CLIMATE CHANGE

IMPACTS ON INFRASTRUCTURE & WATER MANAGEMENT

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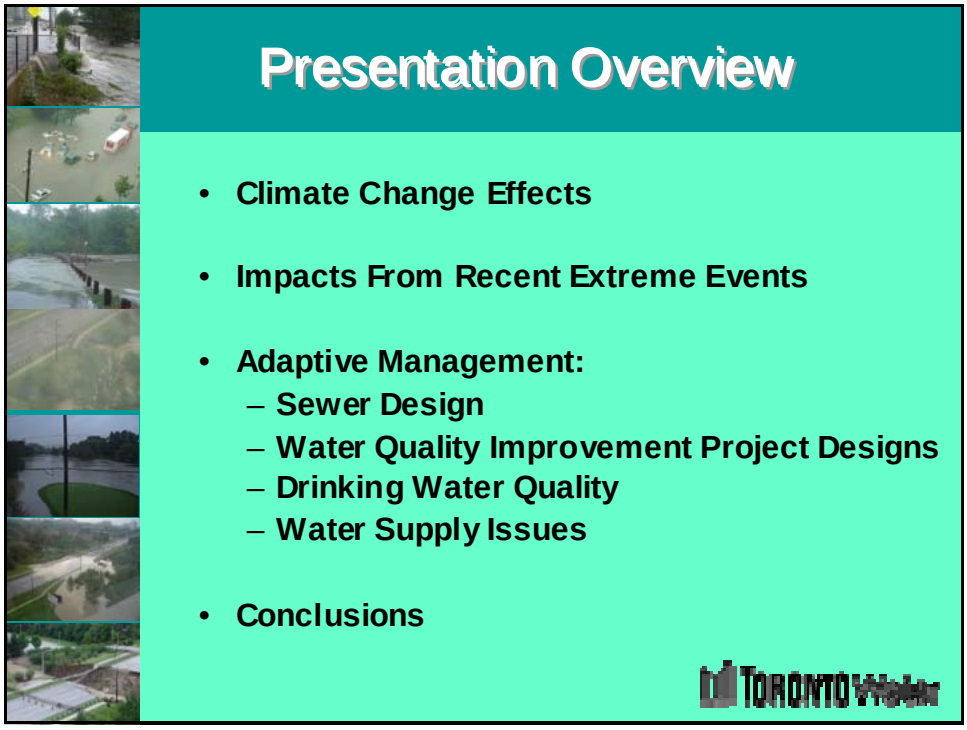
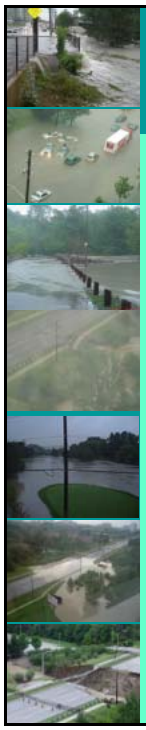


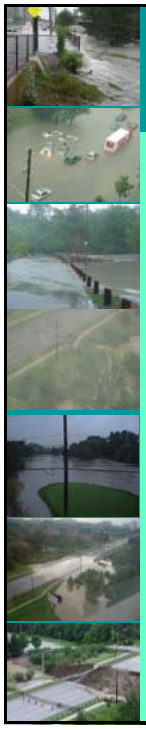
Presentation Overview

- Climate Change Effects
- Impacts From Recent Extreme Events
- Adaptive Management:
  - Sewer Design
  - Water Quality Improvement Project Designs
  - Drinking Water Quality
  - Water Supply Issues
- Conclusions



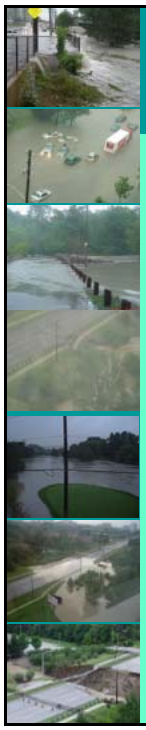
Climate Change Effects

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



Climate Change Effects (cont'd)

- 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 <u>and</u> low flow conditions
  - greater winter runoff
  - reduced summer flows



Our we seeing effects of Climate Change?

YEAR	
1985	
1986	
1987	
1988	
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1990	
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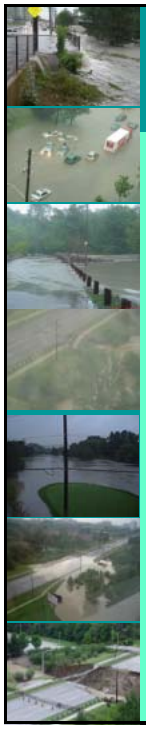
1992	
1993	
1994	
1995	
1996	
1997	
1998	
1999	
2000	
2001	
2002	
2003	
2004	
2005	

North York area of Toronto

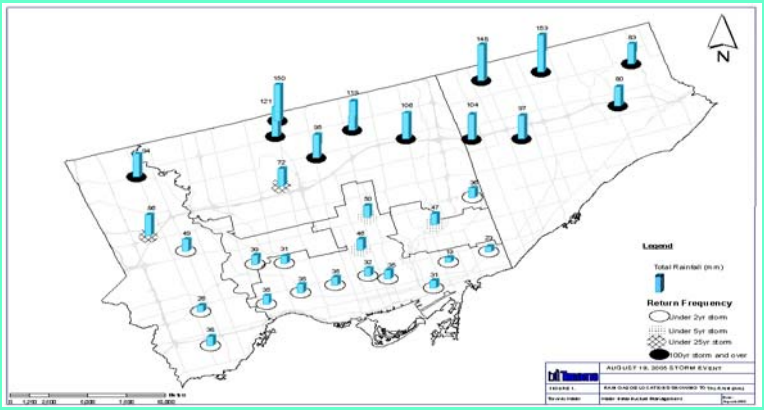
- 7 extreme events over 20 year period
- storm return frequencies > 25 years
- severe flooding: surface and basement
- works designed and implemented for a given storm condition - insufficient for larger/subsequent event
- public confidence?



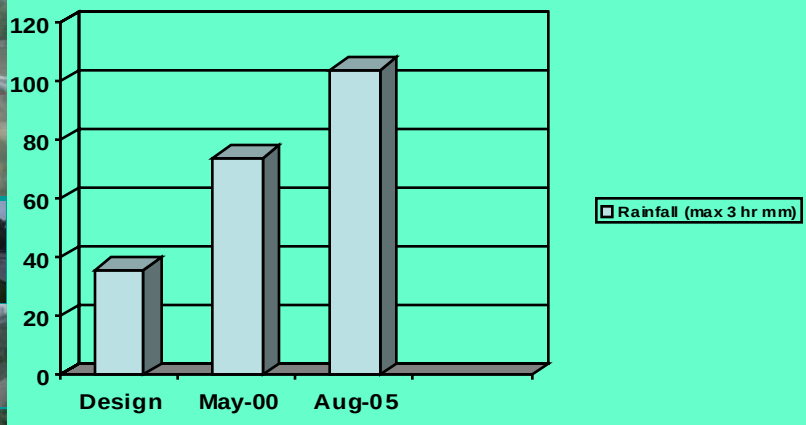
Impacts of August 19, 2005 Storm

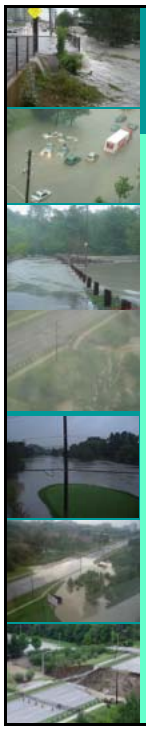
- 2-3 hour storm
- exceeded 1 in 100 year storm in north part of the City
  - Highway 401 to Steeles Avenue corridor
- City of Toronto rain gauge station recorded 153 millimetres

Rain Gauge Data
(August 19, 2005)



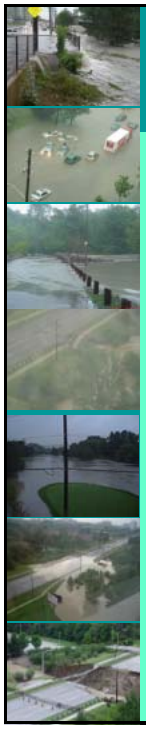
Rainfall Comparison





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



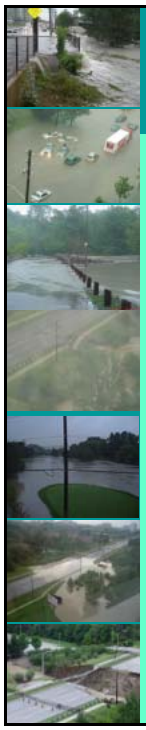
Flooding Damage


Flooding Damage
TORONTO Water

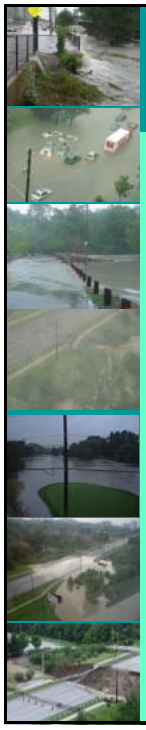

Flooding Damage
TORONTO Water


Flooding Damage
TORONTO Waterfront

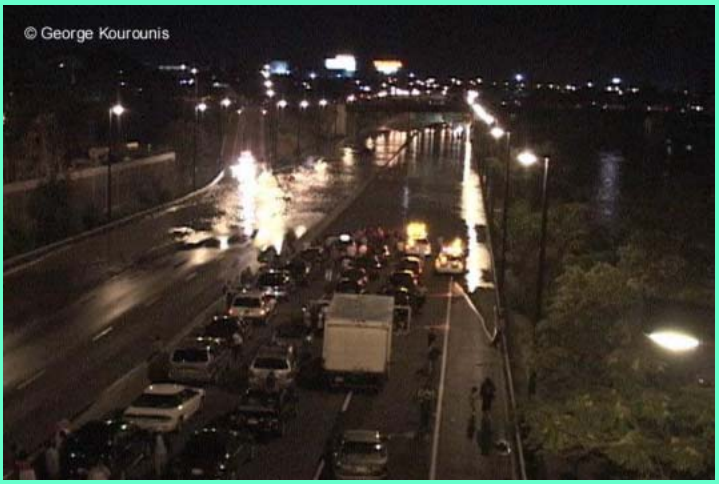

Flooding Damage
TORONTO Waterfront



Steeles Avenue @ Bathurst St
(Friday, August 19, 2005)

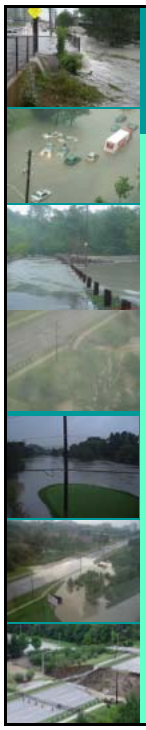


Don Valley Parkway
(Friday, August 19, 2005)




Basement Flooding
TORONTO Water

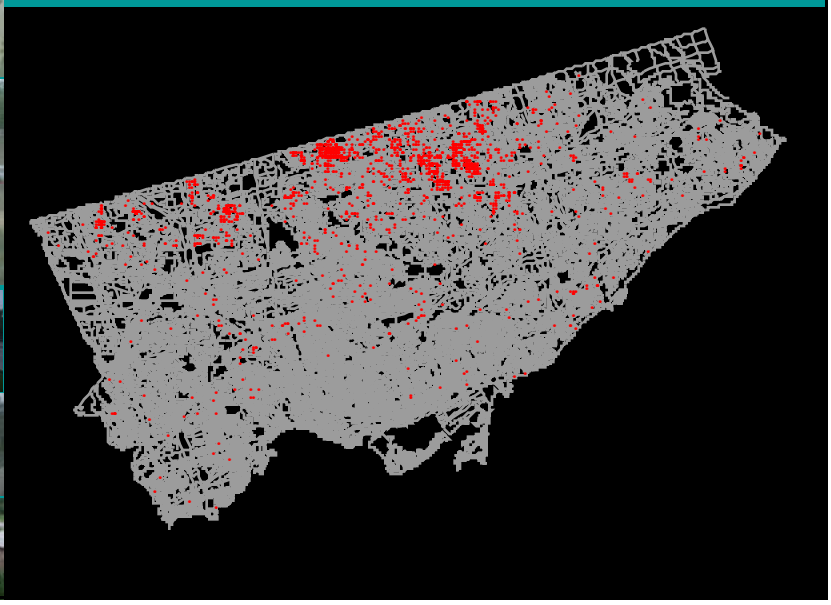

Basement Flooding
TORONTO Water

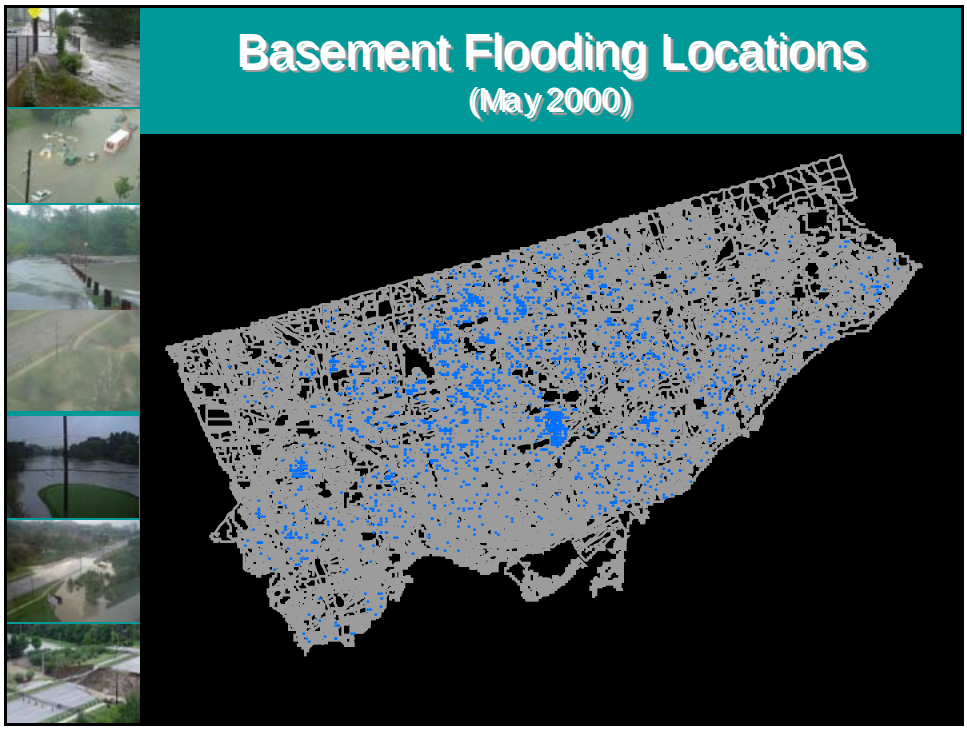


Basement Flooding

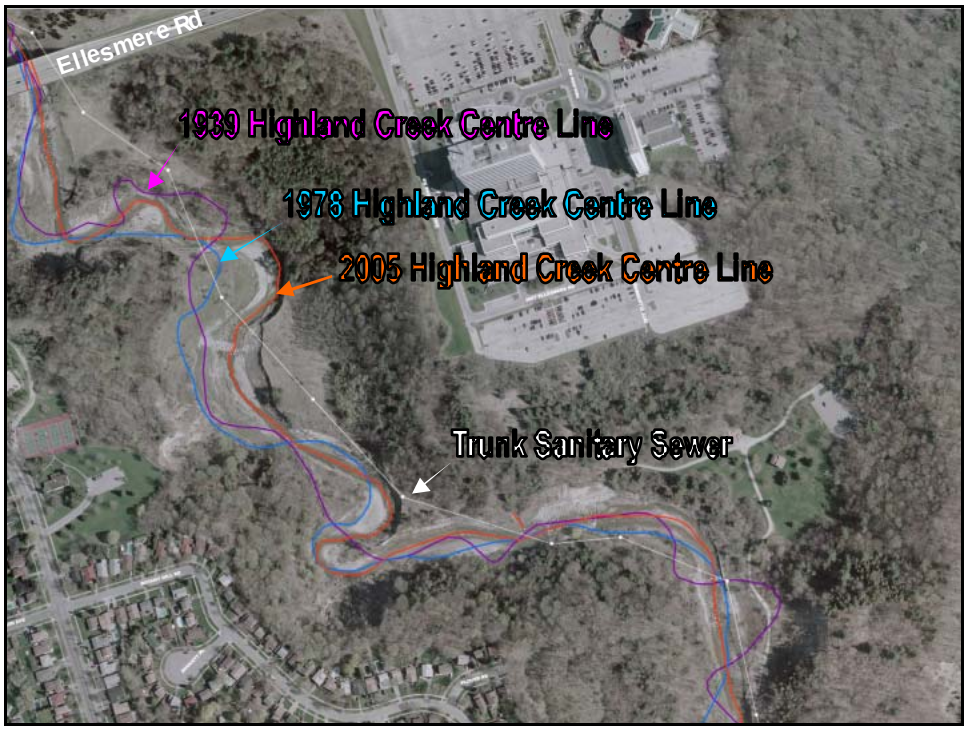
- Over 2,000 complaints & climbing
- Over 3,000 complaints in May 2000

Basement Flooding Locations
(August 2005)



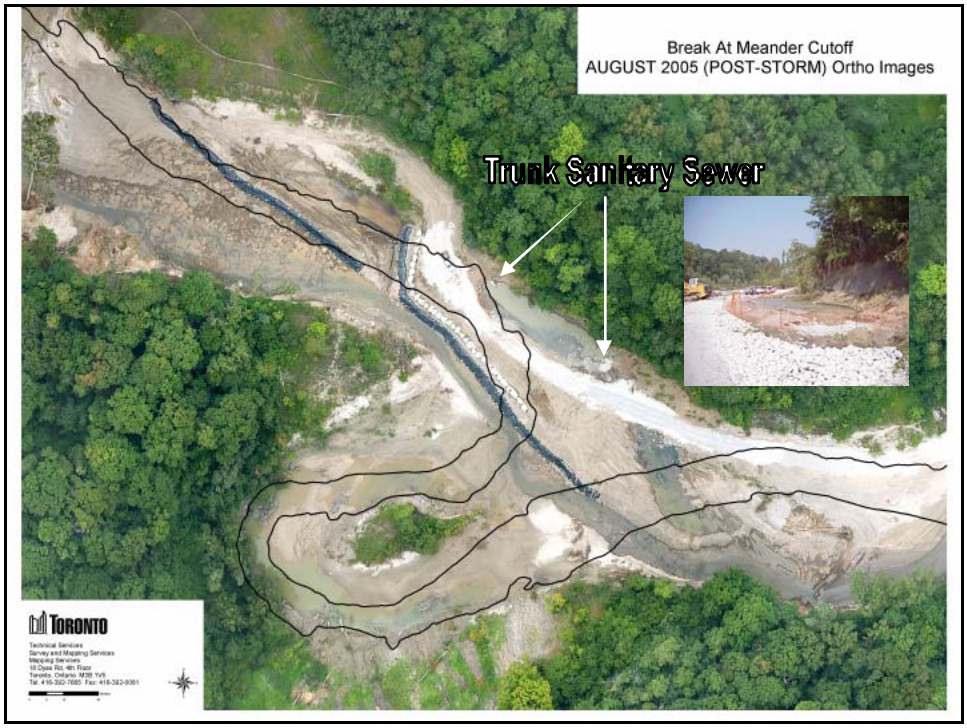

Basement Flooding Locations
(May 2000)


Stream Erosion
• Over 140 sites (Toronto Water, Parks & TRCA) being investigated to prioritize repairs
• Damage ranges from fence damage to stream bank collapse
TORONTO Water


Ellesmere Rd
1930 Highland Creek Centre Line
1978 Highland Creek Centre Line
2005 Highland Creek Centre Line
Trunk Sanitary Sewer


Trunk Sanitary Sewer


TORONTO Water

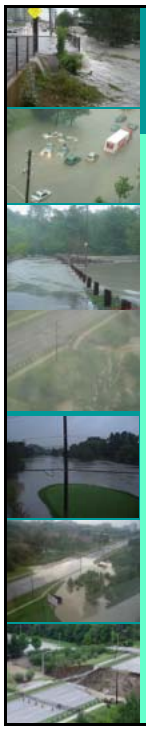

Break At Meander Cutoff
AUGUST 2005 (POST-STORM) Ortho Images
Trunk Sanitary Sewer
TORONTO

Road Infrastructure Damage


Military Trail @ Ellesmere Road
(Saturday, August 20, 2005)
TORONTO

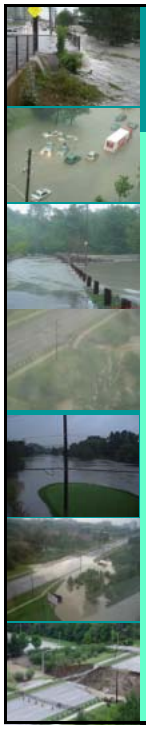

Finch Avenue @ Black Creek
TORONTO

"Adaptive Management"

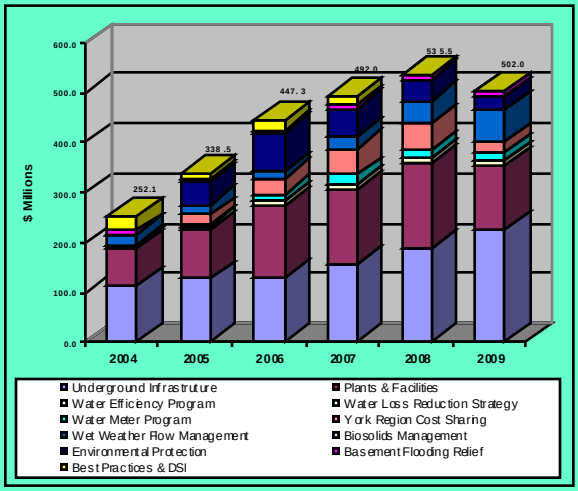


Design Standards?

- Municipal Operations: <u>service delivery focus</u>
- Adapt:
  - change design thresholds?
  - change/alter service delivery expectations?
  - reduce 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 design?
- Rebuild system/s &, if so, when & how?

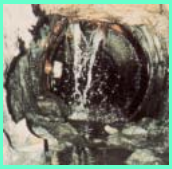


Reality Check: Budget Forecast

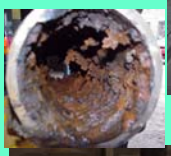


System Deficiencies

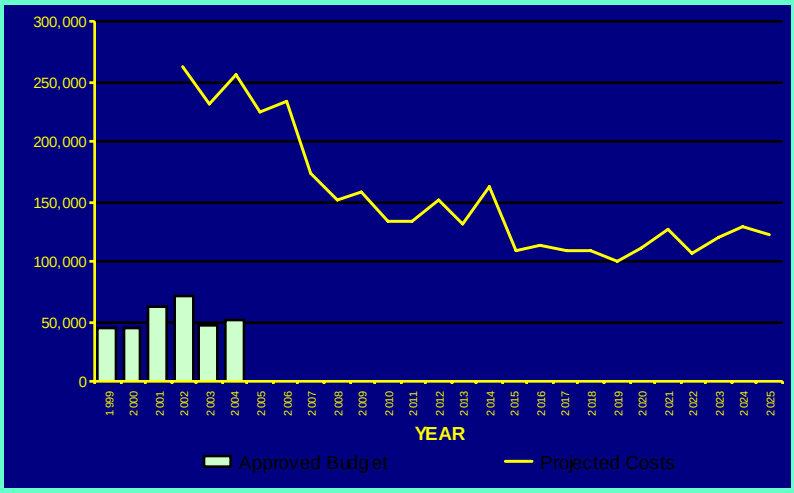
SEWERS

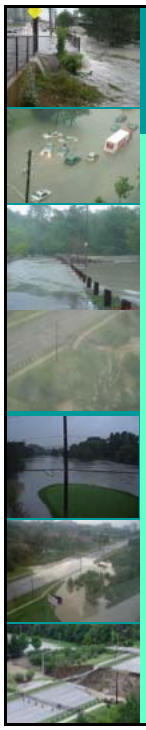


WATER MAINS

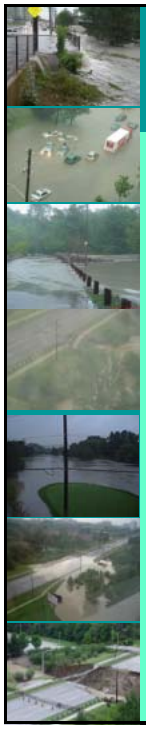


Sewer & Watermain Renewal Needs

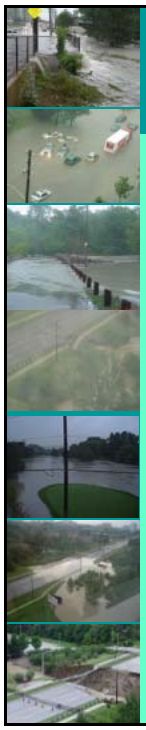




Water Quality Impacts



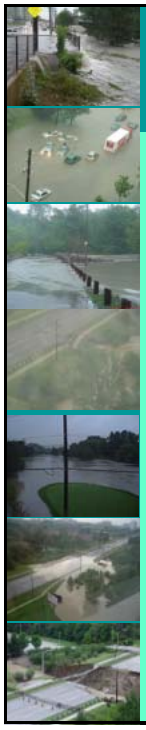
Comined Sewer System



Wet Weather Flow Management Facilities

WESTERN BEACHES STORAGE TUNNEL

- **4 km, 3 metre diameter tunnel - 50 metres deep**
- **7 shafts intercept flow from existing system**
- **3 - 30 metre diameter storage/interception shafts**
- **85,000 cubic metres of total storage**
- **$52 million**



Design Standards?

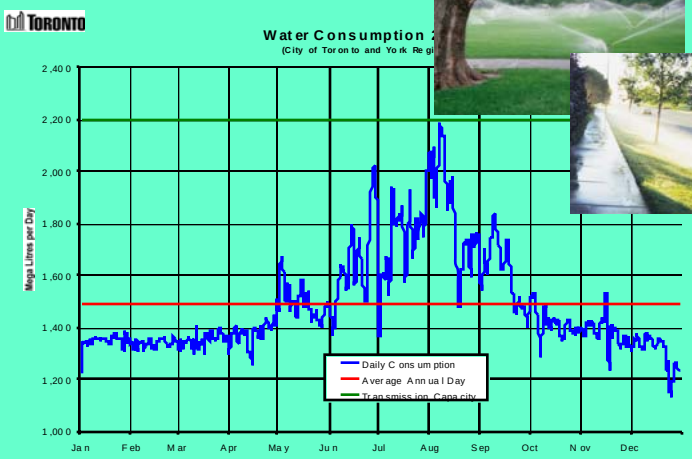
- MOE - Procedure F-5-5: "typical year" based analysis
- 1-2 combined sewer overflows permitted if impacting beach areas
- Questions:
  - does "typical year" need to be reviewed and adjusted over time?
  - is current sizing appropriate - given expected drier summers with "extreme" storms?
  - "reality check" & reduce expectations?

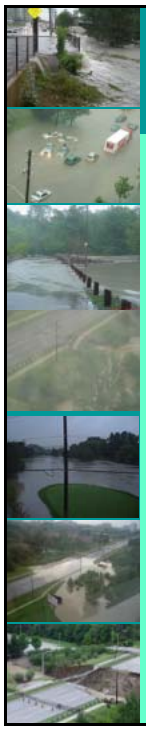
Water Treatment Plants
(Taste & Odour Issues)

Compounding problems:
- warmer lake temperatures
- increased water clarity along Great Lakes nearshore
- nutrient enrichment

Design Considerations:
- deeper intakes
- improve treatment processes
- O&M considerations
- $

Daily Water Consumption

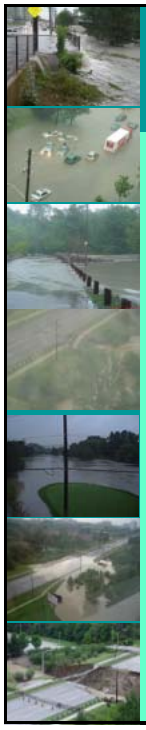




Water Supply Considerations

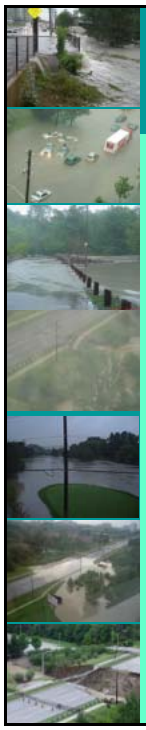
Warmer & Drier Summer Impacts on Supply:

- Groundwater serviced systems may be impacted: move towards servicing by lake based systems
- Increased demand for outdoor water use eg. lawn watering & irrigation:
  - build larger infrastructure?
  - reduce demand: public education, promote xeriscaping, seasonal pricing strategies?



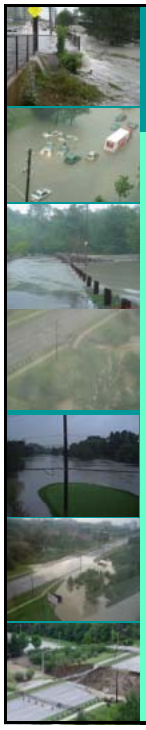
Conclusions

- Climatological changes are observed
- Municipal infrastructure and corresponding service delivery is being impacted by more frequent extreme events
- Public/political expectations are high
- More collaboration required among affected agencies



Conclusions (cont'd)

- Joint responsibility: public also assuming some responsibility and affecting change
- Adaptive management strategy advocated
- Standard design practices based on historical climate records - need to review based on projected new "norms"



Conclusions (cont'd)

- Need to establish service delivery targets & corresponding design standards
- Modify existing infrastructure - rather than build new
- Social/economic standpoint:
  assess the cost of adapting versus the losses that can be expected if we don't!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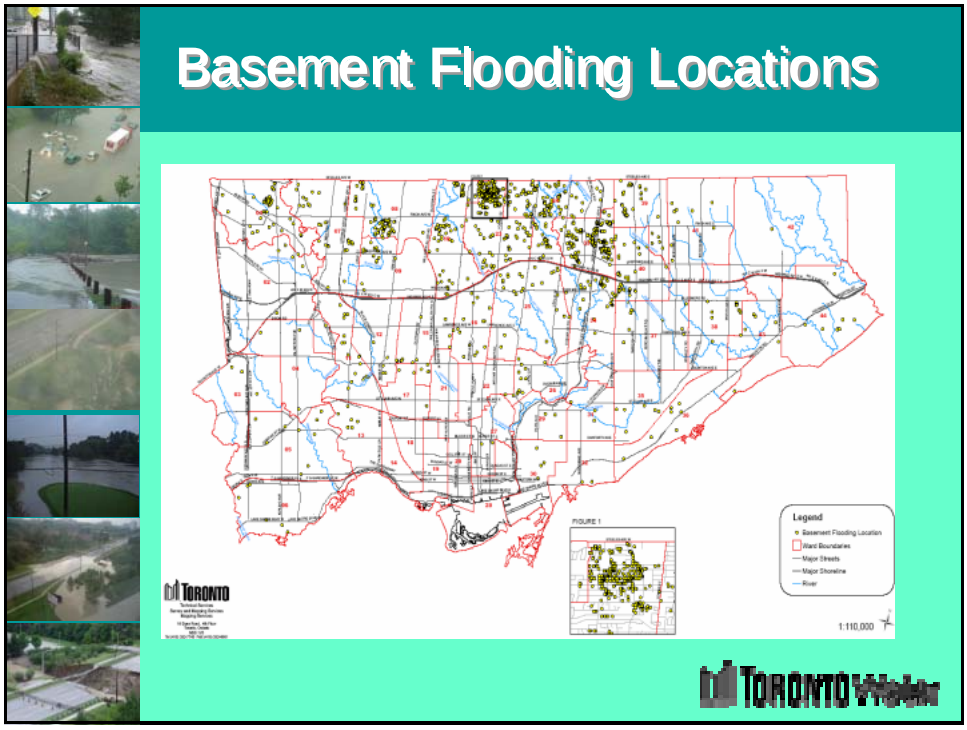
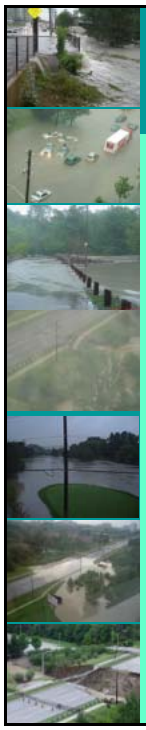
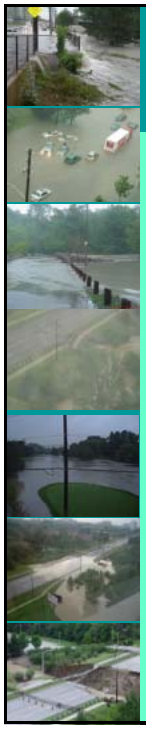

Basement Flooding Locations
FIGURE 1
Legend
Basement Flooding Location
Ward Boundaries
Major Streets
Major Shoreline
River
1:110,000
TORONTO
TORONTO Water



Basement Flooding Sources

- Sanitary Sewer
  - Sewer backup
  - Blocked sewer drains
  - Local drainage problems resulting in high flows in foundation drains
- Surface flooding
  - Poor lot grading
  - Window wells
  - Reverse slope driveways
  - Clogged drain pipes



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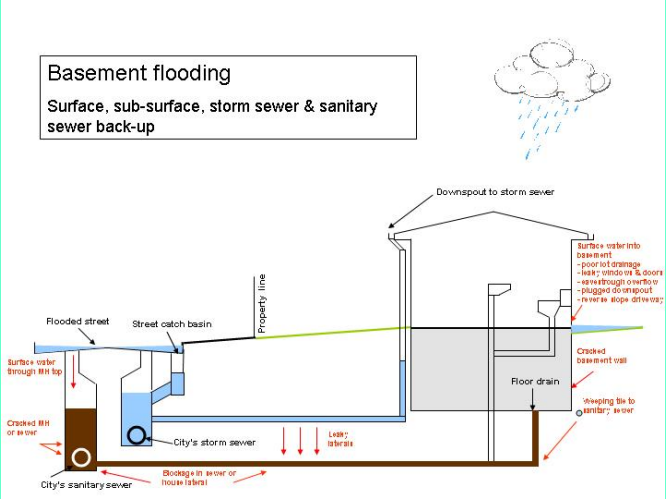


TORONTO Waterfront


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