

Palo Alto Horizontal Levee Pilot Project – Progress Update

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Photo: Ben Botkin



San Francisco
ESTUARY PARTNERSHIP



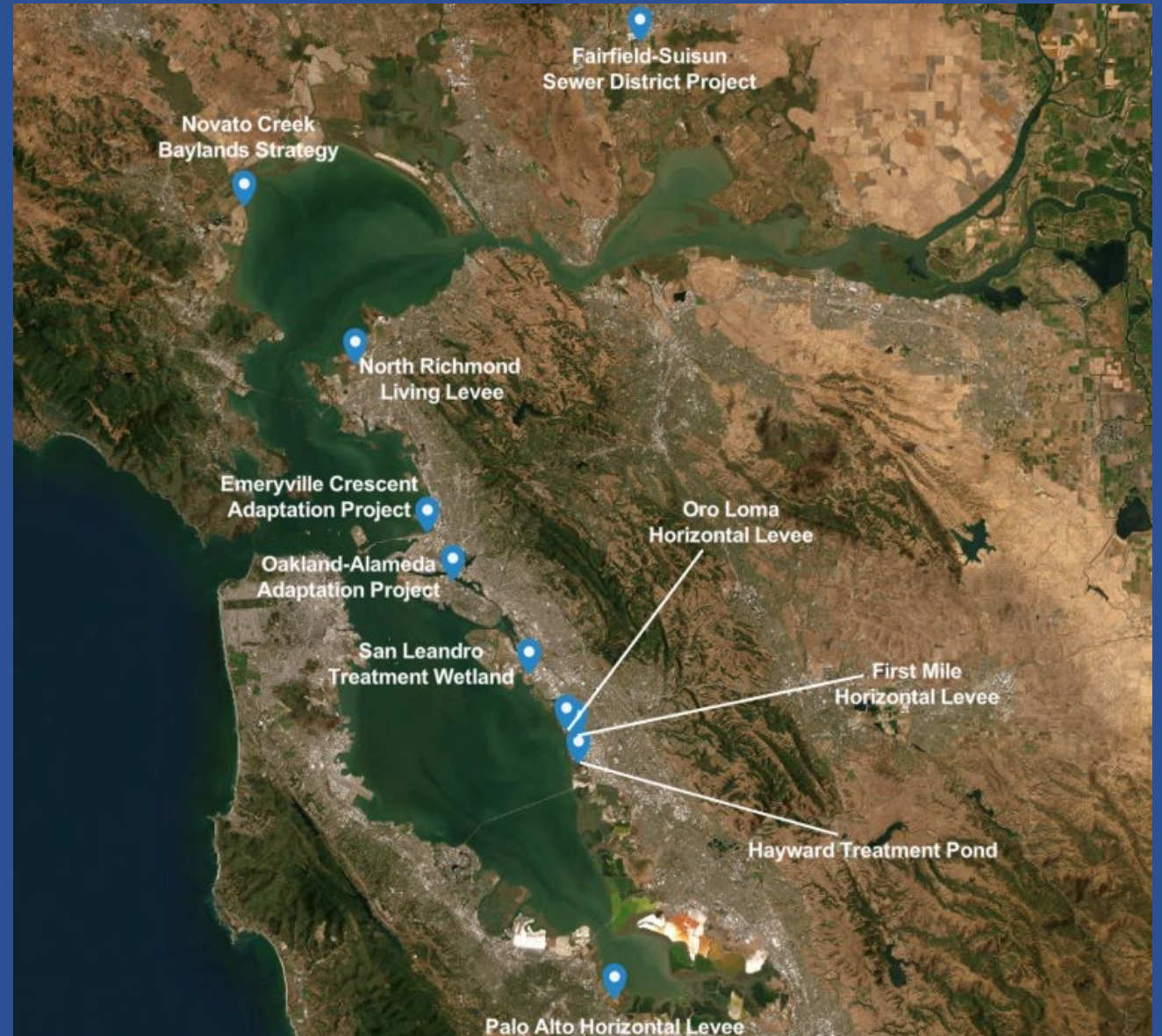
Partnership in Action

Estuary Blueprint – A Roadmap for Nature-based Solutions

- Increase the pace and scale of on the ground projects both at the subregional scale and for individual projects
- Engage communities to create solutions
- Provide more support to improve regulatory permitting
- Align planning for nature-based solutions
- Advance a range of project types, including horizontal levees, ecotones and living shorelines – and the crucial role of pilot projects



Map of Projects





What is a horizontal levee?

“An engineered sloped subsurface treatment wetland built between coastal levees and tidal marshes - essentially an ecotone levee that incorporates nature-based treatment of wastewater effluent.” – Harris-Lovett, et al. 2021.

CONVENTIONAL LEVEES & SEA WALLS

HORIZONTAL LEVEE SOLUTION

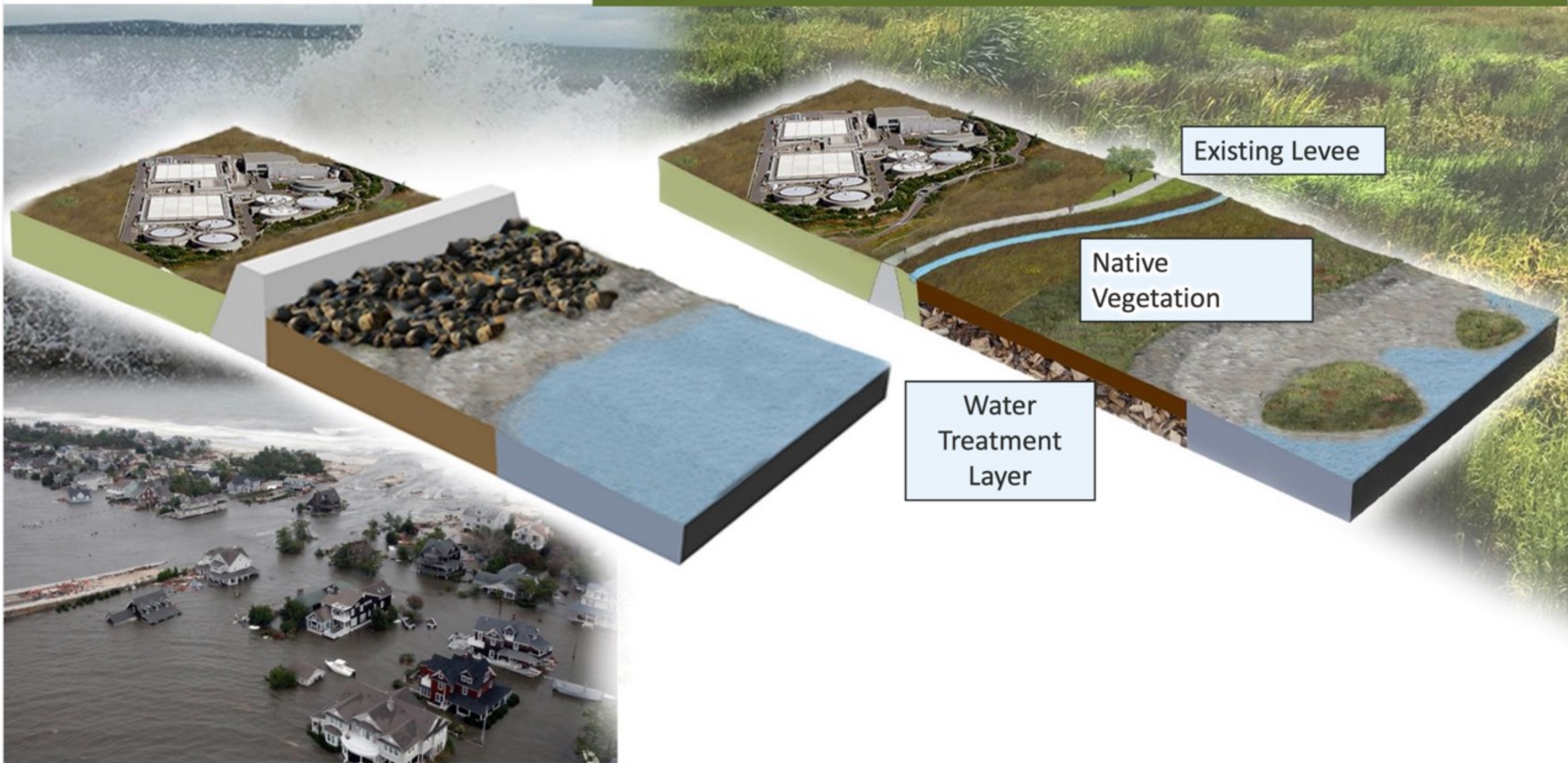


Image credit: Angela Stiegler

Horizontal Levee Benefits

- Habitat Enhancement
 - Transitional habitat: terrestrial & tidal marsh
 - High tide refugia
 - Recreates historic freshwater seeps
- Recurrent Flood Protection
 - Wave attenuation
 - Sediment accretion and accumulation
 - Marsh habitat migration
- Water Quality Improvement
 - Nutrients
 - Contaminants of emerging concern
 - Reverse Osmosis Concentrate
- Recreation and Engagement
 - Increased public access



Photo: Alexandra Thomsen

Palo Alto Horizontal Levee Pilot Project Goals

- Improve habitat along the perimeter of Harbor Marsh for native species
- Restore rare and historic broad ecotone that supports a variety of transitional plant assemblages
- Determine design standards, permitting requirements, and extent of maintenance for incorporation into the future larger levee improvement project (i.e., SAFER Bay/Shoreline Study).
- Provide a transitional slope that will support freshwater plants, which in turn build organic soils, to help prevent recurrent flooding

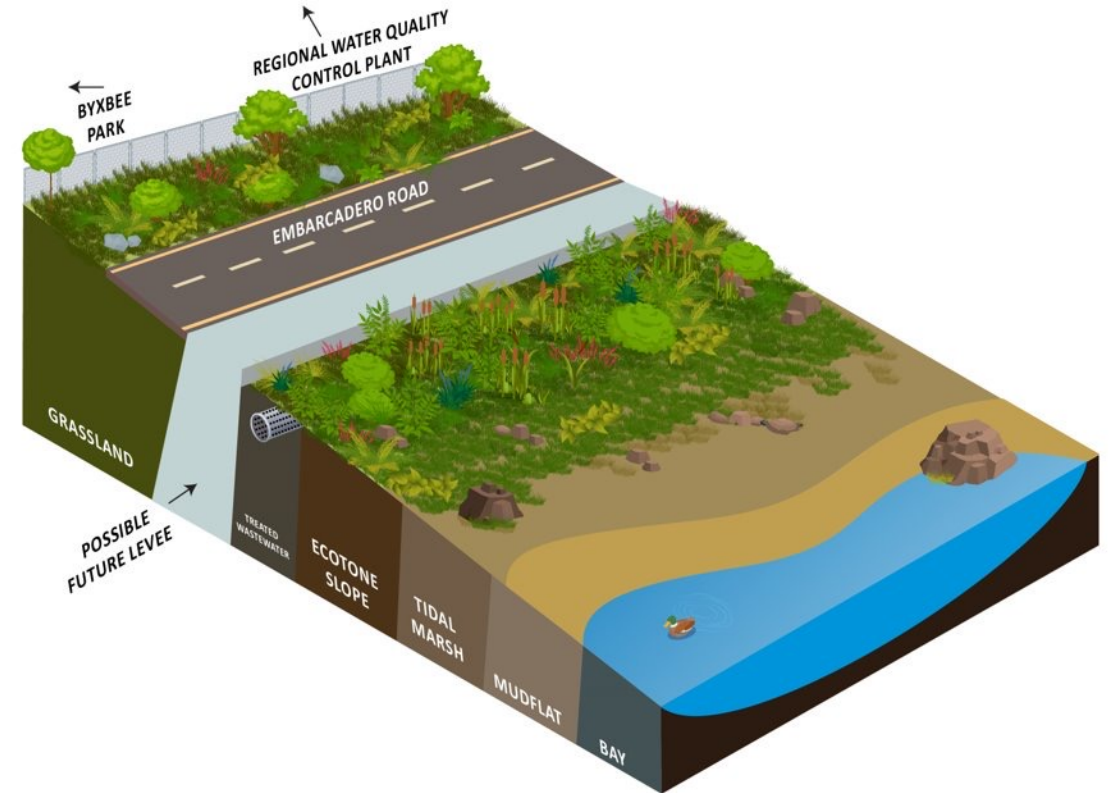


Image: Environmental Science Associates

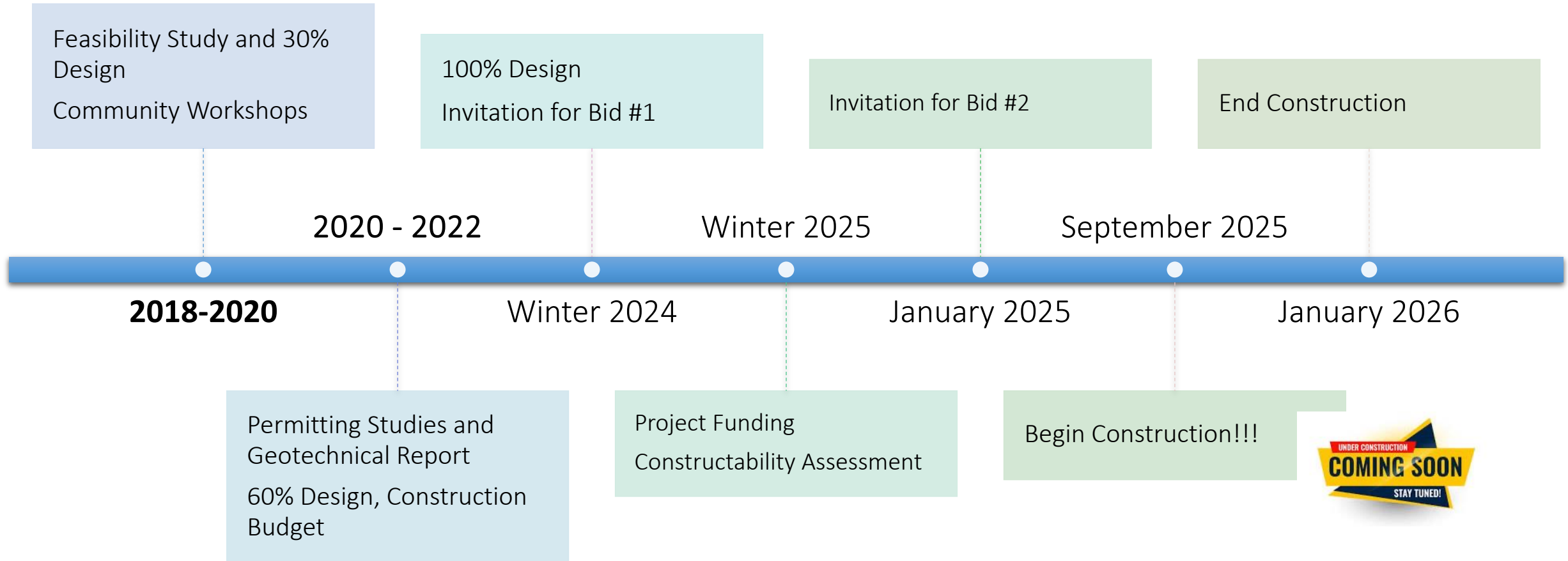
Palo Alto Horizontal Levee Pilot Project Goals



Photo credit: Adrien Baudrimont

- Maintain public access to the existing trail system while providing opportunities for compatible low-impact recreation, increased social infrastructure, and educational opportunities on flooding and hazard mitigation
- Ensure perspectives of adjacent communities are incorporated into infrastructure and educational components
- Provide polishing treatment to discharged treated wastewater

Project Timeline



Roles of Partners

SF Estuary Partnership

- Manage design & engineering contract with Environmental Science Associates and HDR since 2018 (Federal, State and local funds)
- Manage construction bid process and construction contract (Federal and State)
- Construction Management (via consultant) (Federal funds)

City of Palo Alto

- Land owner
- Permit compliance
- Long term maintenance and monitoring

Approach to Community Engagement



Image: Nate Kauffman



Community Engagement at Palo Alto Horizontal Levee

- Nuestra Casa
 - Environmental education
 - Curriculum & Field trips
 - Bioblitzes with Environmental Volunteers
 - Internships
 - Local outreach & public awareness
- CSU Channel Islands
 - Community microplastics monitoring
- Save The Bay
 - Volunteer seed collection, plant propagation, & outplanting



Photo: Sean Anderson, CSU Channel Islands



Partnership in Action

Funder Acknowledgements



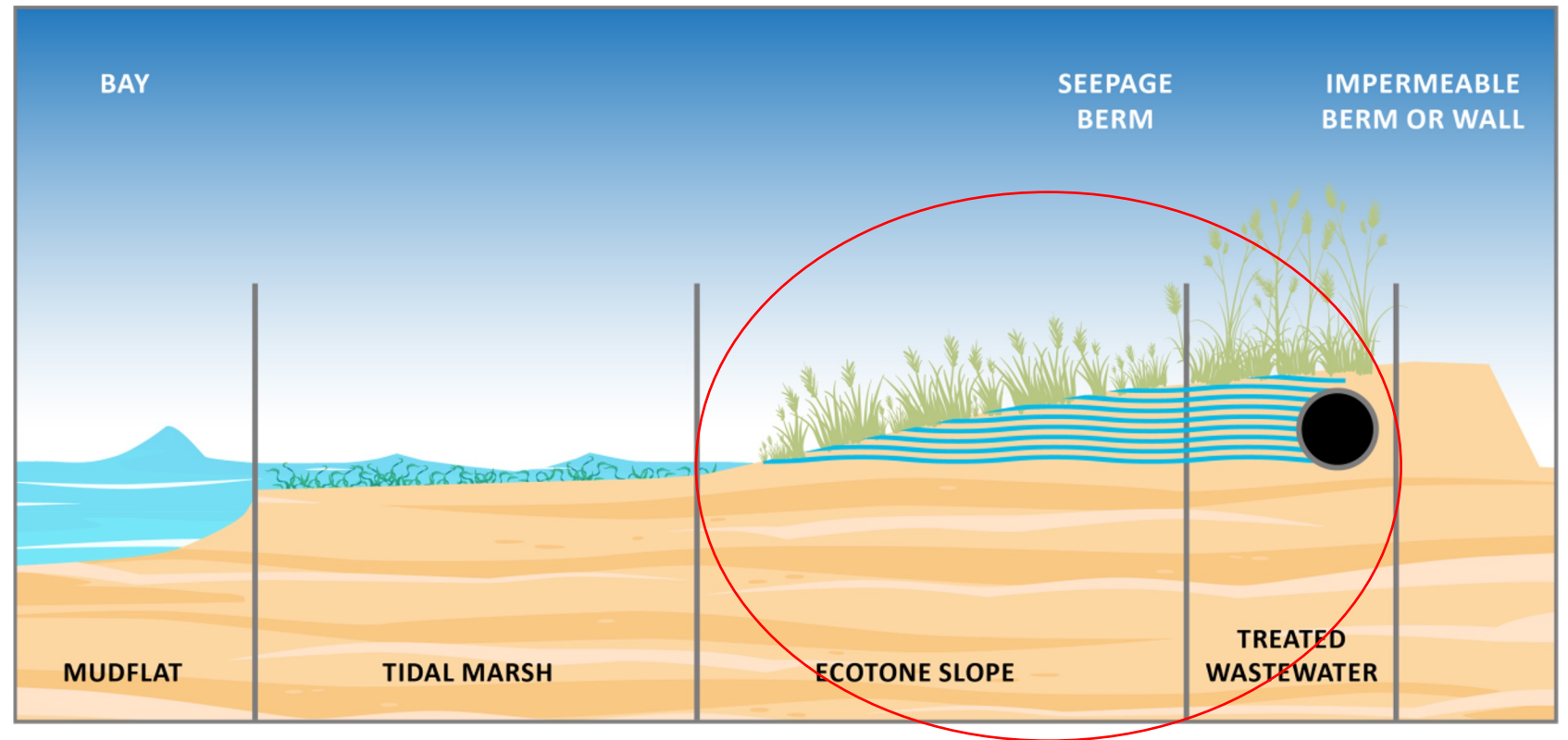


Palo Alto Horizontal Levee Pilot Project

August 2025

WHAT IS A HORIZONTAL LEVEE?

A gently sloping, vegetated berm or ecotone slope that is on the water-side of a flood control levee, irrigated with treated wastewater



HORIZONTAL LEVEE BENEFITS

Recurrent Flooding

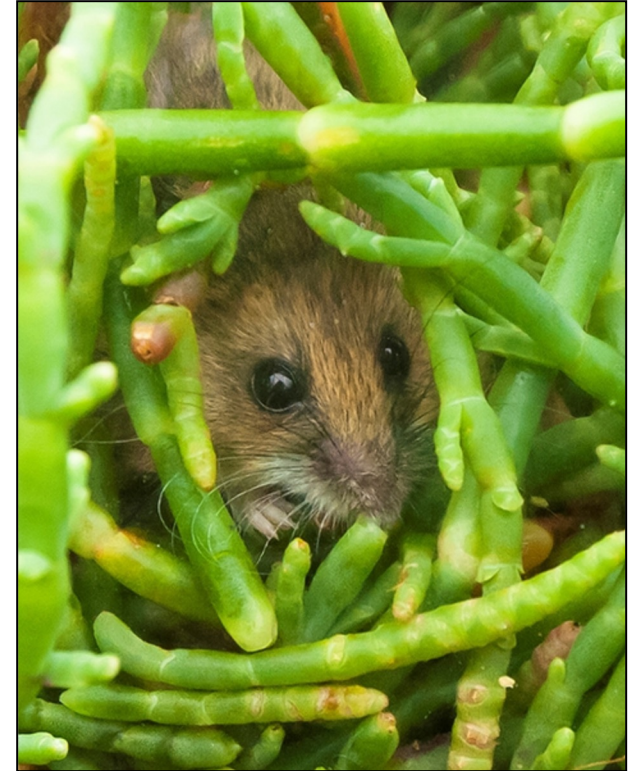
- Wave attenuation
- Sediment accretion and accumulation
- Marsh migration

Habitat Enhancement

- Transitional habitat – terrestrial & tidal marsh
- High-tide refugia
- Recreates historic freshwater seeps

Wastewater Polishing Treatment

- Nutrients
- Contaminants of Emerging Concern



PALO ALTO HORIZONTAL LEVEE PILOT PROJECT - LOCATION



PALO ALTO HORIZONTAL LEVEE PILOT PROJECT – CURRENT CONDITIONS

Baylands ~700,000 visitors/year

Part of regional Bay Trail

Flood-control levees not FEMA
certified and currently experience
overtopping

Poor upland, ruderal habitat

Endangered species use
surrounding marsh

Within BCDC jurisdiction (among
other resource agencies)



PALO ALTO HORIZONTAL LEVEE PILOT PROJECT – CURRENT CONDITIONS



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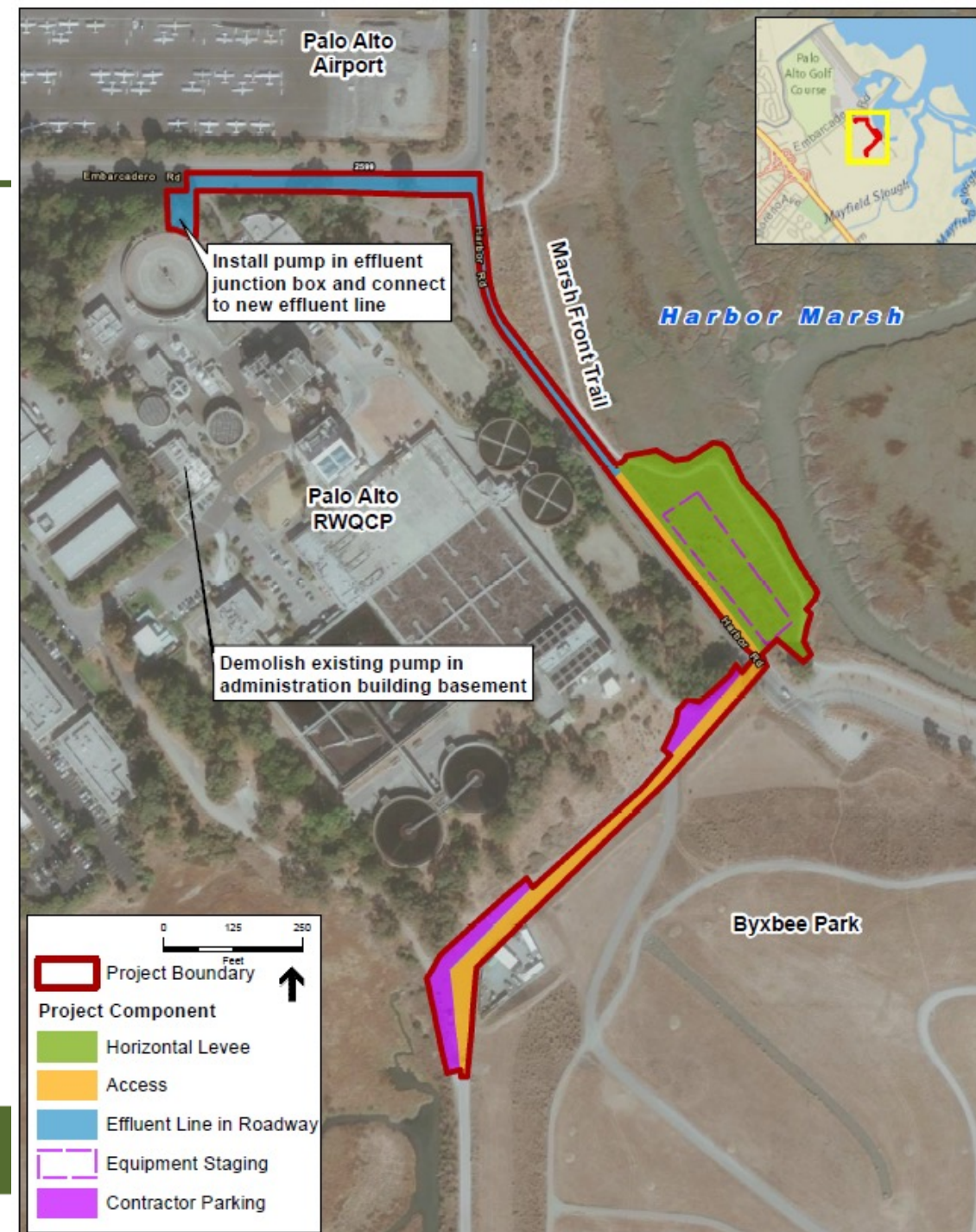
PALO ALTO HORIZONTAL LEVEE PILOT – MAIN GOALS



- Improve habitat for use by endangered and other native species
 - Ridgway's Rail and Salt Marsh Harvest Mice are known to use surrounding marshlands
- Collect information on permitting and implementation of horizontal levees within the Palo Alto Baylands
 - Extend lessons learned from Oro Loma Horizontal Levee Research Site by connecting directly to the Bay and experiencing tidal action
- Integrate information into design elements of larger, flood control levee improvement projects
 - SAFER Bay
 - South San Francisco Bay Shoreline Study Phase II

PAHLPP – MAIN COMPONENTS

- Regrade to create 500 LF berm fronted by 315 LF horizontal levee
- Install 1,650 LF of underground treated wastewater pipeline along Embarcadero & Harbor Roads for irrigation of horizontal levee
 - Replace Renzel Marsh Pump
- Plant horizontal levee with diverse native plants to create ecotone slope
- Realign public Marsh Front Trail to top of new berm and reconnect to existing trail network



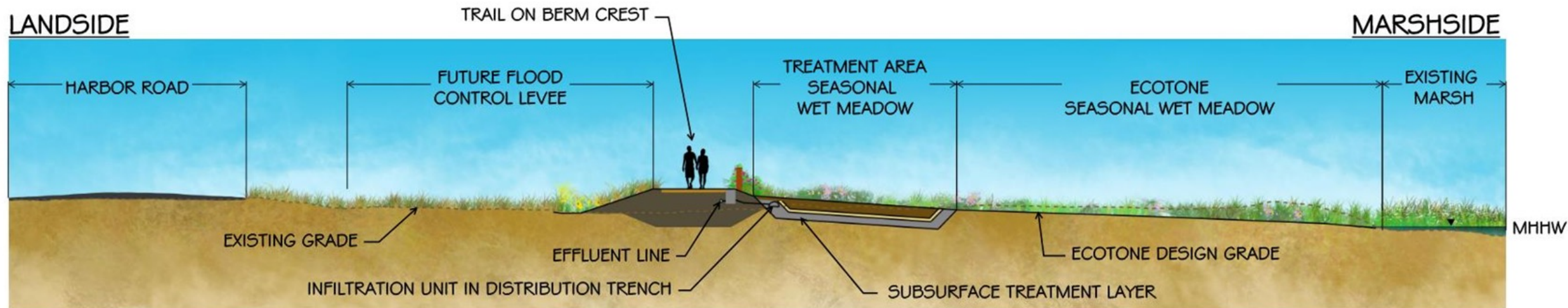
PALO ALTO HORIZONTAL LEVEE PILOT PROJECT

POST-PROJECT CONDITIONS

- ↑ marsh habitat by 0.66 acres (33%)
- ↑ diversity of habitats to include wet meadow, freshwater marsh, and riparian scrub
- ↑ refugia habitat for key species such as Ridgway's Rail and salt marsh harvest mouse
- ↑ habitat connectivity

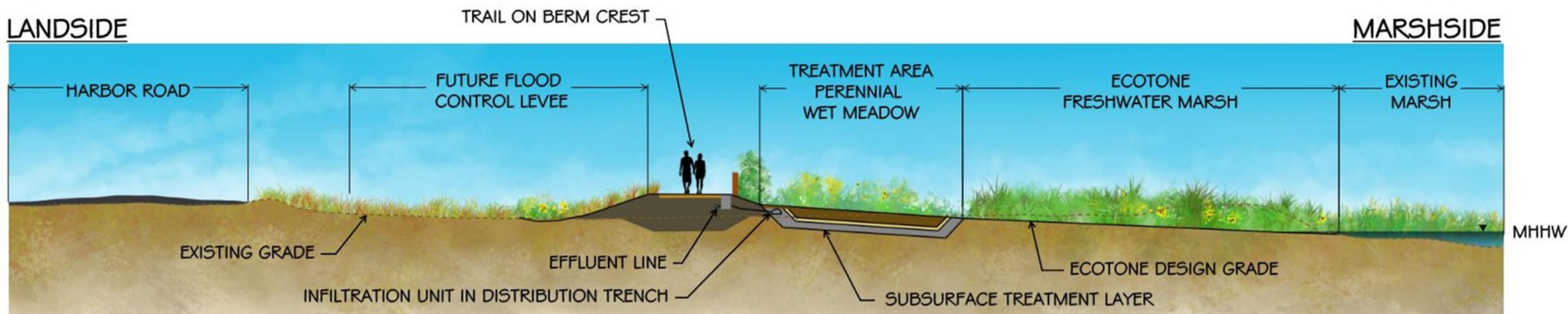


LANDSIDE



TYPICAL RIDGE SECTION

LANDSIDE



TYPICAL SWALE SECTION

PALO ALTO HORIZONTAL LEVEE PILOT PROJECT

KEY STAKEHOLDERS



CITIZENS COMMITTEE TO
COMPLETE THE REFUGE



PALO ALTO HORIZONTAL LEVEE PILOT PROJECT

STAKEHOLDER DESIGN ELEMENTS

- Plant Palette
- Interpretive Signs
- Public Access Trail Location
- Sampling Ports
- Continued Community Engagement Opportunities



PALO ALTO HORIZONTAL LEVEE PILOT PROJECT

CONSTRUCTION PERMITS

- **US Army Corps of Engineers** – CWA Section 404, Rivers and Harbors Act Section 10
- **US Fish and Wildlife Service** – Endangered Species Act, Fish and Wildlife Coordination Act, Migratory Bird Treaty Act
- **National Marine Fisheries Service** – Endangered Species Act, Magnuson-Stevens Fish and Conservation Management Act
- **State Historic Preservation Office (SHPO)** – Section 106 of the National Historic Preservation Act
- **CA Department of Fish and Wildlife** – Fish and Game Code Section 1602, CA Endangered Species Act, Fish and Game Code Section 2081
- **State Water Resources Control Board** – National Pollutant Discharge Elimination System, Stormwater
- **SF Bay Regional Water Quality Control Board** – CWA Section 401, Porter-Cologne Water Quality Act
- **Bay Conservation and Development Commission (BCDC)** – McAteer Petris Act
- **City of Palo Alto** – Street Works Permit and Minor Architectural Review



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ALTO**

PARTICIPATING ORGANIZATIONS - MONITORING



**Nuestra
Casa**



SAVE THE BAY



PALO ALTO HORIZONTAL LEVEE PILOT PROJECT

MONITORING QUESTIONS

Which native plants were successfully planted and which invasives have colonized the site?

How much maintenance will be required and in what project components?

What is the soil build-up (i.e., accretion and accumulation) rate?

Are Salt Marsh Harvest Mice using the site more after construction? If so, for what purposes (e.g., feeding, high-tide refugia, nesting, etc.)?

Have we increased the biodiversity of the site?

Can we use the site to better conduct community science?

NEXT STEPS

Construction: 2025 - 2026

Monitoring and Community Science 2026 – 2030

www.PaloAlto.gov/horizontallevee

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