial.
- Sealing of sanitary manhole covers and replacing perforated manhole covers in the combined sewers is a very cost-effective remedial measure and could be implemented sooner than other measures which require design and tendering stages.
- Higher consideration should be given to measures to reduce storm water entering the combined sewer system and remediation to the combined sewer system, than those to relief the storm sewer system or the overland flow system.
- If the works for sub areas has to be staged, downstream relief sewers should be constructed first before the upstream sewers.

Figure 9.1

Preferred Solutions, Cluster 1



Preferred Solutions, Cluster 2, 3 & 4



Figure 9.3 Preferred Solutions, Cluster 5, 6, 7 & 8

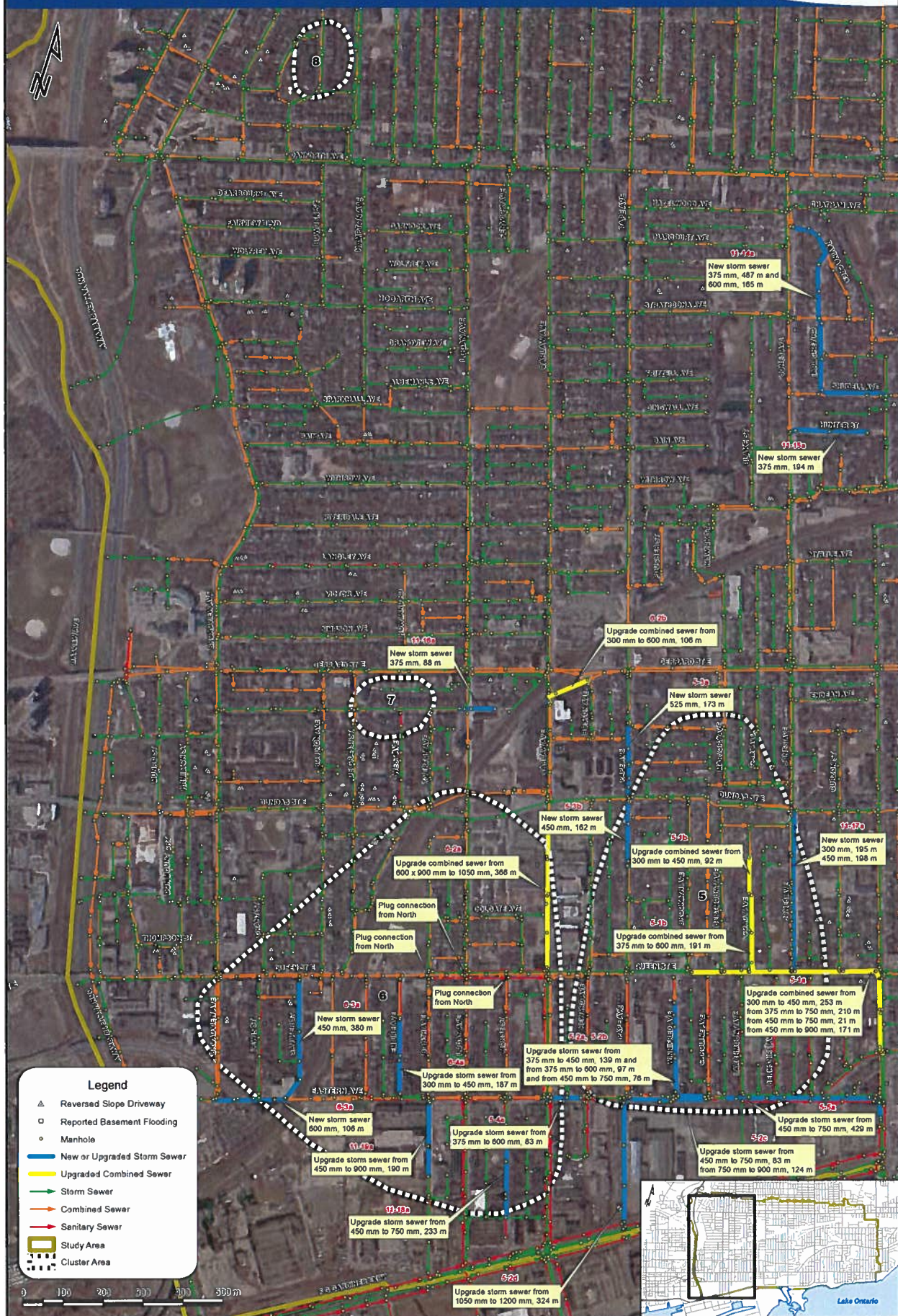
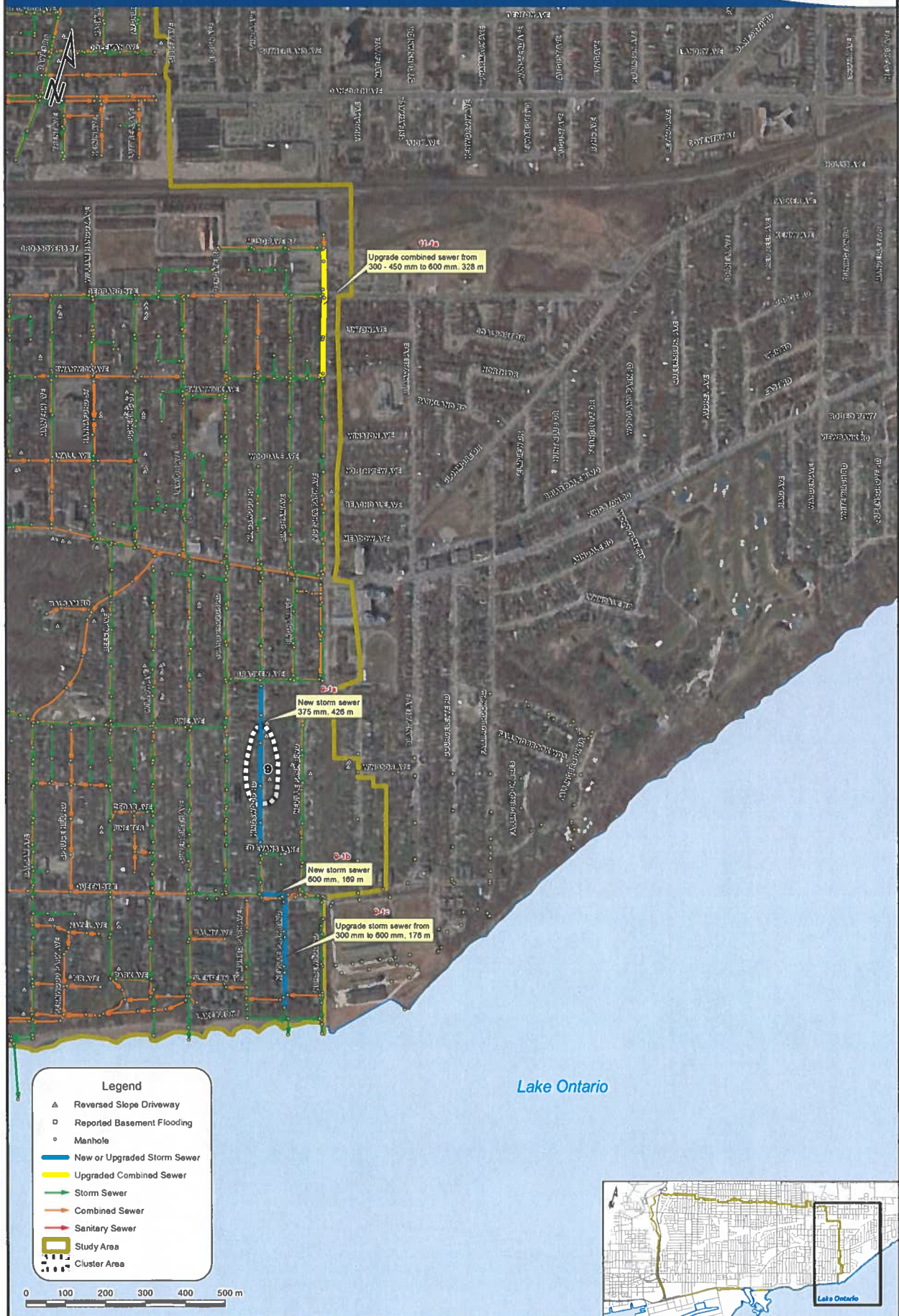
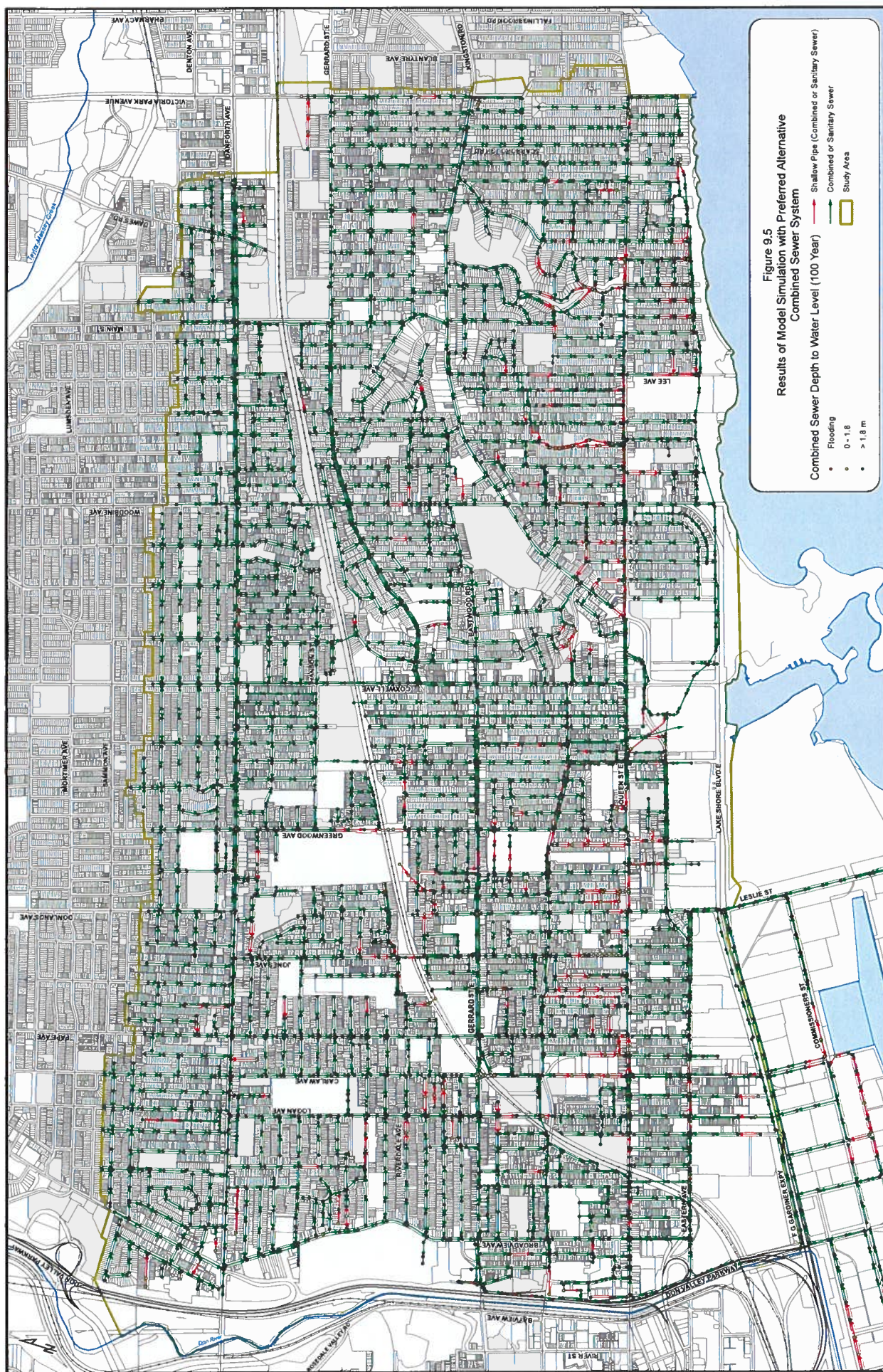
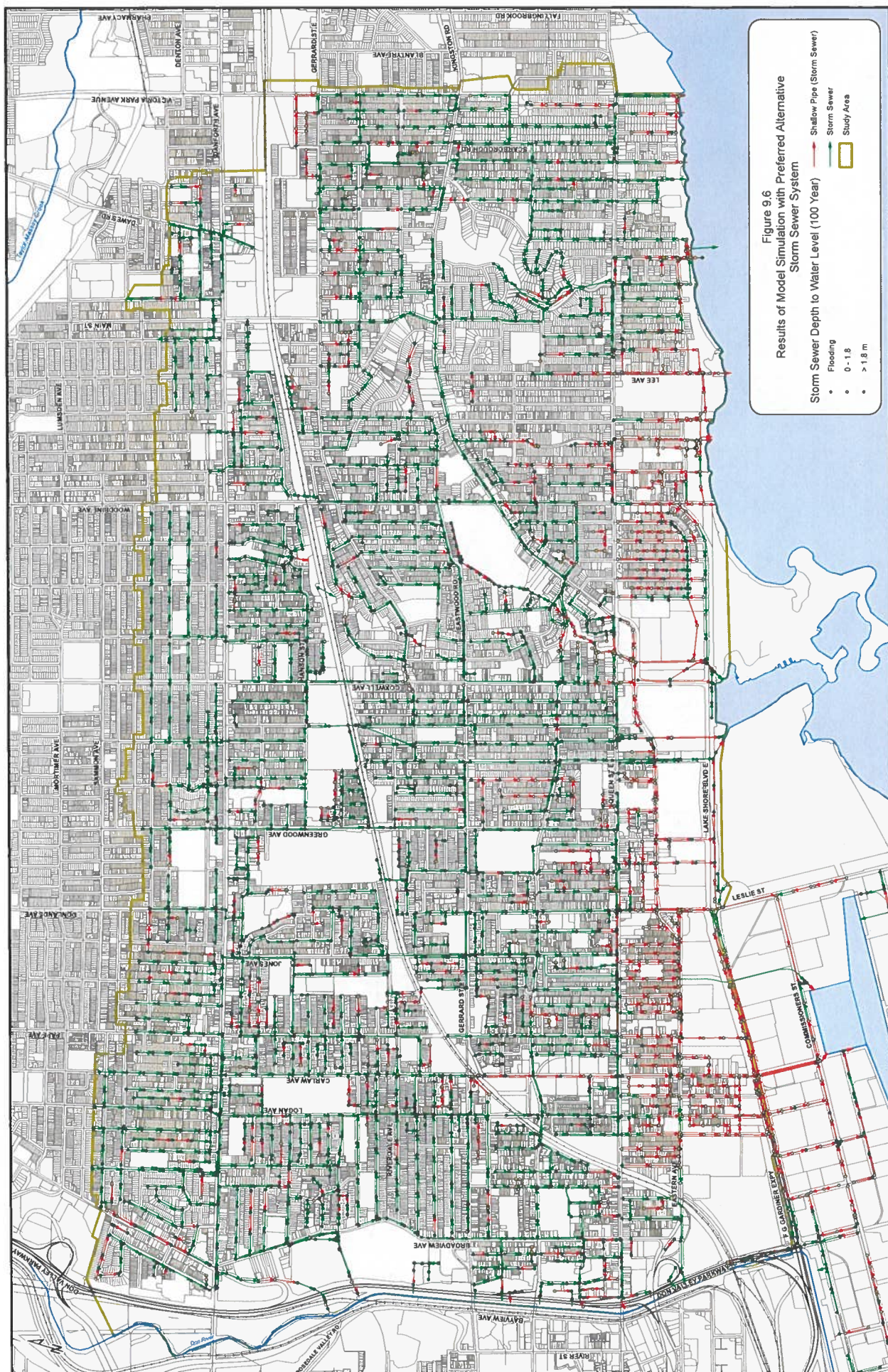


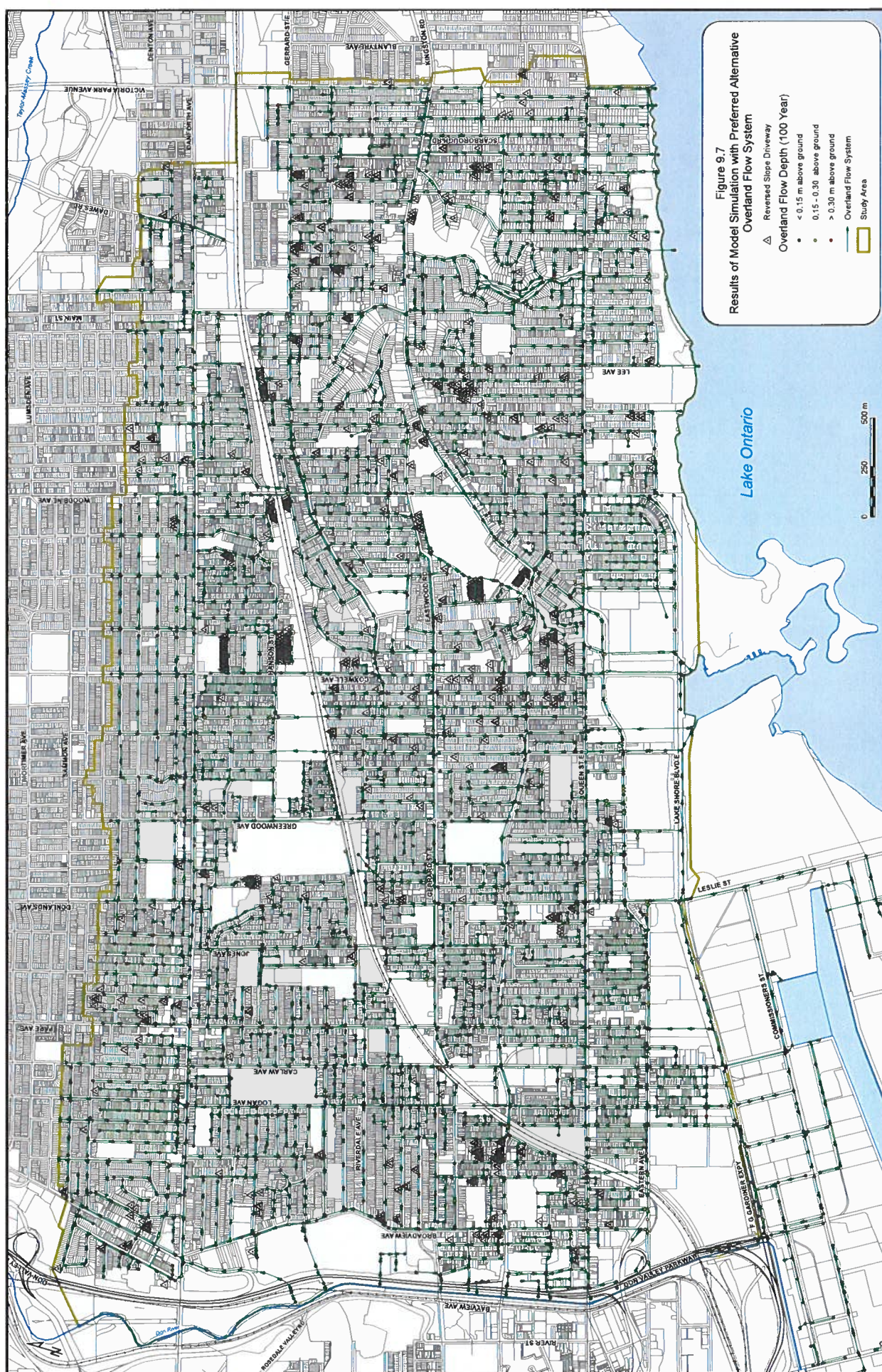
Figure 9.4

Preferred Solutions, Cluster 9









10. Conclusion and Recommendation

10.1 Conclusions

The following conclusions can be drawn from the completion of this study.

- The flow monitoring was useful in the calibration/validation of the model for the in-sewer sanitary/combined and storm sewer conditions but the storm events recorded were not severe enough to calibrate the model for overland (major system) conditions.
- The calibration/validation of the model showed good agreement with recorded flow data in terms of peak flows and volume of runoff. The calibration model was successfully validated using the historic storm event of July 8, 2008.
- Ground water table is between 0-5 m below ground surface over much of the study area. Sewer infrastructure was found therefore to be below the water table in a sizable portion of the study area. In particular, most sewers within 1500 m of Lake Ontario were found to be below the ground water table. As a result of the hydrogeological analysis and the monitoring program, it is possible that groundwater infiltration would have been rapid enough in some areas with shallow ground water levels and contributed to basement flooding.
- Past and present field investigations confirm that the existing outfalls along the Eastern Beaches are subjected to heavy siltation and partial or complete blockage by sediments. These sediments enter pipes by different mechanisms and have several sources including:
 - Sediments carried by sewer flows;
 - Sediments carried by along shore currents and waves from the open lake; and
 - Sediments carried by shoaling waves and wave-generated currents at the shoreline which vary with wind direction and wave height.
- The beach is in dynamic equilibrium at different time-scales, being re-shaped during each wave event to achieve a stable slope, with crescents between the hard points formed by the outfalls. Any proposed control structure or other measures need to preserve the beach amenity while also improving the performance of the outfalls and related sewer systems. Existing designs and conventional outfall designs are not working effectively due to a number of factors. While the need for some outfalls can be eliminated by re-routing sewer flows, the remaining outfalls must function better.
- The causes of flooding which occurred during the July 8, 2008 storm event can be generally attributed to the following:
 - Surcharge of the combined sewer caused by excessive stormwater volume entering through:
 - Perforated manhole covers;
 - Regular covers of manholes in low lying areas;
 - Connected house roof downspouts; and
 - Connected catchbasins in streets with no road storm sewers.

- Back-up from outfall to the Lake due to high Lake level or accumulation of sediment in the outflow conduit, resulting in street flooding.
 - Back-up from the interceptors due to high water level at the pumping station wet well of the treatment plant.
 - High water level at the Kenilworth tank resulting in closure of the upstream flap gates to the contributing sewers to the tank.
 - Reverse sloped driveways due to surface flooding problems.
 - Surcharge of the storm sewer system, which may result in increasing the flow to the combined sewer system through potential interconnections between the two systems.
 - High ground water table, within basement elevation.
 - Accumulation of surface runoff in low-lying areas.
 - High overland flow depth above street right-of-way elevation.
 - Undersized storm sewer or undersized catchbasins resulting in high overland flow.
 - Blocked/broken combined/sanitary sewers and manholes.
 - Blocked catchbasins.
- The majority of the basement flooding has been caused by the combined sewer system with less flooding arising from the storm sewers.
 - Source control measures alone will not significantly reduce basement flooding. Therefore, preferred remedial measures consist of a combination of source control measures and remedial measures applicable to the sewer systems.
 - With the implementation of the preferred remedial measures and under the considered level of service, the combined/sanitary sewer system will not be surcharged. Storm sewer surcharge will occur for areas where it is not feasible to maintain the maximum HGL at no surcharge level and overland flow depth will be maintained within the street pavement.
 - Reported basement flooding in scattered homes are not caused by the combined or the storm drainage system but rather by local condition at the lot level. Flooding may be a result of poor lot grading, cracked basement walls, entry of storm water through windows/doors, blocked or broken house drains, cross connection between the sanitary and storm drains, improper installation or operation of the back flow preventer valve, etc. Homeowners should disconnect roof downspouts where feasible and employ applicable measures supported by the Basement Flooding Protection Subsidy Program.
 - The Schedule 'B' Class EA process has been fulfilled through the two PICs, agency consultation and the submission of this project file document.

10.2 Recommendations

The following recommendations are made with respect to this study:

- City to proceed with short term interim remedial measures. These measures could be implemented without requiring additional investigation or detailed design and specification/tendering procedures. These measures will provide interim improvements to the combined and storm drainage systems resulting in reduction of the risk of basement and surface flooding. Details related the interim remedial measures are provided in Appendix D, and consist of:
 - Local remedial measures at Minto Street, Kingswood Road, Lee Avenue, Waverley Road, Woodbine Avenue, Kerr Road/Highfield Road, and Leslie Street.
 - Sediment removal from the five active storm outfalls and the ten outfalls with flat upstream sewers inspected during the course of the study.
 - Maintenance and repair of sewers identified in the 2009 and 2010 CCTV inspection.
 - Replacement of porous manhole covers on the combined sewer system with solid covers.
 - Sealing of combined/sanitary manhole covers in low lying areas.
- Additional inflow/infiltration study is recommended particularly in the areas with high ground water levels where sewers intersect the ground water table to determine locations where ground water seepage could be a factor to sewer surcharge and basement flooding.
- Reconfiguring the outfall structure is required for the five active outfalls to the lake, namely, Lee Avenue, MacLean Avenue, Waverley Road, Kenilworth Avenue and Nursewood Road outfalls. It is, however, recommended to start with the Kenilworth Outfall Structure, as a pilot project and implement the following:
 - Advance the GENIVAR's conceptual design for a self-silting and scour control outfall structure as presented in T.M. #8, Attachment 5, to preliminary design;
 - Refine the design using 3D computer model and/or laboratory scale model;
 - This shall be accompanied by a joint probability analysis for Lake Ontario water levels and rainfall-runoff storm events. Also more detailed current measurements and numerical analysis should be considered to understand and quantify the near-shore sediment transport characteristics due to currents and or waves.
 - After monitoring the re-configured structure at Kenilworth Avenue outfall for 1-2 years, implementation of re-configuring the other outfall structures should proceed.
- City to continue promoting the Basement Flooding Protection Subsidy Program. Implementation of the measures included in this program will provide protection to most houses and will enhance the performance and level of protection provided by the remedial measures in the preferred alternative.
- City to proceed to detailed design and construction of preferred remediation measures in accordance with available funding from the capital budget and sequencing with other basement flooding protection projects.

Appendix A

Public Consultation





Investigation of Basement Flooding – Study Area 32

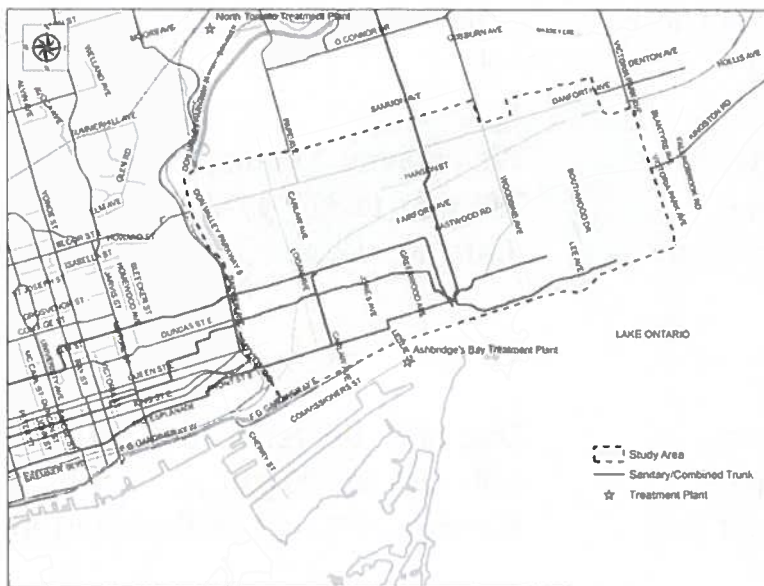
Notice of Study Commencement – Municipal Class Environmental Assessment

Study Overview

The City of Toronto has initiated a Municipal Class Environmental Assessment (EA) study to assess the causes and impacts of flooding problems in Study Area 32 (see map) and to develop solutions to alleviate future basement and surface flooding.

In 2006, the City implemented a Work Plan to mitigate flooding for 31 areas that experienced flooding from severe storms. During the summer of 2008, a series of intense storms flooded many residents' homes in the Eastern Beaches area. As a result, the Eastern Beaches has been identified as Study Area 32 for investigation.

The aim of this study will be to develop a plan that will prevent future flooding and reduce the amount of stormwater entering all storm and sanitary sewer systems.



The Process

The study will follow the requirements set out in the Municipal Class EA document (amended 2007). It will define the problem, consider and evaluate alternative solutions, assess impacts of the proposed solutions, and identify measures to lessen any adverse impacts. Members of the public and interest groups will have opportunities to provide their input at key stages throughout the study.

Public Consultation

Two Public Information Centres (PICs) are planned for this study. The first PIC is tentatively scheduled for Fall 2010. City staff and our consulting team will be present to answer questions and discuss the next steps in the process. Notification of the PIC will be advertised in the local community newspaper and notices mailed to those within the study area.

We would like to hear from you

Public consultation is an important part of this study. If you have any questions or comments or would like to be placed on the study mailing list, please contact:

Josie Franch
Public Consultation Coordinator
City of Toronto
Metro Hall, 19th Floor
55 John Street
Toronto, ON M5V 3C6

Tel: 416-338-2859
Fax: 416-392-2974
TTY: 416-397-0831
jfranch@toronto.ca
toronto.ca/involved/projects
Issue Date: November 20, 2009

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

Investigation of Basement Flooding – Study Area 32

Municipal Class Environmental Assessment Notice of Public Open House #1

Please join us at our first Public Open House to find out about the causes of flooding in the study area and learn more about the alternatives being considered. You will have an opportunity to speak one-on-one with project staff and view displays. Drop-in anytime between 7:00 p.m. and 9:00 p.m. on either of the dates noted below. We look forward to seeing you there. Details are as follows:

Date: Wednesday, September 29, 2010
Time: 7:00 p.m. to 9:00 p.m.
Location: Jimmie Simpson Community Centre • 870 Queen St. E. (Gymnasium)



or

Date: Thursday, September 30, 2010
Time: 7:00 p.m. to 9:00 p.m.
Location: Mennonite New Life Centre of Toronto • 1774 Queen St. E. (Main level)



Background

During the summer of 2008, the Eastern Beaches area experienced a series of intense storms that resulted in the flooding of many residents' homes. As a result, an Environmental Assessment (EA) began in August 2009 with the Eastern Beaches being identified as Study Area 32 for investigation (see map). Study Area 32 is loosely bounded by the Don River (W), Danforth Avenue (N), Victoria Park Avenue (E) and Lake Shore Blvd (S). The study will develop a plan to prevent future flooding and reduce the amount of storm water entering all storm and sanitary sewer systems.

We would like to hear from you:

If you are unable to attend the meeting but would like to be provided with information or would like to be added to the study mailing list, please contact:

Josie Franch
Public Consultation Coordinator
City of Toronto
Metro Hall, 19th Floor
55 John St.
Toronto, ON M5V 3C6
Tel: 416-338-2859
Fax: 416-392-2974
TTY: 416-397-0831
E-mail: jfranch@toronto.ca
Visit: toronto.ca/involved/projects



Issue Date: September 16, 2010

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

Welcome

Investigation of Basement Flooding (Study Area 32)

Public Open House #1

View displays and discuss the study with project staff

Feel free to ask questions and fill out a comment sheet



Purpose of Our Study

The purpose of the study is to:

- Examine existing stormwater drainage, combined and sanitary sewer systems and identify the causes of basement flooding and/or surface flooding; and
- Make recommendations to reduce future flooding.



Study Area

- The study area is bounded by Don River to the west, Victoria Park Ave. to the east, Lakeshore Blvd. East/Lake Ontario to the south and Danforth Avenue to the north.
- The area was subject to several basement and surface flooding incidents specially during the recent July 8 to 23, 2008 storms.



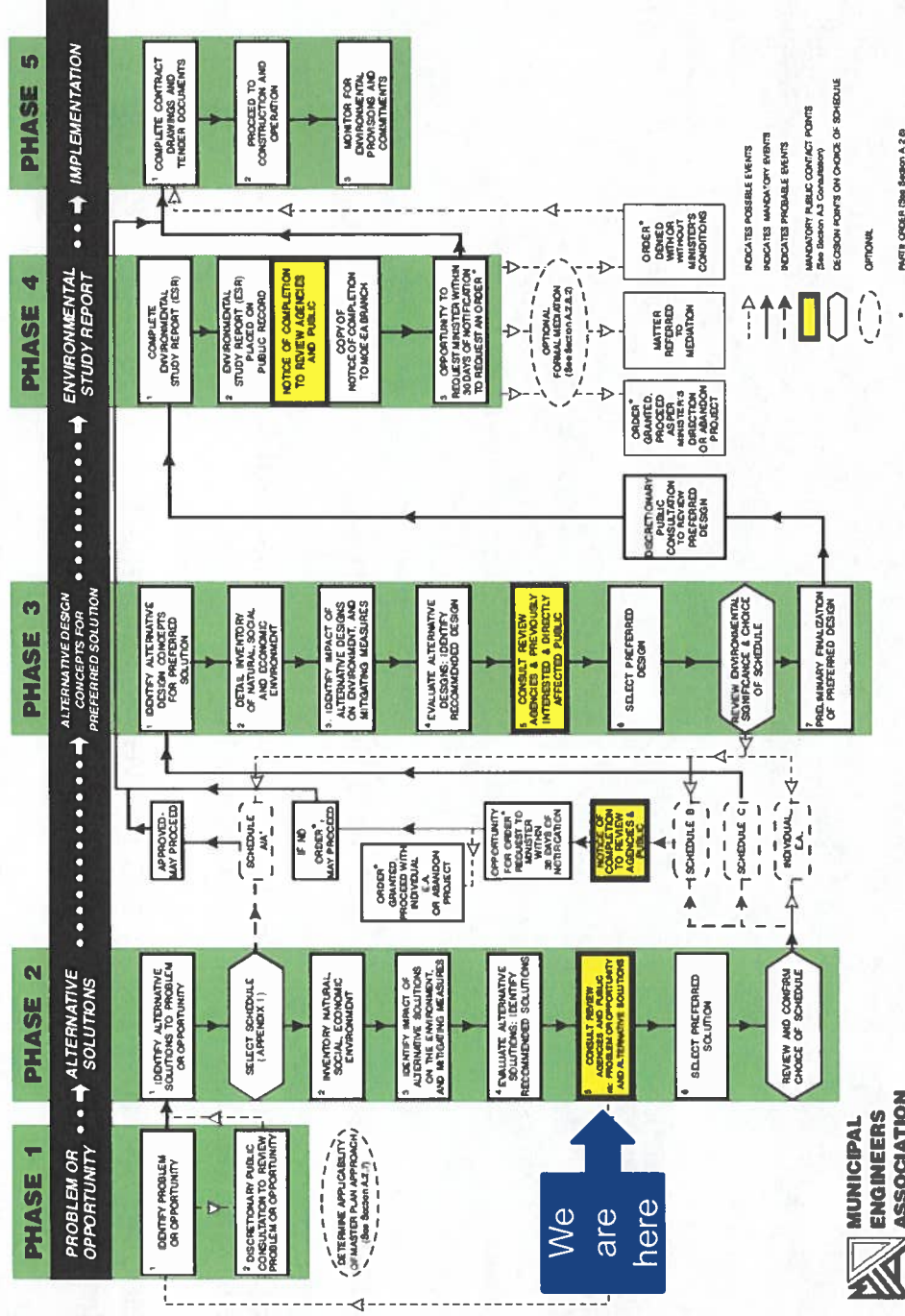
Municipal Class EA

- The City of Toronto must follow the Municipal Class EA process to meet the requirements of Ontario's EA Act for all infrastructure projects.
- The EA Act requires the “protection, conservation and wise management of the environment” while undergoing infrastructure enhancements.
- The EA process is also an opportunity for the public and agencies to provide input throughout the project.

Municipal Class EA Flow Chart

EXHIBIT A.2 MUNICIPAL CLASS EA PLANNING AND DESIGN PROCESS

NOTE: This flow chart is to be read in conjunction with Part A of the Municipal Class EA



We are here



Investigating Basement Flooding: The Steps Involved

Many steps are involved in the study before solutions can be developed. This work includes:

- Collecting and reviewing background data on land use, population, soil conditions, combined/sanitary sewer and storm drainage systems, flooding history, and operation / maintenance records;
- Conducting an extensive field investigation of catchbasins, manhole covers, outfalls and downspout connection/disconnection status;
- Installing meters to monitor rainfalls and flows in sewers;
- Developing computer models to analyse the causes of flooding and to predict flows under various weather conditions;
- Developing and evaluating alternatives to address the issue of flooding in the study area (1st Public Information Centre);
- Gather input from the community and review agencies; and
- Present recommended solutions (2nd Public Information Centre in Nov. 2010).



Our Findings

Under normal rainfall events, the storm, combined and sanitary sewer systems operate as designed. However, during heavy storms, the following takes place:

- Stormwater flow exceeds the combined and storm sewer capacity and overloads the systems.
- Water remains on the surface and flows along roads.
- Many combined sewers still have perforated manhole covers which acts like a catchbasin, after the construction of road storm sewer.
- At low lying areas, water accumulates (ponds) and enters the combined and sanitary sewer system through manhole covers.

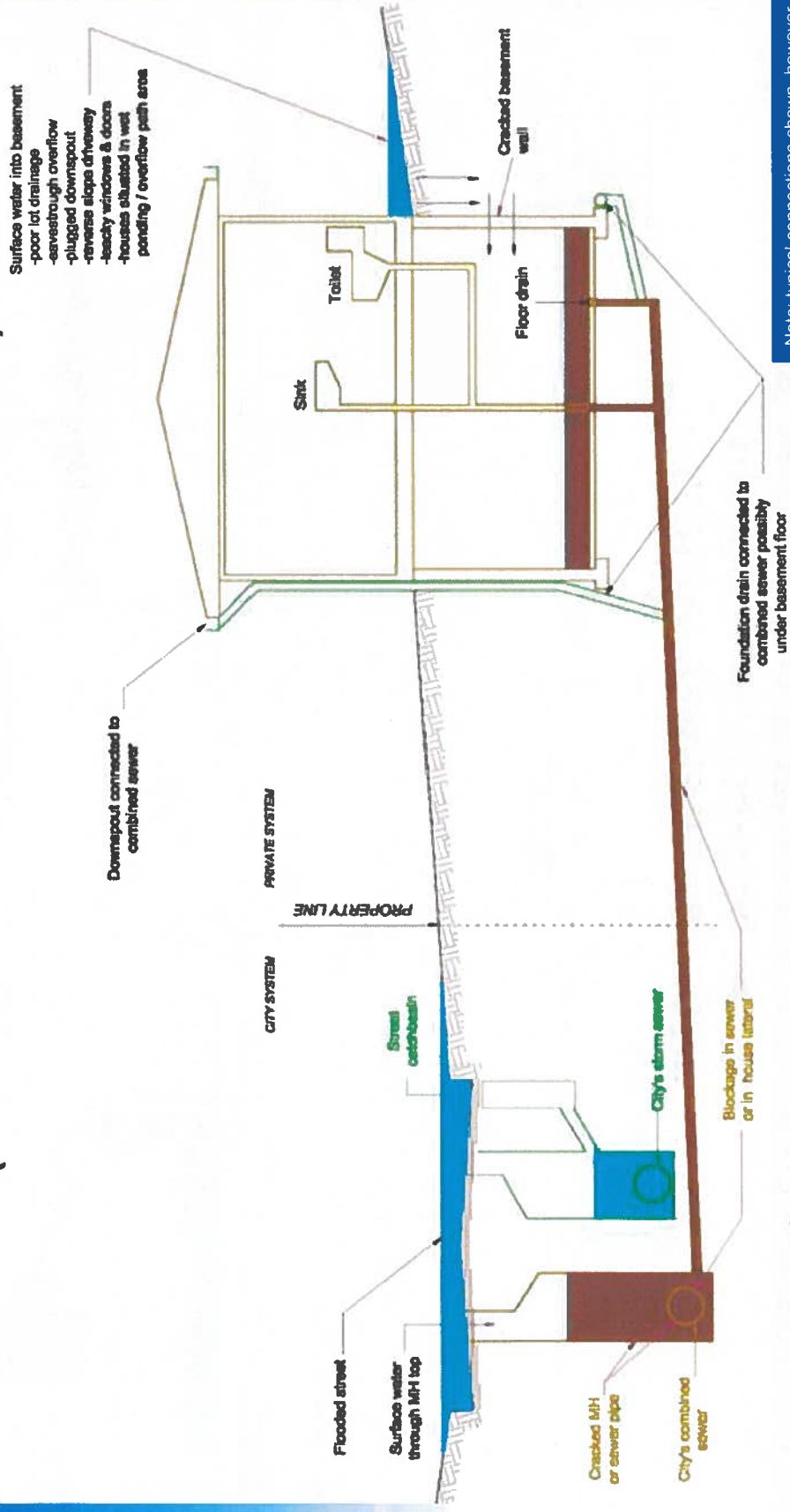
Our Findings

- The ground becomes extremely wet and water may enter the combined system through cracks or broken pipes, cracked maintenance hole walls, loose joints underground and foundation drains:
- Water entering the basement from surface via windows and reverse slope driveways, etc.
- Roof Downspouts and weeping tiles are connected to the combined system, and;



Our Findings

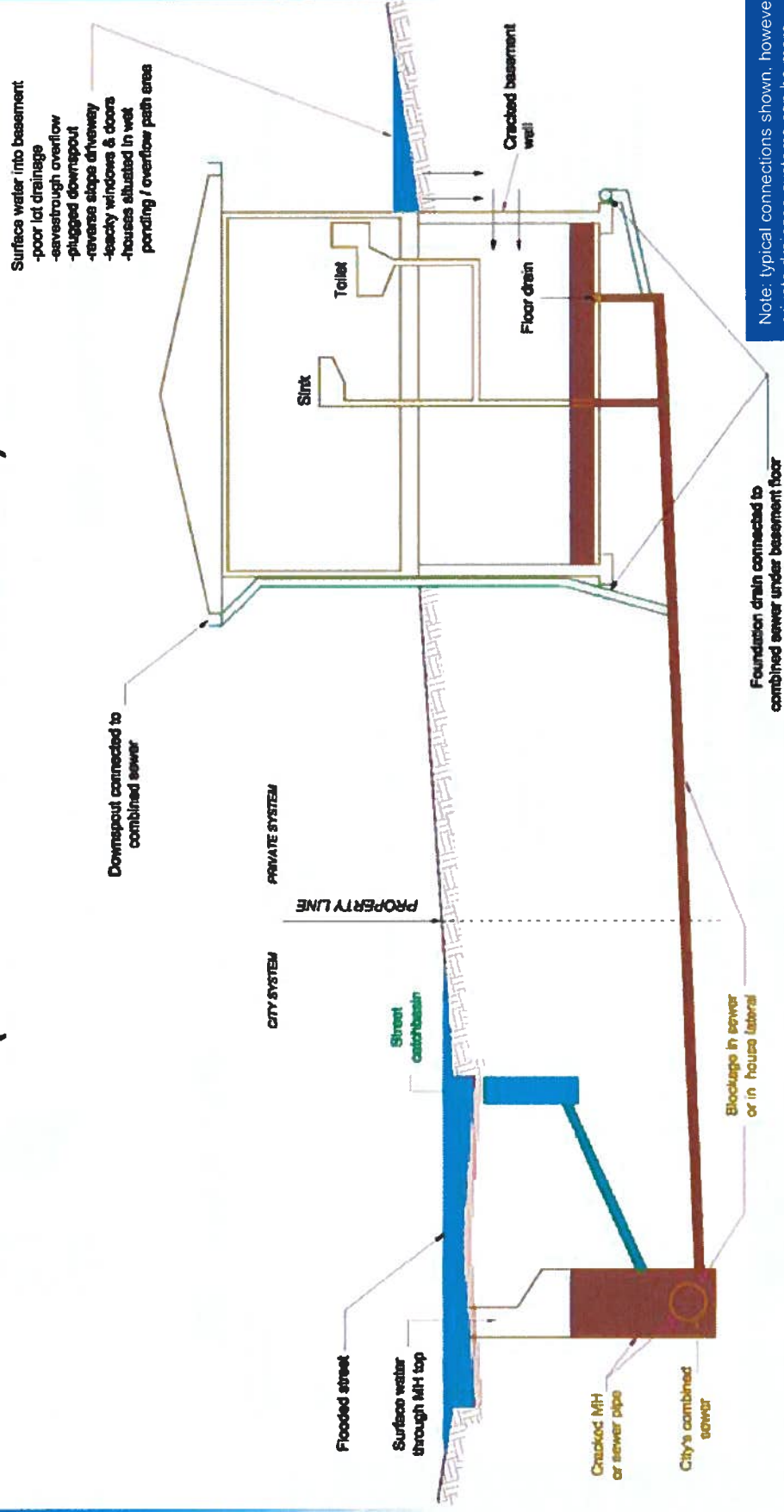
CAUSES OF BASEMENT FLOODING (IN PARTIALLY SEPARATED SEWER SYSTEM)



Note: typical connections shown, however private drainage systems can be more complex and each one is unique. For example, there could be interconnection between the sanitary and storm system or other combinations of connections shown.

Our Findings

CAUSES OF BASEMENT FLOODING (IN COMBINED SEWER SYSTEM)

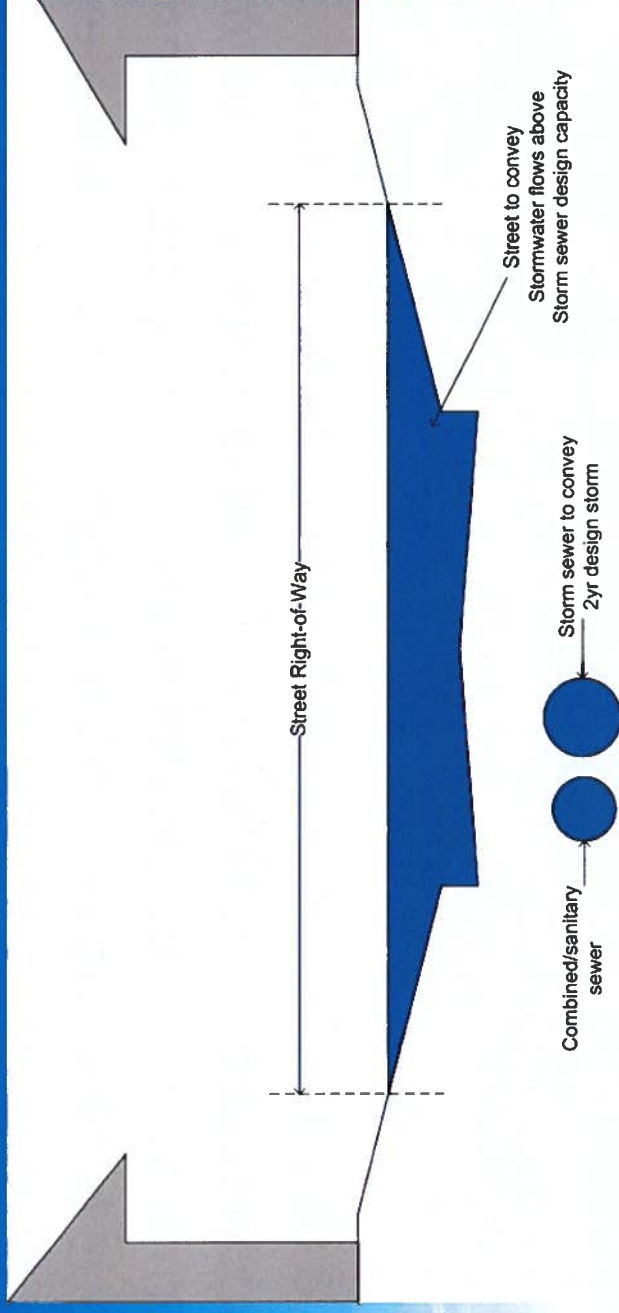


Note: typical connections shown, however private drainage systems can be more complex and each one is unique. For example, there could be interconnection between the sanitary and storm system or other combinations of connections shown.

Our Findings

- Streets convey major storm events exceeding the capacity of storm sewers
- Storm sewer system conveys up to 1:2 year storm events
- As a result of source control such as downspout disconnection, installation of inlet control devices more stormwater will be on the surface. Temporary ponding on roads is okay as long as the depth of surface water does not cause safety issues or basement flooding

Design Standards of Storm Drainage System



Water in the combined/sanitary sewer is below basement elevation
Overland flow not to exceed street right-of-way limits

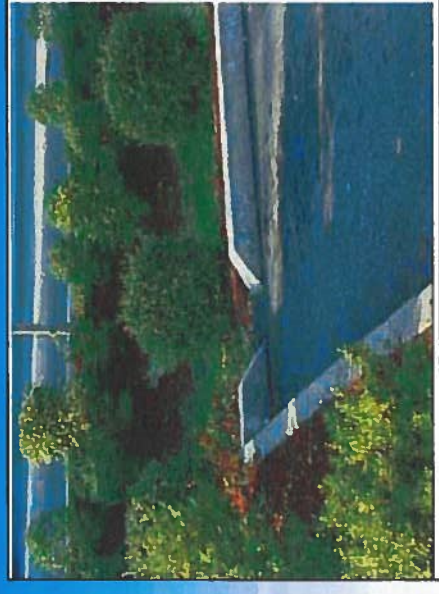
Potential Solutions

Options being considered for the area include:

Downspout
Disconnection

Sealing
Maintenance
Hole Covers

Surface Flow Path
Diversion



Additional source control options:

- Catchbasin inlet controls
- Increased no. of catchbasins
- Sewer maintenance and rehabilitation

Involves:

- Minimal effort and time to implement
- Will control excess stormwater from overloading the sewer system
- CCTV, smoke or dye test, sewer cleaning, relining, and repair

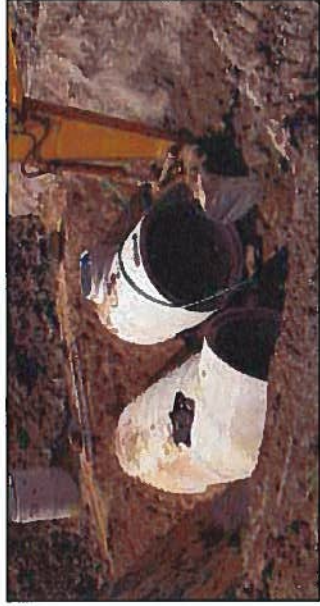
Potential Solutions

Options being considered for the area include:

- Adding new road storm sewer in streets where only combined sewer exists and connect all catch basins to it.
- Replacement of existing storm and/or combined sewers.



- Adding new sewers (Twinning)



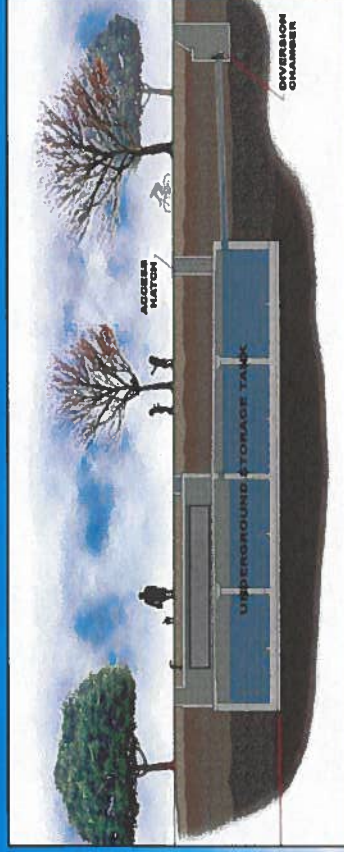
For each one of these options, the following will be considered:

- What does the community prefer?
- How big does the structure need to be?
- Where is the best place to locate it?
- What is the cost?
- Are there any environmental impacts?
- Are there impacts on existing facilities?

Potential Solutions

Options being considered for the area include:

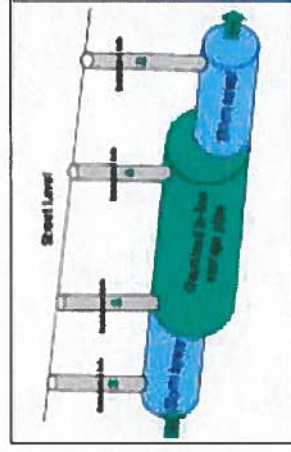
Underground Storage



Dry Pond/Wet Pond



Oversized Pipes



For each one of these options, the following will be considered:

- What does the community prefer?
- How big does the structure need to be?
- Where is the best place to locate it?
- What is the cost?
- Are there any environmental impacts?
- Are there impacts on existing facilities?

Cluster Areas Index Map

Measures to be Implemented in the Entire Study Area

- City's Basement Flooding Protection Subsidy Program
- Complete road sewer separation program (construct storm sewers in streets with only combined sewers)
- Seal combined/sanitary MH covers in low lying/ponding areas
- Replace perforated combined sewer MH covers in partially separated areas (in areas where there exists a road storm sewer)
- Roof leader disconnection
- Clean, spot line and repair sewer sections identified by CCTV inspections conducted 2009 - 2010
- Structural measures to relief sewer systems as required
- Remedial measures to manage overland flow as required



Downspout Disconnection

- In 2007, Toronto City Council approved a mandatory downspout disconnection program.
- The by-law will come into effect by **November 20, 2011** for homeowners who live within the City's combined sewer service area.



Benefits of disconnecting your downspout:

- Helps reduce the amount of stormwater that is sent through the sewers
- Less stormwater in the system will help prevent wastewater from backing up through floor drains
- Less burden on the sewer system and leads to lower energy costs of wastewater treatment facilities – producing fewer greenhouse gas emissions.
- Helps to replenish and protect the groundwater table and reduces and delays stormwater runoff—helping to prevent flash flooding in rivers and streams



Cluster 1

Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from perforated manholes, low lying manholes, connected roof downspouts, sewer below ground water table and sewer receiving surface flow in streets with no storm sewers.
- Higher groundwater table than basement elevation.
- Accumulation of surface flow in low lying areas.
- Reverse slope driveways.
- High overland flow from Woodbine Ave.
- Overland flow ponding due to lack of overland flow route with adequate capacity.
- Accumulation of sediment and debris at the lake outfall structures.
- Back up in the storm sewer system resulting from closure of flap valves.
- System hydraulics constraints under heavy storm events.

Potential Remedial Measures

Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Re-grade street and lower inlet grate.
- Provide inlet control devices at Woodbine Ave. and east area of Greenwood Racetrack Development.
- Divert some of the flow from the Greenwood Racetrack Development to Lake Shore Blvd storm sewer and upgrade the sewer in some sections.
- Extend median and install speed bumps at Woodbine Ave to direct overland flow to Lakefront Blvd East instead of Kewbeach Ave.
- Consider methods to reduce overflow elevation from Kenilworth tank.
- Provide catchbasins in front of house which has reverse slope driveway.
- Provide curb cut at the south corner of Waverley Road to allow overland street flow to discharge to the existing sewer inlet located in the park.
- Provide swale in the park area to relief overland flow to the lake.
- Provide overflow pipe in the storm sewer upstream of flap valves to allow relief and connect to existing outfall pipe from sewer inlet at Lee Ave and Waverley Rd.
- Provide overflow pipe from existing storm sewer to the existing outfall structure to allow relief and reactivate outfall structure at Kippendavie Ave and Woodbine Ave.
- Regrade and divert overland flow to reactivated outfall structure at Woodbine Ave.
- Improve system hydraulics to handle heavy storm events.

Cluster 2 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded sanitary sewer due to potentially connected roof downspouts, low lying manholes, and sewer below ground water table.
- Accumulation of surface flow in low lying areas.
- Lack of capacity of the Highfield Rd Pumping Station.

Potential Remedial Measures

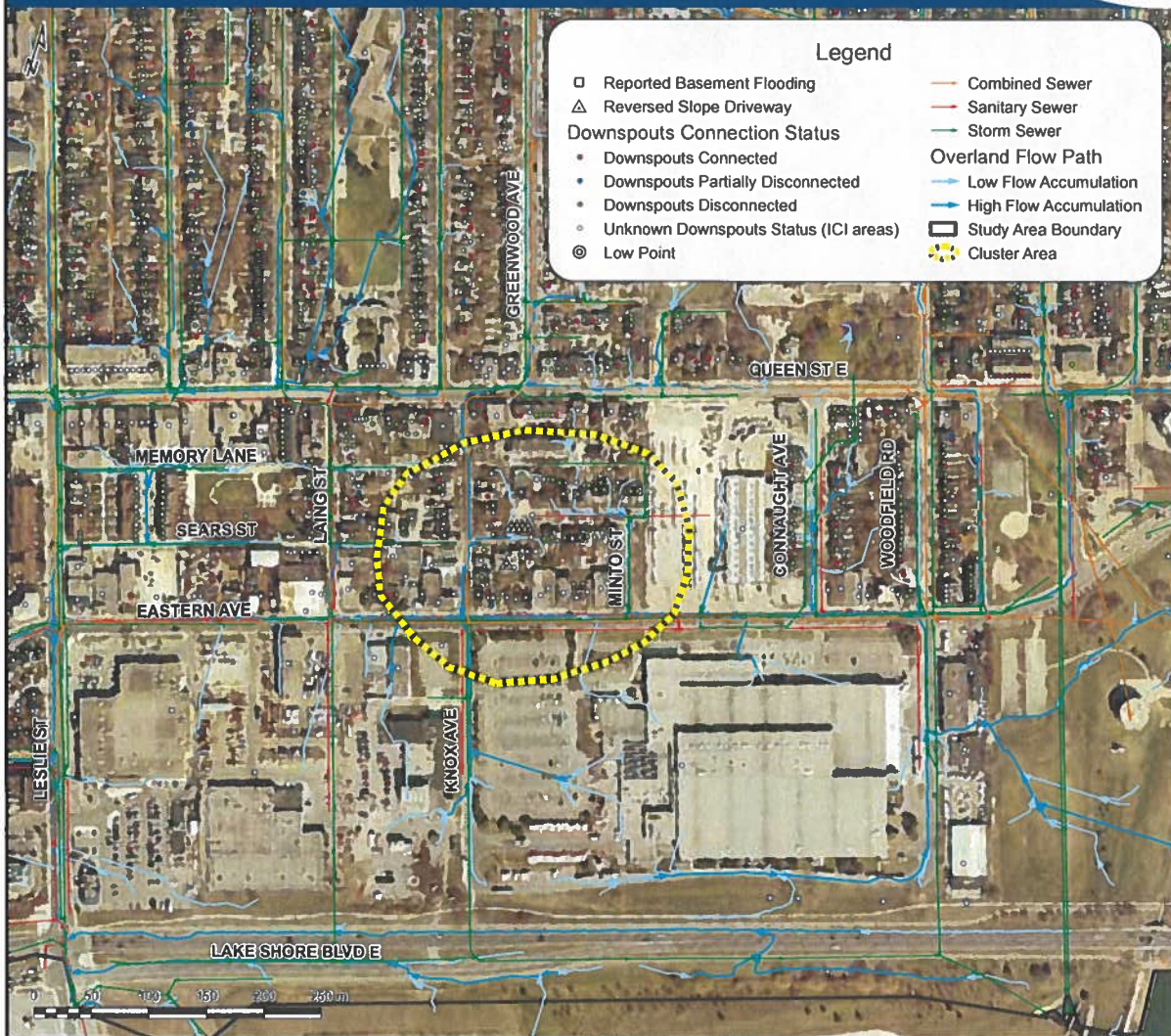
Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Disconnect storm home drain (foundation drains and roof downspout) from combined sewer and connect to storm sewer.
- Increase inlet capacity for overland system in low lying areas.
- Provide near surface conduit storage for overland system.
- Improve capacity of sanitary pumping station.
- Improve system hydraulics to handle heavy storm events.

Cluster 3 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from sewer below ground water table and sewer receiving surface flow in streets with no storm sewers.
- Flow from TTC yard contributed to overloading of combined sewer.
- System hydraulics constraints under heavy storm events.

Potential Remedial Measures

Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Provide backflow valve and sump pump at every home as temporary and back-up remedial measure.
- Provide road sewer separation by constructing a storm sewer in Minto St., West to East and connect it to existing storm sewer.
- Disconnect all catchbasins from combined sewer and connect to new storm sewer.
- Increase inlet capacity for overland system in low lying areas.
- Increase sewer capacity for storm system at select locations for better conveyance.
- Improve system hydraulics to handle heavy storm events.

Cluster 4 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and sewer below ground water table.
- Higher groundwater table than basement elevation.
- Accumulation of surface flow in low lying areas.
- System hydraulics constraints under heavy storm events.

Potential Remedial Measures

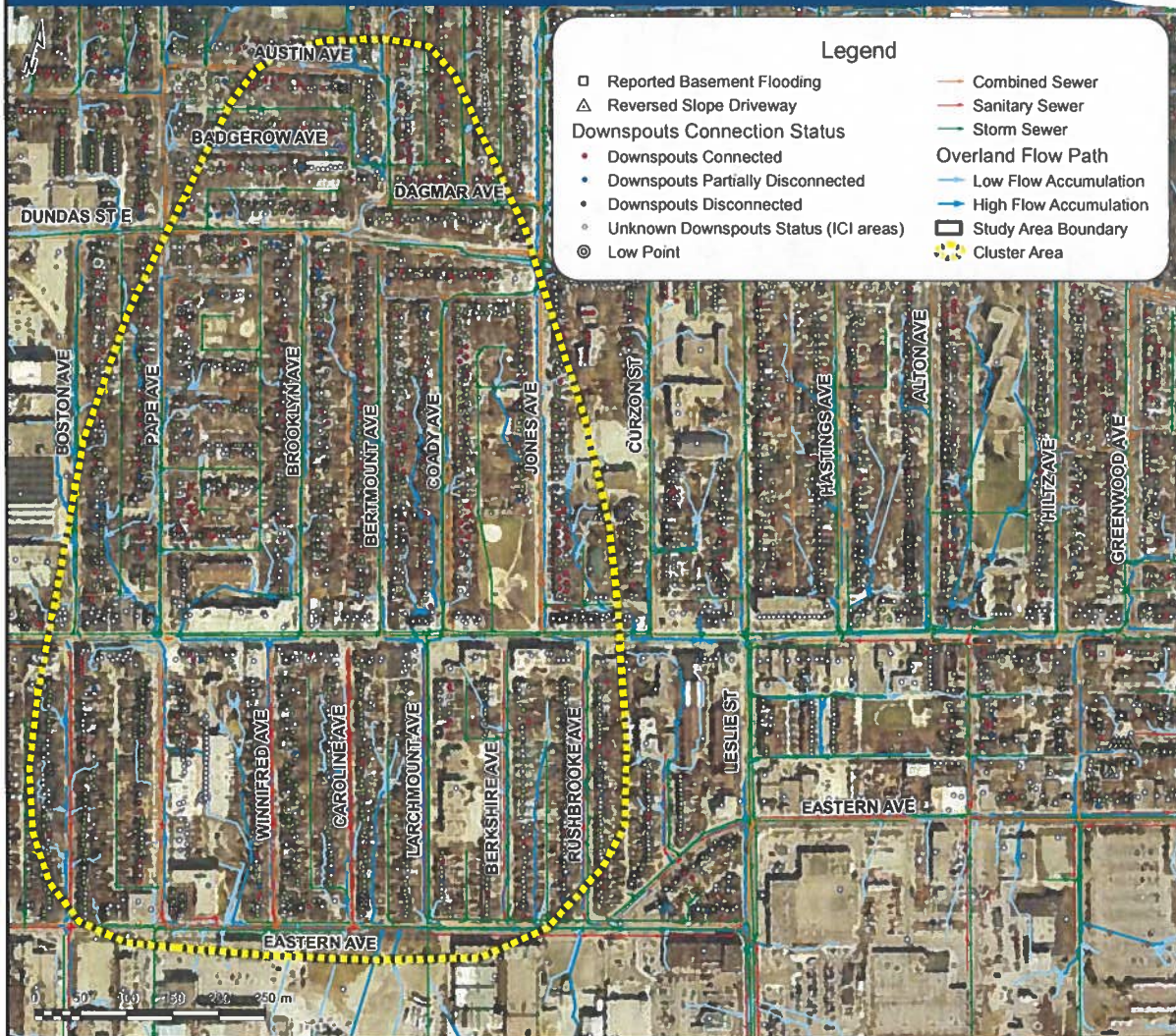
Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Increase inlet capacity for overland system in low lying areas.
- Improve system hydraulics to handle heavy storm events.

Cluster 5 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from perforated manholes, connected roof downspouts, sewer below ground water table and sewer receiving surface flow in streets with no storm sewers.
- System hydraulics constraints under heavy storm events.

Potential Remedial Measures

Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Provide conduit storage for the combined sewer system at select locations.
- Increase capacity of combined sewer, if required.
- Improve system hydraulics to handle heavy storm events.

Cluster 6 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts, sewer below ground water table and sewer receiving surface flow in streets with no storm sewers.
- Accumulation of surface flow in low lying areas.

Potential Remedial Measures

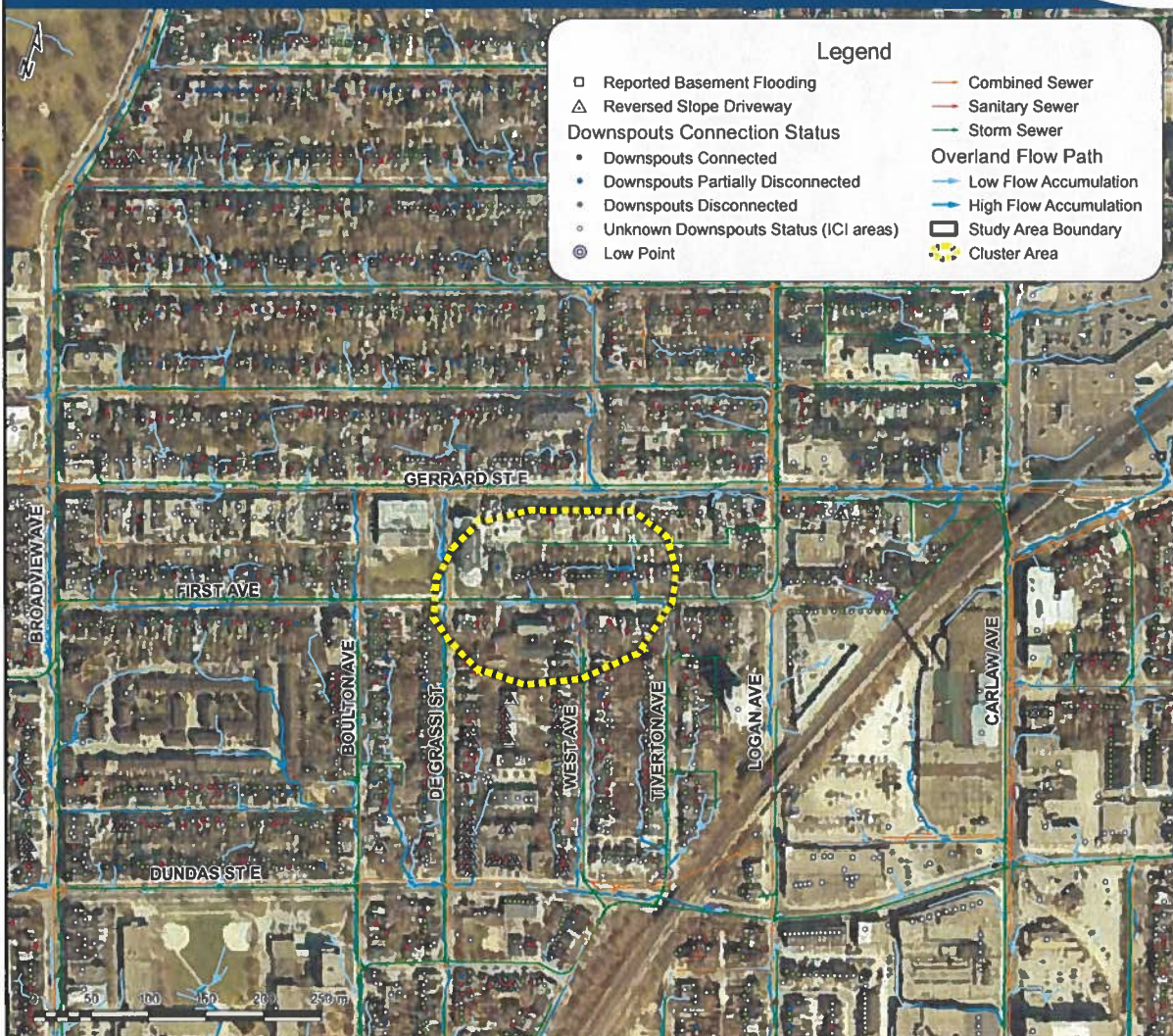
Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Increase inlet capacity for overland system in low lying areas.
- Provide near surface conduit storage for overland system.
- Provide conduit storage for the combined sewer system at select locations.

Cluster 7 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from connected roof downspouts and sewer below ground water table.

Potential Remedial Measures

Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Provide conduit storage for combined sewer system, if required.

Cluster 8 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Overloaded combined sewer due to high storm flows from perforated manholes and connected roof downspouts.

Potential Remedial Measures

Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Provide conduit storage for the combined sewer system at select locations.

Cluster 9 Causes of Flooding and Potential Remedial Measures



Causes of Flooding

- Combined sewer is overloaded due to sewer receiving surface flow, i.e., no storm sewer in the street.
- Flooded homes are located at lower elevation than the street.
- Sewer is flat in one area resulting in inadequate capacity.

Potential Remedial Measures

Source Control

See measures to be implemented in the entire study area (Index Map)

Structural Controls

- Construct storm sewer in the street and direct to it all surface flow.
- Provide inlet control devices and block some catchbasins until storm sewer is constructed.
- Upgrade flat section of the sewer.

Representative Photos of Local Flooding Affected Areas Along with Investigation of Potential Causes



Kew Beach Avenue, May 17, 2006 Storm



Woodbine and Lakeshore Blvd., May 17, 2006 Storm



Kew Beach Avenue, August 9, 2009 Storm



Kew Beach Park, May 17, 2006 Storm



Lee Avenue, July 25, 2009 Storm



Leslie and Lakeshore Blvd., July 25, 2009 Storm



Kew Beach and Lakeshore Blvd., July 25, 2009



Kew Beach Avenue, August 9, 2009 Storm



Inlet Grate at Lee Avenue



Kennilworth Avenue Storm Outfall



Chamber Cover on Woodbine Avenue Ramp



Reversed Driveway at Lee Avenue



Potential Flooding Through Basement Window at Logan Ave.



Low Point at Kerr-Highfield Road



Catchbasin to Combined Sewer on Minto Street



Houses Below Road Elevation at Kingswood Road

Evaluation of Solutions

The following criteria will be used in evaluating each of the options and identifying the recommended solutions:

Natural Environment

- Potential impact on terrestrial systems (vegetation, trees, wildlife)
- Potential impact on aquatic systems (aquatic life and vegetation, groundwater)
- Potential impact on beach, lake front, water quality

Technical

- Effectiveness of control measure in eliminating basement flooding
- Feasibility of control measure (available space, accessibility, construction requirements)
- Impacts to downstream receiving water and treatment systems

Social and Cultural Environment

- Potential to impact the community
- Potential to impact land use compatibility (impacts to visibility, noise, traffic congestion)

Economic

- Capital cost
- Operating/maintenance cost

Next Steps

Following this Open House, the study team will review and consider your comments in the evaluation of alternative options.

The next Public Open House will be held by the end of November to present the recommended options.

For more information on this study, or to provide your comments, please contact:

Josie Franch, Public Consultation Unit
55 John Street, Metro Hall, 19th Floor

Toronto, ON M5V 3C6

Phone: 416-338-2859

Email: jfranch@toronto.ca

Website: www.toronto.ca/involved/projects



Chronic Basement Flooding

City of Toronto programs available to residents

- **Drain Grant Program (for Blocked Sewer Service Lines)**

Grant assistance is available if roots of a City-owned tree are blocking the sewer service line on private property. For more information on the Drain Grant Program: call 311 or draingrant@toronto.ca.

- **Basement Flooding Protection Subsidy Program**

A total subsidy of up to \$3,200 is available, including:

- Backwater valve: 80%, up to a maximum of \$1,250
- Sump pump: 80%: up to a maximum of \$1,750
- Backwater valve and sump pump: 80%, up to a maximum of \$2,800
- Pipe severance and capping: up to a maximum of \$400

To be eligible, the following conditions apply:

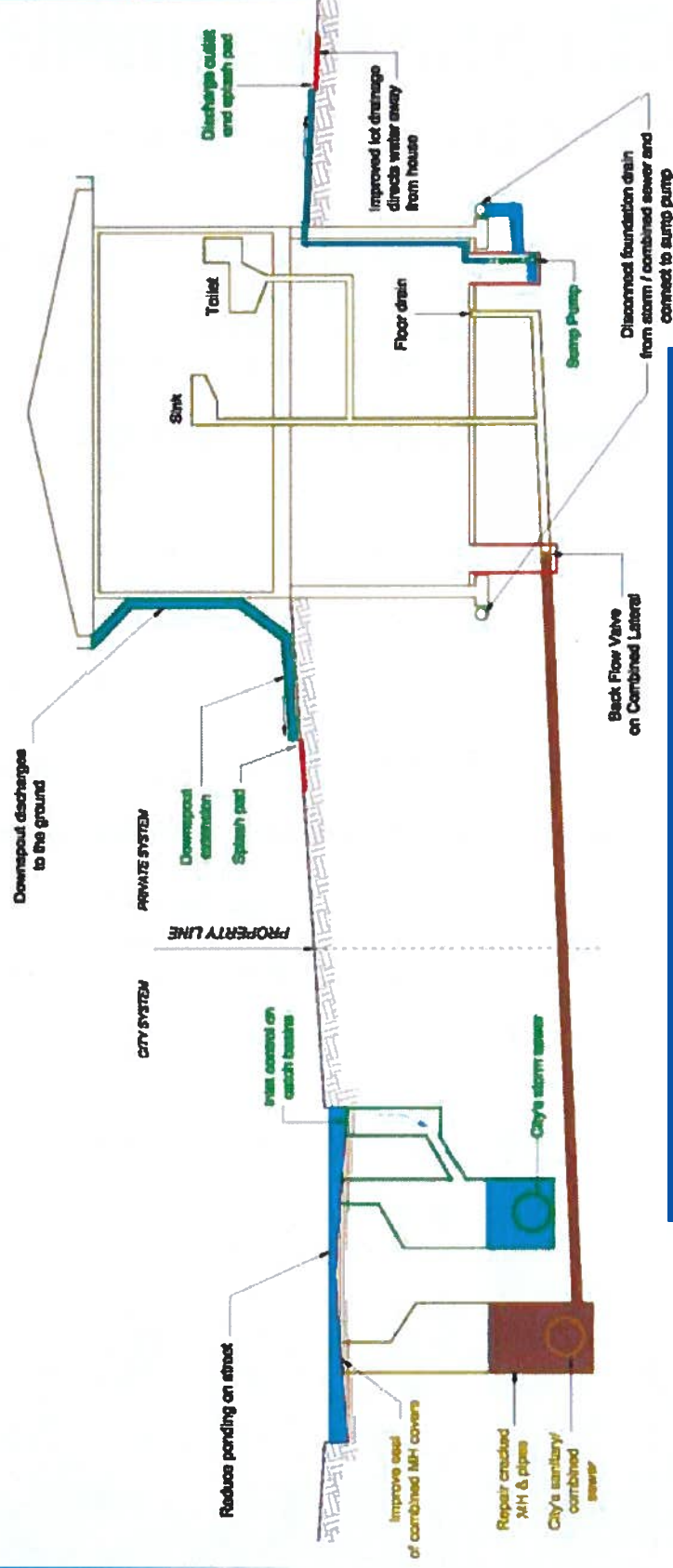
- A City of Toronto-licensed plumber or drain contractor must be hired to install a backwater valve, a sump pump and/or perform severance/capping, up to a maximum of \$400.
- Work must be for an existing home, and not a new home under construction.
- Downspouts must be disconnected (where possible).
- The property must comply with the City's Zoning By-law requirements for front yard paved areas.

**For more information on details or how to apply,
see provided handout or call 311**



Homeowner Measures to Control Flooding

ISOLATING YOUR HOME PLUMBING FROM THE CITY'S SEWER SYSTEMS



Note: Private drainage systems can be complex and could differ from that shown. It is critical that the homeowner carry out a site assessment with a licensed plumber, drain contractor, or drainage engineer to understand how the existing drainage system operates before determining the appropriate isolation solution.



Background

Question 1.

[illegible]

1

**Municipal Class Environmental Assessment
Investigation of Chronic Basement Flooding
Study Area 32**

Question 2.

The alternative solutions will be evaluated using the criteria shown in the table below.

A. Please indicate (mark the appropriate column) **the importance of the evaluation criteria to you and/or your community.**

2 = Very Important

1= Somewhat important

0= Not important

Category	Criteria	Importance		
		2	1	0
Natural Environment	Potential impact on vegetation, trees and wildlife			
	Potential impact on aquatic life and vegetation, groundwater			
	Potential impact on beach, lakefront, water quality			
Socio-Cultural Environment	Potential to impact the community			
	Potential to impact land use compatibility (visibility, noise, traffic congestion)			
Technical Considerations	Effectiveness of control measure in eliminating basement flooding			
	Feasibility of control measure (available space, accessibility, construction requirements)			
	Impacts on downstream receiving water and treatment systems			
Economic Considerations	Capital costs			
	Operating and maintenance costs			

B. Are there any other evaluation criteria that you would like us to consider?

Thank you for participating in this study.

For more information about this project, please visit our website at www.toronto.ca/involved/projects. Please return this completed **Comment Sheet** to our staff at the Registration Table or place in the 'In Box'. You can also fax it or use the provided postage paid envelope to mail the form in by **October 15, 2010** to:

Josie Franch
Senior Public Consultation Co-ordinator
Toronto, ON M5V 3C6
Email: jfranch@toronto.ca

City of Toronto Public Consultation Unit
Metro Hall, 55 John Street, 19th Floor
Fax: 416-392-2974

Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.



Basement Flooding – Study Area 32 Summary of Public Comments – September 29 & 30, 2010

Open House #1

The comments that were received from the public at Open House #1 focused on property-specific flooding issues throughout the study area and helped to reconfirm flooding problems under investigation, as well as the identification and evaluation of solutions at various locations throughout the study area. The table below documents the issues raised by the public and the response from the project Team.

Question 1.

Do you have any comments regarding the potential alternative solutions? Please explain.

	Comments/Questions	Response (where req'd)
1	Carlaw We were approved for the subsidy for the sump pump and backwater valve. It was installed by City approved contractor i.e. Mimico Ent. His name was Harold. This never helped to stop flooding in the basement. A few weeks ago, we called another City approved contractor to have a look at the flooding problem i.e. Metropolitan Plumbing and we were told that the backwater valve is sitting at the wrong spot and is doing nothing. We called Mr. Rooter, paid \$465, to check; same answer – backwater valve is sitting at the wrong spot – not connected to the proper drain. I can't be approved for another subsidy as every homeowner gets approved once. City approved contractor; Mimico, cemented the floor drain which use to have a mesh on it. The last flood in June damaged my property again and as the drywalls are taken down, we found the foundation to be soaked. As for the flooding water, the water has no way to go out.	Responded to homeowner on Oct. 4/10. See response letter.
2.	It was helpful and I received an explanation to possible solutions. The rebate program was explained as well.	

3.	Kenilworth Avenue. Our street floods because during heavy rains, the ground water carries debris from yards, driveways and the street and clogs the catch basins. With clogged catch basins, the water on the street overflows the sidewalk and flows down my reverse driveway. There needs to be a solution to the natural clogging of the catch basins.	District Operations has increased the frequency of cleaning. Long term measures proposed.
4.	Heward Avenue in Cluster 5. After heavy rains, rainwater pushes through our basement drain and floods our basement. Approximately, the water amount is sufficient to cover ½ inch off the basement floor. I want to cap my drain but I understand the water pressure needs to go somewhere. Any advice you can provide would be greatly appreciated.	Long term measures are proposed on Eastern Avenue to relieve the sewer system.
5.	Logan Avenue. My home has 5-6 other homes' backyards on my property line. This year, I've experienced tree roots growing out of the foundation of my basement along with termites. When my home got sprayed with each drill site, about 1 foot down, water came up. My contractor was very concerned. He drilled randomly in my yard to find the ground water level to be very high. My question is whether my home is on a path of an underground stream line. The tree is on city property and is over 100 years old. Disconnecting is a serious issue. I really don't want to add to any more ground water in my yard. Why is the ground water level rising?	Disconnected roof downspout should be directed away from the house and yards should be also graded away from the house.
6.	The solutions have not included stopping the development of 'large' single and multiple dwellings that cover too much of the lots, dug too deep forcing the diversion of underground streams and surface storm water (not seeping down). Masses of water seek the lake and these water heads around these large	Comment noted.

	structures – massing onto our properties and into our basements.	
7.	My neighbour disconnected downspout and water is draining into my backyard (or building). I need someone from MLS to come and inspect the situation. Please advise my neighbour to re-direct the flow onto their own property or street.	Resident was given the telephone number to MLS, Toronto & East York District.
8.	1. Empty Kenilworth tank as soon as possible, especially before heavy rain. 2. Disconnect 3 racetrack development streets from Kew Beach storm sewer. 3. Surface water re-direction from Woodbine Avenue to Kew Beach (swale). 4. Fix storm sewers and sewage sewer to handle higher capacity. #1, 2 and 3 – immediately #4 – longer term but within 2 years.	Interim and long term measures are proposed to address flooding issues.
9.	Cluster #1 The most important issue is to reinstate storm event only out flows into the lake at Woodbine and Kippendavie. Surface solutions do not deal with back flow pressure in the pipes backing into basements.	Comment noted.
10.	1. There does not seem to be any mention of long term improvements to the system. There are obvious deficiencies in the whole system in terms of flow and development/intensification continues in areas that feed into the system. I do not see anything about improving capacity of the system. 2. The TTC yard at Connaught should not be connected to the residential system on Minto Street. Particularly as the TTC apparently refused City engineers access to the site. 3. At the September 11, 2008 meeting, I provided an analysis of the sludge deposited in our neighbourhood to a representative of Toronto Water. I asked at that time	Increasing the capacity of the sewer system is part of the proposed solution. Investigations in April and May 2011 confirmed that TTC sewers drain to Eastern Avenue sewer and not to Minto Street sewer. Capping Minto Street sewer at the TTC yard boundary and constructing new storm sewer at Minto Street have been recommended as measures to solve the flooding problems.

	for someone to contact us to explain the findings but no one got back to us.	
11.	Langley Ave (between Carlaw and Logan) runs westbound. The road grade in from of my house seems to come to a low point. That is, the grade runs in a downward slope towards this part of Langley from the east and also from the west. There's a catch basin directly in front of my house. The catch basin always gets covered with debris, leaves, ice, snow, etc which causes flooding right back to the front of my house. The road then almost becomes impassable. My neighbours basement was flooded a couple of years ago because of this. During storms, the neighbours have to clean the catch basin to avoid possible damage to their properties. During the winter months, we have to dig a channel to allow the melted water to run into the catch basin. I've tried on several occasions over the years to get this matter resolved without any success. The last contact with City staff was in November 2009 with two individuals named Robert Burile and John Carter. Mr Carter actually came to my house and looked at the road. I believe they both work out of the City's Eastern Ave location.	District Operations has increased the frequency of cleaning.
12.	Nothing I haven't heard before. We need action, not words.	Comment noted.
13.	In my home, all sinks, toilets, showers, except 1 sink, are connected to the sanitary sewer line which has a backflow connected. The exception, allowed by the City, connects to the storm sewer. Downspouts are disconnected, but in a heavy rain, water causes back up in the kitchen sink. The storm sewer is much too far under the basement floor to install a backflow preventer, hence none of your potential solutions will work in my case. Also, the staff at your Open House on Queen Street was incredulous when I stated that my home built in 1920, had no foundation drains.	Comment noted.

14.	On Heward Avenue, basement flooding was due to sewage backup. This was solved by moving houses from the combined sewer system to the sanitary sewer system, and their downspouts disconnected. This was done in 1992. Due to my work at that time, I was not available to take advantage of this program. If this program was offered again, it would help myself and other residents of Heward Avenue. Many homes have changed owners since 1992.	Comment noted.
15.	No tank at Dundas Street. Letter to follow.	
16.	1. We understand from the project team that the new development that went in on the west side of Woodbine erroneously is discharging flow through the Kewbeach Avenue area instead of flowing southwest as was approved in their development plan. We believe this should be rectified as soon as possible. 2. Elder residents described how they used to ride in row boats on what is now Pantry Park, and that the reason it is a park today is because of the high groundwater level. It appears that in development of Pantry Park the City has diverted water flow and that is now contributing to flow problems on adjacent properties. a. From living in the neighbourhood we are aware of homes with basement flooding that did not report the damage to the city, and so we believe the basement flooding is worse than that portrayed in the project materials shown to us at the public meeting, especially for cluster 1. With all the water coming down our way we believe that disconnection of weeping tiles and even downspouts in some cases could jeopardize the foundations of homes already in place. Can we be exempted from any such programs? b. After studying the materials posted by your project team, we are wondering if it would be possible to remediate the slope of Pantry Park so that the water flow would go down the centre of	Interim and long term measures are proposed to address flooding issues.

	the park underground and come out the bottom rather than running underneath the homes along the east side of Kippendavie Avenue? Possibly it could also flow into the Kenilworth Tank? This would also relieve the storm sewers along Kippendavie and Kewbeach Avenues. 3. Have groundwater levels been taken into account in this study? 4. Have underground water flows been taken into account in this study? 5. We understand that potential City budget cuts could jeopardize remediation efforts. Given the many issues in our area, please consider emphasizing the need for work in Cluster 1 as a priority over other discretionary projects. 6. Many of us in the community are concerned that the proposed new development at 66-76 Kippendavie Avenue will create further problems with above-ground, below-ground, and with City infrastructure as it relates to water flow. We believe the implications of such a development should be addressed in the final recommendations for Study Area 32 even though City Council is not voting on it until the first week in December, given that the proposal has already been recommended by the City Planner. Even if this particular proposal doesn't go through, we believe that a large development on that property should be considered as a factor in this study. Our specific questions include: a. Has the project team reviewed the proposed development and considered the implications of such a structure in your recommendations for Study Area 32? b. How can we be sure the pipes in the street will be able to handle the additional volume from such a large structure? Do we need larger underground pipes along Kippendavie and KewBeach Avenues?	Yes, it is found to be higher than the sewers in some areas with potential to cause I/I base flow in the sewer. Comment noted. Issue was resolved separately with City Council input. The proposed development was reviewed and the criteria was to implement stormwater control measures to limit run-off to existing conditions and backwater valves to protect from back-up from sanitary sewer downstream. Long term measures include upsizing the combined sewer on Kippendavie.
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	c. What are the implications of such a large structure and it's proposed lack of green space--where there will be substantially more runoff over the surface compared to the 6 small homes on the large grassy properties that exist right now--especially when some of those properties do not even have basements? d. What are the implications on the groundwater flow for a such a large foundation which incorporates a massive level for underground parking and possibly an associated water containment tank(s) being placed in that area when that land already has such a high water table? e. Elderly residents on the street advised that there used to be swampland and an above-ground creek running on the proposed development property and that it was just 'covered over'. Also there is high groundwater, and other underground water flows that are not apparent in the project team flow map (including in Pantry Park as noted above). Indeed the tilting of some houses in that area (including some which have had false fronts put on to mask the tilting) attests to underground water issues in this study area. Given all of this, how can we be sure the new development won't displace a great amount of water and change water flows and water levels possibly increasing risk of future basement flooding and ground shifting damaging other homes in the area? f. Have the project team for the Plan 32 area coordinated with the Engineer(s) requested by City Council to assess the water management plan proposed by the developer of 66-76 Kippendavie Avenue?	
17.	My basement backs up when heavy rain is coming down.	Comment noted.
18.	What must be done must be done. On Woodbine, the cemetery area flooding of basements is a continuing problem. 2009 was not the first time and because of mold, must be fixed. We realize, however, its an aged pipe problem and weather	

	warming will continue to have effects.	
19.	In our area, Kippendavie Avenue, there is a problem beyond sewers and rainwater that tie into the flooding issue. That is the groundwater table or level. Since natural wetlands (historically the whole area, recently the new development at Queen + Woodbine) have been removed and infill development has taken place, the severity of flooding has increased. Long time residents have seen this, though all know there is no study showing it. A groundwater study should be done to compliment this study. It should look at a 20-100 year projection of increased development (especially sub terrain), the effects of the new proposed holding tanks and methods to deal with rain water and sewage. It should study and determine exactly what will happen i.e. will ground water level rise? Will it spread? What is the appearance and height of groundwater under existing structures? Will increased population, higher density development (more toilets, drains) cause greater strain that is manageable? Will the water table hit a non-porous barrier causing it to rise or will it spread further? If it rises and goes above house foundations in low-lying areas, then will it enter through the brick, siding, etc?	Issues were resolved separately with City Council input. Long term measures have been proposed to upsize the combined/sanitary sewer on Kippendavie to address the capacity issue. Groundwater study was included in this EA Study.
STAFF COMMENTS COLLECTED		
	Cluster #1: the proposed condo at 66-76 Kippendavie underground garage will take away room for groundwater and cause basement flooding in the surrounding homes Cluster #4: Councillor Fletcher asked what remedial works are proposed for the reported floodings on Alton Ave between Queen and Dundas (there are no specific measures listed on the panel)	Issue resolved with City Council input. Upgrading the combined sewer system.

	Cluster #5: Councillor Fletcher asked what remedial works are proposed for the reported floodings on Queen at Jones and Queen at Coady Ave (there are no specific measures listed on the panel)	Upgrading the combined sewer system.
	Cluster #6: resident reported basement flooding at 23-25 Lewis St between Queen St and Eastern	Long term measures proposed on Queen Street and Eastern Avenue will address this issue.
	Cluster #6: clear water coming out from basement drain a few times recently (probably due to high groundwater table?)	
	Queen Street • a sinkhole in the private property; • reported to the City and staff told her that the City is not doing anything in the private property; • Her concern is the cause of the sinkhole may be an area-wide (Bisley St./ Queen St.) problem. When the drug store was built, she was told that a creek was running under the properties in the area. • the storm sewer outlet at the corner of Verral Ave. / Queen St. needs to be cleaned.	Sewer Asset Planning to investigate.
	Queen St East - The resident installed a backflow preventer and the installer showed him that it is working properly but still under heavy rainfall events water comes out from the drain. - Suggested talking to the Subsidy Program representative to determine whether the backflow preventer was properly installed.	
	Booth Ave. • flooded 4 times every year for the last 20 years	Connection to the combined sewer from the north is being blocked.

	• flooded water very stinky • wet basement • flooded water from toilet, bathtub, and floor drain • once a big storm comes, his basement floods • all the homes in the neighborhood have the same problem • he understands that their area is situated in a lower area which receives flow from upstream. He thinks the solution would be to build a storage facility which collects all the water and pump it out to the lake.	
	Empire • semi-detached home • no flooding issues • house was renovated in late 70s or early 80s and the basement level was lowered • however, neighbour flooded a few times (why?) and now is under renovation. The basement level is going to be lowered. • On another side neighbour also has been flooded a few times.	Upgrading of the storm sewer on Empire Avenue is proposed.
	Kenilworth - Reversed driveway home, it gets flooded during heavy rainfall events. - Resident mentioned that the house is located on a low point and the debris that is washed by the rain clogs the catchbasin located right in front of the house and water builds up and go over the curb and down the driveway. - Suggested to fill out a comment sheet since they had never filed a complaint with the City.	Long term measures are proposed. Additional catchbasins in the low area.

	Wineva - Installed backflow preventer on main lateral but stormwater still comes through floor drains during some storm events. - Roof leader disconnected. - Concerned over a laneway in the Leuty/Violet area where CBs have not been cleaned for a long time. - Residents complained of 8 houses being flooded during heavy rainfall events. None of the houses is recorded in the City's database. - Residents in most cases reported flooding to the insurance but not to the City.	Comments noted.
	Minto Street - Residents concerned about TTC flows discharging into the local combined sewer on Minto Street. - Informed the residents that communications are underway with the TTC to determine the type of flow being discharged into the sewer and come up with a solution.	Investigation in May 2011 confirmed that TTC Yard sewers drain to Eastern Avenue and not to Minto Street.
	Kippendavie - Concerned over proposed tank in Pantry Park (?) across the street where there is already high groundwater table. Explained to resident that a tank is not being proposed in this study. - Park was an old swamp area with a creek running through it. - House is sitting on piles and she has half a basement. In July 8, 2008 storm event, stormwater backed up the floor drains in the basement.	Long term measures are proposed to upsize the combined/sanitary sewer on Kippendavie to address issue.

	Kippendavie - House has been flooded a couple of times, house has a reversed slope driveway - Resident concerned that flow represented on the mapping is not accurate. There is storm flow that is channelled down Kippendavie Ave. at the south end, and this is not indicated on the map. The flow on the map only shows a blue line to the middle of Kippendavie Ave. In fact, the water flows down Kippendavie Ave. to the south end and crosses the street flowing down into the driveways on both sides of the street.	See above.
	Kippendavie - Residents expressed concern regarding proposed development to the north west and the future impacts this new condo development will have to an already taxed and over burdened system - was under the impression that there was going to be an underground tank located in Kew Beach Crescent Park (behind the Public School) - which would have impacts to the already high water table in the area.	See above.
	Neville Park Blvd - Backyard gets flooded with flows from Kingswood Rd during heavy storm events. - The basement shows some wet spots during heavy rainfall events.	New sewer is proposed.

	- The house has a reversed slope driveway.	
	Heward - Resident mentioned that the houses are connected to the combined sewer system. - Connection to the Sanitary sewer system should had been done in 1992	
	Kew Beach • Mapping does not identify her reports of flooding accurately - resident on Kew Beach Ave. • Did not think the solution of a swale within the park was going to provide enough relief in the system - and mentioned a switch that the City turns on that drains the roadway within minutes. She was under the impression that there was an alternate more immediate solution that could be considered.	A shallow storm sewer and new catchbasins to alleviate overland ponding is proposed.
	Kew Beach • Expressed concern about the lack of resolution on a final solution for alleviating the basement flooding problem • Did not believe the solution of a swale within the park was an adequate interim solution and would rather see a permanent solution implemented • Expressed concern about the proposed condominium development and the City's rationale for considering this development proposal as reasonable.	

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Question 2.

The alternative solutions will be evaluated using the criteria shown in the table below.

A. Please indicate (mark the appropriate column) **the importance of the evaluation criteria to you and/or your community.**

2 = Very Important

1 = Somewhat important

0 = Not important

Category	Criteria	Importance		
		2	1	0
Natural Environment	Potential impact on vegetation, trees and wildlife	X4	X4	X3
	Potential impact on aquatic life and vegetation, groundwater	X5	X3	X2
	Potential impact on beach, lakefront, water quality	X4	X5	X1
Socio-Cultural Environment	Potential to impact the community	X6	X4	
	Potential to impact land use compatibility (visibility, noise, traffic congestion)	X2	X5	X3
	Effectiveness of control measure in eliminating basement flooding	X10		
Technical Considerations	Feasibility of control measure (available space, accessibility, construction requirements)	X5	X3	X1
	Impacts on downstream receiving water and treatment systems	X6	X2	X2
Economic Considerations	Capital costs	X3	X3	X4
	Operating and maintenance costs	X3	X4	X3

B. Are there any other evaluation criteria that you would like us to consider?

- Proper cleaning out of street sewer on a regular basis. Enlarging of the stormwater holding tanks.
- Speak to New York, Boston, Chicago. You are going about it the wrong way.
- Yes. Evaluate all the large footprint buildings entering the area and their impact on groundwater table.



Building a great city - together

Call **3 1 1**

The City of Toronto holds public consultations as one way to engage residents in the life of their city. Toronto thrives on your great ideas and actions. We invite you to get involved.

Investigation of Basement Flooding – Study Area 32 (Eastern Beaches Area)

Municipal Class Environmental Assessment Notice of Public Open House #2

Please join us at our second Public Open House to learn about the options considered and the recommended solutions to mitigate basement and surface flooding in the study area. You will have an opportunity to view displays, speak one-on-one with the project staff, and tell us what you think about the recommended solutions. Drop in anytime between 6:30 p.m. to 8:30 p.m. on either of the dates noted below. We look forward to seeing you there.

Details are as follows:

Date: Monday, June 13, 2011
Time: 6:30 p.m. to 8:30 p.m. 
Location: Jimmie Simpson Community Centre
870 Queen St. E. at Logan Avenue
(Gymnasium)

or

Date: Thursday, June 16, 2011
Time: 6:30 p.m. to 8:30 p.m. 
Location: Mennonite New Life Centre of Toronto
1774 Queen St. E. at Kingston Road
(Main level)

Background

During the summer of 2008, the Eastern Beaches area experienced a series of intense storms that resulted in the flooding of many residents' homes. As a result, the City of Toronto began an Environmental Assessment (EA) study in November 2009 for the Eastern Beaches area, known as Study Area 32. The study is investigating the causes of flooding and developing solutions to help prevent future basement and surface flooding in the study area.

We would like to hear from you

If you are unable to attend but would like to be provided with information or would like to be added to the study mailing list, please contact:

Mae Lee (Rigma)
Senior Public
Consultation Coordinator
City of Toronto
Metro Hall, 19th Floor
55 John St.
Toronto, ON M5V 3C6

Tel: 416-392-8210
Fax: 416-392-2974
TTY: 416-397-0831
E-mail: rigma_lee@toronto.ca
Visit: toronto.ca/involved/projects

Issue Date: June 10, 2011

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

Welcome

Investigation of Basement Flooding (Study Area 32)

Public Open House #2

View displays and discuss the study with project staff

Feel free to ask questions and fill out a comment sheet

Tonight's Open House

The purpose of tonight's meeting is to:

- Provide background on the study,
- Present the results of the evaluation of alternative solutions,
- Present the recommended solutions,
- Receive your comments, and
- Outline the next steps in the study.

Study Objectives

The purpose of the study is to:

- Examine existing stormwater drainage, combined and sanitary sewer systems and identify the causes of basement flooding and/or surface flooding; and
- Make recommendations to reduce the risk of future flooding.



Study Area

- The study area is bounded by Don River to the west, Victoria Park Ave. to the east, Lakeshore Blvd. East/Lake Ontario to the south and Danforth Avenue to the north.

- The area was subject to several basement and surface flooding incidents especially during the summer of 2008.



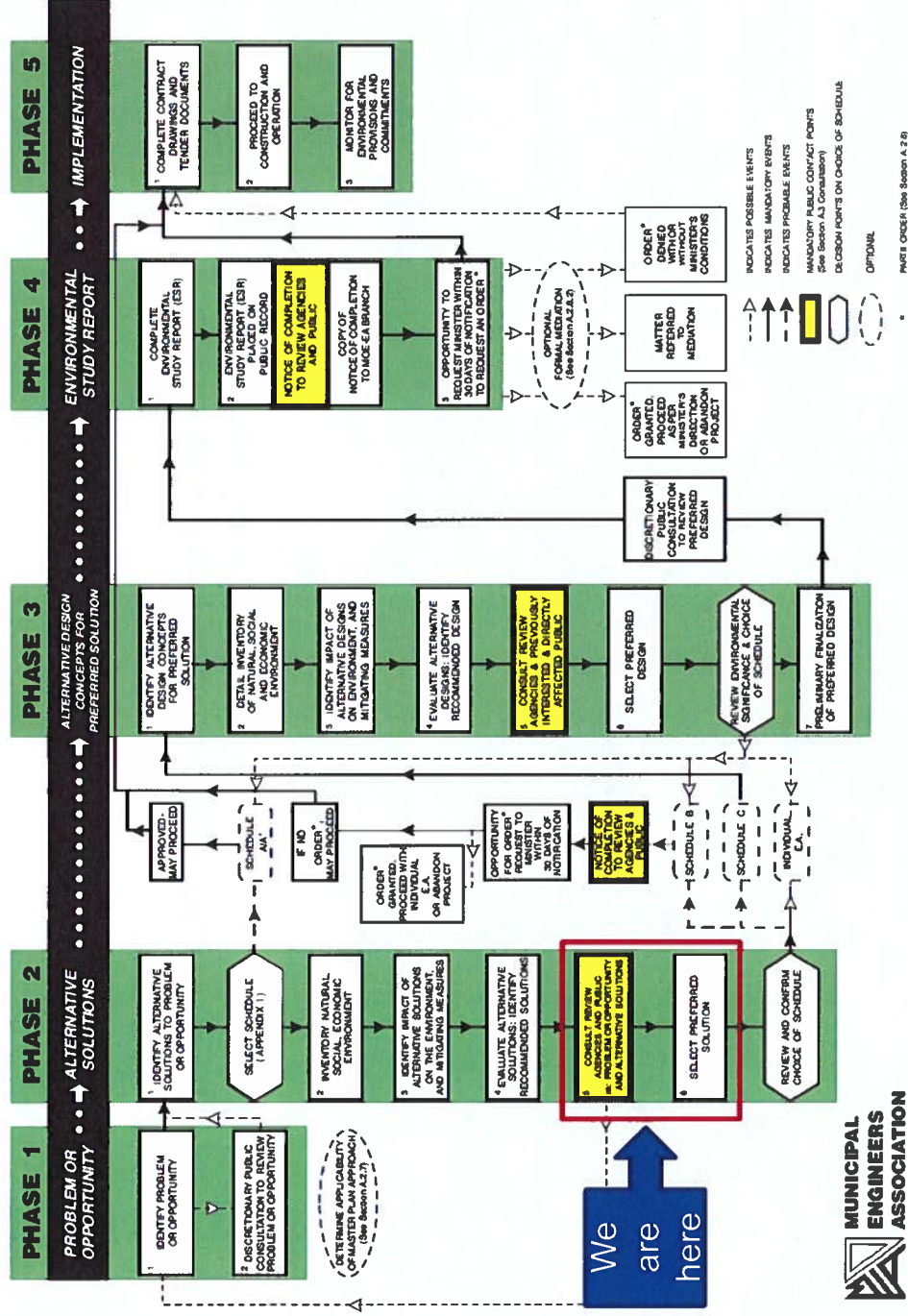
Municipal Class EA

- The City of Toronto must follow the Municipal Class EA process to meet the requirements of Ontario's EA Act for all infrastructure projects.
- The EA Act requires the “protection, conservation and wise management of the environment” while undergoing infrastructure enhancements.
- The EA process is also an opportunity for the public and agencies to provide input throughout the project.

Municipal Class EA Flow Chart

EXHIBIT A.2 MUNICIPAL CLASS EA PLANNING AND DESIGN PROCESS

NOTE: This flow chart is to be read in conjunction with Part A of the Municipal Class EA



We are here



Investigating Basement Flooding: The Steps Involved

Many steps are involved in the study in developing the recommended solutions. This work includes:

- Collecting and reviewing background data on land use, population, soil conditions, combined/sanitary sewer and storm drainage systems, flooding history, and operation / maintenance records;
- Conducting an extensive field investigation of catchbasins, manhole covers, outfalls and downspout connection/disconnection status;
- Installing meters to monitor rainfalls and flows in sewers;
- Developing computer models to analyse the causes of flooding and to predict flows under various weather conditions;
- Developing and evaluating alternatives to address the issue of flooding in the study area (1st Public Information Centre, on September 29 & 30, 2010);
- Gather input from the community and review agencies; and
- Present recommended solutions (2nd Public Information Centre).



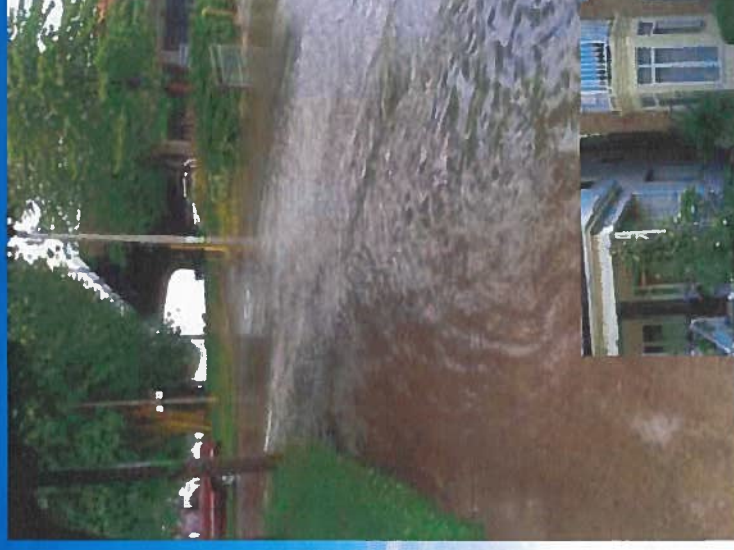
Our Findings

Under normal rainfall events, the storm, combined and sanitary sewer systems operate as designed. However, during extreme storms, the following takes place:

- Stormwater flow exceeds the combined and storm sewer capacity and overloads the systems. Water remains on the surface and flows along roads.
- At low lying areas, water accumulates (ponds) and enters the combined and sanitary sewer system through unsealed or porous manhole covers.
- During extreme storms, water on the streets enter basements via windows and reverse slope driveways.

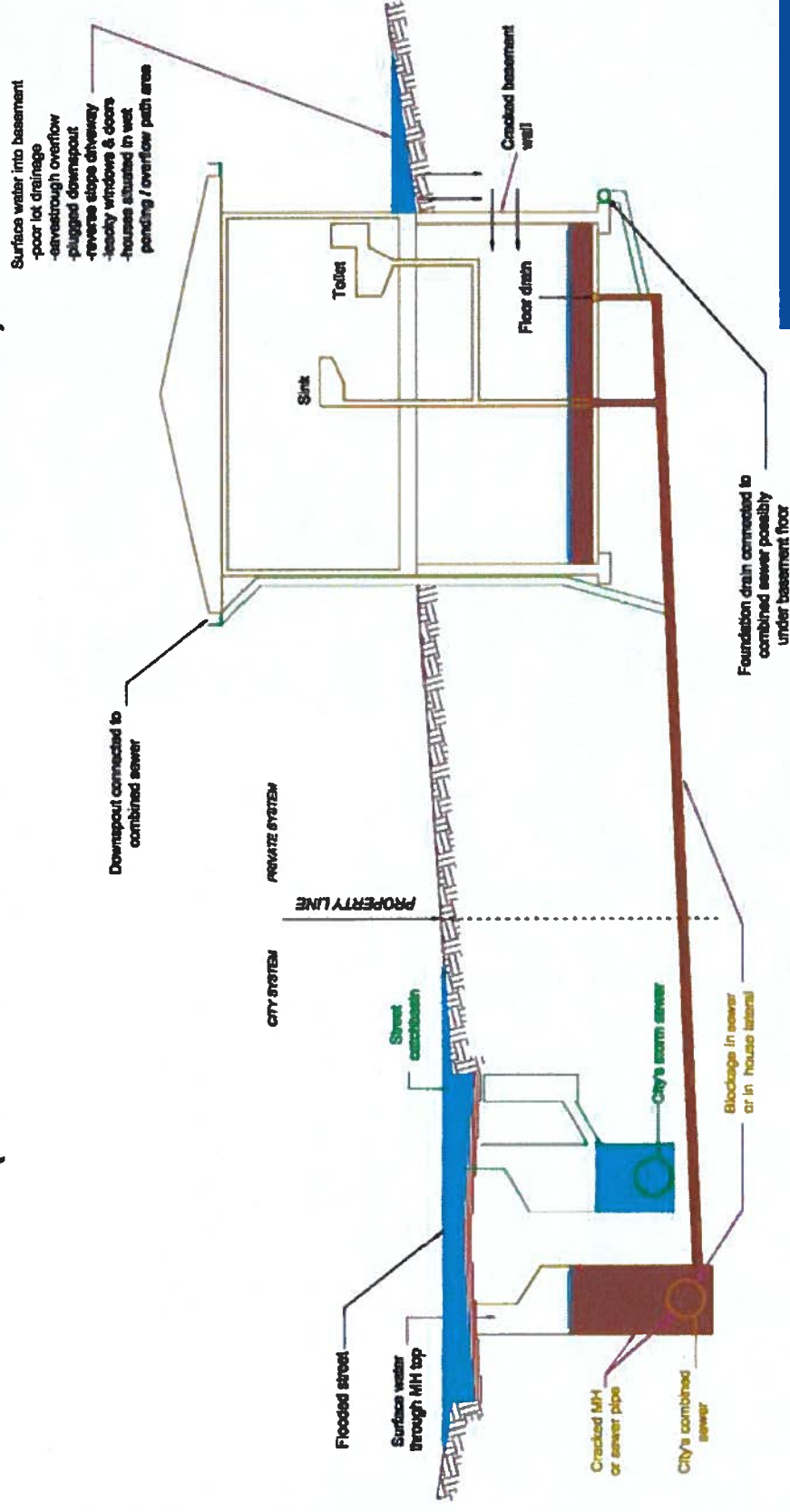
Our Findings

- On roads with storm sewers, many combined sewers still have perforated manhole covers, which allows surface storm water to enter the combined sewers. This causes the sanitary/combined sewers to backup (surcharge) & potentially backup into basements.
- Roof downspouts and weeping tiles are connected to the combined system.
- Inflow/Infiltration of stormwater to the combined/sanitary system through cracks or broken pipes, loose joints, overtaxing the sewers.



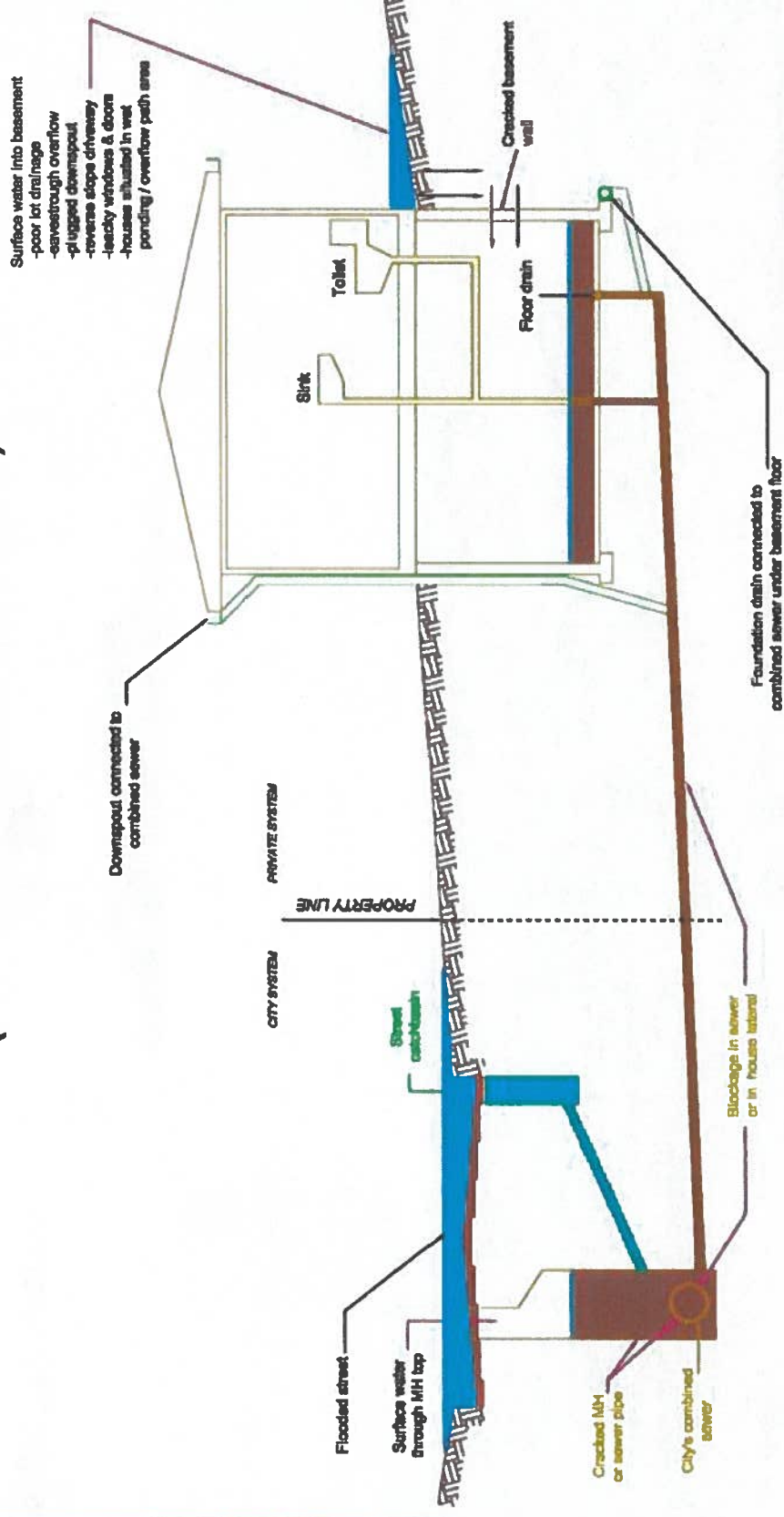
Our Findings

CAUSES OF BASEMENT FLOODING (IN PARTIALLY SEPARATED SEWER SYSTEM)



Our Findings

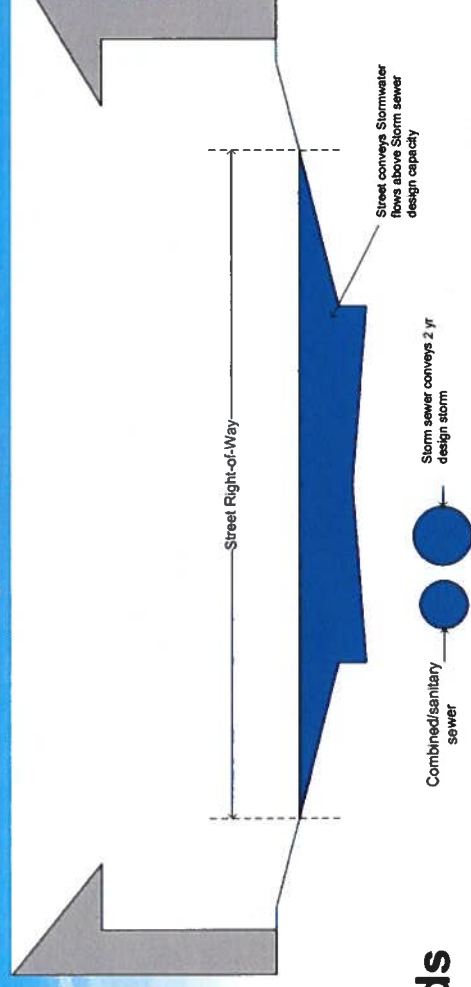
CAUSES OF BASEMENT FLOODING (IN COMBINED SEWER SYSTEM)



Note: typical connections shown, however private drainage systems can be more complex and each one is unique. For example, there could be interconnection between the sanitary and storm system or other combinations of connections shown.

Major (Street) & Minor (Pipe) Storm Drainage System

- Streets (major system) convey major storm events exceeding the capacity of storm sewers
- Storm sewer system conveys up to 1 in 2 year storm events
- Temporary ponding on roads is okay as long as the depth of surface water does not cause safety issues or basement flooding



Design Standards

- Water level in the combined/sanitary sewer is below basement elevation
- Street flow depth not to exceed street right-of-way limits

Evaluation of Alternative Solutions

The following criteria were used in evaluating the alternative solutions and identifying the recommended solutions:

Natural Environment

- Potential impact on terrestrial systems (vegetation, trees, wildlife)
- Potential impact on aquatic systems (aquatic life and vegetation, groundwater)
- Potential impact on beach, lake front, water quality

Technical

- Effectiveness of control measure in eliminating basement flooding
- Feasibility of control measure (available space, accessibility, construction requirements)
- Impacts to downstream receiving water and treatment plant and detention tanks

Social and Cultural Environment

- Potential to impact the community
- Potential to impact land use compatibility (impacts to visibility, noise, traffic congestion)

Economic

- Capital cost
- Operating/maintenance cost

Recommended Solutions

The evaluation of alternative solutions revealed that the preferred solutions include:

**Downspout
Disconnection**



**Sealing Maintenance
Hole Covers**



**Surface Flow Path
Diversion**



**Additional source control
recommendations:**

- Catchbasin inlet controls
- Increase no. of catchbasins
- Sewer maintenance and rehabilitation

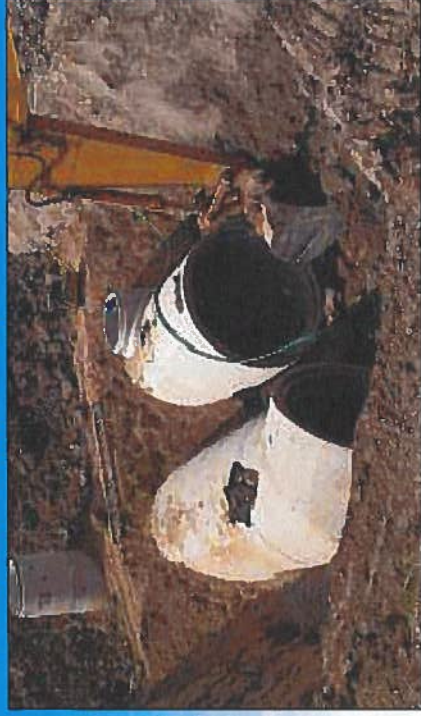
Rationale Involves:

- Minimal effort and time to implement (requires appropriate flow route). Will control excess stormwater from overloading the sewer system
- Reduces overland ponding, if sewer has adequate capacity
- CCTV, smoke or dye test, sewer cleaning, relining, and repair. Significantly minimizes inflow/infiltration to the sewer

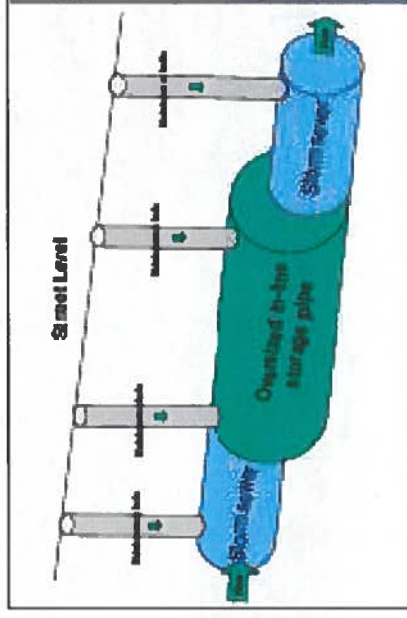
Recommended Solutions

The evaluation of alternative solutions revealed that the preferred solutions include

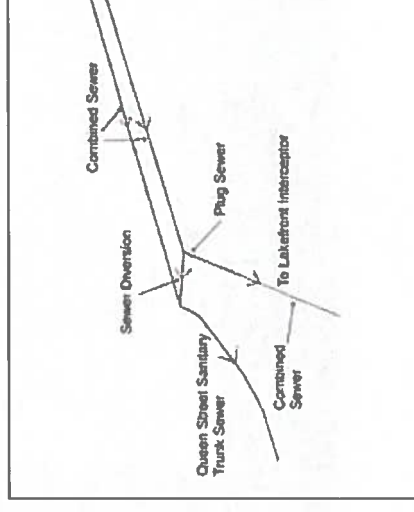
- Adding new road storm sewer in streets where only combined sewer exists and connect all catch basins to it.
- Replace & upgrade existing storm and/or combined sewers
- Add new sewers (Twinning)



- Oversize inline storage pipe



- Sewer Diversion



Cluster Areas Index Map



Measures to be Implemented in the Entire Study Area

- City's Basement Flooding Protection Subsidy Program
- Seal combined/sanitary MH covers in low lying/ponding areas
- Replace perforated combined sewer MH covers in partially separated areas (in areas where there exists a road storm sewer)
- Mandatory downspout disconnection
- Clean, spot line and repair sewer sections identified by CCTV inspections
- Structural measures to relief sewer systems as required
- Install inlet control devices in selected street catchbasins
- Remedial measures to manage overland flow as required



Downspout Disconnection

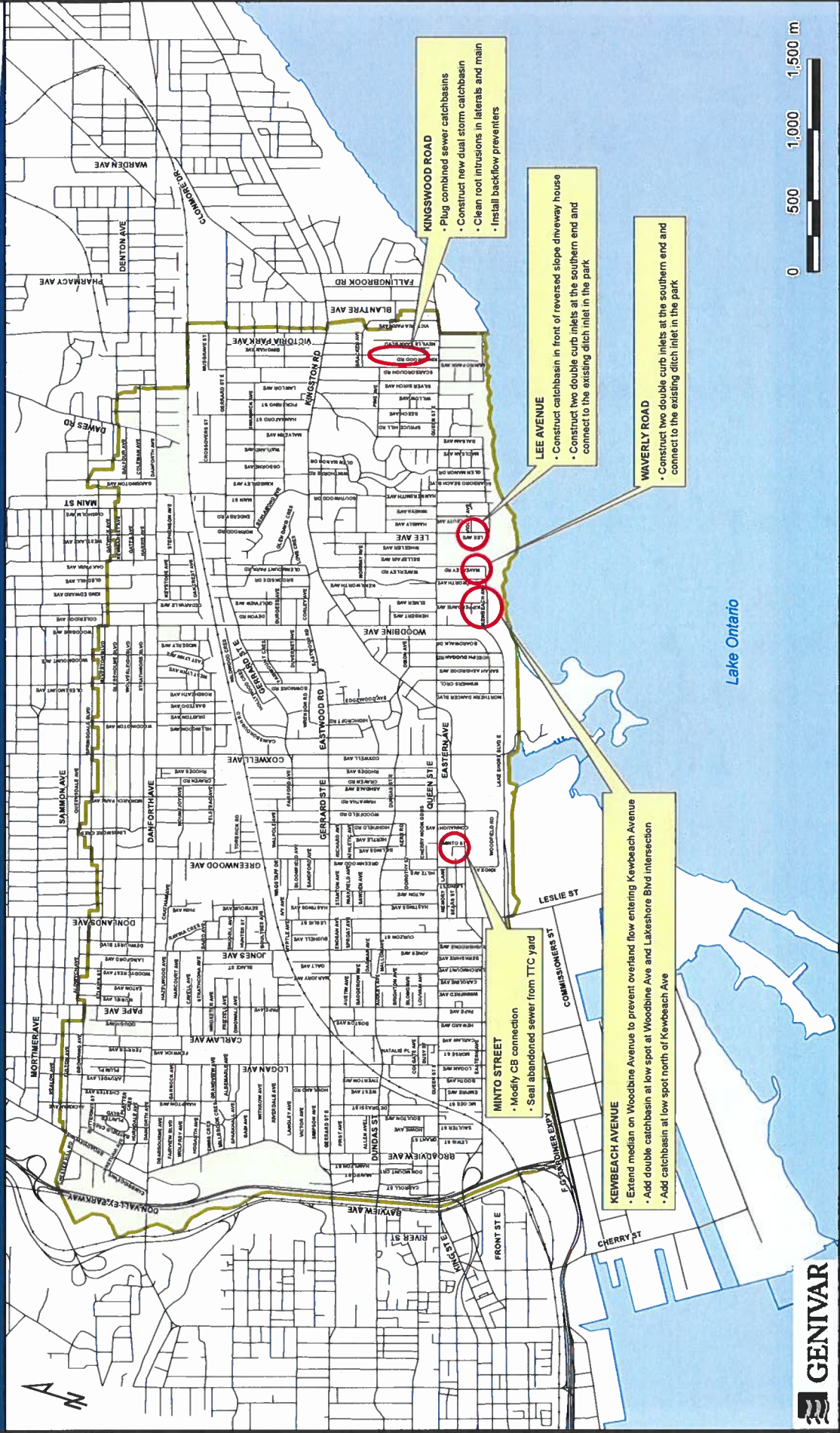
- In 2007, Toronto City Council approved a mandatory downspout disconnection program.
- The by-law will come into effect by **November 20, 2011** for homeowners who live within the City's combined sewer service area.



Benefits of disconnecting your downspout:

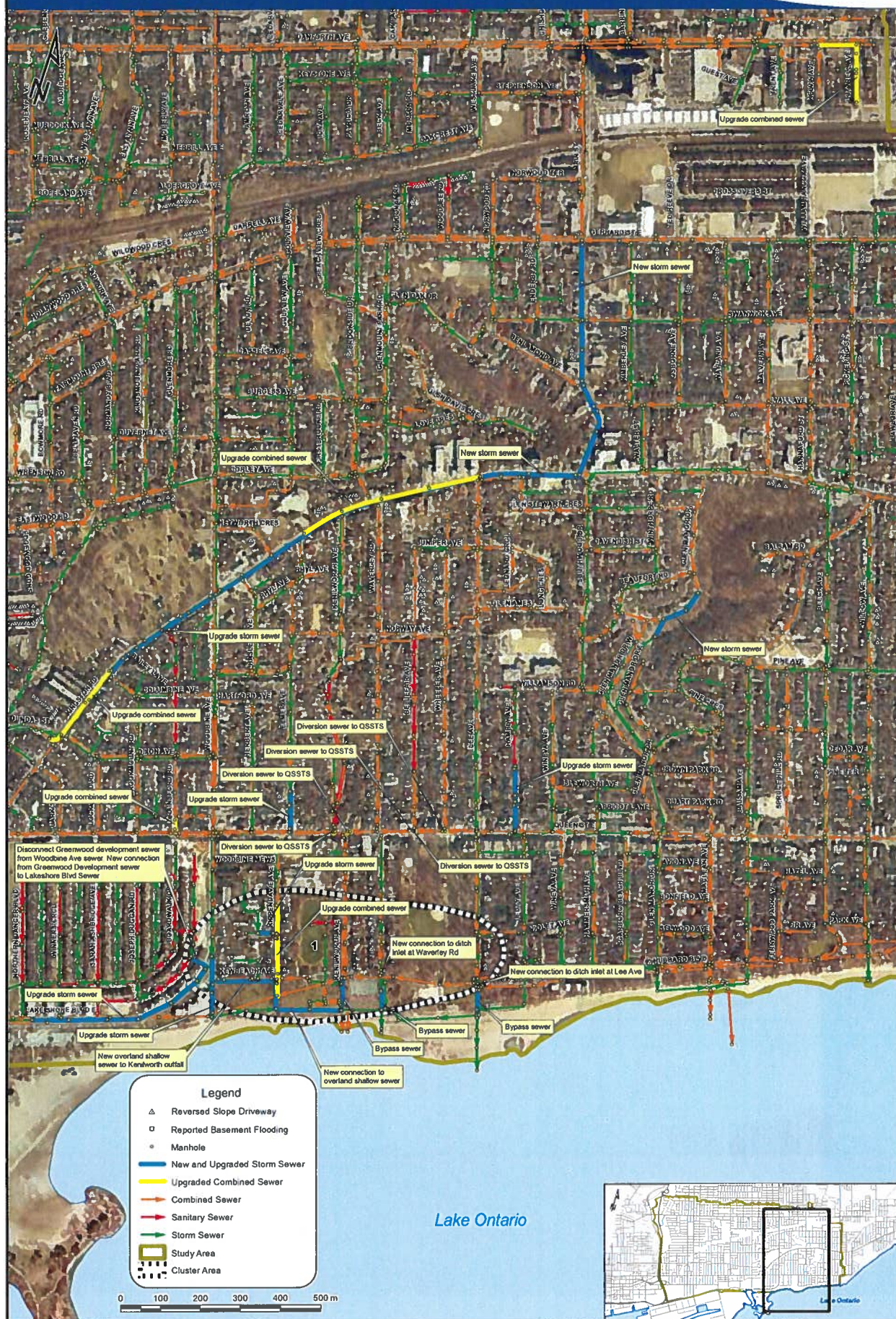
- Helps reduce the amount of stormwater that is sent through the sewers
- Less stormwater in the system will help prevent wastewater from backing up through floor drains
- Less burden on the sewer system and leads to lower energy costs of wastewater treatment facilities – producing fewer greenhouse gas emissions.
- Helps to replenish and protect the groundwater table and reduces and delays stormwater runoff—helping to prevent flash flooding in rivers and streams

Eastern Beaches Basement Flooding Interim Measures

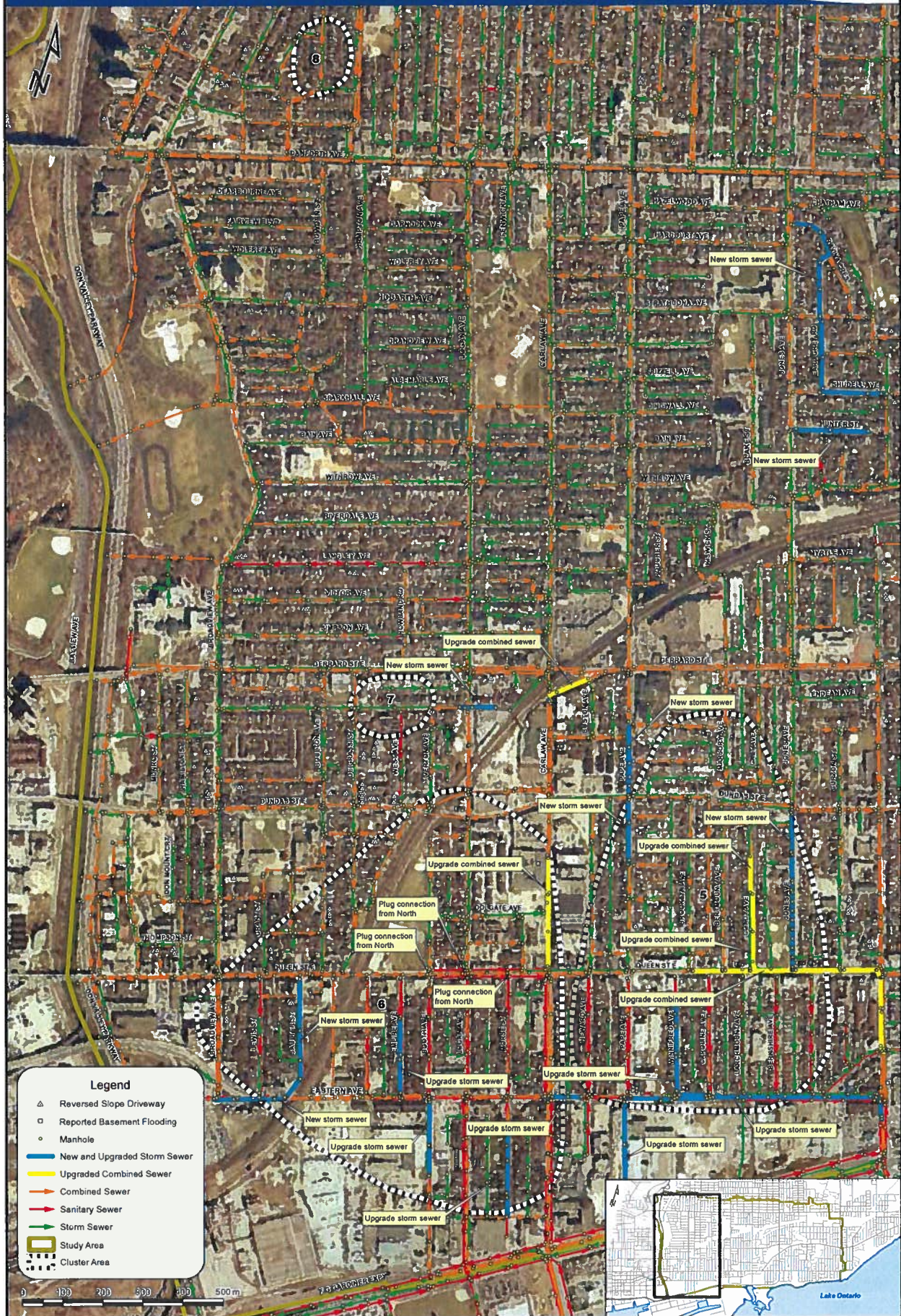


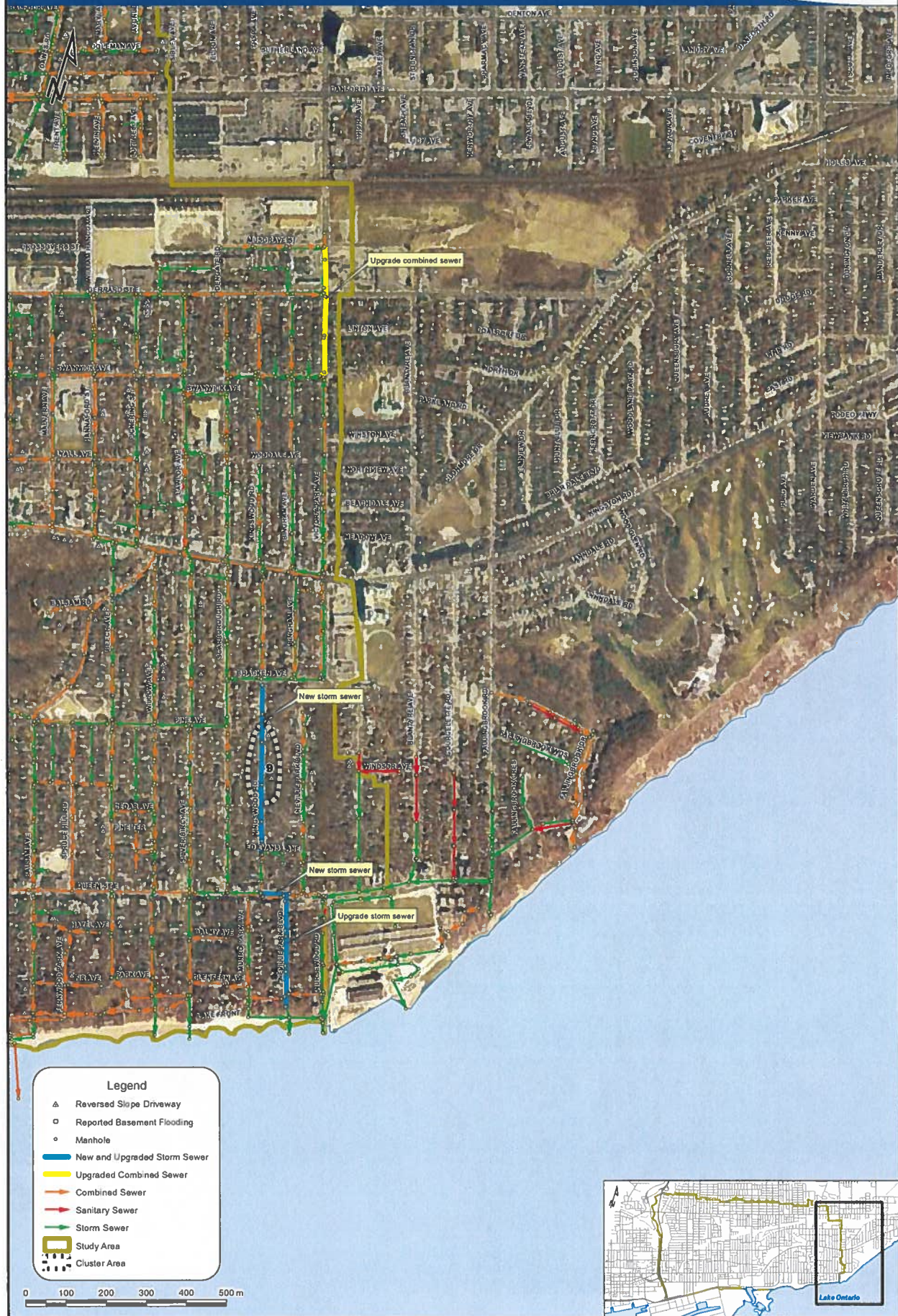
Causes of Flooding and Recommended Solutions

Area	Causes of Flooding	Recommended Solutions
Cluster #1	- Accumulation of sediment and debris at the lake outfall. - Accumulation of surface flow in low lying areas. - Overloaded combined sewer. - High water level at Ashbridges Bay T.P. Pumping station wet well causing back-up in the interceptors and local combined sewer. - Reverse slope driveways. - Back-up in the storm sewer system resulting from high water level in Kenilworth tank.	- Upgrade storm and combined sewers - Divert sewers currently draining to Lakefront Interceptor to Queen St. Sanitary Trunk Sewer - Collect overland flow in shallow pipe and discharge to the outfall. - Provide storm sewer to by-pass storm flows from existing storm sewers draining to Kenilworth Tank to the outfall. - Provide additional catchbasins at low lying areas.
Cluster #2	- Interconnections between the sanitary and storm sewers. - Accumulation of surface flow in low lying areas. - Lack of standby power at the Highfield Road Pumping Station.	- Upgrade storm sewer. - Eliminate interconnection between sanitary and storm sewers, - Provide standby power to pumping station.
Cluster #3	- Overloaded combined sewer and low level interceptor. - High water level at the Ashbridges Bay T.P. Pumping station wet well causing back-up in the interceptors and local combined sewer.	- Provide new storm sewers. - Upgrade storm sewers.
Cluster #4	- Overloaded combined sewer. - High water level at Ashbridges Bay T.P. Pumping station wet well causing back-up in the interceptors and local combined sewer. - Accumulation of surface flow in low lying areas.	- Upgrade combined sewers - Provide additional catchbasins at low lying areas.
Cluster #5	- Overloaded combined sewers - Accumulation of surface flow in low lying areas	- Upgrade combined and storm sewers. - Provide new storm sewers.
Cluster #6	- Overloaded combined sewers. - Accumulation of surface flow in low lying areas.	- Upgrade combined and storm sewers. - Provide new storm sewers.
Cluster #7	Overloaded combined sewer.	Minimize roof and surface storm flow entering the combined sewer by roof downspout disconnection and inlet control devices.
Cluster #8	Overloaded combined sewers.	Minimize roof and surface storm flow entering the combined sewer by roof downspout disconnection and inlet control devices.
Cluster #9	- Combined sewer is overloaded due to sewer receiving surface flow, i.e., no storm sewer in the street. - Flooded homes are located at elevation lower than the street.	- Provide new storm sewer. - Upgrade storm sewer.









Next Steps

- After tonight's open house, the study team will review your feedback and finalize the recommended solutions.
- Prepare project file and make available for 30-day public review in Fall 2011
- Ongoing implementation of interim measures.
- Implement recommended solutions, after completion of the EA (pending necessary approvals)

Mae Lee (Rigmea), Public Consultation Unit

55 John Street, Metro Hall, 19th Floor

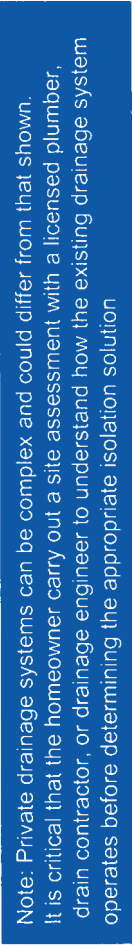
Toronto, ON M5V 3C6

Phone: 416-392-8210

Email: rigmea_lee@toronto.ca

Website: www.toronto.ca/involved/projects

ISOLATING YOUR HOME PLUMBING FROM THE CITY'S SEWER SYSTEMS



Question 2.

Question 2.

Are there any other options the project team has not considered? Please explain.

Question 3.

Do you have concerns about the potential impacts the proposed solution(s) may have on you? Please explain.

Thank you for participating in this study.

For more information about this project, please visit our website at www.toronto.ca/involved/projects. Please return this completed **Comment Sheet** to our staff at the Registration Table or place in the 'Comment Box'. You can also fax it or use the provided postage paid envelope to mail the form in by **July 15, 2011** to:

Mae Lee
Senior Public Consultation Co-ordinator
Toronto, ON M5V 3C6
email: rigmea.lee@toronto.ca

City of Toronto Public Consultation Unit
Metro Hall, 55 John Street, 19th Floor
Fax: 416-392-2974

Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

Toronto Water

COMMENT SUMMARY

Open House # 2 - June 13 & 16, 2011
(Total around 80 – 90 residents attended)

The Comments that were received from the public at Open House #2 focused on property-specific flooding issues throughout the study area. Those in attendance were generally supportive of the recommended solutions and urged the City to move forward quickly with implementation. The issues raised by the public and responses from the project team are documented in the table below.

Comments/Questions	Response
<u>Bain Avenue west of Logan Ave</u> Property Management noted surface flooding in a housing complex during heavy rain. Please include mitigation measures because none are proposed for this street. A resident from Millbrook Crescent commented: There was nothing to indicate the basic research conducted that would suggest any engineered solutions. That basic research would address 1) from where the water comes 2) to where it goes 3) how does it get there For instance, flooding at the Bain Coop could be addressed in an appropriate fashion with the knowledge of the buildings having been constructed above an old stream bed and mitigating actions based upon that.	Bain Avenue is situated at low lying area. It is a former stream and it receives flows from upstream. The street can be subject to frequent street ponding, but buildings are much higher than street level.
<u>Kenilworth Ave north of Queen St E</u> Resident raised issue that during rain events the catchbasins (CB) on this street get plugged, then street flooding starts from these CB locations. District Operations came out to clean the CBs after making phone calls, but the CBs got plugged again quickly. The resident said that some of the CBs were at the wrong locations. Moving those CBs, or adding new ones, would help.	Explained that this was an ongoing maintenance problem and the road grading may create part of the problem too. City and consultants visited the street to investigate the CB and street grading, and proposed additional catchment basins.
<u>Kew Beach Ave</u> Residents raised concerns why the interim measures were not yet installed. The storm sewer from Greenwood Racetrack development should immediately be disconnected and discharged elsewhere.	Explained that the study is required to complete the Class EA process before construction can commence. As well, implementation depends on City available funding through the capital budget.
<u>Wineva Ave north of Al Fresco Lawn</u> A resident asked whether we have any records of the laterals from his house	City staff investigated and responded to the resident that sewer data shows there is a

**Municipal Class Environmental Assessment
Investigation of Chronic Basement Flooding
Study Area 32 - Eastern Beaches**

because there are two laterals from his house. The resident installed backflow preventer on one lateral but his plumber was not able to install on the other because it was very deep (>3 ft below his basement).	storm sewer and a combined sewer in front of the resident's house. The combined sewer is fairly deep, which explains why the resident has a deep private lateral. The City does not have full records of private laterals because it depends on whether the building contractor submitted them when the house was built. The resident's house is also very old house and records are incomplete.
Kewbeach Ave - Resident is very concerned that on the July 2009 storm, surface flooding was severe and runoff went into his basement through windows. However, the resident has not encountered the same problem since that July 2009 event. Would like to know how soon the recommended measures would be implemented.	It was explained to the resident that implementation of interim measures have started and are still on-going.
Carlaw Ave/Eastern Ave Area – Resident experienced basement flooding during rain events usually about a couple of inches. Water was relatively clean, did not smell anything like sewage. Owner thought it could be due to seepage from high groundwater table.	Explained to the resident that water could also get in through basement walls and windows if rain water ponds around the house due to poor grading. With the proposed remedial measures, water ponding will be reduced and occurrences with basement flooding conditions will also be less.
One resident inquired about the mandatory downspout disconnection because he could not find an appropriate location to drain the runoff if he were to disconnect the downspout of his house.	The resident was informed to make a request to staff of the Downspout Program to investigate his property and advise whether his home can be exempted from conducting the downspout disconnection.
Why are there recommendations to upgrade the combined sewers instead of separating them? The intention of sewer separation is to reduce sewage flows sent to the treatment plant for treatment. It will also prevent sanitary sewage from backing up to the basements.	Sewer separation has not been recommended except at select streets where feasible, because there is no downstream storm sewer close by to receive the stormwater flows and it is not cost-effective.
Why can't the City's combined sewer system be completely separated, i.e., why are some of the separated storm sewers connecting back to the combined sewer system at the downstream combined sewer network.	It was explained to the residents that, in principle, this is not a good practice and will no longer be considered. Cost-effectiveness could be the reason used to select the alternative over another. In this case, sewer separation could be required to alleviate local basement flooding problems and when the downstream

**Municipal Class Environmental Assessment
Investigation of Chronic Basement Flooding
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	combined sewer collectors has the capacity, the storm sewer was connecting back to the combined system. However, from a technical perspective, the City cannot completely separate stormwater flow from sanitary flow. The City can, at a significant cost and community disruption, build new storm sewers parallel to existing combined sewers, however this would not completely eliminate stormwater from entering the combined sewer system because of direct connections from private properties (e.g. foundation drains). Even with mandatory downspout disconnection, it is not possible to remove all storm inflow from private drainage systems. This is because: ▪ Existing development will not always allow a safe discharge location for the downpipe. ▪ Existing roof drainage may be internal to the building plumbing system - e.g. flat roof commercial, industrial buildings. ▪ Foundation drains and sump pumps may be connected to combined drains and may receive significant storm inflow due to poor drainage conditions at existing old buildings.
There are also questions as whether there are shared maintenance holes for the combined and storm sewer systems.	This is an old practice which is not done any more.
An individual raised concerns that the poster showing the downspout disconnection is incorrectly displayed because the cut off length of the downspout is too short, i.e., discharging runoff too close to the house.	Comment noted.
Resident on Kingswood Rd • reported a sinkhole on the road in front of a property and other two small sinkholes near Ed Evens Lane • inquired about the implementation schedule for the proposed work on Kingswood • asked the City to make a correction for the information presented in the display for Cluster 9, which stated that "flooded homes are located at	Explained that the study is required to complete the Class EA process before construction can commence. As well, implementation depends on City available funding through the capital budget.

**Municipal Class Environmental Assessment
Investigation of Chronic Basement Flooding
Study Area 32 - Eastern Beaches**

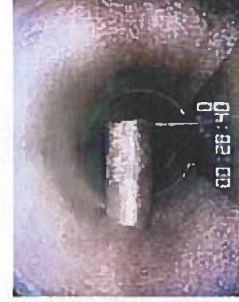
elevations lower than the street" - this is not true because flooding also experienced for the homes situated higher than the street level, such as her home and her next door neighbours.	Comment noted.
Resident on Hogarth Ave requested to mail her the information on sump pump operation presented in the Power Point Presentation	Presentation (hard copy) was mailed to the resident.
Resident on Queen St. East, reported the reoccurrence of the sinkhole in the backyard. The sinkhole was filled 6 or 7 years ago and now the sinkhole comes back again. The resident reported the problem to the City previously and was told that the City is not responsible for occurrences on private property. The resident worries about that the sinkhole was caused by some kind of failure in the City's infrastructure. He would like the City to provide the following information. • Sewer conditions • Groundwater level • Was the land filled? History of the land development • Historical aerial photographs • Any underground stream?	City will investigate sewer conditions. The public is welcome to contact City Archives for historical photographs, contact is: http://www.toronto.ca/archives/ The rest of the information requests require a separate study by itself which City Council funding approval and direction is needed.
There has been basement flooding in houses on the north side of Queen St, east of Kingston Rd that should be corrected by the proposed sewer changes.	Comment noted and provided to the consulting team for consideration.

Understanding Drainage

and the

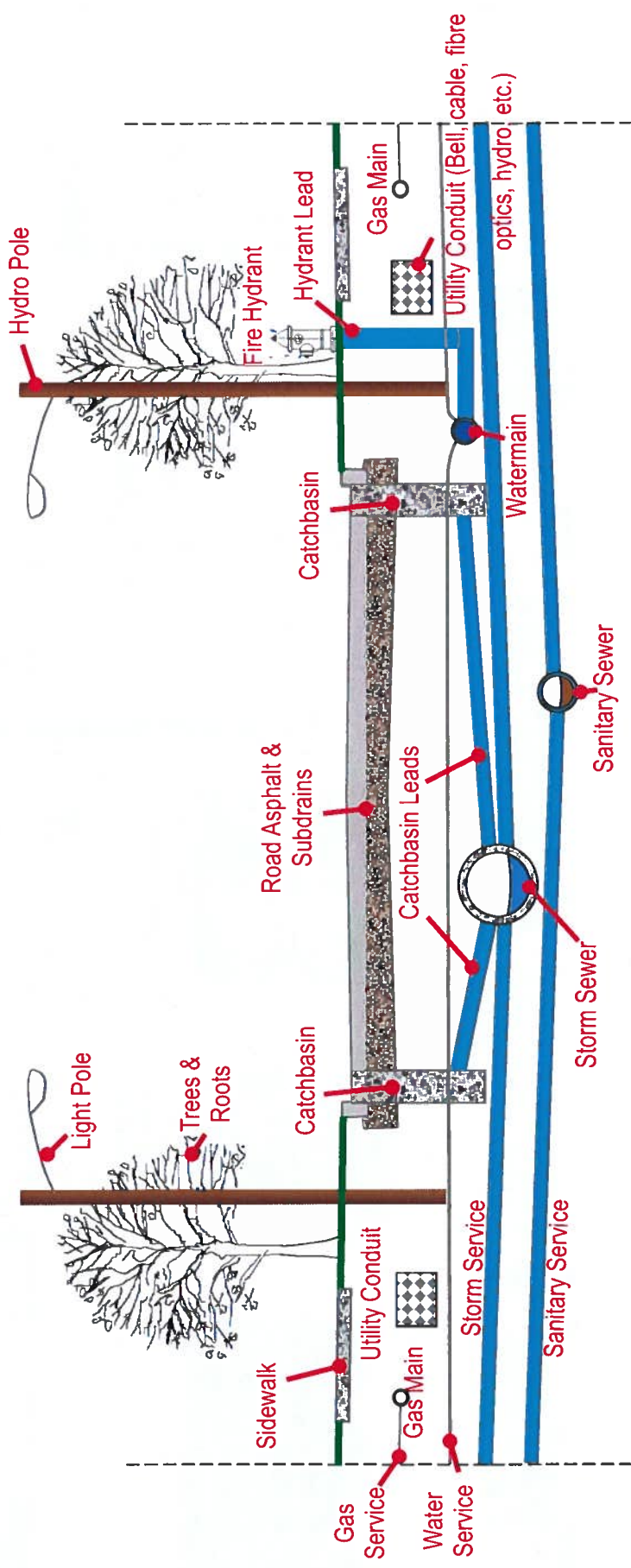
Proposed Remediation Measures

Examples, Explanations & Impacts



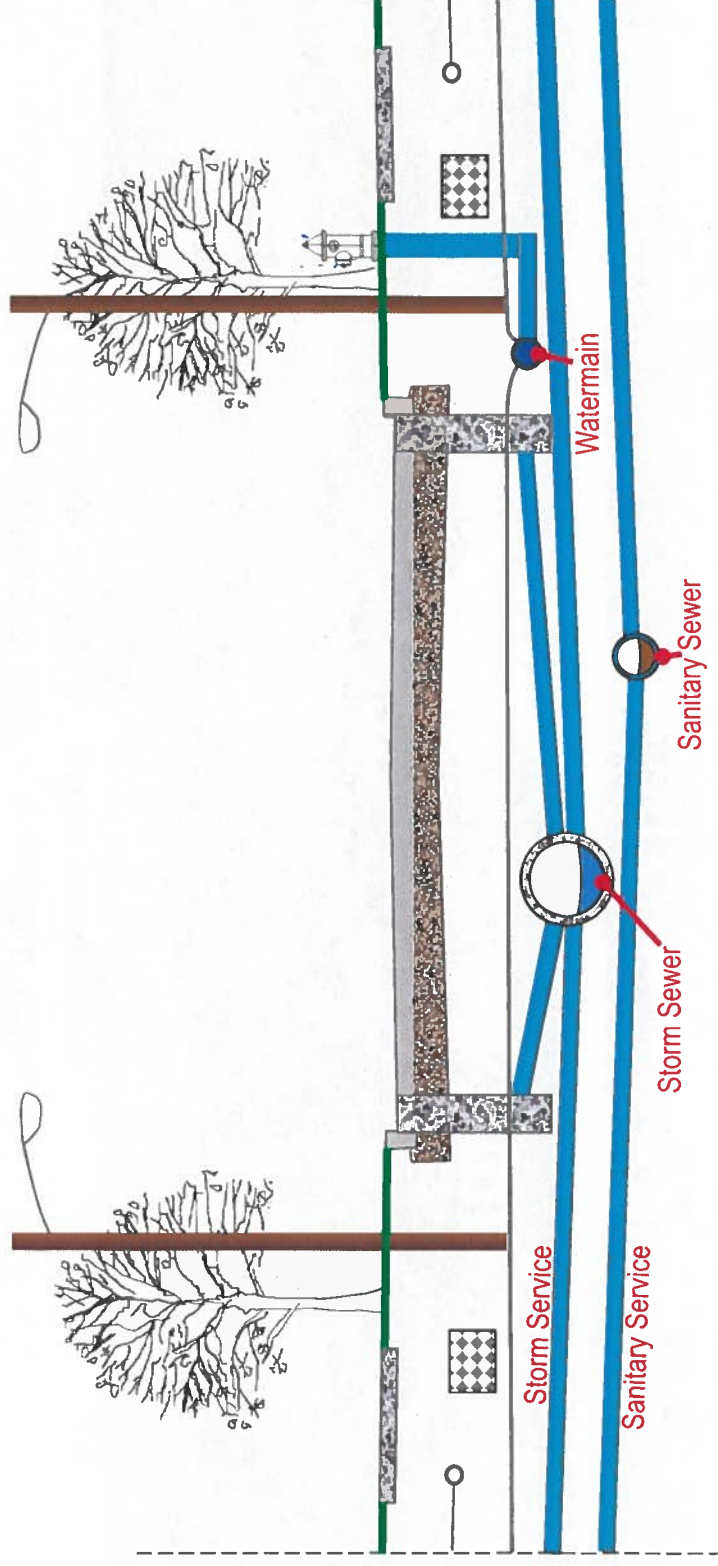
Poor Lot Grading

Typical Road Construction - What's Underground?



Typical Road Construction - What's Underground?

Therefore, there are several things to look at before a sewer remediation measure can be implemented.



Conflicts with Other Infrastructure

pipe bigger creates a conflict with some existing sanitary service lines. Another solution is required, such as a deeper sewer or shallower High-Level sewer not connected to the house.

The diagram illustrates a cross-section of the ground with a house at the top. A 'Proposed Larger Storm Sewer' is shown as a large pipe. An 'Old Storm Sewer Location' is indicated by a dashed line. A 'Conflict with Sanitary Service' is highlighted in a yellow box, showing the proposed sewer intersecting with an existing 'Sanitary Sewer' line. A 'Watermain' is also shown. The diagram includes labels for 'Storm Service', 'Sanitary Service', and 'Sanitary Sewer'.

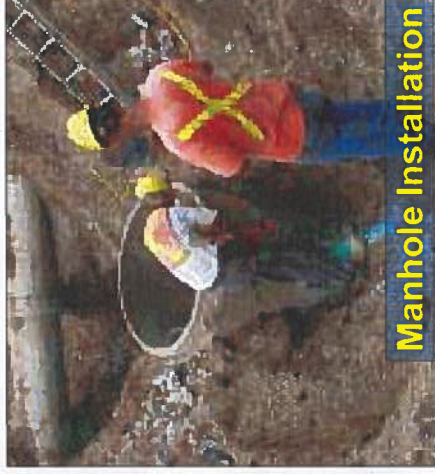
Increase Sewer Pipe Size

Increase the size (diameter and/or shape) of the sewer pipe by replacing the old sewer with a larger one.



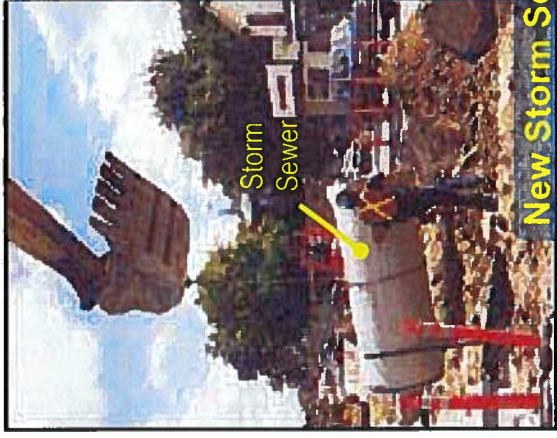
What Does it Involve?

- Road excavation within City limits
- Removal of old sewer and structures (i.e. maintenance holes, catchbasins)
- Disconnection of sewer service line
- Placement of new sewer and structures
- Reconnection of sewer service line to new sewer
- Restoration of road and boulevard

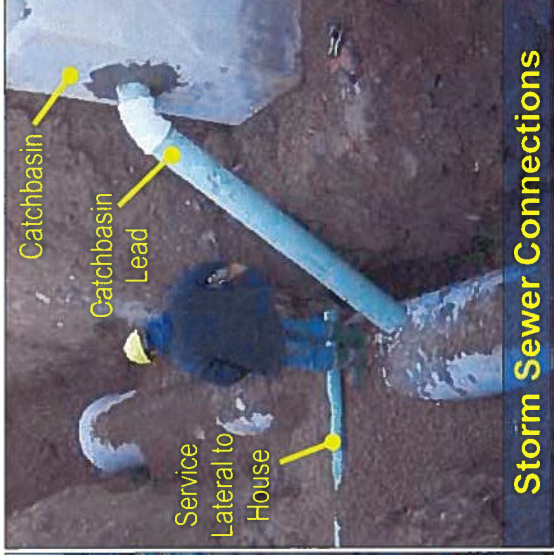


Increase Sewer Pipe Size

Increase the size (diameter and/or shape) of the sewer pipe by replacing the old sewer with a larger one.



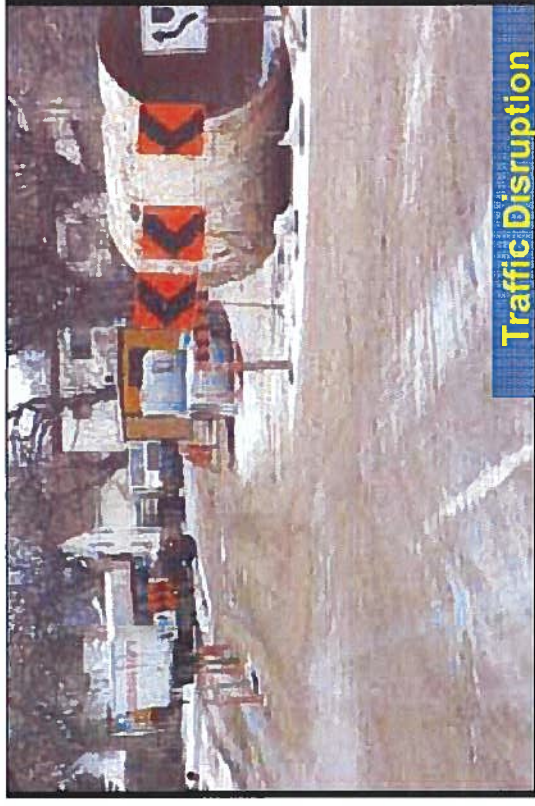
New Storm Sewer Placement



Storm Sewer Connections



Street Repaving



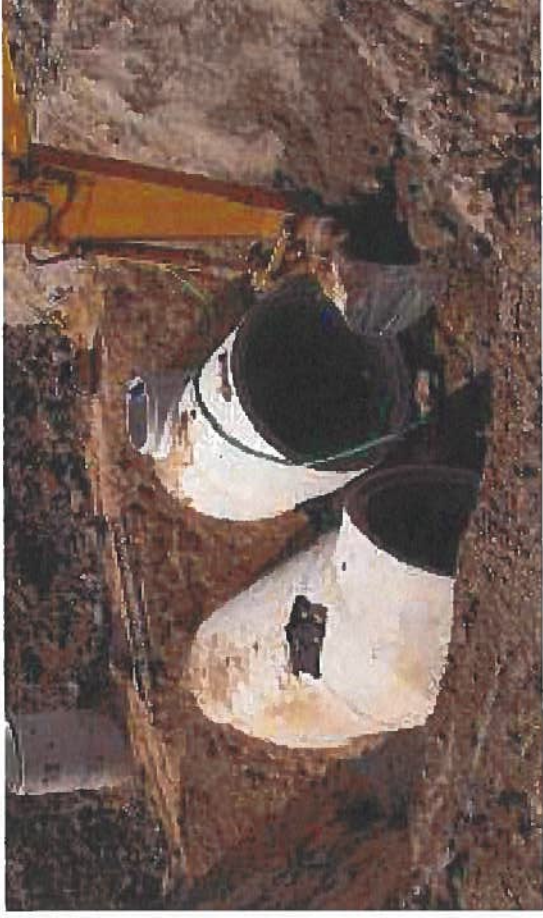
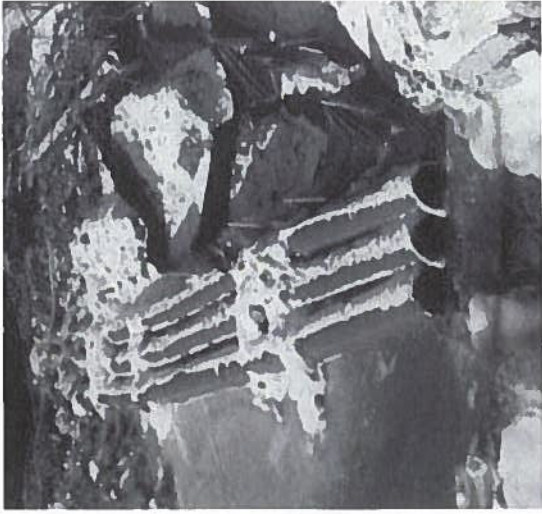
Traffic Disruption

Possible Impacts to Residents

- Traffic disruption
- Temporary home access restrictions
- Possible temporary sewer and water service interruptions
- Dusty and/or muddy street conditions
- Loud machinery and heavy equipment (vibration and noise)

Relief Sewer (Pipe Twinning)

Increase the capacity of the sewer system by adding another pipe in the road.



What Does it Involve?

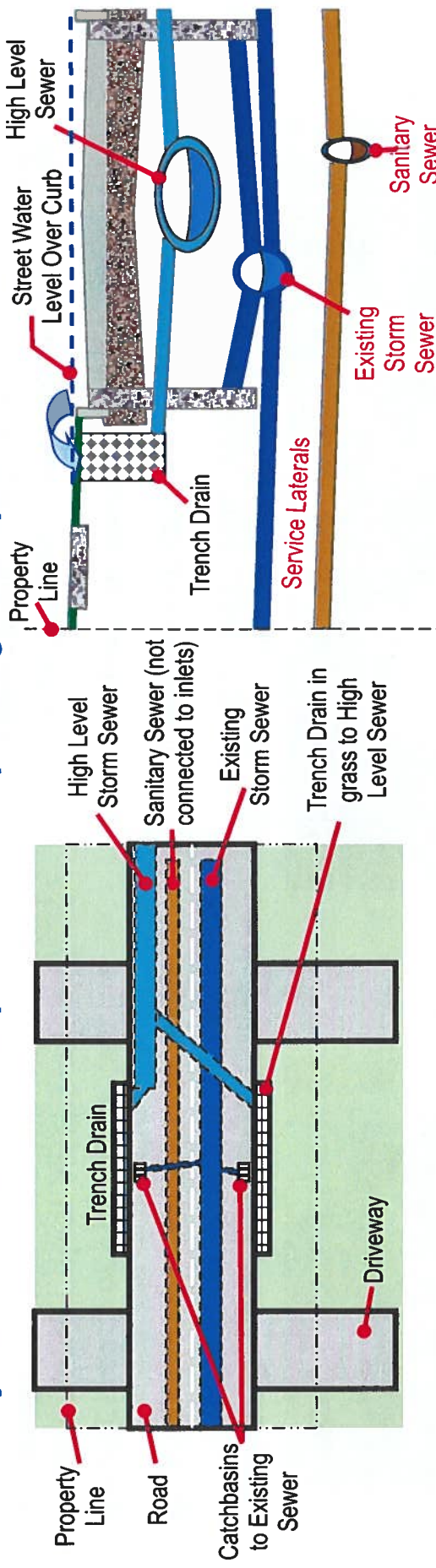
- Road excavation within City limits
- Replacement of old structures (i.e. maintenance holes, catchbasins) if necessary
- Placement of new sewer and structures
- Reconnection of sewer service line to new sewer if necessary
- Restoration of road and boulevard

Possible Impacts to Residents

- Traffic disruption
- Temporary home access restrictions
- Possible temporary sewer and water service interruptions
- Dusty and/or muddy street conditions
- Loud machinery and heavy equipment (vibration and noise)

High Level Relief Storm Sewer

A shallow storm sewer solely connected to separate trench-drain catchbasins behind the curb line that capture excess surface water that cannot enter the existing storm sewer. Primarily used to relieve the depth of surface ponding at low points in the road.



What Does it Involve?

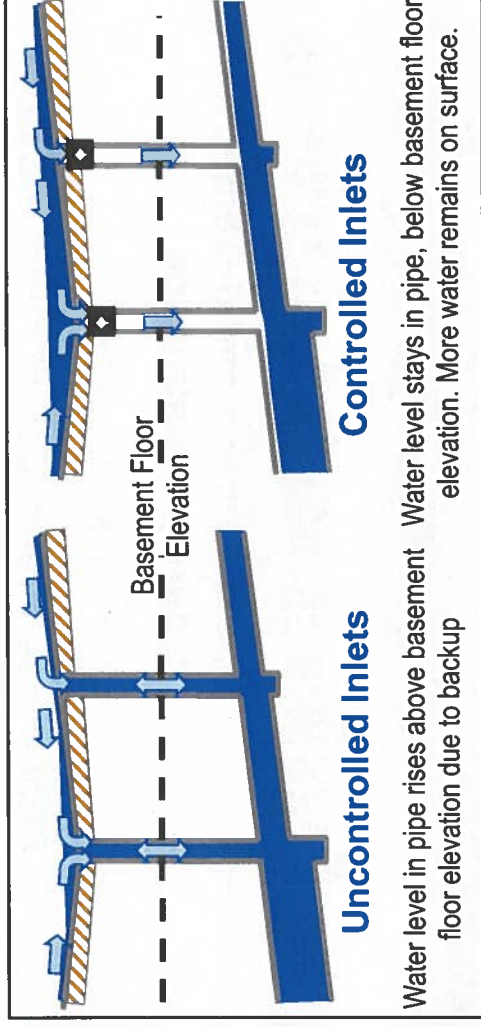
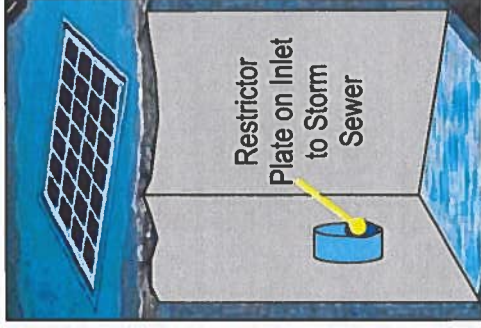
- Road excavation within City limits
- Replacement of old structures (i.e. maintenance holes, catchbasin leads) if necessary
- Placement of new sewer and structures
- Restoration of road and boulevard

Possible Impacts to Residents

- Traffic disruption
- Temporary home access restrictions
- Possible temporary sewer and water service interruptions
- Dusty and/or muddy street conditions
- Loud machinery and heavy equipment (vibration and noise)

Catchbasin Inlet Control

Placement of an 'inlet restriction' within the catchbasin outlet pipe to limit the amount of water that can enter the storm sewer to that which the pipe can handle without backing up.



What Does it Involve?

- Minimal effort and time to install
- A plastic or metal plate or device is placed on the catchbasin outlet, located below the grate (cannot be seen from surface)
- Prevents excess water from overloading the storm sewer
- Immediate results



Possible Impacts to Residents

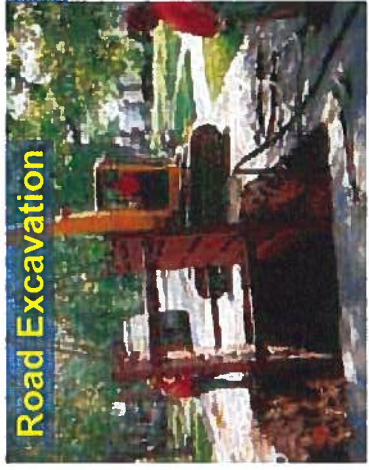
- Additional water ponding on the surface during and after rain, but will be limited to a maximum 1 foot (30cm) depth

Challenges

- Maintaining safe water depths on the surface during extreme events where there is no overland flow path

Increase Number of Catchbasins

Where there is pipe capacity, add more catchbasins to capture more flow into the storm sewer, without impacting the downstream system.



Road Excavation



Catchbasin



Increased Number of Catchbasins

What Does it Involve?

- Minor street excavation
- Installation of additional catchbasin structure, normally at the street curb
- Connection of new catchbasin to storm sewer
- Curb replacement and street restoration

Possible Impacts to Residents

- Minor traffic disruption and dust/mud conditions during construction
- Will see more grates in road
- Should see a reduction of surface water accumulation

Challenges

Avoid existing infrastructure, prevent storm sewer surcharge, and keep grates clear of debris

Sealing Maintenance Hole Covers

Providing a water-tight seal where surface water is prone to entering the sanitary maintenance hole covers, primarily at road low points where water ponds during rain. This reduces the amount rain/storm water that inadvertently enters the sanitary sewer.

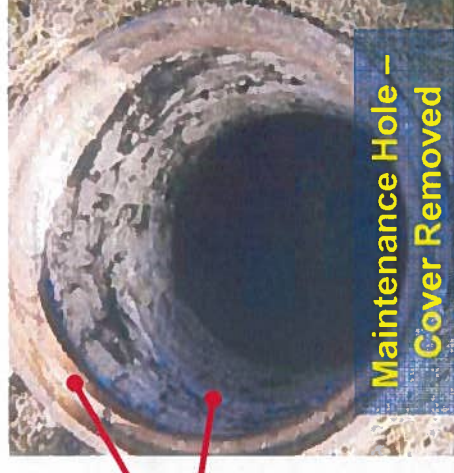


Typical Maintenance Hole, as seen on Street

Place water-tight 'bowl' under lid



'Pick Holes', plugged with rubber insert



Maintenance Hole - Cover Removed

Seal under rim and/or on inside wall

What Does it Involve?

- Possible minor street excavation around maintenance hole (if necessary)
- Installation of rubber plugs in maintenance hole lid, or complete replacement of lid
- Seal (rubber or other material) around and within the structure or place water-tight bowl under lid with gas vent

Possible Impacts to Residents

- Minor traffic interruption during work
- Possible installation of vent pipes in boulevard
- Odour at vents, but can be mitigated

Challenges

- Maintaining sufficient ventilation in sanitary sewer to prevent gas build-up

Surface Flow Path Diversion

The diversion of surface drainage away from low areas that have no outlet, or addition of relief outlets at low points.

What Does it Involve?

- Addition of earthen berms or speed bumps to redirect water away from ponding areas
- Addition of a 'curb-cut', which allows water to spill before overtopping curb
- Interception of road flows with a large inlet grate to oversized sewer

How Does it Work?

- Water is physically diverted away from problem areas through strategic placement of berms, curb-cuts, inlets or ditches

Possible Impacts to Residents

- Physical berms in street boulevard or modified curbs
- Redirection of water to new areas
- Finding suitable space on City lands to safely divert the water to without transferring problem elsewhere
- Achieving required land slope
- Obtaining permissions or legal easements for new overland flow paths
- Protecting existing property from damage

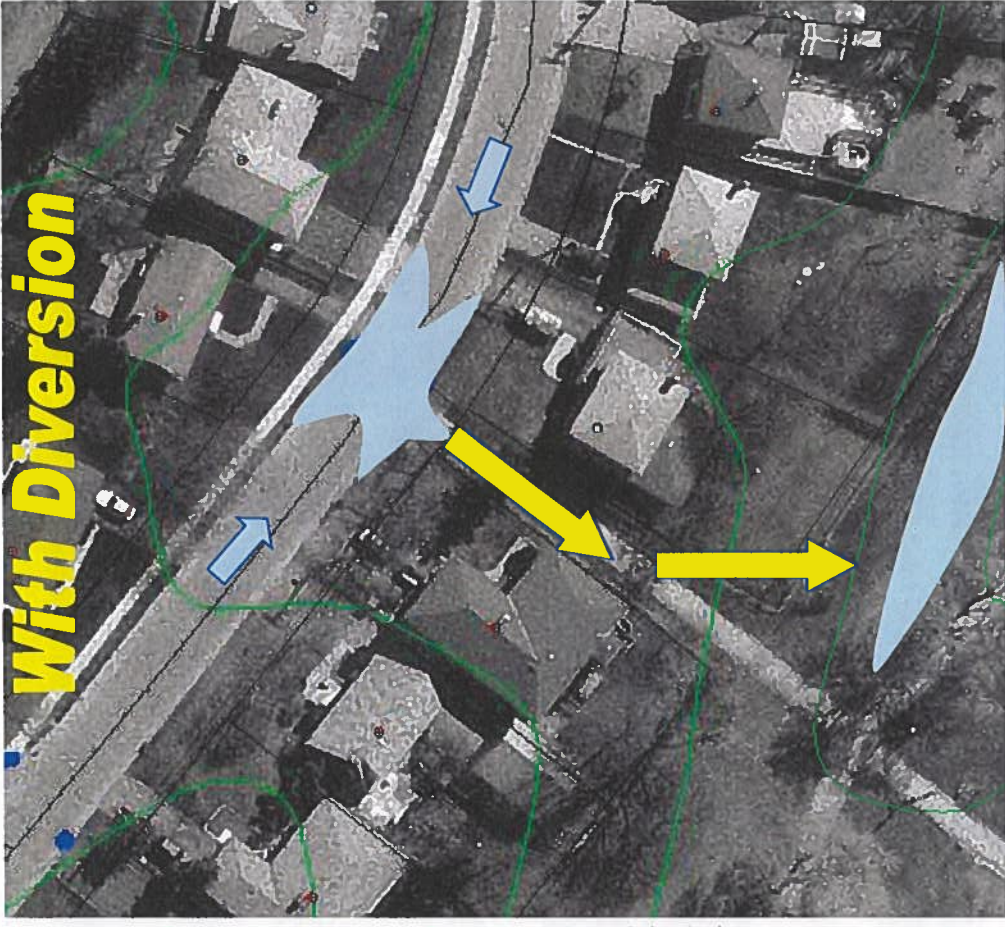


Challenges

- Finding suitable space on City lands to safely divert the water to without transferring problem elsewhere
- Achieving required land slope
- Obtaining permissions or legal easements for new overland flow paths
- Protecting existing property from damage

Surface Flow Path Diversion

The diversion of surface drainage away from low areas that have no shallow outlet, or addition of relief outlets at low points.



Low Point with No Immediate Outlet – water ponding occurs on surface, contributing to overloading of sewer

Low Point with Diversion Channel Created at Pathway to Park – minor excavation work dramatically reduces ponding

Stormwater Management Facility - Underground Storage

An underground storage facility that controls the quantity of inflowing stormwater through detention and slow-release to the receiving sewer, reducing the rate of flow downstream.

What Does it Involve?

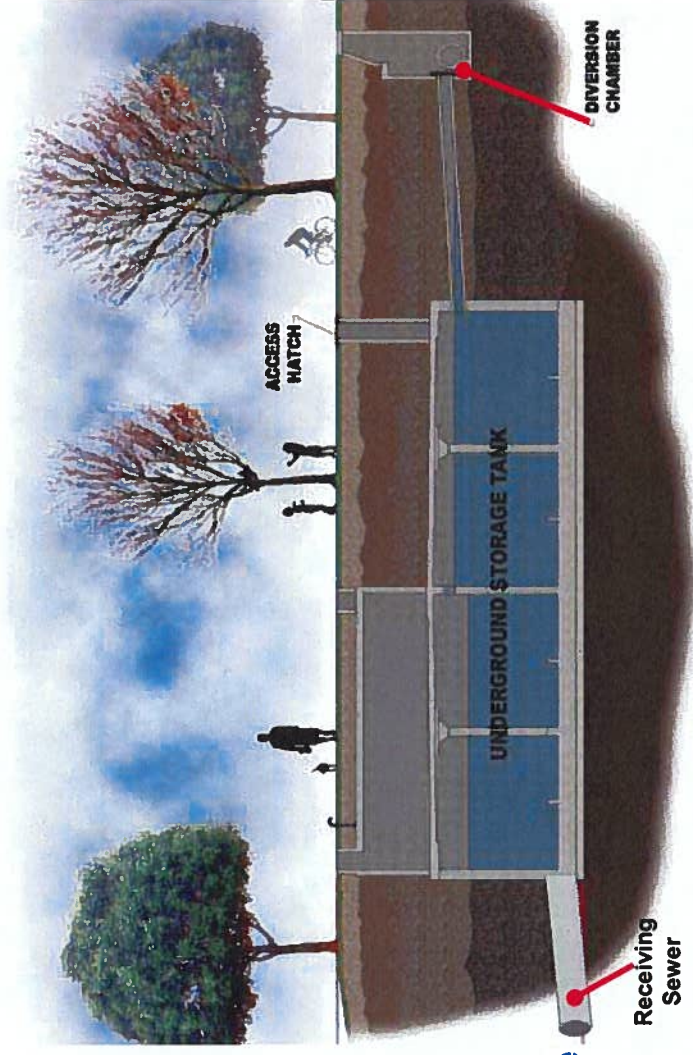
- Excavation and placement of storage elements, including inlet and outlet structures

How Does it Work?

- Storm sewer is directed to tank
- Water is released by an outlet structure that controls the discharge to a reduced rate, causing water to be temporarily stored
- Water slowly drains out to the storm sewer and continues after the storm when there's more space in the sewer

Challenges

- Finding available space on City lands (roads or parks)



Possible Impacts to Residents

- Temporary loss of open space and/or traffic disruptions (depending on location)
- Heavy machinery, dust and mud during construction

Stormwater Management Facility - Dry Pond

An engineered pond that controls the quantity and quality of inflowing stormwater through storage and slow-release to the receiving system (pipe or watercourse). Dry Ponds only fill with water during storm events (but not necessarily all storms).

What Does it Involve?

- Excavation and shaping the ground
- Addition of inlet and outlet structures
- Landscaping
- Can be combined with City parks, and be used for dual purposes (e.g. sports field)

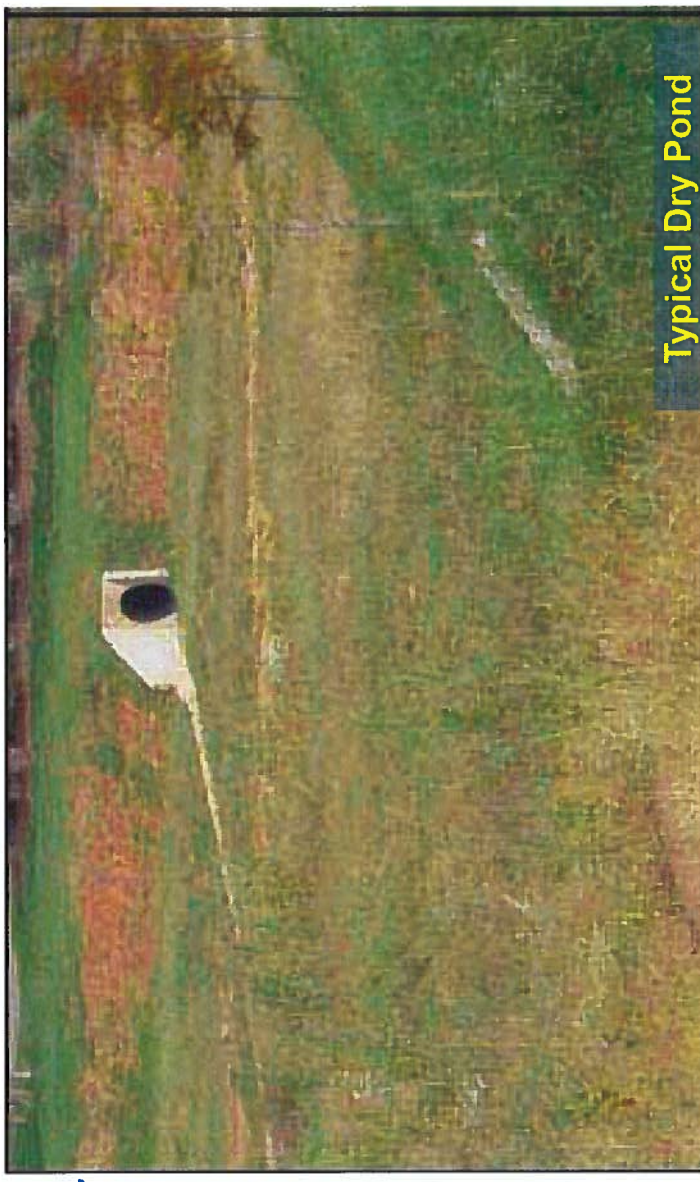
How Does it Work?

- Storm sewer is directed to pond
- Water inflows from pipes and/or overland
- Water is released by an outlet structure that controls the discharge, causing water to be temporarily stored
- After the storm (normally within 12-24 hours) the pond returns to dry conditions



Stormwater Management Facility - Dry Pond

An engineered pond that controls the quantity and quality of inflowing stormwater through storage and slow-release to the receiving system (pipe or watercourse). Dry Ponds only fill with water during storm events (but not necessarily all storms).



Possible Impacts to Residents

- Temporary loss of open space during construction & storm events
- Longer periods of wet ground in pond area
- Heavy machinery, dust and mud during construction

Challenges

- Finding required space to put a facility
- Ability to connect inflow and outflow pipes
- Groundwater level depth
- Maintaining safe water levels during rain
- Maintenance requirements

Stormwater Management Facility - Wet Pond

An engineered pond that controls the quantity and quality of inflowing stormwater through storage and slow-release to the receiving system (pipe or watercourse). Wet Ponds maintain a permanent water surface. Parts of a Wet Pond

What Does it Involve?

- Excavation and shaping the ground
- Addition of inlet and outlet structures
- Landscaping

How Does it Work?

- Storm sewer is redirected to pond
- Water inflows and enters the sediment forebay which promotes settling of sand and grit that contains pollution
- Water is released by an outlet structure that controls the discharge to a reduced rate, causing water to be temporarily stored, providing additional settling opportunity
- After the storm (normally 1 to 2 days later) the water level returns to normal



Stormwater Management Facility - Wet Pond

An engineered pond that controls the quantity and quality of inflowing stormwater through storage and slow-release to the receiving system (pipe or watercourse). Wet Ponds maintain a permanent water surface.



Inlet Structure



Small Wet Pond



Large Wet Pond

Possible Impacts to Residents

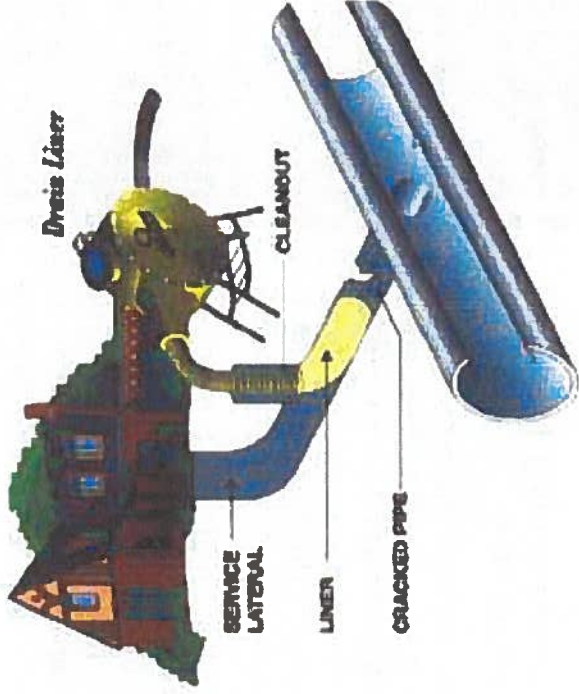
- Loss of open space, but addition of aesthetic water feature
- Plantings will take time to establish
- Heavy machinery, dust and mud during construction
- Safety (open water)
- Increased wildlife and insect population

Challenges

- Finding space to put a facility
- Ability to connect inflow and outflow pipes
- Groundwater table location
- Maintaining safe water levels during storms
- Maintenance requirement

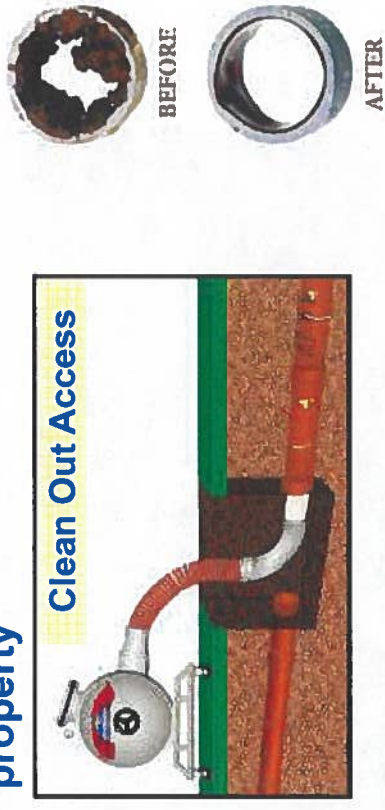
Service Lateral Lining

The service lateral is the private storm and/or sanitary sewer line connecting your house to the City's system. Often, these pipes deteriorate over time and can leak from one pipe to the other, or can allow groundwater in the pipe. Lining this pipe is a less obtrusive method to seal the pipe.



Possible Impacts to Residents

- Temporary service line disruption
- Possible temporary encroachment of construction equipment onto private property



What Does it Involve?

- Plastic liner is forced through the pipe
- No excavation if there's clean out access
- Entire service pipe, including homeowner's portion is lined

Challenges

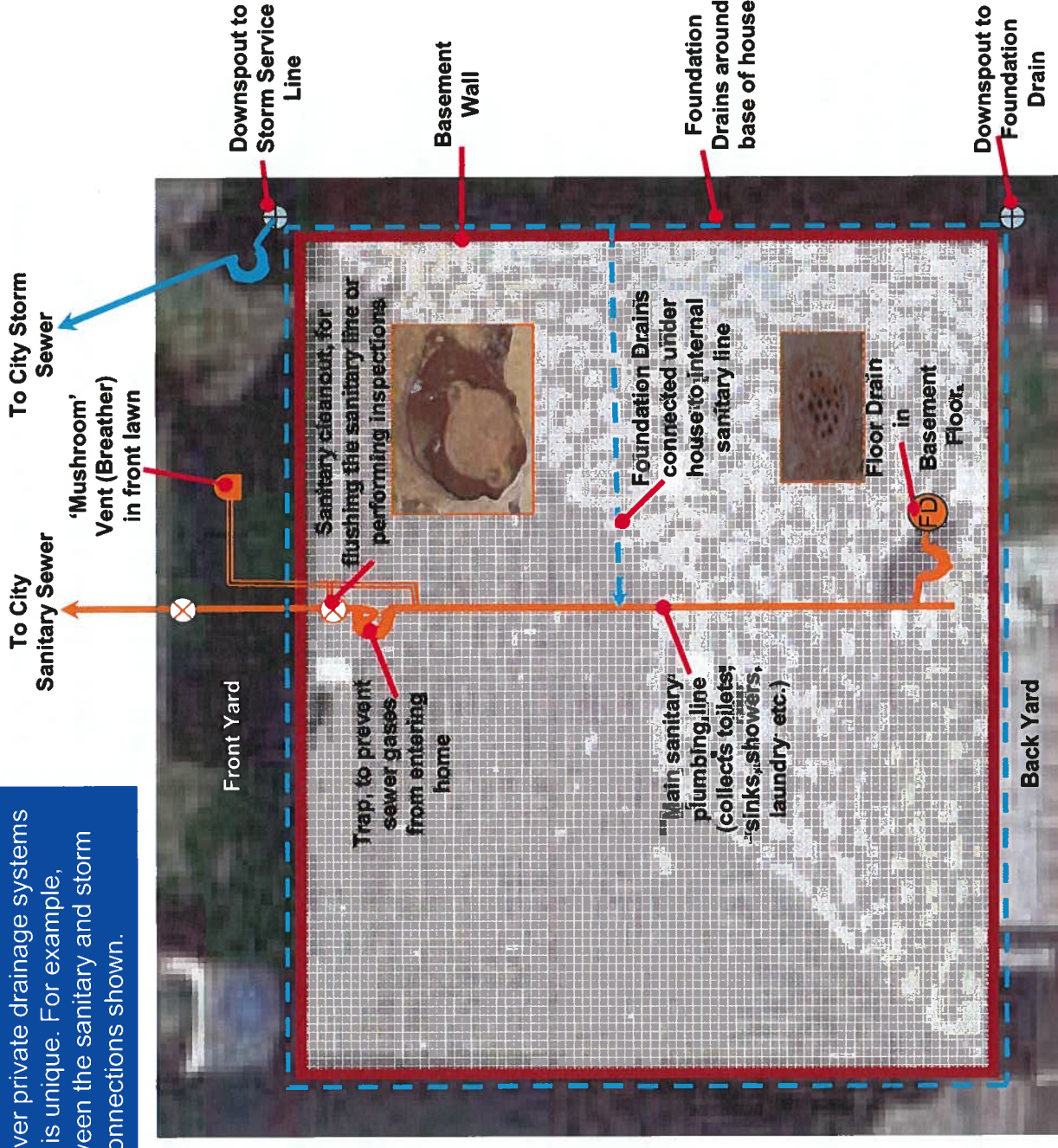
- Working on private property
- Accessing lateral if no clean out
- Does not solve blockage problems

Example Residential Drainage Plan

Example connections shown, however private drainage systems can be very complex and each one is unique. For example, there could be interconnection between the sanitary and storm systems or other combinations of connections shown.

How Does it Work?

- Internal plumbing drains to the sanitary sewer
- Downspouts drain roof water from the eavestroughs, and drain underground to two different locations: the storm sewer at the front, and the foundation drains at the back
- The foundation drains collect groundwater from around the house, in addition to the downspout. They drain internally under the basement floor to the main sanitary line
- A 'breather' vents sewer gases
- Cleanouts provide access for maintenance and inspection
- A trap holds water acting to seal sewer gases from entering
- The floor drain collects any water spilled in the basement and drains to the sanitary line



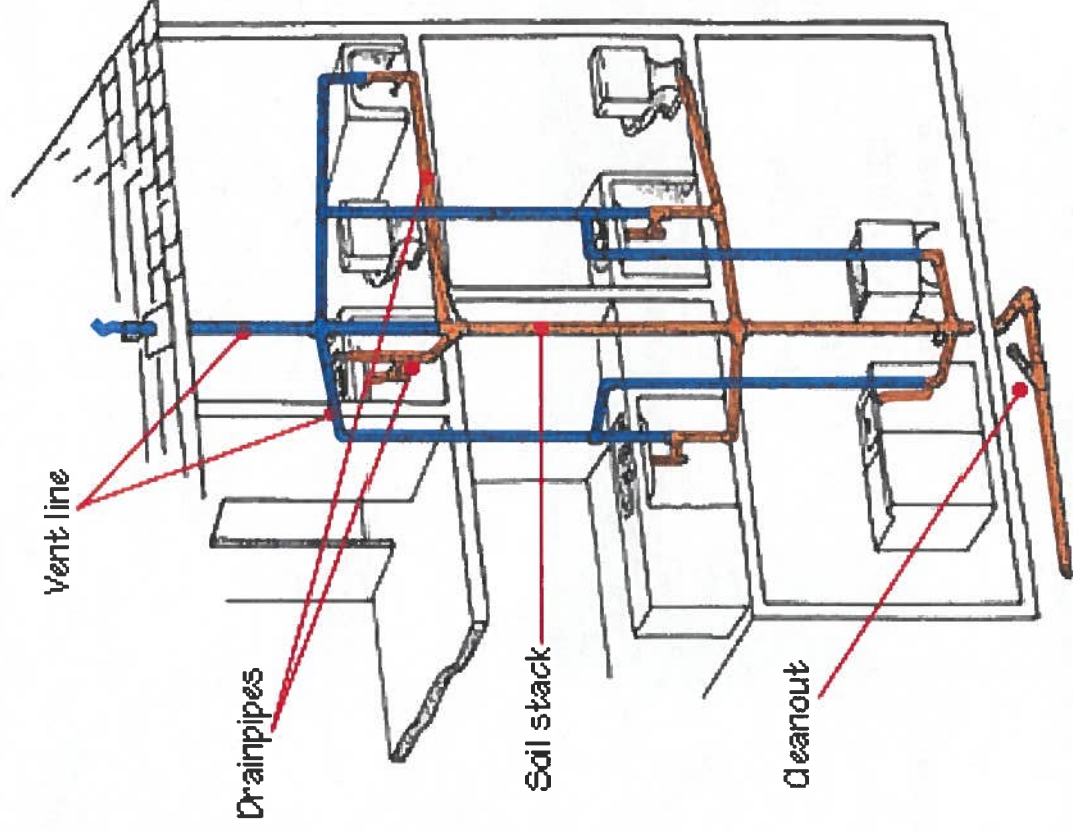
Example Drain Plan for a Home - House Plumbing

What Does it Involve?

- A series of pipes in the house that drain wastewater from fixtures such as sinks, toilets, bathtubs, laundry machines, dishwashers, the floor drain etc.

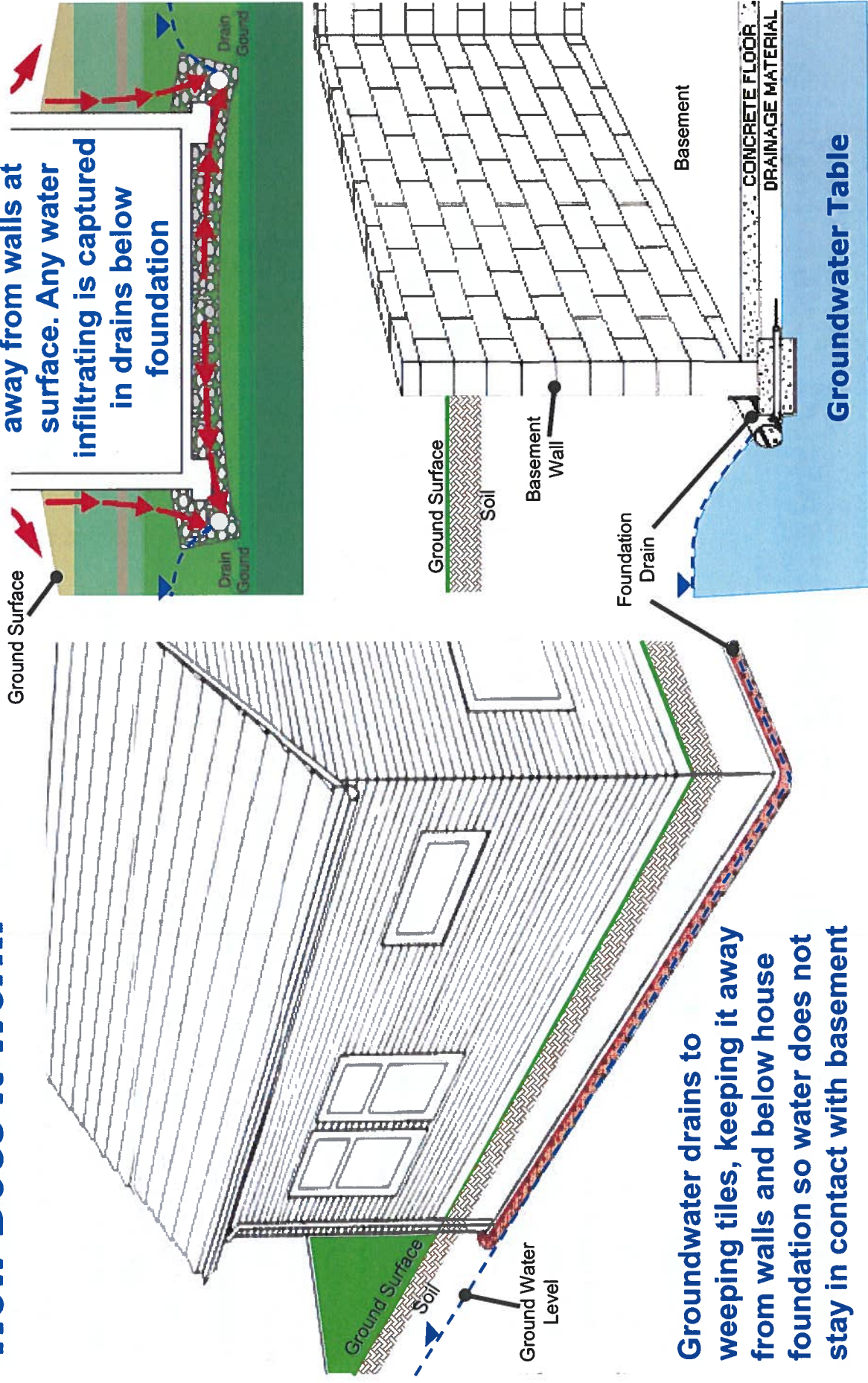
How Does it Work?

- The fixtures drain to a main line through the house that flows to the basement and outlets to the sanitary sewer in the street via the sanitary lateral on your property
- Pipes also vent to the air through a pipe through the roof (called a soil stack), to relieve gas and odour buildup
- A cleanout is normally in the basement and/or outside on the property to allow for maintenance (i.e. flushing, snaking) and inspection (i.e. camera)



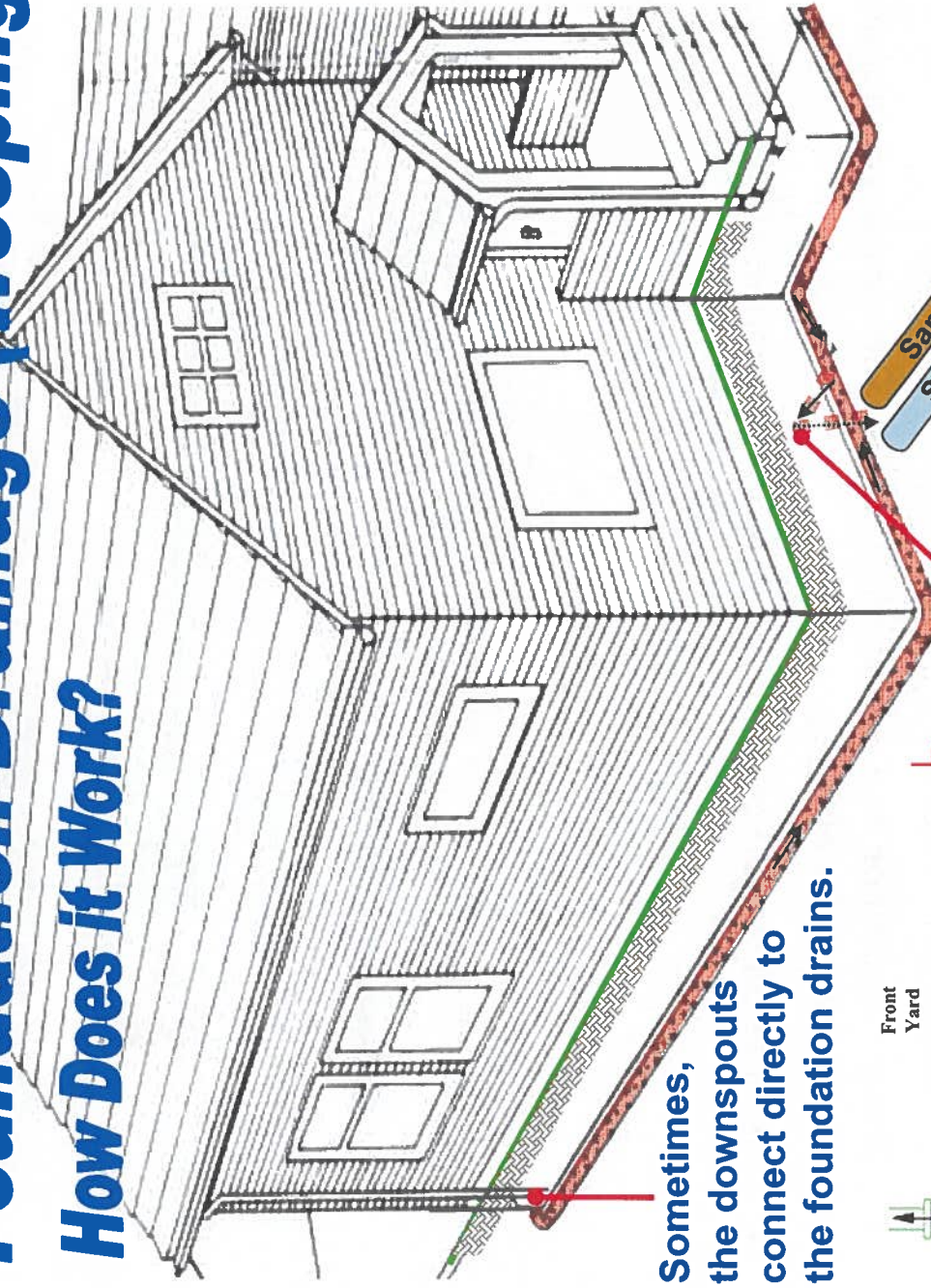
Foundation Drainage (Weeping Tiles)

How Does it Work?



Foundation Drainage (Weeping Tiles)

How Does it Work?



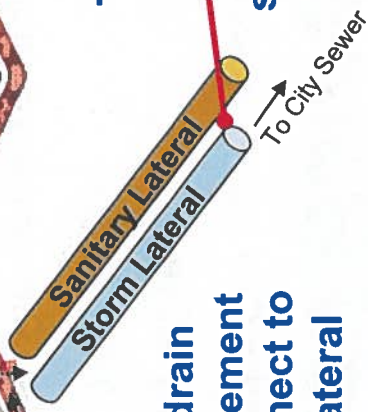
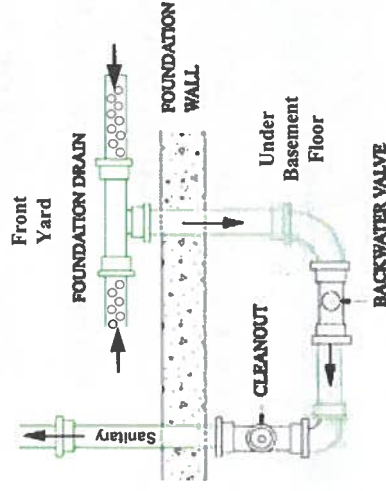
There are several ways a house's foundation drainage can work.

A detailed investigation by a licensed professional is required to determine how your house works.

Not all houses have foundation drainage.

The foundation drains can be connected to either the sanitary sewer, storm sewer, or the surface via sump pump.

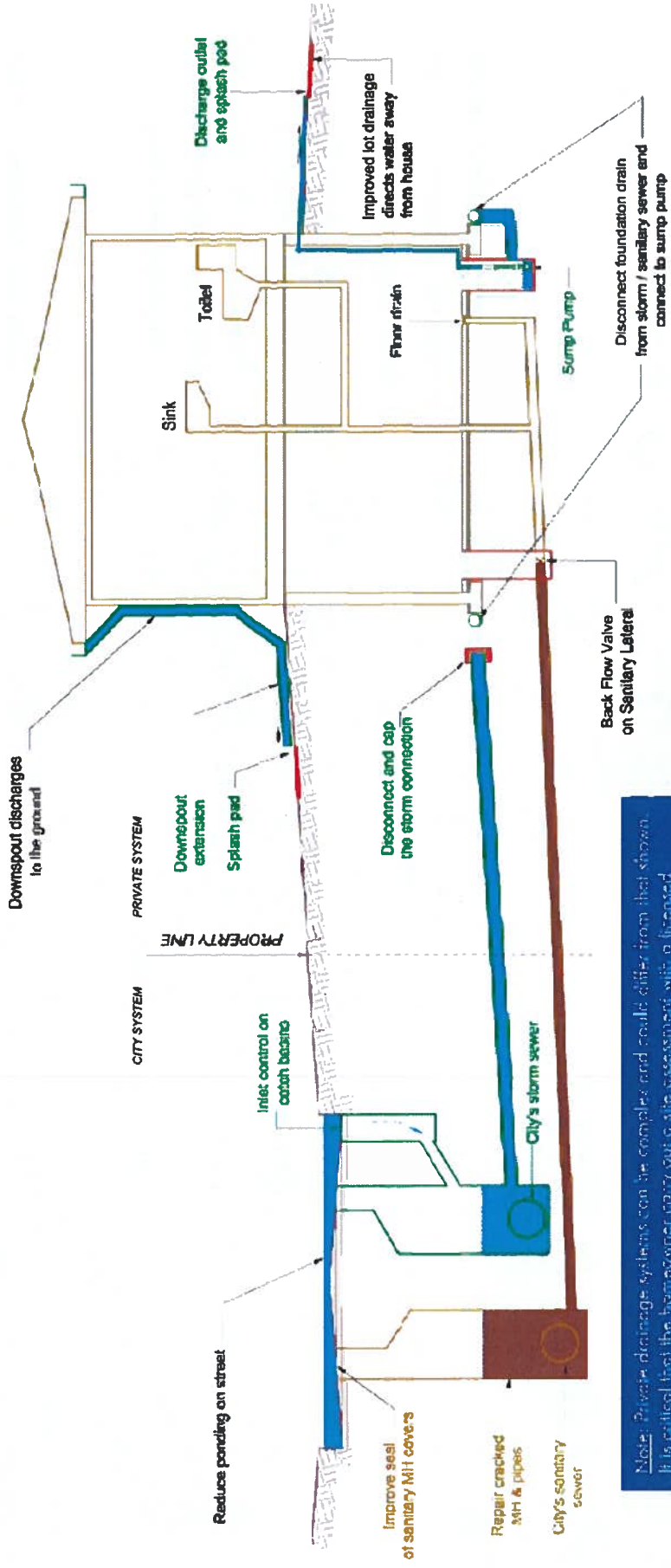
Often, they drain under the basement floor and connect to the service lateral inside the house.



Completely Isolated Home

To be completely isolated from backup in the City sewer system, you need:

1. *Disconnection of downspouts from City sewers*
2. *Backflow valve on the sanitary sewer line*
3. *Disconnection of foundation drains from City sewers and severance (capping) of the storm lead (if it exists)*
4. *Installation of sump pump to drain foundation drain to surface*



Downspout Disconnection

Disconnection of the roof downspouts from the underground sewer system, to reduce the direct inflow of water to the municipal system.



Measuring



Cutting Pipe



Capping Inlet



Direct to Splash Pad

What Does it Involve?

- Assessment of the house layout, number of downspouts, and surrounding land
- Cutting the downspout pipe(s) and adding an elbow joint to redirect the water to a grassed surface away from the building
- Use of a concrete or plastic splash-pad to prevent erosion
- Capping and sealing the old ground connection(s) to be water-tight

Possible Impacts to Residents

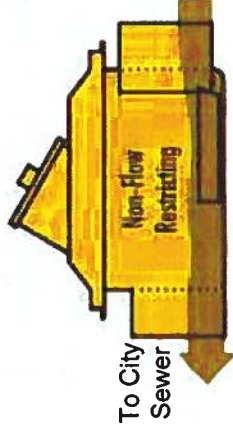
- Moist ground conditions after rainfall
- Temporary ponding in front or rear yard
- Additional downspout pipe discharge locations

Challenges

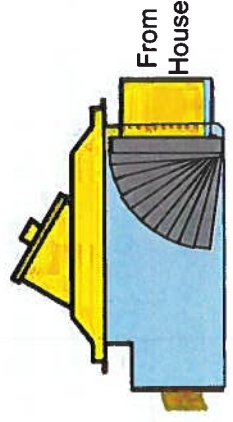
- Finding suitable locations to outlet (grass)
- Preventing outflow from causing flooding or ice on own or neighbouring property

Home Isolation - Backflow Valve(s)

A mechanical valve that only allows one-way flow through it. It is placed on the storm and/or sanitary service line to prevent City-system backup from entering the home.



Normal 'Open'
Position



Backflow 'Closed'
Position



Example Model
"Mainline Fullport Valve"

What Does it Involve?

- Hiring of a qualified professional
- Investigation of what pipe connections the house has, and if interconnection between the storm and sanitary system exists
- Camera of existing service connection
- Small excavation in basement floor, normally at front of house
- Correct installation of valve
- Proper sealing of pipe connections

Possible Impacts to Residents

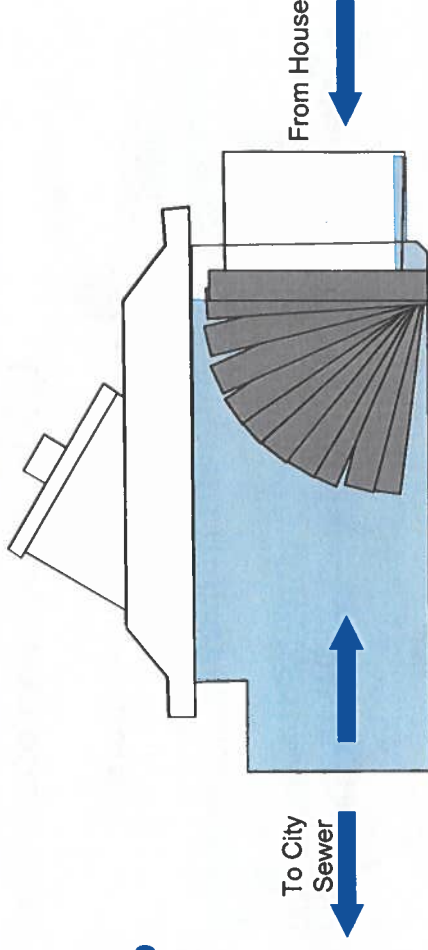
- Homeowner to select and hire a licensed drainage contractor/plumber to do work
- Out-of-pocket expense (City subsidy program available to assist)
- Excavation of basement floor and associated mess/disturbance
- Requires regular maintenance to ensure proper operation

Home Isolation - Backflow Valve(s)

A mechanical valve that only allows one-way flow through it. It is placed on the storm and/or sanitary service line to prevent City-system backup from entering the home.

How Does it Work?

- When water from the City-system backs-up the private service line, floats on the valve gate lift the gate closed
- While this prevents water from the sewer from entering your home, it also prevents internal water from exiting
- Once City sewer is open again, water exits the valve and the gate reopens



Challenges

- Determining proper placement of the valve on house plumbing such that no other connections bypass the valve
- Locating a suitable place in the basement floor to excavate the valve 'pit'
- Making sure that the valve is regularly maintained and operating properly
- Making sure not to use household plumbing during rain storms, because when the valve is closed due to back-up, internal plumbing (sinks, bathtubs, toilets, laundry, etc) when it rains to prevent 'self-flooding' has no outlet

Reverse-Driveway Backflow Valve

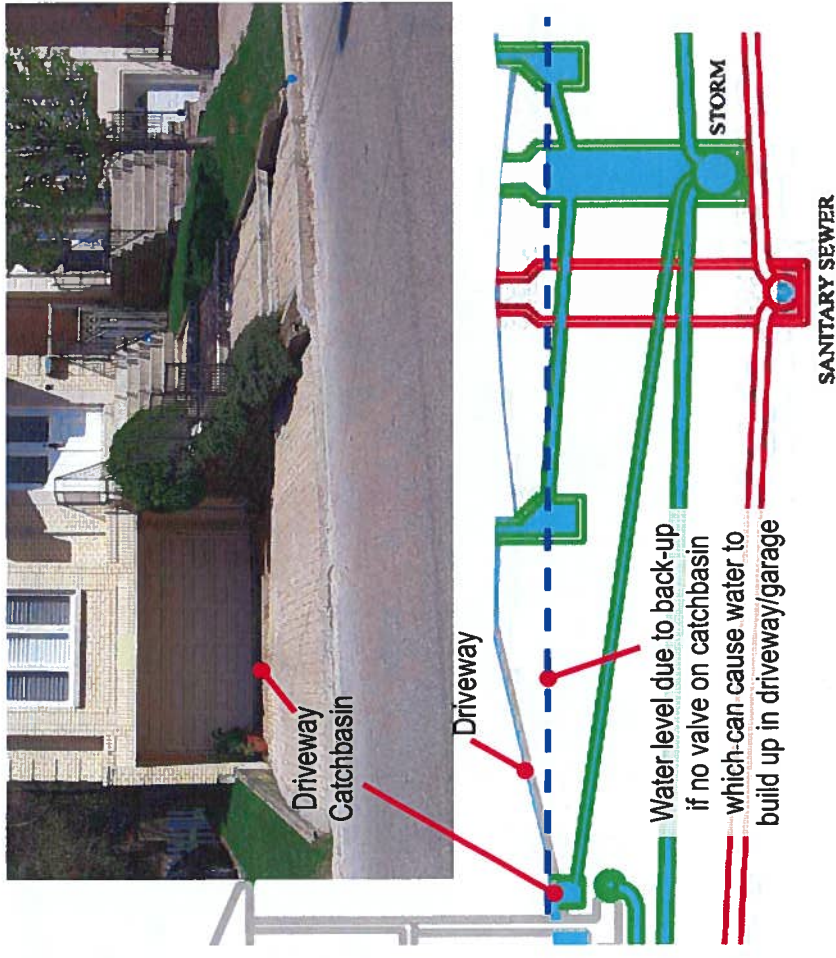
A mechanical valve that only allows one-way flow through it. It is placed on the catchbasin storm connection to prevent City-system backup from entering the driveway/garage.

How Does it Work?

- When water from the City storm system backs-up the private service line, the valve gate closes
- While this prevents water from the sewer from reaching the driveway surface, it also prevents surface water from draining
- Once City sewer is clear again, the gate reopens and the catchbasin can drain
- May require sump pump to drain catchbasin to higher ground when valve is closed

Challenges

- Making sure that the valve is regularly maintained and operating properly
- Potential for blockage by debris and/or ice (during spring thaw)
- Making sure no household plumbing (e.g. weeping tiles or downspouts) is connected to catchbasin or is upstream of new valve. When valve closes due to back-up, water cannot exit service line and could cause 'self-flooding'



Home Isolation - Disconnect Foundation Drain

Disconnecting the house foundation drains (weeping tiles) from the City system will eliminate sewer back-up from impacting your foundation. Foundation drains can be connected to the sanitary sewer, storm sewer, or both, and can be connected to your internal plumbing.



What Does it Involve?

- Hiring of a qualified professional (plumber, drain contractor, or drainage engineer)
- Thorough investigation of all underground connections to the house and foundation drain
- Excavation in the basement and outside along the house where the drains are to be disconnected/reconnected
- Disconnection of foundation drains from City sewers (cap storm connection)
- Reconnection of foundation drains to sump pump
- Restoration of disturbed areas

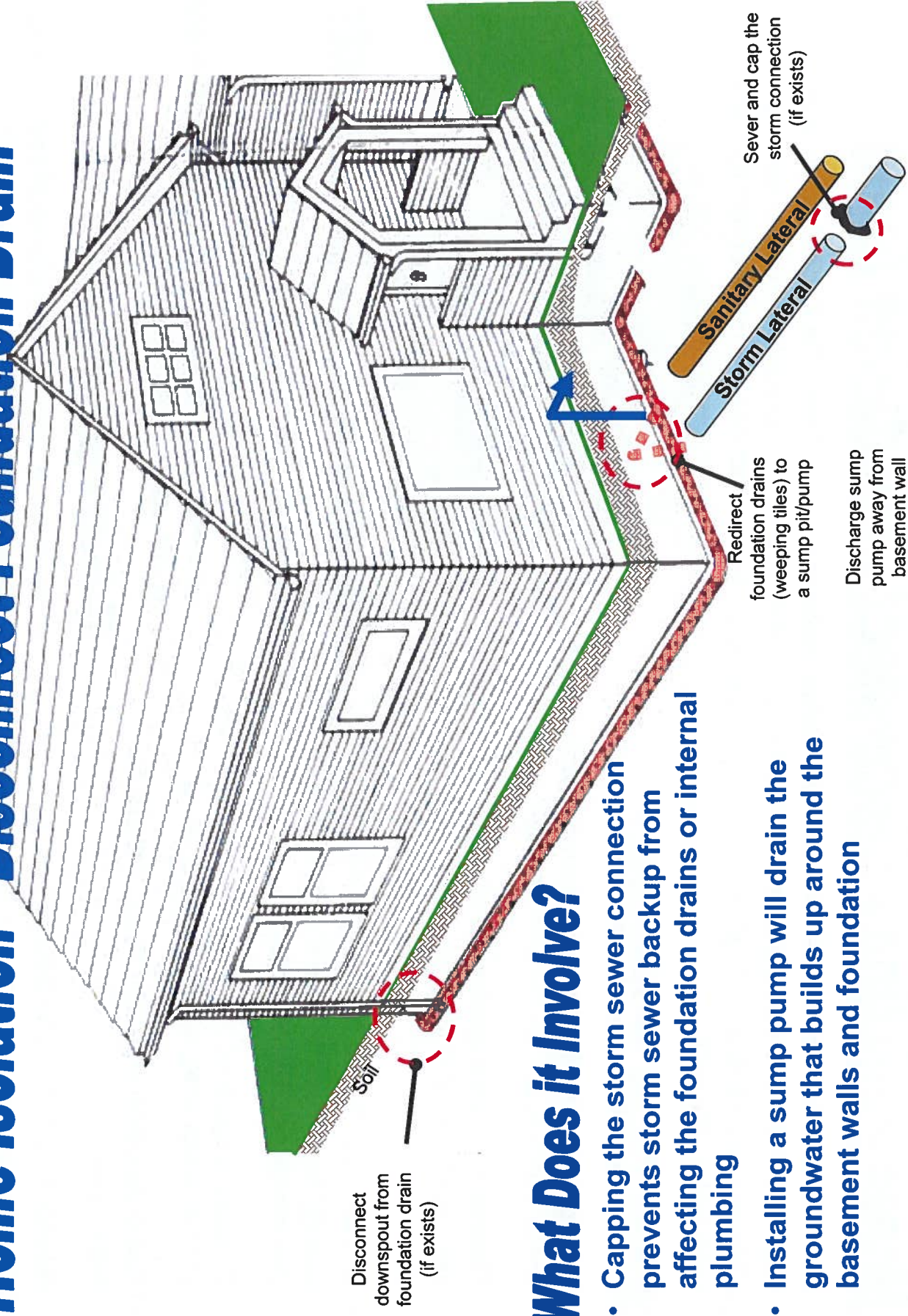
Possible Impacts to Residents

- Out-of-pocket expense (City subsidy program available to assist)
- Excavation of basement floor/outdoors and associated mess/disturbance

Challenges

- Back-up electricity for sump pump during power outage
- Maintenance/replacement over time

Home Isolation - Disconnect Foundation Drain



What Does it Involve?

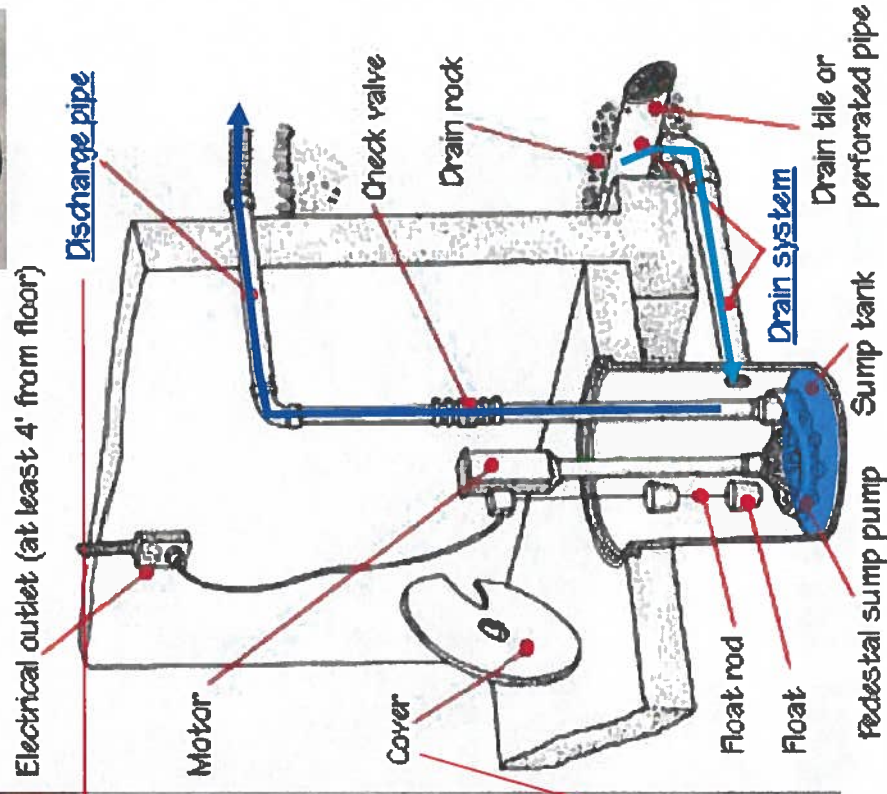
- Capping the storm sewer connection prevents storm sewer backup from affecting the foundation drains or internal plumbing
- Installing a sump pump will drain the groundwater that builds up around the basement walls and foundation

Home Isolation - Sump Pump Operation

Disconnection of the foundation drains from the City sewer requires introducing a new outlet for the groundwater drainage. A sump pump can collect this water and discharge it safely to the surface.

How Does it Work?

- Water collects in a sump 'pit', located within your basement floor
- The foundations drains are reconnected to the sump
- Over time, the sump fills with groundwater
- Once the water level in the sump reaches a set maximum limit, the pump is turned on and the sump pit is drained
- The pumped water is directed to the surface

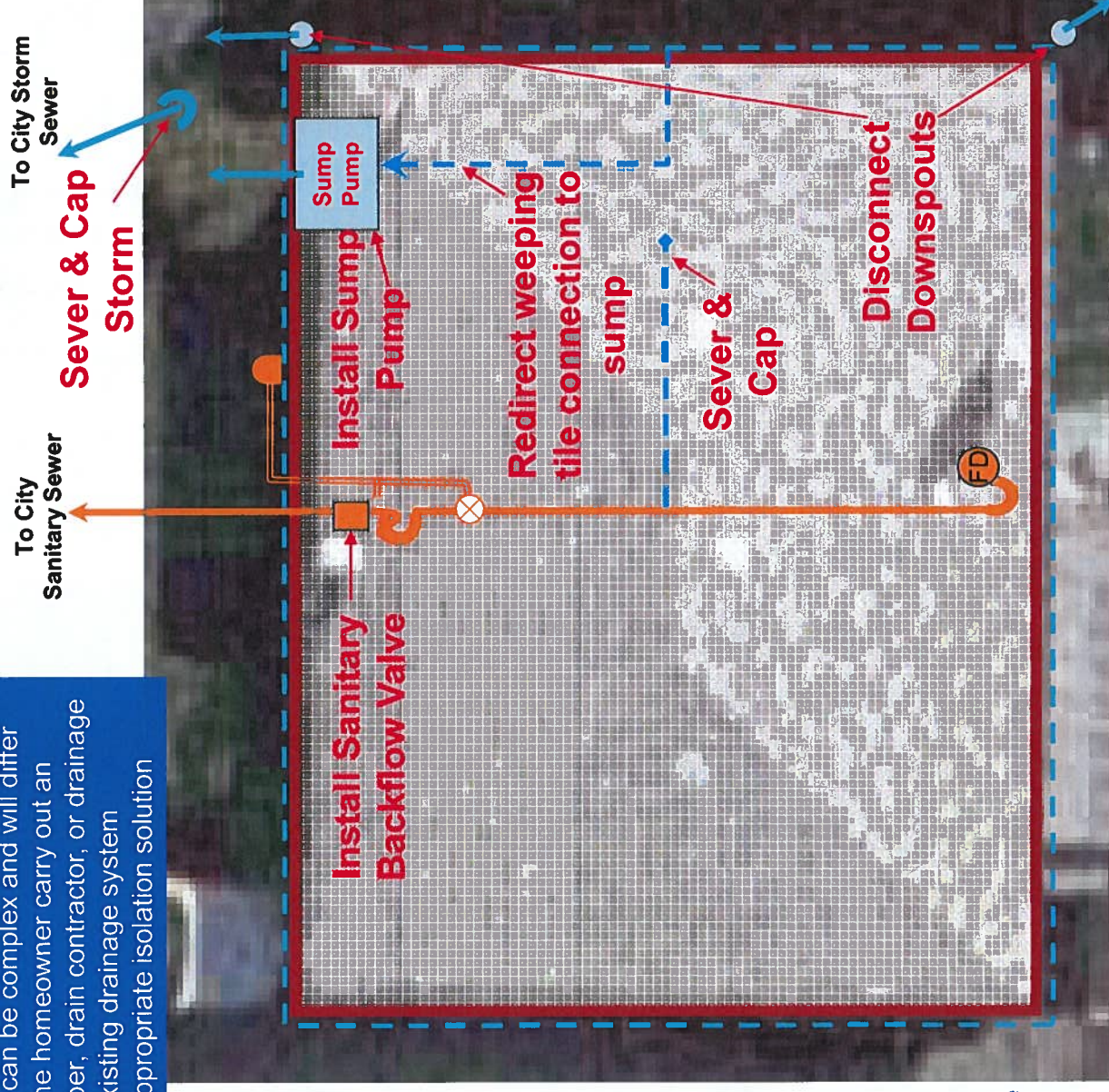


Example Isolated Residential Drainage Plan

Private drainage system solutions can be complex and will differ from that shown. It is critical that the homeowner carry out an investigation with a licensed plumber, drain contractor, or drainage engineer to understand how the existing drainage system operates before determining the appropriate isolation solution

How Does it Work?

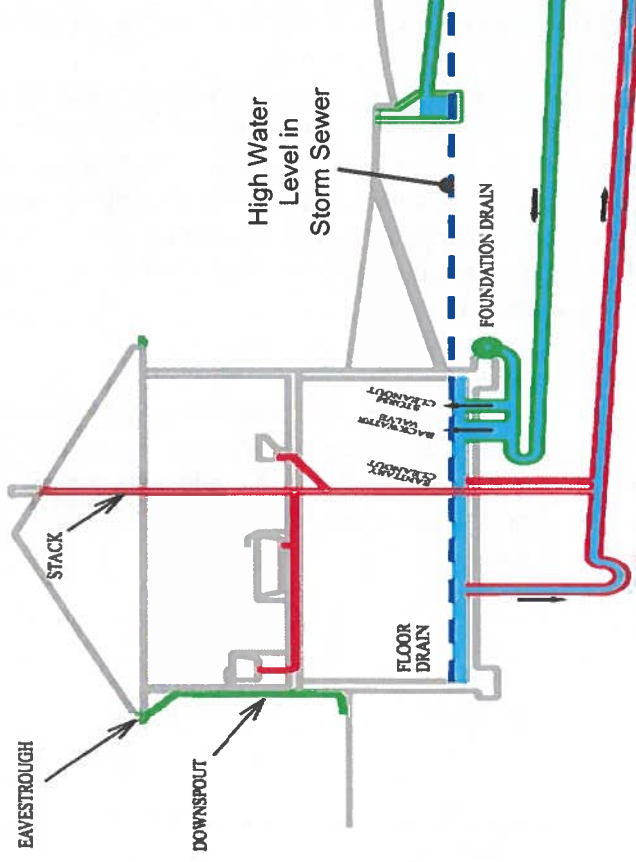
- Internal plumbing drains to the sanitary sewer
- A sanitary backflow valve is installed in the house
- The foundation drains are redirected to a sump pit
- A sump pump is installed and discharges to the surface, away from the building wall
- Downspouts are disconnected from the subsurface systems and directed away from the building walls
- The storm connection is severed (capped), preventing any backup from the storm sewer from affecting the house



Example Comparison of Isolated Homes

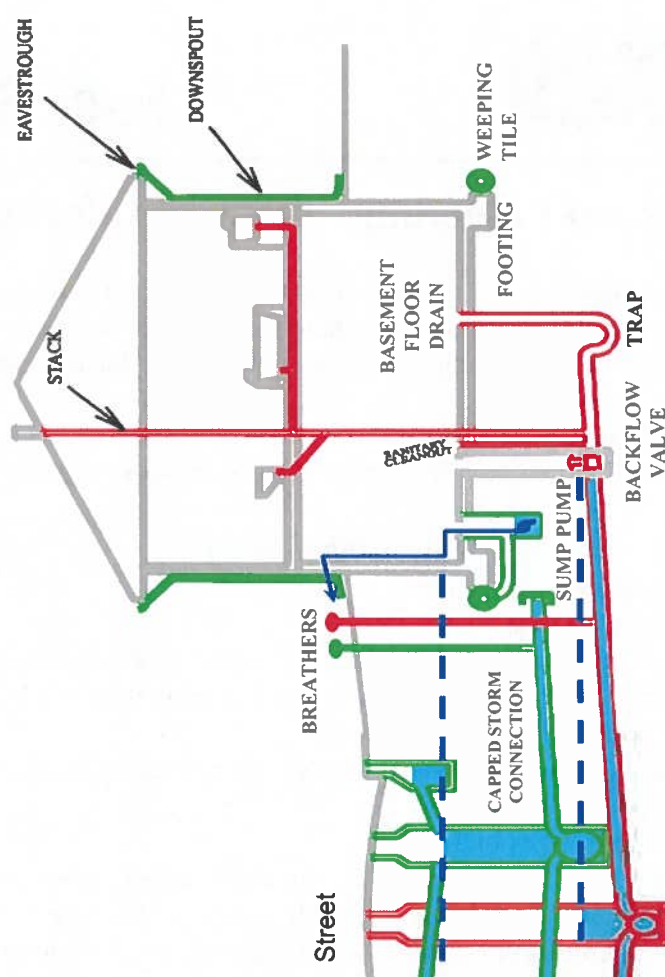
Complete isolation from the sewer system depends on a prior thorough investigation to determine how the system works, proper installation, and continued regular maintenance.

Improperly Isolated



- Loose backflow valve cap on storm sewer causes stormwater to enter house
- Water in basement enters floor drain resulting in overloading of sanitary sewer
- Foundation drains connected to storm pipe; water builds up around basement walls

Properly Isolated



- Backflow valve prevents sanitary backup from entering house
- Storm connection capped preventing storm backup from entering house
- Sump pump installed to drain foundation drains (weeping tiles)

Basement Flooding - General Information

Water can enter your basement for a number of reasons. The good news is that you may be able to prevent or at least reduce the chance of this happening. Water in your basement is most likely to occur when there's been a heavy rainfall, snow is melting or during a spring thaw.

Causes of basement flooding (see Figure 1):

- A leak in your home's foundation, basement walls, or basement windows or door
- Poor lot drainage
- Failure of the weeping tile system (foundation drains)
- Overflowing eavestroughs
- Leaking/plugged downspouts
- A blocked connection between your home and the main sewer in the street
- A back-up of wastewater in the sewer system (or a combination of wastewater and rainwater from the sanitary or combined sewer system)
- Failure of a sump pump (in some areas) used to pump weeping tile water

There are three types of sewers in Toronto

- Sanitary sewer: The sanitary sewer, which carries wastewater (sewage), is connected to your home's plumbing fixtures (toilets, sinks, laundry, etc.) and leads to a sewage treatment plant.
- Storm sewer: The storm sewer collects stormwater from catchbasins (street drains), eavestroughs, weeping tiles (in many areas of the city) and carries these flows into nearby streams or Lake Ontario.
- Combined sewer: In older parts of the city, stormwater and sewage are collected in the same pipe known as a combined sewer. During normal weather conditions all the wastewater in the combined sewer is treated at the sewage treatment plant. However, in a heavy rainfall or spring thaw, the stormwater and the sewage mixture may overload the combined sewer system. Basement flooding may happen because the overloaded sewer forces wastewater back through the sewer pipes where it escapes through floor drains or any other low lying plumbing fixtures in the basement.

Action List for a basement flood

1. Call the appropriate Toronto Water service staff immediately, 24 hours a day, seven days a week at 416-338-8888. City staff will inspect the problem, assess the flooding and attempt to determine the source(s) of the flooding. If the problem is ours, we will make arrangements to fix it. If the problem is the homeowner's responsibility, we will advise you of a possible course of action you should take.

2. Call your insurance company as soon as possible and report property damage caused by the flooding:
 - Take photos of damage caused by flooding for your insurance claim.
 - Keep receipts from emergency repair work or clean-ups done to prevent or reduce further damage.
 - If the flooding is a result of a blocked drain pipe, leaking foundation walls or poor lot drainage on your property, the property owner is responsible for repairs and any subsequent damage caused by flooding for your insurance claim.
 - The City of Toronto will make all repairs to City pipes.
 - Frequently, sewers or drains are blocked by tree roots – the City will help clear the blockage if the tree is on City property and a grant is available for repairs on private property. Call 416-338-ROOT (7668) for details.
 - You may submit a claim in writing with your name, telephone number, home address, date, location and details of incident and send it to: City Clerk's Office, City of Toronto, City Hall, 100 Queen Street West, Toronto, M5H 2N2 or Fax: 416-392-1867 or email Clerk@toronto.ca. Your claim will be forwarded to the City's insurance adjusters for evaluation. A letter of acknowledgement will be sent to you.
3. Be mindful of health and safety when cleaning up your flooded basement. Exposure to contaminants carried by flood water or sewer back-ups into basements can be dangerous. Homeowners may be exposed to waterborne diseases, including diarrhea illnesses, corrosive cleaning agents and irritants found in leftover sludge from a flooded basement. Electrical accidents may occur because of contact with water and electricity.
 - Dress appropriately - wear overalls, gloves, protective eyeglasses, rubber boots and a mask.
 - Open windows to let fresh air in.
 - Stay away from electrical equipment and do not attempt to change any fuses if standing in water or on damp ground.
 - If you can, shut-off the electrical power.
 - Minor debris can be put out for regular garbage pick-up (See your Garbage and Recycling Collection Calendar for information).
 - Scrub furniture affected by flood water with soap and clean water and place it outside in sunny area to dry (weather permitting) or steam clean.
 - Clean and deodorize carpets, or have them professionally cleaned.
 - Disinfect walls and floors using a chlorine bleach and water solution (one part bleach to 10 parts water) – make sure the area is thoroughly aired-out and dry before reoccupying it.
 - Wash clothing following manufacturer's instructions.
 - Throw out canned foods, home-prepared food in jars, meats and dairy products and any packaged foods that may have been affected by the flood waters – check for damaged packaging, leaks, and corrosion at seams and joints of cans.
 - If your freezer's power is off, move the frozen food to another freezer or throw it out if you can't keep it frozen.

3...

- Consider getting help with flooding clean-up – look in the Yellow Pages under “Water Damage Restoration”.
- Call your insurance company because they may cover the cost and do some of the work.

Prevent the flood before it starts

There are some simple steps you can take to reduce the likelihood of basement flooding. If the problem is persistent, further solutions are available:

Possible solutions to wet basements

- Check for and fix leaks in walls, floors, windows and foundations.
- Clear overflowing eavestroughs and downspouts of leaves and other debris preventing proper drainage.
- Make sure your disconnected downspouts are draining properly, at least 1.8 meters (six feet) from your basement walls.
- Disconnect your downspouts from the sewer system
- Have a plumber/drain contractor inspect your home’s flood-proofing devices, such as back-water valves, sump pumps, floor drains or caps, to ensure they’re working properly.
- Consider soft-surface landscaping that allows storm water to soak into the ground rather than run directly into the local sewer systems (i.e. increased sodded areas, porous pavement).
- Be sure your flood insurance is up to date.
- Do not block the sewer connection by pouring grease down the drain or flushing objects down the toilet.
- Be sure the grading around your home drains water away from all exterior walls.
- Repair/replace damaged weeping tile systems.

Expert help needed

Call your plumber or contractor, or check the Yellow Pages for help under “Sewer Cleaning Service” or “Sewer Line Inspection” or “Drainage Contractors.” Consider getting three estimates before going ahead with work.

- Consider installing a **backflow valve** within the private drainage system (and/or storm drainage system) in an effort to prevent the sewer from backing up into your basement. Backflow valves need to be installed properly. They require frequent inspection and maintenance to ensure proper performance and to reduce the risk that the valve may cause a build up of pressure that may cause structural damage to floors or walls. Drainage (weeping tiles) around the foundation of your home must be considered when installing a backflow valve.
- Consider a **floor drain plug** to prevent the flow in or out of the drain. However, be cautioned that in sewer backup conditions, the plug may cause a build-up of pressure that may cause structural damage to the floor or walls.

- Consider disconnecting the foundation drains (weeping tile system) from the municipal sewer system to a sump pump. The sump pump will discharge groundwater to the ground level away from your home.
- For information on these measures and the available Basement Flooding Protection Subsidy Program, see the Backgrounder handout or call **416-395-6376**.

For more information call 416-338-8888 or visit www.toronto.ca/water

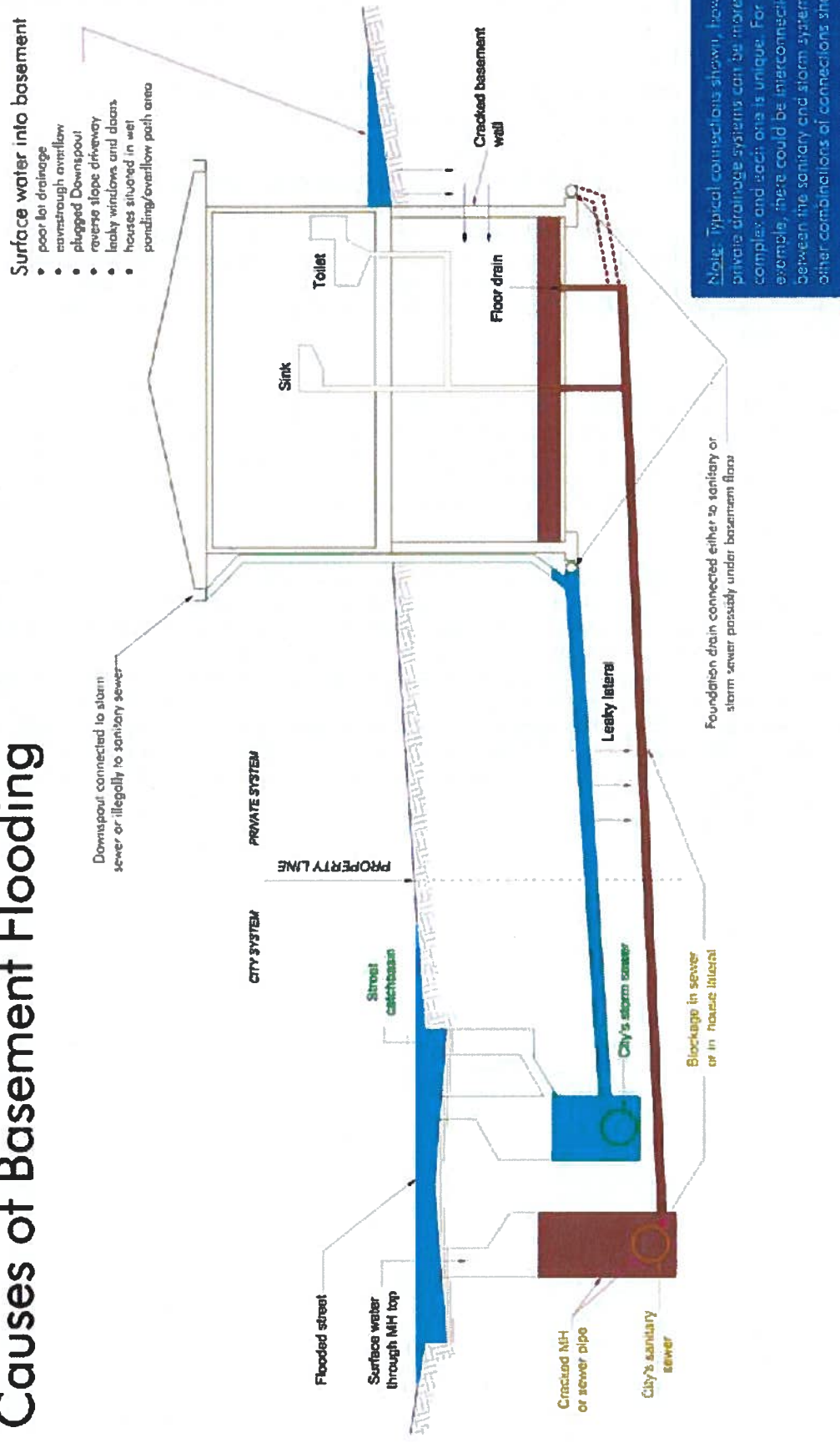
The City in good faith provides this information as a public service to assist private property owners. The information is intended for educational and informational purposes and is only provided for the convenience of users. Because of the varying nature of the elements, weather patterns, sewage systems and houses, no municipal sewer system can offer every house complete protection against basement flooding.

Also, drainage conditions on each private property are unique and private property owners should decide if they need to assess the source of potential flooding to their property and implement all or only some of the flooding protection measures available to them. The City is not responsible for the drainage systems on private property and does not have the ability to assess or recommend improvement works on any private property for this purpose. Where appropriate, professional advice and service should be sought from a knowledgeable and licensed plumber, contractor or civil engineer.

While the information provided is thought to be accurate, it is provided strictly "as is" and the City makes no representations, guarantees, or warranties as to the accuracy, reliability, completeness, currency, or suitability of the information provided. Users relying on this information do so entirely at their own risk. The City does not accept and specifically disclaims any and all warranties, whether express or implied, and any liability for any injury, loss or damage whatsoever incurred as a result of the use of, reliance on, the information provided by the City and in no event will the City, its Councillors, officers, directors, employees or contractors be liable to you or to any third party for any direct, indirect, incidental, consequential, special or exemplary damages or lost profit, including any property damage or loss or personal injury, associated with, resulting from or arising out of any use or misuse of this information.

Causes of Basement Flooding

Figure 1





Investigations of Basement Flooding (Area 28, 29 & 30)
Class Environmental Assessment

Glossary of Terms

Seen or heard a word or two that's new? Here are some definitions to help you better understand the information presented at the Public Information Centre.

Backflow Valve or Check Valve:	A valve that allows one-way flow of sewage out of the home while blocking sewage from flowing into the basement during sewer backup conditions.
Breather (Vent)	A pipe connection from a service lateral to the surface that allows gases to escape the sewer system while not entering the home.
Catchbasin:	A grated inlet structure in a roadway that allows surface water to enter the storm sewer system, while preventing large objects from entering.
Clean Out:	This is a pipe rising from the sewer lateral to the ground surface with a removable cap or plug. It is used to access the sewer lateral for inspection or to free blockages. It is usually located just inside the property line, but there may be additional sewer cleanouts at various other locations on your property, including inside your basement.
Combined Sewers:	A sewer that carries both stormwater and sanitary wastewater.
Cross-connection:	Where a stormwater pipe is incorrectly connected to a sanitary sewer or where a sanitary pipe is incorrectly connected to a storm sewer
Directly Connected Downspout:	A downspout that directly connects below the ground to a service lateral, and not to the surface.
Downspouts:	Pipes connecting to the roof eavestroughs and discharging to the ground level or below ground; also known as roof leaders.
Downspout Disconnection:	The process of disconnecting a home's downspouts from the underground sewer system, to reduce the amount of water entering the sewers.
Dry Weather Flow:	Flow discharging from a sewer during dry periods (i.e., when it isn't raining or snowing). In a sanitary sewer, this consists of domestic wastewater and infiltrated groundwater.
EA Process	EA stands for Environmental Assessment, a provincially mandated decision-making process that outlines the strategic steps and considerations for completing planning & engineering projects that affect the public and the environment.
End-of-Pipe	A stormwater management facility at the outlet of a sewer that deals with

Control:	stormwater and/or combined sewage before it is discharged into a stream, river, or lake. Types of facilities include wet and dry ponds, wetlands, underground storage tanks, and underground infiltration basins etc.
Footing:	A concrete base upon which basement walls are placed. Weeping tile (foundation drains) are placed against this base.
Foundation Drain:	Also called Weeping Tiles. A special piping system that surrounds a basement footing and is designed to lower the groundwater table and drain surface water that has infiltrated alongside the house such that groundwater remains below the basement floor.
Hydraulic Grade Line:	An engineering term used to describe the water level in a system. Also called HGL, It represents the maximum height of water in a sewer or maintenance hole.
Hydraulic/ Hydrologic Model:	A computer program that simulates flow and rainfall events through a drainage system by performing a series of mathematical computations.
Hydraulics:	A branch of engineering that deals with the transmission of water and application of fluid mechanics principles.
Hydrology:	A branch of science that deals with the distribution and movement of water on the surface, below ground, and through the atmosphere.
Impervious Surface:	A surface which does not allow water to pass through, or infiltrate. Example, pavement, concrete, roofs, highly compacted clay etc.
Infiltration:	1) Surface water that moves through the ground into the water table, much like water passes through a coffee filter. 2) Also refers to groundwater (water found below the ground surface) that enters sewer pipes through cracks, pipe joints, and other system leaks. Because sewers are typically buried deep, they are often located below the water table. Storm events can raise groundwater levels and increase infiltration of groundwater into sewer pipes. The highest infiltration flows are observed during or right after heavy rain. Too much infiltration can overload the sanitary sewers and cause backup.
Inflow:	Surface water that directly enters the sanitary sewer system through manhole cover holes, connected downspouts, uncapped clean outs, and/or illegally cross-connected catchbasins.
I/I:	An industry term for Infiltration and Inflow (see above).
MOE:	(Ontario) Ministry of the Environment
O&M:	Operations and Maintenance
One Hundred Year Storm:	A statistical representation of historic rainfall records, meaning there is a 1% chance (probability) that a storm of this magnitude will hit in any given year. This therefore means that it is possible that a storm like this can happen more than once, possibly even in the same year. It is often <u>misinterpreted</u> to mean a storm that only occurs once every 100 years, which is not the case. This can be demonstrated with a deck of cards analogy; the likelihood of getting

	a full house in a given hand is pretty low, but it is not impossible. Nor is it impossible to get 2 full houses in a row, just extremely unlikely.
One Hundred Year Design Storm:	The benchmark for engineering design of new storm drainage systems. Meaning, a one hundred year storm should not cause flooding. This does not mean that the underground sewer can take this flow; instead a combination of the underground and surface drainage systems should combine to protect private property from damage during this event.
Outlet/Outfall:	The discharge point of a sewer system. For storm sewers, normally a waterbody or watercourse; for sanitary sewers, the trunk sewer or treatment plant.
P-trap:	A plumbing fixture that keeps a water seal between the sewer and the house, to prevent sewer gases/odours from entering the home. An example can be found under every sink, and looks like a sideways letter 'P'.
Ponding:	Accumulation, or pooling, of stormwater on the ground surface.
Reverse-slope Driveway:	A driveway that slopes from the road towards the house. Water is typically collected in a catchbasin at the bottom of the driveway.
Road Sag:	A localized low-point in the road, where water has no immediate outlet. Catchbasins are normally located in sags, and sags can be used to help reduce the amount of water entering a storm sewer by retaining it on the surface and slowly letting it enter the system.
Runoff:	Excess rainwater that has reached the surface but cannot soak into the ground, therefore running off and following the natural ground.
Sanitary Sewer:	An underground sewer system designed to receive wastewater and transport it from homes and businesses to the sewage treatment plant. This system is not intended to receive surface rain water.
Service Lateral:	The sewer connection from the house plumbing to the municipal sewer in the street. A house can have up to 2 connections: a sanitary lateral or both a sanitary and storm lateral. Also called a "sewer lateral", or simply "lateral".
Sewer:	An underground pipe that transports storm and/or sanitary waste water by gravity from one location to another.
Sewer Backup:	A condition that occurs when a sewer is under surcharge or if a blockage limits how much flow can pass through a pipe, causing water to back up the sewer and potentially enter the home.
Sewer Surcharge:	A condition that occurs when the amount of water in a sewer is greater than what the sewer can handle, causing the water level to increase rapidly.
Sewershed:	An area defined by the sewer outlet it drains to.
Splash Pad:	These are often concrete or plastic blocks that receive water from downspouts. They help prevent erosion and move water away from the foundation.
Stack:	A pipe in a house that connects to all internal wastewater plumbing and vents to the air through the roof, to eliminate gas build up and odour in the house

Storage:	The temporary detention of water in a surface or subsurface structure, such as a pond, tank, or oversized pipe. Storage helps relieve overloading of the pipe or surface network by storing and slowly releasing water back to the system.
Storm Sewer:	The underground sewer system designed to receive storm water or rainwater that has become runoff. This system carries water away to a receiving water body such as the West Don River, or Newtonbrook Creek.
Stormwater:	Water resulting from rain that enters the surface and subsurface drainage systems.
Sump Pit:	A small pit or chamber located in a house such that it receives discharge from the foundation drains (weeping tile).
Sump Pump:	An automatic pump that drains accumulated weeping tile water in the sump pit to the surface and away from the house, thereby relieving water build-up around basement walls. It is not intended for pumping out large quantities of flood waters.
Trunk Sewer:	The main large diameter sewer that collects smaller neighbourhood sewers and discharges to the outlet.
TRCA	Toronto and Region Conservation Authority. TRCA is responsible for regulating the watercourses in the Greater Toronto Area.
Wastewater:	Water generated by household and commercial plumbing, such as sinks, toilets, washing machines, tubs, and dishwashers.
Watershed:	The surface area draining to a watercourse outlet, such as a creek or river.
Weeping Tile:	Also called Foundation Drains. A special piping system that surrounds a basement footing and is designed to drain the groundwater table or surface water that has infiltrated alongside the house.
Wetland:	A constructed shallow vegetated area, like a marsh, that is designed to treat polluted stormwater and reduce the amount of water entering a downstream stormwater system.
Wet Weather Flow:	Flow generated due to rain or snowmelt in all drainage systems.

June 2008

Basement Flooding Protection Measures

What is the problem?

Sewer and surface drainage systems are designed to handle a certain intensity of storms. It is not practical to design sewer systems to handle all possible types of storms. Depending on the amount of rainfall and how fast it falls, the sewer and surface drainage systems can be overwhelmed in any area of the city resulting in the risk of basement flooding. The potential for basement flooding cannot be eliminated – but the risk of basement flooding can be reduced.

Sewer systems in the City of Toronto consist of both public and private drainage systems that work together to move sanitary flow (sewage and wastewater from toilets, sinks and laundry, etc.) and stormwater (rainfall and snowmelt) safely away from homes and streets. The public system is owned and operated by the City of Toronto. The private system is the responsibility of the property owner. Both the City and the property owner need to take actions to reduce the risk of basement flooding. Figure 1 demonstrates the municipal and private sewer systems, and presents the typical causes of basement flooding.

What is the city doing to reduce the risk of flooding?

The City of Toronto has taken steps to prevent the overloading of the sewers that cause surface and/or basement flooding. Some of these initiatives have also improved stormwater quality.

Actions taken to date include:

- Stormwater detention ponds
- Constructed wetlands – these initiatives keep stormwater out of the sewers and use natural systems to remove pollutants, which leads to a higher quality of stormwater ultimately being released into Lake Ontario
- Downspout disconnection program and public education
- Water-efficiency programs to reduce wastewater volumes
- Improvements to local sewer systems

The City will continue to find ways to lower the volume of wastewater and stormwater handled in the City's sewer systems. The City has on-going programs of sewer system inspection, maintenance, improvement works and other preventive measures to help alleviate basement flooding. The City of Toronto also has an approved Wet Weather Flow Management Master Plan. The plan's goal is to reduce, and ultimately eliminate, the effects of wet weather flow – runoff that is generated when it rains or snows.

In chronic basement flooding areas, the City has initiated a comprehensive engineering work plan to identify system improvements necessary including, where possible, storm drainage enhancements to protect against surface flooding to a higher design standard.

What can homeowners do to help prevent basement flooding?

City sewer system improvements will help reduce basement flooding, but homeowners can still be at some risk. By taking preventative measures homeowners can help to reduce their risk of flooding.

You should consider the installation of flood-protection devices to isolate your home from the city sewer system if your basement has flooded frequently, or is used to store valuables. Isolating your property protects it from having water or sewage enter when there is a high volume in the public sewers. For these devices to be completely effective, it is required that you have your eavestrough downspouts disconnected from the sewer system where possible, as determined by the City.

Private drainage systems can be complex and each one is unique. Each property owner should carry out a site assessment with a Toronto-licensed plumber, drain contractor or drainage engineer to understand how the existing drainage system operates before determining the most suitable solution for isolating their property from the sewer system. City of Toronto staff are not in a position to provide an analysis of the homeowner's drainage system or to recommend solutions.

The following outlines the flood-protection measures, providing a brief explanation of how they work and some things to be considered before installing. Figure 2 presents an example home isolated from the City sewer systems.

- **Disconnect your downspout** to help reduce the amount of stormwater entering both the private and public sewer systems. Once disconnected, add an extension and splash pad, or a rainbarrel (if necessary). Ensure the water is not draining near your home, or onto your neighbour's property.
- **Install a backflow valve** on the sanitary sewer line. The sanitary sewer line, located under the basement floor, conveys all water disposed of inside the house (shower, toilets, washing machines, dishwasher, floor drain, etc.) to the sanitary sewer on the street. When the main sewer on the street is overloaded, this backflow valve will prevent sewage from backing up into the basement. Remember – when the valve is closed water inside the house cannot get out. During, or shortly after a major rain storm, you must not use the shower, toilet, dishwasher, sink, etc. as this water has nowhere to go except through the floor drain and into the basement.

When installing the backflow valve it is extremely important to consider the location in relation to other internal and external drainage connections to your home, i.e. foundation drains, sanitary and storm laterals, or multiple connection points. An improper connection can bypass the valve and cause flooding. A thorough investigation of these connections should be undertaken to be sure the installation will provide the proper protection.

Similarly, the water that seeps into the ground around the house wall and flows through the soil into the foundation drains cannot outlet when the valve is closed. The foundation drain

(also known as weeping tiles) is a perforated plastic or clay pipe that surrounds the outside of the foundation of the house and was historically connected to either, or both, of the sanitary and storm sewers. With the valve closed, water can build up around the foundation and possibly enter the basement through cracks in the walls, unsealed wall/floor piercings (i.e. plumbing fittings, gas lines, etc.), or the backflow valve pit. A sump pump with discharge to the surface can be installed to relieve this water build up.

- **Disconnect your foundation drains** (weeping tiles) from the municipal sewer system. To help protect the basement from sewer backup, the foundation drain connection to the sewer service line should be severed (capped). Whether your foundation drain is connected to the sanitary system, storm system or both, once they are isolated from the sewers there is no longer an outlet to drain this water. To relieve the water build up, the drains should be reconnected to a sump pump that safely discharges to the surface.

What additional preventative measures can homeowners take?

- Repair all leaks in walls, floors, doors windows and foundations.
- Ensure downspouts are disconnected and drain properly away from basement walls (consider soil erosion and winter icing hazards when locating discharge areas).
- Ensure eavestroughs are clean and drain properly.
- Ensure the ground slopes away from the house for a minimum of five feet.
- Have plumbing fixtures (drains, traps, valves, pumps, etc.) inspected by a qualified person at least once a year (preferably in late winter or early spring) to ensure they are in good working order.
- Obtain professional advice and service from a knowledgeable and licensed plumber, drainage contractor or civil engineer.

What City programs are available to residents?

There are several programs available to homeowners to help alleviate flooding.

Blocked (Drain) Sewer Service Line Program

- The City will inspect service pipe connections (laterals) at no cost to the resident and, if damage/blockage is located on City property, the city will repair at no cost to the resident.
- Grant assistance is available if the roots of a City-owned tree are blocking the sewer service line on private property.
- More information available at 416-338-ROOT (7668)

Basement Flooding Protection Subsidy Program

The Basement Flooding Protection Subsidy program will assist homeowners to take the necessary precautions to reduce your property's flooding risk. The subsidy program provides you with an opportunity to install flood-protection measures on the internal and/or external plumbing of homes, and receive a cash subsidy for devices and labour (following certain conditions). For these devices to be completely effective, it is required that you have your eavestrough downspouts disconnected from the sewer system where possible, as determined by the City.

Who is eligible?

- In May 2007, Toronto City Council extended the program to all owners of existing single, duplex or triplex residential buildings only in the City, regardless of past flooding history.
- The following conditions also apply:
 - Homeowners must consult with a licensed professional (plumber, drain contractor, or drainage engineer) to understand how the existing drainage system operates and to determine the most suitable protection measure(s) to reduce the potential for future basement flooding
 - Downspouts must be disconnected where lot conditions allow, as determined by the City, to be eligible for any subsidy under this program
 - The property is an existing home, not a new home under construction
 - The property complies with the City's Zoning By-law requirements for front yard paved areas

The total subsidy can be up to \$3,200, what does it include?

- **A: Backflow Valve**

In consultation with a licensed plumber, drain contractor, or drainage engineer, you may determine that a backflow valve is sufficient protection on your storm and/or sanitary sewage connection.

Subsidy = 80% of the invoiced cost up to a maximum of \$1,000 including eligible labour, materials, permit and taxes.

- **B: Sump Pump (Weeping Tile Drainage)**

In consultation with a licensed plumber, drain contractor, or drainage engineer, you may determine that a sump pump is required to manage the water normally collected by footing weeping tiles (foundation drains) and draining to the sanitary, storm or combined sewer.

Subsidy = 80% of the invoiced cost up to a maximum of \$1,500 including eligible labour, materials, permit and taxes.

- **C: Backflow Valve + Sump Pump**

In consultation with a licensed plumber, drain contractor, or drainage engineer, you may determine that both a backflow valve (called a Mainline Fullport backwater valve) and a sump pump are required (see details above).

Subsidy = 80% of the invoiced cost up to a maximum of \$2,300 including eligible labour,

- **D: Pipe Severance and Capping**

In consultation with a licensed plumber, drain contractor, or drainage engineer, you may determine that in addition to other installations (backflow valve and/or sump pump) the severance and capping of the footing weeping tile pipe location outside the foundation walls and storm sewer lateral is required.

Subsidy = 80% of the invoiced cost up to a maximum of \$400 including eligible labour, materials and taxes.

Note: The difference between submitted costs and the maximum subsidy for any one type of installation cannot be applied in part, or in total, to another type of installation when calculating the total homeowner's subsidy. Homeowners are allowed only one subsidy payment for the appropriate installation or combination of installations per each eligible homeowner in Toronto through this subsidy program.

For more information on how to apply for the Basement Flooding Protection Subsidy Program, call 416-395-6376.

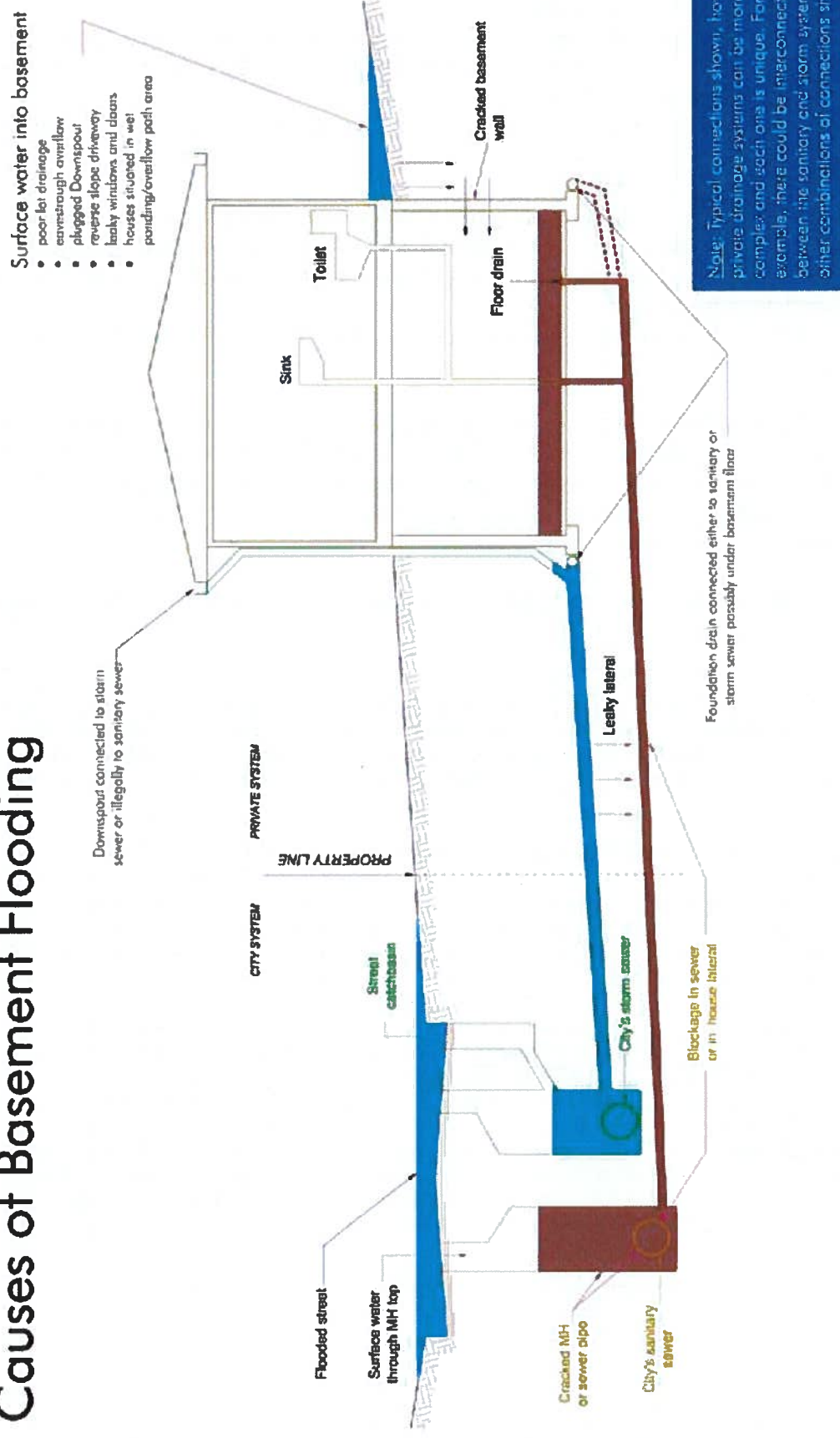
The City in good faith provides this information as a public service to assist private property owners. The information is intended for educational and informational purposes and is only provided for the convenience of users. Because of the varying nature of the elements, weather patterns, sewage systems and houses, no municipal sewer system can offer every house complete protection against basement flooding.

Also, drainage conditions on each private property are unique and private property owners should decide if they need to assess the source of potential flooding to their property and implement all or only some of the flooding protection measures available to them. The City is not responsible for the drainage systems on private property and does not have the ability to assess or recommend improvement works on any private property for this purpose. Where appropriate, professional advice and service should be sought from a knowledgeable and licensed plumber, contractor or civil engineer.

While the information provided is thought to be accurate, it is provided strictly "as is" and the City makes no representations, guarantees, or warranties as to the accuracy, reliability, completeness, currency, or suitability of the information provided. Users relying on this information do so entirely at their own risk. The City does not accept and specifically disclaims any and all warranties, whether express or implied, and any liability for any injury, loss or damage whatsoever incurred as a result of the use of, reliance on, the information provided by the City and in no event will the City, its Councillors, officers, directors, employees or contractors be liable to you or to any third party for any direct, indirect, incidental, consequential, special or exemplary damages or lost profit, including any property damage or loss or personal injury, associated with, resulting from or arising out of any use or misuse of this information.

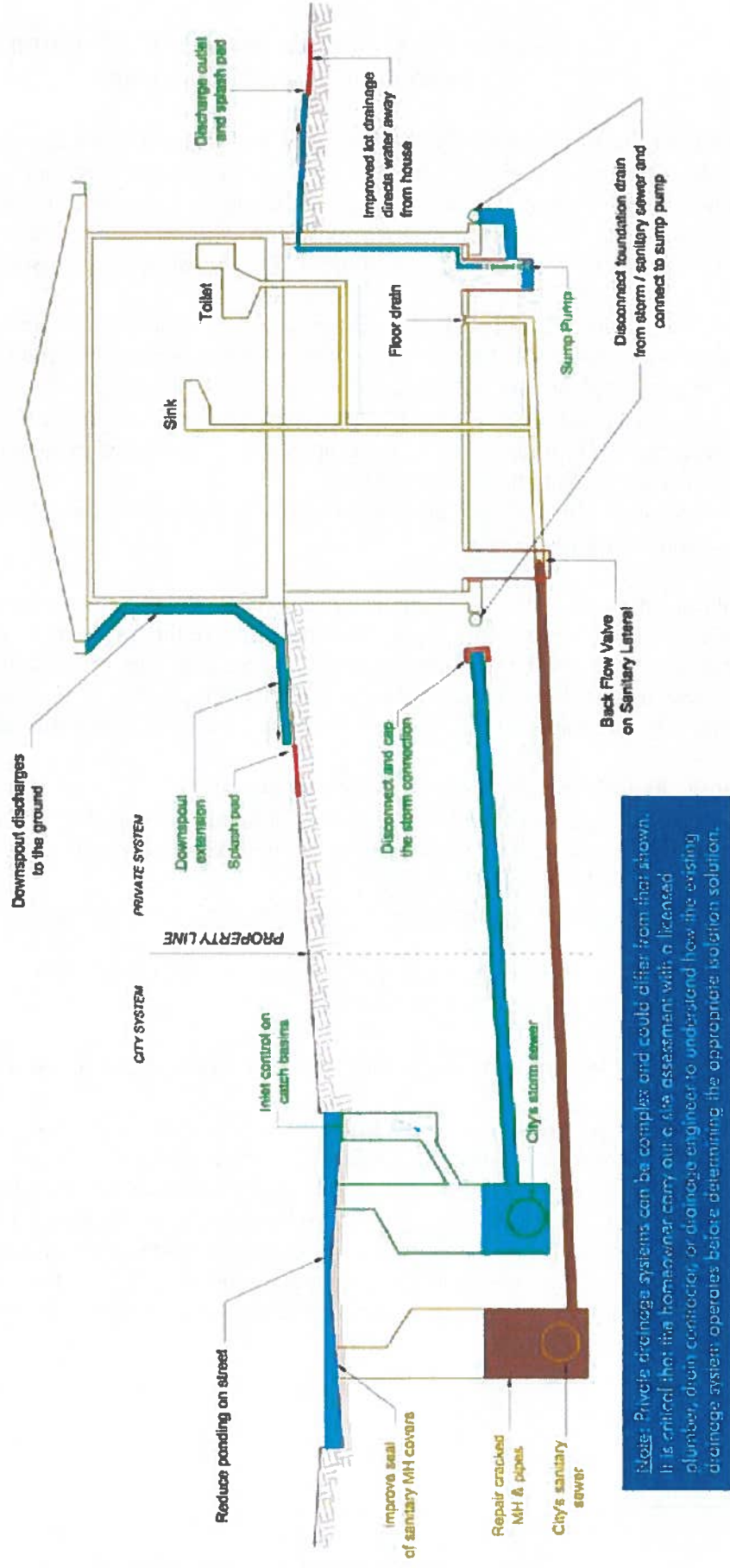
Causes of Basement Flooding

Figure 1



Isolating your home plumbing from the City's sewer systems

Figure 2



Steps to Carry Out the Basement Flooding Protection Subsidy Program

1. **Obtain a minimum of two (2) detailed work estimates.** Private drainage systems can be complex and each house is unique. The homeowner must carry out a site assessment with a licensed plumber, drain contractor, or drainage engineer to understand how the existing drainage system operates before determining the appropriate measures to isolate your home from the sewer system. **You are responsible for choosing the best solution for your home.**
2. **Apply for a City plumbing permit.** Either you or your hired plumber must apply to the City for a permit to undertake the work. The appropriate Basement Flooding Protection Subsidy will be granted if the proposed installation meets the Building Code. To get a permit:
 - You or your authorized agent (i.e. plumber) must present technical sketches or drawings, meeting the Building Code, of the proposed home-isolation installation to any of the City of Toronto's Plumbing Permit Offices.
 - The property owner's signature must be on the sketch or drawing indicating agreement with the proposed plan.
3. **City plumbing inspection.** When the work is complete, you (the homeowner) must request the City's plumbing inspector to examine and approve the finished plumbing work. The inspector will determine whether or not the eligible elements, noted in the technical proposal, have been installed in a manner that meets the Building Code. If the installation is satisfactory, the inspector will provide you with a confirmation certificate.
4. **Submit the following to Toronto Water for payment:**
 - A detailed invoice of the Eligible Work completed by a qualified professional (Toronto-licensed plumber, drain contractor, or drainage engineer) indicating that the Eligible Works have been "Paid in Full";
 - The Confirmation Certificate for the flood-protection works signed by Toronto Building.

Send to: Toronto Water • North York Civic Centre • 5100 Yonge Street • 2nd floor • Toronto, Ontario M2N 5V7, or call 416-395-6376.

5. **A cheque will be mailed to the property owner within eight to ten weeks.**

Elements eligible for subsidies: Assessment costs (site visit by selected plumber); labour costs; backflow valve (approved by Building Materials Evaluation Commission); flood alarm (attached to backflow valve); couplings; pipe; plastic valve access box; concrete and gravel; sump pump; plastic sump barrel; electrical wiring; pump discharge hose; exterior concrete spillway for sump pump discharge water; private drain pipe capping device; exterior pit excavation (to permit drain capping); downspout disconnection rearrangement of property's eavestrough gutters and downspout system (removing direct connection to the sewer system); City of Toronto plumbing permit; and GST and PST.

Basement Flooding Protection Subsidy Program

For more information:

**Basement Flooding Protection
Subsidy Program**

web: www.toronto.ca/water/sewers
telephone: 416-395-6376
email: basementflooding@toronto.ca

**Municipal Licensing and Standards
(Plumbing/contractor license information)**

web: www.toronto.ca/licensing
telephone: 416-392-6700



Help protect yourself against basement flooding >

Basements can flood for many reasons. For its part, the City of Toronto is working to make improvements to its complex system of underground pipes, sewers and catchbasins. But these improvements alone cannot completely protect a home from basement flooding. And with the increasingly frequent and severe weather events related to climate change, it is essential that homeowners take the appropriate action to reduce the risk of basement flooding on their own private property. Those who isolate their home from the City's sewer system can significantly reduce the risk of basement flooding.

To assist homeowners, the City offers owners of single-family, duplex and triplex residential homes a financial subsidy of up to \$3,200 per property to install flood protection devices including a back-water valve, sump pump, and pipe severance and capping of the home's storm sewer or external weeping tile connection.

Work that is eligible

Each property owner is required to have a plumber, licensed by the City of Toronto, carry out a site assessment to determine the suitability of isolating their property from the City's sewer system. Contact Municipal Licensing & Standards at 416-392-6700 to verify plumbing licenses. The following items and works are eligible for a subsidy after proper installation:

A: Back-water valve

In consultation with a plumber licensed by the City of Toronto, homeowners may determine that a **back-water valve** on the sanitary sewage and/or stormwater connection could provide sufficient basement flooding protection.

Available subsidy = 80% of the invoiced cost up to a maximum of \$1,250 including eligible labour, materials, permit and taxes.

B: Sump pump

In consultation with a plumber or contractor licensed by the City of Toronto, homeowners may determine that a **sump pump** is required to manage the water normally collected by footing weeping tiles that drain to the sanitary, storm or combined sewer.

Available subsidy = 80% of the invoiced cost up to a maximum of \$1,750 including labour, materials and taxes.

C: Back-water valve + sump pump

In consultation with a plumber licensed by the City of Toronto, homeowners may determine that both a back-water valve and a sump pump are required (see details in previous section A and B).

Available subsidy = 80% of the invoiced cost up to a maximum of \$2,800 including eligible labour, materials, permit and taxes.

D: Pipe severance and capping

In consultation with a plumber or contractor licensed by the City of Toronto, homeowners may determine that disconnecting foundation drains (weeping tiles) from the City's sewer system by severing and capping the underground storm sewer connection pipe is also required.

Available subsidy = a maximum of \$400 including eligible labour, materials and taxes.

If you are applying for more than one item under the subsidy program, you cannot apply any unused funds from one item to another.

Eligibility requirements and information >

The City of Toronto will determine the eligibility of properties that meet the requirements listed below:

- The property must be registered as a single-family residential, duplex or triplex property within the City of Toronto.
- The subsidy is available only to existing homes, not homes in the planning stages or currently under construction.
- The property must have its eavestrough downspouts properly disconnected from the City sewer system, where possible.
- A plumber currently licensed by the City of Toronto, must be hired to install a back-water valve.
- A contractor currently licensed by the City of Toronto must be hired to install a sump pump and/or perform severance and capping.
- A building permit and approved inspection must be obtained for back-water valve installations.
- Only properties that comply with the City's Zoning By-law requirements for front yard paved areas are eligible.
- All installations must be completed before the applicant applies for the subsidy.
- Invoice(s) must show a cost breakdown of all charges, the total amount paid and be clearly marked as "paid in full."
- The property owner or authorized legal representative must sign and date the application form.
- All documents must be originals. No photocopies will be accepted.
- Applications and supporting documentation must be received by the Basement Flooding Protection Subsidy Program Office within one year of the date of completion of the work.
- Subsidies for eligible work are subject to available funding and provided on a first-come, first-served basis.
- Subsidies are provided one time only for each eligible installation, per property, and on a no-fault basis

STEPS> How to apply for a subsidy

- 1** Consult with a plumber licensed by the City of Toronto for an assessment and recommendation of the appropriate installation(s) that will isolate your property from the City's sewer system.

If you are NOT installing a back-water valve, continue to step number 2.

The following steps are applicable for back-water valve installations only.

- 1a) If a back-water valve is to be installed, you or your plumber must first:**

Obtain a permit from the City of Toronto Building Division. To obtain a permit, you must go to one of the City of Toronto service counters and provide the required fee and a drawing (signed by the property owner). If the proposed work meets the Building Code requirements, you will be provided with a permit.

Permits can be obtained at the following locations:

Toronto and East York District
Toronto City Hall
100 Queen Street West
416-392-7539

Wards: 14, 18, 19, 20, 21, 22, 27, 28, 29, 30, 31, 32

North York District
North York Civic Centre
5100 Yonge Street
416-395-7000

Wards: 8, 9, 10, 15, 16, 23, 24, 25, 26, 33, 34

Etobicoke York District
2 Civic Centre Court
416-394-8002

Wards: 1, 2, 3, 4, 5, 6, 7, 11, 12, 13, 17

Scarborough District
Scarborough Civic Centre
150 Borough Drive
416-396-7322

Wards: 35, 36, 37, 38, 39, 40, 41, 42, 43, 44

- 2** After work has been completed, obtain an itemized invoice marked "paid in full" from your plumber or contractor.

- 3** Complete the Basement Flooding Protection Subsidy Program application form.

- 4** Mail the completed application form with all the required documentation to:

Basement Flooding Protection Subsidy Program
City of Toronto
Metro Hall, Stn 1180, 21st floor
55 John Street
Toronto, ON M5V 3C6

- 5** The Program Office will review your application and determine if you are eligible for a subsidy.

- 6** If your application is incomplete or you have not included the proper documentation, it will not be processed and all documents will be returned to you. If your application is denied, you will be notified by mail.

For more information:

Basement Flooding Protection Subsidy Program

web: www.toronto.ca/water/sewers
telephone: 416-395-6376
email: basementflooding@toronto.ca

Municipal Licensing and Standards (Plumbing/contractor license information)

web: www.toronto.ca/licensing
telephone: 416-392-6700

- 1b) Request an inspection for the completed installation.**

Back-water valve installations require an inspection by Toronto Building. Please be sure to schedule an inspection before enclosing or covering the work. This will ensure the inspector is able to see if the installation meets the applicable Building Code requirements.

Basement Flooding Protection Subsidy Application Form >

Section 1: Applicant and property information

Applicant's first and last name

Property assessment roll number (as listed on your City of Toronto Property Tax Bill)

Address of property that subsidy applies to

Number

Street name

City

Province

Postal Code

Daytime phone

Evening phone

email

Have you disconnected your home's downspouts from the sewer system? ☐ YES ☐ NO ☐ Never connected

Have you constructed a front yard paved parking area? ☐ YES ☐ NO If yes, does it comply with the City's Zoning By-laws? ☐ YES ☐ NO

Mailing address (if different from above)

Number

Street name

City

Province

Postal Code

Daytime phone

Evening phone

email

Section 2: Back-water valve permit and inspection information This section is to be filled out by applicants installing a back-water valve

Permit number

Name of Toronto Building inspector

Date of inspection: Y Y Y Y / M M / D D

Section 3: Plumber/contractor information

Plumber/contractor name

T -

City of Toronto License Number (9 digits)

License expiry date

Section 4: Financial information

Charges as itemized on your invoice (as applicable):

1) Back-water valve \$

2) Sump pump \$

3) Pipe severance/capping \$

Total amount paid: \$

(clearly shown as "paid in full" on your invoice)

If your application is incomplete, or you have not included the required documentation, your application will not be processed and will be returned with a request for the outstanding information.

I/We certify that the information, statements and representations given in this application and any accompanying materials are true, accurate and complete in all respects. I/We understand that any false or deceptive information, statement or representation given in this application and any accompanying materials may result in the rejection or revocation of this application and any approval thereof and immediate demand by the City for full repayment of any subsidy paid by the City. In addition to any other civil remedies available to the City, I/we agree that I/we shall immediately repay the City all subsidy monies pay to me/us and shall indemnify the City for any and all costs it may occur, by reason of the giving or making such false or deceptive information, statement or misrepresentation in this application and any accompanying materials.

Section 5: Document checklist

Please make sure that:

- ☐ This application is completed and signed by the property owner or legally authorized representative.
- ☐ The original invoice(s) marked "paid in full" and itemized with cost breakdowns of all charges are included.

Note: Please keep photocopies of all documents submitted for your personal records. Your original invoice will be returned to you after your application is processed.

Applicant's Signature

Date: Y Y Y Y / M M / D D

Please mail this application and all required original documents to:

Basement Flooding Protection Subsidy Program
City of Toronto, Metro Hall, Stn 1180, 21st floor
55 John Street, Toronto, ON M5V 3C6

The personal information on this form together with any attached documents is collected under the authority of the City of Toronto Act, 2006, s. 136, and By-law 292-1999. The information is used to assess your eligibility for the Basement Flooding Protection Subsidy Program, to process your payment where eligible, and for aggregate statistical reporting. Questions about this collection can be directed to: Supervisor, Service Programs, Metro Hall, Stn. 1180, 21st floor, 55 John Street, Toronto, ON M5V 3C6 or at 416-395-6376.



Blocked Sewer Service Lines — Inspection and Repair Program

DRAIN GRANT APPLICATION FORM

For more information: 416-338-ROOT (7668)

www.toronto.ca/water

draingrant@toronto.ca

Effective October 1, 2007, all applicants must submit this form

Section 1: Property Information

Owner name (as listed on your Property Tax Bill) _____

Property Assessment Roll Number (as listed on your Property Tax Bill) _____

Address of property _____

Date work was completed _____

Mailing address (if different) _____

Day phone _____ Evening phone _____ Email _____

You must submit the original Property Tax Bill for the year in which the work was completed to verify ownership and property eligibility.

Section 2: Investigation Information

Name of City's Toronto Water staff responding on-site to your call _____

Date staff were on site _____ Time _____

Drain Grant Investigation Form number (top of white form) _____

You must submit the original Drain Grant Investigation Form (white form) to verify that the property has been inspected by City staff. If you have not had an on-site inspection by City staff, please call 416-338-8888 as soon as possible to arrange one and ask for a completed copy of the Drain Grant Investigation Form.

Section 3: Licences and Permit Information (Please contact your contractor for this information)

Business name of contractor hired _____

City of Toronto Municipal Business (or contractor) Licence number _____

Licence expiration date _____

All work done by drain or plumbing contractors who are unlicensed or unregistered with the City of Toronto Municipal Licensing and Standards Division are ineligible for a grant.

Was work done on the building drain interior work? ☐ Yes ☐ No (must check one)

If yes, provide the City of Toronto Plumbing Permit number _____

Most building drain (or interior work) requires a plumbing permit issued by the City of Toronto Building Division. If you checked off yes, you must include the original City of Toronto Building Division plumbing permit.

Section 4: Financial Information

Total amount paid to contractor (clearly shown as "paid in full" on your invoice) \$ _____

Breakdown of charges as itemized on your invoice:

1) Replacement of sewer line (exterior work) \$ _____ Full or partial replacement (circle one)

2) Replacement of building drain (interior work) \$ _____ Full or partial replacement (circle one)

You must submit a legible ORIGINAL paid invoice from your licensed drain contractor/plumber (marked "paid in full") and clearly identifying the total amount paid. The invoice must be itemized in detail to indicate the work done, must provide a cost breakdown of charges by item, whether the work was internal and/or external, partial or full replacement, and subject to the satisfaction of Toronto Water. No reimbursement will be made for cleaning, snaking, plunging or closed circuit television inspection. Sewer service line or building drain must be replaced as part of the work done to be eligible for a grant.

Please check off the documents you are including with this application

- ☐ Original property owner's City of Toronto Property Tax Bill for the year the work was completed
- ☐ Original City of Toronto (Toronto Water) Drain Grant Investigation Form (white form)
- ☐ Original City of Toronto (Toronto Building) Plumbing Permit — for interior work
- ☐ Original paid invoice from your licensed drain contractor/plumber (marked "paid in full") and clearly identifying the total amount paid. The invoice must be itemized in detail to indicate the work done, must provide a cost breakdown of all charges by item, whether the work was internal and/or external, partial or full replacement, and subject to the satisfaction of Toronto Water. ***No reimbursement will be made for cleaning, snaking, plunging or closed circuit television inspection. Sewer service line or building drain must be replaced as part of the work done to be eligible for a grant.***
- ☐ Property owner must complete and sign (and mail in) this application form.

For those with a total combined annual property income of less than \$35,000 applying for additional financial assistance:

- ☐ Original Income Tax Notice of Assessments for the year in which the work was completed for each property owner registered on the Property Tax Bill.

INCOMPLETE APPLICATIONS, MISSING INFORMATION, PHOTOCOPIES AND INVOICES NOT MEETING OUR REQUIREMENTS WILL BE SENT BACK TO YOU AND THE APPLICATION WILL NOT BE PROCESSED.

Please keep copies of all documents submitted for your personal records. Once your application has been processed, all original copies will be returned to you.

Property Owner's Signature _____ Date _____

Please mail this application and all required original documents to:

City of Toronto, Drain Grant Program
Metro Hall, Stn. 1180, 21st floor
55 John Street
Toronto, ON M5V 3C6

MFIPPA Notice of Collection

The personal information on this form together with any attached documents is collected under the authority of the *City of Toronto Act*, 2006, s. 136, and By-law 292-1999. The information is used to assess your eligibility for drain grant financial assistance, to process payment where eligible, and for aggregate statistical reporting. Questions about this collection can be directed to Manager, Blocked Sewer Service Line Inspection & Repair Program, Metro Hall, Stn. 1180, 21st floor, 55 John Street, Toronto, ON M5V 3C6 or at 416-338-7668.

Blocked Sewer Service Lines — Inspection and Repair Program Policy

This section to be detached and kept by property owner

Blocked Sewer Service Line

If you suspect that you have a blocked sewer service line between your residence and the main sewer, you must contact the City at 416-338-8888 for assistance.

Drain Grant Response and Investigation Procedure

1. First response to all sewer service line blockage inspection and emergency repair service will be provided by City staff 24 hours a day, seven days per week.
2. After normal business hours, response will be limited to emergency situations where the sewer service lines are completely blocked. All other service calls will be investigated the next business day.

During the Inspection

1. Once the blockage has been verified by City staff, it is the property owner's responsibility to hire a licensed drain contractor and obtain the necessary approvals and permits to carry out the sewer service line work on private property.
2. Investigations will be limited to locations that can provide proper access into the sewer service line (i.e. a cleanout or excavation). Where a cleanout does not exist, the property owner must install one to facilitate proper maintenance and inspection of the sewer service line.
3. The property owner will be responsible for payment of the contractor's invoice. The City will not deal directly with any contractor for payment or dispute resolution.

Drain Grant Financial Assistance Criteria

Financial assistance is available to City of Toronto property owners for blocked private sewer drain repairs or replacement when the City investigation has determined that a portion of the sanitary and/or storm service line on private property has been infiltrated by tree roots from a City-owned tree. **Toronto Water at its sole discretion will determine the eligibility of property owners who meet ALL the following criteria:**

On site field investigation requirements:

1. Toronto Water was contacted (416-338-8888) for first response by the property owner and was on-site as quickly as operationally possible on the date of the incident of the reported sewer blockage to verify the blockage. Blockage verified by a private contractor will not be accepted.
2. A proper access point (a cleanout) into the sewer service line is available and provided to Toronto Water staff to conduct the inspection and investigation.
3. Toronto Water staff (and not private contractors) determined that a portion of the sanitary and/or storm sewer service lines on private property has been infiltrated by tree roots from a City-owned tree, which is verified by City staff.

Office administration requirements:

4. A signed application was made by the registered property owner or authorized representative and submitted within 12 months (1 year) of the paid invoice of the work completed.
5. The property is registered as a single-family residential, duplex or triplex property in the City of Toronto.
6. The property must not have exceeded the life-time maximum amount of \$2,000 per property towards sewer service line repair or replacement work, including exterior work (foundation to wall to property line) whether partial or full replacement and internal work (within the building).
7. A registered City of Toronto Municipal Licensing and Standards Division (<http://www.toronto.ca/licensing/index.htm>) licensed drain contractor or plumber was hired to undertake and perform the necessary repairs and/or replacement work.
8. The work done must meet all local plumbing and building code inspection requirements, including getting all applicable permit approvals from the City of Toronto Building Division (<http://www.toronto.ca/building/index.htm>). Note: most interior work requires a permit.
9. You must submit a legible ORIGINAL paid invoice from your licensed drain contractor/plumber (marked "paid in full") and clearly identifying the total amount paid. The invoice must be itemized in detail to indicate the work done, must provide a cost break down of charges by item, whether the work was internal and/or external, partial or full replacement, and subject to the satisfaction of Toronto Water. **No reimbursement will be made for cleaning, snaking, plunging or closed circuit television inspection. Sewer service line or building drain must be replaced as part of the work done to be eligible for a grant.**
10. To qualify for additional financial assistance, all registered property owners must submit their most recent year's Notice of Income Tax Assessments, and the combined total must be less than the annual gross amount of \$35,000. Additional assistance will be calculated by the following formula.
 - Below \$21,000: 100% of the balance of eligible repair costs
 - \$21,000-\$27,000: 50% of the balance of eligible repair costs
 - \$27,000-\$35,000: 25% of the balance of eligible repair costs

Assessment and Processing

1. When your application form is received by the Drain Grant Program, it will be checked to see if it is complete.
2. If it is incomplete, this means that the form has not been filled in or the attachments have not been included, as required. The application will be sent back to you with a letter informing you which part of your application needs to be completed.
3. Once you have completed the application, return it to the above address for processing.
4. Please remember that we cannot process your application until it is complete.
5. The following original documentation submitted with your application will be reviewed as part of our assessment:
 - Original property owner's City of Toronto Property Tax Bill for the year the work was completed
 - Original City of Toronto (Toronto Water) Drain Grant Investigation Form (white form)
 - Original City of Toronto (Toronto Building) Plumbing Permit for interior work
 - Original paid invoice from your licensed drain contractor/plumber (marked "paid in full") and clearly identifying the total amount paid. The invoice must be itemized in detail to indicate the work done, must provide a cost break down of all charges by item, whether the work was internal and/or external, partial or full replacement, and subject to the satisfaction of Toronto Water. No reimbursement will be made for cleaning, snaking, plunging or closed circuit television inspection. Sewer service line or building drain must be replaced as part of the work done to be eligible for a grant.
 - Property owner must complete and sign (and mail in) the application form

For those with a total combined annual property income of less than \$35,000 applying for additional financial assistance:

- Provide original Income Tax Notice of Assessments for the year in which the work was completed for *each* property owner registered on your Property Tax Bill.
6. The assessment will be made upon review of these documents, specifically work performed and undertaken by the licensed contractor as specified on the invoice.

If Your Application Is Denied

1. If you receive a letter telling you that your application has been denied, you may appeal.
 2. All appeals must be made in writing within 60 days of receiving the denial letter. Details of where to send the letter will be provided in the notification letter.
- Appeals are considered by the Deputy City Manager responsible for Toronto Water.
 - When your appeal has been considered, you will be notified in writing of the outcome.
 - Appeals under the Drain Grant Policy will not be granted for situations where the applicant has been granted the property life-time maximum grant limit provided under the Drain Grant Policy.

How to Apply

Complete the application and submit it with the required original attachments to the following address within one year of the date of the paid invoice:

City of Toronto, Drain Grant Program
Metro Hall, Stn. 1180, 21st floor
55 John Street
Toronto, ON M5V 3C6

Chronic Basement Flooding

City of Toronto programs available to residents

1. Drain Grant Program (for Blocked Sewer Service Lines)

The City will inspect service pipe connections (laterals) at no cost to the resident and, if damage/blockage is located on City property, the City will repair at no cost to the resident. Please call 311 to arrange a service appointment. Grant assistance is available if the roots of a City-owned tree are blocking the sewer service line on private property. More information on the Drain Grant Program: 416-338-ROOT (7668) or draingrant@toronto.ca.

2. Basement Flooding Protection Subsidy Program

A total subsidy of up to \$3,200 is available, including:

- a. Backwater valve: 80%, up to a maximum of \$1,250
- b. Sump pump: 80%, up to a maximum of \$1,750
- c. Backwater valve and sump pump: 80%, up to a maximum of \$2,800
- d. Pipe severance and capping: to a maximum of \$400

As of January 2007, the program is available to all owners of existing single, duplex or triplex residential homes across the City, regardless of previous flooding history.

To be eligible, the following conditions apply:

- a. Downspouts must be disconnected (where possible)
- b. A City of Toronto-licensed plumber or drain contractor must be hired to install a backwater valve, a sump pump and/or perform severance/capping
- c. Must be for an existing home, and not a new home under construction
- d. The property must comply with the City's Zoning By-law requirements for front yard paved areas.

**For more information on details or how to apply,
see provided handout or call 416-395-6376**



Chronic Basement Flooding

Homeowner measures to control basement flooding

✓ Disconnect downspouts



✓ Install backflow valve on sanitary sewer line



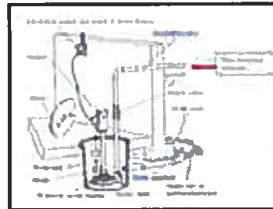
Normal 'Open' Position



Backflow 'Closed' Position



✓ Disconnect foundation drains from any service line and connect them to a sump pump



- Repair cracks/leaks in walls, floor, doors and windows.
- Maintain clean eavestroughs & downspouts.
- Ensure ground slope drains away from the house and not onto neighbouring properties.
- Check and test plumbing fixtures once a year.
- Consult a licensed plumber, drainage contractor or civil engineer to determine the most appropriate combination of measures for your home.

What You Can Do To Help

Quick Tips for the Homeowner

- ☑ Do not pour grease, cooking oil, or fat down kitchen drains and catch basins or flush objects into toilets
- ☑ Do not cover or block catch basins or drain openings on your backyard
- ☑ When disconnecting your downspouts, ensure that water drains properly and does not affect your neighbour's property
- ☑ Clear your eavestroughs and downspouts of leaves and other debris
- ☑ Make sure not to increase your paved parking surface more than is permitted



**Always report flooding
immediately
by calling 416-338-8888**

Appendix B

Agency Consultation



Ministry of the Environment

Central Region
Technical Support Section

5775 Yonge Street, 8th Floor
North York, Ontario M2M 4J1

Tel.: (416) 326-6700
Fax: (416) 325-6347

Ministère de l'Environnement

Région du Centre
Section d'appui technique

5775, rue Yonge, 8^{ème} étage
North York, Ontario M2M 4J1

Tél. : (416) 326-6700
Télééc. : (416) 325-6347



November 25, 2009

File: EA05-02-05

Josie Franch
Public Consultation Coordinator
City of Toronto
Metro Hall, 19th Floor, 55 John Street
Toronto, ON M5V 3C6

**RE: TSS Comments:
Investigation of Basement Flooding – Study Area 32
City of Toronto
Class Environmental Assessment
Response to Notice of Commencement**

Dear Ms. Franch:

This letter is our response to your Notice of Study Commencement for the above noted project. This response acknowledges that the City of Toronto has indicated that its study is following the approved environmental planning process for a project under the *Municipal Engineers Association Municipal Class Environmental Assessment (Class EA)*. *Please note that the Class Environmental Assessment process requires that you choose a schedule to follow for the project appropriate to the work that is to be completed.*

Based on the information submitted, we have identified the following issues of concern with respect to the proposed undertaking:

- Ecosystem Protection and Restoration
- Surface Water
- Groundwater
- Air Quality
- Servicing and Facilities
- Contaminated Soils
- Mitigation and Monitoring
- Planning and Policy
- Class EA Process
- First Nations Consultation

We are providing the following general comments to assist you and your project team members in effectively addressing these issues:

Ecosystem Protection and Restoration

- Any impacts to ecosystem form and function must be avoided where possible. The Project File/ESR should describe any proposed mitigation measures and how project planning will protect and enhance the local ecosystem.
- All natural heritage features should be identified and described in detail to assess potential impacts and to develop appropriate mitigation measures. Our records confirm that the following sensitive environmental features are located within or adjacent to the Study Area:

- Environmentally Sensitive Areas (ESAs)
- Rare Species of flora or fauna
- Watercourses
- Wetlands
- Woodlots

We recommend consulting with the Ministry of Natural Resources (MNR), Fisheries and Oceans Canada (DFO) and your local conservation authority to determine if special measures or additional study will be necessary to preserve and protect these sensitive features.

Surface Water

- The Project File/ESR must include a sufficient level of information to demonstrate that there will be no negative impacts on the natural features or ecological functions of any watercourses within the Study Area. Measures should be included in the planning and design process to ensure that any impacts to watercourses from construction or operational activities (e.g. spills, erosion, pollution) are mitigated as part of the proposed undertaking. The MOE Guideline B-6, *Evaluating Construction Activities Impacting on Water Resources* should be used to plan and construct this project.
- Additional stormwater runoff from new pavement can impact receiving watercourses and flood conditions. Quality and quantity control measures to treat stormwater runoff should be considered for all new impervious areas and, where possible, existing surfaces. MOE's *Stormwater Management Planning and Design Manual* (2003) should be referenced in the Project File/ESR and utilized when designing stormwater control methods. We recommend that a Stormwater Management Plan should be prepared as part of the Class EA process that includes:
 - Strategies to address potential water quantity and erosion impacts related to stormwater draining into streams or other sensitive environmental features, and to ensure that adequate (enhanced) water quality is maintained
 - Watershed information, drainage conditions, and other relevant background information
 - Future drainage conditions, stormwater management options, information on erosion and sediment control during construction, and other details of the proposed works
 - Information on maintenance and monitoring commitments

Groundwater

- The status of, and potential impacts to any well water supplies should be addressed. If the project involves groundwater takings or changes to drainage patterns, the quantity and quality of groundwater may be affected due to drawdown effects or the redirection of existing contamination flows. In addition, project activities may infringe on existing wells such that they must be reconstructed or sealed and abandoned. Appropriate information to define existing groundwater conditions should be included in the Project File/ESR.
- If the potential construction or decommissioning of water wells is identified as an issue, the Project File/ESR should refer to Ontario Regulation 903, *Wells*, under the *Ontario Water Resources Act*.
- Potential impacts to groundwater-dependent natural features should be addressed. Any changes to groundwater flow or quality from groundwater taking may interfere with the ecological processes of streams, wetlands or other surficial features. In addition, discharging contaminated or high volumes of groundwater to these features may have direct impacts on their function. Any potential effects should be identified, and appropriate mitigation measures should

be recommended. The level of detail required will be dependent on the significance of the potential impacts.

- Any potential approval requirements for groundwater taking or discharge should be identified in the Project File/ESR. In particular, a Permit to Take Water (PTTW) under the *Ontario Water Resources Act* will be required for any water takings that exceed 50,000 litres per day. A PTTW application must be accompanied by an assessment of potential effects as noted above, and may require a higher level of detail than what is provided in the Project File/ESR. Please note that when significant long-term water taking is proposed, the maximum rate identified in the Project File/ESR must not be exceeded in any subsequent PTTW applications. For more information on the application and approval process, we suggest you refer to the MOE *Permit to Take Water Manual* (April 2005).

Dust and Noise

- Dust and noise control measures should be addressed and included in the construction plans to ensure that nearby residential and other sensitive land uses within the Study Area are not adversely affected during construction activities. If dust suppressants are proposed to be used, we recommend the use of non-chloride based compounds to protect water quality.
- The Project File/ESR should consider the potential impacts of increased noise levels during the operation of the undertaking given the potentially higher traffic volumes resulting from this project. The proponent should explore all potential measures to mitigate significant noise impacts during the assessment of alternatives.

Servicing and Facilities

- Any facility that releases emissions to the atmosphere, discharges contaminants to ground or surface water, provides potable water supplies, or stores, transports or disposes of waste must have a Certificate of Approval before it can operate lawfully. Please consult with the Environmental Assessment and Approvals Branch to determine whether a new or amended Certificate of Approval will be required for any proposed infrastructure.
- We recommend referring to MOE's "D-Series" guidelines – *Land Use Compatibility* to ensure that all applicable Ministry procedures are followed in planning for any infrastructure or facilities related to wastewater, pipelines, landfills or industrial uses.

Contaminated Soils

- Since the removal or movement of soils may be required, appropriate tests to determine contaminant levels from previous land uses or dumping should be undertaken. If the soils are contaminated, you must determine how and where they are to be disposed of, consistent with *Part XV.1 of the Environmental Protection Act (EPA)* and Ontario Regulation 153/04, *Records of Site Condition*, which details the new requirements related to site assessment and clean up. We recommend contacting the MOE Toronto District Office in Toronto for further consultation if contaminated sites are present.
- The location of any underground storage tanks should be included in the Project File/ESR. Measures should be identified to ensure the integrity of these tanks and to ensure an appropriate response in the event of a spill. The MOE Spills Action Centre must be contacted in such an event.
- Any current or historical waste disposal sites should be identified in the Project File/ESR. The status of these sites should be determined to confirm whether approval pursuant to Section 46

of the *Environmental Protection Act* may be required for land uses on former disposal sites.

- The Project File/ESR should identify any underground transmission lines in the Study Area. The owners should be consulted to avoid impacts to this infrastructure, including potential spills.

Mitigation and Monitoring

- Design and construction reports and plans should be based on a best management approach that centres on the prevention of impacts, protection of the existing environment, and opportunities for rehabilitation and enhancement of any impacted areas.
- All waste generated during construction must be disposed of in accordance with MOE requirements.
- Contractors must be made aware of all environmental considerations so that all environmental standards and commitments for both construction and operation are met. Mitigation measures should be clearly referenced in the Project File/ESR and regularly monitored during the construction stage of the project. In addition, we encourage proponents to conduct post-construction monitoring to ensure all mitigation measures have been effective and are functioning properly. The proponent's construction and post-construction monitoring plans should be documented in the Project File/ESR.

Planning and Policy

- The 2005 *Provincial Policy Statement* contains policies that protect Ontario's Natural Heritage. Applicable policies should be referenced in the Project File/ESR, and the proponent should demonstrate how this proposed project is consistent with these policies. You may wish to consider consulting with the Ministry of Municipal Affairs & Housing in this matter.
- The *Places to Grow Plan* contains policies which guide decisions on a range of issues such as infrastructure planning and land-use planning to ensure that stronger and more prosperous communities are built in the Greater Golden Horseshoe. The Project File/ESR should demonstrate how this project adheres to the relevant policies of the *Places to Grow Plan*, including Section 3, which contain policies for Infrastructure to Support Growth.

Class EA Process

- The Project File/ESR should provide clear and complete documentation of the planning process in order to allow traceability of decision-making. It must also demonstrate how the consultation provisions of the Class EA have been fulfilled, including documentation of all public consultation efforts undertaken during the planning process. Additionally, it should identify all concerns that were raised and how they have been addressed throughout the planning process. The Class EA also directs proponents to include copies of comments submitted on the project by interested stakeholders, and the proponent's responses to these comments.
- The Class EA requires the consideration of the effects of each alternative on all aspects of the environment. The Project File/ESR should include a level of detail (e.g. hydrogeological investigations, terrestrial and aquatic assessments) such that all potential impacts can be identified and appropriate mitigation measures can be developed. Any supporting studies conducted during the Class EA process should be referenced and included as part of the Project File/ESR.
- Please include in the Project File/ESR a list of all subsequent permits or other approvals that may be required for the implementation of the preferred alternative, including Permits to Take

Water, Certificates of Approval or other ministerial approvals, approval under the *Canadian Environmental Assessment Act* (CEAA), and conservation authority permits.

- Please note that MOE guidelines and other information related to the issues noted above are available at www.ene.gov.on.ca under the publications link. We encourage the proponent to review all the available guides and to reference any relevant information in the Project File/ESR.

First Nations Consultation

- Please note that as part of the required stakeholder and agency consultation, proponents are advised to contact the Ministry of Aboriginal Affairs and the Department of Indian and Northern Affairs to determine potentially affected Aboriginal peoples in the project area. Please refer to the website <http://www.ene.gov.on.ca/en/eaab/aboriginal-resources.php> for a list of appropriate government contacts.
- Once identified, you are advised to provide notification directly to the Aboriginal peoples who may be affected by the project and provide them with an opportunity to participate in any planned public consultation sessions and comment on the project.

Thank you for the opportunity to comment on this project. Please ensure that Daniel Delaquis, MOE Central Region EA and Planning Coordinator, is placed on the project mailing list. We recommend a draft copy of the Project File/ESR be circulated to this office prior to the filing of the final draft, allowing approximately 30-days review time for the ministry's technical reviewers to provide comments. Please also forward our office the Notice of Completion and Project File/ESR when completed. Should you or any members of your project team have any questions regarding the above, please feel free to contact me at (416) 326-3525; I would be pleased to assist you.

Yours sincerely,



Daniel Delaquis
Environmental Resource Planner and EA Coordinator
Air, Pesticides and Environmental Planning

- c. Rod Adams, Toronto District Office, MOE
Central Region EA File
A & P File

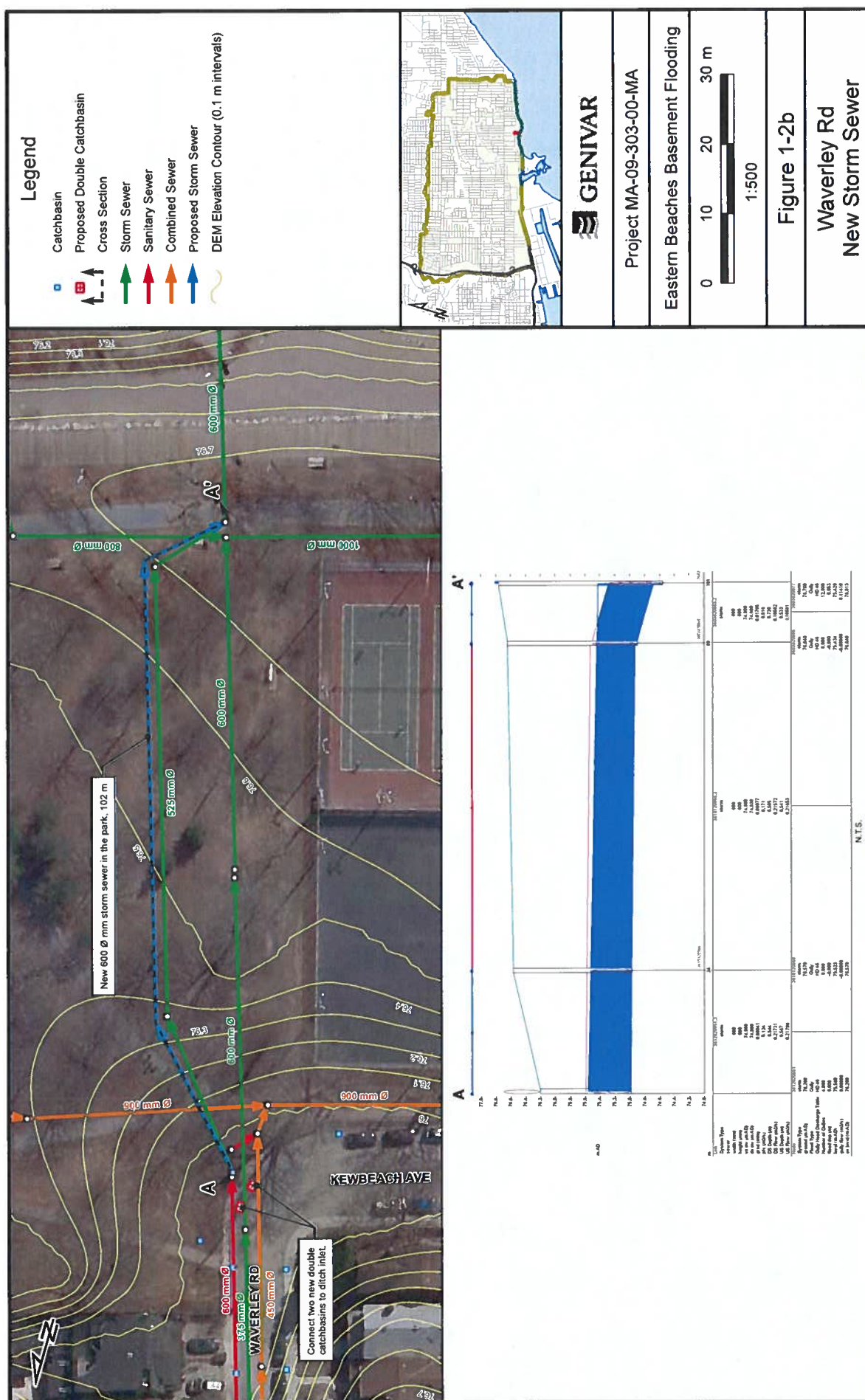
**INVESTIGATION OF BASEMENT FLOODING
EASTERN BEACHES (AREA 32)
PREFERRED ALTERNATIVE
REMEDIAL MEASURES
CONCEPTUAL DESIGN**

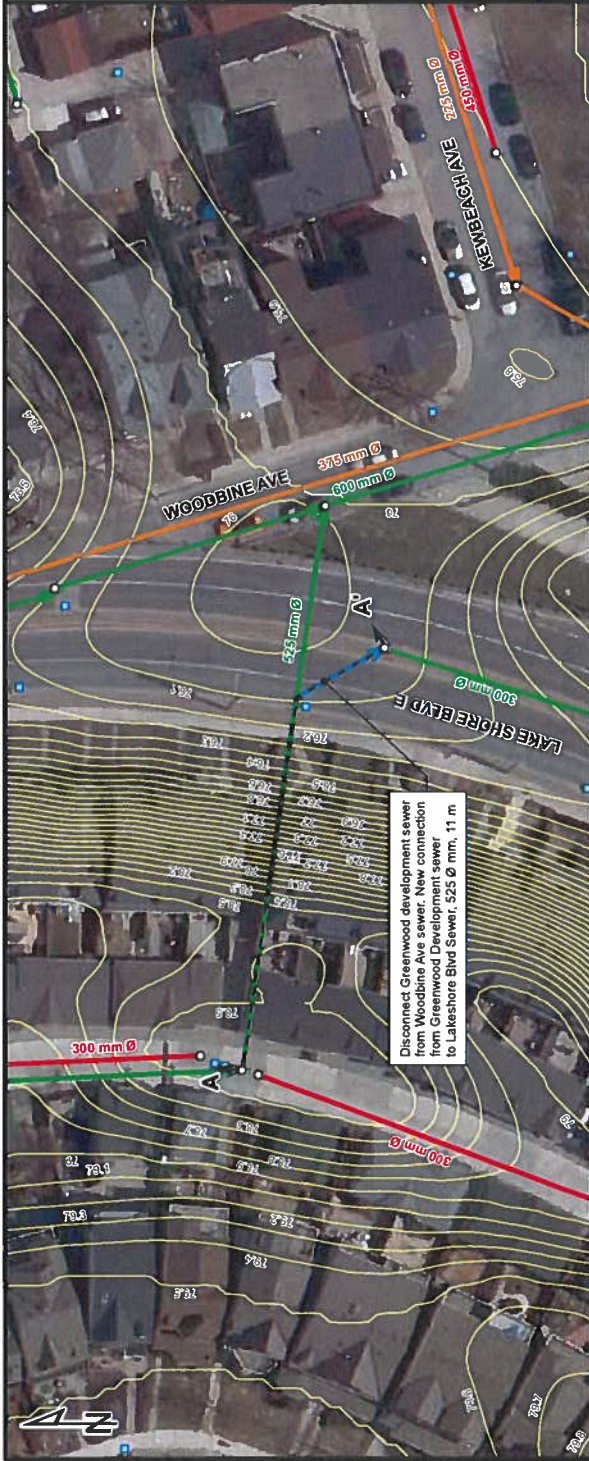
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Disconnect Greenwood development sewer from Woodbine Ave sewer. New connection from Greenwood Development sewer to Lakeshore Blvd Sewer, 525 Ø mm, 11 m.

Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



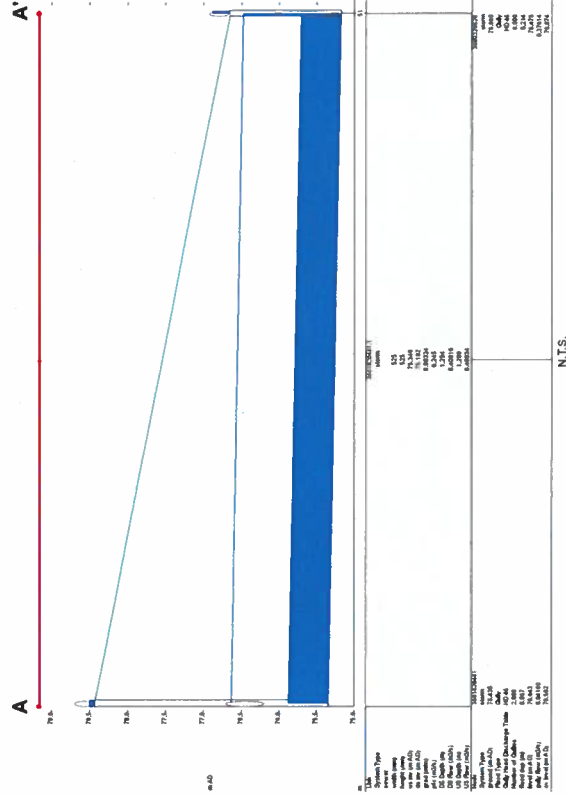
Project MA-09-303-00-MA

Eastern Beaches Basement Flooding



Figure 1-4b

Lake Shore Blvd
New Storm Sewer





- Legend**
- Catchbasin
 - Cross Section
 - Storm Sewer
 - Sanitary Sewer
 - Combined Sewer
 - Upgraded Storm Sewer
 - DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

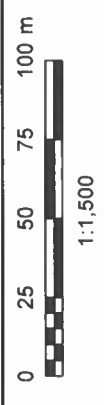
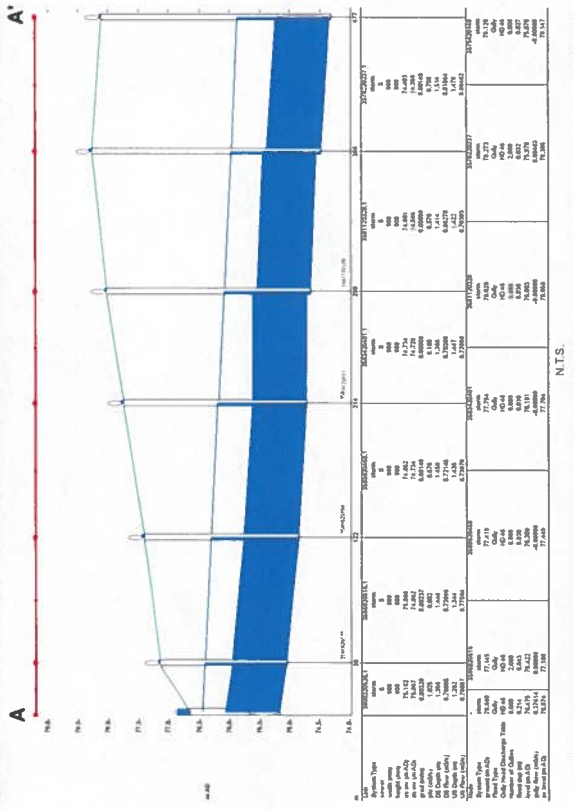
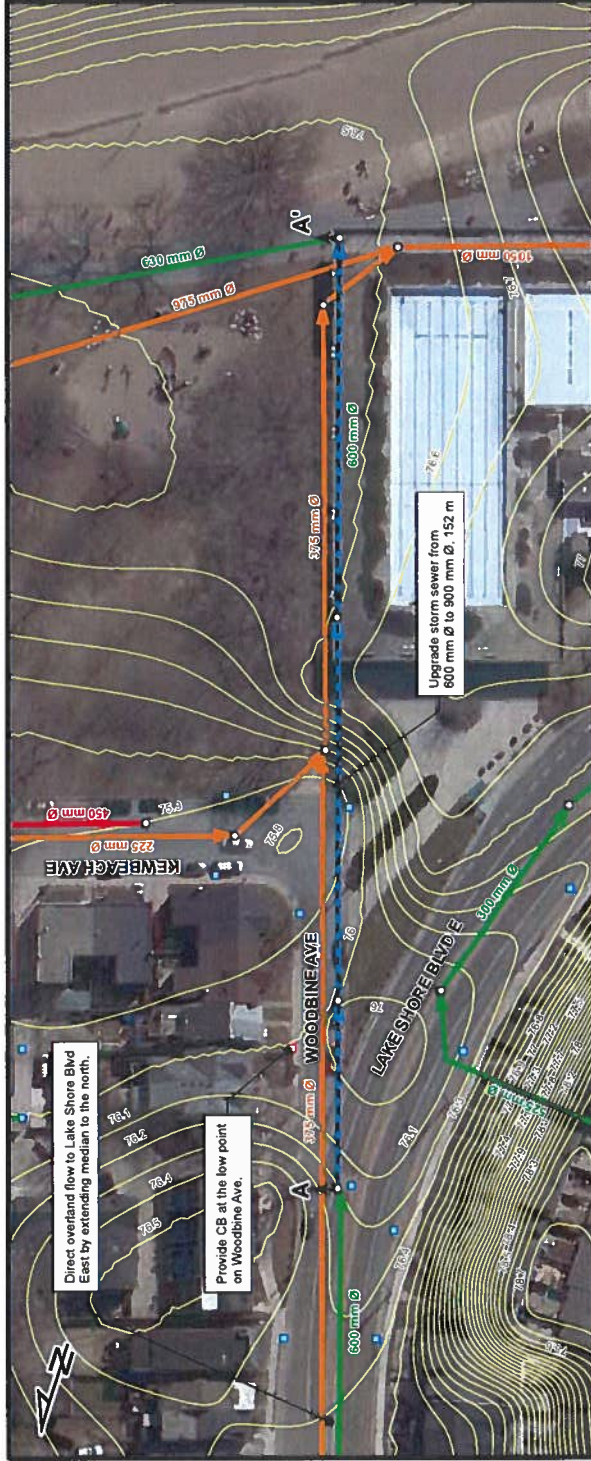


Figure 1-4c

Lake Shore Blvd
Upgrade Storm Sewer



N.T.S.



Legend

- Proposed Catch Basin
- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

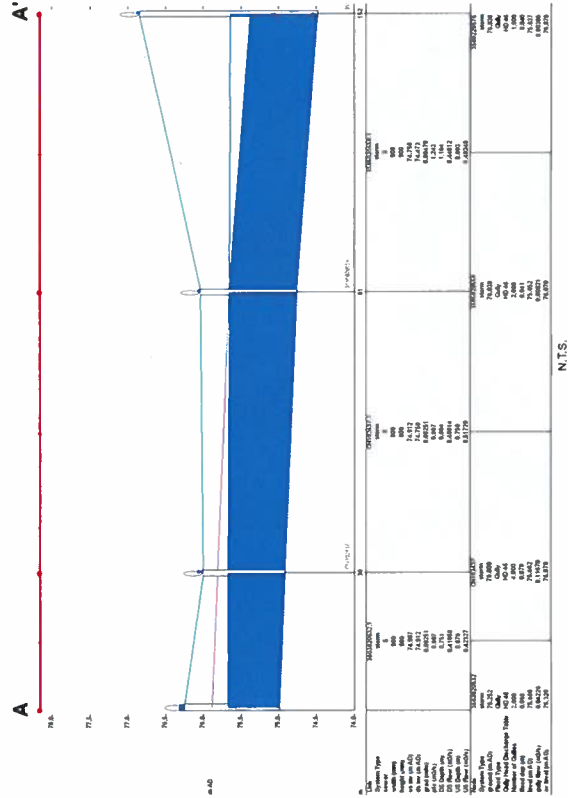
Eastern Beaches Basement Flooding

0 10 20 30 40 50 m

1:750

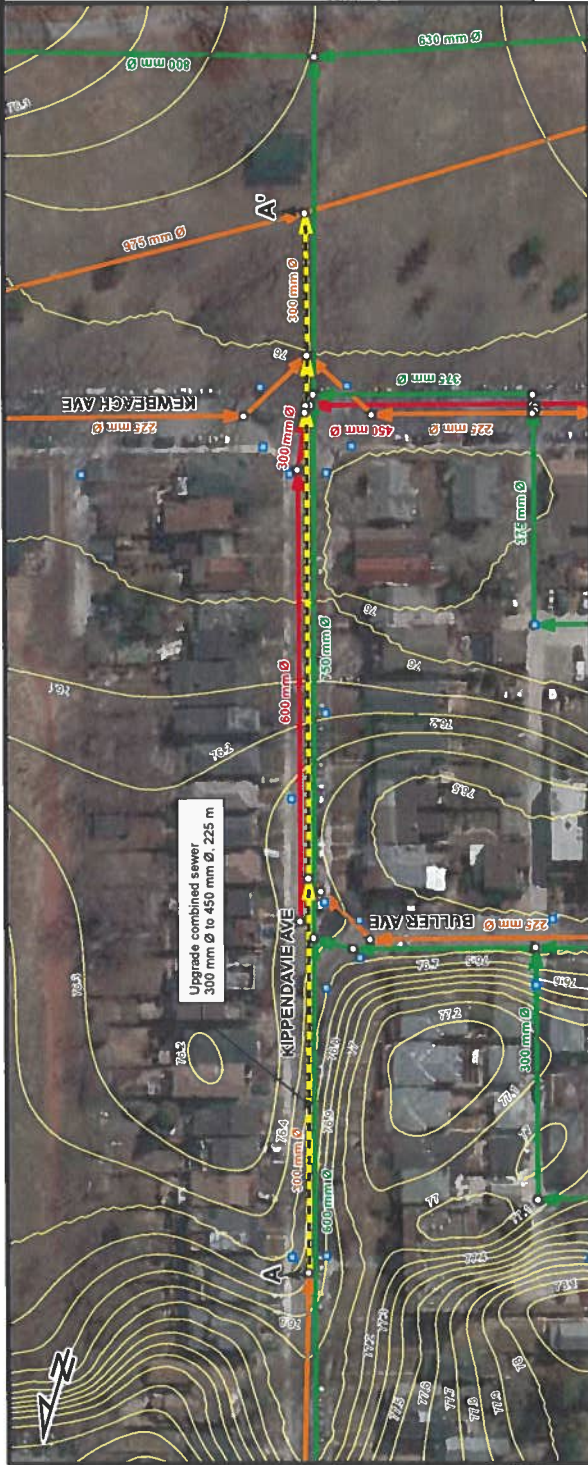
Figure 1-4d

Woodbine Ave
Upgrade Storm Sewer

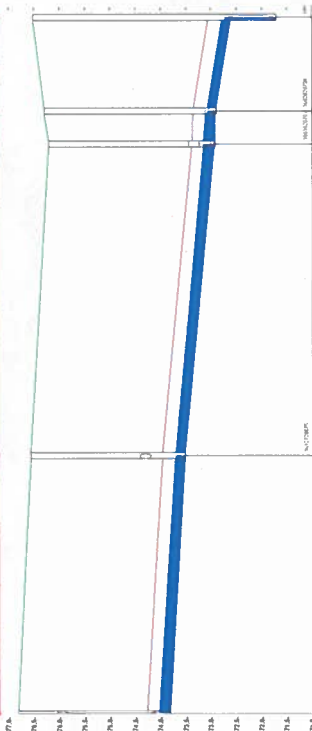


Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Combined Sewer
- DEM Elevation Contour (0.1 m intervals)



A' A'



Station	Profile	Ground	Proposed	Existing	Notes
10+00	72.5	72.5	72.5	72.5	
10+25	72.5	72.5	72.5	72.5	
10+50	72.5	72.5	72.5	72.5	
10+75	72.5	72.5	72.5	72.5	
11+00	72.5	72.5	72.5	72.5	
11+25	72.5	72.5	72.5	72.5	
11+50	72.5	72.5	72.5	72.5	
11+75	72.5	72.5	72.5	72.5	
12+00	72.5	72.5	72.5	72.5	

N.T.S.



Project MA-09-303-00-MA

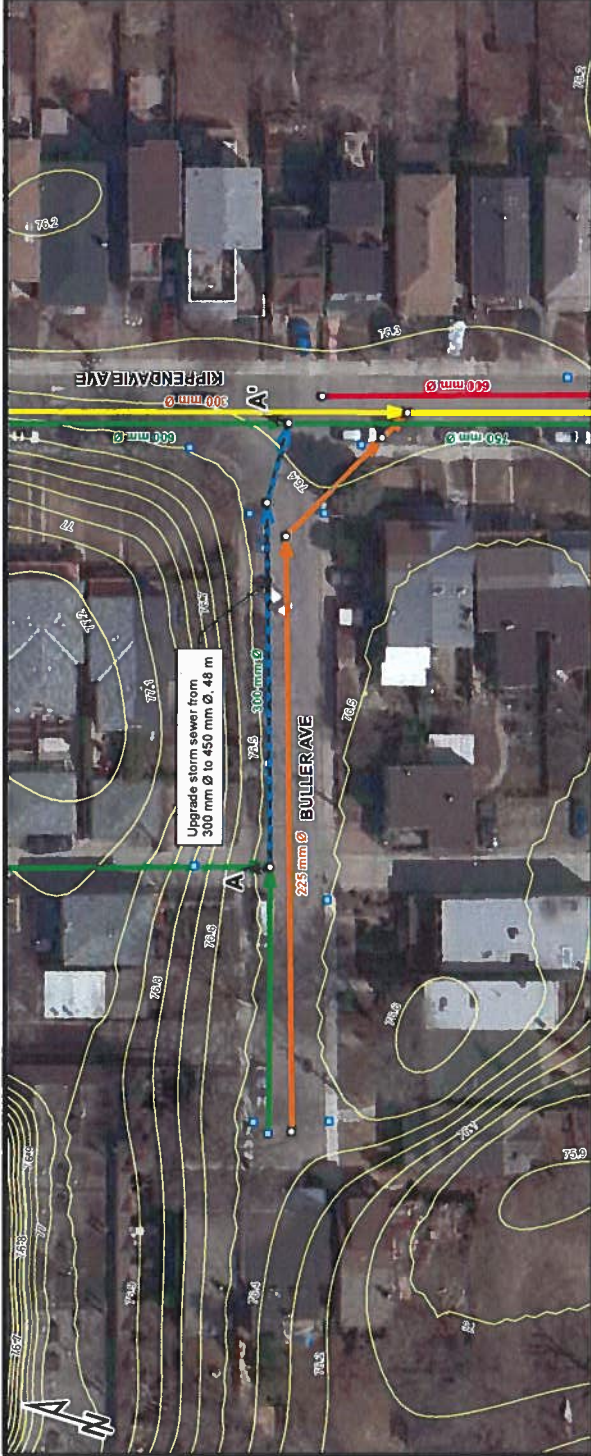
Eastern Beaches Basement Flooding

0 10 20 30 40 50 m

1:1,000

Figure 1-5a

Kippendavie Ave
Upgrade Combined Sewer



Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



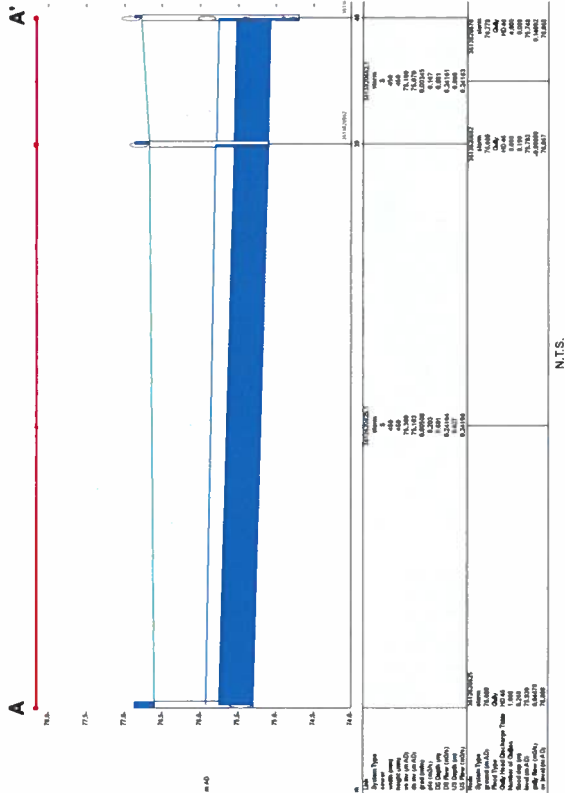
Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

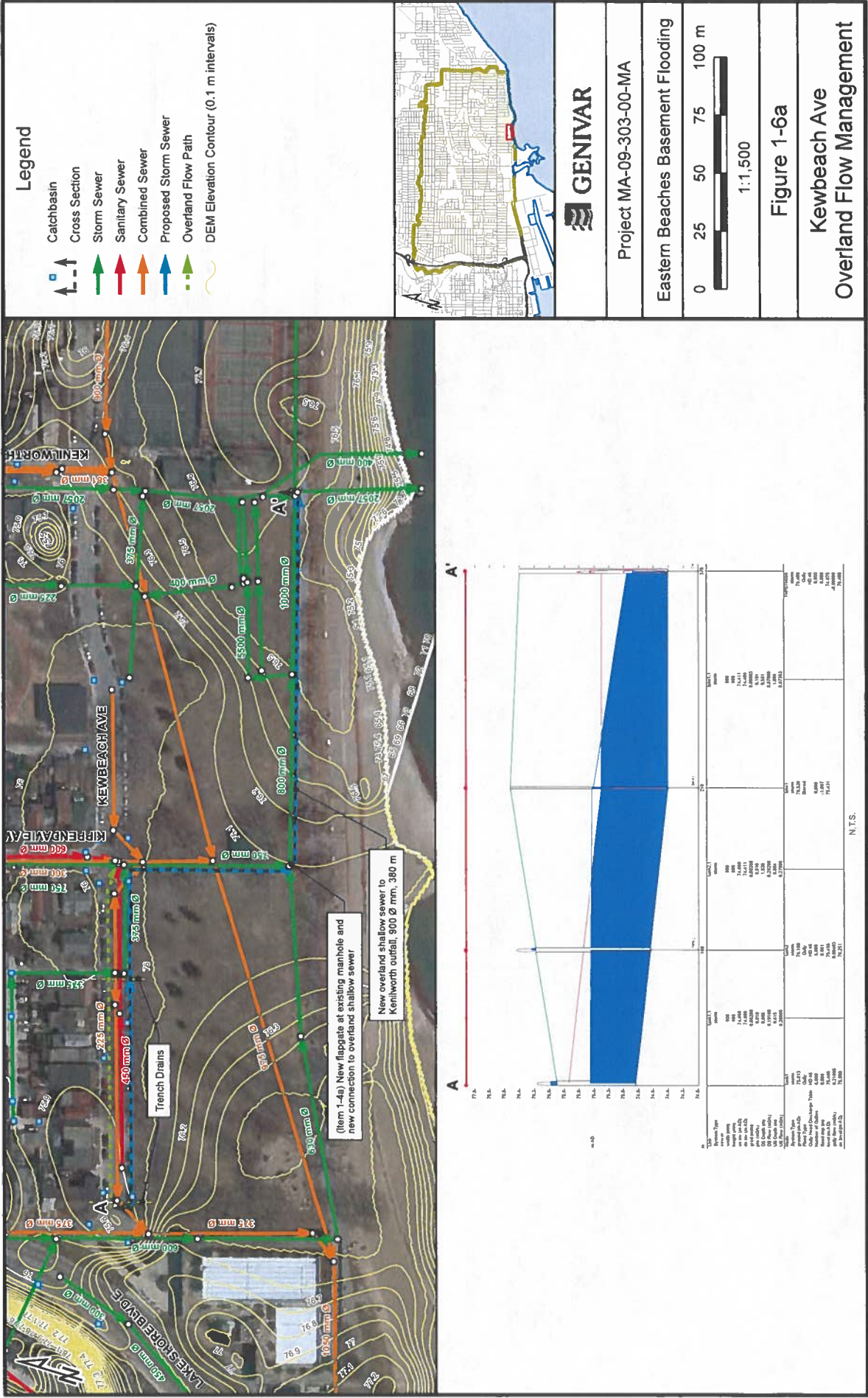


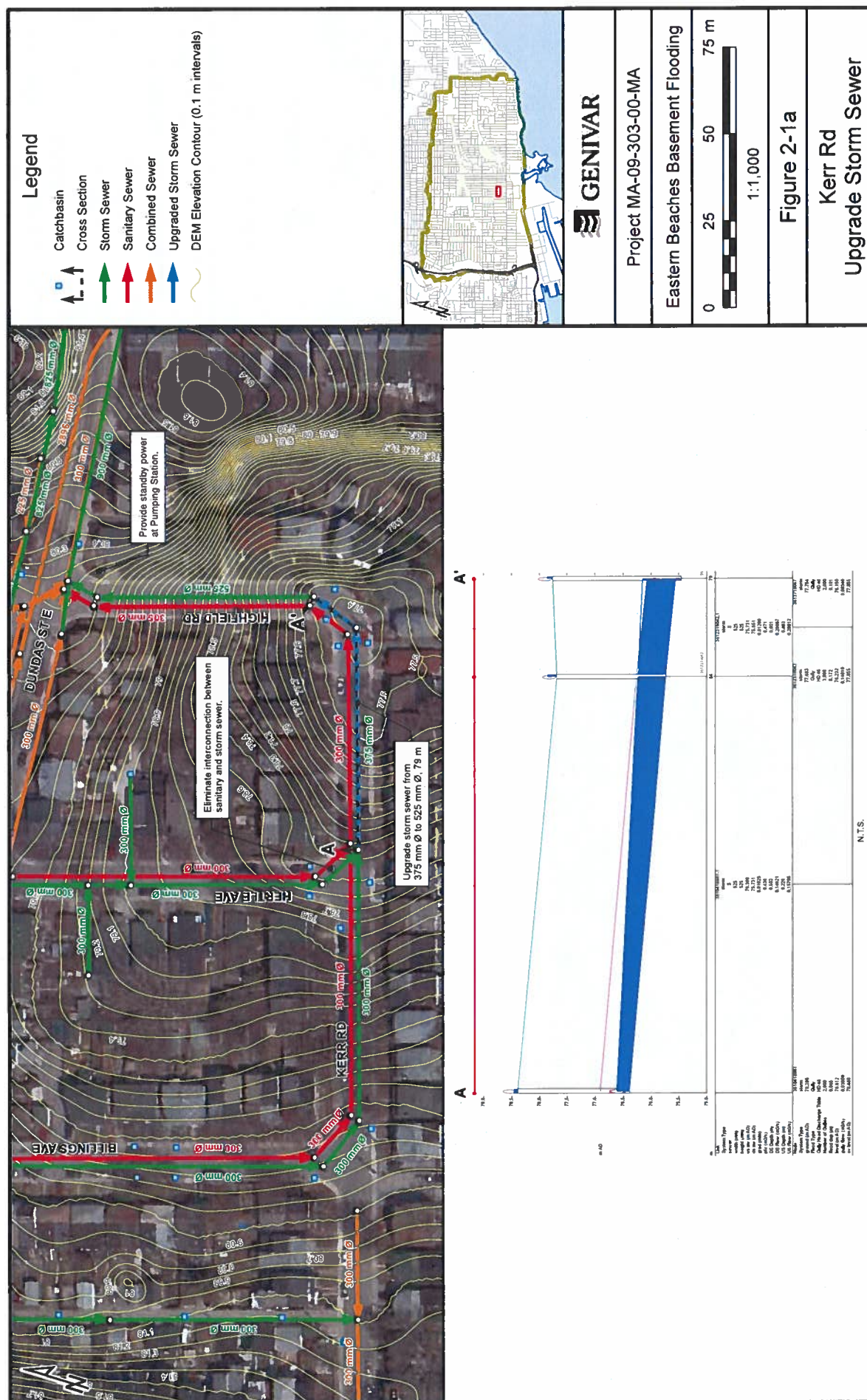
Figure 1-5b

Buller Ave
Upgrade Storm Sewer



N.T.S.







Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

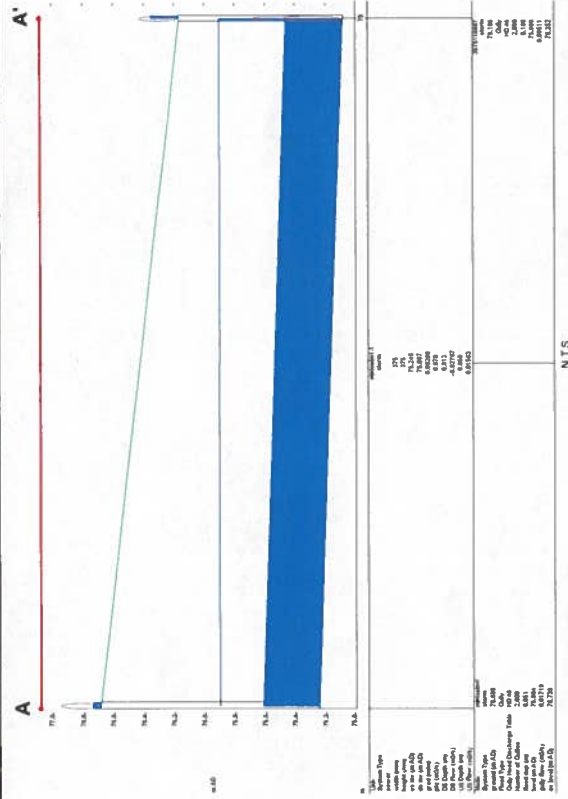
Eastern Beaches Basement Flooding

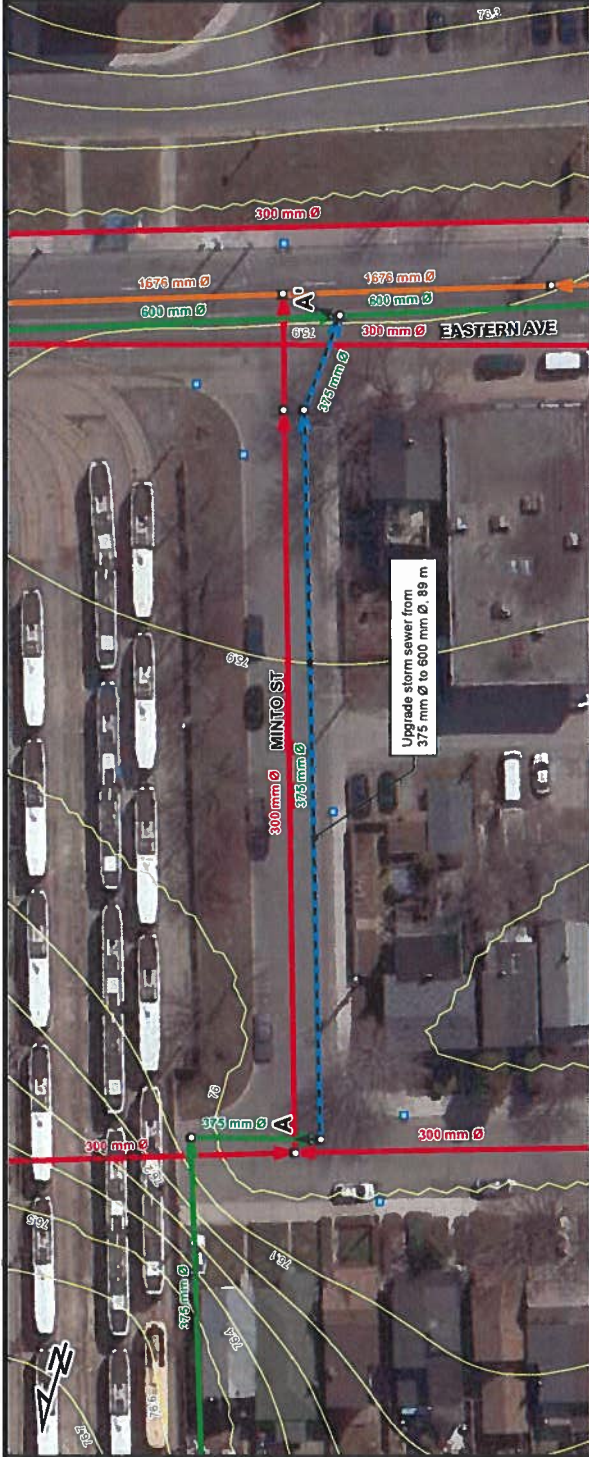


1:500

Figure 3-1a

Minto St
New Storm Sewer





Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

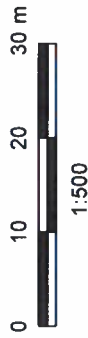
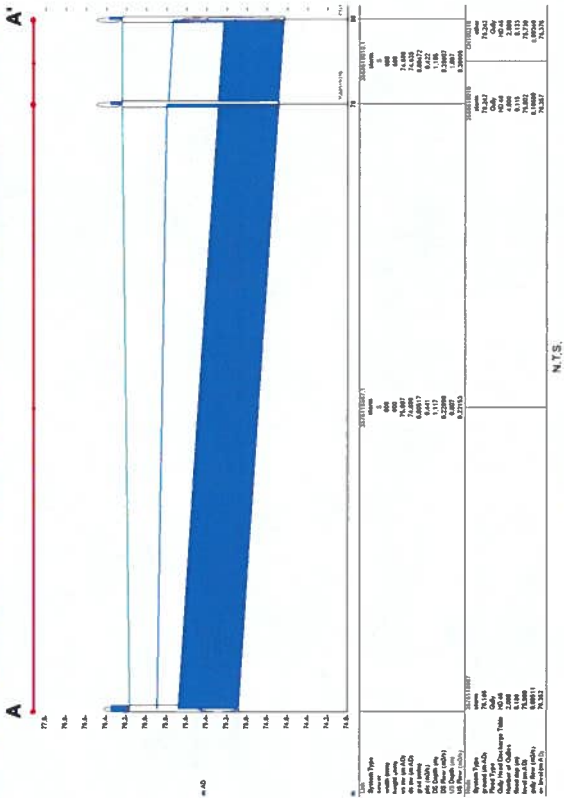


Figure 3-1b

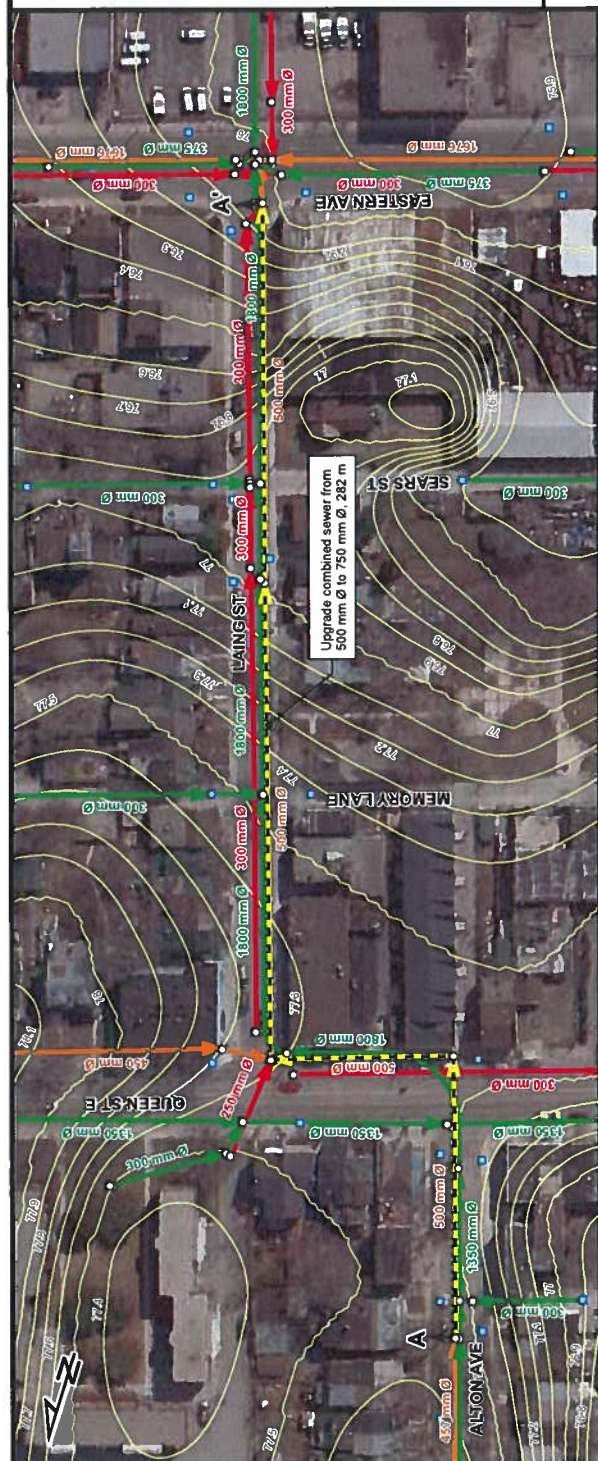
Minto St
Upgrade Storm Sewer



N.T.S.

Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Combined Sewer
- DEM Elevation Contour (0.1 m intervals)



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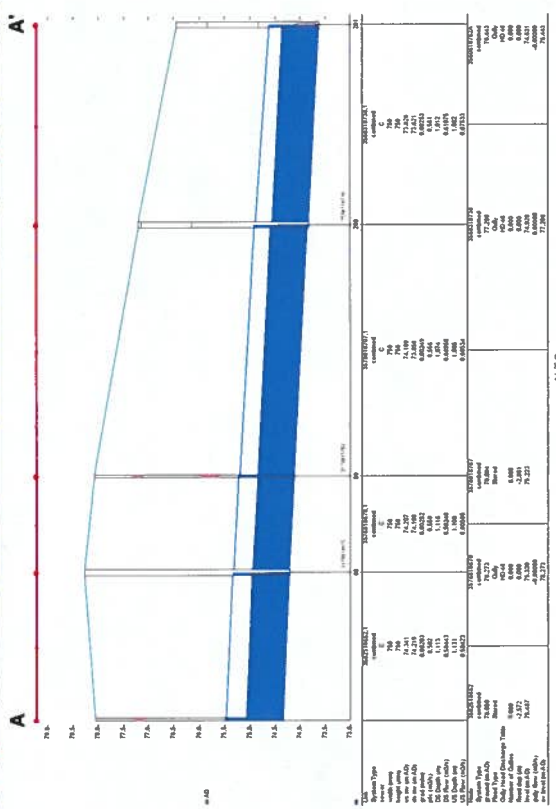
Eastern Beaches Basement Flooding

0 10 20 30 40 50 m

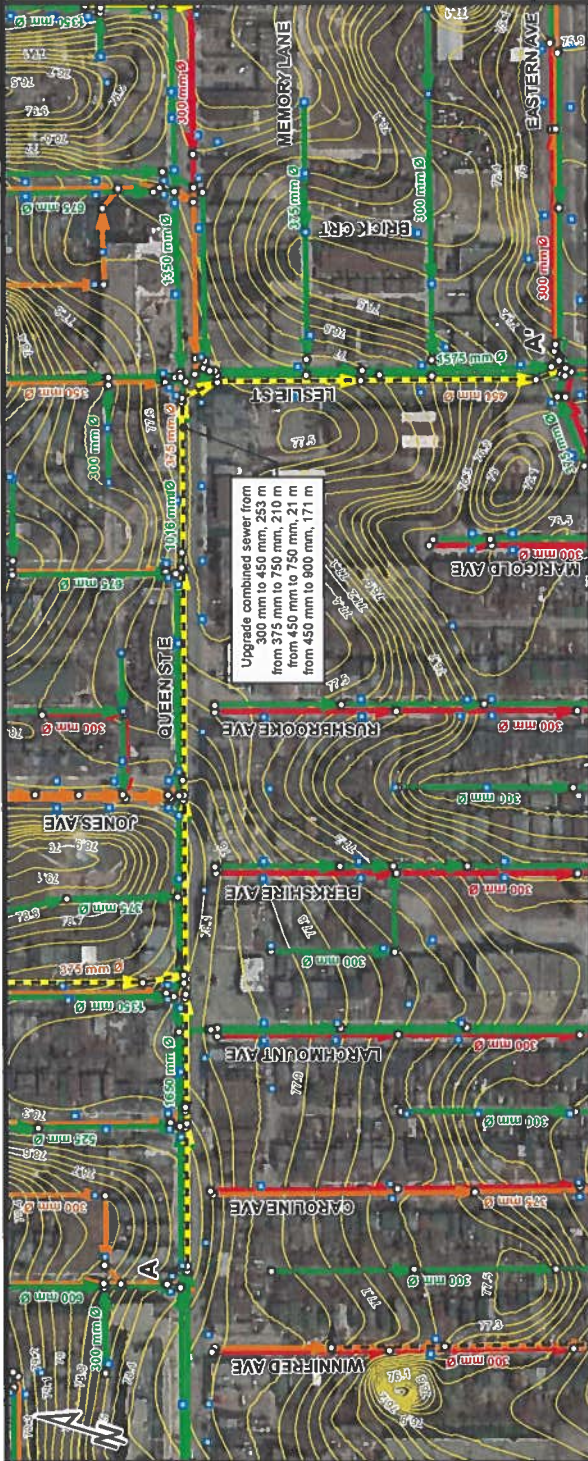
1:1,000

Figure 4-1a

Alton Ave - Laing St
Upgrade Combined Sewer



N.T.S.



Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Combined Sewer
- DEM Elevation Contour (0.1 m intervals)



GENIVAR

Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

0 50 100 150 m

1:2,500

Figure 5-1a

Queen Street

Upgrade Combined Sewer

A' - A



Station	78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100																																																																																																																																						
	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)	Station Type	Ground Elevation (m)	Flow (m³/s)																																																																																																																																			
1	Manhole	78.0	0.00	2	Manhole	78.5	0.00	3	Manhole	79.0	0.00	4	Manhole	79.5	0.00	5	Manhole	80.0	0.00	6	Manhole	80.5	0.00	7	Manhole	81.0	0.00	8	Manhole	81.5	0.00	9	Manhole	82.0	0.00	10	Manhole	82.5	0.00	11	Manhole	83.0	0.00	12	Manhole	83.5	0.00	13	Manhole	84.0	0.00	14	Manhole	84.5	0.00	15	Manhole	85.0	0.00	16	Manhole	85.5	0.00	17	Manhole	86.0	0.00	18	Manhole	86.5	0.00	19	Manhole	87.0	0.00	20	Manhole	87.5	0.00	21	Manhole	88.0	0.00	22	Manhole	88.5	0.00	23	Manhole	89.0	0.00	24	Manhole	89.5	0.00	25	Manhole	90.0	0.00	26	Manhole	90.5	0.00	27	Manhole	91.0	0.00	28	Manhole	91.5	0.00	29	Manhole	92.0	0.00	30	Manhole	92.5	0.00	31	Manhole	93.0	0.00	32	Manhole	93.5	0.00	33	Manhole	94.0	0.00	34	Manhole	94.5	0.00	35	Manhole	95.0	0.00	36	Manhole	95.5	0.00	37	Manhole	96.0	0.00	38	Manhole	96.5	0.00	39	Manhole	97.0	0.00	40	Manhole	97.5	0.00	41	Manhole	98.0	0.00	42	Manhole	98.5	0.00	43	Manhole	99.0	0.00	44	Manhole	99.5	0.00	45	Manhole	100.0	0.00

NTS



Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



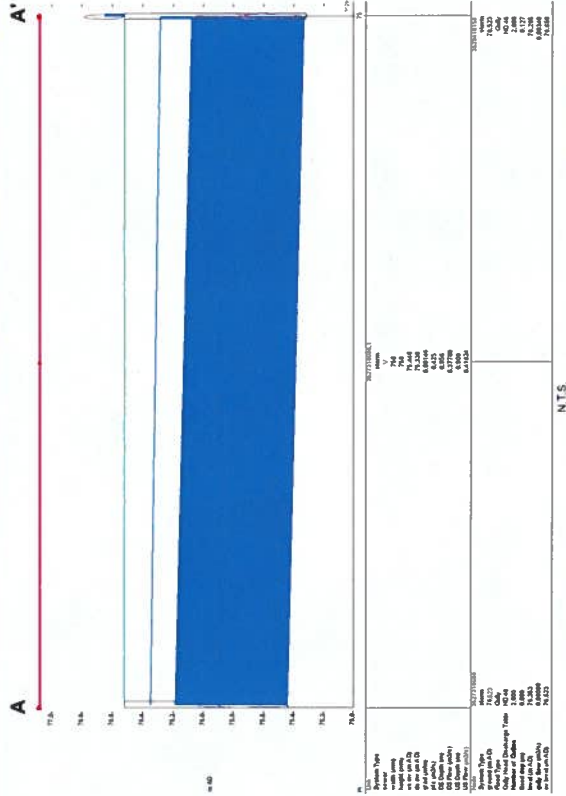
Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

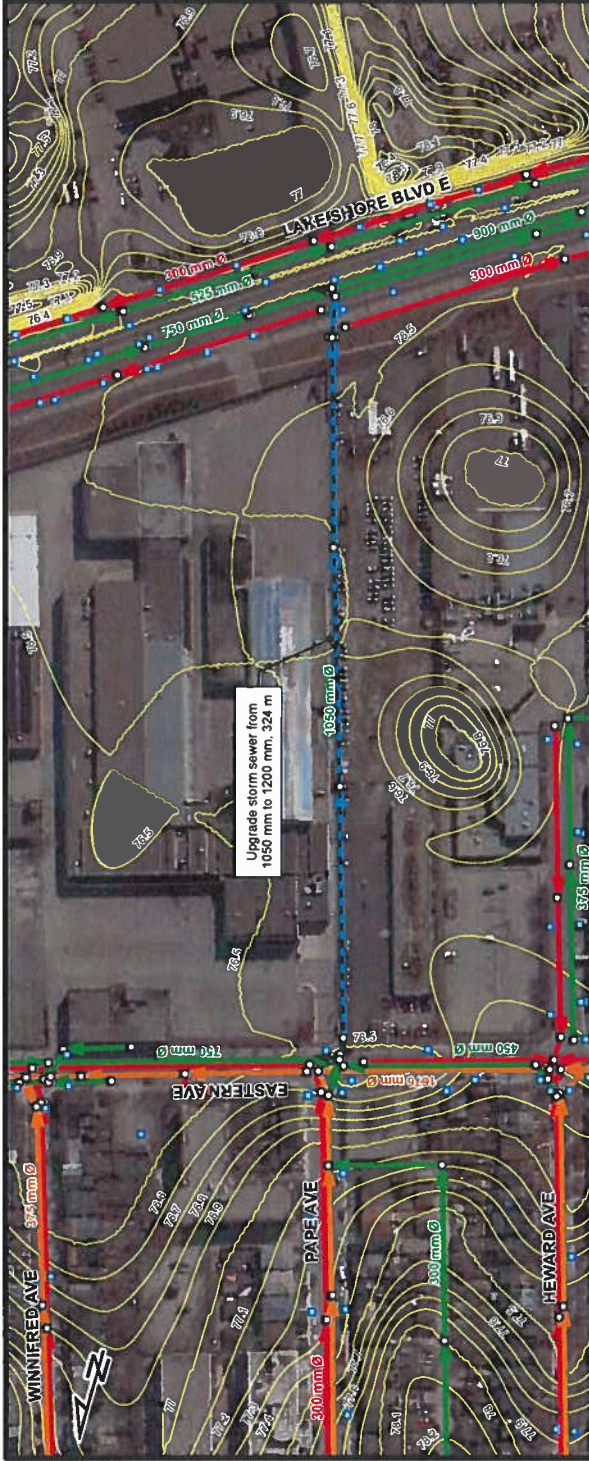


Figure 5-2b

Eastern Ave Upgrade Storm Sewer



NTS



Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

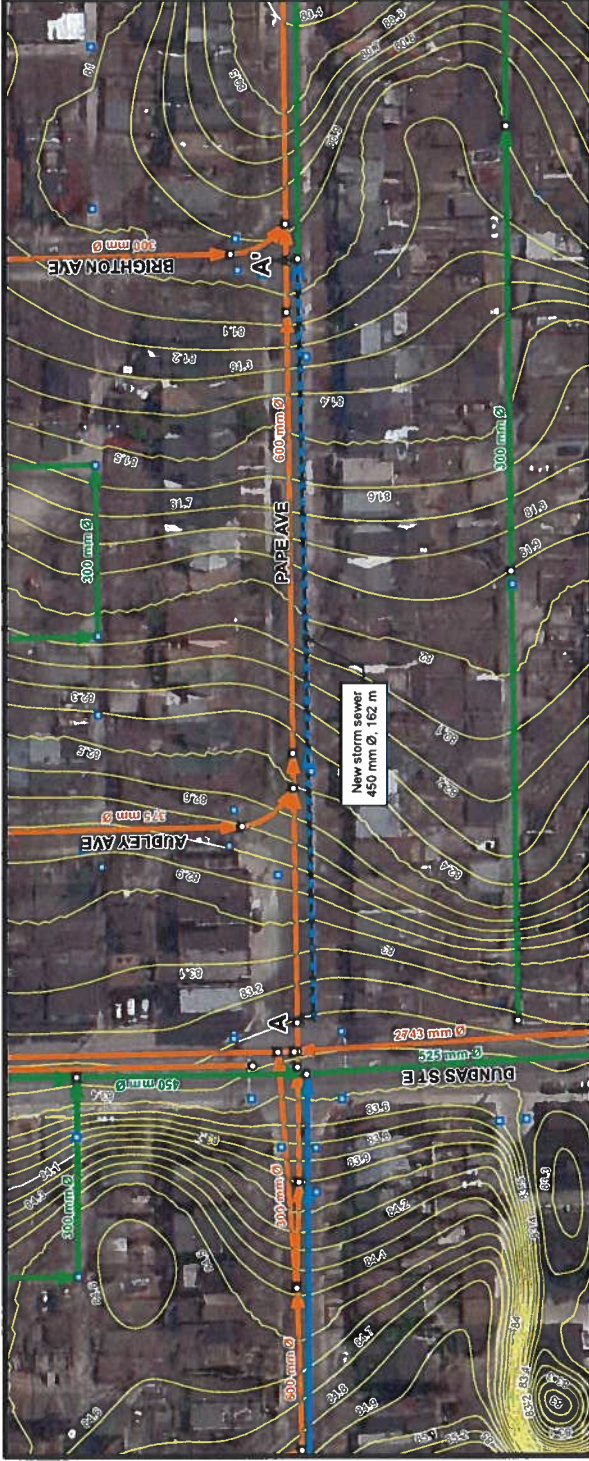


Figure 5-2d

Pape Ave
Upgrade Storm Sewer

A' ——— A

74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6
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Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

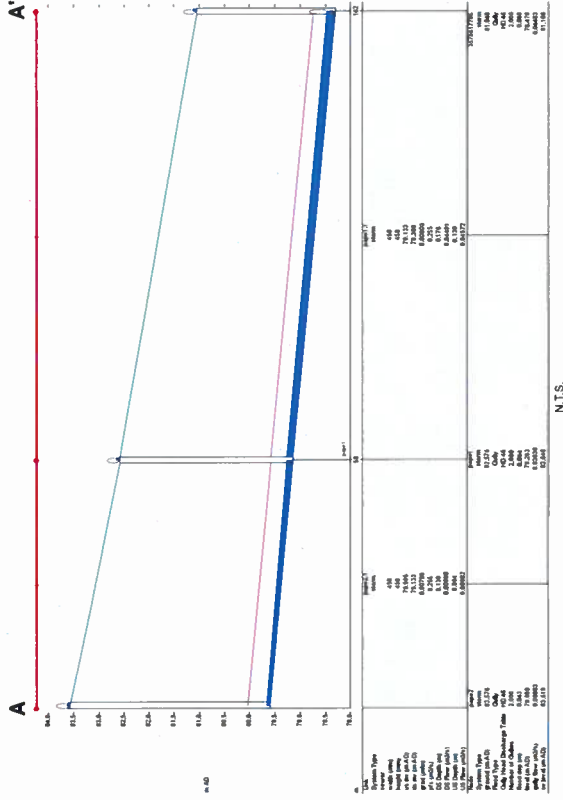
Eastern Beaches Basement Flooding



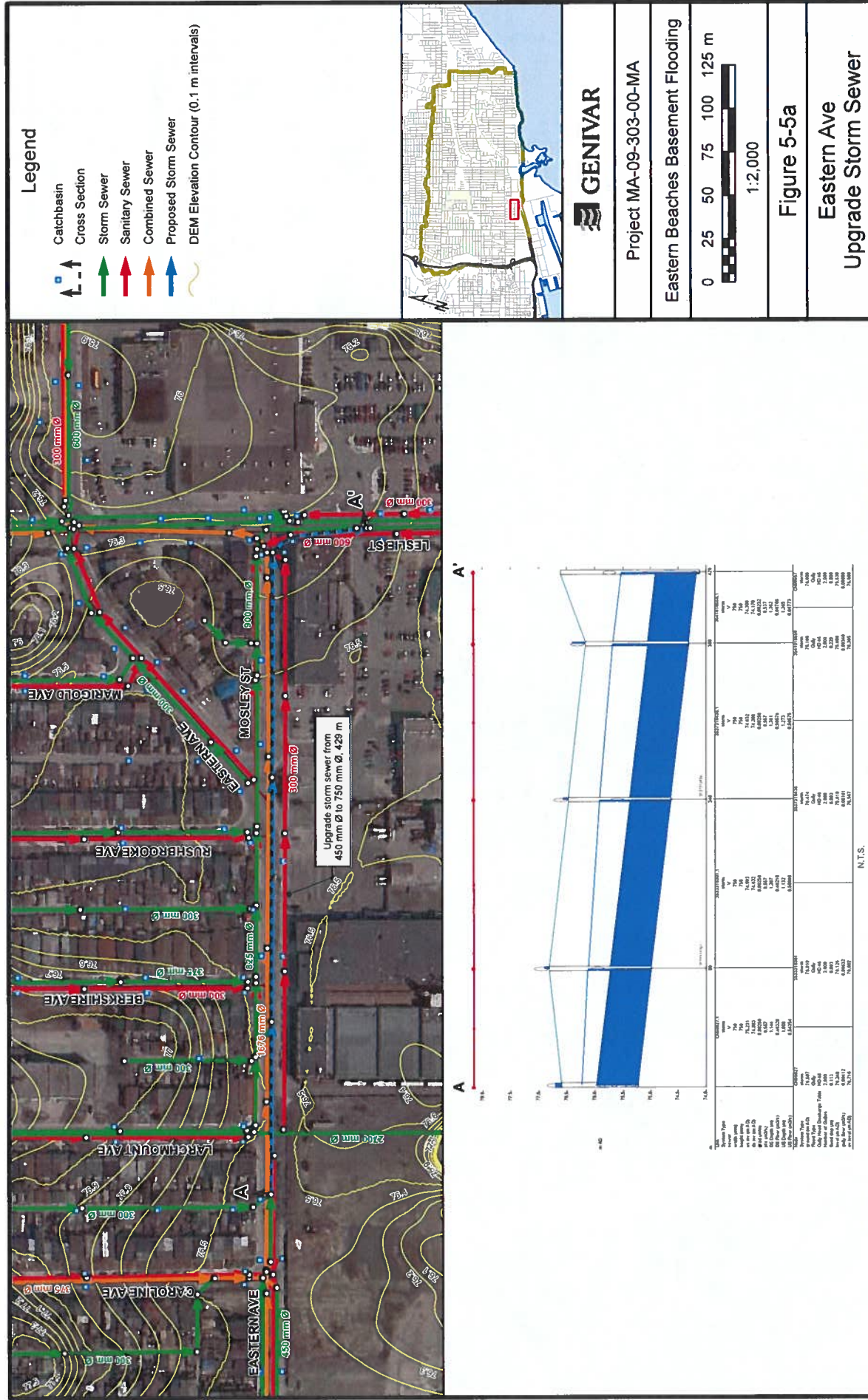
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Figure 5-3b

Pape Ave
New Storm Sewer



NTS





- Legend**
- Catchbasin
 - Cross Section
 - Storm Sewer
 - Sanitary Sewer
 - Combined Sewer
 - DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

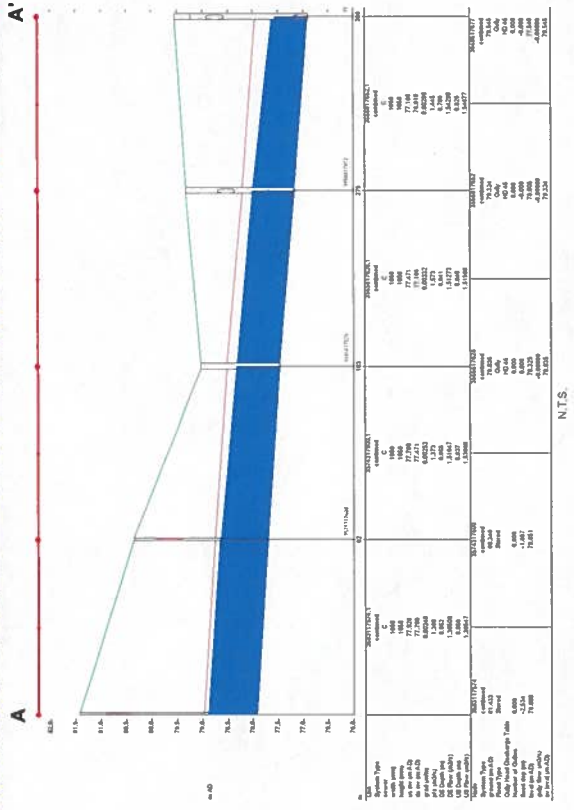
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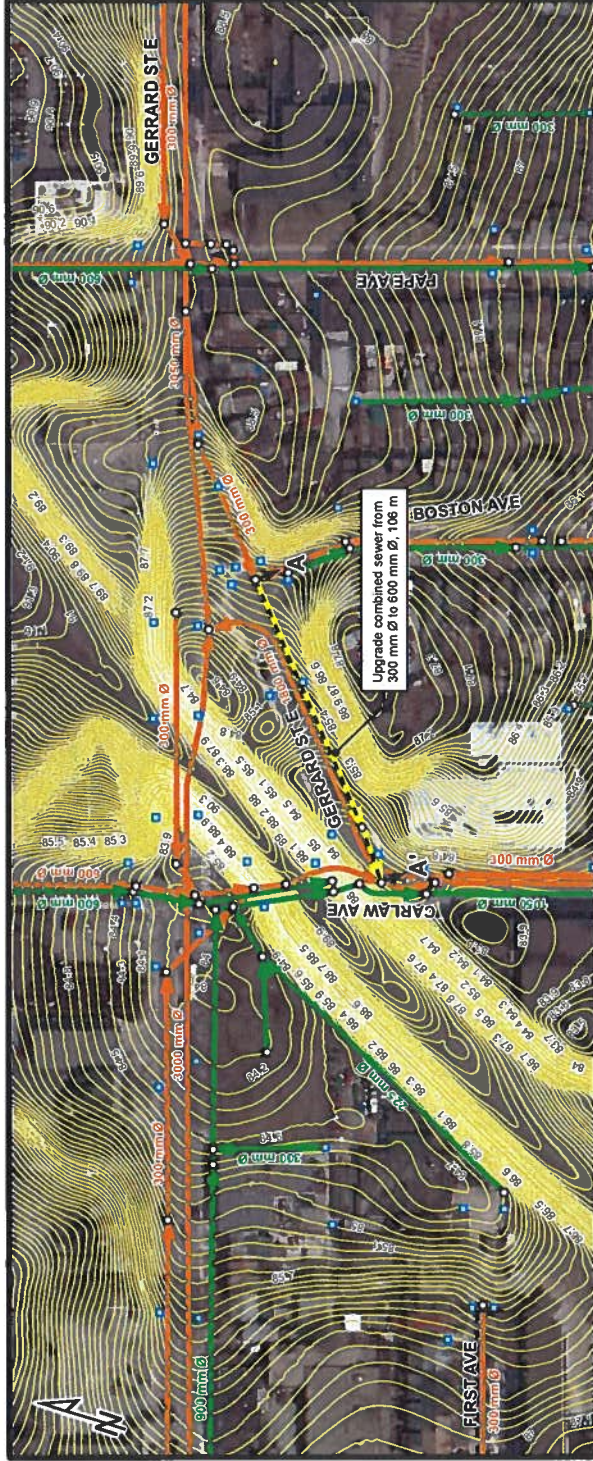
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Figure 6-2a

Carlaw Ave

Upgrade Combined Sewer





Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Combined Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

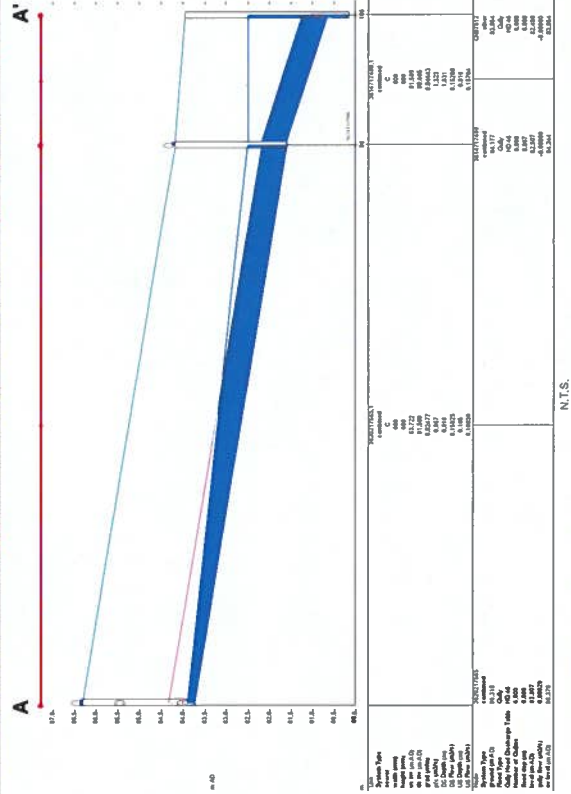
Eastern Beaches Basement Flooding

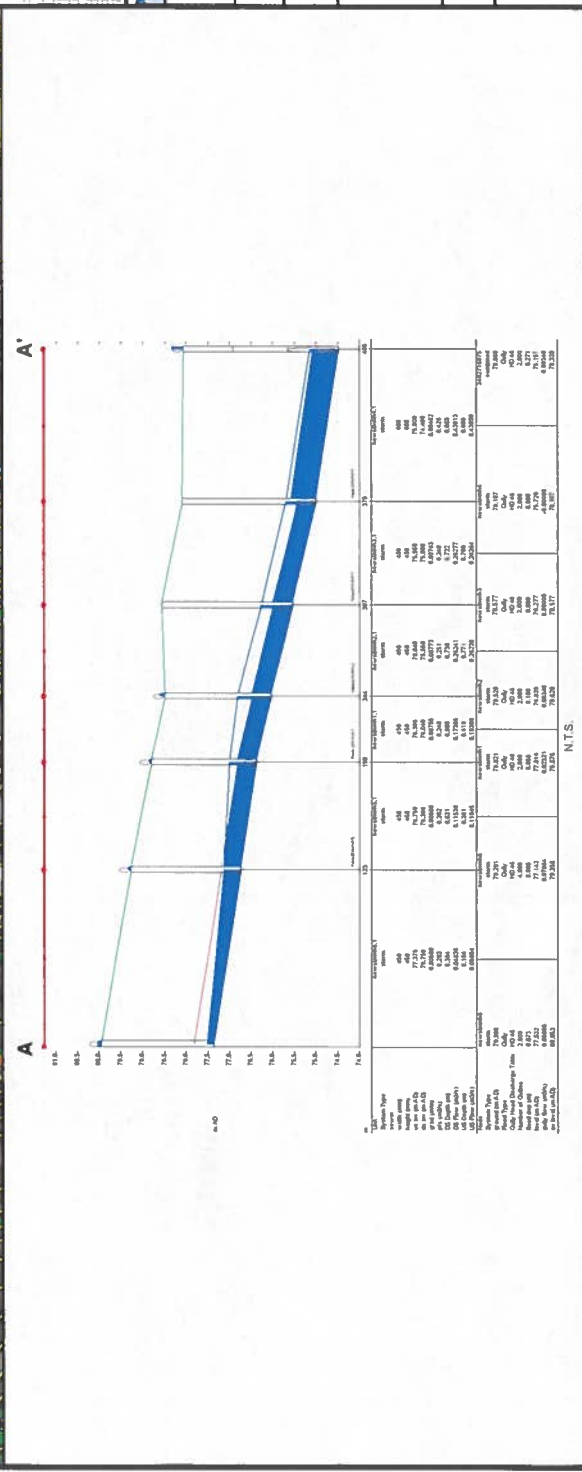


Figure 6-2b

Gerrard St

Upgrade Combined Sewer





GENIVAR

Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

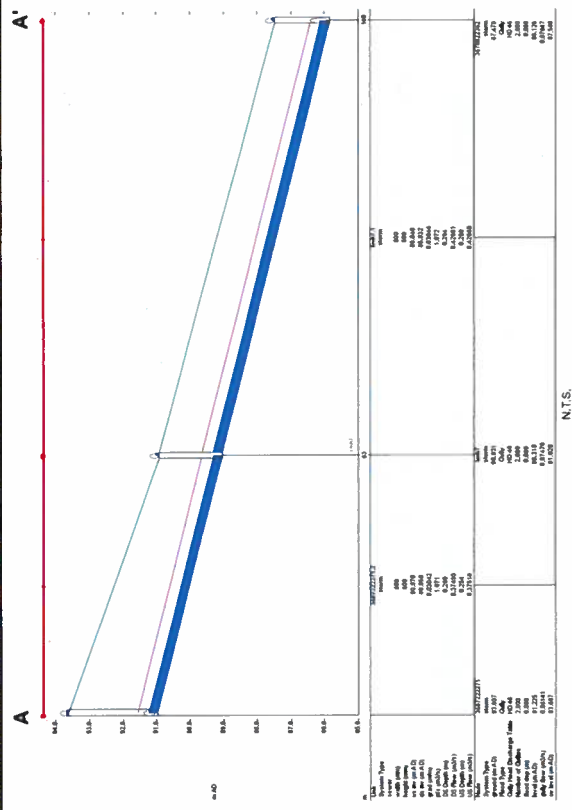
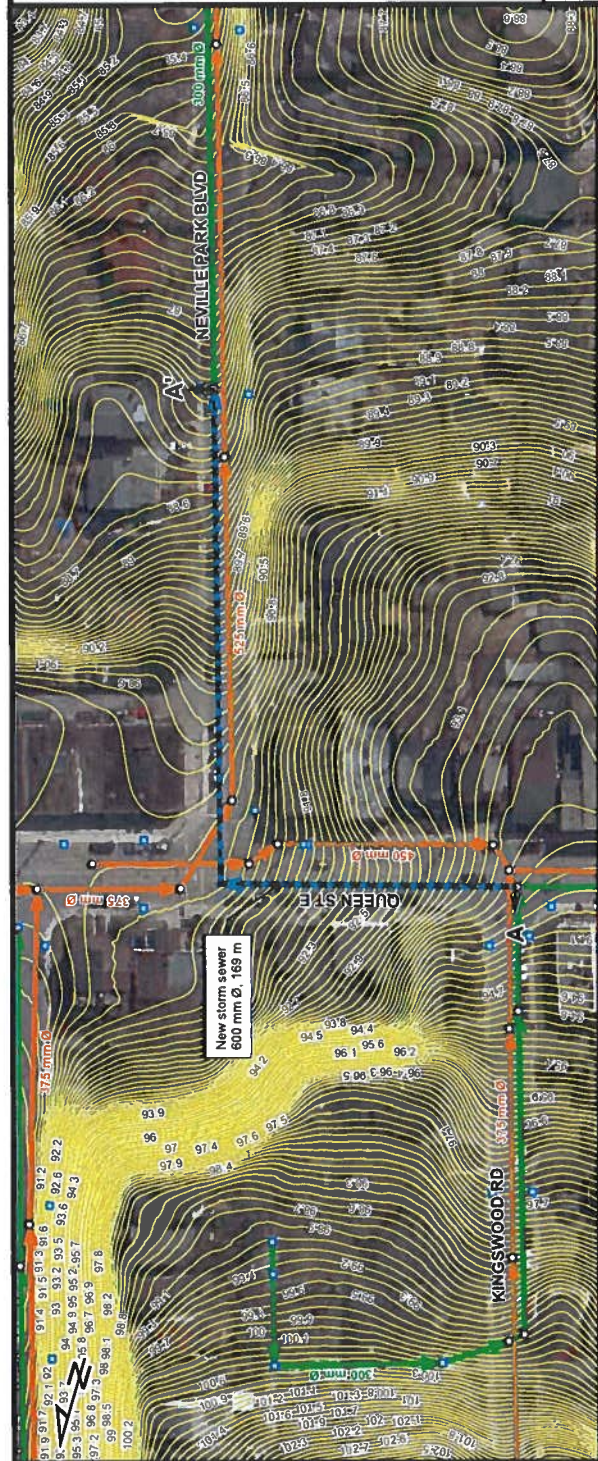
0 25 50 75 100 125 m

1:2,500

Figure 6-3a

Saulter St

New Storm Sewer



GENIVAR

Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

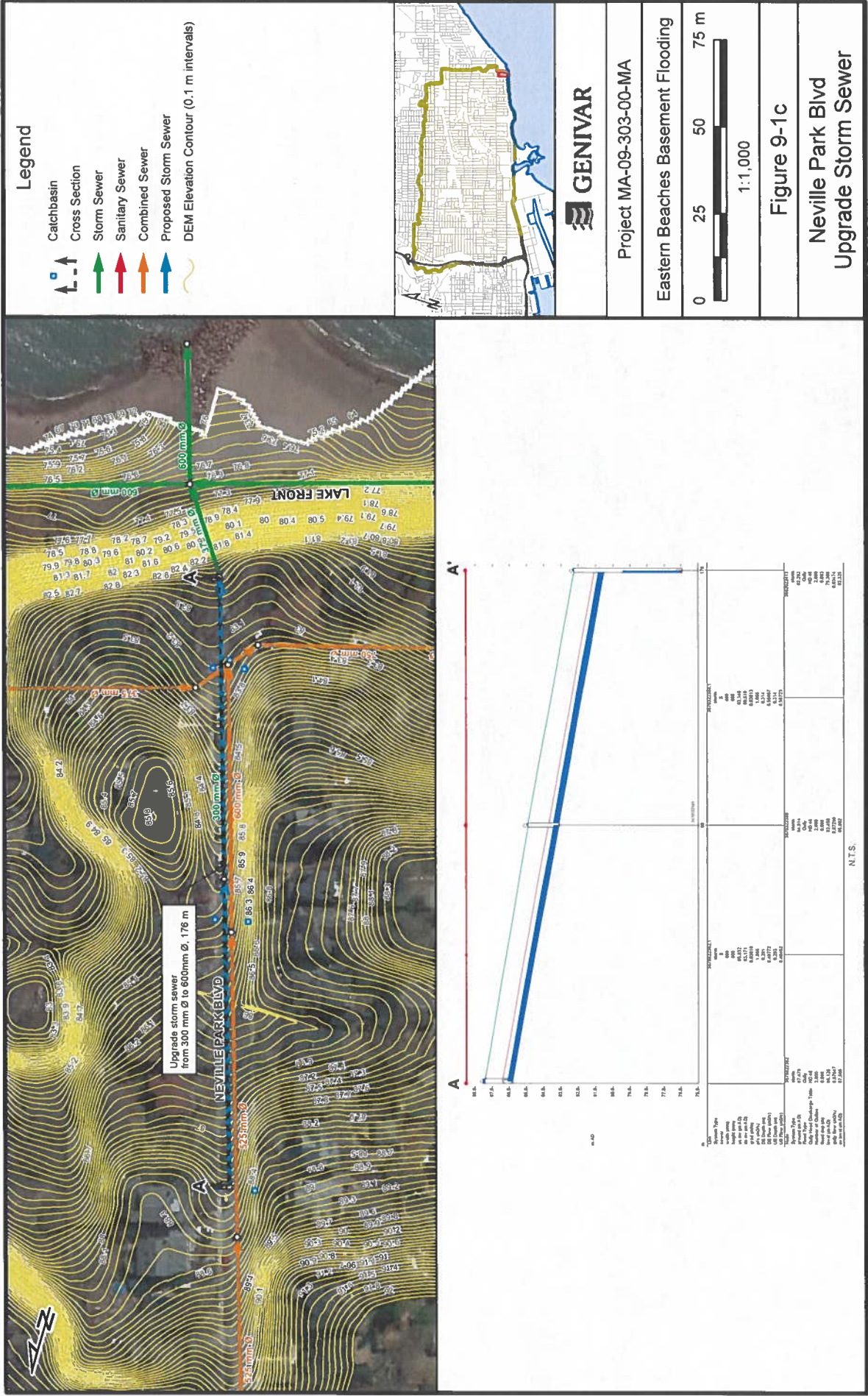
0 20 40 60 m

1:1,000

Figure 9-1b

Queen St E

New Storm Sewer



Station	Proposed Invert	Existing Invert	Notes
1+00	82.50	82.50	Start of upgrade
1+25	82.50	82.50	
1+50	82.50	82.50	
1+75	82.50	82.50	
2+00	82.50	82.50	End of upgrade
2+25	82.50	82.50	
2+50	82.50	82.50	
2+75	82.50	82.50	
3+00	82.50	82.50	
3+25	82.50	82.50	
3+50	82.50	82.50	
3+75	82.50	82.50	
4+00	82.50	82.50	
4+25	82.50	82.50	
4+50	82.50	82.50	
4+75	82.50	82.50	
5+00	82.50	82.50	
5+25	82.50	82.50	
5+50	82.50	82.50	
5+75	82.50	82.50	
6+00	82.50	82.50	
6+25	82.50	82.50	
6+50	82.50	82.50	
6+75	82.50	82.50	
7+00	82.50	82.50	
7+25	82.50	82.50	
7+50	82.50	82.50	
7+75	82.50	82.50	
8+00	82.50	82.50	
8+25	82.50	82.50	
8+50	82.50	82.50	
8+75	82.50	82.50	
9+00	82.50	82.50	
9+25	82.50	82.50	
9+50	82.50	82.50	
9+75	82.50	82.50	
10+00	82.50	82.50	
10+25	82.50	82.50	
10+50	82.50	82.50	
10+75	82.50	82.50	
11+00	82.50	82.50	
11+25	82.50	82.50	
11+50	82.50	82.50	
11+75	82.50	82.50	
12+00	82.50	82.50	
12+25	82.50	82.50	
12+50	82.50	82.50	
12+75	82.50	82.50	
13+00	82.50	82.50	
13+25	82.50	82.50	
13+50	82.50	82.50	
13+75	82.50	82.50	
14+00	82.50	82.50	
14+25	82.50	82.50	
14+50	82.50	82.50	
14+75	82.50	82.50	
15+00	82.50	82.50	
15+25	82.50	82.50	
15+50	82.50	82.50	
15+75	82.50	82.50	
16+00	82.50	82.50	
16+25	82.50	82.50	
16+50	82.50	82.50	
16+75	82.50	82.50	
17+00	82.50	82.50	
17+25	82.50	82.50	
17+50	82.50	82.50	
17+75	82.50	82.50	
18+00	82.50	82.50	
18+25	82.50	82.50	
18+50	82.50	82.50	
18+75	82.50	82.50	
19+00	82.50	82.50	
19+25	82.50	82.50	
19+50	82.50	82.50	
19+75	82.50	82.50	
20+00	82.50	82.50	
20+25	82.50	82.50	
20+50	82.50	82.50	
20+75	82.50	82.50	
21+00	82.50	82.50	
21+25	82.50	82.50	
21+50	82.50	82.50	
21+75	82.50	82.50	
22+00	82.50	82.50	
22+25	82.50	82.50	
22+50	82.50	82.50	
22+75	82.50	82.50	
23+00	82.50	82.50	
23+25	82.50	82.50	
23+50	82.50	82.50	
23+75	82.50	82.50	
24+00	82.50	82.50	
24+25	82.50	82.50	
24+50	82.50	82.50	
24+75	82.50	82.50	
25+00	82.50	82.50	
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25+75	82.50	82.50	
26+00	82.50	82.50	
26+25	82.50	82.50	
26+50	82.50	82.50	
26+75	82.50	82.50	
27+00	82.50	82.50	
27+25	82.50	82.50	
27+50	82.50	82.50	
27+75	82.50	82.50	
28+00	82.50	82.50	
28+25	82.50	82.50	
28+50	82.50	82.50	
28+75	82.50	82.50	
29+00	82.50	82.50	
29+25	82.50	82.50	
29+50	82.50	82.50	
29+75	82.50	82.50	
30+00	82.50	82.50	
30+25	82.50	82.50	
30+50	82.50	82.50	
30+75	82.50	82.50	
31+00	82.50	82.50	
31+25	82.50	82.50	
31+50	82.50	82.50	
31+75	82.50	82.50	
32+00	82.50	82.50	
32+25	82.50	82.50	
32+50	82.50	82.50	
32+75	82.50	82.50	
33+00	82.50	82.50	
33+25	82.50	82.50	
33+50	82.50	82.50	
33+75	82.50	82.50	
34+00	82.50	82.50	
34+25	82.50	82.50	
34+50	82.50	82.50	
34+75	82.50	82.50	
35+00	82.50	82.50	
35+25	82.50	82.50	
35+50	82.50	82.50	
35+75	82.50	82.50	
36+00	82.50	82.50	
36+25	82.50	82.50	
36+50	82.50	82.50	
36+75	82.50	82.50	
37+00	82.50	82.50	
37+25	82.50	82.50	
37+50	82.50	82.50	
37+75	82.50	82.50	
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38+50	82.50	82.50	
38+75	82.50	82.50	
39+00	82.50	82.50	
39+25	82.50	82.50	
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39+75	82.50	82.50	
40+00	82.50	82.50	
40+25	82.50	82.50	
40+50	82.50	82.50	
40+75	82.50	82.50	
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41+50	82.50	82.50	
41+75	82.50	82.50	
42+00	82.50	82.50	
42+25	82.50	82.50	
42+50	82.50	82.50	
42+75	82.50	82.50	
43+00	82.50	82.50	
43+25	82.50	82.50	
43+50	82.50	82.50	
43+75	82.50	82.50	
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44+25	82.50	82.50	
44+50	82.50	82.50	
44+75	82.50	82.50	
45+00	82.50	82.50	
45+25	82.50	82.50	
45+50	82.50	82.50	
45+75	82.50	82.50	
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46+25	82.50	82.50	
46+50	82.50	82.50	
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47+50	82.50	82.50	
47+75	82.50	82.50	
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48+25	82.50	82.50	
48+50	82.50	82.50	
48+75	82.50	82.50	
49+00	82.50	82.50	
49+25	82.50	82.50	
49+50	82.50	82.50	
49+75	82.50	82.50	
50+00	82.50	82.50	
50+25	82.50	82.50	
50+50	82.50	82.50	
50+75	82.50	82.50	
51+00	82.50	82.50	
51+25	82.50	82.50	
51+50	82.50	82.50	
51+75	82.50	82.50	
52+00	82.50	82.50	
52+25	82.50	82.50	
52+50	82.50	82.50	
52+75	82.50	82.50	
53+00	82.50	82.50	
53+25	82.50	82.50	
53+50	82.50	82.50	
53+75	82.50	82.50	
54+00	82.50	82.50	
54+25	82.50	82.50	
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54+75	82.50	82.50	
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55+25	82.50	82.50	
55+50	82.50	82.50	
55+75	82.50	82.50	
56+00	82.50	82.50	
56+25	82.50	82.50	
56+50	82.50	82.50	
56+75	82.50	82.50	
57+00	82.50	82.50	
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57+50	82.50	82.50	
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58+50	82.50	82.50	
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62+75	82.50	82.50	
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64+25	82.50	82.50	
64+50	82.50	82.50	
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65+25	82.50	82.50	
65+50	82.50	82.50	
65+75	82.50	82.50	
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66+50	82.50	82.50	
66+75	82.50	82.50	
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67+25	82.50	82.50	
67+50	82.50	82.50	
67+75	82.50	82.50	
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68+25	82.50	82.50	
68+50	82.50	82.50	
68+75	82.50	82.50	
69+00	82.50	82.50	
69+25	82.50	82.50	
69+50	82.50	82.50	
69+75	82.50	82.50	
70+00	82.50	82.50	
70+25	82.50	82.50	
70+50	82.50	82.50	
70+75	82.50	82.50	
71+00	82.50	82.50	
71+25	82.50	82.50	
71+50	82.50	82.50	
71+75	82.50	82.50	
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72+50	82.50	82.50	
72+75	82.50	82.50	
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74+75	82.50	82.50	
75+00	82.50	82.50	
75+25	82.50	82.50	
75+50	82.50	82.50	
75+75	82.50	82.50	
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76+50	82.50	82.50	
76+75	82.50	82.50	
77+00	82.50	82.50	
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77+50	82.50	82.50	
77+75	82.50	82.50	
78+00	82.50	82.50	
78+25	82.50	82.50	
78+50	82.50	82.50	
78+75	82.50	82.50	
79+00	82.50	82.50	
79+25	82.50	82.50	
79+50	82.50	82.50	
79+75	82.50	82.50	
80+00	82.50	82.50	
80+25	82.50	82.50	
80+50	82.50	82.50	
80+75	82.50	82.50	
81+00	82.50	82.50	
81+25	82.50	82.50	
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82+00	82.50	82.50	
82+25	82.50	82.	



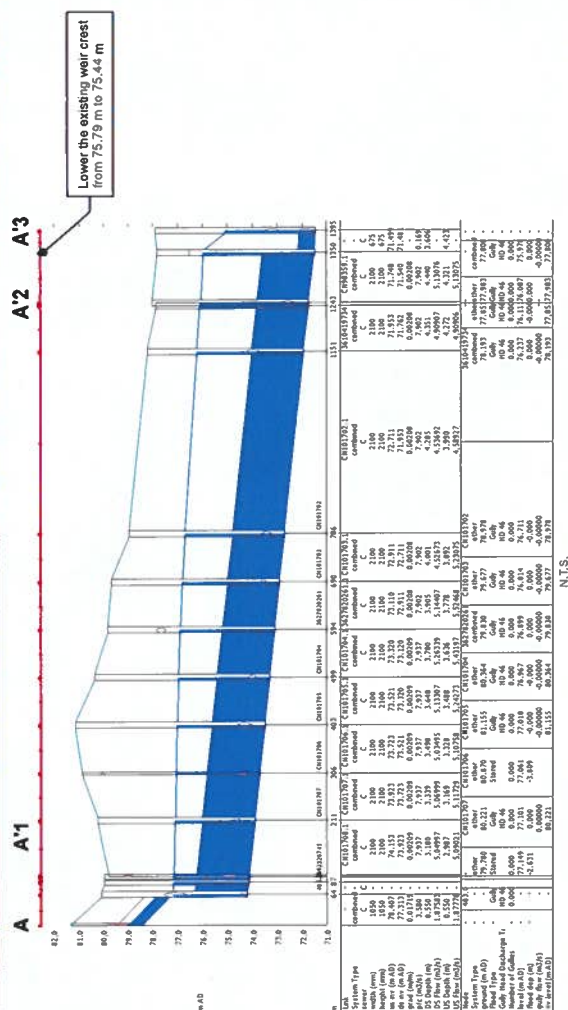
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Eastern Beaches Basement Flooding

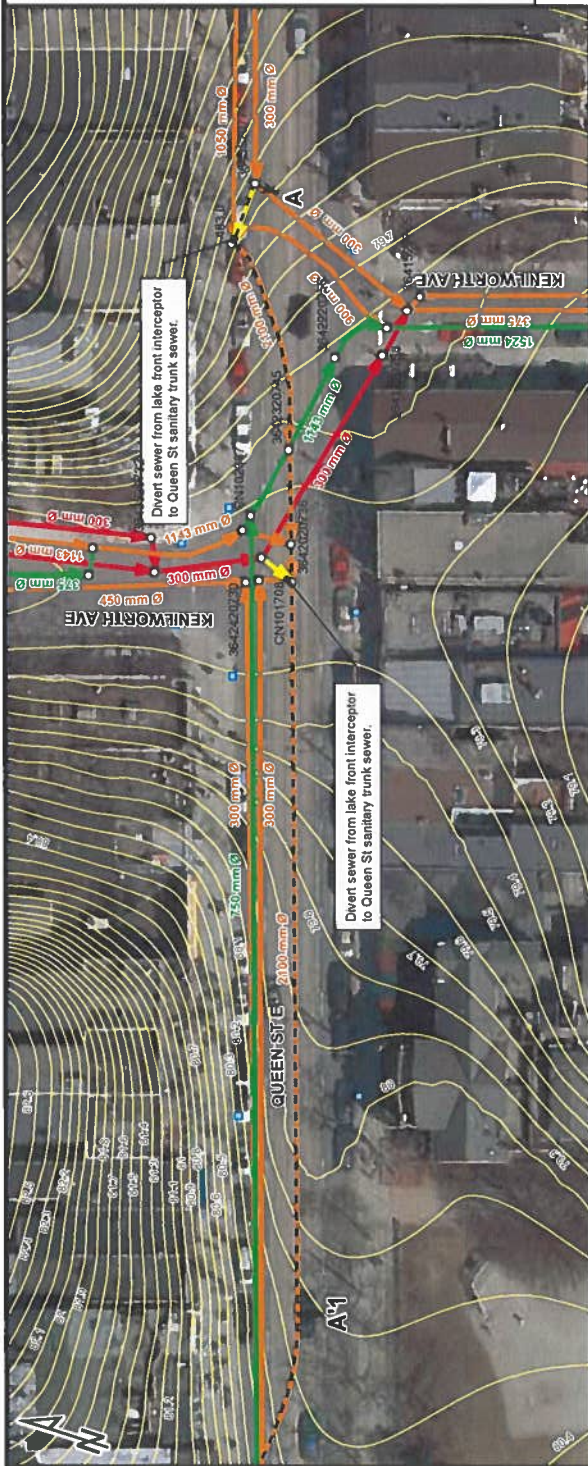


Figure 10-1a

Weir Adjustment at Queen St
Sanitary Trunk Sewer

Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- New Combined Sewer Connection
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

0 10 20 30 m

1:500

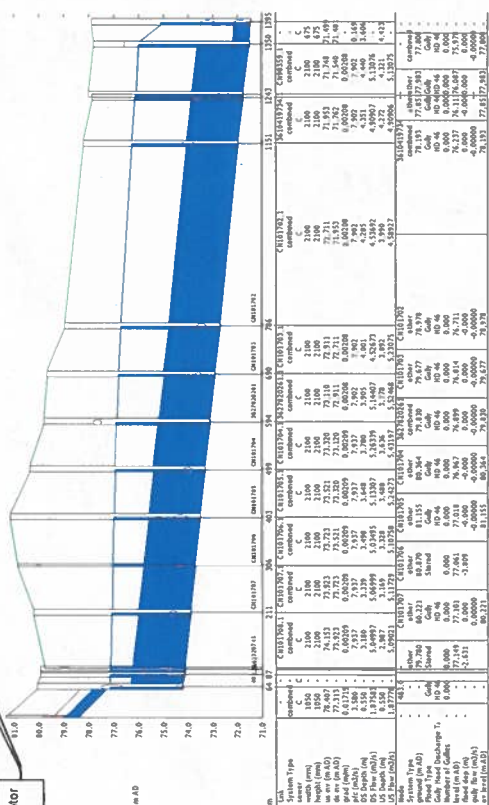
Figure 10-2a

Diversion to Queen St
Sanitary Trunk Sewer

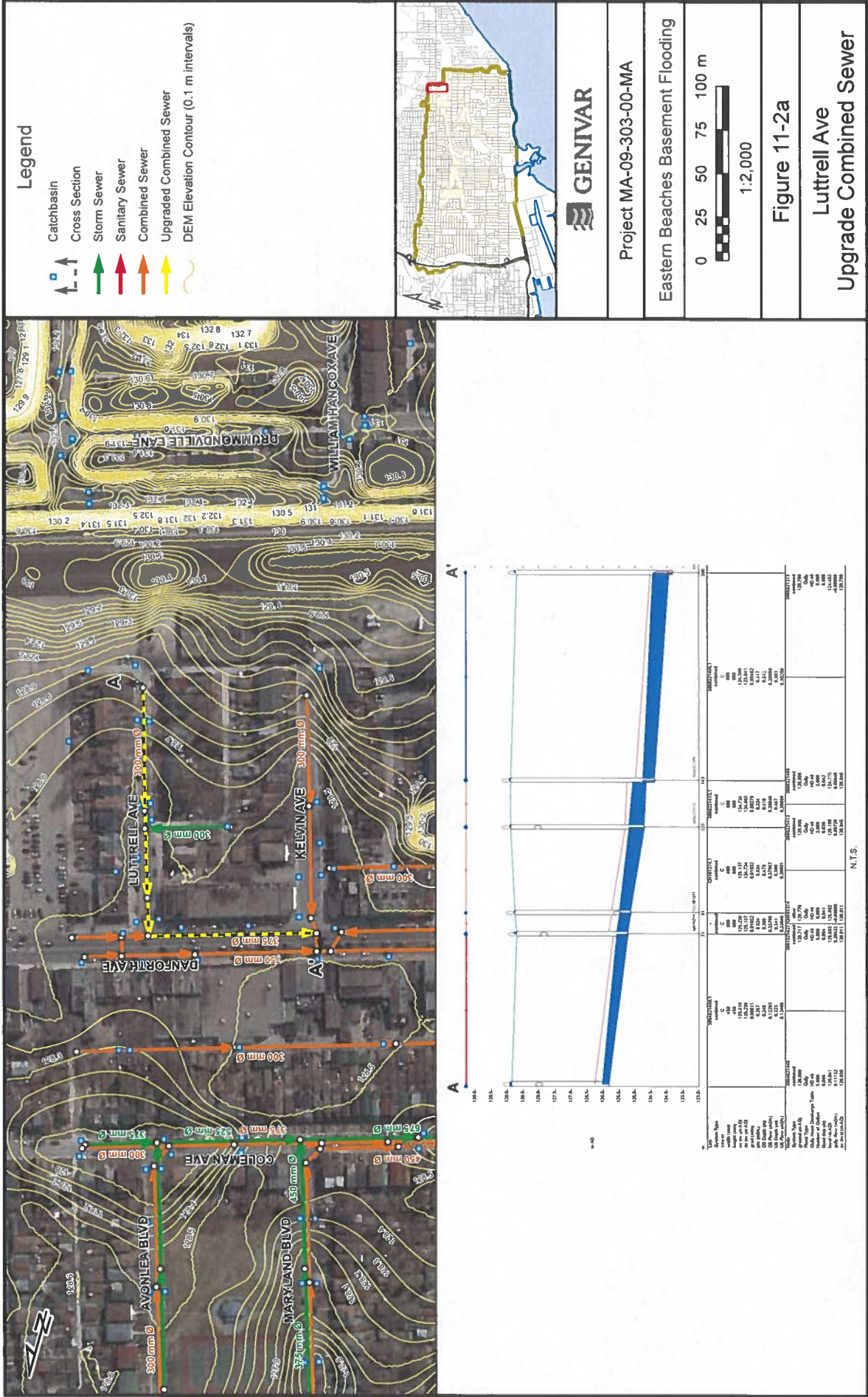
A A'1 A'2 A'3

A A'1

Divert sewer from lake front interceptor to Queen St sanitary trunk sewer.



N.T.S.



Station	Proposed Sewer	Existing Sewer	Proposed Sewer	Existing Sewer	Proposed Sewer	Existing Sewer	Proposed Sewer	Existing Sewer	Proposed Sewer	Existing Sewer
7+00	123.0	123.0	7+25	123.5	123.5	7+50	124.0	124.0	7+75	124.5
7+25	123.5	123.5	7+50	124.0	124.0	7+75	124.5	124.5	8+00	125.0
7+50	124.0	124.0	7+75	124.5	124.5	8+00	125.0	125.0	8+25	125.5
7+75	124.5	124.5	8+00	125.0	125.0	8+25	125.5	125.5	8+50	126.0
8+00	125.0	125.0	8+25	125.5	125.5	8+50	126.0	126.0	8+75	126.5
8+25	125.5	125.5	8+50	126.0	126.0	8+75	126.5	126.5	9+00	127.0
8+50	126.0	126.0	8+75	126.5	126.5	9+00	127.0	127.0	9+25	127.5
8+75	126.5	126.5	9+00	127.0	127.0	9+25	127.5	127.5	9+50	128.0
9+00	127.0	127.0	9+25	127.5	127.5	9+50	128.0	128.0	9+75	128.5
9+25	127.5	127.5	9+50	128.0	128.0	9+75	128.5	128.5	10+00	129.0
9+50	128.0	128.0	9+75	128.5	128.5	10+00	129.0	129.0		

Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgraded Combined Sewer
- DEM Elevation Contour (0.1 m intervals)



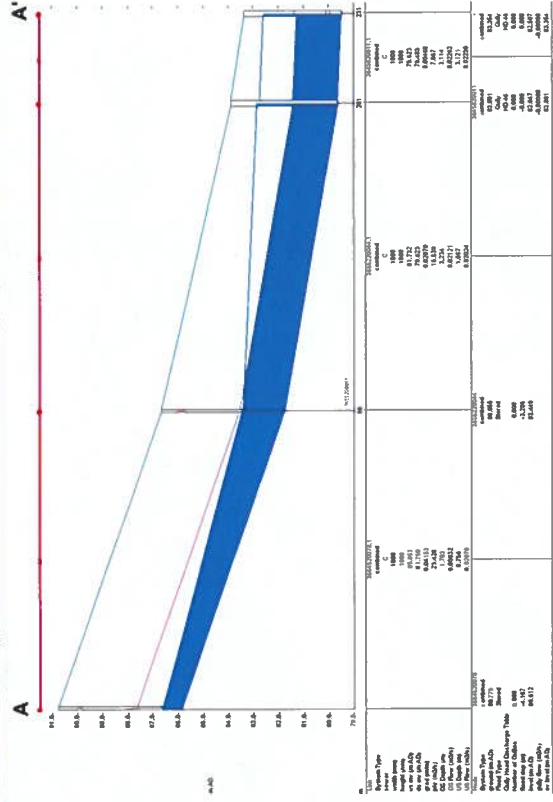
Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

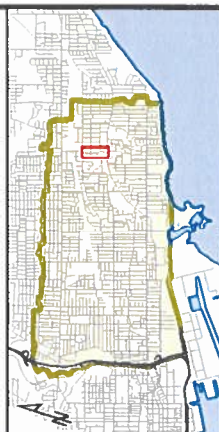
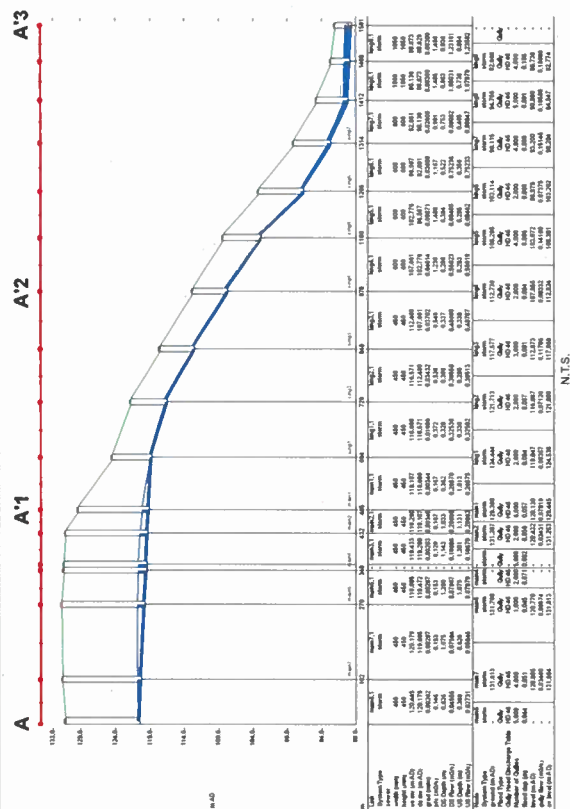


Figure 11-4a-2

Kingston Rd
Upgrade Combined Sewer



N.T.S.



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Eastern Beaches Basement Flooding

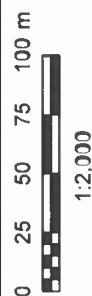
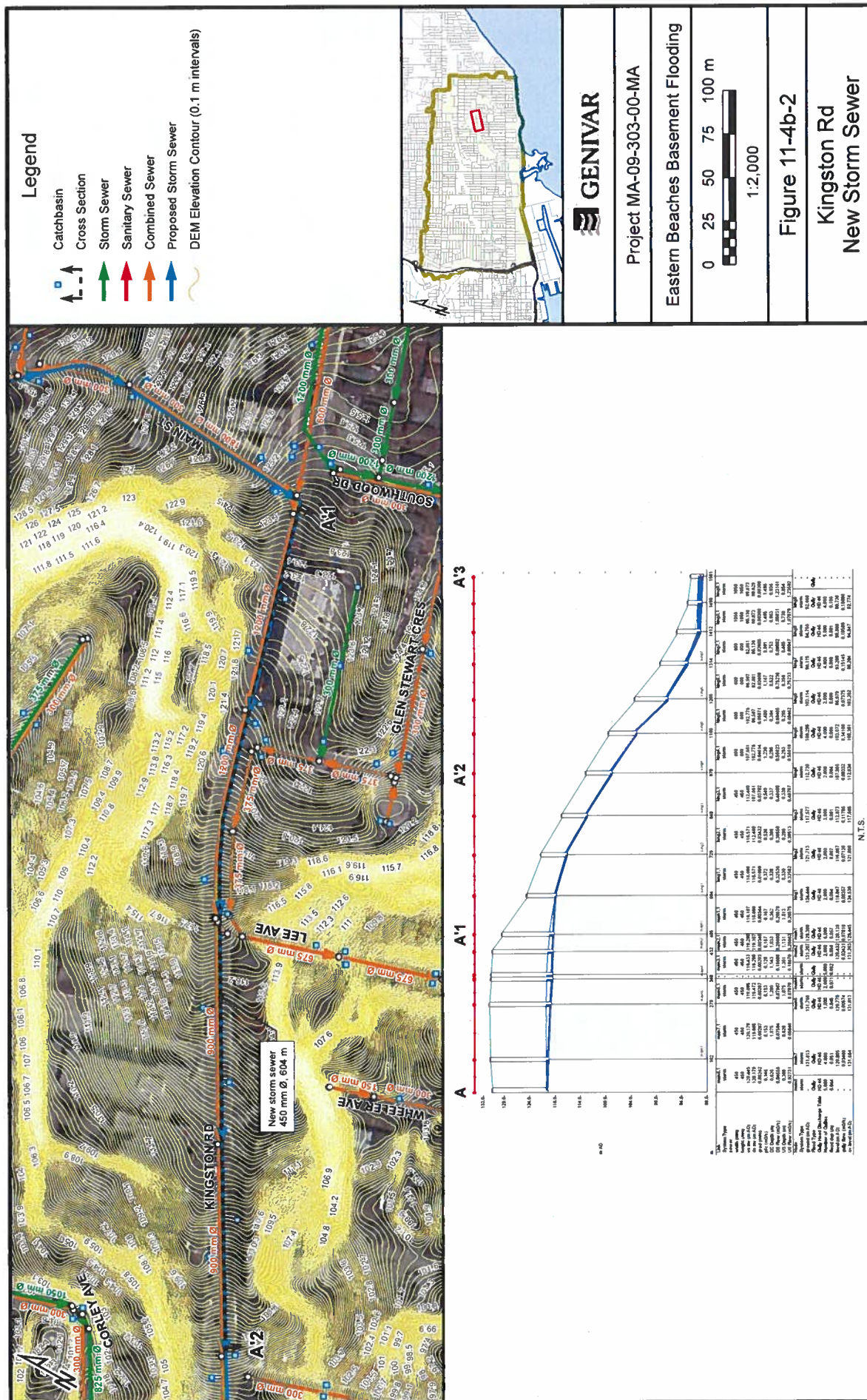
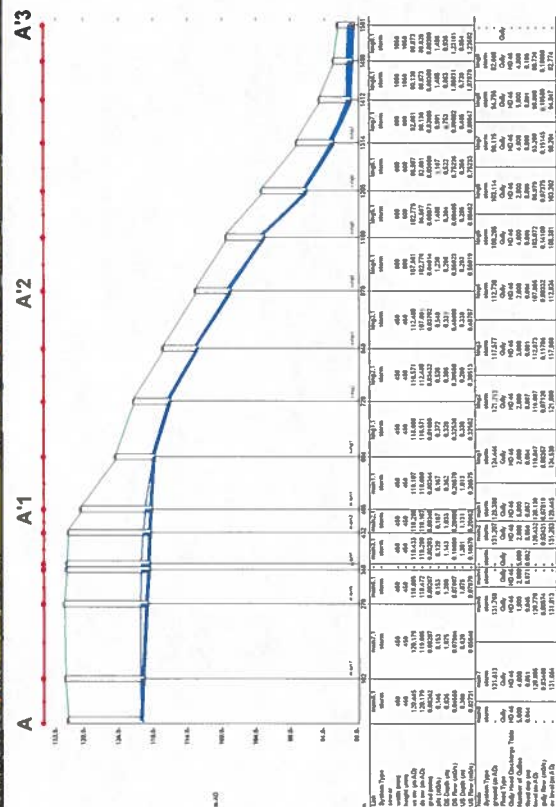


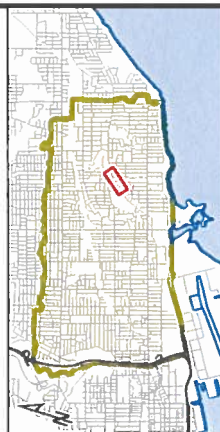
Figure 11-4b-1

Main St
New Storm Sewer





- Catchbasin
Cross Section
Storm Sewer
Sanitary Sewer
Combined Sewer
Proposed Storm Sewer
DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

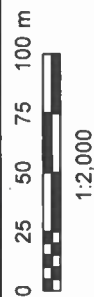
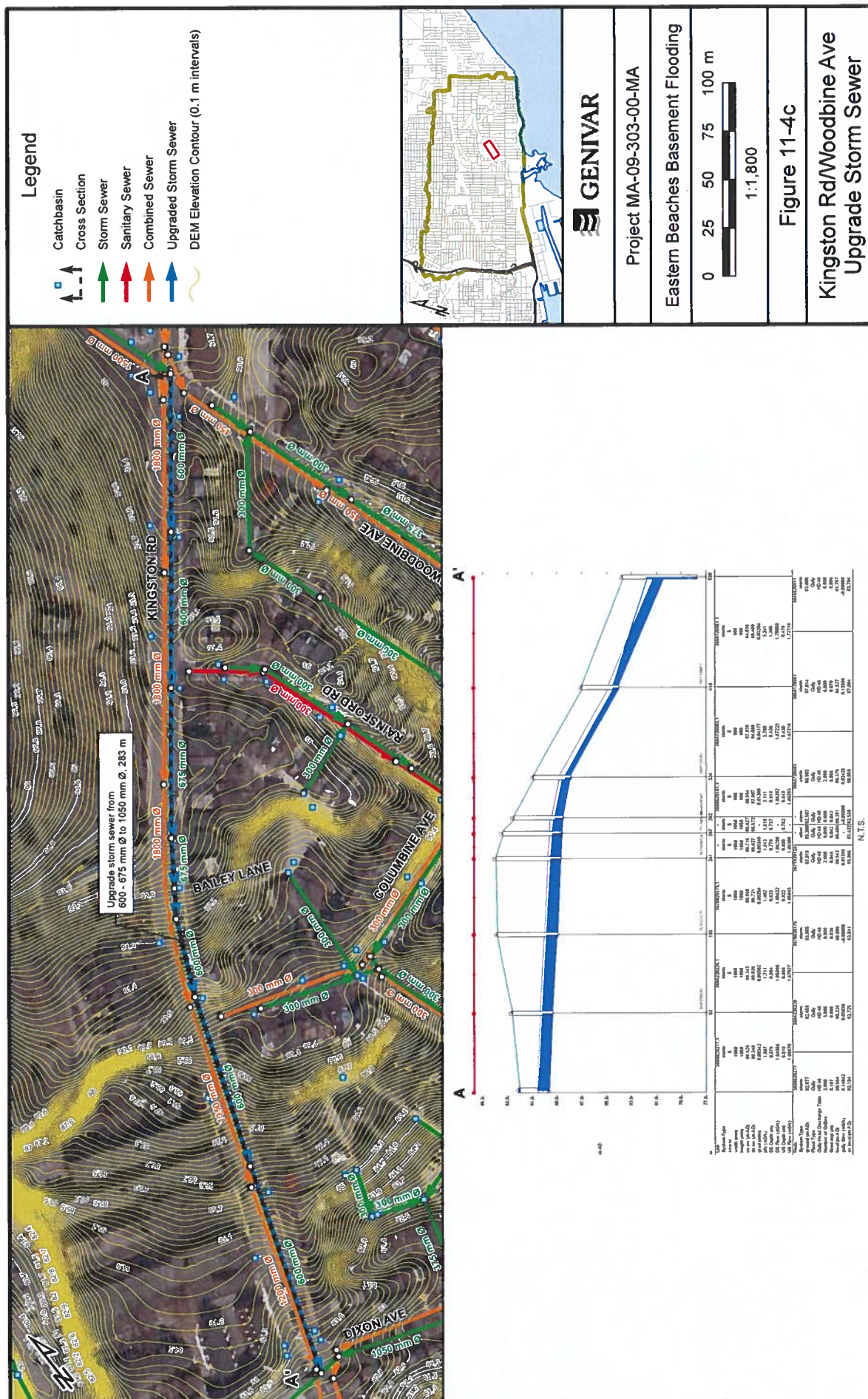
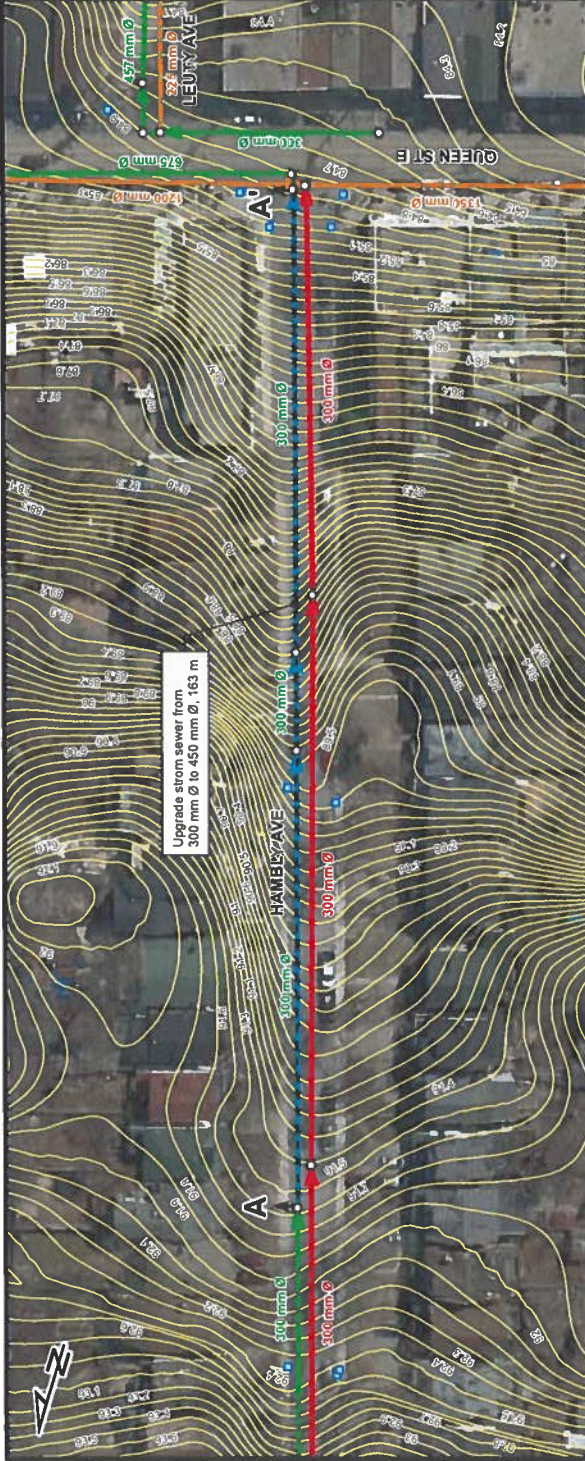


Figure 11-4b-3

Kingston Rd
New Storm Sewer





Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Upgrade Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

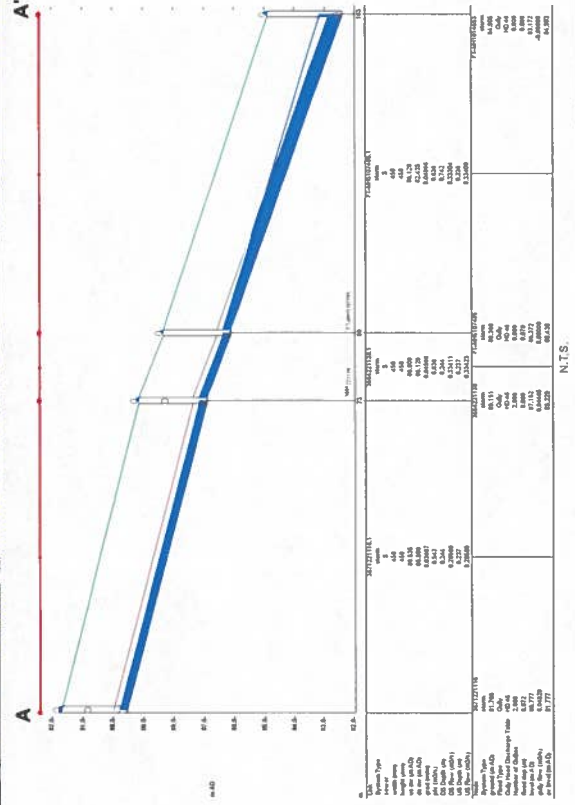
Eastern Beaches Basement Flooding

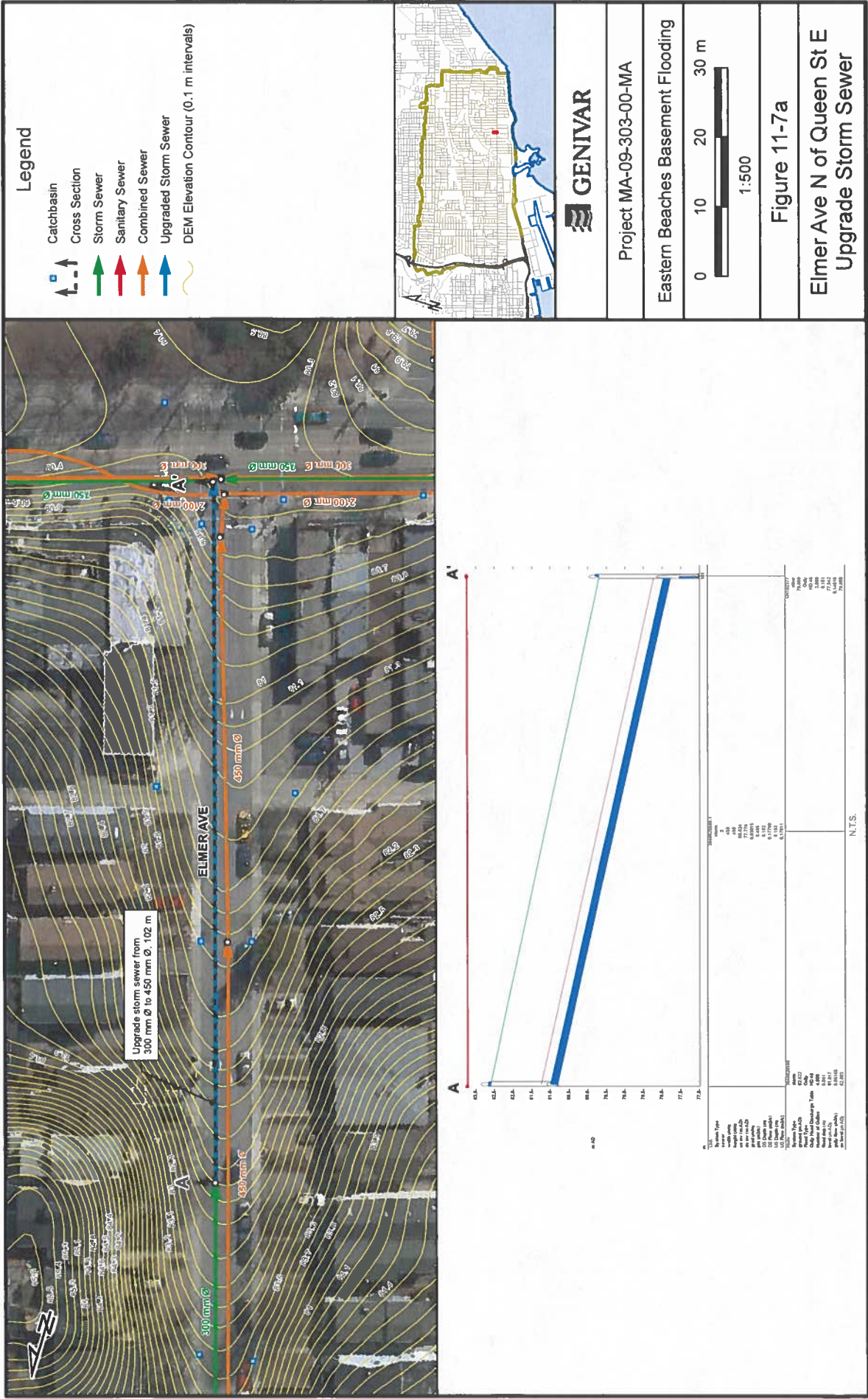


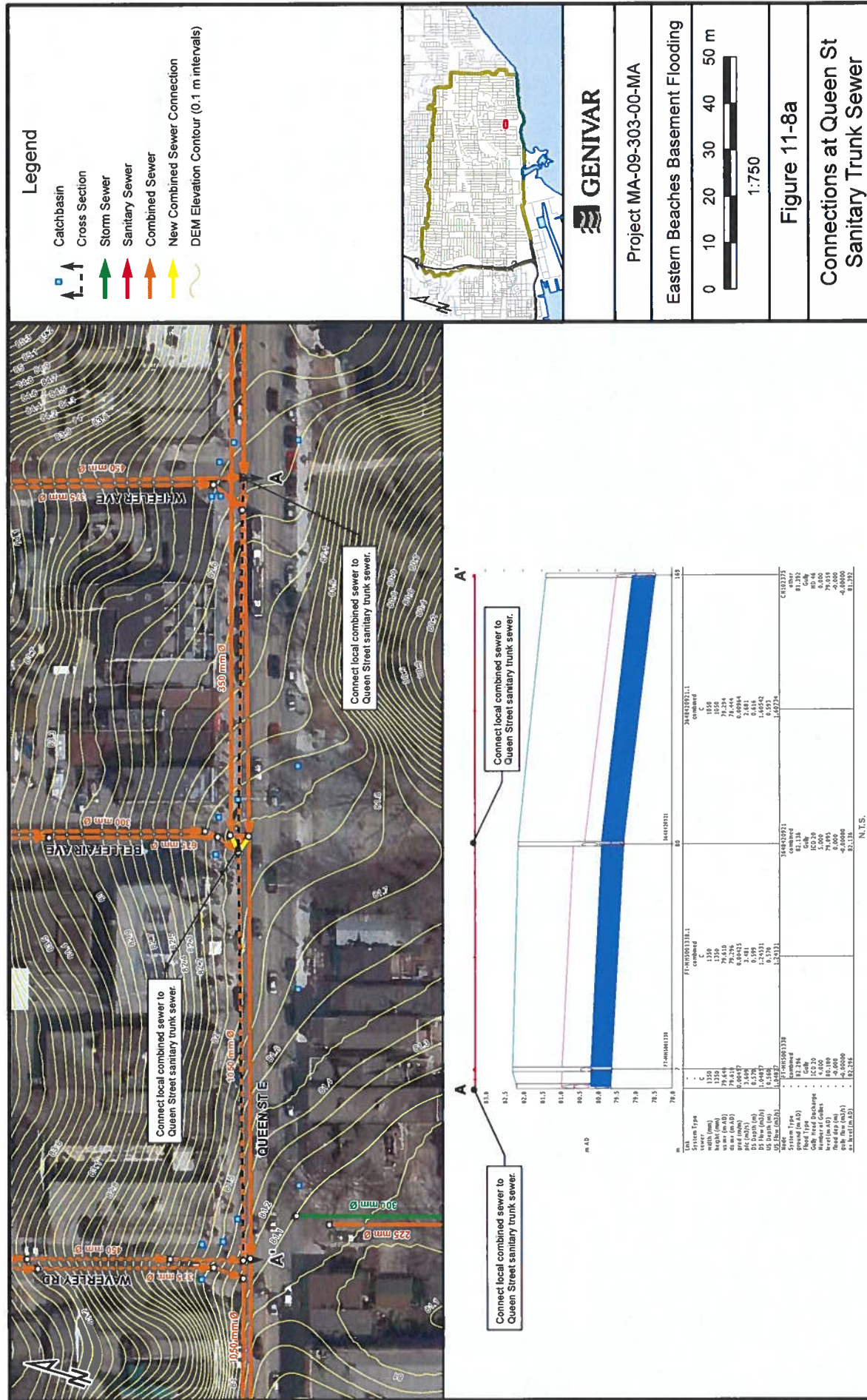
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Figure 11-5a

Hamble Ave N of Queen St E
Upgrade Storm Sewer

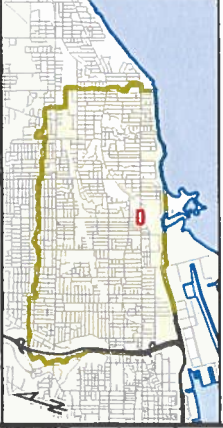








- Legend**
- Catchbasin
 - Cross Section
 - Storm Sewer
 - Sanitary Sewer
 - Combined Sewer
 - Upgrade Combined Sewer
 - DEM Elevation Contour (0.1 m intervals)



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Eastern Beaches Basement Flooding

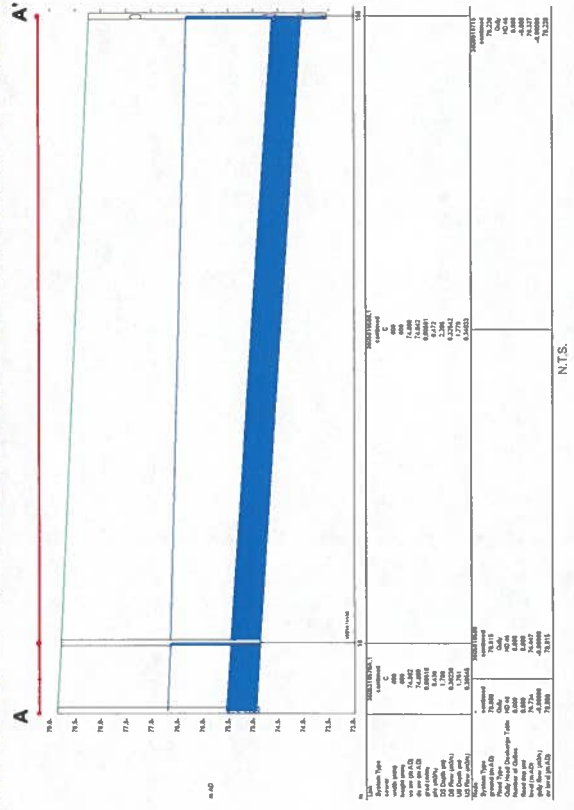
0 10 20 30 40 50 m

1:1,000

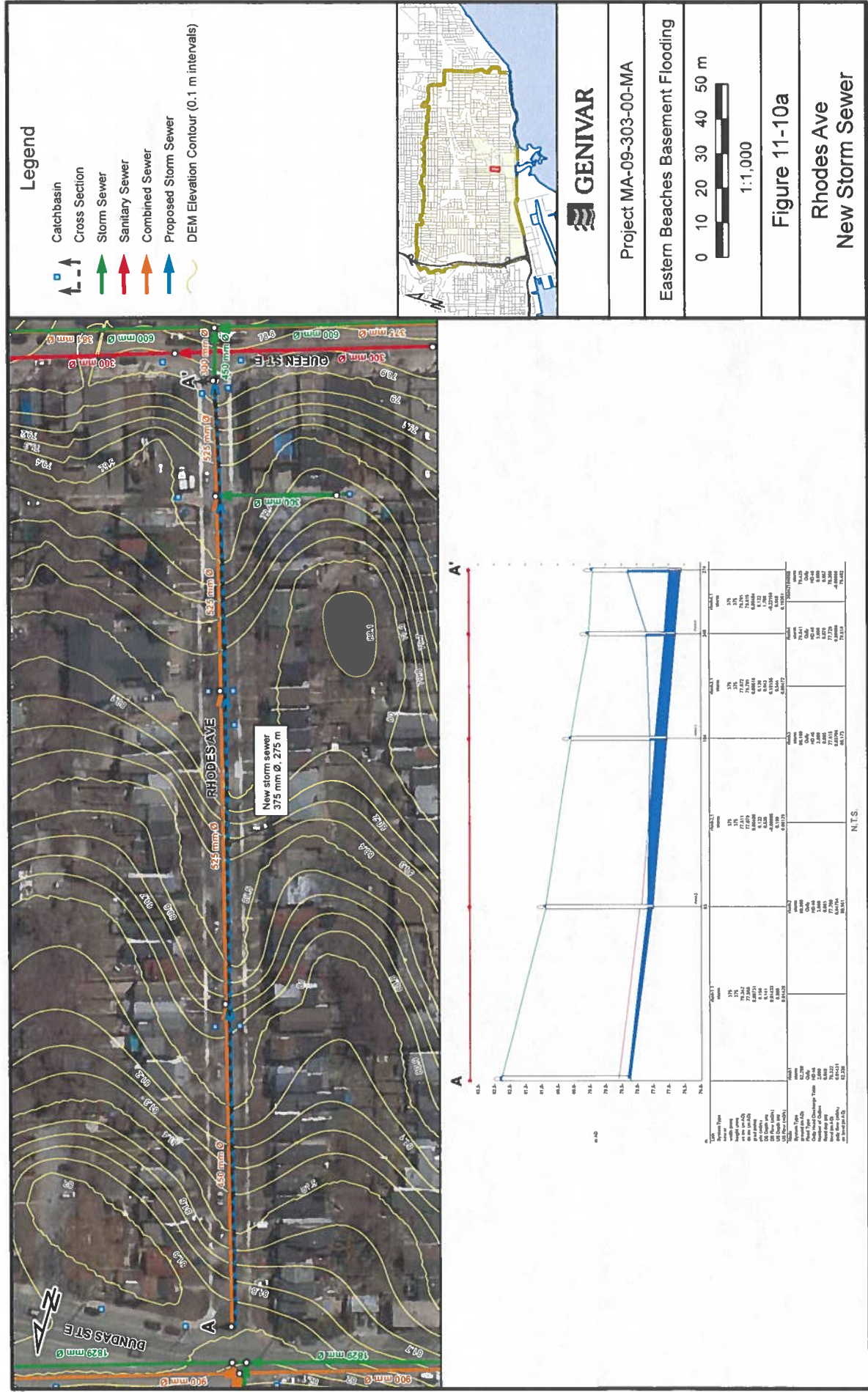
Figure 11-9a

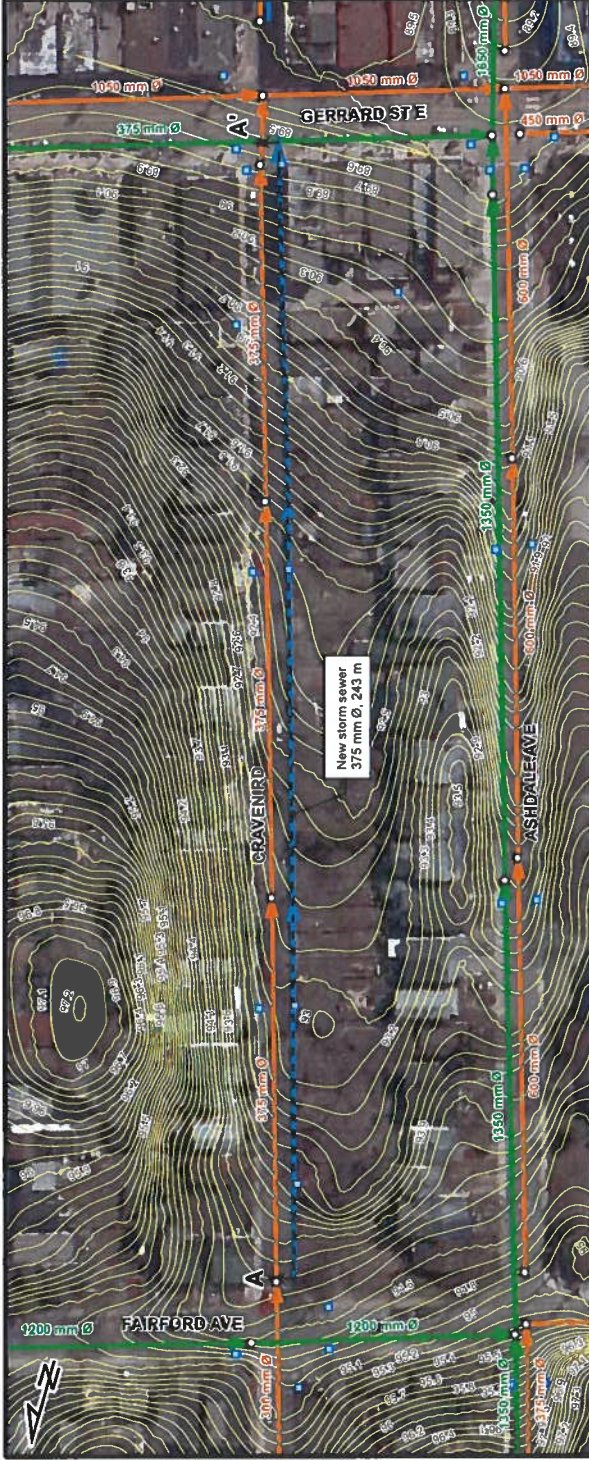
Queen St E W of Coxwell Ave

Upgrade Combined Sewer



N.T.S.





Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



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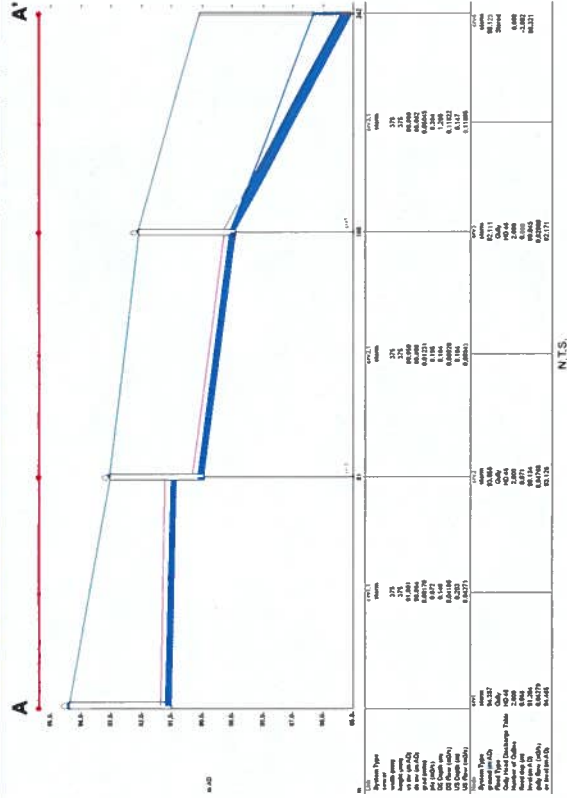
Eastern Beaches Basement Flooding

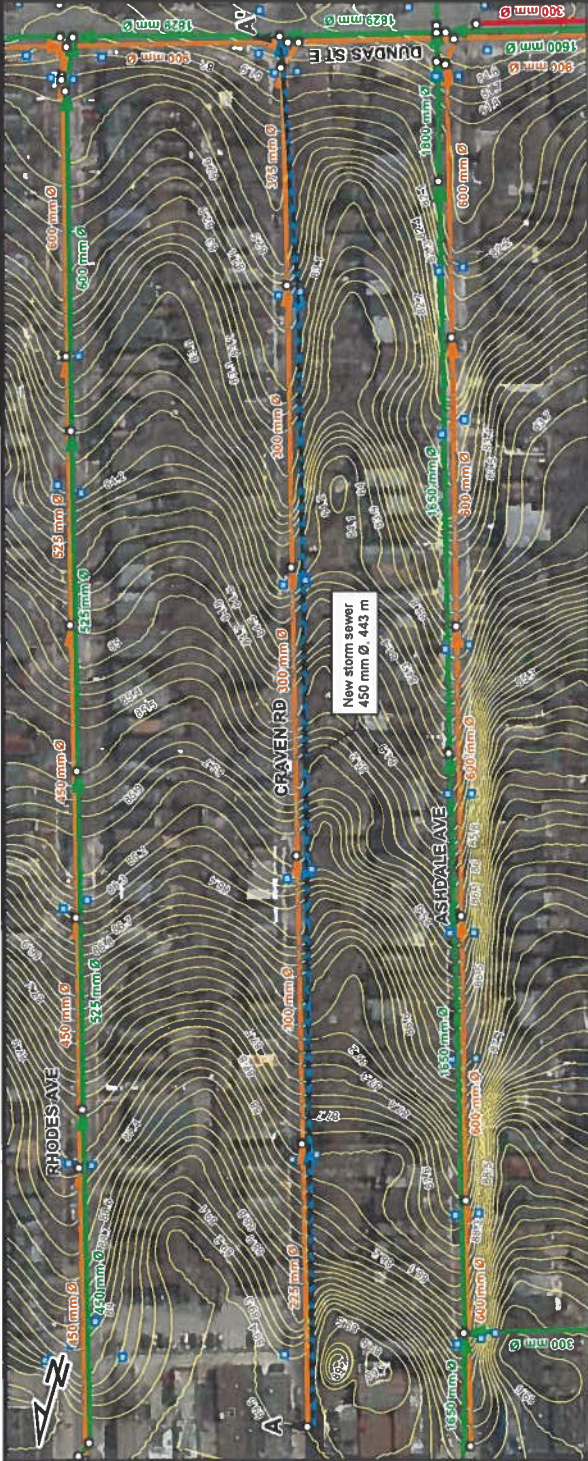
0 10 20 30 40 50 m

1:1,000

Figure 11-11a

Craven Rd
New Storm Sewer





- Legend**
- Catchbasin
 - Cross Section
 - Storm Sewer
 - Sanitary Sewer
 - Combined Sewer
 - Proposed Storm Sewer
 - DEM Elevation Contour (0.1 m intervals)



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding

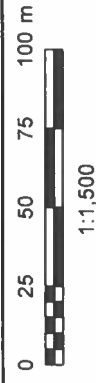
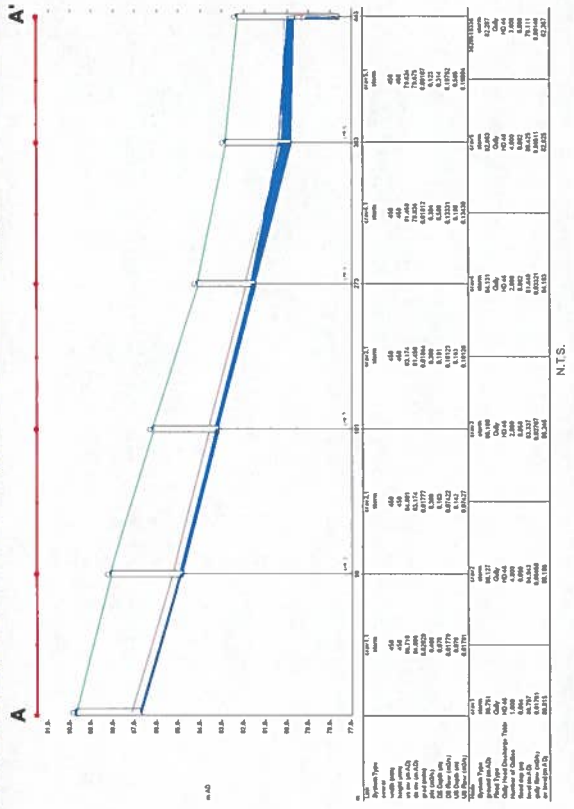
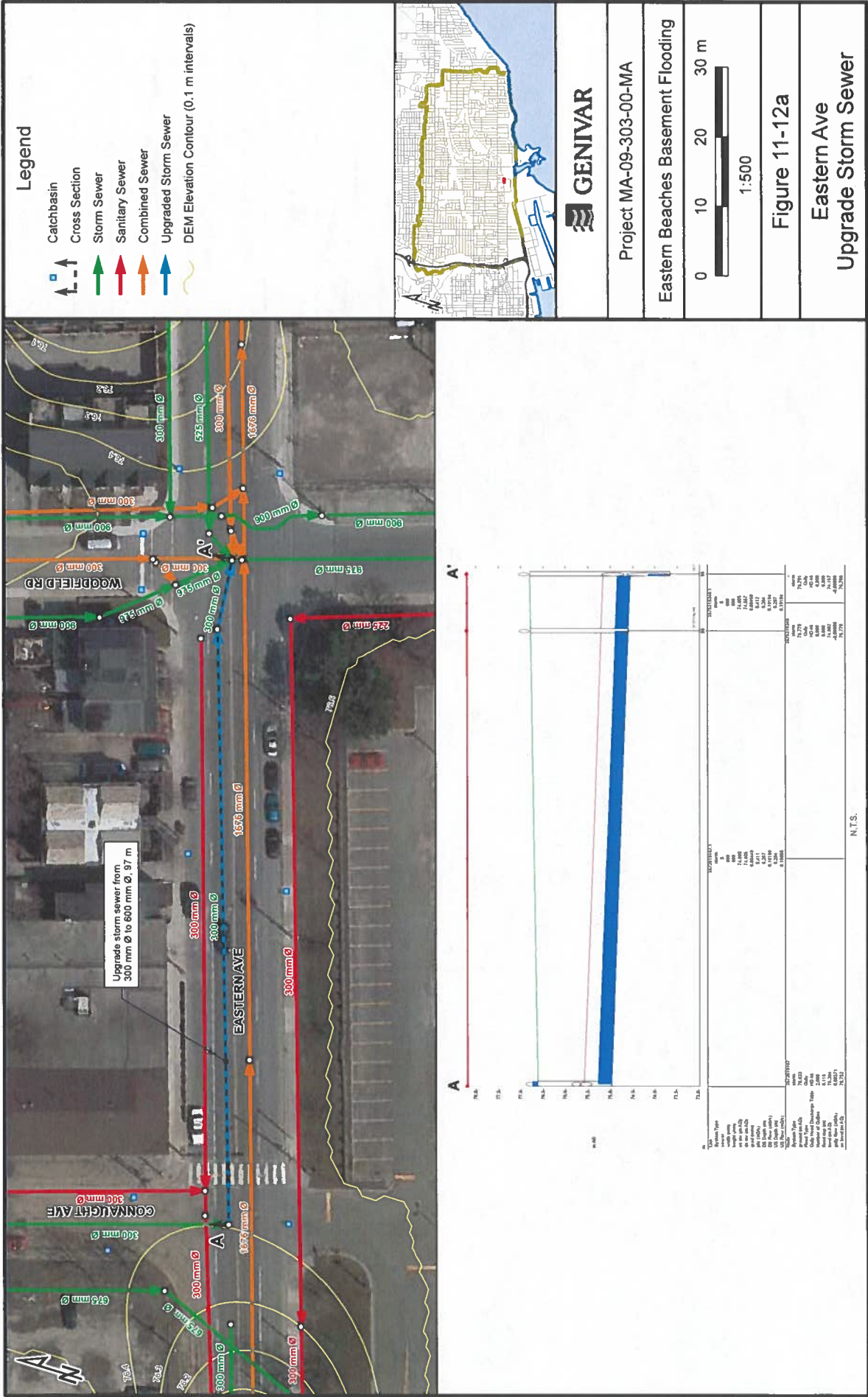


Figure 11-11b

Craven Rd
New Storm Sewer



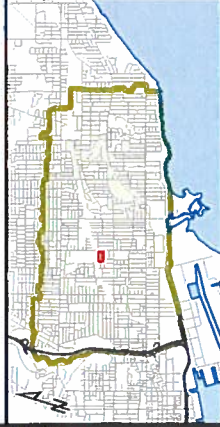
N.T.S.





Legend

- Catchbasin
- Cross Section
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Proposed Storm Sewer
- DEM Elevation Contour (0.1 m intervals)



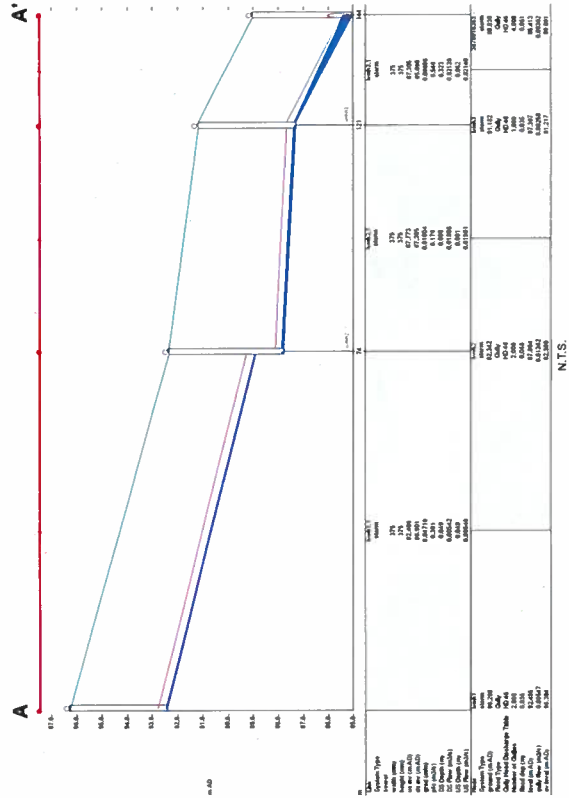
Project MA-09-303-00-MA

Eastern Beaches Basement Flooding



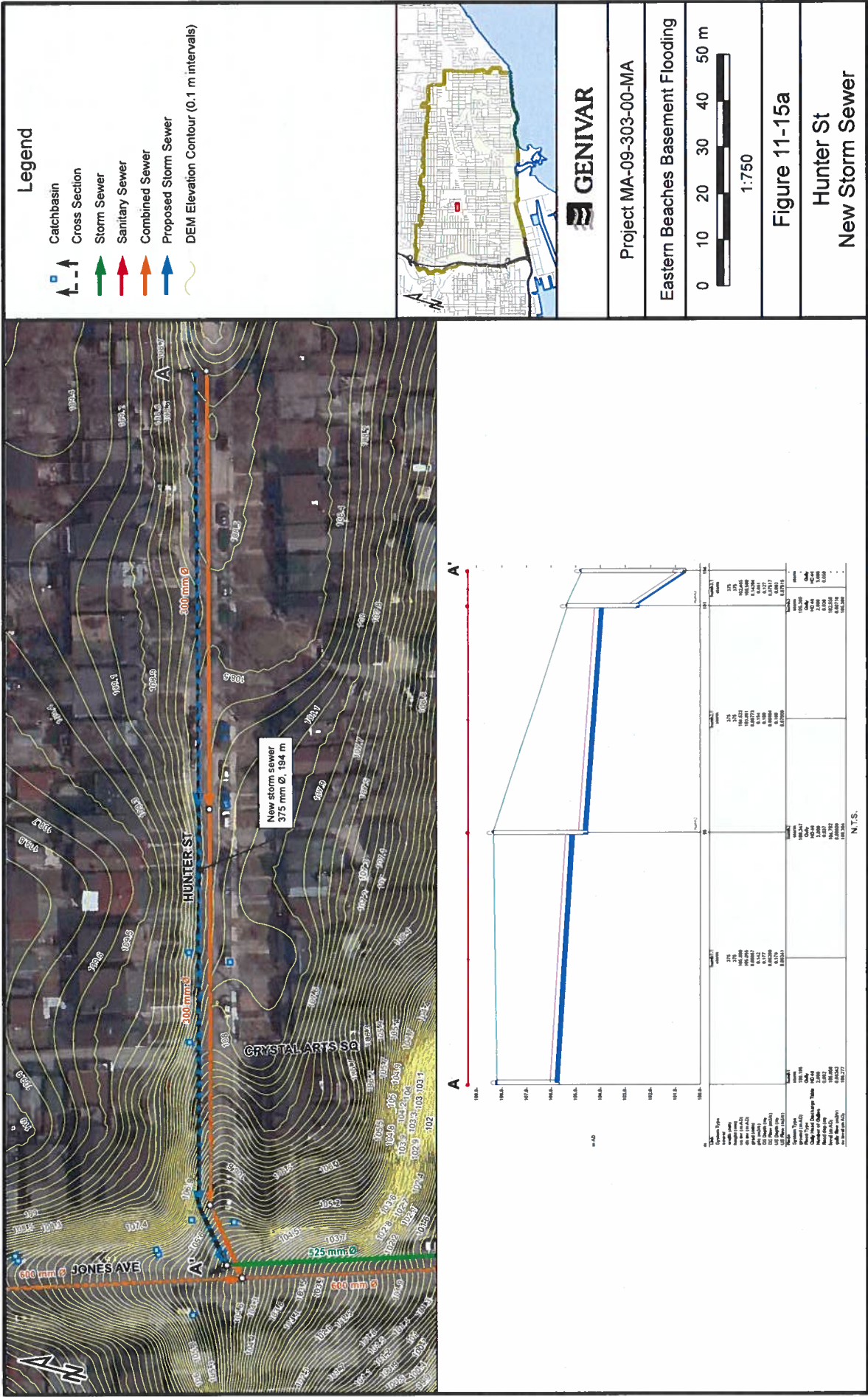
Figure 11-13a

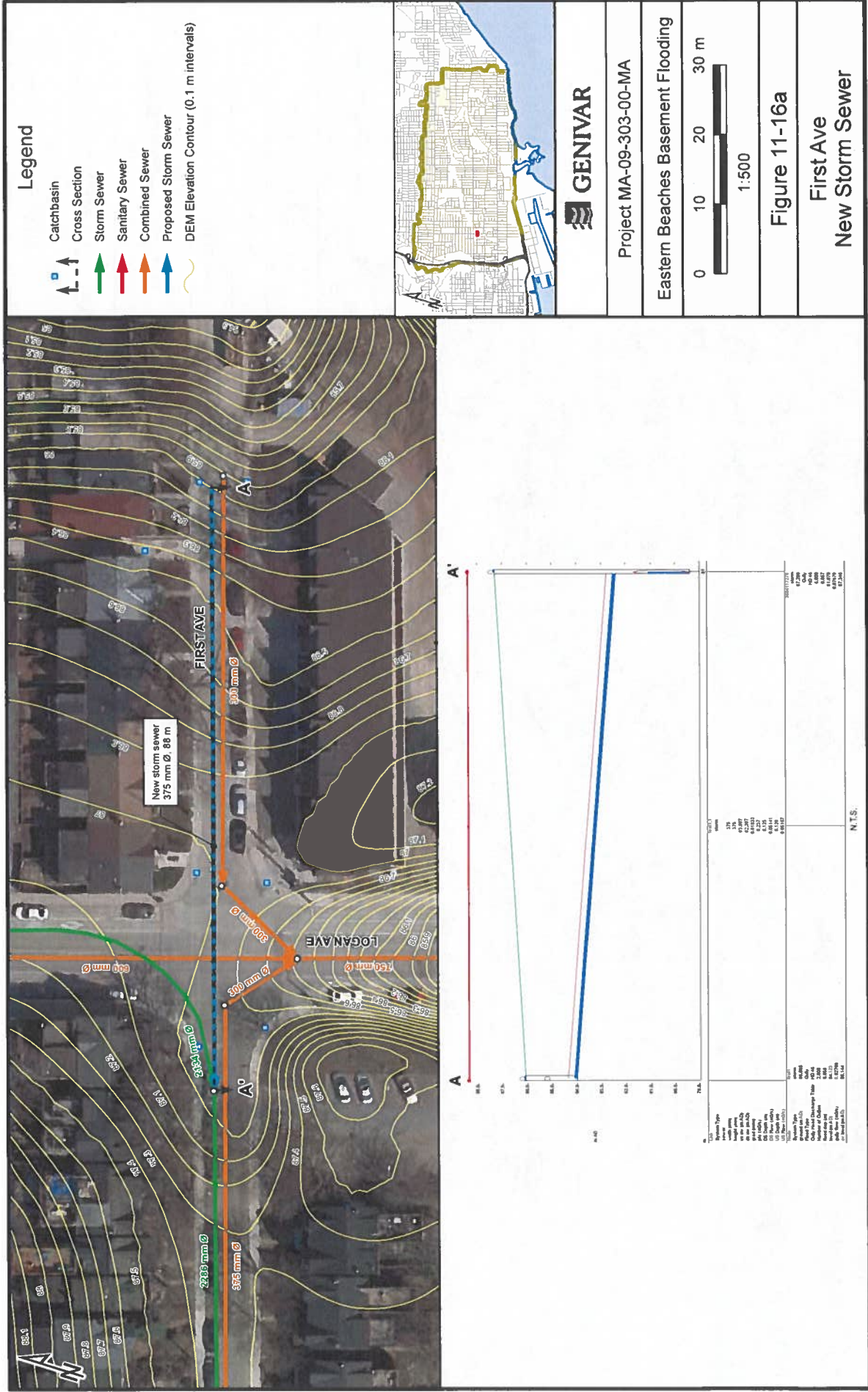
Ivy Ave
New Storm Sewer

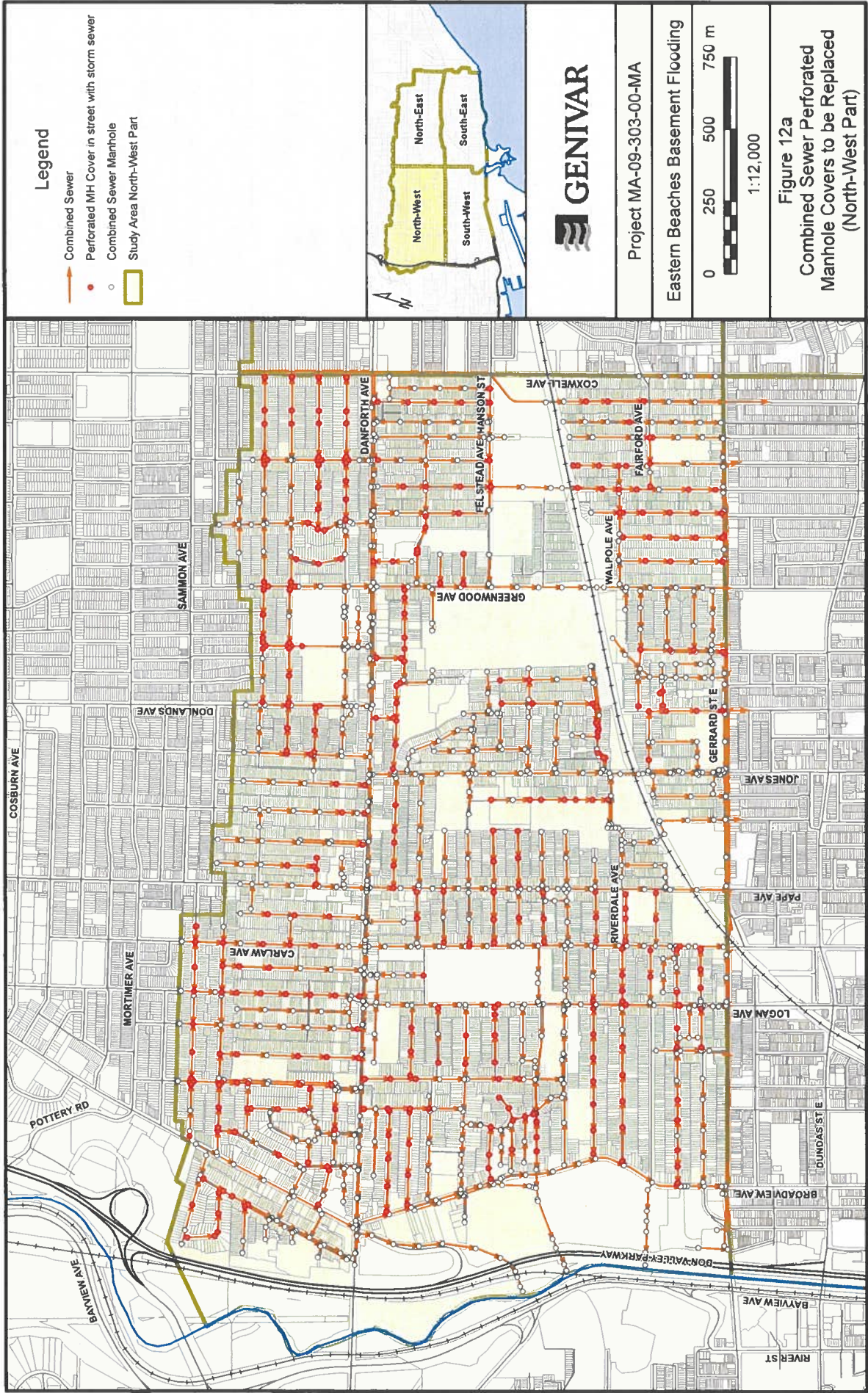


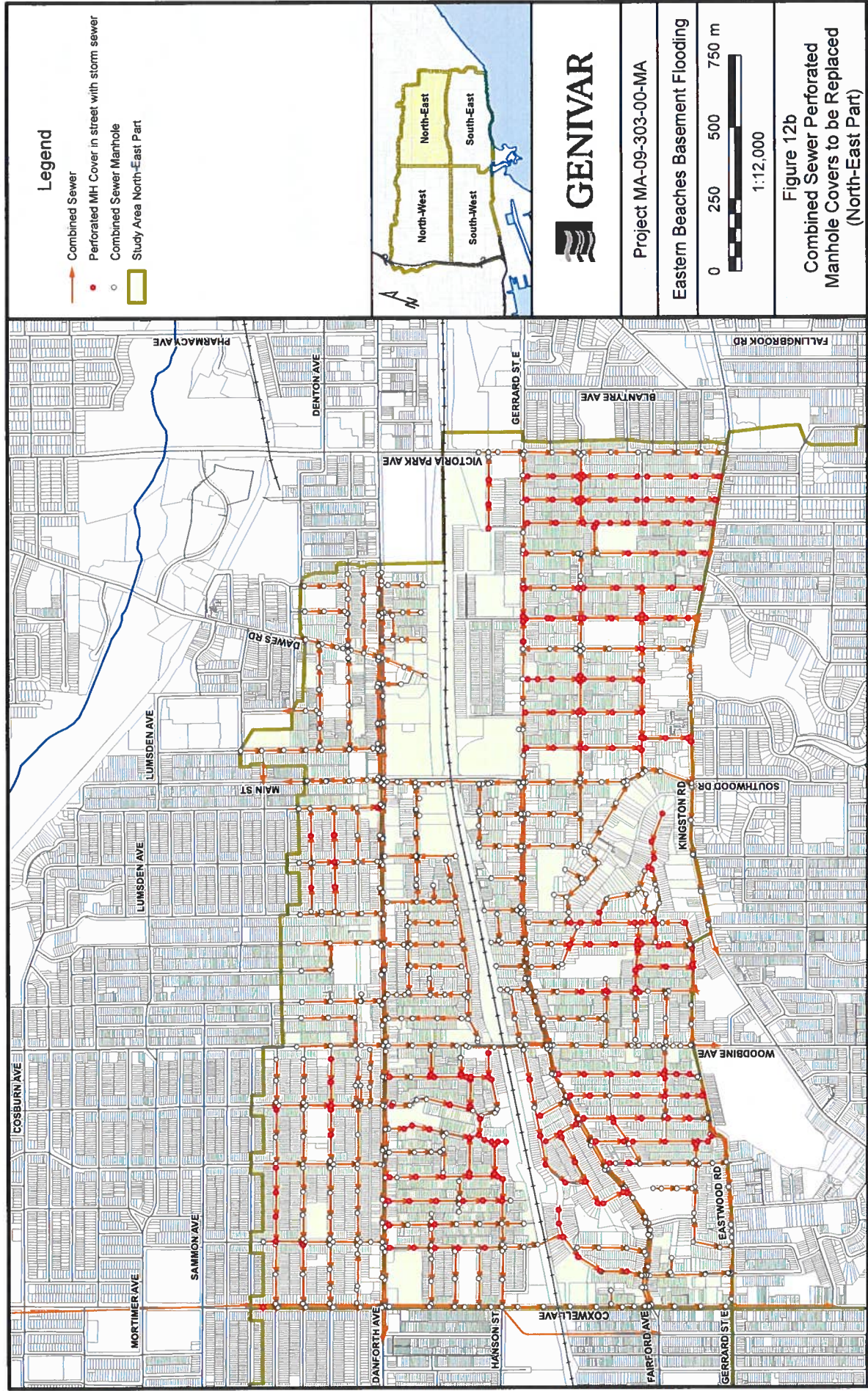
N.T.S.

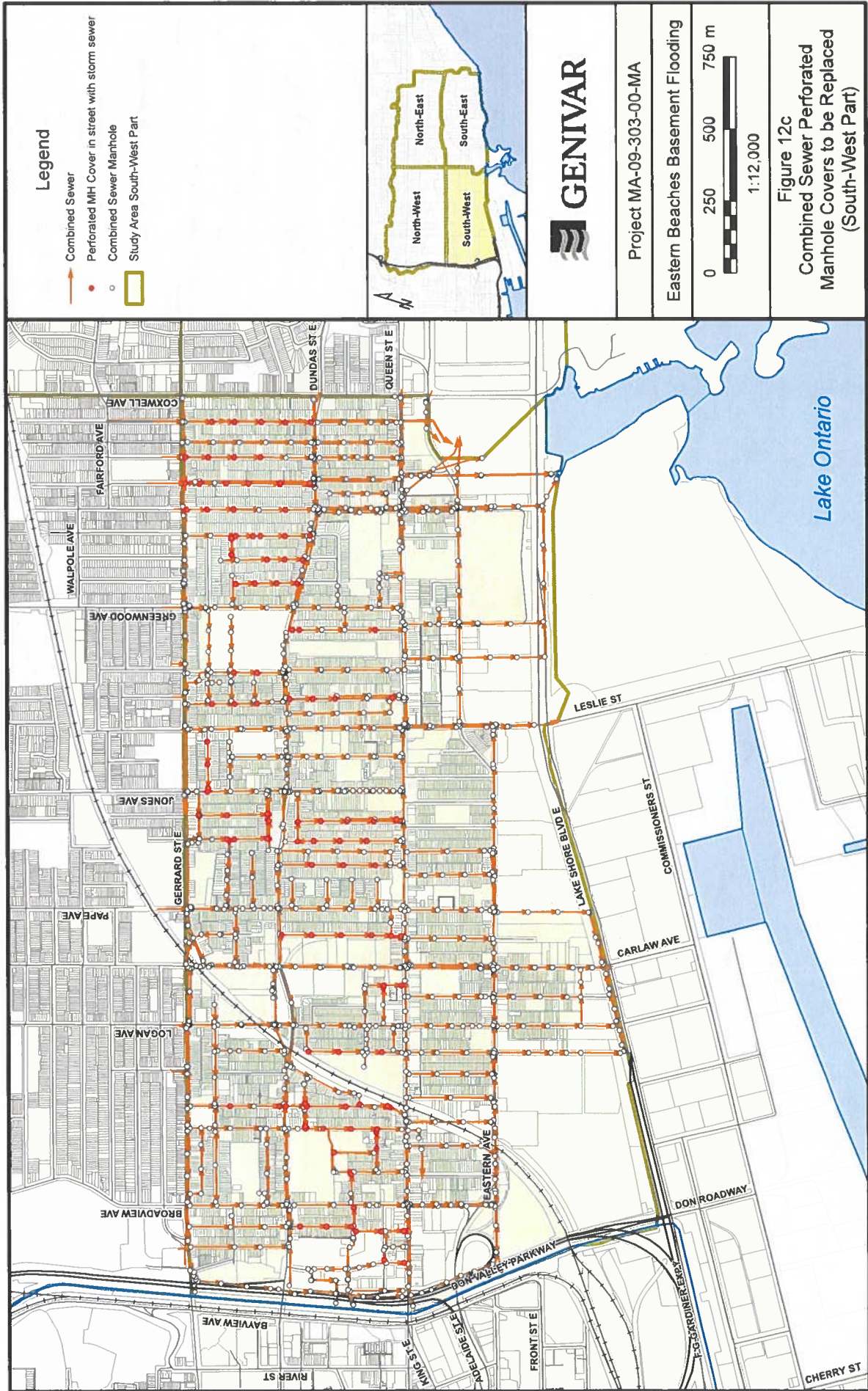


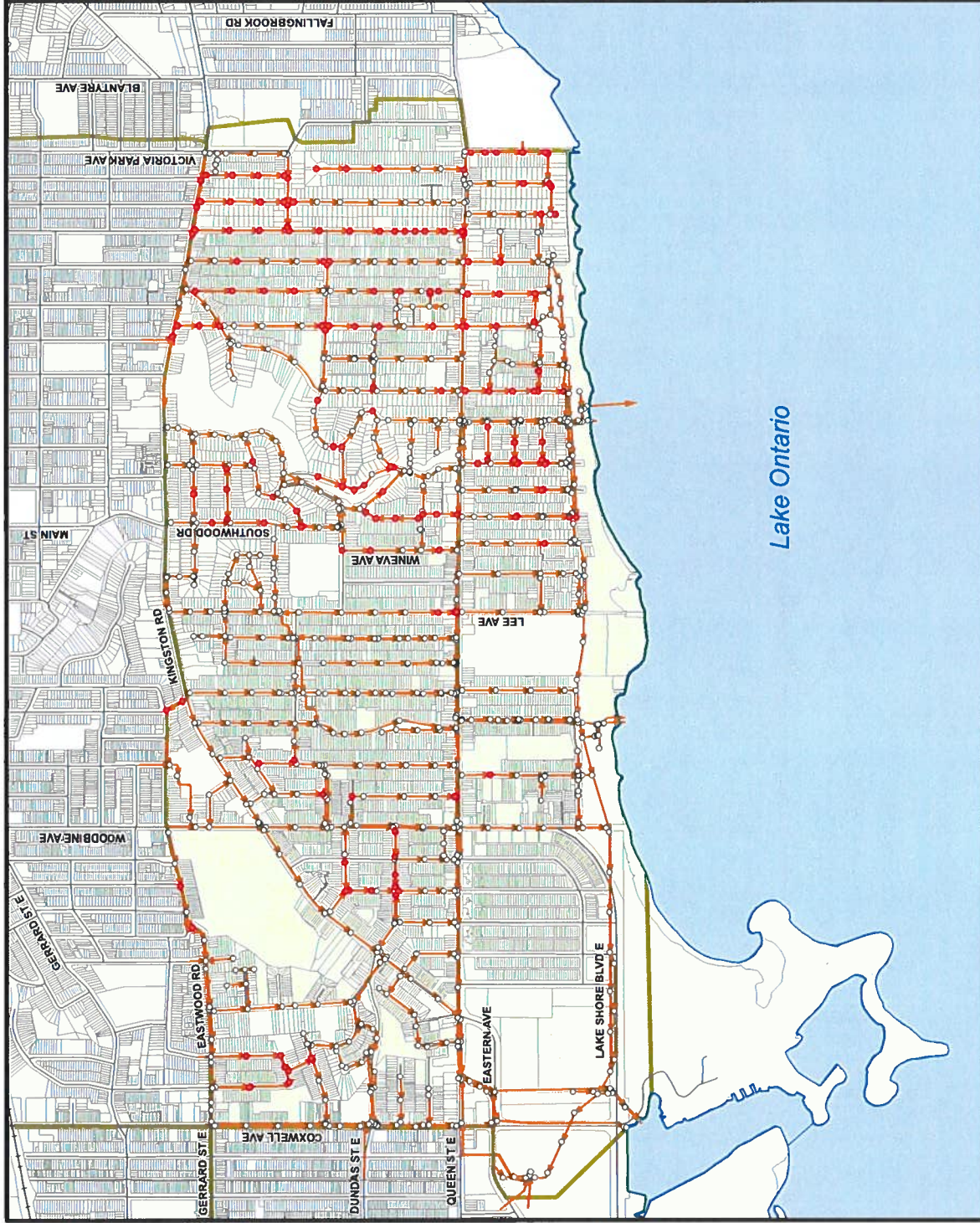












Legend

-  Combined Sewer
-  Perforated MH Cover in street with storm sewer
-  Combined Sewer Manhole
-  Study Area South-East Part



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Eastern Beaches Baseline Flooding

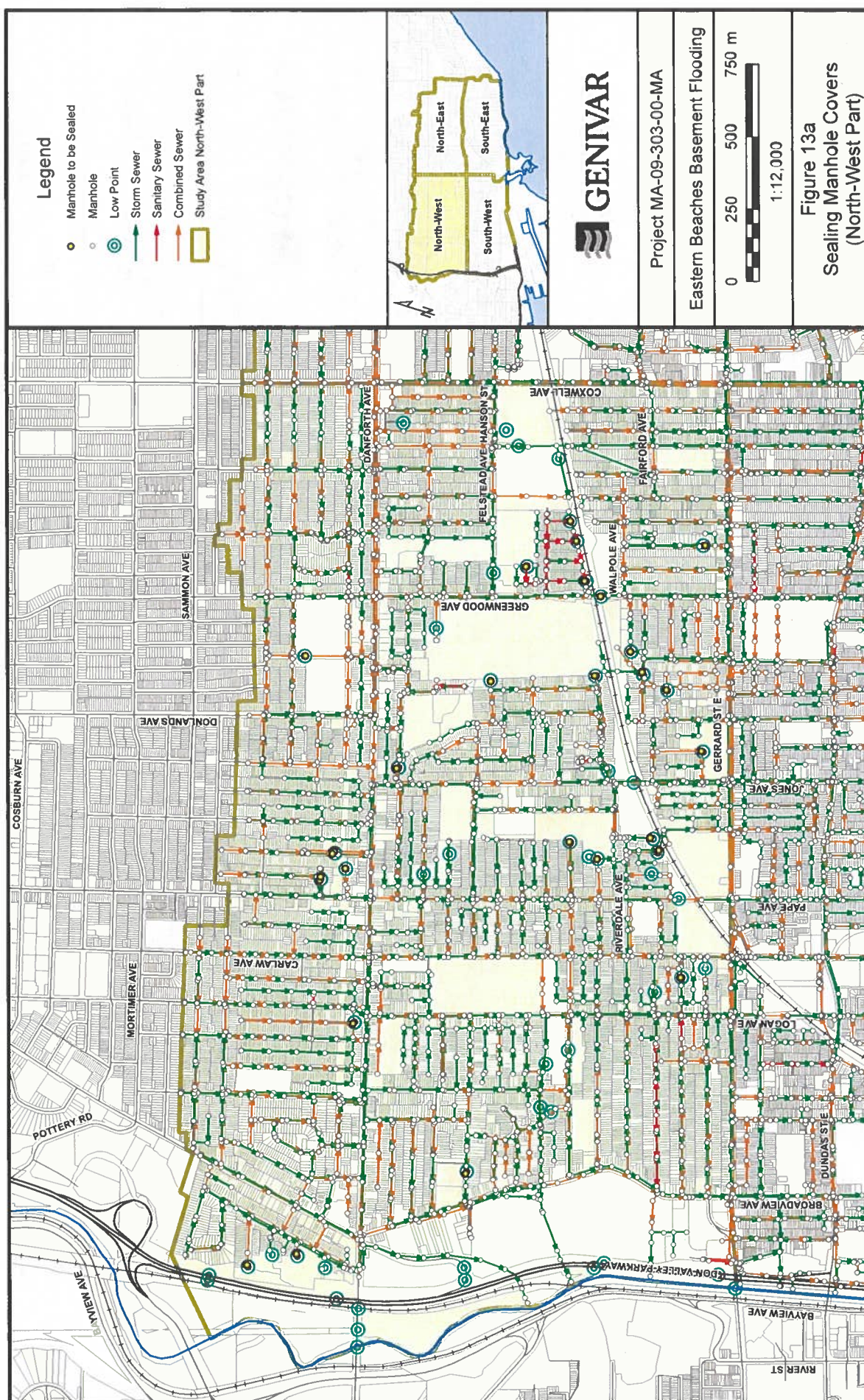
0 250 500 750 m

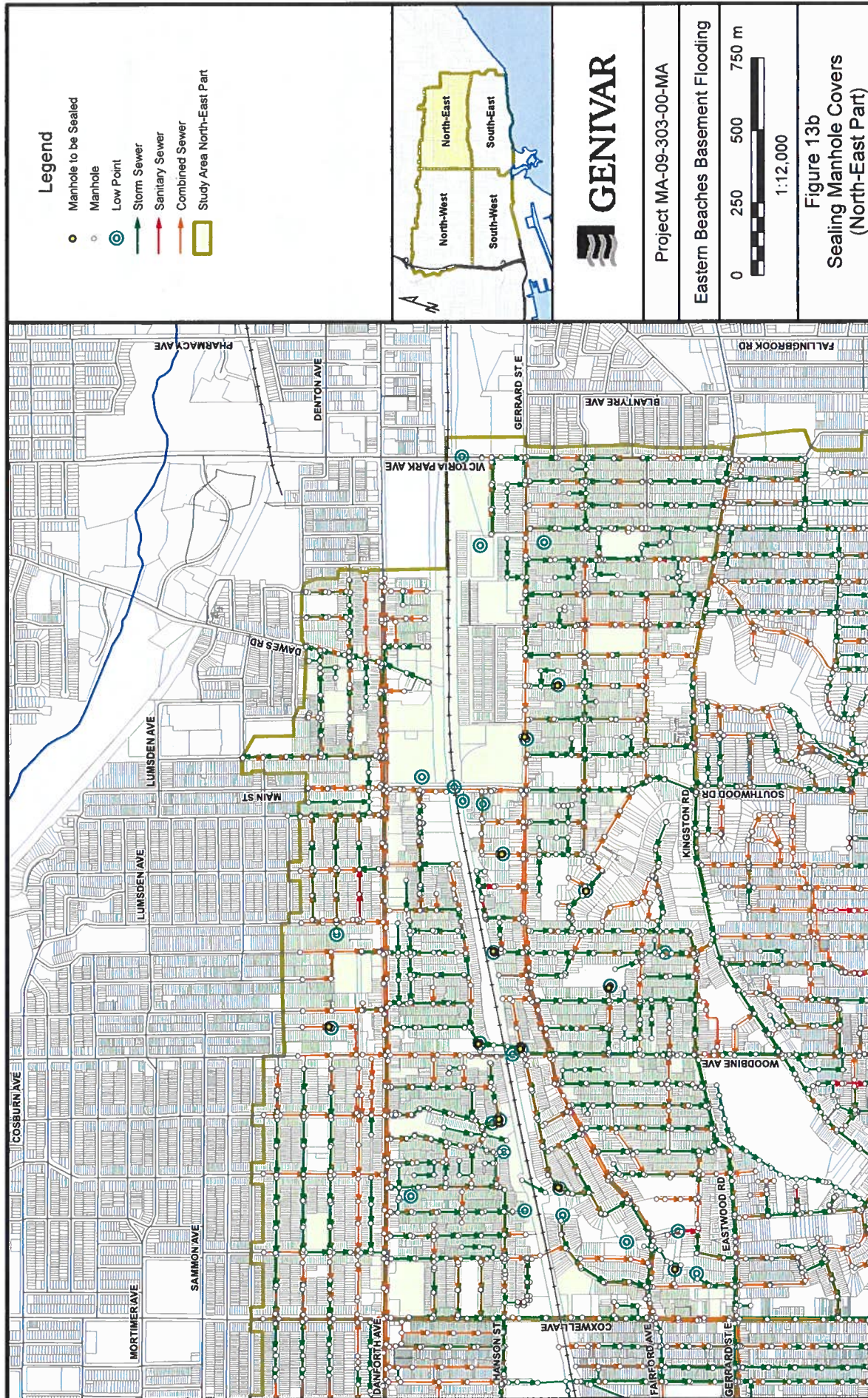


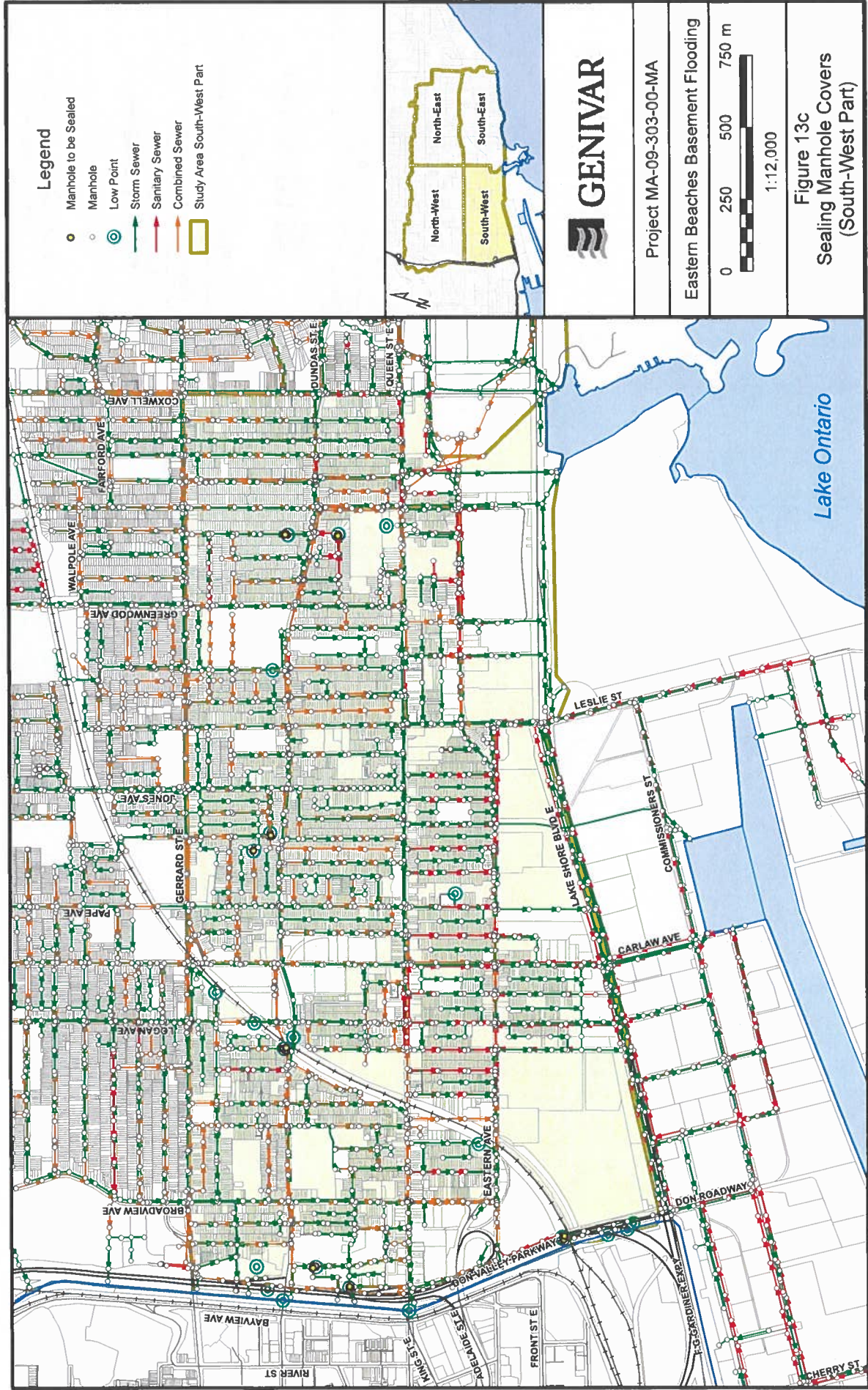
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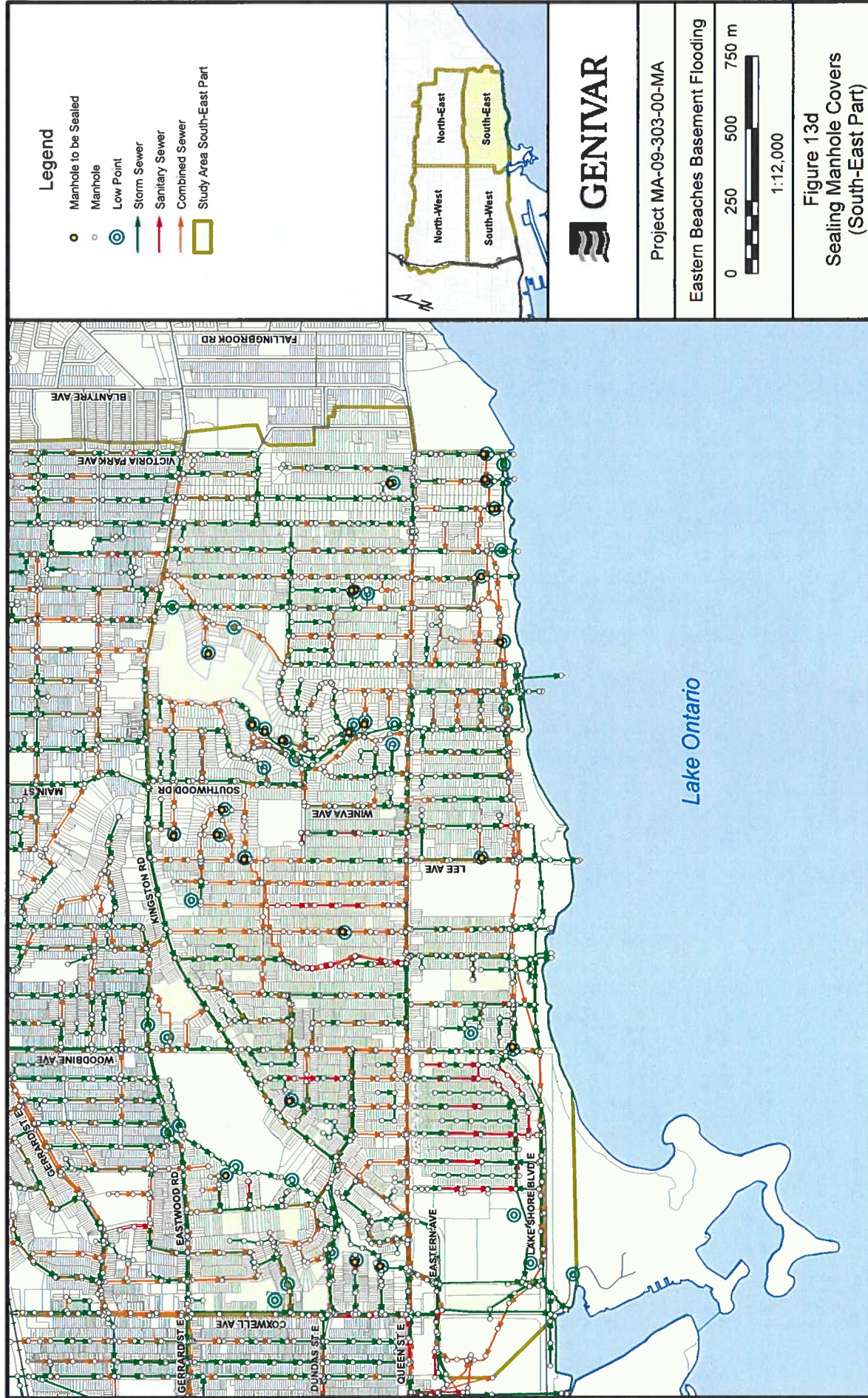
Figure 12d

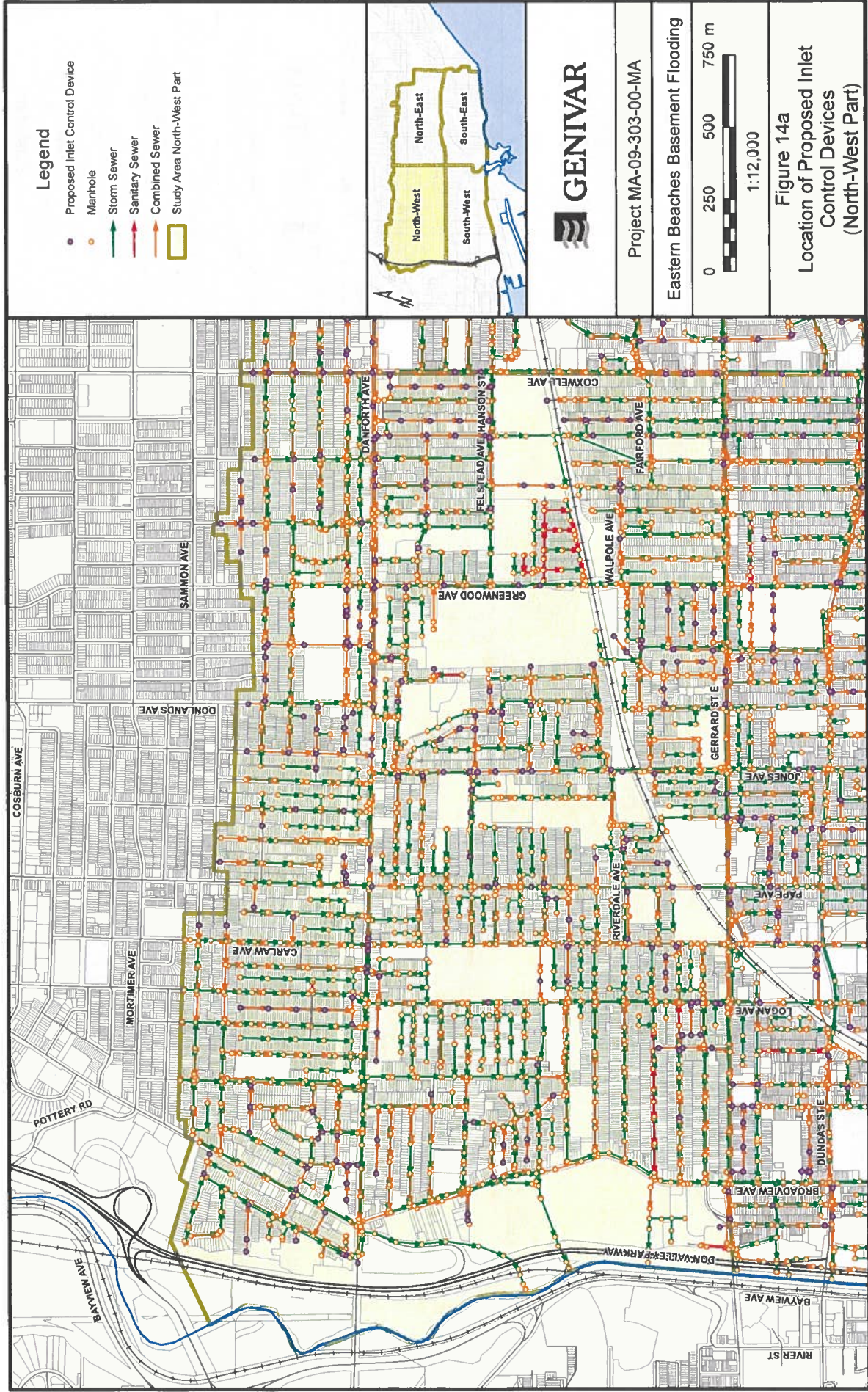
Combined Sewer Perforated
Manhole Covers to be Replaced
(South-East Part)

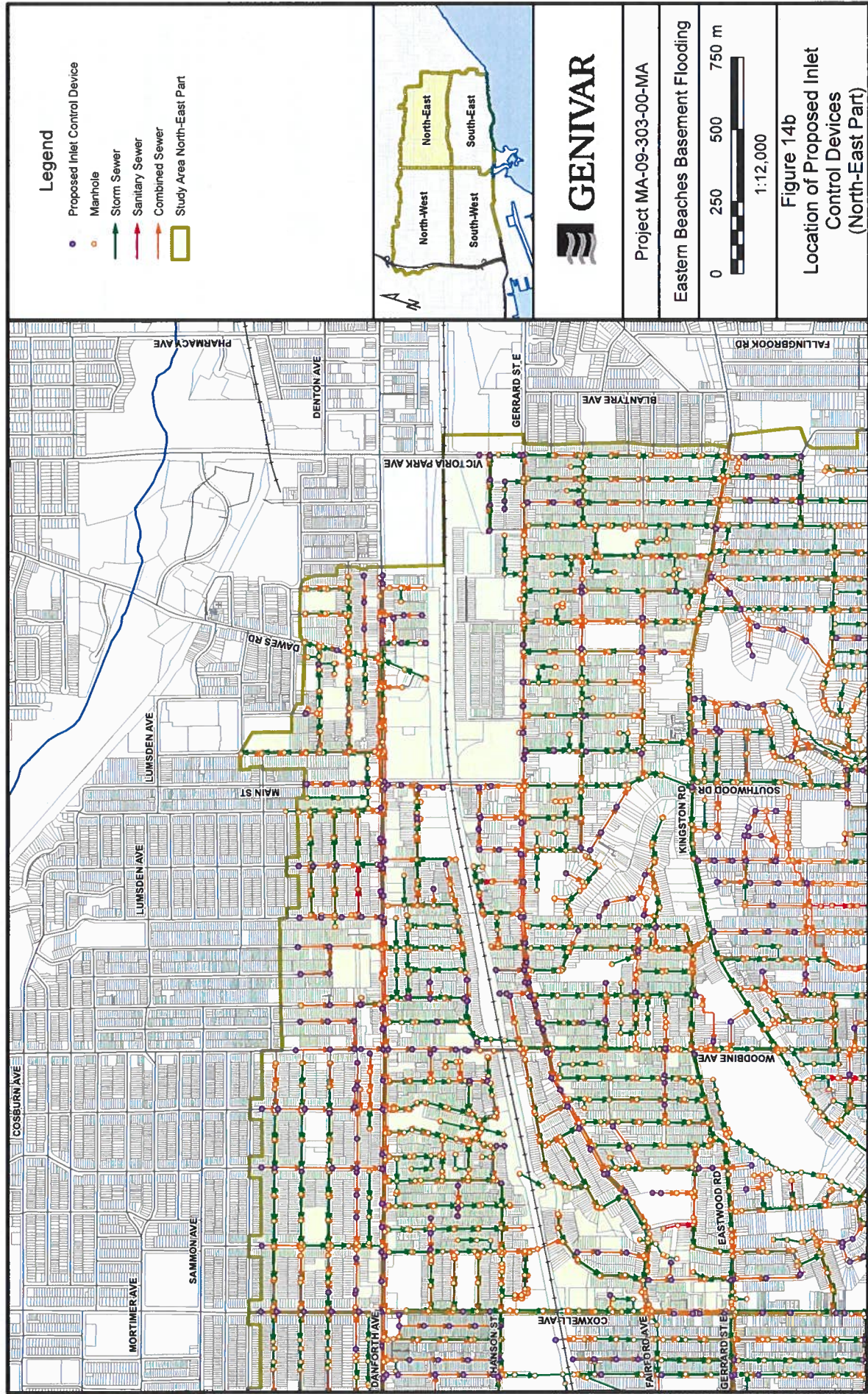


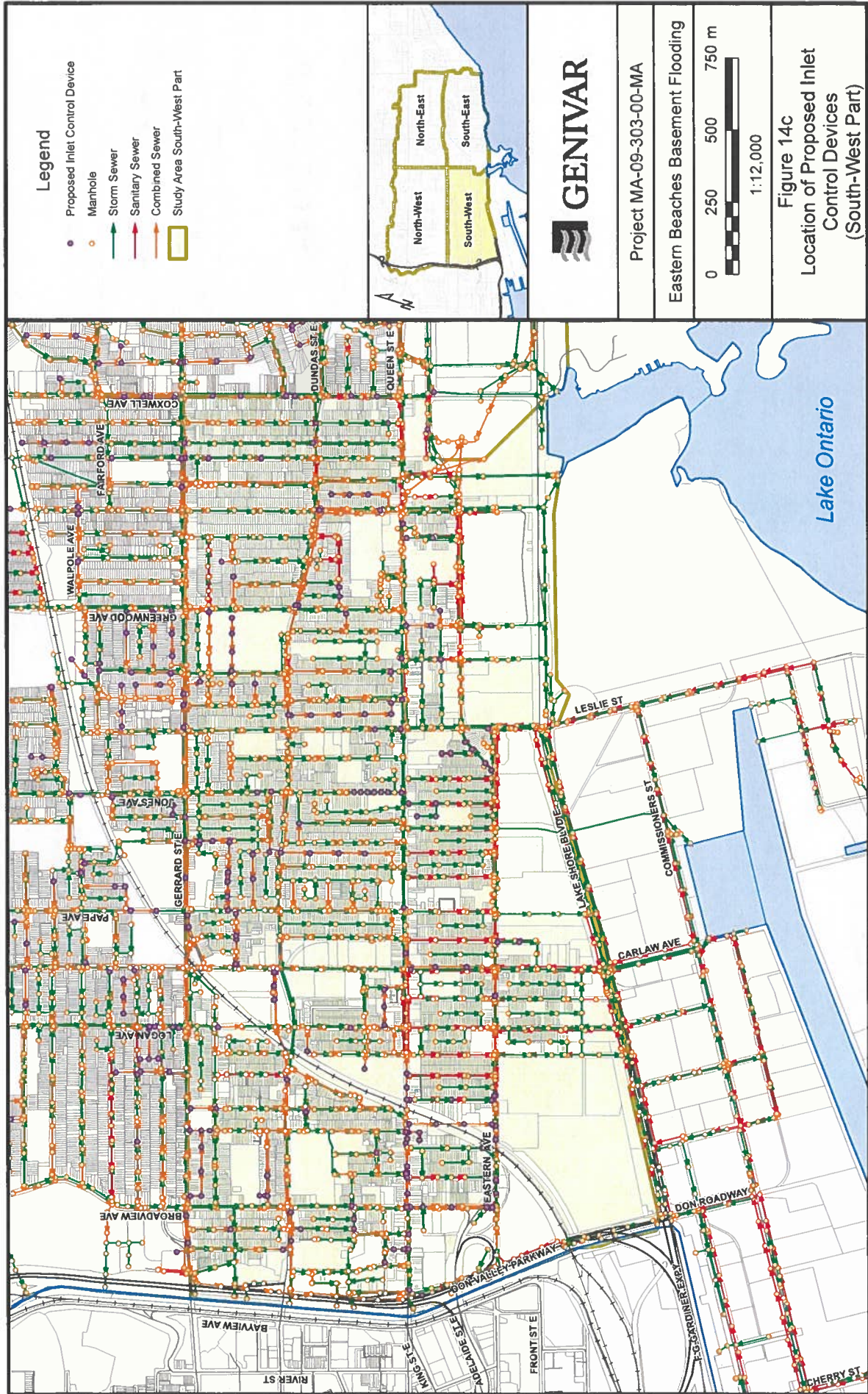


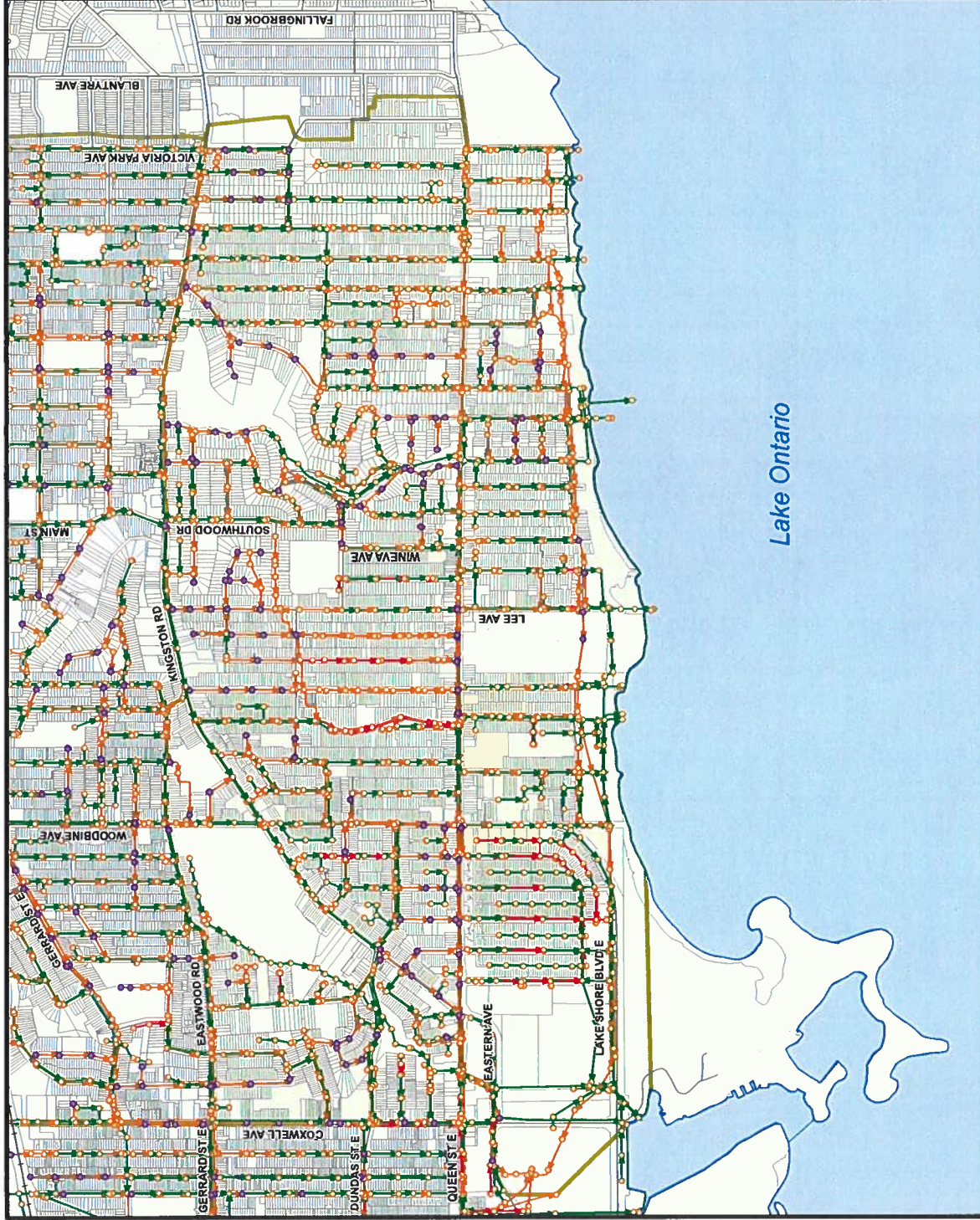












Legend

- Proposed Inlet Control Device
- Manhole
- Storm Sewer
- Sanitary Sewer
- Combined Sewer
- Study Area South-East Part



Project MA-09-303-00-MA

Eastern Beaches Basement Flooding



Figure 14d
Location of Proposed Inlet
Control Devices
(South-East Part)

Appendix D

Interim Remedial Measures



Investigations of the Eastern Beaches Basement Flooding (Area 32)

Interim Remedial Measures

The following interim remedial measures are part of the proposed solution, and could be implemented in the interim without requiring additional investigation or a detailed design and specification/tendering procedures. These measures will provide significant improvement to the combined and storm drainage systems resulting in reduction of the risk of basement and surface flooding.

Interim Remedial Measures

Location	Recommended Remedial Measures	Proposed Ultimate Solution	Supporting Documents
1. Minto St.	Install backflow preventor valve in every house on the street (West to East section)	Provide road sewer separation by constructing 300mm storm sewer in Minto St., West to East and connect it to existing storm sewer. Disconnect all catchbasins from combined sewer and connect to new storm sewer	Exhibit 1
2. Kingswood Rd.	- Clean the root intrusion in the laterals as shown in the last CCTV inspection - Plug catchbasins as shown in Exhibit 2 - Install backflow preventer valves in houses that experienced basement flooding	Provide road sewer separation by constructing 300mm storm sewer in Kingswood Road. Disconnect all catchbasins from existing combined sewer and connect to new storm sewer.	Exhibit 2
3. Lee Av.	- Provide catchbasins in front of house # 13 which has reverse slope driveway - Provide curb inlet at the south corner of the street and connect to the existing ditch inlet in the Park area.		Exhibit 3

Location	Recommended Remedial Measures	Proposed Ultimate Solution	Supporting Documents
4. Waverly Rd	Provide curb inlet at the south corner of Waverly Road to allow overland street flow to discharge to the existing sewer inlet located in the park.		Exhibit 4
5. Woodbine Ave./Lakeshore Blvd. E / Kewbeach Ave.	- Extend the median at the intersection of Woodbine Avenue and Lake Shore Blvd. East for approximately 20m in Woodbine Avenue. - Add catchbasin at the lowest location on the east side of Woodbine Ave., just north of the intersection with Kewbeach Avenue - Disconnect the 525 mm diameter sewer which drains part of the Greenwood subdivision to the Lake Shore Blvd. Storm sewer by constructing a new manhole as shown and connect it to the Lake shore Blvd. storm sewer.	Upgrade the storm sewer along Lake Shore Blvd. in few sections to avoid surface ponding in the street under the 100-year design storm.	Exhibit 5
6. Outfalls	Remove sediment from outfalls inspected by Galcon as shown in the attached map. Disperse sediment away from outfall to avoid being washed off inside the outfall again		Exhibit 6
7. 10 Outfall Structures	Remove sediment from the 10 outfall structures inspected by Robichaud as shown in the attached map		Exhibit 7
8. Various	Repair / maintain sewers at various locations based on 2009 CCTV inspection carried out by the City		Exhibit 8
9. Various	Provide Sewer maintenance and repair as identified by the most recent CCTV inspection conducted within the current study in 2010.		Exhibit 9
10. Various	Replace porous manholes covers with solid covers on combined sewers where there is storm sewer in the same street (Total count 893 manholes)		Exhibit 10

Location	Recommended Remedial Measures	Proposed Ultimate Solution	Supporting Documents
11. Various	Seal manhole covers on the combined/sanitary sewer systems which are located on low lying areas, by blocking the holes in the manhole cover. (Total count 105 manholes)		Exhibit 11
12. Kerr Road / Highfield Road	- Regrade the south intersection of Highfield Road and Dundas St. to eliminate surface flow from Dundas St. East from flowing southward into Highfield Road. Provide additional catchbasin at the south east corner of the intersection. - Provide two (2) double catchbasins at the corner of Kerr Road and Highfield Road. - Clean blocked catchbasins and repair sewer system to eliminate cross-connections between storm and combined sewers as noted in the results of the fog testing carried out in November-December 2010.		Exhibit 12
13. Leslie Street	- Provide double catchbasins on the north east and north west corners of the Leslie Street/Lake Shore Blvd. E. intersection. - Provide double catchbasins at the low area south of Lake Shore Blvd. E. on the west side (at the entrance to the Canadian Tire Store).		Exhibit 13



Legend

- Proposed Storm Sewer
- Existing Combined Sewer
- Existing Sanitary Sewer
- Existing Storm Sewer
- Existing Nodes

Remedial Measure for Early Implementation - Minto St.

Construction of a 375 mm Storm Sewer along
Minto Street to Connect to Existing Storm Sewer System



Exhibit 1

November 2009



Legend

- Existing Combined Sewer
- Existing Sanitary Sewer
- Existing Storm Sewer
- Existing Nodes

Remedial Measure for Early Implementation - 13 Lee Street

Provide a relief catchbasin at low point in the vicinity of house #13 at Lee St. Due to the reverse slope driveway at this location storm water build-up on the street under severe storms tends to back-up in to the basement of house # 13.



Legend

- Existing Combined Sewer
- Existing Sanitary Sewer
- Existing Storm Sewer
- Existing Nodes

Remedial Measure for Early Implementation - Waverly Street

Provide curb cut at Waverly Street. In order to provide relief to the sewer system along Waverly Street during heavy storms, the curb at the location of the relief ditch inlet will be cut to allow entry of runoff flows.



GENIVAR

Exhibit 4

November 2009

Exhibit 5

Eastern Beaches Basement Flooding Investigation Summary of Kew Beach Avenue Interim Measures

1. Installation of two curb cuts and a shallow swale network in Kew Beach Park to relief flow depth on Kew Beach Avenue (see Figure 1). The swale network ends at a shallow pond with several catchbasins connecting to the Kippendavie Avenue storm outfall which will be re-activated.



Figure 1

Profiles of both the proposed swales and the re-activated pipe are shown in Figures 2 and 3.

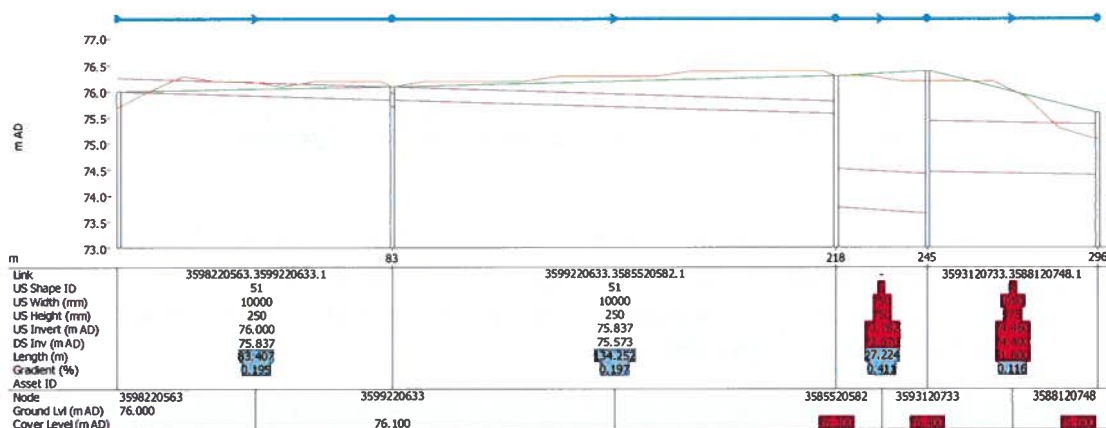


Figure 2

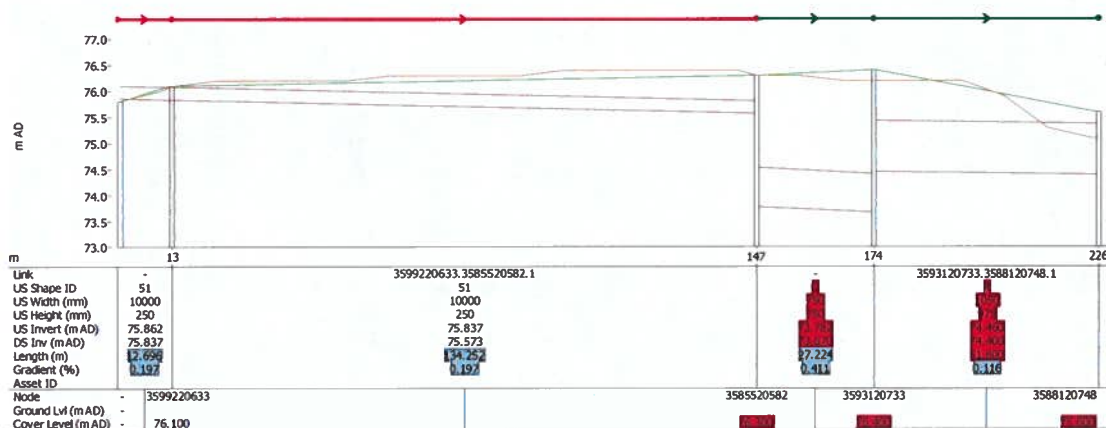


Figure 3

The cross section of the swale is a trapezoidal open channel 10 m wide by 0.25 m deep with a bottom 2 m wide, see Figure 4. The swale will be constructed in grass to promote infiltration.

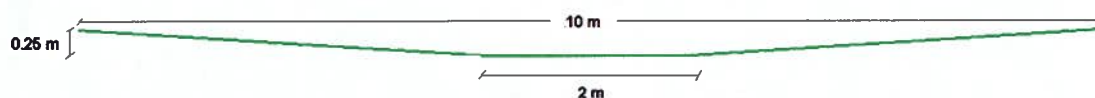


Figure 4

The estimated design flow for the swale is 544 l/s that can provide protection for a 1:100 yr storm.

Due to the presence of trees in the park the swale has to meander around them to avoid damage to their roots. It is possible to have two parallel swales in some areas to have smaller swales, 5 m wide with a bottom 1 m wide, to better accommodate for the trees.

The maximum depth of the swale is around 0.70 m close to the connection to the abandoned storm sewer.

The maximum capacity of the abandoned storm sewer south of Kippendavie Ave. is 713 l/s which can convey the flow from the swale.

2. Diversion of 35% of the storm sewer flow from the residential development west of Woodbine Ave. to the storm sewer on Lakeshore Blvd. Installation of a speed bump at Woodbine Ave. to reduce overland flow from Woodbine Ave. flowing south onto Kew Beach Ave., see Figure 5. Add catchbasin inlet controls in the new development and along Woodbine Ave., south of Queen St. E.

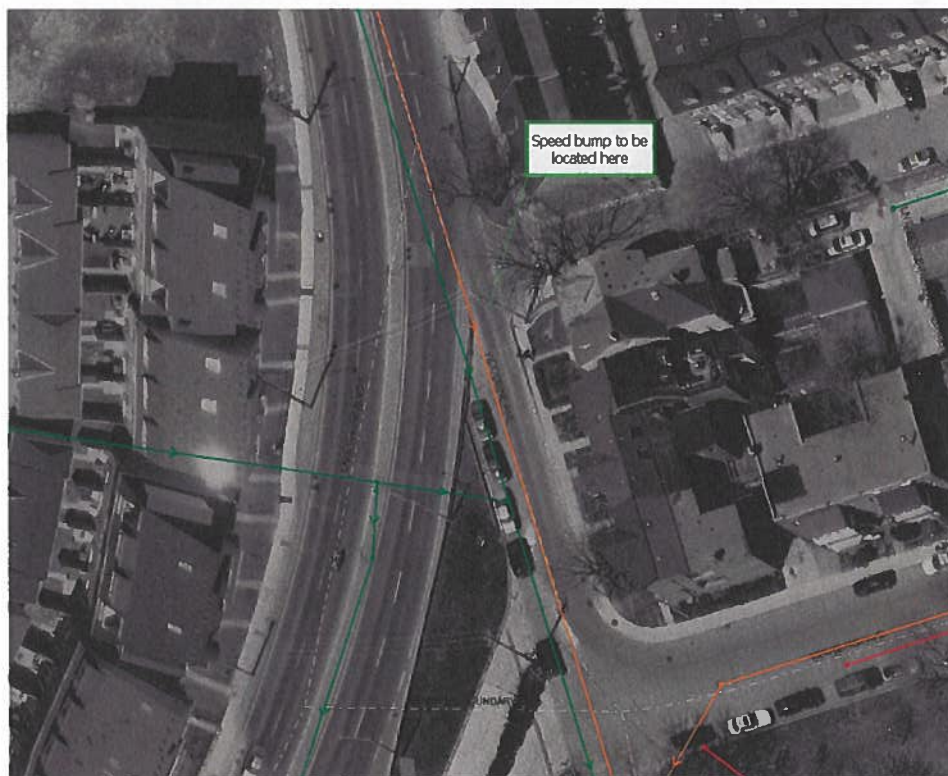


Figure 5

The capacity of the existing sewer was evaluated using the rational method and the following conclusions can be made, see Figure 6:

- The design level of the existing storm sewer system is 1:2 yr storm.
- The runoff coefficient used for the design was 0.55.
- When considering the subcatchment areas including ROW and private properties only, the storm sewer system located along Woodbine Ave. has the capacity to convey the storm flow from south of Queen St. E. The storm pipe from the new development and the storm sewer downstream of Kew Beach Ave. to the Kenilworth Tank does not have capacity.

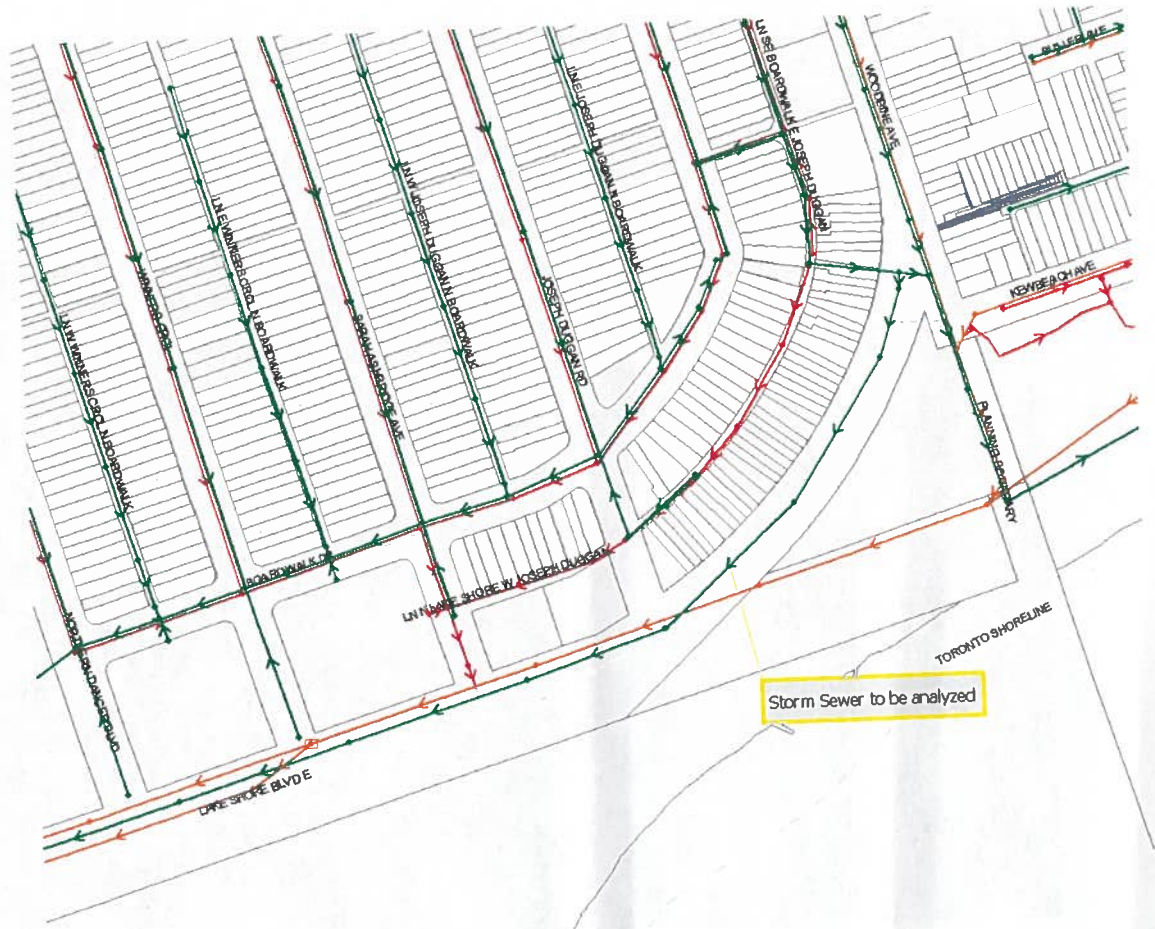


Figure 7

- Up to 35 % of the storm flow from the New Development, 71 l/s, can be diverted to the storm sewer system on Lake Shore Blvd. E. This requires the construction of a 300 mm size pipe, a new MH with a flow control structure. See Figure 8 for the location of the new MH chamber with a flow control structure and the new pipe required.

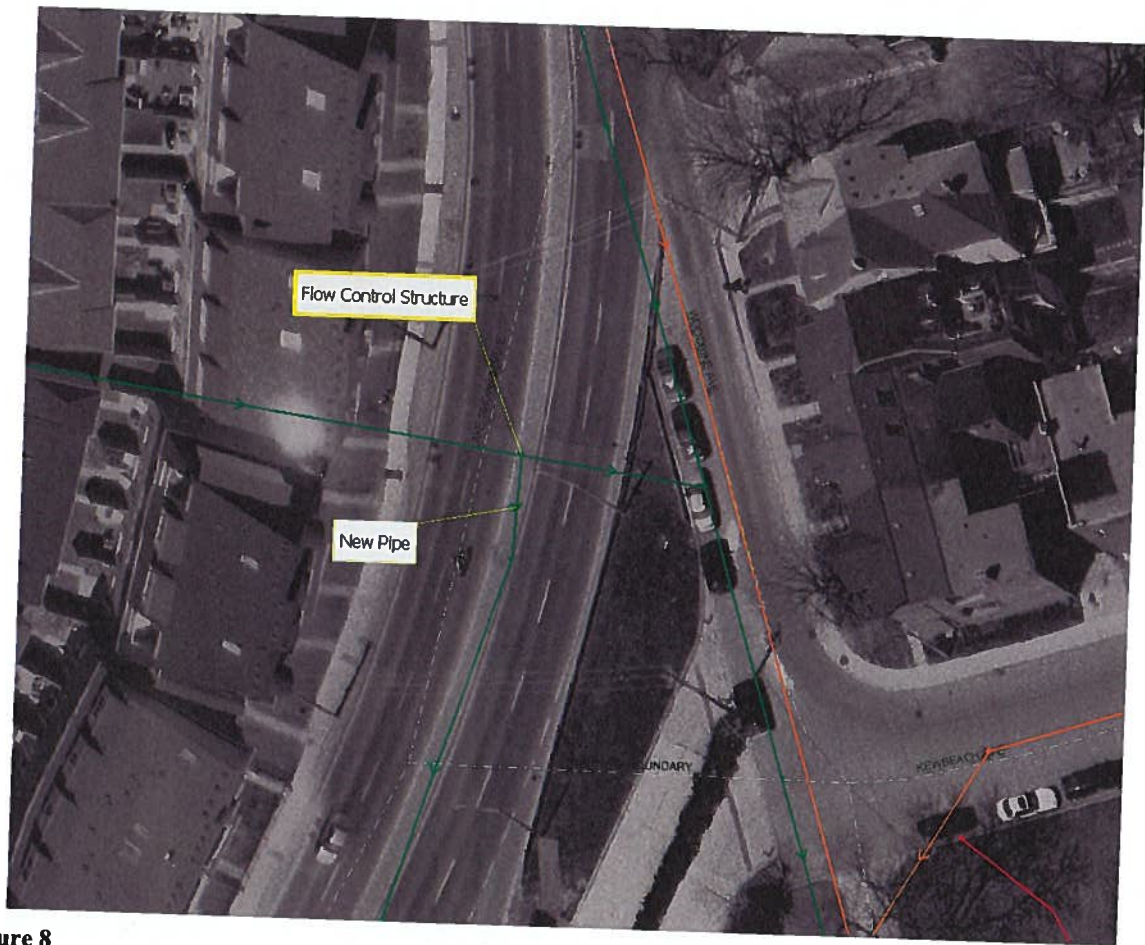
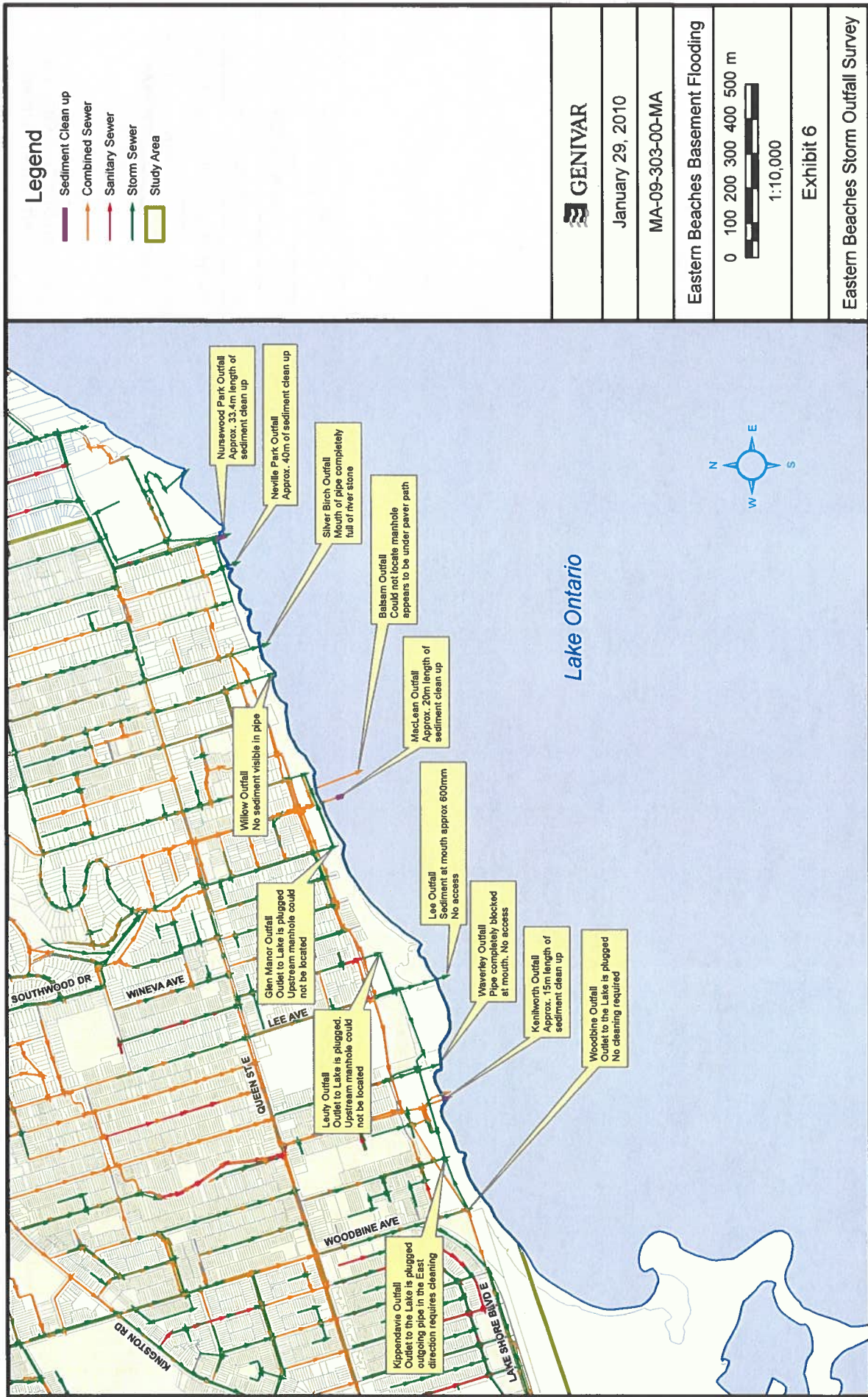
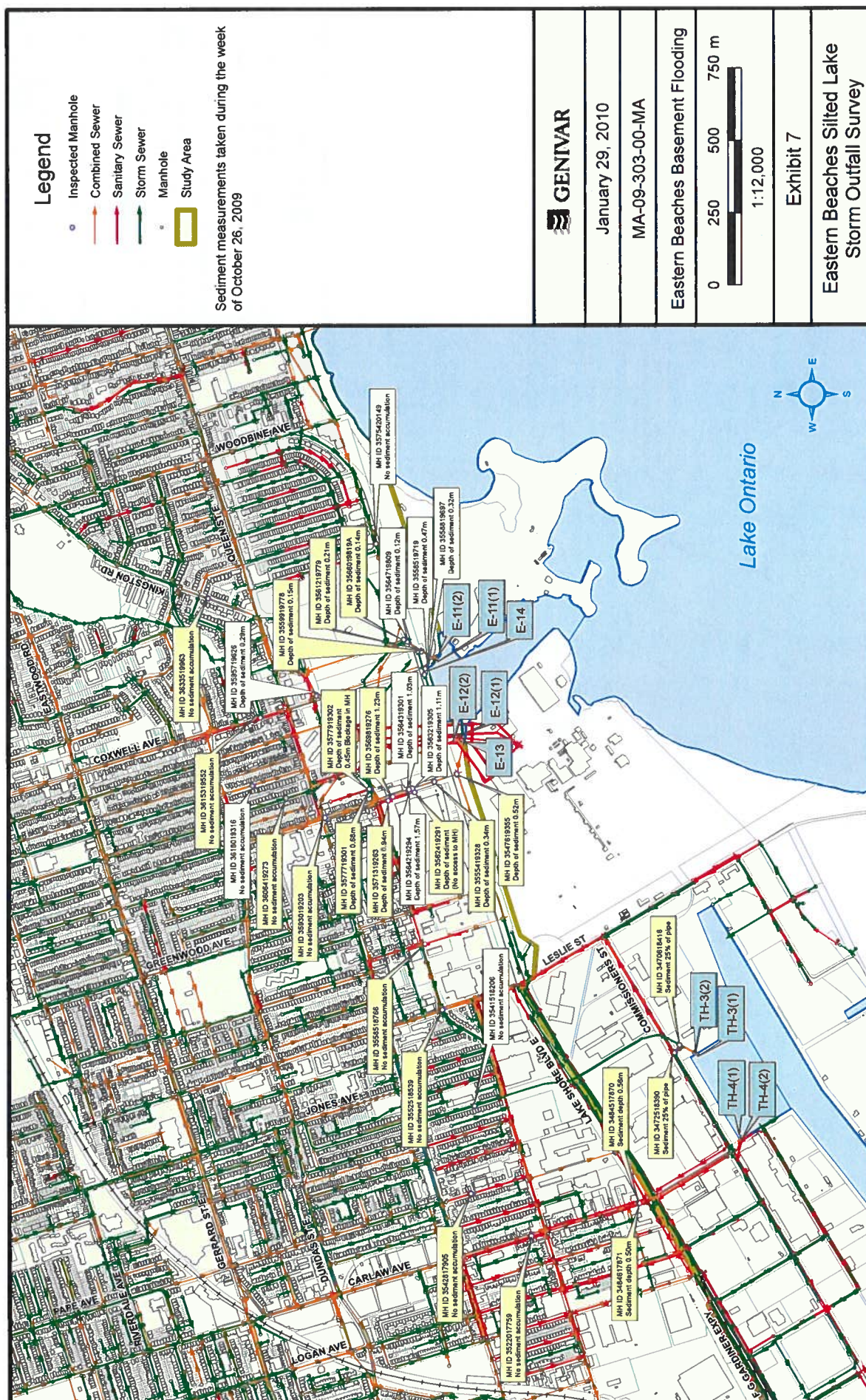


Figure 8

3. Lower the inlet grates at Waverley Rd. and Lee Ave. and create a lower curb cut to provide easier outlet flow route when streets are flooded.
4. Add new catchbasin in the low point in front of 13-13A Lee Avenue; re-grade the low point of the road in front of the Lee Avenue inlet grate relief.
5. Keep the existing backflow valves at Lee Ave. and Waverley Rd.





Sediment measurements taken during the week of October 26, 2009

Exhibit 8 - To be Abandoned

STREET NAME	Ward No.	Sewer Line ID.	Sewer Line New ID.	DIA. (mm)	Upstream Manhole		Downstream Manhole		LEN. (m)	FLOW TYPE	CONTRACT No.	Review Comments	Recommendations
					From Street	Manhole No.	To Street	Manhole No					
KEWBEACH AVE	30	5000036	1425043	225	KEWBEACH AVE	1000146	KIPPENDAVIE AVE	1000152	34.7	COMB	08TEEEY-326WP	RECONNECT ALL SERVICE LATERALS TO 450 SA	TO BE ABANDONED
KEWBEACH AVE	30	5000037	1425048	225	KEWBEACH AVE	1000152	KIPPENDAVIE AVE	1000151	18.3	COMB	08TEEEY-326WP	RECONNECT ALL SERVICE LATERALS TO 450 SA	TO BE ABANDONED
page 1													

Exhibit 8 - Spot Line
South - 2009 SEWER REHABILITATION LIST

Page 2

Exhibit 8 - MH repair

South - 2009 SEWER REHABILITATION LIST

STREET NAME	Ward No.	Sewer Line ID.	Sewer Line New ID.	DIA. (mm)	Upstream Manhole		Downstream Manhole		LEN. (m)	FLOW TYPE	CONTRACT No.	CD No.	LATs.	Review Comments	Recommendations
					From Street	Manhole No.	To Street	Manhole No.							
Laneway	30	5000147	1428277	300	LN N QUEEN JONES	1004508	JONES AVE	1005404	PVC	SAN	08TEEY-328		0	Infiltration in the MH1004508	MH Repair
Carlsw Ave		5000032	1428898	300	EASTERN AVE	5000789	LAKE SHORT BLVD	1000562	VIT	COMB	08TEEY-328			Clean both MH-MH5000789 fix steps	MH Repair
Queen St E	30	5000160	1427215, 1427217	600X1050	COADY AVE	1014850	BERTMOUNT AVE	1014948	CONC	STM	08TEEY-328		11	Expose and raise MH1014948	MH Repair
Broadview Ave	30	5000015	1428840	450	QUEEN ST E	5001395	LN S QUEEN W BROADV	1000382	VIT	COMB	08TEEY-328			Fix MH1000382 and 5001395	MH Repair
KEWBEECH AVE	30	5000040	1427417	450	WOODBINE AVE	1000325	KIPPENDAVIE AVE	1000282	CONC	SAN	08TEEY-328		7	Infiltration in the MH1000325	MH Repair
Woodbine Ave	30	5000067	1421248	375	Queen St E	1000280	Kewbeach Ave	1000259	VIT	COMB	08TEEY-328		6	MH1000280 - full of debris, clean	MH Repair
Woodbine Ave	30	5000068	1421246	375	QUEEN ST E	1000266	KEWBEECH AVE	1000268	VIT	COMB	08TEEY-328		5	MH1000268 - repair & clean debris	MH Repair & Clean
Eastam Ave	32	5000075	1426054	300	Knox Ave	5100185	Minto St	5100193	VIT	SAN	08TEEY-328		4	MH5100185-heavy encrustation - could be under the tracks	MH Repair

South - 2009 SEWER REHABILITATION LIST

Page 4

Exhibit 8 - Replacement

Page 5

Exhibit 8 - Clean

STREET NAME	Ward No.	Sewer Line ID.	Sewer Line New ID.	DIA. (mm)	Upstream Manhole		Downstream Manhole		MAT.	LEN. (m)	FLOW CONTRACT TYPE No.	Review Comments	Recommendations
					From Street	Manhole No.	To Street	Manhole No.					
Queen St E	30	5000162	1427434, 1427435	900x1600	JONES AVE	1014956-7	CURZON ST	5111453	CONC	123	STM	remove pile of bricks @ 8.50	clean
Queen St E	30	5000156	1427668, 1425684	1350	HILTZ AVE	1014800	LESLIE ST	1014864	CONC	415	STM	70% water level	clean
Queen St E	30	5000167	1427704, 1427705	1650	CURZON ST	1014868	BERKSHIRE AVE	1014864	CONC	171	STM	90% water level	clean
Queen St E	30	5000158	1426617	1650	BERKSHIRE AVE	1014864	COADY AVE	1014851	CONC	52	STM	90% water level	clean
Queen St E	30	5000159	1426431, 1426430	1650	COADY AVE	1014861	BERMOUNT AVE	1014847	CONC	70	STM	90% water level	clean
Queen St E	30	5000161	1426751	888x1050		1014850		1014866-7	105	105.5	STM	Heavy debris, remove obstr. @ 84 m	clean
Carlisle Ave	32	5000262	1427630, 600x600	600x600	DUNDAS ST E	1004290	COLGATE AVE	1004286	BRK	58.8	COMB	Heavy debris, remove obstr. @ 84 m	clean
Carlisle Ave	32	5000253	1427631, 600x600	600x600	DUNDAS ST E	1004290	COLGATE AVE	1004291	BRK	91.9	COMB	Heavy debris, remove obstr. @ 84 m	clean
Carlisle Ave	5000171		1426843	1850x3500	LAKE SHORE BLVD	1000475	EASTERN AVE	1000567	CONC	69	COMB	Calcite on the bottom	clean
Carlisle Ave	5000172		1426848	1850x3500	LAKE SHORE BLVD	1000474	EASTERN AVE	1000568	CONC	69	COMB	running full	clean
Carlisle Ave	5000173		1426848	1850x3500	LAKE SHORE BLVD	1000476	EASTERN AVE	1000474	CONC	69	COMB	running full	clean
Carlisle Ave	5000174		1426847	1850x3500	LAKE SHORE BLVD	1000477	EASTERN AVE	1000475	CONC	N/A	COMB	running full	clean
Carlisle Ave	5000175		1426840	1850x3500	LAKE SHORE BLVD	1000479	EASTERN AVE	1000477	CONC	69	COMB	running full	clean
Carlisle Ave	5000031		1426897	300	EASTERN AVE	1000467	LAKE SHORE BLVD	5000789	VIT	86.3	COMB	debris(non-silt/grease), obstruction	clean
Logan Ave	30	5000194	1427684	600x600	DICKENS ST	1004281	DUNDAS ST E	1004280	BRK	63	COMB	Laterals too low @ 4.8 calcite buildup, T Line @ 35.50.4 Clean DE in main pipe	clean
Broadview Ave	30	5000012	1426671	450	BROADVIEW'S EAST E	1000363	SUNLIGHT PARK	1004445	VIT	105	COMB	Clean Debris	Clean
Kingsdome Ave	30	5000034	1423559	450	BULLER AVE	1000363	KEWBEACH AVE	1000280	CONC	95.3	SAN	Clean Debris	Clean
Kentworth Ave	30	5000063	1423618	450	QUEEN ST E	1000068	KEWBEACH AVE	1000018	VIT	86	COMB	Clean Debris	Clean
Woodbine Ave	30	5000069	1421246	375	QUEEN ST E	1000266	KEWBEACH AVE	1000268	VIT	94	COMB	Clean Debris	Clean
Dundas St E	30	5000076	1426304	300	HAMILTON ST	1004224	BROADVIEW AVE	1004220	VIT	87	COMB	Chunk of concrete blocking access to pipe	Remove obstruction and reCCTV
Logan Ave	30	5000077	1426678	675	LAKE SHORE BLVD	Uncharted	EASTERN AVE	5000781	VIT	105	SAN	Heavy debris	Clean & reCCTV
Logan Ave	30	5000079	1426677	675	LAKE SHORE BLVD	5000607	EASTERN AVE	Uncharted	VIT	105	SAN	Heavy debris	Clean & reCCTV
Mosley St	30	5000072	1427332	300	RUSHBROOKIE AVE	5106533	EASTERN AVE	5000871	VIT	78	SAN	Heavy debris	Clean & reCCTV

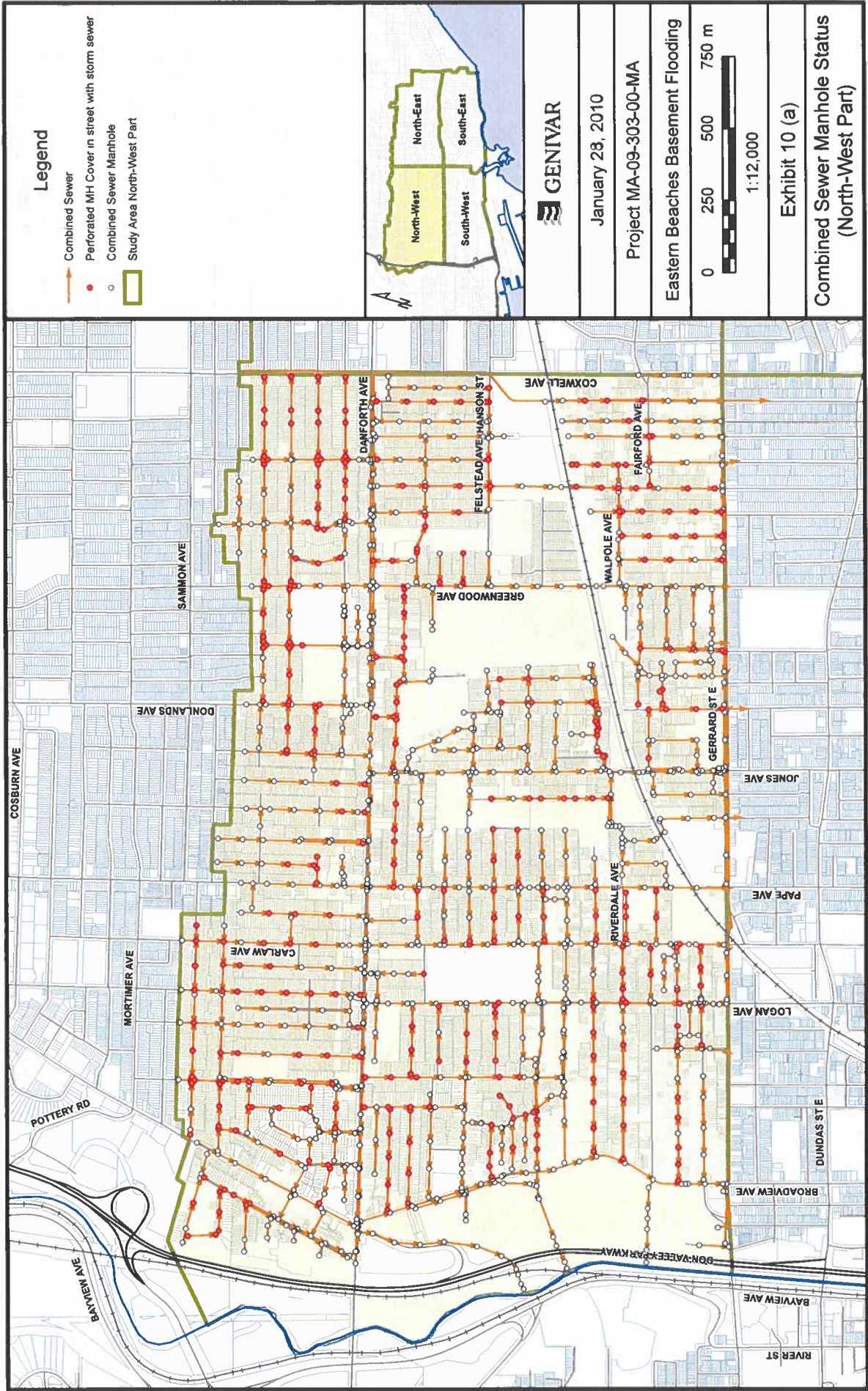
Exhibit 8 - Clean

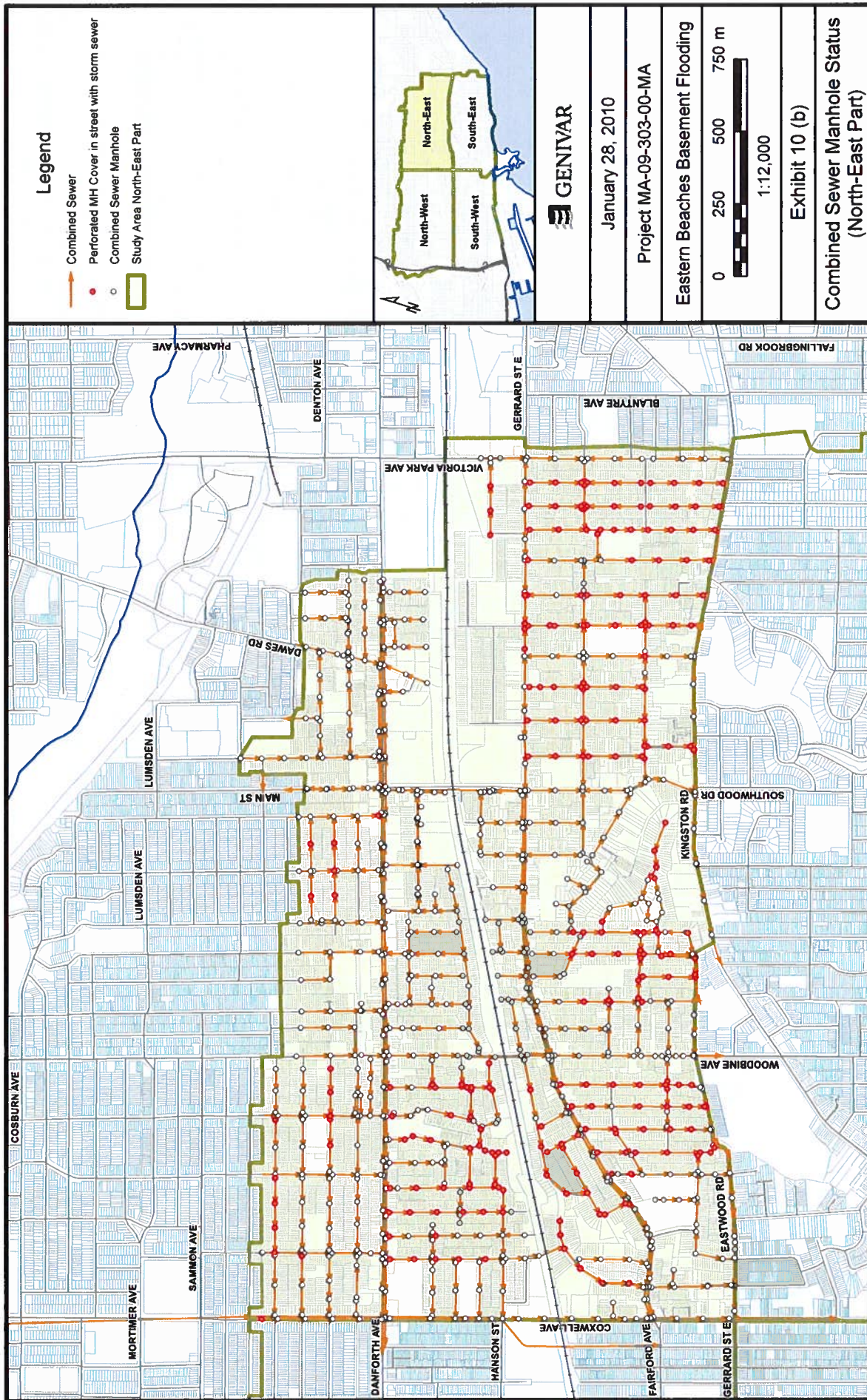
South - 2009 SEWER REHABILITATION LIST

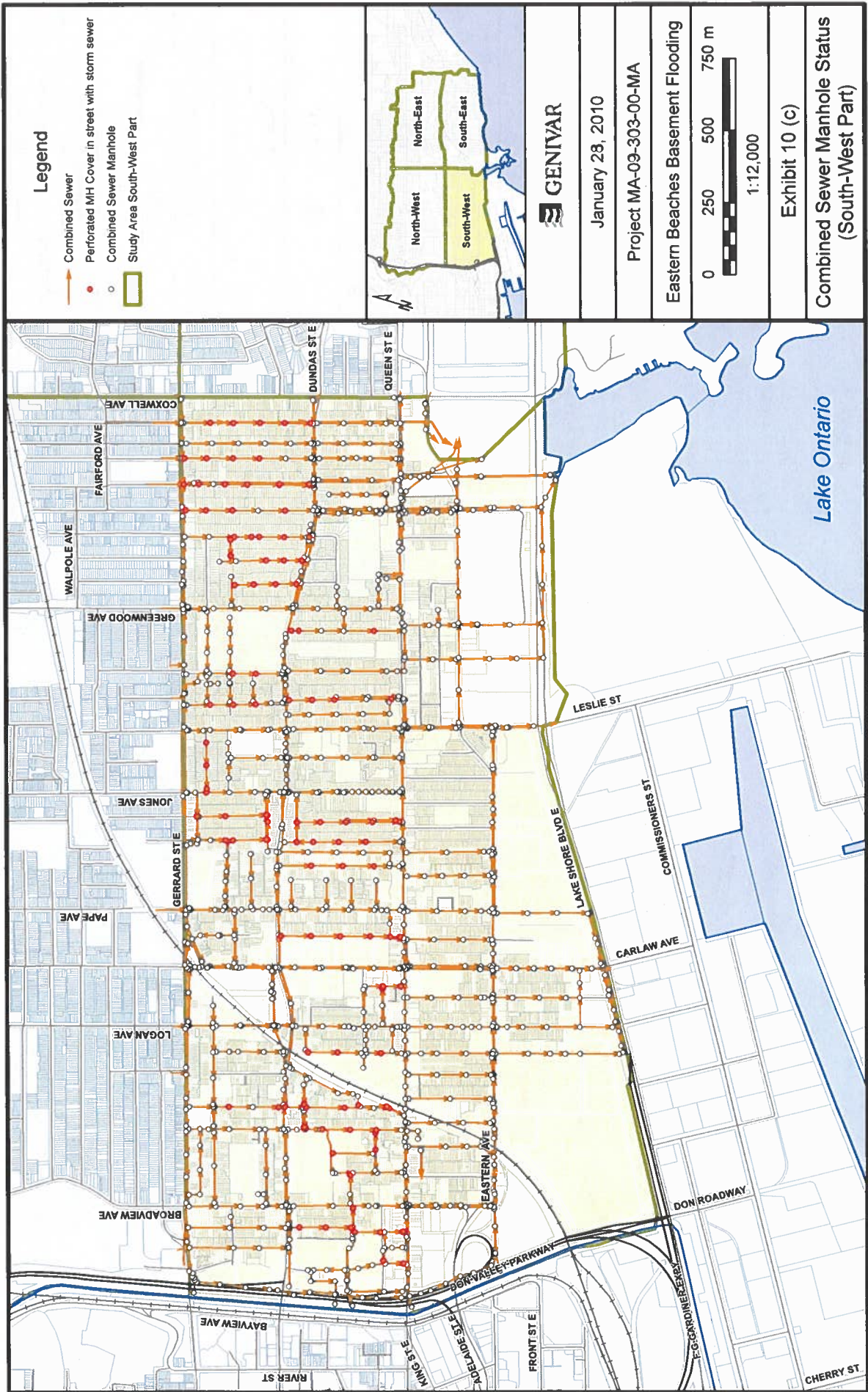
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					From Street	Manhole No	MH Depth	To Street	Manhole No	MH Depth								
Queen St E		5000145		500		5100171			5100154		VIT 39	COMB	08TEEY-326		8	Calclite	Line	39
Jones Ave		5000149		300		1004504			1000419		VIT 24	SAN	08TEEY-326		1	Calclite	Line	24
Keer Rd		5000198		300		1003394			1003393		VIT 33	COMB	08DCS-321				Line	33
Keer Rd		5000198		300		1003397			1003398		VIT 16	COMB	08DCS-321				Line	16
Keer Rd		5000199		300		1003396			1003406		VIT 78	COMB	08DCS-321			Calclite	Line	78
Keer Rd		5000200		300		1003406			1003422		VIT 60	COMB	08DCS-321			Calclite	Line	60
Logan Ave		5000204		300		1000388			1000462		VIT 90.5	COMB	08DCS-321			Calclite	Line	90.5
Logan Ave		5000227		300		1000549			5000808		VIT 90	COMB	08TEEY-326			Debris+calclite	Line	
Logan Ave		5000228		300		5000808			5100459		VIT 115	COMB	08TEEY-326				Line	
Logan Ave		5000228		300		5100459			5100468		VIT 120	COMB	08TEEY-326				Line	
Jones Ave		5000418		300		1004516			1004504		VIT 73	COMB	08TEEY-326			Calclite	Line	73
Kenilworth Ave		5000084		375		1000278			1000285		VIT 61	SAN	08TEEY-326		12	Calclite	Line	61
Kenilworth Ave		5000085		375		1000278			1000288		VIT 41	SAN	08TEEY-326				Line	41
Mealey St		5000071		300		5000871			5000864		VIT 79	SAN	08TEEY-326		6	Clean debris+line	Line	
Mealey St		5000071		300		1000301		Minto St	5100185		VIT 85	SAN	08TEEY-326		3	Clean debris+line	Line	85
Easton Ave	32	5000074		300	Konx Ave	5100185		Minto St	5100183		VIT 90	SAN	08TEEY-326		4	Calclite+line	Line	90
Easton Ave		5000075		300	Konx Ave	5100185			1000284		VIT 100	COMB	08TEEY-326				Line	
Kippendavie Ave		5000033		300		1000085					VIT							

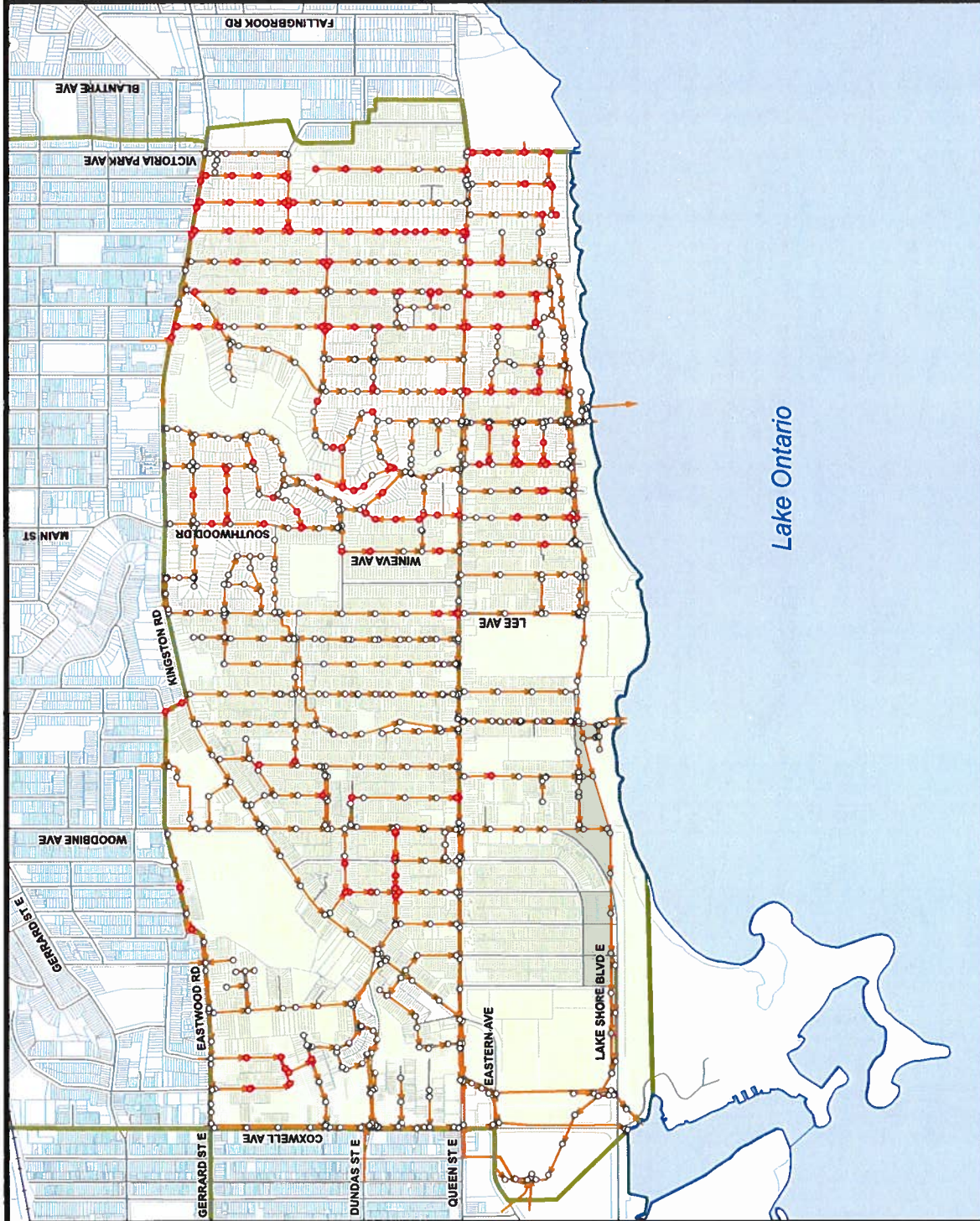
**EXHIBIT 9
SEWER REHABILITATION - BASED ON CCTV INSPECTION CARRIED OUT FEBRUARY 2010**

Upstream MH	Downstream MH	Pipe Length (m)	Surveyed Length (m)	Sewer Type	Pipe Size	Pipe Material	CCTV Comments	Recommendations
WOODWARD AVENUE								
35084 19226	35088 19249	79.1	47.1	Sanitary	300	Verified Clay	- Multiple cracks @ 04-04 - Fire roots - Encrustation light at joint - Intruding connection @ 16.1m (50m in sewer) - No water in sewer	Clean and remove intruding connection
35088 19249	35095 19276	87.3	0	Sanitary	300	Verified Clay	- No water in sewer - Upstream manhole full of debris/water - Inlet and outlet not visible - Survey abandoned	Clean
35095 19276	35793 19279	12.8	71.1	Sanitary	300	Verified Clay/Block	- Several circumferential and longitudinal cracks identified - Several incrustation light identified - Inlet and outlet not visible - Debris and grease encountered	Replace
MINTO AVENUE								
35793 19289	35857 19012	79	79.4	Sanitary	300	N/A	- No comments from CCTV inspection, very good operational and structural integrity	No rehabilitation required
35793 19289	35793 19000	83.3	48.2	Sanitary	300	N/A	- Severe debris encountered, Survey abandoned	Clean
35793 19289	35793 19053	87.2	0	Sanitary	300	N/A	- Line plugged with bricks and debris - Survey abandoned	Clean
WINNIFRED AVENUE								
35452 17900	35452 16009	61.9	25.6	Combined	375	Verified Clay	- Several longitudinal and circumferential cracks encountered - Severe encrustation light at joint encountered at upstream end of pipe - Survey abandoned, camera probe debris encountered	Replace
35452 16009	35435 16027	66.6	61.4	Combined	375	Verified Clay	- Several longitudinal and circumferential cracks encountered - Severe debris encountered at 17.1m (downstream MH) to upstream MH) - Survey abandoned	Replace
35435 16027	35391 16051	77.9	60.4	Combined	375	Verified Clay	- Circumferential fracture and crack encountered at several locations - Survey abandoned	Replace
35391 16051	35281 16078	84.1	54	Combined	375	Verified Clay	- Longitudinal crack encountered at several locations - Hole in sewer @ 48.4m (from upstream MH) - Construction in sewer at 48.4m 47% into pipe - Encrustation light encountered at several locations - Survey abandoned debris encountered and cannot proceed	Replace
35281 16078	35273 16060	12.6	13.8	Combined	375	Verified Clay	- Encrustation light encountered at several locations	Replace
EMPIRE AVENUE								
35348 1723	35233 17262	86.9	100.2	Combined	300	Verified Clay	- Fire roots encountered at several locations - Longitudinal cracks encountered at some locations - Multiple cracks encountered at several locations - Circumferential cracks encountered at several locations - Hole in sewer encountered at several locations - Encrustation light encountered at some locations - Pipe through sewer at 35m, survey abandoned	Clean and spot line
35233 17262	35155 17291	101.9	103.6	Combined	300	Verified Clay	- Multiple cracks encountered at several locations - Circumferential cracks encountered at several locations - Hole in sewer encountered at several locations - Encrustation light encountered at some locations - Pipe through sewer at 35m, survey abandoned	Replace
35155 17291	35072 17417	86	81	Combined	300	Verified Clay	- Circumferential cracks encountered at several locations - Intruding connection encountered at 4.1m from upstream MH 100mm into sewer - Intruding connection encountered at 12.8 and 21.2m 50mm into pipe - Encrustation light encountered at several locations - Encrustation medium at joint - Survey abandoned due to encrustation	Remove intrusions and spot line
35072 17417	35069 17417	3.8	0.8	Combined	300	Verified Clay	- Encrustation medium at joint - Survey abandoned due to encrustation	Clean
ALTON AVENUE								
35044 18260	35069 18013	91.4	34.2	Combined	450	Concrete	- Multiple longitudinal cracks encountered - Multiple cracks encountered at several locations - Circumferential cracks encountered at several locations - High water levels at downstream end of pipe	Replace
35069 18013	35025 18052	137.2	0.8	Combined	450	Concrete	- High water levels at downstream end of pipe - Encrustation heavy 80% of sewer - High water levels at downstream end of pipe	Replace
35025 18052	35789 18070	74.34	0	Combined	450	Concrete	- High water levels at downstream end of pipe - Encrustation medium	Clean
PAPE AVENUE								
35514 17978	35471 17905	101.8	8.4	Combined	625	Regular Masonry/Block	- Encrustation medium - Debris encountered - Survey abandoned	Clean
35471 17905	35323 17933	97.2	84.7	Combined	625	Concrete	- Fire roots encountered at few locations - Circumferential crack - Encrustation light	Clean
35323 17933	35271 17960	56.4	80	Combined	625	Concrete	- Circumferential crack - Encrustation light	Replace
35271 17960	35251 17958	21.9	84	Combined	625	Concrete	- Encrustation light	Replace
KEWBEACH AVENUE								
35055 20275	35037 20217	60.9	0	Combined	250	N/A	- No inlet and outlet visible full of water	Clean
35037 20217	35025 20091	18.6	0	Combined	250	N/A	- Gate door blocking sewer line - Identified in the model. Need City to confirm the existence of the gate	Survey identified gate in sewer. This gate is not identified in the model. Need City to confirm the existence of the gate
35025 20091	35014 20045	48.1	35	Combined	250	N/A	- Encrustation light encountered at several locations - Longitudinal crack - Debris encountered	Clean
35014 20045	35002 20064	84.3	0.8	Combined	250	N/A	- Sewer plugged with bricks and debris	Clean



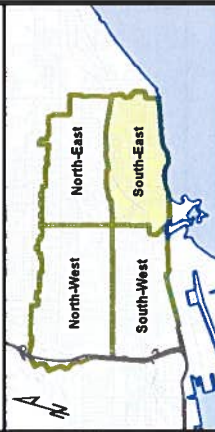






Legend

- Combined Sewer
- Perforated MH Cover in street with storm sewer
- Combined Sewer Manhole
- Study Area South-East Part



GENIVAR

January 28, 2010

Project MA-09-303-00-MA

Eastern Beaches Basement Flooding



Exhibit 10 (d)

Combined Sewer Manhole Status
(South-East Part)

