Draft

MORRO BAY ESTUARY CLIMATE RESILIENCY TRANSPORTATION PLAN

Study Report

Prepared for
San Luis Obispo Council of Governments

January 2026

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CONTENTS

Figures

Tables

Attachments

1. EXECUTIVE SUMMARY

This Study Report for the Morro Bay Estuary Climate Resiliency Transportation Plan (Plan), prepared for San Luis Obispo Council of Governments (SLOCOG), consolidates the findings and recommendations generated throughout the project. The Study Report presents potential solutions and strategies to address the multifaceted challenges facing mobility and infrastructure in the Morro Bay–Los Osos corridor, along with next steps for moving forward with preferred alternatives.

The report presents a concise, actionable roadmap for climate resiliency and transportation adaptation for the Morro Bay-Los Osos transportation corridor. The process emphasized collaboration, transparency, and innovation, leveraging technical expertise, stakeholder insights, and advanced modeling tools to inform decision-making. It also incorporates feedback from public review and stakeholder consultation, making the Plan robust, equitable, and ready for the next steps. The report also integrates deliverables from preceding tasks, including existing conditions assessments, sea level rise scenarios, coastal hazards vulnerability assessment, opportunities and constraints analysis, adaptation alternatives development, benefit analysis results, and documentation of community engagement outcomes, including input received from members of the public; the Advisory Committee, comprised of key stakeholders; and various local Boards and Committees, which are presented as attachments.

The Morro Bay Estuary Climate Resiliency Transportation Plan identifies the following key findings, which will be described in greater detail in the section below:

- Existing Conditions:
  - The corridor's lack of active transportation options, i.e., safe bicycle and pedestrian routes, are its current primary deficiencies. In the future, South Bay Boulevard and State Park Road are anticipated to be vulnerable to sea level rise and in the absence of sea level rise adaptation, i.e., the no action scenario, the corridor's performance could become deficient for all modes of travel, including as a critical evacuation route (see **Attachment B**).
- Coastal Flood Hazards and Vulnerability Assessment:
  - Transportation, recreational and natural assets in the study area are already vulnerable today to temporary inundation and over time they will become increasingly at risk of permanent inundation if no action is taken (see **Attachment C**).
  - South Bay Boulevard between Los Osos and Chorro Creek Bridge, a primary evacuation route and connection between the City of Morro Bay to Los Osos, faces increasing exposure to storm and tidal flooding. Tidal inundation is not expected in the near term, but with 1.8 ft of sea level rise, king tides may reach the roadway from just south of Chorro Creek Bridge to just south of the Cerro Cabrillo Trailhead; with about 4 ft of sea level rise, flooding could occur about 12 times per year, rising to approximate 116 flooding events per year with 5 ft of sea level rise. Storm flooding already closes the segment between Chorro Creek Bridge and the Cerro Cabrillo Trailhead for about 1 day per year, with frequency and duration increasing by mid- and late century. Flooding does not extend further south, and Los Osos Bridge remains above tidal flood elevations.

- Potential Adaptation Solutions and Strategies:
  - Strategies include mid-term mobility enhancements; accommodation strategies such as elevating the roadways on fill or on causeways; protection strategies such as using levees to protect the road; and/or retreat strategies by relocating the roadways (**see Attachment D**).
- Benefit Analysis:
  - The benefits of the adaptation options outweigh the estimated costs, particularly because the no action alternative would result in a major detour that would add about 30 minutes to the trip for drivers and the loss of access would impact the value of recreational resources (see **Attachment E**).
- Community Engagement Outcomes:
  - Public input emphasized the importance of improving biking and walking options along the roadways in the study area as well as the value of the adjacent habitats (see **Attachment F**).
  - Advisory committee input emphasized the implementation challenges of the potential adaptation solutions.
- Solution Prioritization
  - The solution prioritization for the Plan reflects findings from the previous sections, indicating the highest net benefits for elevation on fill, which is also consistent with the feedback obtained from public workshops and advisory committee meetings for improved bicycle/pedestrian facilities and protection of the transportation corridor.
  - The Plan prioritizes a package of near-mid & long-term mobility enhancements and the elevation of critical roadway segments on engineered fill within the existing corridor as the main mid- to long-term strategy.
    - Near-term mobility upgrades to address active transportation issues by advancing bicycle/pedestrian improvements, intersection/transit access, trail connections, and vegetation management, using an adaptation pathways approach with triggers and thresholds while designing and permitting larger capital projects progress.
    - Elevating roads on fill allows integration of Class I/II bike and pedestrian facilities, limits deep excavation in sensitive estuarine/cultural areas, and works largely within the current footprint to reduce environmental and constructability constraints.
    - Levee concepts and selective causeway segments remain an alternative in the long-term that would be considered if monitoring indicates that performance thresholds are exceeded. Low berms/localized protection may be supplemented in specific locations in the mid-term.
- Next Steps:
  - Next steps for the prioritized solutions, summarizing potential timeframe, implementing agencies, estimated cost, permits required, potential funding sources, and anticipated implementation challenges.

- Work with the CA Coastal Commission and partners on the preconstruction phases of a CA Coastal Trail Feasibility, and Environmental and Design along South Bay Blvd preferred alignment.
- Additional policy changes to facilitate implementation include pursuing a countywide sea level rise vulnerability assessment and adaptation plan to inform a San Luis Obispo County LCP amendment consistent with SB 272.

2. INTRODUCTION

This Study Report for the Morro Bay Estuary Climate Resiliency Transportation Plan (Plan), prepared for San Luis Obispo Council of Governments (SLOCOG), consolidates the findings and recommendations generated throughout the project. The Study Report presents potential solutions and strategies to address the multifaceted challenges facing mobility and infrastructure in the Morro Bay–Los Osos corridor, along with next steps for moving forward with preferred alternatives.

The report presents a concise, actionable roadmap for climate resiliency and transportation adaptation for the Morro Bay-Los Osos transportation corridor. The process emphasized collaboration, transparency, and innovation, leveraging technical expertise, stakeholder insights, and advanced modeling tools to inform decision-making. It also incorporates feedback from public review and stakeholder consultation, making the Plan robust, equitable, and ready for the next steps. The report also integrates deliverables from preceding tasks, including existing conditions assessments, sea level rise scenarios, coastal hazards vulnerability assessment, opportunities and constraints analysis, adaptation alternatives development, benefit analysis results, and documentation of community engagement outcomes, including input received from members of the public; the Advisory Committee, comprised of key stakeholders; and various local Boards and Committees, which are presented as attachments.

2.1 Site Characteristics

The project site focuses on a 2.5-mile stretch of South Bay Boulevard between State Route 1 and Los Osos Creek, including spurs along South Park Road (Main Street) through Morry Bay State Park, Quintana Avenue on the northeast side of the project site, and Turri Road on the southeast side of the project site (**Figure 1**). The study area also includes the Morro Bay State Marine Reserve. Flood events frequently close the roads in the study area, disrupting connectivity between Morro Bay and Los Osos and blocking one of the primary evacuation routes for the Los Osos community in the event of a potential radiation accident at Diablo Canyon Nuclear Power Plant.

High tide levels in the estuary combined with high creek flows exacerbate local flooding, particularly in the lower reaches of Chorro Creek and Los Osos Creek. With sea level rise, the frequency and severity of road closures are expected to increase dramatically. The study area includes critical wetland habitats adjacent to South Bay Boulevard and the connecting roadways. These habitats, part of the Morro Bay State Marine Reserve, are vital for a variety of animals and plants, including some special status species, and are vulnerable to sea level rise.

Source: ESRI, ESA, RRM 2025

Figure 1. Project Area (orange lines)

2.2 Key Challenges

The Morro Bay-Los Osos transportation corridor is subject to a range of pressures that threaten both connectivity between the communities and the surrounding recreational assets and natural environment. Its coastal setting exposes infrastructure to frequent flooding and road closures, while sea level rise and storm events increase the risk of disruption of this key transportation corridor for the region.

Tidal marsh habitats adjacent to the corridor are also at risk from permanent inundation and conversion to tidal flats or open water, adding complexity to any proposed improvements. Finally, limited options for non-motorized travel, i.e., biking and walking, and gaps in the California Coastal Trail highlight the need for improved alternative transportation solutions. Coordinating among multiple agencies and stakeholders, each with distinct priorities, further intensifies these challenges.

Key challenges for the Morro Bay-Los Osos transportation corridor, as well as its recreational and natural assets, include:

- **Flooding and road closures:** Increasing frequency and severity of flood events, along with sea level rise and more intense storms, threaten South Bay Boulevard, nearby routes, and low-lying areas, disrupting connectivity, emergency access, increasing roadway maintenance needs, and raising concerns about the long-term viability of current roadway elevations.
- **Critical emergency and evacuation role of the corridor:** South Bay Boulevard and connecting routes connect Morro Bay and Los Osos, especially during emergencies. Flooding or damage can isolate communities, delay aid, and limit evacuations.
- **Sensitive habitats:** Wetland areas within the State Marine Reserve and Natural Preserve support local wildlife and plant species, but face risks from permanent inundation as sea level rises.
- **Recreational resources:** The transportation network runs through and adjacent to the Morro Bay estuary, wetlands, and Morro Bay State Park. These areas support habitat, recreational opportunities, and regional identity.
- **Mobility limitations:** Non-motorized transportation options are limited between Morro Bay and Los Osos, and gaps in the California Coastal Trail restrict safe biking and walking for residents and visitors.
- **Jurisdictional complexity:** Overlapping responsibilities among the City, County, agencies and stakeholders require coordinated planning and consensus-building to move solutions forward, creating complexity for project development, permitting, and long-term stewardship.

2.3 Goals and Objectives

In response to these challenges, the Plan sets out a clear vision for a safer, more resilient, and accessible transportation corridor in the Morro Bay area. The project aims to strengthen transportation links, protect vital habitats, and expand mobility options for all users. By integrating technical analysis, public input, and stakeholder guidance, the Plan provides a pathway for adaptive management and long-term sustainability and a guide to prioritize investments, phasing, and adaptation pathways for the area.

The overarching goals guiding the direction of the project and shaping the strategies developed throughout the planning process include:

- Strengthen transportation links between Morro Bay and Los Osos to maintain reliable access under changing climate conditions;
- Protect and restore critical wetland and estuarine habitats;
- Advance public safety for residents, visitors, and emergency services and
- Promote sustainable, multi-modal mobility options for all users.

To achieve these goals, the Plan identifies specific objectives that directed the actions and decisions required for successful implementation. These objectives translate the broader vision into measurable steps and practical outcomes and include the following:

- Reduce risks to infrastructure and public safety from flooding, sea-level rise, and storm events;
- Integrate nature-based adaptation strategies into transportation and habitat improvements;
- Expand ADA-compliant pathways and close gaps in the California Coastal Trail to improve accessibility;
- Engage the public, advisory committees, and decision-makers to reflect community priorities in the Plan;
- Use benefit analysis to identify solutions that deliver strong public and ecosystem value and
- Develop an adaptive planning framework that supports flexible responses to future challenges.

2.4 Key Findings

The Morro Bay Estuary Climate Resiliency Transportation Plan identifies the following key findings, which will be described in greater detail in the section below:

- Existing Conditions:
  - The corridor's lack of active transportation options, i.e., safe bicycle and pedestrian routes, are its current primary deficiencies. In the future, South Bay Boulevard and State Park Road are anticipated to be vulnerable to sea level rise and in the absence of sea level rise adaptation, i.e., the no action scenario, the corridor's performance could become deficient for all modes of travel, including as a critical evacuation route (see **Attachment B**).
- Coastal Flood Hazards and Vulnerability Assessment:
  - Transportation, recreational and natural assets in the study area are already vulnerable today to temporary inundation and over time they will become increasingly at risk of permanent inundation if no action is taken (see **Attachment C**).
- Potential Adaptation Solutions and Strategies:

- Strategies include mid-term mobility enhancements; accommodation strategies such as elevating the roadways on fill or on causeways; protection strategies such as using levees to protect the road; and/or retreat strategies by relocating the roadways (**see Attachment D**).

- Benefit Analysis:
  - The benefits of the adaptation options outweigh the estimated costs, particularly because the no action alternative would result in a major detour that would add about 30 minutes to the trip for drivers and the loss of access would impact the value of recreational resources (see **Attachment E**).
- Community Engagement Outcomes:
  - Public input emphasized the importance of improving biking and walking options along the roadways in the study area as well as the value of the adjacent habitats (see **Attachment F**).
  - Advisory committee input emphasized the implementation challenges of the potential adaptation solutions.
- Solution Prioritization
  - The solution prioritization for the Plan reflects findings from the previous sections, indicating the highest net benefits for elevation on fill, which is also consistent with the feedback obtained from public workshops and advisory committee meetings for improved bicycle/pedestrian facilities and protection of the transportation corridor.
  - The Plan prioritizes a package of near-mid & long-term mobility enhancements and the elevation of critical roadway segments on engineered fill within the existing corridor as the main mid- to long-term strategy.
    - Near-term mobility upgrades to address active transportation issues by advancing bicycle/pedestrian improvements, intersection/transit access, trail connections, and vegetation management, using an adaptation pathways approach with triggers and thresholds while designing and permitting larger capital projects progress.
    - Elevating roads on fill allows integration of Class I/II bike and pedestrian facilities, limits deep excavation in sensitive estuarine/cultural areas, and works largely within the current footprint to reduce environmental and constructability constraints.
    - Levee concepts and selective causeway segments remain an alternative in the long-term that would be considered if monitoring indicates that performance thresholds are exceeded. Low berms/localized protection may be supplemented in specific locations in the mid-term.
- Next Steps:
  - Next steps for the prioritized solutions, summarizing potential timeframe, implementing agencies, estimated cost, permits required, potential funding sources, and anticipated implementation challenges.
  - Work with the CA Coastal Commission and partners on the preconstruction phases of a CA Coastal Trail Feasibility, and Environmental and Design along South Bay Blvd preferred alignment.

– Additional policy changes to facilitate implementation include pursuing a countywide sea level rise vulnerability assessment and adaptation plan to inform a San Luis Obispo County LCP amendment consistent with SB 272.

3. EXISTING CONDITIONS

The corridor's lack of active transportation options, i.e., safe bicycle and pedestrian routes, is its current primary deficiency. In the future, South Bay Boulevard and State Park Road are anticipated to be vulnerable to sea level rise and in the absence of sea level rise adaptation, i.e., the no action scenario, the corridor's performance could become deficient for all modes of travel, including as a critical evacuation route. The following is a summary of the Existing Conditions Memo, which can be found in **Attachment B**.

3.1 Corridor Performance

3.1.1 Safety

Collisions

South Bay Boulevard has been identified as a Tier 2 High Injury Network south of the intersection with Morro Creek Road (SLOCOG, 2024b). Several intersections in the study area have also been identified as problematic, including the intersection of South Bay Boulevard with Quintana Road, State Park Road, and Turri Road. However, the density of vehicle-vehicle collisions in the study area is relatively low (SLOCOG, 2024e). There were three recorded collisions between vehicles and bicycles or vehicles and pedestrians from 2018-2023 (SLOCOG, 2024e) and no recorded or reported collisions between vehicles and wildlife in the study area for the same time period (UC Davis, 2024) However, there is anecdotal evidence of feral pigs that have been hit on S. Bay Blvd. The pigs are mostly in the watershed but come down to the estuary to feed when conditions are dry.

Evacuation routes

In the event of a natural disaster, such as a wildfire, or a nuclear disaster at the Diablo Canyon Power Plant, there are only two roads that serve as evacuation routes for the community of Los Osos: South Bay Boulevard and Los Osos Valley Road. If South Bay Boulevard was flooded or unusable for any other reason, the only evacuation route would be the two-lane Los Osos Valley Road.[1] Although it is outside the study area for the Plan, Los Osos Valley Road could also be vulnerable to current and future flood risks due to its proximity to nearby creeks.

Emergency response times

In the event of an emergency, any emergency responders, such as police or fire personnel, traveling from Morro Bay to Los Osos would typically use South Bay Boulevard to travel to Los Osos and the travel time is typically 15 minutes, depending on the exact origin and destination. If South Bay Boulevard was flooded or unusable for any other reason, the only available detour (onto Highway 1 east to W Foothill Boulevard returning via Los Osos Valley Road) would double emergency response time to 30 minutes.[2]

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[1] Determined using Google Maps, accessed online.

[2] Estimated using Google Maps, accessed online.

3.1.2 Connectivity

Bike and pedestrian infrastructure

A Class II / designated bike lane exists on South Bay Boulevard and South Bay Boulevard is a part of the Pacific Coast Bike Route (SLOCOG, 2024a). However, the speed limit is 50 miles per hour, which may deter less experienced bicyclists from using the unprotected bike lane. Furthermore, there are no sidewalks or ADA facilities that meet the Federal Accessibility Guidelines for Outdoor Developed Areas along South Bay Boulevard (SLOCOG, 2024a). **Figure 2** shows existing conditions for bikes and pedestrians along South Bay Boulevard.

Trail network

There is an existing trail system within Morro Bay State Park, west and east of South Bay Boulevard, including the trails surrounding Black Hill to the west and trails that lead from trailheads east of South Bay Boulevard to the eastern park boundary (State Parks, 2024). However, there are no existing ADA Accessible trails meeting the Federal Accessibility Guidelines for Outdoor Developed Areas that parallel South Bay Boulevard that would provide an alternative to walking or biking in the shoulder or bike lane on South Bay Boulevard. South Bay Boulevard is identified as a "Bike Only" segment of the California Coastal Trail (CCT). However, there is a gap in the CCT along State Park Road from Bayside Café in Morro Bay State Park to the intersection with South Bay Boulevard (California Coastal Trail, 2024).

Transit routes

San Luis Obispo Regional Transit Authority's Bus Route 12 connects Los Osos and Baywood Park to Morro Bay and San Luis Obispo (SLORTA, 2024). The frequency is once an hour on weekdays and every two to three hours on weekends. There are Route 12 bus stops at the intersection of South Bay Boulevard and Quintana Road and at the intersection of Santa Ysabel Road and 15th St.

Disadvantaged communities

Southeast Morro Bay and northern Los Osos, particularly near South Bay Boulevard, are identified as disadvantaged communities (SLOCOG, 2024c). However, those communities do not score highly as households with no vehicle available.

Figure 2. Existing conditions for bicyclists and pedestrians along South Bay Boulevard

3.1.3 Travel time reliability

Level of service

During peak travel periods, i.e., 8-9 am and 4-5 pm, travel from Morro Bay to Los Osos (and from Los Osos to Morro Bay) along South Bay Boulevard can take several minutes longer than normal, i.e., 16 minutes rather than 14 minutes.[3] Special events, such as a race, might cause congestion, particularly at intersections. However, a traffic survey would need to be conducted to gather more detailed information, which is beyond the scope of this study.

3.1.4 Sustainability

Greenhouse gas emissions / vehicle miles traveled

Greenhouse gas emissions (GHG) and vehicle miles traveled (VMT) data are typically analyzed as required by the California Environmental Quality Act when new development is proposed. Recent data are not available for the study area and therefore, a GHG/VMT survey would need to be conducted to gather more detailed information, which is beyond the scope of this study.

Mode split

The primary mode of travel in the study area is private vehicle (73%) or as a passenger in a private vehicle (21%) with the primary purpose of traveling to/from home (34%), to work (15%) or to shop (11%) (Replica, 2024).

3.1.5 Other considerations

2.5.1 Asset management

Planned projects in the study area include the South Bay Boulevard California Coastal Trail Connector; State Park Road Bike Improvements; and the South Bay Boulevard Bridge Replacement over Los Osos Creek (SLOCOG, 2024d). The upcoming Los Osos Community Services District Water Resiliency Intertie Pipeline Project may also present an opportunity to co-locate with the planned Chorro Valley trail, which would enhance active transportation options in the study area.

[3] Estimated using Google Maps, accessed online.

4. COASTAL FLOOD HAZARDS AND VULNERABILITY ASSESSMENT

4.1 Introduction

This section provides a summary of the Coastal Flood Hazard and Vulnerability Assessment (CFHVA) prepared for the Morro Bay Estuary and presented in detail in **Attachment C**. The CFHVA provides an analysis of flood risks and asset vulnerabilities along the South Bay Boulevard corridor and adjacent areas, including coastal flood hazard modeling and planning-level vulnerability assessment analyses. This assessment supports the Plan by identifying which transportation, recreational, and natural assets are most at risk from coastal flooding and sea level rise, and by informing the development of adaptation strategies that align with the project to increase resilience, safety, and mobility while maintaining community priorities.

In addition, the CFHVA evaluates near-term and future flood exposure for transportation assets that support mobility between Morro Bay and Los Osos, with particular attention to segments that already experience closures during storms and king tides. It identifies when assets transition from episodic storm flooding to regular tidal inundation, quantifies water levels and wave effects at locations repeatedly impacted and flooded, and ranks vulnerability based on exposure, sensitivity, and adaptive capacity.

The CFHVA was prepared using the best available science for sea level rise guidance, based on the 2024 Update of the Ocean Protection Council's (OPC) State of California Sea Level Rise Guidance (OPC 2024) (see **Attachment A** for the Sea Level Rise Scenarios Memo). The assessment builds on prior City of Morro Bay studies and focuses on transportation resiliency along the project site. In addition, the assessment includes a structured vulnerability assessment, results from the United States Geological Survey (USGS) Coastal Storm Modeling System (CoSMoS), tidal flooding analysis, and advanced estuary-scale hydrodynamic and wave modeling under both non-storm (king tide) and storm conditions, integrating recent USGS data and local observations.

The modeling incorporates contributions from Chorro Creek and Los Osos Creek, wind waves, and wave runup, and provides a site-specific estimate of current and future risk under three sea level rise scenarios and for determining hazard exposure for individual transportation, natural resource, and recreational assets. The specific time horizons and amount of sea level rise scenarios selected, based on the Port San Luis National Oceanic and Atmospheric Administration (NOAA) tide gauge, are presented in **Table 1** and represent existing conditions, mid-century high sea level rise, and end-of-century high sea level rise. **Table 2** presents the selected modeled scenarios.

TABLE 1.
SEA LEVEL RISE (SLR) SCENARIOS CONSIDERED

Time Horizon	SLR (ft)	Scenario
2024	0.0	Existing Conditions
2060	1.8	High sea level rise
2100	6.3	High sea level rise

SOURCE: OPC SLR Guidance 2024

TABLE 2.
MODELING SCENARIOS

Scenario	Event	SLR
Storm	January 27, 1983	0.0, 1.8, 6.3 ft
Non-Storm	August 1, 2023	0.0, 1.8, 6.3 ft
Verification Event 1	January 9, 2023	0.0, 1.8, 6.3 ft
Verification Event 2	February 4, 2024	0.0, 1.8, 6.3 ft

The modeled storm scenario uses ocean water levels from January 1983, which were some of the highest on record, and an estimate of the 100-year return period discharge for Chorro Creek. Storm water levels referenced in this Plan approximate the 100-year return period flood based on the storm scenario model results. The designed high-tide line for the project area corresponds to the landward extent of the storm scenario with zero sea-level rise. Additional details regarding the hydrodynamic model setup, as well as data source, detailed results and maps for the CFHVA are presented in Attachment C. The following sections present the summary of results from CFHVA.

4.2 Hydrodynamics and Wave Runup Results

Storm events already cause road closures along the project site. Results from the hydrodynamic modeling for the Non-Storm and Storm scenarios with sea level rise show that as sea level rises, water levels increase accordingly, with Storm scenarios consistently producing higher water levels than Non-Storm conditions. In all scenarios, water levels across the main segment of Morro Bay remain fairly uniform, especially during non-storm periods when Chorro and Los Osos Creeks typically have water levels at or below those of the bay. Under the Storm scenario, however, the eastern edges of the creek inlets experience the most extreme water levels.

Table 3 summarizes the water levels modeled at two selected locations, Windy Cove (Point A) and South Bay Boulevard (Point B), under both Storm and Non-Storm scenarios for three sea level rise conditions. **Figure 3** illustrates the modeling results for these scenarios and shows the locations of Points A and B.

TABLE 3.
MORRO BAY FLOOD MODELING RESULTS

Water Surface Elevation (ft NAVD)	Non-Storm Scenario (King Tide)		Storm Scenario (Surge + Creek Flows)	
SLR (ft)	**Point A – Windy Cove**	**Point B – S. Bay Blvd.**	**Point A – Windy Cove**	**Point B – S. Bay Blvd.**
0.0	7.2	7.2	8.1	8.2
1.8	9.0	9.0	10.3	10.8
6.3	13.4	13.4	16.1	16.3

SOURCE: ESA 2024

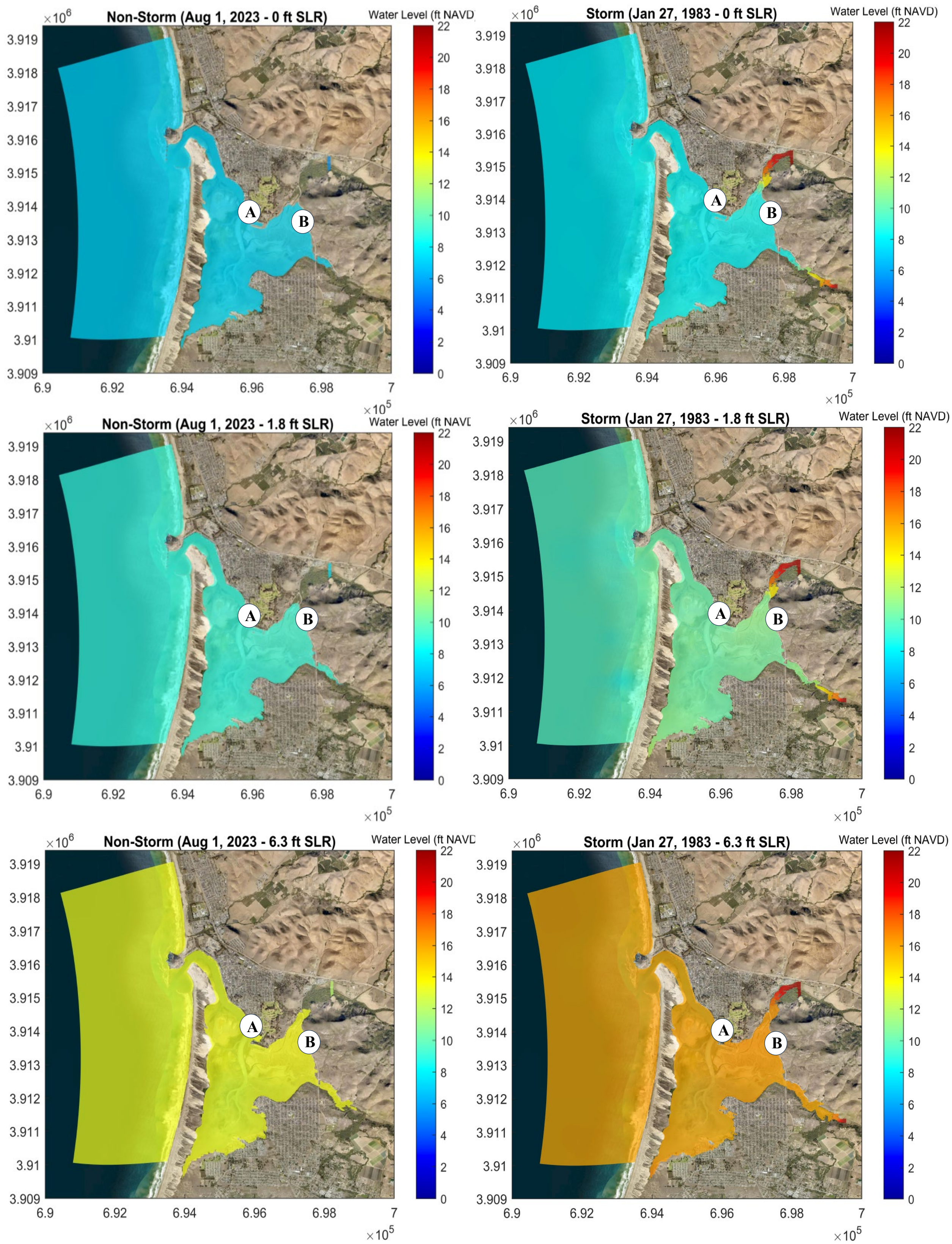


Figure 3. Water levels inside Morro Bay under selected modeling scenarios

Wave runup further increases the total water levels (TWL) within the Bay and poses an additional threat to South Bay Boulevard. Results from the wave runup analysis at the Windy Cove/Main St area and on South Bay Boulevard indicate additional vulnerability to the area. ESA calculated TWL by combining the still water level (SWL) with wave runup for each sea level rise scenario. Both SWL and wave runup increase with sea level rise, driven by larger wave heights and longer wave periods. As a result, TWL also increases at both locations:

- At Windy Cove/Main Street, TWL is:
  - 8.6 ft under current conditions
  - 11.7 ft with 1.8 ft sea level rise
  - 17.0 ft with 6.3 ft sea level rise
- At South Bay Boulevard, TWL is:
  - 9.4 ft for existing conditions,
  - 12.9 ft with 1.8 ft sea level rise
  - 18.6 ft with 6.3 ft sea level rise

Table 4 presents the calculated wave runup and TWL at Windy Cove/Main Street and South Bay Boulevard. **Figure 4** illustrates a representative scenario showing results for a 40-mph wind from 270 degrees under existing conditions, 1.8 ft sea level rise, and 6.3 ft sea level rise, focused on the eastern side of Morro Bay. These findings highlight the increasing risk of overtopping and more frequent road closures as sea levels rise, emphasizing the importance of adaptive planning and resilient infrastructure.

TABLE 4.
WAVE RUNUP AND TOTAL WATER LEVEL ANALYSIS

	Significant Wave Height (ft)	Wave Period (s)	Wave Runup (ft)	SWL (ft NAVD88)	TWL (ft NAVD88)
Windy Cove / Main St					
Existing Conditions	1.0	1.80	0.58	8	8.6
1.8' sea level rise	1.5	1.90	0.75	11	11.7
6.3' sea level rise	2.0	2.30	1.04	16	17.0
South Bay Blvd					
Existing Conditions	1.0	1.80	1.44	8	9.4
1.8' sea level rise	1.5	1.90	1.86	11	12.9
6.3' sea level rise	2.0	2.30	2.61	16	18.6

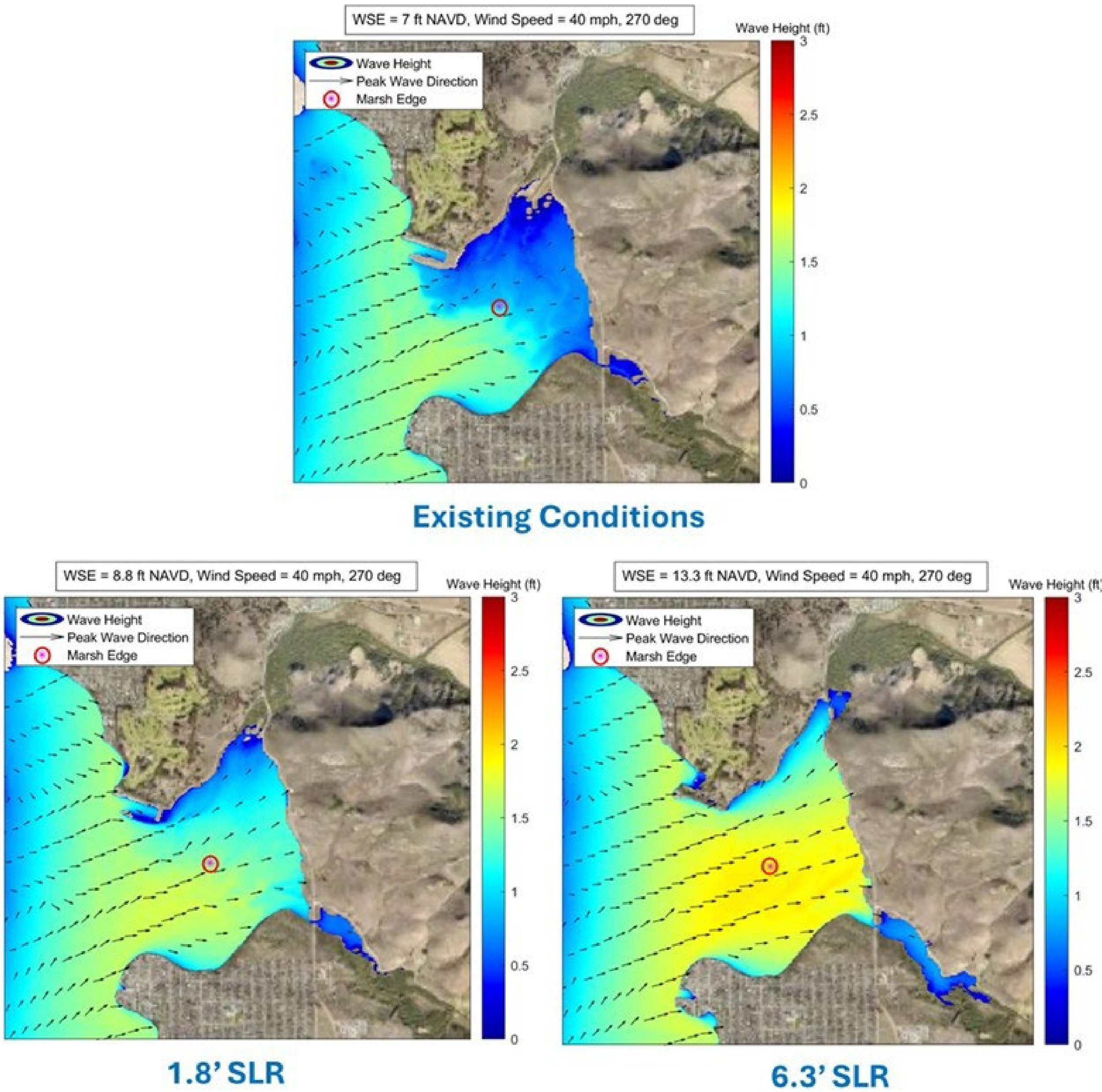


Figure 4. Simulated Wave Height and Direction for a 40-mph Wind from 270 Degrees zoomed in on the eastern side of Morro Bay

4.3 Tidal Flooding Analysis Results

ESA also evaluated how tidal water levels compare to roadway elevations to assess current and projected changes in flooding frequency and road closures, and to identify specific roadway segments vulnerable to regular tidal flooding within the project site. The tidal flooding analysis used long-term tide records from 1948 to 2025 from the Port San Luis Tide Gage (Station #9412110, NOAA 2025), and incremental sea level rise values from 0 ft (existing condition) to 5 ft. Unlike previous sections, this assessment excluded the effects of storm surge, wind waves, and wave action, which would exacerbate flooding.

The tidal flooding analysis assessed the vulnerability of State Park Road, especially at Windy Cove and the stretch from Morro Bay State Park Marina to South Bay Boulevard, and South Bay Boulevard between Chorro Creek Bridge and Los Osos Creek Bridge. These segments are currently at risk due to their proximity to tidally influenced areas.

The analysis selected sea level rise projections based on the updated OPC Sea Level Rise State Guidance (OPC 2024) for the Port San Luis tide gage for the High sea level rise scenarios:

- **1 ft of sea level rise**: Projected to occur by approximately 2048 (between 2040-2050)
- **2 ft of sea level rise**: Projected to occur by approximately 2063 (between 2060-2070)
- **3 ft of sea level rise**: Projected to occur by approximately 2074 (between 2070-2080)
- **4 ft of sea level rise**: Projected to occur by approximately 2082 (between 2080-2090)
- **5 ft of sea level rise**: Projected to occur by approximately 2090 (between 2080-2090)

ESA established a tidal flooding threshold of 0.5 ft above roadway elevation, as this water depth is assumed to impede safe vehicle passage and warrant closure for public safety. **Figure 5** shows sea level scenarios from 2020 to 2150, in feet, with a baseline of 2000 (OPC 2024). **Figure 6** shows the tidal record at Port San Luis for both existing and future conditions, with dashed lines marking the 0.5-foot closure thresholds for State Park Road at Windy Cove (yellow), State Park Road between Morro Bay State Park Marina and South Bay Boulevard (orange), and South Bay Boulevard between Chorro Creek Bridge and Los Osos Creek Bridge (red).

Figure 7 presents histograms showing the duration of inundation events (in hours) for these road segments when tidal water levels exceed flood thresholds, as well as the average number of road closure events per year for existing and future conditions. **Table 5** describes the vulnerability of the segments to tidal flooding exposure under existing and future conditions.

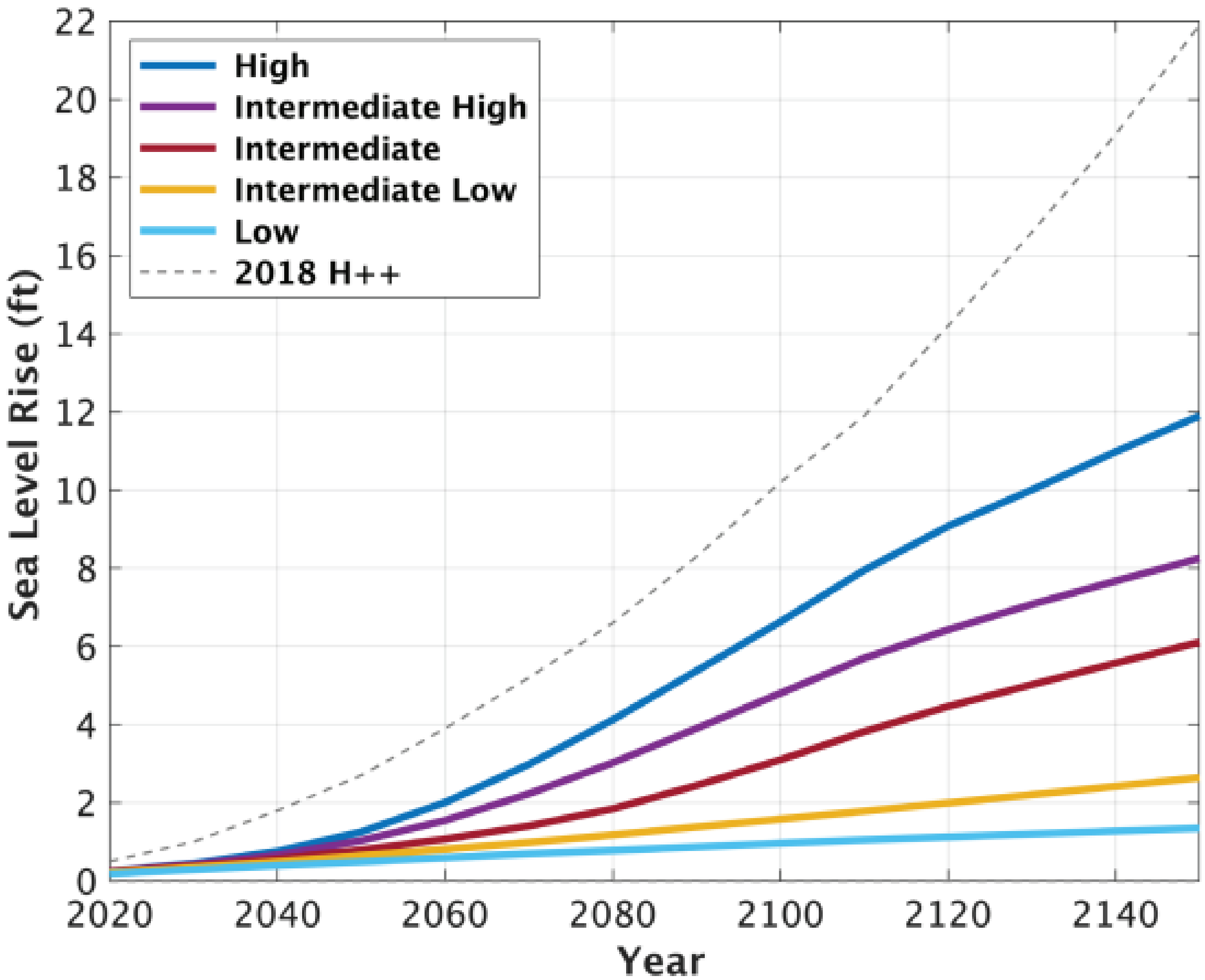


Figure 5. Sea Level Scenarios from 2020 to 2150. (Source: OPC 2024)

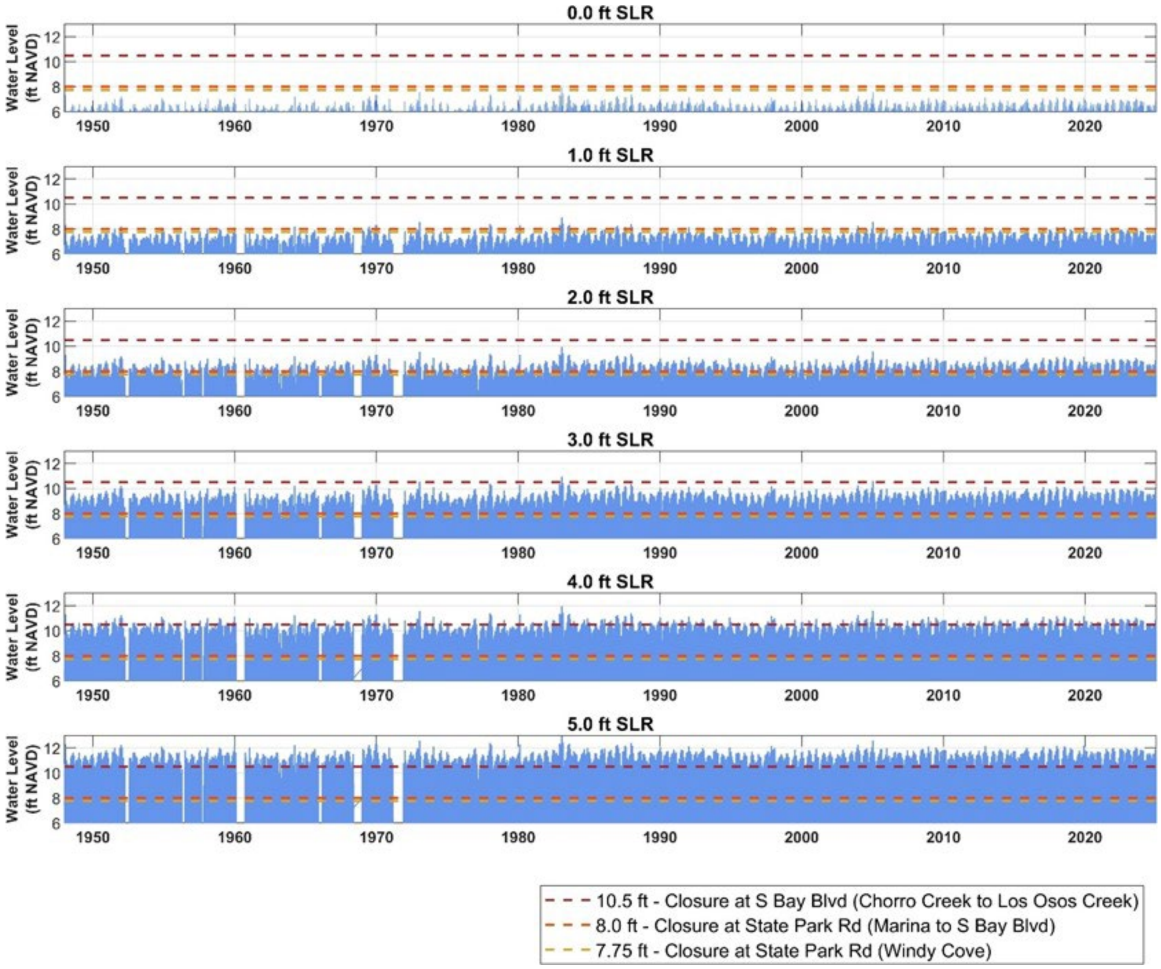


Figure 6. Tidal Water Level at Port San Luis with Sea Level Rise and the Thresholds for Flooding Causing Road Closure

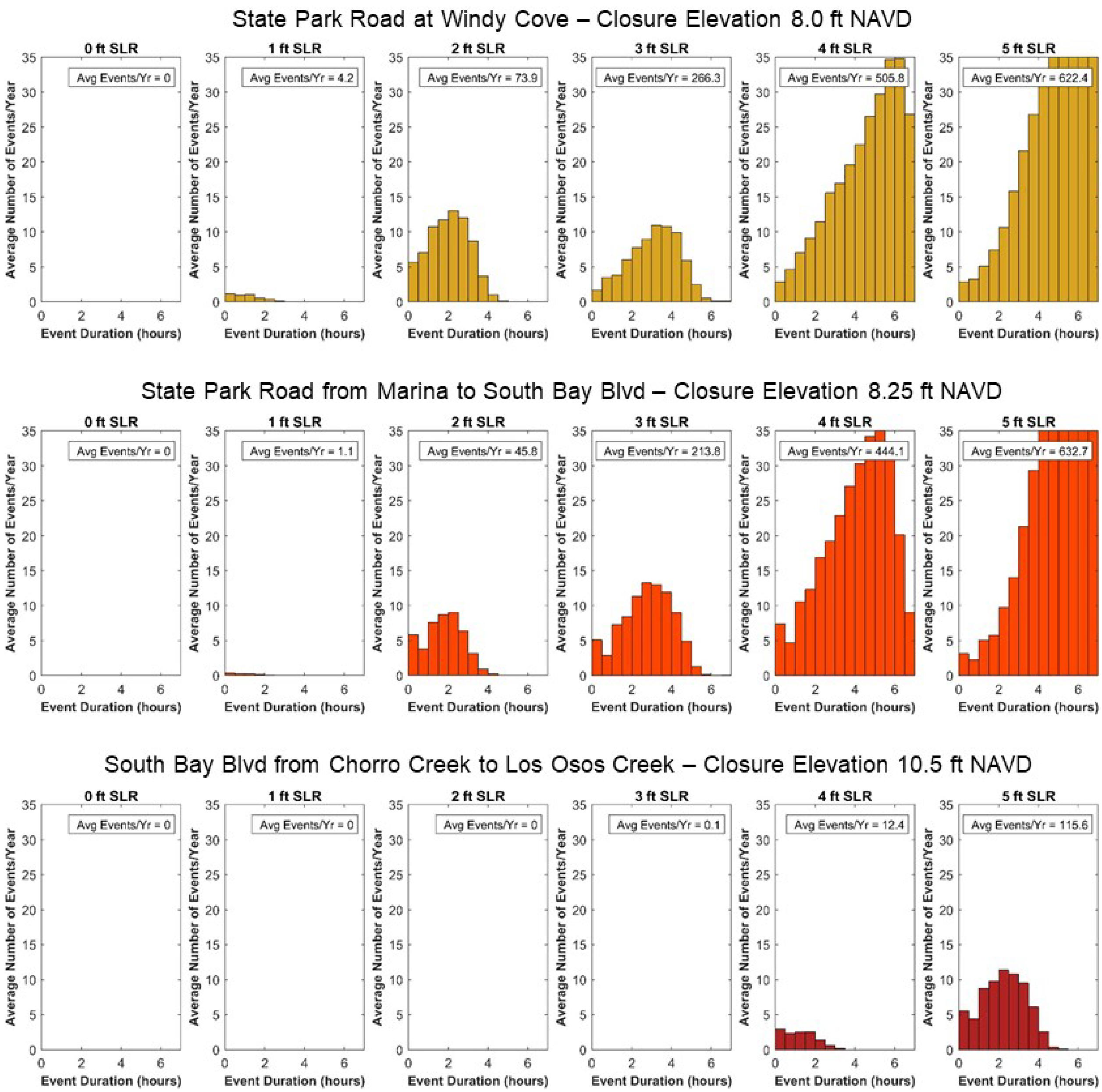


Figure 7. Histograms of Tidal Flooding Causing Road Closure Event Durations for Existing and Future Conditions

TABLE 5.
EXPOSURES TO TIDAL FLOODING

Segment	Vulnerability Exposure
State Park Road at Windy Cove	• The first segment exposed to tidal flooding with sea level rise • Under current conditions, closures are not expected. • With 1 ft sea level rise, closures would occur about 4 times per year. • With 2 ft sea level rise, closures would occur 74 times per year. • With 3 ft sea level rise, closures would occur 266 times per year. • With 4 ft sea level rise and beyond, daily closures are expected.
State Park Road from Marina to South Bay Blvd	• Remains unaffected until 1 ft sea level rise, when closures begin, averaging once per year. • With 2 ft sea level rise, closures would occur 46 times per year. • With 3 ft sea level rise, closures would occur 214 times per year. • With 4 ft sea level rise and beyond, daily closures are anticipated.
State Park Road from Marina to South Bay Blvd	• Not affected by tidal flooding until 3 ft sea level rise, when closures occur about once every ten years. • With 4 ft sea level rise, closures rise to 12 times per year • With 5 ft sea level rise, closures would occur 116 times per year.

4.4 Vulnerability Assessment

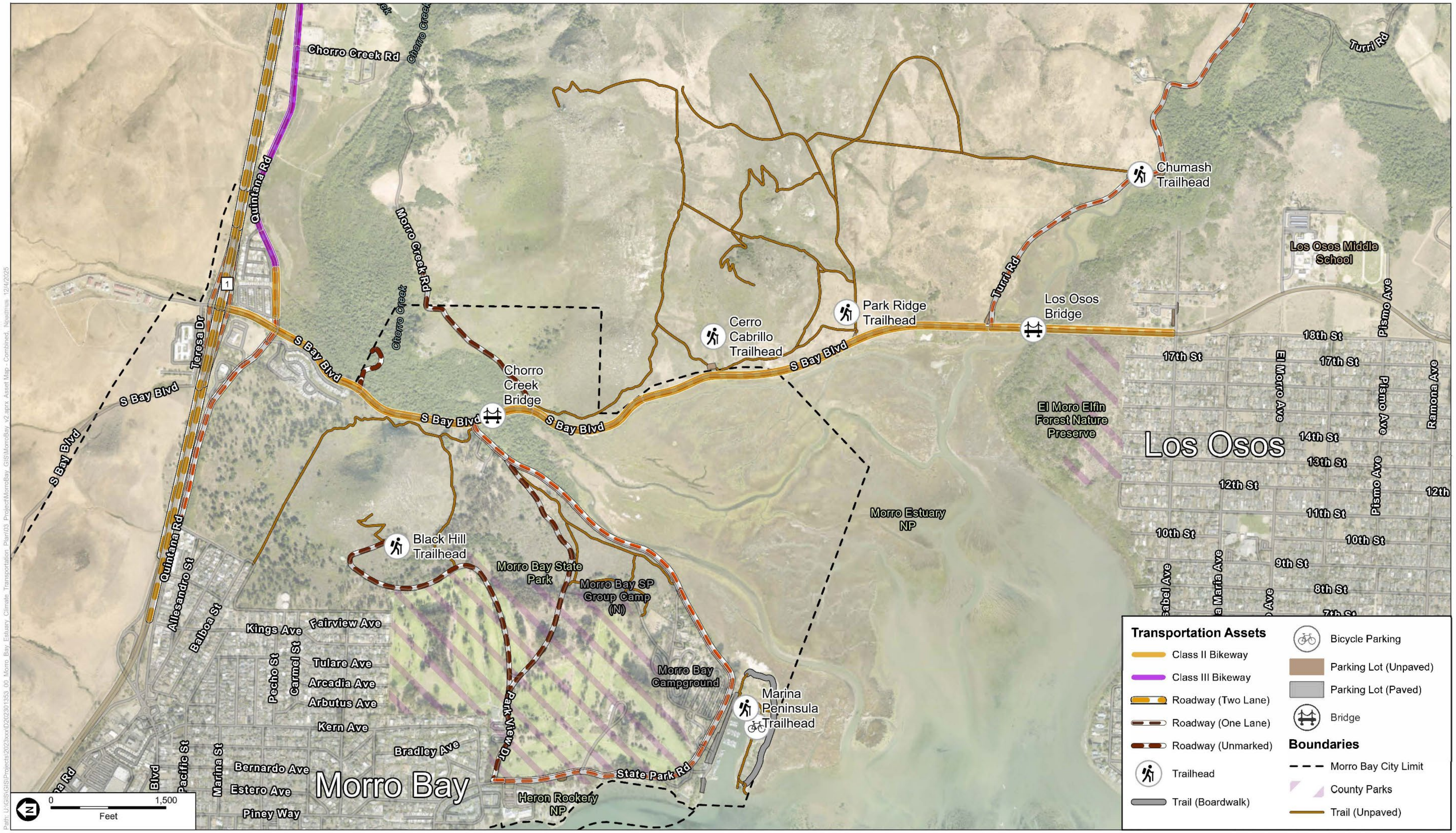
This section summarizes the Coastal vulnerability assessment developed for the Plan and presented in detail in **Attachment D**. ESA assessed transportation, recreational, and natural assets throughout the Morro Bay Estuary that are potentially at risk from sea level rise, including their elevation, exposure to wave hazards, sensitivity to flooding and tidal inundation, criticality, and relative adaptive capacity. The scope of this assessment does not include utilities or other assets. **Figure 8** presents an overview map of the Morro Bay Estuary assets considered in this Vulnerability Assessment (VA), which was divided into four primary study areas for the detailed VA presented in Attachment C.

The VA prepared for this project evaluates asset risk as a combination of three factors: the likelihood of flooding (hazard exposure), the consequence of flooding (asset sensitivity), and the asset's ability to be modified (adaptive capacity). The detailed definition of these factors is presented in Attachment C. The VA analyzes impacts under a hypothetical "no action" scenario, where no adaptation measures are taken to address sea level rise. This approach enables SLOCOG and other decision-makers to understand the full extent of potential impacts, identify the most at-risk assets, and prioritize adaptation strategies. The VA used the hydrodynamic modeling results developed by ESA for the CFHVA.

To determine when assets become vulnerable, ESA applied a threshold approach introduced in the Summary of Additional Guidance Memo (ESA 2024). This method identifies specific sea-level rise thresholds at which assets transition to vulnerability, using results from the VA. Each asset received an approximate timeframe for exposure to temporary (storm) and permanent (tidal inundation) hazards, based on the OPC 2024 High Sea Level Rise scenario. These timeframes represent existing conditions, mid-century High Sea Level Rise (1.8 ft), and end-of-century High Sea Level Rise (6.3 ft), which are the same sea level rise projection utilized for preparing the hydrodynamic modeling for the Morro Bay Estuary.

The VA results indicate that several transportation, recreational, and natural assets are currently exposed to coastal hazards. **Table 6** presents the timeframes when transportation, recreational, and natural assets are expected to be temporally and permanently impacted, with bolded entries highlighting impacts anticipated to occur sooner. ESA considered these timeframes in developing the alternatives and adaptation pathways framework for the Plan.

Based on these results, the assets currently exposed to coastal hazards are State Park Road, Quintana Road, Chorro Creek Bridge, Windy Cove Beach and parking lot, Morro Bay State Park Marina bicycle parking, Morro Bay Golf Course, and Morro Estuary State Marine Reserve. The assets likely to become exposed to coastal hazards in the near future (before 2060) are South Bay Blvd (between Chorro Creek Bridge and Los Osos Creek Bridge), and Turri Road. The following subsections provide a summary discussion of the vulnerabilities for each asset within the three categories considered in the VA.



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure 8. Transportation Assets in the Study Area

TABLE 6.
ASSET VULNERABILITY TIME FRAMES

Asset	Approximate time frame of when the asset is temporarily impacted (storm)	Approximate time frame of when the asset is permanently impacted (non-storm)
	Bay/creek water level with wind setup (ESA Hydrodynamic Model)[1]	**Bay water level with wind setup (ESA Hydrodynamic Model)[1]**
Transportation – Roads and Bicycle/Pedestrian Assets		
State Park Road		
Windy Cove	**Now**	**Now to 2060**
Main St	**Now**	**Now to 2060**
South Bay Blvd		
Chorro Creek Bridge to Bay Pines	**2060 to 2100**	**2100+**
Chorro Creek Bridge to Los Osos Creek Bridge	**Now to 2060**	**Now to 2060**
Quintana Rd	**Now**	**Now to 2060**
Turri Rd	Now to 2060	2060 to 2100
Chorro Creek Bridge	**Now**	2100+
Los Osos Bridge	**2100+**	**2100+**
Recreational Assets		
Windy Cove – Beach	**Now**	Now to 2060
Morro Bay State Park Marina Parking Lot	**Now**	**Now to 2060**
Windy Cove Parking Lot	**Now**	**Now to 2060**
Cerro Cabrillo Trailhead Parking Lot	**2060 to 2100**	**2060 to 2100**
Park Ridge Trailhead Parking Lot	**2100+**	**2100+**
Chumash Trailhead Parking Lot	**2060 to 2100**	**2060 to 2100**
Morro Bay State Park Marina Bicycle Parking	**Now**	**Now to 2060**
Morro Bay Golf Course	**Now**	**Now to 2060**
Natural Assets		
Morro Bay State Marine Reserve	**Now**	Now to 2060
El Moro Elfin Forest Natural Preserve	**2100+**	**2100+**

NOTES:

1. 1.8 ft of sea level rise is projected in 2060, and 6.3 ft of sea level rise is projected in 2100 under a high sea level rise scenario for Port San Luis (OPC 2024)

4.4.1 Vulnerability of Transportation Assets

Transportation assets in Morro Bay, from Windy Cove to Los Osos Bridge, exhibit low adaptive capacity, high sensitivity, and high hazard exposure, making roads and bridges highly vulnerable to coastal hazards. Sea level rise significantly augments this vulnerability over time, increasing the risk of flooding during both storm and non-storm conditions. **Table 7** below details roadway lengths exposed under non-storm and storm conditions for near-term (0 ft sea level rise), mid-term (1.8 ft sea level rise), and long-term (6.3 ft sea level rise) scenarios.

TABLE 7.
LENGTH OF ROAD VULNERABILITY BY SCENARIO, IN MILES

Location	Non-Storm Now	Storm Now	Non-Storm 1.8 ft SLR (2060)	Storm 1.8 ft SLR (2060)	Non-Storm 6.3 ft SLR (2100)	Storm 6.3 ft SLR (2100)
State Park Road – Windy Cove	<0.1	0.1	0.2	0.2	0.2	0.2
State Park Road – Marina to S Bay Blvd	0.4	1.0	0.8	1.1	1.1	1.4
South Bay Blvd – Chorro Creek Bridge to HW1	0.0	0.6	0.0	0.6	<0.1	0.6
Quintana Road	0.0	0.3	0.0	0.3	0.0	0.3
South Bay Blvd – Chorro Creek Bridge to Los Osos	0.5	1.0	0.8	1.1	1.2	1.2
Turri Road	<0.1	0.7	0.2	0.9	0.8	1.3

The section below highlights key findings from the VA, summarizing critical findings for transportation assets and describing how flood risk changes under sea level rise and storm conditions. **Figures 9 and 10** illustrate the flood extents for these assets, and detailed maps and data are provided in Attachment C. **Figures 11 and 12** are screenshots from the virtual reality simulation developed for this project visualizing 6.3 feet of sea level rise at Windy Cove and South Bay Boulevard, respectively.

State Park Road – Windy Cove and Marina segment

State Park Road at Windy Cove already experiences high vulnerability, with large storm events flooding about 0.1 mile of roadway, closing it for about 3 days per year. With about 2 ft of sea level rise, high tides could flood about 0.2 miles, with closures occurring roughly 74 times per year. With 5 ft of sea level rise, daily flooding could render this segment effectively impassable.

State Park Road from Marina to South Bay Boulevard

This segment, confined between the bay and Morro Bay State Park, currently sees about 0.4 miles flooded during king tides, and storm events can extend flooding to 1.0 miles. With 2 ft of sea level rise, about 0.8 miles could flood for roughly 46 days per year, and with 5 ft of sea level rise, storm flooding could extend to 1.4 miles, and tidal inundation could occur almost daily. Storm modeling predicts flood extents could grow from 1 mile now to 1.4 miles in the long-term. Road closures could rise from about 1 day a year in the near-term to nearly daily in the mid- and late-century, with storms worsening tidal flooding.

South Bay Boulevard from Chorro Creek Bridge to Bay Pines Travel Trailer Park

South Bay Boulevard north of Chorro Creek Bridge and Quintana Road remains above tidal elevations under all scenarios but floods during storm events. During extreme events with high tides and high creek flows, backwater at Chorro Creek Bridge could flood the bridge, Quintana Road, and Bay Pines Travel Trailer Park. Historically, Chorro Creek bridge and Quintana Road have been flooded for approximately 2 days during extreme storm events. With sea level rise, creek flood levels and backwater would extend farther upstream, increasing flood depths and durations, and by 2100, with 6.3 ft of sea level rise, Chorro Creek bridge may be flooded daily.

South Bay Boulevard from Los Osos to Chorro Creek Bridge (including Turri Road)

South Bay Boulevard between Los Osos and Chorro Creek Bridge, a primary evacuation route and connection between the City of Morro Bay to Los Osos, faces increasing exposure to storm and tidal flooding. Tidal inundation is not expected in the near term, but with 1.8 ft of sea level rise, king tides may reach the roadway from just south of Chorro Creek Bridge to just south of the Cerro Cabrillo Trailhead; with about 4 ft of sea level rise, flooding could occur about 12 times per year, rising to approximate 116 flooding events per year with 5 ft of sea level rise. Storm flooding already closes the segment between Chorro Creek Bridge and the Cerro Cabrillo Trailhead for about 1 day per year, with frequency and duration increasing by mid- and late century. Flooding does not extend further south, and Los Osos Bridge remains above tidal flood elevations.

Turri Road shows no tidal inundation in the near or mid-term but becomes tidally exposed by 2100. Storm scenarios already produce flooding near the Chumash Trailhead and farther east. By approximately 2060, flood extents expand east of the trailhead, and by 2100, most of the Turri Road segment along Los Osos Creek could become vulnerable to storm-related flooding.

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure 9. Transportation Asset Vulnerability under a Non-Storm Scenario

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure 10. Transportation Asset Vulnerability under a Storm Scenario

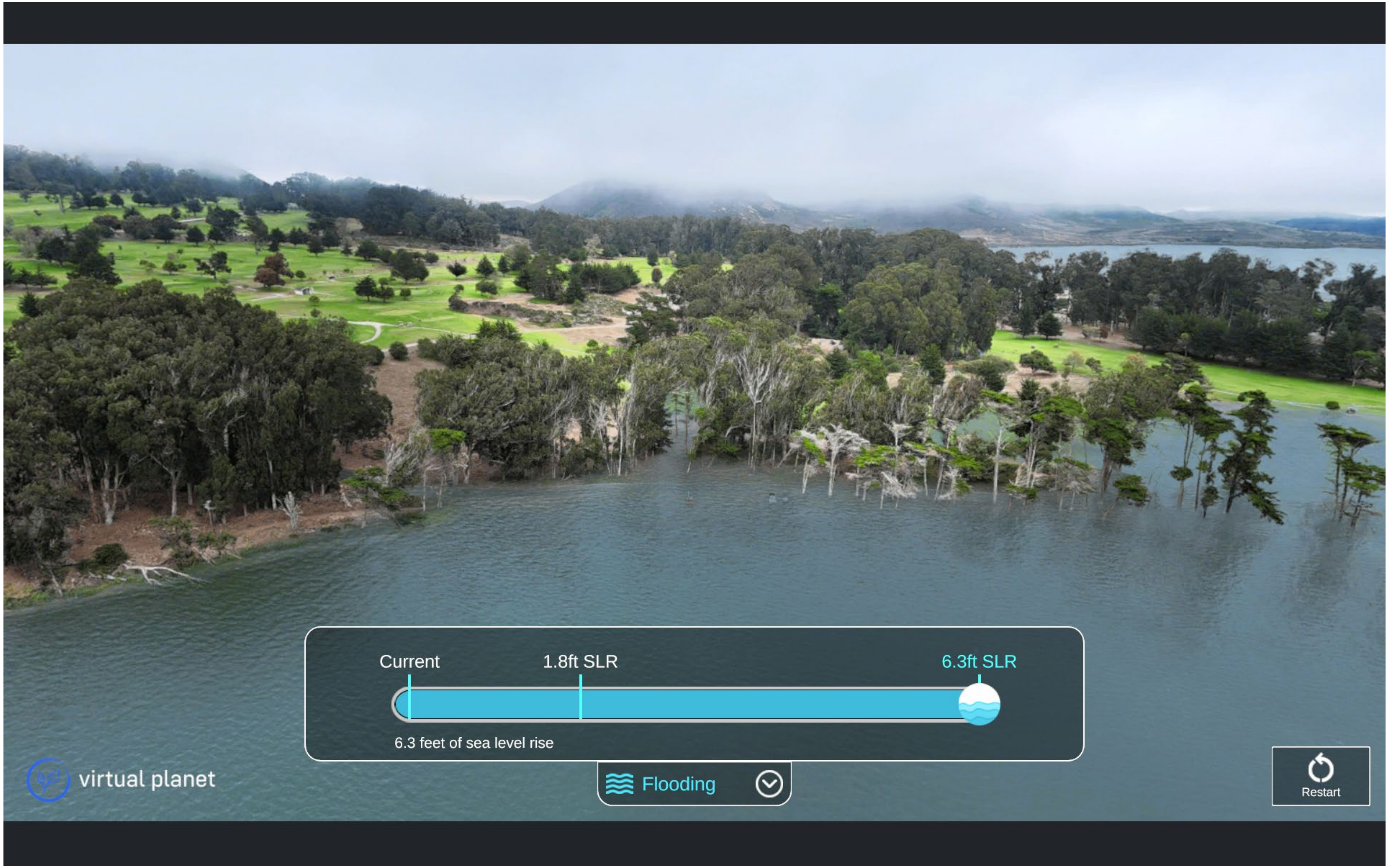


Figure 11. Virtual Reality Simulation Screenshot showing 6.3 ft of SLR at Windy Cove

Figure 12. Virtual Reality Simulation Screenshot showing 6.3 ft of SLR at South Bay Blvd

4.4.2 Vulnerability of Recreational Assets

Recreational assets within the Morro Bay Estuary exhibit varying levels of vulnerability to storm flooding and sea level rise, with exposure and sensitivity increasing significantly by mid- and late-century. Assets with low adaptive capacity and high sensitivity, such as Windy Cove and the Morro Bay State Park Marina, are most at risk, while upland trailhead parking lots remain largely resilient under all modeled scenarios.

The section below highlights key findings from the VA, summarizing critical findings for recreational assets and describing how flood risk changes under sea level rise and storm conditions. Detailed maps and data are provided in Attachment C.

State Park Road near Windy Cove

Windy Cove Beach is already inaccessible during high tides approximately 10 to 20 days per year and is projected to become inaccessible daily with 1.8 ft of sea level rise. The adjacent Windy Cove parking lot floods during large storm events and could experience tidal inundation by mid-century. Both features have high vulnerability due to limited adaptation options and high exposure.

State Park Road from Marina to South Bay Boulevard

The paved Morro Bay State Park Marina parking lot and bicycle parking are currently exposed to storm flooding and will likely experience tidal inundation with 1.8 ft of sea level rise. Although closures of these facilities do not disrupt regional mobility, they affect access to important recreational and visitor-serving amenities and carry repair and maintenance implications.

The western part of Morro Bay Golf Course already floods during storms and experiences increasing storm and tidal exposure with sea level rise. Flooded acreage increases from 1.8 acres under current conditions to 8 acres with 1.8 ft of sea level rise and 27 acres with 6.3 ft of sea level rise. While the course can potentially adapt through routing or design changes, these impacts influence recreational value and may create opportunities for dual-purpose habitat or flood storage concepts.

South Bay Boulevard from Chorro Creek Bridge to Bay Pines Travel Trailer Park

No recreational assets were assessed in this segment.

South Bay Boulevard from Los Osos to Chorro Creek Bridge

Trailhead parking lots at Cerro Cabrillo, Park Ridge, and Chumash present low to very low hazard exposure. Cerro Cabrillo and Chumash lots may flood under storm conditions with 6.3 ft sea level rise, while Park Ridge remains likely unaffected. All lots are unpaved, offering high adaptive capacity and low sensitivity, resulting in low overall vulnerability.

4.4.3 Vulnerability of Natural Assets

Natural assets in the Morro Bay Estuary, including wetlands, intertidal, and subtidal habitats, face unique challenges under sea level rise and increased storm flooding. While periodic inundation is part of their natural functioning, prolonged changes in inundation frequency and water elevation significantly increase vulnerability over time. The section below presents key findings from the VA, summarizing key findings for natural assets within the Project site.

Morro Bay State Marine Reserve

The Morro Bay State Marine Reserve already experiences regular tidal inundation, consistent with estuarine habitat function. Under higher sea levels, however, inundation becomes deeper and more frequent, and the combination of sea level rise and limited landward migration space (due to development and steeper topography) leads to "coastal squeeze." These conditions could create high vulnerability for estuarine habitats, with likely changes in habitat type, distribution, and species composition over time.

El Moro Elfin Forest Natural Preserve

El Moro Elfin Forest Natural Preserve lies at a higher elevation and remains above modeled tidal and coastal flooding, even under late-century scenarios. Although it has low adaptive capacity, its elevation prevents tidal inundation and coastal flooding, resulting in an overall low vulnerability to sea level rise.

5. POTENTIAL ADAPTATION SOLUTIONS AND STRATEGIES

This section summarizes the Alternatives and Adaptation Pathways Framework developed for the Plan and presented in detail in Attachment D. The framework builds directly on the CFHVA (Section 4 of this report), and the thresholds-based vulnerability approach described therein, and focuses on a 2.5-mile stretch of South Bay Boulevard between State Route 1 and Los Osos Creek, including spurs along State Park Road (Main Street), Quintana Road, and Turri Road.

The adaptation pathways framework builds on the adaptation planning framework developed by the California Coastal Commission and Ocean Protection Council. It was tailored specifically to the needs and conditions of the Morro Bay Estuary, incorporating feedback from the local community and SLOCOG. The framework identifies a suite of structural, nature-based, and non-structural measures that can be phased over time to manage increasing coastal flood risk and sea level rise while maintaining mobility, access to recreational amenities, and the function of natural habitats.

The framework organizes measures into three-time horizons aligned with the projected progression of sea level rise and hazard exposure: near-term (2030–2045), mid-term (2045–2075), and long-term (2075 and beyond). Within each horizon, measures are tailored to the specific transportation, recreational, and natural assets identified as vulnerable in the CFHVA. In addition, the framework is tied to measurable thresholds and triggers (adaptation pathways) to support timely, proactive implementation.

5.1 Adaptation Alternatives and Pathways

5.1.1 Adaptation Approaches

Consistent with State coastal guidance, the framework organizes adaptation into three primary strategy types:

- Protect: use engineered or nature-based features like berms, revetments, levees, or green methods (e.g., living shorelines, wetlands) to defend resources or development in place.
- Accommodate: modify assets or design new developments so they can continue to function under higher water levels and more frequent flooding (e.g., raising roads on engineered fill or causeways, lengthening bridge spans, improving drainage and stormwater systems).
- Retreat: relocate or realign infrastructure or facilities away from high-hazard zones (e.g., realigning roadway segments inland, relocating trailhead parking lots).

The preferred strategy for each asset are not mutually exclusive and may evolve over time as conditions change, allowing for phased and flexible adaptation.

5.1.2 Evaluation Criteria

Five evaluation criteria were developed to qualitatively assess the adaptation measures for the Plan, capturing the range of interests for Morro Bay Estuary and the tradeoffs associated to different adaptation approaches. The five evaluation criteria include the following:

- Engineering Considerations
  - Feasibility: the likelihood of implementing a measure based on the physical setting, like topography and hazard exposure (e.g., wetland restoration and vegetation management are more suitable in locations like Windy Cove).
  - Effectiveness: whether a measure is likely to accomplish the vulnerability reduction for the particular asset and site (e.g., elevating roads or creating elevated berms can reduce storm flooding/wave runup on transportation assets).
  - Resilience: measures a system's ability to recover from events like storms and sea level rise, similar to 'sensitivity' in vulnerability assessments (e.g., berms may fail under loads exceeding design parameters, while natural infrastructure like ecotone levees or wetlands can recover after extreme events, making them more resilient)
- Environmental Considerations
  - Consider impacts of adaptation measures on species and habitats, and potential ecological benefits compared to the status quo (e.g., no action or traditional engineering measures). – Temporary and permanent habitat impacts as well as ecological benefits (e.g., habitat creation, water quality improvements).
  - To assess the environmental impacts and benefits, ESA has considered whether each adaptation measure would affect existing habitats and either increase or decrease the overall ecological health of the habitats within the Morro Bay ecosystem region.
- Regulatory Considerations
  - Permitting complexity and the likelihood and duration of approvals across multiple jurisdictions and agencies. Projects with significant environmental impacts face greater permitting challenges, so early coordination is critical.
  - Projects in this document require permits from multiple jurisdictions based on site location, scale, and environmental sensitivity. Agencies cannot confirm approval until applicants submit a formal proposal with design plans and supporting analyses.
  - For construction in Morro Bay Estuary, especially in wetlands, sensitive habitats, or tidal areas, extensive studies, surveys, and public input are required. Beyond the procurement of permits, the overall regulatory compliance process consists of environmental review (i.e., pursuant to the California Environmental Quality Act), followed by permitting and/or agency approvals, and concludes with compliance review and documentation.
  - Permits and/or approval would typically be required from: United States Army Corps of Engineers; U.S. Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS);

California Coastal Commission (CCC) and/or City of Morro Bay and San Luis Obispo County Local Coastal Program jurisdiction; California Department of Fish and Wildlife (CDFW); Regional Water Quality Control Board (RWQCB); and potentially, California State Lands Commission (CSLC).

- Social Considerations
  - Address the effects of adaptation measures on public access and use of the Morro Bay estuary, emphasizing recreation, safety, equity, and compatibility with community character and cultural resources.
- Economic Considerations
  - Include the cost of construction and typical maintenance of individual adaptation measures, how this cost is shared (e.g., individual or multiple property owners, agency, etc.), and comparison to the cost of no action (e.g., from repairing damages and loss of function if no action is taken to address coastal hazards).
  - Economic consideration was quantified and further discussed in Section 7 Benefit Analysis.

For planning-level comparison, engineering, regulatory, and social criteria are ranked qualitatively as *Low*, *Medium*, or *High*. Environmental considerations are ranked qualitatively based on potential impacts of the alternatives (*Low Impact*, *Medium Impact*, or *High Impact*) and the potential habitat benefits of the alternatives (*Low Benefits*, *Medium Benefits*, or *High Benefits*).

5.2 Potential Adaptation Measures for Morro Bay Estuary

The framework identifies adaptation opportunities and constraints for near-term (2030–2045), mid-term (2045–2075), and long-term (2075+ years) horizons. Measures are tailored to the vulnerability and exposure of specific assets, as determined by the VA and hydrodynamic modeling. At each time horizon, the framework outlines adaptation actions designed to maintain resilience until the next horizon, when new actions will be defined. Using a threshold approach, individual assets have specific sea level rise triggers for intervention. For example, South Bay Boulevard near Twin Bridges may require action at a different threshold than State Park Road along Morro Bay State Park.

The adaptation measures are illustrated with a series of cross sections presented in Attachment D. **Figure 13** provides an overview of the locations of the cross sections and the adaptation opportunities in plan view. Legend and descriptions are presented in **Figure 14**. The following sections present opportunities and constraints for the measures in the near, mid, and long-term.

Figure 13. Plan View of Adaptation Options, including Cross Section Locations. Legend is presented in Figure 14 (below).

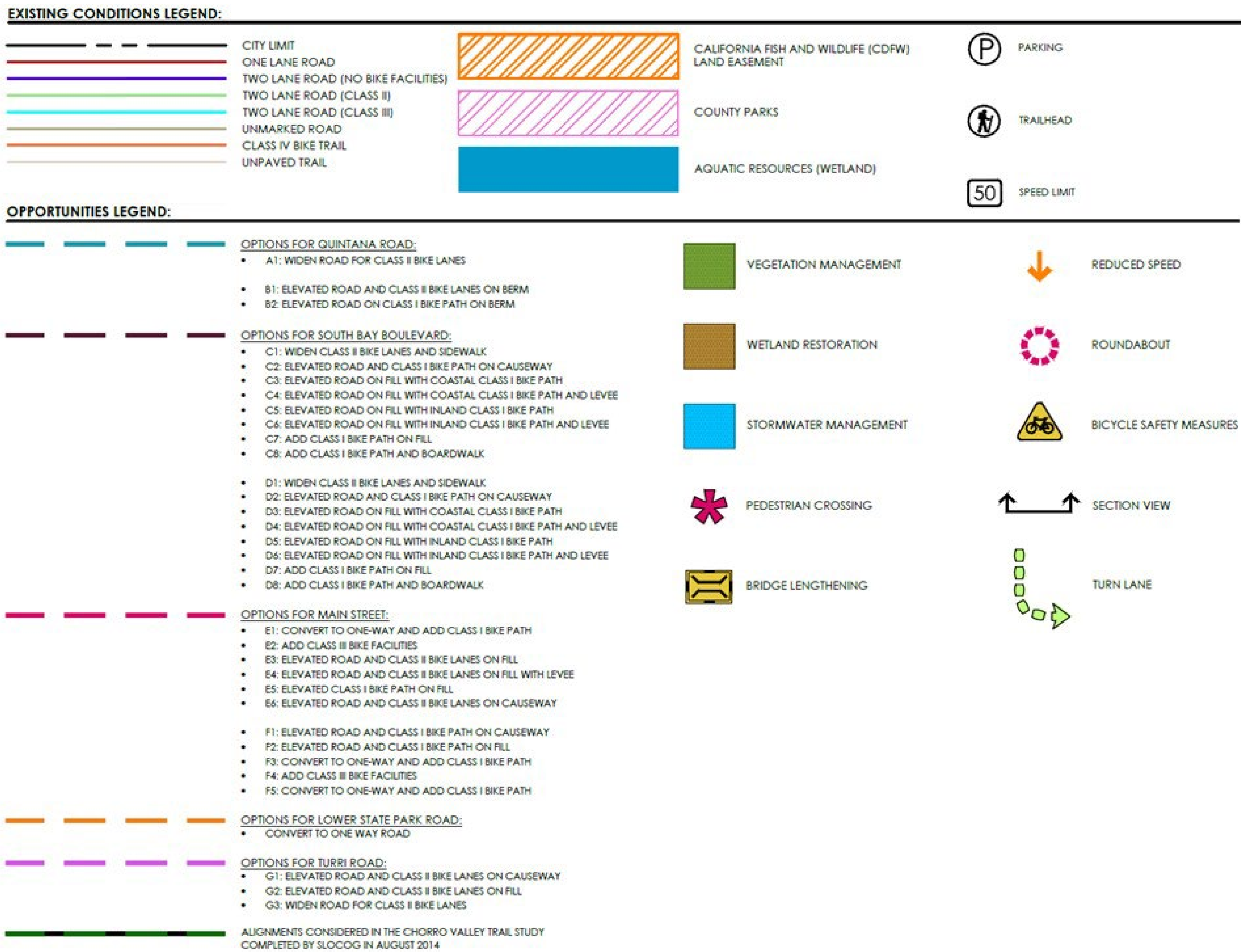


Figure 14. Legend and Description of Opportunities

5.2.1 Near-Term (2030–2045)

Near-term adaptation focuses on assets already exposed to coastal storm flooding, with an emphasis on relatively implementable measures that address existing risk while laying the groundwork for future phases. A detailed description of the near-term measures, opportunities, and constraints is presented in Attachment D. The assets currently exposed to coastal hazards, considering the storm condition under the categories of transportation, recreation, and natural assets, are presented in **Table 8**.

TABLE 7.
ASSETS EXPOSED TO COASTAL HAZARD IN THE NEAR-TERM

Assets Category	Impacted Assets

Transportation	• State Park Road
	  ○ Windy Cove
	  ○ Main St
	• South Bay Blvd
	  ○ Chorro Creek Bridge to Los Osos Creek Bridge
	  ○ Chorro Creek Bridge
	• Quintana Road

Recreational	• Windy Cove – Beach and Parking Lot • Morro Bay State Park Marina Parking Lot • Morro Bay Golf Course
Natural	• Morro Bay State Marine Reserve

Representative near-term measures include:

- Targeted protection and accommodation of roadways, such as localized levees/berms or raising the most vulnerable segments of State Park Road and South Bay Boulevard on fill or low causeways, potentially co-located with Class I or Class II bicycle and pedestrian facilities.
- Mobility and safety enhancements, including improved bike facilities (e.g., widened bike lanes, sharrows, separated trails), reduced speed limits, vegetation management to improve sight distance, and intersection enhancements.
- Recreational access management, such as raising or managing parking areas at the Morro Bay State Park Marina and implementing flood management measures to maintain access during high water.
- Nature-based measures in the State Marine Reserve and near Windy Cove, including wetland restoration, thin-layer sediment placement, and oyster reef restoration to attenuate waves, support habitat resilience, and provide natural flood buffers.

Figure 15 presents the example of an adaptation alternative at Windy Cove on cross-section F-F' (Figure 13). Adaptation alternatives for all cross sections are presented in detail in Attachment D. These near-term interventions are intended to address current flood risk, improve user safety, and create early "wins" while preserving flexibility for more transformative measures in later phases.

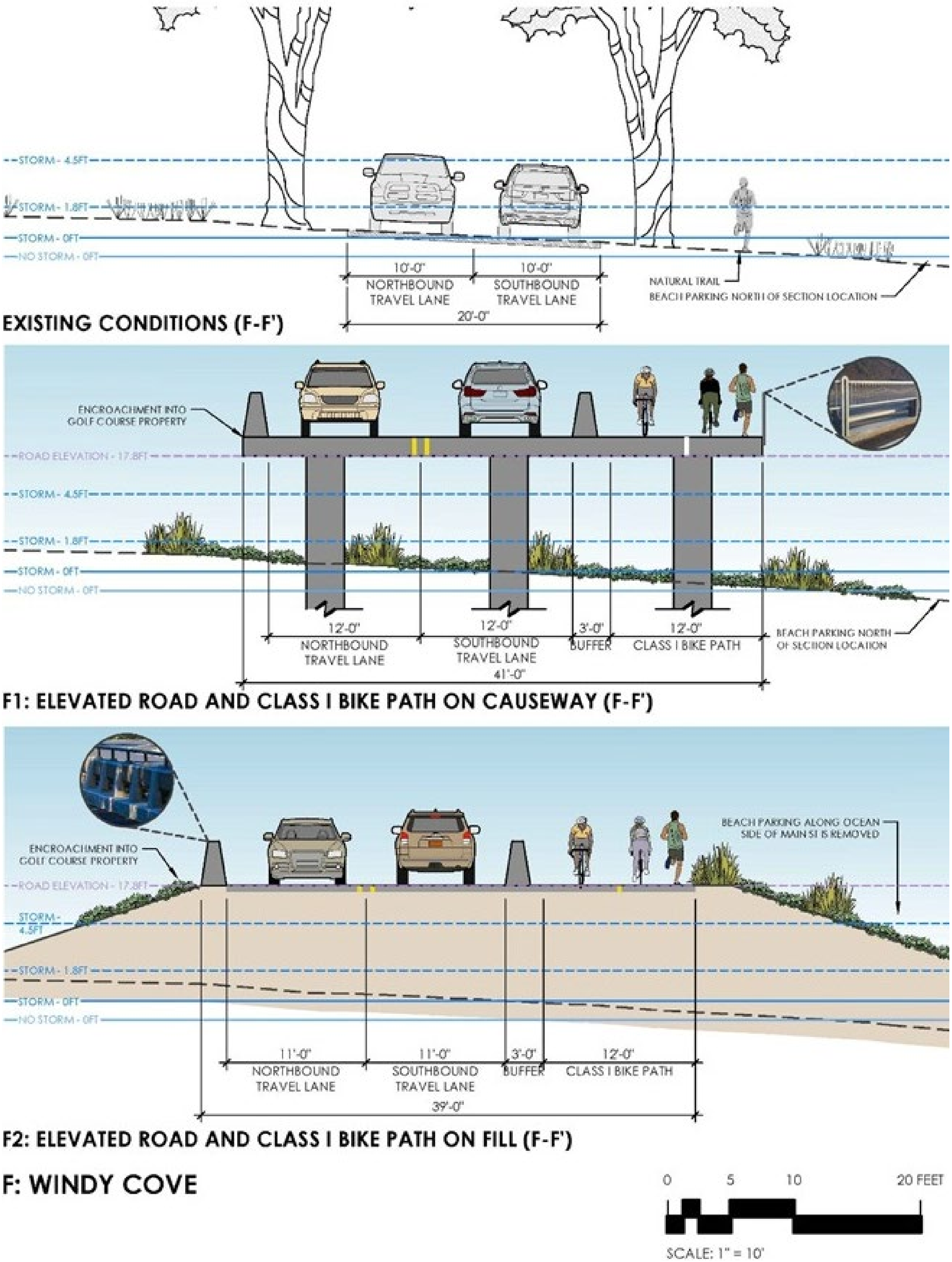


Figure 15. Cross Section F-F' for Near-term Adaptation Alternatives at Windy Cove

5.2.2 Mid-Term (2045–2075)

Mid-term adaptation builds on near-term actions and addresses assets expected to become increasingly exposed as sea level rise approaches approximately 2 to 3 ft. A detailed description of the mid-term measures, opportunities, and constraints is presented in Attachment D. The assets currently exposed to coastal hazards, considering the storm condition under the categories of transportation and recreational assets, are presented in **Table 9**.

TABLE 8.
ASSETS EXPOSED TO COASTAL HAZARD IN THE MID-TERM

Assets Category	Impacted Assets
Transportation	• South Bay Blvd ○ Chorro Creek Bridge to Bay Pines • Turri Road
Recreational	• Cerro Cabrillo Trailhead Parking Lot • Chumash Trailhead Parking Lot

Representative mid-term measures include:

- Raising additional segments of South Bay Boulevard on fill or berms, with the opportunity to integrate enhanced bicycle and pedestrian facilities into the widened roadway prism.
- Further enhancements along Turri Road, including elevating low segments, widening shoulders to add Class II bike lanes, improving crossings at South Bay Boulevard, and implementing stormwater management features to reduce flooding.
- Selective accommodation of trailhead parking, such as raising parking areas at Cerro Cabrillo and Chumash trailheads to maintain recreational access as flooding frequency increases.

Figure 16 presents the example of an adaptation alternative at Turri Road Cove on cross-section G-G' (Figure 13). Adaptation alternatives for all cross sections are presented in detail in Attachment D. In the mid-term horizon, more capital-intensive structural measures become a higher priority, and the performance of near-term measures should be re-evaluated based on observed sea level trends and flood behavior.

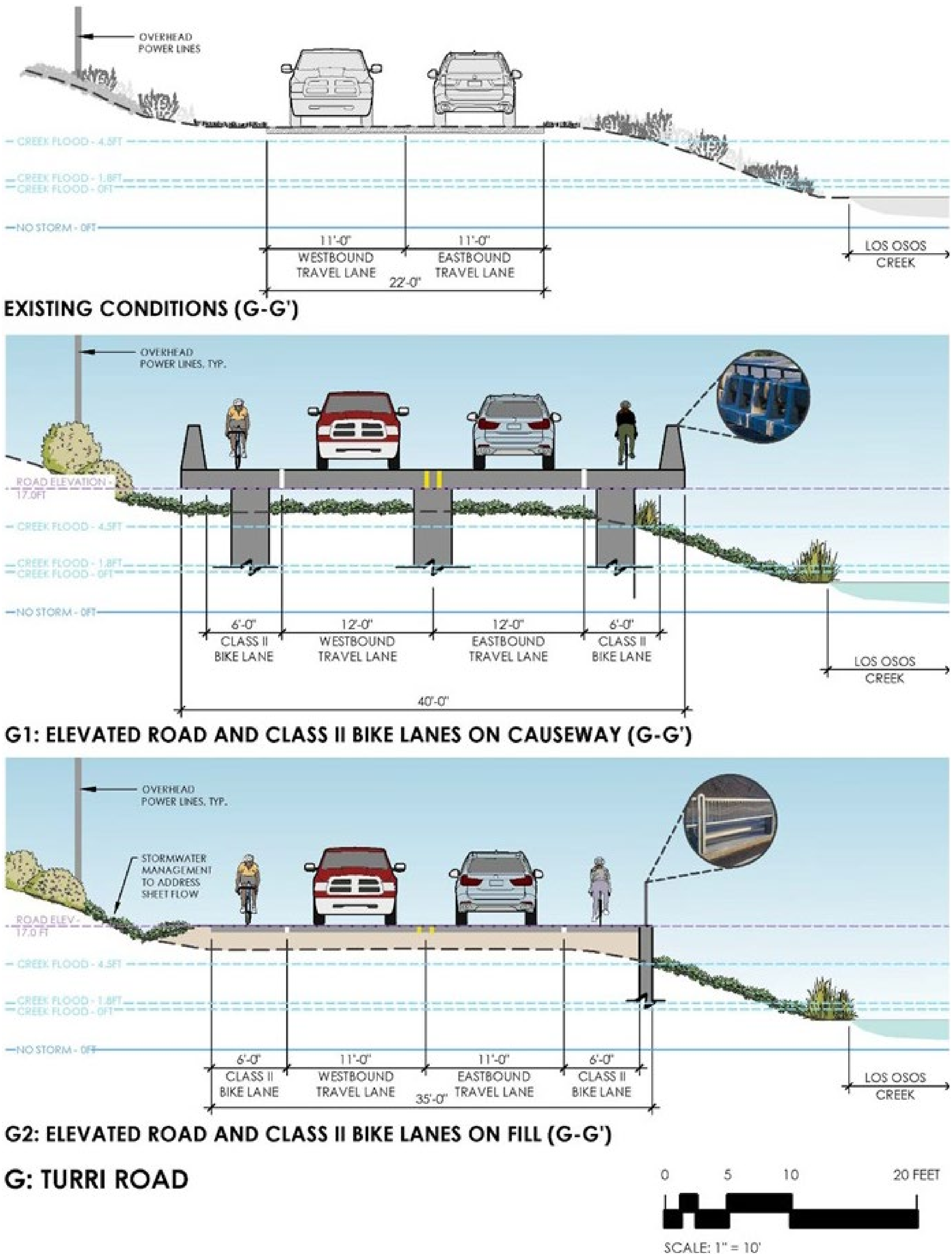


Figure 16. Cross Section G-G' for Mid-term Adaptation Alternatives at Turri Road

5.2.3 Long-Term (2075 and Beyond)

Long-term adaptation addresses assets that are projected to be exposed under higher sea level rise scenarios (up to approximately 6 ft). A detailed description of the mid-term measures, opportunities, and constraints is presented in Attachment D. The assets currently exposed to coastal hazards, considering the storm condition under the categories of transportation, recreational, and natural assets, are presented in **Table 10**.

TABLE 10.
ASSETS EXPOSED TO COASTAL HAZARD IN THE LONG-TERM

Assets Category	Impacted Assets
Transportation	• Los Osos Bridge
Recreational	• Park Ridge Trailhead Parking Lot
Natural	• El Moro Elfin Forest Natural Preserve

Representative long-term measures include:

- Substantial elevation of South Bay Boulevard and the Los Osos Creek Bridge to maintain regional connectivity under high sea level rise, potentially via causeway structures that preserve tidal exchange and sediment transport beneath the roadway.
- Relocation or elevation of Park Ridge Trailhead parking to maintain public access while avoiding recurrent flooding.
- Expanded wetland restoration and habitat migration space in the Morro Bay State Marine Reserve and along the margins of El Moro Elfin Forest, facilitating upland-to-wetland transition where feasible. Short causeway segments may also be considered for wildlife passage.

Adaptation alternatives for all cross sections are presented in detail in Attachment D. These long-term concepts are intended to provide a vision for a fully adapted system under high sea level rise, recognizing that final design and timing will depend on observed conditions and future policy direction.

5.3 Thresholds, Triggers and Timing

The adaptation pathways framework is based on a trigger and thresholds approach that links the timing of actions to observable physical conditions rather than fixed calendar dates. In this framework, thresholds describe the physical conditions at which an asset is no longer performing to an acceptable level, and triggers are the decision points at which planning or implementation of a measure must begin so that it is in place before that threshold is exceeded. The associated lead time reflects the period needed for planning, environmental review, permitting, design, funding, and construction.

Thresholds rely on physical metrics such as roadway conditions, wetland squeeze, and observed sea level rise and are identified by time and location. For this Plan, thresholds and triggers are tied to the coastal hazard metrics evaluated in the CFHVA, including storm total water levels (still water level plus wave runup), creek water levels, tidal flooding frequency, and wetland response. Note that the preferred alternatives and adaptation pathways in the following section include thresholds and triggers based on freeboard, which is the height of infrastructure or assets above a specified flood level (e.g., the height of a road surface or levee crest above the 100-year return period flood water surface elevation). The CHVA modeled a storm scenario to approximate the 100-year return period flood levels. Freeboard thresholds and triggers used in this plan are relative to a design water level, which should be confirmed and refined through subsequent project-level planning and analysis. For this Plan, the alternatives consider freeboard above the storm levels modeled for the CHVA, which approximate the 100-year return period flood. The alternative graphics show these flood levels.

The timing of adaptation measure implementation should be informed by monitoring of sea level rise, flooding or inundation frequency, and progressive or repeated damages. Thus, implementation timing depends on the relative location and exposure of a given asset to hazard(s) with sea level rise.

Lead times for planning and constructing adaptation measures should also consider the speed at which hazards are expected to worsen, translating to the relative timing of sea level rise and/or coastal erosion projections. The advanced pace of sea level rise projected later this century indicates that the timing of planning and implementing adaptation measures will be critical. **Table 11** below lists possible lead times for different adaptation measures that address coastal flooding along the project site.

TABLE 9.
POSSIBLE LEAD TIMES FOR COASTAL FLOODING ADAPTATION

Risk	Actions	Adaptation Options	Time Frame	Lead Times
Coastal Flooding Storm Condition ESA Hydrodynamic Model (ESA 2025)	Protect	Wetland Restoration	5-25 years (near-term)	2-5 years
		Construct a levee or berm to protect the road in its current alignment and elevation	5-25 years (near-term)	1-5 years
	Accommodate	Elevate Road on Fill or Causeway	25-50 years (mid-term)	5-15 years
	Retreat	Relocate Roads and Infrastructure Inland	50 +years (long-term)	10-20 years

Figures 17 and **18** show screenshots from the virtual reality simulation developed for this project showing adaptation options at South Bay Boulevard, elevating the road on fill or a causeway, respectively. **Figures 19** and **20** illustrate phased adaptation measures for sea level rise, from near- to long-term. For instance, near-term measures focus on mobility enhancements to improve bike and pedestrian safety while larger projects are planned and permitted. Mid-term actions include constructing a levee with a bike and pedestrian path on the top to protect South Bay Boulevard and State Park Road. If tides or floods affect these roads, they can also be elevated on fill to match the levee. Over the long term, if fill integrity declines, a causeway may be built on top of the fill to provide greater protection against storm flooding and tidal inundation.

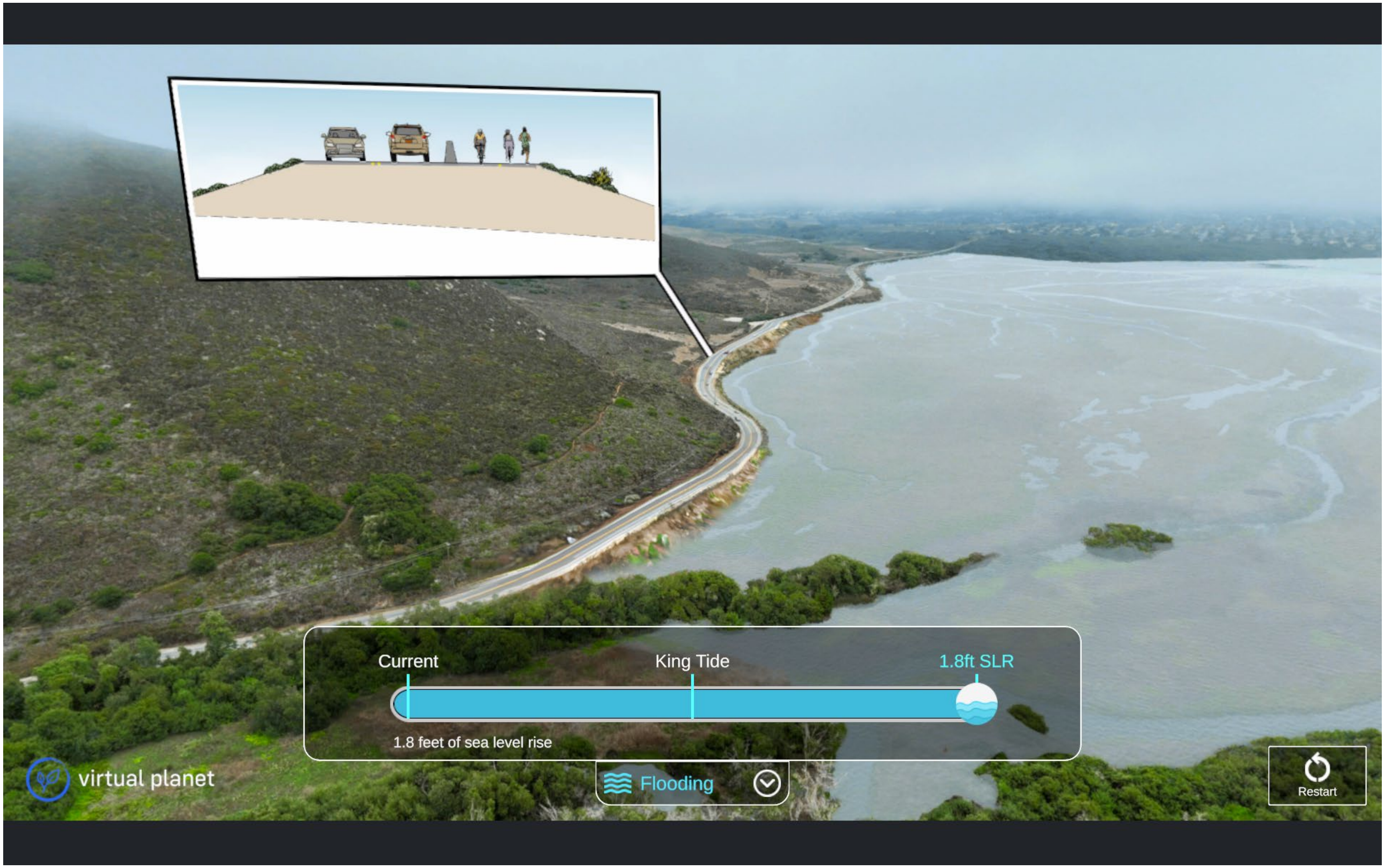


Figure 17. Virtual Reality Simulation Screenshot showing the elevation on fill option for South Bay Boulevard

Figure 18. Virtual Reality Simulation Screenshot showing the elevation on causeway option for South Bay Boulevard

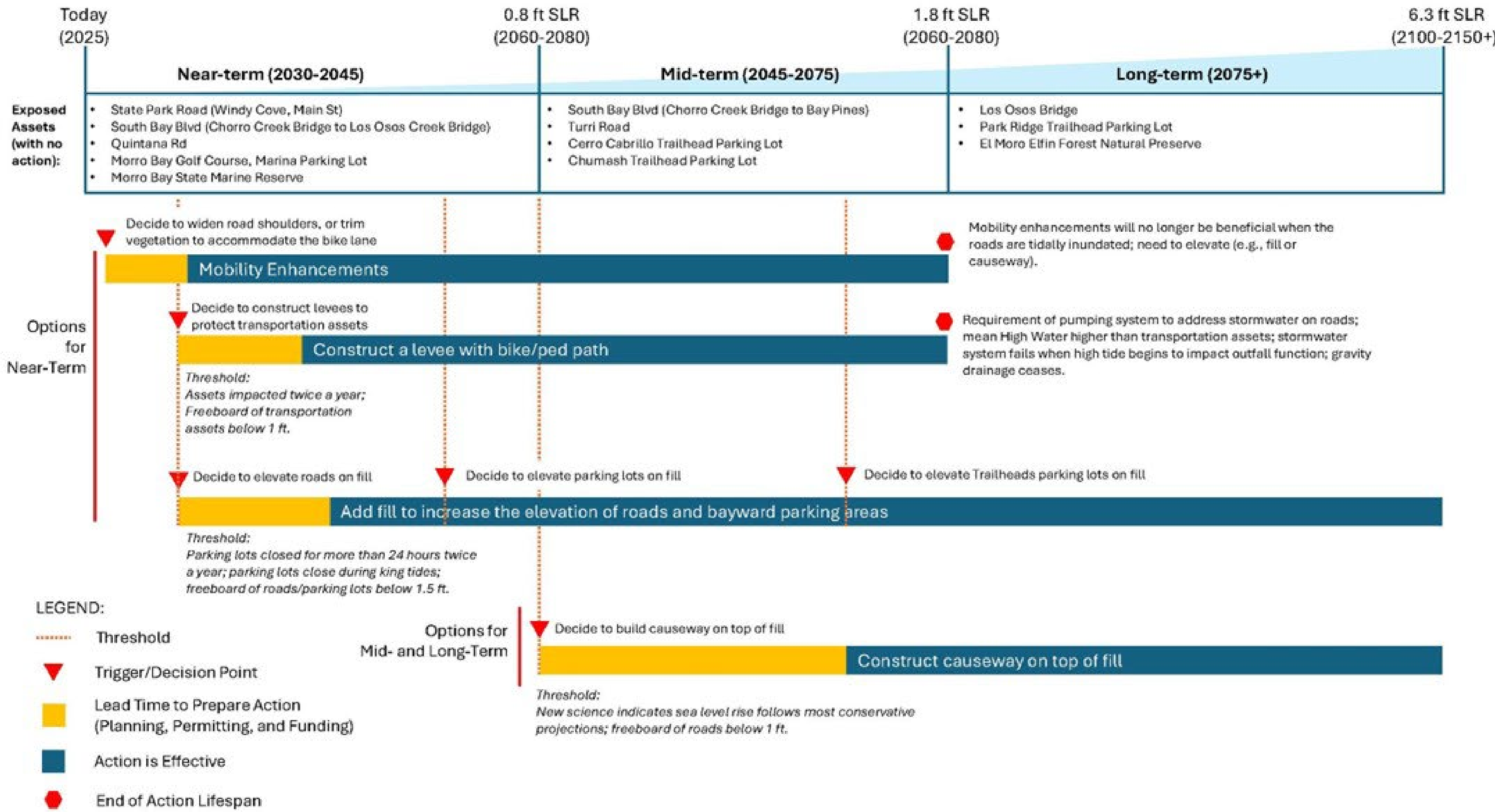


Figure 19. Potential adaptation pathways illustrating the conceptual phasing of measures triggered by sea level rise

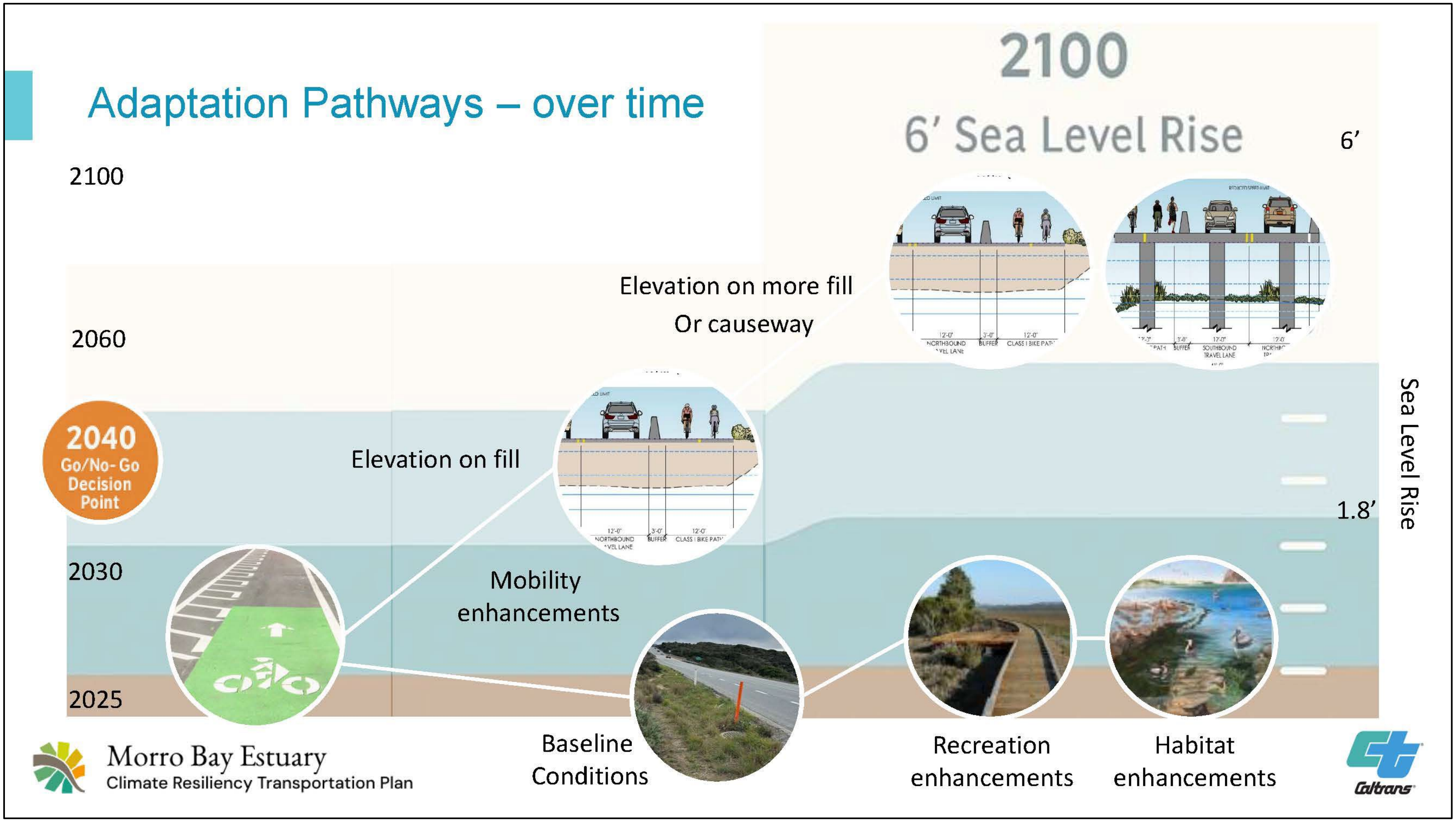


Figure 20. Schematic of alternatives and adaptation pathways for the Project Site

5.4 Preferred Alternatives and Adaptation Pathway

The ESA team, in coordination with SLOCOG and the Advisory Committee, has selected the following preferred adaptation alternatives based on technical analysis, stakeholder input, and alignment with the project's goals. These alternatives reflect a phased approach to adaptation that balances feasibility, environmental and cultural considerations, and near, mid, and long-term resilience of SLOCOG's transportation, recreational, and natural assets to sea level rise.

The Plan considered all three adaptation strategies Protect, Accommodate, and Retreat, consistent with CCC and OPC guidance (described in detail in Attachment D). Nature-based and hybrid measures under the Protect strategy (e.g., wetland restoration, ecotone levees, oyster reef restoration) were evaluated for their ecological benefits and potential to buffer coastal flooding. However, given the physical, ecological, social, and cultural constraints of the project area and adjacent lands, limited space for wetland migration, and the need to maintain regional connectivity, these measures alone do not provide sufficient protection for critical roadway segments.

Hybrid approaches involving hard structures (e.g., submerged artificial reefs, large rock features, or buried revetments) were also considered but are generally infeasible within the Morro Bay Estuary due to its protected status and regulatory constraints under the California Coastal Act, Local Coastal Program policies, and complex permitting requirements from agencies such as, but not limited to, the California Coastal Commission, U.S. Army Corps of Engineers, and Regional Water Quality Control Board.

Options such as extending a seawall or installing a rock revetment or buried revetment are also highly constrained for the same reasons and were not advanced for further consideration. In addition to these regulatory limitations, such measures would not effectively protect transportation assets because the roadway segments are at low elevations relative to projected high-water levels. For example, a rock revetment or seawall are effective in reducing wave energy, which is not a hazard for the assets considered, but would not prevent flooding during extreme tides or storm surge events. Similarly, full retreat or relocation of infrastructure was determined to be infeasible due to land use limitations, impacts to community access and to wetland and estuary ecosystems, and high implementation complexity.

Based on site conditions, the following alternatives emerged as the most feasible strategies to increase resilience of Morro Bay transportation assets in the near, mid, and long-term. These alternatives balance engineering practicality with long-term adaptability while allowing integration of stormwater management and habitat enhancements where possible.

5.4.1 Preferred Alternatives Description

Levee Systems (near to mid-term)

Levee construction along vulnerable segments of State Park Road at Windy Cove and South Bay Boulevard would provide immediate flood protection at a lower initial cost compared to elevated structures. These earthen barriers can be constructed relatively quickly to address current flooding concerns. However, as water levels rise, levees' effectiveness would diminish, and when they approach outfall levels, pumped drainage systems would become necessary, increasing costs and complexity. This alternative could include a bicycle / pedestrian path on top of the levee system.

Triggers, Thresholds and Adaptive Capacity: Construction triggers when extreme events reduce freeboard (i.e., height above the design water level) of transportation assets below 1 ft. The system remains functional until 1.5 ft of freeboard and until drainage fails during high tides, when pumping systems would become necessary. At that point, an alternative to using pumping systems would be to elevate roadways on fill or causeways.

Fill Elevation (near- to mid-term)

Raising road segments with engineered fill offers a practical near to mid-term solution that can be implemented with minimal disruption to surrounding resources. Using fill to increase elevation is particularly advantageous in areas with cultural resources, as it avoids the excavation that would be required for foundation systems to support a causeway while providing immediate flood protection. This alternative could include Class II bike lanes and sidewalks in the northbound and southbound shoulders or Class I protected bike lanes and pedestrian path on the bayward side.

Triggers, Thresholds, and Adaptive Capacity: Implementation triggers when extreme events from creek flooding or coastal storms reduce freeboard to less than 1 ft. Fill remains effective until freeboard is more than 2 ft, transitioning to other solutions when freeboard is 1 ft and when geometric constraints limit further raising. This approach allows for incremental raising of the roadway as conditions change, though eventual transitions to other solutions may be necessary.

Causeway (long-term)

The causeway represents the preferred alternative for the long-term adaptation strategy. South Bay Boulevard could be raised on a causeway above projected flood levels while maintaining critical hydrologic connections beneath the roadway. The causeway design enables continued sediment transport and tidal exchange, thereby supporting the natural inland migration of wetland habitats as sea levels rise. Implementation would occur in the long-term phase, within a trigger- and threshold-based monitoring program to inform the need for this level of protection. This alternative could include Class II bike lanes and sidewalks in the northbound and southbound shoulders or Class I protected bike lanes and pedestrian paths on the bayward side. Short causeway segments may also be considered for wildlife passage in the mid-term.

Triggers, Thresholds, and Adaptive Capacity: Transition planning begins when fill or levee no longer maintains 1.5 ft of freeboard during extreme events. Causeways have low adaptive capacity, meaning that once they are built to a certain elevation, it is not possible to add additional elevation.

Hybrid Approach Combining Fill and Causeway (near-, mid-, and/or long-term)

This strategy employs a phased, hybrid approach, beginning with fill in the near-term and transitioning to a causeway in the long-term. This would allow SLOCOG and other project partners to monitor sea level rise and adjust plans based on observed trends rather than relying solely on present-day projections. As scientific understanding of sea level rise and climate change improves and local conditions evolve, the causeway design can be refined, raising or lowering its elevation to match actual needs. This approach avoids overbuilding infrastructure while maintaining adaptive capacity throughout the transition period.

In addition to the mobility alternatives discussed above, all of these alternatives could be combined with a separated bicycle / pedestrian path on a boardwalk over the Morro Bay estuary.

Triggers and Thresholds: The transition from fill to causeway would be initiated when the fill or levee no longer maintains 1.5 ft of freeboard during extreme events or when fill maintenance costs exceed 50% of causeway construction costs over a 10-year period.

Stormwater Management Integration (Near- to Mid-Term)

Recognizing that traditional drainage systems become less effective as sea levels rise, the ESA team also recommends integrating stormwater management approaches with levee and fill alternatives. Near-term implementation could include constructed wetland areas designed to drain stormwater from the roads before it enters the bay system. In addition to improving flood management along transportation assets, these wetland features would serve multiple purposes: providing initial treatment for urban runoff, creating habitat value, and offering temporary storage during high tide events when gravity drainage is restricted. The wetland systems can be designed with adjustable flow control structures that can be adapted to changing water levels over time.

Triggers and Thresholds: Critical thresholds for stormwater system modifications occur when high tide begins to impact outfall function, and when gravity drainage ceases to function effectively during typical tidal cycles.

5.5 Sea Level Rise Design Basis

Based on the Toro Creek Climate Resilience and Coastal Hazards Adaptation Study developed by Cal Poly (2025), the ESA team recommends designing the preferred alternatives to accommodate 4.5 feet of sea level rise. This recommendation aligns with the Coastal Design Criteria and Technical Adaptation Strategies and Designs outlined in the study (Cal Poly 2025).

The 4.5 ft sea level rise scenario was identified through collaborative discussions between Cal Poly, Caltrans, and project stakeholders, reflecting both technical analysis and practical implementation needs. It is consistent with the State of California Sea Level Rise Guidance (OPC 2024) and provides a balanced, risk-based framework that supports long-term planning while avoiding unnecessary investment in projections that may not occur within the infrastructure's design life. The 4.5 ft sea level rise design threshold provides protection across a range of sea level rise scenarios:

- **Intermediate Scenario:** 4.5 ft of sea level rise is projected to occur in 2130; designing for 4.5 ft of sea level rise support infrastructure resilience under this "most likely" scenario.
- **Intermediate-High Scenario:** Designing to accommodate 4.5 ft of sea level rise provides protection through approximately 2100, aligning with typical infrastructure planning and funding cycles.
- **High Scenario:** Designing to accommodate 4.5 ft of sea level rise maintains effectiveness through approximately 2085, offering substantial protection even under accelerated ice sheet loss.

Although the planning approach for this Plan considers the most conservative scenario of 6 ft of sea level rise, the recommended 4.5 ft design standard offers a high degree of protection for transportation and recreational assets. This approach reflects a cautious and practical balance between long-term risk and implementation feasibility. It also provides flexibility to adjust as sea level rise projections evolve, allowing infrastructure investments to remain aligned with the best available science and observed trends.

In addition, with an adaptive trigger- and threshold-based monitoring program, SLOCOG and other project partners could track observed sea level rise and refine long-term designs, such as the causeway, based on updated science and real-world conditions. If future observations indicate that sea level rise is following a more extreme pathway, there would still be time and flexibility to adjust the design of long-term measures to accommodate higher sea level rise projections.

5.6 Implementation Pathway

The adaptation pathway for the preferred alternatives is structured to allow for flexibility and responsiveness to future conditions. The pathway includes:

Near-Term Phase (2030-2045): focuses on immediate protection through fill elevation or levee construction where flooding currently threatens infrastructure. During this period, wetland construction for stormwater management could be integrated with transportation improvements. Establishing a monitoring program is also critical to allow SLOCOG and other project partners to track actual sea level rise rates, storm patterns, and infrastructure performance against established thresholds.

Mid-Term Phase (2045-2075): represents a critical evaluation and transition period as sea level rise approaches 2.0 to 3.0 feet. The performance of near-term measures will be assessed against actual conditions, and planning for long-term solutions will advance based on observed trends. This phase also marks a key transition point, where the shift from temporary to more permanent protection measures, such as causeways, may be initiated. These decisions will be guided by defined thresholds and informed by updated projections and site-specific monitoring. Once triggered, the process would move through planning, design, funding procurement, and implementation phases to support timely adaptation.

Long-Term Phase (2075 and beyond): implements permanent solutions including causeway construction. The specific elevation and extent of these improvements will reflect measurements obtained through the monitoring program of local observations, allowing for more efficient and effective infrastructure investments tailored to actual rather than projected conditions.

This phased approach acknowledges the uncertainty inherent in long-term climate projections while providing clear decision points for infrastructure transitions. It also supports a resilient and adaptive strategy that balances engineering feasibility, environmental stewardship, and cultural sensitivity, while also allowing for continued engagement with stakeholders and the community as conditions evolve. By establishing specific triggers and thresholds, along with a monitoring program, SLOCOG and other project partners can respond proactively to changing conditions while avoiding premature infrastructure investments.

6. COMMUNITY ENGAGEMENT OUTCOMES

This section summarizes the public outreach and input received, as well as input received from the Advisory Committee for the Plan and other local boards. The full memos summarizing public input received can be found in **Attachment F**.

6.1 Public Outreach and Input Received

This Plan has been supported and informed by numerous public engagement opportunities, starting in December 2024 with a public workshop that was well attended by over 100 people. **Figure 21** shows photos from the December 2024 workshop. At the first public workshop, the project was introduced, and the existing conditions were described. Input was gathered on the future of South Bay Boulevard with a focus on new bike path and trail improvements. The workshop included engagement exercises at feedback stations, focused on the topics of mobility and flooding adaptation, where participants engaged in discussions with workshop facilitators and provided input by writing comments on boards, sticky notes, and project area maps. Comment sheets were also distributed to participants. Feedback received from workshop participants focused on the public's concern with flooding hazards on the roads in the study area, as well as the lack of safe biking and walking options. The public shared numerous ideas for how to improve biking and walking options in the study area including expressing support for one-way couplets and converting roads into protected bike lanes or trails; adding left turn lanes and other intersection improvements; improving existing bike lanes through vegetation management; reducing the speed limit on South Bay Boulevard; and/or adding separated bike/ped paths bayward of South Bay Boulevard.

In January 2025, SLOCOG staff set up a table at the Morro Bay Farmers' Market to provide another opportunity for the public to learn about the project and provide input on their concerns with existing conditions.

In October 2025, a second public workshop was held to share the results of the coastal hazards vulnerability assessment and the adaptation options and to share the virtual reality products that had been developed in support of the Plan. Input collected during the second public workshop focused on the various sea level rise adaptation options, including potential improvements to biking and walking in the study area. The public again shared numerous ideas about how to improve bike and pedestrian safety in the study area, including intersection improvements; wider bike lanes and/or separated paths on the bay side of South Bay Boulevard. The public also expressed support for a causeway design to maintain vehicular access during storms and sea-level rise.

The project has also utilized a project website (https://sbbclimateplan.org/) to share information with the public as it was developed and virtual reality was created for the project to visualize the coastal hazards vulnerability and to educate the public about the adaptation options that could address those vulnerabilities (**Figure 22**).

6.2 Advisory Committee and Board Input Received

In addition to public outreach, the Plan has also been informed by input from an Advisory Committee throughout this process. The Advisory Committee is comprised of staff from the Morro Bay National Estuary Program; the City of Morro Bay; State Parks; Los Osos Community Services District; Caltrans; San Luis Obispo County; Coastal San Luis Resource Conservation District; and the State Coastal Conservancy. Four meetings were held with the Advisory Committee as the Plan was developed: a kickoff meeting in May 2024 to introduce the advisory committee to the project; a site visit in October 2024 to explore the study area; a discussion of the results of the coastal hazards vulnerability assessment in June 2025; and a discussion of the potential adaptation solutions in September 2025. **Figure 23** shows photographs from the October 2024 site visit.

In addition to input from the Advisory Committee, the Plan was also discussed with the Los Osos Advisory Committee in May 2025. Plan progress was also presented to the SLOCOG Board through an informational item on the August 2025 agenda. Finally, Plan progress was presented to the Morro Bay Public Works Advisory Board (PWAB) in October 2025. Input from the PWAB focused on the importance of protecting South Bay Boulevard as an evacuation route for the community of Los Osos and a discussion regarding the details of implementation, such as the potential impacts to circulation during construction. PWAB members suggested prioritizing the segments of South Bay Boulevard that are low-lying and the benefits of causeways for improving wildlife connectivity were also noted.

Figure 21. Photos from the December 2024 Workshop

Figure 22. Virtual Reality Simulation

Figure 23. Photos from the October 2024 site visit with the Advisory Committee

7. BENEFIT ANALYSIS

This section summarizes the Benefit- Analysis developed for the Plan and presented in detail in **Attachment E**. Benefit analysis is a way of comparing values gained and lost because of a proposed decision. In the private sector, the values of capital and operating expenditures are compared with the revenues to be gained from sales of goods and services. Sales are not a measure for public sector investors so alternate measures of value are chosen. In the present case, expenditures to alter the roads in Morro Bay to minimize the effects of sea level rise are compared with the values of recreation and transportation offered by the public infrastructure.

The assignment of the terms “costs” and “benefits” is a function of the question being asked. The first question with respect to Morro Bay before any choice of adaptation strategy is made is “what are the consequences of taking no action”. It may be that the effects of sea level rise are not serious enough to warrant major expenses. The basic analysis discussed here is the consequences of the no action alternative. The effects on recreational users and travelers are costs and expenditures that might be made are benefits. They are benefits in the sense that the funds saved could be put to another purpose.

Once the no action alternative consequences are measured, the question can then be turned around: What will be the values gained (or losses avoided) if a decision is made to invest in road alterations to deal with sea level rise? In this case, the costs and benefits of the no action alternative are reversed. The result is what is shown in **Table 12**.

In other words, in the no action alternative, the costs to travelers and park users are larger than the benefits of not spending $54 million and $134 million. Taking action will be economically superior to taking no action. The question then becomes which of the three options being evaluated should be selected. The standard answer to the question is to pick the option with the largest net benefits, which in this case is the roadway elevated on fill.

TABLE 10.
SUMMARY OF RESULTS

	Scenario	Project Location	2 Lane Road + Bike Path on Fill	2 Lane Road + Bike Path on Fill With Retaining Wall	2 Lane Road + Bike Path on Causeway
Benefits	Without Waves	Windy Cove	$9,316,103	$9,316,103	$9,316,103
		Marina	$54,615,284	$54,615,284	$54,615,284
		South Bay Blvd	$552,686	$552,686	$552,686
		Total	$64,484,073	$64,484,073	$64,484,073
	With Waves	Windy Cove	$25,045,556	$25,045,556	$25,045,556
		Marina	$68,396,334	$68,396,334	$68,396,334
		South Bay Blvd	$2,951,610	$2,951,610	$2,951,610
		Total	$96,393,501	$96,393,501	$96,393,501
Net Benefits		Without Waves	$6,543,830	$722,221	-$79,538,967
		With Waves	$38,453,259	$32,631,649	-$47,629,539

Table 12 summarizes the benefit analysis of sea level rise adaptation measures in the Morro Bay-Los Osos region of San Luis Obispo County, California. The basic conclusions are:

- Under the assumptions and using the data available, as described below, the benefits of altering the road structures to accommodate expected sea level rise will exceed the costs for two of the three options. Elevation on fill or with a retaining wall pass a cost-benefit test, but it is a close result. Costs exceed benefits for a causeway elevation of the road.

- The take no action alternative is rejected. This conclusion is driven primarily by the benefits of retaining recreation opportunities in Morro Bay State Park.

- Additional benefits exist in maintaining the traffic along South Bay Boulevard, though these are not sufficient to justify the investments in adaptation on their own. This is due in large part because of the assumption that benefits do not start to accrue until the flood level for each stretch of road is reached. For South Bay Boulevard this is in 2073 based on the specified sea level forecasts.

- Benefits exceed costs with or without assumptions of wave run up, though the analysis including wave run up does yield significantly higher net benefits.

- The choice of discount rates affects the results and the determination of economically acceptable projects. For the base analysis, a discount rate of 1% is used on the basis of the long period over which benefits are measured. All project options fail the cost-benefit test if higher discount rates are used, meaning the outcome is sensitive to the assumptions used in the analysis.

The analysis described here is done in real (unadjusted for inflation) 2025 dollars. Adjustments for inflation, if done so as to use different rates of inflation for different cost and benefit components, will significantly complicate the calculation process. Present values are calculated at a discount rate of 3%. The results are not sensitive to the choice of discount rates.

7.1 Background Conditions

The extent of sea level rise specified for this study are 1.8 feet by 2060 and 6.3 feet by 2100 (**Table 13**). However, it is not possible to conduct an analysis with just two data points since the fundamental assumption in a benefit study of an infrastructure investment is that expenditures up front will be repaid with a flow of future benefits. To appropriately structure the analysis, annual data must be used.

The annual data are calculated as the simple interpolation of constraint change between 2025 and 2060 and then between 2060 and 2100. For purposes of the analysis, the area of concern is subdivided into three zones: Windy Cove; the area around the marina; and together comprise the State Park subsection. The area along South Bay Boulevard comprises the third (**Figure 24**).

TABLE 11.
SEA LEVEL RISE AND EFFECTS ASSUMPTIONS

Tidal Inundation Scenario Without Wave Runup (Conservatively Lower Estimate of Inundation)

Location	Road Elevation (ft NAVD)	Flooding Threshold (ft NAVD)	Sea Level Rise		
			0 ft	1.8 ft	6.3 ft
			Avg Hrs Closed per Year	Avg Hrs Closed per Year	Avg Hrs Closed per Year
State Park Road – Windy Cove	7.25	7.75	0.0	92.5	6589.3
State Park Road – Morro Bay State Park Marina to S Bay Blvd	7.5	8	0.0	46.5	6280.3
S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge	10	10.5	0.0	0.0	1505.2

Storm Inundation Scenario With Wave Runup (Conservatively Higher Estimate of Inundation)

Location	Road Elevation (ft NAVD)	Flooding Threshold (ft NAVD)	Sea Level Rise		
			0 ft	1.8 ft	6.3 ft
			Avg Hrs Closed per Year	Avg Hrs Closed per Year	Avg Hrs Closed per Year
State Park Road – Windy Cove	7.25	7.75	0.4	441.9	7656.5
State Park Road – Morro Bay State Park Marina to S Bay Blvd	7.5	8	0.1	283.9	7428.5
S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge	10	10.5	0.0	2.6	6419.6

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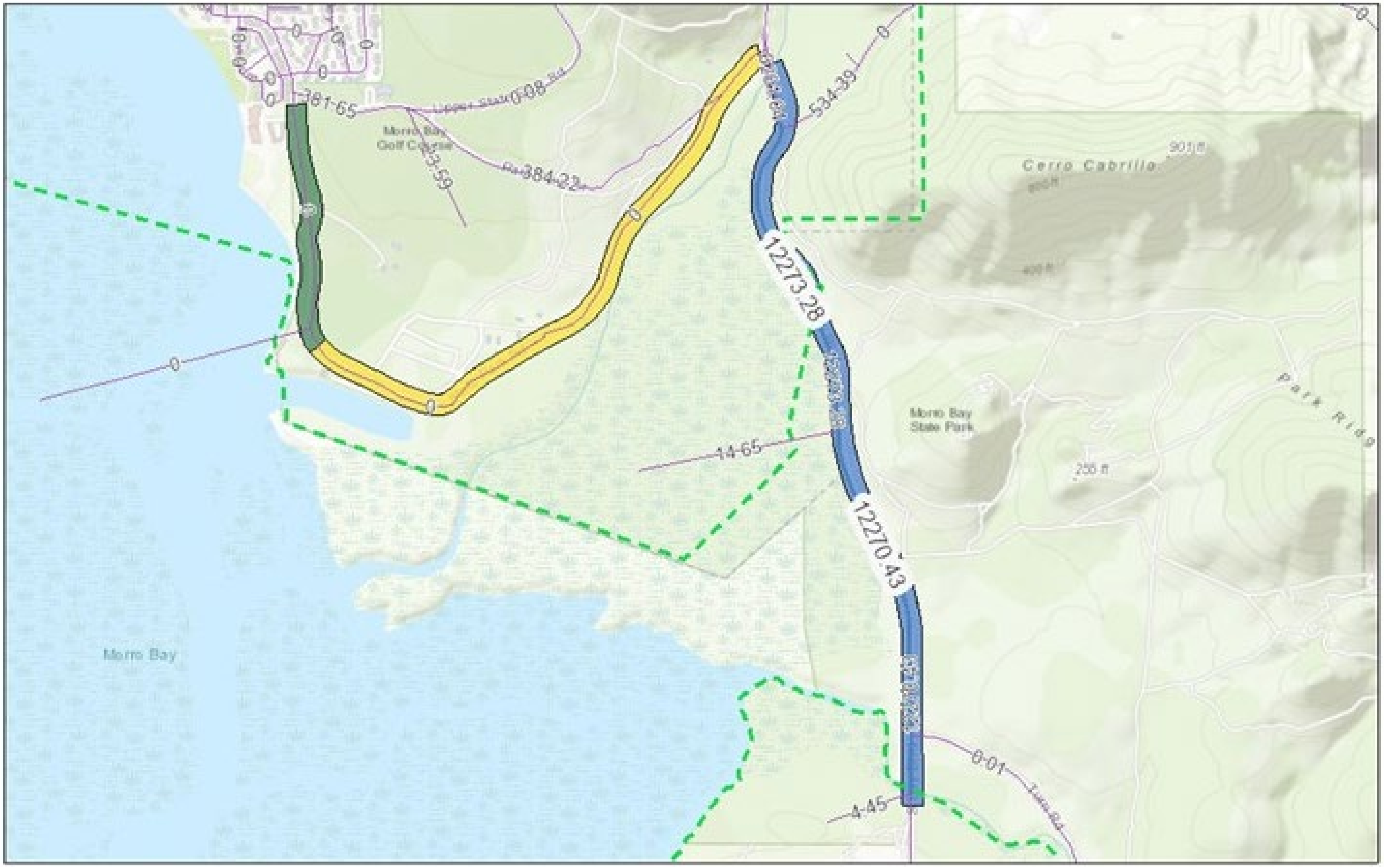


Figure 24. Study Area Subsections and Traffic Counts for South Bay Boulevard

Windy Cove is shown outlined in green; The Marina section is in yellow, while the South Bay Boulevard section is in blue. The traffic counts estimated by the San Luis Obispo Council of Governments transportation model are also shown. The South Bay Boulevard section has a traffic count of about 12,170 vehicles per day (both directions).

However, the traffic count for the State Park segments is shown as zero. The State Park is excluded from the transportation model because its roads do not fall within Caltrans jurisdiction. This is sensible with most state parks which lay apart from the road network but is unfortunate here because the road segment transiting the state park is, in fact, an important thoroughfare. For purposes of this analysis the absence of traffic data requires relying on another source of benefits, as discussed in the next section.

7.2 No Action Costs - State Park Section

Table 14 provides a summary of the costs of no action estimated for the State Park section and the two subsections at Windy Cove and the marina. The estimates are presented with and without waves and assuming planning horizons to 2060 and to 2100. The costs in this section of the study are the losses in the value of recreation in the state park. Visitor use data from the Monterey Bay Natural Estuary Program are combined with the estimated values to visitors at various locations around coastal California. No direct measurement of recreation values at Morro Bay is available.

TABLE 12.
SUMMARY OF NO ACTION COSTS - STATE PARK SECTION

		Present Value to 2060		Present Value to 2100	
		Without Waves	With Waves	Without Waves	With Waves
State Park	Windy Cove	$95,244	$486,925	$9,316,103	$25,045,556
	Marina	$301,513	$920,750	$54,615,284	$68,396,334
	Total	$396,757	$1,407,675	$63,931,387	$93,441,891

Table 15 shows the data used to calculate the gross costs. The value per person per day is taken from studies of recreational values in the U.S. compiled by Rosenberger (2016). From this master list of over 3,000 studies, over 100 studies were selected of California recreation values. The preponderance of these studies were conducted of the marine sanctuaries in California. The database was updated to 2016 dollars and then further adjusted to 2025 dollars, which are shown in Table 15 as the value per person per day.

TABLE 15.
RECREATION VALUE CALCULATION

	Value Per Person Per Day	Windy Cove	Total Value Per Day	Windy Cove Distribution	Weighted Values Per Day
Relaxing on coastline	$65.69	22	$1,035	25%	$16.49
Kayak/SUP/Rowing	$150.77	4	$475	5%	$7.57
Walking or playing with pet(s)	$65.69	13	$662	15%	$9.63
Sitting in car	$65.69	10	$455	11%	$7.25
Fishing	$203.99	0	$0	0%	$0.00
Boating	$55.74	0	$0	0%	$0.00
Walking/Running/Exercise	$41.93	33	$977	37%	$15.57
Other	$65.69	6	$290	7%	$4.62
TOTAL		89	$3,894	100%	$61.14

	Value Per Person Per Day	State Park Marina	Total Value Per Day	State Park Distribution	Weighted Values Per Day
Relaxing on coastline	$65.69	31	$1,982	7%	$4.60
Kayak/SUP/Rowing	$150.77	85	$12,346	19%	$28.65
Walking or playing with pet(s)	$65.69	62	$3,964	14%	$9.20
Sitting in car	$65.69	31	$1,982	7%	$4.60
Fishing	$203.99	4	$879	1%	$2.04
Boating	$55.74	36	$1,922	8%	$4.46
Walking/Running/Exercise	$41.93	191	$7,770	43%	$18.03
Other	$65.69	4	$283	1%	$0.66
TOTAL		445	$31,129	100%	$72.22

The columns labeled Windy Cove and State Park Marina show the daily use of each park area provided by the Morro Bay National Estuary Program (MBNEP). These are broken down by principal activity reported in a survey conducted by MBNEP. The use categories and values data bases did not match exactly so several more detailed categories in the data were grouped as "relaxing on the coastline" for purposes of calculating values.

Total value per day equals the value per person per day times the number of respondents. The Windy Cove distribution shows weights for each activity based on the number of respondents. These weights are then used to calculate a composite value per day. The value is $61.81 per person per day for Windy Cove and $72.22 per person per day for the State Park Marina.

To estimate the costs each year, the sea level rise estimates are matched to a linearly interpolated time effect based on the number of hours specified in Table 15. The interpolation begins in the year in which flooding is projected to occur and continue to 2060 and is then re-estimated to 2100. The number of hours projected for a given year is then taken as a proportion of hours in the year and divided by two to reflect the fact that recreational activity in the park is unlikely to take place over 24 hours. This yields the proportion of time with flooding and, it is assumed, eliminated recreation. The proportion of flood time is then multiplied by the number of people in that section of the park.

The estimated population multiplied by the value per day provides the total recreation value per day. The population of recreationists is increased each year at a rate consistent with population growth in San Luis Obispo county. This growth rate was provided by the SLO Council of Governments. The total recreation value is then reduced by the SLR flooding hours as a percent to derive the annual loss in recreation. The percentage loss increases with sea level rise and the number of hours each year in which flooding occurs.

Figures 25 and **26** illustrate the results of the calculations for Windy Cove using the without wave runup assumption. Figure 25 shows the relationship between sea level rise and hours closed at Windy Cove. Figure 26 shows the growth in users at Windy Cove and the annual change in value lost due to flooding.

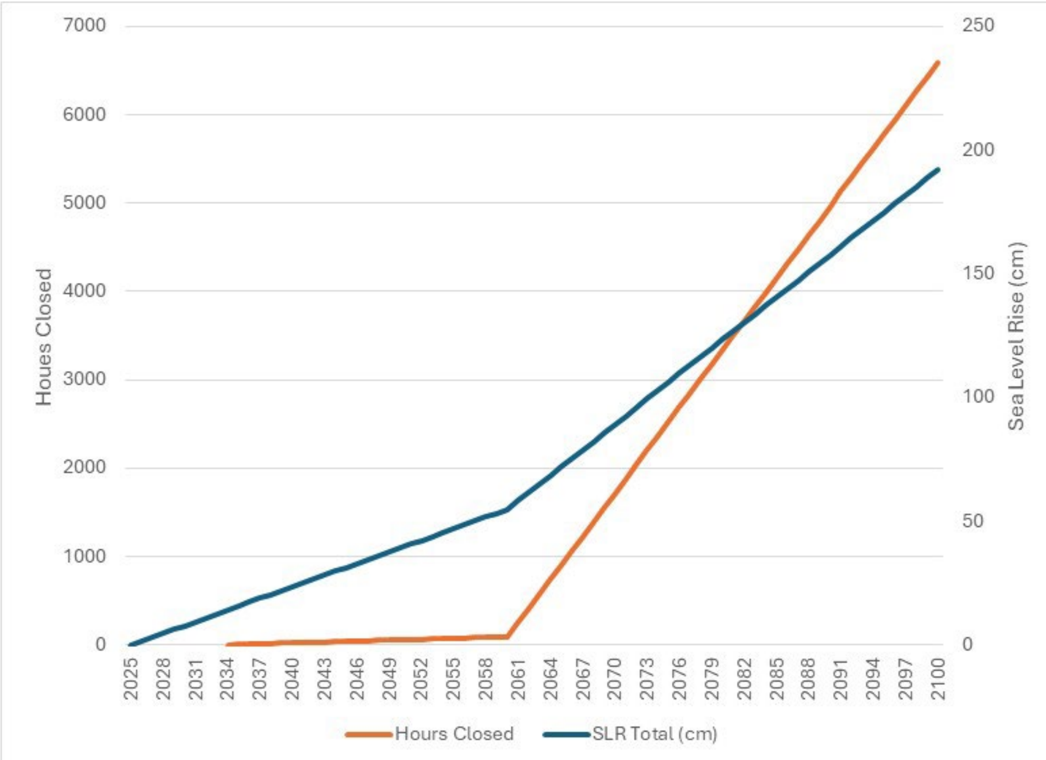


Figure 25. Sea Level Rise and Hours Closed at Windy Cove

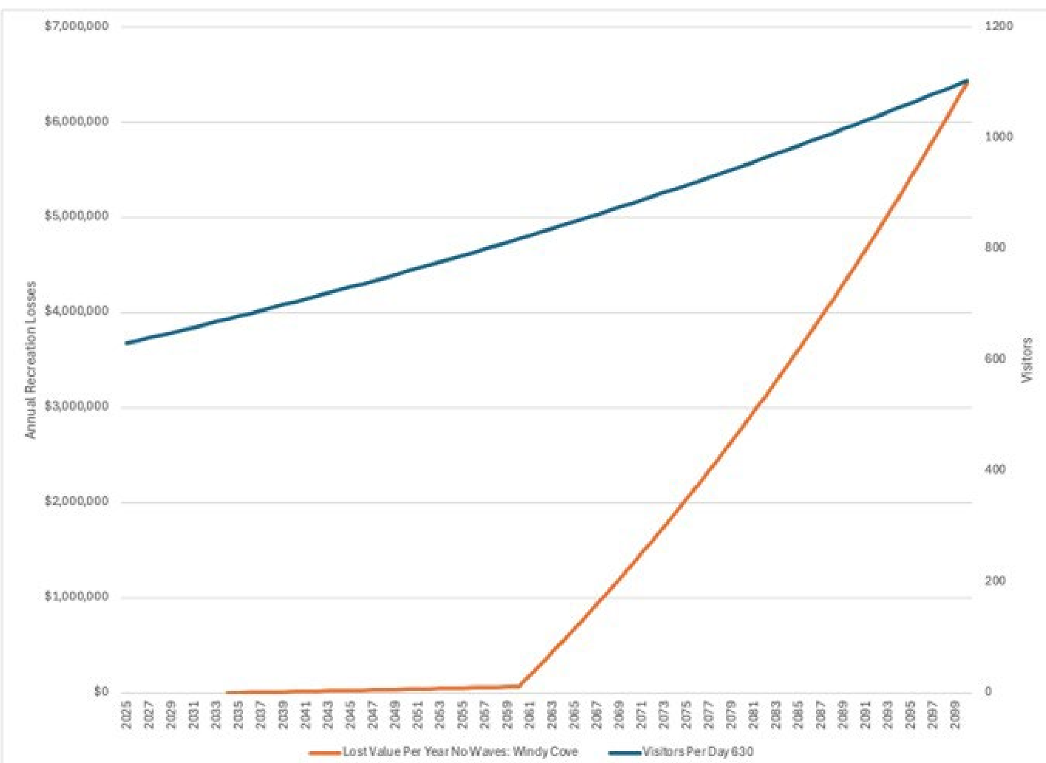


Figure 26. Number of Visitors and Lost Value at Windy Cove

7.3 Economic Change - South Bay Boulevard Section

The methodology for assessing the economic effects of highway construction or modification is well established and is described in a framework published by the Federal Highway Administration (White, 2016). The framework defines the economic values affected by highways as consisting of the value of time for users and vehicle operating costs. A cost-benefit analysis should identify changes in the value of time and in vehicle operating costs. Increases in the time spent travelling and in vehicle miles traveled are counted as costs. Costs are the result of increases in time and distance. In this case, the value of time and operating costs can be expected to increase significantly if flooding eliminates travel on South Bay Boulevard. Taking action to avoid these increases in costs creates benefits as avoided costs.

Table 16 summarizes the present value of no action costs for the South Bay Boulevard section of the study area. Before discussing these results, the method of calculation requires explanation. South Bay Boulevard is a highly vulnerable road partly because of the length of roadway which could be flooded and partly because it is the only road connecting Morro Bay and Los Osos over a short distance. If it is no longer passable due to flooding, there are no quick alternative routes between the two settlements without significant driving because of the topography and placement of roads.

TABLE 16.
COSTS OF FLOODING DISRUPTIONS ON SOUTH BAY BOULEVARD

			Change in Time of Travel Valued At:	
			Without Waves	With Waves
South Bay Blvd	Present Value in 2030-2060	SLO County Wage	$6,654	$393,937
		California Wage	$92,308	$394,551
		Change in Vehicle Operating Costs	$243,848	$1,042,279
		Total Change @SLO	$250,502	$1,436,216
		Total Change@ CA	$336,156	$1,436,830
	Present Value in 2073-2100	SLO County Wage	$10,727	$635,115
		California Wage	$148,821	$636,105
		Change in Vehicle Operating Costs	$393,138	$1,680,390
		Total Change @SLO	$403,865	$2,315,505
		Total Change@ CA	$552,686	$2,951,610

Figure 27 shows the current route and the alternative route selected for analysis. The flood-risked portion of South Bay Boulevard is shown in blue. If South Bay Boulevard is not in service, then the connection between the two communities must take place using Highway 1. This route is shown in green. For this analysis, the intersection of Market Street and Morro Bay Boulevard was chosen as a centroid for Morro Bay. The corresponding centroid for Los Osos is at 4th street and Santa Maria Avenue.

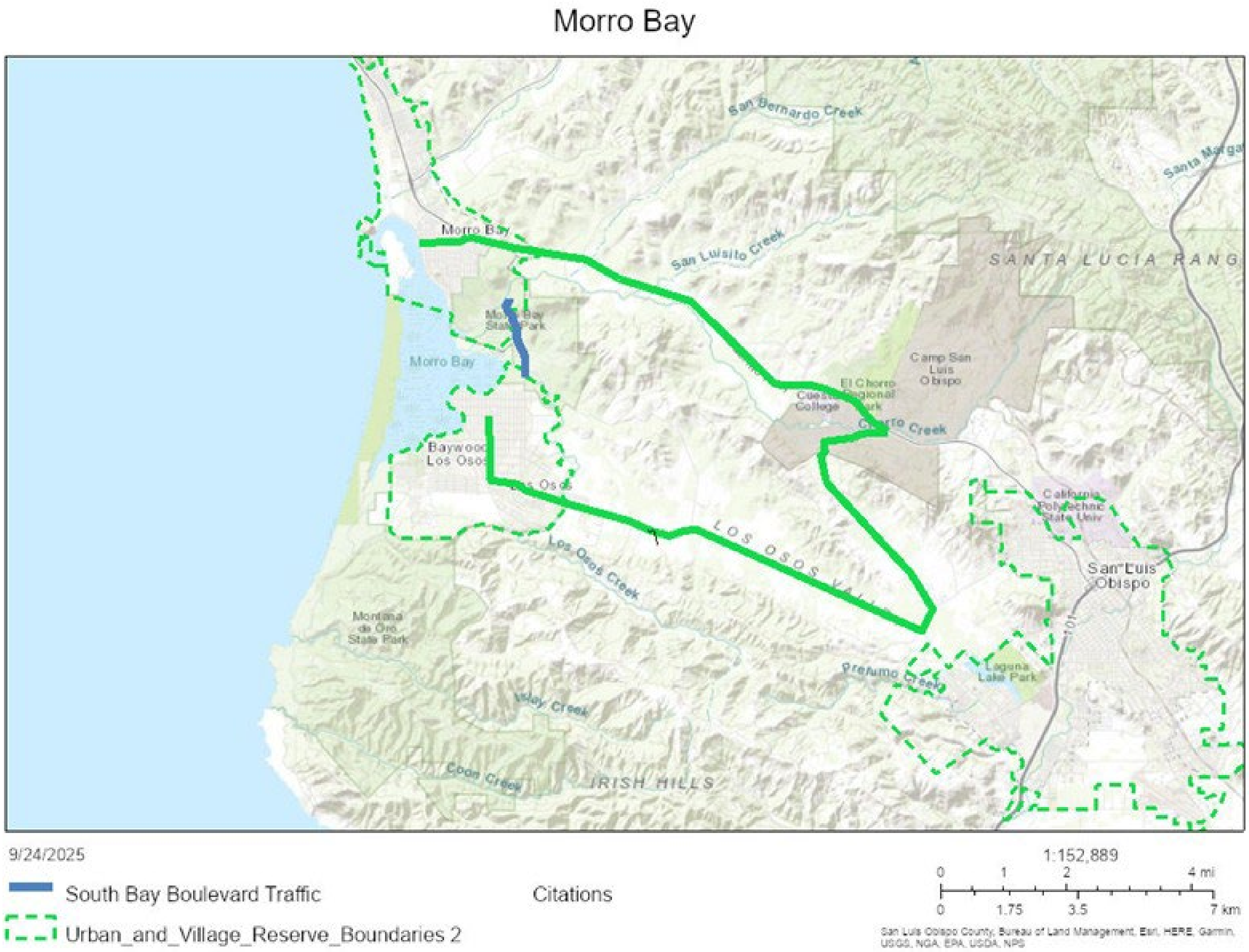


Figure 27. Direct and Indirect Road Connections Morro Bay and Los Osos

The costs for South Bay Boulevard are the increases in time and vehicle operation from having to take the longer route if South Bay Boulevard is flooded. For this analysis the calculations are set out in **Table 17** and **Table 18**. Table 17 shows the costs which covers the calculations for South Bay Boulevard assuming no flooding. Table 18 covers the calculation for the alternate route. Each table is divided into four sections for ease of explanation.

The FEMA standard for estimating the value of travel time is based on the average wage for a given region. The FEMA standard is to use the U.S. average wage, but the Morro Bay area, particularly the State Park and South Bay Boulevard road segments are more appropriately viewed as local or regional segments. For this analysis the average wage for San Luis Obispo County and California are both tested. The average hourly wage is calculated at the weekly wage divided by 35 (the length of a full-time work week). The value of time is assigned at the full hourly wage. All other uses are assigned a value at less than the full wage. The value is generally 50% for general travel and 30% for leisure travel. Trip purpose data was not available so 50% was used.

Table 18, row 2 sets out the distance and time elements. The current route over South Bay Boulevard is 4.6 miles between Morro Bay and Los Osos (assuming the centroids defined above). Travel time is estimated at 30 miles per hour for a trip time of 9.2 minutes. The assumption is that 25% of travel is employment-related. The number of person hours of travel as the total vehicles (12,170 from the SLOCOG travel model) times 9.2 minutes. This assumes single occupancy vehicles since no more detailed information is available. The number of employee-related trips is estimated at 467, and non-employment as 1,400. The results for travel related value of time ranges from $15,715 at the San Luis Obispo average wage and $23,632 at the California average wage.

TABLE 17.
UNOBSTRUCTED SOUTH BAY BOULEVARD

1			**Avg Weekly Wage**	**Average Hourly**	**50% Average**
		CA Avg Wage	$1,773.00	$50.66	$25.33
		SLO County Avg Wage	$1,179.00	$33.69	$16.84
2	**Miles**	**Time (in minutes at 30 mph)**	**Hours Employee-related travel**	**Employee-related travel Costs**	**Non Emp -N**
	4.6	9.2	467	$23,632	1,400
	4.6	9.2	467	$15,715	1,400
3		**Employment %**	**Other %**	**Daily Traffic**	**Person Hours**
	CA Avg Wage	25%	75%	12,170	1,866
	SLO County Avg Wage	25%	75%	12,170	1,866
4		**Non Emp $**	**Total Value**	**Total Vehicle Miles**	**Total Vehicle Cost**
	CA Avg Wage	$35,449	$59,081	55,982	45,905
	SLO County Avg Wage	$23,572	$39,287	55,982	45,905

Table 18, row 4 shows the non-employment values are calculated, the total value (sum of employment and non-employment related values of time). The total vehicle miles (4.6 times 12,170) are calculated. The operating cost is estimated at $0.82 per mile, the standard vehicle operating value for the IRS. This is the standard value used.

Table 18 shows the calculations for the alternate route plus the change between the alternative and the present route. The calculations are essentially the same as Table 17, with two exceptions. First, the route is now extended to 23.7 miles from Morro Bay to Los Osos. This route is subdivided into an urban portion within each community and a highway portion along Highway 1. Travel is assumed at 30 mph in the urban section and 60 mph on the highway section. With these adjustments, total time, distance, and values are constructed assuming the same level of total vehicles.

TABLE 18.
ALTERNATE ROUTE TO SOUTH BAY BOULEVARD

1		**Urban Miles**	**Urban Minutes**	**Highway Miles**	**Highway Minutes**	**Total Miles**	**Total Minutes**
		4.6	9.2	19.1	21	23.7	25.6
		4.6	9.2	19.1	21	23.7	25.6
2		**Avg Weekly Wage**	**Average Hourly**	**50% Average**	**Employmen t %**	**Other %**	**Daily Traffic**
	CA Avg Wage	$1,773.00	$50.66	$25.33	25%	75%	2,170
	SLO County Avg Wage	$1,179.00	$33.69	$16.84	25%	75%	12,170
3	**Person Hours**	**Hours Employee-related travel**	**Employee-related travel Costs**	**Occupancy**	**Non Emp -N**	**Non Emp $**	**Total Cost**
	4,807	1,502	$95,124	1.25	2,929	$74,196	$169,320
	4,807	1,202	$50,604	1.25	3,605	$60,725	$111,328
4	**Net Change in Cost of Time**	**Total Vehicle Miles**	**Total Vehicle Cost**	**Vehicle Operating Change**	**Total Value Change**		
	$110,239	288,429	236,512	$190,607	$300,846		
	$72,041	288,429	236,512	$190,607	$262,648		

Table 18, row 4 shows the total changes in value of time and operating costs are calculated using both the San Luis Obispo County and California. These are used to calculate the present value of costs. However, there is an important issue in the calculation of the present values for the South Bay Boulevard portion of the analysis. The flood stage for South Bay Boulevard between Los Osos Creek Bridge and Chorro Creek Bridge is estimated to be 10.5 feet. This water level of 10.5 ft may not occur on an annual basis until around 2060. Infrequent flooding due to extreme events could occur much sooner. However, the assumptions for the cost-benefit analysis place the start of costs from maintaining access to South Bay Boulevard nearly 50 years in the future, for the purposes of this study. At that distance in time the discounting process reduces the economic effects substantially, which is why in the final summary the South Bay Boulevard costs are shown as small relative to the recreation benefits, which are estimated to begin in 2034.

The reason is that for this analysis, costs and benefits are assumed to occur in the same time period. That is adaptation projects are built to become effective approximately a decade from now and benefits begin immediately for the State Park area but are delayed substantially for South Bay Boulevard. The costs to users of the State Park area will likely be sufficient to justify the investments in adaptation if they can be avoided.

An alternative analysis could delay construction of the South Bay Boulevard section until the 2060s, when more frequent inundation is projected.. This would allow a perhaps more realistic comparison of costs and benefits. But in this case a separate South Bay project cost would be needed, and it is likely that calculation of benefits would have to extend beyond 2100, which is the end of the current planning horizon.

A note should be made about the benefits of a proposed bicycle path, which is included in the planning of all versions of the adaptation project. A bicycle path will undoubtedly increase the benefits from an adaptation project. But it cannot be determined at this time how much that increase will be because it is unknown how many people will use the bike path. There are undoubtedly people who currently travel along South Bay Boulevard by bike, but the road in the vulnerable area has a narrow shoulder and currently is likely used only by experienced cyclists. A bike path, particularly one with some form of barrier between it and the road (that is a bike path and not a bike lane), would be used by a much wider range of cycling skill level and of ages.

8. SOLUTION PRIORITIZATION

The prioritization of adaptation solutions for the Morro Bay - Los Osos transportation corridor builds on technical analysis, economic evaluation, and extensive engagement with the community and stakeholders presented in the previous sections of the Plan. The prioritization process integrates findings from the existing conditions (Section 3), coastal flood hazards and vulnerability assessments (Section 4), the potential adaptation solutions and strategies identified for the near-, mid-, and long-term (Section 5). It also incorporates feedback gathered during public workshops and advisory committee meetings (Section 6) and outcomes from the benefit analysis (Section 7).

The analysis identified segments of South Bay Boulevard and State Park Road as highly vulnerable, with current road closures due to flooding during storms and high tides projected to increase with sea level rise. In addition, the benefit-cost analysis shows that proactive adaptation delivers substantial value, especially when compared to the losses associated with a no-action scenario. As a result, solution prioritization for the region centers on maintaining reliable regional mobility, supporting long-standing recreational use and habitat function, and delivering strong value for public investment, while working within the existing corridor footprint where feasible.

The Plan prioritizes a package of near-term mobility improvements and the elevation of critical roadway segments on fill as the main strategy for advancing climate-resilient transportation in the corridor, described in detail in Attachment D. This direction reflects:

- The vulnerability of South Bay Boulevard and State Park Road to tidal and storm flooding, as documented in the coastal hazards and vulnerability assessment;
- The performance of adaptation approaches evaluated in the Alternatives and Adaptation Pathways framework;
- The economic results of the benefit-cost analysis, which show the highest net benefits for roadway elevation on fill; and
- Consistent public and stakeholder input calling for improved bike and pedestrian facilities and protection of the transportation corridor between Morro Bay and Los Osos.

8.1 Near-Term Mobility Enhancements

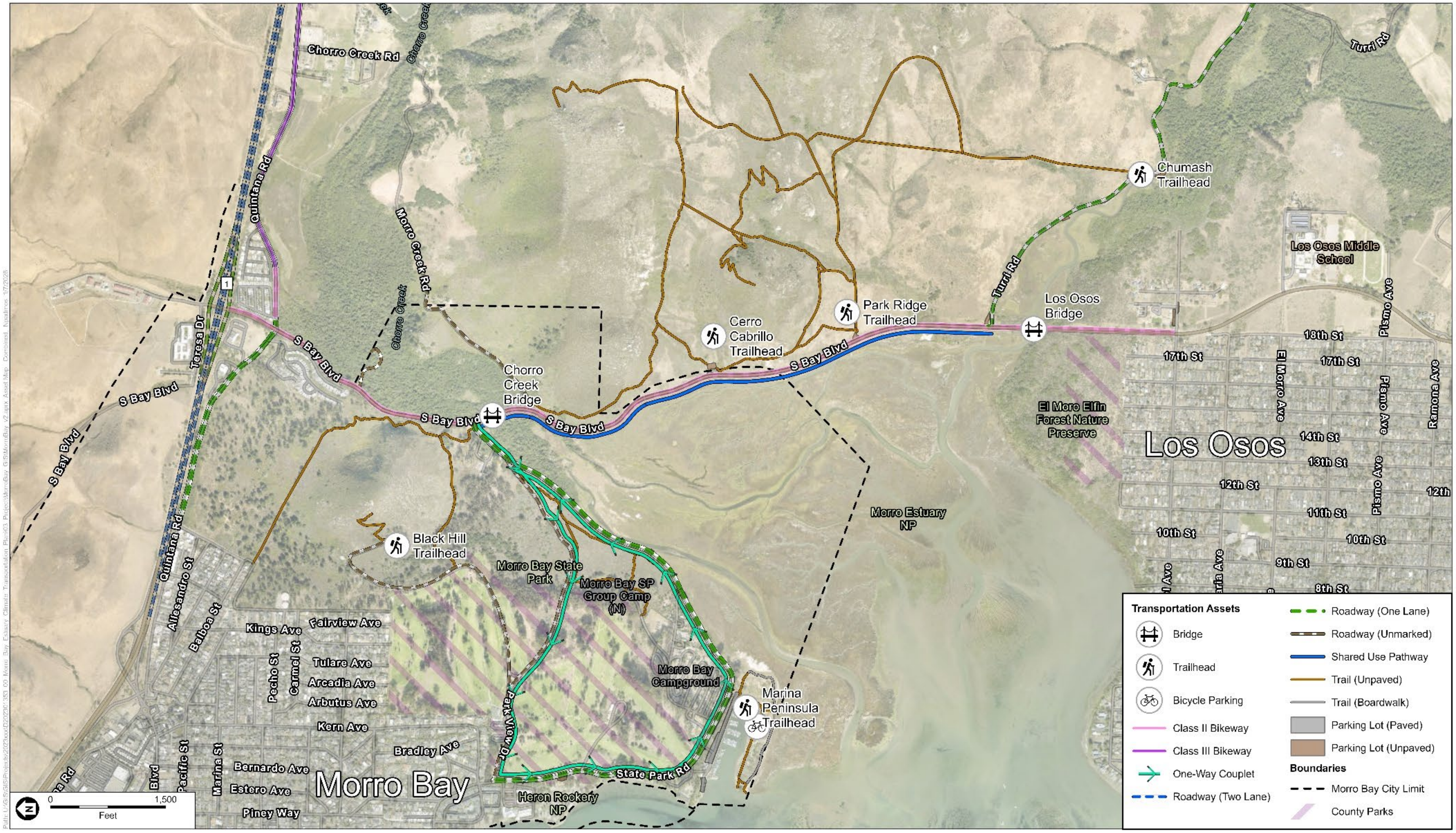
The Plan advances near-term mobility improvements as a foundational step for increasing climate resilience of the Morro Bay - Los Osos transportation corridor. Near-term aligns with the San Luis Obispo County's Regional Transportation Plan (RTP)'s near-term planning horizon (2026-2035). These measures respond directly to existing deficiencies in active transportation, address safety concerns surfaced through public outreach, and can move forward while designing and permitting for larger capital projects progress. The key near-term mobility enhancements could be implemented in an adaptation pathways approach based on triggers and thresholds (described in sections 4.3 and 4.4) and include:

- Bicycle and pedestrian improvements along South Bay Boulevard and State Park Road. The Plan recommends advancing actions such as widening bike lanes and adding separated paths where feasible, striping and signing for Class II bike lanes, or adding shared-lane markings (sharrows) in constrained segments to improve safety for cyclists and pedestrians.
- Update Best Management Practices (BMPs) to manage roadside vegetation. The Plan suggests updating BMPs for roadside vegetation to increase visibility distance, reduce hazards, and improve cyclists' comfort.
- Intersection and transit access enhancements. Targeted improvements at the South Bay Boulevard intersections with Quintana Road, State Park Road, and Turri Road, such as left turn lanes and/or roundabouts along with better connections to existing Route 12 bus stops, to support safer and more reliable multimodal travel.
- Trail and Coastal Trail connections. The Plan prioritizes closing gaps in the California Coastal Trail and improving connections between the on-street network and the State Park trail system, particularly near Windy Cove and the Marina area, so that recreation assets can continue serving the local community as coastal conditions change due to climate change.

These proposed near-term mobility improvements respond to public input, which emphasized the need for safer and more accessible biking and walking routes. By targeting road segments already exposed to flooding, the Plan would deliver immediate benefits while preparing the corridor for future adaptation phases.

8.2 Planning-Level Trail Concept and Interagency Partnership Framework

This Plan identifies limited non-motorized connectivity and gaps in the California Coastal Trail (CCT) as a key challenge in the Morro Bay–Los Osos corridor, which also could be pursued in the RTP's near-term time horizon of 2026-2035. South Bay Boulevard currently functions as a "Bike Only" segment of the CCT, with constrained roadway geometry, high vehicle speeds, and limited comfort for many users. Public input consistently emphasized the desire for safer, more accessible walking and bicycling options that complement transportation resiliency investments and protect sensitive estuarine resources. In response, this section introduces a planning-level trail concept intended to support future decision-making and interagency coordination, which could include a one-couplet in Morro Bay State Park and/or a shared use pathway adjacent to South Bay Boulevard (**Figure 28**). The concept is presented for discussion purposes only and does not represent a proposed project, alignment selection, or commitment by any agency to design, construct, operate, or maintain a trail facility. Given that portions of the study area are located within or adjacent to Morro Bay State Park and State Marine Reserve, any future trail concept would need to be explored through a collaborative partnership framework led by California State Parks and implemented in coordination with regional and local agencies.



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure 28. Planning-Level Trail Concepts

This Plan recognizes that California State Parks evaluates trail concepts through a district-led process that prioritizes:

- Resource protection and habitat integrity;
- Cultural and tribal considerations;
- Operational feasibility and long-term stewardship; and
- Public access consistent with park unit classification and management plans.

Accordingly, this Plan does not advance a specific trail alignment within State Parks. Instead, it establishes a framework for future, grant-funded feasibility planning, should State Parks determine that further exploration is appropriate. A planning-level trail concept may complement the broader adaptation strategies evaluated in this Plan by:

- Providing redundant non-motorized connectivity during roadway closures or detours;
- Supporting multi-modal evacuation and emergency access in constrained conditions;
- Allowing trail facilities to be co-located or integrated with future roadway adaptation measures (e.g., raised roadway prism, levees, or causeways), where feasible; and
- Offering opportunities for nature-based design that aligns with wetland migration, habitat restoration, and coastal resilience objectives.

Any future trail feasibility effort would need to assess how trail concepts interact with near-, mid-, and long-term adaptation pathways identified in Section 5, including thresholds and triggers related to sea level rise. The Morro Bay Estuary contains sensitive habitats, cultural resources, and areas subject to coastal squeeze. Any future trail feasibility effort would require:

- Full compliance with the California Environmental Quality Act (CEQA);
- Early and appropriate tribal engagement, following State Parks protocols;
- Evaluation of impacts to wetlands, tidal processes, and wildlife movement; and
- Consideration of climate change stressors, including sea level rise and storm surge.

This Plan acknowledges that avoiding or minimizing impacts is a primary determinant of feasibility and that some conceptual corridors may ultimately be determined infeasible. California State Parks has limited capacity to assume new long-term maintenance responsibilities. Accordingly, any future planning effort would need to evaluate alternative stewardship models, which may include:

- Interagency maintenance agreements;
- Third-party or local agency maintenance responsibilities;

- Permit-based trail segments; and
- Dedicated funding or endowment strategies.

No assumptions are made in this Plan regarding future ownership, operations, or maintenance responsibilities. This Plan does not propose a trail project. Instead, it identifies a potential planning opportunity and recommends the following next steps, subject to State Parks' interest and guidance:

1. Initial staff-level coordination with California State Parks Central Coast District to confirm whether further exploration is appropriate;
2. Grant-funded feasibility study, if supported, focused on high-level alternatives, constraints, and partnership models;
3. Integration with adaptation pathway monitoring, ensuring trail concepts remain compatible with evolving sea level rise conditions; and
4. Ongoing coordination with local agencies, including the County of San Luis Obispo, City of Morro Bay, Los Osos Community Services District, and Caltrans, to align transportation, utility, and resiliency investments.

This phased approach allows trail concepts to remain flexible, responsive to environmental conditions, and aligned with State Parks' mission and operational realities.

8.3 Roadway Elevation on Fill

Based on the outcomes of the adaptation alternatives and pathways analysis and the results of the benefit analysis, the Plan identifies the elevation of key roadway segments on fill as the preferred structural strategy for adapting the transportation corridor against coastal hazards in the near- to mid-term. This adaptation option consists of raising South Bay Boulevard, State Park Road, Turri Road and Quintana Road within their existing alignments using engineered fill, which could be pursued in the RTP's longer term planning horizon (2035-2045).

Raising road segments with engineered fill offers a practical near to mid-term solution that can be implemented with minimal disruption to surrounding resources. Using fill to increase elevation is particularly advantageous in areas with cultural resources, as it avoids the excavation that would be required if the road were to be relocated inland while providing immediate flood protection. This alternative also allows for enhanced bike and pedestrian facilities to be integrated into the design.

The Plan evaluated that elevation on fill is the priority solution for addressing increasing coastal hazards in the Morro Bay–Los Osos corridor, considering:

- **Economic performance.** Among the three adaptation options evaluated (roadway on fill, roadway on fill with retaining wall, and roadway on causeway), elevation on fill yields the highest net benefits for both tidal and storm inundation scenarios. The benefits of maintaining recreation access in Morro Bay

State Park and preserving a direct regional connection between Morro Bay and Los Osos outweigh the construction costs by a substantial margin.

- **Constructability and phasing.** Fill can be implemented incrementally along the most vulnerable segments in the near-term, coordinated with bridge replacement timelines and other planned projects. This approach supports phased elevation of low segments as thresholds for freeboard and closure frequency are reached, consistent with the trigger-based framework.
- **Compatibility with cultural and environmental constraints.** Elevating the roadway on fill limits deep excavation and foundation work within sensitive estuarine and cultural resource areas, which aligns with agency and stakeholder feedback to work largely within the existing corridor where possible.
- **Opportunity to combine flood protection with mobility upgrades.** The cross-sections developed for the Plan illustrate how fill-based elevation can co-locate Class I or Class II bicycle facilities and pedestrian paths, responding to the strong public interest in safer and more comfortable non-motorized travel. For instance, Class II bike lanes and sidewalks could be included in the northbound and southbound shoulders or Class I protected bike lanes and pedestrian path could be added on the bayward side of the roadways.

Levee concepts and long-term alternatives, such as causeways, remain part of the longer-term adaptation pathway, and are considered for subsequent phases if sea level rise and flood frequency exceed the performance of fill-based elevation. In the near-term, low berms and localized protection may supplement fill in specific locations, while the causeway concept is reserved for later horizons or along short segments for wildlife passage corridors. Ongoing monitoring of sea level rise, flood frequency, and infrastructure performance will inform future decisions.

Throughout the planning process, community members and stakeholders consistently advocated for solutions that improve mobility and protect access to natural and recreational assets. Advisory committee members highlighted the importance of maintaining South Bay Boulevard as a critical evacuation route and supported phased adaptation that allows for monitoring and adjustment over time. The Plan's prioritization reflects these preferences, advancing solutions that deliver immediate improvements and position the corridor for long-term resilience.

The following figures illustrate the conceptual adaptation alternatives for different segments along the transportation corridor, focusing on elevating the roads on fill. Figure 13 shows the location of the cross-sections presented below. The figures also show examples of BMPs for vegetation management and long-term alternatives of levees and causeways, which may be considered if sea level rise and flood frequency begin to exceed the performance of fill-based elevation. Short causeway segments may also be considered for wildlife passage. A complete description and presentation of all cross sections is provided in Attachment D.

Figure 29 presents the adaptation concepts for Main Street, including an example of vegetation management along the southbound travel lane (Cross Section E3). **Figure 30** shows the conceptual illustration of the road at Windy Cove raised on fill, including an elevated Class I bike path (Cross Section F2), and it also shows the long-term alternative of the road elevated on a causeway (Cross Section F1). **Figures 31 and 32** present the prioritized solutions for South Bay Boulevard, north and south, respectively, with the road elevated on fill (Cross Section C5) and also a long-term alternative of the road elevated on fill and a levee (Cross Section C6). **Figure 33** presents the near-term alternative for Quintana Road, with road and class 1 and class 2 bike paths elevated on fill, it also shows example of vegetation management to improve visibility and safety (Cross Section B1).

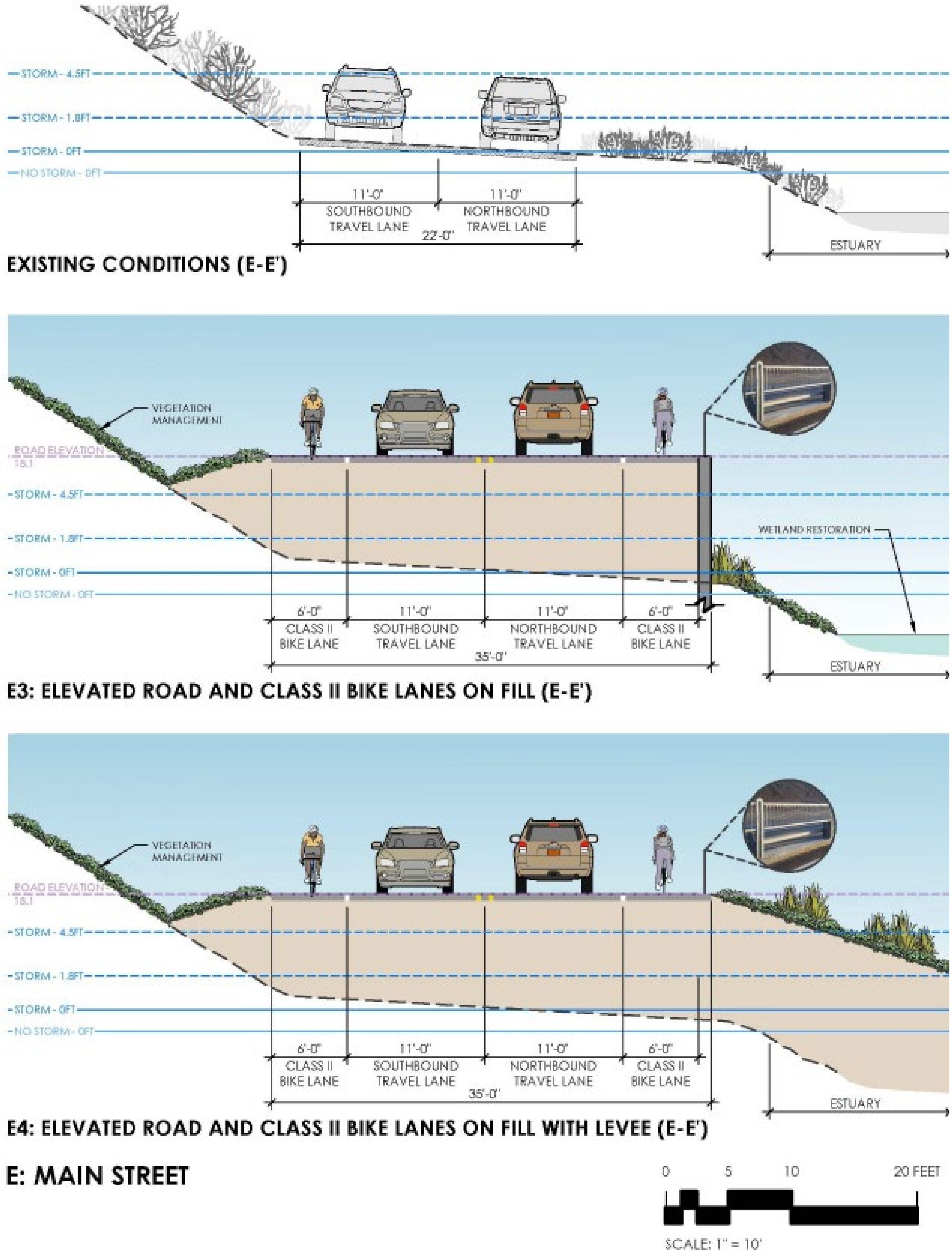


Figure 29. Cross Sections E-E' with Near-term Adaptation Alternatives for Main Street

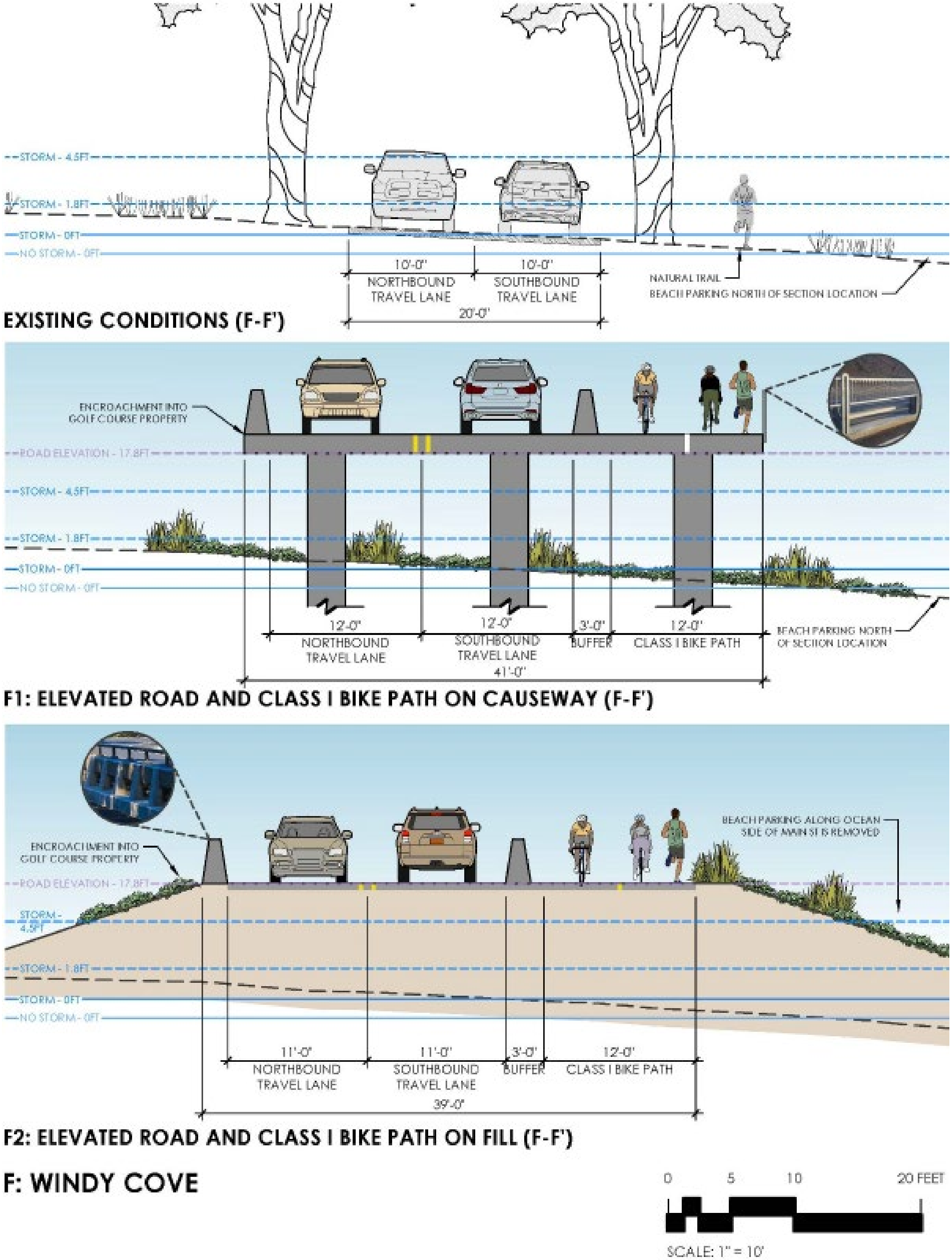


Figure 30. Cross Sections F-F' with Near-term Adaptation Alternatives for Windy Cove

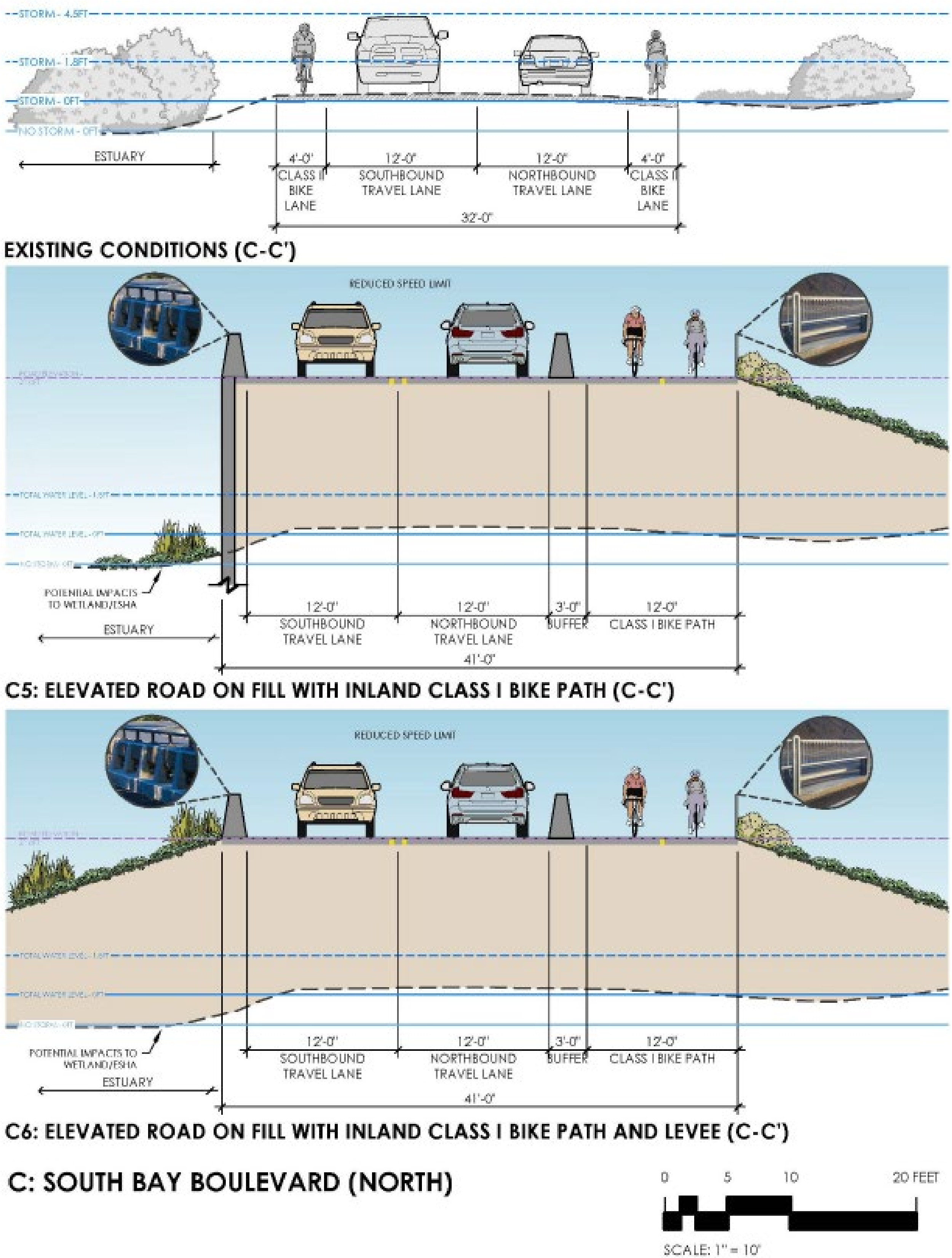


Figure 31. Cross Sections C-C' with Near-term Adaptation Alternatives for South Bay Boulevard (North)

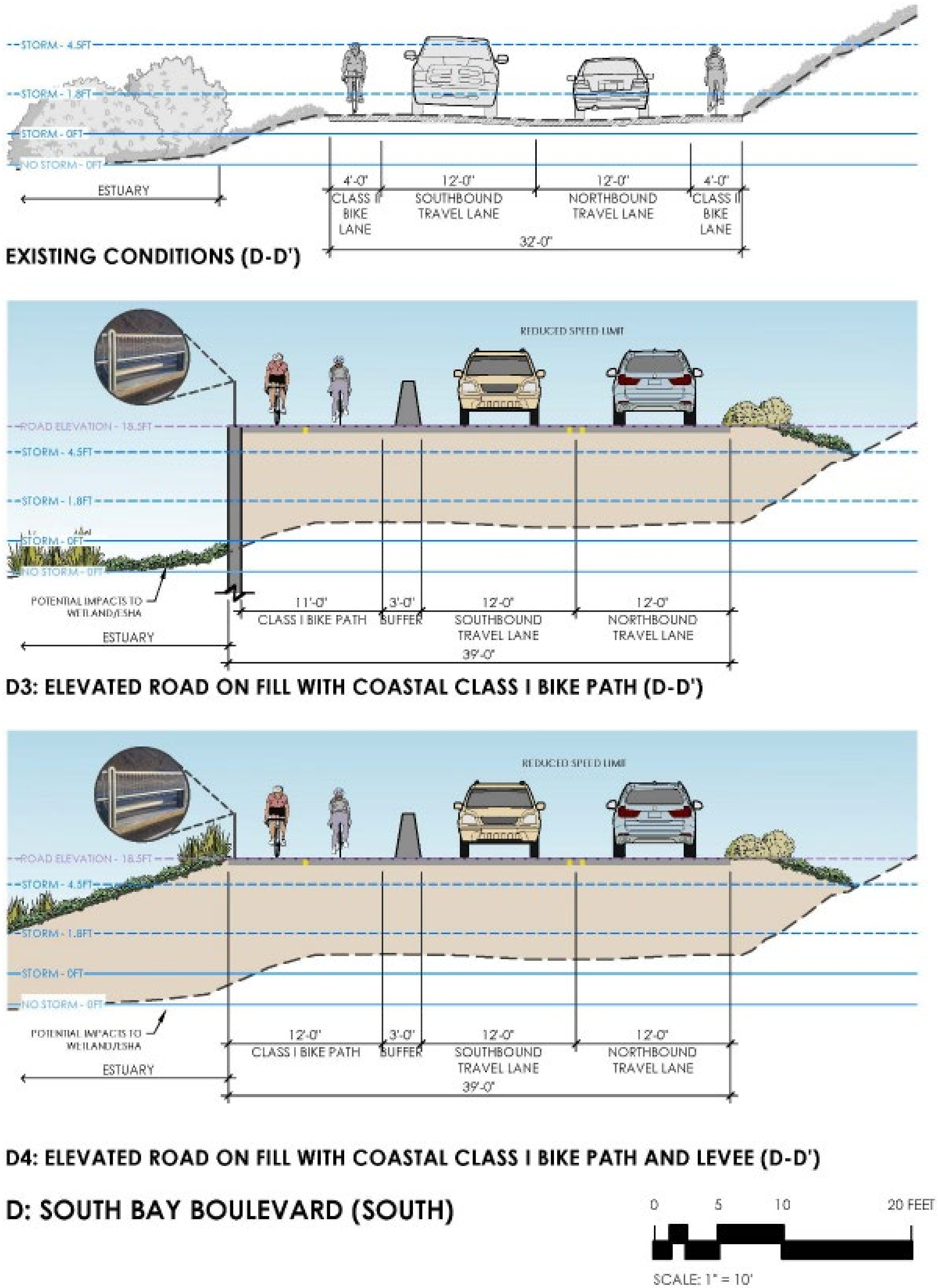


Figure 32. Cross Sections D-D' with Near-term Adaptation Alternatives for South Bay Boulevard (South)

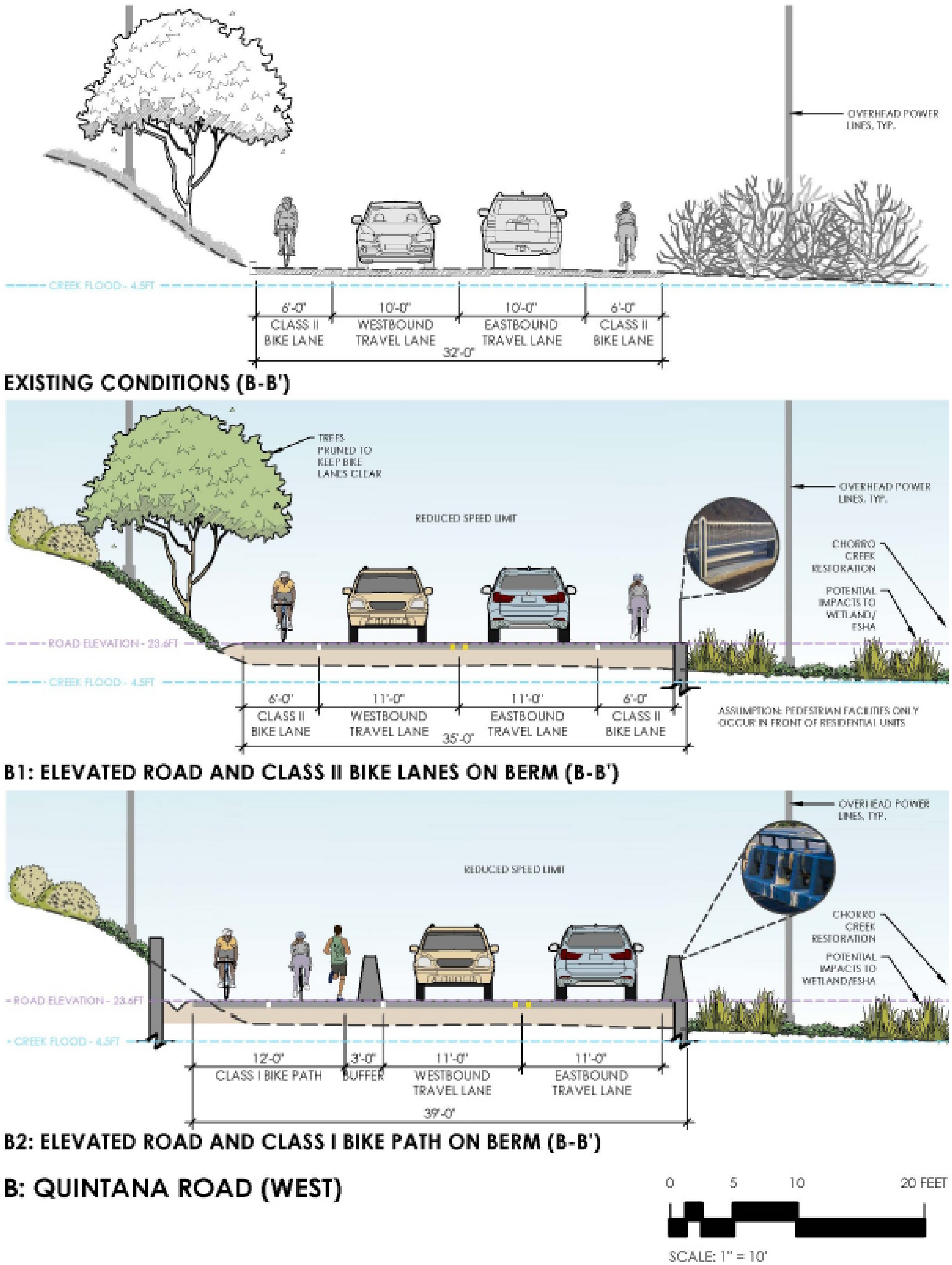


Figure 33. Cross Sections B-B' with Near-term Adaptation Alternatives for Quintana Road

9. NEXT STEPS

This section describes next steps for the solutions that were prioritized through the analysis and through input received from the public and stakeholders. **Table 19** describes the potential timeframe, implementing agencies, estimated cost, permits required, potential funding sources, and anticipated implementation challenges, including permitting requirements for local, state and federal agencies. Depending on the details of the proposed project, construction of the prioritized solutions would potentially require permits from California Coastal Commission (CCC), California Department of Fish and Wildlife Service (CDFW), the Central Coast Regional Water Quality Control Board (RWQCB), United States Army Corps of Engineers (USACE), National Marine Fisheries Service (NMFS) and/or United State Fish and Wildlife Service (USFWS). The project would also need to satisfy the requirements of the California Environmental Quality Act (CEQA). Early coordination with regulatory agencies would be critical in identifying design constraints and mitigation requirements to expedite permitting for the prioritized solutions.

For example, if implementing agencies decided to pursue a separated boardwalk that is elevated over the Morro Bay Estuary, there would be permit requirements related to building a structure over waters of the state / United States, wetlands, environmentally sensitive habitat areas (ESHA), special status species habitat (state and federal), as well as water quality concerns and visual impact concerns. The design of the structure would have to minimize impacts to wetland and eelgrass functions, including minimizing shading, scour around pilings, turbidity, and habitat fragmentation. The project would need to minimize construction access impacts by using temporary mats, barges, or adjacent staging areas. The boardwalk piers would need to minimize impacts to sediment transport. Finally, the project would need to analyze the potential risk of coastal hazards, including wave runup and sea level rise and the implications for long-term maintenance, debris, and damage risk in a dynamic tidal system. The structure should be designed to minimize risks from coastal hazards over the expected life of the structure, which could result in a boardwalk that is significantly elevated above the wetland, leading to visual impacts and higher construction costs. The following regulations could constrain the design and complicate the implementation of an elevated boardwalk:

- CEQA (California Environmental Quality Act): A new elevated boardwalk would require CEQA review, i.e., an Initial Study / Mitigated Negative Declaration or Environmental Impact Report depending on the potential impacts of the project. CEQA requires analysis of a project’s impacts to certain resources, including biological resources, cultural resources, hydrology and water quality, visual resources. If impacts are determined to be significant, then the project is required to include avoidance and minimization measures, as well as robust alternatives analysis. CEQA typically precedes permitting.

- Federal Clean Water Act (CWA): CWA Section 404 requires USACE authorization for any discharge of dredged/fill material into “waters of the U.S.” including wetlands. CWA Section 401 water quality certification (or waiver) is typically required for projects needing Section 404 permits. Analysis and permit conditions often target turbidity, sediment, pollutants, construction timing, and habitat protection.

- Federal Rivers and Harbors Act: Section 10 is required by USACE for structures in navigable waters. If the alignment is below the high tide line and/or in tidal waters used (or susceptible to use) for navigation, a Section 10 permit may be required for any structure (pilings, piers, boardwalks) in navigable waters.

- California Coastal Act and/or San Luis Obispo County Local Coastal Program (LCP): Under the Coastal Act and LCP, a Coastal Development Permit (CDP) would be required from CCC and/or SLO County for any of the prioritized solutions. Coastal permitting carefully analyzes potential impacts to wetlands, ESHA, public access, shoreline hazards, sea level rise and the least environmentally damaging feasible alternatives.

- Federal and California Endangered Species Acts (FESA/CESA): Depending on the presence of special status species and construction window, the project could require consultation with USFWS/NMFS if listed species or their critical habitat may be affected by the project. Likewise, consultation with CDFW may be required if state-listed species could be affected. These laws can result in seasonal work windows, monitoring, buffers, lighting limits, noise controls, or require redesign/relocation if impacts to listed species cannot be avoided.

- California Fish & Game Code, Section 1600: A Lake Streambed Alteration Agreement may be required for the project from CDFW if the project would affect riparian areas, streams, or wetlands.

- Landownership constraints: In addition to the permits described above, the project may also need separate real-property authorization (e.g., an easement or lease) if it crosses sovereign tidelands/submerged lands or State Parks/Harbor-managed property.

The project would first formulate its CEQA strategy. Then early regulatory agency coordination would include conducting a wetland delineation, holding pre-application meetings with relevant permitting agencies, such as California Coastal Commission, USACE, RWQCB, USFWS/NMFS and CDFW, in order to confirm CWA Section 401/404 requirements and special status species constraints. The environmental review process is shown in **Figure 34** below.

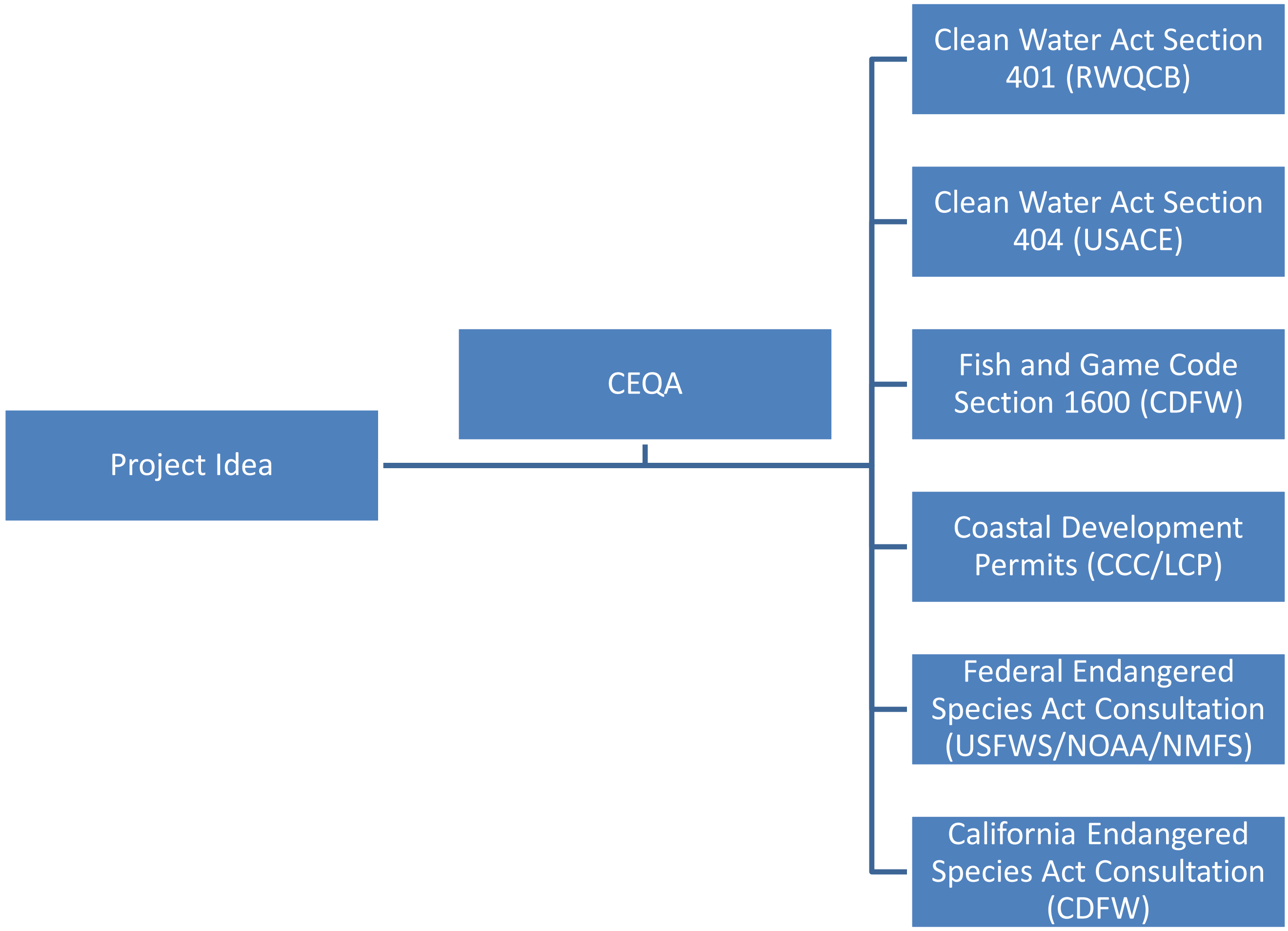


Figure 34. Simplified Environmental Review Process

A boardwalk over the estuary would also need to comply with the Federal Accessibility Guidelines for Outdoor Developed Areas (OFDOAG), which are designed to provide meaningful access while recognizing the environmental and topographic constraints of natural settings. Unlike fully urban sidewalks, OFDOAG focuses on outdoor conditions and sets performance-based criteria for elements such as trail width, running slope, cross slope, surface firmness and stability, passing spaces, and resting intervals. Importantly, the guidelines allow flexibility where compliance would fundamentally alter the natural character or cause significant environmental harm—an approach that is highly relevant in sensitive coastal and estuarine landscapes. For the Morro Bay proposal, this framework is salient because it allows the trail to be framed as "ADA-accessible where feasible" rather than universally ADA-compliant end-to-end. Shorter accessible segments, loop trails, overlooks, or connections to parking and transit nodes can substantially expand inclusive access without forcing uniform design standards across environmentally constrained areas. This aligns well with California State Parks practice, where accessibility improvements are often implemented incrementally and in partnership, rather than as a single continuous facility.

Other projects provide a useful precedent for how major infrastructure can integrate regional trail systems without over-committing to final design. For example, the Foster City Levee Protection Planning and Improvements Project EIR treated the Bay Trail as a co-located public access feature that would be maintained or reconstructed as part of levee improvements, while deferring precise trail geometry and surfacing to later phases. This approach allowed the City to acknowledge recreation and accessibility benefits while keeping the environmental analysis focused on the primary flood-protection purpose. A key lesson from Foster City is the value of conceptual inclusion with clear disclaimers. The EIR consistently emphasized that trail configurations could evolve as levee types (earthen, floodwall, horizontal levee) were refined, and it analyzed recreation and access impacts at a programmatic level rather than locking in standards prematurely. For Morro Bay, a similar strategy—acknowledging OFDOAG-informed accessibility goals while deferring alignment, width, and surface decisions to a future, State-Parks-led feasibility effort—can strengthen the proposal's inclusivity without triggering unnecessary environmental or operational concerns.

Finally, the Foster City example demonstrates that accessibility and resilience can be mutually reinforcing. By pairing trail continuity with adaptation infrastructure, the project framed public access as a co-benefit of climate investment rather than a competing objective. That framing is directly transferable to Morro Bay, where accessible trail segments can be positioned as part of a broader, partnership-based strategy to maintain coastal access over time in the face of sea level rise, consistent with both State Parks' mission and federal accessibility principles.

In addition to next steps for implementing the prioritized solutions, additional policy changes could be made to facilitate the implementation of adaptation planning. For example, the City of Morro Bay and San Luis Obispo County have a certified Local Coastal Programs (LCP). The City of Morro Bay recently updated their LCP to include coastal hazards policies, but the County's LCP does not address coastal hazards resulting from sea level rise. A potential next step would be for the County to pursue a countywide sea level rise vulnerability assessment and adaptation plan that could be used to inform a Local Coastal Program amendment that would satisfy the requirements of SB 272.

Future planning efforts should also include coordination with ongoing regional studies and modeling, such as sediment accretion and sea level rise research conducted by the Morro Bay National Estuary Program and USGS. These efforts are providing new insights into wetland response and coastal resilience under changing conditions, and their findings may inform adaptation strategies for transportation and habitat management in the project area.

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TABLE 19.
IMPLEMENTATION PLAN

Prioritized Solution	Implementing Agency	Estimated Cost	Potential Permits Required	Potential Funding Sources
Bicycle and pedestrian improvements along South Bay Boulevard and State Park Road, including widening bike lanes, striping and signing for Class II bike lanes, or adding shared-lane markings (sharrows) in constrained segments to improve safety for cyclists and pedestrians	City of Morro Bay Public Works Department / San Luis Obispo County Department of Public Works	Relatively low	None	Capital Improvement Program
Update Best Management Practices (BMPs) to manage roadside vegetation	City of Morro Bay Public Works Department / San Luis Obispo County Department of Public Works	Relatively low	None	General Fund (staff time)
Intersection and transit access enhancements	City of Morro Bay Public Works Department / San Luis Obispo County Department of Public Works / San Luis Obispo Regioanl Transit Authority	Potentially high	CDFW Incidental Take Permit USACE CWA Section 404 RWQCB CWA Section 401 CCC CDP USFWS / NMFS	Capital Improvement Program; Caltrans Local Assistance Program

Prioritized Solution	Implementing Agency	Estimated Cost	Potential Permits Required	Potential Funding Sources
Trail and Coastal Trail connections.	City of Morro Bay Public Works Department / San Luis Obispo County Department of Public Works / California State Parks	Potentially high	CDFW Incidental Take Permit USACE CWA Section 404 RWQCB CWA Section 401 CCC CDP USFWS / NMFS	State Coastal Conservancy; Capital Improvement Program
Elevation on fill	City of Morro Bay Public Works Department / San Luis Obispo County Department of Public Works	Design Fees: $150,000 per mile Construction Cost: $11,000,000 per mile	CDFW Incidental Take Permit USACE CWA Section 404 RWQCB CWA Section 401 CCC CDP USFWS / NMFS	Caltrans Local Assistance Program; Capital Improvement Program
Planning and Coordination Actions, including submitting grant applications	California State Parks; City of Morro Bay; San Luis Obispo County Public Works; SLOCOG	Relatively low	N/A	State Coastal Conservancy; California Coastal Commission; Ocean Protection Council; Caltrans Local Assistance Program;

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11. ACKNOWLEDGMENTS

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Attachment A.
Sea Level Rise Scenarios Memo

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memorandum

date September 11, 2024

to John Dinunzio, SLOCOG

cc

from Louis White PE, Amber Inggs PE, ESA

subject FINAL Summary of Additional Guidance Memorandum for the Morro Bay Estuary Climate Transportation Plan

1 Introduction

This memo presents a preliminary assessment of sea level rise for the Morro Bay Estuary Climate Transportation Plan (The Plan) to be used by the ESA team under contract to the San Luis Obispo Council of Governments (SLOCOG). The sea level rise scenarios and planning horizons presented below will be used to provide analyses to explore a variety of strategies that could cultivate transportation and ecological resilience over a range of time horizons.

These sea level rise scenarios are consistent with the latest State guidance documents and available coastal hazard maps for the Port San Luis area, including the California Ocean Protection Council and United States Geological Survey (USGS) CoSMoS 3.0 (OPC, 2024; O'Neill, et al., 2018).

ESA recommends using a thresholds approach in the Morro Bay Estuary Climate Transportation Plan to examine the sea level rise impacts by incremental amounts. The method involves identifying specific amounts of sea level rise, or thresholds, at which assets become vulnerable. The sea level rise guidance, projections, and threshold approach are summarized in the following sections.

2 California State Sea Level Rise Policy Guidance

The California Ocean Protection Council (OPC) recently finalized the State of California Sea Level Rise Guidance: 2024 Science and Policy Update (OPC, 2024), which provides projections for sea level rise at various locations along the coast of California through 2150. OPC produced this guidance in partnership with the California Ocean Science Trust (OST) and a scientific Task Force. The guidance is based on the National Oceanic and Atmospheric Administration (NOAA) 2022 Global and Regional Sea Level Rise Scenarios for the United States (Sweet, et al., 2022), which provides updated sea level rise scenarios for the United States based on global projections from the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report. The updated 2024 guidance **(Table 1)** presents five sea level rise scenarios and values that incorporate: (1) sea level rise observations, estimated and modeled projections, and uncertainties, and (2) a range of global greenhouse gas emissions scenarios, which rely on shared socioeconomic pathways (SSPs).[1] The following summaries of each scenario are provided in the State of California Sea Level Rise Guidance (2024):

Low Scenario: Aggressive emissions reductions leading to very low future emissions; the scenario is on the lower bounding edge of plausibility given current warming and sea level trajectories, and current societal and policy momentum.

Intermediate-Low Scenario: A range of future emissions pathways; a reasonable estimate of the lower bound of most likely sea level rise in 2100 based on support from sea level observations and current estimates of future warming.

Intermediate Scenario: A range of future emissions pathways; could include contribution from low confidence processes. Based on sea level observations and current estimates of future warming, a reasonable estimate of the upper bound of most likely sea level rise in 2100.

Intermediate-High Scenario: Intermediate-to-high future emissions and high warming; this scenario is heavily reflective of a world where rapid ice sheet loss processes are contributing to sea level rise.

High Scenario: High future emissions and high warming with large potential contributions from rapid ice-sheet loss processes; given the reliance on sea level contributions for processes in which there is currently low confidence in their understanding, a statement on the likelihood of reaching this scenario is not possible.

Several changes were made from the previous State of California Sea Level Rise Guidance (OPC, 2018) (**Table 2**). The updated 2024 Guidance removes the extreme sea level rise scenario (H++) that was included in the previous guidance. The H++ scenario assumed rapid ice sheet loss on Antarctica, which could drive rates of sea level rise 30-40 times faster than the sea level rise experienced over the last century. This scenario is not included in the 2024 update, as the rates and amounts of sea level rise are not supported by best available science. Additionally, the 2024 guidance provides a greater certainty of sea level rise through 2050, with a California statewide average of 0.8 feet. By 2100, the expected range of sea level rise is between 1.6 and 3.1 feet, although higher amounts cannot be ruled out. Beyond 2100, sea level rise uncertainty increases, with the potential for statewide sea levels to rise from 2.6 to 11.9 feet or greater by 2150.

The updated guidance recommends evaluation of the Intermediate, Intermediate-High, and High Scenarios in sea level rise planning and projects. The High Scenario is sufficiently precautionary for even the most risk averse applications. The High Scenario assumes high future greenhouse gas emissions. Note that future emissions are inherently uncertain because emissions depend on societal choices; therefore, it is not possible to estimate the probability that future emissions will be high. Assuming high emissions and considering the range of model projections for a high emissions scenario, the High Scenario's sea level rise estimates have less than a 1% chance

---

[1] SSP background from OPC 2024 guidance: *Developed more recently, the SSPs are a collection of narrative descriptions of alternative futures of socio-economic development in the absence of climate policy intervention. Five SSPs describe five different pathways that the world could take, drawing on data including population, economic growth, education, urbanization, and the rate of technological development. The SSPs are important inputs into the IPCC sixth assessment and are used to explore how societal choices will affect greenhouse gas emissions. Pathways 5-85 (SSP 585) assumes heavy fossil-fueled development with high percentage of coal and energy-intensive lifestyles worldwide and assumes a radiative forcing of 8.5 W/ m^2.*

of exceedance in 2100.[2] Each of the three recommended scenarios corresponds with low, medium-high, and extreme risk aversion applications:

- *Low risk aversion* is appropriate for adaptive, lower consequence projects (e.g., unpaved coastal trails). The *Intermediate Scenario* is recommended for consideration in low risk aversion applications.
- *Medium-high risk aversion* is appropriate as a precautionary projection that can be used for less adaptive, more vulnerable projects or populations that will experience medium to high consequences as a result of underestimating sea level rise (e.g., coastal housing development). The *Intermediate-High Scenario* is recommended for consideration in medium-high risk aversion applications.
- *Extreme risk aversion* is appropriate for high consequence projects with little to no adaptive capacity and which could have considerable public health, public safety, or environmental impacts (e.g., coastal airport, power plant, wastewater treatment plant, etc.). The *High Scenario* is recommended for consideration in extreme risk aversion applications.

The OPC guidance recommends utilizing data from one of twelve NOAA tide gauges that are located along the coast of California. Using the data from the nearest tide gauge to the project site can capture local variations due to tectonic activity or subsidence. The nearest NOAA tide gauge to Morro Bay Estuary is located at Port San Luis near Avila Beach.

[2] As stated in OPC (2024): "It is important to note that probabilistic projections do not provide actual probabilities of occurrence of sea level rise but provide probabilities that the ensemble of climate models used to estimate contributions of sea-level rise (from processes such as thermal expansion, glacier and ice sheet mass balance, and oceanographic conditions, among others) will predict a certain amount of sea-level rise." Also, note that the High Scenario has an 8% chance of exceedance when accounting for low confidence processes associated with Antarctica and Greenland ice-sheet loss.

Sea level rise projections for Port San Luis from the 2024 OPC Guidance and 2018 OPC Guidance are shown through 2150 for each risk aversion in **Figure 1**.

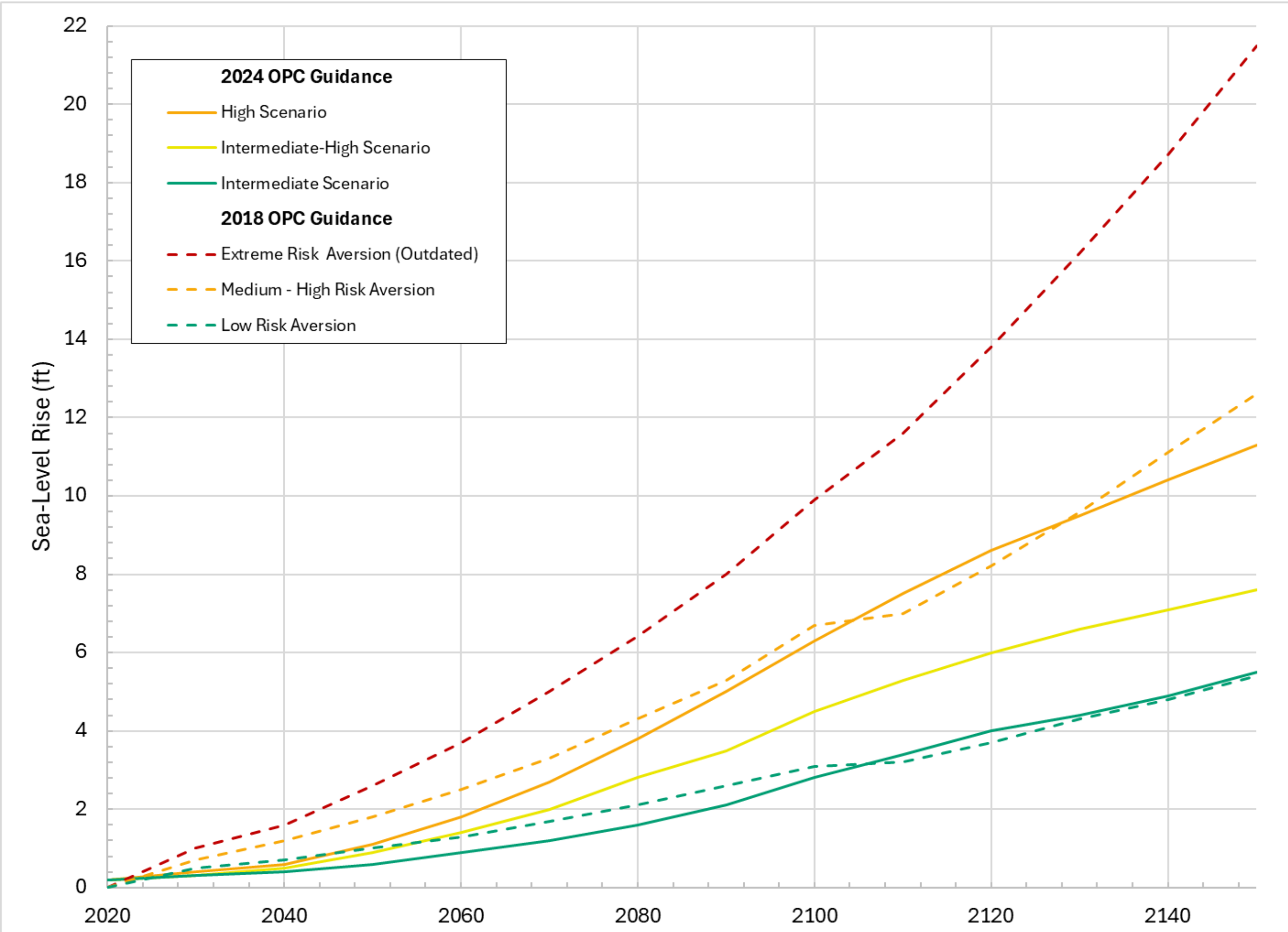

Figure 1
Sea level rise projections for Port San Luis from 2020 to 2150 from 2024 and 2018 CA OPC Sea Level Rise Guidance

While the OPC Guidance provides projections through 2150, it is important to note that sea level rise is expected to continue for centuries, because the earth's climate, cryosphere,[3] and ocean systems will require time to respond to the emissions that have already been released to the atmosphere. Although sea level rise is typically presented as a range in the amount of sea level rise that will occur by a certain date (e.g., 0.6-1.1 feet of sea level rise by 2050), it can also be presented as a range of time during which a certain amount of sea level rise is projected to occur (e.g., 1.6 feet of sea level rise between 2060 and 2080). Even if emissions are reduced to levels consistent with the low-emissions-based projections, sea level will continue to rise to higher levels, just at a later date.

[3] The cryosphere is the portions of the Earth's surface where water is in solid form, like glaciers and ice caps.

Table 1 presents State-recommended projections for the Morro Bay area in terms of Low, Intermediate-Low, Intermediate, Intermediate-High, and High Scenarios. The recommended scenarios for evaluation (Intermediate, Intermediate-High, and High) are outlined by the dark blue box.

TABLE 1
2024 OPC STATE GUIDANCE: PROJECTED SEA LEVEL RISE FOR PORT SAN LUIS AREA IN FEET

Year	Low	Int-Low	Intermediate (Low Risk Aversion)	Int-High (Medium-High Risk Aversion)	High (Extreme Risk Aversion)
2020	0.1	0.2	0.2	0.2	0.2
2030	0.2	0.3	0.3	0.3	0.4
2040	0.3	0.4	0.4	0.5	0.6
2050	0.3	0.5	0.6	0.9	1.1
2060	0.4	0.6	0.9	1.4	1.8
2070	0.5	0.7	1.2	2.0	2.7
2080	0.5	0.9	1.6	2.8	3.8
2090	0.5	1.1	2.1	3.5	5.0
2100	0.6	1.2	2.8	4.5	6.3
2110	0.6	1.4	3.4	5.3	7.5
2120	0.7	1.5	4.0	6.0	8.6
2130	0.7	1.7	4.4	6.6	9.5
2140	0.7	1.9	4.9	7.1	10.4
2150	0.8	2.0	5.5	7.6	11.3

NOTE:

Median values of Sea Level Scenarios, in feet, for each decade from 2020 to 2150, with a baseline of 2000. All median scenario values incorporate the local estimate of vertical land motion.

SOURCE: 2024 OPC Guidance

Table 2 presents the outdated 2018 State-recommended projections for the Morro Bay area in terms of Low, Medium-High, and Extreme Risk Aversion scenarios.

TABLE 2
2018 OPC STATE GUIDANCE: PROJECTED SEA LEVEL RISE FOR PORT SAN LUIS AREA IN FEET

Year	Low Risk Aversion	Medium-High Risk Aversion	Extreme Risk Aversion
2030	0.5	0.7	1.0
2040	0.7	1.2	1.6
2050	1.0	1.8	2.6
2060	1.3	2.5	3.7
2070	1.7	3.3	5.0
2080	2.1	4.3	6.4
2090	2.6	5.3	8.0
2100	3.1	6.7	9.9
2110	3.2	7.0	11.6
2120	3.7	8.2	13.8
2130	4.3	9.6	16.2
2140	4.8	11.1	18.7
2150	5.4	12.6	21.5

NOTE:
Median values of Sea Level Scenarios, in feet, for each decade from 2020 to 2150, with a baseline of 2000. All median scenario values incorporate the local estimate of vertical land motion. Projections after 2100 should be used with caution as there is increased uncertainty due to most available climate models at the time did not extend beyond 2100.

2.1 Critical Infrastructure Guidance for Sea Level Rise Adaptation Planning

In 2021, the California Coastal Commission (CCC) adopted the Critical Infrastructure Guidance for Sea Level Rise Adaptation Planning with specific guidance for sea level rise adaptation of at-risk critical infrastructure (CCC, 2021). The CCC Critical Infrastructure Guidance is based on the previous 2018 OPC California Sea Level Rise Guidance (OPC, 2018), which is superseded by the 2024 OPC guidance. The CCC Critical Infrastructure Guidance is summarized below for reference.

The CCC 2021 guidance document is focused on transportation and water/wastewater infrastructure and builds upon the 2018 science update to the CCC Sea Level Rise Policy Guidance (CCC, 2018). The purpose of the critical infrastructure guidance is to provide policy and planning information to inform sea level rise planning and adaptation decisions that are consistent with the California Coastal Act. The guidance presents key considerations for successful infrastructure adaptation planning with specific recommendations for each infrastructure category, describes the regulatory framework for infrastructure adaptation planning and provides model policies.

Consistent with direction from OPC 2018 guidance on the potential for extreme sea level rise, CCC recommended evaluating the extreme risk aversion (H++) scenario for critical infrastructure due to the long lifespans and significant consequences associated with extreme sea level rise and related hazard impacts. CCC guidance was to:

> *"understand and plan for the H++ scenario, not necessarily to site and design for the H++ scenario. In other words, in some cases it may not be appropriate or feasible to site or design a project today such that it will avoid the impacts associated with, for example, ~10 feet of sea level rise (the approximate H++ scenario in 2100 for much of the California coast). However, it is important to analyze this scenario to understand what the associated impacts could be and to begin planning options to adapt to this scenario if and when it occurs, and to ensure that the risks and benefits of economic investments in critical infrastructure are fully understood."*

Given that the 2024 OPC guidance is the best available science and does not include the H++ scenario, the superseded OPC 2018 guidance's extreme risk aversion (H++) scenario is not recommended for this study and the 2024 OPC guidance's High sea level rise scenario is used instead.

3 Suggested Approach for the Morro Bay Estuary Climate Transportation Plan

Sea level rise scenarios are recommended by considering the 2024 OPC guidance discussed above (which is based on the latest sea level rise science) and the availability of existing sea level rise hazard data for this study.

3.1 Thresholds Approach

ESA recommends using a thresholds approach in the Morro Bay Estuary Climate Transportation Plan to examine the sea level rise impacts by incremental amounts. The method involves identifying specific amounts of sea level rise, or thresholds, at which assets become vulnerable.

This approach differs from the chosen sea level rise scenario approach, which chooses three or so sea level rise amounts that are applied to the entire project. In the threshold approach, specific assets will have different sea level rise thresholds. For example, South Bay Blvd near Twin Bridges may have a different sea level rise threshold than the State Park Road bordering the bay in the Morro Bay State Park.

Sea level rise thresholds will be determined in the vulnerability analysis task of the Morro Bay Estuary Climate Transportation Plan. To determine the approximate timing of the sea level rise thresholds, the state recommended 2024 OPC projections for the Intermediate, Intermediate-High, and High will be used. Each projection is given an approximate year, and thus there will be a time range based on the risk level, Intermediate to High.

This is a different approach than what was used in the 2021 Plan Morro Bay, which analyzed sea level rise in the years 2030, 2050, and 2100, associated in the plan with 0.5 ft, 0.9 ft, and 3.1 ft of sea level rise, respectively. The timing of these sea level rise amounts corresponds to a superseded "low risk aversion" from the 2018 State of California Sea Level Rise Guidance (OPC, 2018).

Note that future global greenhouse gas emissions scenarios drive the sea level rise projections reported by the OPC. These emissions scenarios are influenced by societal choices and therefore their likelihood of occurrence is inherently uncertain. Sea level rise scenarios are determined by modeling a range of global emissions projections and considering a range of uncertainties in sea level rise processes. Due to the inherent uncertainty of future emissions scenarios, the probability of sea levels rising a specific amount by a specific date cannot be determined. Instead, the probability of exceedance of a particular sea level rise scenario provided by the 2024 OPC guidance is contingent or conditional on the assumption of a particular future emissions and warming scenario.

4 References

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O'Neill, A., Erickson, L., Barnard, P., Vitousek, S., Warrick, J., Foxgrover, A., & Lovering, J., 2018. *Projected 21st Century Coastal Flooding in the Southern California Bight. Part 1: Development of the Third Generation CoSMoS Model*. Journal of Marine Science and Engineering, 6(2), 59. May 24, 2018. Accessed online: https://doi.org/10.3390/jmse6020059.

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Attachment B.
Existing Conditions Memo

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memorandum

date	October 4, 2024
to	John Dinunzio, SLOCOG
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from	Shannon Fiala, Louis White, PE, Amber Inggs, PE
subject	FINAL Assessment Memorandum for the Morro Bay Estuary Climate Transportation Plan (ESA Ref. D202301353.00)

1 Introduction

This memo presents a preliminary assessment of existing conditions and performance of the transportation corridor to identify deficiencies along the corridor that will be used by the ESA team to focus development of adaptation actions as part of the Morro Bay Estuary Climate Transportation Plan (The Plan) with the San Luis Obispo Council of Governments (SLOCOG). Results will highlight specific issues caused by the mobility corridor's deficiencies in terms of safety, connectivity, travel time reliability, and sustainability. The assessment will also include a preliminary description of a scenario where no action is taken, which will be built upon by findings of subsequent tasks (e.g., Task 2.2 Coastal Flood Hazard and Vulnerability Analysis).

2 Corridor Performance

2.1 Safety

2.1.1 Collisions

South Bay Boulevard has been identified as a Tier 2 High Injury Network south of the intersection with Morro Creek Road (SLOCOG, 2024b). Several intersections in the study area have also been identified as problematic, including the intersection of South Bay Boulevard with Quintana Road, State Park Road, and Turri Road. However, the density of vehicle-vehicle collisions in the study area is relatively low (SLOCOG, 2024e). There were no recorded or reported non-motorized collisions between vehicles and bicycles or vehicles and pedestrians from 2016-2020 (SLOCOG, 2024e) and there have been no recorded or reported collisions between vehicles and wildlife in the study area (UC Davis, 2024). However, there is anecdotal evidence of feral pigs that have been hit on S. Bay Blvd. The pigs are mostly in the watershed but come down to the estuary to feed when conditions are dry.

2.1.2 Evacuation routes

In the event of a natural disaster, such as a wildfire, or a nuclear disaster at the Diablo Canyon Power Plant, there are only two roads that serve as evacuation routes for the community of Los Osos: South Bay Boulevard and Los Osos Valley Road. If South Bay Boulevard was flooded or unusable for any other reason, the only evacuation route would be the two-lane Los Osos Valley Road.[1] Although it is outside the study area for the Plan, Los Osos Valley Road could also be vulnerable to current and future flood risks due its proximity to nearby creeks.

2.1.3 Emergency response times

In the event of an emergency, any emergency responders, such as police or fire personnel, traveling from Morro Bay to Los Osos would typically use South Bay Boulevard to travel to Los Osos and the travel time is typically 15 minutes, depending on the exact origin and destination. If South Bay Boulevard was flooded or unusable for any other reason, the only available detour (onto Highway 1 east to W Foothill Boulevard returning via Los Osos Valley Road) would double emergency response time to 30 minutes.[2]

2.2 Connectivity

2.2.1 Bike and pedestrian infrastructure

A Class II / designated bike lane exists on South Bay Boulevard and South Bay Boulevard is a part of the Pacific Coast Bike Route (SLOCOG, 2024a). However, the speed limit is 50 miles per hour, which may deter less experienced bicyclists from using the unprotected bike lane. Furthermore, there are no sidewalks along South Bay Boulevard (SLOCOG, 2024a).

2.2.2 Trail network

There is an existing trail system within Morro Bay State Park, west and east of South Bay Boulevard, including the trails surrounding Black Hill to the west and trails that lead from trailheads east of South Bay Boulevard to the eastern park boundary (State Parks, 2024). However, there are no existing trails that parallel South Bay Boulevard that would provide an alternative to walking or biking in the shoulder or bike lane on South Bay Boulevard. South Bay Boulevard is identified as a "Bike Only" segment of the California Coastal Trail (CCT). However, there is a gap in the CCT along State Park Road from Bayside Café in Morro Bay State Park to the intersection with South Bay Boulevard (California Coastal Trail, 2024).

2.2.3 Transit routes

San Luis Obispo Regional Transit Authority's Bus Route 12 connects Los Osos and Baywood Park to Morro Bay and San Luis Obispo (SLORTA, 2024). The frequency is once an hour on weekdays and every two to three hours on weekends. There are Route 12 bus stops at the intersection of South Bay Boulevard and Quintana Road and at the intersection of Santa Ysabel Road and 15th St.

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[1] Determined using Google Maps, accessed online.
[2] Estimated using Google Maps, accessed online.

2.2.4 Disadvantaged communities

Southeast Morro Bay and northern Los Osos, particularly near South Bay Boulevard, are identified as disadvantaged communities (SLOCOG, 2024c). However, those communities do not score highly as households with no vehicle available.

2.3 Travel time reliability

2.3.1 Level of service

During peak travel periods, i.e., 8-9 am and 4-5 pm, travel from Morro Bay to Los Osos (and from Los Osos to Morro Bay) along South Bay Boulevard can take several minutes longer than normal, i.e., 16 minutes rather than 14 minutes.[3] Special events, such as a race, might cause congestion, particularly at intersections. However, a traffic survey would need to be conducted to gather more detailed information, which is beyond the scope of this study.

2.4 Sustainability

2.4.1 Greenhouse gas emissions / vehicle miles traveled

Greenhouse gas emissions (GHG) and vehicle miles traveled (VMT) data are typically analyzed as required by the California Environmental Quality Act when new development is proposed. Recent data are not available for the study area and therefore, a GHG/VMT survey would need to be conducted to gather more detailed information, which is beyond the scope of this study.

2.4.2 Mode split

The primary mode of travel in the study area is private vehicle (73%) or as a passenger in a private vehicle (21%) with the primary purpose of traveling to/from home (34%), to work (15%) or to shop (11%) (Replica, 2024).

2.5 Other considerations

2.5.1 Asset management

Planned projects in the study area include the South Bay Boulevard California Coastal Trail Connector; State Park Road Bike Improvements; and the South Bay Boulevard Bridge Replacement over Los Osos Creek (SLOCOG, 2024d). The upcoming Los Osos Community Services District Water Resiliency Intertie Pipeline Project may also present an opportunity to co-locate with the planned Chorro Valley trail, which would enhance active transportation options in the study area.

3 Conclusion

In conclusion, the corridor’s lack of active transportation options, i.e., safe bicycle and pedestrian routes, are its current primary deficiencies. In the future, South Bay Boulevard and State Park Road are anticipated to be vulnerable to sea level rise and in the absence of sea level rise adaptation, i.e., the no action scenario, the corridor’s performance could become deficient for all modes of travel, including as a critical evacuation route.

[3] Estimated using Google Maps, accessed online.

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Attachment C.
Coastal Hazards Vulnerability Assessment Memo

ESA

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memorandum

date	June 20, 2025
to	John DiNunzio, San Luis Obispo Council of Governments
from	ESA
subject	Morro Bay Estuary Coastal Flood Hazard and Vulnerability Assessment Memorandum

1 Background and Purpose

This memo documents the coastal flood hazard modeling and planning-level vulnerability assessment analyses performed by ESA. It reports the transportation, recreational, and natural assets most vulnerable to coastal flooding and sea level rise (SLR) as part of The Morro Bay Estuary Climate Resiliency Transportation Plan ("The Plan") developed under contract with the San Luis Obispo Council of Governments (SLOCOG).

The Plan aims to enhance mobility between Morro Bay and Los Osos while considering the natural environment, the estuary, and Morro Bay State Park. It focuses on a 2.5-mile stretch of South Bay Boulevard, which is the only route connecting both jurisdictions and is prone to flooding, especially with rising sea levels. Flooding disrupts connectivity and poses risks during emergencies, highlighting the need for a detailed model to address these challenges. The study area includes critical wetland habitats vulnerable to SLR, necessitating a holistic approach that integrates community input and nature-based solutions.

The plan involves developing a conceptual design to adapt to fluvial and coastal flood hazards and to improve non-motorized mobility along South Bay Boulevard. The project uses GIS mapping, community engagement, and technical analyses, including flood modeling, to create adaptive solutions and predict flood risk throughout the bay, beyond the reach of current data. Funded by the California Department of Transportation (Caltrans) Sustainable Transportation Planning Grant Program, this study lays the groundwork for future adaptation projects, ensuring the community's vision and values are prioritized in addressing flood risks and improving infrastructure resilience.

ESA reviewed available coastal flood hazard data from the United States Geographic Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the Federal Emergency Management Agency (FEMA). ESA developed a 2D Delft3D model of the site, building from an existing USGS model (Taherkhani et al. 2023). The model was run for storm and non-storm conditions for SLR scenarios of 0', 1.8', and 6.3'. Output from this model was overlayed on an asset inventory for the area to determine areas and assets that are at risk to tidal inundation and fluvial flooding. At-risk infrastructure, recreational, and natural assets were assessed based on their exposure to hazards, sensitivity to exposure, and adaptive capacity to assign overall vulnerability ratings to the assets. This memo describes the site characteristics, SLR scenarios, hydrodynamic model setup and results, and methodology and results of the vulnerability assessment.

1.1 Literature Review

The City of Morro Bay has conducted several prior studies on the potential effects of climate change and SLR to the area's infrastructure, natural resources, recreational spaces, and water quality. Notable relevant reports, and their key findings are detailed in Table 1 below.

TABLE 1
RELEVANT REPORTS – KEY FINDINGS

Report	Key Findings
City of Morro Bay Community Baseline Assessment (CBA) [1]	*The Morro Bay CBA* was part of the City of Morro Bay's *Plan Morro Bay,* a strategy for conservation and development of the city through 2040. The CBA describes historic and existing conditions to provide the information required to update the City's General Plan and plan for future changes to these conditions. As part of the report, a quantitative vulnerability assessment of beaches, public access ways, state parks, coastal development, utilities, and transportation for SLR horizons of 2016, 2030, 2050, and 2100 is provided. The most vulnerable assets were determined to be transportation (road, bike, pedestrian), state parks, and beaches due to their higher exposure and sensitivity and lower adaptive capacity than other asset classes. This analysis was based on SLR guidance from the National Research Council (NRC) in 2012.
City of Morro Bay Community Vulnerability and Resilience Assessment (CRVA)[2]	*The Morro Bay CRVA* provides a comprehensive analysis of the city's vulnerability to demographic, economic, and climate change-related hazards through 2040. The report found that: residential land uses in Morro Bay are poorly prepared for future changes; more frequent electricity shortages are likely; vulnerability of Morro Bay's roadway network could degrade infrastructure quality and increase maintenance costs; and drought, flood, and SLR pose risks of habitat degradation and special-status species loss in Morro Bay's wetland areas.
Sea Level Rise Adaptation Strategy Report[3]	In 2018, the *Sea Level Rise Adaptation Strategy Report* prepared for the City of Morro Bay to analyze coastal adaptation strategies for Highway 1, the Morro Rock parking lot, and the Embarcadero Waterfront. The report recommended that the city develop a long-term monitoring plan, identify funding mechanisms, make proposed land use zoning consistent with adaptation approaches, and define triggers for adaptive actions.
City of Morro Bay Environmental Sensitive Habitat Area (ESHA) Analysis: 2050 Sea Level Rise Scenario[4]	*The City of Morro Bay Environmental Sensitive Habitat Area (ESHA)* analysis analyzes the potential future effects of climate change and SLR to environmentally sensitive habitats. The report concludes that "increases in tidal inundation, coastal flooding, and dune and bluff erosion are anticipated to result in a net loss of ESHAs in the Morro Bay coastal zone, with pronounced effects on foredune and backdune communities, estuarine coastal salt marshes, stream mouths, and areas of riparian and freshwater wetland immediately adjacent to the coast. Landward retreat may occur to some extent but existing topographic features, roads, and structures limit the area available for retreat, and the expected outcome is a narrowing of the bands of coastal habitat" (Rincon Consultants Inc., 2018).
Plan Morro Bay Coastal Resources & Resiliency H++ Update[5]	In 2019, The City of Morro Bay updated their coastal hazard and vulnerability assessment to incorporate the most up-to-date SLR projections published by the Ocean Protection Council (OPC) in 2018, especially the Extreme Risk Aversion Scenario (H++). With the updated model, nearly all ocean fronting roadways were found vulnerable to flooding and inundation, wetlands and intertidal habitats were impacted by inundation by 2030, coastal dunes were impacted by 2030, there was significant loss of beach area by in 2050, as well as moderate vulnerability to coastal developments in 2050 and to the existing wastewater treatment plant by 2100. Note that in the most recent OPC SLR guidance in 2024, the H++ scenario was removed as the rates and amounts of SLR are no longer supported by the best available science.

SOURCE:

1. Michael Baker International, 2016
2. Michael Baker International, 2017
3. Moffat & Nichol, 2018
4. Rincon Consultants, Inc., 2018
5 Moffat & Nichol, 2019

This analysis differs from previous studies in that it focuses on transportation resiliency, specifically along South Bay Boulevard between State Route 1 and Los Osos Creek with spurs along South Park Road (i.e., Main Street), Quintana Avenue, and Turri Road. It also includes the Morro Estuary Natural Reserve and Morro Bay State Marine Reserve. The report uses 2024 OPC SLR guidance that has been updated based on best-available science since the guidance from the OPC in 2018 and NRC in 2012 used in previous studies. It develops a hydrodynamic model for the area for three SLR scenarios to determine hazard exposure rankings for individual transportation, natural resource, and recreational assets. Uniquely, this vulnerability assessment provides cumulative vulnerability scores for individual at-risk assets.

2 Site Characteristics

The project site focuses on a 2.5-mile stretch of South Bay Boulevard between State Route 1 and Los Osos Creek, including spurs along South Park Road (Main Street), Quintana Avenue, and Turri Road (Figure 1). The study area also encompasses the Morro Bay State Marine Reserve. Flood events frequently close roads, severing connectivity between Morro Bay and Los Osos and blocking one of the primary evacuation routes in the event of a radiation accident at Diablo Canyon Nuclear Power Plant. High estuary tide levels combined with high creek flows exacerbate flooding, particularly in the lower reaches of Chorro Creek and Los Osos Creek. With SLR, the frequency and severity of road closures are expected to increase dramatically.

The study area includes critical wetland habitats adjacent to South Bay Boulevard and its spurs. These habitats, part of the Morro Bay State Marine Reserve , are vital for various animals and plants, including some endemic species found only locally. These habitats are also vulnerable to SLR.

These existing vulnerabilities, along with potential future vulnerabilities, will be addressed in further detail later in the report.

Figure 1
Project Area

2.1 Site Hydrology

The tides at the project site are semi-diurnal with a tidal range approximately from 0 to 5.4 feet (ft) above the North American Vertical Datum of 1988 (NAVD 88). Local tidal datums are given in Table 2. Tidal water levels were characterized at the site using the following:

- Existing records from National Oceanic Atmospheric Administration (NOAA) gauge at Port San Luis (Station # 9412110);
- Existing records from Cal Poly State University Station MBXC1 at the Coast Guard T-Pier;
- Previous reporting by Phil Williams Associates (PWA) at the site location.

TABLE 2
TIDAL DATUMS AND OTHER KEY WATER LEVELS

Datum/Water Level	NOAA Port San Luis Gauge (ft NAVD88) [1]	Coast Guard Pier (ft NAVD) [2]	PWA Report (ft NAVD) [3]
Highest Observed Water Level	7.6 (1/18/1973)	6.9 (7/14/2022)	--
Highest Astronomical Tide (HAT)	7.0	--	--
Mean Higher-High Water (MHHW)	5.3	5.4	5.5
Mean High Water (MHW)	4.5	4.6	5.0
Mean Tide Level (MTL)	2.8	2.9	3.1
Mean Sea Level (MSL)	2.7	2.9	--
Mean Diurnal Tide Level (DTL)	2.6	2.7	--
Mean Low Water (MLW)	1.0	1.2	1.2
NAVD88 Datum	0.0	0.0	0.0
Mean Lower-Low Water (MLLW)	-0.1	-0.0	0.2
Lowest Astronomical Tide (LAT)	-2.1	--	--
Lowest Observed Water Level	-2.5 (1/07/1951)	-2.0 (1/22/2023)	-2.3

SOURCE:
1. NOAA Tides & Currents, 2024
2. Cal Poly State University San Luis Obispo, 2024
3. Philip Williams & Associates, 2007

2.2 Modeled Sea Level Rise Scenarios

ESA provided a series of recommended SLR scenarios for evaluation after reviewing the Ocean Protection Council's (OPC) State of California SLR Guidance (OPC 2024) and local SLR projections at the site. The specific time horizons and amount of SLR scenarios selected are presented in Table 3 and represent existing conditions, mid-century high SLR, and end-of-century high SLR. The SLR scenarios are produced from water level and conditions data gathered by the Port San Luis NOAA tide gauge and incorporate the local estimate of vertical land motion.

In addition, we utilized results from the USGS Coastal Storm Modeling System (CoSMoS), which is a dynamic modeling approach developed by USGS that provides detailed meter-scale predictions of coastal flooding across large geographic areas, integrating both future SLR and storm scenarios. CoSMoS simulates coastal flooding for the 100-year return period storm scenario under multiple incremental SLR scenarios ranging from 0 to 3 meters (0 to 9.8 ft), plus an extreme 5-meter (16.4 ft) scenario.

TABLE 3
SLR SCENARIOS CONSIDERED

Time Horizon	SLR (ft)	Scenario
2024	0.0	Existing Conditions
2060	1.8	High SLR
2100	6.3	High SLR

SOURCE: OPC SLR Guidance 2024

2.3 Sources of Vulnerability

Sources of vulnerability in the project study area include fluvial flooding from Chorro Creek and Los Osos Creek, sheet flows over South Bay Boulevard during heavy precipitation events, wave run-up and tidal flooding during high tide events, as well as potential for tidal inundation over time.

2.4 Data Sources

Table 4 summarizes the data sources for the coastal hazards assessment. This assessment relied on publicly available coastal datasets, and data collected previously by ESA and others.

TABLE 4
DATA SOURCES

Data Type	Time Range	Source	Notes
Hydrodynamics			
Ocean Tides	1983-2001 8/10/2021 – 9/6/2024 8/5/1987 – 8/7/1987	NOAA #9412110 Cal Poly State University San Luis Obispo PWA 1988	Long-term ocean tides 15 miles south of the site at Port San Luis Coast Guard Pier State Park Marina
Bathymetry/Topography			
Bay Bathymetry	2014	USGS CoNED	CoNED data with a corrected LiDAR segment stitched into the original bathymetry provided by USGS direct correspondence
Wind			
Wind Speed and Direction	1/1/2023 - 3/1/2024	NOAA #9412110	Meteorological observations
Long-term Wind Speed and Direction for SWAN Model	2006-present	NOAA NCEI SLO Airport	Meteorological observations
Fluvial			
Streamflow		USGS	Estimated a 10-year event using the USGS StreamStats for Chorro Creek and Los Osos Creek

3 Hydrodynamic Model Setup

This section describes the model and selected modeling scenarios that ESA used to conduct hydrodynamic analysis at Morro Bay.

3.1 Model Domain

ESA developed a 2D Delft3D model of the site by building upon an existing USGS model (Taherkhani et al. 2023). This model includes all areas inside Morro Bay that are submerged by "king tides" (exceptionally high tides) and extends three kilometers offshore of the bay mouth to allow forcing from ocean tides. The curvilinear grid was developed from the original USGS grid and modified with grid refinement inside the bay. The model uses a structured mesh, enabling local mesh refinement in specific areas to accurately capture the key physical dimensions of the study area.

The model that ESA developed for the project site includes a grid extension of the USGS model prepared by Taherkhani et al. (2023) to better represent Chorro Creek and Los Osos Creek's influence on the project study area. ESA's model encompasses the entirety of Morro Bay, including the intertidal zone, covering an area of approximately 10,000 acres in extent. The domain was extended to cover a greater area around the inlets of Chorro Creek and Los Osos Creek, which are critical to the hydrodynamic processes being modeled.

Tidal conditions were generated in the model by downloading tidal data from the NOAA Port San Luis Station and applying them at the north, south, and west ocean boundaries of the model. Initial conditions were set based on downloaded water level data to represent realistic starting points for water level in Morro Bay Estuary. Streamflow was simulated in the model with inputs from Chorro Creek and Los Osos Creek. Wind conditions were similarly generated in the model by downloading wind data at the NOAA Port San Luis Station. Uniform wind was added as a physical parameter to the model with linear interpolation.

The model was run to focus on the events from January 27, 1983, January 9, 2023, February 4, 2024, and August 1, 2023. The first three events were modeled as storm events with extreme water levels in the region, and the August 1, 2023, event was modeled as non-storm spring tide conditions. The model created full 2D outputs of the site at 30-minute intervals to evaluate the spatial characteristics and water level of the bay.

3.2 Model Grid and Bathymetry

The initial model uses a curvilinear grid consisting of approximately 77,000 grid cells. The grid is coarsest inside the bay at the north and south boundary, where the resolution is roughly 260x220m (850x720 ft), and the resolution gradually increases in some locations along the central, intertidal portions of the bay, where the resolution is roughly 12x15m (39x49 ft). The Chezy roughness coefficient for the bed was set to 65 everywhere and some dry points were incorporated in the grid. The existing model was calibrated with four monitoring stations: at the mouth (BM), near the center (BC), towards the back center near oyster farms (BO), and at the far south end of the bay near the head (BS).

The model grid was extended landward after several initial runs to cover the extent of CoSMoS scenario of 5m (16.4 ft) SLR combined with the 100-year return period coastal flood inside the bay (Figure 2). The new grid extent was informed by this scenario because it results in the floodplain. The new grid includes approximately

86,000 elements with main differences being the area covered around Chorro Creek, Los Osos Creek, Main St. along the southern end of the Morro Bay Golf Course, and into the neighborhoods on the southeast side of the bay.

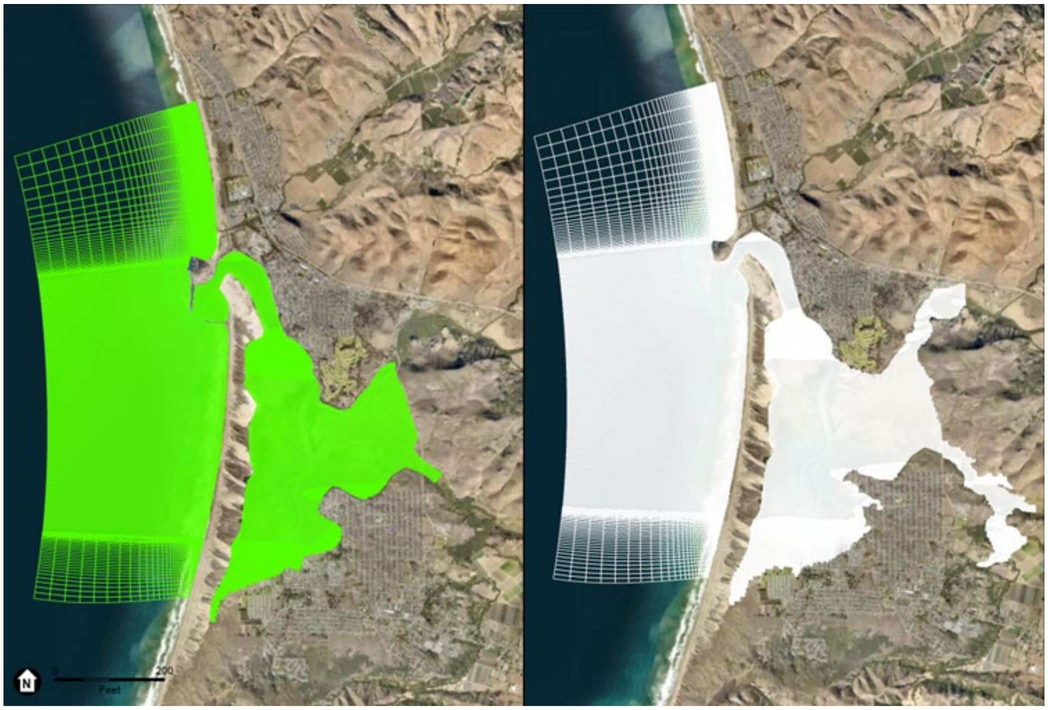

Figure 2

Original USGS Model grid(left) and Extended ESA Grid including Chorro and Los Osos Creeks, and the Extension of the CoSMoS 5m SLR Scenario (right)

The bathymetry for the model (Figure 3) used USGS Coastal National Elevation Database CoNED (2014) data with a marsh Light Detection and Ranging (LiDAR) correction factor based on 2014 real-time kinetic positioning (RTK) data of the marsh stitched into the model. The corrected marsh digital elevation model (DEM) shows about 1ft lower marsh at the creek outlet and allows for greater definition of the channel on the west side of the marsh along State Park Road.

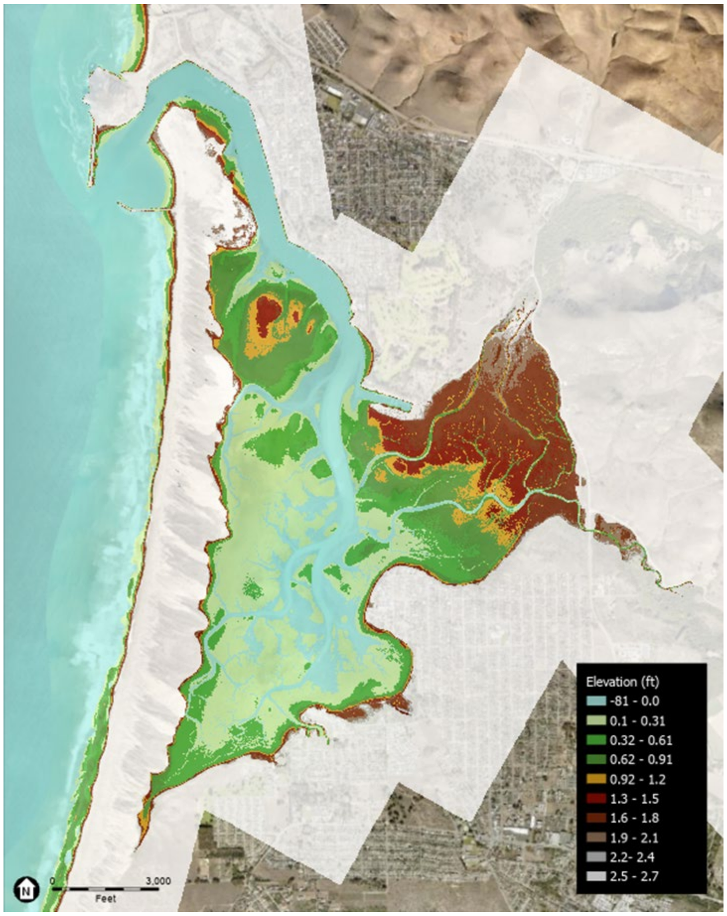

Figure 3
Model Bathymetry

3.3 Boundary Conditions

NOAA Station Port San Luis is the closest observation station to the project study area. Time series data was downloaded for storm and non-storm periods from NOAA's public access Tides & Currents water level website. These water levels were then used as boundary conditions for inputs to the Deflt3D model at the north, south, and west boundaries.

ESA selected storm events from January 9th, 2023, and February 4th, 2024, to represent water levels under storm conditions. Further investigation revealed that these events had water levels only slightly higher than those observed during the non-storm conditions that ESA analyzed. Thus, ESA added a storm run from the extreme water levels recorded on January 27th, 1983 to utilize conservatively high water levels for the region. These additional water levels were subsequently used as the boundary conditions for storm scenario model runs (Figure 4).

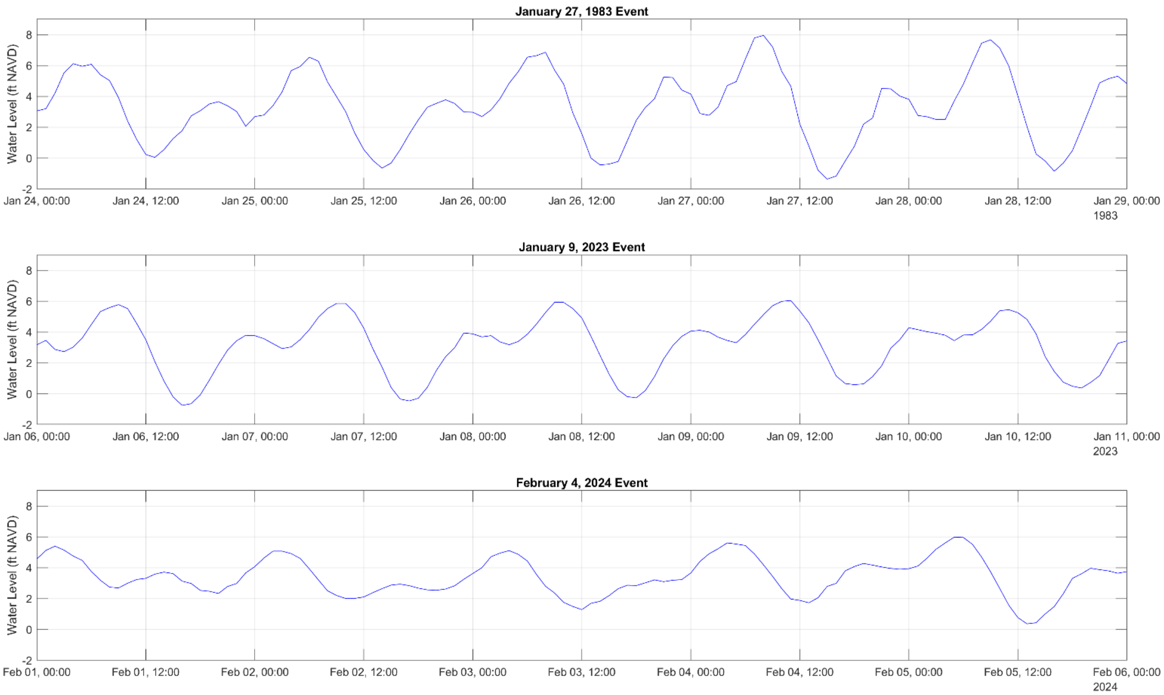

Figure 4
Water Level Time Series NOAA Station Port San Luis

The flood pattern in areas influenced by both coastal and fluvial sources is more complex. To better represent the physics in these compound flood areas more accurate river bathymetry and streamflow input was needed. For the purpose of this project, ESA chose to add constant streamflow estimated as 100-year return period event using the USGS StreamStats online tool to conservatively represent the two creek inputs.

3.4 Model Verification

ESA verified the Delft3D model results by comparing water level outputs with observational data collected by Cal Poly and the Central & Northern California Ocean Observing System (CeNCOOS). Both sources of observational data were collected at the T-Pier near the mouth of Morro Bay along the Embarcadero. Cal Poly provided observational data from 8/10/2021 – 9/6/2024 and CeNCOOS observational data covered 1/1/2023-1/5/2023 and 1/11/2023- 2/1/2023. The CeNCOOS data does not include the validation period of 1/6/2023-1/11/2023 modeled by the January 9th run, so the model was only verified against the Cal Poly data on this date. The alignment of the observational data with the model data at the T-Pier shows that the model accurately captured the tidal patterns and magnitudes during the validation period (Figure 5).

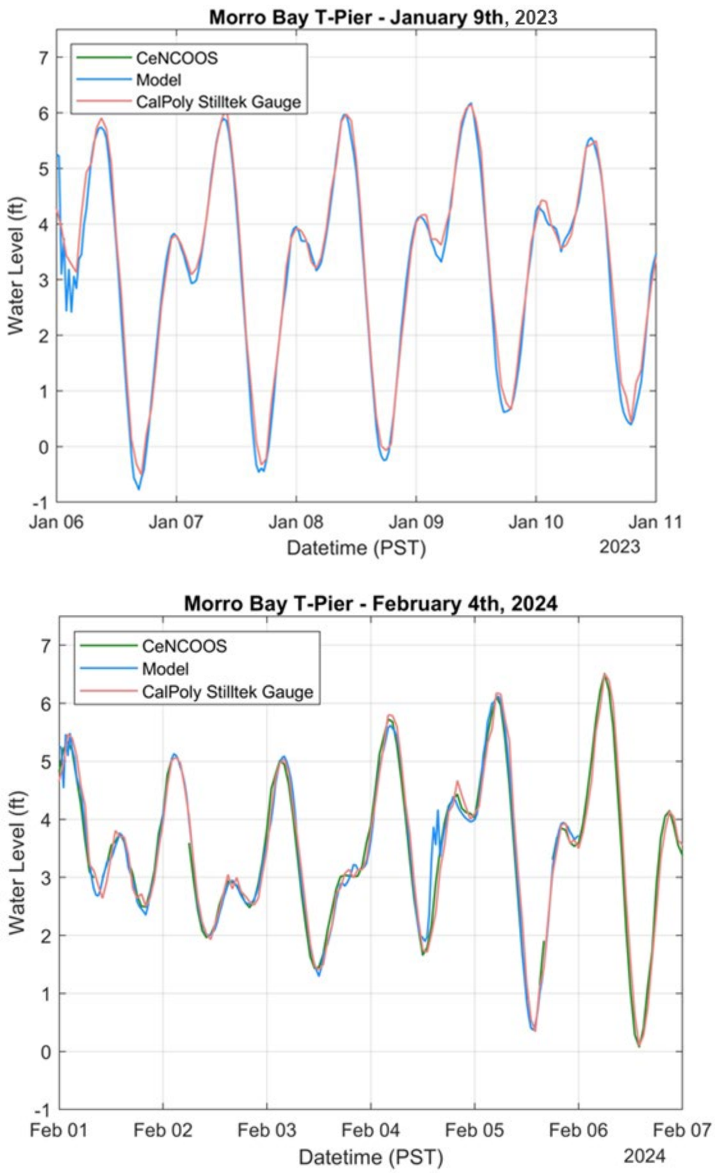

Figure 5
Validation of model results with Cal Poly water level data for January 9th, 2023 (top) and with CeNCOOS and Cal Poly water level data for February 4th, 2024 (bottom)

Although streamflow and river bathymetry were not fully simulated, ESA plotted model results from the mouth of Chorro Creek to compare with Cal Poly's Hobo 1 observation data. The plot shows that the model output is consistently higher than the observed data, as expected because ESA conservatively chose to use a constant extreme streamflow as the creek discharge boundary condition.

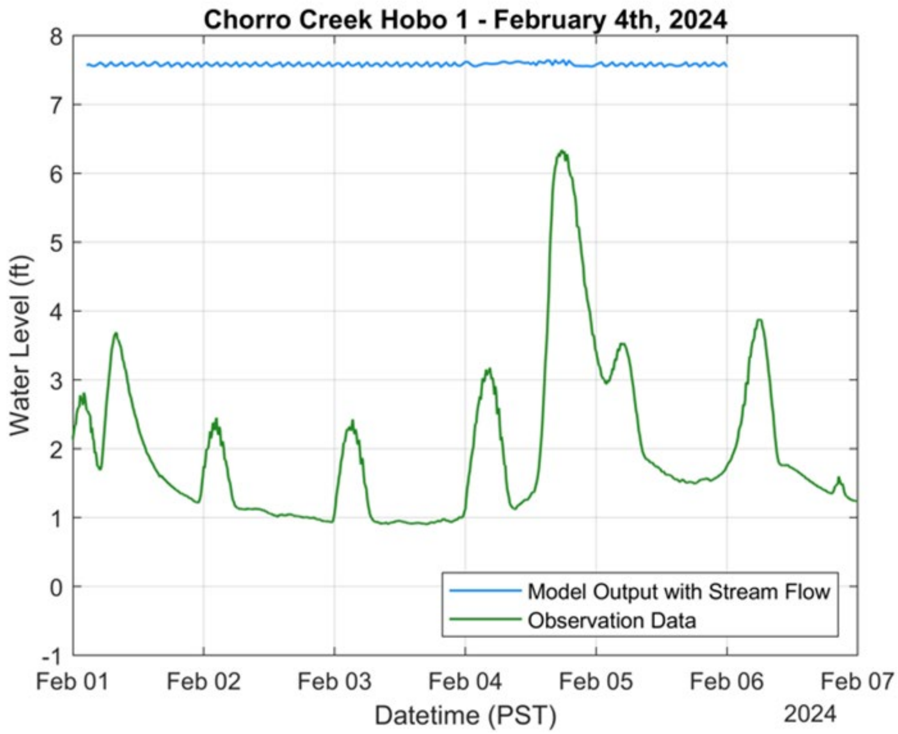

Figure 6
Comparison of modeled and observed Chorro Creek water level for February 4th, 2024.

4 Hydrodynamic Model Scenarios

ESA selected several scenarios to model in developing an understanding of current and potential future site conditions. Table 5 presents the selected scenarios. The selected storm event produced the highest historical water levels in the area, providing a conservative estimate of water levels in Morro Bay under storm conditions. We chose the non-storm event as a representation of water level conditions seen in Morro Bay without storms enhancing water levels in the area. ESA modeled two verification runs to test the fit of the model output results with verified observational data. Model verification results are further discussed above in Section 3.4. We modeled each selected event for three scenarios of SLR. Further discussion of the selected SLR scenarios is presented above in Section 2.2.

TABLE 5
MODELING SCENARIOS

Scenario	Event	SLR
Storm	January 27, 1983	0.0, 1.8, 6.3 ft
Non-Storm	August 1, 2023	0.0, 1.8, 6.3 ft
Verification Event 1	January 9, 2023	0.0, 1.8, 6.3 ft
Verification Event 2	February 4, 2024	0.0, 1.8, 6.3 ft

5 Hydrodynamic Results

Figure 7 shows the modeling results from the Non-Storm and Storm scenarios for the three selected SLR amounts. Higher water levels are predicted for each increasing amount of SLR, and storm conditions are expected to see higher water levels than non-storm conditions. For each scenario, water levels throughout the main segment of the Bay remain relatively even, especially in non-storm conditions where the reaches of Chorro and Los Osos Creeks experience water levels at or below those of the Bay. For Storm scenarios, extreme water levels are seen at the eastern edges of the creek inlets. Note that modeling results can be viewed in Appendix B at a legible scale.

ESA selected two points in the study area to quantify water level modeling results. We placed Point A along Main Street behind the pocket beach. We placed Point B at the eastern edge of the study area along S. Bay Blvd. These areas are presently known to flood during storm conditions, limiting road access. The quantified water level results at these points are presented in Table 6 below. Water levels at the two points are similar for each modeling scenario.

TABLE 6
MORRO BAY FLOOD MODELING RESULTS

WSE (ft NAVD)	Non-Storm Scenario (King Tide)		Storm Scenario (Surge + Creek Flows)	
SLR (ft)	**Point A – Windy Cove**	**Point B – S. Bay Blvd.**	**Point A – Windy Cove**	**Point B – S. Bay Blvd.**
0.0	7.2	7.2	8.1	8.2
1.8	9.0	9.0	10.3	10.8
6.3	13.4	13.4	16.1	16.3

SOURCE: ESA 2024

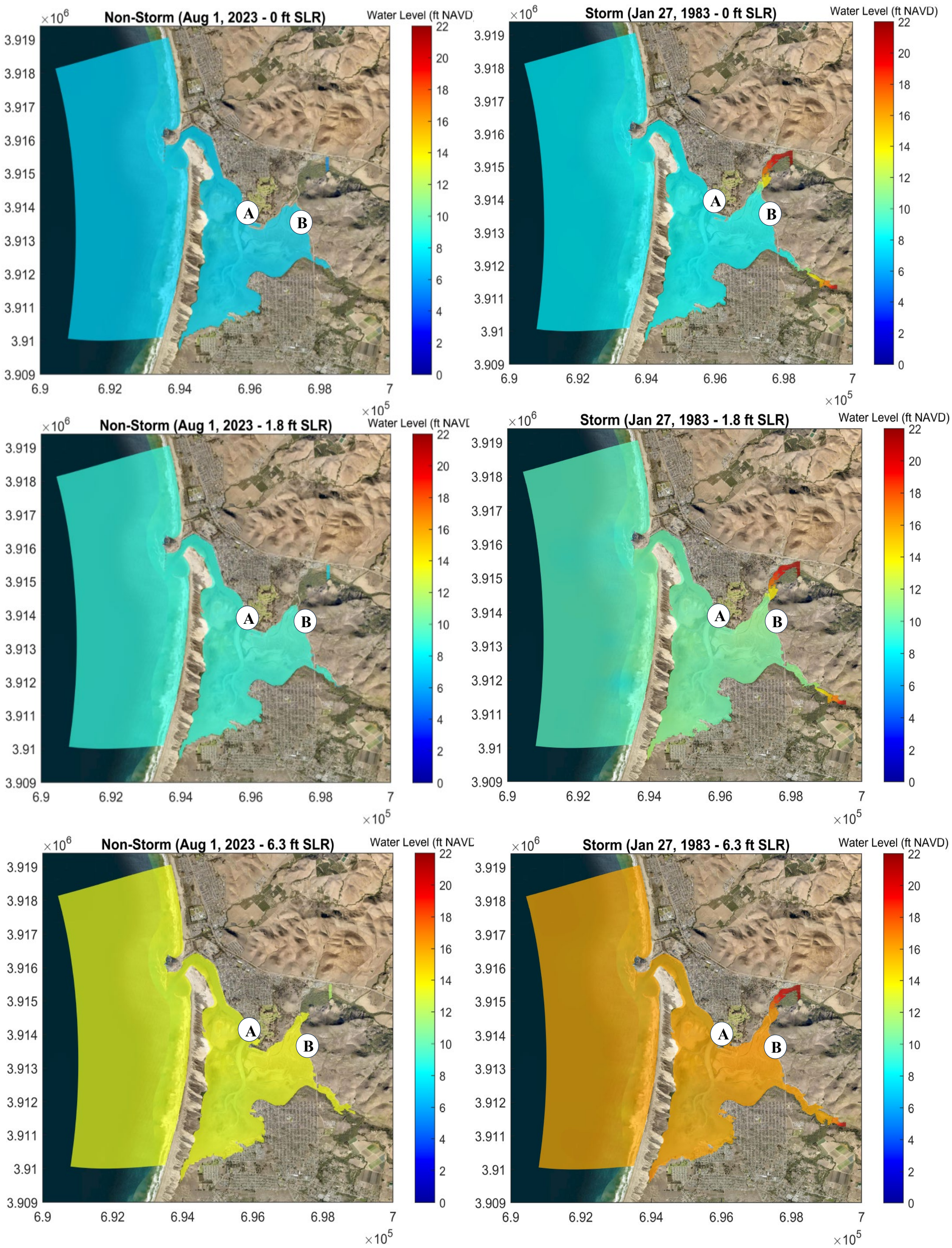

Figure 7

Water levels inside Morro Bay under selected modeling scenarios

6 Wave Modeling

Wind waves were simulated using the Simulating Waves Nearshore (SWAN) model. SWAN is a third-generation phase-averaged wave action model developed at Delft University of Technology (Delft University of Technology 2019). Delft3D software (Version 4.04.01, Deltares 2011) was used to prepare inputs and execute the SWAN model. The same grid used in the Hydrodynamic modeling was used in SWAN for wind wave simulation.

6.1 Wind Analysis

Observed wind data from the nearby San Luis Obispo County Regional Airport (SLO) was downloaded from NOAA National Center for Environmental Information (NCEI)'s website. The data was processed with the QA/QC flag so data flagged as bad quality was removed for any further analysis and converted to 10-m over water. Two blocks of data are available, one from 1973-1997 and the other from 2006 to present. After initial examination, the data used for the windy analysis covers the period from 2006 to the present (2025), as the earlier dataset from the 1900s contained unrealistically high measurements and was therefore excluded from further analysis..

The wind environment at the project site can be inferred by examining the wind rose at SLO (Figure 8). It can be observed that the dominant wind direction is from the northwest, with strong winds over 25 mph. The secondary wind direction is from the southeast.

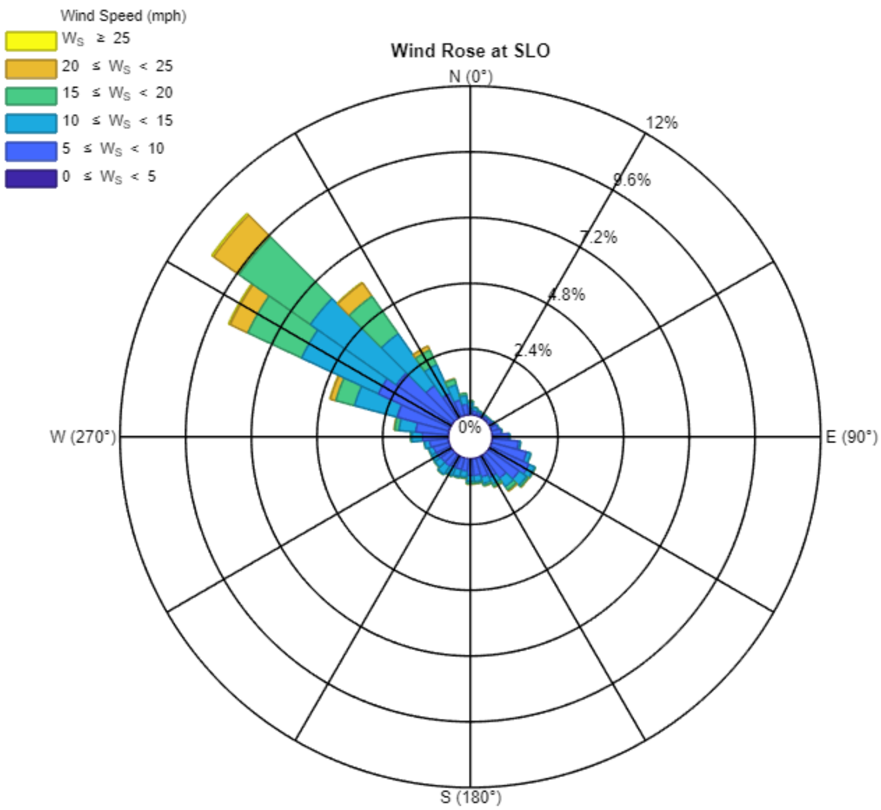

Figure 8
Wind Rose at San Luis Obispo County Regional Airport (SLO)

An extreme value analysis (EVA) was conducted on the wind data at SLO, plotted in Figure 9 and documented in Table 7. The analysis shows the 1-, 10-, and 100-year return period values for wind speed are approximately 25, 32, and 40 mph respectively, according to different variations of extreme value distributions including Gumbell, Weibull, and Generalized Extreme Value (GEV). Based on this analysis and the orientation of the shorelines at the project site, we chose to simulate wind speeds of 30 and 40 mph from 180 to 360 at a 10-degree increment. For wind waves and water levels, we simulated the following scenarios: existing conditions, 1.8 ft of SLR, and 6.3 ft of SLR, selected based on OPC 2024.

TABLE 7
WIND EVA

Return Period (Year)	Wind Speed (mph)					
	Gumbell (ML)	Gumbell (LS)	Weibull (ML)	Weibull (LS)	GEV (PWM)	GEV (MPS)
1	25.1	25.1	25.1	25.1	25.1	25.1
2	28.6	28.6	29.2	29.3	28.3	28.5
5	30.6	31.5	31.7	31.7	30.4	31.1
10	32.0	33.4	32.8	32.7	32.2	33.0
20	33.3	35.2	33.7	33.5	34.2	34.9
50	35.0	37.6	34.5	34.4	37.3	37.6
100	36.3	39.4	35.1	34.9	40.1	39.8
500	39.3	43.5	36.1	35.9	48.6	45.5

ML = Maximum Likelihood (estimation method)
LS = Least Squares (fitting method)
PWM = Probability-Weighted Moments
MPS= Maximum Product of Spacings

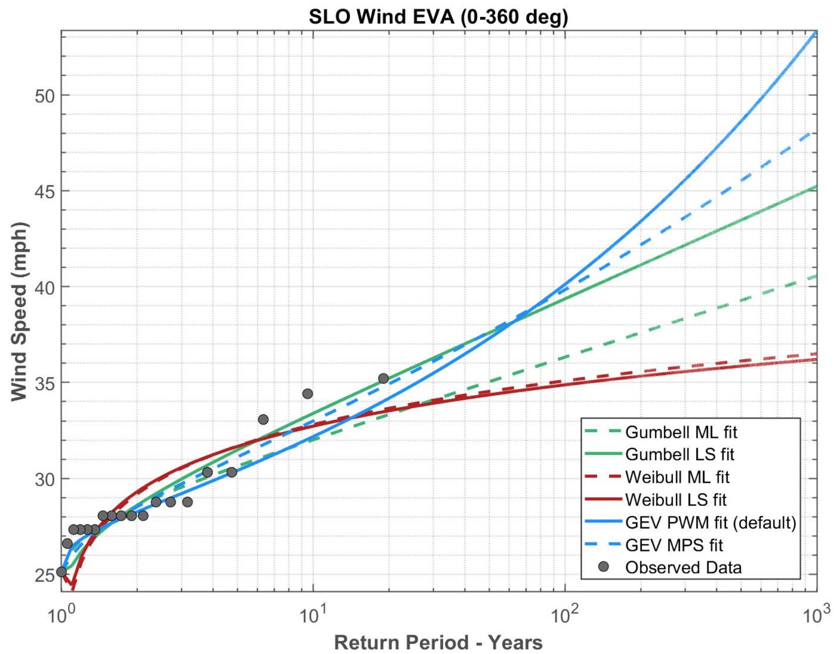

Figure 9
Extreme Value Analysis of Wind Data at SLO

Figure 10 shows an example result for one of the scenarios (40-mph Wind from 270 Degrees for existing conditions 1.8’ SLR, and 6.3’ SLR), zoomed in on the eastern side of Morro Bay. The simulated significant wave heights, peak wave period, and peak wave direction for all scenarios are extracted at a point at the edge of the marsh and documented in Table 8 to Table 10. For existing water levels, we see a maximum wave height of about

1 foot; with higher sea levels, waves increase to 2 ft, likely associated with the loss of dissipation from the marsh with higher sea levels. The 1.8 ft of SLR scenario potentially represents wave height during extreme storms for existing conditions. Therefore, it can be inferred that wave heights are about 1 to 1.5 ft for existing conditions, 1.5 to 2 ft with 2 ft of SLR and more than 2 ft for 6 ft of SLR.

TABLE 8
SIMULATED SIGNIFICANT WAVE HEIGHT (FT) AT MARSH EDGE

Significant Wave Height (ft)	WSE = 7' NAVD		WSE = 8.8' NAVD		WSE = 13.3' NAVD	
Wind Direction	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**
180	0.8	1.0	1.0	1.3	1.2	1.6
190	0.9	1.1	1.1	1.4	1.3	1.7
200	0.9	1.1	1.1	1.4	1.3	1.7
210	0.9	1.1	1.1	1.4	1.3	1.7
220	0.9	1.1	1.1	1.4	1.4	1.8
230	0.9	1.1	1.1	1.4	1.4	1.8
240	0.9	1.1	1.1	1.4	1.4	1.8
250	0.9	1.0	1.2	1.4	1.4	1.9
260	0.9	1.0	1.2	1.5	1.4	1.9
270	0.9	1.0	1.2	1.5	1.4	1.9
280	0.8	1.0	1.1	1.4	1.4	1.9
290	0.8	0.9	1.1	1.3	1.3	1.7
300	0.8	0.9	1.0	1.3	1.2	1.7
310	0.7	0.9	1.0	1.3	1.2	1.6
320	0.7	0.8	1.0	1.2	1.2	1.6
330	0.7	0.8	0.9	1.2	1.2	1.6
340	0.6	0.8	0.9	1.2	1.2	1.5
350	0.6	0.8	0.9	1.1	1.1	1.5
360	0.6	0.8	0.8	1.1	1.1	1.5

TABLE 9
SIMULATED PEAK PERIOD (S) AT MARSH EDGE

Peak Period (s)	WSE = 7' NAVD		WSE = 8.8' NAVD		WSE = 13.3' NAVD	
Wind Direction	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**
180	1.6	1.7	1.6	1.8	1.8	2.0
190	1.6	1.7	1.7	1.8	1.8	2.0
200	1.6	1.8	1.7	1.8	1.9	2.1
210	1.6	1.8	1.7	1.9	1.9	2.1
220	1.6	1.8	1.7	1.9	1.9	2.1

Peak Period (s)	WSE = 7' NAVD		WSE = 8.8' NAVD		WSE = 13.3' NAVD	
Wind Direction	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**
230	1.6	1.8	1.7	1.9	1.9	2.2
240	1.6	1.8	1.7	1.9	1.9	2.2
250	1.6	1.8	1.8	1.9	1.9	2.2
260	1.6	1.8	1.7	1.9	1.9	2.3
270	1.6	1.7	1.7	1.9	1.9	2.3
280	1.5	1.7	1.7	1.9	1.9	2.2
290	1.5	1.6	1.7	1.8	1.8	2.1
300	1.4	1.6	1.6	1.8	1.8	2.1
310	1.4	1.5	1.6	1.8	1.8	2.0
320	1.4	1.5	1.6	1.7	1.8	2.0
330	1.4	1.5	1.6	1.7	1.8	1.9
340	1.4	1.5	1.6	1.7	1.8	1.9
350	1.4	1.5	1.6	1.7	1.7	1.9
360	1.4	1.5	1.6	1.6	1.7	1.8

TABLE 10
SIMULATED PEAK DIRECTION AT MARSH EDGE

Peak Direction	**WSE = 7' NAVD**		**WSE = 8.8' NAVD**		**WSE = 13.3' NAVD**	
Wind Direction	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**	**Wind Speed = 30 mph**	**Wind Speed = 40 mph**
180	225	215	225	225	225	225
190	225	225	225	225	225	225
200	225	225	225	225	235	225
210	225	225	225	225	235	225
220	225	225	225	225	235	235
230	225	225	225	225	235	235
240	225	225	225	225	235	235
250	225	225	235	225	235	235
260	225	225	235	235	235	235
270	235	235	235	235	255	245
280	235	235	245	245	275	285
290	245	235	275	275	285	285
300	245	245	275	275	295	295
310	255	245	275	275	295	295
320	285	255	285	275	295	295
330	285	335	285	285	295	295
340	345	335	285	285	295	295
350	5	5	15	5	295	295
360	5	15	15	15	25	25

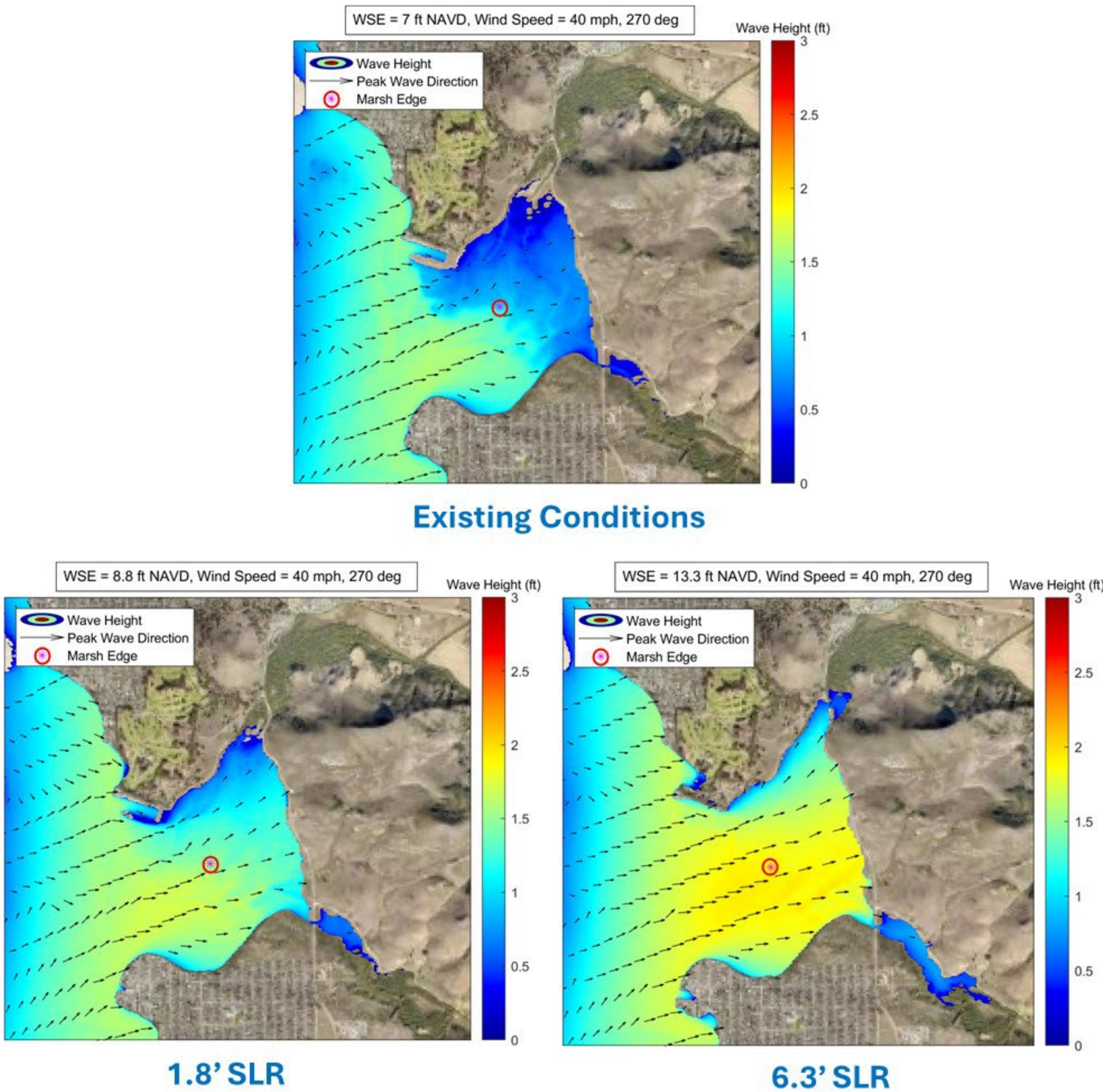

Figure 10
Simulated Wave Height and Direction for a 40-mph Wind from 270 Degrees zoomed in on the eastern side of Morro Bay.

6.2 Wave Runup Analysis

Wave runups further increase the total water levels and pose additional threat to South Bay Boulevard. ESA conducted a simple wave runup analysis using the Technische Adviescommissie voor de Waterkeringen (TAW) method on representative nearshore slopes at the site. The TAW method is a specific empirical formula used to calculate wave runup, primarily developed by the Dutch Technical Advisory Committee for Flood Defenses, which is considered a widely accepted standard for estimating wave runup on structures like dikes and seawalls.

After examining the topography, it was determined that a representative slope of 0.2 can be used for South Bay Boulevard and 0.08 can be used for the Windy Cove and Main St area. Table 11 documents the calculated wave runup and total water level.

TABLE 11
WAVE RUNUP AND TOTAL WATER LEVEL ANALYSIS

	Significant Wave Height (ft)	Wave Period (s)	Wave Runup (ft)	SWL (ft NAVD88)	TWL (ft NAVD88)
Windy Cove / Main St					
Existing Conditions	1.0	1.80	0.58	8	8.6
1.8' SLR	1.5	1.90	0.75	11	11.7
6.3' SLR	2.0	2.30	1.04	16	17.0
South Bay Blvd					
Existing Conditions	1.0	1.80	1.44	8	9.4
1.8' SLR	1.5	1.90	1.86	11	12.9
6.3' SLR	2.0	2.30	2.61	16	18.6

ESA conducted a wave runup analysis at the Windy Cove/Main St area and on South Bay Blvd. Table 11 presents the results, showing the wave runup and total water level (TWL) under various SLR scenarios. The TWL is the sum of the still water level (SWL) and the wave runup at each location. As both wave runup and SWL increase with increasing SLR, due to the associated increase in significant wave height and wave period, we expect TWL to increase at both locations. The analysis shows the TWL at Windy Cove/Main St. is 8.6ft, 11.7ft, and 17.0ft for existing conditions, 1.8 ft of SLR, and 6.3 ft of SLR respectively. The TWL at South Bay Blvd is 9.4ft, 12.9ft, and 18.61ft for existing conditions, 1.8 ft of SLR, and 6.3 ft of SLR respectively. Analysis under these SLR conditions were selected based on OPC 2024.

7 Tidal Flooding

State Park Road has sections located next to Morro Bay at Windy Cove and sections running along the Morro Bay Estuary from the Morro Bay State Park Marina to S Bay Boulevard. Additionally, S Bay Blvd runs adjacent to Morro Bay Estuary from Chorro Creek Bridge to Los Osos Bridge. These sections of road are potentially at risk of becoming exposed to regular tidal flooding with SLR due to their proximity to tidally influenced systems. ESA conducted a still water analysis to evaluate the impacts of tidal flooding on these roadways with SLR.

Tidal water levels with and without SLR were compared to roadway elevations to assess how the frequency of roadway flooding and closure would change with SLR. Different than previous sections, the analysis conducted in this section examined incremental SLR scenarios ranging from 0 to 5 ft to specifically identify which segments of roadway would be vulnerable to inundation during regular tidal flooding events, without considering the addition of water level due to storm surge or wave action.

The selected scenarios cover the following period range for the High SLR scenario, based on the OPC 2024 SLR State Guidance:

- **1 ft of SLR**: Projected to occur by approximately 2048 (between 2040-2050)
- **2 ft of SLR**: Projected to occur by approximately 2063 (between 2060-2070)
- **3 ft of SLR**: Projected to occur by approximately 2074 (between 2070-2080)
- **4 ft of SLR**: Projected to occur by approximately 2082 (between 2080-2090)
- **5 ft of SLR**: Projected to occur by approximately 2090 (between 2080-2090)

Tidal data were compared to the roadway elevations of State Park Road and S Bay Boulevard obtained from USGS CoNED LiDAR data, described in Section 3.2. Table 12 presents the critical elevations of the most vulnerable sections of State Park Road and S Bay Boulevard, along with the corresponding tidal water levels that would trigger flooding and necessitate road closures. A road closure threshold has been established at 0.5 ft of water above the roadway elevation, as this water depth is assumed to impede safe vehicle passage and warrant closure for public safety. Therefore, tidal water levels exceeding roadway elevations by, for example, 0.25 ft are assumed to not trigger a roadway closure event in this analysis. Note that the purpose of this analysis is to inform the vulnerability assessment and is not intended to inform flood thresholds for managing actual road closures.

TABLE 12
MORRO BAY ESTUARY TIDAL FLOODING THRESHOLDS

Roadway	Roadway Area Minimum Elevation (ft NAVD)	Tidal Water Level to Cause Road Closure (ft NAVD)
State Park Road – Windy Cove	7.25	7.75
State Park Road – Morro Bay State Park Marina to S Bay Blvd	7.5	8.0
S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge	10.0	10.5

The tide record from the Port San Luis Tide Gage (Station #9412110, NOAA 2025**)** was obtained from 1948 to 2025. This 77-year record is assumed to be representative of the local tidal patterns and is used as a proxy for future tidal records. Figure 11 presents the tidal record at Port San Luis for existing conditions (top pane), and potential future conditions with SLR (lower four panes) with dashed lines indicating the thresholds for flooding causing road closure of State Park Road at Windy Cove (yellow), State Park Road between Morro State Park Marina and S Bay Blvd (orange), and S Bay Blvd between Chorro Creek Bridge and Los Osos Creek Bridge (red). The water levels shown represent tidal water levels as measured at Port San Luis and, therefore, may differ from the actual water level that occurs in the project area. Also, these water levels represent tidal still water levels and do not include an added wind or wave setup component that may increase the likelihood of roadway flooding.

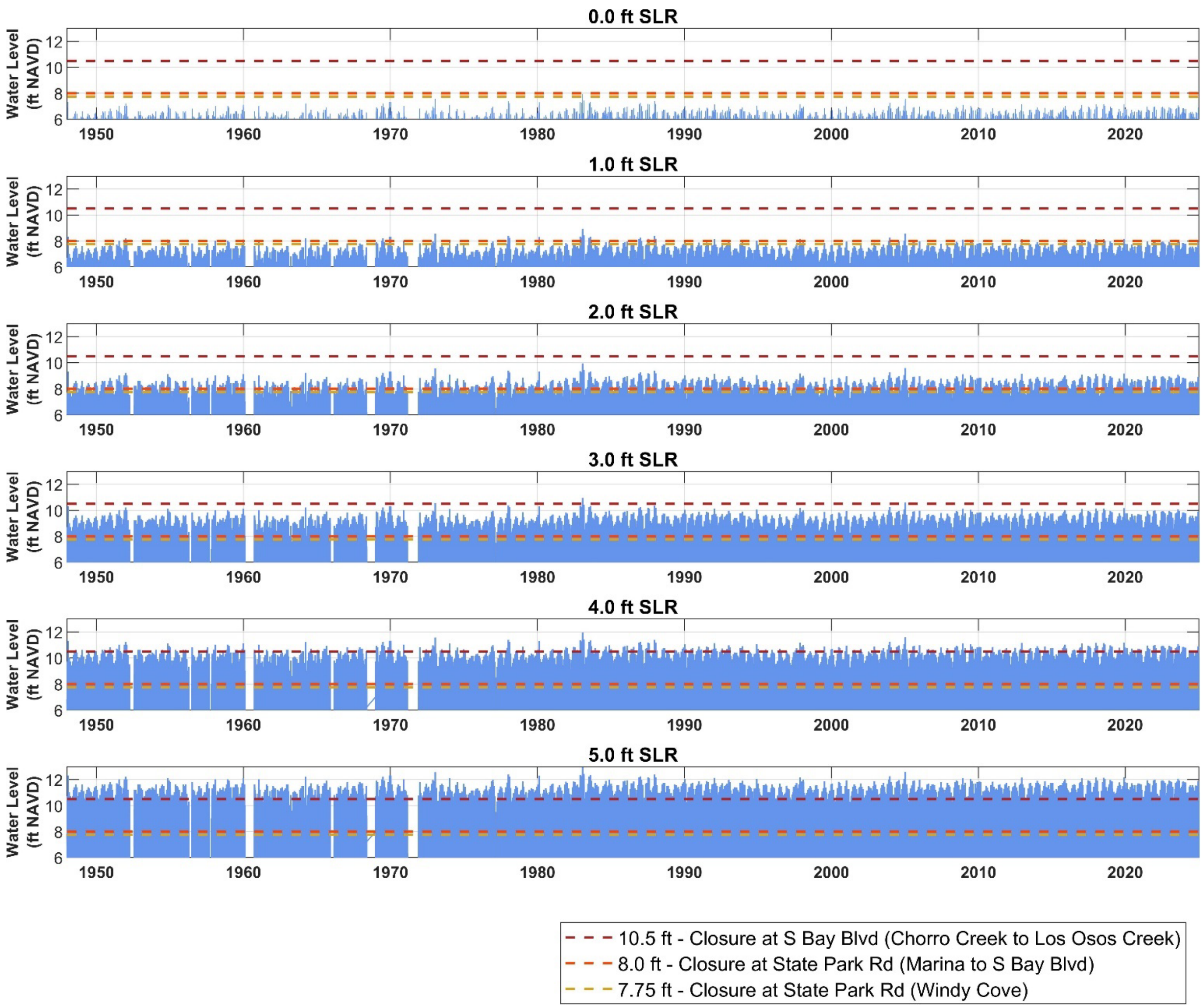

Figure 11
Tidal Water Level at Port San Luis with SLR, with the Thresholds for Flooding Causing Road Closure

Figure 12 shows histograms of the inundation event durations where the tidal water surface elevation exceeds flood condition elevations. The three rows represent closure of State Park Road at Windy Cove (top), State Park Road from the marina to S Bay Blvd (middle), and S Bay Blvd (bottom). Each column represents a SLR scenario from 0 to 5 ft. In addition, unlike the ESA Hydrodynamic Model, the results from the histograms (Figure 12) were derived solely from the Morro Bay tide gauge dataset, which does not include storm-driven processes like wave runup, resulting in lower water levels than those produced by the hydrodynamic modeling.

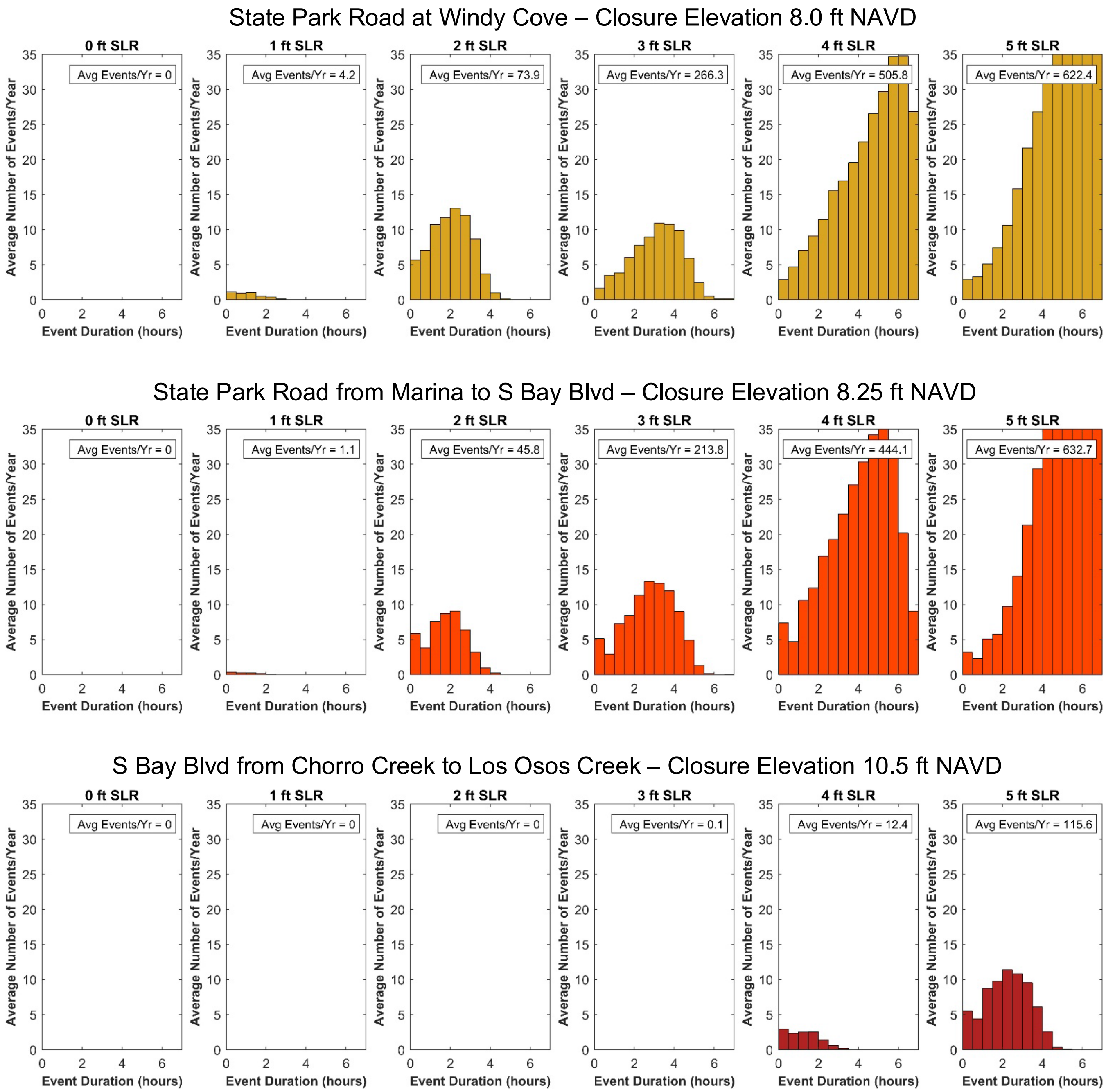

Figure 12
Histograms of Tidal Flooding Causing Road Closure Event Durations With SLR at State Park Road and South Bay Boulevard

State Park Road at Windy Cove is the first area to be exposed to tidal flooding with SLR. Under existing conditions, it is not expected to close due to tidal flooding, but with 1 ft of SLR tidal flooding causing closure is expected to occur approximately four times per year. With 2 ft of SLR, there are projected to be 74 closure events per year, rising to 266 closure events per year after 3 ft of SLR. With 4 ft of SLR and beyond, the Windy Cove roadway is expected to close daily.

The next roadway affected by tidal flooding is the section of State Park Road from the Morro Bay State Park Marina to S Bay Boulevard. It is unaffected by tidal flooding until 1 ft of SLR , at which point closure is expected on average once per year. Closure events are projected to increase to 46 events per year after 2 ft of SLR and 214 events per year with 3 ft of SLR . With 4 ft of SLR and beyond, this section of State Park Road is expected to close daily.

Finally, S Bay Boulevard between Chorro Creek and Los Osos Creek is not expected to be affected by tidal flooding before 3 ft of SLR, at which point the roadway is projected to flood on average once every ten years. With 4 ft of SLR, the frequency of flooding causing closure rises to 12 times per year on average, rising to 116 times per year after 5 ft of SLR.

Note that this tidal flooding assessment does not consider the effects of wind waves, which will exacerbate flooding.

8 Vulnerability Assessment

This section presents the methods and findings of the flood and SLR vulnerability assessment. This assessment and quantification of the vulnerability of transportation, recreational, and natural assets surrounding the Morro Bay Estuary integrated multiple approaches: field observations, stakeholder and community engagement, and technical analyses.

The technical component included hydrodynamic modeling of estuary water levels under SLR scenarios to identify flood hazards and quantify impacts to essential transportation assets. The results of the vulnerability assessments were developed using the ESA Hydrodynamic Model under both storm and non-storm conditions, representing the most conservative scenarios by incorporating dynamic coastal processes such as storm surge, wave setup, and runup, along with SLR scenarios. In addition, the study focused on the vulnerability of wetland areas, which may be affected by SLR and the worsening of coastal hazards due to climate change. It is important to note that the scope of this assessment does not include utilities or other assets, as these were deemed outside the study's parameters.

8.1 Introduction

To develop effective adaptation alternatives to address flood and SLR vulnerability, the risk of not acting must be understood first. For this reason, the vulnerability assessment analyzes impacts from a hypothetical “no action” scenario, where no measures are taken to adapt to SLR. By considering the “no action” scenario, SLOCOG and other decision makers can understand the full potential impacts of flooding and SLR, identify areas and/or individual assets with the greatest vulnerabilities, and then plan adaptation to reduce identified vulnerabilities.

ESA assessed transportation, recreational, and natural assets throughout Morro Bay Estuary that are potentially at risk from SLR, including their elevation, exposure to wave hazards, sensitivity to flooding and tidal inundation, criticality, and relative level of adaptive capacity. Using these criteria, ESA assigned a vulnerability rating to rank the assets by when they will become vulnerable to the hazard considering storm and non-storm (e.g. regular tidal inundation) hazard conditions as well as the consequences of their exposure to these hazards.

To estimate vulnerability under various flooding scenarios, ESA utilizes GIS to create flood layers for short-, medium- and long-term flooding with and without modeled storm conditions (modeled storm conditions defined in Section 3.3). Short-term vulnerabilities affect areas/assets under storm conditions, which are characterized by the boundary conditions applied in the model (Section 3), with 0 ft of SLR, medium-term vulnerabilities are affected under storm conditions with 1.8 ft of SLR, and long-term vulnerabilities are affected under storm conditions with 6.3 ft of SLR. Overlaying these flood layers with transportation, recreational, and habitat maps reveal which assets are vulnerable at each time horizon. In addition to the flood layers created with the Delft-3d model, the ESA team reviewed existing and available coastal flood hazard data sets, including CoSMoS, NOAA SLR Viewer, and FEMA Flood Insurance Rate Maps (FIRMs). See section 8.3 for further clarification.

8.2 Assets

Assets throughout Morro Bay Estuary were divided into three primary categories: Transportation – roads and mobility assets, recreational assets, and natural assets. The specific assets within each category are listed in Table 13 below. Chorro Creek Bridge is also referred to as Twin Bridges. These assets are shown on maps of Morro Bay Estuary in Appendix A.

TABLE 13
MORRO BAY ESTUARY ASSETS

Asset Category	Assets
Transportation	State Park Road – Windy Cove Main Street South Bay Boulevard – Chorro Creek Bridge to Bay Pines Chorro Creek Bridge to Los Osos Creek Bridge Quintana Road Turri Road Chorro Creek Bridge Los Osos Creek Bridge
Recreational	Windy Cove Beach Morro Bay State Park Marina Parking Lot Windy Cove Parking Lot Cerro Cabrillo Trailhead Parking Lot Park Ridge Trailhead Parking Lot Chumash Trailhead Parking Lot Morro Bay State Park Marina Bicycle Parking Morro Bay Golf Course
Natural	Morro Bay State Marine Reserve El Moro Elfin Forest Natural Preserve

The vulnerability assessment is divided into four primary study areas. These study areas were visited during the Morro Bay Estuary Climate Resiliency Stakeholder Field Tour on October 21, 2024. Their locations are as follows:

- **Area 1** – State Park Rd near water access
- **Area 2** – State Park Rd from Marina to S Bay Blvd

- **Area 3** – S Bay Blvd from Chorro Creek Bridge to Bay Pines Travel Trailer Park
- **Area 4** – S Bay Blvd from Los Osos to Chorro Creek Bridge

The study areas are represented as linear dashed lines shown in light blue, dark blue, lavender, and purple, respectively, in an overview asset map of the area of the field tour map in Figure 13. In addition, Figure 14 provides a zoomed view of specific points of interest, which include Los Osos Creek Bridge, Chorro Creek, and Wind Cove. A summary of each study area's primary transportation function, transportation assets, recreational assets, natural assets, types of hazards, proximity to hazards, potential modes of failure, and consequences of failure is provided in Table 14 below.

TABLE 14
SUMMARY OF STUDY AREAS

Area 1 – State Park Rd near water access	
Assets: State Park Rd – Windy Cove, Windy Cove, Windy Cove Parking Lot	
Location	• Connecting South Morro Bay to the Marina and beyond • Passes by Morro Bay Golf Course and Morro Bay water access
Function	• A main route to South Bay Blvd • Provides beach access, marina access, and other coastal amenities
Mobility assets	• Unpaved pedestrian trail • No bicycle facility
Types of hazards	• Temporary flooding caused by storm events • Tidal inundation from SLR • Increased erosion resulting from waves rushing up on the adjacent coast
Exposure to hazards[1]	• Parts of the road are within a 100-year flood hazard zone. With 0.8 ft of SLR, a 20-year storm is expected to encroach on the road • Tidal encroachment of the road is expected to occur with 1.6 to 2.5 ft of SLR
Modes of failure	• Large storm causes coastal flooding of the roadway • SLR leads to water levels slowly encroaching on the roadway • Increased erosion due to SLR and wave activity encroach on the roadway
Consequence of failure	• Access to marina, beach, and other coastal amenities lost • Costs associated with roadway repair
Area 2 – State Park Rd from Marina to S Bay Blvd	
Assets: State Park Rd – Main St, Morro Bay State Park Marina Bicycle Parking, Morro Bay Golf Course, Morro Bay State Marine Reserve	
Location	• From the marina to S Bay Blvd • Passing by the Morro Bay Estuary to the south and Morro Bay campground and county park to the north
Function	• Connects south Morro Bay, the marina, beach access, and county park to S Bay Blvd
Mobility assets	• No pedestrian facilities • No bicycle facilities • Trailhead and hiking access
Types of hazards	• Temporary flooding caused by storm events • Tidal inundation from SLR • Increased erosion resulting from waves rushing up on the adjacent coast
Exposure to hazards[1]	• Currently not expected to be impacted by an extreme storm event. With 2.5 ft of SLR or less, a 20-year storm is expected to flood parts of the roadway • Tidal encroachment of the road is expected to occur with 2.5 to 3.3 ft of SLR
Modes of failure	• Large storm causes coastal flooding of the roadway • SLR leads to water levels slowly encroaching on the roadway • Increased erosion due to SLR encroach on the roadway
Consequence of failure	• Limits accessibility to and from south Morro Bay, as well as coastal resources and recreational amenities

	• Costs associated with roadway repair
Area 3 – S Bay Blvd from Chorro Creek Bridge to Bay Pines Travel Trailer Park	
Assets: S Bay Blvd – Chorro Creek Bridge to Bay Pines, Quintana Rd	
Location	• From Cabrillo Hwy to the State Park Rd intersection • Has Black Hill to the east, Chorro Creek to the west, and Morro Bay Estuary to the south
Function	• Provides access to Bay Pines Travel Trailer Park • Connects Cabrillo Hwy to Baywood Park, Los Osos, and Morro Bay (via State Park Rd) • Crosses Chorro Creek
Mobility assets	• No pedestrian facilities • Class II bicycle lanes • Bus stop
Types of hazards	• Temporary flooding caused by storm events raising water levels in Chorro Creek
Exposure to hazards[1]	• Expected to be impacted by extreme storm events. Flooding is likely to become more frequent with climate change. • Not expected to be tidally inundated by SLR
Modes of failure	• Large storm leads to significantly increased flows through Chorro Creek that flood S Bay Blvd near the Chorro Creek Bridge.
Consequence of failure	• Limits accessibility between Baywood Park and Los Osos and Morro Bay and Bay Pines Travel Trailer Park and adds 30 minute detour, as well as limits emergency evacuation options • Costs associated with roadway repair
Area 4 – S Bay Blvd from Los Osos to Chorro Creek Bridge	
Assets: Chorro Creek Bridge, S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge, Los Osos Creek Bridge, Turri Rd, Cerro Cabrillo Trailhead Parking Lot, Park Ridge Trailhead Parking Lot, Chumash Trailhead Parking Lot, Morro Bay State Marine Reserve, El Moro Elfin Forest Natural Preserve	
Location	• From Los Osos to Chorro Creek crossing • Bordered to the west by Morro Bay Estuary and to the east by various hiking trails
Function	• Provides access to Bay Pines Travel Trailer Park • Connects Baywood Park and Los Osos to Morro Bay • Crosses Los Osos Creek
Mobility assets	• No pedestrian facilities • Class II bicycle lanes • Trailhead and hiking and mountain biking access
Types of hazards	• Temporary flooding caused by storm events raising water levels in Los Osos Creek and coastal storm events • Tidal inundation from SLR • Increased erosion resulting from higher water levels in the estuary
Exposure to hazards[1]	• Expected that the roadway will be encroached during a extreme storm events under current conditions. With 2.5 to 3.3 ft of SLR, an extreme storm is anticipated to inundate the roadway • Tidal inundation of the roadway is expected to begin between 4.9 and 5.7 ft of SLR or less
Modes of failure	• Large storm leads to significantly increased flows through Los Osos Creek that flood S Bay Blvd near the Los Osos Creek bridge • Coastal storm leads to increased sea levels that temporarily flood the roadway from the estuary • SLR leads to water levels slowly encroaching on the roadway • Increased erosion due to SLR encroach on the roadway
Consequence of failure	• Severs connectivity between Morro Bay and Los Osos and blocks one of the primary evacuation routes in the event of a radiation accident at Diablo Canyon Nuclear Power Plant. • Costs associated with roadway repair

NOTES:

1. Hazard exposure based on results from CoSMoS 3.1 (Barnard et al. 2018)

SOURCE: ESRI, 2024; RRM, 2024; ESA, 2024

Figure 13
Morro Bay Estuary Assets Overview

SOURCE: ESRI, 2024; RRM, 2024; ESA, 2024

Figure 14
Zoomed-In Views of Specific Points of Interest at Morro Bay Estuary

ESA

Prior to the Delft3D modeling, the tables were developed to gain a preliminary understanding of the assets and hazards for a stakeholder visit to the project area. Modes of failure and proximity to hazards were developed using existing and available data, results from CoSMoS, NOAA SLR viewer, and FEMA Flood Insurance.CoSMoS provides publicly accessible projections of tidal inundation, coastal flooding, and beach and bluff erosion for existing conditions, with SLR scenarios and 1-year, 20-year, and 100-year storm return periods, across the central coast of California (Barnard et al. 2018).

Note that CoSMoS storm scenarios assume that the storm coincides with a "high spring tide" (tide levels that occur approximately twice every month), representing a near-worst-case scenario. CoSMoS data provides regional projections with relatively coarse resolution while the Delft3D model created for this study is tailored to the Morro Bay Estuary with specific site topography and bathymetry and run for specified SLR and storm scenarios.

8.3 Methods and Definitions

This section presents a summary of asset vulnerabilities to flooding with SLR and climate change. The vulnerability of each asset category was assessed based on three factors: hazard exposure, sensitivity, and adaptive capacity. The factors contributing to an asset rating in each category are explained in Table 15. Each asset was assessed in each category from high to low as described and an overall aggregated vulnerability score was assigned. Storm conditions are characterized by the boundary conditions applied in the model (Section 3), which consist of extreme coastal and fluvial water levels.

TABLE 15
VULNERABILITY ASSESSMENT OUTLINE

Factor	Rating	Explanation
Hazard Exposure – Does the asset have short-, medium-, or long-term vulnerability?		
Hazard Exposure	Very Low	Not exposed under storm conditions after 6.3 ft of SLR
	Low	Exposed under storm conditions only after 6.3 ft of SLR
	Medium	Exposed under storm conditions after 1.8 ft of SLR
	High	Exposed under storm conditions with 0 ft of SLR
Sensitivity – What is the sensitivity of the asset to hazard exposure and what is the consequence of exposure?		
Sensitivity	Low	Flooding would have no or low impact on the asset function. The asset would quickly rebound
	Medium	Flooding would cause minor damage or temporary operational interruption
	High	Flooding would cause significant damage or longer-term operational interruption
Adaptive Capacity – What is the asset's ability to change in response to hazard exposure with rising sea levels?		
Adaptive Capacity	Low	Requires significant effort to modify and adapt
	Medium	Requires moderate effort to modify and reduce flooding impacts
	High	Could be easily modified to reduce/avoid flooding impacts

Hazard Exposure: Each asset was assigned a flooding exposure level of very low, low, medium, or high, depending on the storm and SLR conditions under which the asset is exposed. Example maps showing asset exposure in one of six project area sections are shown in Figure 15, where light blue, blue, and dark blue flood layers indicate short-, medium-, and long-term exposure, respectively. Hazard maps for all project area sections, including all SLR scenarios with both non-storm and storm conditions, are available for transportation and recreational assets in Appendix B. Hazard Exposure ratings for each asset are defined in Section 8.4.

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

Figure 15
Example of Transportation and Recreation Asset Hazard Exposure Map (Map 1 of 6)
See Appendix B for Detailed Maps 1 to 6

Sensitivity: Each asset was assigned a level of sensitivity relating to its susceptibility to harm from SLR and/or the consequences of its exposure. For example, a key through-road that disrupts the area's transportation system when inoperable has high sensitivity, whereas an unpaved parking lot with a relatively small effect when closed has a low sensitivity. Sensitivity ratings for each asset are defined in Section 8.4.

Adaptive Capacity: Each asset was assigned an adaptive capacity based on its ability to change and adapt in response to increasing exposure to hazards associated with rising sea levels. For instance, an unpaved trail that could be easily rerouted or raised has a high adaptive capacity, while a large road that is difficult to reroute or raise has a low adaptive capacity. Adaptive Capacity ratings for each asset are defined in Section 8.4.

8.4 Vulnerability Results

The vulnerability of assets to flooding and SLR is a combination of the likelihood of being flooded (hazard exposure), consequence of being flooded (sensitivity), and ability to be modified (adaptive capacity). Table 16 summarizes asset exposure, sensitivity, and adaptive capacity rankings and the composite vulnerability ranking based on the ranking system described in Section 8.3. A more detailed explanation of each asset's hazard exposure, sensitivity, and adaptive capacity is provided in the sub-sections below.

TABLE 16
SUMMARY OF VULNERABILITY ASSESSMENT RESULTS

Asset	Hazard Exposure	Sensitivity	Adaptive Capacity	Vulnerability Rating
Transportation Assets				
State Park Road				
Windy Cove	High	High	Low	High
Main St	High	High	Low	High
S Bay Blvd				
Chorro Creek Bridge to Bay Pines	Low	High	Low	Medium
Chorro Creek Bridge to Los Osos Creek Bridge	High	High	Low	High
Quintana Rd	High	High	Low	High
Turri Rd	Medium	High	Low	High
Chorro Creek Bridge	High	High	Low	High
Los Osos Bridge	Low	High	Low	Medium
Recreational Assets				
Windy Cove – Beach	High	Medium	Low	High
Morro Bay State Park Marina Parking Lot	High	Medium	Low	High
Windy Cove Parking Lot	High	Medium	Medium	Medium
Cerro Cabrillo Trailhead Parking Lot	Low	Low	High	Low
Park Ridge Trailhead Parking Lot	Very Low	Low	High	Low
Chumash Trailhead Parking Lot	Low	Low	High	Low
Morro Bay State Park Marina Bicycle Parking	High	Medium	Low	High
Morro Bay Golf Course	High	Medium	High	Medium

Asset	Hazard Exposure	Sensitivity	Adaptive Capacity	Vulnerability Rating
Natural Assets				
Morro Bay State Marine Reserve	High	Medium	Low	High
El Moro Elfin Forest Natural Preserve	Very Low	Medium	Low	Low

8.4.1 Thresholds

The thresholds approach was used to examine the approximate timeframe of asset impact. The threshold method, introduced in the ESA Summary of Additional Guidance Memo, involves identifying specific amounts of SLR, or thresholds, at which assets become vulnerable, using model results from both this study and CoSMoS. Specific assets were assigned approximate time frames as to when they may become vulnerable. The approximate date of exposure to temporary (storm) and permanent (tidal inundation) hazards for each asset were determined based on the OPC 2024 High SLR scenario.

The results from this analysis are shown in Table 16. Note that modeling for this study by ESA accounts for ocean water levels, Bay hydrodynamics and wind waves, and creek flooding, whereas CoSMoS results only account for ocean water levels and exclude Bay hydrodynamics and wind waves and creek flooding. For this study, ESA modeled 1.8 ft of SLR (2060) and 6.3 ft of SLR (2100). Therefore, in most cases, ESA's model results show higher water levels that indicate impacts occur sooner compared to CoSMoS results. In certain cases, CoSMoS results show impacts occurring sooner due to the fact that CoSMoS modeled additional SLR scenarios between 1.8 ft and 6.3 ft or other modeling differences. The bold timeframes in Table 17 highlight impacts that are expected to occur sooner. ESA recommends these timeframes for planning purposes.

Based on these results, the assets currently exposed to coastal hazards are State Park Road, Quintana Road, Chorro Creek Bridge, Windy Cove Beach and parking lot, Morro Bay State Park Marina bicycle parking, Morro Bay Golf Course, and Morro Estuary State Marine Reserve. The assets likely to become exposed to coastal hazards in the near future (before 2060) are S Bay Blvd (between Chorro Creek Bridge and Los Osos Creek Bridge), and Turri Road.

TABLE 17
ASSET VULNERABILITY TIME FRAMES

Asset	**Approximate time frame of when the asset is temporarily impacted (storm)**		**Approximate time frame of when the asset is permanently impacted (non-storm)**	
	Bay/creek water level with wind setup (ESA Hydrodynamic Model)[1]	**Ocean water level excluding Bay & creek dynamics & wind waves (CoSMoS 100-yr)[2]**	**Bay water level with wind setup (ESA Hydrodynamic Model)[1]**	**Ocean water level excluding Bay & creek dynamics & wind setup (CoSMoS 100-yr)[2]**
Transportation – Roads and Mobility Assets				
State Park Road				
Windy Cove	**Now**	**Now**	**Now to 2060**	2057 to 2068
Main St	**Now**	Now to 2044	**Now to 2060**	2068 to 2075
S Bay Blvd				
Chorro Creek Bridge to Bay Pines	**2060 to 2100**	2116 to 2133	**2100+**	2150+
Chorro Creek Bridge to Los Osos Creek Bridge	**Now to 2060**	2068 to 2075	**Now to 2060**	2089 to 2103
Quintana Rd	**Now**	2116 to 2133	**Now to 2060**	2150+
Turri Rd	Now to 2060	**Now**	2060 to 2100	**2057 to 2068**
Chorro Creek Bridge	**Now**	2044 to 2057	2100+	**2089 to 2103**
Los Osos Bridge	**2100+**	2103 to 2116	**2100+**	2116 to 2133
Recreational Assets				
Windy Cove – Beach	**Now**	**Now**	Now to 2060	**Now to 2044**
Morro Bay State Park Marina Parking Lot	**Now**	Now to 2044	**Now to 2060**	2068 to 2075
Windy Cove Parking Lot	**Now**	**Now**	**Now to 2060**	2044 to 2057
Cerro Cabrillo Trailhead Parking Lot	**2060 to 2100**	2089 to 2103	**2060 to 2100**	2103 to 2116
Park Ridge Trailhead Parking Lot	**2100+**	2150+	**2100+**	2150+
Chumash Trailhead Parking Lot	**2060 to 2100**	2075 to 2089	**2060 to 2100**	2075 to 2089
Morro Bay State Park Marina Bicycle Parking	**Now**	Now to 2044	**Now to 2060**	2068 to 2075
Morro Bay Golf Course	**Now**	Now to 2044	**Now to 2060**	2068 to 2075
Natural Assets				
Morro Bay State Marine Rreserve	**Now**	Now	Now to 2060	**Now to 2044**
El Moro Elfin Forest Natural Preserve	**2100+**	2150+	**2100+**	2150+

NOTES:
1. 1.8 ft of SLR is projected in 2060 and 6.3 ft of SLR is projected in 2100 under a high SLR scenario for Port San Luis (OPC 2024)
2. SLR time frames are calculated using CoSMoS SLR converted to years based on a high SLR scenario (OPC 2024)

8.4.2 Transportation Assets

Generally, the transportation assets surrounding Morro Bay, from Windy Cove to Los Osos Bridge have a low adaptive capacity, high sensitivity, and high hazard exposure. Thus, roads and bridges are highly vulnerable to coastal hazards, which is further exacerbated by SLR. Table 18 below describes the extent of each roadway that is exposed to storm flooding with SLR in the near-term (now with 0 ft of SLR), mid-term (1.8 ft of SLR in 2060), and long-term (6.3 ft of SLR in 2100).

TABLE 18
LENGTH OF ROAD VULNERABILITY BY SCENARIO

	Length of Road Vulnerability (mi)					
Location	**Non Storm Now**	**Storm Now**	**Non Storm 1.8 ft SLR (2060)**	**Storm 1.8 ft SLR (2060)**	**Non Storm 6.3 ft SLR (2100)**	**Storm 6.3 ft SLR (2100)**
1 State Park Road – Windy Cove	<0.1	0.1	0.2	0.2	0.2	0.2
2 State Park Road – Marina to S Bay Blvd	0.4	1.0	0.8	1.1	1.1	1.4
3 South Bay Blvd – Chorro Creek Bridge to HW1	0.0	0.6	0.0	0.6	<0.1	0.6
4 Quintana Road	0.0	0.3	0.0	0.3	0.0	0.3
5 South Bay Blvd – Chorro Creek Bridge to Los Osos	0.5	1.0	0.8	1.1	1.2	1.2
6 Turri Road	<0.1	0.7	0.2	0.9	0.8	1.3

As described below, the four study areas will become more impacted by flooding during storm events and during non-storm conditions. The methodology for determining closure events per year in non-storm conditions is described in Section 7. Storm conditions are based on the hydrodynamic modeling described in Sections 3 to 5.

Area 1 – State Park Rd near water access

Due to low elevation and exposure, State Park Road in Windy Cove is currently highly vulnerable. State Park Rd. at this specific location is currently impacted by storm event flooding. The flooding is expected to worsen with SLR. The road is flooded and impassable during large storm events, which occurs for approximately 3 days per year. By about 2060, with 2 ft of SLR or less, State Park Road could be flooded during high tides approximately 74 times per year. By about 2090, with 5 ft of SLR or less, State Park Road could be impassable due to daily flooding.

Area 2 – State Park Rd from Marina to S Bay Blvd

This section of State Park Rd is on the edge of the Morro Bay Estuary, confined by the bay and the Morro Bay State Park. In this section, State Park Rd is highly sensitive due to its location, and it is susceptible to flooding and erosion from the Chorro Creek outlet channel. Currently, approximately 0.4 miles of State Park Road are impacted by tidal inundation during exceptionally high tides (king tides). By about 2060, with 2 ft of SLR or less, 0.8 miles of State Park Road are estimated to have regular flooding approximately 46 days per year. By about 2090, with 5 ft of SLR or less, the road could be flooded daily.

Results from hydrodynamic modeling show that portions of State Park Road from the marina to Chorro Creek Bridge are susceptible to flooding during storm events (as defined in Section 8.3). SLR will increase the length of road flooded from approximately 1 mile to 1.4 miles in the long-term. In the near-term with 1 ft of SLR or less (2050 or sooner), the road is expected to be impassable for approximately 1 day per year during storm events. The mid-term and long-term could see the road flooded nearly daily, so a storm event will only exacerbate the existing flooding.

Area 3 – S Bay Blvd from Chorro Creek Bridge to Bay Pines Travel Trailer Park

South Bay Blvd north of Chorro Creek Bridge and Quintana Road are generally higher in elevation and out of the coastal hazard zone in non-storm conditions. Modeling results show that the roads are above the 2100 SLR tide elevations.

Flood hazard results from ESA's hydrodynamic model as well as CoSMoS show that Area 3 is not likely to be flooded by tides. However, during periods of exceptionally high tides and high creek flows, the high tides and potentially the constriction of flows through the Chorro Creek bridge contribute to floodwaters backing up in Chorro Creek. This causes flooding to Chorro Creek Bridge, Quintana Road, and the Bay Pines Travel Trailer Park. Historically, Chorro Creek bridge has been flooded for approximately 2 days during extreme storm events. Quintana Road has historically remained flooded for approximately 2 days as well. With SLR, creek flood levels may be higher and back up further into Chorro Creek and onto the floodplain, increasing flood elevations and durations during storm events. In addition, by 2100, with 6.3 ft of SLR, Chorro Creek bridge may be flooded daily.

Area 4 – S Bay Blvd from Los Osos to Chorro Creek Bridge

South Bay Blvd is a primary evacuation route from Los Osos and provides connectivity from the City of Morro Bay to Los Osos. Similar to State Park Road on the northwest side of Morro Bay, South Bay Blvd between Chorro Creek Bridge and Los Osos is on the edge of Morro Bay Estuary, confined by the bay and the state park. The road here is susceptible to temporary flooding caused by storm events, tidal inundation with SLR, and erosion. Tidal inundation is not predicted to occur in the near-term. By 2060 with 1.8 ft of SLR (the mid-term), exceptionally high tides may encroach onto South Bay Blvd from just south of Chorro Creek Bridge to just south of the Cerro Cabrillo Trailhead. In the long term, following 4 ft of SLR this flooding would extend to Chorro Creek Bridge and is expected to occur 12 times per year, rising to 116 events per year with 5 ft of SLR or less (around 2090 or sooner). South of the Cerro Cabrillo Trailhead, South Bay Blvd gains elevation and is above tidal elevations in the long-term. Los Osos Bridge is also above tidal elevations in the long-term.

Flood hazard results show this section of South Bay Blvd is susceptible to flooding during storm events in the near-term, from Chorro Creek Bridge to the Cerro Cabrillo Trailhead. Flooding in this section of the road could close the road for approximately one day per year on average now/in the near-term without SLR. With SLR, in the mid- (2060) and long-term (2100), flooding along this section of South Bay Blvd is predicted to worsen and may increase in duration. The flooding does not extend further south towards Los Osos in storm events with SLR. Los Osos Bridge shows flooding in the hazard maps (Figure B-12), but the Delft3D model results do not include the bridge structure. The Los Osos Bridge is not expected to flood with SLR.

Area 4 includes Turri Road, the turnoff just directly north of Los Osos Bridge. The flood hazard maps show the model predicts no tidal inundation of Turri Road in the near- or mid- term. In the long-term, by 2100, Turri Road is susceptible to tidal inundation. The storm scenario predicts there are segments of Turri Road that could flood during storm events in the near-term (now, without SLR), near the Chumash Trailhead and further east (see Figure B-11). By 2060, flood inundation extends to segments of the road east of the Chumash Trailhead, and by 2100, most of the portion of Turri Road that is along the Los Osos creek is vulnerable to storm flooding.

8.4.3 Recreational Assets

This section describes the vulnerability of recreational assets around the Morro Bay Estuary to storm flooding and SLR.

Area 1 – State Park Rd near water access

Windy Cove in Area 1 is inaccessible currently during high tides. Based on an approximate flooding limit of 6.5 ft NAVD, there are approximately 10 to 20 days of the year that the beach is currently inaccessible at high tide and is expected to become inaccessible daily during high tide by the mid-term (2060). Combined with the high sensitivity and difficulty providing adaptation measures to the cove, Windy Cove has a high vulnerability to SLR. The Windy Cove parking lot likewise is currently inundated during large storm events and could become tidally inundated by the mid-term (2060).

Area 2 – State Park Rd from Marina to S Bay Blvd

The paved Morro Bay State Park Marina Parking Lot is currently exposed to storm flooding and is anticipated to become exposed to tidal inundation by the mid-term (2060). Flooding of the parking lot may cause closure but is unlikely to have broader impacts on the transportation network. Overall, the Morro Bay State Park Marina Parking Lot has a high vulnerability. The bicycle parking has the same exposure conditions.

The western portion of the Morro Bay Golf Course is currently exposed to storm flooding. The flood risk area is expected to increase in the mid and late century with SLR, with tidal inundation of the area between now and 2060. Currently, 1.8 acres are within the storm flooding area, which rises to 8 acres with 1.8 ft of SLR and 27 acres after 6.3 ft of SLR. The golf course has moderate sensitivity to storm flooding and tidal inundation as it is. Although these events are unlikely to affect the broader transportation network they could render the course inoperable.

Area 3 – S Bay Blvd from Chorro Creek Bridge to Bay Pines Travel Trailer Park

No recreational assets in Area 3 were included in the vulnerability assessment.

Area 4 – S Bay Blvd from Los Osos to Chorro Creek Bridge

The Cerro Cabrillo, Park Ridge, and Chumash trailhead parking lots have low to very low hazard exposures. The Cerro Cabrillo and Chumash trailhead parking lots become exposed to flooding under storm conditions in the long-term (2100), while the Park Ridge trailhead parking lot is not exposed under any modeled scenarios. Each of the trailhead parking lots is unpaved, providing a high adaptive capacity, and has low sensitivity to storm flooding and tidal inundation. Each of the trailhead parking lots has a low overall vulnerability.

8.4.4 Natural Assets

This section discusses the hazard exposure, sensitivity, and adaptive capacity of natural assets surrounding the Morro Bay Estuary.

Natural assets, including wetlands, intertidal, and subtidal habitats are subject to different impacts from SLR and increased storm flooding compared to transportation and recreational assets. As shown in Appendix B, the Morro Bay State Marine Reserve is inundated under existing conditions during king tides, though this does not necessarily make it typically exposed to a hazard, as this is part of the natural functioning of the habitat. However, prolonged changes to inundation frequency may convert marsh habitat to a different habitat type. At the Morro Bay Estuary, where development and steeper topography surrounding the estuary limit the ability of habitats to migrate to higher elevations (lower adaptive capacity due to coastal squeeze), SLR threatens the loss of habitat area and species diversity. Overall, the Morro Bay State Marine Reserve has a high vulnerability to SLR because of the limited ability of the habitats to adapt to changing environmental conditions, such as SLR and the increased frequency of flooding.

Despite a low adaptive capacity, El Moro Elfin Forest Natural Preserve has a low vulnerability to SLR. Its higher elevation indicates that it is not exposed to tidal inundation or coastal flooding, even in the long-term.

9 Conclusions and Next Steps

This section summarizes the key findings and conclusions of hydrodynamic modeling and the vulnerability assessment. Additionally, the next steps in the Morro Bay Estuary Climate Resiliency Transportation Plan are discussed below.

The area surrounding the Morro Bay Estuary is flood-prone, and many of its transportation, recreational, and natural assets are vulnerable to storm flooding and tidal inundation that will worsen in the future with SLR. ESA developed a Delft3D hydrodynamic model by building upon an existing USGS model (Taherkhani et al. 2023). This model includes all areas inside Morro Bay that are submerged by king tides, and it extends three kilometers offshore of the Bay mouth to allow forcing from ocean tides. ESA verified the model by comparing outputs to observational data collected by Cal Poly and CeNCOOS. ESA ran this model for three SLR scenarios from OPC 2024: 0 ft representing existing conditions, 1.8 ft representing a mid-century (2060) high SLR projection, and 6.3 ft representing a late-century (2100) SLR projection. All scenarios were run for storm and non-storm conditions. Additionally, ESA conducted a simple wave runup analysis using the TAW method to estimate the extent of wave runup at Windy Cove/Main Street and South Bay Blvd.

In addition to technical analyses of modeling the estuary water level with SLR, this study also included conducting observations and working with stakeholders and community members to assess and quantify the vulnerability of transportation, recreational, and natural assets surrounding the Morro Bay Estuary. The results of the technical analyses were overlayed with transportation, recreational, and natural resource assets in and around the Morro Bay Estuary to determine when and under what conditions the assets are exposed to tidal inundation and storm flooding with SLR. The hazard exposure timeframe was combined with a sensitivity rating (consequence of being flooded) and an adaptive capacity rating (ability to be modified) to assign overall vulnerability ratings to the area's assets.

The transportation assets surrounding Morro Bay are highly vulnerable to SLR. Results from the analyses show that the most vulnerable assets include State Park Road at Windy Cove and along the Estuary towards Chorro Creek Bridge, and South Bay Blvd from the Chorro Creek Bridge to the Cerro Cabrillo Trailhead Parking Lot. By 2060, these assets could experience daily tidal inundation. The cumulative vulnerability ratings for each asset are shown in Table 19 below. All high vulnerability assets except Turri Rd are exposed to storm flooding under existing conditions or with 1.8 ft of SLR, projected to occur by 2060 under a high SLR scenario. Tidal inundation also threatens the high vulnerable assets between now and 2060.

TABLE 19
MORRO BAY ESTUARY ASSET VULNERABILITY

Vulnerability	Assets
High	State Park Rd – Windy Cove State Park Rd – Main St S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge Quintana Rd Turri Rd Chorro Creek Bridge Windy Cove Beach Morro Bay State Park Marina Parking Lot Morro Bay State Park Marina Bicycle Parking Morro Bay State Marine Reserve
Medium	S Bay Blvd – Chorro Creek Bridge to Bay Pines Los Osos Bridge Windy Cove Parking Lot Morro Bay Golf Course
Low	Cerro Cabrillo Trailhead Parking Lot Park Ridge Trailhead Parking Lot Chumash Trailhead Parking Lot El Moro Elfin Forest Natural Preserve

The next step in The Plan is to develop an opportunities, constraints, and alternatives analysis. The ESA team will use the coastal hazard maps created during this vulnerability assessment to identify the opportunities and constraints for enhancing transportation and mobility in the Morro Bay Estuary area. This phase will include identifying potential enhancements that increase the resilience of the transportation system, preserve or restore habitats, maintain or improve recreation, and enhance non-motorized mobility. It will also identify constraints that may limit the feasibility of these solutions. Alternatives will be developed and a framework will be developed for adaptation measures in the near-term (now), mid-term (2060), and long-term (2100). This analysis will be conveyed in a Summary of Alternatives and Adaptation Pathways Framework memorandum.

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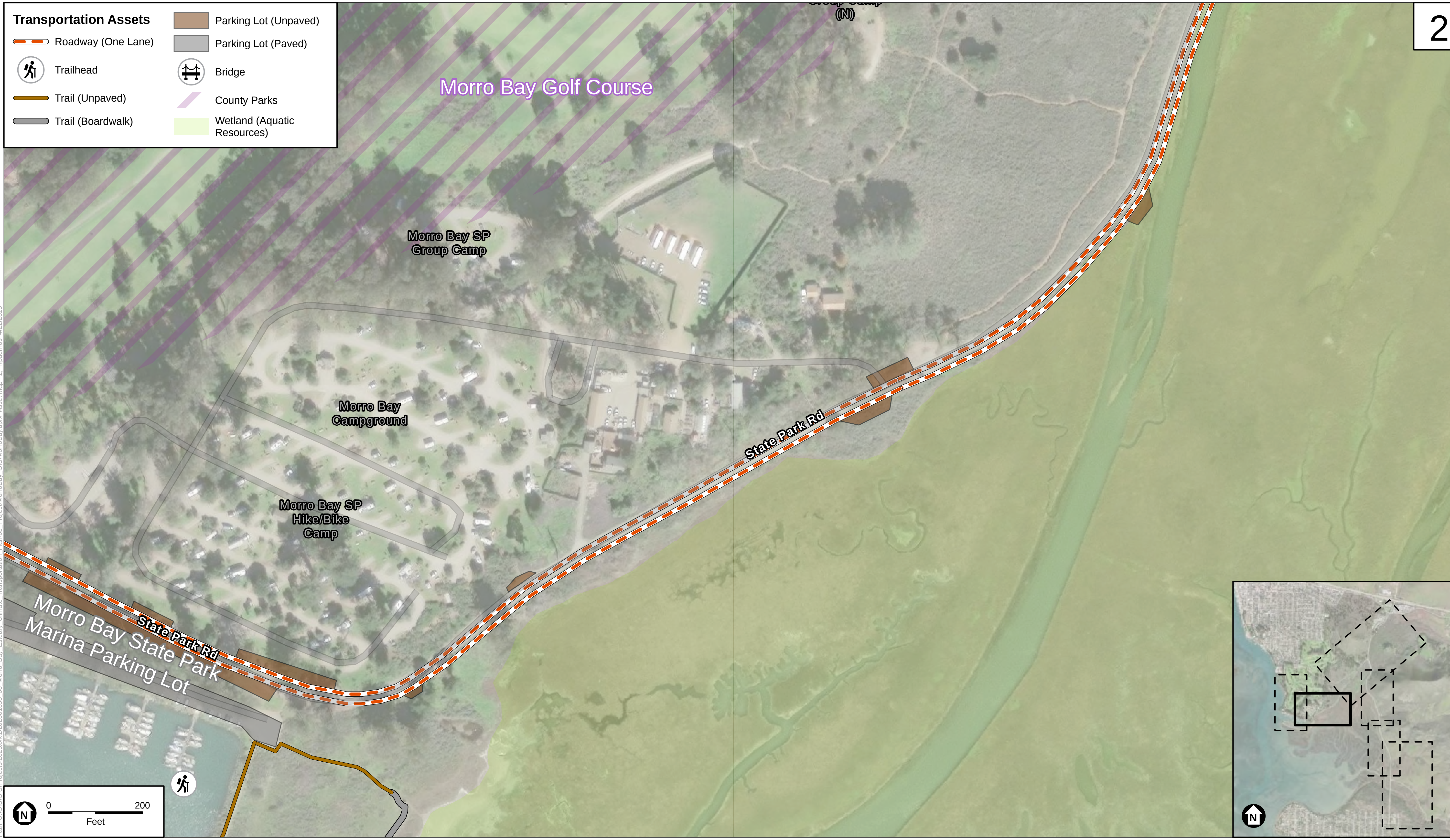
Appendix A
Morro Bay Estuary Asset Maps

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Figure A-1
Morro Bay Estuary Transportation Assets
1 of 6

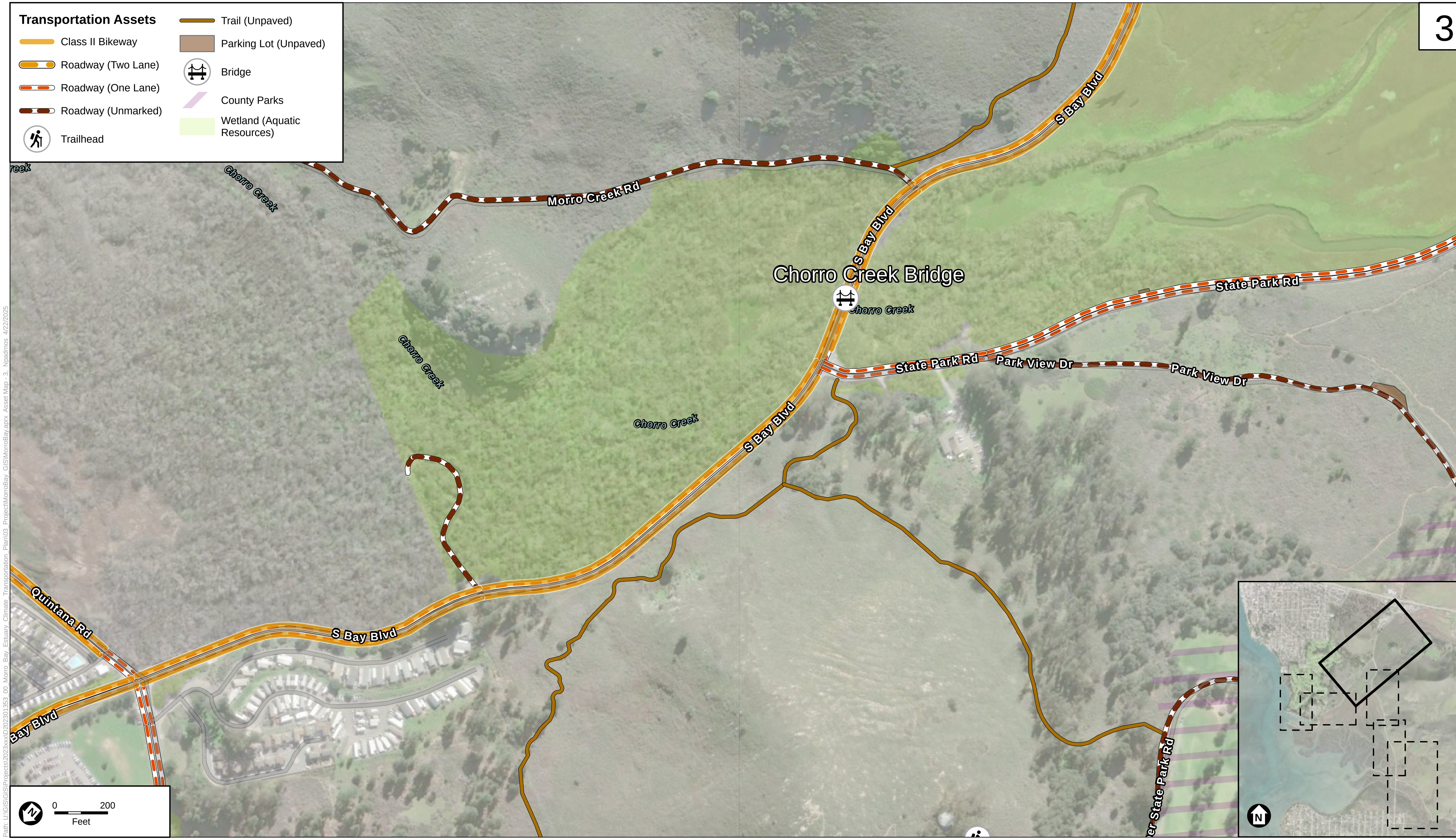
ESA



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Figure A-2
Morro Bay Estuary Transportation Assets
2 of 6

ESA

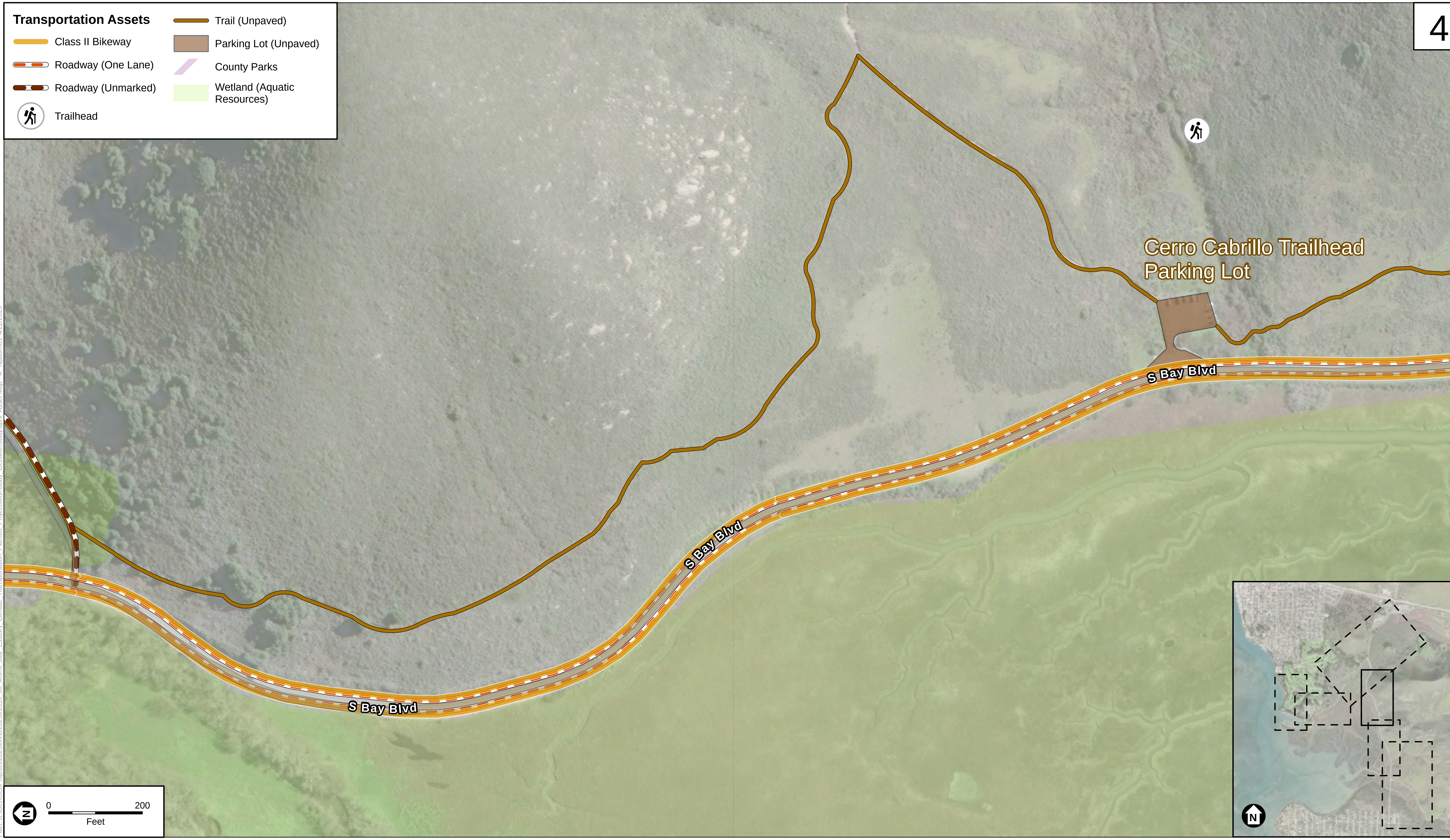


SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure A-3
Morro Bay Estuary Transportation Assets
3 of 6

ESA



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Figure A-4
Morro Bay Estuary Transportation Assets

ESA

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Figure A-5
Morro Bay Estuary Transportation Assets
5 of 6

ESA

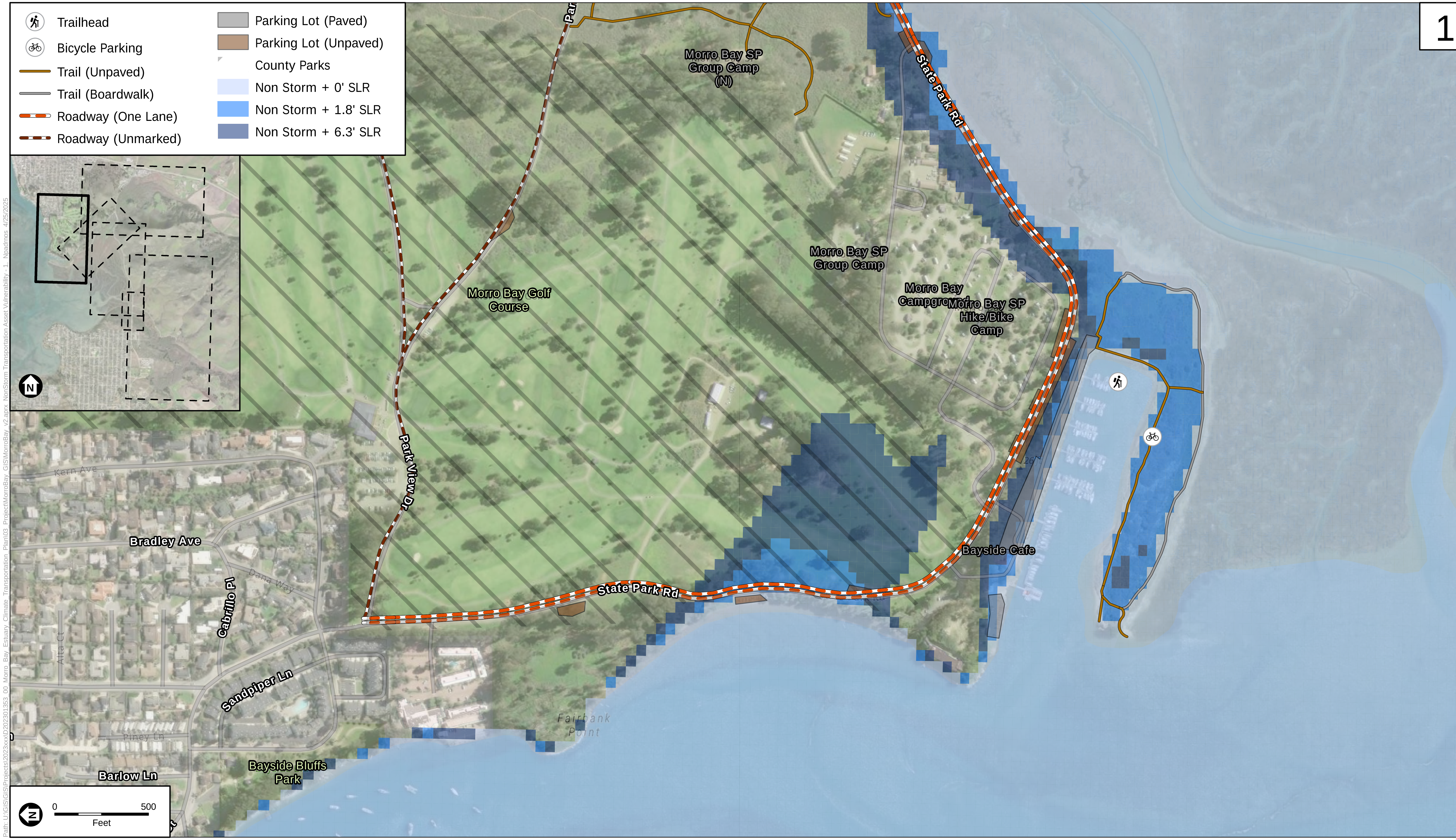
SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure A-6
Morro Bay Estuary Transportation Assets
6 of 6

ESA

Appendix B
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps

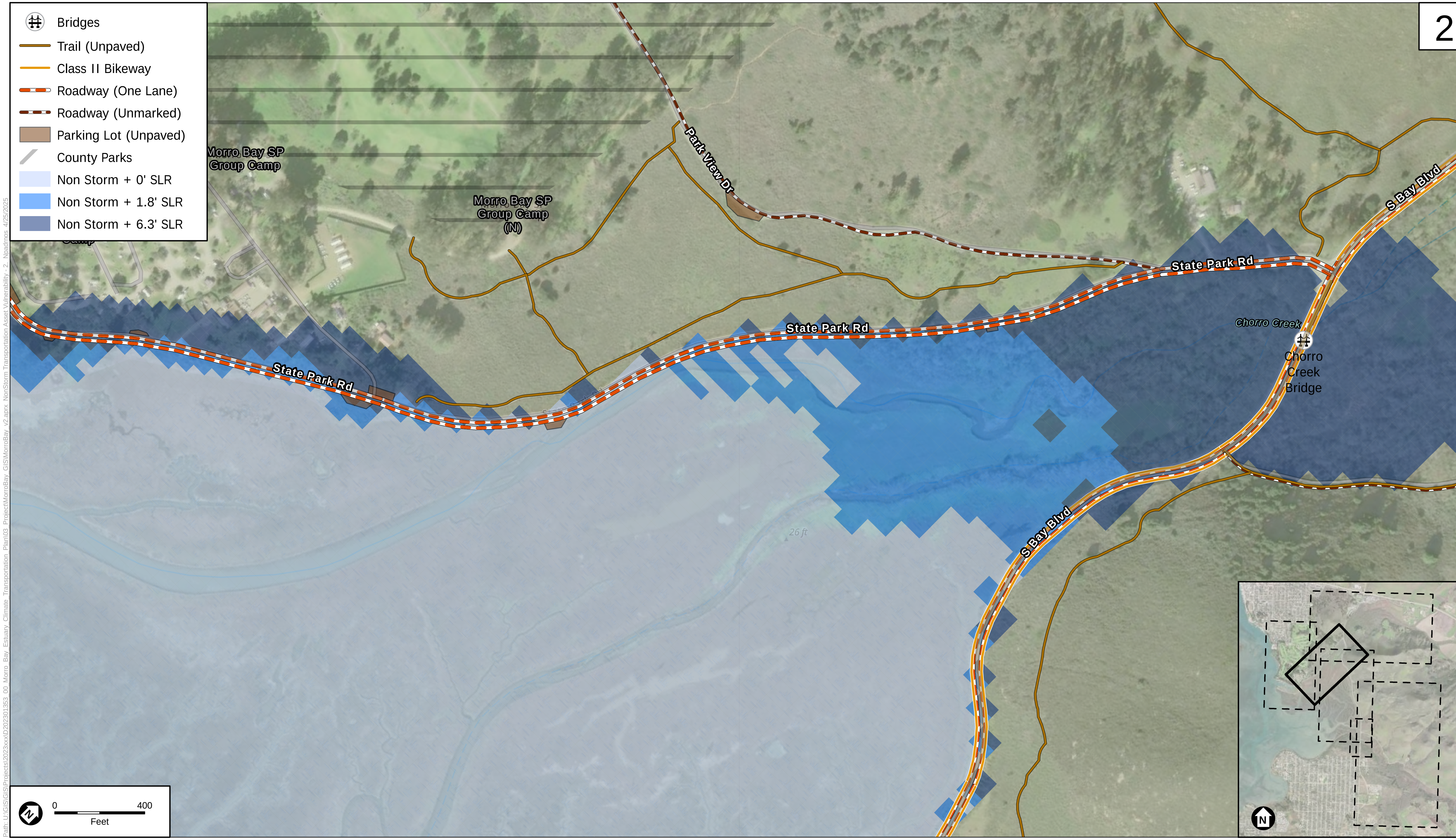


SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure B-1
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Non Storm Scenario
1 of 6

ESA

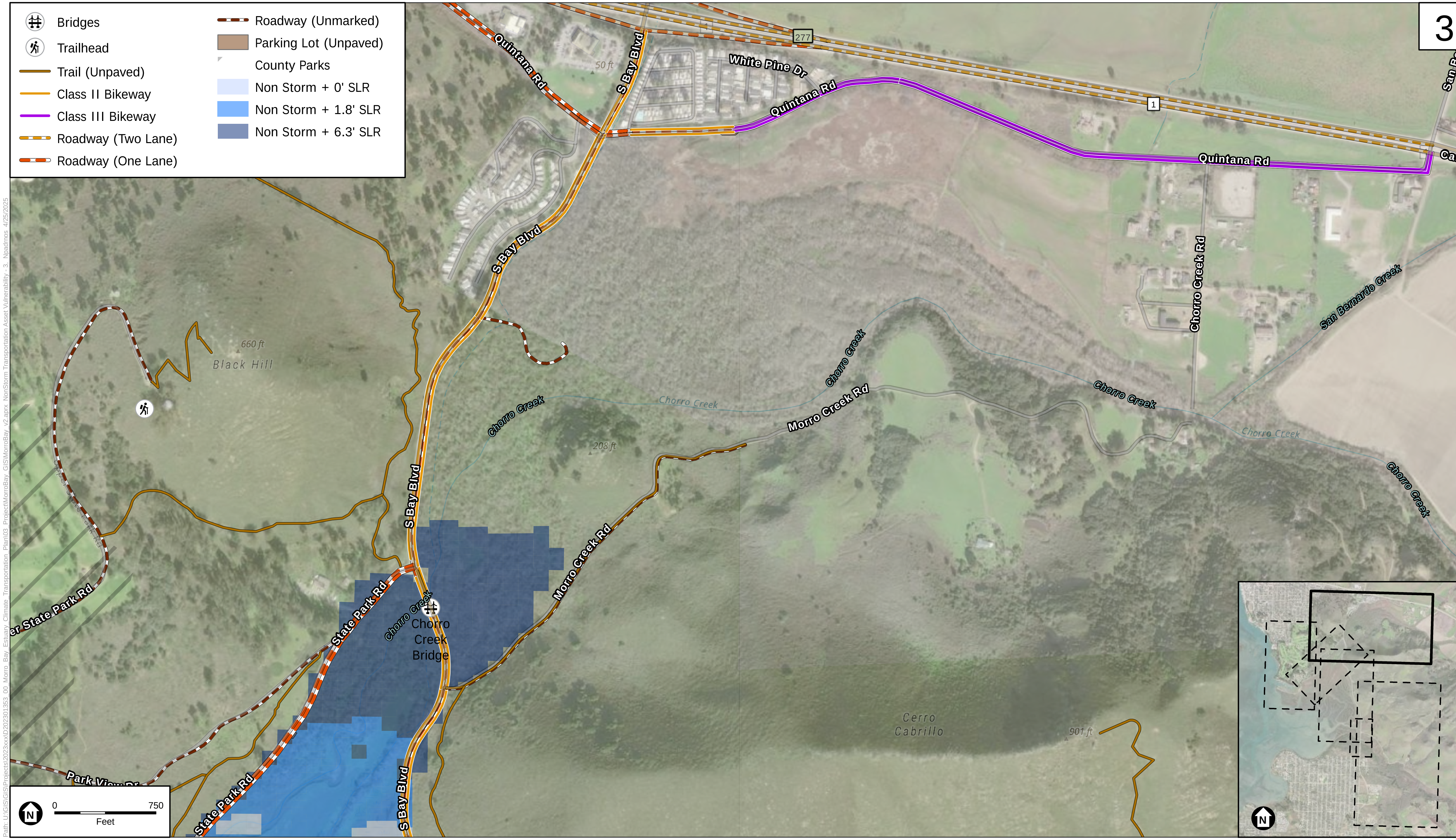


SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure B-2
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Non Storm Scenario
2 of 6

ESA



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: The hydrodynamic model for this study did not extend beyond 1000 feet north of Chorro Bridge

Morro Bay Estuary Climate Transportation Plan

ESA

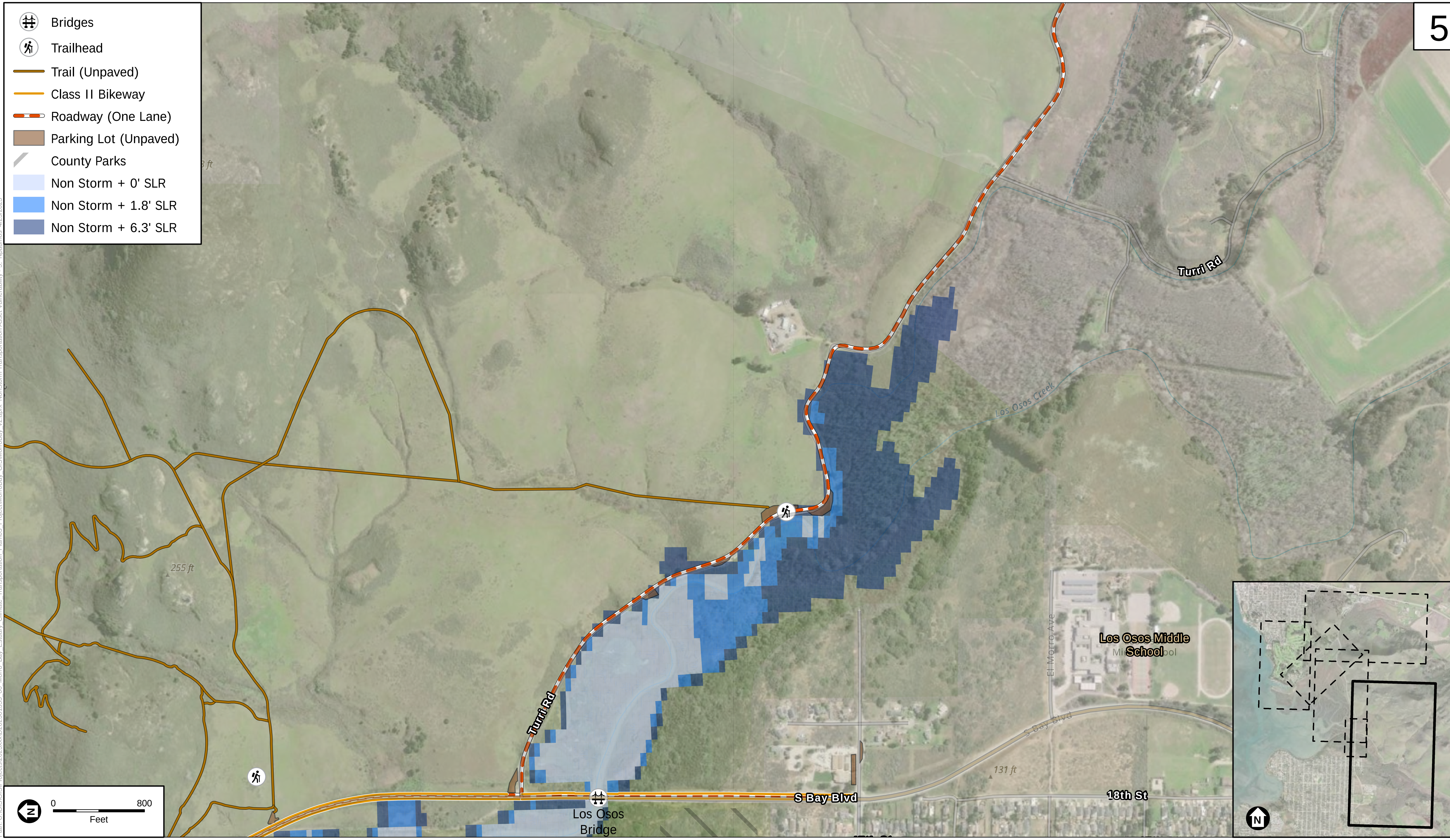
Figure B-3
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Non Storm Scenario
3 of 6

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure B-4
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Non Storm Scenario
4 of 6

ESA

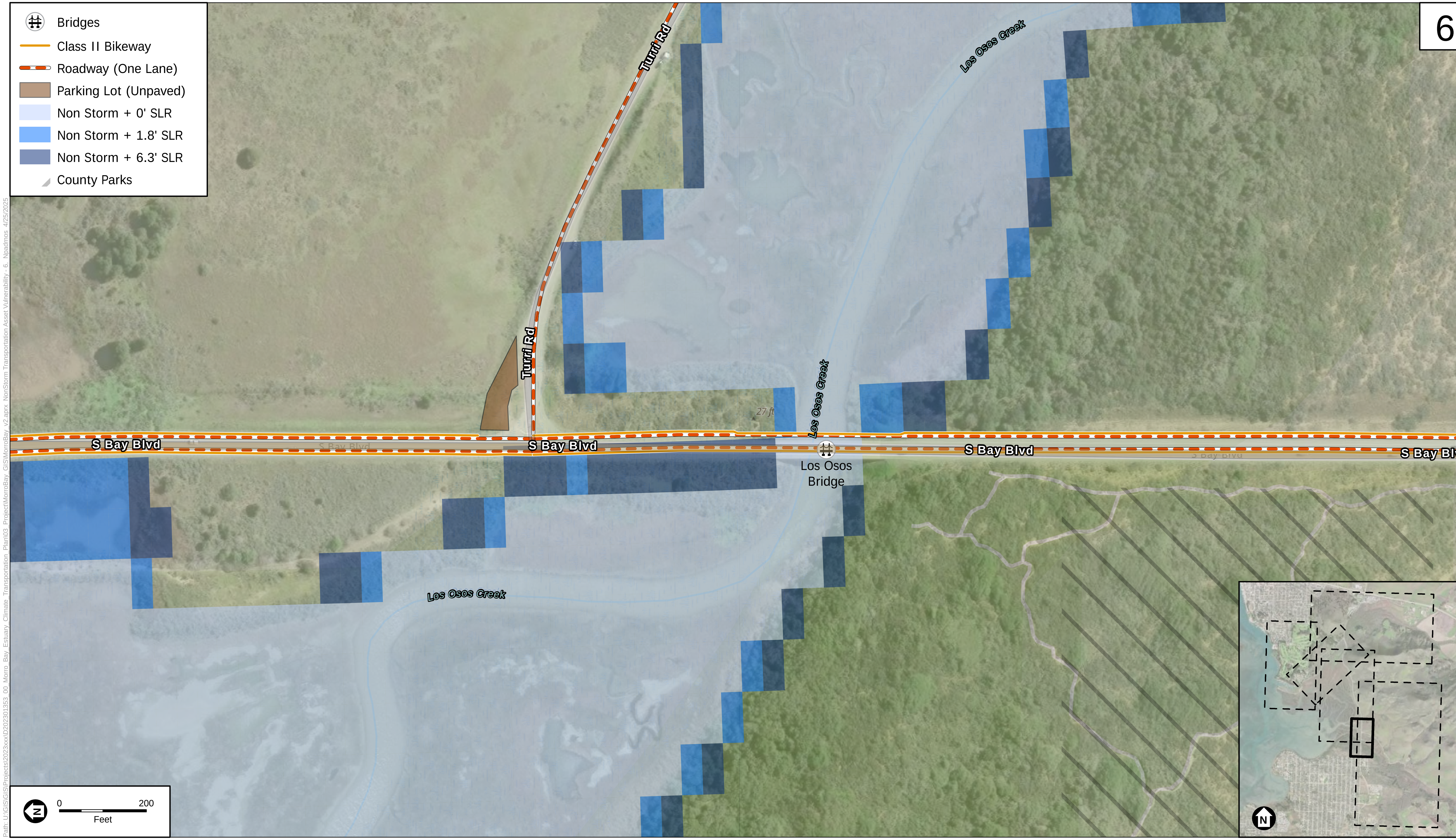


SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

ESA

Figure B-5
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Non Storm Scenario
5 of 6



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

Figure B-6
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Non Storm Scenario
6 of 6

ESA

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

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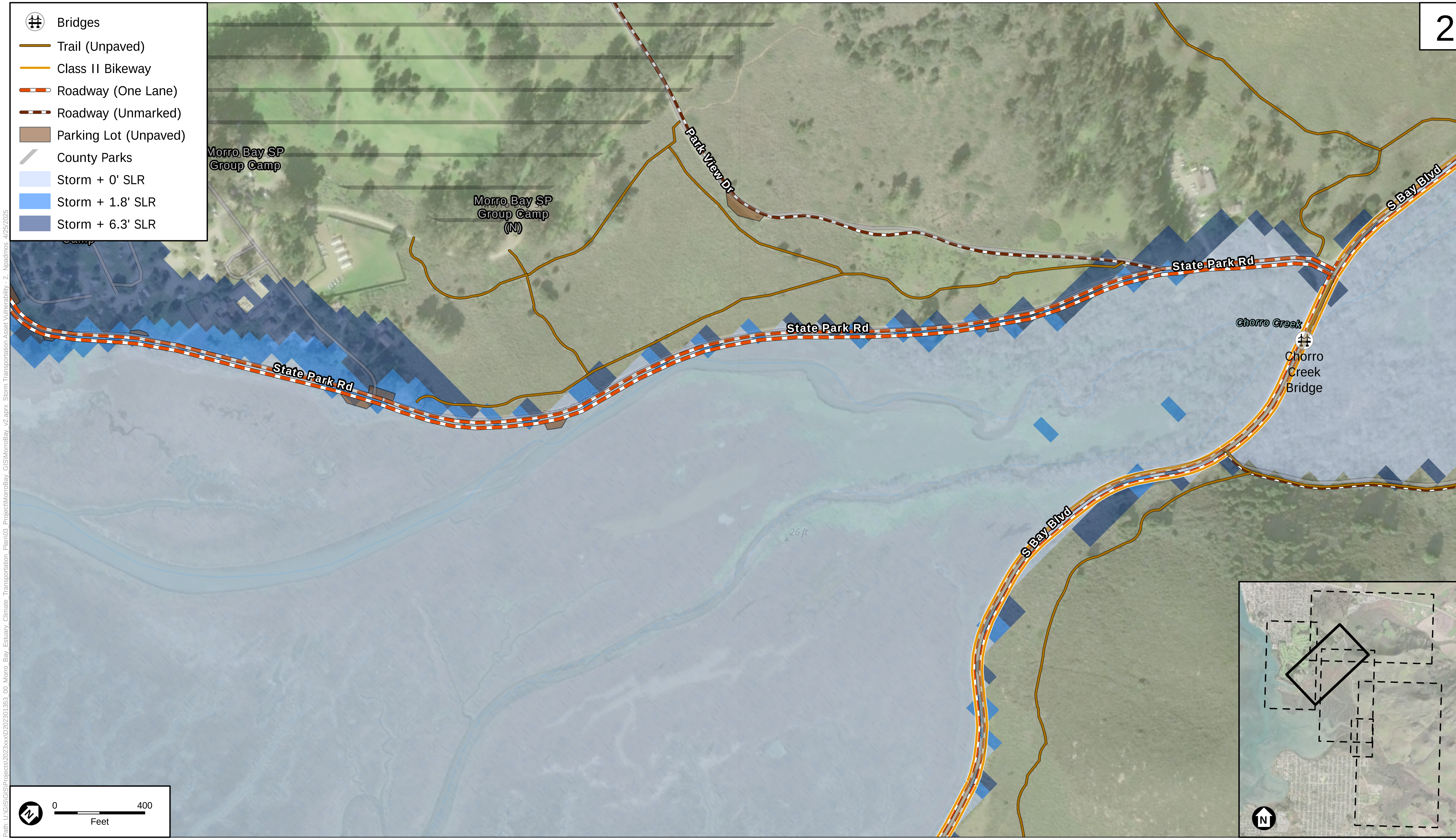
Figure B-7
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Storm Scenario
1 of 6



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

Figure B-8
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Storm Scenario
2 of 6

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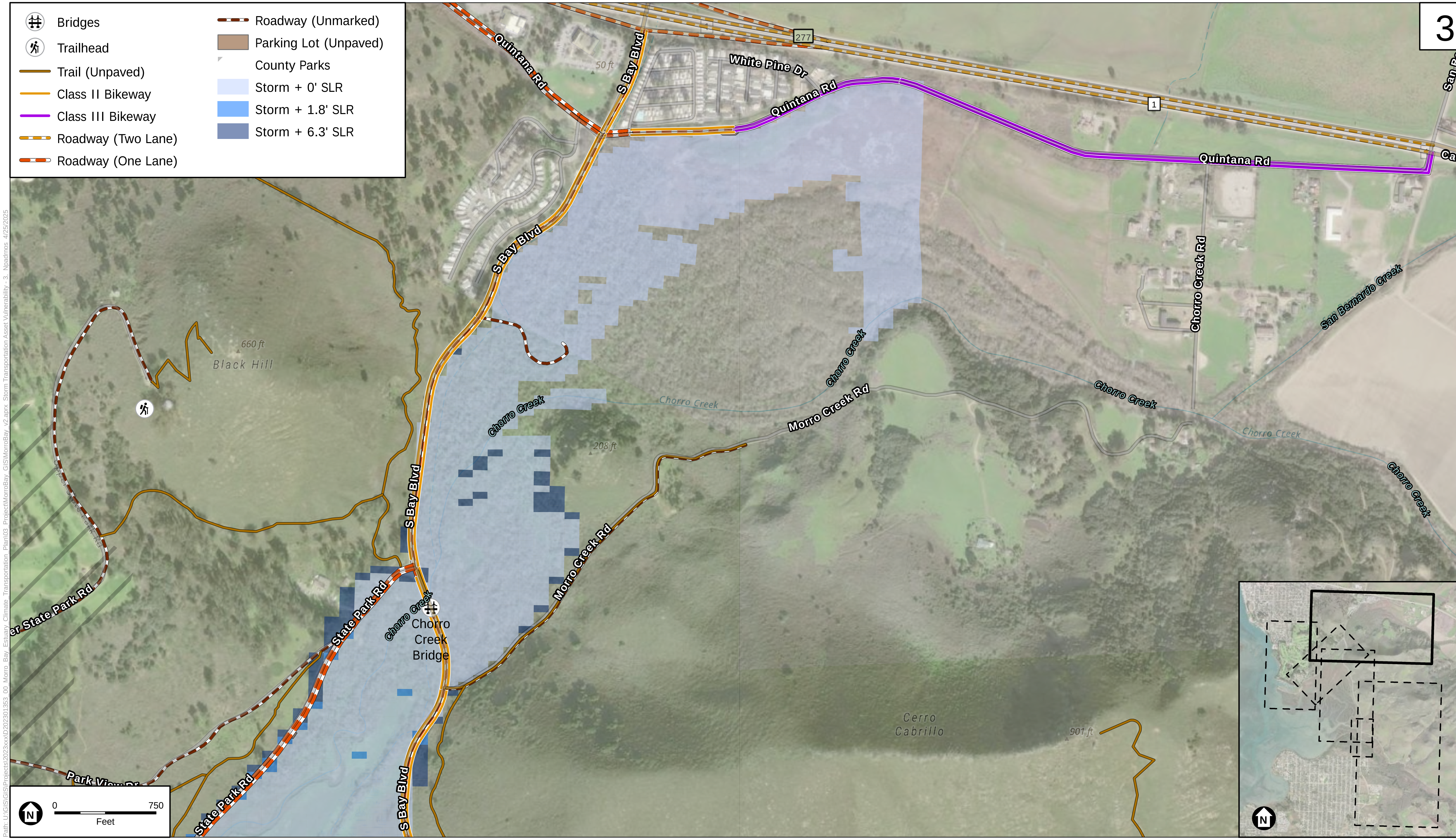

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTES: The hydrodynamic model for this study did not extend beyond 1000 feet north of Chorro Bridge

Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

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Figure B-9
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Storm Scenario
3 of 6

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

Morro Bay Estuary Climate Transportation Plan

Figure B-10
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Storm Scenario
4 of 6

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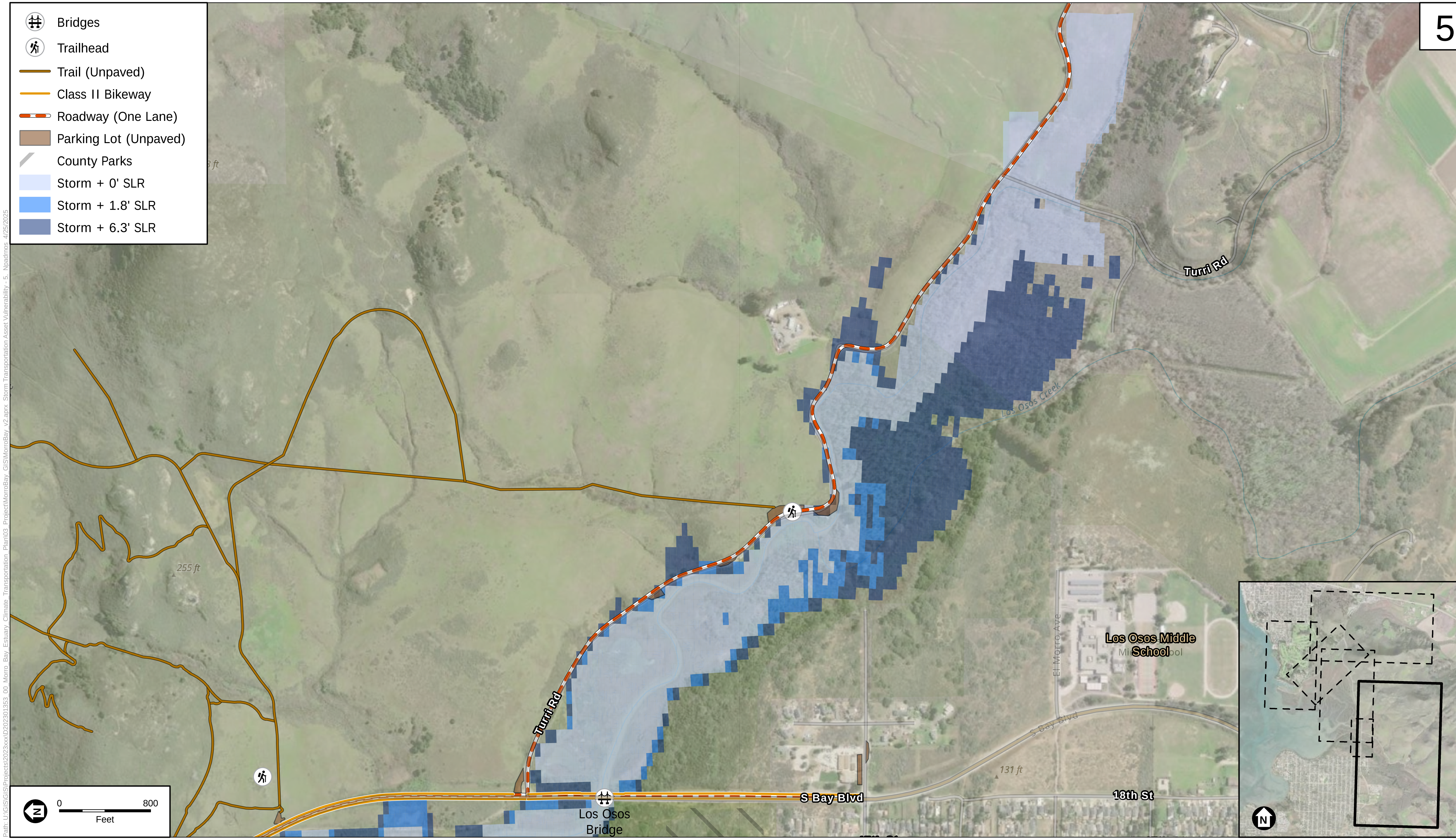

SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

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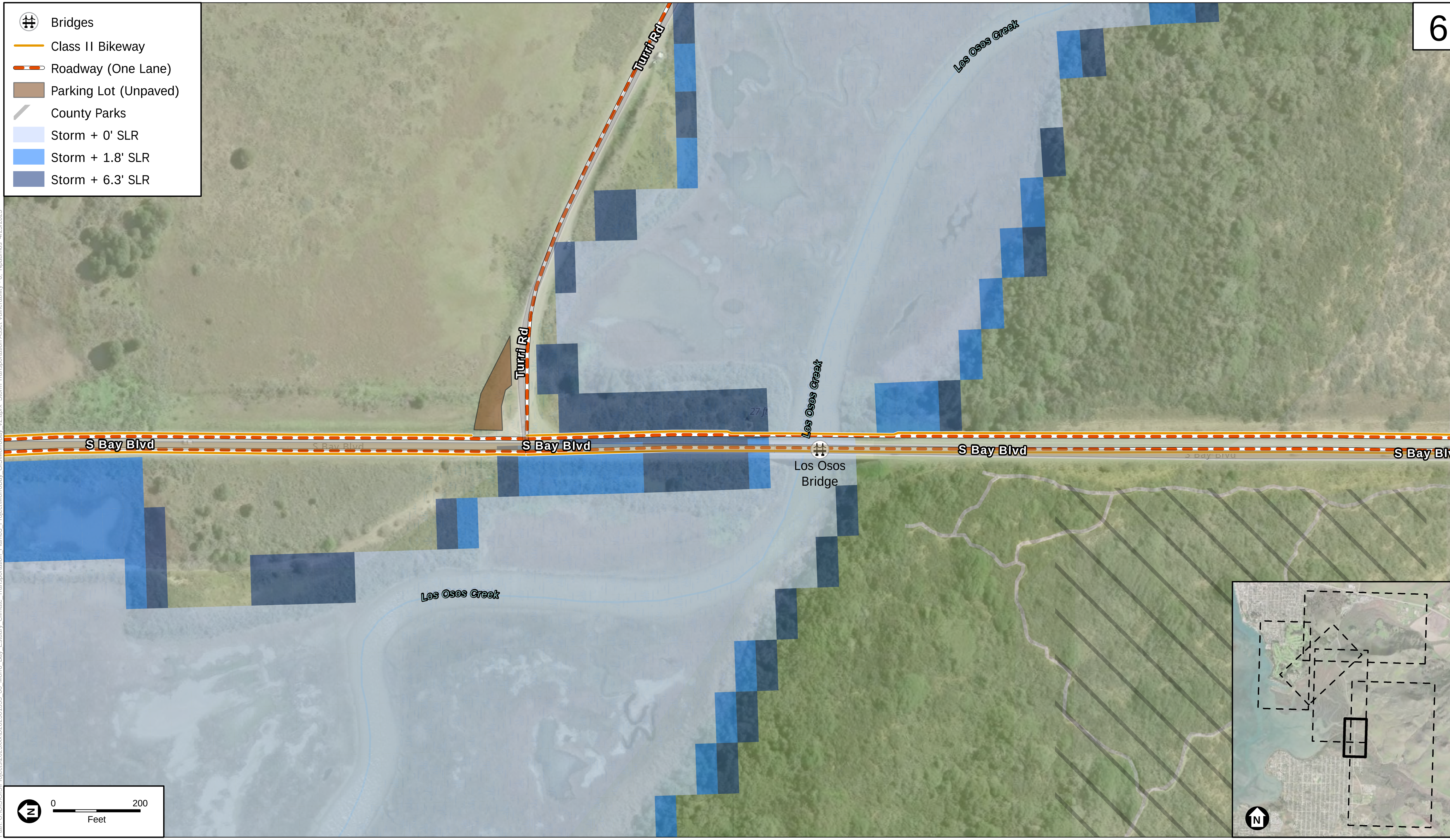
Morro Bay Estuary Climate Transportation Plan

Figure B-11
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Storm Scenario
5 of 6



SOURCE: ESRI, 2024; SLO County, 2024; RRM, 2024; ESA, 2024

NOTE: Storm conditions are characterized by the boundary conditions applied in the model (Section 3) which consist of extreme coastal and fluvial water levels

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Morro Bay Estuary Climate Transportation Plan

Figure B-12
Morro Bay Estuary Transportation and Recreational Assets Hazard Exposure Maps
Storm Scenario
6 of 6

Attachment D. Adaptation Solutions Memo

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memorandum

date	September 26, 2025
to	John Dinunzio, SLOCOG
from	Frederico Scarelli, PhD, Shannon Fiala, Nick Garrity, PE, ESA
subject	FINAL Summary of Alternatives and Adaptation Pathways Framework Memorandum for the Morro Bay Estuary Climate Transportation Plan

1 Introduction

This memo presents a preliminary assessment of the alternatives and sea level rise (SLR) adaptation pathways for the Morro Bay Estuary Climate Transportation Plan (The Plan) to be used by the ESA team under contract to the San Luis Obispo Council of Governments (SLOCOG). In this memo, ESA recommends an approach for developing SLR adaptation alternatives and an adaptation pathways framework focused on a 2.5-mile stretch of South Bay Boulevard between State Route 1 and Los Osos Creek, including spurs along South Park Road (Main Street), Quintana Avenue, and Turri Road (**Figure 1**).

In partnership with technical consultants, local agencies, and the community, SLOCOG will assess which adaptation options are available to reduce risk to transportation, recreational, and natural assets threatened by SLR. The forthcoming Plan will then help the Morro Bay community and agency partners make informed adaptation and resilience decisions. The first task of the Plan consisted of preparing a Coastal Flood Hazard and Vulnerability Assessment (VA) that addresses SLR risk (ESA 2025) that is summarized in Section 2 of this memo. In Section 3, we describe the various adaptation measures that could be used to increase SLR resiliency in the project study, which extends from Morro Bay State Park to the community of Los Osos, along State Park Road and South Bay Boulevard and includes portions of Quintana Road and Turri Road. The analysis of adaptation measures includes a discussion of tradeoffs using evaluation criteria. In Section 4, ESA summarizes the SLR impact thresholds, triggers and timing of potential adaptation actions based on findings of the VA.

The information presented in this memorandum is an important step in the process of developing an adaptation plan for the transportation, recreational, and natural assets surrounding the Morro Bay Estuary. Our approach follows the adaptation planning framework developed by the California Coastal Commission and Ocean Protection Council. In addition, adaptation measures were compiled and detailed for the specific needs and suitability to the Morro Bay Estuary setting. Evaluation criteria developed for this project are based on input from the community and the SLOCOG. Next steps following this memorandum will include:1) sharing the information in this document with the community, agency partners, and other interested parties, 2) developing a Conceptual Roadway and Multiuse Trail Alignment Plan, 3) developing a benefit-cost analysis of the preferred adaptation alternatives, and 4) developing the draft and final Plan.

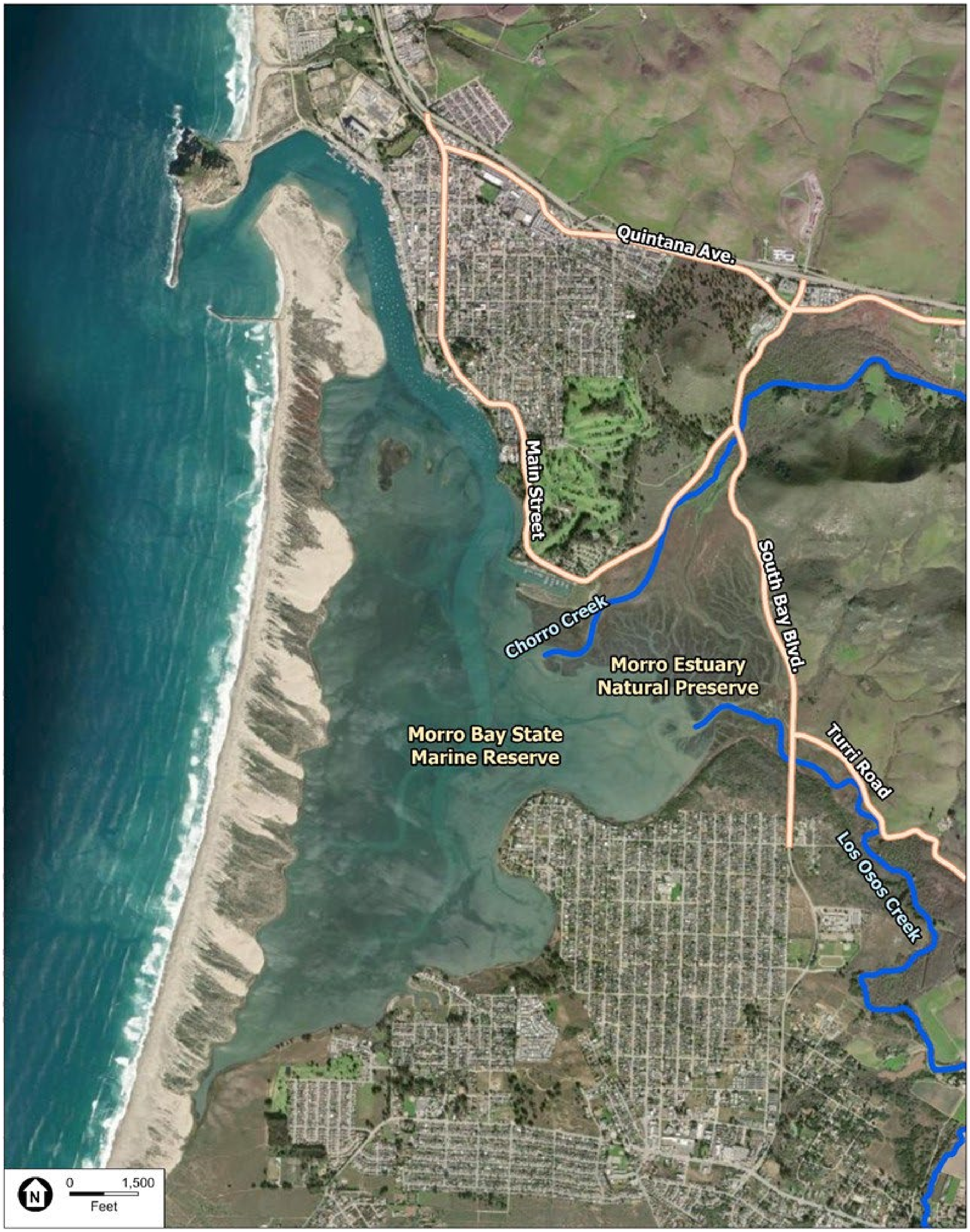

Figure 1.
Project Area (orange lines)

2 Summary of Asset Vulnerability – No Action Alternative

As described in the VA prepared for this project (ESA 2025), the vulnerability of assets is a combination of the likelihood of being flooded (hazard exposure), consequence of being flooded (asset sensitivity), and the asset's ability to be modified (adaptive capacity). The VA analyzes impacts from a hypothetical "no action" scenario, where no measures are taken to adapt to SLR. This allows SLOCOG and other decision-makers to evaluate the full extent of potential impacts, identify the most at-risk assets, and prioritize adaptation strategies accordingly. The thresholds approach, which was introduced in the Summary of Additional Guidance Memo (ESA 2024), was used to determine the approximate timeframe of asset vulnerability and it involves identifying specific amounts of SLR, or thresholds, at which assets become vulnerable, using results from the VA.

Specific assets were assigned approximate time frames as to when they may become vulnerable. The approximate date of exposure to temporary (storm) and permanent (tidal inundation) hazards for each asset was determined based on the OPC 2024 High SLR scenario and represents existing conditions, mid-century high SLR (1.8 ft of SLR), and end-of-century high SLR (6.3 ft of SLR). In addition, the hydrodynamic modelling prepared by ESA (2025) for the Morro Bay Estuary considers storm and non-storm scenarios and included 1.8 ft and 6.3 ft of SLR.

The results from the VA indicate that the assets *currently* exposed to coastal hazards are State Park Road, Windy Cove Beach and parking lot, Morro Bay State Park Marina and parking lot, Morro Bay Golf Course, South Bay Boulevard's Chorro Creek bridge, Quintana Road, and Morro Bay State Marine Reserve. The assets likely to become exposed to coastal hazards in the near future (i.e., before 2060) are South Bay Blvd between Chorro Creek bridge and Los Oso Creek bridge and Turri Road.

Table 1 presents the time frame when the transportation, recreational, and natural assets would be impacted, and highlights (bolded) the impacts that are expected to occur sooner. ESA has considered these time frames in developing the alternatives and adaptation pathways framework for the Plan.

For reference, the study corridors are represented as linear dashed lines shown in light blue, dark blue, lavender, and purple, respectively, in an overview asset map of the area of the field tour map in **Figure 2**. In addition, **Figure 3** provides a closer view of specific points of interest, which include South Bay Boulevard's Los Osos Creek bridge and Chorro Creek bridge, and Windy Cove parking lot and beach.

Table 1.
Asset Vulnerability Time Frames

Asset	Approximate time frame of when the asset is temporarily impacted (storm)	Approximate time frame of when the asset is permanently impacted (non-storm)
	Bay/creek water level with wind setup (ESA Hydrodynamic Model)[1]	**Bay water level with wind setup (ESA Hydrodynamic Model)[1]**
Transportation – Roads and Bicycle/Pedestrian Assets		
State Park Road		
Windy Cove	**Now**	**Now to 2060**
Main St	**Now**	**Now to 2060**
South Bay Blvd		
Chorro Creek Bridge to Bay Pines	**2060 to 2100**	**2100+**
Chorro Creek Bridge to Los Osos Creek Bridge	**Now to 2060**	**Now to 2060**
Quintana Rd	**Now**	**Now to 2060**
Turri Rd	Now to 2060	2060 to 2100
Chorro Creek Bridge	**Now**	2100+
Los Osos Bridge	**2100+**	**2100+**
Recreational Assets		
Windy Cove – Beach	**Now**	Now to 2060
Morro Bay State Park Marina Parking Lot	**Now**	**Now to 2060**
Windy Cove Parking Lot	**Now**	**Now to 2060**
Cerro Cabrillo Trailhead Parking Lot	**2060 to 2100**	**2060 to 2100**
Park Ridge Trailhead Parking Lot	**2100+**	**2100+**
Chumash Trailhead Parking Lot	**2060 to 2100**	**2060 to 2100**
Morro Bay State Park Marina Bicycle Parking	**Now**	**Now to 2060**
Morro Bay Golf Course	**Now**	**Now to 2060**
Natural Assets		
Morro Bay State Marine Reserve	**Now**	Now to 2060
El Moro Elfin Forest Natural Preserve	**2100+**	**2100+**

NOTES:
1. 1.8 ft of SLR is projected in 2060 and 6.3 ft of SLR is projected in 2100 under a high SLR scenario for Port San Luis (OPC 2024)

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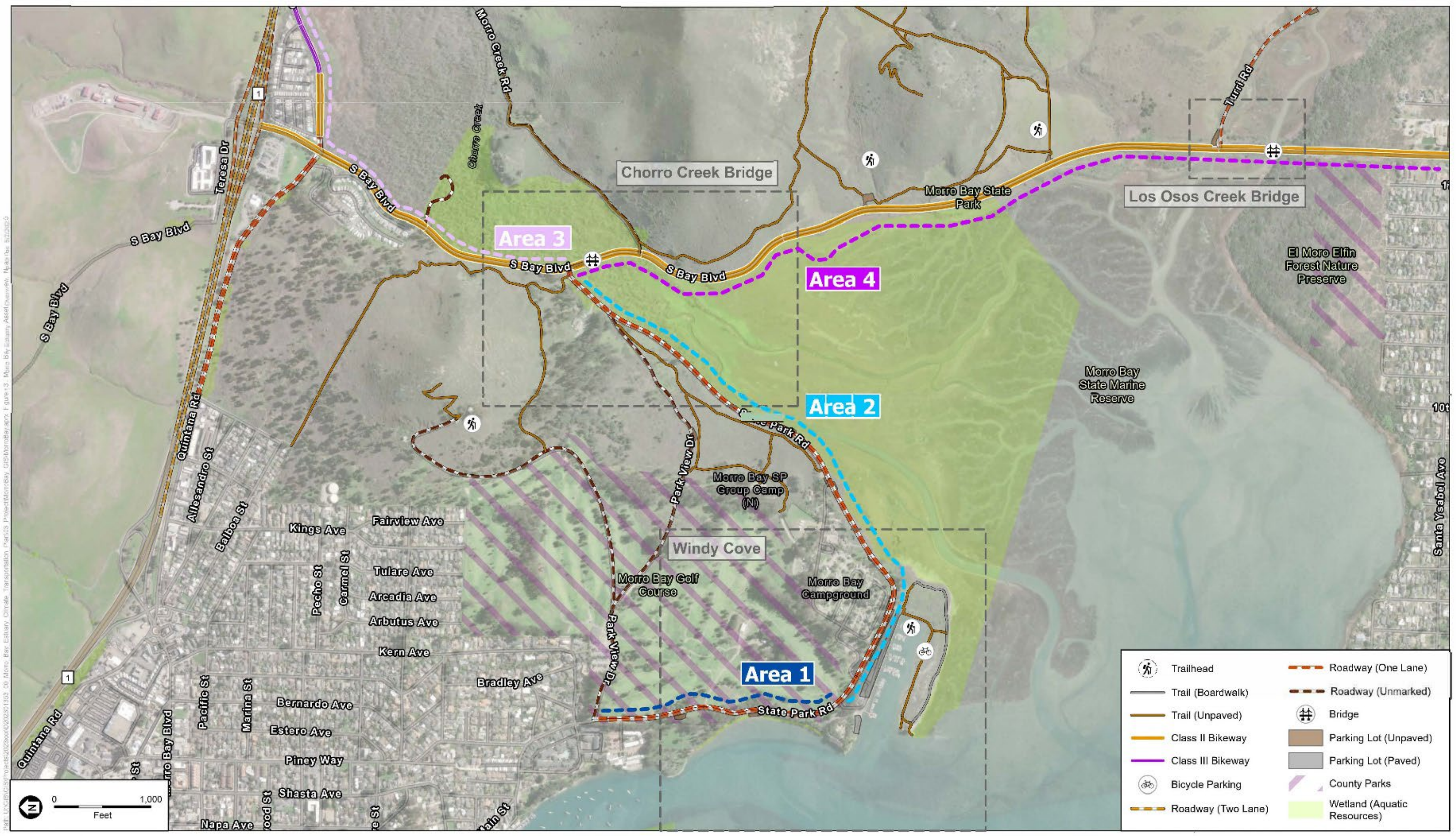

SOURCE: ESRI, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure 2
Morro Bay Estuary Assets Overview

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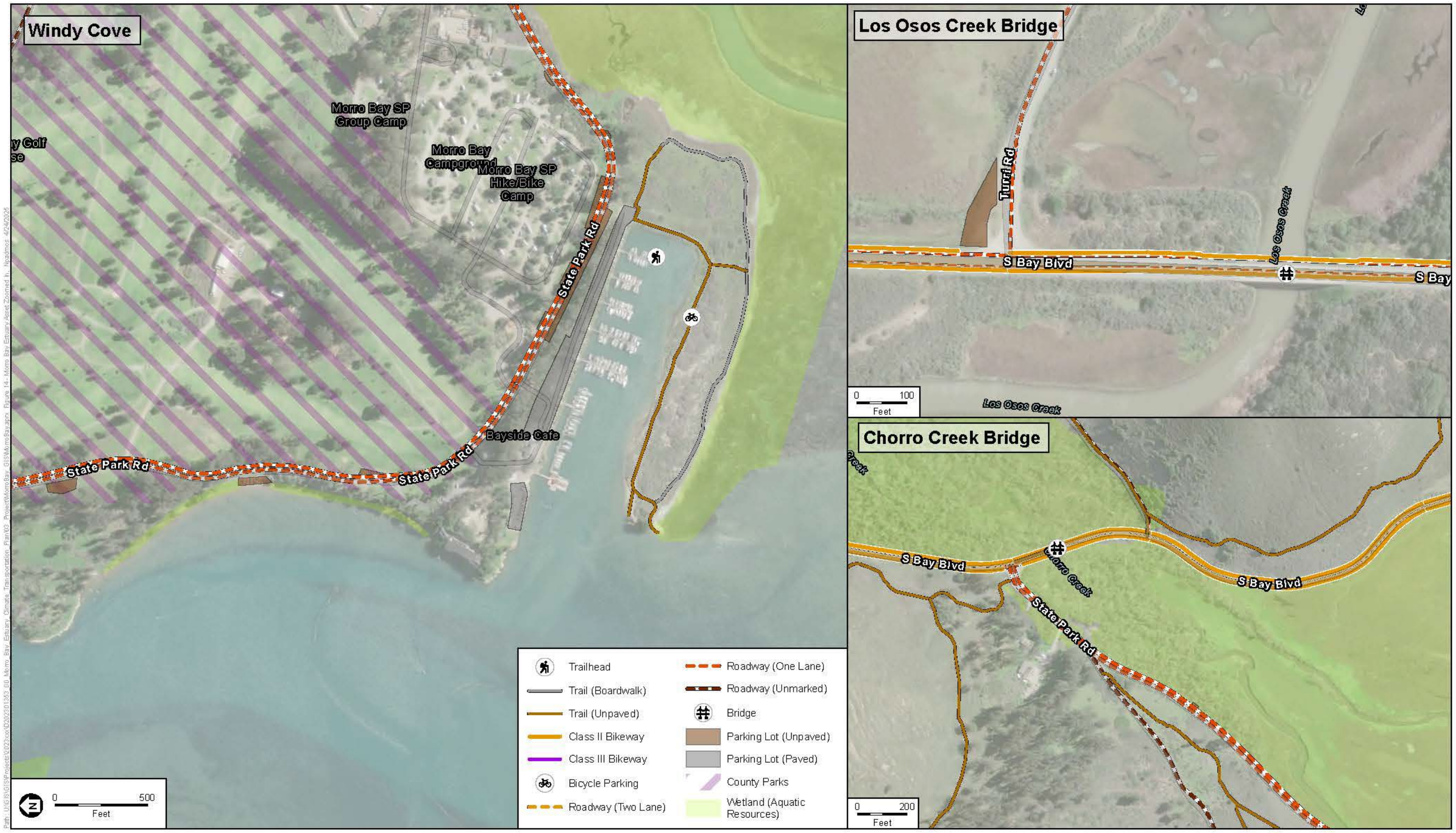
Figure 2. Morro Bay Estuary Asset Overview Map



SOURCE: ESRI, 2024; RRM, 2024; ESA, 2024

Morro Bay Estuary Climate Transportation Plan

Figure 3
Zoomed-In Views of Specific Points of Interest at Morro Bay Estuary

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Figure 3. Zoomed-In Views of Specific Points of Interest at Morro Bay Estuary

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3 Adaptation Alternatives and Pathways

For this analysis, ESA built upon state guidance and transportation guidelines to refine a suite of adaptation measures that address anticipated coastal hazards for the different physical settings in the Morro Bay Estuary. The adaptation measures span a range of types including traditional engineered structures, natural infrastructure, such as wetlands, and regulatory or land use measures. The following subsections describe the typical adaptation approaches (Section 3.1), the evaluation criteria (Section 3.2) and summarize the potential adaptation measures that could be applied at Morro Bay Estuary with future SLR based on the evaluation criteria (Section 3.3).

3.1 Adaptation Approaches

SLR adaptation approaches typically fall into one or more thematic strategies: protect, accommodate, and retreat.

- **Protect –** use an engineered structure or other measure to defend development (or resources) in its current location. Example measures include berm; revetments; levees; and natural or "green" methods (e.g., living shorelines and wetland restoration to buffer coastal areas); and hybrid approaches that use both engineered structures and natural infrastructure elements.
- **Accommodate** – modify existing development, or design new development in a way that decreases hazard risks and increases the resiliency of the development. Examples include elevating and/or retrofitting structures and using materials that increase the strength of development. In Morro Bay Estuary, this could include raising the elevation of roads on berms or causeways to accommodate high-water-level flooding events.
- **Retreat** – relocate or realign existing development and infrastructure, limit substantial redevelopment, or prevent new development in hazardous areas. Development setbacks, buyouts, and easements and inland roadway realignment are examples of retreat-focused measures.

The preferred adaptation strategy for a location may vary depending on the type of asset (e.g., roads, bridges, bike paths). Additionally, the strategy may change over time as conditions change (e.g., protection in the near-term and shifting to accommodation or retreat in the long-term). Note that an adaptation measure can combine more than one of the above approaches. For example, wetland restoration can play a role under a protection strategy (e.g., restoring wetlands adjacent to a road to reduce flooding) as well as a retreat strategy (e.g., restore wetland along the corridor after relocating the road).

3.2 Evaluation Criteria

ESA has initially developed five criteria to evaluate the adaptation measures for the Plan. The evaluation criteria capture the range of interests for Morro Bay Estuary and the various tradeoffs associated with different adaptation approaches. Considerations for each of these evaluation criteria are described in detail below.

- Engineering Considerations
- Environmental Considerations
- Regulatory Considerations

- Social Considerations
- Economic Considerations (will be addressed in the Benefit-Cost Analysis as part of Task 2.4)

3.2.1 Engineering Considerations

The following three categories describe potential feasibility considerations for each engineering adaptation measure.

Feasibility: This refers to the likelihood of implementing a measure based on the physical setting, such as topography and exposure to hazards. For instance, wetland restoration in locations such as Windy Cove and other sites, vegetation management would be more suitable.

Effectiveness: Effectiveness refers to whether a measure is likely to accomplish the vulnerability reduction for the particular asset and site. For example, elevating roads or creating elevated berms can reduce storm flooding/wave runup on transportation assets.

Resilience: Resilience refers to the ability of a measure to accommodate and recover from increased loadings such as storms and SLR. Therefore “resilience’ is similar to the term ‘sensitivity’ that is often used in vulnerability assessments. For example, berms are likely to incur permanent damage and potentially fail when loadings exceed those used in design. However, natural infrastructure (e.g., ecotone levees, wetland restoration, oyster reefs) can recover following extreme events. As a result, natural infrastructure can be more resilient than traditional infrastructure.

3.2.2 Environmental Considerations

Potential environmental considerations include temporary and permanent impacts that an adaptation measure could have on species and their habitats, as well as the ecological benefits that a measure could provide. In many cases, the benefits of a given adaptation measure are achieved in comparison to the status quo (i.e., no action or traditional engineering measures).

To develop the environmental impacts and benefits, ESA has considered whether each adaptation measure would impact existing habitats and increase or decrease the overall ecological health of the habitats within the Morro Bay ecosystem region.

3.2.3 Regulatory Considerations

The diverse set of alternatives evaluated in this document would require permits from a range of jurisdictions and regulatory agencies. Depending on the nature and scale of the measure being evaluated, the geographic location of the site, and environmental sensitivity at the site, there are various jurisdictions and regulations involved. Agency staff cannot provide extensive review or definitive answers on whether such a project would be approved until there is an actual proposed project with preliminary design plans and other required information and analyses. Generally, projects with high potential levels of environmental impact are much more challenging to get permitted, and early coordination and consultation is often critical.

As with any project involving construction on the California coast, a proposed project in Morro Bay Estuary involving construction on wetlands, Environmentally Sensitive Habitat, or tidal areas would require numerous studies, surveys, and reports, and an extensive public input process. Beyond the procurement of permits, the overall regulatory compliance process consists of environmental review (i.e., pursuant to the California Environmental Quality Act), followed by permitting and/or agency approvals, and concludes with compliance review and documentation. Permits and/or approval would typically be required from: United States Army Corps of Engineers; U.S. Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); California Coastal Commission (CCC) and/or City of Morro Bay and San Luis Obispo County Local Coastal Program jurisdiction; California Department of Fish and Wildlife (CDFW); Regional Water Quality Control Board (RWQCB); and potentially, California State Lands Commission (CSLC).

3.2.4 Social Considerations

Social considerations address the effects of adaptation measures on public access and use of the Morro Bay estuary, emphasizing equitable access and recreation. For context, the California Coastal Commission's Environmental Justice Policy[1] includes principles for Respecting Tribal Concerns, Meaningful Engagement, Coastal Access, Housing, Local Government, Participation in the Process, Accountability and Transparency, Climate Change, and Habitat and Public Health. Public access and recreation are important considerations when planning for coastal adaptation, as different adaptation measures can impact access along the estuary.

3.2.5 Economic Considerations

Economic considerations include the cost of construction and typical maintenance of individual adaptation measures as well as how this cost is shared (individual or multiple property owners, agency, etc.). The cost of adaptation measures will also be compared to the cost of no action, e.g., from repairing damages and loss of function if no action is taken to address coastal hazards. Planning-level unit cost estimates will be compiled for individual adaptation measures based on examples from various studies and escalated to 2025 dollars. Economic considerations will be analyzed in a benefit-cost analysis of adaptation pathways in a future task for this project.

3.2.6 Levels for Evaluation Criteria

To clearly capture the range of interests for Morro Bay Estuary and the various tradeoffs associated with different adaptation approaches, ESA used three levels to rank the evaluation criteria for each adaptation measure, which include ***low***, ***medium***, and ***high***. These three levels for each evaluation criteria are described below.

- **Engineering Considerations (feasibility, effectiveness, resilience):**
  - *Low*: minimal complexity and basic engineering considerations.
  - *Medium*: moderate complexity and resources required, may need specialized engineering solutions.
  - *High*: highly complexity and requiring advanced engineering solutions.
- **Environmental Considerations (habitat impacts and benefits):**
  - *Low Impact*: Low environmental impact, minimal disruption to existing habitats.
  - *Medium Impact*: Moderate environmental impacts and potential impact to existing habitats.
  - *High Impact*: Significant environmental impacts .
  - *Low Benefits*: Basic habitat benefits.

[1] More information at https://documents.coastal.ca.gov/assets/env-justice/CCC_EJ_Policy_FINAL.pdf

– *Medium Impact*: Moderate habitat benefits.

High Impact: Significant habitat benefits.

- **Regulatory Considerations (permitting, etc.):**
  – *Low*: Requires minimal regulatory approval and is straightforward to permit.
  – *Medium*: Requires some regulatory approvals and may involve moderate permitting complexity.
  – *High*: Requires extensive regulatory approvals and involves high permitting complexity.
- **Social Considerations (public access, recreation, equity):**
  – *Low*: Maintains public access, recreation, and equity.
  – *Medium*: Enhances public access, recreation, and equity.
  – *High*: Significantly enhances public access, recreation, and equity.
- **Economic Considerations (cost):**

This evaluation criteria will be considered and developed as part of Task 2.4 of this project, once a set of preferred adaptation measures is defined.

3.3 Potential Adaptation Measures for Morro Bay Estuary

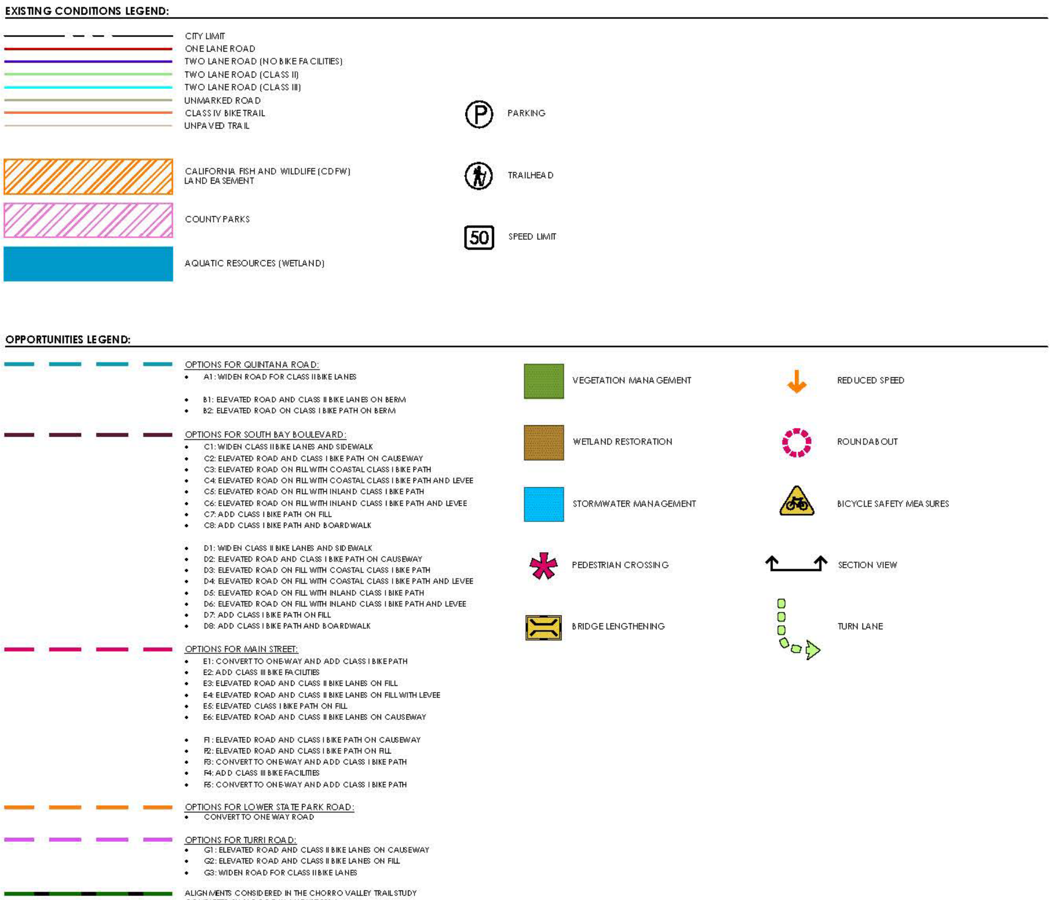
In this section, ESA presents an adaptation pathways framework that includes different adaptation actions that can be taken during the near-term (~5-20 years), mid-term (~20-50 years), and long-term (~50+ years) time horizons. At each time horizon, adaptation actions are described that would provide resilience until the next time horizon, at which point another set of potential actions would be defined. In the threshold approach, specific assets will have different sea level rise thresholds. For example, South Bay Blvd near Twin Bridges may have a different sea level rise threshold than the State Park Road bordering the bay in the Morro Bay State Park. As described above, the VA identified the potential impacts that transportation, recreational, and natural assets could face because of SLR.

The adaptation measures are categorized into four groups that are either structural (physically constructed nature-based or traditional engineered features) or non-structural (regulatory or financial mechanisms to encourage or enforce adaptation). The adaptation measures for the near, mid, and long term for transportation, recreational, and natural assets are presented in sections 3.3.1, 3.3.2, and 3.3.3 below. The adaptation measures are illustrated with a series of cross sections. **Figure 4** provides an overview of the locations of the cross sections and the adaptation opportunities in plan view.

TABLE 2.
CATEGORIZATION OF PROPOSED ADAPTATION MEASURES

Measure Category	Description	Examples from Proposed Measures
Natural and Nature-Based Measures	Natural and nature-based measures, as well as hybrid measures that combine natural and traditional structures, can perform similarly or better than traditional structures and provide increased benefits to recreation and ecology.	• Wetland restoration • Ecotone levees • Oyster reef restoration • Create retention ponds and bioswales along roadways • Vegetation management along roads
Traditional Structural Measures	Traditional engineered measures can be effective to design standards (withstand erosion/wave runup forces) but may have negative side effects such as leading to the squeeze of wetland habitats.	• Raise road on fill • Elevate road on fill/causeway • Lengthen bridge spans • Install roundabouts • Install more efficient drainage system • Install more permeable pavement in bikeways
Policy and Regulatory Measures	Regulatory measures are used to manage how communities develop/redevelop and maintain themselves in a way that responds to or prepares for sea level rise.	• Develop asset management databases to track vulnerable infrastructure • Establish monitoring systems to track infrastructure performance during flooding
Financial Measures	Financial measures that encourage or facilitate adaptation.	• Establish dedicated funding mechanisms

Figure 4. Plan View of Adaptation Options, including Cross Section Locations and Legend (below)


EXISTING CONDITIONS LEGEND:
CITY LIMIT
ONE LANE ROAD
TWO LANE ROAD (NO BIKE FACILITIES)
TWO LANE ROAD (CLASS II)
TWO LANE ROAD (CLASS III)
UNMARKED ROAD
CLASS IV BIKE TRAIL
UNPAVED TRAIL
CALIFORNIA FISH AND WILDLIFE (CDFW) LAND EASEMENT
COUNTY PARKS
AQUATIC RESOURCES (WETLAND)
PARKING
TRAILHEAD
50
SPEED LIMIT
OPPORTUNITIES LEGEND:
OPTIONS FOR QUINTANA ROAD:
A1: WIDEN ROAD FOR CLASS II BIKE LANES
B1: ELEVATED ROAD AND CLASS II BIKE LANES ON BERM
B2: ELEVATED ROAD ON CLASS I BIKE PATH ON BERM
OPTIONS FOR SOUTH BAY BOULEVARD:
C1: WIDEN CLASS II BIKE LANES AND SIDEWALK
C2: ELEVATED ROAD AND CLASS I BIKE PATH ON CAUSEWAY
C3: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH
C4: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH AND LEVEE
C5: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH
C6: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH AND LEVEE
C7: ADD CLASS I BIKE PATH ON FILL
C8: ADD CLASS I BIKE PATH AND BOARDWALK
D1: WIDEN CLASS II BIKE LANES AND SIDEWALK
D2: ELEVATED ROAD AND CLASS I BIKE PATH ON CAUSEWAY
D3: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH
D4: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH AND LEVEE
D5: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH
D6: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH AND LEVEE
D7: ADD CLASS I BIKE PATH ON FILL
D8: ADD CLASS I BIKE PATH AND BOARDWALK
OPTIONS FOR MAIN STREET:
E1: CONVERT TO ONE-WAY AND ADD CLASS I BIKE PATH
E2: ADD CLASS III BIKE FACILITIES
E3: ELEVATED ROAD AND CLASS II BIKE LANES ON FILL
E4: ELEVATED ROAD AND CLASS II BIKE LANES ON FILL WITH LEVEE
E5: ELEVATED CLASS I BIKE PATH ON FILL
E6: ELEVATED ROAD AND CLASS II BIKE LANES ON CAUSEWAY
F1: ELEVATED ROAD AND CLASS I BIKE PATH ON CAUSEWAY
F2: ELEVATED ROAD AND CLASS I BIKE PATH ON FILL
F3: CONVERT TO ONE-WAY AND ADD CLASS I BIKE PATH
F4: ADD CLASS III BIKE FACILITIES
F5: CONVERT TO ONE-WAY AND ADD CLASS I BIKE PATH
OPTIONS FOR LOWER STATE PARK ROAD:
CONVERT TO ONE WAY ROAD
OPTIONS FOR TURRI ROAD:
G1: ELEVATED ROAD AND CLASS II BIKE LANES ON CAUSEWAY
G2: ELEVATED ROAD AND CLASS II BIKE LANES ON FILL
G3: WIDEN ROAD FOR CLASS II BIKE LANES
ALIGNMENTS CONSIDERED IN THE CHORRO VALLEY TRAIL STUDY COMPLETED BY SLOCOG IN AUGUST 2014
VEGETATION MANAGEMENT
WETLAND RESTORATION
STORMWATER MANAGEMENT
PEDESTRIAN CROSSING
BRIDGE LENGTHENING
REDUCED SPEED
ROUNDABOUT
BICYCLE SAFETY MEASURES
SECTION VIEW
TURN LANE

3.3.1 Near-term (~2030-2045)

In the near-term, the focus is on addressing the assets currently exposed to coastal hazards. The vision is to implement immediate and practical measures that provide resilience against current and anticipated near-term impacts of coastal hazards and SLR. These measures aim to enhance transportation and mobility, protect critical infrastructure, increase natural defenses, and allow continued access and usability of recreational areas.

The assets currently exposed to coastal hazards, considering the storm condition (Table 1), under the categories of transportation, recreation, and natural assets, include:

Transportation – Roads and Mobility Assets:

- State Park Road
  - Windy Cove
  - Main St
- S Bay Blvd
  - Chorro Creek Bridge to Los Osos Creek Bridge
  - Chorro Creek Bridge
- Quintana Road

Recreational Assets:

- Windy Cove – Beach and Parking Lot
- Morro Bay State Park Marina Parking Lot
- Morro Bay Golf Course

Natural Assets:

- Morro Bay State Marine Reserve

Table 3 presents the **opportunities**, including potential solutions and enhancements that would increase resilience of the transportation, recreational and natural assets that are vulnerable in the near-term, **constraints** that may limit or restrict the ability of the opportunities to provide a feasible solution, including special status species, land use, construction /maintenance cost, permitting feasibility, and **evaluation criteria** of the measure, based on the three levels described above, that could be considered in the near-term.

TABLE 3.
NEAR-TERM MEASURES OPPORTUNITIES AND CONSTRAINTS

Asset	Adaptation Measure	Opportunities	Constraints	Evaluation Criteria [A]
Transportation Assets				
State Park Road (Main St, Windy Cove)	Protect: Construct a levee or berm to protect the road in its current alignment and elevation (See **Figure 5 and 6** for cross section)	A class I bike / ped path could be placed on top of the berm / levee.	The low-lying segments of the road may still flood due to rainfall runoff stormwater drainage; construction of the levee would	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium – High Impact / Low Benefits***

			permanently impact habitat and parking adjacent to the road	• Regulatory Considerations: ***Medium - High*** • Social Considerations: ***Medium***
	Accommodate: Raise the most vulnerable segments of the road on fill or a causeway (See **Figures 5, 7** and 8 for cross section)	Would serve as flood protection for golf course; bayward side of road could support a living shoreline/migration space/high tide refugia for the wetland	Potential impacts to special status species: banded dune snail or Morro shoulderband; biological and cultural resource constraints	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / Low Benefits/*** • Regulatory Considerations: ***Medium - High*** • Social Considerations: ***Medium***
	Retreat: Relocate the road inland into the golf course out of the coastal hazard zone or reroute traffic onto Parkview Drive	Allows for increased inland wetland migration space; the former road alignment could be converted to coastal trail	Inland relocation would impact the golf course; Potential impacts to special status species: banded dune snail or Morro shoulderband; biological and cultural resource constraints	• Engineering Considerations: ***High*** • Environmental Considerations: ***High Impact / Low Benefit*** • Regulatory Considerations: ***High*** • Social Considerations: ***High***
	Mobility: Convert to one-way traffic and add Class I bike/ped facility on bayward side (See **Figures 9 and 10** for cross section)	Use abandoned lane for bike/ped paths; short implementation time and low cost	Impacts to traffic circulation; would not address flood vulnerability	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Add sharrows for Class III bike lane (See **Figures 9 and 10** for cross section)	Low-cost cycling improvement	Sharrow paint can decompose, affecting water quality; would not address flood vulnerability	• Engineering Considerations: Low • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
	Mobility: Vegetation management	Increased space and visibility for bikes/peds	State Parks policies regarding vegetation management	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Medium Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
S Bay Blvd (Chorro Creek Bridge to Los Osos Creek Bridge)	Protect: Construct a levee or berm to protect the road in its current alignment and elevation (See **Figure 11** for cross section)	A bike / ped path could be placed on top of the berm / levee.	The low-lying segments of the road may still flood due to rainfall runoff stormwater drainage	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium - High*** • Regulatory Considerations: ***High*** • Social Considerations: ***Medium***
	Accommodate: Elevate the most vulnerable segments of the road on fill or a causeway (See **Figures 11**, **13-17** for cross sections)	Road could be enhanced with a living shoreline levee that provides high tide refugia for wetland species	Potential permanent Wetland/ESHA impacts	• Engineering Considerations: ***High*** • Environmental Considerations: ***Medium Impact / High Benefits*** • Regulatory Considerations: ***High*** • Social Considerations: ***Medium***
	Accommodate: Lengthen span of bridges over Chorro and Los Osos Creek	Accommodates increased water flow	Temporary/permanent riparian ESHA impacts; Would not address other flooding issues on SBB, but could be combined with other options	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / Medium Benefits*** • Regulatory Considerations: ***Medium***

				• Social Considerations: ***Low***
	Mobility: Create separated trail paralleling SBB (See **Figure 18** for cross section)	Alternative alignment options (e.g., co-located with Los Osos State Water Line)	Permanent Wetland/ESHA impacts; Would need enhanced crosswalks, beacons/stoplights for trailhead access	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Widen NB/SB existing bike lanes (See **Figure 11**)	Improved cycling infrastructure	Would not address flooding vulnerability; Permanent Wetland/ESHA impacts	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium-High Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Vegetation management	Improved safety at SBB/State Park Road intersection where vegetation blocks drivers' views	State Parks policies	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Medium Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
	Mobility: Reduce speed limit	Improved safety for all road users	Implementation and enforcement requirements	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
Quintana Road	Accommodate: Elevate the road on fill (See **Figure 19** for cross section)	Maintained access during high water events; Flood protection for neighborhoods to the north; could be combined with Class I or Class II bike facilities	Potential wetland/ESHA impacts to the south	• Engineering Considerations: ***Low*** • Environmental Considerations: ***High Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Medium***
	Mobility: Install roundabout at intersection with SBB	Improved traffic flow	Potential Wetland/ESHA impacts	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Widen road to include Class II bike lanes on both sides or Class I bike lane on north side (See **Figures 19 and 20** for cross sections)	Reduced hazards for cyclists	Would not address flooding vulnerability	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium-High Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Address storm drains and debris	Reduced hazards for cyclists	Regular maintenance requirements	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Medium***

				• Social Considerations: ***Low***
Recreational Assets				
Windy Cove Beach and Parking Lot	Protect: Wetland restoration to limit waves at the shoreline and associated flooding, and mitigate potential impacts of other adaptation measures	Natural flood protection	Not needed until 2060 due to natural accretion of creek sediment; after that, availability of sediment could be a constraint to sustaining restored wetlands (See USGS)	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / High Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
Morro Bay State Park Marina Parking Lot	Accommodate: Raise parking area on fill	Maintained access during high water events	Construction costs; Potential Wetland/ESHA impacts	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Accommodate: Implement flood management, such as pumps	Maintained access during high water events	Implementation costs	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
Morro Bay Golf Course	Accommodate: Implement flood management, such as pumps	Improved drainage	Implementation costs	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
Natural Assets				
Morro Bay State Marine Reserve	Protect: Wetland restoration	Increased resilience to sea level rise and enhanced ecological function	Implementation timing and costs	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / High Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Protect: Thin-layer placement of sediment to increase the elevation of the marsh	Increased resilience to sea level rise	Implementation timing and costs; temporary habitat impacts	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / High Benefits*** • Regulatory Considerations: ***High*** • Social Considerations: ***Low***
	Protect: Implement oyster reef restoration	Enhance coastal resilience through wave attenuation and habitat enhancement	Feasibility and effectiveness	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Medium Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***

Note:
[A] Economic consideration not included since it will be defined in Task 2.4 of the Project

Figure 5 Cross Sections for Near-term Adaptation Alternatives

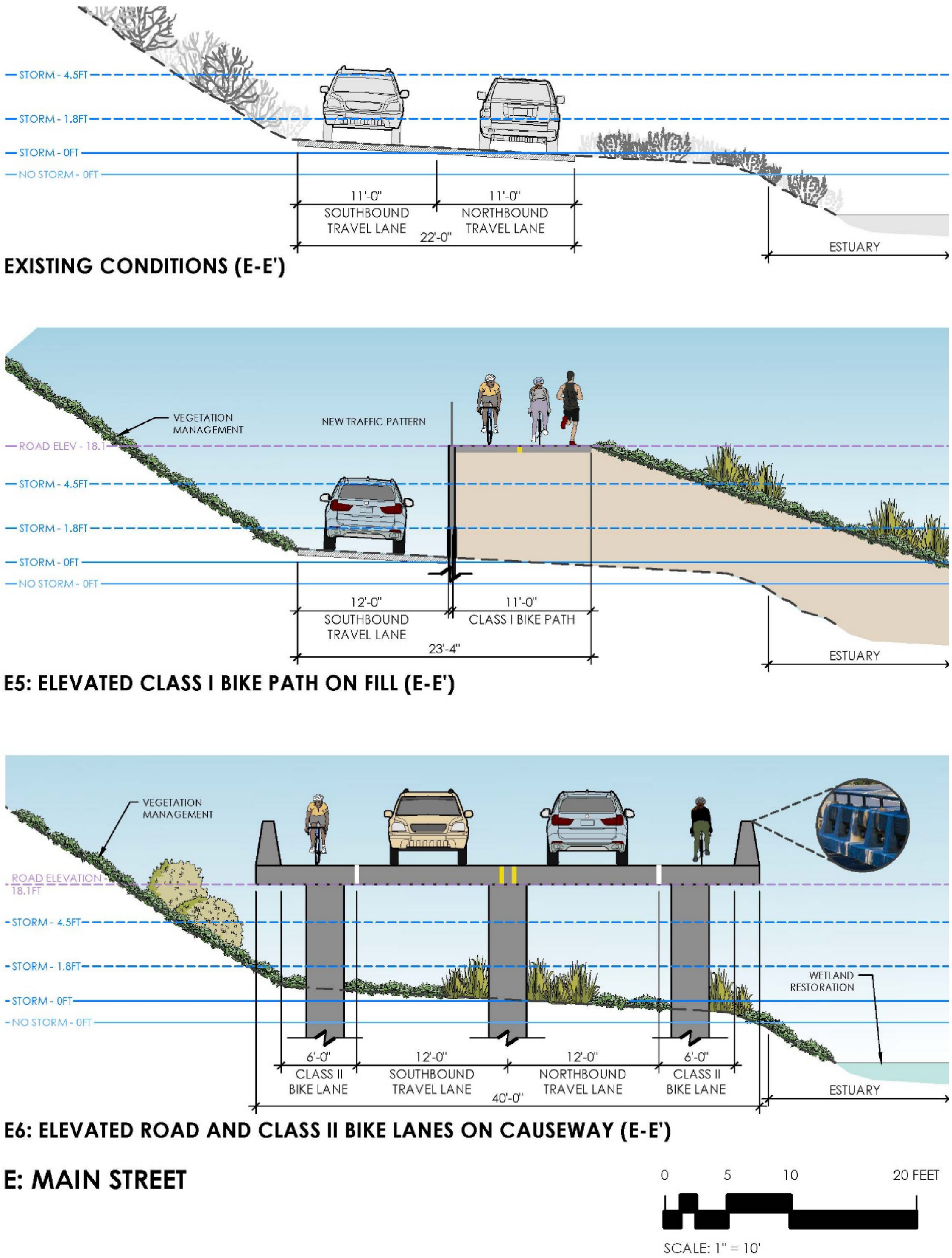
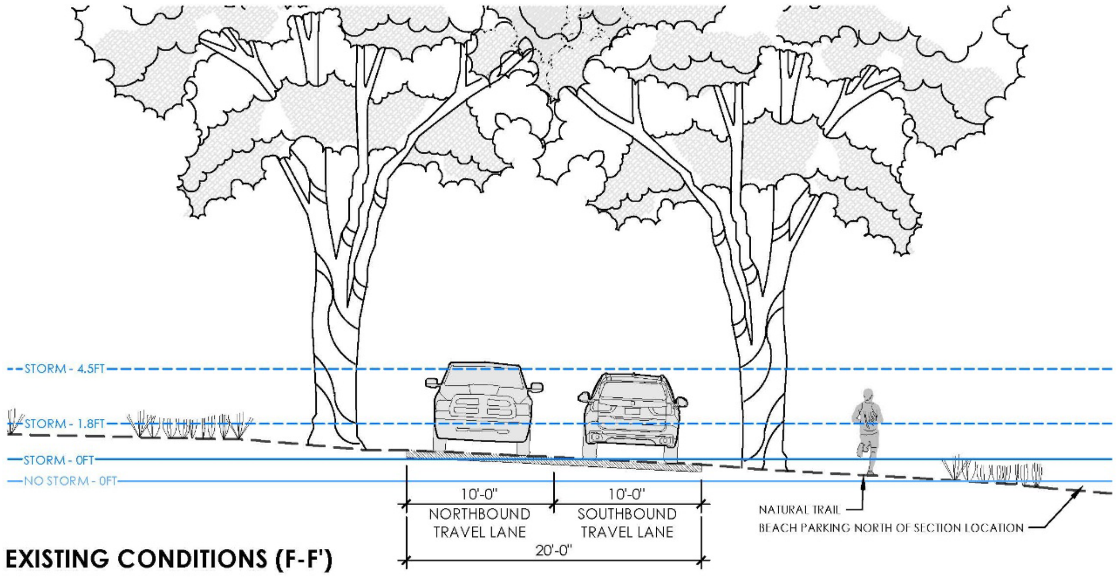


Figure 6 Cross Sections for Near-term Adaptation Alternatives



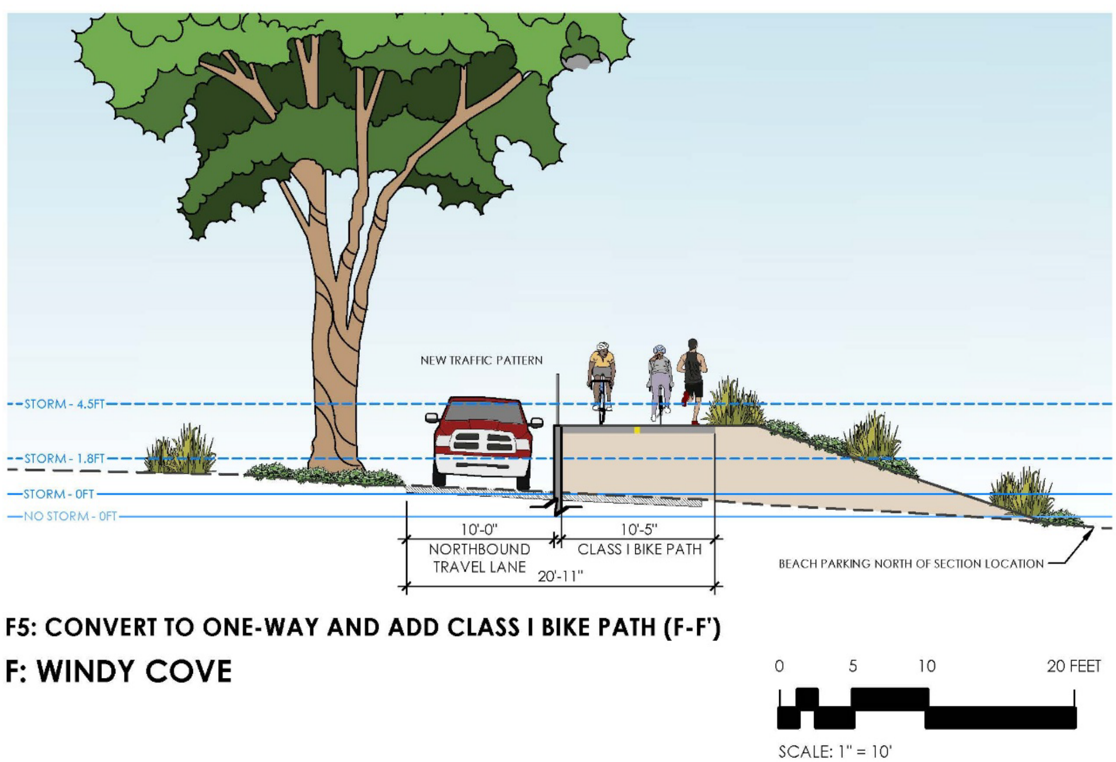


Figure 7 Cross Sections for Near-term Adaptation Alternatives

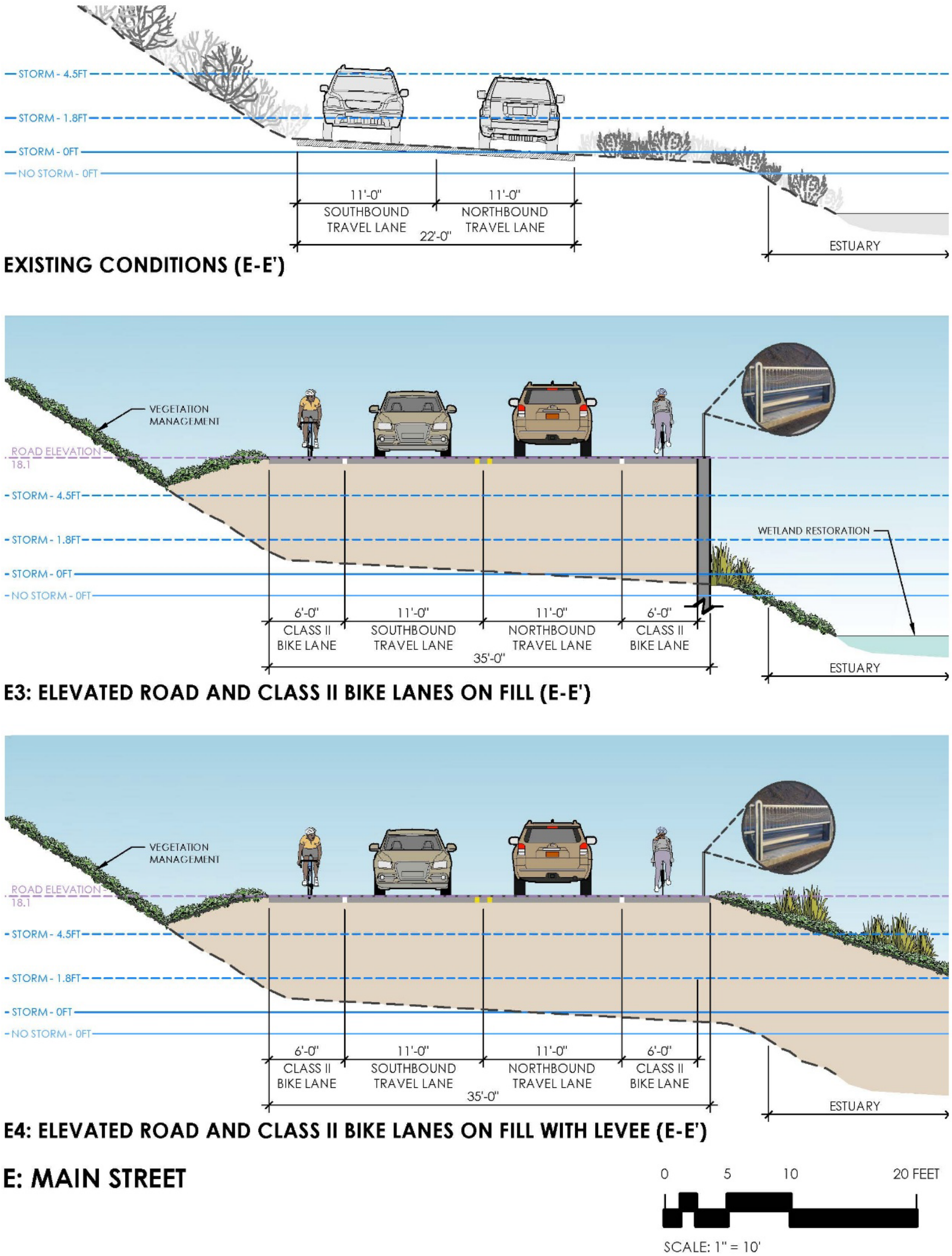


Figure 8 Cross Sections for Near-term Adaptation Alternatives

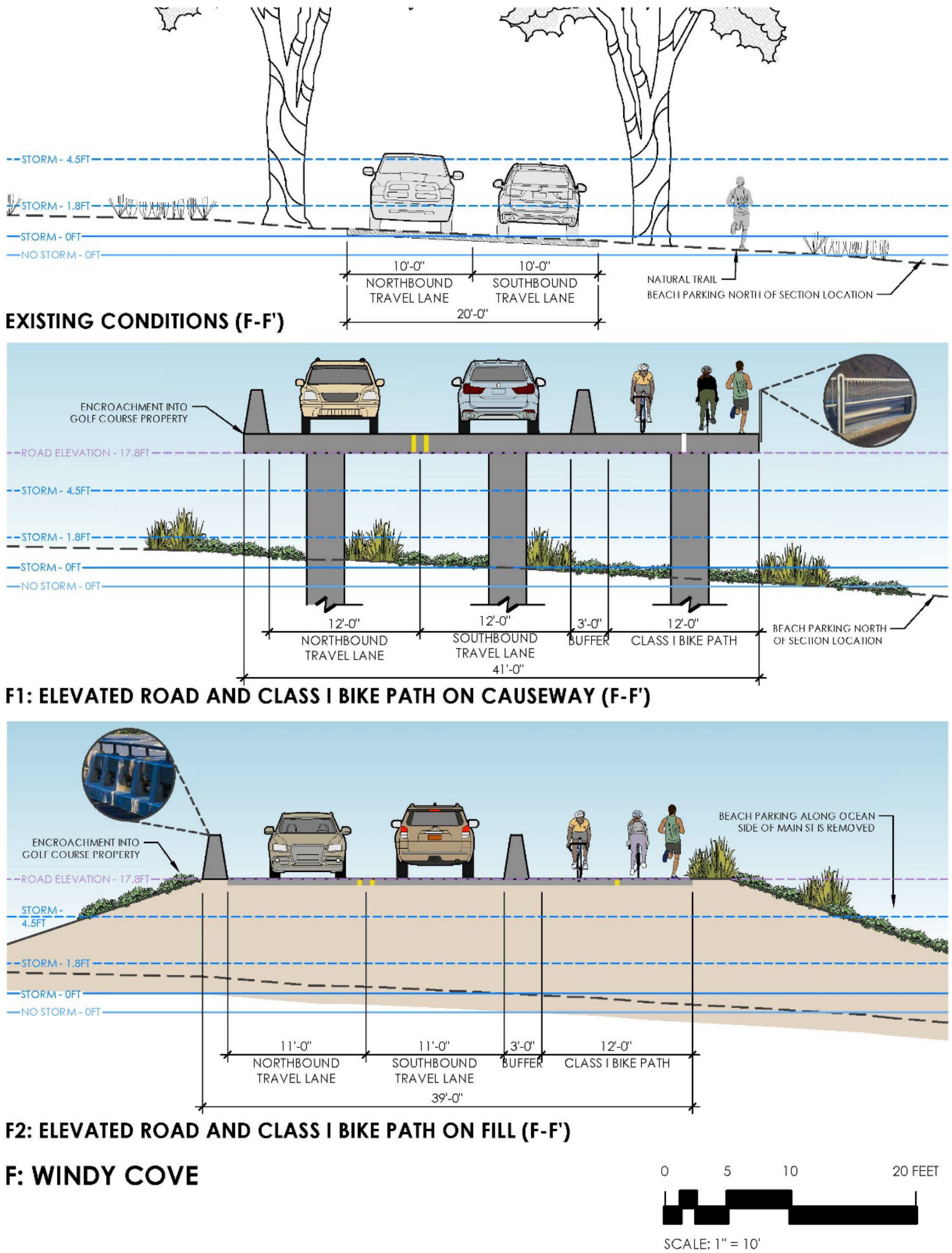


Figure 9 Cross Sections for Near-term Adaptation Alternatives

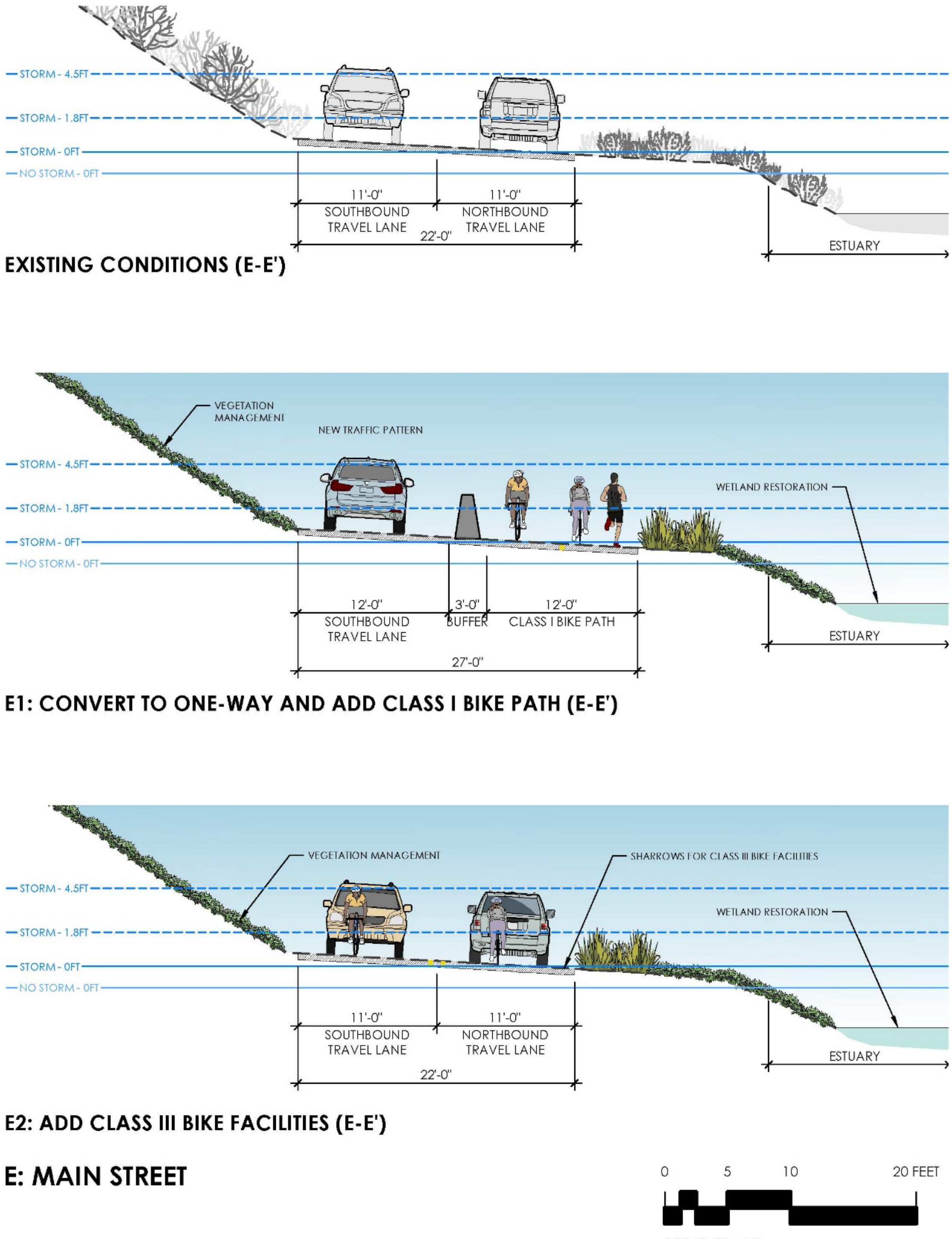


Figure 10 Cross Sections for Near-term Adaptation Alternatives

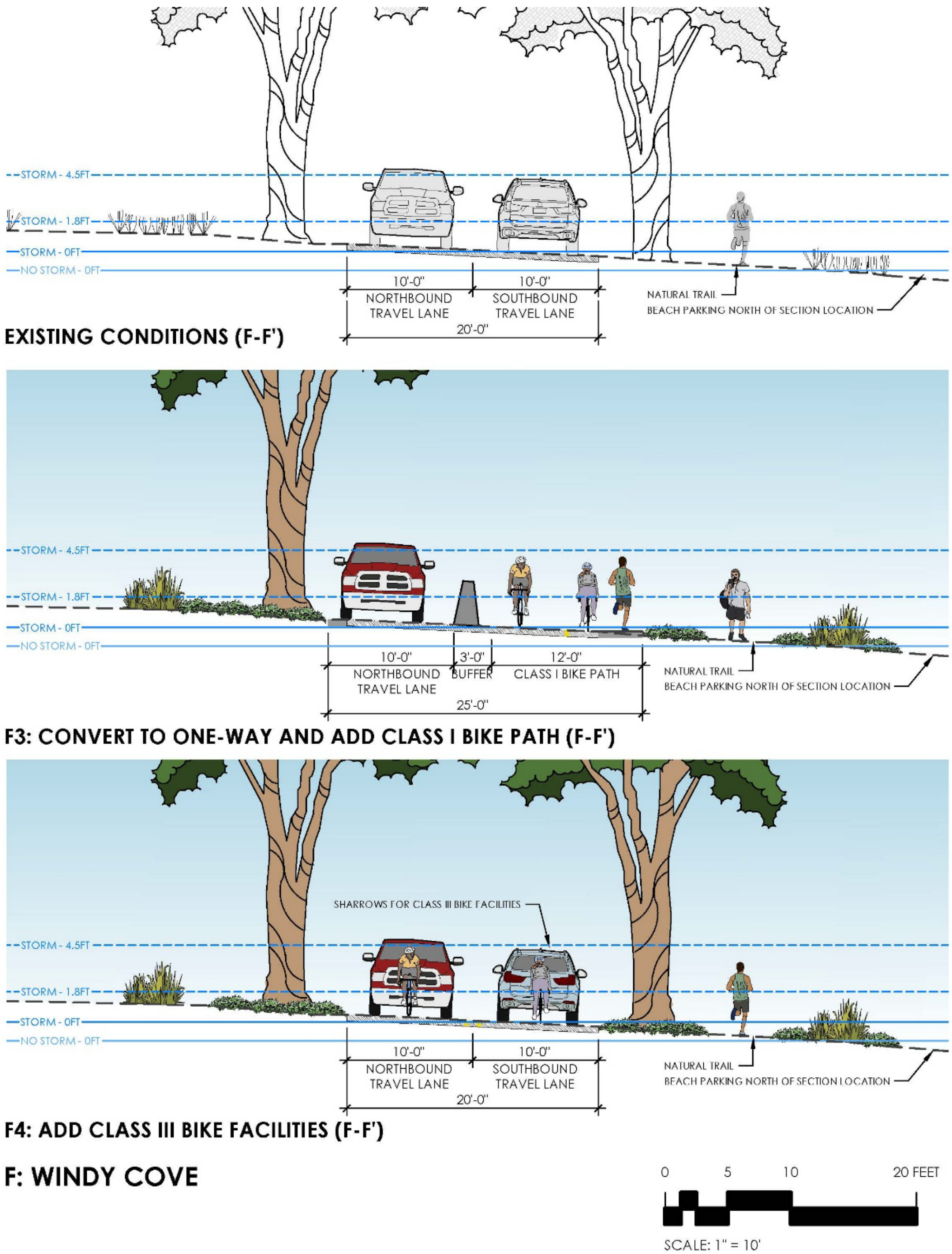


Figure 11 Cross Sections for Near-term Adaptation Alternatives

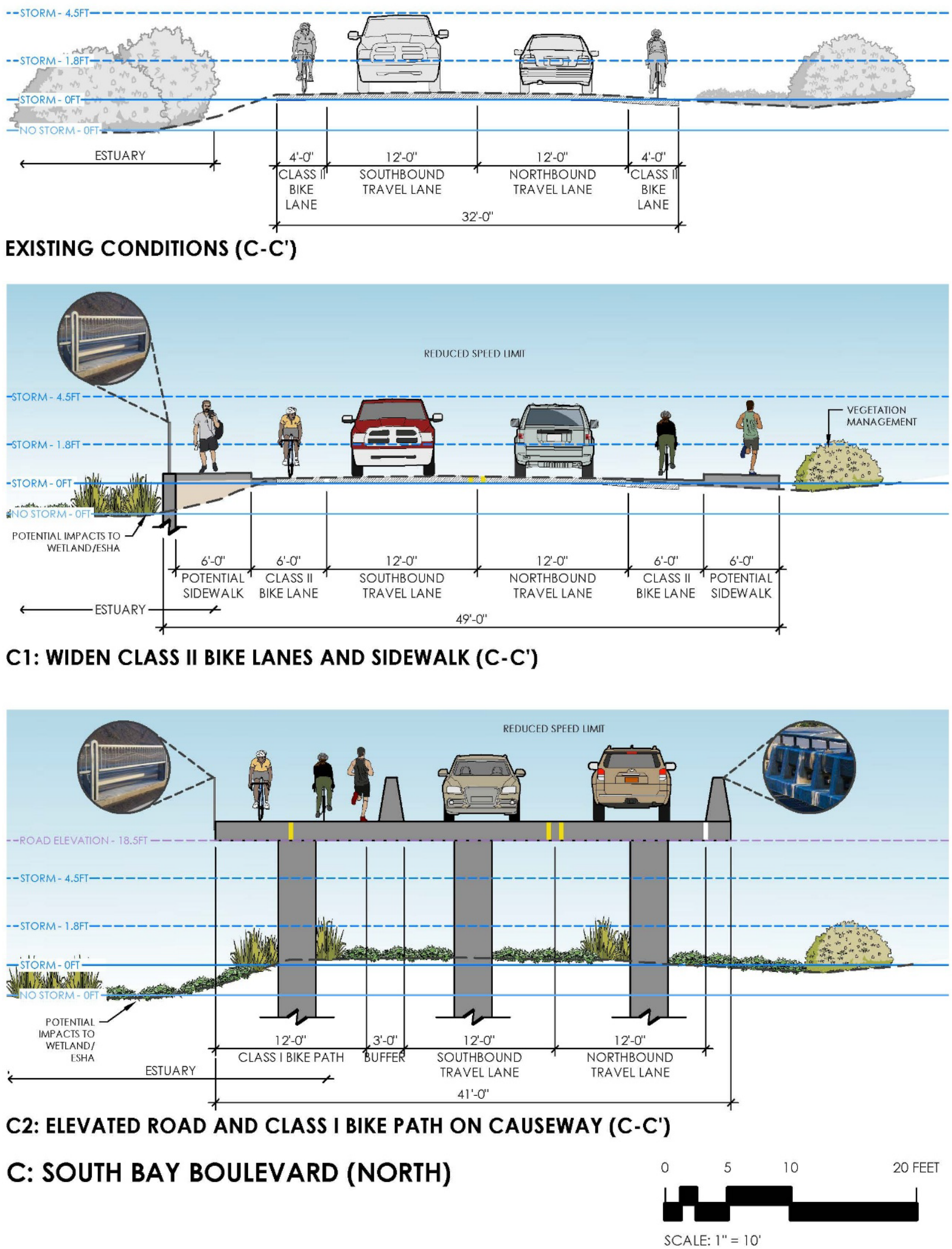


Figure 12 Cross Sections for Near-term Adaptation Alternatives

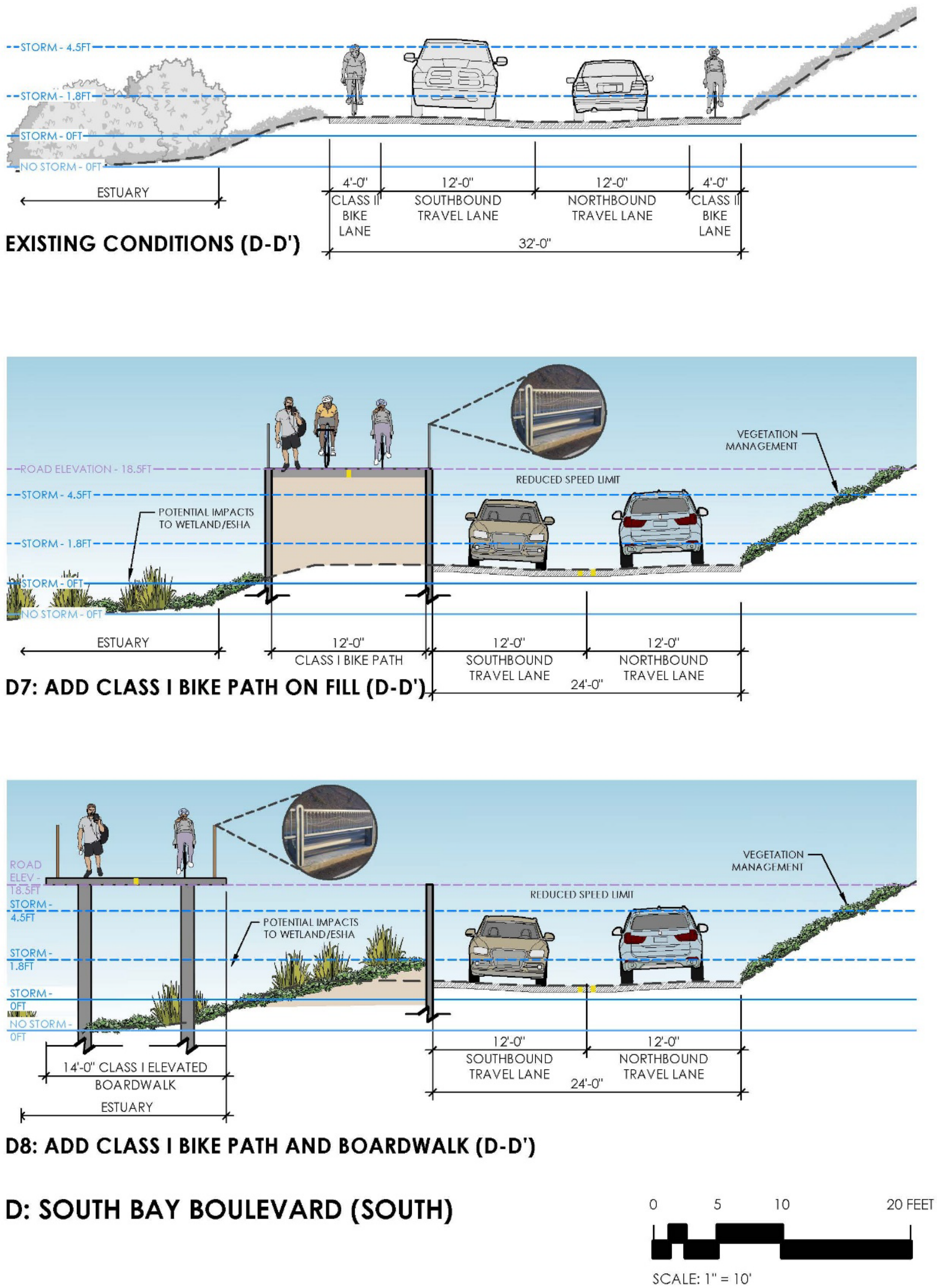


Figure 13 Cross Sections for Near-term Adaptation Alternatives

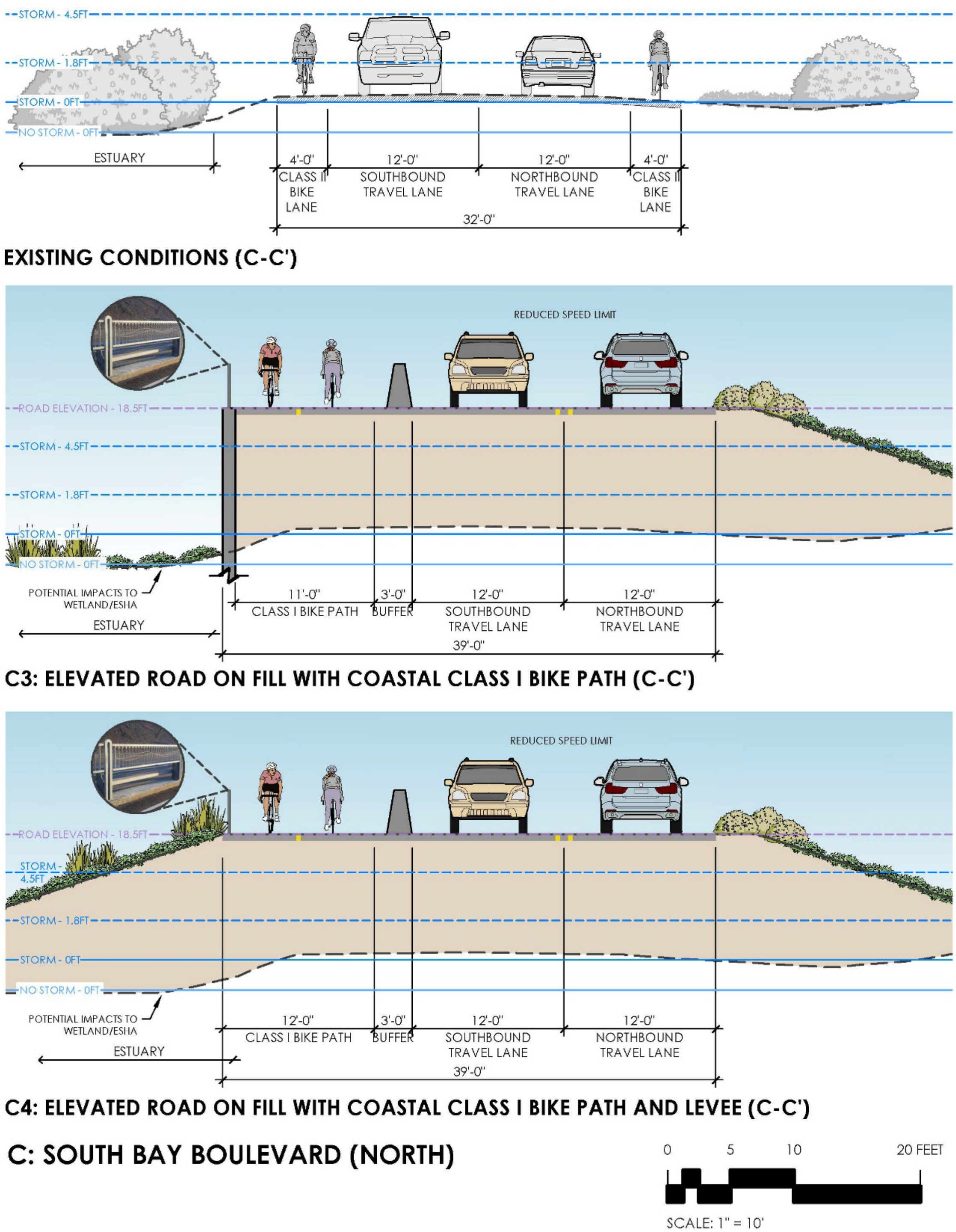


Figure 14 Cross Sections for Near-term Adaptation Alternatives

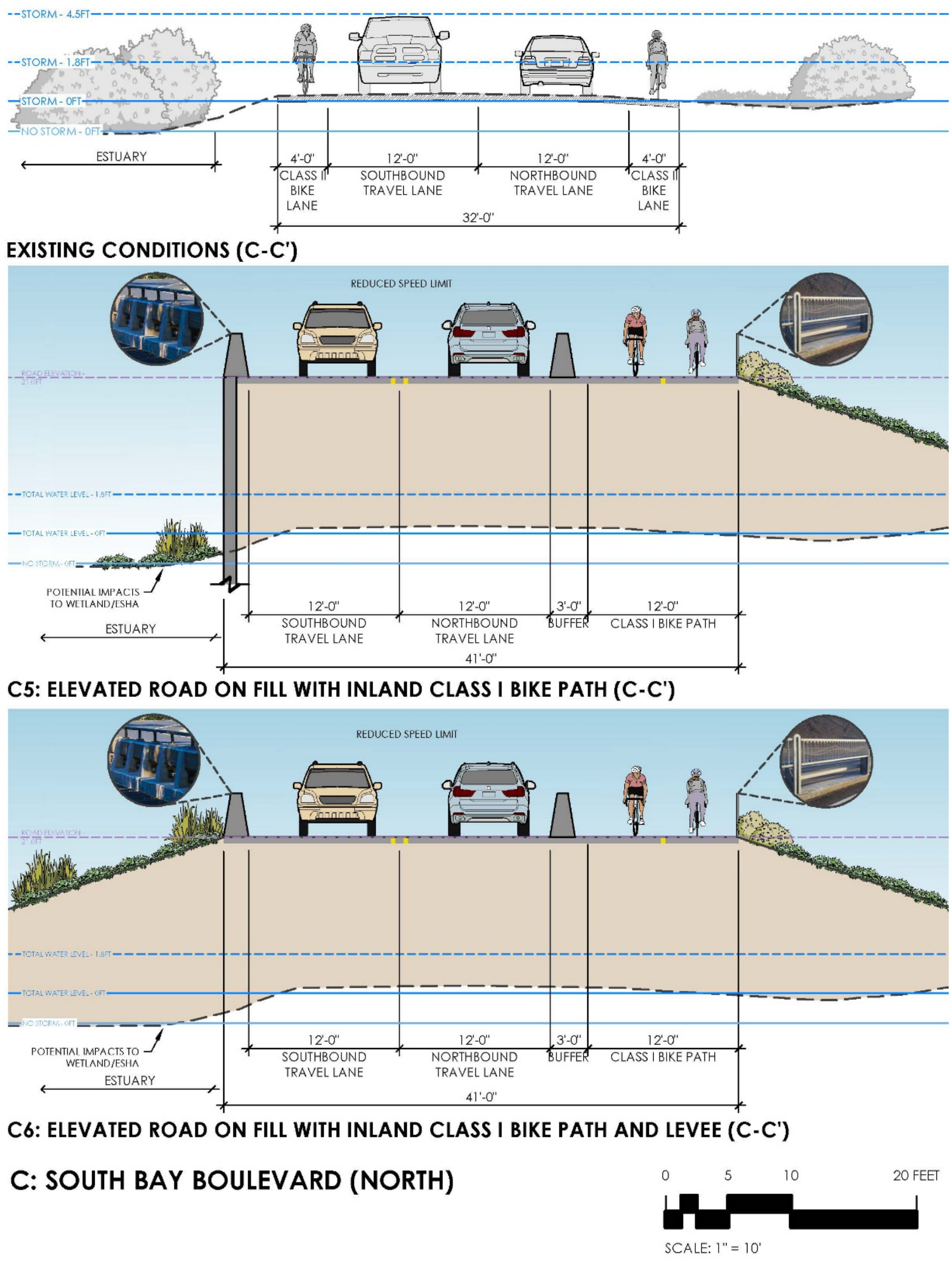


Figure 15 Cross Sections for Near-term Adaptation Alternatives

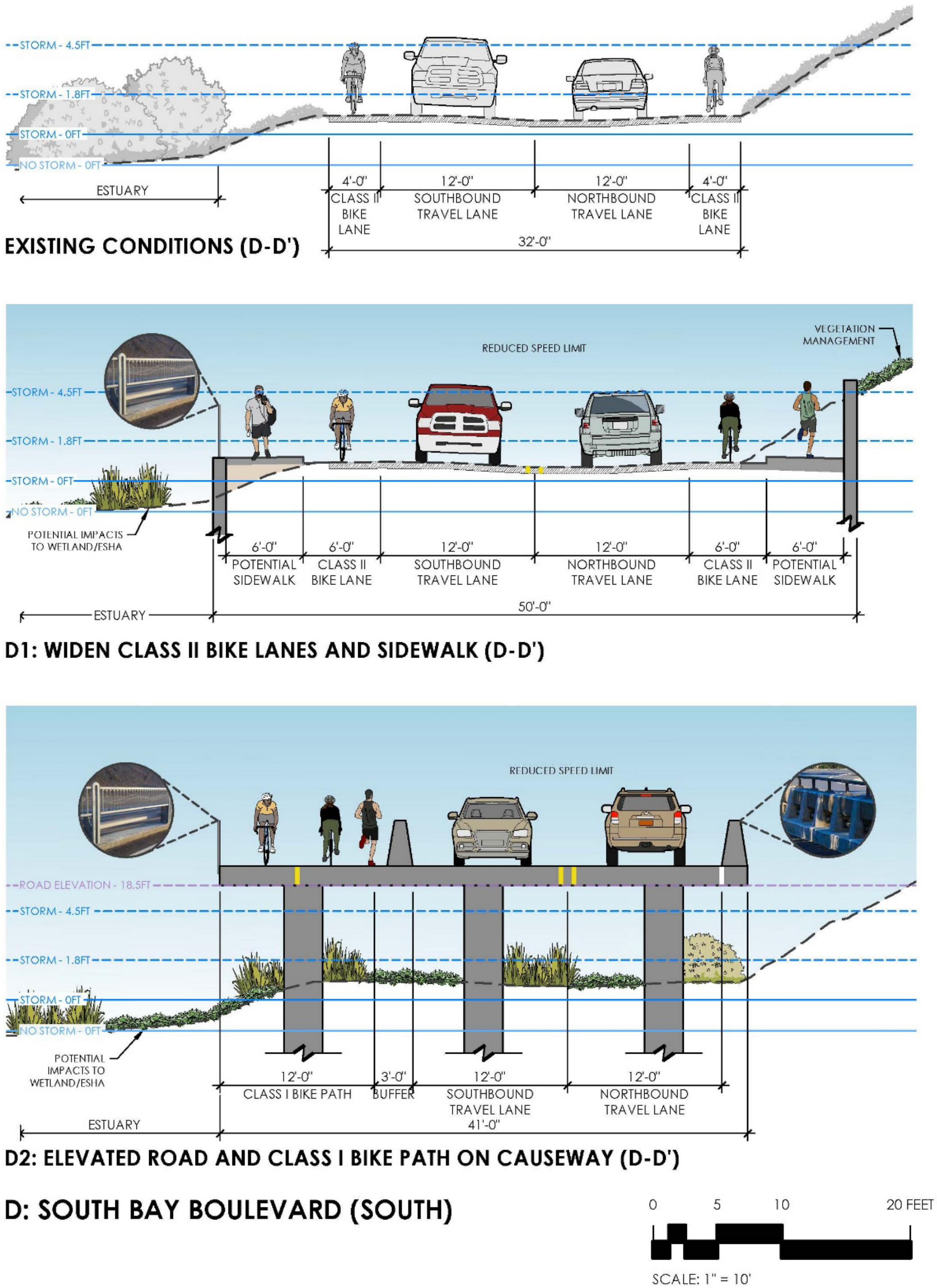


Figure 16 Cross Sections for Near-term Adaptation Alternatives

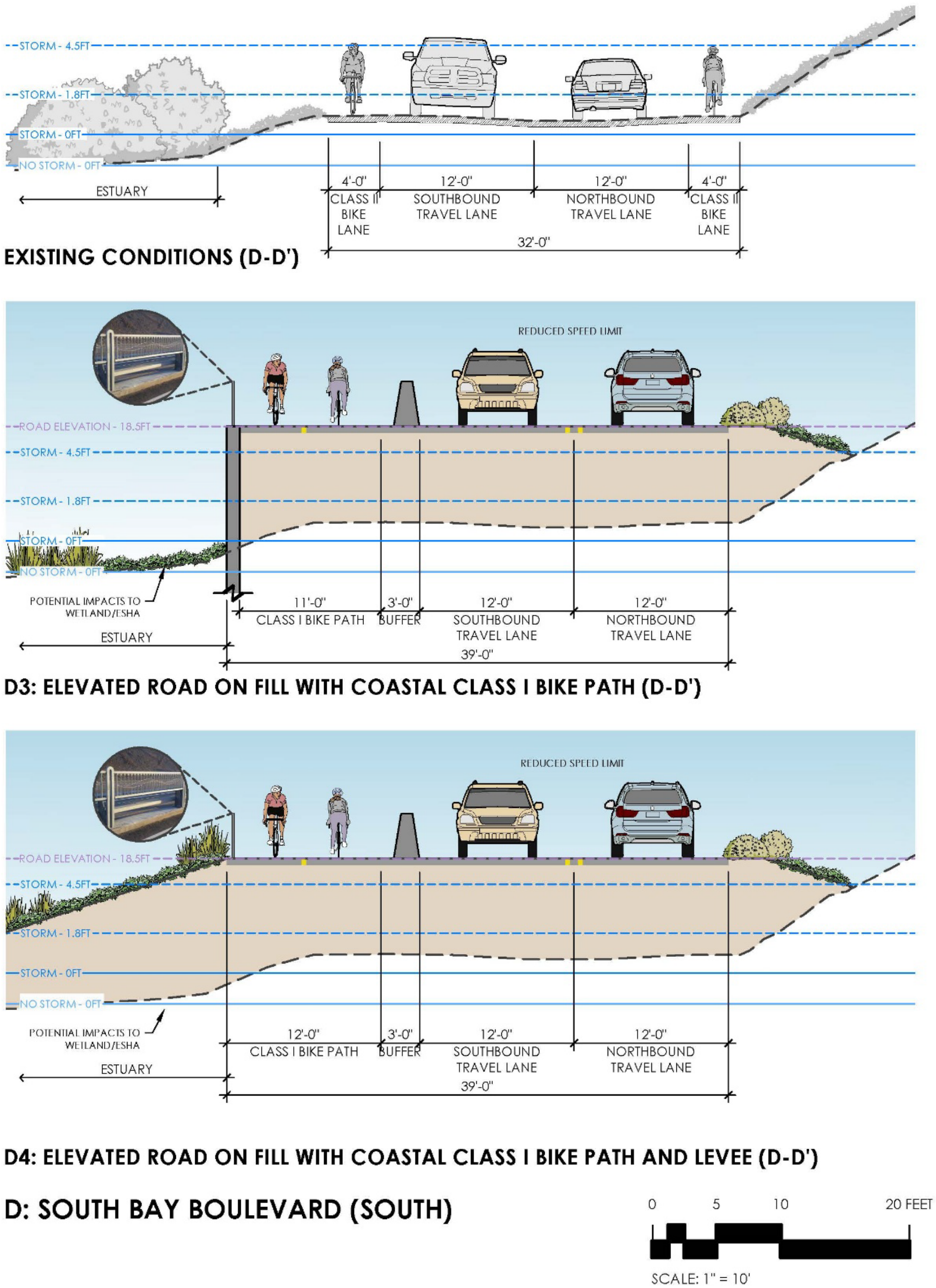


Figure 17 Cross Sections for Near-term Adaptation Alternatives

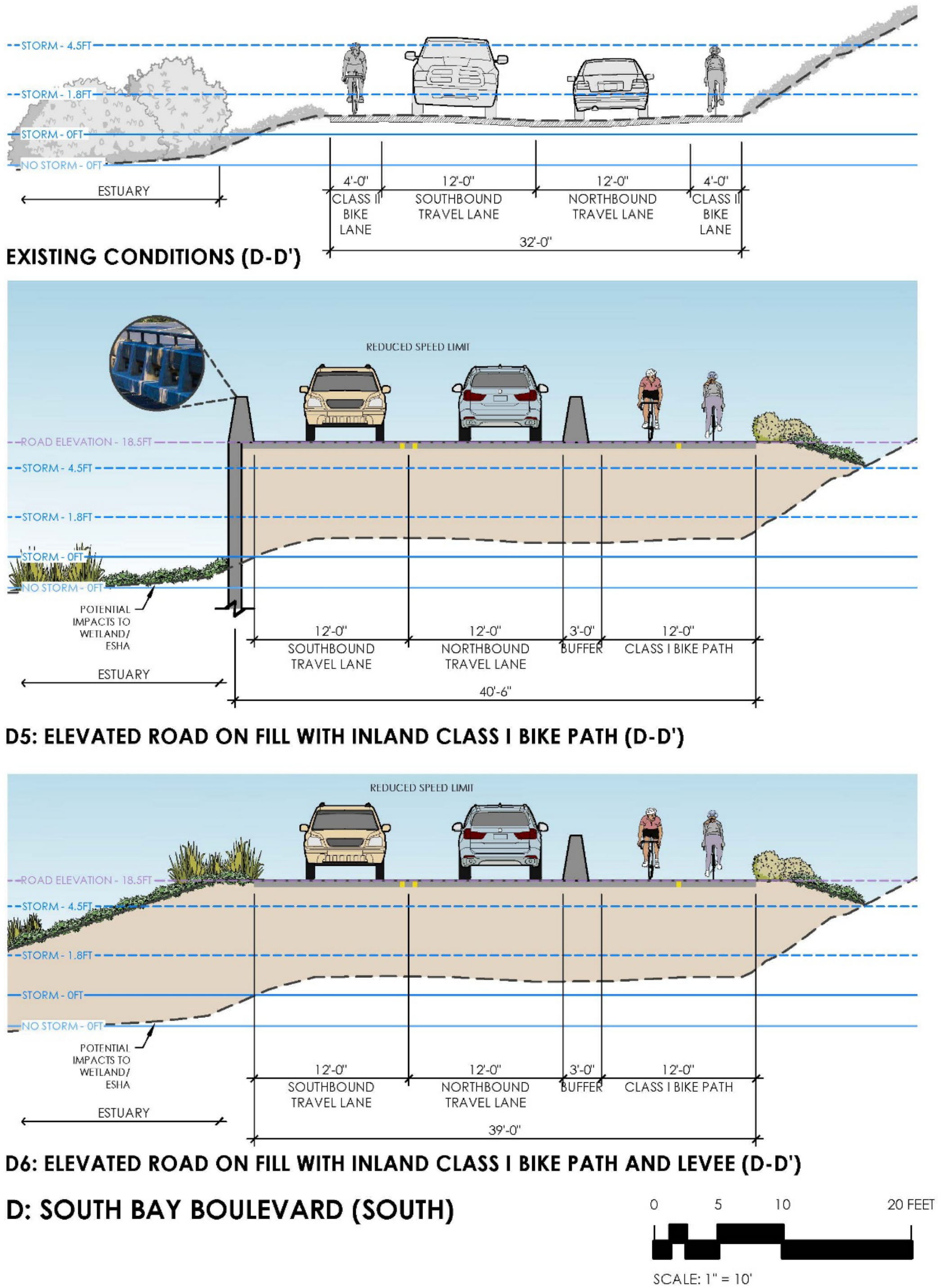


Figure 18 Cross Sections for Near-term Adaptation Alternatives

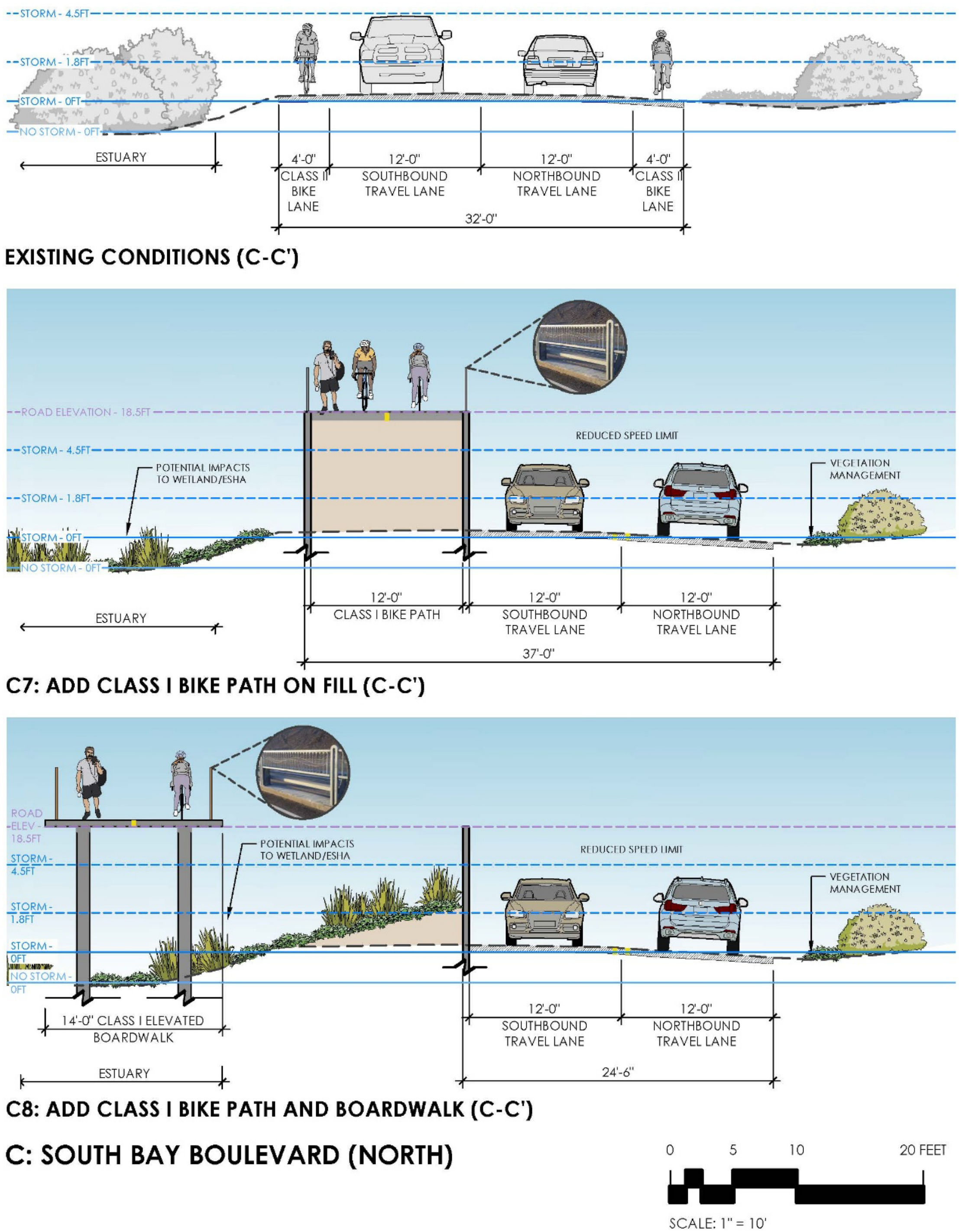


Figure 19 Cross Sections for Near-term Adaptation Alternatives

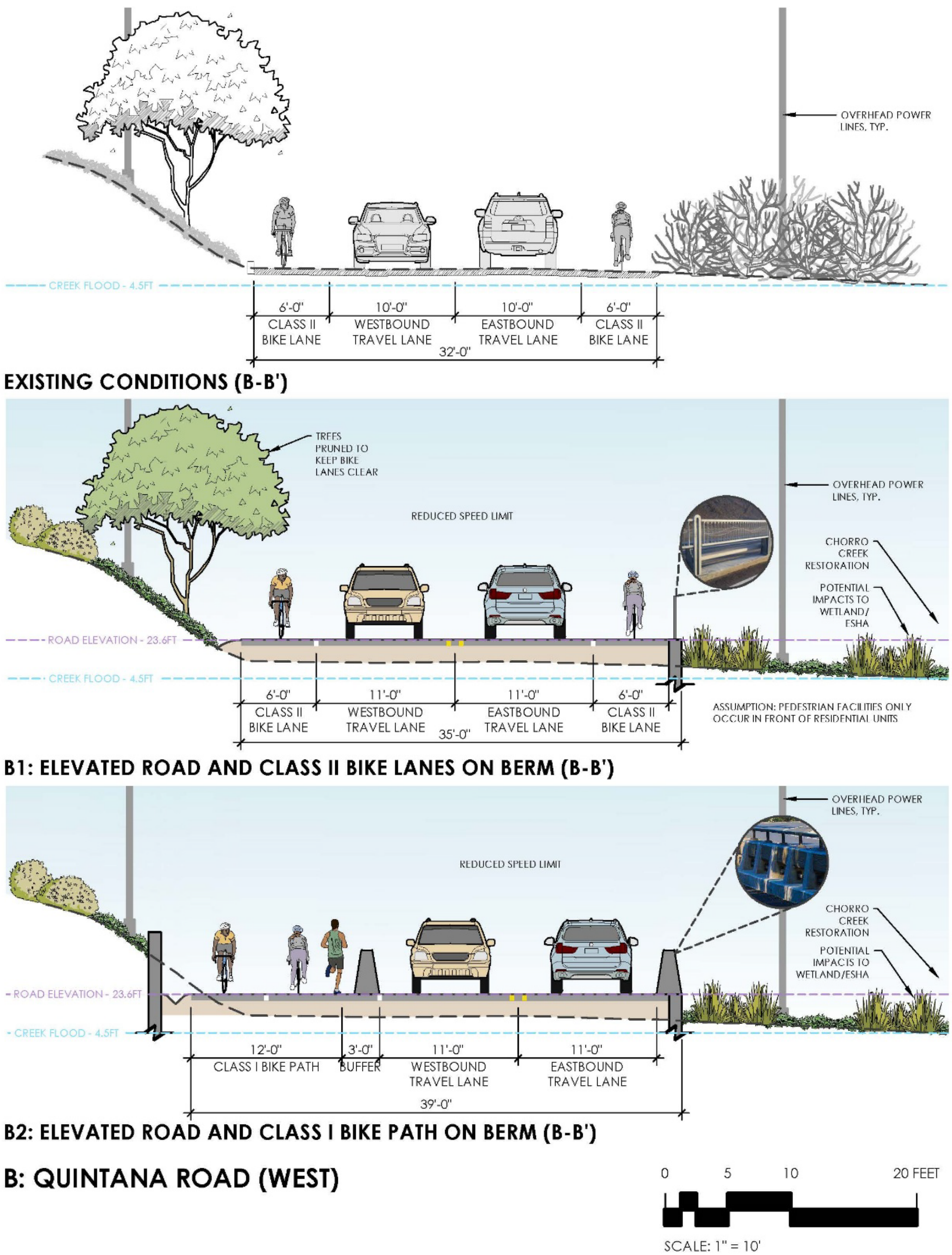
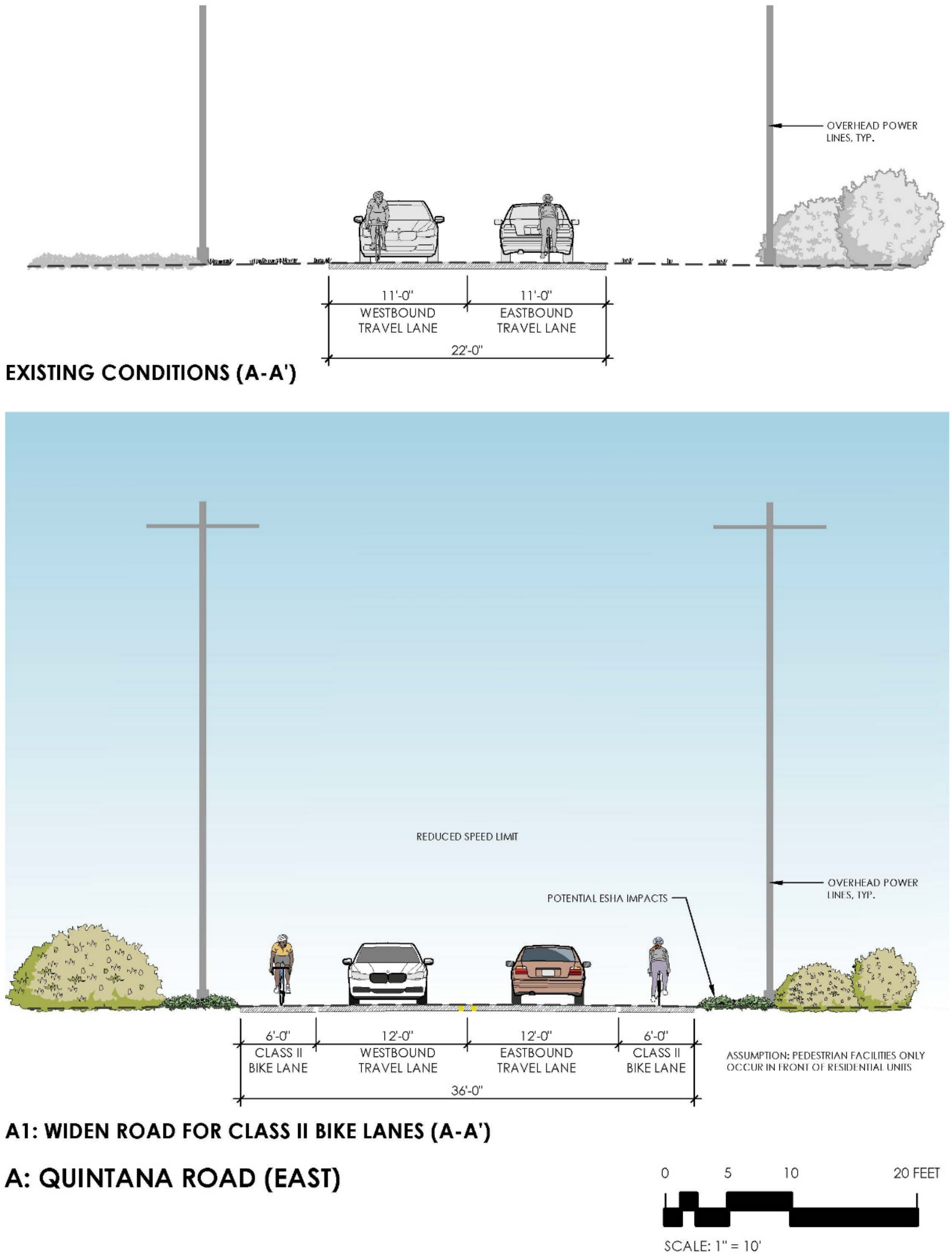


Figure 20 Cross Sections for Near-term Adaptation Alternatives



3.3.2 Mid-term (~2045-2075)

In the mid-term, the focus shifts to assets that are likely to become exposed to coastal hazards in the near future. The vision is to build on the near-term actions and implement measures that provide continued resilience and adaptability to changing conditions. These measures aim to protect infrastructure, enhance natural defenses, and ensure the sustainability of recreational and natural assets.

The additional assets exposed to coastal hazards in the mid-term, considering the storm condition (Table 1), under the categories of transportation, recreation, and natural assets, include:

Transportation – Roads and Mobility Assets:

- S Bay Blvd
  - Chorro Creek Bridge to Bay Pines
- Turri Road

Recreational Assets:

- Cerro Cabrillo Trailhead Parking Lot
- Chumash Trailhead Parking Lot

Table 4 presents the **opportunities**, including potential solutions and enhancements that would increase resilience of the transportation, recreational and natural assets, **constraints** that may limit or restrict the ability of the opportunities to provide a feasible solution, including special status species, land use, construction /maintenance cost, permitting feasibility, and **evaluation criteria** of the measures that could be considered in the mid-term.

TABLE 4.
TABLE OF MID-TERM MEASURES OPPORTUNITIES AND CONSTRAINTS

Asset	Adaptation Measure	Opportunities	Constraints	Evaluation Criteria [A]
Transportation Assets				
S Bay Blvd (Chorro Creek Bridge to Bay Pines)	Accommodate: Raise the most vulnerable segments of the road on fill/berm	Add Class I or Class II bike lane to the widened roadway prism	Potential impacts to adjacent habitat	• Engineering Considerations: ***High*** • Environmental Considerations: ***Medium-High Impact / Low Benefits*** • Regulatory Considerations: ***Medium - High*** • Social Considerations: ***Medium***
	Mobility: Create separated trail paralleling SBB	Alternative alignment options (e.g., co-located with Los Osos State Water Line)	Permanent Wetland/ESHA impacts; Would need enhanced crosswalks, beacons/stoplights for trailhead access	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Widen NB/SB existing bike lanes	Improved cycling infrastructure	Permanent Wetland/ESHA impacts	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium-High Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Vegetation management	Improved safety at SBB/State Park Road intersection where vegetation blocks drivers' views	State Parks policies	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Medium Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
	Mobility: Reduce speed limit	Improved safety for all road users	Implementation and enforcement requirements	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
Turri Road	Accommodate: Elevate road on fill/causeway (See **Figure 21** for cross section)	Long-term flood protection; improved bike / ped safety; Maintained access during flood events	Potential Wetland/ESHA impacts	• Engineering Considerations: ***High*** • Environmental Considerations: ***Medium-High Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Mobility: Improved pedestrian crossing at SBB	Enhanced safety for pedestrians	Implementation costs	• Engineering Considerations: ***Low***

				• Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
	Mobility: Add left turn lane on SBB	Improved traffic flow	Widening roadway could impact wetland	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
	Mobility: Widen road at add Class II bike lanes in shoulders (See **Figure 22** for cross section)	Safer biking	Permanent Wetland/ESHA impacts	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
	Stormwater management	Reduced flooding during storm events	Implementation costs; potential habitat impacts	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Medium Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
Recreational Assets				
Cerro Cabrillo Trailhead Parking Lot	Accommodate: increase elevation of trailhead parking lot using fill	Maintained access during flood events	Implementation costs	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
Chumash Trailhead Parking Lot	Accommodate: increase elevation of trailhead parking lot using fill	Maintained access during flood events	Implementation costs	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***

Note:

[A] Economic consideration is not included because it will be defined in Task 2.4 of the Project

Figure 21 Cross Sections for Mid-term Adaptation Alternatives

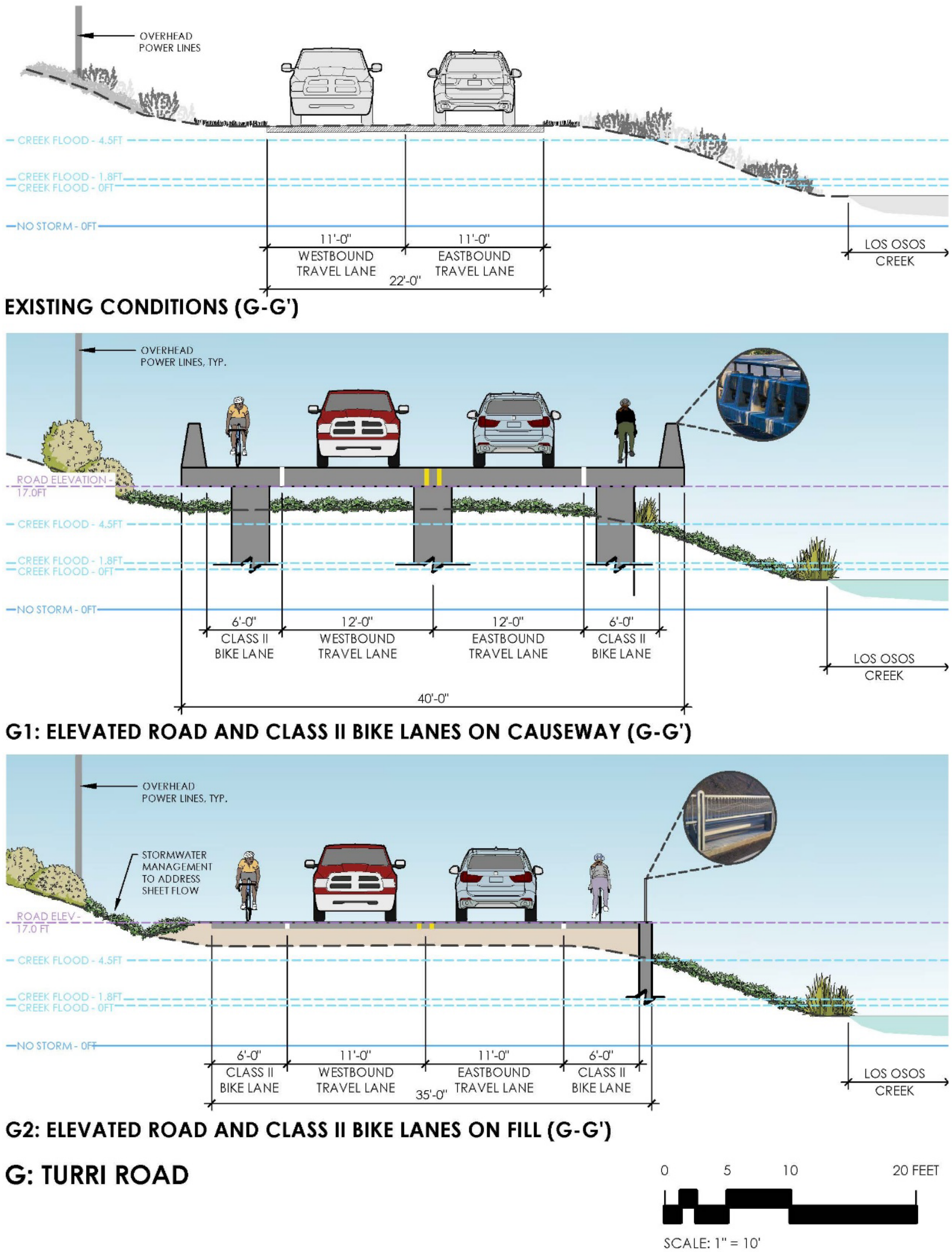
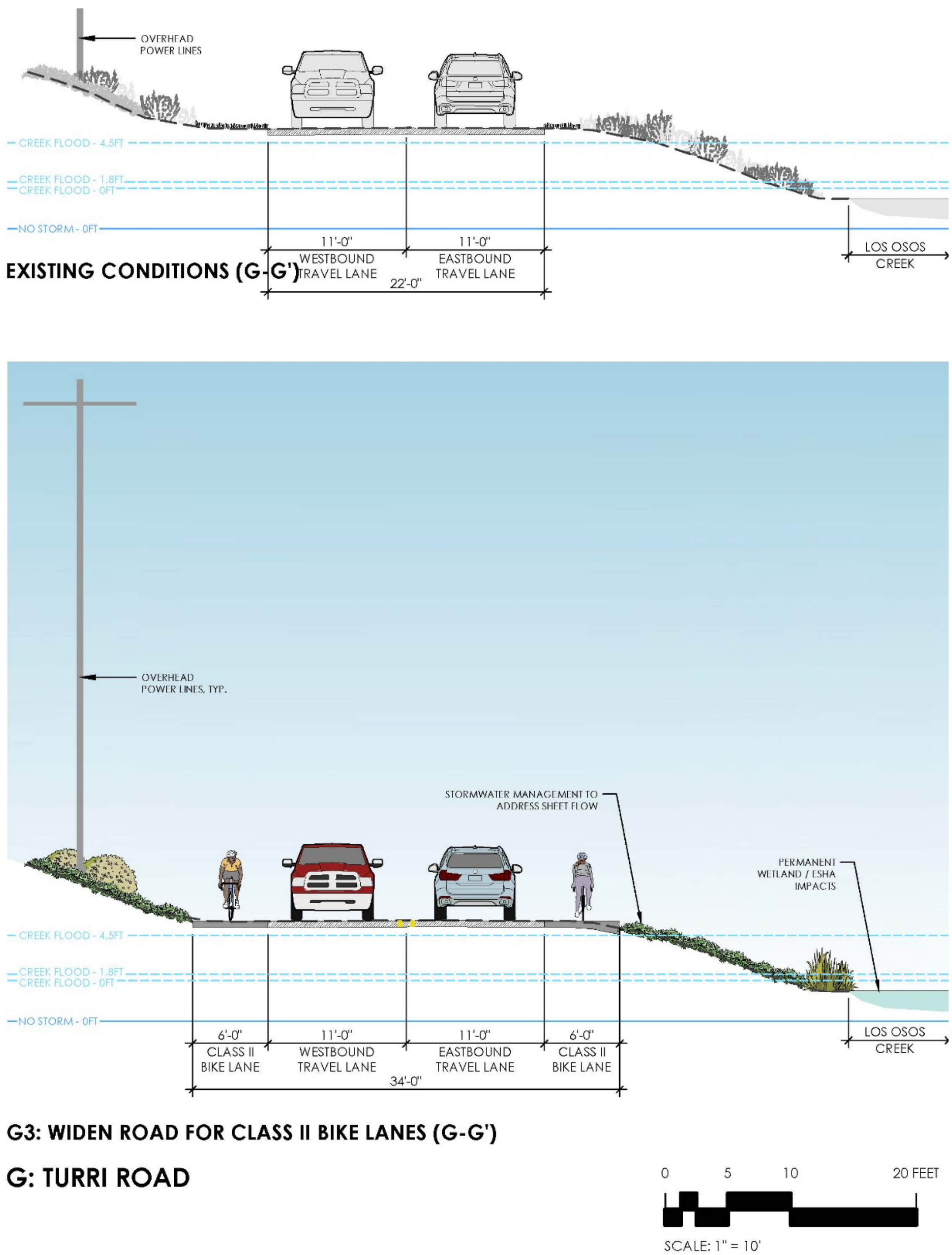


Figure 22 Cross Sections for Mid-term Adaptation Alternatives



3.3.3 Long-term (~2075+years)

The long-term vision for the Morro Bay Estuary includes creating a resilient and adaptive infrastructure that can withstand up to 6 ft of SLR. This vision will be informed by stakeholder and public input and will focus on sustainable and nature-based solutions.

The assets exposed to coastal hazards in the long-term, considering the storm condition (Table 1), under the categories of transportation, recreation, and natural assets, include:

Transportation – Roads and Mobility Assets:

- Los Osos Bridge

Recreational Assets:

- Park Ridge Trailhead Parking Lot

Natural Assets:

- El Moro Elfin Forest Natural Preserve

Table 5 presents the **opportunities**, including potential solutions and enhancements that would increase resilience of the transportation assets and habitats, **constraints** that may limit or restrict the ability of the opportunities to provide a feasible solution, including special status species, land use, construction /maintenance cost, permitting feasibility, and **evaluation criteria** of the measures that could be considered in the long-term.

TABLE 5.
TABLE OF LONG-TERM MEASURES OPPORTUNITIES AND CONSTRAINTS

Asset	Adaptation Measure	Opportunities	Constraints	Evaluation Criteria [A]
Transportation Assets				
Park View Drive (Lower State Park Road)	Mobility: Convert to one-way	Would allow more space for bikes and pedestrians	Impacts to traffic circulation	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***
South Bay Blvd	Accommodate: Increase elevation	Long-term flood avoidance.		• Engineering Considerations: ***High*** • Environmental Considerations: ***High Impact / Low Benefits*** • Regulatory Considerations: ***High*** • Social Considerations: ***High***

Los Osos Bridge	Accommodate: Elevate	Avoid repeated flooding	Implementation costs; sensitive habitats; visual impacts	• Engineering Considerations: ***High*** • Environmental Considerations: ***Medium-High Impact / Low Benefits*** • Regulatory Considerations: ***High*** • Social Considerations: ***Medium***
Recreational Assets				
Park Ridge Trailhead Parking Lot	Relocate: out of the coastal hazard zone, e.g., uphill, or increase elevation of facilities by adding fill	Maintained access	Limited suitable alternatives	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Low-Medium Impact / Low Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
Natural Assets				
Morro Bay State Marine Reserve	Protect: Expand wetland restoration, including thin-layer placement if needed	Natural buffers against sea-level rise. Enhanced ecological resilience	Not needed until 2060 due to natural accretion; sediment availability	• Engineering Considerations: ***Medium*** • Environmental Considerations: ***Low Impact / High Benefits*** • Regulatory Considerations: ***Medium*** • Social Considerations: ***Low***
El Moro Elfin Forest Natural Preserve	Protect: Habitat protection and creation of wetland migration space	Allowing for the conversion of habitat at the margins from upland to wetland over time	Implementation constraints	• Engineering Considerations: ***Low*** • Environmental Considerations: ***Low Impact / Low Benefits*** • Regulatory Considerations: ***Low*** • Social Considerations: ***Low***

Note:

[A] Economic consideration were not included because they will be defined in Task 2.4 of the Project

4 Thresholds, Triggers and Timing

This section presents thresholds, timing, and triggers for adaptation actions to prepare for and/or respond to the coastal hazards evaluated for Morro Bay's transportation, recreational, and natural assets (ESA 2025). These elements of the adaptation process can be used to combine and sequence multiple measures to create an adaptation pathway

The Morro Bay Estuary VA Memorandum incorporates exposure thresholds for Morro Bay's transportation, recreational, and natural assets (ESA 2025). Adaptation is a process of planning and implementing successive or phased adaptation measures over time. In the context of coastal hazards and sea level rise, the timing of adaptation actions is based on the progression of coastal flooding and coastal hazards in relation to assets (e.g., roads, bridges, habitat areas). Thresholds inform the timing of implementation and maintenance of an adaptation measure or signal a need to transition to another adaptation measure as sea level rises and impacts occur or worsen. An adaptation trigger is the decision point at which to start implementation so that a measure is in place before it is needed. The duration of the typical planning and implementation process is called lead time.

Ideally, an adaptation measure should be implemented before exposure thresholds are reached, so trigger points for action must include lead times for planning and construction. Thresholds are defined for physical metrics associated with each relevant hazard that will be monitored over time (e.g., conditions of roads and bikeways, squeezing of wetlands, observed sea level rise amount). For each physical metric, the thresholds can be identified in both time (with respect to projected sea level rise) and space for the range of assets and hazard exposures evaluated in this project.

The timing of adaptation measure implementation should be informed by monitoring of sea level rise, flooding or inundation frequency, and progressive or repeated damages. Thus, implementation timing depends on the relative location and exposure of a given asset to hazard(s) with sea level rise.

Figure 23 shows how near-, mid- and long-term adaptation measures can be phased in response to SLR. For example, mobility enhancements could be implemented in the near-term to improve bike and pedestrian safety while sea level rise adaptation projects are planned, designed, permitted and constructed. In the example used in the graphic, a levee could be constructed first to provide protection for South Bay Boulevard and State Park Road on their current alignments while also providing a separated bike and pedestrian path. If and when stormwater and/or groundwater management affects the functioning of those roadways, the roadways themselves could be elevated on fill to meet the level of the adjacent levee. Over the long-term, if the integrity of fill-raised infrastructure is compromised, then a causeway could potentially be constructed on top of the fill to provide higher levels of accommodation for storm flooding and tidal inundation.

ESA

115 S La Cumbre Lane
Suite 300
Santa Barbara, CA 93105
805.880.0922 phone
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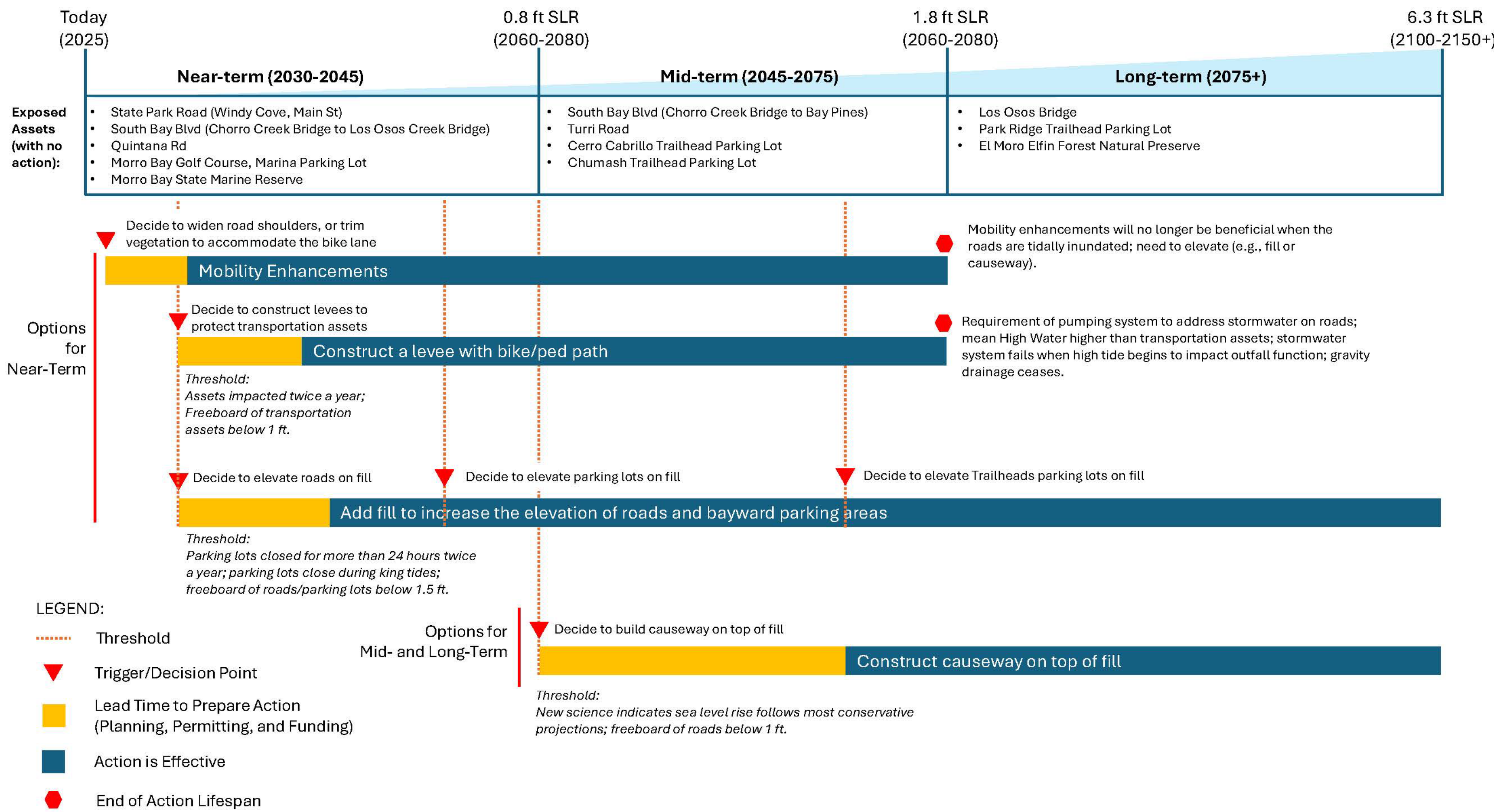

Figure 23. Potential adaptation pathways illustrating conceptual phasing of measures triggered by SLR.

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Lead times for planning and constructing adaptation measures should also consider the speed at which hazards are expected to worsen, translating to the relative timing of sea level rise and/or coastal erosion projections. The advanced pace of sea level rise projected later this century indicates that the timing of planning and implementing adaptation measures will be critical. For example, the 2024 State of California SLR Guidance (OPC 2024) indicates that one foot of sea level rise could occur within the next 25 years under the High SLR scenario, or around 2070 under the Intermediate SLR scenario. Individual adaptation projects for a given asset may take less severe sea level rise projections into account when developing timeframes, depending on the asset's risk tolerance and the best available sea level rise science.

According to the vulnerability assessment prepared by ESA (ESA 2025), coastal storm flooding can currently impact the transportation, recreational, and natural assets within Morro Bay Estuary. In this memo, we modelled and examined the potential exposure of extreme coastal storm events. Thresholds for coastal flooding include the impact of these assets from storm surge.

Threshold – The selected water level for this study is the water level obtained from verified extreme flood events that corresponds to total water levels, including wave run-up generated by wind-driven waves and the water level in creeks. The extreme flood events were analyzed in the vulnerability assessment and provides the most conservative approach (compared to the non-storm condition).

Trigger – Indicators that determine when to initiate future planning and/or implementation of adaptation actions. A measure is triggered when the freeboard (vertical distance between an asset and the storm flood water level) falls below a threshold equal to the projected sea level rise expected during the lead time for implementing adaptation. . For example, if a trail along the Morro Bay Estuary is expected to be inundated with 1 foot of SLR within a certain timeframe, planning and permitting should be initiated with enough time to implement the project before the trail is flooded and unusable. Note that for most transportation assets, adaptation planning and action should be triggered by projected storm flooding impacts to avoid potential damages (i.e., adaptation should occur sooner than progression of regular tidal inundation suggests).

Table 6 below lists possible lead times for different adaptation measures that address coastal flooding along the project site.

TABLE 6.
POSSIBLE LEAD TIMES FOR COASTAL FLOODING ADAPTATION

Risk	Actions	Adaptation Options	Time Frame	Lead Times
Coastal Flooding Storm Condition ESA Hydrodynamic Model (ESA 2025)	Protect	Wetland Restoration	5-25 years (near-term)	2-5 years
		Construct a levee or berm to protect the road in its current alignment and elevation	5-25 years (near-term)	1-5 years
	Accommodate	Elevate Road on Fill or Causeway	25-50 years (mid-term)	5-15 years
	Retreat	Relocate Roads and Infrastructure Inland	50 +years (long-term)	10-20 years

5 Preferred Alternatives and Adaptation Pathway

The ESA team, in coordination with SLOCOG and the Advisory Committee, has selected the following preferred adaptation alternatives based on technical analysis, stakeholder input, and alignment with the project's goals. These alternatives reflect a phased approach to adaptation that balances feasibility, environmental and cultural considerations, and near, mid, and long-term resilience of SLOCOG's transportation, recreational, and natural assets to SLR.

5.1 Preferred Alternatives Description

5.1.1 Levee Systems (near to mid-term)

Levee construction along vulnerable segments of State Park Road at Windy Cove and South Bay Boulevard would provide immediate flood protection at a lower initial cost compared to elevated structures. These earthen barriers can be constructed relatively quickly to address current flooding concerns. However, as water levels rise, levees' effectiveness would diminish, and when they approach outfall levels, pumped drainage systems would become necessary, increasing costs and complexity. This alternative could include a bicycle / pedestrian path on top of the levee system.

Triggers, Thresholds and Adaptive Capacity: Construction triggers when extreme events reduce freeboard of transportation assets below 1 ft. The system remains functional until 1.5 ft of freeboard and until drainage fails during high tides, requiring transition to causeway or fill when pumping systems would become necessary. Or rather than using pumping systems, the roads could be elevated to meet the height of the levee.

5.1.2 Fill Elevation (near- to mid-term)

Raising road segments with engineered fill offers a practical near to mid-term solution that can be implemented with minimal disruption to surrounding resources. Using fill to increase elevation is particularly advantageous in areas with cultural resources, as it avoids the excavation that would be required for foundation systems to support a causeway while providing immediate flood protection. This alternative could include Class II bike lanes and sidewalks in the northbound and southbound shoulders or Class I protected bike lanes and pedestrian path on the bayward side.

Triggers, Thresholds, and Adaptive Capacity: Implementation triggers when extreme events from creek flooding or coastal storms reduce freeboard to less than 1 ft. Fill remains effective until freeboard is more than 2.0 ft of total water level, transitioning to other solutions when freeboard is 1 ft and when geometric constraints limit further raising. This approach allows for incremental raising of the roadway as conditions change, though eventual transitions to other solutions may be necessary.

5.1.3 Causeway (long-term)

The causeway represents the preferred alternative for the long-term adaptation strategy. South Bay Boulevard could be raised on a causeway above projected flood levels while maintaining critical hydrologic connections beneath the roadway. The causeway design enables continued sediment transport and tidal exchange, thereby supporting the natural inland migration of wetland habitats as sea levels rise. Implementation would occur in the long-term phase, as a trigger and threshold monitoring program would inform the need for this level of protection.

This alternative could include Class II bike lanes and sidewalks in the northbound and southbound shoulders or Class I protected bike lanes and pedestrian paths on the bayward side.

Triggers, Thresholds, and Adaptive Capacity: Transition planning begins when fill or levee no longer maintains 1.5 ft of freeboard during extreme events. Causeways have low adaptive capacity, meaning that once they are built to a certain elevation, it is not possible to add additional elevation.

5.1.4 Hybrid Approach Combining Fill and Causeway (near-, mid-, and/or long-term)

This strategy employs a phased, hybrid approach, beginning with fill in the near-term and transitioning to a causeway in the long-term. This would allow SLOCOG and other project partners to monitor SLR and adjust plans based on observed trends rather than relying solely on present-day projections. As scientific understanding of SLR and climate change improves and local conditions evolve, the causeway design can be refined, raising or lowering its elevation to match actual needs. This approach avoids overbuilding infrastructure while maintaining adaptive capacity throughout the transition period. In addition to the mobility alternatives discussed above, all of these alternatives could be combined with a separated bicycle / pedestrian path on a boardwalk over the Morro Bay estuary.

Triggers and Thresholds: The transition from fill to causeway would be initiated when the fill or levee no longer maintains 1.5 ft of freeboard during extreme events or when fill maintenance costs exceed 50% of causeway construction costs over a 10-year period.

5.1.5 Stormwater Management Integration (Near- to Mid-Term)

Recognizing that traditional drainage systems become less effective as sea levels rise, the ESA team also recommends integrating stormwater management approaches with levee and fill alternatives. Near-term implementation could include constructed wetland areas designed to drain stormwater from the roads before it enters the bay system. In addition to improving flood management along transportation assets, these wetland features would serve multiple purposes: providing initial treatment for urban runoff, creating habitat value, and offering temporary storage during high tide events when gravity drainage is restricted. The wetland systems can be designed with adjustable flow controls to structures that adapt to changing water levels over time. As mean sea levels rise and outfalls are increasingly submerged, these systems can transition into tidal wetlands, continuing to provide ecological value to Morro Bay.

Triggers and Thresholds: Critical thresholds for stormwater system modifications occur when high tide begins to impact outfall function, and when gravity drainage ceases to function effectively during typical tidal cycles.

5.2 Sea Level Rise Design Basis

Based on the Toro Creek Climate Resilience and Coastal Hazards Adaptation Study developed by Cal Poly (2025), the ESA team recommends designing the preferred alternatives to accommodate 4.5 feet of SLR. This recommendation aligns with the Coastal Design Criteria and Technical Adaptation Strategies and Designs outlined in the study (Cal Poly 2025).

The 4.5 ft SLR scenario was identified through collaborative discussions between Cal Poly, Caltrans, and project stakeholders, reflecting both technical analysis and practical implementation needs. It is consistent with the State of California Sea Level Rise Guidance (OPC 2024) and provides a balanced, risk-based framework that supports long-term planning while avoiding unnecessary investment in projections that may not occur within the infrastructure's design life. The 4.5 ft SLR design threshold provides protection across a range of SLR scenarios:

- **Intermediate Scenario:** Projected to occur in 2130, supporting infrastructure resilience under the most likely trajectory.
- **Intermediate-High Scenario:** Provides protection through approximately 2100, aligning with typical infrastructure planning and funding cycles.
- **High Scenario:** Maintains effectiveness through approximately 2085, offering substantial protection even under accelerated ice sheet loss.

Although the planning approach for this Project considers the most conservative scenario of 6 ft of SLR, the recommended 4.5 ft design standard offers a high degree of protection for transportation and recreational assets. This approach reflects a cautious and practical balance between long-term risk and implementation feasibility. It also provides flexibility to adjust as SLR projections evolve, allowing infrastructure investments to remain aligned with the best available science and observed trends.

In addition, with an adaptive trigger and threshold monitoring program, SLOCOG and other project partners could track observed SLR and refine long-term designs, such as the causeway, based on updated science and real-world conditions. If future observations indicate that SLR is following a more extreme pathway, there would still be time and flexibility to adjust the design of long-term measures to accommodate higher SLR projections.

5.3 Implementation Pathway

The adaptation pathway for the preferred alternatives is structured to allow for flexibility and responsiveness to future conditions. The pathway includes:

Near-Term Phase (2030-2045): focuses on immediate protection through fill elevation or levee construction where flooding currently threatens infrastructure. During this period, wetland construction for stormwater management could be integrated with transportation improvements. Establishing a monitoring program is also critical to allow SLOCOG and other project partners to track actual SLR rates, storm patterns, and infrastructure performance against established thresholds.

Mid-Term Phase (2045-2075): represents a critical evaluation and transition period as SLR approaches 2.0 to 3.0 feet. The performance of near-term measures will be assessed against actual conditions, and planning for long-term solutions will advance based on observed trends. This phase also marks a key transition point, where the shift from temporary to more permanent protection measures, such as causeways, may be initiated. These decisions will be guided by defined thresholds and informed by updated projections and site-specific monitoring. Once triggered, the process would move through planning, design, funding procurement, and implementation phases to support timely adaptation.

Long-Term Phase (2075 and beyond): implements permanent solutions including causeway construction. The specific elevation and extent of these improvements will reflect measurements obtained through the monitoring program of local observations, allowing for more efficient and effective infrastructure investments tailored to actual rather than projected conditions.

This phased approach acknowledges the uncertainty inherent in long-term climate projections while providing clear decision points for infrastructure transitions. It also supports a resilient and adaptive strategy that balances engineering feasibility, environmental stewardship, and cultural sensitivity, while also allowing for continued engagement with stakeholders and the community as conditions evolve. By establishing specific triggers and thresholds, along with a monitoring program, SLOCOG and other project partners can respond proactively to changing conditions while avoiding premature infrastructure investments.

6 Summary

Adaptation alternatives and potential adaptation pathways were evaluated based on engineering, environmental, regulatory, social, and economic considerations. The memo outlines near-term (2030-2045), mid-term (2045-2075), and long-term (2075+) adaptation measures and pathways, including raising roads, implementing wetland restoration, and enhancing mobility options. Informed by the Coastal Hazards Vulnerability Assessment Memorandum and based on input from stakeholders, the community and the advisory committee regarding potential adaptation measures, the ESA team identified five preferred adaptation alternatives that represent the most feasible conditions up to 6 ft of SLR. These preferred alternatives are presented in Table 7 below. Conceptual graphics presenting these preferred alternatives are included in Attachment A.

TABLE 7.
DESCRIPTION OF THE PREFERRED ALTERNATIVES FOR MORRO BAY ESTUARY

Preferred Alternative	Timeframe	Description
Levee Systems	Near to Mid-Term	Earthen barriers along vulnerable segments to provide immediate flood protection. The elevated structure could also serve as a multi-use path for bikes and pedestrians, enhancing mobility and recreational connectivity.
Fill Elevation	Near to Mid-Term	Raising road segments with engineered fill to avoid excavation and provide flood protection
Causeway Elevation	Long-Term	Elevated roadway allowing tidal exchange and wetland migration
Hybrid Fill + Causeway	Near to Long-Term	Phased approach starting with fill and transitioning to causeway based on observed SLR trends
Stormwater Management Integration	Near to Mid-Term	Constructed wetlands to treat runoff and store water during high tides

This document outlines the framework under which adaptation pathways have been developed for the Morro Bay Estuary Climate Transportation Plan. The memo emphasizes the importance of timely implementation of adaptation measures, informed by monitoring sea level rise and coastal hazards, and will help SLOCOG, project partners, and the community make informed decisions regarding next steps for coordination, monitoring, and action. In the next phases, the project team will conduct cost-benefit analysis of the preferred alternatives to inform the development of the final Plan. Following the benefit-cost analysis, the project will culminate in the Morro Bay Estuary Climate Transportation Plan. The goal is to create a resilient and adaptive infrastructure that can withstand future SLR impacts, supporting the sustainability of transportation, recreational, and natural assets in the Morro Bay Estuary.

7 References

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Attachment E.
Benefit Cost Analysis Memo

Cost-Benefit Analysis of Options for Sea Level Rise Adaptation

between Morro Bay and Los Osos, California

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Principal
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South Portland, Maine

1. Analysis Summary

			2 Lane Road + Bike Path on Fill	2 Lane Road + Bike Path on Fill With Retaining Wall	2 Lane Road + Bike Path on Causeway
Benefits	Without Waves	Windy Cove	$9,316,103	$9,316,103	$9,316,103
		Marina	$54,615,284	$54,615,284	$54,615,284
		South Bay Blvd	$552,686	$552,686	$552,686
		Total	$64,484,073	$64,484,073	$64,484,073
	With Waves	Windy Cove	$25,045,556	$25,045,556	$25,045,556
		Marina	$68,396,334	$68,396,334	$68,396,334
		South Bay Blvd	$2,951,610	$2,951,610	$2,951,610
		Total	$96,393,501	$96,393,501	$96,393,501
Costs			-$57,940,242	-$63,761,852	-$144,023,040
Net Benefits		Without Waves	$6,543,830	$722,221	-$79,538,967
		With Waves	$38,453,259	$32,631,649	-$47,629,539

Table 1 Summary of Results

Table 1 summarizes the benefit cost analysis of sea level rise adaptation measures in the Morro Bay-Los Osos region of San Luis Obispo County, California. The basic conclusions are:

- Under the assumptions and using the data available, as described below, the benefits of altering the road structures to accommodate expected sea level rise will exceed the costs for two of the three options. Elevation on fill or with a retaining wall pass a cost-benefit test, but it is a close result. Costs exceed benefits for a causeway elevation of the road.
- The take no action alternative is rejected. This conclusion is driven primarily by the benefits of retaining recreation opportunities in Morro Bay State Park.
- Additional benefits exist in maintaining the traffic along South Bay Boulevard, though these are not sufficient to justify the investments in adaptation on their own. This is due in large part because of the assumption that benefits do not start to accrue until the flood level for each stretch of road is reached. For South Bay Boulevard this is in 2073 based on the specified sea level forecasts.
- Benefits exceed costs with or without assumptions of wave run up, though the analysis including wave run up does yield significantly higher net benefits.
- The choice of discount rates affects the results and the determination of economically acceptable projects. For the base analysis, a discount rate of 1% is used on the basis of the long period over which benefits are measured. All project options fail the cost-benefit test if higher discount rates are used, meaning the outcome is sensitive to the assumptions used in the analysis.

The analysis described here is done in real (unadjusted for inflation) 2025 dollars. Adjustments for inflation, if done so as to use different rates of inflation for different cost and benefit components, will significantly complicate the calculation process. Present values are calculated at a discount rate of 3%. The results are **not** sensitive to the choice of discount rates.

2. Cost-Benefit Analysis Overview

Cost-benefit analysis is a way of comparing values gained and lost because of a proposed decision. In the private sector, the values of capital and operating expenditures are compared with the revenues to be gained from sales of goods and services. Sales are not a measure for public sector investors so alternate measures of value are chosen. In the present case, expenditures to alter the roads in Morro Bay to minimize the effects of sea level rise are compared with the values of recreation and transportation offered by the public infrastructure. The assignment of the terms “costs” and “benefits” is a function of the question being asked. The first question with respect to Morro Bay before any choice of adaptation strategy is made is “what are the consequences of taking no action”. It may be that the effects of sea level rise are not serious enough to warrant major expenses. The basic analysis discussed here is the consequences of the no action alternative. The effects on recreational users and travelers are costs and expenditures that might be made are benefits. They are benefits in the sense that the funds saved could be put to another purpose.

Once the no action alternative consequences are measured, the question can then be turned around: What will be the values gained (or losses avoided) if a decision is made to invest in road alterations to deal with sea level rise? In this case, the costs and benefits of the no action alternative are reversed. The result is what is shown in **Table 1**.

In other words, in the no action alternative, the costs to travelers and park users are larger than the benefits of not spending $54 million and $134 million. Taking action will be economically superior to taking no action. The question then becomes which of the three options being evaluated should be selected. The standard answer to the question is to pick the option with the largest net benefits, which in this case is the roadway elevated on fill.

3. Background Conditions

The extent of sea level rise specified for this study are 1.8 feet by 2060 and 6.3 feet by 2100 (**Table 2**). However, it is not possible to conduct an analysis with just two data points since the fundamental assumption in a cost-benefit study of an infrastructure investment is that expenditures up front will be repaid with a flow of future benefits. To appropriately structure the analysis, annual data must be used.

Without Wave Runup					
Location			Sea Level Rise		
			0 ft	1.8 ft	6.3 ft

	Road Elevation (ft NAVD)	Flooding Threshold (ft NAVD)	Avg Hrs. Closed per Year	Avg Hrs. Closed per Year	Avg Hrs. Closed per Year
State Park Road – Windy Cove	7.25	7.75	0.0	92.5	6589.3
State Park Road – Morro Bay State Park Marina to S Bay Blvd	7.5	8	0.0	46.5	6280.3
S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge	10	10.5	0.0	0.0	1505.2

With Wave Runup					
	Road Elevation	Flooding Threshold (ft NAVD)	Sea Level Rise		
			0 ft	1.8 ft	6.3 ft
			Avg Hrs. Closed per Year	Avg Hrs. Closed per Year	Avg Hrs. Closed per Year
State Park Road – Windy Cove	7.25	7.75	0.4	441.9	7656.5
State Park Road – Morro Bay State Park Marina to S Bay Blvd	7.5	8	0.1	283.9	7428.5
S Bay Blvd – Chorro Creek Bridge to Los Osos Creek Bridge	10	10.5	0.0	2.6	6419.6

Table 2 Sea Level Rise and Effects Assumptions

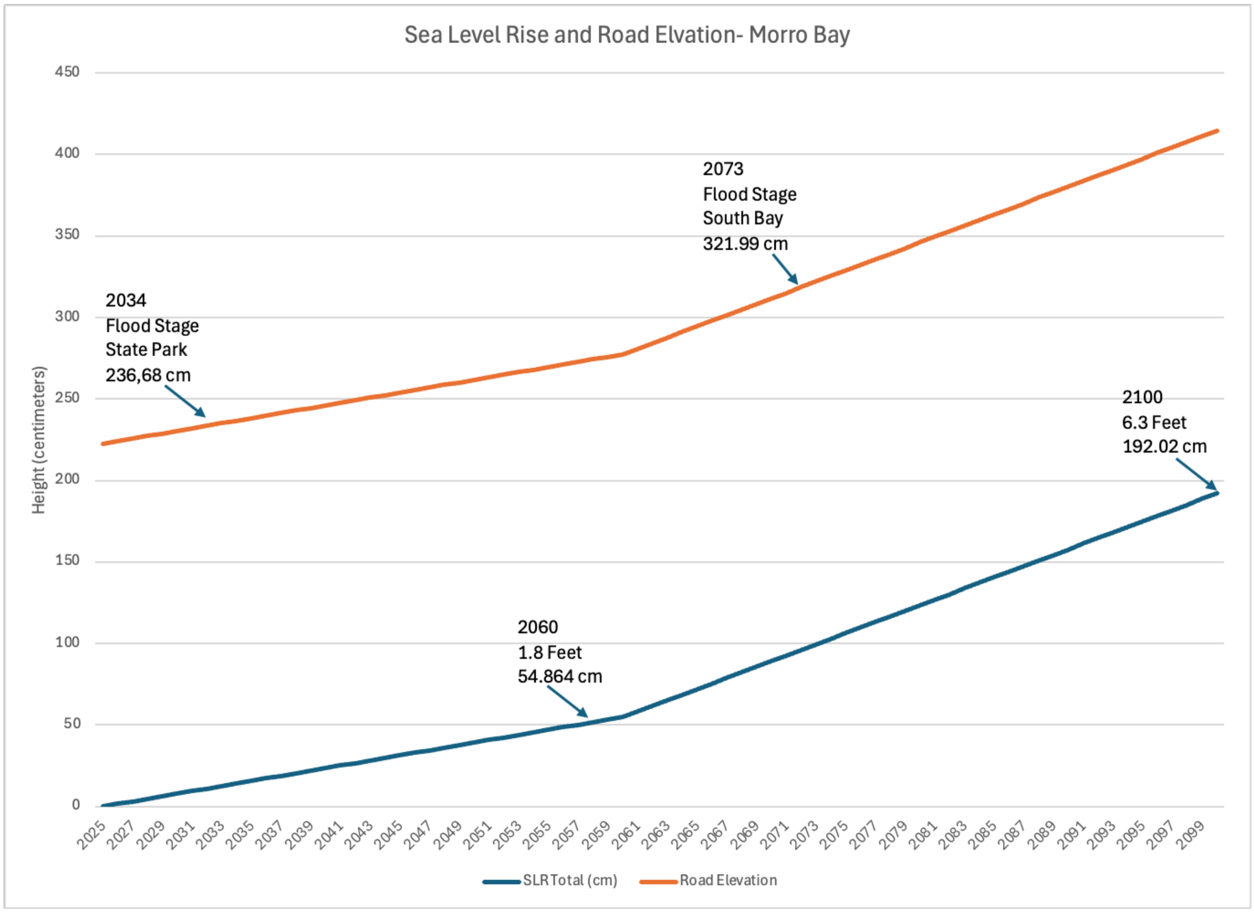


Figure 1 Sea Level Rise and Road Flood Exposure

The annual data are calculated as the simple interpolation of constraint change between 2025 and 2060 and then between 2060 and 2100. **Figure 1** shows the interpolated estimates for sea level rise and for the height of the road above NAVD from 2025 to 2100. The specified sea levels are shown in the bottom line, and the road height and specified flood levels and timing are shown in the upper line. The specified flood levels are assumed to be the year in which the benefits of investment in the road begin.

For purposes of the analysis, the area of concern is subdivided into three zones: Windy Cove; the area around the marina; and together comprise the State Park subsection. The area along South Bay Boulevard comprises the third (**Figure 2).**

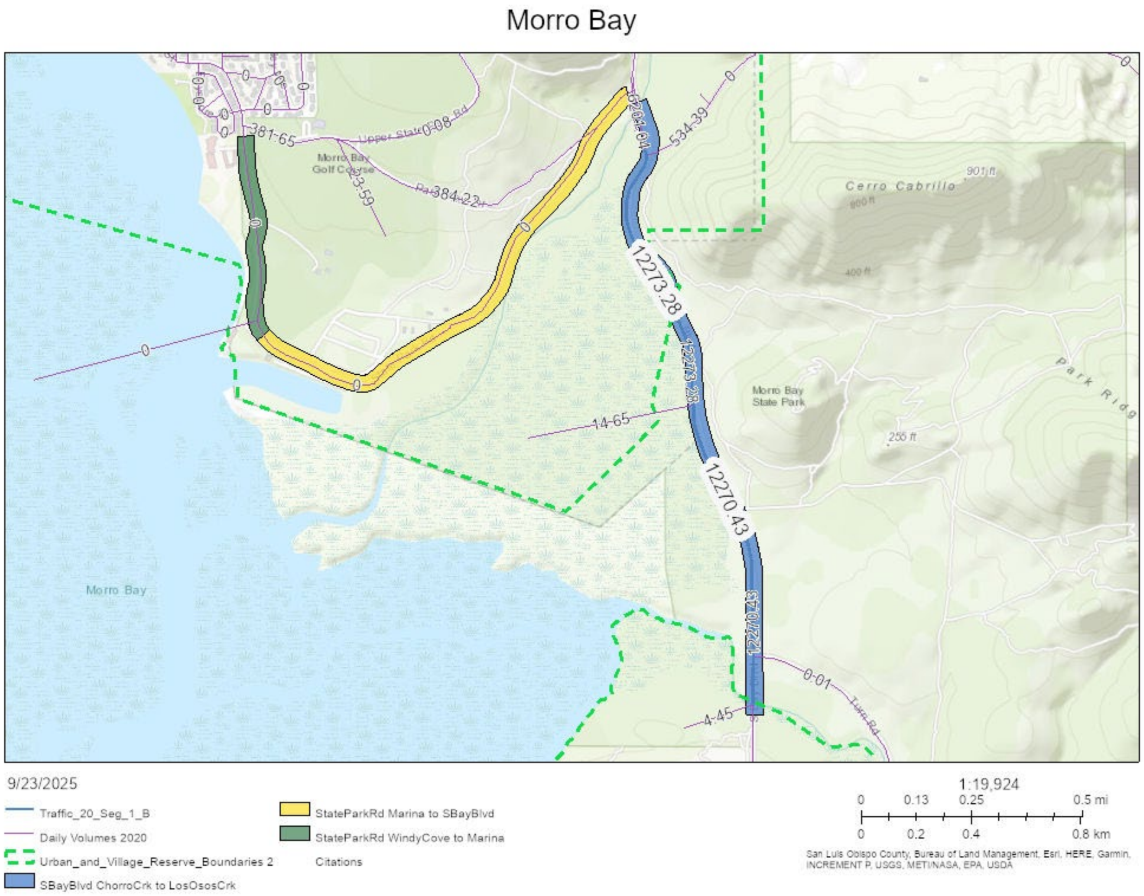


Figure 2 Study Area Subsections

Windy Cove is shown outlined in green; The Marina section is in yellow, while the South Bay Boulevard section is in blue. The traffic counts estimated by the San Luis Obispo Council of Governments transportation model are also shown. The South Bay Boulevard section has a traffic count of about 12,170 vehicles per day (both directions). The traffic count for the State Park segments is shown as zero because the State Park is excluded from the transportation model. For purposes of this analysis, the absence of traffic data requires relying on another source of benefits, as discussed in the next section.

4. No Action Costs- State Park Section

Table 3 provides a summary of the costs of no action estimated for the State Park section and the two subsections at Windy Cove and the marina. The estimates are presented with and without waves and assuming planning horizons to 2060 and to 2100. The costs in this section of the study are the losses in the value of recreation in the state park. Visitor use data from the Monterey Bay Natural Estuary Program are combined with the estimated values to visitors at various locations around coastal California. No direct measurement of recreation values at Morro Bay is available.

		Present Value to 2060		Present Value to 2100	
		Without Waves	With Waves	Without Waves	With Waves
State Park	Windy Cove	$95,244	$486,925	$9,316,103	$25,045,556
	Marina	$301,513	$920,750	$54,615,284	$68,396,334
	Total	$396,757	$1,407,675	$63,931,387	$93,441,891

Table 3 Summary of No Action Costs - State Park Section

Table 4 shows the data used to calculate the gross costs. The value per person per day is taken from studies of recreational values in the U.S. compiled by Rosenberger (2016). From this master list of over 3,000 studies, over 100 studies were selected of California recreation values. The preponderance of these studies were conducted of the marine sanctuaries in California. The database was updated to 2016 dollars and then further adjusted to 2025 dollars, which are shown in Table 4 as the value per person per day.

The columns labeled Windy Cove and State Park Marina show the daily use of each park area provided by the Morro Bay National Estuary Program (MBNEP). These are broken down by principal activity reported in a survey conducted by MBNEP. The use categories and values data bases did not match exactly so several more detailed categories in the data were grouped as “relaxing on the coastline” for purposes of calculating values.

Total value per day equals the value per person per day times the number of respondents. The Windy Cove distribution shows weights for each activity based on the number of respondents. These weights are then used to calculate a composite value per day. The value is $61.81 per person per day for Windy Cove and $72.22 per person per day for the State Park Marina.

	Value Per Person Per Day	Windy Cove	Total Value Per Day	Windy Cove Distribution	Weighted Values Per Day
Relaxing on coastline	$65.69	22	$1,035	25%	$16.49
Kayak/SUP/Rowing	$150.77	4	$475	5%	$7.57
Walking or playing with pet(s)	$65.69	13	$662	15%	$9.63
Sitting in car	$65.69	10	$455	11%	$7.25
Fishing	$203.99	0	$0	0%	$0.00
Boating	$55.74	0	$0	0%	$0.00
Walking/Running/Exercise	$41.93	33	$977	37%	$15.57
Other	$65.69	6	$290	7%	$4.62
TOTAL		89	$3,894	100%	$61.14

	Value Per Person Per Day	State Park Marina	Total Value Per Day	State Park Distribution	Weighted Values Per Day
Relaxing on coastline	$65.69	31	$1,982	7%	$4.60
Kayak/SUP/Rowing	$150.77	85	$12,346	19%	$28.65
Walking or playing with pet(s)	$65.69	62	$3,964	14%	$9.20
Sitting in car	$65.69	31	$1,982	7%	$4.60
Fishing	$203.99	4	$879	1%	$2.04
Boating	$55.74	36	$1,922	8%	$4.46
Walking/Running/Exercise	$41.93	191	$7,770	43%	$18.03
Other	$65.69	4	$283	1%	$0.66
TOTAL		445	$31,129	100%	$72.22

Table 4 Recreation Value Calculation

To estimate the costs each year, the sea level rise estimates from Figure 1 are matched to a linearly interpolated time effect based on the number of hours specified in Table 2. The interpolation begins in the year in which flooding is projected to occur and continue to 2060 and is then re-estimated to 2100. The number of hours projected for a given year is then taken as a proportion of hours in the year and divided by two to reflect the fact that recreational activity in the park is unlikely to take place over 24 hours. This yields the proportion of time with flooding and, it is assumed, eliminated recreation. The proportion of flood time is then multiplied by the number of people in that section of the park.

The estimated population multiplied by the value per day provides the total recreation value per day. The population of recreationists is increased each year at a rate consistent with population growth in San Luis Obispo county. This growth rate was provided by the SLO Council of Governments. The total recreation value is then reduced by the SLR flooding hours as a percent to derive the annual loss in recreation. The percentage loss increases with sea level rise and the number of hours each year in which flooding occurs.

Figure 3 and **Figure 4** illustrate the results of the calculations for Windy Cove using the without wave runup assumption. Figure 3 shows the relationship between sea level rise and hours closed at Windy Cove. Figure 4 shows the growth in users at Windy Cove and the annual change in value lost due to flooding. The present value of the lost value in Figure 4 is reported in Table 3.

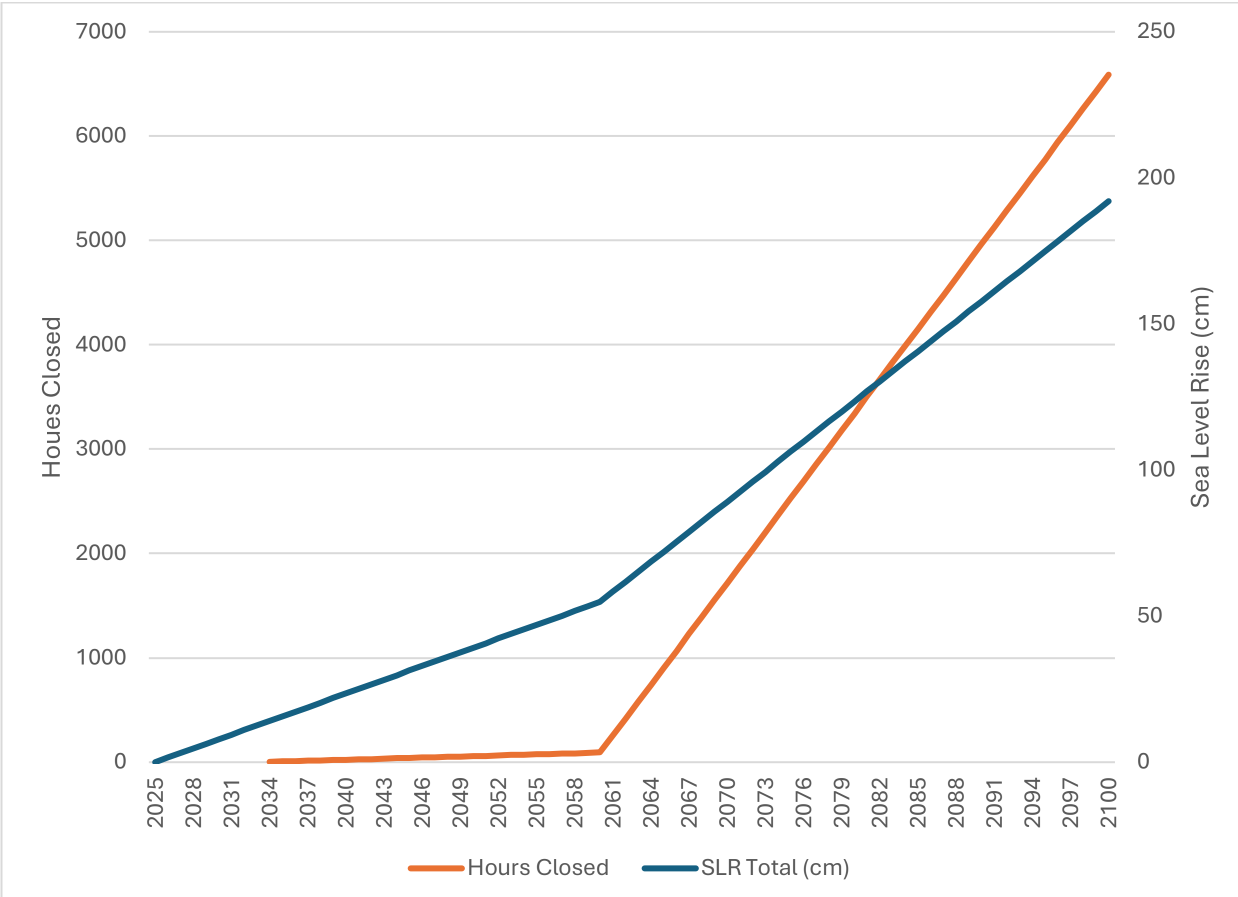


Figure 3 Sea Level Rise and Hours Closed at Windy Cove

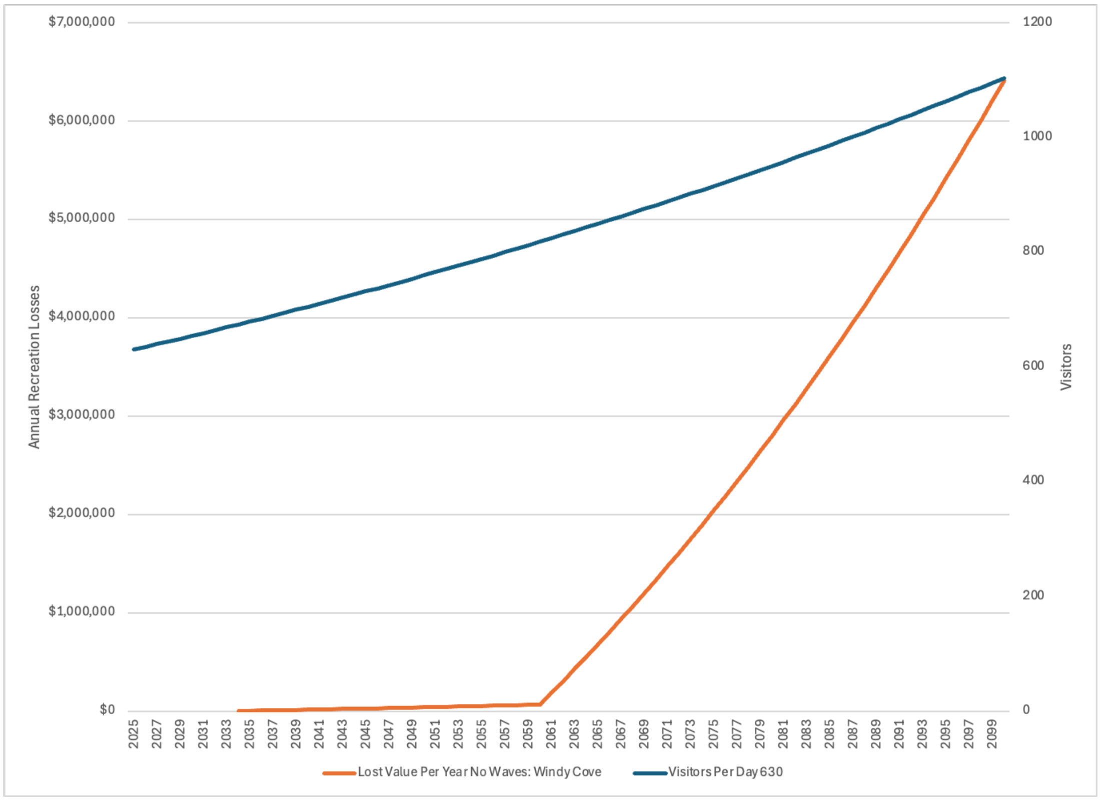


Figure 4 Number of Visitors and Lost Value at Windy Cove

5. Economic Change in the South Bay Boulevard Section

The methodology for assessing the economic effects of highway construction or modification is well established and is described in a framework published by the Federal Highway Administration (White, 2016). The framework defines the economic values affected by highways as consisting of the value of time for users and vehicle operating costs. A cost-benefit analysis should identify changes in the value of time and in vehicle operating costs. Increases in the time spent travelling and in vehicle miles traveled are counted as costs. Costs are the result of increases in time and distance. In this case, the value of time and operating costs can be expected to increase significantly if flooding eliminates travel on South Bay Boulevard. Taking action to avoid these increases in costs creates benefits as avoided costs.

Table 5 summarizes the present value of no action costs for the South Bay Boulevard section of the study area. Before discussing these results, the method of calculation requires explanation. South Bay Boulevard is a highly vulnerable road partly because of the length of roadway that could be flooded and partly because it is the only road connecting Morro Bay and Los Osos over a short distance. If it is no longer passable due to flooding, there are no quick alternative routes between the two commnities without a significant detour because of the topography and placement of roads.

			Change in Time of Travel Valued At:	
South Bay Blvd			Without Waves	With Waves
	Present Value in 2030-2060	SLO County Wage	$6,654	$393,937
		California Wage	$92,308	$394,551
		Change in Vehicle Operating Costs	$243,848	$1,042,279
		Total Change @SLO	$250,502	$1,436,216
		Total Change@ CA	$336,156	$1,436,830
	Present Value in 2073-2100	SLO County Wage	$10,727	$635,115
		California Wage	$148,821	$636,105
		Change in Vehicle Operating Costs	$393,138	$1,680,390
		Total Change @SLO	$403,865	$2,315,505
		Total Change@ CA	$552,686	$2,951,610

Table 5 Costs of Flooding Disruptions on South Bay Boulevard

Figure 5 shows the current route and the alternative route selected for analysis. The flood-risked portion of South Bay Boulevard is shown in blue. If South Bay Boulevard is not in service, then the connection between the two communities must take place using Highway 1. This detour is shown in green. For this analysis, the intersection of Market Street and Morro Bay Boulevard was chosen as a centroid for Morro Bay. The corresponding centroid for Los Osos is at 4th street and Santa Maria Avenue.

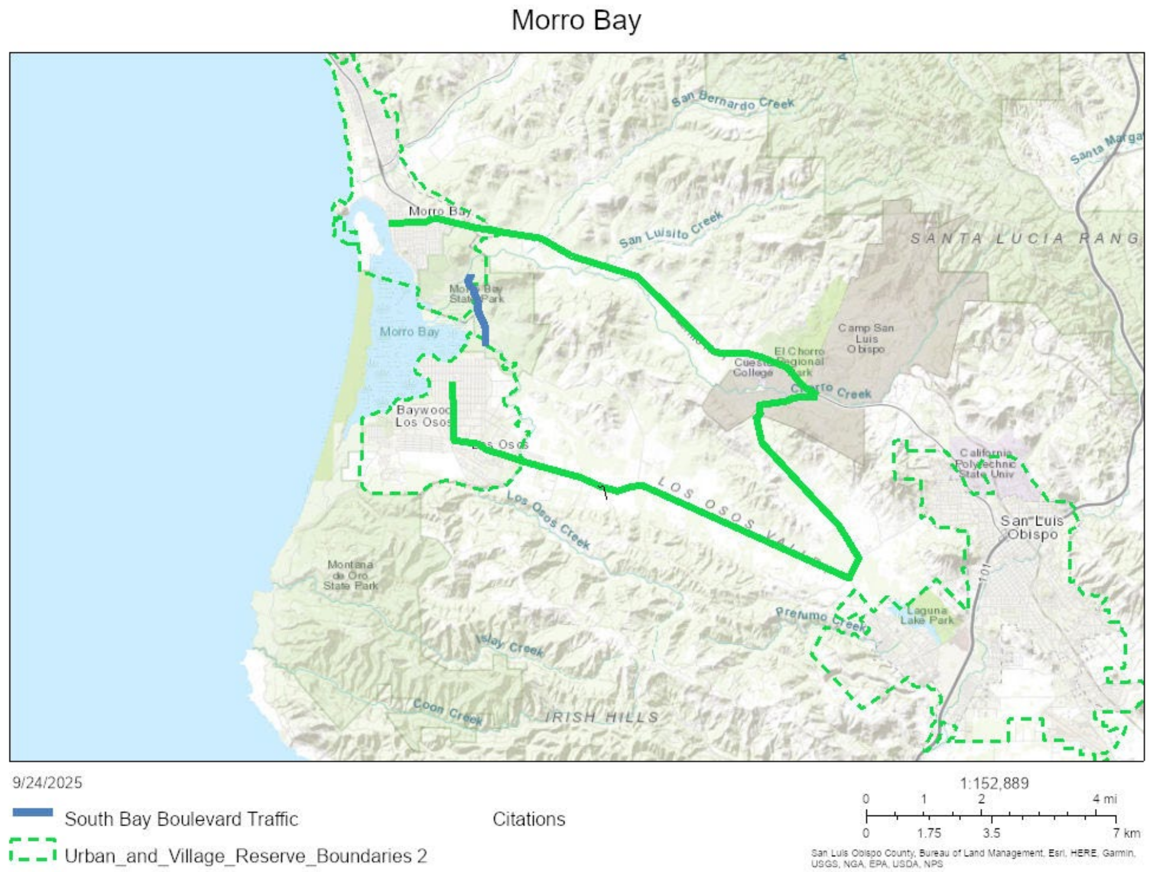


Figure 5 Direct and Indirect Road Connections Morro Bay and Los Osos.

The costs for South Bay Boulevard are the increases in time and vehicle operation from having to take the longer route if South Bay is flooded. For this analysis the calculations are set out in **Table 6** and **Table 7**. Table 6 shows the costs and covers the calculations for South Bay Boulevard assuming no flooding. Table 7 shows the calculation for the alternate route. Each table is divided into four sections for ease of explanation.

1			Avg Weekly Wage	Average Hourly	50% Average
		CA Avg Wage	$1,773.00	$50.66	$25.33
		SLO County Avg Wage	$1,179.00	$33.69	$16.84
2	Miles	Time (in minutes at 30 mph)	Hours Employee-related travel	Employee-related travel Costs	Non Emp -N
	4.6	9.2	467	$23,632	1,400
	4.6	9.2	467	$15,715	1,400
3		Employment %	Other %	Daily Traffic	Person Hours
	CA Avg Wage	25%	75%	12,170	1,866
	SLO County Avg Wage	25%	75%	12,170	1,866
4		Non Emp $	Total Value	Total Vehicle Miles	Total Vehicle Cost
	CA Avg Wage	$35,449	$59,081	55,982	45,905
	SLO County Avg Wage	$23,572	$39,287	55,982	45,905

Table 6 Unobstructed South Bay Boulevard

1		Urban Miles	Urban Minutes	Highway Miles	Highway Minutes	Total Miles	Total Minutes
		4.6	9.2	19.1	21	23.7	25.6
		4.6	9.2	19.1	21	23.7	25.6
2		Avg Weekly Wage	Average Hourly	50% Average	Employment %	Other %	Daily Traffic
	CA Avg Wage	$1,773.00	$50.66	$25.33	25%	75%	12,170
	SLO County Avg Wage	$1,179.00	$33.69	$16.84	25%	75%	12,170
3	Person Hours	Hours Employee-related travel	Employee-related travel Costs	Occupancy	Non Emp -N	Non Emp $	Total Cost
	4,807	1,502	$95,124	1.25	2,929	$74,196	$169,320
	4,807	1,202	$50,604	1.25	3,605	$60,725	$111,328
4	Net Change in Cost of Time	Total Vehicle Miles	Total Vehicle Cost	Vehicle Operating Change	Total Value Change		
	$110,239	288,429	236,512	$190,607	$300,846		
	$72,041	288,429	236,512	$190,607	$262,648		

Table 7 Alternate Route to Santa Bay Boulevard

The FEMA standard for estimating the value of travel time is based on the average wage for a given region. The FEMA standard is to use the U.S. average wage, but the Morro Bay area, particularly the State Park and South Bay Boulevard road segments are more appropriately viewed as local or regional segments. For this analysis, the average wage for San Luis Obispo County and California are both tested as shown in Table 6, Row 1. The average hourly wage is calculated at the weekly wage divided by 35 (the length of a full-time work week). The value of time is assigned at the full hourly wage. All other uses are assigned a value at less than the full wage. The value is generally 50% for general travel and 30% for leisure travel. However, trip purpose data were not available and 50% was used.

In Table 6, Row 2 sets out the distance and time elements. The current route over South Bay Boulevard is 4.6 miles between Morro Bay and Los Osos (assuming the centroids defined above). Travel time is estimated at 30 miles per hour for a trip time of 9.2 minutes. The assumption shown in Row 3 is that 25% of travel is employment-related. The number of person hours of travel as the total vehicles (12,170 from the SLOCOG travel model) times 9.2 minutes. This assumes single occupancy vehicles because no more detailed information is available. The number of employee-related trips is estimated at 467, and non-employment as 1,400. The results for travel related value of time ranges from $15,715 at the San Luis Obispo average wage and $23,632 at the California average wage.

In Table 6, Row 4 shows the non-employment values, the total value (sum of employment and non-employment related values of time). The total vehicle miles (4.6 times 12,170) are calculated. The operating cost is estimated at $0.82 per mile, the standard vehicle operating value for the IRS. This is the standard value used.

Table 7 shows the calculations for the alternate route plus the change between the alternative and the present route. The calculations are essentially the same as in Table 6, with two exceptions. First, the route is now extended to 23.7 miles from Morro Bay to Lake Osos. This route is subdivided into an urban portion within each community and a highway portion along Highway 1. Travel is assumed at 30 mph in the urban section and 60 mph on the highway section. With these adjustments, total time, distance, and values are constructed assuming the same level of total vehicles.

In Table 7, Row 4 shows the total changes in value of time and operating costs calculated using both the San Luis Obispo County and California. These are used to calculate the present value of costs. However, there is an important issue in the calculation of the present values for the South Bay Boulevard portion of the analysis. The flood stage for South Bay Boulevard is projected at 10.5 feet (see Table 2). This water level is not projected to occur until 2073 using the interpolated estimates. This places the start of costs from maintaining access to South Bay Boulevard nearly 50 years in the future. At that distance in time the discounting process reduces the economic effects substantially, which is why in the final summary the South Bay Boulevard costs are shown as small relative to the recreation benefits, which are estimated to begin in 2034. The reason is that for this analysis, costs and benefits are assumed to occur in the same time period. That is adaptation projects are built to become effective approximately a decade from now and benefits begin immediately for the State Park area but are delayed substantially for South Bay Boulevard. The costs to users of the State Park area will likely be sufficient to justify the investments in adaptation if they can be avoided.

An alternative analysis could delay construction of the South Bay Boulevard section until the 2060s in anticipation of hitting flood stage in 2073. This would allow a more realistic comparison of costs and benefits. But in this case a separate South Bay project cost would be needed, and it is likely that calculation of benefits would have to extend beyond 2100, which is the end of the current planning horizon.

A note should be made about the benefits of a proposed bicycle path, which is included in the planning of all versions of the adaptation project. A bicycle path will undoubtedly increase the benefits from an adaptation project. But it cannot be determined at this time how much that increase will be because it is unknown how many people will use the bike path. There are undoubtedly people who currently travel along South Bay Boulevard by bike, but the road in the vulnerable area has a narrow shoulder and currently is likely used only by experienced cyclists. A bike path, particularly one with some form of protection from the road would be used by a much wider range of cycling skill level and of ages.

5. Adaptation Construction Costs

Table 8 shows the construction expenditure calculations.[1] In the no action alternative, these projects are not undertaken and the funds that would have been allocated to them can be repurposed to generate benefits elsewhere. Three projects are evaluated. All three consist of maintaining a two-lane road and adding a bike path. The differences lie in how the road/path will be protected against sea level rise. The least expensive option would simply raise the road on fill. The second option would add a retaining wall to protect the roadways from flooding. The third would elevate the roadway onto a causeway. This would be the most expensive option owing to the costs of drilling and constructing piles on which the road would be set.

	2 Lane Road + Bike Path on Fill	2 Lane Road + Bike Path on Fill With Retaining Wall	2 Lane Road + Bike Path on Causeway
Expenditure Per Mile	$150,000	$170,000	$225,000
	$10,560,000	$11,616,000	$26,400,000
Total Expenditure for 5.6 Miles	$840,000	$952,000	$1,260,000
	$59,136,000	$65,049,600	$147,840,000
Nominal			
2030	$420,000	$476,000	$630,000
2031	$420,000	$476,000	$630,000
2032	$29,568,000	$32,524,800	$73,920,000
2033	$29,568,000	$32,524,800	$73,920,000
Discounted			
2030	$407,767	$462,136	$611,650
2031	$395,890	$448,676	$593,835
2032	$27,058,909	$29,764,799	$67,647,271
2033	$26,270,785	$28,897,864	$65,676,963
Present Value of Expenditure at 2030	$54,133,351	$59,573,475	$134,529,720

[1] For planning purposes, we have provided order of magnitude (Class 5) estimates to allow cost comparison of alternatives. These cost estimates are intended to provide an approximation of total project costs appropriate for the conceptual level of design. The opinion of probable construction costs for these alternatives are approximately -50% to +100% accurate and include a 50% contingency to account for project uncertainties (such as final design, permitting restrictions and bidding climate). These estimates are subject to refinement and revisions as the design is developed in future stages of the project. Please note that in providing opinions of probable construction costs, ESA has no control over the actual costs at the time of construction. The actual cost of construction may be impacted by the availability of construction equipment and crews and fluctuation of supply prices at the time the work is bid. ESA makes no warranty, expressed or implied, as to the accuracy of such opinions as compared to bids or actual costs.

Table 8 Adaptation Project Expenditure Calculations

For each project, the cost per mile is given and an assumption of 5.6 miles of road will be constructed. For purposes of the analysis, the project is broken into a two-year planning and permitting phase and a two-year construction phase for four total years of direct project expenditures. These periods may be extended, but so long as the extension does not increase the real expenditure significantly there should be no effect on the underlying conclusion about benefits relative to costs.

6. Summary of the No Action Alternative

			2 Lane Road + Bike Path on Fill	2 Lane Road + Bike Path on Fill With Retaining Wall	2 Lane Road + Bike Path on Causeway
Costs	Without Waves	Windy Cove	-$9,316,103	-$9,316,103	-$9,316,103
		Marina	-$54,615,284	-$54,615,284	-$54,615,284
		South Bay Blvd	-$552,686	-$552,686	-$552,686
		Total	-$64,484,073	-$64,484,073	-$64,484,073
	With Waves	Windy Cove	-$25,045,556	-$25,045,556	-$25,045,556
		Marina	-$68,396,334	-$68,396,334	-$68,396,334
		South Bay Blvd	-$2,951,610	-$2,951,610	-$2,951,610
		Total	-$96,393,501	-$96,393,501	-$96,393,501
Benefits			$57,940,242	$63,761,852	$144,023,040
Net Benefits		Tidal inundation (Without Waves)	-$6,543,830	-$722,221	$79,538,967
		Storm inundation (With Waves)	-$38,453,259	-$32,631,649	$47,629,539

Table 9 Costs and Benefits of the No Action Alternative

Table 9 summarizes the costs of taking no action to deal with sea level rise in Morro Bay and the benefits in the form of saved expenditures. It shows that taking no action results in significant net economic losses. Table 9 is the inverse of Table 1. That is, the no action alternative's costs become the benefits of choosing one of the adaptation options and the expenditures not made in the no action alternative and so benefits become the costs in the 'take action' case.

7. Discount Rate Discussion

The analysis shown in Table 1 uses a discount rate of 1%. In general, the expectation is that higher discount rates will be used for project evaluation. The U.S. Office of Management and Budget annually publishes discount rates to be used in evaluating Federal projects. For 2025, the maximum project evaluation period is 30 years, for which a real (unadjusted for inflation) discount rate of 2.3% is to be used.

The use of a 1% discount rate is justified by the long period of evaluation. High discount rates mean that benefits received decades hence are reduced to the point where they make little contribution to the results. However, the choice of discount rates is always a matter of judgment. A useful test is to calculate the internal rate of return, which is the discount rate at which the net present value of benefits exactly equals the present value of costs (the net present value equals zero).

Table 10 shows the estimated internal rates of return (IRR) for the options elevating the road on fill and on retaining wall. The option for elevation on a causeway fails the cost benefit test at any discount rate. The internal rate of return is assessed by comparing it to the discount rate. Dividing the analysis between with and without waves shoes that the highest IRR is for the road on fill including the effects of waves. This is closest to the federal standard and, when adjusted for the additional length of evaluation (out to 2100), it reinforces that this option has the best economic case.

Nonetheless, the discount rate analysis indicates that any of the projects are close between economic and noneconomic. Estimates that can reduce costs or expand benefits would solidify the positive evaluation of the fill and retaining wall options.

	2 Lane Road + Bike Path on Fill	2 Lane Road + Bike Path on Fill With Retaining Wall	2 Lane Road + Bike Path on Causeway
W/O Waves	1.188%	1.020%	
W/ Waves	1.9365%	1.757%	

Table 10 Internal Rates of Return

Attachment F.
Public Outreach Input

Morro Bay Estuary Climate Resiliency Transportation Plan

Community Workshop Input

A Community Workshop for the Morro Bay Estuary Climate Resiliency Transportation Plan was held December 3rd, 2024, to exploring sea level rise vulnerability and adaptation options for transportation infrastructure between Morro Bay and Los Osos. Input was gathered on the future of South Bay Boulevard with a focus on new bike path and trail improvements. Approximately 100 community members were in attendance. The workshop included an introductory presentation followed by exercises at Mobility and Flooding Adaptation information and feedback stations where participants engaged in discussions with workshop facilitators and provided input by writing comments on boards, sticky notes, and project area maps. Comment sheets were also distributed to participants. Feedback received from workshop participants is included below.

Workshop photos

Workshop Feedback, organized by theme

Flooding Adaptation options

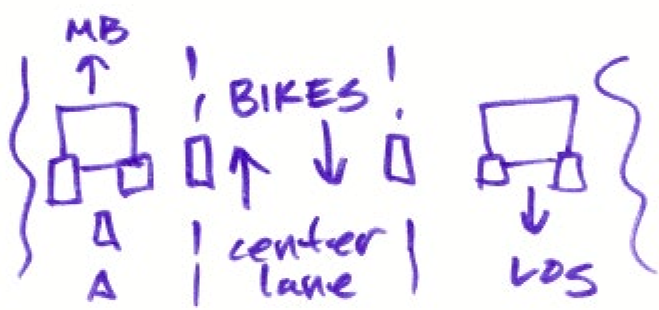
- California Coastal Commission (CCC) says to retreat yet this project is widening South Bay in its current location
- Causeway this half century
- I am concerned about the model you're using for climate rise. There are many different models
- People go under to avoid unsafe but can't pass after rain
- Bike lane narrows because of erosion after most recent storms, there is very little bike lane because the shoulder was rebuilt with gravel
- Support for elevating Quintana Road – would serve as a flood control levee
- Keep in mind that the aquifer is shallow and adaptation options should not inadvertently cause saltwater intrusion; in other words, consider whether adaptation options should affect the aquifer
- Request to analyze the cost of no action, i.e., maintenance and emergency actions
- Note that hillside runoff sheets across South Bay Blvd
- Many concerns regarding Chorro Creek and the wetland restoration project that was conducted by Resource Conservation District (RCD) 15-20 years ago and the related flooding issues for residents near the creek
- Larger scale topographic map would help visualize sea level rise

Mobility, i.e., Bike, and Pedestrian improvement options

- State Park Roads
    - Couplet at State Park is a good idea. During Covid when it was shut down it was great!
    - One-way couplets on State Park roads would allow unused side of road to be Class IV path
    - Convert State Park Rd to one way and put a protected bike lane.
    - State Park Road should just be a pedestrian/bike trail
    - No room for bikes on Lower State Park Road, the one closer to the water, barely enough room even in a car
    - Bushes block bike lane on State Park Road
    - More "sharrows" painted throughout streets. Needed as soon as possible on State Park Road
    - Would be nice to walk from Quarry Trail trailhead to trailheads on Lower State Park Road
    - Turtle Rock Trail trailhead to Lower State Pak Road is dangerous for cars and bikes because of bushes and wet

- South Bay Blvd and State Park Road Intersection
    - Death trap at Lower State Park Road and South Bay Boulevard intersection area
    - Intersection of South Bay Blvd and State Park Road is dangerous. The vegetation along South Bay Blvd and State Park Road regularly blocks the bike lane completely.
    - Blind spot for vehicles at Lower State Park Road and South Bay Boulevard intersection area, dangerous intersection

- South Bay Blvd
    - Create a Class I path west of South Bay Blvd that floats and is anchored with chain and anchor every 20 feet. Two or more bridges would be needed over Chorro Creek and Los Osos Creek
    - Class I or Class IV – bike path is needed on South Bay Blvd, needs positive protection from traffic
        - Look at narrow ones
        - Class II lane doesn't go far enough for protection
    - Instead of bike lanes on right and left sides (like it is currently), consider a two-way bike lane in the center of South Bay Blvd. With vertical barriers that separates bike usage and cars. Washington D.C. does it this way.



    - I like the idea of combining pipeline project with ped/bike path. Why not do it on East side of South Bay Blvd
    - Bike path on east side of South Bay Boulevard from Santa Ysabel to Turri
    - How about we use hillside of South Bay Blvd. Use a existing trail decomposed granite if put a raised bike/ped bridge down South Bay Blvd to Morro Bay State Park. At park entrance.
    - Have South Bay Blvd elevated just before Turri Rd (going North) and end just past Turri Road. This will allow the underpass for bikes to cross safely with the bike/ped lane on westside of South Bay Blvd.
    - Is there short term (like now) temporary protections that can put into place to improve bike safety? Especially on the "curves" between Quintana and the State Park Road?
        - Called a Class II but some of it is less than 2 ft of a bike lane.
    - Currently tree branch at bridge is a bike hazard – frequent trimming needed
    - My major concern is safe biking on South Bay Boulevard and State Park Roads
    - Dangerous and blind curves on South Bay Boulevard
    - Pedestrian crossing very difficult at South Bay Boulevard and Turri Road
    - No room for any biker mishap on South Bay Boulevard. I fell off my bike when I reached to adjust my shock, and over-corrected. Flew into middle of lane because no room. I am so lucky to be alive.
    - Bridge or trail connection over South Bay Boulevard adjacent to South Bay Trail
    - Decomposed granite path off roadway east of South Bay Boulevard from Park Ridge Trail to Quarry Trail
    - Windy and unsafe at South Bay Boulevard South Bay Bridge
    - New bridge at South Bay Boulevard South Bay Bridge
    - Too narrow at South Bay Boulevard South Bay Bridge

- Too steep, should be wider at South Bay Boulevard South of South Bay Bridge
- Bike lane narrows because of erosion after most recent storms, there is very little bike lane because the shoulder was rebuilt with gravel
- Turri to State Park Rd cut into lower quarry trail and area bridge over South Bay Blvd twin

- Quintana Road
  - Quintana and South Bay Blvd is a dangerous intersection: suggest creating a roundabout at this intersection like the one in MB
  - Quintana Road going west is uphill, fast cars are not best for biking
  - Storm drain barriers and eucalyptus tree debris push bikers into car lanes on South Bay Boulevard from Quintana Road to Lower State Park Road
- Turri Road
  - A left turn lane is needed at Turri Road coming south (from Morro Bay to Los Osos)
  - Does the bike lane improvements on Turri Road go all the way to LOVR? It should as Turri Road is heavily traveled by bicyclists
  - Turri Bridge connecting Chumash Trail to trails at the end of Santa Ysabel Ave
  - Turri wildlife/bike overpass to west side of South Bay Boulevard
  - Elevation at Chumash Trail is too great for coast trail. Better at road level or with boardwalk
- Speed Limits
  - I think the speed limit on South Bay Blvd needs to be reduced. Separate bike lane all along South Bay Blvd necessary; there's only two ways out of Los Osos – both South Bay Blvd & Los Osos Valley Road (LOVR) are dangerous for bikes.
  - Does South Bay Blvd need to have 50 mph speed limit?
  - Reduce speed limit to 40 on all South Bay Blvd
  - Support for reducing the speed limit on South Bay Blvd to 35mph and lowering the speed limit on Quintana Road
  - Slower speed limit on South Bay Boulevard
  - Slow down! 35 MPH speed limit
  - If speed can't be lowered, a barrier is needed to separate bikes and pedestrians from vehicles
- Causeway
  - Causeway design needs to also accommodate bikes and pedestrians because our old road won't always be accessible
  - I love the idea of a totally separate bike and pedestrian path from the road (like road on causeway or dedicated bridge from Baywood to State Park!)
  - If doing a causeway, consider homeless encampments and safety for all
- Other mobility improvement ideas
  - Floating bike path if it is feasible
  - How about a floating bike/pedestrian path?
  - Class I west of South Bay Blvd. Floating, anchor with chain, bridges over Chorro and Los Osos Creeks
  - Floating Class I Bike Lane west of South Bay Boulevard

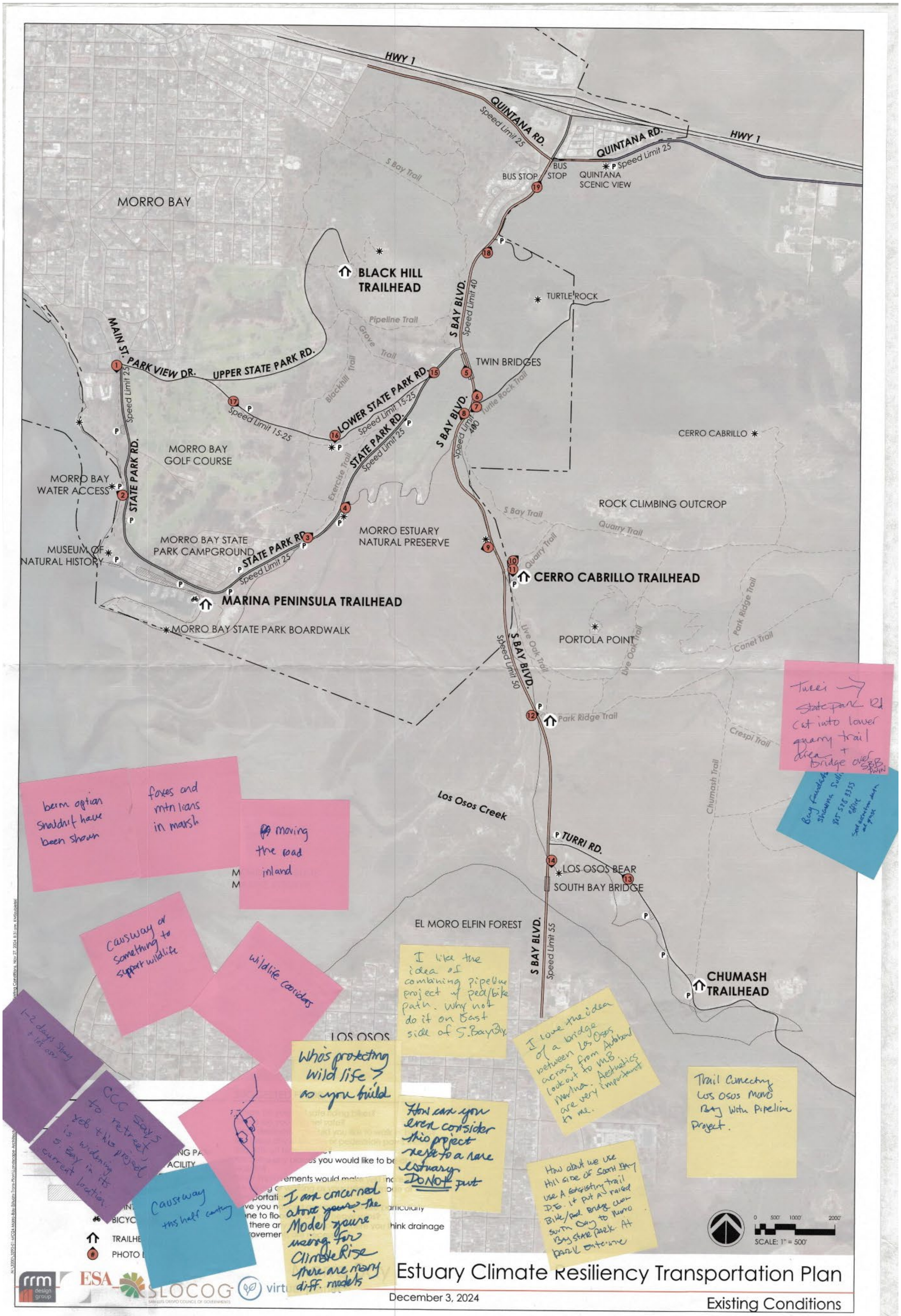
  - Boardwalk floating adjacent to South Bay Boulevard
- Bike commuters… what's the best route for Los Osos-Morro Bay?
  - Dedicated Class I multipurpose two-way
    - South Bay Blvd
    - Estuary Boardwalk (new)
  - State Park Class I, two-way
- A dedicated bike and pedestrian pathway separate from the roadway is much preferred over a Class II or similar shared system.
- Two-way bike/pedestrian path – min 10' wide with 2' shoulders
- Two-way left-turn lanes doesn't seem needed
- Are there ways to keep cars out of bike lanes now? Green paint? Bumps installed on the white lane of the bike path? Flexible sticks installed (like the ones at Cal Poly)?
- Minimize elevation changes for bike/pedestrian connections
- Share the road signs throughout as soon as possible
- Over cross tunnel or bridge for bikes
- More people would bike if safer
- Scary to ride on bridge
- These must be separate and dedicated, not on road (Class II, Class IV).
- We need short-, medium- and long-term solutions for bikes and pedestrians
- Keep bus route in mind
- Please make any solution have a provision for dog walking! And have Morro Bay National Estuary Program, Mutts for the Bay, provide trash bins and poop bags
- Consider E-bikes; "non-motorized" is not right term
- I would love to be able to bike between Los Osos and Morro Bay
- Make sure both ends of the bike and pedestrian paths have good connections into Morro Bay and Los Osos. Otherwise, it's a "path to nowhere"!
- Trail connecting Los Osos to Morro Bay with preliminary project
- Need safe walking/running path between Los Osos and Morro Bay
- I love the idea of a bridge between Los Osos across from Audubon lookout to Morro Bay Marina. Aesthetics are very important to me.
- High School commuter route current is (they have up to 30 people):
  - South Bay Blvd to Park Ridge trailhead
    - Enter follow Live Oak
    - Up quarry
    - Down South Bay Blvd
    - Down Turtle Hill
    - Under Bridge
    - Out to State Park Rd and up on to "lower" State Park
    - After the golf course they go into the neighborhood
- If the solution is something that brings people joy (beautiful access to views and nature) people will take it – mode shift to riding and walking
- Roundabouts would slow and helps crossing

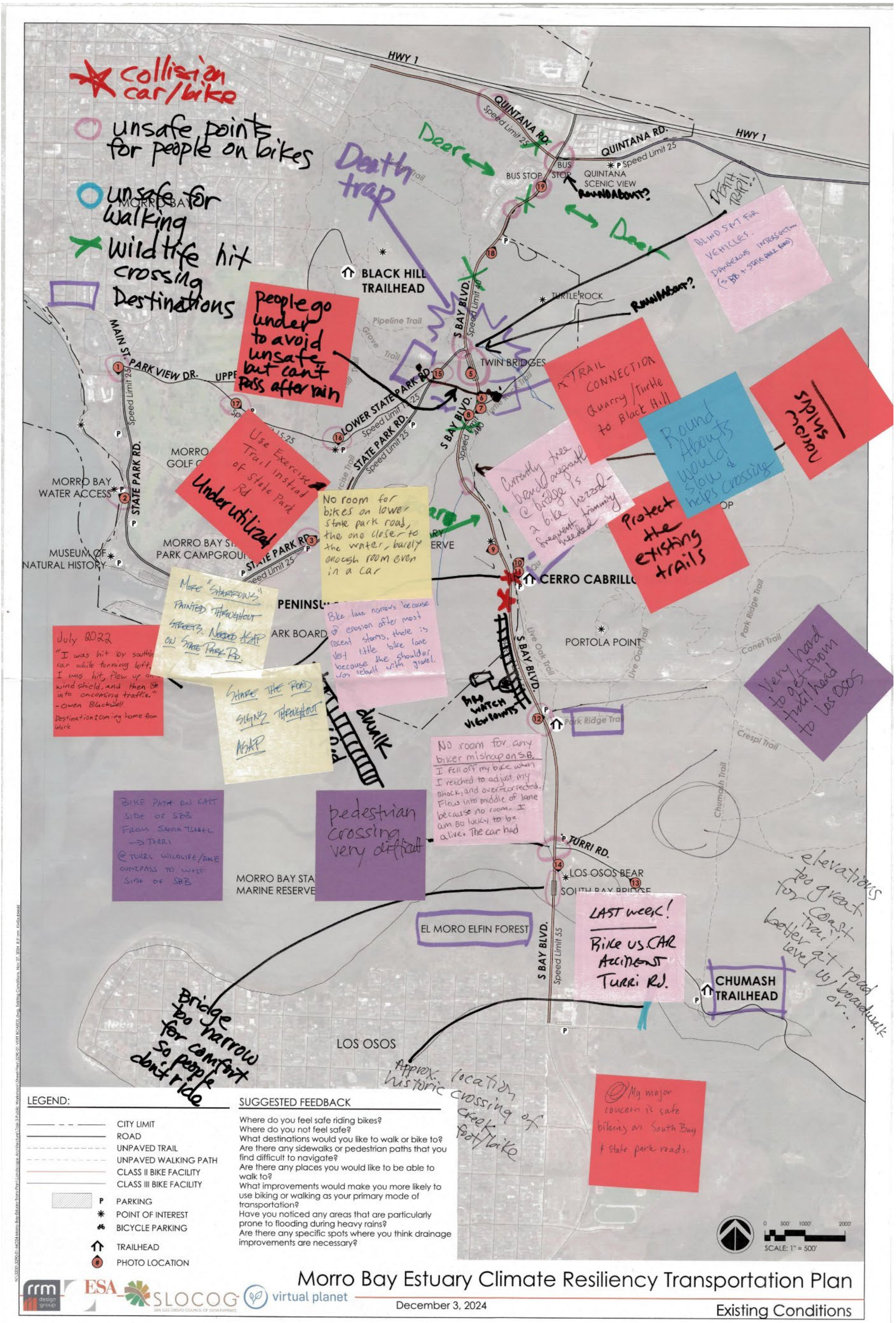
- Something to consider – I'm a teacher at Los Osos Middle school. Our admin has instructed all of the students that live in Morro Bay to not ride their bike to school on bike to school day advertised nationally.
- Unsafe points for people on bikes
    - Quintana Road west of South Bay Boulevard
    - Quintana Road and South Bar Boulevard intersection – roundabout?
    - South Bay Boulevard south of Quintana Road
    - Lower State Park Road and South Bay Boulevard intersection
    - South Bay Boulevard south of Lower State Park Road
    - Lower State Park Road west of South Bay Boulevard
    - At points of interest on Lower State Park Road and State Park Road
    - Intersection of State Park Road and Park View Drive
    - State Park Road at Morro Bay Water Access
    - South Bay Boulevard at Park Ridge Trail
    - South Bay Boulevard at Turri Road
    - South Bay Boulevard at South Bay Bridge
- Collisions
    - Get crash and incident date from San Luis Obispo County Office of Emergency Services and County Dispatch. Way more than what is reported here.
    - South Bay Boulevard at Quarry trailhead
    - There was a bike versus car accident on Turri Road and South Bay Blvd last week
    - Report of a cyclist that was struck by a truck at South Bay Blvd and Turri Road
    - July 2022: I was hit by southbound car while turning left. I was hit, flew up onto windshield, and then 15 ft into oncoming traffic – Owen Blackwell. Destination: coming home from work
- Destinations
    - Park Ridge Trail
    - El Moro Elfin Forest
        - Need trail connecting Elfin Forest to Cerro Cabrillo area trails.
    - Bird watch spot viewpoints at South Bay Boulevard north of Park Ridge Trail trailhead
- Trails and Connections
    - Trail connection at Quarry/Turtle to Black Hill
    - Keeping mountain biking/hiking trails intact is important! These are an important resource (Brian Fuller – brianf777@gmail.com)
    - Protect the existing trails
    - Exercise Trail is underutilized, use it instead of State Park Road
    - Very hard to get from trailhead to Los Osos
    - Connect the Quarry Trail trailhead and Turtle Rock Trail trailhead off road

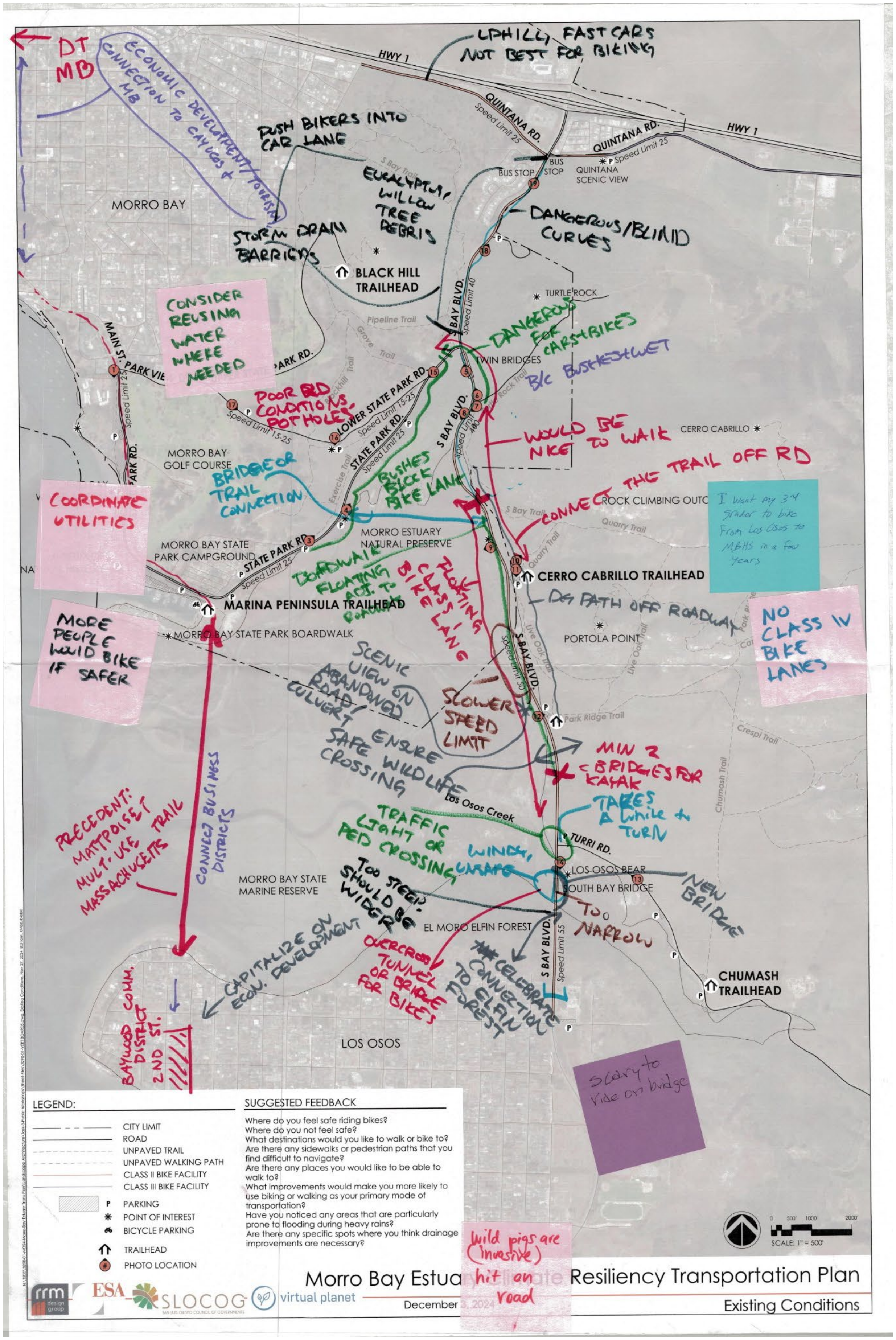
Other comments

- My main concern is wildlife habitat. I want as little destruction as possible. Enhancement would be nice.
- The Bay Foundation of Morro Bay– Shauna Sullivan 805-598-3355 office. Sea accretion data
- Berm option shouldn't have been shown
- Foxes and mountain lions in marsh

- Moving the road inland
- Causeway or something to support wildlife
- Wildlife corridors
- Who's protecting wildlife as you build?
- How are you even considering this project next to a rare estuary? Do not put in estuary.
- Economic development/tourism connection to Cayucos and Morro Bay
- Consider reusing water where needed
- Coordinate utilities
- Support for installing one or more wildlife crossing overpass on South Bay Blvd
- Note that when South Bay Blvd is flooded, the detour adds 20 miles
- Explore whether Morro Bay could share drinking water with Los Osos (outside the scope of the project)
- Scenic view on abandoned road adjacent to South Bay Boulevard across from Park Ridge Trail trailhead
- Wildlife hit crossing
    - Quintana Road west of South Bay Boulevard
    - South Bay Boulevard south of Quintana Road
    - South Bay Boulevard at Turtle Rock Trail trailhead
- Celebrate connection from South Bay Boulevard to Elfin Forest
- Precedent: Mattapoisett Multi-Use Trail in Massachusetts
- Connect Baywood Commercial District on 2nd Street to Business Districts in Downtown Morro Bay. Economic development/tourism connection to Cayucos and Morro Bay
- Wild pigs are (invasive) hit on road
- A wildlife crossing overpass can afford safe passage to mammals, both predator and prey alike, as they, too, make a daily pilgrimage from hillside to estuary and back again come dusk
- Signage alerting drives that mountain lions are known to frequent the area and the estuary is a designated State Marine Reserve
- Establishing one or more wildlife crossings


HWY 1
QUINTANA RD.
Speed Limit 25
QUINTANA RD.
Speed Limit 25
HWY 1
BUS STOP
BUS STOP
QUINTANA SCENIC VIEW
S Bay Trail
MORRO BAY
BLACK HILL TRAILHEAD
TURTLE ROCK
Pipeline Trail
Grove Trail
Blackhill Trail
S BAY BLVD.
Speed Limit 40
MAIN ST.
PARK VIEW DR.
UPPER STATE PARK RD.
TWIN BRIDGES
LOWER STATE PARK RD.
Speed Limit 15-25
Speed Limit 15-25
STATE PARK RD.
Speed Limit 25
Turtle Rock Trail
Speed Limit 25
STATE PARK RD.
MORRO BAY GOLF COURSE
CERRO CABRILLO
MORRO BAY WATER ACCESS
Exercise Trail
S Bay Trail
ROCK CLIMBING OUTCROP
Quarry Trail
MORRO ESTUARY NATURAL PRESERVE
MORRO BAY STATE PARK CAMPGROUND
STATE PARK RD.
Speed Limit 25
MUSEUM OF NATURAL HISTORY
Quarry Trail
CERRO CABRILLO TRAILHEAD
MARINA PENINSULA TRAILHEAD
MORRO BAY STATE PARK BOARDWALK
PORTOLA POINT
Live Oak Trail
Live Oak Trail
Park Ridge Trail
Canet Trail
S BAY BLVD.
Speed Limit 50
Park Ridge Trail
Crespi Trail
Chumash Trail
Los Osos Creek
TURRI RD.
LOS OSOS BEAR
SOUTH BAY BRIDGE
EL MORO ELFIN FOREST
S BAY BLVD.
Speed Limit 55
CHUMASH TRAILHEAD
LOS OSOS
SCALE: 1" = 500'
Estuary Climate Resiliency Transportation Plan
December 3, 2024
Existing Conditions
Turri → State park Rd cut into lower quarry trail area + Bridge over SBB TWIN
berm option shouldn't have been shown
foxes and mtn lions in marsh
moving the road inland
Causway or something to support wildlife
wildlife corridors
1-2 days stay + less cars
CCC says to retreat, yet this project is widening S. Bay in its current location.
Causeway this half century
I like the idea of combining pipeline project w/ ped/bike path. Why not do it on East side of S. Bay Blvd
Who's protecting wild life? as you build
How can you even consider this project next to a rare estuary. DO NOT put
I am concerned about your the Model you're using for Climate Rise there are many diff. models
I love the idea of a bridge between Los Osos across from Audubon lookout to MB Marina. Aesthetics are very important to me.
How about we use Hill side of South Bay use A existing trail D.E. it put A raised Bike/Ped. Bridge over South Bay to Morro Bay State Park. At park entrance
Trail Connecting Los Osos Morro Bay With Pipeline Project.


collision car/bike
unsafe points for people on bikes
unsafe for walking
wildlife hit crossing
Destinations
Death trap
Deer
Deer
DEATH TRAP!!
ROUNDABOUT?
ROUNDABOUT?
BLIND SPOT FOR VEHICLES. DANGEROUS INTERSECTION (S BB + STATE PARK ROAD)
people go under to avoid unsafe but can't pass after rain
TRAIL CONNECTION Quarry/Turtle to Black Hill
Round Abouts would slow & helps crossing
Use Exercise Trail instead of State Park Rd
Underutilized
No room for bikes on lower State park road, the one closer to the water, barely enough room even in a car
Protect the existing trails
More "SHARROWS" PAINTED THROUGHOUT STREETS. NEEDED ASAP ON STATE PARK RD.
Bike lane narrows because of erosion after most recent storms, there is very little bike lane because the shoulder was rebuilt with gravel.
July 2022
"I was hit by southbound car while turning left. I was hit, flew up onto windshield, and then 15ft into oncoming traffic." -Owen Blackwell
Destination: coming home from work
SHARE THE ROAD SIGNS THROUGHOUT ASAP
boardwalk
BIRD WATCH VIEWPOINTS
Very hard to get from trailhead to Los Osos
No room for any biker mishap on S.B.
I fell off my bike when I reached to adjust my shock, and over-corrected. Flew into middle of lane because no room. I am so lucky to be alive. The car had
BIKE PATH ON EAST SIDE OF SBB FROM SANTA YSABEL → TURRI
@ TURRI WILDLIFE/BIKE OVERPASS TO WEST SIDE OF SBB
pedestrian crossing very difficult
LAST WEEK!
BIKE VS. CAR ACCIDENT TURRI RD.
elevations too great for Coast trail; better at road level w/ boardwalk or...
Bridge too narrow for comfort so people don't ride
Approx. location historic crossing of creek foot/bike
My major concern is safe biking on South Bay & State park roads.
HWY 1
QUINTANA RD.
Speed Limit 25
BUS STOP
QUINTANA SCENIC VIEW
BLACK HILL TRAILHEAD
TURTLE ROCK
Pipeline Trail
S BAY BLVD.
TWIN BRIDGES
MAIN ST.
PARK VIEW DR.
LOWER STATE PARK RD.
STATE PARK RD.
MORRO BAY WATER ACCESS
MUSEUM OF NATURAL HISTORY
MORRO BAY STATE PARK CAMPGROUND
PENINSULA
CERRO CABRILLO
PORTOLA POINT
Live Oak Trail
Park Ridge Trail
Crespi Trail
Chumash Trail
TURRI RD.
LOS OSOS BEAR
SOUTH BAY BRIDGE
MORRO BAY STATE MARINE RESERVE
EL MORO ELFIN FOREST
CHUMASH TRAILHEAD
LOS OSOS
Speed Limit 55
LEGEND:
CITY LIMIT
ROAD
UNPAVED TRAIL
UNPAVED WALKING PATH
CLASS II BIKE FACILITY
CLASS III BIKE FACILITY
PARKING
POINT OF INTEREST
BICYCLE PARKING
TRAILHEAD
PHOTO LOCATION
SUGGESTED FEEDBACK
Where do you feel safe riding bikes?
Where do you not feel safe?
What destinations would you like to walk or bike to?
Are there any sidewalks or pedestrian paths that you find difficult to navigate?
Are there any places you would like to be able to walk to?
What improvements would make you more likely to use biking or walking as your primary mode of transportation?
Have you noticed any areas that are particularly prone to flooding during heavy rains?
Are there any specific spots where you think drainage improvements are necessary?
SCALE: 1" = 500'
rrm design group
ESA
SLOCOG
virtual planet
Morro Bay Estuary Climate Resiliency Transportation Plan
December 3, 2024
Existing Conditions


DT MB
ECONOMIC DEVELOPMENT/TOURISM CONNECTION TO CAYUCOS & MB
UPHILL, FAST CARS NOT BEST FOR BIKING
HWY 1
QUINTANA RD.
Speed Limit 25
BUS STOP
QUINTANA SCENIC VIEW
PUSH BIKERS INTO CAR LANE
EUCALYPTUS/ WILLOW TREE DEBRIS
DANGEROUS/BLIND CURVES
MORRO BAY
STORM DRAIN BARRIERS
BLACK HILL TRAILHEAD
TURTLE ROCK
CONSIDER REUSING WATER WHERE NEEDED
S BAY BLVD.
Speed Limit 40
DANGEROUS FOR CARS+BIKES
B/C BUSHES+WET
TWIN BRIDGES
MAIN ST.
PARK VIEW
STATE PARK RD.
POOR RD CONDITIONS - POTHOLES
LOWER STATE PARK RD.
Speed Limit 15-25
WOULD BE NICE TO WALK
CERRO CABRILLO
MORRO BAY GOLF COURSE
BRIDGE OR TRAIL CONNECTION
BUSHES BLOCK BIKE LANE
CONNECT THE TRAIL OFF RD
COORDINATE UTILITIES
ROCK CLIMBING OUTC
Quarry Trail
I want my 3rd grader to bike from Los Osos to MBHS in a few years
MORRO ESTUARY NATURAL PRESERVE
MORRO BAY STATE PARK CAMPGROUND
BOARDWALK FLOATING ADJ. TO ROADWAY
FLOATING CLASS I BIKE LANE
CERRO CABRILLO TRAILHEAD
DG PATH OFF ROADWAY
MARINA PENINSULA TRAILHEAD
MORE PEOPLE WOULD BIKE IF SAFER
MORRO BAY STATE PARK BOARDWALK
PORTOLA POINT
NO CLASS IV BIKE LANES
SCENIC VIEW ON ABANDONED ROAD/ CULVERT
SLOWER SPEED LIMIT
Speed Limit 50
Park Ridge Trail
ENSURE SAFE WILDLIFE CROSSING
MIN 2 BRIDGES FOR KAYAK
Los Osos Creek
Crespi Trail
Chumash Trail
PRECEDENT: MATTPOISETT MULT. USE TRAIL MASSACHUSETTS
CONNECT BUSINESS DISTRICTS
TRAFFIC LIGHT OR PED CROSSING
TAKES A while to TURN
TURRI RD.
WINDY, UNSAFE
LOS OSOS BEAR
SOUTH BAY BRIDGE
NEW BRIDGE!
MORRO BAY STATE MARINE RESERVE
TOO STEEP. SHOULD BE WIDER
TOO NARROW
EL MORO ELFIN FOREST
CAPITALIZE ON ECON. DEVELOPMENT
OVERCROSS TUNNEL OR BRIDGE FOR BIKES
CELEBRATE CONNECTION TO ELFIN FOREST
Speed Limit 55
CHUMASH TRAILHEAD
BAYWOOD COMM. DISTRICT 2ND ST.
LOS OSOS
scary to ride on bridge
LEGEND:
CITY LIMIT
ROAD
UNPAVED TRAIL
UNPAVED WALKING PATH
CLASS II BIKE FACILITY
CLASS III BIKE FACILITY
PARKING
POINT OF INTEREST
BICYCLE PARKING
TRAILHEAD
PHOTO LOCATION
SUGGESTED FEEDBACK
Where do you feel safe riding bikes?
Where do you not feel safe?
What destinations would you like to walk or bike to?
Are there any sidewalks or pedestrian paths that you find difficult to navigate?
Are there any places you would like to be able to walk to?
What improvements would make you more likely to use biking or walking as your primary mode of transportation?
Have you noticed any areas that are particularly prone to flooding during heavy rains?
Are there any specific spots where you think drainage improvements are necessary?
wild pigs are (invasive) hit on road
SCALE: 1" = 500'
Morro Bay Estuary Climate Resiliency Transportation Plan
December 3, 2024
Existing Conditions
rrm design group
ESA
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virtual planet

Morro Bay Estuary Climate Resiliency Transportation Plan

Community Workshop Summary – October 22, 2025

October 28, 2025
John DiNunzio
San Luis Obispo Council of Governments
1114 Marsh Street
San Luis Obispo, CA 93401

Dear John,

A series of community engagement efforts has continued the conversation around the Morro Bay Estuary Climate Resiliency Transportation Plan. The workshop held on October 22, 2025, provided a forum for residents, stakeholders, and visitors to share feedback on the coastal hazards vulnerability assessment results, sea level rise adaptation options, and proposed mobility enhancements. This workshop built on previous outreach activities including:

- December 2024 – First workshop, well attended by approximately 80 participants
- January 2025 – Morro Bay Farmers' Market "pop-up" outreach event
- May 2025 – Los Osos Citizen Advisory Committee meeting
- August 2025 – SLOCOG Board Meeting staff report
- October 2025 – Morro Bay Public Works Advisory Board update

At the October workshop, participants engaged with interactive boards, experienced a virtual reality simulation of proposed improvements, shared comments on design alternatives, and voiced priorities related to bike and pedestrian safety, environmental preservation, and scenic access. Feedback from this event and prior meetings will help guide the next steps in developing the Morro Bay Estuary Climate Resiliency Transportation Plan.

Community Workshop

October 22, 2025 – El Morro Church of the Nazarene, 1480 Santa Ysabel Ave, Los Osos, CA 93402

Over 60 participants attended the workshop, including community members and the consultant team. The event began with an introductory video and a presentation covering a project recap, coastal hazards analysis, and adaptation options. Breakout stations then provided opportunities for discussion, interactive boards to gather feedback on hazards and adaptation strategies, and a virtual reality experience showcasing proposed project concepts and potential coastal vulnerabilities. Community members expressed several priorities, including a strong interest in improving bike and pedestrian safety, maintaining scenic views, and protecting the ecological integrity of the estuary. There was broad support for solutions that balance transportation resilience with habitat preservation, particularly in light of increasing flood risks and sea-level rise.


Images from the Community Workshop

In summary, community priorities included:

- Safer bicycle and pedestrian connections between Los Osos and Morro Bay, wider bike lanes, and separated paths on the water side of South Bay Boulevard.
- Flood resilience and connectivity through a causeway that favors long-term durability, wildlife migration, and maintaining access during storm events and sea-level rise.
- Environmental preservation through protection of wetlands and estuary ecosystems while managing vegetation for visibility and cyclist safety.
- Access and amenity improvements such as parking pull-outs, improved boardwalks, and scenic viewing areas for birdwatching and nature appreciation.
- Traffic and intersection improvements, including intersection control at Turri Road and other key intersections to improve safety for cyclists and drivers.

Workshop Participant Feedback

<u>Existing Conditions</u>

Participants shared their thoughts on existing conditions within the study area. Temporary improvement ideas were also expressed.

- *This area – Morro Creek and Chorro Creek need to address the salt causing flooding and willow tree overgrowth*
- *Please pay attention to this post*
- *What improvements will be made to St Park Rd.?? Including Windy Cove?? Below sea level*
- *Until bike lane enhancements occur please lower 55-60mph to 40mph. Lower 40mpg to 30 mph. Thank you*

<u>Opportunities and Constraints</u>

Participants shared ideas for improving mobility and access while preserving the estuary's natural character. Feedback emphasized safe, scenic routes, and thoughtful integration with the environment.

- *Expand on vegetation management*
- *Elevated & separated bike/walking path on the water side: safe, close to nature*
- *Look at countries with a developed bike culture for inspiration ex Holland & Belgium*

- *We would love to see a separate bike path to ride safely to MB with kids. Great potential, I think many would use it on water side*
- *Sustainable dirt parking pull outs along Main Street. There has been concern over the years with these pull outs growing*
- *Morro Bay St Park boardwalk too narrow, needs railings to allow walkers/runner/elderly to pass each other safely*
- *Main & State Park Rd being one way is a low-cost short-term improvement*
- *Dedicated one way bike paths on each side of South Bay Blvd and separate walking path on bay side of South Bay Blvd? (road bikers and walkers probably shouldn't be sharing on path)*
- *Will bike lanes be wider on the proposed S Bay Bridge? (very narrow now)*
- *Bike walk on water side is better to avoid intersection crossing (+1)*
- *Water-side path is appealing for views. East side path is appealing for Mtn bike access…*
- *Yes to above comment – I'd love to see a separate path on the water side. Could on over-pass at one or two spots on South Bay be an option, to connect the path to mountain bike terrain*
- *For mountain bikers' intersection @ Turri then an inland bike trail that parallels South Bay*
- *I agree! Intersection at Turri Rd!!*
- *Add an intersection where Turri Road connects to South Bay Blvd. It is currently difficult to turn left out on South Bay from Turri or right out of Turri coming from Morro Bay*
- *Will bike lanes be wider on the proposed S Bay Bridge? (very narrow now)*
- *Traffic control at Turri and S Bay? There are many bikers that turn from Sout Bay cast on Turri South onto Sout Bay Ongoing overnight parking & trash dumping issue in pull outs*

<u>Adaptation Options</u>
Several adaptation options were presented for key roadway segments. These options explore how roads can respond to flooding and sea-level rise while maintaining connectivity, safety, and ecological integrity. Below is a summary of community feedback for each segment.

South Bay Boulevard (North)
- *Best for bikes & pedestrians (C1 & C2)*
- *Integrated. Delightful. Drivers will hate (C3)*
- *"Second" of the above comment*
- *C5 is good*
- *Love from ecological perspective (C8)*
- *This one (C5)*
- *Prefer causeway (C8)*
- *Absolutely not! Causeway would be for that convenience of H2O pipeline to LO*

South Bay Boulevard (South)
- *It's so beautiful making access is important*
- *Think a combined sidewalk/bike would be fine*
- *Concerns about drainage on roadway (D2)*
- *Instead of rail, low curb islands (D6)*
- *Least favorite option (D3). Loss of view*
- *Not liking this: drainage on road loss of view (D3)*

- *How would fill affect fragile life? (wetlands, birds)*
- *Having the bike lane on the west side sounds lovely – could there be protected crossings of some sort for Mountain bike/hiker trail head access on east side of rd.?*
- *Prefer walking/biking on water side (D5)*
- *D4 has better bike access to Turri, Hwy 1, than D5*
- *Absolutely NOT!! This option is only for the convenience of the H2O pipeline!! (D8)*
- *Causeway seems most resilient. Maybe best for wetlands biodiversity*
- *No never (D8)*
- *I love that the bike/pedestrian path is on the water side of South Bay, not inland*
- *Cyclist and path on water side*
- *No barriers*
- *Scenic: yes barrier*
- *These comments show there's no concern for the estuary*
- *Have a barrier between cars/pedestrians/bikes*
- *Protected bike/ped path on Bayside Yes!*
- *Causeway is my favorite*
- *Would love to see the marsh connect to hills! Agree with below*
- *Causeway best for people & nature in the long run. How long will other options be viable, just look at twin bridges today*
- *Causeway is the best strategy for efficient use & estuary expansion. Bike bath should be places based on a primary use – dedicated and separated*

Main Street: State Parks and Windy Code

- *Please do not rely on sharrows*
- *We'd love to see one-way Main St & lower State Park Rd for bike path options/safely now*
- *Concern that access to businesses w/ one-way is too far*
- *Will there be wildlife migration in this option? There should be*
- *Is it possible to use curb islands to keep 2 way*
- *Causeways preferred for allowing wildlife migration & hydrology (E6)*
- *Causeway is the best strategy. Bike path variations depend on whether or not they are primarily used for vacation (dedicated & separate path) or for commuting (path on either side of traffic lanes (image 3180, bottom right yellow sticky) (F5)*

Quintana Road and Turri Road

- *Bikes on views side please*
- *Elevated causeway with Class 1 bike lane instead of Class 2?*

Overall:

- *Your poster pictures & printing are too small to read – ditto*
- *Your science is speculative & you're using numbers to base this expensive – ridiculous huge project*
- *Address only areas that need immediate attention now*
- *No barriers between cars & bikes*
- *Class 1 bike trail adjacent to Bay!*

Coastal Hazards Analysis

The Coastal Hazards Analysis outlined current and projected risks from flooding, storm events, and sea-level rise along South Bay Boulevard and adjacent corridors. The analysis highlighted how combinations of high estuary tides and creek flows increase vulnerability, particularly in low-lying areas near Chorro Creek and Los Osos Creek. Participants were invited to review maps and data and provide feedback on assumptions and implications for adaptation planning.

- *Chorro Creek & Morro Creek need to be addressed.*
- *Silt is coming down & creating issues under the bridge; willow trees*

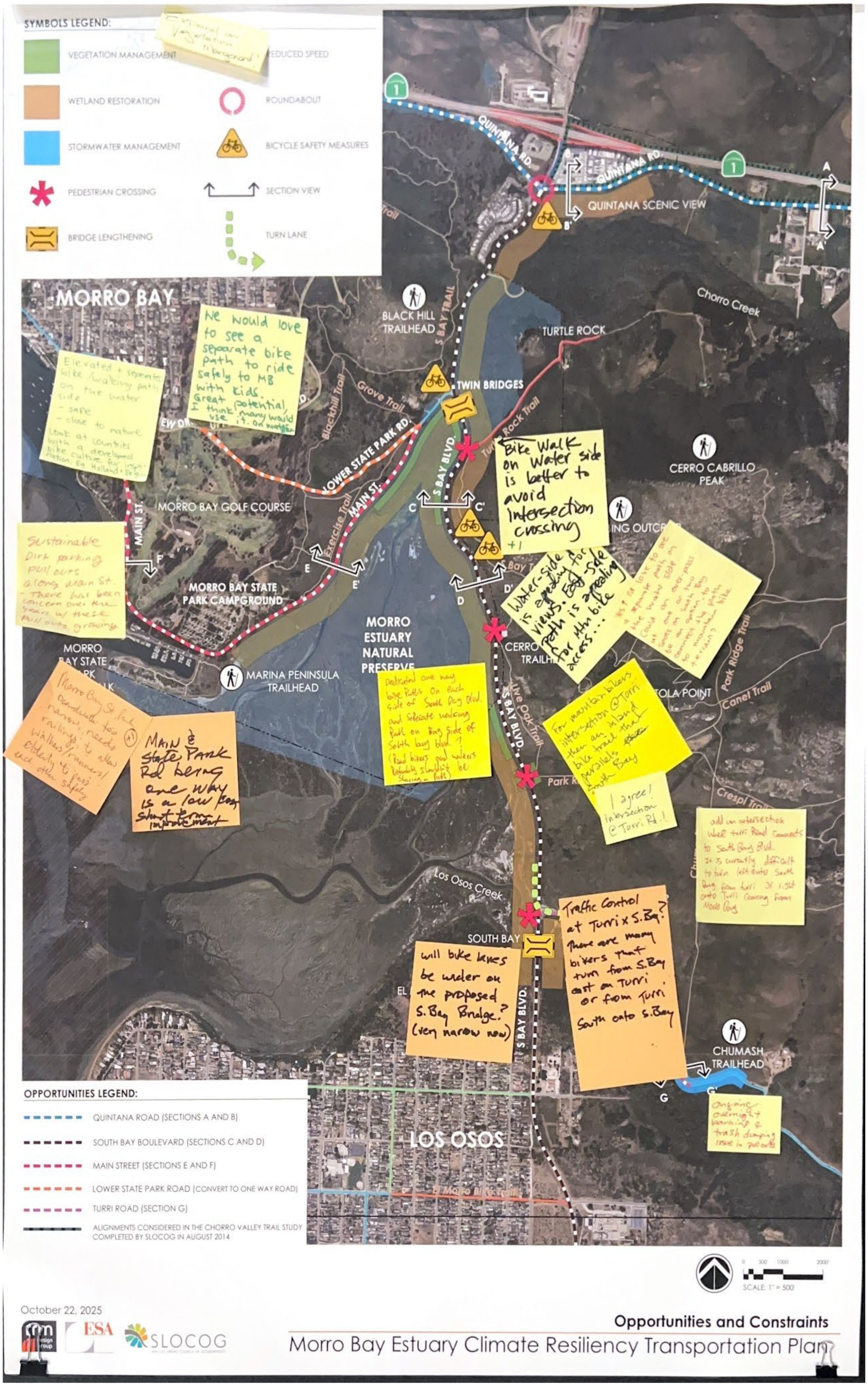
Workshop Participant Comment Sheets

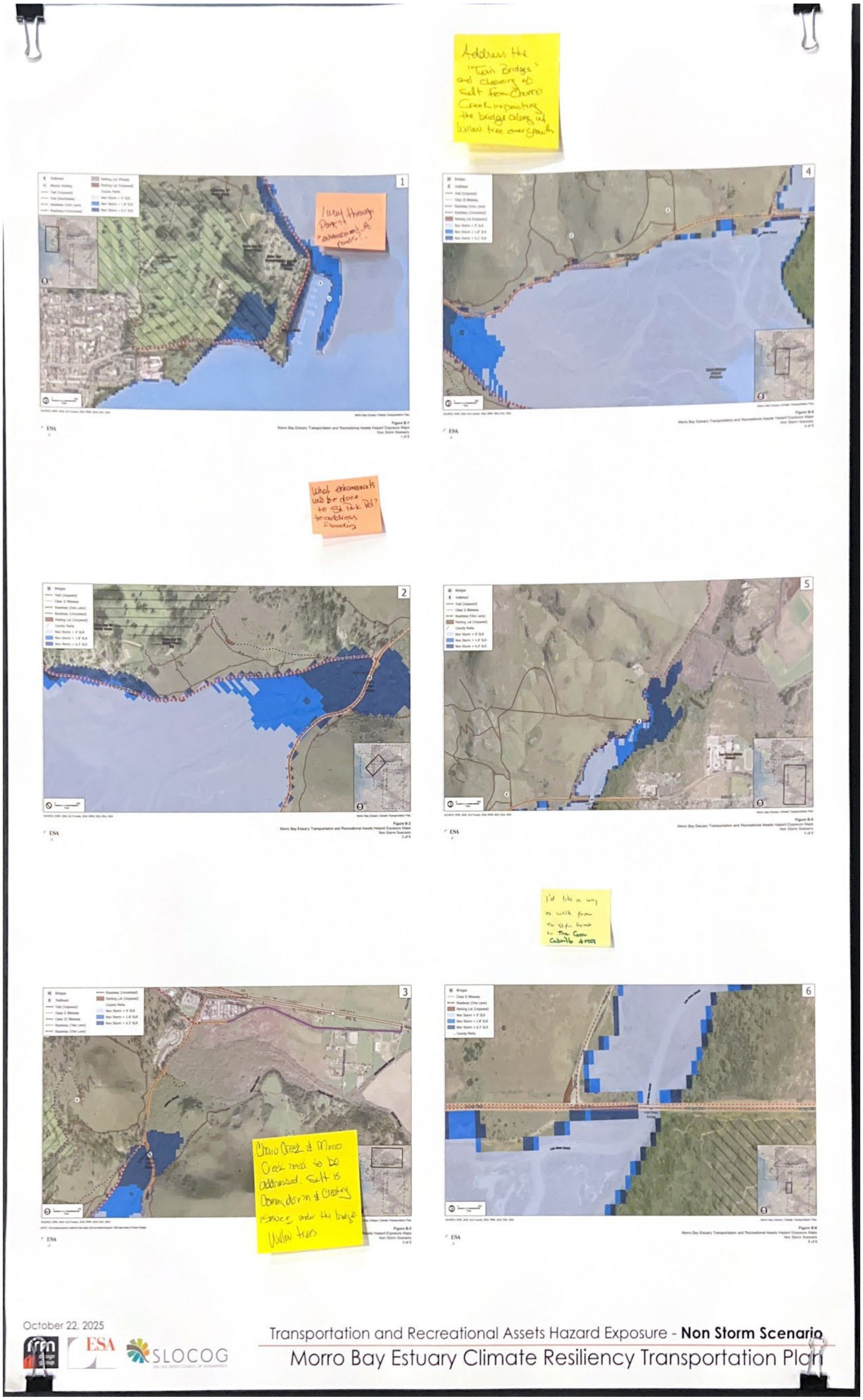
- *Don't like the idea of the levee only option. This leaves cars unable to enjoy the natural beauty of this commute*
- *Please put all pedestrian and bike traffic regardless of direction of travel on the water side of road*
- *Somewhere in the center of South Bay Blvd there should be ability to park and walk out to a bay viewing area for scenic views and bird watching*
- *Very interesting presentation. A suggestion to improve it: in order to hear the information, it helps if presenters used the mic properly. The last person was easily heard because she held the mic close to her mouth*
- *Thank you for holding these workshops. We need to prepare now to protect the environment*
- *My main priorities are 1) improving the safety of cycling along South Bay Blvd. and 2) creating a safe way to walk from Los Osos to Morro Bay*
- *Your science is pure speculation*
- *Where is the budget and the money you've already spent for a feasibility study based on only one Sided Science at climate changes*
- *Adjusting the vegetation to allow for "safety" for cyclists – how many people have been consulted with long term experience of the estuary behavior. The estuary must be preserved. People do not have to bike. You could easily disrupt the safety of the estuary.*
- *Your maps are just plain inaccurate. You're making "science" predictions without consulting people who have lived here for decades. Why? It's money & more projects.*
- *Why are you not addressing up the hill where the water can come from?*
- *You'll repeat the past if you don't hire for a few days consultants who have worked as engineers for the community for decades. You need history of projects. Real data*

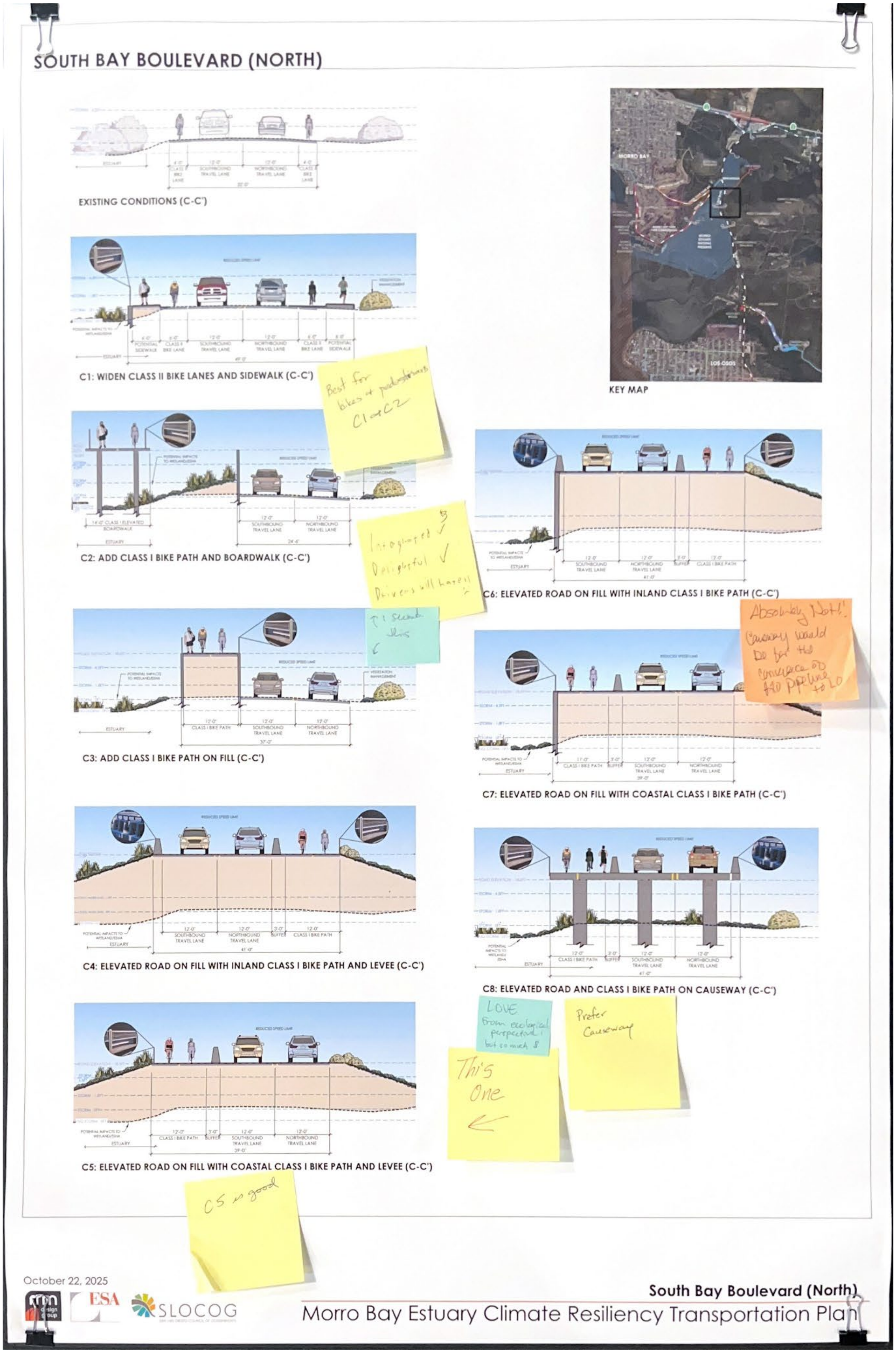
Workshop Conclusion

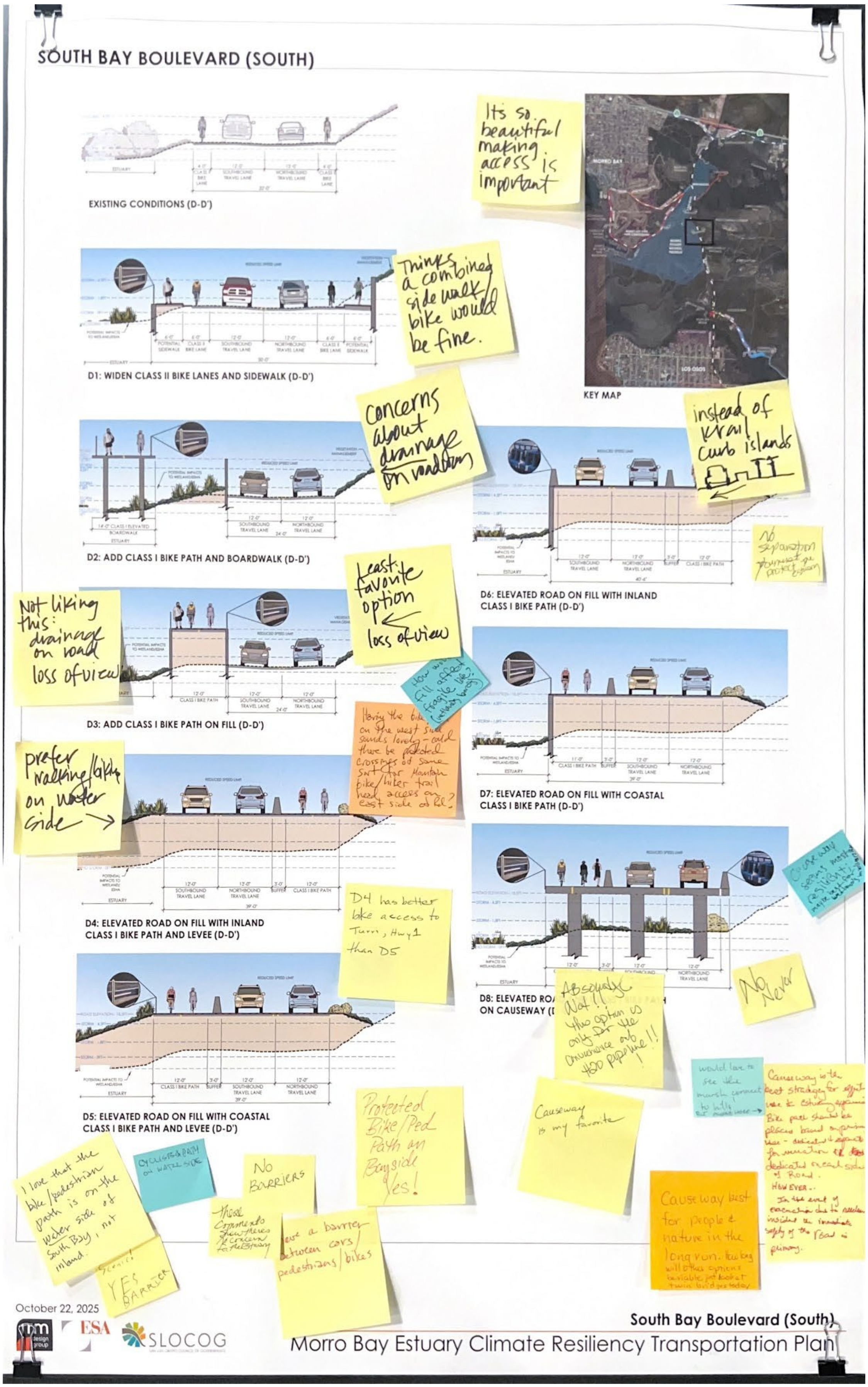
The October 2025 workshop for the Morro Bay Estuary Climate Resiliency Transportation Plan provided important input on how roadways can adapt to flooding and sea-level rise while maintaining connectivity and ecological integrity. Participants prioritized safer bicycle and pedestrian connections, including wider bike lanes and separated paths on the water side of South Bay Boulevard. Feedback also emphasized environmental preservation, with strong support for protecting wetlands and estuary ecosystems while managing vegetation for visibility and cyclist safety. Additional priorities included access and amenity improvements such as parking pull-outs, boardwalk enhancements, and scenic viewing areas, as well as traffic and intersection improvements to enhance safety. Most participants supported solutions that balance mobility improvements with habitat protection, ensuring the corridor remains functional and resilient as climate risks increase.

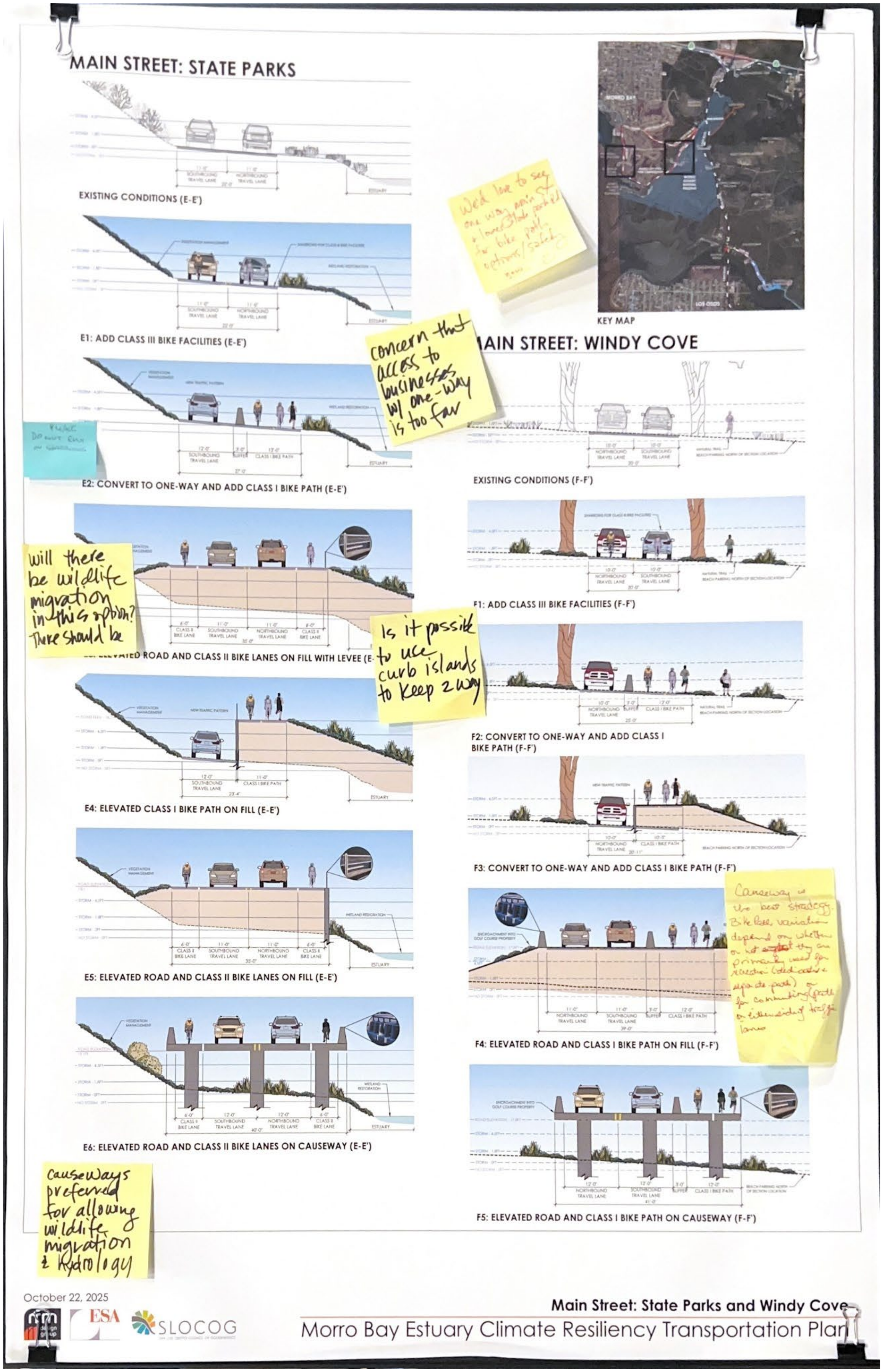

MORRO BAY
QUINTANA RD.
QUINTANA SCENIC VIEW
S Bay Trail
BLACK HILL TRAILHEAD
S BAY TRAIL
TURTLE ROCK
Chorro Creek
TWIN BRIDGES
PARK VIEW DR.
UPPER STATE PARK RD.
Grove Trail
Blackhill Trail
LOWER STATE PARK RD.
S BAY BLVD.
MORRO BAY GOLF COURSE
MAIN ST.
MORRO BAY WATER ACCE
CERRO CABRILLO PEAK
CLIMBING OUTCROP
Exercise Trail
MUSEUM OF NATURAL HISTORY
MORRO BAY STATE PARK CAMPGROUND
Bay Trail
Quarry Trail
MORRO ESTUARY NATURAL PRESERVE
CERRO CABRILLO TRAILHEAD
MORRO BAY STATE PARK BOARDWALK
PORTOLA POINT
Live Oak Trail
Park Ridge Trail
Canet Trail
Crespi Trail
Chumash Trail
Los Osos Creek
LOS OSOS BEAR
TURRI RD.
SOUTH BAY BRIDGE
EL MORO ELFIN FOREST
CHUMASH TRAILHEAD
LOS OSOS
What improvements will be made to St. Park Rd?? Including Windy Cove?? Below Sea Level
Until bike lane enhancements occur please lower 55+50 mph to 40mph, Lower 40mph to 30 mph Thank you
EXISTING CONDITIONS LEGEND:
CITY LIMIT
ONE LANE ROAD
TWO LANE ROAD (NO BIKE FACILITIES)
TWO LANE ROAD (CLASS II)
TWO LANE ROAD (CLASS III)
UNMARKED ROAD
CLASS IV BIKE TRAIL
UNPAVED TRAIL
PARKING
TRAILHEAD
SPEED LIMIT
CALIFORNIA FISH AND WILDLIFE (CDFW) LAND EASEMENT
COUNTY PARKS
AQUATIC RESOURCES (WETLAND)
October 22, 2025
ESA
SLOCOG
Existing Conditions
Morro Bay Estuary Climate Resiliency Transportation Plan

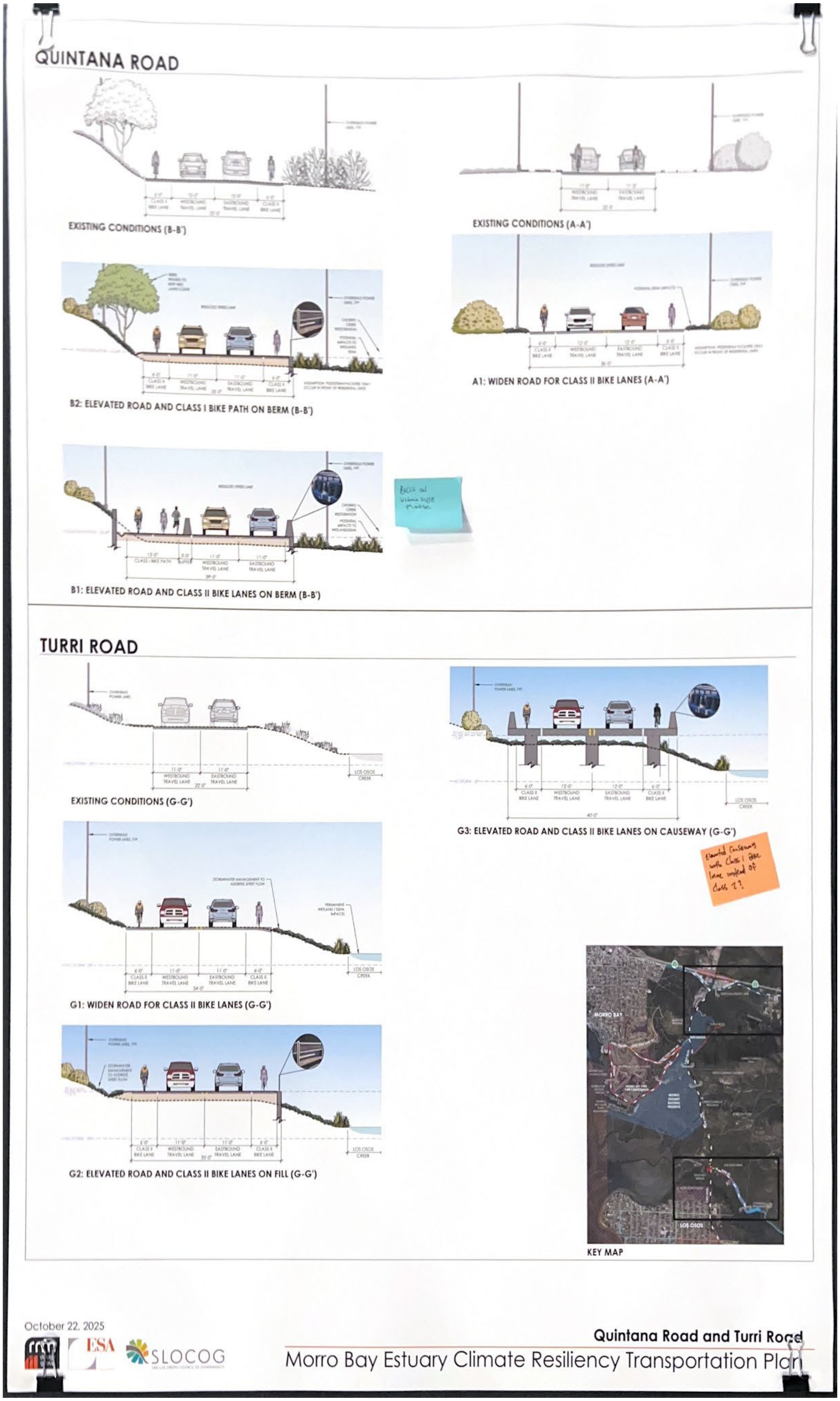

SYMBOLS LEGEND:
VEGETATION MANAGEMENT
WETLAND RESTORATION
STORMWATER MANAGEMENT
PEDESTRIAN CROSSING
BRIDGE LENGTHENING
REDUCED SPEED
ROUNDABOUT
BICYCLE SAFETY MEASURES
SECTION VIEW
TURN LANE
MORRO BAY
QUINTANA RD.
QUINTANA SCENIC VIEW
Chorro Creek
BLACK HILL TRAILHEAD
TURTLE ROCK
TWIN BRIDGES
Turtle Rock Trail
Grove Trail
Blackhill Trail
LOWER STATE PARK RD.
MAIN ST.
S BAY BLVD.
MORRO BAY GOLF COURSE
CERRO CABRILLO PEAK
MORRO BAY STATE PARK CAMPGROUND
MORRO ESTUARY NATURAL PRESERVE
MARINA PENINSULA TRAILHEAD
Park Ridge Trail
Canet Trail
Live Oak Trail
Los Osos Creek
SOUTH BAY
CHUMASH TRAILHEAD
LOS OSOS
Elevated + separate bike/walking path on the water side - safe - close to nature Look at countries with a developed bike culture for inspiration. Eg Holland + Belgium
We would love to see a separate bike path to ride safely to MB with kids. Great potential, I think many would use it.
Sustainable Dirt parking pull outs along Main St. - There has been concern over the years w/ these pull outs growing
Bike Walk on Water side is better to avoid intersection crossing +1
Water-side is appealing for views. East-side path is appealing for Mtn bike access...
Morro Bay St. Park boardwalk too narrow, needs railings to allow walkers/runners/elderly to pass each other safely +1
MAIN & State Park Rd being one way is a low cost short term improvement
Dedicated one way bike Paths On each side of South Bay blvd. and Seperate walking Path on Bay side of South bay blvd.? (Road bikers and walkers probably shouldn't be sharing a Path)
For mountain bikers intersection @ Turri then an inland bike trail that parallels South Bay
I agree! Intersection @ Turri Rd.!
add an intersection where Turri Road connects to South Bay Blvd. It is currently difficult to turn left onto South Bay from Turri or right onto Turri coming from Morro Bay
Traffic Control at Turri x S. Bay? There are many bikers that turn from S. Bay east on Turri or from Turri South onto S. Bay
will bike lanes be wider on the proposed S. Bay Bridge? (very narrow now)
Ongoing overnight parking & trash dumping issue in pull outs
OPPORTUNITIES LEGEND:
QUINTANA ROAD (SECTIONS A AND B)
SOUTH BAY BOULEVARD (SECTIONS C AND D)
MAIN STREET (SECTIONS E AND F)
LOWER STATE PARK ROAD (CONVERT TO ONE WAY ROAD)
TURRI ROAD (SECTION G)
ALIGNMENTS CONSIDERED IN THE CHORRO VALLEY TRAIL STUDY COMPLETED BY SLOCOG IN AUGUST 2014
SCALE: 1" = 500'
October 22, 2025
ESA
SLOCOG
Opportunities and Constraints
Morro Bay Estuary Climate Resiliency Transportation Plan


October 22, 2025
ESA
SLOCOG
Transportation and Recreational Assets Hazard Exposure - **Non Storm Scenario**
Morro Bay Estuary Climate Resiliency Transportation Plan


SOUTH BAY BOULEVARD (NORTH)
EXISTING CONDITIONS (C-C')
C1: WIDEN CLASS II BIKE LANES AND SIDEWALK (C-C')
C2: ADD CLASS I BIKE PATH AND BOARDWALK (C-C')
C3: ADD CLASS I BIKE PATH ON FILL (C-C')
C4: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH AND LEVEE (C-C')
C5: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH AND LEVEE (C-C')
KEY MAP
C6: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH (C-C')
C7: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH (C-C')
C8: ELEVATED ROAD AND CLASS I BIKE PATH ON CAUSEWAY (C-C')
Best for bikes + pedestrians C1 or C2
Integrated ✓
Delightful ✓
Drivers will hate it
Absolutely Not!!
LOVE from ecological perspective but so much $
This One
Prefer Causeway
C5 is good
October 22, 2025
ESA
SLOCOG
South Bay Boulevard (North)
Morro Bay Estuary Climate Resiliency Transportation Plan


SOUTH BAY BOULEVARD (SOUTH)
EXISTING CONDITIONS (D-D')
D1: WIDEN CLASS II BIKE LANES AND SIDEWALK (D-D')
D2: ADD CLASS I BIKE PATH AND BOARDWALK (D-D')
D3: ADD CLASS I BIKE PATH ON FILL (D-D')
D4: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH AND LEVEE (D-D')
D5: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH AND LEVEE (D-D')
D6: ELEVATED ROAD ON FILL WITH INLAND CLASS I BIKE PATH (D-D')
D7: ELEVATED ROAD ON FILL WITH COASTAL CLASS I BIKE PATH (D-D')
D8: ELEVATED ROA… ON CAUSEWAY (D…
KEY MAP
Its so beautiful making access is important
Thinks a combined sidewalk bike would be fine.
concerns about drainage on roadway
instead of k rail curb islands
Not liking this: drainage on road loss of view
Least favorite option loss of view
prefer walking/biking on water side
D4 has better bike access to Turri, Hwy 1 than D5
Absolutely Not!! This option is only for the convenience of 420 pipeline!!
No Never
Causeway is my favorite
Protected Bike/Ped Path on Bayside Yes!
No BARRIERS
CYCLISTS PATH ON WATER SIDE
I love that the bike/pedestrian path is on the water side of South Bay, not inland.
YES BARRIER
Causeway best for people & nature in the long run.
October 22, 2025
South Bay Boulevard (South)
Morro Bay Estuary Climate Resiliency Transportation Plan
ESA
SLOCOG


MAIN STREET: STATE PARKS
EXISTING CONDITIONS (E-E')
E1: ADD CLASS III BIKE FACILITIES (E-E')
E2: CONVERT TO ONE-WAY AND ADD CLASS I BIKE PATH (E-E')
E4: ELEVATED CLASS I BIKE PATH ON FILL (E-E')
E5: ELEVATED ROAD AND CLASS II BIKE LANES ON FILL (E-E')
E6: ELEVATED ROAD AND CLASS II BIKE LANES ON CAUSEWAY (E-E')
KEY MAP
MAIN STREET: WINDY COVE
EXISTING CONDITIONS (F-F')
F1: ADD CLASS III BIKE FACILITIES (F-F')
F2: CONVERT TO ONE-WAY AND ADD CLASS I BIKE PATH (F-F')
F3: CONVERT TO ONE-WAY AND ADD CLASS I BIKE PATH (F-F')
F4: ELEVATED ROAD AND CLASS I BIKE PATH ON FILL (F-F')
F5: ELEVATED ROAD AND CLASS I BIKE PATH ON CAUSEWAY (F-F')
concern that access to businesses w/ one-way is too far
will there be wildlife migration in this option? There should be
Is it possible to use curb islands to keep 2 way
Causeway is the best strategy.
Causeways preferred for allowing wildlife migration & hydrology
October 22, 2025
ESA
SLOCOG
Main Street: State Parks and Windy Cove
Morro Bay Estuary Climate Resiliency Transportation Plan


QUINTANA ROAD
EXISTING CONDITIONS (B-B')
EXISTING CONDITIONS (A-A')
B2: ELEVATED ROAD AND CLASS I BIKE PATH ON BERM (B-B')
A1: WIDEN ROAD FOR CLASS II BIKE LANES (A-A')
B1: ELEVATED ROAD AND CLASS II BIKE LANES ON BERM (B-B')
TURRI ROAD
EXISTING CONDITIONS (G-G')
G3: ELEVATED ROAD AND CLASS II BIKE LANES ON CAUSEWAY (G-G')
G1: WIDEN ROAD FOR CLASS II BIKE LANES (G-G')
G2: ELEVATED ROAD AND CLASS II BIKE LANES ON FILL (G-G')
KEY MAP
October 22, 2025
ESA
SLOCOG
Quintana Road and Turri Road
Morro Bay Estuary Climate Resiliency Transportation Plan