A CLIMATE CHANGE ADAPTATION STRATEGY TO ADDRESS URBAN FLOODING

The City of Toronto's Basement Flooding Protection Program

Michael D'Andrea
Toronto Water, City of Toronto

ICLR Basement Flooding Symposium
May 26, 2011
Toronto, Ontario

TORONTO Water

Presentation Overview

- City of Toronto & Water Infrastructure – Background
- Climate Change Effects & Impacts From Recent Extreme Storms
- Basement Flooding Causes
- Adaptive Management Approach
- Implementation & Policy Considerations
- Conclusions

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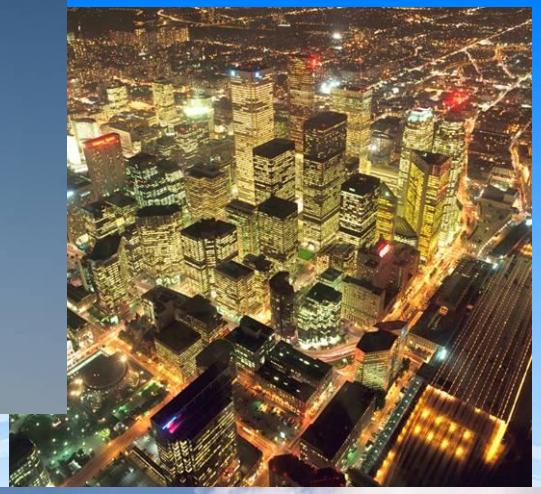
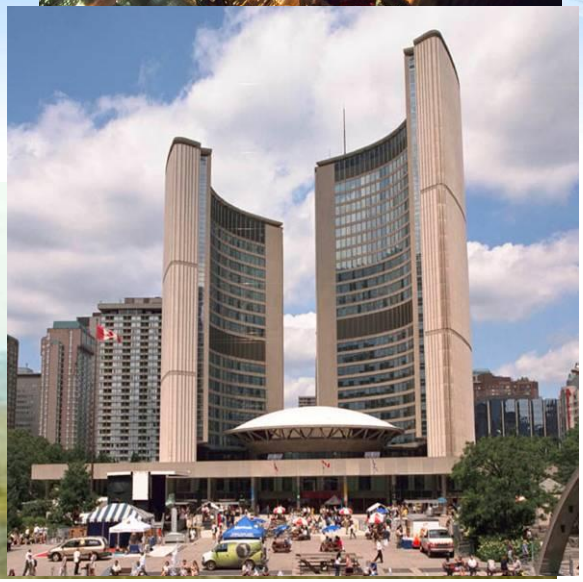
City of Toronto





- **Canada's largest City: 2.5 million**
- **Total City of Toronto area: 641 km²**
- **Land Uses:**
  - **45% residential**
  - **23% open space & natural areas**
  - **10% industrial**
  - **9% commercial**
  - **13% other**
- **Waterfront along Lake Ontario: 43 km**
- **Waterfront Beaches: 11**

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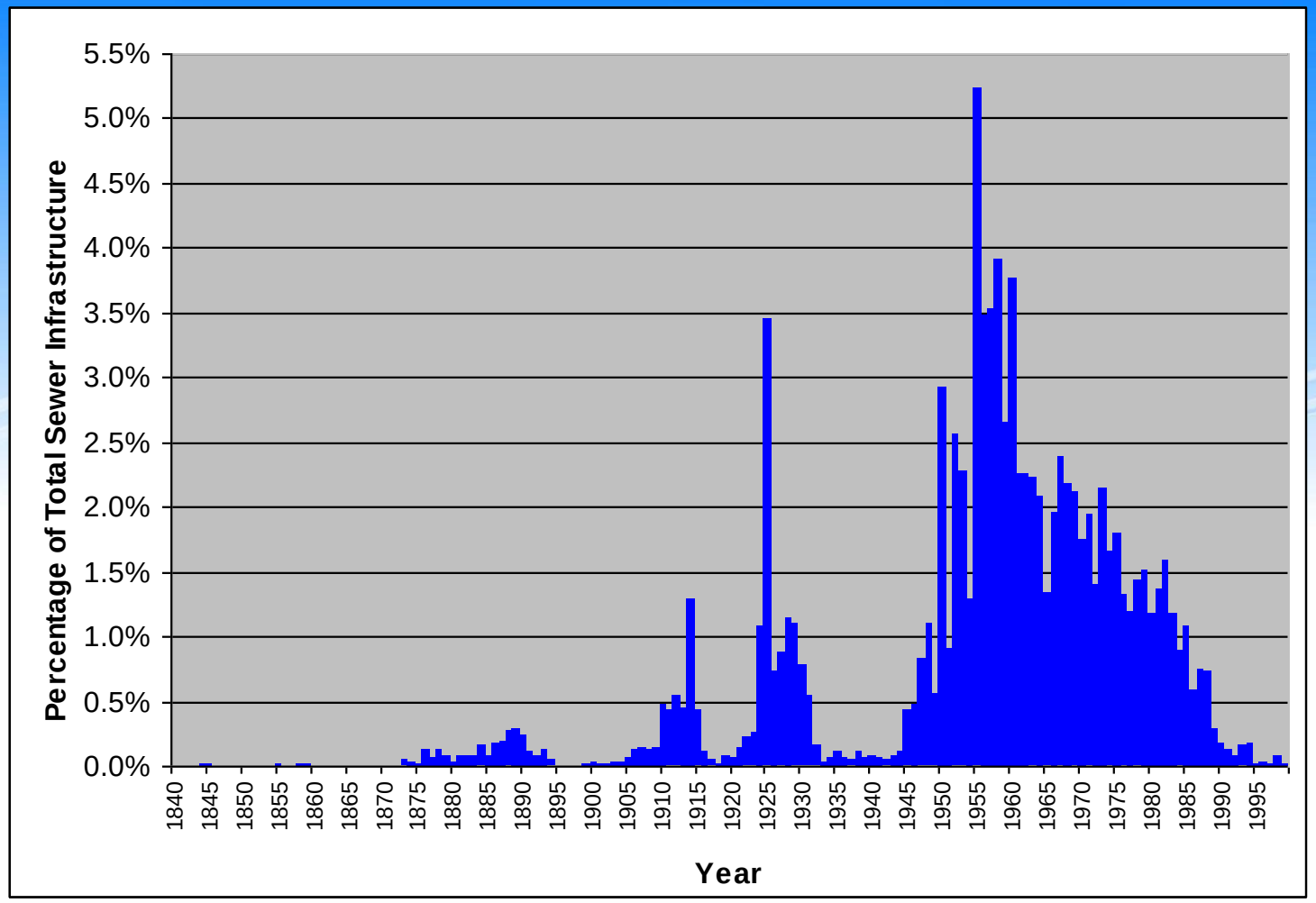
Sewer Construction History



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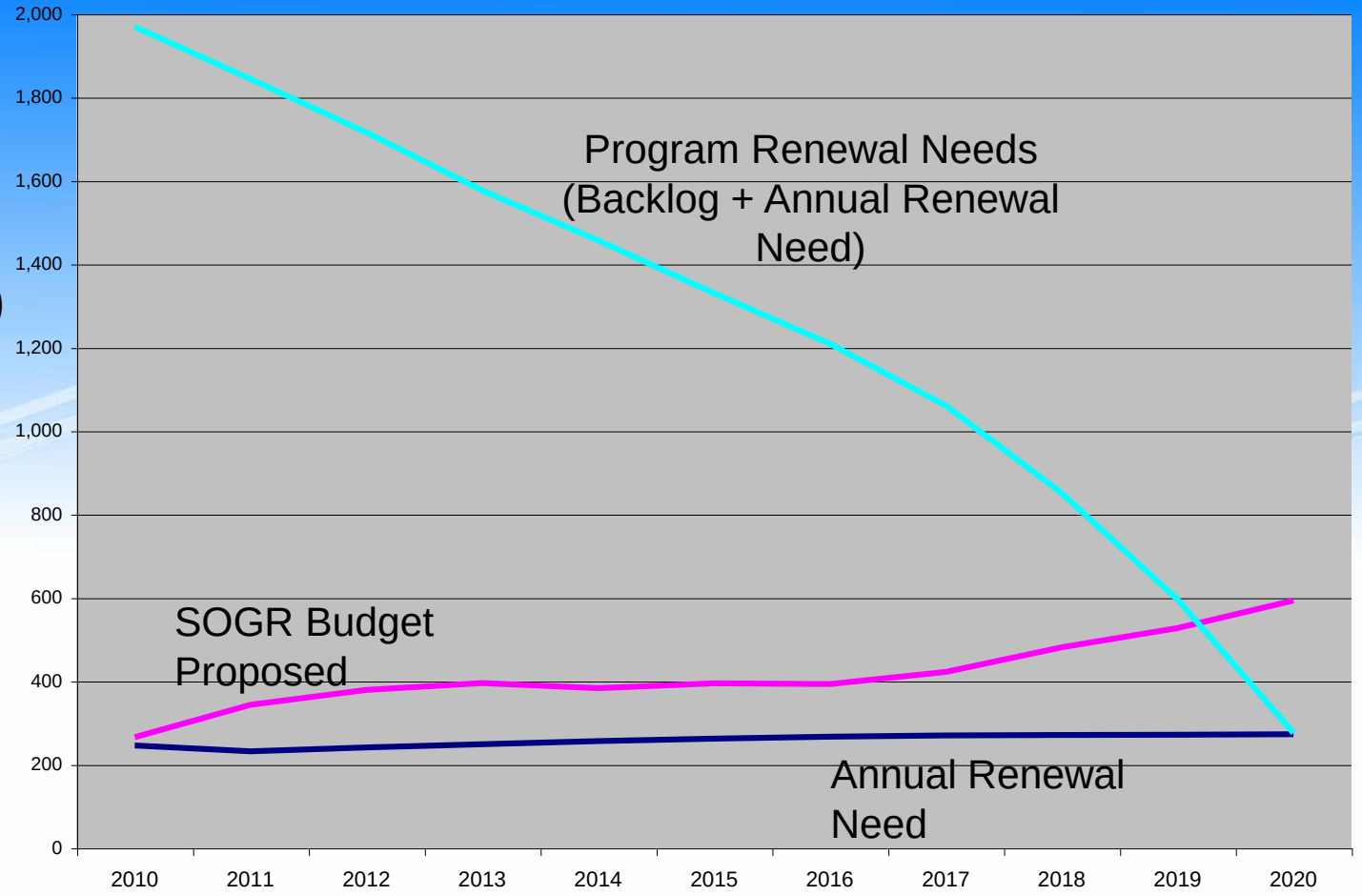
Addressing State of Good Repair (2010 – 2020)



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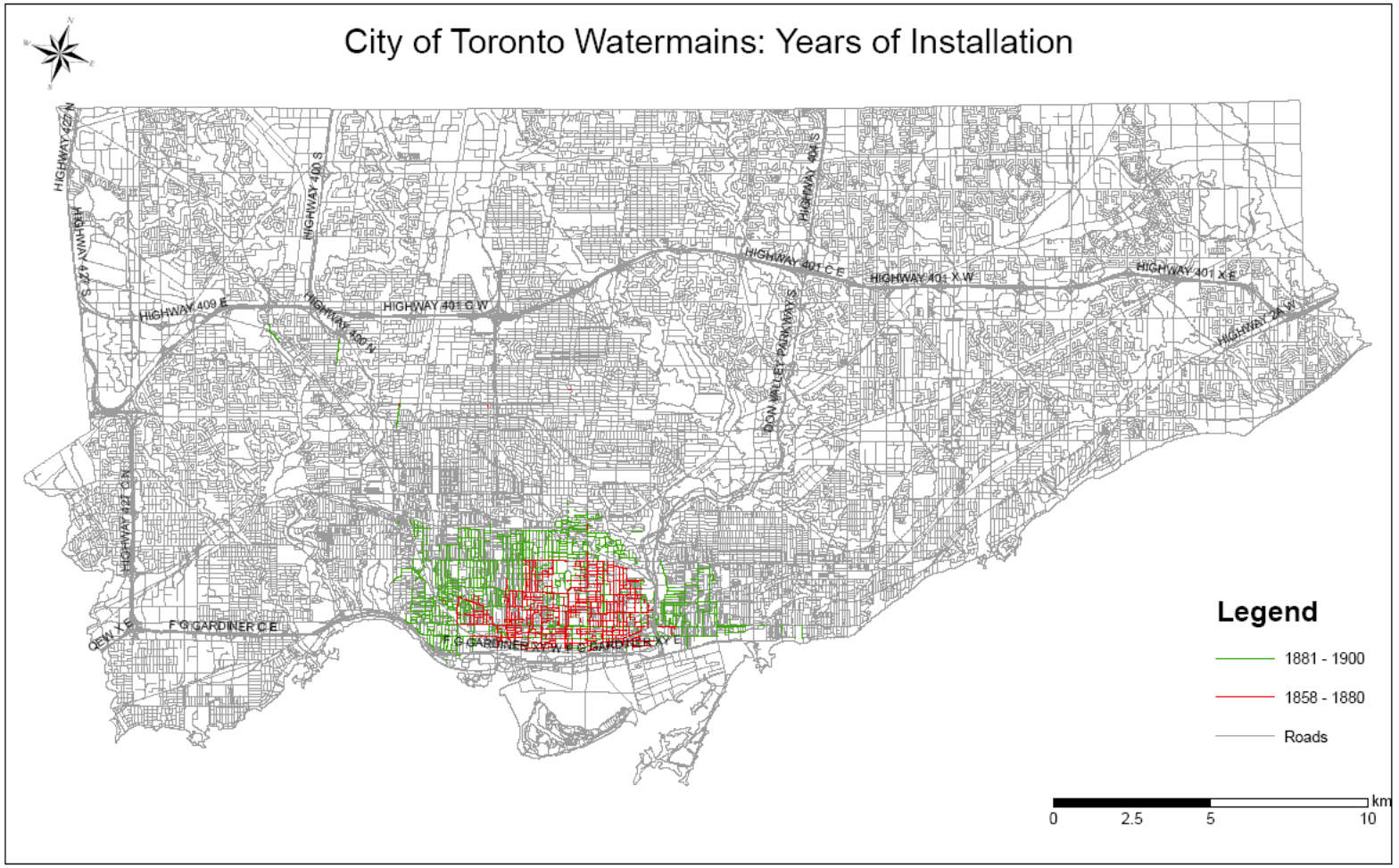
WATERMAIN CONSTRUCTION HISTORY (1858-1900)



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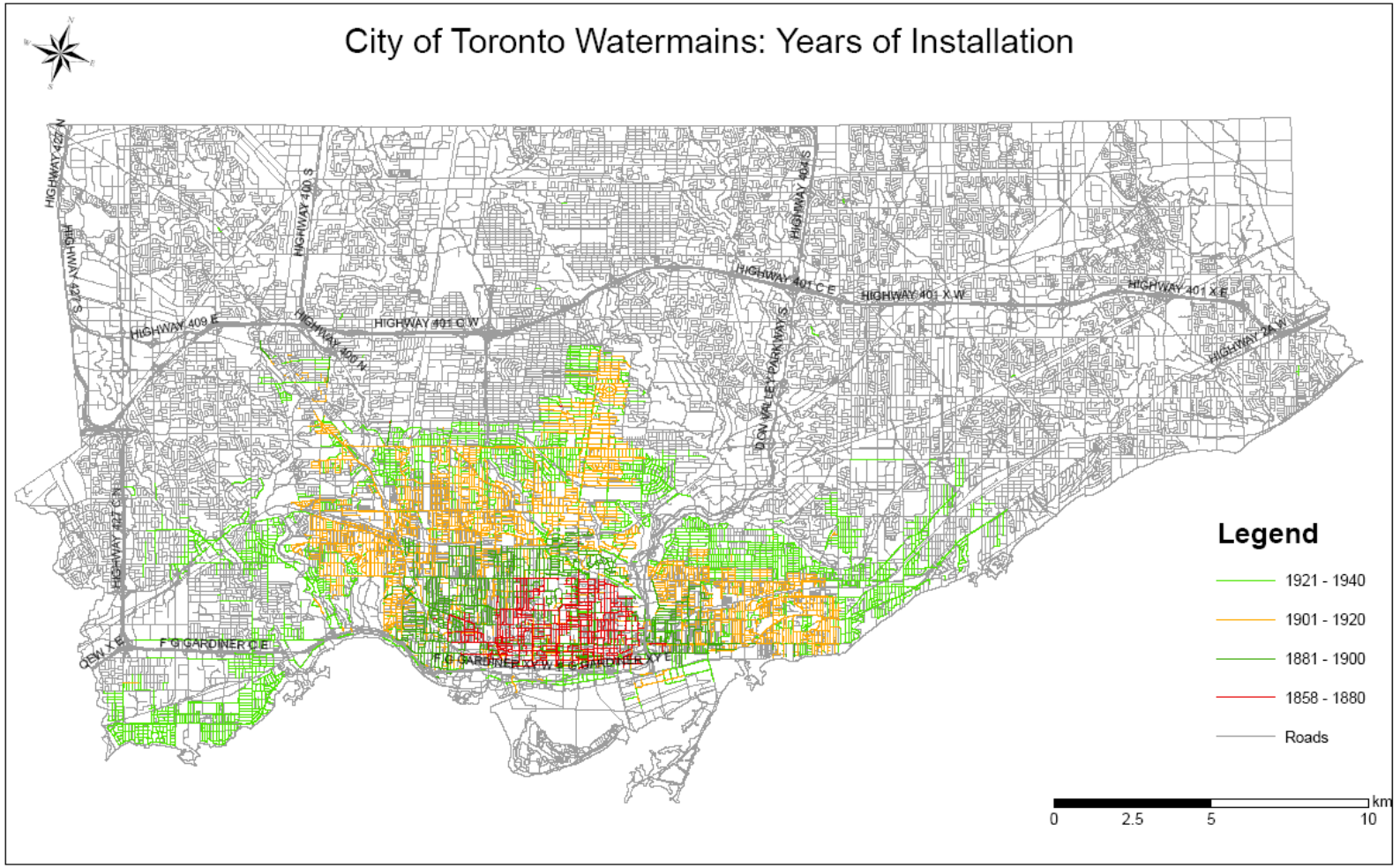
WATERMAIN CONSTRUCTION HISTORY (1858-1940)



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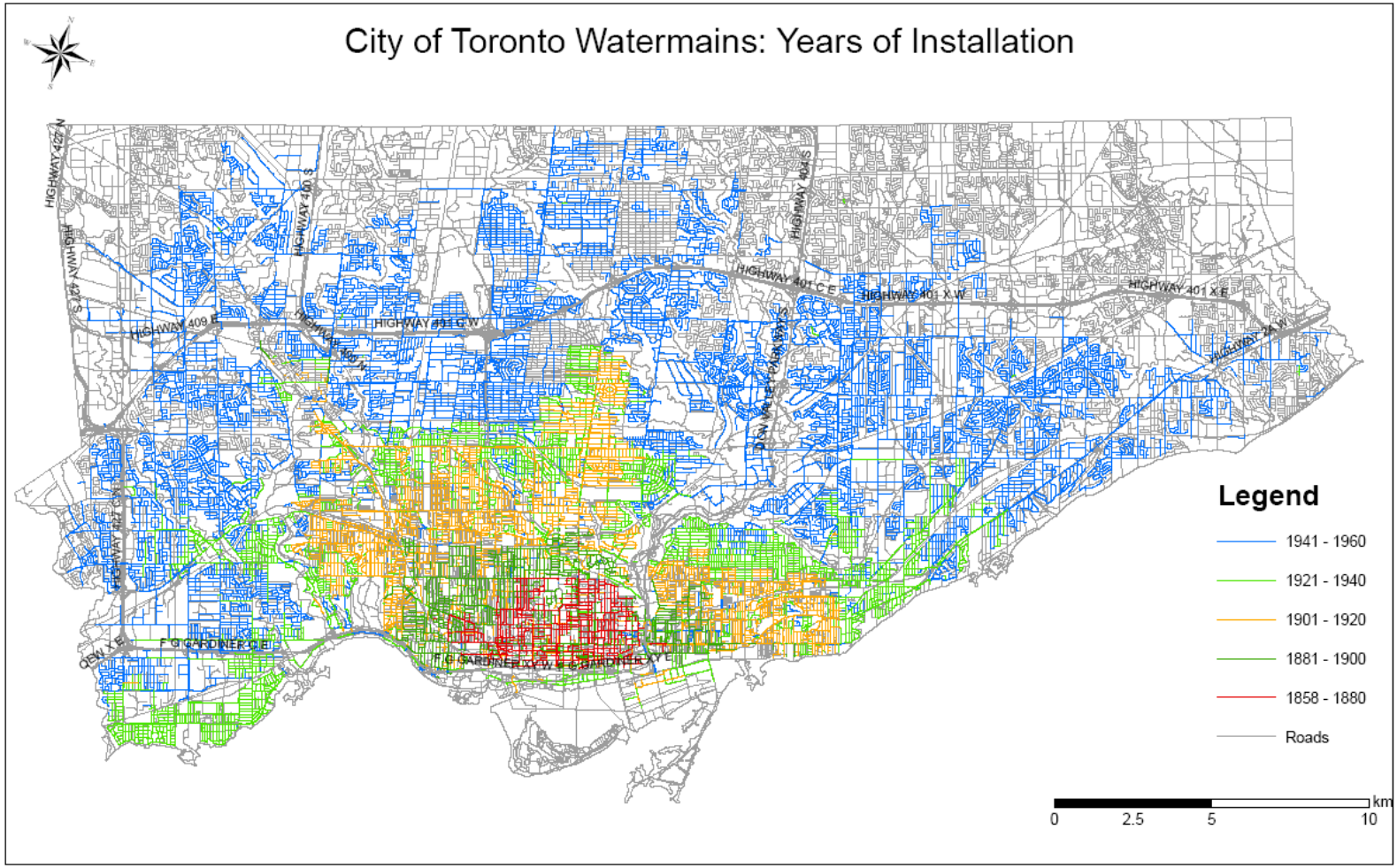
WATERMAIN CONSTRUCTION HISTORY (1858-1960)



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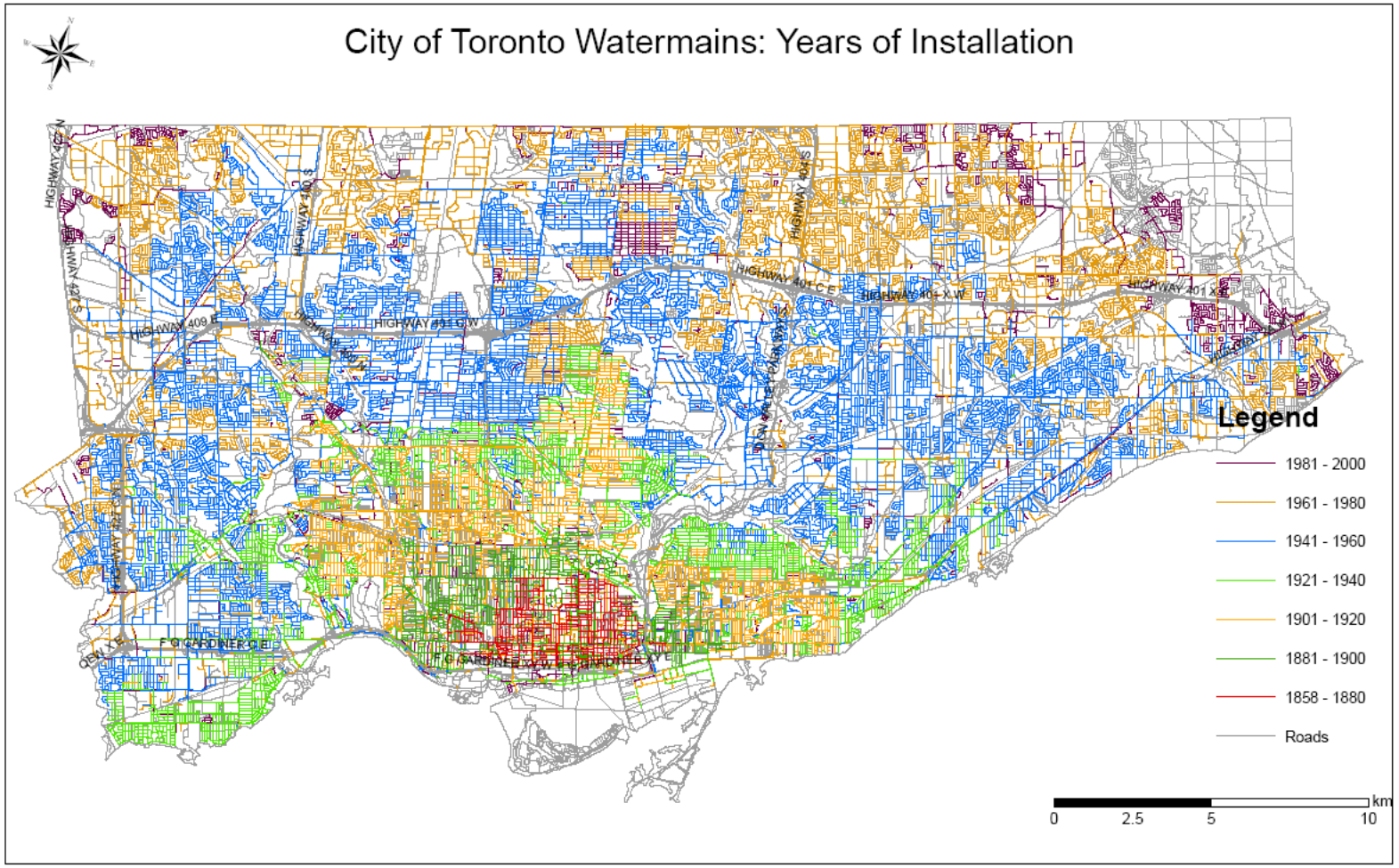
WATERMAIN CONSTRUCTION HISTORY (1858-2000)



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Are We Seeing the Effects of Climate Change?

YEAR	
1986	
1987	
1988	
1989	
1990	
1991	
1992	
1993	
1994	
1995	
1996	
1997	
1998	
1999	
2000	
2001	
2002	
2003	
2004	
2005	
2006	

North York area of Toronto

- 8 extreme events over 20 year period
- storm return frequencies > 25 years
- severe flooding: surface and basement
- works designed and implemented for a given storm condition - insufficient for larger/subsequent event
- public confidence?

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Impacts of August 19, 2005 Storm

- **Storm lasted 2-3 hours**
- **Exceeded 1 in 100 year storm in north part of the City (Highway 401 to Steeles Avenue corridor)**
- **City of Toronto rain gauge station recorded 153 millimetres**

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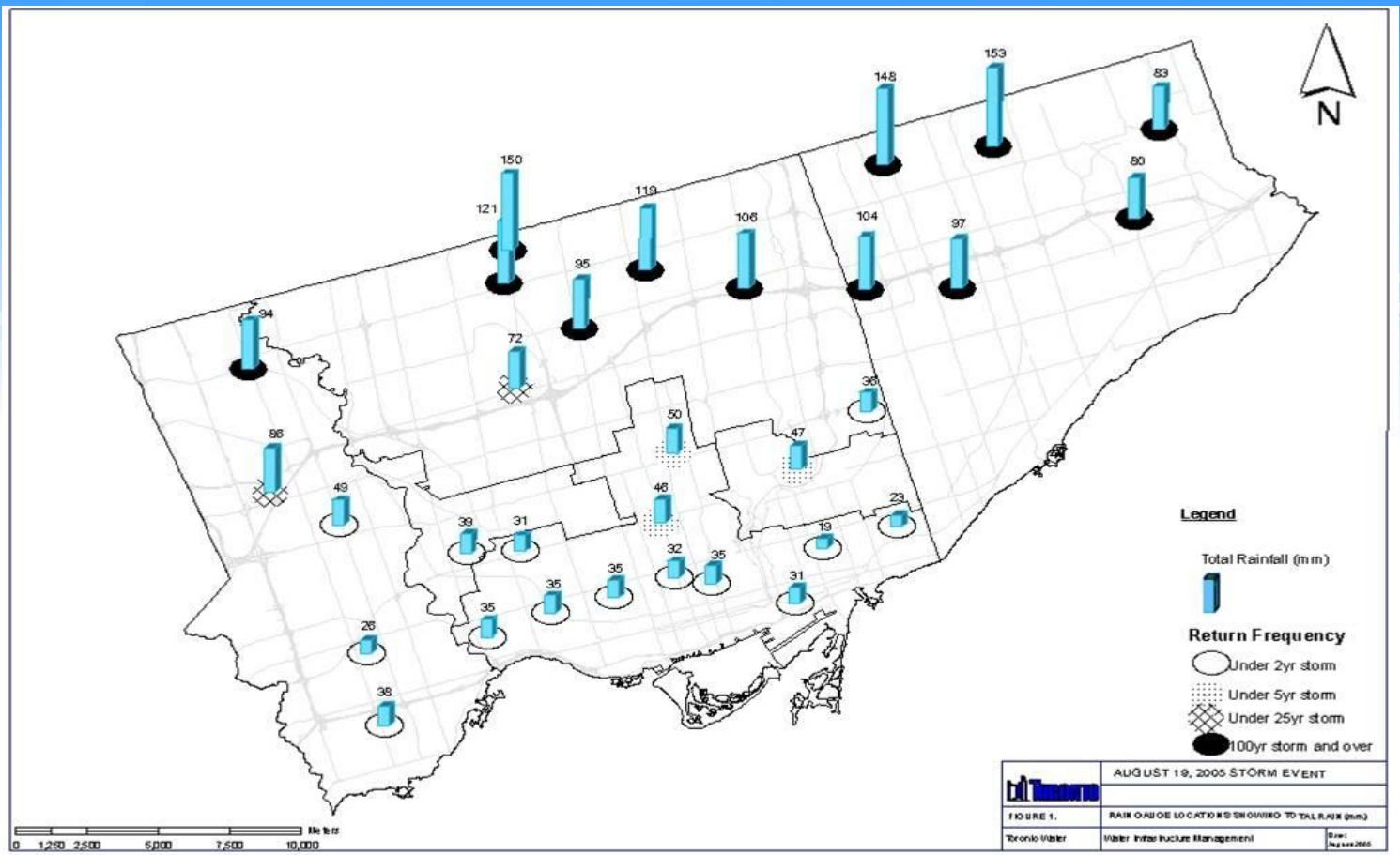

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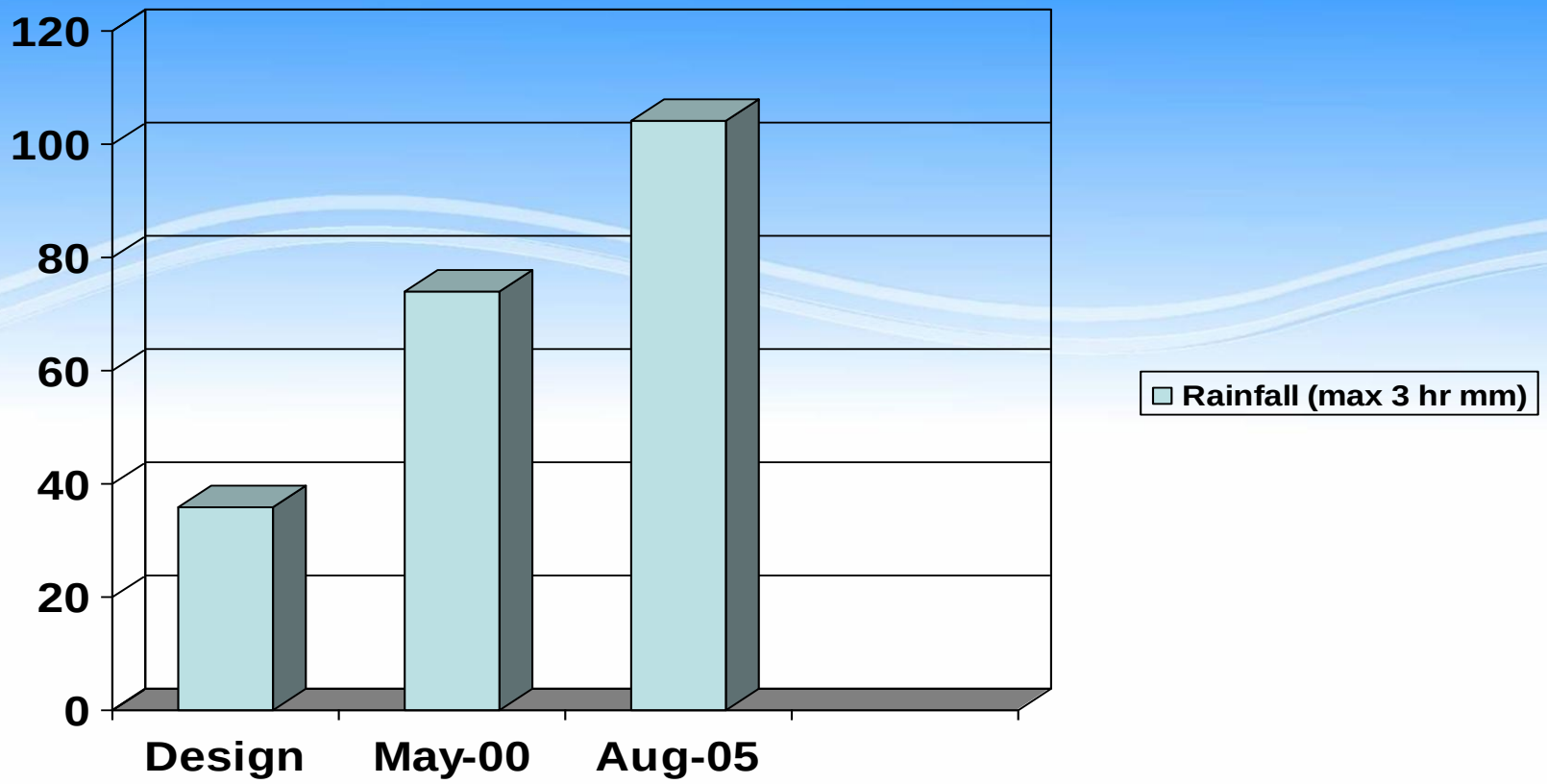
Rainfall Comparison



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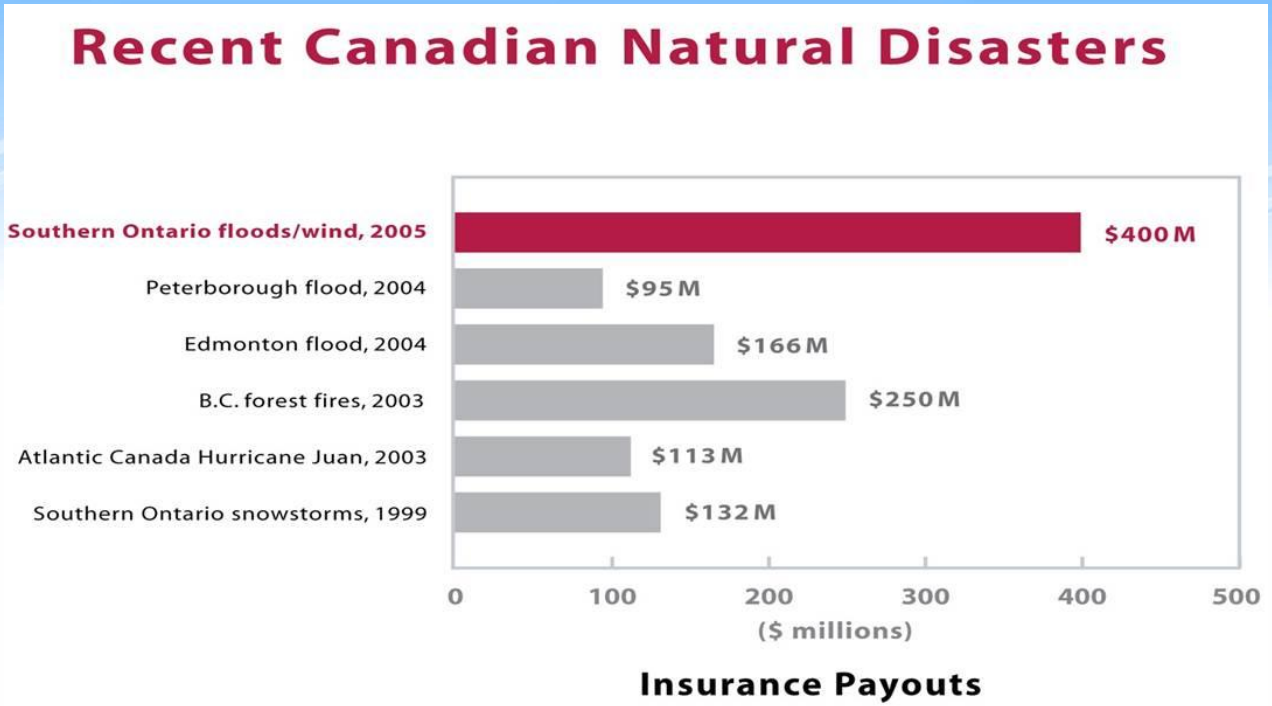
Insurance Bureau of Canada

- most expensive natural disaster in Ontario history
- expected to pay out more than $400 million
- impact from Kitchener to Toronto to Durham & beyond
- vast majority of claims for sewer back-ups



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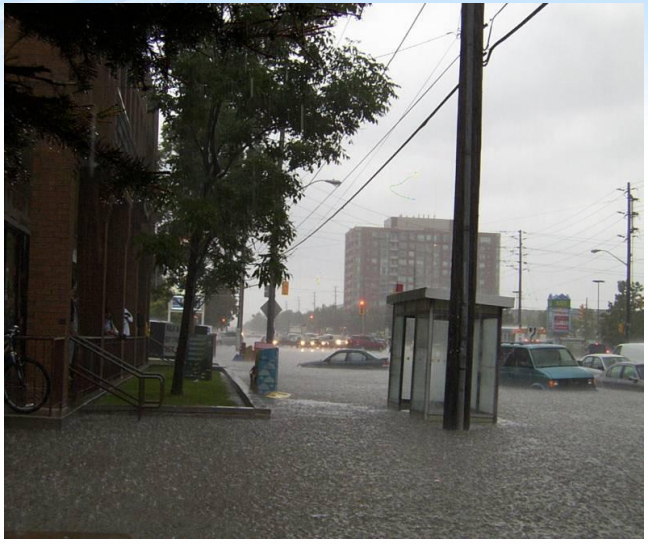
Source: http://insurance-canada.ca/consinfohome/IBC-Ontario-storm-509.php

Steeles Avenue



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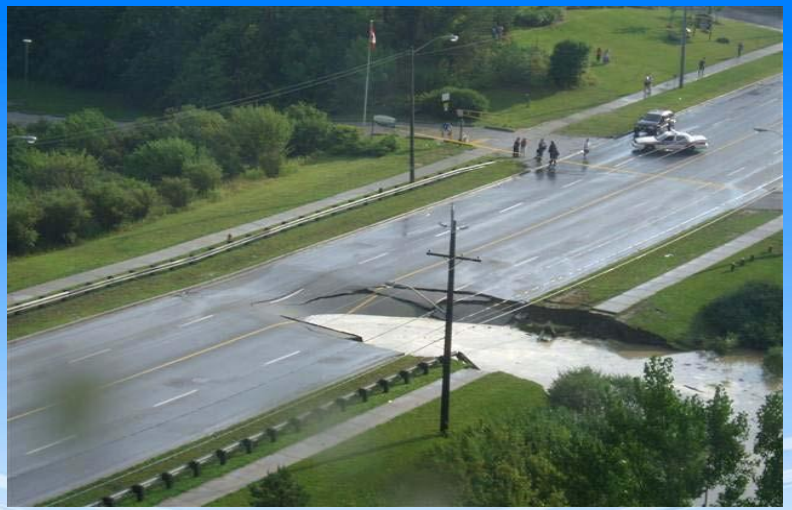
(Finch Avenue at Black Creek)



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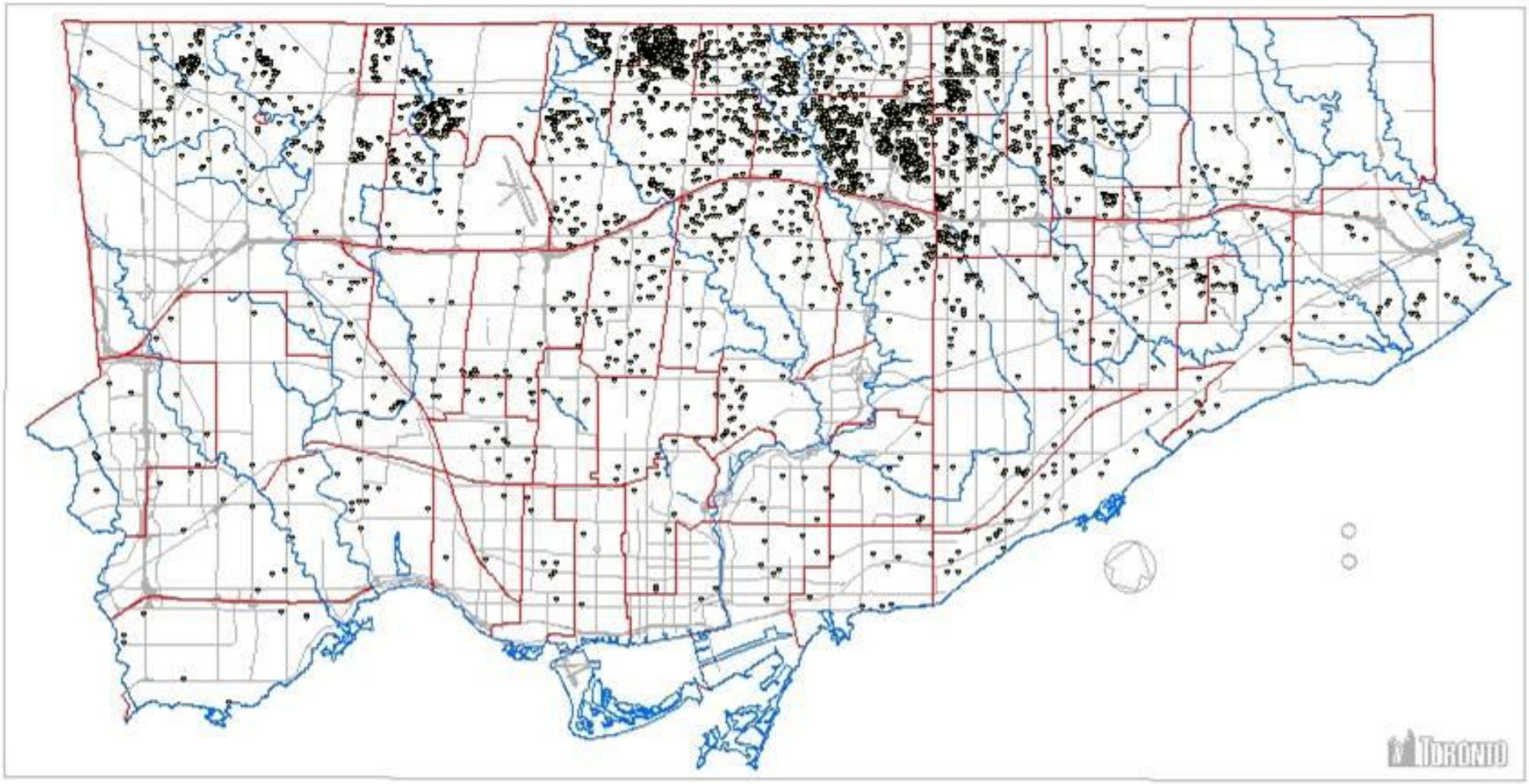
Highland Creek Sanitary Trunk Sewer

(Exposed Sections of 48” Trunk Sanitary Sewer)

Basement Flooding

(Over 4,200 complaints received)



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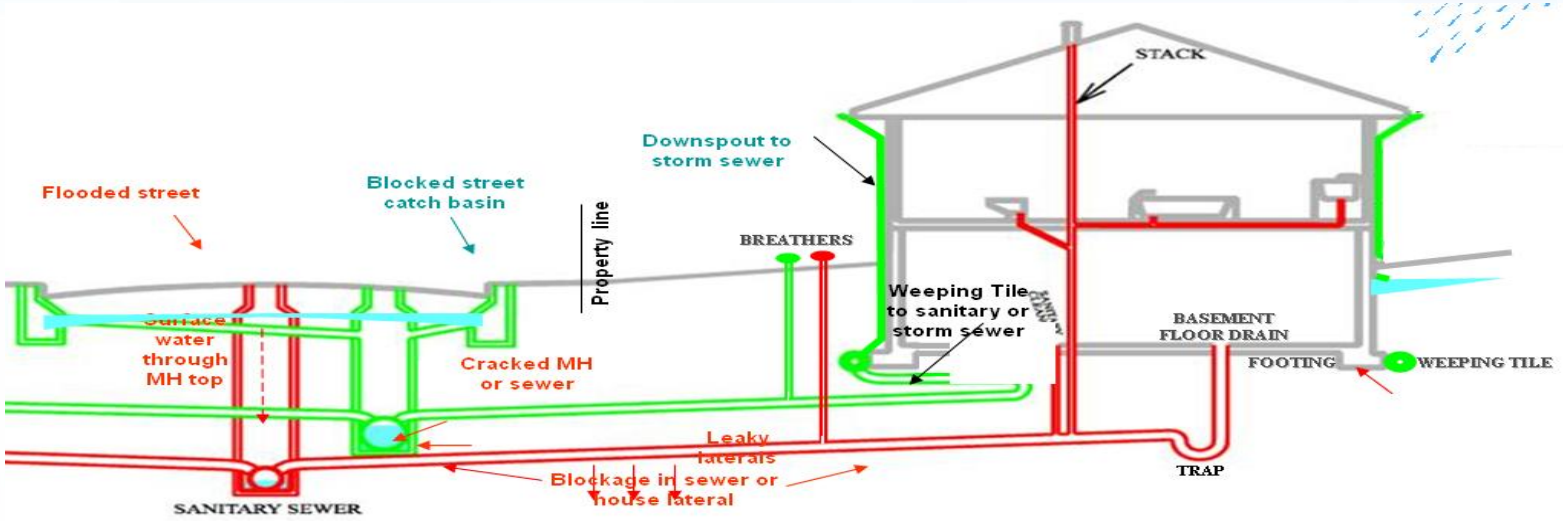
General Observations

- **Sewer systems perform as designed ("normal" storm conditions)**
- **During extreme storms:**
  a) **sanitary sewer system is overloaded**
  b) **widespread surface flooding (including private property)**

Sanitary Sewer System

Sources of high flows to sanitary sewers:

- Foundation drains
- Joints and pipe connections
- Broken pipes
- Cracks in the sewer system and maintenance holes
- Holes in maintenance covers (low areas)
- Stormwater-flooded basement (floor drain)



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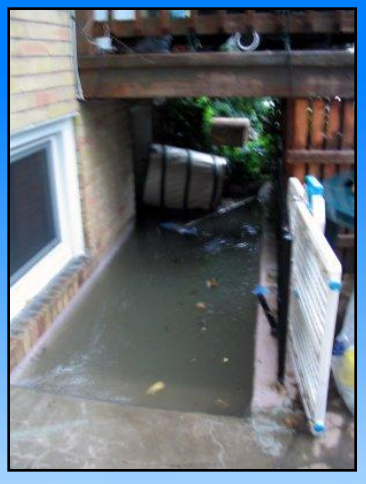
Surface Flooding



- **Many low-points create ponding**
- **No outlet for extreme flooding**
- **Water backs onto private property**
- **Water enters basement:**
  - cracks in the basement walls
  - doors
  - window wells
  - reverse-sloped driveways
- **Poor lot grading**
- **Downspouts connected to sewer system**

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General Surface Conditions of Ward 23

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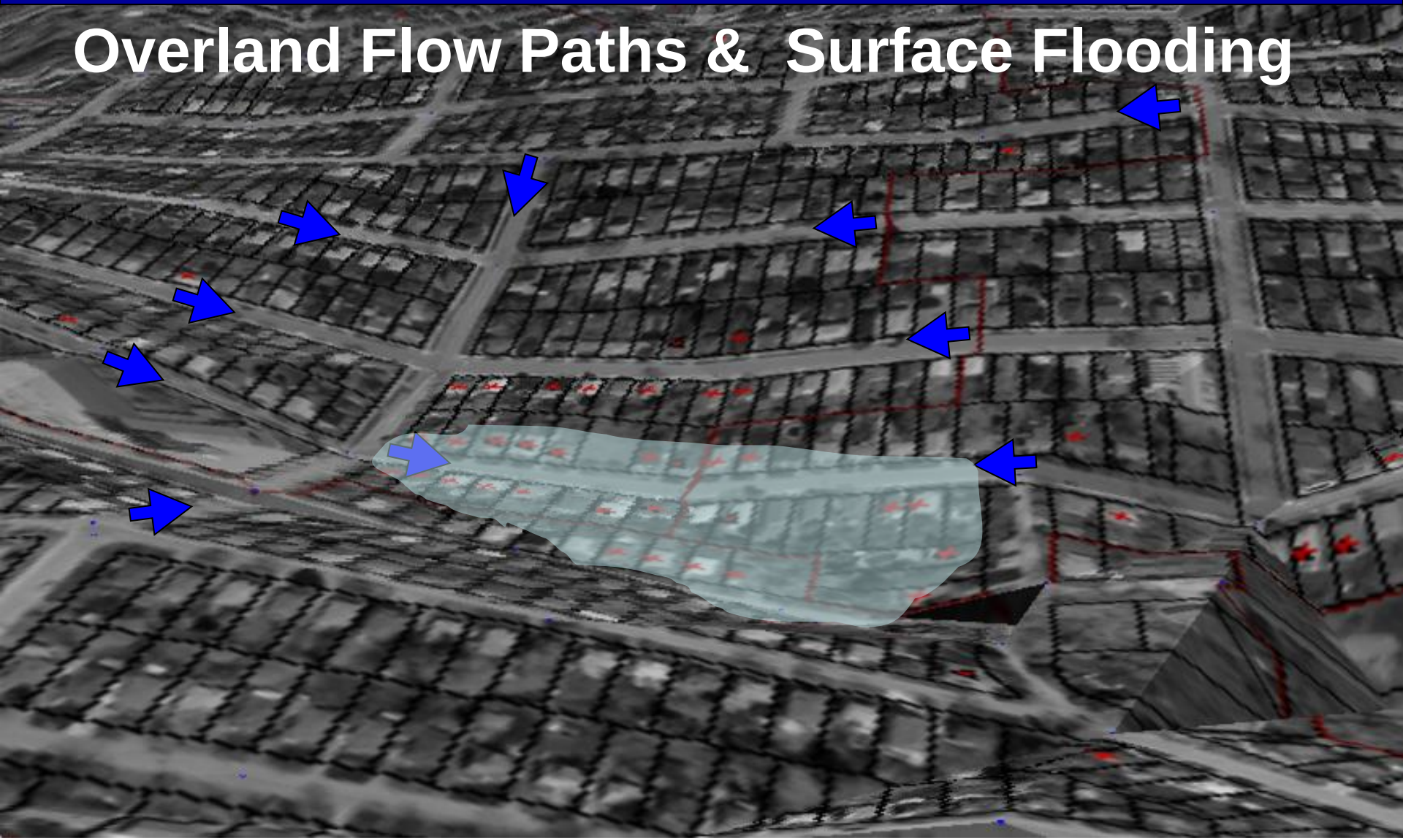
Overland Flow Paths & Surface Flooding



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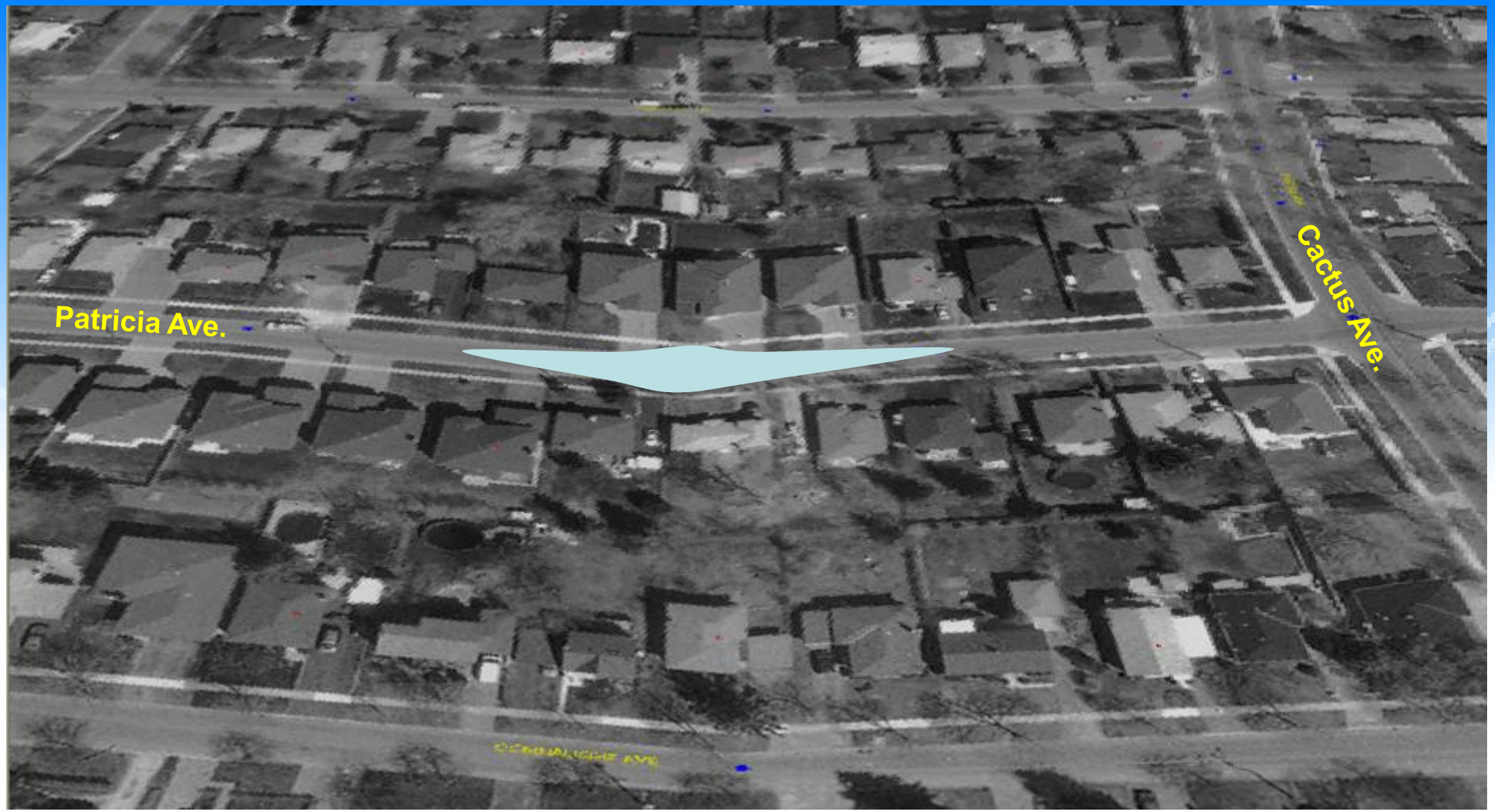
Under extreme events & once sewer capacity is reached, if no overland outlet, ponding will occur on the surface

General Surface Conditions (Ward 23)



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Overland Flow Paths

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City-Wide Work Plan

- **Approved by Council in April 2006**

- **32 Priority Study Areas Identified:**

  Investigations to take place over 6 year period

- **Required to follow the Class EA for storm drainage & sanitary sewer system improvements**

- **Design Standards approved:**
  - **Sanitary sewer back-up protection for the May 2000 storm**
  - **Upgrade storm drainage system to “New Development” standards: 100 year storm**

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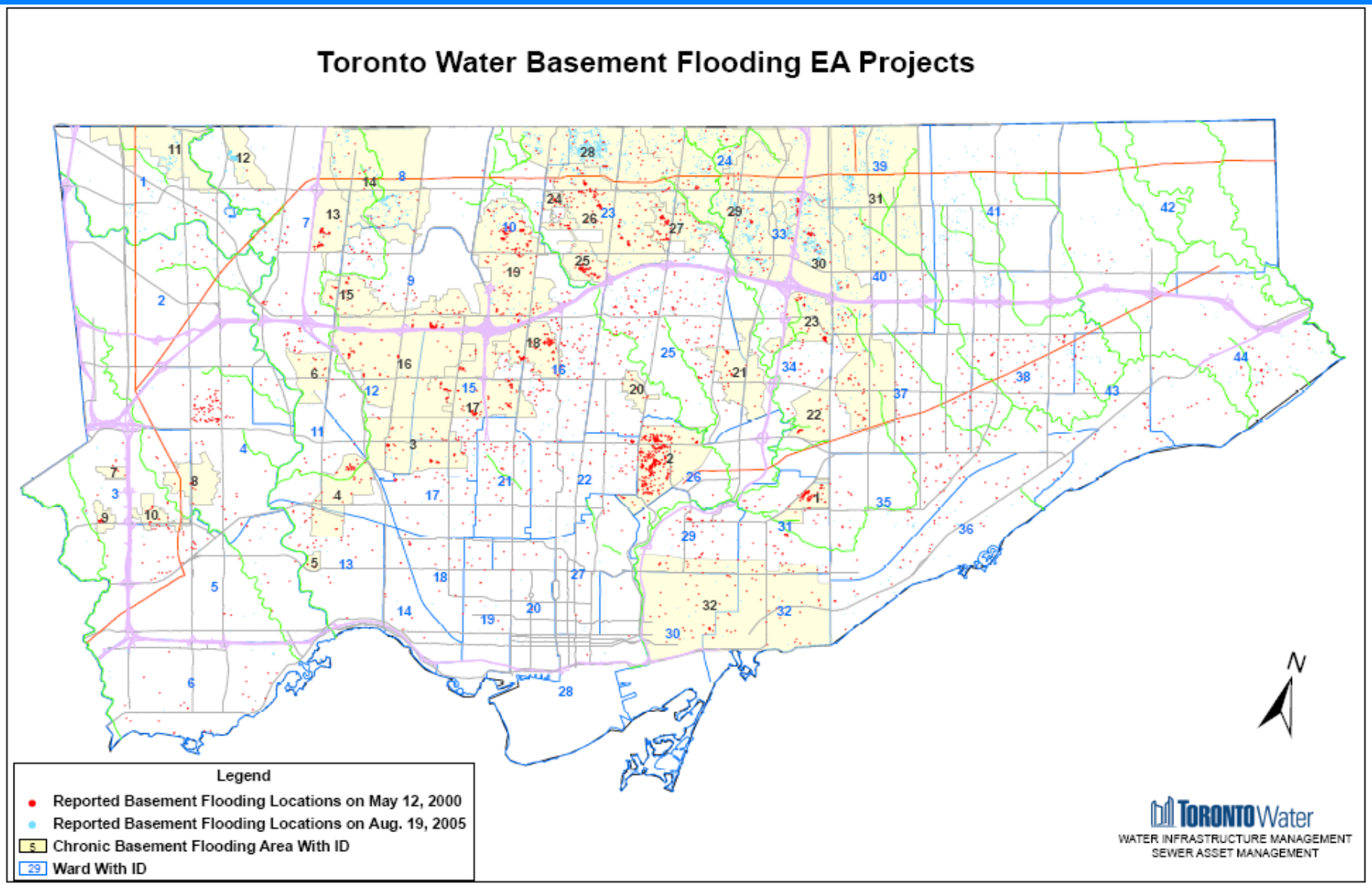
Map of Study Areas



Basement Flooding Protection Strategy

Adaptive Management Approach:

- Lot Level Controls
- Sanitary Sewer System Improvements – as necessary
- Inlet Controls on Storm Sewer System
- Provision of Overland Flow Control and/or Storage, as feasible
- Prioritization of Construction of System Improvements

Basement Flooding Protection Strategy

Lot Level Controls

- Mandatory Downspout Disconnection:
  - Chronic Basement Flooding Areas (2013)
- Proper Lot Grading
- Installation of Backwater Valves on Sanitary Laterals
- Capping off of Storm Laterals & Installation of Sump Pump
- Repairing Cracks in Foundation Walls & Sealing Window Wells
- Covering Basement Stairwells
- Disconnecting “illegal” Sanitary Sewer Connections
- **PUBLIC EDUCATION !**

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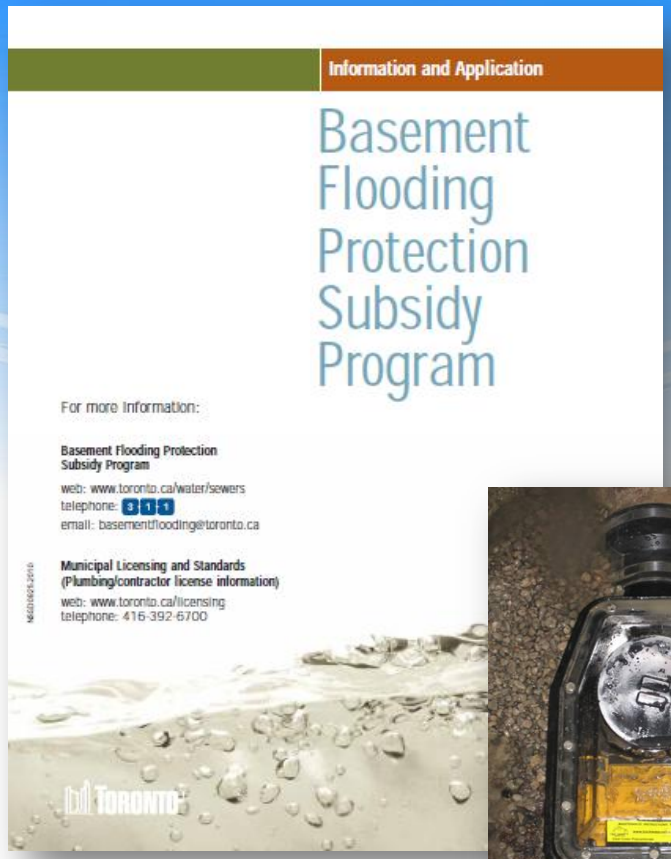
Basement Flooding Protection Subsidy Program

- Provides financial subsidies (up to $3,200) to help isolate home from City's sewer systems & prevent basement flooding:
  - Backwater value
  - Sump pump
  - Pipe severance and capping



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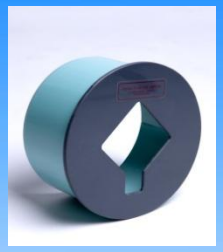
Basement Flooding Protection Strategy

Surface Flow Controls

- Catchbasin Inlet Control



- Increased No. of Catchbasins

- Sealing Maintenance Hole Covers

- Surface Flow Path Diversion

Involves:

- Minimal effort and time to implement
- Will control excess stormwater from overloading the sewer system

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Basement Flooding Protection Strategy

Pipe Conveyance Controls (Storm and Sanitary)

- Increasing Sewer Pipe Size
- Relief Sewer (Twinning)
- High Level Relief Storm Sewer

Involves

- Road excavation within City limits
- Removal of old sewer and structures
- Disconnection of sewer service line
- Placement of new sewer and structures
- Reconnection of to new sewer
- Restoration of road and boulevard

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Basement Flooding Protection Strategy

Storage for Sanitary and Storm

- Offline and online underground storage tanks
- Dry Pond

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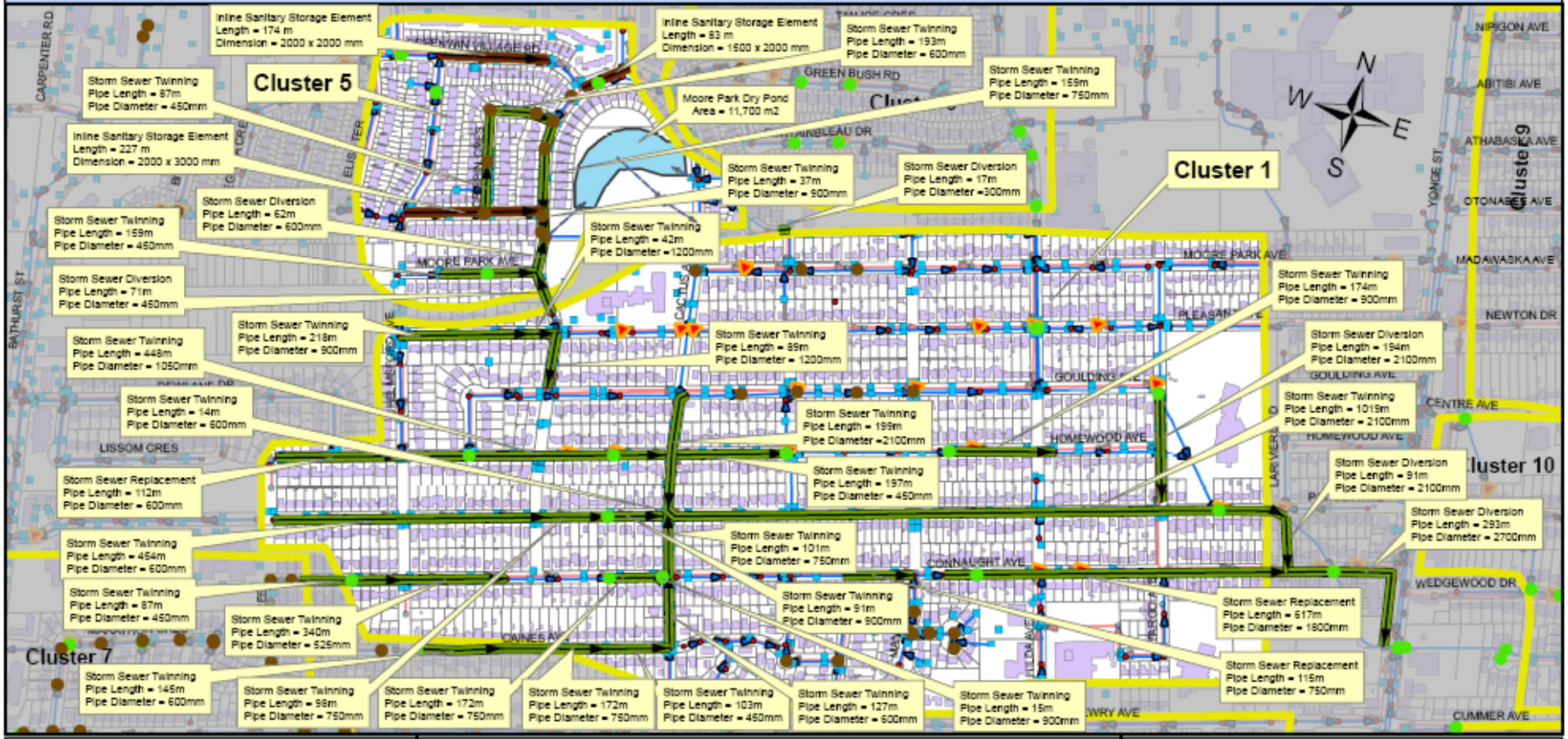
Involves

- Facilities to be constructed in existing Parks or open spaces
- Temporary loss of open space and/or traffic disruptions
- Excavation and placement of storage elements
- Landscaping opportunities

RECOMMENDED SOLUTIONS FOR CLUSTER 1 & 5



TORONTO
clarifica
MacViro
Gartner Lee

Drawn By: J.H. Checked By: A.F.
Date: Aug 12, 2008

Investigation of Chronic Basement Flooding Sewershed Area 28

Figure 8.1: Recommended Solutions for Cluster 1 & 5

Legend

- Cluster Area
- Storm Sewer Manhole
- Sanitary Sewer Manhole
- Manhole to be sealed
- Proposed inlet control devices to existing catchbasins
- Sanitary Storage Elements
- Remedial Storm Sewer Pipe / Overland Flow Route
- Catchbasin
- Existing Storm Sewer
- Existing Sanitary Sewer
- Outfall
- Proposed additional capacity
- Future SWM Pond

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Cost Basement Flooding Protection Strategy

Study Areas 14, 28, 29 & 30 only

Improvement Work Category	Cost
Sanitary Sewer Conveyance Controls (16 projects: replacement pipes, twinning, etc.)	$ 6 M
Sanitary On-line/Off-line Storage Tanks (13 projects)	$ 14 M
Storm Sewer Conveyance Controls (261 projects: replacement pipes, twinning, etc.)	$163 M
Stormwater Storage Facilities (10 projects: underground storage tanks, dry ponds)	$ 47 M
Lot Level & Surface Control Measures (downspout disconnection, add catchbasins, inlet controls, MH sealing, diversion etc.)	$ 30 M
Basement Flooding Protection Subsidy	$ 12 M
Total	**$272 M**

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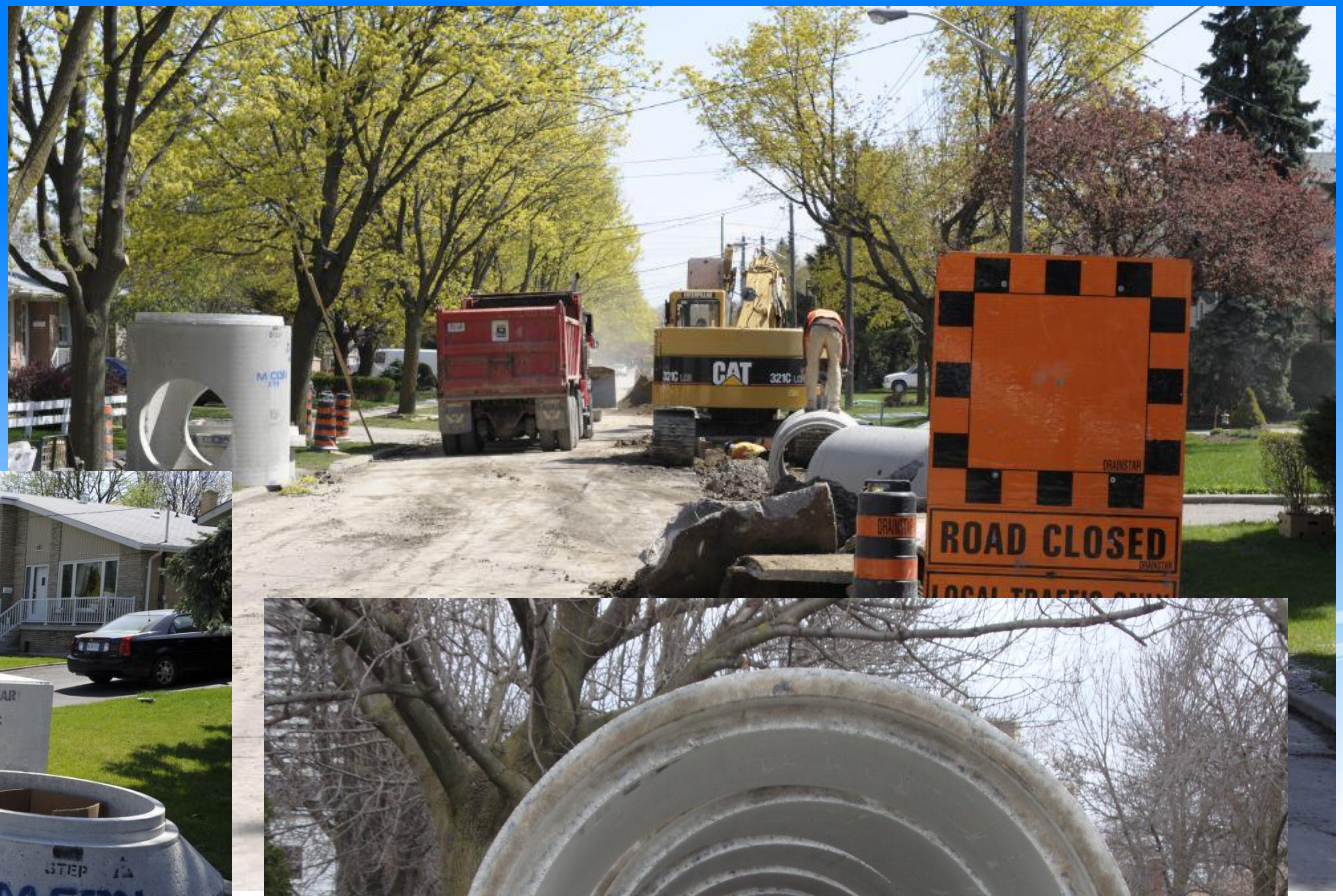

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Policy Considerations

First Priority:

- **Sanitary sewer improvements as identified by modelling**

- **Storm drainage system improvements where:**
  - "Cost per benefiting property" is "$25,000" or less
  - Prioritized from highest to lowest # of benefiting properties

- **Extend mandatory downspout disconnection program**

- **Amend By-Laws/Requirements:**
  - **Backwater valves for all new developments**
  - **Banning construction of reverse slope driveways**

- **Public Education Campaign:**
  - **Opportunity to work with insurance industry**

Policy Considerations (cont'd)

Other Areas – not included in First Priority:

- **Longer implementation schedule for remaining projects:**
  - high "cost to benefiting property" ratio
  - only used during "extreme" storm events
  - implement through City's longer term infrastructure renewal programs (ie. roads and sewers)

- **Apply adaptive management approach City-wide:**
  - incorporate elements of Basement Flooding Protection Strategy, in areas prone to flooding, or have history of flooding complaints, in coordination with infrastructure renewal
  - What about other areas not "yet" affected?

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Conclusions

- **Climatological changes are observed**
- **Municipal infrastructure and corresponding service delivery is being impacted by more frequent extreme events**
- **Public/political expectations are very high**
- **Strong collaboration required among affected City departments and external agencies**
- **Joint responsibility: public must also assume some responsibility and affect change**

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Conclusions (cont'd)

- **Adaptive management strategy advocated**
- **Standard design practices based on historical climate records - need to be reviewed based on projected new "norms"**
- **Need to establish service delivery targets & corresponding design standards**
- **Need to consider acceptable or upset limit on expenditures eg. cost per "benefiting property" and/or number of benefiting properties**

Conclusions (cont'd)

- **Seize the opportunities to integrate adaptation:**
  - **new urban development:**
    opportunity to do it right!
    (lessons learned from other municipalities)
  - **infrastructure renewal:**
    opportunities to "shoe-horn" in adaptation

- **Social/economic standpoint:**
  ***assess the cost of adapting versus the losses that can be expected if we don't*!**

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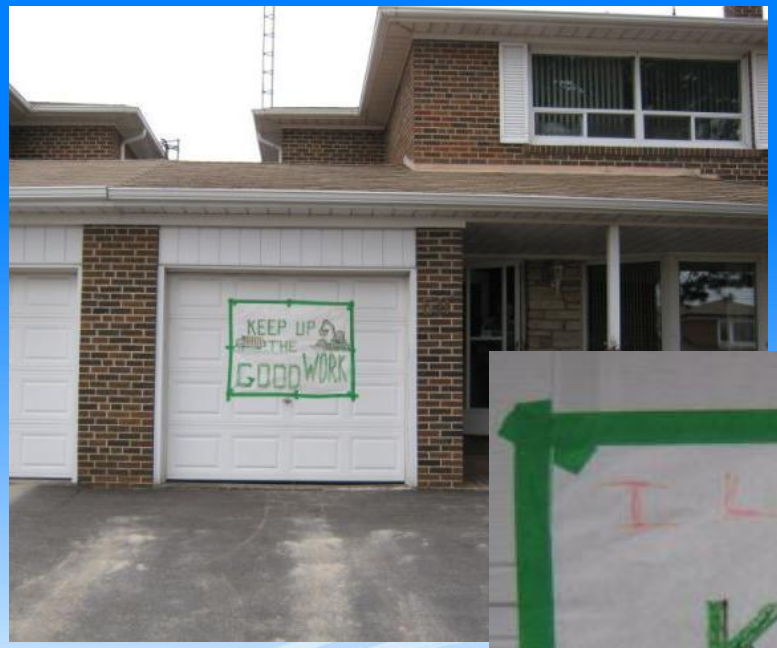
Resident's Appreciation



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