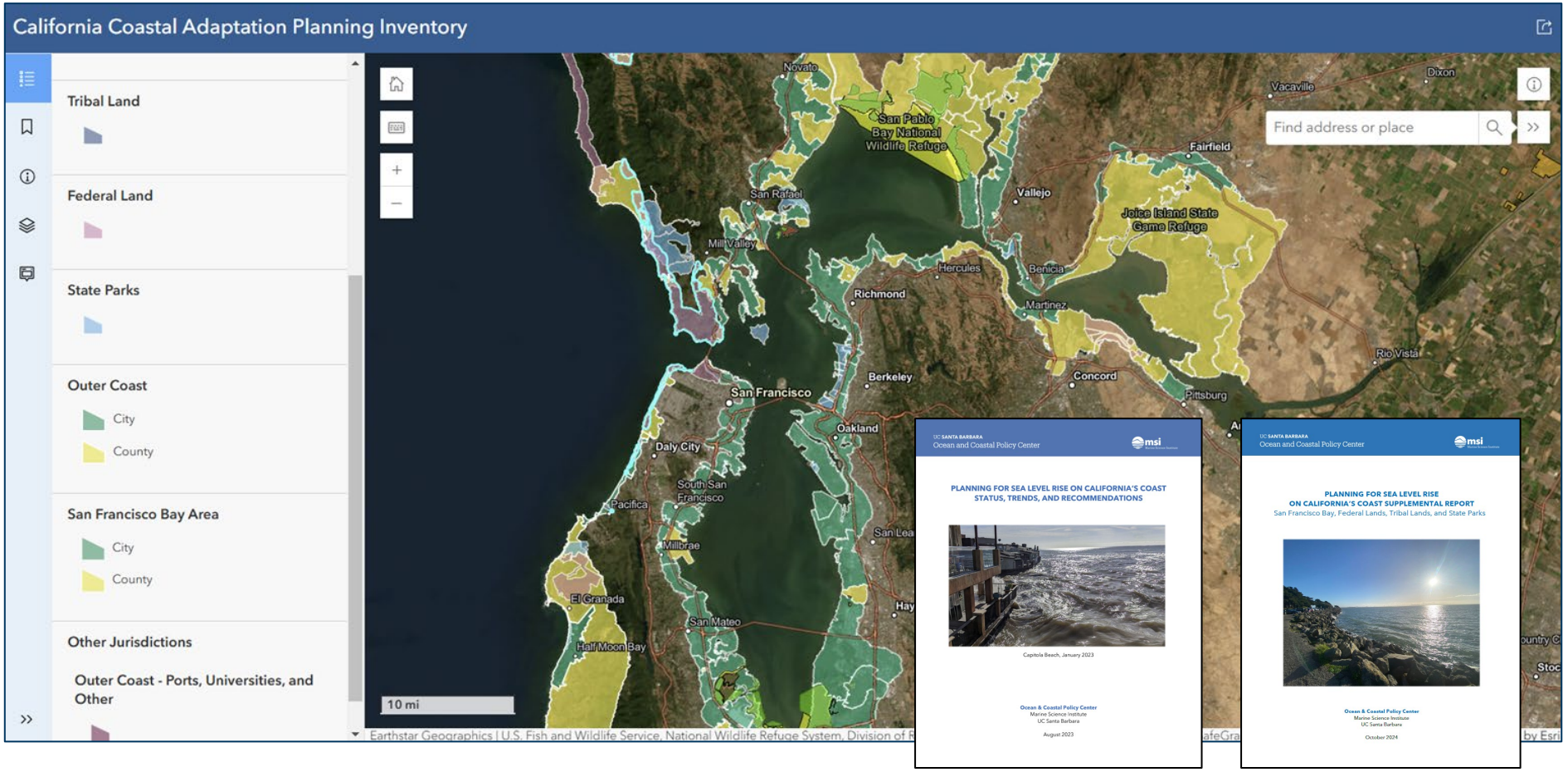
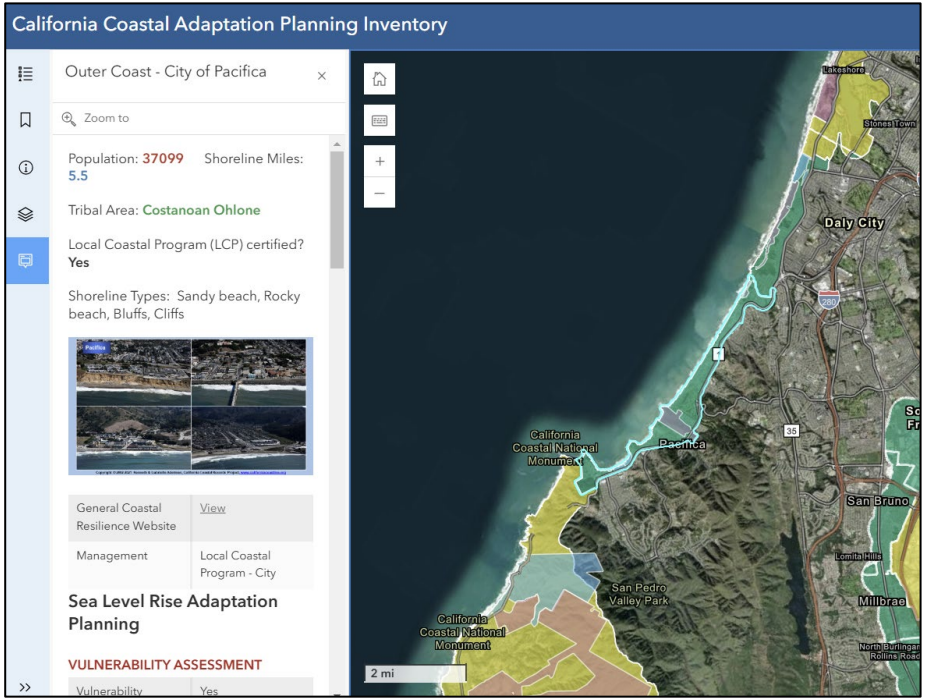
Planning for Sea Level Rise on California's Coast

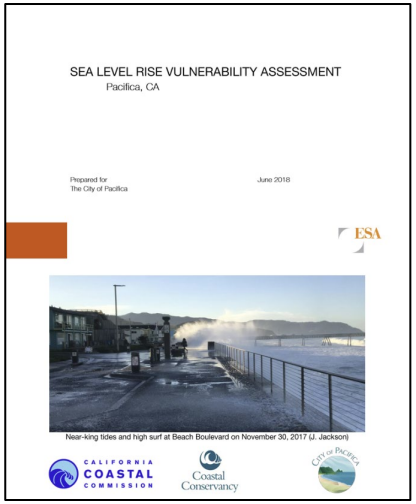
CMANC Spring Meeting

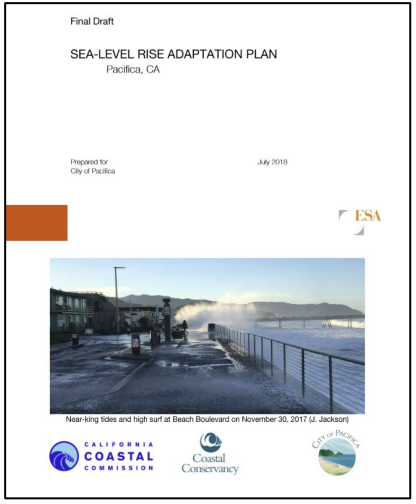
UCSB Ocean and Coastal Policy Center

May 15, 2025


California Coastal Adaptation Planning Inventory
Tribal Land
Federal Land
State Parks
Outer Coast
City
County
San Francisco Bay Area
City
County
Other Jurisdictions
Outer Coast - Ports, Universities, and Other
Find address or place
Novato
San Pablo Bay National Wildlife Refuge
Vacaville
Dixon
Fairfield
Vallejo
Joice Island State Game Refuge
San Rafael
Mill Valley
Hercules
Benicia
Richmond
Martinez
Rio Vista
Berkeley
Concord
Pittsburg
San Francisco
Oakland
Daly City
South San Francisco
Pacifica
Millbrae
El Granada
San Mateo
Half Moon Bay
10 mi
Earthstar Geographics | U.S. Fish and Wildlife Service, National Wildlife Refuge System, Division of
PLANNING FOR SEA LEVEL RISE ON CALIFORNIA'S COAST STATUS, TRENDS, AND RECOMMENDATIONS
PLANNING FOR SEA LEVEL RISE ON CALIFORNIA'S COAST SUPPLEMENTAL REPORT
San Francisco Bay, Federal Lands, Tribal Lands, and State Parks

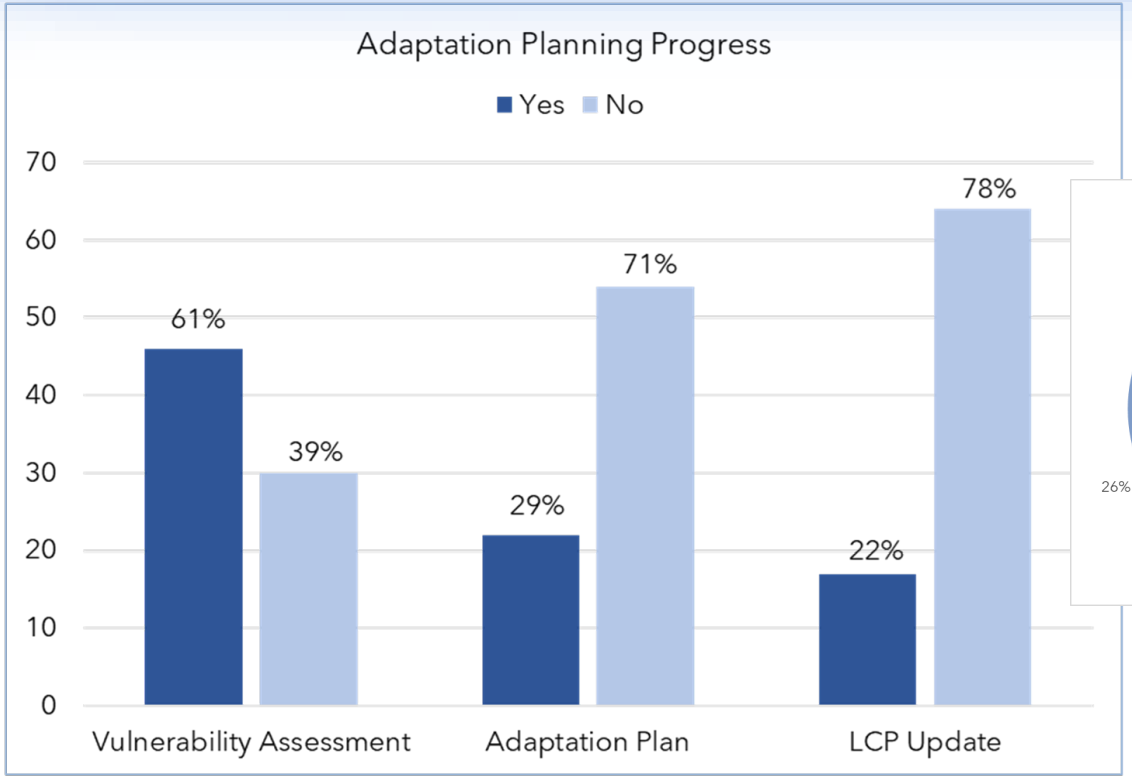

California Coastal Adaptation Planning Inventory
Outer Coast - City of Pacifica
Zoom to
Population: 37099 Shoreline Miles: 5.5
Tribal Area: Costanoan Ohlone
Local Coastal Program (LCP) certified? Yes
Shoreline Types: Sandy beach, Rocky beach, Bluffs, Cliffs
General Coastal Resilience Website
View
Management
Local Coastal Program - City
Sea Level Rise Adaptation Planning
VULNERABILITY ASSESSMENT
Vulnerability
Yes
Lakeshore
Stonea Town
Daly City
280
1
35
California Coastal National Monument
Pacifica
San Bruno
Lomita Hills
San Pedro Valley Park
Millbrae
California Coastal National Monument
North Burlingame Rollins Road
2 mi

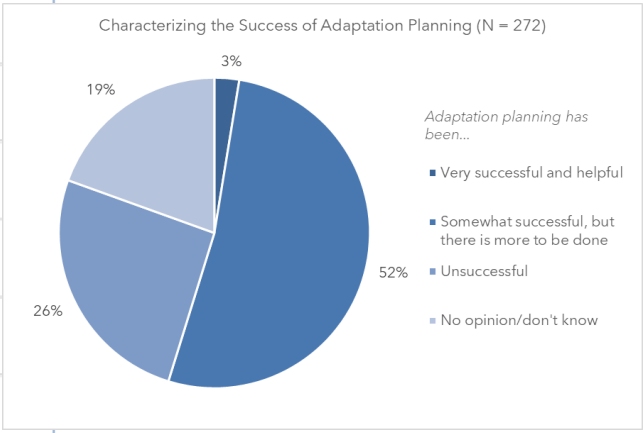

SEA LEVEL RISE VULNERABILITY ASSESSMENT
Pacifica, CA
Prepared for
The City of Pacifica
June 2018
ESA
Near-king tides and high surf at Beach Boulevard on November 30, 2017 (J. Jackson)
CALIFORNIA COASTAL COMMISSION
Coastal Conservancy


Final Draft
SEA-LEVEL RISE ADAPTATION PLAN
Pacifica, CA
Prepared for
City of Pacifica
July 2018
ESA
Near-king tides and high surf at Beach Boulevard on November 30, 2017 (J. Jackson)
CALIFORNIA COASTAL COMMISSION
Coastal Conservancy

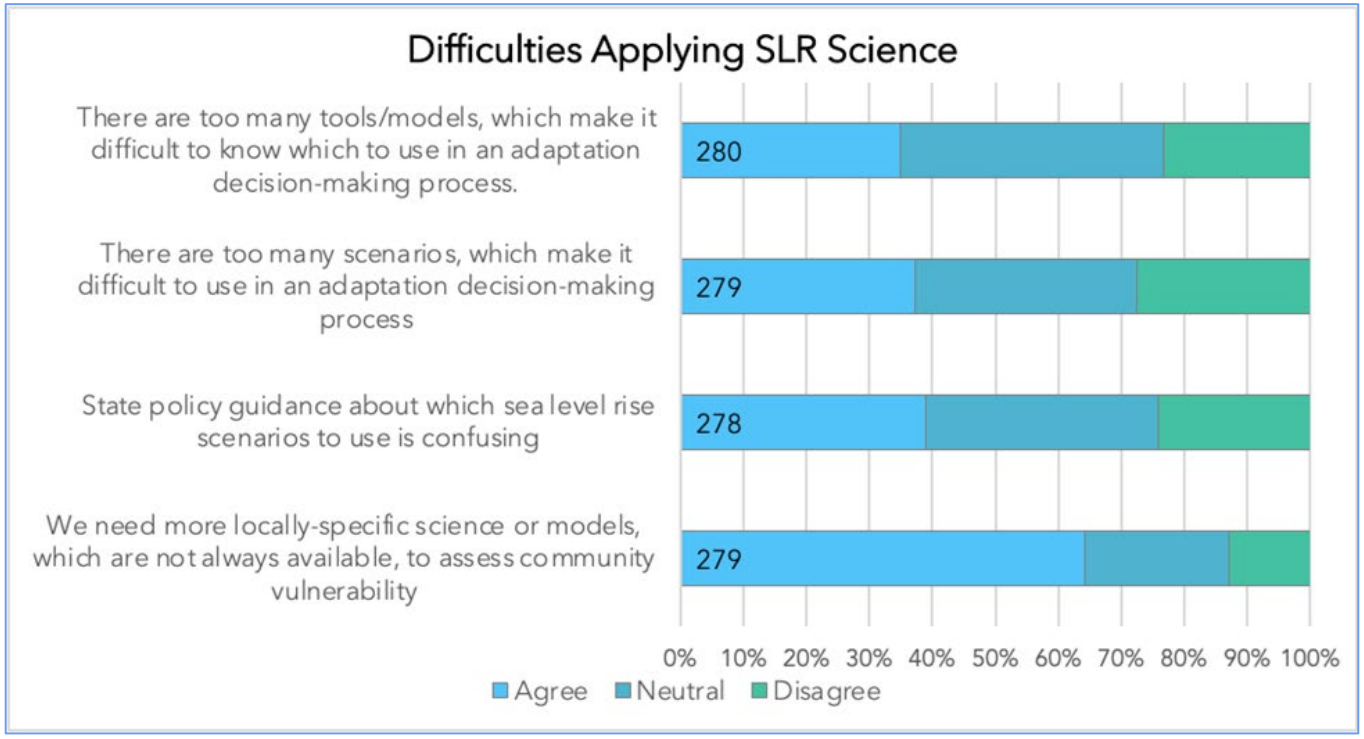

Plan Pacifica 2040
LOCAL COASTAL LAND USE PLAN
Projects
GENERAL PLAN
LOCAL COASTAL PROGRAM
SHARP PARK SPECIFIC PLAN
HOUSING ELEMENT
CLIMATE ACTION AND ADAPTATION PLAN
What Is A Local Coastal Land Use Plan?
In 1976, the California Coastal Act was passed to protect coastal resources and maximize public access to the shoreline. Local governments may prepare and implement Local Coastal Programs (LCPs), which can be certified by the California Coastal Commission. The Coastal Commission then delegates responsibility for issuing coastal permits for most new development to the local jurisdiction,

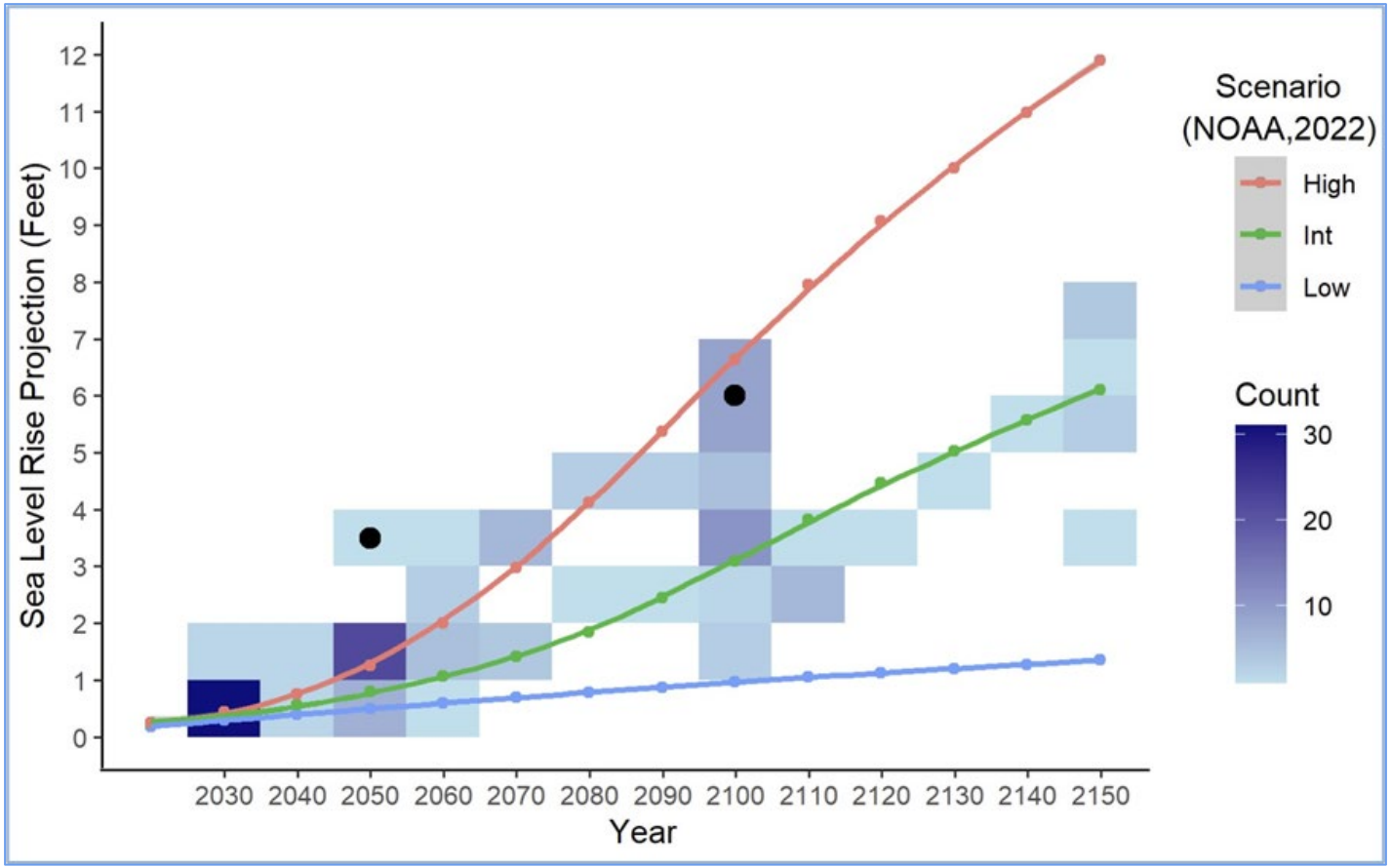
Goal: Actionable adaptation plans that prioritize the protection of nature and social equity.



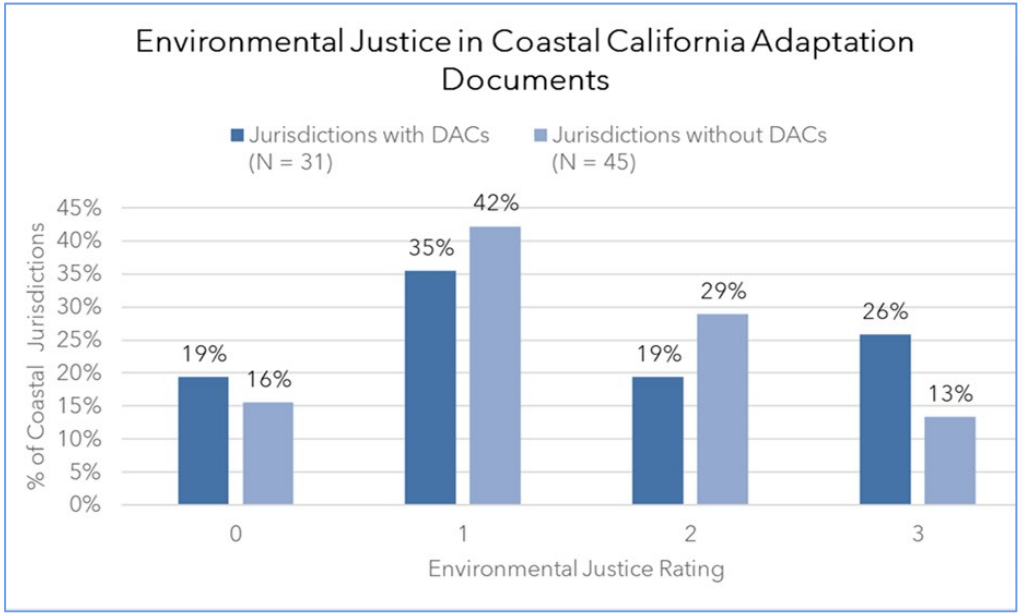


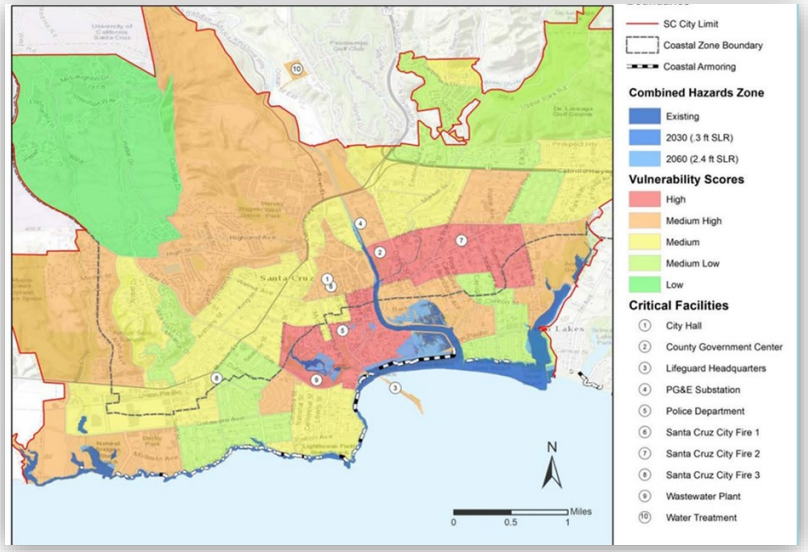
”I feel like sea level rise planning is like flying the ship as you build it or flying the plane as you build it . . .”




Sea Level Rise Projection (Feet)
0
1
2
3
4
5
6
7
8
9
10
11
12
2030
2040
2050
2060
2070
2080
2090
2100
2110
2120
2130
2140
2150
Year
Scenario
(NOAA,2022)
High
Int
Low
Count
30
20
10

"When I first started hearing about these vulnerability assessments several years back, I was kind of shocked because it seemed like the focus [was on] what property might be lost . . . instead of thinking about vulnerable peoples . . .."





C. Lester, CA SLR Adaptation Planning
Ocean and Coastal Policy Center | Marine Science Institute

UC SANTA BARBARA

. . . we are always thinking that coastal communities are the primary stakeholder because they are there and they live there, but that a lot of what we're talking about in terms of public resources, things held in public trust, the stakeholder is much bigger, right?

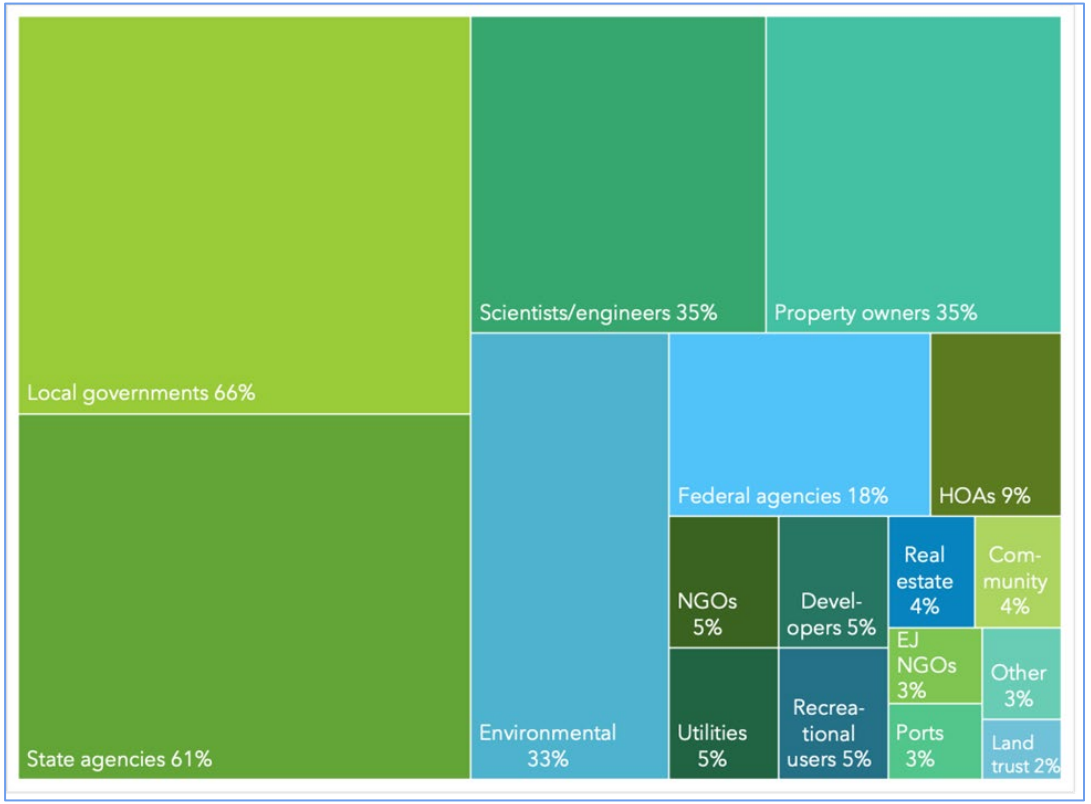
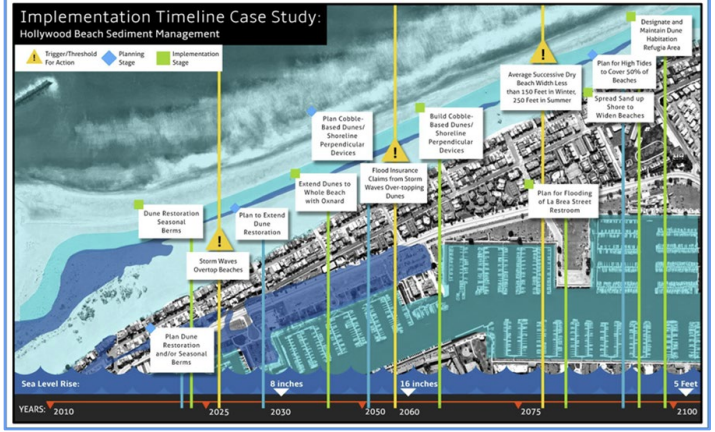


Table 9: Managed Retreat Pathway (2019 $)

	2030		2050		2100	
Strategy	**Amount**	**Cost**	**Amount**	**Cost**	**Amount**	**Cost**
Public Costs						
Demolish bike paths[37]	0 ft	$0	80 ft	$2,560	2,758 ft	$88,256
Relocate bike paths	0 ft	$0	80 ft	$9,848	2,758 ft	$339,527
Demolish water lines	0 ft	$0	0 ft	$0	120 ft	$7,200
Relocate water lines	0 ft	$0	0 ft	$0	120 ft	$73,200
Demolish stormwater lines	230 ft	$13,800	273 ft	$18,940	1,870 ft	$112,200
Relocate stormwater lines	230 ft	$138,000	273 ft	$163,800	1,870 ft	$1,122,000
Relocate parking lots	0 ft^2	$0	0 ft^2	$0	145,687 ft^2	$4,370,610
Purchase private property[38]	0 buildings	$0	0 buildings	$0	12 buildings	$20,325,986
Flood clean-up costs	Estimate	$2,500,000	Estimate	$2,500,000	Estimate	$2,500,000
TOTAL COST		**$2,651,800**		**$2,695,148**		**$28,938,979**
Non-market Annual Losses						
Recreational value	154 acres	$26,096,840	194 acres	$91,847,320	231 acres	$287,573,620

Figure 3-4: Hypothetical Adaptation Pathway Case Study for Hollywood Beach Sediment Management. Note that the yellow-colored line representing a "Trigger for Action" would initiate the next phase of adaptation measures.



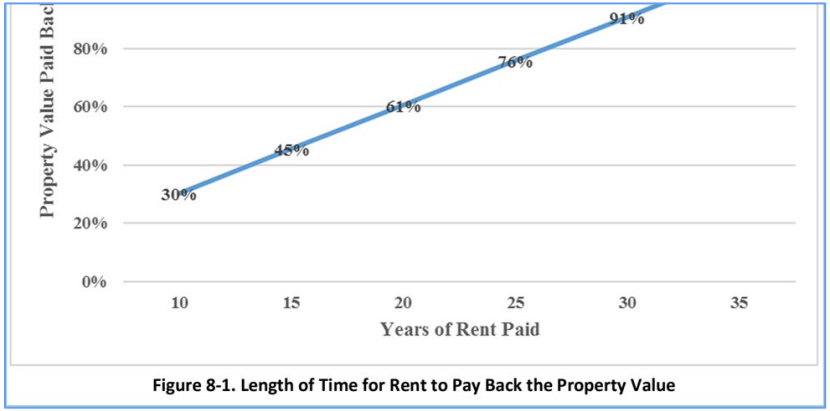


Figure 8-1. Length of Time for Rent to Pay Back the Property Value

TABLE 8.6
POSSIBLE LEAD TIMES FOR PLANNING BEACH EROSION ADAPTATION

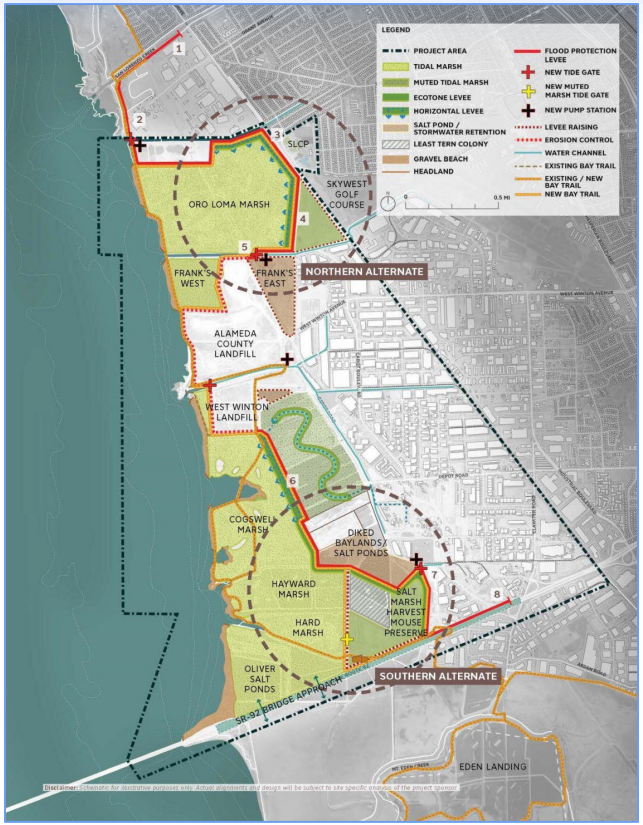
Risk	Actions	Lead Times	Adaptation Options
Beach erosion	Protect	5-10 years	Beach and dune nourishment
		10-15 years	Raise and improve sea walls
		15-20 years	Sand retention strategies
	Accommodate	5-10 years	Elevate structures
	Retreat	15-20 years	Relocate public infrastructure

“Critical” and “Relocatable” Assets at Point Mugu Naval Base

Topic	Reference	Description/Link
INTEGRATED FRAMEWORKS		
Sea Level Rise Framing	Marin County Santa Barbara County City of Del Mar	https://www.marincounty.org/main/sea-level-rise https://www.countyofsb.org/735/Coastal-Resiliency https://www.delmar.ca.us/498/Sea-Level-Rise-Local-Coastal-Program-Ame
Framework Guidance/Curriculum	Southern California Association of Governments	https://scag.ca.gov/climate-change-regional-adaptation-framework https://scag.ca.gov/sites/main/files/file-attachments/3000_sb379guidebook_final.pdf
Integrated Vulnerability	SeaChange, San Mateo County	https://seachangesmc.org/vulnerability-assessment/
VULNERABILITY ASSESSMENT		
SLR Projections/Risk Discussion	City of Santa Barbara	https://santabarbaraca.gov/sites/default/files/documents/Services/SLR%20Adaptation%20Plan/AppendixA_Santa%20Barbara%20SLR%20Vulnerability_PublicDraft_Part1.pdf https://youtu.be/rXrx3uWJmZQ (English) https://youtu.be/8d1C1Wlg2Oc (Spanish)
SLR Projections/Application	Draft UC Santa Barbara Sea Lever Rise Strategy	https://drive.google.com/file/d/1Du5d9yqMgmEwxQgmP_URWWBo2xr49pSc/view
Beach Loss Assessment	Marin County	https://www.marincounty.org/-/media/files/departments/cd/planning/slr/c-smart/2018/01_draft_title_pages_toc_va_slr_18_02_05.pdf?la=en
Social Vulnerability Assessment & Equity	City of Santa Cruz	https://www.cityofsantacruz.com/home/showpublisheddocument/82484/637436621427930000 https://www.cityofsantacruz.com/home/showpublisheddocument/82212/637407180899930000
County wide assessment	San Mateo County - Seachange	https://seachangesmc.org/wp-content/uploads/2018/03/2018-03-12_SLR_VA_Report_2.2018_WEB_FINAL.pdf
Coastal Habitat	Humboldt County	https://drive.google.com/file/d/1zS1wi6hX1FI4Lm_705LrjmLktirPlsVt/view?usp=sharing
Wetland Change	San Mateo County South County Assessment	https://seachangesmc.org/wp-content/uploads/2022/12/NoDiv-South-Coast-SLR-VA-Edited-Final-Draft-vgc-11-29-22.pdf

ADAPTATION STRATEGIES		
Integrated Vulnerability and Adaptation Plan	City of Santa Barbara	https://santabarbaraca.gov/sea-level-rise-adaptation-plan-and-vulnerability-assessment
Cost-Benefit Analysis	Manhattan Beach	https://www.manhattanbeach.gov/home/showpublisheddocument/48276/637708394401200000
Adaptation Pathways	City of Santa Cruz Ventura County	https://www.cityofsantacruz.com/home/showpublisheddocument/78993/637165013150570000 https://docs.vcrma.org/images/pdf/planning/programs/vcrcap/adaptation_report_final.pdf
Tiered/Phased Planning	City of SB UCSB	https://santabarbaraca.gov/sea-level-rise-adaptation-plan-and-vulnerability-assessment https://drive.google.com/file/d/1Du5d9yqMgmEwxQgmP_URWWBo2xr49pSc/view
Capital Improvements Programming	San Francisco City of Santa Cruz	https://onesanfrancisco.org/sites/default/files/inline-files/200103SLRGuidance.pdf https://www.cityofsantacruz.com/government/city-departments/public-works/engineering
LCP UPDATES		
Comprehensive Planning	City of Half Moon Bay City of Morro Bay	https://www.half-moon-bay.ca.us/154/Local-Coastal-Program-Land-Use-Plan https://www.morrobayca.gov/DocumentCenter/View/15424/Plan-Morro-Bay-GP-LCP-Final
Hazards Policy	City of Santa Barbara	https://santabarbaraca.gov/sites/default/files/documents/Services/LCP%20Update/Chapter%205.1%20Coastal%20Hazards.pdf
REGIONAL COLLABORATION		
Regional Collaborative	San Diego Regional Climate Collaborative Cal Poly Humboldt Sea Level Rise Institute	https://www.sandiego.edu/soles/centers-and-institutes/nonprofit-institute/signature-programs/climate-collaborative/ https://humboldtslri.org/
ENGAGEMENT		
Engagement	City of Del Mar Stakeholder Technical Advisory Committee City SB, Sea-Level Rise Adaptation Plan Subcommittee	https://www.delmar.ca.us/719/Meetings https://santabarbaraca.gov/sea-level-rise-adaptation-plan-subcommittee/sea-level-rise-adaptation-plan-subcommittee-agendas
IMPLEMENTATION		
Integrated Implementation	OneSF Hazards and Climate Resilience Plan	https://onesanfrancisco.org/hazards-and-climate-resilience-plan

City of Hayward: Hybrid Adaptation



City of Alameda: Phased and Triggered

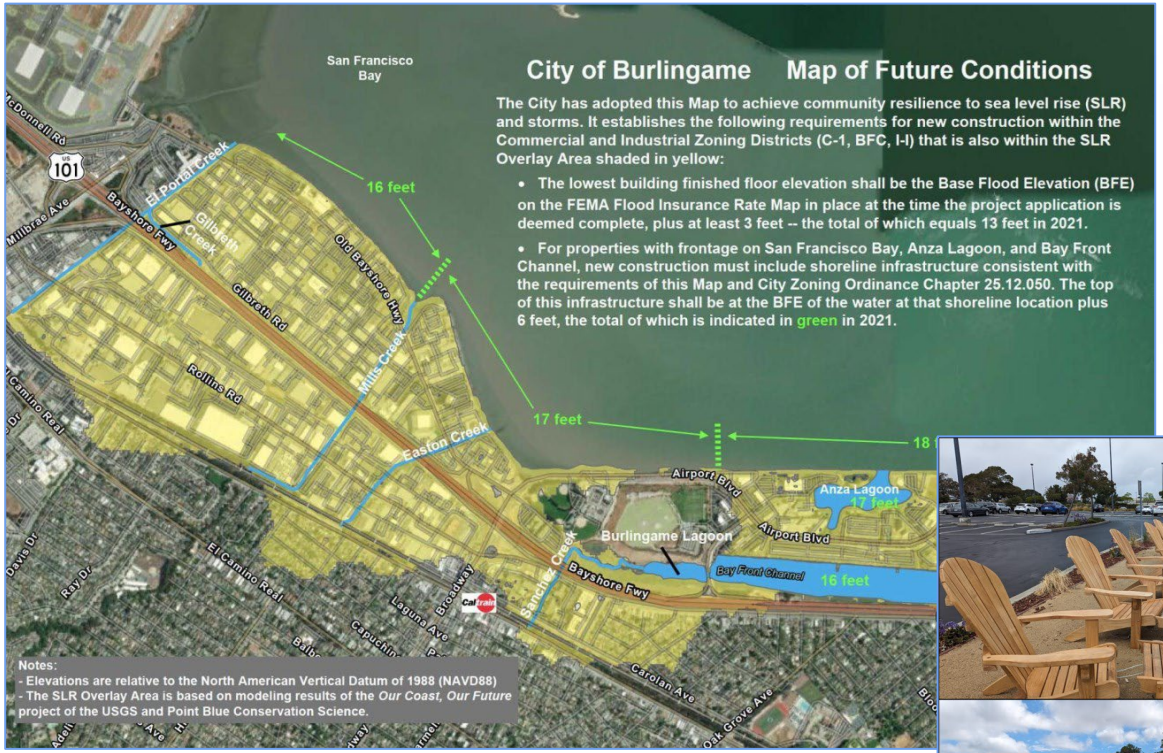
Table 4-6. Adaptation Planning: Crown Beach

Short-Term (<5 years)	ALL	• **Coordinate with EBRPD on master planning for the site**, including the public process.
	ALL	• **Study the geomorphology** of the beach. Study sand movement to predict where/how beach elevation will change over time and refine future strategies.
	1	• **Study opportunities for Elsie Roemer salt marsh to migrate with sea level rise.** Consider purchase of property as they become available. Fund native plant restoration to support long-term marsh health.
	2	• **Increase current dune management.** Dunes stabilize the beach and provide additional protection to the road. Strengthen and build existing dunes by further establishing native plants. Limit vehicular access to promote plant growth on the beach.
	ALL	• **Continue current practice of annually redistributing sand down the beach** (as needed).
Mid-Term (5–10 years)	3	• **Widen shoreline into the Bay.** Consider opportunities to move the shoreline into the Bay at a more gradual slope to protect against erosion.
	ALL	• **Develop long-term monitoring and trigger thresholds plan.** After 2 to 3 feet of sea level rise, additional strategies may need to be considered and 10 years of lead time will be needed (for feasibility studies, funding, etc.). Thresholds can be developed to trigger exploration of additional strategies, such as adding jetties/groins, oyster reefs (integrated into existing eel grass), or cobble berms to further control erosion.
Long-Term (>10 years)	4	• **Allow the beach to move inland.** If the beach erodes, there may be opportunities to simply allow it to move inland given the amount of open space available in the park.

CROWN BEACH

Crown Memorial State Beach is a 2.5-mile sandy beach, owned by California State Parks and the City of Alameda. Operated and managed by EBRPD, the beach is a popular spot for recreation and provides wildlife habitat. It also serves as shoreline protection for Shoreline Drive, the adjacent community, and important infrastructure such as stormwater outfalls. Sand is not naturally transported to the beach, so it must be periodically redistributed and replenished as it erodes slowly over time or suddenly in a large storm.

Figure 7. Foster City levee improvements with public access (Photos: C. Lester).



City of Burlingame
Sea Level Rise Zoning Map and Ordinance

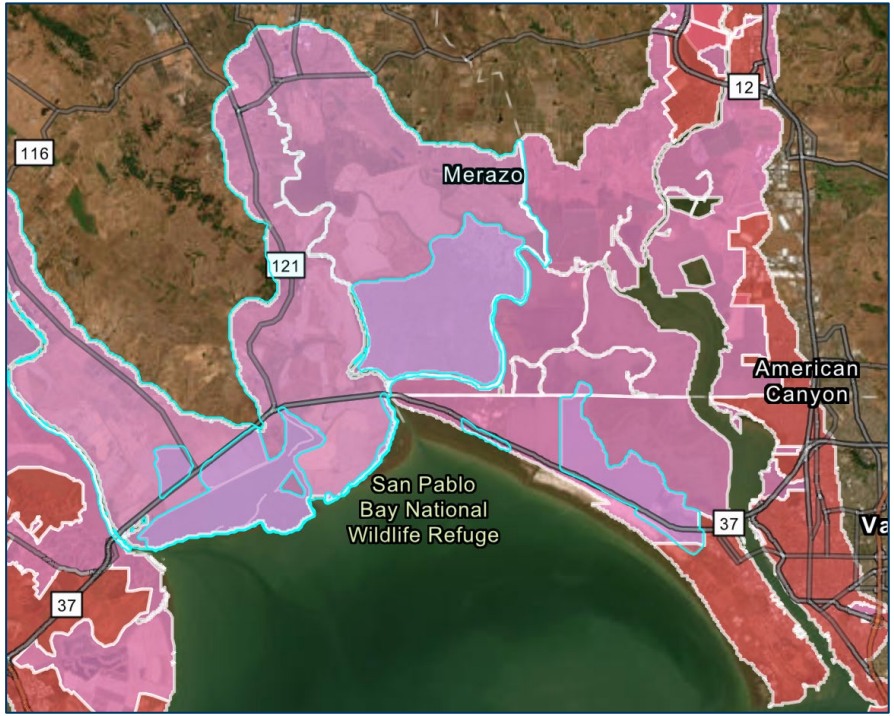
City of Mountain View
Sea Level Rise Capital Improvement Projects

Table 3: Updated Sea Level Rise CIP Project Budget Timeline

	Project	Estimated Cost ($ in millions)*			
		Total	5 Year	10 Year	10+ Year
1	Charleston Slough and PAFB Levee Improvement	$30.98			$43.7
2	Coast-Casey North Levee Improvement	$6.93	$4.9	$2.5	
3	North Landfill Erosion Protection	$4.91	$2.9	$2.3	
4	Permanente Creek Levee and Floodwall Improvements	$7.35			$10.4
5	Golf Course Facilities High Ground Augmentation	$4.05			$5.7
6	Lower Stevens Creek Levee Improvements	$9.01	$7.2	$2.1	
7	Coast-Casey Pump Station Improvement	$6.39	$1.3	$6.1	
8	Lower Permanente Creek Storm Drain Improvements	$6.72			$9.5
9	Sailing Lake Access Road Improvement	$2.68	$2.7		
10	Sailing Lake Intake Pump Station Modification	$2.40	$0.5	$2.3	
11	Charleston Slough Restoration	$4.22	$3.4	$1.0	
12	Sea Level Rise Assessment and Monitoring	$0.50		$0.6	
13	Crittenden Pump Station Improvement	$7.30	$1.5	$6.9	
14	As-needed Storm Drain Improvements	$3.17			$4.5
	COST ESTIMATE AT EACH PLANNING TIME STEP	**-**	$24.3	$23.8	$73.7
	TOTAL COST ESTIMATE IN PRESENT VALUE	**$96.61**	$24.3	$20.1	$52.3

* The Total and 5-Year Estimated Costs are based on present value. The 10-Year and 10+ Year Estimated Costs are based on 2026 and 2031 future value, respectively, using a 3.5% annual rate.

San Pablo Bay National Wildlife Refuge



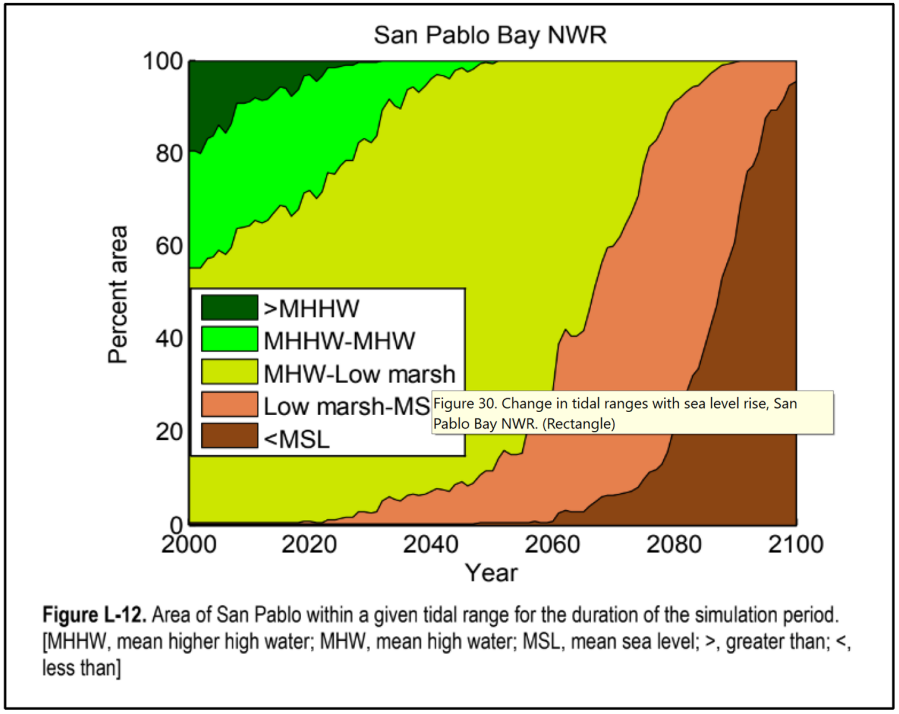
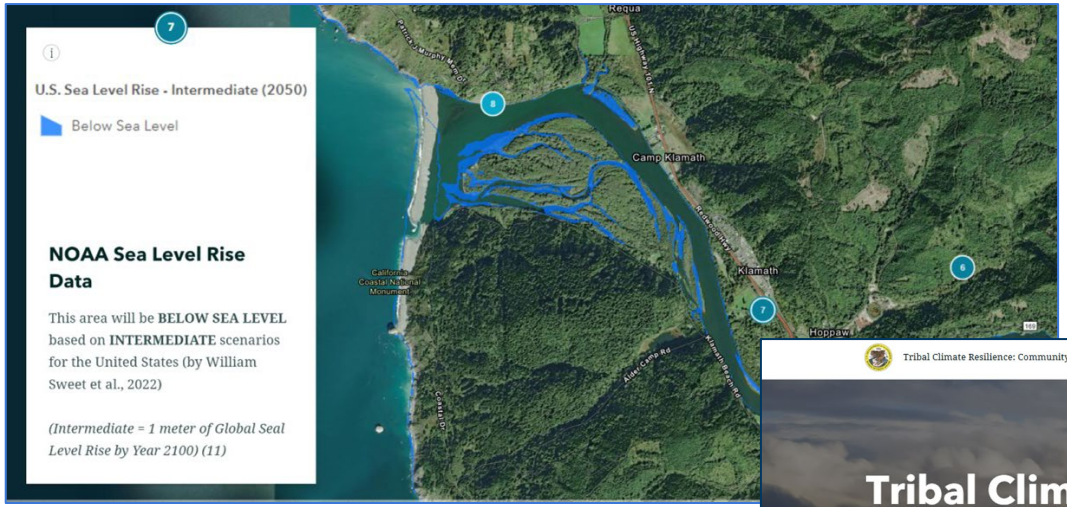
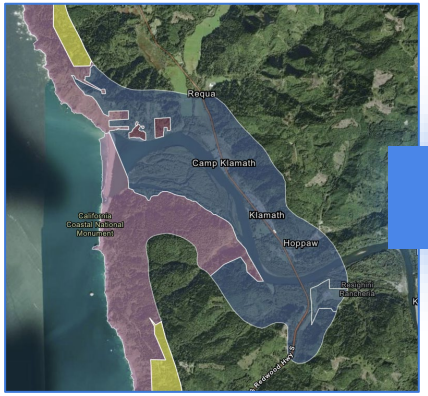


Figure L-12. Area of San Pablo within a given tidal range for the duration of the simulation period. [MHHW, mean higher high water; MHW, mean high water; MSL, mean sea level; >, greater than; <, less than]

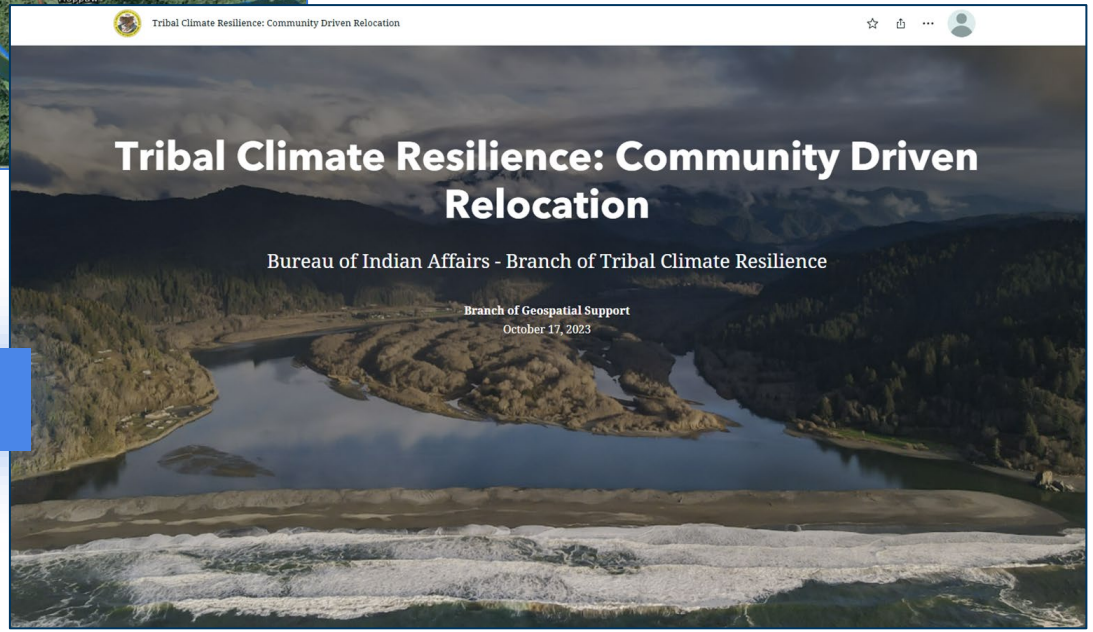
Figure 30. Change in tidal ranges with sea level rise, San Pablo Bay NWR.

California Tribes and SLR Planning



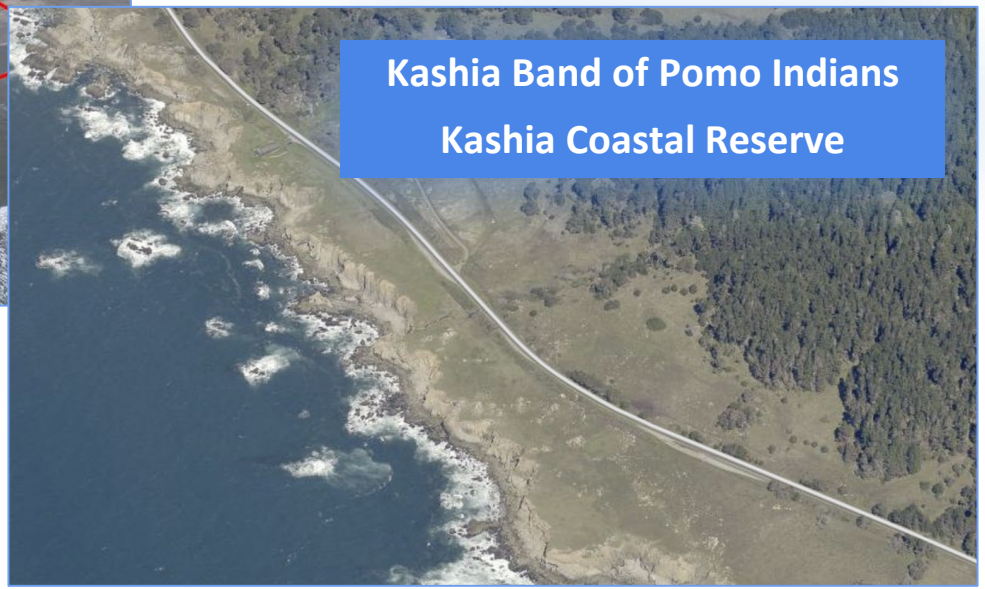


Yurok Tribe



California Tribes, Land Back, and SLR Planning

Elk Valley Rancheria
10 acres at Crescent Beach



Kashia Band of Pomo Indians
Kashia Coastal Reserve

California State Parks, SLR Planning for 25% of the Coast

Table E-1: Summary of SLR-VA vulnerability ratings by subarea.

Asset	Sea Level Rise (ft) 1'	2'	4'	6'	WR	OT	BE	SR	CR
Seacliff SB									
Campground	H	S	S	S		◉	◉	○	●
Day Use Area	M	H	S	S	○	◉	◉	○	●
Upper Lot	L	M	S	S					●
Rio Del Mar	M	H	S	S	○	●	◉	○	●
New Brighton SB									
Campground	M	S	S	S					●
New Brighton Beach	M	H	S	S	○	●	◉	◉	○
Porter-Senon	M	H	H	H					●
Potbelly Beach	L	L	M	H	○		●	◉	

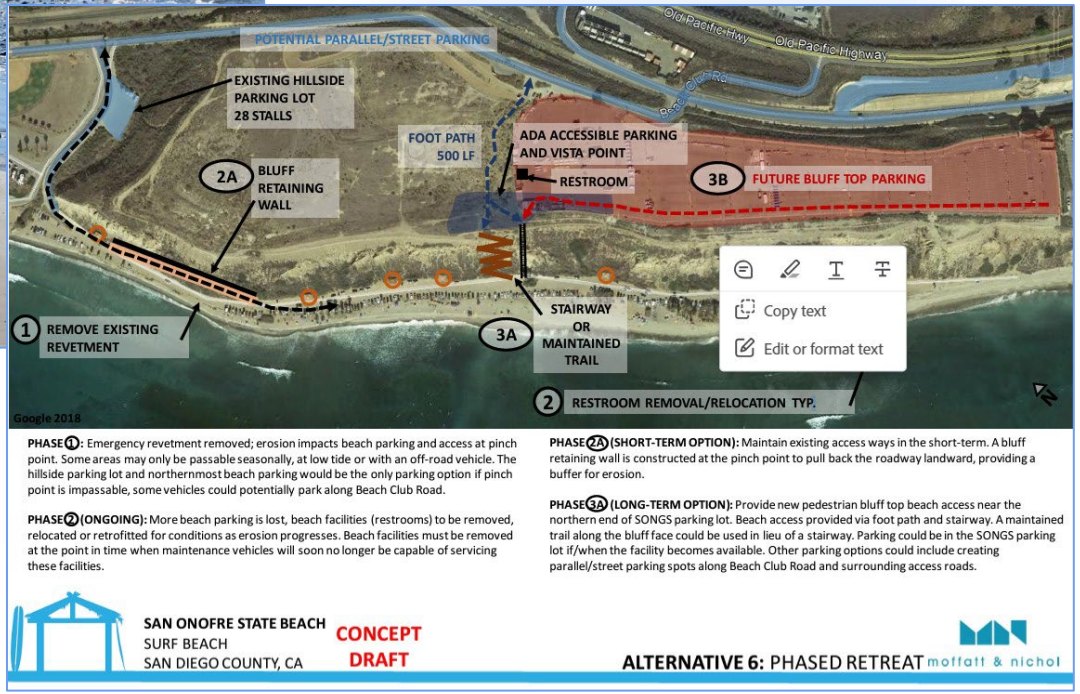
Vulnerability Rating:
- L Low
- M Moderate
- H High
- S Severe

Legend:
- WR Wave Runup
- OT Wave Overtopping
- BE Beach Erosion
- SR Shoreline Retreat
- CR Cliff Retreat

Influence of Coastal Processes:
- ○ Slight influence
- ● Moderate influence
- ⬤ High influence
- ◉ Very high influence

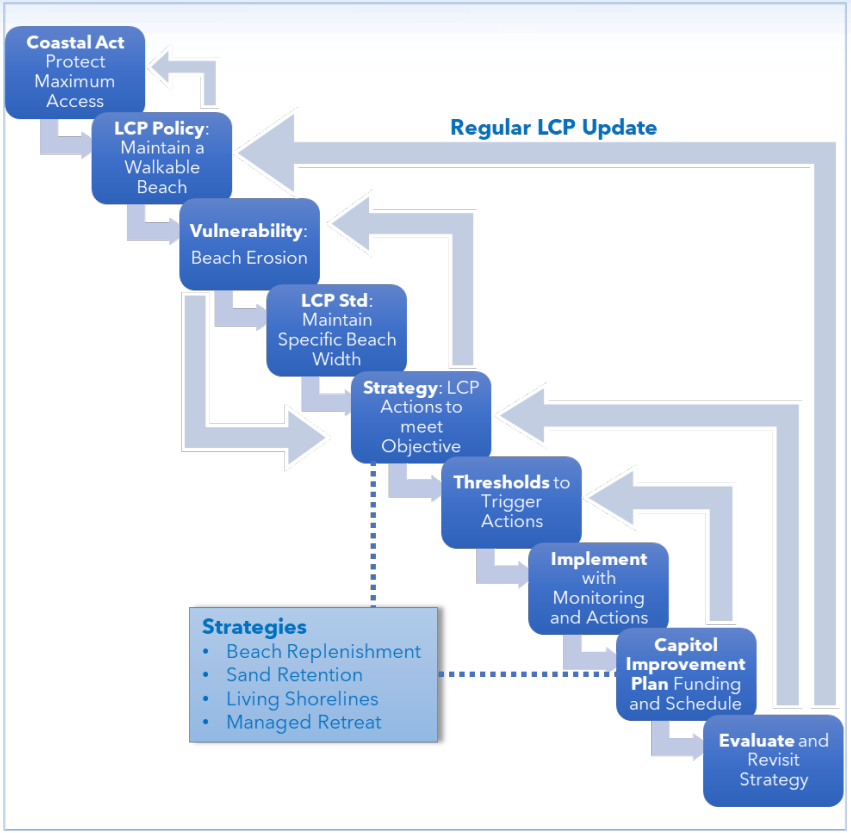
Seacliff & New Brighton State Beaches Community Workshop, 2024

California State Parks Projects ⟷ Planning



San Onofre State Beach

Actionable SLR Adaptation Planning – Visions to CIP and Back Again



Smart SLR Adaptation Planning Investments – Community Engagement to Project Implementation

Sea Level Rise Planning at California Ports

- - San Diego
- - Long Beach
- - Los Angeles
- - Hueneme
- - Oakland
- - San Francisco
- - Humboldt Bay
- **Smaller Ports:**
- - Ventura Harbor
- - Santa Barbara Harbor
- - Port San Luis
- - Morro Bay
- - Monterey Harbor
- - Santa Cruz Harbor
- - Half Moon Bay/Pillar Point
- - Point Arena
- - Noyo Harbor
- - Crescent City

Status:

- SLR vulnerability assessments completed or underway
- Integrated into Climate Action or Master Plans
- Regional collaborations
- SLR incorporated into LCPs and Harbor District Plans

Strategies

- Infrastructure resilience
- Flood protection
- Natural buffers
- Emergency preparedness
- Focus on access, docks, marinas

Common Vulnerabilities and Strategies (Major Ports)

- Vulnerabilities:
- - Flooding of cargo yards and access roads
- - Seismic and flooding compound risks
- - Damage to energy and communication systems

- Strategies:
- - Seawall reinforcement
- - Infrastructure elevation
- - Flood barriers
- - Nature-based solutions
- - Improved drainage
- - Adaptive pathways

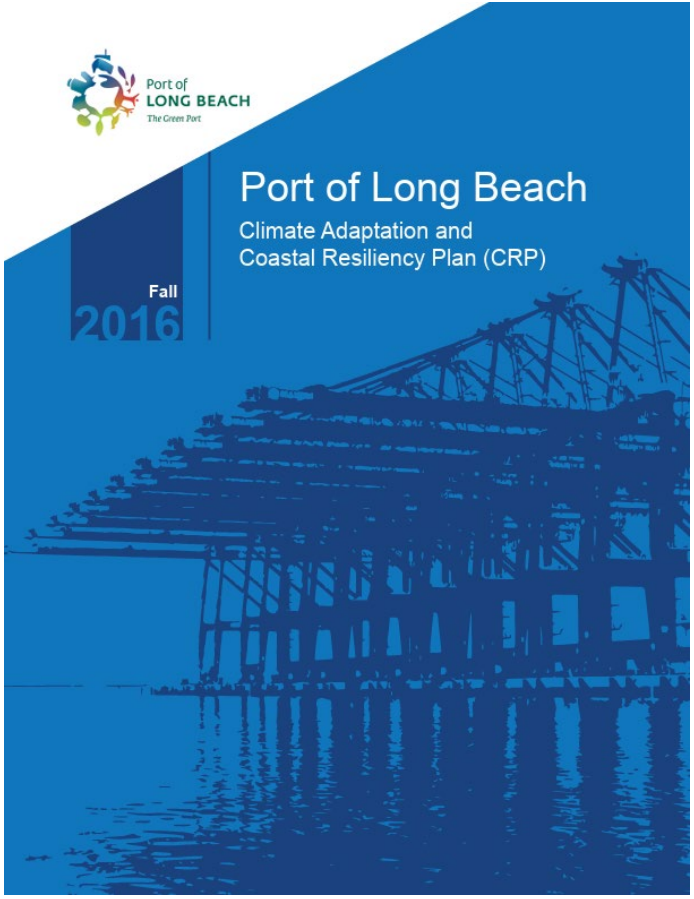
Port-Specific Highlights (Major Ports)

- San Diego: Climate Action Plan, hardening infrastructure
- Long Beach: Coastal Resiliency Plan, elevation
- Los Angeles: Flood barriers, green infrastructure
- Hueneme: Vulnerability assessments
- Oakland: Seaport Climate Action Plan
- San Francisco: Embarcadero Seawall Program
- Humboldt Bay: Marsh restoration, adaptation planning

Common Vulnerabilities and Strategies (Smaller Ports)

- Vulnerabilities:
- - Dock/pier flooding
- - Shoreline erosion
- - Impacts on small craft harbors

- Strategies:
- - Seawall/revetment improvements
- - Elevated docking facilities
- - Shoreline retreat discussions
- - Monitoring and data collection
- - Integration with broader coastal planning



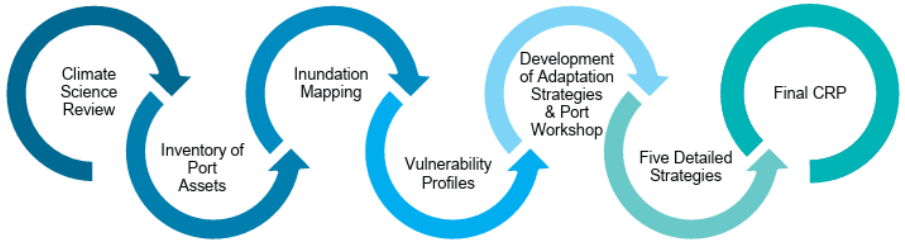


Figure ES-2. Steps to Developing the CRP

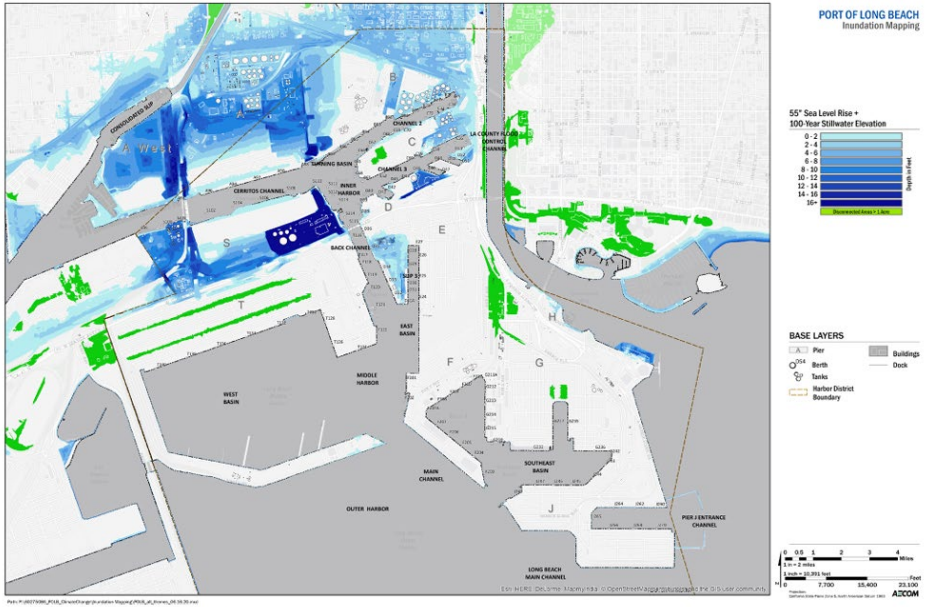
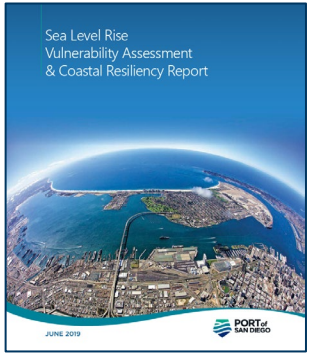


Figure ES-4. 55-inch SLR + 100-year Storm Surge

San Diego Port District



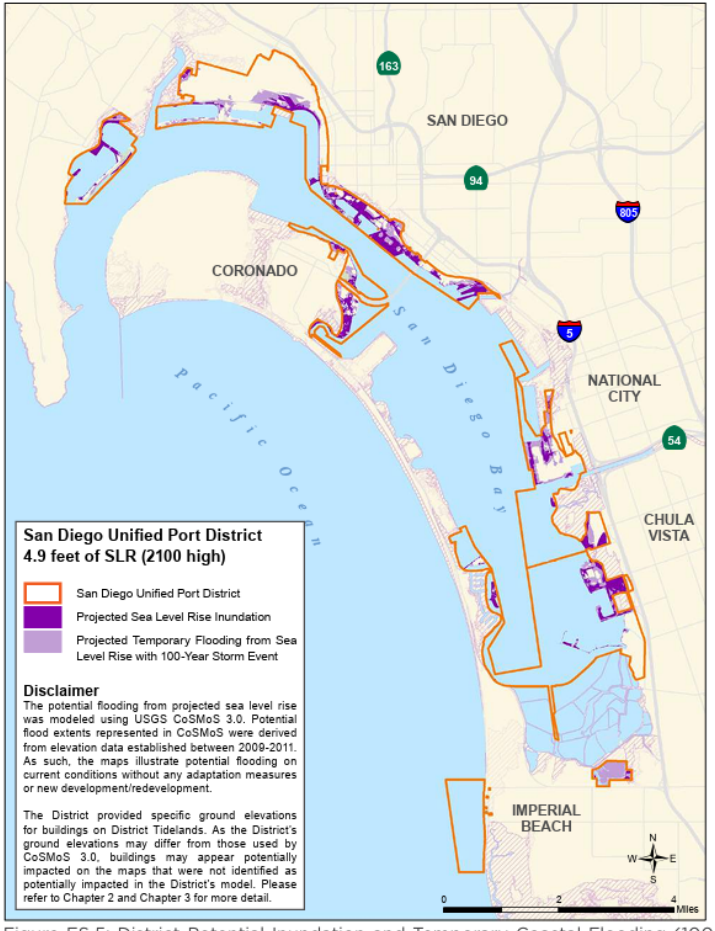
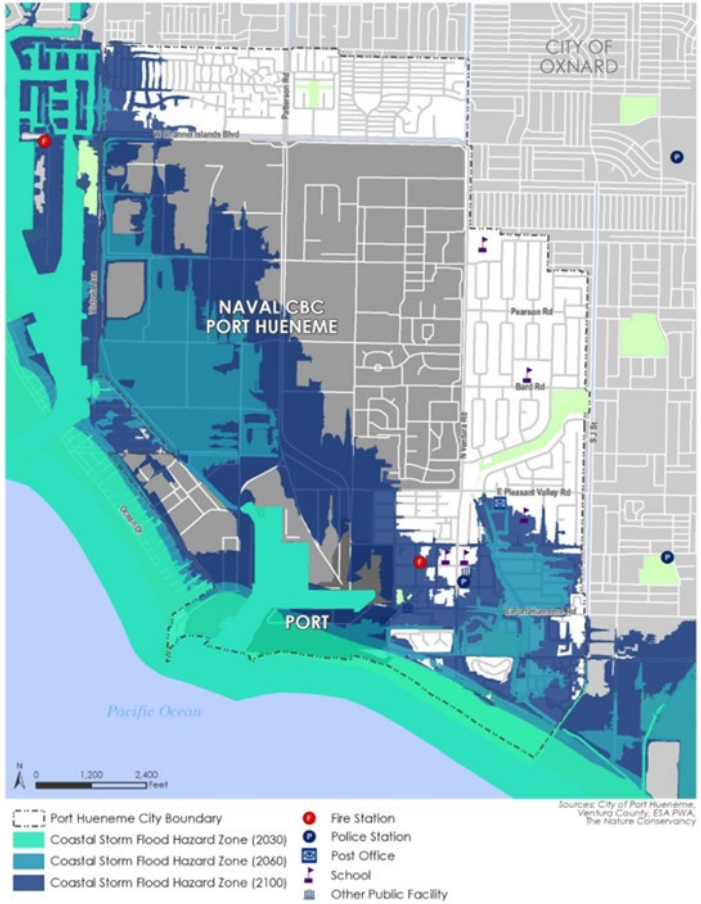


Figure ES.5: District Potential Inundation and Temporary Coastal Flooding (100-year storm event) with Projected Sea Level Rise in 2100 (High Scenario)

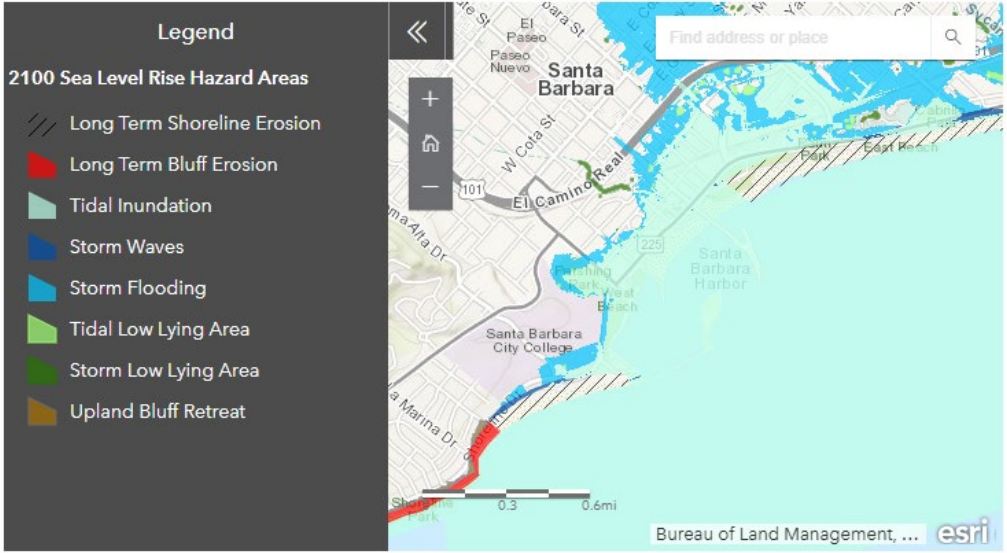
Table ES.3: District Asset Vulnerability from Potential Inundation with Projected Sea Level Rise

Assets	Total Quantity in District	Sensitivity	Adaptive Capacity	Exposure to Inundation			
				0.8 ft SLR	1.6 ft SLR	2.5 ft SLR	4.9 ft SLR
Roads (linear miles)	47.9	HIGH	LOW	1%	1%	2%	26%
Rail (linear miles)	16.2	HIGH	LOW	0%	0%	0%	57%
Bikeways (linear miles)	5.9	LOW	HIGH	1%	2%	10%	55%
Pathways (linear miles)	22.2	LOW	HIGH	7%	8%	15%	60%
Marine Terminals (acres)	233.4	HIGH	LOW	0%	0%	1%	37%
Buildings (count)	590	HIGH	LOW	0%	0%	1%	23%
Piers (count)	15	HIGH	LOW	0%	0%	0%	75%
Stormwater Management (count)	458	HIGH	LOW	4%	4%	7%	45%
Sewer Lifts (count)	10	HIGH	HIGH	20%	20%	30%	70%
Boat Launch Ramps (count)	3	LOW	HIGH	100%	100%	100%	100%
Beach Accessible Areas (acres)	11	HIGH	LOW	71%	75%	80%	93%
Parks (acres)	144.6	LOW	HIGH	3%	3%	6%	45%

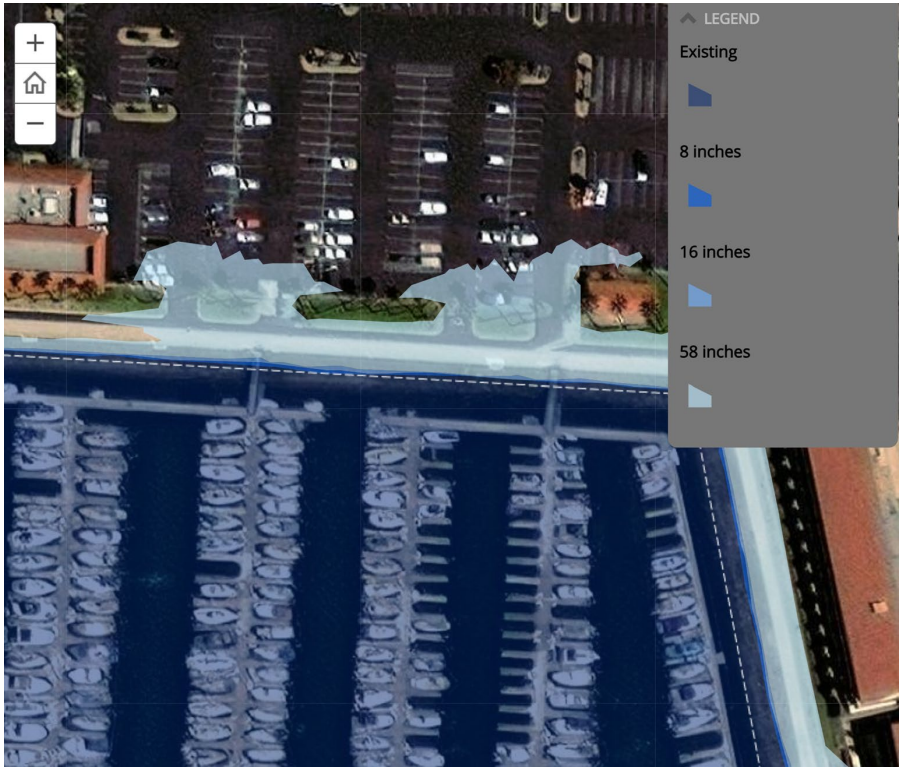
Figure13.3 Coastal Flood Hazard Zones



6.6 Ft. of Sea-Level Rise (± 2100) Hazard Areas



Source: USGS, ESA


LEGEND
Existing
8 inches
16 inches
58 inches

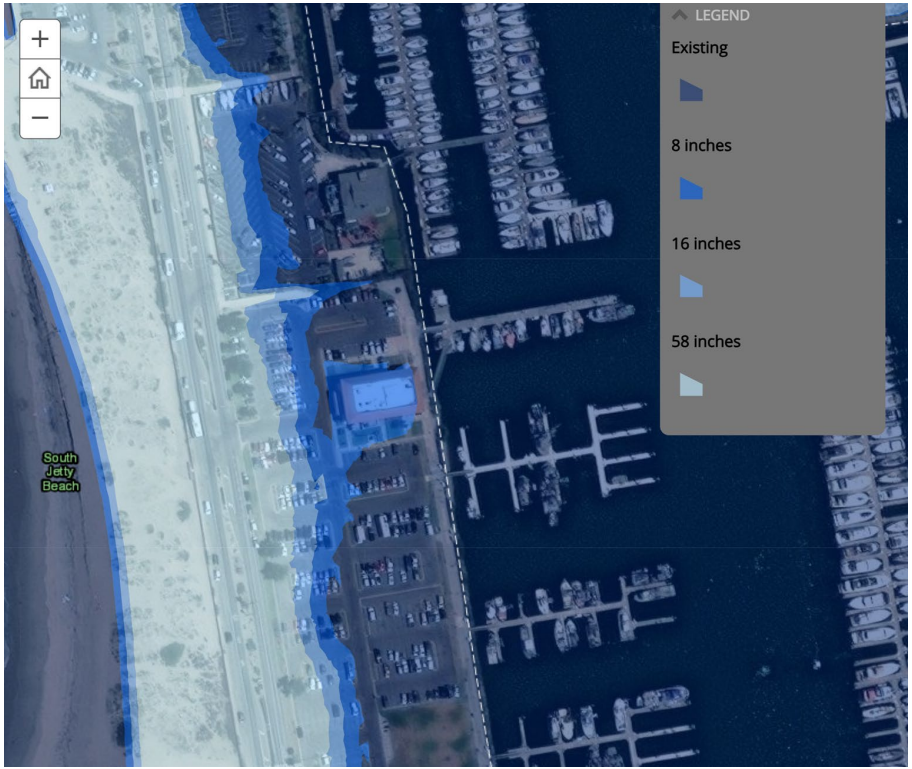
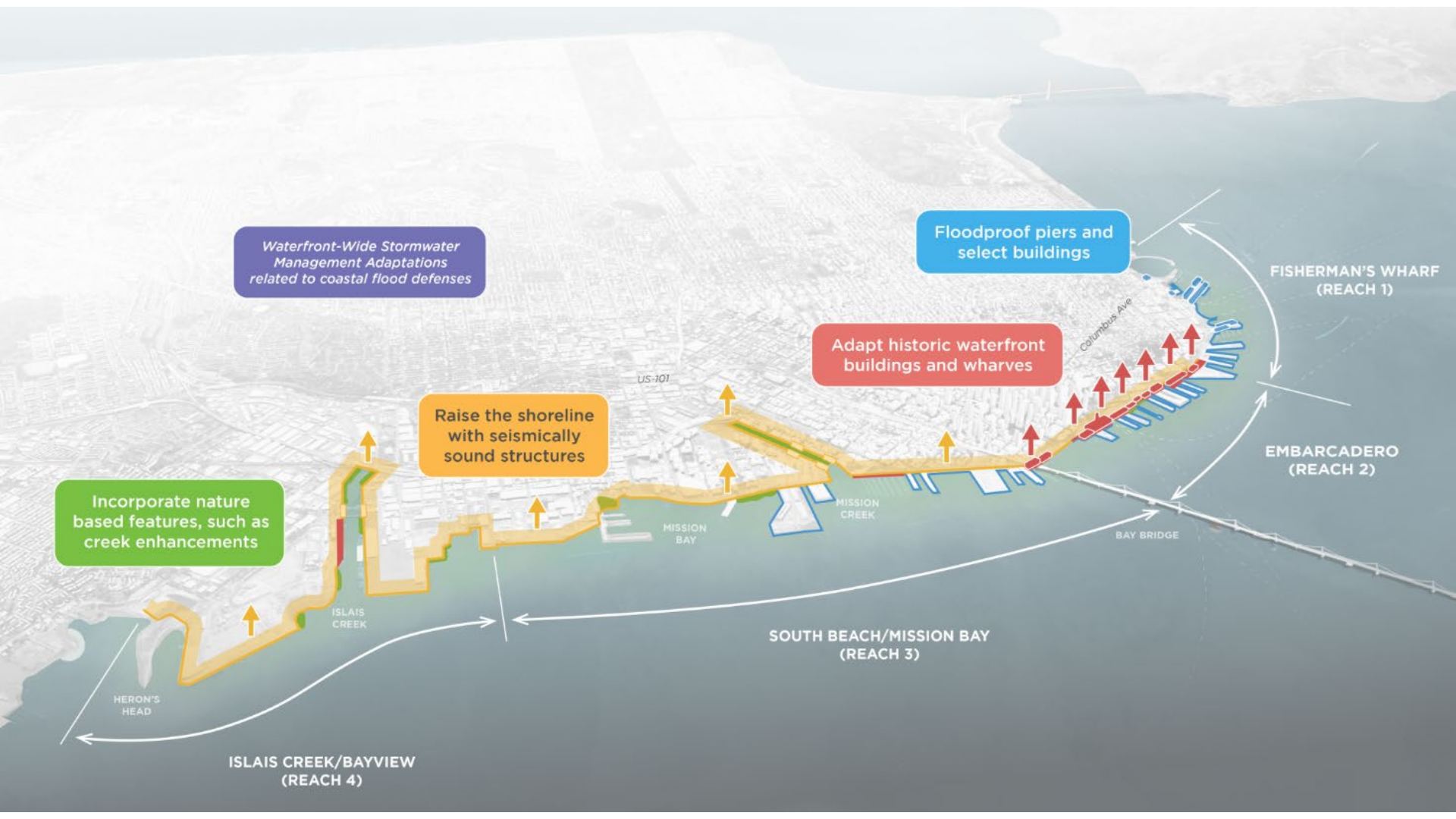
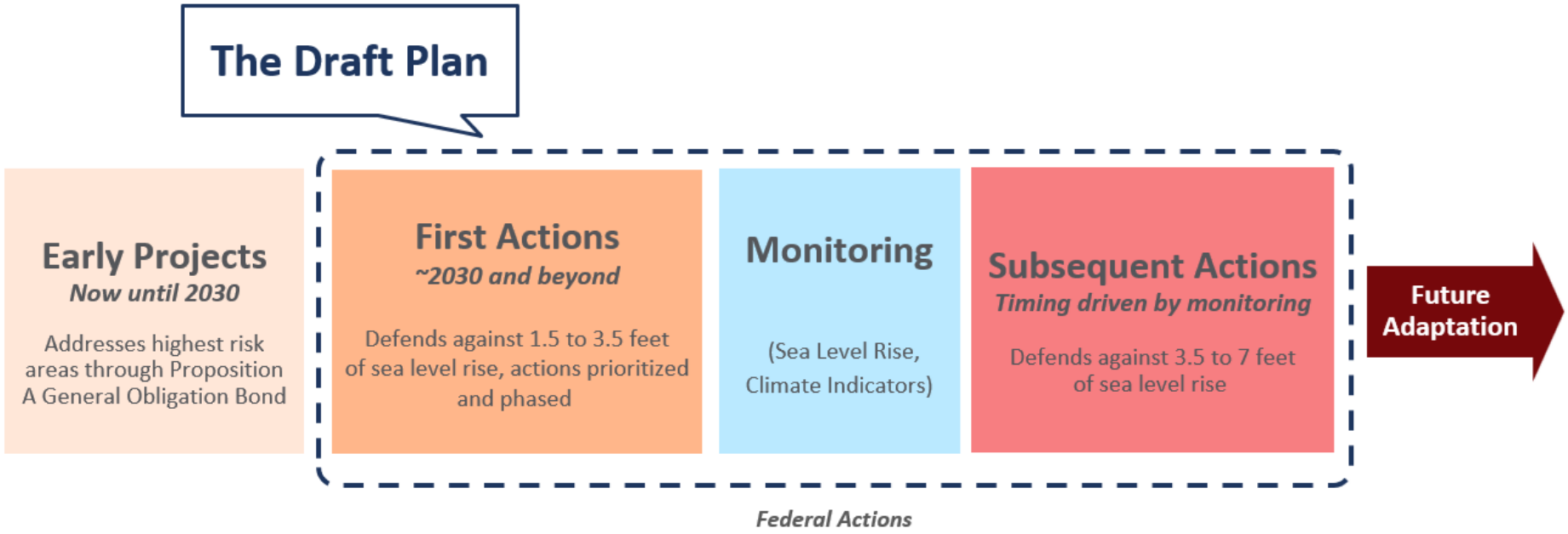

LEGEND
Existing
8 inches
16 inches
58 inches
South Jetty Beach

Image Credit: CMG Landscape Architecture and SITELAB urban studio


Waterfront-Wide Stormwater Management Adaptations related to coastal flood defenses
Floodproof piers and select buildings
Adapt historic waterfront buildings and wharves
Raise the shoreline with seismically sound structures
Incorporate nature based features, such as creek enhancements
FISHERMAN'S WHARF (REACH 1)
EMBARCADERO (REACH 2)
SOUTH BEACH/MISSION BAY (REACH 3)
ISLAIS CREEK/BAYVIEW (REACH 4)
Columbus Ave
US-101
MISSION BAY
MISSION CREEK
BAY BRIDGE
ISLAIS CREEK
HERON'S HEAD



Note: Dates are approximate and subject to change. Projects will occur in phases.

THANK YOU