

Crescent Beach Community Meeting Series

MEETING 2: COMMUNITY DIALOGUE ON ADAPTATION
RESPONSES

Saturday, June 4, 2016

Elgin Hall

10:00 am – 3:00 pm



ACT
Adaptation to
Climate Change
Team



Ideaspace
Think Big

Meeting Agenda

- | | | |
|-------|--|--|
| 10:15 | Welcome and Introduction | <i>Diana Bulley, Facilitator, Ideaspace</i> |
| 10:30 | Charrette #1 Overview | <i>Deborah Harford, ED, ACT</i> |
| 10:45 | The Crescent Beach Community | <i>Table Activity</i> |
| 11:15 | Presentation: Sea Level Rise | <i>Matt Osler, Senior Project Engineer, City of Surrey</i> |
| 12:00 | LUNCH | |
| 12:30 | Impacts of Sea Level Rise on the Community | <i>Table Activity</i> |
| 1:00 | Exploring Adaptation Responses | <i>Matt Osler</i> |
| 1:20 | In Focus: Adaptation Responses in Crescent Beach | <i>Table Activity</i> |
| 2:30 | Reporting back and final thoughts | <i>Diana Bulley</i> |
| 2:55 | Charrette #3 | <i>Diana Bulley</i> |
| 3:00 | Meeting Adjourns | |

Discussion Guidelines

- Hold questions until after each presentation
- Respect each other and different points of view
- Please turn phones to silent and take any calls outside

What makes Crescent Beach so special?

- The ever changing environment and conditions...
- Draws in mass amounts of biodiversity.



Courtesy of Surrey Archives



Tides – Highs to Lows

Sand Shoreline

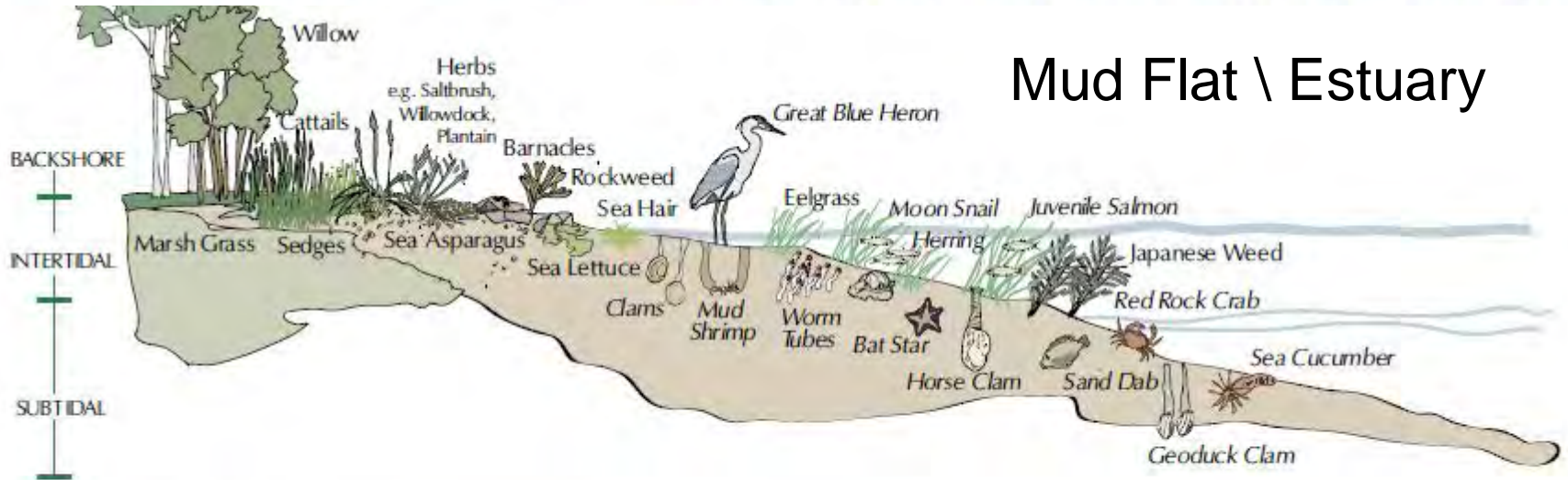


Adapted from a sketch by Archipelago Marine Research Ltd.

COASTAL SHORE STEWARDSHIP

28

Mud Flat \ Estuary



Adapted from a sketch by Archipelago Marine Research Ltd.

COASTAL SHORE STEWARDSHIP

30

The Climate Change Challenge



The world is committed to significant changes in climate regardless of future emissions of greenhouse gases.

While **emissions reduction is important** to avoid catastrophic changes in climate, this means that **adaptation to the effects of global warming is necessary to reduce vulnerability and enhance resilience.**

Projected Climate Change Impacts



**Sea level rise – locked in now.
(Province estimates 1m by 2100):**

Increased storminess and storm surge

Erosion

Infrastructure impacts

Loss of beaches and coastal ecosystems

Soil salinization

River influence – e.g. levels, salt wedging

Groundwater pooling

Result: New Conditions



Result of climate changes plus additional influences:

- **Traditional approaches need updating on an ongoing basis, including engineering and building standards**
- **Ability to project conditions based on experience not reliable**
- **Extreme weather of magnitudes we cannot foresee**
- **Levels of damage beyond our experience**

Current Weather Effects in Crescent Beach



Key Adaptation Actions Needed

1. **Engage** stakeholders from community and business to ensure they understand the challenges and participate in developing solutions.

2. **Coastal response options:**

Protect – build protection around buildings and services

Accommodate – raise buildings and services

Retreat – move out of the way

3. **Innovate:** Resist, recover, *creative transformation?*

Adaptation: Local Benefits



Benefits:

- Less stress
- Safer
- Cheaper in the long run
- Lower insurance
- Creation of recreation and/or natural beauty benefits through responses featuring new nature-based areas
- Robust property values

Adaptation: Local Benefits



Incentives:

- Increased attractiveness for investors/homeowners in resilient cities as concern over sea level rise grows.
- Opportunity to stand out with innovative ecosystem-based infrastructure responses.

Adaptation: Local Benefits

Need to:

- Collaborate and think regionally, e.g., on coastlines/watersheds/forests.

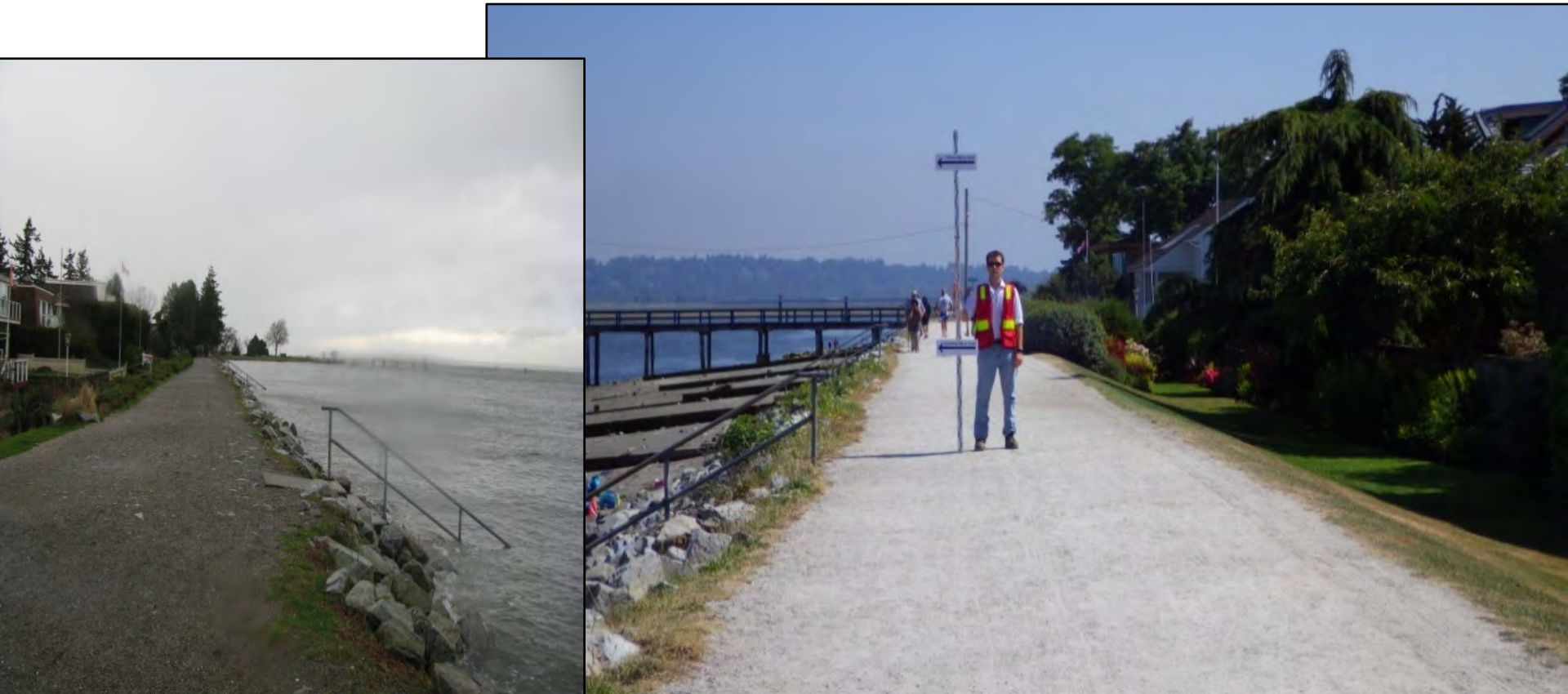


And...
Work together
to develop
solutions.

FBC, 2016

Sea Level Rise Impacts

City of Surrey is looking at projections of challenges and requirements for responses.



Working Together on Sea Level Rise

- No legal prescription for how exactly to respond to sea level rise in neighbourhoods like Crescent Beach.
- No perfect, one-size-fits-all technical responses.
- Need to work through possible responses with communities.
- Need input from community, stakeholders and experts to develop appropriate strategies.

Crescent Beach: Dynamic, Beautiful, Changing



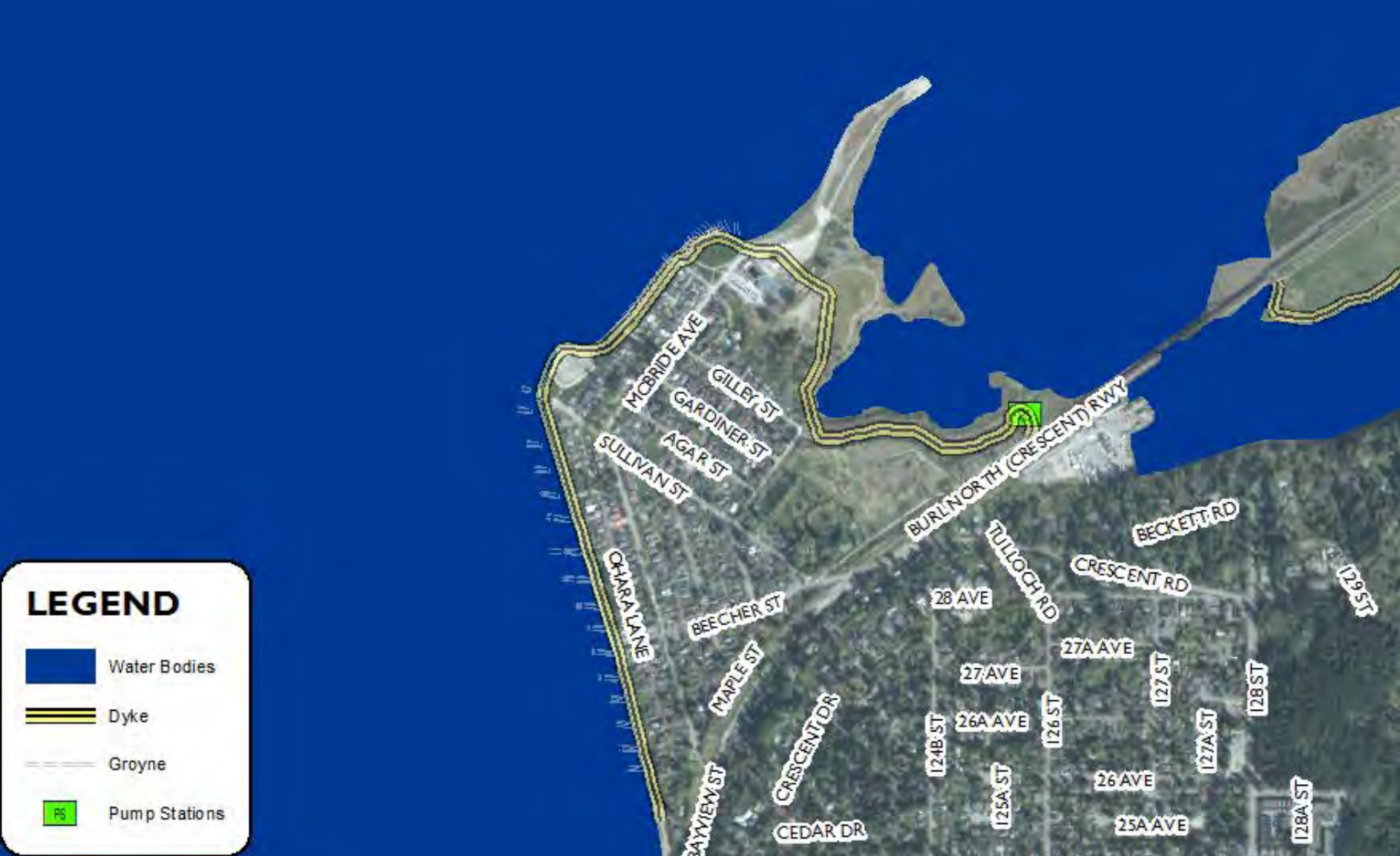
Crescent Beach Sea Level Rise



June 4, 2016

Matt Osler, Project Engineer

Ocean Exposure



Ocean Exposure



Potential Causes of Coastal Flooding in Crescent Beach



Overtopping

Occurs when water levels are high.

Potential Causes of Coastal Flooding in Crescent Beach



Overtopping

Occurs when water levels are high.



Piping

Occurs when water works its way through cracks in the dyke. These are often a result of plant roots or animal burrows.



Erosion

Occurs when waves pound dyke face or when dyke is saturated for a long period of time.



Sliding

Occurs when dyke dries or cracks causing portion of dyke to slide away.

Potential Causes of Coastal Flooding in Crescent Beach

Boundary Bay



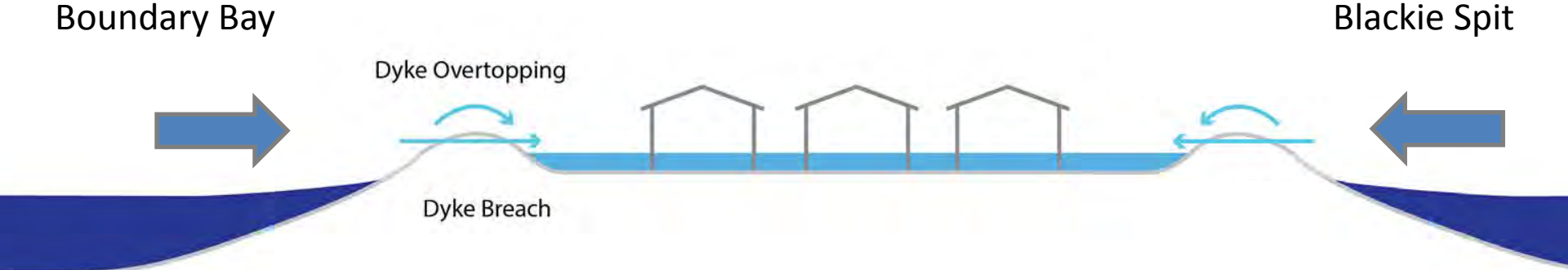
Dyke Overtopping



Dyke Breach



Potential Causes of Coastal Flooding in Crescent Beach



ADAPTING TO CLIMATE CHANGE

Coastal Flood Management:



LANARC

From **You Tube** Channel: <http://youtube.com/provinceofbc>
Complete BC Adapts Playlist: <http://ow.ly/JaoK300TLRX>



https://youtu.be/oMXFn_2MKOw?t=1m26s

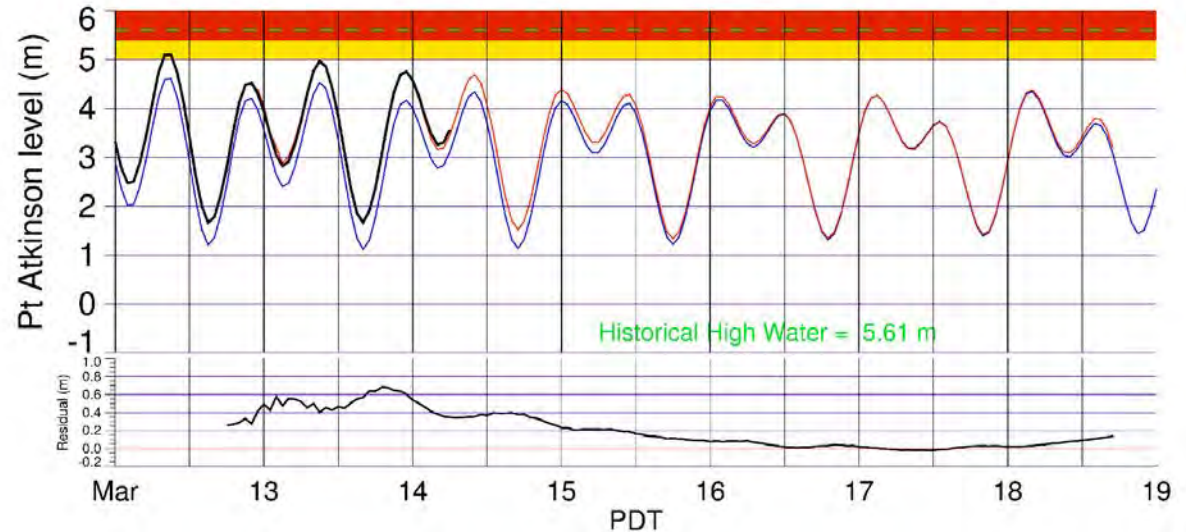
Excerpt from BC Adapts: Coastal Flood Management 4

4 Drivers of Coastal Flooding

4 Drivers of Coastal Flooding

1) High Tide

Hourly water levels: Black = observed Blue = predicted tide Red = forecast total water level

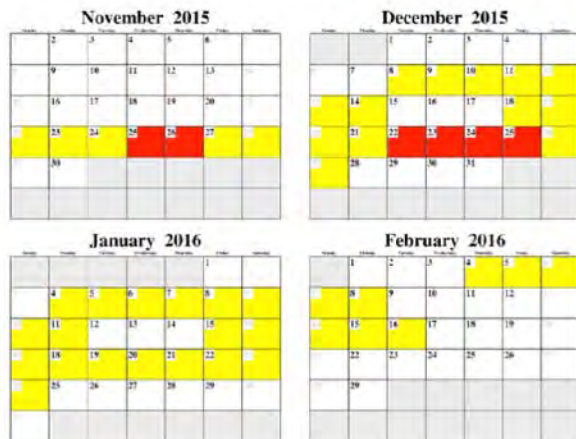


Source:

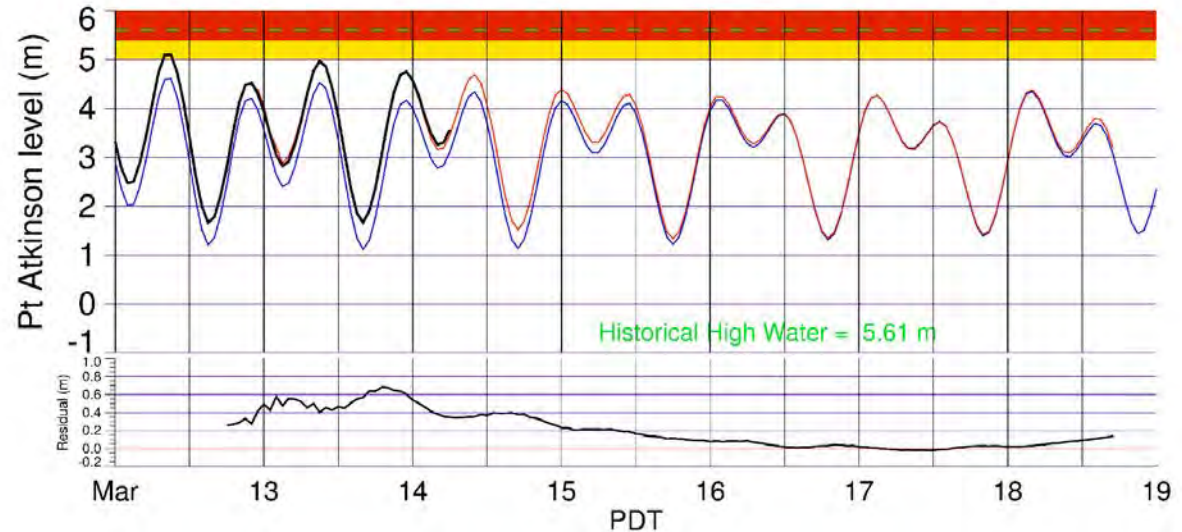
<http://www.stormsurgebc.ca/files/bulletins/ptatkinson.png> and <http://www.stormsurgebc.ca/almanac.html>

4 Drivers of Coastal Flooding

1) High Tide



Hourly water levels: Black = observed Blue = predicted tide Red = forecast total water level



Yellow indicates moderate risk, red indicates elevated risk of flooding in exposed coastal areas

Source:

<http://www.stormsurgebc.ca/files/bulletins/ptatkinson.png> and <http://www.stormsurgebc.ca/almanac.html>

December Tidal Variation – Nicomekl River



Bushnell®

17°F / -8°C

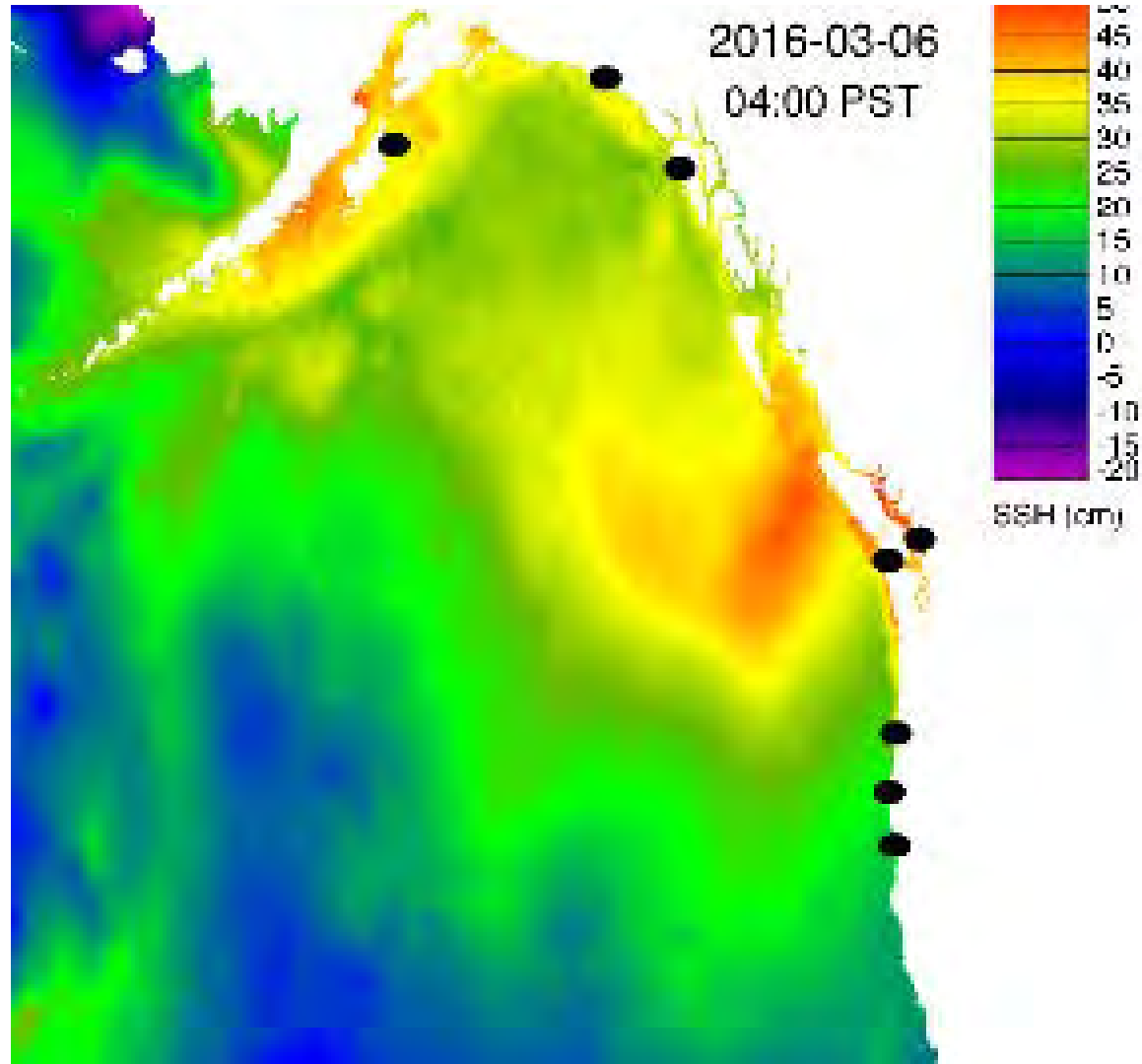


FS

12/09/2013 07:42:00

4 Drivers of Coastal Flooding

2) Storm Surge



Source: <http://stormsurgebc.ca/ne-pacific-ssh-animation.html>

4 Drivers of Coastal Flooding

3) Wind and Waves



4 Drivers of Coastal Flooding

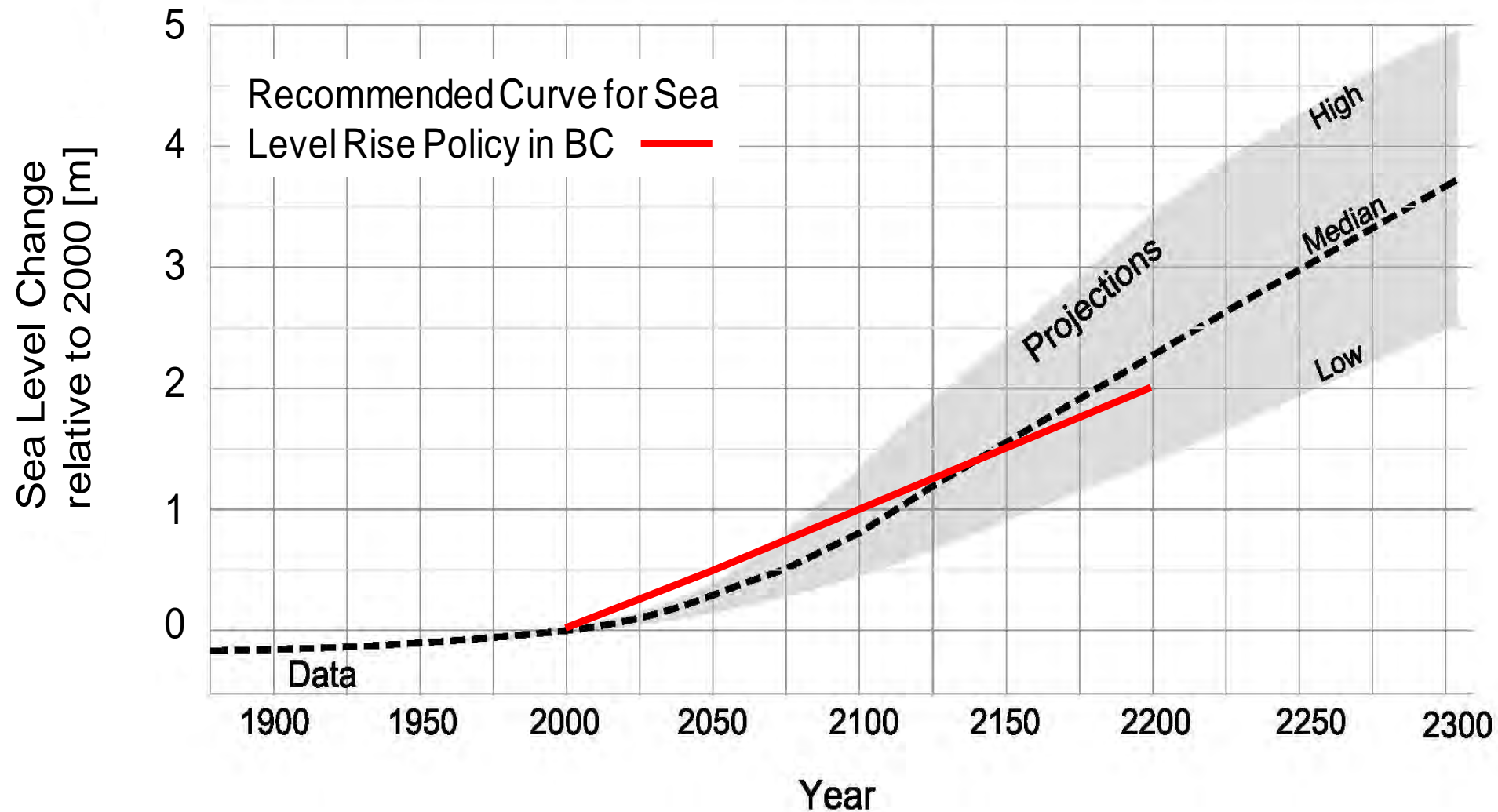
3) Wind and Waves

Crescent Beach is exposed to a 30+ km length of ocean where wind can drive waves towards Crescent Beach

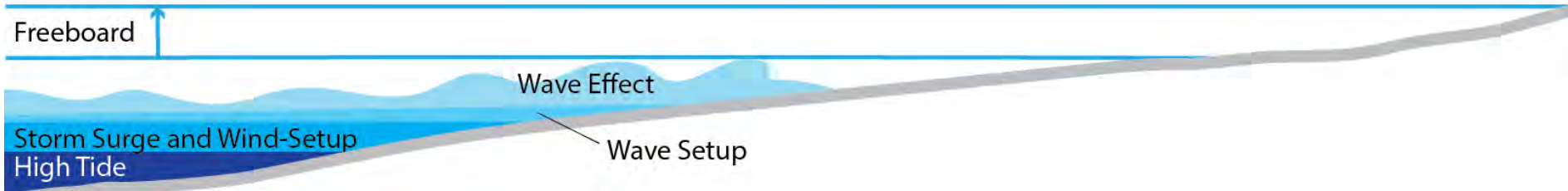


4 Drivers of Coastal Flooding

4) Sea Level Rise



What Elevation?



What Elevation?

Minimum
Elevation of
Underside of
Floor System



Flood Construction Level:

High Tide

Storm Surge and Wind Setup

Wave Setup

50% Wave Effect

Freeboard

Freeboard



Storm Surge and Wind-Setup
High Tide

Wave Effect

Wave Setup

What Elevation?

Minimum
Elevation of
Underside of
Floor System



Flood Construction Level:

- High Tide
- Storm Surge and Wind Setup
- Wave Setup
- 50% Wave Effect
- Freeboard

Dyke Construction Elevation:

- High Tide
- Storm Surge and Wind Setup
- Wave Setup
- 100% Wave Effect
- Freeboard

Freeboard



Storm Surge and Wind-Setup
High Tide

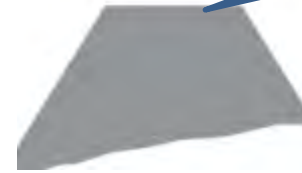
Wave Effect

Wave Setup

What Elevation?



Minimum
Elevation of
Underside of
Floor System



Minimum Dyke
Crest Elevation

Flood Construction Level:

- High Tide
- Storm Surge and Wind Setup
- Wave Setup
- 50% Wave Effect
- Freeboard

Dyke Construction Elevation:

- High Tide
- Storm Surge and Wind Setup
- Wave Setup
- 100% Wave Effect
- Freeboard

Freeboard



Storm Surge and Wind-Setup
High Tide

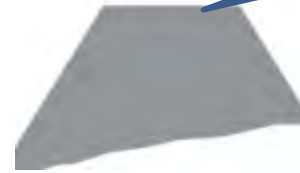
Wave Effect

Wave Setup

What Elevation?



Minimum Elevation of Underside of Floor System



Minimum Dyke Crest Elevation

Flood Construction Level:

- High Tide
- Storm Surge and Wind Setup
- Wave Setup
- 50% Wave Effect
- Freeboard

Dyke Construction Elevation:

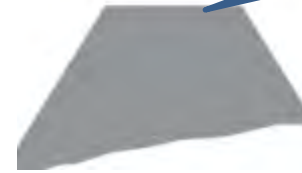
- High Tide
- Storm Surge and Wind Setup
- Wave Setup
- 100% Wave Effect
- Freeboard



What Elevation?



Minimum Elevation of Underside of Floor System



Minimum Dyke Crest Elevation

Flood Construction Level:

High Tide
Storm Surge and Wind Setup
Wave Setup
50% Wave Effect
Freeboard

Dyke Construction Elevation:

High Tide
Storm Surge and Wind Setup
Wave Setup
100% Wave Effect
Freeboard

Freeboard



Storm Surge and Wind-Setup
High Tide

Wave Effect

Wave Setup

The water levels are calculated based on extreme conditions having: "one in 200 hundred year probability of occurring in any given year"

Flood Construction Levels

Bridgeview Example



Minimum
Elevation of
Underside of
Floor System

Significant grade change to
match older construction

Flood Construction Levels in Crescent Beach

In the past, there have been Development Variance Permits granted that allow a reduction of the Flood Construction Level in Crescent Beach only to reduce the level to be 300mm above the centreline of the fronting road.

Excerpt from: https://www.city.surrey.bc.ca/files/BP_for_Crescent_Beach.pdf

Example of building at year 2100 Flood Construction Level

Minimum
Elevation of
Underside of
Floor System



Street and Home Damage Example

- June, 2013
- Calgary, AB
- Photos taken one block from Elbow River
- Dyke overtopped



Calgary Emergency Response



Minimum
Elevation of
Underside of
Floor System

Calgary Garage Flood Damage Example



Minimum
Elevation of
Underside of
Floor System

Peak Flood
Level

Calgary Emergency Response



Home Example (Gardiner Street)



Home Example (Gardiner Street)



Flood Scenario 2020

Home Example (Gardiner Street)



Flood Scenario 2040

Home Example (Gardiner Street)



Flood Scenario 2070

Home Example (Gardiner Street)



Flood Scenario 2100

Street Example (McBride Ave)



No Flood

Street Example (McBride Ave)



Potential Flood Scenario 2020

Street Example (McBride Ave)



Potential Flood Scenario 2040

Street Example (McBride Ave)



Potential Flood Scenario 2070

Dyke Example (Sullivan St)

Note: Full wave effect omitted



No Flood

Dyke Example (Sullivan St)

Note: Full wave effect omitted



Potential Flood Scenario 2020

Dyke Example (Sullivan St)

Note: Full wave effect omitted



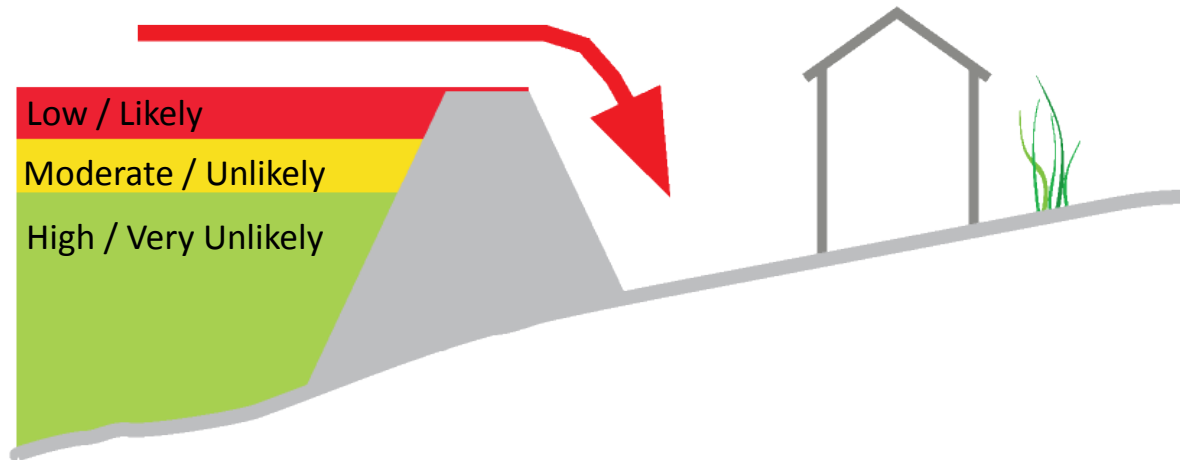
Potential Flood Scenario 2040



Potential Flood Scenario 2070

Serpentine, Nicomekl & Campbell Rivers Climate Change Floodplain Review - Phases 1 & 2

Dyke Integrity / Likelihood of Breach under extreme water levels



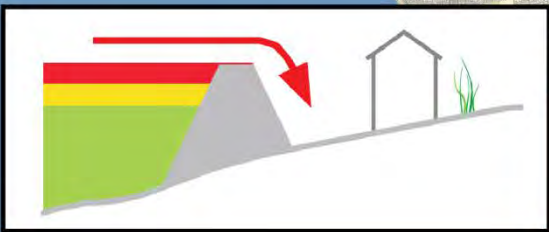
Infrastructure Impact from 200 yr. return Water Level

Sea Dams:	Dry	◇	Compromised	◇	Wet	◇
Bridges:	Dry	●	Compromised	●	Wet	●

2015



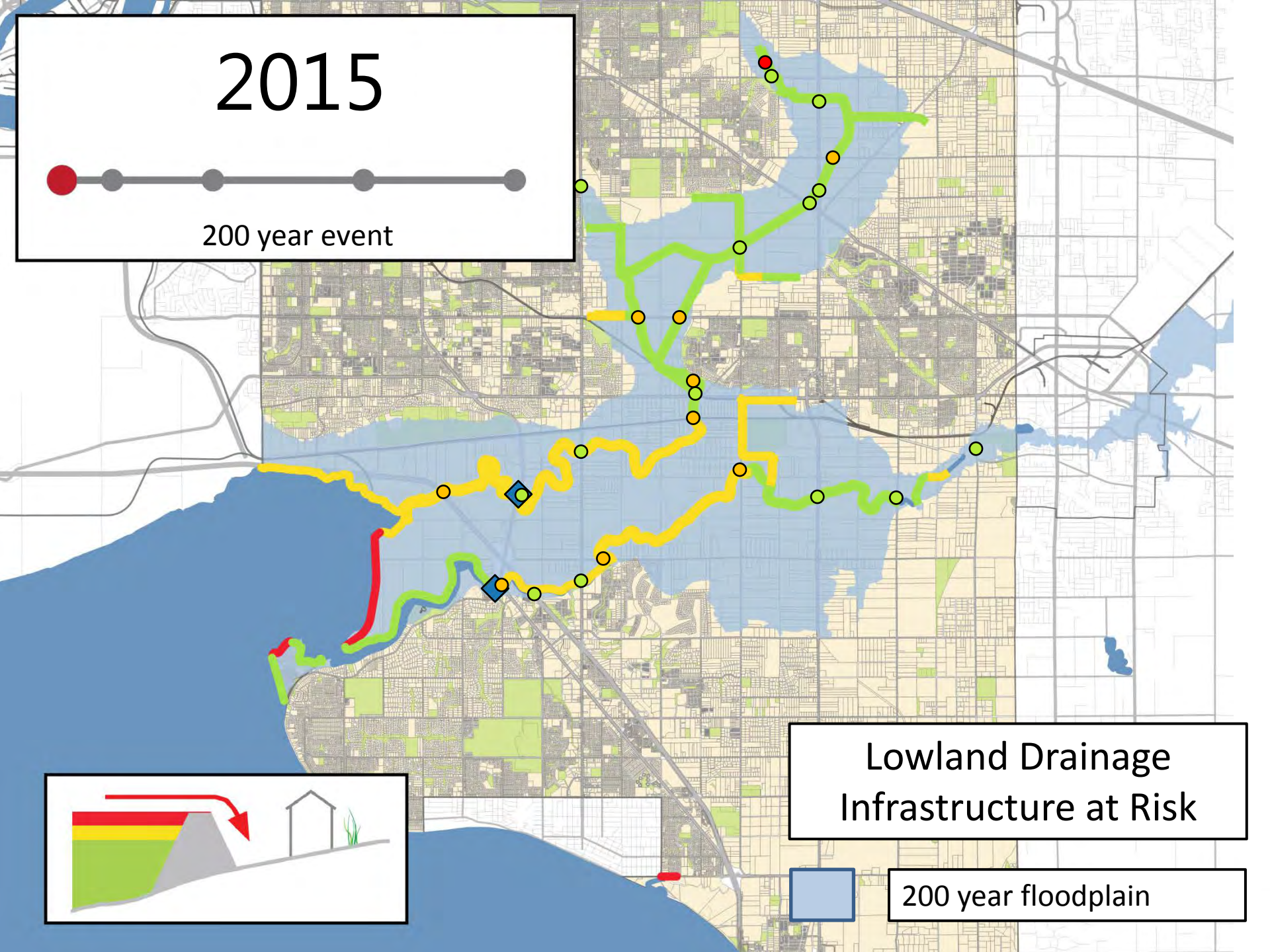
200 year event



Lowland Drainage Infrastructure at Risk



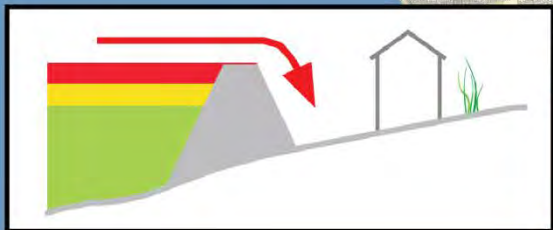
200 year floodplain



2020

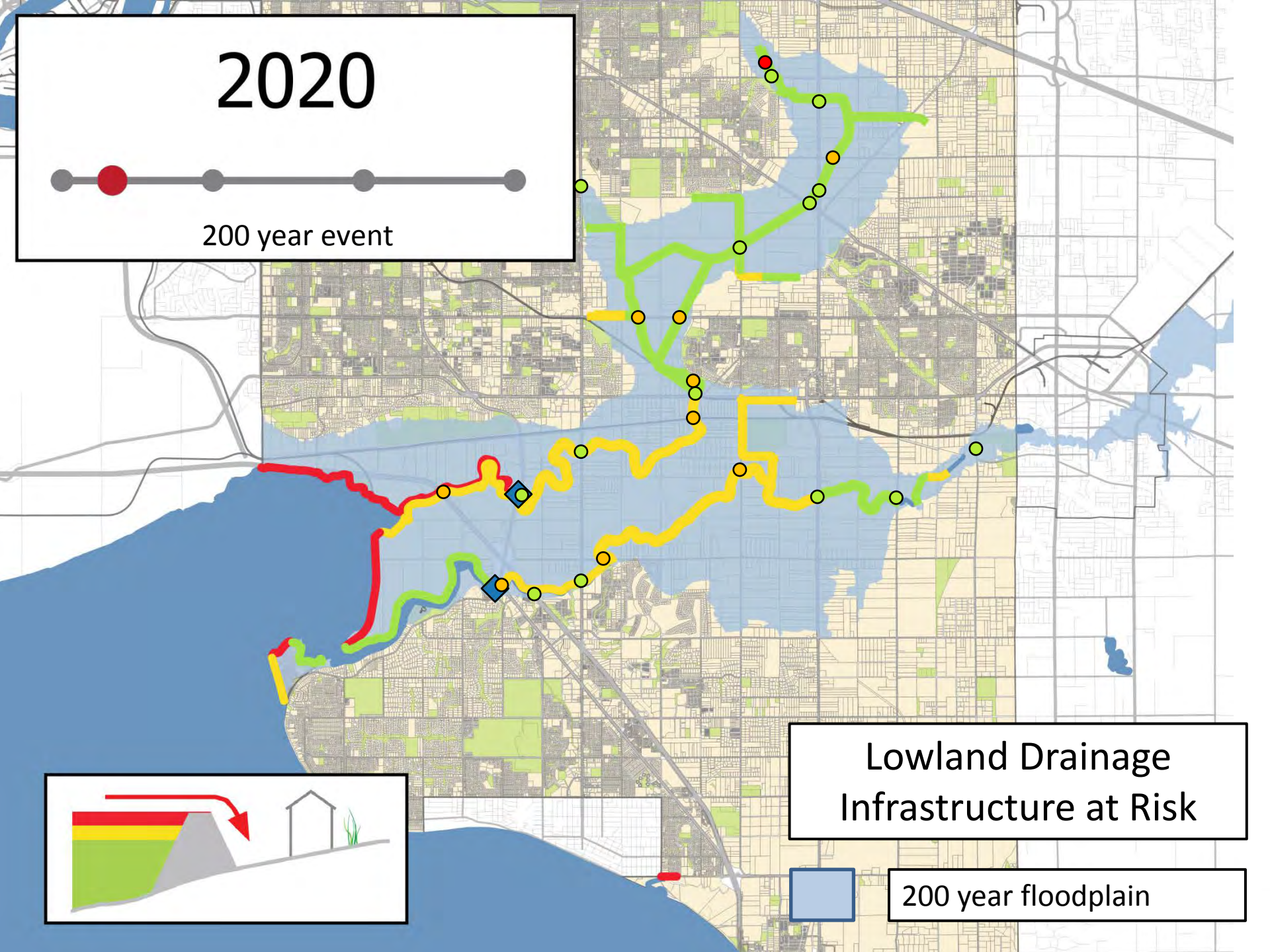


200 year event



Lowland Drainage
Infrastructure at Risk

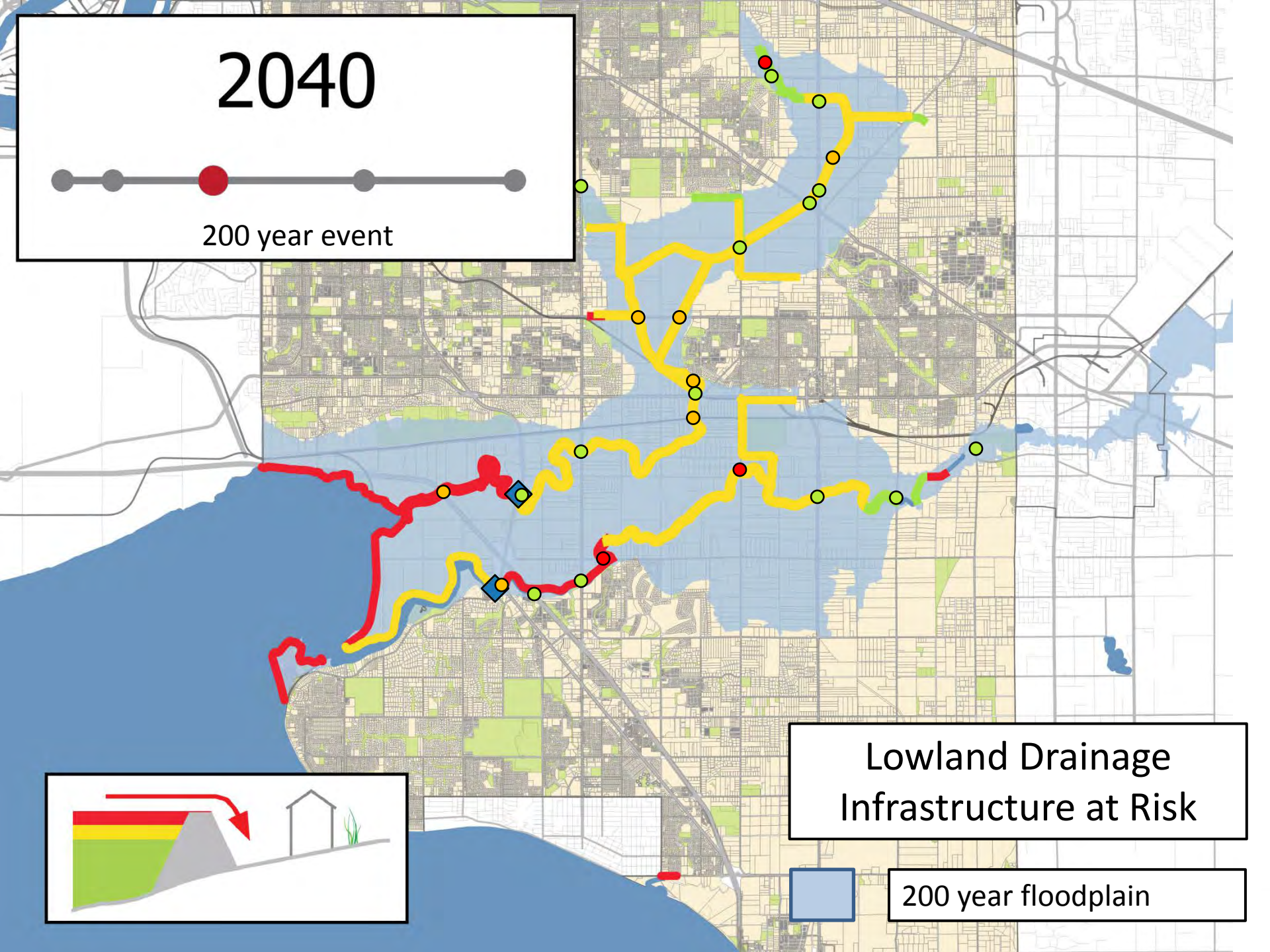
200 year floodplain



2040

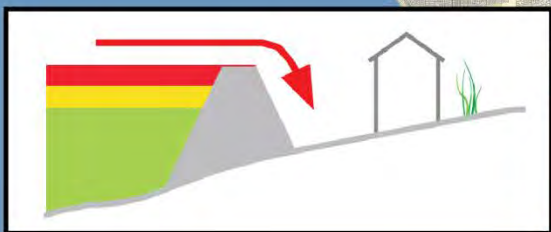


200 year event



Lowland Drainage
Infrastructure at Risk

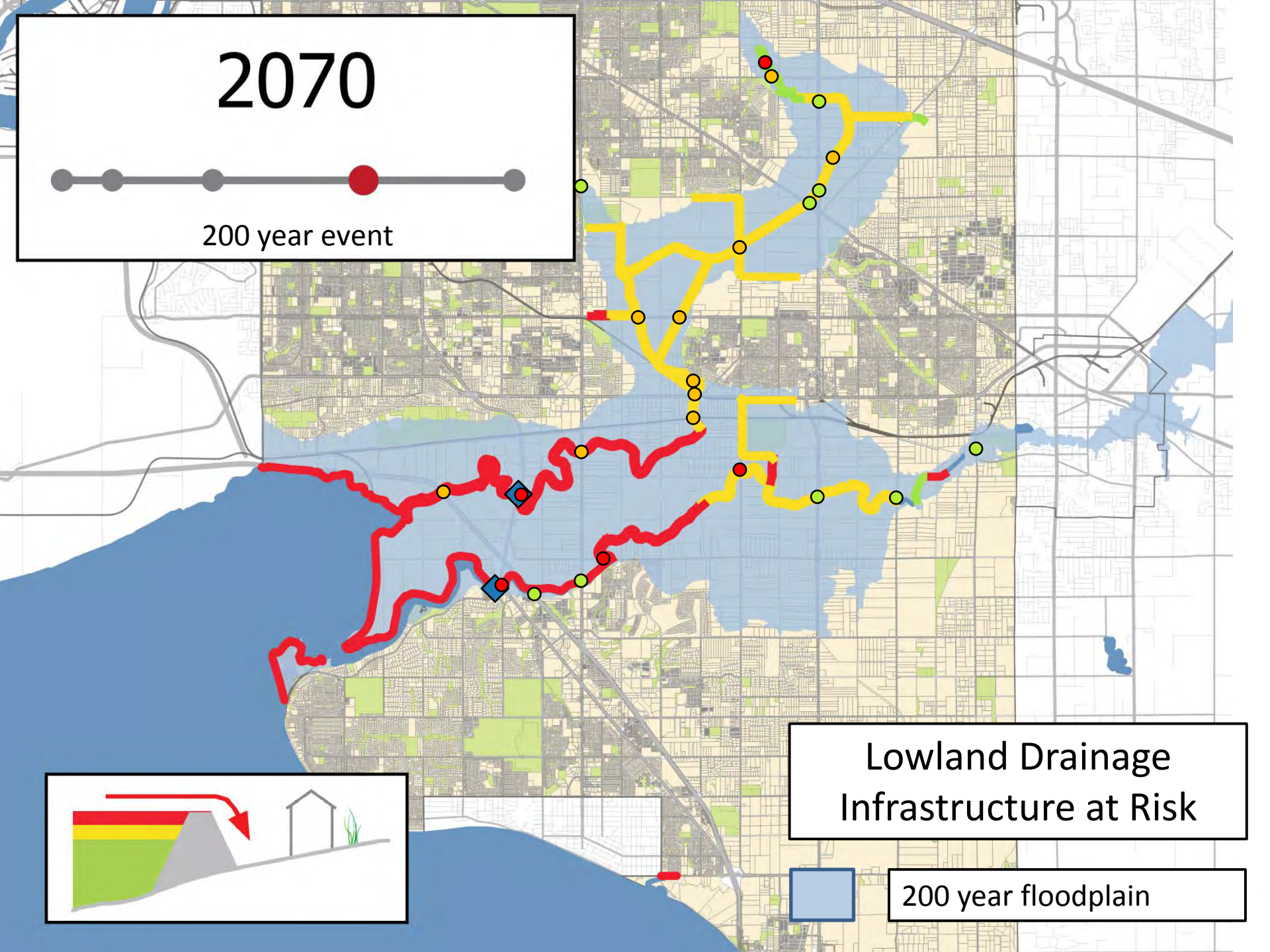
200 year floodplain



2070

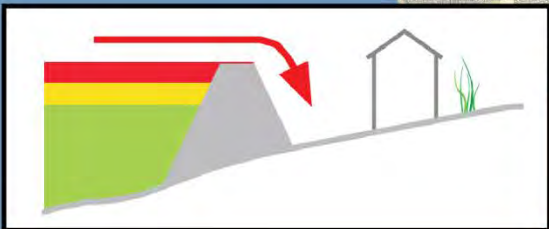


200 year event



Lowland Drainage
Infrastructure at Risk

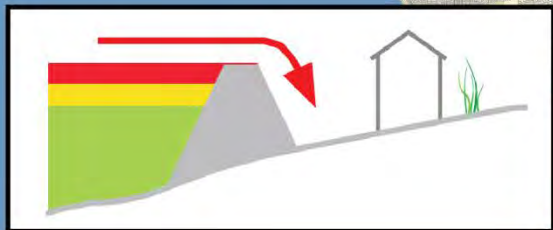
200 year floodplain



2100

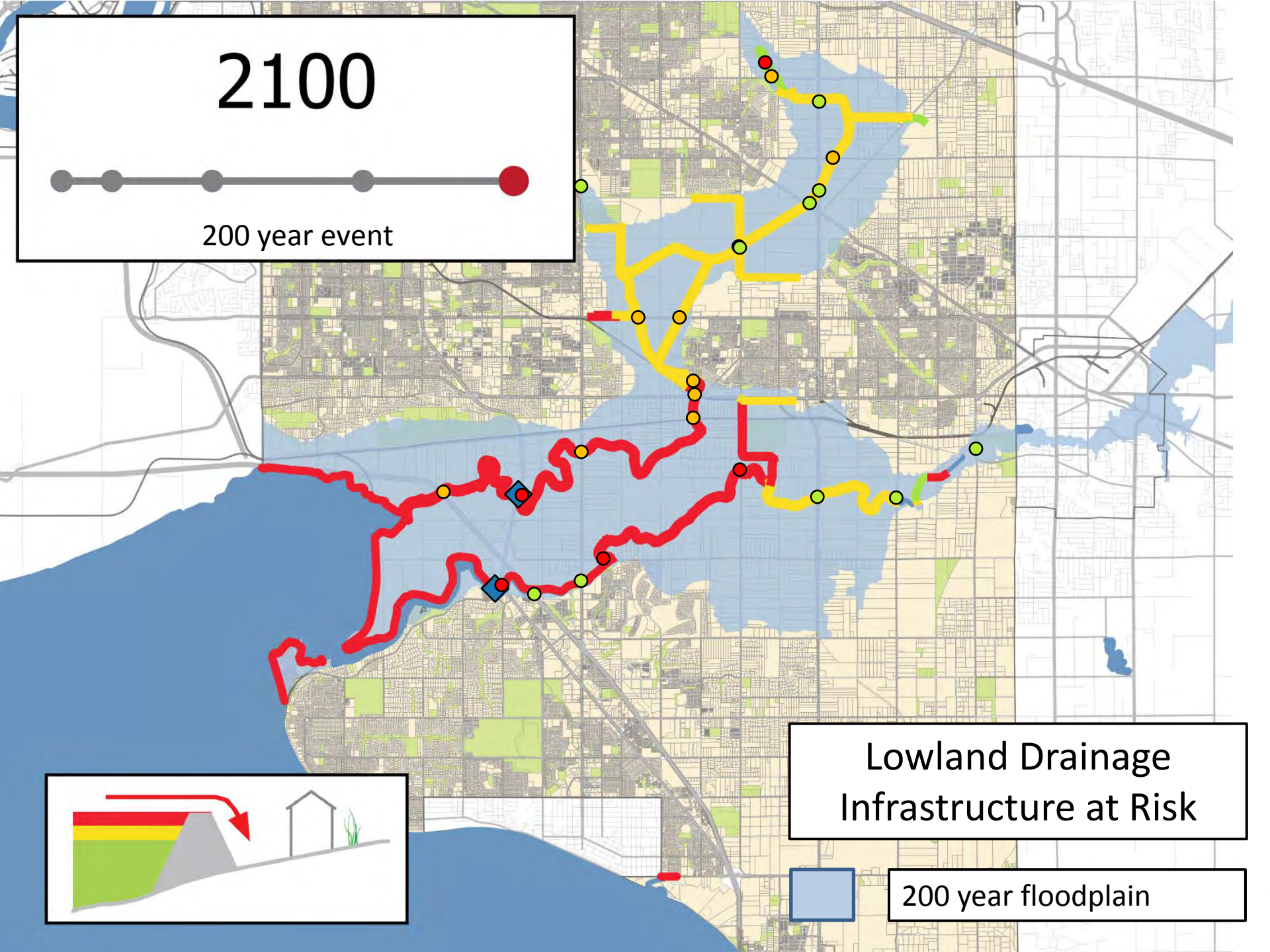


200 year event

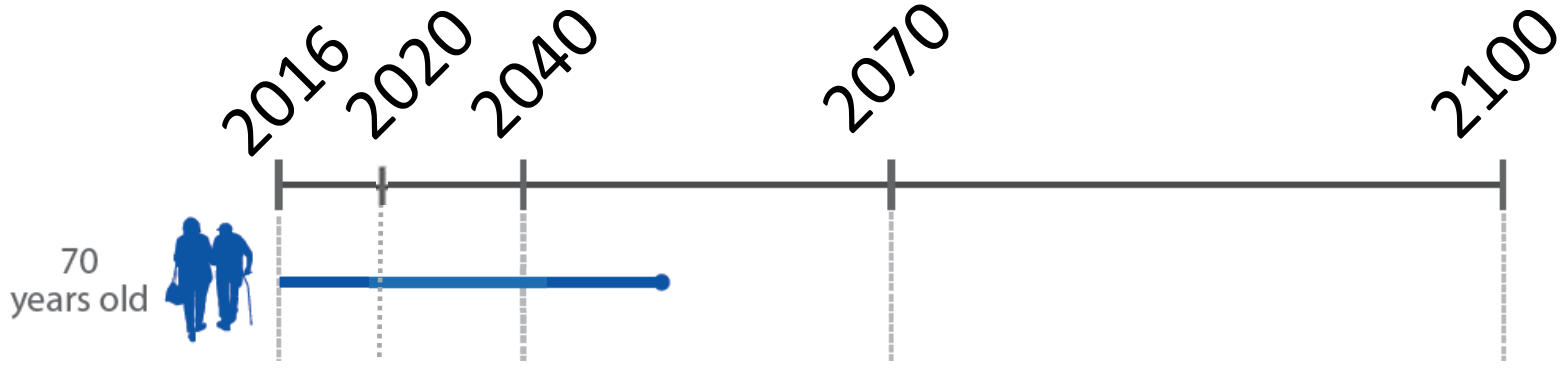


Lowland Drainage
Infrastructure at Risk

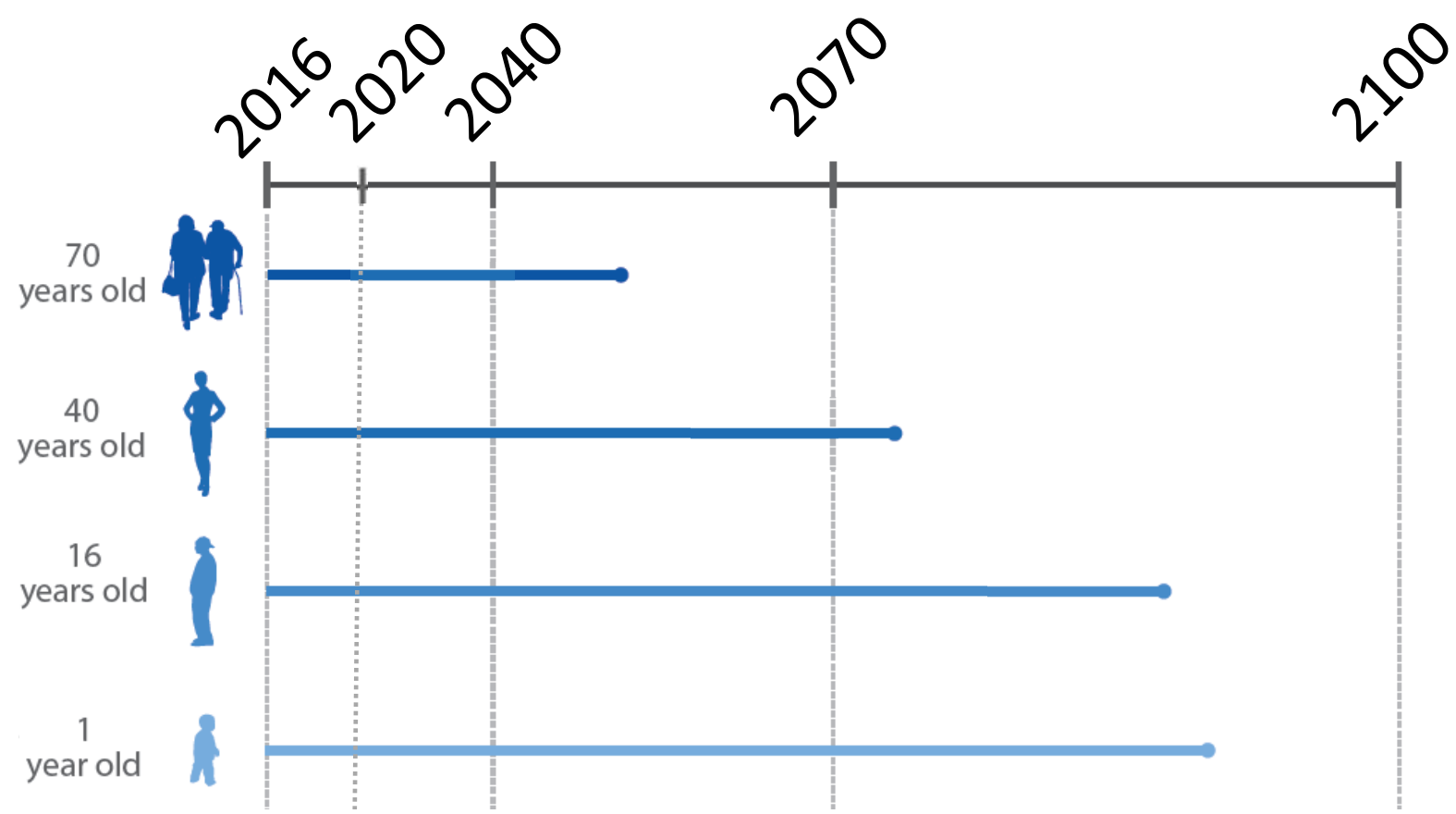
200 year floodplain



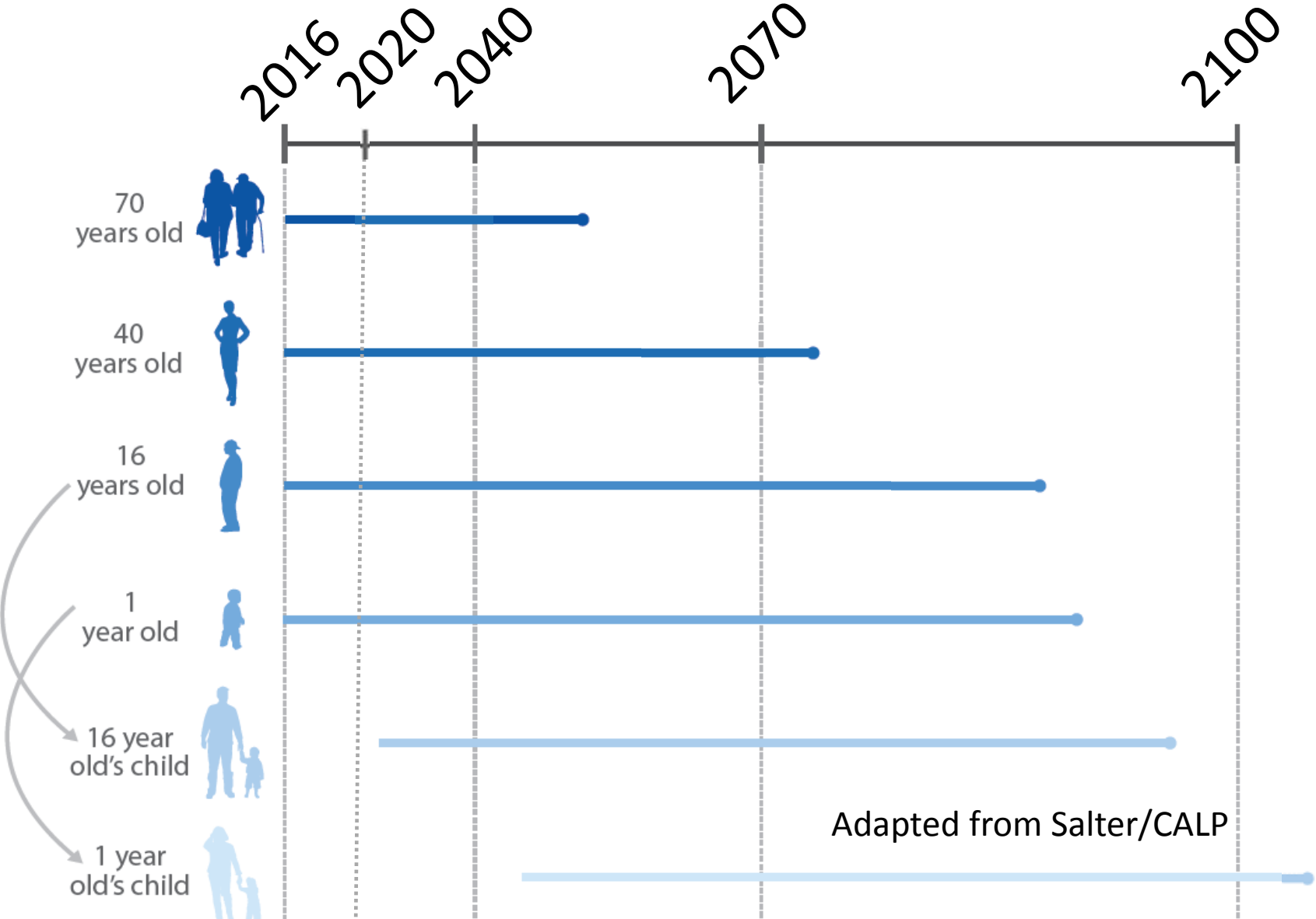
Different times, different generations



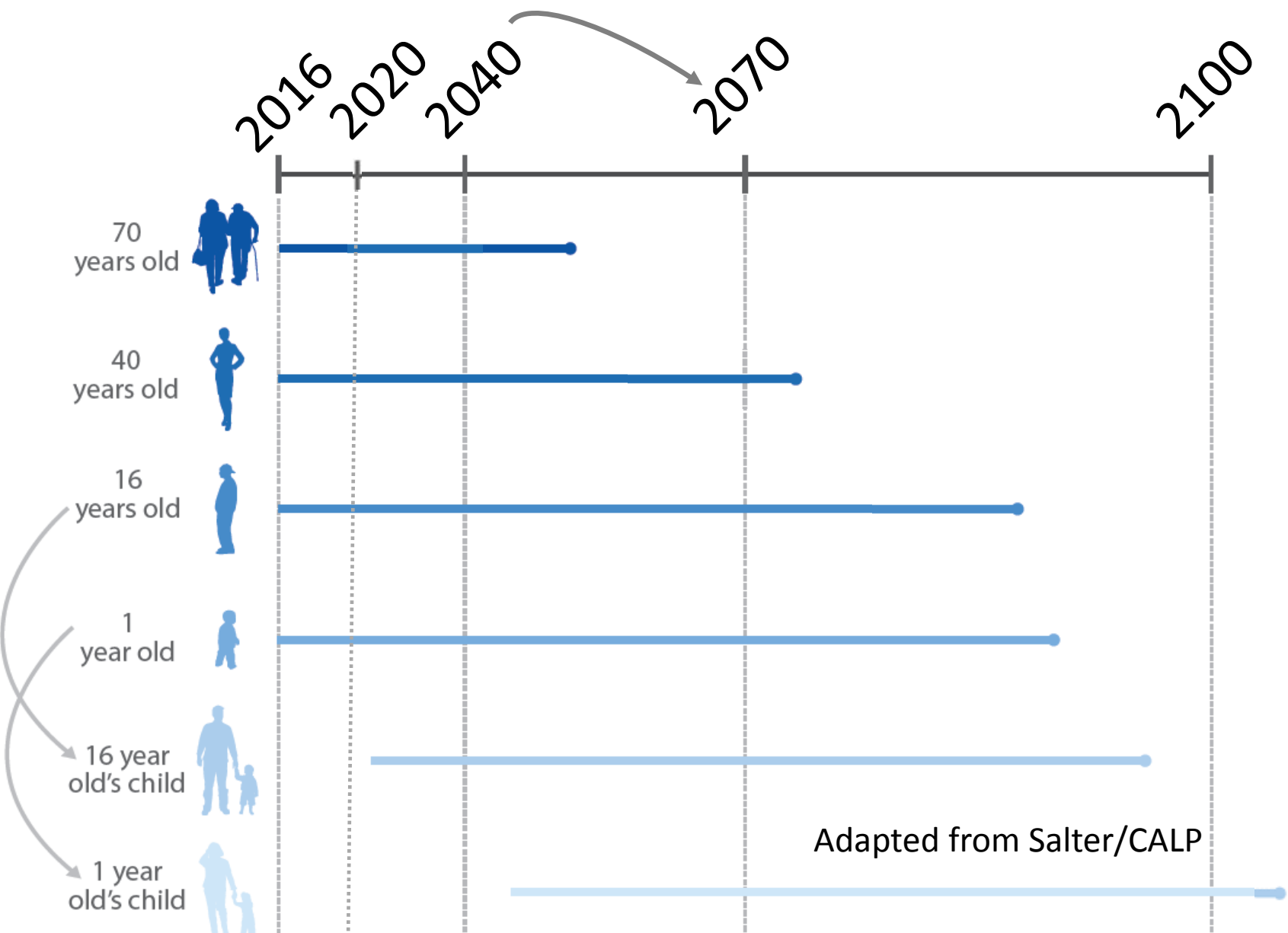
Different times, different generations



Different times, different generations



Different times, different generations

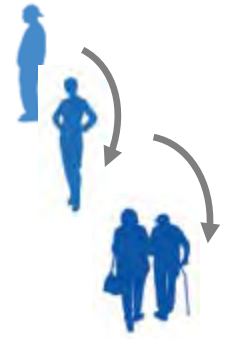


Different times, different generations

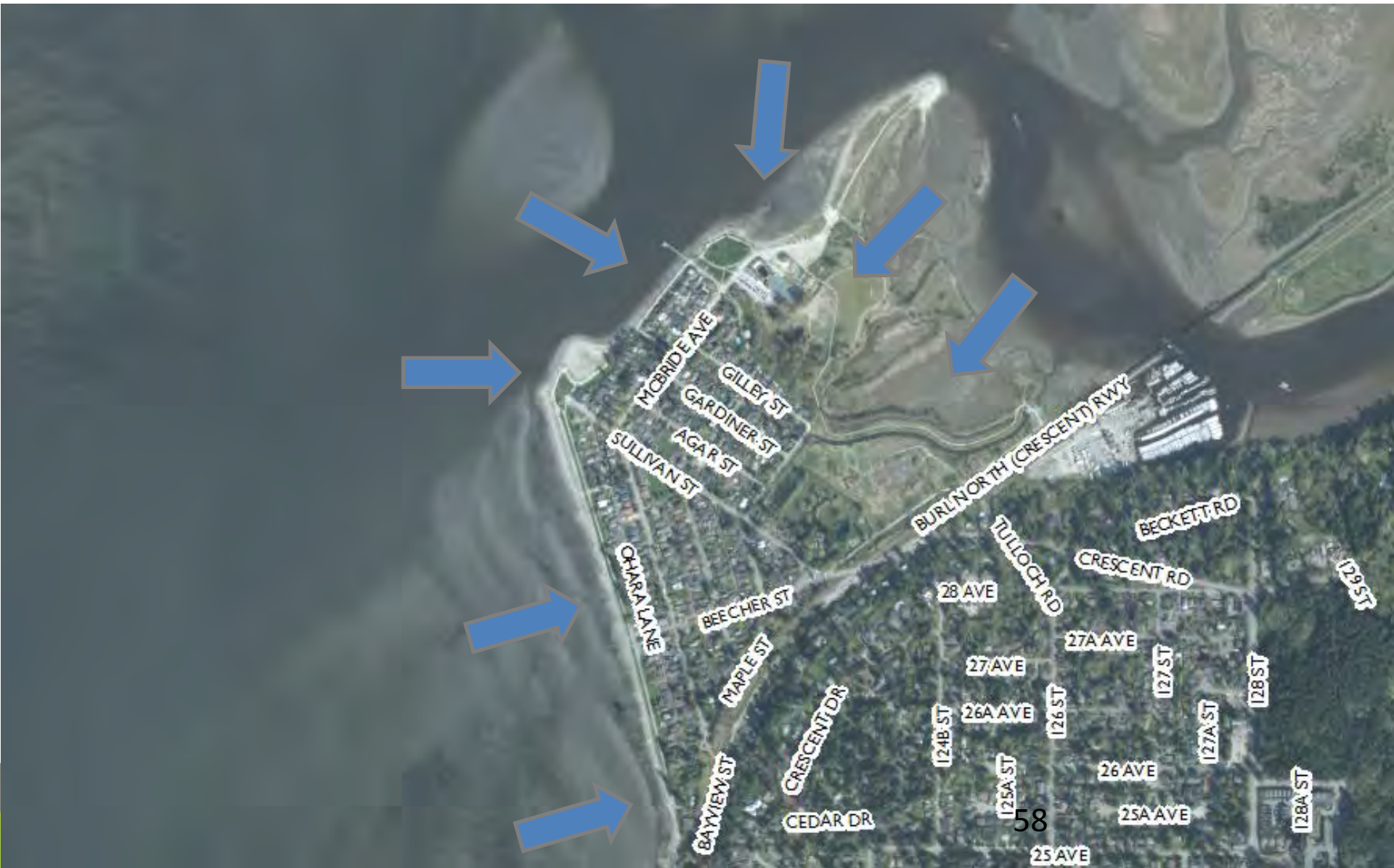
Time Horizon	Years Away	16 year old today
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Different times, different generations

Time Horizon	Years Away	16 year old today
2040	24 years	40 years old
2070	54 years	70 years old



Potential Community Impact: Flood Scenarios



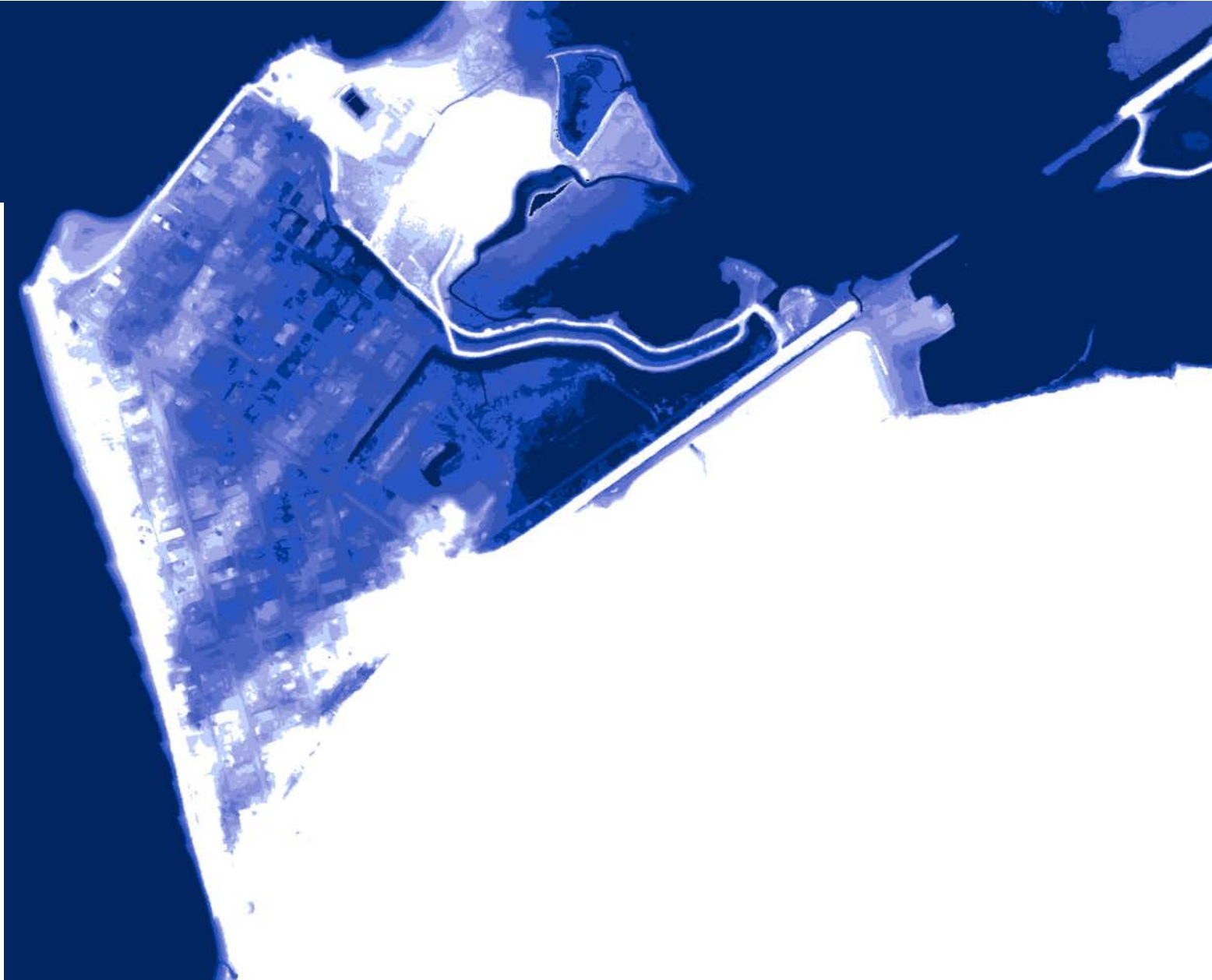
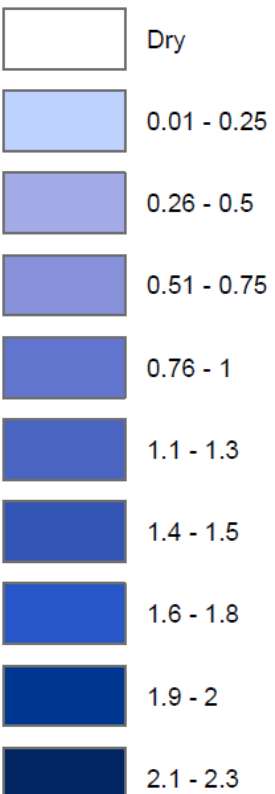
Potential Community Impact: Flood Scenarios

- Flood waters shown on following maps have same depth as shown on in the time lapse photos from Gardner Road house, Lifeguard Station at Sullivan Street and on McBride Avenue at Camp Alexandra)
- Elevations are the estimated flood construction levels with sea level rise estimates into the future and correspond to extreme conditions
- Water will flow to low areas and could come from most sections of the coastline in extreme conditions
- Emergency Services have response plans based on the flood extents depicted

Potential Community Impact - 2020

Legend

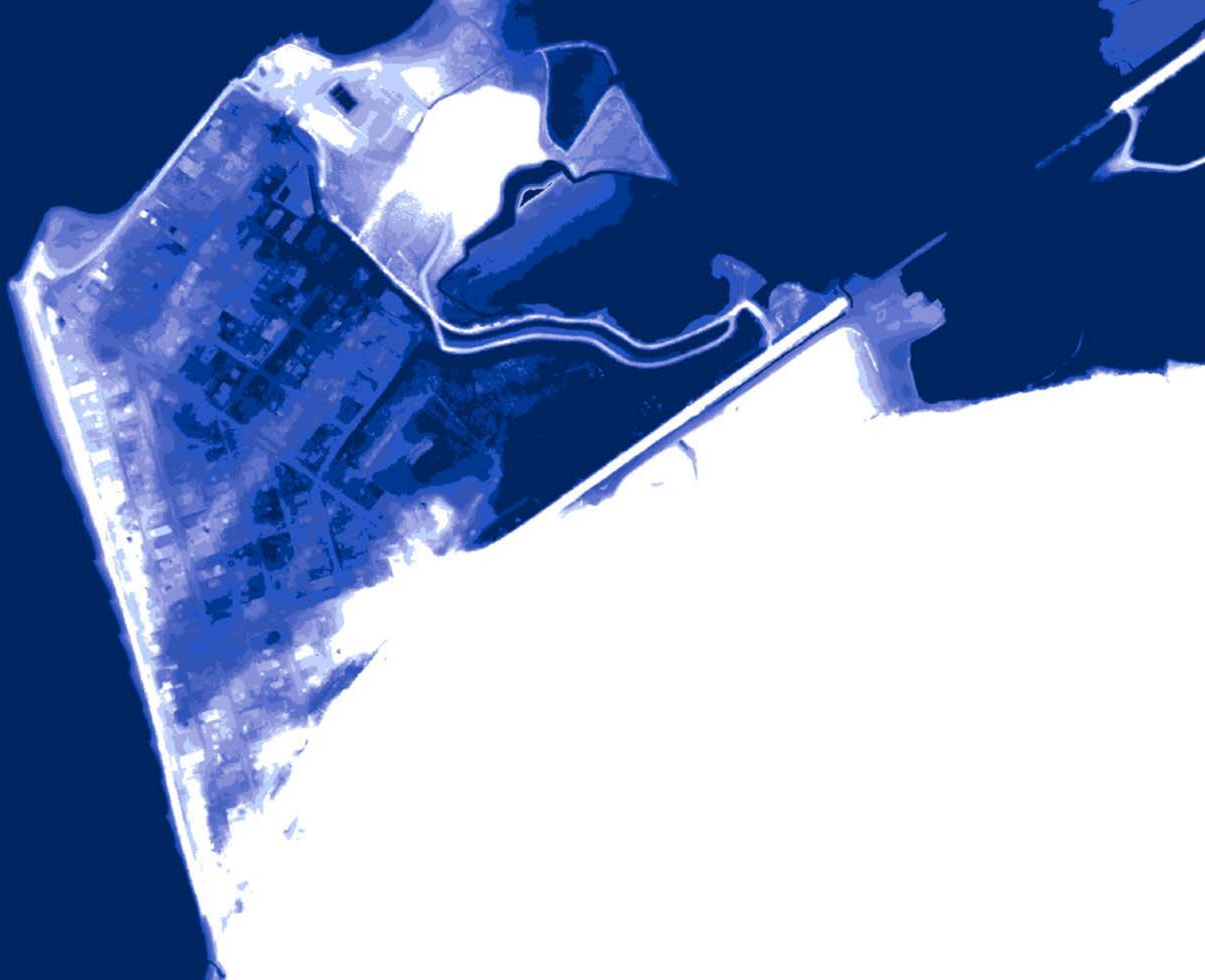
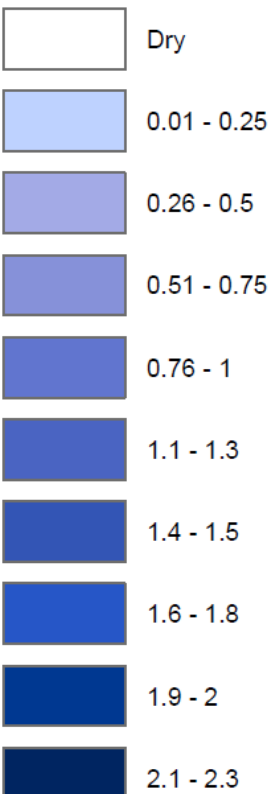
Flood Depth (metres)



Potential Community Impact - 2040

Legend

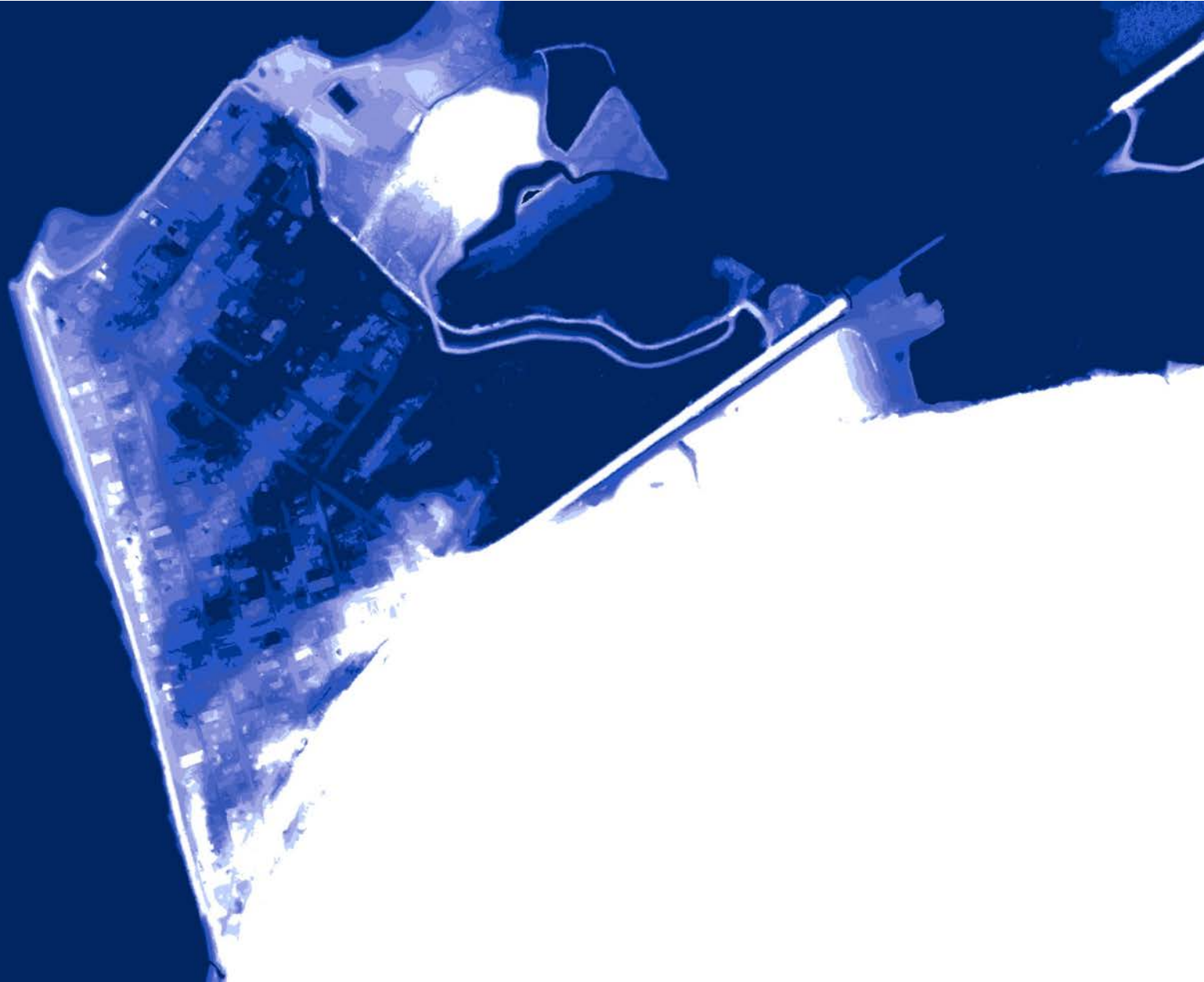
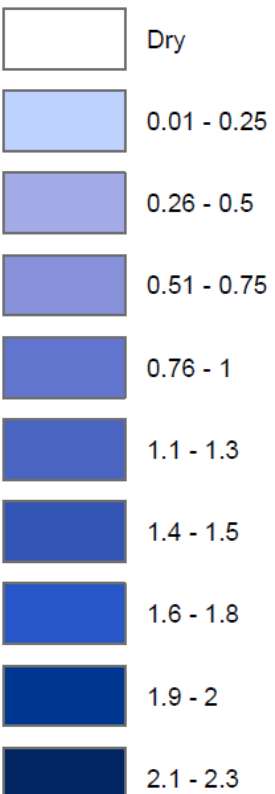
Flood Depth (metres)



Potential Community Impact - 2070

Legend

Flood Depth (metres)



Exploring Adaptation Responses



Matt Osler, Project Engineer

June 4, 2016

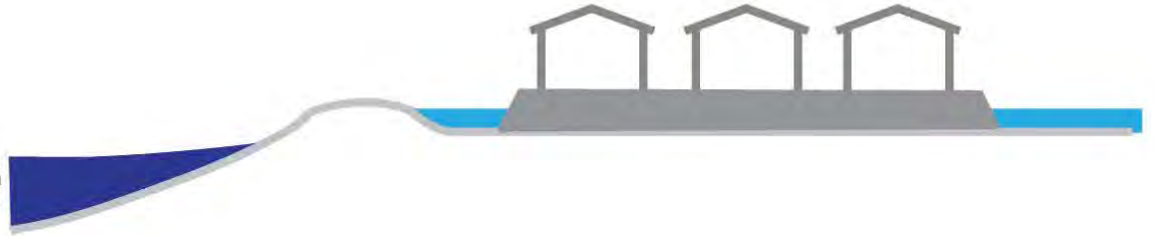


https://www.youtube.com/watch?v=_8E66BaNcvw&feature=youtu.be&t=1m3s

BC Adapts: Coastal Flood Management 6

Adaptation Pathways

Accommodate



Protect



Retreat



Introduction to examples of Protect Adaptation

Response 1: Upgrade the existing dyke to meet Provincial Standards

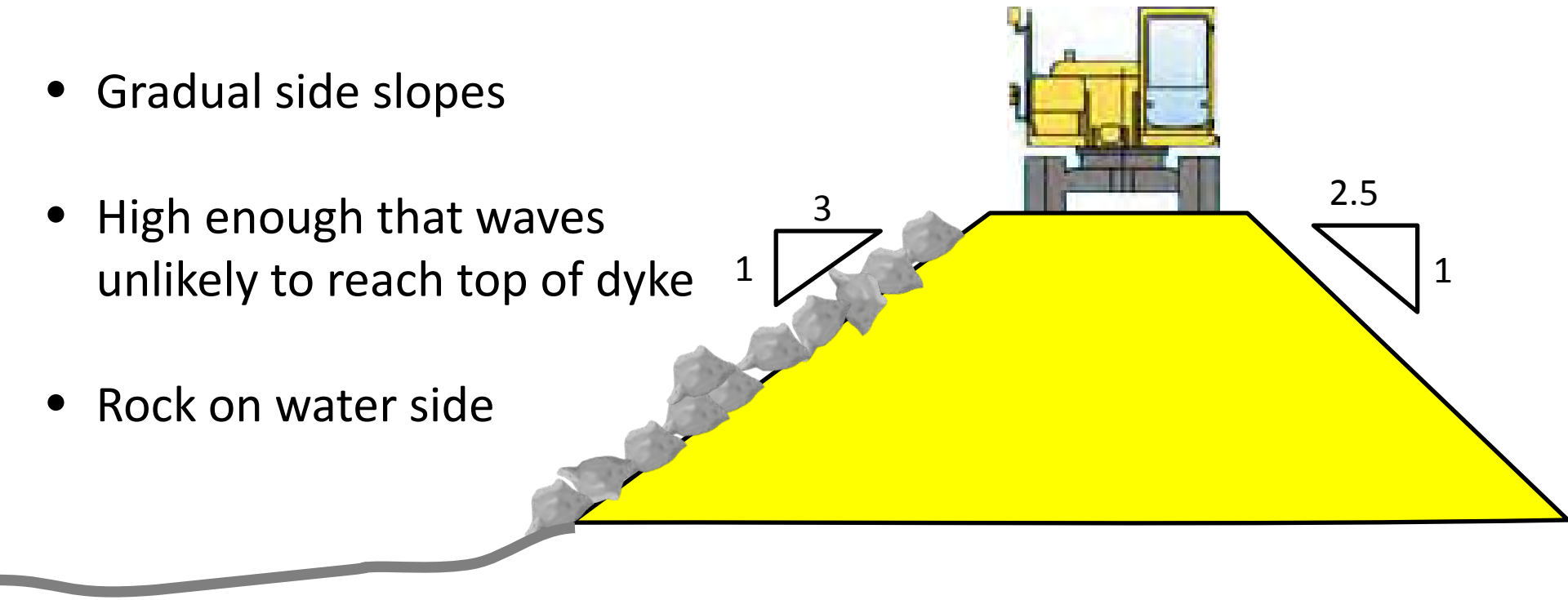
Response 2: Build a wall

Response 3: Build Soft Shore and modified dyke

Response 4: Build Offshore islands/features

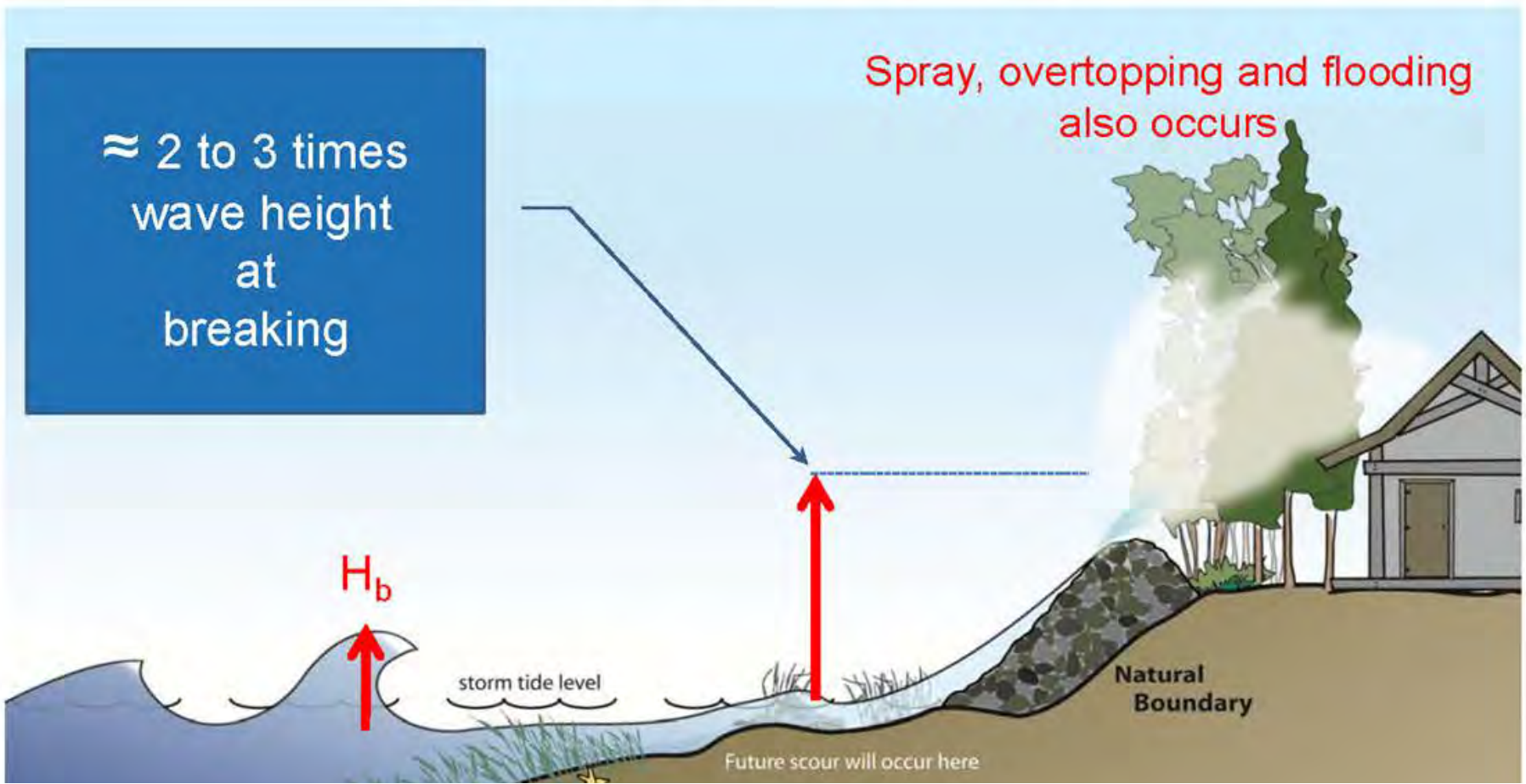
Response 1: Upgrade the existing dyke to meet Provincial Standards

- 4 metres wide at top
- Gradual side slopes
- High enough that waves unlikely to reach top of dyke
- Rock on water side



Considerations for Response 1

Wave Effect and Structures Steep Slopes - Revetments

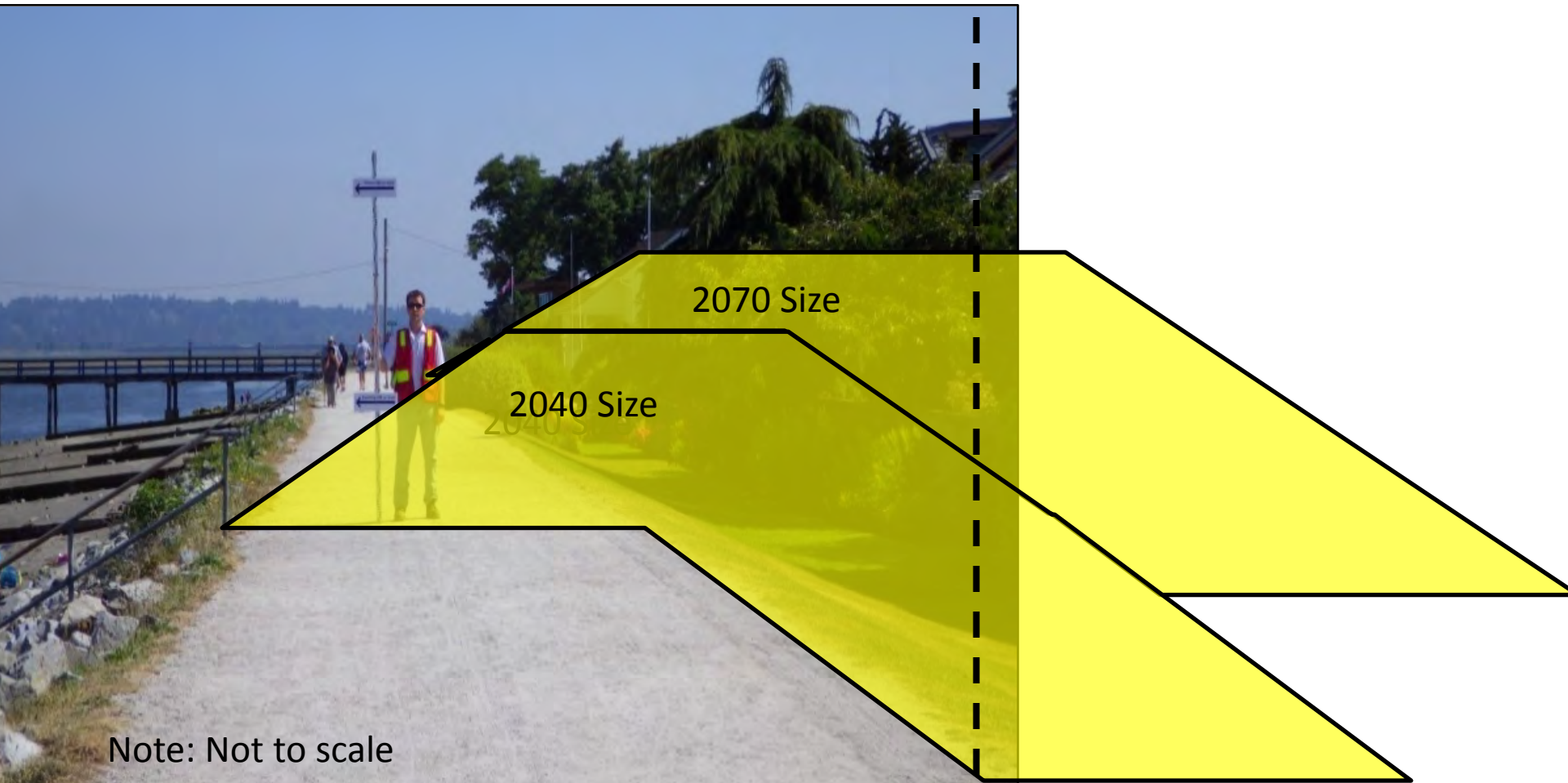


Source: <http://prow.ca/wp-content/uploads/2013/04/Readshaw%20Presentation%20on%20Sea%20Level%20Rise%20North%20Saanch.pdf>

Considerations for Response 1

12 metres wider

8 metres wider



Note: Not to scale

Considerations for Response 1

12 metres wider

8 metres wider

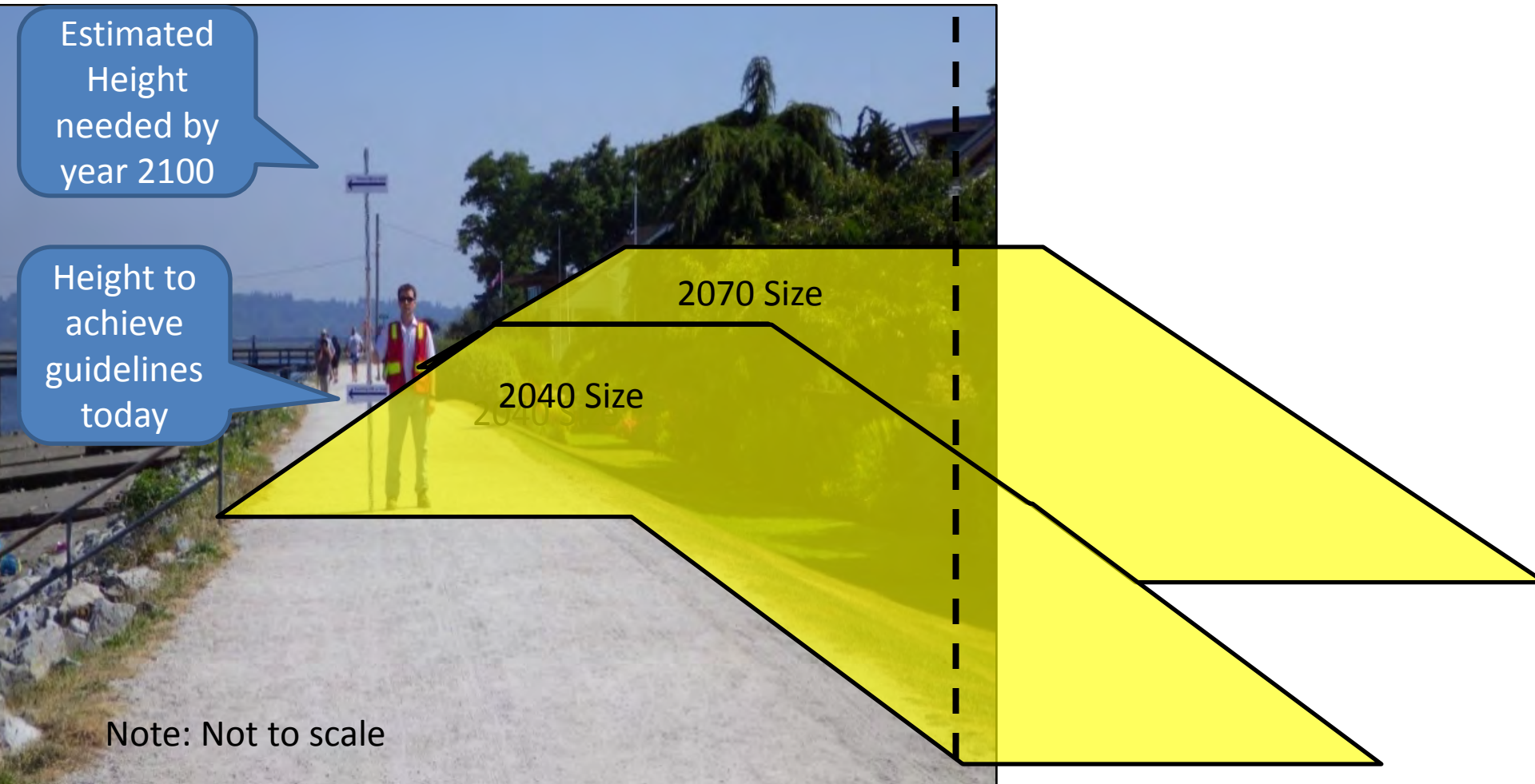
Estimated Height needed by year 2100

Height to achieve guidelines today

2070 Size

2040 Size

Note: Not to scale



Considerations for Response 1

- Low maintenance
- Wider pathway on top of dyke for access
- Height Considerable height increase required from present:

Currently: Approximately 1.0m raising

2040: Approximately 1.5m raising

2070: Approximately 2.0m raising

- Takes up considerable footprint
- Impedes beach and water access
- Impacts water view of fronting homes

Example of Response 1: Nicomekl River



Example of Response 1: Richmond



Response 2: Build a wall

Two types of wall:

A) Near ocean

- Made of concrete
- 2040: 3 m tall wall
- 2070: 7 m tall wall

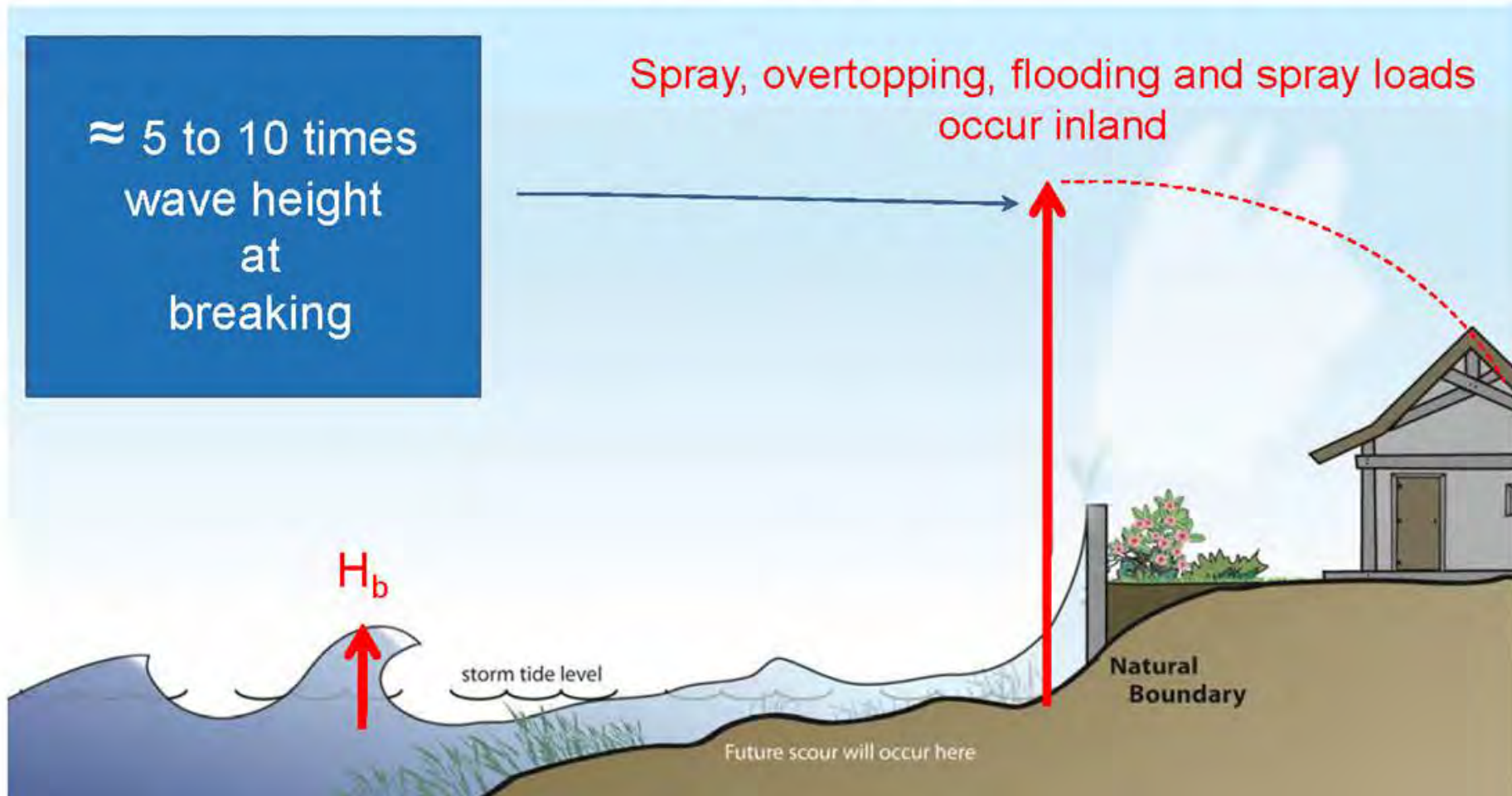
B) Setback Landscaping Wall

- Stone or concrete
- 2040: 1m tall made
- 2070: Implement Different option

Considerations for Response 2

Wave Effect and Structures

Vertical Walls



Considerations for Response 2

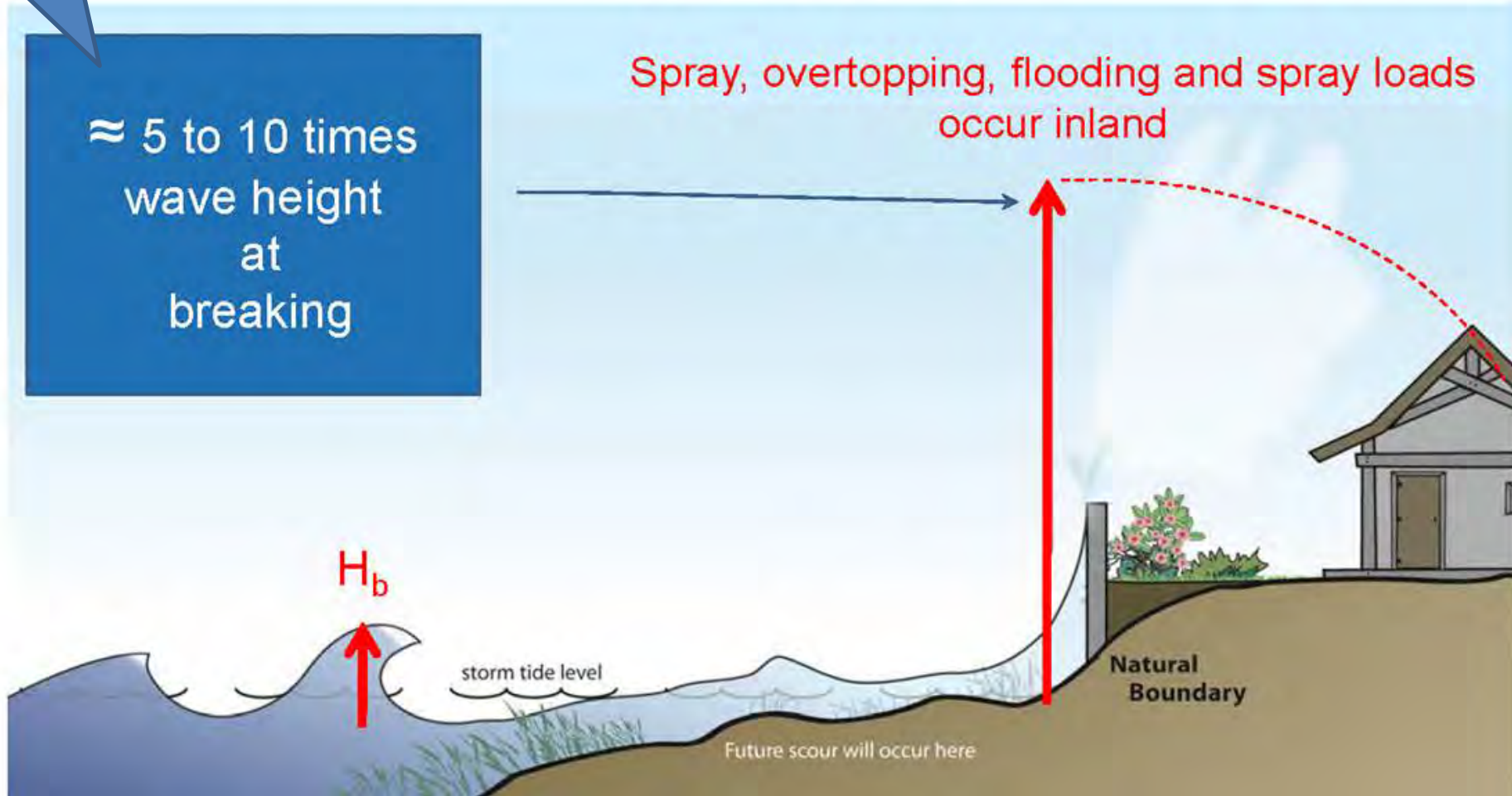
Wave Effect and Structures

Vertical Walls

2.5 to 5 times greater than a steep slope

≈ 5 to 10 times wave height at breaking

Spray, overtopping, flooding and spray loads occur inland



Considerations for Response 2

1948: Stone and mortar wall existed in Crescent Beach



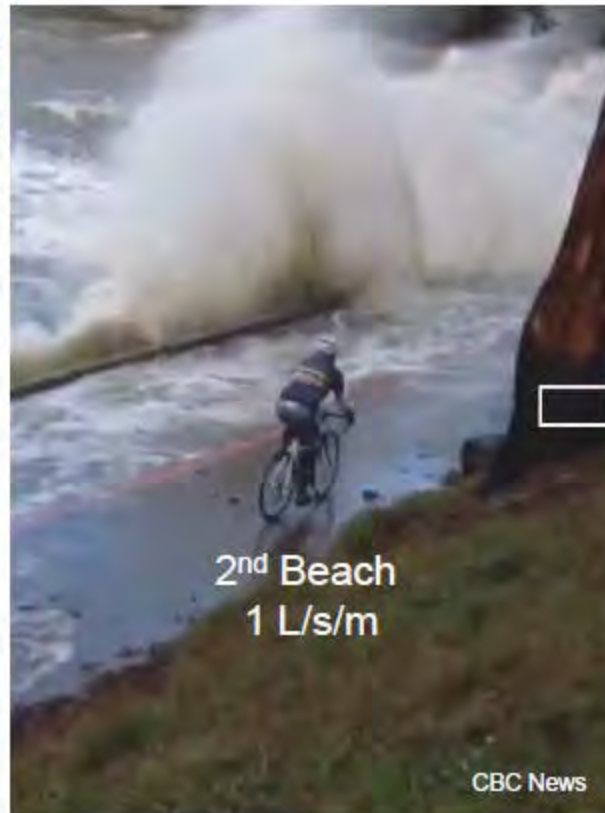
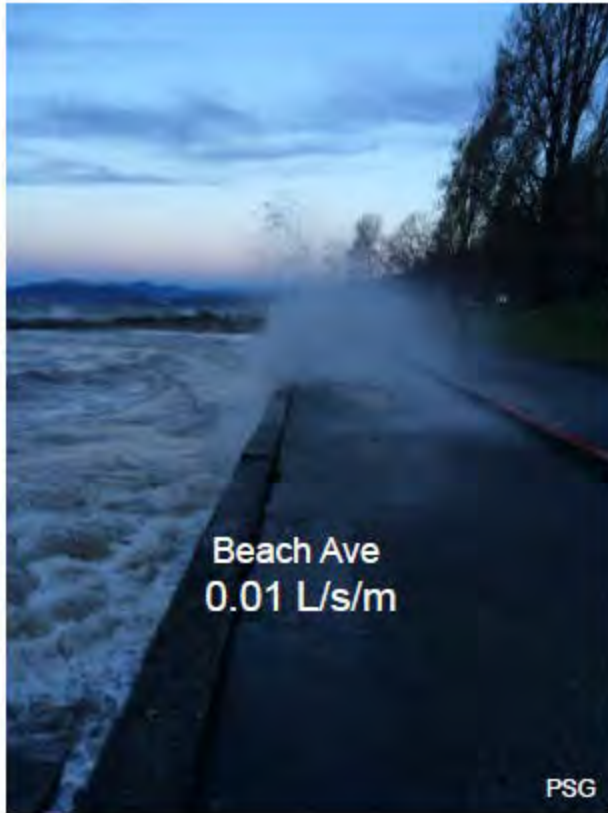
1953: Timber Wall



<http://www.surreyhistory.ca/cresbeach.html>

Photo Courtesy Trevor Roberts

Considerations for Response 2



November - 2014

Light Damage

Source: SNC Lavalin Presentation November 25, 2015

Considerations for Response 2

- Compact footprint
- Impedes access to the ocean and beach
- Urban look contrasts with natural environment
- Difficult to make urgent repairs if damaged
- Increases in sea level will magnify impacts due to waves crashing against wall

Examples of Response 2 A)



Examples of Response 2 B)



Response 3: Build Soft Shore and Dyke

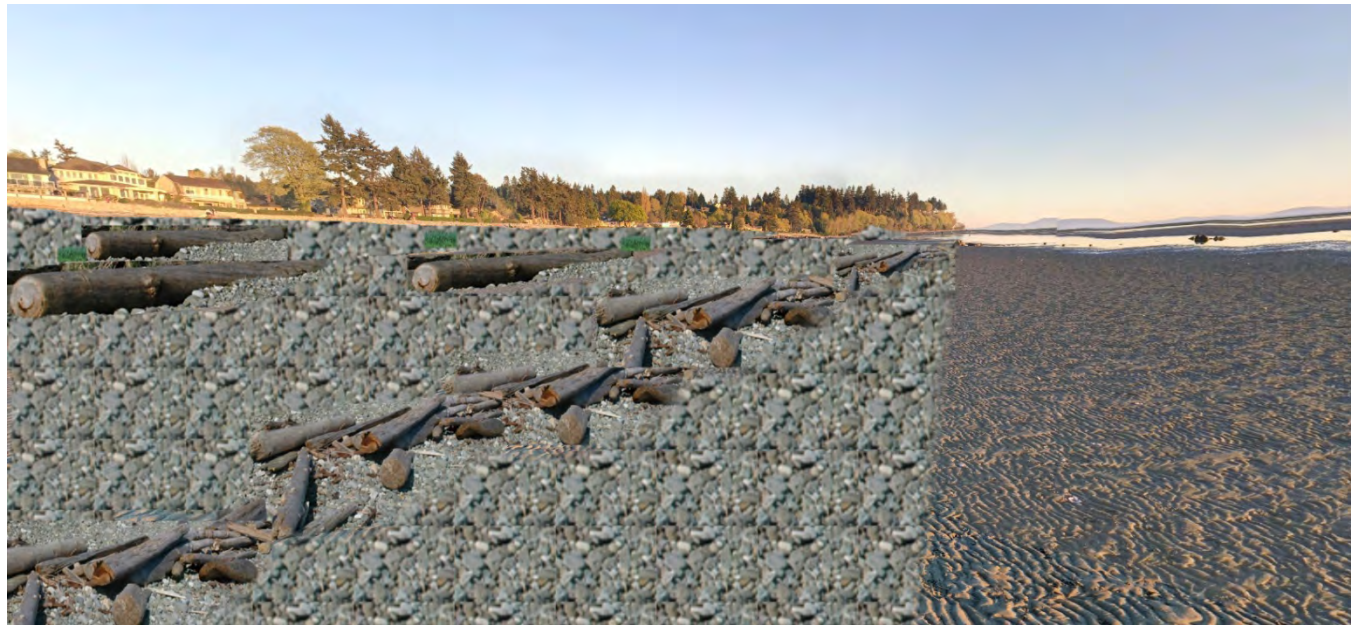


BC Adapts: Coastal Flood Management 1 (Qualicum Beach Example)

Source: <https://youtu.be/4wbPrudCTlw?t=3m2s>

Response 3: Build Soft Shore and Dyke

- Place fill over beach to make a more gradual slope
- Thousands of truck loads of gravel, cobbles, rocks and other fill
- Logs anchored to beach
- Raise groynes and dyke higher
- Periodically nourish and replace material that has washed away



Response 3 Considerations

- Natural look and feel to foreshore
- Reduces wave effects on shoreline
- Replaces sandy beach
- Requires periodic maintenance
- Disturbs large footprint of beach and natural habitat

Response 3 Example

Campbell River (Dick Murphy Park)



Source: http://stewardshipcentrebc.ca/PDF_docs/greenshores/projects/GS_Case_Study_DickMurphy.pdf

Response 3: Modified Dyke with Soft Shore Stabilization



Response 4: Build Offshore islands/features

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 - Breakwater made of rock could be have steep slopes

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 - Breakwater made of rock could be have steep slopes
- Reduces the wave impacts driving coastal flooding

Response 4 Considerations

Range of possible locations



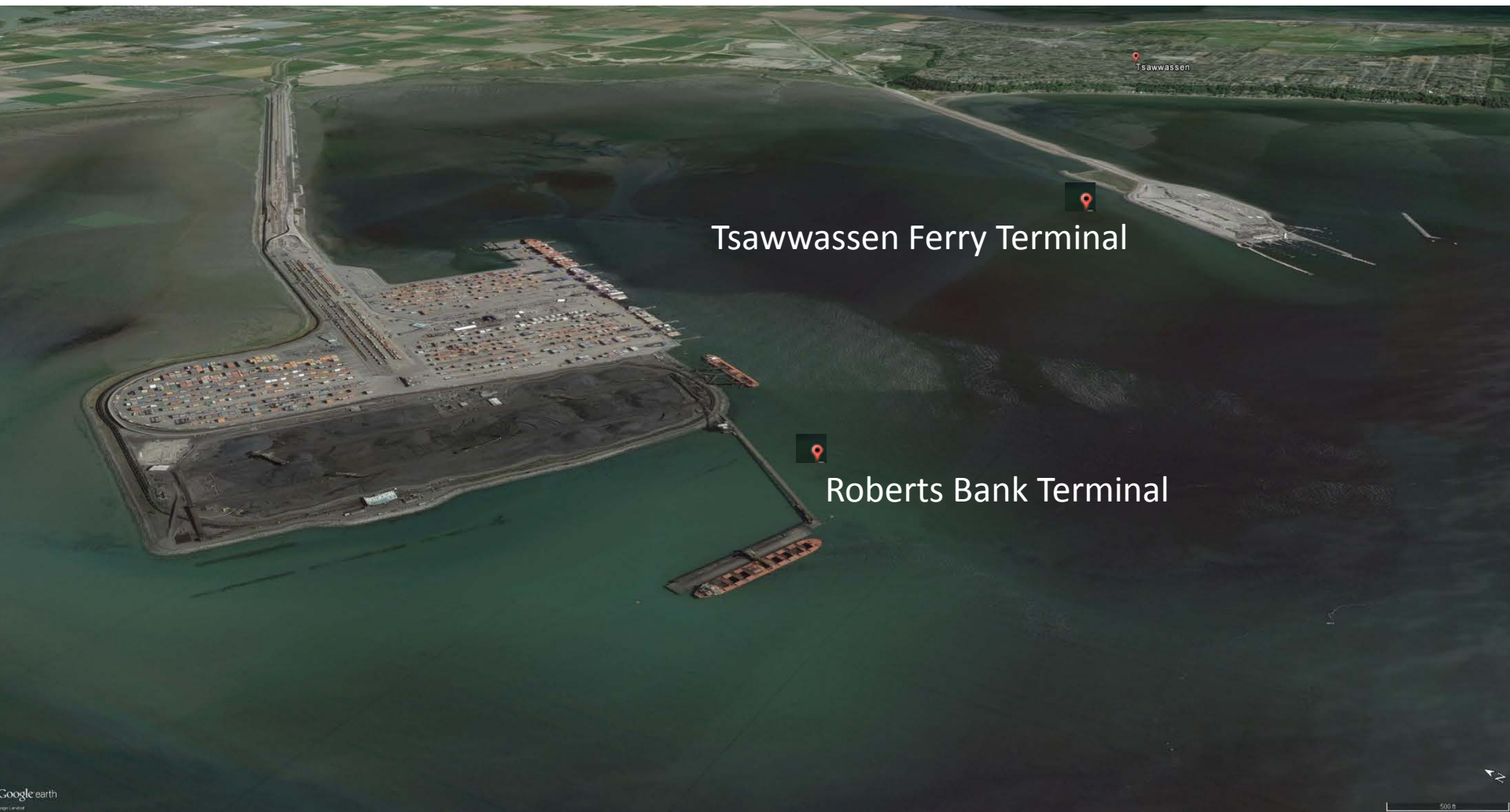
Response 4 Considerations

- Reduces wave impact in Mud Bay
- Could provide recreational opportunities
- Could provide new inter tidal areas to offset existing areas lost to sea level rise
- Potential for flood gates beyond 2070
- Impact navigation and ocean dynamics
- Disturbs Provincial Wildlife Management Area
- View from shore would have less water at low tide
- Large amount of fill material required over many years
- Challenging construction, complex regulations and approval process

Response 4 Example: Ogden Pt, Victoria Harbour



Response 4 Example: Tsawwassen & Roberts Bank



Tsawwassen Ferry Terminal

Roberts Bank Terminal

Response 4 Example: Drayton Harbour, Blaine



Response 4 Example: Point Roberts



Response 4 Example: Point Roberts



Response 4 Example: Louisiana



Source: <http://www.industrytap.com/the-great-wall-of-louisiana/677>

Response 4 Example: Shady Island



Adaptation Response Summary

Response 1: Upgrade the existing dyke to meet Provincial Standards

Response 2: Build a wall (high or low)

Response 3: Soft Shore treatment with modified dyke

Response 4: Offshore islands/features

Questions



Thank you for joining us

Before you go, please:

- Leave your nametag at the front for next time
- Fill out a feedback form

See you at Charrette #3 in September!