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# **HAYWARD REGIONAL SHORELINE MASTER PLAN**

**FOR THE HAYWARD AREA SHORELINE PLANNING  
AGENCY (HASPA)** PART OF A JOINT POWERS AGREEMENT OF COH, HARD AND EBRPD

## **TASK 4**

### **GOALS AND POLICIES MEMO**

### **ADAPTATION STRATEGIES REPORT**

**DRAFT SUBMITTED 12/23/2019**

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# PROJECT GOALS

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## PROJECT STATEMENT:

The Hayward Regional Shoreline Master Plan creates a framework for resilience to prepare for sea level rise (SLR), groundwater intrusion, and storm surge. The Master Plan is being managed by the Hayward Area Shoreline Planning Agency (HASPA), a joint power authority including the City of Hayward, Hayward Area Recreation and Park District (HARD), and East Bay Regional Park District (EBRPD).

The Hayward Regional Shoreline Master Plan project area is bounded on the north by the Bockman Channel (also called the Bockman Canal) and extends approximately 3.25 miles south to the State Route 92 San Mateo Bridge approach. The extent of the project area into the Bay was defined by the outermost limit of the Hayward Area Shoreline Planning Agency Jurisdictional boundary, and the inland extent of the project area are drawn at the rail corridor. In total, the project area covers six square miles of various land uses, including open space, urban infrastructure, industrial, and residential.

The project area supports ecological bayland resources, hosts recreational opportunities along the San Francisco Bay Trail, and facilitates educational programming for adjacent residential neighborhoods and businesses at the Hayward Shoreline Interpretive Center. The shoreline is also home to critical urban infrastructure, including wastewater treatment plants, the San Mateo-Hayward Bridge approach (State Route 92), and landfills. The Master Plan will develop various multi-benefit strategies for the shoreline, its existing infrastructure, and the surrounding natural habitat. The Master Plan will consider multiple planning time horizons and sea level rise scenarios. Additionally, it will consider a range of adaptation strategies that can evolve and respond over time to changing sea levels.

The shoreline master plan encompasses four goals.

## PROJECT GOALS

### **Create a Resilient Shoreline Environment for People and Ecology**

- Enhance the shoreline’s ecological value and adapt to sea level rise
- Enhance recreational opportunities and adapt to climate change
- Create a management framework for adapting to sea level rise over time
- Provide refuge to help endangered shoreline species to adapt climate change

### **Enhance the Shoreline Environment to Reduce Risk to Critical Infrastructure and Built Assets**

- Align with and enhance existing management and capital improvement plans
- Reduce risk to regional critical utilities from sea level rise, groundwater intrusion, and flood events
- Reduce risk to transportation infrastructure from sea level rise, groundwater intrusion, and flood events
- Reduce risk to agency assets such as the San Francisco Bay Trail and marsh restoration project(s)

### **Build Social Resilience in the Community**

- Promote social equity, environmental justice, and public health
- Preserve the local economy and increase resilience to climate change
- Prevent the disruption of key community services

### **Build Capacity for Future Generations to Adapt to climate change**

- Build organizational and community capacity
- Provide a place for education, interpretation and understanding of the shoreline and climate change
- Foster stewardship of the shoreline’s cultural and ecological resources

# **POLICY CONSIDERATIONS**

# POLICY CONSIDERATIONS

## ROLE OF POLICIES IN THE HAYWARD SHORELINE MASTER PLAN

Before developing adaptation strategies, it is important to understand the planning and policy context for the Hayward Shoreline Master Plan. There are a variety of ways in which the plans and policies of project stakeholders will inform the development of strategies and the eventual master plan. Policies can present opportunities, such as the ability to shape a funding plan or regulatory change to promote the shoreline master plan's implementation. Policies can also shape the project or the process by presenting regulations or processes that must be accommodated.

## KEY POLICY CONSIDERATIONS

Following an extensive review of stakeholders in the project area, we've identified the following initial key policy considerations. These can be updated as the project progresses.

- **There is broad support and consensus around the need to plan for sea level rise with a focus on habitat restoration, and an evolving playbook on how to balance long-term, conflicting needs.**  
Planning agencies, regulatory bodies, and infrastructure operators are well-aligned on the need to plan for sea level rise. Not all wetland restoration projects have considered sea level rise in the past, but the concept of adaptive management is gaining acceptance and becoming part of regulation. While there is no clear answer on how to balance the needs of vulnerable infrastructure and communities with the opportunities to maintain and improve habitat, there are many active organizations focused on developing policies and plans to address all aspects of these issues.
- **There is an extensive permitting process and many regulatory requirements that will likely drive the implementation process.**  
There are numerous agencies that will likely be involved in the permitting processes for any modifications to the Hayward shoreline. Recent reforms aimed at streamlining the process are positive signs, though they are focused on ecological restoration, and it is unclear how hybrid grey infrastructure approaches will be treated.
- **There are many stakeholders in how water is managed with specific interests that will need to be navigated in order to identify an implementable strategy.**  
The Hayward shoreline contains an extensive water management infrastructure network, including water treatment, wetland management, and flood control. Changes to the system may have system-wide impacts and require buy-in from agencies and authorities involved.
- **Innovative approaches to shoreline access may be needed to allow for a full exploration of potential strategies.**  
While the Bay Trail has historically prioritized a "blue water" experience with the trail directly adjacent to the shoreline, there is an opportunity to create a diverse shoreline recreational experience, including moving inland to accommodate shoreline habitats and the inclusion of high points at vistas.
- **There are opportunities for the Shoreline Master Plan to advance regional policy on climate adaptation and ecosystem management.**

There are numerous organizations and agencies active in sea level rise adaptation and habitat restoration in the Bay Area. While numerous studies and toolkits are being advanced, there is a need for built projects to test and advance innovative ideas for how to adapt to sea level rise while improving ecosystem health. This project can serve as a test bed for such ideas and serve to advance this issue across the region.

- **The East Bay Regional Park District Master Plan sets forth policies on climate change that should guide the Shoreline Master Plan.**

Climate Change is expected to affect the park's resources in various ways. Changes in the ranges of various species and increased potential for wildfires and pests are anticipated with this change in weather. In a manner consistent with the desire to "conserve and enhance" its resources, the District must closely track the impact of this phenomenon, and if necessary, act to relocate or protect in-situ resources that are being degraded or potentially lost by this change.

The District will specifically track and monitor the effects of Climate Change on its resources, interceding when necessary to relocate or protect in-situ resources that are being degraded or lost by this shift in the environment.

To help mitigate the effects of climate change, the District will endeavor to conserve and connect habitat for native species through its acquisition and planning processes.

- **The City of Hayward General Plan includes a Hazards Element with policies relevant to flooding and sea level rise that should guide the Shoreline Master Plan.**

One of the plan's goals is to "protect life and minimize property damage from potential flood hazards." As part of this goal, the plan calls for the City to coordinate with the Alameda County Flood Control and Water Conservation District to evaluate the need to expand the capacity of flood control facilities due to climate change, and to promote greater public awareness of flooding hazards and promote resources and programs to help property owners protect their homes and businesses from flood damage.

Another goal is to "safeguard the Hayward shoreline, open space, recreational resources, and urban uses from flooding due to rising sea levels." As part of this goal, the plan calls on the City to coordinate with the Hayward Area Shoreline Planning Agency, the Bay Conservation Development Commission, and other agencies to develop and implement a "Regional Shore Realignment Master Plan" that shall identify a preferred long-term strategy and implementation program to protect the shoreline, interim standards to regulate development within areas potentially affected by sea level rise prior to the construction of shoreline protection, and potential flood mitigation measures to apply to development projects within potentially affected areas.

The attached chart provides a summary of relevant organizations, agencies, plans, and policies. The first column summarizes the agency or organization general role or mission. The second column highlights the specific regulatory or planning jurisdictions, land ownership, or policies that specifically relate to the study area or master plan. The last column identifies and links to relevant regulations, plans, or guidance documents.

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
Hayward Area Shoreline Planning Agency (HASPA)	<ul style="list-style-type: none"> <li>Joint powers agency comprised of representatives from Hayward Area Recreation and Park District, East Bay Regional Park District, and the City of Hayward.</li> <li>Works with the Hayward Area Shoreline Citizens Advisory Committee (HASCAC) to coordinate agency planning activities and adopt and carry out policies for the improvement of the Hayward Shoreline for future generations.</li> </ul>	<ul style="list-style-type: none"> <li>Under a joint exercise of powers agreement, HASPA is charged with the power to undertake all planning activities associated with sea level rise, and the power to develop plans, prepare studies and reports, and make recommendations for the Hayward Shoreline.<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Preliminary Study of the Effect of Sea Level Rise on the Resources of the Hayward Shoreline (2011)</li> <li>Adapting to Rising Tides Resilience Study (March 2015)<sup>2</sup></li> </ul>
Hayward Area Recreation and Park District (HARD)	<ul style="list-style-type: none"> <li>Independent special use district created to provide park and recreation services for the over 280,000 residents in the Hayward area.</li> <li>HARD's park system includes 104 sites covering about 1,357 acres.</li> <li>Member of HASPA</li> </ul>	<ul style="list-style-type: none"> <li>Owns and manages 788 acres in the project area including: HARD marsh (a 79-acre, fully tidal marsh), Triangle Marsh (an 8-acre muted tidal marsh system restored in 1990), Oliver Salt Ponds, the San Lorenzo Community Park and other diked ponds and wetlands south of Sulphur Creek. In addition HARD owns and manages over 40 parks and trails in Hayward, as well as playground areas and playing fields at local schools.<sup>3</sup></li> <li>Runs the Hayward Shoreline Interpretive center.</li> <li>Manages the Skywest Golf Course, which is leased from the City of Hayward.</li> </ul>	<ul style="list-style-type: none"> <li>Regulations Governing Use of Parks, Recreation Areas, and Facilities<sup>4</sup></li> </ul>
East Bay Regional Park District (EBRPD)	<ul style="list-style-type: none"> <li>Regional park district managing 73 parks and 124,000 acres of space and 1,250 miles of trails throughout East Bay in Alameda and Contra Costa counties.</li> <li>Member of HASPA</li> </ul>	<ul style="list-style-type: none"> <li>Owns and manages Cogswell Marsh (250 acres tidal/low marsh habitat), Salt Marsh Harvest Mouse Preserve (27 acres muted tidal system), and the Hayward Marsh (145-acre fresh and brackish water marsh that relies on secondary treated effluent as freshwater source).</li> <li>Supports proposed project to modify Hayward Marsh to convert from a freshwater effluent fed system to a fully tidal or muted tidal system. EBRPD plans to put out a bid for full design in the future.</li> </ul>	<ul style="list-style-type: none"> <li>Ordinance 38 Rules and Regulations<sup>5</sup></li> <li>2013 Master Plan<sup>6</sup> - defines the mission and vision for the Park District for its stewardship and development</li> <li>Board of Directors has adopted multiple plans including: ADA Self Evaluation and Transition Plan, Environmental Review Manual, Park Operations guidelines, Sustainability Policy, Wildlife Hazard Reduction and Resource Management Plan</li> <li>District Standard Plans<sup>7</sup> - design guidelines for districts</li> <li>Climate Smart Initiative<sup>8</sup> that promotes adaptive management</li> </ul>

1 [https://lafco.acgov.org/lafco-assets/docs/JPAs/HASPA%20\(Hayward%20Area%20Shoreline%20Planning%20Agency\).pdf](https://lafco.acgov.org/lafco-assets/docs/JPAs/HASPA%20(Hayward%20Area%20Shoreline%20Planning%20Agency).pdf)  
2 [http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/HaywardShorelineResilienceStudyReport\\_sm.pdf](http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/HaywardShorelineResilienceStudyReport_sm.pdf)  
3 <https://www.hayward-ca.gov/residents/arts-leisure/parks-recreation>  
4 <https://www.haywardrec.org/DocumentCenter/View/2874/District-Regulation-Handbook?bidId=>  
5 <https://www.ebparks.org/activities/ord38.htm>  
6 <https://www.ebparks.org/civicax/filebank/blobdload.aspx?BlobID=23499>  
7 [https://www.ebparks.org/about/bids/district\\_standard\\_plans.htm](https://www.ebparks.org/about/bids/district_standard_plans.htm)  
8 <https://www.ebparks.org/climatesmart.htm>

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City of Hayward	<ul style="list-style-type: none"> <li>Land use planning and zoning</li> <li>Conducts development and environmental review</li> <li>Capital improvement planning</li> <li>Hazard mitigation planning</li> <li>Member of HASPA</li> </ul>	<ul style="list-style-type: none"> <li>Manages capital improvement plan for city infrastructure, including the wastewater treatment plant and local roadways.</li> <li>Owns and operates Hayward Executive airport.</li> <li>Owns the Skywest Golf Course that is leased to HARD.</li> <li>Develops changes to the zoning code to implement land use plans</li> </ul>	<ul style="list-style-type: none"> <li>General Plan<sup>9</sup></li> <li>Zoning maps and use charts<sup>10</sup></li> <li>Capital Improvement Budget<sup>11</sup></li> <li>Economic Development Strategic Plan<sup>12</sup></li> <li>Design Guidelines<sup>13</sup></li> <li>Neighborhood Plans<sup>14</sup></li> <li>2016 Hayward Local Hazard Mitigation Plan<sup>15</sup></li> <li>Green Infrastructure Plan<sup>16</sup></li> </ul>
San Francisco Bay Restoration Regulatory Integration Team (BRRIT) <sup>17</sup>	<ul style="list-style-type: none"> <li>Composed of staff from the six state and federal regulatory agencies with jurisdiction over wetland restoration projects: U.S. Army Corps of Engineers (Corps); U.S. Fish and Wildlife Service (USFWS); NOAA National Marine Fisheries Service (NOAA Fisheries); San Francisco Bay Regional Water Quality Control Board (RWQCB); California Department of Fish and Wildlife (DFW); and San Francisco Bay Conservation and Development Commission (BCDC). Also includes representatives from the U.S Environmental Protection Agency (EPA).</li> </ul>	<ul style="list-style-type: none"> <li>The purpose of the BRRIT is to improve the permitting process for multi-benefit wetland restoration projects and associated flood management and public access infrastructure in San Francisco Bay.</li> </ul>	<ul style="list-style-type: none"> <li>Webinar on how to submit projects<sup>18</sup></li> </ul>
California Natural Resources Agency	<ul style="list-style-type: none"> <li>The Natural Resources Agency develops guidelines for the implementation of the California Environmental Quality Act (CEQA), a broad environmental law with the goal of disclosing to the public the significant environmental effects of a proposed project through the preparation of an Initial Study (IS), Negative Declaration (ND), or Environmental Impact Report (EIR).</li> <li>Unlike NEPA, requires adoption of all feasible measures to mitigate environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>CEQA applies to all discretionary projects proposed to be conducted or approved by a California public agency, including private projects requiring discretionary government approval</li> <li>Construction of seawalls, revetments/riprap, bulkheads, or super levee that would modify land near the shoreline or the elevation of land might trigger CEQA</li> <li>Geologic Hazard Abatement Districts are exempt from CEQA</li> <li>Impacts to wetlands would have to be addressed under CEQA</li> </ul>	<ul style="list-style-type: none"> <li>Governor's Office of Planning and Research (OPR) and the Natural Resources agency develop CEQA guidelines<sup>19</sup></li> </ul>

9 <https://www.hayward2040generalplan.com/>  
10 <https://www.hayward-ca.gov/services/city-services/explore-zoning-use-charts>  
11 <https://www.hayward-ca.gov/your-government/documents/capital-improvement-program>  
12 <https://www.hayward-ca.gov/your-government/documents/economic-development-strategic-plan>  
13 <https://www.hayward-ca.gov/your-government/documents/planning-documents>  
14 <https://www.hayward-ca.gov/your-government/documents/planning-documents>  
15 <https://www.hayward-ca.gov/sites/default/files/pdf/2016%20City%20of%20Hayward%20Local%20Hazard%20Mitigation%20Plan.pdf>  
16 <https://www.hayward-ca.gov/green-infrastructure-plan>  
17 <http://www.sfbayrestore.org/san-francisco-bay-restoration-regulatory-integration-team-brrit>  
18 <https://www.youtube.com/watch?v=UBcWVP9qQfM8&feature=youtu.be>  
19 <http://opr.ca.gov/ceqa/updates/guidelines/>

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
Alameda County Flood Control & Water Conservation District (ACFCWCD)	<ul style="list-style-type: none"> <li>Provides flood protection for the citizens and business of Alameda County, while safeguarding the Bay Area's natural environment</li> <li>Prevents waste of water or diminution of the water supply</li> <li>Owns and operates flood control infrastructure (system of pump stations, erosion control structures, dams, and pipeline, channels, levees, and creeks)</li> <li>Works with federal, state, and local governmental agencies (USACE, FEMA, USGS, NOAA, Water Board, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Owns and operates flood control infrastructure in the study area, including: Storm drains, channels, pipelines to San Lorenzo Creek Cull and Don Castro Reservoirs Nine pump stations (Eden Landing, Ruus Road, Besco, Westview, Alvarado, Industrial, Ameron, Stratford, Eden Shores)<sup>20</sup></li> <li>Channel property under ACFWCD ownership (Bockman, Sulfur, Line A) could be opened up to public access, potentially aligning with project goals (if maintenance and liability responsibilities can be passed on to another agency).</li> <li>Considers larger-scale, regional flood protection planning to be beyond their mission.</li> </ul>	<ul style="list-style-type: none"> <li>Currently conducting Coastal and Riverine Flood Assessment</li> <li>Hydrology &amp; Hydraulics Manual: Defines current practices for the hydrologic and hydraulic design of all flood control facilities in Alameda County that are subject to District approval</li> <li>Alameda County Public Works Agency Engineering Design Guidelines</li> <li>Floodplain Management Ordinance<sup>21</sup></li> <li>Stormwater Management and Discharge Ordinance<sup>22</sup></li> <li>Grading, Erosion, and Sediment Control Ordinance<sup>23</sup></li> <li>California Regional Water Quality Board, Municipal Regional Stormwater NPDES Permit<sup>24</sup></li> <li>Zone 3A Drainage Master Plan Study<sup>25</sup></li> </ul>
Alameda County Mosquito Abatement District (ACMAD)	<ul style="list-style-type: none"> <li>Formed by City Councils of Berkeley, San Leandro, Hayward, Oakland, Alameda, Piedmont, and Emeryville to address the problem of large flights of mosquitoes from the bay marshes to the hills from March to October</li> <li>Developed ditching in the marshes to promote drainage of salt marsh mosquito breeding sources</li> <li>Committed to improving the health and comfort of Alameda County residents by controlling mosquitoes and limiting the transmission of mosquito-borne diseases</li> </ul>	<ul style="list-style-type: none"> <li>Provides assistance to local code enforcement agencies to enforce state laws, regulations, and local ordinances related to rodent, wildlife, or insect vectors that pose a threat to public health and safety</li> </ul>	<ul style="list-style-type: none"> <li>Control Program<sup>26</sup></li> <li>Invasive Mosquito Response Plan<sup>27</sup></li> <li>ACMAD Strategic Plan 2018-2021<sup>28</sup></li> <li>BMPs for Mosquito Control<sup>29</sup></li> </ul>

20 <http://acffloodcontrol.org/wp-content/uploads/2016/02/acfcd2004report.pdf>  
21 [https://library.municode.com/ca/alameda\\_county/codes/code\\_of\\_ordinances?nodeId=TIT15BUCO\\_CH15.40FLMA](https://library.municode.com/ca/alameda_county/codes/code_of_ordinances?nodeId=TIT15BUCO_CH15.40FLMA)  
22 [https://library.municode.com/ca/alameda\\_county/codes/code\\_of\\_ordinances?nodeId=TIT13PUSE\\_CH13.08STMADICO](https://library.municode.com/ca/alameda_county/codes/code_of_ordinances?nodeId=TIT13PUSE_CH13.08STMADICO)  
23 [https://library.municode.com/ca/alameda\\_county/codes/code\\_of\\_ordinances?nodeId=TIT15BUCO\\_CH15.36GRERSECO](https://library.municode.com/ca/alameda_county/codes/code_of_ordinances?nodeId=TIT15BUCO_CH15.36GRERSECO)  
24 [https://www.waterboards.ca.gov/rwqcb2/board\\_decisions/adopted\\_orders/2009/R2-2009-0074.pdf](https://www.waterboards.ca.gov/rwqcb2/board_decisions/adopted_orders/2009/R2-2009-0074.pdf)  
25 <https://acffloodcontrol.org/projects-and-programs/flood-control-projects/zone-3a-drainage-master-plan-study/>  
26 <https://www.mosquitoes.org/files/c1804f413/Control+Program.pdf>  
27 [https://www.mosquitoes.org/files/12711fa88/ACMAD-Invasive-Mosquito-Species-Response-Plan-09\\_07\\_2017-1.pdf](https://www.mosquitoes.org/files/12711fa88/ACMAD-Invasive-Mosquito-Species-Response-Plan-09_07_2017-1.pdf)  
28 <https://www.mosquitoes.org/files/8206d6935/Alameda+Strategic+Plan.pdf>  
29 <https://www.mosquitoes.org/files/4210fdde3/BMPsforMosquitoControl.pdf>

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
Union Sanitary District	<ul style="list-style-type: none"> <li>Independent special district which provides wastewater collection, treatment and disposal services to the residents and businesses of the cities of Fremont, Newark and Union City in Southern Alameda County, CA</li> <li>Sanctioned under California law to perform specific local government functions within certain boundaries</li> <li>Derives authority from California Health &amp; Safety Code</li> </ul>	<ul style="list-style-type: none"> <li>Operates a 33 million gallon per day wastewater treatment facility in Union City and provides collection, treatment and disposal services to a total population of over 347,000 in Fremont, Newark, and Union City, CA</li> <li>Maintains over 800 miles of underground pipelines in its service area</li> </ul>	<ul style="list-style-type: none"> <li>Sewer System Management Plan<sup>30</sup></li> </ul>
East Bay Dischargers Authority (EBDA)	<ul style="list-style-type: none"> <li>Formed in 1974 by a joint exercise of powers agreement by the City of Hayward, City of San Leandro, Oro Loma Sanitary District, Union Sanitary District, and Castro Valley Sanitary District</li> <li>Purpose is to collectively manage the wastewater treatment and disposal of these agencies, servicing about 800,000 people<sup>31</sup></li> <li>Owns and operates four effluent pump stations, a dichlorination facility, and a force main and Bay Outfall system for effluent disposal into the San Francisco Bay<sup>32</sup></li> </ul>	<ul style="list-style-type: none"> <li>Operates pipelines connecting various wastewater treatment facilities, allowing treated effluent to enter a single pipeline that discharges into the center of the Bay – this infrastructure runs through the Hayward Regional Shoreline project area, crossing tidal marshes, diked baylands, and industrial lands</li> <li>EBDA is a partner in the Hayward Marsh redesign (see above).</li> <li>Joint Powers Agreement (JPA) sets flow amounts, and that is in the process of being updated for the next 20 years, to plan for future alternatives to the EBDA system</li> </ul>	<ul style="list-style-type: none"> <li>East Bay Dischargers Authority Sea Level Rise Adaptation Planning Project, 2015<sup>33</sup></li> <li>Wastewater Reclamation and Reuse Study for the Union Sanitary District Area, May 1976<sup>34</sup></li> <li>Joint Powers Agreement</li> </ul>
East Bay Municipal Utility District (EBMUD)	<ul style="list-style-type: none"> <li>Provides high-quality drinking water for 1.4 million East Bay customers in a 332 square mile area</li> <li>Wastewater system serves 685,000 people in an 88-square mile area</li> </ul>	<ul style="list-style-type: none"> <li>Some properties in the City of Hayward get water from EBMUD</li> </ul>	<ul style="list-style-type: none"> <li>East Bay Watershed Master Plan<sup>35</sup></li> <li>Watershed Rules and Regulations<sup>36</sup></li> </ul>
Calpine (Russell City Energy Center)	<ul style="list-style-type: none"> <li>Private power company serving 600,000 households</li> <li>PG&amp;E is contracted to buy the energy produced by the plant and will ship it to San Francisco and San Mateo counties<sup>37</sup></li> </ul>	<ul style="list-style-type: none"> <li>Plant is in study area, opened in 2013, built on former landfill site, owned by Union Sanitary District.</li> <li>Combined-cycle, natural gas-powered electric generating facility with advanced air emissions control technologies. Plant consists of two combustion turbine generators, two heat recovery steam generators with duct burners and a single condensing steam turbine generator.</li> <li>Plant will likely be decommissioned in the next thirty years, making the land available for reuse by Sanitary District.</li> </ul>	

30 <https://www.unionsanitary.com/images/documents/USD-SSMP-2018-19-Update.pdf>  
31 <http://www.ebda.org/>  
32 <http://www.ebda.org/about-us>  
33 [http://www.ebda.org/sites/default/files/EBDA%20Climate%20Ready%20Final%20Report%20Report\\_August2015.pdf](http://www.ebda.org/sites/default/files/EBDA%20Climate%20Ready%20Final%20Report%20Report_August2015.pdf)  
34 [http://www.ebda.org/sites/default/files/WW\\_Reclamation\\_and\\_Reuse\\_Study\\_1976.pdf](http://www.ebda.org/sites/default/files/WW_Reclamation_and_Reuse_Study_1976.pdf)  
35 <https://www.ebmud.com/recreation/east-bay/east-bay-watershed-master-plan-update/>  
36 <https://www.ebmud.com/recreation/rules-and-regulations/>  
37 <https://www.eastbayexpress.com/oakland/foes-of-hayward-power-plant-fight-back/Content?oid=1905883>

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
San Francisco Bay Trail	<ul style="list-style-type: none"> <li>Partnered with State Coastal Conservancy to develop 500-mile regional trail</li> <li>Offers grants to local entities to assist in completion of the trail</li> <li>Works with state and federal agencies, towns, cities, counties, park districts, etc.</li> <li>Connects communities to parks, open spaces, schools, transit and to each other and provides a commute corridor</li> </ul>	<ul style="list-style-type: none"> <li>Bay Trail Plan adopted by the Association of Bay Area Governments per Senate Bill 100 in 1989</li> <li>Policies and design guidelines are intended to complement rather than supplant adopted regulations and guidelines of local managing agencies</li> <li>Alternative locations for the Bay Trail were investigated during the Adapting to Rising Tides study, including inland routes, that were considered incompatible with the Bay Trail's 'blue water experience' that they prioritize.</li> <li>Preference for hard surfaces, though may accommodate other surfaces on top of a levee.</li> </ul>	<ul style="list-style-type: none"> <li>Bay Trail Plan, Design Guidelines &amp; Toolkit<sup>38</sup></li> </ul>
PG&E	<ul style="list-style-type: none"> <li>Provides natural gas and electric service to 16 million people throughout a 70,000 square mile service area</li> <li>Although the company has infrastructure throughout Hayward, the City now requires all commercial and residential properties to switch from PG&amp;E and instead buy power from non-profit provider East Bay Community Energy<sup>39</sup></li> <li>Overseen by California Public Utilities Commission</li> </ul>	<ul style="list-style-type: none"> <li>PG&amp;E overhead transmission lines cross the Hayward Regional Shoreline project area. The towers are on concrete bases, but sea level rise could cause issues with access for maintenance and repairing the infrastructure.</li> <li>Additional energy infrastructure is present in the study area that may impact project design.</li> </ul>	
Union Pacific Railroad	<ul style="list-style-type: none"> <li>Freight railroad owner and operator in Western U.S.</li> </ul>	<ul style="list-style-type: none"> <li>Owens and operates freight rail line in the study area. Part of the Union Pacific Coast Line that runs from Los Angeles to the Bay Area.</li> <li>Work near the railroad must be coordinated with Union Pacific</li> </ul>	
California Public Utilities Commission (CPUC)	<ul style="list-style-type: none"> <li>CPUC regulates electric, natural gas, telecommunications, water, railroad, rail transit, and passenger transportation utilities and companies.</li> </ul>	<ul style="list-style-type: none"> <li>PG&amp;E and Union Pacific Railroad are regulated by CPUC. Changes to their assets may be subject to review by CPUC.</li> </ul>	

38 [https://baytrail.org/wp-content/uploads/2015/12/San-Francisco-Bay-Trail\\_-Bay-Trail-Plan-Summary.pdf](https://baytrail.org/wp-content/uploads/2015/12/San-Francisco-Bay-Trail_-Bay-Trail-Plan-Summary.pdf)  
39 <https://sanfrancisco.cbslocal.com/2018/03/08/hayward-goodbye-pge-renewable-energy/>

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
San Francisco Bay Conservation & Development Commission	<ul style="list-style-type: none"> <li>California state planning and regulatory agency with regional authority over the San Francisco Bay, the Bay's shoreline, and the Suisun Marsh</li> <li>Mission is to protect and enhance San Francisco Bay and encourage the Bay's responsible and productive use</li> <li>Leads the Bay Area's multi-agency regional effort to address impacts of rising sea level on shoreline communities and assets</li> <li>Authority found in McAteer-Petris Act, San Francisco Bay Plan, and other special area plans and laws and policies.</li> <li>Issues Coastal Zone Management consistency determination.</li> </ul>	<ul style="list-style-type: none"> <li>Issues permits for fill in the Bay (including intertidal lands and salt ponds) and for projects within a 100-foot buffer from the bay. Permit conditions require projects to minimize any fill and maximize feasible public access for all projects within the Bay's 100-foot shoreline band.</li> <li>Interested in highlighting and sharing this project as example of innovative projects in the bay and as a way to share lessons learned around the region.</li> <li>Proposed Habitat for Fill Bay Plan Amendment is intended to ease the permitting burden for habitat restoration projects. This change may make it easier to get a permit for fill to pursue thin layer placement, gravel beaches, strategic placement of dredge / mudflat seeding. Such projects are likely to require monitoring and adaptive management plans.<sup>40</sup></li> </ul>	<ul style="list-style-type: none"> <li>San Francisco Bay Plan (updated with environmental justice and social equity amendment) – includes policies to guide future use of the Bay and shoreline and maps that apply the policies to the Bay and shoreline</li> <li>Special area plans and design guidelines<sup>41</sup></li> </ul>
California State Coastal Conservancy (SCC)	<ul style="list-style-type: none"> <li>State agency established in 1976 to protect and improve natural lands and waterways, help people access and enjoy the outdoors, and sustain local economies along the length of California's coast and San Francisco Bay<sup>42</sup></li> <li>Climate Ready Program helps natural resources and human communities along California's coast and San Francisco Bay adapt to the impacts of climate change</li> </ul>	<ul style="list-style-type: none"> <li>Provides grants and guidance for climate adaptation planning and projects consistent with the Strategic Plan</li> </ul>	<ul style="list-style-type: none"> <li>"The Baylands and Climate Change: What We Can Do: The 2015 Science Update to the Baylands Ecosystem Habitat Goals Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project"  Strategic Plan<sup>43</sup>  Adaptation Tools Spreadsheet<sup>44</sup></li> </ul>
Metropolitan Transportation Commission (MTC)	<ul style="list-style-type: none"> <li>Metropolitan planning organization for nine-county San Francisco Bay Area (federal designation) and regional transportation planning agency (state designation), responsible for Bay Area transportation and long-range planning</li> <li>Assigned duties by federal government, state Legislature, and Bay Area voters</li> <li>Regional transportation and financing in the Bay Area, oversee toll revenue on State-owned bridges</li> </ul>	<ul style="list-style-type: none"> <li>Have decision-making authority over the State Transportation Improvement Program (STIP) and administer various federal funding</li> <li>With ABAG, developing regional plan (Bay Plan 2050), which identifies priority conservation areas, priority development areas, and priority production areas. Hayward Shoreline is eligible to be a PDA-Connected Community, which may provide opportunities for transit funding. Requires passage of policies to reduce vehicle miles traveled.</li> </ul>	<ul style="list-style-type: none"> <li>Plan Bay Area 2040<sup>45</sup></li> <li>Plan Bay Area 2050<sup>46</sup></li> </ul>

40 <https://bcdca.gov/BPAFHR/FillHabitat.html>  
41 <https://bcdca.gov/publications/>  
42 <https://scc.ca.gov/>  
43 [https://scc.ca.gov/files/2018/01/CoastalConservancy\\_StrategicPlan\\_2018\\_2022.pdf](https://scc.ca.gov/files/2018/01/CoastalConservancy_StrategicPlan_2018_2022.pdf)  
44 <https://scc.ca.gov/climate-change/climate-change-projects/#slr-adaptation>  
45 [https://mtc.ca.gov/sites/default/files/Final\\_Plan\\_Bay\\_Area\\_2040.pdf](https://mtc.ca.gov/sites/default/files/Final_Plan_Bay_Area_2040.pdf)  
46 <https://www.planbayarea.org/>

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
CA State Lands Commission	<ul style="list-style-type: none"> <li>Established in 1938, manages 4 million acres of tidal and submerged lands and beds of navigable rivers, streams, lakes, bays, estuaries, inlets, and straits (mostly Public Trust lands)</li> <li>Monitors sovereign land granted in trust by the California Legislature to approximately 70 local jurisdictions that generally consist of prime waterfront lands and coastal waters</li> <li>Issues leases for use or development, provides public access, resolves boundaries between public and private lands, and implements regulatory programs to protect state waters from oil spills and invasive species</li> </ul>	<ul style="list-style-type: none"> <li>Mostly has jurisdiction over sovereign land (tidal and navigable waters) and school lands (lands granted to public school system)</li> </ul>	<ul style="list-style-type: none"> <li>Strategic Plan 2016-2020<sup>47</sup></li> </ul>
San Francisco Estuary Institute	<ul style="list-style-type: none"> <li>Aquatic and ecosystem science institute dedicated to providing scientific support and tools for decision-making and communication through collaborative efforts</li> <li>Through Resilient Landscapes, develops strategies to adapt to climate change<sup>48</sup></li> <li>Advises state, federal, and regional agencies, as well as business and NGO leaders</li> </ul>	<ul style="list-style-type: none"> <li>On the Hayward Shoreline Master Plan team</li> <li>Prepared the San Francisco Bay Shoreline Adaptation Atlas with SPUR, which includes the study area</li> </ul>	<ul style="list-style-type: none"> <li>San Francisco Bay Shoreline Adaptation Atlas<sup>49</sup></li> <li>Regional Monitoring Program for Water Quality in San Francisco Bay<sup>50</sup></li> <li>Alameda Creek Historical Ecology study<sup>51</sup></li> <li>Forthcoming Healthy Watershed Resilient Baylands study looking at an updated sediment budget for the Bay</li> </ul>
SPUR (San Francisco Bay Area Planning and Urban Research Association)	<ul style="list-style-type: none"> <li>Non-profit research, education, and advocacy organization focused on planning and governance issues in SF</li> </ul>	<ul style="list-style-type: none"> <li>Prepared the San Francisco Bay Shoreline Adaptation Atlas with SPUR, which includes the study area</li> </ul>	<ul style="list-style-type: none"> <li>San Francisco Bay Shoreline Adaptation Atlas</li> <li>SPUR's Agenda for Change</li> <li>SPUR Regional Strategy 2070<sup>52</sup></li> </ul>
San Francisco Bay Restoration Authority	<ul style="list-style-type: none"> <li>Regional agency created to fund shoreline projects that will protect, restore, and enhance San Francisco Bay</li> <li>Allocates funds raised by the Measure AA parcel tax</li> </ul>	<ul style="list-style-type: none"> <li>Measure AA funding can go towards projects that protect, restore and enhance the San Francisco Bay, including habitat restoration projects; flood protection projects that are part of a habitat restoration project; and shoreline access and recreational amenity projects that are part of a habitat restoration project.<sup>53</sup></li> </ul>	<ul style="list-style-type: none"> <li>Grant Program Guidelines<sup>54</sup></li> </ul>

47 <https://www.slc.ca.gov/wp-content/uploads/2018/07/StrategicPlan.pdf>

48 <https://www.sfei.org/contact#sthash.WinLZ0L2.dpbs>

49 <https://www.sfei.org/adaptationatlas>

50 [https://www.sfei.org/sites/default/files/biblio\\_files/2019%20Multi-Year%20Plan%20-%20SC%20Approved%2020190430%20-%20050119.pdf](https://www.sfei.org/sites/default/files/biblio_files/2019%20Multi-Year%20Plan%20-%20SC%20Approved%2020190430%20-%20050119.pdf)

51 <https://www.sfei.org/projects/AlamedaCreekHE#sthash.1JuSjXnU.dpbs>

52 <https://www.spur.org/featured-project/regional-strategy>

53 <http://www.sfbayrestore.org/>

54 [http://sfbayrestore.org/sites/default/files/2019-09/final\\_grant\\_program\\_guidelines\\_9.17.19.pdf](http://sfbayrestore.org/sites/default/files/2019-09/final_grant_program_guidelines_9.17.19.pdf)

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
Alameda County Water District (ACWD)	<ul style="list-style-type: none"> <li>Supplies water to residents and businesses of southern Alameda County</li> <li>Sources of water supply – 40% State Water Project, 20% San Francisco PUC, 40% Alameda Creek Watershed Runoff</li> <li>Service area includes about 357,000 residential and 84,000 business customers<sup>55</sup></li> </ul>	<ul style="list-style-type: none"> <li>The District's jurisdictional boundary includes the southern portion of the City of Hayward</li> <li>Owns and operates groundwater wells in the project area</li> </ul>	<ul style="list-style-type: none"> <li>Five Year Strategic Plan<sup>56</sup></li> <li>Urban Water Management Plan 2015-2020</li> </ul>
Association of Bay Area Governments (ABAG)	<ul style="list-style-type: none"> <li>Regional planning agency and council of governments for the counties, cities, and towns of the Bay region.</li> <li>Works on regional issues such as land use, environmental stewardship, energy efficiency, and water resource protection.</li> <li>Shares joint responsibility for Plan Bay Area with MTC.</li> </ul>	<ul style="list-style-type: none"> <li>With MTC, developing regional plan (Bay Plan 2050), which identifies priority conservation areas, priority development areas, and priority production areas. Hayward Shoreline is eligible to be PDA-Connected Community, which may provide opportunities for transit funding. Requires the passage of policies to reduce vehicle miles traveled.</li> </ul>	<ul style="list-style-type: none"> <li>Plan Bay Area 2050</li> </ul>
Cal Trans (California Department of Transportation)	<ul style="list-style-type: none"> <li>Manages California's highway and freeway lanes, provides inter-city rail services</li> <li>Executive department of the US State of California, part of the cabinet-level California State Transportation Agency</li> </ul>	<ul style="list-style-type: none"> <li>Owns State Route 92 (plaza and eastern approach to San Mateo-Hayward Bridge) which is vulnerable to SLR and has drainage issues.</li> <li>Cal Trans sees the need for more study of the hydrologic conditions around the bridge approach, hasn't yet developed an adaptation plan for the asset.</li> </ul>	<ul style="list-style-type: none"> <li>Caltrans Climate Change Vulnerability Assessment<sup>57</sup></li> <li>Climate Change Vulnerability Assessment<sup>58</sup></li> </ul>
SF Regional Water Quality Control Board (WQCB)	<ul style="list-style-type: none"> <li>A division of the State Water Resources Control Board charged with the protection of water quality through regulation of stormwater discharges, landfills, alteration of federal water bodies, and other activities.</li> <li>Issues water discharge requirements, takes enforcement action against violators, and monitors water quality</li> </ul>	<ul style="list-style-type: none"> <li>Submerged features, like fill, require Water Board permits, as do modifications of the shoreline.</li> <li>Regulates landfills and waste ponds, including both active and closed facilities. Regulation consists of design standards for liners, covers, etc., environmental monitoring, and cleanup when necessary.</li> <li>Consultation likely required in permitting process.</li> </ul>	<ul style="list-style-type: none"> <li>Water Quality Control Plan for the San Francisco Bay Basin<sup>59</sup></li> </ul>
California Department of Fish and Wildlife (CDFW)	<ul style="list-style-type: none"> <li>Mission is to manage the State's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.</li> <li>Issues permits to ensure regulatory compliance and statewide consistency with the California Endangered Species Act.</li> </ul>	<ul style="list-style-type: none"> <li>Issues permits to ensure regulatory compliance and statewide consistency with the California Endangered Species Act.</li> <li>Consultation likely required in permitting process.</li> </ul>	

55 <https://www.acwd.org/DocumentCenter/View/1264/ACWDs-2015---2020-UWMP?bidId=>

56 <https://www.acwd.org/DocumentCenter/View/2048/2018-ACWD-Strategic-Plan-?bidId=>

57 <https://dot.ca.gov/programs/transportation-planning/office-of-smart-mobility-climate-change/climate-change>

58 <https://www.arcgis.com/apps/webappviewer/index.html?id=517eefc1b5a542e5b0e25f337f87f5bb>

59 [https://www.waterboards.ca.gov/sanfranciscobay/basin\\_planning.html](https://www.waterboards.ca.gov/sanfranciscobay/basin_planning.html)

AGENCY OR ORGANIZATION	GENERAL ROLE(S) / MISSION	PLANNING & REGULATORY JURISDICTION / LAND OWNERSHIP RELEVANT TO STUDY AREA AND MASTER PLAN	RELEVANT REGULATIONS, PLANS, POLICIES, GUIDANCE, AND STUDIES
U.S. Fish and Wildlife Service (USFWS)	<ul style="list-style-type: none"> <li>Issues permits for activities that impact plants and animals designated as endangered or threatened, and the habitats upon which they depend.</li> </ul>	<ul style="list-style-type: none"> <li>Several known species in the study area (Salt Marsh Harvest Mouse, Ridgway's Rail, California Least Tern, and the Western Snowy Plover) are federally designated endangered species.</li> <li>Consultation likely required in permitting process.</li> </ul>	
NOAA National Marine Fisheries Service (NMFS)	<ul style="list-style-type: none"> <li>With USFWS (above) implements the National Endangered Species Act.</li> <li>Responsible for endangered and threatened marine and anadromous species</li> </ul>	<ul style="list-style-type: none"> <li>Consultation may be required in permitting process.</li> </ul>	
Federal Emergency Management Agency (FEMA)	<ul style="list-style-type: none"> <li>Develops Flood Insurance Rate Maps (FIRMs) and administer National Flood Insurance Program</li> <li>Administers standards for flood resistant construction codes</li> </ul>	<ul style="list-style-type: none"> <li>Accreditation of flood protection structures and levees to enable neighborhoods, infrastructure, and developed areas to be eligible for reduced or eliminated flood insurance rates under the NFIP</li> <li>Sets insurance rates under the NFIP, currently under reform<sup>60</sup></li> </ul>	<ul style="list-style-type: none"> <li>FIRMS<sup>61</sup></li> <li>Guidance on Levee Accreditation<sup>62</sup></li> </ul>
United States Army Corps of Engineers (USACE)	<ul style="list-style-type: none"> <li>Regulatory agency responsible for issuing permits for all structures and work on waterways within its jurisdiction of waters of the United States, including dredging, marinas, piers, wharves, floats, intake/outtake pipes, pilings, bulkheads, ramps, fills, and overhead transmission lines.</li> <li>Develops plans for regional dredge management and is studying strategic placement of dredge material and identifying opportunities for beneficial use in the Bay Area.</li> </ul>	<ul style="list-style-type: none"> <li>Developed and constructed Alameda County's flood control system, including the Alameda Creek, San Lorenzo Creek, and San Leandro Creek flood channels (although the channels are maintained by the ACFCWCD)</li> </ul>	<ul style="list-style-type: none"> <li>Regional Dredge Material Management Plan<sup>63</sup></li> <li>Permitting regulations and guidance<sup>64</sup></li> </ul>

60 <https://www.fema.gov/nfiptransformation>

61 <https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd&extent=-122.43945211509653,37.43674391029817,-121.86129659751919,37.708853832347565>

62 <https://www.fema.gov/media-library/assets/documents/9208>

63 [https://www.spn.usace.army.mil/Portals/68/docs/Dredging/DDMP/PMP\\_SFBay\\_RDMMP\\_DRAFT%205-23-19docx.pdf?ver=2019-07-09-184445-433](https://www.spn.usace.army.mil/Portals/68/docs/Dredging/DDMP/PMP_SFBay_RDMMP_DRAFT%205-23-19docx.pdf?ver=2019-07-09-184445-433)

64 <https://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/Federal-Regulation/>

# **ADAPTATION STRATEGIES**

# **NATURE-BASED STRATEGIES**

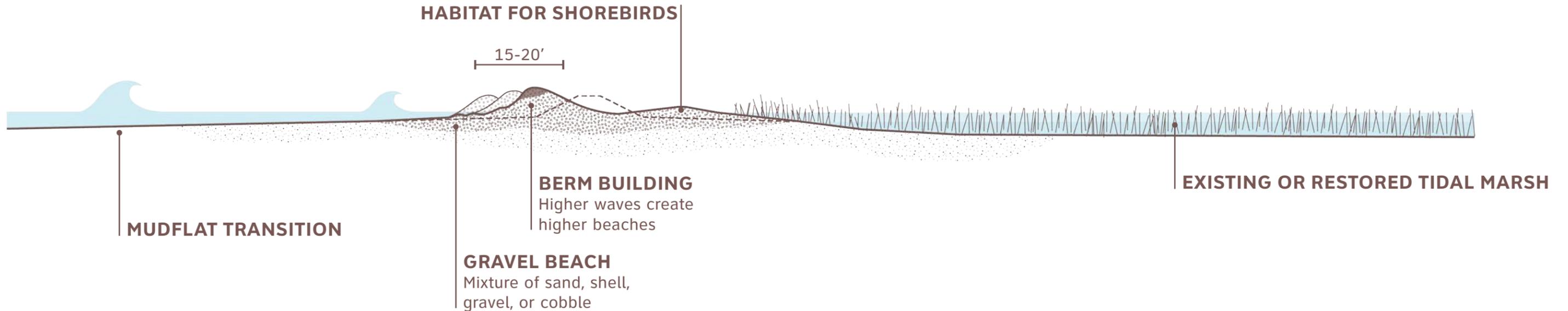
# FINE AND COARSE GRAIN BEACHES

## Definition

Coarse or composite estuarine beaches are **dynamic features** that consist of a mixture of **sand, shell, gravel, or cobble**. Beaches include a supratidal beach berm and a beach face. Gravel and cobble beaches can **dissipate wave energy over shorter distances** and are generally more suitable within the urbanized and constrained estuary than sand beaches. They can be placed in front of levees, roads or other vulnerable infrastructure to **reduce erosion**. Many beaches provide **habitat benefits to shorebirds**.

## GOAL / OBJECTIVE

- Reduce erosion to levees
- Ecological enhancement (provides nesting habitat)



# FINE AND COARSE GRAIN BEACHES

## Precedents

### Arambaru Island Enhancement Project Richardson Bay, CA

**Size:** 3 acres of new beach

**Cost:** \$2.2 million

**Implementation Timeline:** Completed 2012

**Applicability:** A gravel beach and associated marsh restoration can help create a layered shoreline, reduce erosion, provide new habitat, and grow with SLR.

**Description:** A restoration project to stabilize the eroding eastern shoreline, enhance habitats, and encourage seabird and seal use. A new beach gives the habitats time to transition as sea levels rise.

- Focus on creating habitat for terns and other water birds
- Gravel, sand, and oyster shell hash shoreline with eucalyptus log stabilization infrastructure
- Larger rocks and driftwood help trap finer sediments
- Reduced rapid erosion of island, holding up against winter storms and continual increases in waves



Open expanse of gravel provides nesting habitat



Gravel deposition during construction

# FINE AND COARSE GRAIN BEACHES

## Option 1: Beaches in front of Landfills

### GOAL / OBJECTIVE

Reduce the risk of erosion to the two landfills and enhance shoreline ecology with gravel nesting habitat.

### DESCRIPTION

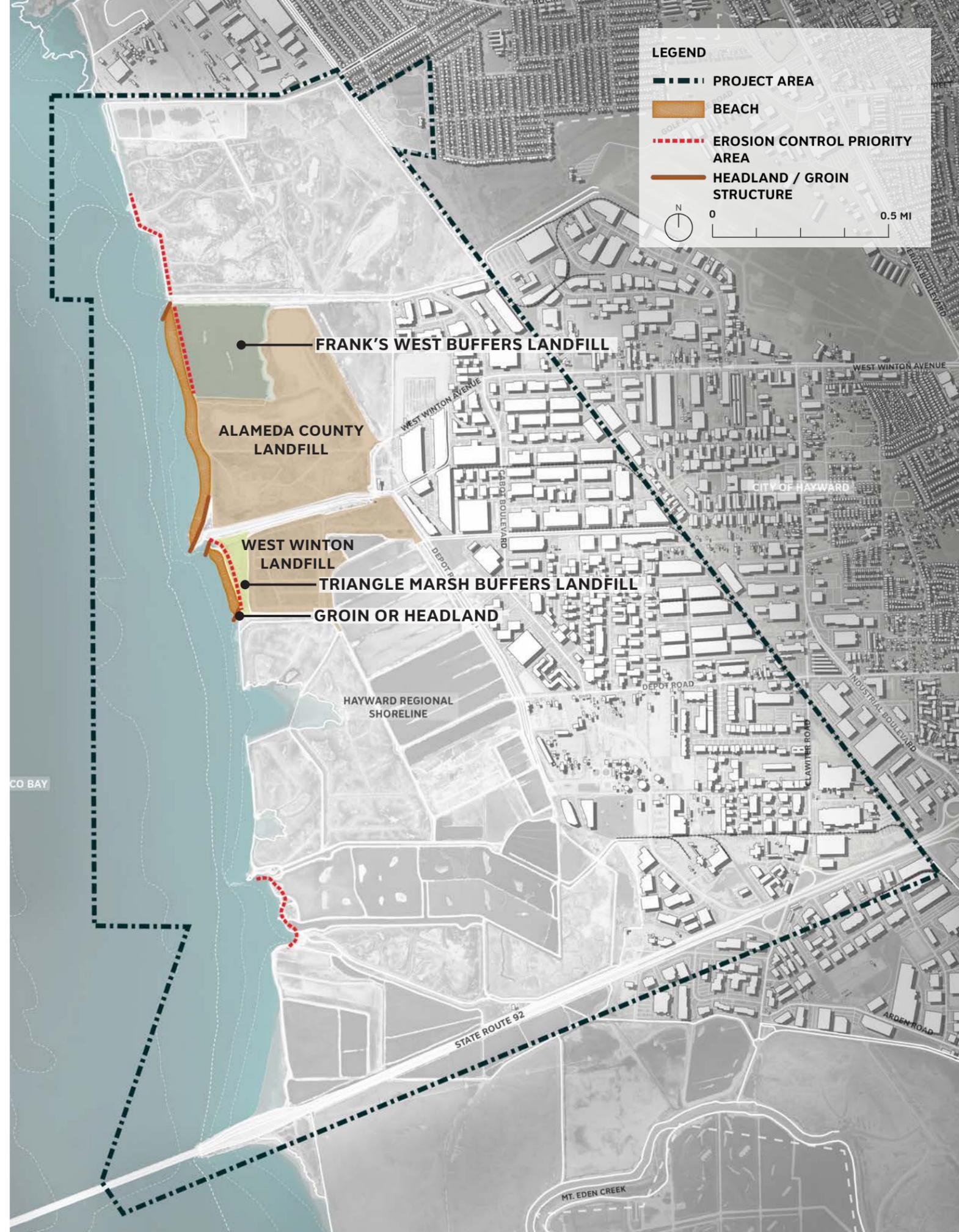
- Gravel beaches in front of Bay shoreline structures in front of Alameda County and West Winton Landfills

### PROS

- Reduce erosion to landfill edges
- Reduce levee/berm maintenance adjacent to landfills
- Could enhance shorebird and beach habitat

### CONS

- May require artificial replenishment
- May require the installation of lateral containment structures
- Considered as fill under current regulations, which might present permitting challenges



# FINE AND COARSE GRAIN BEACHES

## Option 2: Beaches in front of Existing Marsh Berms

### GOAL / OBJECTIVE

Reduce the risk of erosion to outboard berms and levees in front of existing marshes and enhance shoreline ecology with gravel nesting habitat.

### DESCRIPTION

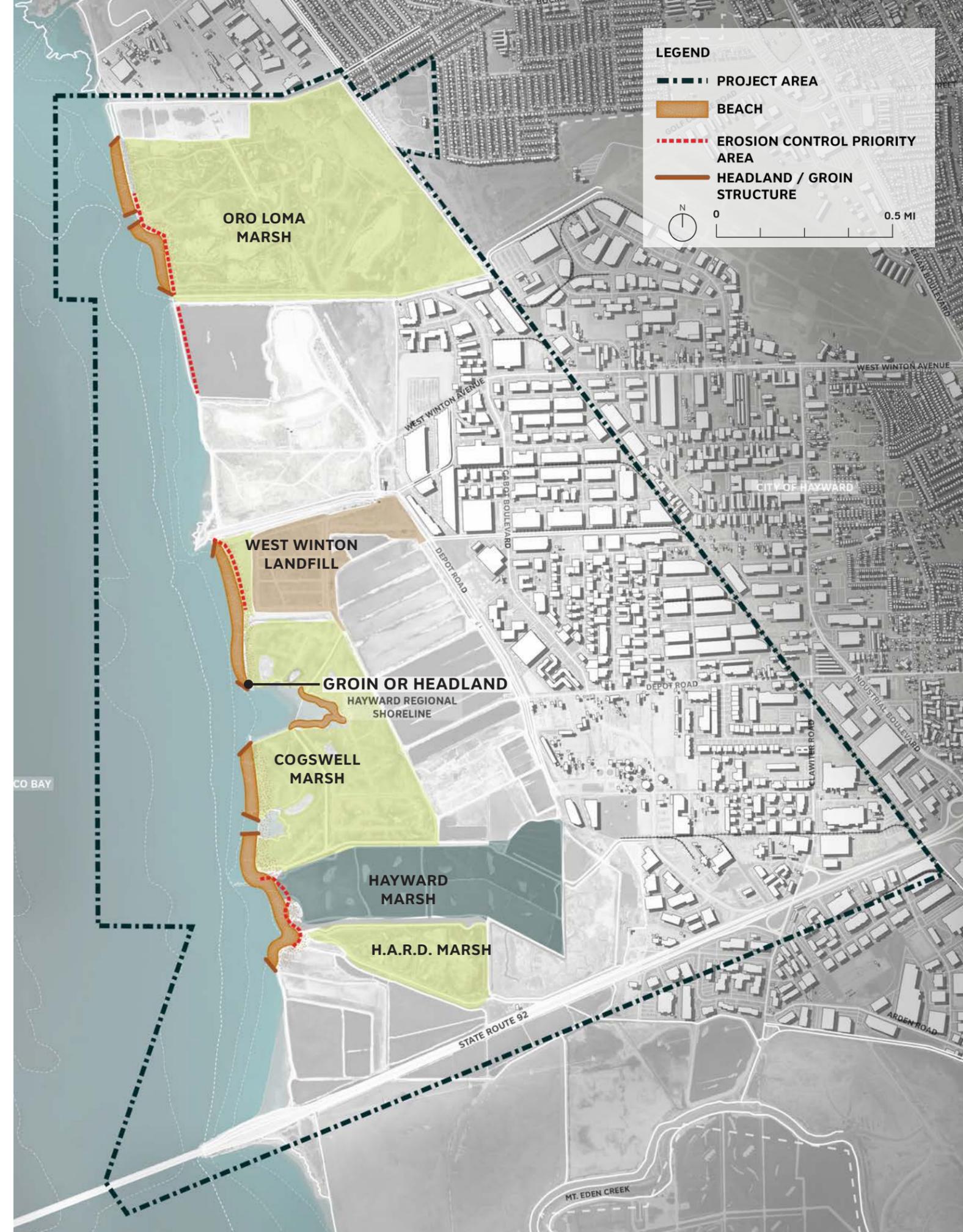
- Gravel beaches in front of the Bay shoreline structures in front of existing marshes

### PROS

- Reduce erosion of outboard marsh edges
- Potential to lower maintenance of bayside levee/berms
- Reduced maintenance costs of outboard berms

### CONS

- May require artificial replenishment
- May require the installation of lateral containment structures
- Considered as fill under current regulations, which might present permitting challenges



# FINE AND COARSE GRAIN BEACHES

## Option 3: Beaches along Entire Shoreline

### GOAL / OBJECTIVE

Reduce the risk of erosion along the entire shoreline and enhance shoreline ecology with gravel nesting habitat.

### DESCRIPTION

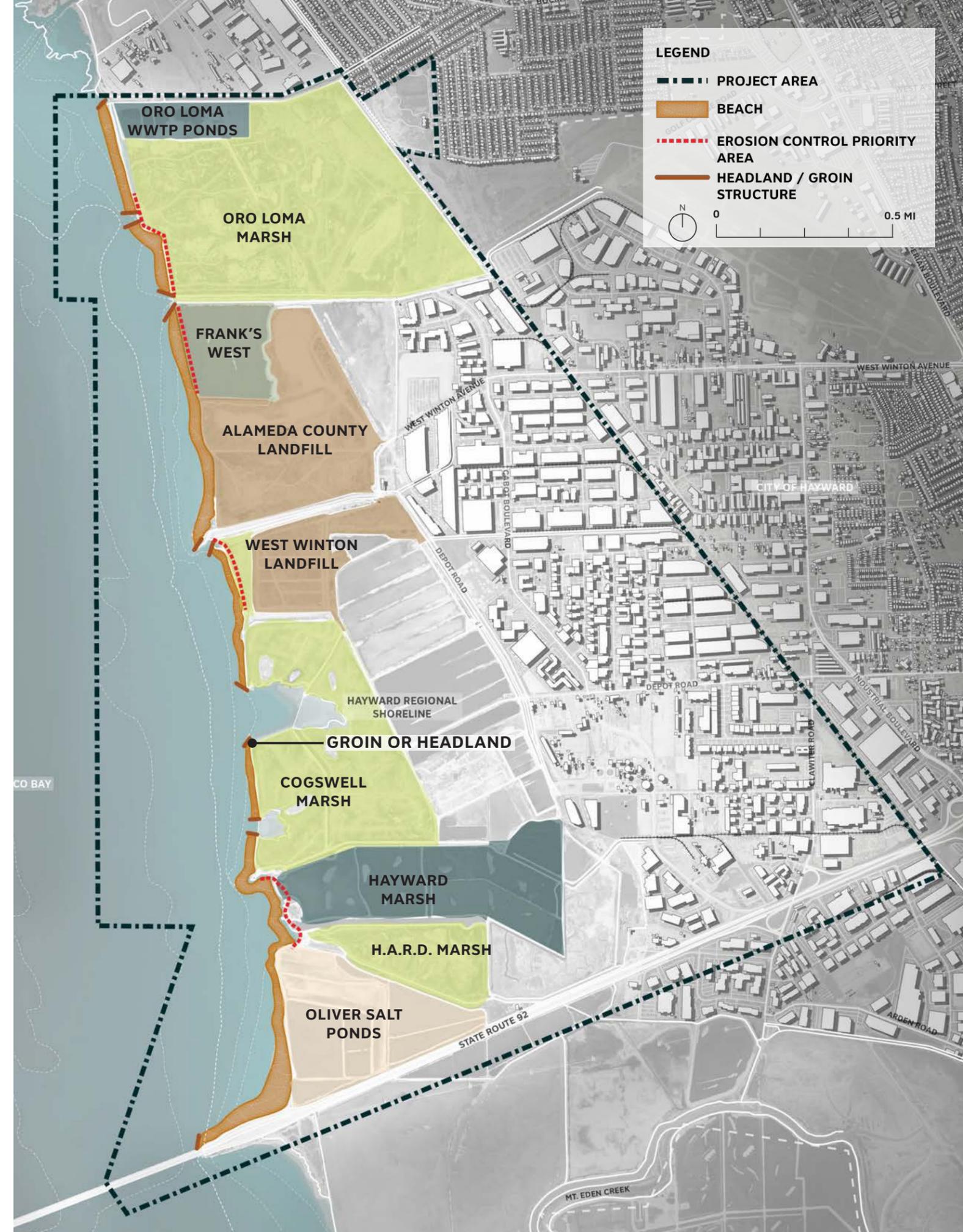
- Gravel beaches in front of all outboard Bay shoreline structures

### PROS

- Reduce erosion to all outboard shoreline structures
- Reduce erosion and maintenance costs of shoreline berms and levees

### CONS

- May require artificial replenishment / Long-term cost
- May require the installation of lateral containment structures
- Would require a lot of material / High initial cost
- Could require the implementation of multiple groins to hold beaches between channels
- Considered as fill under current regulations, which might present permitting challenges



# FINE AND COARSE GRAIN BEACHES

## Compiled Options

### 1: Beaches in front of Landfills



#### COMMENTS

- EBRPD: How deep is the gravel supposed to be? What will the size be? SCAPE: Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: What impacts will it have to nesting birds? How will it change the breeding habitat? SCAPE: Gravel beaches have the potential to be designed to provide nesting habitat. Additional feasibility studies to breeding habitat will have to be considered with any identified project. Additional studies are not part of the current scope of work.
- EBRPD: How will gravel impact the mudflats adjacent to the existing outboard levees? SCAPE: SFEI has advised that coarse or composite estuarine beaches are often characterized by a transition to mudflat in their lowest portion. A gravel beach has the potential to be designed to limit nearshore drift of material with minimal impacts to adjacent mudflats.
- EBRPD: It may only be practical in areas where it won't need to be replenished so you don't have to regularly go back and address erosion. SCAPE: The majority of sediment is transported parallel to the shoreline through longshore drift. The design of groin structures or headlands can limit or contain longshore drift and create suitable conditions for establishment. Further maintenance studies would be required based on the site conditions. Additional studies are not part of the current scope of work.

### 2: Beaches in front of Existing Marshes



#### COMMENTS

- EBRPD: What happens to the land that is immediately adjacent? Will it flood or erode on the sides? SCAPE: A gravel beach does not provide flood protection, however it may reduce erosion.
- EBRPD: Do you expect scouring to occur at the inlets to Oro Loma and Cogswell Marsh? SCAPE: The presented options are high-level strategies that will require further feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: Where will all the sand end up? SCAPE: We are considering coarse grain estuarine beaches that would be placed in front of the existing levees and contained by groin or headland structures. The sand and shell that comprises the beach face may be intermittently lost to longshore drift but also naturally redeposited by the tides and waves.
- EBRPD: Could you have sand and gravel coexisting? SCAPE: The final material would likely be a mixture of different grain sizes depending on the design criteria and intended performance. Coarse or composite estuarine beaches characterize the historic condition. A predominately coarse beach is highly permeable and needs less space compared to a composite or fine beach that can form a steep profile in response to storm events.
- EBRPD: Would sediment drift into the adjacent marshes? SCAPE: A gravel beach mainly moves longshore, parallel to the shore in the direction of the prevailing wind. Migration inland will happen, but the beach could be placed in front of an existing levee or berm that would prevent drift into the marsh. Additional study based on site conditions and design would be required and additional studies are not part of the current scope of work.

### 3: Beaches along Entire Shoreline



#### COMMENTS

- EBRPD: How will this impact other areas to the north and south that are not protected? SCAPE: These beaches only target shoreline segments within the study and would be contained with headland or groin structures that would minimize impacts to the north and south and prevent longshore drift.
- EBRPD: Have there been more impacts due to widening of San Mateo bridge? SCAPE: Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: What is the benefit to marshes or landfill protection? SCAPE: Gravel beaches may help reduce erosion to outboard berms that shelter inland marshes or landfills.

## GENERAL COMMENTS

- EBRPD: It may not be a good option where it will need to be replaced regularly. How often will the gravel need to be maintained and replenished? SCAPE: Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: What will be the environmental disturbance of replenishing the gravel? SCAPE: Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: Is the assumption that overtime the gravel will erode or accrete sediment? SCAPE: Over time, the erosion of sediment may occur and some replenishment may happen naturally, but this is all dependent on specific site conditions. Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD is not sure if we want to be the pilot project of this method. SCAPE: The SCC has already begun a 300' gravel beach pilot project at Eden Landing in front of an existing levee. This pilot may be valuable to apply lessons learned. If other criteria are desired to be tested, we will work to identify another partner.
- COH: DG: These look like great options for the Park Districts (EBRPD & HARD) to consider for their assets. Hayward's Public Works Utilities may need to provide comment regarding these options. SCAPE will present these options to Public Works in our upcoming stakeholder meeting.

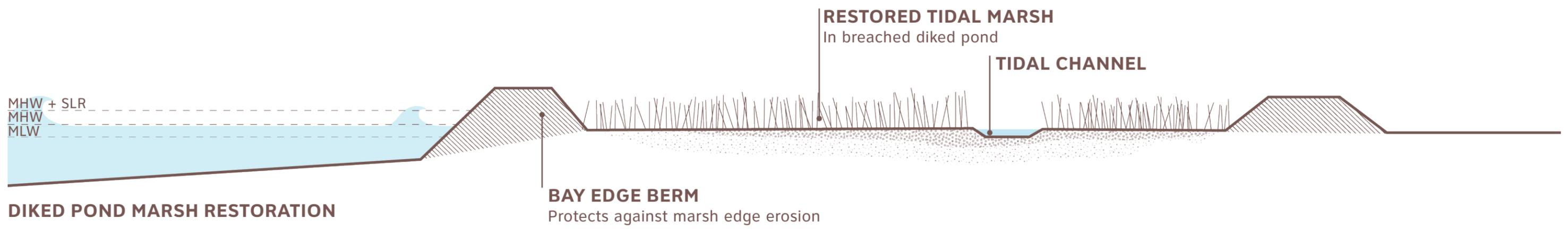
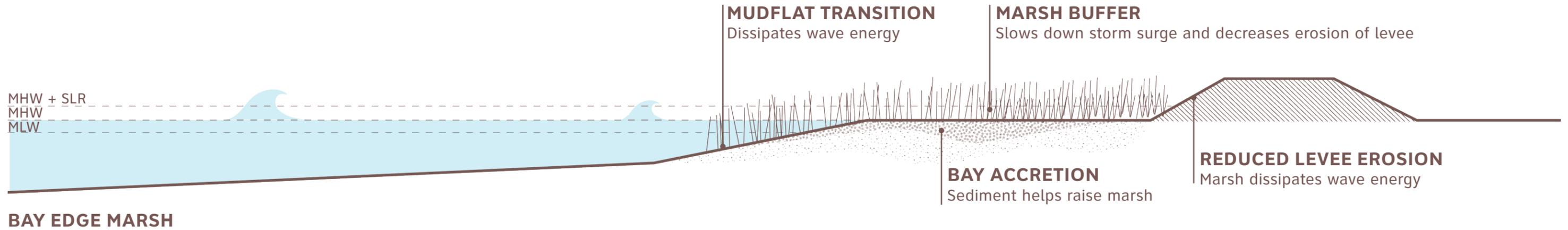
# TIDAL MARSH RESTORATION

## Definition

In the face of climate change, protecting, maintaining, and restoring tidal marshes and their associated mudflats is critical to **maintain flood control and ecosystem services**. Techniques include restoring diked baylands, planting native species to accelerate colonization, placing sediment to raise subsided areas, and creating high tide refugia within marshes. Existing marshes have the **capacity to vertically accrete along with sea level rise if they have sufficient sediment supply**. In low sediment scenarios, they may convert to mudflats or subtidal ecosystems.

## GOAL / OBJECTIVE

- Ecological enhancement (provides critical habitat)
- Reduce risk along the shoreline and attenuate waves



# TIDAL MARSH RESTORATION

## Precedents

### Bair Island Wetland Restoration Redwood City, CA

**Size:** 1,400 acres of tidal marsh restoration

**Cost:** \$10 million

**Implementation Timeline:** 2006-2015

**Applicability:** Utilizing upland fill to lift subsided ponds is applicable before breaching and restoring to tidal marsh.

**Description:** The breaching of perimeter levees of this formerly diked complex allowed for the restoration of tidal marshes to improve water quality, expand and enhance wildlife habitat, and reduce mosquito breeding conditions by restoring tidal flow.

- Formerly diked and drained for agriculture
- Restored 1,552 acres of tidal wetland
- Pedestrian bridge and trail access
- Subsided ponds were raised with dredge material and upland fill over 8 years with over 1.5 million CY of fill
- Perimeter levee was breached in the restoration



Aerial View of Restoration



Levee Breach

# TIDAL MARSH RESTORATION

## Option 1: Hayward Marsh Restoration

### GOAL / OBJECTIVE

Restore Hayward Marsh to a tidal marsh that can accrete sediment, adapt with SLR, and create habitat.

### DESCRIPTION

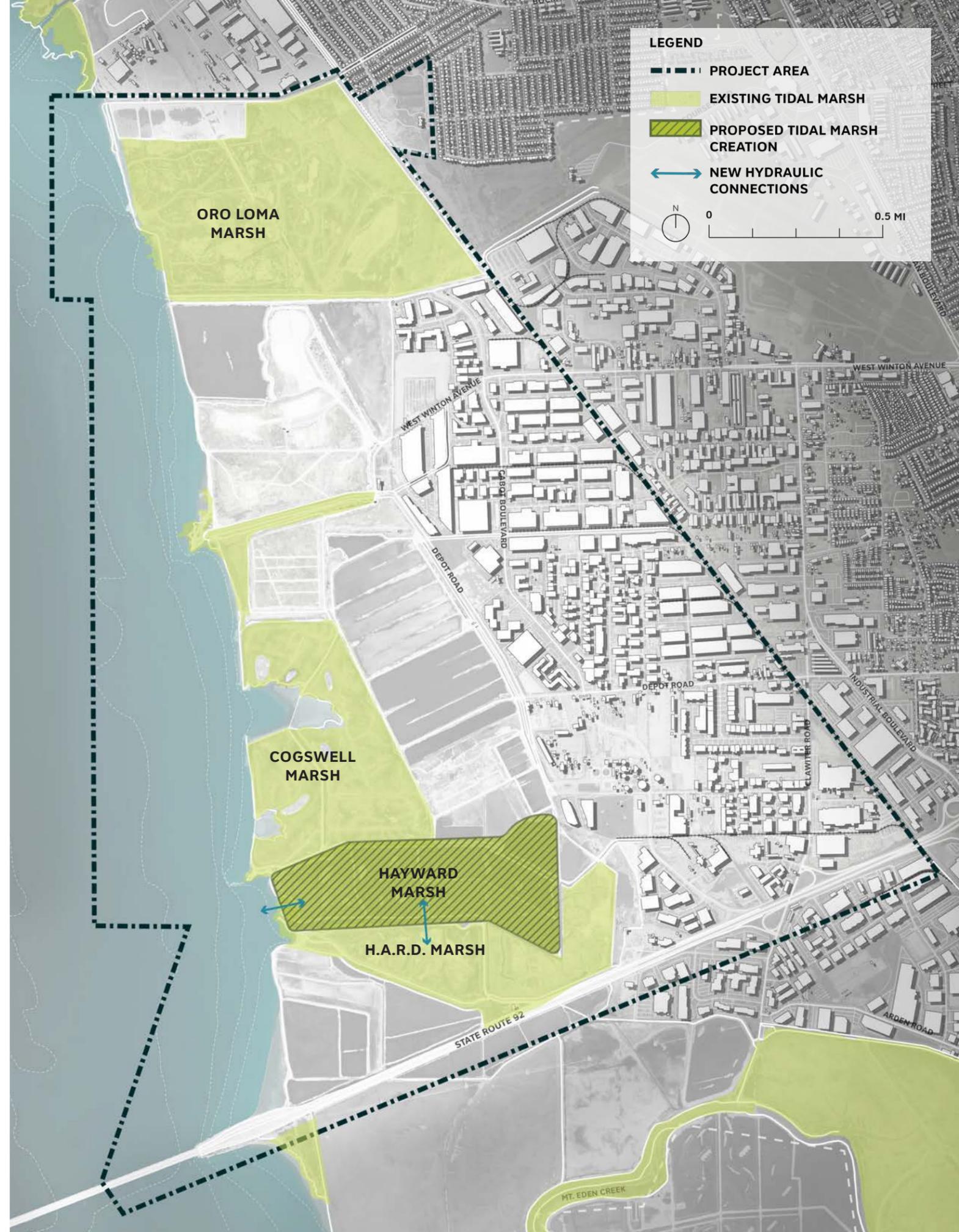
- Restore Hayward Marsh to a tidal marsh

### PROS

- Hayward Marsh restoration is already being planned

### CONS

- If Hayward Marsh is restored as a muted marsh, it will need improved levees for water control and may not accrete as much sediment as a fully tidal system
- Once you restore a diked Bayland to a tidal marsh, you can't use the area again for stormwater storage because it becomes regulated and protected



# TIDAL MARSH RESTORATION

## Option 2: Restore Bay-Side Ponds to Tidal Marsh

### GOAL / OBJECTIVE

Restore diked ponds along the shoreline to tidal marshes that can accrete sediment, adapt with SLR, and create habitat.

### DESCRIPTION

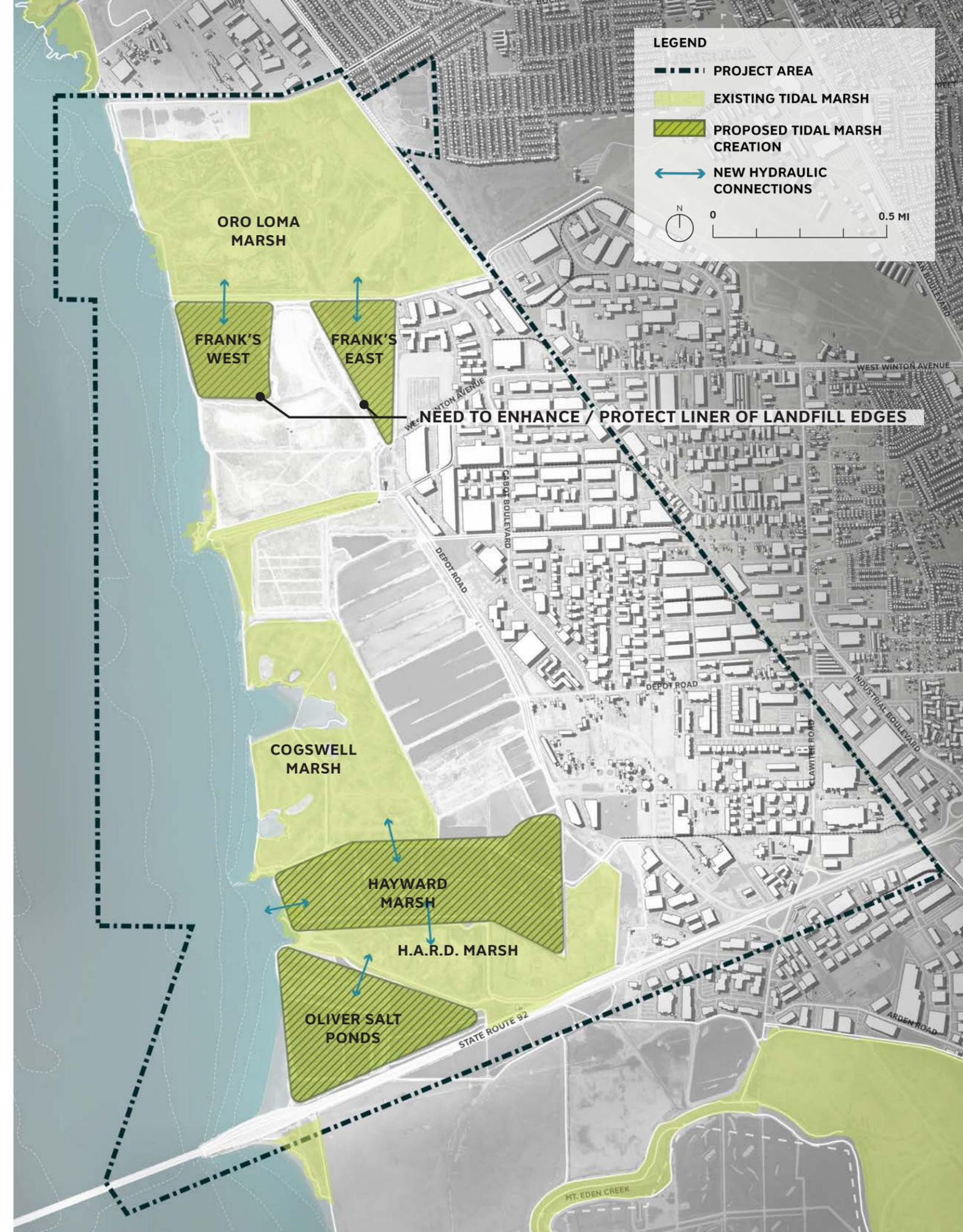
- Restore Frank's West, Frank's East, Hayward Marsh, and Oliver Salt Ponds to tidal marshes

### PROS

- Marshes at Bay edge may be able to accrete more sediment (from Bay and fluvial sources)
- If paired with fine sediment augmentation, it will the marshes keep pace with SLR
- Frank's East and West could help buffer the landfill against erosion

### CONS

- Lose existing salt pond shorebird habitat- impacts to endangered species habitat
- Once you restore a diked Bayland to a tidal marsh, you can't use the area again for stormwater storage because it becomes regulated and protected
- Lose shorebird refuge at Frank's West during high tide.



# TIDAL MARSH RESTORATION

## Option 3: Restore all Diked Ponds and Golf Course

### GOAL / OBJECTIVE

Maximize tidal marsh restoration to buffer the shoreline and enhance its ecological value.

### DESCRIPTION

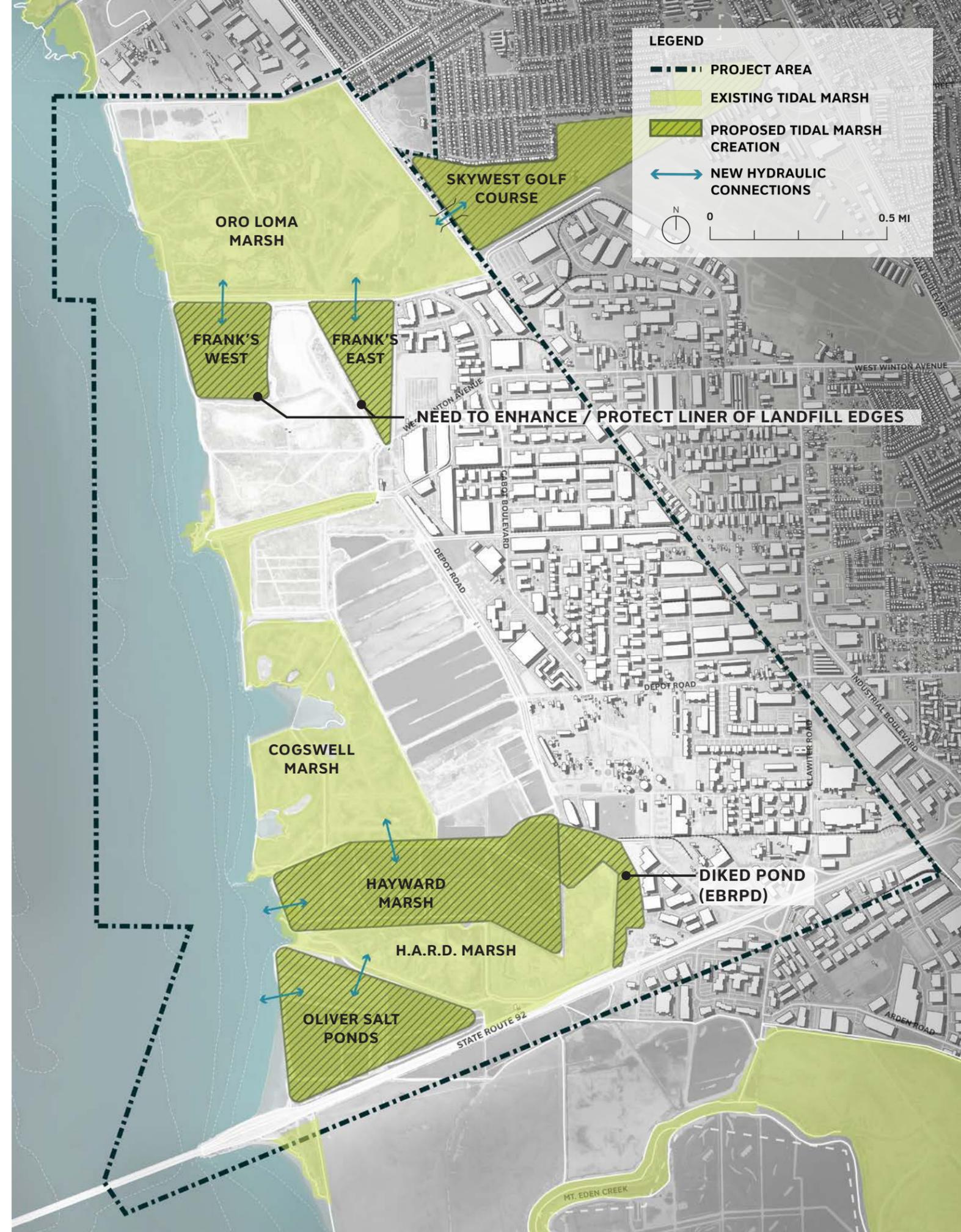
- Restore Skywest Golf Course, Frank's West, Frank's East, Hayward Marsh, and Oliver Salt Ponds to tidal marshes

### PROS

- Increased marsh may buffer the shoreline from storm surge and reduce erosion
- Increased habitat benefits
- Larger tracts of connected marshes

### CONS

- Loss of stormwater detention storage space
- Loss of existing shorebird habitat at Oliver Salt Ponds- impacts endangered species habitat
- Once you restore a diked Bayland to a tidal marsh, you can't use the area again for stormwater storage because it becomes regulated and protected



# TIDAL MARSH RESTORATION

## Compiled Options

### 1: Hayward Marsh Restoration



#### COMMENTS

- EBRPD: Will Hayward Marsh need a combination of tidal and muted/managed tidal marsh to be resilient and preserve shorebird nesting habitat? SCAPE: The resilience of Hayward Marsh is dependent on the goals of the restoration plan and management procedures. We will work with EBRPD to identify the habitat goals of Hayward Marsh and provide recommendations accordingly. Shorebird nesting habitat is located upland of the tidal marsh zone, which is not inundated with daily tides, and requires a unique design not addressed in this option.

### 2: Restore Bay-Side Ponds to Tidal Marsh



#### COMMENTS

- EBRPD: Park District is working to enhance habitat near/ in Oliver Salt Pond. If it is fully tidal, will the marsh protect the inboard areas from erosion? SCAPE: Marshes help buffer shorelines and dampen wave action to a certain extent. If full erosion protection is desired, it will likely require a suite of strategies to create a layered risk-reduction shoreline.
- EBRPD: Where along the area should we expect a fully tidal area and keep it? SCAPE: What area are you referring to?
- EBRPD: Frank's West offers shorebird refuge during high tide SCAPE will add this point to the Cons section.
- EBRPD: How would you bring sediment in? SCAPE: In this option, sediment would flow into the restored marshes through select breaches from the adjacent channels, drawn in blue arrows.

### 3: Restore all Diked Ponds and Golf Course



#### COMMENTS

- EBRPD: Muted/managed tide? SCAPE: In this option, all of the marshes would be restored fully tidal, besides Skywest Golf Course, which is be muted tidal.
- EBRPD: The Pro section says "may," will it actually buffer the shoreline from storm surge and reduce erosion? SCAPE: Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: How does the relate to the Bay Habitat Goals in SFEI Adaptation Report? SCAPE: Tidal marsh restoration was identified at Frank's West, the Oxidation Ponds, and Oliver Salt Ponds in the SFEI Adaptation Atlas. However, their maps were based on conceptual maps and suitability analysis and further study, planning, and engineering would be required to identify fully suitable sites. Additional studies are not part of the current scope of work.

## GENERAL COMMENTS

- Should review SF Bay Habitat Goals and see what is proposed or designated have for this area. SCAPE: The SF Bay Habitat Goals note that landward migration of marsh is constrained, diverse habitat pockets could be linked together to create a subregional habitat corridor, low elevation marsh and wetland could be restored, creating wetlands bay-ward of the flood-protection levees, using wastewater to enhance habitat on the slope, could provide space for landward migration, and that 'warping up' diked ponds could be undertaken to allow accretion of the ponds to avoid deep tidal ponds.
- COH: DG: Options 1 and 2 will need input from park district staffs. Option 3, which is to use the Skywest golf course as a tidal marsh, ultimately would need City of Hayward Public Works Utilities staff's, City Manager, and City Council review of this proposed option. SCAPE will solicit feedback from these parties.

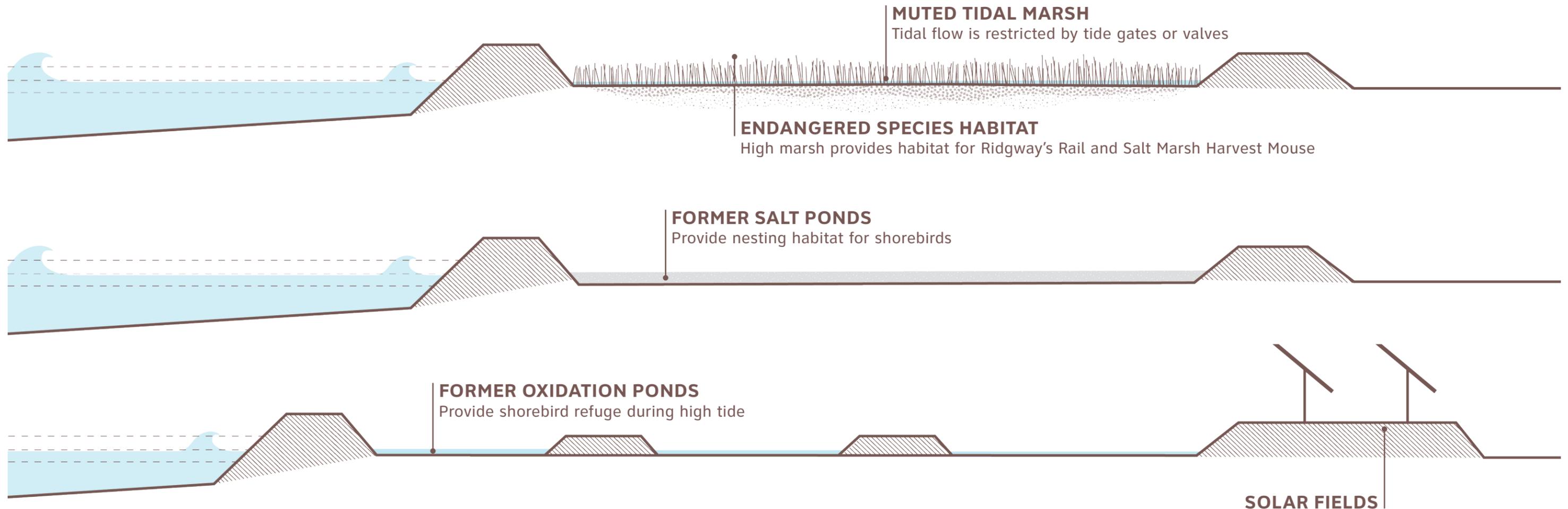
# DIKED POND MANAGEMENT

## Definition

Diked baylands are managed as flood retention basins or can be used for habitat purposes. They are also used to locate transmission lines, rail lines, wastewater lines, and other infrastructure. The low-lying diked baylands **often accumulate runoff that needs to be drained and pumped to the bay**. Diked ponds can be **used or expanded to increase stormwater water storage** from precipitation or flood events. They can also be used to store groundwater pumped from urban areas. Salt ponds **provide critical habitat** to endangered species, particularly shorebirds.

## GOAL / OBJECTIVE

- Flood control (provide stormwater storage space)
- Ecological enhancement (provide shorebird habitat)



# DIKED POND MANAGEMENT

## Precedents

### Shorebird Marsh Corte Madera, CA

**Size:** 11 acres

**Cost:** \$332 million

**Implementation Timeline:** 1983-1974

**Applicability:** Utilizing diked ponds for shorebird and stormwater detention can provide multiple benefits for flood control and ecological services.

**Description:** Former tidal marsh that was diked and filled with construction refuse. Efforts between 1983-1974 restored tidal flow and designed the marsh with the dual purpose of providing shorebird habitat while serving as a stormwater detention basin.

- Delivered by a series of channels and lagoons, treated stormwater from the Town of Corte Madera collects in the low-lying marsh area
- Flows between Shorebird Marsh and the San Francisco Bay are managed by the Town's pump station
- Water levels are adjusted to increase storage capacity for winter storms and for seasonal enrichment of bird habitat
- The water flow management regime reduces erosion and sedimentation from the connecting channel
- Ring levee surrounds and protects critical habitat within the marsh



Aerial view of Shorebird Marsh



Restored marsh provides habitat

# DIKED POND MANAGEMENT

## Precedents

### Noordwaard Polder Project Noordwaard Polder, The Netherlands

**Size:** 4,450 hectares

**Cost:** \$332 million

**Implementation Timeline:** 2012-2015

**Applicability:** Lowering or breaching select dikes can open up marshes and/or salt ponds to tidal flows, mitigating the effects of SLR.

**Description:** Elimination of the a 14 mile levee along the Noordwaard polder allows high tides to flow in a number of creeks within the polder. Lowering dikes creates inlets and outlets for water and allows the Nieuwe Merwede river to overflow in flood conditions, reducing water levels by up to 2' as far as 5 miles downstream.

- 43 miles of new dikes and quays were constructed to control flood waters within the polder
- Over 141 million cubic feet of earth was moved, 33 new bridges constructed, and 31 pumping stations added in addition to various hydrological infrastructure
- Existing infrastructure is kept intact as much as possible. Roads in the high-water polders are suitable for cars, agricultural vehicles and cyclists. Roads in the low-water polders are primarily intended for agricultural vehicles and bicycles. During periods of extreme high water, high quays form evacuation routes.



River has room to flood during periods of high water



Dike relocation opens up tidal flow

# DIKED POND MANAGEMENT

## Option 1: No Action

### GOAL / OBJECTIVE

Maintain all diked pond uses with sea level rise, storm surge, and groundwater emergence.

### DESCRIPTION

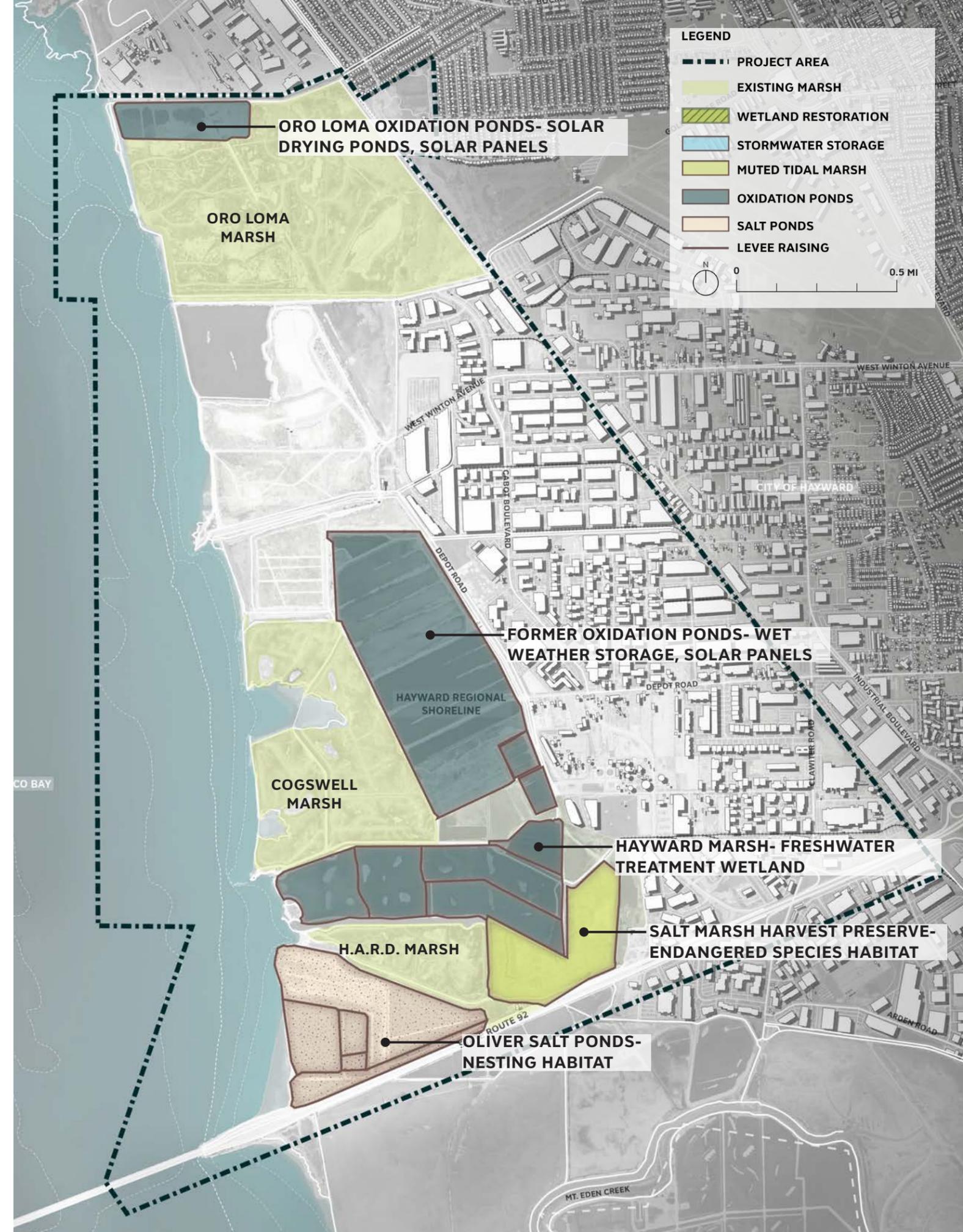
- Raise levees and provide erosion protection to maintain all diked pond uses as they exist today

### PROS

- Maintain current uses and stormwater storage capacity

### CONS

- Long-term and costly strategy to maintain uses with sea level rise- will require more pumping and raising / repair of berms and levees
- This is not a viable option for EBRPD



# DIKED POND MANAGEMENT

## Option 2: Tidal Restoration + Stormwater Management

### GOAL / OBJECTIVE

Restore ecological services at the Bay's edge and manage stormwater inland.

### DESCRIPTION

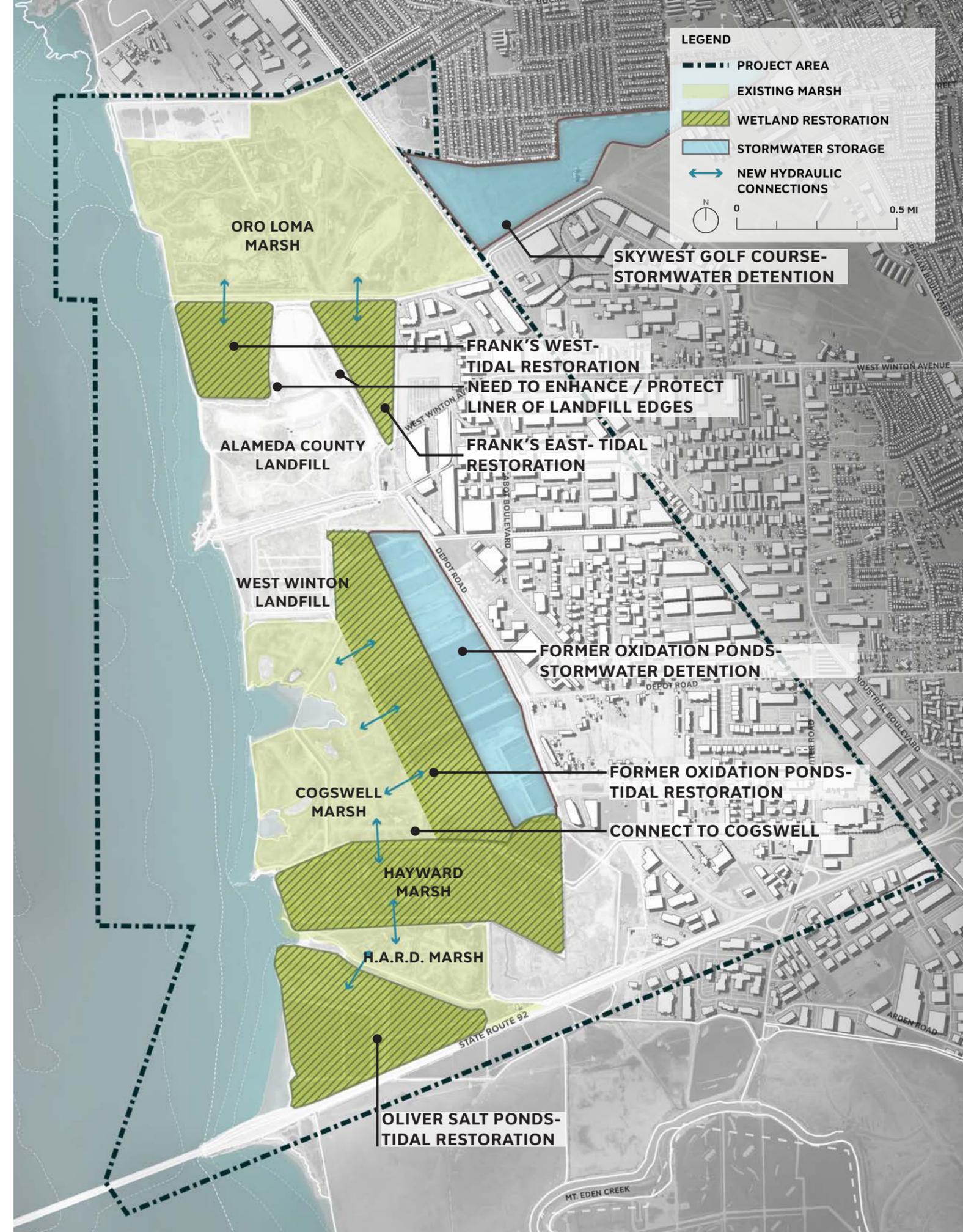
- Restore Frank's East and West, half of the Oxidation Ponds, Hayward Marsh, and Oliver Salt Ponds to tidal marshes
- Utilize Skywest Golf Course and half of the Oxidation Ponds for wet weather storage

### PROS

- Increase stormwater detention capacity
- Large areas of new marsh restoration
- New marshes at bay edge that may accrete and sustain with SLR

### CONS

- Disrupts shorebird habitat at Oliver Salt Ponds
- Loss of the oxidation ponds and the critical uses they provide, including wastewater wet weather storage, biosolids management/drying, and solar fields
- Will require more pumping as sea levels rise



# DIKED POND MANAGEMENT

## Option 3: Restore Salt Ponds Inland, Double as Stormwater Detention

### GOAL / OBJECTIVE

Maintain and restore habitat and ecological services, while managing stormwater inland.

### DESCRIPTION

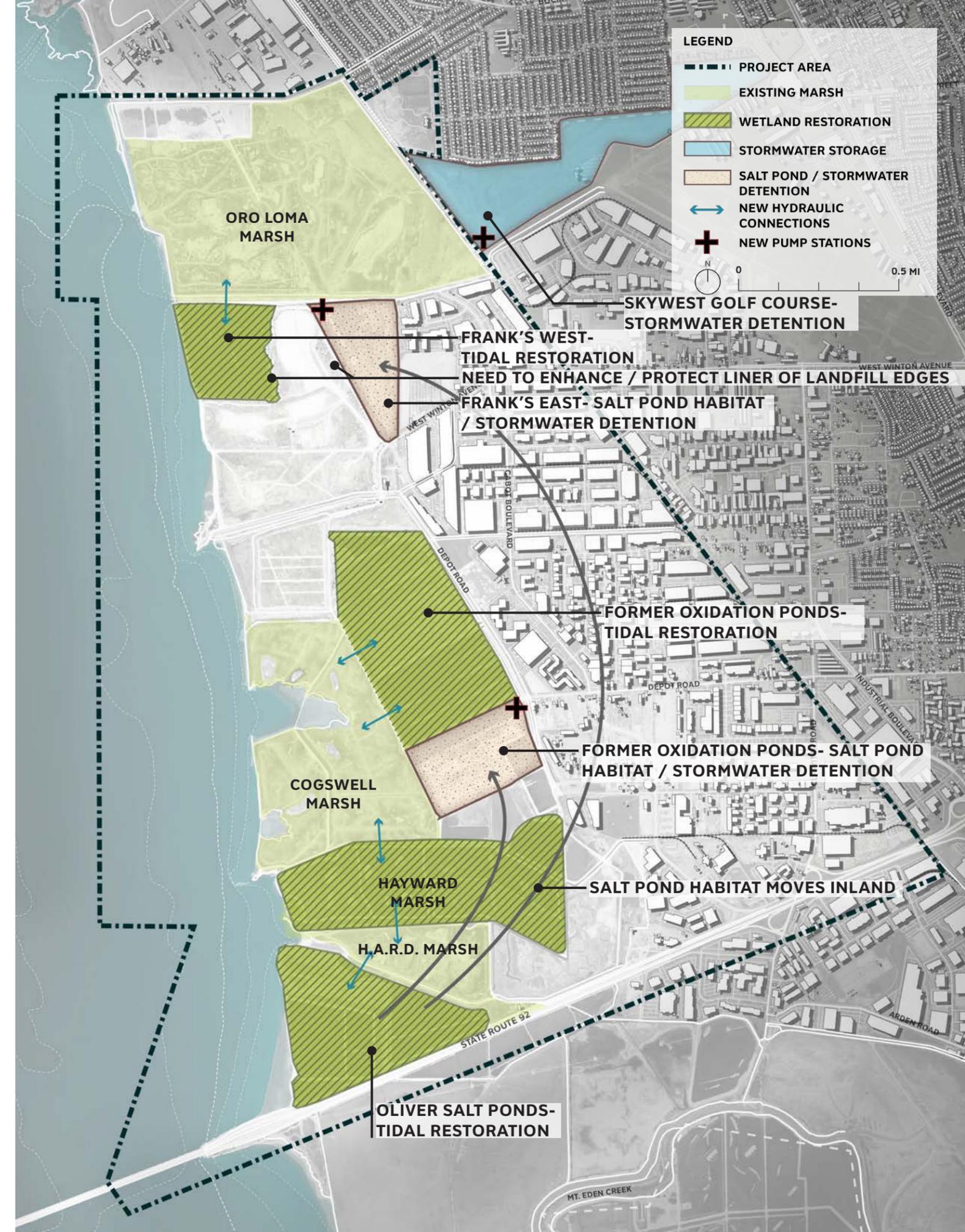
- Restore Frank's West, 2/3 of the Oxidation Ponds, Hayward Marsh, and Oliver Salt Ponds to tidal marshes
- Move salt pond habitat inland to Frank's East and part of the Oxidation Ponds. Salt ponds can be utilized for stormwater detention during storm events.
- Use Skywest Golf Course for wet weather storage

### PROS

- Maintain salt pond habitat, while moving it inland so it's less vulnerable to SLR

### CONS

- Loss of the oxidation ponds and the critical uses they provide, including wastewater wet weather storage, biosolids management/drying, and solar fields
- Area show as salt ponds at the oxidation ponds is not pond land and has been raised approximately 10' above grade



# DIKED POND MANAGEMENT

## Compiled Options

### 1: No Action



#### COMMENTS

- EBRPD: This is not an option for EBRPD. SCAPE will not consider this option moving forward.
- COH: EP: Former Oxidation Pond is still actively being used as part of the Wastewater process. Also the areas shaded don't accurately depict the actual oxidation ponds. For better clarity, we might want to redefine the Former Oxidation Pond, Wet Weather Storage, and Solar Panels as Wastewater Wet Weather Storage, and Solar Panels. Please also note that the area that is now the Solar Fields are not ponds and the area has been raised to approximately 10 feet above grade. SCAPE will not consider this option moving forward.
- COH: EP: Hayward Marsh color coded as part of Oxidation ponds. SCAPE will not consider this option moving forward.

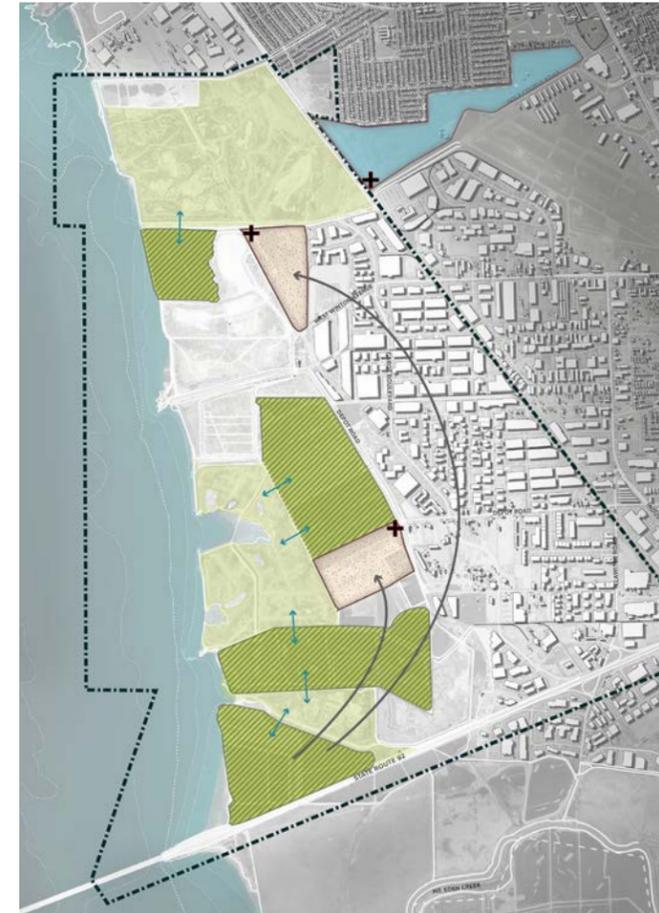
### 2: Tidal Restoration + Stormwater Management



#### COMMENTS

- COH: DG: All options involving either the Skywest golf course or City of Hayward oxidation ponds will need review by the Public Works Utilities staff and/or the City Manager's Office if all options below are seriously considered by HASPA. SCAPE will review these options with Public Works.
- EBRPD: Simplify the graphic and need more clarity SCAPE will edit the diagram to enhance clarity.
- EBRPD: Will Oliver Salt Ponds be fully opened to tidal action? Is it already? SCAPE: Oliver Salt Ponds is not currently open to tidal action. In this option it would be breached from the channel. SCAPE will add breach locations to the diagram.
- COH: EP: Options 2 is not viable and should be removed. If we must keep them, then the Cons should not say "loss of the oxidation ponds". It should somehow refer to the loss of wet weather storage, which is critical WPCF overall process and function. SCAPE will add "loss of the oxidation ponds" to the Cons and list the critical uses they provide.

### 3: Restore Salt Ponds Inland, Double as Stormwater Detention



#### COMMENTS

- EBRPD: Need to add management elements to detention ponds SCAPE will add pump stations to the diagram.
- EBRPD: Are retention ponds required? SCAPE: Additional feasibility and engineering studies will be needed to address this question. With climate change, increased precipitation may require additional storage space for flood control. Additional studies are not part of the current scope of work.
- EBRPD: Where will the ponds discharge to? SCAPE: The ponds will discharge to adjacent flood control channels.
- COH: EP: 3 is not viable and should be removed. If we must keep them, then the Cons should not say "loss of the oxidation ponds". It should somehow refer to the loss of wet weather storage, which is critical WPCF overall process and function. SCAPE will add "loss of the oxidation ponds" to the Cons and list the critical uses they provide.
- COH: EP: Area pictured for Hayward WPCF as Salinas/Stormwater Retention is not pond land and has been raised approximately 10 feet above grade for Solar fields. SCAPE will add this to the Cons.

#### GENERAL COMMENTS

- COH: DG: All options involving either the Skywest golf course or City of Hayward oxidation ponds will need review by the Public Works Utilities staff and/or the City Manager's Office if all options below are seriously considered by HASPA. SCAPE will review these options with Public Works.

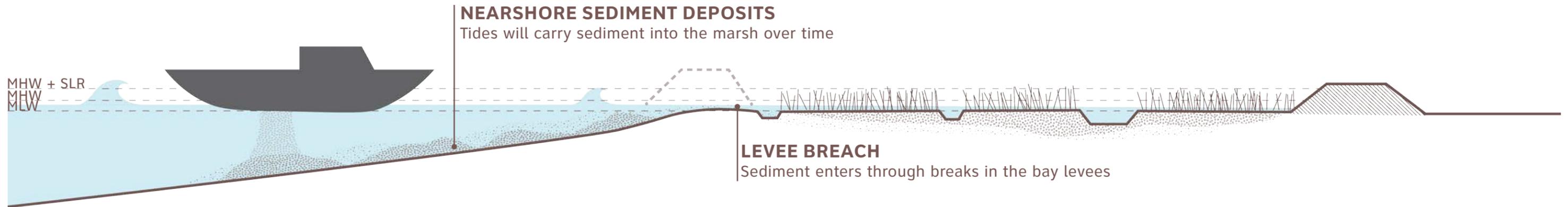
# FINE SEDIMENT AUGMENTATION

## Definition

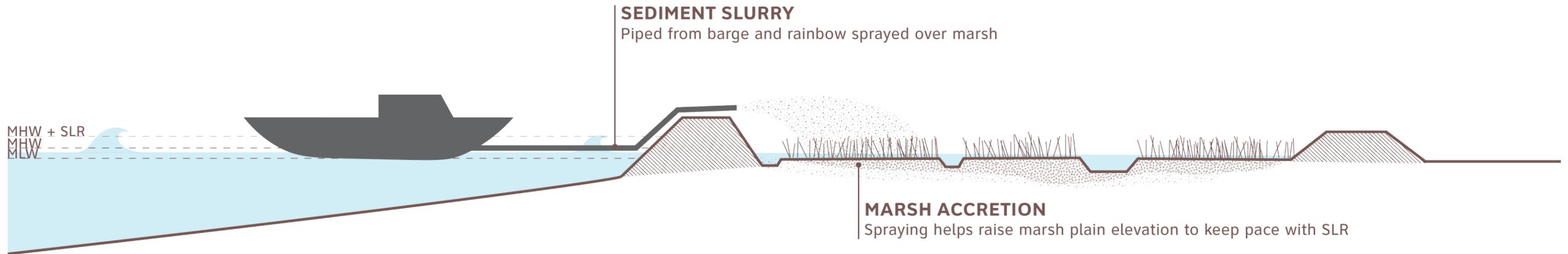
The direct or indirect placement of fine sediments to **increase mudflat and marsh elevation** relative to the tides. This can help **protect and sustain marshes**, mudflats, and shorelines when sediment supply is low to **help them accrete and keep pace with sea level rise**. Techniques include water column seeding, nearshore placement, and thin layer placement.

## GOAL / OBJECTIVE

- Maximize the potential of marshes to maintain themselves in the future with sea level rise



SHALLOW WATER PLACEMENT



MARSH SPRAYING

# FINE SEDIMENT AUGMENTATION

## Precedents

### Salt Marsh Sediment Augmentation Project Seal Beach, CA

**Size:** 8 acres

**Cost:** \$3.3 million

**Implementation Timeline:** Completed 2016

**Applicability:** This technique may be used on existing marshes to help them keep pace with SLR. Establishment of vegetation after spraying has proved sparse.

**Description:** Subsidence, limited sediment accretion, and sea level rise led to the complete inundation of the refuge's Pacific cordgrass and eliminates natural nesting areas for the rail during high tide

- 10" layer of sediment applied through rainbow spraying from sediment slurry delivered via a floating or submerged pipeline directly from a dredge or barge
- Thin-layer placement of sediment on 8 acres of existing low salt marsh habitat
- One of the goals was to improve habitat for the rail



Sediment being sprayed on marsh



Marsh after spraying

# FINE SEDIMENT AUGMENTATION

## Option 1: Feed from the Bay

### GOAL / OBJECTIVE

Enhance Bay ecology and adapt with SLR through natural processes.

### DESCRIPTION

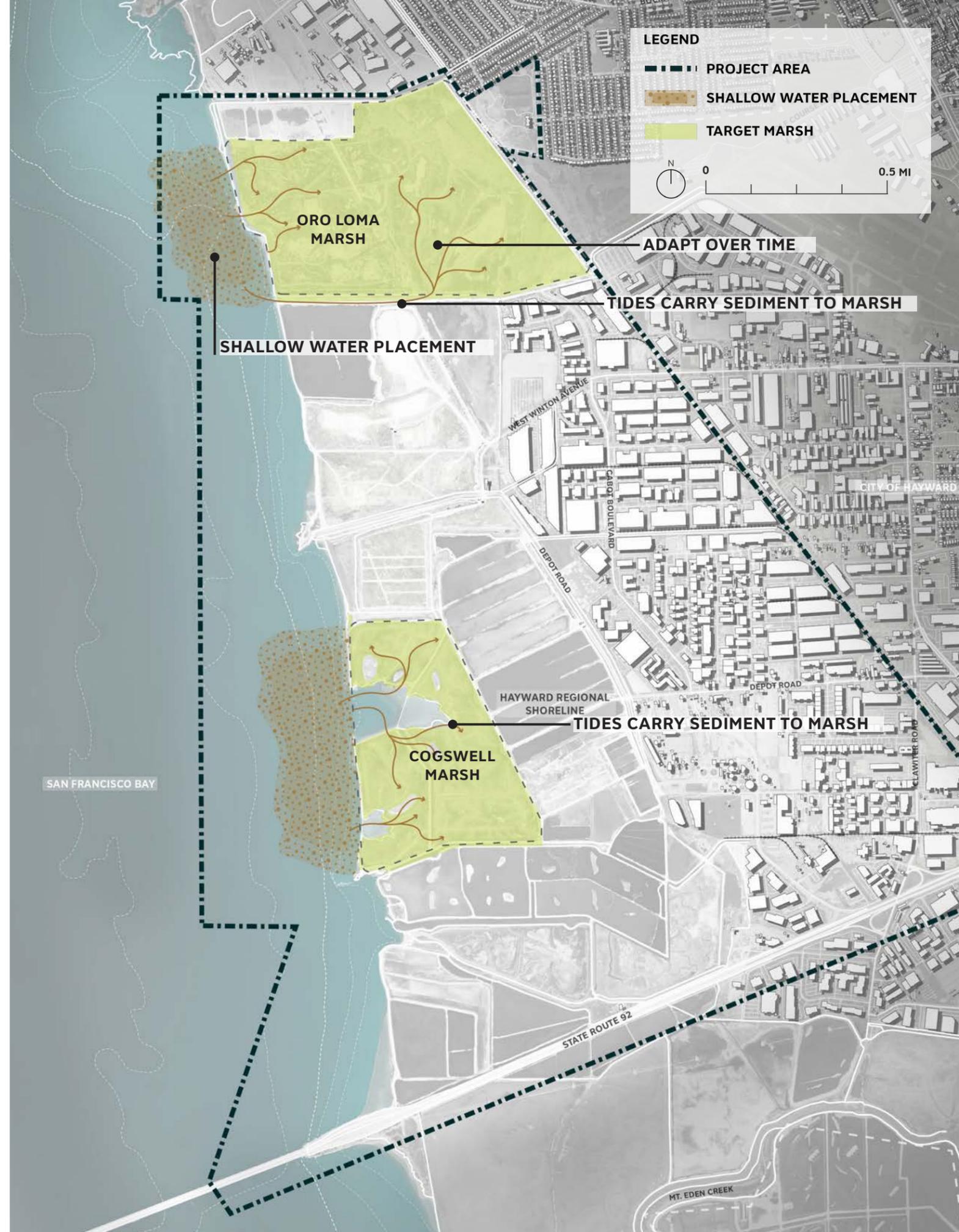
- Shallow water sediment placement on the mudflats in front of Oro Loma and Cogswell Marsh

### PROS

- Allow natural processes to facilitate accretion
- Prioritize large marsh adaptation to keep pace with SLR

### CONS

- Might be considered as fill. Filling the Bay is a regulatory challenge.
- Hard to get material to the mudflat because it is shallow
- Many unknowns about sediment transport and retention. Highly dependent on local hydrology
- Potential negative impacts to existing habitat



# FINE SEDIMENT AUGMENTATION

## Option 2: Nourish from an Upland Pipeline

### GOAL / OBJECTIVE

Enhance Bay ecology and adapt to SLR.

### DESCRIPTION

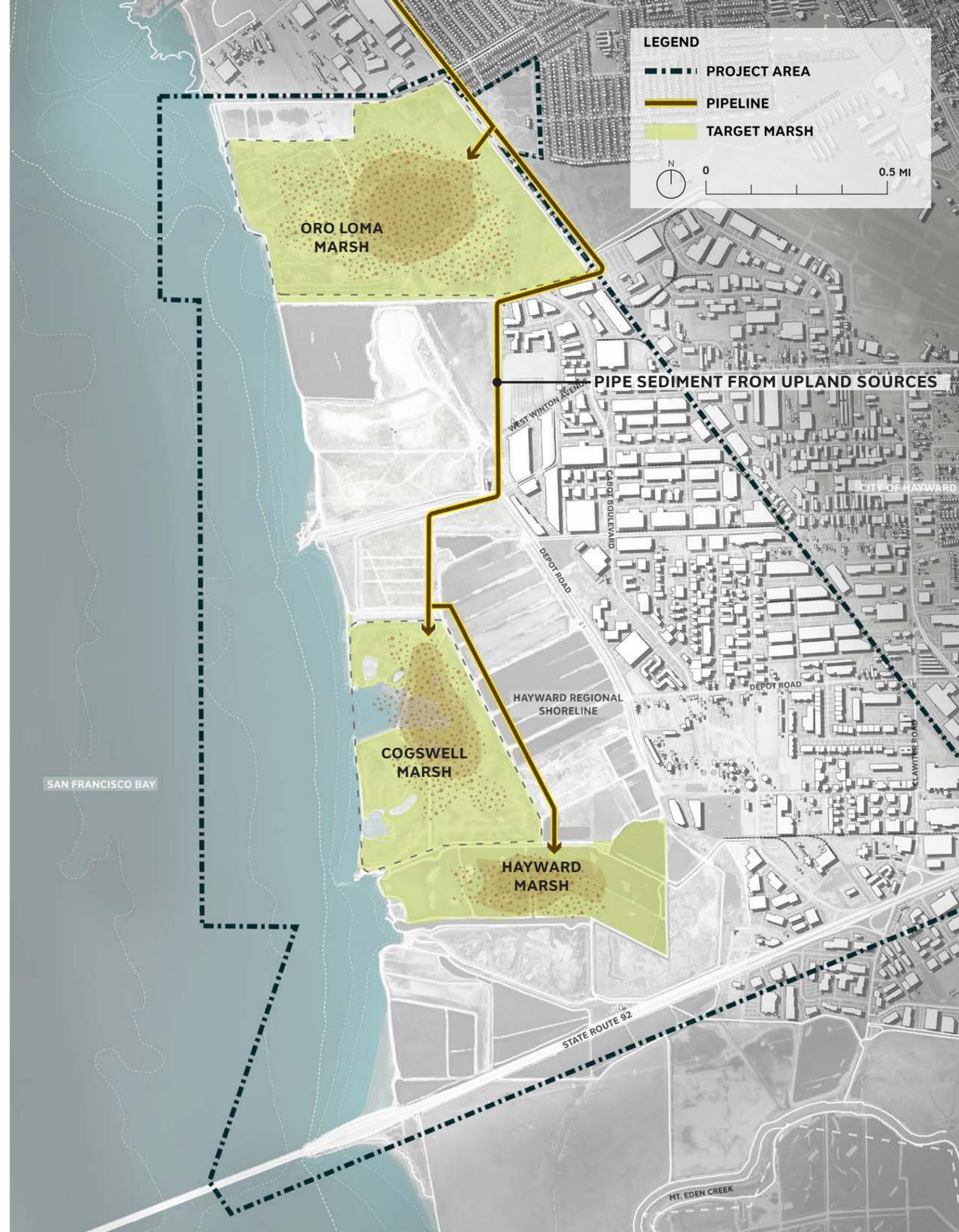
- Pipe sediment for deposition in existing marshes from Don Castro reservoir or other upland sources
- Deposit sediment at Oro Loma Marsh, Cogswell Marsh, and Hayward Marsh

### PROS

- Pipe infrastructure could be used for sediment delivery over time
- Utilize upland sediment sources

### CONS

- Might be considered as fill. Filling the Bay is a regulatory challenge.
- Pipeline infrastructure could be costly
- Many unknowns about sediment transport and retention
- Potential negative impacts to existing habitat



# FINE SEDIMENT AUGMENTATION

## Option 3: Prep Sites for Future Inundation

### GOAL / OBJECTIVE

Prepare sites for future tidal marsh restoration.

### DESCRIPTION

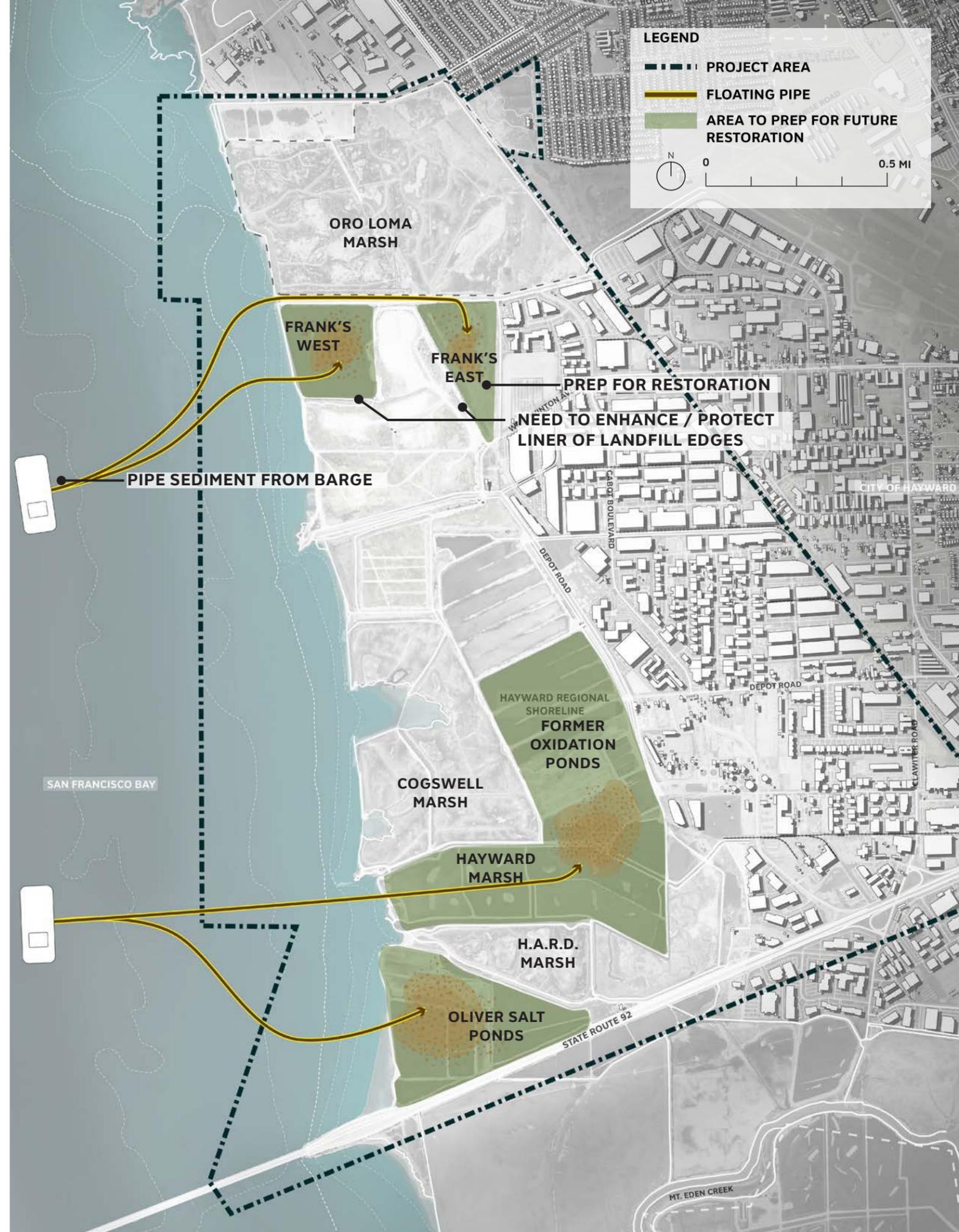
- Deposit sediment via floating pipes from a barge onto Frank's West, Frank's East, Hayward Marsh, part of the Oxidation Ponds, and Oliver Salt Ponds to lift them to marsh plain elevation

### PROS

- Proactive approach to prep diked baylands for marsh restoration

### CONS

- Potential negative impacts to existing habitat
- Power for pumping the sediment is very expensive
- An offloader and booster pumps will likely be required, which are very expensive



# FINE SEDIMENT AUGMENTATION

## Compiled Options

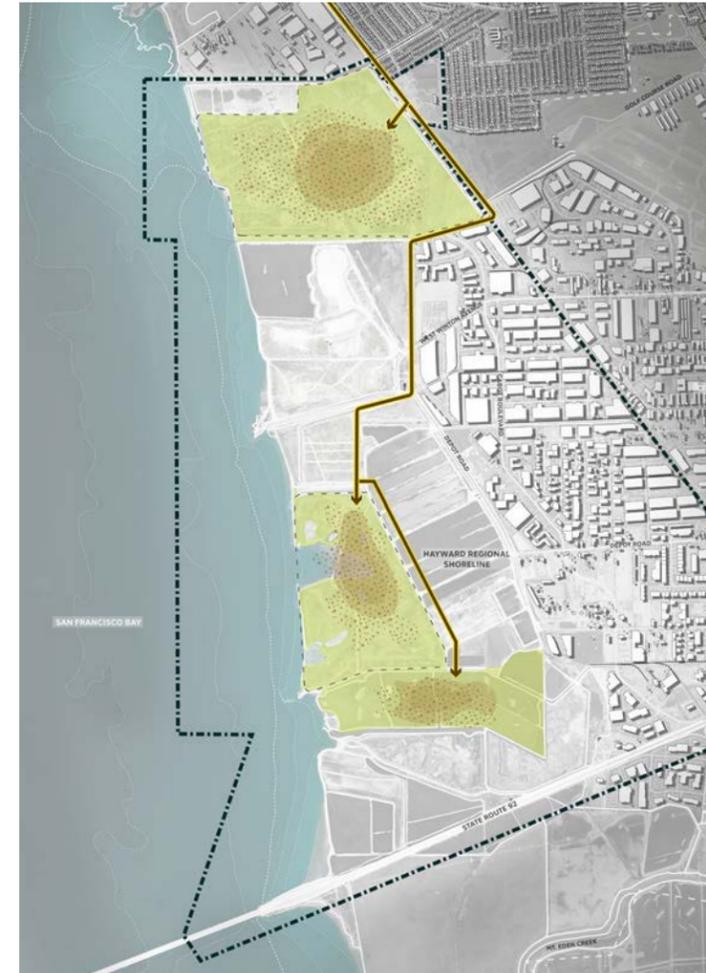
### 1: Feed from the Bay



#### COMMENTS

- See General Comments

### 2: Nourish from an Upland Pipeline



#### COMMENTS

- See General Comments

### 3: Prep Sites for Future Inundation



#### COMMENTS

- See General Comments

## GENERAL COMMENTS

- EBRPD: Have you thought about material quality? What criteria should be used to screen sediment before placement? SCAPE: Material quality should be compliant with existing state and local regulations. Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.
- EBRPD: Do you have examples of how this has been utilized? How often would sediment need to be added to create meaningful elevation changes? SCAPE: There is a precedent for marsh spraying in this document. We do not have any precedents for shallow water placement. The USACE is advancing a pilot project for these techniques, but it is still in the planning stages. Additional feasibility and engineering studies will be needed to address how often sediment would need to be added. Additional studies are not part of the current scope of work.
- COH: DG: Great idea. Key input from our park district partners is needed here. Option 3 might need input from Hayward's Public Works Utilities staff. SCAPE will review these options with the Park District and Public Works.

# TRIBUTARY CONNECTION TO BAYLANDS

## Definition

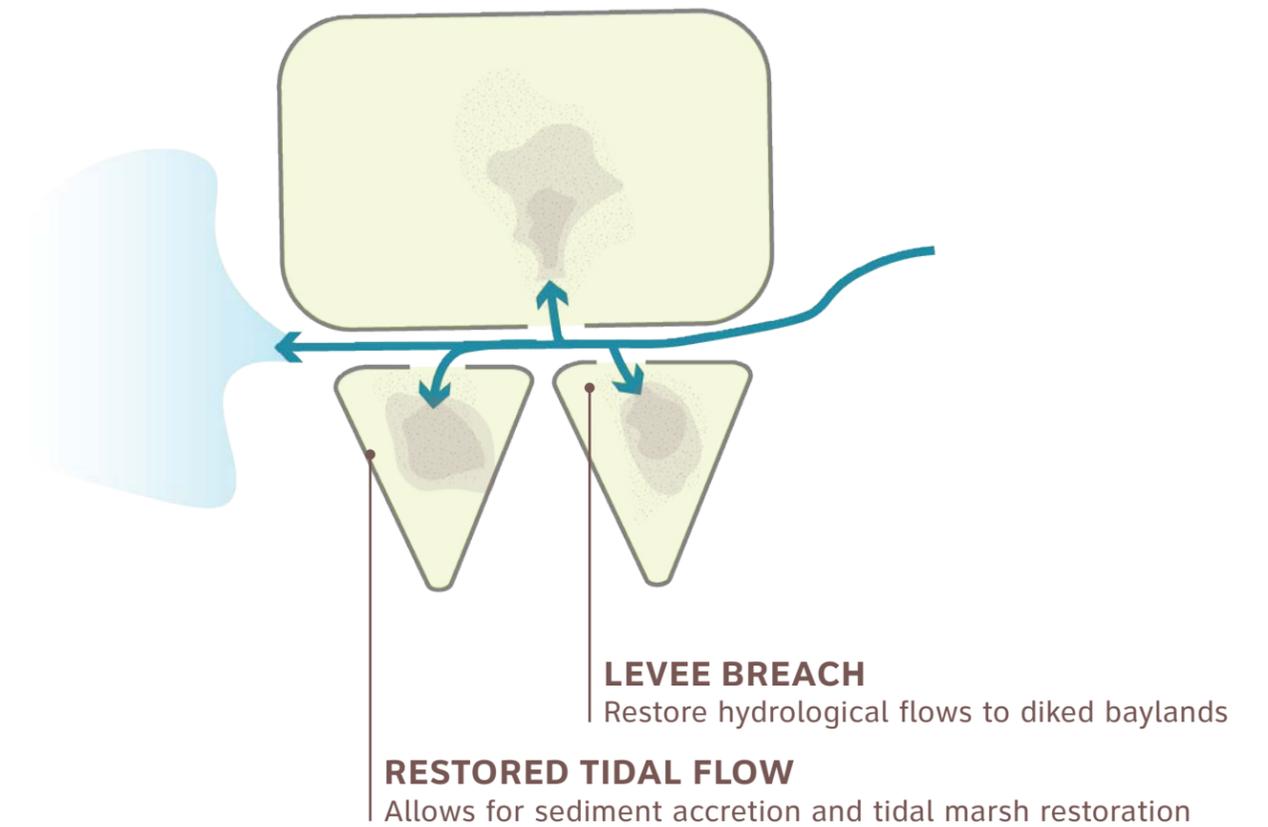
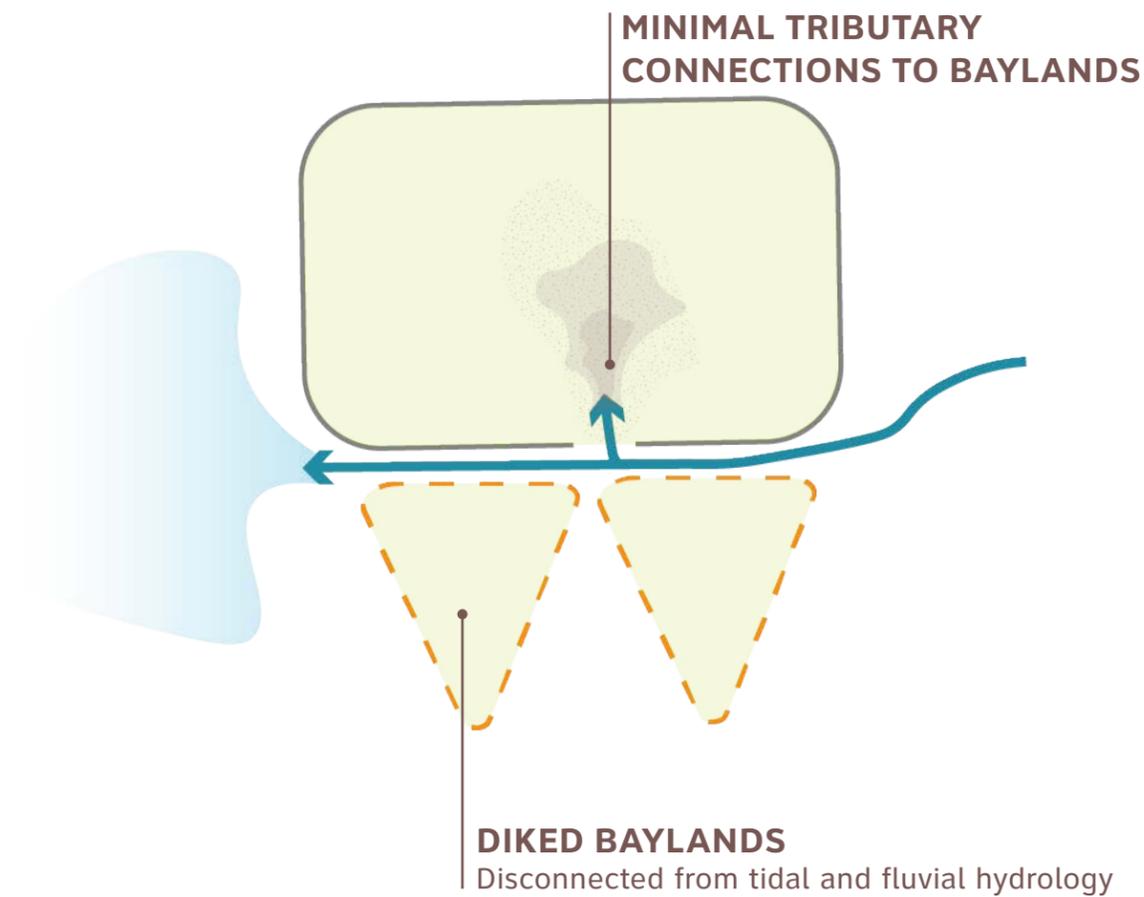
Reconnecting creeks to their adjacent baylands through **levee breaching or removal** helps **improve sediment supply, nutrient, and freshwater delivery** to the Baylands while achieving **flood risk management** and **habitat benefits**.

## GOAL / OBJECTIVE

- Ecological enhancement (restore sediment and tidal flows for marsh restoration / health)

BEFORE

AFTER



# TRIBUTARY CONNECTION TO BAYLANDS

## Precedents

### Lower Walnut Creek Restoration Project Contra Costa County, CA

**Size:** 224 acres

**Cost:** \$10.3 million

**Implementation Timeline:** 2017-2021

**Applicability:** Breaching existing flood control levees will restore tidal inundation to existing non-tidal wetlands. Restored tidal marshes develop complex vertical biotic structures that support diverse plant and wildlife communities, and support SLR resiliency.

**Description:** The project will restore and enhance wetlands and associated habitats while also providing sustainable flood management and increased resiliency to sea level rise. Restoration will allow increased opportunities for public access and recreation.

- In 2014 legislation removed the USACE from management of the lowest 4 miles of Walnut and Pacheco Creek
- Creeks are now locally controlled by the FCD, allowing restoration work
- On-site placement of material
- Improved biological connectivity- levee lowering and marsh plain excavation



Plan of restoration project



Walnut Creek and adjacent marsh

# TRIBUTARY CONNECTION TO BAYLANDS

## Option 1: Sulphur Creek

### GOAL / OBJECTIVE

Enhance marsh ecology and facilitate adaptation to SLR.

### DESCRIPTION

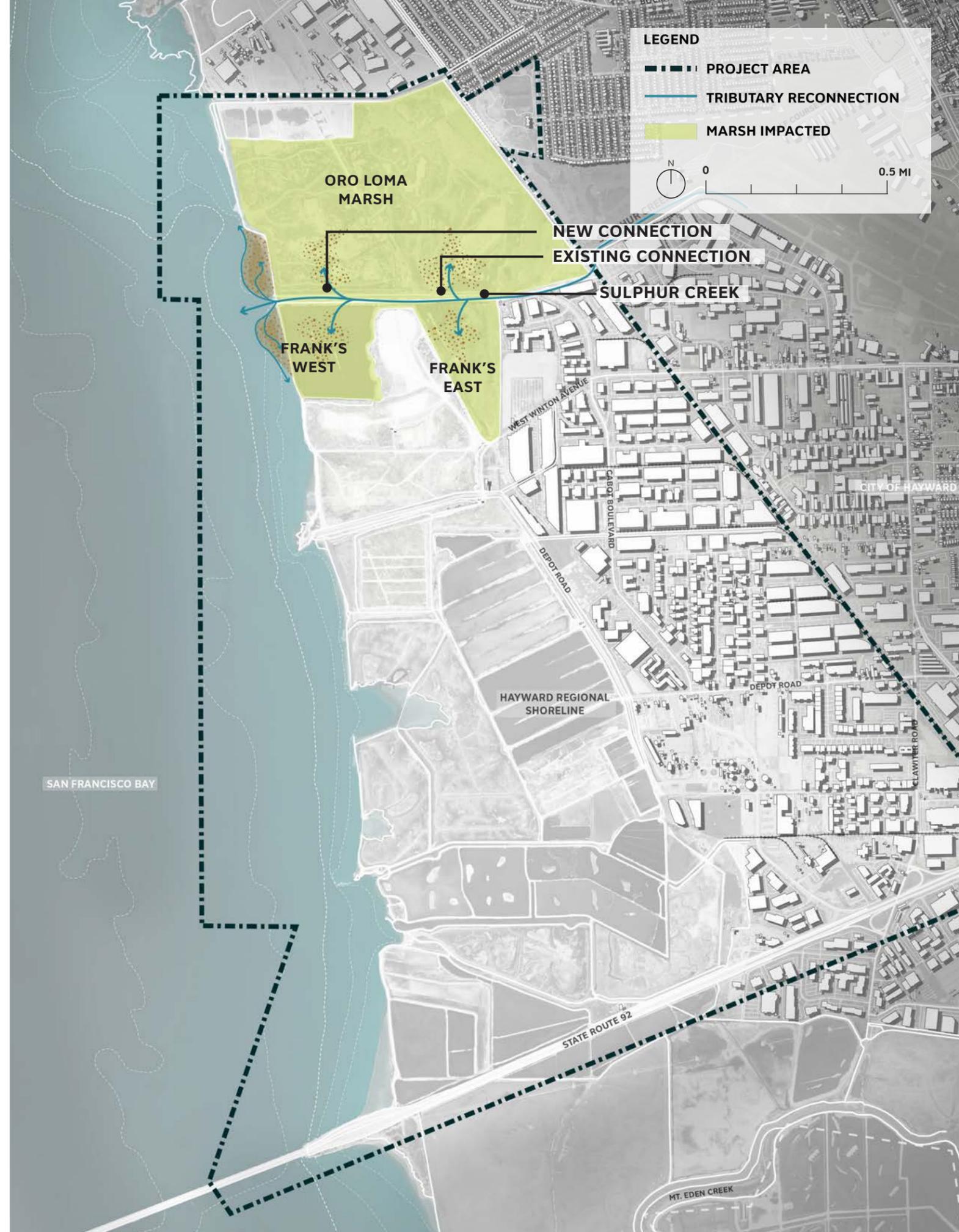
- Breach berms between Sulphur Creek and Oro Loma Marsh, Frank's East, and Frank's West

### PROS

- Connect marshes to a large upland watershed
- Can help restore tidal marshes

### CONS

- May impact flood control upstream- need to relocate tide gate
- May not do much for flood protection or SLR adaptation



# TRIBUTARY CONNECTION TO BAYLANDS

## Option 2: All Channels

### GOAL / OBJECTIVE

Enhance marsh ecology and facilitate adaptation to SLR.

### DESCRIPTION

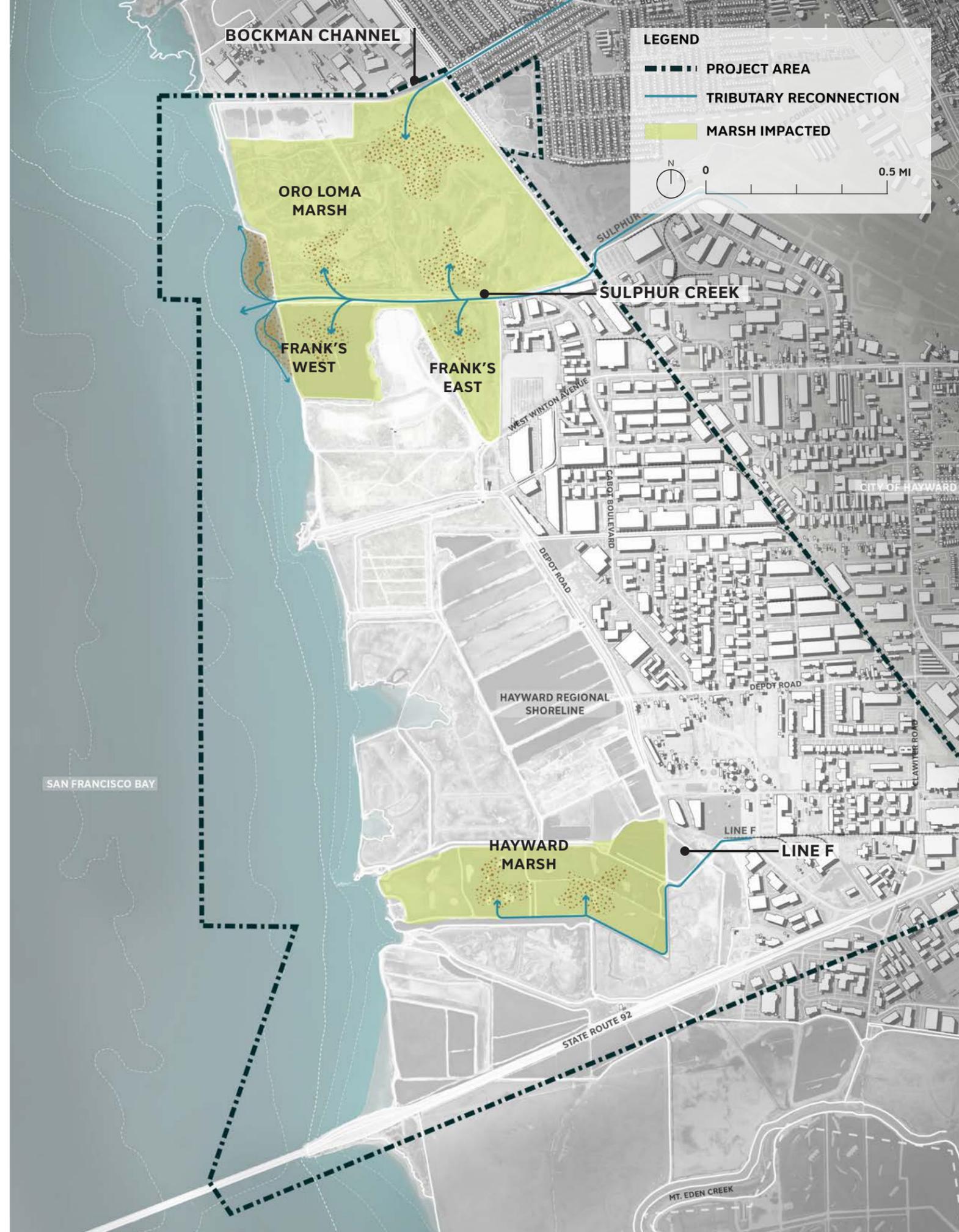
- Breach berms between Sulphur Creek and Oro Loma Marsh, Frank's East, and Frank's West
- Breach berms between Like F and Hayward Marsh

### PROS

- Connect marshes to most viable upland watersheds
- Potential to nourish a large extent of marsh with sediment

### CONS

- May impact flood control upstream- need to relocate tide gate
- Bockman Channel has low water quality today which may negatively impact Oro Loma marsh
- May not do much for flood protection or SLR adaptation



# TRIBUTARY CONNECTION TO BAYLANDS

## Compiled Options

### 1: Sulphur Creek



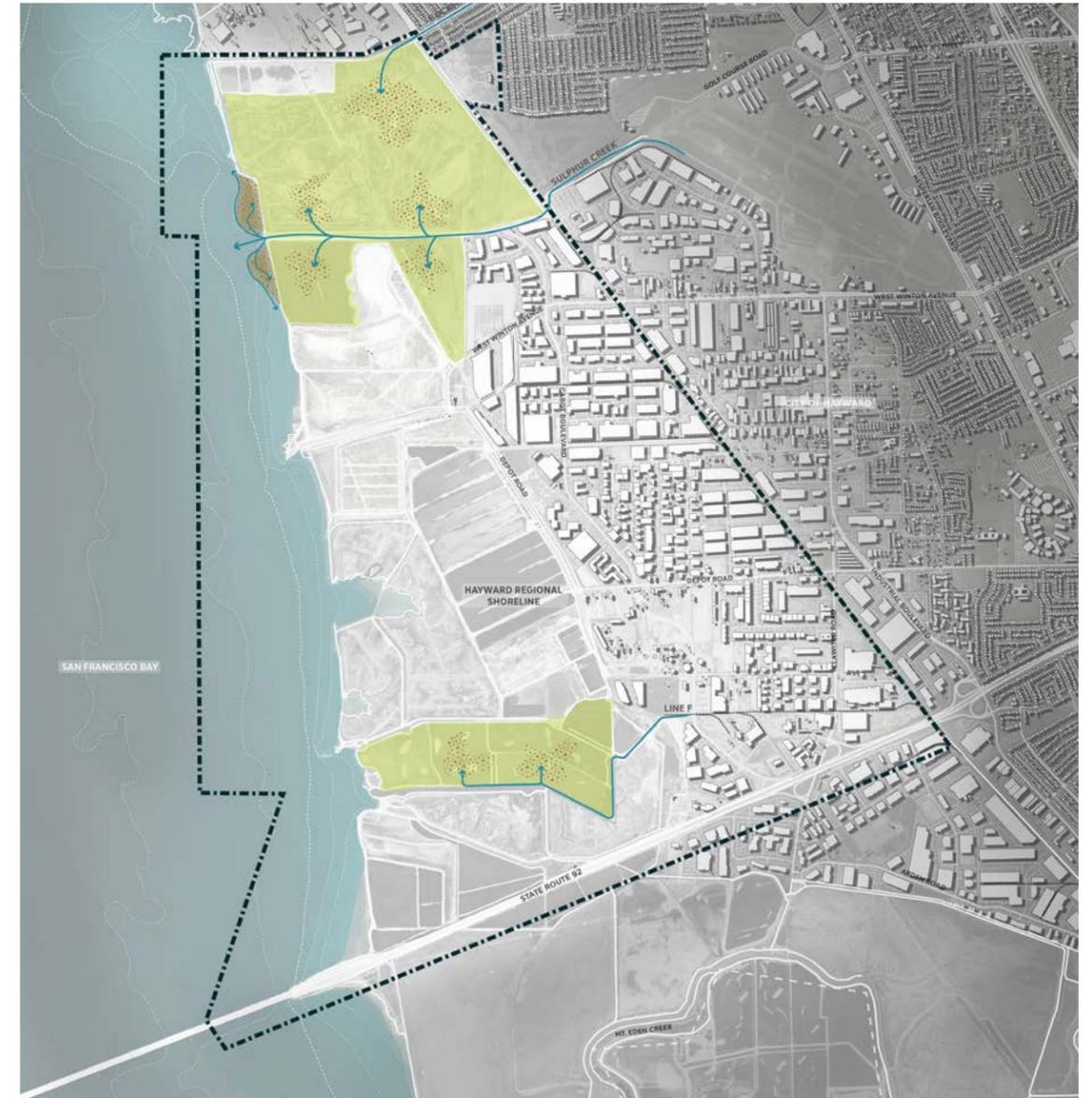
#### COMMENTS

- See General Comments.
- EBRPD: EBRPD has concerns about water quality present in Line F. Will this water contaminate/ impact marshlands? SCAPE will review and discuss this option with ACFC.

#### GENERAL COMMENTS

- COH: DG: The park districts should provide comments on these options. SCAPE will continue to solicit comments from the Park Districts.

### 2: All Channels



#### COMMENTS

- See General Comments.

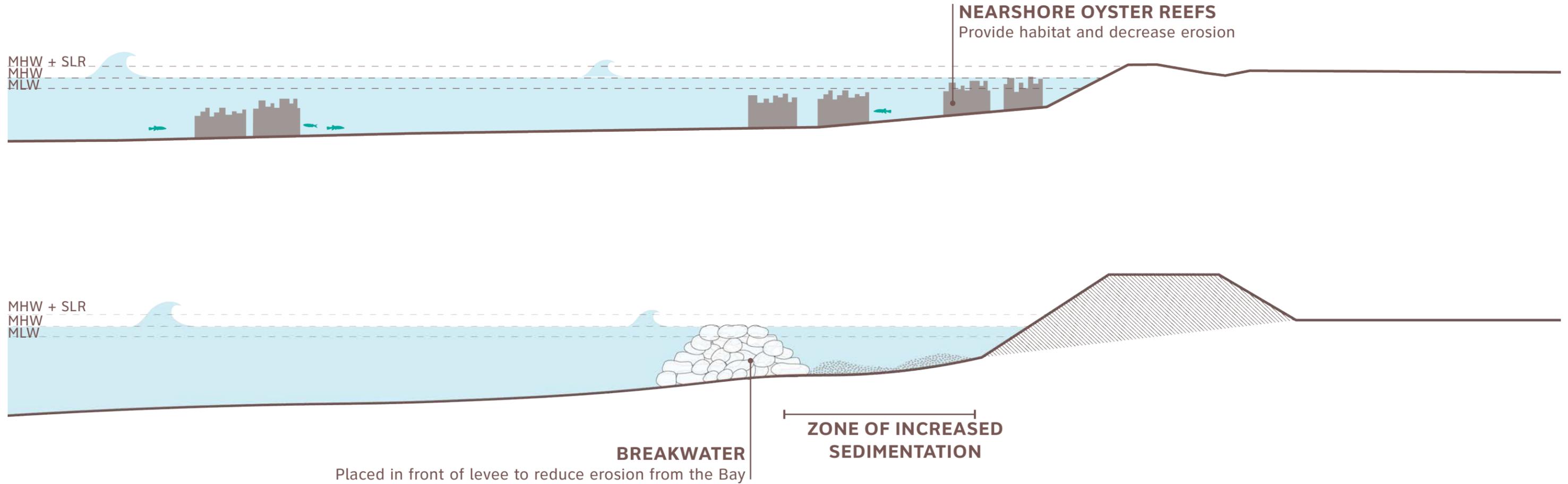
# REEFS AND LIVING BREAKWATERS

## Definition

Nearshore reefs made of **oyster shell and Baycrete** (a cement mixture composed mostly of Bay sand and shells) **provide hard substrate** for shellfish and other aquatic plants and animals. They can **reduce wave transmission** at lower tidal elevations and **stabilize areas in their lee**. Breakwaters **reduce the intensity of wave action** in inshore waters, thereby reducing coastal erosion.

## GOAL / OBJECTIVE

- Reduce erosion to critical infrastructure
- Ecological enhancement (hard substrate habitat)



# REEFS AND LIVING BREAKWATERS

## Precedents

### SCC Living Shorelines Project Point Pinole, Richmond, CA

**Size:** 2 acres

**Cost:** \$3 million (cost of pilot, experimentation, monitoring)

**Implementation Timeline:** 2018

**Applicability:** A layered shoreline with enhanced ecosystems is applicable to the transect from subtidal to upland transition.

**Description:** Living shorelines use nature-based infrastructure to create shoreline buffers that reduce impacts of sea level rise and erosion, while creating habitat for fish and wildlife.

- 350 oyster reef elements are made of a mixture of native sand and oyster shell mixed with cement
- Subtidal habitat restoration of native oyster + eelgrass beds, provide habitat for Pacific Herring and Olympia Oyster
- Use natural structures to buffer and protect adjacent tidal wetlands



Plan of project restoration



Installation of oyster reef

# REEFS AND LIVING BREAKWATERS

## Precedents

### Wave Screen Loggerhead Marina, Stuart, FL

**Size:** 1,300 LF

**Implementation:** 2015 (5 months)

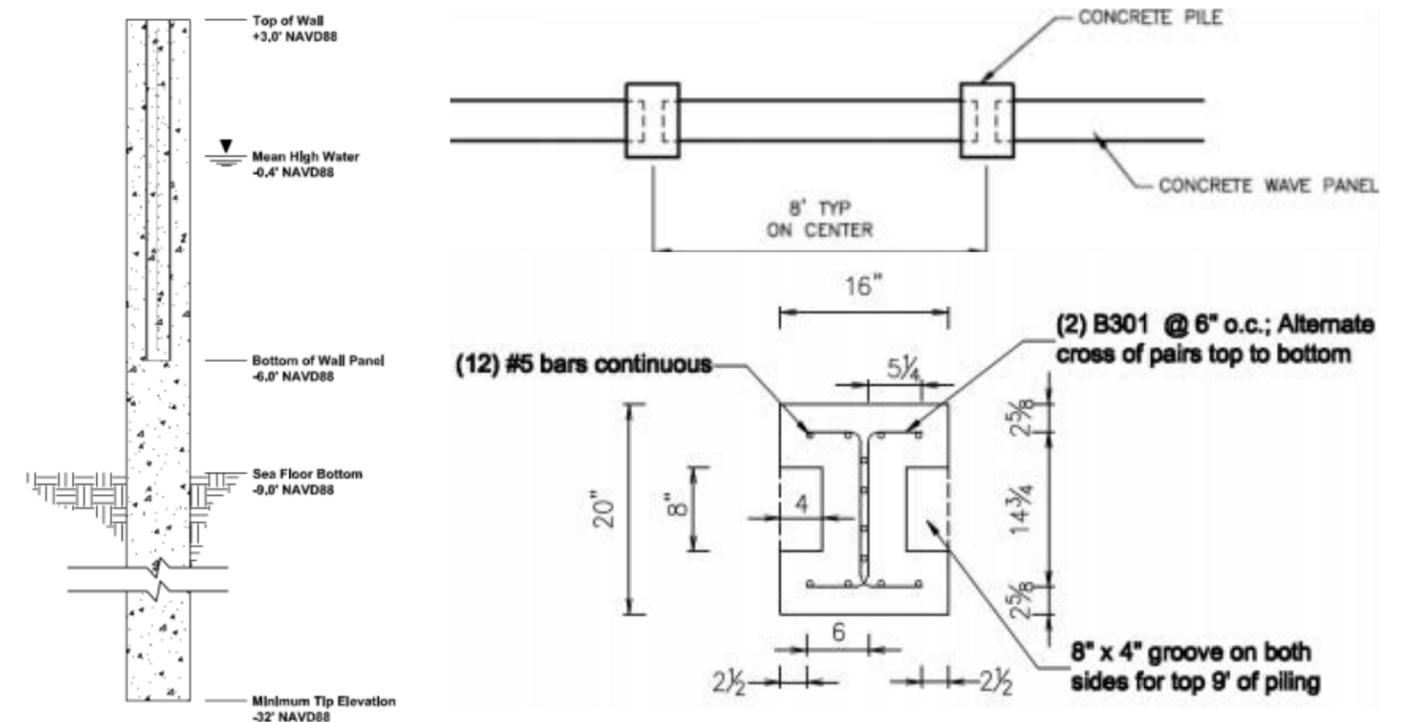
**Applicability:** A wave screen may be more applicable in

**Description:** Wave screens offer an alternative form of protection against coastal erosion, picking up on some of the shortcomings/challenges of fixed breakwater and floating attenuator structures. The original floating attenuator at Loggerhead Marina was not enough.

- Standard fabricated king pile and panel system
- These structures are mainly intended to minimize wave damage caused by wind or boat traffic.
- Panels were installed every 8' using a barge around the perimeter of the basin
- Wave screen received minimal damage during Hurricane Irma (slight settlement of some panels). It was overtopped but provided superior wave protection during the storm.
- Wave screens provide protection against longer wave periods than floating attenuator, max 7-8 seconds



Wave screen along the perimeter of the basin, made of all concrete



Design details

# REEFS AND LIVING BREAKWATERS

## Option 1: Offshore Oyster Reefs

### GOAL / OBJECTIVE

Enhance shoreline habitat for oysters and shellfish and potentially reduce the risk of erosion.

### DESCRIPTION

- String of oyster reefs offshore of the shoreline in front of Oro Loma Marsh to Hayward Marsh

### PROS

- Reduce erosion along shoreline
- Provide hard substrate habitat

### CONS

- Has to be far offshore because the Bay is shallow- may not get as much accretion along shoreline
- May not be stable on bay mud- potential to sink
- Considered as fill under current regulations, which might present permitting challenges
- Oyster Reef may cause issues with NPDES permit and near shore discharge requirements



# REEFS AND LIVING BREAKWATERS

## Option 2: Engineered Breakwaters

### GOAL / OBJECTIVE

Reduce the risk of erosion along vulnerable shoreline structures in front of critical infrastructure.

### DESCRIPTION

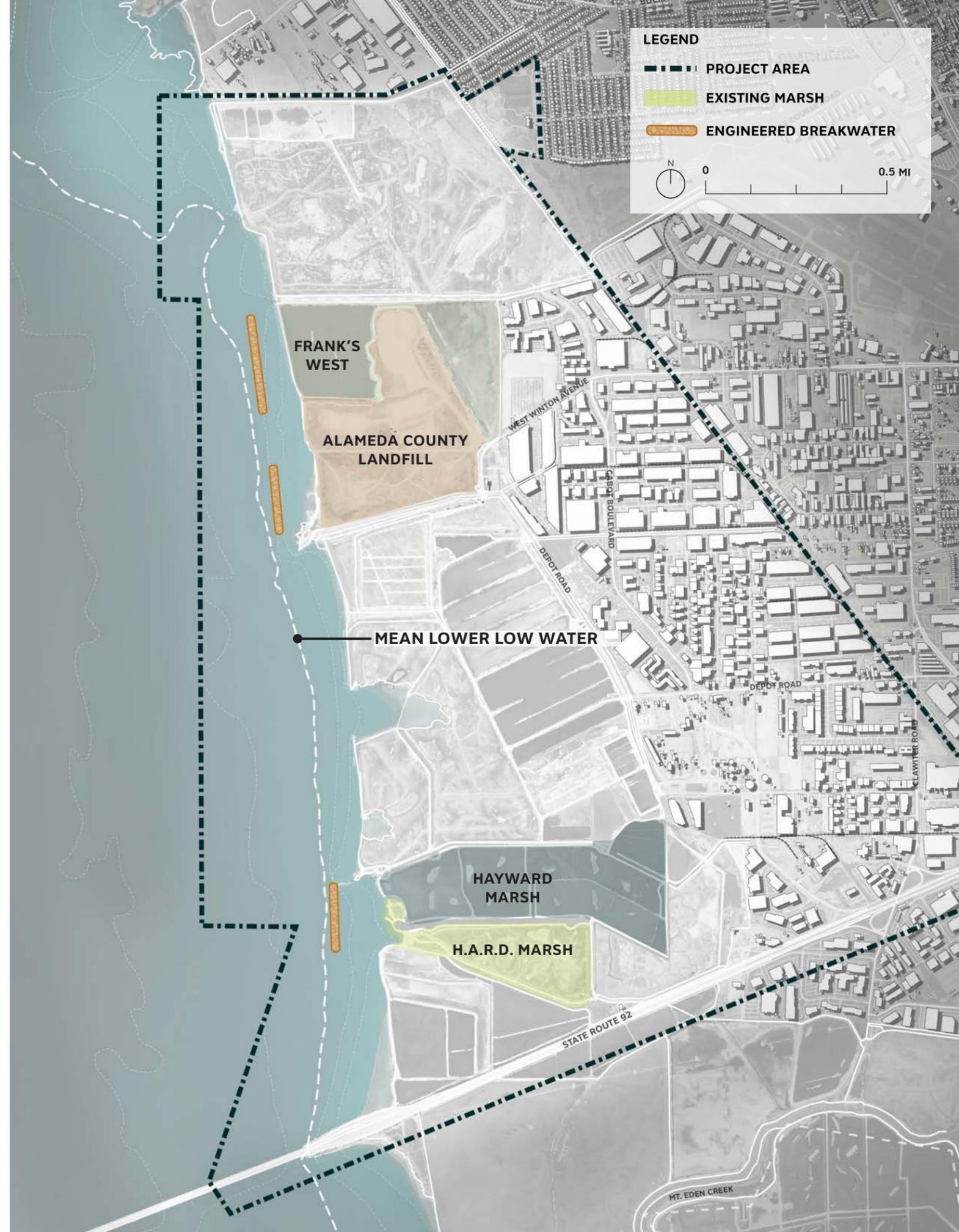
- Breakwaters in front of Frank's West, Alameda County Landfill, and Hayward Marsh

### PROS

- Reduce erosion to outboard levees and berms in front of critical infrastructure
- May provide rocky substrate habitat

### CONS

- May not be stable on bay mud- potential to sink
- May have negative impacts to muddy bottom habitats
- Considered as fill under current regulations, which might present permitting challenges



# REEFS AND LIVING BREAKWATERS

## Option 3: Floating Breakwaters at Breaches

### GOAL / OBJECTIVE

Reduce the risk of erosion at marsh breaches.

### DESCRIPTION

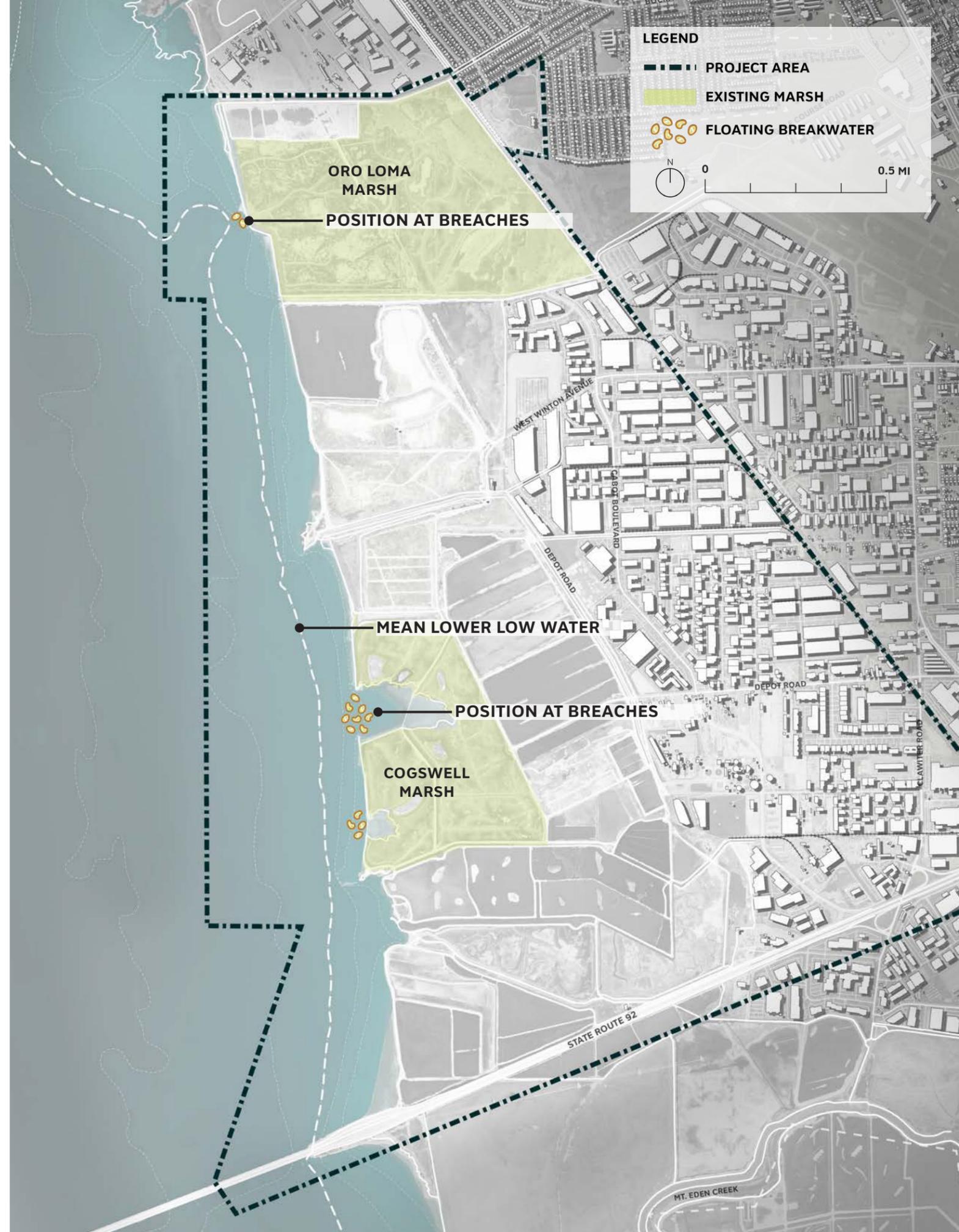
- Floating breakwaters at all Bay-side marsh breaches

### PROS

- Less risk of sinking into bay mud
- May help accrete sediment along shoreline
- May reduce shoreline erosion during daily tides

### CONS

- High maintenance structures
- Won't reduce erosion due to storm surge, only daily tides
- Suited for small marinas- best for attenuating boat wake
- May not provide as much accretion along shoreline



# REEFS AND LIVING BREAKWATERS

## Option 4: Wave Screens

### GOAL / OBJECTIVE

Reduce the risk of erosion due to wave action in front of critical infrastructure

### DESCRIPTION

- Wave screens in front of Frank's West Alameda County Landfill, Cogswell Marsh Breach, and Hayward Marsh

### PROS

- Structurally sound from deep pile construction
- Could incorporate e-concrete in the panels to provide additional habitat
- May facilitate tidal flow underneath the screen if the lowest panel is lifted off the ground
- Maintains most natural water circulation

### CONS

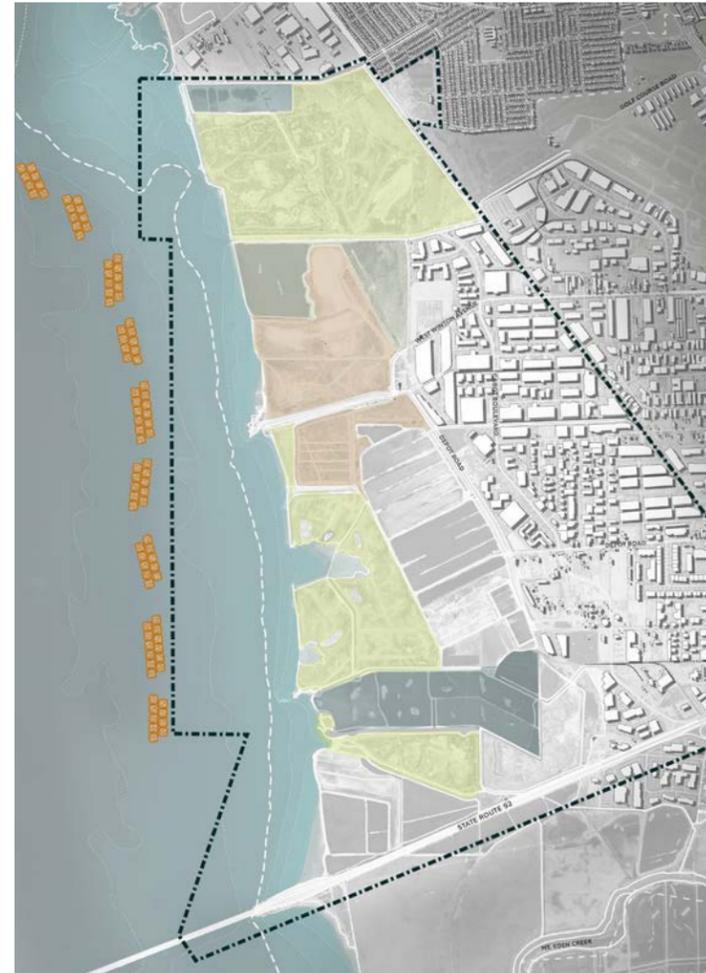
- Potential permitting issues
- May cause wave reflection issues



# REEFS AND LIVING BREAKWATERS

## Compiled Options

### 1: Offshore Oyster Reefs



#### COMMENTS

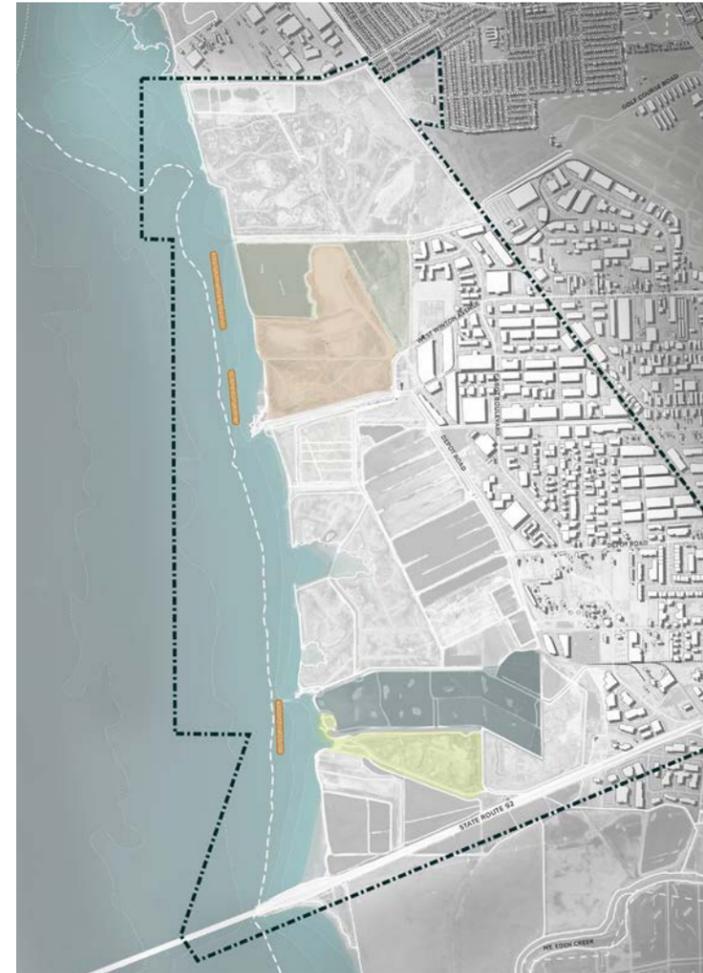
- COH: EP: Oyster Reef may cause issues with NPDES permit and near shore discharge requirements. SCAPE will add this point under the Cons. SCAPE will review these options with BCDC.

#### GENERAL COMMENTS

General Comments:

- COH: DG: Love the options. The park districts should provide input since these options will impact their shoreline assets. SCAPE will continue to solicit the Park District's feedback.

### 2: Engineered Breakwaters



#### COMMENTS

- EBRPD: Concerned about engineered breakwaters becoming raptor/predator perches adjacent to the marsh. What techniques could be used to prevent perching? SCAPE: Additional feasibility studies will be needed to address this question. Additional studies are not part of the current scope of work.

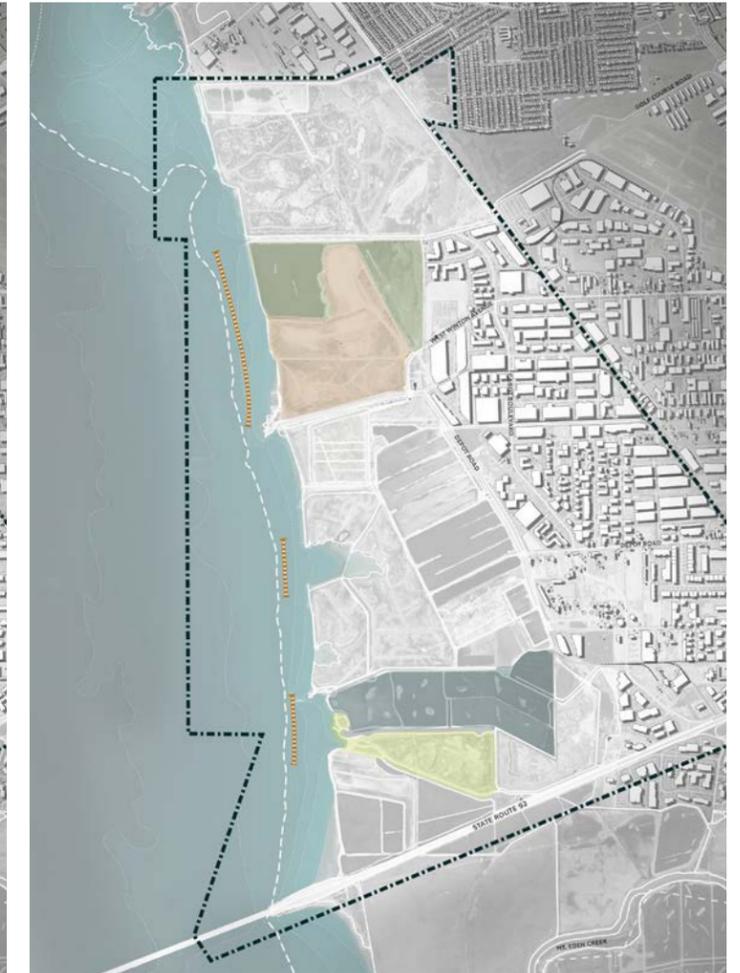
### 3: Floating Breakwaters at Breaches



#### COMMENTS

- See general comments.

### 4: Wave Screens



#### COMMENTS

- EBRPD: Wave screens seem to require detailed engineering. Has this technique been used to successfully protect marshes? SCAPE: Smaller scale techniques, such as wood fascines or wave screens with treated marine timber, have been used to attenuate wave energy and reduce marsh erosion and are successful for certain locations. Harder structures and wave screens with concrete panels are typically found around marinas.
- EBRPD: What maintenance will be required? SCAPE: Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work.

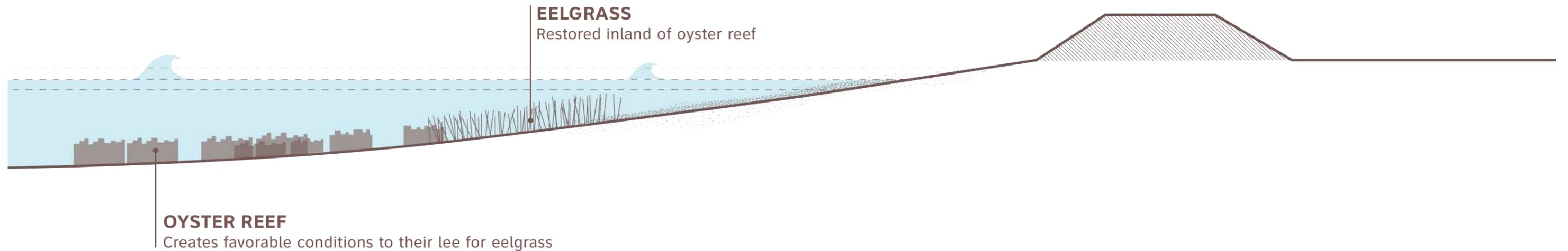
# EELGRASS RESTORATION

## Definition

Eelgrass is **submerged aquatic vegetation** that contributes to **trapping sediment** and **slowing shoreline erosion**. Habitat suitability depends on depth of water, light, current speed, exposure to wind waves, water temperature, and salinity.

## GOAL / OBJECTIVE

- Ecological enhancement (provides habitat)



# EELGRASS RESTORATION

## Precedents

### SCC Living Shorelines Project Point Pinole, Richmond, CA

**Size:** 2 acres

**Cost:** \$3 million (cost of pilot, experimentation, monitoring)

**Implementation Timeline:** 2018

**Applicability:** Eelgrass restoration is highly site specific and some of the planting methods explored in this project may prove useful if implemented. Eelgrass did better on the shoreside, rather than bayside of the reefs.

**Description:** Eelgrass provides valuable ecological services by supporting diverse communities of invertebrates, fish, and waterfowl. Eelgrass is one of several habitat elements combined at Giant Marsh to create a living shoreline.

- Subtidal habitat restoration of native oyster + eelgrass beds
- Use natural structures to buffer and protect adjacent tidal wetlands



Plan of project restoration



Eelgrass planting

# EELGRASS RESTORATION

## Option 1: Enhance Existing Bed

### GOAL / OBJECTIVE

Enhance shoreline ecology.

### DESCRIPTION

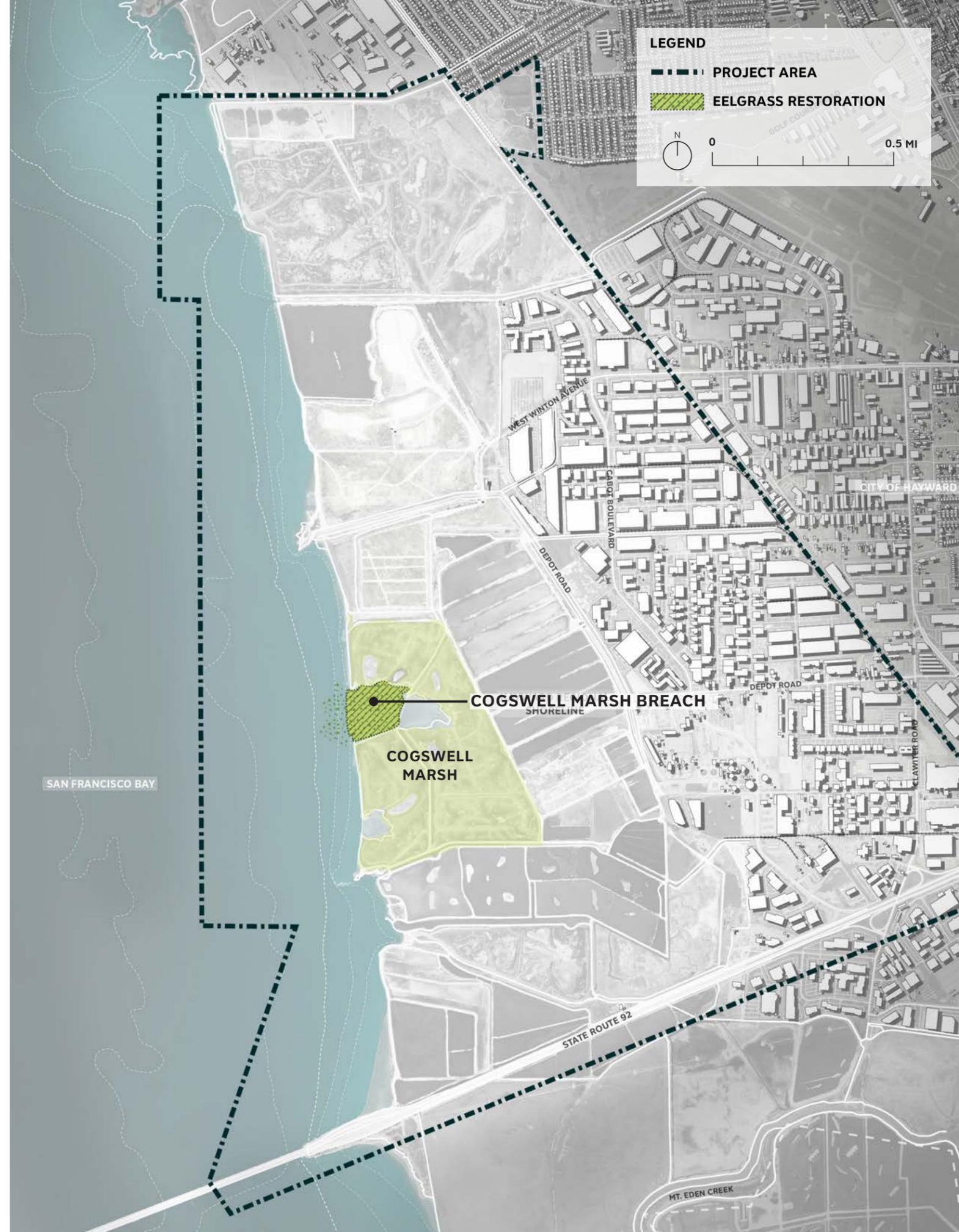
- Restore eelgrass at the larger Cogswell Marsh breach

### PROS

- Eelgrass is already located at the breach in conditions that facilitate its growth
- Eelgrass could help minimally reduce erosion as part of a layered ecological shoreline

### CONS

- Highly erosive environment
- Eelgrass is highly sensitive to changing environmental conditions



# EELGRASS RESTORATION

## Option 2: Promote at Breaches

### GOAL / OBJECTIVE

Enhance shoreline ecology.

### DESCRIPTION

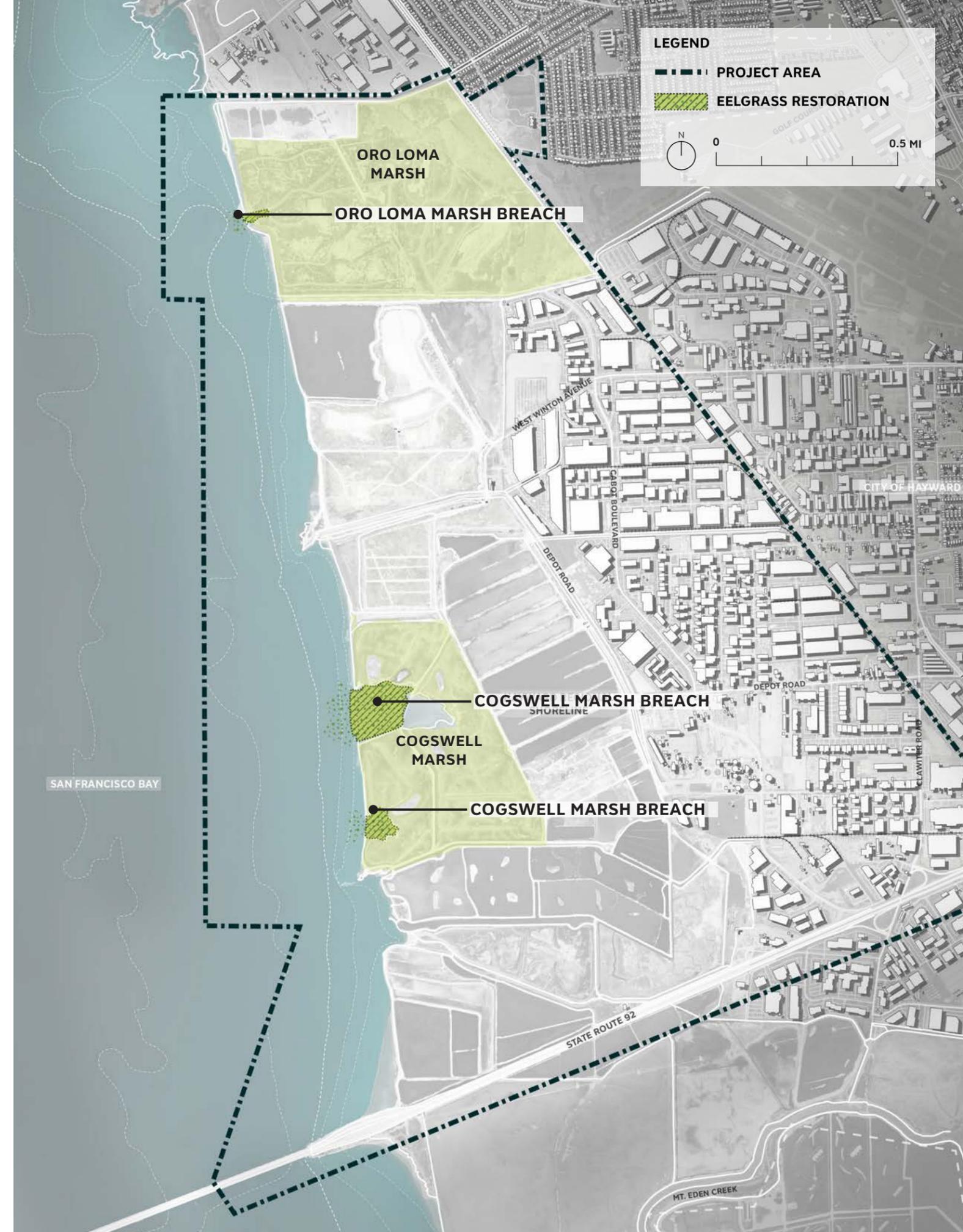
- Restore eelgrass at Oro Loma Marsh breach and Cogswell Marsh breaches

### PROS

- Eelgrass could help minimally reduce erosion as part of a layered ecological shoreline

### CONS

- May not be ideal conditions for eelgrass
- May need to increase open water to encourage eelgrass growth
- Eelgrass is highly sensitive to changing environmental conditions



# EELGRASS RESTORATION

## Compiled Options

### 1: Enhance Existing Bed



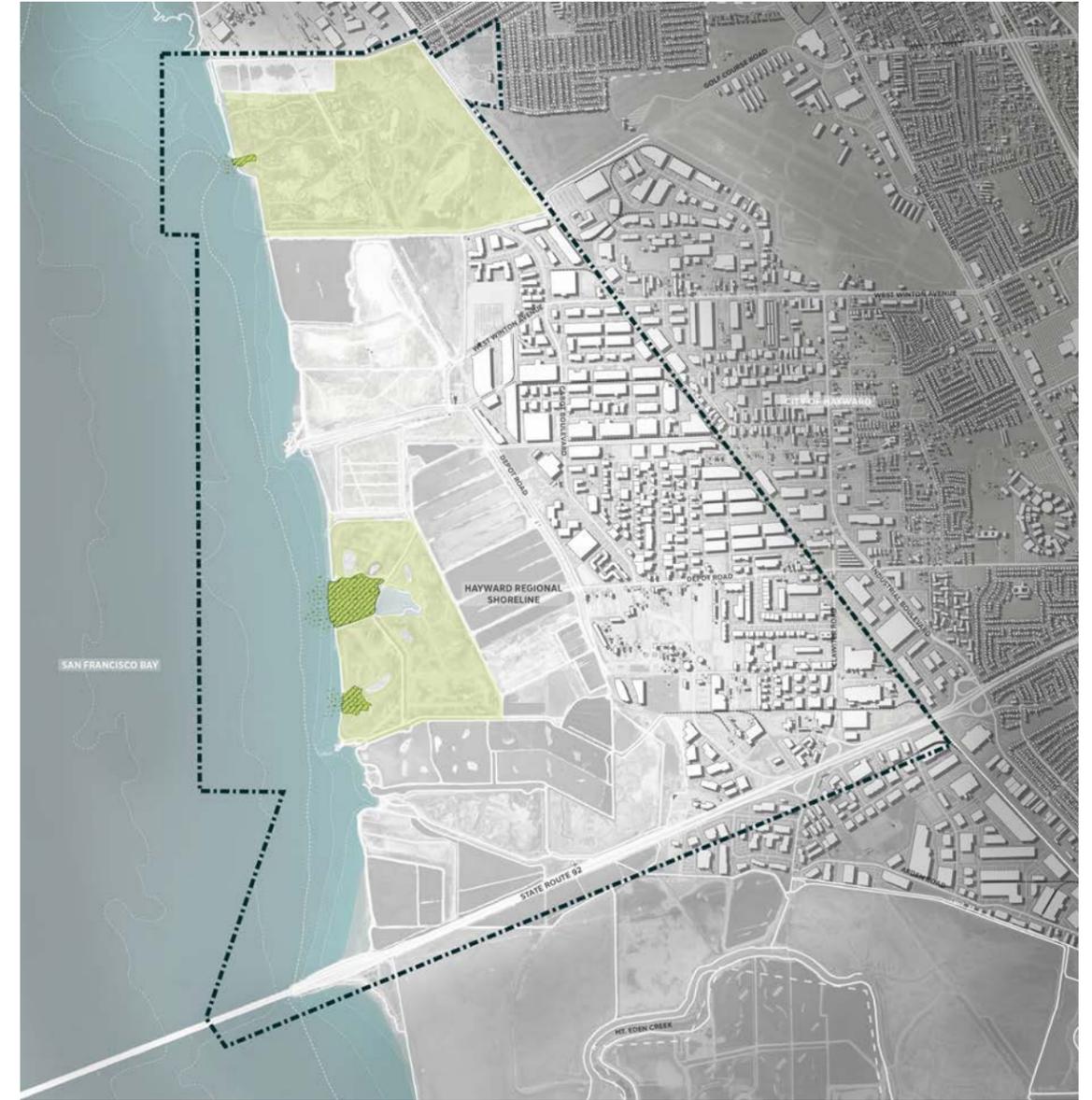
#### COMMENTS

- See General Comments.

#### GENERAL COMMENTS

- COH: DG: Love all the options. The park districts should provide input here since these options will directly impact their shoreline assets. SCAPE will continue to solicit feedback from the Parks Districts.

### 2: Promote at Breaches



#### COMMENTS

- See General Comments.

# **ENGINEERED STRATEGIES**

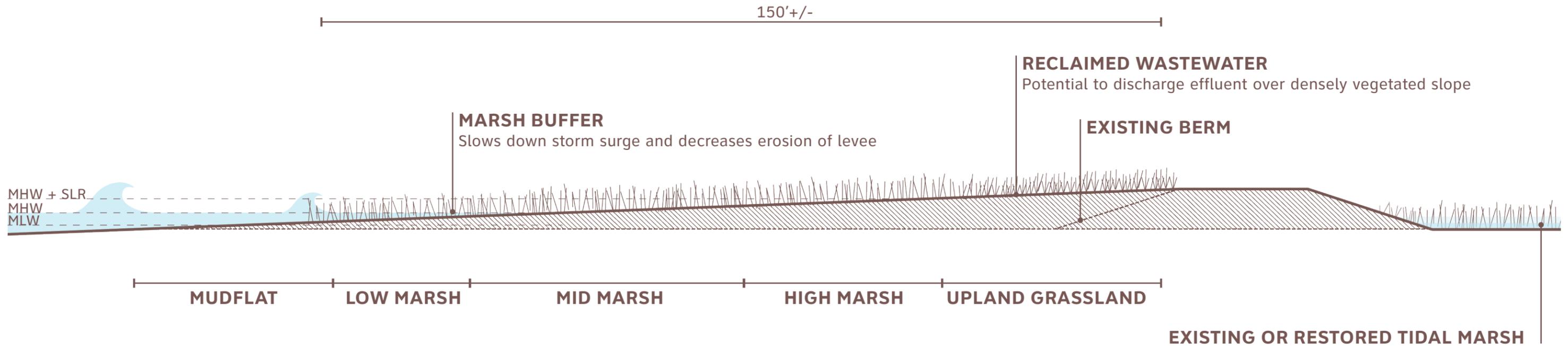
# ECOTONE LEVEE

## Definition

Ecotone levees are **vegetated gentle slopes** or ramps on the bay side of a levee. They can attenuate waves, provide high-tide refuge for marsh wildlife, and allow room for marshes to migrate upslope with sea level rise. Ecotone levees have a **larger footprint** but can provide many **resilience benefits**.

## GOAL / OBJECTIVE

- Provide flood protection
- Enhance ecological function (provide transition zone, marsh migration space)



# ECOTONE LEVEE

## Precedents

### Oro Loma Sanitary District San Lorenzo, CA

**Size:** 1.7 acres spread across a 456 LF horizontal levee / 2 acre treatment wetland

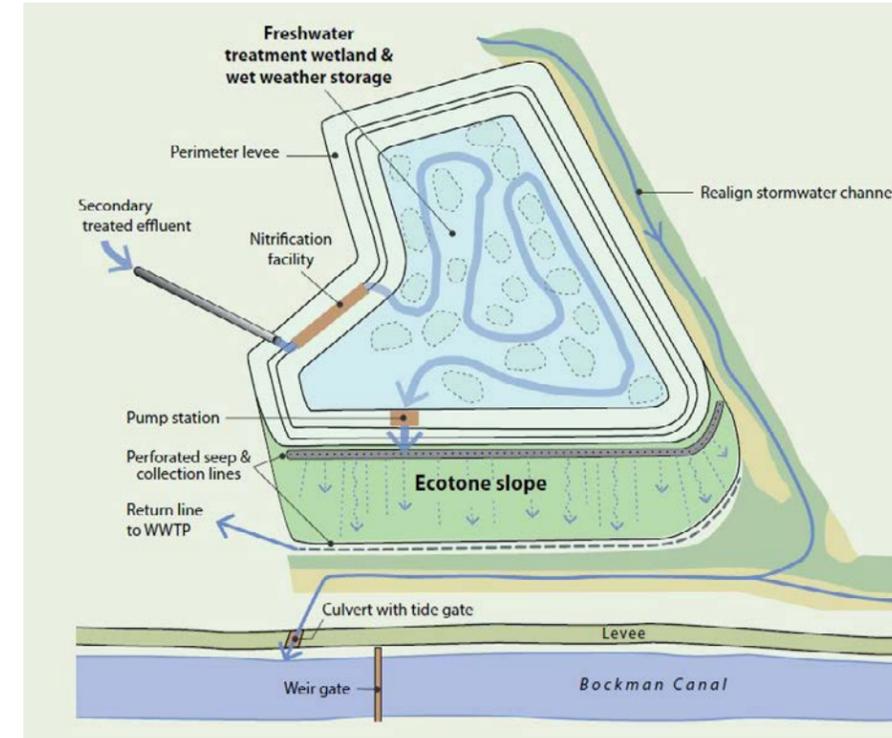
**Cost:** \$6.8 million (only cost for experimental facility)

**Implementation Timeline:** 2014-2017

**Applicability:** The dual system of wet weather storage and horizontal levee has potential to be deployed at the oxidation ponds with local discharge into an adjacent marsh.

**Description:** A partnership between the Oro Loma and Castro Valley Sanitary Districts, UC Berkeley, Save the Bay, and others, this project is testing different techniques to utilize natural systems to filter wastewater and protect the shoreline.

- Vegetated slope on bay side of levee is emulated as a natural alluvial fan / creek mouth
- Restores groundwater flow that used to occur with treated wastewater
- Vegetated slope of 30h:1v filters the water over 150 linear feet
- Potential to further decentralize EBDA pipeline
- Operated to deliver 30,000-70,000 gpd
- Vegetation establishment has exceeded all expectations- nearly 100% of native cover has been observed. Plants are growing with vigor, irrigated with the nitrogen content of treated effluent has provided abundant water supply and high nutrient loads
- Containment berm was constructed with standards similar to a flood control levee- holds up to 7.5 million gallons of primary treated effluent during extreme wet weather events



Plan diagram of WWTP system



View of ecotone levee

# ECOTONE LEVEE

## Precedents

### South San Francisco Bay Shoreline Project Alviso, CA

**Size:** 4 miles of levee / 2,900 acres of tidal wetlands and transition habitats

**Cost:** \$177 million

**Rough Unit Costs:** \$10k per acre of marsh /

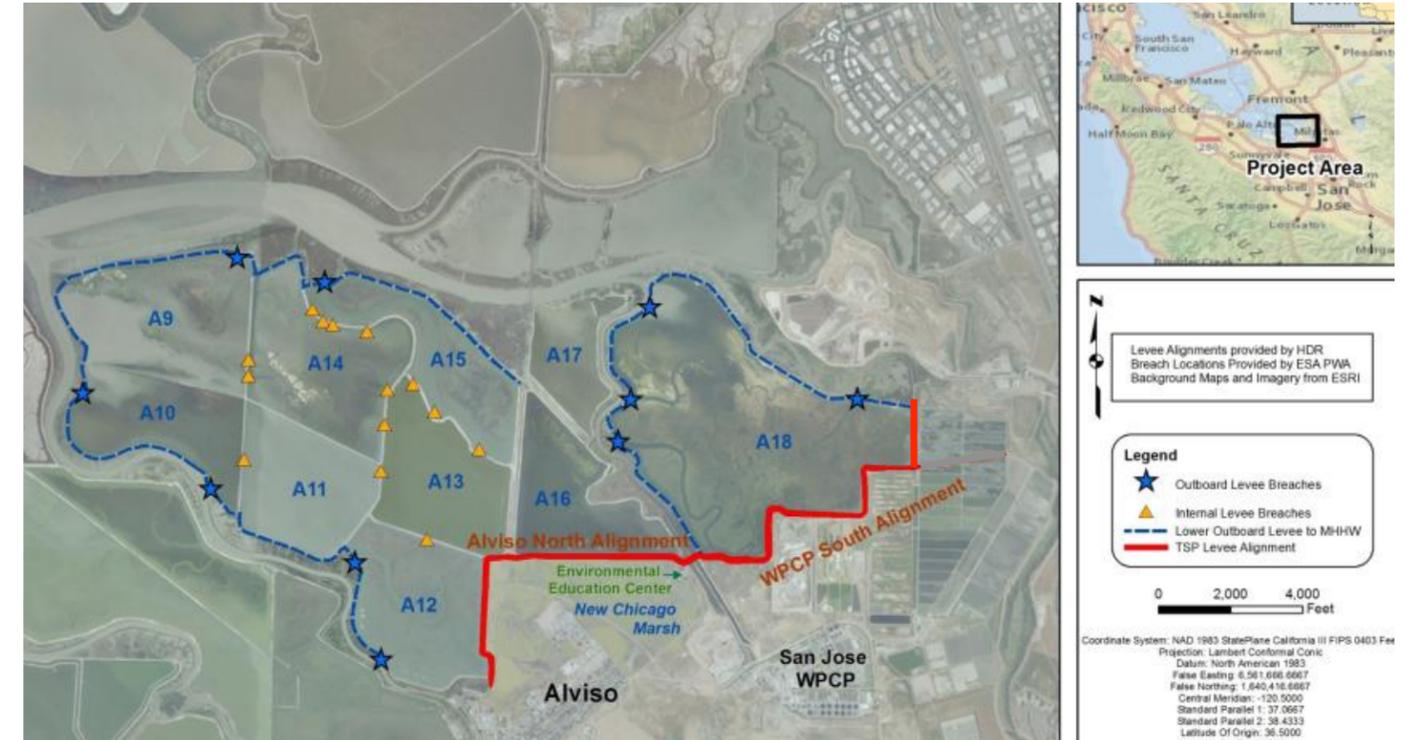
\$3.7k per LF of FRM levee + \$2.3k per LF of ecotone slope = \$6k per LF of levee.

**Implementation Timeline:** 3 Phases from 2018-2032

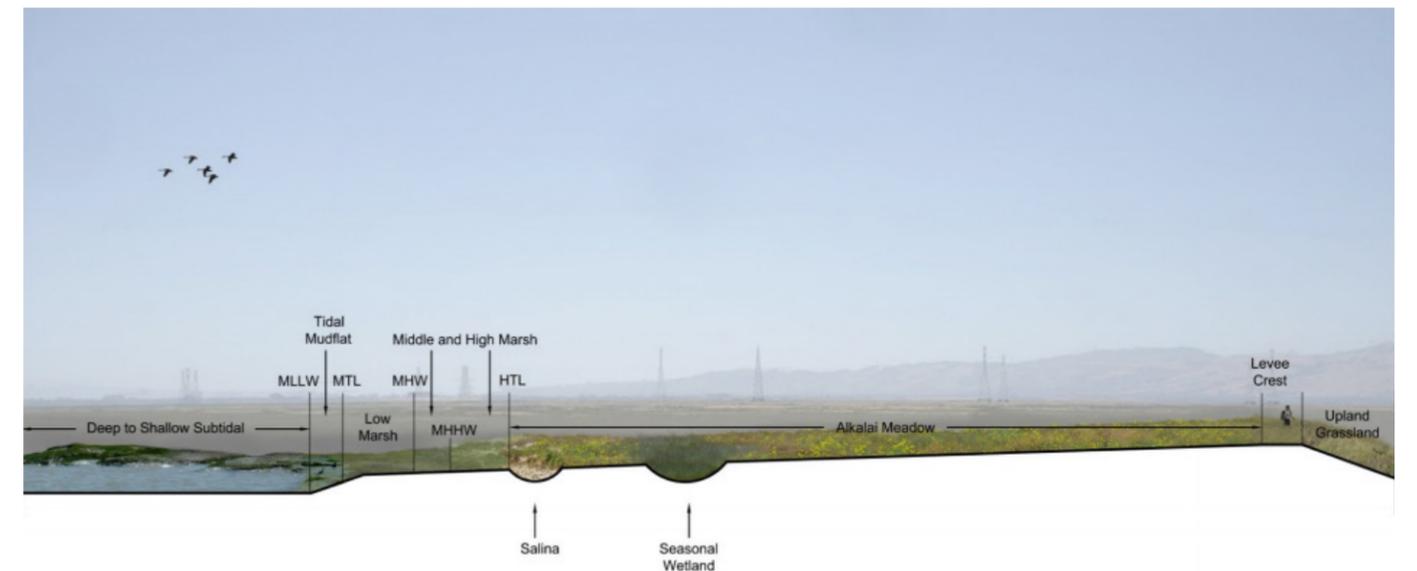
**Applicability:** This layered shoreline with multi-benefit infrastructure manages flood risk for adjacent communities while incorporating ecosystem restoration and increasing habitat. An ecotone levee is more resilient and adaptable over time.

**Description:** Uses natural infrastructure to provide increased flood protection, restore Bay habitats, and evolve in the future, with public access.

- Authorized by the USACE, Santa Clara Valley Water District, and the SCC
- Ties into existing accredited levees on both ends of the project
- Combination of traditional levee and ecotone levee with restored marsh
- Utilizes flood protection levees and wetlands
- Provides key connections to the SF Bay Trail and viewpoints
- Manages flood risk for population of ~5,500, ~1,100 structures and a regional wastewater facility



Plan of proposed levee alignments



Section diagram of flood protection levee, ecotone slope, and wetlands

# ECOTONE LEVEE

## Option 1: Protect Critical Infrastructure

### GOAL / OBJECTIVE

Reduce risk to critical infrastructure (Hayward WWTP and CalPine / Russell Energy Center). Enhance marsh migration space and transition zone.

### DESCRIPTION

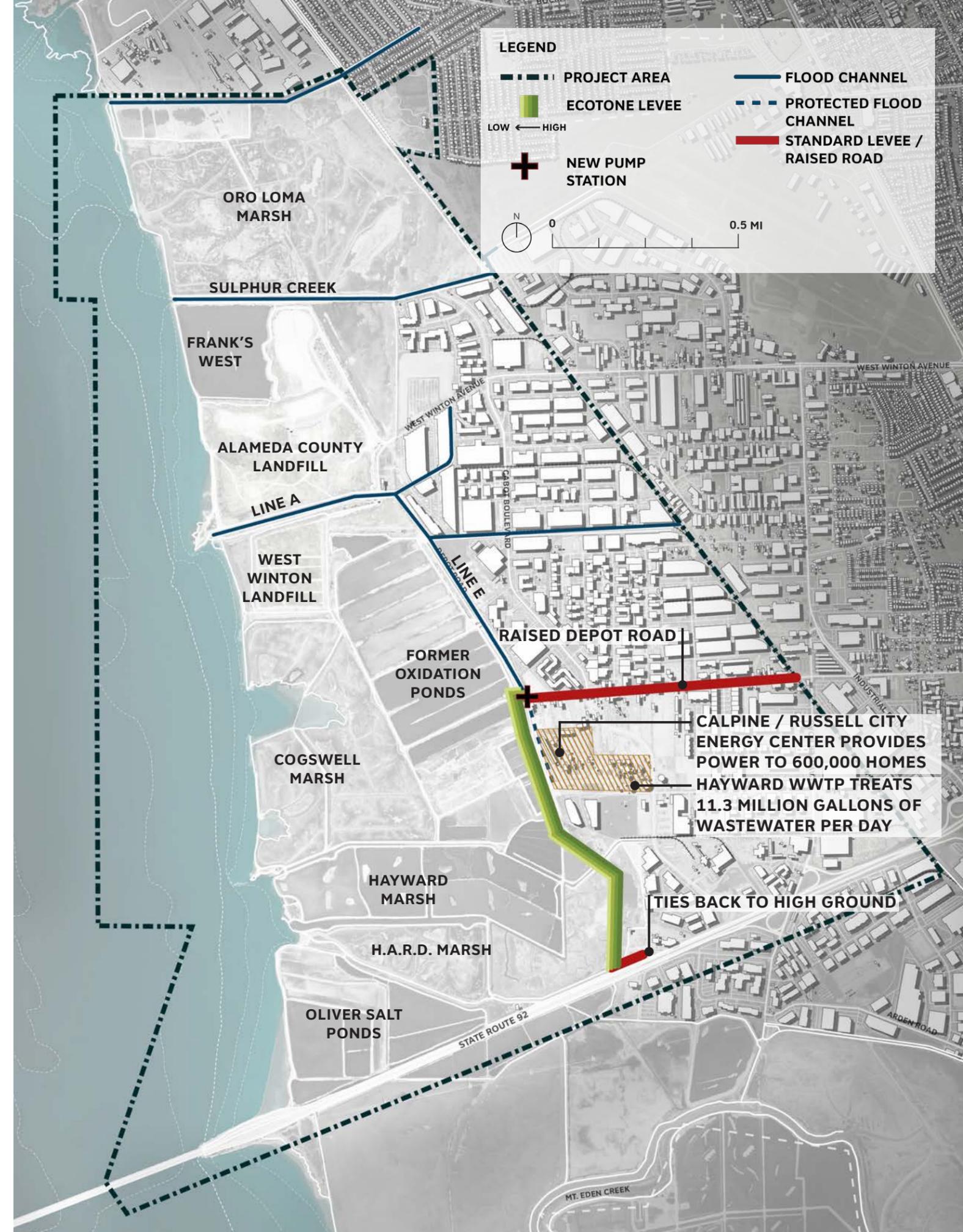
- Ecotone levee from SR-92 to Depot Road
- Road raising along Depot Road that ties back to high ground
- Standard levee along SR-92 that ties back to high ground

### PROS

- Existing tidal connections remain
- Some water control structures will be preserved (Line A)
- Increases level of flood protection from a potential increased in frequency of storm events

### CONS

- May require a portion of Line E to be relocated
- Oxidation ponds are unprotected
- A large amount of power would be required to operate pump stations behind the levee
- Predators may roost on the ecotone levee



# ECOTONE LEVEE

## Option 2: Maintain Oxidation Ponds

### GOAL / OBJECTIVE

Provide flood protection for a majority of the southern portion of the Industrial Business district. Enhance marsh migration space and transition zone.

### DESCRIPTION

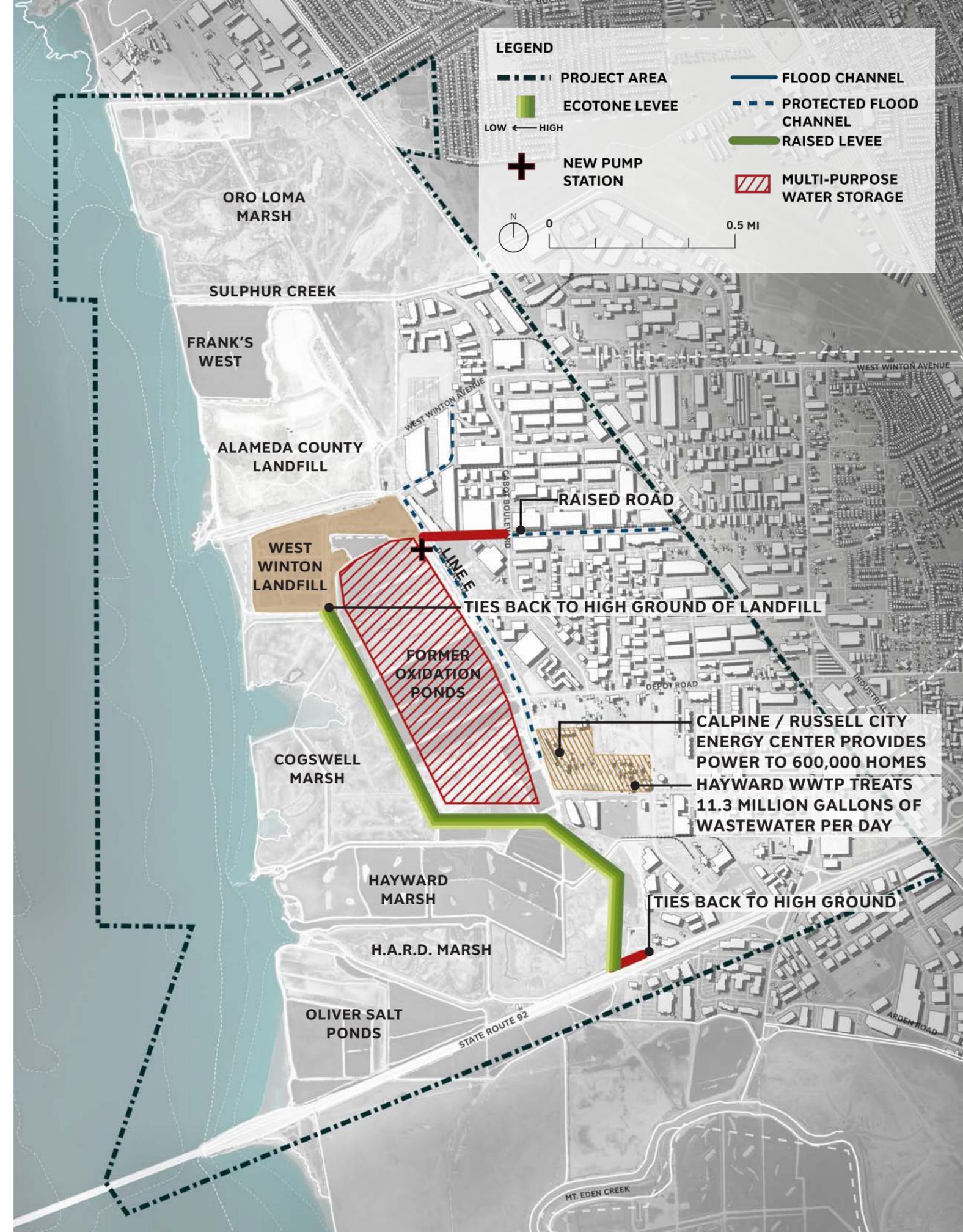
- Ecotone Levee that extends from SR-92, on the Bayward side of the Oxidation Ponds, and ties back to the West Winton Landfill
- Levee raising along Line E to prevent inundation with 4' of SLR
- Utilize the Oxidation Ponds for multi-purpose wet weather storage (groundwater, stormwater, wet weather equalization)

### PROS

- Increases level of flood protection from a potential increase in the frequency of storm events

### CONS

- Requires the management of a larger amount of stormwater on the inland side of the levee with increased storage space or pump stations
- A large amount of power would be required to operate pump stations behind the levee
- Predators may roost on the ecotone levee
- Negatively impacts Cogswell Marsh



# ECOTONE LEVEE

## Option 3: Upland Levee

### GOAL / OBJECTIVE

Reduce risk to critical infrastructure and provide flood protection for inland neighborhoods. Enhance marsh migration space and transition zone.

### DESCRIPTION

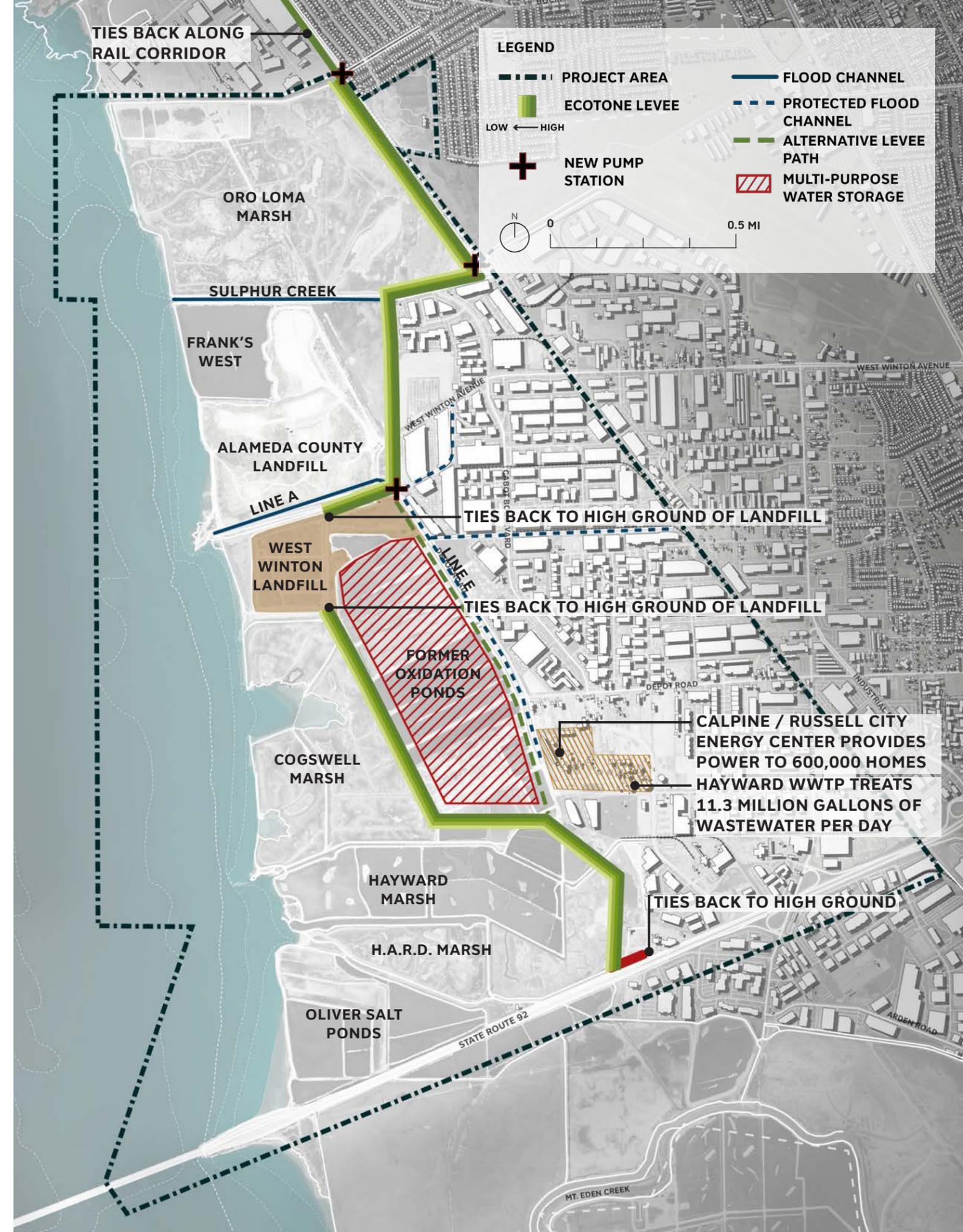
- Ecotone Levee
- Pump stations along Line A, Sulphur Creek, and Bockman Channel
- Multi-purpose water storage at Oxidation Ponds
- Standard levee tie back along SR-92 to high ground

### PROS

- Provides potential groundwater (pumped from underground), stormwater, and WWTP wet weather equalization storage areas in oxidation ponds
- Allows for upland marsh migration
- Increases level of flood protection from a potential increase in the frequency of storm events
- Low-gradient slope does not need to be constructed from highly engineered levee core

### CONS

- Requires the management of a larger amount of stormwater on the inland side of the levee with increased storage space or pump stations
- A large amount of power would be required to operate pump stations behind the levee
- Dependant on levee raising along the rail corridor outside of the project boundary to the north
- Line A unprotected, Line E to be relocated
- Sulphur Creek to be re-routed
- FEMA does not certify transition slope levees and would not recognize the flood protection benefits of this levee in their flood maps
- Construction would require filling the bay and modifying shoreline topography - requires multiple permits
- Predators may roost on the ecotone levee
- Negatively impacts Cogswell Marsh



# ECOTONE LEVEE

## Compiled Options

### 1: Protect Critical Infrastructure



### COMMENTS

- See General Comments.

### 2: Maintain Oxidation Ponds



### COMMENTS

- COH: TR: What is the extent of the raised road? SCAPE: The extent of the raised road is indicated by the red line. We will clarify the diagram and legend accordingly. The specific extent would require additional feasibility study.
- COH: EP: What is multi-purpose water storage? Possible issues concerning NPDES permits and regulations. SCAPE will add the NPDES permit to the cons. Multi-purpose water storage is indicating a zone that could be used for storing stormwater, groundwater, or overflow wastewater during storm events.
- COH: EP: We should not show storage on the areas currently labeled as former oxidation ponds. SCAPE: The indication of storage areas in this option at the former oxidation ponds would maintain their critical uses.

### 3: Upland Levee



### COMMENTS

- COH: TR: What is the extent of the raised road? SCAPE: There are no raised roads in this option.

## GENERAL COMMENTS

- EBRPD: Concern over predators staying there. SCAPE will add this point to the Cons.
- EBRPD: We don't like this because it negatively effects Cogswell marsh SCAPE will add this point to the Cons. Could you please list the specific concerns?
- EBRPD: Why don't we move it to the back of the oxidation ponds? SCAPE: There is an alternate levee path in the back of the oxidation ponds indicated by a dashed green line in option 3. The oxidation ponds provide critical WWTP infrastructure and the City of Hayward would like to preserve their uses.
- COH: DG: Options need review by the City of Hayward's Public Works Utilities staff. SCAPE will review this option with Public Works

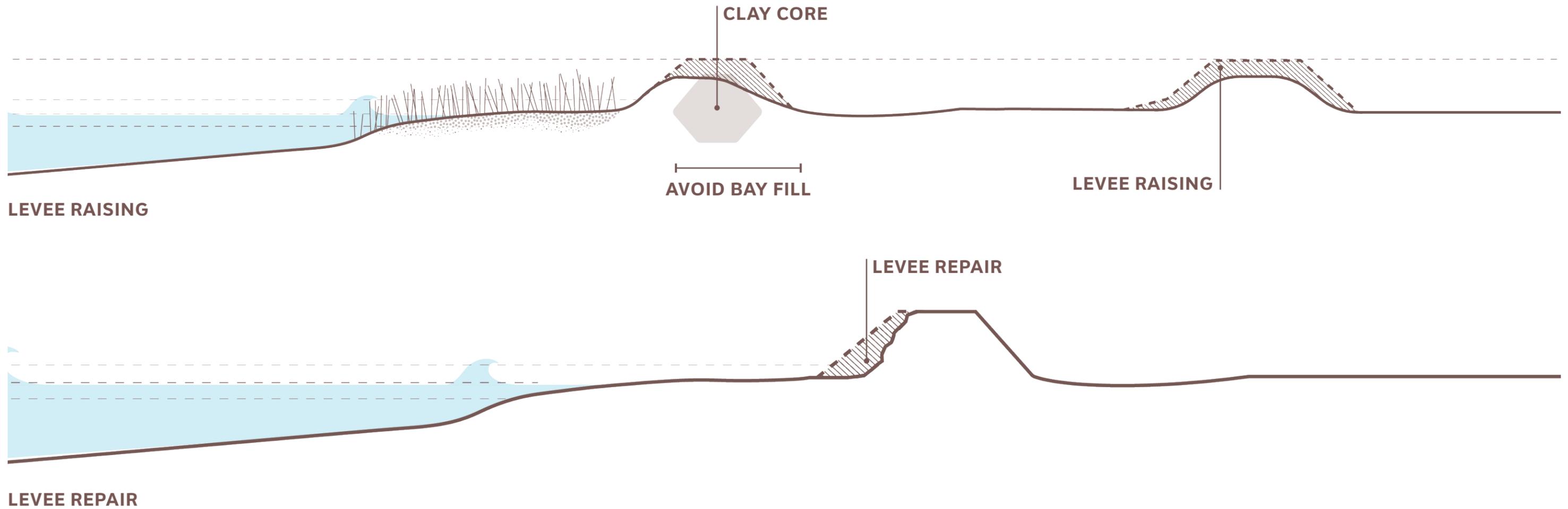
# LEVEE IMPROVEMENTS

## Definition

Existing levees can be raised, repaired, or strengthened to **increase their resiliency** to storms and sea level rise.

### GOAL / OBJECTIVE

- Provide further flood protection
- Reduce erosion to marshes / infrastructure in their lee
- Enhance recreational opportunities



# LEVEE IMPROVEMENTS

## Precedents

### Southport Sacramento River Levee Improvement Project Sacramento, CA

**Size:** 5.6 mile levee

**Cost:** \$80 million

**Implementation Timeline:** 2017-2018

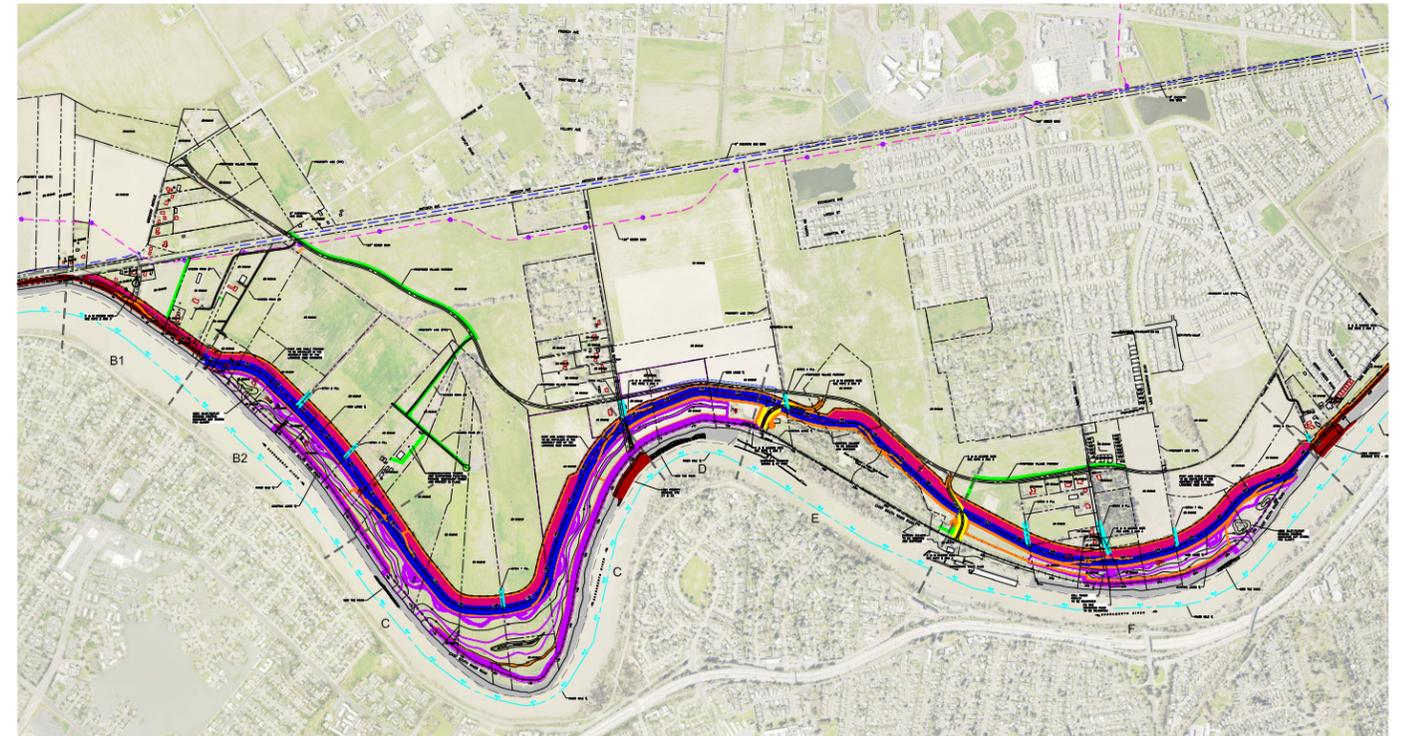
**Applicability:** Targeted levee repairs and setbacks combine with other strategies to improve flood protection and provide other benefits. Repairing and enhancing existing levees along the shoreline may prove useful for inland flood protection and enhanced ecosystem services.

**Description:** A combination of existing levee improvements and embankment setbacks will increase flood protection and repair the most vulnerable part of the City's levee system to achieve a 200-year level minimum of levee performance for West Sacramento.

- Flood-risk reduction measures along vulnerable levee segments of the Sacramento River
- Includes construction of levee embankment, cutoff walls, seepage berms, and associated relocation and improvement measures
- An increased floodplain between the old and new levee allows for wetland creation and increased storage space



View of levee improvements



Plan for levee improvements

# LEVEE IMPROVEMENTS

## Option 1: Targeted Raising

### GOAL / OBJECTIVE

Reduce risk of levee overtopping and provide flood protection.

### DESCRIPTION

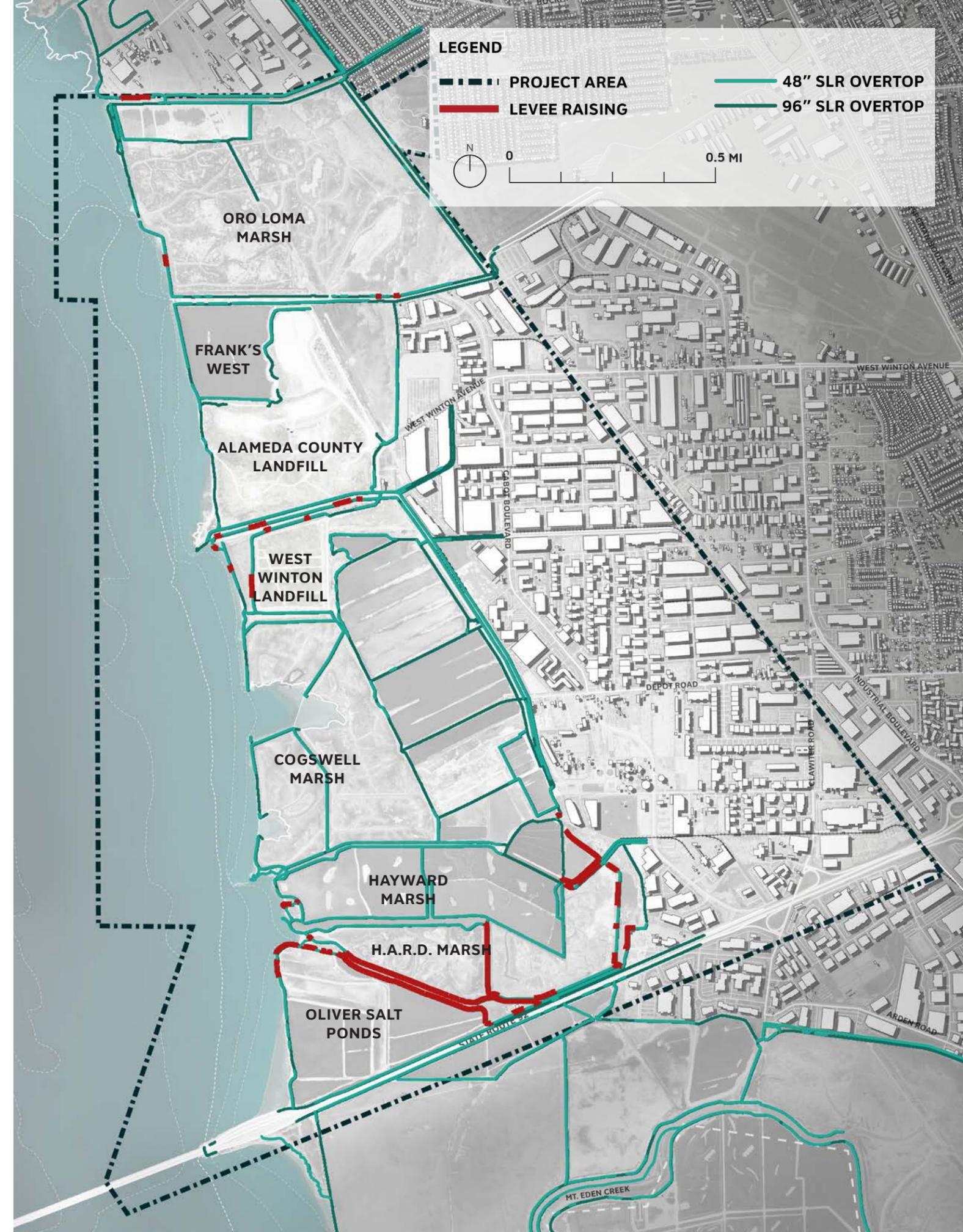
- Raise all levees that are projected to overtop with 2' of SLR

### PROS

- May help prevent localized flooding and erosion

### CONS

- Does not address future storm surge or sea level rise
- Short-term strategy that only addresses a 2' SLR scenario
- Does not account for freeboard- levees may still overtop with storm surge or wave action



# LEVEE IMPROVEMENTS

## Option 2: Address 4' of SLR

### GOAL / OBJECTIVE

Reduce risk to critical infrastructure and provide flood protection to inland communities.

### DESCRIPTION

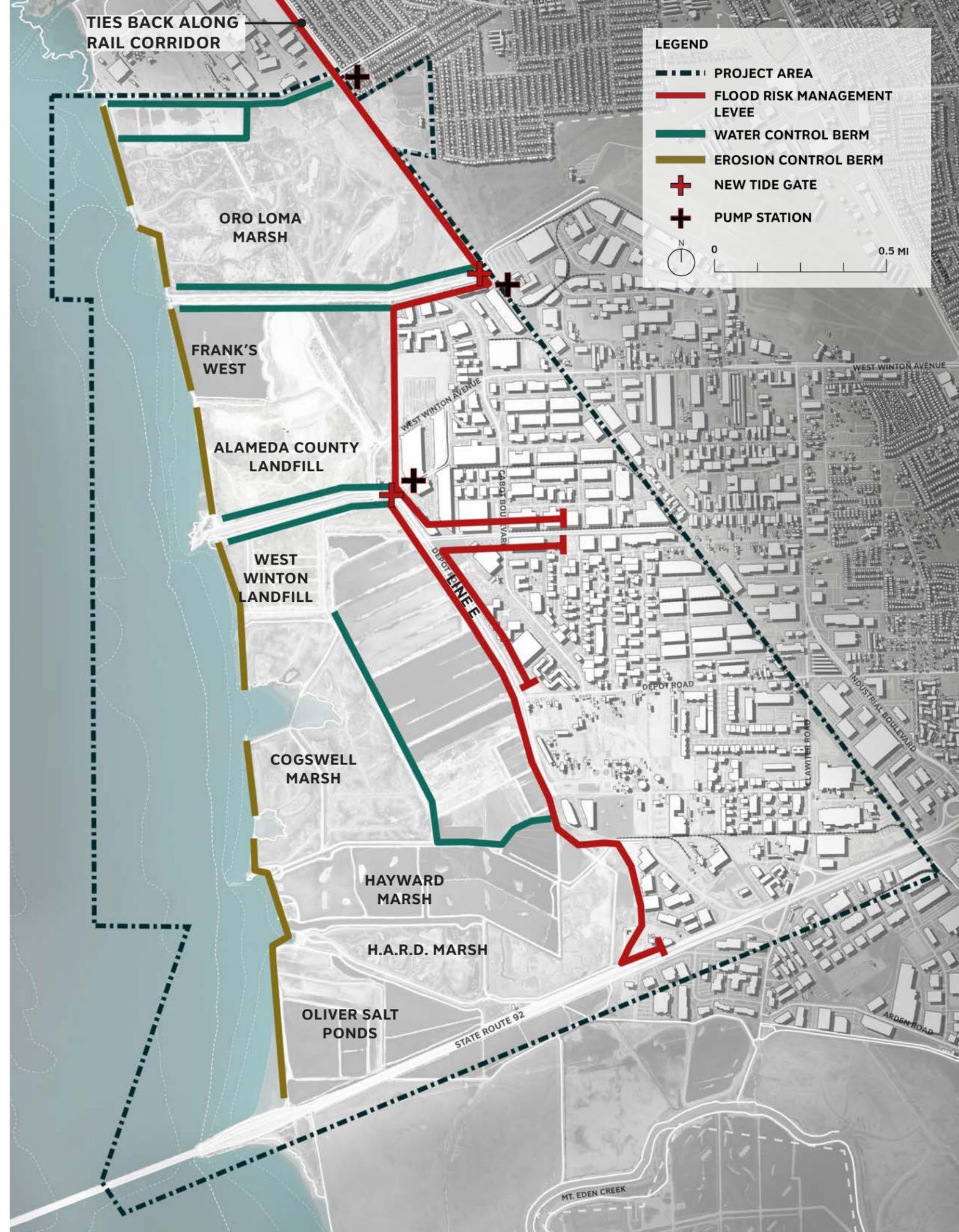
- Raise and repair inland levees for flood risk management
- Raise and repair levees along flood control channels
- Maintain Bay levees to reduce erosion

### PROS

- Provides full protection to upland communities
- Prevents flooding from sea level rise in most areas
- Permits may be easier to attain if there is precedent in the area
- Preserves existing infrastructure, less disruptive than demolishing or replacing with a new construction

### CONS

- Requires pump stations on all flood control channels or increased inland stormwater storage space
- Removes tidal connection for all marshes
- Levees could be extremely tall and wide
- May cause displacement of people, infrastructure and wildlife
- May require the demolition of pre-existing structures to raise ground
- Mid-term strategy that only addresses a 4' SLR scenario





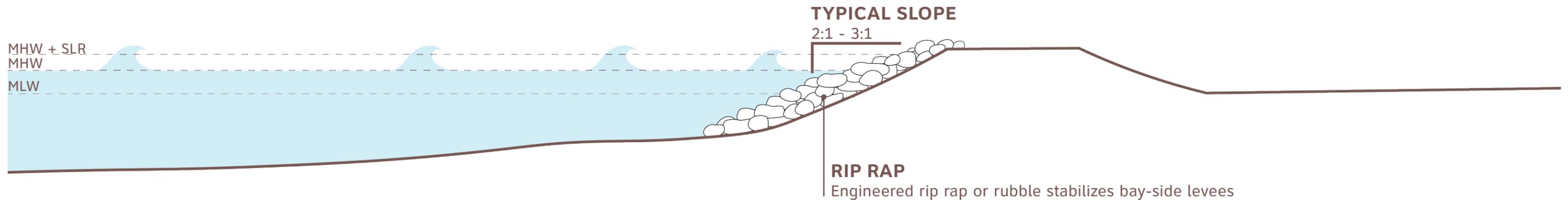
# REVETMENTS

## Definition

Edge stabilization provides **protection along tidal areas to prevent wave erosion**. Revetments are hardened structures made of concrete, rocks, wood, or other materials that are placed along waterways to **stabilize them against wave erosion**. Riprap, which is rock or concrete rubble, is the most common form of shoreline protection revetment structure in San Francisco Bay.

## GOAL / OBJECTIVE

- Reduce erosion along levees, landfills, and marshes



# REVETMENTS

## Precedents

### Eastern Scheldt Diike Enhancement The Netherlands

**Size:** 1.25 miles

**Cost:** ~ \$370/ft

**Implementation Timeline:** 2008-2013

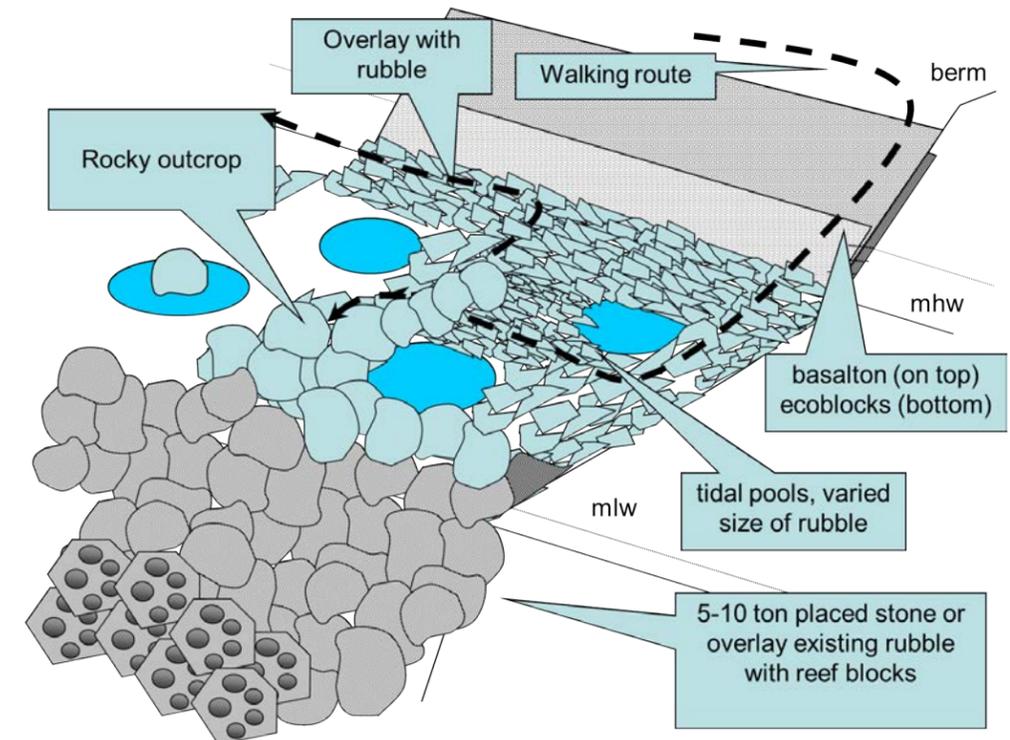
**Applicability:** Ecological enhancement can be tied to the implementation of new and existing dike improvement projects, adding habitat near shoreline marshes and spurring ecological processes (e.g reef building) that increase coastal resiliency. However, these species may not occur in the muddy shore of the Hayward shoreline.

**Description:** Dike enhancement included the provision of tidal pools, or “eco-basins,” intended to improve biodiversity and bio-productivity.

- Important design parameters include the shape and the slope of the structure, the choice of materials, the size distribution and the porosity of the structure.
- Materials such as limestone and lava stone were selected to provide different substrates for species to attach to. Stones were loosely stacked to provide heaps that shelter species from predators. Stones are heavy enough to withstand the forces of wave impact.
- The design could be tailored to provide habitat for reef builders such as mussels and oysters (including associated species, such as crabs), or for macro-algae, which provide habitat to fish and invertebrates.
- A design with dune or salt marsh vegetation could be achieved at the supratidal level.



Tidal pool along stabilized revetment



Dike enhancement components

# REVETMENTS

## Precedents

### Foster City Levee Foster City, CA

**Size:** 8 miles

**Cost:** \$75 million

**Implementation Timeline:** 2015-ongoing

**Applicability:** Targeted revetments along levees reduces erosion and could be combined with further flood protection benefits.

**Description:** Foster City improved their existing levee system to provide flood protection in accordance with updated FEMA guidelines, and to regain FEMA levee accreditation. The flood maps of 2014 showed levee vulnerability, which required the raising and repair of levee segments.

- Roughly 85% of the levee system does not meet FEMA requirements
- FEMA granted Foster City a temporary 'seclusion mapping' designation in 2015 to remain classified as Zone X, as long as progress was made to address the deficiencies of the levee



Aerial view of proposed levee improvement project. Source: Adapting to Rising Tides



Rip rap levee along Beach Park Blvd, looking north

# REVETMENTS

## Option 1: Address Current Erosion Issues

### GOAL / OBJECTIVE

Reduce erosion at vulnerable locations.

### DESCRIPTION

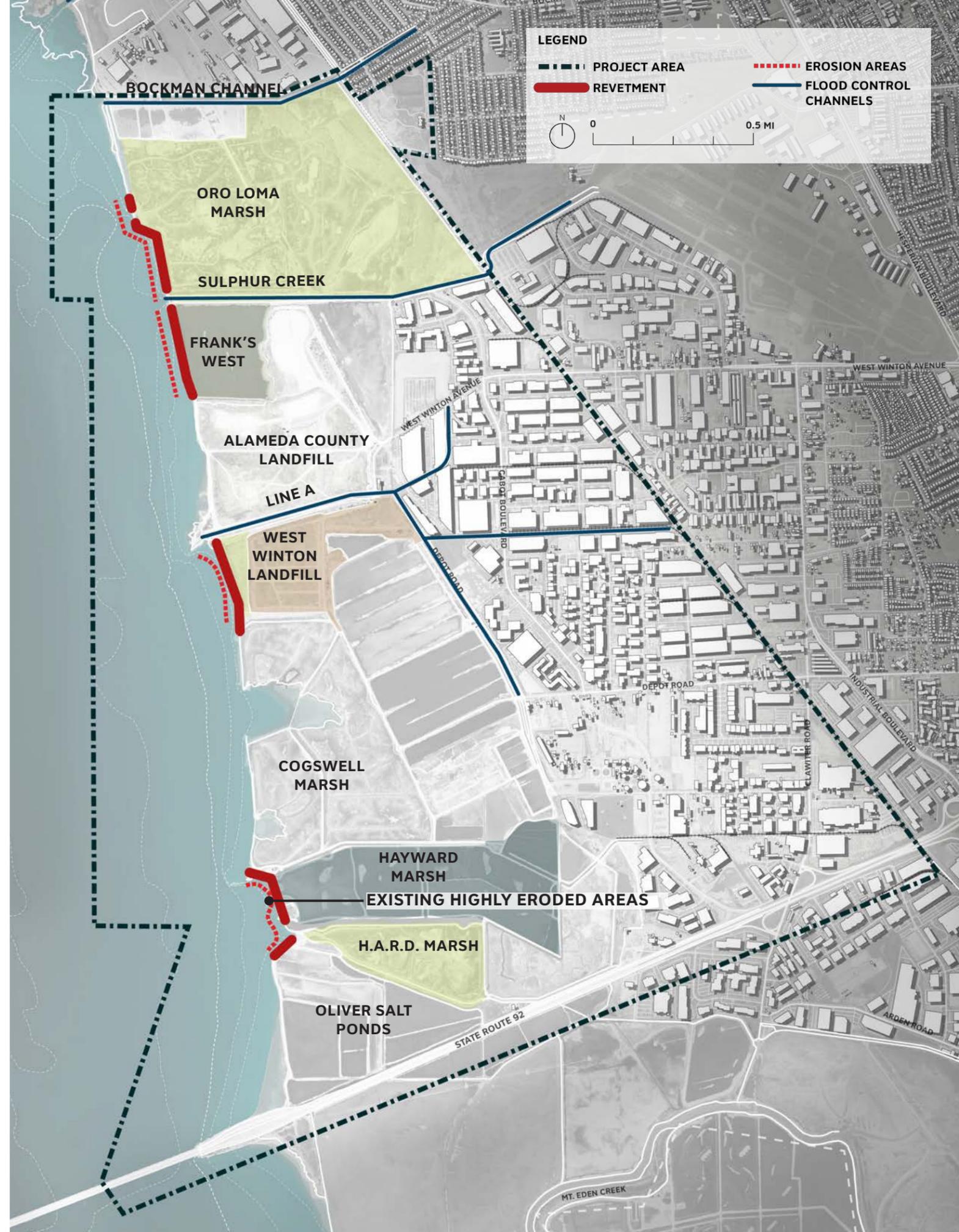
- New revetments along the Bay berms at Oro Loma Marsh, Frank's West, Triangle Marsh, and Hayward Marsh

### PROS

- Stabilizes landfill edges / erosion control
- More cost-effective than bulkheads or seawalls
- Can be designed to provide habitat value
- May facilitate water access
- Can incorporate habitat for animal and plant species

### CONS

- Requires more space for implementation (typically 2:1 slope)
- Requires multiple permits



# REVETMENTS

## Option 2: Stabilize Vulnerable Infrastructure

### GOAL / OBJECTIVE

Reduce erosion to critical infrastructure

### DESCRIPTION

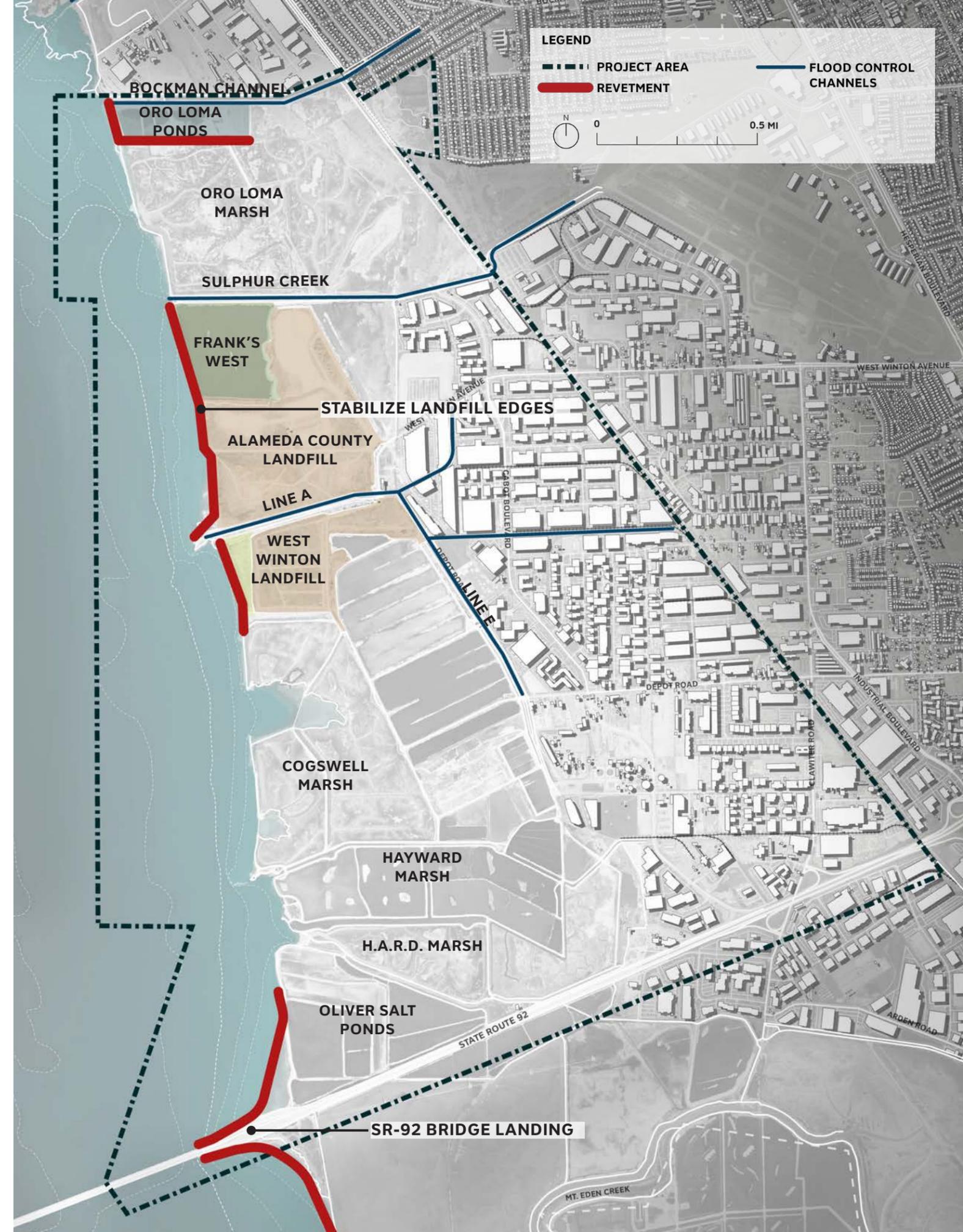
- New revetments along the berms at Oro Loma Ponds, Frank's West, Alameda County Landfill, Triangle Marsh, and SR-92 Bridge Landing

### PROS

- Stabilizes landfill edges / erosion control
- More cost-effective than bulkheads or seawalls
- Can be designed to provide habitat value
- May facilitate water access
- Can incorporate habitat for animal and plant species

### CONS

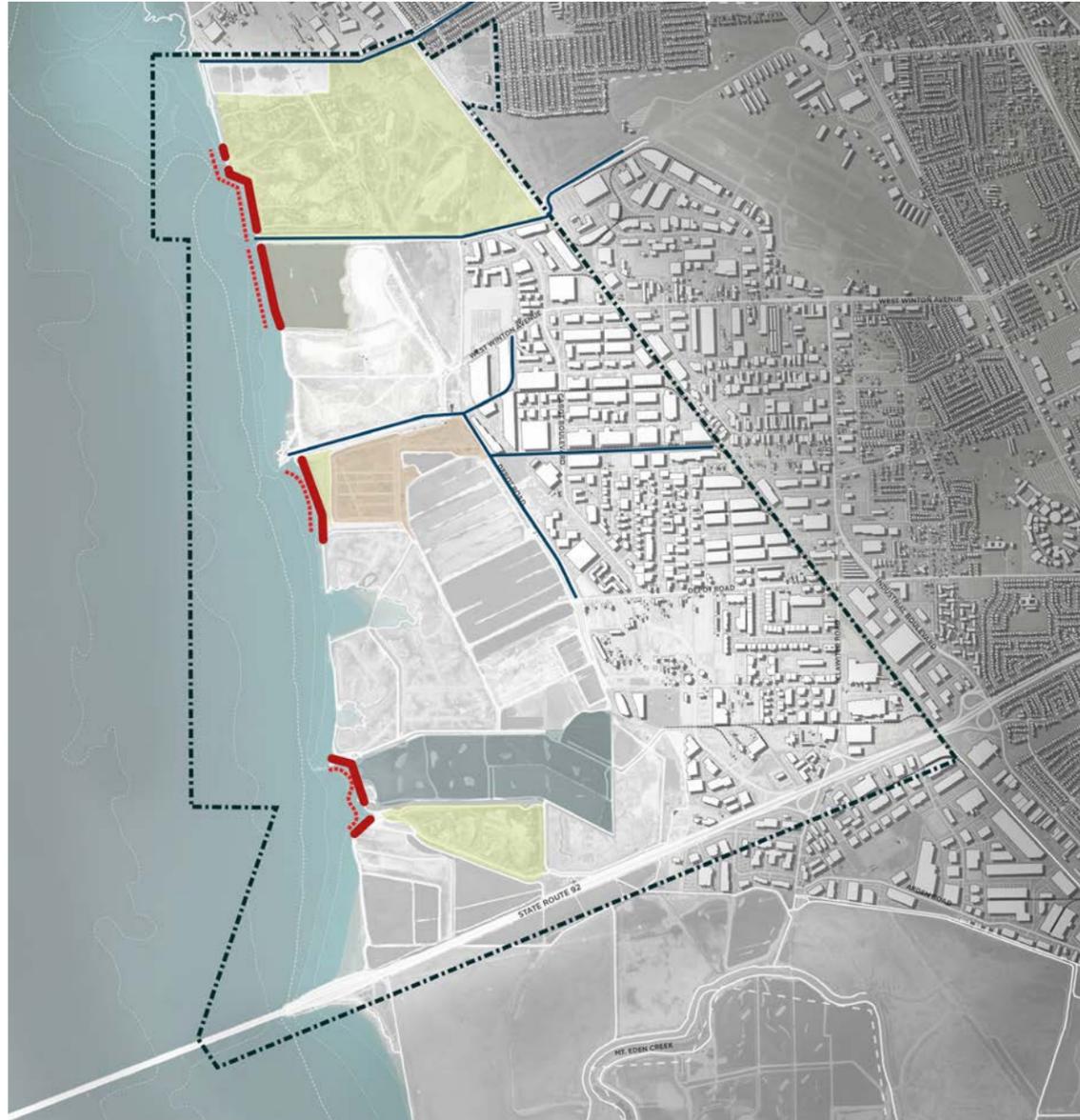
- Requires more space for implementation than a wall (typically 2:1 slope)
- Requires multiple permits



# REVETMENTS

## Combined Options

### 1: Address Current Erosion Issues



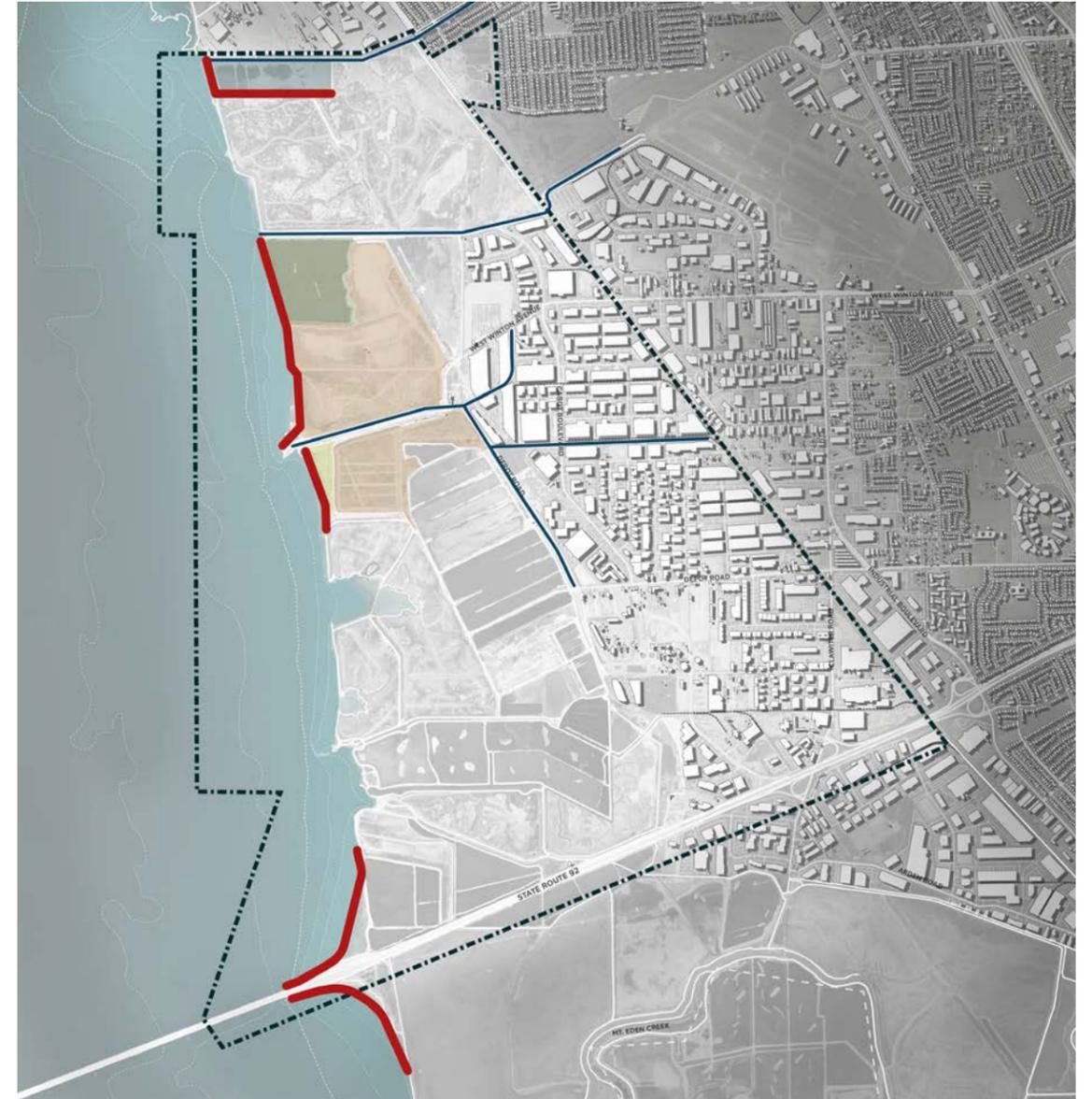
#### COMMENTS

- See General Comments.

#### GENERAL COMMENTS

- COH: DG: It appears that both revetment options benefit HARD and EBRPD asset, which is supported by the City of Hayward. Option 2 also appears to benefit the Caltrans San Mateo Bridge approach, also supported by the City of Hayward. SCAPE: Comment noted.

### 2: Stabilize Vulnerable Infrastructure



#### COMMENTS

- EBRPD: Red line needs to wrap around Oro Loma Ponds in North corner SCAPE will update the diagram accordingly.

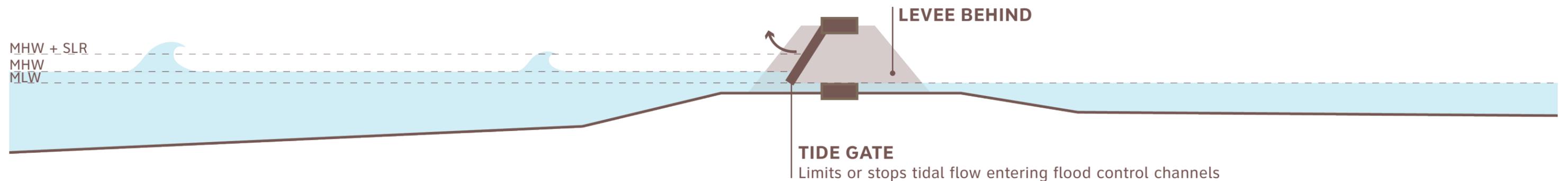
# TIDE GATES & WATER CONTROL STRUCTURES

## Definition

Tide gates **control the movement of water**, specifically from a **tidewater area and a drained, upland area**. Hinged doors at the end of culverts make up the gates and they are controlled by mechanisms that regulate when they open or close.

## GOAL / OBJECTIVE

- Flood protection (stop tidal water from entering channel, allow stormwater out)
- Limit maximum elevation of water (“muted tidal”- tide gates close at a certain elevation, open at same elevation on ebb tide)



# TIDE GATES & WATER CONTROL STRUCTURES

Existing Conditions, 2019



Bockman Channel Tide Gate



Marathon Pump Station at Sulphur Creek



Line E Tide Gate at Depot Road



Tide gate at southern end of Hayward Marsh

# TIDE GATES & WATER CONTROL STRUCTURES

## Precedents

### Ballona Wetlands Project Los Angeles, CA

**Size:** 600 acres

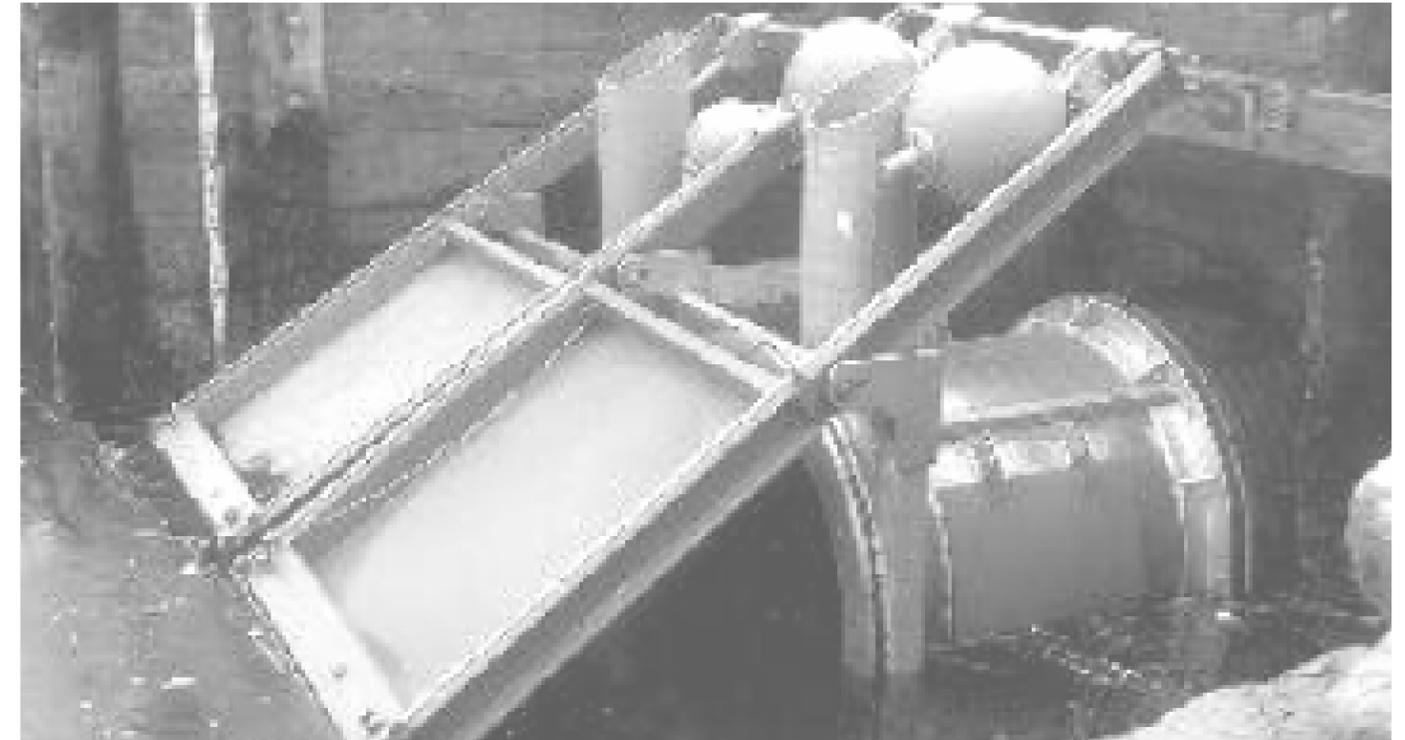
**Cost:** \$10.3 million

**Implementation Timeline:** 2004

**Applicability:** The use of tide gates can provide benefits for flood control, while opening up areas for marsh restoration.

**Description:** 600 acres of the once 2,000-acre mosaic of marshes, mud flats, salt pans, and sand dunes make up the Ballona Wetlands Reserve. A new tide gate is part of the Ballona Wetlands Restoration Project to revive natural coastal wetland functions where they were drastically reduced by residential development.

- Manages flood control while allowing water to flow into the Reserve - recreating a tidal influence
- Enables fish to access wetland habitat
- Increased tidal flushing enhances aquatic habitat
- Seawater within the salt marsh reaches one meter in height



Tide gate manages flood control



Tide gate enables water flow into the reserve

# TIDE GATES & WATER CONTROL STRUCTURES

## Option 1: Upland Tide Gate Relocation

### GOAL / OBJECTIVE

Enhance Bayland ecology.

### DESCRIPTION

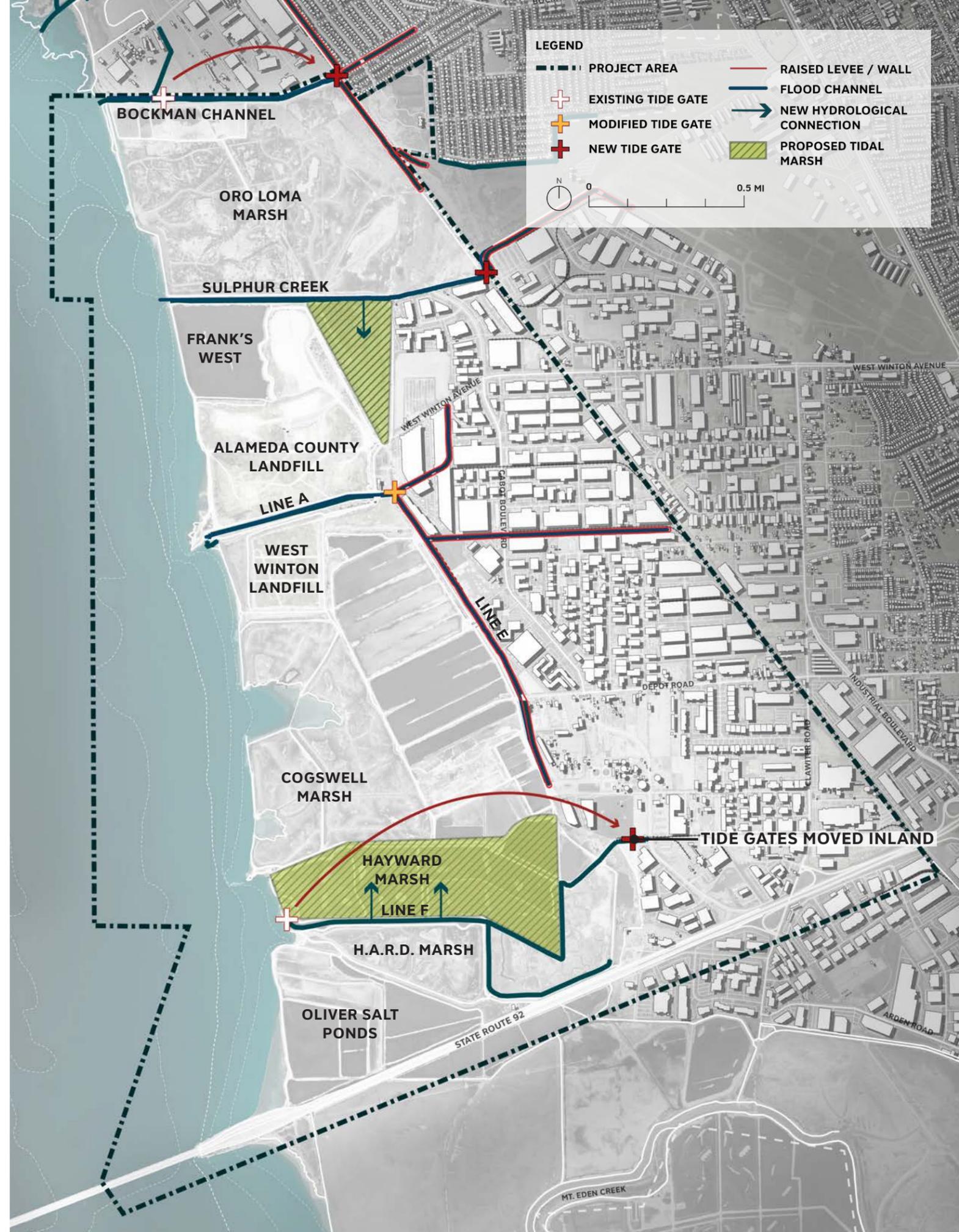
- Tide gate at Sulphur Creek is moved inland to the rail corridor
- Levees are raised along flood control channels inland of tide gates at Bockman Channel, Sulphur Creek, and Line F. Outboard levees could be lowered or removed.

### PROS

- Opens up the potential to breach tributaries into the Baylands to restore tidal marsh
- Cheaper to locate control structures as close to the line of protection as possible
- Cheaper to raise and maintain shorter lengths of levees along the channels

### CONS

- Need for automated tide gate in a more complex hydraulic system



# TIDE GATES & WATER CONTROL STRUCTURES

## Option 2: Storage In Flood Channels / Downstream Tide Gate Relocation

### GOAL / OBJECTIVE

Increase stormwater storage capacity in the channels only.

### DESCRIPTION

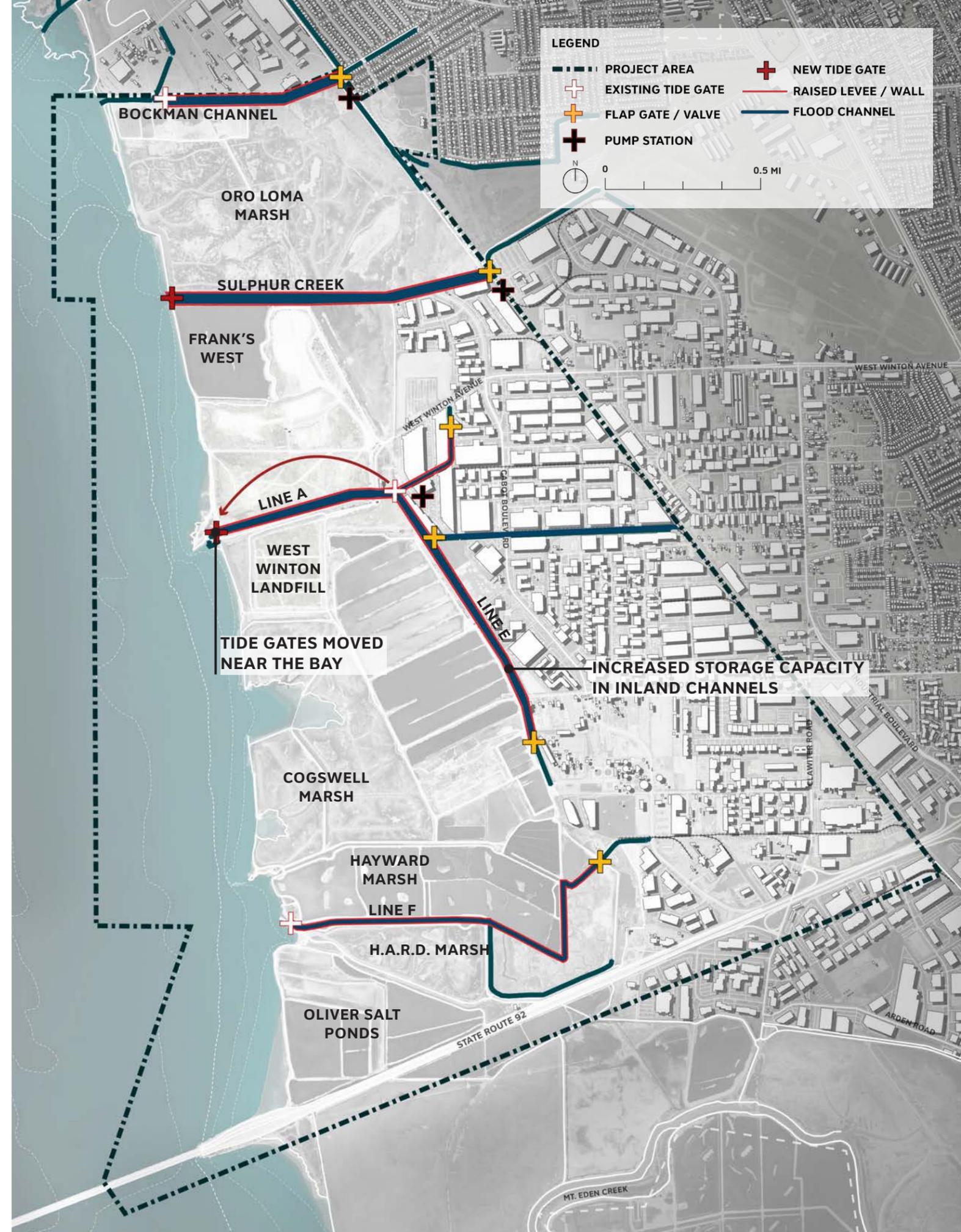
- New tide gates at the Bay's edge along Bockman Channel, Sulphur Creek, and Line A
- New flap gates inland along Sulphur Creek and Line E
- Levees are raised along Bockman Channel, Sulphur Creek, Line A, and Line F, inland of the new tide gate locations
- New pump stations at Bockman Channel, Sulphur Creek, and Line A

### PROS

- Improved storage capacity

### CONS

- Would require pump stations
- Would require increasing the length of levee and raising
- Few viable locations for significant storage volumes
- Limits or eliminates tidal flow in channels which could provide habitat
- May trap sediment before it reaches the Bay, which would require maintenance dredging
- Storage volume assessment required



# TIDE GATES & WATER CONTROL STRUCTURES

## Option 3: Detention Pond Storage / Improving Flood Channels

### GOAL / OBJECTIVE

Increase stormwater storage capacity.

### DESCRIPTION

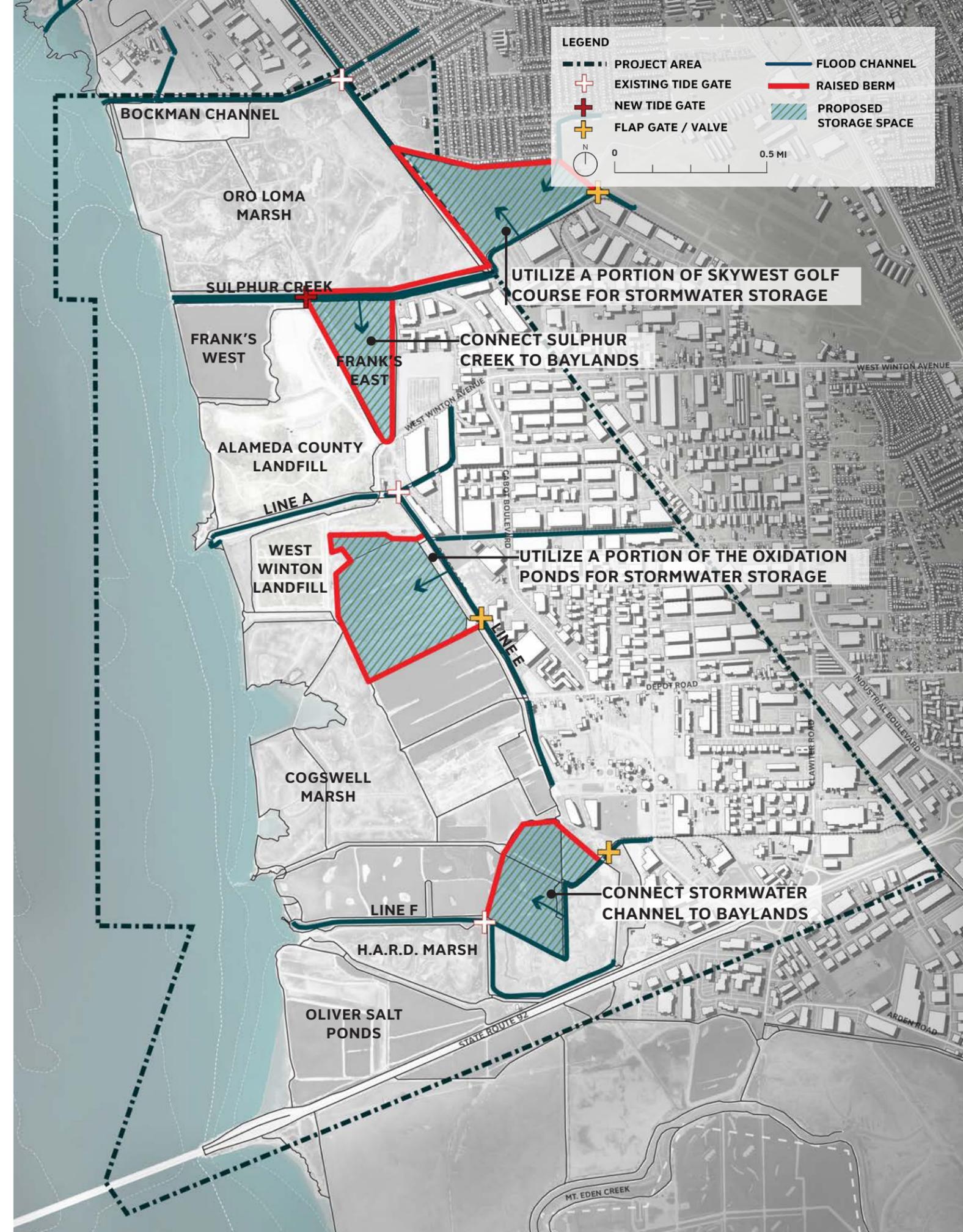
- New flap gates at Sulphur Creek, Line E, and Line F
- New berms around portions of Skywest Golf Course, Frank's East, Oxidation Ponds, and Hayward Marsh

### PROS

- Improved storage is beneficial
- Provides further protection from sea level rise

### CONS

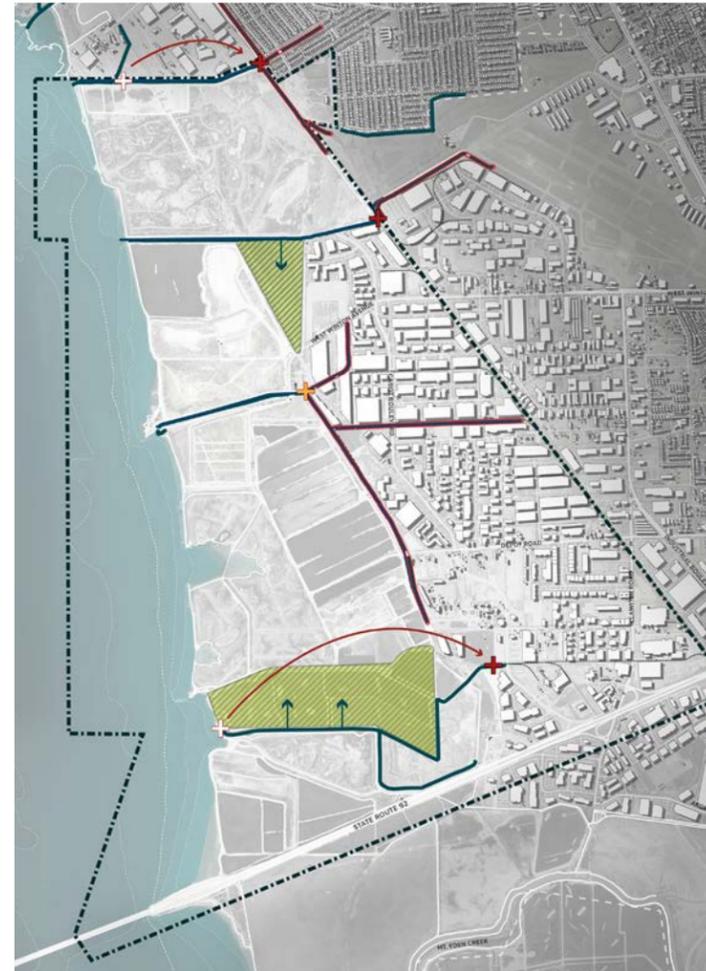
- May contribute to groundwater ponding
- May exacerbate flooding if you don't have sufficient pumping capacity
- Public Works is concerned about the partial loss of oxidation ponds
- Would require pump stations long-term
- May have negative ecological impacts in the water storage areas- salinity shocking
- Storage volume assessment required



# TIDE GATES & WATER CONTROL STRUCTURES

## Compiled Options

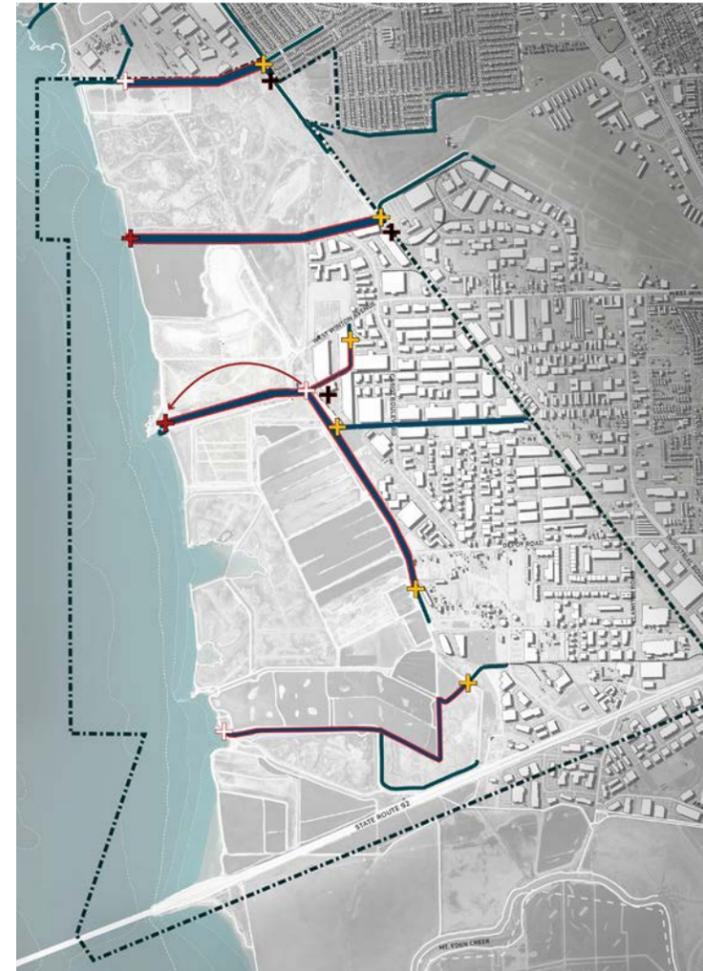
### 1: Upland Tide Gate Relocation



#### COMMENTS

- See General Comments.

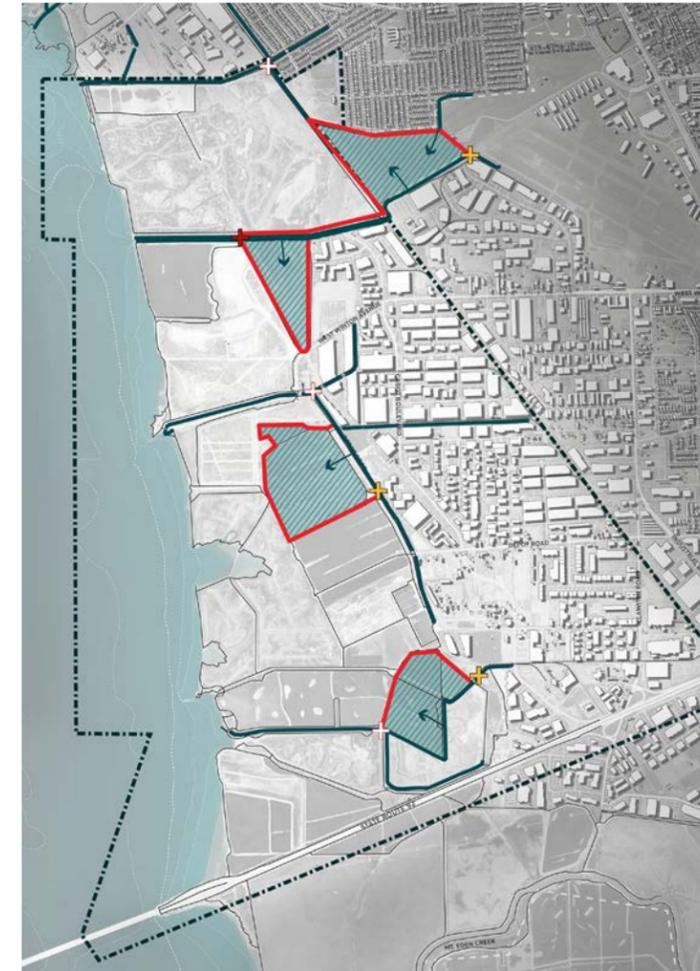
### 2: Storage In Flood Channels / Downstream Tide Gate Relocation



#### COMMENTS

- See General Comments.

### 3: Diked Pond Storage / Improving Flood Channels



#### COMMENTS

- EBRPD: Use of the Skywest golf course might be considered by the City of Hayward. City Manager and City Council review of this idea would be needed. SCAPE will review these options with the City Manager and City Council.

#### GENERAL COMMENTS

- EBRPD: Need to address height of gates. SCAPE: At this point we are not addressing height. Additional feasibility and engineering studies will be needed to address this question. Additional studies are not part of the current scope of work. Those options will also require additional coordination with ACFC.
- COH: DG: Any options involving the oxidation ponds would need input from Hayward's Public Works Utilities staff. Use of the Skywest golf course would need to be consideration by the City Manager and Hayward's City Council. Most options would also need input from the County Flood Control District staff. SCAPE will review these options with Public Works and ACFC.

# WASTEWATER TREATMENT ADAPTATION

## Definition

There is potential to **retrofit wastewater treatment plants** along the shoreline, which are vulnerable to sea level rise. There is interest in studying the **decentralization of WWTP treated discharge**, the decommissioning of the EBDA pipeline, and the potential to **introduce freshwater inputs** to the shoreline with horizontal levee features and other methods of **water polishing and local discharge**.

## GOAL / OBJECTIVE

- Reduce risk to regional critical utilities



MAP OF EBDA PIPELINE

# WASTEWATER TREATMENT ADAPTATION

## Precedents

### Novato Wastewater Treatment Plant Novato, CA

**Size:** 16.5 acres

**Cost:** \$90 million (only for WWTP upgrade)

**Implementation Timeline:** Completed in 2011

**Applicability:** Upgrading or retrofitting existing WWTP's can prove effective to increase their resilience in the future with climate change.

**Description:** An upgraded plant replaced two aging facilities and combines the capacity to meet future needs with a reduced carbon footprint through greater energy efficiency.

- New WWTP was raised to improve the hydraulic gradient so wastewater flows depend more on gravity and less on pumping. Added bonus is that it is less vulnerable to sea level rise, some parts were raised 10 to 14 feet higher
- Lowered energy costs dramatically by cutting pumping demand in half
- The sewer collection system master plan is working to upgrade, improve, and maintain the whole collection system for the Novato Sanitary District



Aerial view of upgraded plant

# WASTEWATER TREATMENT ADAPTATION

## Precedents

### Bay Park Sewage Treatment Plant Nassau County, NY

**Size:** 46 acres / 6,700 LF flood wall

**Cost:** \$830 million

**Implementation Timeline:** 30 months / 2.5 years

**Applicability:** Facility specific protection with community benefits / amenities.

**Description:** A flood barrier system was constructed around the perimeter of the facility and unit substations were raised for added flood protection.

- A berm and flood wall perimeter protection system act as the primary line of defense, protecting the facility from projected 500-year storm surge while providing two points of access to the facility.
- Non-submersible equipment was elevated and new electrical unit substations were constructed above projected flood elevations
- Improvements to surrounding park facilities including green infrastructure and enhancements and alternative drainage systems eliminated standing water under normal storm and tidal conditions, which had previously been an issue.



View of berm and flood wall



View of upgraded flood wall and flood gate

# WASTEWATER TREATMENT ADAPTATION

## Option 1: Oro Loma Local Discharge

### GOAL / OBJECTIVE

Adapt critical infrastructure and enhance marsh migration space.

### DESCRIPTION

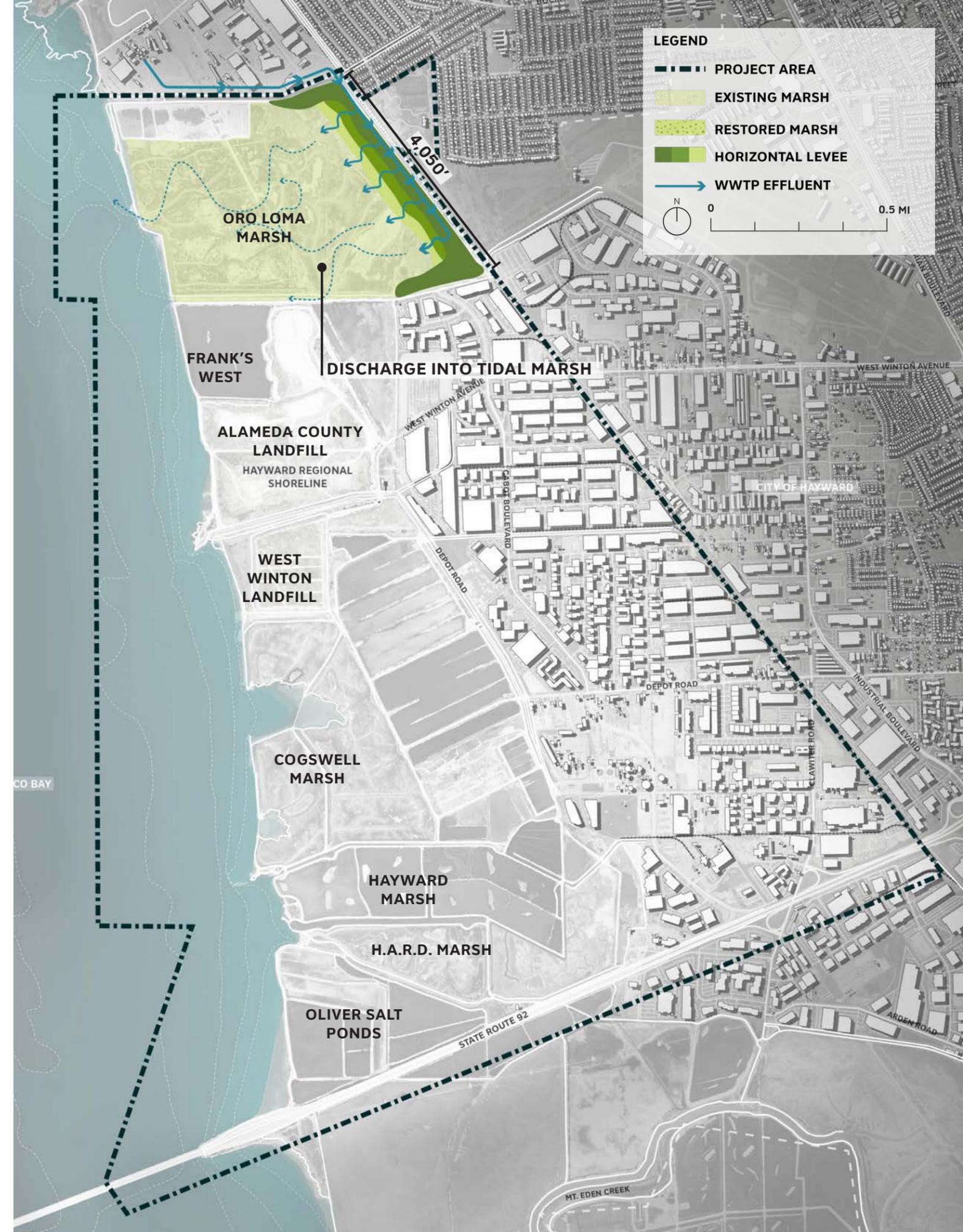
- Horizontal levee along the back of Oro Loma Marsh

### PROS

- Restore salinity gradient to tidal marsh
- Local discharge with EBDA retirement

### CONS

- Need to maintain and raise levee with sea level rise
- May have negative impacts to Oro Loma marsh- increased freshwater would change salinity gradient
- Endangered species habitat loss
- Water board permit is difficult to obtain



# WASTEWATER TREATMENT ADAPTATION

## Option 2: Hayward Treatment + Storage

### GOAL / OBJECTIVE

Adapt critical infrastructure, provide stormwater storage, and enhance freshwater marsh habitat.

### DESCRIPTION

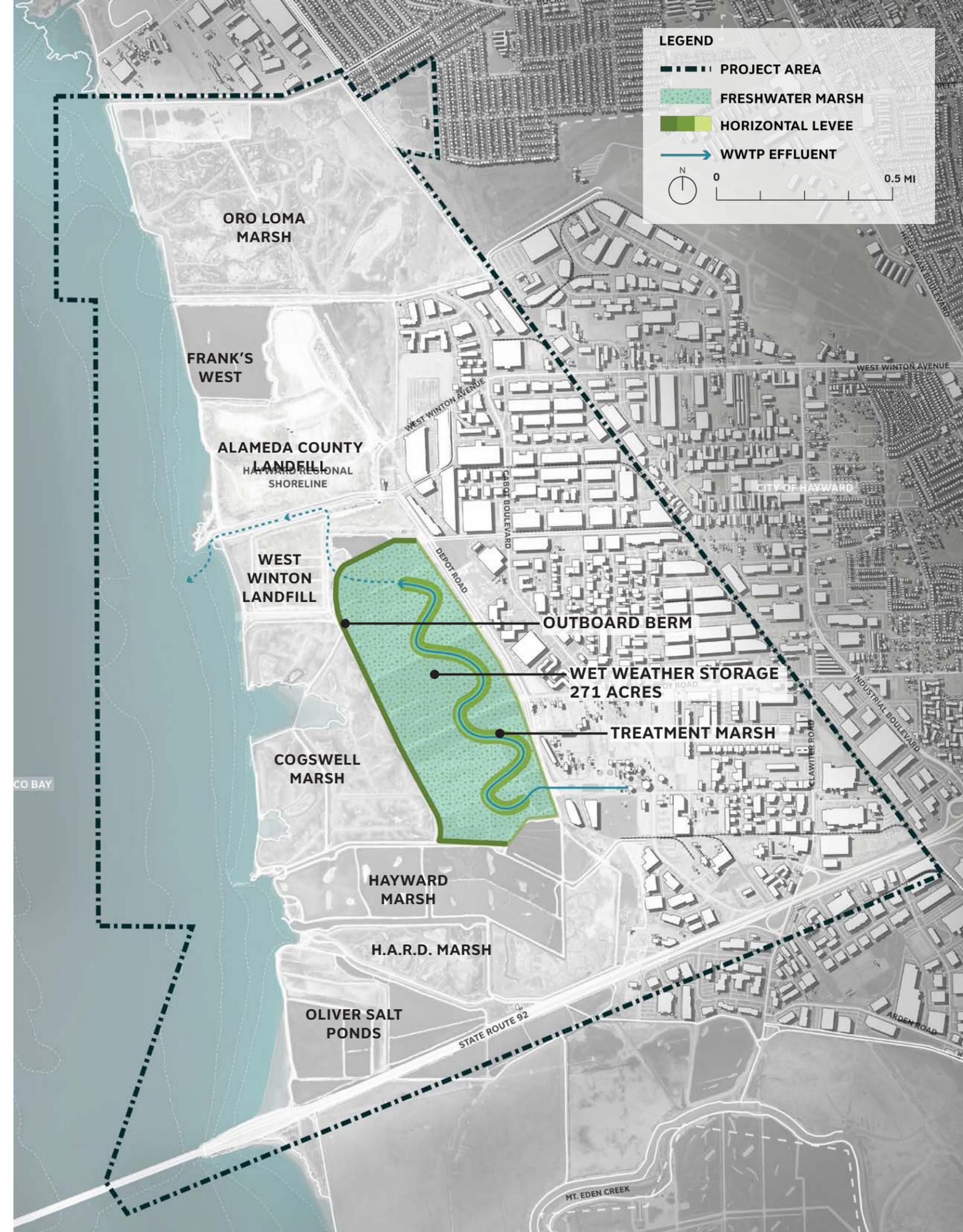
- Freshwater treatment marsh in the Oxidation Ponds
- Raised outboard berm

### PROS

- Increase storage capacity during wet weather events
- Hayward is one of the only WWTPs that can do wet weather equalization

### CONS

- Not directly connected to the bay
- Need to maintain and raise levee with sea level rise
- Water board permit is difficult to obtain
- Loss of solar fields and biosolids management/drying area near the oxidation ponds



# WASTEWATER TREATMENT ADAPTATION

## Option 3: Hayward Local Discharge

### GOAL / OBJECTIVE

Adapt critical infrastructure, enhance marsh migration space, provide stormwater storage space.

### DESCRIPTION

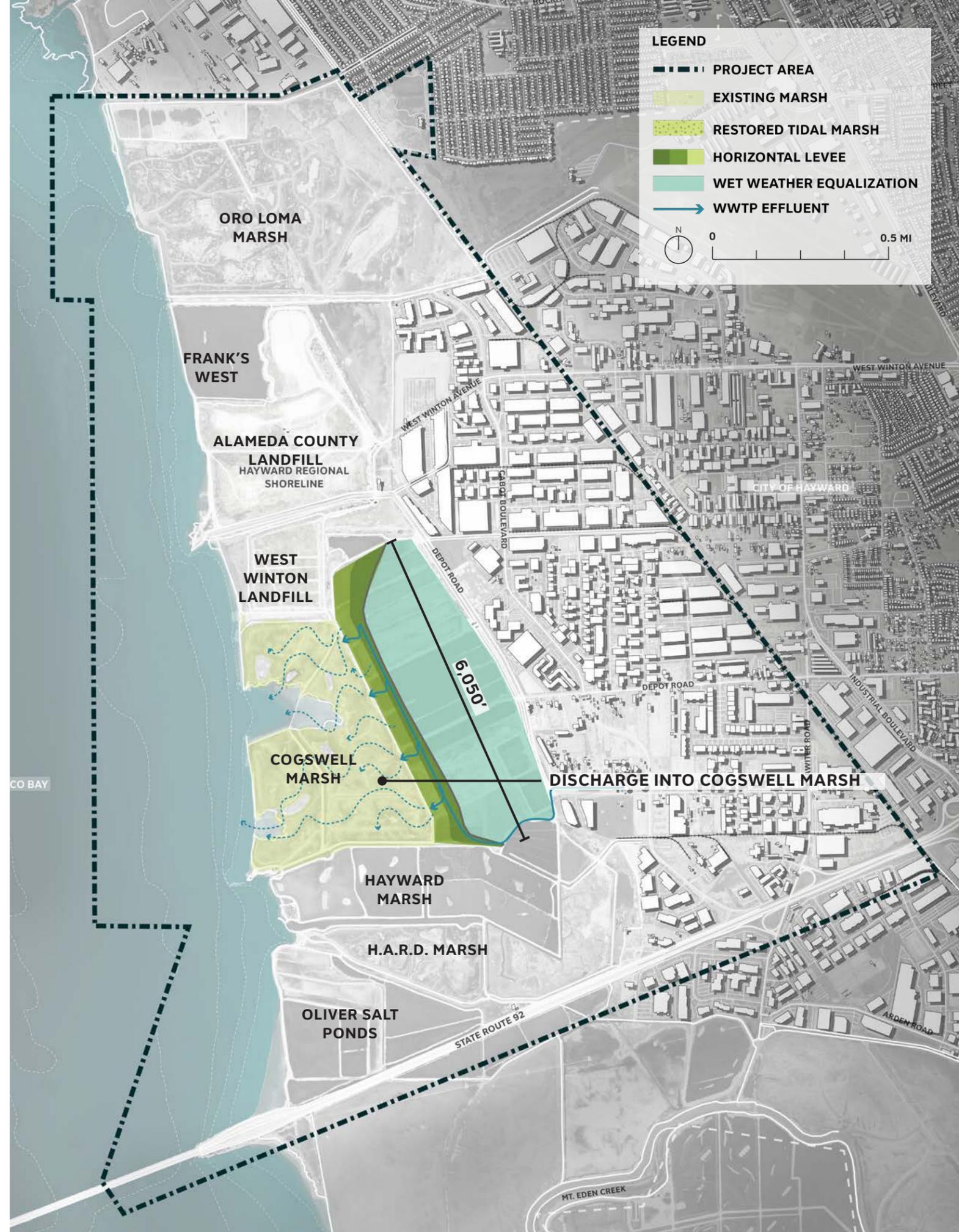
- Horizontal levee along the western extent of the Oxidation Ponds
- Stormwater storage improvements in the rest of the Oxidation Ponds

### PROS

- Locally discharge effluent
- Protects oxidation ponds
- Can tie into a larger ecotone levee

### CONS

- May have negative impacts to Cogswell marsh- increased freshwater would change salinity gradient
- Partial loss of oxidation ponds
- Water board permit is difficult to obtain



# WASTEWATER TREATMENT ADAPTATION

## Option 4: Fully Tidal Discharge

### GOAL / OBJECTIVE

Adapt critical infrastructure, enhance marsh migration space, provide stormwater storage space.

### DESCRIPTION

- Horizontal levee in the back of Oro Loma Marsh and through the middle of the Oxidation ponds
- Water storage improvements on the inland side of the Oxidation Ponds

### PROS

- May be able to discharge from other WWTPs
- Fully tidal system, able to accrete and connect to Cogswell Marsh
- Pair with horizontal levee
- Restore salinity gradient to tidal marsh
- Local discharge with EBDA retirement

### CONS

- Restrictions on discharge into fully tidal system- not permitted yet
- Nearshore discharge would be less likely than maintaining the EBDA pipeline
- May negatively impact existing marsh systems- increased freshwater would change salinity gradient and may lead to loss of habitat over time if the area is fully tidal
- Partial loss of oxidation ponds
- Water board permit is difficult to obtain
- Not a viable option for the City of Hayward



# WASTEWATER TREATMENT ADAPTATION

## Compiled Options

### 1: Oro Loma Local Discharge



#### COMMENTS

- See General Comments.

#### GENERAL COMMENTS

- COH: DG: All possible adaptation measures should be reviewed and commented on by the City of Hayward's Public Works Utilities staff. SCAPE will review these options with Public Works

### 2: Hayward Treatment + Storage



#### COMMENTS

- COH: EP: Significant portion of freshwater marsh and horizontal levee are not oxidation ponds, but have been repurposed for solar fields and biosolids management/drying area. SCAPE will note the loss of these uses in the Cons.
- COH: EP: Not viable option for the City of Hayward SCAPE will not consider this option moving forward.

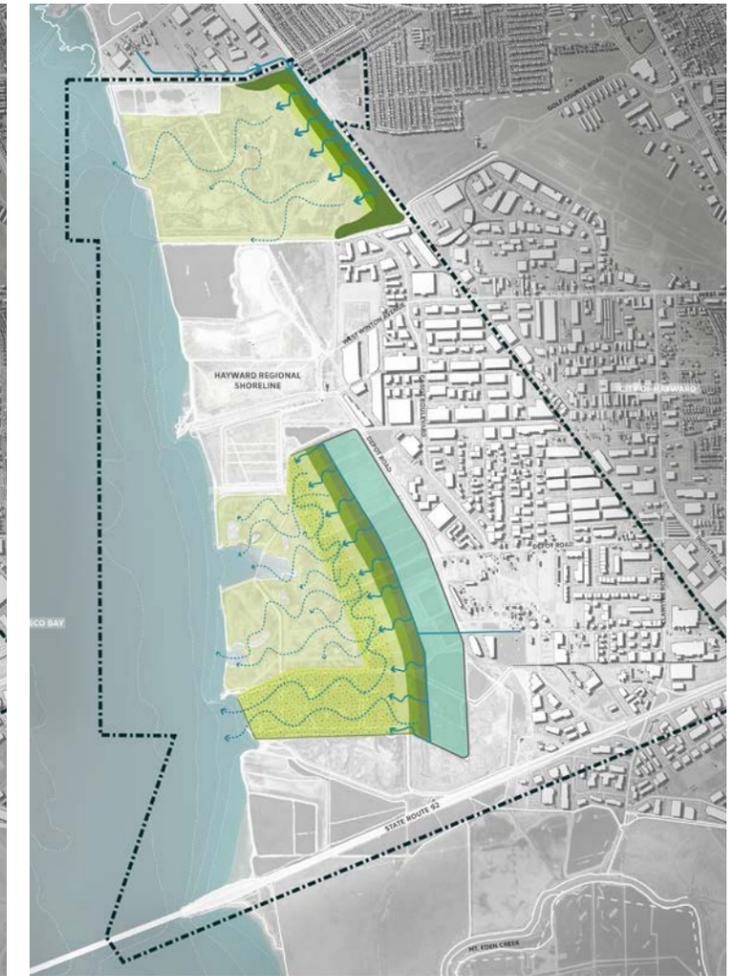
### 3: Hayward Local Discharge



#### COMMENTS

- See General Comments.

### 4: Fully Tidal Discharge



#### COMMENTS

- EBRPD: Concerned about the impacts to the existing marsh system and loss of habitat overtime if area is fully tidal. SCAPE will add this to the Cons.
- COH: EP: Not viable option for the City of Hayward SCAPE will add this to the Cons.

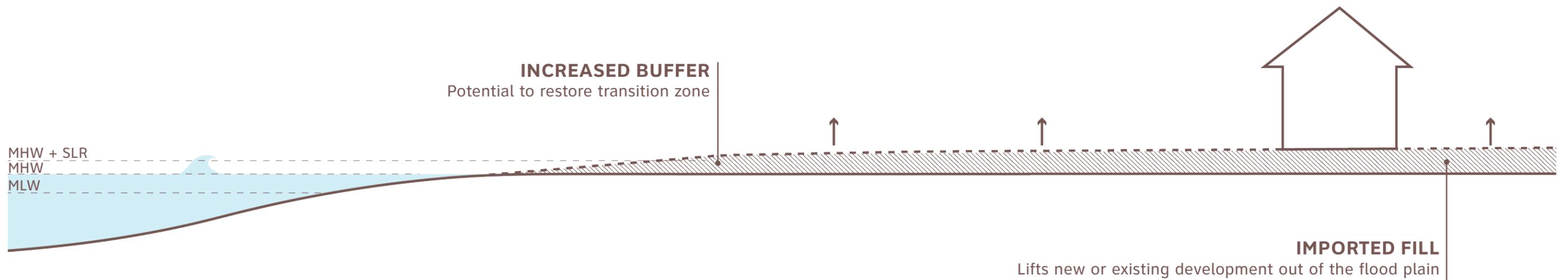
# LAND ELEVATION

## Definition

Elevating land at the site or district scale above a design flood elevation to **lift future development and transportation assets out of the flood zone**. This is often done to **reduce the risk of flooding** for new development or new uses.

## GOAL / OBJECTIVE

- Reduce risk to SLR, flood events, and groundwater emergence



# LAND ELEVATION

## Precedents

### Arverne-By-The-Sea Queens, NY

**Size:** 120 acres

**Cost:** \$1 billion

**Implementation Timeline:** 2003-2017

**Applicability:** Land elevation of key sites may be applicable for infrastructure assets that would be hard to relocate. This would lift them out of the flood or SLR inundation elevation, however connectivity to these areas may be impacted.

**Description:** Developers added more than half a million cubic yards of fill to raise most of the site 3-9 feet above the 100 year floodplain. Combined with a number of resiliency features such as expanded beach, fortified dunes, extensive stormwater drainage, and on-site stormwater retention, the site fared well during Superstorm Sandy.

- Wide beach and fortified dunes act as first line of defense against storm surges and sea level rise
- Sandy dunes may not settle as much as compacted fill
- Utilities were installed underground and some, like electrical infrastructure, were protected with waterproofing measures.
- Storm drains throughout development connected to underground drainage system that included on-site water retention
- Resilience measures help avoid significant damage in storm events and save costs associated with flood insurance



Open expanse of gravel provides nesting habitat



Gravel deposition during construction

# LAND ELEVATION

## Option 1: West of Cabot Boulevard

### GOAL / OBJECTIVE

Reduce risk of groundwater emergence and SLR inundation.

### DESCRIPTION

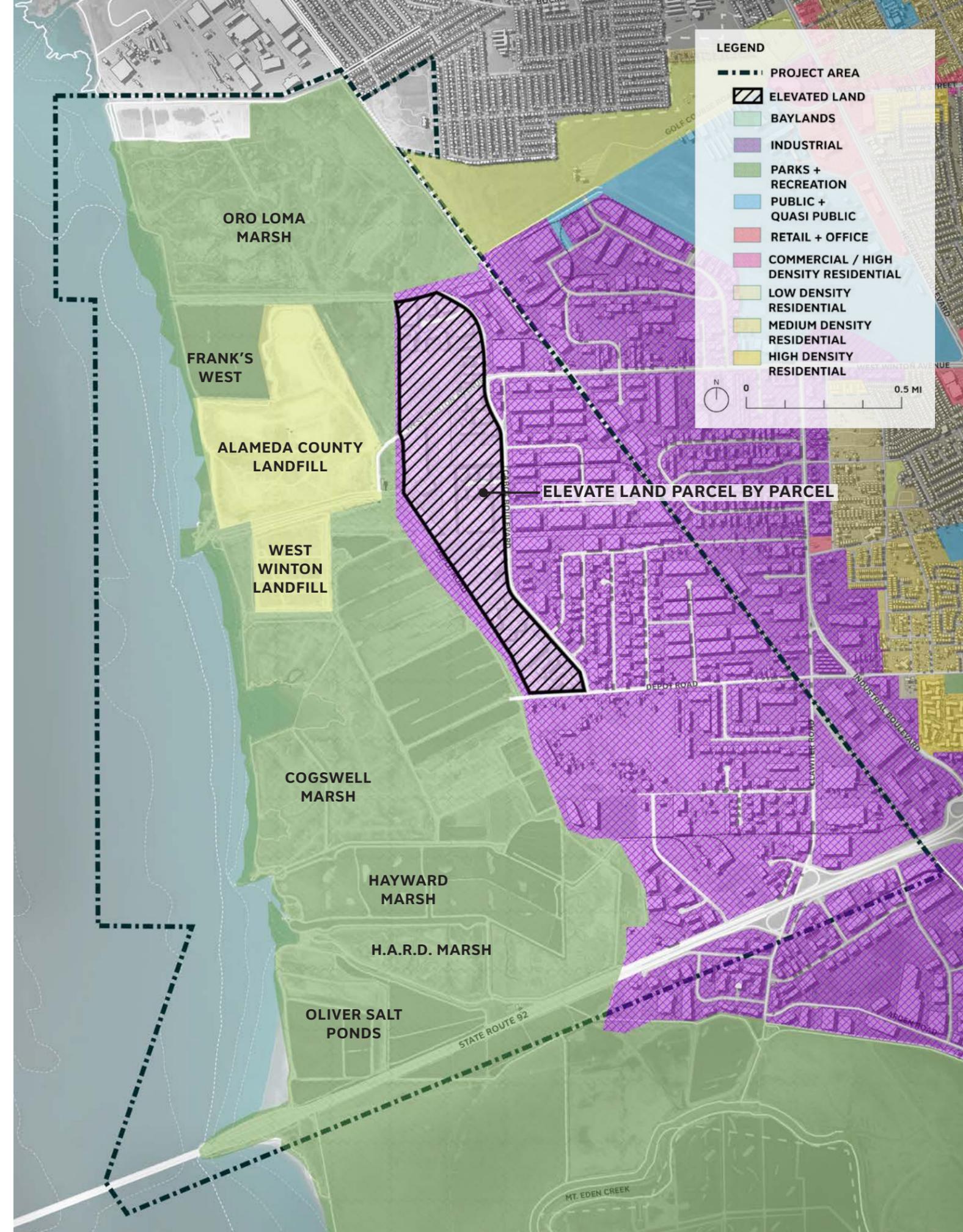
- Elevate land parcel-by-parcel as businesses retrofit buildings or build new ones

### PROS

- Reduces risk of future development and transportation assets to flooding and groundwater emergence in targeting area of highest risk
- May help remediate brownfields and reduce flood insurance rates

### CONS

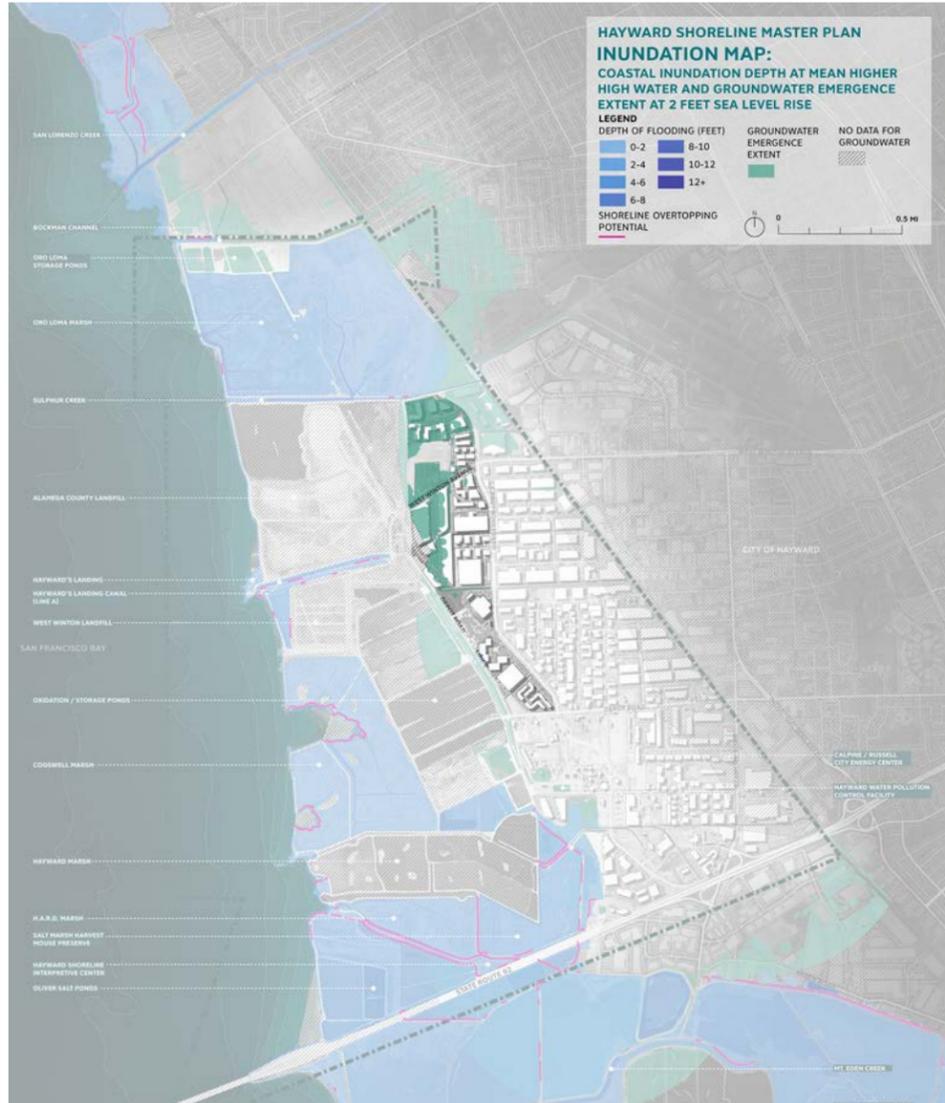
- Requires a significant amount of clean dirt or fill
- Raising land elevation on historic marshes and Bay mud may lead to significant settlement and subsidence
- Raising elevations in a patchwork pattern is difficult for transportation and drainage connectivity
- Can lead to compaction and subsidence
- May cause disturbance to adjacent land
- May only provide short-term solution for sea level rise
- Would be very costly
- May create an isolated island with SLR and connectivity may be compromised



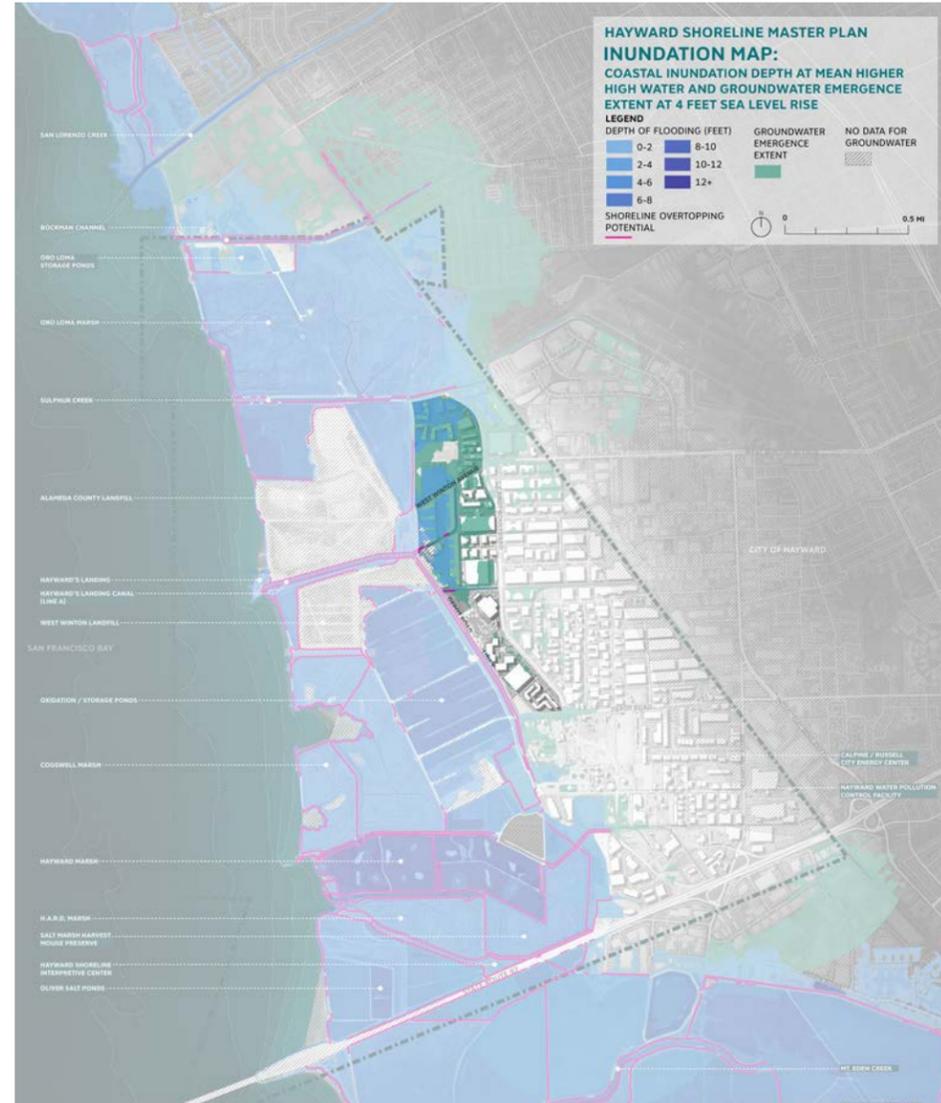
# LAND ELEVATION

## Option 1: West of Cabot Boulevard

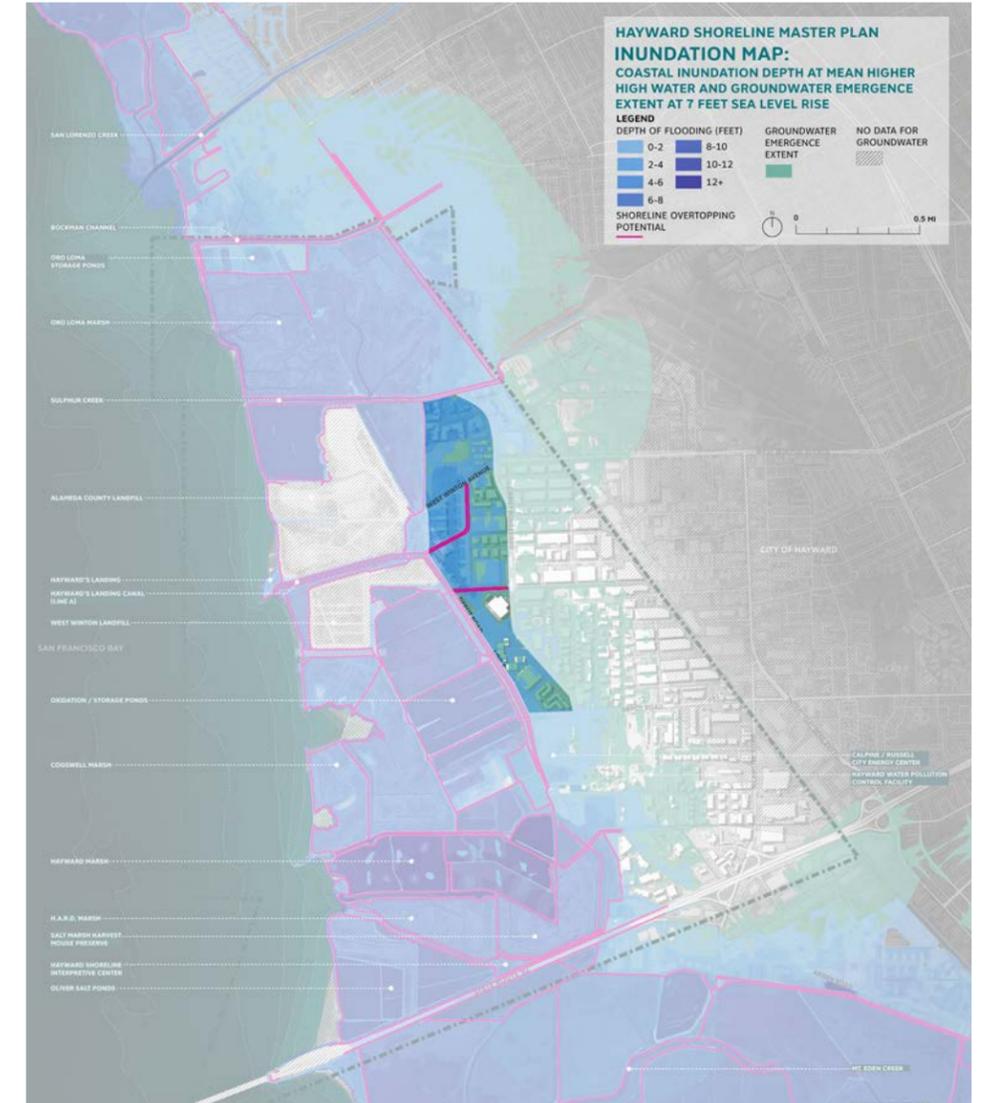
### 2' SLR



### 4' SLR



### 7' SLR



# LAND ELEVATION

## Option 2: Bay Buffer

### GOAL / OBJECTIVE

Reduce risk of groundwater emergence and SLR inundation.

### DESCRIPTION

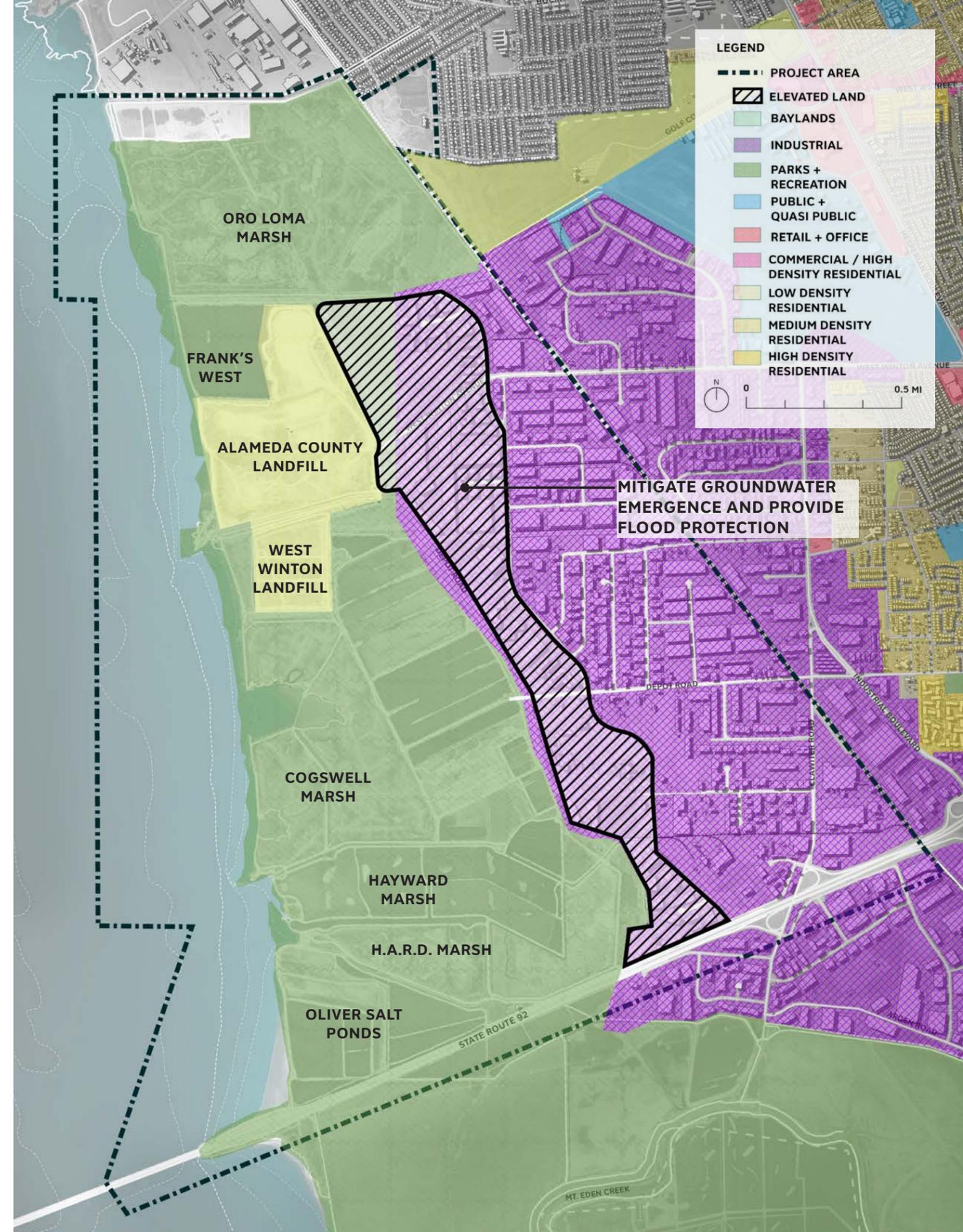
- Elevate industrial parcels west of Cabot Blvd

### PROS

- Reduces risk of industrial park to flooding and groundwater emergence
- May help remediate brownfields and reduce flood insurance rates
- Potential to connect to a regional line of protection
- Connectivity is less of an issue- specific sites can raise the road to the new development

### CONS

- Requires redevelopment of a portion of the industrial park, causing significant temporary displacement
- Requires a significant amount of clean dirt or fill
- Raising land elevation on historic marshes and Bay mud may lead to significant settlement and subsidence
- Can lead to compaction and subsidence
- May cause disturbance to adjacent land
- Would be very costly



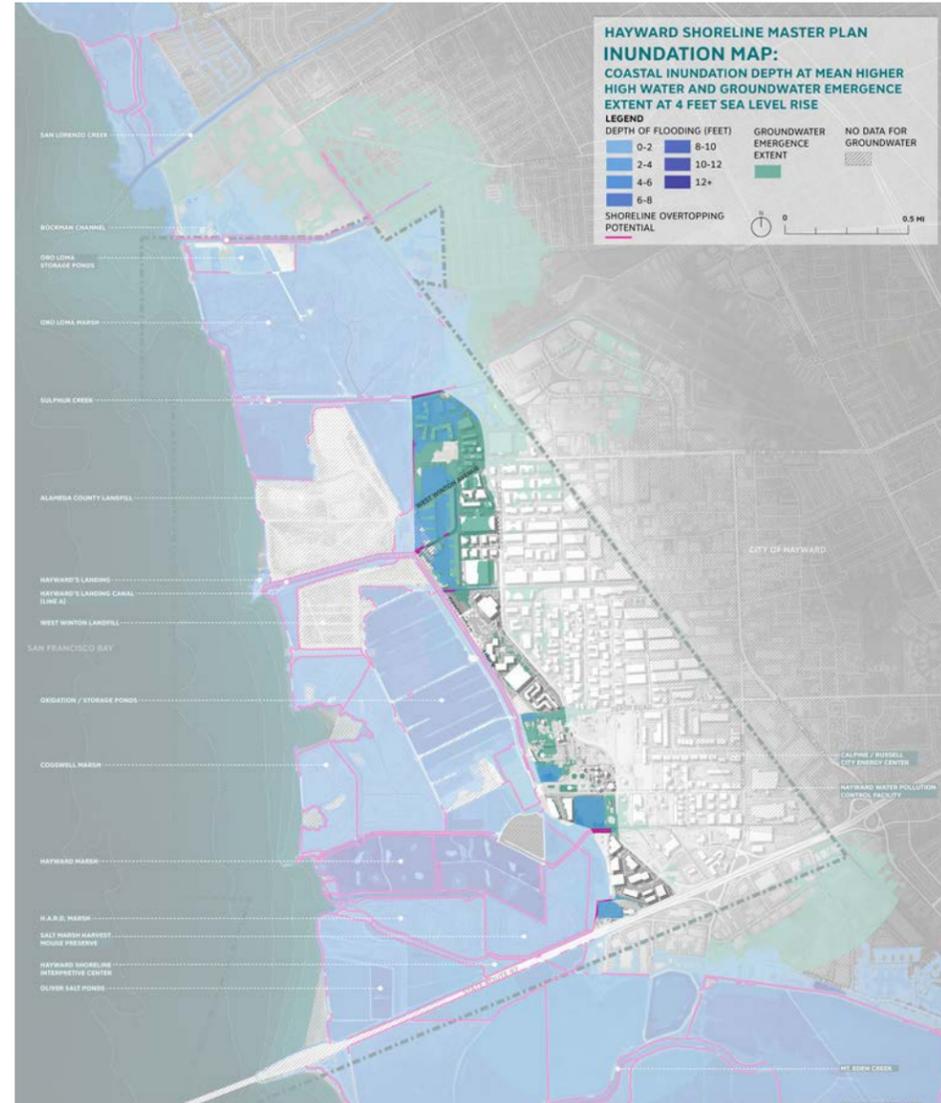
# LAND ELEVATION

## Option 2: Bay Buffer

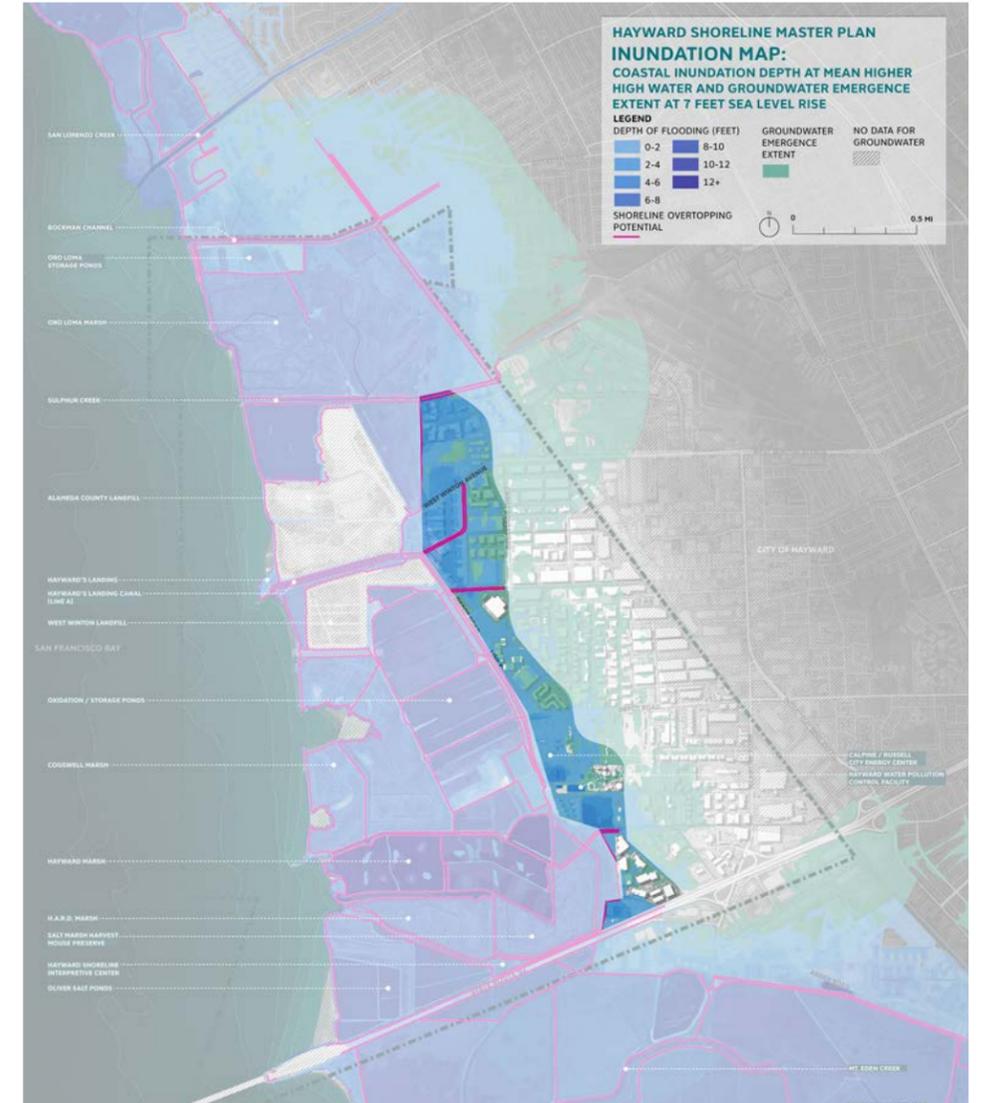
### 2' SLR



### 4' SLR



### 7' SLR



# LAND ELEVATION

## Option 3: Industrial Neighborhood

### GOAL / OBJECTIVE

Reduce risk of groundwater emergence and SLR inundation.

### DESCRIPTION

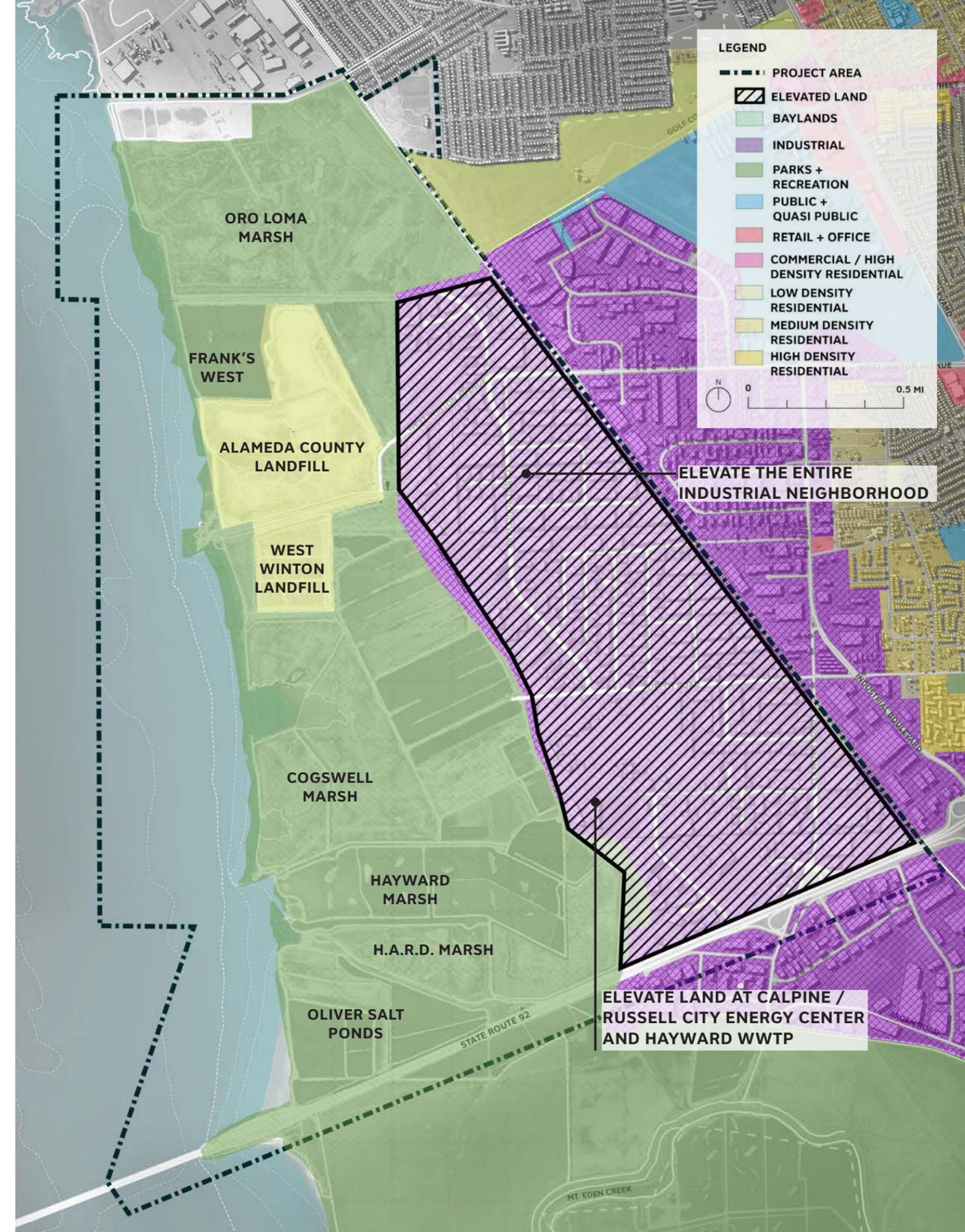
- Elevate the entire industrial neighborhood

### PROS

- Reduces risk of industrial park to flooding and groundwater emergence
- May help remediate brownfields and reduce flood insurance rates

### CONS

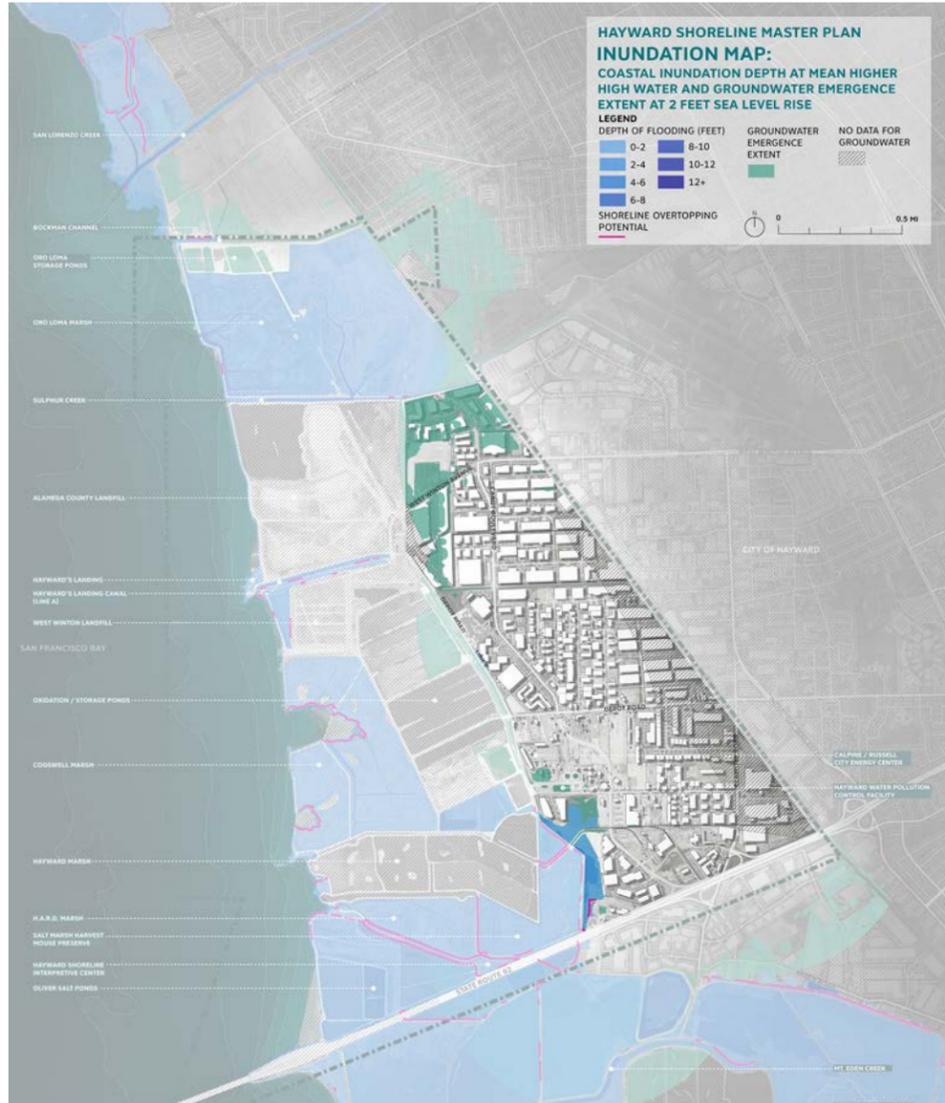
- Requires complete redevelopment of industrial park, causing significant temporary displacement
- Requires a significant amount of clean dirt or fill
- Raising land elevation on historic marshes and Bay mud may lead to significant settlement and subsidence
- Raising elevations in a patchwork pattern is difficult for transportation and drainage connectivity
- Can lead to compaction and subsidence
- May cause disturbance to adjacent land
- May only provide short-term solution for SLR
- Would be very costly
- May create an isolated island with SLR and connectivity may be compromised



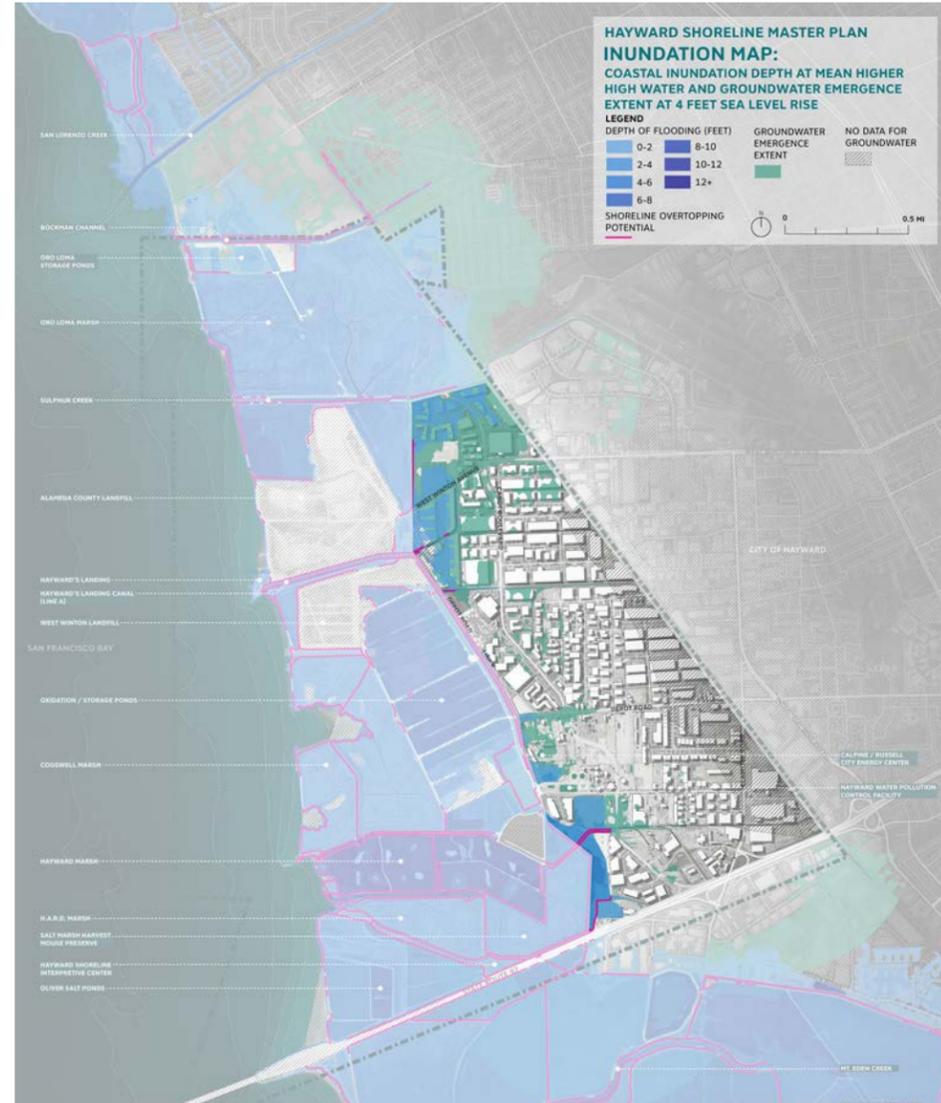
# LAND ELEVATION

## Option 3: Industrial Neighborhood

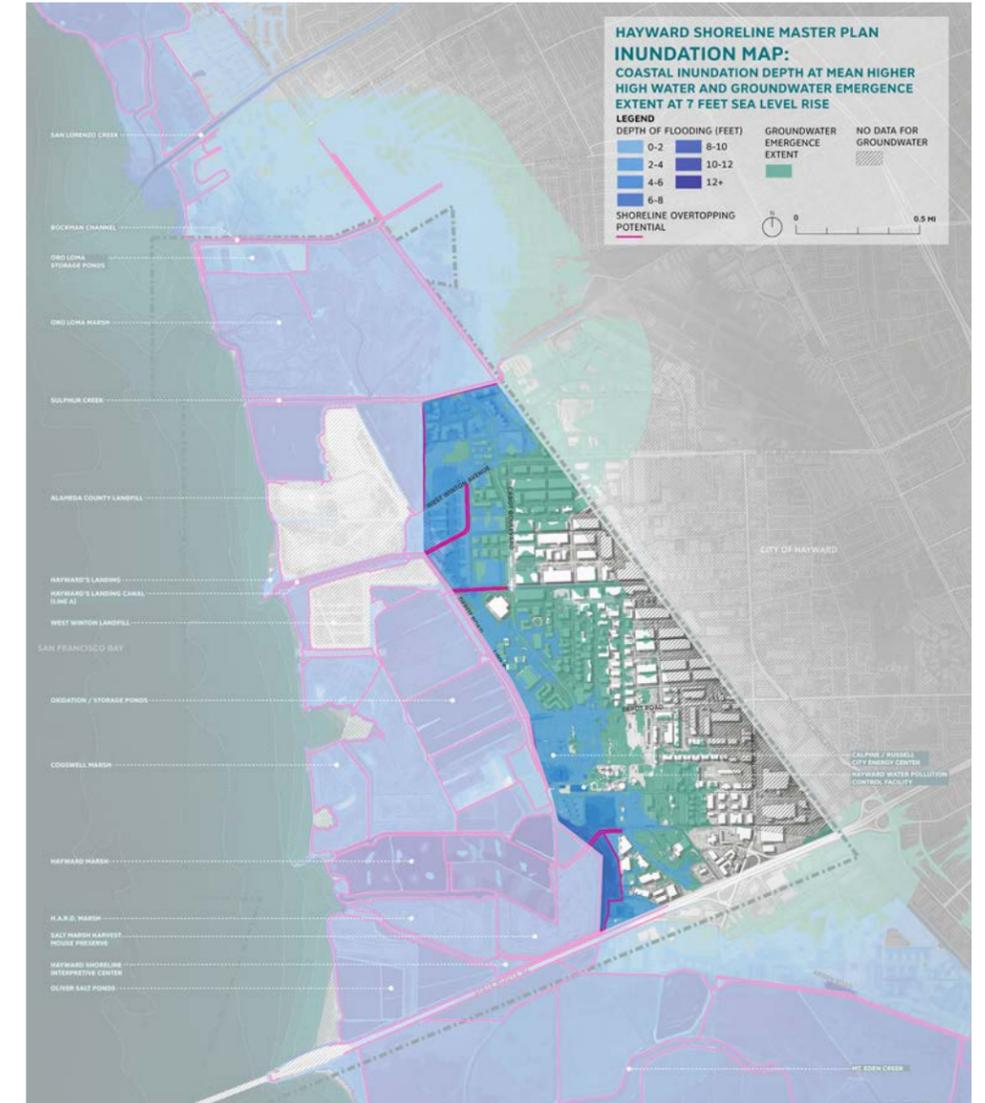
### 2' SLR



### 4' SLR

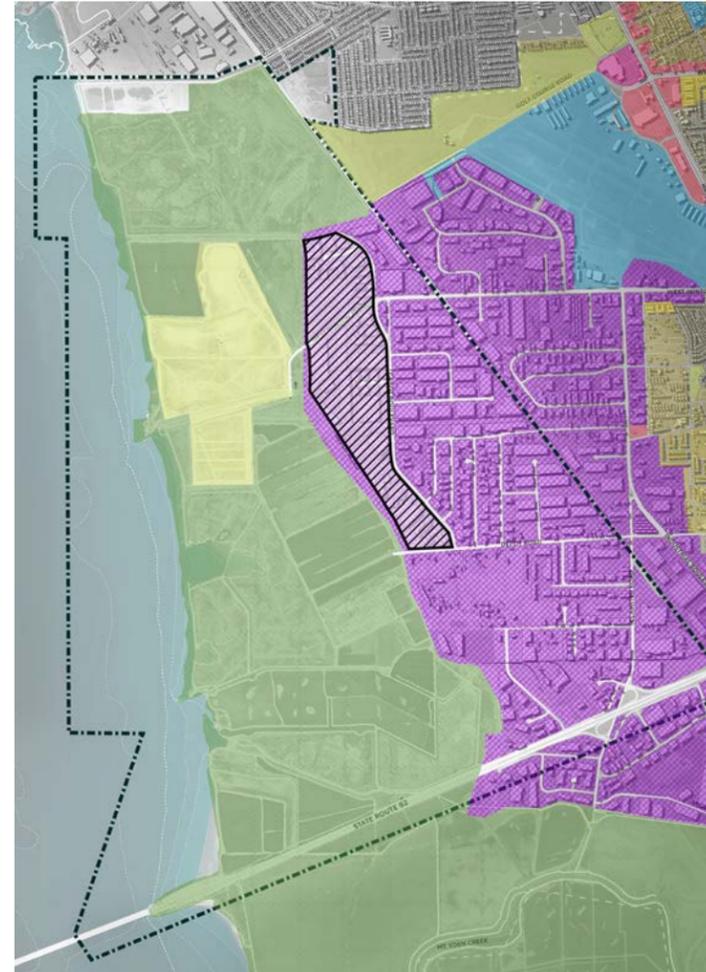


### 7' SLR



# LAND ELEVATION Compiled Options

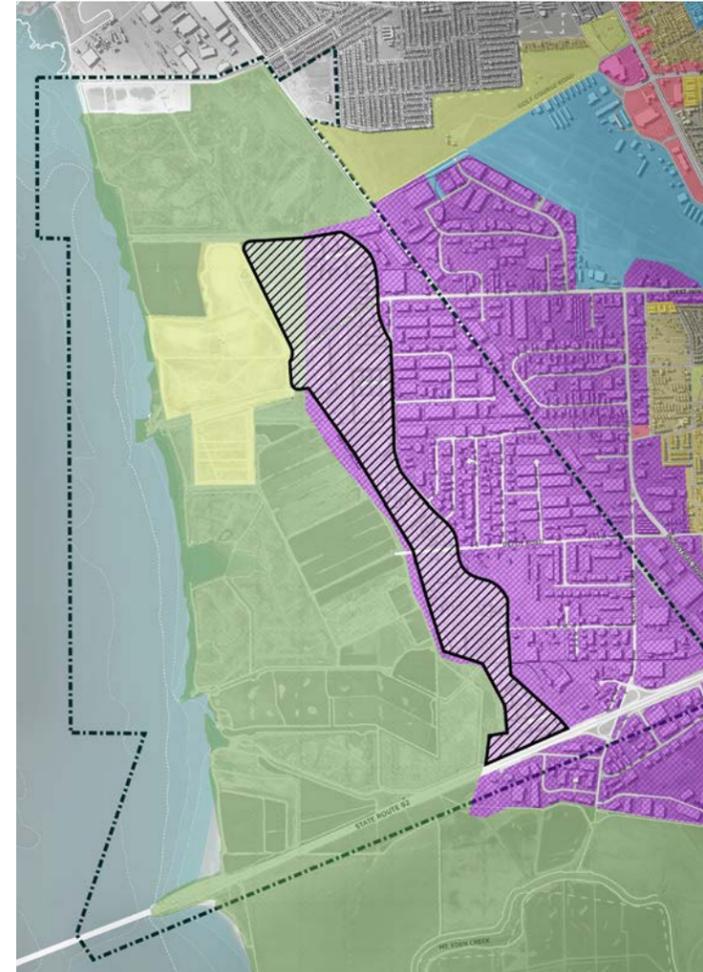
## 1: West of Cabot Boulevard



### COMMENTS

- See General Comments.

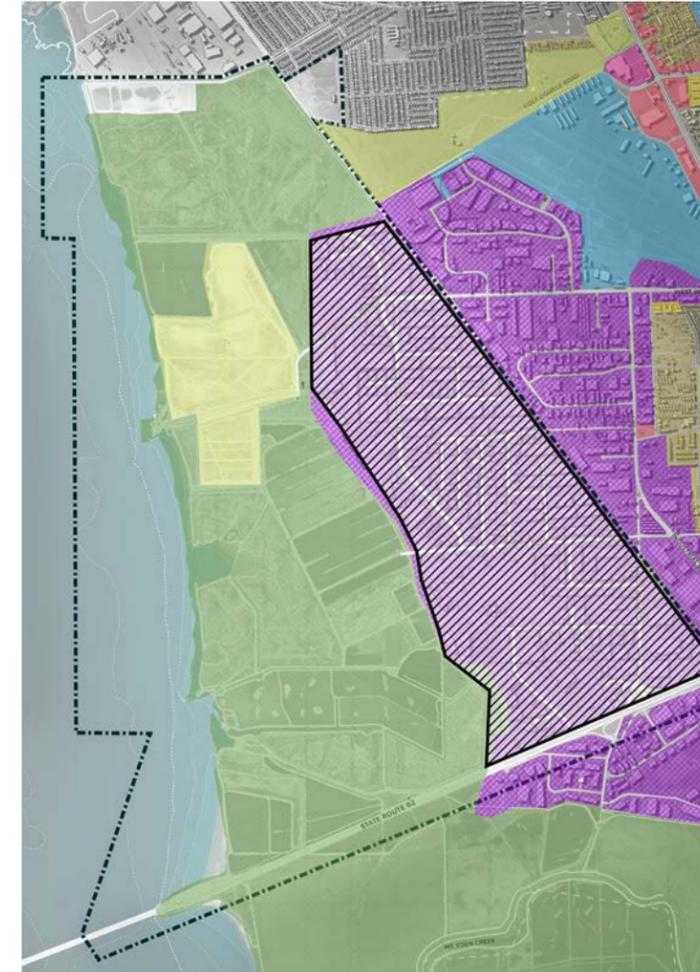
## 2: Bay Buffer



### COMMENTS

- See General Comments.

## 3: Industrial Neighborhood



### COMMENTS

- See General Comments.

## GENERAL COMMENTS

- EBRPD: Does not address protection of the marshes. SCAPE: Marsh adaptation and protection strategies are covered in other strategies, such as fine sediment augmentation, levee improvements, and fine and coarse grain beaches. Ultimately options will be combined in the design alternatives.
- COH: DG: Given the cost implications and disruption to existing business operation in the westerly most City of Hayward industrial areas, no proposed option would be supported by the City of Hayward. SCAPE: This is understood. However, SCAPE do recommend maintaining this as an option in the building scale adaptation strategies. It is one of the only 2 solutions to reduce risk of groundwater emergence and could be implemented parcel by parcel with new construction or building retrofits.

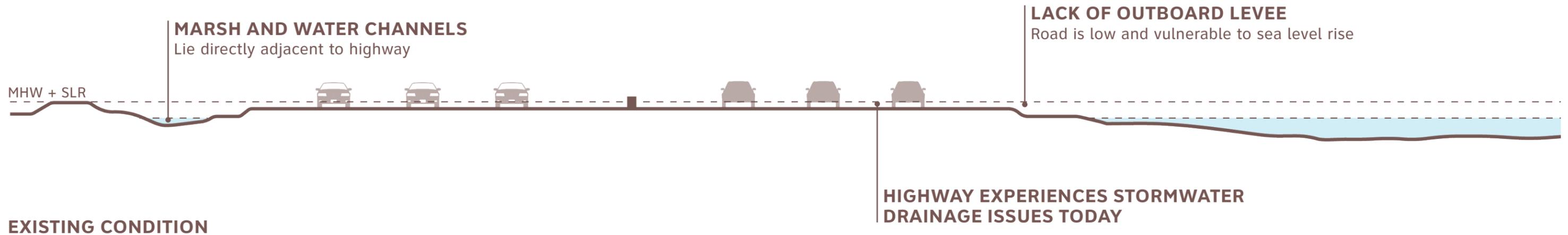
# SAN MATEO BRIDGE LANDING

## Definition

The eastern approach to the San Mateo-Hayward Bridge (SR-92) is **critical infrastructure** that is vulnerable to inundation by sea level rise. SR-92 is used by 86,000 passengers, 1,600 transit riders, and 6,000 trucks daily. Any flooding of the bridge would **impact regional mobility** and increase congestion.

## GOAL / OBJECTIVE

- Reduce risk to transportation infrastructure from SLR, groundwater intrusion, and flood events



# SAN MATEO BRIDGE LANDING

## Precedents

### Miami Beach: Rising Above Miami Beach, FL

**Cost:** \$500 million

**Implementation Timeline:** 2015- 2025

**Applicability:** Raising the road above MHW + SLR would help alleviate risk of flooding and disruption to critical transportation infrastructure. Miami beach is built on limestone, while the Bay is on Bay mud, which tends to settle more.

**Description:** City of Miami Beach aims to have all roads elevated to 3.7'NAVD88 to mitigate flooding issues.

- Roadways in Sunset Harbor Neighborhood have been raised by approximately 3 feet
- Sidewalks and adjacent public space have been retrofitted with the increased road elevation



Raised road during construction



Public space and sidewalk along a raised road

# SAN MATEO BRIDGE LANDING

## Precedents

### KTA Bridge Raising Program Sumner and Sedgwick Counties, Kansas

**Size:** 21 bridges

**Cost:** \$3.7 million

**Implementation Timeline:** 2016

**Applicability:** The potential to raise the portion east of the toll booths inland to Clawiter Road on a low pile structure could lift the roadbed out of the flood zone.

**Description:** Kansas Turnpike Authority raised 21 bridges between 12 and 21 inches to accommodate and encourage freight traffic, streamline maintenance, and improve safety in nearby communities.

- 10 hydraulic pumps were used to push 486,000 pounds of steel girders and concrete deck upward, 1 inch at a time. Within one day of pumping, shimming, inspecting and repeating, each bridge rested on new bearings, secured with steel anchor bolts.



Construction of bridge raising



Construction of bridge raising

# SAN MATEO BRIDGE LANDING

## Precedents

### SR 520 Floating Bridge Seattle/Medina, WA

**Size:** 7,708 ft

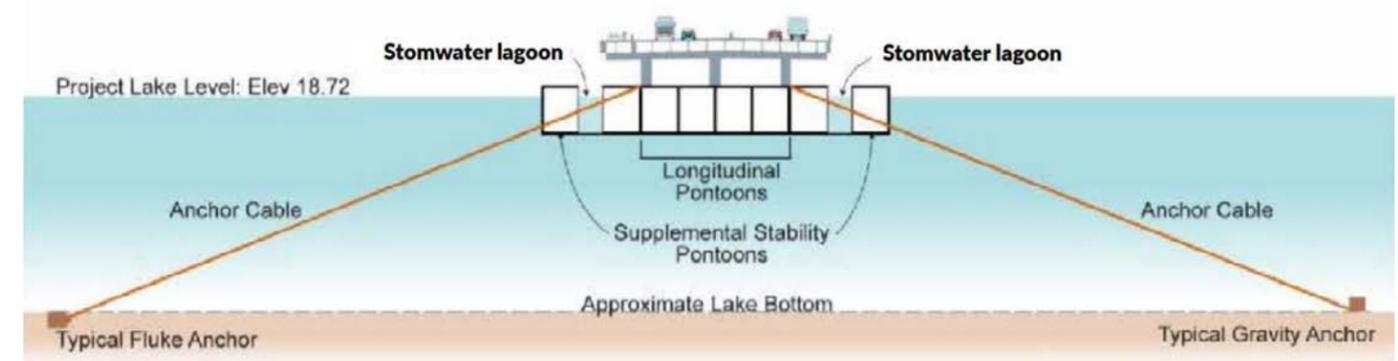
**Cost:** \$2.75 billion (includes highway enhancements to E and W of bridge)

**Implementation Timeline:** 2011-2016

**Applicability:** Retrofitting bridges as floating could eliminate the risk of highway flooding. Floating bridges are also well suited to areas with soft ground conditions.

**Description:** The SR 520 floating bridge replaces the old bridge which had become vulnerable to windstorms and earthquakes after over 50 years in use. At 7,708', it is the world longest floating bridge.

- A floating bridge is used in Lake Washington because soft silts and sediments on the lake bed would make a conventional bridge more expensive to construct.
- Individual bridge pontoons are built on dry land and floated to the bridge site. Pontoons connected rigidly from end to end and are held in place by steel cables to anchors deep in the lake bed.
- Constructed atop 77 watertight concrete pontoons, the deck height sits at 20' above water, 13.5' higher than the previous bridge.
- Bridge includes separated bicycle and pedestrian path.



Bridge Cross Section and Anchor System



SR 520 Floating Bridge

# SAN MATEO BRIDGE LANDING

## Option 1: Flood Walls

### GOAL / OBJECTIVE

Reduce risk to critical transportation infrastructure with future SLR, storm surge, and groundwater emergence.

### DESCRIPTION

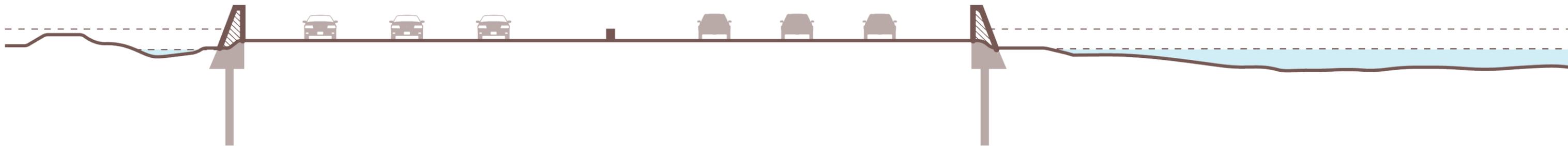
- Build two flood walls along the SR-92 bridge landing

### PROS

- May not disrupt traffic flow during construction
- Does not need a new R.O.W. to the north or south of the existing R.O.W.
- Reduces risk of still water flooding and SLR inundation
- Flood walls occupy a relatively small footprint

### CONS

- Would create a bathtub effect- need to drain and pump water off the bridge itself
- Maintenance costs
- May have issues with exits that would require temporary gates / barriers



# SAN MATEO BRIDGE LANDING

## Option 2: Flood Protection Levees

### GOAL / OBJECTIVE

Reduce risk to critical transportation infrastructure with future SLR, storm surge, and groundwater emergence.

### DESCRIPTION

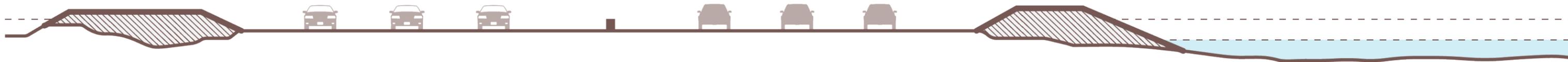
- Build two levees on either side of the SR-92 bridge landing

### PROS

- May not disrupt traffic flow during construction
- Reduces risk of still water flooding and SLR inundation
- Does not need a new R.O.W. to the north or south of the existing R.O.W.

### CONS

- Levees would be vulnerable to erosion
- Would create a bathtub effect- need to drain and pump water off the bridge itself
- Maintenance costs



# SAN MATEO BRIDGE LANDING

## Option 3: Elevate Land

### GOAL / OBJECTIVE

Reduce risk to critical transportation infrastructure with future SLR, storm surge, and groundwater emergence.

### DESCRIPTION

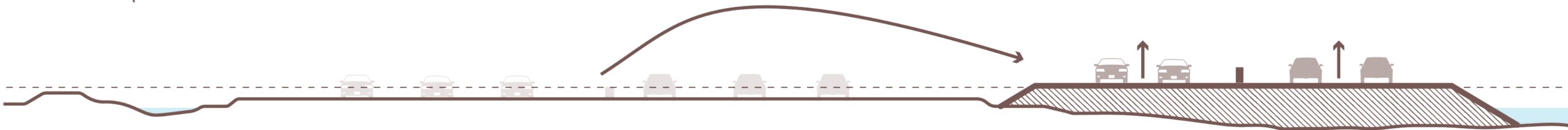
- Rebuild SR-92 on elevated land above the flood plain and SLR inundation zones

### PROS

- Potential to lift the whole road out of flood and SLR inundation zones

### CONS

- Would require a new R.O.W. to the south of the existing R.O.W.
- Levee edges would be vulnerable to erosion
- In order to avoid traffic disruption, would require fill in existing marsh, which is a permitting challenge
- May experience a significant amount of settlement and subsidence
- Would require modifications to road connections



# SAN MATEO BRIDGE LANDING

## Option 4: Raise on Piles

### GOAL / OBJECTIVE

Reduce risk to critical transportation infrastructure with future SLR, storm surge, and groundwater emergence, and restore tidal connectivity between marshes.

### DESCRIPTION

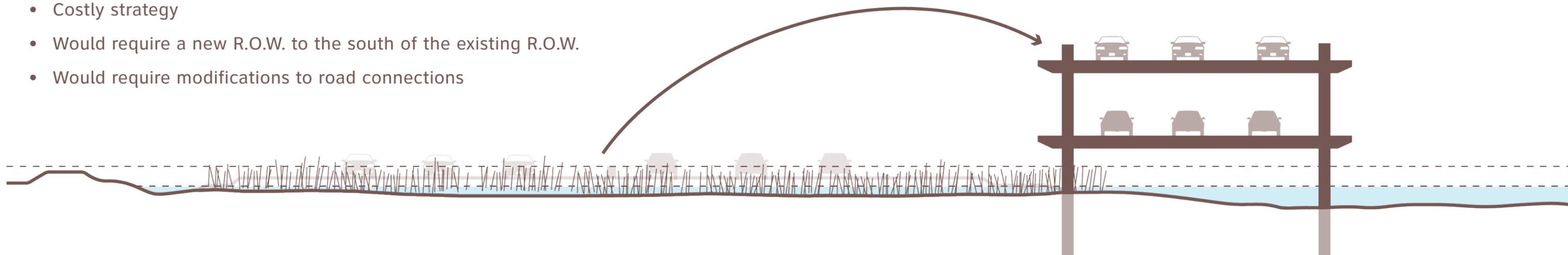
- Rebuild SR-92 on piles
- Restore tidal marsh in its current location

### PROS

- Increase ecological connectivity of the marshes below
- Potential to raise out of the floodplain and all SLR inundation zones

### CONS

- Costly strategy
- Would require a new R.O.W. to the south of the existing R.O.W.
- Would require modifications to road connections



# SAN MATEO BRIDGE LANDING

## Option 5: Floating Bridge

### GOAL / OBJECTIVE

Reduce risk to critical transportation infrastructure with future SLR, storm surge, and groundwater emergence.

### DESCRIPTION

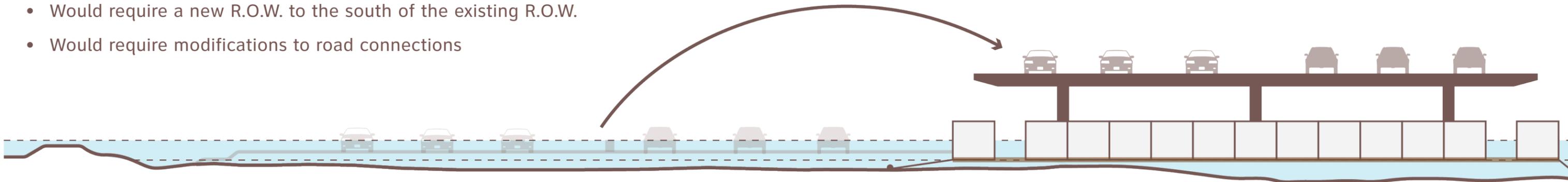
- Rebuild SR-92 as a floating bridge adjacent to the existing highway
- The existing approach may be retreated further inland if the existing approach is converted to floating

### PROS

- Potential to lift the whole road out of flood and SLR inundation zones
- Adaptable to varying water levels

### CONS

- Costly strategy
- Would require a new R.O.W. to the south of the existing R.O.W.
- Would require modifications to road connections

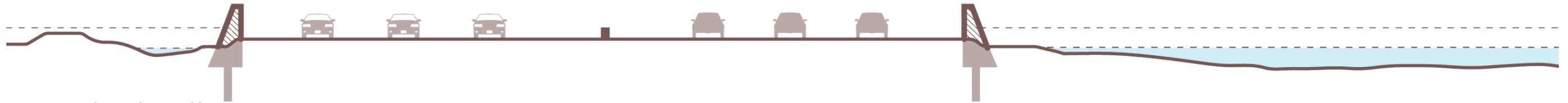


# SAN MATEO BRIDGE LANDING

## Compiled Options

### GENERAL COMMENTS

- EBRPD Prefers option #2. SCAPE will add this to the comments.
- EBRPD: How will rising groundwater influence these options? SCAPE: Additional pumping or engineering to prevent seepage may be required. The bathtub effect that would be created, and stormwater management, represent challenges to some of those options. These are reflected in the cons. Additional studies are not part of the current scope of work.
- COH: DG: DG: All proposed options should be considered for the San Mateo Bridge approach. SCAPE: Comment noted.
- COH: DG: City of Hayward supports all options. SCAPE will add this to the comments.



Option 1: Flood Walls

### COMMENTS

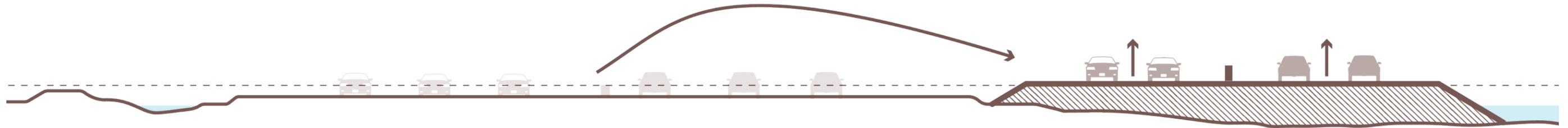
- See General Comments.



Option 2: Flood Protection Levees

### COMMENTS

- See General Comments.



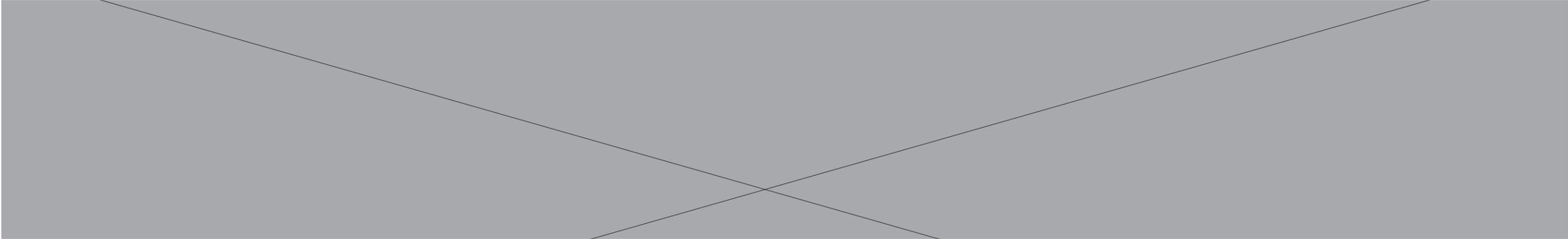
Option 3: Elevate Land

### COMMENTS

- See General Comments.

# SAN MATEO BRIDGE LANDING

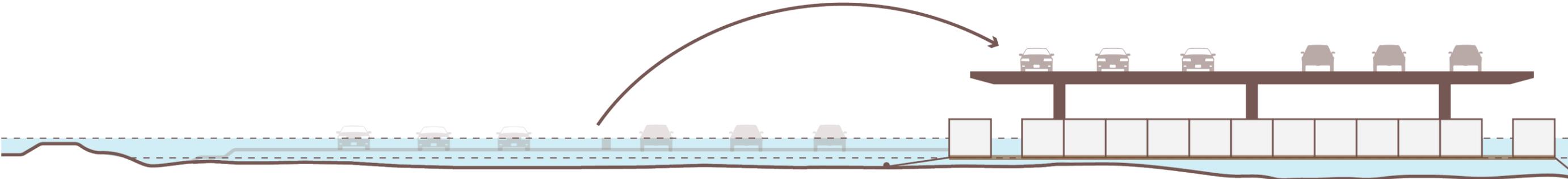
## Compiled Options



Option 4: Raise on Piles

### COMMENTS

- See General Comments.



Option 5: Floating Bridge

### COMMENTS

- See General Comments.

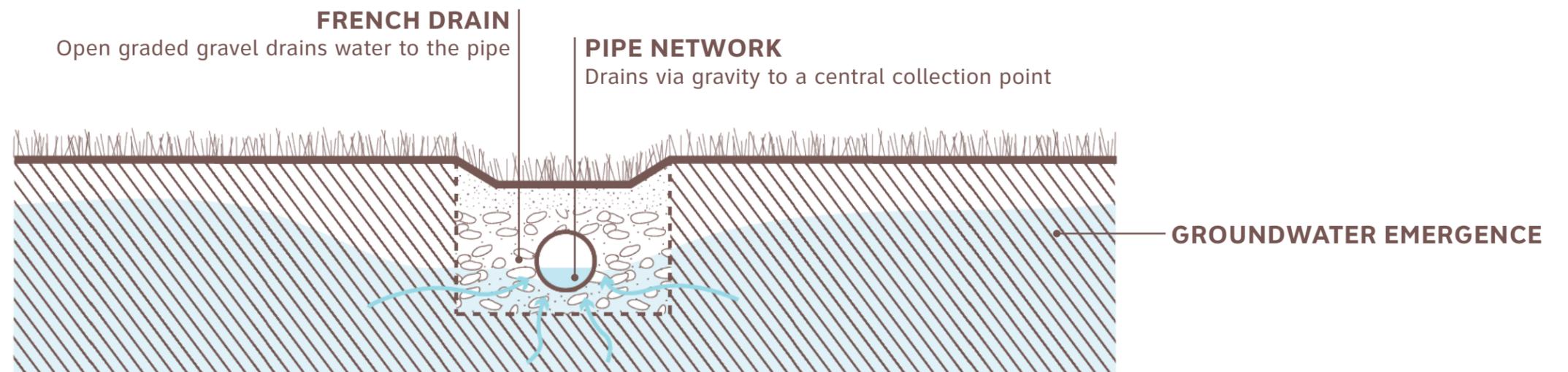
# SUBSURFACE DRAINAGE

## Definition

Rising groundwater tables can be addressed through an **expanded subsurface drainage network** that feeds into trenches/canals that flow to the bay at low tide. Tide gates are needed to prevent influx of high tides. Would require **additional inland storage space** to manage groundwater storage.

## GOAL / OBJECTIVE

- Reduce risk from groundwater emergence



# SUBSURFACE DRAINAGE

## Option 1: Subsurface Drainage Network

### GOAL / OBJECTIVE

Reduce risk of groundwater emergence.

### DESCRIPTION

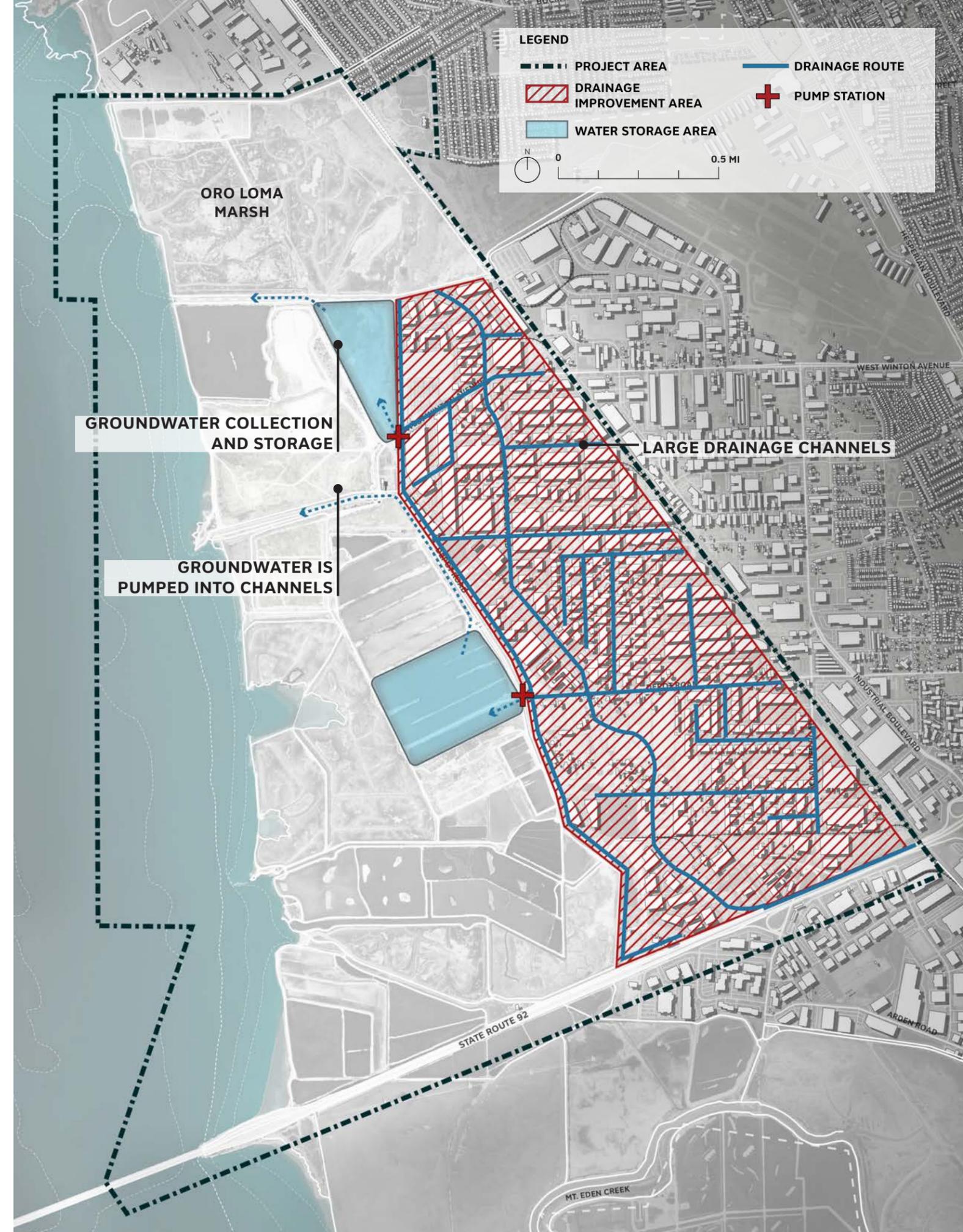
- Underground network of french drains to drain groundwater to collection point. Must be as dense as a stormwater or sewer system to substantially affect the water table
- Create storage ponds at Frank's East and part of the Oxidation Ponds to collect groundwater
- Pump stations at each water storage pond discharge groundwater into adjacent channels

### PROS

- Addresses rising groundwater tables
- Good medium-term strategy

### CONS

- Requires additional inland storage space
- Need to use in combination with other measures, such as tide gates and making use of the existing flood control structures.
- Needs an outlet for the collected water, and therefore it is not a long-term solution
- Requires the creation of a high density system of trenches/ditches and perforated pipelines
- If the drainage network is too flat, pumps will be required



# SUBSURFACE DRAINAGE

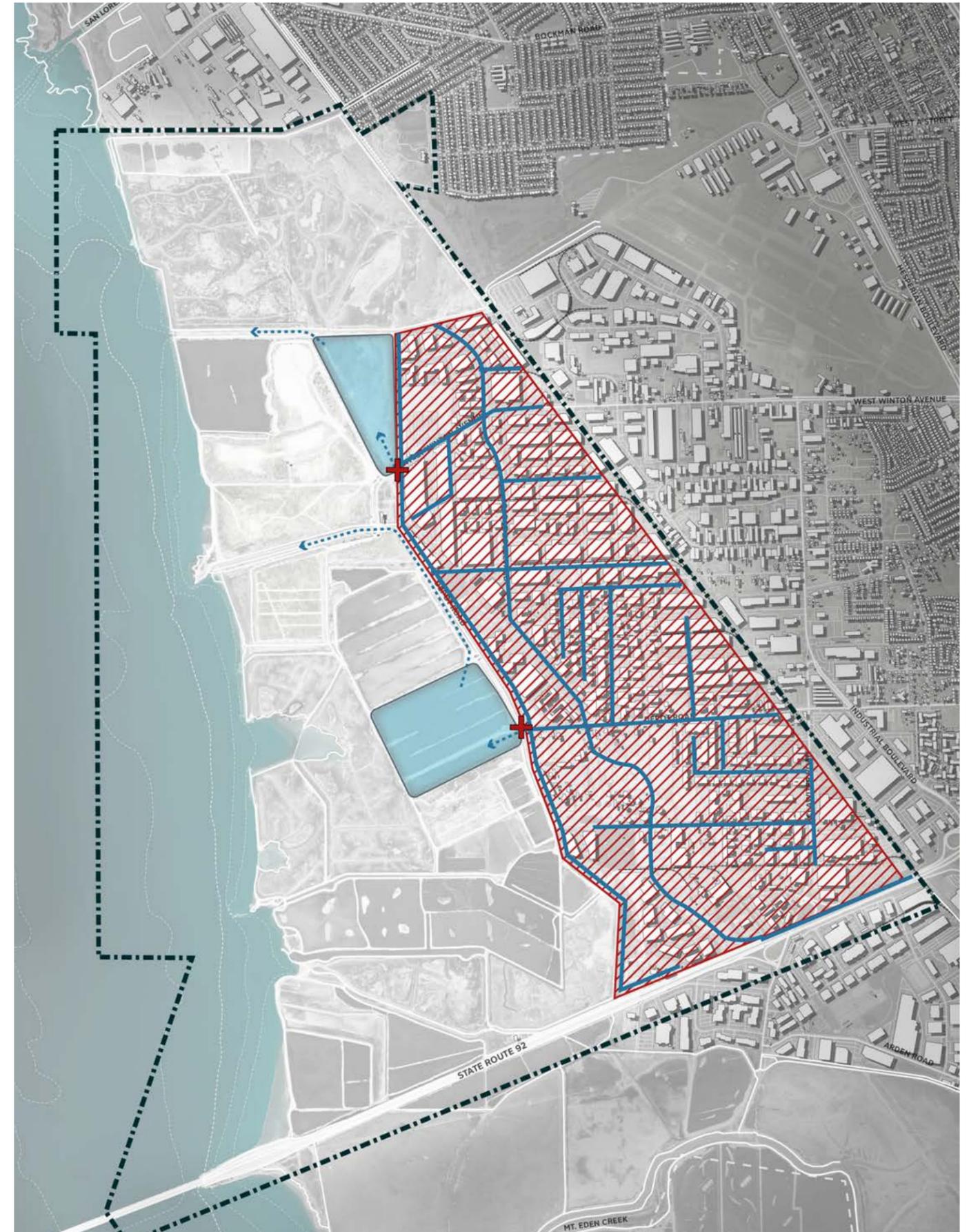
## Compiled Options

### GENERAL COMMENTS

- COH: DG: Given the extreme cost associated with creating this infrastructure, no City of Hayward support for this concept at this time. SCAPE understands and will reflect this in the comments. However, we recommend keeping this strategy since it is only one of two solutions to mitigate groundwater emergence.

### COMMENTS

- COH: DG: No City of Hayward support for this option. SCAPE understands and will reflect this in the comments. However, we recommend keeping this strategy since it is only one of two solutions to mitigate groundwater emergence.



**NON-  
STRUCTURAL  
STRATEGIES**

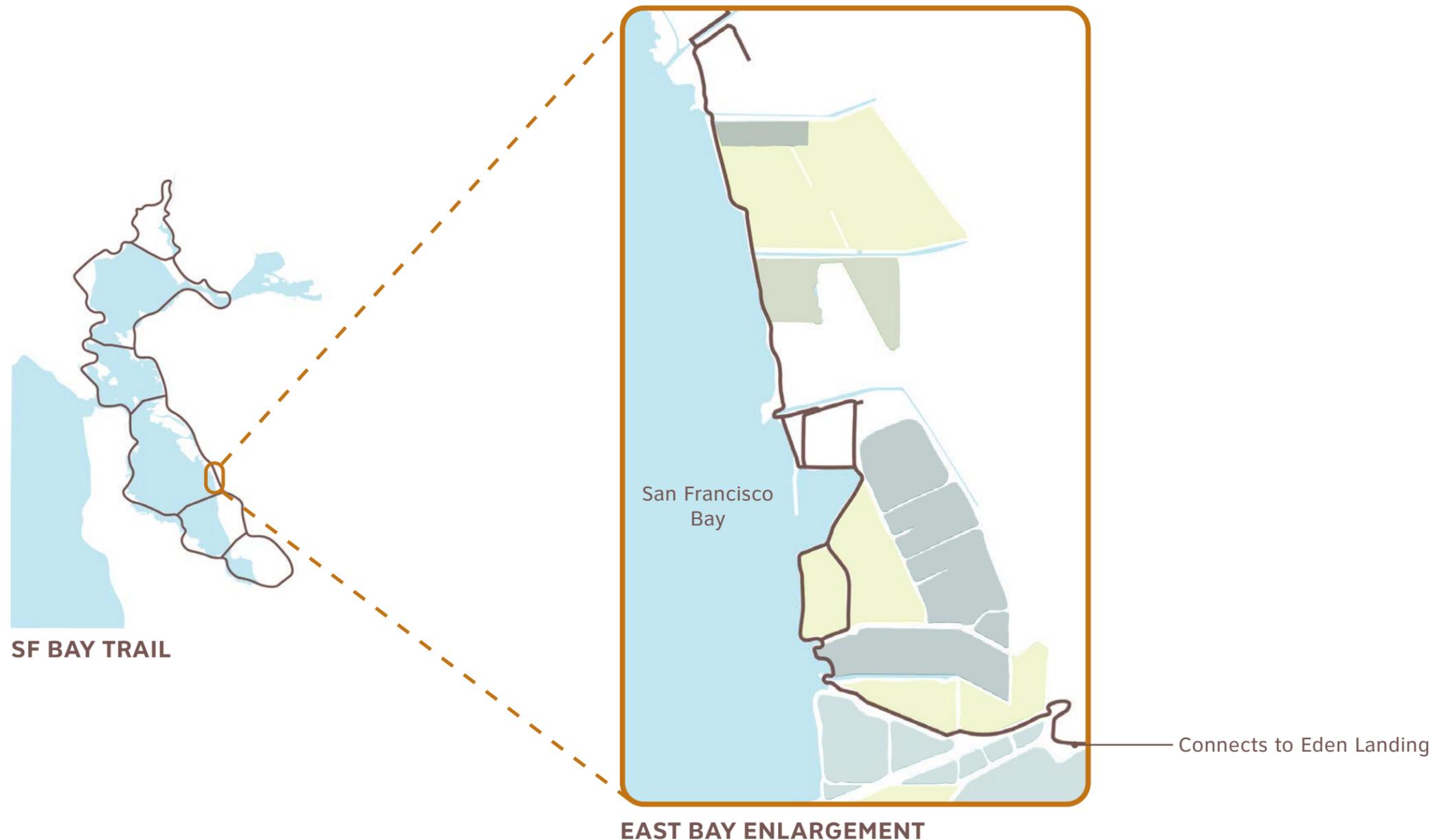
# PUBLIC ACCESS & THE BAY TRAIL

## Definition

Public access strategies include **Bay Trail adaptation plans**, additional sites for public access, new types of recreation, expansion of the SF Bay Water Trail, and enhanced connections. Aligning with other adaptation and restoration projects may **enhance recreation benefits** and **increase community connections**.

## GOAL / OBJECTIVE

- Enhance recreational opportunities and adapt to SLR
- Create a management framework for adapting to SLR over time



# PUBLIC ACCESS & THE BAY TRAIL

Bay Trail site photos, 2019



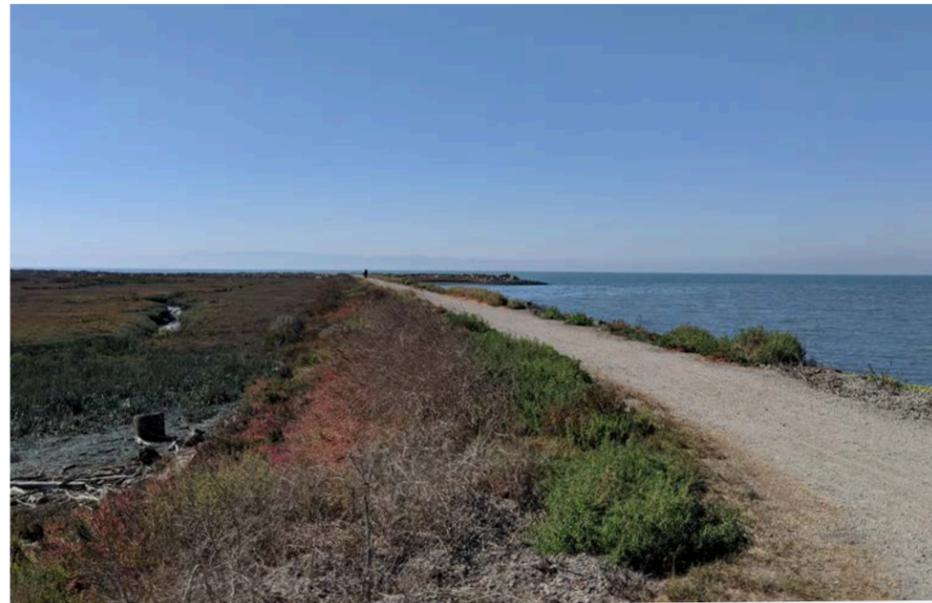
View at Cogswell Marsh breach



View from West Winton landfill



View at Bay's edge



View at Oro Loma Marsh



# PUBLIC ACCESS & THE BAY TRAIL

## Option 1: Maintain Current Alignment of the Bay Trail

### GOAL / OBJECTIVE

Maintain recreational opportunities.

### DESCRIPTION

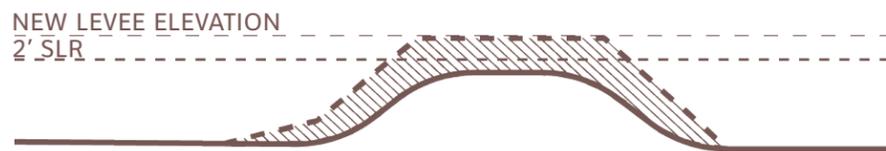
- Raise and repair all levees projected to overtop with 2' SLR (accounting for 2' freeboard)

### PROS

- Diverse bay experience adjacent to blue water
- Maintains current alignment which is existing and permitted
- Maintains existing habitats

### CONS

- Short-term solution
- Bay trail remains in exposed position near bay edge
- May have to elevate, repair levees that are not associated with other restoration / flood protection projects
- Costly to elevate and repair levees



### LEVEE RAISING



# PUBLIC ACCESS & THE BAY TRAIL

## Option 2: Adapt the Bay Trail over Time

### GOAL / OBJECTIVE

Develop a management framework to adapt recreational resources over time with SLR.

### DESCRIPTION

- Relocate the Bay Trail in 3 phases over time with SLR

### PROS

- Phased approach may be easier to implement and fund

### CONS

- Trail connections at the bay will be vulnerable with SLR
- Proximity to WWTP uses could pose an issue



Phase 1



Phase 2



Phase 3



# PUBLIC ACCESS & THE BAY TRAIL

## Option 3: Realign with New Infrastructure Improvements

### GOAL / OBJECTIVE

Create a management framework to adapt recreational resources with SLR.

### DESCRIPTION

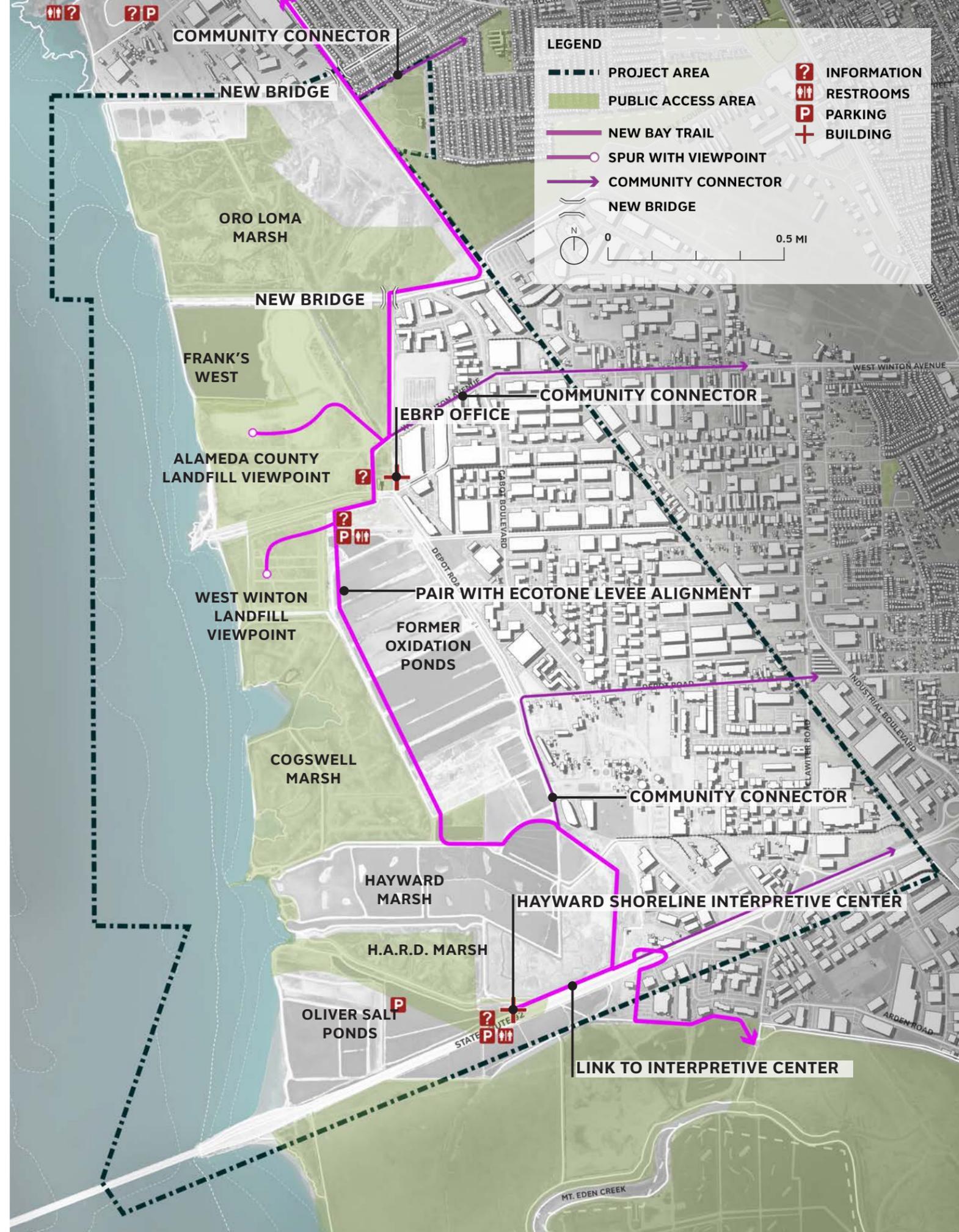
- Move the Bay Trail inland to higher ground with new infrastructure improvements

### PROS

- Closer to adjacent community- enhance key connections inland
- Could be paired with horizontal levee / other infrastructure projects
- Landfill spurs provide unique views of the shoreline and bay
- Buffered from direct wave erosion from the bay
- Bypasses existing infrastructure (restrooms, parking, etc.)

### CONS

- Bay trail could be far from blue water experience if construction occurs before SLR inundates
- Proximity to WWTP or industrial uses could be an issue



# PUBLIC ACCESS & THE BAY TRAIL

## Compiled Options

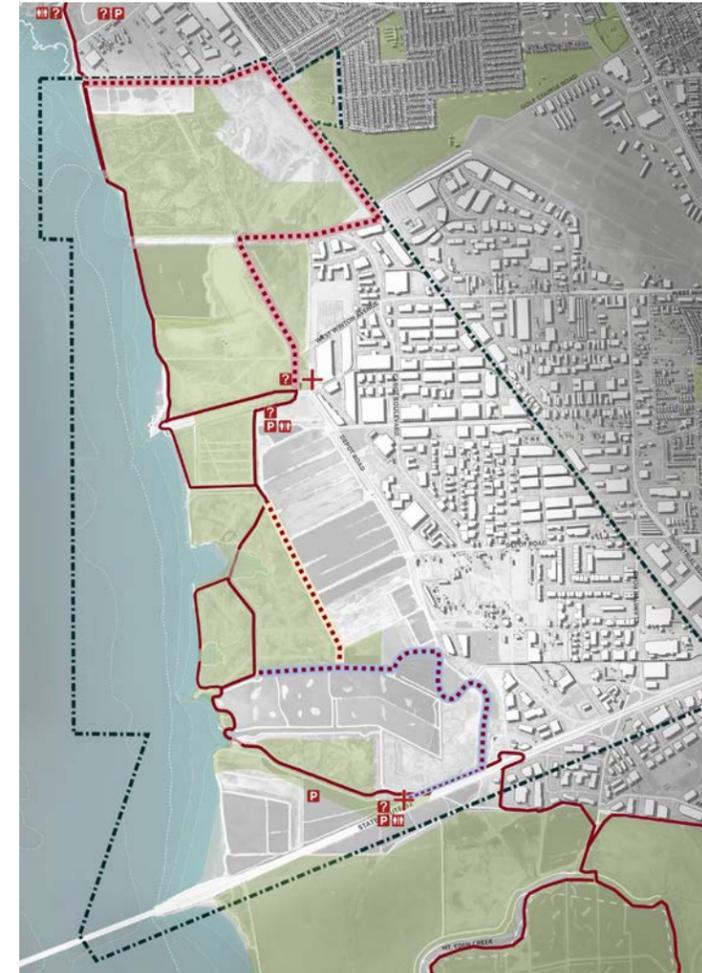
### 1: Maintain Current Alignment of the Bay Trail



#### COMMENTS

- EBRPD: Positive: keeps habitats. SCAPE will add this to the Pros.
- EBRPD: Need to raise north levee of Cogswell Marsh to protect others. SCAPE: The Bay Trail levee on the north edge of Cogswell Marsh would be raised in this option, as indicated in the diagram. Please clarify this point.
- COH: DG: Very little support from the City of Hayward for this option. SCAPE will add this to the comments.

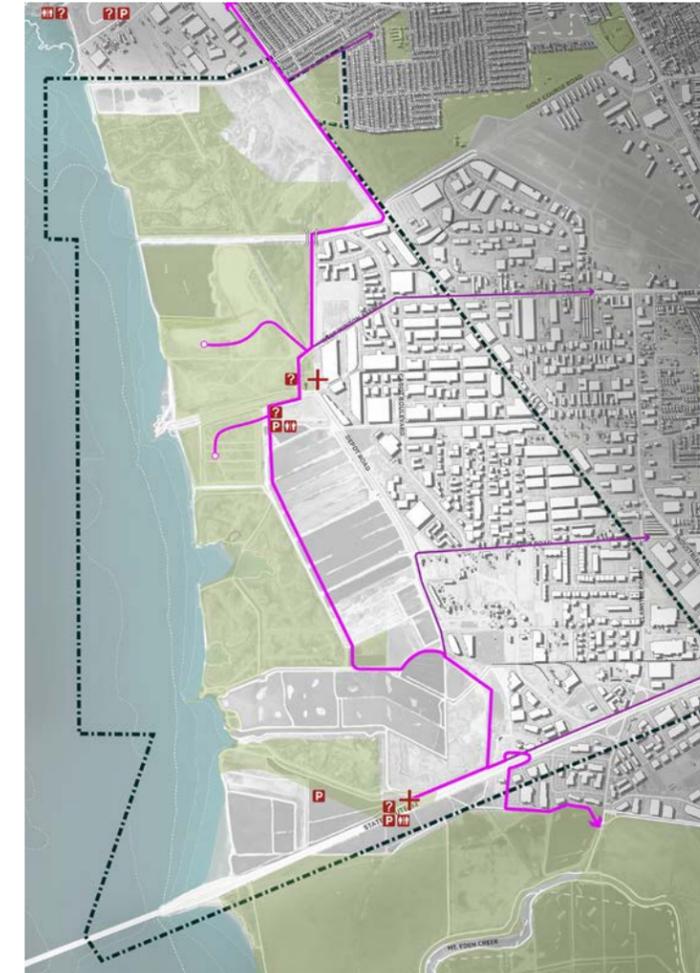
### 2: Adapt the Bay Trail over Time



#### COMMENTS

- EBRPD: For phase 2 – have it follow the west side of former oxidation ponds. SCAPE will update the diagram accordingly.
- COH: DG: City of Hayward support for this option. SCAPE will add this to the comments.

### 3: Realign with New Infrastructure Improvements



#### COMMENTS

- EBRPD: Where is the new bridge? SCAPE will clarify the diagram to indicate bridge symbols.
- EBRPD: Use different colors, too much red. SCAPE will update the colors.
- COH: DG: City of Hayward support for this option. SCAPE will add this to the comments.

#### GENERAL COMMENTS

- COH: DG: The City of Hayward supports long-term solutions to any future alignment of the Bay Trail. This is important since the current Bay Trail location will be extremely difficult to save pursuant to sea level rise more than 2 feet. SCAPE will add this to the comments.

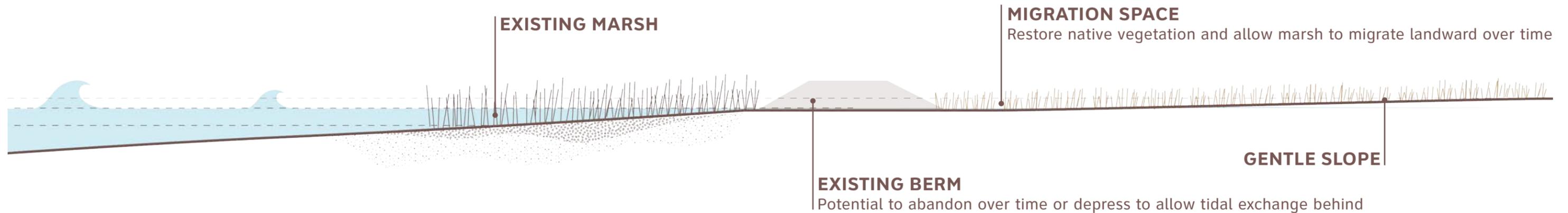
# MARSH AND MUDFLAT MIGRATION PLANNING

## Definition

Natural **wetland-upland transition zones** adjacent to present and potential marshes can be protected, enhanced, or restored to **allow marshes to migrate landward as sea level rises**. This can be paired with levee / berm realignment and other flood control projects and may require the removal of berms to **ensure hydrological connectivity**.

## GOAL / OBJECTIVE

- Create a management framework for adapting to SLR over time



# MARSH AND MUDFLAT MIGRATION PLANNING Precedent

## North Richmond Shoreline Vision North Richmond, CA

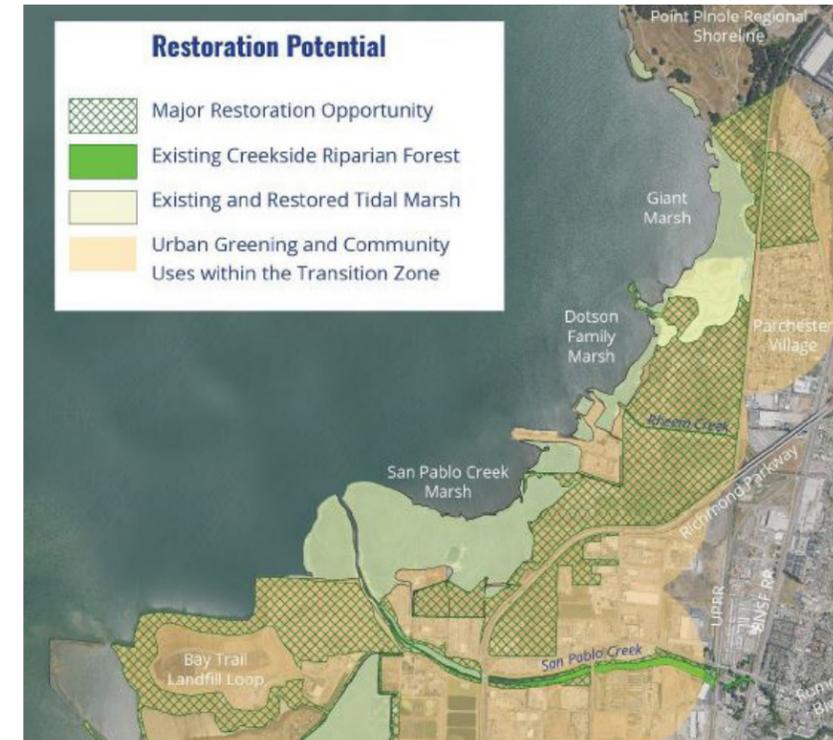
**Size:** 2790 acres

**Implementation Timeline:** 2017-2050

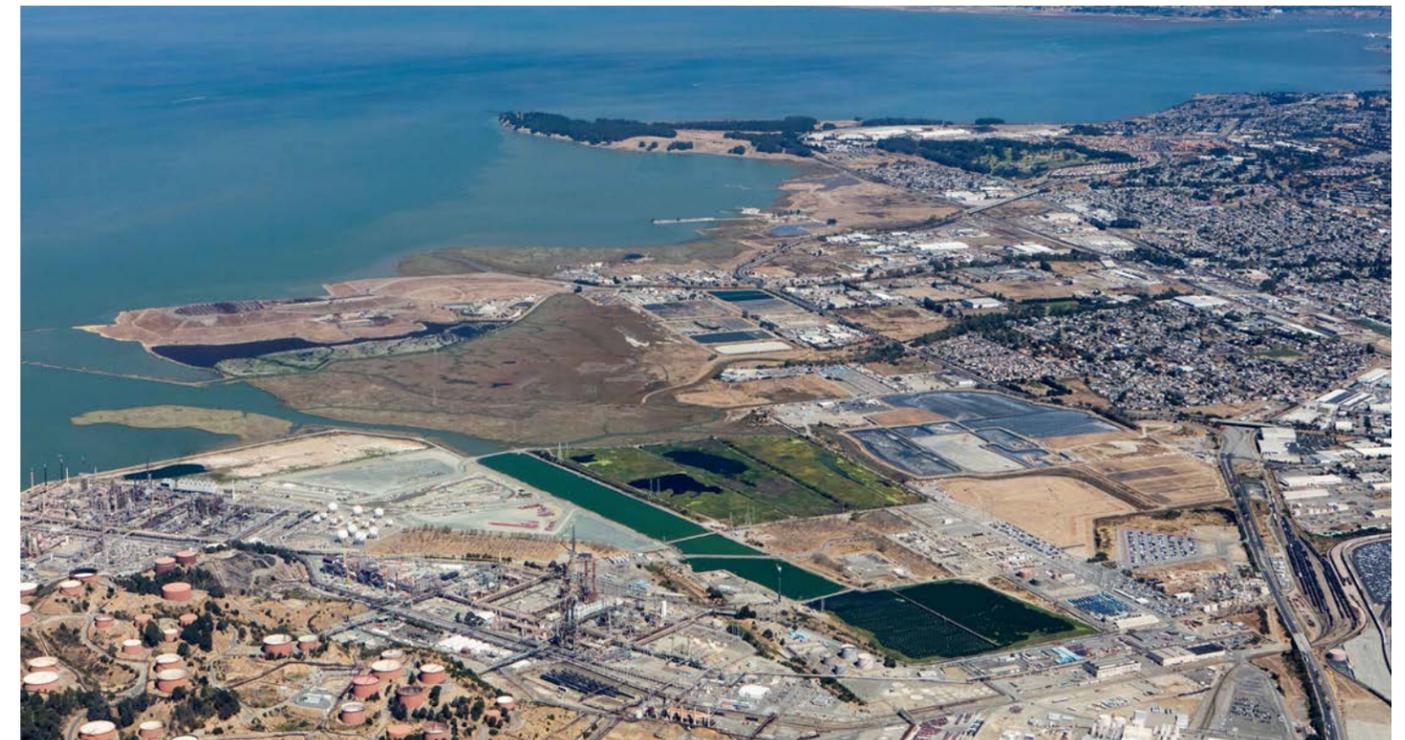
**Applicability:** Anticipating SLR can allow for robust planning processes to facilitate marsh and mudflat migration. Similar planning strategies nearby can provide a template for action and opportunity to incorporate lessons learned.

**Description:** Sea level rise will subject the North Richmond shoreline to inundation and greater wave action, increasing shoreline erosion and threatening the viability of tidal marshes. An area between the Baylands and uplands was historically composed of wet meadows and alluvial fans. Though the area is highly urbanized, it remains an important area of connection between the Bay and watershed, providing wildlife movement corridors and habitat for sensitive species. This area will provide space for marshes to migrate landward as sea level rises. The plan's strategies include:

- Acquiring contiguous shoreline parcels from willing sellers to protect and conserve open space
- Connecting and completing Bay Trail segments to improve and increase shoreline public access and understanding
- Supporting compatible uses within the transition zone such as renewable energy pilot projects
- Complete Giant Marsh Living Shorelines project and other opportunities to restore and enhance a diversity of habitats
- Developing economic incentives for businesses and homeowners to contribute for sustainable economic and environmental development



Plan of potential migration space



Aerial view of North Richmond Shoreline

# MARSH AND MUDFLAT MIGRATION PLANNING

## Option 1: Oro Loma Marsh Migration

### GOAL / OBJECTIVE

Maintain Oro Loma Marsh ecosystem with sea level rise.

### DESCRIPTION

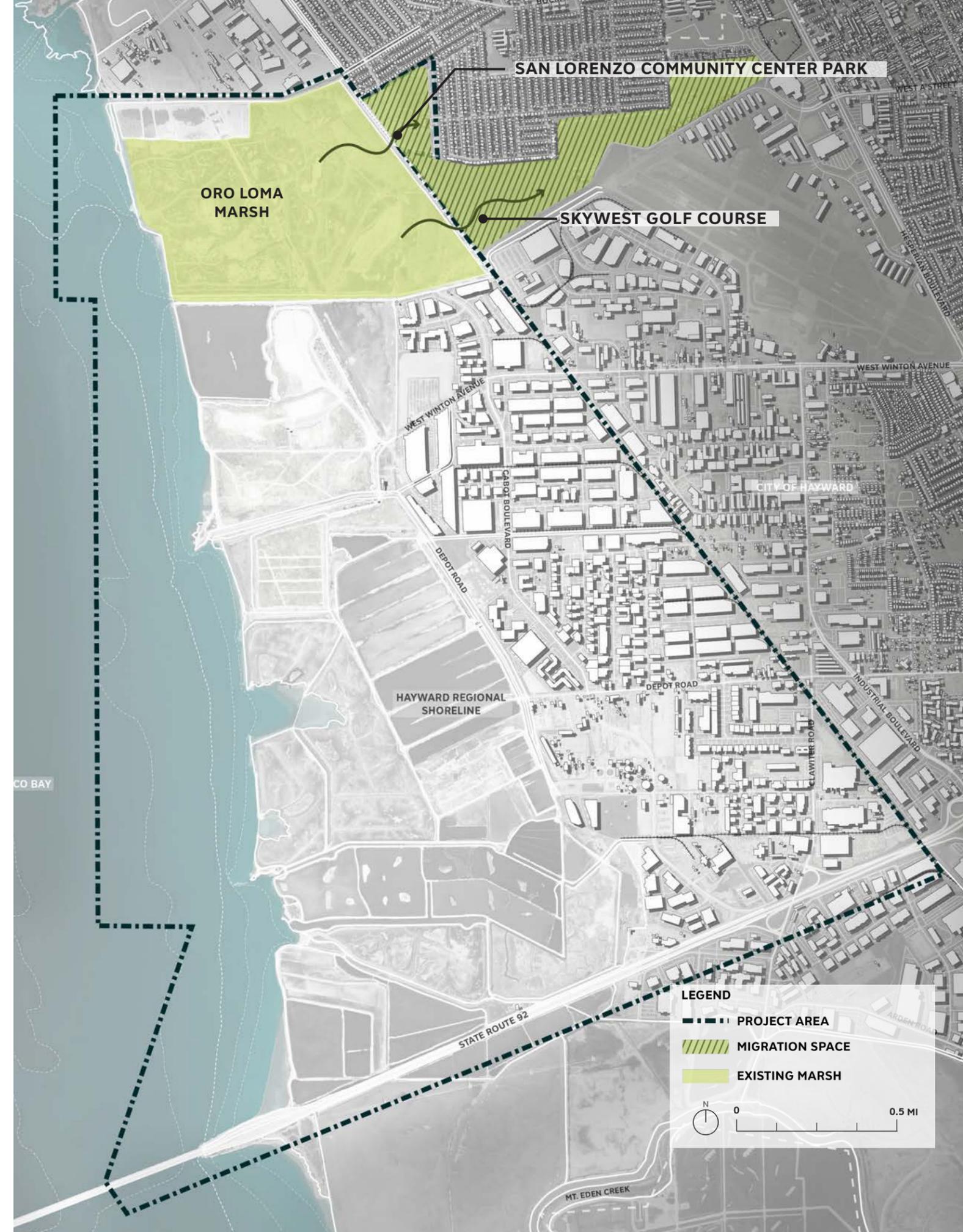
- Prep San Lorenzo Community Center Park, Skywest Golf Course as future migration space (upland grassland with shallow slope)

### PROS

- Large space for migration
- Connect new recreation space to adjacent community

### CONS

- Need to cross railroad through culverts, which is a tough right of way
- Need to cross existing utility corridor in Oro Loma Marsh
- Land could require significant prep to facilitate migration and disrupt the current uses



# MARSH AND MUDFLAT MIGRATION PLANNING

## Option 2: Larger Migration Potential

### GOAL / OBJECTIVE

Maintain marsh ecosystems with sea level rise.

### DESCRIPTION

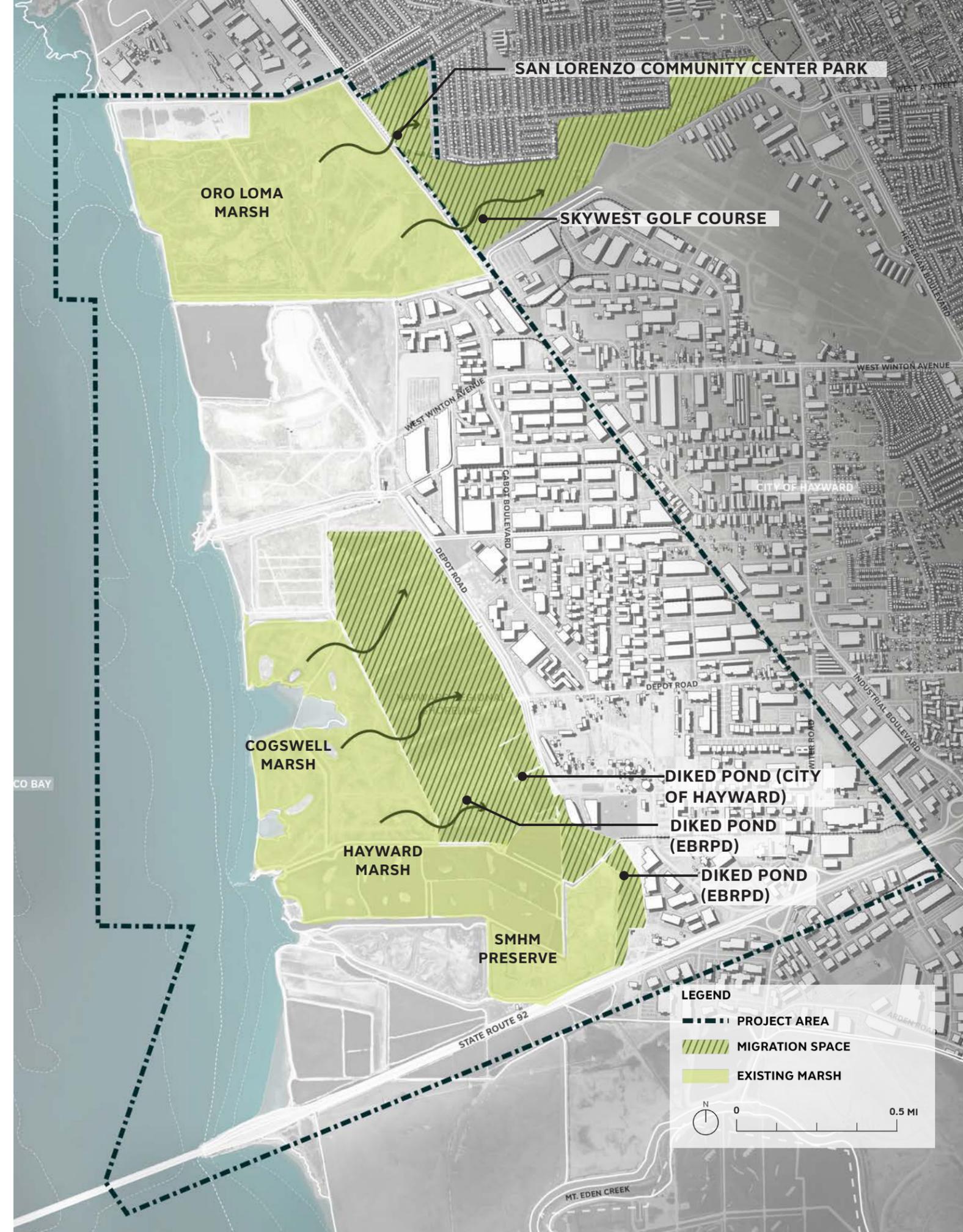
- Prep San Lorenzo Community Center Park, Skywest Golf Course, and the Oxidation Ponds as future migration space (upland grassland with shallow slope)

### PROS

- Two large migration spaces

### CONS

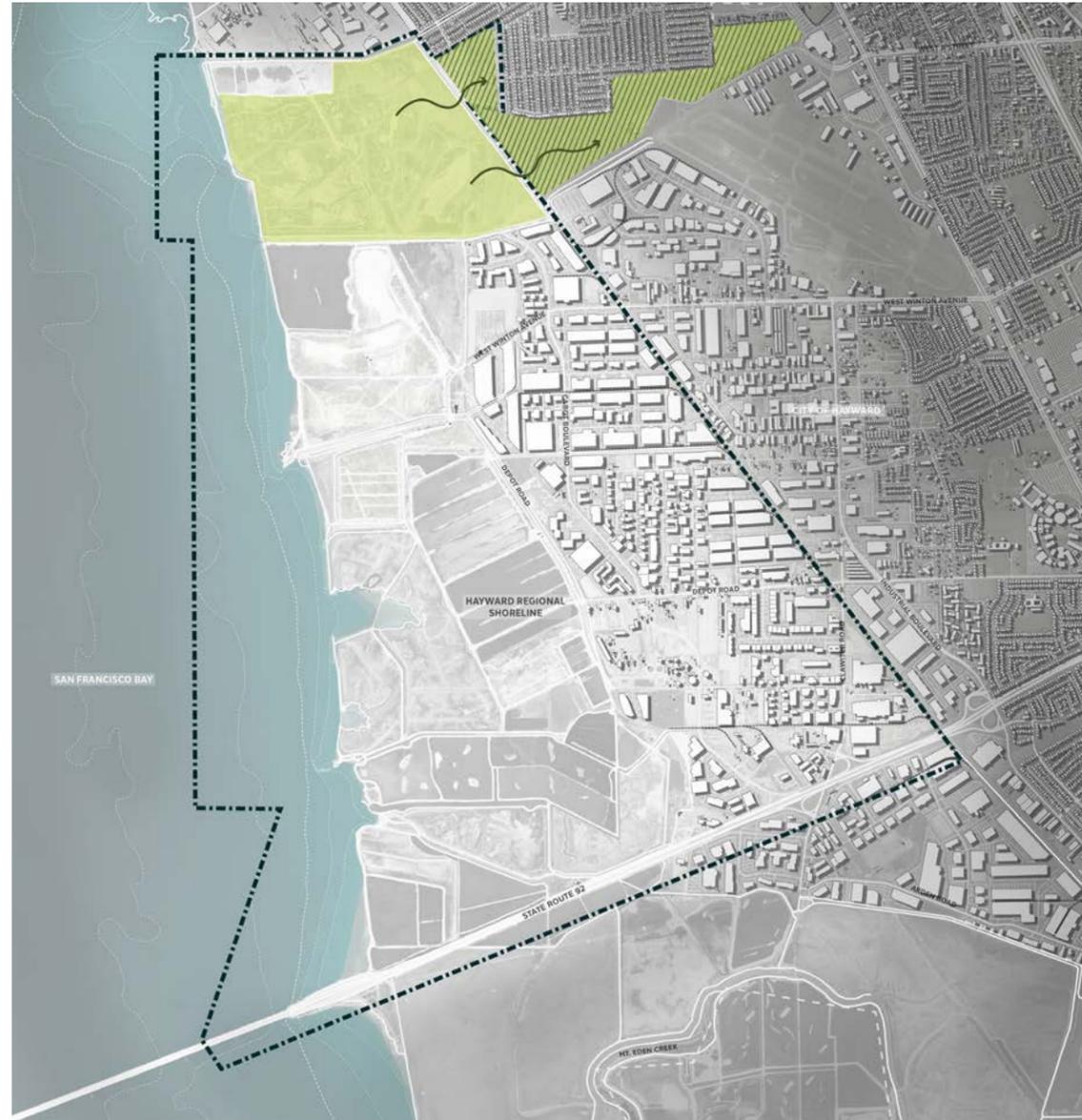
- Loss of stormwater detention capacity at oxidation ponds
- Need to cross existing utility corridor in Oro Loma Marsh
- Land could require significant prep to facilitate migration and disrupt the current uses



# MARSH AND MUDFLAT MIGRATION PLANNING

## Compiled Options

### 1: Oro Loma Marsh Migration



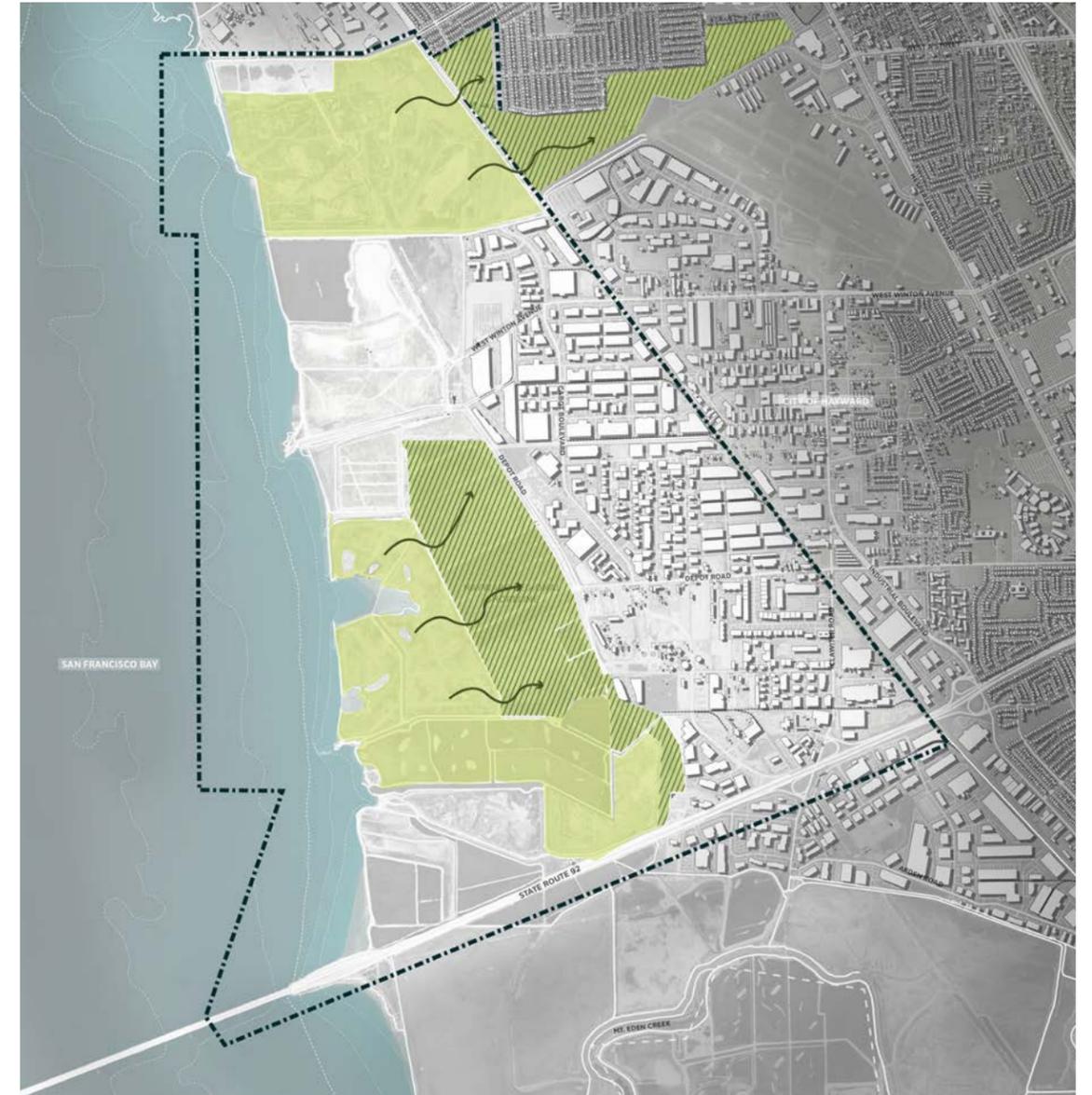
#### COMMENTS

- EBRPD: What about the railroad? SCAPE: Culverts would have to be constructed below the railroad in this option, which may be costly.

#### GENERAL COMMENTS

- COH: DG: All possible adaptation measures should be reviewed and commented on by the City of Hayward's Public Works Utilities staff. There might be some support for the Skywest golf course transformation. SCAPE will review these options with Public Works.

### 2: Larger Migration Potential



#### COMMENTS

- See General Comments.

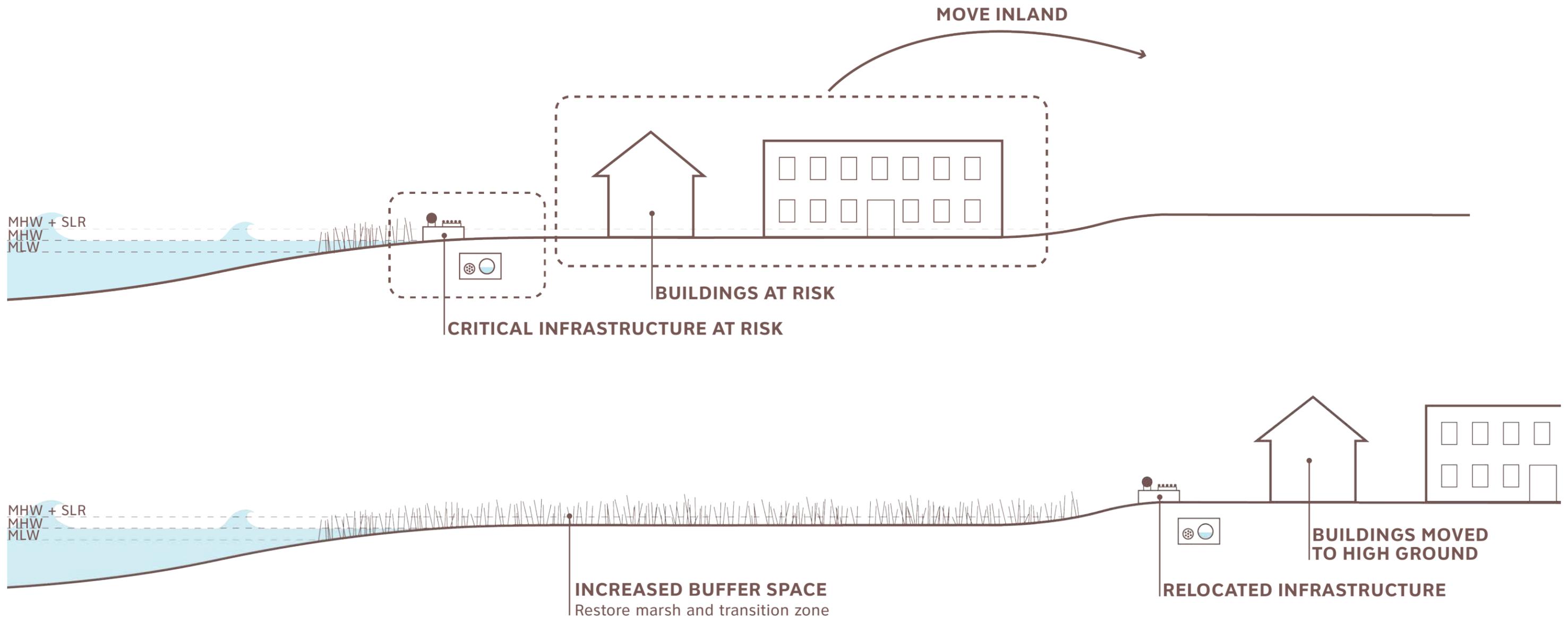
# MANAGED RETREAT

## Definition

Managed retreat is a management strategy for **retreating from vulnerable coastal areas**, moving the shoreline inland and **restoring natural areas** thereby **providing a buffer from flooding** and better managing hazard risk.

### GOAL / OBJECTIVE

- Create a management framework for adapting to SLR over time



# MANAGED RETREAT

## Precedents

### America Center Drive Alviso, CA

**Size:** 63 acres

**Implementation Timeline:** 2007-2009

**Applicability:** Landfills can provide raised sites to move nearby infrastructure/developments above SLR levels.

**Description:** America Center is a 63-acre brownfield redevelopment project that contains 30 acres of land preserve dedicated for Burrowing Owl habitat. Phase 1 of the project included two six-story office buildings located on top of a closed landfill that extends 65' deep. Phase 2 added two more buildings in 2018.

- Concrete reinforced piles were used after cores were drilled out to avoid environmental contamination from pile driving through land fill



Access roads were raised to reach the higher elevation



Aerial view looking towards Alviso

# MANAGED RETREAT

## Precedents

### Neighborhood Retreat after Sandy Staten Island, NY

**Size:** Approx. 3.75 square miles

**Implementation Timeline:** 2012-2022

**Applicability:** The managed retreat of vulnerable neighborhoods reduces future risk and damage, and opens up the potential to restore natural systems along the shoreline.

**Description:** A response to the aftermath of Hurricane Sandy for Graham Beach, Oakwood Beach and Ocean Breeze neighborhoods, the retreat of these neighborhoods is part of New York City's strategy to face sea level rise and goal to limit "exposure to increasing coastal hazards"

- Purchased by New York State government to be demolished and preserved as restored wetland, creating a coastal buffer for future storms
- Homeowners offered buyout at pre-storm value and relocation assistance; or face newly restrictive zoning codes
- Careful consideration necessary for the livability and economy for the relocated and remaining populations



Number of days the residents have been displaced



Vacant parcel

# MANAGED RETREAT

## Precedents

### Isle de Jean Charles Resettlement Isle de Jean Charles, LA

**Size:** 2 miles long, 1/4 mile wide (historically 11 miles long, 5 miles wide)

**Cost:** \$48.3 million

**Implementation Timeline:** 2016- ongoing

**Applicability:** Retreat from vulnerable coastal areas can reduce long-term costs associated with flooding and can open up land to help mitigate flooding in nearby areas.

**Description:** Isle de Jean Charles Resettlement is a federally funded initiative to voluntarily resettle the residential population of Isle de Jean Charles, a small settlement on the coast of Louisiana. Due to a number of environmental factors, the island has experienced 98 percent land loss since 1955.

- 515 acres of farmland purchased in a more resilient and historically contextual community 40 miles north for resettlement
- Residents may opt to move to a new home in the newly settled community, a vacant lot in the new community, or an existing home elsewhere in Louisiana outside current 100-year floodplains.
- Program aims to ensure community is economically sustainable in new location.
- Program aims to facilitate preservation of islanders' cultural identities and traditions



Vulnerable roads and infrastructure



Raised homes

# MANAGED RETREAT

## Precedents

### Yup'ik Village Relocation Newtok, Alaska

**Size:** 380 people / 44 housing units

**Cost:** \$92-\$96 million

**Implementation Timeline:** 2003 (agreement) - 2023 (approximate)

**Applicability:** Retreat from vulnerable coastal areas can reduce long-term costs associated with flooding and can open up land to help mitigate flooding in nearby areas.

**Description:** Disappearing land beneath Newtok, through the slow and steady process of thawing permafrost and erosion, has seen the development of Mertarvik, a new village to where the Yup'ik community is in the process of relocating.

- Melting sea ice and rising seas send water surging up rivers, causing erosion and flooding
- As permafrost soils thaw, they crumble and the land (and town) succumbs to the Ninglik River
- Created by Congress, the village of Mertarvik is located on higher, volcanic ground
- In an exchange with Congress, the Newtok area will transition to become part the Yukon Delta National Wildlife Refuge
- Pilot for relocation of other Alaskan communities due to erosion



Existing community



Erosion and flooding have lead to the relocation

# MANAGED RETREAT

## Precedents

### Ecomaine Landfill Mining South Portland, Maine

**Size:** 10,5000 CY material removed / added space

**Cost:** \$7.42 million revenue in recovered metals,  
Estimated value of new space: \$430,000

**Implementation Timeline:** November 2011- March 2014

**Applicability:** The excavation, mining, and relocation of landfills has the potential to decrease their vulnerability to erosion and SLR inundation, which may lead to an increase in leaching and pollution.

**Description:** The old landfill was filled with ash, a by-product of waste combustion. The metal content of the ash was processed, separated, and repurposed. The removal of this material opened up valuable space.

- Harvested metals turned into electricity source
- The value of mined resources helped to offset the cost
- Faced the challenge of costs associated with excavating, sorting, and reburial of waste exceeding the value of recovered materials
- Alternative benefits that offset the cost include pollution prevention; transforming waste into electricity; space recovery for environmentally friendly disposal methods; reducing greenhouse gas emissions; eliminating groundwater contamination



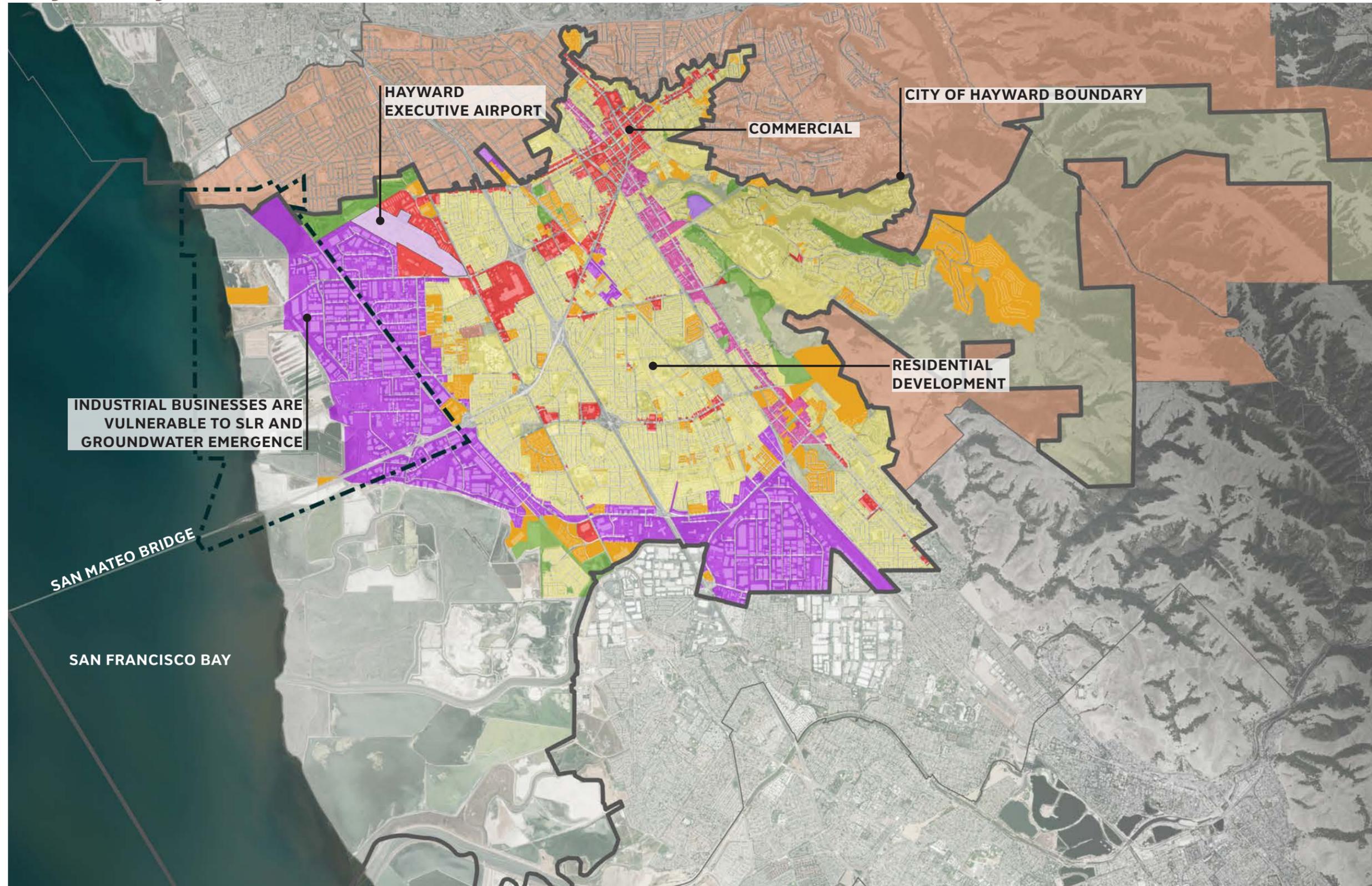
A private company reclaimed metals from the landfill



Excavation of the landfill

# MANAGED RETREAT

## City of Hayward



City of Hayward Land Use

# MANAGED RETREAT

## Option 1: Relocation of Key Assets

### GOAL / OBJECTIVE

Relocate key assets out of future tidal inundation zones.

### DESCRIPTION

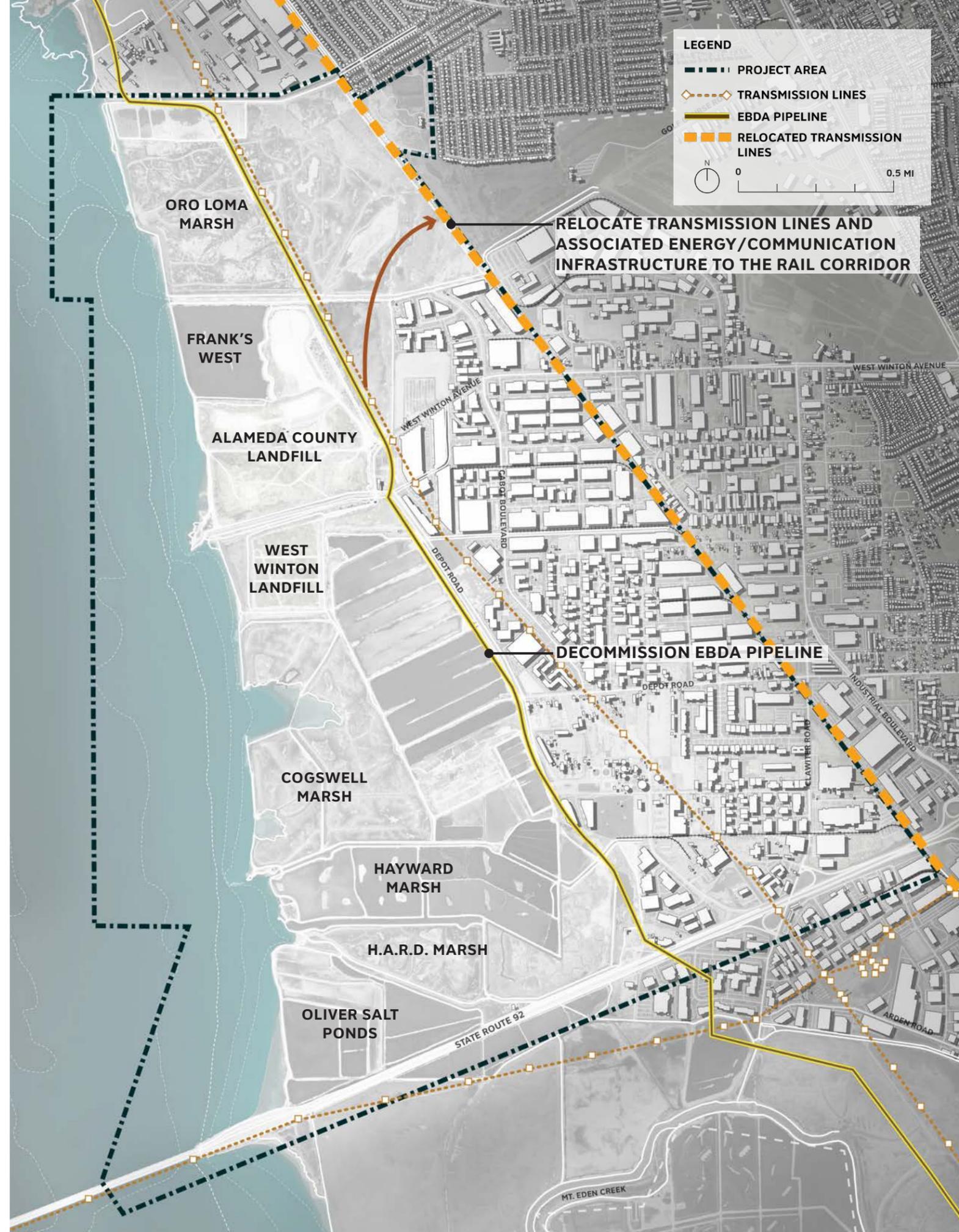
- Decommission EBDA pipeline and retrofit WWTP's for local discharge
- Relocate transmission lines and associated energy/communication infrastructure to the rail corridor

### PROS

- Reduce risk of damage from future SLR and flooding

### CONS

- Requires multiple-agency coordination and long-term planning
- Short-term solution



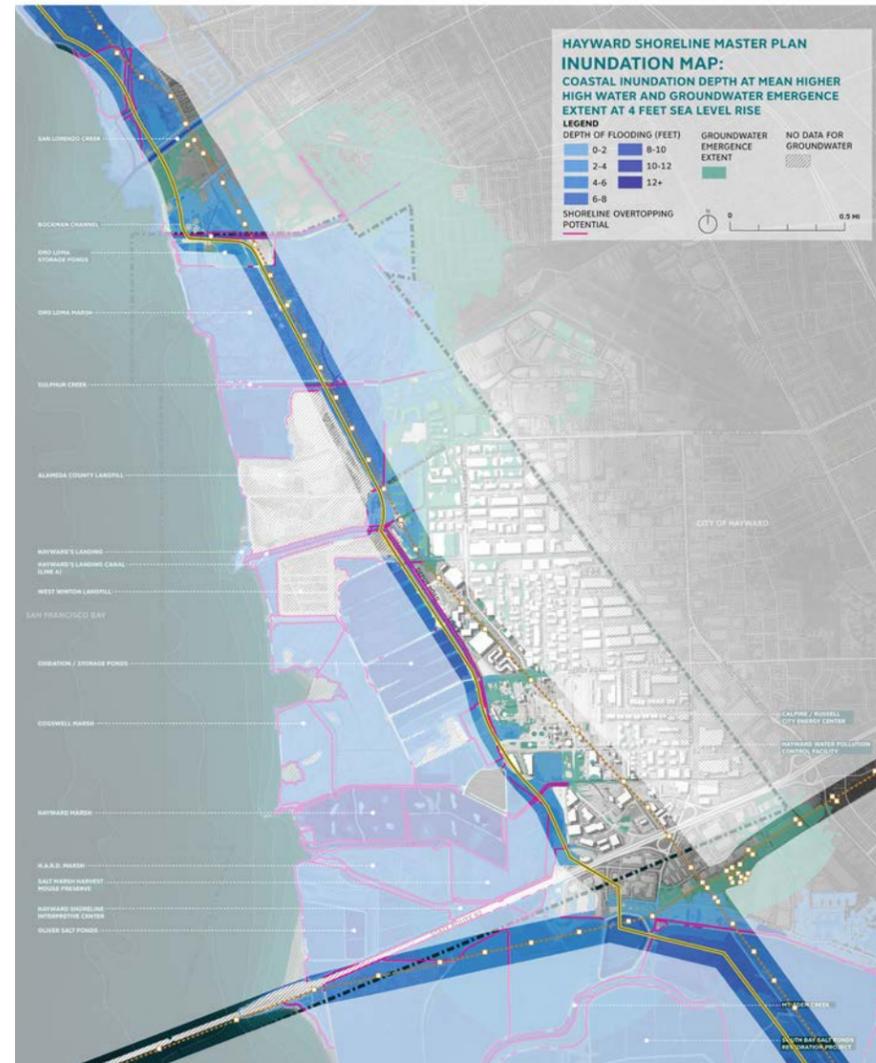
# MANAGED RETREAT

## Option 1: Relocation of Key Assets

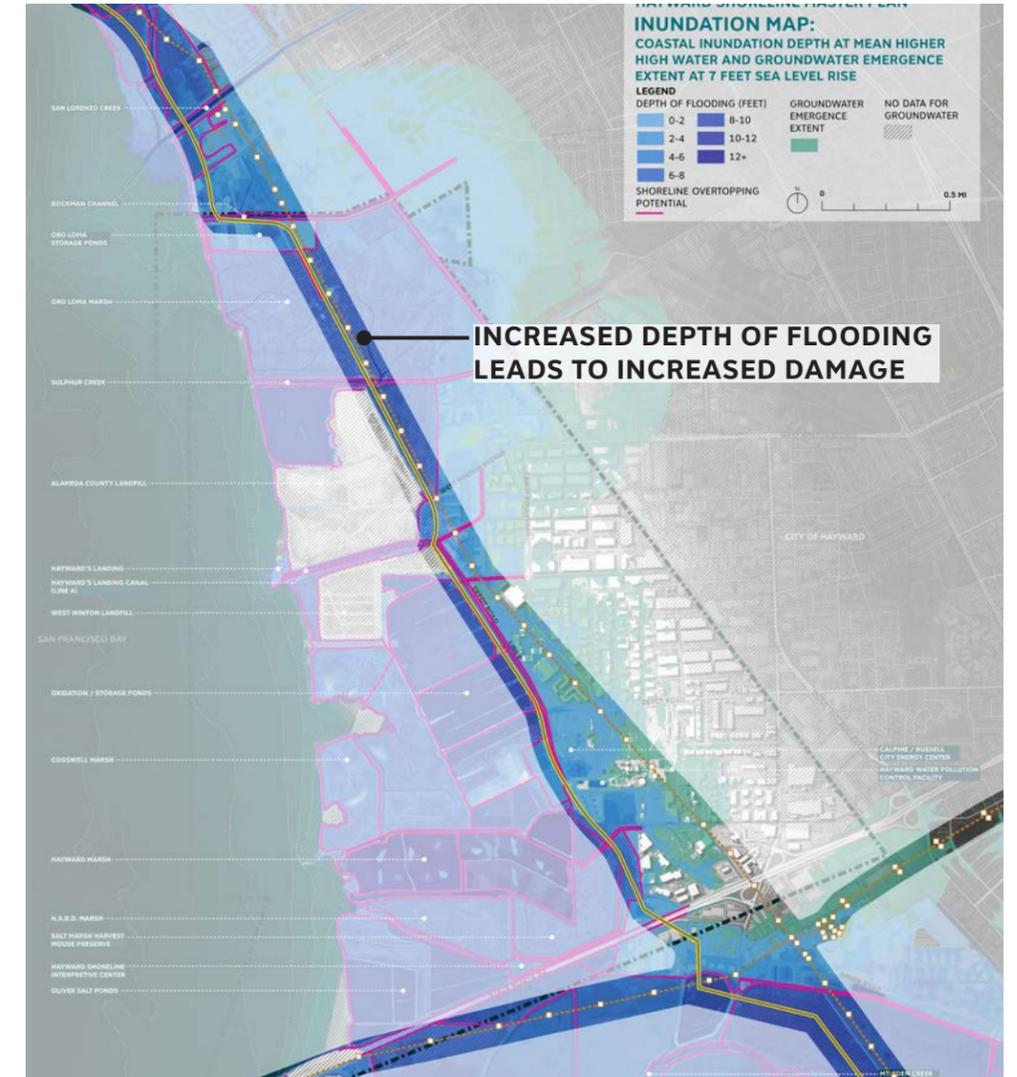
### 2' SLR



### 4' SLR



### 7' SLR



# MANAGED RETREAT

## Option 2: Relocation of All Critical Infrastructure

### GOAL / OBJECTIVE

Relocation of critical infrastructure assets out of the tidal inundation zone.

### DESCRIPTION

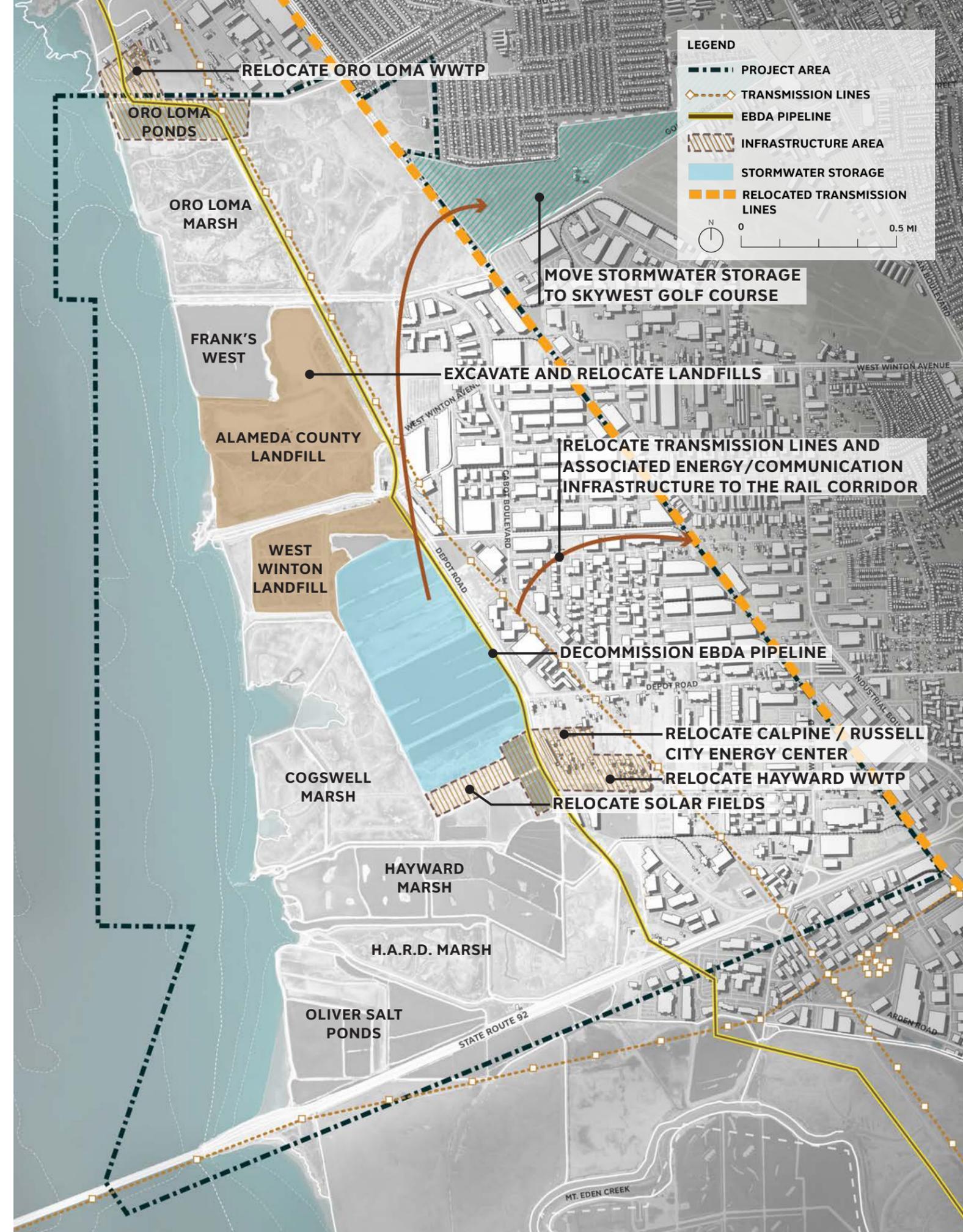
- Excavate landfills and remove materials
- Relocate Oro Loma and Hayward WWTP's upland
- Relocate CalPine / Russell city energy center upland
- Decommission EBDA pipeline and retrofit WWTP's for local discharge
- Relocate transmission lines to the rail corridor

### PROS

- Reduce risk of damage from future SLR and flooding
- Maintain access to coastal areas while enhancing protection
- Enhance ecosystem function with natural infrastructure by returning land to natural habitat

### CONS

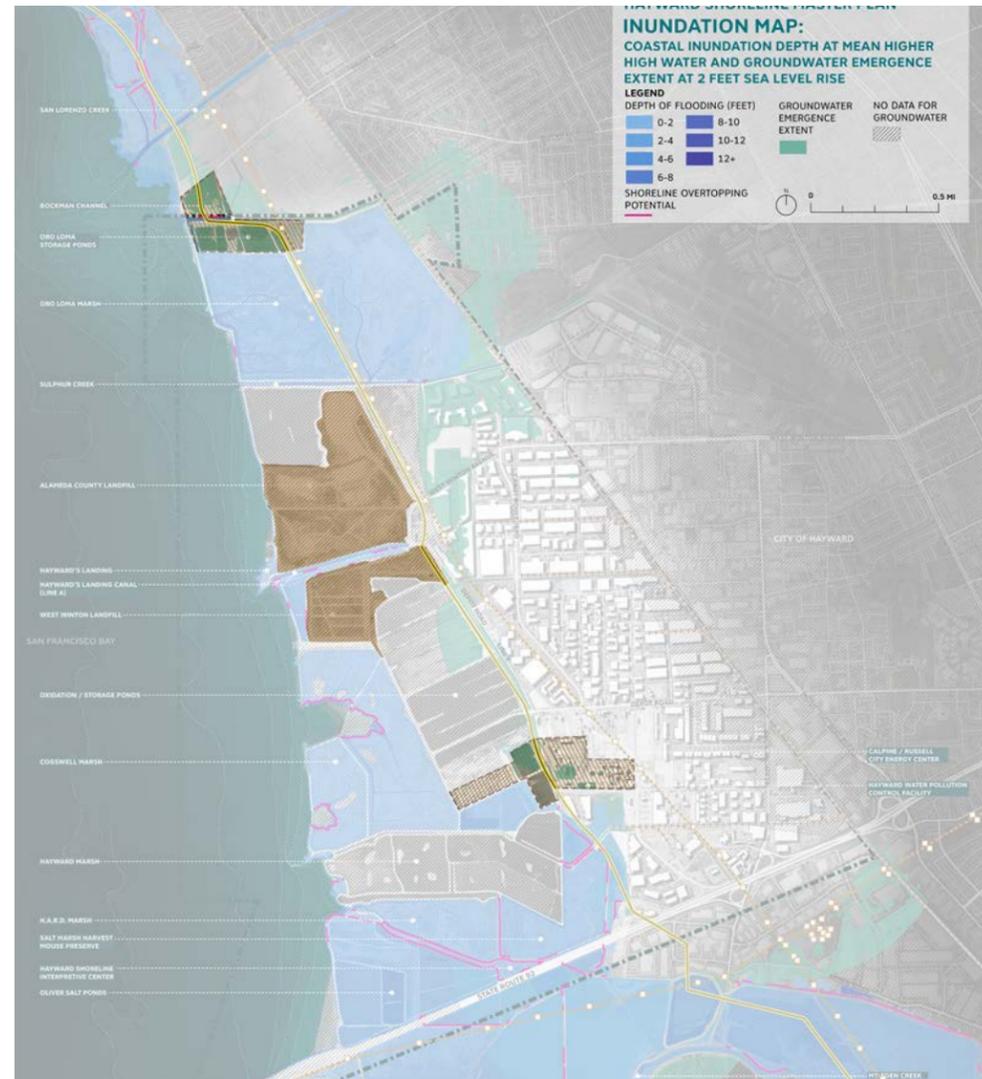
- Very costly
- In order to substantially reduce vulnerability, would require raising land at rail corridor to lift out of SLR inundation and storm surge zones
- Lack of available land to move these assets, which may require eminent domain
- Requires multiple-agency coordination and long-term planning
- "Takings" Law



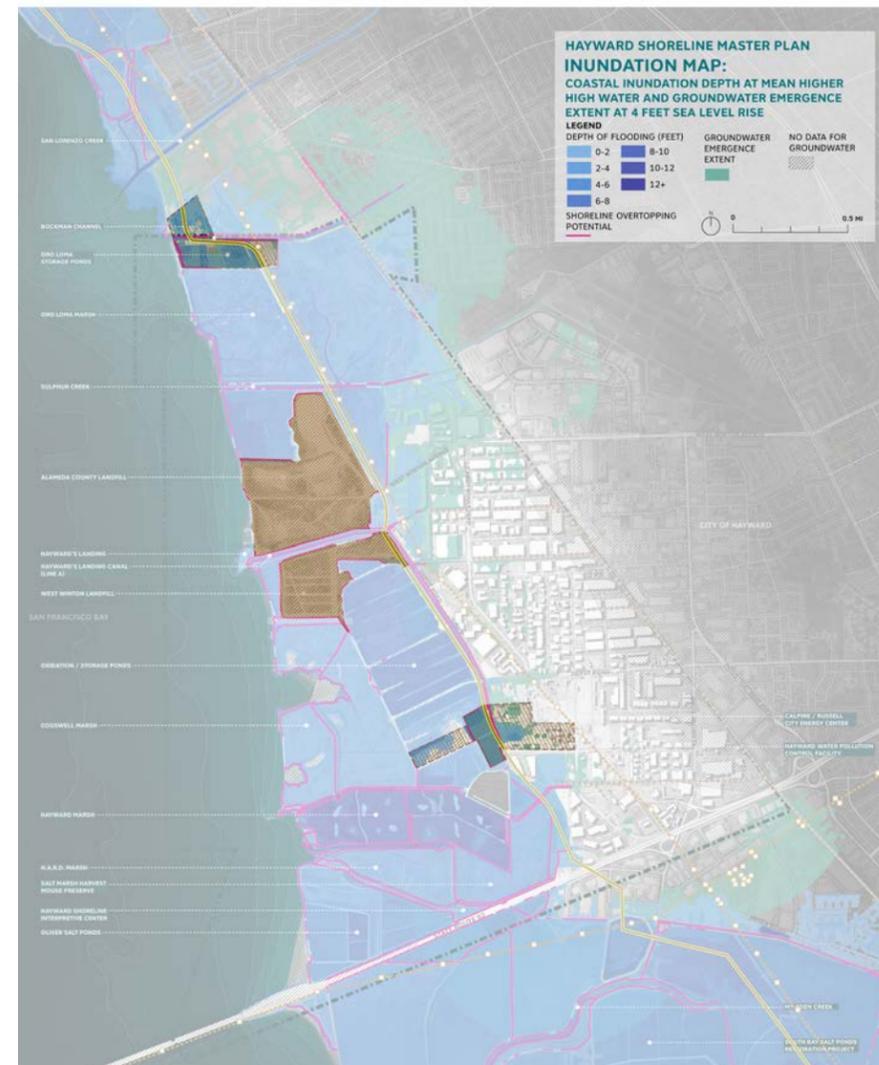
# MANAGED RETREAT

## Option 2: Relocation of All Critical Infrastructure

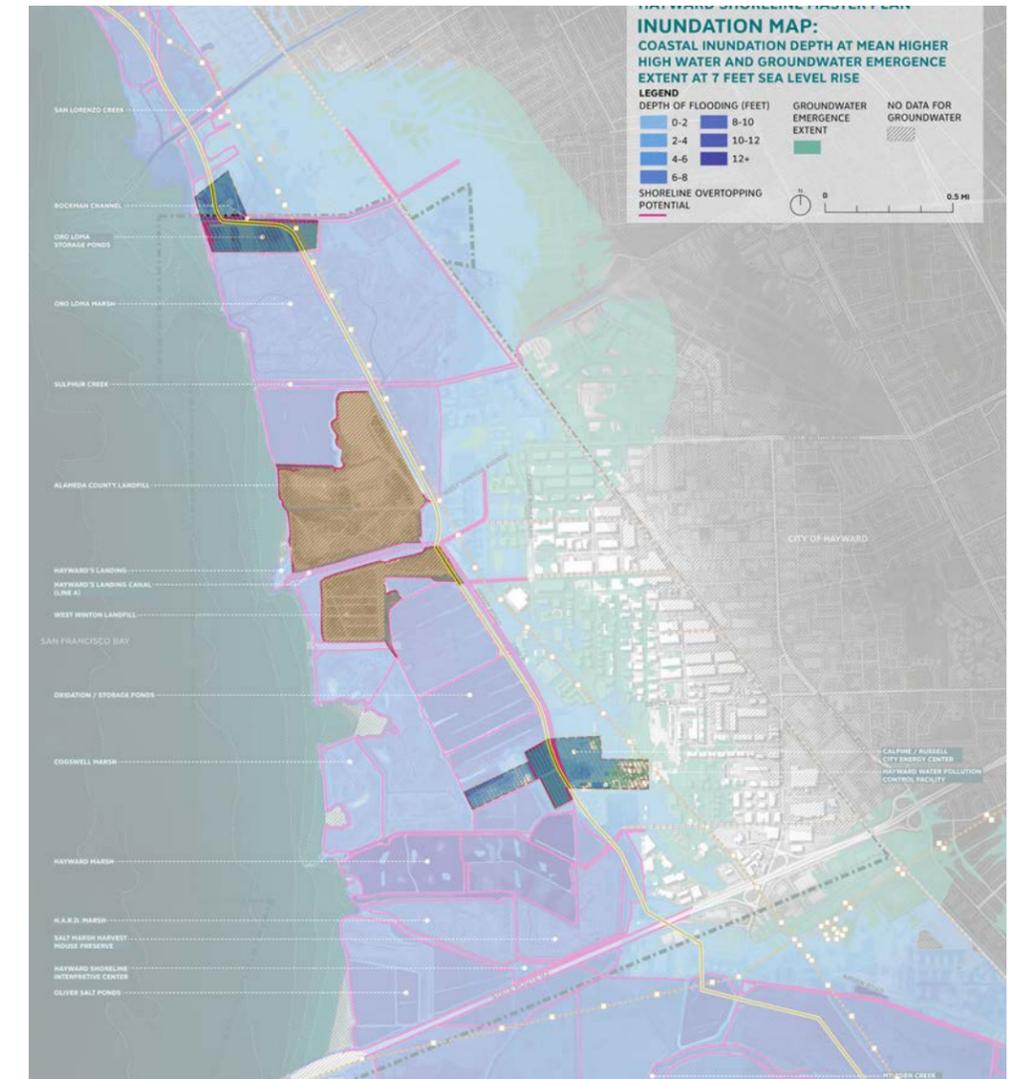
2' SLR



4' SLR



7' SLR



# MANAGED RETREAT

## Option 3: Managed Retreat of Vulnerable Neighborhoods/ Industrial Areas

### GOAL / OBJECTIVE

Relocate vulnerable neighborhoods out of the tidal inundation zone.

### DESCRIPTION

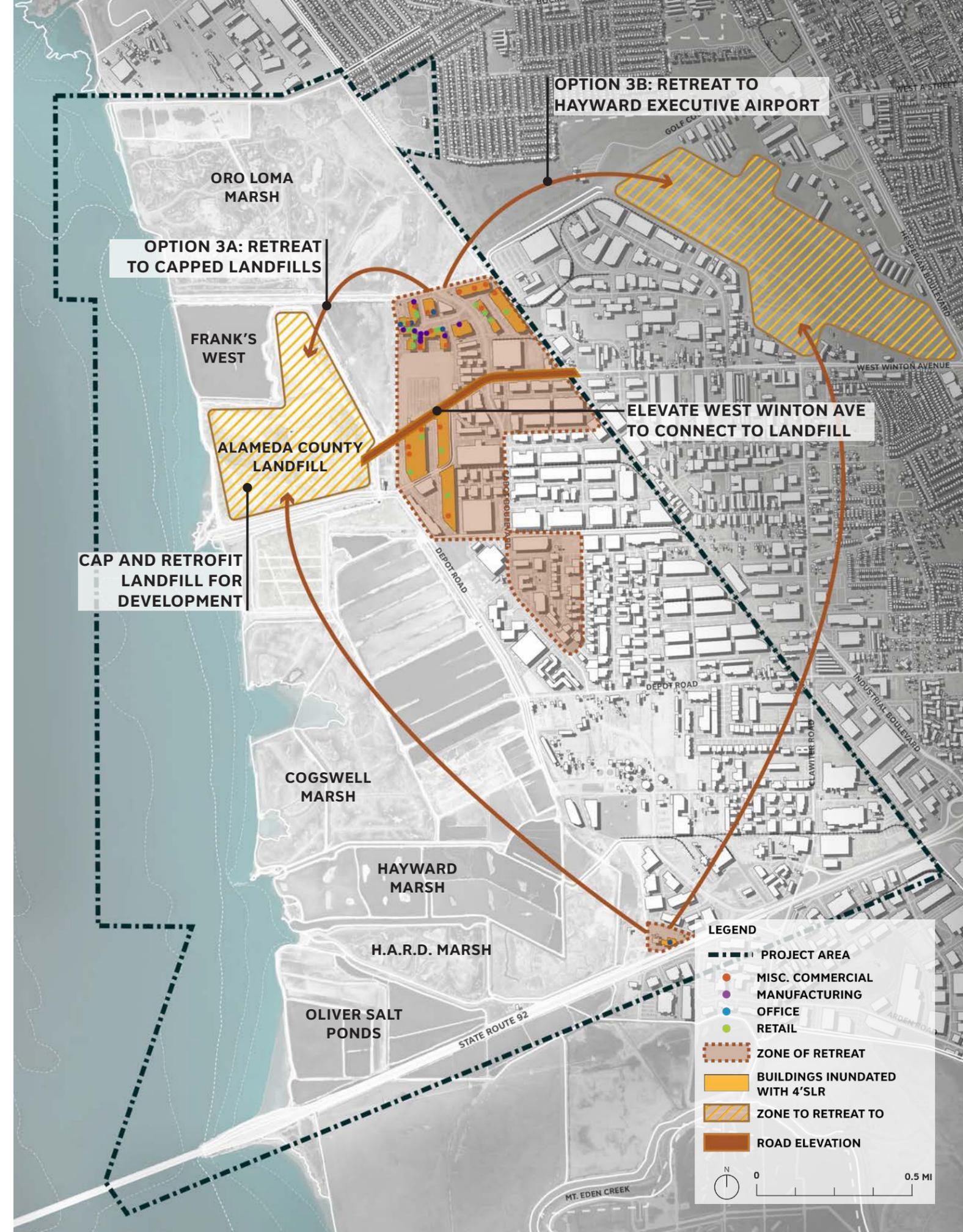
- Retreat businesses impacted by 4' of SLR or groundwater emergence to
- 3a: Retreat to the landfills
- 3b: Retreat to Hayward Executive Airport

### PROS

- Reduce risk of damage from future SLR and flooding
- Reduce cost associated with recovery if not relocated
- Maintain access to coastal areas while enhancing protection
- Enhance ecosystem function with natural infrastructure by returning land to natural habitat

### CONS

- Requires available land to move neighborhoods and industrial areas to
- Industrial land use encroaching on other land use further inland
- Potential remediation concerns
- Very costly
- No precedent for buyout program of industrial area
- Counter to City's goals for economic development
- Requires property-owner buy-in
- Reduces tax base



# MANAGED RETREAT

## Option 3: Managed Retreat of Vulnerable Neighborhoods/ Industrial Areas

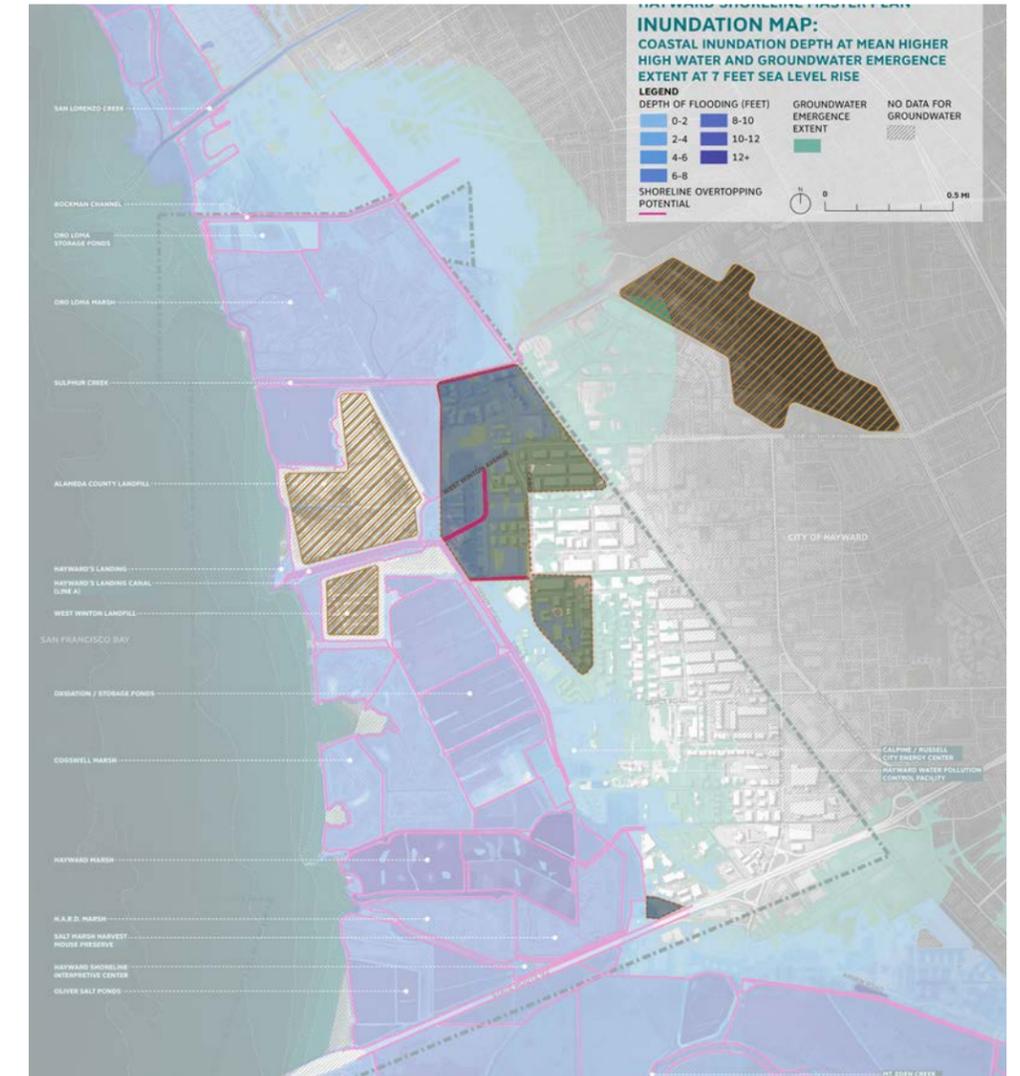
2' SLR



4' SLR



7' SLR



# MANAGED RETREAT

## Option 4: Discourage rebuilding in vulnerable locations while increasing growth in other areas

### GOAL / OBJECTIVE

Discourage rebuilding in vulnerable locations while increasing growth in other areas.

### DESCRIPTION

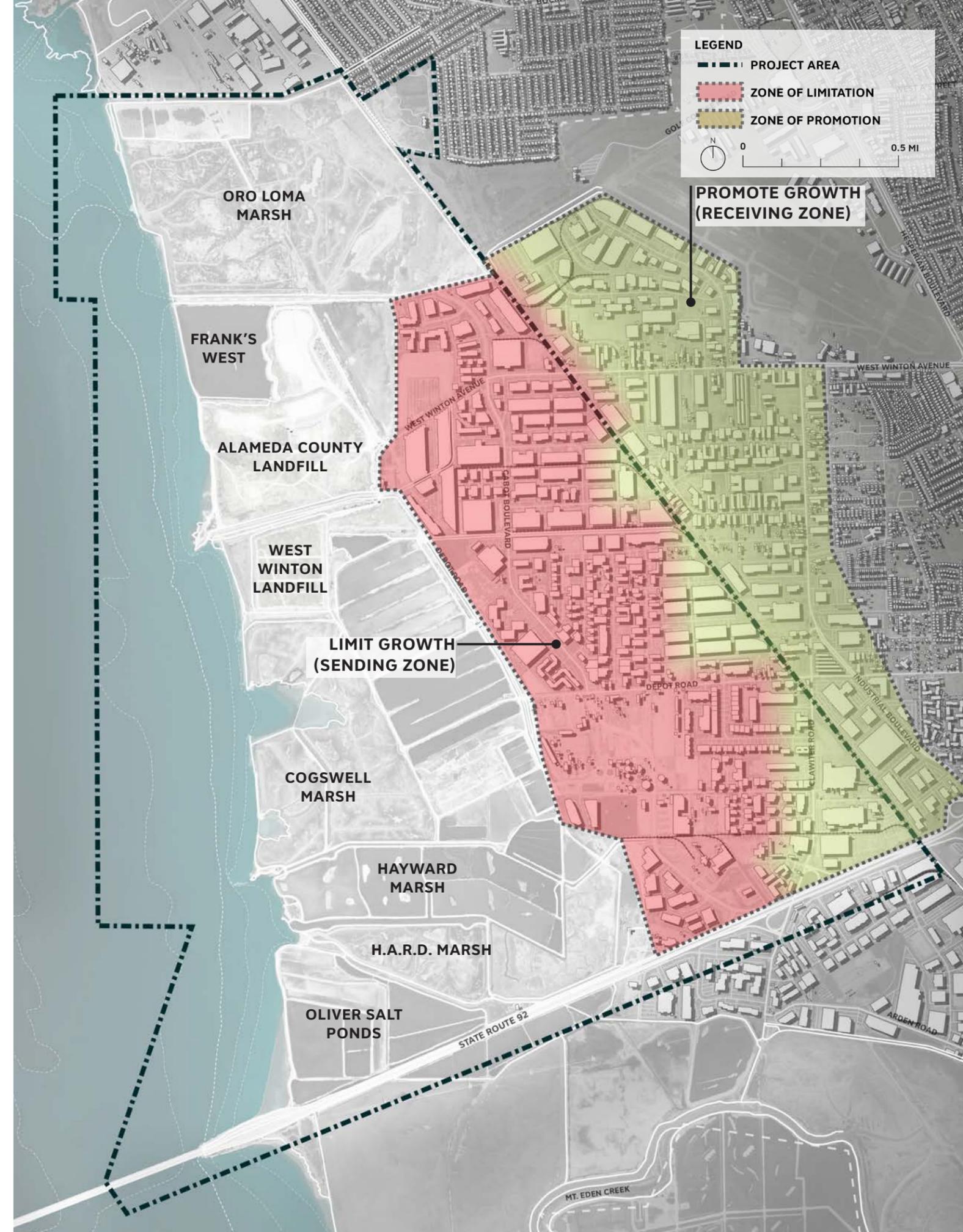
- Enact policies to limit investments and development potential of high-risk areas and encourage growth and investment in less risky areas

### PROS

- Reduce risk of damage from future SLR and flooding
- Maintain access to coastal areas while enhancing protection
- Enhance ecosystem function with natural infrastructure by returning land to natural habitat
- Can be implemented through zoning changes, or creating a transfer of development rights (TDR) program
- Can complement economic development strategy of increasing intensity of industrial uses towards tech/innovation sector

### CONS

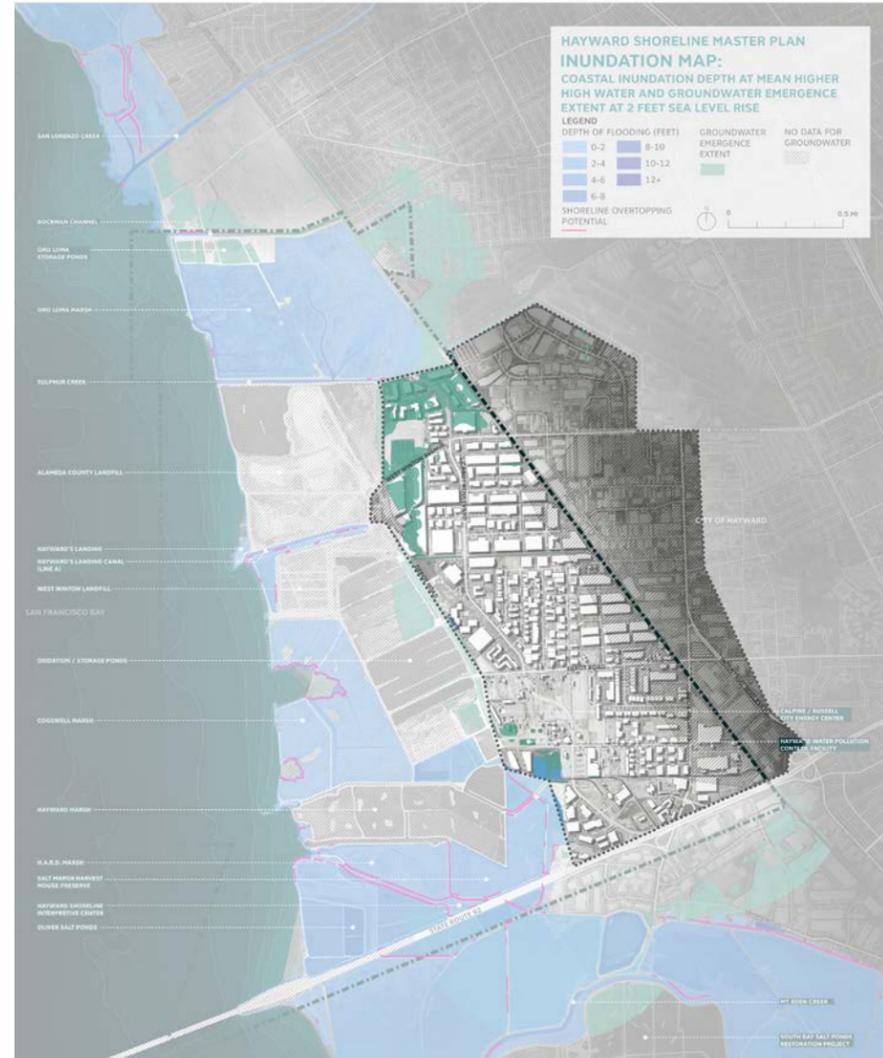
- Could be placing those who are unable to retreat at a disadvantage
- May lead to a patchwork of remaining properties
- Displacement
- Legal aspects of restricted development
- Could reduce tax base
- Areas for growth already built out



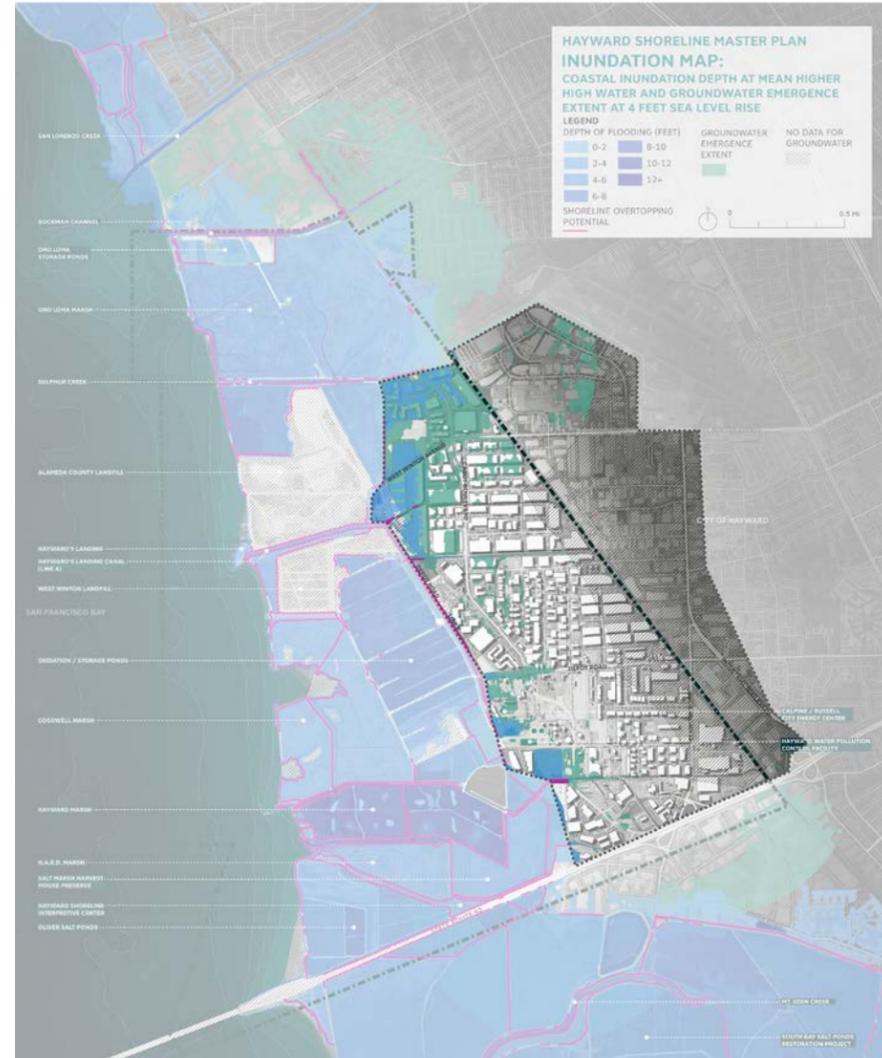
# MANAGED RETREAT

Option 4: Discourage rebuilding in vulnerable locations while increasing growth in other areas

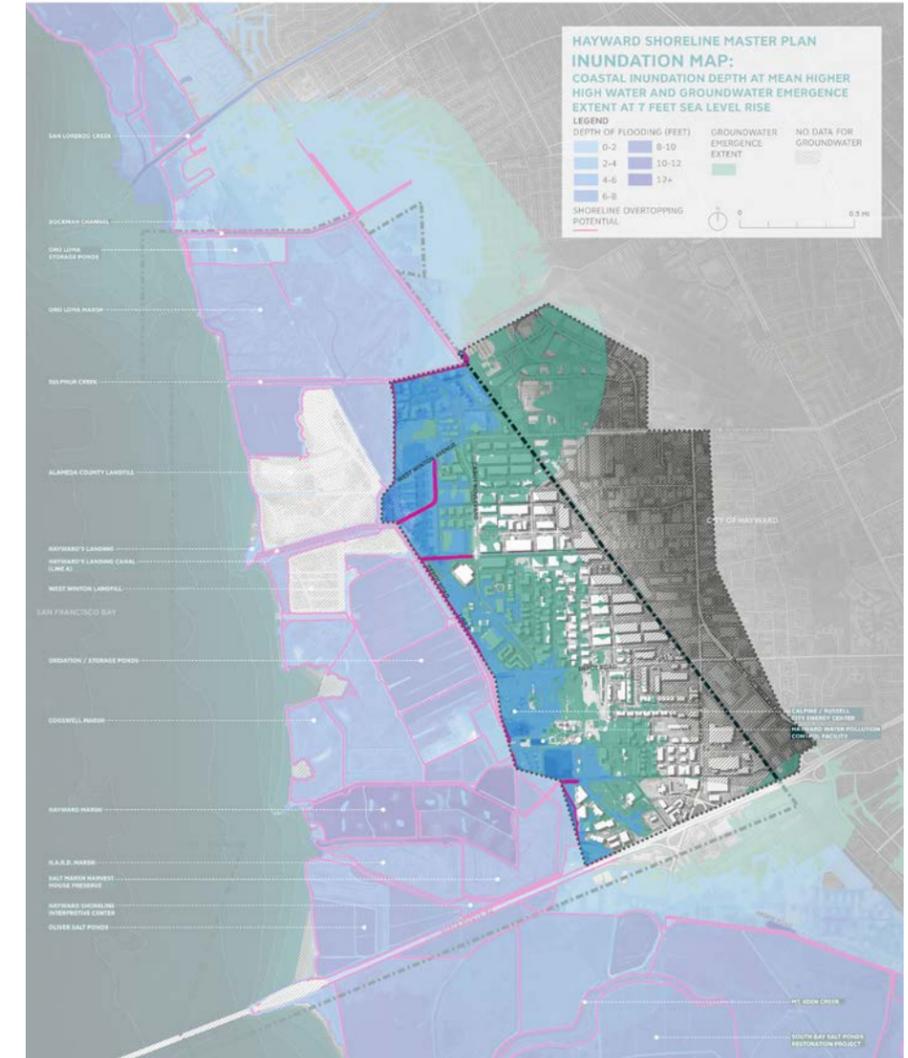
2' SLR



4' SLR



7' SLR



# MANAGED RETREAT

## Compiled Options

### 1: Relocation of Key Assets



#### COMMENTS

- See General Comments.

#### GENERAL COMMENTS

- EBRPD: Why don't you view the marshes as an asset in the relocation of key assets? SCAPE: Marsh planning, restoration, and adaptation are covered in other strategies. Specifically Marsh and Mudflat Migration Planning looks at marsh migration / relocation over time. Marshes and other ecologically valuable features are seen as assets. To clarify, these options are looking into relocation of built assets.
- COH:DG: All possible adaptation measures related to the City of Hayward WWTP should be reviewed and commented on by the City's Public Works Utilities staff. SCAPE will review these options with Public Works.

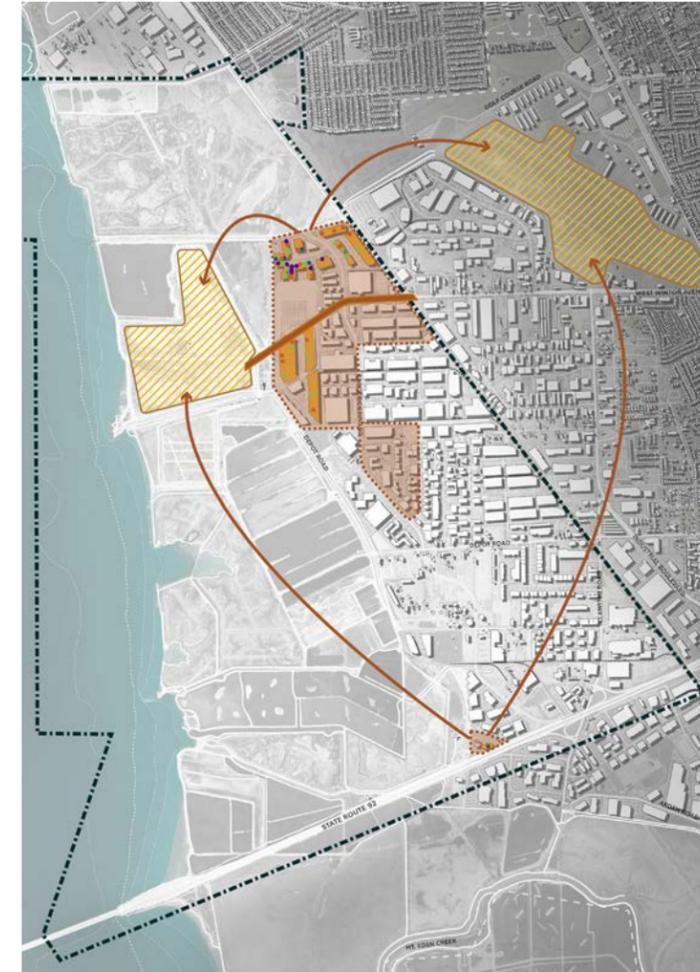
### 2: Relocation of All Critical Infrastructure



#### COMMENTS

- EBRPD: How would you relocate landfills? SCAPE: The landfills would have to be excavated and remediated. The material could be mined for valuable metals, as is indicated by the Ecomaine Landfill Mining precedent in this report, and relocated to another landfill site that is less vulnerable.

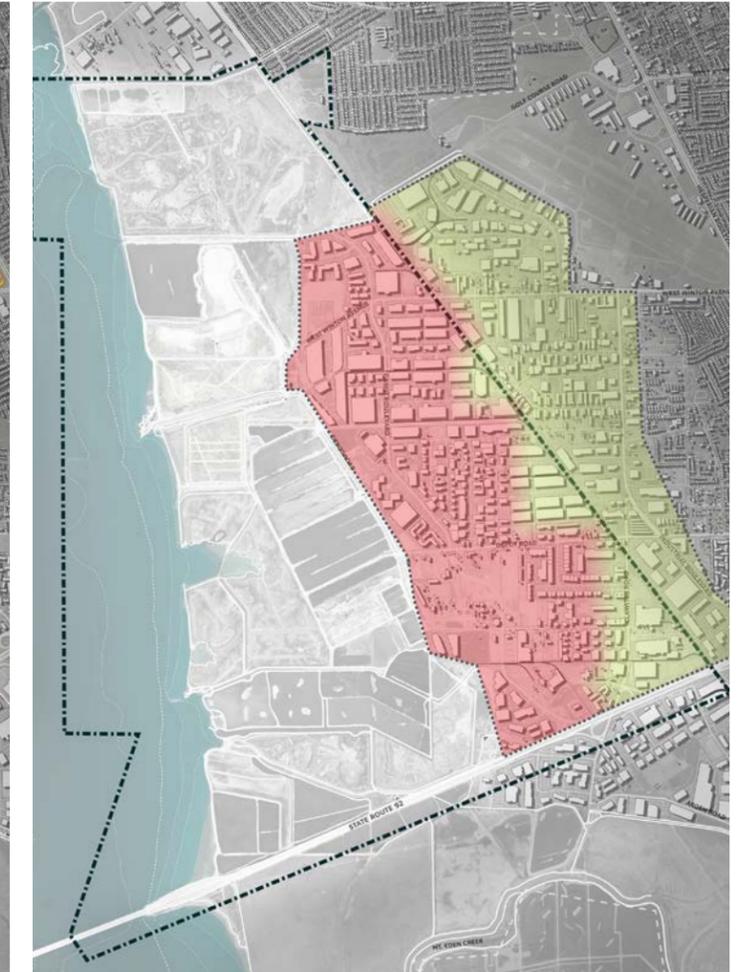
### 3: Managed Retreat of Vulnerable Neighborhoods/ Industrial Areas



#### COMMENTS

- EBRPD: What would you develop in the landfills?. SCAPE: The landfills could potentially accommodate industrial uses or businesses if they were capped and retrofitted accordingly. This would also necessitate raising access roads to the landfill to ensure connectivity over time.
- COH: TR: Why is retreat towards the bay? It seems counterintuitive. Also, if you move neighborhoods/industrial areas to the landfill, how will you maintain connectivity? SCAPE: The landfills were identified as a potential retreat location since they are the main high point in the study area that is undeveloped. This option would have to be paired with a road raising of West Winton Ave to ensure connectivity, as indicated in the diagram.
- COH: DG: Since there could be a potential high cost associated with this option, Option 3 is not supported by the City of Hayward. SCAPE will not consider this option moving forward.

### 4: Discourage rebuilding in vulnerable locations while increasing growth in other areas



#### COMMENTS

- COH: DG: Support from the City of Hayward regarding this adaptation option. SCAPE will note this in the comments.

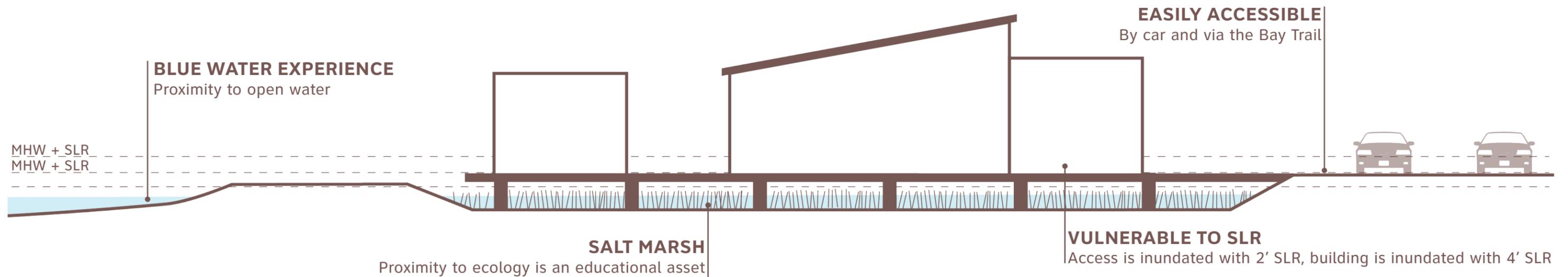
# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Description

Relocation or retrofitting strategies may help the Hayward Shoreline Interpretive Center maintain its educational program and **adapt to sea level rise**. Pairing with new restoration or pilot projects can provide **new educational and stewardship opportunities**.

## GOAL / OBJECTIVE

- Enhance educational opportunities and adapt to SLR
- Create a management framework for adapting to SLR over time



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Precedents

### Makoko Floating School Lagos, Nigeria

**Size:** 2,350 SF

**Implementation Timeline:** 2013

**Applicability:** A floating building / educational center has the ability to adapt with fluctuating water levels, SLR, and storm surge.

**Description:** A floating school pilot project was developed to address social and physical community needs in the face of climate change and increased urbanization to generate sustainable, ecological, and alternative building systems for Africa's coastal regions.

- Built from locally sourced wood and bamboo
- Buoyed by recycled plastic barrels in an ideal shape for tall floating objects on water
- 3 levels- open play area, community space, enclosed space for 2 classrooms and 60 students
- Adapts to tidal changes and varying water levels- invulnerable to flooding and storm surges
- Designed to use renewable energy, recycle organic waste, and to harvest rainwater



Network of floating buildings



Floating school built with local materials

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Precedents

### Elizabeth River Project Learning Barge Norfolk, VA

**Size:** 120' x 32'

**Cost:** \$163,000 / year to operate

**Implementation Timeline:** 2009-ongoing

**Applicability:** A floating barge has the ability to adapt to fluctuating water levels, SLR, and storm surge.

**Description:** The Learning Barge is a floating wetland classroom and “stewardship ship” that teaches children about river environmental stewardship.

- Floating Wetland Classroom ‘steward ship’
- Teaches children of the river environmental stewardship actions and shows how to make the Elizabeth River healthier
- Every 4th grader in Norfolk visits
- Powered by solar and wind
- Live wetlands, enclosed classroom, composting toilets, and a rainwater filtration system



Floating wetland facilitates educational activities



Floating Barge with wind and solar power

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Precedents

### Science Barge Yonkers, NY

**Size:** 115' long

**Cost:** \$1 million in renovations (past 2 years)

**Implementation Timeline:** 2017-2019

**Applicability:** A floating barge has the ability to adapt to fluctuating water levels, SLR, and storm surge.

**Description:** The Science Barge is a prototype sustainable urban farm that is operated by Groundwork Hudson Valley and operated as an environmental education center.

- Sustainable urban farm and environmental education center
- Net zero carbon emissions, zero pesticides, zero runoff- solar panels, wind turbines, biofuels, hydroponic greenhouse irrigated by rainwater
- Used for field trips for schools, camps, and other groups



Floating Science Barge



Greenhouses on the Science Barge

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Precedents

### Arcata Marsh & Wildlife Sanctuary Arcata, CA

**Size:** 1,540 SF

**Cost:** \$580,000

**Implementation Timeline:** 1991-1993

**Applicability:** The pairing of an interpretive center with pilot projects, as well as increased accessibility and recreation, provides enhanced educational opportunities.

**Description:** The Arcata Marsh Interpretive Center has interactive exhibits, free maps and literature, and a bookstore. It is located directly adjacent to a series of sewage treatment ponds and wetlands.

- Arcata's wastewater is treated locally, utilizing natural wetland processes
- Combination of treatment plant, publicly accessible wetlands, wildlife habitat, and recreational opportunities
- Integration of conventional wastewater treatment with natural processes of constructed wetlands
- Freshwater marshes, salt marsh, tidal sloughs, grassy uplands, mudflats, brackish marsh, and 5 miles of trails
- Interpretive Center has interactive exhibits, free maps and literature, bird checklists, and a bookstore.



Aerial view of WWTP pond system



Arcata Marsh Interpretive Center

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 1: Remain in Place / Elevation

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

- Maintain current location of the Interpretive Center and elevate with SLR

### PROS

- Maintain current location
- Blue water experience - proximity to shoreline marshes
- Building is highly visible in its current location

### CONS

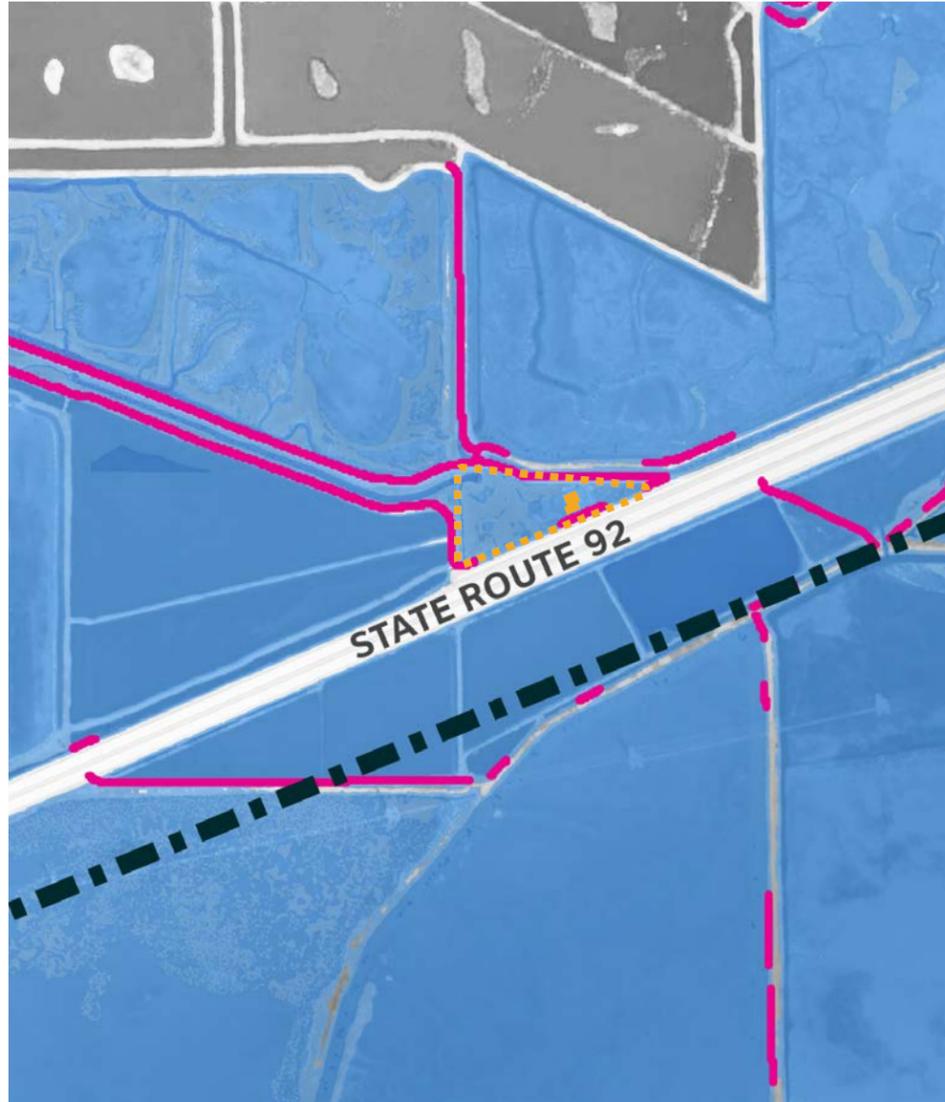
- Access paths to the shoreline and bay are inundated with SLR
- Raising the building may be costly, only to be inundated with 7' SLR
- ADA accessibility might be a challenge



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

Option 1: Remain in Place / Elevation

2' SLR



- Bay Trail access is inundated

4' SLR



- Need to raise building, which becomes inundated

7' SLR



- Site is severely compromised
- Need to relocate building- all access, including roads, is inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 2: West Winton Landfill

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

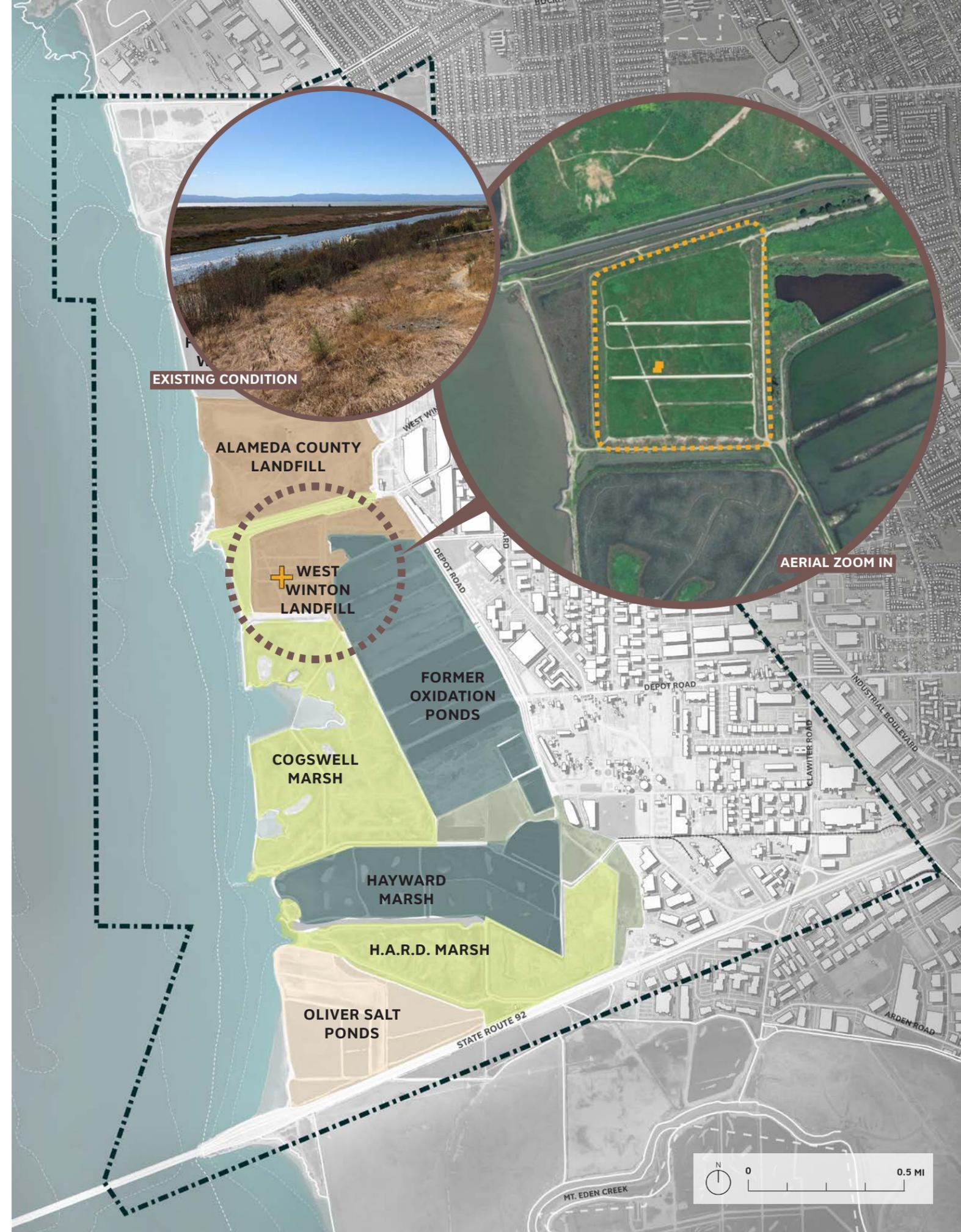
- Relocate the Interpretive Center to the West Winton Landfill

### PROS

- Blue water experience - proximity to marshes
- Expansive views of the shoreline

### CONS

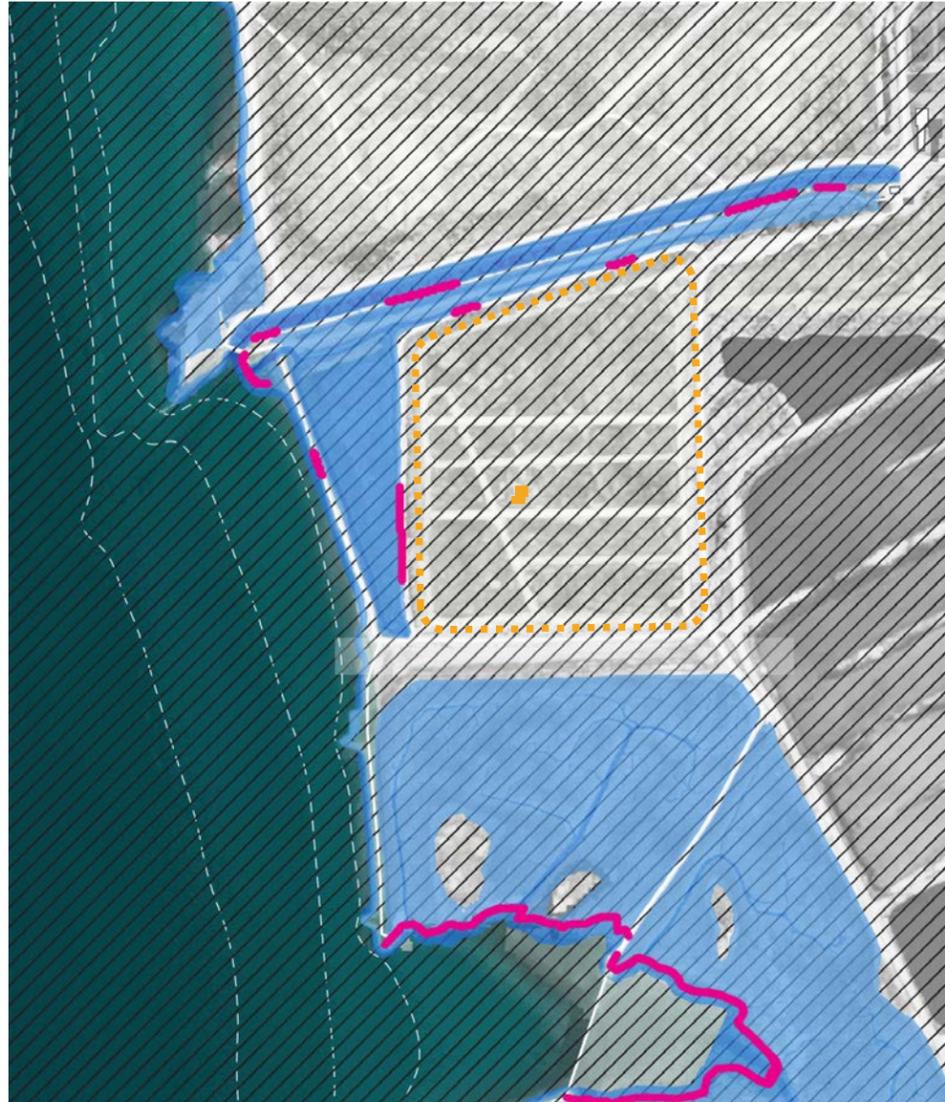
- Landfill poses maintenance concerns- may be unstable. Building would likely require deep piles that go through the landfill
- May be costly to puncture foundations through landfill
- Car access inundated with 4' SLR- would require raising the road



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 2: West Winton Landfill

2' SLR



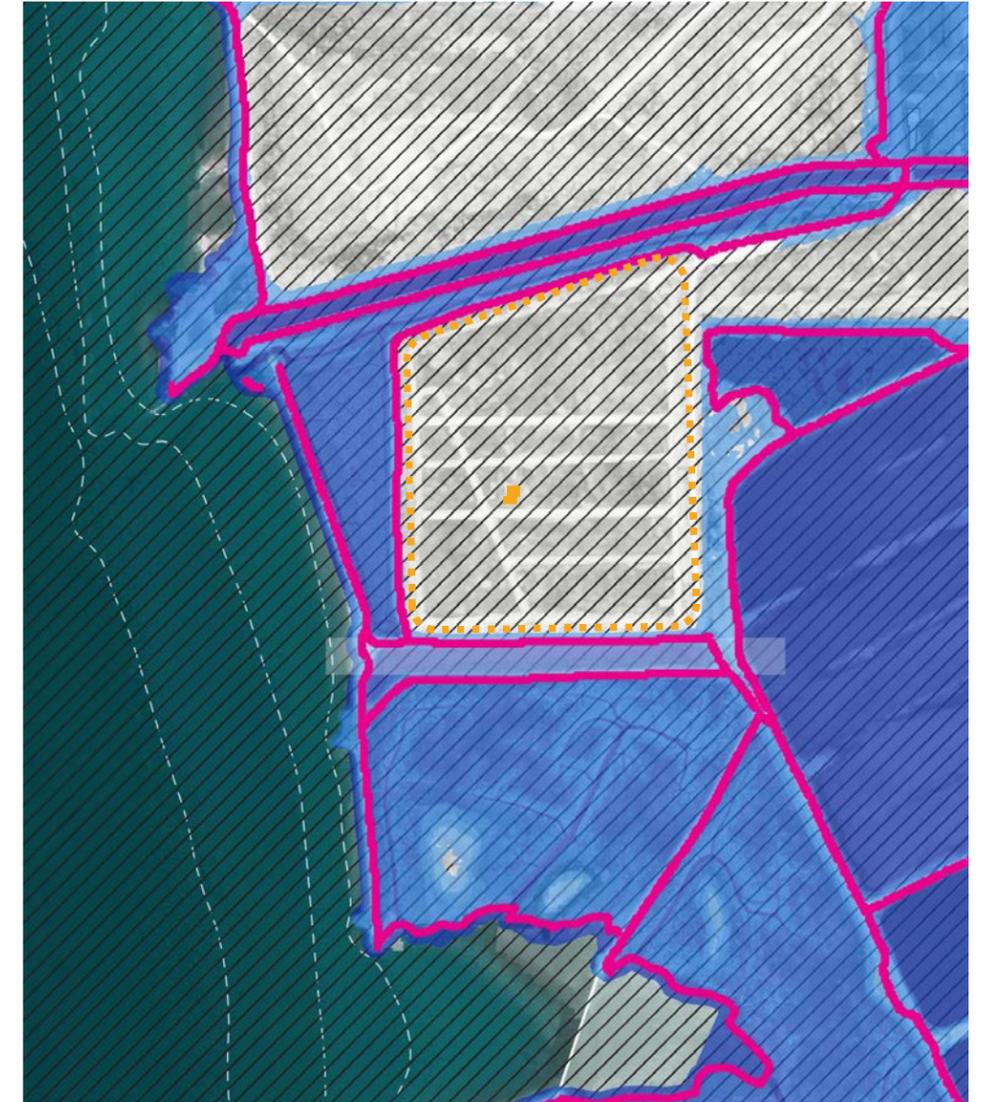
- Minimal impacts

4' SLR



- W. Winton Ave is inundated

7' SLR



- Site is severely compromised
- W. Winton Ave is severely inundated
- Access by car and trails is lost

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 3: Regional Park Office

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

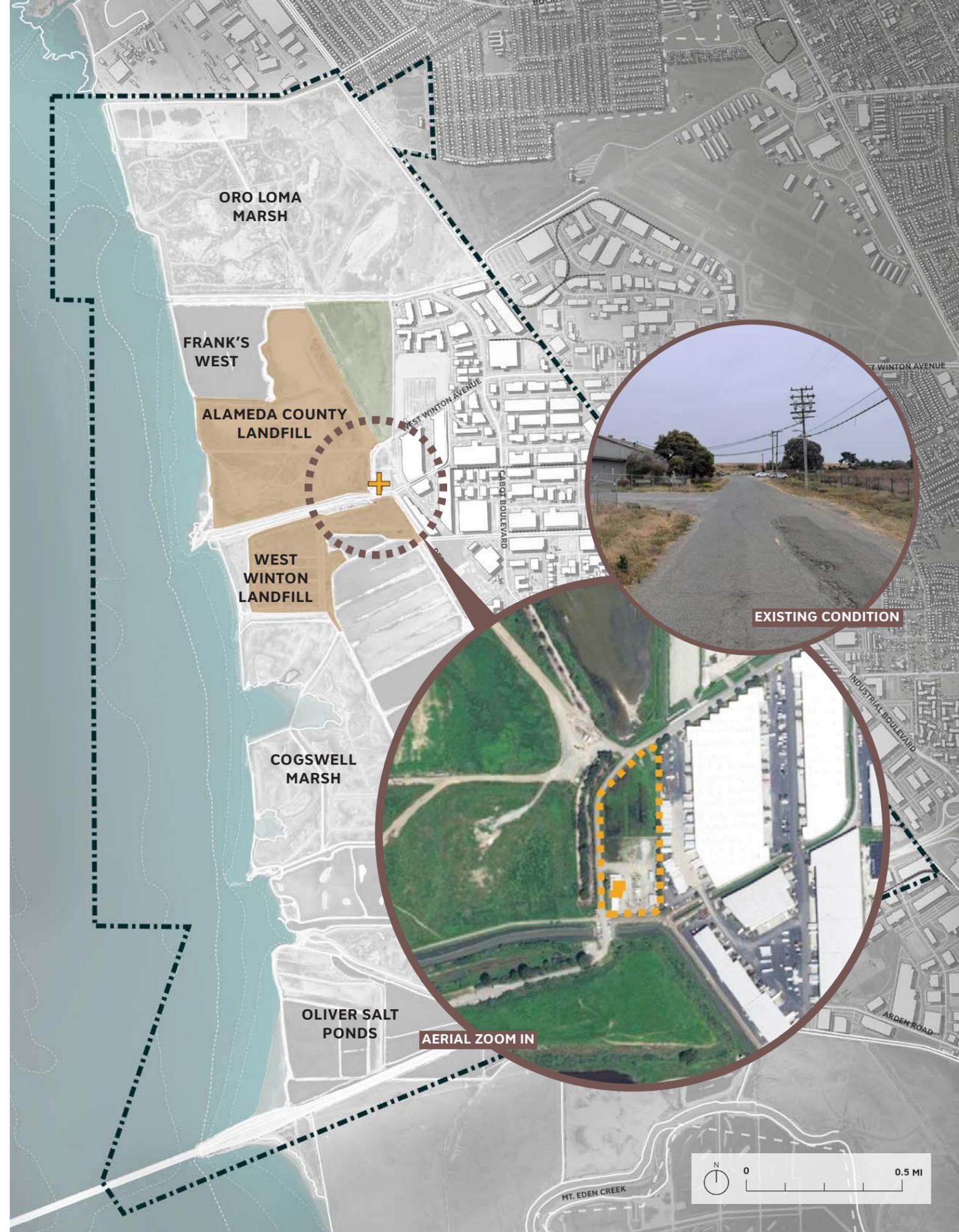
- Relocate the Interpretive Center to the Regional Park Office site

### PROS

- Proximity to marshes
- Could be paired with horizontal levee on landfill edge
- Easily accessible from West Winton Ave

### CONS

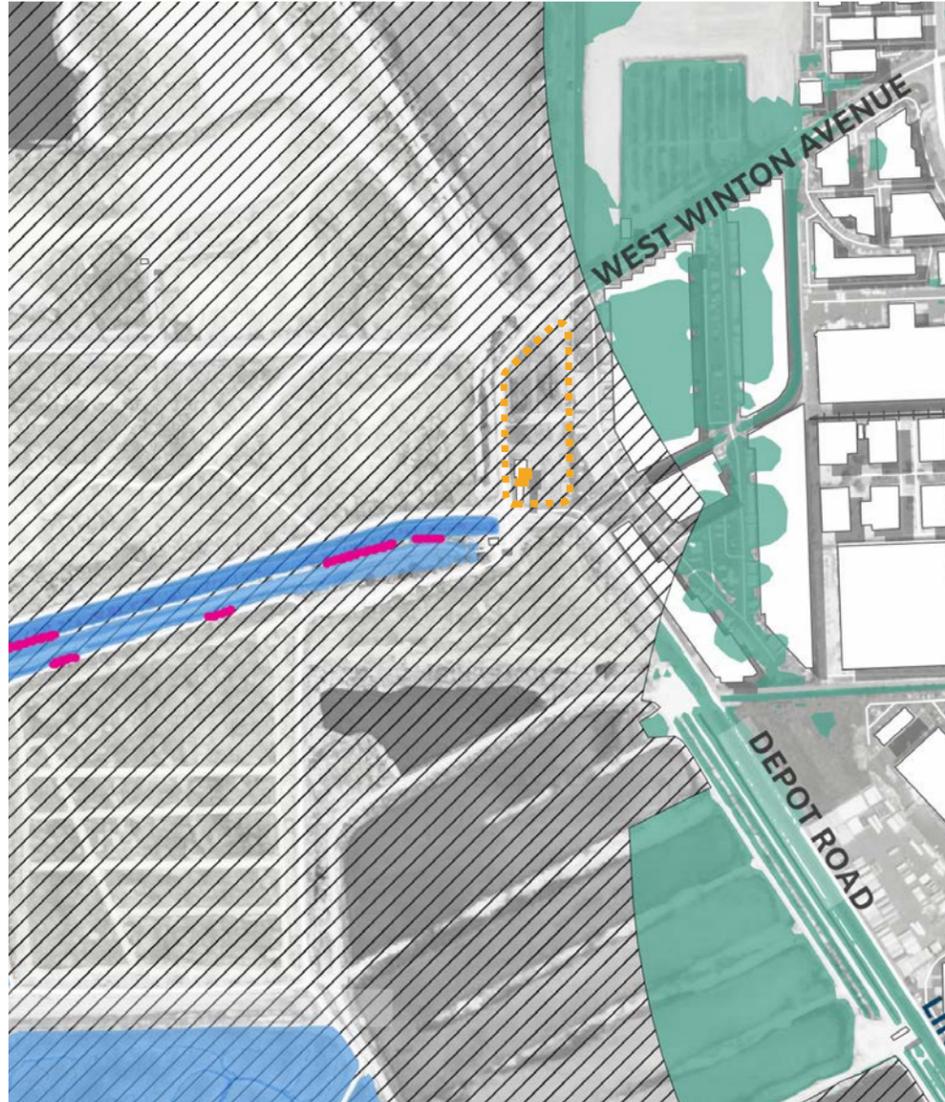
- No true blue experience
- Access and building are inundated with 4' SLR
- Transmission lines go through this site, which may present an issue



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

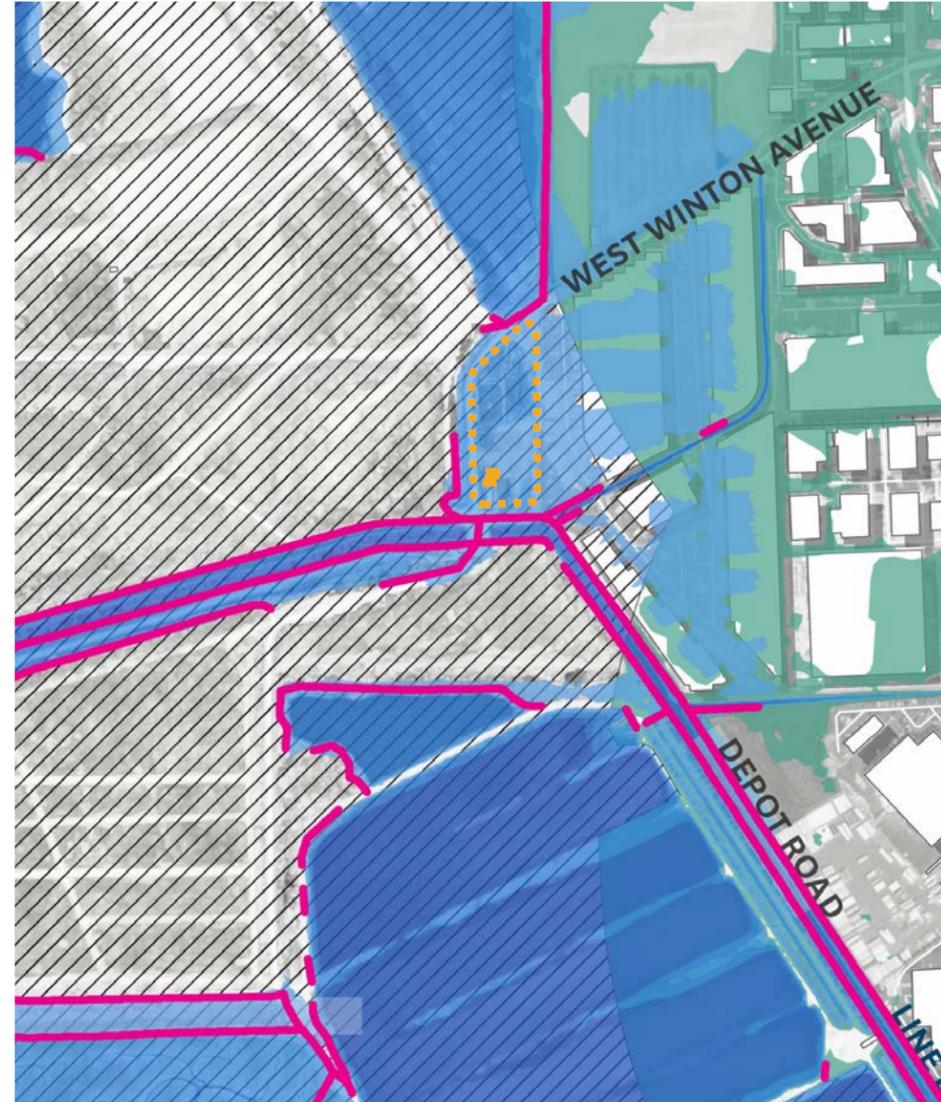
## Option 3: Regional Park Office

### 2' SLR



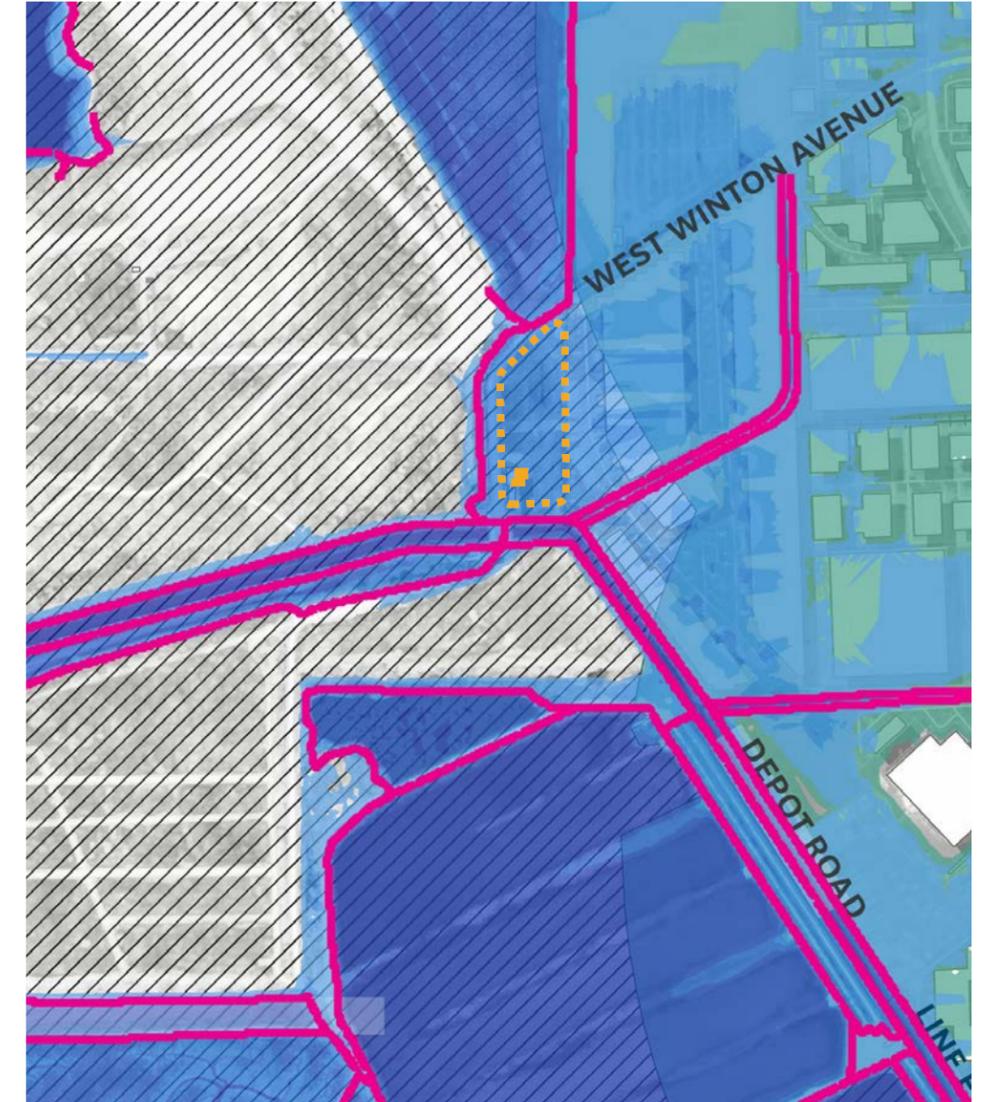
- Minimal impacts
- Potential groundwater emergence (no data)

### 4' SLR



- Building and access road are inundated

### 7' SLR



- Site is severely compromised
- Building is severely inundated
- Access is severely inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 4: San Lorenzo Community Center Park

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

- Relocate the Interpretive Center to San Lorenzo Community Center Park

### PROS

- Potential to paired with marsh migration space pilot project
- Proximity to residential community
- Proximity to Oro Loma Marsh
- Blue water experience with SLR inundation

### CONS

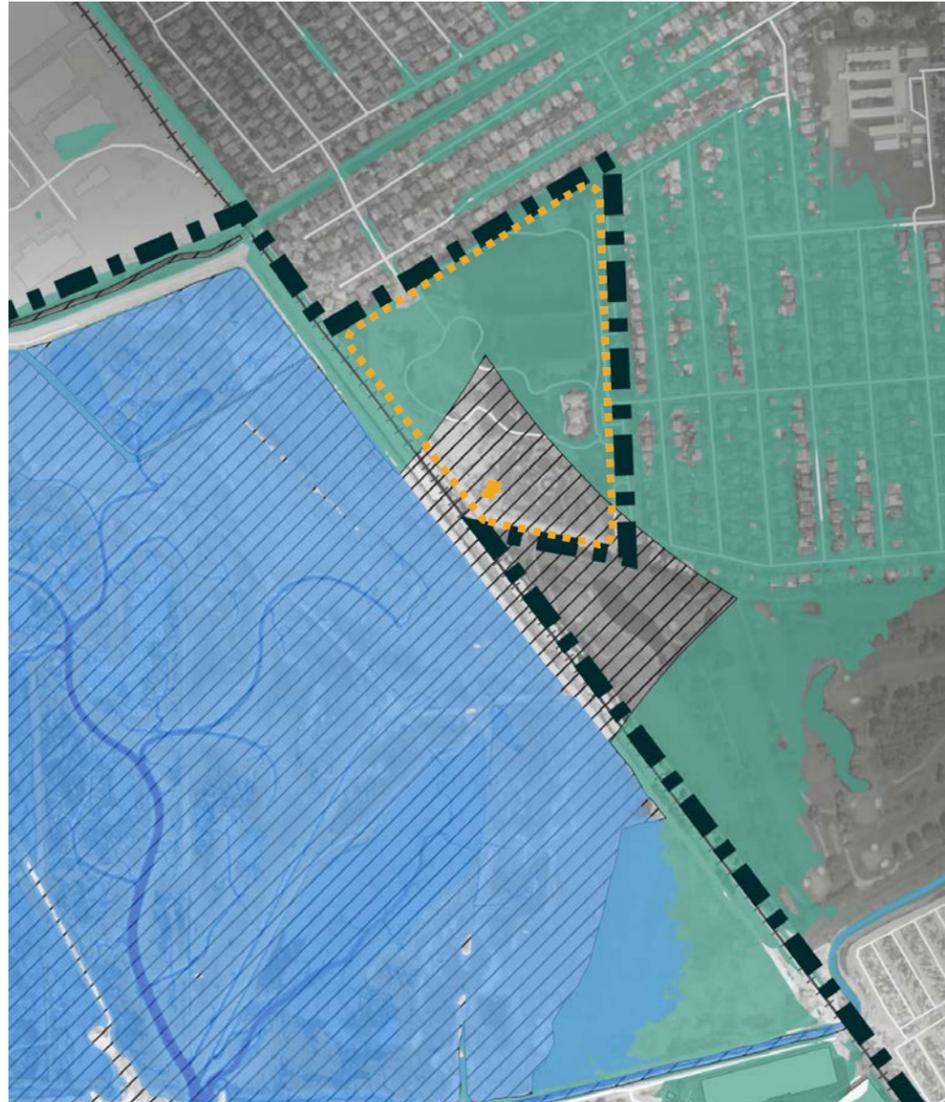
- Inundated with 4' SLR
- Potential groundwater impacts



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 4: San Lorenzo Community Center Park

2' SLR



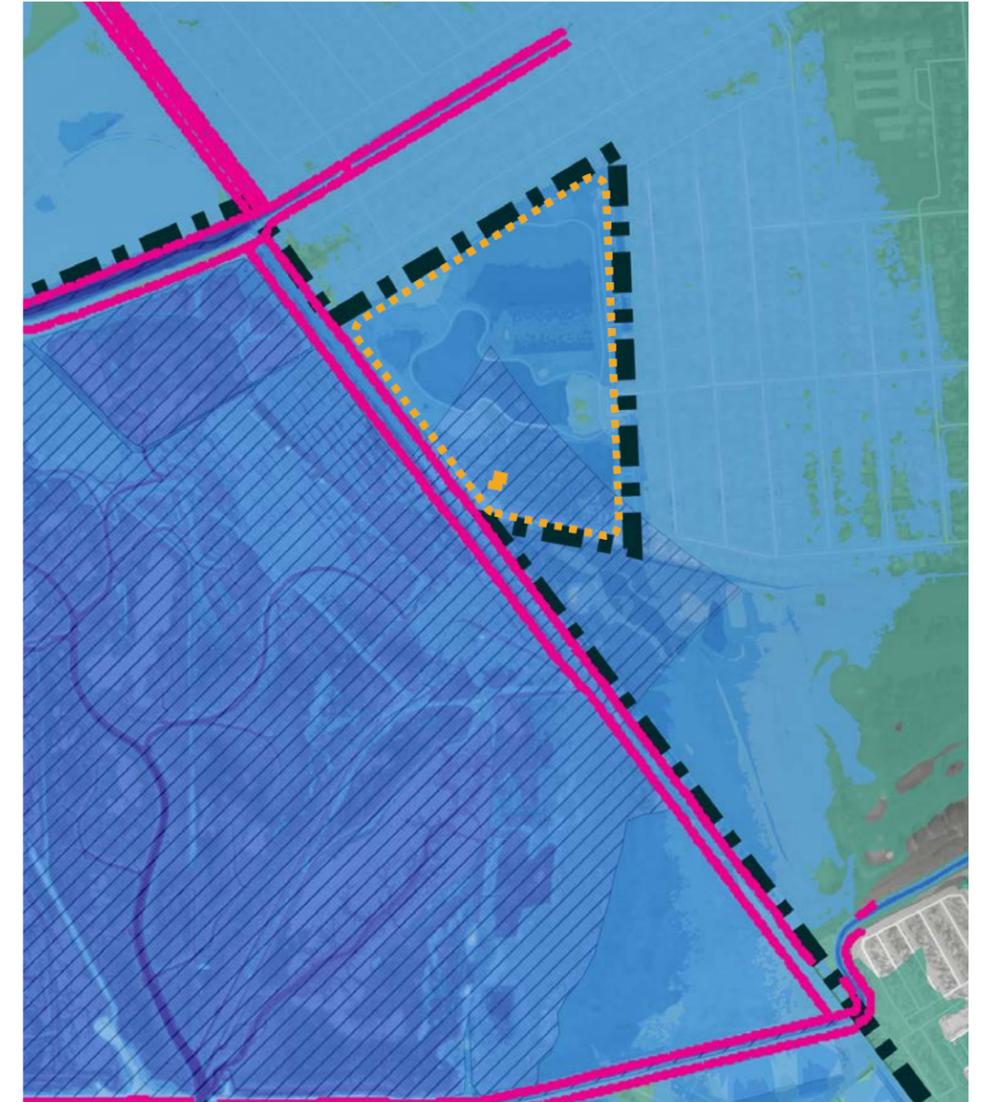
- Potential groundwater impacts (no data)

4' SLR



- Building is inundated

7' SLR



- Site is severely compromised
- Building is severely inundated
- All adjacent access is inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 5: Frank's East

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

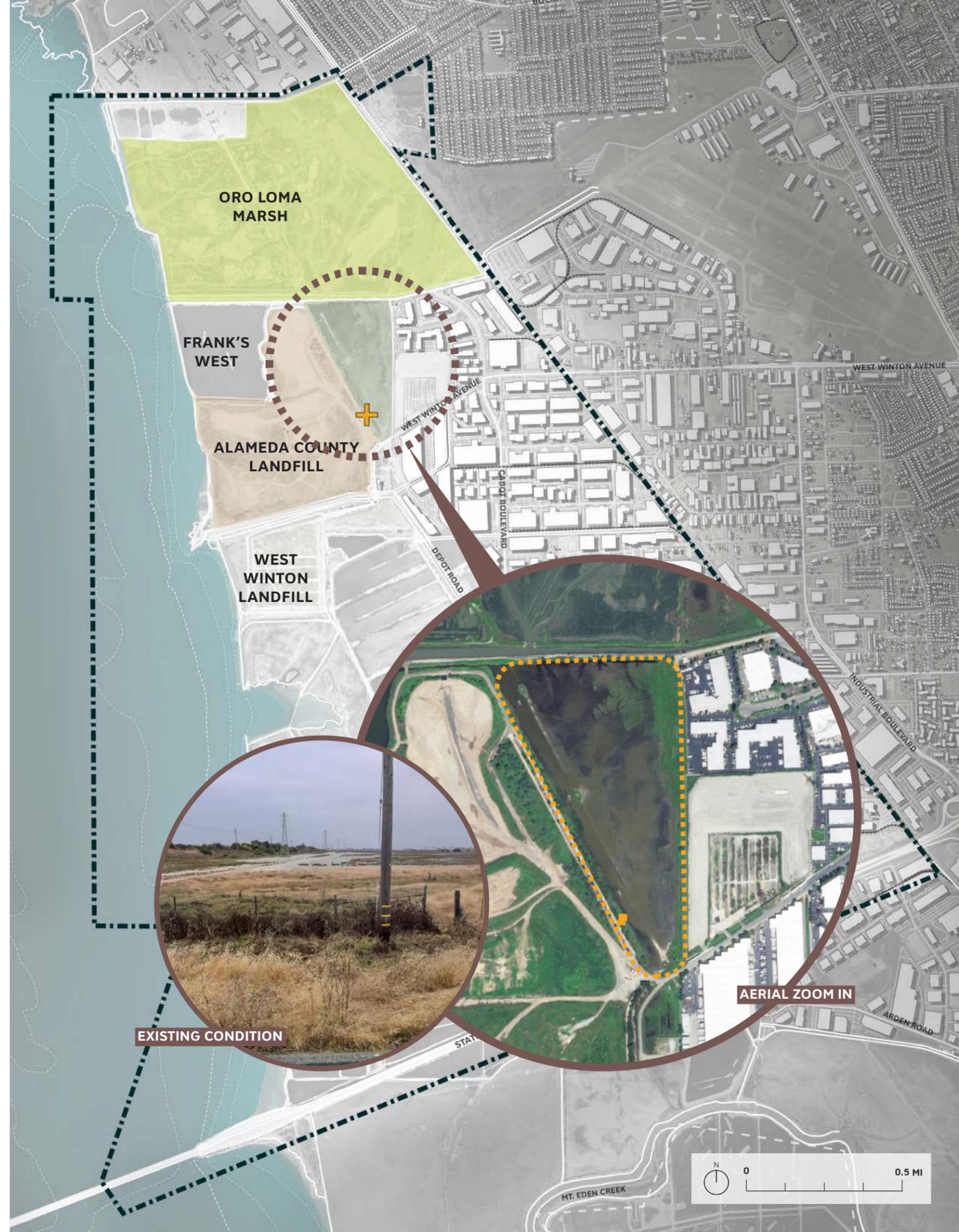
- Elevate a portion of Frank's East
- Relocate the Interpretive Center to Frank's East

### PROS

- Potential to paired with a horizontal levee on the landfill edge + tidal marsh restoration + Bay Trail realignment
- Easy vehicular access and parking along West Winton Ave

### CONS

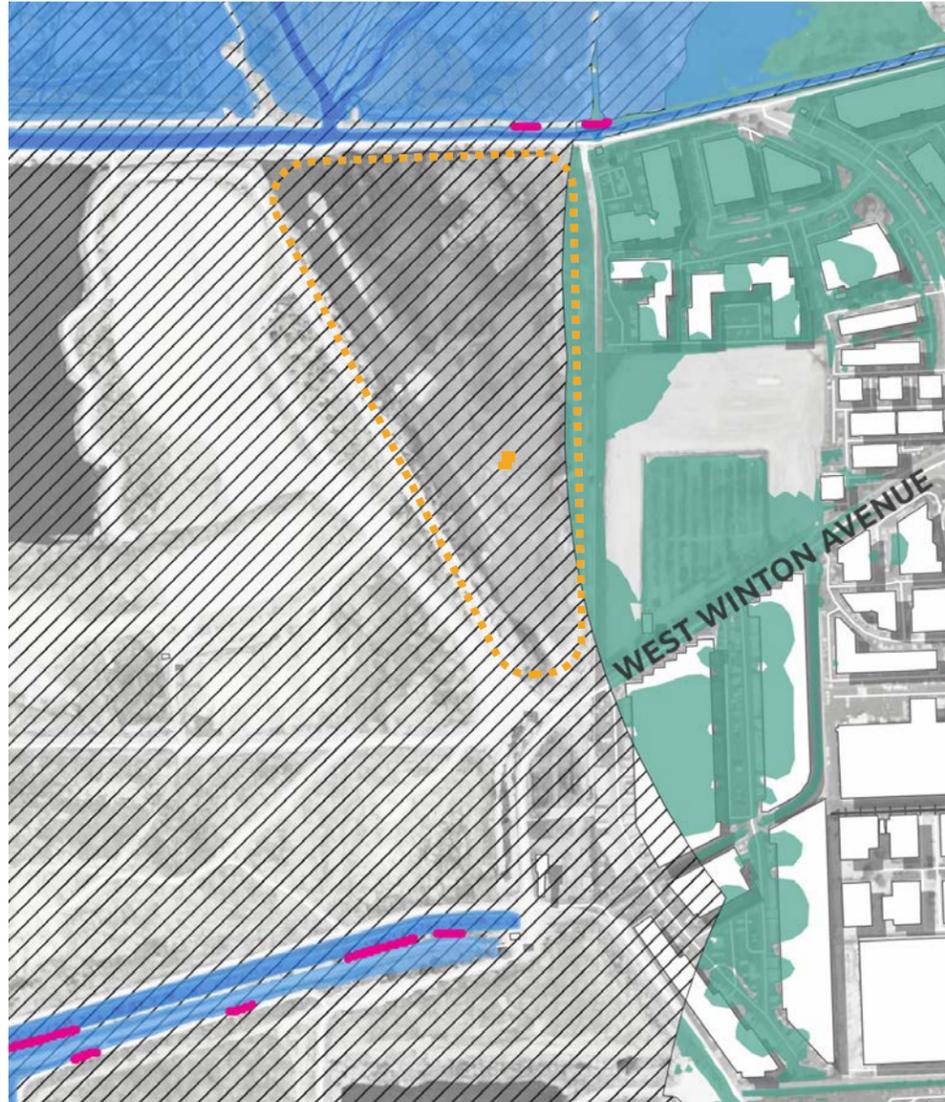
- No parking infrastructure in proximity
- No blue water experience
- Transmission lines go through this site, which may present an issue



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

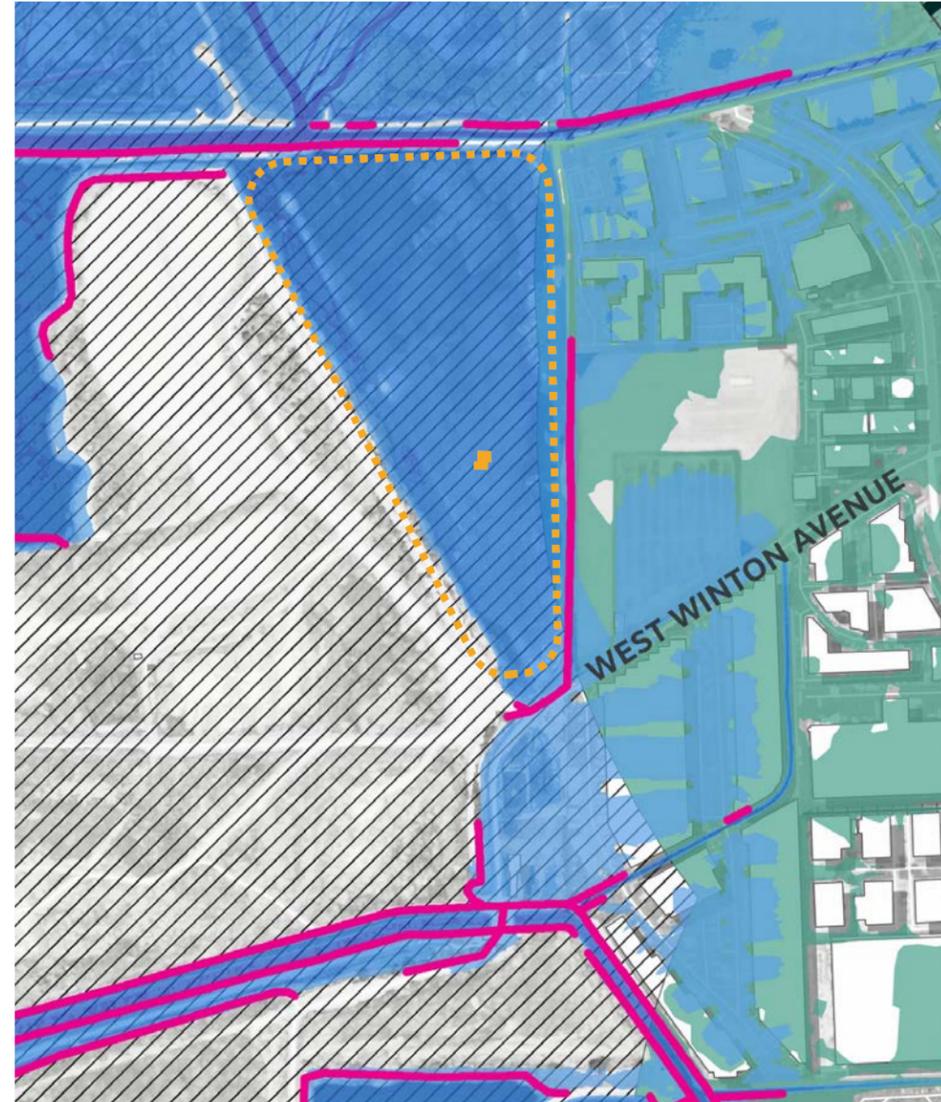
## Option 5: Frank's East

### 2' SLR



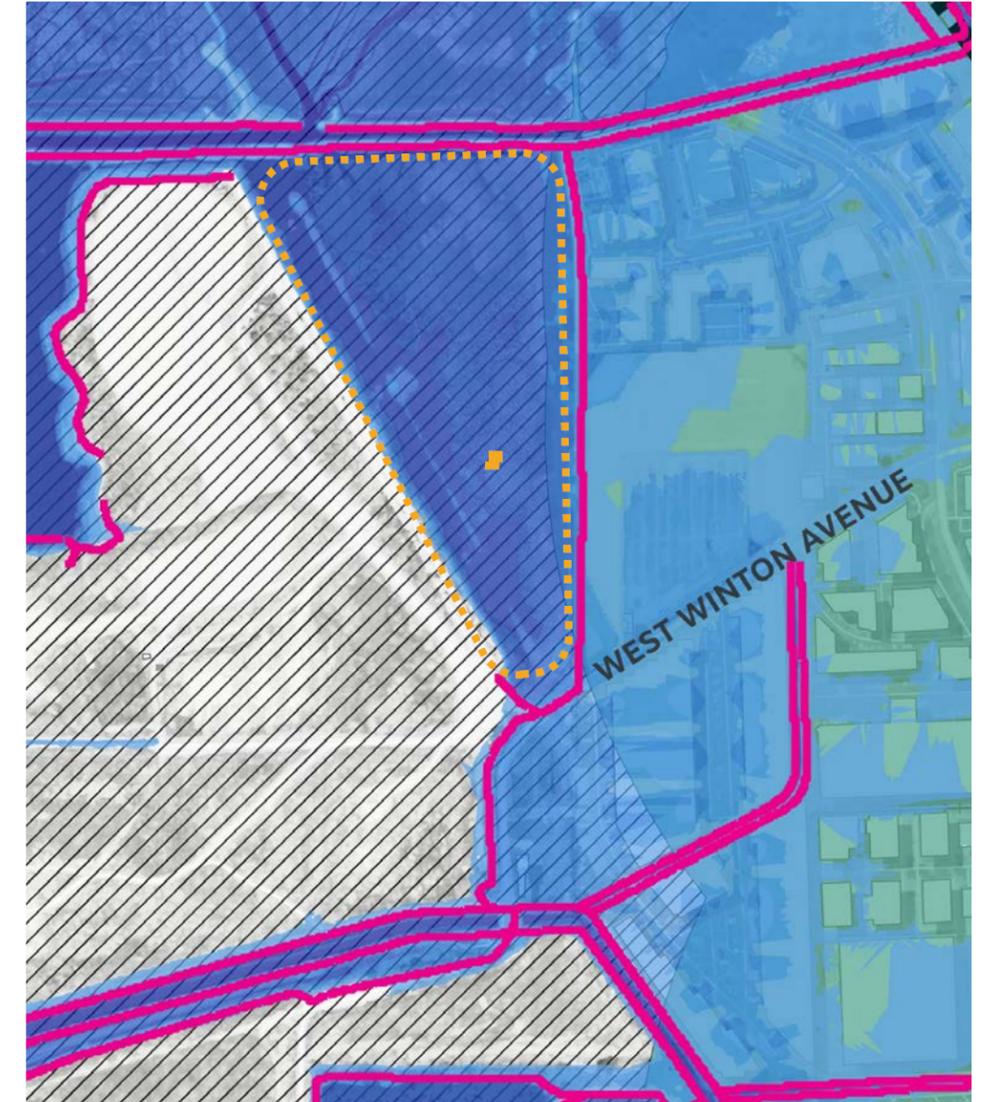
- No impacts

### 4' SLR



- Building is inundated
- Access is inundated

### 7' SLR



- Site is severely compromised
- Building is severely inundated
- Access is inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 6: Eden Landing

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

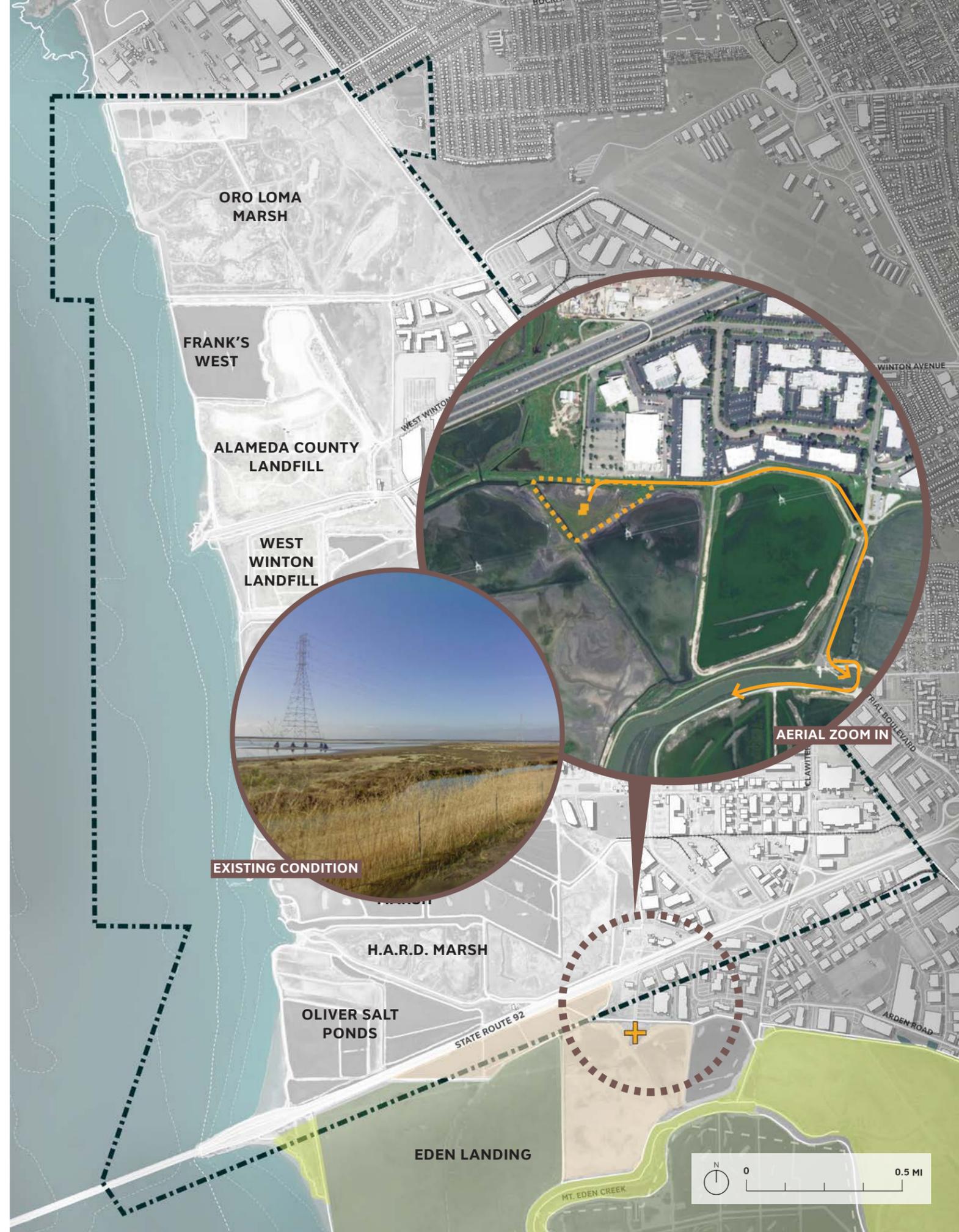
- Relocate the Interpretive Center to Eden Landing

### PROS

- Blue water experience
- Adjacent to kayak launch and Eden Landing public access

### CONS

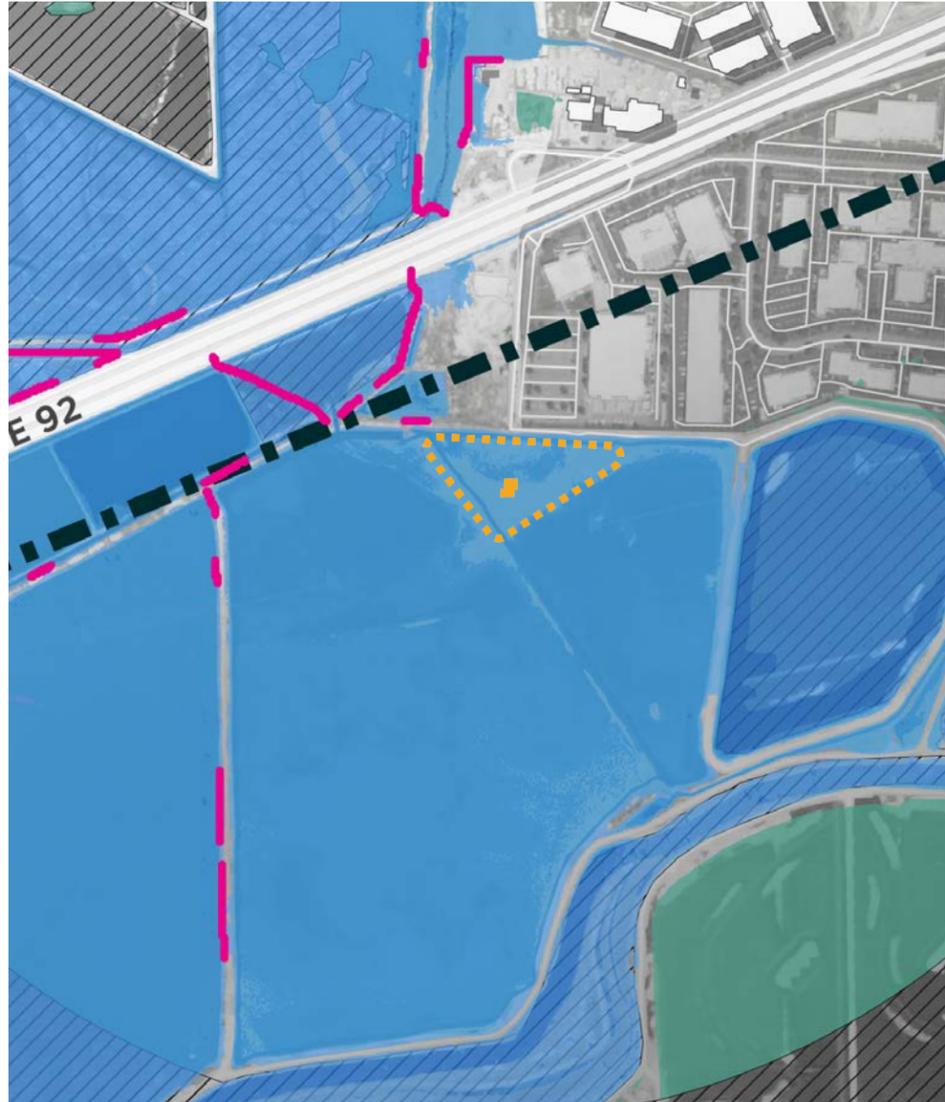
- Inundated with 2' SLR
- No immediate public parking



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

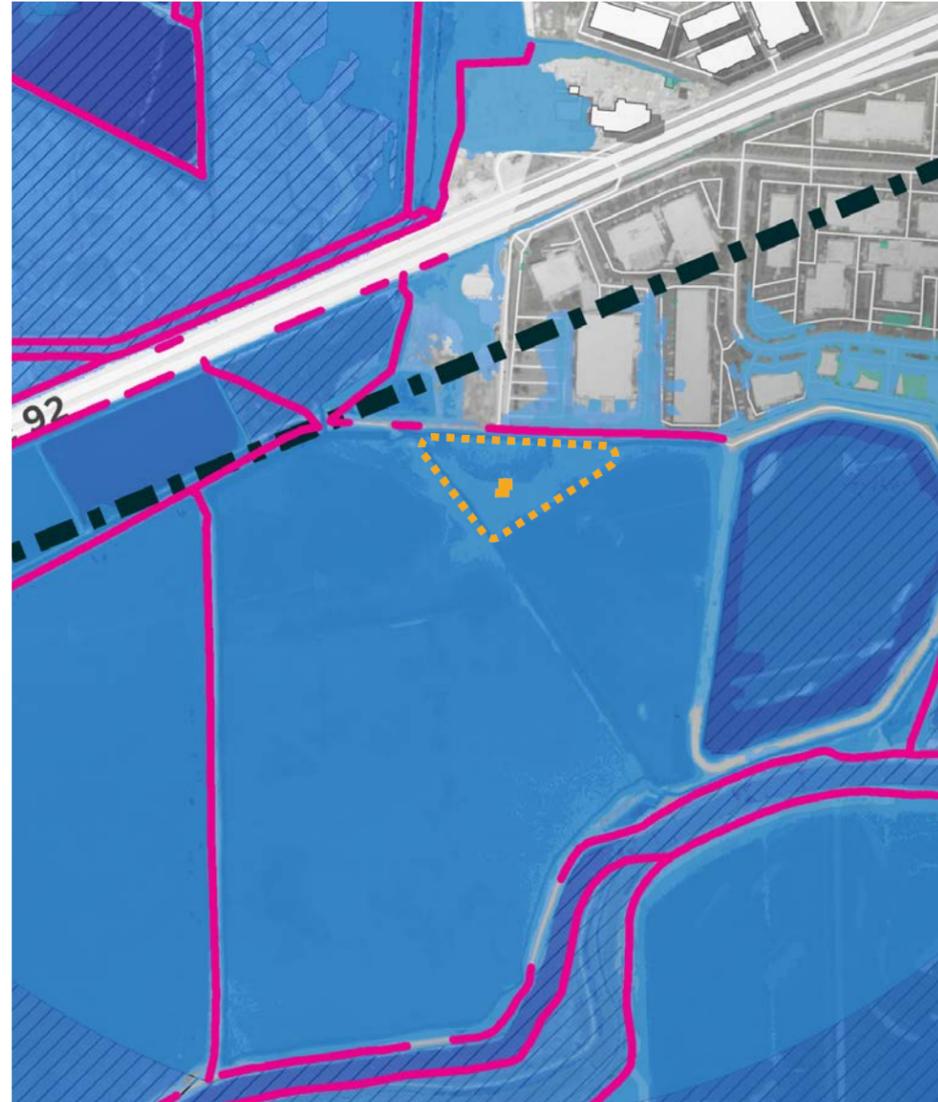
## Option 6: Eden Landing

### 2' SLR



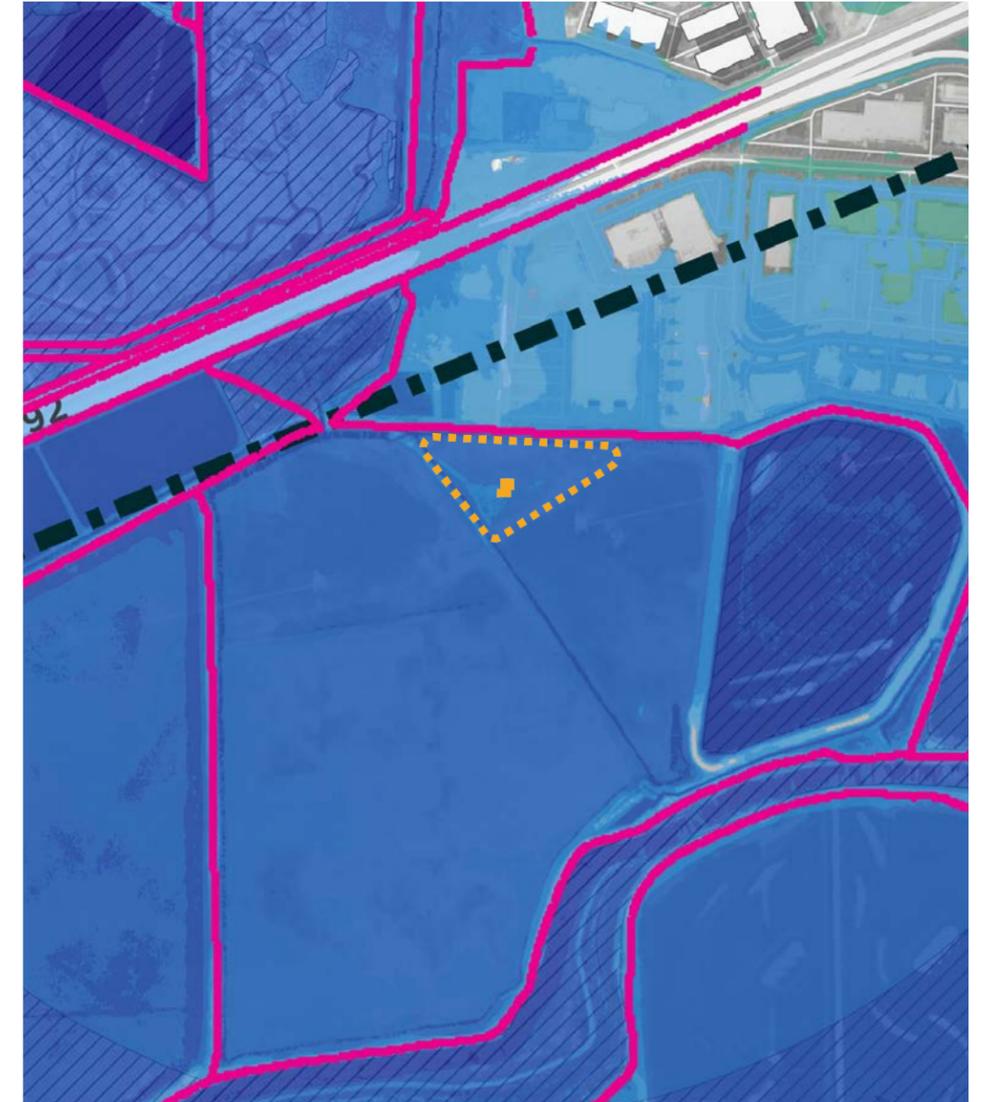
- Building is inundated

### 4' SLR



- Building is inundated
- Bay Trail is inundated

### 7' SLR



- Site is severely compromised
- Building is severely inundated
- All access is inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 7: Floating Building / Barge

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

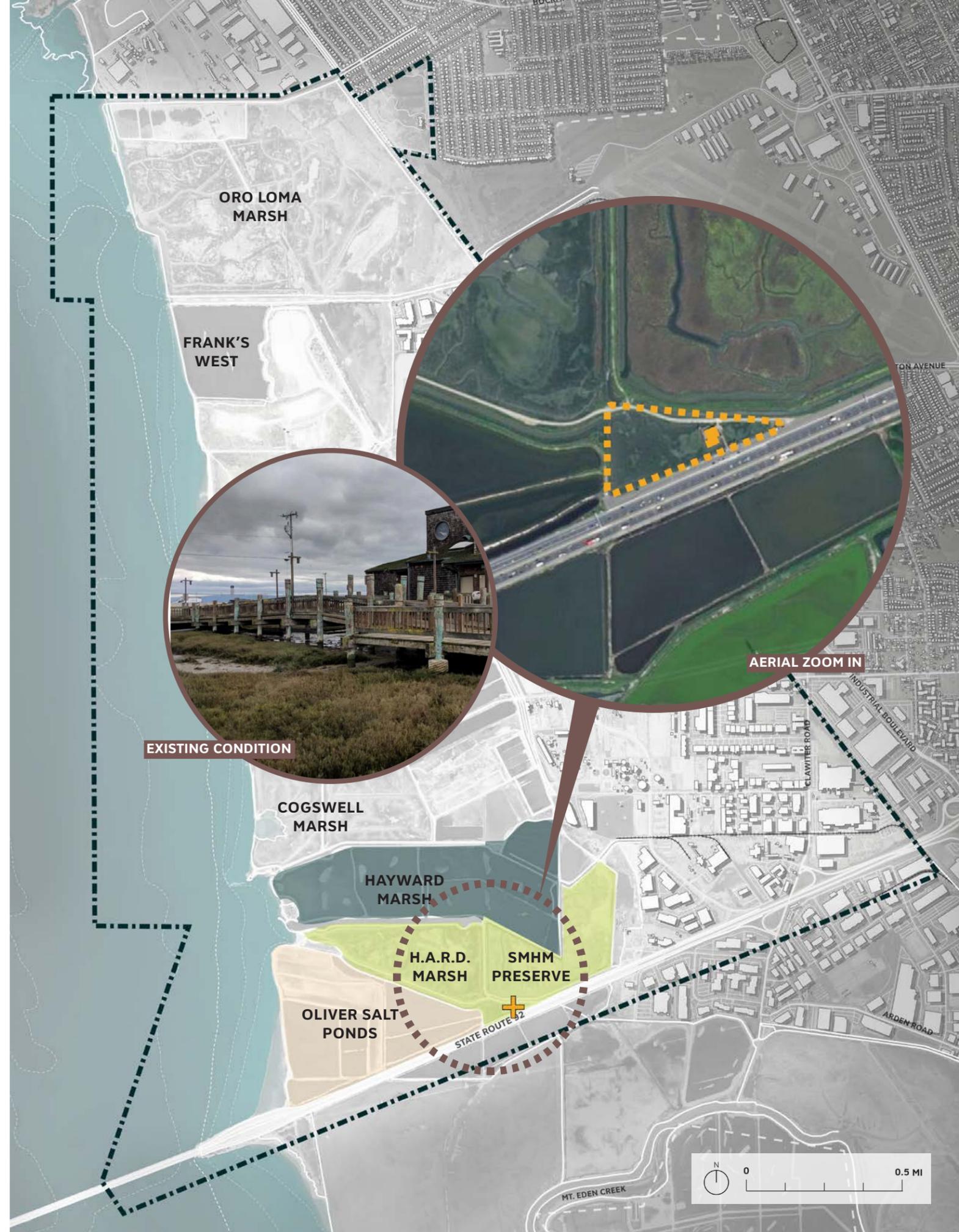
- Retrofit the Interpretive Center as a floating building or barge

### PROS

- Adapts to flooding and SLR
- Blue water experience
- Ability to move to different locations
- Maintain current location and visibility

### CONS

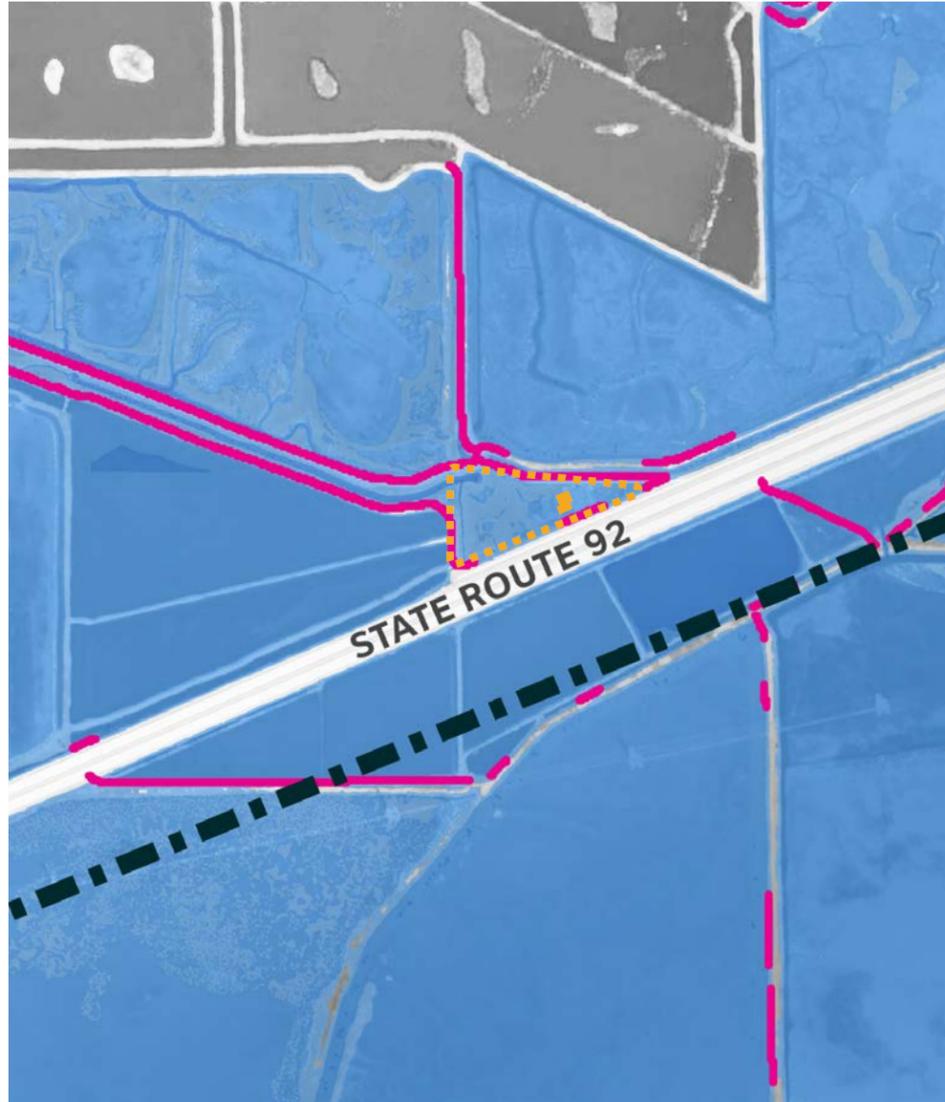
- May be hard to move a barge in shallow water and narrow channel
- All access is inundated with 7' SLR
- Strong tidal run and wind would prohibit barge movement
- Parking and trail access becomes an issue with SLR



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

Option 7: Floating Building / Barge

2' SLR



- Bay Trail access is inundated

4' SLR



- All trail access is inundated

7' SLR



- All access, including roads, is severely inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Option 8: SMHM Preserve

### GOAL / OBJECTIVE

Enhance educational opportunities and adapt with SLR.

### DESCRIPTION

- Relocate the Interpretive Center to the diked pond adjacent to the SMHM Preserve

### PROS

- Potential to pair with wastewater treatment pilot project / horizontal levee
- Potential to pair with trail realignment
- Owned by EBRPD

### CONS

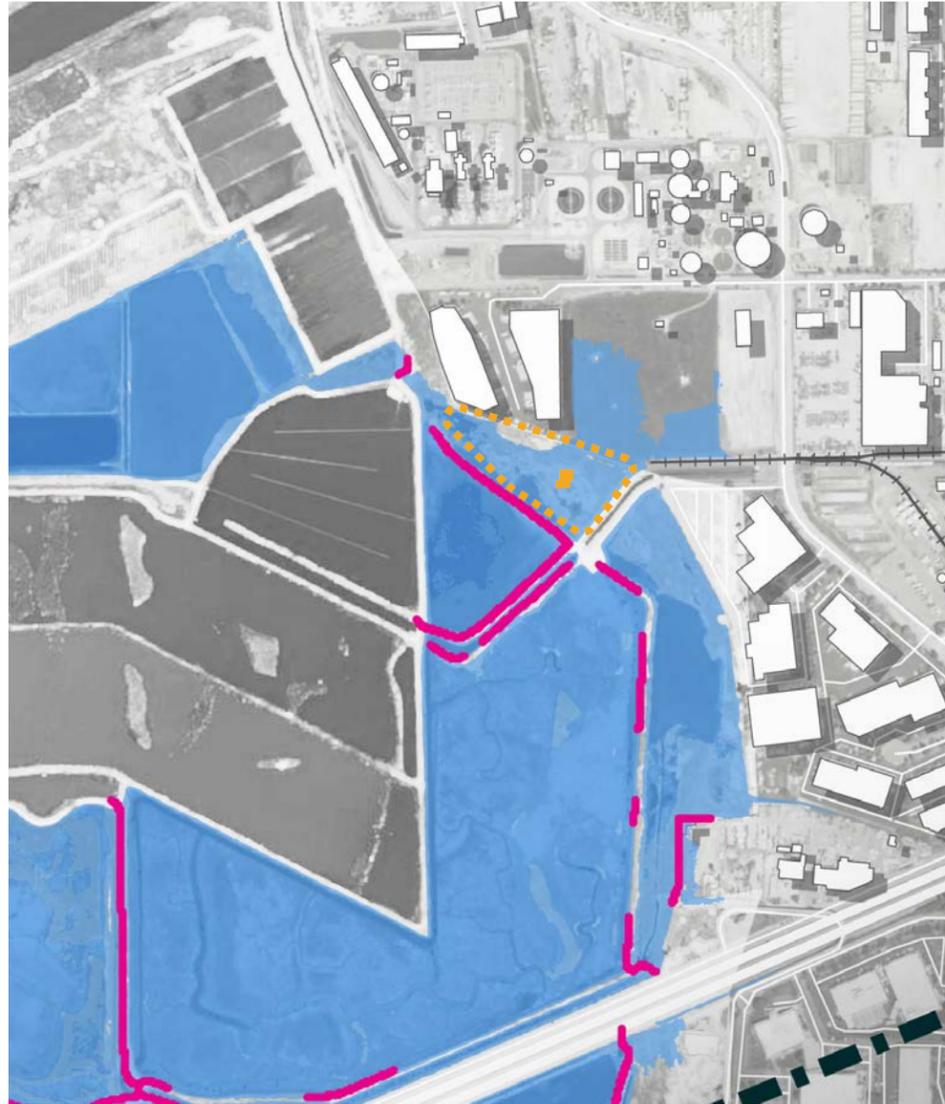
- Site is inundated in all SLR scenarios
- Not easily accessible by car
- No direct blue water experience
- Public access adjacent to wastewater uses is problematic



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

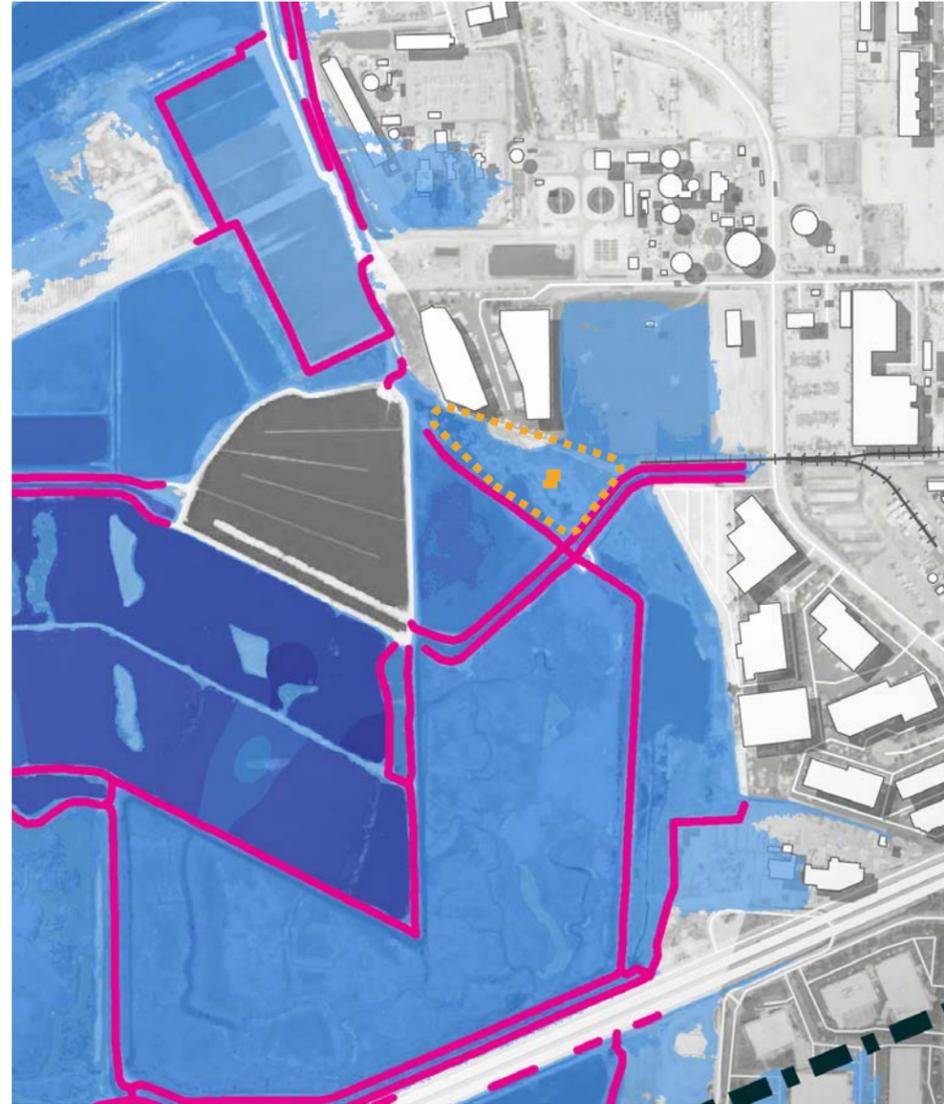
## Option 8: SMHM Preserve

### 2' SLR



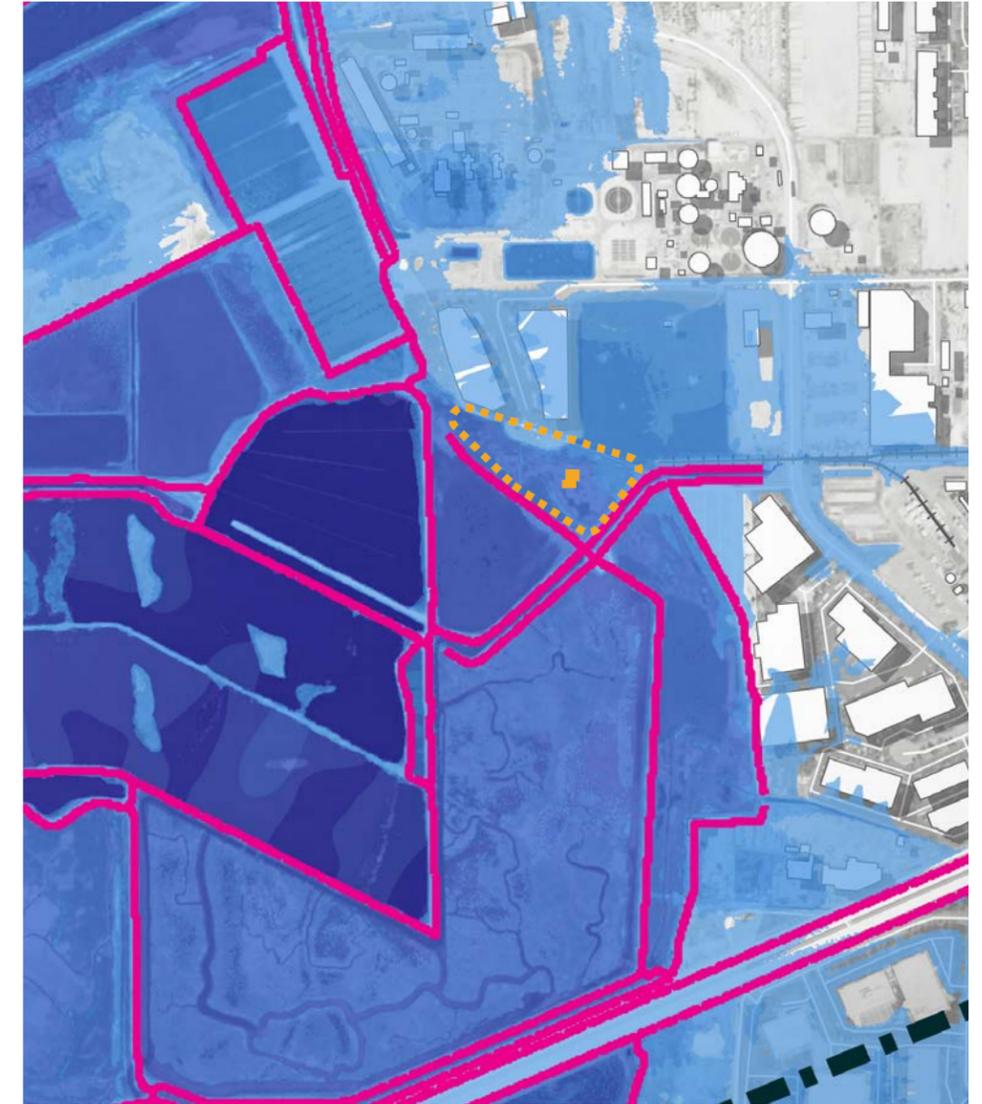
- Site is inundated
- Some access is inundated

### 4' SLR



- Site is inundated
- Most access is inundated

### 7' SLR



- Site is severely compromised
- All access is severely inundated

# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Compiled Options

### GENERAL COMMENTS

- COH: DG: The City of Hayward is supportive of any adaptation measure related to the Hayward Shoreline Interpretive Center that's supported by the Hayward Recreation and Park District (or HARD). SCAPE will note this in the comments.
- HARD: Key takeaways for the Interpretive Center Relocation include:
  - Locate in proximity to educational opportunities that won't be fully inundated with SLR
  - Locate along the Bay Trail, or maintain the link
  - Parking and access by car is essential
  - Consider the building's visibility, which will increase awareness about the center
  - HARD has the opportunity to do something that sets the bar and tone for forward-thinking
  - SCAPE will note these in the comments.

### OPTION 1 COMMENTS

- HARD: It is hard to address this without knowing what other types of infrastructure improvements are projected. SCAPE will note this in the comments.
- HARD: A strong pro of this option is the building's visibility- people recognize it and are aware it is there. SCAPE will note this in the Pros.
- HARD: It was noted that building retrofit may not be recommended if the building is projected to be inundated in the immediate future, which is dependent on the planning horizon. SCAPE will note this in the comments.

### OPTION 2 COMMENTS

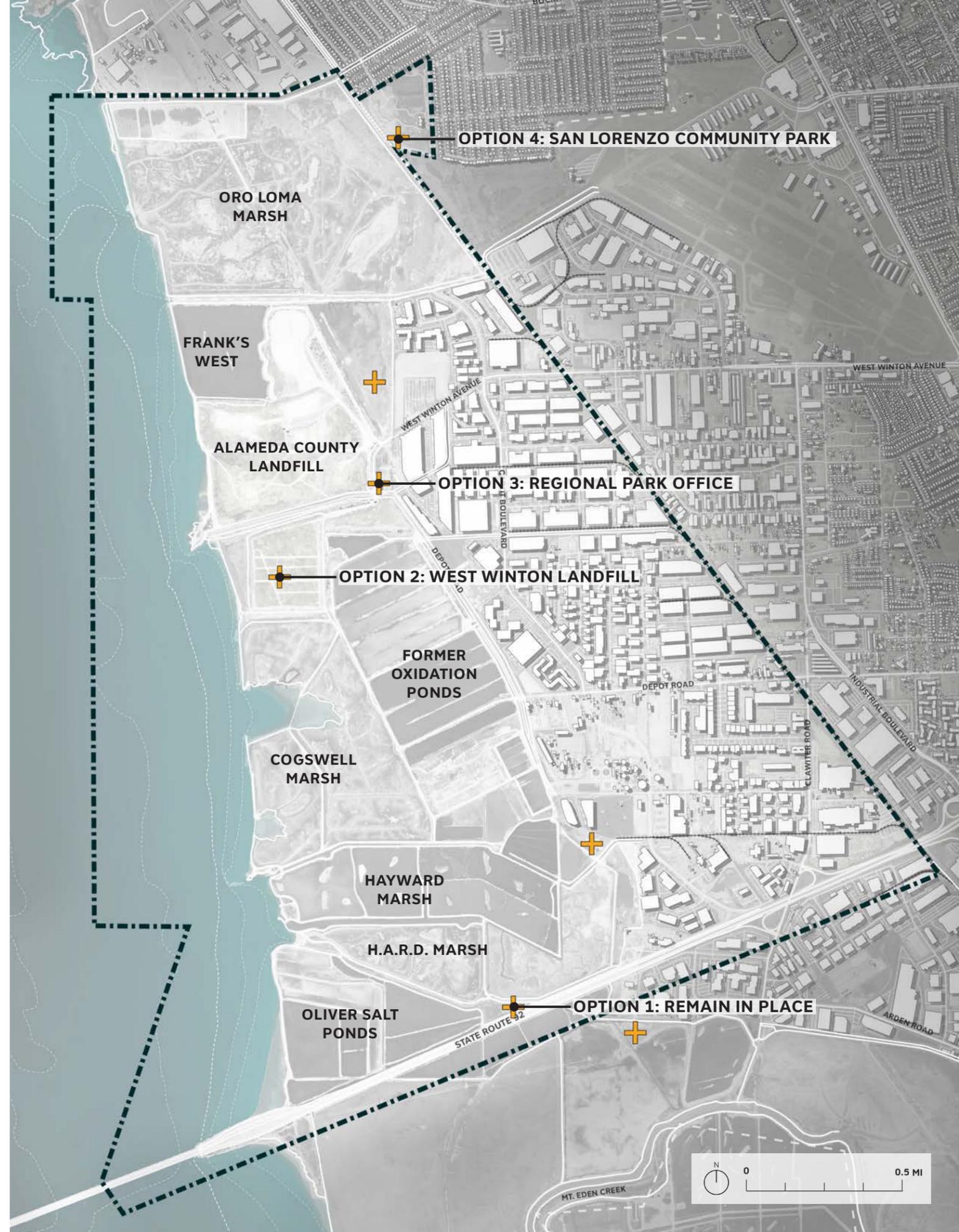
- HARD: It was indicated that ACFCO wants to take ownership of this landfill and that they have committed to incorporating a recreational trail. It was agreed that ACFCO would be a good partner and relocation to the landfill could work out. SCAPE will note this in the comments.
- HARD: A question about piles into the landfill was brought up. SCAPE: The building will likely require deep piles that will go through the landfill, and any contamination or capping issues may increase the cost. SCAPE will note this in the comments.

### OPTION 3 COMMENTS

- HARD: This piece of land is owned by the City of Hayward, but leased out. SCAPE will note this in the comments.
- HARD: The transmission lines that go through this site may present an issue. SCAPE will note this in the Cons.

### OPTION 4 COMMENTS

- HARD: It was noted that in 2015, 2016, and part of 2017, with the reconstruction of the park, the western edge was raised 5.5' to increase resilience to sea level rise. SCAPE will note this in the comments.
- HARD: The park has invested a lot in dewatering on site and is vulnerable to groundwater impacts today. SCAPE will note this in the comments.
- HARD: It was brought up that the railroad would inhibit access to the Interpretive Center. SCAPE will note this in the comments.
- HARD: It was agreed that this option should be removed from the report, in response to the site's vulnerability to SLR and groundwater, and access issues. SCAPE will not consider this option moving forward.



# HAYWARD SHORELINE INTERPRETIVE CENTER RELOCATION

## Compiled Options

### OPTION 5 COMMENTS

- HARD: It was noted that this option would have the best vehicular access and parking potential along W Winton Ave (Nick noted that this option would be paired with a line of protection to the west that would reduce inland flooding, or a road raising to maintain access with SLR). **SCAPE will note this in the comments.**
- HARD: The transmission lines that go through this site may present an issue. **SCAPE will note this in the Cons.**

### OPTION 6 COMMENTS

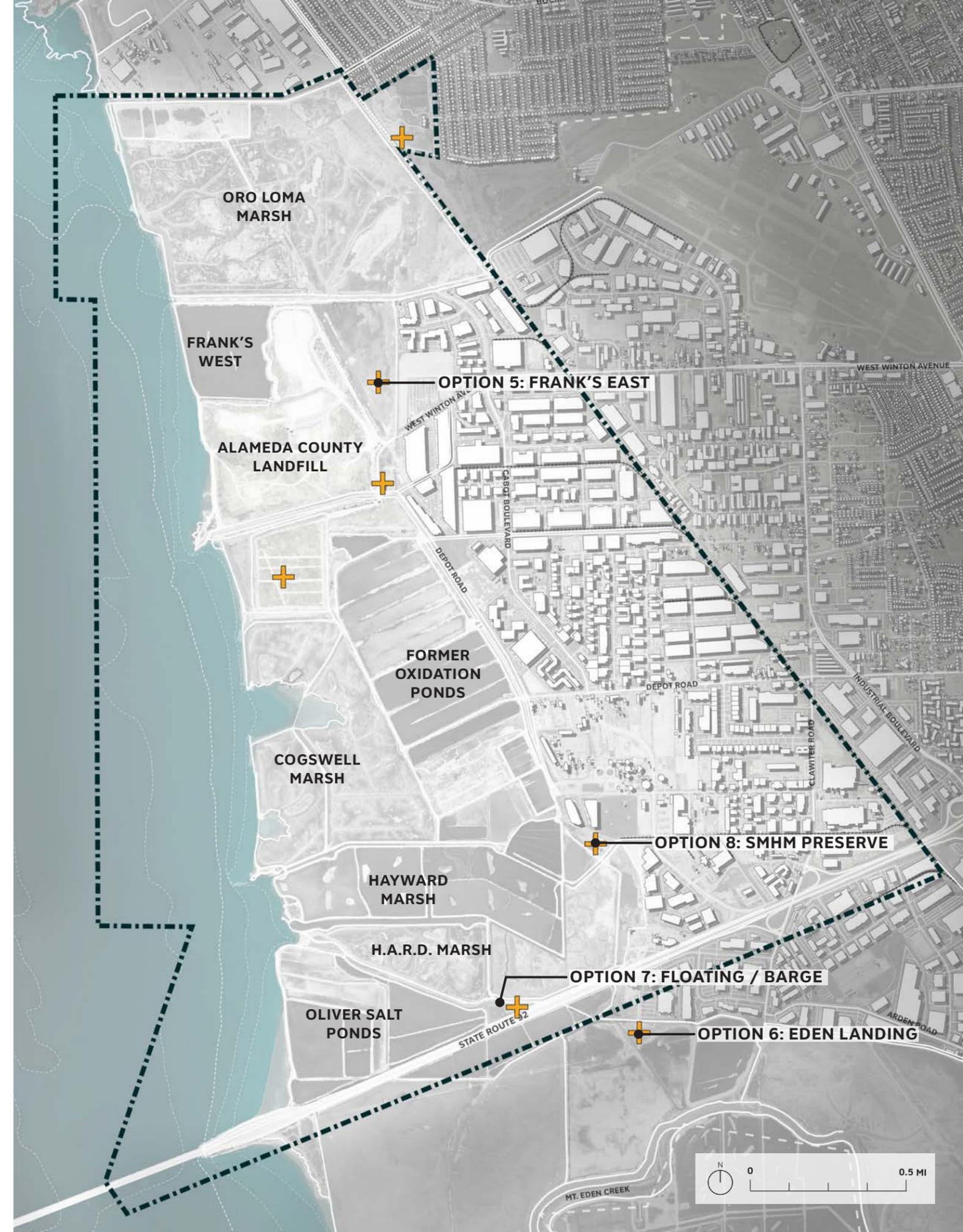
- HARD: It was agreed upon that this option should be removed from the report, due to the site's vulnerability **SCAPE will not consider this option moving forward.**

### OPTION 7 COMMENTS

- HARD: Due to the tidal run and wind, you wouldn't want to take a barge anywhere along this shoreline. **SCAPE will note this in the Cons.**
- HARD: This option would maintain visibility, but parking and trail access becomes an issue with SLR. **SCAPE will note this in the Cons.**
- HARD: It was agreed upon that this option is the most viable so far. **SCAPE will note this in the comments.**
- COH: TR: TR: Have you considered ADA regulations? Will a barge comply? **SCAPE: Barges can be designed to accommodate ADA accessibility through a floating dock or pier structure.**

### OPTION 8 COMMENTS

- HARD: This option would locate the Interpretive Center in a diked pond adjacent to Hayward Marsh and has the potential to be paired in proximity to WWTP adaptation, such as a horizontal levee. **SCAPE will note this in the comments.**



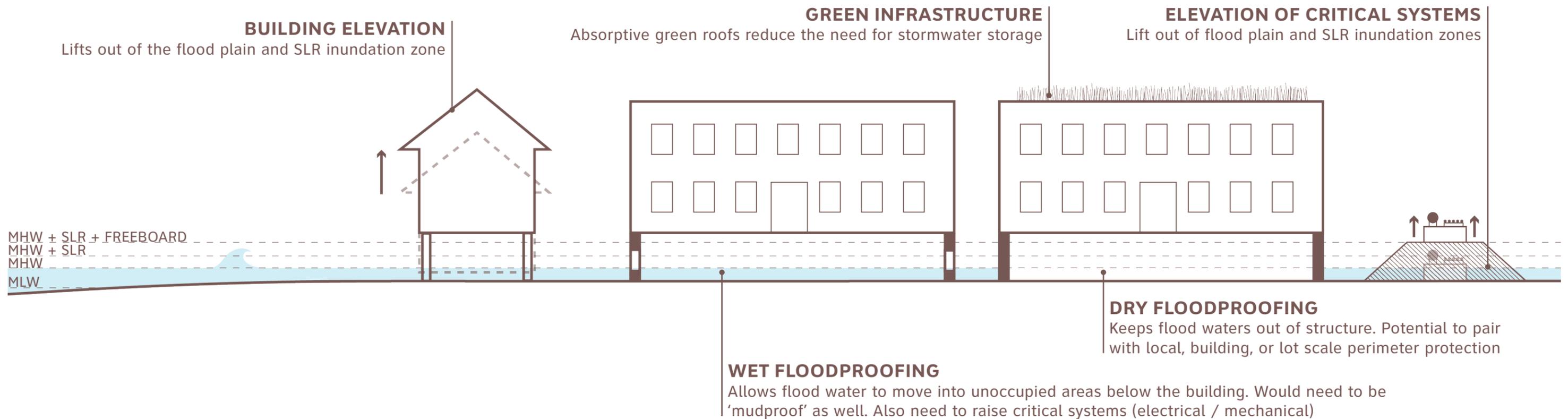
# BUILDING SCALE STRATEGIES

## Definition

There are many building scale strategies that can be implemented to adapt to sea level rise. From improving standards, such as building codes and removing regulatory impediments, such as zoning height restrictions. The City can also aid businesses and homeowners to assist them with understanding the resilience options available to them and with finding the funding to support those options.

### GOAL / OBJECTIVE

- Improve design of buildings to increase resiliency to SLR and climate change



# BUILDING SCALE STRATEGIES

## Precedents

### Brooklyn Grange, Rooftop Farm Industry City, Sunset Park, NY

**Size:** 250,000 SF

**Implementation Timeline:** 2010-2019

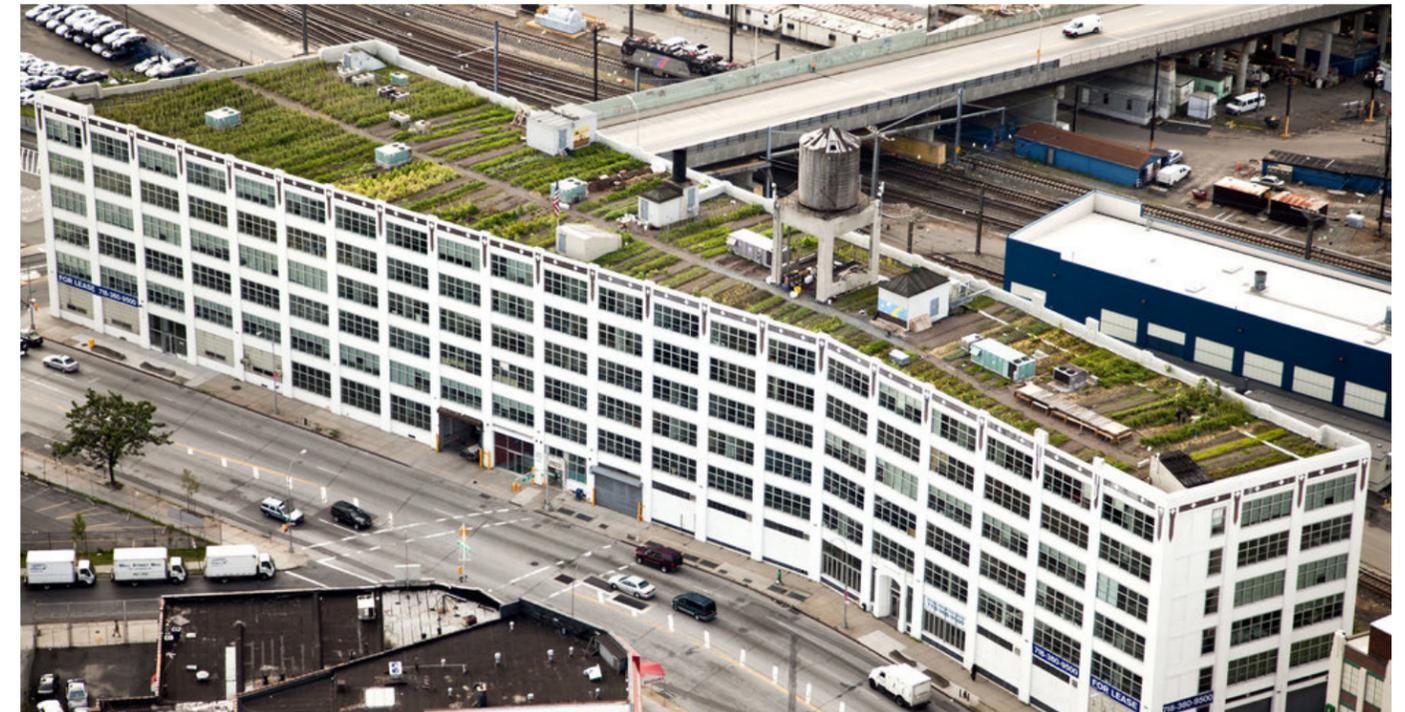
**Applicability:** Green infrastructure strategies may be implemented in upland watersheds to reduce the need for stormwater storage space near the Baylands.

**Description:** Brooklyn Grange is composed of three rooftop farms in NYC totaling 5.6 acres with 135,000 square feet of cultivated area, growing over 80,000 pounds of produce each year.

- The green roofs reduce pressure of the city's stormwater sewer system by managing an estimated 2 million gallons of stormwater per year
- The rooftop farms incorporate habitat for migratory birds and pollinators
- Buildings work to reduce the urban heat island effect through evapotranspiration, while also reducing the heating and cooling needs of the upper floors of the building.



Brooklyn Navy Yard farm- 1.5 acres



Long Island City farm- 1 acre

# BUILDING SCALE STRATEGIES

## Precedents

### Hafen City Hamburg, Germany

**Size:** 593 acres

**Cost:** Multi-billion dollar project

**Applicability:** District-wide building standards can help facilitate new resilient development that reduces vulnerabilities with climate change.

**Description:** To protect itself from storm surges all buildings in HafenCity are built on artificially structured plinths that are compacted to a height of 8-9 meters above sea level. In the interior of HafenCity, the plinths provide ample space for underground carparks, reducing the amount of car parking space required in the streets of the new development.

- Hafen City's location in relation to the main dike of Hamburg leaves it exposed to storm surge
- All streets and bridges are sited at flood-protected levels, at least 7.8-8.5 meters above sea level to prevent flooding
- Alternative motivated by the disadvantages of building dikes
- Building construction on plinths 8-9 meters above sea level
- Allow storm surges to occur without impact
- Construction is mandated to meet "Ecolabel" criteria following methods and resources that lower energy consumption
- Aquarium glass, concrete walls and watertight doors are used to seal ground floors – enhanced with increased trees and ornamentation
- Space beneath raised buildings provides ample room for parking



Hafen City is design to withstand repeated flooding front the Elbe River



Select buildings use aquarium glass to seal ground floors

# BUILDING SCALE STRATEGIES

## Option 1: Increasing Standards for New Construction

### GOAL / OBJECTIVE

Improve design of buildings to increase resiliency to SLR and climate change.

### DESCRIPTION

- Review building code and incorporate higher standards of flood protection

### PROS

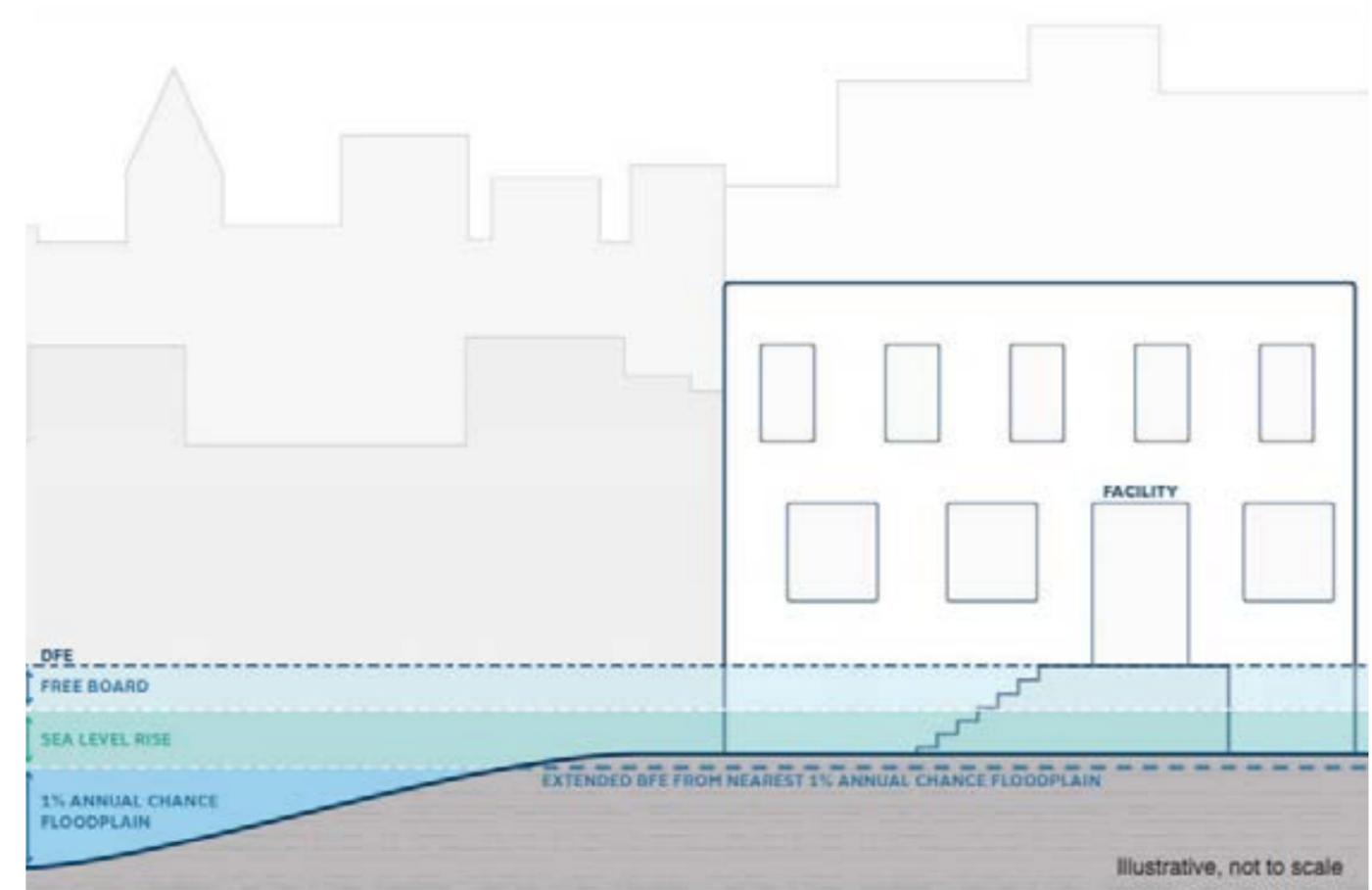
- Reduces risk to future development
- Ensures resilient development
- Savings on flood insurance premiums
- Can be implemented over time as buildings are improved
- Incremental increased costs are low

### CONS

- May discourage construction in floodplain
- Older developments are still at risk
- Can conflict with urban design goals (street activation, façade design, etc.)
- May not be appropriate for permanent inundation
- Connectivity to the building would be compromised in floods or with SLR inundation

### EXAMPLES

- Increasing freeboard to include SLR projections
- Extending flood resistant construction requirements to the 500-year floodplain
- Increase storage requirements for hazard materials



# BUILDING SCALE STRATEGIES

## Option 2: Providing Loans / Grants / Tax Incentives for Implementation

### GOAL / OBJECTIVE

Provide support to help businesses and homeowners adapt to climate change.

### DESCRIPTION

- Provide loans, grants, or tax incentives to encourage resilient new construction and retrofits

### PROS

- Promotes resilient development
- Funding will ensure more property owners are able to retrofit buildings
- Can be combined or modeled on CA water board brownfield remediation loans/grants, and solar tax credit
- Can be structured as competitive grant program to spur innovation (like the NYC RISE program)

### CONS

- Requires funding and ongoing program support
- Need to ensure people will take advantage of offerings
- Can be cumbersome to initiate and manage
- May require coordination with state government

### EXAMPLES

- Competitive funding for innovative flood mitigation technologies (e.g. NYC rise program)
- Loans/grants modeled on CA water board brownfield remediation loans/grants
- Tax incentives modeled on CA solar tax credit



Deployable flood panels



Sump pumps



Onsite stormwater management

# BUILDING SCALE STRATEGIES

## Option 3: Technical Support & Education

### GOAL / OBJECTIVE

Improve design of buildings to increase resiliency to SLR and climate change.

### PROS

- Provides resources to recover from and prepare for future floods and climate risks
- Cost-effective way to prepare residents / property owners for future challenges

### CONS

- May require additional staff and funding to coordinate support and education levels
- Requires effective community engagement to ensure participation in programs

### EXAMPLES

- Modeled after seismic retrofitting awareness campaigns
- NYC business emergency preparedness risk audits



# BUILDING SCALE STRATEGIES

## Option 4: Removing Regulatory Impediments

### GOAL / OBJECTIVE

Improve design of buildings to increase resiliency to SLR and climate change.

### PROS

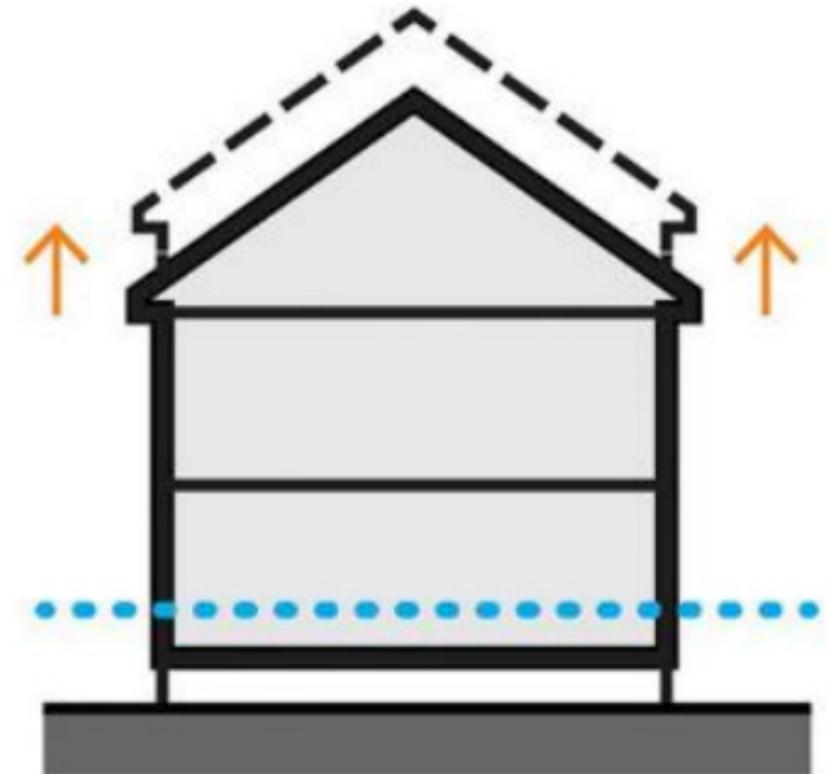
- Provides the structure to allow for resilience initiatives to be adopted
- Makes its easier, faster, and more affordable to adopt resilience measures

### CONS

- Could require overhaul of existing building or zoning standards
- Could be unintended side effects of removing regulatory impediments

### EXAMPLES

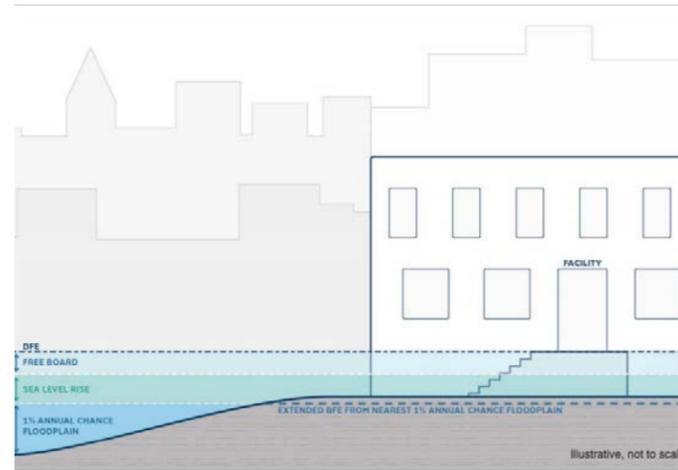
- Zoning height limits
- Permitting requirements & fees



# BUILDING SCALE STRATEGIES

## Compiled Options

### 1: Increasing Standards for New Construction



#### COMMENTS

- See General Comments.

#### GENERAL COMMENTS

- COH: DG: The City of Hayward is supportive of all suggested building scale strategies. *SCAPE will note this in the comments.*

### 2: Providing Loans / Grants / Tax Incentives for Implementation



#### COMMENTS

- See General Comments.

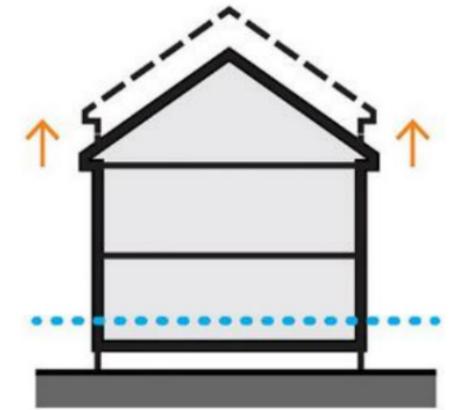
### 3: Technical Support & Education



#### COMMENTS

- See General Comments.

### 4: Removing Regulatory Impediments



#### COMMENTS

- See General Comments.

