

An aerial photograph of a coastal town and beach. The town is built on a hillside overlooking a sandy beach and a large body of blue water. The text is overlaid on a semi-transparent green circle in the foreground.

Coastal Climate Adaptation *Prioritizing Risk – Hazards, Assets and Corporate-wide approaches*

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FCM Climate and Asset Management Workshop

January 14 & 15, 2020

Journey Overview

- Understanding the **Climate Risks**
- **Planning** for Change
 - Strategy Development
 - Actions
 - Strategic Directions
 - Key Outcomes
- **Funding and Partnerships**
- **Implementation Highlights**
- **Lessons Learned**
- **Questions**



Poll Question

How important is climate change in your work?

(1 – Extremely important, 5 – Not at all important)

- 1 – Extremely important
- 2
- 3
- 4
- 5 – Not at all important

Poll Question

Rank your top barriers to climate adaptation from the list below:

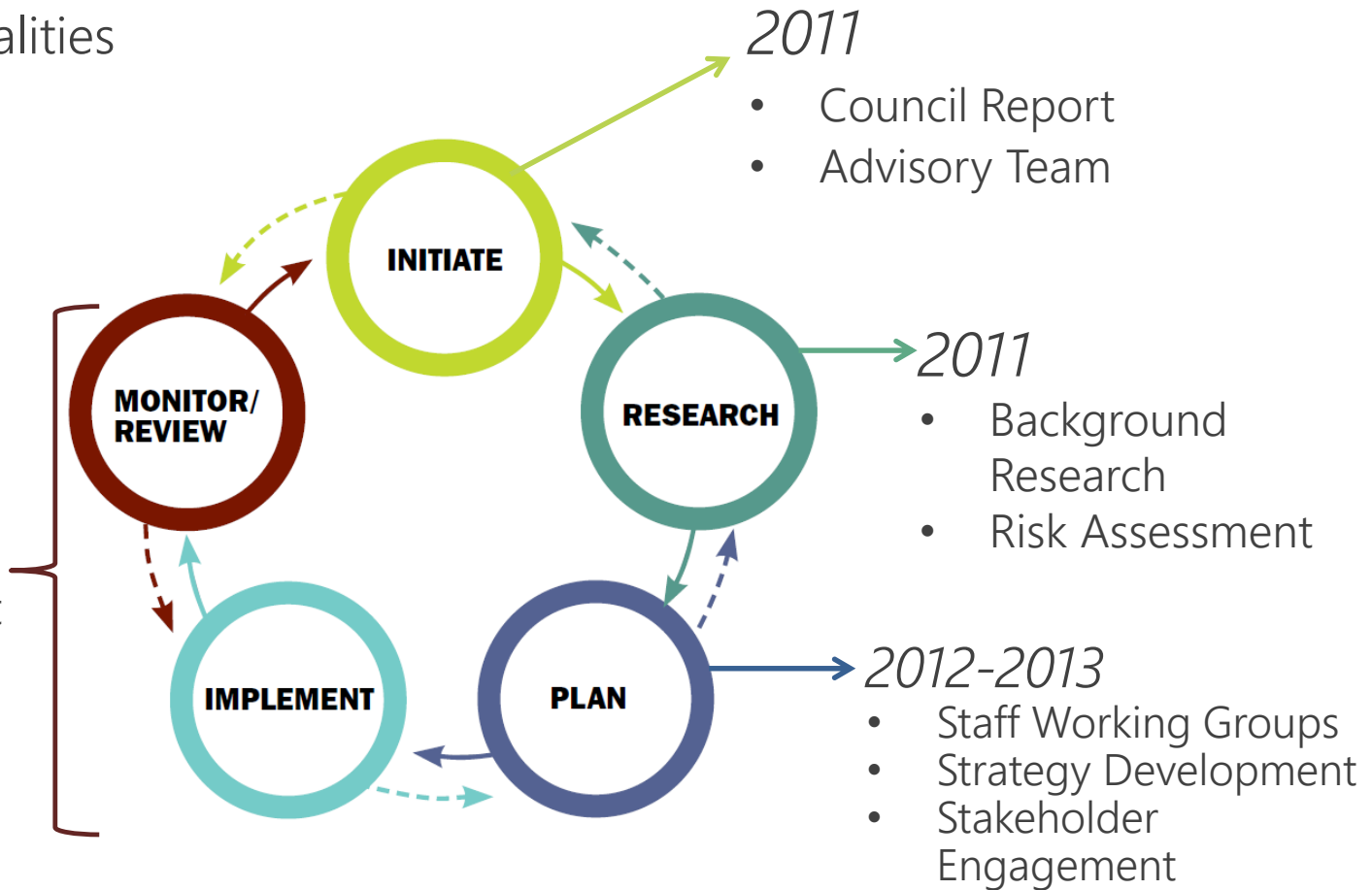
- Resources
- Political
- Technical Complexity

Adaptation Strategy Process

Worked with *ICLEI* and six other municipalities using the BARC approach

2013 - present

- Top 10 Actions
- Risk Management Framework
- Adaptation Advisory Team



Assessing Climate Risk in Surrey

- 18 impact statements developed describing key ways Surrey would be affected by projected climatic changes
- High-level vulnerability and risk assessment conducted for each impact statement to prioritize City efforts
- > 30 staff from departments citywide participated to create risk ratings

Risks removed

14 risks addressed through Strategy

No risks identified

5-20
Very Low

21-35
Low

36-35
Medium-Low

51-65
Medium

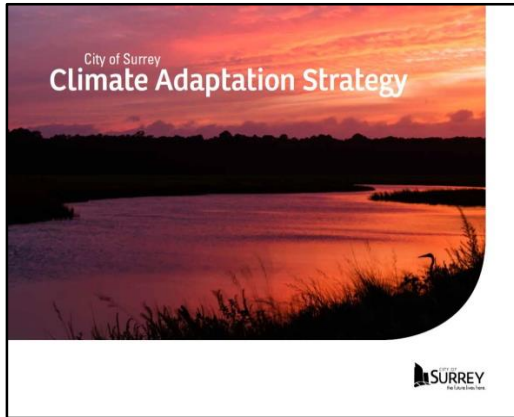
66-80
Medium-High

81-95
High

96-110
Very-High

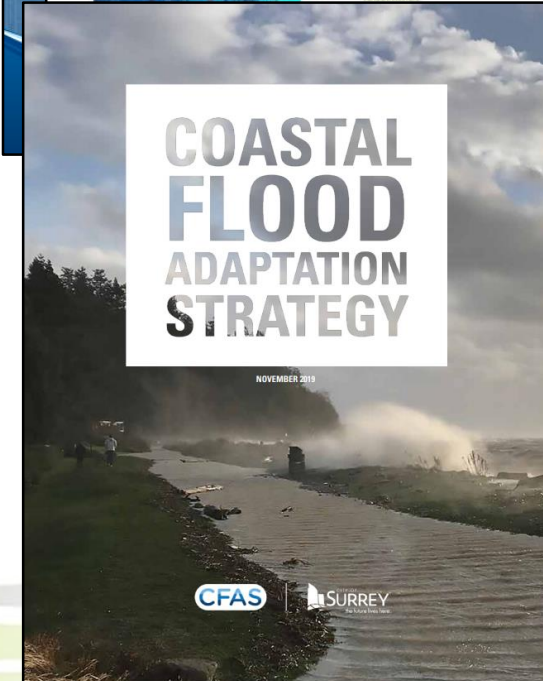
111-125
Extreme

Climate Change Planning - Floods




Priority Action:

“Conduct detailed analysis on Surrey-specific climate impacts, including timelines and extent of sea level rise and its related effects on flood construction levels and floodplain designations”



Climate Change & Coastal Floods

An aerial photograph showing a coastal area. On the left, there is a large body of water, likely a bay or estuary, with a river or inlet flowing into it. The water is a mix of grey and blue, suggesting some sediment or shallow depths. To the right of the water, there are green agricultural fields, a road, and several buildings, including a large barn or industrial structure. The overall scene depicts a rural coastal area that is vulnerable to sea level rise.

- Coastal cities around the world are facing challenges of sea level rise
- Province directed municipalities to plan for at least 1 m sea level rise by 2100
- In Surrey and Metro Vancouver most drainage and flood control assets not designed for projected changes

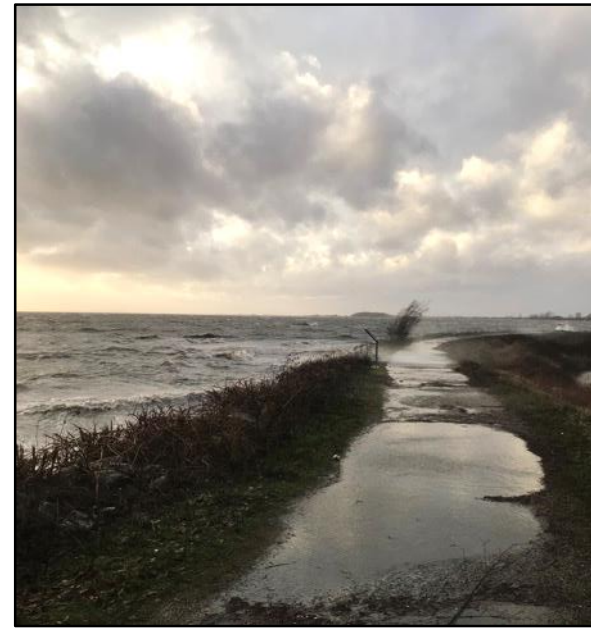
Poll Question

Is climate change an emergency in British Columbia?

- Yes
- No

What are we seeing?

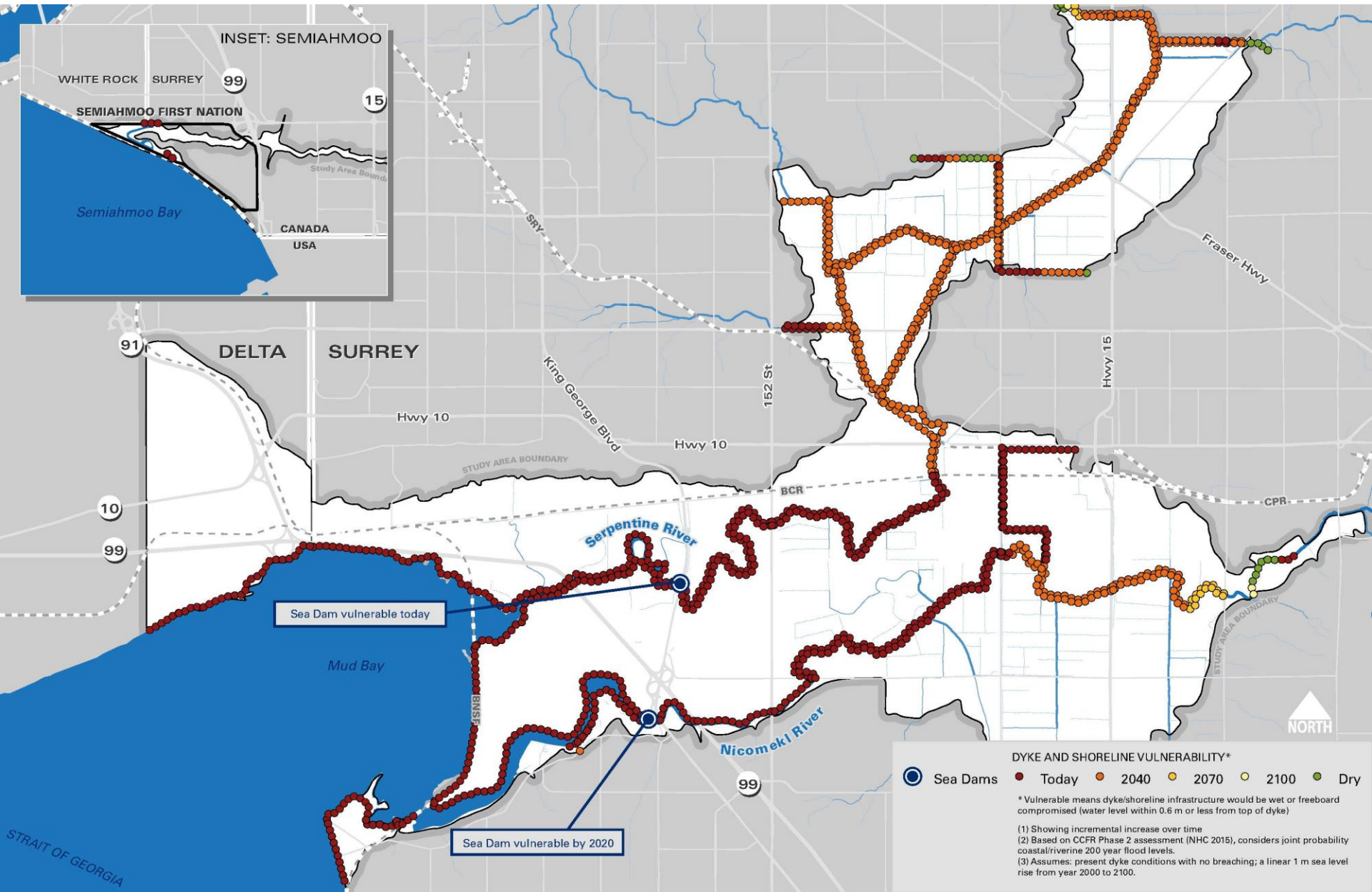
December 20, 2018 high wind event



© Tom Ewasiuk
@residualimage

Existing Infrastructure Video

<https://www.youtube.com/watch?v=bn4RQQaEfV8&list=PLtVfxe1fnZNtBjzAXgQ7kwMNf6bQFrQnI&index=3&t=0s>



CFAS

Surrey Coastal Flood Adaptation Strategy (CFAS)

- Climate Adaptation Strategy adopted November 2013
- Council adopted recommendation to develop a coastal flooding strategy in 2016
- Three-year project recently completed!



The Purpose of CFAS

San Juan Islands (WA)

Gulf Islands (BC)

Point Roberts (WA)

Crescent Beach

To prepare for a
changing climate
and increase
resilience of our
coastal communities





*Making memories,
by Praveena Killamsetty*



*The tracks,
by Amanda Sanderson*



*Serpentine Bird Sanctuary,
by William Vanarke*

COMMUNITIES AND PEOPLE

- Many residential areas and neighbourhoods
- Semiahmoo First Nation
- 2,500+ residents
- Approximately 20% of Surrey's land area

PARKS AND ENVIRONMENT

- Destination regional and City parks
- Beaches and recreation areas
- Critical foreshore, coastal, and riparian areas

LOCAL AND REGIONAL ECONOMY

- Over \$100M in annual farm gate revenue
- Over \$1B in assessed property value
- Almost \$25B annual truck and rail freight traffic

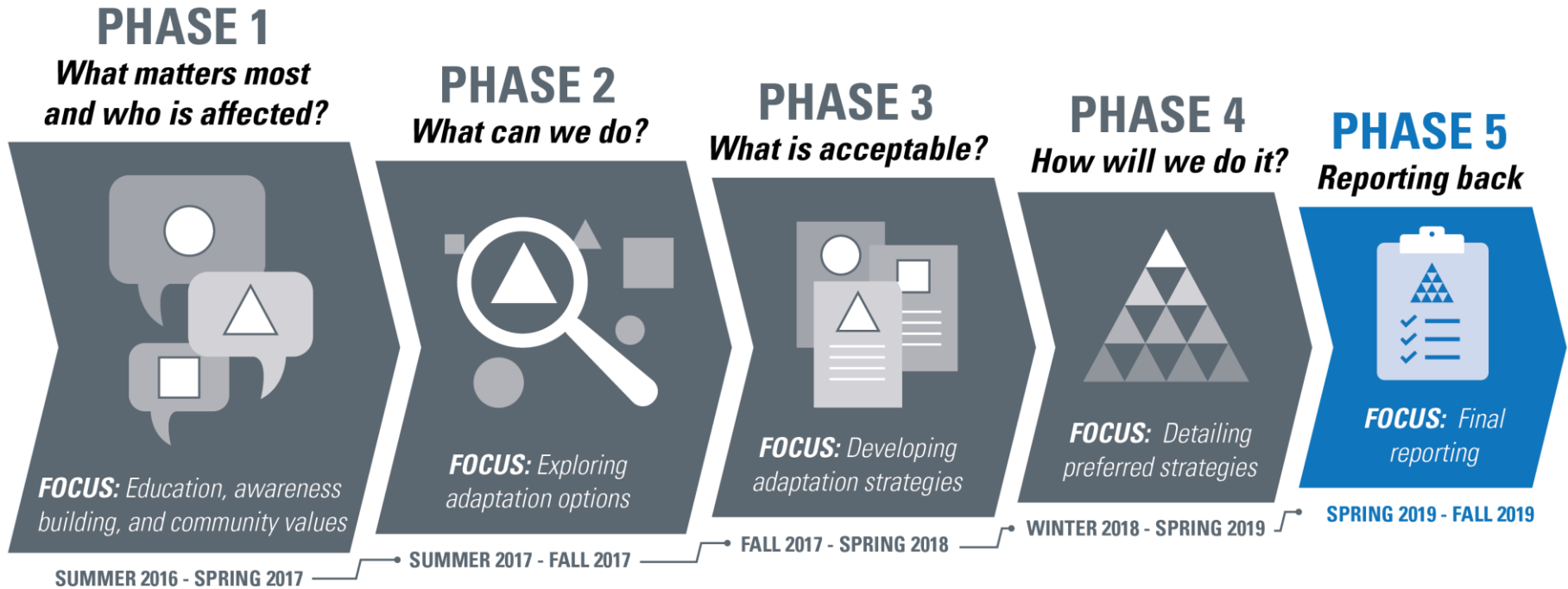
INFRASTRUCTURE

- Over 10km of Provincial Highways
- Over 200,000 vehicle trips a day
- Over 30km of railway (freight, passenger)
- Critical power, gas, water and sewer lines

FOOD SECURITY

- ~60km² agricultural land
- ~10% of Metro Vancouver's farmland

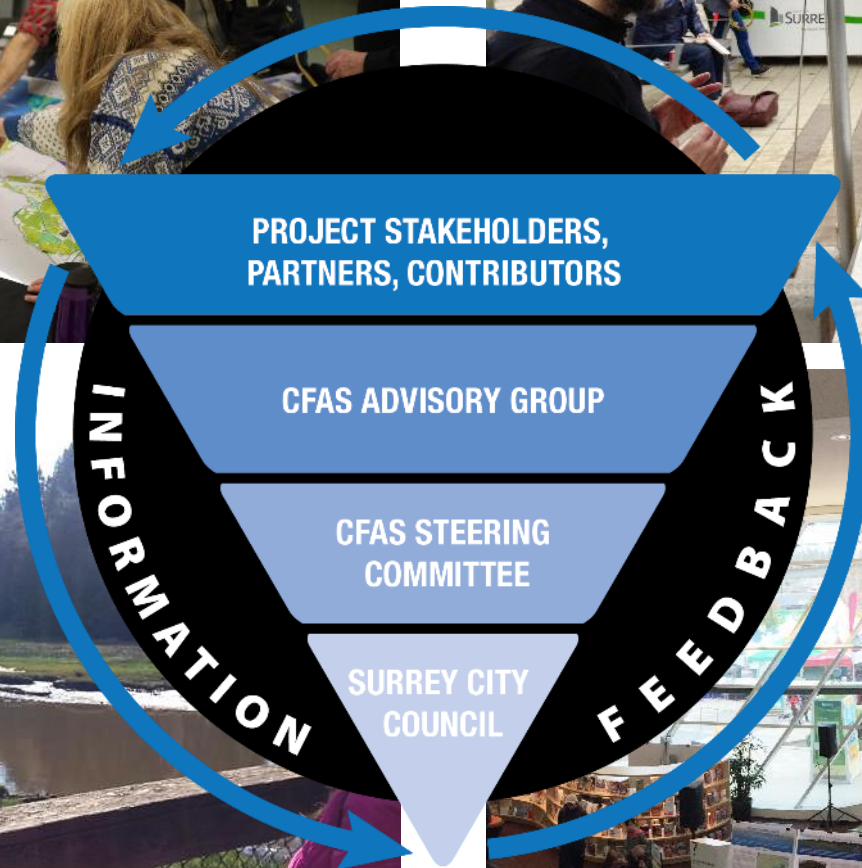
CFAS Overview



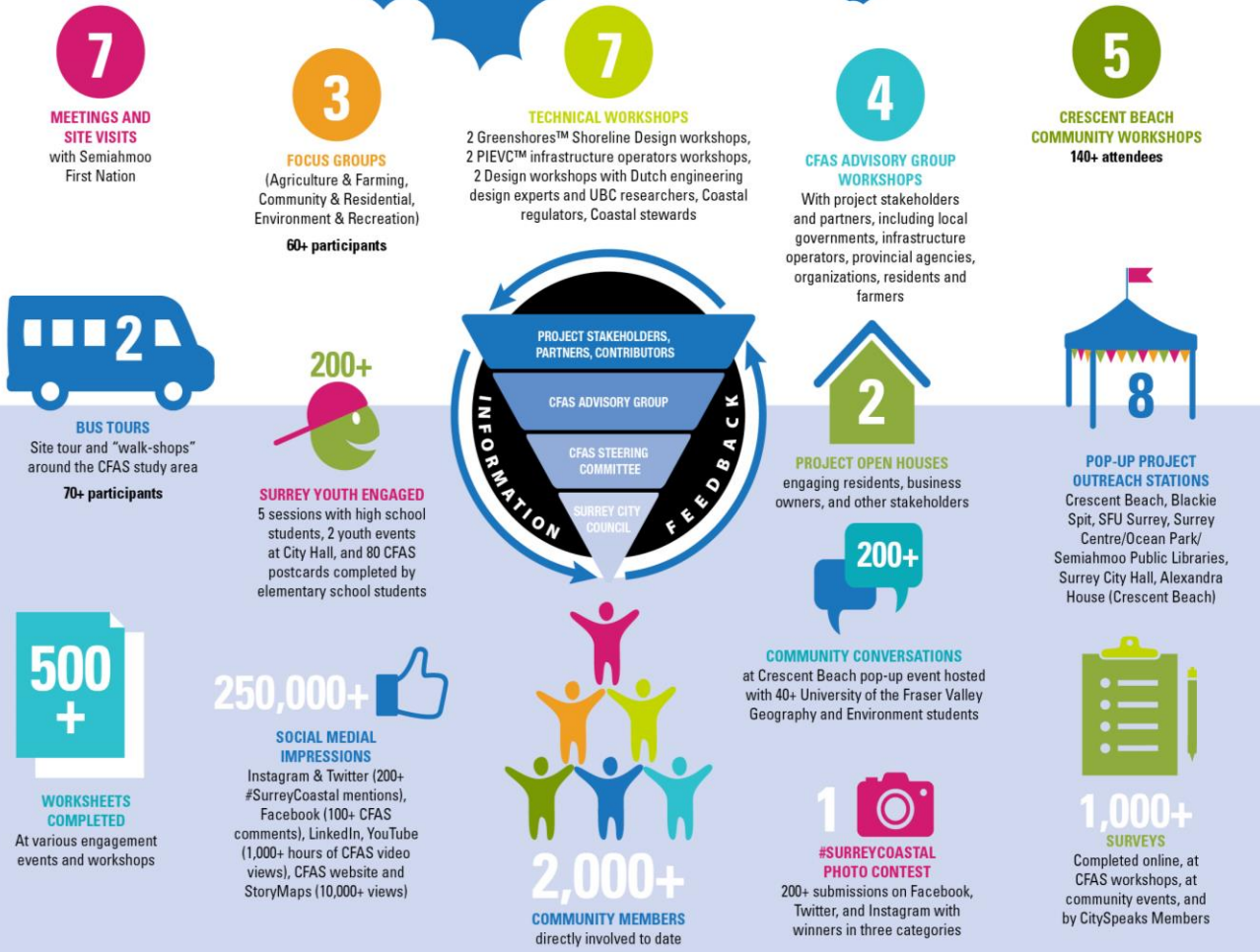
Approach & Process



Participatory Process



Engagement Highlights



- 2,000+ directly engaged
- 8 pop-up events
- 2 bus tours
- 200+ students (elementary & high school)
- 30+ organizations involved
- Advisory Group representing wide range of organizations, agencies, and governments
- 3 surveys, including technical options review
- Engaging and partnering with local expertise and capacity – UBC, SFU, UFV

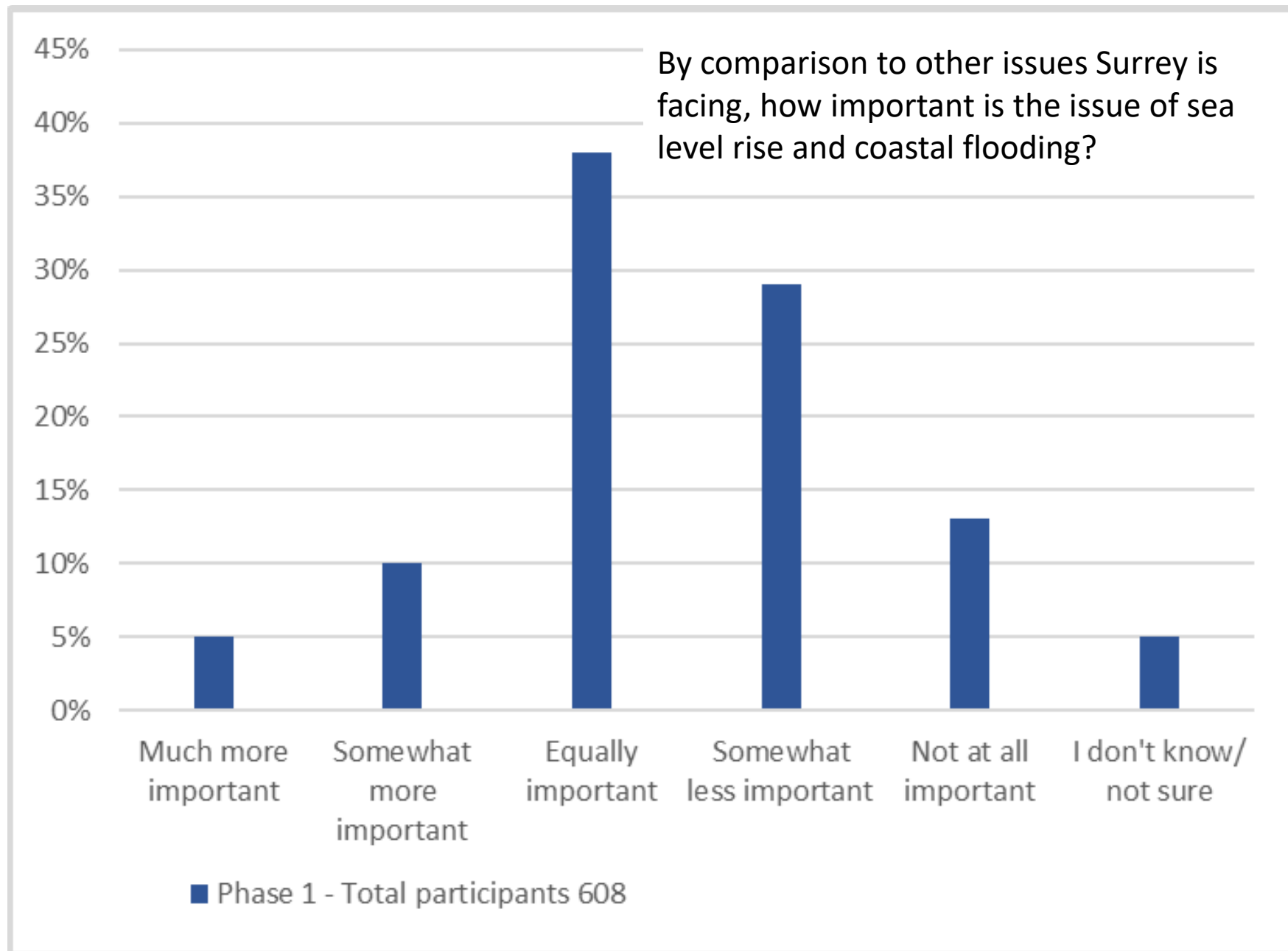
Poll Question

By comparison to other issues coastal communities are facing, how important is the issue of sea level rise and coastal flooding compared to other issues?

(1 – Extremely important, 5 – Not at all important)

- 1 – Much more important
- 2 – Somewhat more important
- 3 – Equally important
- 4 – Somewhat less important
- 5 – Not at all important
- I don't know / not sure

Engagement Results



Flood Adaptation Approaches

PROTECT (RESIST)



ACCOMMODATE



RETREAT (PULLBACK)



Flood Adaptation Approaches

COMBINATION



Draft Adaptation Options

CURRENT CONVENTIONS



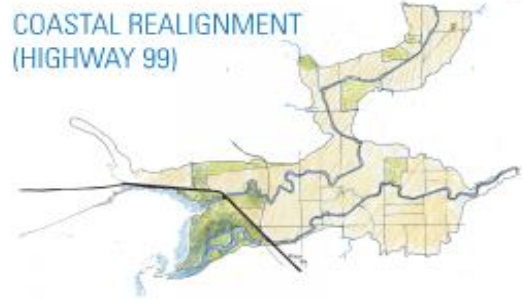
MUD BAY BARRIER



RIVER REALIGNMENT



COASTAL REALIGNMENT (HIGHWAY 99)



COASTAL REALIGNMENT (152ND STREET)



EDGE REALIGNMENT



MANAGED RETREAT



NO ADAPTATION



Values-based



RESIDENTS:

Minimize people displaced



AGRICULTURE:

Reduce permanent loss of agricultural land



ENVIRONMENT:

Minimize impacts to wetland habitats and riparian areas



INFRASTRUCTURE:

Minimize vulnerabilities



ECONOMY:

Minimize loss of local businesses



RECREATION:

Maximize recreational opportunities



CULTURE:

Maximize opportunities for traditional practices

Values Ranking:



WORSE ← ————— NO CHANGE ————— → BETTER

Technical Review



FLOOD DAMAGE PREVENTION:

How well would the option reduce or prevent flood damage from sea level rise and storm surges?



OUTCOME OF A FAILURE:

If the option failed, what would the consequences be to people, infrastructure and the environment?



GEOTECHNICAL STABILITY:

How effective would the option be at withstanding hazard events given the soil's stability?



ADAPTABILITY OVER TIME:

How well can the option be adjusted or phased to changing sea level rise?



CAPITAL COST:

What are the capital costs for the City of implementing the option?



OPERATIONS & MAINTENANCE COST:

What are the operation and maintenance costs for the City of implementing the option?

Technical Ranking:



Capital Costs:

\$ = <100M
 \$\$ = 100M – 1B
 \$\$\$ = 1B+

	FLOOD DAMAGE PREVENTION	
	OUTCOME OF A FAILURE	
	GEOTECHNICAL STABILITY	
	ADAPTABILITY OVER TIME	
	CAPITAL COST CoS	\$\$
	O&M COST CoS	

SHORTLISTED OPTIONS – MUD BAY

The summary table compares the short-listed options for the Mud Bay study area. The overview includes a “Baseline” or “No Adaptation” option for reference. Full descriptions of the short-listed options are available in the Primer (Primer Part II: Options) and at the video station.



VALUES CRITERIA	BASILINE - NO ADAPTATION	CURRENT CONVENTIONS	MUD BAY BARRIER	HIGHWAY 99 REALIGNMENT	MANAGED RETREAT
RESIDENTS <i>People permanently displaced</i>	FAR WORSE	SLIGHTLY WORSE	NO CHANGE	SLIGHTLY WORSE	FAR WORSE
AGRICULTURE <i>Permanent loss of agriculture land</i>	FAR WORSE	SLIGHTLY WORSE	NO CHANGE	SLIGHTLY WORSE	FAR WORSE
ENVIRONMENT <i>Impacts to wetland habitats, freshwater fish habitat & riparian areas</i>	MODERATELY WORSE	FAR WORSE	FAR WORSE	SLIGHTLY BETTER	FAR BETTER
INFRASTRUCTURE <i>Percent of service/transportation infrastructure made vulnerable</i>	FAR WORSE	NO CHANGE	NO CHANGE	NO CHANGE	SLIGHTLY WORSE
ECONOMY <i>Revenue</i>	FAR WORSE	SLIGHTLY WORSE	NO CHANGE	SLIGHTLY WORSE	MODERATELY WORSE
RECREATION <i>Diversity of recreational opportunities</i>	FAR WORSE	NO CHANGE	SLIGHTLY WORSE	SLIGHTLY BETTER	MODERATELY BETTER
CULTURE <i>Opportunities for traditional practices</i>	SLIGHTLY WORSE	NO CHANGE	MODERATELY WORSE	NO CHANGE	NO CHANGE
IMPACT & RISK OF FAILURE					
OVERALL RISK	VERY HIGH	VERY HIGH	VERY HIGH	MEDIUM	VERY LOW
COST CRITERIA					
CAPITAL COST	—	\$100M - \$1B	MORE THAN \$4B	\$1B - \$4B	\$1B - \$4B
OPERATION & MAINTENANCE COST	MORE THAN \$10M	MORE THAN \$10M	\$1M - \$10M	\$1M - \$10M	LESS THAN \$1M
OTHER INFRASTRUCTURE COST	MORE THAN \$100M	\$10M - \$100M	LESS THAN \$10M	\$10M - \$100M	MORE THAN \$100M
FUTURE ADAPTATION COST	\$1B - \$4B	\$1B - \$4B	\$1B - \$4B	\$1B - \$4B	LESS THAN \$100M

RISK ASSESSMENT HEAT MAP

		IMPACT				
		Very Low	Low	Medium	High	Very High
LIKELIHOOD	Very High				CURRENT CONVENTIONS	
	High					MUD BAY BARRIER
	Medium			HIGHWAY 99 REALIGNMENT		
	Low					
	Very Low		MANAGED RETREAT			

Poll Question

How does infrastructure that incorporates resilience to climate change compare to regular infrastructure?

- Materially different throughout the asset's life
- Initially the same, then becomes different as it adapts over the asset's life
- Substantially the same throughout the asset's life
- Identical throughout the asset's life
- It depends

PIEVC™ Vulnerability Assessment

Workshop 1: March 28, 2017

- Infrastructure operators, owners & emergency service providers
- 66 participants from 28 organizations
- Utilizing the PIEVC Protocol
Developed by Engineers Canada and heavily used by Ministry of Transportation and Infrastructure
- Systematically **assess current and future coastal flooding risks for individual assets**
- Identify issues, concerns and potential vulnerabilities of infrastructure assets



Organizing Committee



Flood Risk	Coastal Flood with Dyke Breach Current	Coastal Flood with Dyke Breach 2100
Low	20	6
Medium	21	15
High	2	22

PIEVC™ Adaptation Approaches

Workshop 2: October 10, 2017

- Impacts of selected CFAS **adaptation options** on **key infrastructure assets** and land-use
- Utilizing the PIEVC Protocol triple bottom line (TBL) decision-making module
- Optional pre-workshop study tour

Triple bottom line analysis



Environmental



Social



Economic



Asset Risk Assessment Findings & Feedback

Cost-sharing and collaboration is a high priority

- Aim to seek **co-benefits**
- Regional and **interjurisdictional coordination** is needed
- Flood and transportation infrastructure are heavily **interconnected**

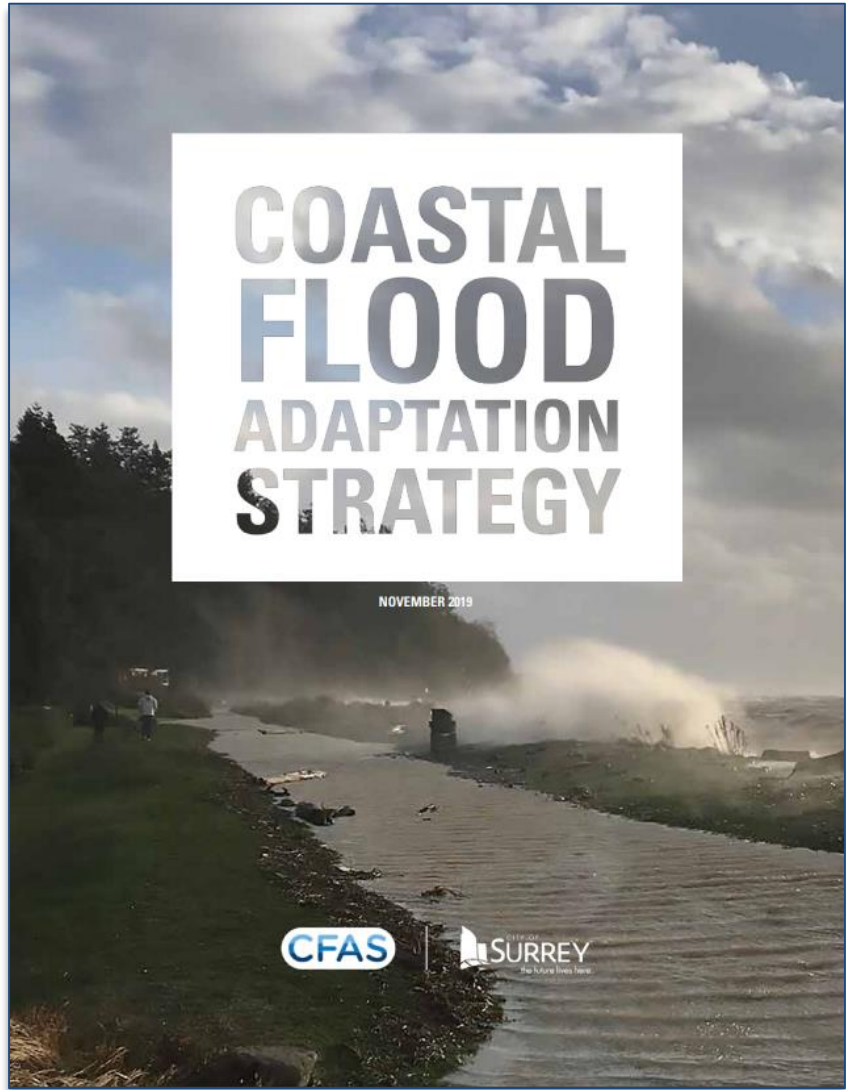
Opportunities for improvement

- **Capital renewal** creates opportunities for adaptation
- Consider **overall resilience** of solutions to **multiple hazards**
- Key infrastructure assets are **adaptable**
- Infrastructure owners are mostly **reactive** without specific adaptation plans at the moment

Shared utility corridors

- Reduce **costs**
- Can increase **risk**





CFAS Actions

Program & 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									

CFAS Actions

Planning Area-Specific Actions

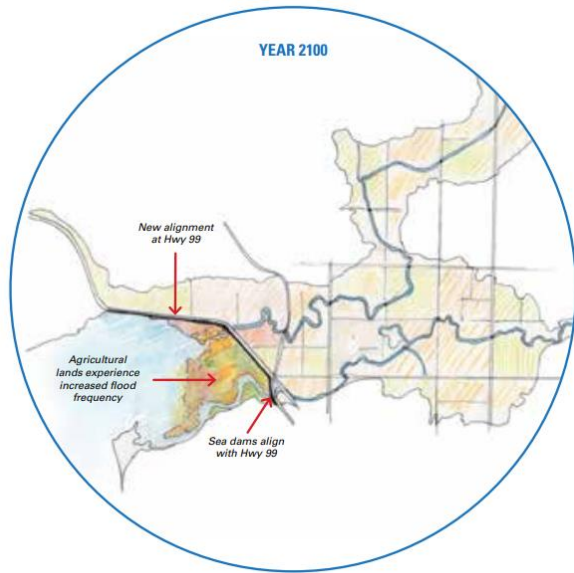
	2020-30	2030-40	2040-50	2050-60	2060-70	2070-80	2080-90	2090-2100
MUD BAY (see Section 4.2.1 for summary)								
Mud Bay Foreshore								
19 Foreshore enhancements	✓							
20 Sediment augmentation in foreshore area								
Inter River West (west of 152nd St)								
21 152nd St upgrades and raising	✓							
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 summary)								
41 Maintenance of Crescent Beach Dyke								
42 Maintenance of Shoreline								
43 Drainage improvements	✓							
44 Expanded edge								
SEMAHMOO BAY (see Section 4.2.3 for summary)								
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 SSM capital cost are omitted for clarity.

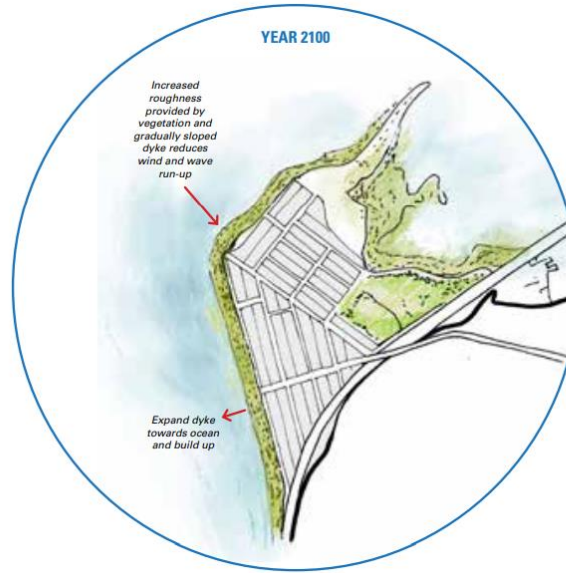


Long-term Strategic Directions (Year 2100)

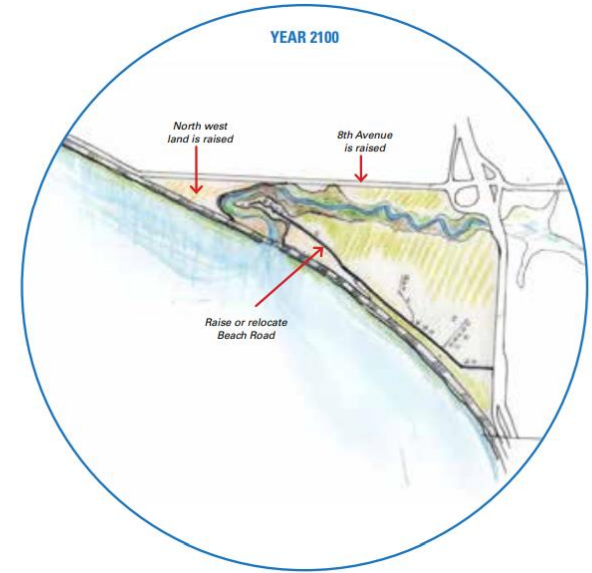
Mud Bay



Crescent Beach



Semiahmoo Bay



Outcomes of CFAS

- Increased awareness of the impacts of sea level rise
- Stakeholder buy-in
- Partnerships
- High level actions to advance long term strategic directions
- Community Energy Association's Climate Adaptation Award
- Funding commitments for implementation of capital works



Building Partnerships

UNIVERSITY
OF THE FRASER VALLEY



\$449,125 grant funding approved



Disaster Mitigation Adaptation Fund (DMAF)

- 13 projects valued at \$187 million, implementing short-term CFAS actions that are required no matter what long-term adaptation direction is chosen
- Government of Canada investment of over \$76 million
- Projects make smart investments in the protection of residential neighbourhoods, businesses, significant habitat areas and critical infrastructure by:
 - Establishing multiple lines of defense against coastal flooding
 - Lowering nationally significant coastal and riverine flood and seismic vulnerabilities
 - Improving emergency response connectivity and disaster recovery time



* Second location is Delta between 88 and 96 St on Boundary Bay

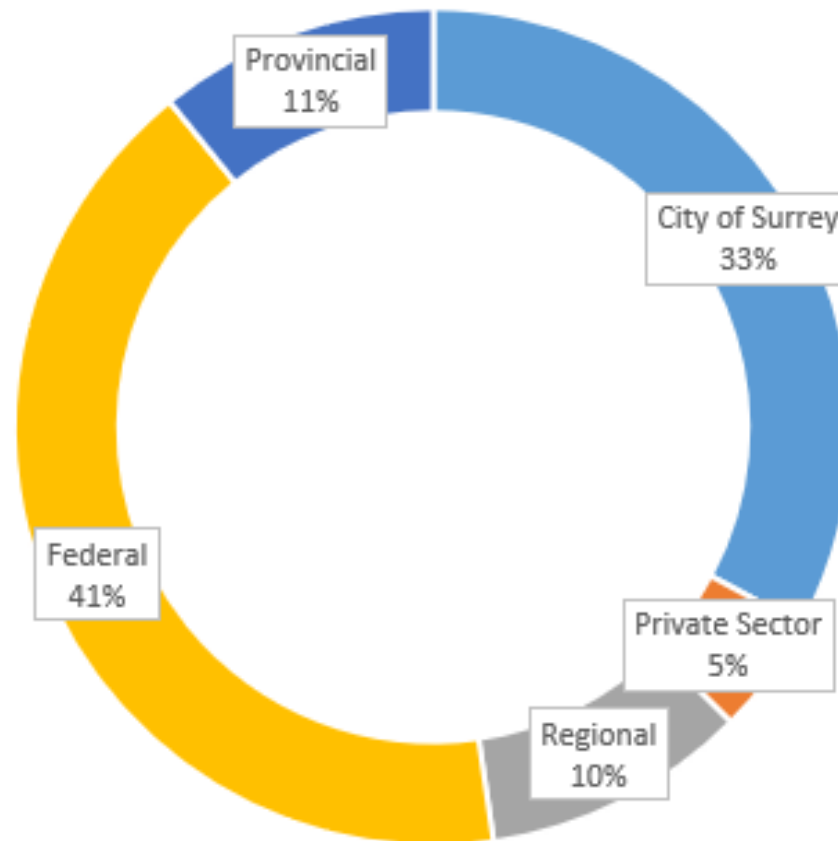
#	Name	Asset Type	Hazard Mitigation	Community Co-benefits	Values Protected	Project Partners
1	Colebrook Dyke Upgrades	Coastal Dyke		Recreation, bird watching, food security		Province of BC
2	Colebrook Drainage Pump Station Replacement	Drainage Pump Station		Increased agricultural productivity and food security		
3	Sea Dam – Serpentine River	Sea Dam (drainage and irrigation)		Agriculture irrigation, fish passage, worker safety		
4	152 St Road Upgrades and Raising	Integrity of Transportation Network and Asset		Congestion relief, transportation safety, accommodate growth, cycling, pedestrian		Translink FortisBC Energy
5	Nicomekl Riverfront Park - Phase 1	Flood storage alternative to riverine dyking		Recreation (blue way), nature trails, wetlands, culture, open space		
6	King George Boulevard Bridge and Nicomekl River Sea Dam Replacement	Arterial Bridge (integrated with one sea dam) Integrity of Transportation Network and Asset		Congestion relief, transportation safety, accommodate growth, cycling, pedestrian, integrated to Nicomekl Park, fish passage, agriculture irrigation		Metro Vancouver Ministry of Transportation & Infrastructure
7	Crescent Beach Storm Sewer System Upgrades - Perforated Piping	Flood Protection increases transportation resilience		Street beautification/ road improvements, transportation safety		
8	Dyking - Lower reaches of Nicomekl and Serpentine	Flood Protection (nuisance and extreme event)		Food security and transportation flood safety		
9	Serpentine SRY Rail Link Bridge Replacement and Dyking	Flood Protection (nuisance and extreme event)		Economy (freight and heritage railway), worker safety and goods movement		SRY LINK (Southern Railway of BC)
10	Burrows Drainage Pump Station Upgrade	Drainage Pump Station		Increased agricultural productivity and food security		
11	Stewart Farm Sanitary Pump Station Coastal Flood Proofing	Integrity of Sanitary Sewer Network		Sanitation, worker safety and water quality		
12	Campbell River Pedestrian and Emergency Access Bridge Replacement	Integrity of Transportation Network		Emergency access, Multi Use Path		Semiahmo First Nation
13	Foreshere Enhancements	Structural and nature based flood control and environmental enhancements		Wetlands (birds, fish, clams) and food security		City of Delta

Hazard Mitigation
 = flood = seismic = drought

Values Protected
 = economy = infrastructure = environment = communities

\$187M 9-year program (\$76.6M federal contribution)

Surrey-Delta-Semiahmoo First Nation DMAF Funding



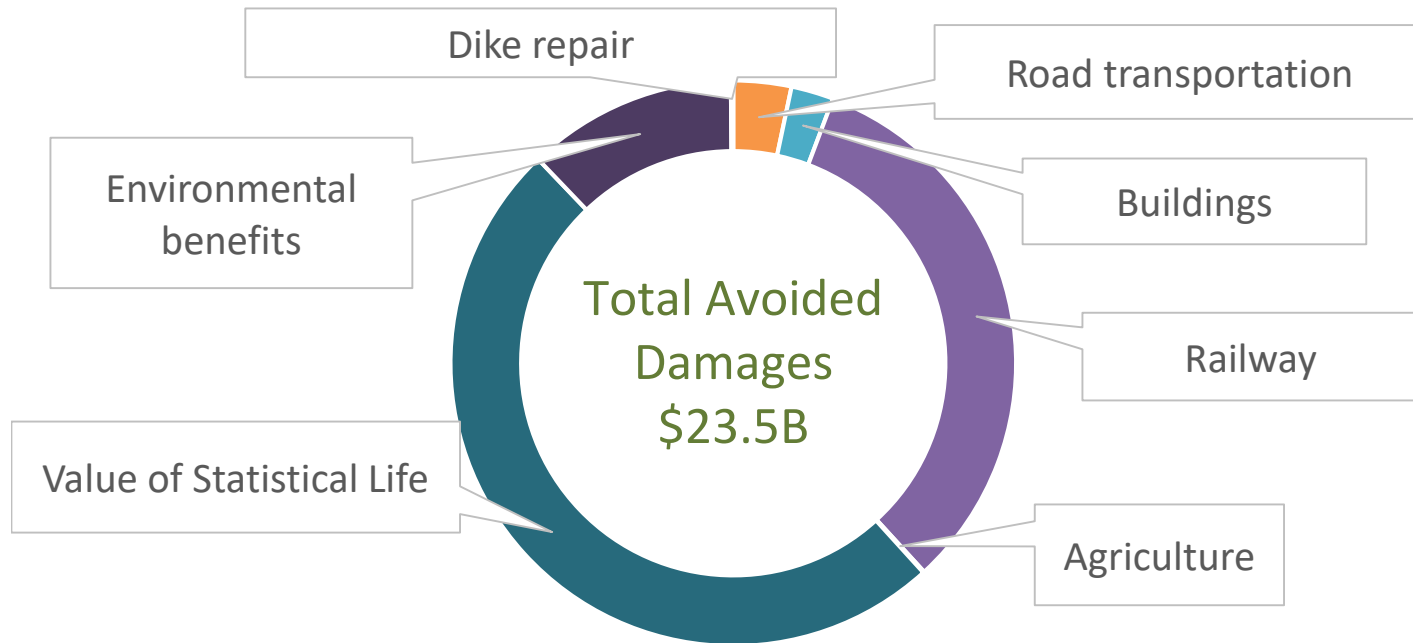
Total Estimated Funding \$187,000,000



(Southern Railway of BC)

Return on Investment

- Nationally significant infrastructure is protected
- Avoided damages calculated over life of assets
- Benefit to Cost ratio 126:1



Shovel-Ready Projects

- City of Surrey
 - Colebrook Dyke Upgrades
 - Stewart Pump Station
 - Burrows Pump Station
 - Southern Railway of BC Serpentine Bridge
- City of Delta
 - Boundary Bay Dyke Upgrades



High Priority Projects

- Nicomekl King George Blvd Bridge
- Nicomekl Riverfront Park
- 152nd St Raising and Widening
- Colebrook Pump Station



Innovative Projects

- Foreshore protection
- Nature-based solution for coastal squeeze and coastal flooding

Steering Committee:

- Lower Fraser Fisheries Alliance and First Nations Emergency Planning Secretariat,
- West Coast Environmental Law,
- FLNRORD,
- First Nations,
- DFO,
- Canadian Wildlife Service; and
- BC Municipalities

Existing salt marsh at risk from coastal squeeze in Boundary Bay



A COMMUNITY LED, BOTTOM UP APPROACH IDENTIFIED THE VALUES TO PROTECT IN A CHANGING CLIMATE



Economy



Infrastructure



Environment



Communities

Ongoing Adaptation

- **New data** – or changes in the data such as acceleration in sea level rise
- **New policies/directives** – global, national, provincial, regional, and local
- **New participants and collaborations** – new partners and actions taken by stakeholders
- **New funding** – and the requirements/opportunities that come with them
- **Extreme Events** – occurrence of an extreme coastal flood or other disasters



Lessons Learned

- No adaptation is **NOT** an option
- There's no silver bullet
- All strategic directions involve trade-offs
- Start with "no-regret" Actions that address pressing issues
- Engagement and partnerships are key
- Recognize the challenge
- Be adaptive



Questions & Comments



Learn More

- 1) Engineers Canada Sustainability in Practice Course
 - SDES 101–Polytechnique Montréal
<https://catalogue.edulib.org/en/courses/polymtl-sdes101/>
 - Next intake expected Spring 2020
- 2) Adaptation Canada 2020
 - Collaboration through Cost Sharing workshop
 - February 17, 18 2020
 - www.AdaptationCanada.ca
- 3) CFAS Planning
 - www.surrey.ca/Coastal
- 4) CFAS Implementation
 - www.surrey.ca/CoastalTakingAction