

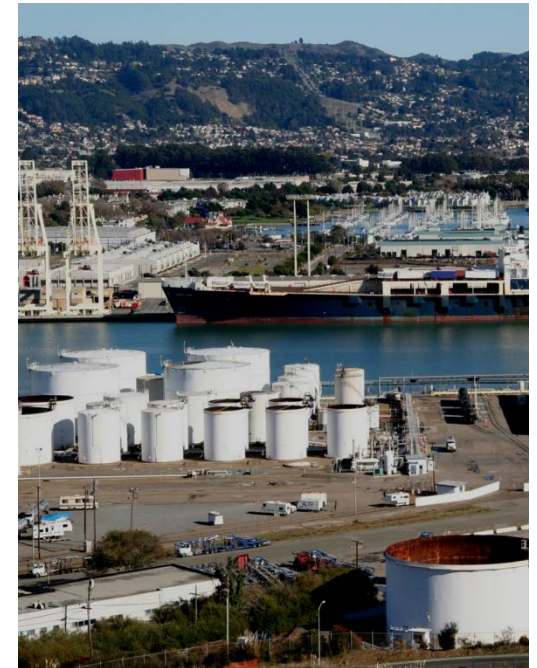
# Sea Level Rise and Shoreline Adaptation – Lessons from the Bay Area

Lina Velasco, Project Manager  
City of Richmond

AEP Conference, May 20, 2017

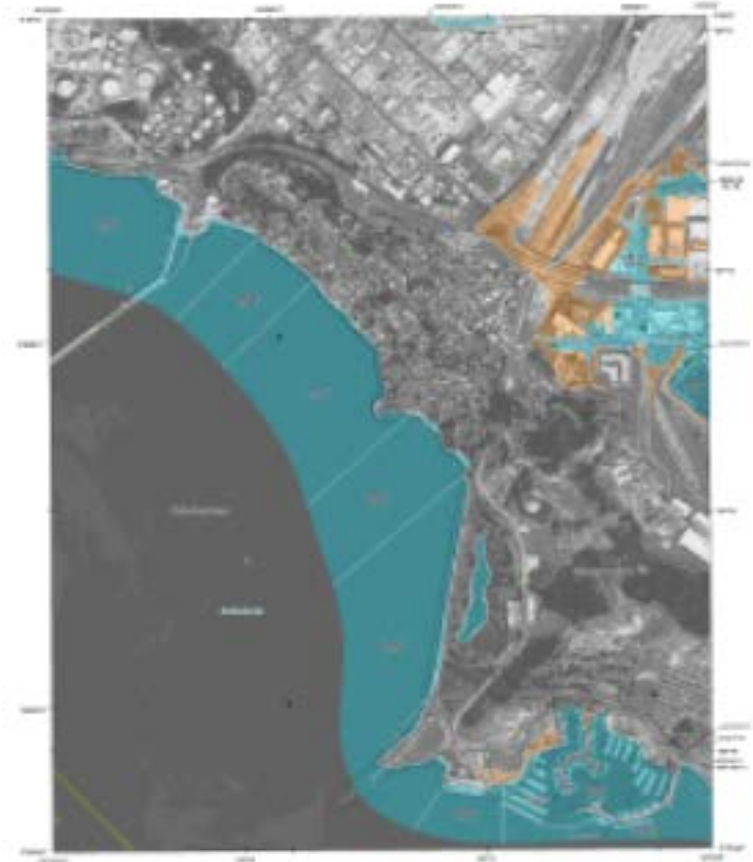


# City of Richmond, California



# Flood Hazard Mitigation Ordinance

- Richmond Municipal Code § 12.56  
Flood Damage Prevention
- Applies to new construction and substantial improvements in all areas of special flood hazards (Zone A, AO, AE, A99, AH, D, E, M, VE, V, or X)
- Requires anchoring to prevent flotation, collapse or lateral movements of structure
- Construction materials and methods shall resist and minimize flood damage
- Requires construction of lowest floor (including basement) be elevated one foot above base flood elevation (BFE) or flood proofing –varying standards for residential and non-residential uses



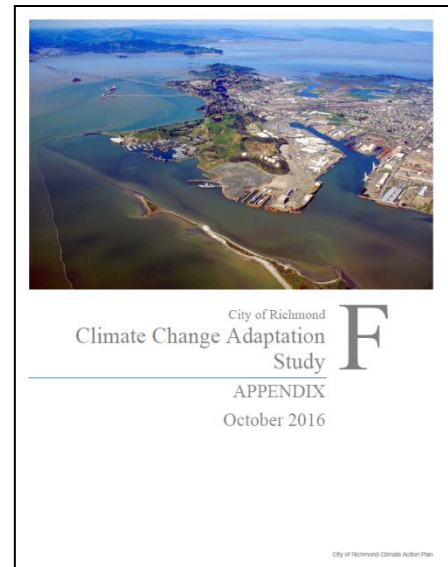
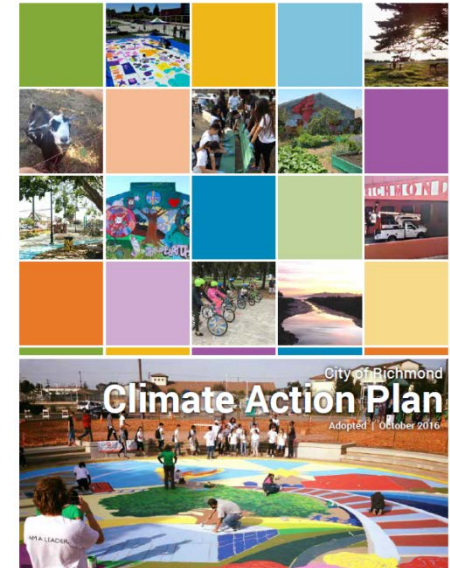
FEMA FIRM Maps, September 30, 2015

# Energy and Climate Change Element

- **Goal EC6 Climate-Resilient Communities** – “protect residents and businesses from increased risks of natural disasters such as flooding and drought.”
- **Action EC1.A Climate Action Plan** – “develop a climate action plan for reducing greenhouse gas emissions to meet or exceed state reduction targets.....Adaptation strategies will focus on potential local impacts of climate change such as sea level rise, increased risk of flooding, diminished water supplies and public health.”
- **Action EC6.2 Low-Lying Areas in Richmond** – “protect and manage low-lying areas that are likely to be affected by sea level rise and storm surges. Encourage development patterns, infrastructure and flood management practices that can adapt to potential climate change impacts in low-lying areas.”
- **EC6.3 Adapting to Climate Change** – “prepare for and adapt to future impacts of changing weather patterns and sea level fluctuations. Protect neighborhoods, infrastructure and facilities, the shoreline and natural resources from the impacts of climate change. Require new development to include an evaluation of climate change impacts in the project review process. Shoreline and public access improvements shall be designed to allow future increased in elevation along the shoreline edge to keep up with higher sea level values when they occur. Design elements shall include providing adequate setbacks to allow for future elevation increases of at least 3 feet from existing elevations along the shoreline.”
- **EC6.G Adaptive Management Plan** – “Develop an Adaptation Strategy that would include preparing an Adaptive Management plan that outlines an institutional framework, monitoring triggers, and a decision-making process, and creates an entity with taxing authority that would pay for infrastructure improvements necessary to adapt to higher than anticipated levels.”

# Climate Action Plan

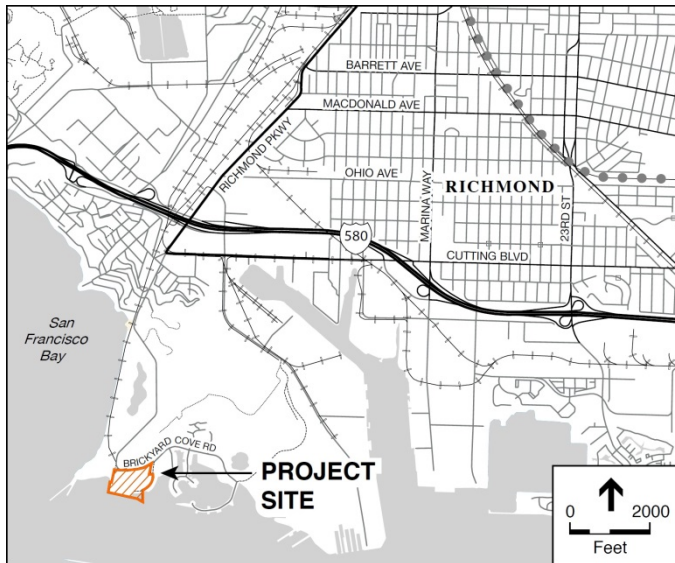
- Includes a Climate Change Adaptation Study as an appendix.
- Adaptation Study assesses vulnerabilities for 11 categories of community assets including water supply, stormwater, and shoreline flood management.
- Study found that some of the City's most critical assets are located in close proximity to low-lying shoreline where risk of damage or disruption from sea level rise is significant.
- Critical assets includes wastewater treatment facilities, stormwater management infrastructure, residential neighborhoods, historical landmarks, the Chevron Refinery and other industrial areas including Port of Richmond , highways, rail lines, emergency response facilities, and parks.



# Local Hazard Mitigation Plan (LHMP)

- City is an annex to Contra Costa County LHMP
- Currently being updated to include climate change risks including sea level rise and increased flooding risk
- SB379 requires LHMP or safety element to be reviewed and updated as necessary to address climate adaptation and resiliency strategies
- Safety Element Update to align with LHMP
- LHMP anticipated to be adopted by Fall 2017

# Terminal One Project - Site Location



# Terminal One Sea Level Rise

## Sea Level Definitions:

**BFE - Base Flood Elevation:** The computed elevation to which floodwater is anticipated to rise during the base flood. Base Flood Elevations (BFEs) are shown on Flood Insurance Rate Maps (FIRMs) and on the flood profiles.<sup>1</sup>

**MHHW - Mean High High Water:** The average height of the higher high waters over a 19-year period. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value.<sup>2</sup>

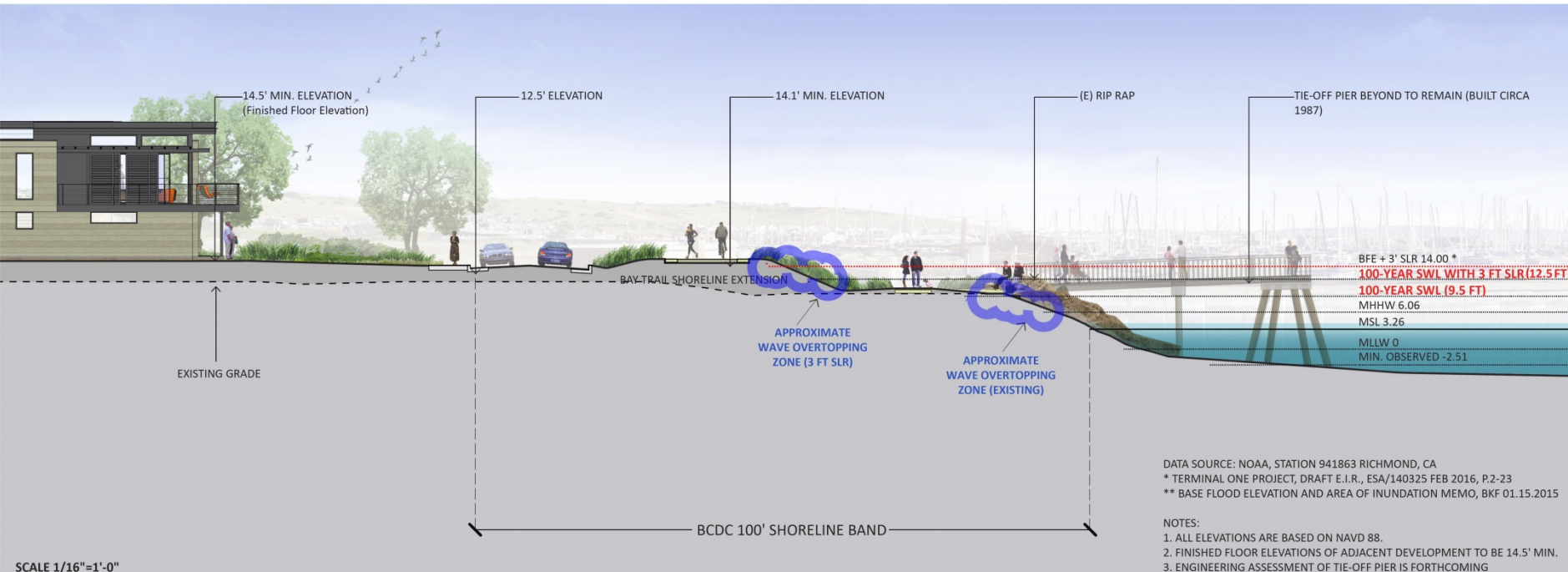
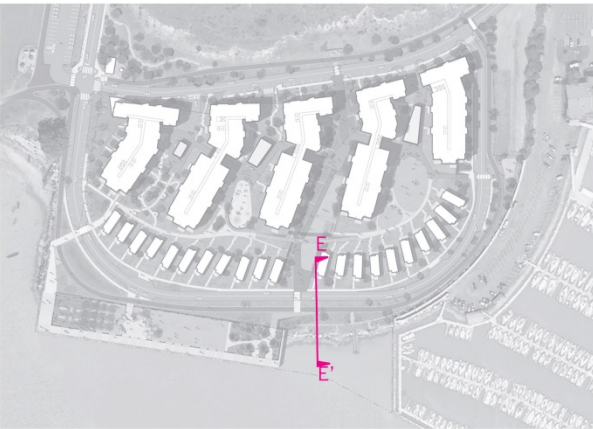
**MSL - Mean Sea Level:** The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.<sup>2</sup>

**MLLW - Mean Low Low Water:** The average height of the lower low waters over a 19-year period. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value. Frequently abbreviated to Lower Low Water.<sup>2</sup>

**SWL - Still Water Level:** The flood level not including the effects of waves (wave amplitude and setup) or tsunamis, but including storm surge and astronomic tide.<sup>2</sup>

<sup>1</sup>Definition provided by FEMA <http://www.fema.gov/base-flood-elevation>

<sup>2</sup>Definition provided by NOAA <http://shoreline.noaa.gov/glossary.html>



## SECTION E-E': SHORELINE DRIVE

TERMINAL ONE/PLANNED AREA DISTRICT/MASTER PLAN  
JUNE 2016

# Mitigation Measures For Sea Level Rise

**PROJECT DESIGN FEATURE HYD-2: Sea Level Rise Measures.** The applicant will ensure that the project design includes the following measures to address sea level rise of up to 3 feet:

1. Placement of finished floor elevations of residential structures above 14.5 feet NAVD88, an elevation greater than the current site BFE, or 11 feet NAVD88, plus 3 feet of sea level rise and a 0.5 feet additional margin; and
2. The installation of appropriate stormwater inlet infrastructure, and/or the installation of back flow prevention devices on storm drain lines (and/or the design of the stormwater infrastructure to accommodate the future installation of back flow prevention devices on an as-needed basis).
3. Placement of the finished elevation of the Bay Trail Loop at or above 14.1 feet NAVD88, an elevation greater than the current site BFE (11 feet NAVD88) plus 3 feet of sea level rise;

If feasible, design of the Bay Trail Loop to function as a flood mitigation embankment either as initially constructed or as retrofitted on an as needed basis. Because the project site's shoreline is a VE zone, indicating it is currently susceptible to wave overtopping, the Bay Trail Loop embankment may be subject to wave runup and overtopping. These processes shall be considered when setting the Bay Trail Loop's final design and evaluating its flood mitigation performance.

# Mitigation Measures for Sea Level Rise

## **PROJECT DESIGN FEATURE HYD-3: Sea Level Rise Adaptation**

**Strategies:** The applicant shall include provisions in the project's Covenants, Conditions, and Restrictions that require the Homeowner's Association to engage a degreed coastal geomorphologist, a licensed engineer, or a comparably qualified expert in the management of flood risks associated with sea level rise to prepare an Adaptive Flood Risk Management Plan. The initial adaptive management plan shall be completed and submitted to the City for review and comment by January 1, 2035. The plan shall be updated every ten years, with the first plan update to be completed and submitted to the City for review and comment by January 1, 2045 and with subsequent updates to be completed and submitted to the City on January 1 every ten years thereafter.

The Adaptive Flood Risk Management Plan shall include:

1. A Monitoring and Reporting Program
2. An Adaptive Flood Risk Management Strategy
3. A Financing Plan

[actual mitigation measure includes more text]

# Richmond Bay Specific Plan Area

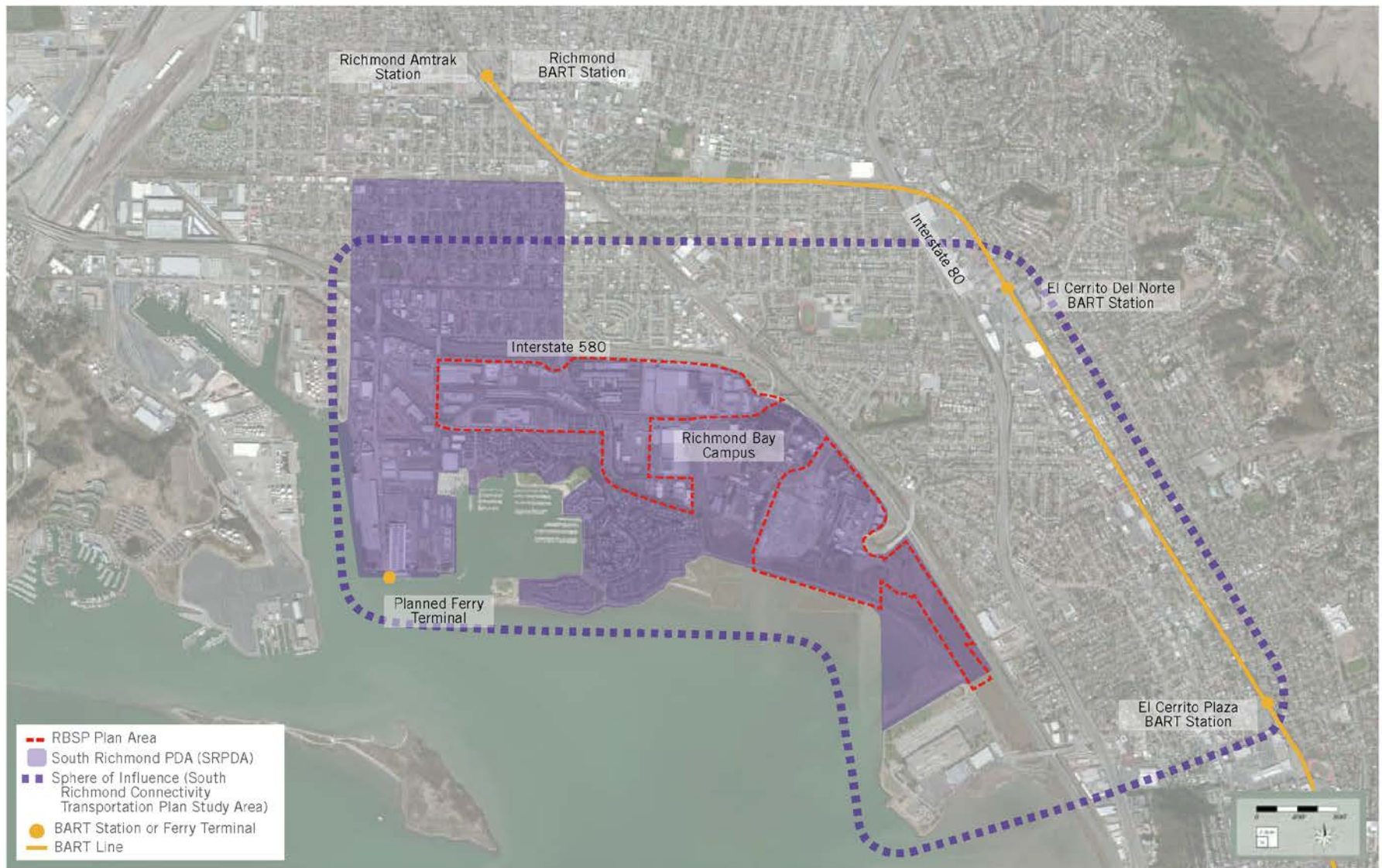
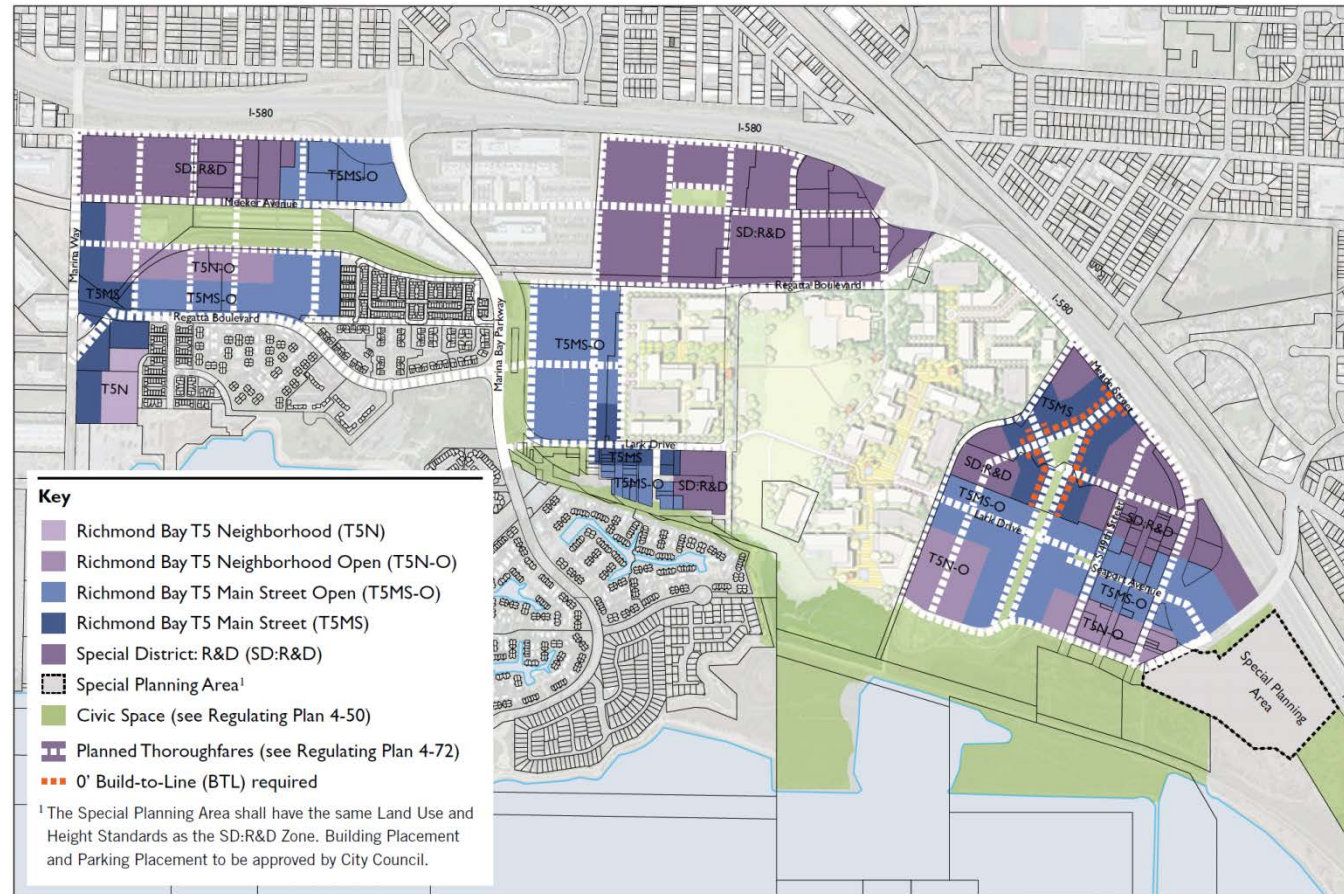


Figure 1.2: Richmond Bay Specific Plan Area in the context of the South Richmond Priority Development Area

# Richmond Bay Specific Plan: Transect Zone Regulating Plan

- Plan includes four distinct Sub-Areas
- Mixed use allowed in five different types of zones
- Flooding and sea level rise evaluated on program-level and project-level



City of Richmond, 2016 (prepared by Opticos Design, Inc.)

# Richmond Bay Specific Plan EIR: 3-foot Sea Level Rise + MHHW + 100 Year Storm Event

- Extent of 3 ft SLR inundation (**General Plan policy EC6.3**)
- Overtopping (wave action) also mapped
- With addition of 100-year flood effects, substantial parts of Sub-Areas 1 and 2 affected, as well as parts of Sub-Area 4

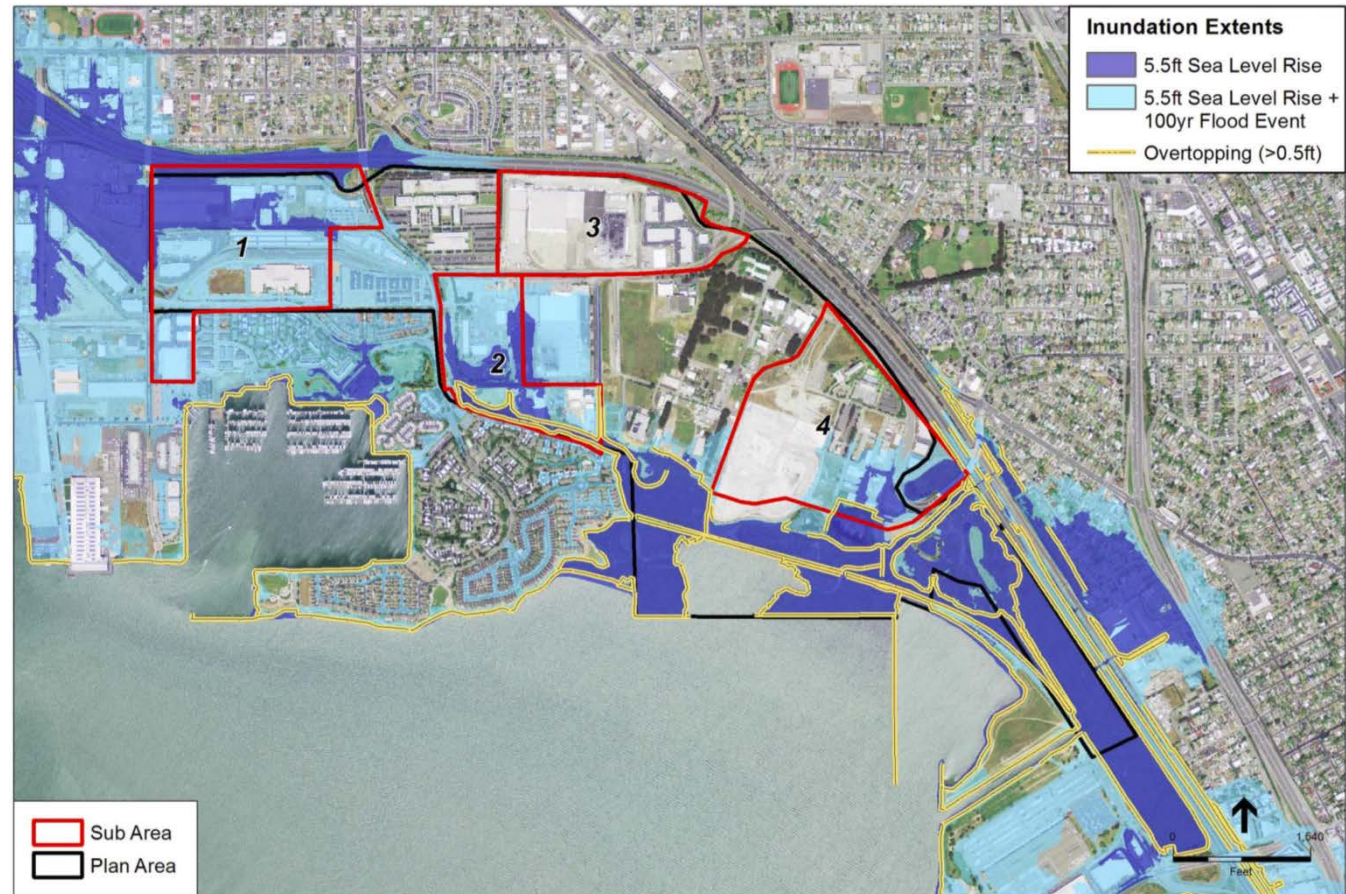


City of Richmond, 2016 (prepared by ESA/BCDC ART Project)

# Richmond Bay Specific Plan EIR:

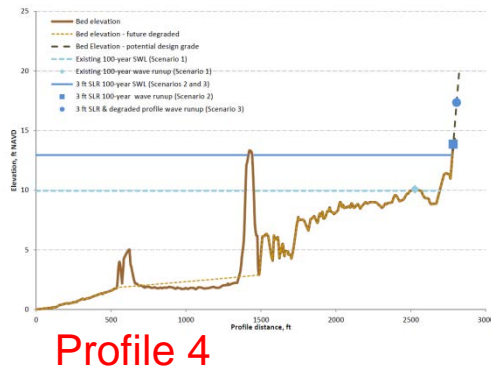
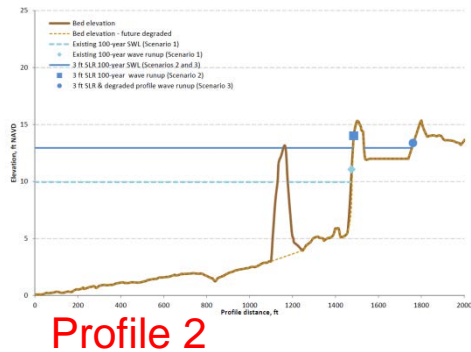
## 5.5-foot Sea Level Rise + MHHW + 100 Year Storm Event

- Extent of 5.5 ft SLR inundation (**General Plan policy EC6.3, EC6.G, also BCDC CC Policy 2, CC Policy 3**)
- 5.5 feet = High end of 2100 estimate (OPC, 2013)
- Larger areas shown to be affected



City of Richmond, 2016 (prepared by ESA/BCDC ART Project)

# Richmond Bay Specific Plan EIR: Sea Level Rise Impacts for Sub-Area 4 Project



*City of Richmond, 2016 (prepared by ESA)*

Additional analysis prepared for Sub-Area 4 Project site = Preliminary coastal flooding assessment (four profiles across Project site, three coastal flooding scenarios)

# Richmond Bay Specific Plan EIR:

## Plan Measures and Mitigation for Sea Level Rise

- Specific Plan:

- Sea Level Rise Action Plan required
- Projects within Plan Area will be developed at least 1 foot above BFE at 3 feet of SLR (consistent with **GP Policy EC6.3**)
- Recommendations to increase elevation of Shoreline Promenade and shoreline road
- Assumption: Bay Trail embankment and marsh remain intact



- Mitigation:

- **3 Feet SLR: Sea Level Rise Measures (Stormwater).** Installation of stormwater inlet infrastructure and/or back flow prevention devices, and/or design of stormwater infrastructure to accommodate future installation. Include capacity to adapt to up to 5.5 feet of sea level rise.
- **5.5 Feet SLR: Sea Level Rise Adaptation (Adaptive Flood Risk Management Plans).** All projects must prepare an Adaptive Flood Risk Management Plan consistent with City policies (**GP Policies EC6.3, EC6.G**) and Specific Plan policies. Adaptive strategies may include development setbacks, regrading, construction of raised berms or a wall, or other measure, and shall include discussion of financing mechanisms.

# Recommendations

- Specify requirements for sea level rise analyses in policy document(s)
- Consider adaptation measures that include monitoring, identification of adaptation measures and identification of funding source

# Thank you!

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