OPERATIONAL LANDSCAPE UNITS FOR SF BAY

Using nature's jurisdictions to plan for sea level rise

Briefing to the Implementation Committee of the CCMP

SFEI + SPUR

May 23, 2018

Funded by:
SF Bay Regional Water Quality Control Board
Marin Community Foundation
Moore Foundation

SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

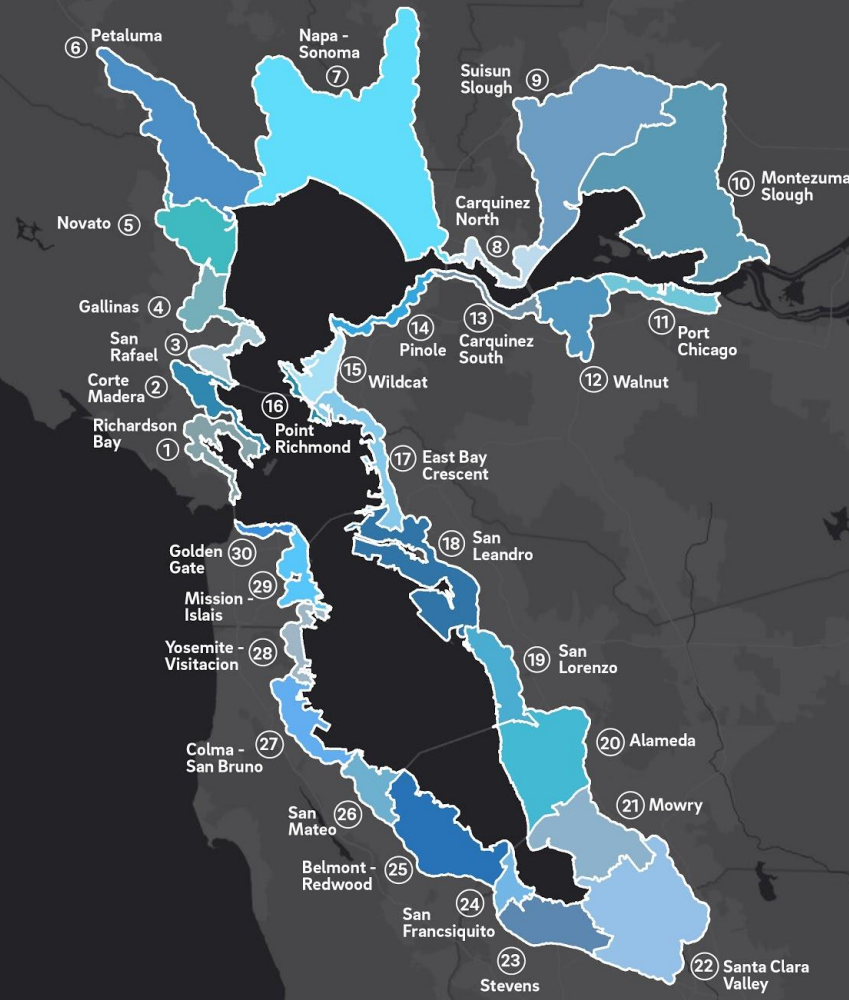
Goals of today

- Introduction (or update) to the Operational Landscape Units project

- How it could fit within actions of the CCMP

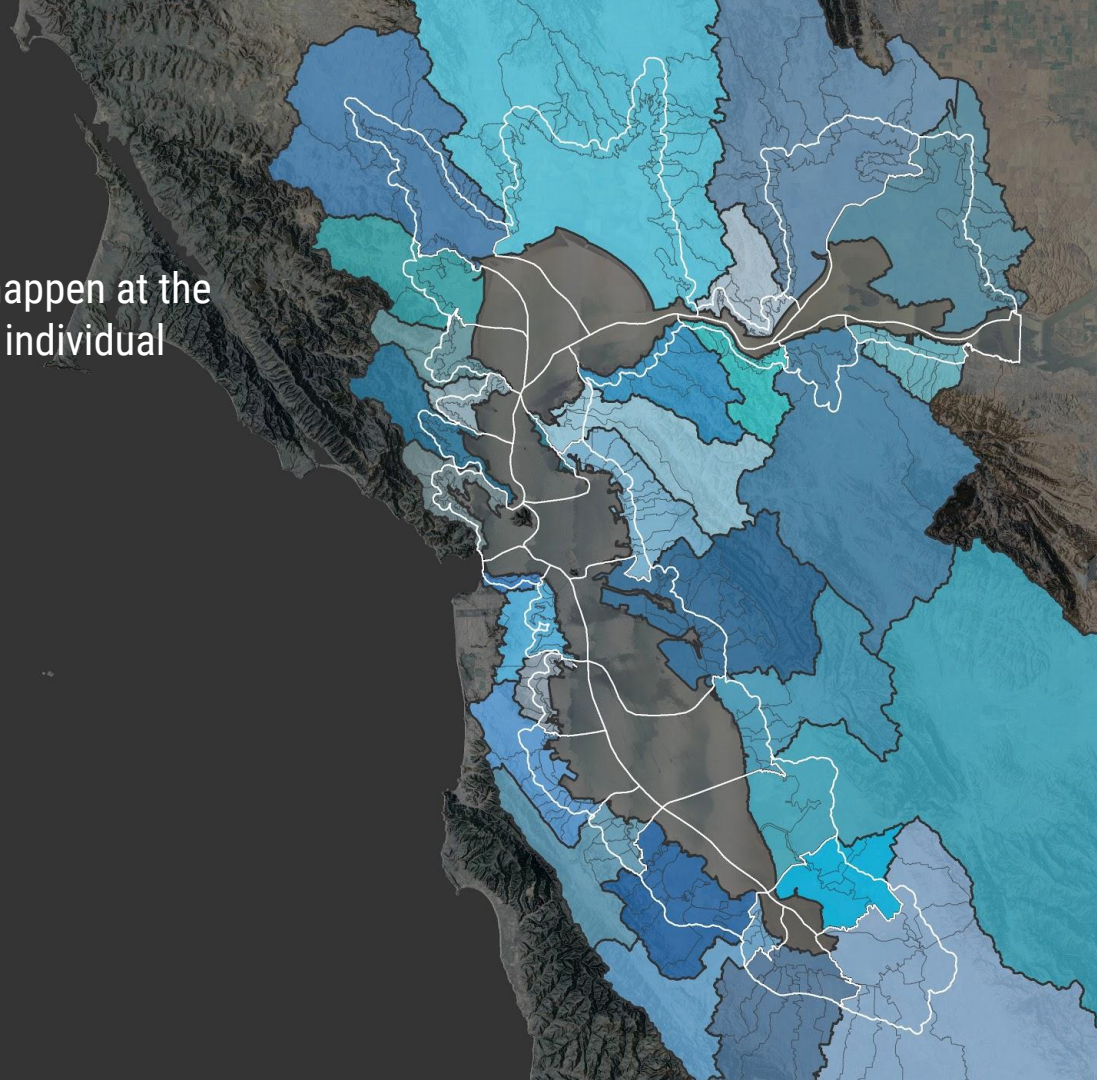
A new look at the Bay

- Create spatial framework to guide nature-based adaptation strategies for sea-level rise
- “Nature’s jurisdictions”
- Pairing problems with adaptation measures in appropriate places



Project Rationale

1. Processes that govern the shoreline happen at the **Bay scale**. Too large and complex for individual projects.

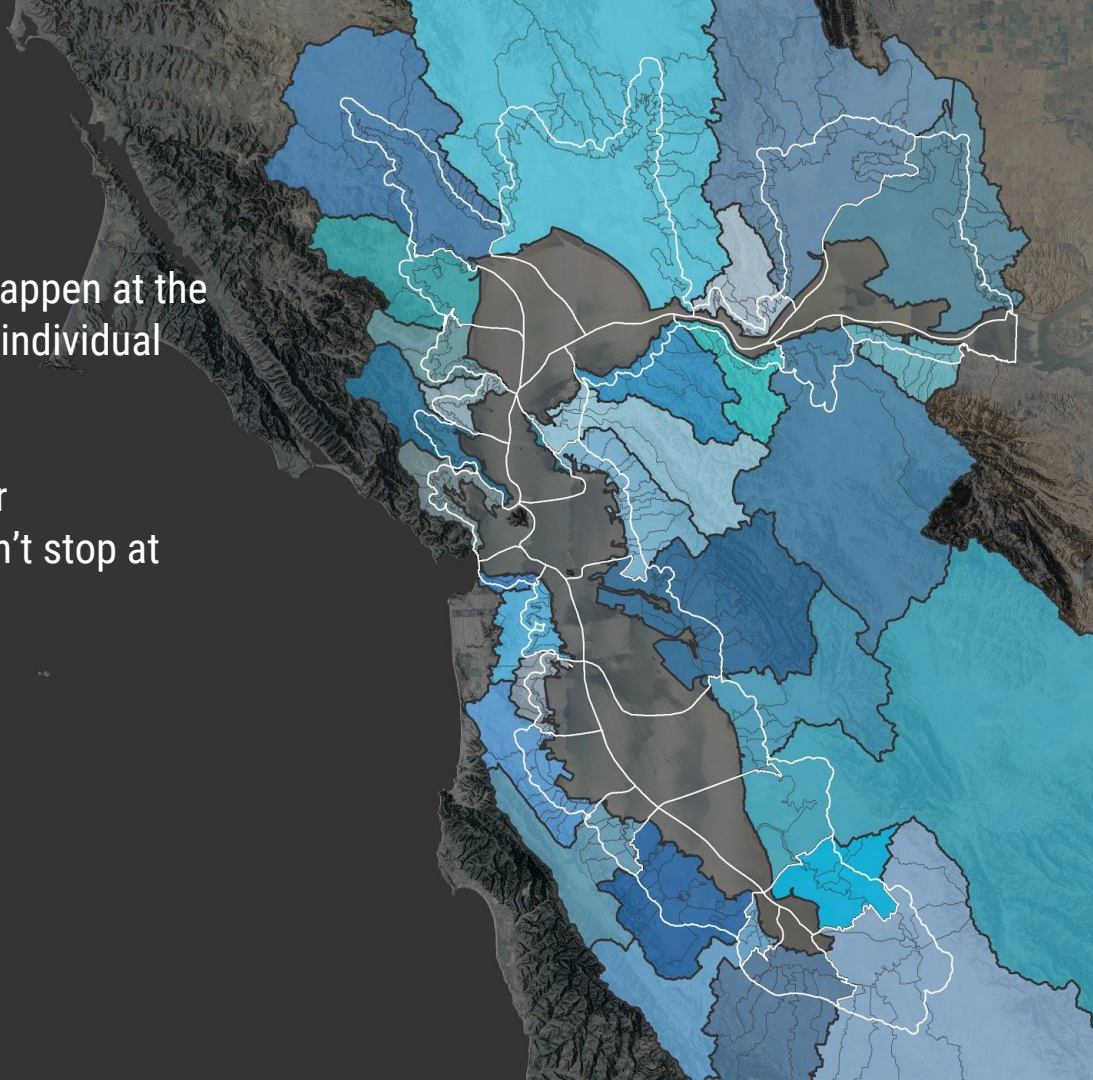



OCEAN / BAY PROCESSES
WATERSHED PROCESSES
ESTUARINE PROCESSES
Google Earth

Project Rationale

1. Processes that govern the shoreline happen at the **Bay scale**. Too large and complex for individual projects.

2. Need to **divide up the Bay** into smaller manageable pieces: Sea level rise won't stop at city boundaries.



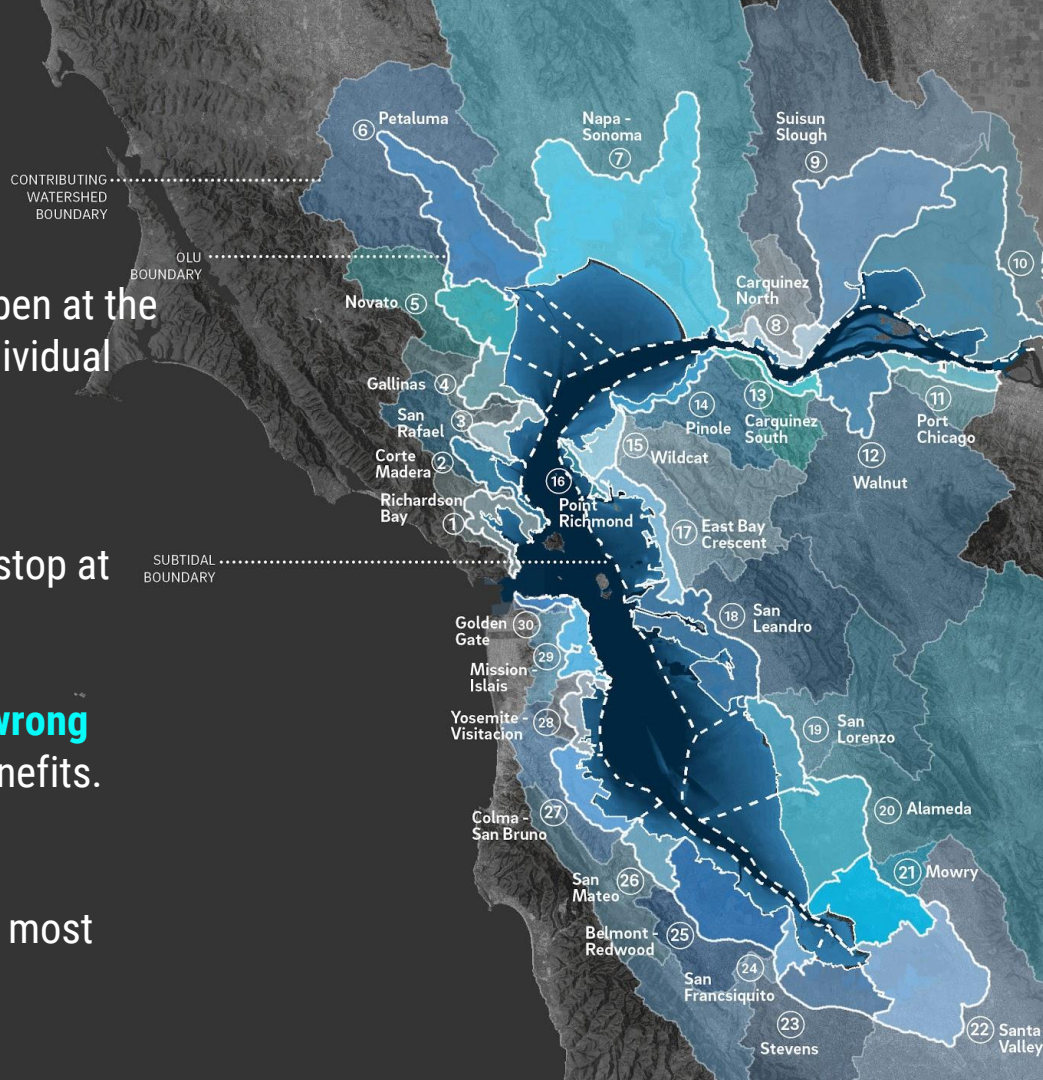
Project Rationale

1. Processes that govern the shoreline happen at the **Bay scale**. Too large and complex for individual projects.

2. Need to **divide up the Bay** into smaller manageable pieces: Sea level rise won't stop at city boundaries.

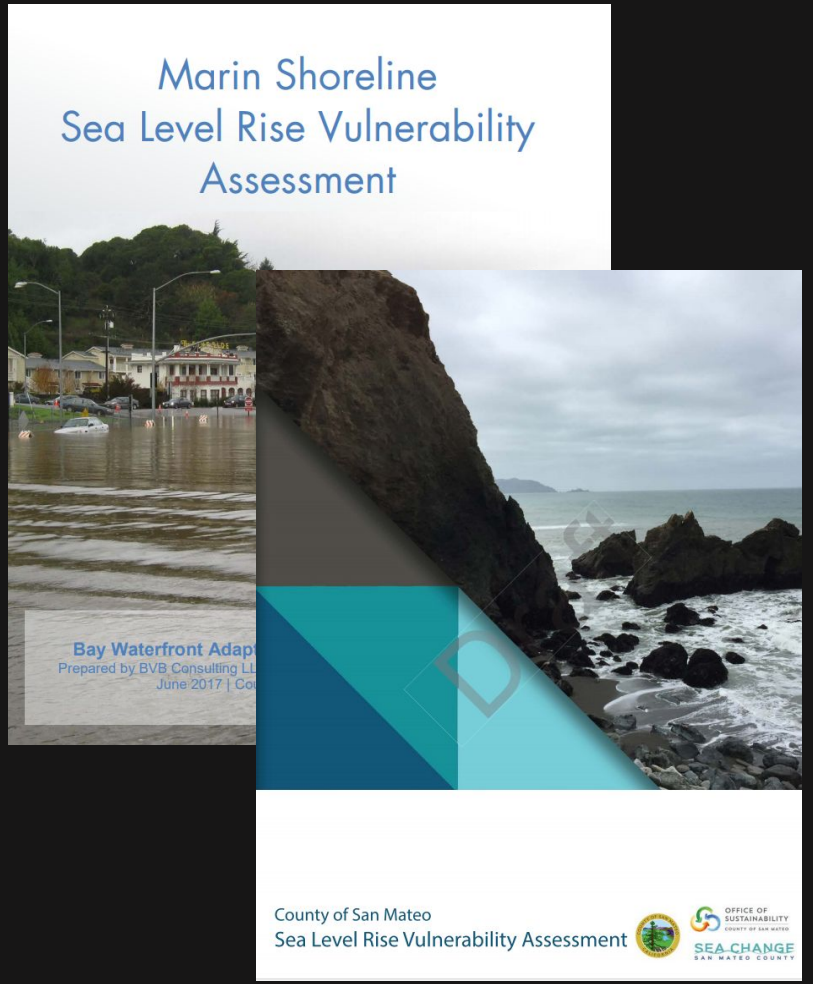
3. Risk of the **wrong type** of actions in the **wrong places,** less resilience, and not all the benefits.

4. Opportunity to maximize **multi-benefit, nature-based solutions**. More resilience, most co-benefits, more adaptable over time.



HOW CAN THIS BE USED?

- A resource to assist environmental review and permitting
- Guidance for restoration practitioners
- Inform local and regional vulnerability analyses and adaptation actions

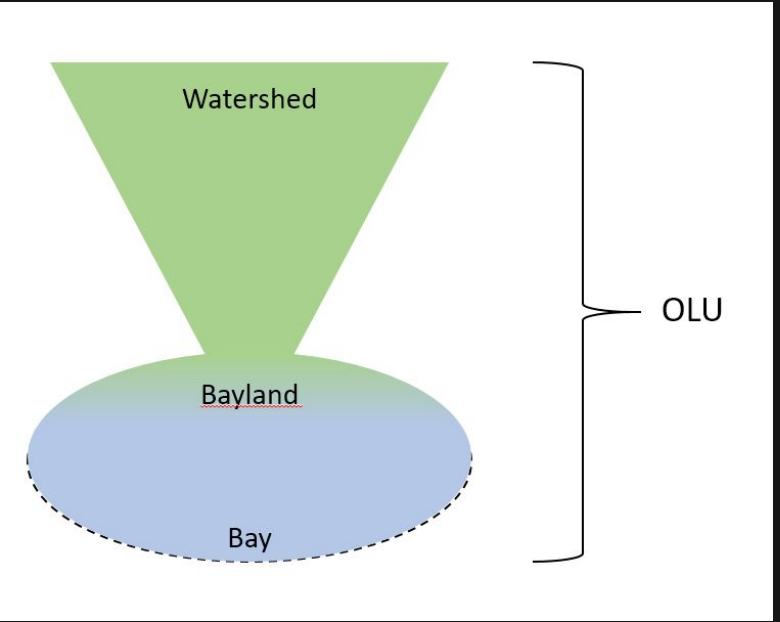


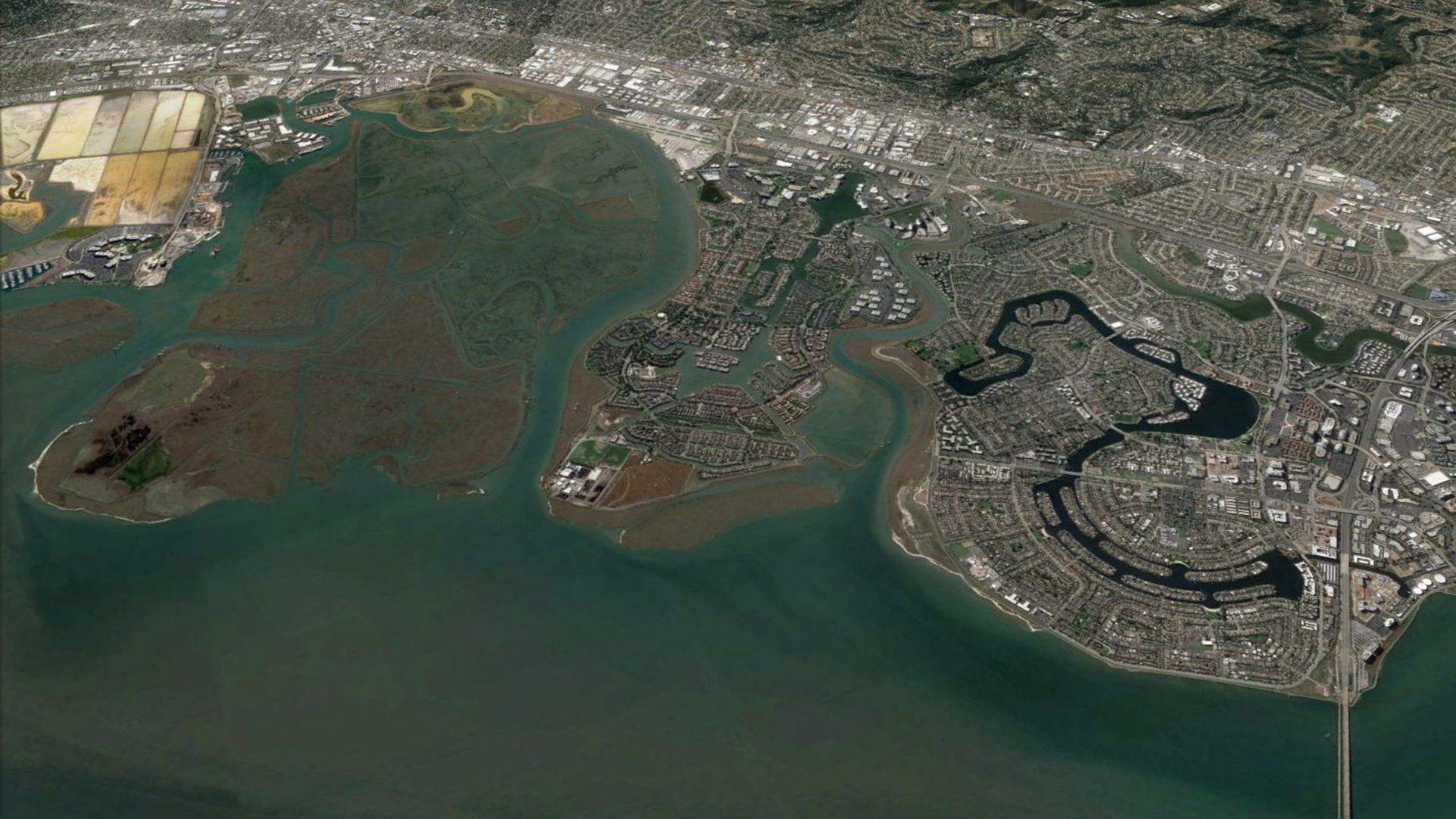
Defining OLU Boundaries

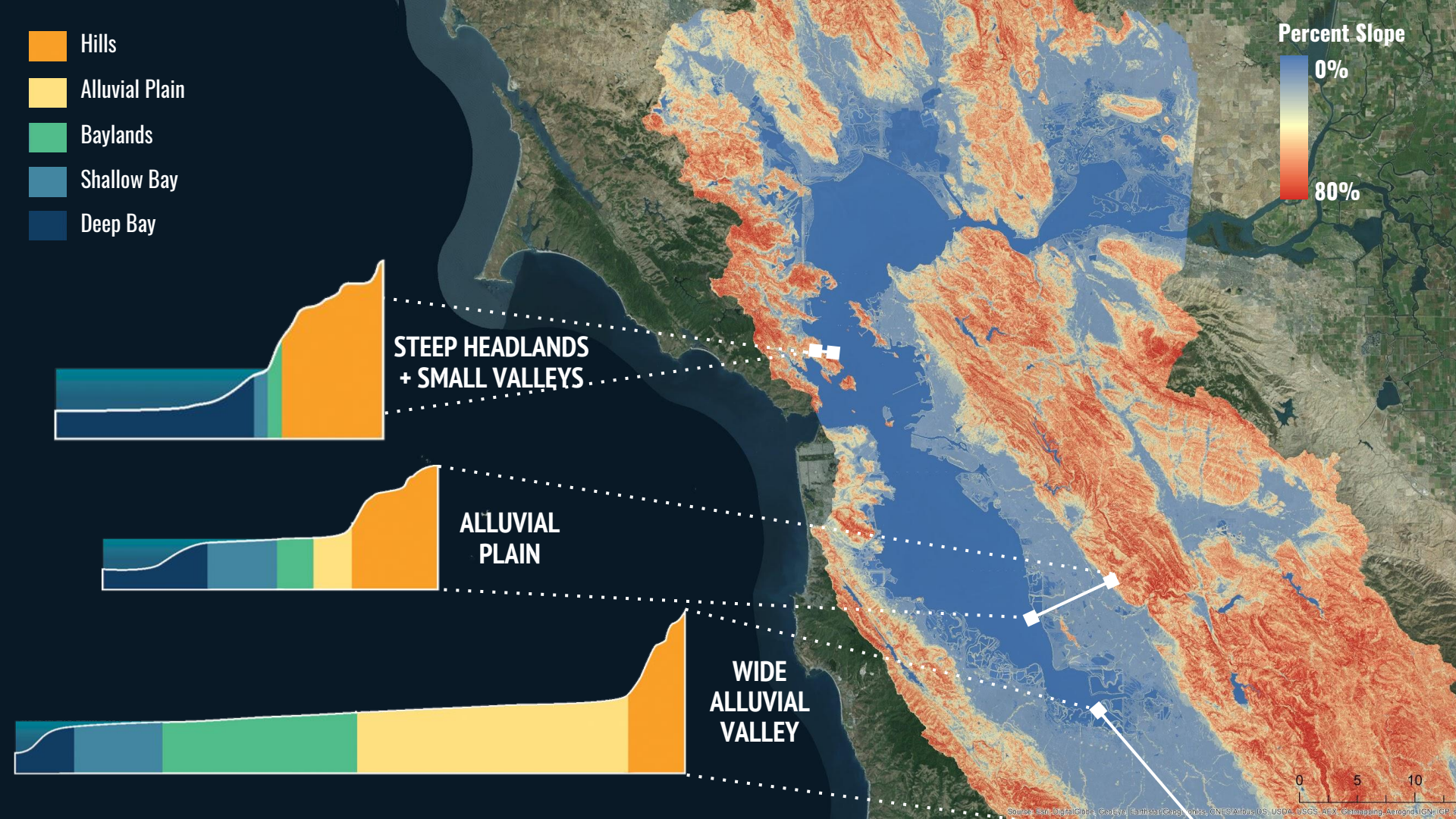
OPERATIONAL LANDSCAPE UNITS: Defined

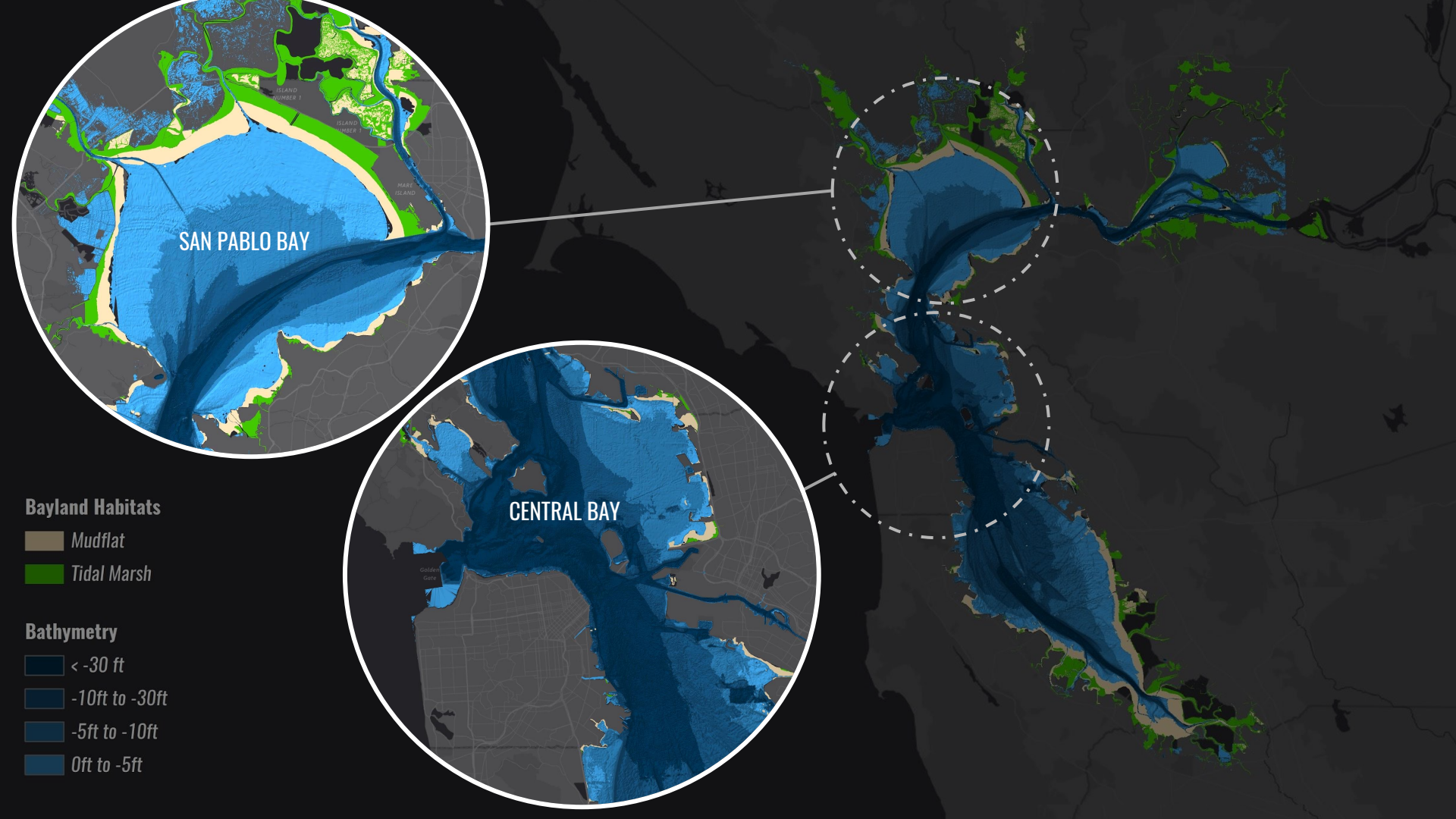
*Areas of the **Baylands and their watersheds** that are expected to support a coherent suite of upland, intertidal, and subtidal ecosystem functions as appropriate for **their location in the Bay,** along with the physical processes of water and sediment needed to sustain these functions.*

Adapted from Verhoeven et al. 2008





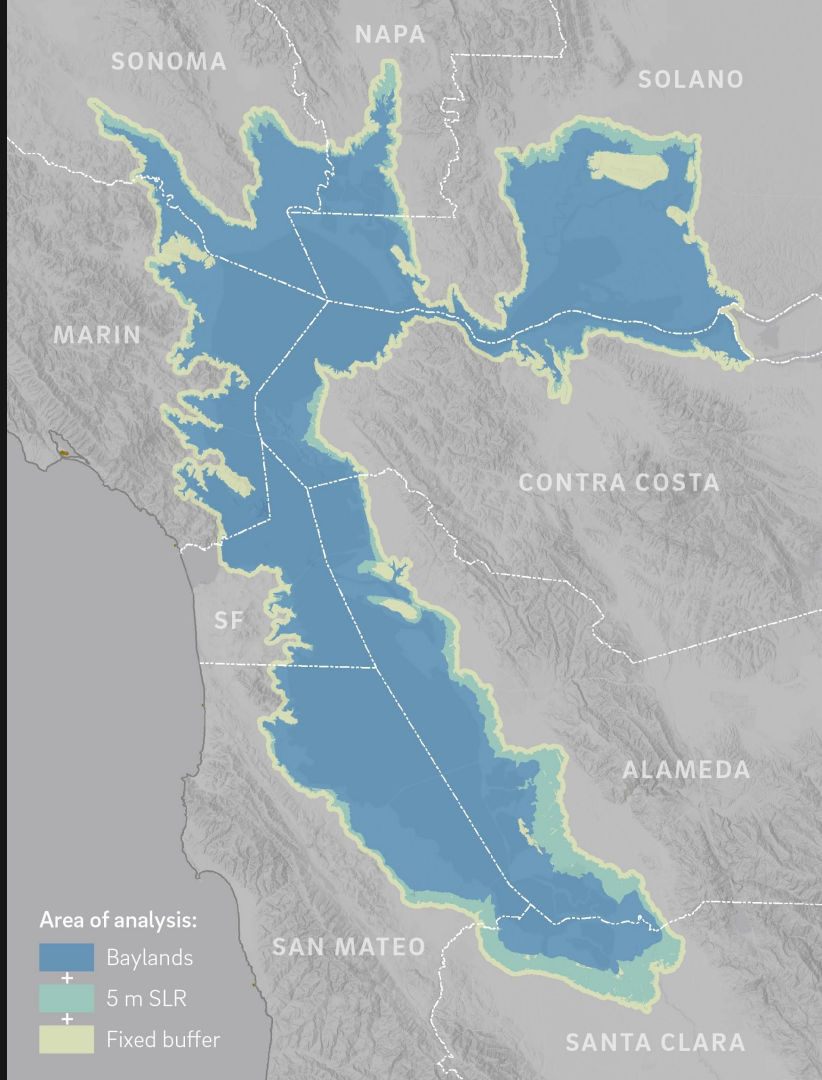

Hills
Alluvial Plain
Baylands
Shallow Bay
Deep Bay
Percent Slope
0%
80%
STEEP HEADLANDS
+ SMALL VALLEYS
ALLUVIAL
PLAIN
WIDE
ALLUVIAL
VALLEY
0
5
10


SAN PABLO BAY
CENTRAL BAY
Bayland Habitats
Mudflat
Tidal Marsh
Bathymetry
< -30 ft
-10ft to -30ft
-5ft to -10ft
0ft to -5ft

AREA OF ANALYSIS

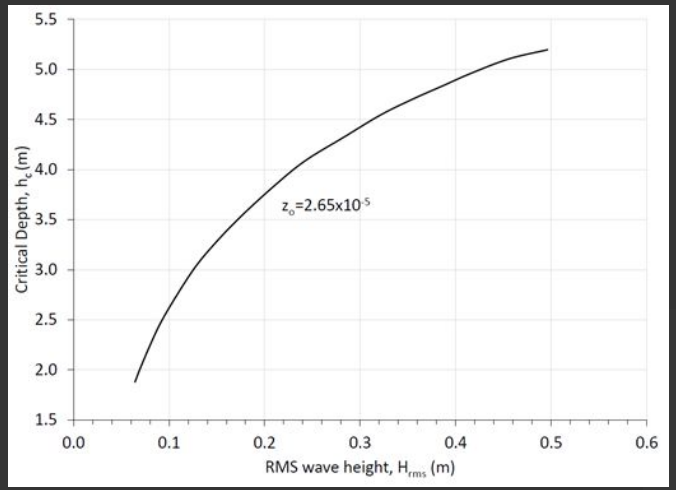
- Back boundary
  - Baylands + 5 m SLR + Transition zone with SLR

- Side boundaries
  - Drainage divides, tidal sheds

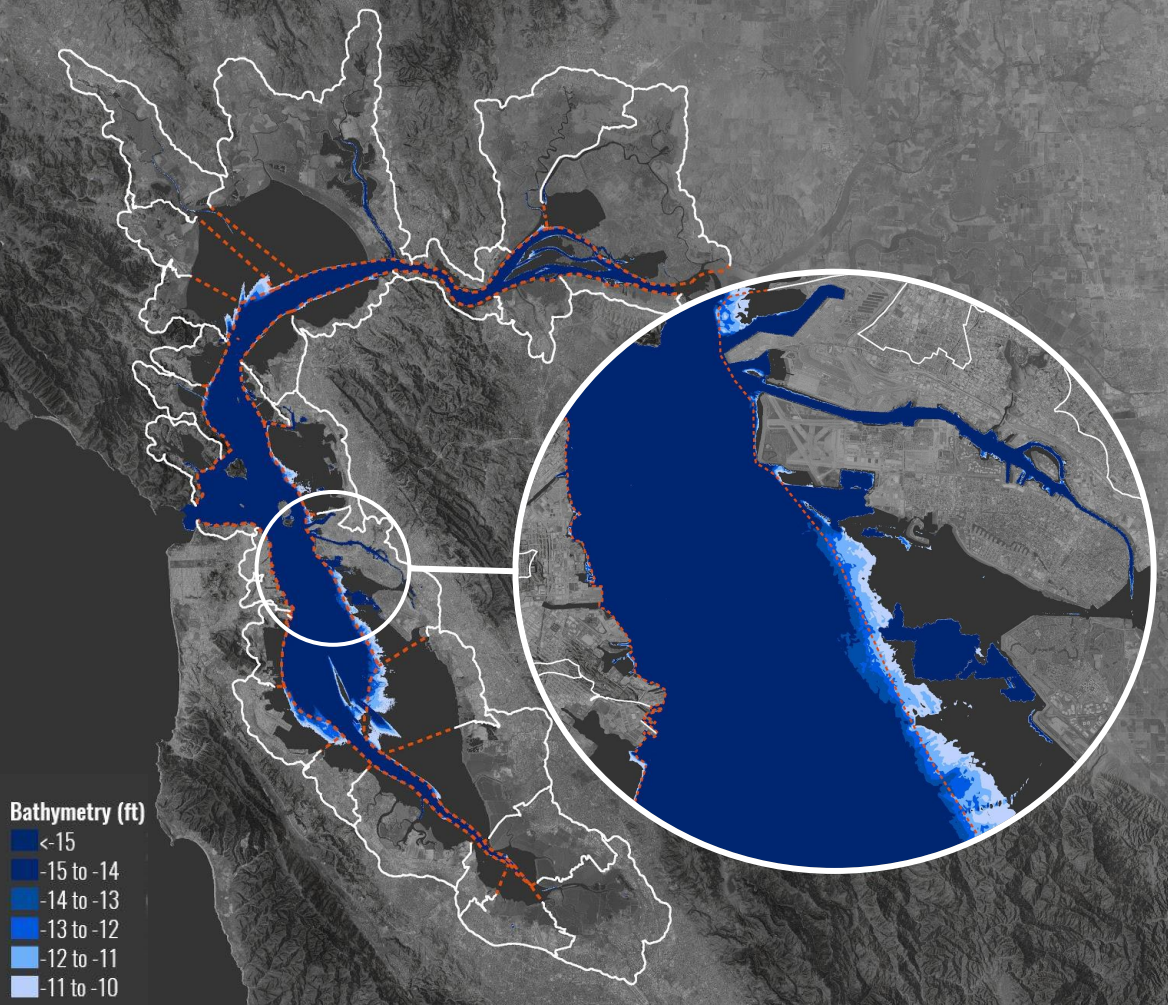


Subtidal Boundary

Depth of Closure



Influence of wave height on critical depth of resuspension



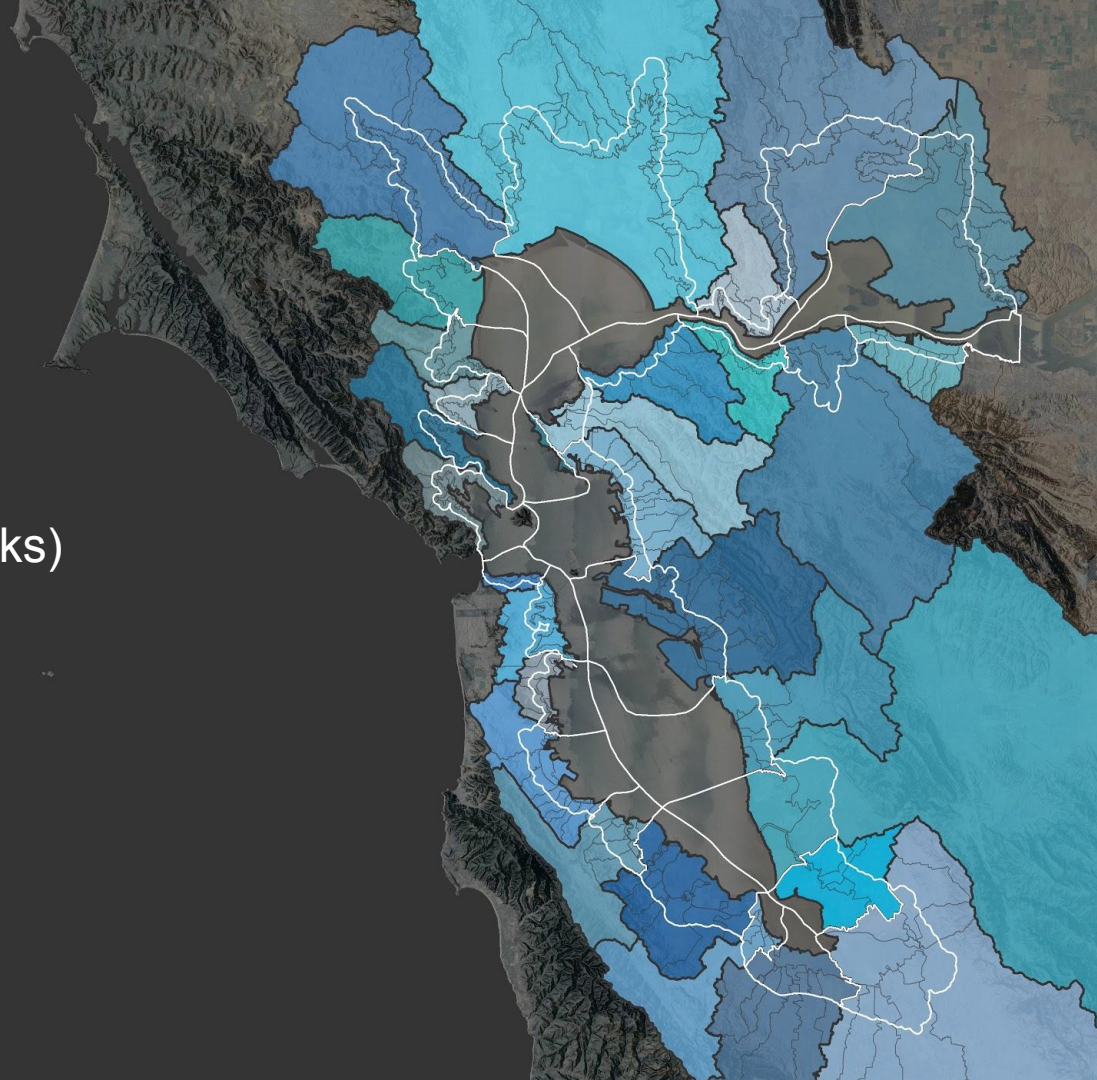
Why do we need another way of splitting up the Bay?

- Watersheds
  - Poorly defined in flat Baylands
- Bayland Goals segments
  - Based on historical wetlands
  - Next step called for in BEHGU
- County boundaries
  - Often split creeks

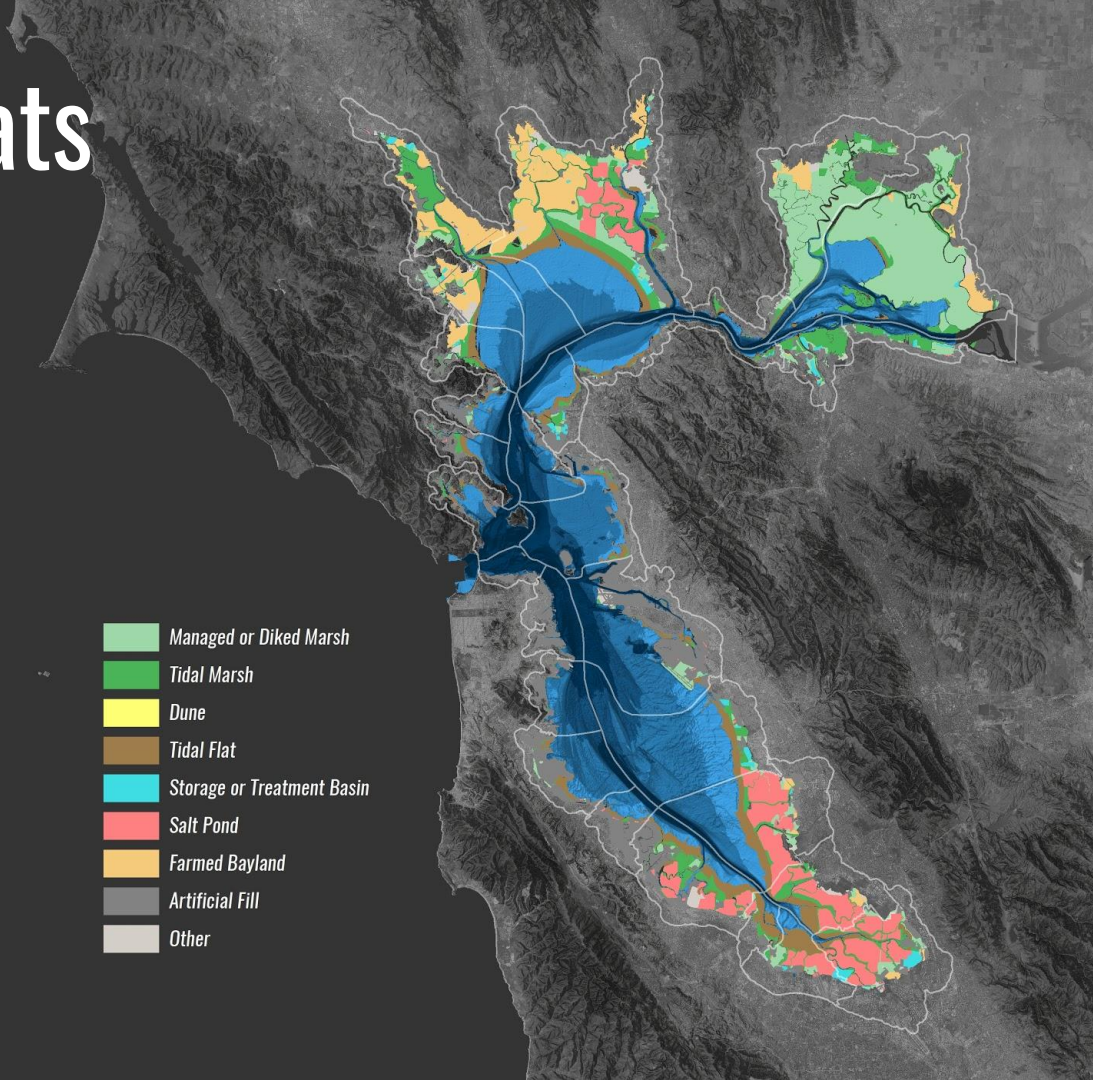
Characterizing OLUs

Watershed inputs

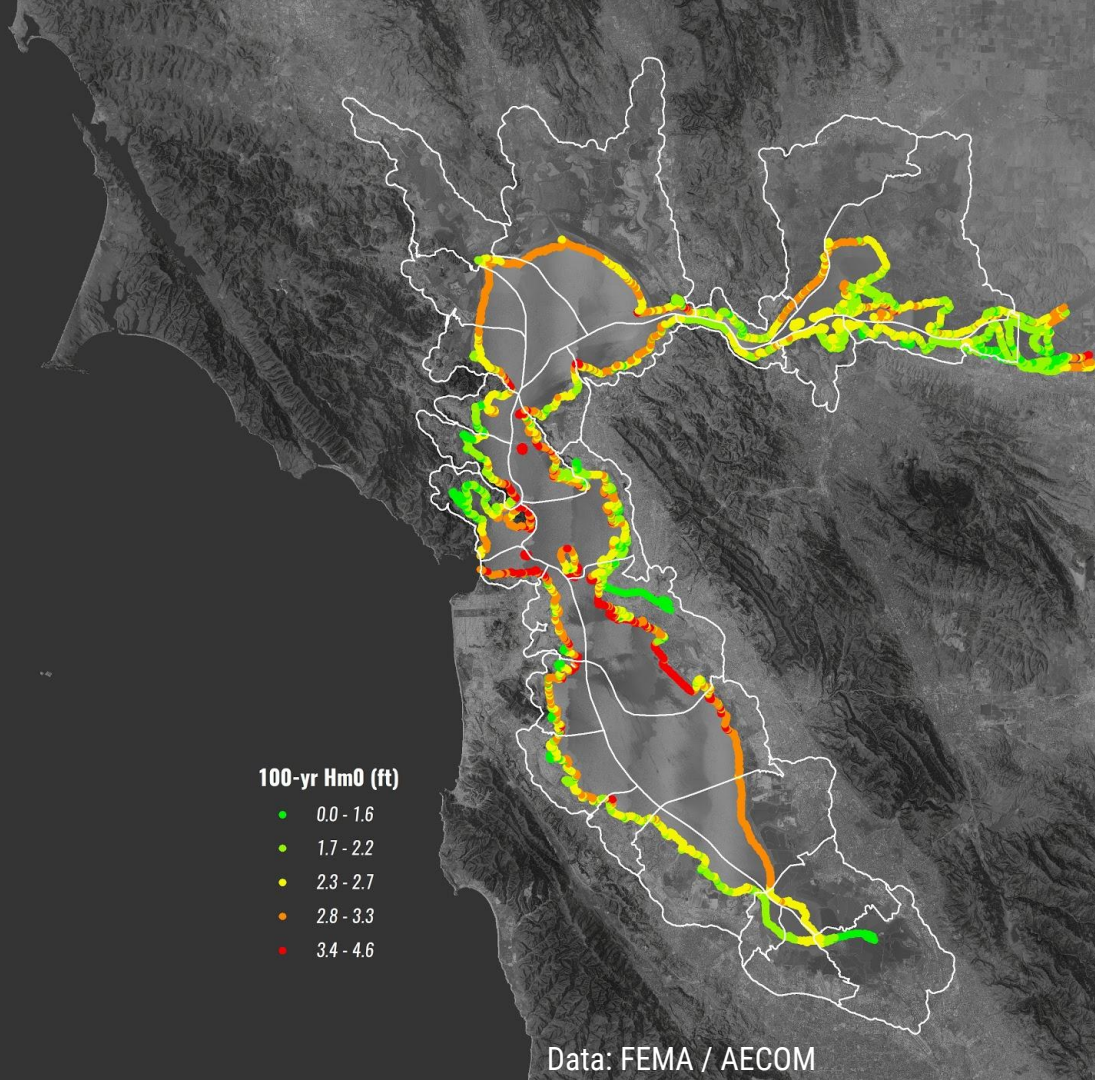
- Sediment loads
- Freshwater (Rivers and Creeks)
- Nutrients
- Creek-Bay Interfaces
- Head of Tide zones



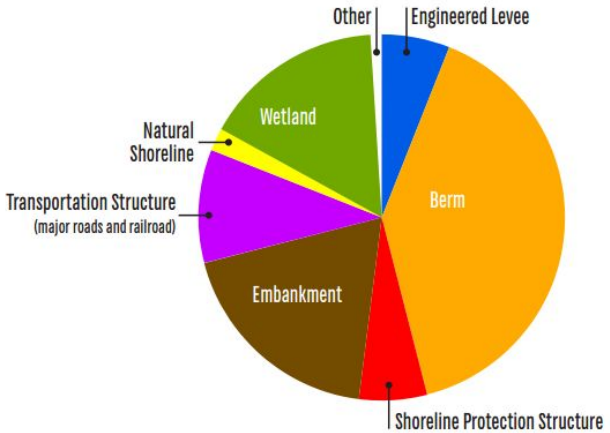
Marshes & Tidal Flats



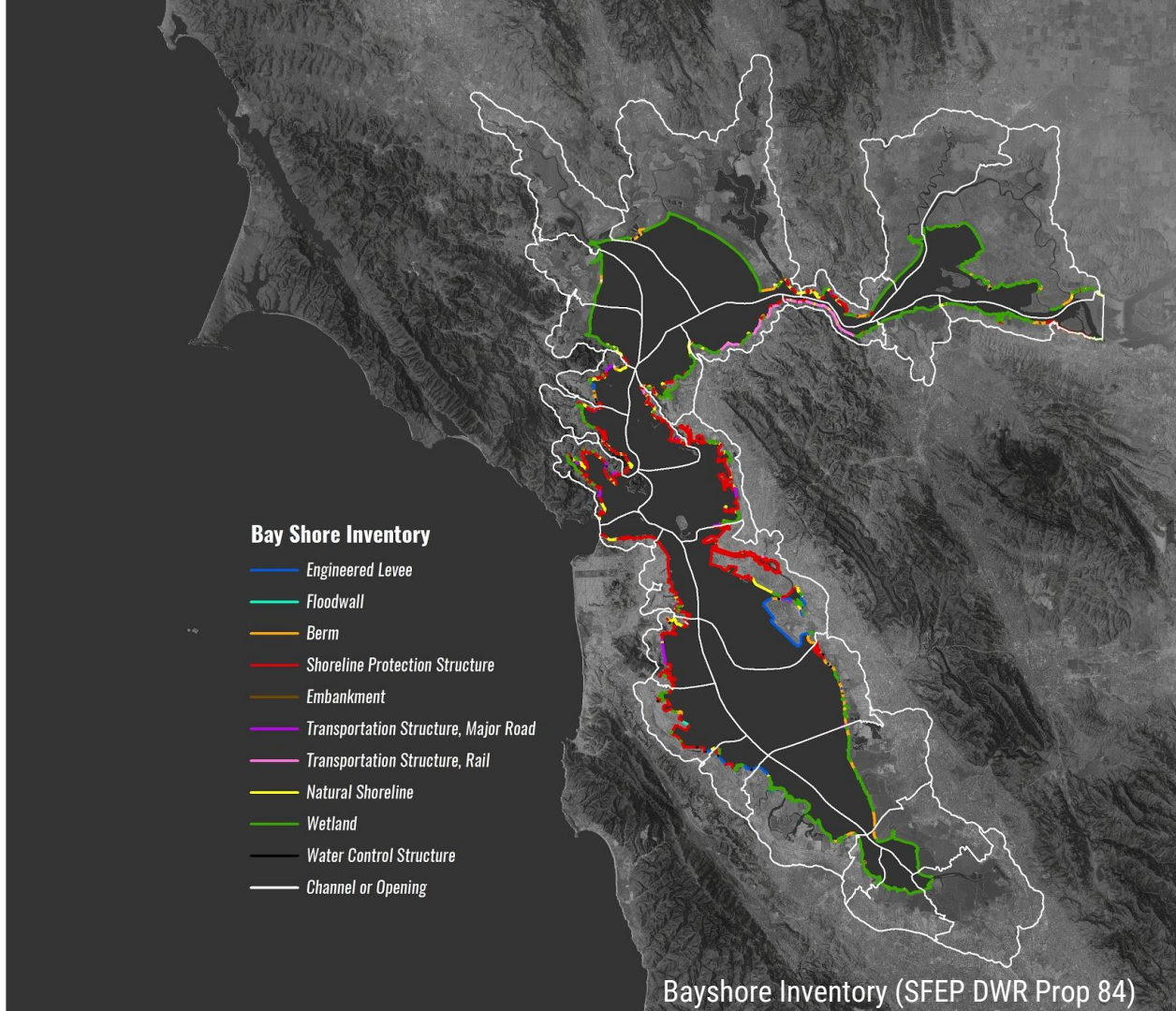
Wave Heights



Shoreline Inventory

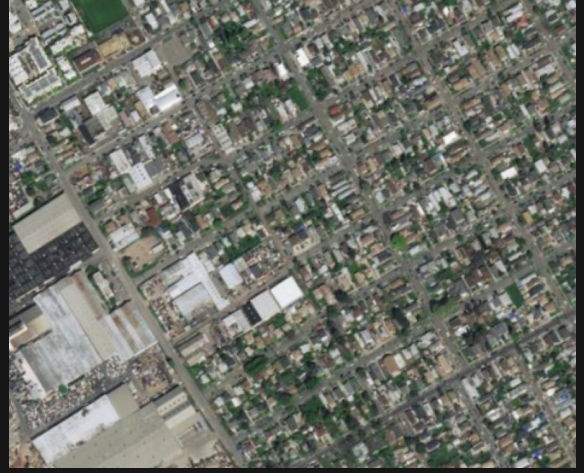


Class	Percent	Miles
Engineered Levee	6%	170
Berm	40%	1,215
Shoreline Protection Structure	6%	175
Embankment	19%	558
Transportation Structure (major roads, railroad)	10%	313
Natural Shoreline	2%	66
Wetland	16%	486
Other	1%	29
TOTAL	**100%**	**3,012**

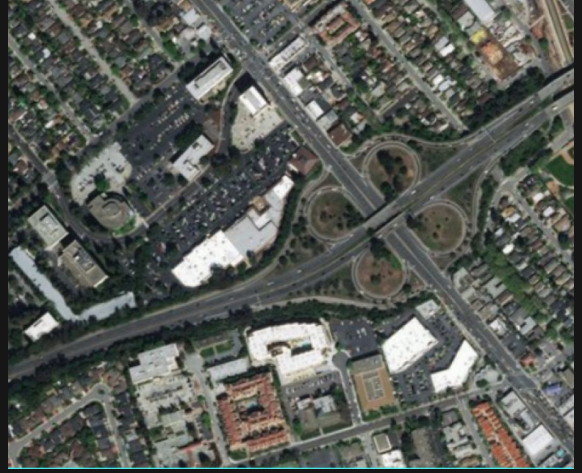


Bayshore Inventory (SFEP DWR Prop 84)

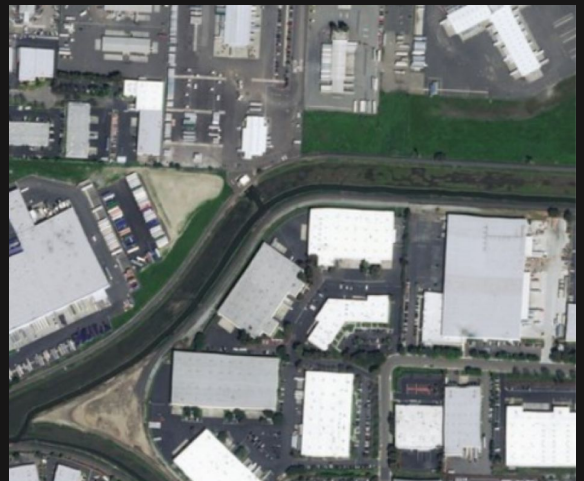
Open Space
Low-density residential

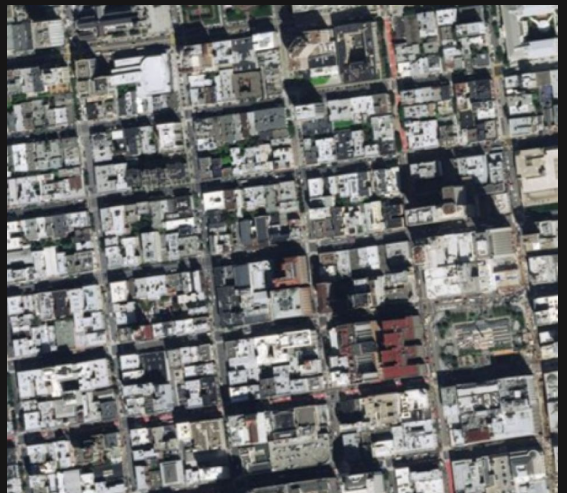


Small-lot residential with mixed use
Low-density commercial and industrial

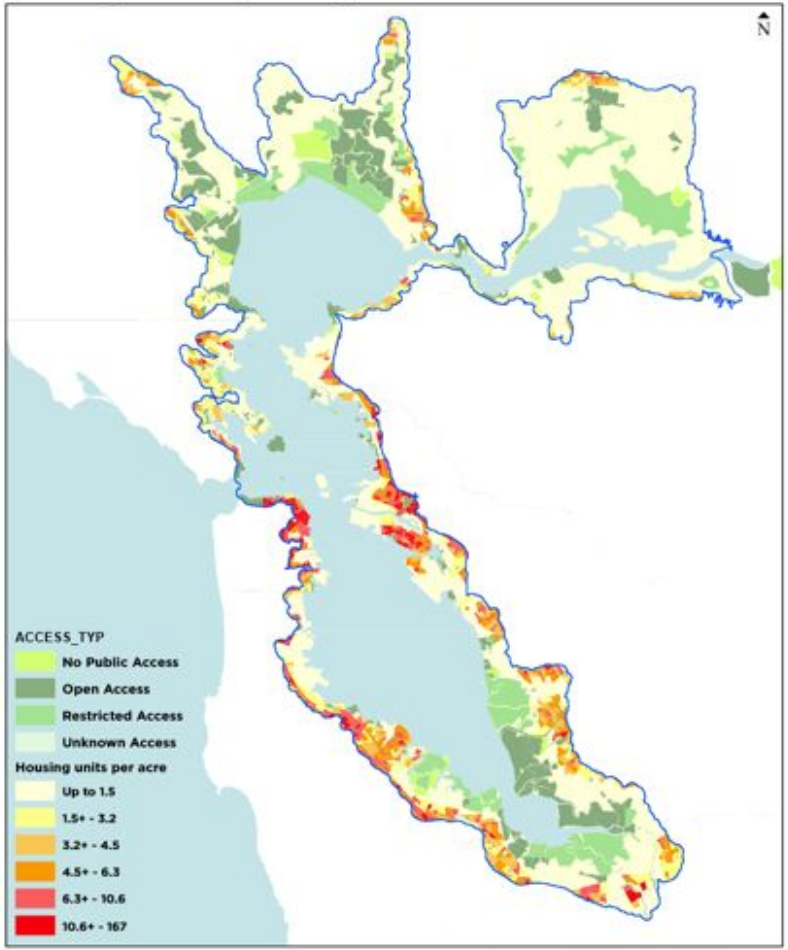


Job-dense suburban centers
High-density downtowns

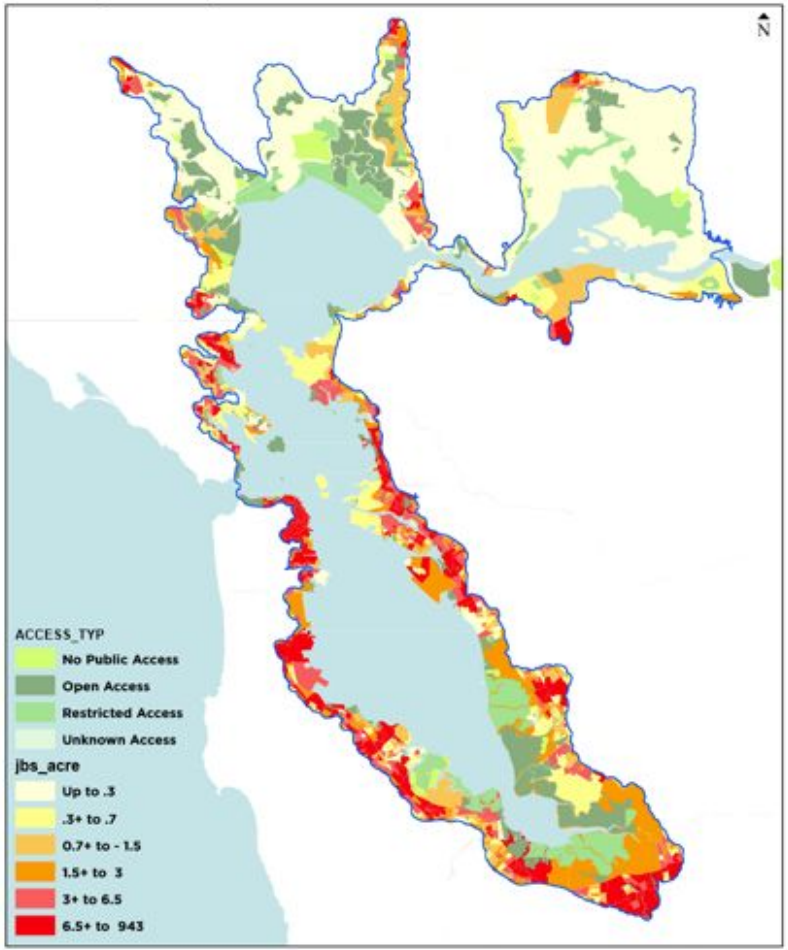


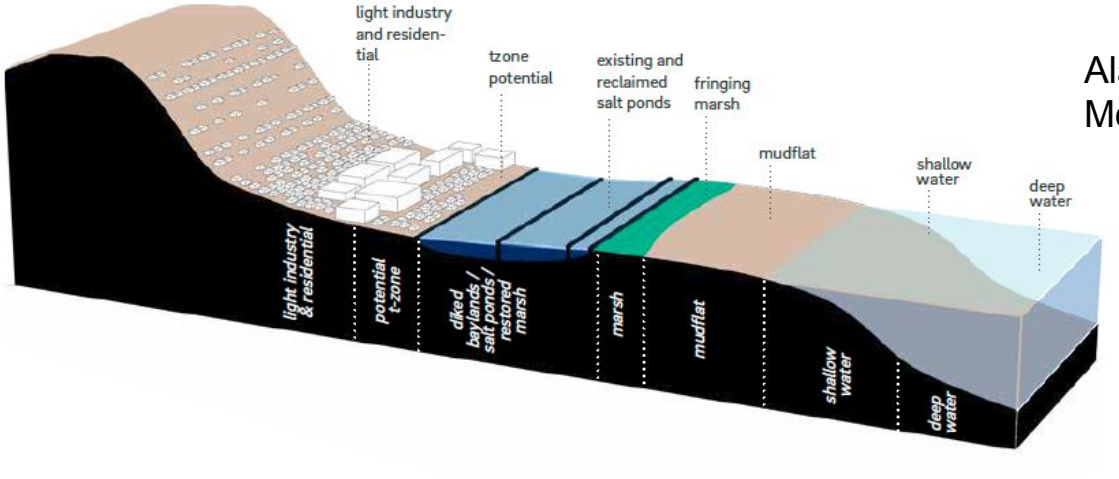


Density: Housing units per acre

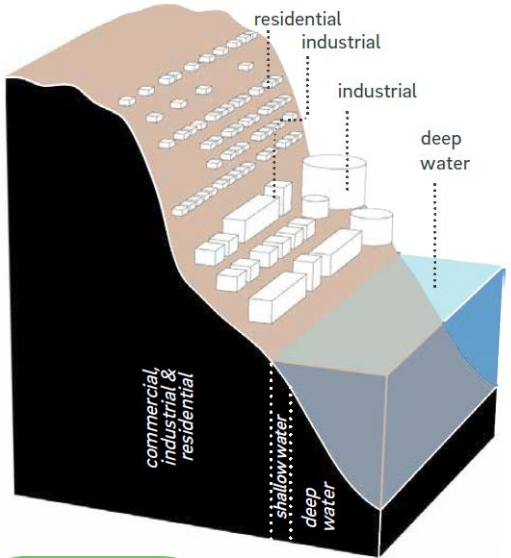


Density: Jobs per acre

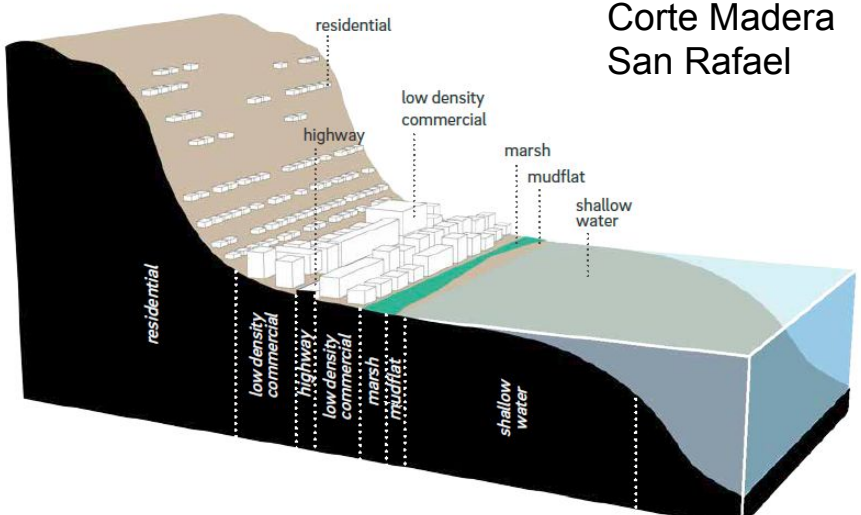




Alameda ck
Mowry



Carquinez South
Mission Islais



Corte Madera
San Rafael

Pairing OLUs with Adaptation Measures

Adaptation measures

Nature based measures (examples)

- Oyster Reefs, Eel grass
- Mudflat recharge
- Beaches (sand, cobble, shell)
- Marsh restoration (various)
- Warping in polders
- Horizontal levees
- Preparing transition zone

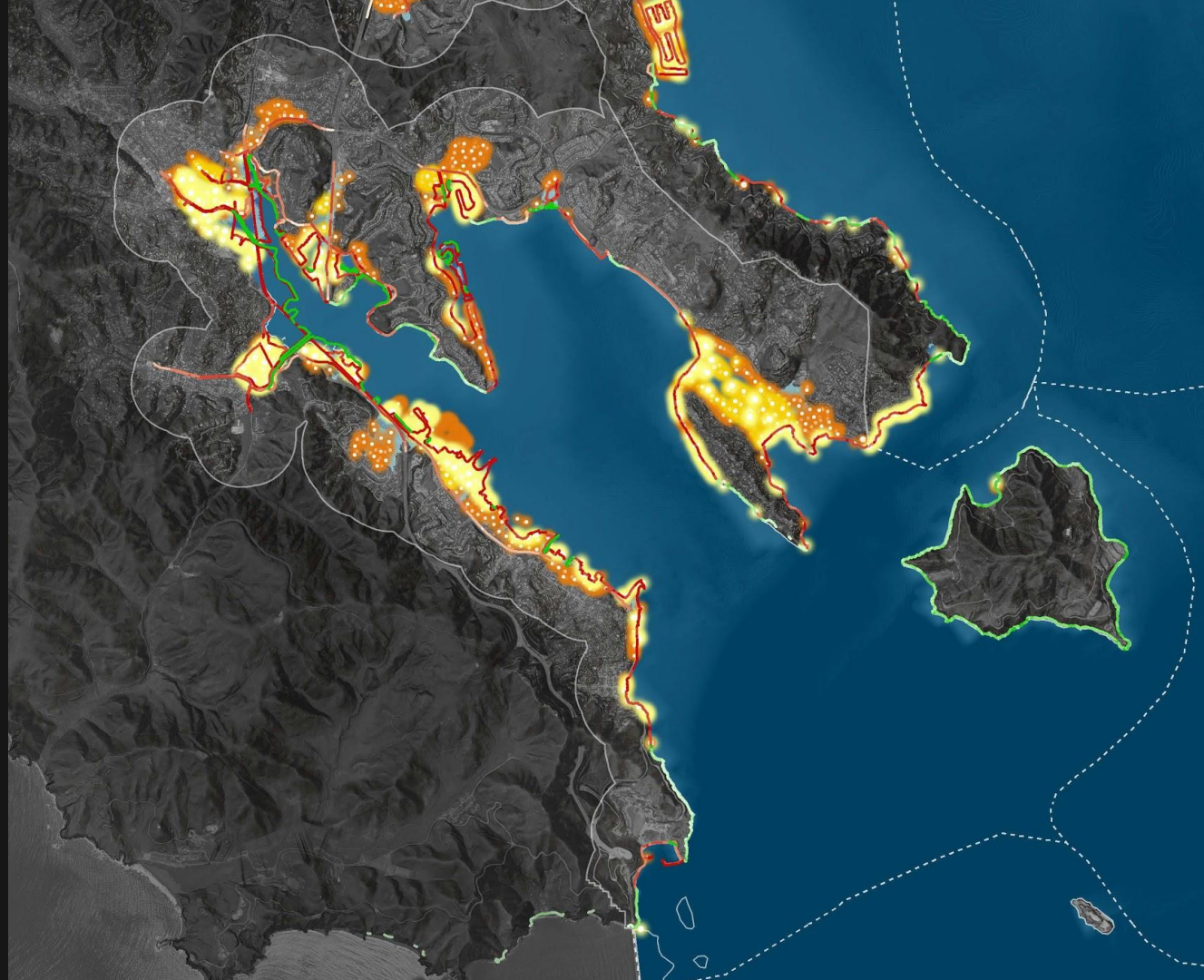
Regulatory, Financial, Policy tools

- Easements
- Building restrictions
- Policy changes
- Zoning changes or overlays
- Buyouts
- Transfer of Development Rights
- Temporary use?

Pairing Problems with Measures

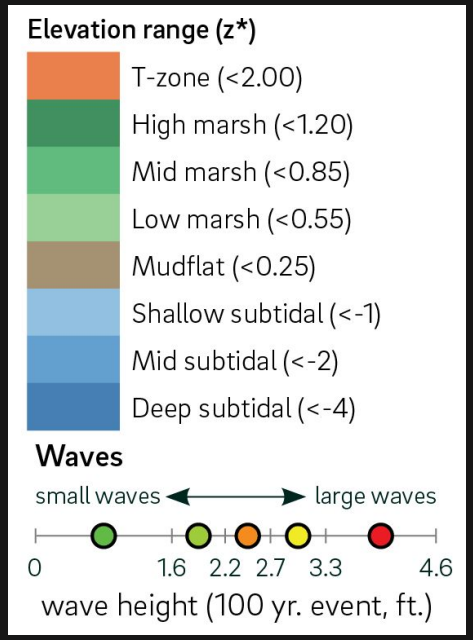
Problem	Cause	Example measure
Wave overtopping or erosion of levee with wide foreshore	Large waves reach levee	Marsh, fine beach, horizontal levee
Waves overtopping or erosion with narrow foreshore	Close to deep water	Coarse beach
Combined flooding	Loss of floodplain	Retention basins, setback levee
Combined flooding	Channel conveyance	Tidal restoration, geomorphic channels
Loss of marsh area	Wave erosion of scarp	Coarse beach, oyster reef
Loss of elevation capital	Low accretion rate	Strategic placement
No space to migrate marsh	Development up to levee	Horizontal levee
Subsided areas behind levee	Diking and draining of marshes	Reconnect to creeks, warping

Vulnerability



Data from BayWave

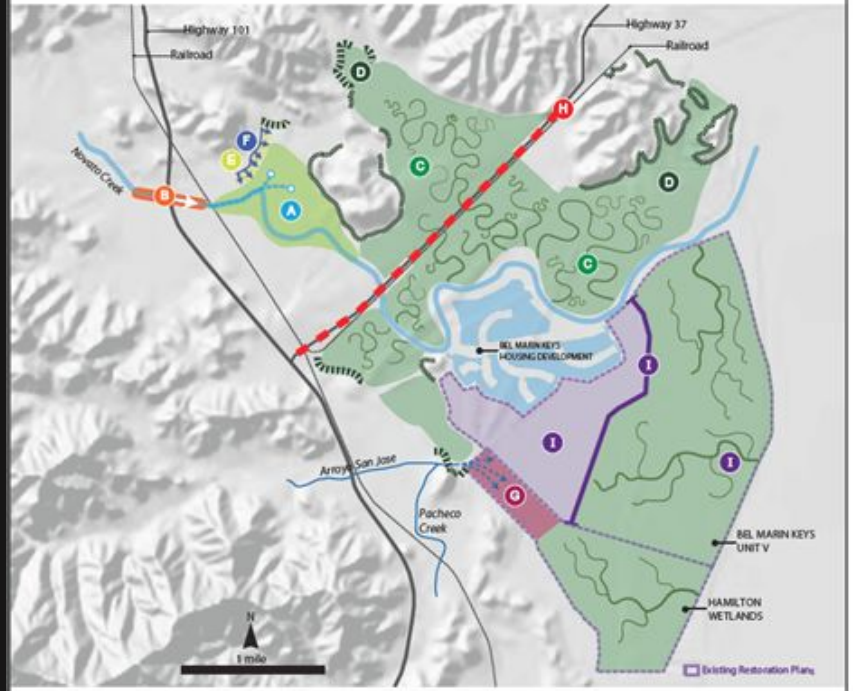
Physical Processes & Drivers



Also **sediment load**
(see large map)

Step 2
At Workshop

NOVATO CREEK BAYLANDS LONG-TERM VISION



Please Note:

- Bel Marin Keys Unit V & Hamilton Wetlands have existing restoration plans. The anticipated restored tidal marsh shown on Bel Marin Keys Unit V & Hamilton Wetlands is illustrated from the State Coastal Conservancy's completed and proposed restoration plans. Please reference the State Coastal Conservancy's plans for additional site actions and associated habitats that are not shown.
- This visioning did not include any modifications to the Bel Marin Keys Housing Development.

A DEPOSITIONAL MARSH PLAIN
(Sediment Accumulation Zone)

ACTIONS
- Natural and managed accumulation of sediment
- Allow deltaic distributary formation and channel movement
- Designed in relation to floodwater detention basins

BENEFITS
- Builds marsh elevation to keep pace with sea level rise
- In long term, reduces potential and severity of tidal flooding in relation to sea level rise and storm surge
- Reduces channel sedimentation
- Provides rare brackish tidal marsh

B ACTIVE STREAM SEDIMENT MANAGEMENT

ACTIONS
- Transport fine sediment to marsh depositional plain via slurry and/or short distance truck transport
- Use coarse sediment to build and/or maintain seepage levees
- Use sediment for coastal flood protection structures/ slopes

BENEFITS
- Potential to reduce sediment maintenance removal costs
- Maintains channel capacity and flood protection
- Increases marsh resilience to accelerated sea level rise
- Protects developed areas and infrastructure from coastal flooding

C TIDAL MARSH

ACTION
- Remove levees and reconnect lower Novato Creek to adjacent baylands

BENEFITS
- Reestablishes functioning marsh plain (with tidal channels, mudflat, shallows)
- Increases tidal prism to widen Novato Creek channel and improve floodwater transport capacity
- Increases edge habitat between marsh and Bay
- Increases marsh patch size for special status species
- Reduces wave action due to wave attenuating vegetated marshes
- Possible decrease in flood elevation with water spreading out onto the floodplain

D ESTUARINE-TERRESTRIAL TRANSITION ZONE

Natural, narrow ecotone (hillslope transition)
Natural, wide ecotone (lowland transition)

ACTION
- Reconnect tidal marsh to adjacent undeveloped grassland and oak woodland areas

BENEFITS
- Increases high water refuge habitat and migratory corridors for tidal marsh species
- Provides opportunity for tidal marsh migration landward in response to sea level rise

E HORIZONTAL LEVEES*
(Constructed Transition Zone)

ACTION
- Establish wide, gently sloped flood protection levees

BENEFITS
- Protects vital infrastructure from flooding
- Reuses dredged sediment
- Provides transition zone habitats and marsh migration space

* The term "Horizontal Levee" is a registered trademark of The Bay Institute.

F PERMEABLE SEEPAGE SLOPE
(Freshwater Inflow Zone)

ACTION
- Redirect treated wastewater from treatment ponds to permeable horizontal levees

BENEFITS
- Provides nutrient processing functions (e.g., denitrification, nutrient sequestration)
- Creates brackish marsh gradients and habitat heterogeneity

G SEASONAL WETLANDS/SALT PANNES

ACTION
- Reroute Arroyo de San Jose and Pacheco Creek to support seasonal wetland habitat with direct freshwater and sediment inflow (possibly transitioning to salt pannes with sea level rise)

BENEFITS
- Takes flood water out of mainstem Novato Creek
- Provides shorebird and waterfowl habitat
- Provides potential area for tidewater goby reintroduction

H ELEVATED TRANSPORTATION INFRASTRUCTURE

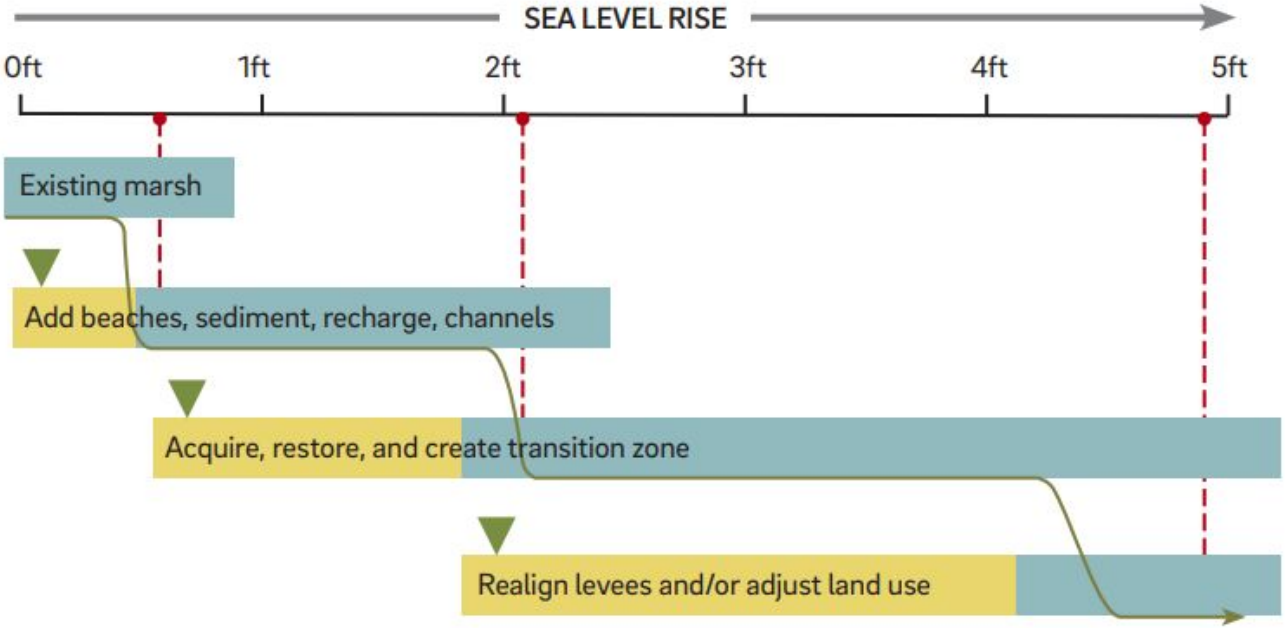
ACTION
- Elevate highway and railroad to allow tidal flows to the northeast portion of the historical baylands

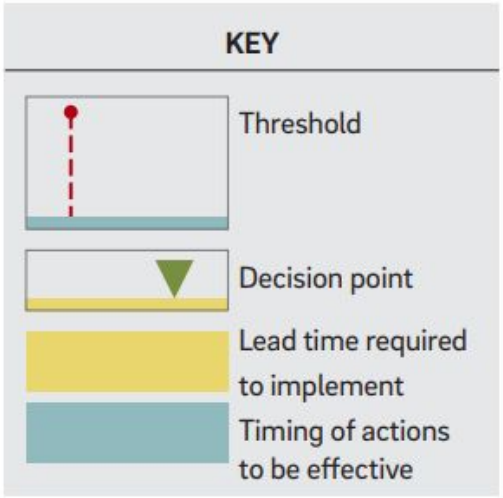
BENEFITS
- Increases total marsh area, tidal channel length, and natural transition zone
- Increases tidal prism and flood control channel capacity
- Decreases infrastructure vulnerability

I BEL MARIN KEYS UNIT V RESTORATION

ACTIONS
- Increase ground elevation
- Remove Bay levee and establish tidal channel networks that drain to Bay
- Build new levee inland to protect freshwater marsh area

BENEFITS
- Maximizes cost effectiveness of lower Novato Creek habitat restoration efforts
- Increases resiliency to sea level rise with elevated marshes
- Reduces wave action due to wave attenuating vegetated marshes





Conceptual phasing of measures triggered by sea-level rise, rather than a chronological timeline (adapted from Goals Project 2015).

TECHNICAL FEEDBACK



- **Technical Advisory Committee**
  - *Peter Baye, Coastal Ecologist*
  - *Mark Stacey, UC Berkeley*
  - *Roger Leventhal, Marin County Flood*
  - *Kristina Hill, UC Berkeley*
  - *Andy Gunther*

- **Regional Advisory Committee**
  - *Luisa Valiela, EPA*
  - *Naomi Feger, RB2*
  - *Lindy Lowe, formerly BCDC*
  - *Matt Gerhart, SCC*
  - *Caitlin Sweeney, SFEP*
  - *David Lewis, Save the Bay*

ACTION 14

Demonstrate how natural habitats and nature-based shoreline infrastructure can provide increased resiliency to changes in the Estuary environment

- Develop a primer on how bayshore projects can be designed and optimized to achieve multiple benefits

- **Develop a system for describing the variety of shorelines around the estuary**

- Based on steps 1 and 2, develop guidelines for nature-based adaptation measure that increase resilience of the Estuary

Possible Ties to the CCMP

Action 14: Characterize shoreline

Action 1: Watershed-scale approach

THANK YOU

Contact Us: Julieb@sfei.org Jeremyl@sfei.org

Thanks to our team: Katie McKnight, Sam Safran, Letitia Grenier
Laura Tam, Sarah Jo Szambelan, SPUR

Funded by: **SF Bay Regional Water Quality Control Board (thank you!)**

RESILIENCE.SFEI.ORG

SPUR

SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER