

Port of San Francisco

# RESILIENCY

## Sea Level Rise

Waterfront Plan Update  
March 23, 2016



# STORMS



# DEFINITIONS

## Base Flood Elevation (BFE)

A 1% chance flood in a given year ("100 Year Flood"), accounts for tides, storm surge, wind waves & precipitation

## King Tide

A very high tide when Earth, Moon and Sun align, several times annually

## Mean Higher High Water (MHHW)

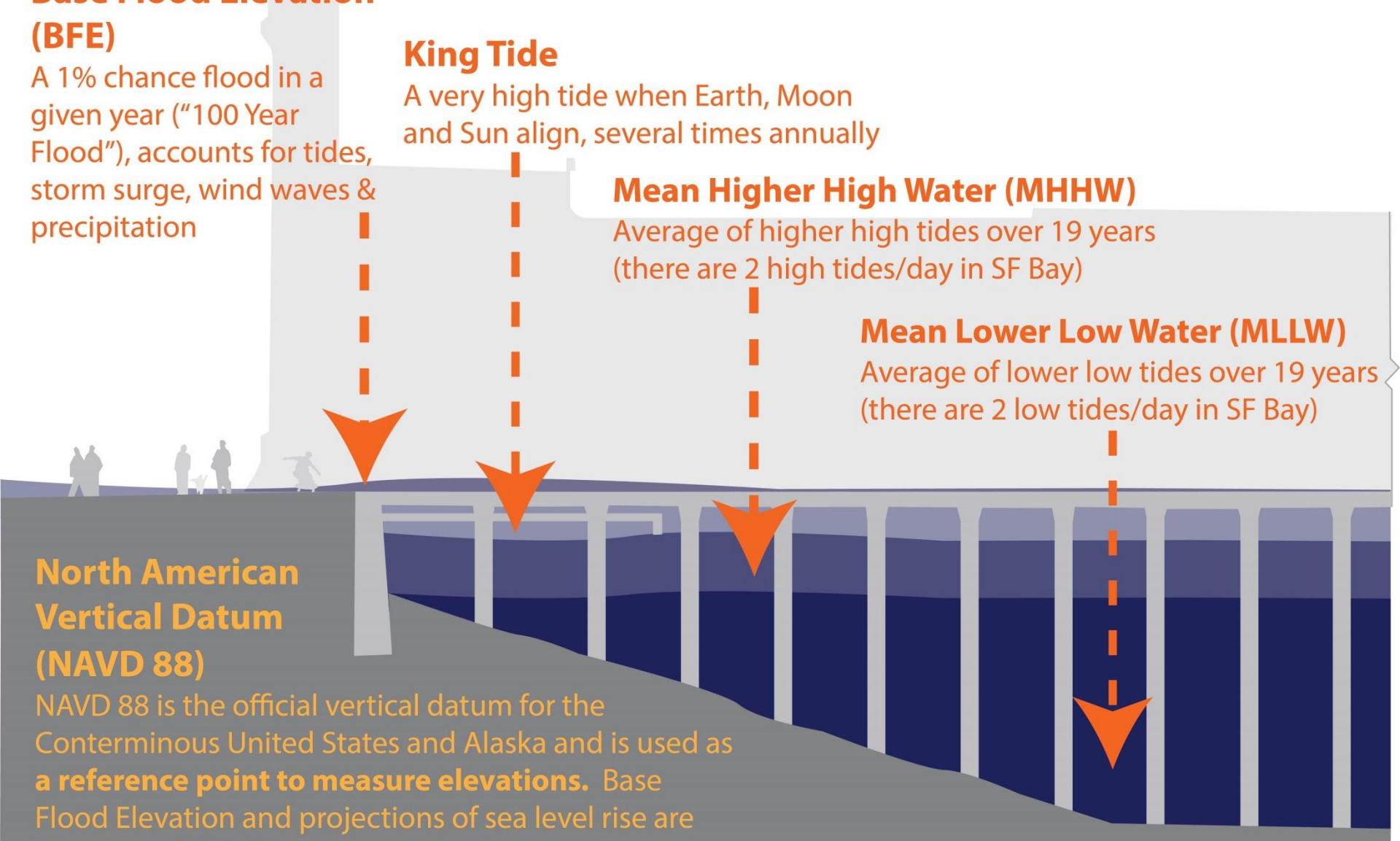
Average of higher high tides over 19 years (there are 2 high tides/day in SF Bay)

## Mean Lower Low Water (MLLW)

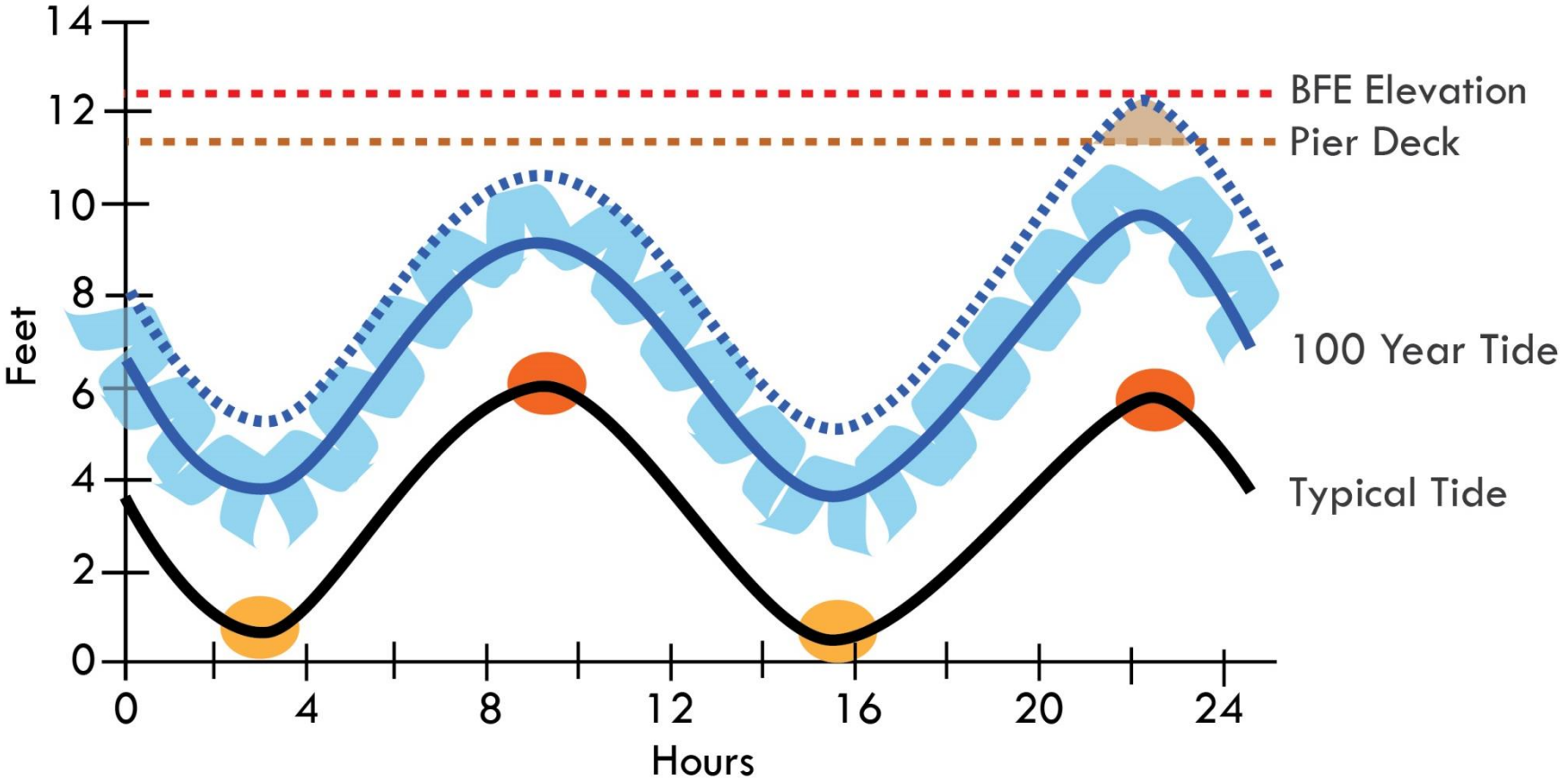
Average of lower low tides over 19 years (there are 2 low tides/day in SF Bay)

## North American Vertical Datum (NAVD 88)

NAVD 88 is the official vertical datum for the Conterminous United States and Alaska and is used as **a reference point to measure elevations.** Base Flood Elevation and projections of sea level rise are based on NAVD 88.



# WATER LEVELS



- 100 Year Tide with waves
- Low Tide 2/day
- BFE wave overtopping exposure
- High Tide 2/day

# FEMA FLOOD RISK ZONES

Islais Creek

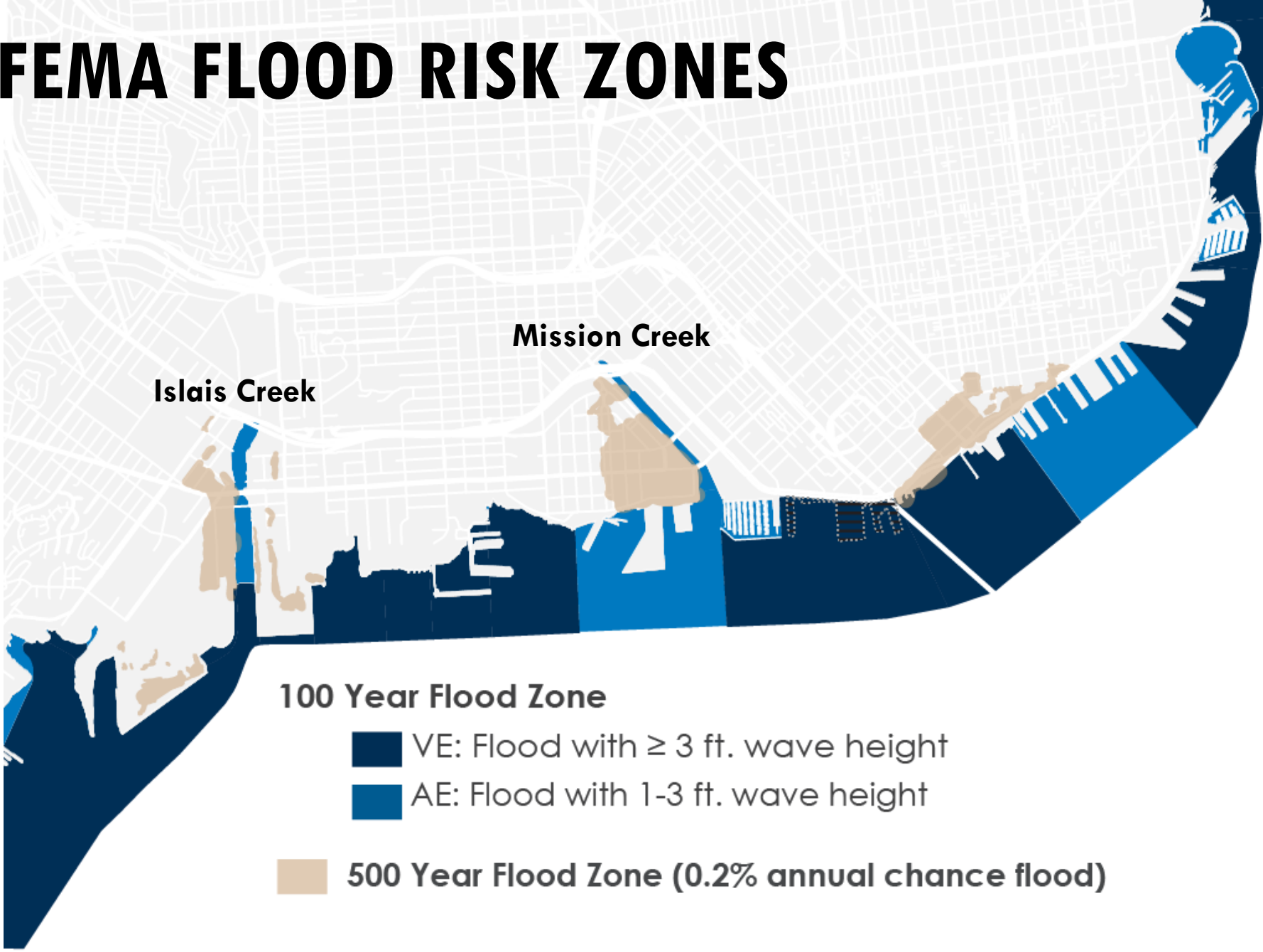
Mission Creek

## 100 Year Flood Zone

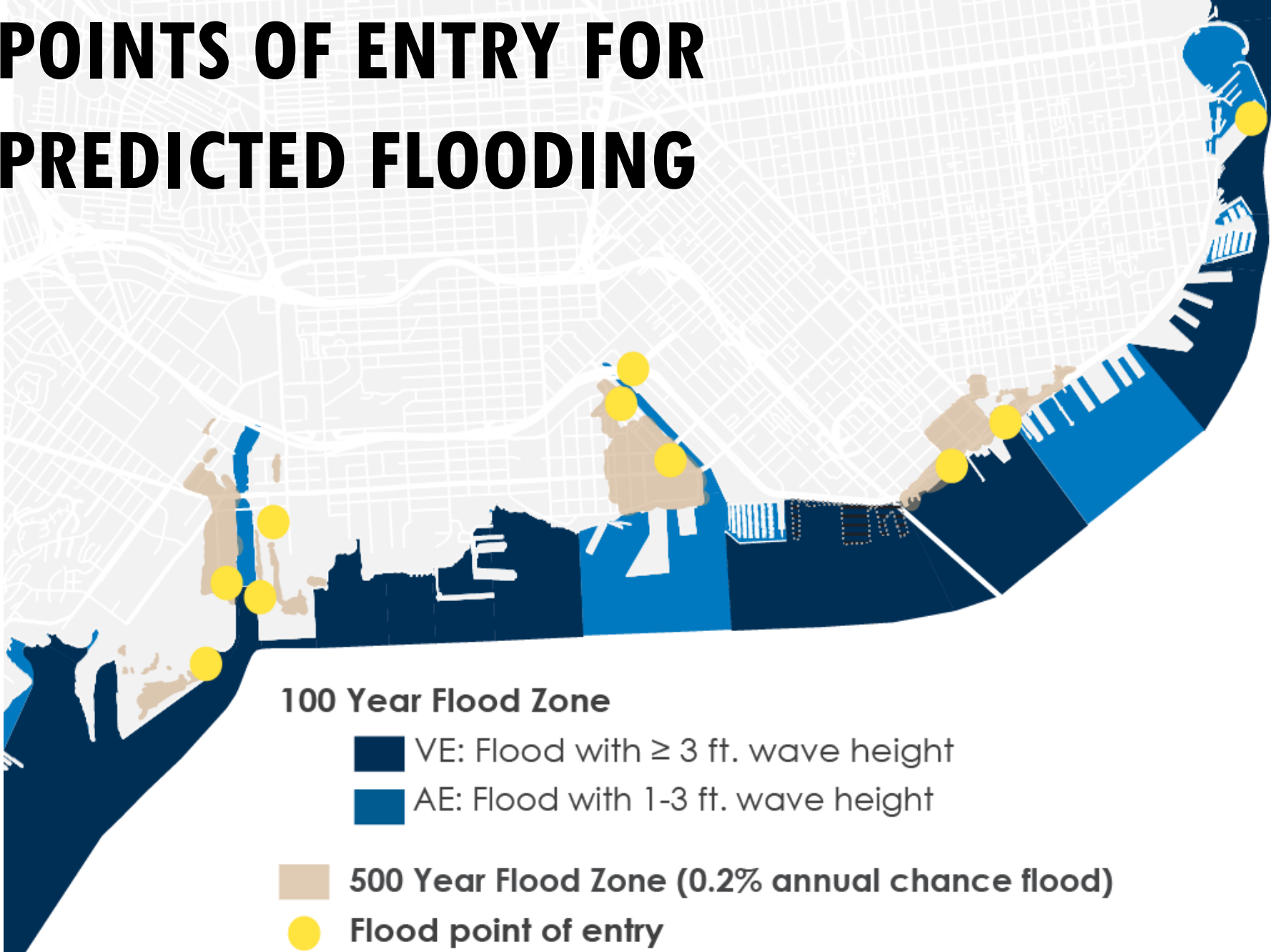
■ VE: Flood with  $\geq 3$  ft. wave height

■ AE: Flood with 1-3 ft. wave height

■ 500 Year Flood Zone (0.2% annual chance flood)



# POINTS OF ENTRY FOR PREDICTED FLOODING



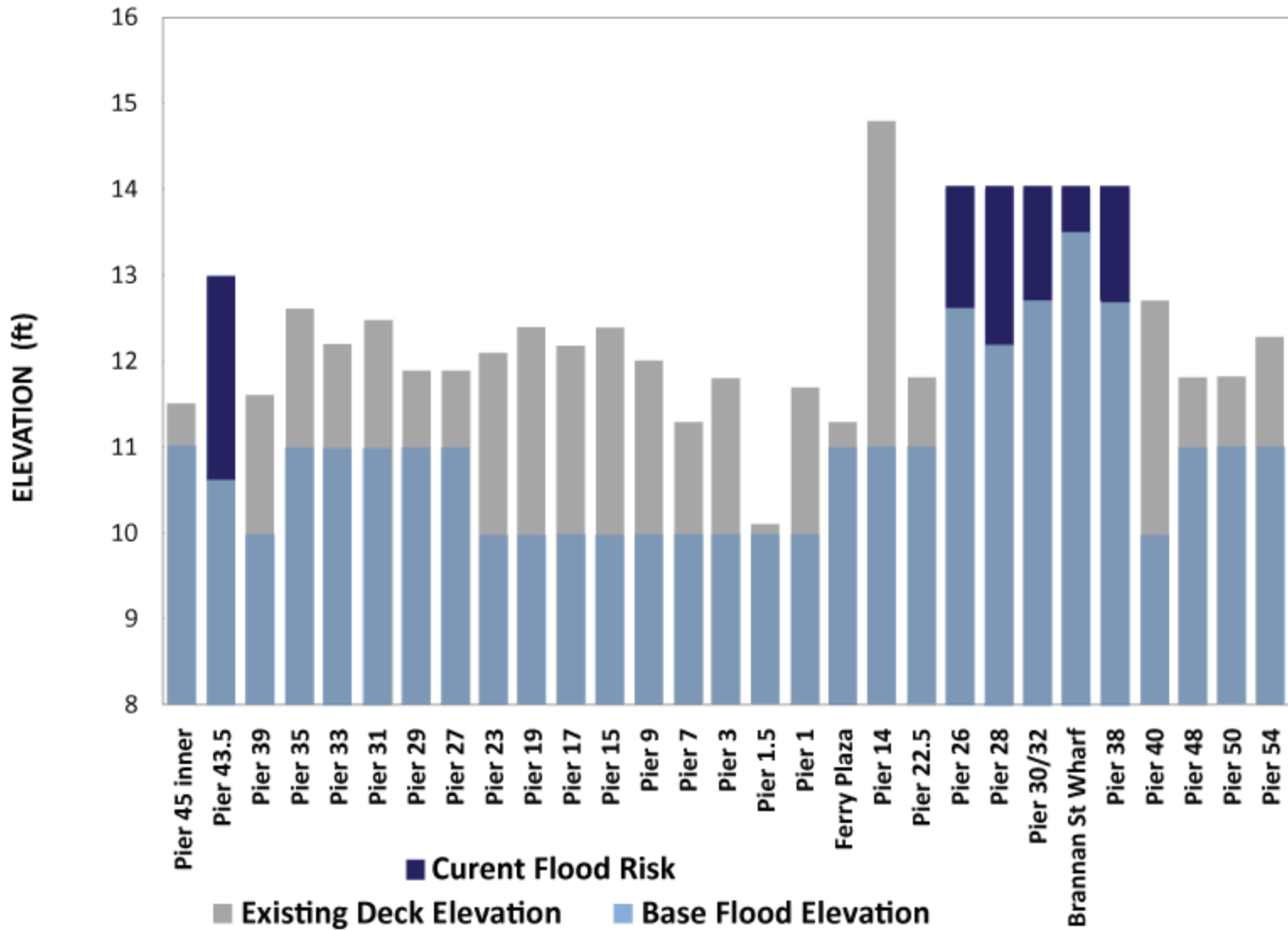
## 100 Year Flood Zone

- VE: Flood with  $\geq 3$  ft. wave height
- AE: Flood with 1-3 ft. wave height

■ 500 Year Flood Zone (0.2% annual chance flood)

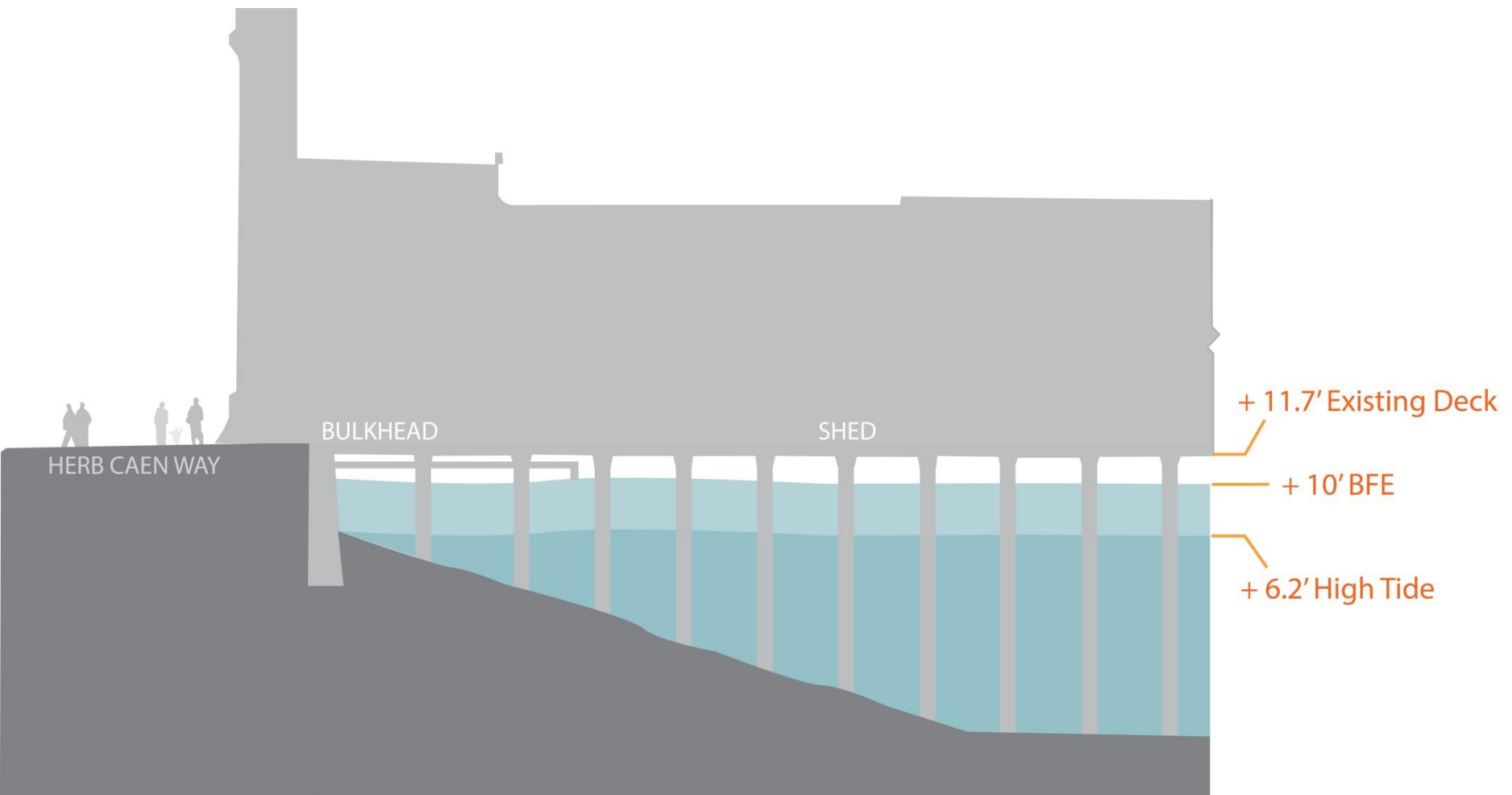
● Flood point of entry

# PIER ELEVATION VS. BASE FLOOD ELEVATION (BFE)



# PIER 1

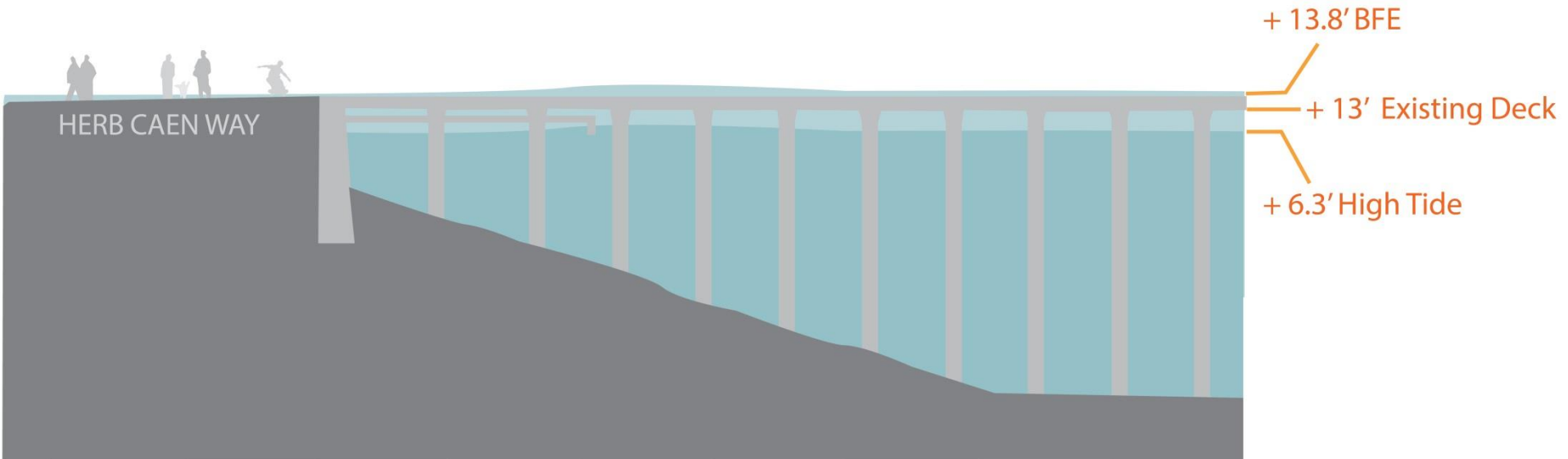
## 1.7' ABOVE BASE FLOOD ELEVATION





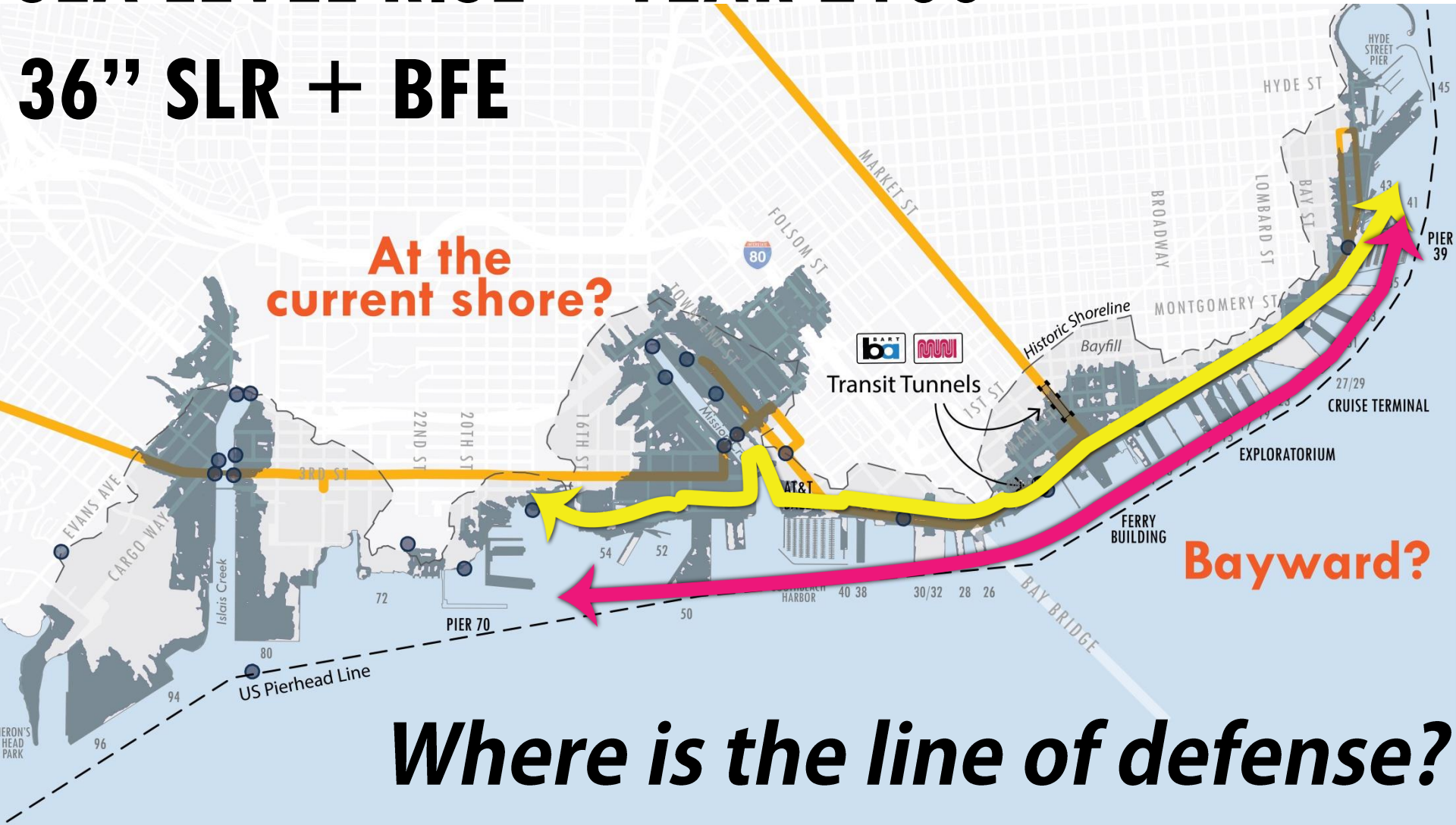
# PIERS 30-32

## 0.8' BELOW BASE FLOOD ELEVATION



# SEA LEVEL RISE – YEAR 2100

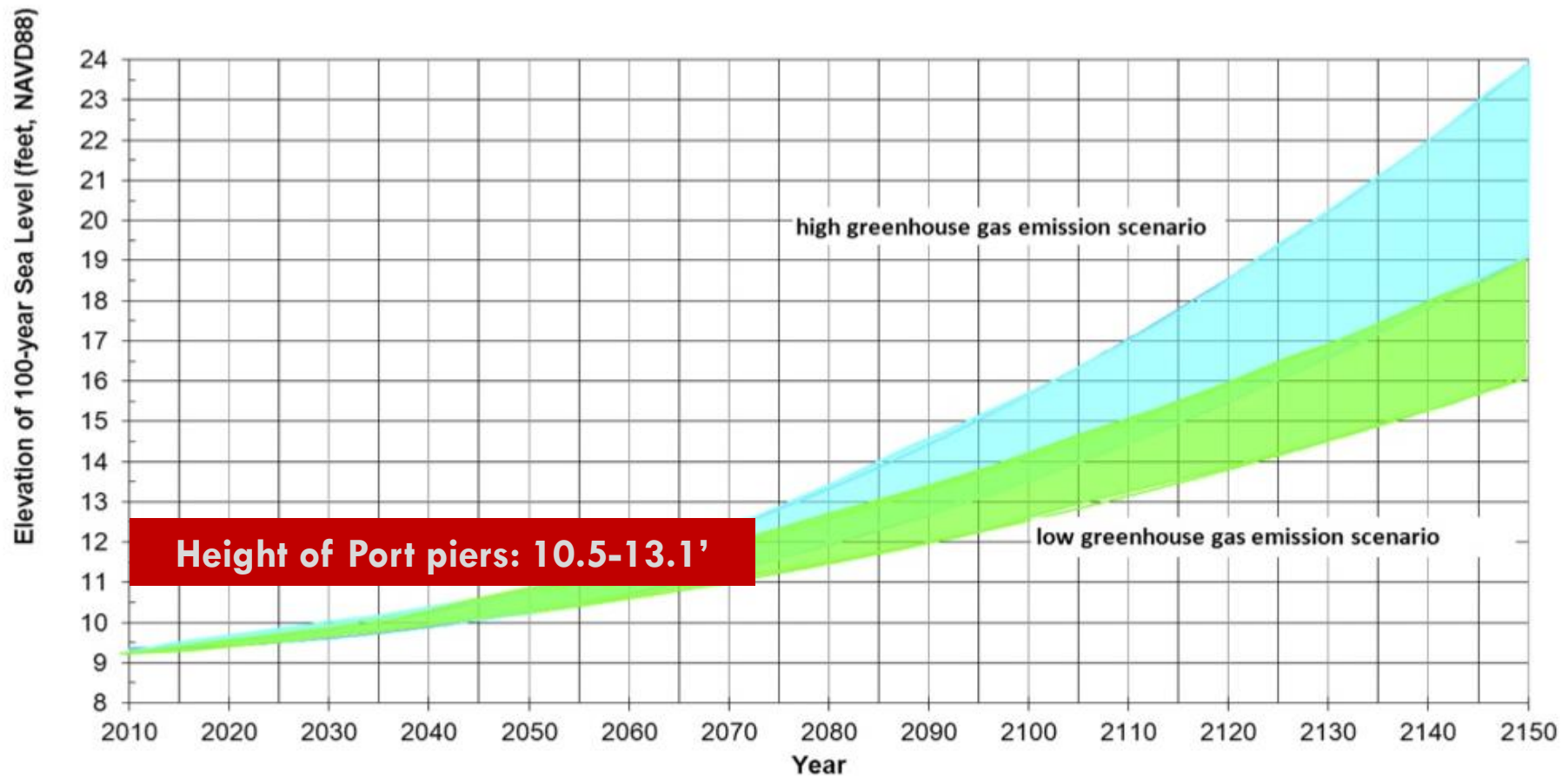
## 36" SLR + BFE



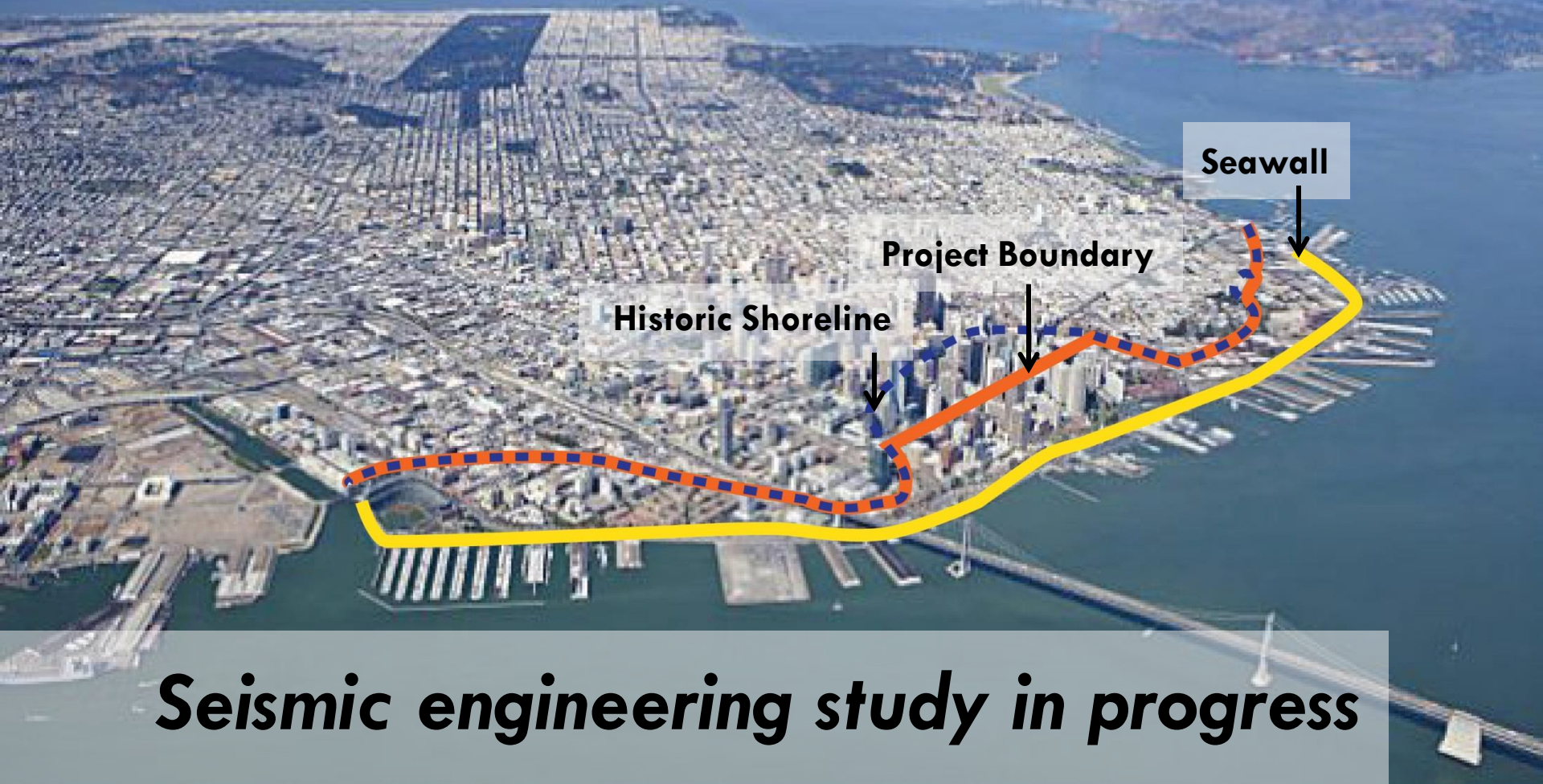
- Combined Storm/ Sewer Outfall
- Transit Infrastructure

# PORT COASTAL ENGINEERING ANALYSIS

## URS STUDY (2012)



# NORTHERN WATERFRONT SEAWALL PROJECT



*Seismic engineering study in progress*

# BRANNAN STREET WHARF



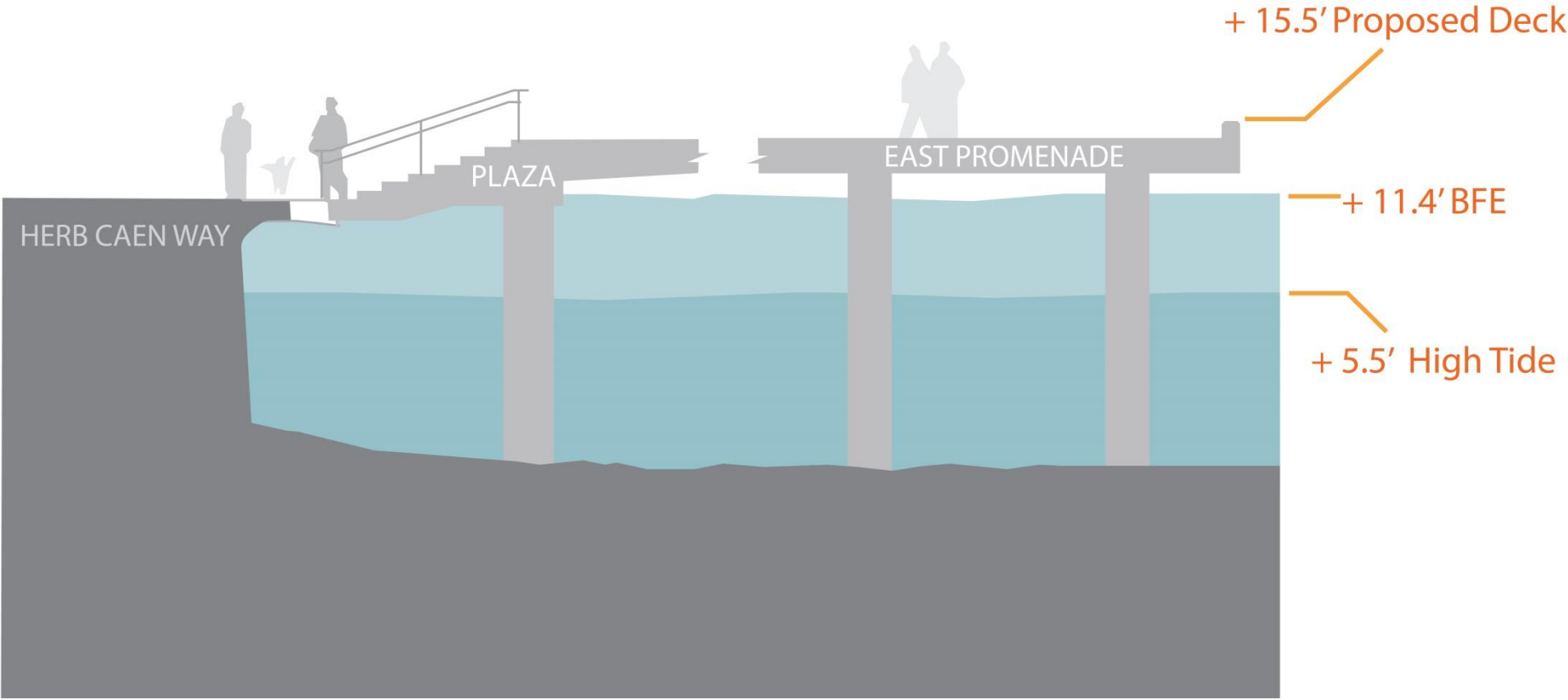
*Adapted to 16" of SLR*

# **DOWNTOWN FERRY TERMINAL SOUTH BASIN EXPANSION PROJECT**



***Redesigned waterfront to endure SLR  
to 2065, adaptive through 2100***

# DOWNTOWN FERRY TERMINAL SOUTH BASIN EXPANSION PROJECT



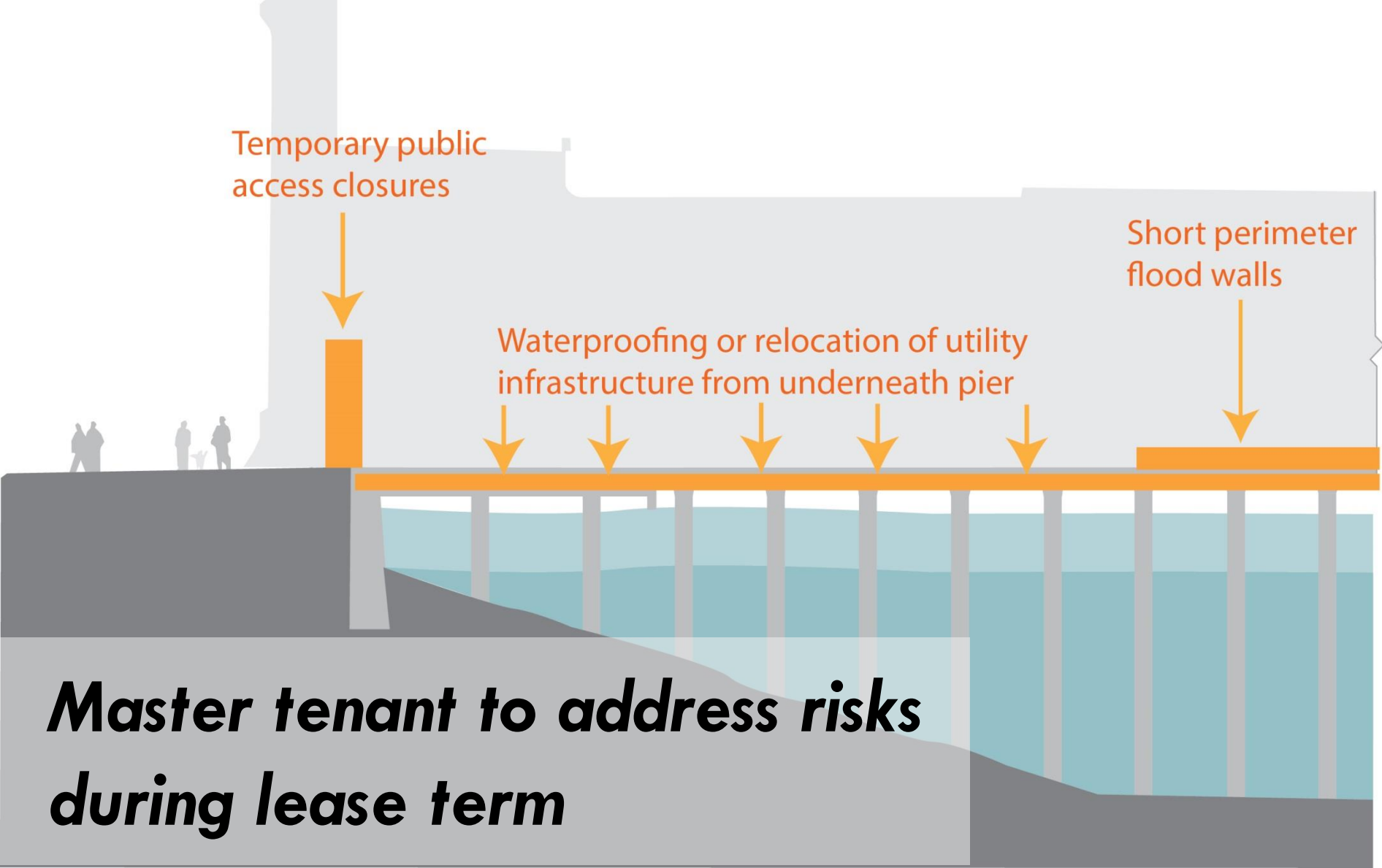
# BAYFRONT SHORELINE RESTORATION



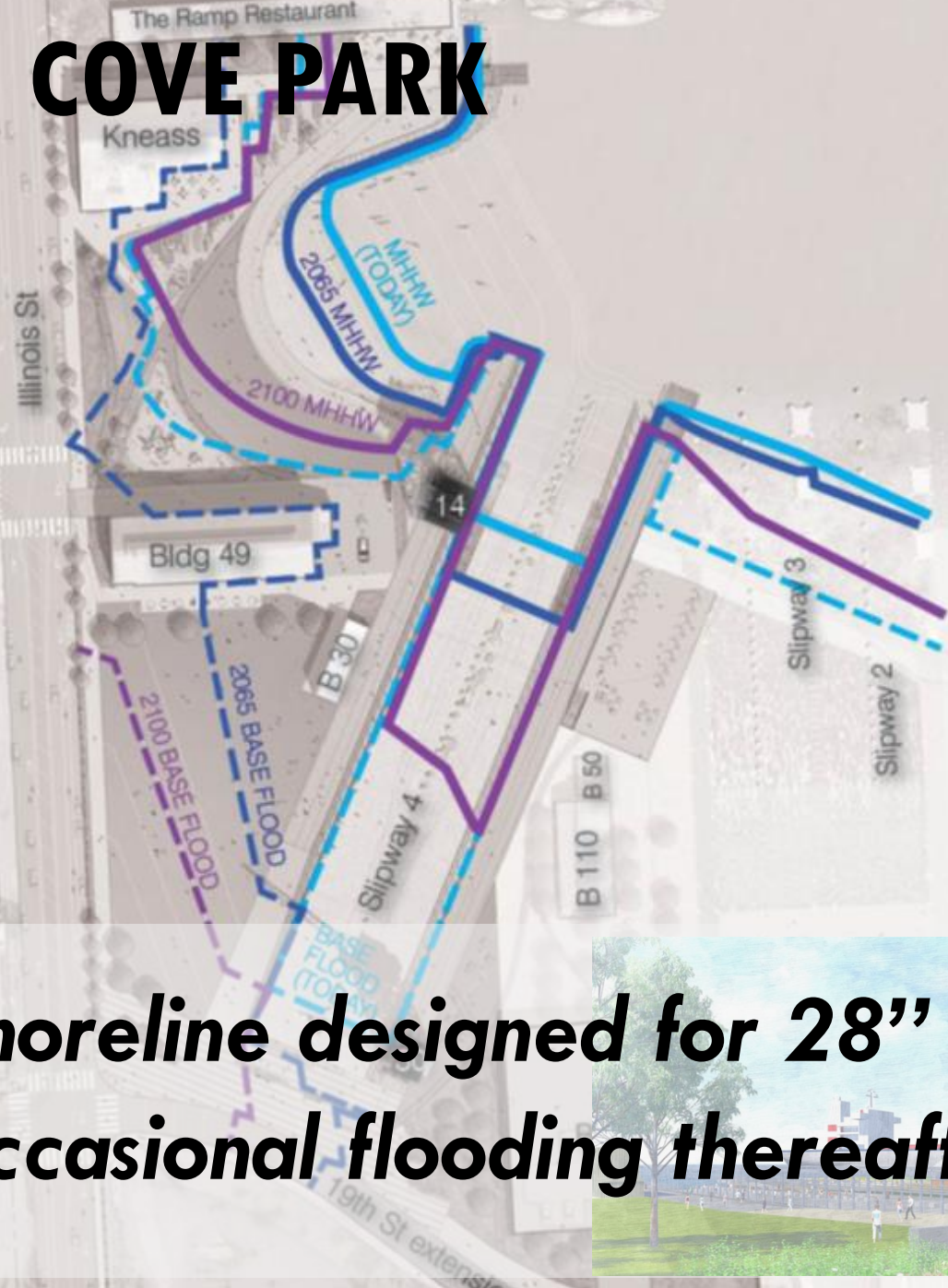
***Rip rap adaptable to 16" SLR***



# PIER 1 FLOOD PROTECTION MEASURES



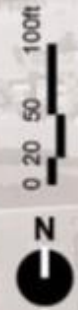
# CRANE COVE PARK



- MHHW (-4.52 FT)
- Base Flood (0.99 FT)
- 2065 MHHW (-2.61 FT)
- 2065 Base Flood (+2.90 FT)
- 2100 MHHW (-0.34 FT)
- 2100 Base Flood (+5.17 FT)

Elevations shown based on San Francisco City Datum.  
Based on Sea Level Rise projections of 16" at 2050 and 55" at 2100 (from 2000 level). Elevations today are 2015.

*Shoreline designed for 28" SLR with occasional flooding thereafter*

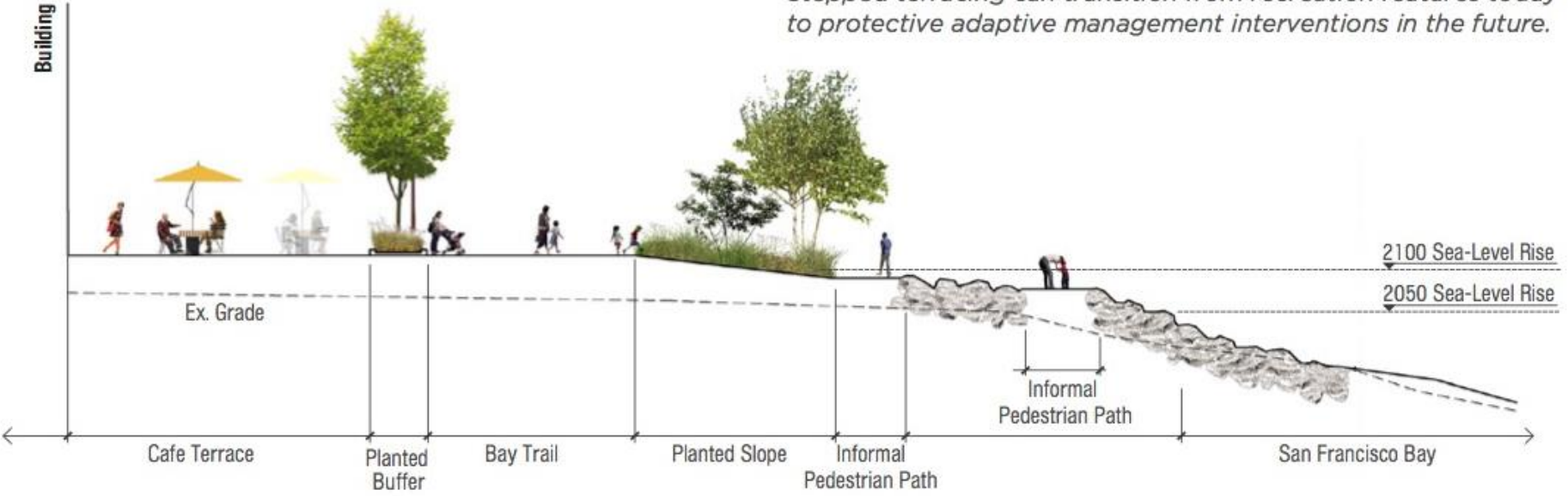


# PIER 70 FOREST CITY

## Pier 70 Special Use District (SUD)



*Stepped terracing can transition from recreation features today to protective adaptive management interventions in the future.*



# SWL 337 MISSION ROCK



*Elevation raised up to 4.5'*

# SEA LEVEL RISE ADAPTATIONS

2016

2050

2100

## Interim Pier Flood Management

- Relocate utilities to topside
- Solid edge railings around piers
- Temporary flood barriers at doorways

PORT

## Long Term Shoreline Adaptation

- Citywide Adaptation Plan
- Funding needed
- Regional policy and funding collaboration

CITY

# SUMMARY

- **FEMA indicates current flood risk for some Port piers, Agriculture Building, Mission Creek and Islais Creek.** The duration of flood risk today is limited and can be managed during the next few decades, but will grow with sea level rise.
- **Like Port piers, City facilities (e.g. MUNI tunnels, wastewater outfalls) may be affected by Sea Level Rise after approximately 11-inches of SLR rise from today** – expected in 2050, but could occur in worst case scenarios by 2030.
- **City Planning and Public Works are leading efforts towards a Citywide Sea Level Rise Adaptation Plan,** with Port participation and active community engagement.
- **The Port has incorporated projected sea level rise into planning and projects since 2009.** The City formalized this requirement for capital project planning in 2014.
- **Port will continue regional coordination, including BCDC,** to identify solutions and will monitor storm events, water levels and evolving SLR projections.

# **SAN FRANCISCO SEA LEVEL RISE ACTION PLAN**

**Port of San Francisco  
March 22<sup>nd</sup>, 2016**



# MAYOR EDWIN M. LEE

## SLR COORDINATING COMMITTEE

**Co-Chair: Fuad Sweiss, San Francisco Public Works Department**

**Co-Chair: Gil Kelley, San Francisco Planning Department**

City Administrator's Office  
San Francisco International Airport  
San Francisco Public Utilities Commission  
San Francisco Municipal Transportation Agency  
Office of Economic and Workforce Development  
Port of San Francisco  
Office of Community Investment and Infrastructure  
Department of Building Inspection  
Capital Planning



# SAN FRANCISCO SLR PROJECTIONS

Year	Most Likely Projection (CEQA/Project Approvals*)	Upper Range (Long-range Planning*)
2030	6 in	12 in
2050	11 in	24 in
2100	36 in	66 in

*Reference: Sea level rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future (NRC 2012)*

*\*Note: the City uses the National Research Council's (NRC) most likely SLR projection of 36" for ongoing planning and development purposes related to environmental review and project approvals. This Action Plan considers adaptive strategies to address the NRC's upper end estimate of 66" of SLR by 2100 in the event that future GHG emissions and land ice melting accelerates beyond current predictions.*

**\*With Storm Surge + King Tides: add ~ 40" (108" in 2100)**



# SLR Vulnerability Zone

*(Note: blue line marks end of century, upper range projection with no action)*



## Legend

Sea Level Rise Vulnerability Zone



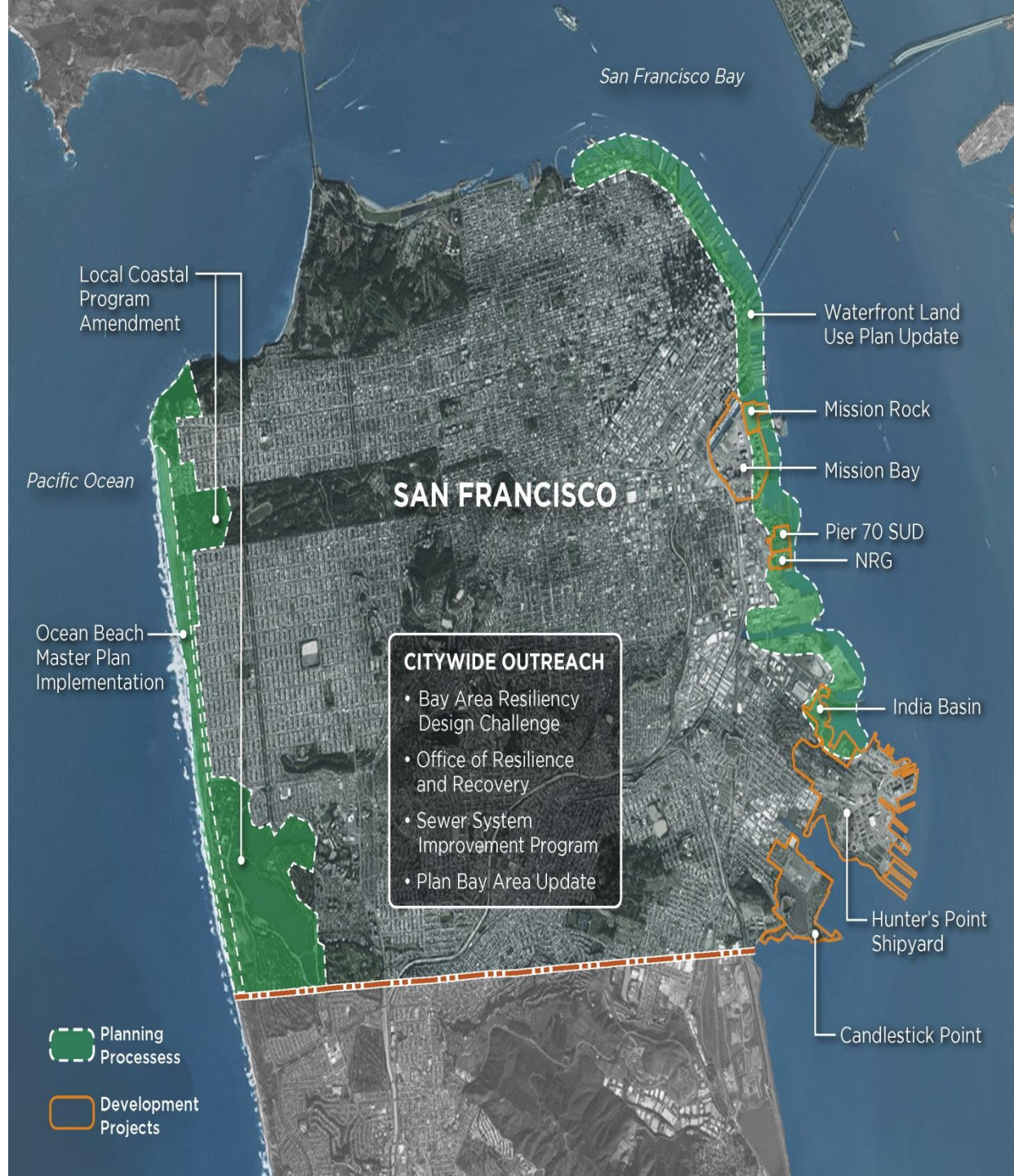
# COST OF INACTION

	Private Property	Public Property	Total Exposure
<b>66''</b> (Year 2100)	<b>\$19 Billion</b>	<b>\$35 Billion</b>	<b>\$54 Billion</b>
<b>108''</b> (Year 2100 w/storm surge)	<b>\$38 Billion</b>	<b>\$37 Billion</b>	<b>\$75 Billion</b>

*(Note: numbers reflect end of century, upper range projection with no action in today's dollars)*

# PAST AND ONGOING OUTREACH AND ENGAGEMENT EFFORTS

*(Note: dotted line marks end of century, upper range projection with no action)*



# VULNERABILITY AND RISK ASSESSMENTS

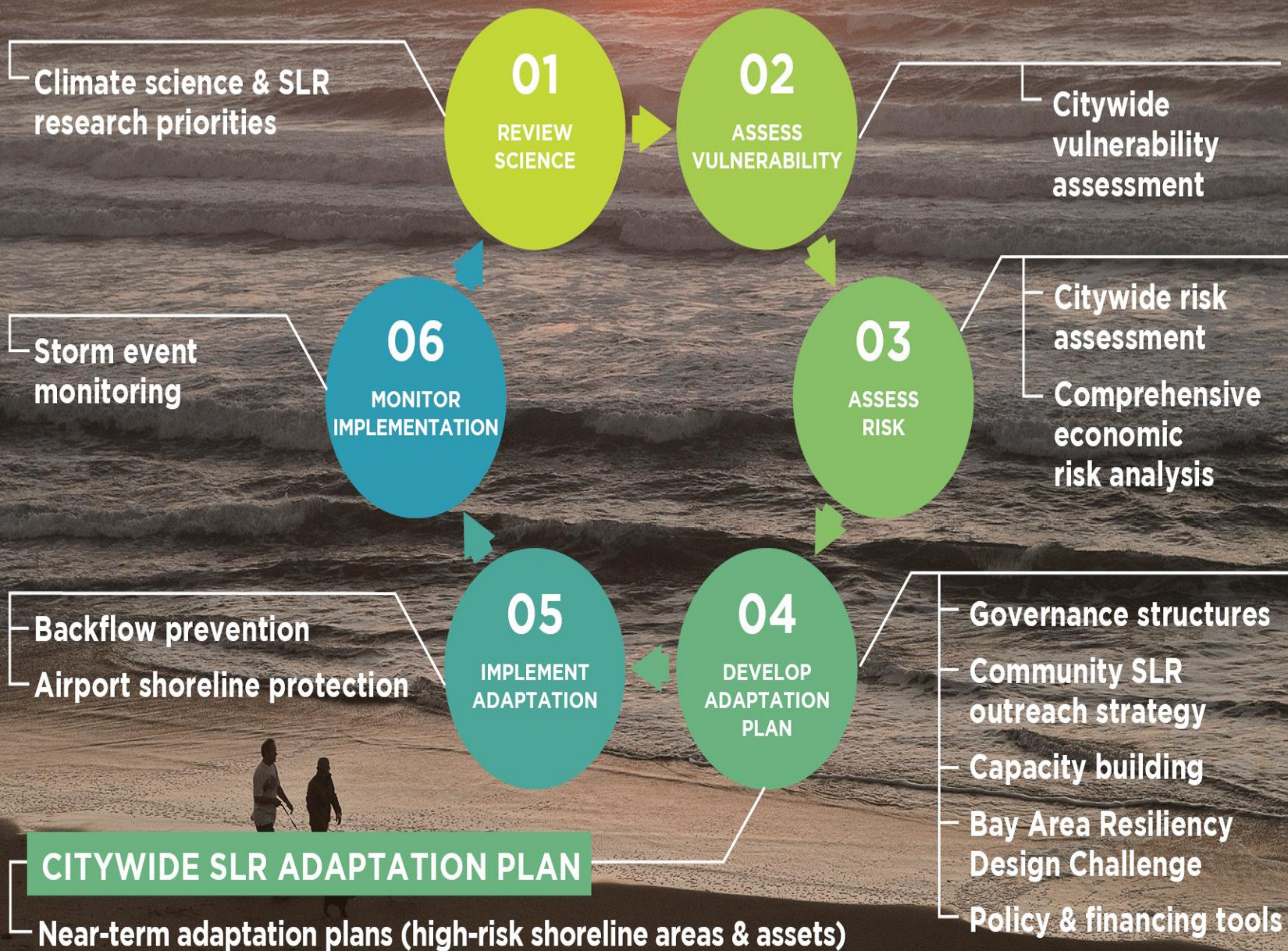
## Completed

- Property/Assets
  - Port
  - SFO
  - SFPUC
- Vulnerable Communities

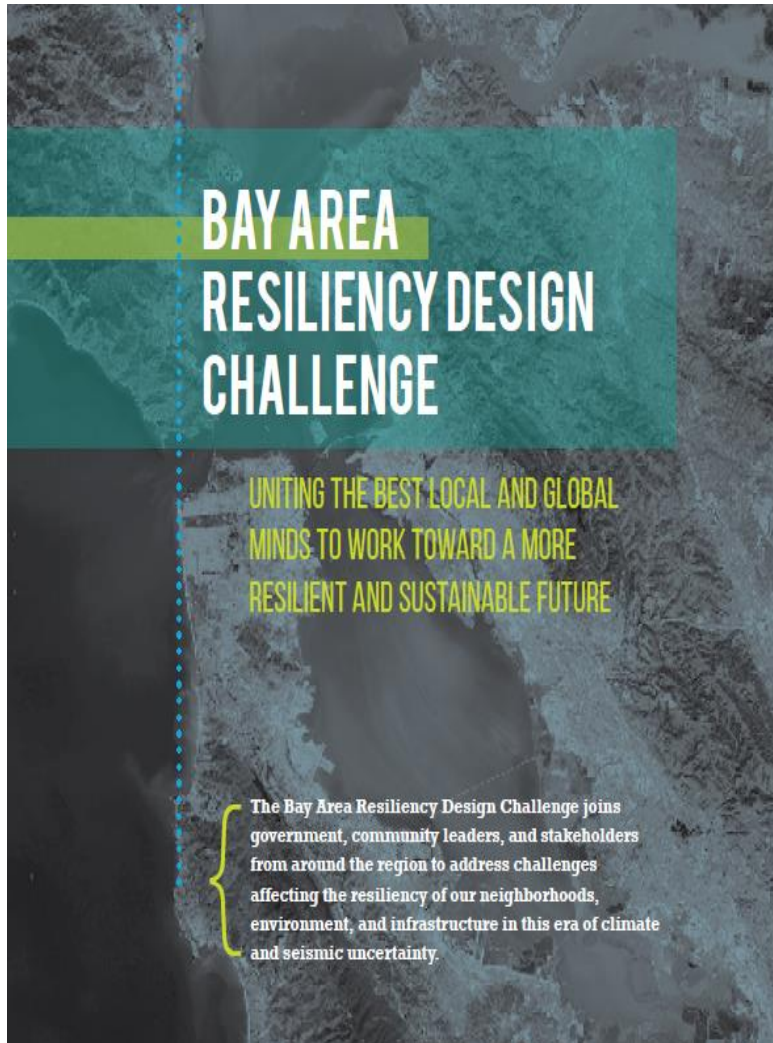
## STILL needed

- SFMTA Property/Assets
- Other Buildings and Properties
- Energy, Waste Systems
- Parks/Open Space
- Communications

# SEA LEVEL RISE PRIORITY ACTIONS [2016-2018]

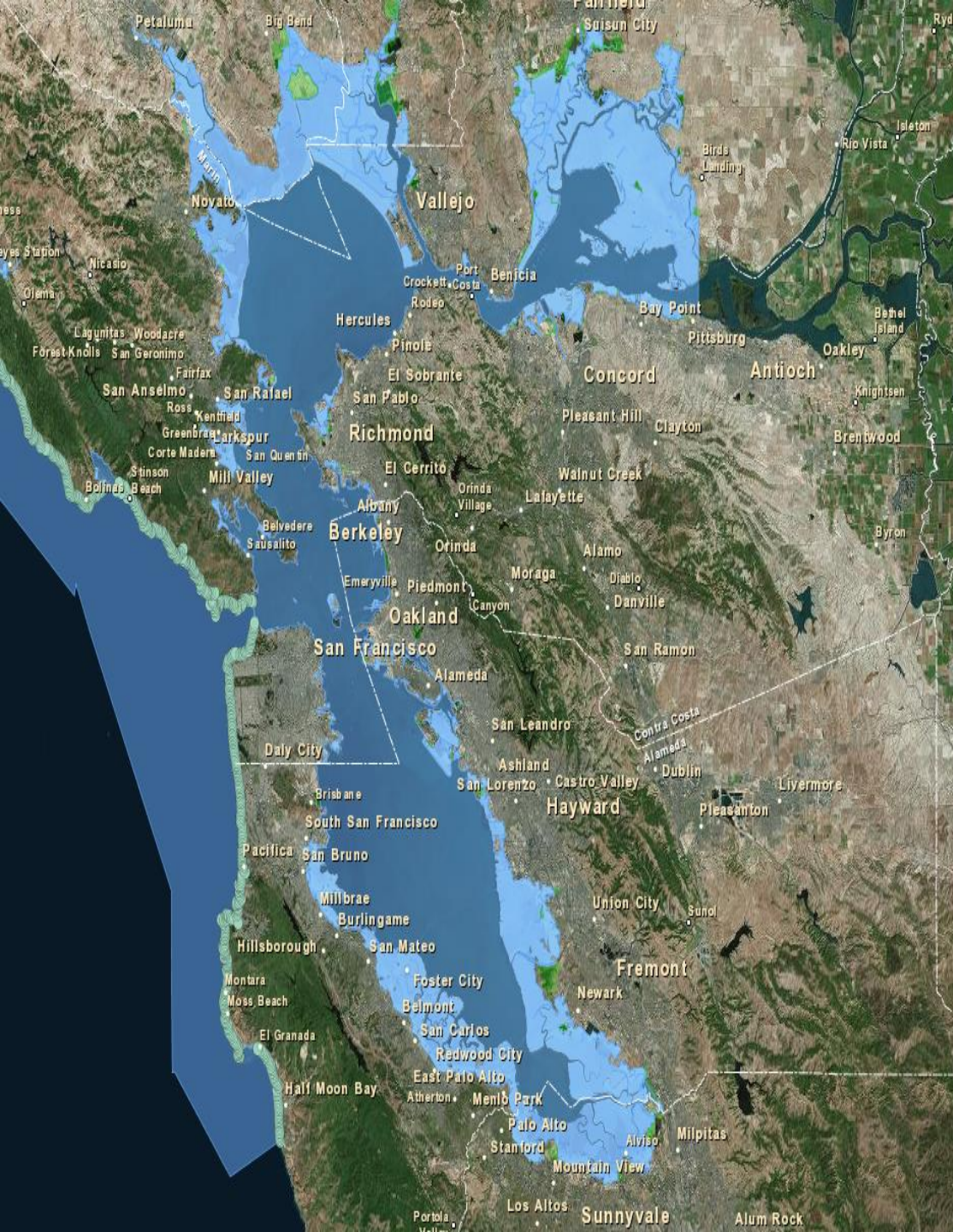


# RESILIENCE BY DESIGN CHALLENGE



- **Equitable**
- **Collaborative and Interdisciplinary**
- **Replicable and Implementable**
- **Innovative and Inspiring**
- **Community and Design-driven**

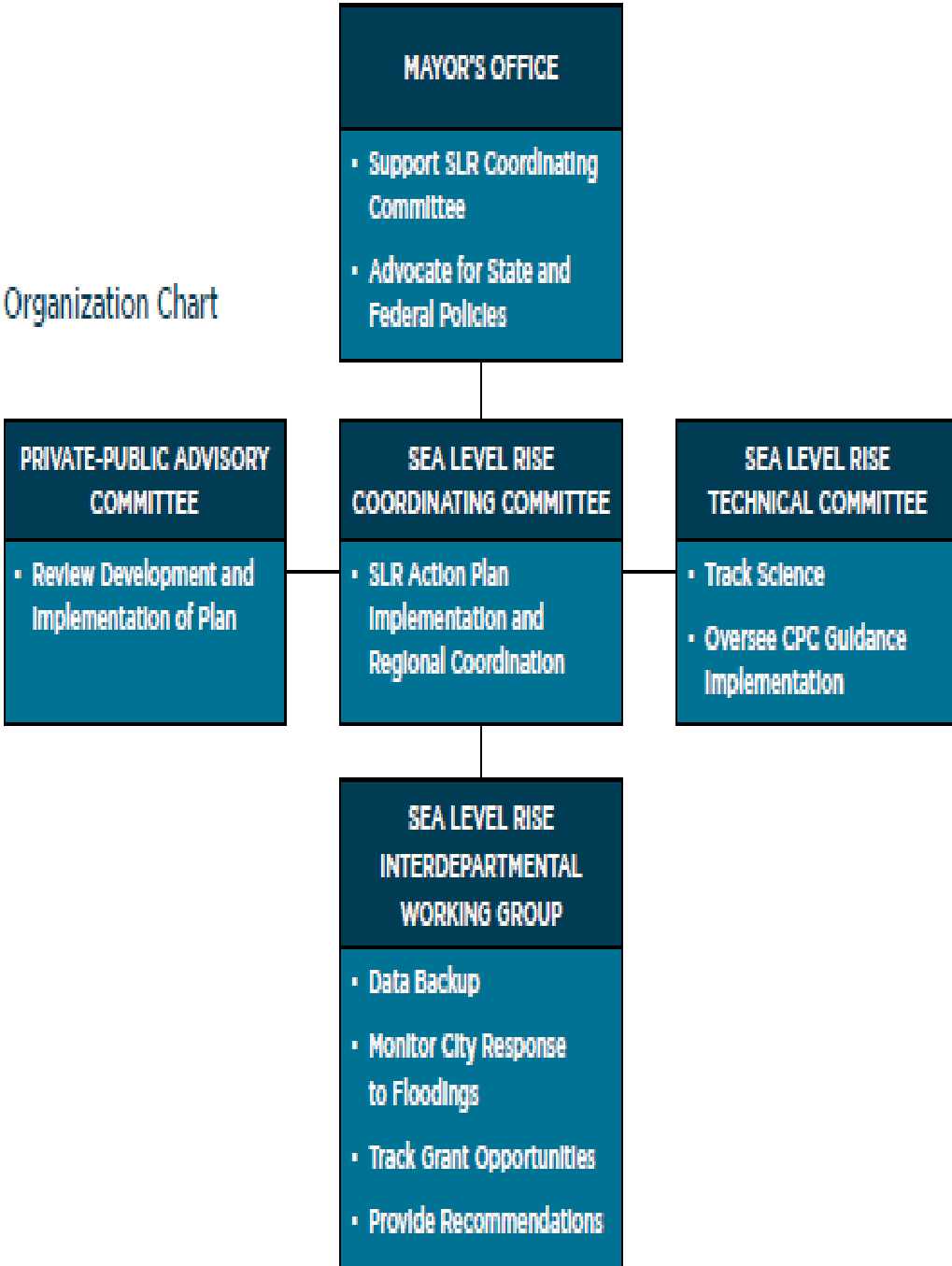




# LOCAL AND REGIONAL COOPERATION

# ON-GOING COORDINATION

Organization Chart







Aerial view of San Francisco skyline at sunset. The city is silhouetted against a golden sky. The Golden Gate Bridge is visible on the left. A large yellow circle on the right contains the text "THANK YOU." in white, bold, uppercase letters.

**THANK  
YOU.**

**Diana Sokolove, Senior Planner**  
**Citywide Planning**  
San Francisco Planning Department  
**PH:** 415-575-9046  
**EM:** [diana.sokolove@sfgov.org](mailto:diana.sokolove@sfgov.org)

*Photo by Michael Estigoy*

# Adapting to Rising Tides

Working together to increase the resilience of Bay Area communities to sea level rise and storm events



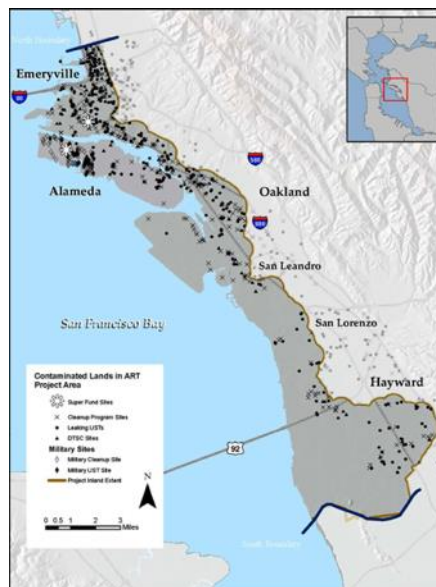
San Francisco Bay Conservation and Development Commission

# Adapting to Rising Tides Project

Initiated in 2011, the ART Alameda County Project was the first in the region to evaluate current and future flooding across multiple jurisdictions and sectors

Key factors of the ART approach – collaborative by design, a transparent process, and sustainable from start to finish – were foundational to the project

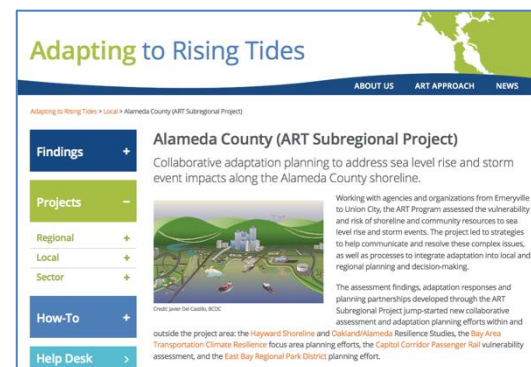
## Multi-jurisdiction



Diverse Working Group ART emphasizes close collaboration among stakeholders to ensure a shared understanding of the issues, build trust, and achieve buy-in for shared solutions and joint action

## Multi-sector

- Airport
- Community characteristics
- Community services
- Contaminated lands
- Energy, pipelines, telecom
- Flood control
- Hazardous material sites
- Ground transportation
- Parks and recreation
- Natural shorelines
- Residential land uses
- Seaport
- Storm water
- Structural shorelines
- Wastewater



# ART Program

Transitioned from leading a single county effort to a regional program that uses findings, processes, tools and relationships developed in ART Alameda to lead and support:

- ✧ efforts at multiple geographic scales
- ✧ efforts that are multiple or single sector

*For example, Hayward and Oakland/Bay Farm Island focus area studies, Capitol Corridor hot spots assessment, City of Benicia Adaptation Plan, Marin County shoreline planning, and regional resilience planning with ABAG, MTC, Caltrans and BART*



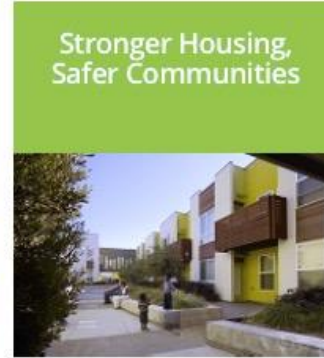
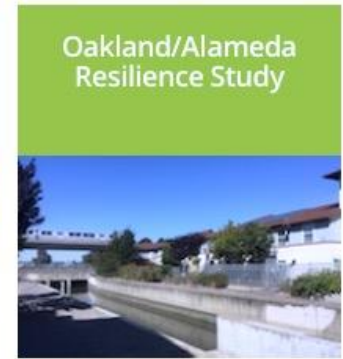
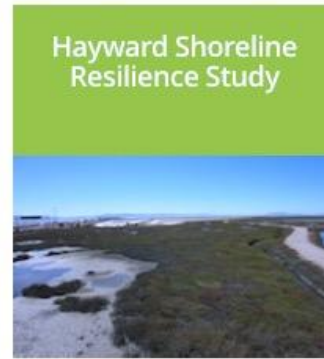
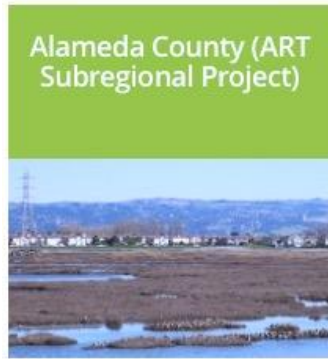
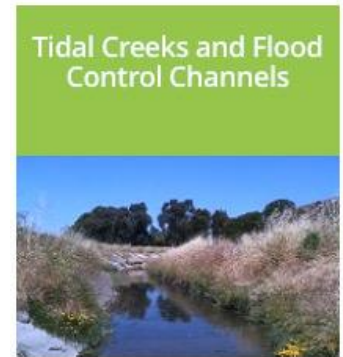
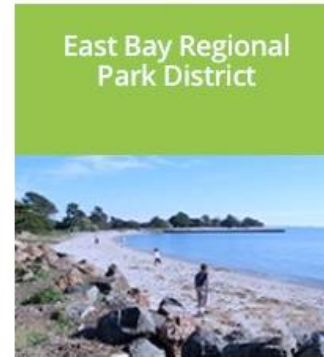
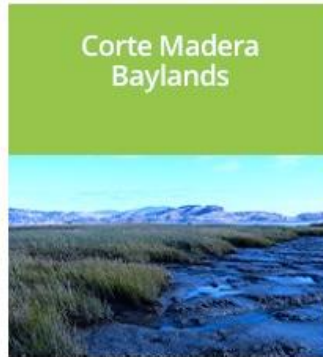
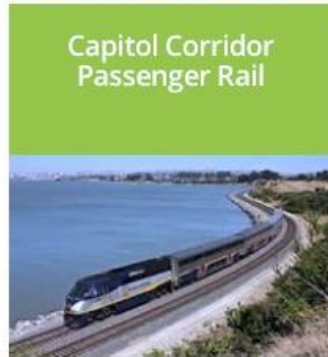
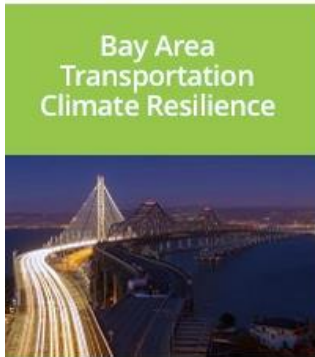


# ART Program Projects

Sector

Local

Regional



# ART Program Technical Assistance

## ART Portfolio

- Keeping the ART Portfolio up to date with new and refined resources, data, tools, information, and findings
- Providing ART Help Desk technical assistance to local jurisdictions, communities and agencies that are working on climate adaptation and hazard mitigation

**Adapting to Rising Tides**

ABOUT ART SUPPLIES ART APPROACH

The Adapting to Rising Tides (ART) Program is an initiative led by the San Francisco Bay Conservation and Development Commission. ART provides staff support and other resources to help agencies and organizations collaboratively plan for sea level rise and storm impacts.

Welcome to the **ART Portfolio**, a place to find planning guidance, tools and information that have been developed, tested and refined by the Adapting to Rising Tides Program to address the specific challenges of climate change.

Findings	Projects	How-to
ART Program outcomes summarized by sectors and adaptation planning issues	Latest information about current and past projects of the ART Program	Background information, step-by-step guidance and "supplies" for leading an adaptation planning project
<a href="#">Findings by sector &gt;</a>	<a href="#">Regional scale projects &gt;</a>	<a href="#">ART approach to adaptation &gt;</a>
<a href="#">Findings by issue &gt;</a>	<a href="#">Local scale projects &gt;</a>	<a href="#">Design your own project &gt;</a>
	<a href="#">Sector specific projects &gt;</a>	<a href="#">ART supplies &gt;</a>

[Help Desk >](#)  
Answers to frequently asked questions. How to contact us for additional help.

# ART Program Technical Assistance

## ART Help Desk Support:

- Marin County Assessments
- San Mateo County Assessment
- Cities of San Rafael, Oakland, Benicia, Hayward, San Francisco
- Caltrans District 4, Congestion Management Agencies and MTC
- East Bay Regional Park District and Hayward Recreation
- Questions from other regions and states

The screenshot shows the 'Adapting to Rising Tides' website. The header includes the title 'Adapting to Rising Tides' and navigation links for 'ABOUT US', 'ART APPROACH', and 'NEWS'. Below the header, there is a breadcrumb trail: 'Adapting to Rising Tides > Help Desk'. A sidebar on the left contains four menu items: 'Findings', 'Projects', 'How-To', and 'Help Desk', each with a plus sign. The main content area is titled 'Help Desk' and contains the following text: 'Connect with knowledgeable ART Program staff who can assist you with understanding and using Portfolio content, and connect you with other relevant information and expertise.' Below this is a paragraph: 'Leading your own adaptation planning project is a daunting task. The ART Program staff know this firsthand. Beginning in 2010 with the Alameda County pilot project, ART Program staff have led, supported and collaborated on more than ten different planning efforts around San Francisco Bay that range in scope and scale. Through this work, we have learned a great deal about how to design and conduct an adaptation planning process that is effective and efficient, and appropriate to the needs of project partners and available resources.' To the right of this paragraph is a quote box: 'I wasn't planning to lead, I was standing in the back and then everyone turned around. - Avery Hiebert'. Below the main text is another paragraph: 'Now we want to put all of this knowledge and experience to further good use by helping you with your planning efforts. The ART Program team is available to answer questions, to help and support efforts, and to brainstorm with you about how to approach resilience planning within your community, jurisdiction, organization or agency.' At the bottom, there are three bullet points: 'The bios for our program staff can help to lead you to the staff member(s) most familiar with your topics of concern. Or, feel free to contact any of us and we will connect you with the right support.', 'The ART Approach page describes the planning process that the ART Program has developed, tested and refined in past projects, and that we continue to use and build upon.', and 'Our Deliverables and FAQs can help answer questions that we commonly get about the ART approach and the Portfolio resources.'

# ART Program Partnerships

## Regional Partnerships

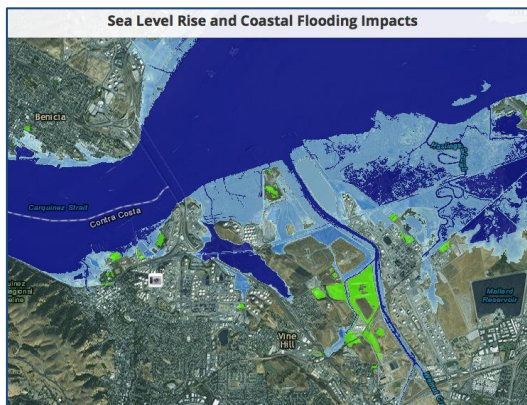
- Bay Area Regional Collaborative Member Agency
  - Cross-agency staff team, 2017 Sustainable Communities Strategy Update, regional resilience logic model/process map, technical assistance
- Partnership with the ABAG Resilience Program
  - Safer Housing, Stronger Communities Project; Safe, Smart Growth Initiative (EPA, FEMA, NOAA); Guidance and support for addressing hazard mitigation and climate adaptation planning



# ART Program Partnerships

## Regional Partnerships

- Continuing to partner with MTC, Caltrans, BART, Capitol Corridor and other transportation agencies on regional transportation vulnerabilities
  - ART regional shoreline mapping and analysis for the rest of the region, presentations to congestion management agencies, Caltrans staff teams, coordinating and assisting with the District 4 assessment that is currently underway



## Regional Partnerships

- CHARG Steering Committee
  - Providing guidance and support to CHARG and its committees
- Resilience By Design Managing Partner
  - Assisting with framing, research and identifying partners
- Regional research with San Francisco Estuary Institute
  - Head of Tide Project, Regional shoreline delineation, Flood Control 2.0
- Bay Area Ecosystems Climate Change Consortium Steering Committee
  - Collaborative science assessments for Bay ecosystems climate vulnerability and a forum for understanding how resilience in natural systems builds regional resilience

# Other BCDC Initiatives

## Current BCDC initiatives

- Policies for a Rising Bay:
  - An assessment of BCDC's laws and policies in relation to potential adaptation actions with an emphasis on affects on equity, environment and economy in the region
- BCDC's 2016 Workshop Series on Rising Sea Levels:
  - January 21st: Five Year Review of BCDC's Climate Policies
  - March 3rd: The Regional Role and Approach, Issues and Actions
  - April 7th: Review and discussion of January and March Findings
  - May 19th: Commissioner Conversation-Next Steps and Direction