City of Richmond

Report to Committee

To PWT - July 18 2012

To:	Public Works and Transportation Committee	**Date:**	June 27, 2012
From:	John Irving, P.Eng. MPA Director, Engineering	**File:**	10-6060-01/2012-Vol 01
Re:	**Dike Master Plan - Phase 1**		

Staff Recommendation

That the public and key external stakeholders be consulted to provide feedback on the Steveston area and the West Dike flood protection concepts identified in the attached staff report from the Director, Engineering.

John Irving, P.Eng. MPA
Director, Engineering
(604-276-4140)

Att. 3

REPORT CONCURRENCE			
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**	
Real Estate Services	☑		
Sustainability	☑		
Roads and Construction	☑		
Sewerage and Drainage	☑		
Parks	☑		
Development Applications	☑		
Policy Planning	☑		
Transportation	☑		
REVIEWED BY SMT SUBCOMMITTEE	**INITIALS:**	**REVIEWED BY CAO**	**INITIALS:**

Staff Report

Origin

The 2008 – 2031 Richmond Flood Protection Strategy identified the need to "Prepare and implement a comprehensive dike improvement program". On June 13, 2011 Council approved that $200,000 of surplus from the 2010 operating budget be used to initiate a Dike Master Plan. This budget is being used to fund Phase 1 of the master plan, which is primarily focused on identifying a long term flood protection improvement plan for the Steveston and southern West Dike area.

The purpose of this staff report is to present preliminary concepts for flood protection works that will be required to address long-term sea level rise and future flood risks.

Analysis

Richmond has grown into a large thriving City with considerable assets to protect. Directed by the 2008 – 2031 Richmond Flood Protection Strategy, the Drainage and Diking Utility was created to fund the construction, operation and maintenance of City dikes, drainage pump stations and drainage conveyance systems that protect the City against floods. The Drainage, Dike and Sanitary System Bylaw No 7551 and Watercourse Protection and Crossing Bylaw No. 8441 regulate drainage activities to minimise the risk of flooding inside of the City's dike. The Flood Plain Designation and Protection Bylaw No. 8204 prevents development from encroaching onto dikes and requires that all new finished floor areas susceptible to flood damage be above the flood plain construction level.

The Dike Master Plan is intended to be a comprehensive guide to upgrade flood protection infrastructure to:

- Adequately protect Richmond from both ocean storm surges and Fraser River freshet events,
- Adapt to sea level rise,
- Meet appropriate seismic and other design standards,
- Follow the five strategic directions of the City's 2009 Waterfront Strategy, and
- Prioritize dike improvement phasing to efficiently use resources.

Sea and river dikes form the backbone of Richmond's flood protection infrastructure. As a Local Diking Authority the City of Richmond manages the integrity of 49 km of dike on Lulu and Sea Islands. In the medium to long term, dike crest elevations will need to be raised to mitigate sea level rise caused by climate change.

Richmond's dikes are located in City right-of-ways, City owned land, Federal/Provincial Land and private land. Land ownership and land use issues create a number of challenges that the City must address as dike crest elevations are raised. Creating a long-term dike master plan for the Steveston area has been identified as a priority. The Steveston dike impacts many things, for example, existing roads and buildings, heritage structures, harbour functionality and Steveston Village's unique character. Development is also hindered without a long-term master plan. Actual implementation of any approved master plan would occur over many decades as the identified sea level risk will largely materialize beyond the 50-year timeline.

The City has engaged Delcan/DHV as the lead consultant to complete Phase 1 of the Dike Master Plan. Tasked with identifying traditional and creative flood protection solutions that have minimal impact, Delcan has identified two primary dike alignments between Garry Point Park and London Farm: 1) raising the dikes in their current or similar alignment, or 2) using Steveston (Shady) Island to form a new dike structure. These alignments are illustrated in **Attachment 1** and are explained below.

Primary Alignment 1: Raise dikes in their current alignment or a close parallel alignment on Lulu Island

Raising dikes in their current location presents a number of challenges that include limited space, utility conflict, development conflict and construction scheduling. Leaving dikes in their existing alignment also excludes a number of properties from current and future flood protection. **Attachment 1** shows the dike divided into a number of reach boundaries (sections). Within each reach the dike's current alignment as well as some proposed alternative alignment options are shown.

Attachment 2 presents a series of dike alignment options within each reach boundary. Options vary with location and seismic design considerations. For reasons relating mainly to land ownership, land use and heritage preservation, dike alignment options are presented that exclude some City, Provincial and Federal property from flood protection. Should these alternatives be chosen and property is left outside of the City's main dike the property owners could use a number of strategies to prevent local flood damage that include changing property and building usage, raising building elevations, raising ground elevations or constructing private flood walls.

Moving the dike closer to the water's edge presents challenges and would significantly change the look and feel of the existing harbour and potentially disrupt sensitive shoreline ecology. In some areas sheet pile walls with backfilled dike material will likely be required to create a seismically stable dike that is capable of meeting today's dike crest planning elevation (4.7 m geodetic is used in this study) and those required further into the future.

Primary Alignment 2: Raise a dike on Steveston Island and install gate structures to enclose the harbour

This alignment uses a similar layout to the Steveston Community Fishing Harbour Long Term Development Plan that is proposed under the City's Waterfront Strategy Implementation Plan. However, while the Community Fishing Harbour Plan is envisaged to have two clear openings at each end of the Harbour's channel, this alternative would use gates or other structures that would close the channel during combined high tides and storm surge events. Assuming that water quality can be maintained, another option is to completely close the channel at its east end. The implications of full enclosure on dredging needs has not yet been analysed. Similarly, the ecological impacts on existing wetlands located within and east of the harbour and authorization from Federal Agencies in relation to ecological, First Nations, and/or fisheries values have not yet been evaluated.

Primary Alignment 2 (**Attachment 3**) shows that the proposed dike would begin somewhere west of 7th Avenue where a new structure would be built heading South into the Steveston Harbour that would intersect the west end of Steveston Island. At this point, Steveston Island would be modified along its entire length to form a dike. Additional structures or embankments would then be needed to enclose the Harbour approximately 250 m east of No. 2 Road. At its

west end, a gate structure would be built to close off the Harbour during periods of combined storm surge and high tide. A pump station may also be required to ensure stable water elevations during closure periods. **Attachment 3** shows renderings that have previously been presented to Council of the Steveston Community Fishing Harbour Long Term Development Concept. The rendering has been modified to show the compatibility of the dike development concept with the Integrated Flood Protection Strategy.

Option Comparison

In preparation for stakeholder discussions, **Table 1** makes a preliminary comparison of the pros and cons of Primary Alignment 1 versus Primary Alignment 2.

The two primary alignments are not exclusive of each other. Elements of each could be used over time to provide a complete flood protection package.

Table 1. The pros and cons of Primary Alignment 1 versus Primary Alignment 2

	Primary Alignment 1 – Lulu Island		Primary Alignment 2 – Steveston Island	
Topic	**Pros**	**Cons**	**Pros**	**Cons**
Cost	Neutral – initial cost estimates are similar for both options			
Property and Land Use	City owns land and right of ways for some options	Existing structures must be accommodated	Steveston Island is vacant of development	Government jurisdiction issues with land use
Construction	Can build in pieces and use temporary infrastructure for effective flood protection	High community disruption	Low community disruption	Must be built as one project to be effective
Adaptability to Future Raising		Will disturb the community if raised in the future	Relatively easy to raise in the future	
Environmental	Needs further assessment			
Geotechnical Implications		Ground improvement may impact existing buildings and infrastructure	Minimises ground improvement impacts to existing buildings and infrastructure	
Community impact		High impact on existing village character & heritage assets	Minimises the impact on village character and heritage assets. Aligns with the Steveston Harbour Authority Concept	
Operation and Maintenance	Design resembles existing or traditional infrastructure for relatively simple O&M	The replacement cost of sheet pile sections is high. Maintenance may impact the local community	Maintenance can be achieved with little impact to the local community	A harbour gate requires new O&M procedures with additional short and long term costs
Roadway Disruptions		Disruption likely for some options	No disruption	

Sturgeon Bank, Roberts Bank and River Training Structures

The existing river training structures (rock groynes and timber pilings) at the Fraser River's mouth and the extensive Sturgeon Bank mud flats protect Richmond's West Dike and the Steveston area from large waves that develop in the Georgia Strait. As sea levels rise water washing over these areas will become deeper and the current level of wave protection will be reduced.

Sediment deposition and erosion on Sturgeon Bank occurs due to a multitude of factors that changed significantly through the 19th Century. Tidal drift, river dredging and river training structures all impact sedimentation in the Fraser River Delta. It is unclear how current sedimentation patterns will effect Sturgeon Bank's ability to mitigate wave action, however, any net erosion is anticipated to exacerbate the loss of wave protection caused by rising sea levels.

The maintenance and enhancement of river training structures is anticipated to help protect Richmond from waves and will also benefit shipping and local harbour activities. As is now being practiced around the world, beach nourishment (the addition of sand and sediment to a "beach") may be used to grow mud flat and sand banks to restore (e.g. New Orleans, Louisiana) or enhance (e.g. ocean beaches, The Netherlands) wave protection. Although its effectiveness in the Fraser River Delta is not yet understood, the careful planning of beach nourishments may mitigate wave action from the Georgia Strait and benefit the natural environment (Steveston Island is partially manmade which over the last 50 to 100 years has changed from a low lying sand bank into its current make up of trees, plants and intertidal beaches that support an abundance of wildlife). Sturgeon Banks are currently designated as Provincially protected for their high wetland ecological value and migratory bird habitat.

Reach 8, Options B and C (**Attachment 2**) indicate how elevating Sturgeon Bank or creating a chain of islands along it (similar to Steveston Island) could reduce current and future wave action on the west dike that would minimise future dike crest elevation upgrades.

Next Steps

Staff plan to gain feedback from key stakeholders and the public. Key stakeholders include:

- Steveston Harbour Authority
- Small Craft Harbours
- Port Metro Vancouver
- Department of Fisheries and Oceans
- BC Inspector of Dikes
- Gulf of Georgia Cannery Society / Parks Canada
- Britannia Heritage Shipyard Society
- Heritage Advisory Committee
- Advisory Committee on the Environment

The key stakeholder group will be engaged through ongoing meetings and communications. Public consultation would include two public open houses held before the end of September.

Financial Impact

None.

Conclusion

Consistent with the City's 2008 – 2031 Richmond Flood Protection Strategy, Phase 1 of a Dike Master Plan is being prepared. Two primary dike alignments in the Steveston area as well as wave mitigation strategies for the southern West Dike area have been prepared for key stakeholder consultation. Staff plan to engage stakeholders so that they may provide input into determining a preferred future dike alignment in the Steveston area.

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Project Engineer, Engineering Planning
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LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

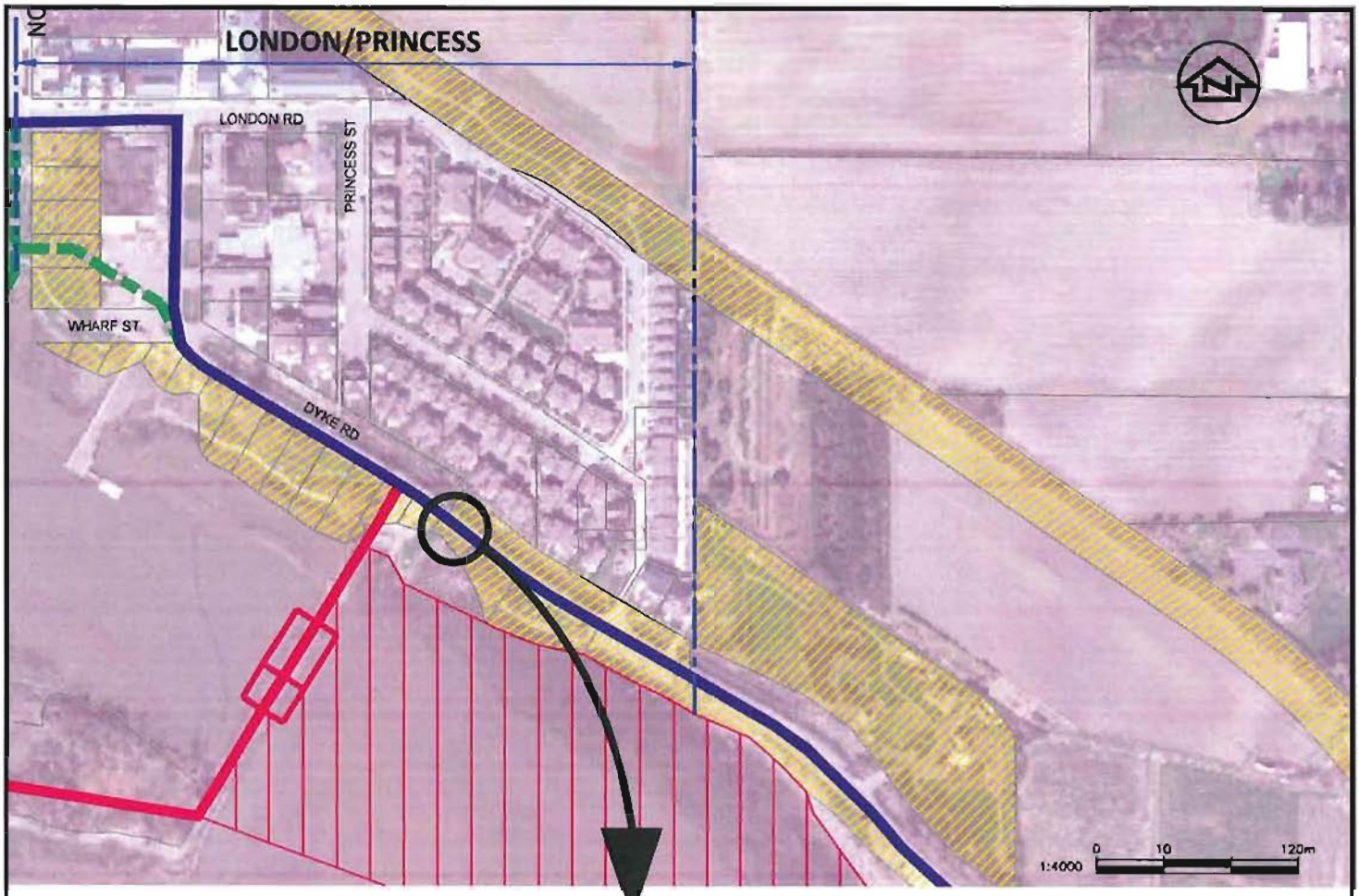
PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

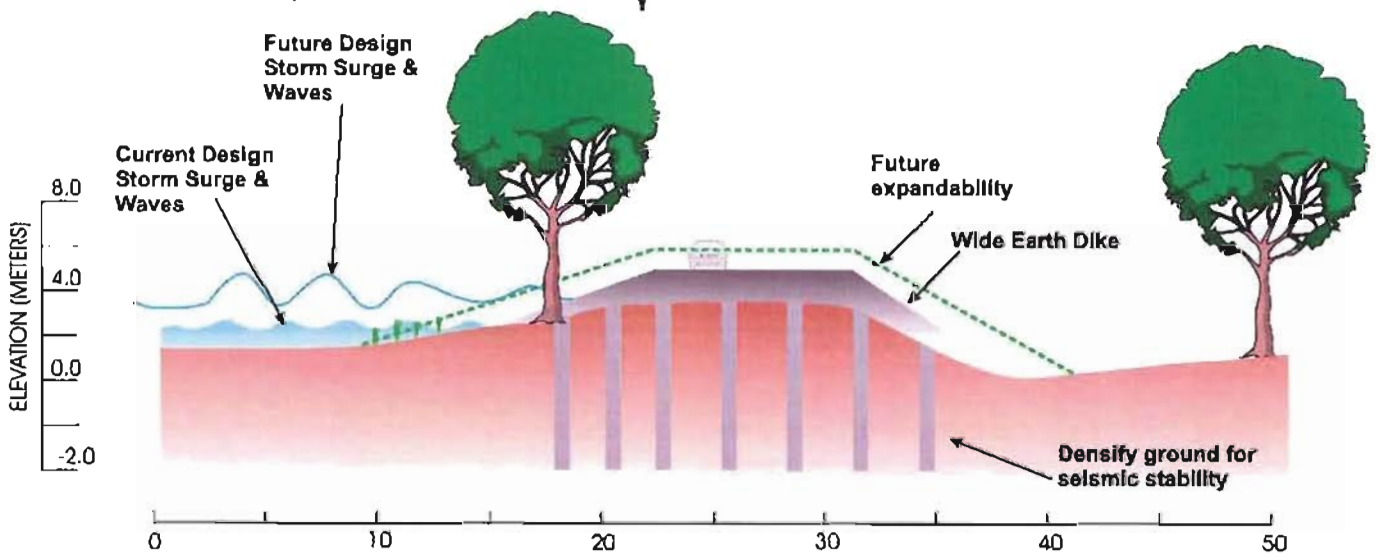
CITY OF RICHMOND

LULU ISLAND DIKE MASTER PLAN PHASE 1

CONCEPTUAL DESIGN ALTERNATIVES

Attachment 1





LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 1: London/Princess Option A

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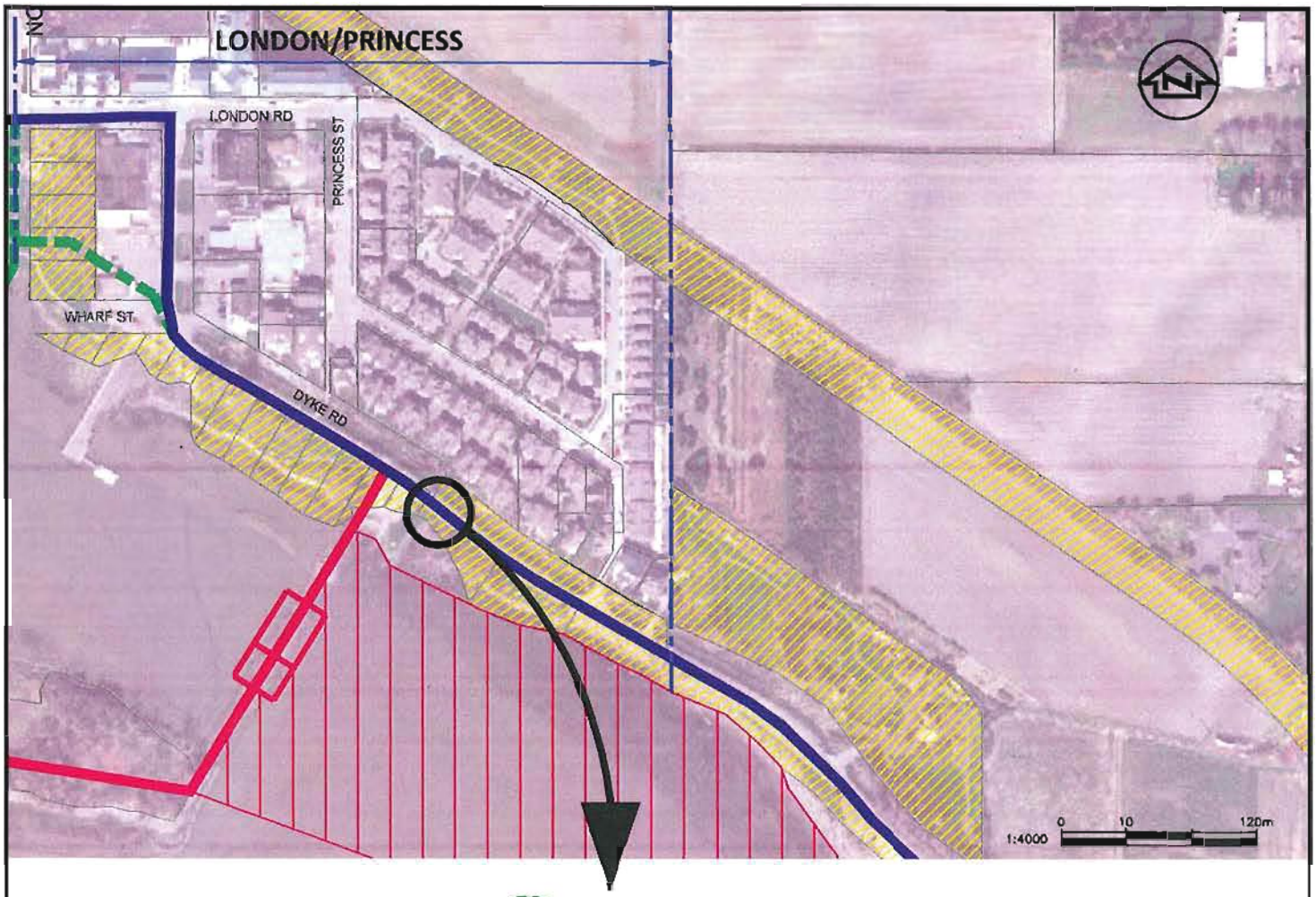

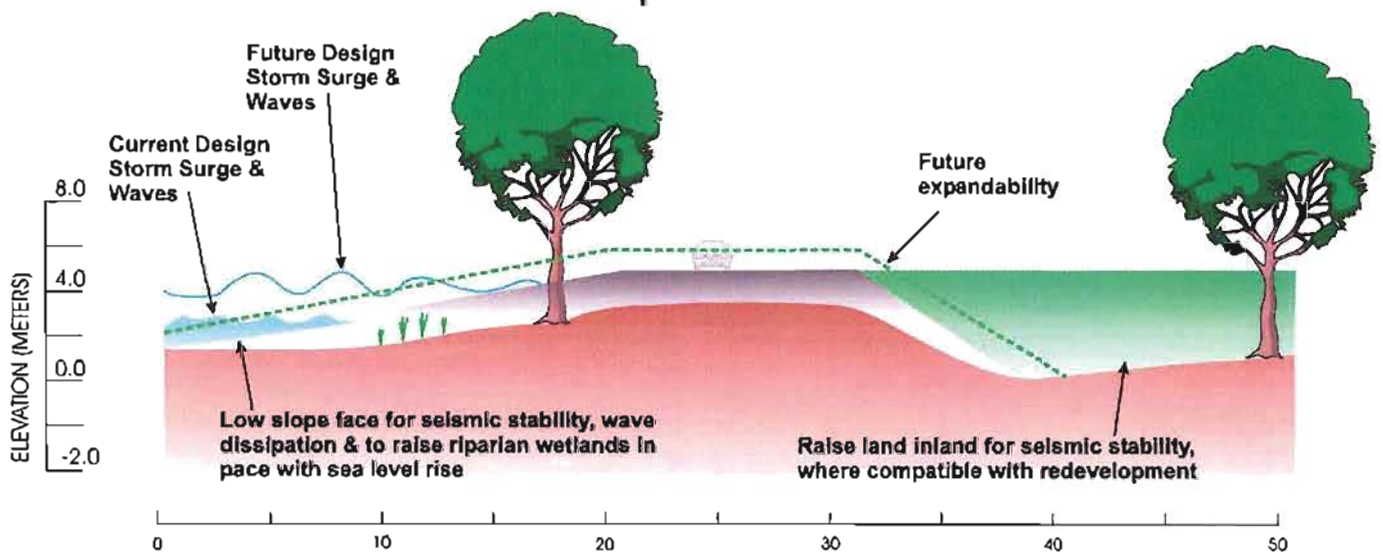

LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 1: London/Princess Option B

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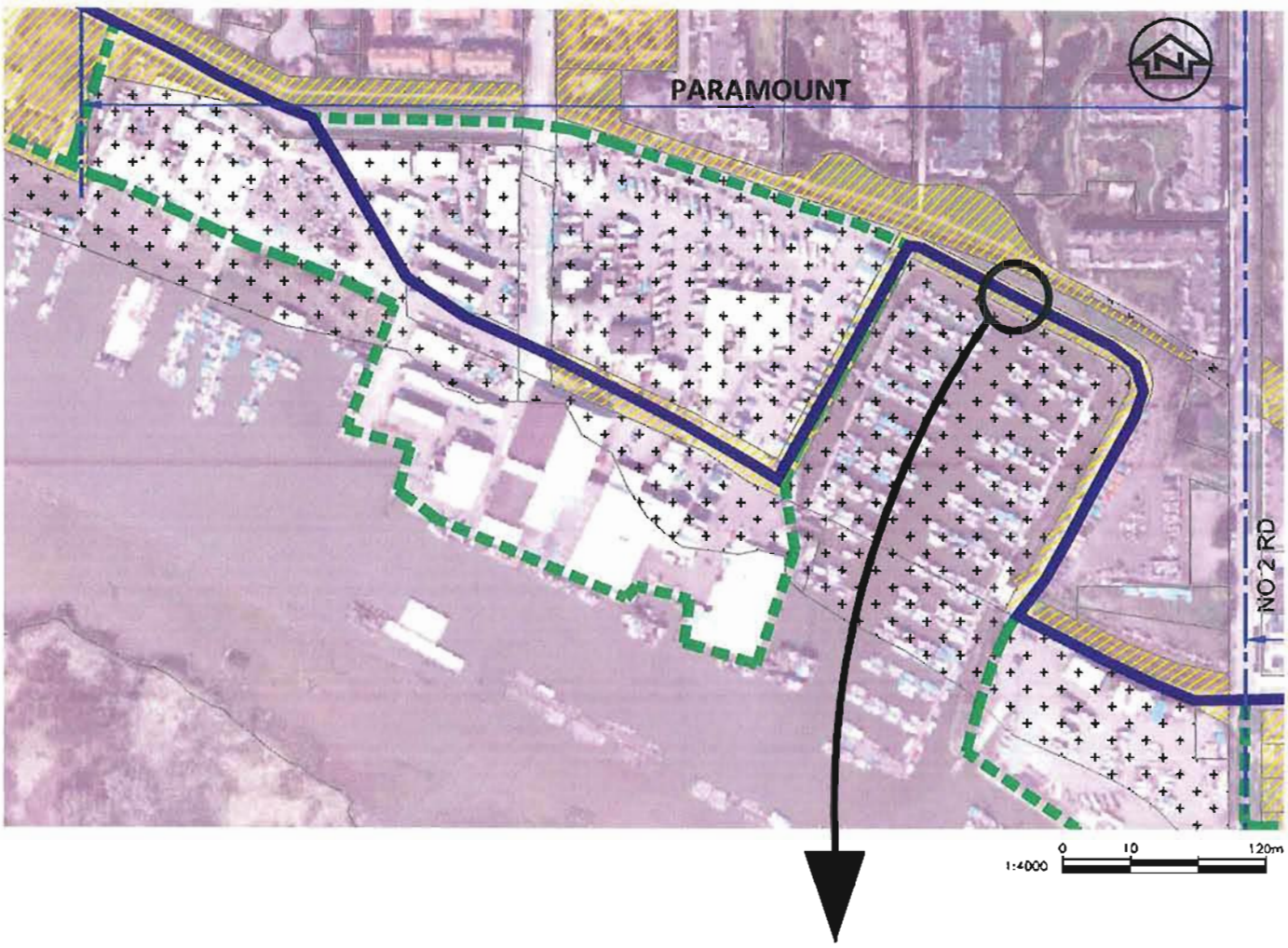

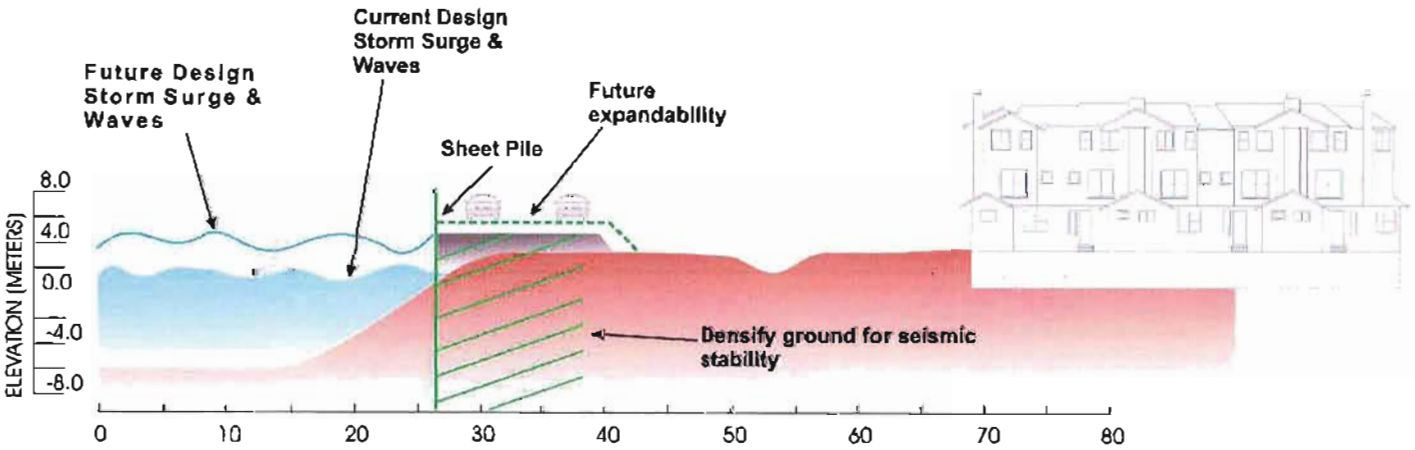

LEGEND:

- CURRENT DIKE ALIGNMENT
- PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS
- PRIMARY ALIGNMENT 2 - STEVESTON ISLAND
- REACH BOUNDARIES
- FEDERAL/PROVINCIAL OWNED LAND
- CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 2: Paramount Option A

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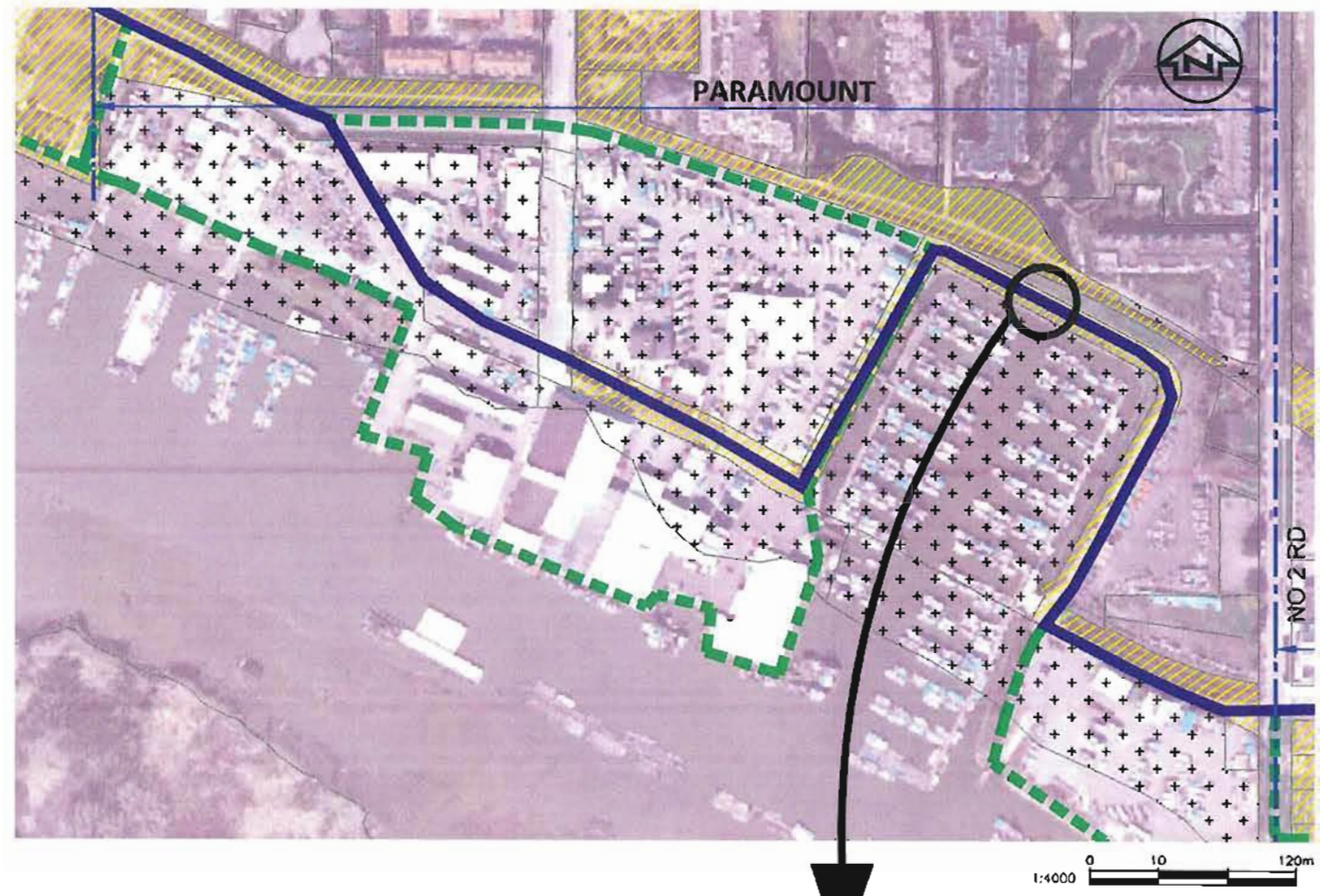

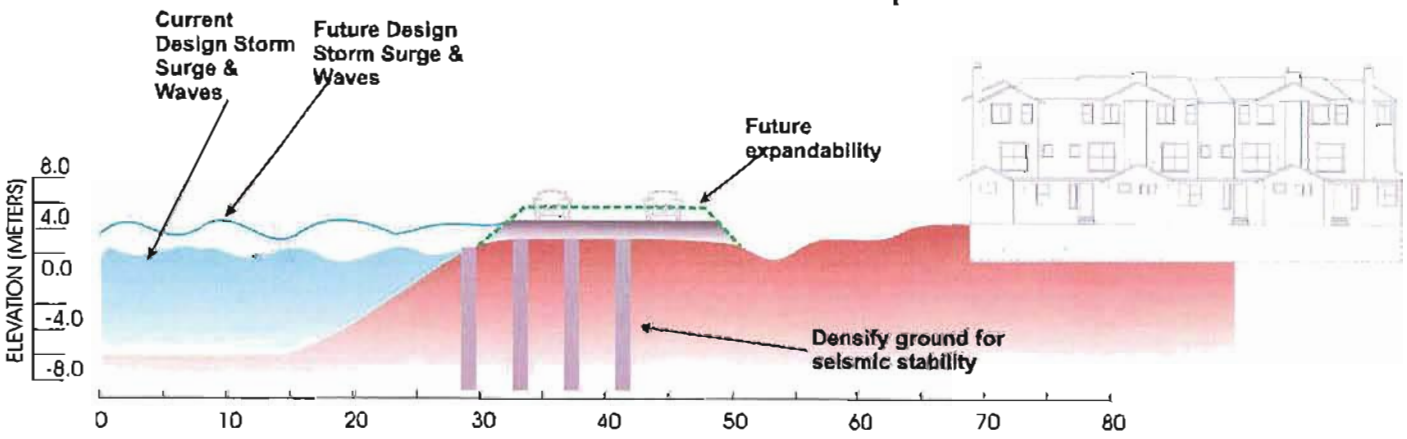

LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 2: Paramount Option B

Delcan

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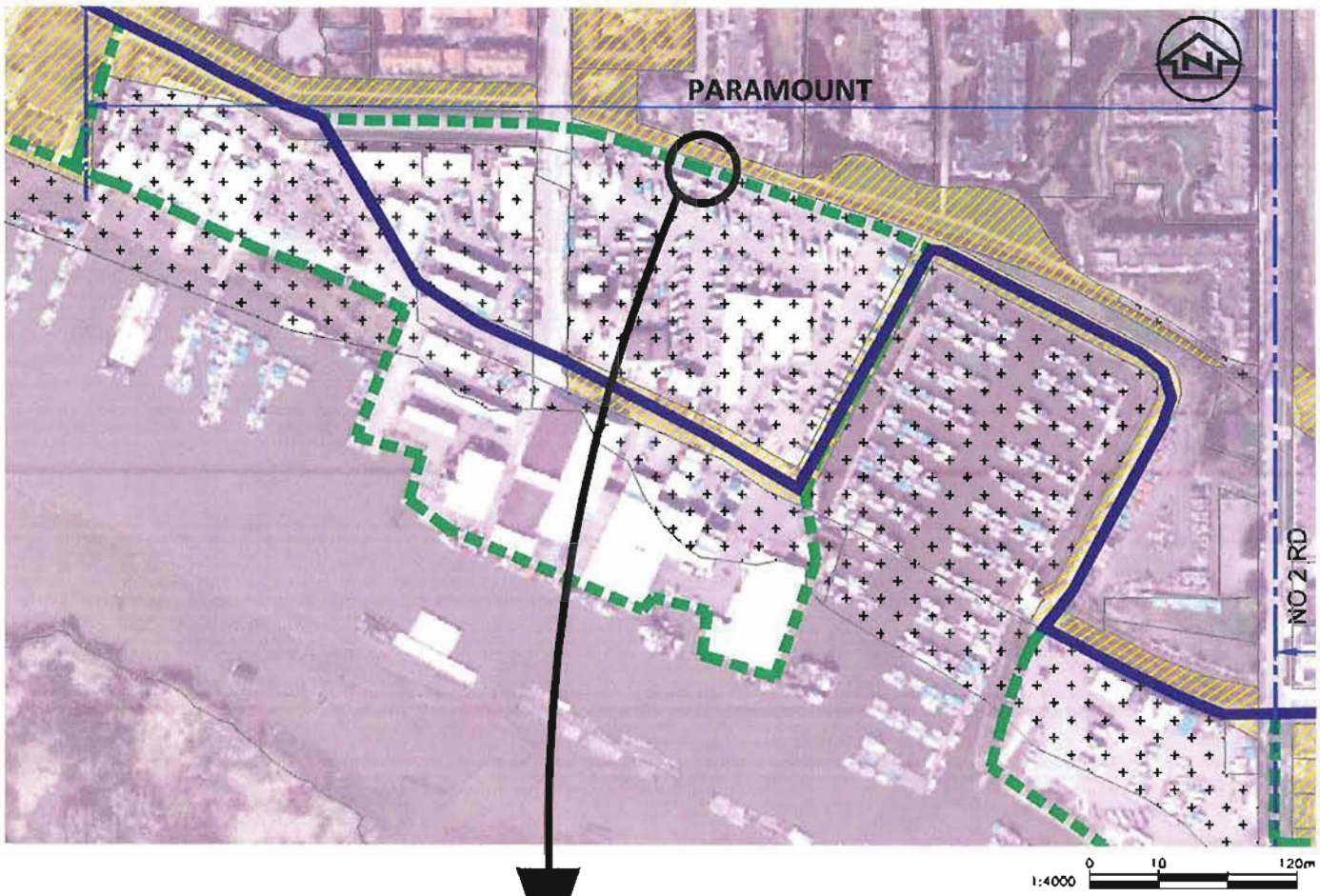

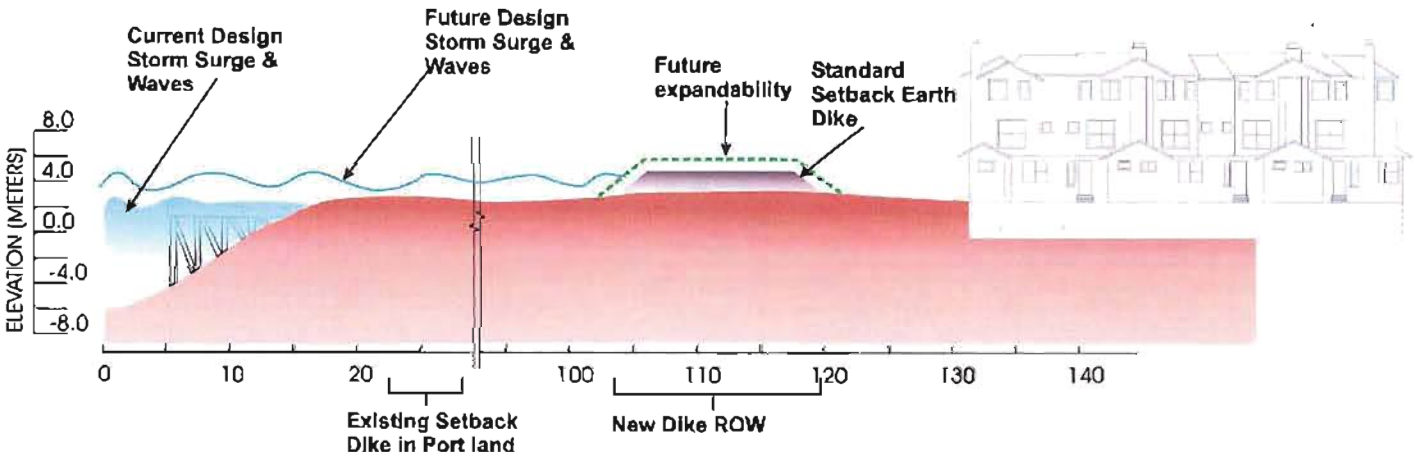

LEGEND:

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PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 2: Paramount Option C

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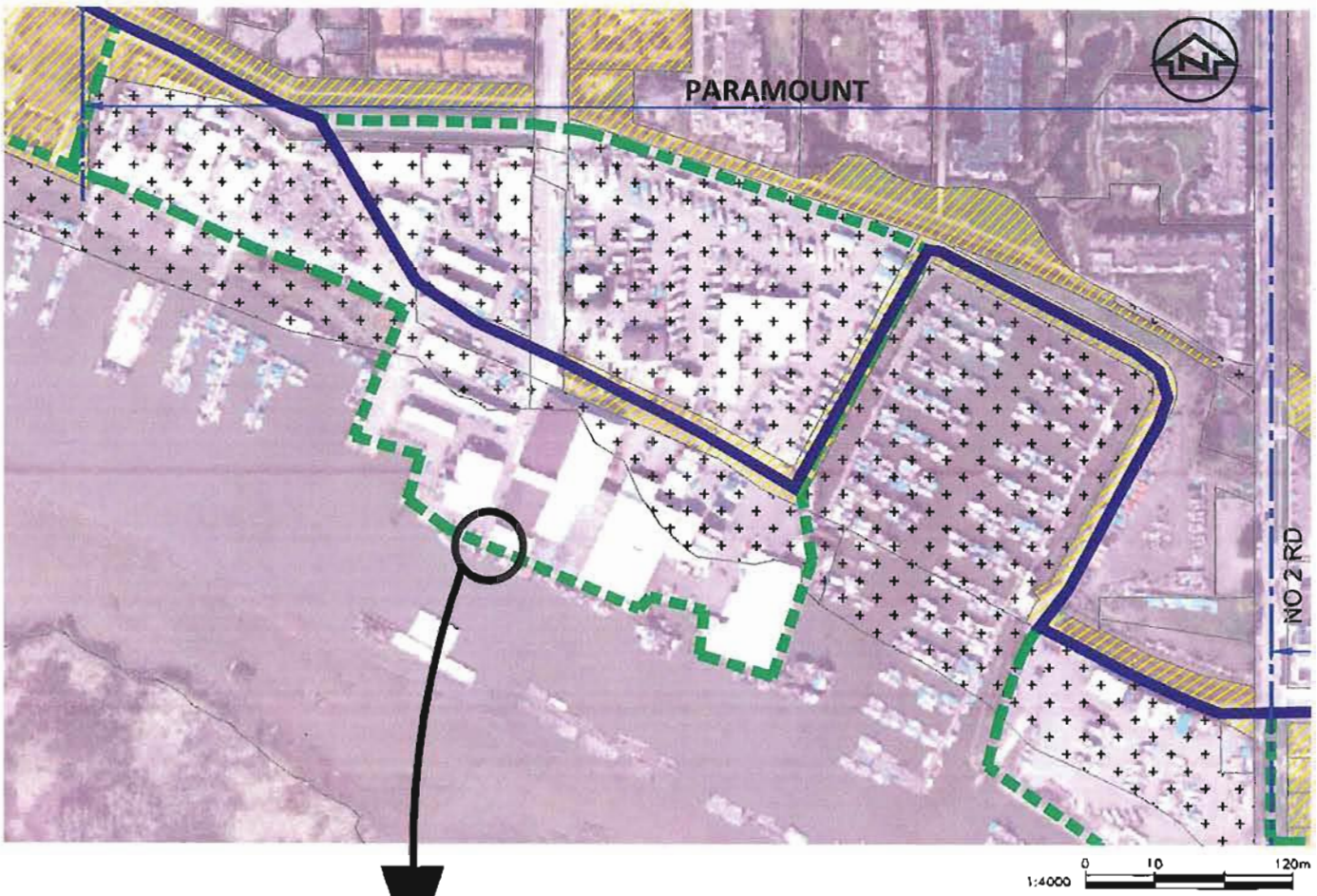

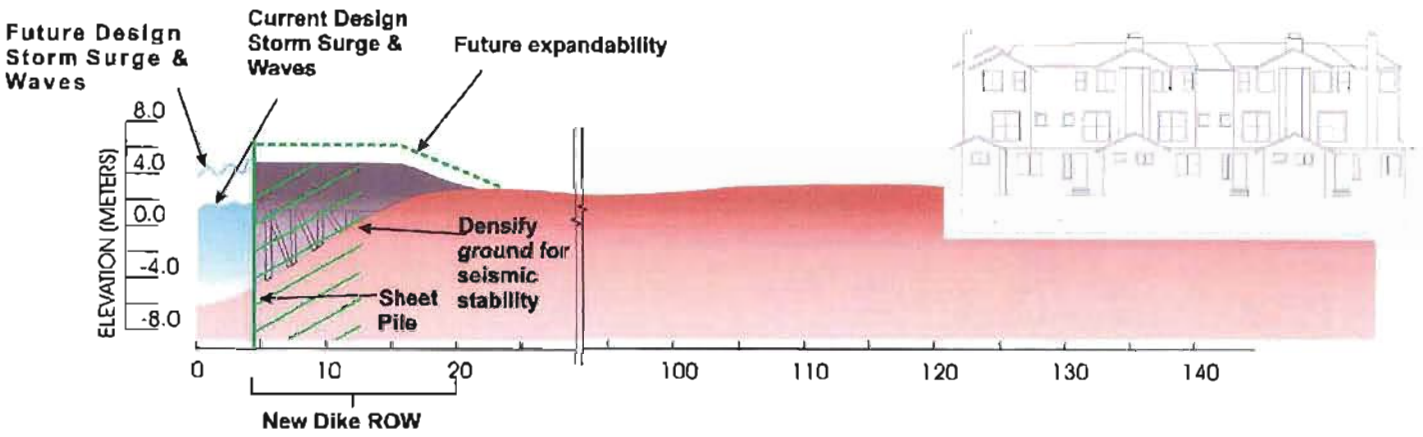

LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 2: Paramount Option D

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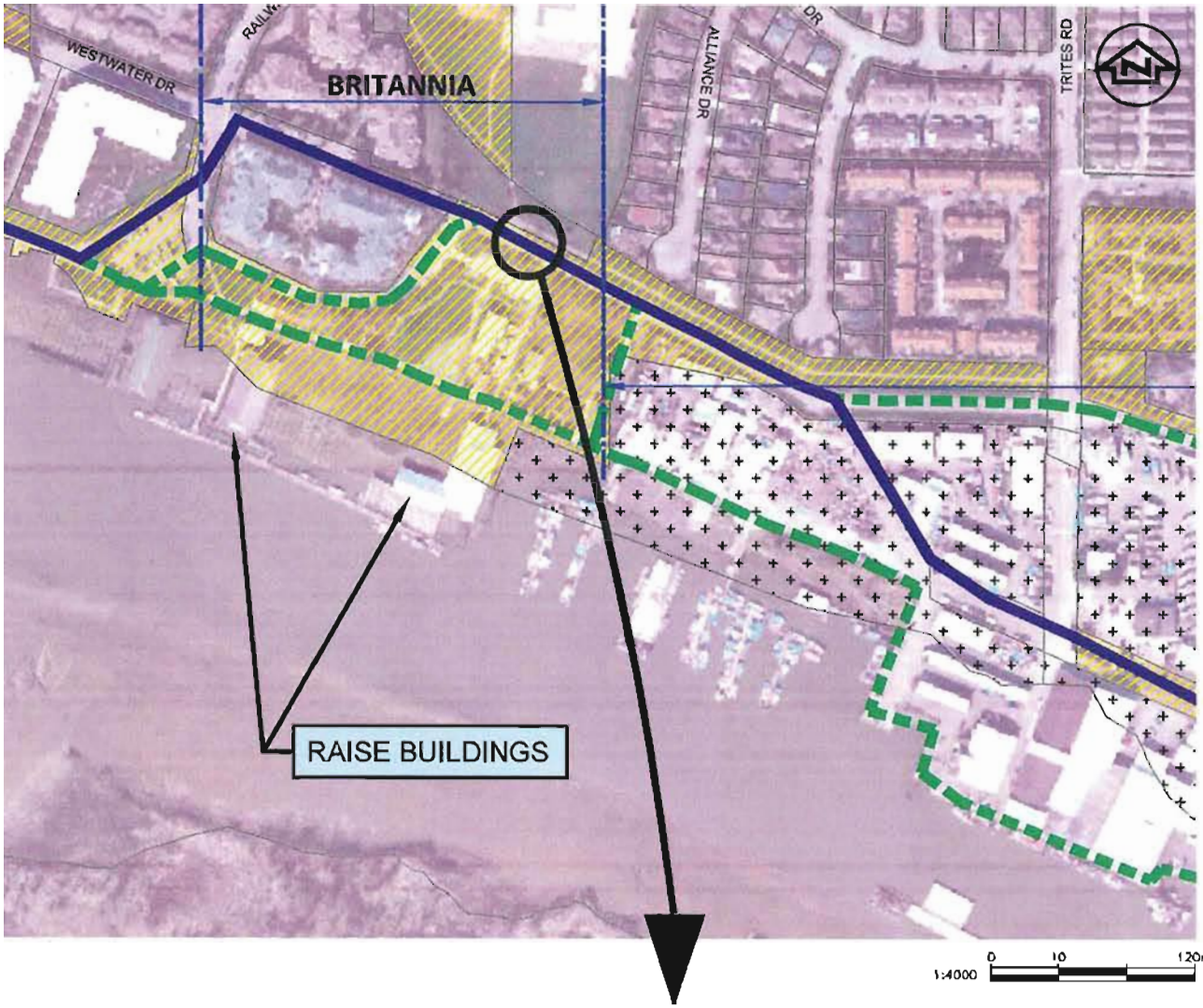

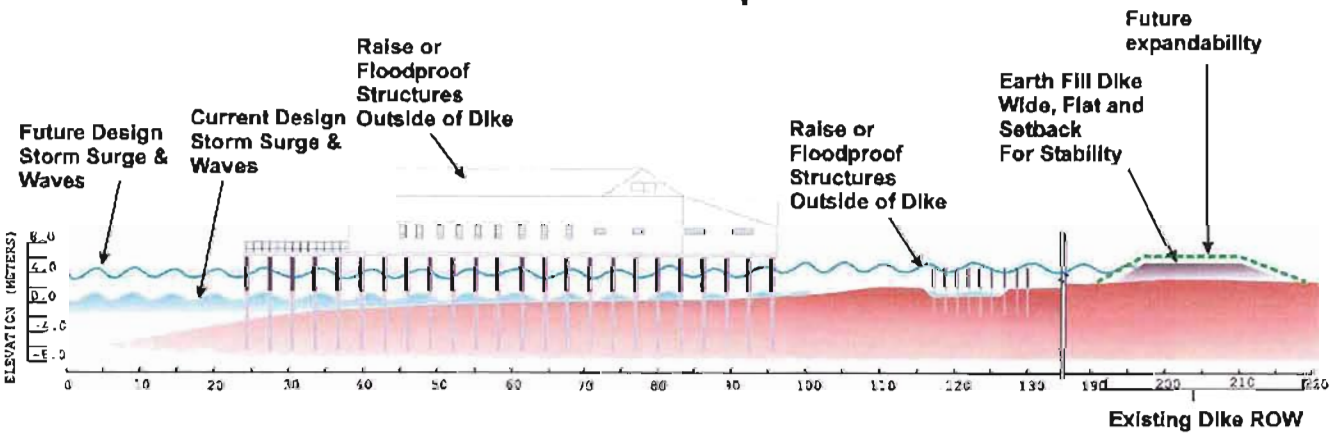

LEGEND:

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- PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS
- PRIMARY ALIGNMENT 2 - STEVESTON ISLAND
- REACH BOUNDARIES
- FEDERAL/PROVINCIAL OWNED LAND
- CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 3: Britannia Option A

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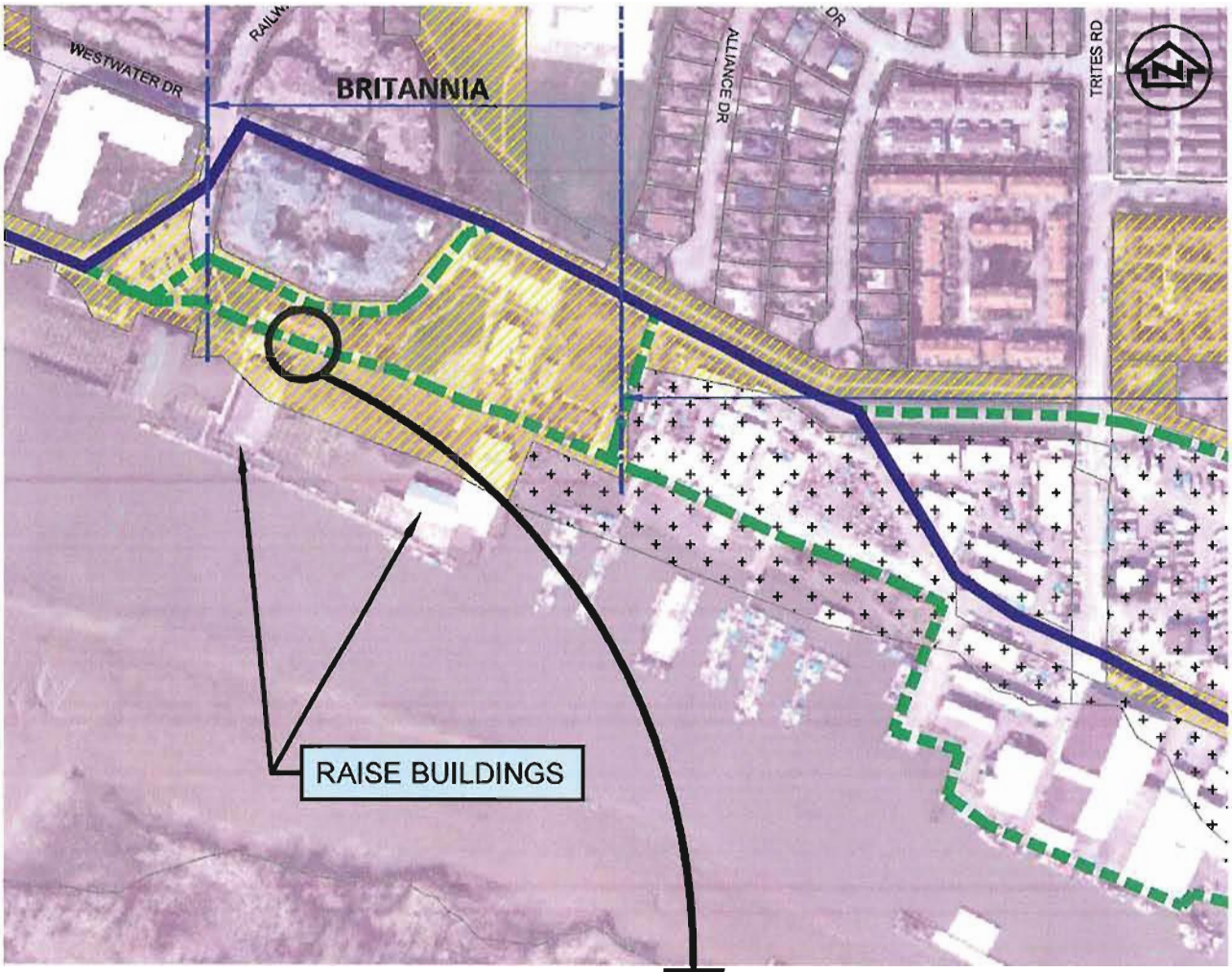

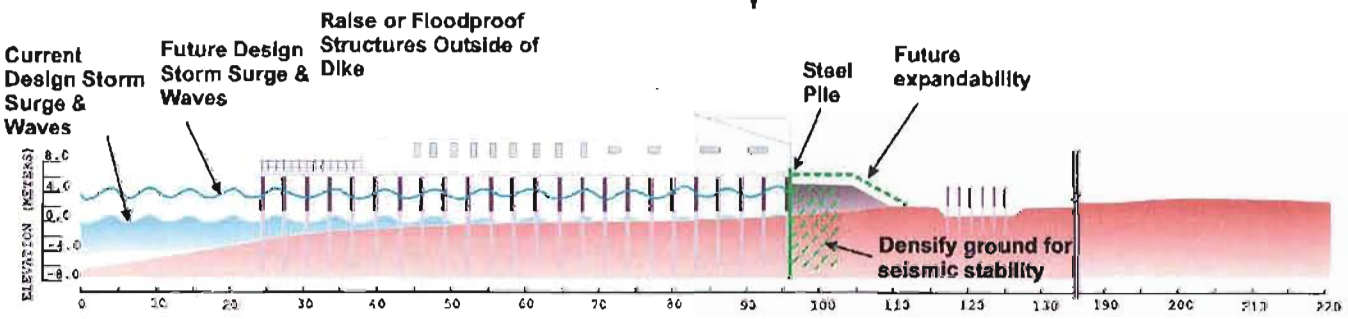

LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 3: Britannia Option B

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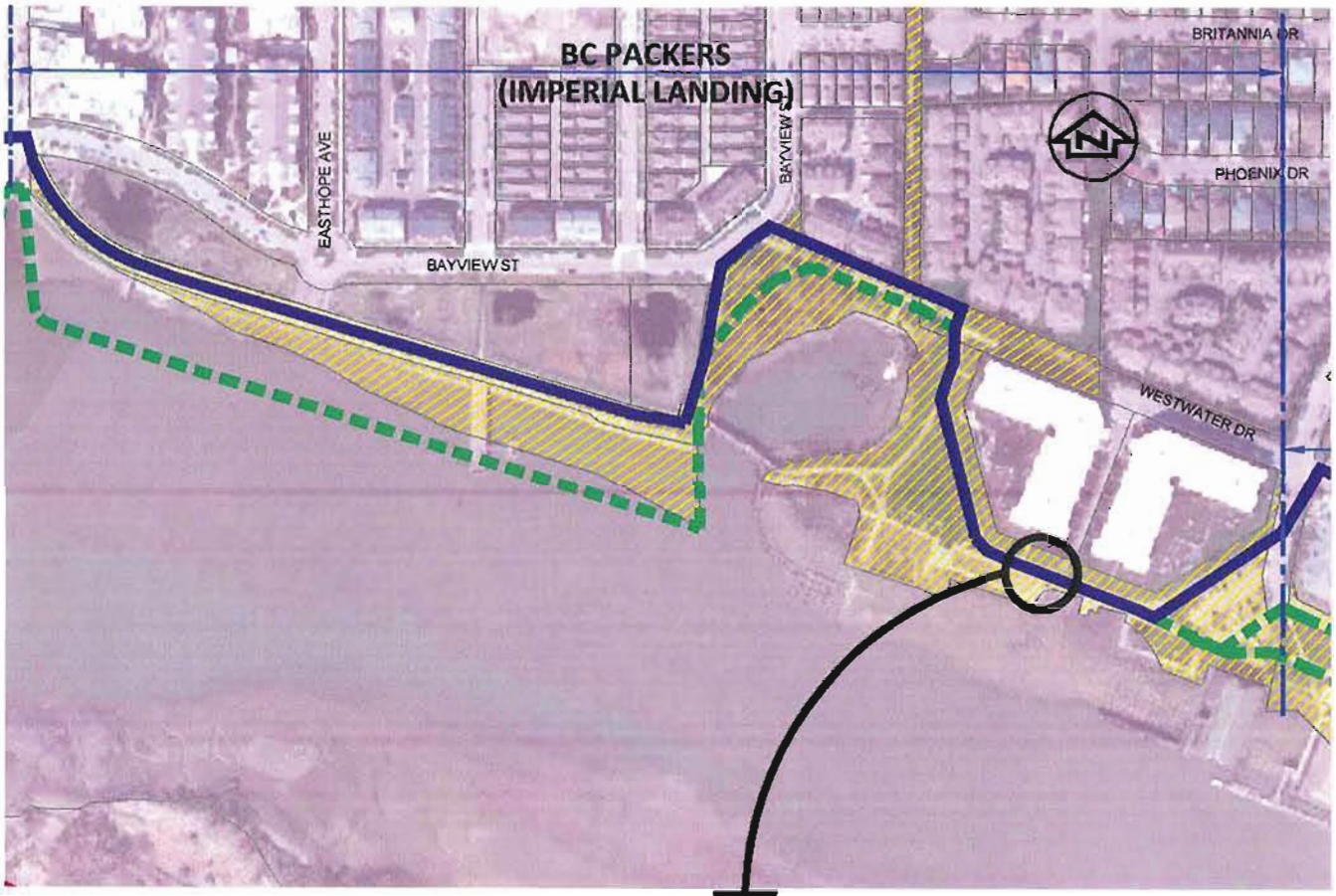

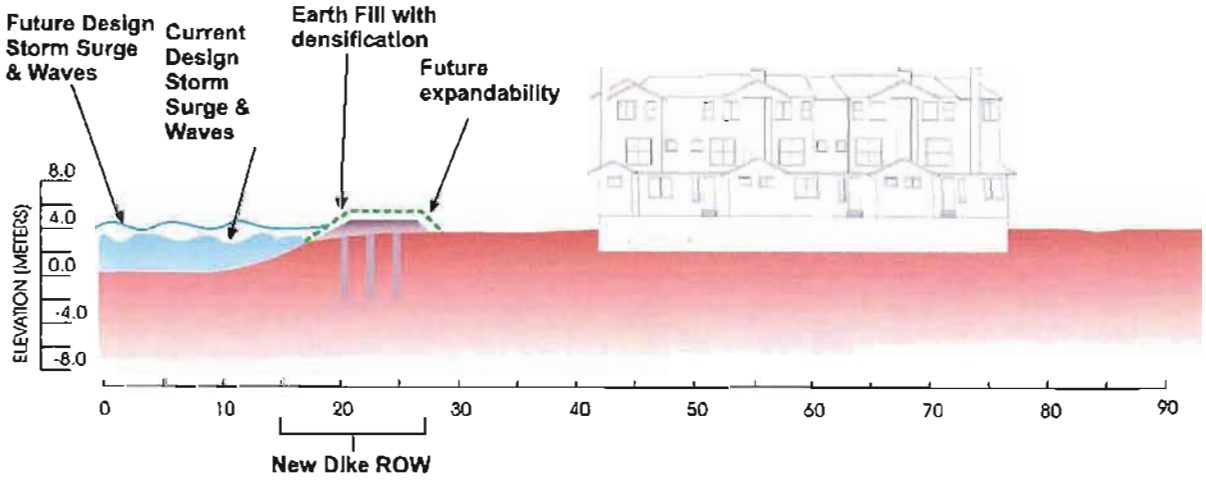

LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 4: BC Packers

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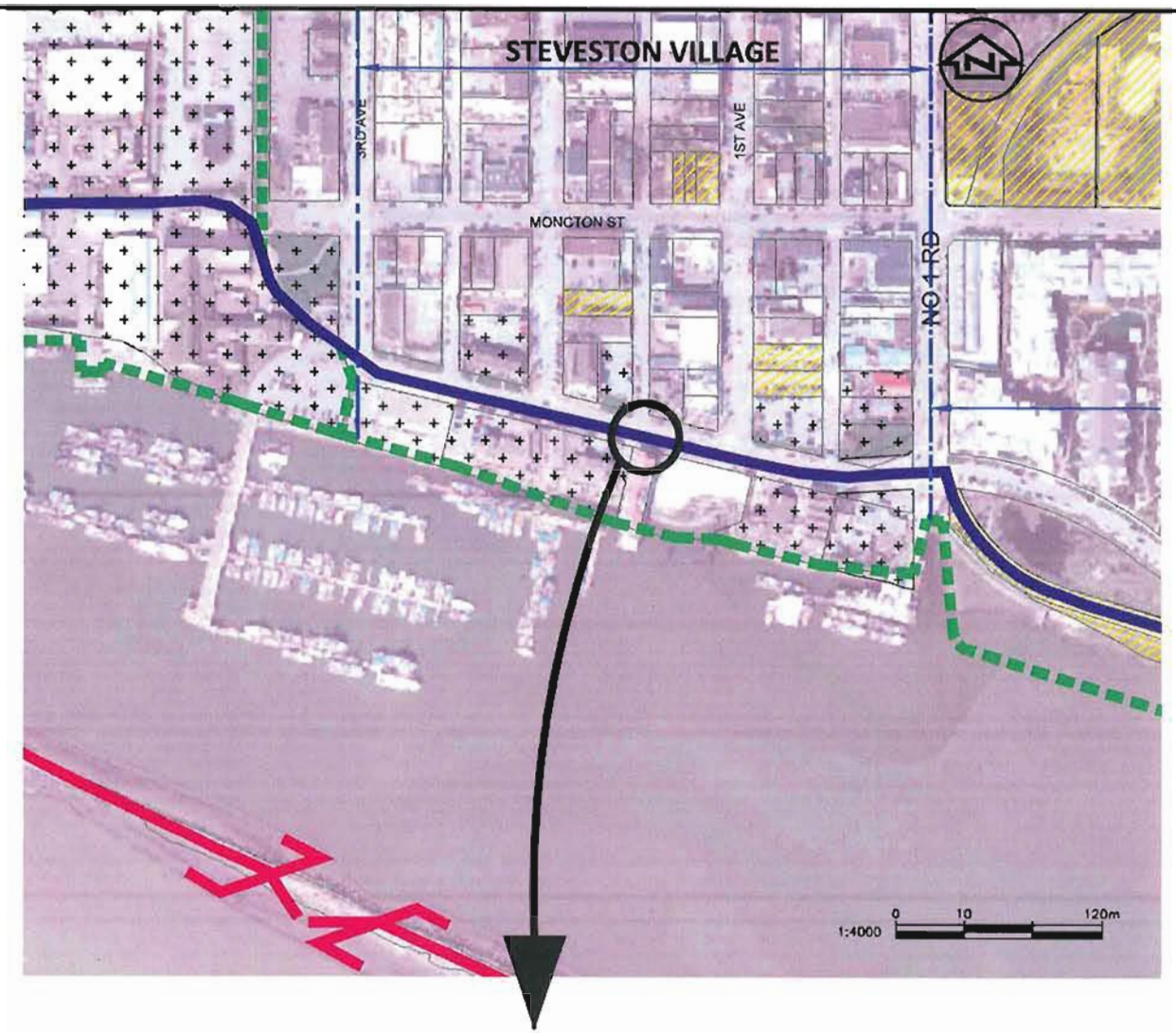

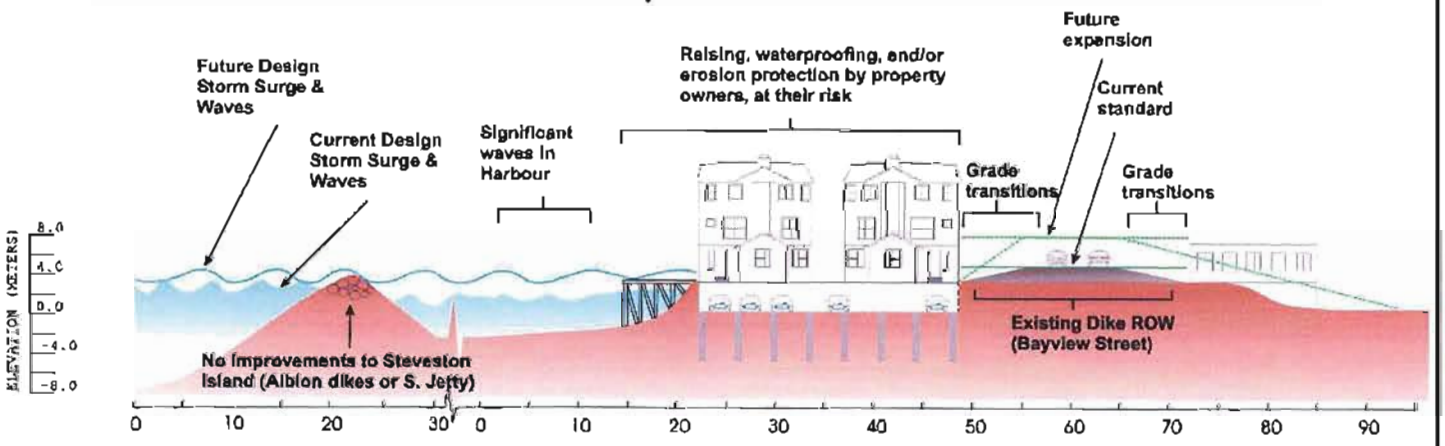

LEGEND:

CURRENT DIKE ALIGNMENT

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REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 5: Steveston Village Option A

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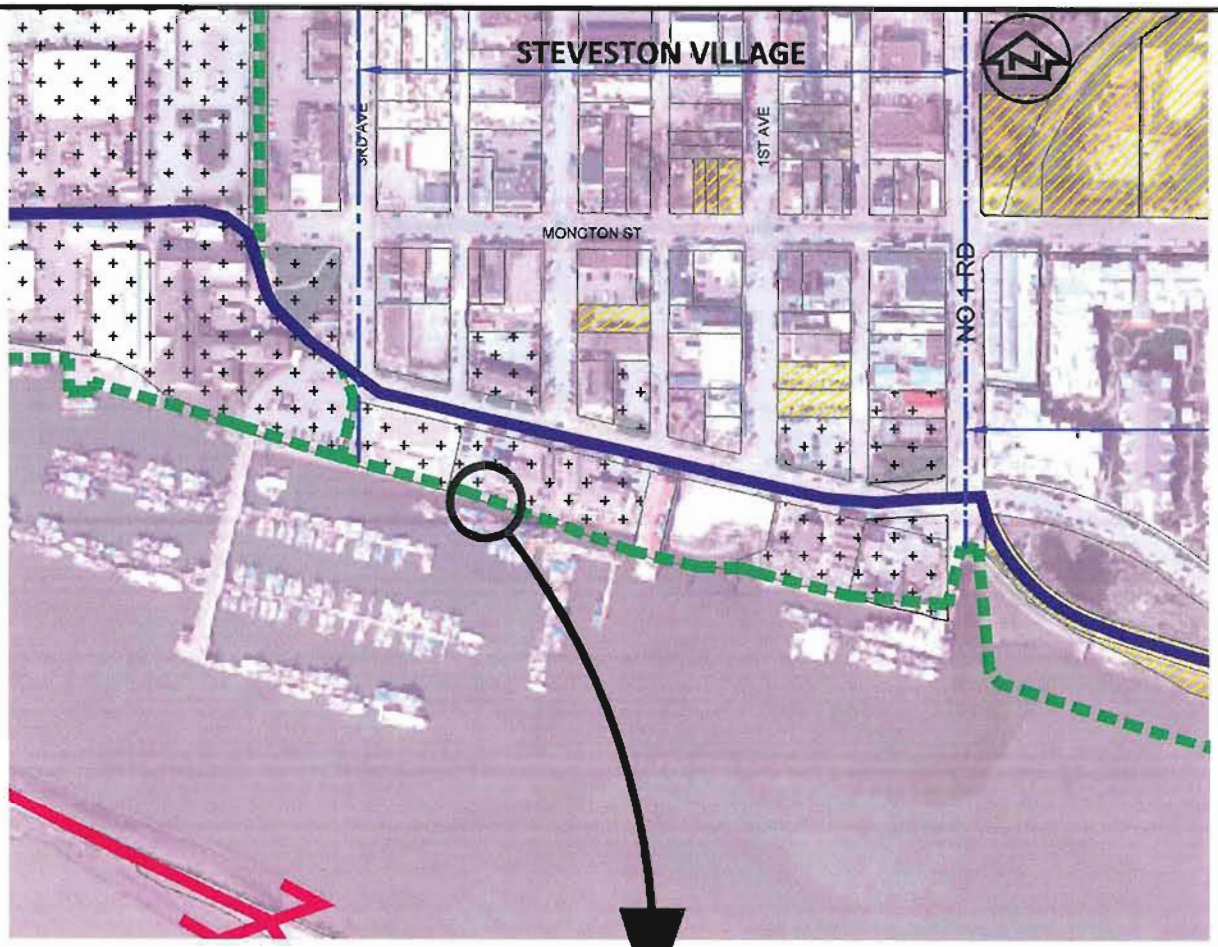

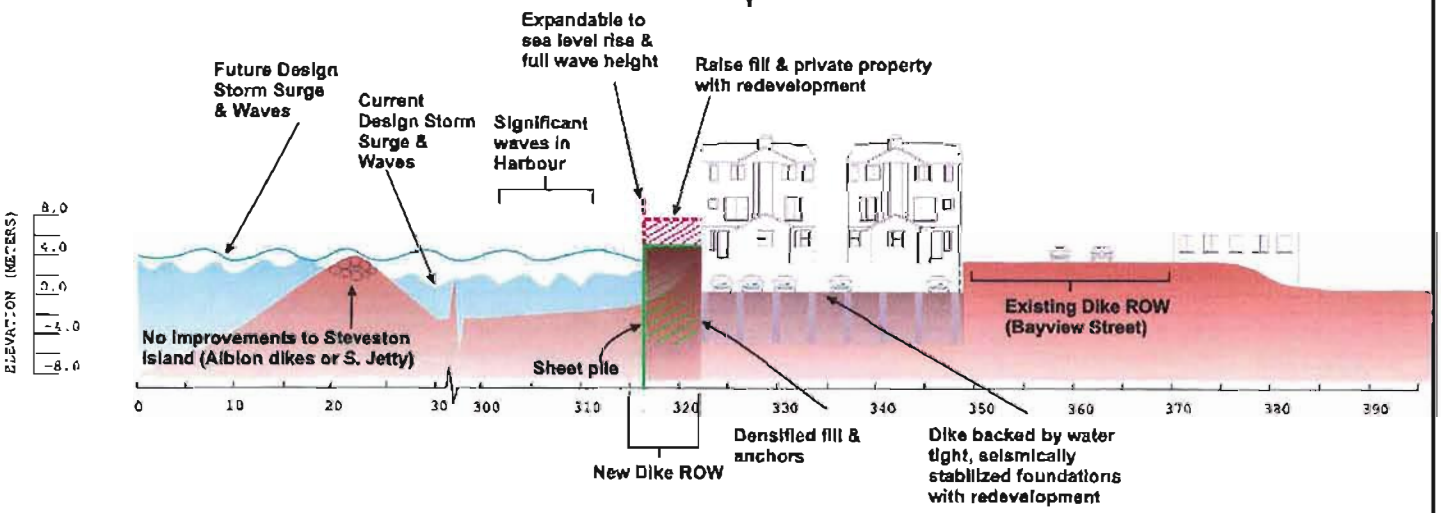

LEGEND:

CURRENT DIKE ALIGNMENT

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REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 5: Steveston Village Option B

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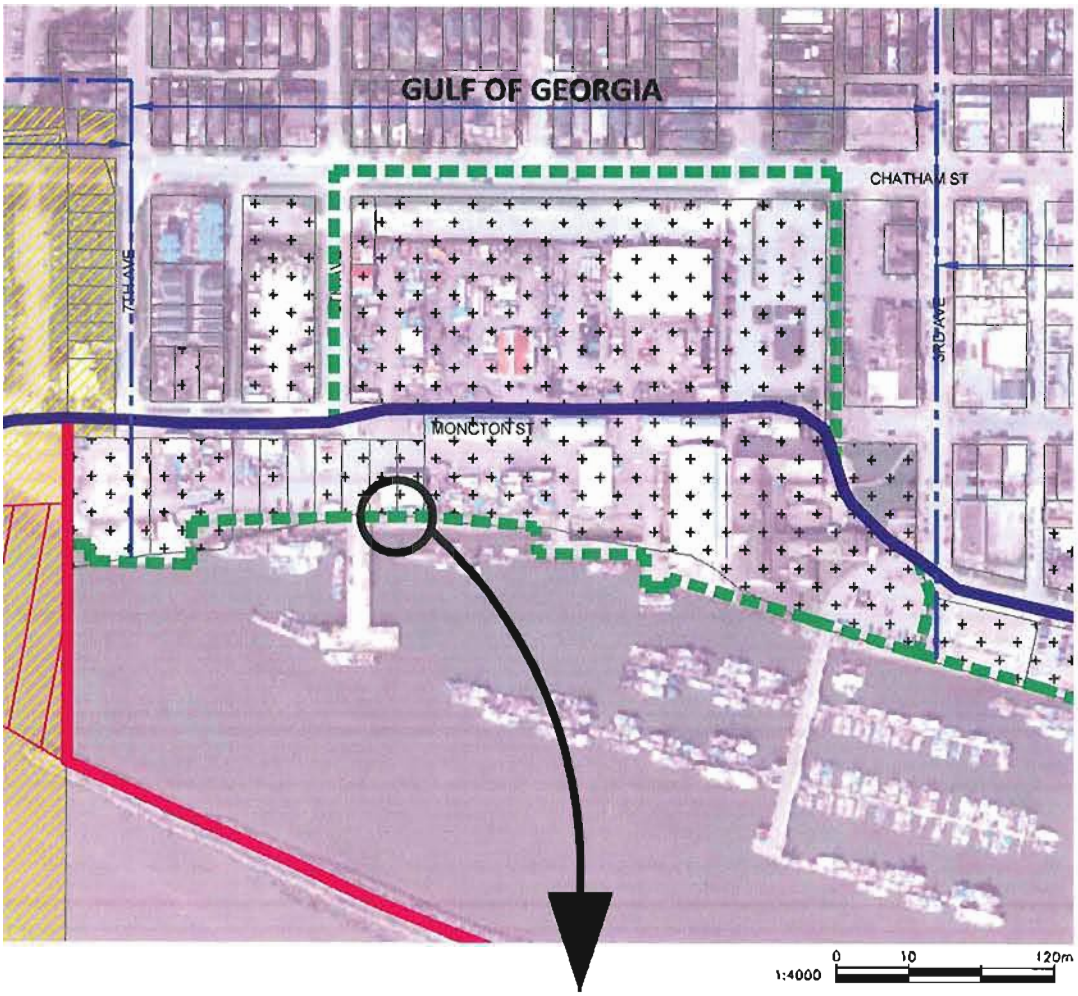

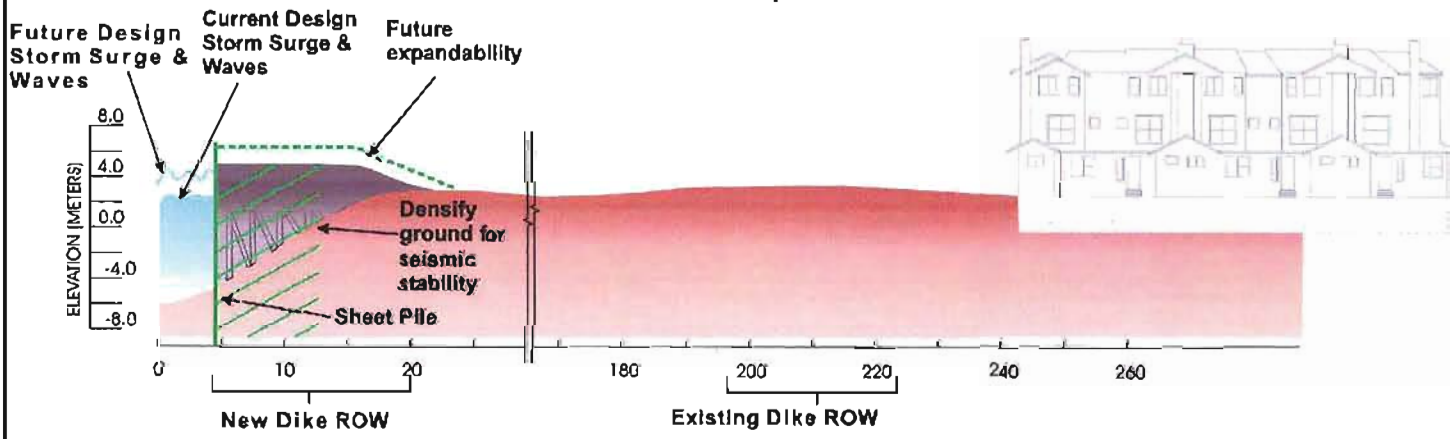

LEGEND:

CURRENT DIKE ALIGNMENT

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PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 6: Gulf of Georgia

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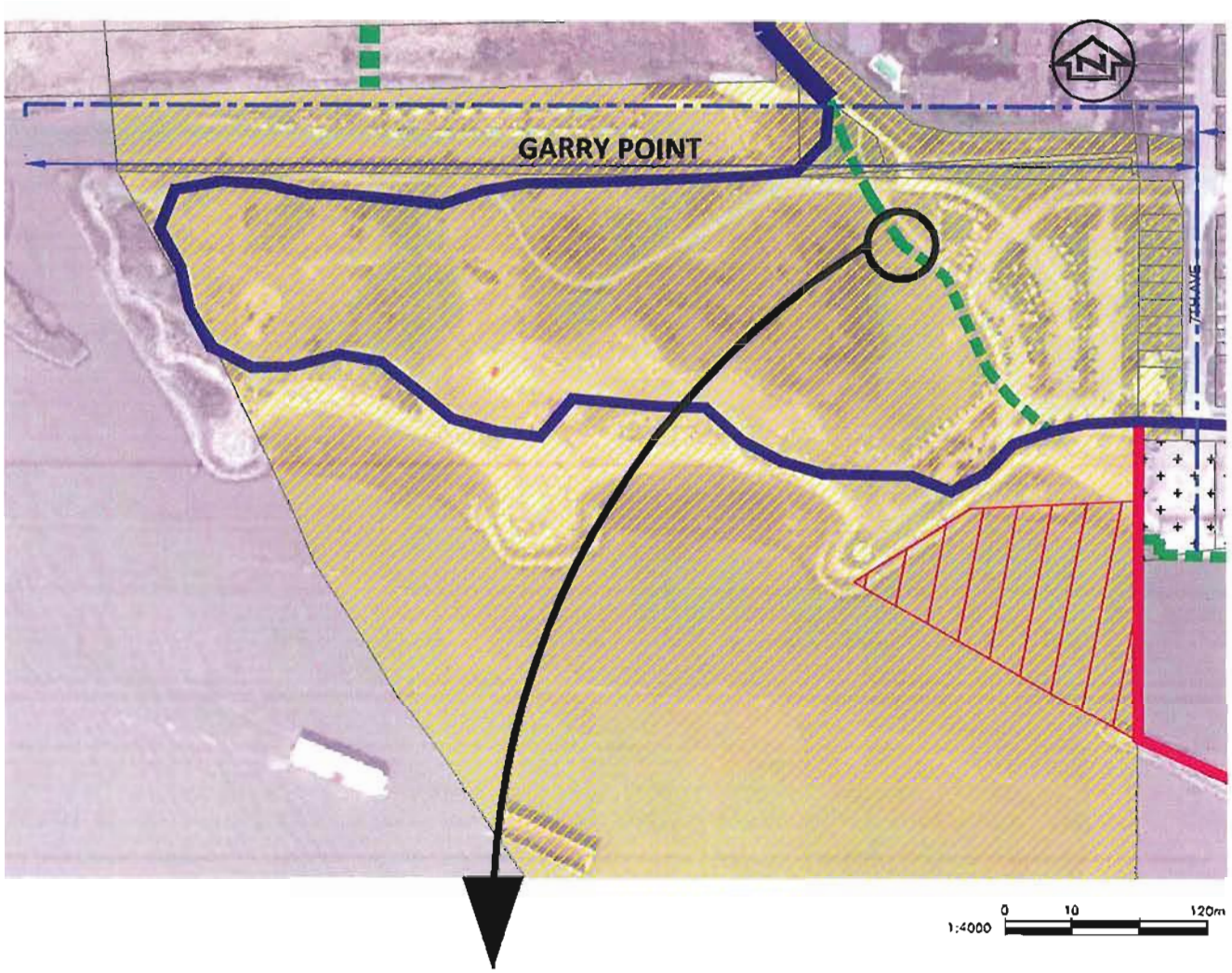

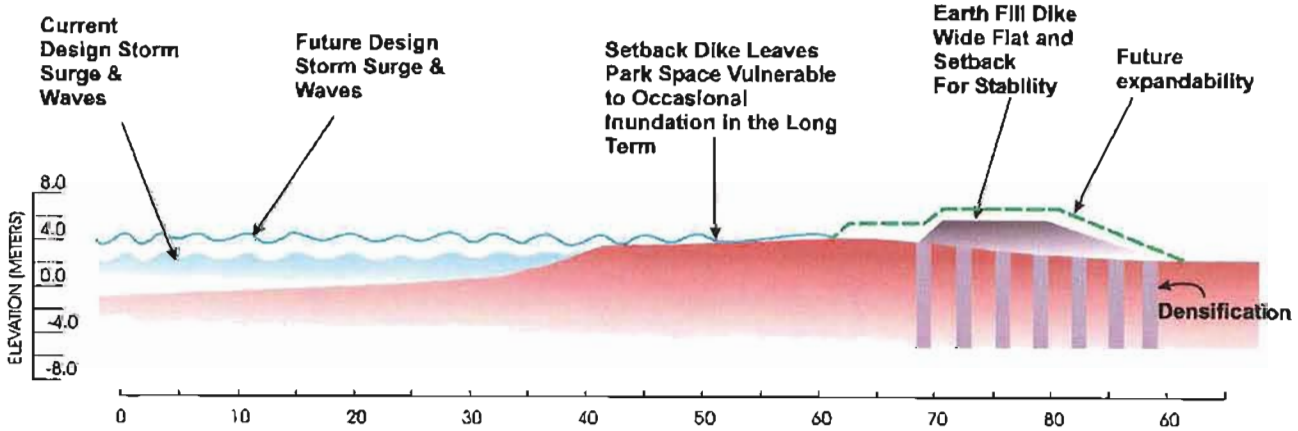

LEGEND:

CURRENT DIKE ALIGNMENT

PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS

PRIMARY ALIGNMENT 2 - STEVESTON ISLAND

REACH BOUNDARIES

FEDERAL/PROVINCIAL OWNED LAND

CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 7: Garry Point

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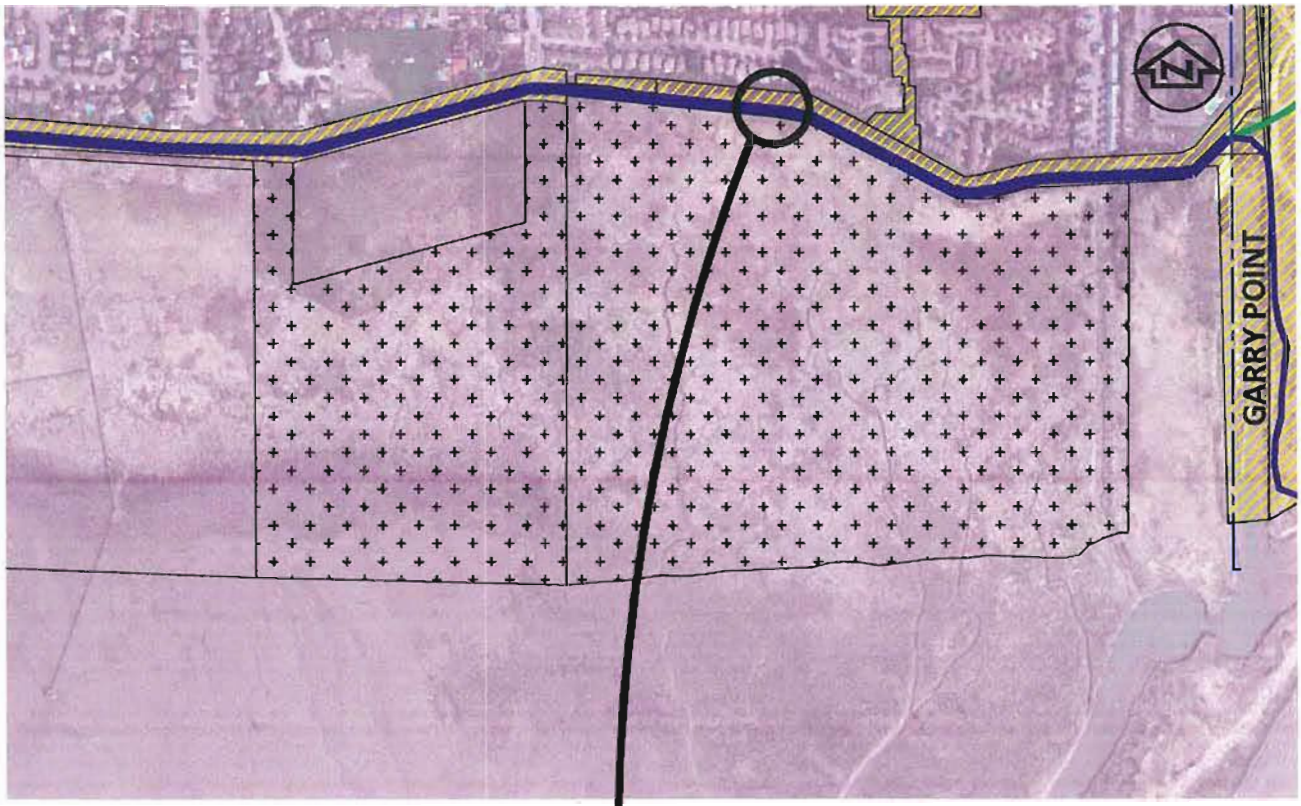

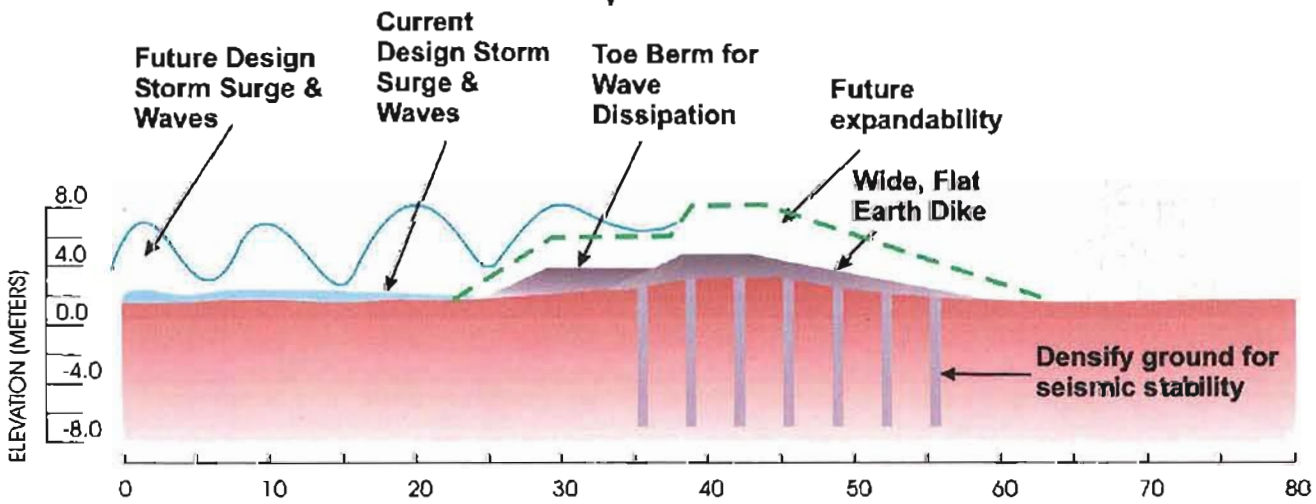

LEGEND:

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- FEDERAL/PROVINCIAL OWNED LAND
- CITY OWNED LAND

Flood Protection Improvement Alternatives Reach 8: West Dike Option A

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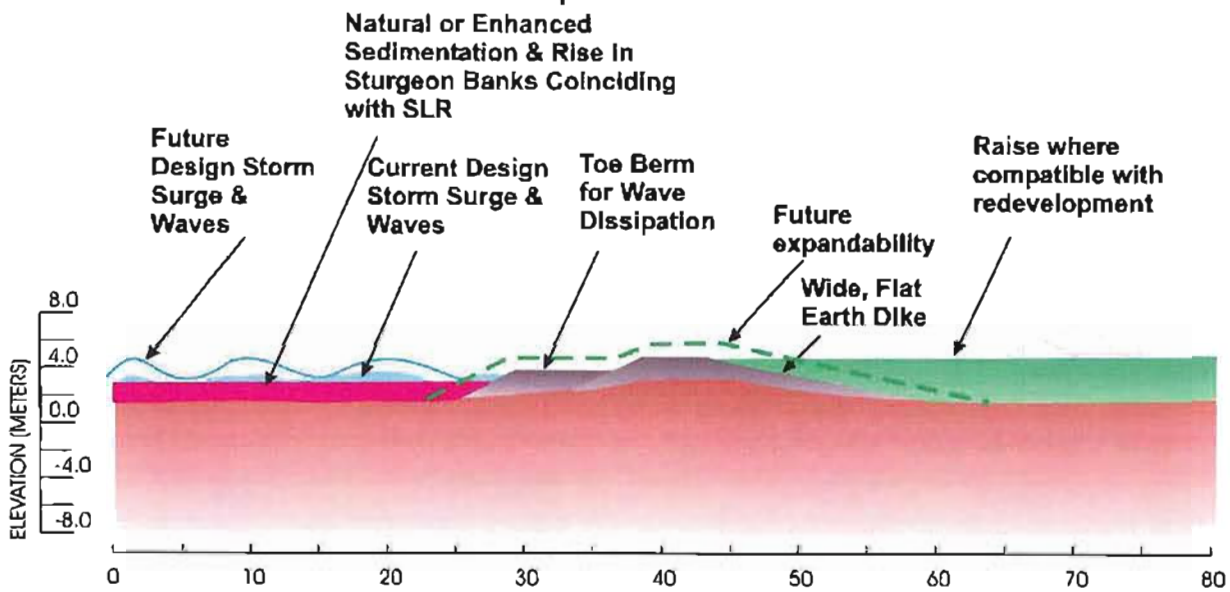

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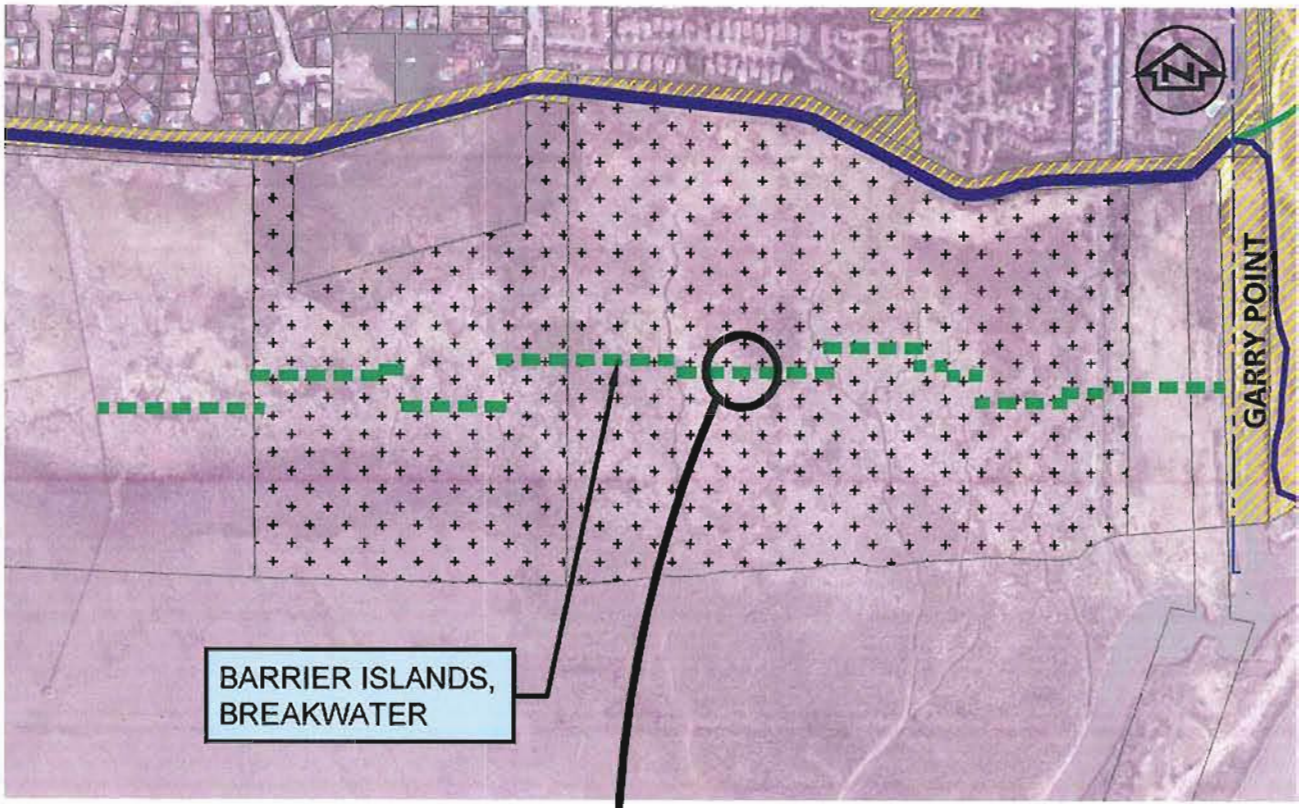
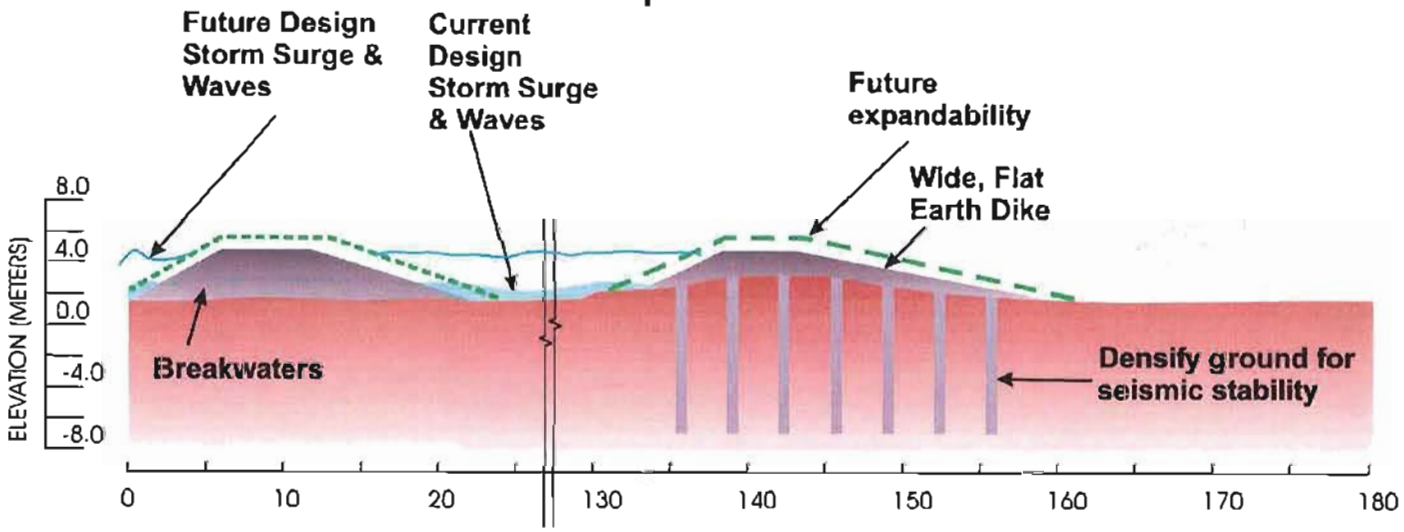
- CITY OWNED LAND

Flood Protection Improvement Alternatives
Reach 8: West Dike
Option B

Delcan

EB3763 July 2012





LEGEND:

- CURRENT DIKE ALIGNMENT
- PRIMARY ALIGNMENT 1 - LULU ISLAND ALIGNMENTS
- PRIMARY ALIGNMENT 2 - STEVESTON ISLAND
- REACH BOUNDARIES
- FEDERAL/PROVINCIAL OWNED LAND
- CITY OWNED LAND

Flood Protection Improvement Alternatives
Reach 8: West Dike
Option C

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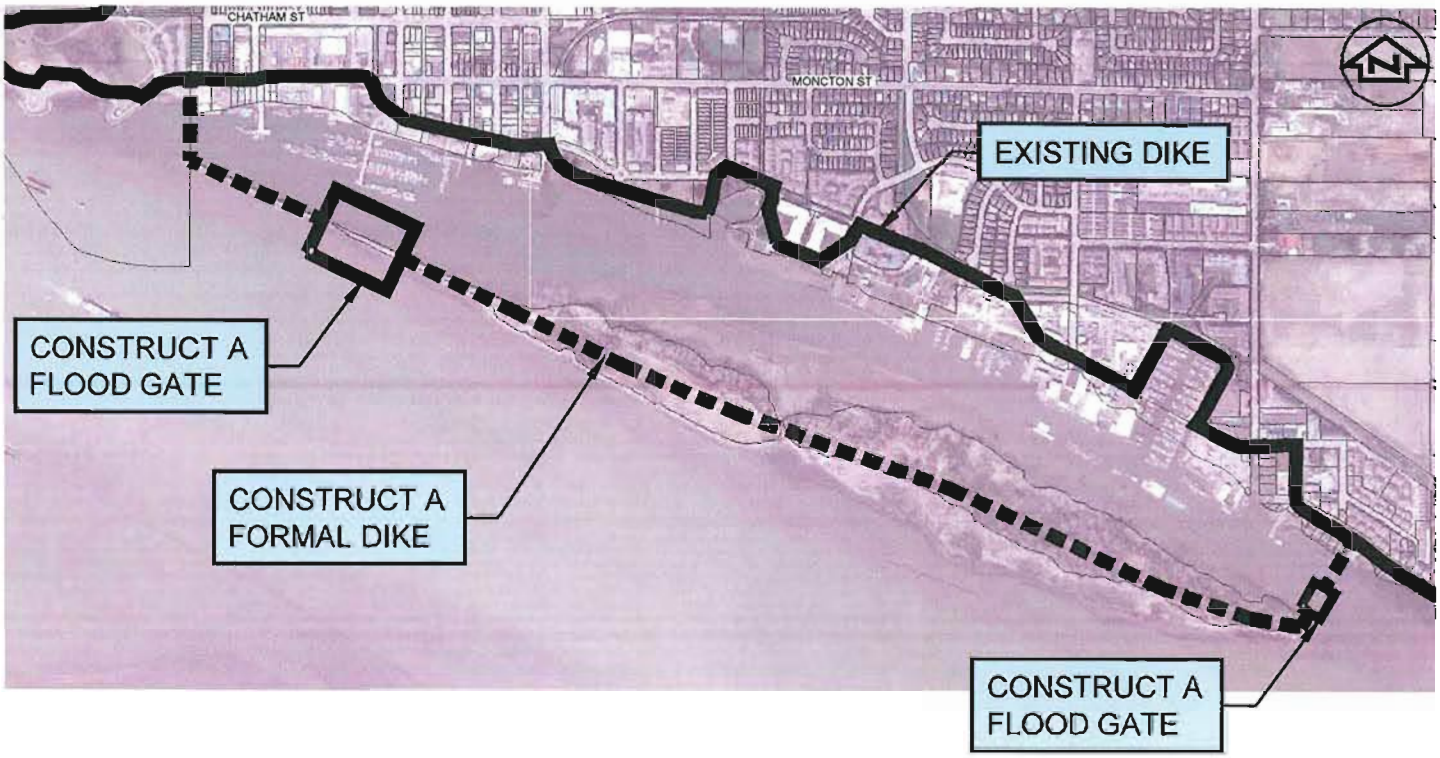

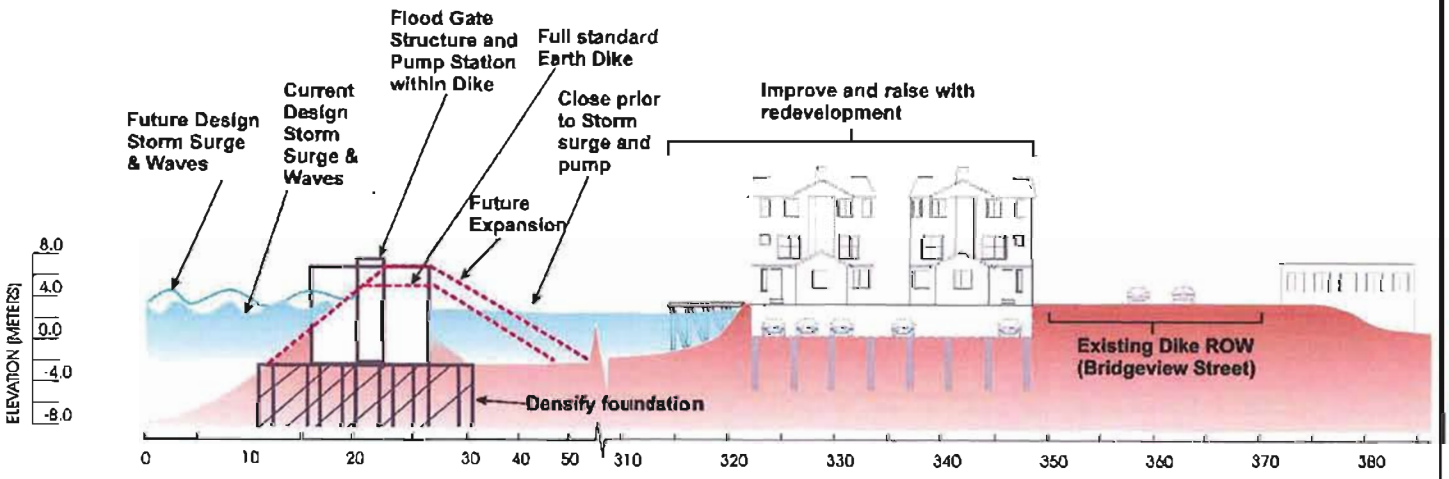

City of Richmond Dike Master Plan
Primary Alignment 2 - Steveston Island

Richmond

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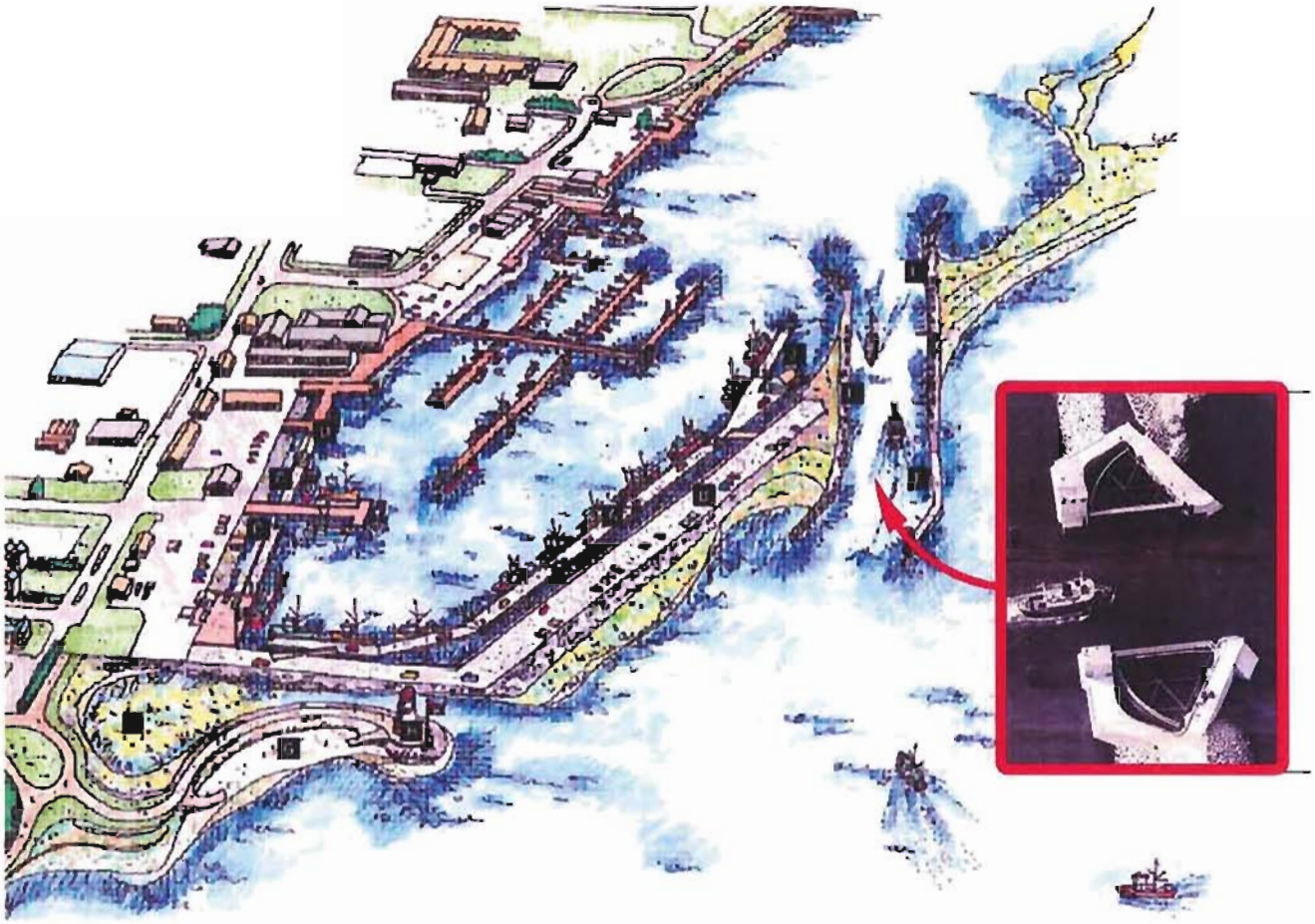

City of Richmond Dike Master Plan
Steveston Community Fishing Harbour Longterm Development Concept with Integrated Flood Protection

Richmond

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EB3763 June 2012