



**PROTECT THE CITY
STRENGTHEN
THE SEAWALL**

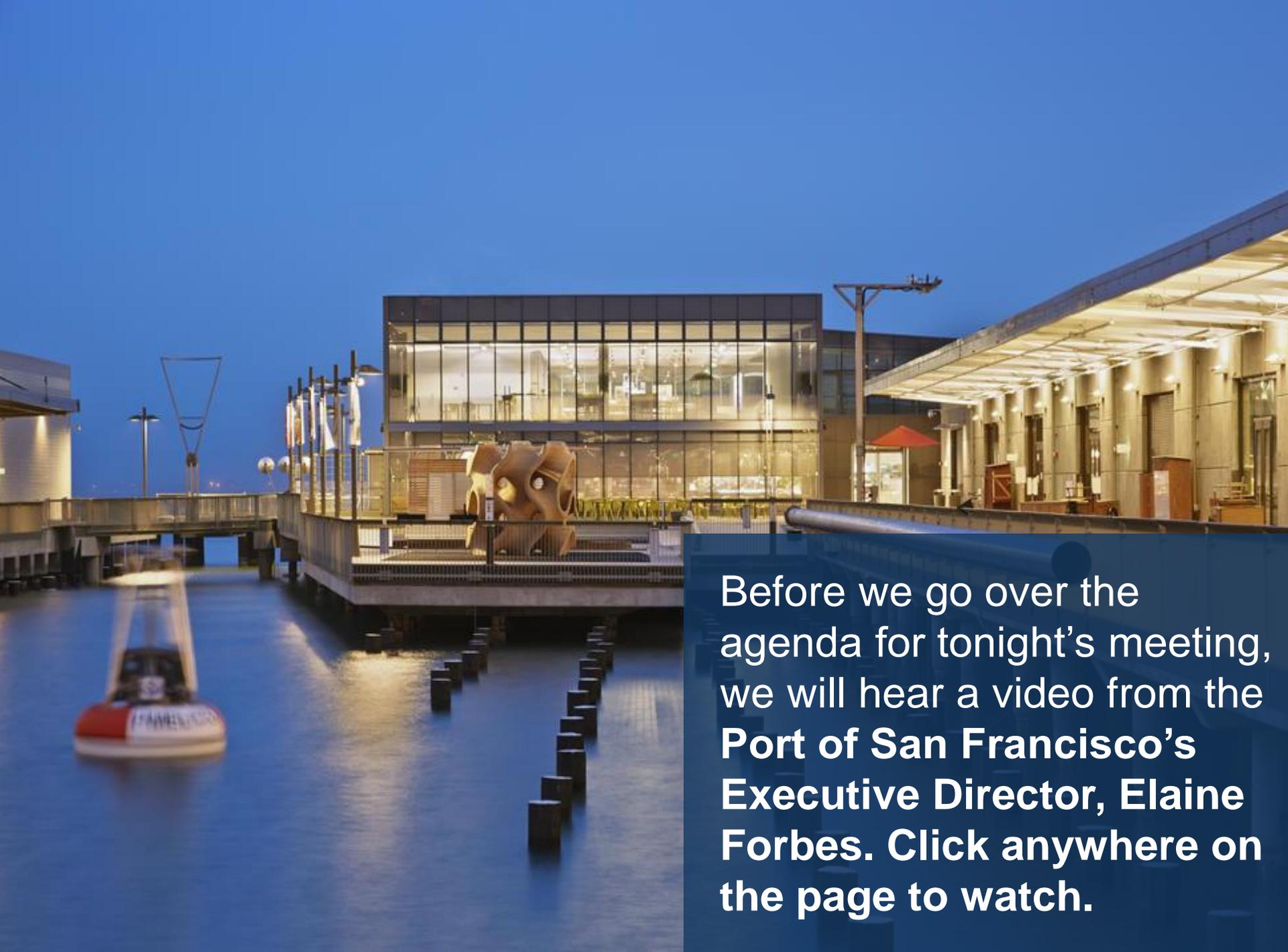
Seawall Earthquake Safety + Disaster
Prevention Program
Community Meeting 2
September 26, 2018



WELCOME!

Welcome back to those of you who joined us in June for our first meeting and **welcome aboard** the Seawall Program if this is your first time joining us!

We also want to **thank our partners at the Exploratorium** for hosting us and helping us plan this event.



Before we go over the agenda for tonight's meeting, we will hear a video from the **Port of San Francisco's Executive Director, Elaine Forbes**. Click anywhere on the page to watch.



MEETING AGENDA

Tonight, we will cover:

- Recap of first meeting
- Overview of the Seawall Program (upstairs)
- Presentation of the flood and seismic hazards (upstairs)
- Presentation of the assets and services (upstairs)
- Table engagement around hazards, assets, and services (downstairs)

We need to hear from you!

COMMUNITY MEETING PROCESS

MEETING

1

June 2018

INTRODUCTION:
**THE SEAWALL
PROGRAM**

MEETING

2

Sept. 2018

ASSETS & RISKS:
**WHAT'S OUT
THERE AND WHAT'S
AT STAKE**

MEETING

3

Jan. 2019

TRADEOFFS:
**BALANCING
PRIORITIES &
RESOURCES**

MEETING

4

April 2019

SOLUTIONS TOOLKIT:
**WHAT CAN
WE DO?**

MEETING

5

Summer 2019

ALTERNATIVES:
**CONSIDERING
SOLUTIONS
AND
ADAPT PLAN**



COMMUNITY MEETING OBJECTIVES

MEETING

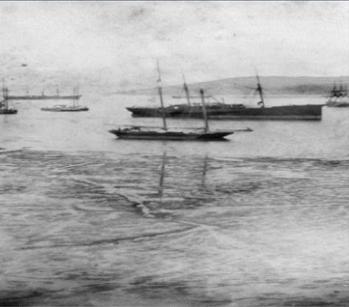
2

Sept. 2018

ASSETS & RISKS:
**WHAT'S OUT
THERE AND WHAT'S
AT STAKE**

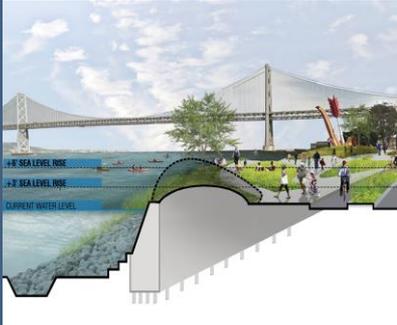
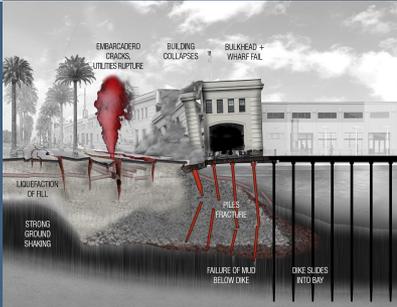
1. Informational: Understand hazards and assets and what's at stake
2. More deeply engage with the information presented
3. Think about the challenges we face as a city and a region
4. Discuss what it means to us collectively, and hear what it means to your fellow community members
5. Identify opportunities to increase participation outside of these meetings and broaden the perspectives

RECAP OF SEAWALL COMMUNITY MEETING #1



Held on June 21, 2018 at the Ferry Building, the first Seawall Community Meeting included:

- Introduction to the Embarcadero Seawall!
- Framework and Approach: how we plan to develop an adaptive planning framework to solve these problems with your help
- Specifics about the project area, program financing, stakeholder engagement, goals, timeline
- Opportunities to discuss specific issues with Seawall Program team at information boards, which are also presented around the room this evening





SEAWALL PROGRAM GOALS

- Act Quickly
- Reduce Earthquake Damage
- Improve Flood Resilience
- Engage the Community
- Enhance the City and the Bay
- Preserve Historic Resources

SEAWALL PROGRAM OVERVIEW

- Seismic risk and current and future flooding
- Up to \$5 billion over 30 years
- Funding will come from City, state, federal and private sources
- First priority is to **protect life safety and emergency response** from seismic events
- Will address **as much flood risk as possible** and **create a foundation** for addressing additional flood risk over time
- **Adaptive program framework** to be able to respond to changes in science, priorities, monitoring
- **Robust engagement and outreach**





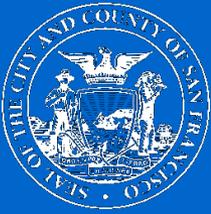
WAYS TO ENGAGE

- Talk to a member of the Seawall Team
- Review the Boards
- Comment Cards
- Take a brochure (overview, seismic, sea level rise, adaptive program framework)
- Request a presentation for your group
- Review the website <https://sfseawall.com/>
- Engage tonight!
- Attend future Seawall Community Meetings



WHAT'S NEXT

- Steven Reel, the Port's Seawall Program Manager, will provide a presentation of the hazards
- Pamela Conrad, our wonderful consultant from CMG Landscape Architecture, will present the assets and services at risk from seismic or flood events and present the engagement exercise

A stylized graphic of a city skyline in yellow and white, with a large yellow seawall structure in the foreground. The seawall is composed of several parallel yellow beams with white outlines, receding into the distance. The background is a solid blue color.

**PROTECT THE CITY
STRENGTHEN
THE SEAWALL**

Thank you!

Lindy Lowe, Port of San Francisco
Resilience Program

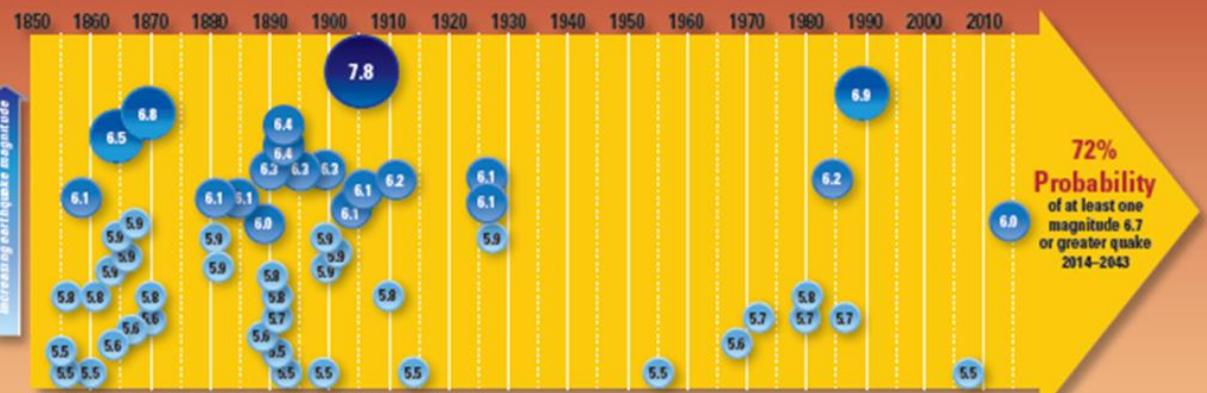


**PROTECT THE CITY
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Seawall Earthquake & Flood Hazards
Community Meeting 2
September 26, 2018

EARTHQUAKE HAZARD: LIKELIHOOD OF AN EARTHQUAKE

San Francisco Bay Region Earthquake Timeline



1850–1926 earthquakes from Bakun, W.H., 1992, Seismic Activity of the San Francisco Bay Region, Bulletin Seismological Society of America, v. 82, p. 764–784 and 1967–2014 earthquakes from the Northern California Seismic Network.

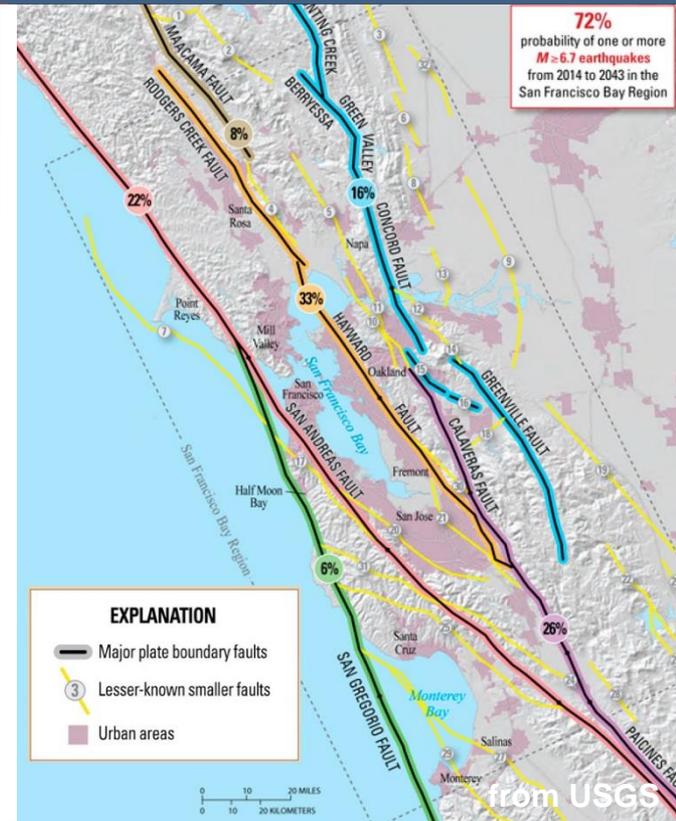
Earthquake magnitude
 5.5–5.9 6.0–6.4 6.5–6.9 >7.0

Likelihood of at least one earthquake greater than a given magnitude in the San Francisco Bay region between 2014 and 2043.

Magnitude (M)	30-year likelihood of at least one earthquake in the San Francisco Bay region
$M \geq 6.0$	98 percent
$M \geq 6.7$	72 percent
$M \geq 7.0$	51 percent
$M \geq 7.5$	20 percent

Timeline of magnitude 5.5 and greater earthquakes in the San Francisco Bay region 1850–2014. In the 50 years prior to the 1906 Earthquake, there were 13 earthquakes with a magnitude between 6 and 7, but only 6 earthquakes of similar magnitude in the 110 years since 1906. The rate of large earthquakes is expected to increase from this low level as tectonic plate movements continue to increase the stress on the faults in the region.

from USGS



EXPLANATION
 — Major plate boundary faults
 ③ Lesser-known smaller faults
 Urban areas

0 10 20 MILES
 0 10 20 KILOMETERS

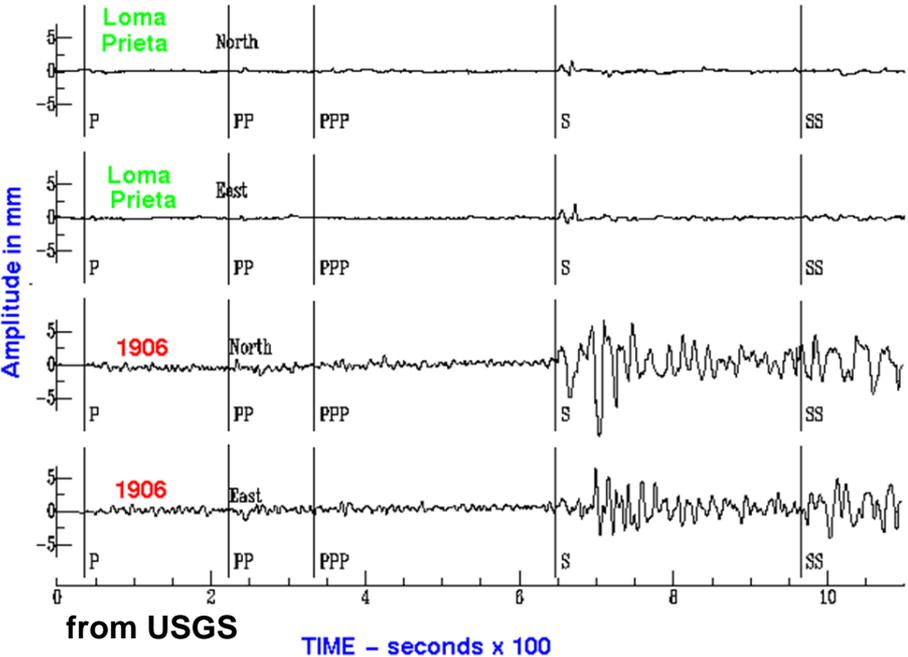
from USGS

The likelihood of a major earthquake is high and is increasing every day:

- USGS forecast: **72% likelihood of at least one major earthquake by 2043.**
- **Historically quiet period since 1906:** In the 50 years prior to the great 1906 Earthquake, there were 13 M6-M7 earthquakes, but only 6 in the 112 years since.
- **San Andreas & Hayward Faults are highest risk.**

EARTHQUAKE HAZARD: GROUND SHAKING INTENSITY

Comparison of 1906 and Loma Prieta records at Gottingen, Germany



Higher intensity & longer duration of ground shaking increases damages.

Ground shaking at a specific location depends on:

Earthquake Energy (Magnitude)

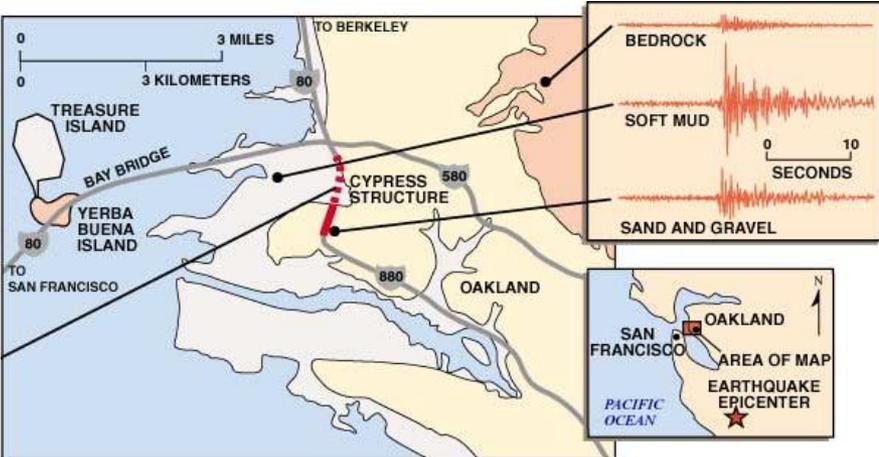
- M8 is 32 x greater than M7
- M8 is 1,000 x greater than M6

Distance from epicenter

- Loma Prieta was 60 miles away
- 1906 was only 2 miles away

Type of ground

Soft soil can amplify motions



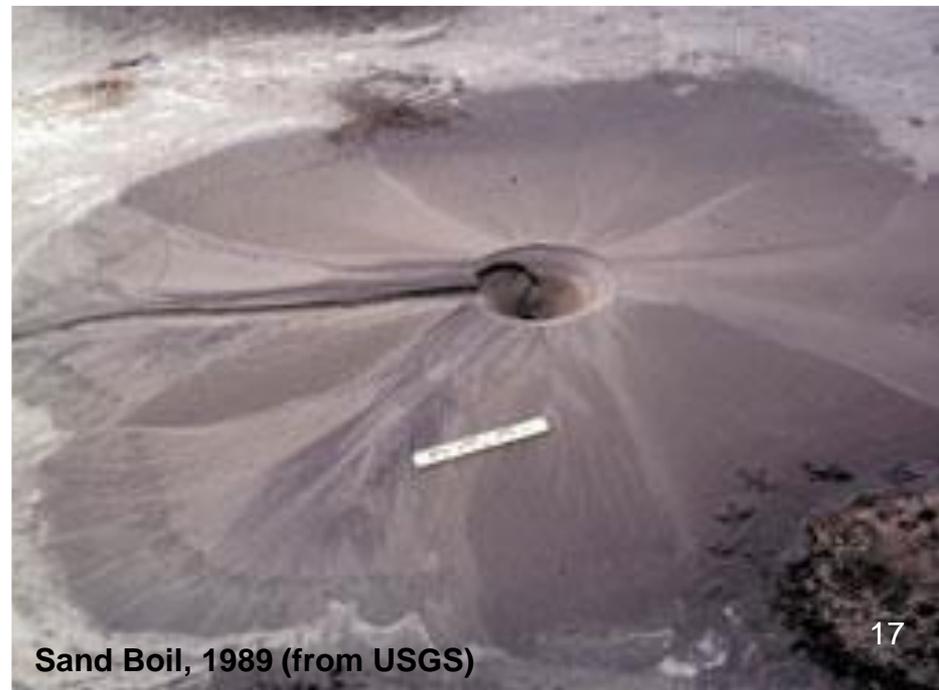
EARTHQUAKE HAZARD: *LIQUEFACTION*



Liquefaction: ground shaking can cause the ground to lose strength and stiffness, causing severe damage to structures, pavements, and utilities.

Liquefaction is more likely in saturated soils:

- Recent sediments (many shorelines)
- Sand (Marina District)
- Loose fill (historic shoreline to Seawall)



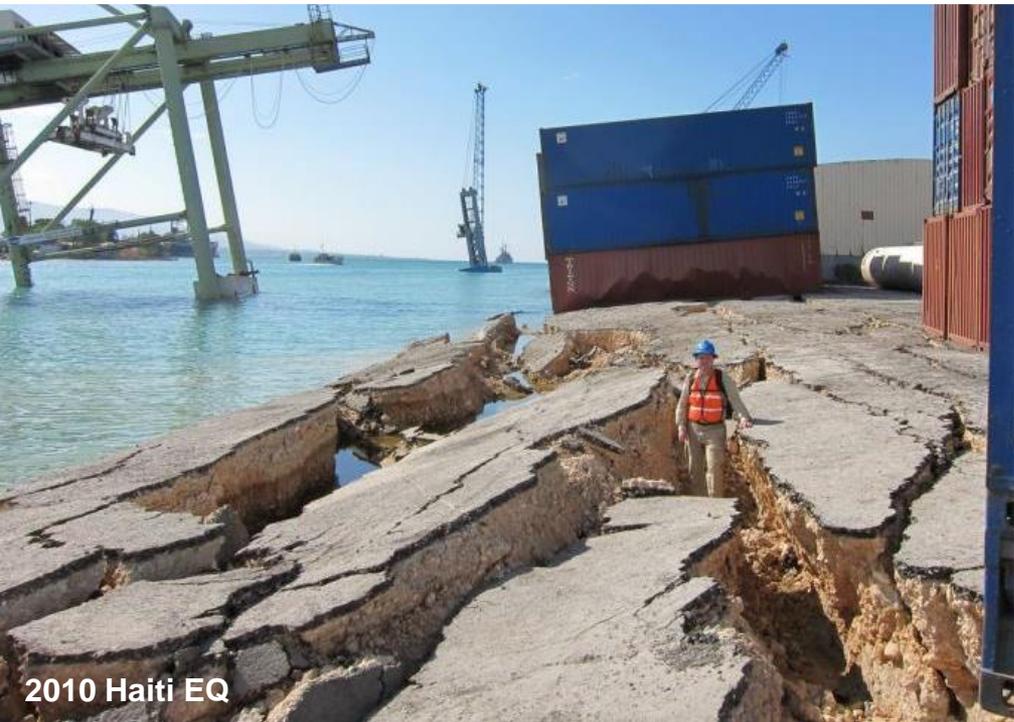
EARTHQUAKE HAZARD: *LATERAL SPREADING*



1995 Kobe EQ

Lateral Spreading: when soils liquefy, they can permanently slide downslope, crack, and settle.

Recent earthquakes have caused lateral spreading where seawalls failed to hold back filled land.



2010 Haiti EQ



1995 Kobe EQ

EARTHQUAKE HAZARD: *LATERAL SPREADING*



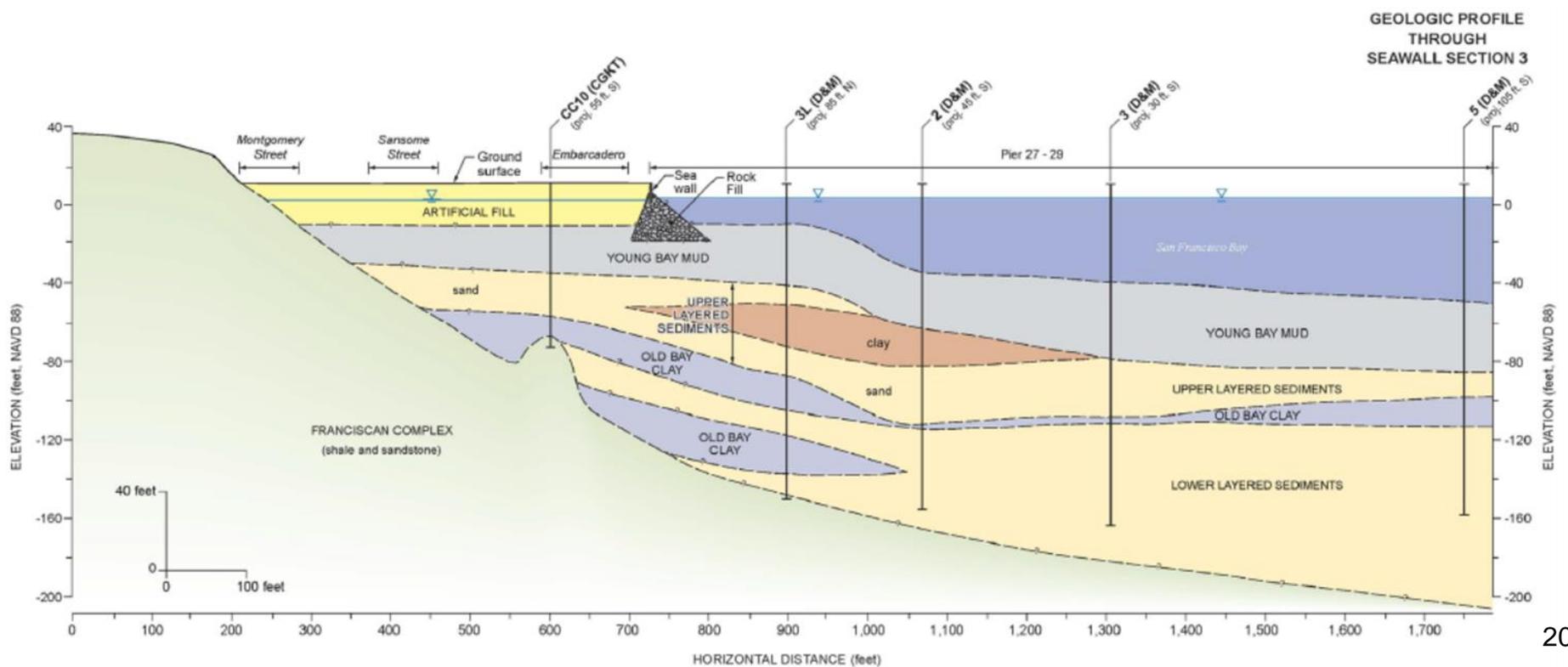
1906 San Francisco, The Embarcadero near Pier 27

EARTHQUAKE HAZARD: 2016 SEAWALL EARTHQUAKE STUDY (Screening Level)

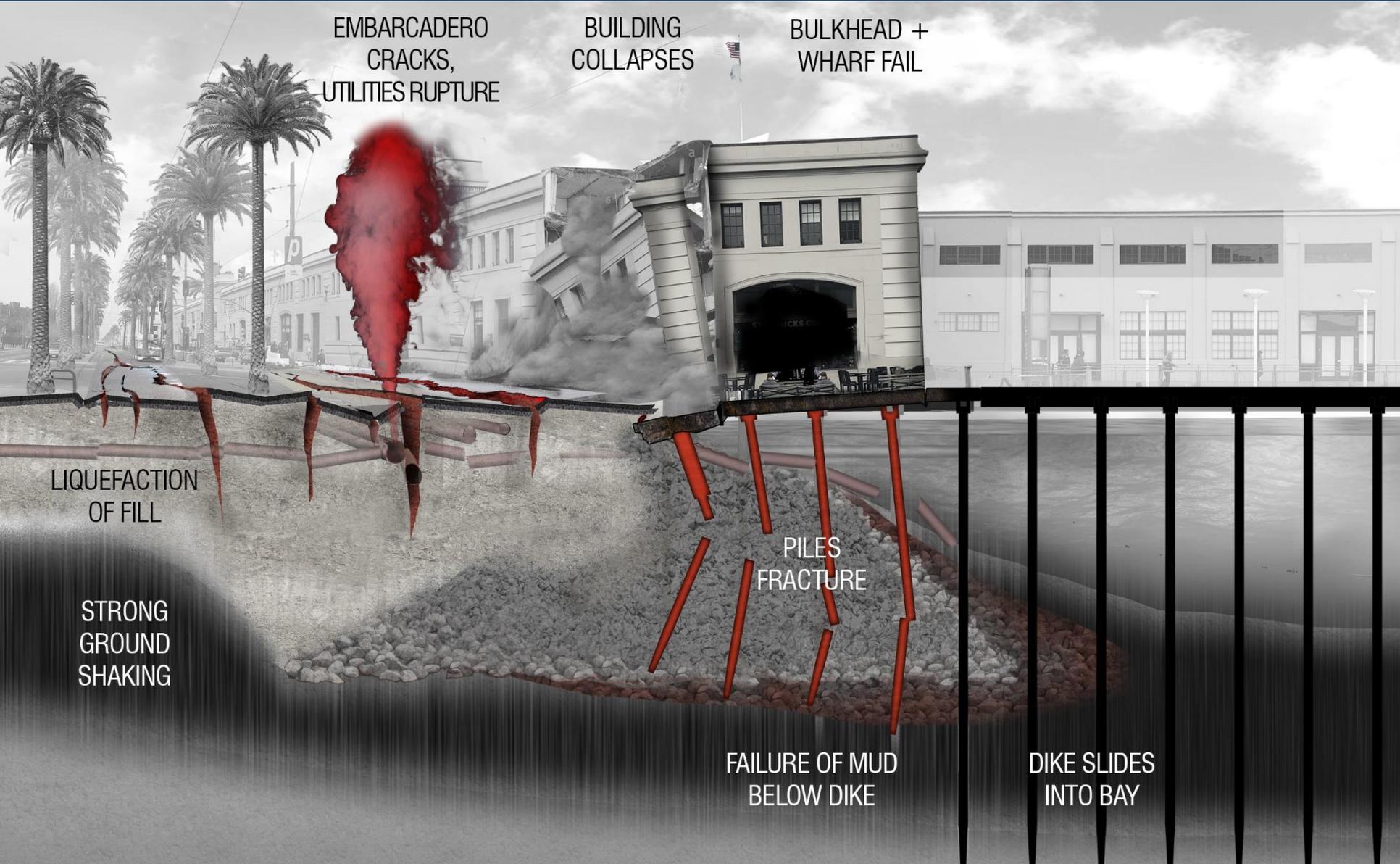
What is under the ground matters.

The 2016 Seawall Earthquake Study found:

- Liquefiable fill behind the Seawall
- Poor soils including Bay Mud and liquefiable sand under the Seawall
- Conditions that differ substantially along 3 miles
- Additional investigations and engineering study is needed to improve accuracy



SEAWALL EARTHQUAKE HAZARD: LIQUEFACTION LATERAL SPREADING & NON-DUCTILE STRUCTURES



EMBARCADERO
CRACKS,
UTILITIES RUPTURE

BUILDING
COLLAPSES

BULKHEAD +
WHARF FAIL

LIQUEFACTION
OF FILL

STRONG
GROUND
SHAKING

PILES
FRACTURE

FAILURE OF MUD
BELOW DIKE

DIKE SLIDES
INTO BAY

EARTHQUAKE HAZARD ZONES



EARTHQUAKE HAZARD ZONES: *FILL BACK TO ORIGINAL SHORELINE*



----- 1850'S SHORELINE

Hazards:

- Amplified ground shaking
- Liquefaction potential

EARTHQUAKE HAZARD ZONES: SEAWALL EQ HAZARD ZONE

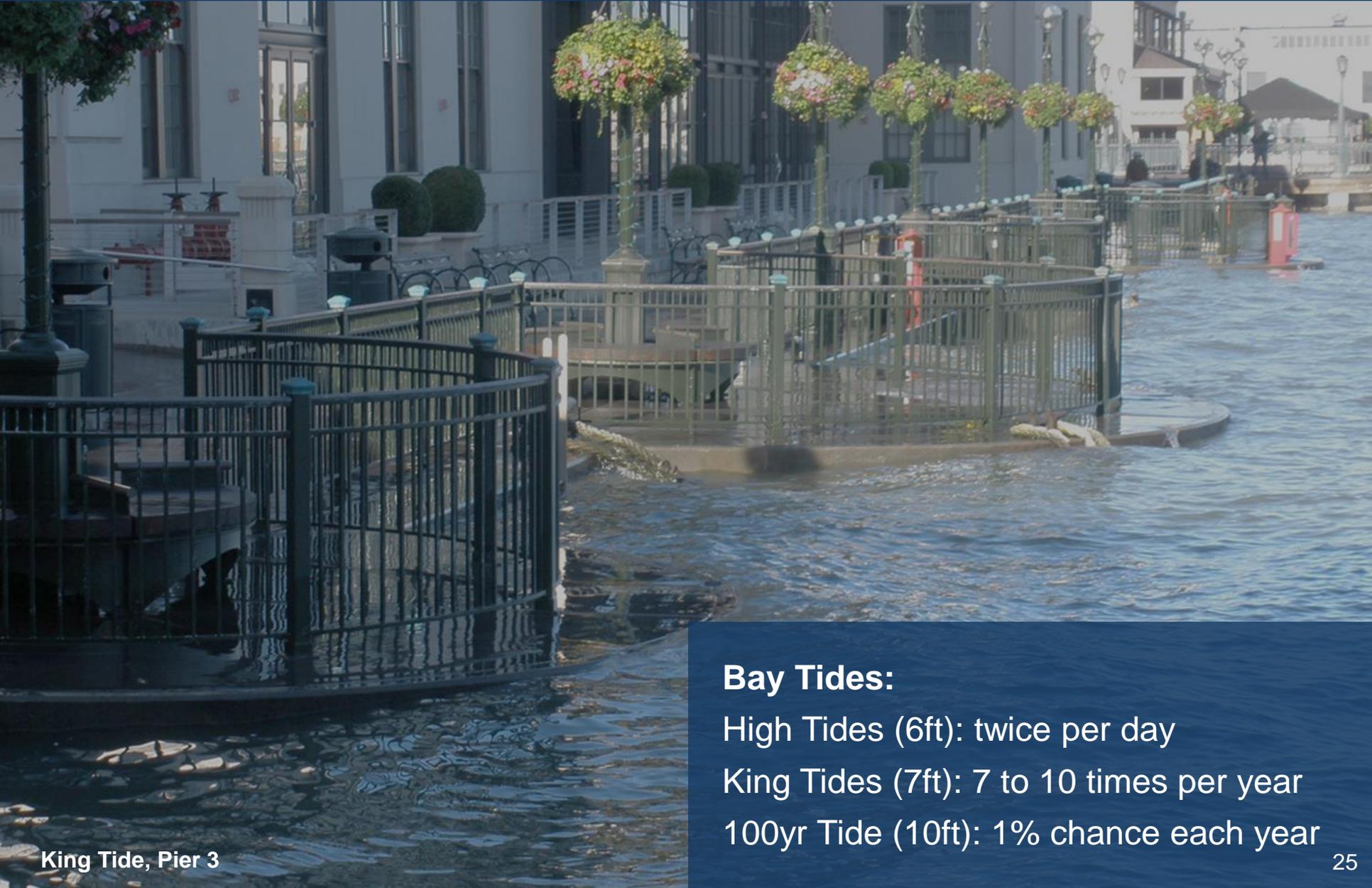


- 1850'S SHORELINE
- ////// SEAWALL SEISMIC HAZARD ZONE

Hazards:

- Lateral spreading & settlement
- 200 to 300 feet behind Seawall
- 100 to 200 feet Bayward of Seawall (not shown)

FLOOD HAZARD: *TIDES AND COASTAL FLOOD RISK*



King Tide, Pier 3

Bay Tides:

High Tides (6ft): twice per day

King Tides (7ft): 7 to 10 times per year

100yr Tide (10ft): 1% chance each year



FLOOD HAZARD: *SEA LEVEL RISE*

Sea Level is on the rise & we're running out of time!

History:

- 8 inches from 1900 to 2000

Future:

- 12 to 24 inches by 2050 (CCSF 2016)
- 36 to 66 inches by 2100 (CCSF 2016)
- New CA guidance up to 10 ft by 2100 (H++)

FLOOD HAZARD ZONES



FLOOD HAZARD ZONES: *Near Term (Up to 12 inches of SLR)*



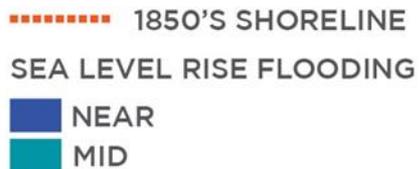
courtesy of SFPW

- 1850'S SHORELINE
- SEA LEVEL RISE FLOODING
- NEAR

Near Term Flood Hazards:

- Embarcadero between Pier 7 & Pier 22-1/2
- Muni & BART underground
- Several blocks of Downtown

FLOOD HAZARD ZONES: *Mid-Term (Up to 36 inches of SLR)*



Mid Term Flood Hazards:

- Entire Embarcadero
- Ferry Building and all piers
- Parts of Downtown, Fisherman's Wharf, Ballpark

FLOOD HAZARD ZONES: *LONG TERM* (up to 66 inches of SLR)



courtesy of SFPW

- 1850'S SHORELINE
- SEA LEVEL RISE FLOODING
- NEAR
- MID
- LONG

Long Term Flood Hazards:

- All areas within the original shoreline
- Transbay Terminal to Transamerica Pyramid

SEAWALL EARTHQUAKE & FLOOD HAZARD ZONES: PUTTING IT ALL TOGETHER



courtesy of SFPW

SEA LEVEL RISE FLOODING

- NEAR
- MID
- LONG

SEISMIC HAZARDS

- SEAWALL SEISMIC HAZARD ZONE
- 1850'S SHORELINE



EARTHQUAKE & FLOOD HAZARDS: *TODAY'S INVESTMENTS*

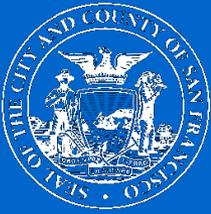
Downtown Ferry Terminal:

- New Pier and Terminal Expansion under construction
- 3 feet higher than prior terminals due to SLR
- Massive steel piles to withstand up to 6 feet of lateral spreading



Fire Station 35 at Pier 22-1/2:

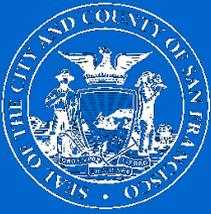
- In design, and soon to be floating with the tides
- Guidepiles designed to withstand lateral spreading

A stylized graphic of a city skyline in yellow and orange, with a large yellow seawall structure in the foreground. The seawall is composed of several parallel yellow bars with white outlines, receding into the distance. The background is a solid blue color.

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Thank you!

Steven Reel, PE, Port of San Francisco
Seawall Program Manager

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Seawall Assets
& Community Engagement Exercise
Community Meeting 2
September 26, 2018

WHAT'S OUT THERE
AND WHAT'S AT STAKE?



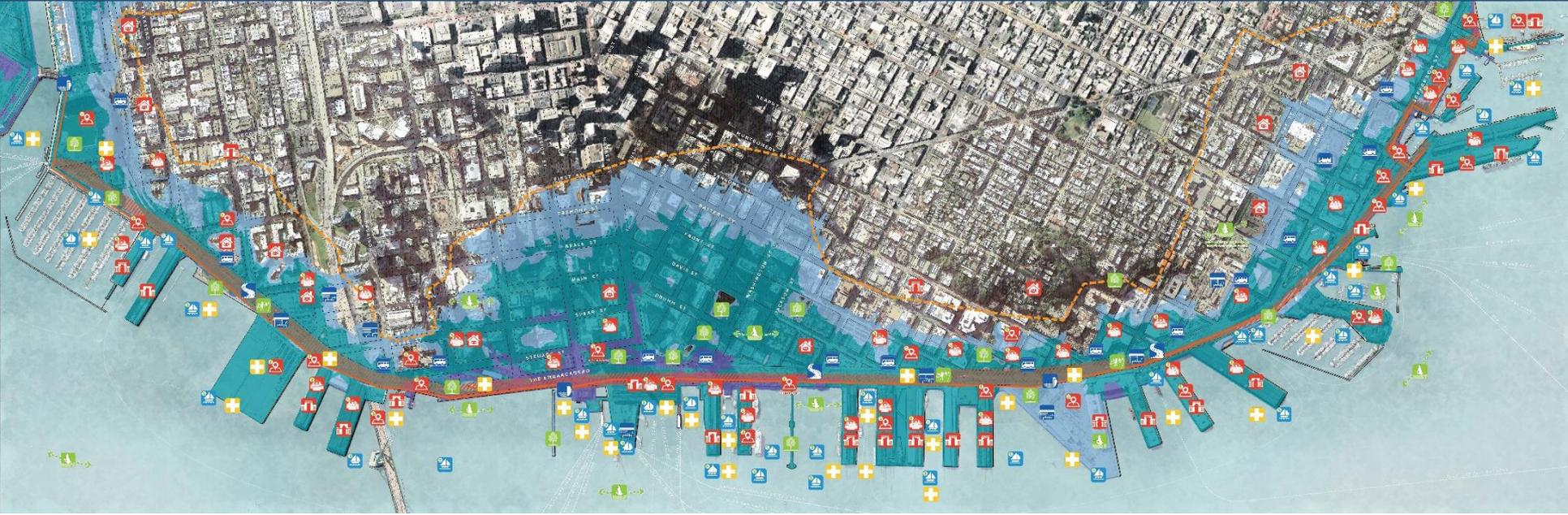
SAN FRANCISCO'S WATERFRONT TODAY

- Emergency response
- BART/Muni railway
- Utilities
- \$100 billion in assets and activities
- Maritime facilities
- Embarcadero Historic District

SAN FRANCISCO'S WATERFRONT



SAN FRANCISCO'S WATERFRONT



GAME OF HAZARDS!

INFRASTRUCTURE



UTILITIES



STREETS



TRANSIT



SEAWALL



INFRASTRUCTURE



UTILITIES



STREETS



TRANSIT



SEAWALL



INFRASTRUCTURE



UTILITIES



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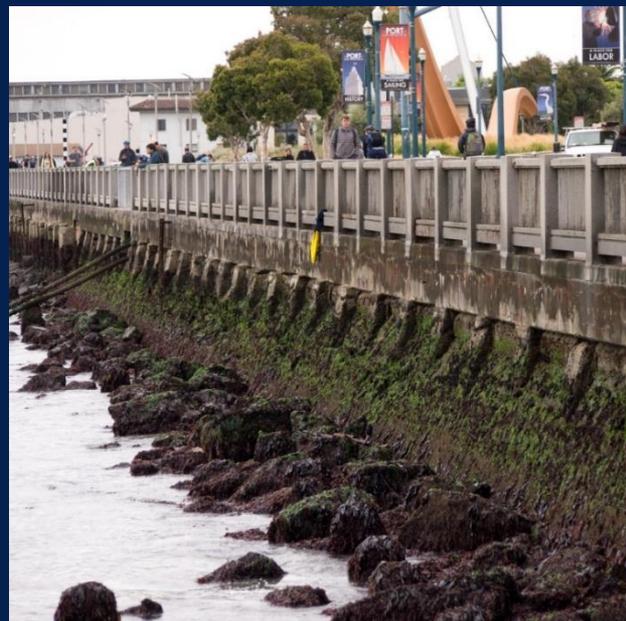
STREETS



TRANSIT



SEAWALL



INFRASTRUCTURE



UTILITIES



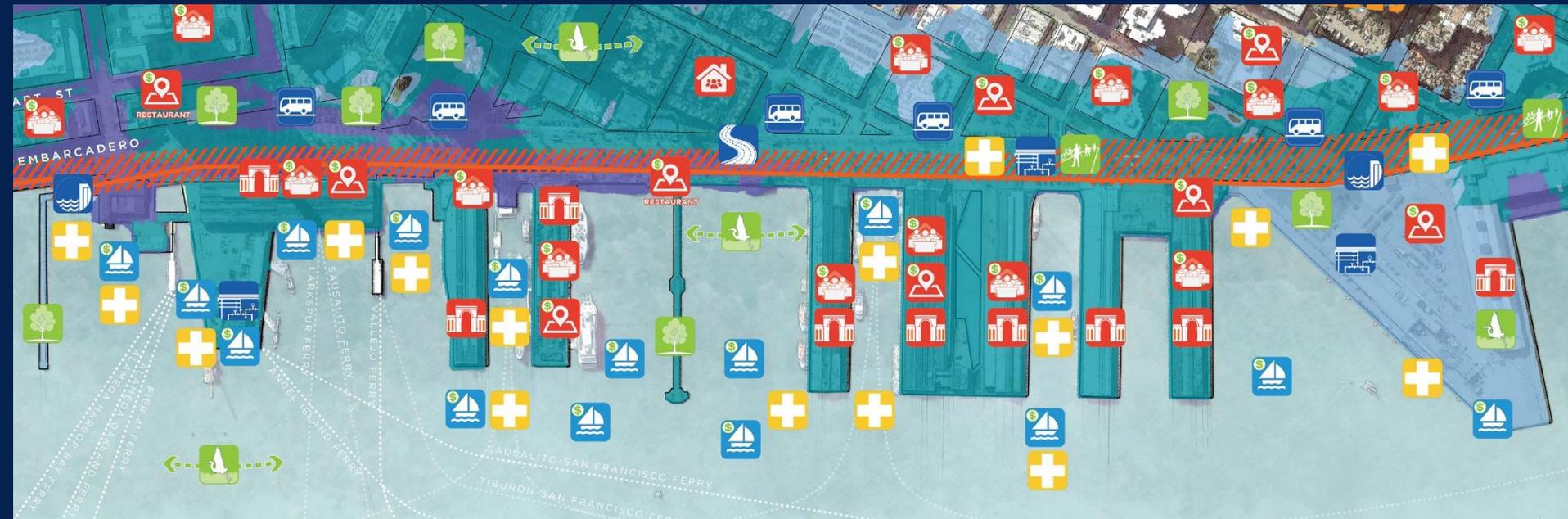
STREETS



TRANSIT



SEAWALL



INFRASTRUCTURE



UTILITIES



STREETS



TRANSIT



SEAWALL



URBAN AND CULTURAL



HISTORIC



LIVE



WORK



VISIT

URBAN AND CULTURAL



HISTORIC



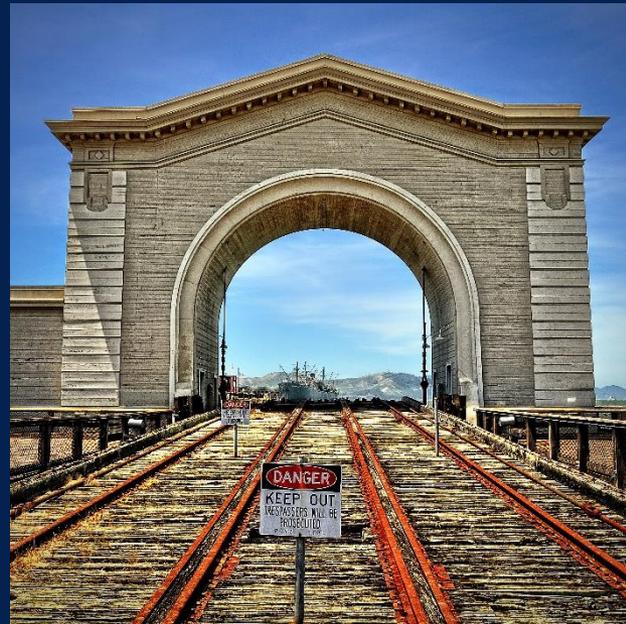
LIVE



WORK



VISIT



URBAN AND CULTURAL



HISTORIC



LIVE



WORK



VISIT



URBAN AND CULTURAL



HISTORIC



LIVE



WORK



VISIT



AUTODESK

PIER 9

LAW OFFICES
PIER 9

URBAN AND CULTURAL



HISTORIC



LIVE



WORK



VISIT



PARKS AND ECOSYSTEMS



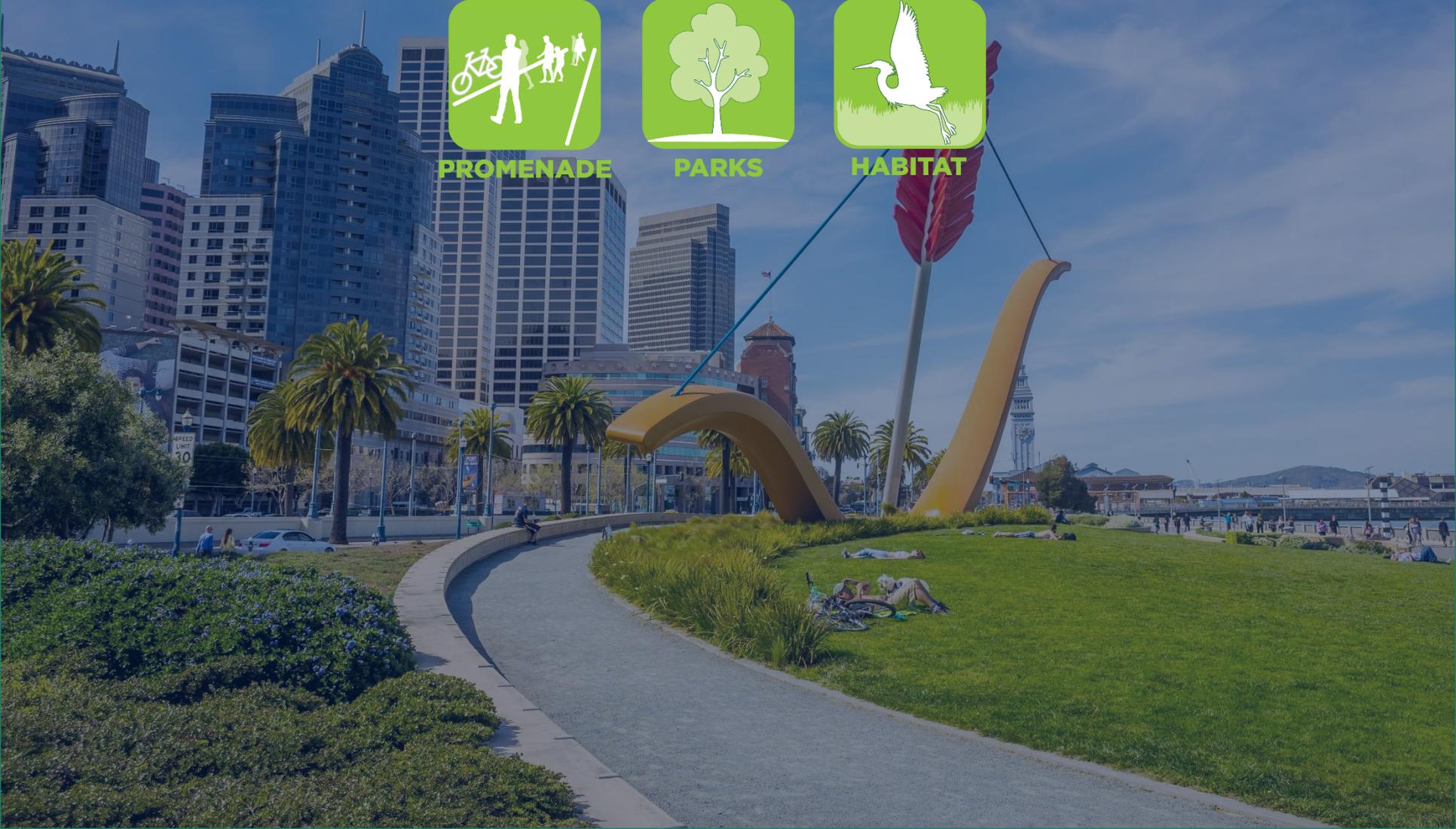
PROMENADE



PARKS



HABITAT



PARKS AND ECOSYSTEMS



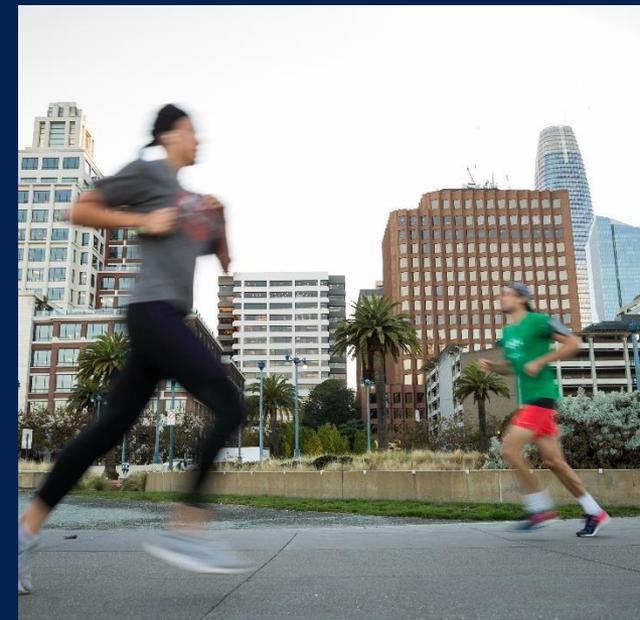
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PARKS



HABITAT



PARKS AND ECOSYSTEMS



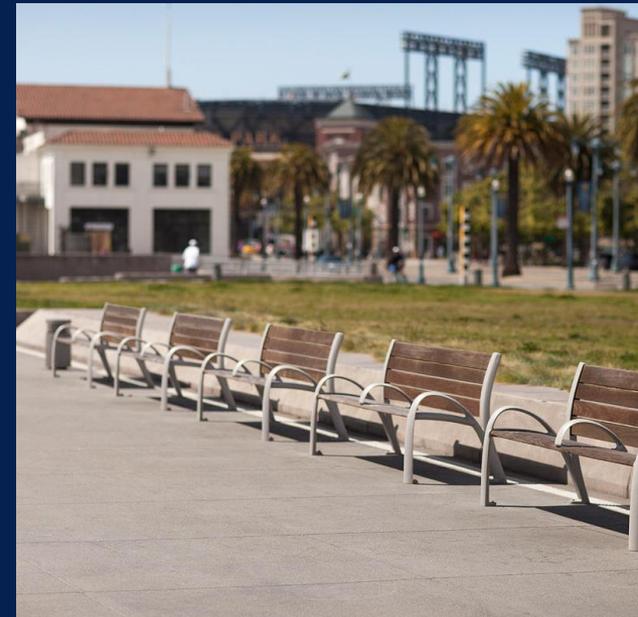
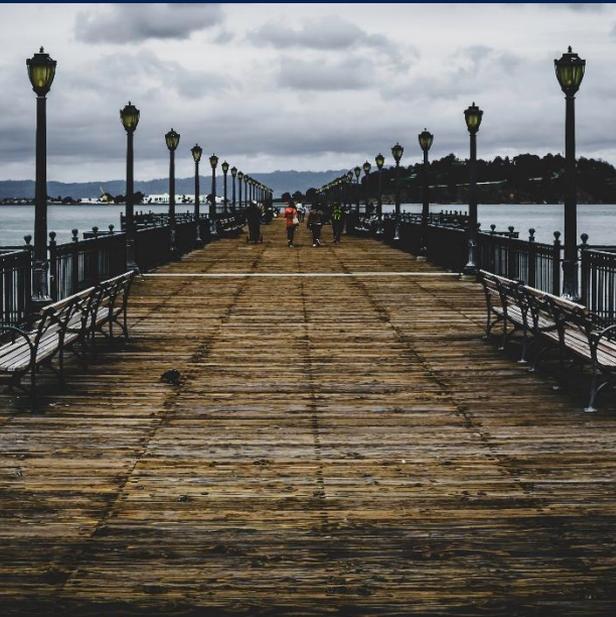
PROMENADE



PARKS



HABITAT



PARKS AND ECOSYSTEMS



PROMENADE



PARKS



HABITAT



MARITIME ASSETS



MARITIME &
PUBLIC TRUST



MARITIME ASSETS



MARITIME &
PUBLIC TRUST



MARITIME ASSETS



MARITIME &
PUBLIC TRUST



DISASTER RESPONSE



DISASTER
RESPONSE



DISASTER RESPONSE



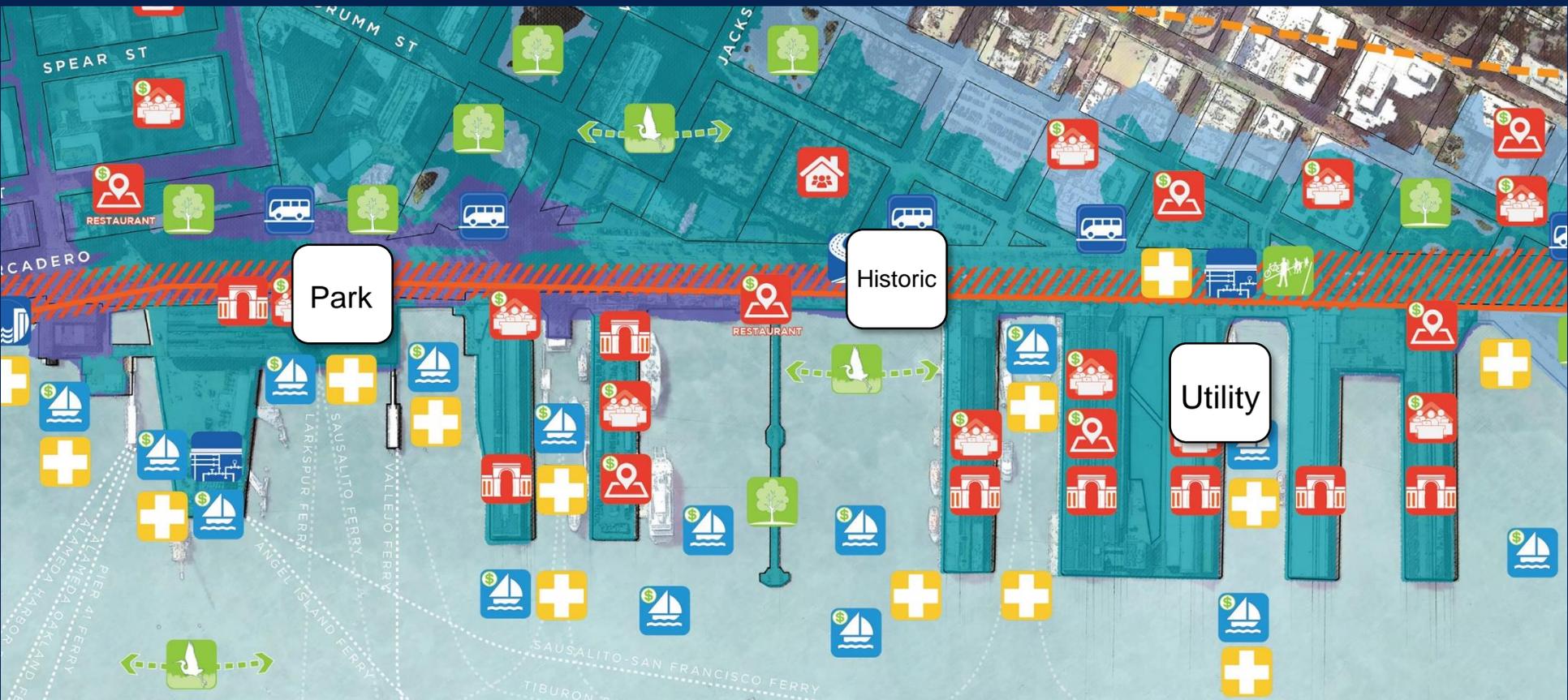
**DISASTER
RESPONSE**



STEP 1: STUDY THE MAP



STEP 1: AND TELL US WHAT WE MISSED



5 min

STEP 2: SAY WHAT YOU LOVE ABOUT THE WATERFRONT



STEP 2: AND WHAT IS MOST IMPORTANT TO THE CITY

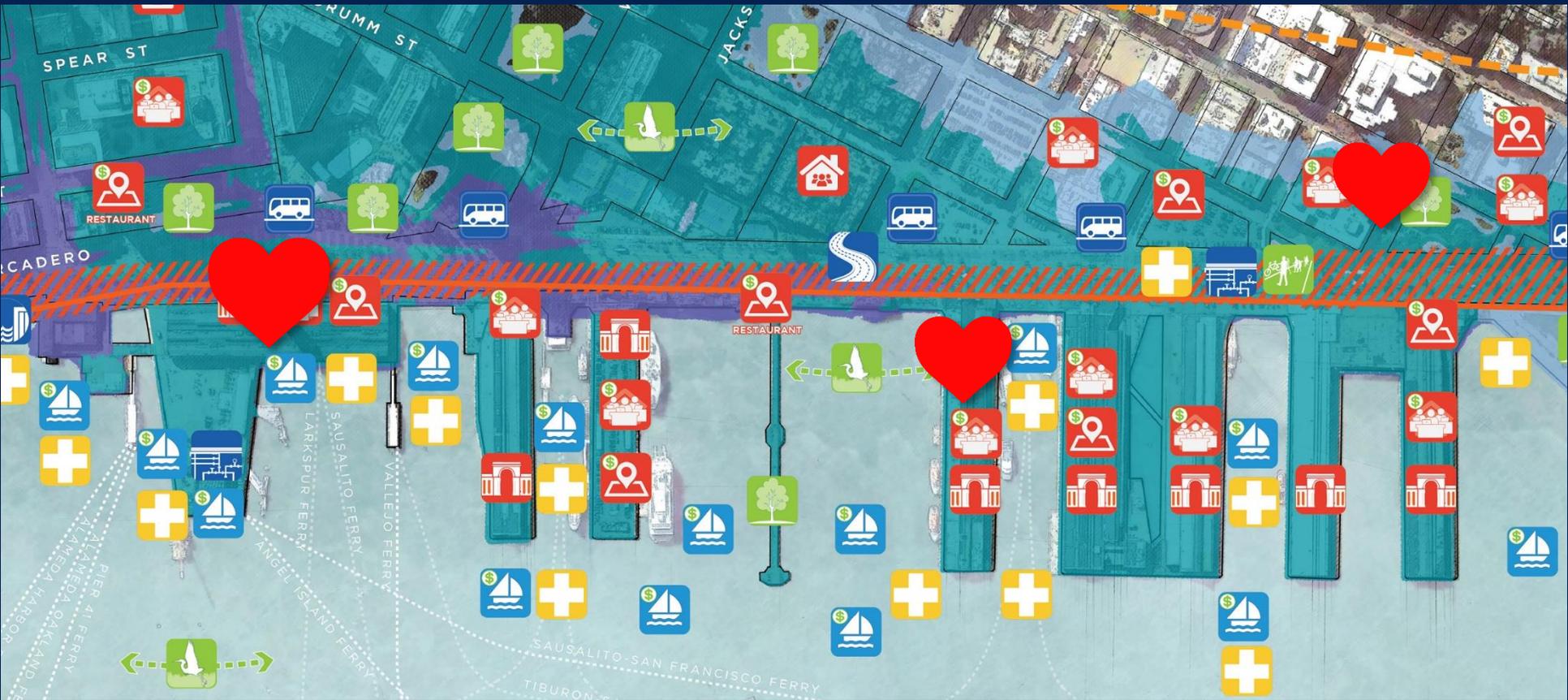


10 min

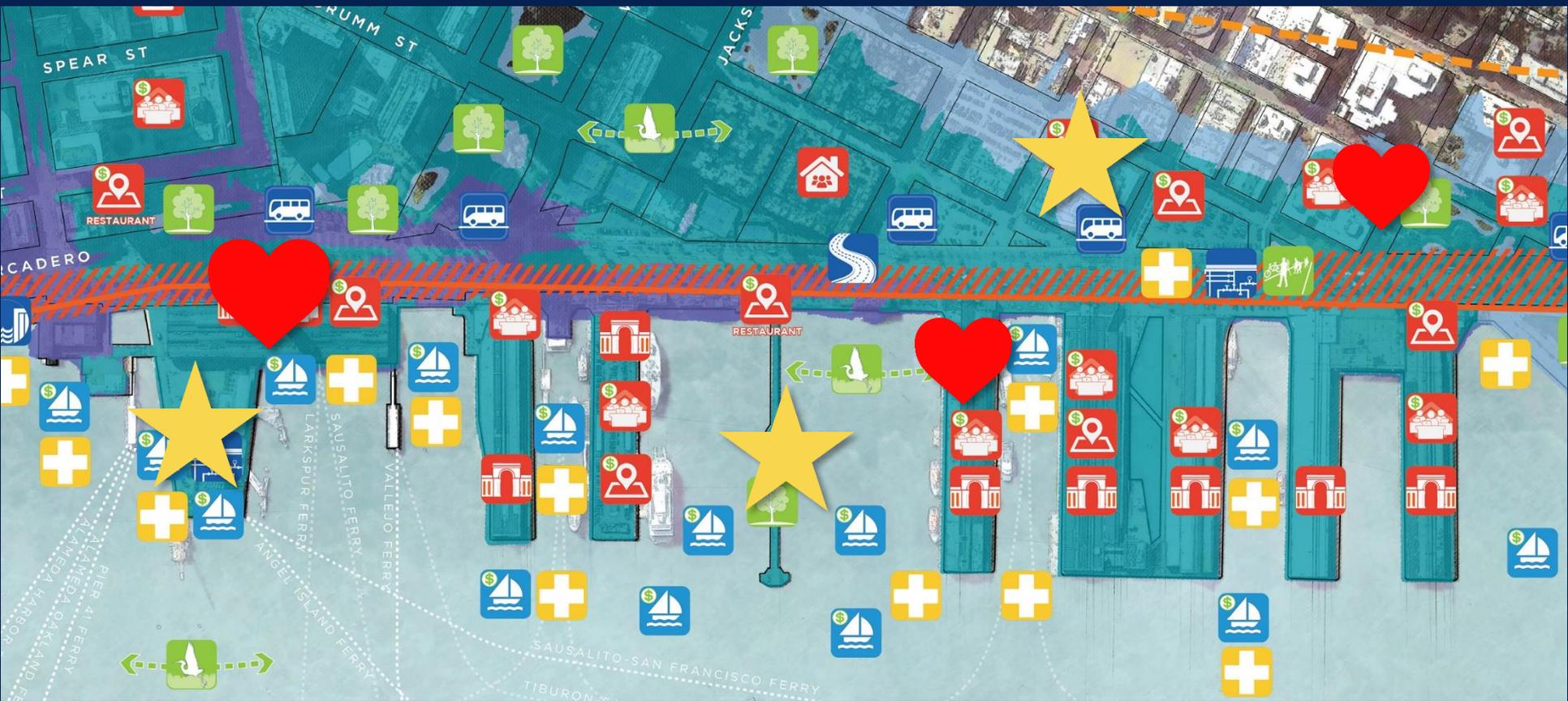
STEP 2: DECIDE WHAT YOU LOVE THE MOST AS A GROUP



STEP 2: DECIDE WHAT YOU LOVE THE MOST AS A GROUP

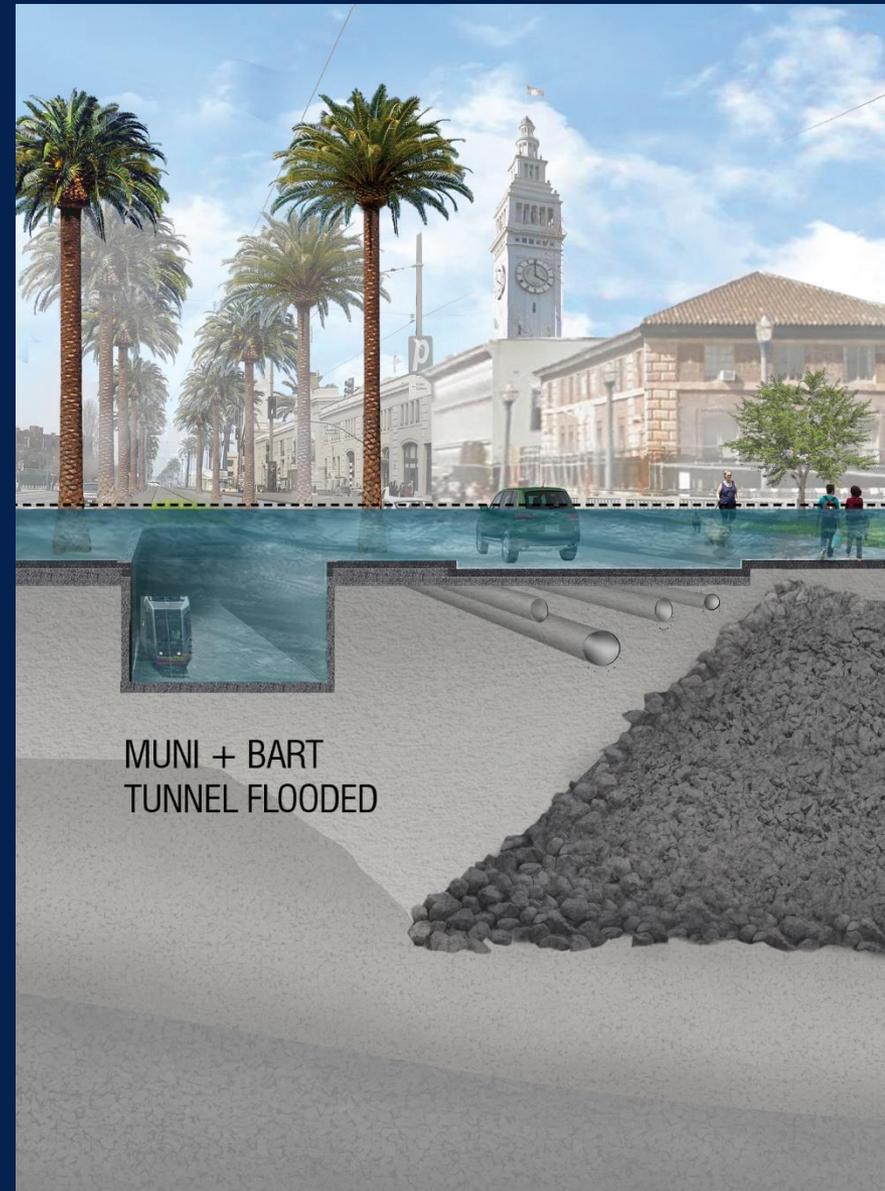
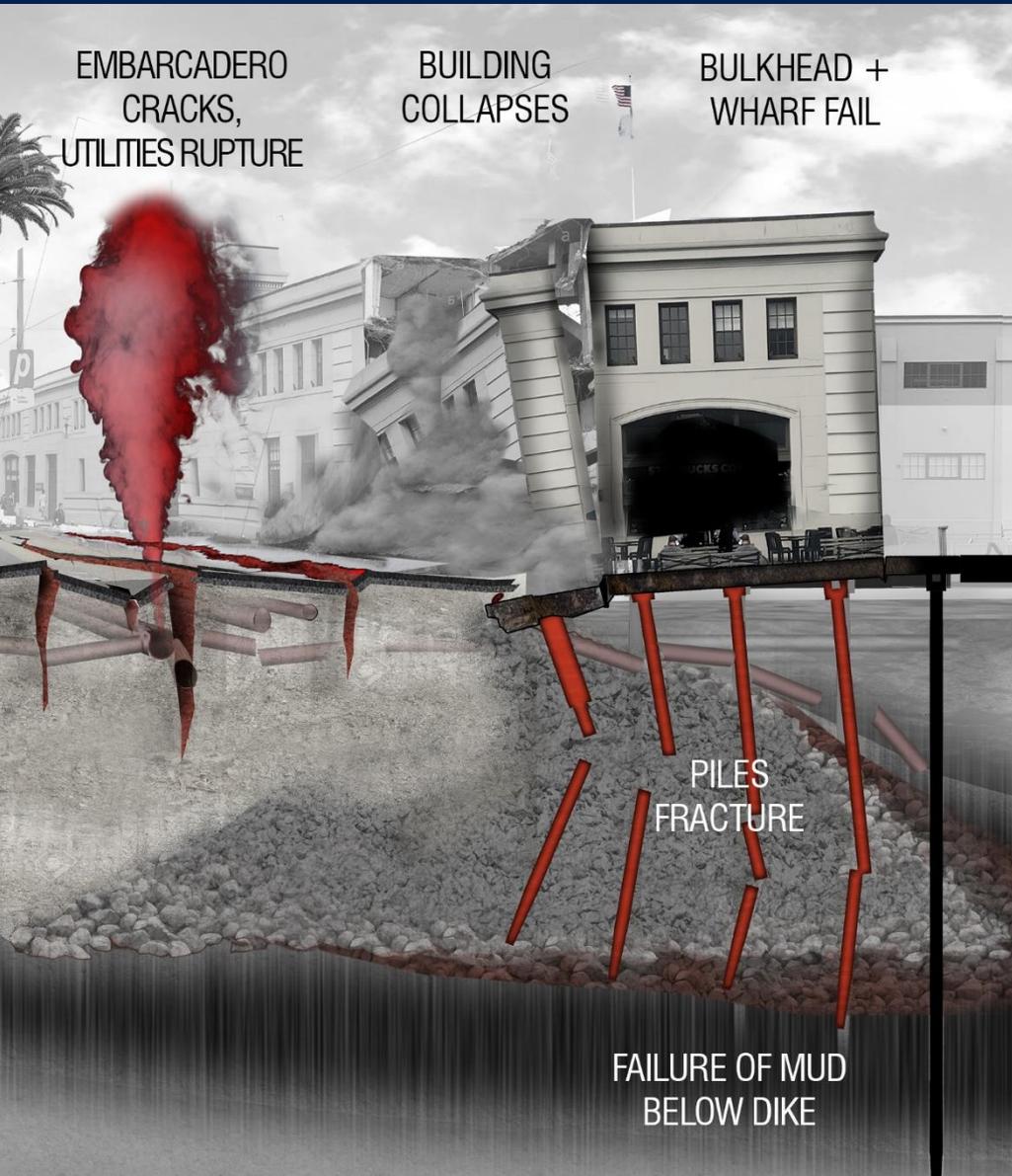


STEP 2: AND WHAT'S MOST IMPORTANT TO THE CITY



3 min

STEP 3: DISASTER STRIKES



...SHARE WHAT CONCERNS YOU THE MOST

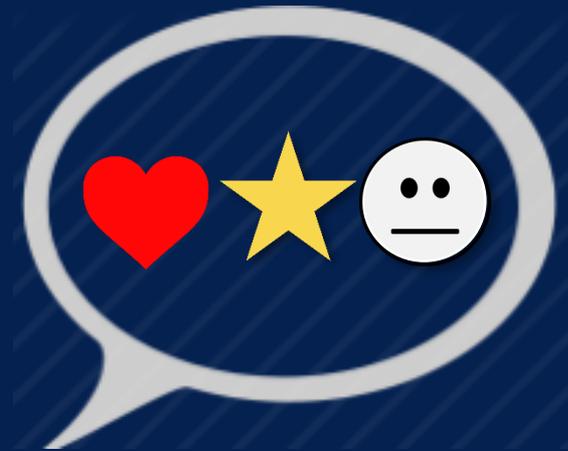


10 min

STEP 3: DECIDE AS A GROUP WHAT CONCERNS YOU THE MOST



STEP 4: REPORT OUT



6 min

TIME TO FORM GROUPS

Hello
my name is

AWESOME!

A stylized graphic of a city skyline in yellow and white, with a large yellow seawall structure in the foreground. The seawall is composed of several parallel yellow bars of varying lengths, creating a stepped effect. The background is a solid blue color.

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Thank you!

Pamela Conrad, Senior Associate
CMG Landscape Architecture