

# How Tidal Wetlands and Nature-Based Infrastructure Support a Clean, Healthy Bay



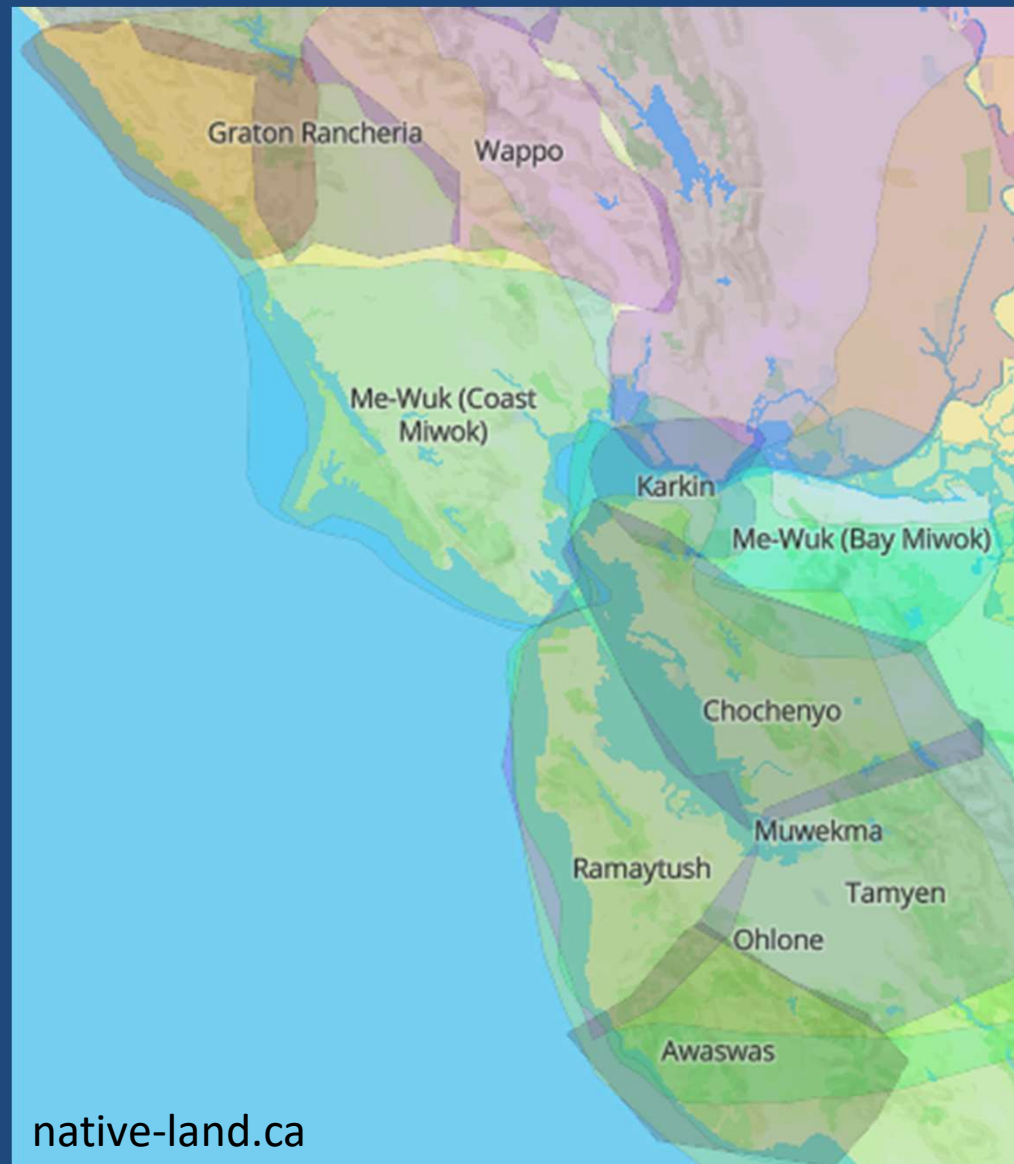
**Christina Toms**

Ecological Engineer and Senior Environmental Scientist  
SF Bay Regional Water Quality Control Board



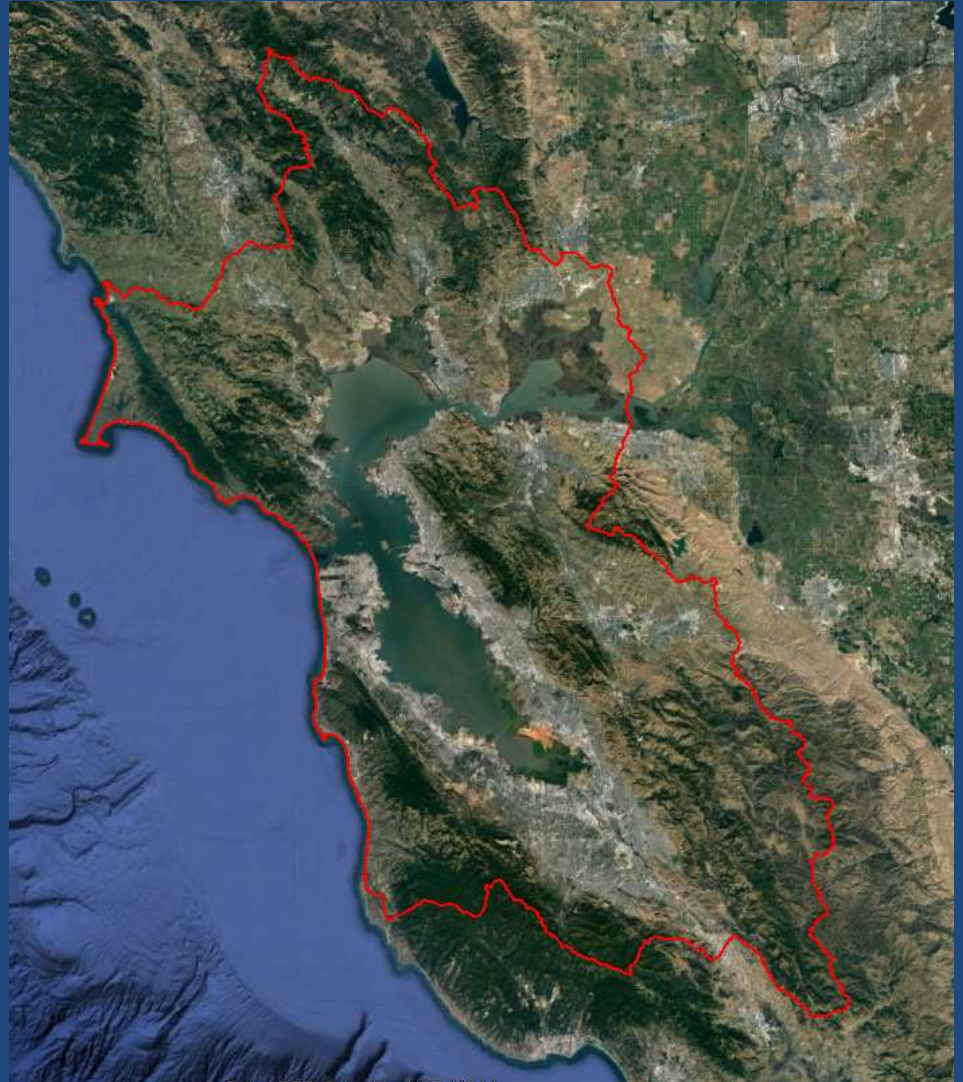
# Territory Acknowledgement

This talk will discuss occupied indigenous lands stolen from multiple native peoples, including the Ohlone, Miwok, and Patwin tribes. Colonization is ongoing - few of these tribes are federally recognized.



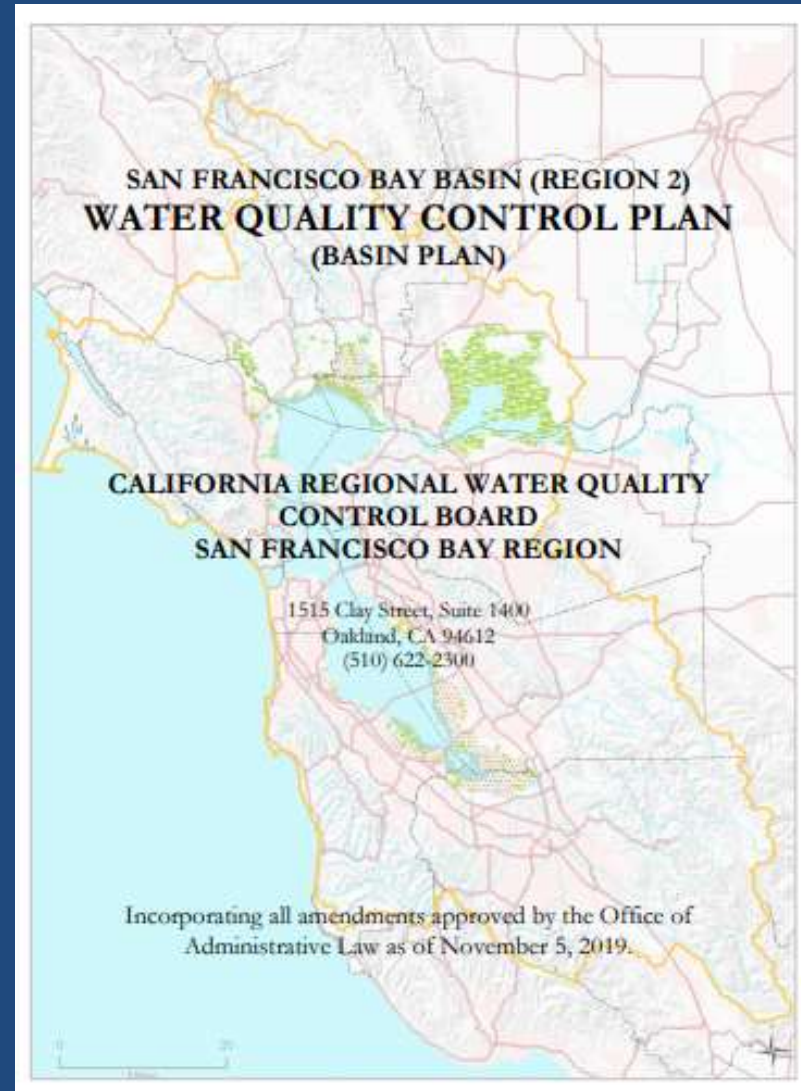
# Water Board Jurisdictional Authority

- Clean Water Act
- Porter-Cologne Water Quality Control Act
- Basin Plan Policies
- State's anti-degradation policy



# SF Bay Basin Plan

- Chapter 2: Beneficial Uses
- Chapter 3: Water Quality Objectives
- Chapter 4: Implementation Plans



# Key Activities We Regulate

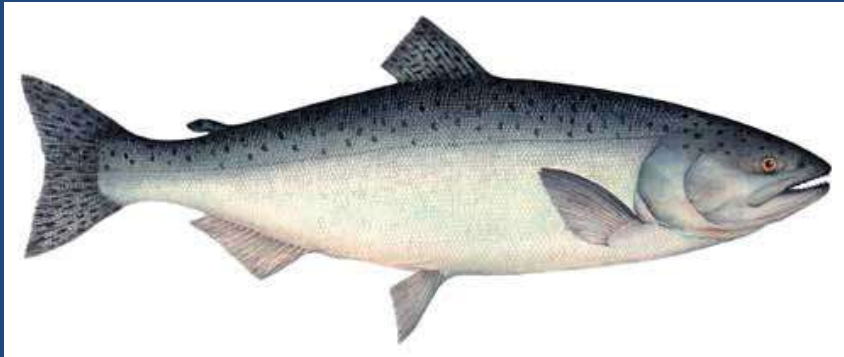
- Placement of fill in wetlands and waters
- Dredging and beneficial reuse of dredged sediment
- Discharge of treated wastewater (nearshore and offshore)
- Stormwater management
- Cleanup of polluted sites (including groundwater)

# Key Beneficial Uses of San Francisco Bay and its Wetlands

- Estuarine habitats: mudflats; tidal fresh, brackish, and saline marshes
- Habitat for wildlife, including rare and special-status plant + wildlife species
- Recreation, commercial fisheries, shellfish harvesting



# Rare & Special-Status Species



chinook salmon  
*Onchorhynchus tshawytscha*



Ridgway's rail  
*Rallus obsoletus*



salt marsh harvest mouse  
*Reithrodontomys raviventris*



saltmarsh bird's beak (CNPS 1B.2)  
*Chloropyron maritimum ssp. palustre*

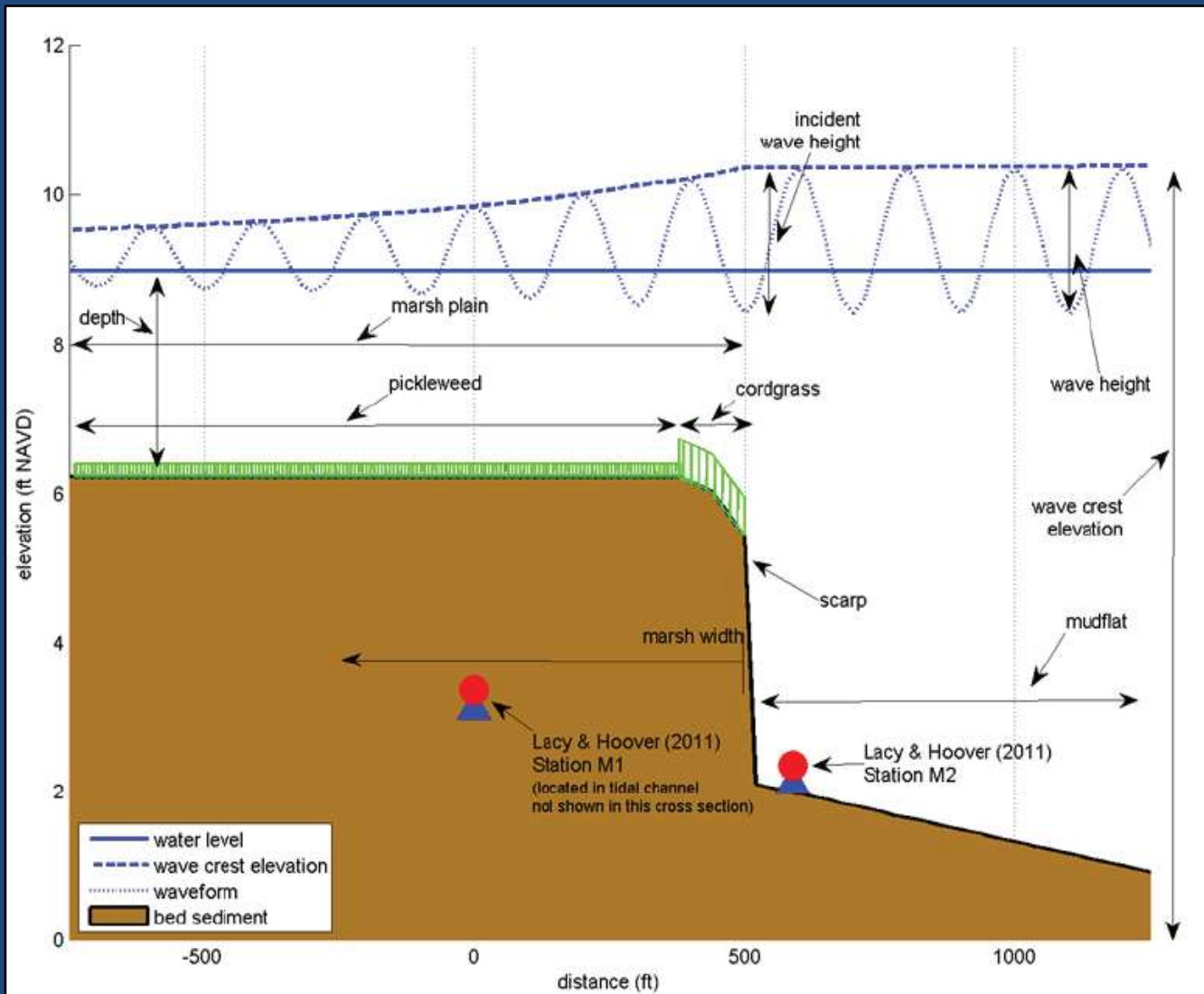
# Rare Tidal Wetland Ecotype

Yellow-rayed goldfields  
*Lasthenia glabrata* ssp. *glabrata*  
tidal salt and brackish high marsh ecotones  
downslope from vernal pools





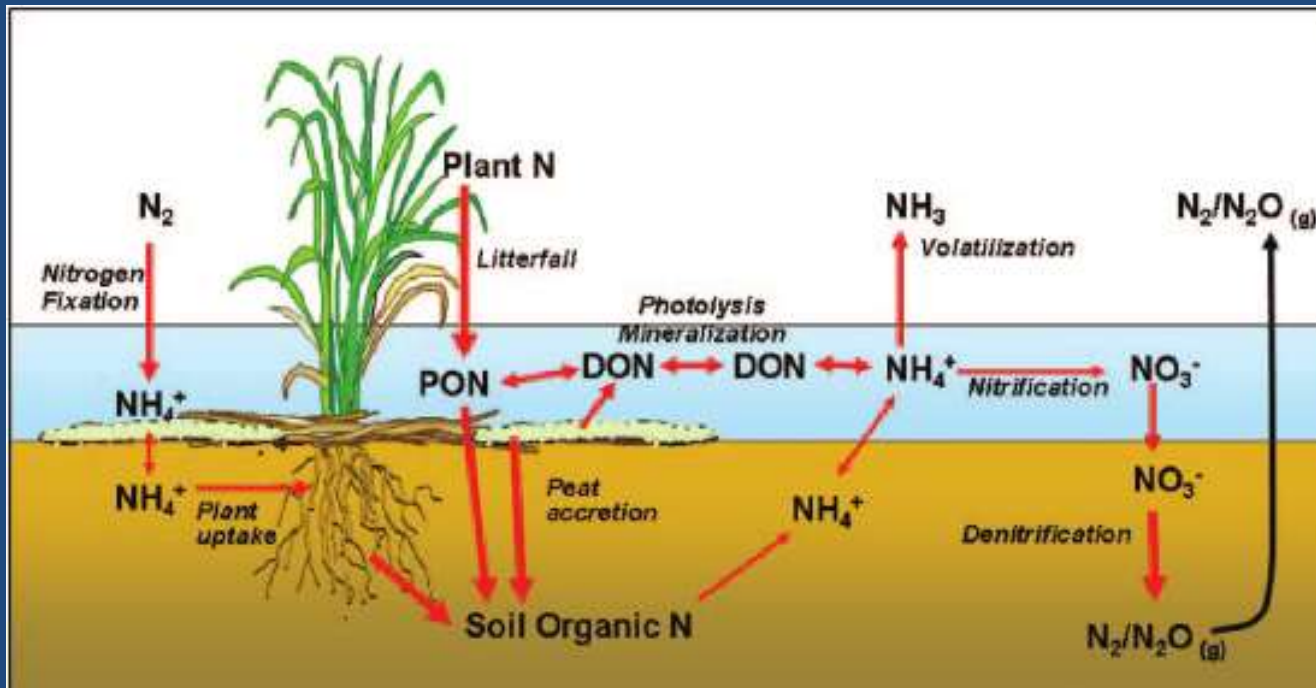
# Protection From Waves and Floods



Vegetated marshes attenuate wave energy and reduce flood risk from shoreline overtopping

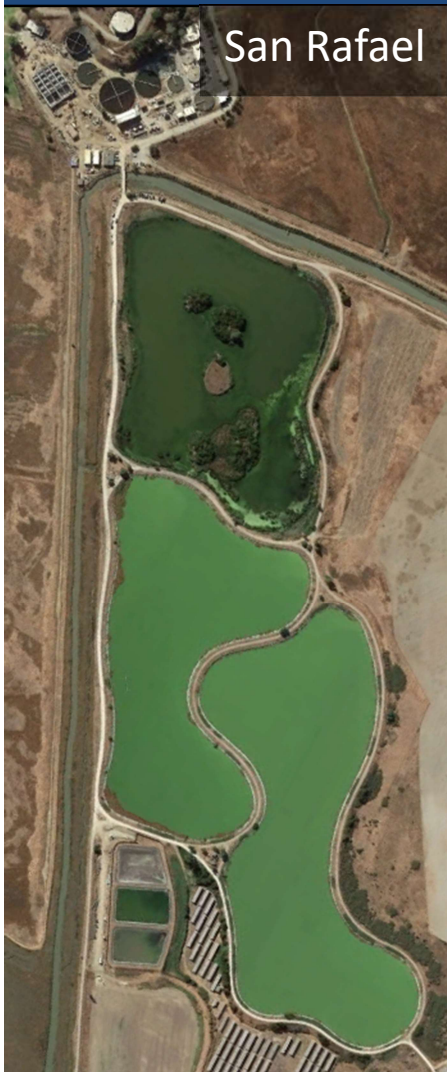
# Water Quality Improvement

- Sediment filtration
- Biogeochemical processes (e.g. denitrification, removal/transformation of pollutants)
- Carbon sequestration



# Treatment Wetlands

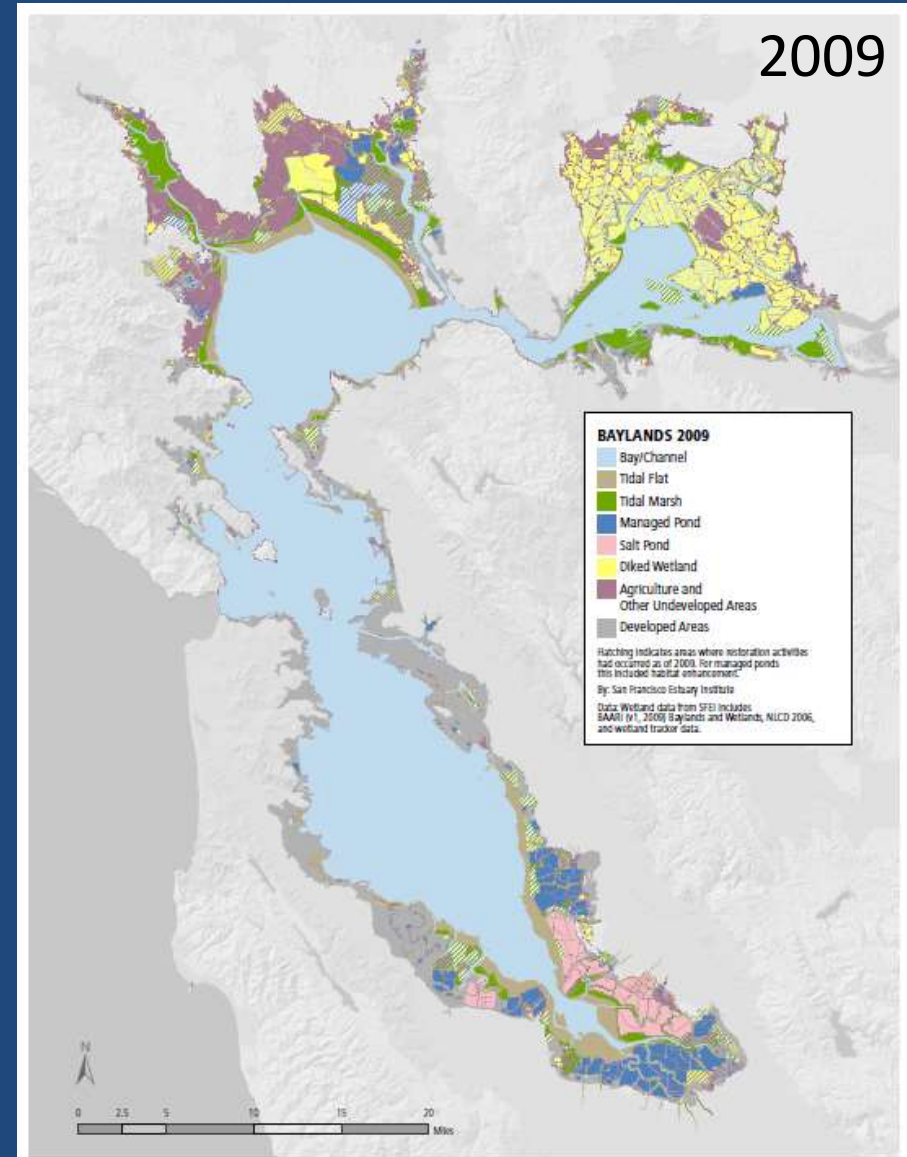
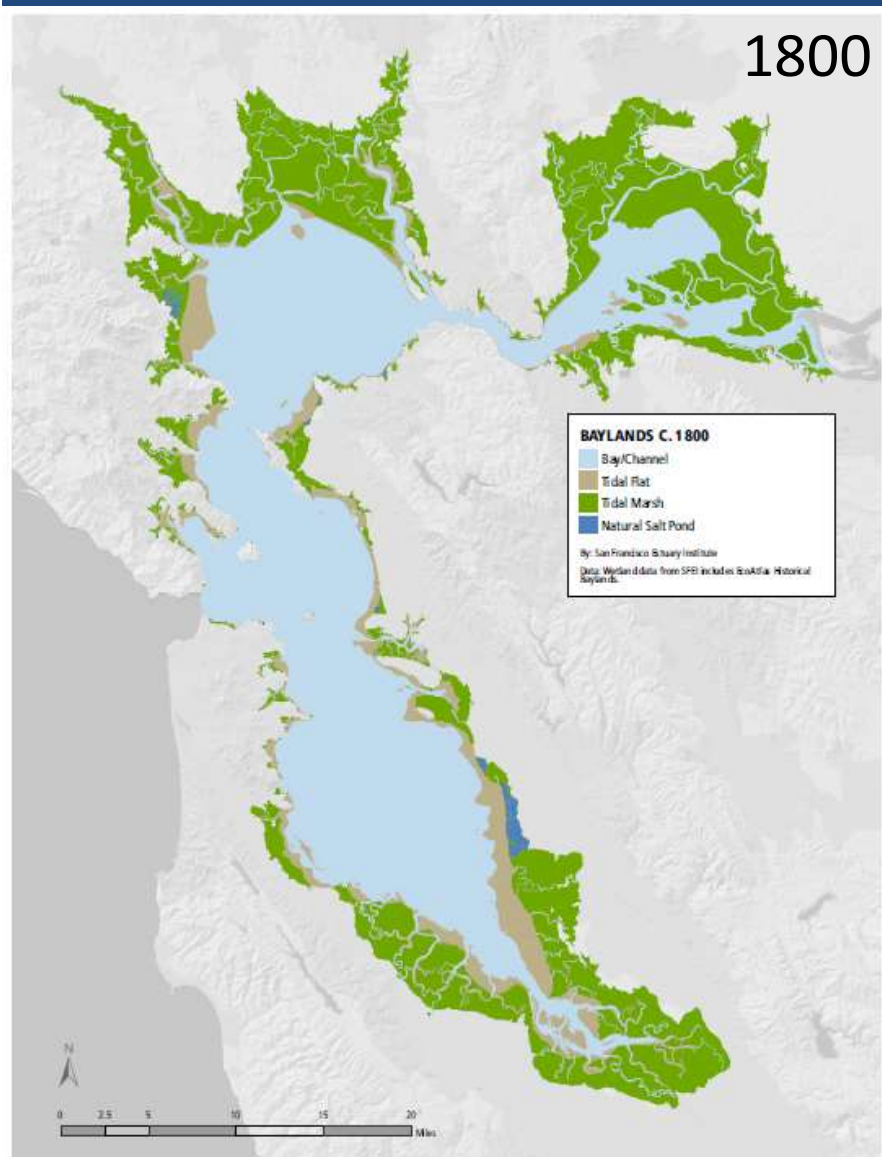
Treat wastewater, stormwater, etc.



(photos are not to scale)

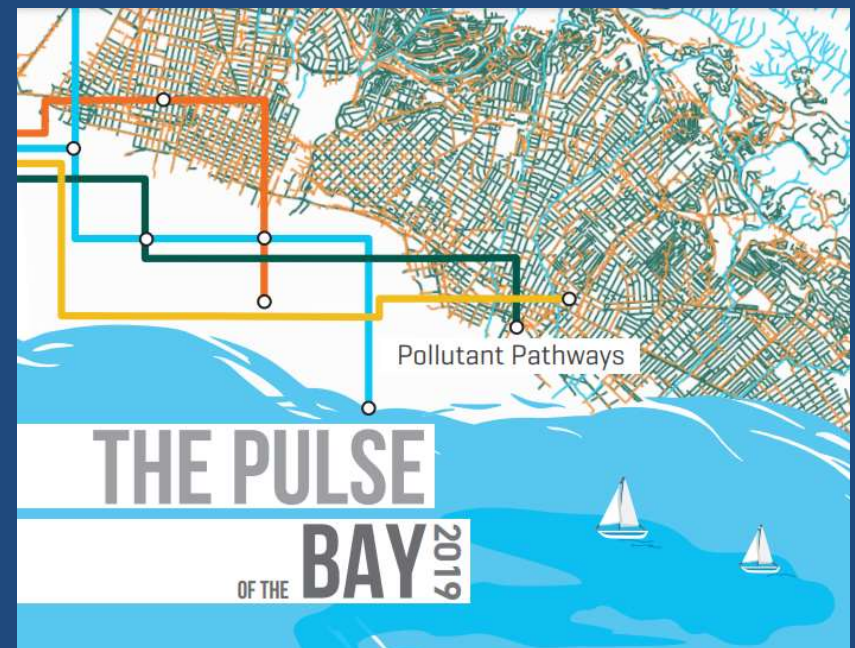


# Tidal Wetland Loss in SF Bay



# Impacts of Colonization

- Urbanization + agriculture + tidal wetland reclamation = a polluted Bay
- Common pollutants: **Nutrients**, metals, PCBs, dioxin, organics, **emerging contaminants**, microplastics
- Regional monitoring:
  - Bay water
  - Bay sediment
  - Bivalve tissue
  - Sport fish tissue
  - Cormorant and tern eggs



# Nutrients in SF Bay

- Eutrophication: nutrient enrichment → algal blooms + die-offs → low dissolved oxygen
- SF Bay is nutrient-enriched (nitrogen + phosphorus) but not eutrophic... *yet*.
- Why? Combination of factors:
  - Tidal mixing
  - Light limitation from high turbidity
  - Grazing pressure from clams
- Climate change → shifting baseline?

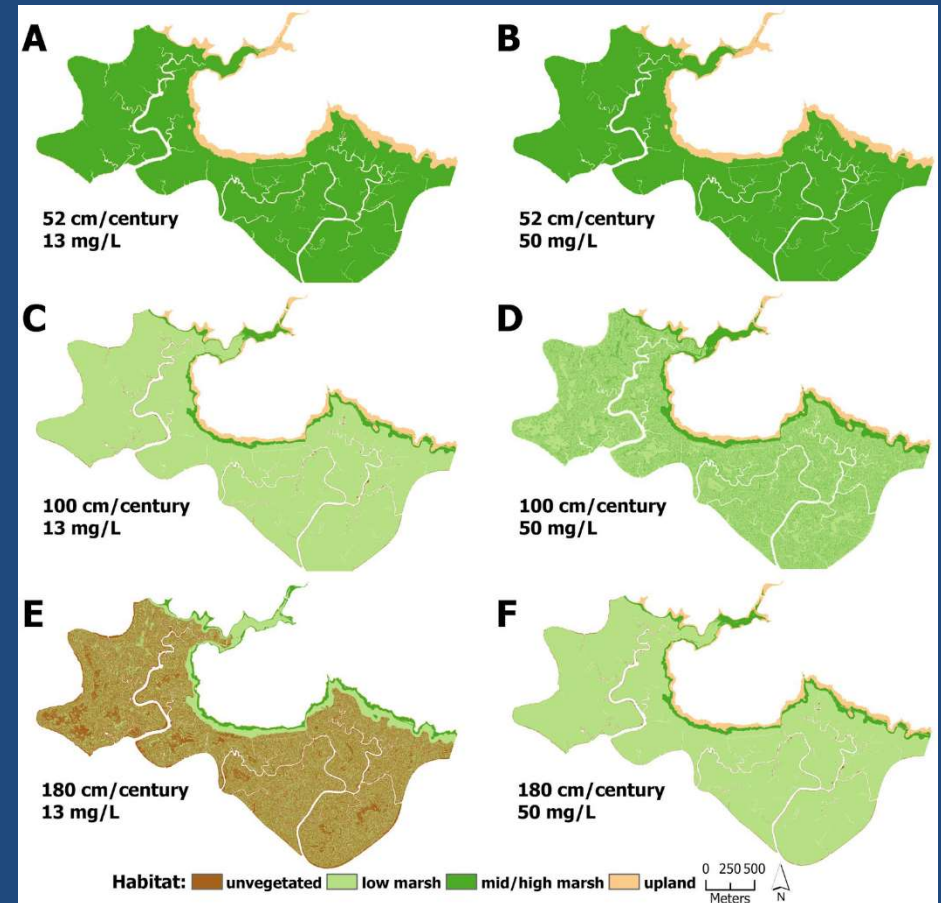
# Emerging Contaminants

- Pollutants that aren't treated well in traditional wastewater treatment plants
  - Complex organic compounds
  - Pharmaceuticals – antibiotics, painkillers, contraception, etc.



# Climate Change Threats

- More frequent and severe droughts and floods
- Sea level rise + higher groundwater tables
- Drowning of tidal marshes
- Coastal flooding, overtopping, erosion



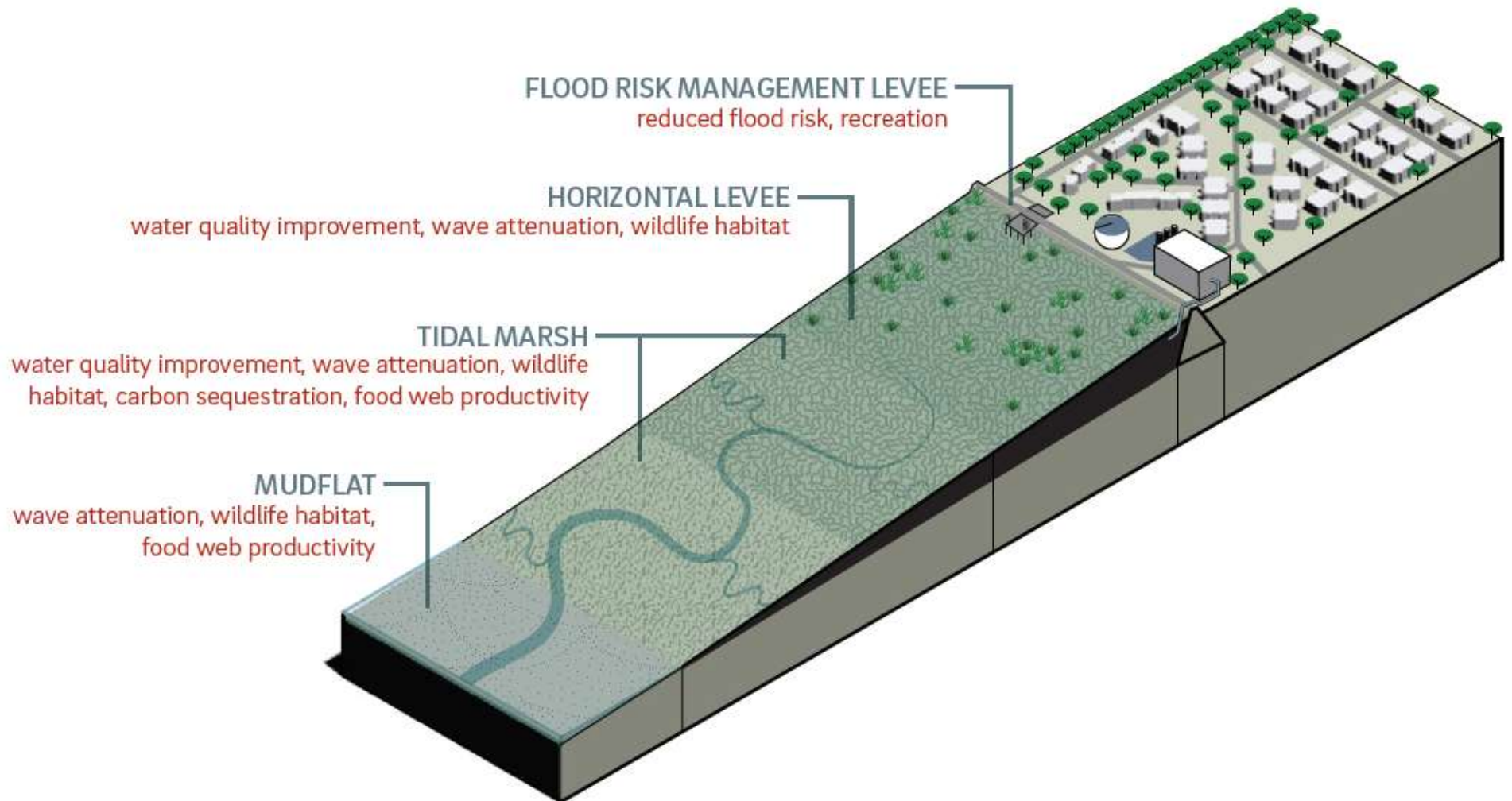


# Multiple Challenges...

- Historic and potential future losses of tidal wetlands
- Degraded water quality in the Bay
- Shorelines and low-lying communities vulnerable to flooding and erosion
- Much less habitat for native plants + wildlife
- Limited green space for marginalized and minoritized urban communities, including to support cultural use by tribes

# ...Require Multi-Benefit Solutions!

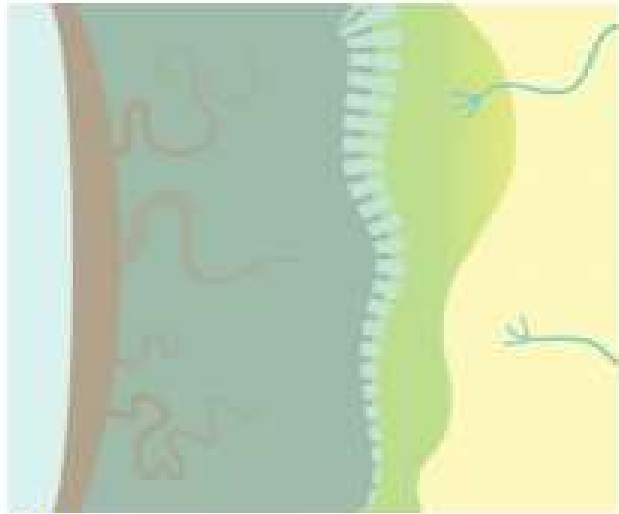
Example: Subsurface seepage or “horizontal” levees



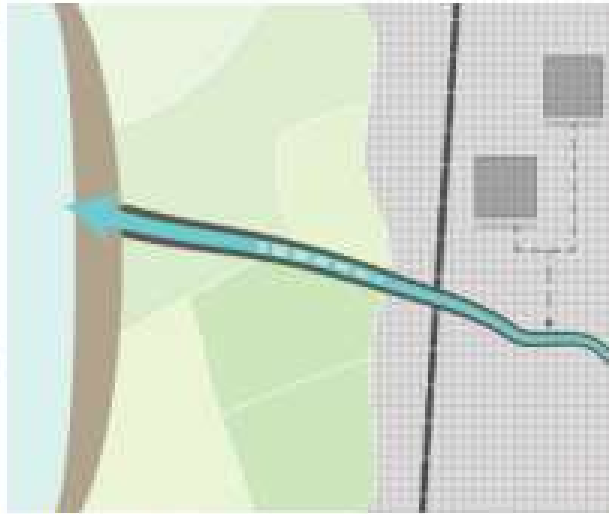
# Oro Loma Horizontal Levee



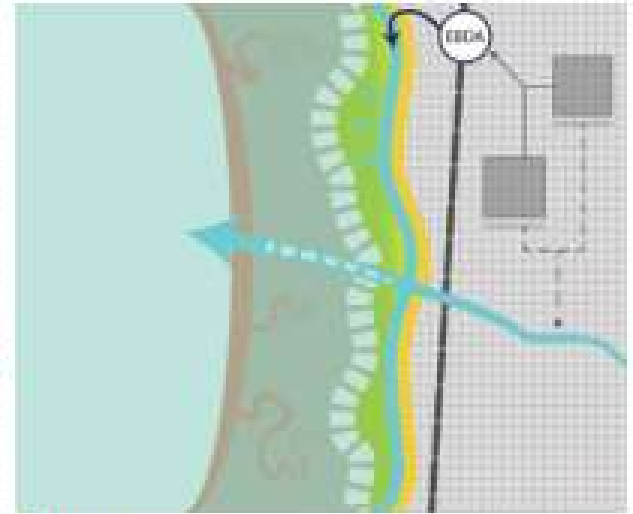
# Recreate Fresh → Salt Marsh Gradients



Past



Present



Future



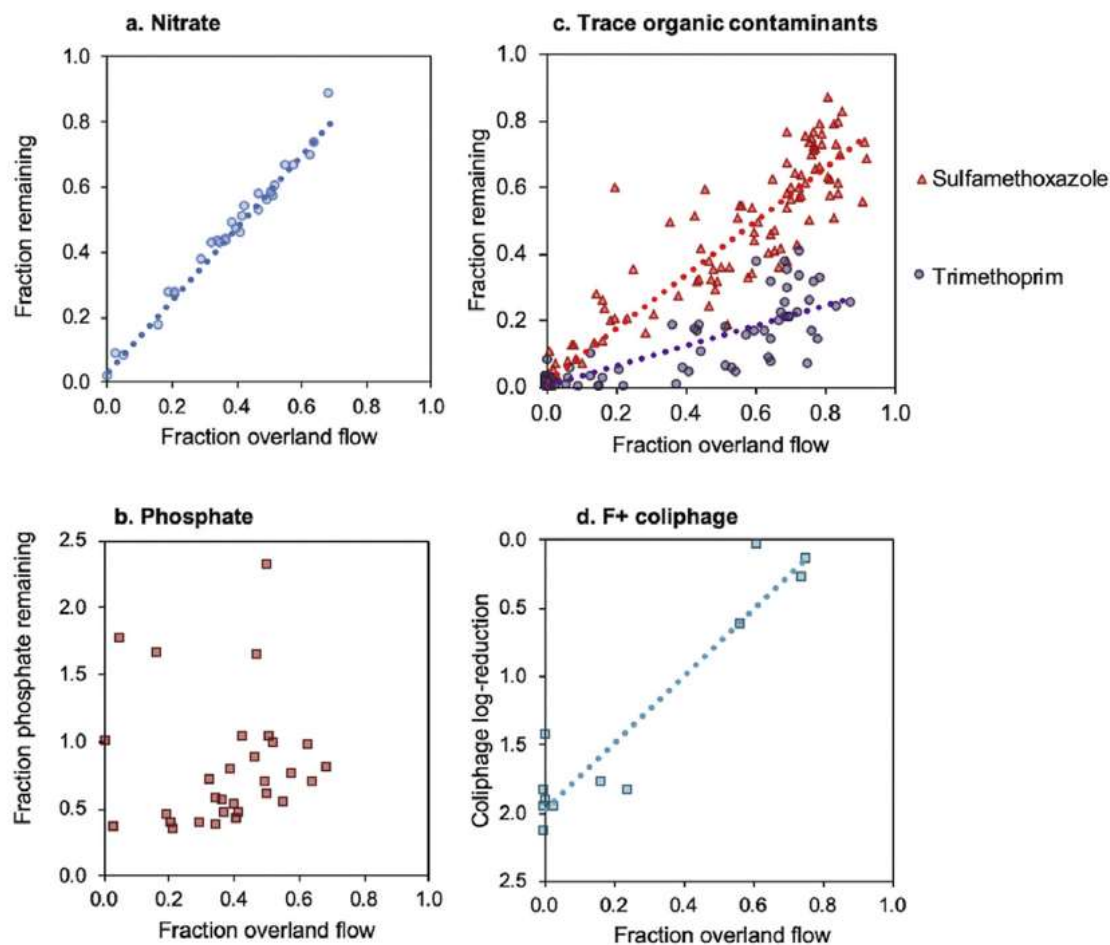
# The horizontal levee: a multi-benefit nature-based treatment system that improves water quality and protects coastal levees from the effects of sea level rise

Aidan R. Cecchetti <sup>a, c</sup>, Angela N. Stiegler <sup>a, c</sup>, Katherine E. Graham <sup>b, c</sup>, David L. Sedlak <sup>a, c, \*</sup>

<sup>a</sup> Department of Civil and Environmental Engineering, University of California, Berkeley, CA, 94720, USA

<sup>b</sup> Department of Civil and Environmental Engineering, Stanford University, Stanford, CA, 94305, USA

<sup>c</sup> US National Science Foundation Engineering Research Center (ERC) for Re-Inventing the Nation's Urban Water Infrastructure (ReNUWit), USA



Remove  
Nutrients  
and Other  
Pollutants

# Reduce FRM Levee Size

## A new kind of levee

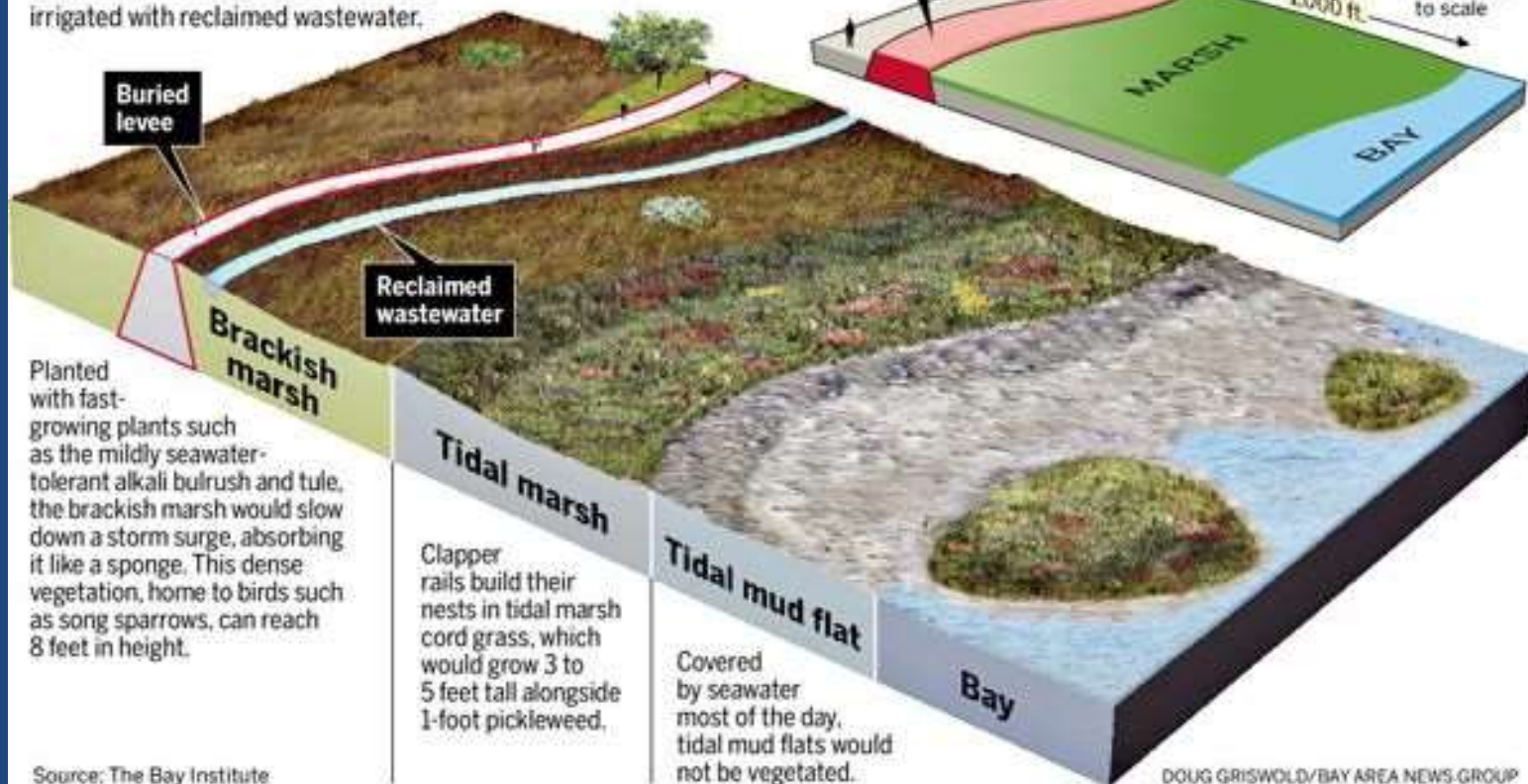
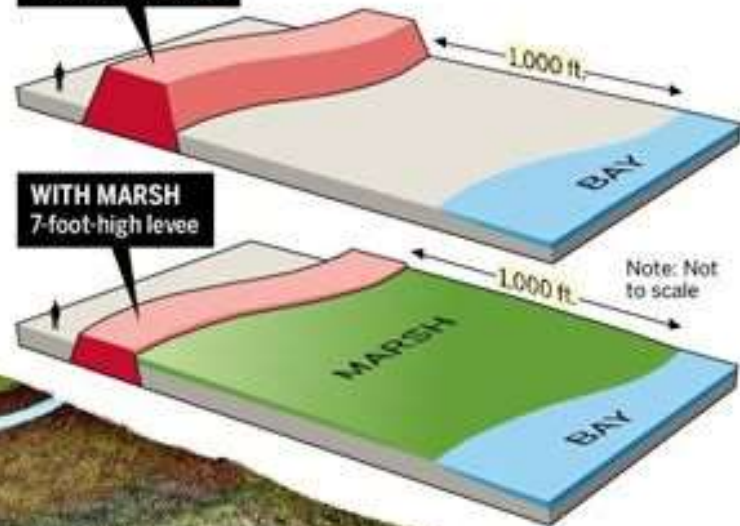
The Bay Institute, an environmental group, has proposed a number of "horizontal levees" for San Francisco Bay that blend a traditional earthen levee with restored tidal marshes. The marshes would be built up with sediment from local flood control channels. Marsh vegetation would be irrigated with reclaimed wastewater.

## Marshes as barriers

Tidal marshes can slow down storm surges, meaning levees fronted by marshes can be built half as tall, and at half the cost, as traditional levees made of earth and clay.

**WITH NO MARSH**  
13.5-foot-high levee

**WITH MARSH**  
7-foot-high levee



Planted with fast-growing plants such as the mildly seawater-tolerant alkali bulrush and tule, the brackish marsh would slow down a storm surge, absorbing it like a sponge. This dense vegetation, home to birds such as song sparrows, can reach 8 feet in height.

Clapper rails build their nests in tidal marsh cord grass, which would grow 3 to 5 feet tall alongside 1-foot pickleweed.

Covered by seawater most of the day, tidal mud flats would not be vegetated.

Source: The Bay Institute

DOUG GRISWOLD/BAY AREA NEWS-GROUP

# Provide Accessible Green Space

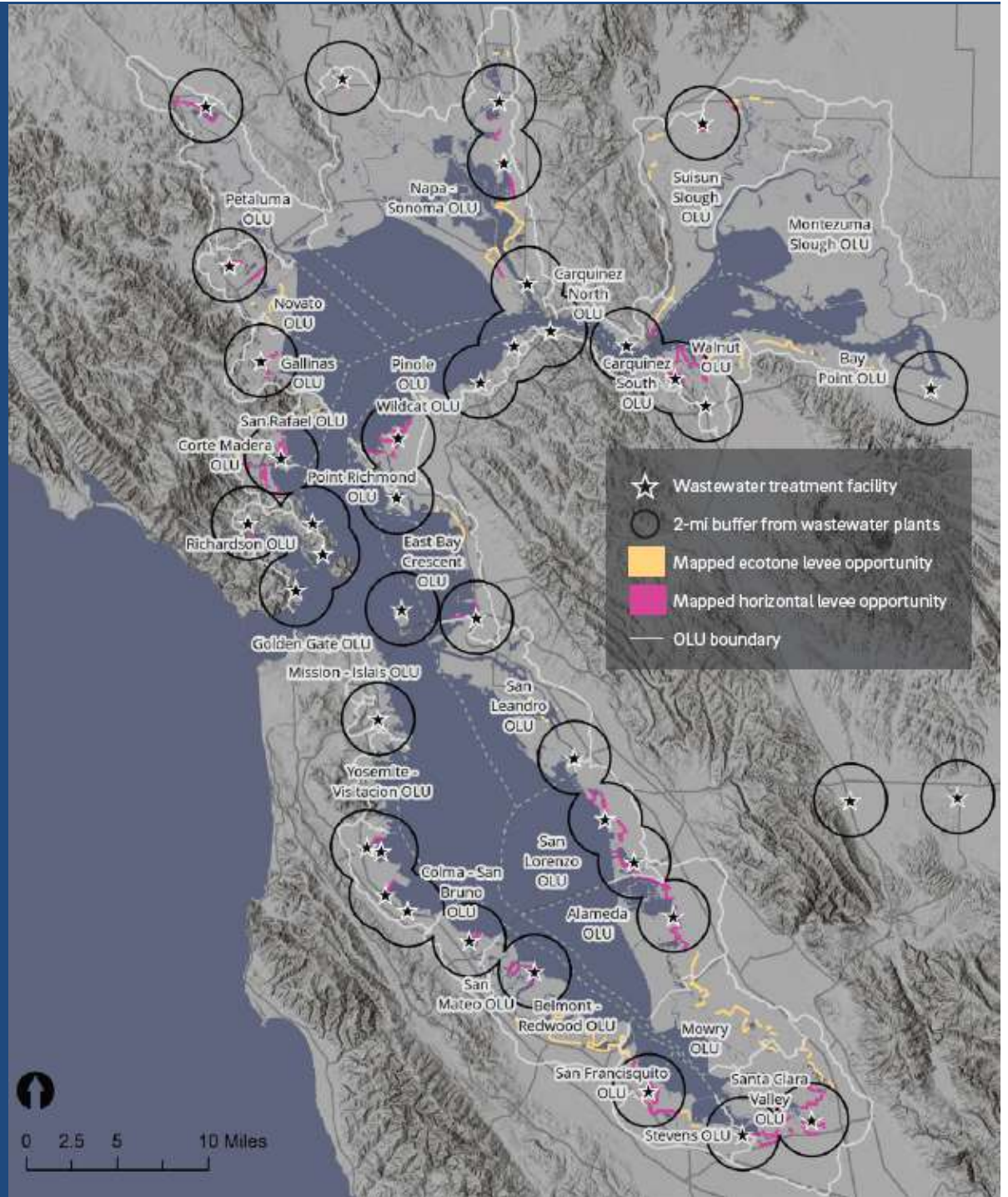


See Jeremy's talk on  
May 27th!




# Regional Horizontal Levee Opportunities

(Adaptation  
Atlas Phase 2:  
Preliminary  
Analysis!)








**Updated Ecotone Levee Opportunities\***


 Conditions suitable for ecotone levee


**Development Type**

 Wastewater treatment facility


 Bayfront landfill


 Major road

 Rail line


 Other urban development


**Tidal Marsh**

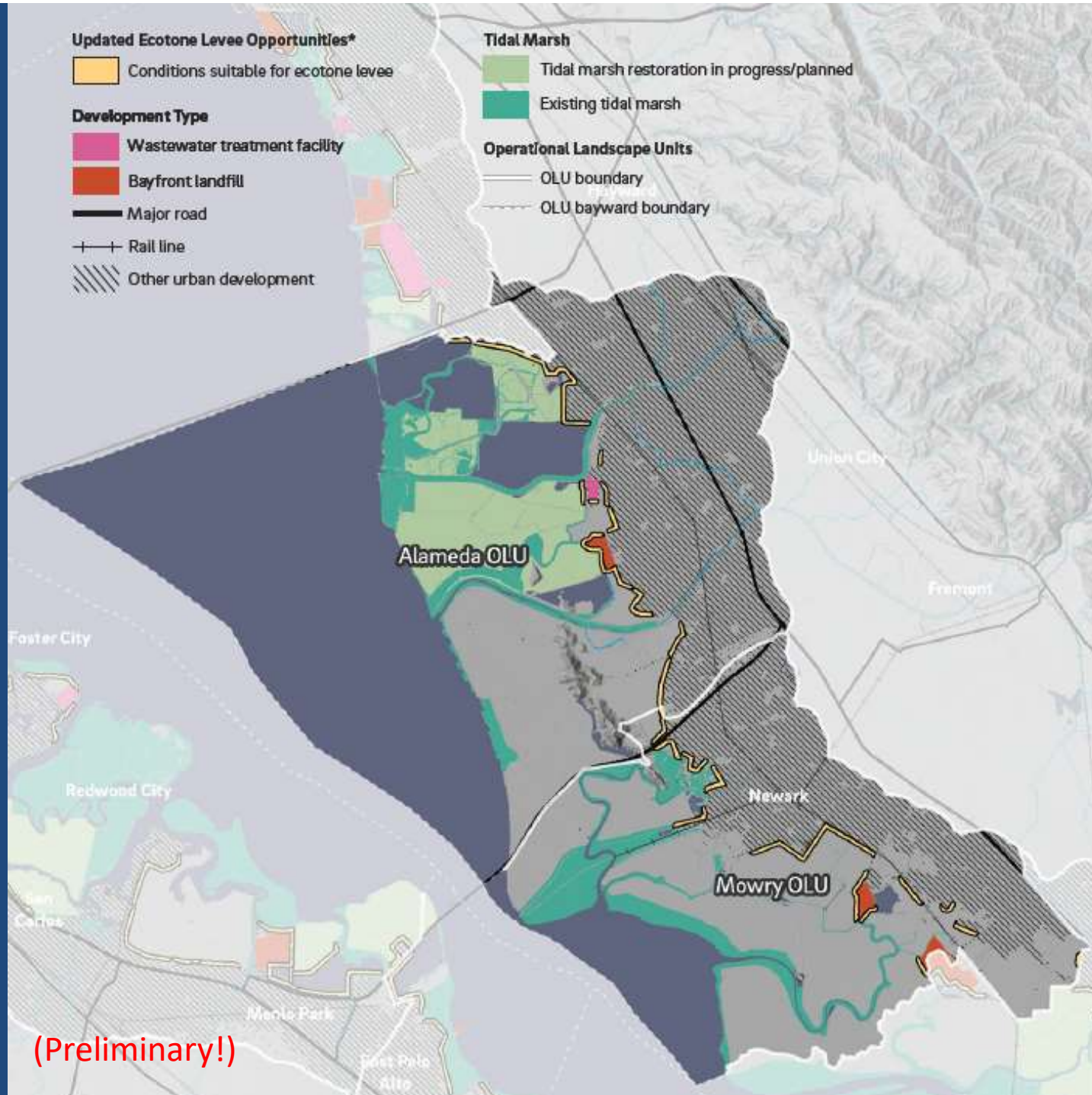
 Tidal marsh restoration in progress/planned

 Existing tidal marsh

**Operational Landscape Units**

 OLU boundary

 OLU bayward boundary



(Preliminary!)

# Summary

- The historic and potential future losses of tidal wetlands around SF Bay negatively impact water quality, habitats, flood vulnerability, and recreational/cultural uses
- Multi-benefit strategies such as horizontal (subsurface seepage) levees can help address these impacts
- Work is ongoing to optimize the location and design of these levees throughout the region

Thank you: Scott Dusterhoff (SFEI), Peter Baye, Jeremy Lowe (SFEI), Julie Beagle (former SFEI, now USACE), Xavier Fernandez (RWQCB)



Questions?

[christina.toms@waterboards.ca.gov](mailto:christina.toms@waterboards.ca.gov)