# CAMA ACAM

2023 CAMA CONFERENCE | MAY 29-31, 2023 | DEERHURST RESORT, ON

# “INNOVATIVE BEST PRACTICES FOR BUILDING CAPACITY & COMMUNITY RESILIENCE IN THE FACE OF A CHANGING CLIMATE”


FEUX DE FORÊT
DIRECT
L'ÉTAT D'URGENCE DÉCLARÉ EN ALBERTA

## Let's face it!

Local government must make a sharp turn to deal with the issues that will accompany future events in order to reduce their community's overall vulnerability.

# MEET THE PANELLISTS

Raffaelle Di Stasio

Ian McVey

Mike Dolter

Matt Osler

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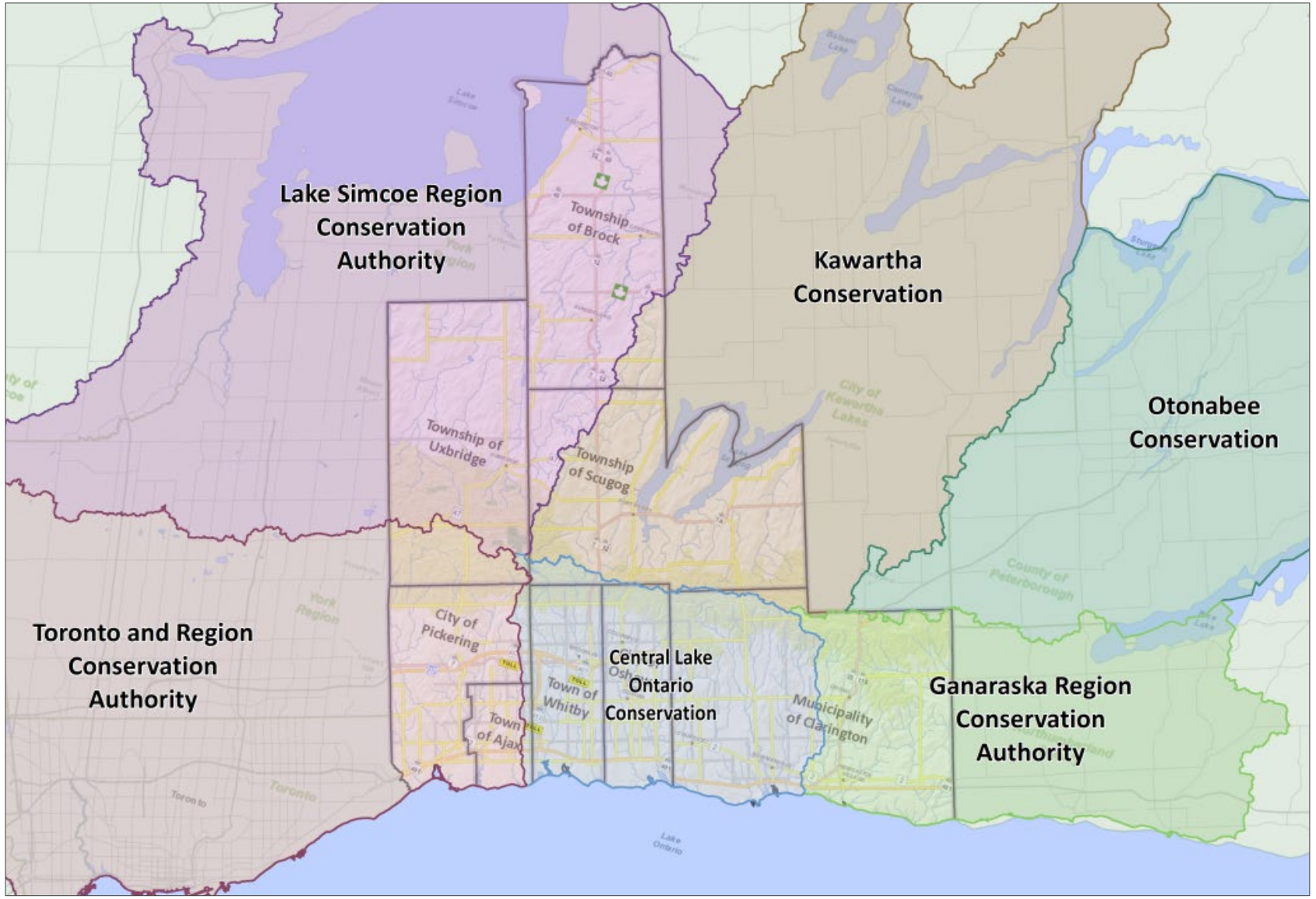
# Moving Beyond Resilience Planning Towards Implementation – Durham Region Transportation Infrastructure Case Study

Ian McVey, Manager of Sustainability
Office of the CAO – Strategic Initiatives Division
CAMA Conference Climate Change Panel - May 30th, 2023

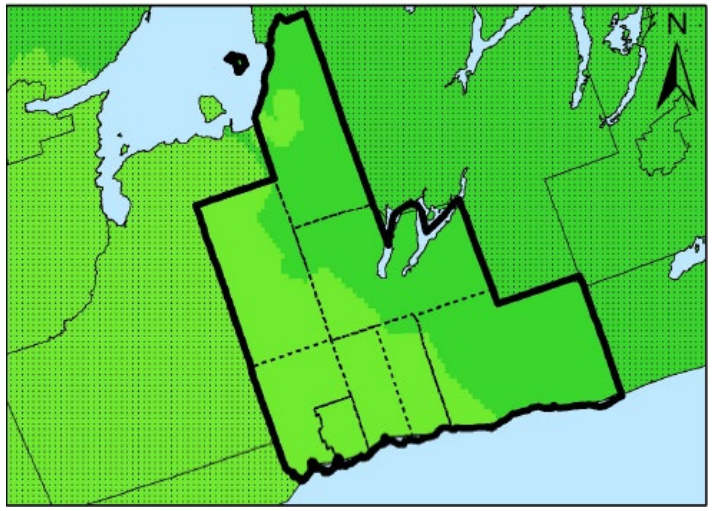
# Introduction to Durham Region & Stakeholders in Flood Management

- Regional Municipality of Durham
- 8 Local Area Municipalities
- 5 Conservation Authorities



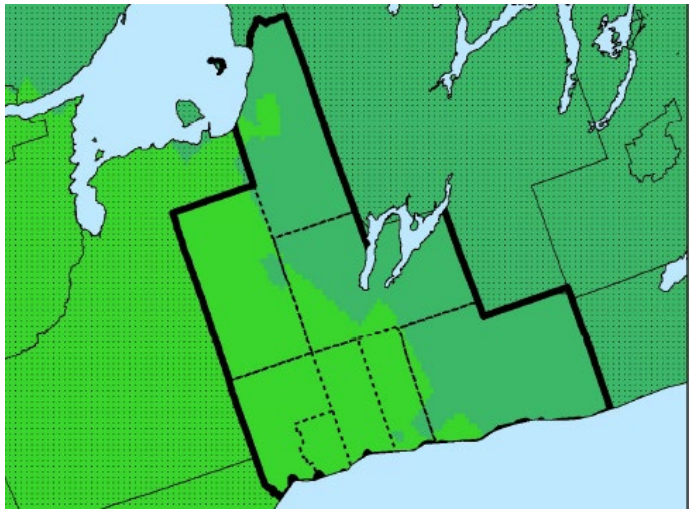
# Durham's Future Climate Projections

2020s



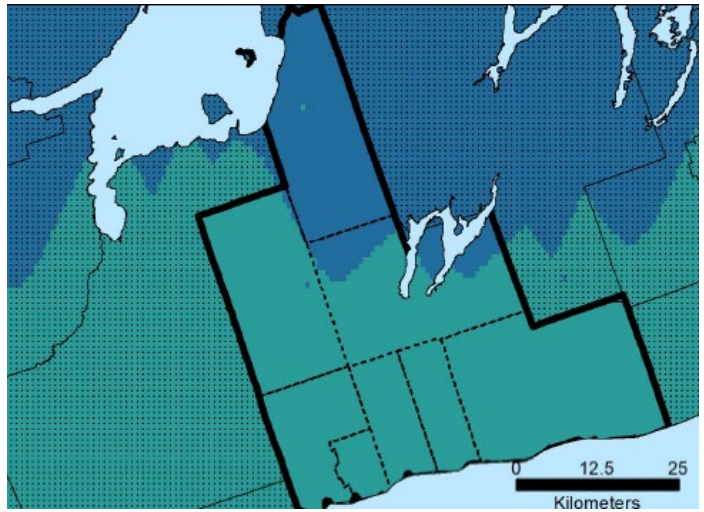

Baseline

2050s



17%

2080s




29%

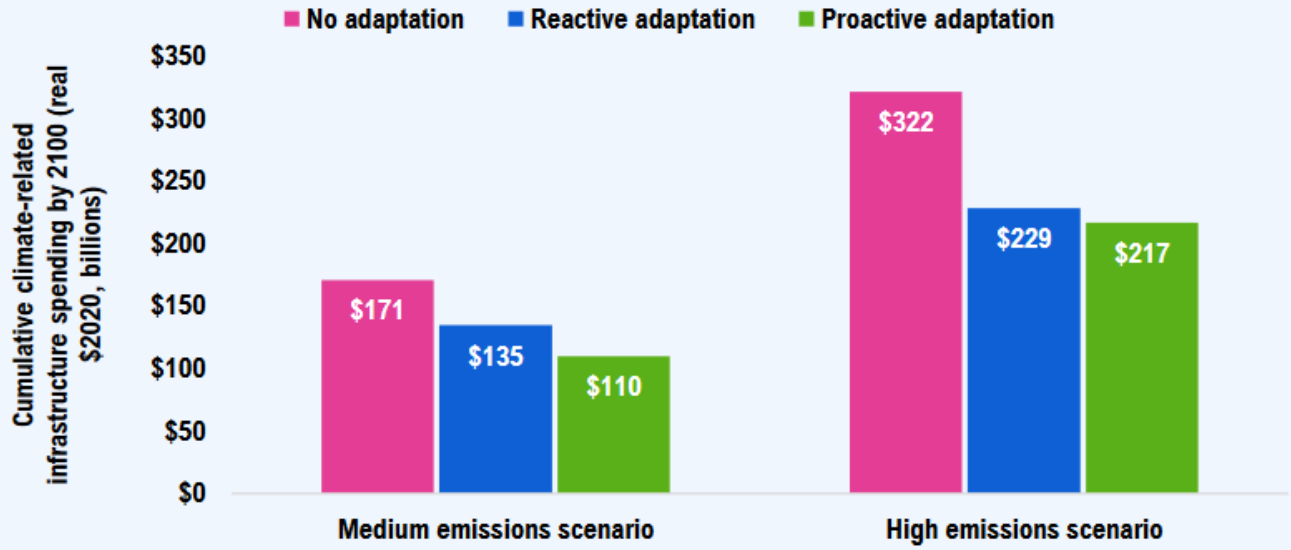
Average rainfall increase

# Financial Accountability Office of Ontario: Costing Climate Change Impacts to Public Infrastructure

- Cost to maintain existing portfolio is **substantial**, even in a stable climate
- Changes in extreme rainfall, extreme heat and freeze-thaw cycles are **already increasing** costs
- Climate hazards will continue to **increase the costs of maintaining** transportation infrastructure
- Adapting public transportation infrastructure to withstand these climate hazards **will cost less than not adapting over the long term**

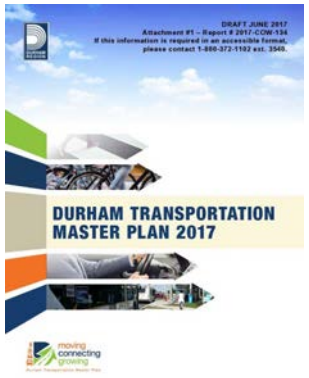
Figure 2-1

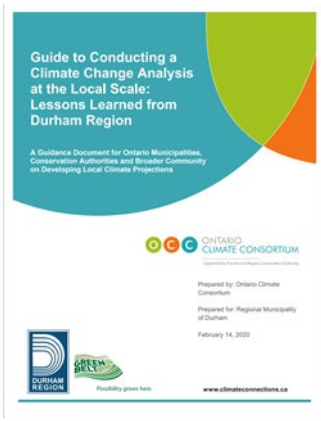
**Adapting Ontario's public transportation infrastructure will cost Provincial and municipal governments less than not adapting in a changing climate**




Note: The costs in this chart are based on the median (or 50th percentile) projection under each emissions scenario and are in addition to the baseline costs over the same period. For presentation purposes, the uncertainty bands are not shown in this figure.
Source: FAO.

# Durham's Climate Adaptation Journey to Date




ENVISION DURHAM

2014 Climate Adaptation Task Force set up

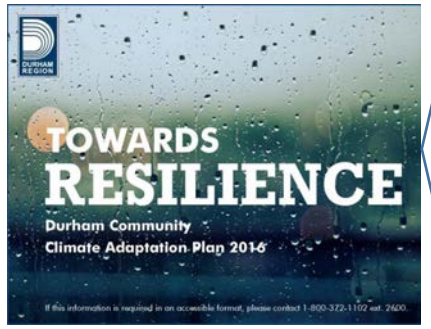
2016 Community Climate Adaptation Plan complete

2017 Adaptation Plan incorporated into the TMP

2019 Flood Risk Assessment begins

2022 TRCA Systems Level Assessment Complete

2023 Adaptation Incorporated into Official Plan




**Transportation**
Building
Electrical
Health
Food Security
Nat. Environment
**Flooding**

# Flood Risk Assessment Strategy for Transportation Infrastructure Assets

Climate Projections (Shifts in Storm Return Periods)

e.g. "Today's 100 yr. storm will be tomorrows 30 yr. storm"

e.g. how critical is the road crossing/segment to the community the Region serves?

Vulnerability Assessment → Criticality Assessment → Prioritization

e.g. Does the road crossing meet performance criteria under current/future storms?

e.g. where does this fit into the capital/asset management plan?

# Criticality Assessment

**Assessment Criteria**

Functional Road Classification

Traffic volume

Transit routes

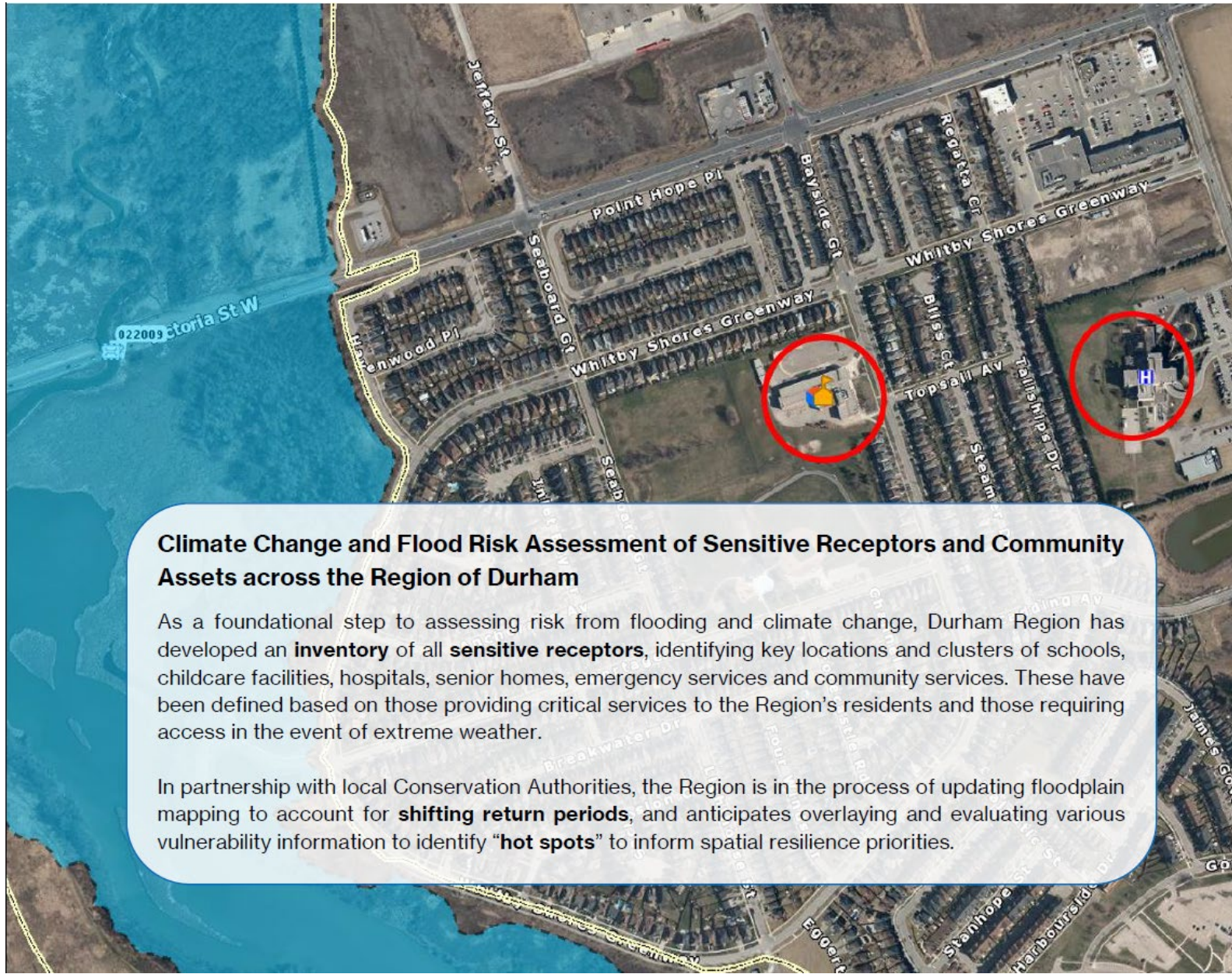
Goods movement routes

Degree of redundancy

Evacuation and disaster recovery-proximity to nuclear hazards

Sensitive receptors

Social equity and justice




**Climate Change and Flood Risk Assessment of Sensitive Receptors and Community Assets across the Region of Durham**

As a foundational step to assessing risk from flooding and climate change, Durham Region has developed an **inventory** of all **sensitive receptors**, identifying key locations and clusters of schools, childcare facilities, hospitals, senior homes, emergency services and community services. These have been defined based on those providing critical services to the Region's residents and those requiring access in the event of extreme weather.

In partnership with local Conservation Authorities, the Region is in the process of updating floodplain mapping to account for **shifting return periods**, and anticipates overlaying and evaluating various vulnerability information to identify "**hot spots**" to inform spatial resilience priorities.

# Climate Justice

**Social Equity Measures**

Low-income

Unemployment

Mental health

Indigenous population

Visible minorities

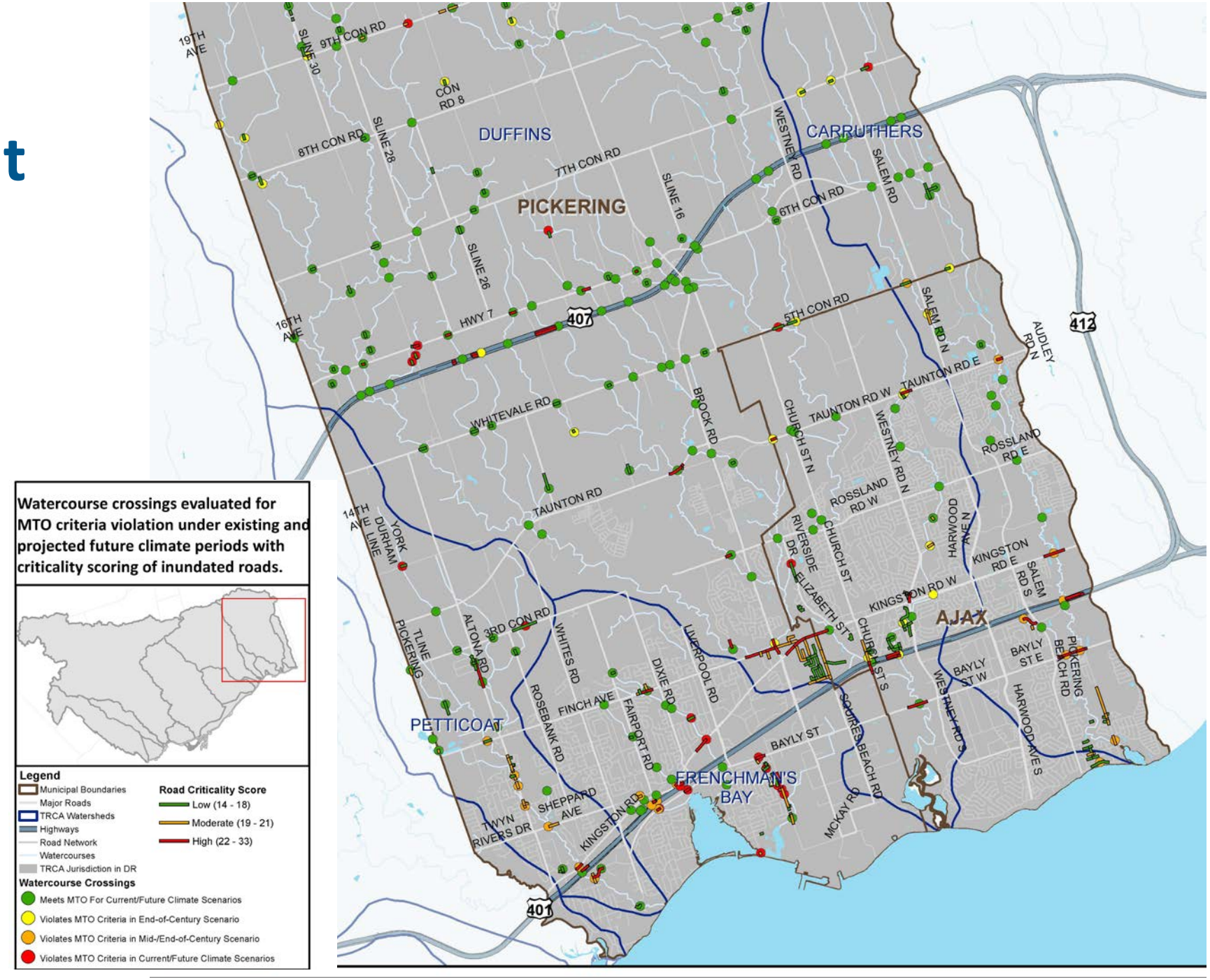
Seniors living alone

**Exposure** to climate change impacts is not evenly distributed.

Communities are not equally **prepared**.

Some communities are more **vulnerable** than others.

# Criticality Assessment Results




**Watercourse crossings evaluated for MTO criteria violation under existing and projected future climate periods with criticality scoring of inundated roads.**



**Legend**

- Municipal Boundaries
- Major Roads
- TRCA Watersheds
- Highways
- Road Network
- Watercourses
- TRCA Jurisdiction in DR

**Road Criticality Score**

- Low (14 - 18)
- Moderate (19 - 21)
- High (22 - 33)

**Watercourse Crossings**

- Meets MTO For Current/Future Climate Scenarios
- Violates MTO Criteria in End-of-Century Scenario
- Violates MTO Criteria in Mid-/End-of-Century Scenario
- Violates MTO Criteria in Current/Future Climate Scenarios

# Next Steps

- Continue to mainstream adaptation into high-level municipal policy documents (e.g. Regional Official Plan)
- Expand risk assessment/criticality assessment
- Detailed review of high risk crossing/segments
- Mainstream climate risk information into departmental decision-making systems (e.g. asset management, capital plans)
- Develop “resilience” project pipeline report

# Questions?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**durham.ca**
**@RegionofDurham**

# Lessons learned? What would you do differently?

# Truro Flood Mitigation Strategies

*May 30th, 2023*

*Mike Dolter CD, MBA, CPA, CMA*

*CAO, Town of Truro*

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# Outline

- Previous Flooding
- Mitigation Projects 2013 - 2016
- CBCL Flood Risk Study of 2017
- Salt Marsh Restoration Project

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# Previous Flooding


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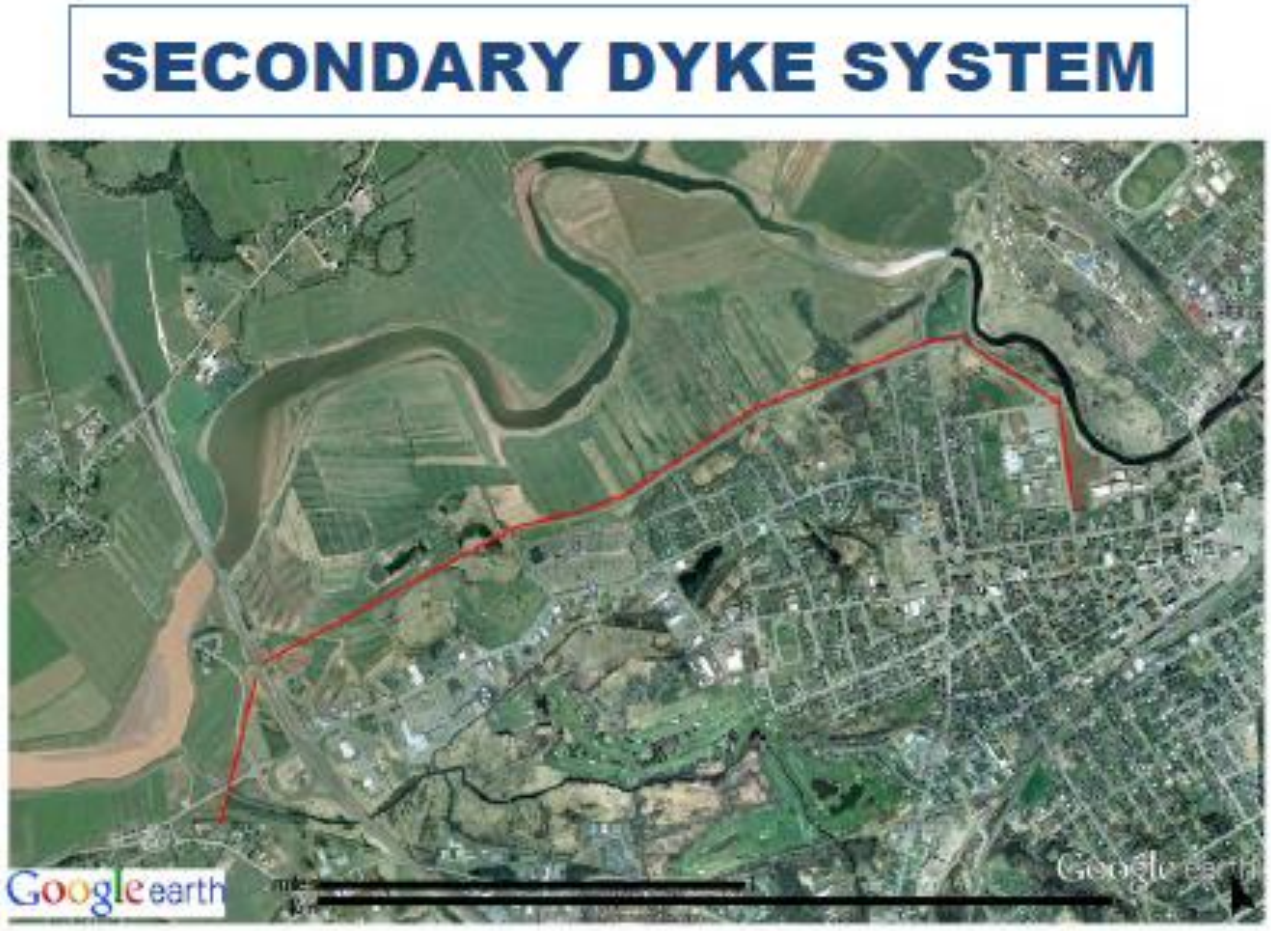
# Previous Flooding

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# Previous Flooding


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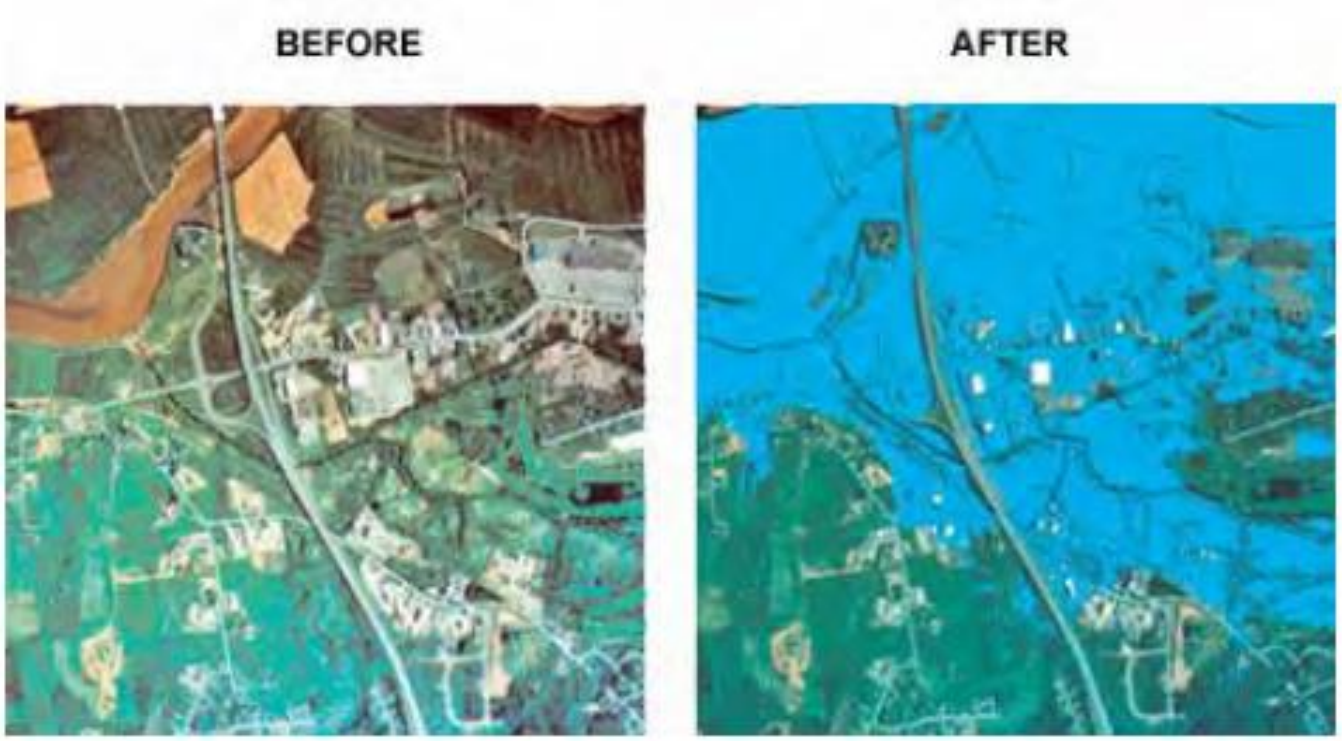
# Previous Flooding

## MAP OF 2M STORM SURGE

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# Previous Flooding

**SAXBY GALE - OCT 5, 1869**


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# Previous Flooding

**SAXBY GALE**

**Environment Canada**
**Computer Model**

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# Previous Flooding

| Flooding Types: | Solutions Considered: |
| --- | --- |
| Extreme Rain Events | Stormwater management<br>Floodwater Management |
| Ice Jams | Secondary Dike System<br>Reinstate Salt Marsh |
| Storm Surge | Storm Surge Wall |

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# Mitigation Projects 2013–2016

## Floodwater Management - Riverbed Restoration

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# Mitigation Projects 2013–2016

## Floodwater Management - Riverbed Restoration


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# Mitigation Projects 2013–2016

## Floodwater Management - Dyke Restoration


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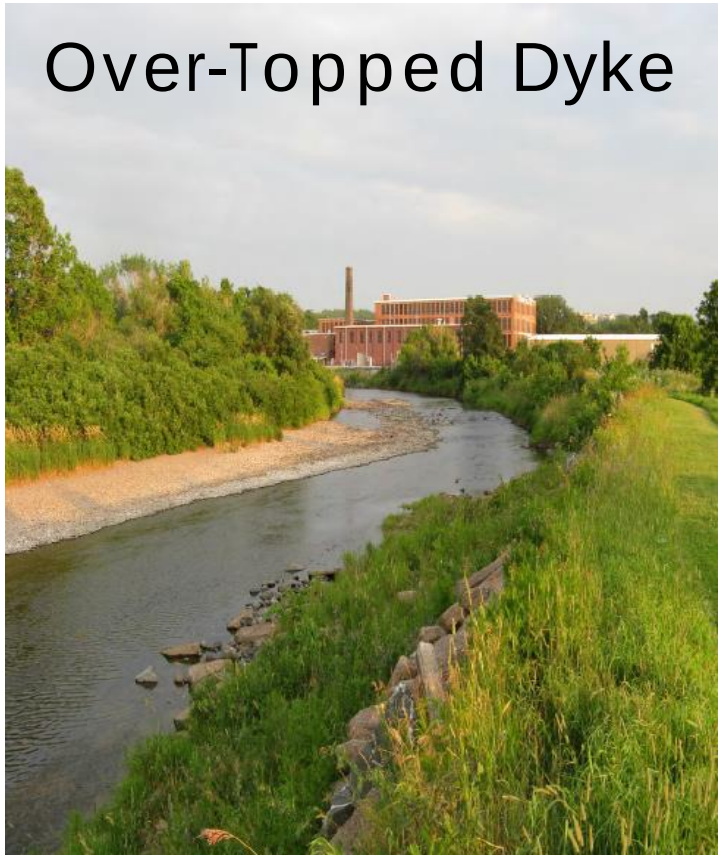
# Mitigation Projects 2013–2016

## Floodwater Management - Dyke Restoration

Over-Topped Dyke



Dyke Rebuild

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# Mitigation Projects 2013–2016

## Stormwater Management – Detention Ponds

School Property above streets with undersized storm pipes

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# Mitigation Projects 2013–2016

## Stormwater Management – Detention Ponds

### Black Brook above MFN Community

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# Mitigation Projects 2013–2016

## Stormwater Management – Other Projects

- Permeable Concrete Projects
- Rain Gardens in Downtown Parking Lots
- Bottomless Catchbasins disconnected from storm sewers
- Regulating Permeable surface areas in MPS

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# CBCL Flood Risk Study of 2017

## JFAC set out RFP for Flood Risk Study:

- 8-10 month project
- Major modelling exercise (LiDAR)
- Field data gathering
- Update floodplain boundaries
- Options for flood mitigation – short/long term
- Update standards, bylaws, policies
- Liaison with public, elected officials, province

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# CBCL Flood Risk Study of 2017

JFAC awarded $410,000 Study to CBCL in 2014


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# CBCL Flood Risk Study of 2017

## Main Goals:

- Present possible infrastructure projects and policy changes for flood mitigation
- Define new flood lines
- Assess impacts under various rain, ice and sediment conditions
- Focus on protection of priority areas
- Provide order of magnitude costs for various solutions

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# CBCL Flood Risk Study of 2017

## Flood Mitigation Options to be Evaluated:

- Reduce flows –storage and infiltration
  - Protect vulnerable areas –keep water out
  - Increase flow capacity
  - Control development
- Larger Project Options included:
  - Aboiteaux, new and modified
  - Modify, remove or relocate existing dykes
  - Construct new dykes
  - Modify existing river channels
    - In total 40 Options being Reviewed

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# CBCL Flood Risk Study of 2017

## Evaluation of Flood Mitigation Options:

| Option Name | Option Description | Cost Effectiveness | % Protection of Priority Areas | Net Cost | Recommend? |
|---|---|---|---|---|---|
| RaiseDykes 1 | Raise all Dykes by 1 m | 0.34% | 7.0% | $M 20.5 | - |
| RaiseDykes 2 | Raise all Dykes (Varied Height) to Contain all River Flood | 0.16% | 14.6% | $M 93.4 | - |
| RaiseDykes 3 | Raise all Dykes (Varied Height) to Contain all River Flood & Pump Drainage from Behind Dykes | 0.10% | 29.6% | $M 300.0 | - |
| RaiseDykes 4 | Build Dykes Upstream of CN Bridge to Protect Elizabeth St | 0.01% | 0.3% | $M 60.0 | - |
| | | | | | |
| Runoff Reduction 1 | Upstream Dams: North River, Salmon River, Farnham Brook and McClures Brook | 0.17% | 2.4% | $M 14.5 | - |
| Runoff Reduction 2 | Upstream Flow Control Dams on Farnham Brook | 0.05% | 0.2% | $M 3.7 | - |
| Runoff Reduction 3 | Construct Six Dams in McClures Brook to Reduce Flooding in McClures Brook | 0.20% | 1.0% | $M 5.0 | - |
| Runoff Reduction 4 | Implement Stormwater Detention Systems in Millbrook Area Upstream of Willow St Culvert | 1.20% | 1.0% | $M 0.8 | Recommended |
| Runoff Reduction 5 | Implement BMPs to Reduce Runoff to Pre-Development Conditions | 0.01% | 38.4% | $Bn 2.7 | Recommended, but through policies and by-laws |

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# CBCL Flood Risk Study of 2017

## Evaluation of Flood Mitigation Options:

| Option Name | Option Description | Cost Effectiveness | % Protection of Priority Areas | Net Cost | Recommend? |
|---|---|---|---|---|---|
| FloodPlain Restoration 1 | Widen Dykes to Larger Floodplain | 0.24% | 4.9% | $M 20.3 | - |
| FloodPlain Restoration 2 | Widen Dykes to Larger Floodplain, Add Dykes to Reduce Flooding in McClures Brook & Pump | 0.29% | 28.6% | $M 99.0 | Recommended |
| FloodPlain Restoration 3 | Add Wider Secondary Dyke System to Existing Dyke System (to Maintain Protection of Farmland) | 0.18% | 20.5% | $M 113.0 | - |
| FloodPlain Restoration 4 | Widen Dykes to Larger Floodplain & Pump Drainage from Behind Dykes | 0.09% | 1.9% | $M 22.0 | - |
| Floodway By-pass 1 | Floodway Bypass Channel - 100m Wide to McClures Brook (4.3km) | 0.36% | 9.0% | $M 25.0 | Recommended |
| Floodway By-pass 2 | Floodway Bypass Channel - 100m Wide - Extended to the WWTP (6km) | 0.41% | 13.2% | $M 32.0 | |
| Floodway By-pass 3 | Floodway Bypass - Extended to Lower Truro (7.75km) | 0.39% | 15.2% | $M 39.0 | |

OR

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# CBCL Flood Risk Study of 2017

## Evaluation of Flood Mitigation Options:

| Option Name | Option Description | Cost Effectiveness | % Protection of Priority Areas | Net Cost | Recommend? |
|---|---|---|---|---|---|
| Priority Area Protection 1 | Raise Priority Areas 1 -3 to Elevation 13m | -0.08% | -7.7% | $M 102.0 | - |
| Priority Area Protection 2 | Raise Priority Areas 1-8 to Elevation 13m | 0.56% | 79.0% | $M 118.0 | Recommended where other measures cannot help |
| Priority Area Protection 3 | Raise Priority Areas 1-8 (excluding Residential) & Purchase and Remove Residential Properties | 0.43% | 79.0% | $M 167.0 | |
| Priority Area Protection 4 | Raise Priority Areas 1-8 (excluding Residential) & Physically Move Residential Buildings | 0.43% | 79.0% | $M 167.0 | |
| Priority Area Protection 5 | Raise Priority Areas 1-4 to Elevation 13m | 0.56% | 66.0% | $M 140.0 | |
| Priority Area Protection 6 | Raise Priority Areas 1-4 (excluding Residential) & Purchase and Remove Residential Properties | 0.40% | 66.0% | $M 183.0 | |
| Priority Area Protection 7 | Raise Priority Areas 1-4 (excluding Residential) & Physically Move Residential Buildings | 0.40% | 66.0% | $M 183.0 | |
| Additional Infrastructure 4 | Raise Park Street, Install Culverts | -0.53% | -10.4% | $M 19.5 | NOT Recommended |

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# CBCL Flood Risk Study of 2017

## Study Conclusions:

- Flood levels are fairly consistent with all rain events
- Always be a risk of flooding
- Most effective approach -re establish natural/wider floodplain (ie a Salt Marsh Project)
- Most cost-effective approach - Implementing BMP for Stormwater Management

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# Salt Marsh Project

## Project Summary:

- Large tidal wetland (ie Salt Marsh) restoration project on the confluence of the North and Salmon Rivers
- ~90ha of tidal wetland restored
- Construction of two new dykes, two new aboiteauxs

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# Salt Marsh Project

## Project Summary:

- Created habitat offsetting for NSPW (HWY 101 twinning – Windsor NS).
- Reduced length of dykes maintained by Dept of Ag
- Provided flood mitigation for Town of Truro
  - Key recommendation from CBCL Flood Study

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# Salt Marsh Project


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# Salt Marsh Project

## Project Implementation:

- Rigorous baseline data
  - Topographic surveys, hydrology, flood and drainage modelling, ecology and mosquito monitoring.
- Data informed dyke configuration, breach locations, and internal drainage modifications
- Ongoing monitoring plan (5 yrs) by CBWES/SMU
  - Several Research, Masters' and PhD studies (SMU, Dal, StFX, McGill)

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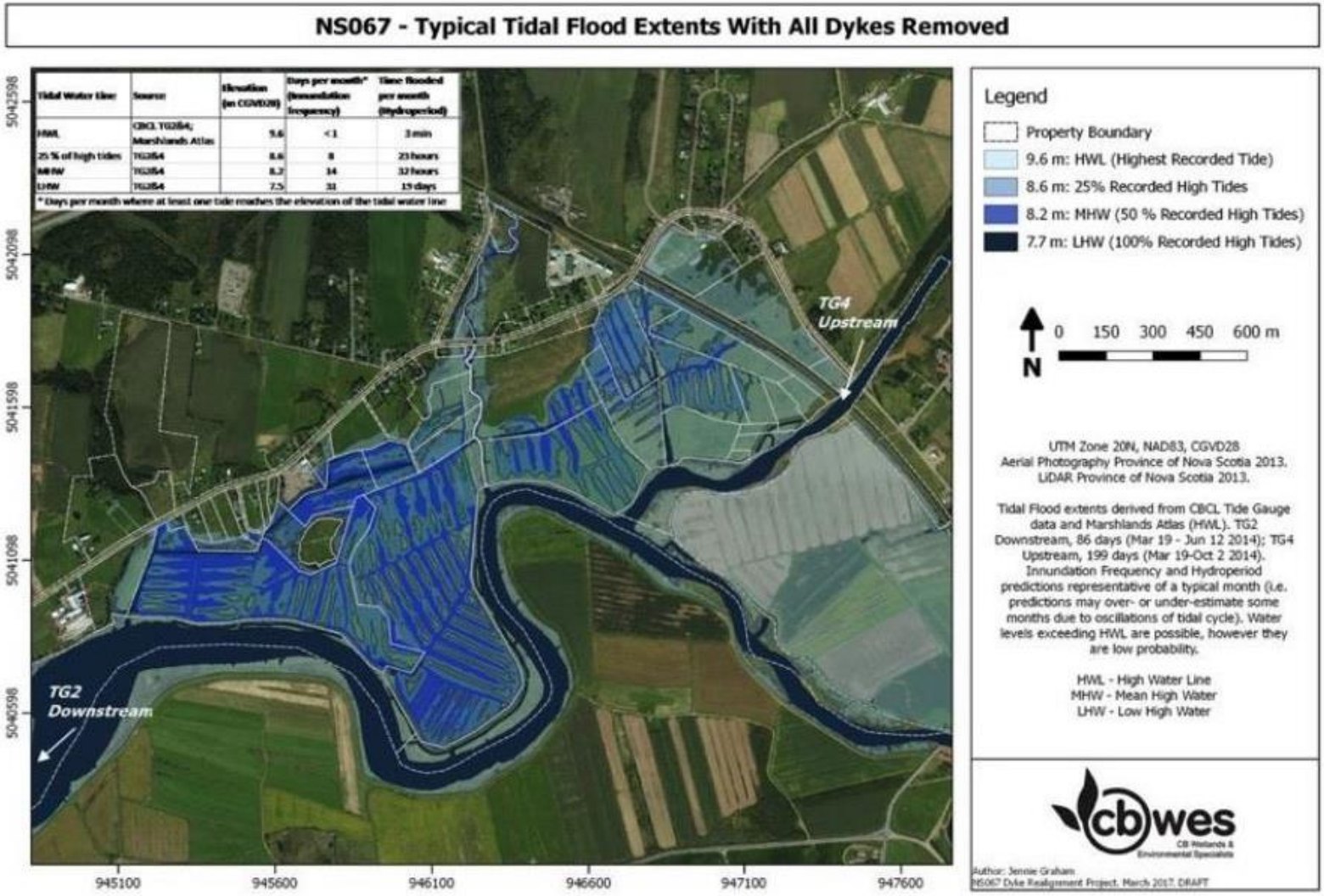
# Salt Marsh Project

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# Overall Lessons Learned

- NO SILVER BULLET to prevent flooding
- Best method is to re-establish as many natural systems as possible
- Always follow Stormwater Management Best Practices and promote Low Impact Development

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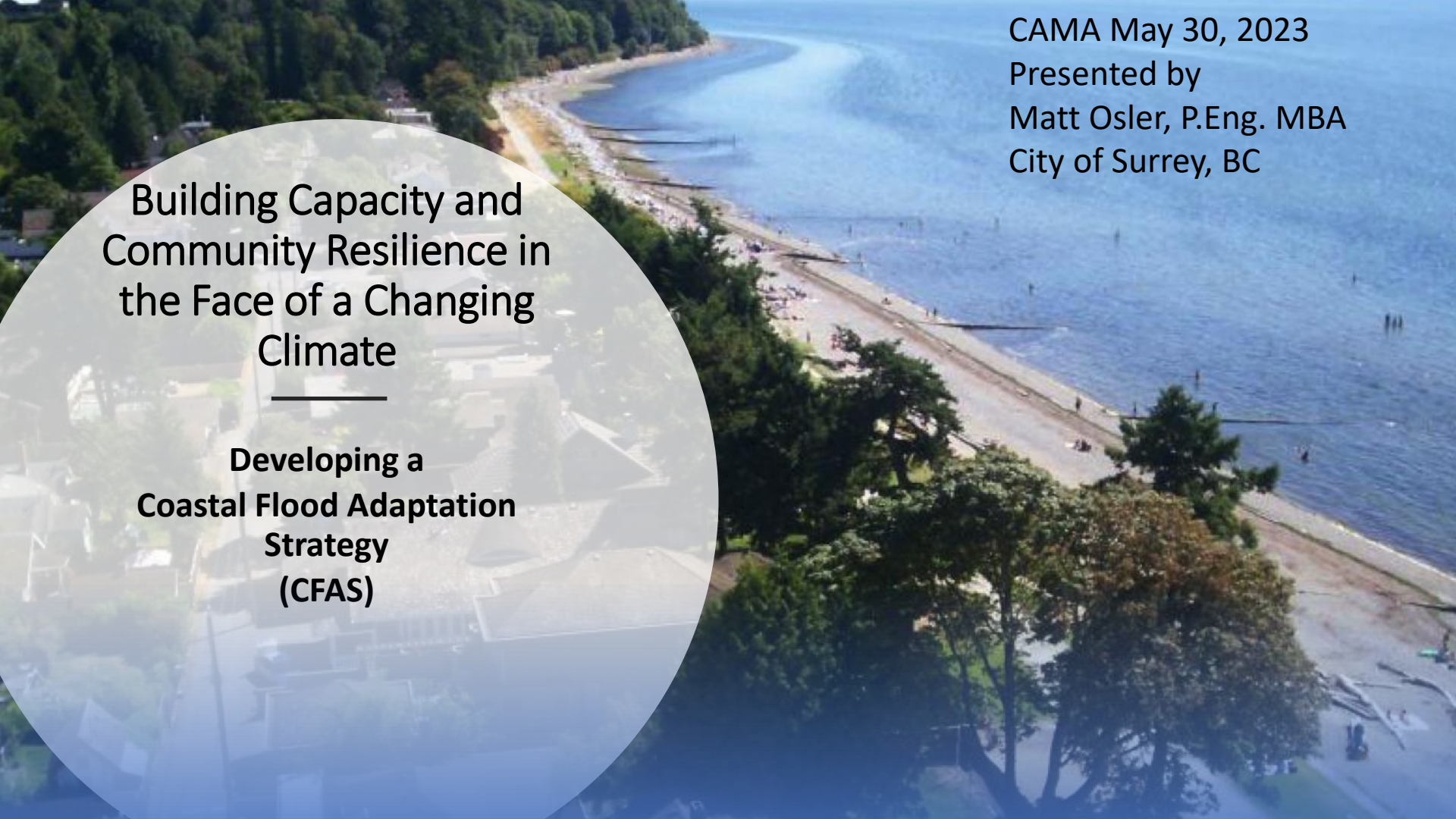


# Building Capacity and Community Resilience in the Face of a Changing Climate

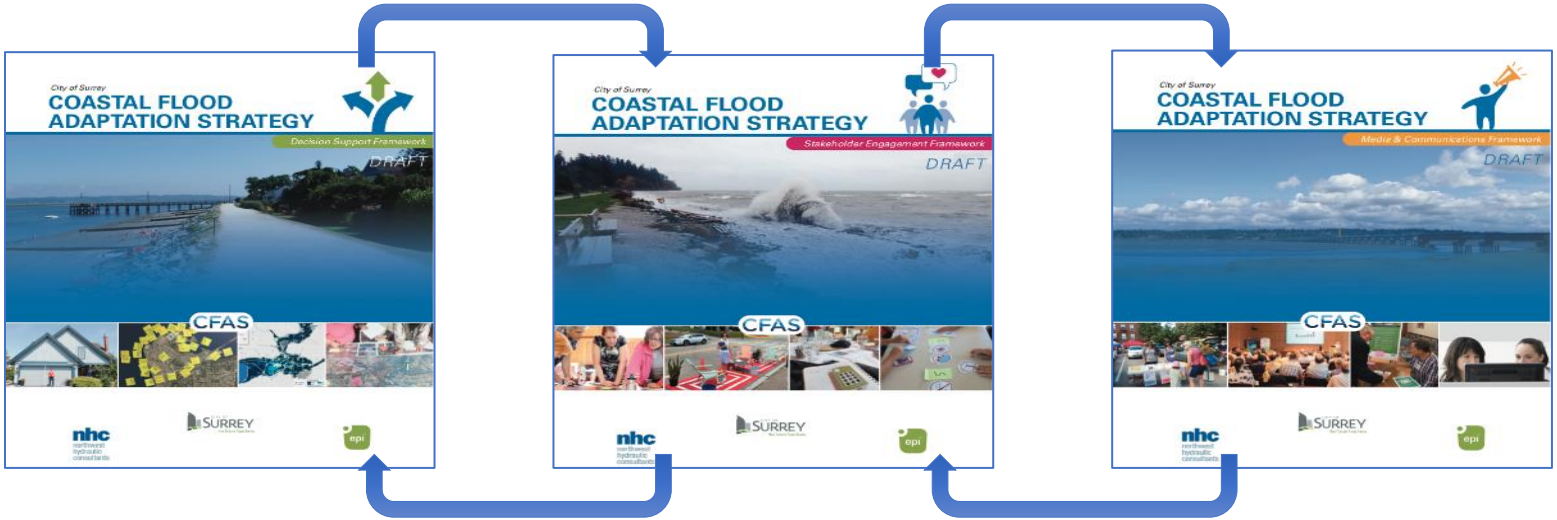
**Developing a Coastal Flood Adaptation Strategy (CFAS)**

CAMA May 30, 2023
Presented by
Matt Osler, P.Eng. MBA
City of Surrey, BC

# Project Summary

Coastal Flood Adaptation Strategy

- What
  - Engage public, stakeholders and partners in a **participatory, decision-making process**
- Goal
  - Develop a **broadly supported strategy to increase resilience to coastal flooding**
- How
  - Through a linked and integrated framework of decision support, engagement and communication 2016-2019



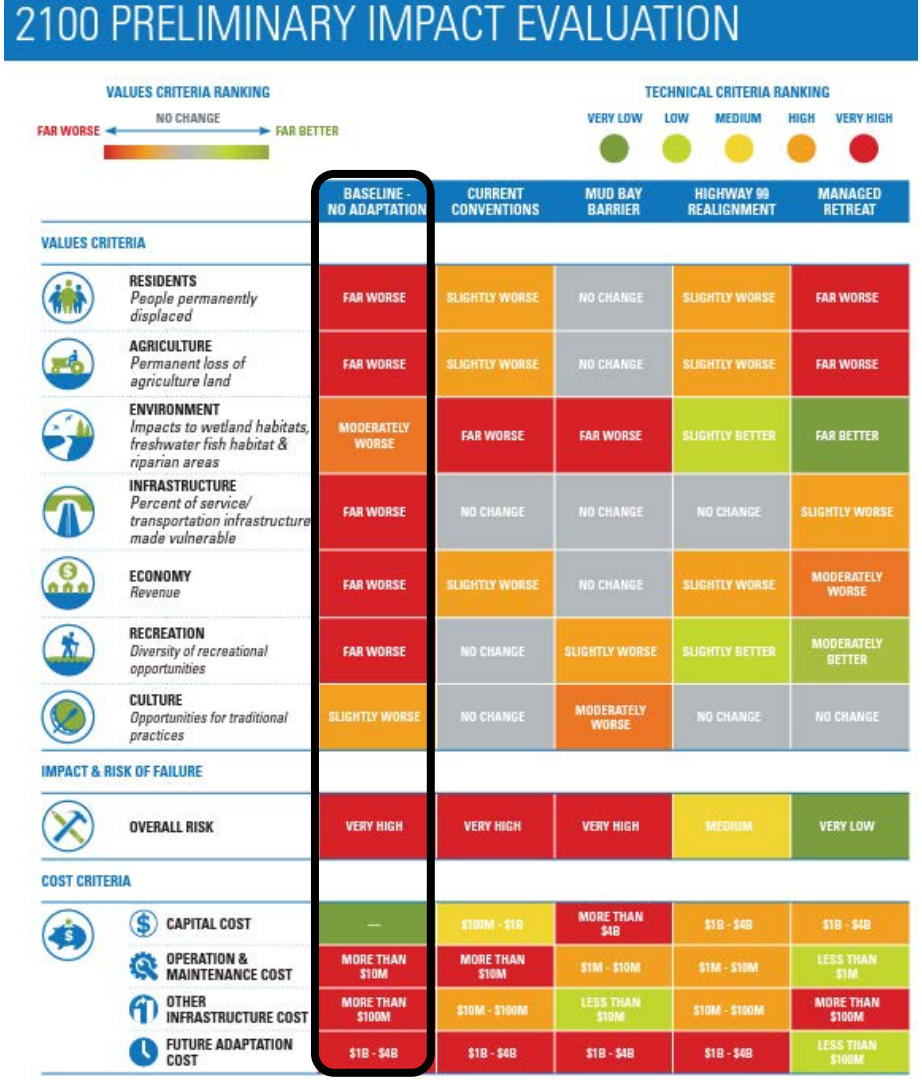
# Process


Foundational Studies

2011-2015

2019-2027

- ✓ Additional grant funding for in-depth studies
- ✓ Funding through Federal Disaster Mitigation & Adaptation Fund (DMAF)
- ✓ Additional Cost Sharing Partnerships




# Iterative Process to select Strategic Directions

- 4 options **shortlisted** for each study area
- Survey, Advisory Group, Focus Group review and evaluation narrowed down to 1 **strategic direction** for each study area

# What Worked?

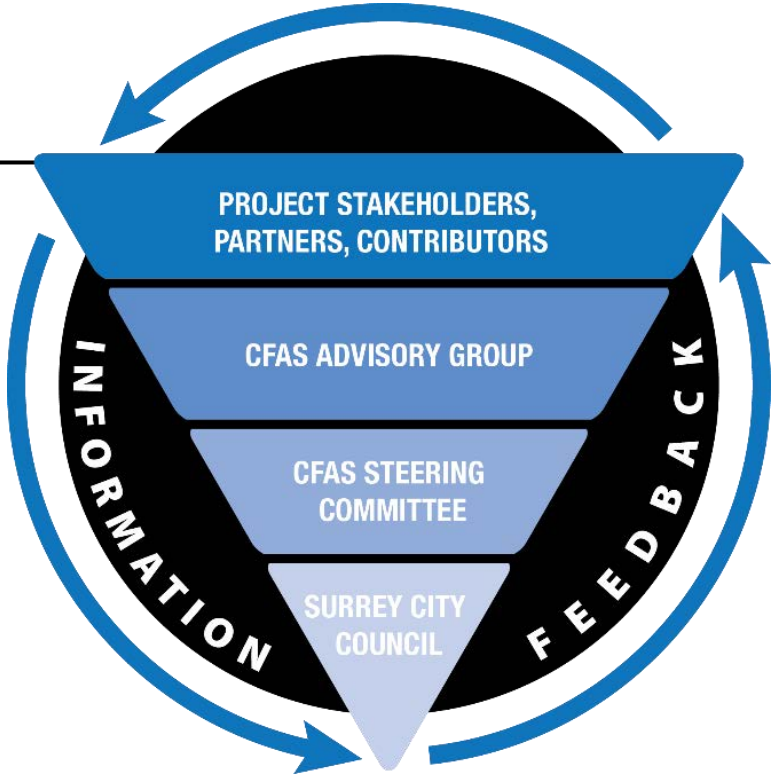
**Two-way dialogue**

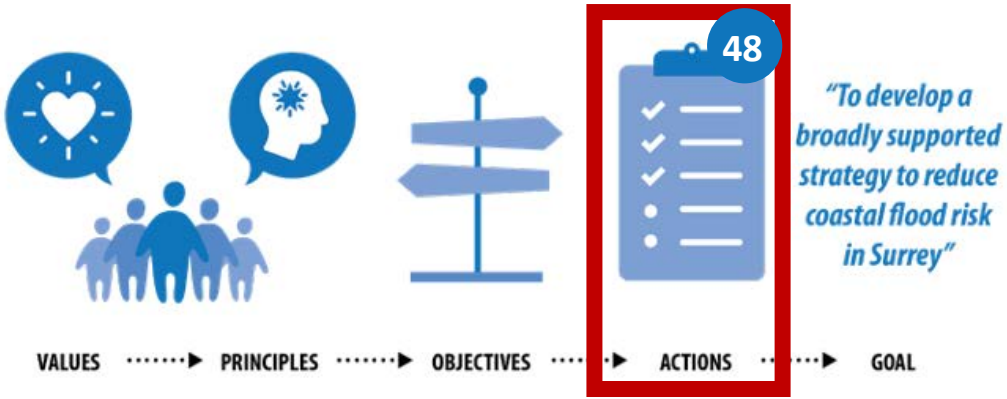
**Partnerships**

**Testing, monitoring & pivoting**

**Participatory process**

**Co-developed solutions**




Complete documents available from http://www.surrey.ca/Coastal

# Sequencing Actions over the long-term

Disaster Mitigation & Adaptation Fund (DMAF)

✓ Canada

18 Area-wide

28 Area-specific

**14 shorter-term (2020-2030), Area-specific tactical Actions**

**FIGURE 1:** *CFAS Program and Policy Actions*

| | | 2020-30 | 2030-40 | 2040-50 | 2050-60 | 2060-70 | 2070-80 | 2080-90 | 2090-2100 |
|---|---|---|---|---|---|---|---|---|---|
| **Ongoing Education, Communications, and Advocacy Initiatives** | | | | | | | | | |
| 1 | CFAS Steering Committee | | | | | | | | |
| 2 | Internal Updates | | | | | | | | |
| 3 | CFAS Advisory Group | | | | | | | | |
| 4 | CFAS Website | | | | | | | | |
| 5 | Advocacy Partners Workshop | | | | | | | | |
| 6 | Communications and Media | | | | | | | | |
| **Detailed Planning, Studies, and Data Collection** | | | | | | | | | |
| 7 | Update hazard bibliography | | | | | | | | |
| 8 | Update coastal flood hazard assessment | | | | | | | | |
| 9 | Detailed studies - Strategic Actions | | | | | | | | |
| **Regulatory Controls, Design Standards, and Guidelines** | | | | | | | | | |
| 10 | Review Development Variance practices | | | | | | | | |
| 11 | Support flood resilient design and construction | | | | | | | | |
| 12 | Explore Sea Level Rise Planning Area | | | | | | | | |
| 13 | Design Standards Guidebook | | | | | | | | |
| **Extreme Flood Management** | | | | | | | | | |
| 14 | Hazard review | | | | | | | | |
| 15 | Training and readiness | | | | | | | | |
| 16 | Improve flood warning systems and communications | | | | | | | | |
| 17 | Temporary protection measures assessment | | | | | | | | |
| 18 | Build Back Better program | | | | | | | | |

| | | 2020-30 | 2030-40 | 2040-50 | 2050-60 | 2060-70 | 2070-80 | 2080-90 | 2090-2100 |
|---|---|---|---|---|---|---|---|---|---|
| **MUD BAY** *(see Section 4.2.1 for summary)* | | | | | | | | | |
| **Mud Bay Foreshore** | | | | | | | | | |
| 19 | Foreshore enhancements | | | | | | | | |
| 20 | Sediment augmentation in foreshore are | | | | | | | | |
| **Inter River West (west of 152nd St)** | | | | | | | | | |
| 21 | 152nd St upgrades and raising | | | | | | | | |
| 22 | Serpentine and Nicomekl sea dams | | | | | | | | |
| 23 | Upgrade Serpentine left bank and Nicomekl right bank dykes | | | | | | | | |
| 24 | Install pumps at sea dams in phases | | | | | | | | |
| 25 | Hwy 99 Works – New dyke west of Hwy 99 | | | | | | | | |
| 26 | Pullback to Hwy 99 Protection Works | | | | | | | | |
| **Inter River East (east of 152nd St)** | | | | | | | | | |
| 27 | Upgrade Serpentine left bank and Nicomekl right bank dykes | | | | | | | | |
| 28 | Drainage upgrades – Cloverdale neighbourhood | | | | | | | | |
| 29 | Serpentine and Nicomekl floodplain storage | | | | | | | | |
| **Colebrook** | | | | | | | | | |
| 30 | Coordinate with MOTI – Hwy 99/ Colebrook dyke upgrades | | | | | | | | |
| 31 | Upgrade Colebrook Dyke | | | | | | | | |
| 32 | Replace Colebrook Drainage Pump Station | | | | | | | | |
| 33 | 'Good neighbour dyke' – Delta | | | | | | | | |
| 34 | Shared drainage improvements – Delta | | | | | | | | |
| 35 | Serpentine floodgates – BNSF | | | | | | | | |
| **Serpentine North** | | | | | | | | | |
| 36 | Upgrade Serpentine right bank and left bank dykes | | | | | | | | |
| **Nicomekl South (east of 152nd St)** | | | | | | | | | |
| 37 | Upper Nicomekl flood storage | | | | | | | | |
| 38 | Upgrade Nicomekl left bank dyke | | | | | | | | |
| 39 | Upgrade drainage system – Morgan Creek area | | | | | | | | |
| **Nico Wynd Area** | | | | | | | | | |
| 40 | Upgrade Nico Wynd area flood management | | | | | | | | |
| **CRESCENT BEACH** *(see Section 4.2.2 for sum ary)* | | | | | | | | | |
| 41 | Maintenance of Crescent Beach Dyke | | | | | | | | |
| 42 | Maintenance of Shoreline | | | | | | | | |
| 43 | Drainage improvements | | | | | | | | |
| 44 | Expanded edge | | | | | | | | |
| **SEMIAHMOO BAY** *(see Section 4.2.3 for sum ary)* | | | | | | | | | |
| 45 | Little Campbell River emergency access | | | | | | | | |
| 46 | Comprehensive flood improvements | | | | | | | | |

*Notes:* ✓ *indicates that the project scope is included in Surrey DMAF program and has confirmed funding. See Appendix II for a summary. Planning Area-Specific Actions under $5M capital cost are omitted for clarity.*

# Examples of Coastal Adaptation Design Principles driving priorities & project scope

Disaster Mitigation & Adaptation Fund (DMAF)

✓ Canada

**Plan for multiple values**
(co-benefits)

**Plan for adaptability**
(adaptive management)

**Design for/with nature**
(mitigation & adaptation)

**Design for resilience**
(multiple lines of defence)

**Plan for collaboration /partnerships**
(we all have a role)

**Plan for food security**
(adapting & stewarding agriculture)

- ✓Riverfront Park
- ✓Dams that become pump stations
- ✓Living Dyke
- ✓Flood proofing an arterial road
- ✓Interjurisdictional bridges
- ✓Pump Stations to ↑ agricultural yield

# Portfolio of Complex Adaptation Projects

Disaster Mitigation & Adaptation Fund (DMAF)

✓ Canada 13

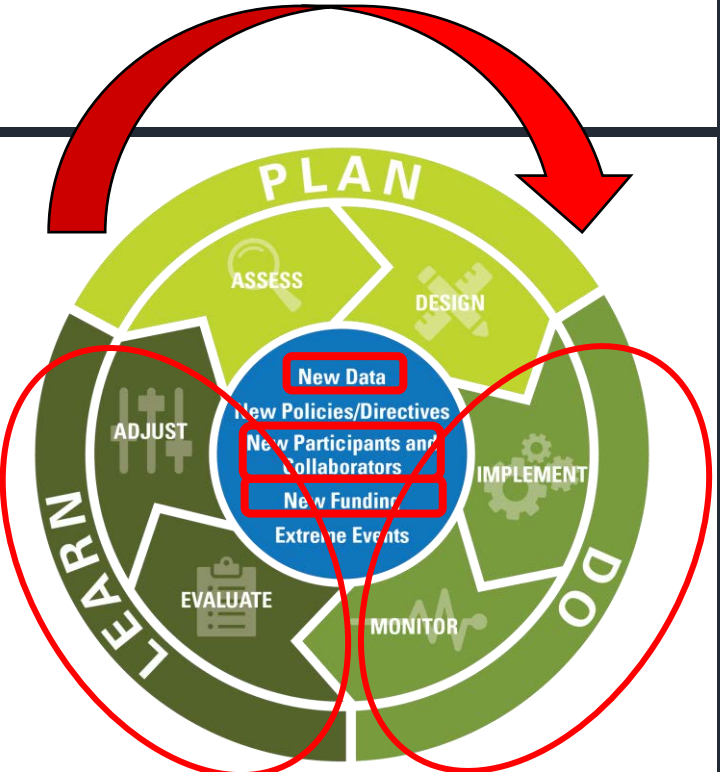
Construction Complete……3

Construction Underway…..7

Design Underway……3

Complex projects further broken down into 2 - 4 phases

# Case Study: Mud Bay Living Dyke




- ✓Municipal Innovation in Coastal Climate Adaptation
- ✓8 year DMAF grant made adaptive management possible
- ✓R&D partnerships (National Research Council)
- ✓Extensive participation by Semiahmoo First Nation
- ✓Building capacity in industry and reducing risk thru initial pilot
- ✓Plan-Do-Learn
  - ✓Pilot construction, monitor, evaluate, adjust, full scale construction




## City of Surrey Pilot

- 4 plots constructed March-June ‘23
- $1M construction value

## City of Delta Pilot

- 3 plots constructed May-June ‘23
- $0.5M construction value

# Key Takeaways

## Planning Process:

- Foundational studies
- Transparency in decision making
- Engage commensurate with complexity
- Building relationships

## Implementation:

- Win-win-win Solutions
- Build capacity to deliver projects
- Stakeholders and partners engaged
- Management & control

# More information?


CFAS

CITY OF SURREY
the future lives here.