Newfoundland Labrador

Water Resources Management Division

# Reducing the Vulnerability of Public Drinking Water Systems in Newfoundland and Labrador to Climate Change Impacts

Drinking Water Safety Workshop, Gander
Paula Dawe, P.Eng
pauladawe@gov.nl.ca
March 27-29, 2018

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Outline

- Value of public drinking water systems
- Climate change projections for NL
- Observed climate change effects
- Observed climate change impacts on drinking water systems
- Reducing vulnerability to climate change impacts

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Expected Useful Live

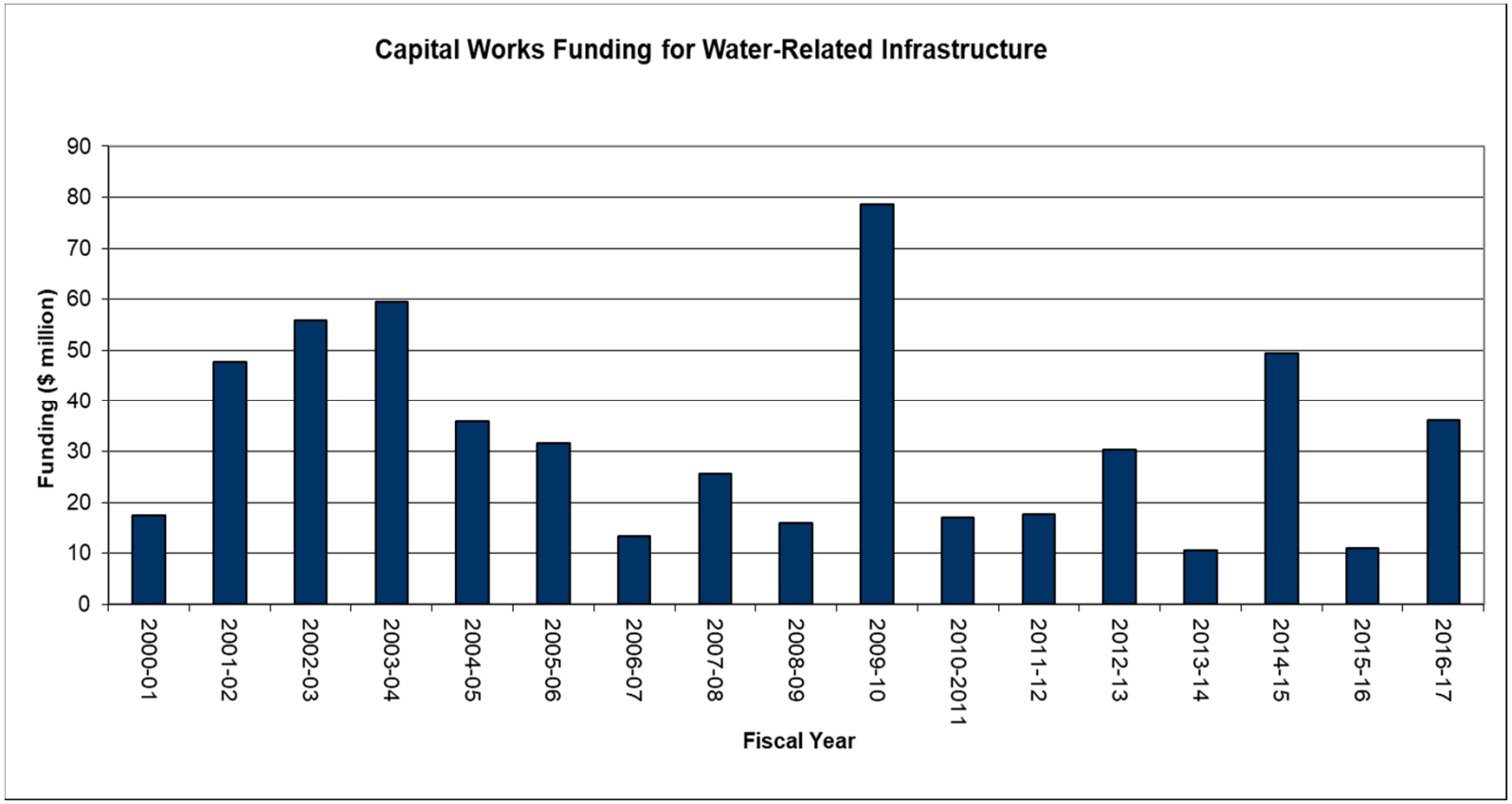
| Drinking Water Component | Years |
|---|---|
| Reservoirs and Dams | 15-100 |
| Intake (no impoundment) | 20-50 |
| Groundwater Wells | 15-35 |
| Water Treatment Plants- concrete structures | 20-50 |
| Water Treatment Plants- mechanical and electrical | 15-25 |
| Chlorination Equipment | 10-15 |
| Trunk mains and distribution mains | 25-100 |
| Water Storage Tank | 25-80 |
| Electrical Systems | 7-10 |
| Meters | 10-15 |
| Buildings | 30-60 |

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Value of Public Water Systems



Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# NL Climate Change Projections

- Climate change is expected to bring weather that is warmer, wetter and stormier
  - Air temperatures rising
  - Increasing sea surface temperatures
  - More extreme weather events
  - Increasing rainfall intensity
  - Rising sea level
  - Less snowpack
  - Earlier melting of snowpack

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Climate Change Projections: Temperature

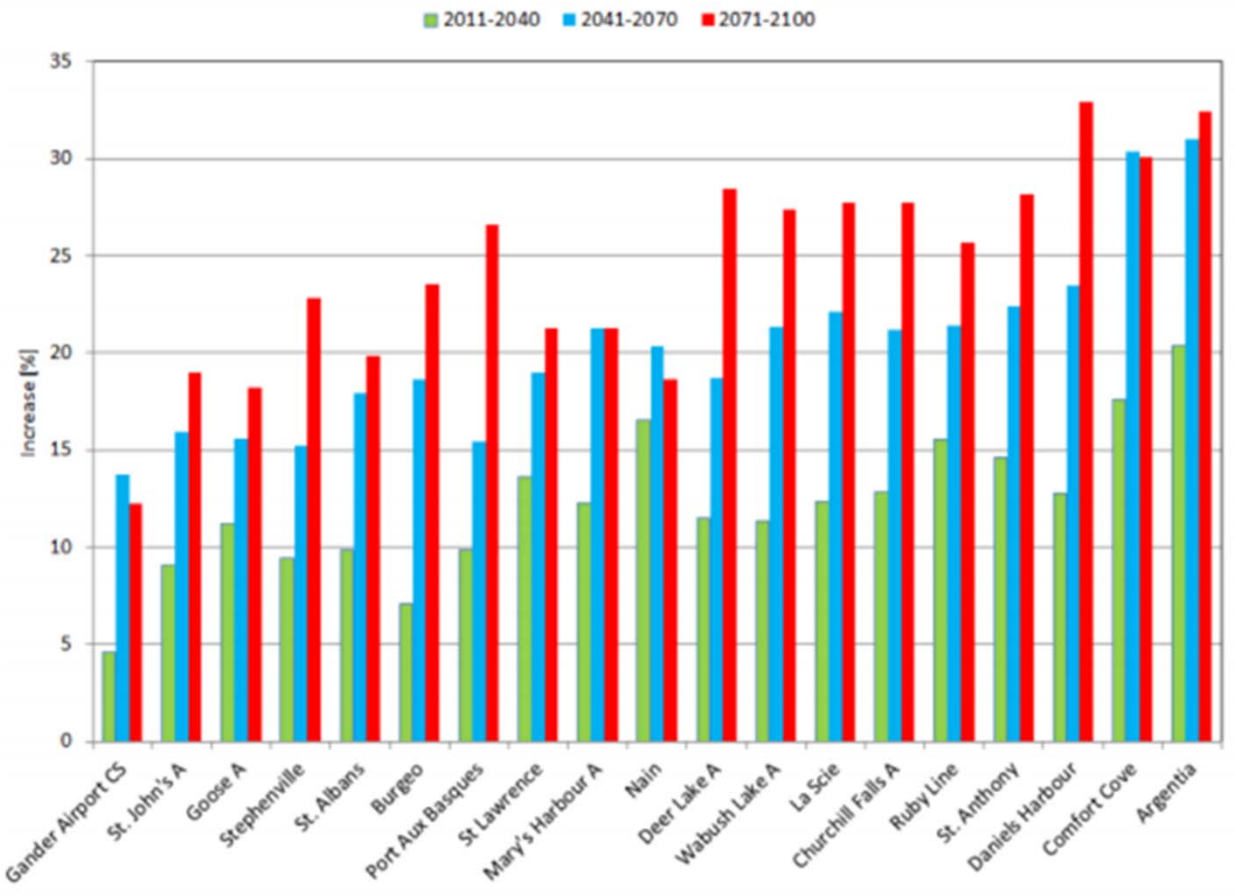
- By the mid-21st century temperatures are projected to rise
  - between 2° and 3° C in Newfoundland
  - between 3° and 4° C in Labrador
  - fewer "heating degree days" (meaning less demand for energy to heat buildings)
  - fewer days with frost resulting in a shorter winter
  - increase in "growing degree days" (meaning longer growing seasons)

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Climate Change Projections: Precipitation



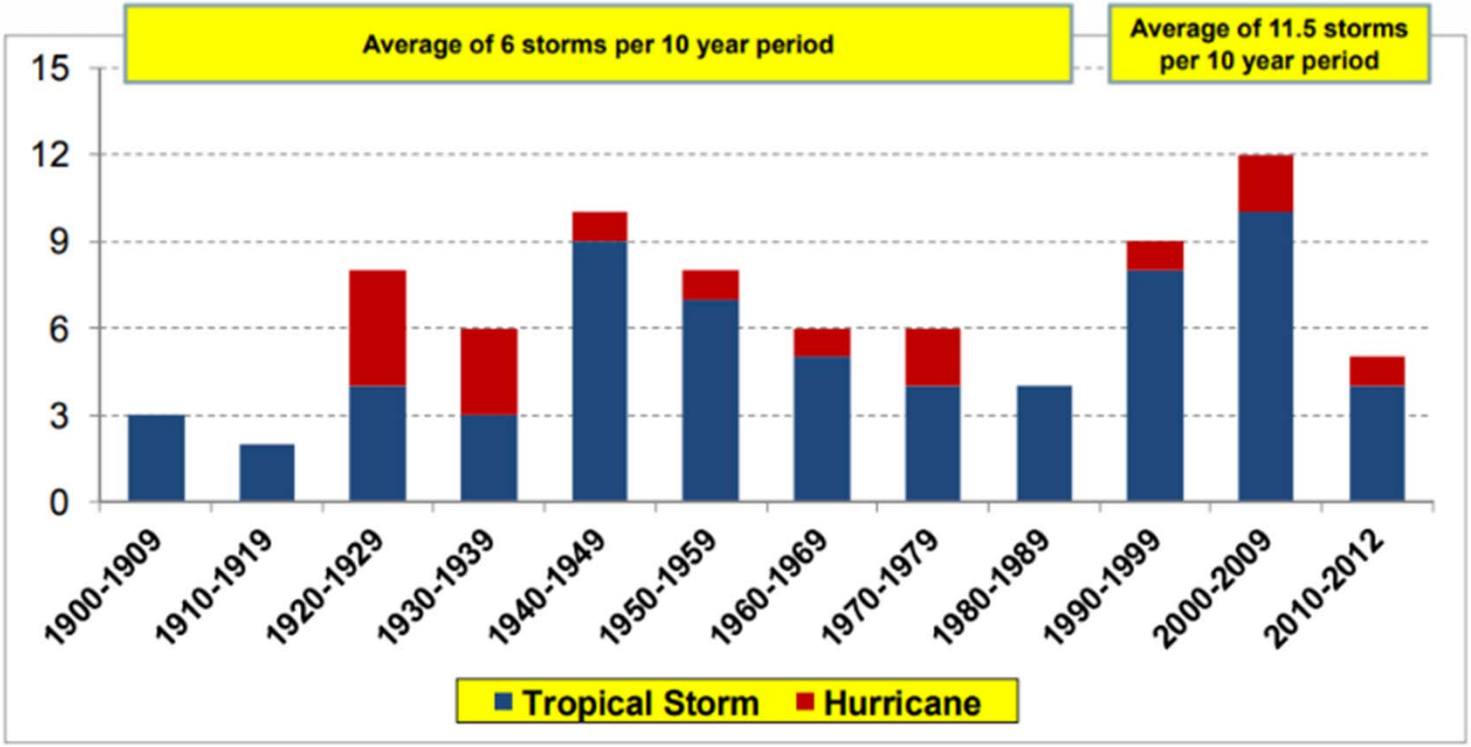

- Increase in rainfall
- More intense precipitation (fall & winter)
- More days with precipitation > 10 mm
- More precipitation over a 3 day period
- More rainfall from short duration events

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Climate Change Projections: Storm Frequency



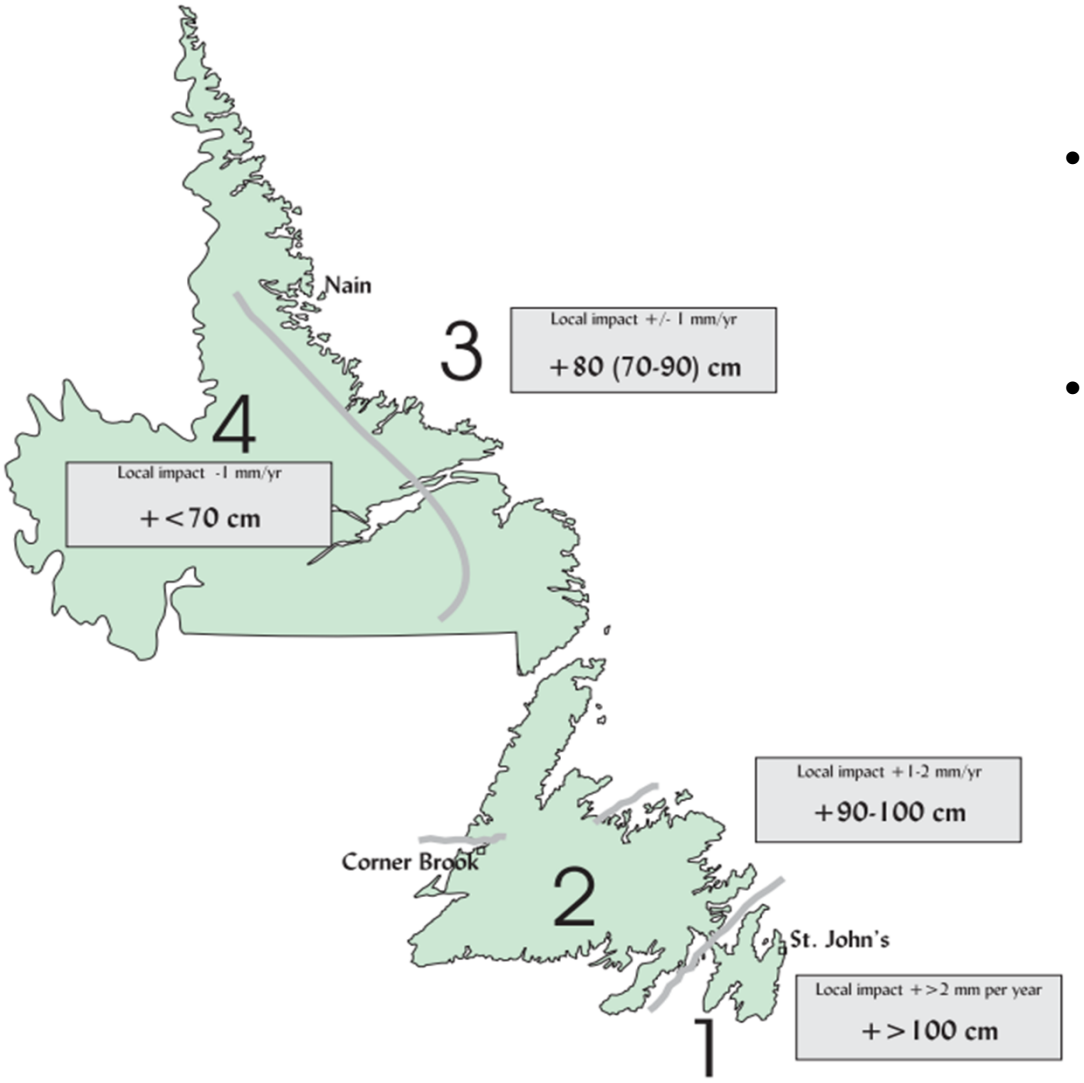

- By the 2080s:
  - Current 1-in-100-year storms are projected to become 1-in-25-year storms
  - Current 1-in-50 year storms are projected to become 1-in-20 year storms
  - Current 1-in-20 year storms are projected to become 1-in-5 or 1-in-2 year storms

Newfoundland Labrador

Water Resources Management Division

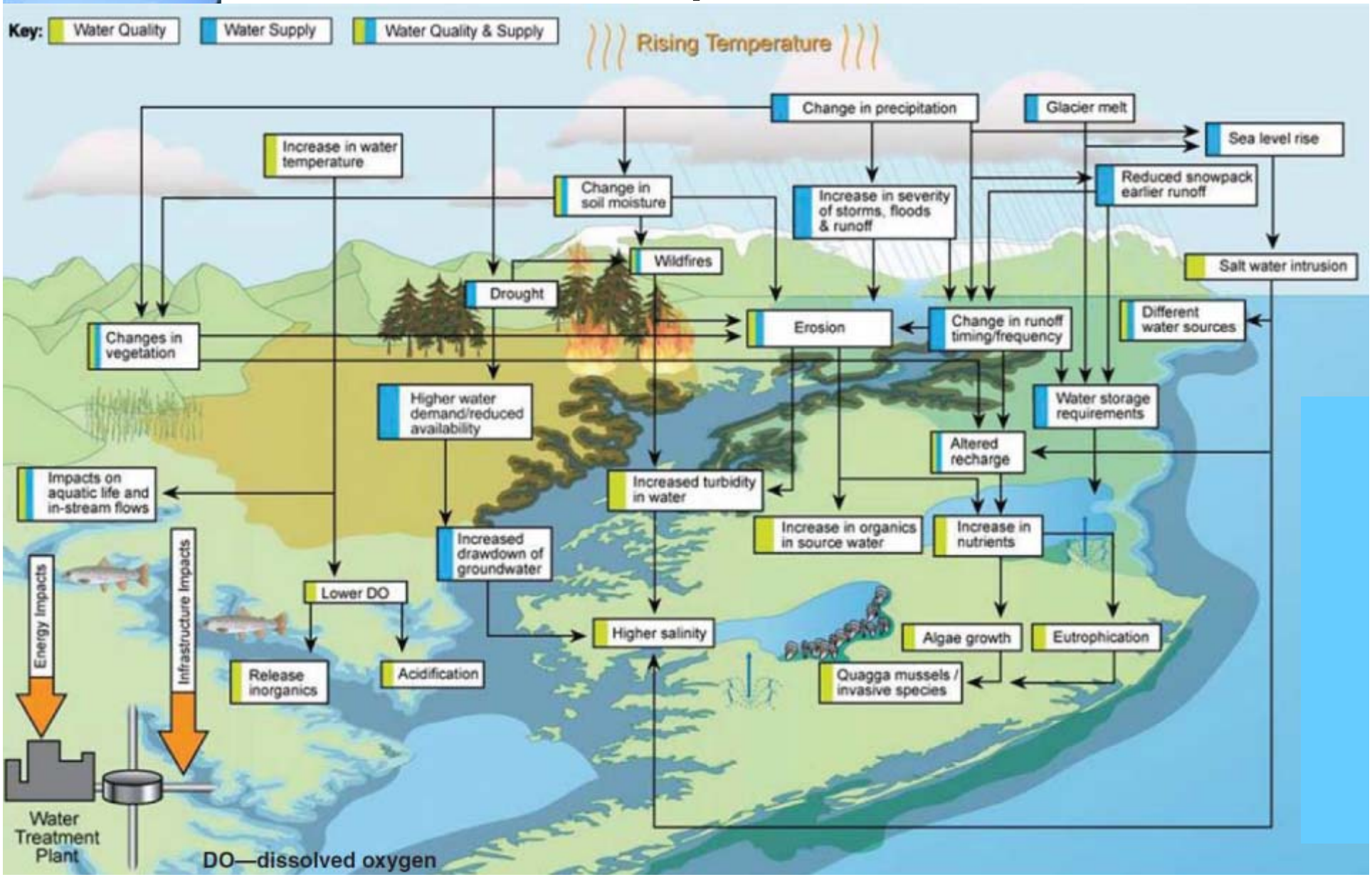
Department of Environment & Conservation

# Climate Change Projections: Sea Level Rise




- Potential sea-level rise of 100+ cm by 2099 will be seen in NL
- Frequency of storm surge events in NL expected to increase

# Climate Effects on Drinking Water Systems

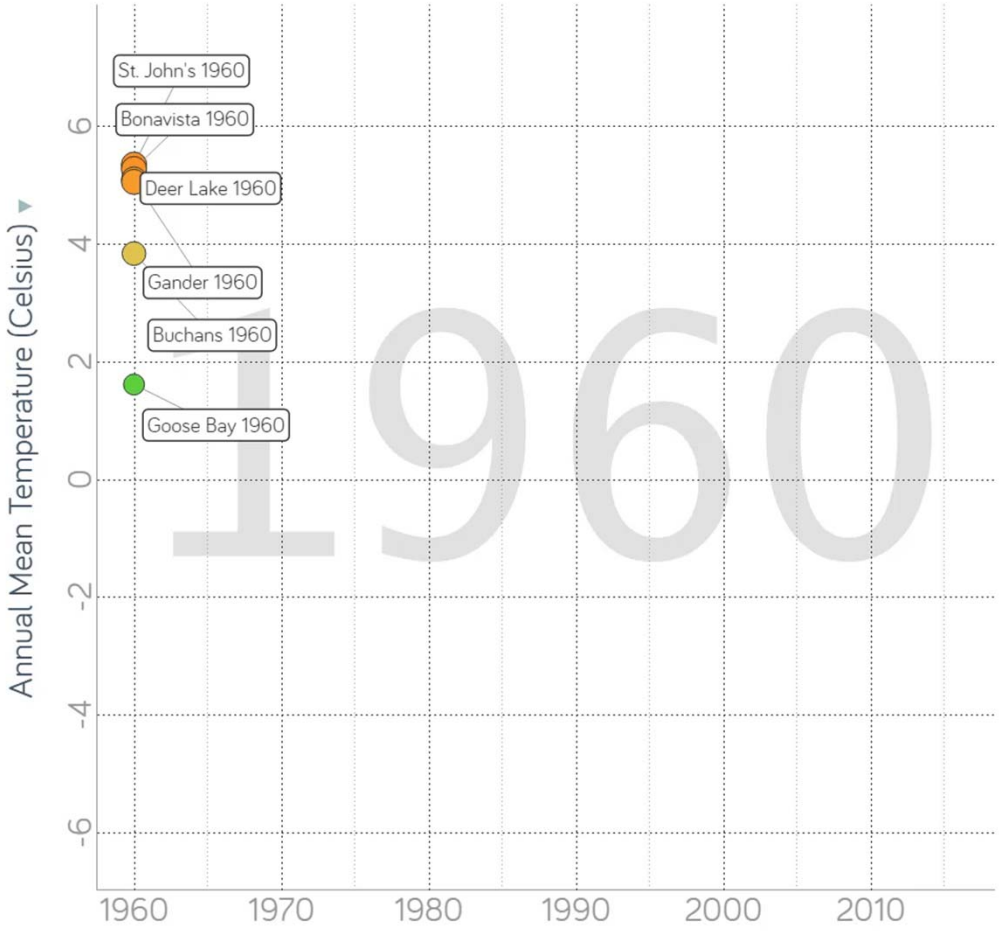


Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Observed Climate Change Effects: Temperature

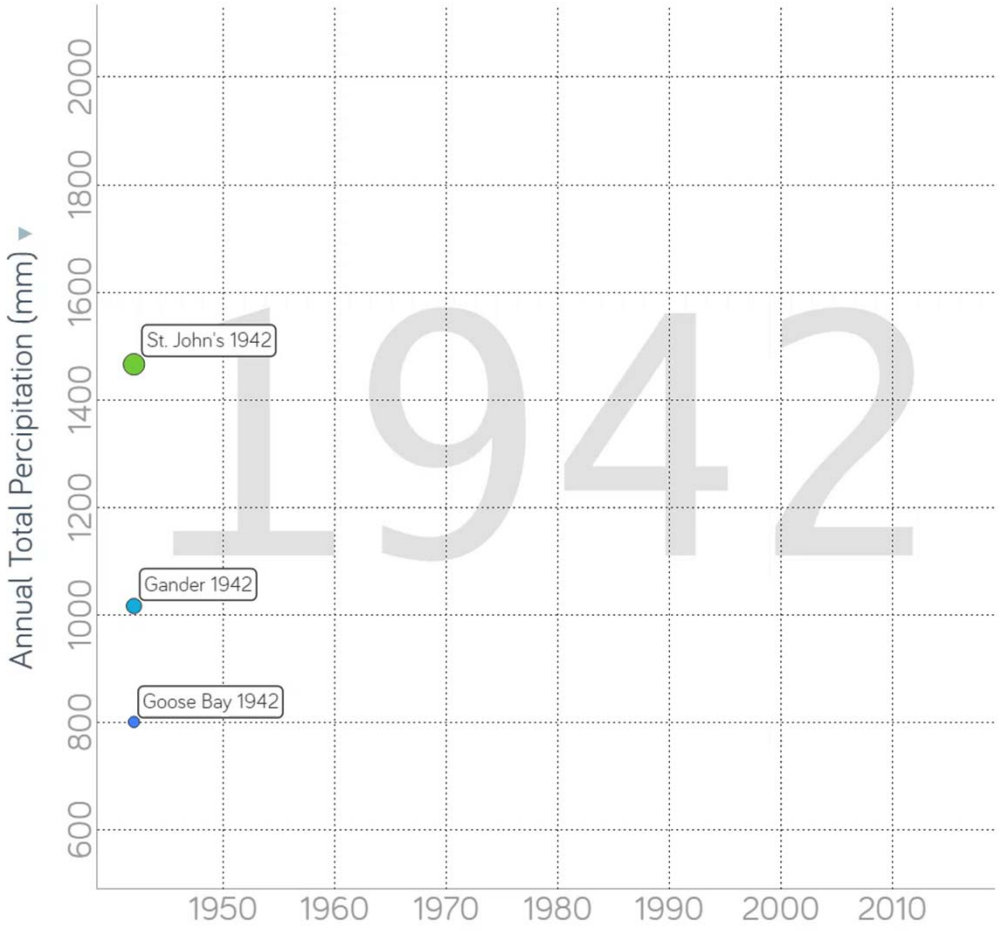


Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Observed Climate Change Effects: Precipitation

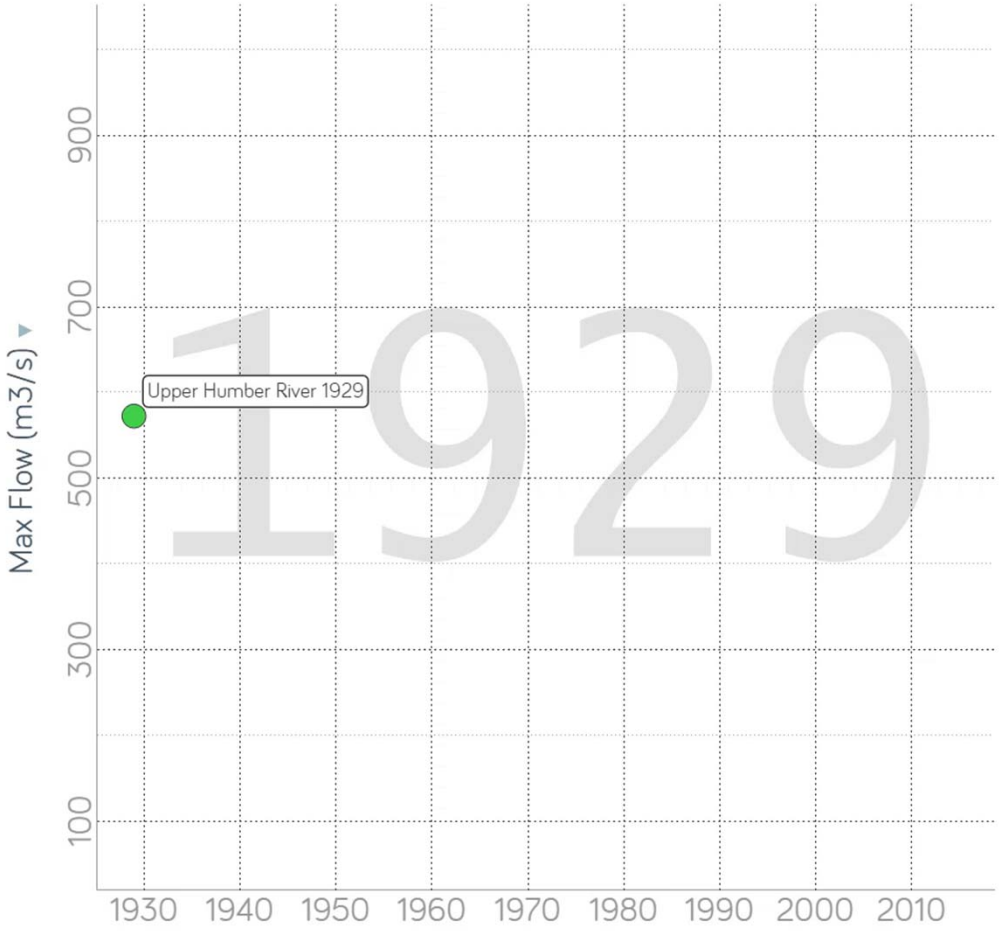


Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Observed Climate Change Effects: Streamflow

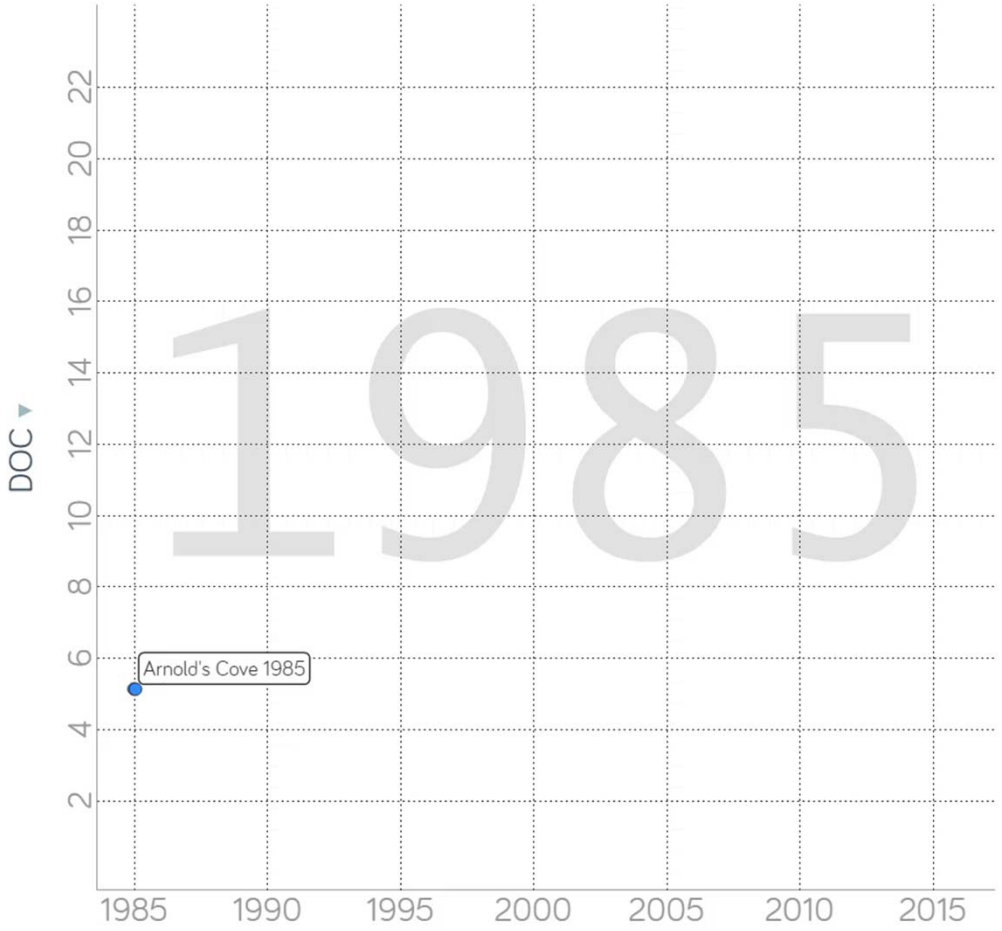


Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Observed Climate Change Effects: Water Quality

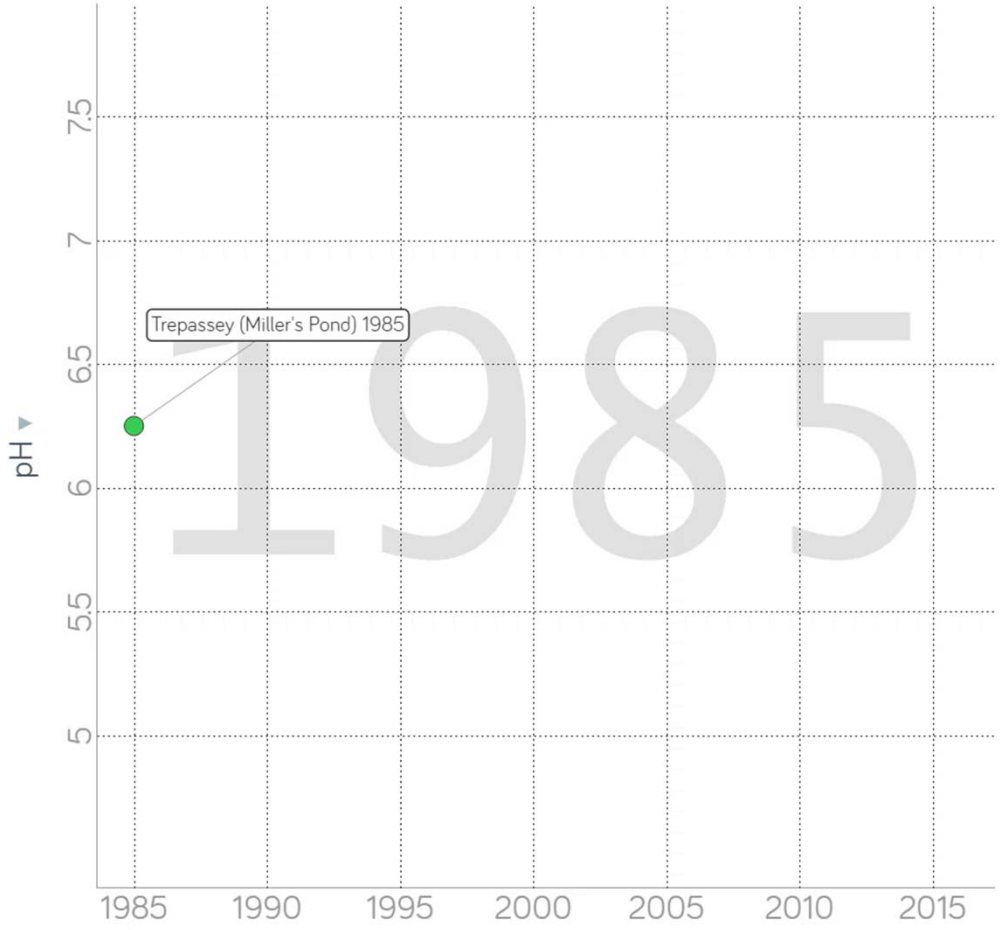


Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Observed Climate Change Effects: Water Quality



Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Observed Climate Change Impacts on Drinking Water Systems in NL

- Greater variability in source drinking water quality
- More water shortages
- Water supply dam failures increasing
- Storm surge and saltwater inundation (Ramea)
- Sediment and debris accumulation in surface water reservoirs
- Forest fires in water supply areas
- More algae and taste and odour issues
- Ice issues with intakes
- Increased risk of waterborne illness outbreaks after heavy rainfall events
- Alterations in lake turn-over times
- Landslides
- More groundwater quantity and quality issues
- Flooding and storm surge damaging infrastructure
- Wind damage
- Coastal erosion
- Power outages
- Interruption in transportation networks and shipping
  - Roads
  - Ferries
- Increased water demand
- More communities with water conservation programs

- **Combination of events can exacerbate the vulnerability**

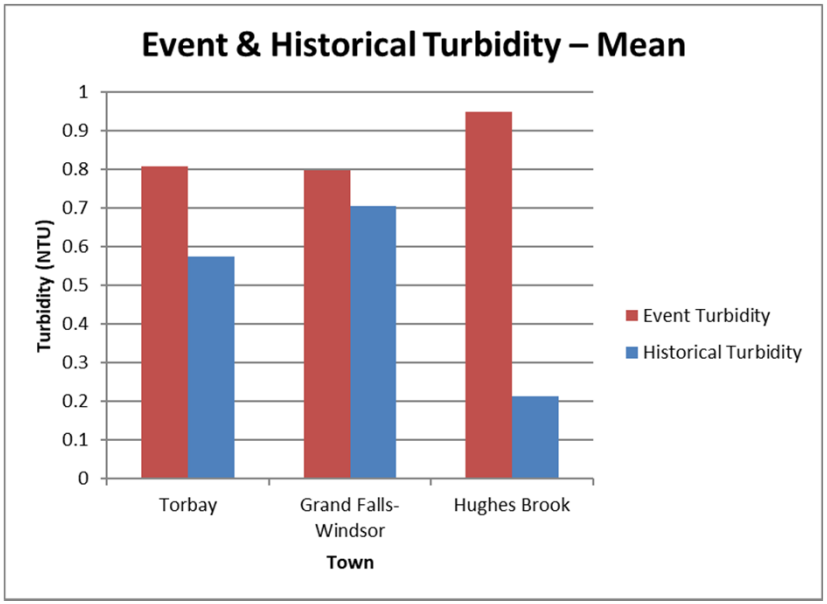
Newfoundland Labrador

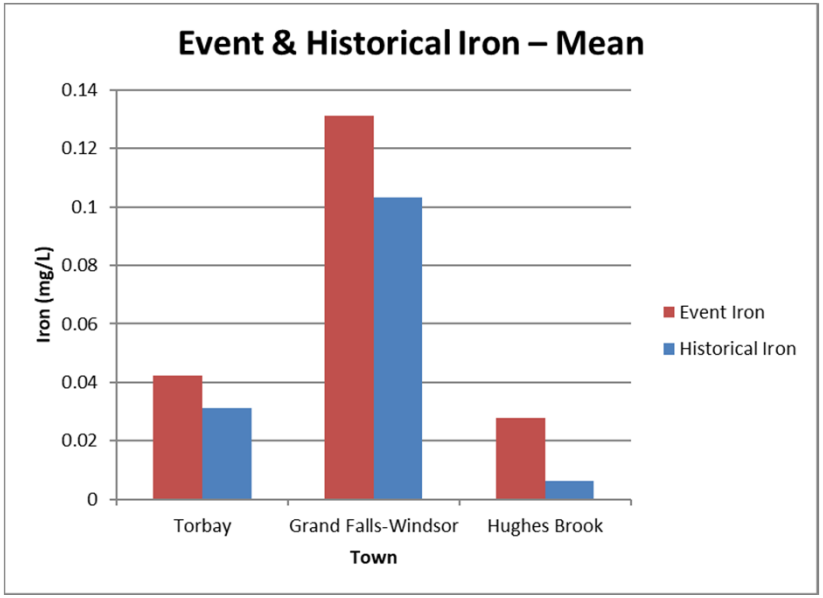
Water Resources Management Division

Department of Environment & Conservation

# Water Quality Variability

- Event based sampling indicates significant increases in some parameters from historical means after high rainfall events
- Challenges for water treatment and disinfection
- More variability in source water quality makes water treatment more challenging



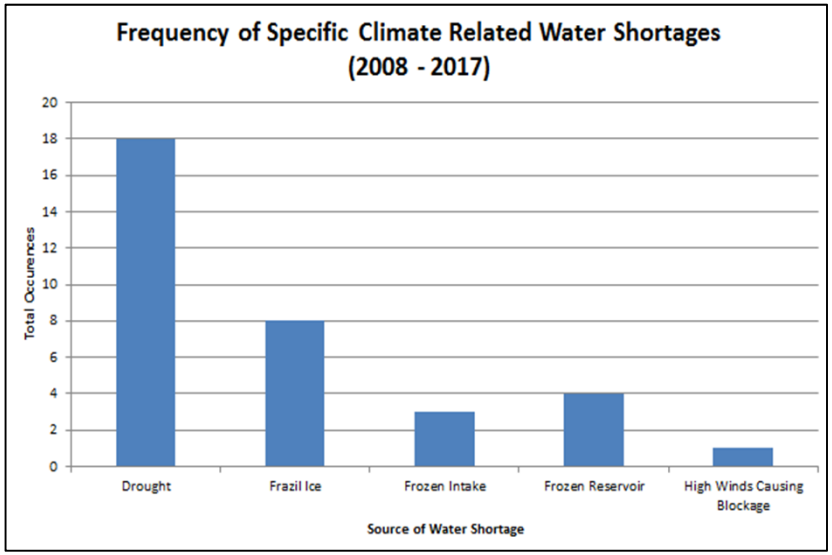
Newfoundland Labrador

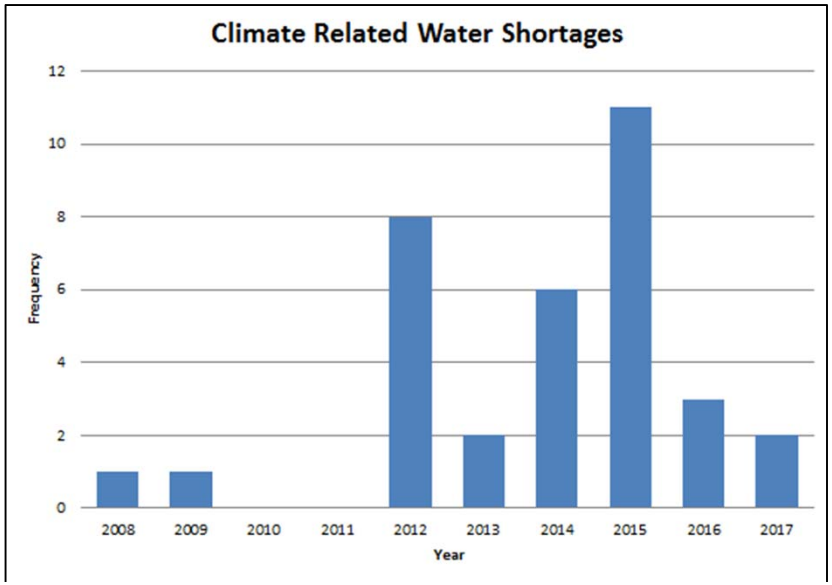
Water Resources Management Division

Department of Environment & Conservation

# Water Shortages

- 31% of water shortages in province caused by climate conditions
  - 2012- 8 shortages due to drought
- Majority of climate shortages linked to drought
- Frequency of occurrence of water shortages increasing



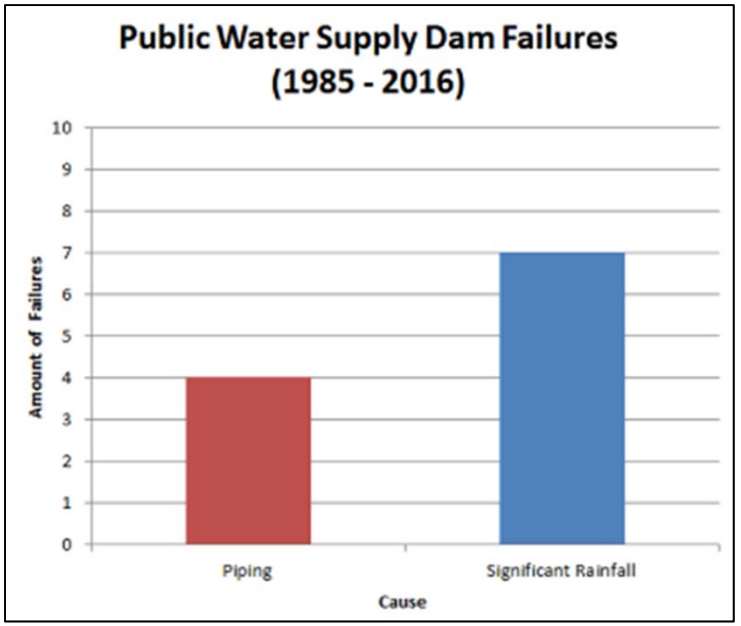
Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Water Supply Dam Failure

- 11 water supply dam failures have occurred in the province
  - Majority due to high rainfall events
- 1-in-400 chance of a water supply dam failure in any given year
- Past dam failures have resulted in:
  - loss of water supply for the community
  - the washout of roads in some cases isolating the community from the rest of the province
  - millions in economic loses and rehabilitation costs
- Dam design flow may no longer be adequate




Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Reservoir Issues

- During high rainfall events there is sediment deposition in the reservoir as the dam blocks the free movement of eroded material and debris
- Accumulation of sediment in the reservoir can impact drinking water quality with higher levels of turbidity, colour and iron
- Reduces storage capacity in reservoir
- Intakes can become buried in sediment and draw sediment into the distribution system
- Debris can also block dam spillways reducing the capacity of the dam to spill water

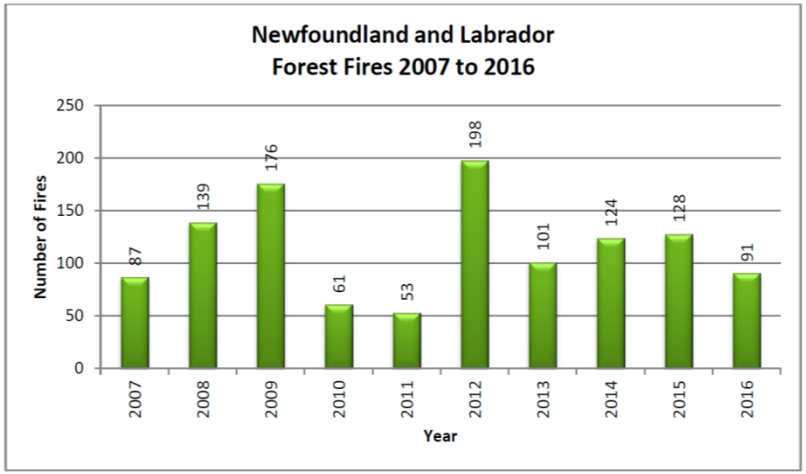

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Forest Fires

- Average of 116 forest fires per year
- Dry years (2012) when a number of communities also experienced water shortages, tend to have more forest fire incidents
- Water bombers using water sources for fire fighting
- Dropping fire retardant foam in water supply areas




Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Ice and Intakes

- More incidents of frazil ice blocking intakes
  - Nov-Dec
- Intake damage due to weight of ice and snow
- Intake ponds frozen to the bottom of the pond

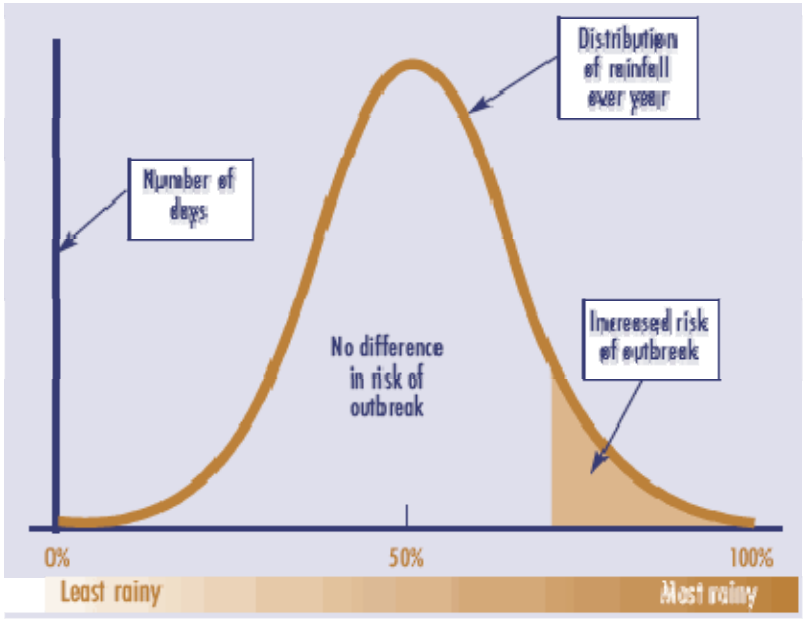
Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Waterborne Illness

- 10 waterborne illness outbreaks in NL between 1983 and 2002
  - Outbreaks occurred in months with above average monthly rainfall
  - Month of outbreak had at least one high rainfall event
    - 20 mm of rainfall or more
- Warmer temperatures and very heavy rainfall increase the risk of waterborne disease outbreaks within a six-week period



Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Landslides and Coastal Erosion

- Triggered by heavy rainfall events
- Sediment and debris from landslides
  - Damming water sources
  - Impeding access roads
  - Clogging up reservoirs
- Moving water mains away from areas susceptible to coastal erosion

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Groundwater

- Quality
  - Increase in concentration in contaminants with less recharge
    - Strontium
    - Arsenic
  - More dirty water incidents at wells with lack of recharge to aquifer
  - More saltwater intrusion into groundwater wells
- Quantity
  - Less recharge to groundwater aquifers
    - Effects are seen months later
  - Over pumping of wells is damaging permeability of surrounding soil and decreasing recharge
  - Too much recharge in low lying areas

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Flooding and Storm Surge

- Water infrastructure being flooded and damaged
  - Groundwater pump houses
  - Chlorination buildings
  - Pump houses
  - Water mains
- Storm surge destroying water mains along low lying areas
- Access roads being damaged

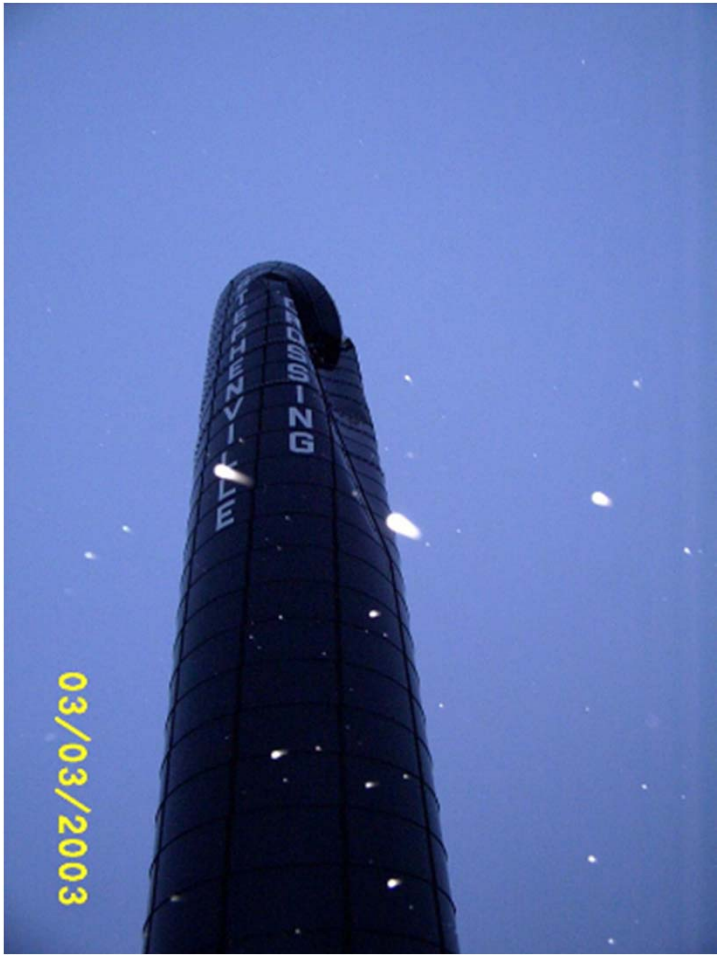
Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Wind Effects

- Wind damage to storage tanks, water treatment buildings, pump houses
- Sediment turn up in water supply ponds affecting water quality



Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Reducing Vulnerability to Climate Change Impacts- General

- Keep infrastructure out of flood zones
  - Flood risk maps for NL communities available at: http://www.mae.gov.nl.ca/waterres/flooding/flooding.html#risk
- Have dam break flood inundation mapping available for your water supply dam
- Keep infrastructure above projected sea level rise
- Greater awareness of forecasted climate warnings
  - Increased time for operators to prepare
- Protect groundwater recharge zones
- Source water protection
- Having Emergency Management Plan in place
- Establish a municipal water conservation program
- Insurance
- Establish mutual aid agreements with neighboring communities
- Climate change impacts and adaptation training

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Reducing Vulnerability to Climate Change Impacts- Design

- Incorporate climate change into the design
  - Climate change IDFs available at: http://www.exec.gov.nl.ca/exec/occ/publications/idf_curve_2015.pdf
  - Design of dams and road culverts
  - Designing for "safe failure" vs. "fail safe"
- Increased flexibility in design of drinking water systems:
  - Multi-level intakes
  - Systems to deal with frazil ice on the intake
  - System redundancy
  - Storage tank mixing
  - Increase treatment capability
- Design of WTPs should consider expected future water quality variability
- Retroactive climate change proofing
  - Armoring flood prone areas
  - Relocation of infrastructure
  - Upgrading infrastructure to maintain or prolong its useful life under changing climate conditions
- Consider infrastructure adaptation and resilience to climate change as part of design
- Alternative and emergency water supply sources

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Reducing Vulnerability to Climate Change Impacts- Operations

- Monitor weather, flood, and surface water conditions
- Changing routine operational practices to be more responsive to extreme events:
  - Increasing chlorine dosage
  - Optimize water treatment
  - Maximize tank storage capacity
  - Ensure dam spillway not blocked
- Ensure adequate water treatment chemical supply
- Operational measures to isolate and protect the most vulnerable systems or assets
- Water metering
- Leak detection
- Regular clean out of impounded reservoirs to remove accumulated sediment
- Ensure any access road culverts are unblocked
- Planning operations around power failures and communications blackouts
  - Ensure adequate fuel supply for generators
- Additional/revised O&M and inspection procedures
- Understand your climate risks
  - Examine operating conditions in light of the potential for climate change challenges

Newfoundland Labrador

Water Resources Management Division

Department of Environment & Conservation

# Climate Change Adaptation Strategies

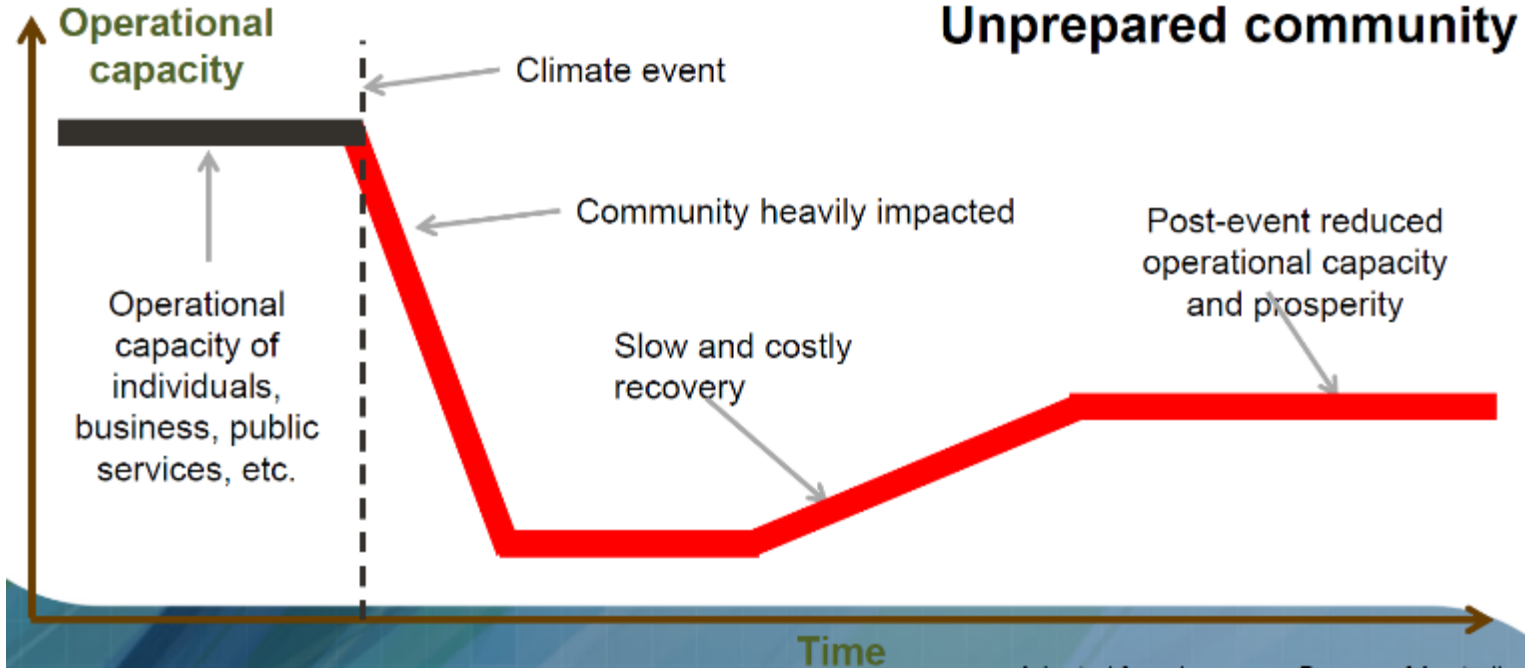
- **Planning strategies:**
  - Use of models
  - Research
  - Training
  - Supply and demand planning
  - Natural resource management
  - Land use planning
  - Collaboration at watershed and community scales
- **Operational strategies:**
  - Efficiency improvements
  - Monitoring
  - Inspections
  - Conservation
  - Demand management
  - Flexible operations
- **Capital / infrastructure strategies:**
  - Construction
  - Water resource diversification
  - Repairs, retrofits and upgrades
  - Phased construction
  - New technology adoption

Newfoundland Labrador

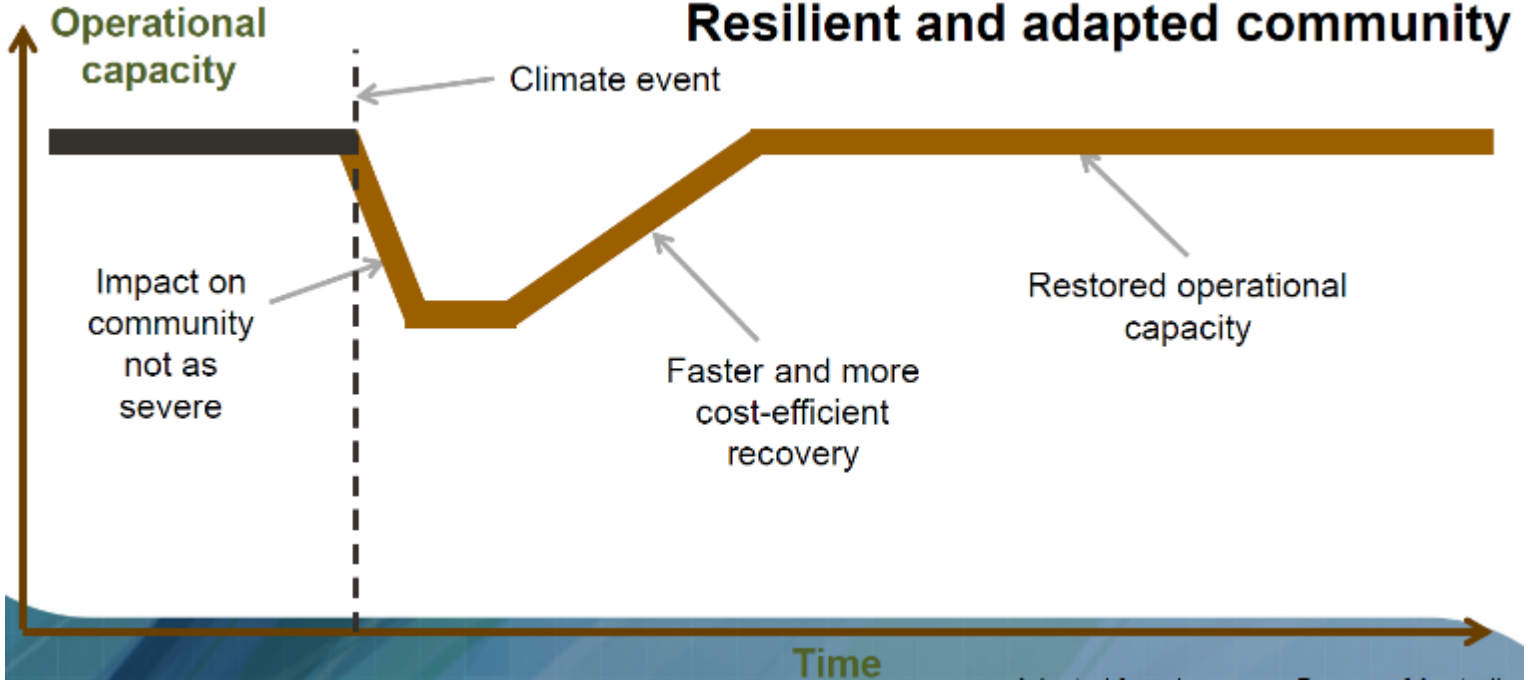
Water Resources Management Division

Department of Environment & Conservation

## Unprepared community




## Resilient and adapted community



Newfoundland Labrador

Water Resources Management Division

# Path Forward

- Government to produce guidance document on flooding and public water supplies
- Develop more community flood risk maps
- Develop dam break flood inundation mapping for municipal water supply dams
- Develop storm surge mapping for low lying coastal communities
- Improved forecasting and alert systems for flooding, drought, or other conditions that may affect drinking water systems
- Event based source water sampling to better understand water quality variability
- SOP for operating drinking water systems during extreme weather events
- Develop guidance for communities on water conservation programs
- Application of the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol to assess vulnerability of drinking water infrastructure to climate change
  - https://pievc.ca/

Newfoundland Labrador

Water Resources Management Division

# Questions?