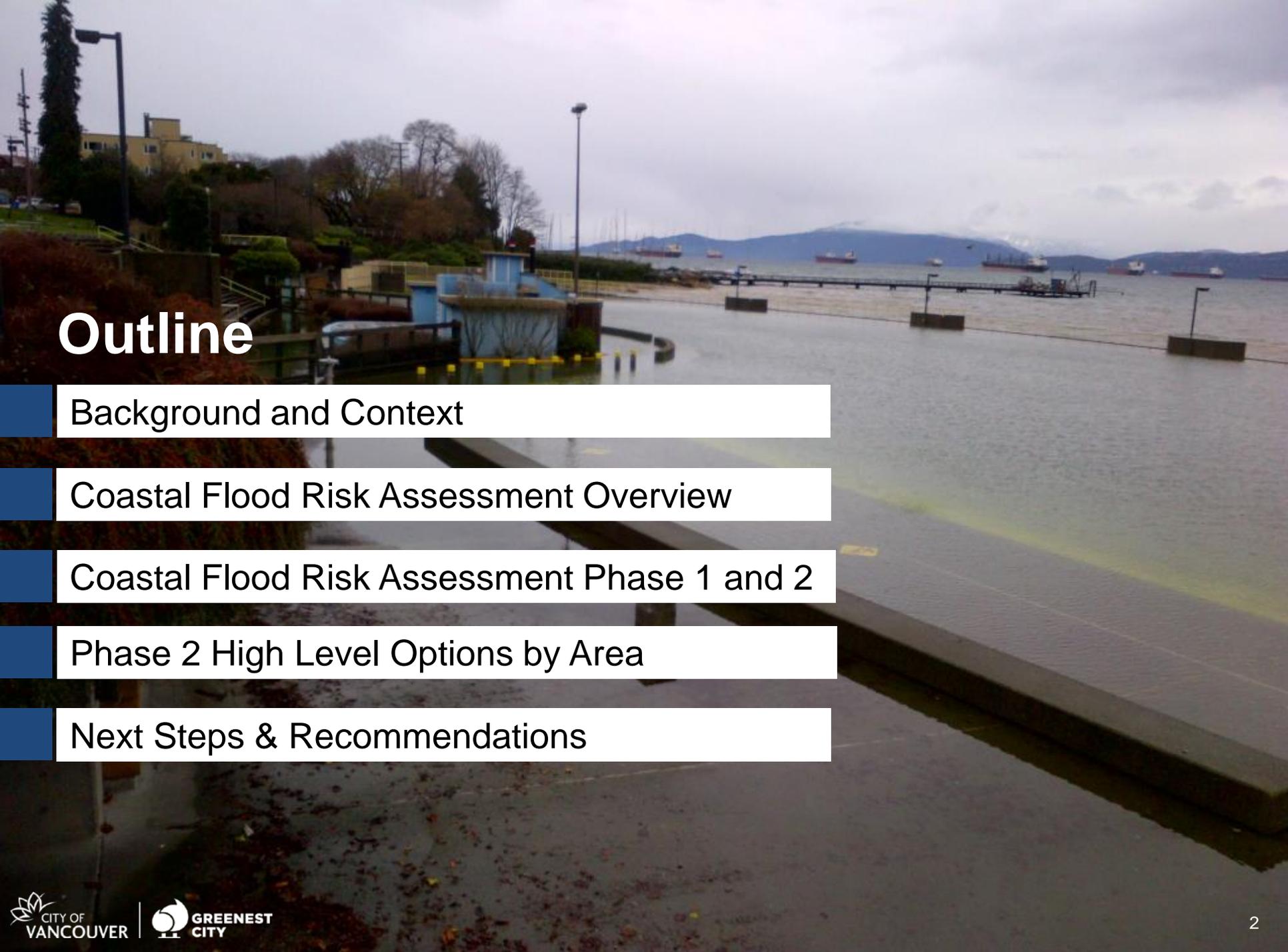


A scenic photograph of a sunset over a body of water. The sun is low on the horizon, partially obscured by the silhouettes of large, leafy trees in the foreground. The sky is a warm, golden-orange color. In the distance, a city skyline is visible across the water. A few people are sitting on a bench near the water's edge. The overall mood is peaceful and contemplative.

Preparing for Sea Level Rise

Climate Change Adaptation Strategy Update

Council Presentation // November 2nd, 2016



Outline

Background and Context

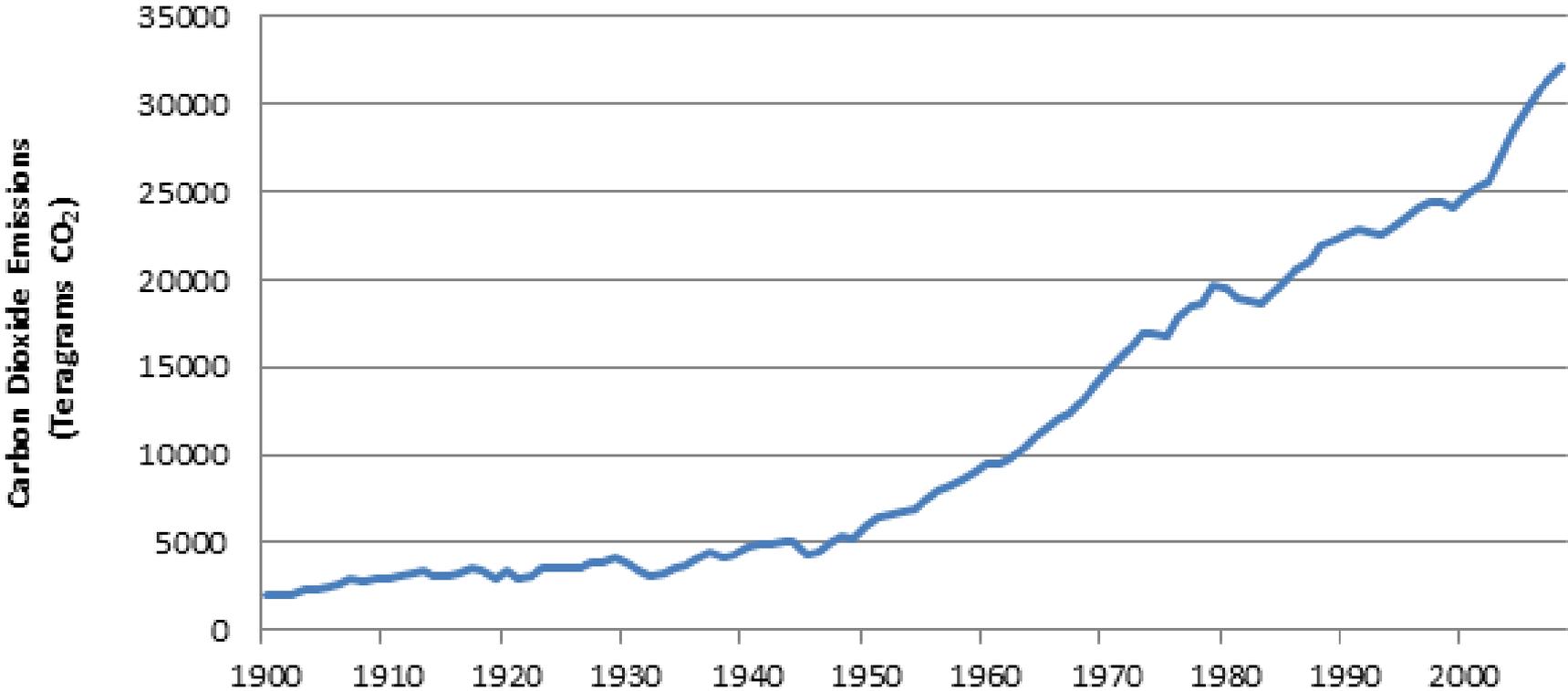
Coastal Flood Risk Assessment Overview

Coastal Flood Risk Assessment Phase 1 and 2

Phase 2 High Level Options by Area

Next Steps & Recommendations

Despite local efforts, global greenhouse gas emissions keep growing.



Extreme weather events cost Canadian insurers \$3.2B in 2013

“Once climate change becomes a defining issue for financial stability, it may already be too late.”

Mark Carney, Governor of the Bank of England (2015)



Calgary Flood 2013

By 2100 the direct economic losses to the region due to floods could exceed \$30B and adaptation costs will approach \$10B

Lower Mainland Flood Management Strategy and B.C.



UK Floods 2014



GREENEST CITY 2020
Climate Adaptation

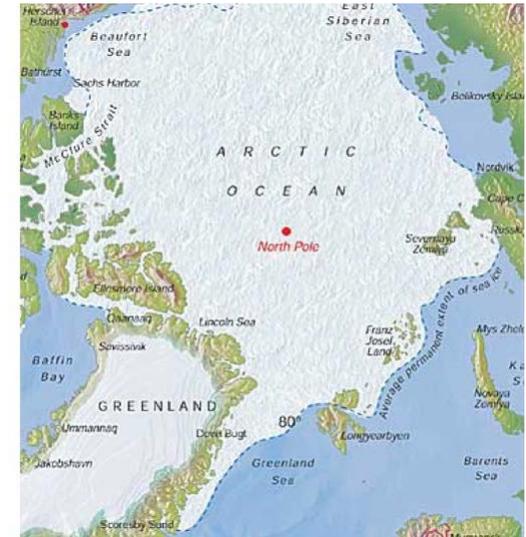
CLIMATE CHANGE ADAPTATION STRATEGY

- Impacts from sea level rise include increased coastal flooding, erosion and storm damage
- Actions: Complete a Coastal Flood Risk Assessment and develop a City-wide Sea Level Rise Response Plan



- ↘ Use the best available science and practice adaptive management
- ↘ Seek adaptable, green and robust solutions that can be phased over time
- ↘ Seek “no regret” actions with co-benefits
- ↘ Pursue funding strategies based on value and equity
- ↘ Take a risk-based approach
- ↘ Be resilient by providing redundancy

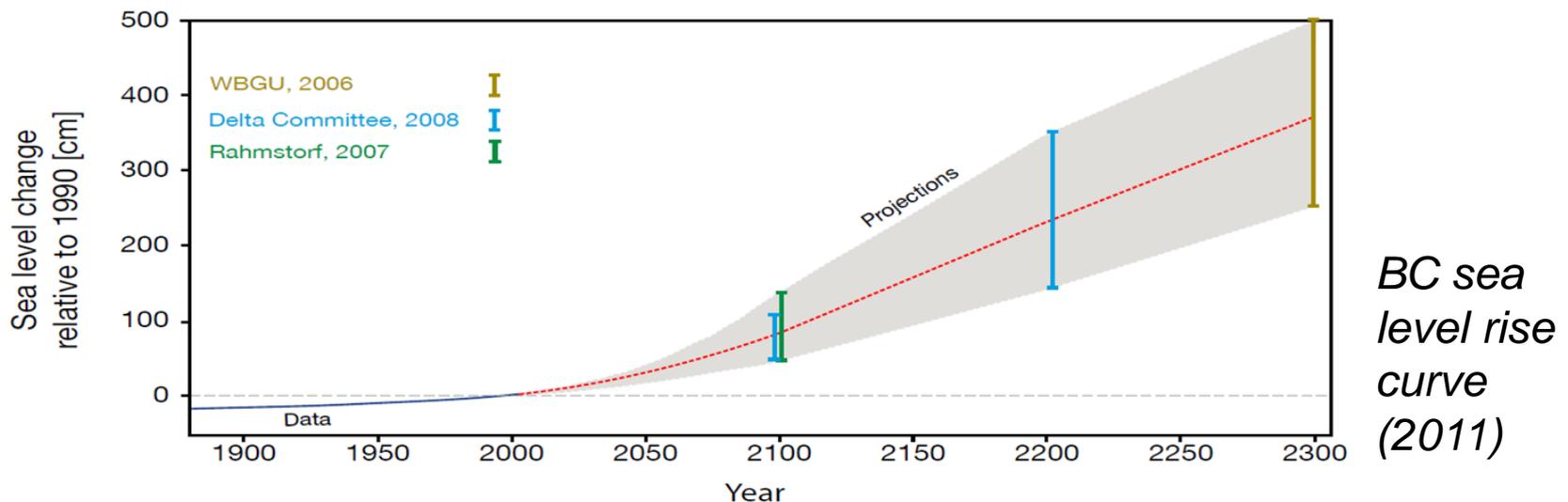
- ↘ 2015 warmest year on record (since 1880)
- ↘ 90% of new, excess heat is stored in the oceans – Thermal Expansion
- ↘ Melting of land ice (glaciers) – Antarctica and Greenland



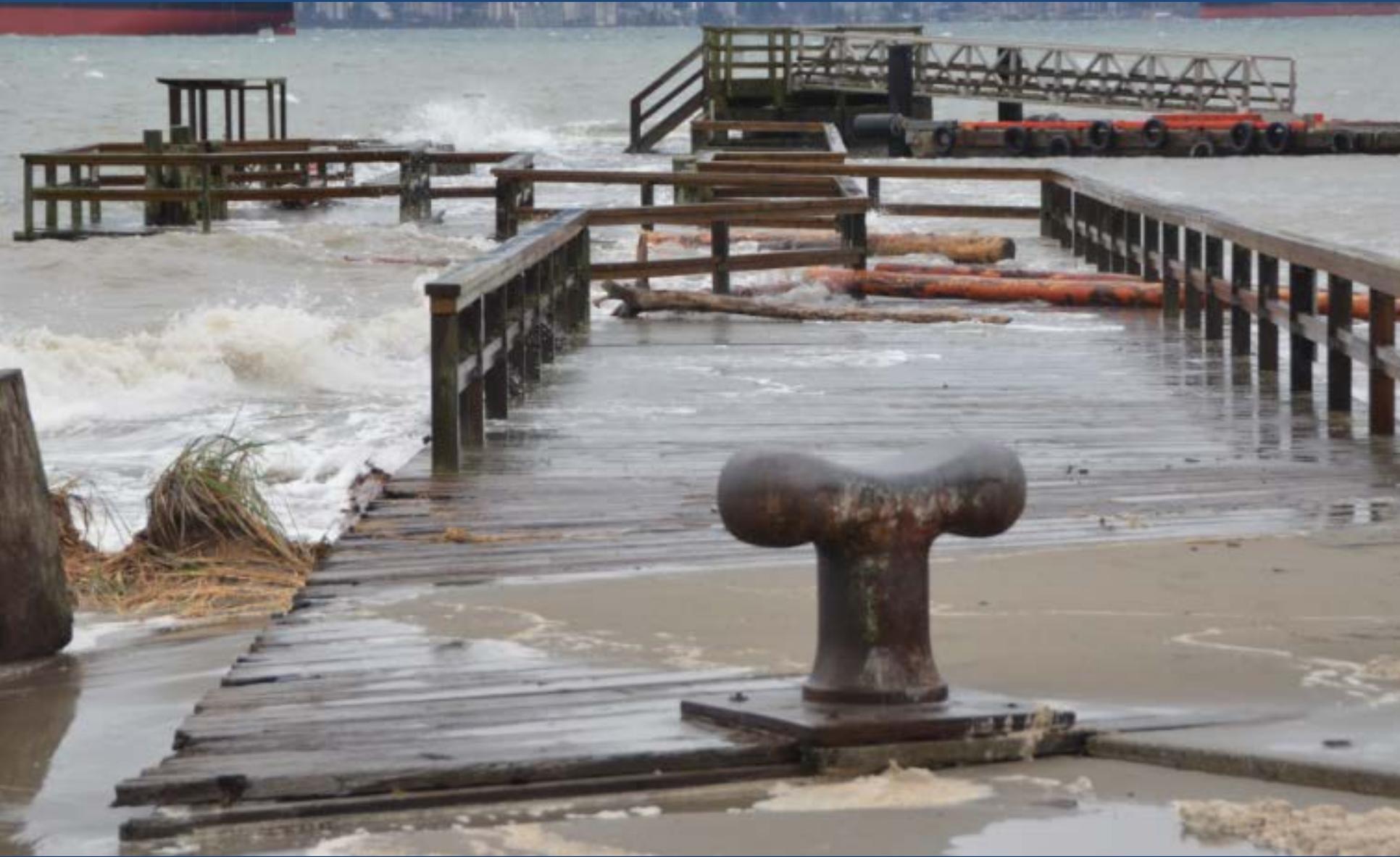
Credit: JohnEnglander.net

Sea Level Rise

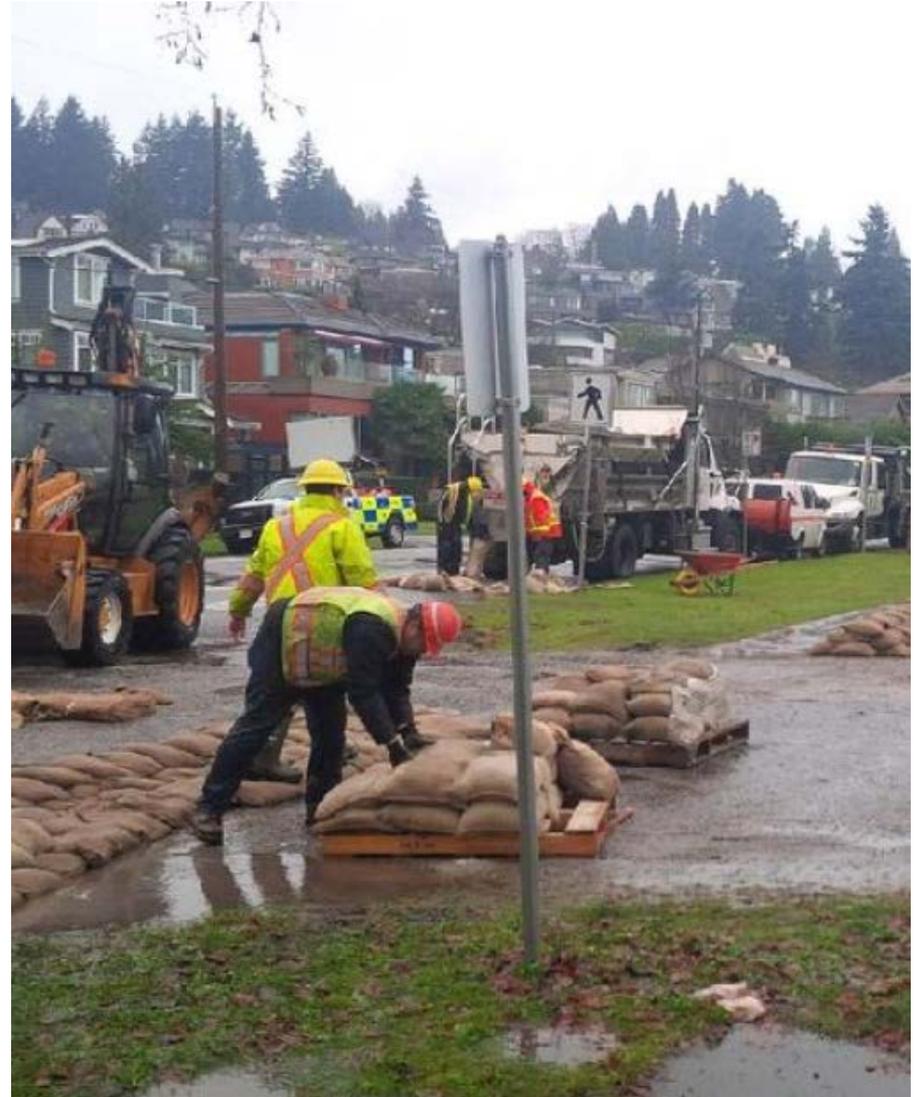
- ↘ Rising sea level is “the single most profound geological change in recorded human history” *John Englander, 2016*
- ↘ Not a possible or a probable but a question of WHEN
- ↘ Amounts are unpredictable
- ↘ Unstoppable and irreversible for centuries
- ↘ Good news: slow so we can plan and adapt but must think BIG and FLEXIBLE enough



Context: King Tide flooding Jericho Pier



Context: King Tide flooding Jericho



Context: King Tide flooding Seawall



Context: King Tide flooding Seawall



The background image shows a waterfront scene. In the foreground, there is a concrete pillar with a blue and white striped pattern. The pillar is situated on a rocky shore. In the background, there are modern buildings and a body of water with a boat. The sky is clear and blue.

CONTEXT

Fraser Basin Council
Lower Mainland Flood Management
Strategy

Provincial
Amendment to Flood Hazard
Management Guidelines

Federal
National Disaster Mitigation Program &
National Flood Mapping Standards Project

Coastal Flood Risk Assessment (CFRA) Overview

PHASE

1

Flood hazard today and in 2100
What is at risk
and potential losses

2012

VBBL

Flood Construction Level
from 3.5m to 4.6m

2014

PHASE

2

Develop response options for 11 areas
and compare options

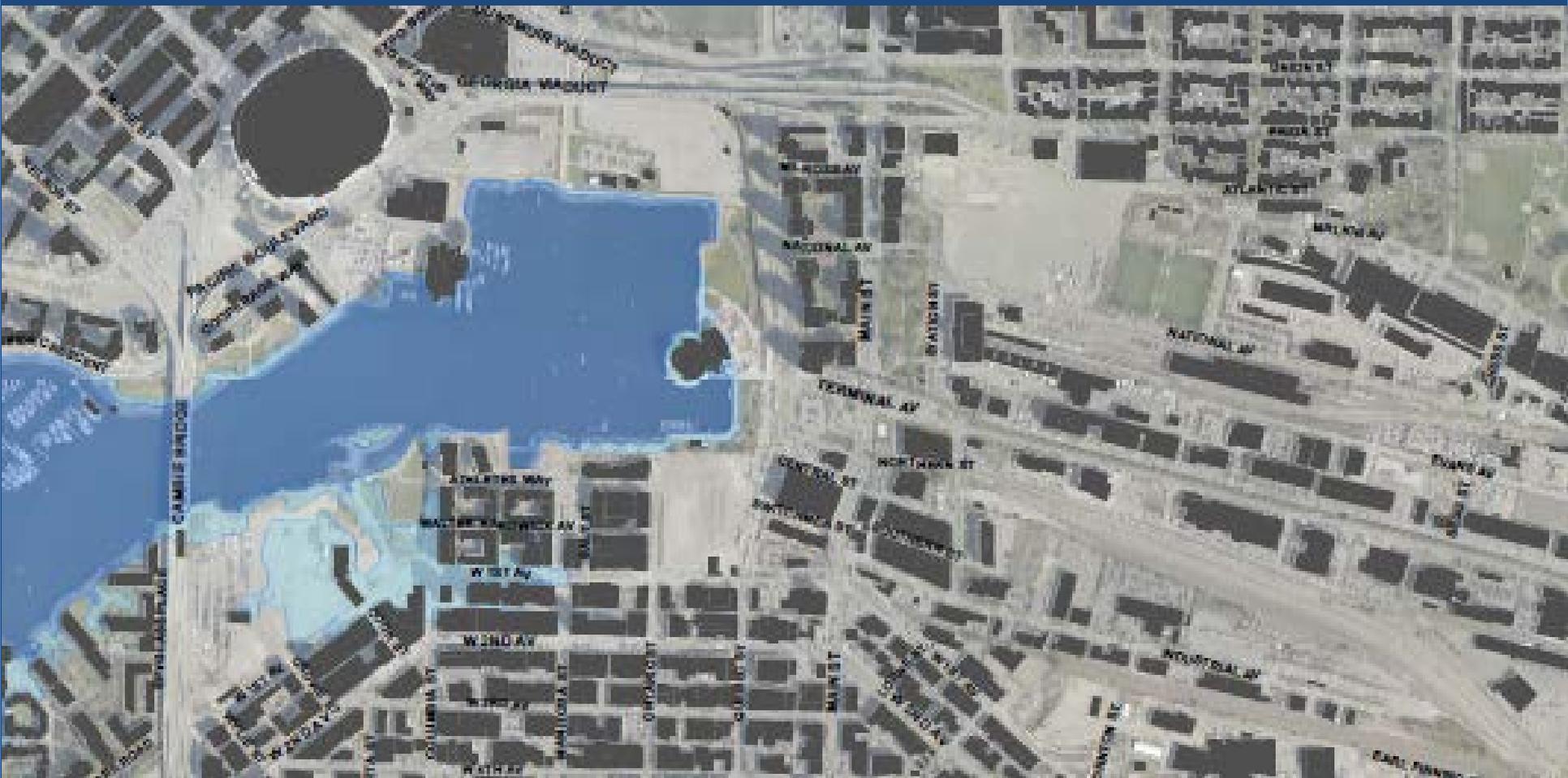
2015



CFRA – Phase 1 Current and Future flood hazard

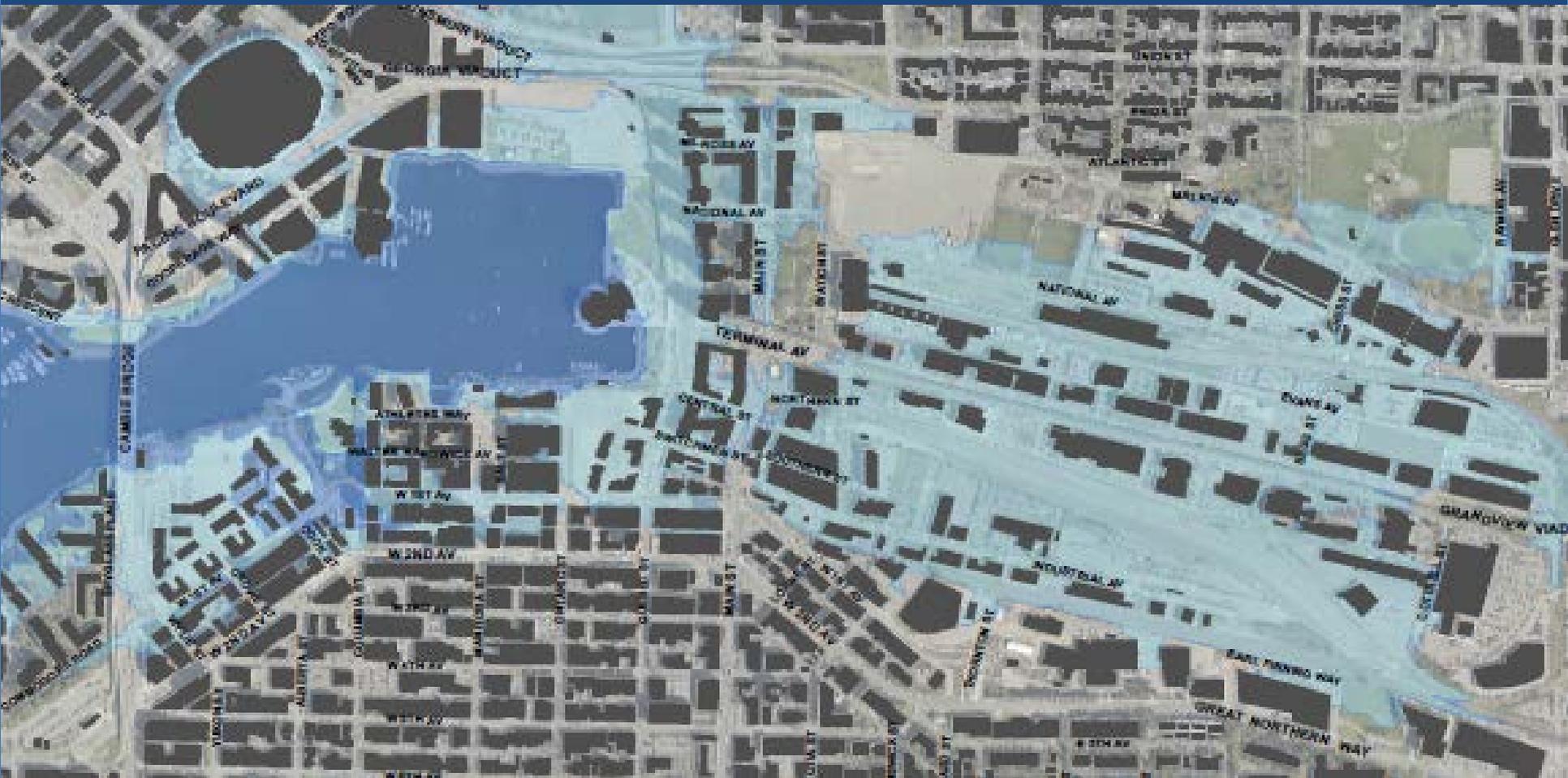


With increasing sea level rise our risk grows significantly



Extreme Storm Event, High Tide 2020

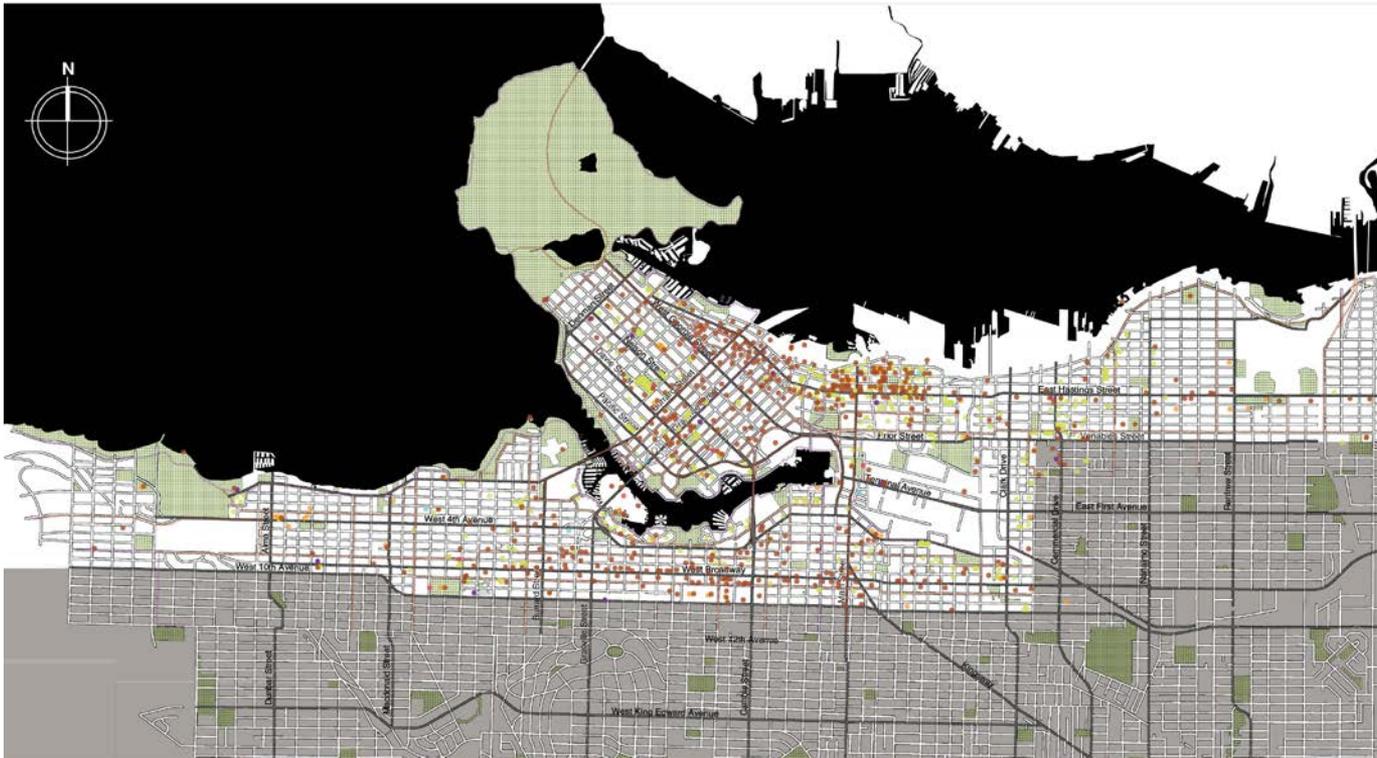
Future Flood Hazard Mapping



Extreme Storm Event, High Tide 2100

Identifying Elements at Risk

COMMUNITY DATA MAP



LEGEND

- Social Services
- Friendship Centres
- Farmers Markets
- Seniors Centres
- Community Centres
- Non-Market Housing
- Hospitals and Care Facilities
- Food Shelter
- Homeless Shelters



Infrastructure



People

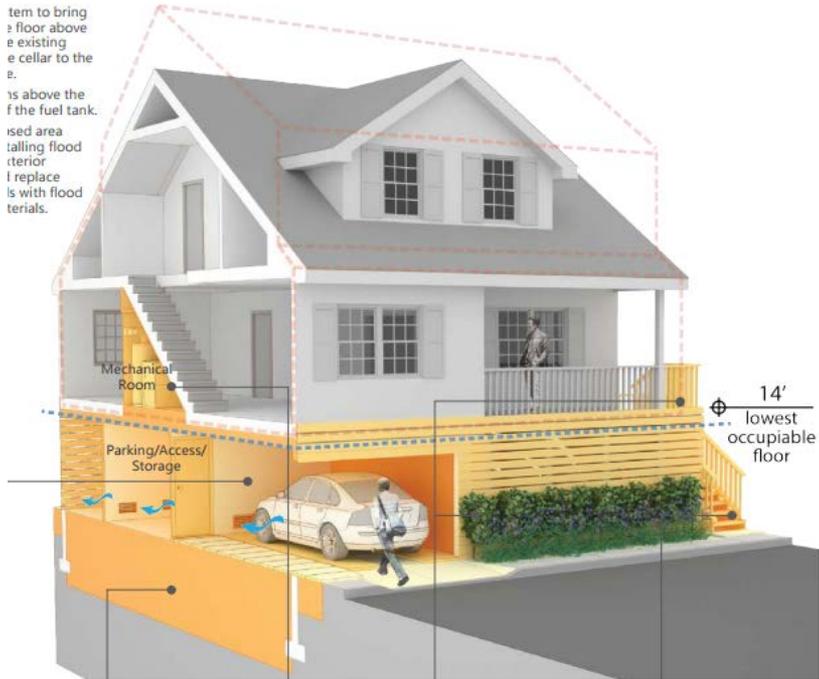


Economy/Assets



Environment

Phase 1 Outcome: FCL from 3.5m to 4.6m



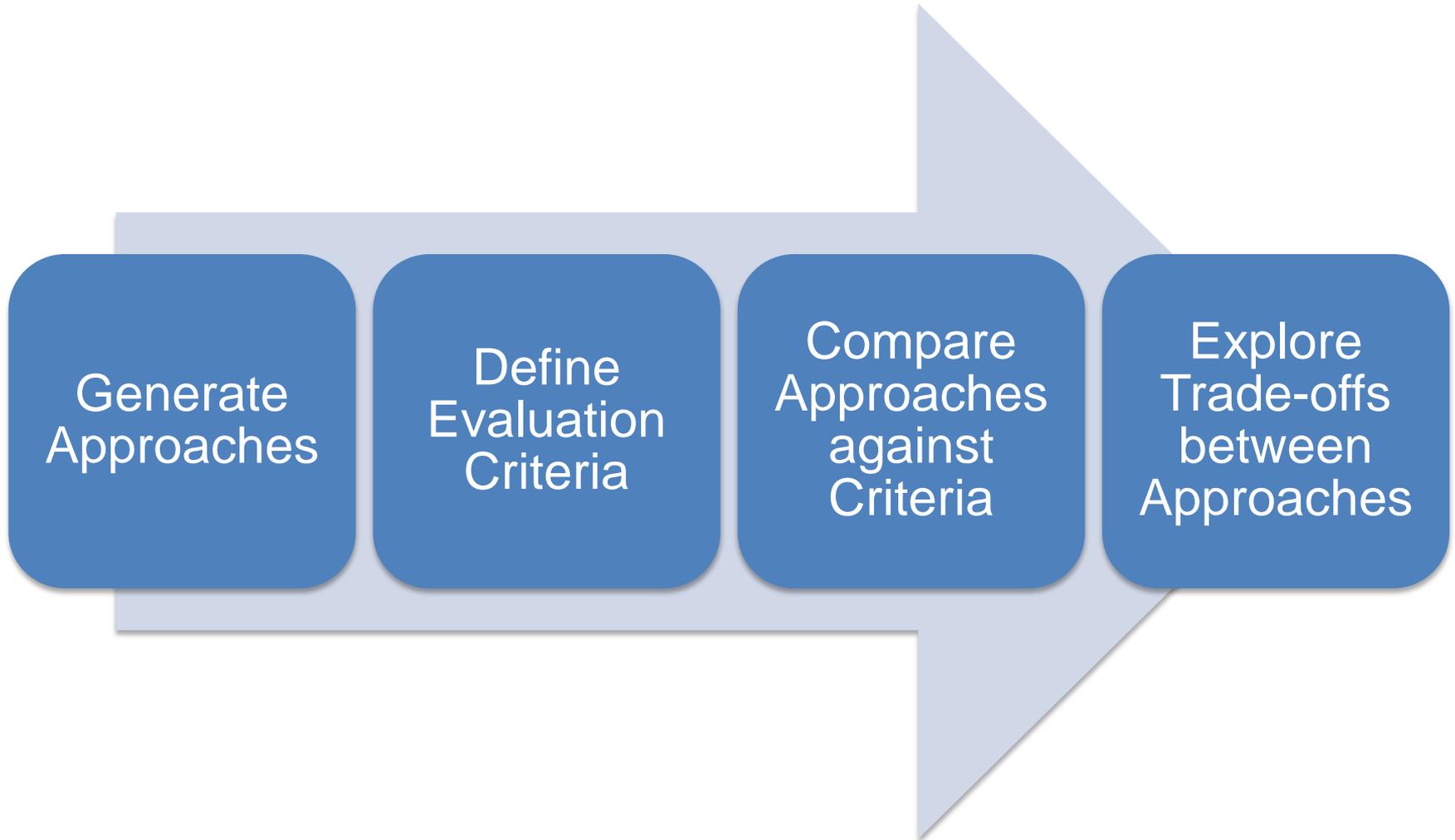


CFRA – Phase 2

Seek Flexible, Adaptive and Robust Solutions



Phase 2 Process – Preliminary Evaluation



Phase 2 – Stakeholders Involved

CITY STAFF

Parks
OEM
Planning
Engineering
Social Planning
Facilities

EXTERNAL

BC Hydro
BC Government
City of Surrey
CMHC (Granville Island)
Metro Vancouver
Port Metro Vancouver
TransLink
University of British Columbia
Urban Development Institute

CFRA Phase 2: Preliminary Evaluation of Approaches

RESPONSE APPROACHES

CONSIDERATIONS

Adapt



Protect



Retreat



PEOPLE



ENVIRONMENT

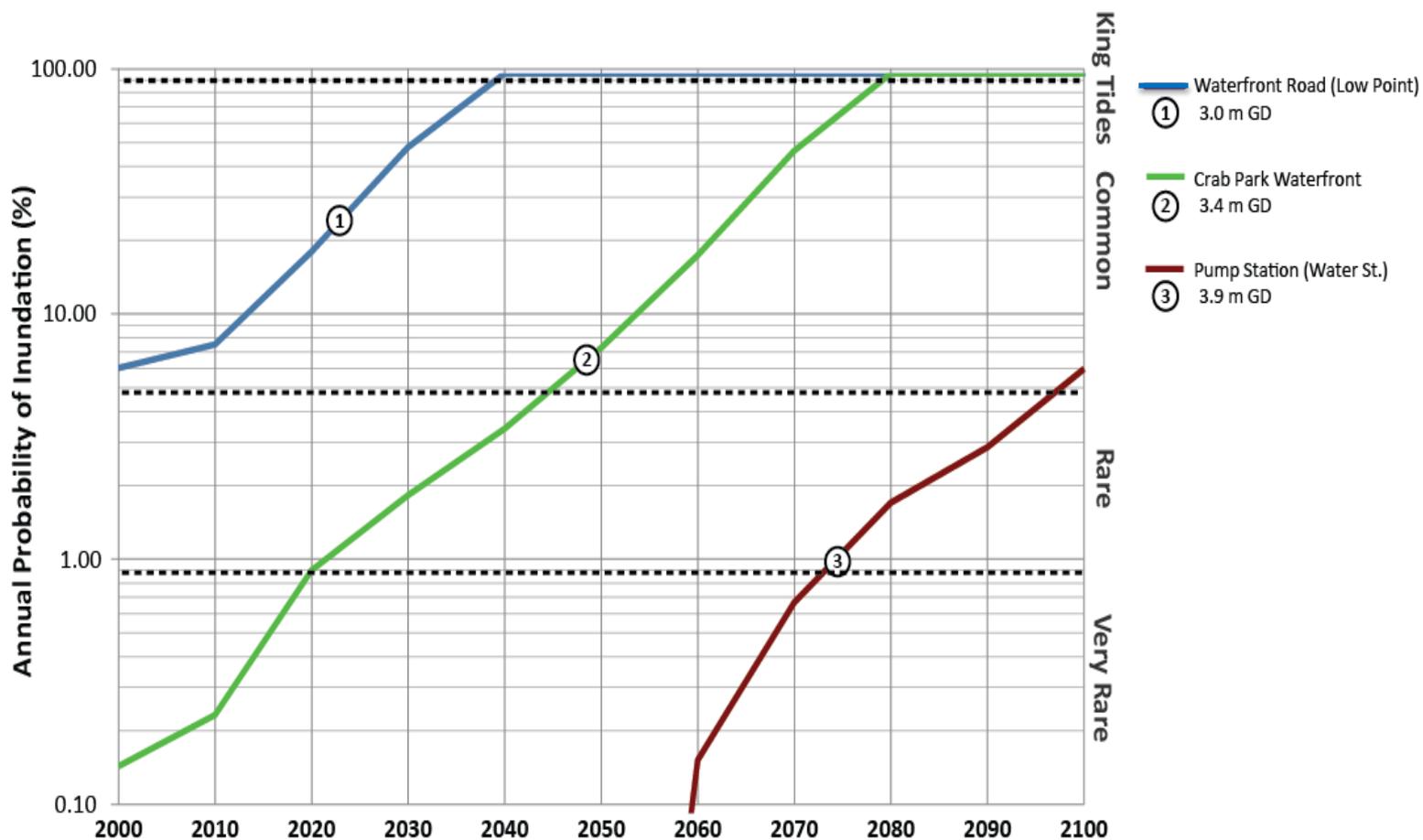


ECONOMY



IMPLEMENTATION

CFRA Phase 2: It is important to consider WHEN an option should be implemented



Precedent: Dry-line New York City



RIVER AS TIDAL PARK

CONNECTING CITY AND RIVER



Precedent: NYC design competition



Layered landscapes (with slope)



5 Focus Areas - Preliminary Response Approaches

1. False Creek
2. Fraser River Industrial
3. Southlands
4. Jericho/Locarno
5. Kitsilano

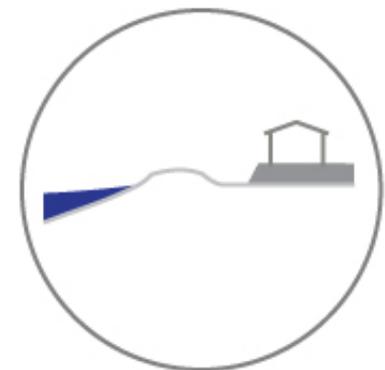
Protect
With Sea Barrier



Protect
With Raised Seawall



Adapt
Multiple Tools



Legend

- Option Alignment
- Protected Floodplain: 0m SLR, 1:500 Storm AND 1m SLR, High Tide
- Protected Floodplain: 1 m SLR, 1:500 Storm
- Floodplain: 0m SLR, 1:500 Storm AND 1m SLR, High Tide
- Floodplain: 1 m SLR, 1:500 Storm

closed 3-4 days/yr;
increasing over time
~10m high
360m wide



**Ramspol, the Netherlands:
Storm Surge Barrier
Example**

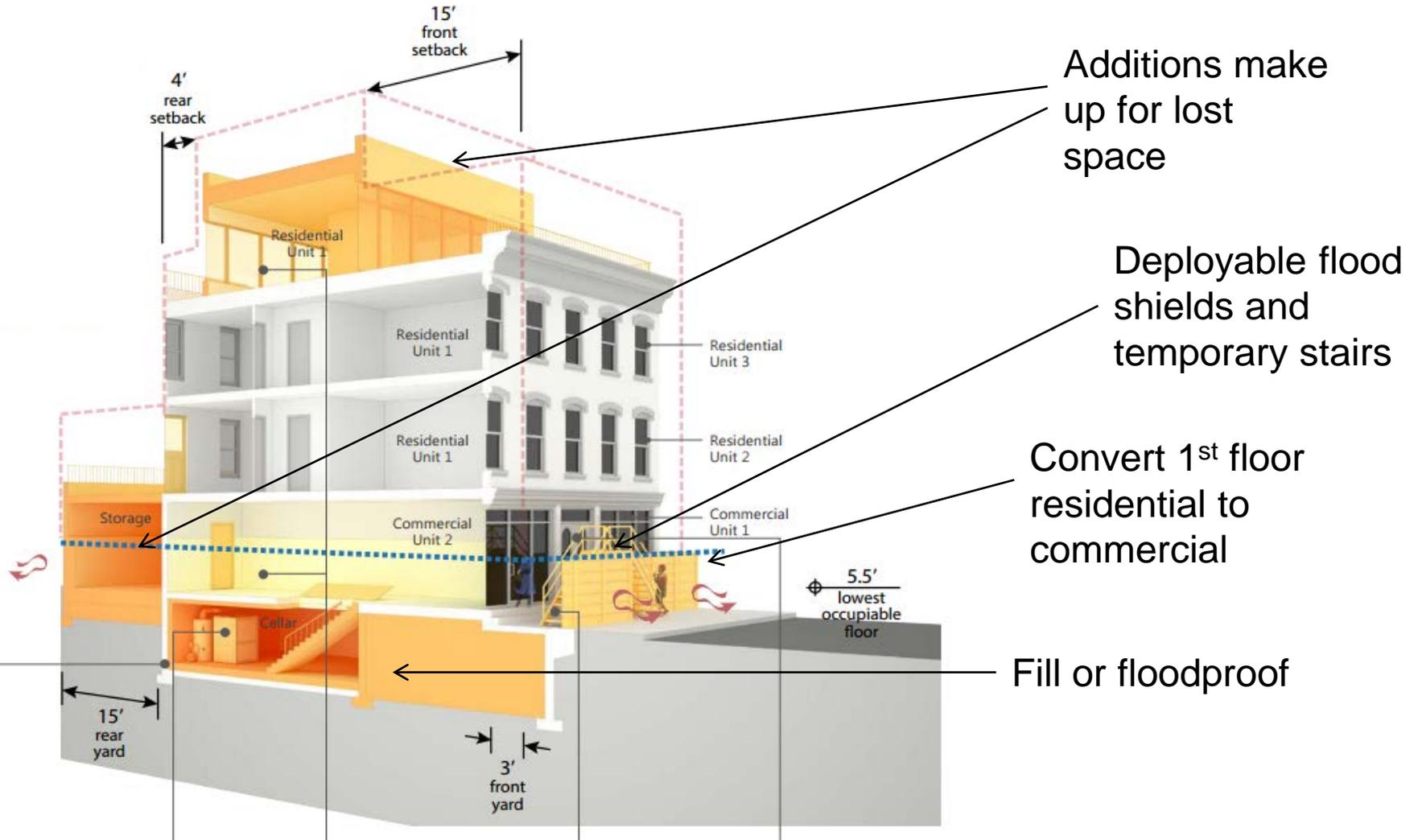


Source: boxbarrier.com

8.6 km long seawall to be raised to FCL of 4.6m

On average 2.3m of height increase is required







Protect

With Shoreline
Dike



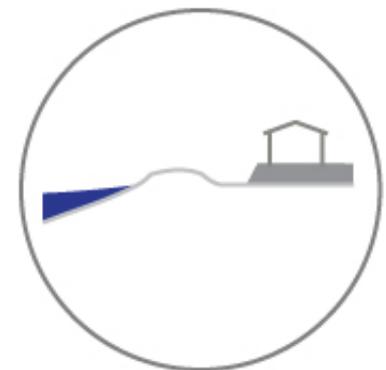
Protect

With Inland Dike



Adapt

Multiple Tools



Fraser River Industrial: Protect with shoreline Dike

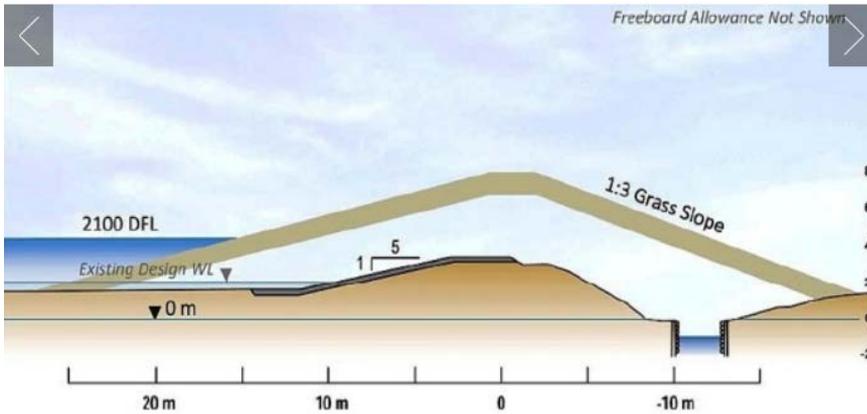


Figure 1-13 Example Sea Dike for 2100 – West Richmond
elevations: CGD



Fraser River Industrial: Protect with Inland Dike



Fraser River Industrial: Adapt with Multiple Planning Tools

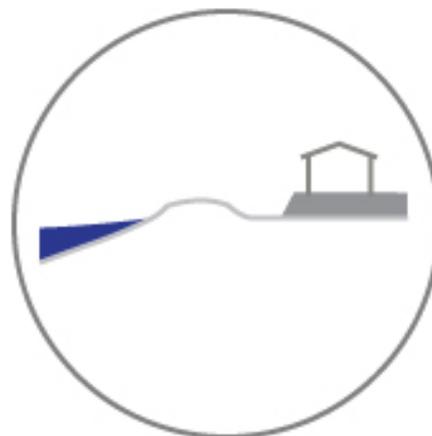


Image from: Brooke Peninsula Project Assael Architecture Limited, UK

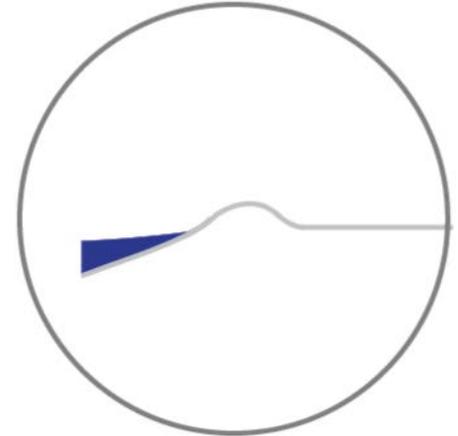
Protect With Dike



Adapt Multiple Tools



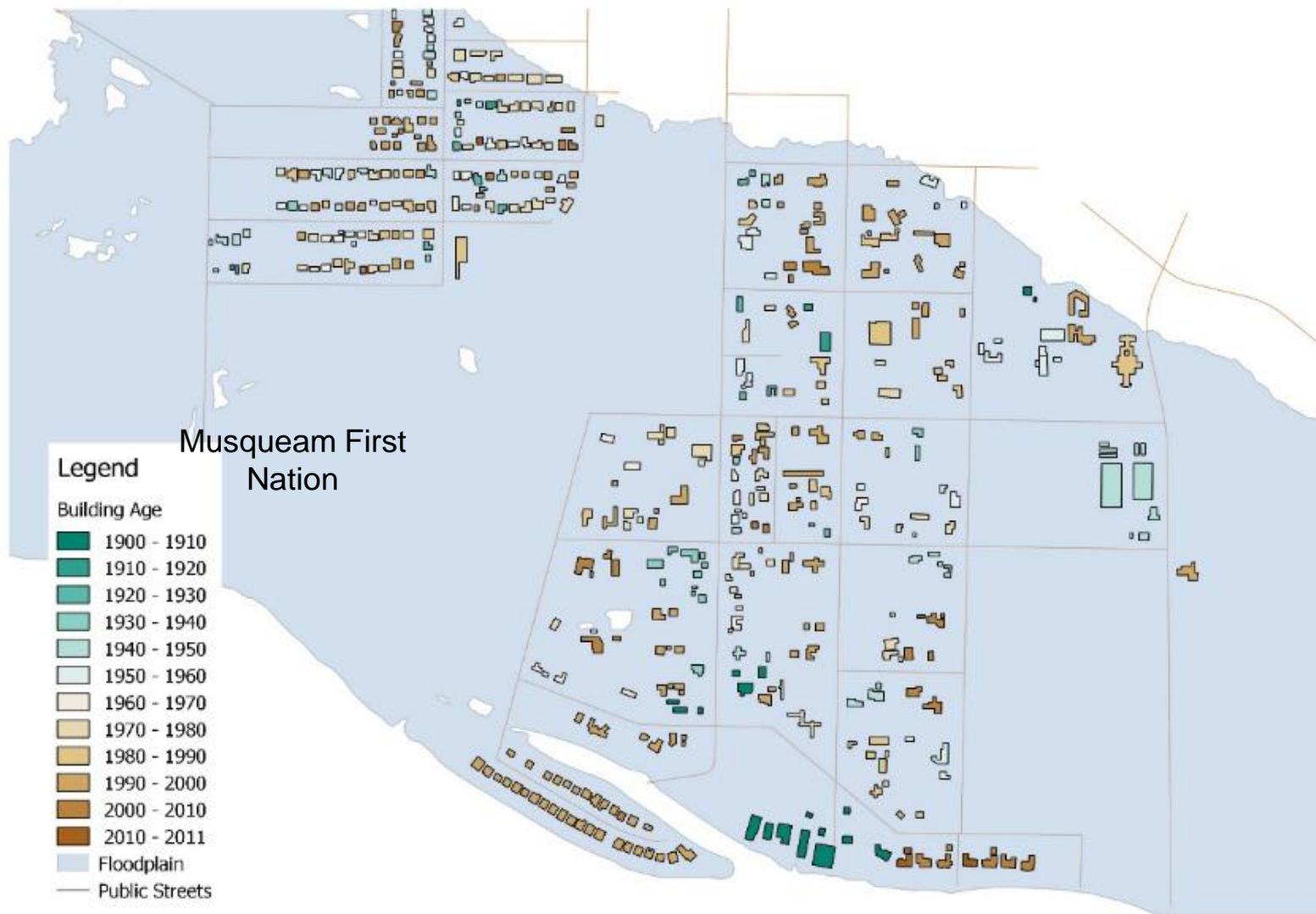
Managed Retreat



Southlands: Protect with Dike



Southlands: Managed Retreat



Southlands: Adapt with Multiple Tools



Temporary Flood Barriers (England)



Image from: McFarland Marceau Architects Ltd. North Vancouver Outdoor School, Squamish, BC

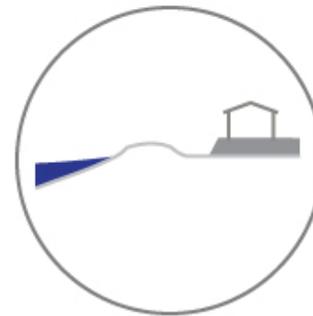
Protect With Park Dike



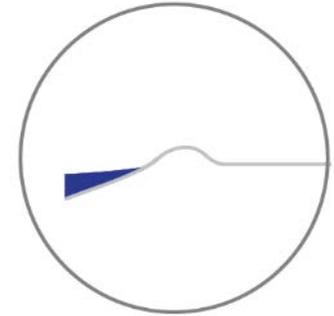
Protect With Road Dike



Adapt Multiple Tools



Managed Retreat



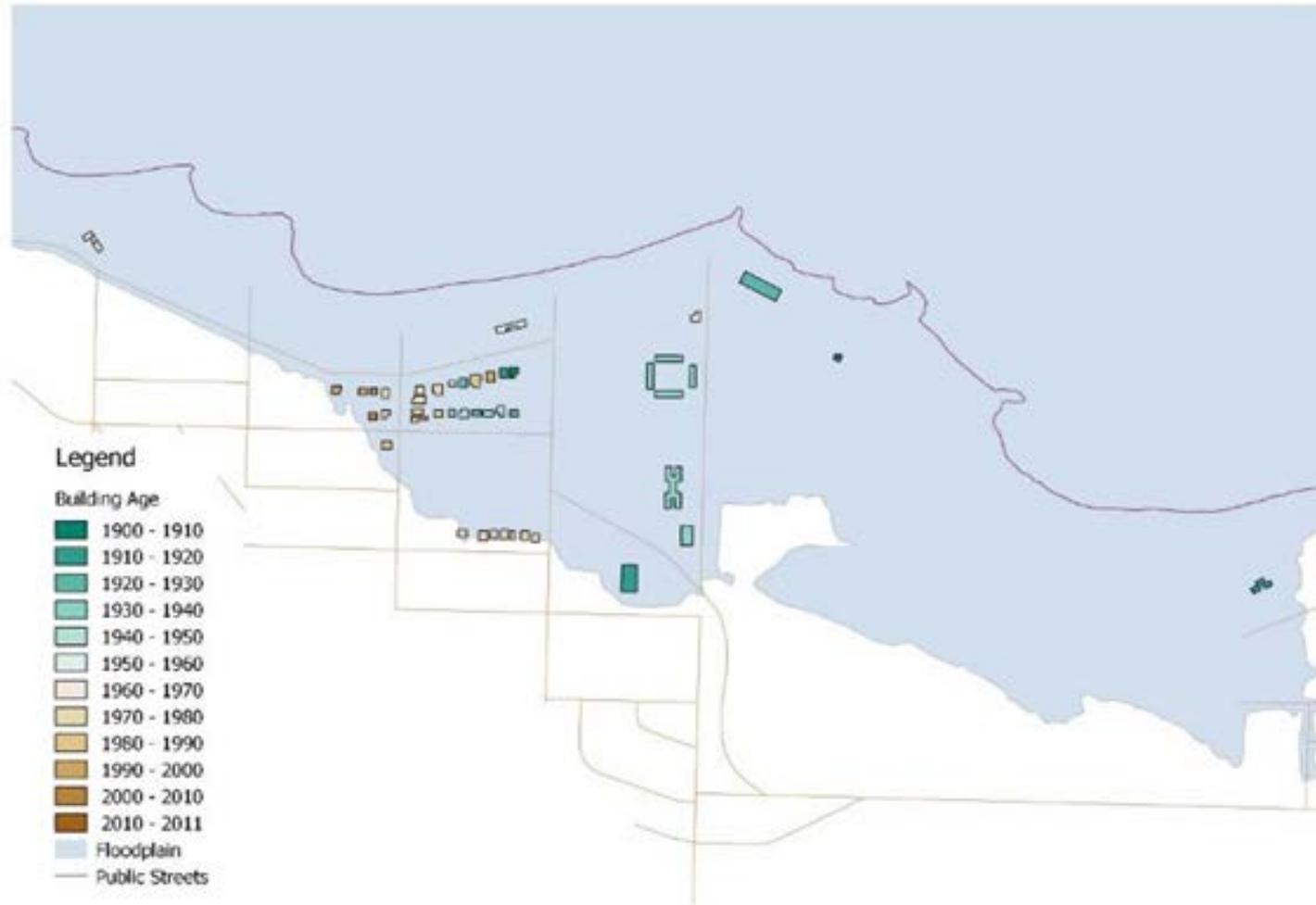
Jericho: Protect with Park Dike



Jericho: Protect with Road Dike



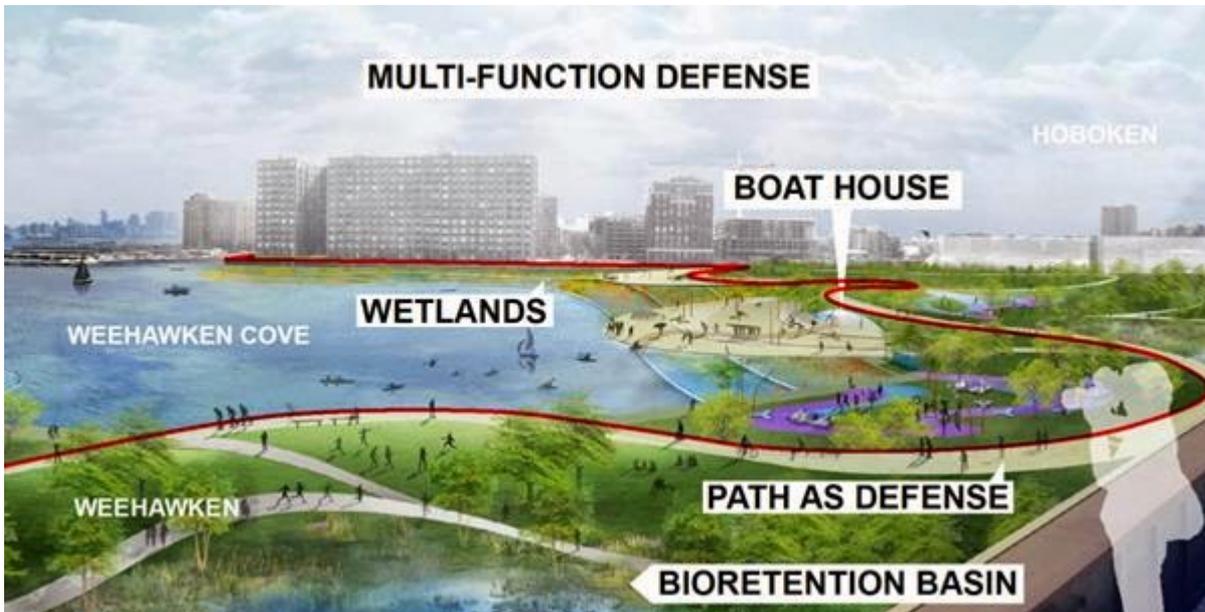
Jericho: Managed Retreat



Jericho: Adapt



Jericho Example: Fine Grained Shoreline Planning



Jericho: Example of a Resilient Park



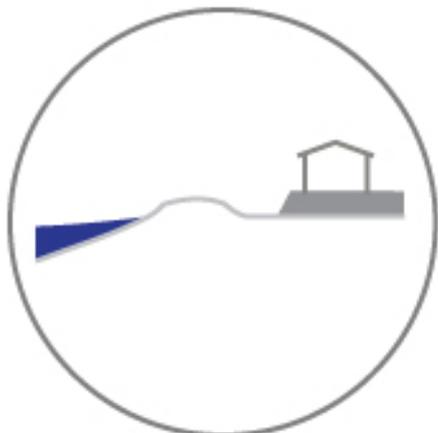
Protect With Park Dike



Protect With Road Dike



Adapt Multiple Tools



Protect with Park Dike



Protect with Road Dike



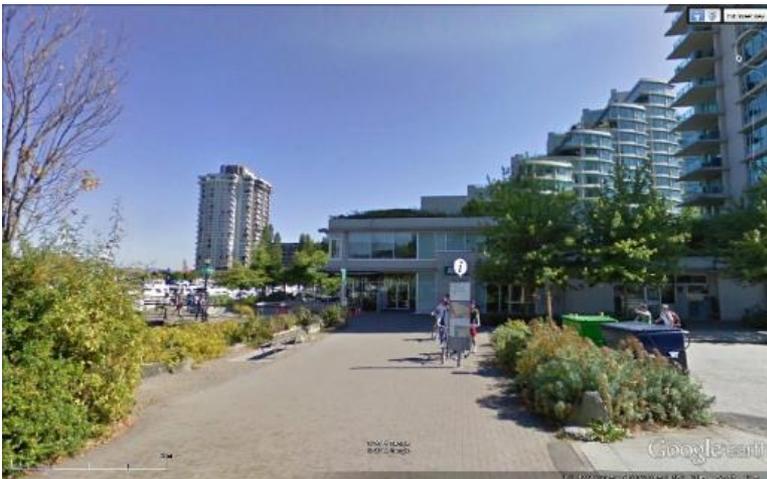
Adapt with Planning Tools

2015 High Level Cost Estimate

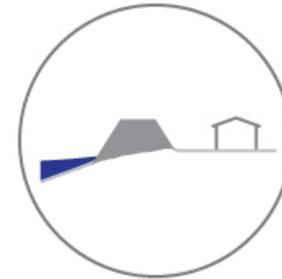
	Barrier	Raised seawall	Adapt
False Creek	\$500M-\$800M \$9.5M/yr. mtn.	\$300M-\$400M \$4M/yr. mtn.	\$338M \$0.5M/yr. mtn.
	Shoreline Dike	Inland Dike	Adapt
Fraser Industrial	\$160M \$107K/yr. mtn.	\$55M \$107K/yr. mtn.	\$405M \$0.5M/yr. mtn.
	Shoreline Dike	Retreat	Adapt
Southlands	\$90M \$66K/yr. mtn.	\$990M	\$150M \$0.5M/yr. mtn.
	Park Dike	Road Dike	Retreat
Jericho	\$10M - \$24M \$20K/yr. mtn.	\$10M - \$20M \$15K/yr. mtn.	\$620M
	Park Dike	Road Dike	Adapt
Kitsilano	\$4M - \$9M \$7K/yr. mtn.	\$6M - \$15M \$10K/yr. mtn.	\$13M \$0.5M/yr. mtn.

Secondary Focus Areas – Preliminary Response Approaches

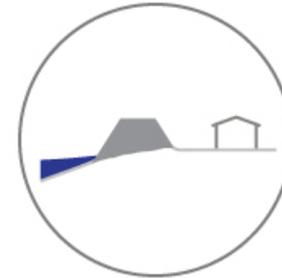
1. Coal Harbour
2. Waterfront Road Area
3. New Brighton Park
4. Stanley Park
5. Point Grey Road
6. Port Lands



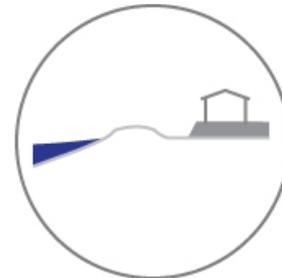
Protect
With Raised
Seawall



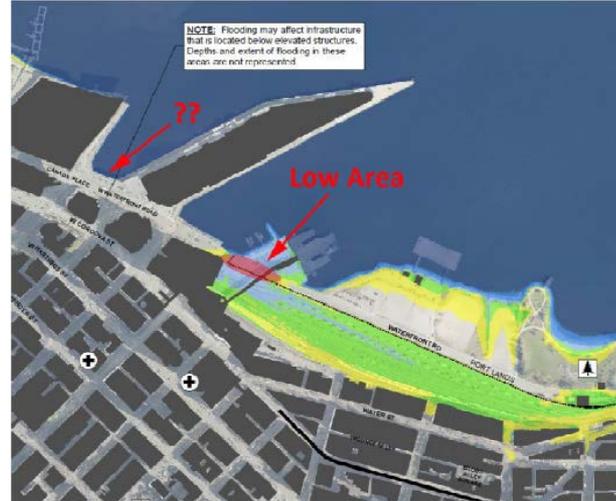
Protect
With Structured
Wall



Adapt
Multiple Tools



Waterfront Road Area



Concepts from
Sean Smith, Port
MetroVancouver



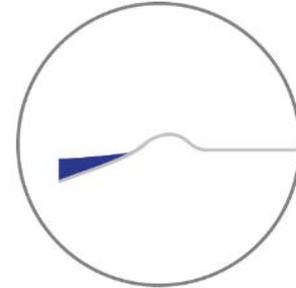
New Brighton Park



**Protect
With Dike**



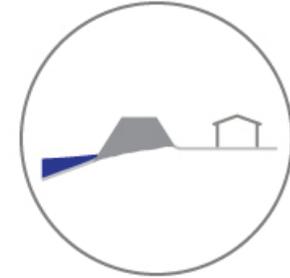
**Managed
Retreat**



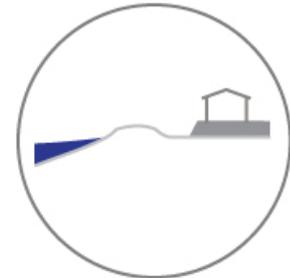
Stanley Park



Protect
With Raised
Seawall



Adapt
Multiple Tools





**Protect
With
Armoring**

Phase 2 Conclusions

- Protect land regardless of use
- Prioritize maintaining natural shoreline for as long as possible and incorporating green infrastructure solutions where possible.
- Enhance amenities where possible
- Phase solutions to obtain best value and provide for course correction as more information is available

Next Steps

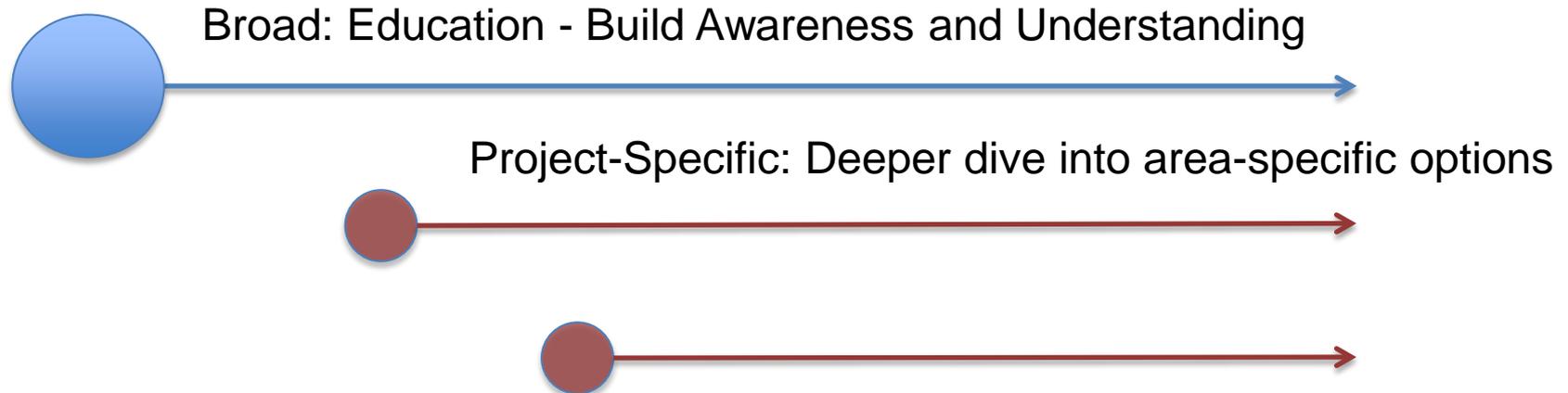


Begin Short Term projects: Jericho, Fraser River, Waterfront Road

Work with other levels of Government:

- Lower Mainland Flood Management Strategy, NDMP funding, First Nations Collaboration

Engagement



- ↘ **Broad community-wide Education:**
 - ↘ Causes and impacts of sea level rise
 - ↘ What to expect in Vancouver
 - ↘ Options for response



- ↘ **Project-specific engagement (e.g. Southlands)**
 - ↘ Tell us what you think of the preliminary approaches
 - ↘ Other approaches to consider
 - ↘ Concurrently explore technical feasibility of options

↘ Immediate Next Steps

- ↘ Develop flood warning systems and flood response plans
- ↘ Develop an Adaptive Management Strategy and start monitoring
- ↘ Limit Critical Infrastructure in floodplains
- ↘ Initiate a Financing Strategy
- ↘ Preserve Future Options through redevelopment, acquiring space, park planning



- ↘ Funding Sources:
 - ↘ Federal Government Funding
 - ↘ Provincial Government Funding
 - ↘ Regional / local contributions

- ↘ Potential Sources of Regional / Local Contributions
 - ↘ Regional / Local Development Cost Charges
 - ↘ Local Improvement Tax
 - ↘ New area specific or city-wide fees or levies

- ↘ Next Steps
 - ↘ Start planning now for long term funding mechanisms including advocacy for reliable and predictable Sr. Gov't funding
 - ↘ Area-specific projects will include funding strategy

- ↘ Begin broad community education campaign
- ↘ Implement immediate next steps
- ↘ Initiate short term projects by 2017
 - ↘ Concurrent engagement and engineering refinement
- ↘ In parallel develop a Sea Level Rise Response Strategy to outline medium and long term actions
 - ↘ Project Initiation Dates and Decision Thresholds
 - ↘ Project Team Requirements, Roles and Responsibilities
 - ↘ Project Funding

QUESTIONS?

