

# A Work-in-Progress:

## Integrating Engineering with Nature into USACE projects in the San Francisco Bay Area

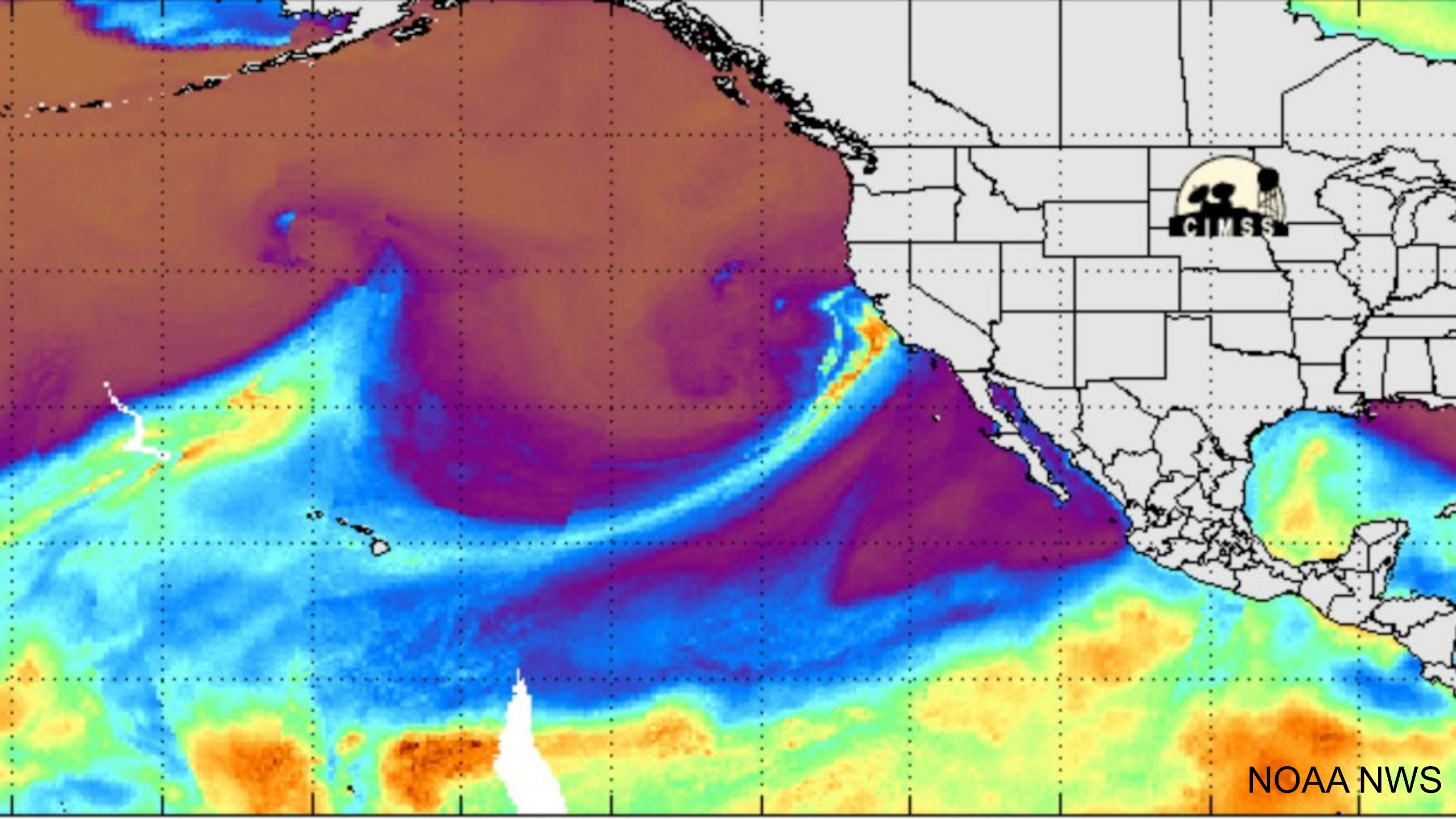
**Julie Beagle**  
**Environmental Planning Section Chief**  
**Engineering with Nature Practice Lead**  
**San Francisco District, US Army Corps of Engineers**  
**State of the Estuary Conference**  
**29 May 2024**



# KEY MESSAGES

- Adapting to climate change will require us to manage landscapes differently than we have in the past
- If we work with nature rather than fight against it, we will likely be more successful in enhancing resilience for species, habitats, and humans.
- There are real challenges between our status quo and where we need to be as the sea level rise and climate curves tick upwards.
- Collaboration across agencies, communities, and sectors will be increasingly important for equitable nature-based adaptation.





NOAA NWS













Bay Nature: Mill Valley, CA



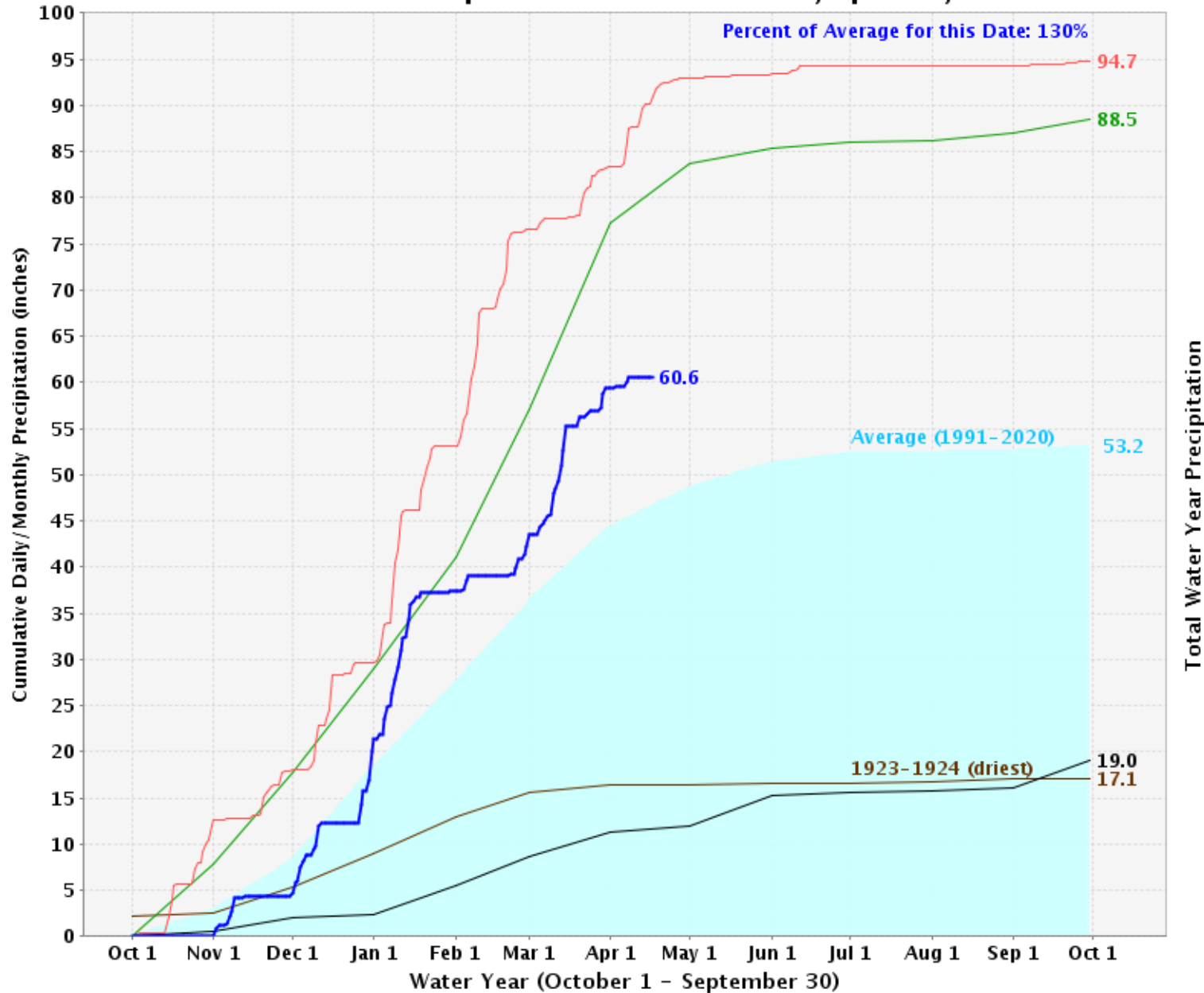


Wall Street Journal: Capitola shoreline



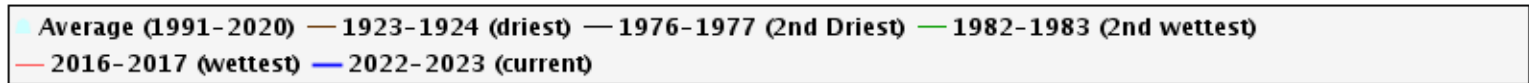
KSBW News: San Lorenzo River in Felton CA

# Northern Sierra Precipitation: 8-Station Index, April 17, 2023



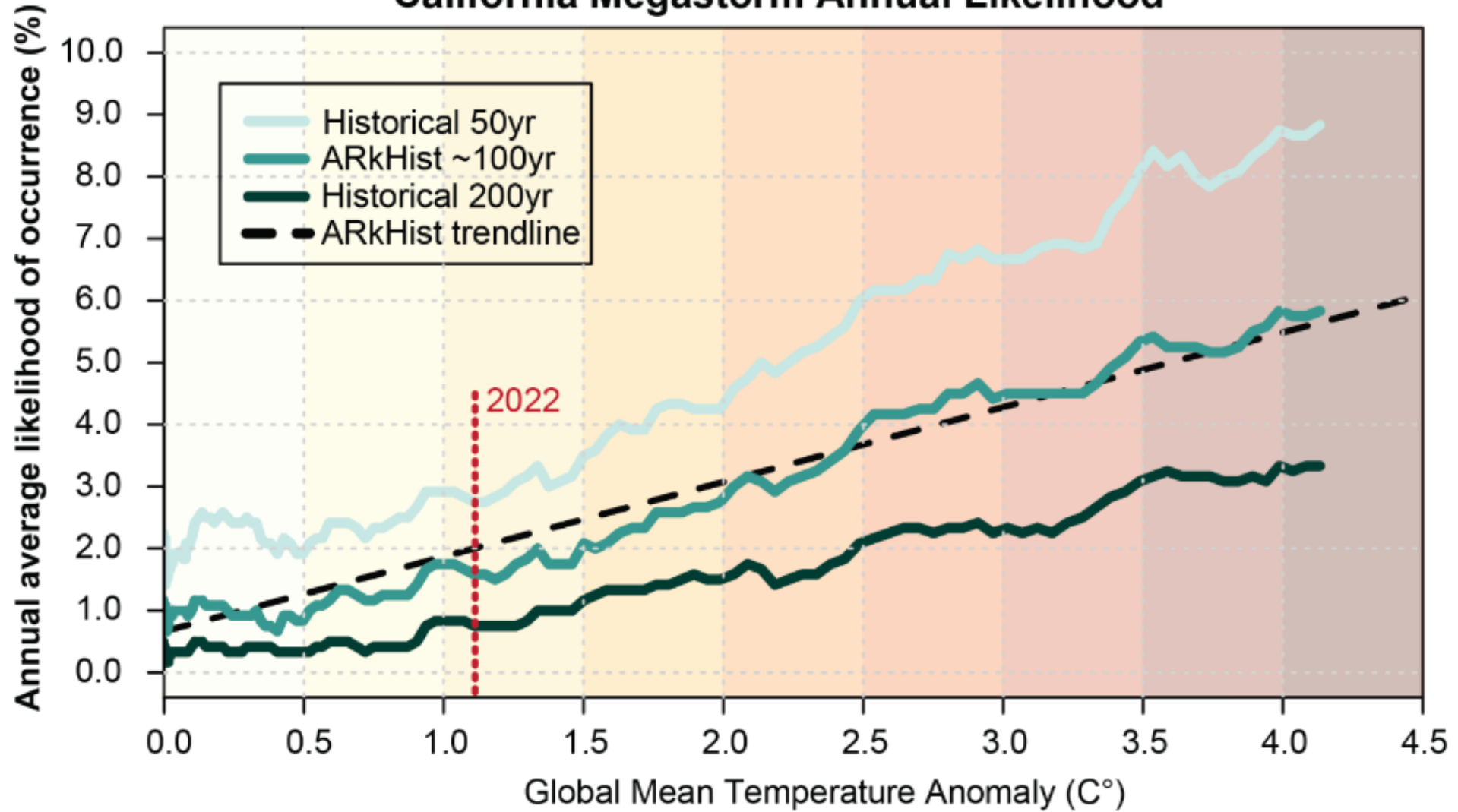
DWR

Cdec.water.ca.gov





## California Megastorm Annual Likelihood



The risk of a California megastorm event increases approximately linearly with global warming. Climate change to date has already doubled the risk relative to a century ago. (Adapted from Huang and Swain 2022)



# WHAT I HOPE TO CONVEY:

1. Intro to EWN and Natural and Nature Based Features (NNBF) and why they are more important than ever (climate change)
2. How they can be applied into USACE Civil Works projects
3. Challenges to overcome (including culture change)
4. How to collaborate and move the needle



# ENGINEERING WITH NATURE (EWN)



An engineering philosophy that uses natural and engineering processes to deliver economic, environmental, and social benefits, including:

- Flood, coastal storm, and erosion risk mitigation
- Ecosystem restoration
- Equitable outcomes for EJ communities
- Recreation
- Climate resilience

Nature-based solutions referred to as Natural and Nature-based Features (NNBF) in EWN context.





# What is nature-based adaptation?

Actions that **harness biodiversity and ecosystem services** to **reduce vulnerability** and **build resilience** to climate change.



Eelgrass



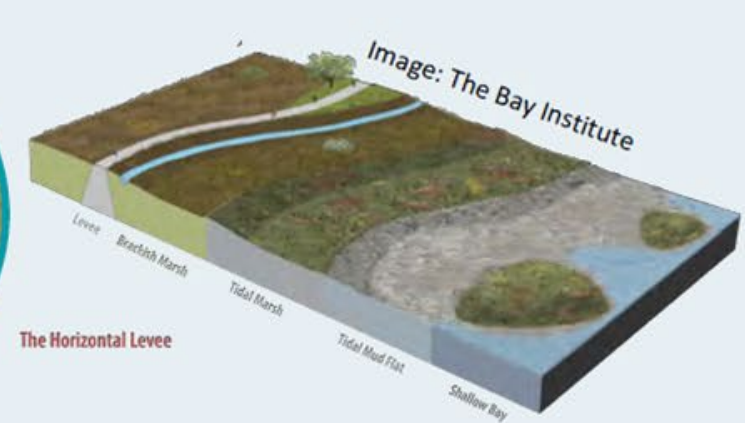
Oysters



Mudflats



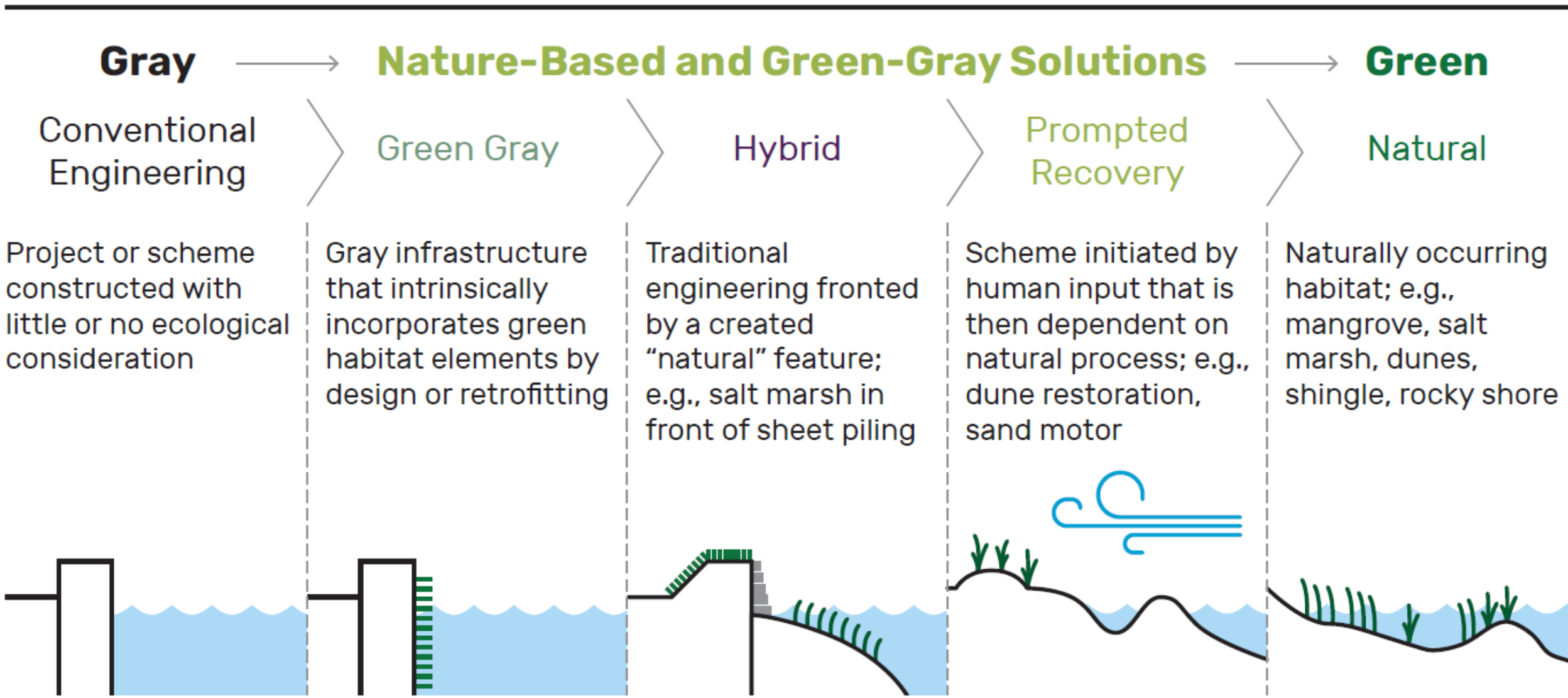
Marshes



The Horizontal Levee

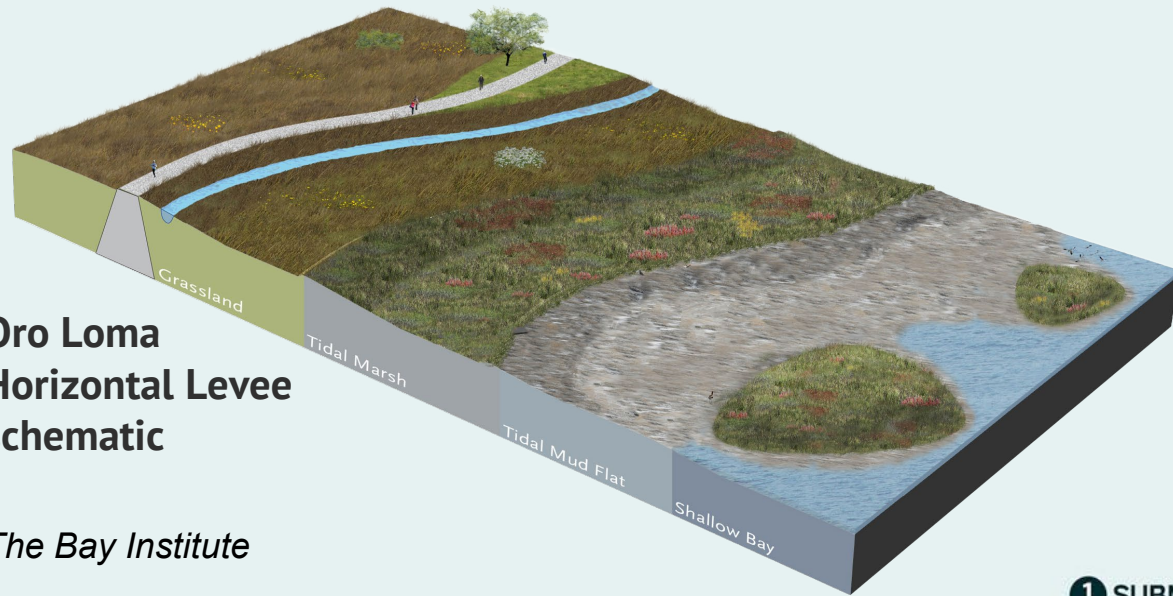
Ecotone levee  
(marsh + levee)

Range from fully natural → Hybrid (natural + engineered)





# EXAMPLES APPROPRIATE TO SF ESTUARY

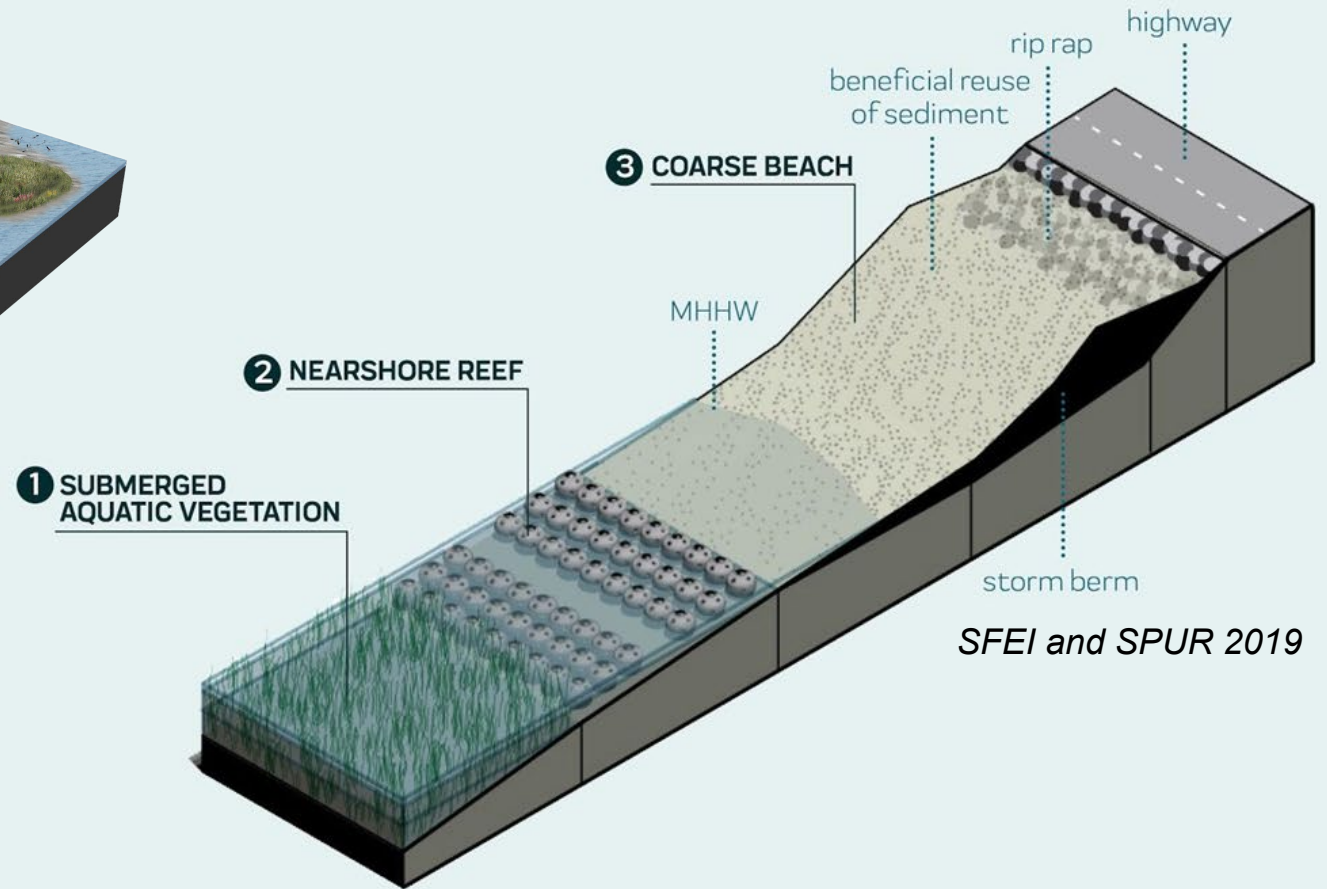


Oro Loma  
Horizontal Levee  
schematic

*The Bay Institute*



Arambaru beach enhancement project



*SFEI and SPUR 2019*

*Marin County DPW*

# USACE PROVING GROUND NETWORK

## Proving Grounds

Implement. Document. Share.

EWN Proving Grounds are USACE districts and divisions committed to the broad integration of EWN principles and practices into all business lines in the form of constructed projects. Proving grounds are places where innovative ideas are tested on the ground, throughout USACE missions. They document processes, project milestones, and lessons learned in the implementation of EWN measures so others can learn from their experience.



[Mobile District](#)



[San Francisco District](#)



[St. Louis District](#)

<https://ewn.ercd.dren.mil/>



# HISTORY OF CHALLENGES AT USACE

- **Lack of multi-benefit approaches**, budgeting, planning, policies, and business lines
- Knowledge **gaps** and unfamiliarity with options
- Inability to **measure benefits equitably**
- **Top-down** and **internally driven approaches** (as opposed to community and partnership-focused)
- “We’ve **always** done it this way”
- **Short-term** impact for **long-term** ecological benefit

# INSTITUTIONALIZING EWN

## NOW

USACE pursues and supports EWN and EJ opportunistically and on a project by-project basis.

**2030**  
USACE consistently delivers EWN and EJ outcomes in all services, products and collaborations

Invest in **PEOPLE**  
Build **PORTFOLIO**  
Develop **PROCESS**  
Develop and test **POLICY**  
Grow **PARTNERSHIPS**



# CULTURE CHANGE

Educate – Outreach – Share – Adapt  
Learn – Experiment – Partnerships

## Getting to Yes with EWN Interactive Training

By **Tammy L. Reed** / USACE SAN FRANCISCO DISTRICT

Published Nov. 6, 2023 / Updated: Oct. 18, 2023



## S7 E3 A Personal Journey To Make NBS “Just Part Of The Fabric” In The San Francisco District

Air Date: February 21, 2024

Season 7 Episode: 3 38 minutes



PREVIOUS



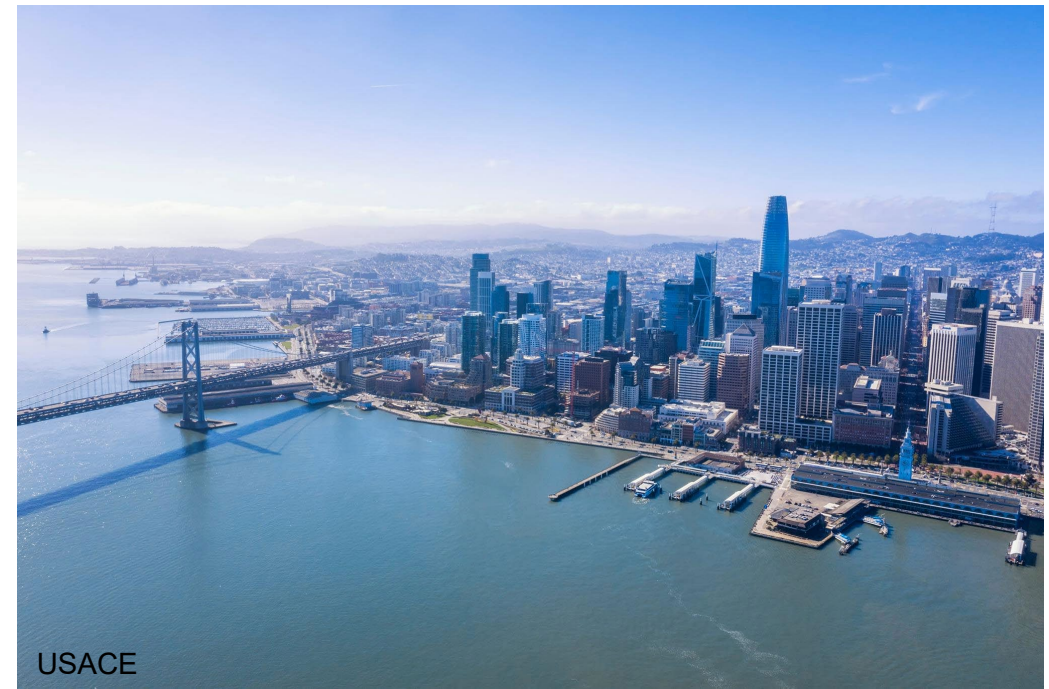


# CASE STUDY: SF WATERFRONT

- **Coastal Storm Risk Management Study** for 7 miles of shoreline
- **Highly-urbanized** iconic shoreline, wealth disparities
- SF Port-led **EWN working group** to integrate nature-based features equitably across the project area
- **Drawing on experience** in Australia, Seattle, New York, and other steep urban shorelines

~~Public comment period until March 29, 2024~~

<https://sfport.com/wrp/draft-report>



USACE



Cris Benton, Flickr



# NATURE IS ALREADY HERE



**Sea Lions, Pier 39**

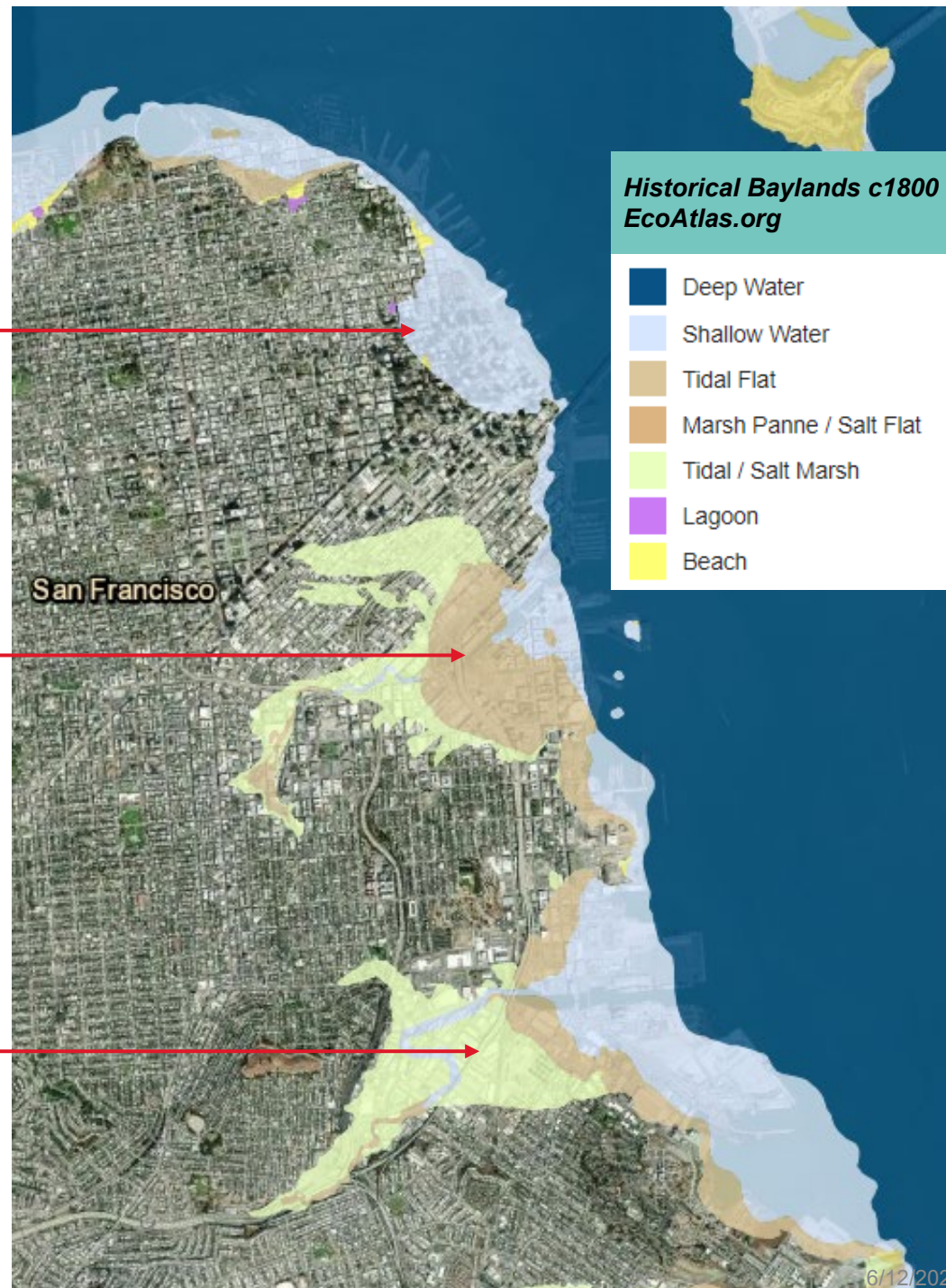
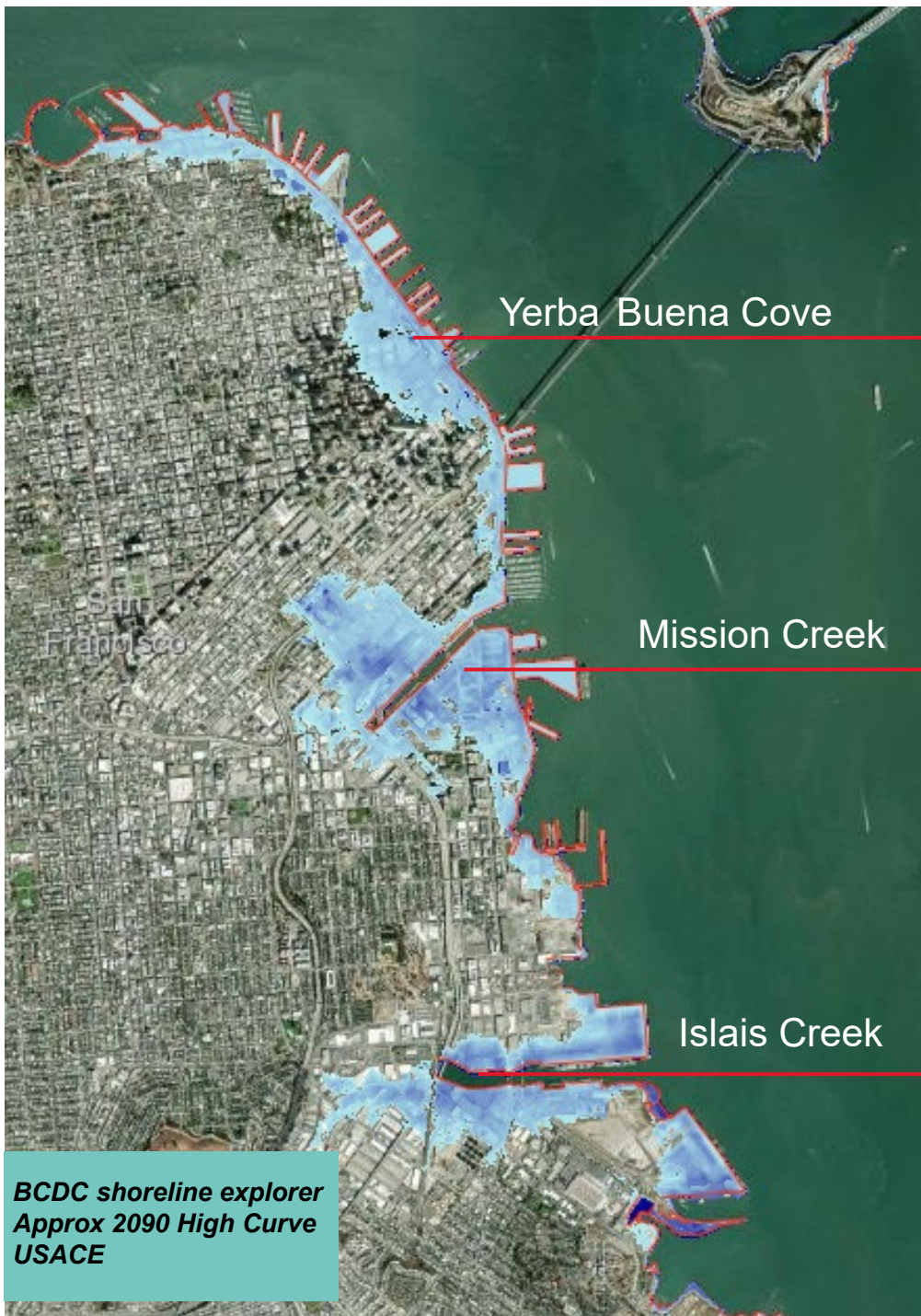
Source: Wikimedia Commons



**Pier 94 + Islais Creek Backlands**

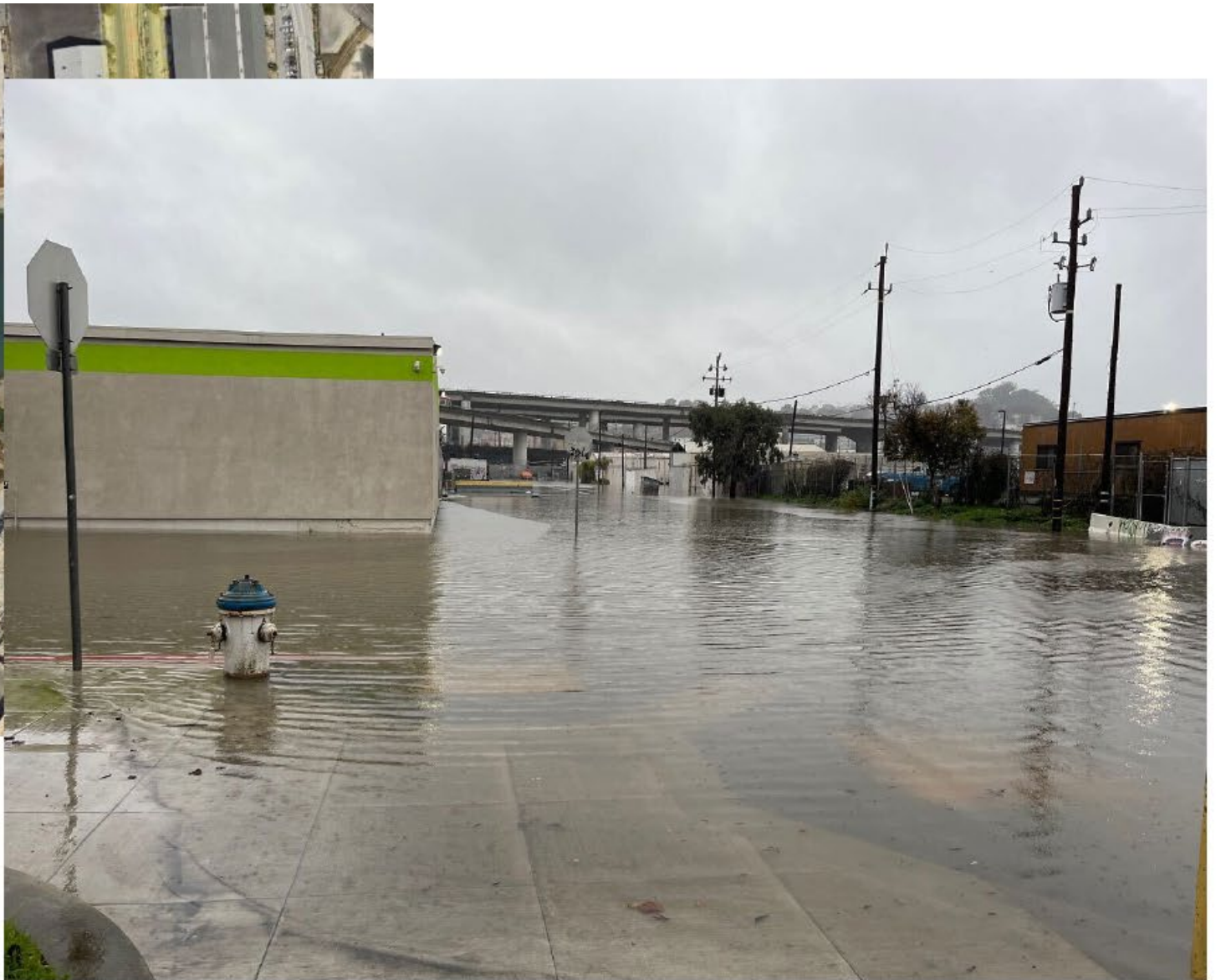
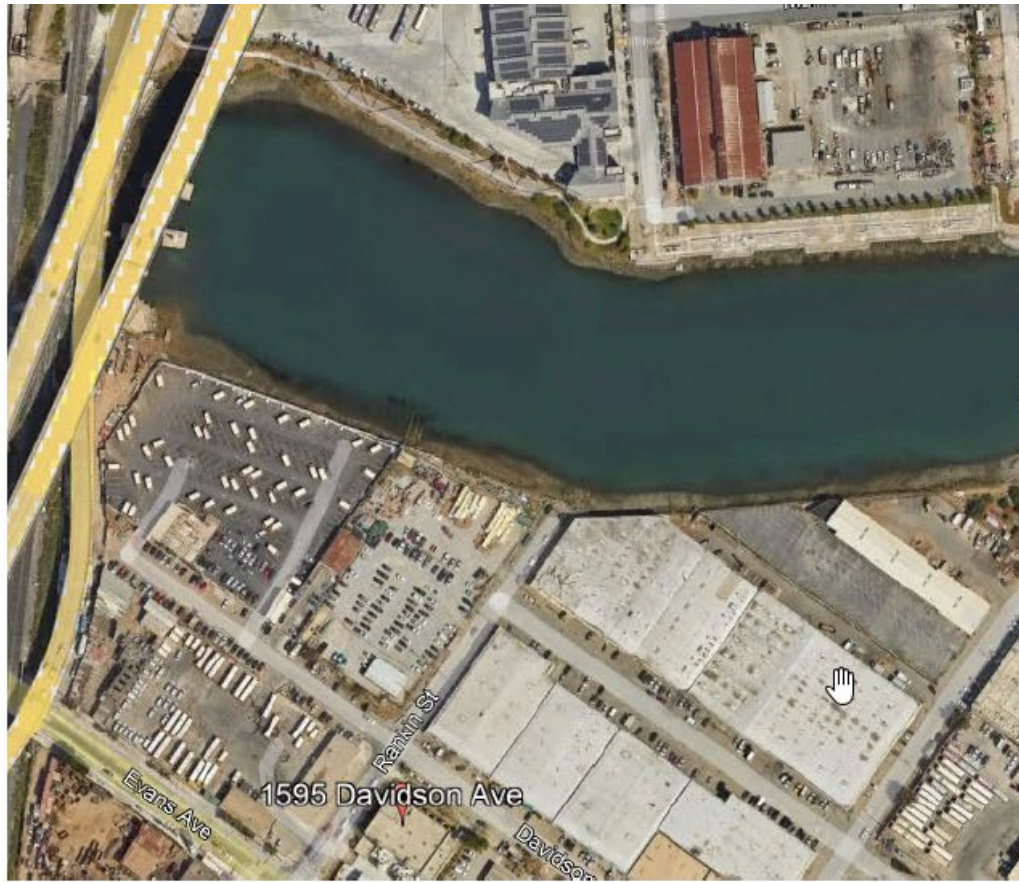
Source: Port of SF







# FLOODING – ISLAIS CREEK



March 2023



# GOAL OF EWN WORKING GROUP



Identify a **range** of potential opportunities to integrate EWN measures , which will then be subject to further analysis (cost-benefit, feasibility, environmental impact)



# EWN WORKING GROUP

- Local, national, and international leaders/practitioners
  - Experts in Bay geography, history, ecology
- 6 workshops between May 2022-Jan 2023
- Identified appropriate NBS
- Criteria to help guide the incorporation of NBS
- Knowledge gaps and potential pilot projects

Input was refined by the Port's consultant team and workshopped with the SF Waterfront Team



## Ideas from Workshop 1

- perched spending beaches @ base of wall + pilings
- Light-penetrating materials in nearshore area
- Seawall texturing/ Living seawall
- herring habitat
- Piling habitat
- low CO2-emitting concrete / enzymatic concrete materials

# Opportunity for a new relationship between the city and natural systems

## Historical

Varied habitat types across interconnected coastal and riparian systems



## Today

Limited patches of habitat and disconnected environmental systems



## Hybrid Opportunity

Layer in naturalized edges, strategically re-connect habitats and restore natural systems





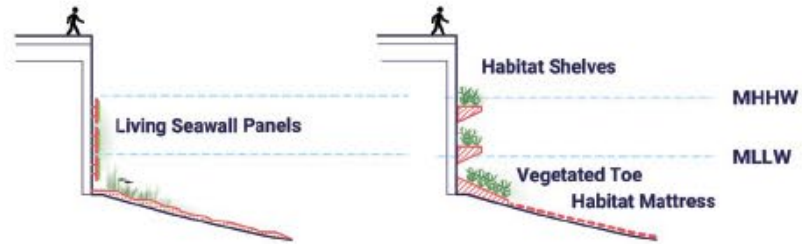
# Natural and Nature-Based Features (NNBFs)

Included in EIS Report

*Coarse Beach*



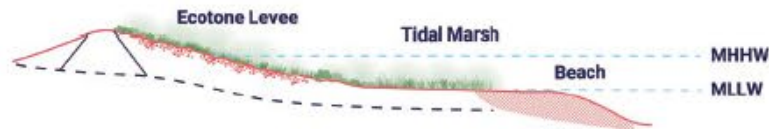
*Living Seawall*



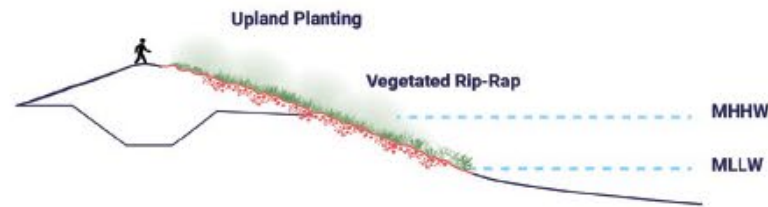
*Wetland Creation*



*Ecotone Levee*



*Embankment Shoreline*



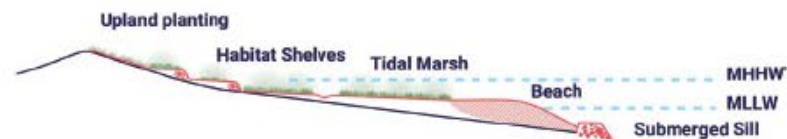
*Enhancement of Existing Wetlands*



*Ecological Armoring*

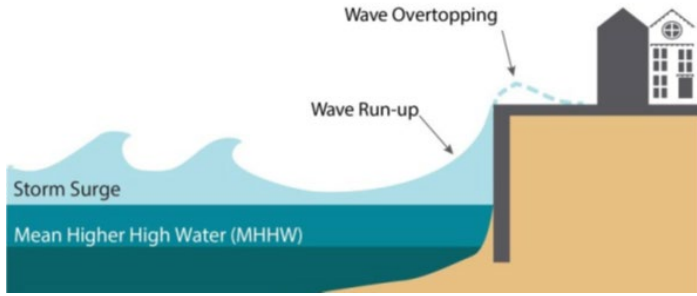


*Naturalized Shoreline*



*Creek Enhancements*





- Reducing/dissipating wave energy
- Reducing wave run-up
- Reducing erosion

### Coastal Storm Risk Reduction

- Marine economic uses (e.g., fishing)
- Coastal asset risk reduction

### Economic

## MULTIPLE BENEFITS

### Infrastructure

- Extending typical lifespan
- Can reduce O&M costs

### Social

- Improving access to the Bay and nature
- Increasing educational opportunities

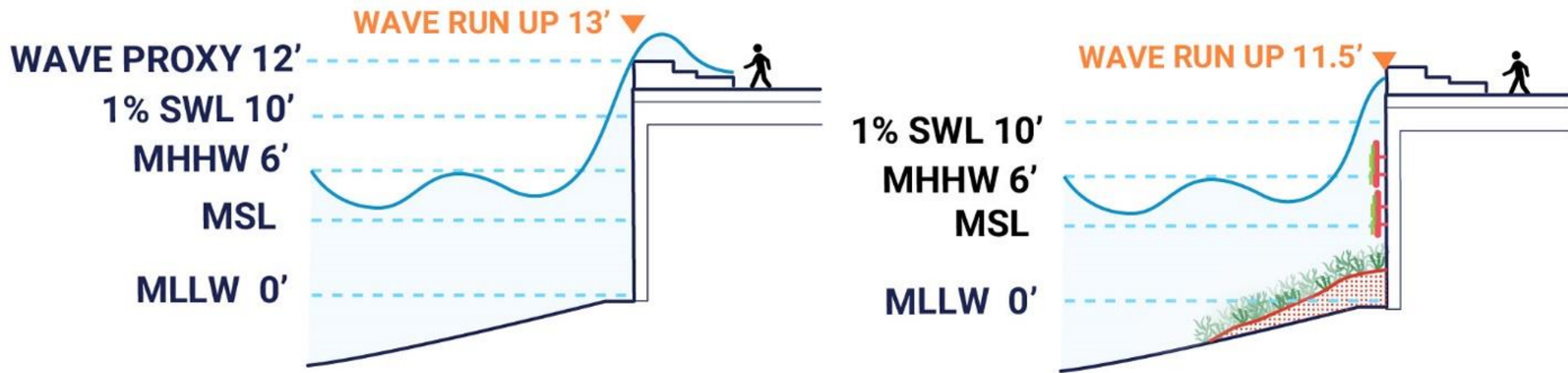
### Environmental

- Providing varied habitat for a range of species
- Reducing inland stormwater flooding
- Connecting existing habitat patches



**Coastal Storm  
Risk Reduction**





Source: Pathways Institute, CMG

Caption: On the left, the wall height exceeds the 1% AEP stillwater elevation (10 feet NAVD88), but the 1% AEP wave run up elevation is 13 feet NAVD88, exceeding the 2-foot wave proxy by 1 foot and overtopping the wall. On the right, hybrid structures in the lower intertidal area coupled with surface texturing on the upper intertidal area that attract native biota help dissipate wave energy, resulting a 1% AEP wave runup elevation of 1.5 feet and therefore not overtopping the wall (11.5 feet NAVD88).

## Figure I-8: Wave Runup Reduction with Hybrid Green-Gray Measures



# ENVIRONMENTAL JUSTICE/EWN

## Social

- Burdened populations in Reaches 3 and 4
- Port did outreach with fishing community in three languages to understand recreation needs/interests for EWN

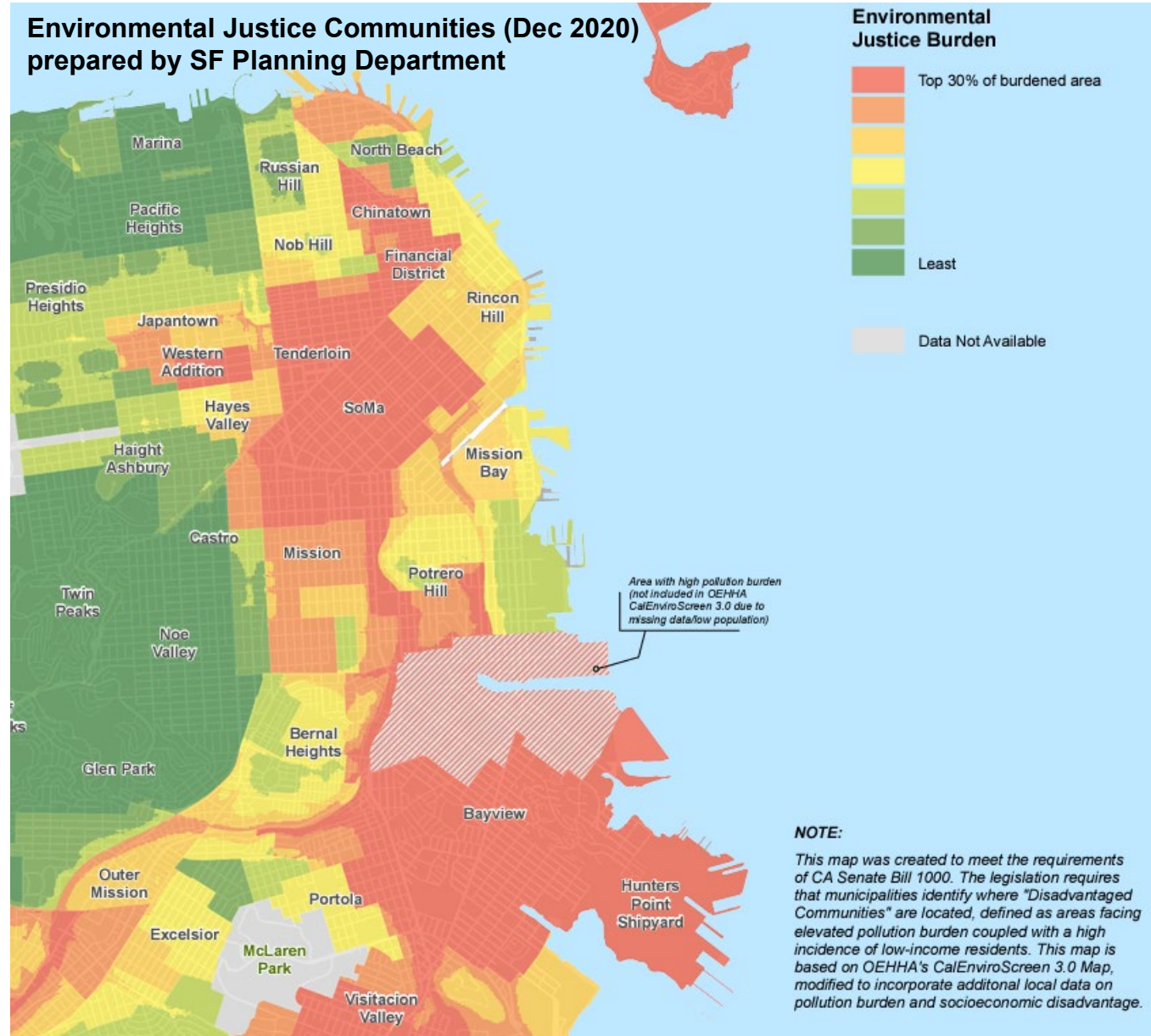
### INDICATOR(S)

#### Pollution exposure:

- Ozone
- PM2.5
- Diesel particulate matter
- Pesticide use
- Toxic release from facilities
- Cleanup sites
- Hazardous waste generators and facilities
- Solid waste sites and facilities
- Drinking water contaminants
- Traffic density

#### Population characteristics:

- Educational attainment
- Linguistic isolation
- Poverty
- Unemployment
- Housing burdened low-income household
- Asthma
- Cardiovascular disease
- Low birthweight infants



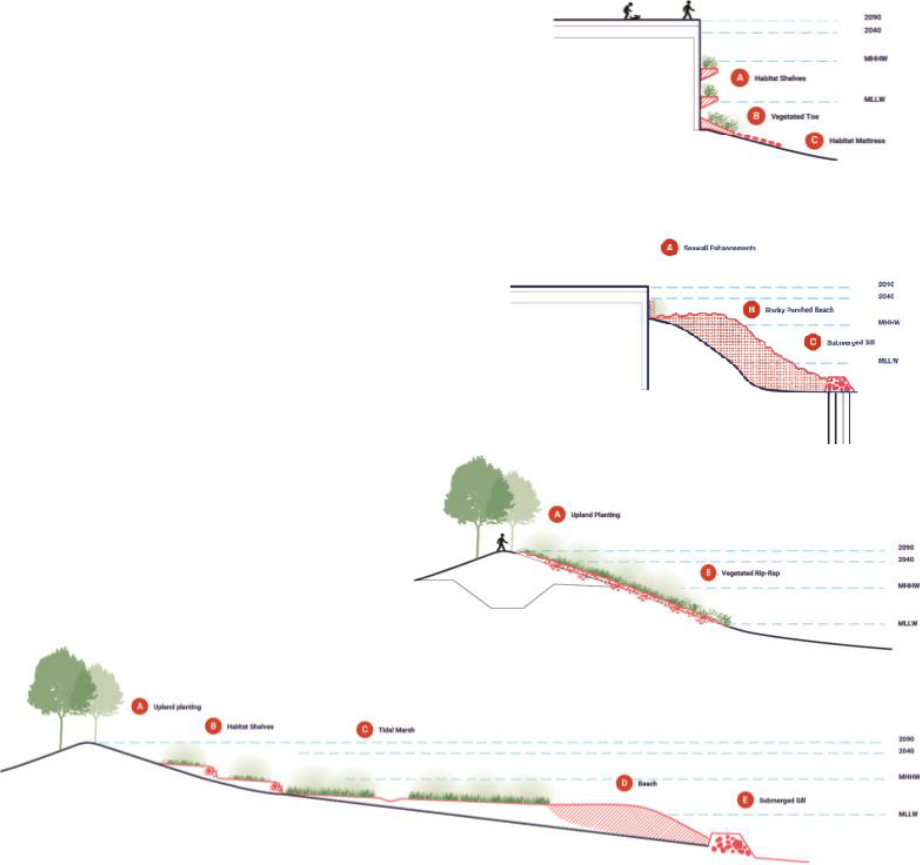
# ADAPTABILITY OF EWN SHORELINE TYPES

Vertical Structure

Perched beach/marsh

Embankment

Naturalized Bayland



Narrower section/  
more constrained



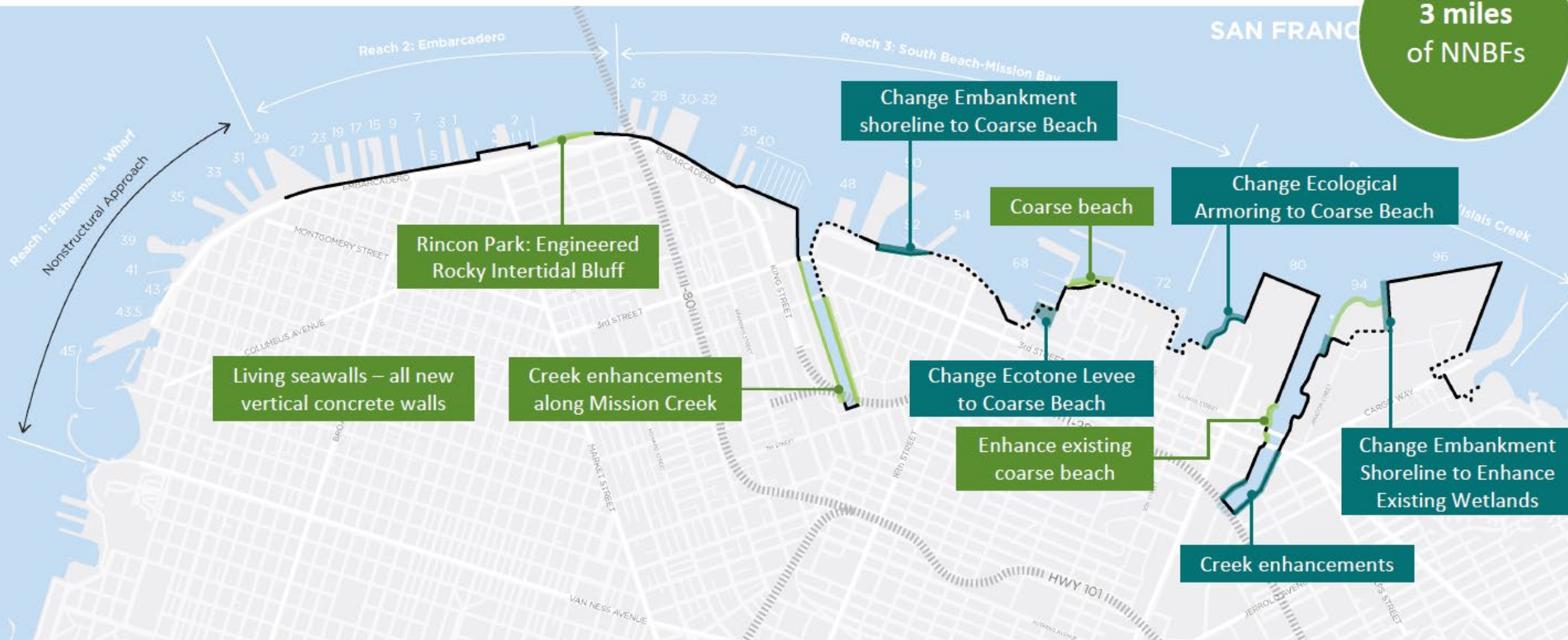
Wider section/more  
opportunities



# DRAFT OPTIMIZED EWN PLAN

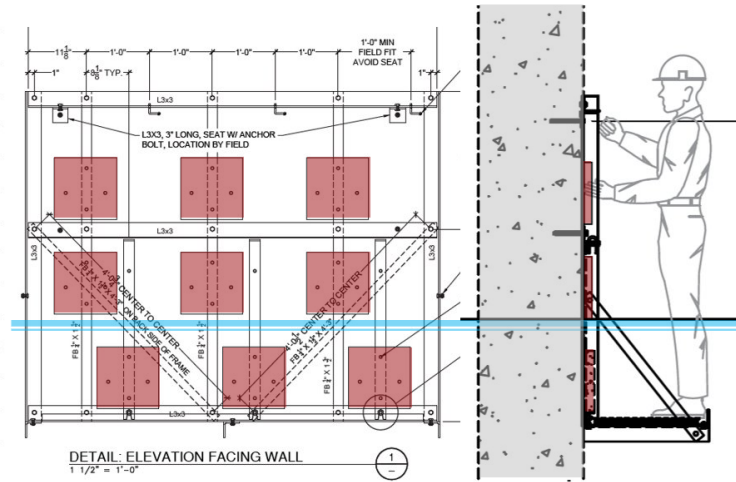
## Proposed NNBFs

3 miles  
of NNBFs



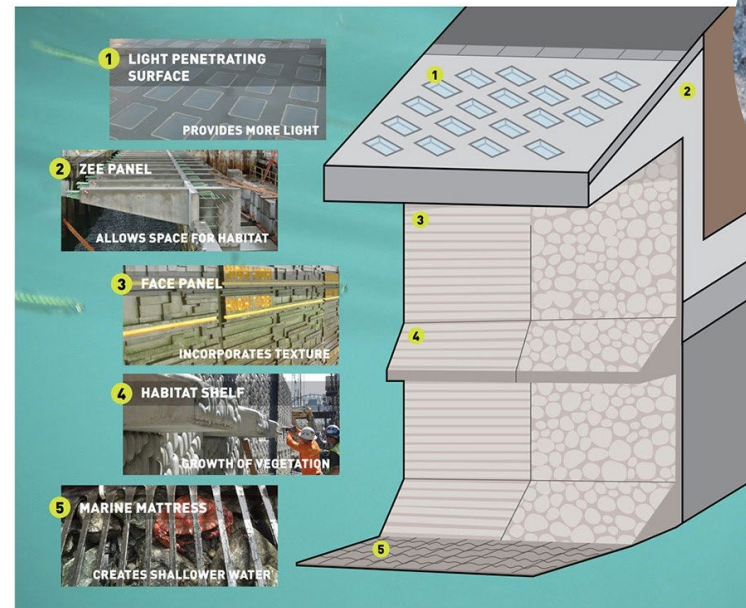
# EWN LIVING SEAWALL

- **Assumption:** none to very small amount of additional fill for habitat
- **Opportunity** for new seawall construction in suitable locations
- **Can be designed** to target desired species



## BENEFITS

- **Flood risk reduction benefits:** may provide modest wave attenuation benefits, depending on design
- **Ecosystem benefits:** Enhance diversity and complexity of hardened habitat
- **Community benefits:** Support fishing community and improve interest for maritime recreation





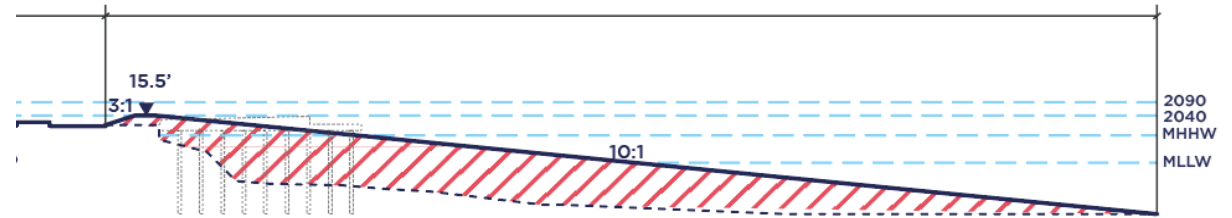
# EWN INTEGRATION

## Coarse Beach

- Width: Varies (120' - ~280')
- Height: up to 2-3' of elevation gain
- Slope: Coarse beach 10:1

### BENEFITS

- **Flood risk reduction benefits:** reduce wave run-up; reduce wave energy; Opportunity to establish habitat patch of more meaningful size + create stepping stones connecting to regionally significant patches
- **Ecosystem benefits:** Off-site mitigation opportunity;
- **Community benefits:** Climate justice neighborhood with limited open spaces access; Opportunity to improve recreational connectivity to Bay + Water Trail; Improve availability and access to waterfront open space for existing neighbors + future developments (Other sites)



Marsh-fringing barrier beaches in South Bay SFEI

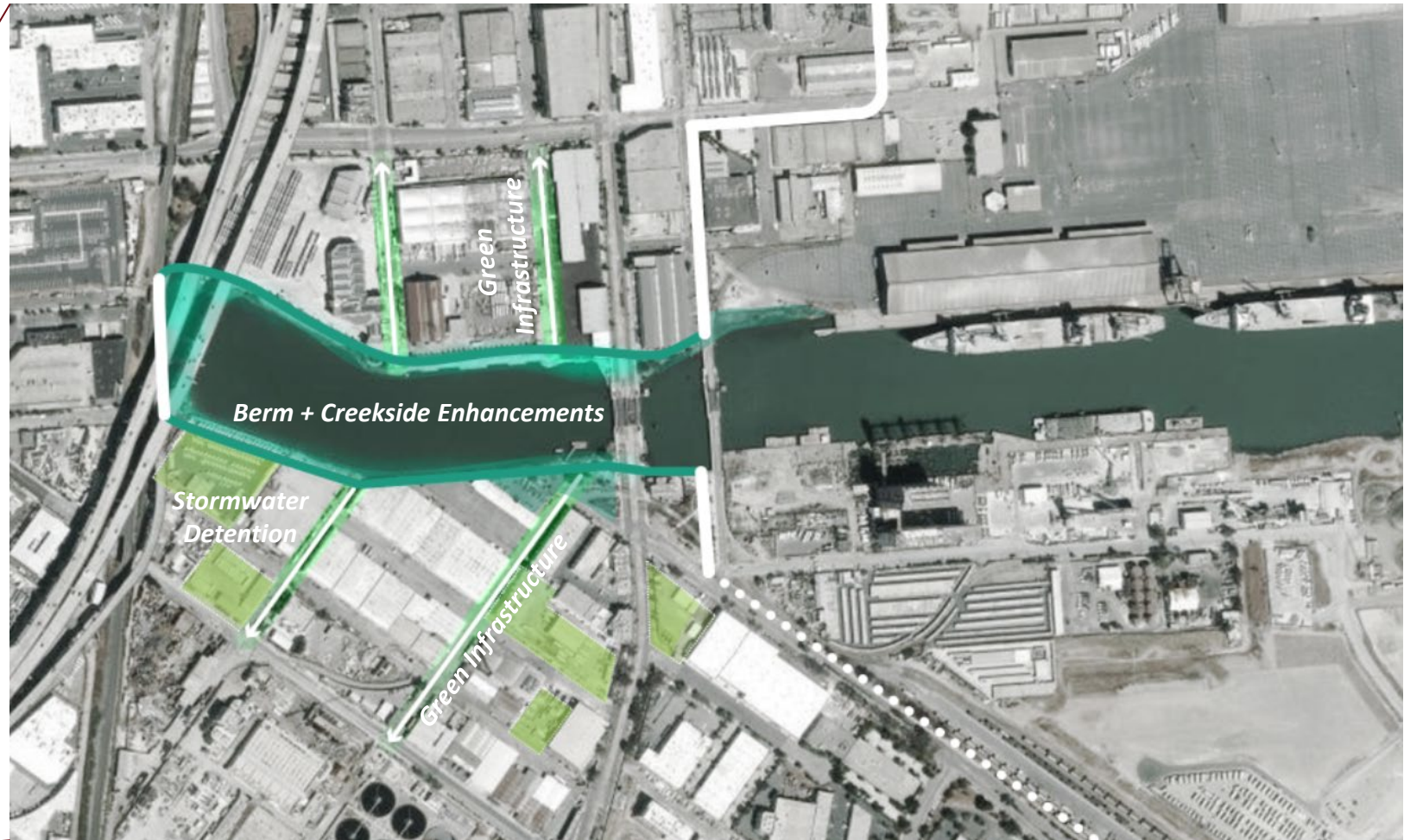
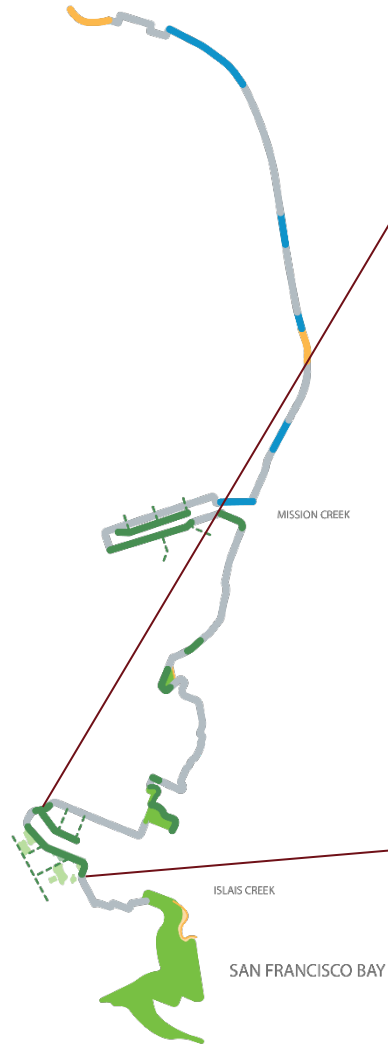


Late stage development barrier beaches at Pier 94 April 2018, SFEI

# EWN INTEGRATION

## Big Moves

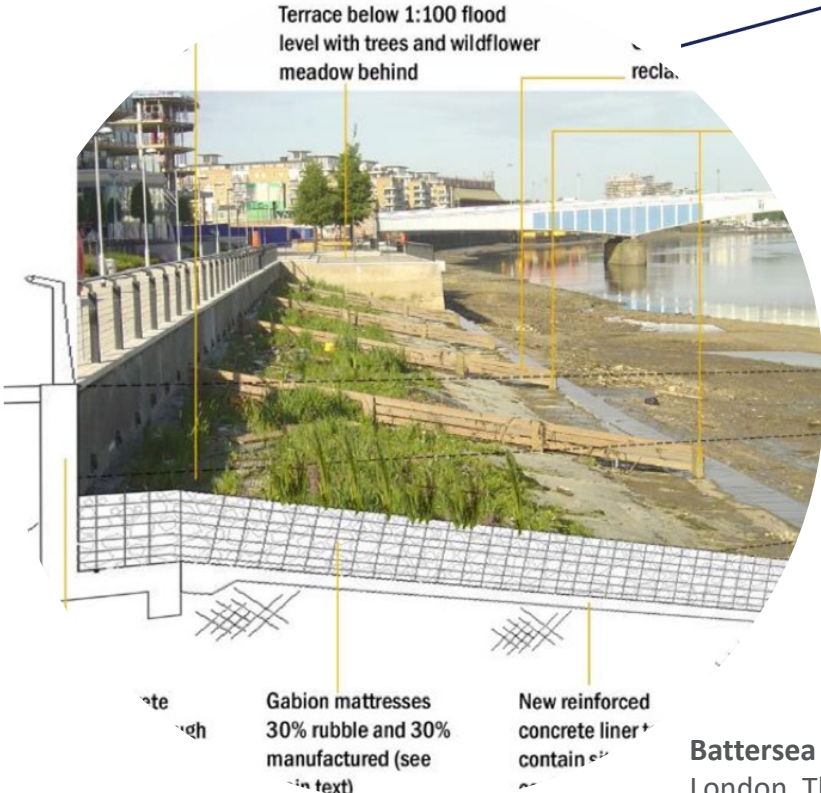
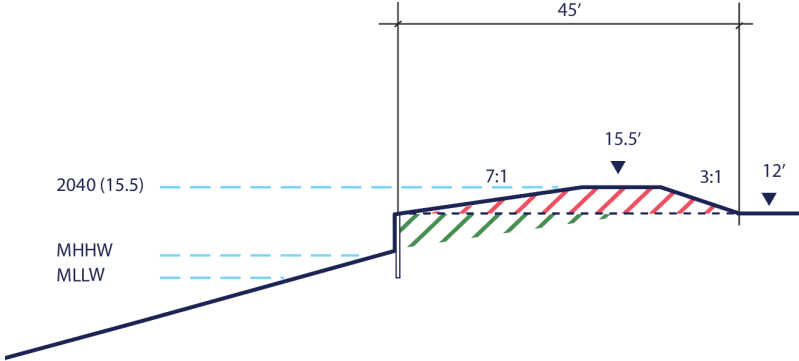
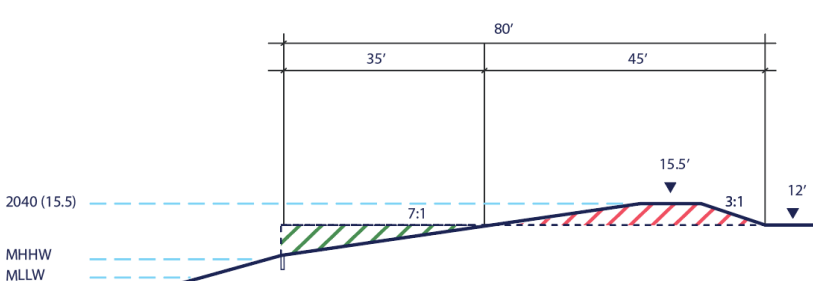
Strategy G  
2040





# EWN INTEGRATION

## Berm + Creekside Enhancements



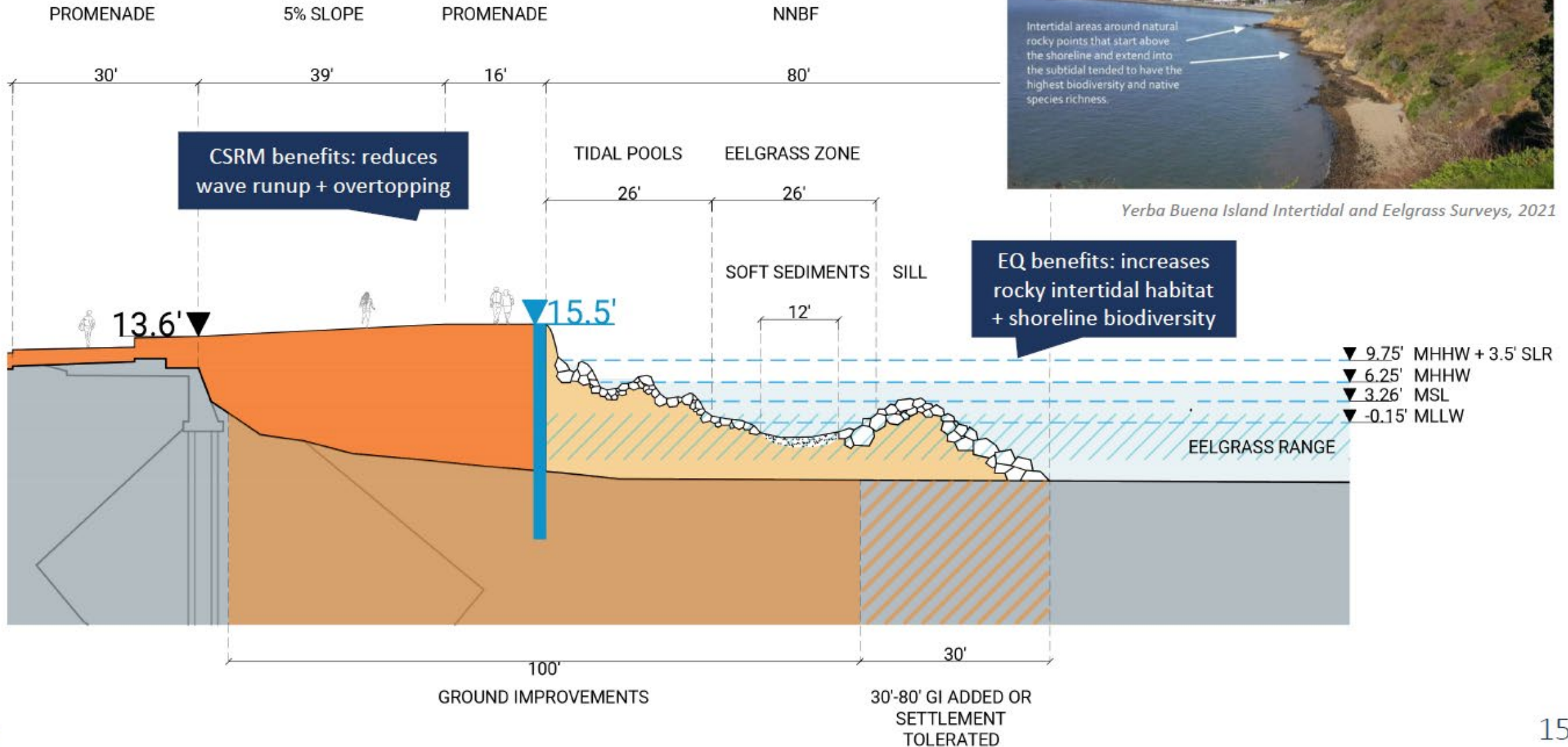
Battersea Reach habitat terraces London, Thames Estuary Edges

### BENEFITS

- **Flood risk reduction benefits:** mitigates erosion; mitigates stormwater flooding collected behind LOD (detention)
- **Ecosystem benefits:** Mitigate stormwater runoff impacts to water quality; Habitat + biodiversity corridors - green infra. connects terrestrial to aquatic habitats
- **Community benefits:** Climate justice neighborhood with limited open spaces access; Could be tied to contamination remediation/clean up - improve environmental health impacts to communities

# ENGINEERED ROCKY INTERTIDAL BLUFF

## Concept Section





# NEXT STEPS

- How much **wave runup reduction** do NBS provide?
- Tradeoff between **Fill** and **habitat/shoreline softening**?
- How much does this all **cost**?
- Public comment period end of March 2024.
  - **Make your voice heard!**
- Project will go on for several more years. More opportunities to **refine/design/engage** etc.



*The Port of San Francisco's Heron's Head project constructed a gravel beach to protect a restored marsh from erosion, completing work in late 2022. This tiny urban marsh supports shorebirds and federally-protected species, and provides waterfront access and open space to communities in nearby Hunter's Point. Photo: Port of San Francisco.*



# THANK YOU

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[ewn.erdc.dren.mil/proving-grounds/region/san-francisco/](http://ewn.erdc.dren.mil/proving-grounds/region/san-francisco/)

