Final

EXECUTIVE SUMMARY
CITY OF SANTA BARBARA
SEA-LEVEL RISE ADAPTATION PLAN

Prepared for
City of Santa Barbara

Adopted by City Council February 2, 2021

ESA

Funded by:

Coastal Conservancy

CALIFORNIA COASTAL COMMISSION

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California Coastal Commission
California State Coastal Conservancy
City of Santa Barbara

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Front page photo of Leadbetter Beach taken by David Davis during an approximate 6ft high tide in January 2020.

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The City thanks the individuals and groups who gave up their personal time to participate in the Sea-Level Adaptation Plan process. The City appreciates the civic investment these individuals and groups have made in the future of Santa Barbara's shoreline.

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EXECUTIVE SUMMARY

INTRODUCTION

The City of Santa Barbara includes approximately six miles of shoreline. Although Santa Barbara has experienced a relatively small amount of sea-level rise to date from climate change, the rate of sea-level rise in the region is expected to accelerate significantly in upcoming years. The purpose of this Adaptation Plan is to identify vulnerabilities to coastal hazards expected from sea-level rise in the City of Santa Barbara and possible actions to prepare for and adapt to sea-level rise.

Preparation of a sea-level rise adaptation plan is identified as a priority in the Coastal Land Use Plan, Safety Element, and Hazard Mitigation Plan. Additionally, the State requires the City, as a trustee of state tidelands, to proactively plan for sea-level rise at the Harbor and Stearns Wharf and to consider sea-level rise as part of coastal development permitting. The 2019 Coastal Land Use Plan includes interim policies that begin to incorporate the effects of sea-level rise into coastal development permitting, but a more comprehensive plan for addressing sea-level rise was needed. The California Coastal Commission, therefore, partially funded the preparation of this Adaptation Plan as part of the City's efforts to update its Local Coastal Program.

A vulnerability assessment was prepared for this Adaptation Plan to identify the areas of the city that, in the absence of intervention, are projected to be exposed to sea-level rise and related coastal hazards. This Adaptation Plan provides the framework for the City to monitor sea-level rise impacts and reduce vulnerabilities in phases as specific thresholds for action are reached. A wide range of adaptation options are presented, providing the City flexibility to consider different adaptation strategies over time.

The study area includes portions of the city that are projected to be impacted by coastal hazards through the year 2100, except the Santa Barbara Airport and Goleta Slough, which have been studied separately.

Information surrounding sea-level rise and how to adapt to it is quickly evolving. While the plan provides a framework for decision-making and further study in the mid- and long-term, specific recommendations are focused on the near-term (i.e., the next 10 years). Reevaluation of the plan is recommended to occur approximately every five to ten years as major updates occur to the State of California Sea-Level Rise Guidance or other substantive changes in best available information occur. This Adaptation Plan

presents an initial framework for planning for sea-level rise that will continue to evolve over time as conditions change.

SEA-LEVEL RISE VULNERABILITY

Sea levels in Santa Barbara have increased by 0.39 feet in the last 100 years (NOAA Tides and Currents Station #9411340). Under current sea levels, Santa Barbara is already vulnerable to bluff and beach erosion (Figures ES-1 and ES-2), coastal flooding and wave impacts (Figure ES-3), and flooding of low-lying areas (Figure ES-4). Historically, the worst flooding and erosion events have occurred as a result of winter storms occurring during El Niño conditions in the North Pacific Ocean when sea levels along the California coast often rise substantially for weeks at a time (Griggs and Russel 2012). The rate of sea-level rise is expected to increase over time due to the effects of climate change and global warming. This will result in increased flooding and erosion hazards along the City's shoreline, with the highest risks continuing to be during winter storms in El Niño years.

SOURCE: Griggs and Russel 2012

Figure ES-1
January 2008 Landslide at Shoreline Park

SOURCE: Griggs and Russel 2012

Figure ES-2
Beach Erosion at Leadbetter Beach Parking Lot from the March 1983 El Niño Event

SOURCE: Griggs and Russel 2012

Figure ES-3
Waves Overtopping West Cabrillo Boulevard in 1914

SOURCE: Griggs and Russel 2012

Figure ES-4
Southern Pacific Railroad Station Covered in Mud
Following Flooding in 1914

The *City of Santa Barbara Sea-level Rise Vulnerability Assessment Update* (Vulnerability Assessment Update) evaluated hazards for three sea-level rise scenarios: 0.8 feet by 2030,[1] 2.5 feet by 2060, and 6.6 feet by 2100. These amounts of sea-level rise are with respect to a baseline of the year 2000, or more specifically, the average relative sea level over 1991 – 2009. Since 2000, sea levels are estimated to have increased by just under an inch, as of the writing of this report, but the rate of sea-level rise is expected to increase in the coming decades.

The State of California, in the 2018 *State of California Sea-Level Rise Guidance* (OPC 2018), recommends using these precautionary and more risk adverse scenarios when planning for structures, infrastructure, and other development that is not easily moved. The state guidance estimates that these sea-level rise values have a 0.5% chance of being met or exceeded by the year 2100. The state guidance identifies these as the "medium-high risk aversion scenarios" which are based on the assumption that existing levels of greenhouse gas emissions continue and are not significantly reduced ("high emission scenarios").

[1] The 2018 *State of California Sea-Level Rise Guidance* recommends 0.7 feet at 2030. The closest Coastal Storm Modeling System (CoSMoS) Scenario, which has been used to generate maps and conduct vulnerability analyses is 25 cm, which is 0.8 feet. This difference is negligible at the scale of this study, and 0.8 feet at 2030 is used throughout.

The 2018 *State of California Sea-Level Rise Guidance* also includes much more likely scenarios that present sea-level rise values that have a 17% chance of being met or exceeded in the future ("low risk aversion scenarios") that can be used for planning for adaptable development with few consequences of being impacted (e.g., dirt trails). The state guidance also presents an "extreme risk aversion" scenario called the H++ scenario that is based on recent scientific studies that indicate that there is a possibility that sea levels could rise faster than originally anticipated due to the potential loss of large portions of the West Antarctic Ice Sheet. While the probability of this extreme scenario is not known at this time, the state guidance recommends considering the H++ scenario in the planning of very critical infrastructure (e.g., coastal power plant). For very critical infrastructure, therefore, this Adaptation Plan considers the possibility that 6.6 feet (2100) of sea-level rise may occur sooner, at 2080 rather than 2100, under the extreme H++ sea-level rise scenario. Table ES-1 and Figure ES-5 below present the low-rise, medium-risk, and extreme risk aversion scenarios. All of these aversion scenarios correspond to the high greenhouse gas emissions scenario.

The State of California has updated the sea-level rise projections for the Santa Barbara area contained in the State of California Sea-Level Rise Guidance approximately every five years based on best available information. While there is uncertainty in the timing of sea-level rise in any particular area, the amounts of sea-level rise considered in this Adaptation Plan are expected to occur at some time. Because of the timing uncertainty, this Adaptation Plan provides a framework of planning based on amounts of sea-level rise, rather than when those amounts of sea-level rise will occur.

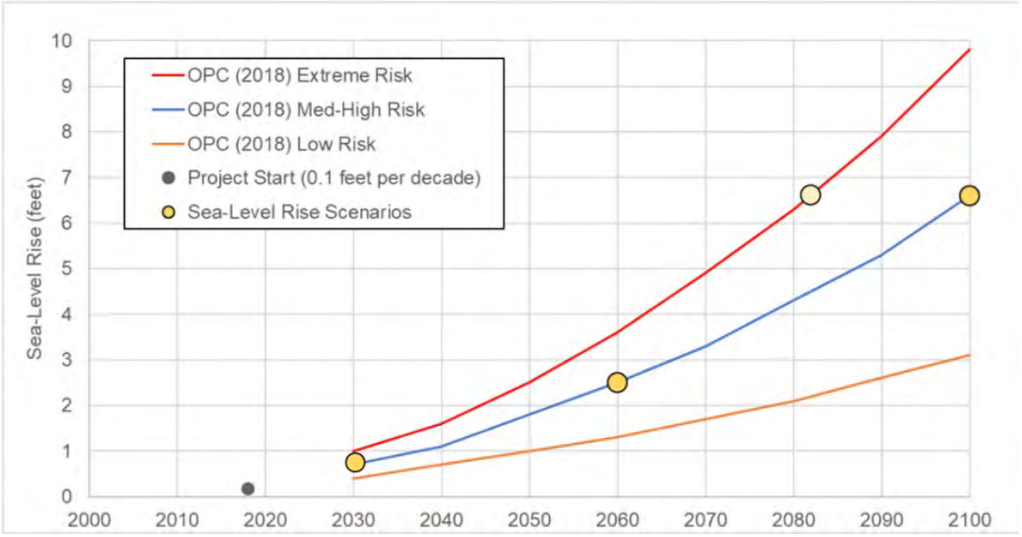
TABLE ES-1
SEA-LEVEL RISE SCENARIOS FOR CITY OF SANTA BARBARA

Scenario	Low Risk Aversion[a] *17% chance of being met or exceeded*	Med High Risk Aversion *0.5% chance of being met or exceeded*	Extreme Risk Aversion *Unknown probability*
0.8 feet of sea-level rise	Occurs by ~2040	Occurs by ~2030	Occurs before 2030
2.5 feet of sea-level rise	Occurs by ~2090	Occurs by 2060	Occurs by 2050
6.6 feet of sea-level rise	Occurs after 2150	Occurs by 2100	Occurs by ~2080

NOTES:

[a] Low Risk Aversion values were not used for this analysis

~ Approximately



SOURCE: OPC 2018

Figure ES-5
OPC (2018) Sea-Level Rise Guidance Curves, with Selected Scenarios

This Adaptation Plan considers potential impacts to public and private assets (e.g., buildings, roads, utilities, parks) from the following hazards:

- Coastal Erosion – permanent loss of sandy beaches, dunes, and the low-lying backshore that occurs with changing sea-level or sand supply.
- Coastal Bluff Erosion – permanent loss of coastal bluffs as material falls or collapses onto the beach or into the ocean below.
- Tidal Inundation – coastal flooding during regular high tides under non-storm conditions.
- Storm Waves – exposure of the coast to large waves generated by local and distant storms.
- Coastal Storm Flooding – high water levels that occur during coastal storm events. The Vulnerability Assessment Update analyzed the "100-year storm" event, which has a 1% chance of occurring each year.

Low-lying areas that may potentially be subject to tidal and storm flooding but are not directly connected to flooding sources were also identified in the Vulnerability Assessment Update. The hazards mapped were developed using the United States Geological Survey (USGS) Coastal Storm Modeling System (CoSMoS), with some data augmented by a regional sea-level rise study called Coastal Resilience Santa Barbara (ESA 2016).

Figures ES-6 through ES-13 illustrate the hazard areas under existing and future sea-level rise scenarios. Note that coastal erosion, bluff erosion, storm waves, and storm flooding occur episodically, particularly in response to extreme coastal storms during El

Niño events (Griggs and Russel 2012). The hazard maps account for these extreme events and show the projected areas of flood risk and cumulative erosion over time.

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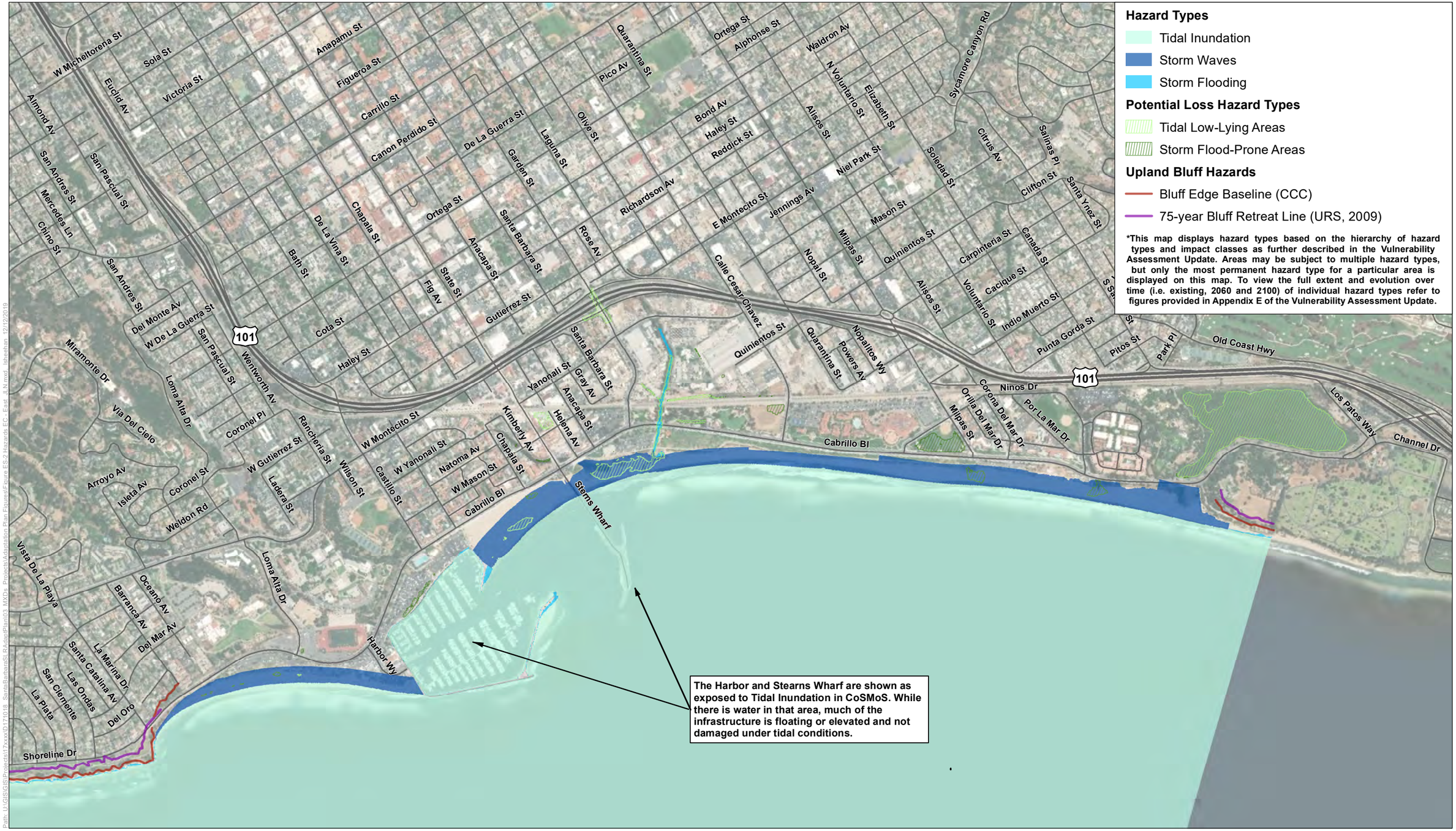


SOURCE: ESRI, 2018; USGS, 2018; ESA, 2018.

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-6
Existing Conditions Hazards (East)

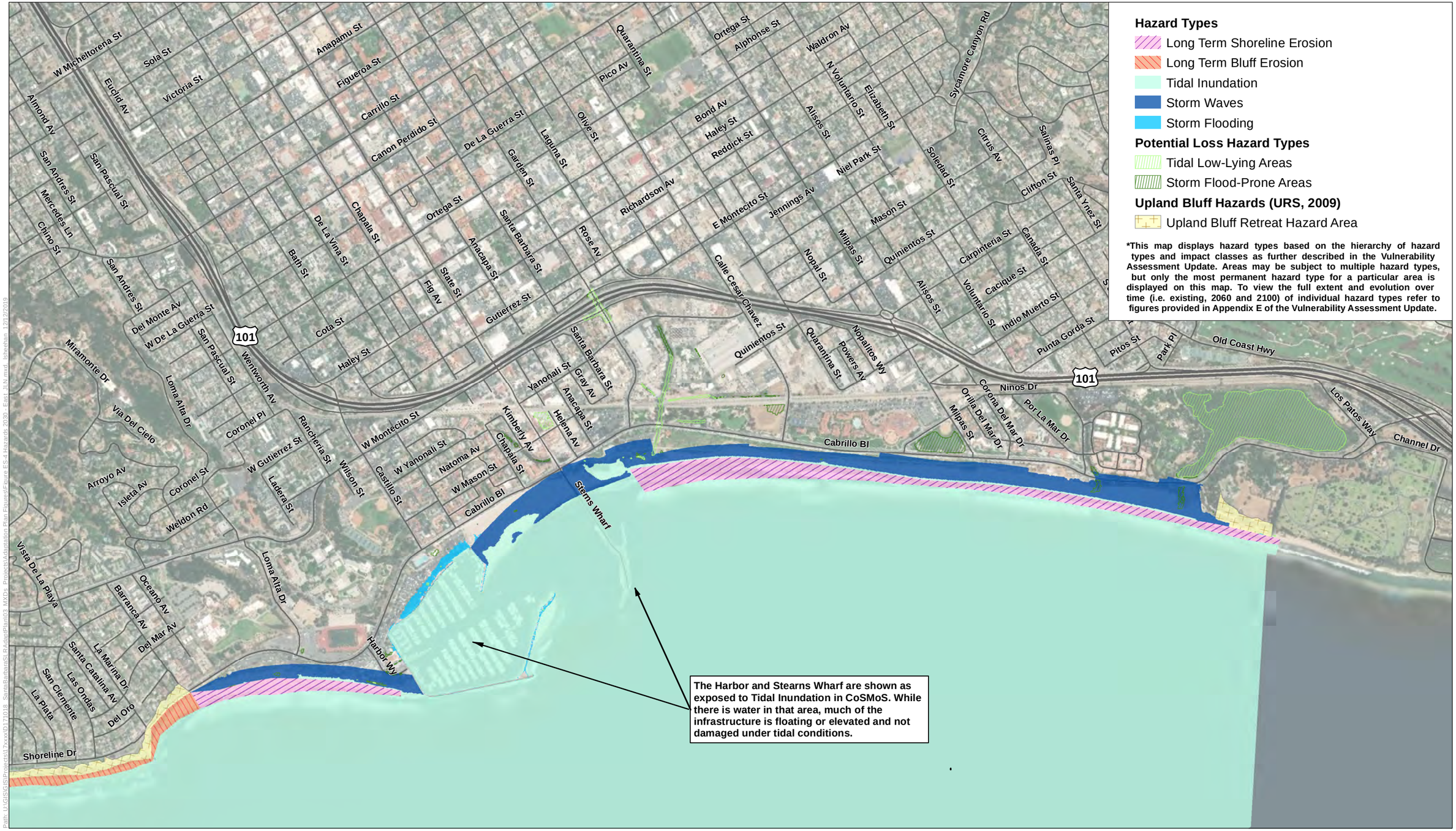
ESA

SOURCE: ESRI, 2018; USGS, 2018; ESA, 2018.

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-7
Existing Conditions Hazards (West)

ESA



SOURCE: ESRI, 2018; USGS, ESA, 2018.

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-8
Hazards with 0.8 Feet of Sea-Level Rise (±2030) (East)

ESA

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SOURCE: ESRI, 2018; USGS, 2018; ESA, 2018.

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-9
Hazards with 0.8 Feet of Sea-Level Rise (±2030) (West)

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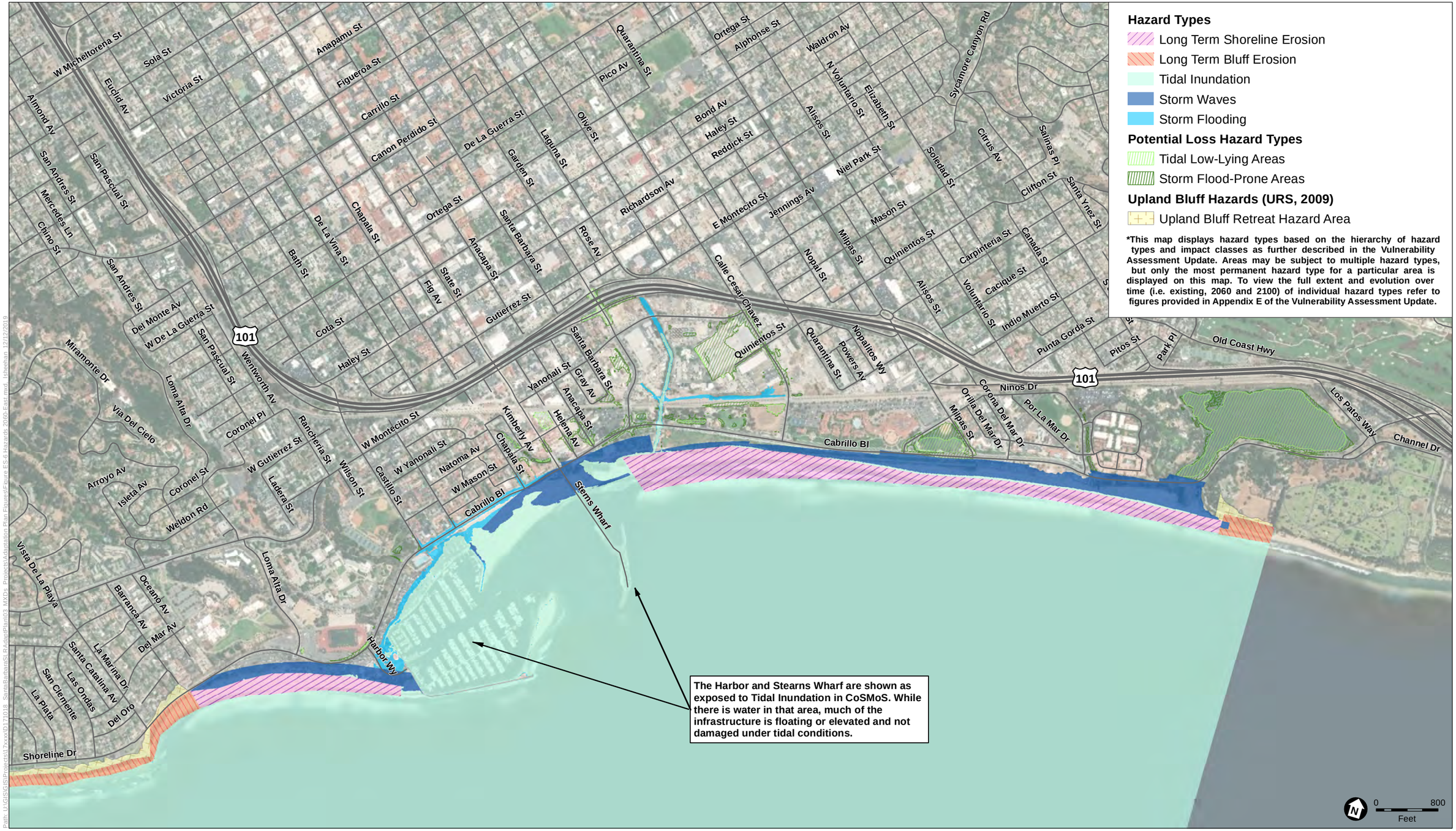

SOURCE: USGS, ESA

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-10
Hazards with 2.5 Feet of Sea-Level Rise (±2060) (East)

ESA

Hazard Types

- Long Term Shoreline Erosion
- Long Term Bluff Erosion
- Tidal Inundation
- Storm Waves
- Storm Flooding

Potential Loss Hazard Types

- Tidal Low-Lying Areas
- Storm Flood-Prone Areas

Upland Bluff Hazards (URS, 2009)

- Upland Bluff Retreat Hazard Area

***This map displays hazard types based on the hierarchy of hazard types and impact classes as further described in the Vulnerability Assessment Update. Areas may be subject to multiple hazard types, but only the most permanent hazard type for a particular area is displayed on this map. To view the full extent and evolution over time (i.e. existing, 2060 and 2100) of individual hazard types refer to figures provided in Appendix E of the Vulnerability Assessment Update.**

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SOURCE: USGS, ESA

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-11
Hazards.with 2.5 Feet of Sea-Level Rise (±2060) (West)

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Hazard Types

- Long Term Shoreline Erosion
- Long Term Bluff Erosion
- Tidal Inundation
- Storm Waves
- Storm Flooding

Potential Loss Hazard Types

- Tidal Low-Lying Areas
- Storm Flood-Prone Areas

Upland Bluff Hazards (URS, 2009)

- Upland Bluff Retreat Hazard Area

***This map displays hazard types based on the hierarchy of hazard types and impact classes as further described in the Vulnerability Assessment Update. Areas may be subject to multiple hazard types, but only the most permanent hazard type for a particular area is displayed on this map. To view the full extent and evolution over time (i.e. existing, 2060 and 2100) of individual hazard types refer to figures provided in Appendix E of the Vulnerability Assessment Update.**

The Harbor and Stearns Wharf are shown as exposed to Tidal Inundation in CoSMoS. While there is water in that area, much of the infrastructure is floating or elevated and not damaged under tidal conditions.

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SOURCE: USGS, ESA

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-12
Hazards with 6.6 Feet of Sea-Level Rise (±2100) (East)

ESA

SOURCE: USGS, ESA

City of Santa Barbara Sea-Level Rise Adaptation Plan for the LCP Update

Figure ES-13
Hazards with 6.6 Feet of Sea-Level Rise (±2100) (West)

ESA

GUIDING PRINCIPLES FOR ADAPTATION

The City's Sea-Level Rise Adaptation Plan Subcommittee, in consultation with City staff, developed the following principles to guide the prioritization and selection of adaptation strategies. These Guiding Principles provide a foundation upon which future project decisions could be made and help in evaluating how well adaptation actions could help meet established community values and expectations:

1. Prioritize:
    a. Protection of human life, health, and safety
    b. Critical facilities, public transportation systems, and public services for basic city functions
2. Minimize the impacts of sea-level rise and related hazards to:
    a. Coastal-dependent development
    b. Public access to and along the shoreline, beaches, parks, open spaces, and recreation
    c. Existing and future development
    d. The local economy
    e. Coastal resources
3. Design adaptation strategies that:
    a. Use best available science and technology
    b. Are flexible and which have processes for updates based on new information.
4. Ensure that adaptation strategies:
    a. Minimize the risks of coastal hazards
    b. Are legally, technically, and financially feasible
    c. Are consistent with federal and state laws
    d. Avoid, where feasible, or minimize impacts to coastal resources
    e. Do not preclude or prevent implementation of future adaptation strategies to address longer-term hazards
5. Encourage:
    a. Adaptation strategies that broadly protect the community's health, safety, and welfare.
    b. Equitable sharing of costs and benefits of sea-level rise and related hazards
    c. Adaptation strategies that benefit or minimize impacts to vulnerable populations that may have a higher sensitivity and lower adaptive capacity to hazards
    d. Adaptation strategies that have co-benefits, such as greenhouse gas reduction, resiliency to other climate change impacts, habitat protection or creation, protection and creation of recreation opportunities, improvements to coastal resources, or economic enhancement

e. Emergency response and recovery coordination that factor in increased hazards due to sea-level rise

f. Greenhouse gas reductions as a key aspect of resiliency planning.

g. Voluntary and proactive resilience actions through incentives such as streamlining permitting.

h. Adaptation strategies and programs that build coastal resiliency partnerships.

ADAPTATION APPROACH

This Adaptation Plan considers three planning horizons which are consistent with the sea-level rise scenarios presented in the Vulnerability Assessment Update:

1. ***Near-term***: 0–0.8 feet of sea-level rise (approximately 2020–2030).
2. ***Mid-term***: 0.8–2.5 feet of sea-level rise (approximately 2030–2060).
3. ***Long-term***: 2.5–6.6 feet of sea-level rise (approximately 2060–2100).

Vulnerabilities and recommendations for adaptation are summarized below by area or resource (**Figure ES-14**) of the city affected. Tables and figures at the end of each section below also summarize the recommendations.

In the near-term, it is recommended that the City develop and implement a Shoreline Monitoring Program in coordination with other regional, state, and federal agencies. The program should include:

- Monitoring of sea-level-rise-related hazards, including tracking of sea levels, future sea-level rise projections, groundwater levels, beach width, and bluff top position;
- Identification of action thresholds; and
- Regular reassessment of the need for implementation actions.

The program should be designed to be cost-effectively maintained. The program should also emphasize transparency and communicating the results to the public. All data should be available for public use and the results readily available.

SOURCE: ESA

Figure ES-14
Adaptation Plan Hazard Areas

Coastal Bluff Areas

Coastal bluffs extend along the westerly portion of the city's coastal zone from Sea Ledge Lane to Santa Barbara Point by Leadbetter Beach. There are also coastal bluffs at the far easterly portion of the city by the Bellosguardo Estate. Only a few small portions of the bluff area along the City's shoreline are currently protected by shoreline protection devices. Shoreline protection devices, such as seawalls and rock revetments, are structures along the coast that can provide flood and erosion protection for properties, but which can result in accelerated erosion of sandy beach areas in front of (seaward) and adjacent to the devices.

Historic coastal bluff erosion rates could increase by 40% with 2.5 feet of sea-level rise and 140% with 6.6 feet of sea-level rise. The increased erosion rates would threaten bluff-top infrastructure, private development, and public development. By 2.5 feet of sea-level rise, bluff erosion is expected to affect properties in the bluff-top residential neighborhoods, infrastructure at Shoreline Park, and portions of Shoreline Drive. By 6.6 feet of sea-level rise, erosion could extend to Shoreline Drive, Cliff Drive, and other bluff-top streets at several locations.

Most of the sandy beaches along the city's westerly coastal bluff areas are likely to be lost from beach erosion by 2.5 feet of sea-level rise.

Recommended near-term actions along the bluffs include the following:

- Closely monitoring beach and bluff erosion.
- Expansion of existing drainage best management practices to reduce the rate of bluff erosion from runoff and irrigation.
- Continuation of current policies that require bluff setbacks for new development and substantial redevelopment and limitations on the use of revetments except to protect essential public services, major public roads, and public beach access stairways.
- Relocation or removal of non-critical assets (e.g., pathways, benches) in Shoreline Park and Douglas Family Preserve.

Beach nourishment and sand retention structures could possibly preserve the beaches along the bluffs and reduce bluff erosion to a certain extent; however, due to high sediment transport rates and a relatively steep slope of the beach along the bluffs, the effectiveness and feasibility of beach nourishment and sand retention structures is questionable and would need to be analyzed further. Multiple sand retention structures (e.g., a groin field) along the bluffs are not expected to be a practical or economical approach to reduce bluff erosion. Focused use of sand retention structures could possibly help to maintain beach sand in select locations along the bluff (e.g., for access), but would likely increase erosion immediately down-current of the structure.

Installation of revetments along the bluffs in the near-term would likely substantially increase the rate of beach loss and limit near-term public access along the beaches. Because of high costs and difficulties associated with permitting, revetments are not recommended unless used to protect major public roads, essential public services, or public beach access stairways.

In the mid-term, erosion of public and private assets will accelerate and public use of many of the bluff-backed beaches will likely be lost to erosion. During the mid-term, the City could consider:

- Use of revetments and slope stabilization on a larger scale to protect Shoreline Drive, Cliff Drive, public access along the top of the bluffs, or a useable portion of Shoreline Park, or
- Removal and relocation of infrastructure, roads, and development.

Additional information and studies will be needed to inform selection of options in the mid and long-term. **Figure ES-15** summarizes the vulnerabilities and adaptation options for the coastal bluff areas.

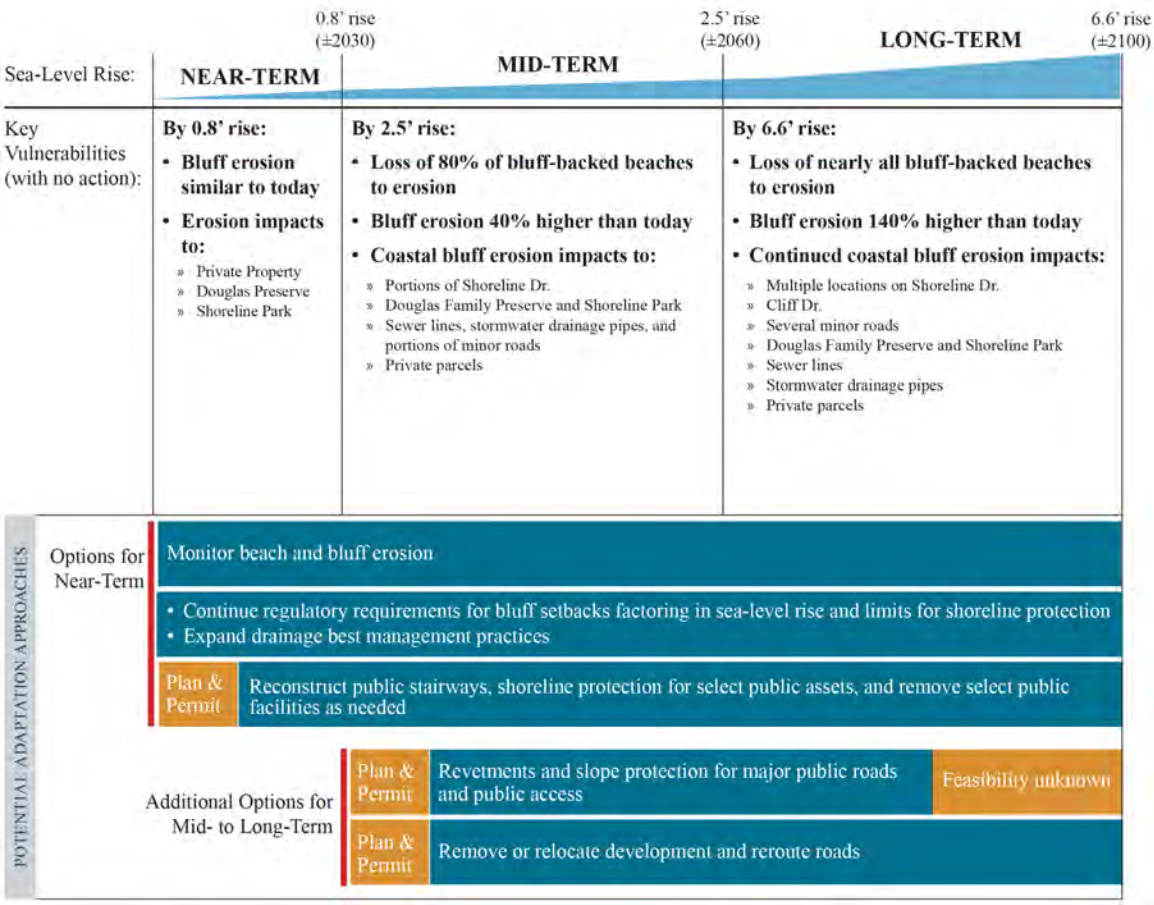

Figure ES-15
Bluff Adaptation Plan Framework

Low-Lying Waterfront and Beach Areas

The low-lying waterfront and beach areas are publicly owned and include Arroyo Burro Beach and the city's waterfront south of Cabrillo Boulevard spanning from Leadbetter Beach to East Beach.

While the beaches at the waterfront will not experience the same level of loss as the bluff areas due to the presence of the Harbor breakwater, sea-level rise will still cause increased levels of erosion, with East Beach most affected. If no action is taken, storm waves are expected to impact beach parking lots and Cabrillo Pavilion by 0.8 feet of sea-level rise. By 2.5 feet of sea-level rise, impacts from storm waves could extend to Shoreline Boulevard near Leadbetter Beach and Cabrillo Boulevard by Stearns Wharf. At 2.5 feet of sea-level rise, the Boathouse Restaurant at Arroyo Burro Beach could be

impacted by erosion and storm flooding. By 6.6 feet of sea-level rise, tidal inundation could extend along much of Cabrillo Boulevard northward to Highway 101.

In the near-term, it is recommended that the City optimize its existing sand bypassing and study expansion of its beach nourishment and seasonal sand berm programs at East Beach, Leadbetter Beach, and Arroyo Burro Beach. Regardless of any beach nourishment that occurs, the City will need to plan for either the relocation, floodproofing, or protection of major wastewater and water pipelines that are located south of Cabrillo Boulevard and possibly other assets. As public assets in this area are redeveloped, options to avoid hazard areas or mitigation of hazards through elevation of structures or flood walls should be considered.

In the mid and long-term, the City could consider options such as:

- Installation of large-scale shoreline protection devices or levees along the city's waterfront, either by raising Cabrillo Boulevard and Shoreline Drive or by installing a seawall along the waterfront;
- Relocation or removal of waterfront assets;
- Rerouting portions of Shoreline Drive and Cabrillo Boulevard; and
- Installation of groins or artificial reefs if additional studies show them to be feasible and effective.

Additional information and studies will be needed to inform selection of options in the mid- and long-term. **Figure ES-16** summarizes the vulnerabilities and adaptation options for the low-lying waterfront and beach areas.

Low-Lying Flood Areas

The low-lying flood areas are the areas north of Cliff Drive by Arroyo Burro Creek, north of Shoreline Drive by Santa Barbara City College, and north of Cabrillo Boulevard that are projected to be impacted by increased flooding as a result of sea-level rise.

Impacts are projected to be mostly limited to the area seaward of Cabrillo Boulevard, Shoreline Drive, and Cliff Drive with 2.5 feet of sea-level rise. By 6.6 feet of sea-level rise, however, flooding from regular high tides and coastal storms could extend north of Cabrillo Boulevard to Highway 101. Low-lying areas north of Highway 101 that currently flood during extreme storms could see a higher frequency of flooding during large coastal storms.

Low-Lying Waterfront and Beach Areas Adaptation Plan Framework

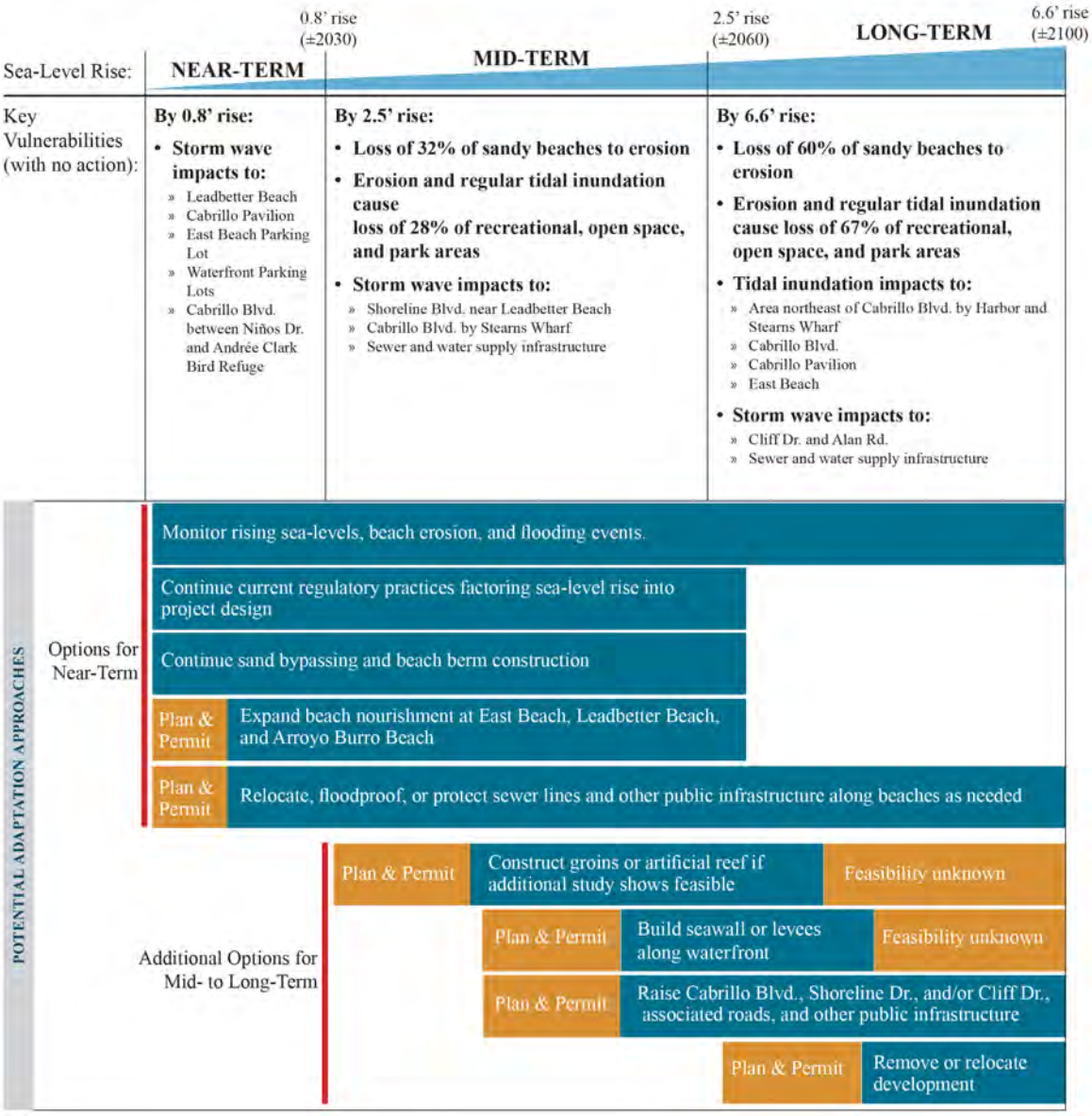

Figure ES-16
Low-Lying Waterfront and Beach Adaptation Plan Framework

In the near-term, it is recommended that the City reconstruct and redesign the tide gates and pumps at Laguna Creek. The City could also consider altering floodplain and building regulations to require new and substantially redeveloped buildings to be elevated or floodproofed to higher flood elevations, particularly south of Highway 101. The City could also consider changes to creek setbacks, particularly if additional studies on the interaction of sea-level rise and increased precipitation and creek flooding with climate change are conducted and indicate the need. Other additional studies needed include the effects of sea-level rise on groundwater levels, the potential for groundwater contamination to spread with changing water levels, and changes in rainfall patterns.

In the mid- and long-term, the City could consider options such as:

- Use of creek floodwalls,
- Groundwater pumping,
- Continuous seawalls or levees along the waterfront,
- Pumping of stormwater,
- Elevation and floodproofing of development, and
- Phased removal or relocation of development in tidal inundation areas.

Several additional studies will be needed to inform selection of options in the mid- and long-term. **Figure ES-17** summarizes the vulnerabilities and adaptation options for the low-lying flood areas.

Harbor and Stearns Wharf

By 2.5 feet of sea-level rise, the effects of sea-level rise could impede most Santa Barbara Harbor (Harbor) functions, high tides would exceed marina guide pile heights, and storm waves could significantly impact the Harbor if no action is taken. By 6.6 feet of sea-level rise, the Harbor would be unusable without major reconstruction.

Raising or modifying the Harbor breakwater, rock groin, and sandspit is recommended for the near-term and is the key to any other adaptation measures at the Harbor. The walkway and wall spanning from the breakwater to the Harbor commercial area should be raised or modified at the same time. The City should pursue U.S. Army Corps of Engineers (USACE) funding and assistance with these projects.

Renovation of the marinas and the City Pier (fueling dock) could be done in phases. All the marina piles need to be raised by the time 1 foot of sea-level rise occurs. The City Pier will need to be modified and raised by the time 0.5–1.0 foot of sea-level rise occurs.

At around 0.5 foot of sea-level rise, the City will need to consider how to protect the Harbor commercial area and parking lots. This could begin with raising the walkway or adding walls around the Harbor and along the beachfront. As structures are reconstructed, relocation and/or floodproofing should be considered. In the mid- and long-term, the City could consider options such as continuing to raise seawalls,

floodproofing development, raising the grades of the Harbor commercial area and parking lots, or removal or relocation of certain Harbor facilities.

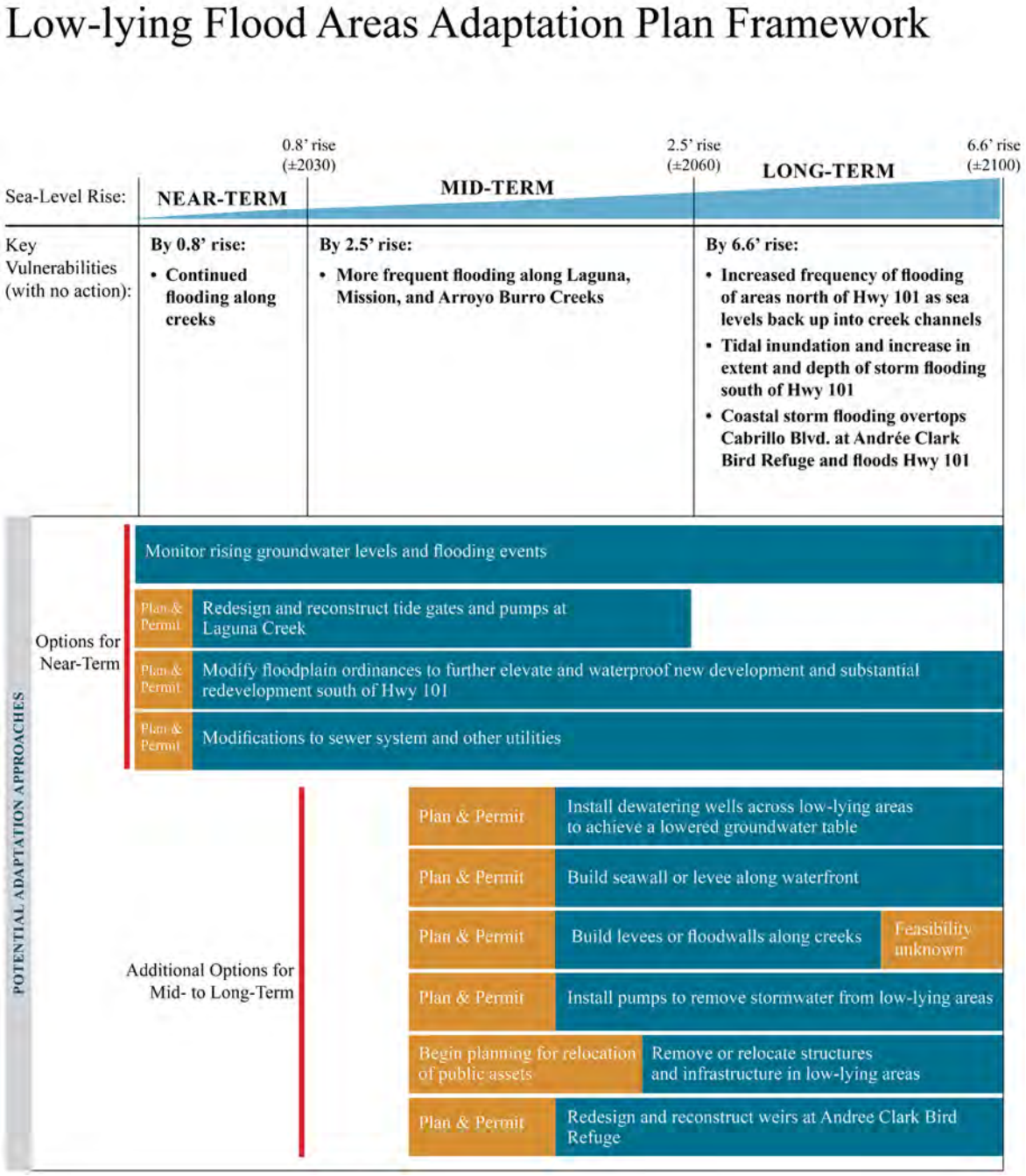

Figure ES-17
Low-Lying Flood Area Adaptation Plan Framework

Stearns Wharf is already at risk for damage under extreme coastal storm events. It is likely that by 2.5 feet of sea-level rise, storm waves would have already significantly damaged the wharf, as currently constructed. In the near-term, the City should initiate further studies to inform either reconstructing, relocating, or removing Stearns Wharf when the hazard impacts become too great. **Figure ES-18** summarizes the vulnerabilities and adaptation options for the Harbor and Stearns Wharf.

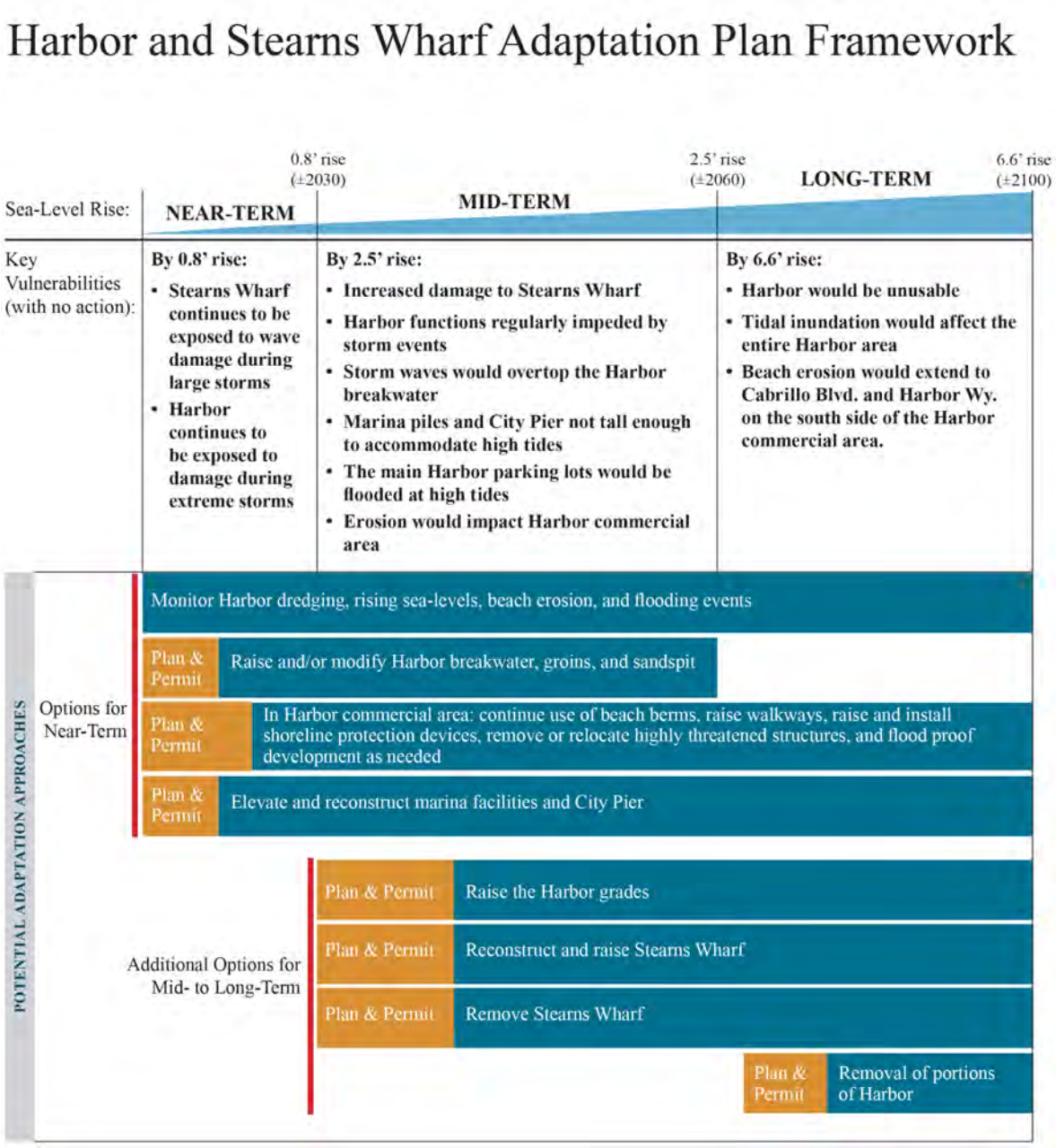

Figure ES-18
Harbor and Stearns Wharf Adaptation Plan Framework

Major Infrastructure

The El Estero Water Resource Center is located on a property higher in elevation than surrounding areas. The primary issue in the next thirty years or so, therefore, is not the plant itself, but the collection and distribution systems feeding into and out of the plant. By 2.5 feet of sea-level rise, portions of the wastewater system south of Cabrillo Boulevard could be affected by tidal inundation and storm flooding. If no action is taken, El Estero Water Resource Center would be permanently inoperable as currently designed by 6.6 feet of sea-level rise. This would impact wastewater service and recycled water service for the City's entire service area, including service to inland residential and commercial areas.

While the Vulnerability Assessment Update and this Adaptation Plan contain some information about exposure of the City's wastewater and recycled water systems, it is recommended that, in the near-term, the City initiate a comprehensive study of vulnerabilities and adaptation options for the wastewater, water, recycled water, and stormwater systems. The study should include possible redesign of portions of the systems, possible service point improvements, and options for the El Estero Water Resource Center. In the near-term, the City should also study specific options for relocation and/or floodproofing of major wastewater, water, and utility lines and infrastructure south of Cabrillo Boulevard.

The Charles E. Meyer Desalination Plant is located north of the El Estero Water Resource Center and is not likely to be exposed to increased hazards by 2.5 feet of sea-level rise, but is likely to be exposed to tidal inundation and storm flooding by 6.6 feet of sea-level rise if no action is taken. When the facility is due for major renovations (20–30 years), the City should consider options such as berms and floodwalls, or relocating the facility.

Most major streets in the coastal areas are not likely to be significantly impacted by 2.5 feet of sea-level rise; however, some protection may be needed at select locations along Shoreline Drive and Cabrillo Boulevard. However, by 6.6 feet of sea-level rise, portions of Cabrillo Boulevard, Shoreline Drive, Cliff Drive, and Highway 101 could be impacted by erosion, tidal inundation, or storm flooding if no action is taken. Additionally, the Union Pacific Railroad is projected to be exposed to tidal inundation and storm flooding at multiple locations by 6.6 feet of sea-level rise. Adaptation options for these transportation corridors match with the adaptation options identified for each hazard area they are located in (see above) and include options such as raising roads and the railroad, use of seawalls and revetments, and rerouting of transportation corridors as necessary.

SOCIOECONOMIC, ECONOMIC, AND FISCAL IMPACTS

In total, approximately 1,250 parcels could be impacted by increased levels of flooding and erosion with 6.6 feet of sea-level rise. In addition, increased flooding could potentially impact socially and economically vulnerable populations in the lower westside and eastside neighborhoods that could have a lower capacity to respond and adapt to hazards.

A Benefit-Cost Analysis prepared by AECOM (Appendix B) estimates that if no action is taken to mitigate hazards, the cumulative economic, fiscal, business, and direct property impacts from now through to 6.6 of sea-level rise (approximately 2100) could be as much as $4.1 billion (2018 dollars and values). As analyzed in the Benefit-Cost Analysis, implementing adaptation strategies to protect development in place would result in the avoidance of many of these economic and fiscal impacts, but would also be very costly. In some cases, costs of protection can outweigh the economic and fiscal impacts avoided. Moving forward, the City will need to be selective in choosing adaptation actions. A key step moving forward with implementation will be prioritizing adaptation actions and closely looking at costs, funding options, and relative benefits of various projects as they are proposed.

NEAR-TERM ACTIONS AND NEXT STEPS

The following are recommended potential near-term (0–0.8 feet of sea-level rise; approximately 10 years) actions to address the hazards associated with sea-level rise. Actions that are important to initiate in the next five years are preliminary designated below as “high priority in the next five years.” Actions that are of the highest priority to initiate in the first few years of implementation are bolded. In addition to the near-term actions listed below, all projects proposed near the potential hazard areas outlined in the Adaption Plan should be developed with consideration for how they affect or may be impacted by the phased sea-level rise adaptation approach presented in this plan.

The immediate next step that the City should take is the development of a Five-Year Implementation Plan that prioritizes and further refines these actions and identifies potential costs, funding options, timelines, resources needed, and responsible staff for each action. Implementation of adaptation actions will require continuous tracking to measure effectiveness. Changing conditions, changes in best available science, new technologies, new funding sources, and changes in community priorities will necessitate regular reevaluation of appropriate adaptation strategies and, potentially, identification of new strategies. The Five-Year Implementation Plan should be regularly updated as projects are scoped and undertaken and in response to finding from the proposed Shoreline Monitoring Program. Reevaluation of the overall Adaptation Plan is then recommended to occur approximately every five to ten years in response to substantive new information, such as major updates to the State of California Sea-Level Rise Guidance sea-level rise projections. As the City further develops its Adaptation Program, emphasis should be placed on public transparency and outreach.

During implementation, specific near-term actions recommended in this Adaptation Plan would be further scoped and developed by the City department with the expertise needed for the project, and the normal City approval process associated with each particular action would be undertaken. There is a need, however, for a central staff team to coordinate the Adaptation Program, including leading studies, developing the Shoreline Monitoring Program, developing the five-year implementation plan, tracking progress, tracking funding, sharing relevant information, and conducting public education and outreach.

Citywide Actions	
High Priority for Next Five Years	• Develop and regularly update a Five-Year Implementation Plan that further refines and prioritizes actions and identifies potential costs, funding options, timelines, resources needed, and responsible staff for each action. • Reevaluate the Adaptation Plan approximately every five to ten years and amend the plan based on changed conditions, changes in best available science, new technologies, new funding sources, and changes in community priorities. • **Develop and implement a Shoreline Monitoring Program in coordination with other regional, state, and federal agencies. The program should include: monitoring of sea-level-rise-related hazards; identification of action thresholds; and regular reassessment of the need for implementation actions. The program should emphasize public understanding and transparency. All data should be available for public use and the results readily available*. (Highest Priority)*** • Amend or create City administrative policies, procedures, initiatives, and staffing to implement the Adaptation Plan and ensure consistency in approach for addressing sea-level rise citywide. • Track grant programs and vigorously pursue other funding sources for implementation. • **Amend the City's Hazard Mitigation Plan to include potential adaptation actions so that the City is eligible for federal funding for adaptation projects. *(Highest Priority)*** • Initiate amendments to update the City's Local Coastal Program, General Plan, Climate Action Plan, and the Municipal Code to implement Adaptation Plan policies and to incorporate adaptation to sea-level rise into hazard maps and development standards. • Incorporate adaptation actions into the City's Capital Improvement Program. • Engage with the California State Legislature's office, the Governor's office, and California State Legislature Representatives on local needs, funding, and legislative changes related to sea-level rise adaptation. • Coordinate with regional, state, and federal agencies on monitoring, joint studies, and implementation of adaptation strategies. • Participate in regional and statewide climate collaboratives. • Maintain a working group composed of key City departmental staff involved in adaptation planning for the City. • Maintain a Sea-Level Rise Subcommittee comprised of members of City council and relevant City advisory bodies and commissions to guide adaptation planning for the City. • Engage with the community and stakeholders during Adaptation Plan and Local Coastal Program updates and implementation of adaptation projects. • Identify funding sources to assist property owners with adaptation. • Continue and expand public education on sea-level rise and adaptation. • Where appropriate, include hazard disclosures and risk indemnifications in conditions of approval for permits and other City documents such as parcel information documents and databases, leases, or service contracts to properties in hazard areas. • Consider amending the City's legislative platform and working with the State to include information about the hazards related to sea-level rise in real estate disclosures. • Research and monitor case studies, laws, and court cases that may affect implementation of the Adaptation Plan. • Further study the socioeconomic impacts of sea-level rise and potential adaptation options.

Coastal Bluff Areas (see Section 6)	
	• For new development and substantial redevelopment, continue the current regulatory practice of requiring bluff setbacks that factor in accelerated bluff erosion rates from • Continue the current regulatory practice of limiting the construction of shoreline protection devices where feasible, except when necessary to protect essential public
Additional Actions	• Expand best management practices to reduce the rate of bluff erosion as a result of runoff and irrigation. • Plan for removal, relocation, or, as needed, protection of public assets and natural resources in Shoreline Park and Douglas Family Preserve. • Plan for repairs or replacement of public access beach stairways as needed. • Plan for protection of Shoreline Drive at select locations when erosion levels trigger action. • Further study safe bluff setbacks and trigger distances, which will be used to inform the City on when adaptation measures are needed. • Further study whether slope protection measures along the upper bluff face (gunite, soldier piles, etc.) would be needed in addition to shoreline protection at the base of bluffs to protect major public roads and bluff-top access areas in the mid- and long-term.

Low Lying Waterfront and Beach Areas (see Section 7)	
High Priority for Next Five Years	• Monitor rising sea-levels, beach erosion, and flooding events (see Shoreline Monitoring Program above). • **Study and implement options to optimize existing sand bypassing and beach berm construction programs at East Beach and Leadbetter Beach. Monitor amounts of bypassed sand regionally. *(Highest Priority)*** • **Study and implement additional beach nourishment, additional seasonal sand protective berms, or formation of dunes at East Beach, Leadbetter Beach, and Arroyo Burro Beach. *(Highest Priority)*** • Work with the Beach Erosion Authority for Clean Oceans and Nourishment to update the 2009 Coastal Regional Sediment Management Plan to factor in changes associated with sea-level rise. • Continue current regulatory practice of limiting uses in the low-lying waterfront and beach areas and requiring that new development and substantial redevelopment be designed to avoid or mitigate hazards associated with sea-level rise.
Additional Actions	• As needed, consider options such as shoreline protection, floodproofing, and removal or relocation of select public facilities as they are redeveloped or become threatened. • Further study specific beach width thresholds for initiating consideration and planning for large-scale adaptation options along the waterfront and beach area.

Low Lying Flood Areas (see Section 8)	
	• Monitor rising groundwater levels and flooding events (see Shoreline Monitoring • **Redesign and reconstruct the Laguna tide gate and pump system. (Highest** • Study extreme rainfall runoff and creek discharge flooding in Laguna Channel with • Consider changes to the City's floodplain ordinance in flooding areas impacted by sea-level rise. In particular, consideration should be given to requiring additional floodproofing of new development and substantial redevelopment in the areas south of Highway 101 that could, as a result of sea-level rise through the long-term (6.6 feet of sea-level rise), experience tidal inundation and storm flooding levels that are deeper and more extensive than those currently mapped on FEMA Flood Insurance • Develop incentives for floodproofing and raising existing structures in areas at risk of increased flooding (e.g. potential permit streamlining or relief from design, zoning, or
Additional actions	• Study changes in flooding as a result of: (1) riverine flood events interacting with higher sea levels and (2) changes in rainfall and riverine flooding due to climate change. Develop monitoring and adaptation thresholds for creek flooding. • Evaluate whether existing creek and estuary development setbacks and other development regulations near creeks (e.g. bridge designs) are adequate based on impacts of sea-level rise and changes in riverine flooding from climate change. • Study existing groundwater elevations, the freeboard from typical levels up to a flood threshold, and potential impacts of sea-level rise. Study the potential of raised groundwater levels to spread contamination in soils and groundwater. Study the feasibility of groundwater pumping to lower the water table. • Further study feasibility of creek floodwalls, tide gates, continuous seawall, levees, or other identified measures to prevent inundation and storm flooding. Incorporate habitat considerations into designs to the extent feasible.

Harbor (see Section 9)	
High Priority for Next Five Years	• Monitor Harbor dredging, rising sea-levels, beach erosion, and flooding events (see Shoreline Monitoring Program above). • **Raise or modify the Harbor breakwater, rock groin, sandspit, and the walkway and wall spanning from the breakwater to the Harbor commercial area. Pursue Army Corps of Engineers feasibility studies, funding, and assistance with these projects. *(Highest Priority)*** • **Renovate marina facilities and the City Pier in phases. All marinas piles need to be raised by the time 1 foot of sea-level rise occurs. The City Pier needs to be modified and/or raised by the time 0.5–1.0 foot of sea-level rise occurs. *(Highest Priority)*** • Continue use of beach berms and consider additional beach or dune nourishment south of the Harbor commercial area. • Continue the current regulatory practice of limiting uses in the Harbor and requiring that new development and substantial redevelopment be designed to avoid or mitigate the impacts associated with sea-level rise.

Harbor (see Section 9)	
Additional Actions	• As needed, consider raising existing seawalls, adding new shoreline protection, floodproofing development, and removing or relocating structures as they are either redeveloped or become threatened. • At 0.5 foot of sea-level rise, start planning for the protection of the Harbor commercial area and parking lots. This could start with raising the walkway or raising/adding walls around the Harbor and along the beachfront. In the mid-term, options to study could include raising Harbor grades and elevating and floodproofing structures.

Stearns Wharf (see Section 9)	
High Priority for Next Five Years	• **Study appropriate triggers for temporarily closing Stearns Wharf during major storms and other safety measures. *(Highest Priority)***
Additional Actions	• At 0.5–1.0 foot of sea-level rise, prepare alternatives analysis considering raising, relocating, redesigning, or removing the Wharf. Study should also assess thresholds for initiating actions on Stearns Wharf based on acceptable levels of risk.

Major Infrastructure (see Section 10)	
High Priority for Next Five Years	• Monitor utility system and transportation system interruptions, rising sea-levels, beach erosion, and flooding events (see Shoreline Monitoring Program above). • **Study options for relocation and/or flood proofing of major wastewater, water, and utility lines and infrastructure south of Cabrillo Boulevard. *(Highest Priority)*** • Initiate a comprehensive study of adaptation options for threatened portions of the wastewater system, including redesign of portions of the system, adaptation options for El Estero Water Resource Center, and possible service point improvements.
Additional Actions	• Study the potential impacts to the stormwater system from sea-level rise and possible adaptation options. • Study the potential impacts to the water system from sea-level rise and possible adaptation options. • Coordinate with electrical and natural gas utility providers to further assess potential impacts and adaptation options for the energy transmission and distribution systems.