Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Susceptibility of Regional Ecological Features to Climate Change

Spencer Creek Watershed

Ontario Climate Consortium May 2017

Project Partners

Matrix Solutions Inc.
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RBC

RBC Blue Water Project™

MITACS Accelerate

McMaster University

OCC ONTARIO CLIMATE CONSORTIUM

Hamilton Conservation Authority
Healthy Streams...Healthy Communities!

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

Hamilton

Study Overview

Purpose

- Recent increase in damage caused by extreme weather
- Analyze effects of future climate conditions
- Model watershed-specific potential impacts

Study Approach

- Develop 100 years of potential future climate data
- Watershed model to predict the impacts of climate change
- Evaluate ecological susceptibilities to future climate
- Assess infrastructure resiliencies and vulnerabilities

Study Area

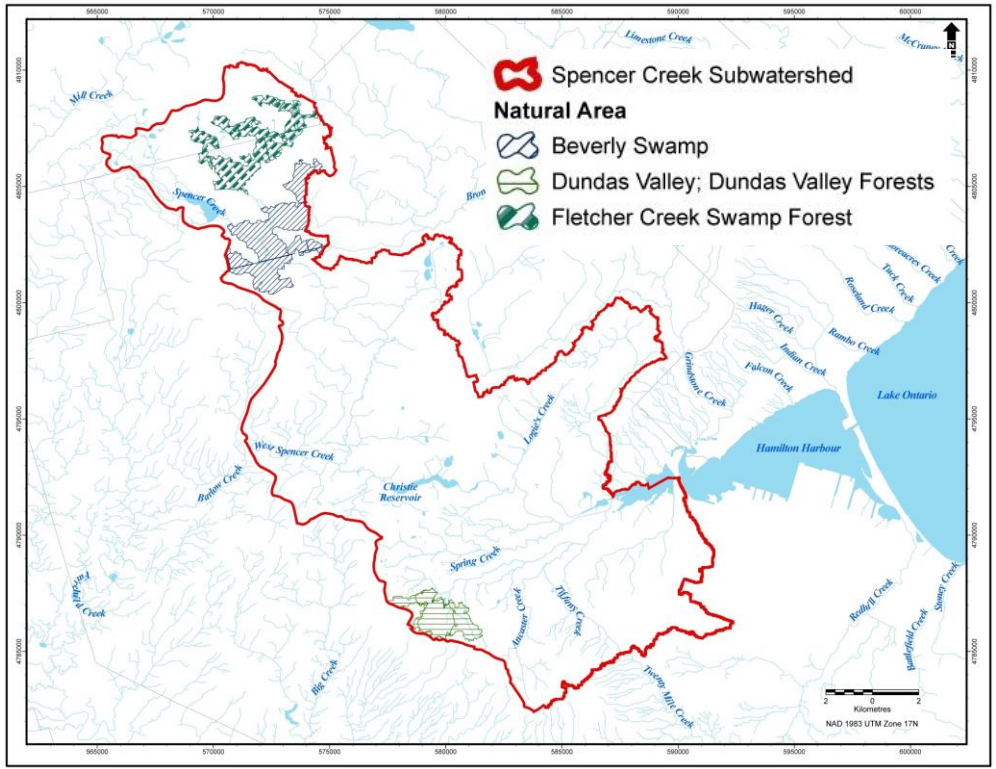
- Spencer Creek watershed
- City of Hamilton
- Tributary to Lake Ontario
- Discharges into the Hamilton Harbour

Spencer Creek Watershed

- Drainage area: 230 km^2

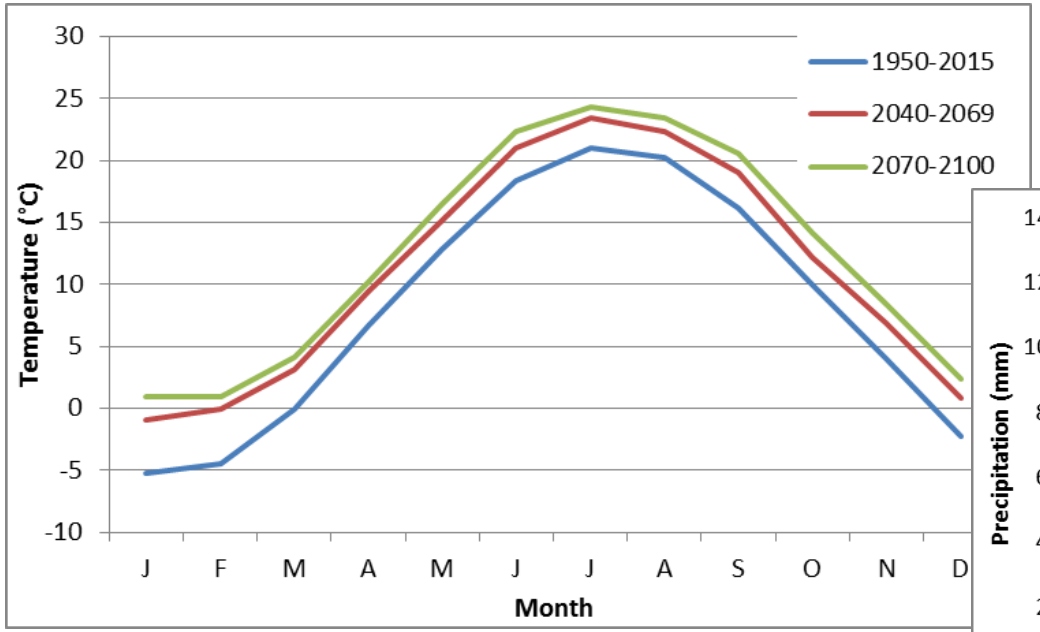
- Rural headwaters
- Urban lower reaches
- Niagara Escarpment

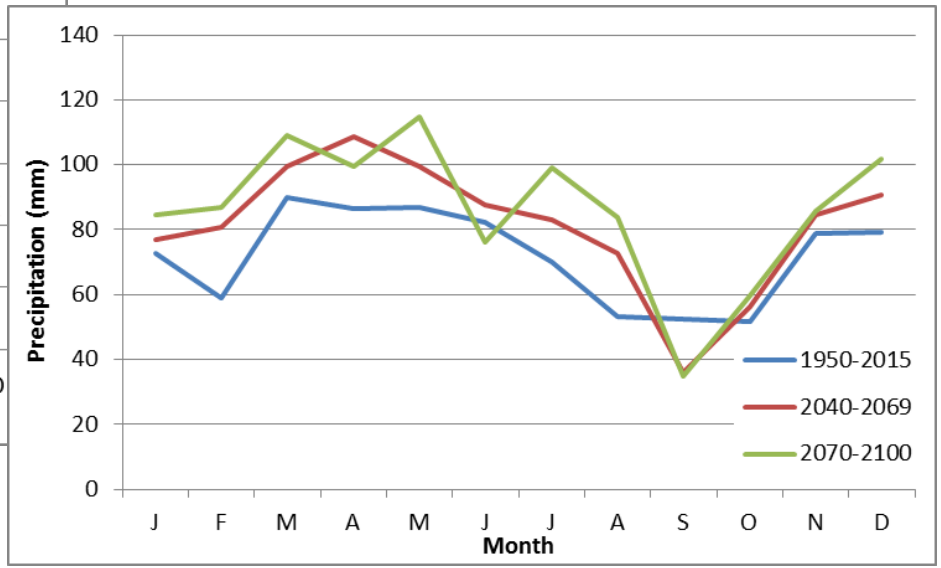
- Natural areas include:
  - Dundas Valley Forest
  - Fletcher Creek Swamp
  - Beverly Swamp
  - Christie Lake Reservoir



Climate Trends

Climate Model Forecast

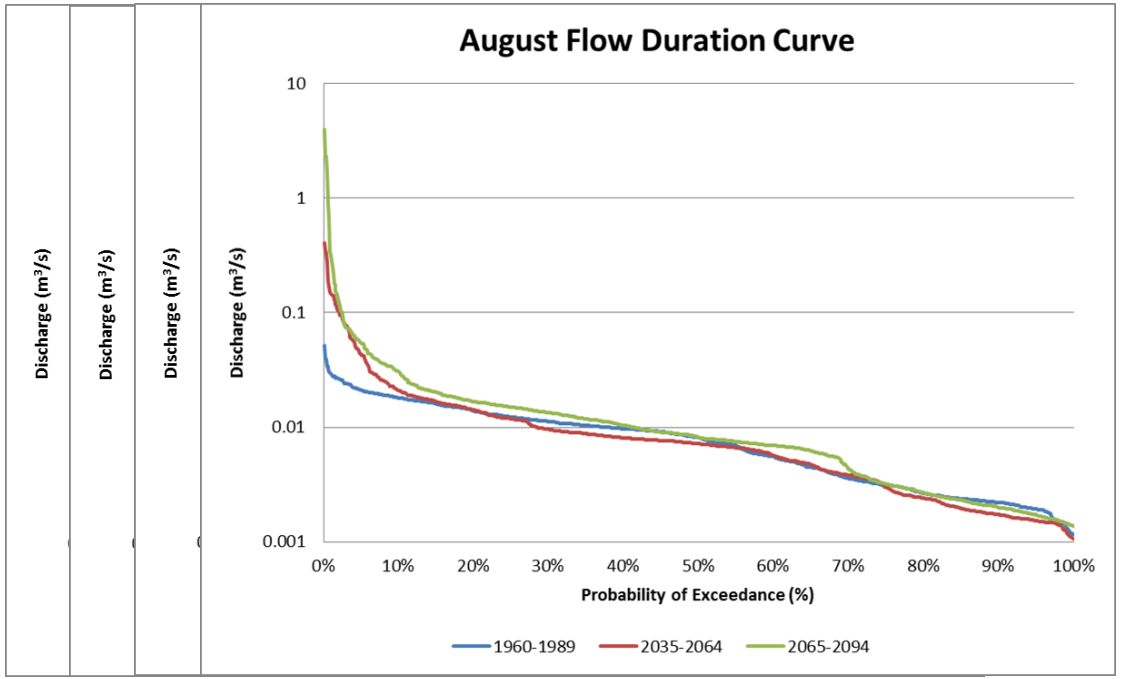




Climate Trends

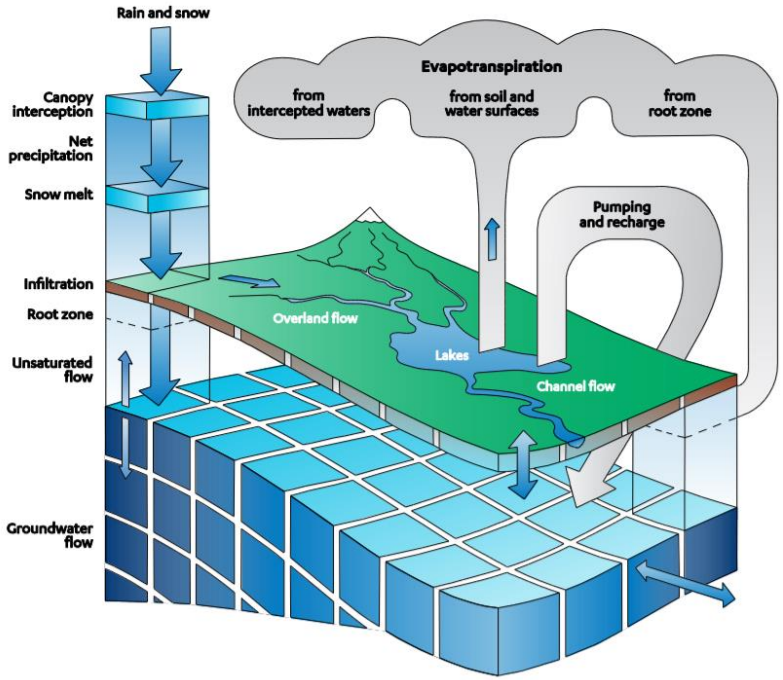
- Higher temperatures, greater annual precipitation, larger precipitation events

Future Trend	
Mean Annual Temperature	↑
Days Above 35°C	↑
Days Below -15°C	↓
Annual Precipitation	↑
Days with > 20 mm	↑



Watershed Impacts

How do we evaluate watershed impacts?



- Integrated groundwater / surface water model (MIKE SHE)
- Watershed scale analysis
- Continuous long term simualtions
- CRCM4 with intermediate emissions scenario

Water Budget

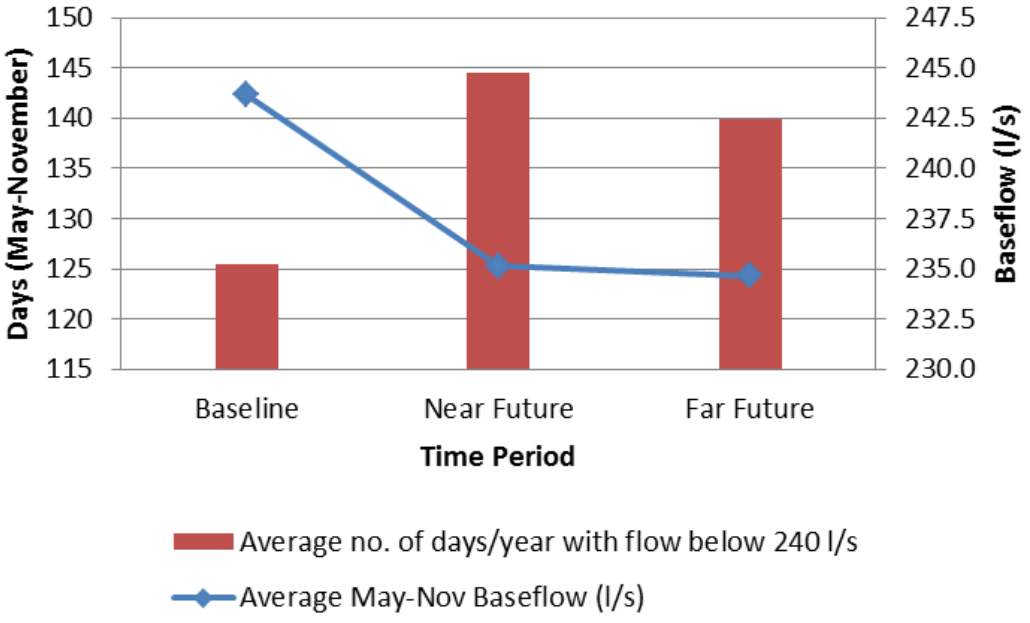
- Increased precipitation, evapotranspiration, and overland flow
- Decreased fall precipitation and summer/fall baseflow

Water Budget Component	Baseline	Near Future	Far Future
	Mean Annual Rate (mm/year)	Mean Annual Rate (mm/year)	Mean Annual Rate (mm/year)
Precipitation	876	938	1,036
Evapotranspiration	626	695	746
Streamflow - Overland Component	139	146	180
Streamflow - Interflow Component	91	89	94
Streamflow - Baseflow Component	38	37	37
Recharge	217	244	254
Groundwater Discharge	95	106	118

Water Budget Component	Season	Future Trend
Precipitation	Winter	↑
	Spring	↑
	Summer	↑
	Fall	↓
Evapotranspiration	Winter	↑
	Spring	↑
	Summer	↑
	Fall	↑
Streamflow - Overland	Winter	↑
	Spring	↑
	Summer	↑
	Fall	↑
Streamflow - Interflow	Winter	↑
	Spring	↓
	Summer	-
	Fall	↓
Streamflow - Baseflow	Winter	-
	Spring	-
	Summer	↓
	Fall	↓
Total Streamflow	Winter	↑
	Spring	↑
	Summer	↑
	Fall	↑

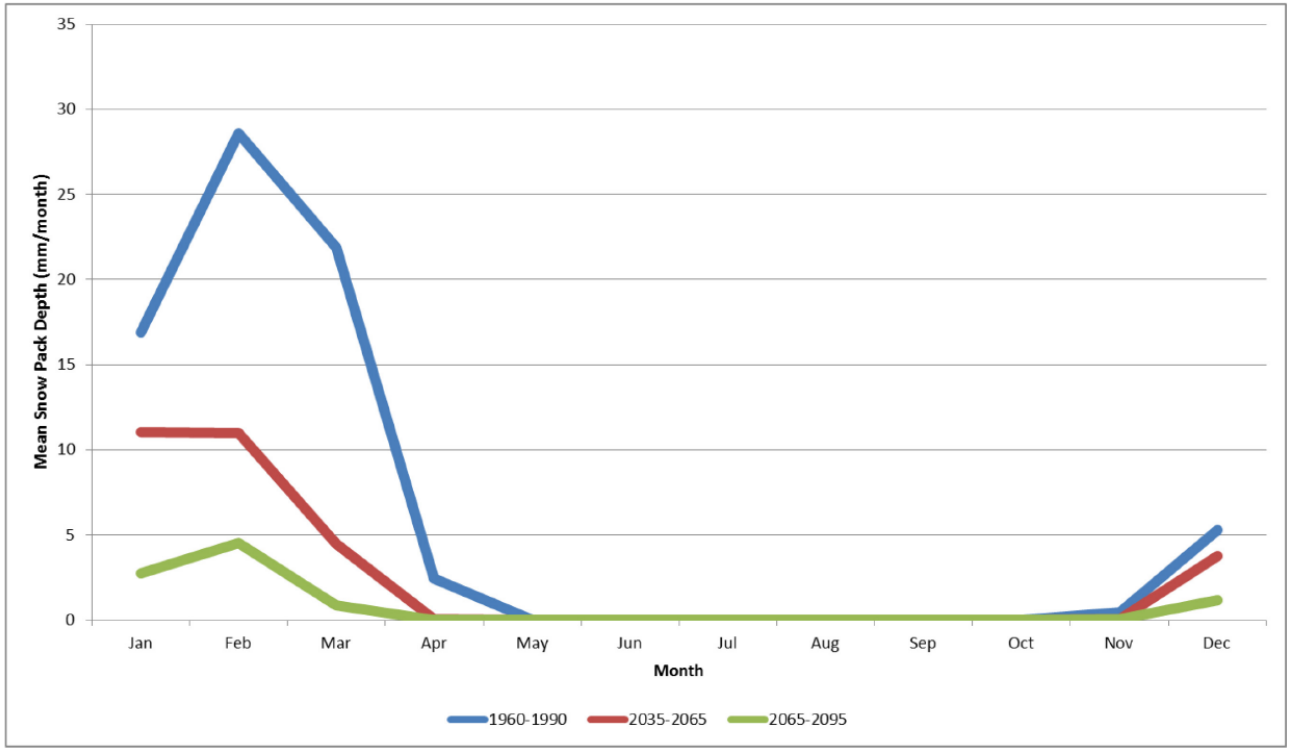
Baseflow Impacts

- Lower baseflow
- Baseflow occurs more often



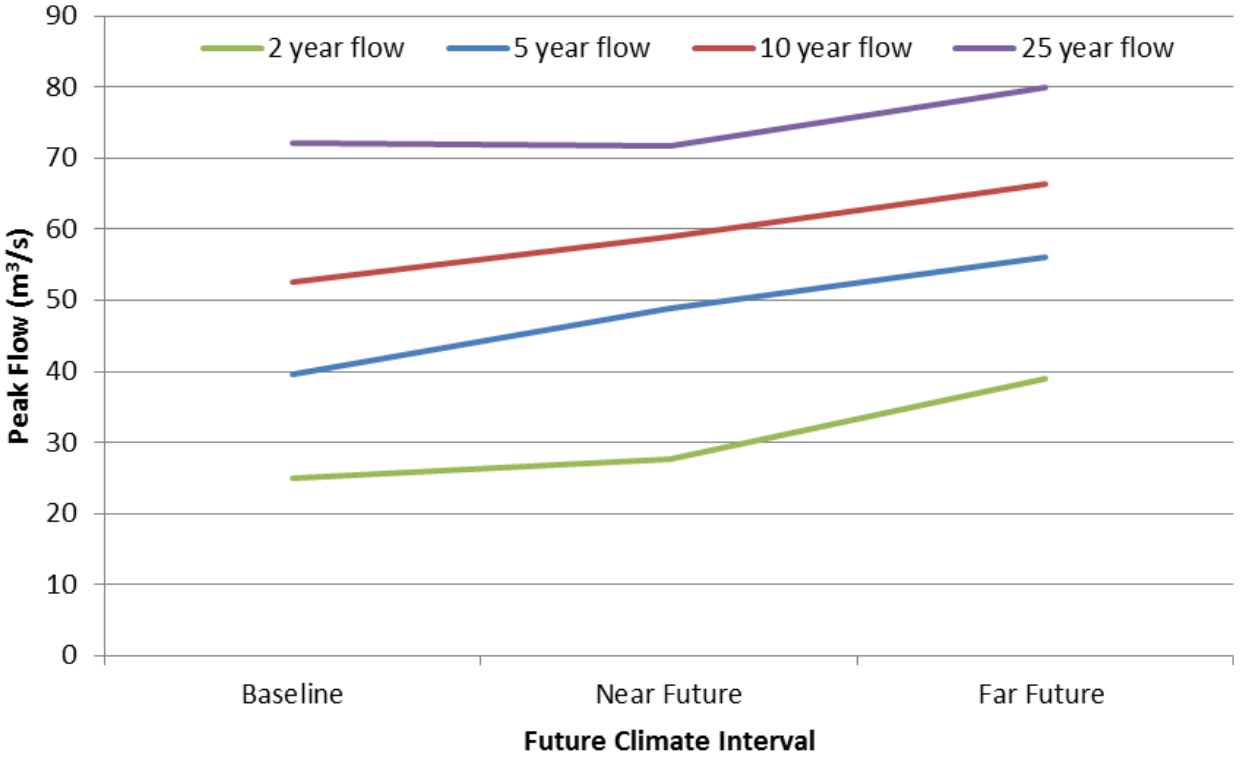
Snowpack

- Reduced snowpack

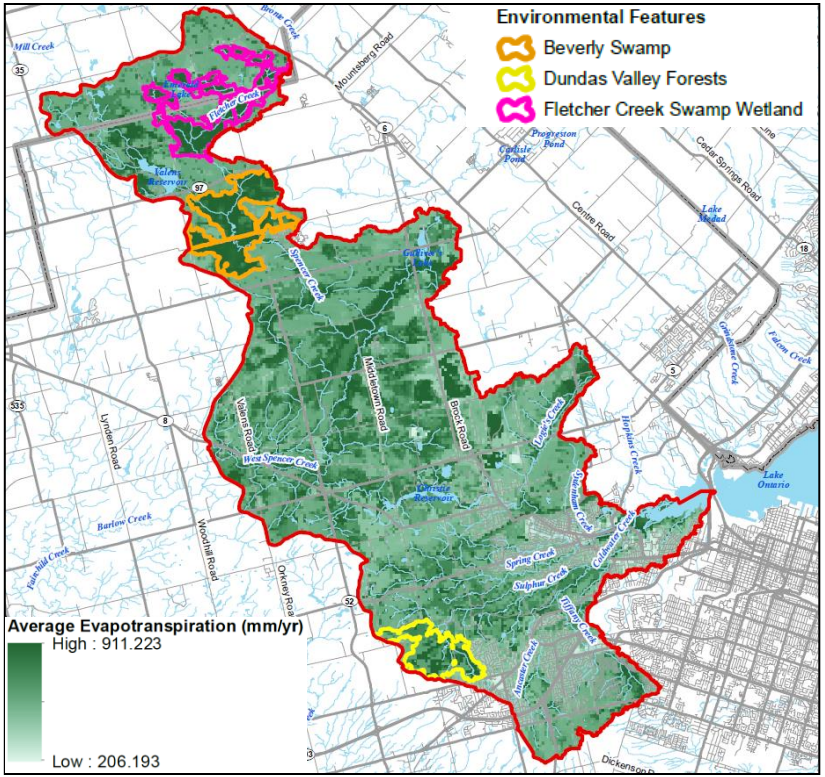


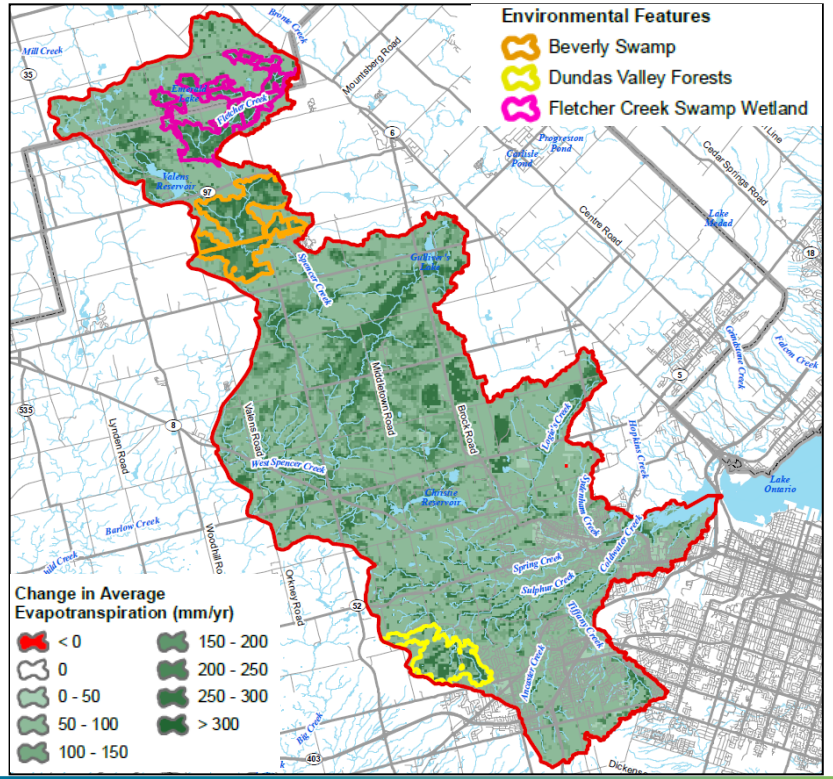
High Flow Events

- More frequent and larger flood events

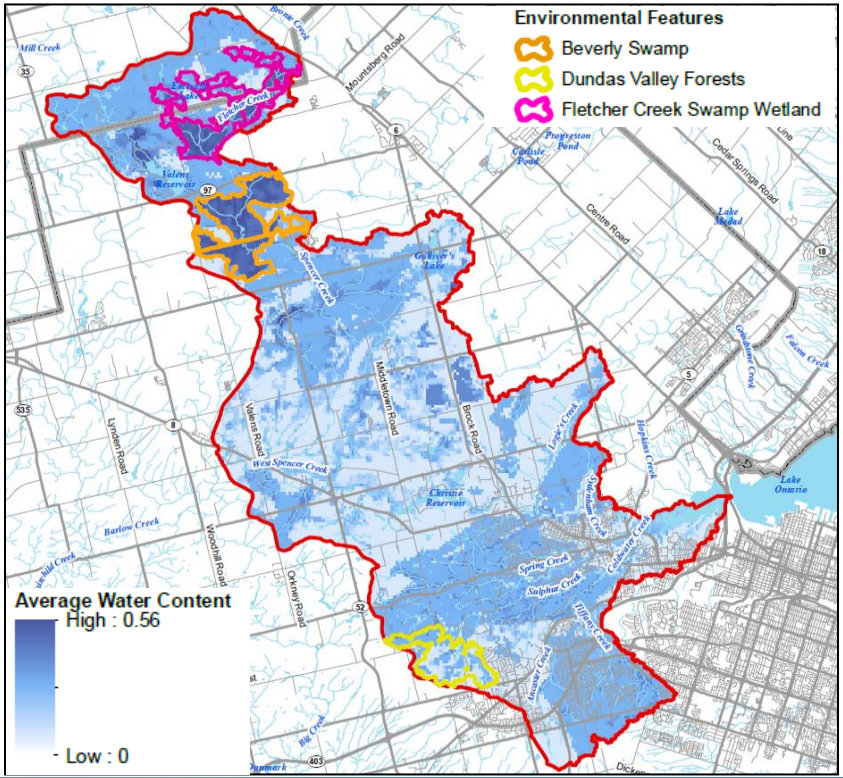


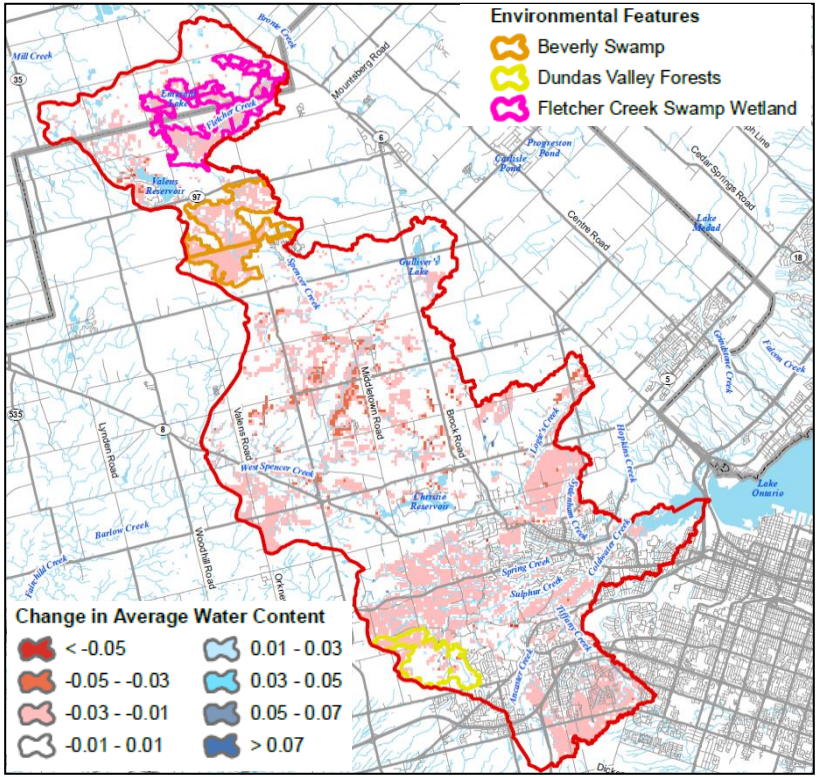
Evapotranspiration



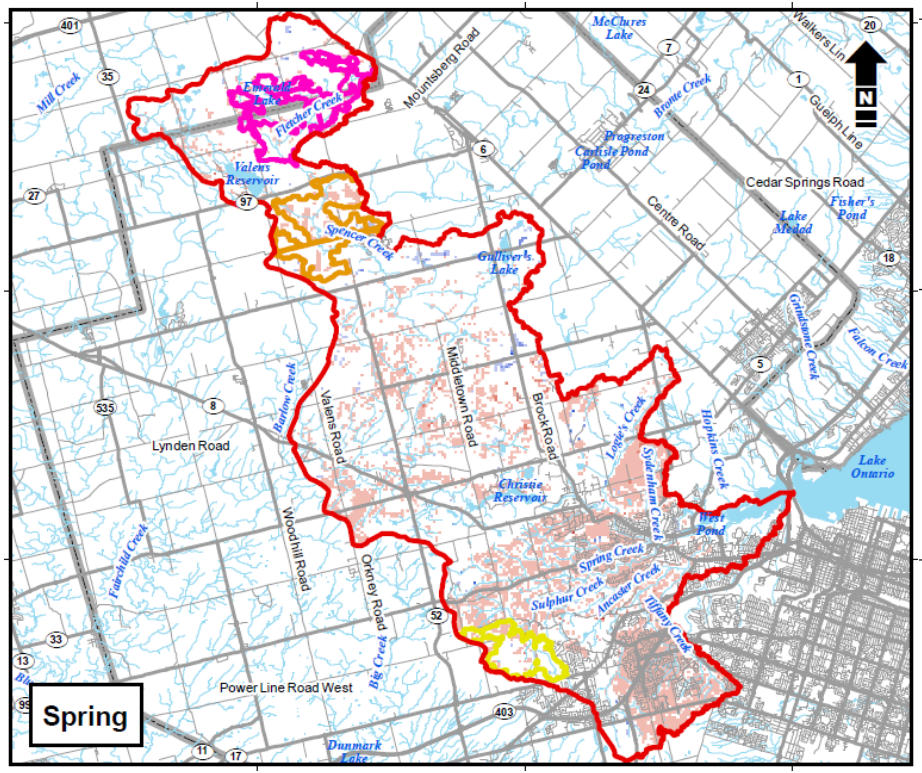


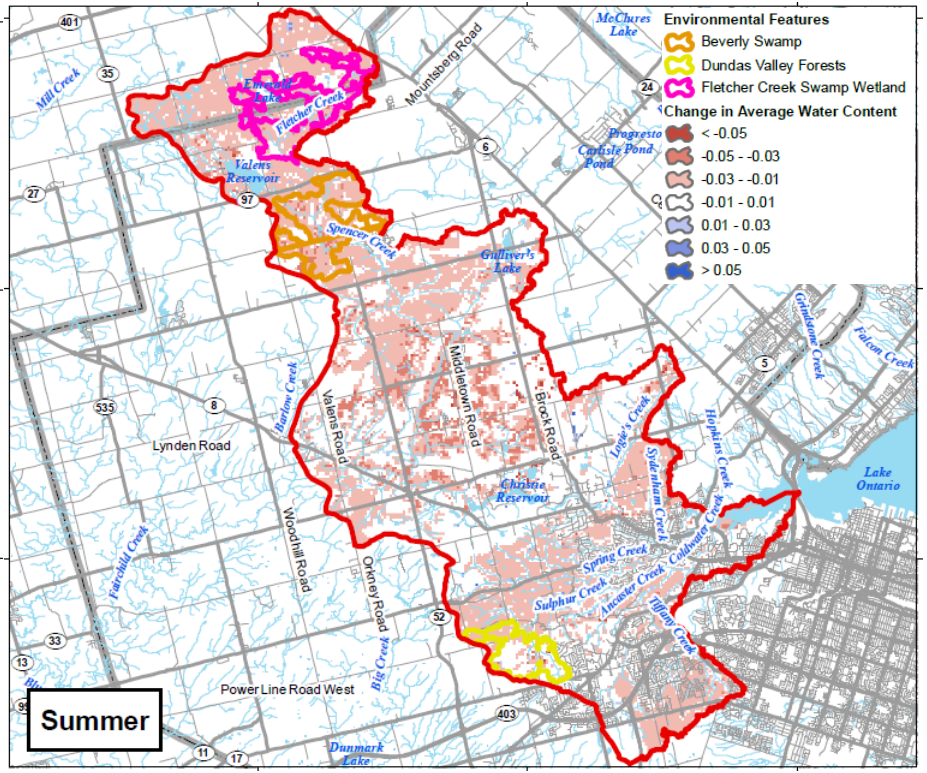
Water Content



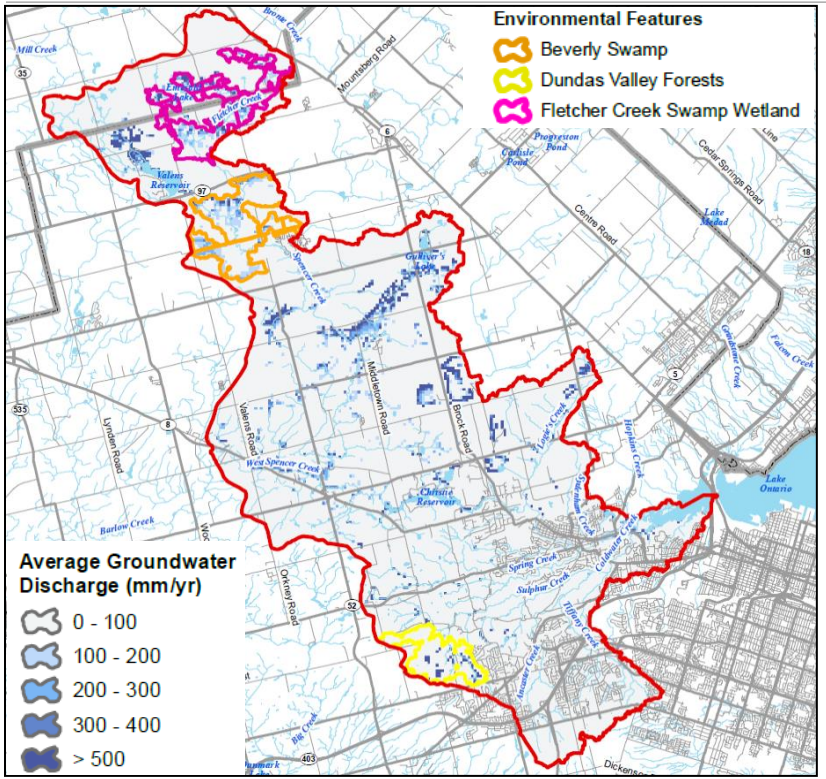


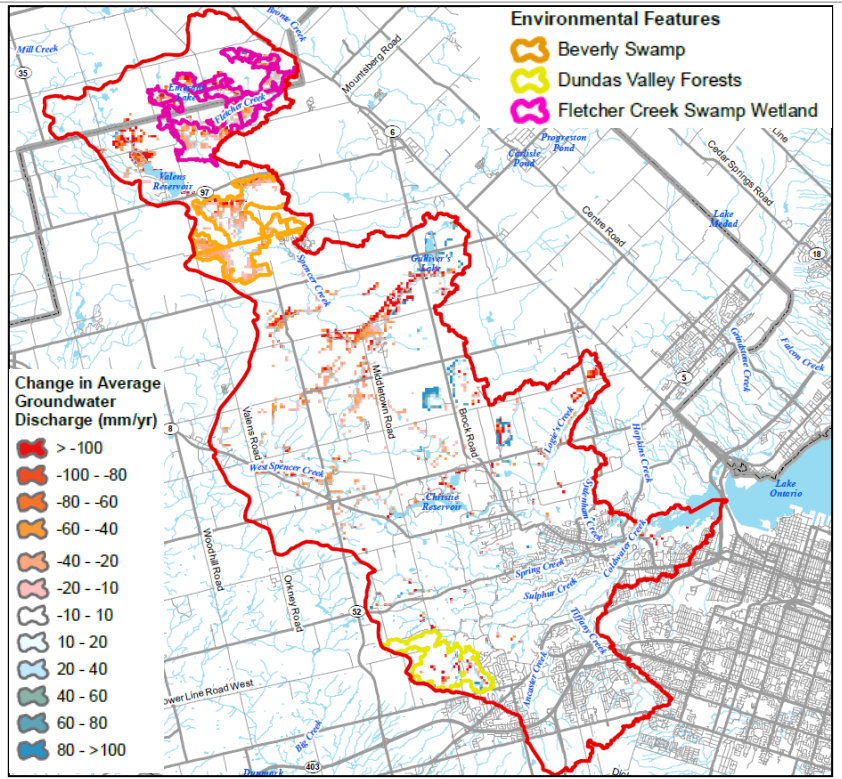
Seasonal – Water Content



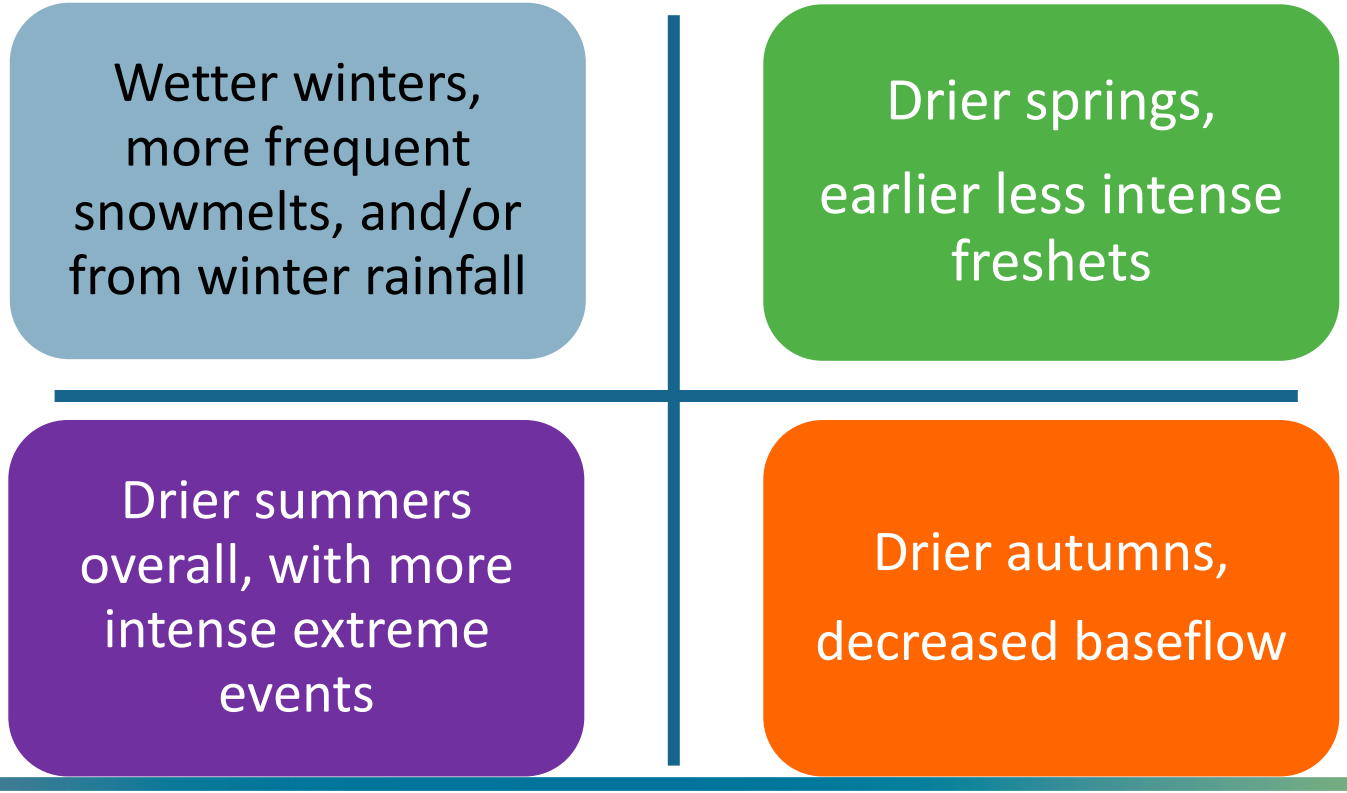


Groundwater Discharge





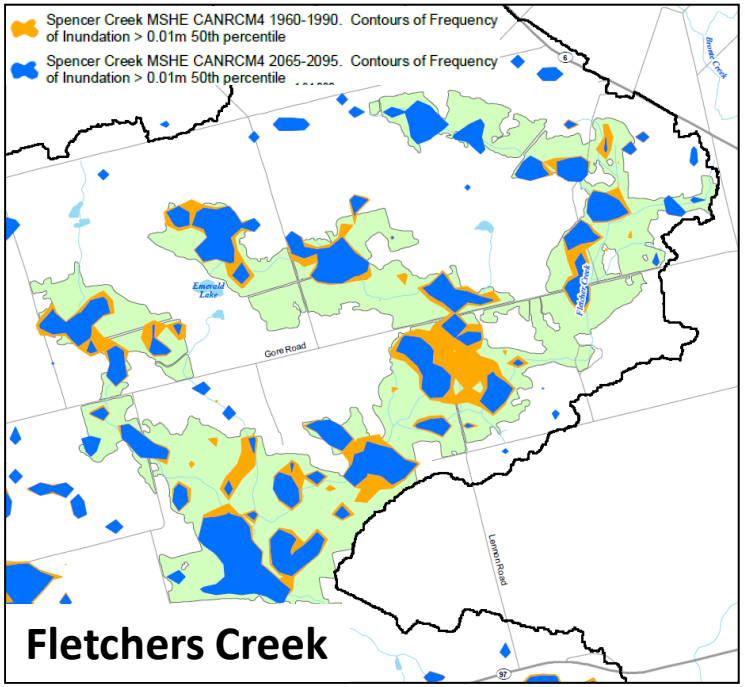
Summary


Wetter winters, more frequent snowmelts, and/or from winter rainfall
Drier springs,
earlier less intense freshets
Drier summers overall, with more intense extreme events
Drier autumns,
decreased baseflow

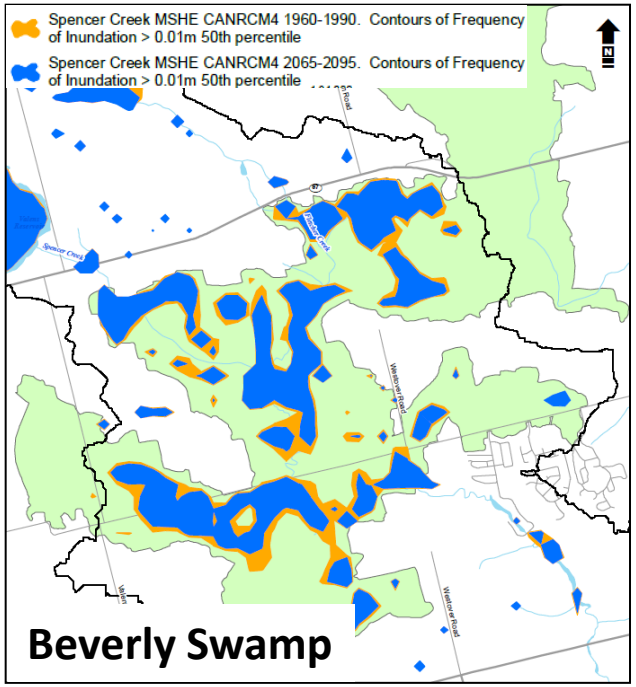
Environmental Features

Wetlands

- Further stress to S.A.R.
- Loss of extent of suitable habitat for wetland wildlife
- Increased probability for invasive and exotic species



35% Reduction



28% Reduction

Creeks

- Increased water temperatures
- Greater fluctuation in water levels
- Water quality
  - Increased turbidity
    - Organic Loading
    - Sediment Loading
- Change in habitat
  - Increase in invasive species

Agricultural and Rural Watershed

- Longer growing season
- Increase in probability and duration of drought
- Drier soils increase in irrigation

Dundas Forest

- Reduced soil moisture and the persistence of drought conditions may result in tree mortality
  - creation of gaps in the forest canopy allowing the encroachment of drier soil conditions.
- Increased growing season provides the opportunity for invasive or exotic plant life to inhabit these gaps and increased edge habitats
- Impacts to reproductive success of breeding amphibians

Christie Reservoir and Dam

- Operational changes
  - Low flow maintenance
  - Flood control
- Fish habitat changes
  - Temperature and flow changes at spawning
- Water quality impacts on recreation

Urban Watershed

- Increased erosion
  - channel stability and scour at piers and abutments
- Increased flood risk
- Maintenance SWM facilities
- Increased dredging at outlet


Mitigation and Adaptation

Adaptive Measures

- The City and Conservation Authority have an opportunity to incorporate adaptation measures into regional planning activities and guidelines and improve resiliency of the environmental features.
- Adaptation options include:
  - making changes to existing policy and regulations involving environmental and infrastructure planning, or creating new policies
  - maintenance
  - land use planning
  - enhancing monitoring
  - incorporating climate change into planning and design for future projects

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