AN ADAPTIVE MANAGEMENT STRATEGY TO ADDRESS BASEMENT FLOODING

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TORONTO Water

Presentation Overview

- City of Toronto Water Infrastructure – Background
- Climate Change Effects
- Impacts From Recent Extreme Storm Event
- Basement Flooding Causes
- City-Wide Work Plan – Overview
- Basement Flooding Protection Strategy

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Inventory of Assets
Replacement Value of ~ $26.6 Billion

WATER - $8.7 Billion

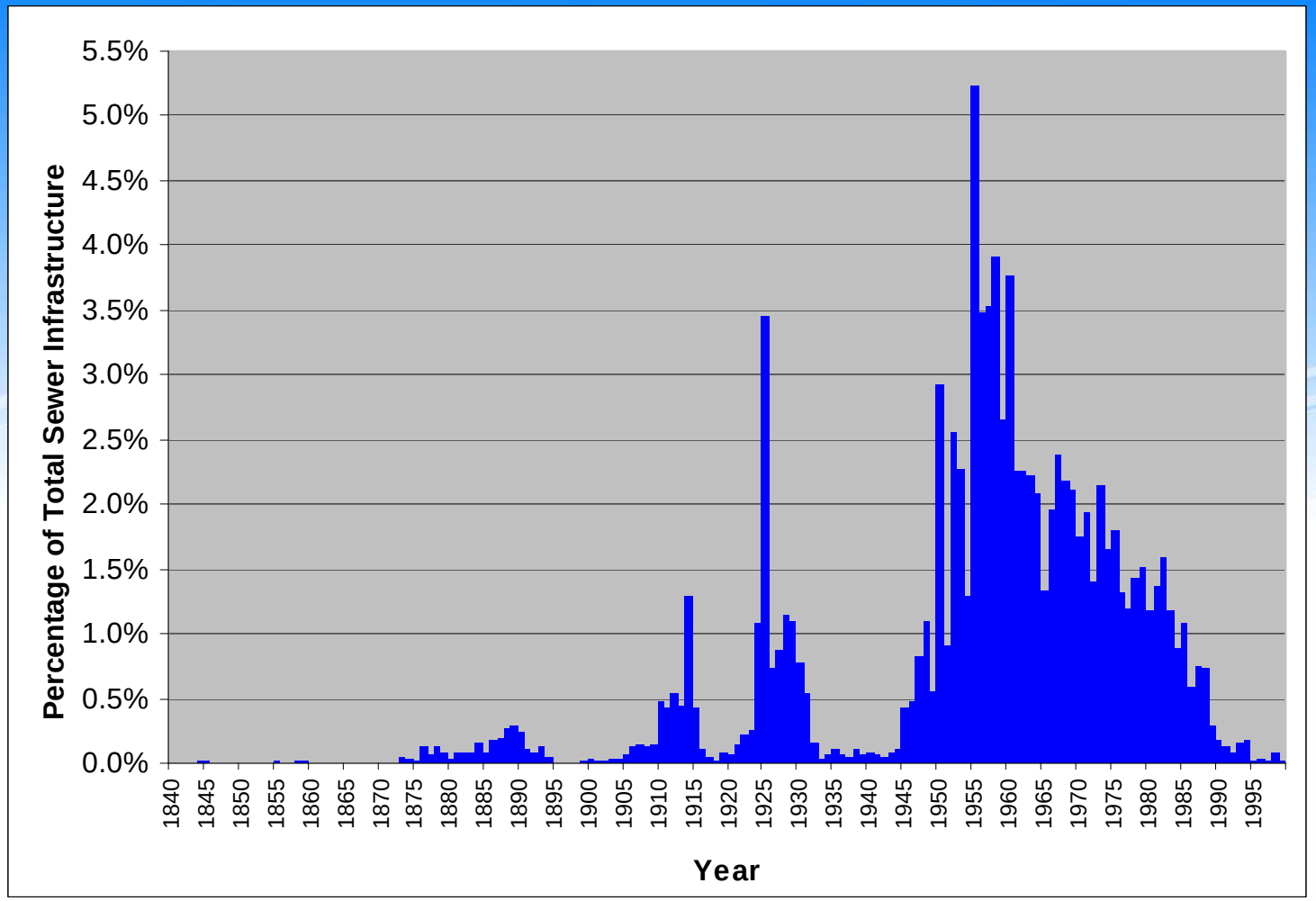
- 4 water filtration plants
- 5,015 km of distribution watermains, 510 km of trunk watermains
- 18 pumping stations
- 14 storage reservoirs
- 470,202 water service connections, plus York Region (population served 400,000)

WASTEWATER - $17.9 Billion

- 4 wastewater treatment plants
- 4,397km of sanitary, 1,301km of combined and 358km of trunk sewer
- 4,305 km of storm sewers and 546km of roadside ditches
- 371km of watercourses,
- 43 stormwater management ponds
- 2,300 sewer outfalls

TORONTO Water

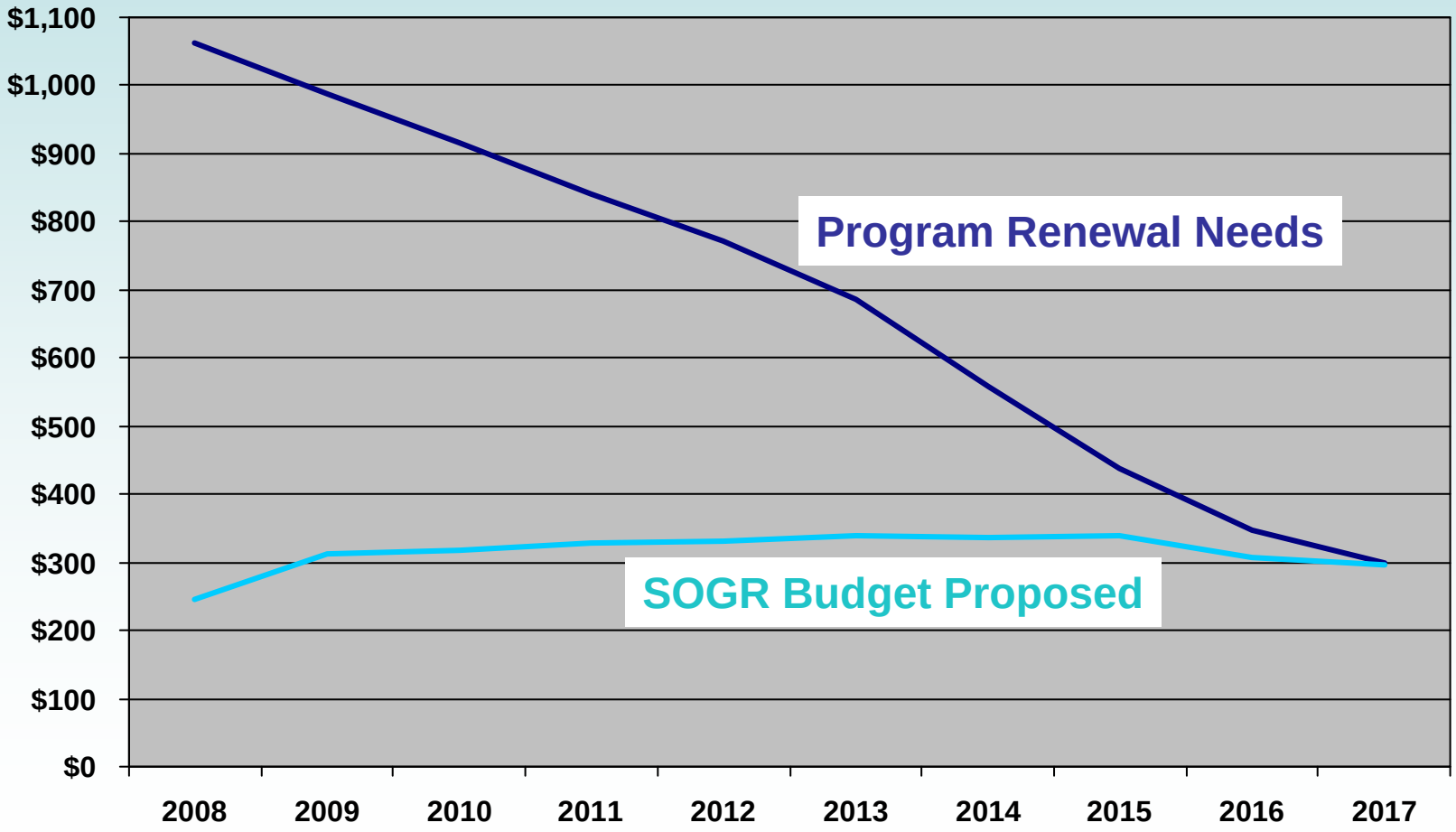
Sewer Construction History



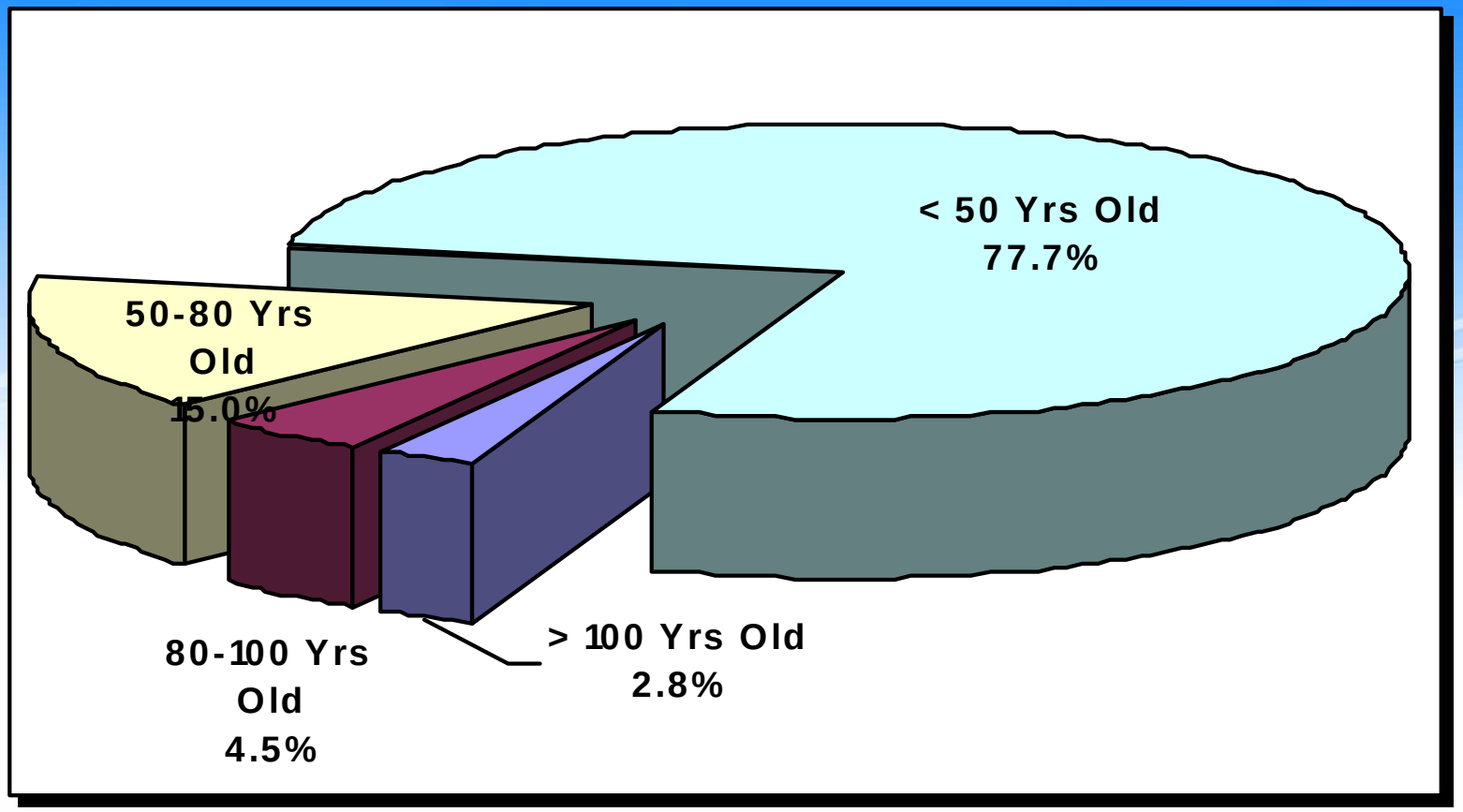
TORONTO Water

“State of Good Repair”

Addressing Toronto Water’s state of good repair needs

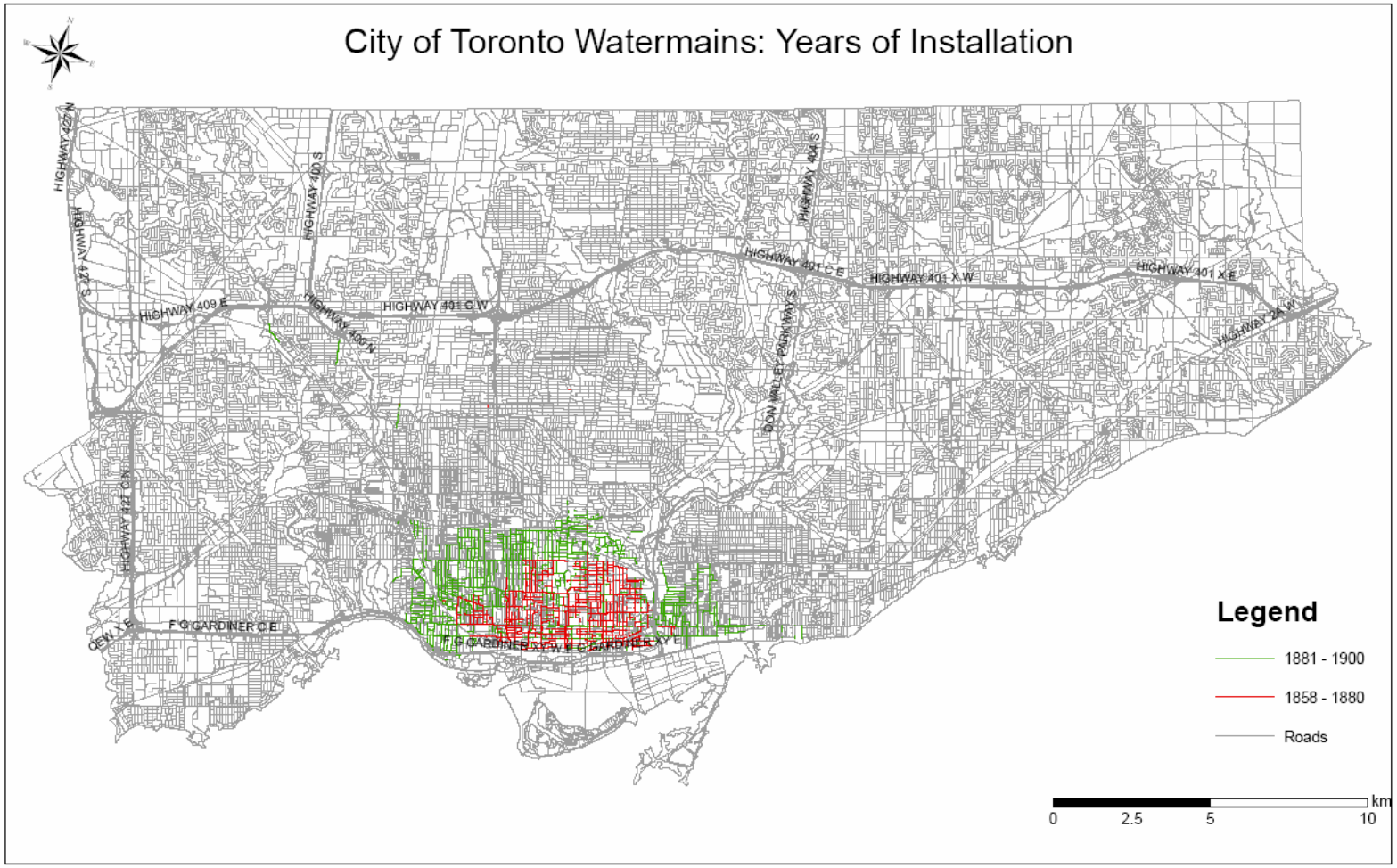


Sewer Pipes by Age



TORONTO Water

WATERMAIN CONSTRUCTION HISTORY (1858-1900)



TORONTO Water

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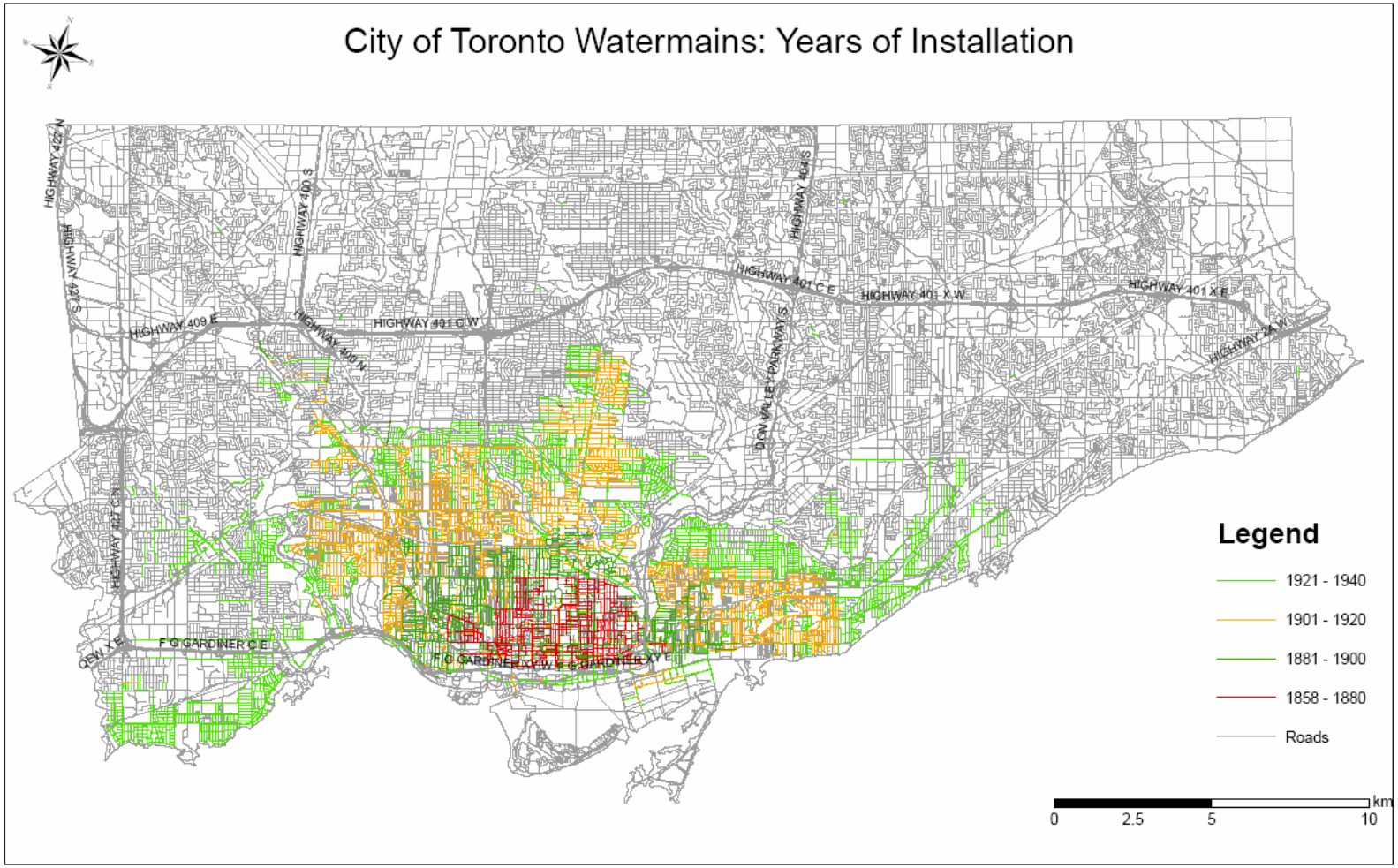

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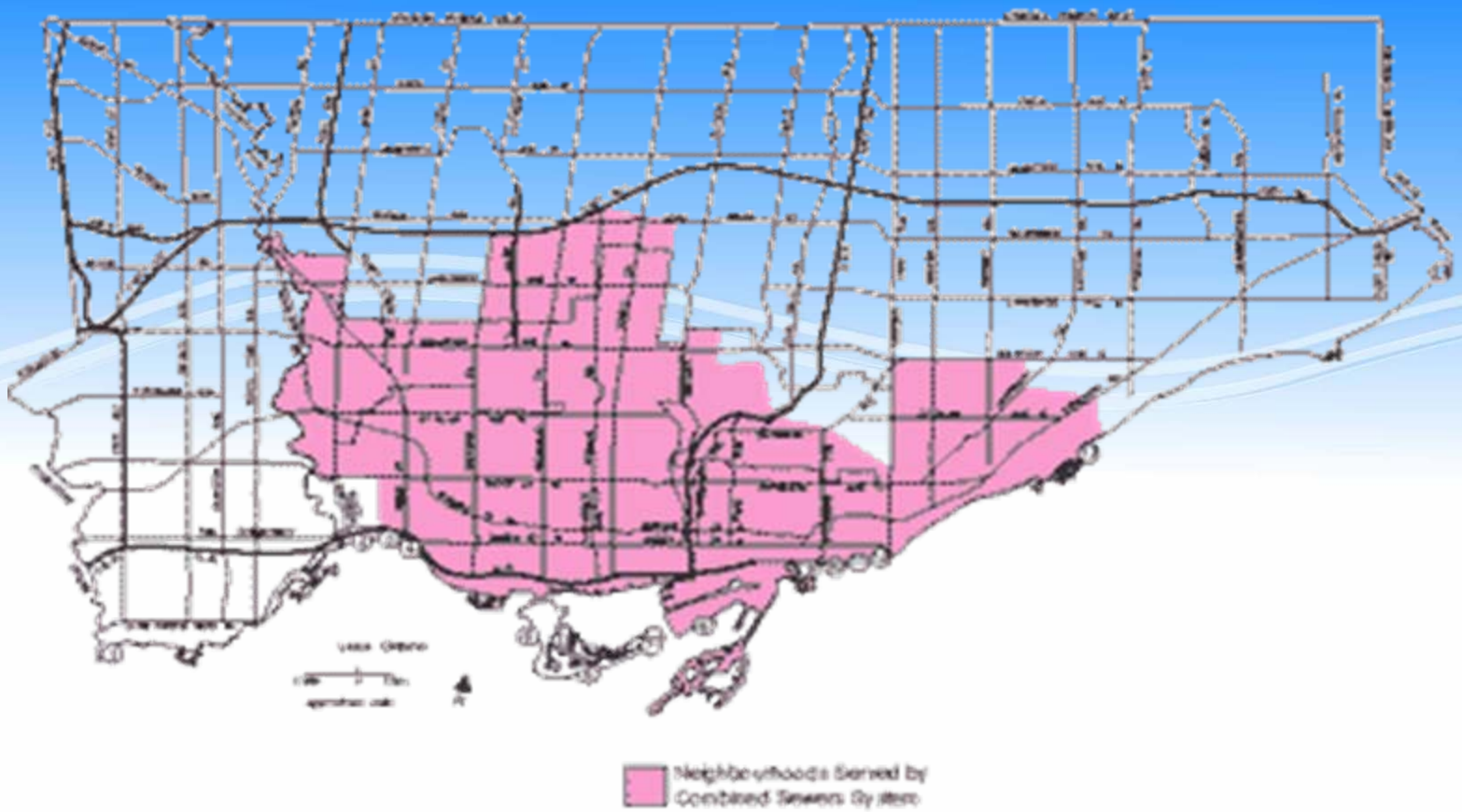
COMBINED SEWER SERVICE AREA



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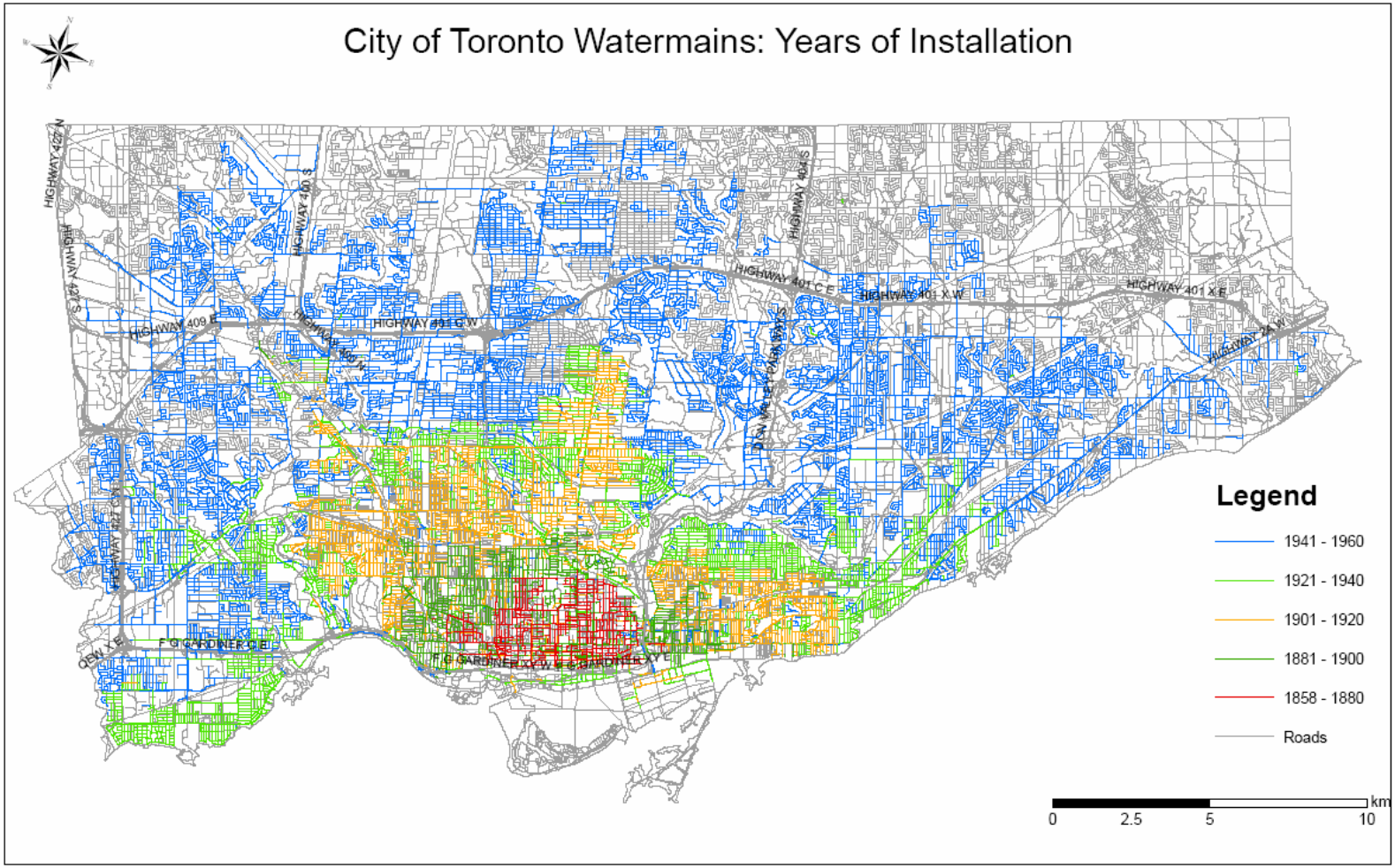
WATERMAIN CONSTRUCTION HISTORY (1858-1960)



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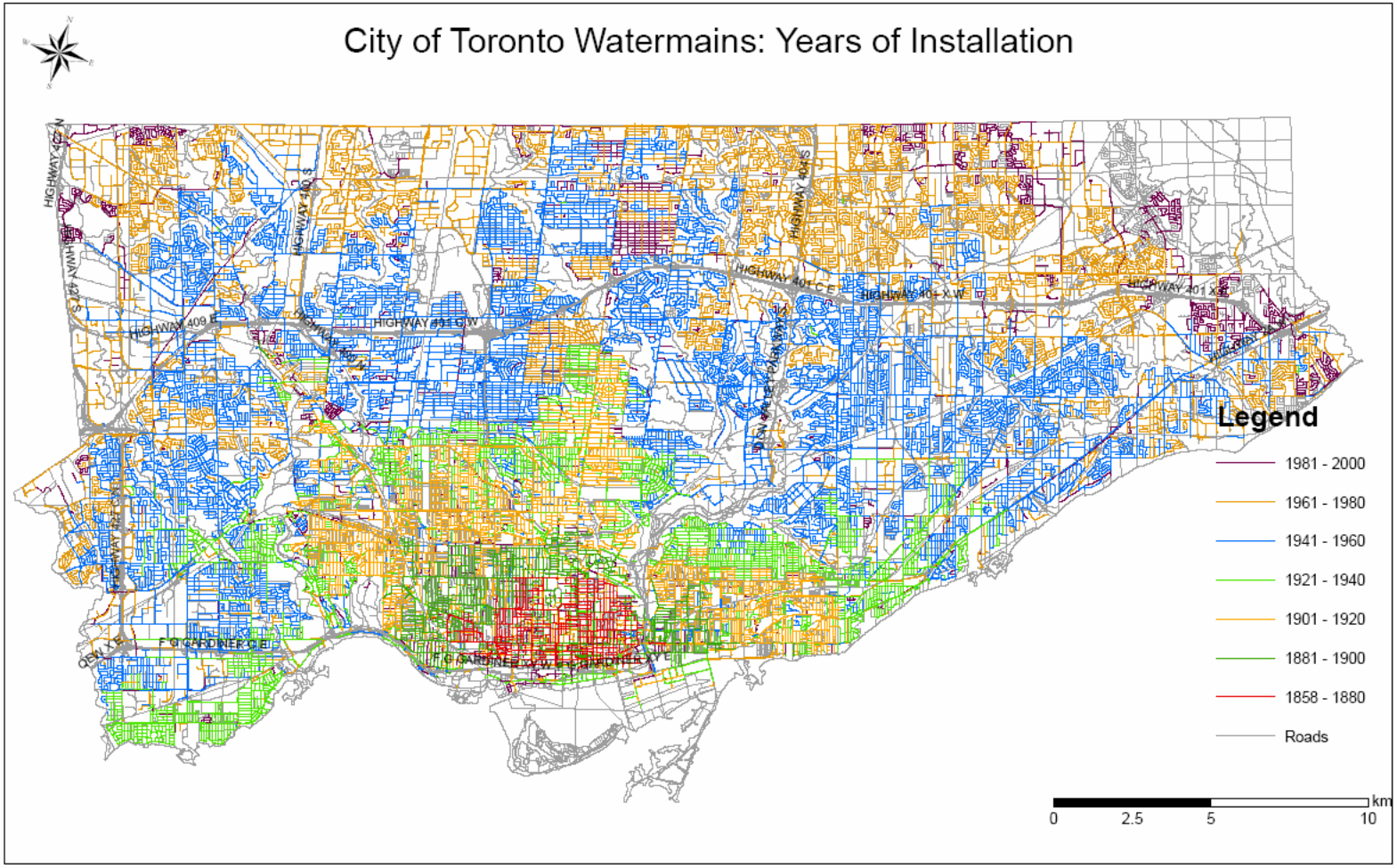
WATERMAIN CONSTRUCTION HISTORY (1858-2000)



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The Effects of Climate Change

- **There is confidence in our ability to forecast global warming trends/projections on air temperature.**
- **Increased open water evaporation expected as a result of warmer water temperatures: likely to affect future lake levels.**
- **Less certain about effects on precipitation.**

The Effects of Climate Change

- **Evidence suggests that intensity of rainfall events may increase, as a result of increases in "precipitable water" content of the atmosphere:**
  - **- increased flooding risks**
  - **- increased stream erosion**

- **Evidence leading to suggest substantial changes in seasonal distribution of flows and extremes:**
  - **- high and low flow conditions**
  - **- greater winter runoff**
  - **- reduced summer flows**

TORONTO Water

Are We Seeing the Effects?

YEAR	
1986	
1987	
1988	
1989	
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1993	
1994	
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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?

TORONTO Water

Design Standards?

- **Municipal Operations: <u>service delivery focus</u>**
- **Adapt:**
  - **change design thresholds?**
  - **change/alter service delivery expectations?**
  - **reduce infiltration/inflow (I/I) to sanitary sewer systems to the degree practical**
  - **joint responsibility (eg. Homeowner: lot grading)**
- **Considerations in implementing changes:**
  - **increase sizing of storm sewers for minor system design?**
  - **what about areas without a major system (overland flow) design?**
- **Rebuild system/s &, if so, when & how?**

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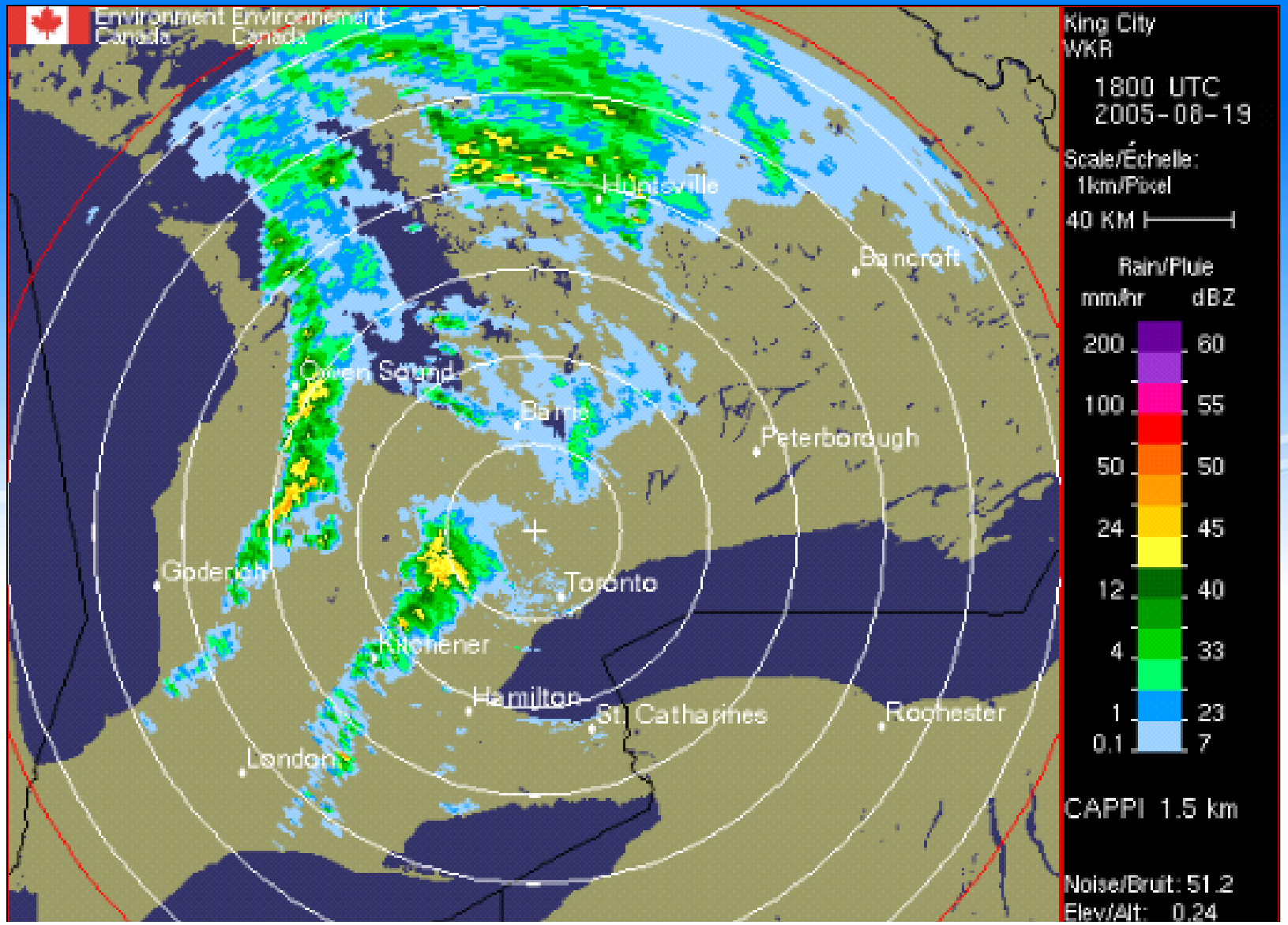
TORONTO Water

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 (6 inches)**

TORONTO Water

August 19 – 3:00 pm



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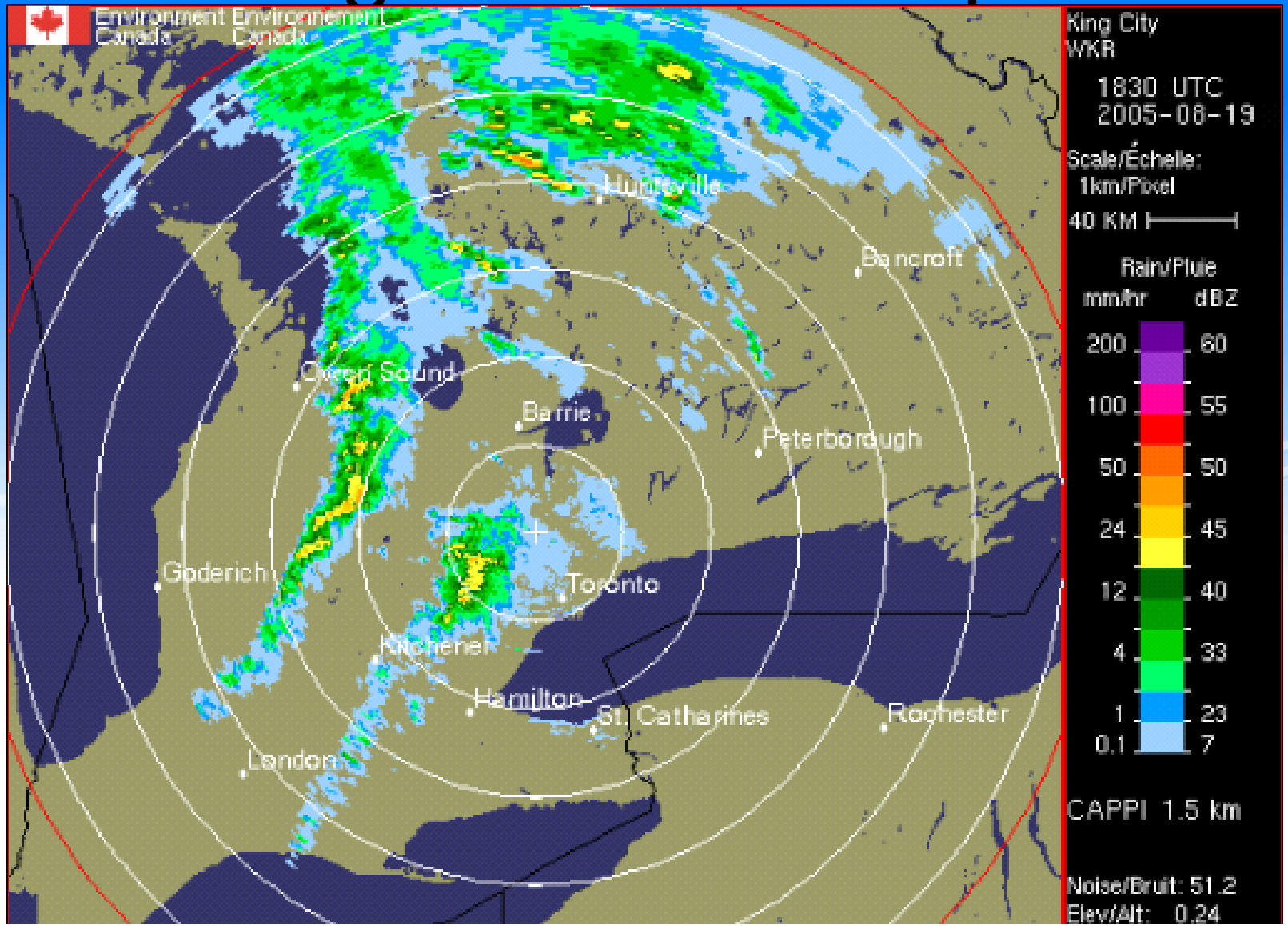
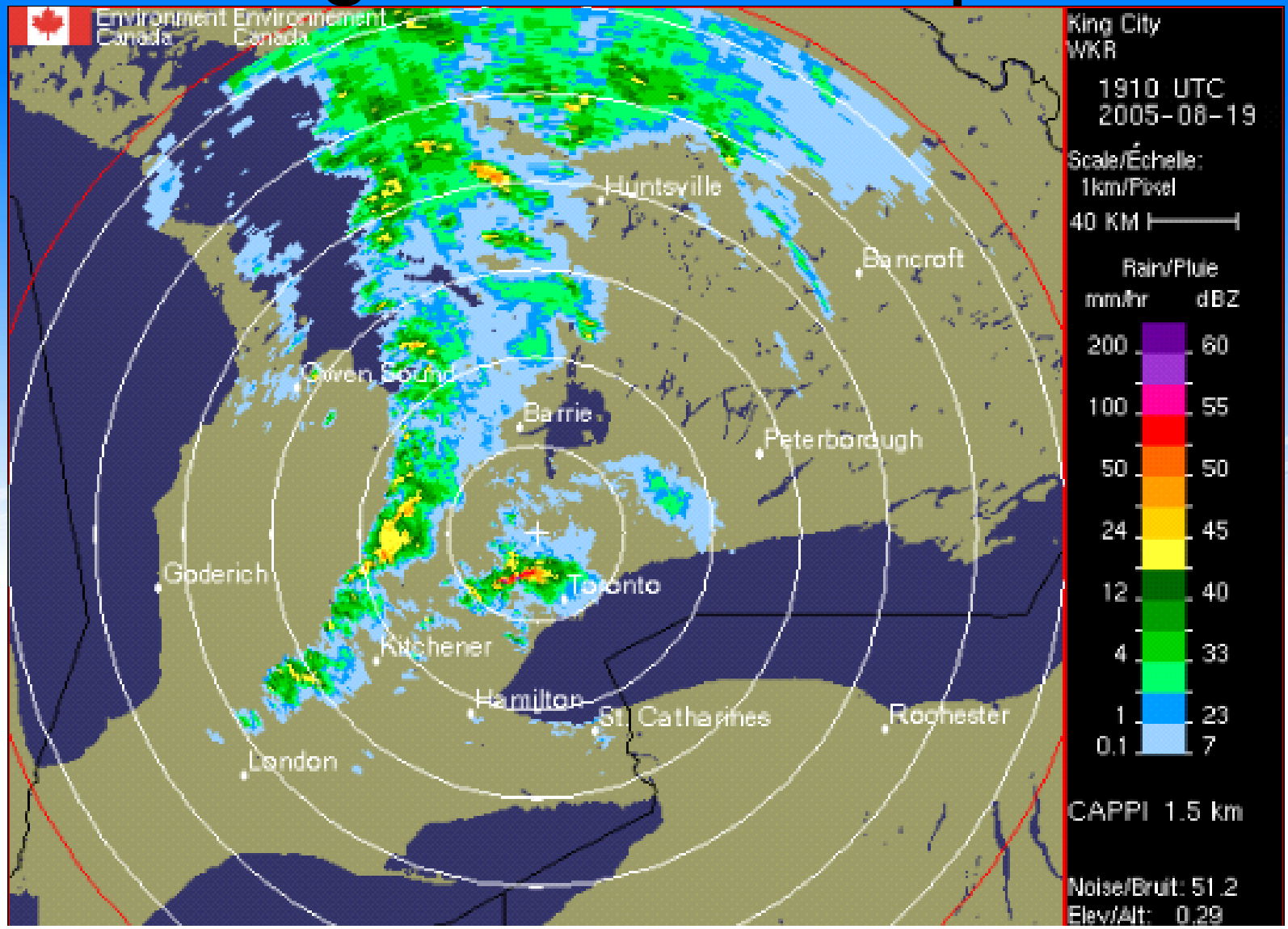
August 19 – 3:30 pm



TORONTO Water

August 19 – 4:10 pm



TORONTO Water

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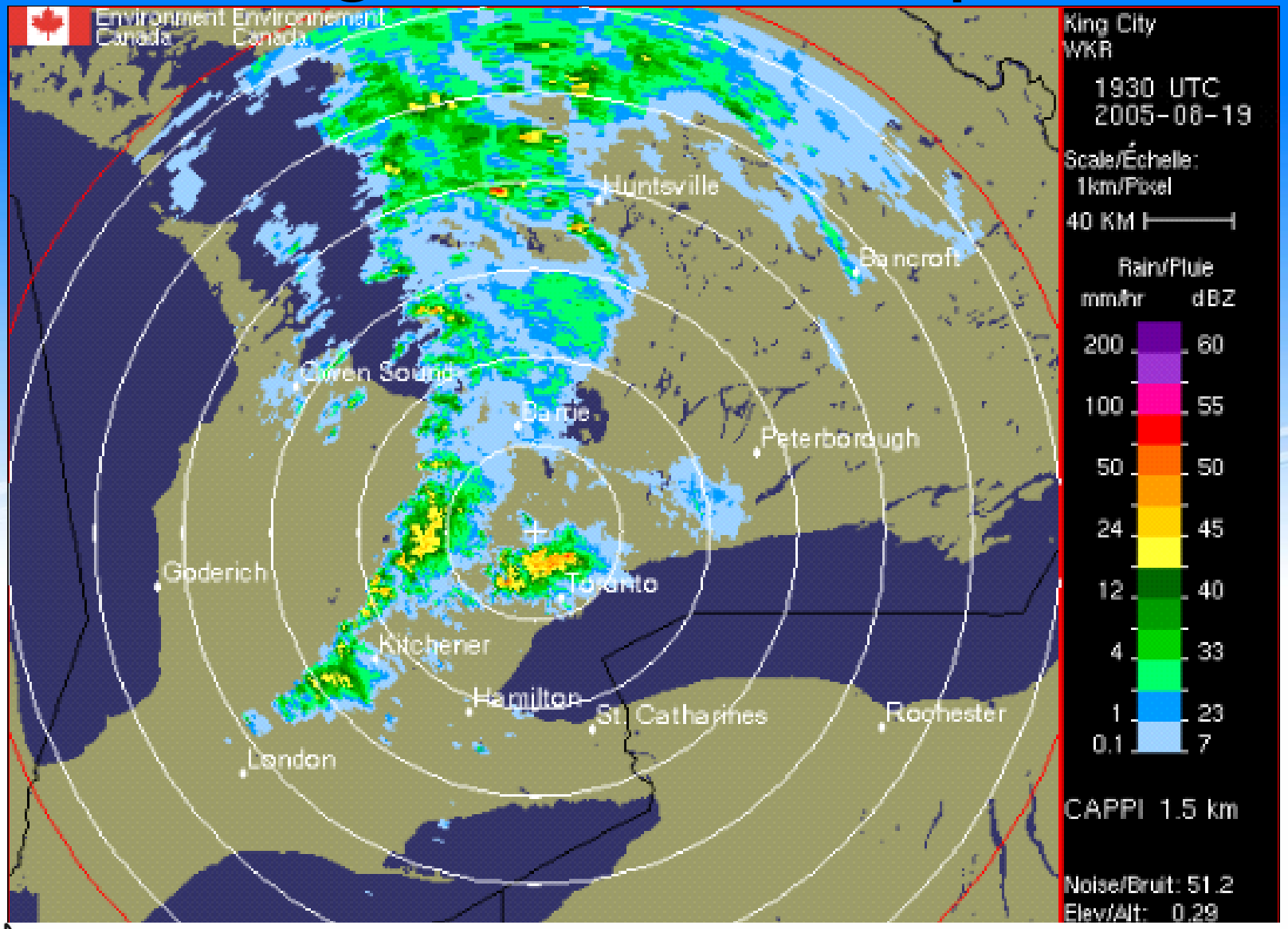
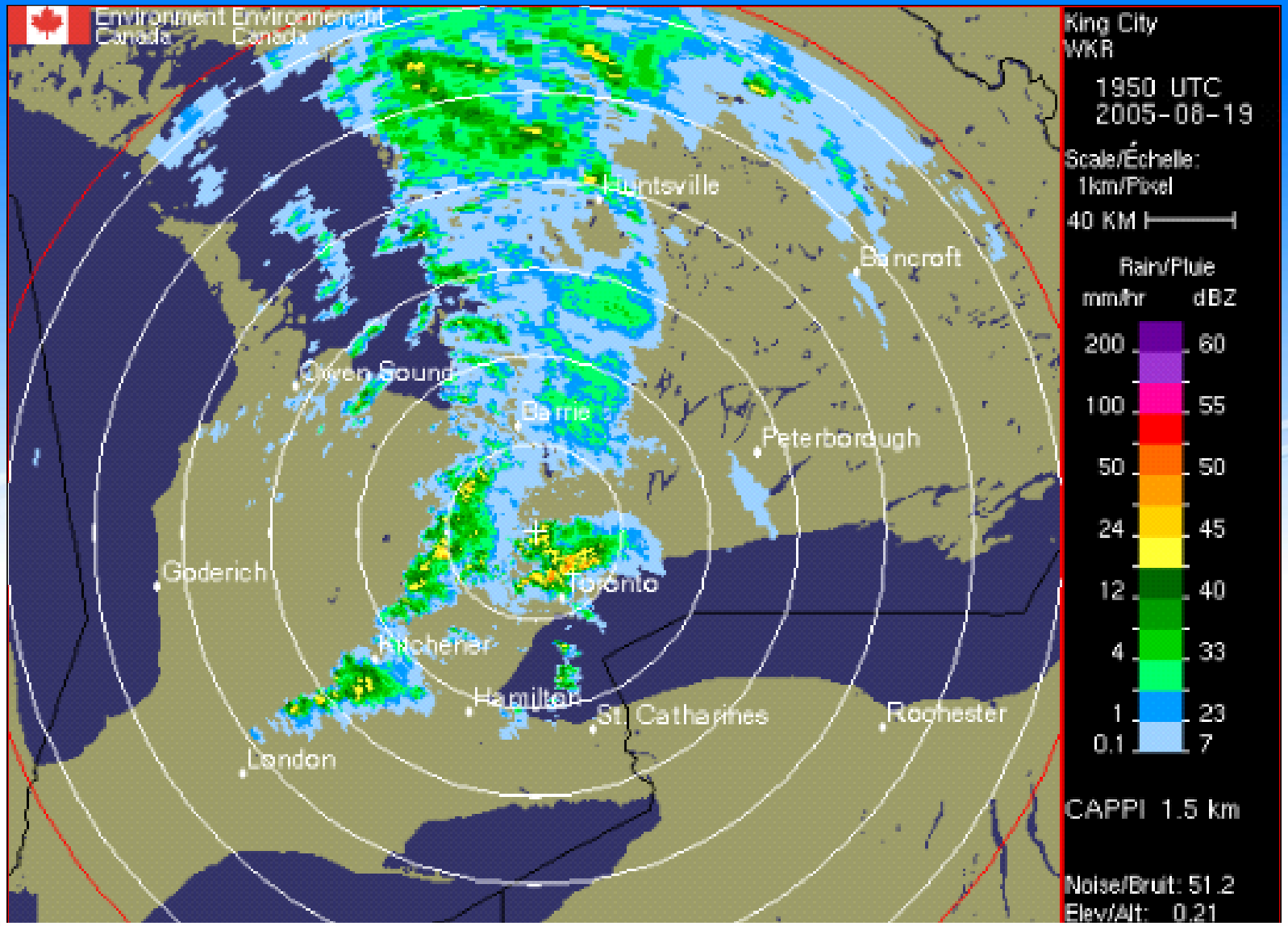


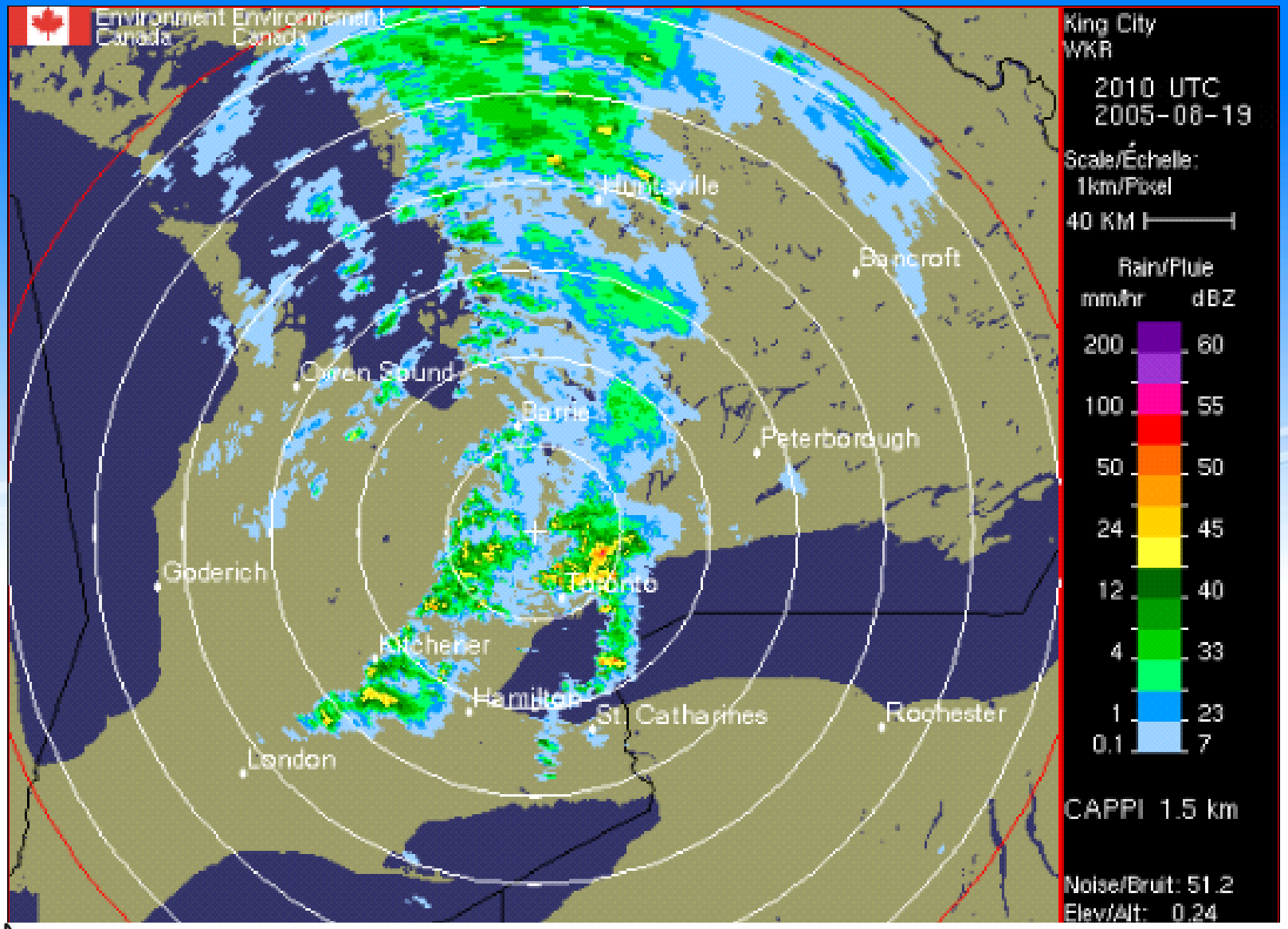
TORONTO Water

August 19 – 4:50 pm



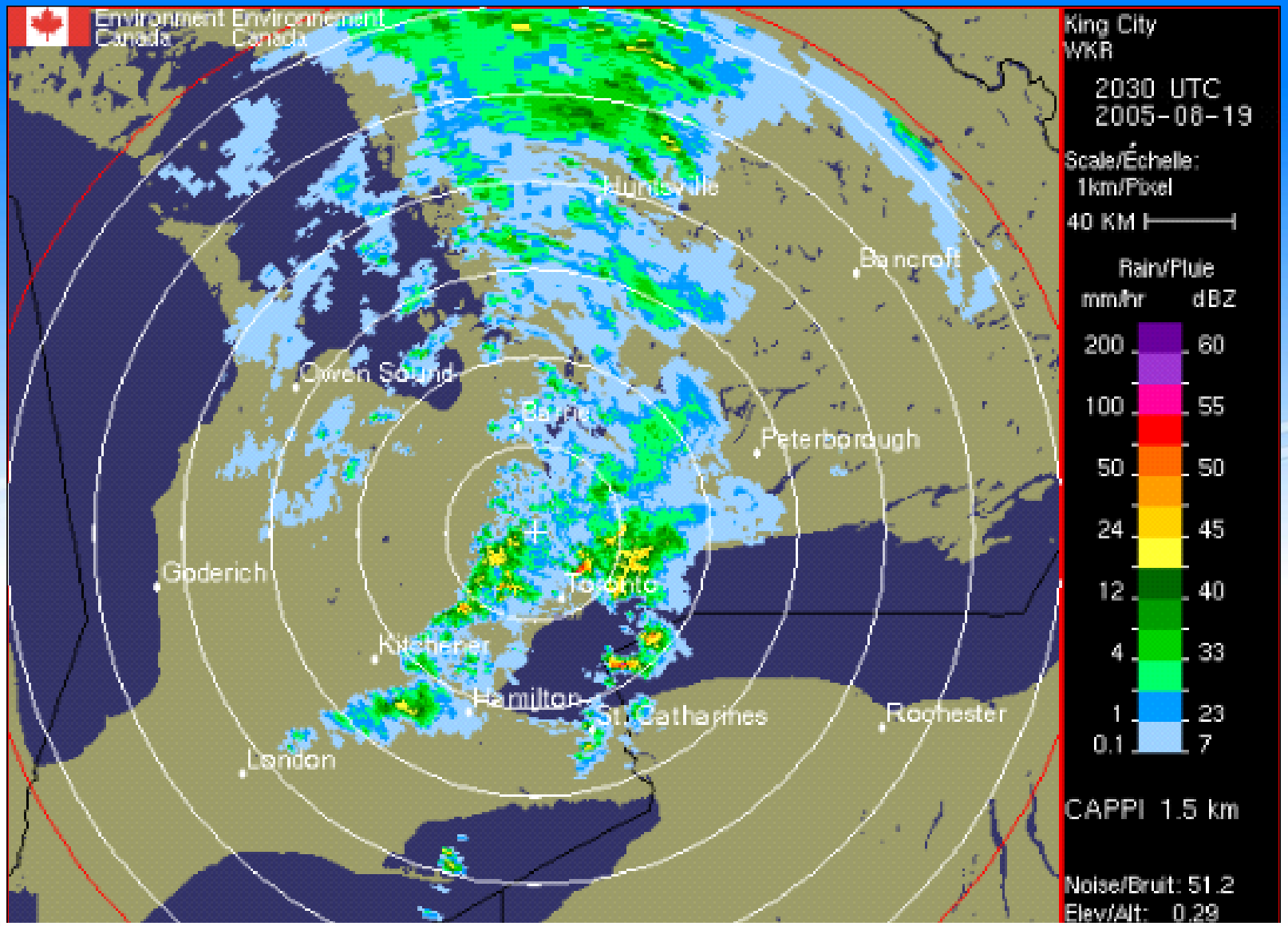
TORONTO Water

August 19 – 5:10 pm



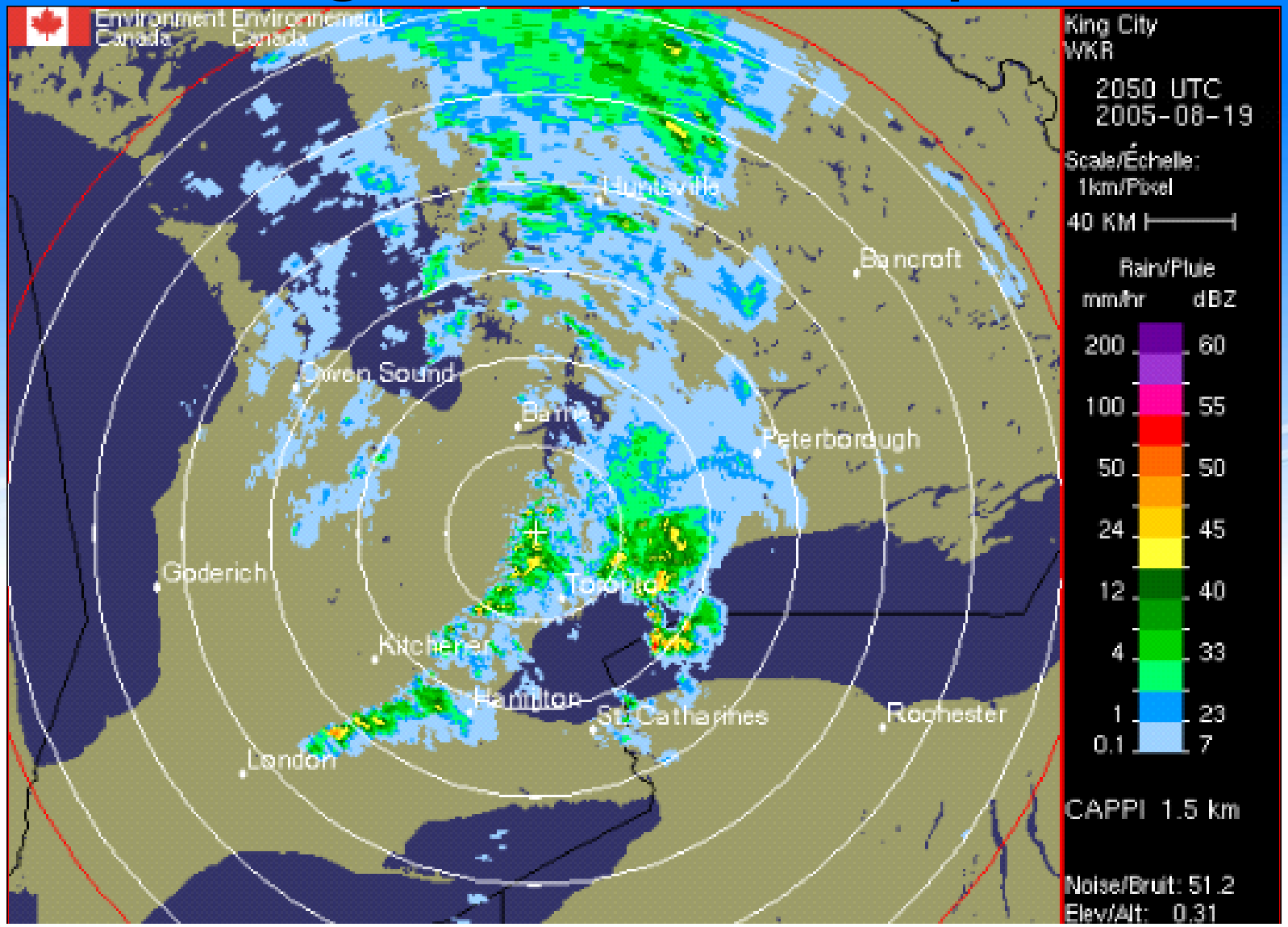
TORONTO Water

August 19 – 5:30 pm



TORONTO Water

August 19 – 5:50 pm



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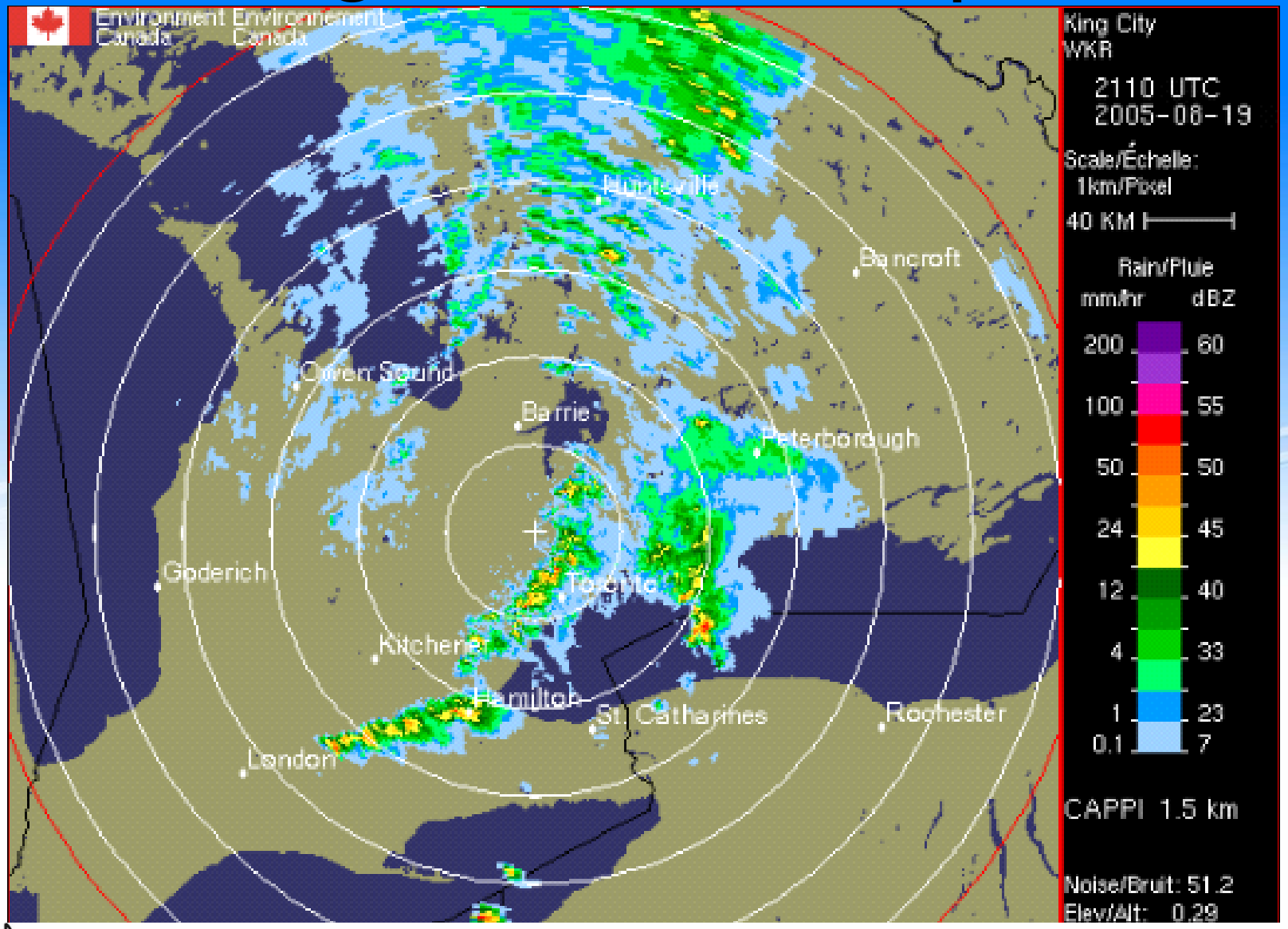
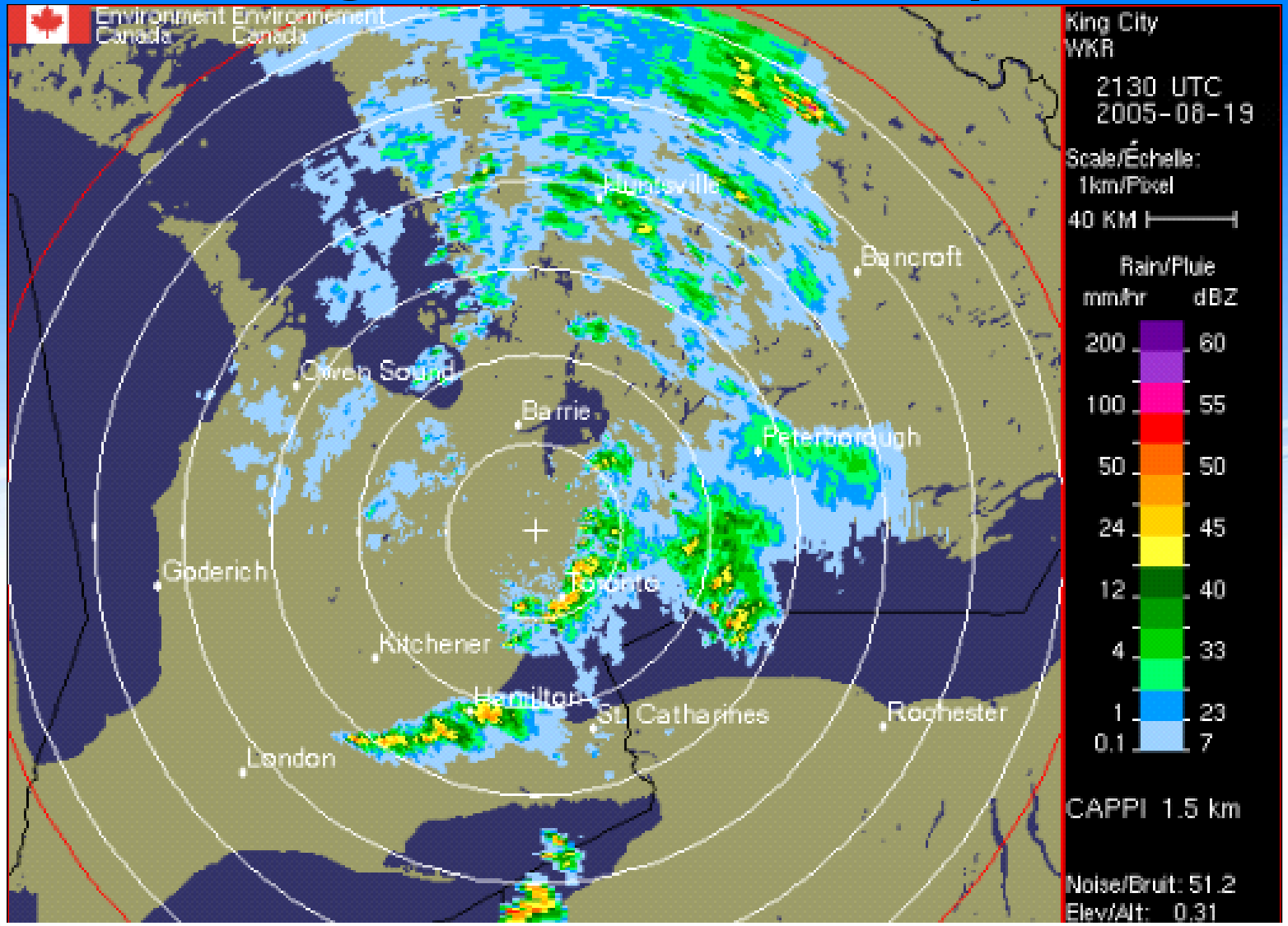
August 19 – 6:10 pm



TORONTO Water

August 19 – 6:30 pm



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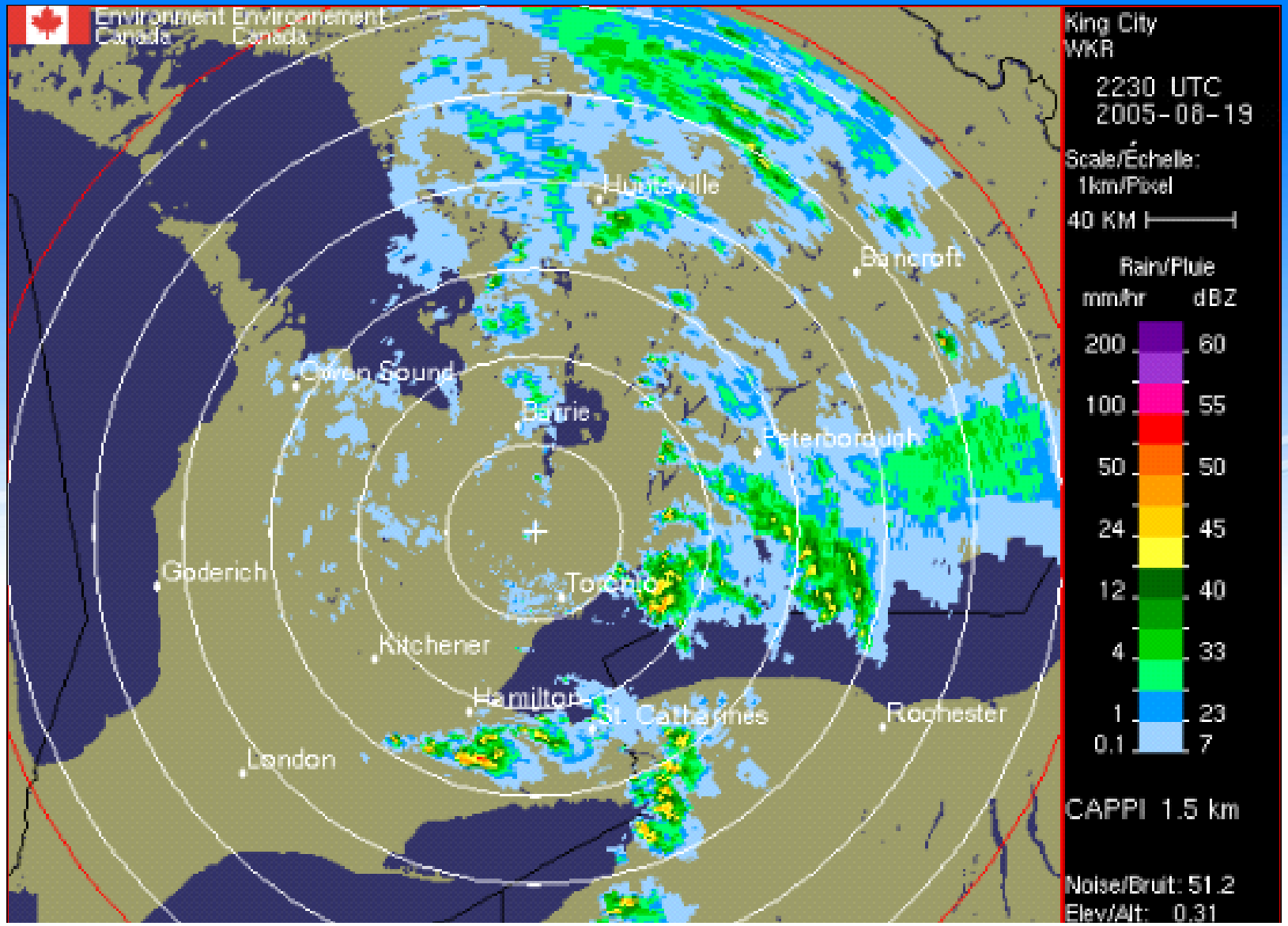
August 19 – 7:30 pm



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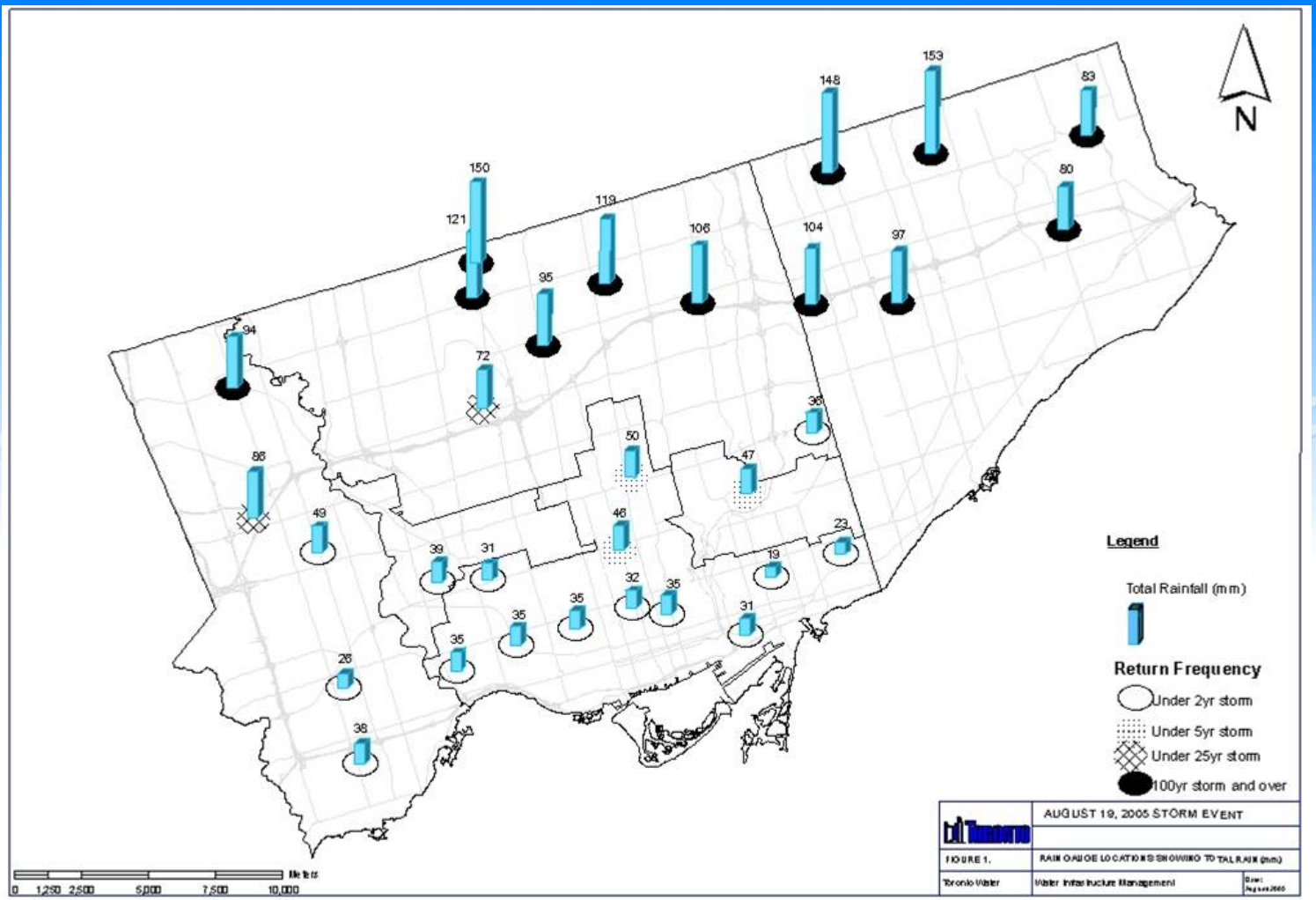
Rain Gauge Data
(August 19, 2005)



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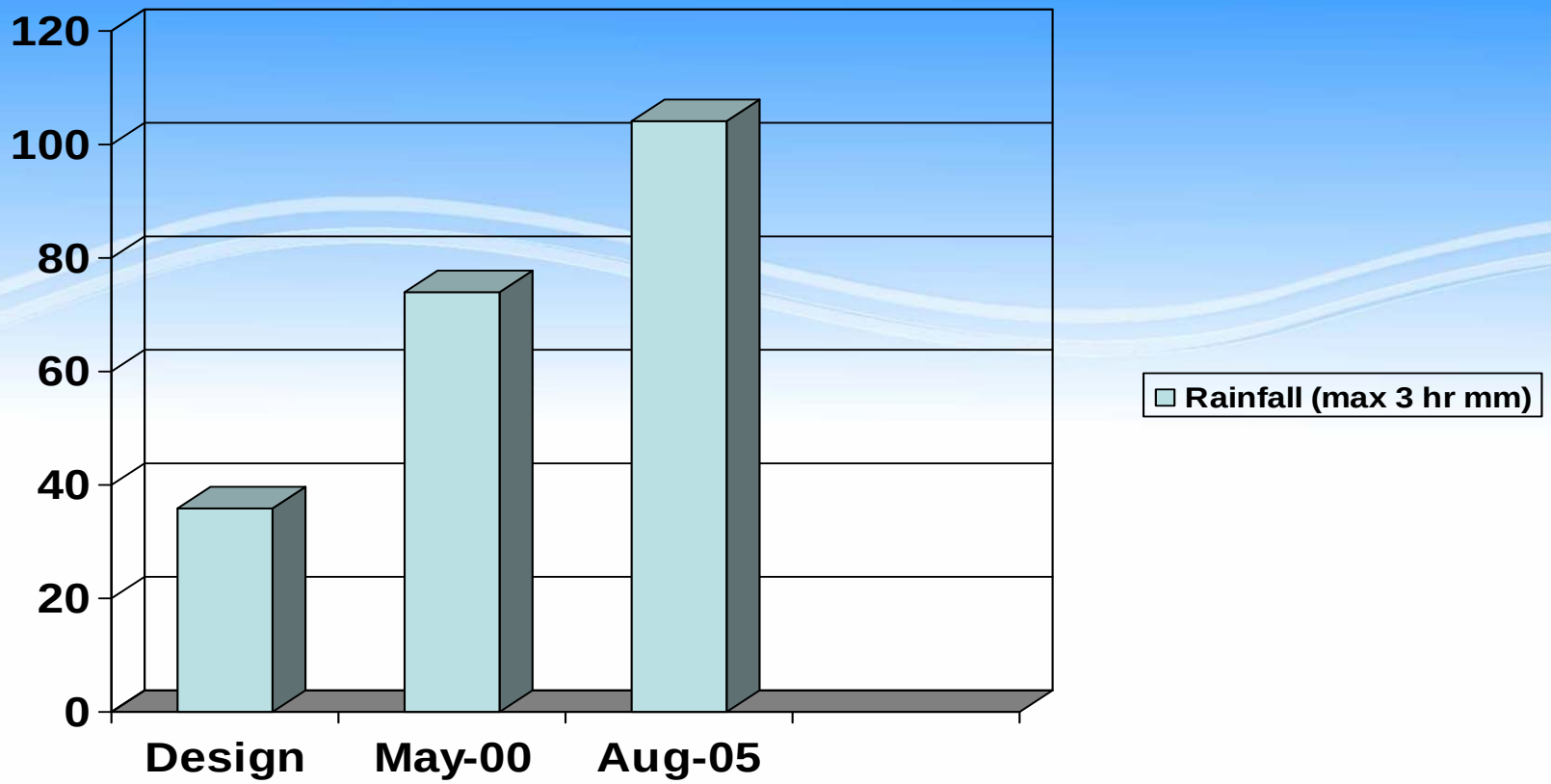
Rainfall Comparison



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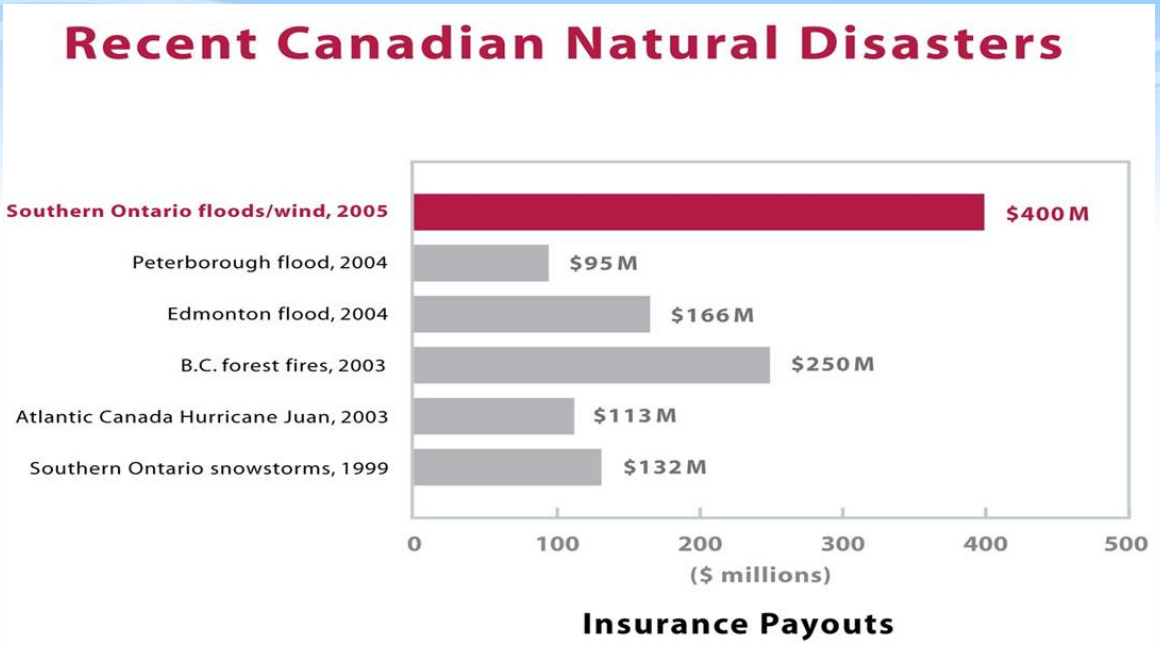
Insurance Bureau of Canada

- 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



TORONTO Water

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

Damage Summary

- Flash floods of creeks, rivers and ravines
- Overflowed stream banks
- Watercourse bank erosion
- Damage to public and private infrastructure and property
- Sewer Backups

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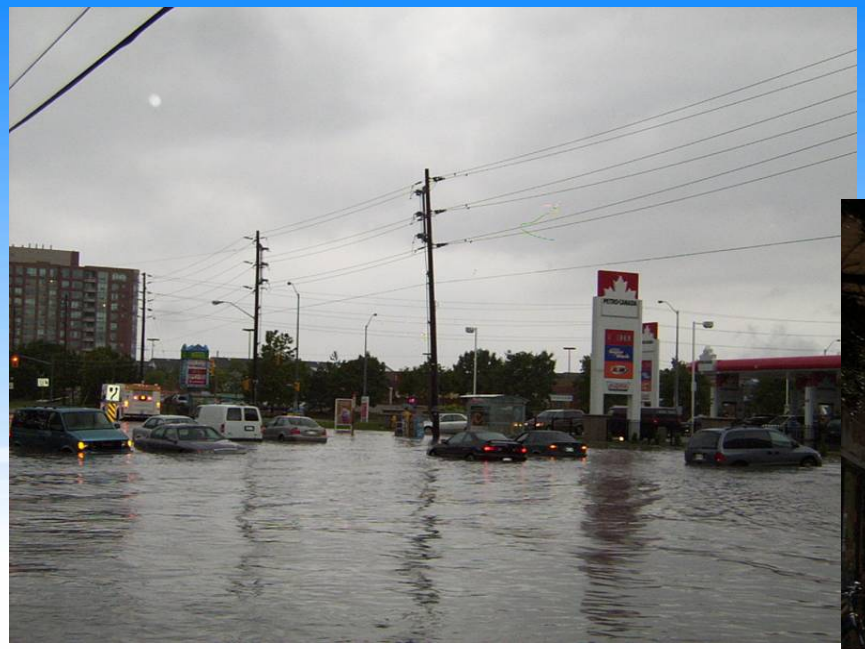
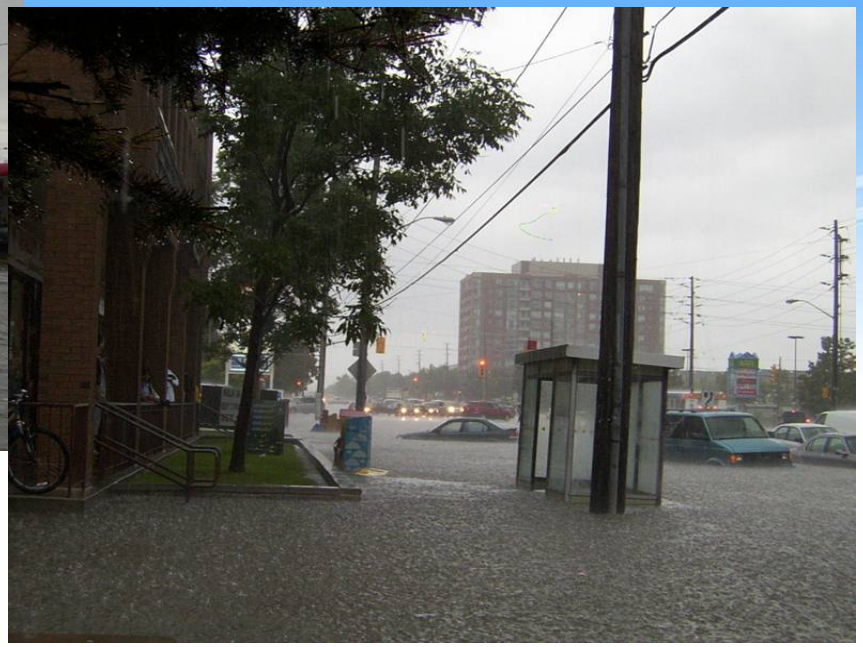
Steeles Avenue @ Bathurst St





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Steeles Avenue & Bathurst Street

Acton Avenue

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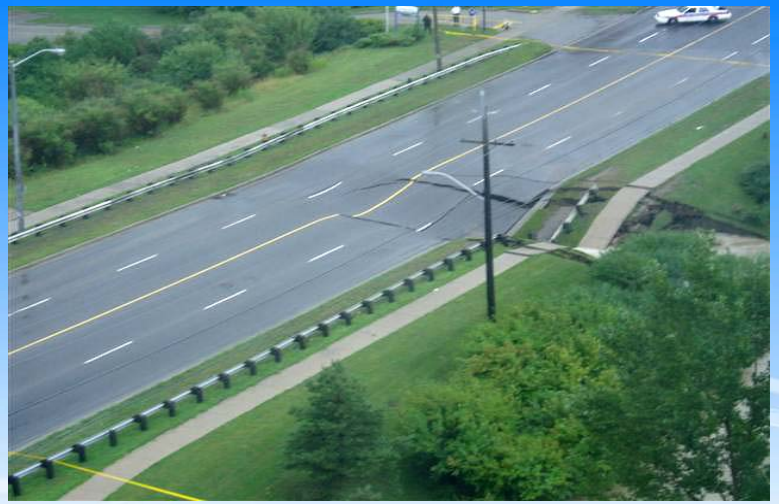
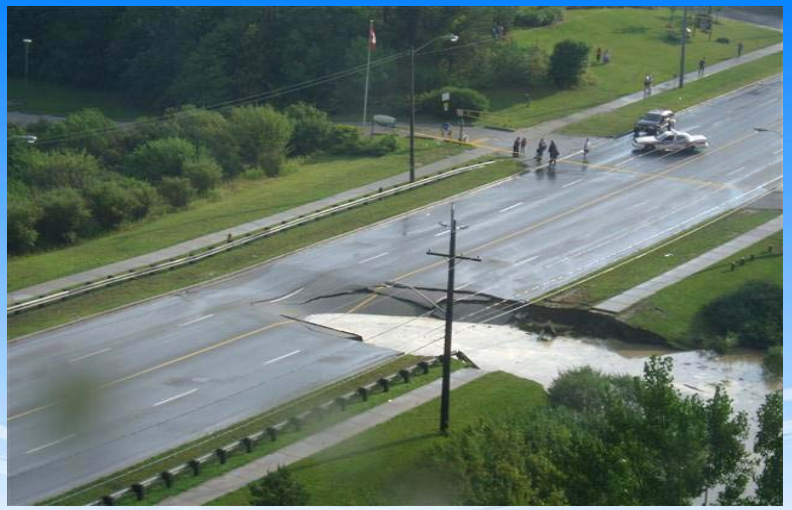
(Finch Avenue at Black Creek)





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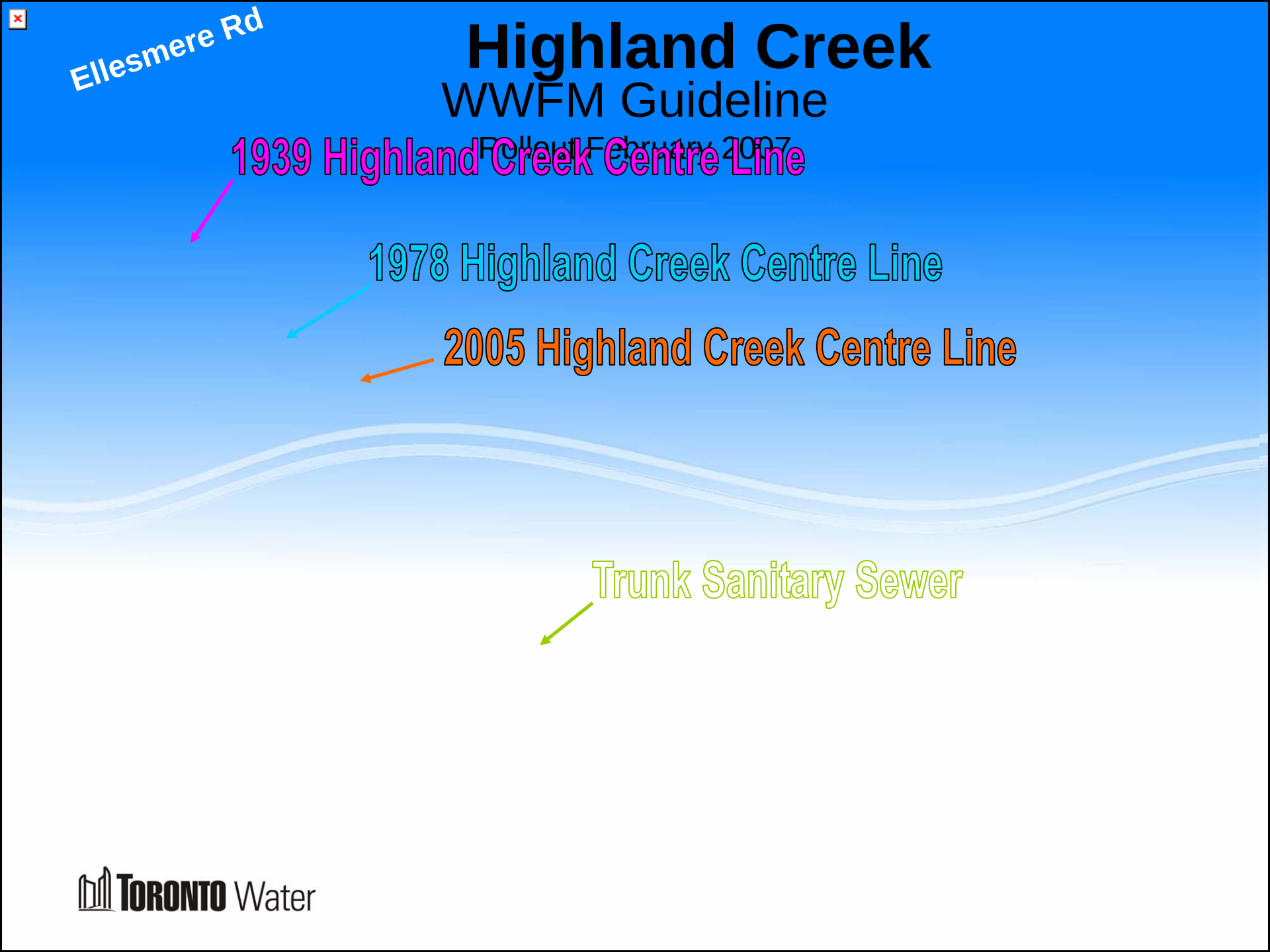
Ellesmere Rd
Highland Creek
WWFM Guideline
Rollout February 2007
1939 Highland Creek Centre Line
1978 Highland Creek Centre Line
2005 Highland Creek Centre Line
Trunk Sanitary Sewer
TORONTO Water


Trunk Sanitary Sewer

August 19, 2005

(48” Trunk Sanitary Sewer Collapse)

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August 19, 2005

(Exposed Sections of 48” Trunk Sanitary Sewer)

Basement Flooding

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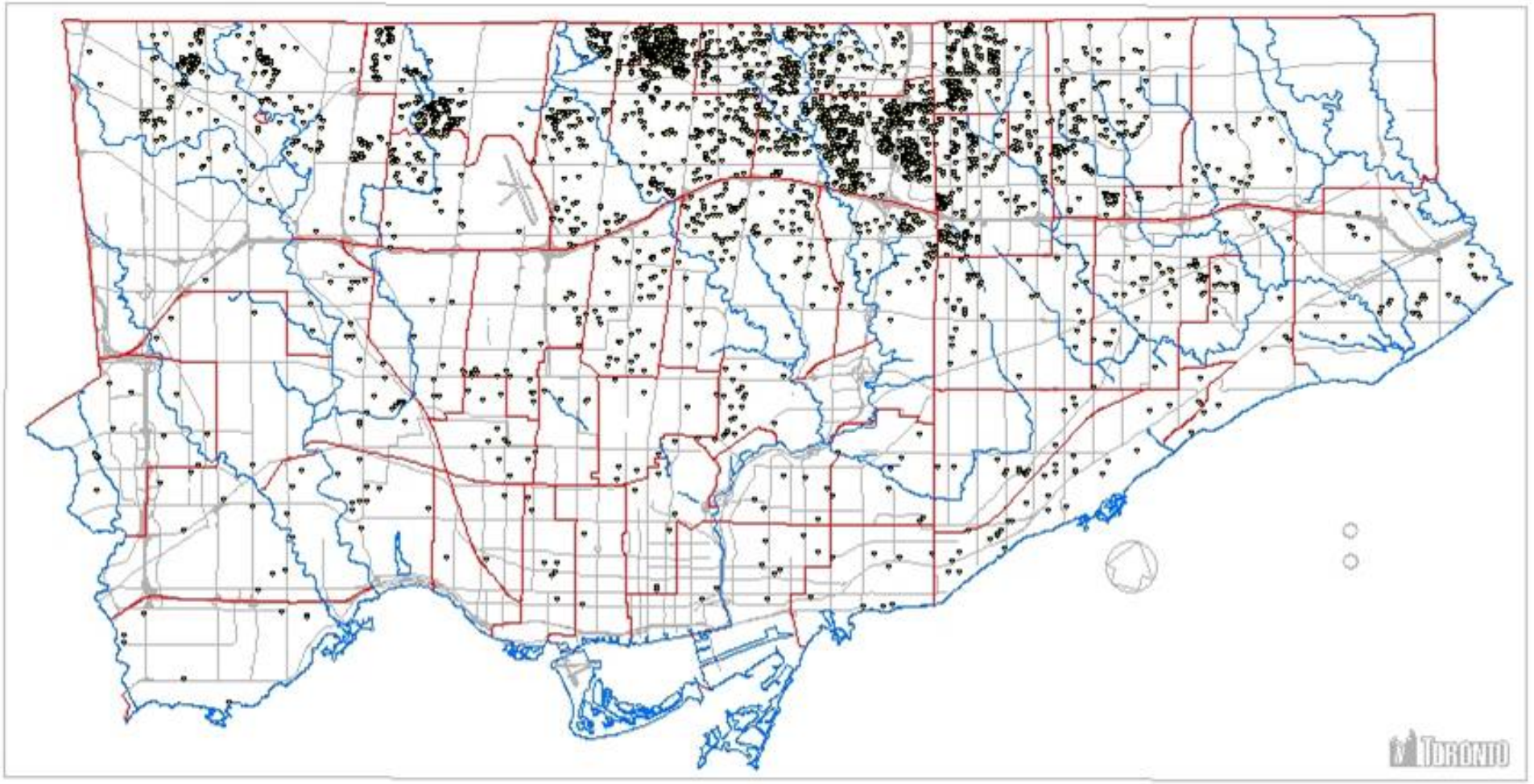
Basement Flooding
(Over 4,200 complaints received)



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General Observations

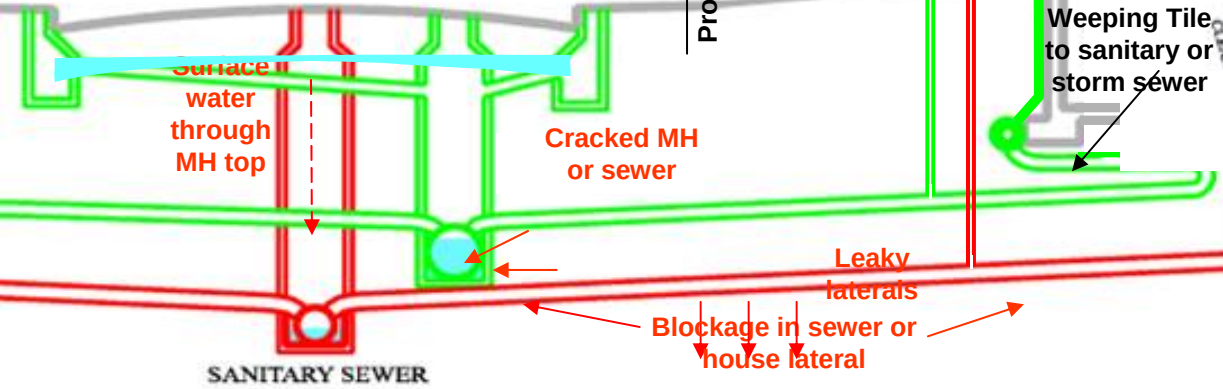
- **Sewer system performs as designed ("normal" storm conditions)**
- **During extreme storms:**
  a) **sanitary sewer system overloaded**
  b) **surface flooding onto private property**

Causes of Basement Flooding

Flooded street

Blocked street catch basin

Downspout to storm sewer



Surface Water Into Basement

- poor lot drainage
- eavestrough overflow
- plugged downspout
- leaky windows & doors

Cracked Basement Wall

Cracked Sewer

Sewer Blockage

Sewer Protrusion

Reverse-slope Driveway

Poor Lot Grading

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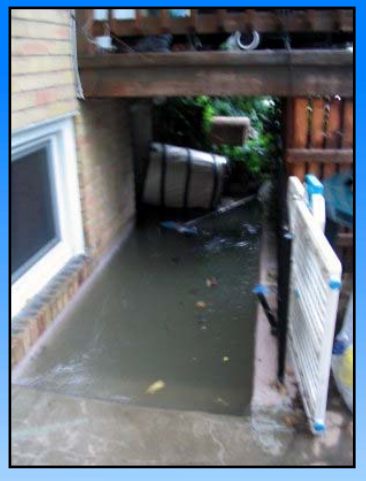
Sanitary Sewer System

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)

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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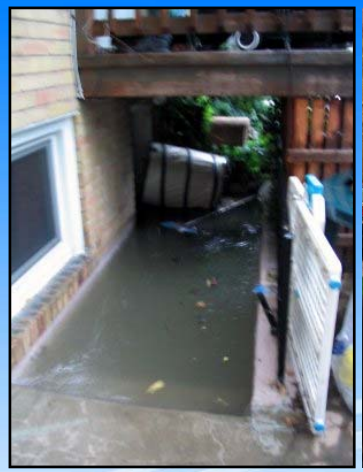
Lot Level Problems



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General Surface Conditions of Ward 23

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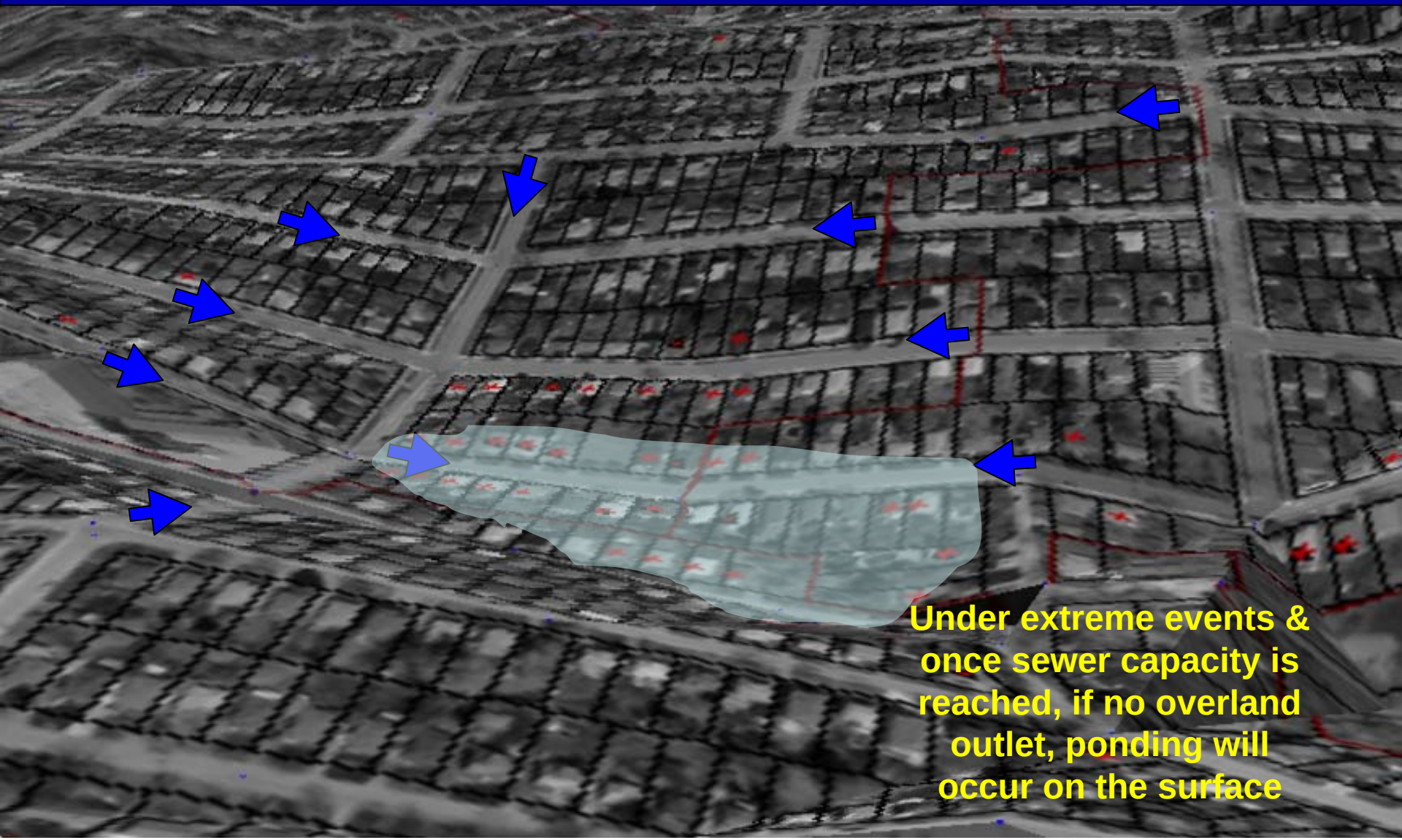

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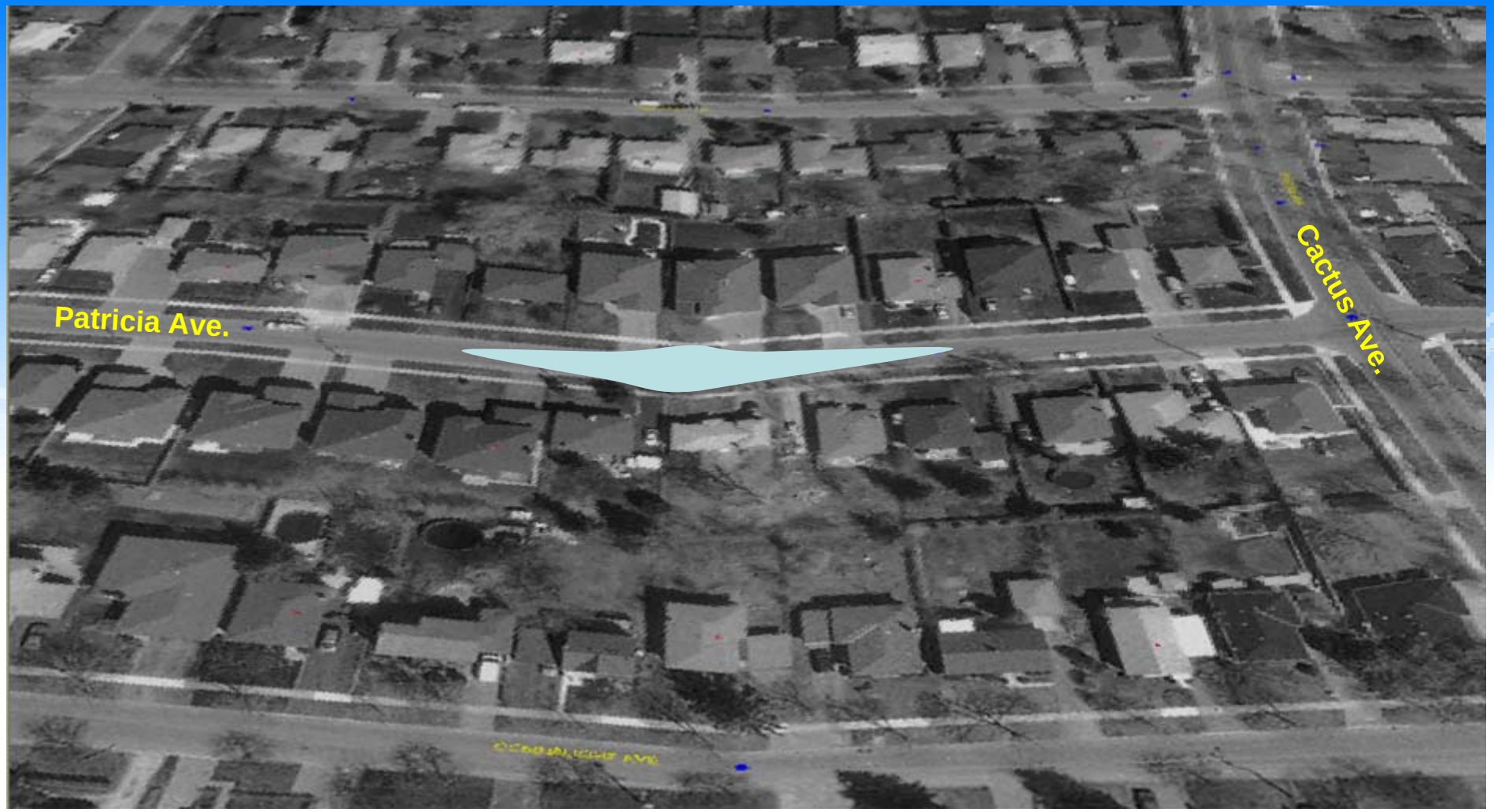

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Overland Flow Paths

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Street Flooding Animation

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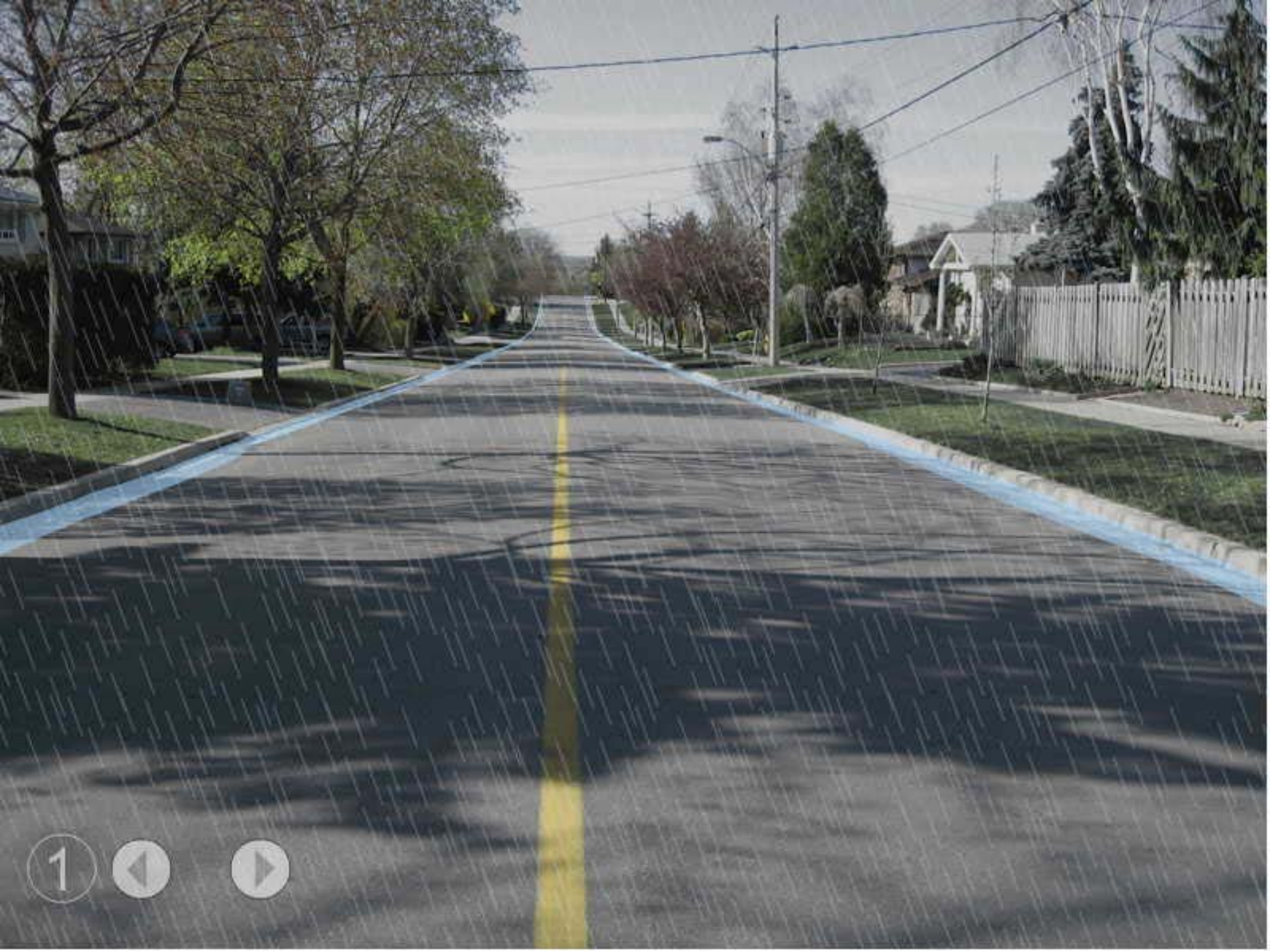
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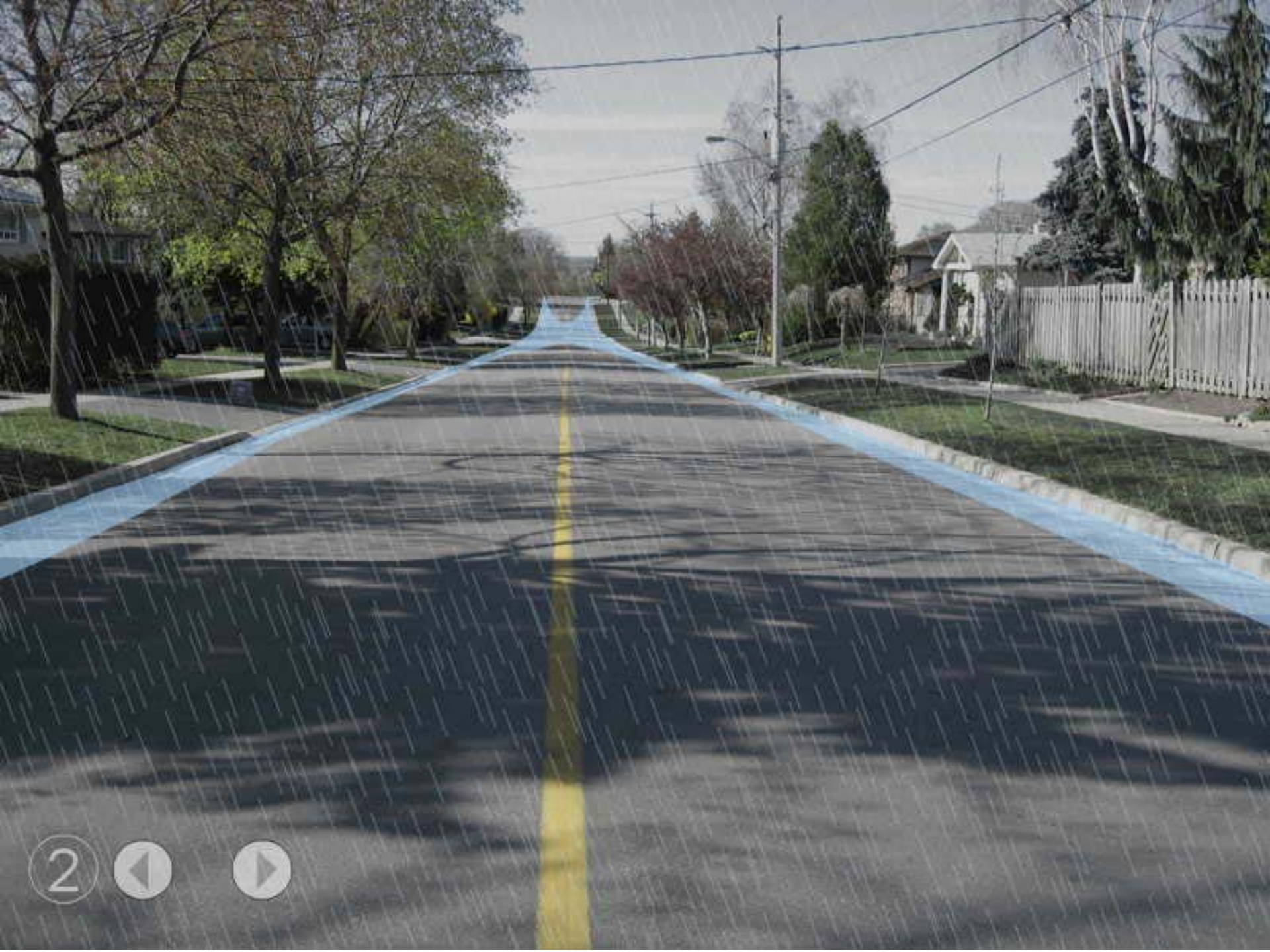
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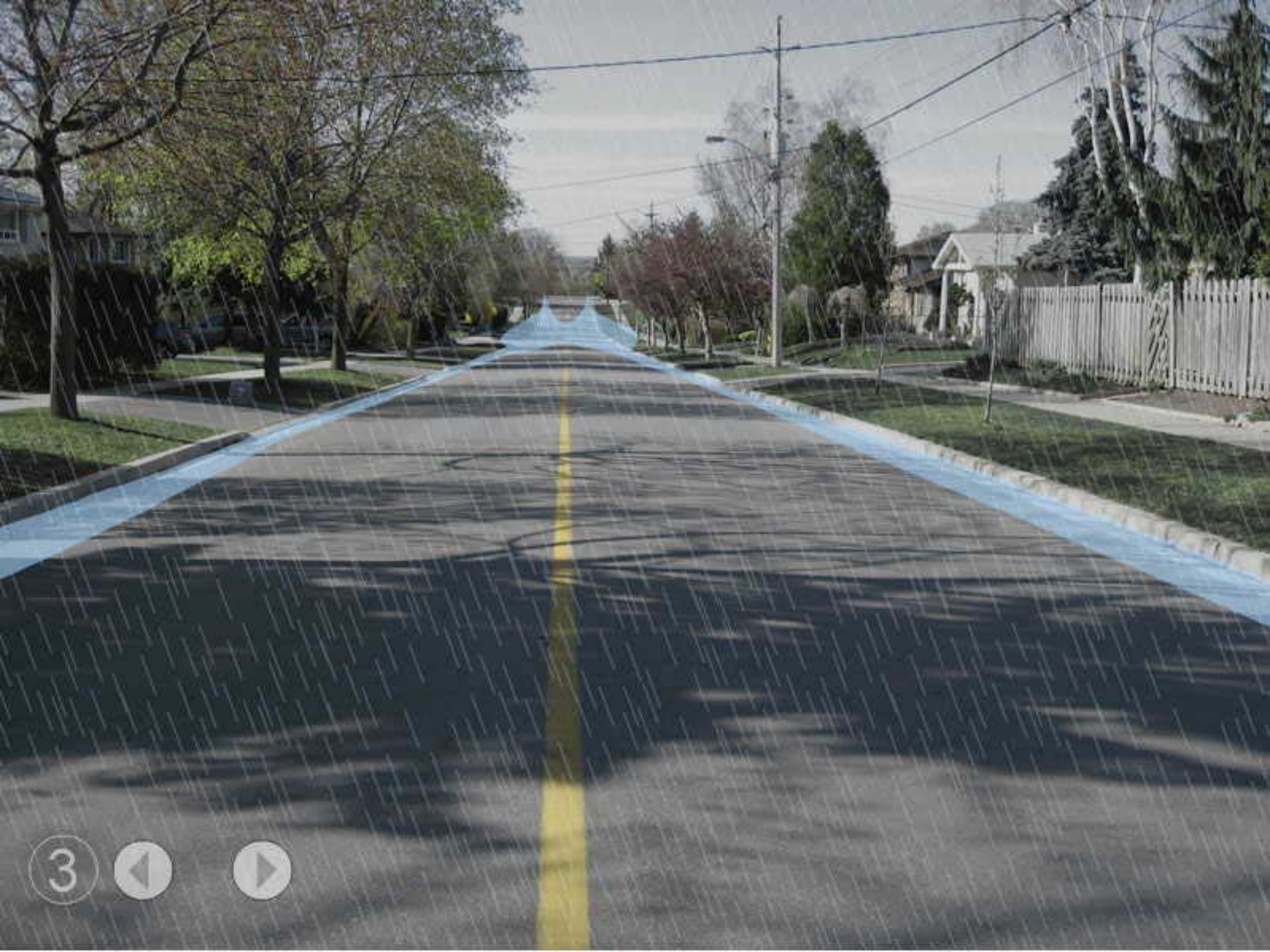
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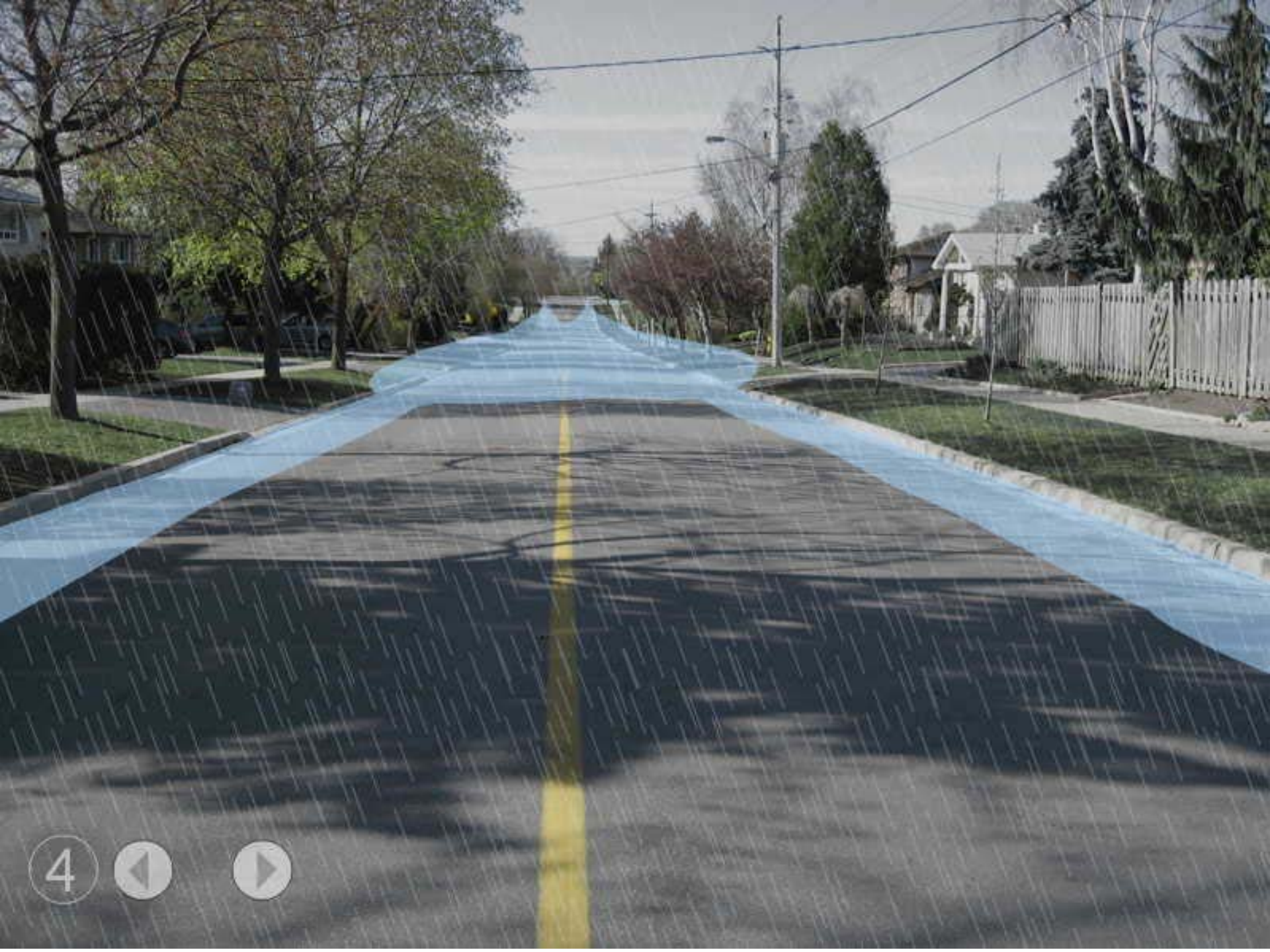
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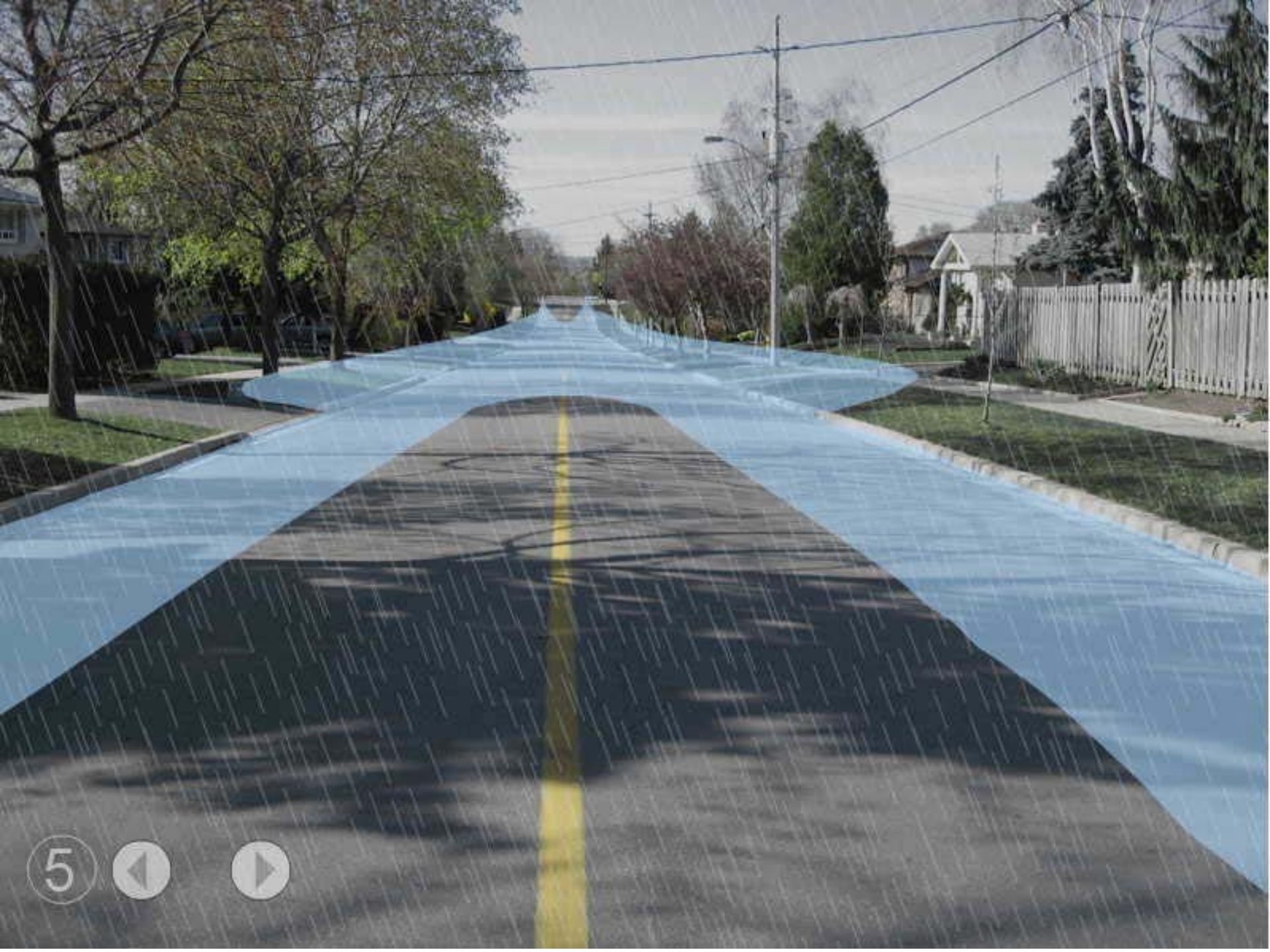
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Basement Flooding Animation

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2


3


4


5


6


7

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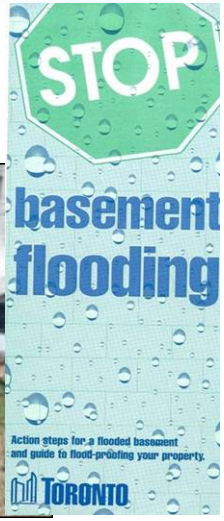
City-Wide Work Plan

- **Approved by Council in April 2006**
- **31 Priority Study Areas Identified:**
  - **Investigations to take place over 6 year period**
- **Required to follow the Class Environmental Assessment (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**

Short-term Preventive Measures

- **In short-term, the following measures are (or have been) being undertaken:**
  - Closed circuit television camera inspection and corrective action taken
  - Sewer cleaning in areas hardest hit
  - Promotion of city programs to assist residents implementing preventive measures
    - Basement Flooding Protection Subsidy Program
    - Downspout Disconnection
    - Blocked Drain Program



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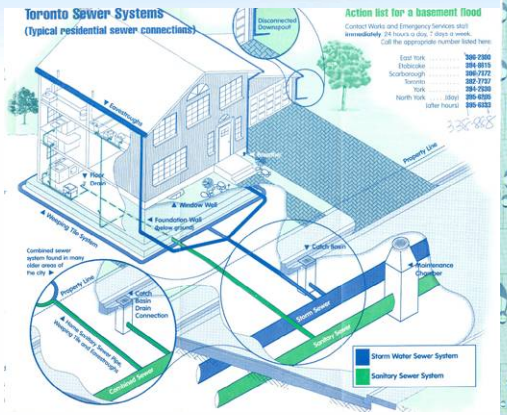
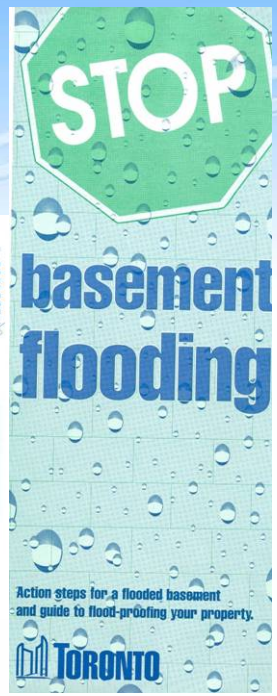
Basement Flooding Protection Subsidy Program

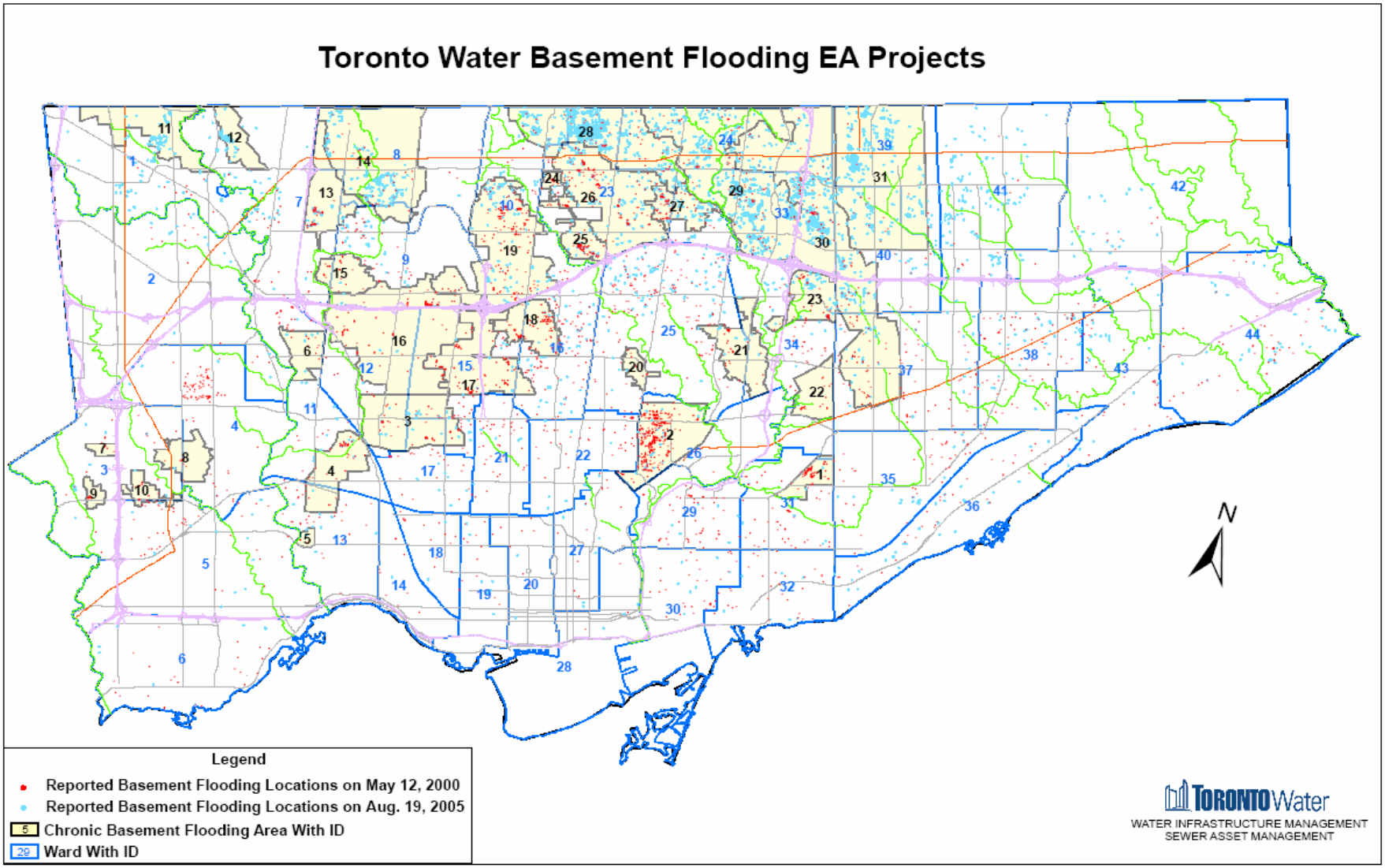
- **Provides financial subsidies (up to $3200) to help isolate home from City's sewer systems & prevent basement flooding:**
  - sewer service connection severing & capping
  - downspout disconnection
  - sump pump
  - backflow valve
  - **low uptake!**





TORONTO Water

Map of Study Areas

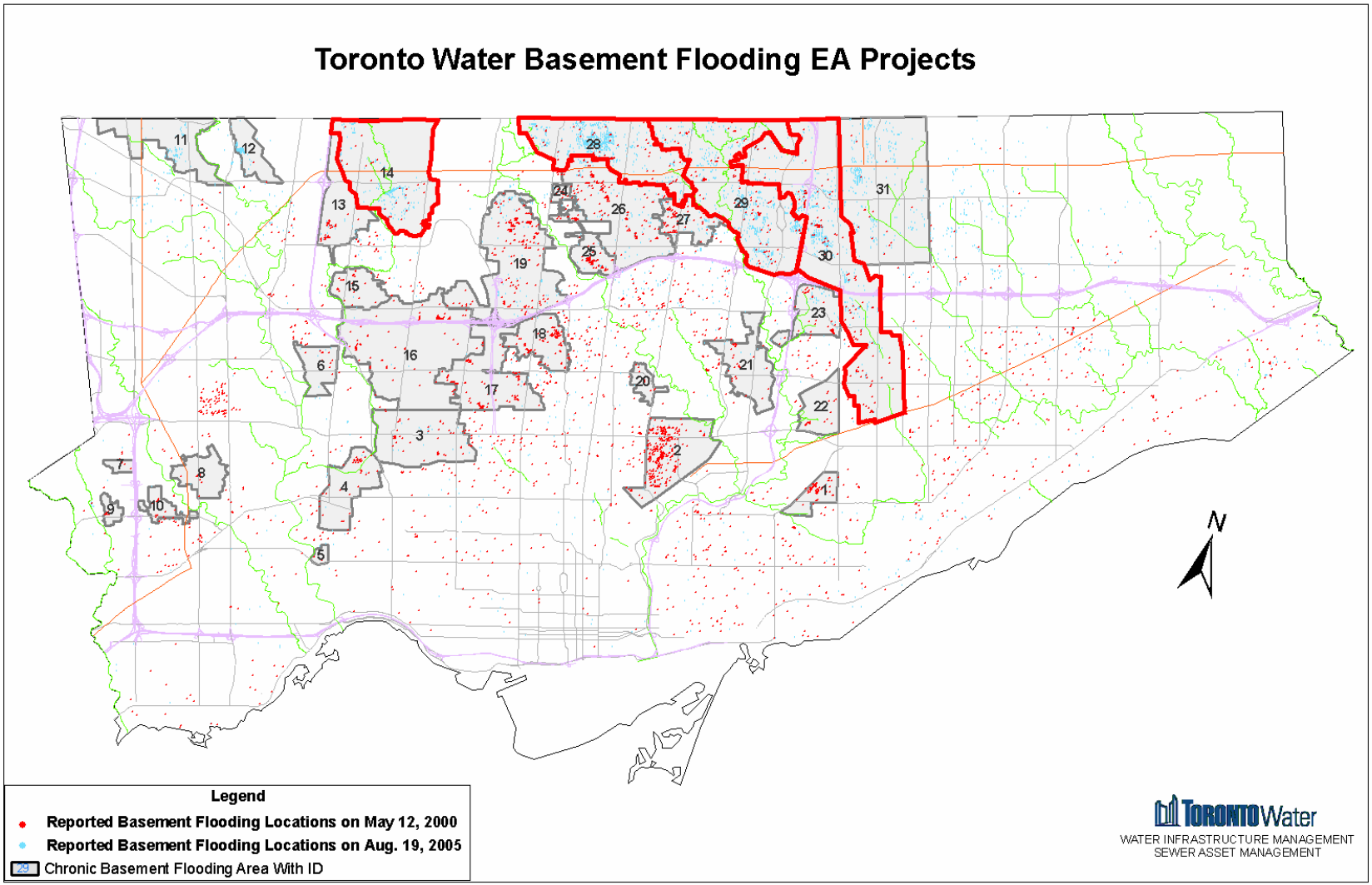


TORONTO Water

Class EA Studies

- **Studies involve a detailed analysis, consisting of:**
  - Flow monitoring
  - Developing and calibrating computer modes of the sanitary, storm, and overland drainage systems
  - CCTV inspection of sewers
  - Die and smoke testing to identify defects in system
  - Separate meetings with Councillors, public, affected City divisions (eg. Parks, Transportation) and review agencies (eg. TRCA) at key stages
  - Assessment and evaluation of a range of alternatives
  - Documentation of recommended solutions
  - 30-day public review period

Map of First 4 Study Areas



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Presentation Overview

- City of Toronto Water Infrastructure – Background
- Climate Change Effects
- Impacts From Recent Extreme Storm Event
- Basement Flooding Causes
- City-Wide Work Plan – Overview
- **Basement Flooding Protection Strategy**

Adaptive Management Approach Advocated

- 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

- Downspout Disconnection
- 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 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

Basement Flooding Protection Strategy

Storage for Sanitary and Storm

- Offline and online underground storage tanks
- Dry Pond

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

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Implementation Considerations

- **Preliminary analysis of 4 study areas:**
  - **over 200 infrastructure improvement projects**
  - **~$240M**
- **City-wide: several hundred $Millions**
- **Approved 2008-2012 Capital Budget only ~$80 million**
- **Apply a phased-in implementation schedule**

Implementation Considerations (Cont'd)

First Priority:

- **Sanitary sewer improvements as identified by modelling**
- **Storm drainage system improvements where:**
  - **More than "X" properties affected**
  - **"Cost per benefiting property" is "$X" or less?**
- **Extend mandatory downspout disconnection program, City-wide**
- **Amend By-Laws/Requirements:**
  - **Backwater valves for all new developments**
  - **Banning construction of reverse slope driveways**
- **Public Education Campaign: Opportunity to work with IBC?**

Implementation Considerations (Cont'd)

- **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**

Next Steps

- **Finalize Class EA documents and reports**
- **Report to Committee/Council on update of work completed to date & recommendations on implementation of Basement Flooding Protection Strategy**

Comments/Thoughts?

- What can we do to increase public awareness of the issue & the need to undertake lot level improvements?
- How can we work together on a Public Education Campaign?
- Comments on criteria proposed for selecting high priority projects:
  - Benefiting large clusters of properties
  - “Cost per benefiting property” concept?
- Comments on longer term phased-in approach for the “high cost to benefit” projects?
- Longer term adaptive management strategy, as we renew infrastructure?

AN ADAPTIVE MANAGEMENT STRATEGY TO ADDRESS BASEMENT FLOODING

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