Shallow Groundwater Mapping and Baylands Resilience in Contra Costa County

Contra Costa Resilient Shoreline Committee

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Ellen Plane, Senior Scientist

February 18, 2025

Agenda

1. Groundwater rise context
2. New shallow groundwater mapping for Contra Costa County
3. Brief introduction to SFEI's adaptation and resilience tools

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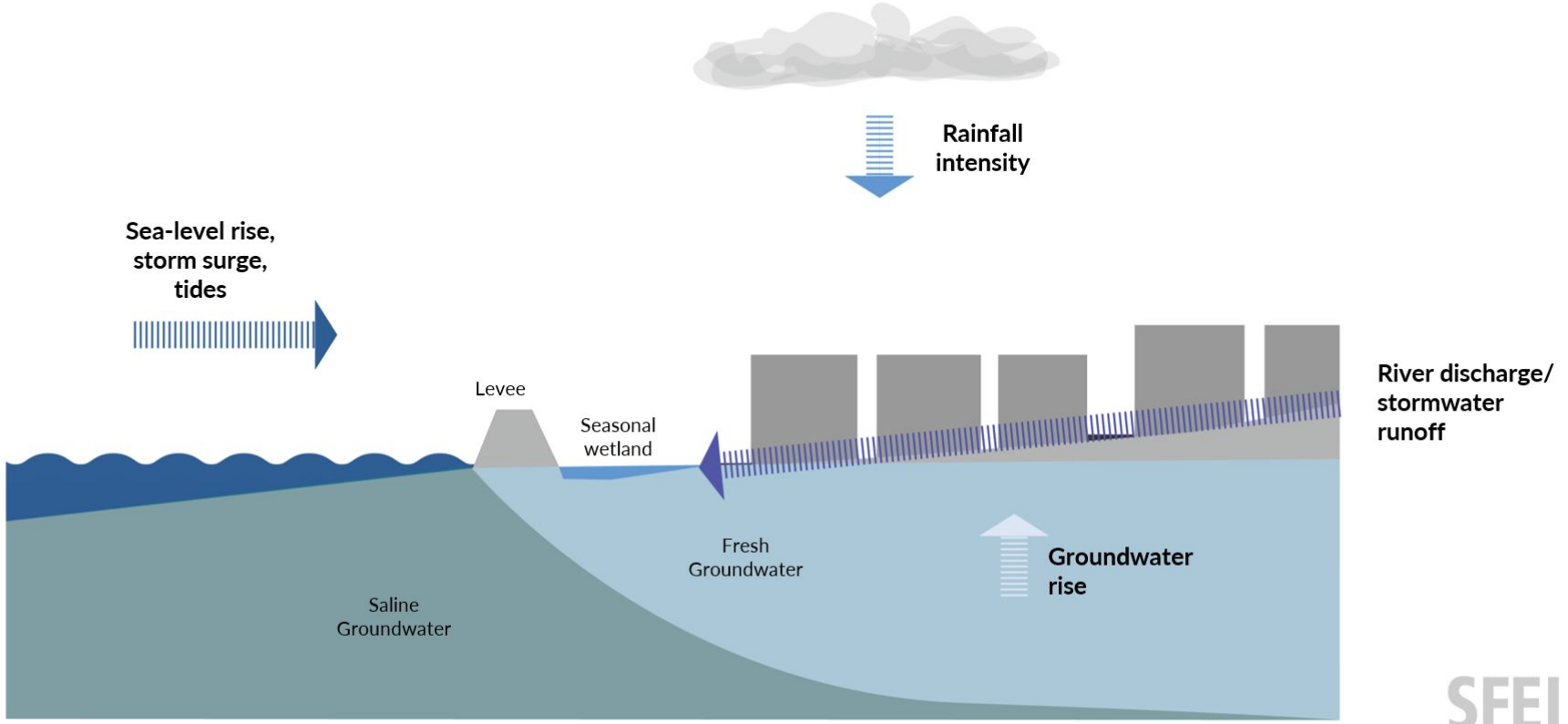
Sources of flooding



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What is groundwater rise?

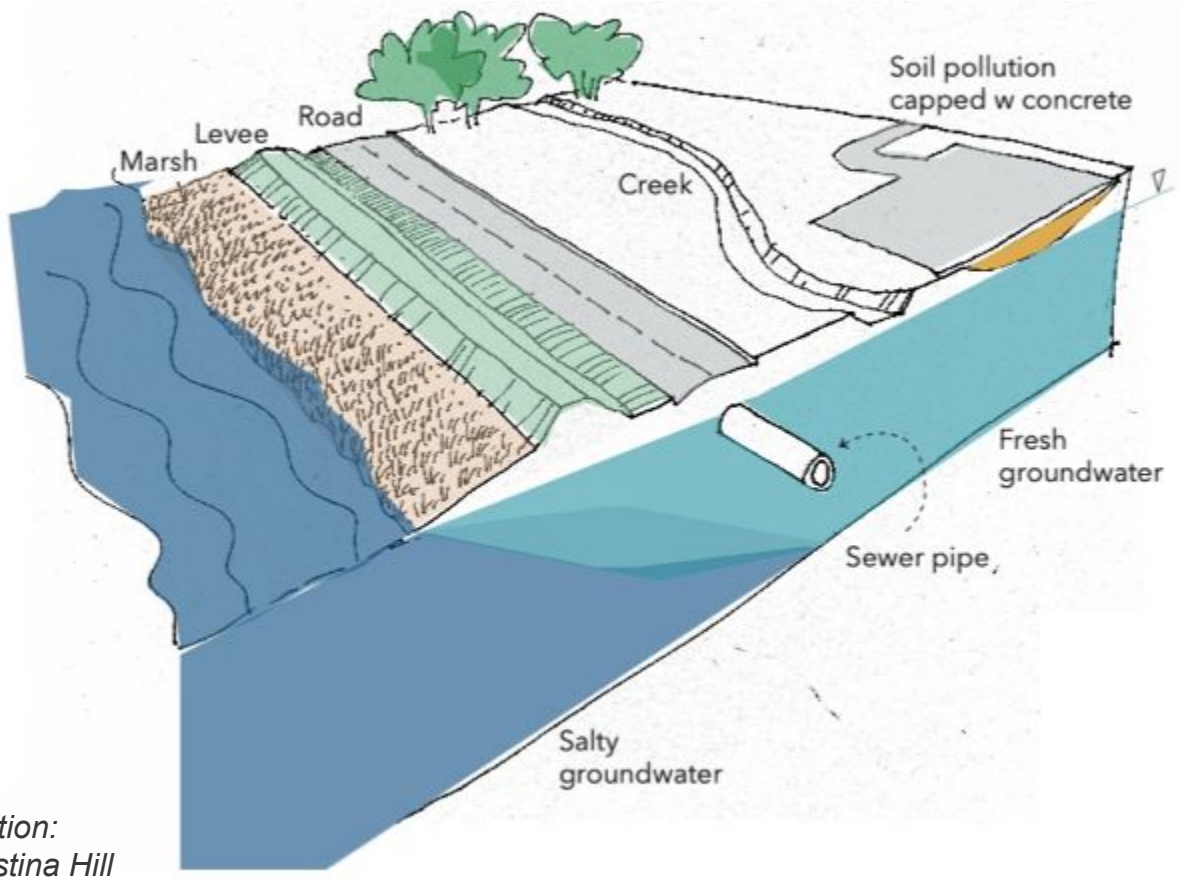
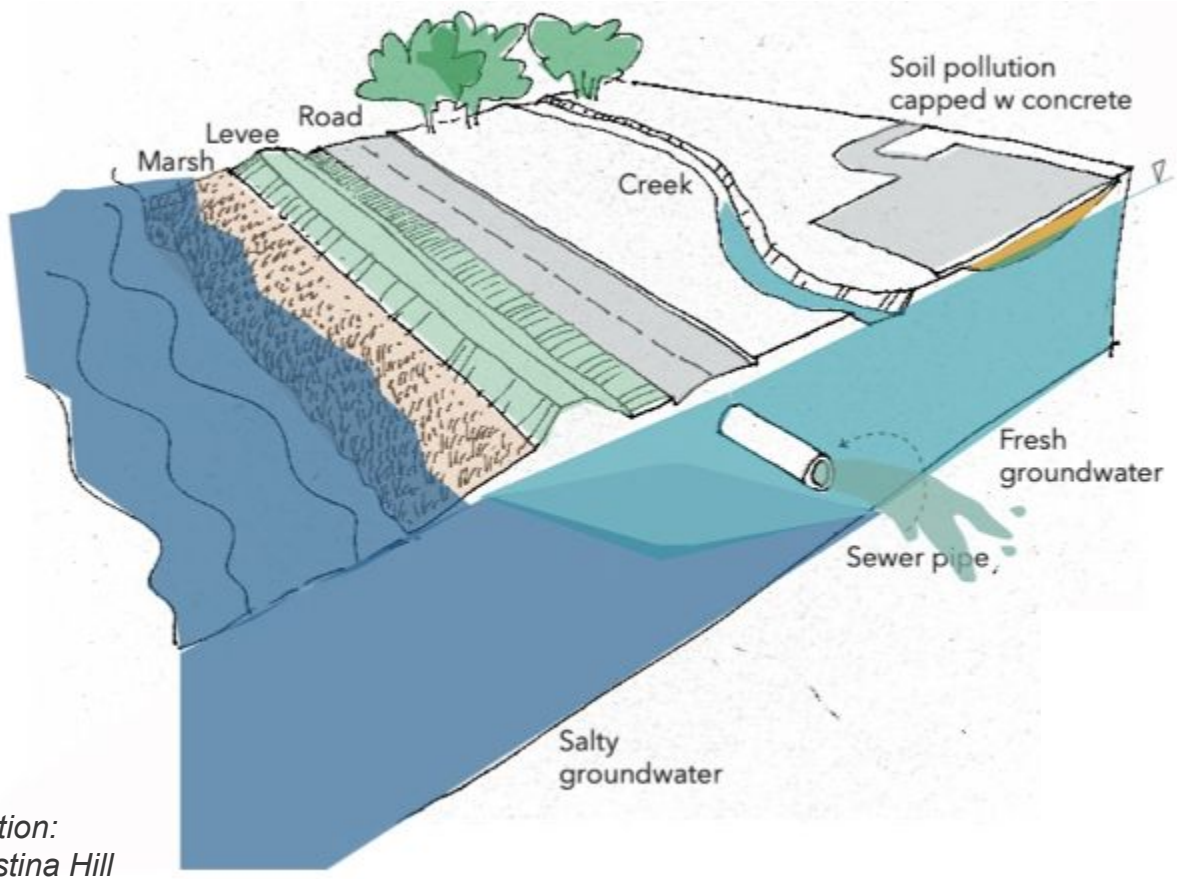


Illustration:
Dr. Kristina Hill

What is groundwater rise?



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What is groundwater rise?

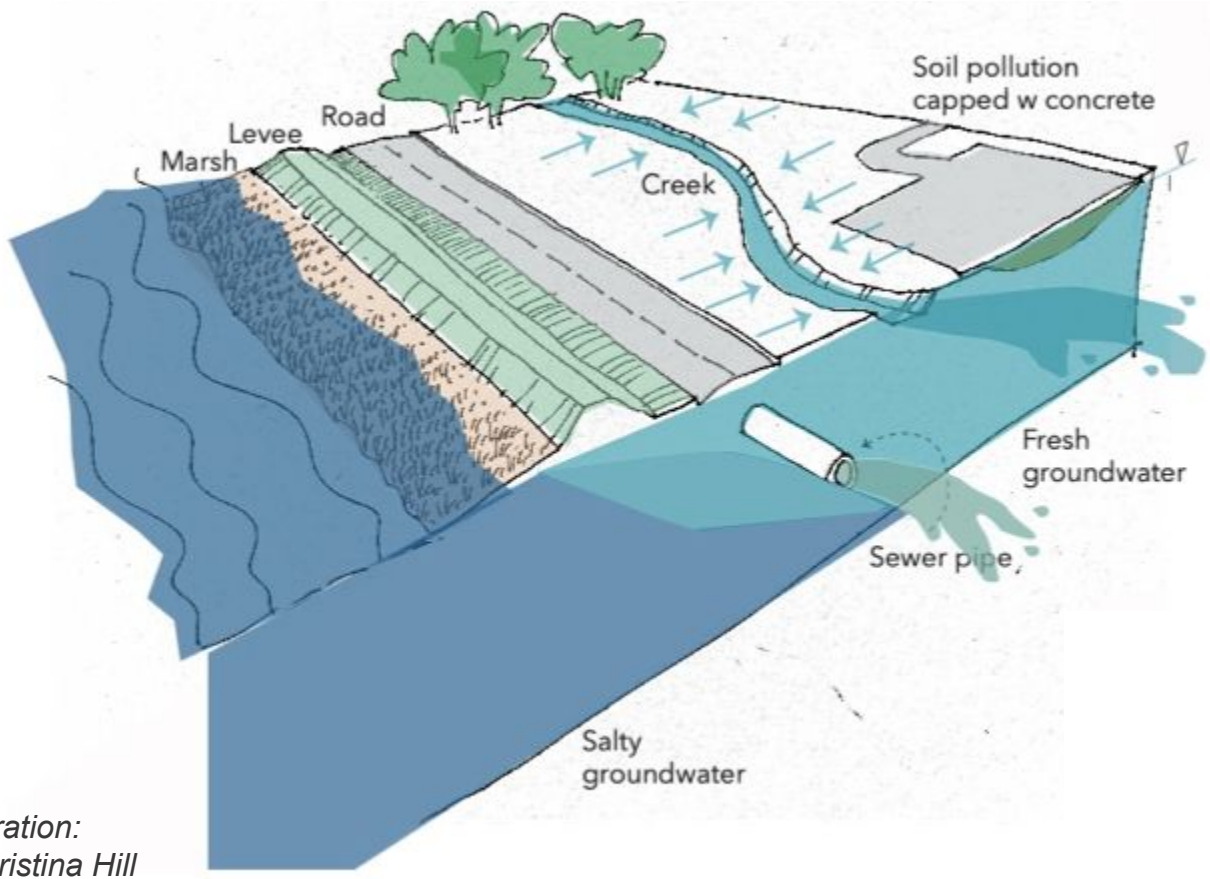

Illustration:
Dr. Kristina Hill

Background on present effort

- Previous study mapped shallow groundwater response to sea level rise for 4 Bay Area counties (Pathways & SFEI 2022)
- Report, StoryMaps (English & Spanish), publicly available GIS data
- Now adding Contra Costa County with funding from the Regional Water Quality Control Board

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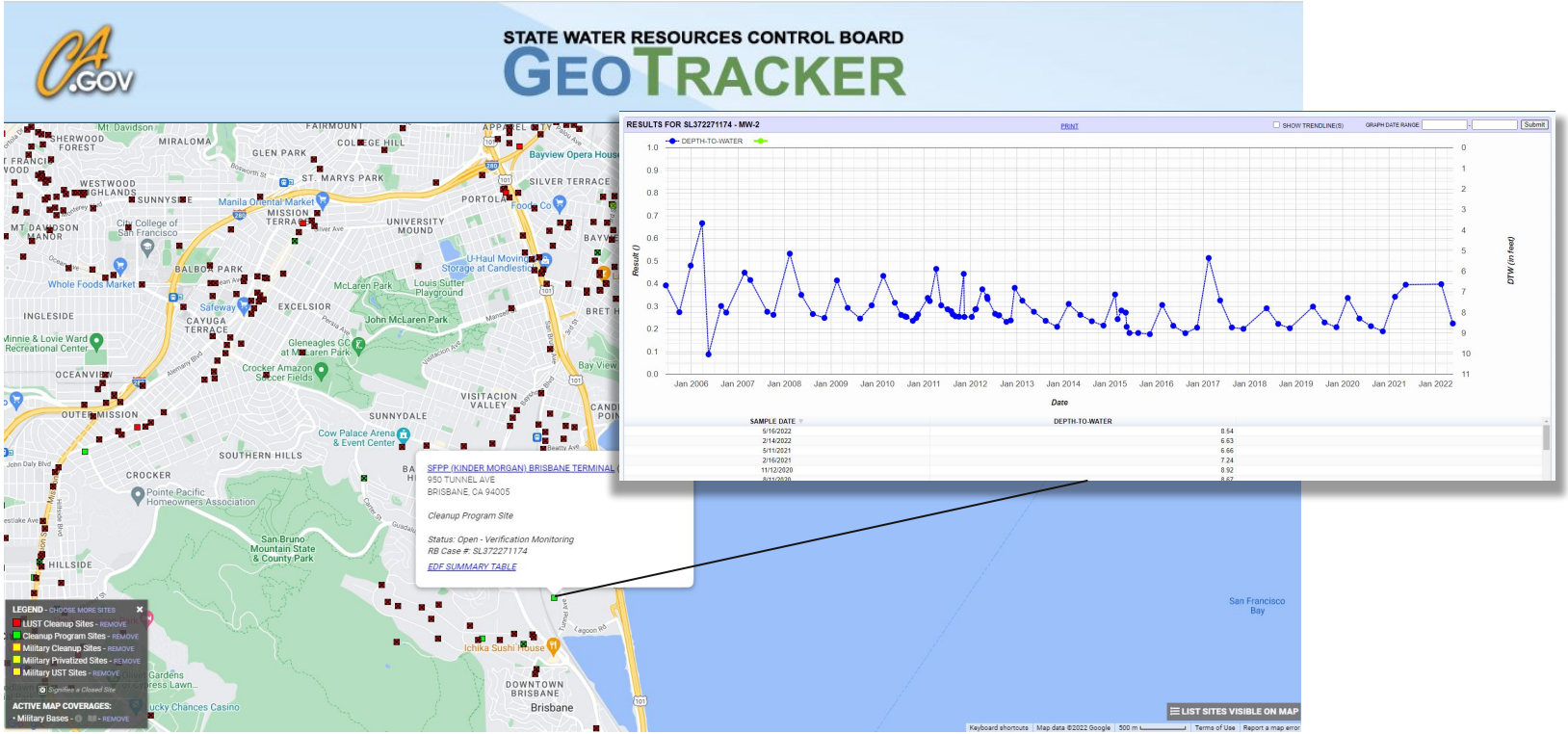
Primary data source: monitoring wells



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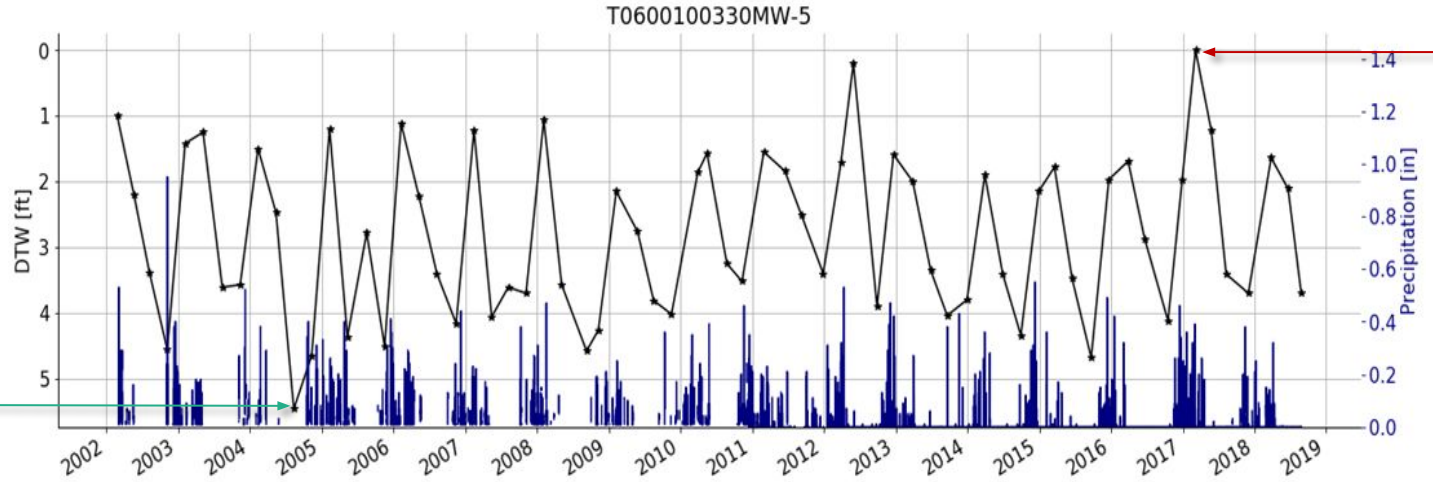
Groundwater response to precipitation



Wet Winter Conditions

Dry Summer Conditions

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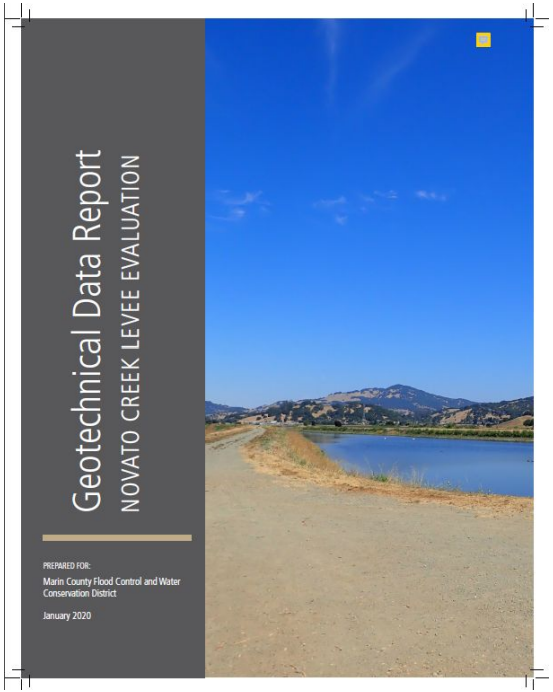
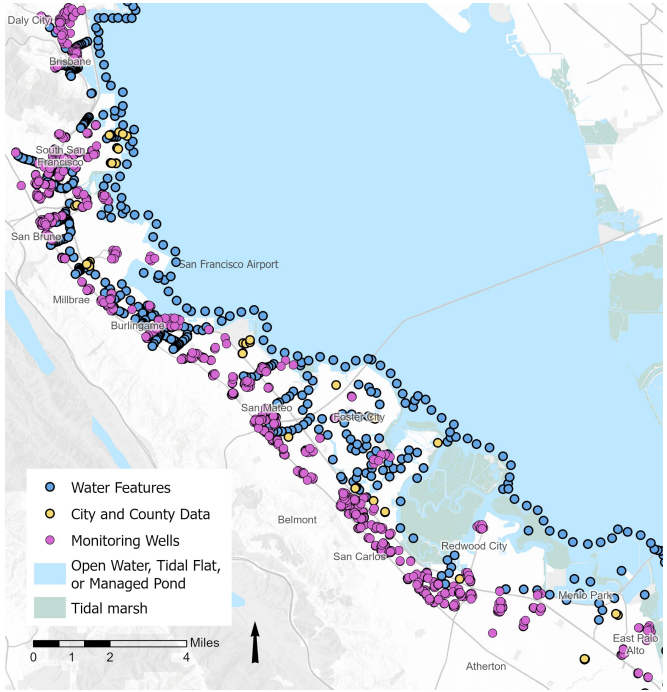
Additional data sources



Boring logs from geotechnical reports and well completion reports

Tidal datums, lagoon and stream water elevations



Data compilation (San Mateo County)

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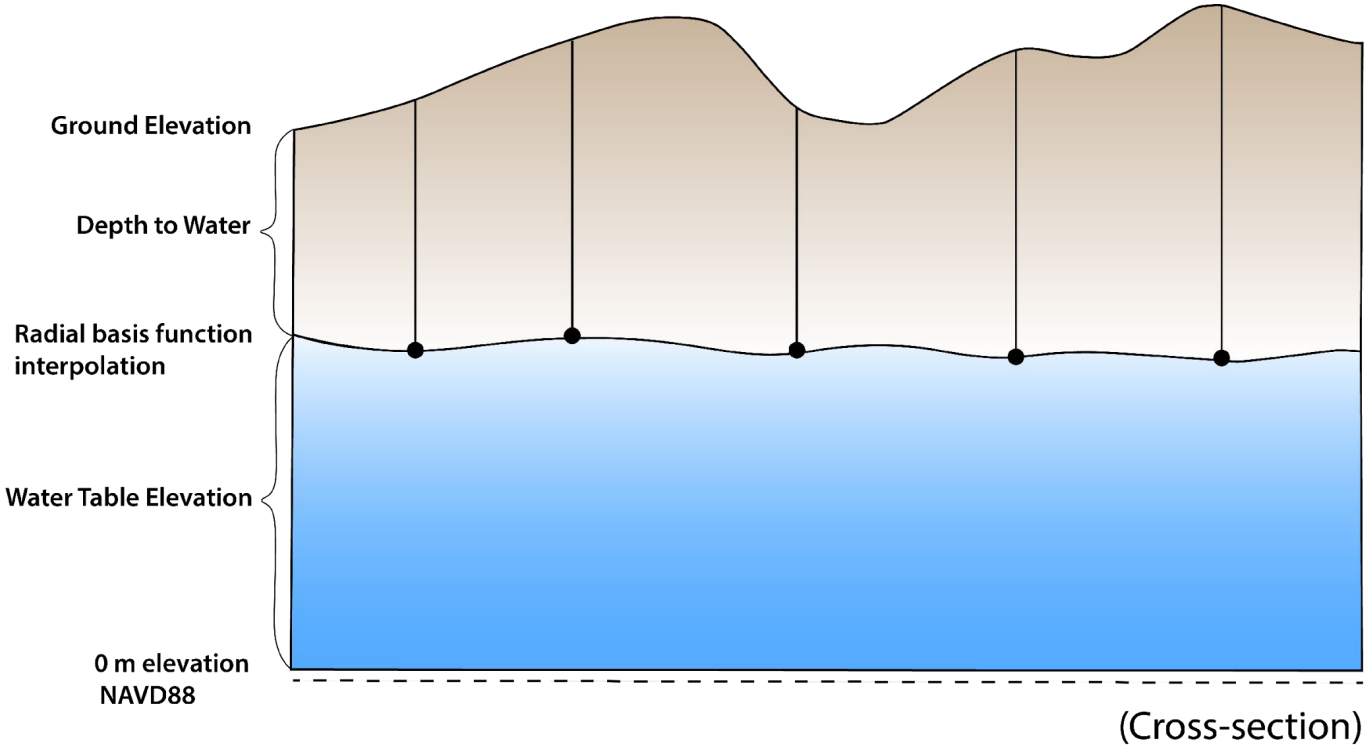
Interpolation



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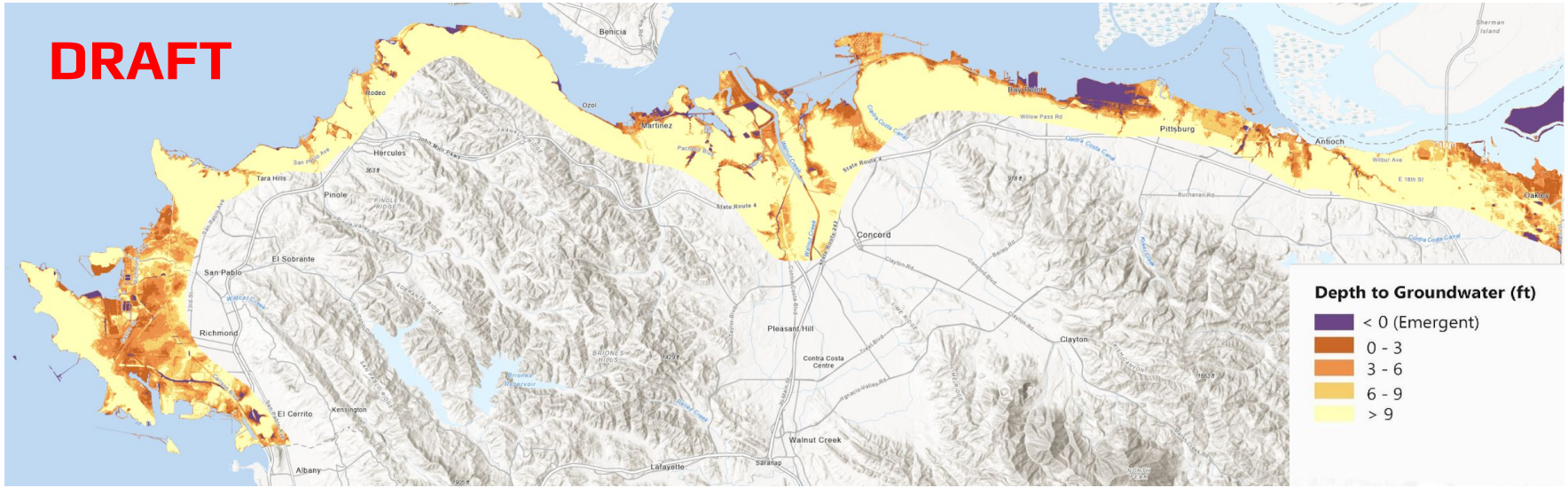
Contra Costa County: Depth to Water (DTW)

Results from interpolations for existing conditions (wet winters/maximum measured water table)



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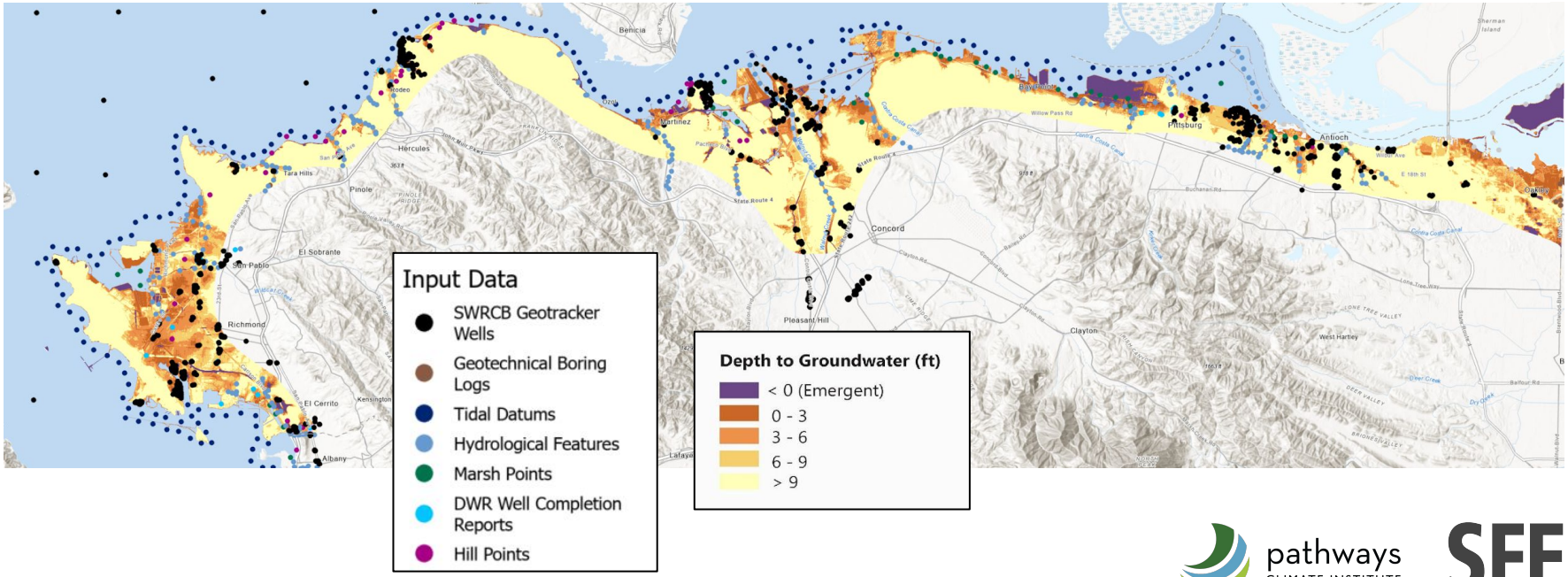
Contra Costa County: Depth to Water (DTW)

Existing conditions interpolation and data sources



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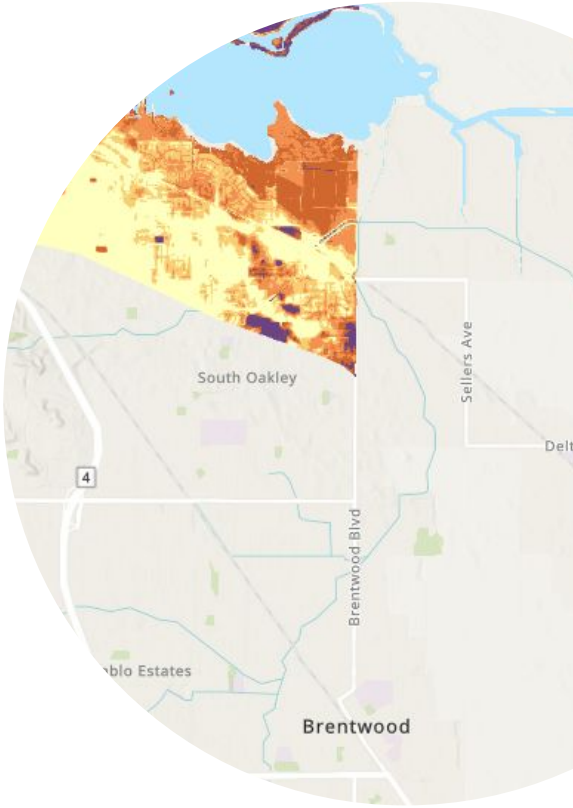
Boundary of analysis

- Eastern extent of analysis is Oakley/Brentwood Blvd
- East of here, groundwater dynamics are less influenced by the Bay and more influenced by Delta inflow and groundwater pumping
- A special study would be needed to determine the influence of sea level rise on groundwater in this area



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Shallow groundwater datasets for Contra Costa County

USGS 2020

- MODFLOW regional dataset
- Long term annual average groundwater surface
- 10-meter resolution, less detailed

Pathways & SFEI 2025

- Data driven, locally refined
- Highest annual groundwater surface (wet winter)
- 1-meter resolution, greater detail

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Contra Costa County: USGS Mapping

- USGS mapping, modeled 2020
- Different methodology
- Only up to Pittsburg

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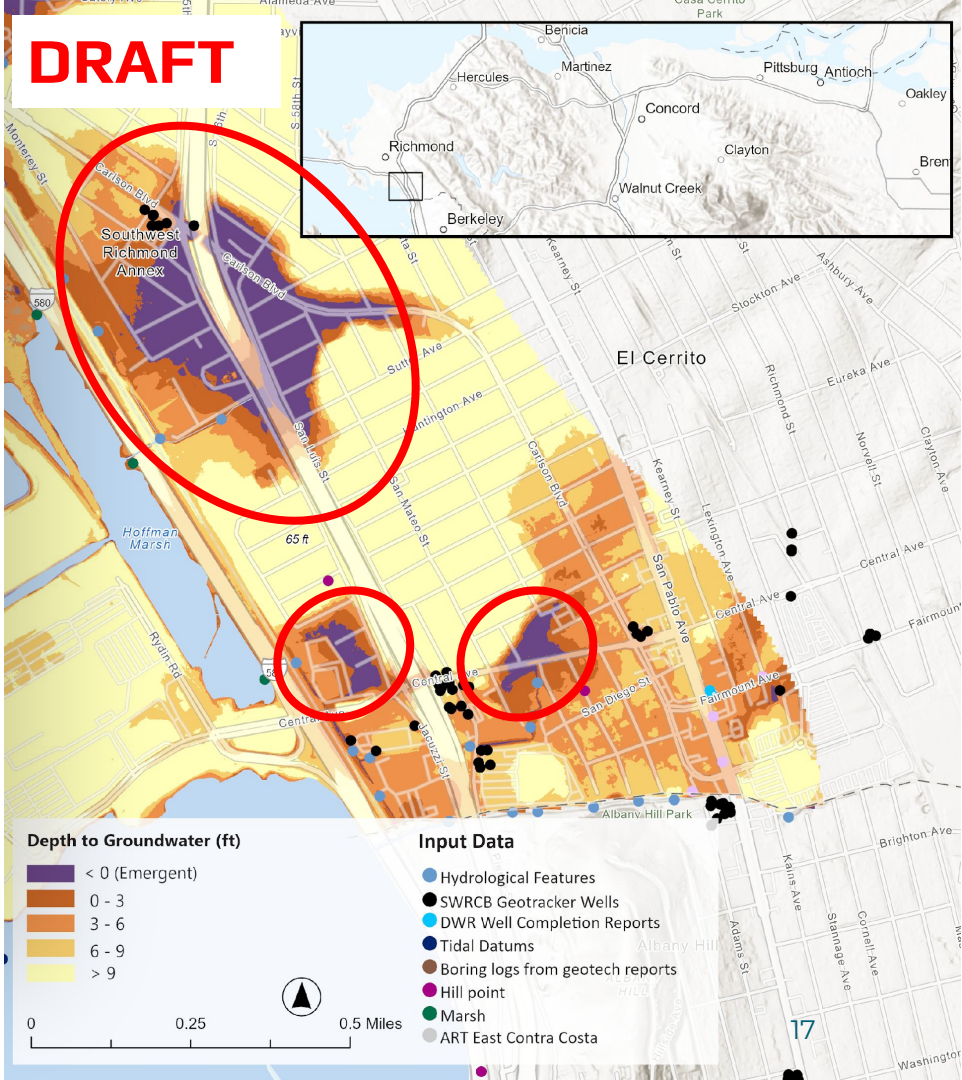
Example ground truthing location explored with County and City staff

- **Location Top:** Residential / industrial area on either side of the I-80 freeway
- **Location Bottom:** Residential / mixed use areas
  - Does this area see flooding today? Is there pumping or other mitigation measures in place?
  - Has emergent groundwater been observed in this area?
  - Are there any projects or active construction sites in this area?



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What is emergent groundwater?


Getty Images


Kristina Hill

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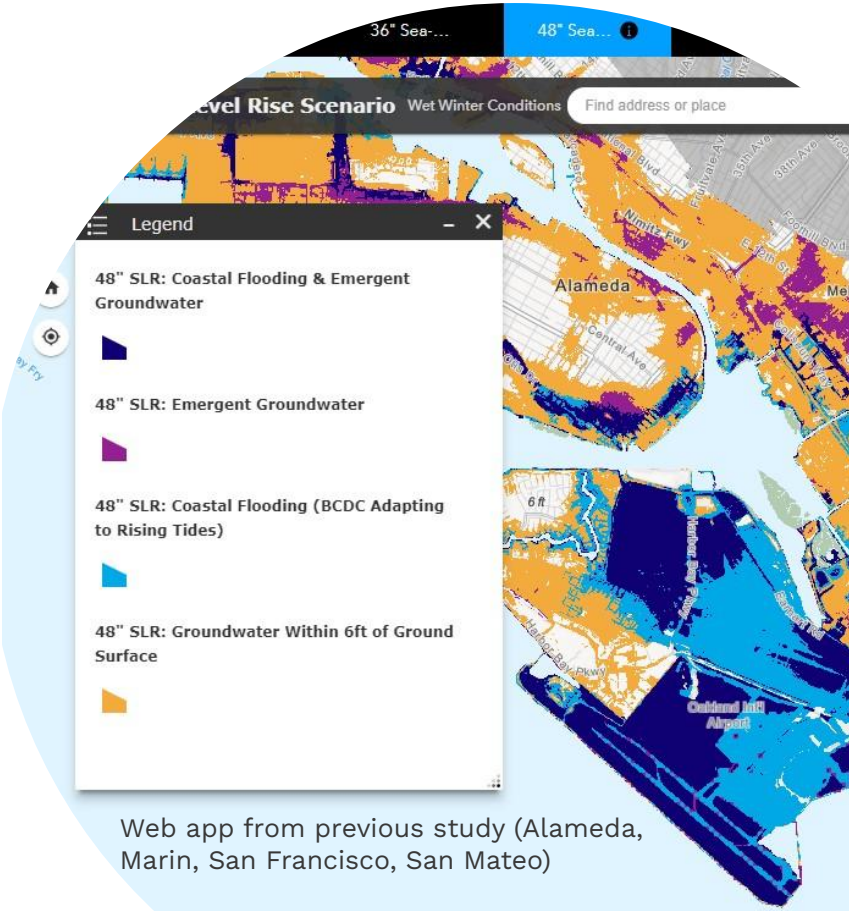
Next steps

- Revise mapping based on feedback received from County and City staff to better reflect existing conditions
- Adjust the existing conditions baseline for various sea-level rise scenarios to show projected future groundwater conditions.



Web app from previous study (Alameda, Marin, San Francisco, San Mateo)

SFEI's baylands and shoreline resilience work

Developing nature-based adaptation strategies that can improve shoreline resilience and provide multiple benefits like wildlife habitat, flood reduction, and recreational amenities

Adaptation Atlas:

Suitability: What areas are suitable for nature-based solutions?

Baylands Resilience Framework:

Effectiveness: Where are nature-based solutions needed and why?

Baylands resilience metrics for the Bay Point OLU

The shoreline of the Bay Point OLU has a relatively continuous stretch of connected tidal marshes (about 6 miles), which generally score highly on resilience metrics such as migration space connectivity, patch connectivity, and elevation relative to the tides (0-17% below MHW elevation). Bayward of road and railroads, there are almost 900 acres of migration space, with half of this area connected to the baylands today. If protected from development, this presents a significant opportunity for marsh migration in the future. However, connections to uplands landward of this band of migration space are constrained by transportation infrastructure. The OLU's watershed is highly modified, with creeks draining through straightened flood control channels, bypassing the baylands and reducing connectivity between uplands and marshes.

Many opportunities exist to enhance baylands resilience along the Bay Point shoreline. Restoring diked baylands would link more marshes to undeveloped migration space. The close proximity to a deepwater channel for access makes the beneficial reuse of dredged sediment for restoration purposes particularly feasible in this area. Additionally, reconnecting creeks to flow into the backs of marshes, rather than bypassing them in leveed channels, could enhance natural freshwater and sediment delivery to the baylands. The existing set of resilience metrics indicates that these marshes are performing well, but ground surveys could help identify resilience challenges and identify targeted enhancement projects to address them.

How extensive are the baylands in this OLU?

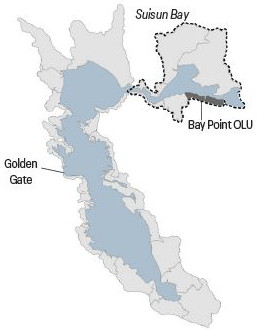
A relatively high proportion of Suisun Bay's tidal marsh is found in the Bay Point OLU, considering its small size compared to the Montezuma and Suisun Slough OLUs.

704 acres of diked baylands | 1,382 acres of tidal marsh

SUISUN BAY SIGNIFICANCE (AREA)

1% of diked baylands in Suisun Bay are located in this OLU

10% of tidal marsh in Suisun Bay is located in this OLU



LEGEND (for map on facing page)

Boundaries
- Operational Landscape Unit

Analysis units
- Undeveloped diked bayland unit
- Tidal marsh unit

Landscape features
- Creek

Tidal baylands (2020)
- Tidal marsh
- Muted tidal marsh
- Intertidal channel
- Tidal flat
- Shallow subtidal
- Deep subtidal

Undeveloped diked baylands (2020)
- Managed/open marsh
- Other open water
- Agriculture/other non-aquatic diked bayland

Upland connection opportunities
- Marsh migration elevation (connected to Bay)
- Marsh migration elevation (disconnected from Bay)
- Upper boundary transition zone

0.5 mile
0.5 km
N

Six ideas to increase baylands resilience in the Bay Point OLU

The resilience challenges and opportunities identified for this OLU are based on the Baylands Resilience Framework metrics. Click the links in each box (below) to explore more opportunities in the metrics web map.

PATCH CONNECTIVITY

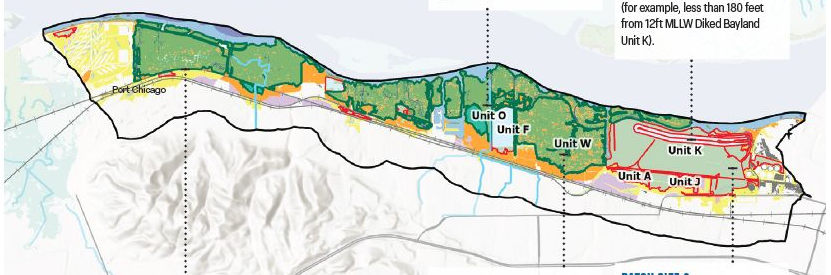
Tidal marshes and diked baylands along the Bay Point shoreline rank highly for habitat connectivity. Protecting and maintaining these patches as habitat would support wildlife population resilience.

TIDAL CONNECTIVITY

Tidal connections could be improved for some muted marshes or diked baylands, such as the muted marsh Unit O and the diked bayland Unit F. Restoring full tidal action to muted tidal areas can improve tidal flushing, increase sediment delivery, and reduce hypersalinity.

SEDIMENT PLACEMENT

The diked baylands Units A, K, and J sit 4 feet below restoration elevation (5 feet below marsh elevation). Direct sediment placement prior to restoration may be possible here, as this entire OLU has close access to deep water that allows a scow to approach and offload sediment closer to shore (for example, less than 180 feet from 12ft MLLW Diked Bayland Unit K).



TRANSITION ZONE CONNECTIVITY

Railroads interrupt connectivity between marshes and uplands, such as at Port Chicago. Transition zone connectivity could be improved by raising or relocating railroads, or by enhancing connectivity underneath them (such as by enlarging culverts).

COMPLETE MARSHES

This OLU has 8 marsh units classified as "complete," i.e. they have connectivity to migration space and upland transition zone. Protecting and enhancing migration space at these marshes (e.g., Marsh Unit W) could help these marshes adapt to sea level rise. Enhancement actions could include planting native vegetation and removing invasive species.

PATCH SIZE & COMPACTNESS

Overall, this OLU has two large tidal marsh patches. The western patch is 490 ac and the eastern patch is 890 acres. Connecting these two areas would increase patch size and compactness. Restoring diked bayland Unit F or the group of diked baylands Units A, K, and J would also increase patch size and compactness.

*** Disclaimer: This is not an adaptation plan.** These are ideas for increasing baylands resilience based on our interpretation of the metrics we have calculated to date. The metrics are based on remotely sensed data from 2020 or earlier. This is a regional scale analysis and there is varying quality of the underlying data.

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Baylands resilience metrics for the Walnut OLU

The Walnut OLU contains the Suisun Bay subembayment's largest and most compact tidal marsh patch, 2,280 acres at West Navy Marsh (Point Edith Wildlife Area), as well as another substantial marsh patch of 580 acres at Peyton Slough and along Walnut Creek. However, some marshes here are low-lying, with elevations skewed toward the lower end of the tidal frame (60-75% below MHW for the lowest-elevation marshes), and many are not fully tidally connected. This reduced tidal connectivity will hinder marsh resilience by limiting tidal flushing, sediment delivery, and the ability of marshes to migrate upland with sea level rise.

Supporting natural processes and restoring diked baylands to create more marsh could significantly improve baylands resilience in this OLU. Roads and railroads interrupt connectivity between marshes in complexes both east and west of Walnut Creek. Raising roads and railroads or improving connectivity beneath them would enhance drainage and habitat connectivity. There are over 600 acres of connected migration space in the OLU, but this space needs to be better connected to the tides to support marsh migration. These actions would help preserve the large and valuable West Navy Marsh habitat patch in the context of rising sea levels. Additionally, continued restoration (150+ acres of potential restoration) along lower Walnut Creek to expand the floodplain offers a chance to connect a creek with high sediment supply to baylands and reduce compound flooding in the Walnut Creek watershed (Dusterhoff et al., 2016).

How extensive are the baylands in this OLU?

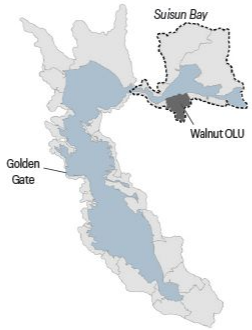
About a fifth of the tidal marsh in Suisun Bay is found in the Walnut OLU. There are many more acres of tidal marsh than diked bayland here.

676 acres of diked baylands | 2,925 acres of tidal marsh

SUISUN BAY SIGNIFICANCE (AREA)

1% of diked baylands in Suisun Bay are located in this OLU

21% of tidal marsh in Suisun Bay is located in this OLU



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Upland connection opportunities
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0.5 mile
0.5 km
N

Six ideas to increase baylands resilience in the Walnut OLU

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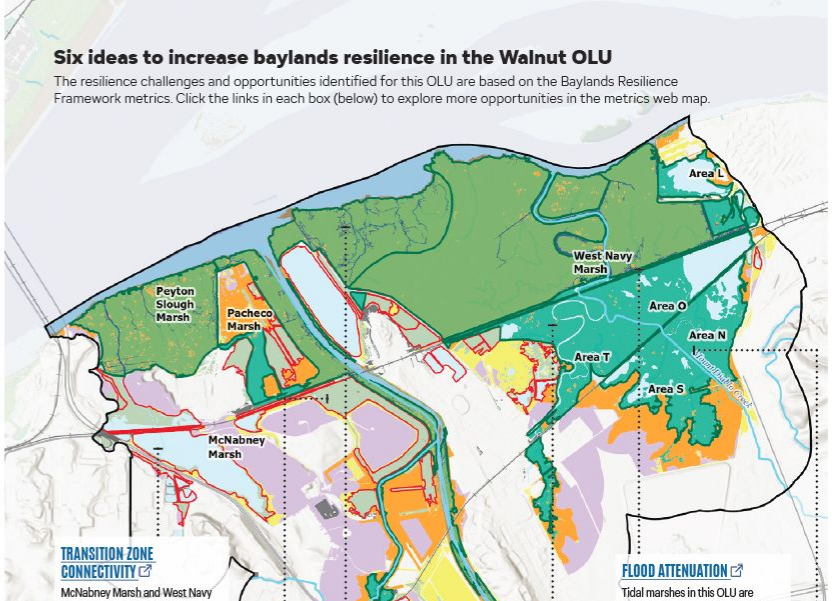

TRANSITION ZONE CONNECTIVITY

McNabney Marsh and West Navy Marsh (Area S) both have good connectivity to transition zone and migration space. These upland areas could be protected from development and enhanced (e.g., through vegetation management) to make the marshes more resilient to sea level rise.

FLOOD ATTENUATION

Tidal marshes in this OLU are protecting infrastructure, such as the Union Pacific railroad, from wave erosion. Preserving and adaptively managing these marshes will allow them to continue providing this ecosystem service.

PATCH SIZE & COMPACTNESS

Continuing to restore the lower Walnut Creek baylands would increase the size and compactness of the habitat patch west of Walnut Creek. Restoration could include continued floodplain expansion at the mouth of Walnut Creek (for instance at Diked Bayland Unit 11), following the model of the recent restoration at Pacheco Marsh *(completed since 2020).*

SEDIMENT PLACEMENT

There may be an opportunity to use dredged sediment from Walnut Creek for diked baylands restoration in the future. Point Edith Marshes have good access to deep water to facilitate sediment offloading; for example, West Navy Marsh is less than 150 feet from 12-foot deep water at MLLW.

TIDAL CONNECTIVITY

West Navy Marsh inland of Waterfront Road and McNabney Marsh are both muted marshes with limited connectivity to the Bay. Drainage and tidal connectivity could be enhanced for these marshes by improving flow through water control structures. Other marshes where tidal connectivity could be improved include those south of Waterfront Road and those next to Port Chicago (West Navy Area L and Walnut Unit 2).

ELEVATION & VEGETATION COVER

West Navy Marsh has mixed elevation. Closer to Carquinez Strait, marshes are close to MHHW. Inland of Waterfront Road marshes are very low lying (several units have more than more than 60% of their area below MHW). Improving tidal connectivity as well as connections to Mt Diablo Creek could help improve natural sediment supply.

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Baylands Resilience Metrics

- Units
- Wildlife Support Metrics
  - A1.1 Transition zone connectivity
  - A1.2 Mudflat connectivity
  - A2.1 Patch connectivity
  - A3.1 Patch size and compactness
  - A4.1 Marsh elevation
    - Percent of marsh area below Mean High Water (lower percent associated with marsh resilience)
    - Elevation skewness (negative values associated with marsh resilience)
  - A4.2 Marsh pannes and UVVR
  - A5.1 Redundancy of complete marshes
  - A6.1 Tidal connectivity
- Flood Attenuation Metrics

Companion Report

Baylands Resilience Framework

Help

Units

Analysis Units

Diked Bayland Unit

Marsh Unit

Operational Landscape Units (OLUs)

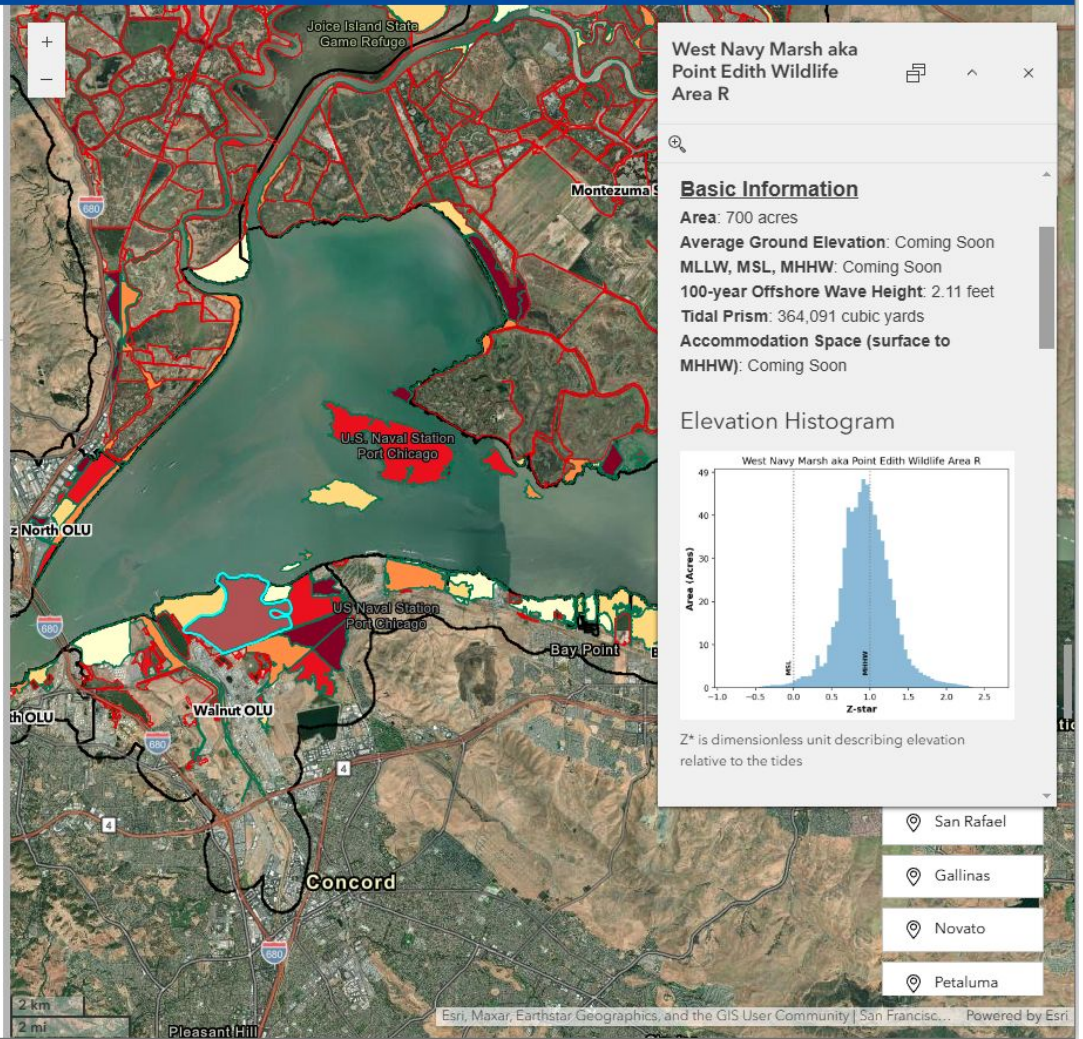
Wildlife Support Metrics

A4.1 Marsh elevation

Percent of marsh area below Mean High Water (lower percent associated with marsh resilience)

Percent below MHW elevation

- 59 - 100
- 27 - 58
- 14 - 26
- 7 - 13
- 0 - 6



West Navy Marsh aka Point Edith Wildlife Area R

Basic Information

Area: 700 acres
Average Ground Elevation: Coming Soon
MLLW, MSL, MHHW: Coming Soon
100-year Offshore Wave Height: 2.11 feet
Tidal Prism: 364,091 cubic yards
Accommodation Space (surface to MHHW): Coming Soon

Elevation Histogram

Z* is dimensionless unit describing elevation relative to the tides

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Upcoming work: Baylands Decision Support System

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- **Research institute** with over 80 staff working in the Bay Area and California
- We **deliver visionary science** to empower people to revitalize nature

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Thank you

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