City of Toronto's Climate Change Adaptation Strategy to Address Urban Flooding

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CERIU – INFRA 2017 Congress
December 4, 2017
Montreal, Canada

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Presentation Overview

- City of Toronto Background
- Legislative and Policy Framework for Water Management in Toronto
- Climate Change Effects & Impacts From Recent Extreme Storms
- Adaptive Management Approach to Mitigating Urban Flooding
  - Watershed
  - Municipal
  - Private Property
- Policy Considerations and Conclusions

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City of Toronto - Background

- **Canada's largest City:** 2.8 million
- **City of Toronto area:** 641 km²
  - Parkland (ravines, open space, etc.): 80 km²
- **Land Uses:**
  - 45% Residential
  - 23% Open space & natural areas
  - 10% Industrial
  - 9% Commercial
  - 13% Other
- **Rivers & Creeks:** 370 km
- **Elevation:**
  - 76.5 m at waterfront
  - 209 m at northern boundary
- **Lake Ontario Waterfront**: 43 km
- **Waterfront Beaches:** 11

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City of Toronto – Funding Water Infrastructure

- Water and wastewater services in Toronto are rate-supported funding operating expenses and capital infrastructure improvements
  - NO reliance on property taxes
  - NO reliance on Provincial or Federal grants or funding
- Water Rate (2017): $3.62/m^3
- Average Annual Residential Annual Consumption: 265 m^3
- Average Annual Residential Cost for Water: $960
- Cost for all residential drinking water, wastewater and stormwater services: $2.63 /day

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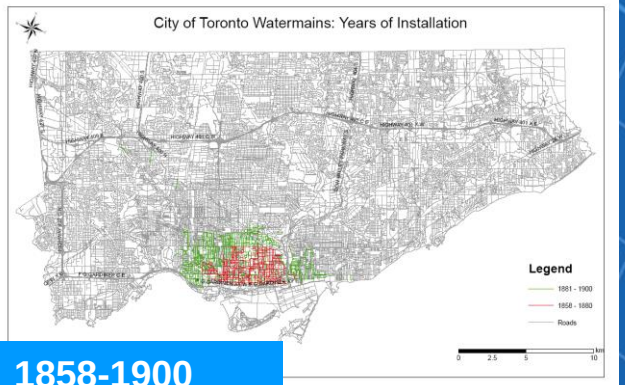
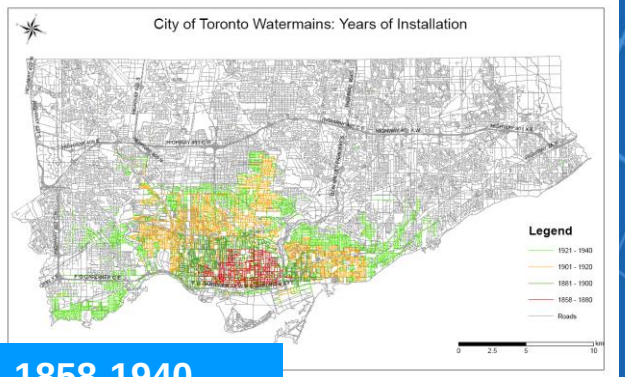
Toronto's Water Infrastructure Assets

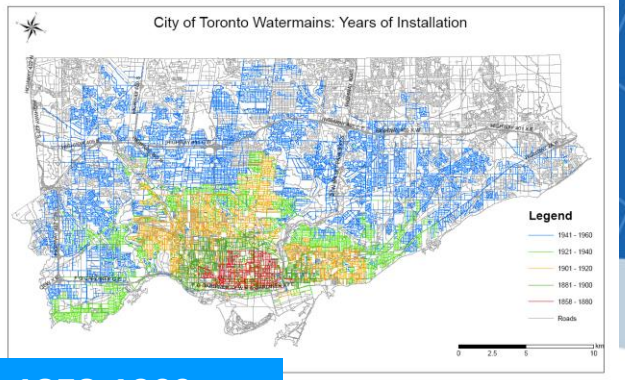
(Build-out History)



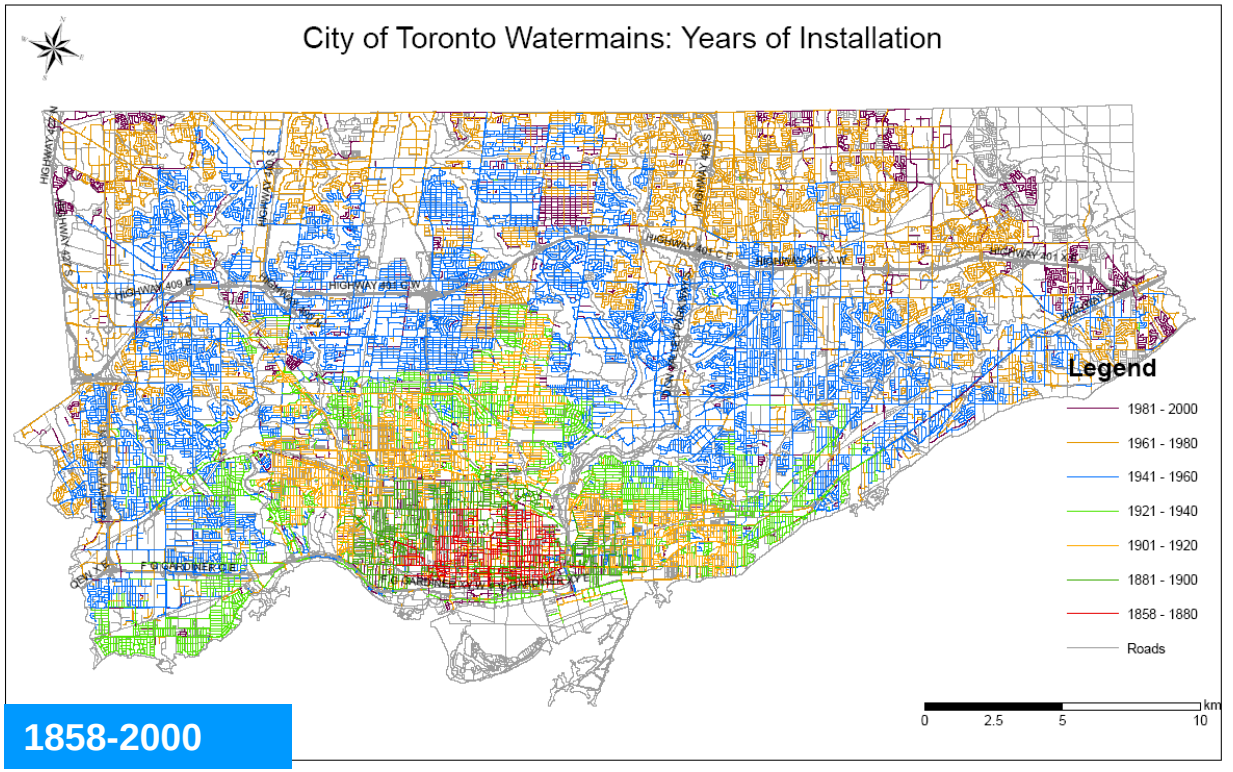
1858-1900



1858-1940



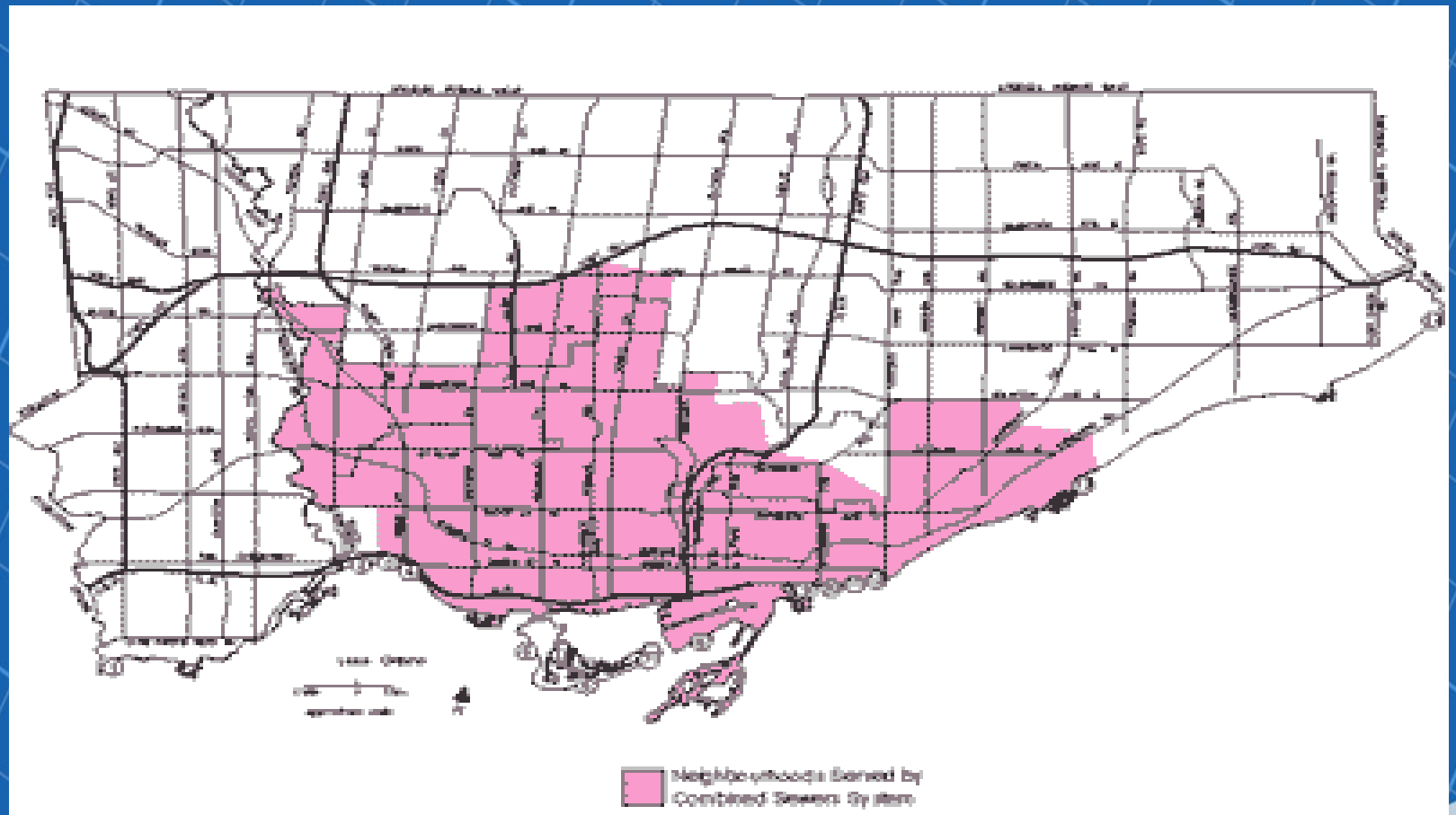
1858-1960



1858-2000

Toronto's Water Infrastructure Assets

- **Combined Sewer Service Area**



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Legislative and Policy Framework

- **Legislation and regulations governing water are set by the Province of Ontario**
  - Provision of safe and reliable drinking water – applies to municipalities
  - Collection and treatment of wastewater – applies to municipalities
  - Management of stormwater – applies to municipalities AND "Conservation Authorities"

- **Provincial *Conservation Authorities Act*:**
  - First enacted in 1946 in response to concerns about poor land, water and forestry practices which were resulting in extensive soil loss and flooding
  - Governs watershed planning and enables the Province and municipalities to form "Conservation Authorities" within a specified watershed based geographic area to:
    - Manage watershed resources
    - Protect lives and property from riverine flooding and erosion

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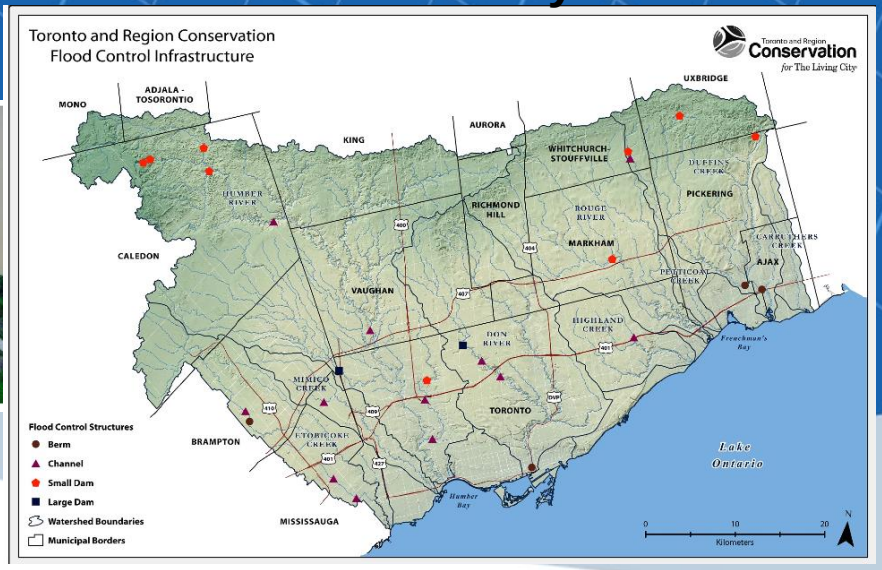
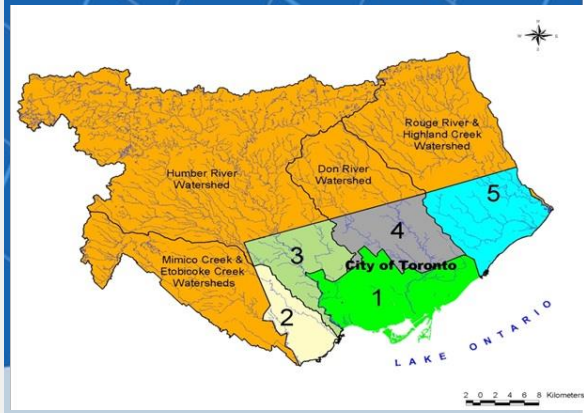
Legislative and Policy Framework

- Amendments to the Act (1956) as a result of the devastation caused by Hurricane Hazel (1954), where 81 lives lost
- Amendments empowered the Conservation Authorities to:
  - Prohibit filling of valley lands and flood plains
  - Implement proper land use planning, prohibiting urban development within flood-hazard areas such as floodplains
  - Construct flood protection works such as dams, reservoirs, flood control channels and erosion control works

Toronto & Region Conservation Authority – Flood Control Structures

Regional Flood Control





12 dams

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Legislative and Policy Framework

- City of Toronto By-Laws and Standards:
  - Sewer and Watermain Design Criteria
  - Toronto Green Standard for New Urban Developments
  - Sewers (Sewage & Land Drainage) By-Law (Chapter 681 of the Municipal Code)
    - Mandatory Downspout Disconnection
    - Reverse Slope Driveway Prohibition
    - New Storm Sewer Connection Prohibition

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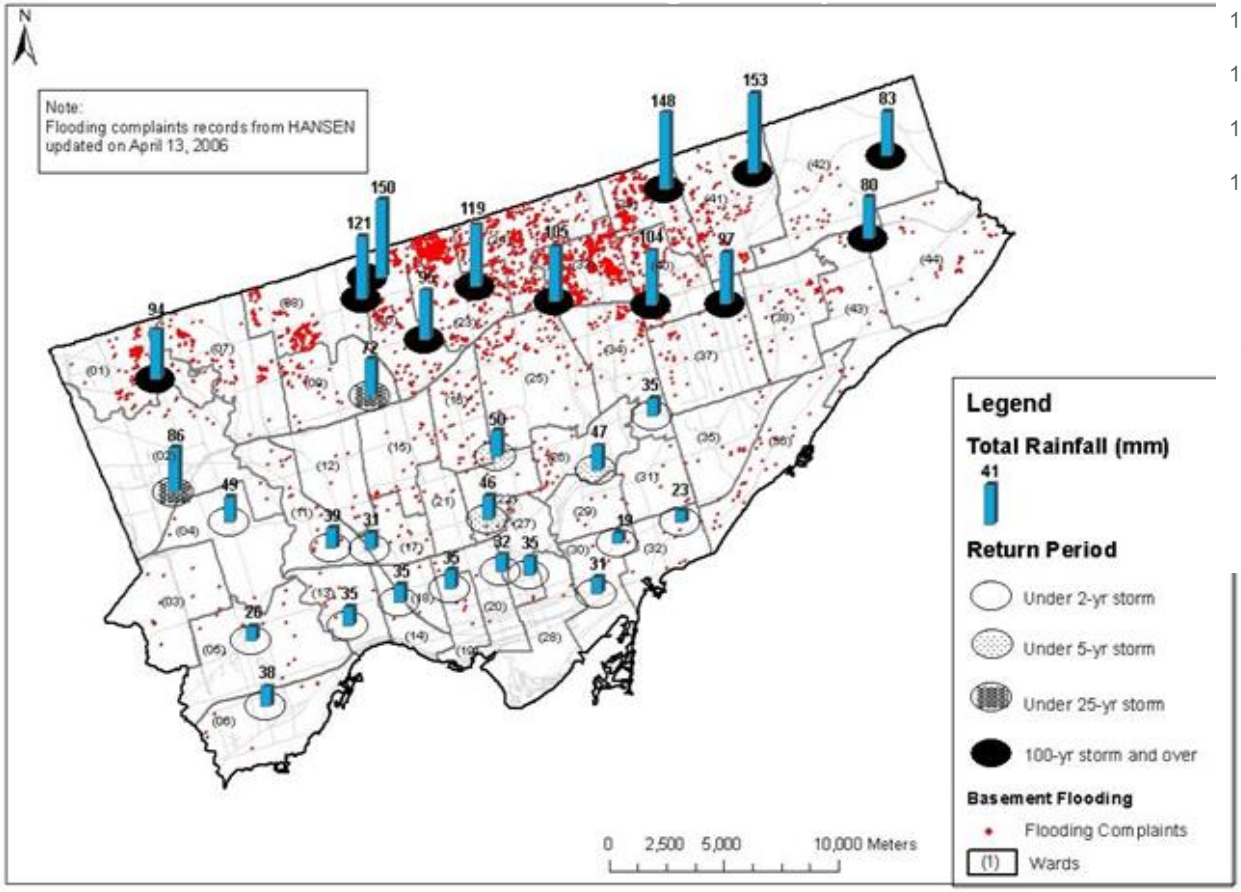
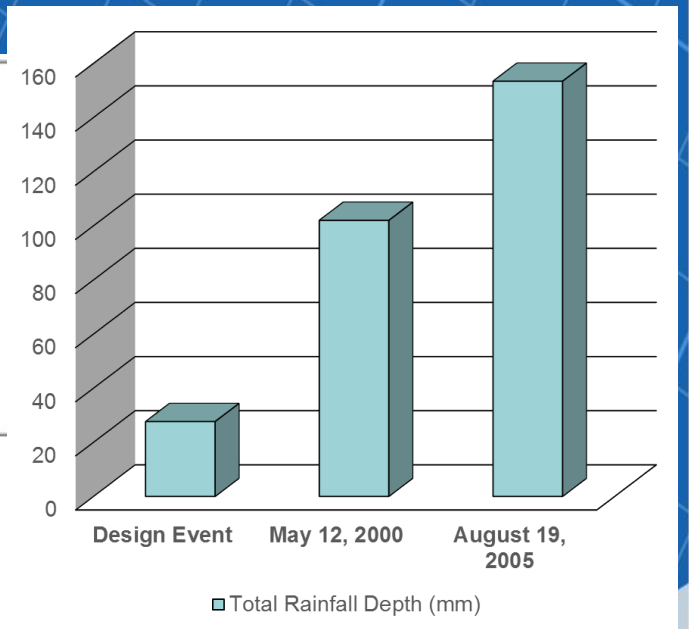
Impacts from Extreme Storms

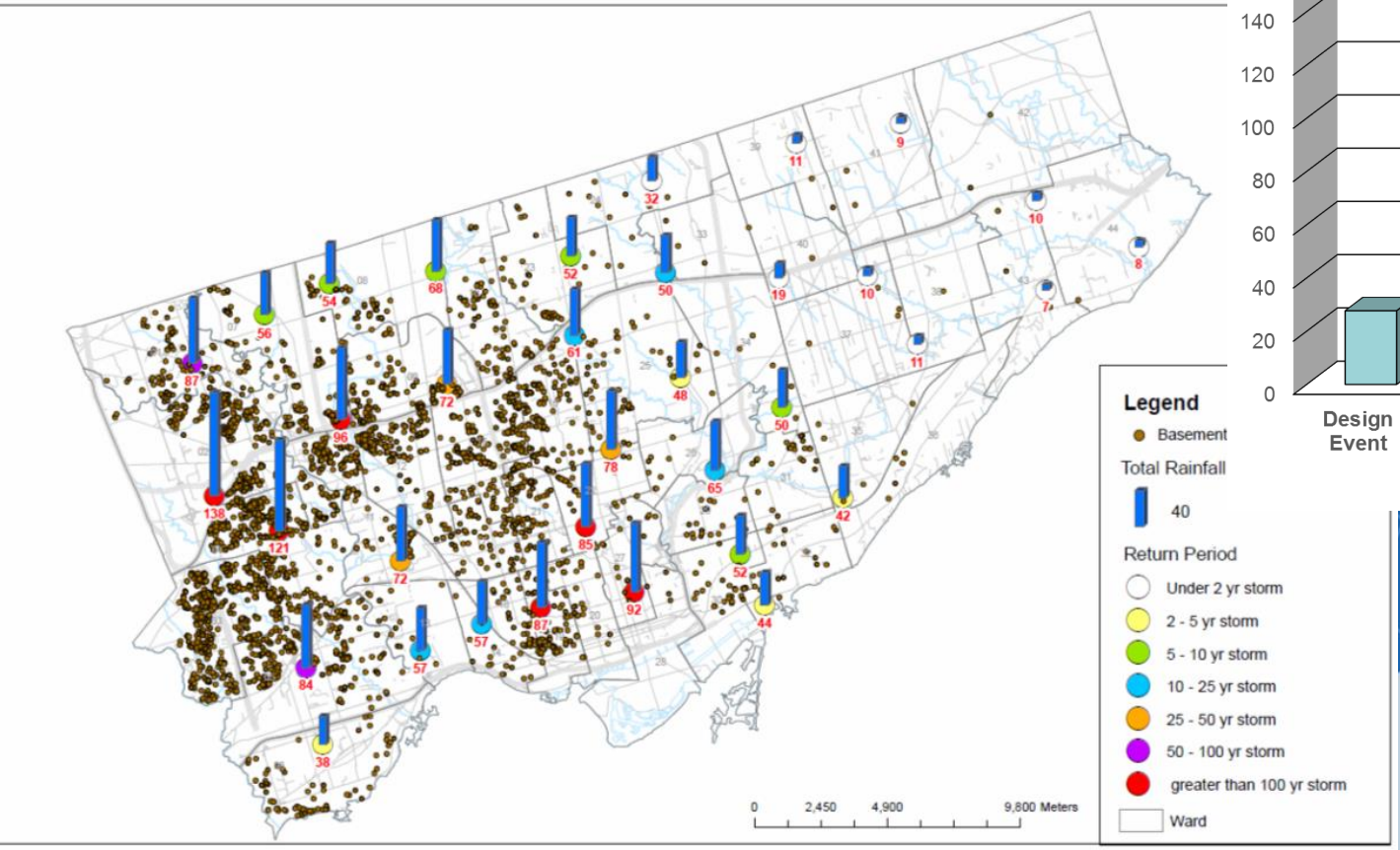
- Storm of August 19, 2005
  - Storm lasted 2 to 3 hours
  - Exceeded 1 in 100 year storm in northern part of City
  - Toronto's rain gauge station recorded 153 mm (6 inches)
  - Over 4,200 flooding complaints

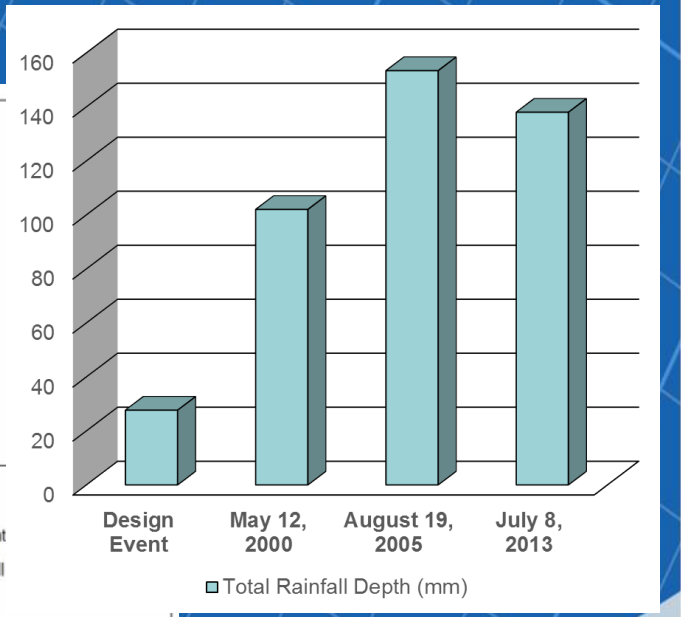




Impacts from Extreme Storms

- Storm of July 8, 2013
  - Storm lasted 9 hours
  - Exceeded 1 in 100 year storm in western part of City
  - Toronto's rain gauge station recorded 138 mm (5.4 inches)
  - Over 4,700 flooding complaints





Impacts from Extreme Storms

- **Municipal Damage Summary**
  - Damage to public infrastructure – roads, sewers and utilities
  - Damage to streams, rivers and ravines – flash floods and bank erosion/collapse
  - Impacts and threats to source water

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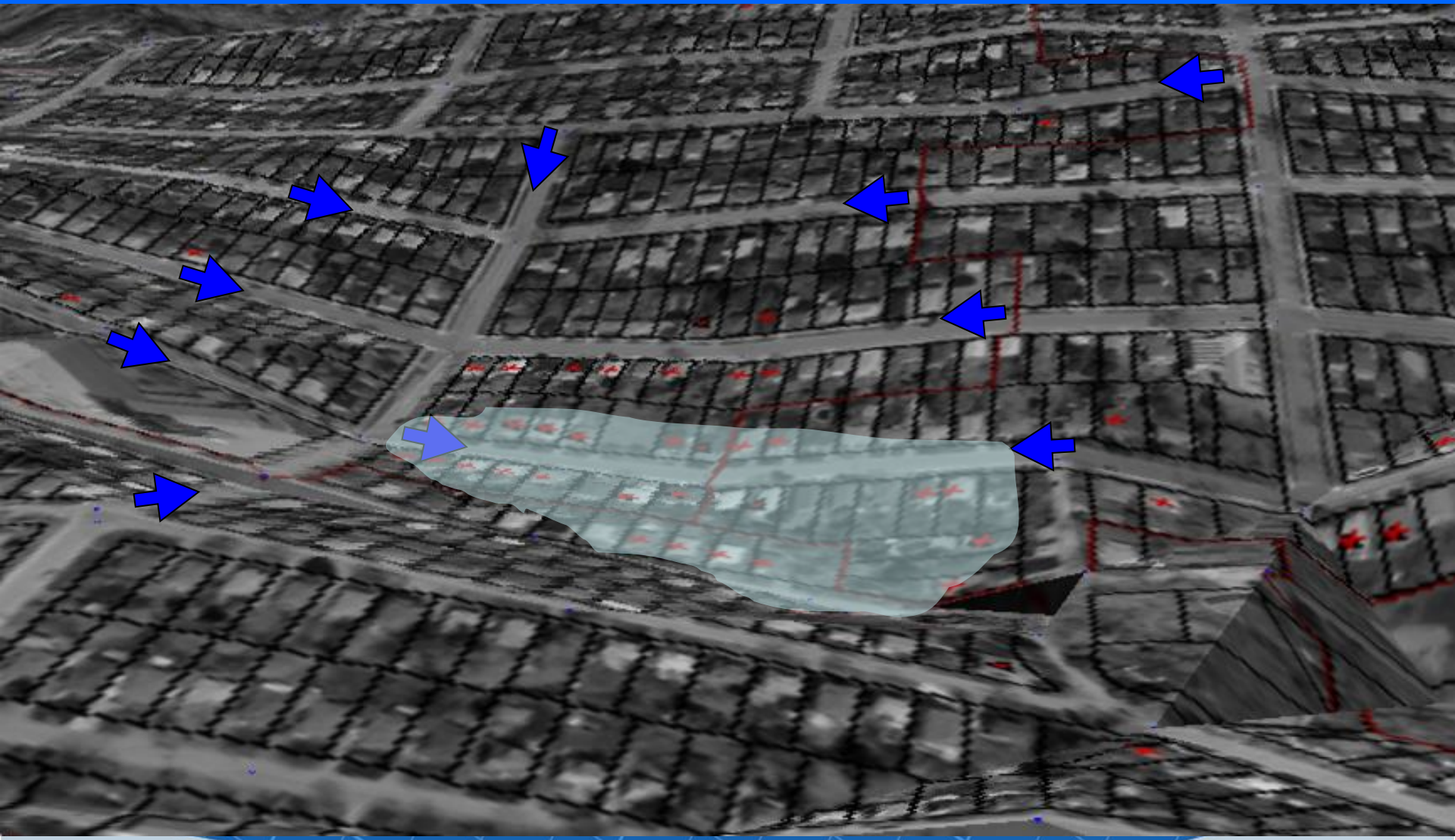
Overland Flow Paths & Surface Flooding



Under extreme events & once sewer system is overloaded, ponding will occur, if there is no overland outlet

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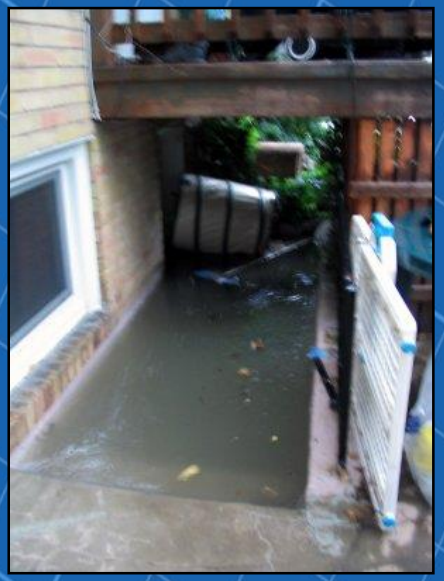
Impacts from Extreme Storms

- **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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Impacts from Extreme Storms

General Observations

- Under “normal” storm conditions
  - Sewer systems perform as designed

- During extreme storms
  - Sanitary sewer system is overloaded
  - Widespread surface flooding (including private property)

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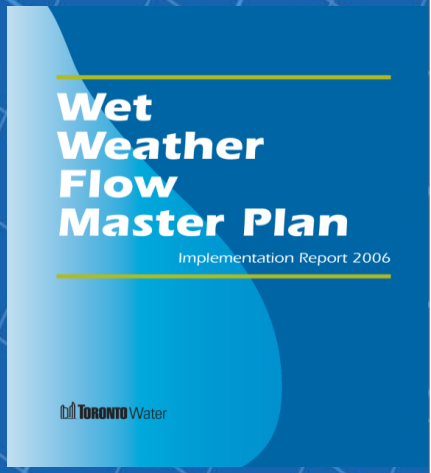
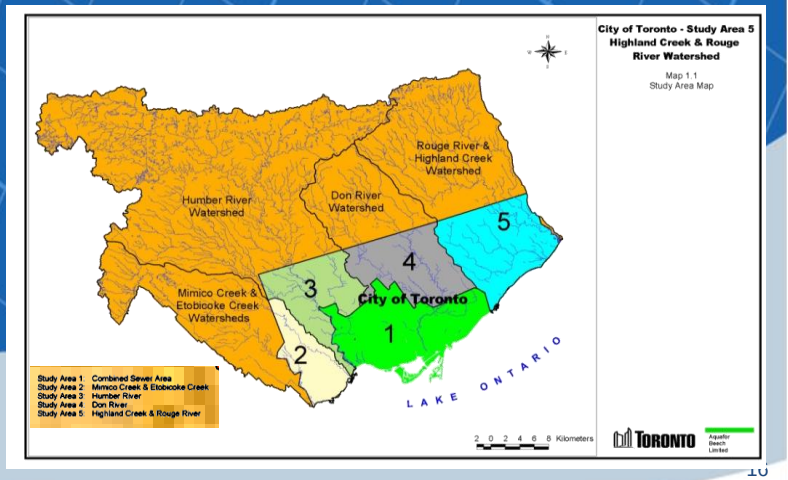
Adaptive Management Approach to Mitigating Wet Weather Flow Impacts (*Water Quality and Urban Flooding*)



- **At the Municipal (City of Toronto) level**
  - Wet Weather Flow Master Plan (WWMFP)
    - Adopted by City Council in 2003
  - Watershed based approach
  - Uses a hierarchical approach to managing stormwater
    - Source Control (lot level)
    - Conveyance System (road allowance)
    - End-of-pipe (before discharge)
  - Public education a key component
  - 25-year implementation schedule



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Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Adaptive Management Approach:**
  - Approved by Council in April 2006
  - Class Environmental Assessments required for storm drainage and sanitary sewer system improvements
  - Upgrade Sewer Design Standards for Retrofit of Existing Systems:
    - Sanitary sewer back-up protection for May 2000 storm
    - Upgrade storm drainage systems to “New Development” standards: 100 year storm
  - Lot Level Controls
  - Sanitary Sewer System Improvements – as necessary
  - Inlet Controls on Storm Sewer System
  - Provide Overland Flow Control and/or Storage, as feasible
  - Prioritization of Construction of System Improvements

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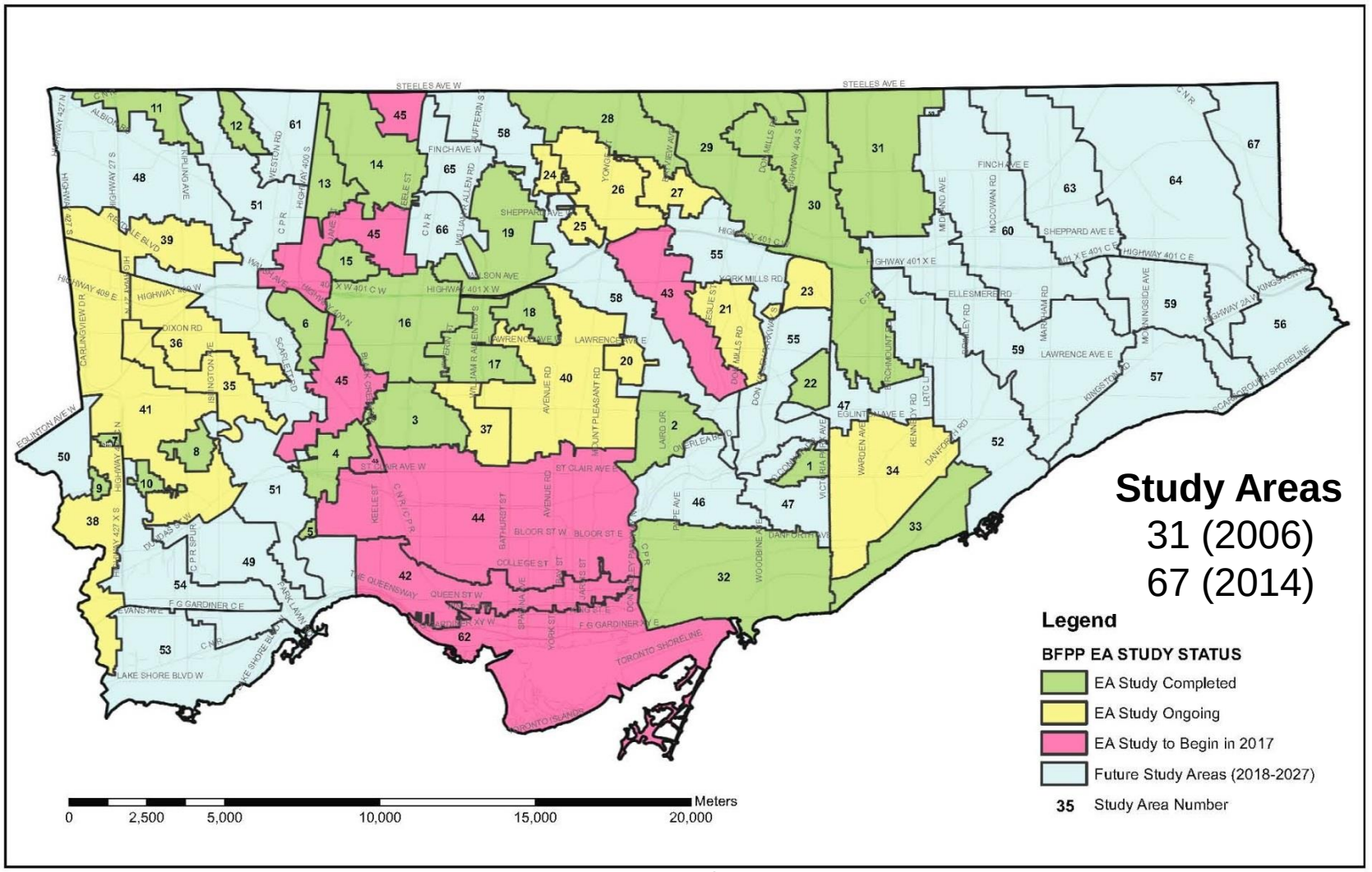
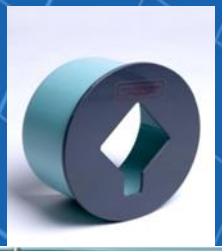
Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

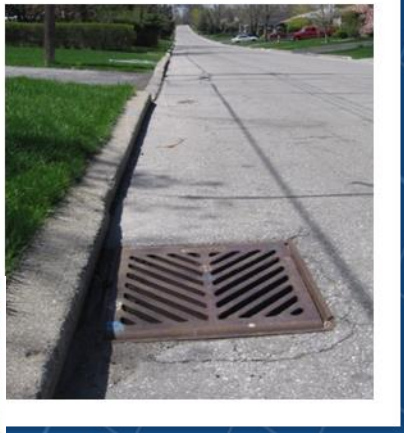


Source: https://www1.toronto.ca/City%20Of%20Toronto/Policy%2C%20Planning%2C%20Finance%20&%20Administration/Public%20Consultation%20Unit/Basement%20Flooding/Study%20Area%2041/small%20size%20BF_Study_Areas_Map_2017.jpg

Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Surface Flow Controls**
  - Catchbasin Inlet Control
  - Increase number of Catchbasins
  - Seal Maintenance Hole Covers
  - Surface Flow Path Diversion





- **<u>Involves:</u>**
  - Minimal effort and time to implement
  - Will control excess stormwater from overloading the sewer system

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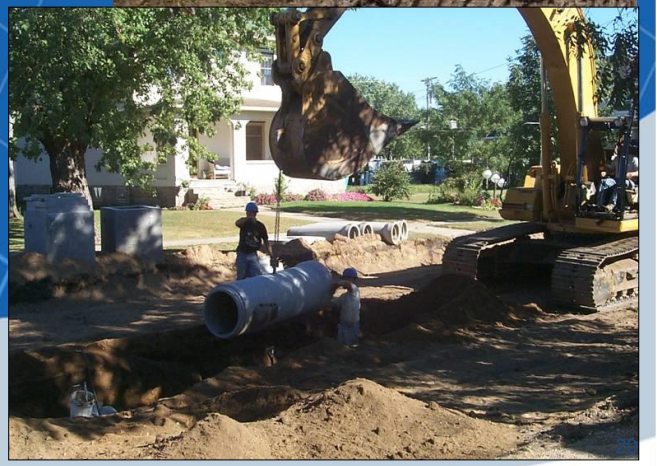
Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Pipe Conveyance Controls (Storm and Sanitary)**
  - Increasing Sewer Pipe Size
  - Relief Sewer (Twinning)
  - High Level Relief Storm Sewer
- **<u>Involves:</u>**
  - 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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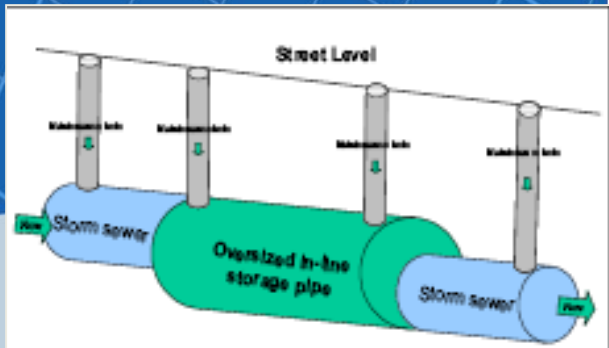
Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Storage for Sanitary and Storm**

Offline and online underground storage tanks

Dry Pond

- **Involves:**
  - Facilities constructed in existing parks or open spaces
  - Temporary loss of open space and/or traffic disruptions
  - Excavation and placement of storage elements
  - Landscaping opportunities



Oversized Pipes (In-line storage)

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Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Lot Level Controls**
  - Mandatory Downspout Disconnection (Phased in by 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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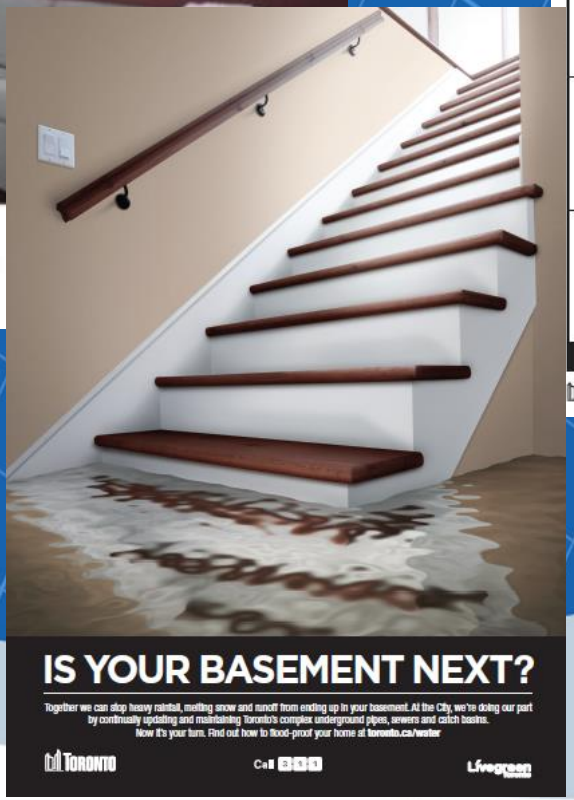
Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Public Education and Outreach**



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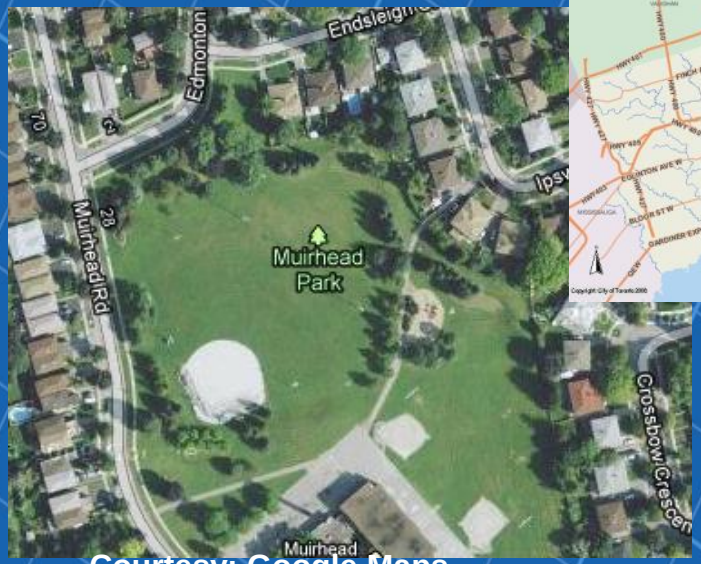
Dry Pond - Muirhead Park

- Dry pond built in Muirhead Park in northern part of the City
- Completed in 2012 ($2.3M)



Courtesy: Google Maps

During Construction – 2011

Dry Pond – Spring 2012

Old Sheppard Park – Stormwater Tank

- Located in North Toronto
- 12,000 m^3 underground stormwater storage tank
- Completed in 2012 ($10.2M)

(Courtesy: Google Maps)

Old Sheppard Park - Stormwater Tank

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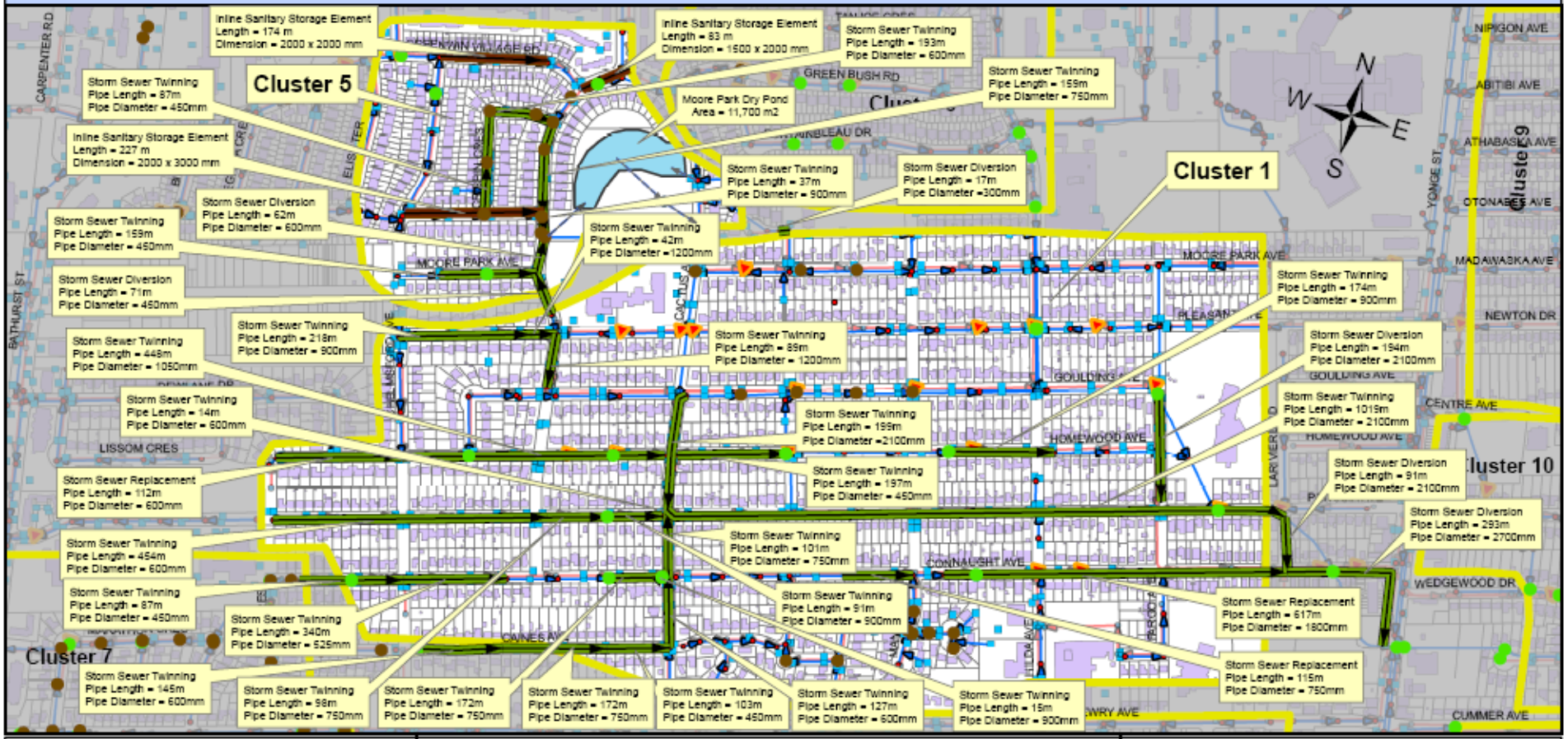
RECOMMENDED SOLUTIONS FOR CLUSTER 1 & 5



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

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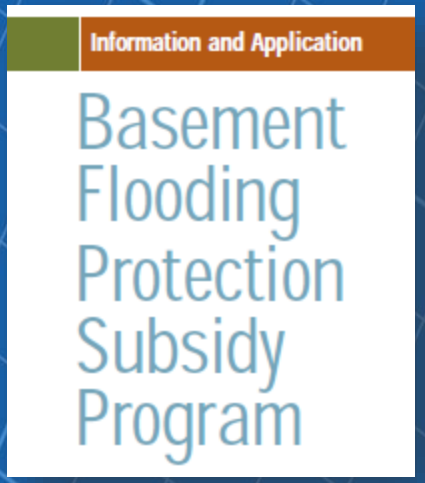
Basement Flooding Protection Program
Cost Summary – (4 Study Areas Only: 14, 28, 29 & 30)

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**

Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- **Basement Flooding Protection Subsidy Program**
  - Financial subsidy of up to $3,200 per property, to install flood protection devices including:
    - Backwater valve (max $1,250)
    - Sump pump (max $1,750)
    - Disconnection of a home's foundation drains (weeping tile) from the sewer system (max $400)



- **Since the subsidy program was expanded City-wide (2006)**
  - Over 19,500 applications have been approved
  - More than $32.4 million in total subsidy payments issued to property owners by Toronto Water as of the end of June 2016.
  - On average, the City currently issues approximately $1,600 in subsidy payments to participating properties.

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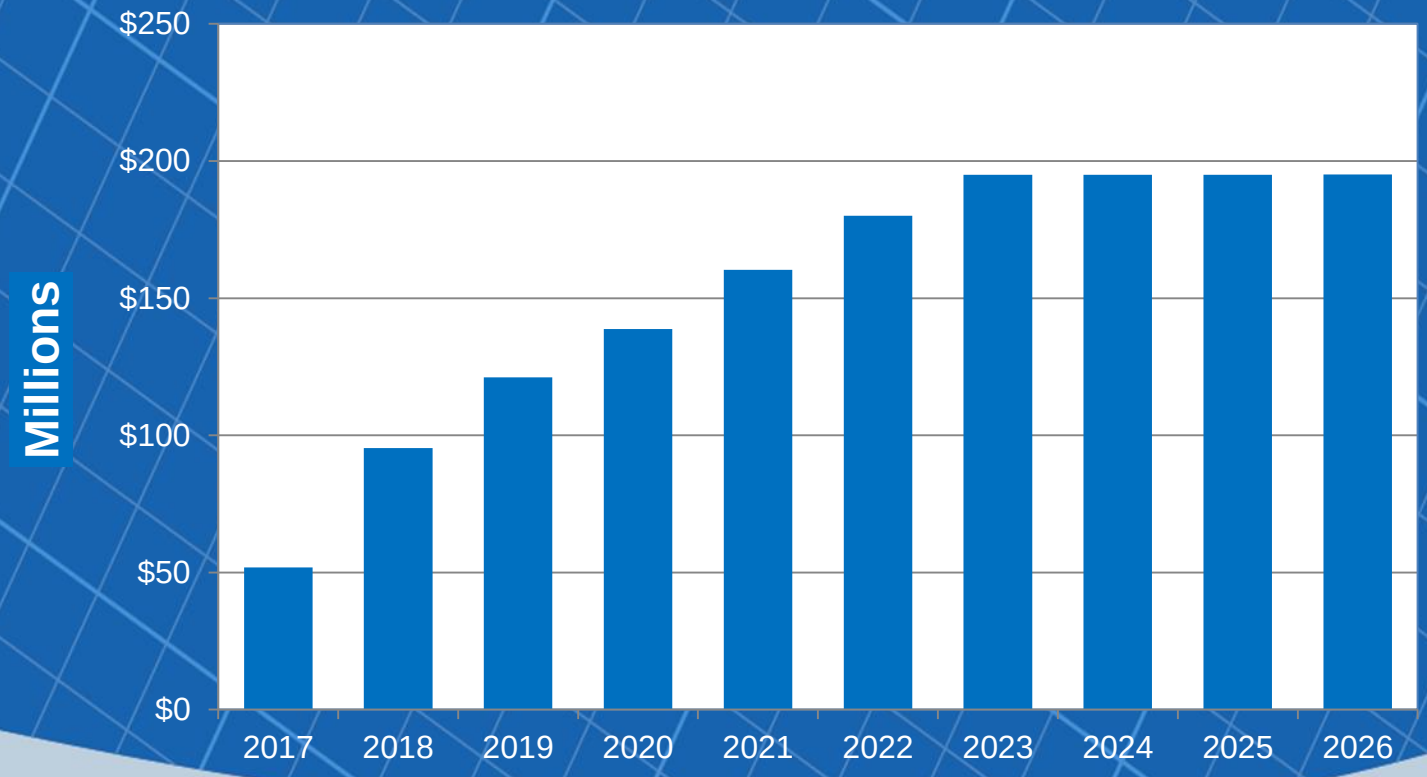
Adaptive Management Approach to Mitigating Urban Flooding – *Basement Flooding Protection Program*

- Basement Flooding Protection Program Capital Plan:
  - $1.53 Billion over the next 10 years



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Residents' Appreciation

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Policy Considerations and Conclusions

- 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
- Funding considerations for system improvements:
  - Currently through water revenues
  - Future consideration for stormwater utility charge

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Policy Considerations and Conclusions

- Standard design practices based on historical climate records
  - need to be reviewed based on projected new “norms”
- Advocate for “shared risk”:
  - Municipality, insurance industry…and property owner
- Establish design standard based on “acceptable risk”:
  - Ideally with insurance industry
- Need to consider acceptable or upset limit on expenditures:
  - e.g., cost per “benefiting property”

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Policy Considerations and Conclusions

- Seize the opportunities to integrate adaptation:
  - New urban development:
    - Opportunity to do it right!
    - Lessons learned from older municipalities
  - Infrastructure renewal:
    - Opportunities to “shoe-horn” in adaptation
- From a social/economic standpoint:

Assess the cost of adapting versus

the losses that can be expected if we don’t!

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THANK YOU / MERCI

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