GREAT LAKES & ST. LAWRENCE CITIES INITIATIVE
2015 Annual Meeting & Conference
June 17-19, 2015

HAMILTON WATER
WATER IS LIFE

Hamilton
Public Works

"Municipal Climate Change Adaptation and Resilience Pilot Project in Hamilton, Ontario"

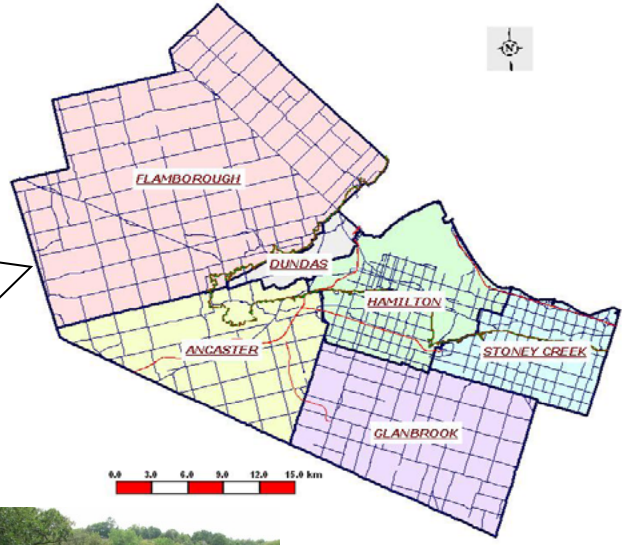
Nahed Ghbn

Infrastructure Planning and Systems Design

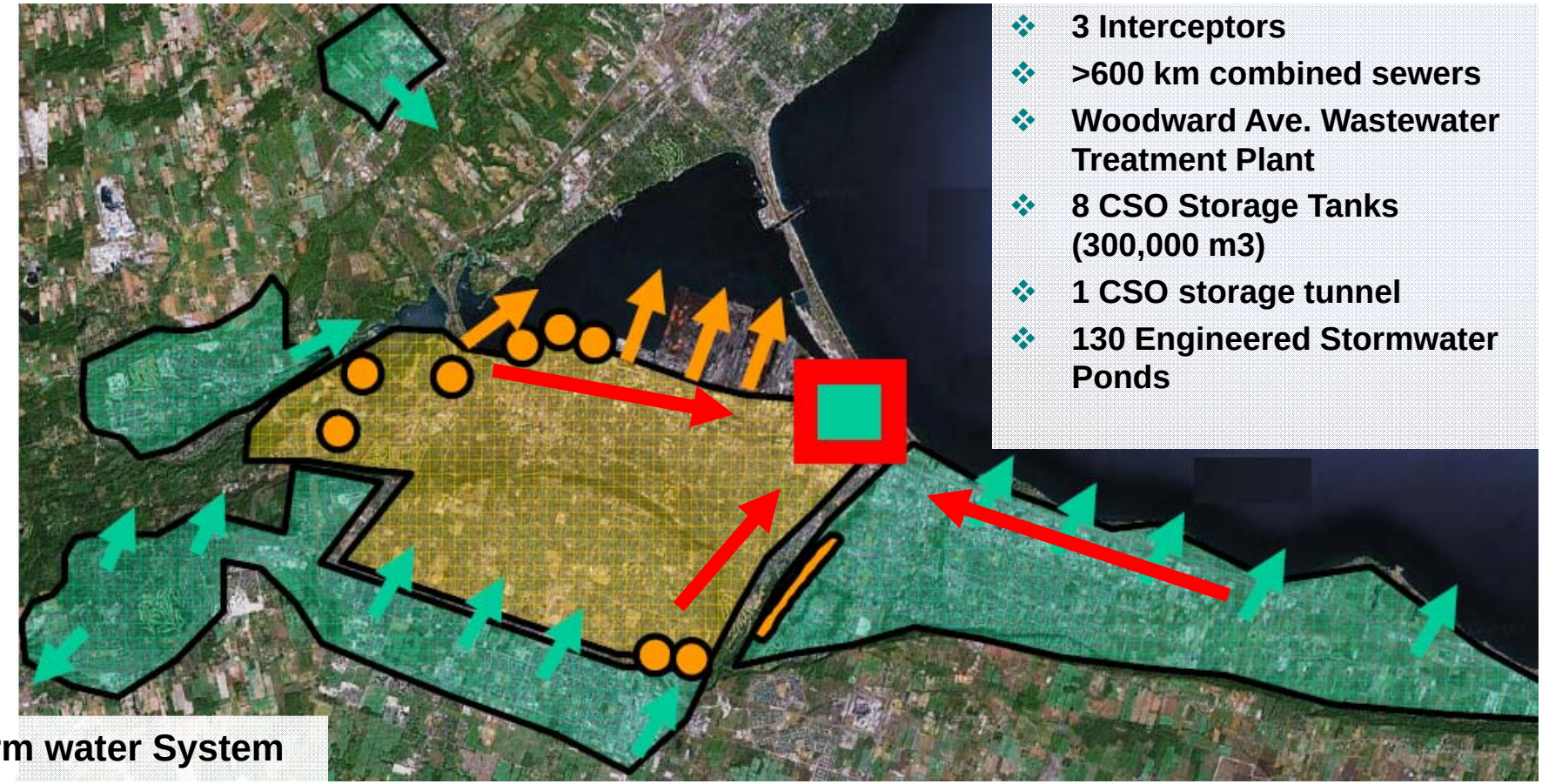
Presentation Overview

- About City of Hamilton
- Hamilton's Stormwater Management Systems
- Extreme Events & Precipitation
- Climate Change Challenges, Mitigation & Adaptation
- Hamilton Pilot Project for Environmental and Infrastructure Vulnerabilities from Climate Change
- Goal, Objectives & Methodology
- Modeling Approach
- Preliminary Results, Potential Impact & Mitigation Measures

City of Hamilton, Ontario



Existing Stormwater Management

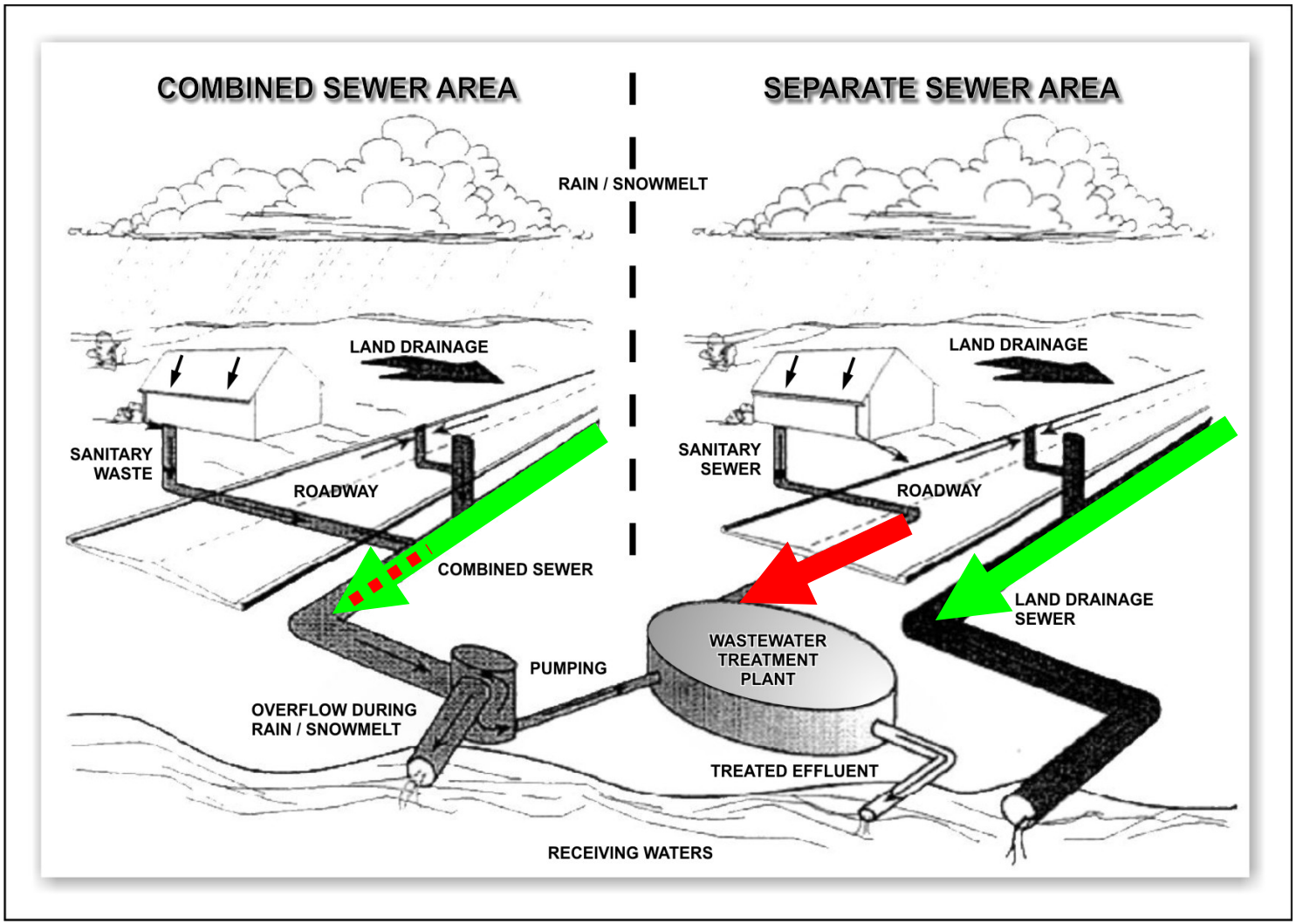


- 3 Interceptors
- >600 km combined sewers
- Woodward Ave. Wastewater Treatment Plant
- 8 CSO Storage Tanks (300,000 m3)
- 1 CSO storage tunnel
- 130 Engineered Stormwater Ponds

Storm water System

- Conveyance
- Control
- Treatment

Stormwater Management Systems

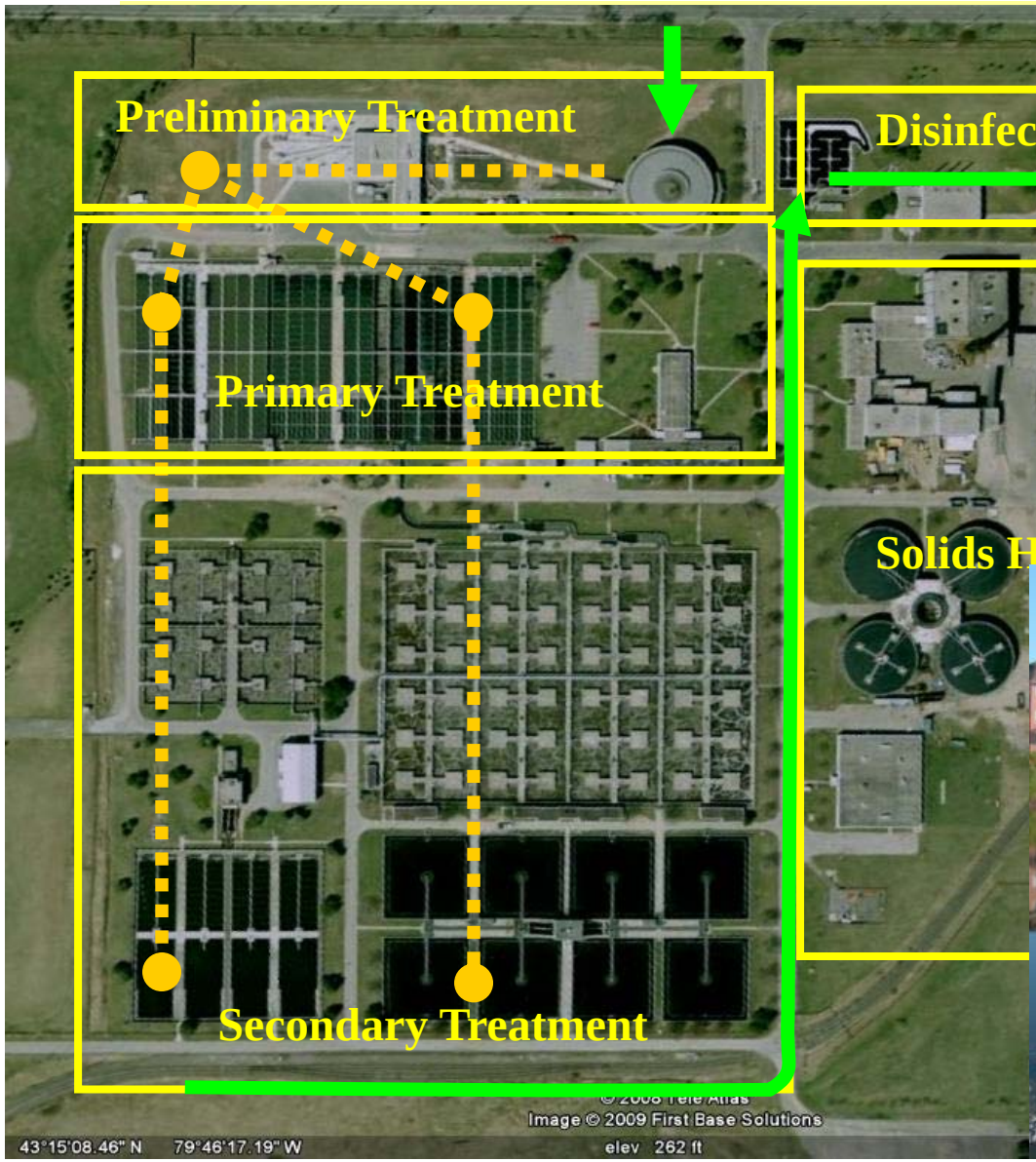


Stormwater Management

Conveyance

Stormwater Management
Control

Stormwater Management
Treatment



Extreme Events are not out of the ordinary any more

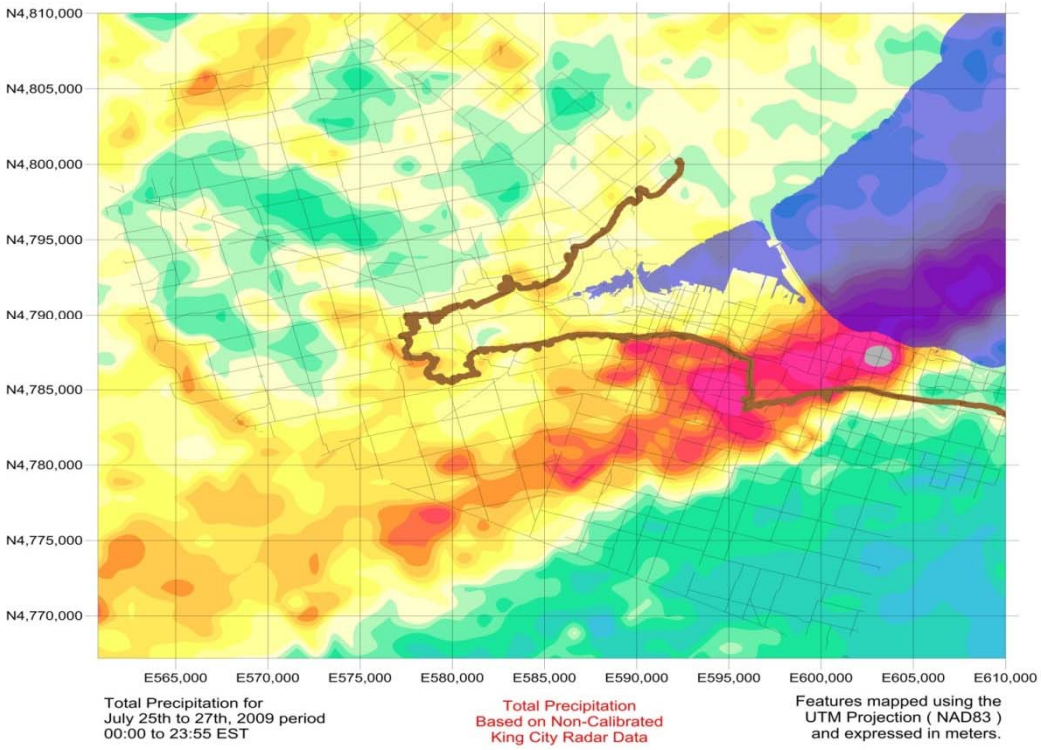
- 4 Extreme Events in 6 years – City of Hamilton
- 3 Extreme Events in 1 year- Windsor
- 2 Extreme Events in 2 weeks- Newmarket
- 4 Extreme Events in 4 Years- Ottawa
- 4 Extreme Events in 10 years- Mississauga/Toronto

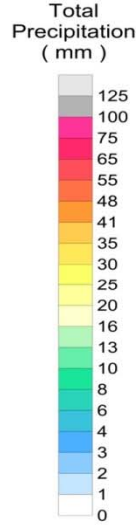
Since 1995 a state of emergency almost every year in Ontario

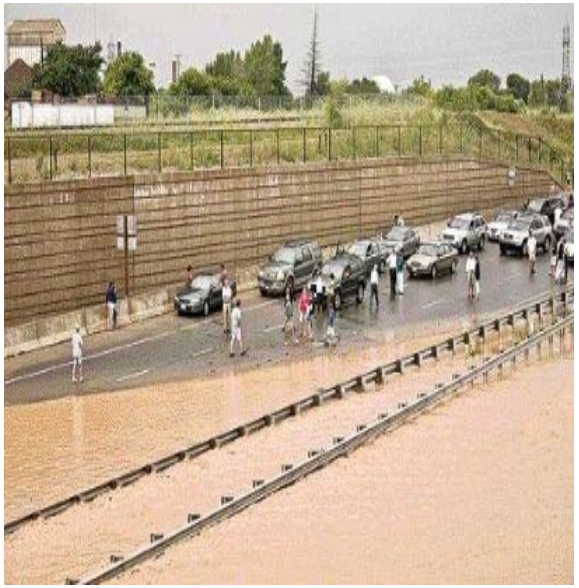
Example of Extreme Events (July 2009)

Kije Sipi Ltd
WATER RESOURCES AND GEOMATICS CONSULTANTS

RadHyPS
Radar Hydrological Products and Services



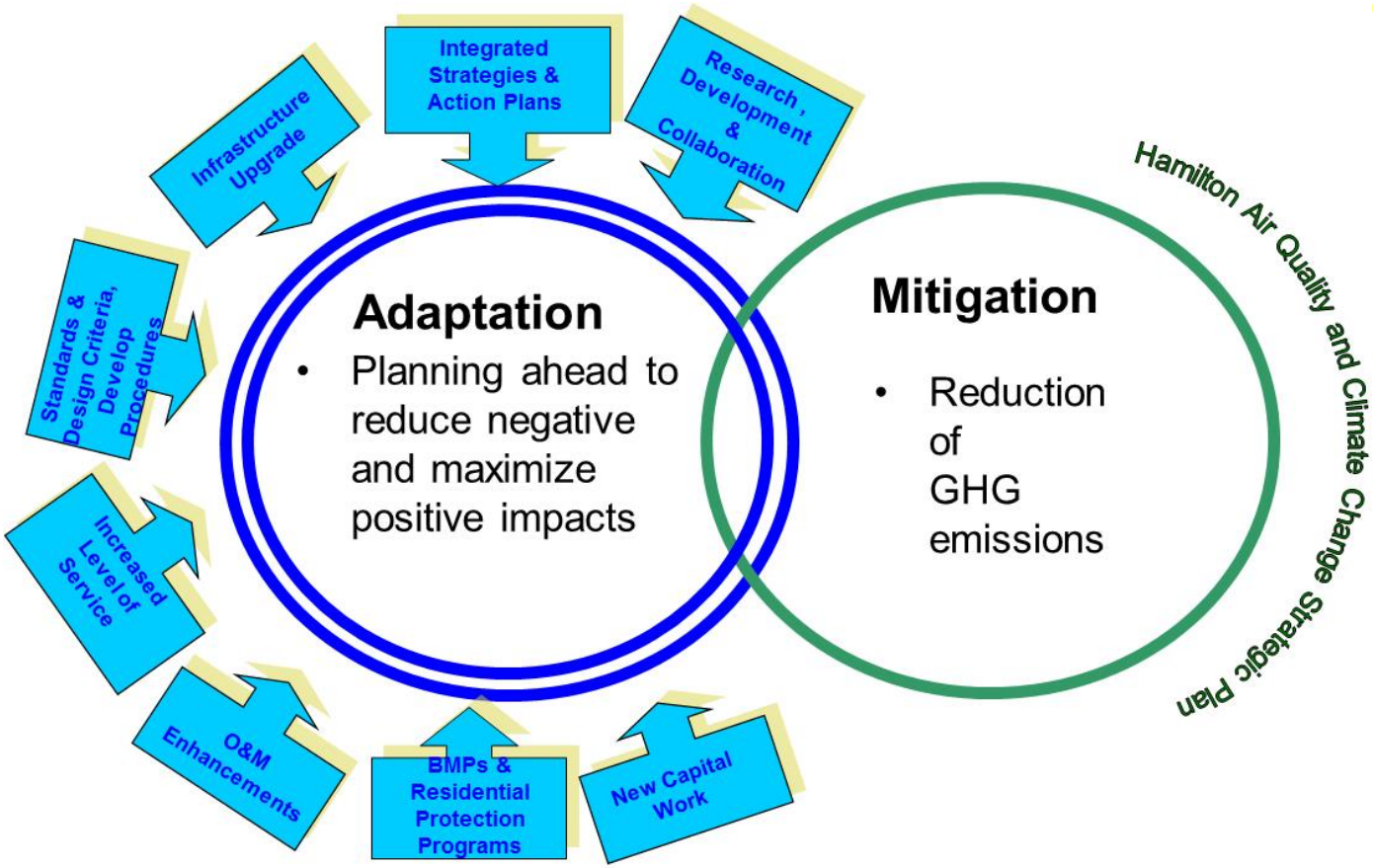




Climate Change Challenge

- How is the climate changing and how to measure the change?
- What are the causes and consequences of climate change?
- How will climate change impact existing infrastructure and environmental features?
- What are our strategies to deal with climate change?

Climate Change Mitigation & Adaptation (City of Hamilton)



- Hamilton Climate Change and Storm Events Adaptation Plan
- Hamilton Community Climate Change Action Plan
- ***Environmental and Infrastructure Vulnerabilities from Climate Change-Spencer Creek Watershed. "Pilot Showcasing Program"***

“Environmental and Infrastructure Vulnerabilities from Climate Change- Pilot Project Hamilton, Ontario”

Brian Hindley, Environmental Studies Specialist, Matrix Solutions Inc.
Nahed Ghbn, Senior Project Manager, City of Hamilton
Jonathan Bastien, Water Resources Engineering, Hamilton Conservation Authority

Study Goal and Objectives

- Increase knowledge and awareness of sustainable water management for climate change:
  - Flood damage reduction
  - Stormwater runoff
  - Improved water quality
  - Increased awareness of urban water management
- Tasks:
  - Evaluate and select climate change models
  - Assess vulnerability of environmental and infrastructure features to climate change
  - Detailed hydrologic/hydraulic modeling of future climates
  - Erosion and Sedimentation Study
  - Increase the knowledge and awareness

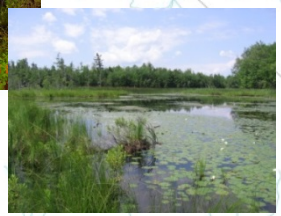
Study Approach

- Review and compare predicted future values from several current climate models
- Generate a series of environmental indicators of temperature and precipitation change
- Downscale climate future values for use in hydrologic/hydraulic models
- Generate a series of future flood flows and stream characteristics indicative of threats to watershed infrastructure and environmental features
- Develop adaptation recommendations for future municipal/conservation authority policy and planning

Spencer Creek Watershed

- 230 km2 Drainage Area
- Typical of Southern Ontario Streams
- Rural headwaters;
- Urban lower reaches

Environmental Features



- **Fletcher's Creek Swamp Forest**
- **Beverley Swamp**
- **Christie Reservoir**
- **Dundas Valley Forest**

Infrastructure Features

- 14 Crossings
- Cootes Road
- McMurray Street
- Crookes Hollow
- Erosion, Foundations, other infrastructure

Future Climate Predictions

- Several models used to generate results
- Each model has strengths and weaknesses
- Data variability causes uncertainty in model results
- Need for expert judgement
- Analysis of trends, not absolutes
- Current policy/planning based on past not future trends

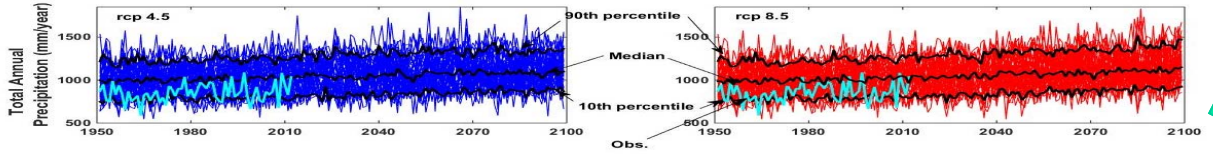
Climate Change Models

- Climate models selected:
  - CIMP5 ensemble – RCP 4.5/8.5
  - CanRCM4 – RCP 4.5/8.5
  - PRESIC ensemble
- Climate models typically generate continuous output – daily/weekly predicted values
- Hydrologic/Hydraulic models typically require continuous (hourly) and event-based (return frequency) input
- Model outputs downscaled and converted to hourly data for hydrologic/hydraulic modeling

- IDF curves typically generated from historic datasets to characterize rare events – time series flow datasets
- IDF curves for future climate values generated in 3 ways:
  - IDFCC tool Website (Western U)
  - Ontario IDF parameters – Ontario Climate Change & Data Portal
  - IDF curves generated from predicted continuous data values

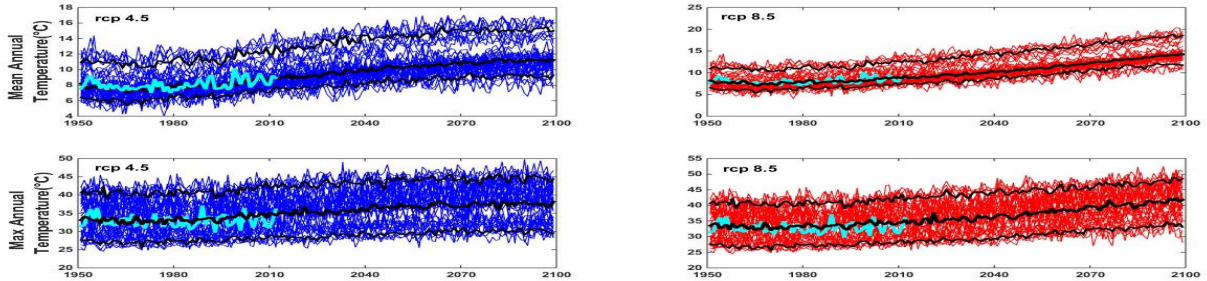
Climate Datasets – Predicted Values

- Standard practice is to use multiple models to generate future predicted values – high uncertainty



Projected Precipitation values

- Projected Temperature values



Most Confident

Least / Less Confident

More CERTAINTY → **Less CERTAINTY**

Long Term Trends in temperature and precipitation (Monthly/ annually)

courtesy RSI RISK SCIENCES INTERNATIONAL

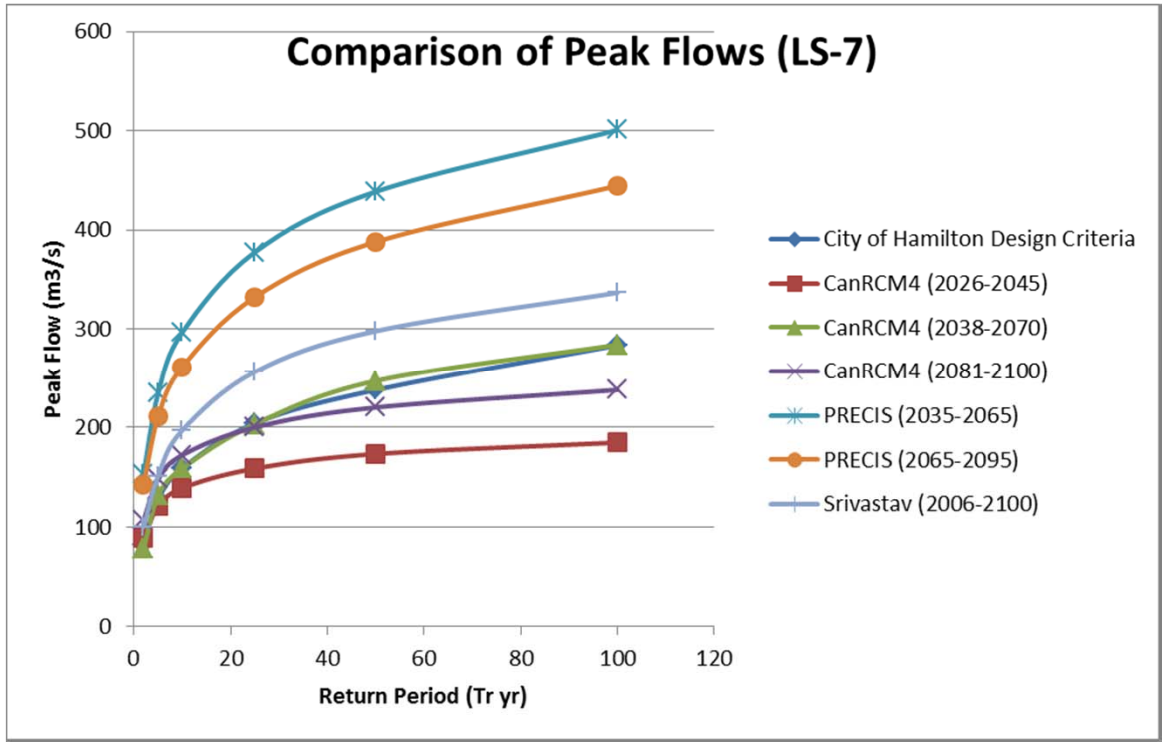
Short Term Trends in temperature and precipitation (Daily/ weekly)

Preliminary results Infrastructure

Sample of Projected “Family” of IDF Curves

- Results for frequent events are more certain
- Increases in magnitude of frequent events greater than infrequent event
- Trends not absolutes

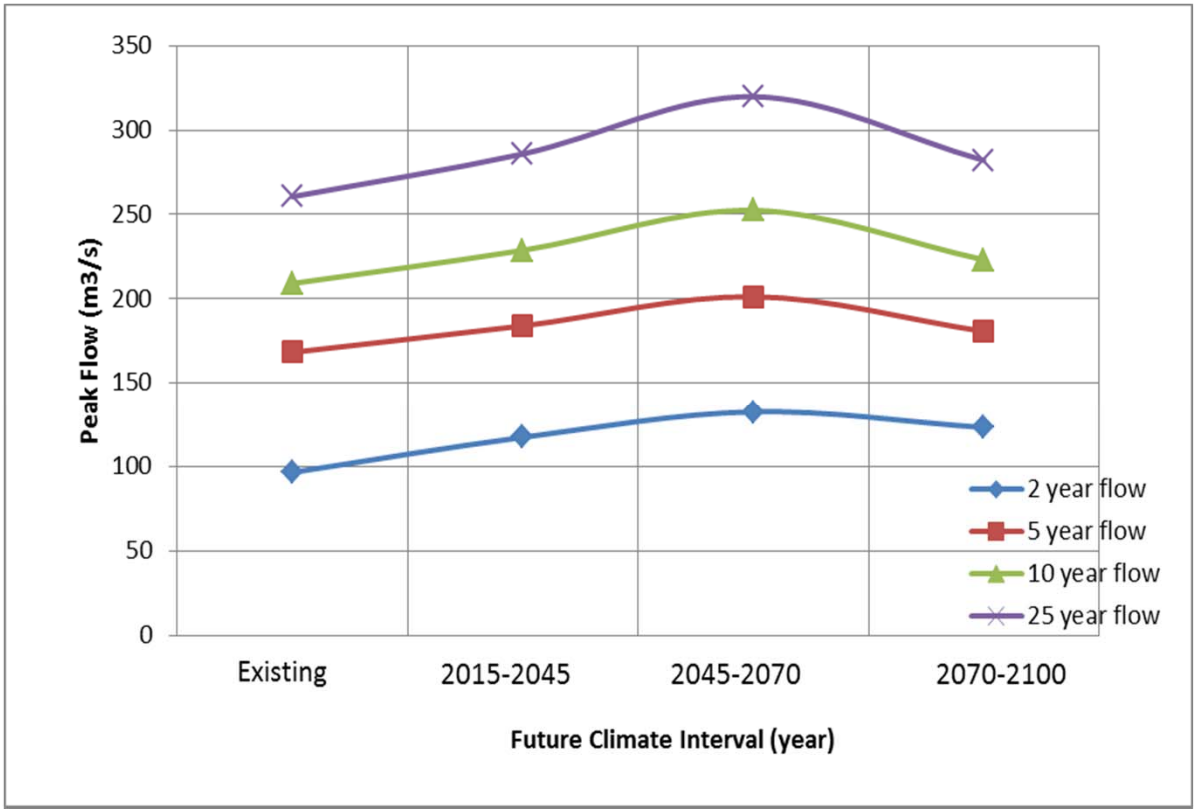
Real story is that these infrequent events will occur more frequently!!!



Preliminary Results
Infrastructure

Changes in Return Frequency of Flows:

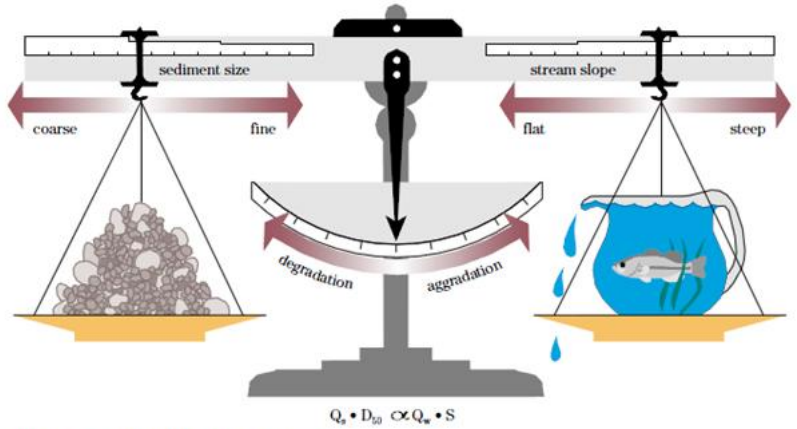
- Increased magnitude of flows
- Substantial increase in frequency of current time series flows
- Less confidence in changes to 50+ flows



Preliminary Results
Infrastructure

Erosion Vulnerability:

- IDF curve trend indicates greatest change occurs for more frequent events – increase in magnitude and frequency



From Rosgen (1996), from Lane, Proceedings, 1955.
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- Critical Flows – show a similar trend

- Increased erosion vulnerability means increased risk of erosion damage to infrastructure

Preliminary Results
Environmental Features

- Long term trends in temperature: increases in mean annual temperature, maximum summer temperatures, growing season length; reduction in winter minimum temperatures
- Long term trends in precipitation: increases in total annual precipitation, large events
- Greater evapotranspiration, less winter snowpack, shifts in monthly stream flow patterns

WHAT DOES IT ALL MEAN?

Environmental Features

Impacts of Climate Change

- Fletcher's Wetland and Coldwater Stream:
  - increasing Potential threats to brook trout habitat – thermal effects
  - Increased potential for instream erosion
  - Potential Expansion of invasive wetland species
- Beverley Swamp
  - Increased evapotranspiration – Potential for reduced water levels
  - More temperature/precipitation extremes – potential expansion of invasive species, loss of rare species' habitat
  - Less Snowpack/more evapotranspiration – Potential Loss of water storage function?
- Christie Reservoir
  - Potential for greater unpredictability in water management
  - Less snow pack; winter rain – potential for less water for baseflow maintenance
  - More variable spring reservoir levels – potential threats to fish spawning
- Dundas Forest
  - Less snowpack; winter rains – Potential threats to vernal pools and amphibian habitat
  - More evapotranspiration; greater storm intensity – potential threats to old growth forest; expansion of invasive species habitat

Infrastructure Vulnerability

Impacts of Climate Change

- Potential of increased erosion– potential threats to channel stability, bridge substructures
- Potential of increased frequency of floods– potential threats to flooding on roads; bridge conveyance capacity; associated infrastructure
- Potential changes to creek hydrology and hydraulics

Adaptation Measures
Possible actions to take?

- Environmental Features:
  - Enhanced monitoring
  - Restoration planning
  - Policies/planning
  - Species Management Plans
- Infrastructure
  - (Re)Define acceptable risks
  - Enhanced monitoring
  - Emergency Response
  - Design Guidelines
  - Operation and Maintenance Enhancement
  - Flood protection measures
  - Weather/ Rainfall forecast and prediction

Acknowledgements

Partners:

Hamilton

Hamilton Conservation Authority
Healthy Streams...Healthy Communities!

Great Lakes and St. Lawrence Cities Initiative
Alliance des villes des Grands Lacs et du Saint-Laurent

RBC Blue Water Project™

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

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McMaster University

OCC ONTARIO CLIMATE CONSORTIUM