# City of Pismo Beach
# Local Coastal Program/General Plan Update

# Sea Level Rise Adaptation Plan

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# Acronyms and Abbreviations

| | |
|---|---|
| CCC | California Coastal Commission |
| CCSMW | California Coastal Sediment Management Workgroup |
| CDIP | Coastal Data Information Program |
| CIP | Capital Improvement Plan |
| CRSMP | Coastal Regional Sediment Management Plan |
| City | City of Pismo Beach |
| cm | centimeter |
| COAST | Coastal One-line Assimilated Simulation Tool |
| CoSMoS | Coastal Storm Modeling System |
| cy | cubic yards |
| cy/yr | cubic yards per year |
| EPA | U.S. Environmental Protection Agency |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| ft | Foot/Feet |
| ft/yr | feet per year |
| GIS | Geographic Information System |
| GP | General Plan |
| H++ | Extreme SLR scenario due to rapid Antarctic ice sheet mass loss (Sweet et al, 2017) |
| $H_s$ | Significant Wave Height |
| HMA | Hazard Mitigation Assistance |
| in | inch |
| IP | Implementation Plan |
| IPCC | Intergovernmental Panel on Climate Change |
| LCP | Local Coastal Program |
| LCPAC | Local Coastal Program Advisory Committee |
| lf | linear foot |
| LHMP | Local Hazard Mitigation Plan |
| LUP | Land Use Plan |
| m | meter |
| M&N | Moffatt & Nichol |

| | |
|---|---|
| MHHW | mean higher high water |
| MLLW | mean lower low water |
| MSL | mean sea level |
| NAVD 88 | North American Vertical Datum of 1988 |
| NE | northeast |
| NFIP | National Flood Insurance Program |
| NOAA | National Oceanic and Atmospheric Administration |
| OCOF | Our Coast, Our Future |
| OPC | Ocean Protection Council |
| PCH | Pacific Coast Highway |
| RSM | Regional Sediment Management |
| RV | recreational vehicle |
| SLOCOG | San Luis Obispo Council of Governments |
| SLR | sea level rise |
| SW | southwest |
| USACE | United States Army Corps of Engineers |
| USGS | United States Geological Survey |
| VA | Vulnerability Assessment |
| WWTP | Wastewater Treatment Plant |
| yr | year |

# Executive Summary

Sea level rise (SLR) poses a unique adaptation challenge for cities throughout California. This Adaptation Plan lays the foundation for an adaptive management approach to addressing SLR within the City of Pismo Beach. Near-term adaptation strategies are included to address vulnerabilities identified for existing hazards and those projected for a 1.6-ft SLR scenario. Potential long-term SLR adaptation strategies for various portions of the City are also outlined. Though the vulnerabilities identified for long-term SLR projections are significant, there is time to plan, fund, and implement adaptation strategies in response to these evolving hazards.

## SLR Adaptation Overview

Changing coastal hazards due to SLR can be addressed in a number of different ways including hazard protection, accommodation, and retreat. Protection refers to strategies that employ an engineered structure or other measure to defend existing development from future SLR hazards without changes to the development itself. Accommodation refers to strategies that involve modifying existing development or designing new developments in a way that reduces the potential future impacts of SLR. Adaptation strategies centered on retreat focus on measures to relocate or remove existing development from identified high-hazard areas, while also limiting the construction of any new development in hazardous areas. In practice, SLR adaptation often relies on hybrid approaches that combine elements from multiple categories over different spatial and temporal scales.

One of the primary functions of this Adaptation Plan is to provide a bridging document between the information presented in the Vulnerability Assessment (VA) and the policies and ordinances included in the updated General Plan/Local Coastal Program (GP/LCP). Potential planning-level SLR adaptation measures could include the establishment of SLR hazard zones, ongoing public outreach and education efforts, and measures to coordinate adaptation efforts among the multiple stakeholders involved in the management of coastal resources. A variety of policy measures can also be included in the GP/LCP to accomplish the following goals: understand SLR hazards, managing development within potential SLR hazard zones, mitigating coastal hazard impacts due to SLR, and maximizing the protection of coastal resources throughout the SLR adaptation process.

## Preferred SLR Adaptation Approach

- **Integrate SLR into existing Capital Improvement Planning (CIP) processes:** Incorporating the probability of SLR and coastal hazards into the CIP process through measures such as identifying a design life and risk tolerance for various CIP investments provides an effective way to ensure public projects account for future hazard risks. These projects also present opportunities to include strategies to increase resilience and build adaptive capacity into coastal resources where feasible.

- **Participate in county-level sediment management planning efforts:** Exploring opportunities for beach nourishment in collaboration with other local jurisdictions such as San Luis Obispo County or the Port San Luis Harbor District could help mitigate some of the near-term impacts associated with coastal squeeze. The Coastal Regional Sediment Management Plan (CRSMP) identifies multiple areas of interest in Pismo Beach where placement of sediment dredged from Port San Luis could reduce the threat of coastal erosion. Developing a local or regional beach and bluff monitoring program would also be a useful way to gather data that will greatly benefit the implementation, evaluation, and adjustment of future SLR adaptation measures. This monitoring program could also be coupled with an effort to inventory and evaluate the existing shoreline protection infrastructure throughout the City to estimate remaining design life and capacity to function under near-term SLR scenarios. Based on this information, maintenance and improvement timelines can be developed as well as an initial feasibility analysis of alternatives to shoreline protection.
- **Continue participation in county level hazard planning documents:** The San Luis Obispo County Local Hazard Mitigation Plan (LHMP) is a regional planning document where the effects of SLR on coastal hazards can be incorporated into adaptation strategies to benefit multiple jurisdictions. Participation in the National Flood Insurance Program (NFIP) and the LHMP update process also presents opportunities for pre-disaster mitigation funding from FEMA that could reduce fluvial flood hazards along Pismo Creek and increase the areas adaptive capacity for SLR.
- **Incorporate SLR into local hazard mitigation policies:** SLR can be incorporated into several existing City hazard mitigation policies and practices to reduce the impacts of changing coastal hazards. Potential policy updates include developing local definitions for key terms such as existing development, redevelopment, and new development as well as accounting for SLR in policies related to development in proximity to bluff erosion hazards and development within the 100-year floodplain.

### Phased SLR Adaptation Plan

Developing a phased adaptation approach can provide a flexible implementation mechanism for future SLR adaptation efforts. A key benefit of a phased adaptation approach is that the timing of phases can be adjusted as new SLR hazard information becomes available, mitigating the uncertainty surrounding long-term SLR projections. An example of a phased series of SLR adaptation strategies is provided in Table 2.

*Table 1: Example of a phased SLR adaptation approach for the City of Pismo Beach.*

| SLR Scenario | Adaptation Trigger | Adaptation Measures[1] |
|---|---|---|
| 0ft | N/A | • Incorporate SLR into Capital Improvement Planning and updated GP/LCP documents.<br>• Evaluate fluvial flood hazard reduction measures that increase adaptive capacity to SLR.<br>• Evaluate existing shoreline and bluff protection structures.<br>• Develop bluff and beach width monitoring programs.<br>• Explore opportunities for beach nourishment. |
| 1.6ft | • Sustained loss of beach fronting Downtown or Bluffs.<br>• Increased rate of bluff erosion.<br>• Coastal storm flooding in development adjacent to Pismo Creek. | • Pursue beach nourishment opportunities to maintain beach width in Downtown or Bluffs study area.<br>• Dry floodproofing retrofits to Downtown structures in high-hazard areas.<br>• Shoreline and bluff protection improvements in critical areas, where no feasible alternative is available.<br>• Improve drainage and utilize deployable flood barriers within Low-Lying study area.<br>• Develop a shoreline management program to identify specific adaptation measures to be applied along the Downtown waterfront in response to SLR scenarios of 3.3 ft or more. |
| 3.3ft+ | • Inundation of Downtown beach area during spring tides.<br>• Limited non-storm flooding within Low-Lying study area.<br>• Loss of bluff-backed beach areas. | • Adjust any shoreline management program as needed to account for additional coastal hazard impacts.<br>• Implement flood hazard mitigation measures along Pismo Creek. Develop long-term plan for adapting low-lying resources to SLR scenarios higher than 3.3 ft.<br>• Evaluate feasible alternatives for at-risk buildings and infrastructure within Bluffs study area. |

1. Measures listed for each progressive SLR scenario may be necessary only if previously implemented measures become insufficient based on performance and hazard monitoring

# 1. Introduction

Sea level rise is unique among other natural hazards because it is a slow-moving disaster of uncertain magnitude that will develop over the span of decades, the impacts of which will be permanent. Initially, SLR may be difficult to distinguish among the variable water levels, wave climate and dynamic littoral processes of Pismo Beach, but even small amounts of SLR will increase bluff and shoreline erosion hazards and fluvial flooding, which threaten a variety of coastal resources today.

The Sea Level Rise Vulnerability Assessment (VA) and this Adaptation Plan are informational documents that lay the foundation for an adaptive management approach to addressing SLR in the updated General Plan and Local Coastal Program, as well as other hazard management plans prepared at the County level, or for other jurisdictions. A range of potential adaptation strategies are described in this document to assist the City with developing policies and programs that will govern development in the coastal zone of Pismo Beach over the next several decades.

Adaptation strategies come in a variety of forms and may include planning measures, policy measures and specific projects intended to mitigate vulnerability to current and future coastal hazards. Near-term adaptation strategies described in this plan represent an initial phase of adaptation, occurring over the next 30 years, and are intended to address vulnerabilities identified for existing hazards and those projected for a 1.6-ft SLR scenario. The list of adaptation strategies is not intended to be fully exhaustive nor exclusive but provides a range of typical strategies implemented to address natural hazards such as coastal erosion and flooding.

The vulnerabilities identified for SLR projections of 3.3 ft and higher are overwhelming, but unlikely to occur until the end of the century or later. Given the long-term planning horizon associated with these scenarios, there is time to plan, fund and implement adaptation strategies in response to the evolving hazards. SLR of this magnitude would result in significant vulnerabilities to the entire coastline of Pismo Beach and require more consequential adaptation strategies as a result. Several long-term adaptation strategies are discussed in this plan and may come in the form of protection, accommodation, retreat, or a combination of these approaches.

A variety of coastal resources exist along Pismo Beach. Public and private coastal development is present along most of the coastline and will be vulnerable to increasing coastal hazards, most notably erosion. In many locations, these hazards have been mitigated with shoreline protective devices. Resources seaward of these protective devices, such as coastal access amenities, beaches, and environmental resources will be increasingly vulnerable to “coastal squeeze” as rising water levels encroach upon non-erodible structures. A key challenge of sea level rise adaptation in Pismo Beach will be balancing the trade-offs associated with each strategy on the wide variety of coastal resources. This plan provides an overview of the benefits and challenges associated with each strategy to highlight the potential impacts on different resource categories.

## 1.1 Guiding Principles for Adaptation Planning

Sea level rise adaptation will be most effective if integrated into the systems, programs, and planning efforts conducted by the City of Pismo Beach. Based on extensive community outreach and engagement, the following vision was developed by the City of Pismo Beach and will guide the goals, policies, and actions of the updated General Plan/Local Coastal Program:

"*Provide a safe place; maintain its small beach town character; manage growth effectively; and enhance a vibrant tourist-based economy, while becoming a world-renowned tourist destination.*" - Adopted by the Pismo Beach City Council, February 5, 2013

This vision statement, originally adopted in 2013, was reconfirmed through outreach conducted as part of the Fiscal Year 2020 and 2021 budgeting process. Based on this vision, the following principles have been developed to guide the adaptation planning process:

- Reduce potential for loss of life, health and property from current and future coastal hazards.
- Promote responsible growth and resilient development, especially in areas exposed to current and future coastal hazards.
- Preserve environmental resources, access and recreation opportunities along the coast which help make Pismo Beach an iconic tourist destination.
- Pursue opportunities to increase adaptive capacity of coastal resources through local projects (i.e., Capital Improvement Plan) and regional projects.
- Account for the uncertainty and probability associated with sea level rise and coastal hazards to develop adaptation strategies that are flexible and account for the risk tolerance of vulnerable coastal resources.

## 1.2 SLR Hazard Overview

The Sea Level Rise Vulnerability Assessment (VA) described how rising sea levels and coastal hazards could impact coastal resources in Pismo Beach. The VA informs adaptation planning by outlining potential consequences and key SLR thresholds, which can be used to support policies and adaptation strategy development aimed at mitigating these potential consequences. The vulnerability of an individual asset or resource is dependent on three factors:

- Exposure to coastal hazards (shoreline erosion, flooding, and inundation);
- Sensitivity to coastal hazards (potential for damage or loss of function); and,
- Adaptive capacity (ability to adapt to changing coastal hazards).

The degree to which exposure, sensitivity, and adaptive capacity contribute to a resource's vulnerability is important when considering adaptation strategies. Effective adaptation strategies will reduce exposure and sensitivity while increasing adaptive capacity. For example, if exposure is the key driver of vulnerability, then adaptation strategies such as protection or managed

retreat (relocation away from hazard zones) could be effective adaptation strategies. If sensitivity is a key driver, then resource-focused adaptation strategies such as accommodation, which aim to reduce the consequence of hazard exposure, may be effective.

### 1.2.1 Study Areas

In order to capture the variety of coastal settings, littoral processes, and coastal resources found within Pismo Beach, the study evaluated SLR vulnerability across three coastal reaches: the bluff-backed beaches northwest of the Downtown waterfront (Bluffs Study Area), Pismo State Beach and the Downtown waterfront itself (Downtown Study Area), and the low-lying areas southeast of Pismo Creek (Low-Lying Study Area). The typical shoreline profiles of each area are shown in Figure 1-1 with a plan view extent of the study reaches shown in Figure 1-2.

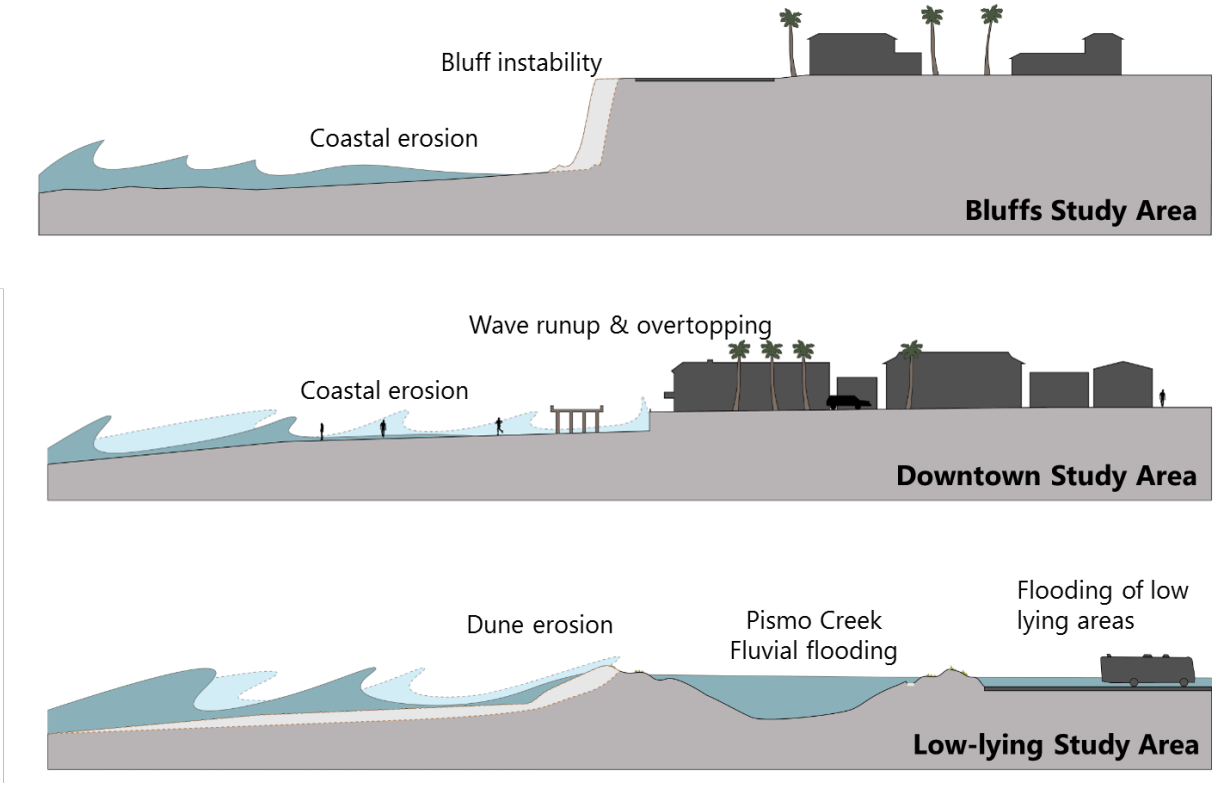



*Figure 1-1: Typical shoreline profiles of each Study Area*

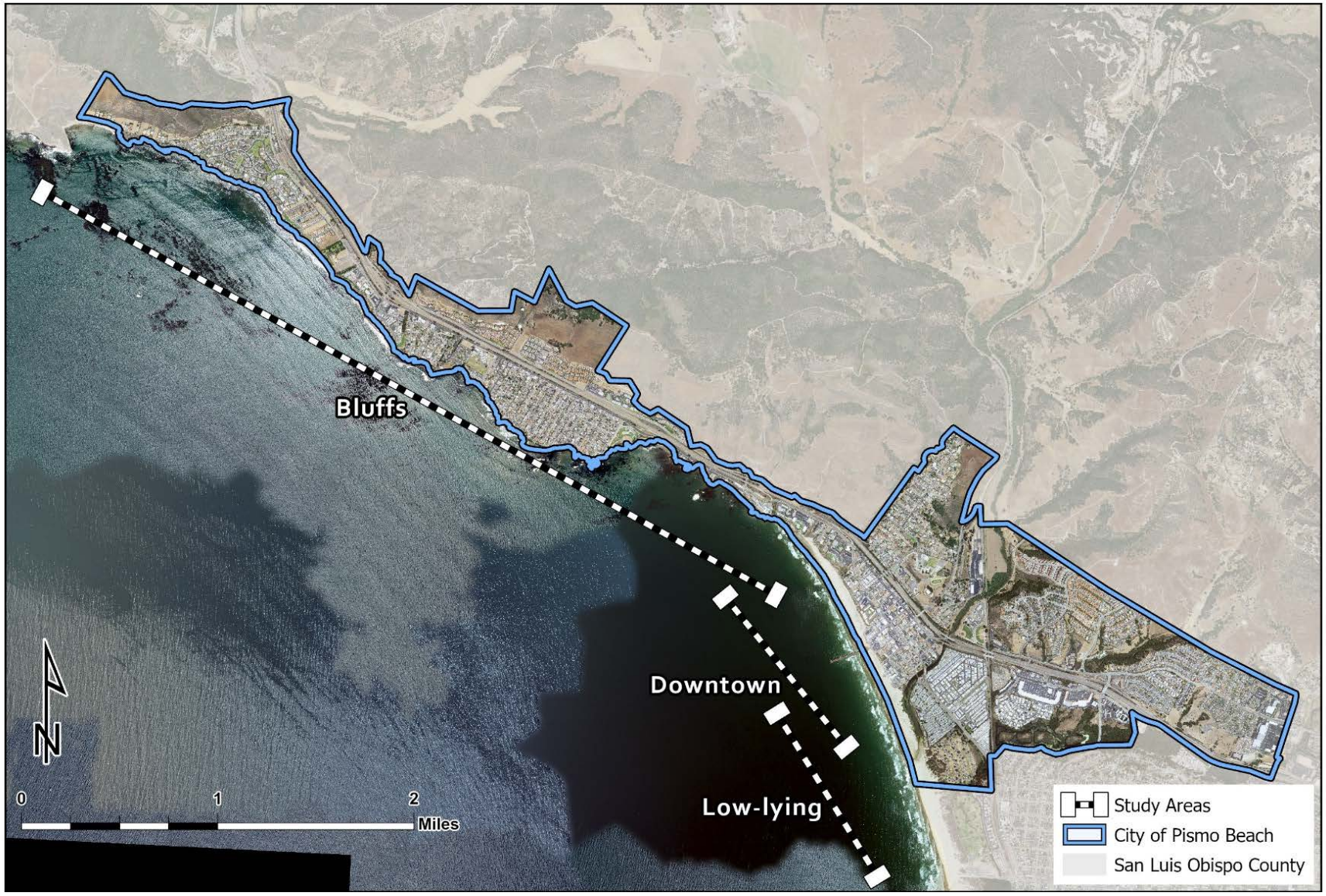



*Figure 1-2: City limits and locations of each Study Area*

### 1.2.2 Primary Hazards of Concern (Near-Term)

The primary storm-related hazards affecting coastal resources in Pismo Beach are bluff erosion and fluvial flooding from Pismo Creek. Bluff erosion is an unpredictable and episodic process; therefore, it is difficult to forecast these hazards with any certainty. However, each increment of SLR will result in additional wave energy at the base of the bluffs and, therefore, increase the potential for bluff collapse. The CoSMoS bluff erosion hazard projections indicate there could be 5-15 ft of bluff-top retreat under a 1.6-ft SLR scenario. However, a variety of coastal protection structures are in place along the Bluffs Study Area that were not factored into these hazard projections. More likely, the rates of erosion will vary from parcel to parcel based on several factors including the geological makeup of the bluff, presence of shoreline protection, drainage patterns, etc.

Based on the existing 100-year floodplain extents along Pismo Creek, published in San Luis Obispo County's most recent FEMA flood insurance study (FEMA, 2017), fluvial hazards present the most significant source of flooding in the Downtown Study Area and Low-Lying Study Area over the next several decades. This type of flood hazard would also be influenced by SLR, especially along the lower reaches of Pismo Creek where SLR will push the beach profile upward and landward, potentially impacting the breaching patterns of Pismo Creek and Meadow Creek.

Non-storm hazards could also result in significant impacts to coastal resources Citywide. Sea level rise can result in a process known as "coastal squeeze," depicted in Figure 1-3, in which resources reliant on sandy beach and intertidal areas are squeezed between rising sea levels and a coastal protection structure or erosion-resistant bluff formation. Coastal habitats may be able to migrate inland with SLR in the absence of armoring or development if local coastal processes are favorable for the formation of sandy beach or rocky intertidal habitat as a result of bluff erosion. A 1.6-ft SLR scenario is expected to result in partial loss of sandy beach areas and potential impacts to vertical coastal access pathways along the Bluffs Study Area. Along the Downtown and Low-Lying Study Areas, the 1.6-ft SLR scenario is projected to result in about 75 ft of shoreline retreat along Pismo State beach.

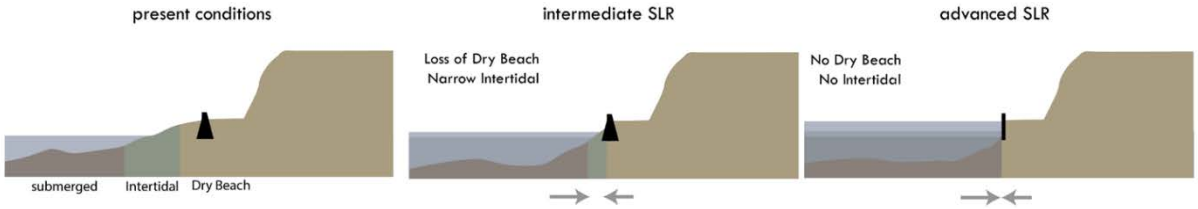



*Figure 1-3: Illustration of coastal squeeze in front of a non-erodible structure*

### 1.2.3 Long-Term Hazards of Concern

The primary hazards of concern discussed above continue to threaten coastal resources for each additional increment of SLR evaluated. A 3.3-ft rise in sea level represents a significant threshold

along the Bluffs Study area as many of the pocket beaches would likely be eroded or submerged, impacting recreation, access, and environmental resources. The loss of protective beaches would also result in regular wave attack along the natural bluffs or shoreline protection structures.

Along the Downtown Study Area, nearly half of Pismo State Beach's width is predicted to be eroded under a 3.3-ft SLR scenario (Figure 1-4), reducing the natural storm buffer for Downtown development and potentially impacting beach recreation and coastal access opportunities. The Pier itself could also be at risk of severe damage during a 100-year coastal storm event, especially at the outer end where waves could impact the Pier deck. More frequent coastal flooding during high tide conditions is a more significant concern in this scenario, affecting the low-lying areas adjacent to Pismo Creek.




*Figure 1-4: Shoreline erosion projections along the Downtown Study Area*

The 4.9-ft SLR scenario is another notable long-term hazard threshold due to widespread coastal flooding of low-lying areas adjacent to Pismo Creek. Residential development, infrastructure, and parks within the Downtown Study Area on the northwest bank of Pismo Creek could be exposed to flooding during monthly high tides and 100-year coastal storm conditions under this scenario. Nearly all of the Low-Lying Study Area, Pismo Lake Ecological Reserve, and the North Beach Campground would be vulnerable to coastal flooding in a 100-year storm event. High tides at 4.9 ft of SLR combined with significant long-term shoreline retreat could result in limited and seasonal beach access along the Downtown waterfront.

### 1.2.4 Probability and Timing

SLR projections referenced within this study are based on the Point San Luis projections included in the 2018 California Ocean Protection Council (OPC) SLR guidance, identified by the California Coastal Commission as the best available science on the subject. In the case of SLR in California, the OPC has high confidence in estimates for SLR to around year 2050, after which emissions scenarios cause predictions to diverge. These projections will be updated by the OPC in approximately 5-year intervals.

At each future time horizon, the guidance provides a range of potential sea level rise outcomes. For the 2050 time horizon, the likely range of SLR as defined by OPC is between 0.5 to 1.0 ft, which means there is a 66% probability that SLR will fall within this range. The guidance document also acknowledges the potential for less probable scenarios that result in higher amounts of SLR. For example, the document indicates there is a 0.5% chance SLR reaches 1.8 ft by 2050. In other words, the 1.6-ft SLR scenario presented within this study represents a conservative projection for the 2050 time horizon.

The potential vulnerabilities identified for SLR scenarios of 3.3 ft and higher are unlikely to occur before 2100, but there is a slight chance (0.5% probability) that 3.3 ft of SLR could occur by 2070. The likely range of SLR in 2100 is 1.3 to 3.1 ft, but there is a slight chance (0.5% probability) that SLR could reach 6.7 ft. Under a worst-case scenario, described as the H++ scenario in the OPC guidance, SLR could reach 9.9 ft in 2100. Though this scenario is theoretically possible, the latest update to global SLR projections (IPCC, 2019) specifically excluded this scenario from their projections, citing deep uncertainty and ongoing discussion in the scientific community over the assumptions underlying the H++ scenario.

With each update, we can expect the range of SLR projections will be adjusted based on the latest and best available science. For this reason, adaptation strategies and triggers will be based on an amount of SLR (i.e., 1.6 ft), not a specific time horizon (i.e., 2050). As future projections are published, the SLR triggers will not change, but the timing and probability of a given SLR scenario may change.

## 1.3 Relevant Planning Documents

There are several local and county level planning documents that consider the potential for natural hazards and their impact on Pismo Beach. These documents include principles, policies and mitigation actions to reduce the potential for loss of life, property and other resources during a disaster. Sea level rise and the potential for changing coastal hazards over the decades to come are an important factor to consider as these planning documents are updated. A description of several planning documents and how the information in this adaptation plan relates to each is provided below.

### 1.3.1 San Luis Obispo County Local Hazard Mitigation Plan (LHMP)

This is a multi-jurisdictional hazard mitigation plan led by the County with participation from seven municipalities, including Pismo Beach, nine Community Services Districts, and four Special Districts. This plan is updated at five-year intervals and submitted to the Federal Emergency Management Agency to satisfy requirements of the Disaster Mitigation Act of 2000, so the jurisdictions covered by the plan are eligible for Hazard Mitigation Assistance (HMA) grant

program funds. An update of the LHMP is in progress, and a draft dated October 2019 is available on the County's website[1].

The Draft LHMP does include a discussion of SLR and associated coastal flooding hazards that could potentially impact low-lying development adjacent to Pismo Creek. However, specific thresholds of SLR that result in consequential impacts are not included, and no mitigation actions related to SLR, coastal erosion, bluff erosion, or coastal flooding are included in the draft. As these hazards increase over the coming decades, some of the adaptation strategies discussed in this plan could be incorporated into the LHMP as mitigation actions to be eligible for federal grant funding opportunities.

### 1.3.2 San Luis Obispo County Coastal Regional Sediment Management Plan (May 2016)

The Coastal Regional Sediment Management Plan (CRSMP) was prepared for the California Coastal Sediment Management Working Group by the United States Army Corps of Engineers (USACE) in partnership with Everest International Consultants and the San Luis Obispo Council of Governments (SLOCOG). The CRSMP frames policy and guidance strategies to restore, create, and maintain coastal beaches to mitigate against current and expected future problems associated with erosion. Areas of interest where public infrastructure or private development is at risk of erosion include several beaches in the City such as Palisades Beach, Spyglass Beach, Dinosaur Caves Beach and Pismo Beach.

A variety of SLR adaptation measures are discussed at a high level in the CRSMP though none are specifically identified for use at each area of interest. Similar to this Adaptation Plan, the CRSMP is not intended to prescribe site-specific strategies but rather presents a range of potentially viable strategies that could be implemented in the future. One strategy identified for Pismo Beach is the potential for beach nourishment using material dredged from Port San Luis. This is one example of how collaboration between jurisdictions could result in mutually beneficial projects that could help mitigate the adverse impacts associated with SLR and coastal erosion. SLOCOG was identified as the implementation body for regional sediment management measures, and they have established a Policy Advisory Committee made up of elected officials from several jurisdictions. Active participation from a representative of Pismo Beach could be an effective way to advocate for regional solutions that could offer local benefits.

### 1.3.3 City of Pismo Beach General Plan/Local Coastal Program

An update of the General Plan and Local Coastal Program are in progress. One of the primary functions of this Adaptation Plan is to provide a bridging document between the information presented in the VA and the policies and ordinances included in the updated General Plan/Local

[1] https://www.slocounty.ca.gov/Departments/Planning-Building/Forms-Documents/Plans/Elements/Local-Hazard-Mitigation-Plan.aspx

Coastal Program (GP/LCP). The updated GP/LCP will govern development in the coastal zone and include planning and policy measures aimed at mitigating potential vulnerabilities associated with SLR while allowing for adaptation strategies that are in compliance with the Coastal Act and consistent with the CCC SLR Policy Guidance.

# 2. Adaptation Overview

Changing coastal hazards due to SLR can be addressed in a number of different ways. Though numerous adaptation methods are available, individual adaptation measures generally fall into one of three main categories: protection, accommodation, and retreat (Figure 2-1). In an SLR adaptation context, protection refers to those strategies that employ an engineered structure or other measure to defend existing development from future SLR hazards without changes to the development itself. Accommodation refers to strategies that involve modifying existing development or designing new developments in a way that reduces the potential future impacts of SLR. Adaptation strategies centered on retreat focus on measures to relocate or remove existing development from identified high-hazard areas, while also limiting the construction of any new development in hazardous areas. In practice, SLR adaptation often relies on hybrid approaches that combine elements from multiple categories over different spatial and temporal scales.

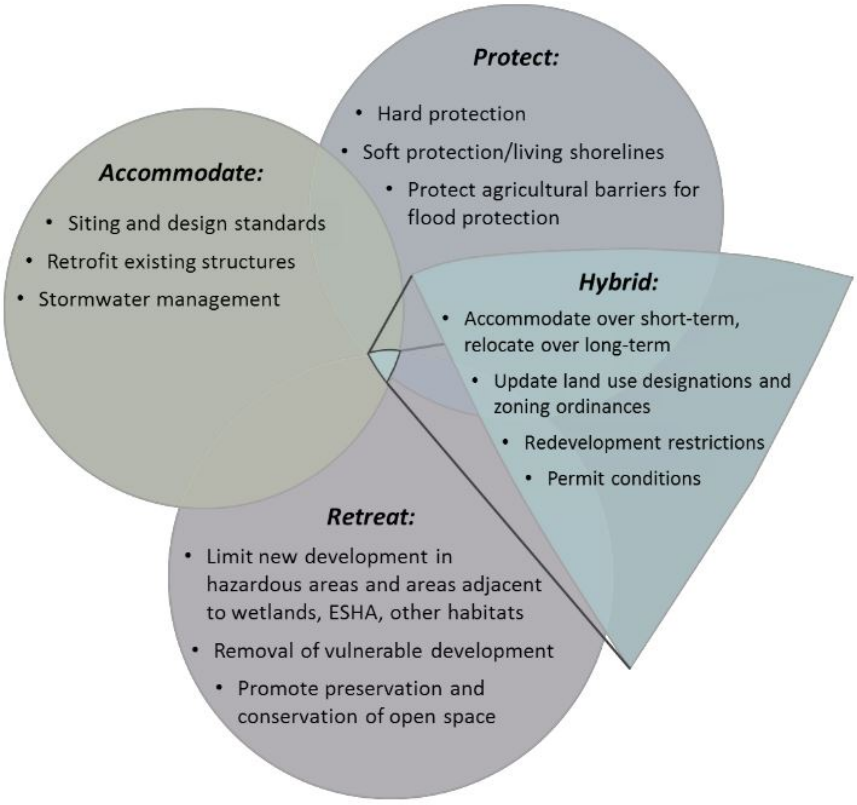



*Figure 2-1: General SLR adaptation strategies and mechanisms* (California Coastal Commission, 2018a).

For the purposes of this study, no individual adaptation strategy or category is to be considered a categorical "best" option for SLR adaptation planning within the City of Pismo Beach. It is understood that a variety of adaptation strategies will be necessary to account for the different hazard vulnerabilities and coastal resources present at various locations within the City, and that

adaptation strategies will need to be adjusted over time in response to changing coastal hazards and the effectiveness of each strategy.

## 2.1 Protection

Adaptation aimed at protecting coastal resources can come in the form of hard and soft shoreline protection strategies. Hard shoreline protection strategies have been a key element of coastal hazard adaptation for the City of Pismo Beach throughout its history. A variety of shoreline protection structures have been constructed along the City's coastline to limit damage from erosion and storm-related hazards. Concrete seawalls have lined downtown areas near the pier since the 1970s, and steel sheet pile seawalls line much of the Pier plaza and development to the south. A variety of shoreline and bluff stabilization measures are also in place along the northern bluffs, including armor stone revetments and multiple types of seawalls. An example of bluff stabilization is illustrated in Figure 2-2, where the bluff stabilization structure has been designed to match the aesthetics of the natural bluff face.



*Figure 2-2: Bluff Stabilization and access stairway at St Andrews lift station*

Soft shoreline protection strategies typically refer to nature-based measures such as beach nourishment, dune restoration, and construction of living shorelines. Apart from temporary sand berms constructed to provide bluff protection along Pismo State Beach, there is no record of any significant beach nourishment activities within the City; however, beach nourishment and dune restoration could potentially be effective measures to offset the beach width loss projected with each increment of SLR. An example of beach nourishment applied along the bluff-backed beaches of Solana Beach in Southern California is illustrated in Figure 2-3.



*Figure 2-3: Beach nourishment in progress at Solana Beach in 2018*

## 2.2 Accommodation

Accommodation strategies can be employed as an alternative to or in conjunction with protective measures. These strategies are often employed for low-lying coastal structures or resources that are exposed to temporary flooding during extreme storm events. Depending on the characteristics of the coastal resource and type of accommodation employed, accommodation strategies can potentially address coastal hazards across low, moderate, and severe SLR scenarios.

Coastal resources and structures can accommodate SLR hazards through both modification of existing development and design of new development. Accommodation strategies based on structural modification include actions such as structural elevation, retrofitting existing structures with floodproofing measures, and the use of flood resistant materials during construction (Figure 2-4). Accommodation strategies based on design can address SLR hazards by including potential relocation, redesign, or other forms of adaptation in initial structural plans or by employing additional shoreline setbacks where possible. These strategies can be employed

on an individual basis or on a community-wide scale through specific land-use designations, zoning ordinances, or other measures.

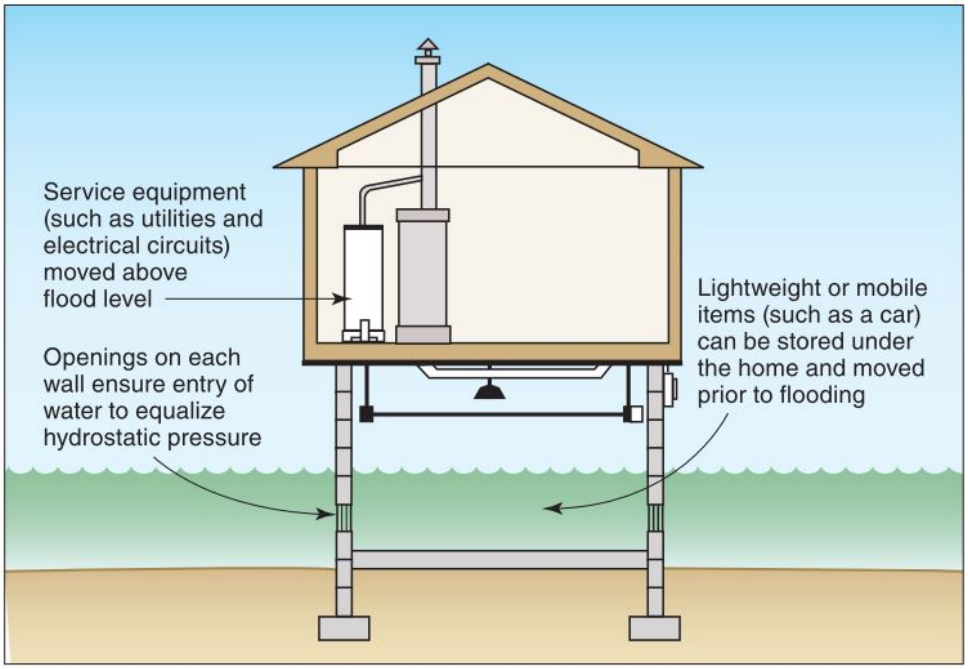



*Figure 2-4: Example cross section of an elevated home using continuous foundation walls (FEMA, 2014).*

## 2.3 Retreat

Directly removing or relocating vulnerable structures away from hazard areas (Figure 2-5) represents an effective long-term form of SLR adaptation under high to extreme SLR scenarios. Retreat strategies can be employed for cases in which any feasible protection or accommodation strategies become insufficient to address coastal hazards. Retreat strategies can be implemented in a variety of ways including land use designations or zoning ordinances designed to encourage new development within less vulnerable areas. Property acquisition programs, rolling easements, transfer of development rights programs, and permit conditions can additionally be used to gradually move highly vulnerable existing development away from current and future hazard areas.

Successful employment of retreat strategies often requires available areas located landward of vulnerable structures or resources. Limited available space is a complicating factor throughout much of the City due to the high density of development along the bluffs and downtown study areas. However, some elements of retreat, such as bluff-top setbacks, can be combined with other adaptation measures to further reduce vulnerabilities from coastal hazards. Despite these limitations, retreat strategies can potentially result in greater resilience to SLR hazards at a lower cost than protecting structures in place under extreme SLR scenarios while also avoiding recreation and coastal access issues that could result from additional shoreline protection.

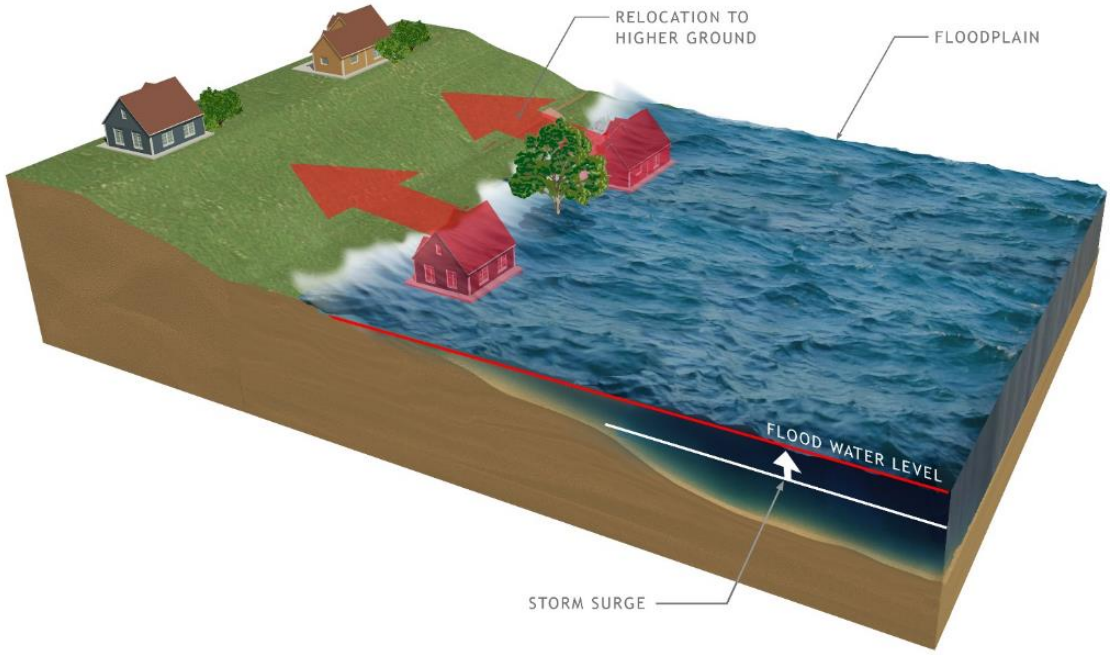



*Figure 2-5: Example of retreat strategies within high-hazard areas.*

# 3. Planning Measures

## 3.1 SLR Hazard Zones

Planning level SLR adaptation within the City of Pismo Beach requires knowledge of the potential timing and extent of coastal hazards under various SLR scenarios. Coastal flood hazard maps that include areas projected to be subject to wave impacts, flooding, bluff erosion, or shoreline erosion can address this informational need and facilitate planning decisions related to SLR adaptation. Coastal hazard map development can leverage existing flood hazard mapping conducted within the City, such as the current FEMA Flood Insurance Rate Map, but should also account for projected increases in coastal hazards due to SLR, potentially through the inclusion of USGS CoSMoS modeling results used in preparation of the City SLR Vulnerability Assessment.

If developed, coastal flood hazards maps can be utilized for purposes such as the identification of areas where actions would require site-specific SLR hazard evaluations, incorporating factors such as the anticipated project life, vulnerability to SLR hazards under various SLR scenarios, and potential consequences of hazard impacts. Any coastal flood hazard mapping efforts used for SLR adaptation planning purposes should be updated as necessary to reflect changes in best available SLR science and projections.

## 3.2 Public Outreach and Education

Public education and outreach programs can also be utilized as a form of planning-level SLR adaptation within the City. Outreach measures can potentially build on previous SLR hazard mapping efforts discussed in Section 3.1. Hosting any SLR hazard maps within publicly accessible City websites or advertising hazard maps within City planning documents or proceedings can help improve community understanding of potential SLR hazards and how they may affect coastal resources within the City.

Community workshops also provide an opportunity to conduct public outreach and education efforts related to SLR. Multiple workshops have been or are planned to be completed as a component of the VA, Adaptation Plan and updated General Plan/Local Coastal Program. Future workshops may also be necessary based on factors such as any updates to best available SLR science and projections, updates to the VA or Adaptation Plan, or any significant adaptation projects or coastal hazard events that raise community concern.

## 3.3 Support Regional Adaptation Actions

Coastal processes and hazards affected by SLR often extend beyond the parcel scale. Participating in coordinated regional SLR hazard mitigation planning efforts can substantially increase the efficiency and cost-effectiveness of SLR resilience measures. Coordinated SLR adaptation efforts are especially necessary for measures addressing sediment management within the City, as

actions such as beneficial reuse of sediment are often coordinated as a part of Regional Sediment Management programs or other forms of coordination with neighboring jurisdictions. The CRSMP outlines a governance framework in which SLOCOG acts as the implementation body with the appropriate jurisdictional authorities to pursue regional adaptation projects that could benefit multiple jurisdictions.

Coordinated efforts are also necessary for SLR adaptation efforts involving transportation infrastructure, which is managed by a combination of state and local public works and transportation agencies. SLR adaptation efforts for transportation infrastructure require input and coordinated action among these agencies to ensure that alternate transportation routes or parking are made available as necessary to allow for continuous access to beaches and other coastal resources within the City. While this represents a significant planning and coordination effort, the outcome could produce multiple benefits for a wide variety of resources both within the City and on a regional scale.

## 3.4 Local Adaptation Planning

Aligning planning documents within the City is another method to efficiently finance and implement SLR adaptation. The Capital Improvement Plan (CIP) is an important planning process that outlines the budget expenditures to address current needs and long-term capital needs. Many of these expenditures relate to public facilities, infrastructure and amenities that are within potential hazard zones. Incorporating the probability of SLR and coastal hazards into the CIP process would be an effective way to ensure public projects are accounting for future hazard risks. These projects also present opportunities to include strategies to build adaptive capacity into coastal resources where feasible.

Policies that address compatibility between the Local Hazard Management Plan and the Local Coastal Program help to ensure that proactive adaptation efforts are coordinated across City departments and that responses to damage from future coastal hazards are streamlined. These policies can also help secure additional SLR mitigation funding by identifying project types that meet the goals of both planning documents, allowing the City to fully leverage available federal and state funding opportunities.

# 4. Policy Measures

The updated GP/LCP document will include policies intended to disseminate information related to coastal hazards and sea level rise, manage development in hazard areas, and reduce impacts to coastal resources from coastal hazards. These planning goals for which policies may be developed are discussed in this section. Policy content examples are provided below each goal to describe how information from the VA could be translated into GP/LCP policies.

## 4.1 Understand SLR Hazards

Knowledge of the timing, magnitude, and location of future SLR hazards is critical to SLR planning and adaptation efforts. Policies in pursuit of this goal focus on ways to best obtain, utilize, and disseminate current and forecasted SLR information to inform decision-making in coastal areas. Ensuring the use of best available climate science provides a consistent standard for SLR adaptation planning in the City and facilitates the coordination of adaptation strategies with other jurisdictions.

Disseminating identified best available science is also necessary to support public understanding and participation in SLR adaptation and planning. Policies designed to inform the general public of projected future hazards due to SLR encourage responsible decision-making at the individual level and can potentially increase public support for SLR adaptation initiatives within the City. Policies focused on disclosing risks associated with new development can also provide an important mechanism for educating property owners about projected SLR hazards and their options for addressing them.

Adaptation policies focused on continued hazard monitoring can be used to update SLR adaptation strategies and provide concrete information on when critical hazard thresholds have been reached. Hazard monitoring programs can take a number of forms including tracking regional SLR rates, documenting bluff erosion processes, and quantifying shoreline change trends. Potential monitoring programs are discussed further in Section 5.3.

<u>Policy Content Examples</u>

- Identification of specific sources of best available SLR science and projections for consistent application throughout the City.
- Standards and timelines for updates to best available science and SLR vulnerability assessments.
- Standards for coastal hazard map development.
- Standards regarding incorporation of SLR into site-specific coastal hazard reports.
- Requirements related to disclosure of coastal hazards in real estate transactions.

## 4.2 Manage Development in Hazard Zones

Siting and construction standards for new coastal development or redevelopment projects represent key mechanisms to reduce SLR hazard impacts to new and existing development. Existing policies related to development on or near the bluff top, which involve site-specific hazard assessments and setbacks from defined hazard areas, are an example of how development can be managed to reduce impacts from natural hazards such as bluff erosion.

Incorporating projected SLR hazards into the initial siting of new development is an important step in mitigating SLR vulnerabilities and avoiding the need for future adaptation measures, which could impact coastal uses and resources. Considerations for SLR scenarios higher than 3.3 ft, though unlikely to occur this century, could be included in the design of new development or redevelopment in the form of parcel-scale adaptation measures that could be implemented at a future date in response to SLR or other hazards, if needed.

Managing redevelopment is another method to control SLR vulnerability. Policies that establish limitations on continued redevelopment of high-risk structures in hazard areas reduce future SLR vulnerability and the potential for repetitive losses due to increased hazards. These policies can potentially be triggered by specific SLR thresholds at which impacts from coastal hazards are expected to occur more frequently.

Policy Content Examples

- Blufftop or shoreline-specific siting requirements for new development that take SLR into account.
- Siting requirements addressing the potential need for future shoreline or bluff armoring.
- Standards regarding incorporation of SLR into bluff or geologic setback line determinations.
- Standards regarding potential hazard disclosures or assumption of risk for new development or redevelopment.

## 4.3 Mitigate Coastal Hazard Impacts

Enhancements and additions to existing coastal hazard reduction measures are often necessary to account for potential increases in hazard levels due to SLR. Policies in pursuit of this goal focus on protection from and accommodation of current and future SLR hazards through both structural and nature-based means.

Managing the establishment and maintenance of shoreline protection structures can provide multiple benefits to SLR adaptation efforts. Policies that establish standards for the evaluation, repair, and maintenance of existing shoreline armoring enable the ongoing functionality of protective structures as coastal hazards change with rising water levels, reducing potential for structural failure under future conditions. Policies related to new or additional shoreline

armoring can reduce the potential for unwarranted or ineffective shoreline protection structures and can also help ensure that alternative, nature-based strategies are given appropriate consideration.

Standardizing approaches to structural floodproofing can also benefit adaptation efforts. Policies that establish appropriate situations and best practices for floodproofing retrofits or redesign allow for the consistent and effective application of these strategies within hazard areas. These types of policies can also improve awareness of available floodproofing mechanisms by providing a standardized reference for interested parties.

Policy Content Examples

- Flood mitigation standards above FEMA requirements within coastal hazard areas.
- Standards regarding permitted uses of shoreline and bluff protection devices.
- Standards regarding siting and design of shoreline and bluff protection devices.
- Standards regarding the evaluation, maintenance, and repair of shoreline or bluff protection devices.
- Requirements related to prioritization of types of shoreline protection.

## 4.4 Maximize Protection of Coastal Resources

Coastal resources, including public access points, parks, marine habitats, and scenic resources, play important cultural, social, and economic roles within the City of Pismo Beach. Policies in pursuit of this goal help ensure that these important resources are maintained and enhanced as a part of future SLR adaptation efforts.

Replacing any projected loss of coastal access points, recreation areas, or visitor-serving facilities is an important consideration for SLR adaptation efforts. Policies that establish appropriate standards for replacement of any access or recreational resources within hazard areas reduce the potential for permanent or temporary loss of these functions within coastal areas as SLR increases. Requirements related to consideration of SLR in planning for any new or redeveloped public access or recreation facilities can also mitigate potential hazards, future disruptions in service, and the need for additional SLR adaptation measures.

Policy Content Examples

- Standards related to minimum beach width necessary to maintain public recreational access and function.
- Monitoring requirements related to public access, beach use, or impacts to public trust lands.
- Formalization of a beach nourishment or other beach width maintenance program.
- Siting and design standards for access sites and facilities to avoid SLR impacts.

- Mitigation requirements for any unavoidable impacts to coastal access and recreation resources.
- Incorporation of SLR into coastal habitat restoration, creation, or enhancement plans.
- Mechanisms to allow for removal of ineffective coastal protection structures.

# 5. Project Measures

This section describes projects which could be implemented to mitigate some of the vulnerabilities identified for near-term and long-term SLR scenarios. A key challenge of sea level rise adaptation in Pismo Beach will be balancing the trade-offs associated with each strategy on the wide variety of coastal resources. This plan provides an overview of the benefits and challenges associated with each strategy to highlight the potential impacts on different resource categories.

## 5.1 Near-Term Adaptation Strategies

Near-term adaptation strategies described in this section represent an initial phase of adaptation, intended to address vulnerabilities identified for existing hazards and those projected for a 1.6-ft SLR scenario. The list of adaptation strategies is not intended to be fully exhaustive nor exclusive but provides a range of typical strategies implemented to address the most urgent hazards associated with sea level rise such as coastal erosion and fluvial flooding.

### 5.1.1 Bluffs

#### Opportunistic Beach Nourishment

A logical adaptation strategy to offset the coastal squeeze impacts expected along the Bluffs Study Area is beach nourishment. This reach includes several beaches identified in the CRSMP as vulnerable to coastal erosion now or in the future and could be receiver sites for material dredged from Port San Luis. Other sources of sediment include upland sources from construction or maintenance of flood control infrastructure such as debris basins and channels. Opportunistic beach nourishment could be a feasible strategy to maintain the narrow beaches that provide important habitat and lateral coastal access along segments of the coast. Even relatively small amounts of material could result in a lasting benefit since many of these pocket beaches are semi-contained littoral cells in between headlands resulting in lower rates of alongshore sediment transport.

Benefits

- Mitigates adverse effects of coastal squeeze on environmental and coastal access resources.
- Provides additional buffer against wave attack at base of bluffs.
- Limited sediment losses in the downcoast direction could prolong benefits of beach nourishment.

Challenges

- Required CEQA and NEPA environmental permitting processes associated with sediment placement in the coastal zone.
- Access to the receiver beaches for placement of material could be a challenge.

- Ongoing beach width and elevation monitoring requirements.
- Potential loss of nourishment material following coastal storm events.

### Maintenance or Targeted Improvement of Bluff Stabilization Infrastructure in Critical Areas

Due to the widespread presence of bluff protection structures within the Bluffs study area, continued maintenance or targeted improvement of bluff stabilization infrastructure will be an important component of mitigating hazards such as bluff erosion and coastal storm damage under the near-term, 1.6-ft SLR scenario. Many of the existing modern engineered bluff protection structures will continue to be effective under the hazard conditions projected under the 1.6-ft SLR scenario provided they are regularly inspected and maintained to ensure ongoing protective functions. Other existing structures that have been in place for extended time periods or those that are approaching the end of their service life will likely require significant retrofits or replacement to protect against the additional coastal hazards under 1.6 ft of SLR.

A thorough assessment of potential environmental impacts and alternative coastal hazard mitigation measures is an essential component of any bluff stabilization infrastructure maintenance or improvement project in order to ensure compliance with relevant state and local policies. These assessments must consider the potential trade-offs associated with armoring projects outlined in the "Benefits" and "Challenges" sections below, taking into account local geology, littoral processes, and the types of infrastructure present. Given the potential trade-offs associated with bluff infrastructure maintenance or improvement, these types of projects are generally recommended for cases in which armoring would not result in significant adverse impacts to coastal resources, armoring is utilized as a temporary solution while alternative strategies are developed, or where potential impacts could be easily mitigated or offset through measures such as upgrades to allow for new or enhanced public access to coastal areas.

A potential initial step in assessing the future performance of existing protective structures would be to establish an inventory of all structures, their associated design lives, and capacity to function under near-term SLR scenarios. Maintenance and improvement requirements and timelines could then be developed, as well as an initial feasibility analysis of alternatives to shoreline protection. Any necessary maintenance or replacement of an existing structure provides an opportunity to incorporate additional protective capacity to account for projected near-term SLR hazards, allowing for incremental SLR adaptation over time, provided the improved structure remains in compliance with the Coastal Act and other local hazard mitigation policies.

<u>Benefits</u>

- Maintains current protective functions considering potential increases in bluff erosion hazards due to SLR.
- Any improvements to protective structures can be incorporated into existing maintenance practices and timelines.
- Based on existing hazard mitigation practices and programs.

- Provides reliable protection of landward areas with changing coastal hazard conditions.

Challenges

- The fixed barrier created by hard shoreline structures prevents the inland migration of natural beaches and habitats over time as SLR increases, a phenomenon often referred to as "coastal squeeze."
- Reliable monitoring of bluff infrastructure performance and maintenance needs under changing coastal hazard conditions.
- Potential regulatory and permitting challenges associated with improvement of shoreline stabilization infrastructure.
- Cost considerations if widespread infrastructure improvements or additional maintenance becomes necessary.
- Potential impacts to littoral processes and sand supply to beaches within the Bluffs study area.

### Rocky Intertidal Habitat Restoration

As an alternative to bluff protective structures, restoration of rocky intertidal habitat at risk under near-term SLR scenarios can potentially enhance the erosion protection functions provided by such habitat to surrounding bluffs. This could be accomplished through placement of native rock or bio-activated material in targeted areas to allow existing habitats to keep pace with SLR. Such a measure would be conceptually similar to oyster reef living shorelines implemented in calm wave environments, though an application within the Bluffs study area would have to account for a more energetic wave environment.

Serving as transition zones, rocky intertidal areas provide important habitat areas for a diverse array of marine invertebrates and plant life. An essential element of what maintains the high levels of biodiversity found in rocky intertidal areas is the dynamic environment provided by tidal cycles, wave action, and sediment movement. SLR has the potential to disrupt this ecological balance, reducing benefits to surrounding ecosystems and diminishing shoreline protection functions. A living shoreline approach that incorporates rocky intertidal habitat restoration could be employed to offset these adverse impacts within the Bluffs study area.

Living shorelines have been employed in a number of forms including coastal mangroves, salt marshes, oyster reefs, reef balls, dunes, and seagrass or kelp beds, but limited examples exist that aim to replicate or enhance rocky intertidal habitat. Most living shoreline projects have been implemented along sheltered coastlines as opposed to the open coast within the Bluffs study area. A living shoreline project based on stable rocky intertidal habitat, potentially in combination with restored or enhanced reef structures, would represent a novel approach to living shorelines that, while currently lacking established standards and guidelines, could prove to be an important element of long-term climate resilience. While standards and guidelines are currently limited for such an approach, recent studies have shown that biological communities associated with riprap along Southern California shorelines are largely similar to communities in natural rocky habitats

(Pister 2009), suggesting that placement of rocky structures could successfully recruit existing intertidal communities over time. The use of products such as an ECOncrete tide pool (Figure 5-1), which are designed to mimic naturally-occurring rock pools, can also help to maintain local biodiversity and biological productivity. The design of these features could also be fine-tuned to mimic the different nearshore rocky intertidal habitat types within the Bluffs study area or provide additional benefits such as sediment retention.



*Figure 5-1: An example of an ECOncrete tide pool designed to mimic natural environments.*

Benefits

- Habitat restoration provides the co-benefits of coastal erosion reduction and enhancement of critical habitat values.
- Working within the context of existing ecosystems reduces maintenance needs by employing structures that are compatible with natural coastal processes.
- Use of nature-based techniques minimizes potential aesthetic impacts along the Bluffs study area.

Challenges

- Evaluation of associated benefits is more complex than traditional approaches and would most likely require pilot projects with detailed monitoring to quantify impacts and benefits.
- The level of protection provided by restored areas may vary due to the natural fluctuations associated with coastal habitats. As such, restoration efforts would have to strike a balance between allowing the shoreline to naturally adapt and conducting routine maintenance to achieve a reliable level of protection.

- Regulatory requirements within the intertidal zone may restrict the amount or type of material placement allowed.

### 5.1.2 Downtown

#### Maintenance and Improvement of Existing Shoreline Protection

Shoreline protection is currently a key coastal hazard adaptation strategy within the Downtown study area. Significant portions of the Downtown shoreline currently have some form of protective device in place, including seawalls in the vicinity of Pismo Beach Pier and areas of rock revetment to the north and south. Due to the widespread presence and long history of shoreline protection structures within the Downtown study area, the continued maintenance and improvement of shoreline infrastructure will be an important component of adaptation efforts under the near-term, 1.6-ft SLR scenario.

Current shoreline protection structures provide a means to minimize damage and disruption from coastal erosion, high water levels, and wave impacts associated with severe storm events. The frequency and severity of these coastal hazards are projected to increase under a 1.6-ft SLR scenario, but projected impacts to development within the Downtown area remain limited to storm-related flooding. Ongoing evaluation, maintenance, and improvement of existing shoreline protection infrastructure will allow structures to maintain their current level of hazard mitigation and reduce the chance of infrastructure failure as coastal conditions change due to SLR. Planned maintenance or replacement of existing infrastructure provides an opportunity to incorporate SLR into infrastructure design over time. As is the case with bluff stabilization infrastructure, any maintenance, improvement, or replacement of shoreline protection in the Downtown study area must consider the trade-offs associated with such projects discussed in Section 5.1.1.

<u>Benefits</u>

- Adaptation efforts can utilize and enhance existing infrastructure within the Downtown study area as opposed to constructing new shoreline protection structures.
- Structures can be designed to specific levels of protection to account for projected coastal hazards under the near-term, 1.6-ft SLR scenario.
- Improvements to existing infrastructure required to address hazards under a 1.6-ft SLR scenario are unlikely to cause aesthetic impacts or alter the character of existing coastal communities.

<u>Challenges</u>

- Regulatory barriers to shoreline infrastructure improvement may be present depending on the date of construction and type of improvement proposed.
- Extensive improvements to existing shoreline protection could alter existing littoral processes.

- The fixed barrier created by hard shoreline structures prevents the inland migration of natural beaches and habitats over time as SLR increases.

### Dry Floodproofing in High-Hazard Areas

Dry floodproofing refers to building techniques or retrofit measures that prevent floodwaters from entering a building. Dry floodproofing can provide a redundant layer of flood damage protection for buildings sensitive to flooding or for structures located near the shoreline that may experience flood hazard exposure on a more frequent basis. A number of methods are available for dry floodproofing, including the use of waterproof coatings or installation of removable shields at structure openings as shown in Figure 5-2 and Figure 5-3.

Floodproofing measures may be prudent for structures that are likely to be exposed to coastal hazards, such as those in the area surrounding the Pier that must maintain close proximity to the shoreline as part of a coastal-dependent use. One location where dry floodproofing could be implemented is the below-grade parking structure of the Vespera Hotel which has vents located just above the dry beach that could experience coastal flooding in an extreme event. All dry floodproofing efforts must consider the potential depth of flooding to properly account for hydrostatic pressure applied to walls and floors and are generally only suitable for addressing temporary, storm-related flood hazards. Given the lack of non-storm flooding projected under the near-term, 1.6-ft SLR scenario, floodproofing could potentially provide a valuable means to reduce flood damages and loss of services following severe storm events. The need for future dry floodproofing retrofits can be reduced if potential storm-related flood conditions are incorporated into structural design updates or redevelopment planning along the Downtown shoreline.

Benefits

- No additional space needs to be dedicated to flood protection.
- Can be used to improve resilience of existing structures vulnerable to storm related flooding.
- Measures can be applied to buildings at a future date in response to sea level rise or other flood hazards.

Challenges

- Effectiveness may be limited by potential flood duration, flow velocity, wave action, or debris. Measures are typically feasible for flood depths of up to three feet.
- Adequate warning time prior to installation may be required depending on type of measure employed.
- Ongoing maintenance efforts are often required to maintain watertight connections.

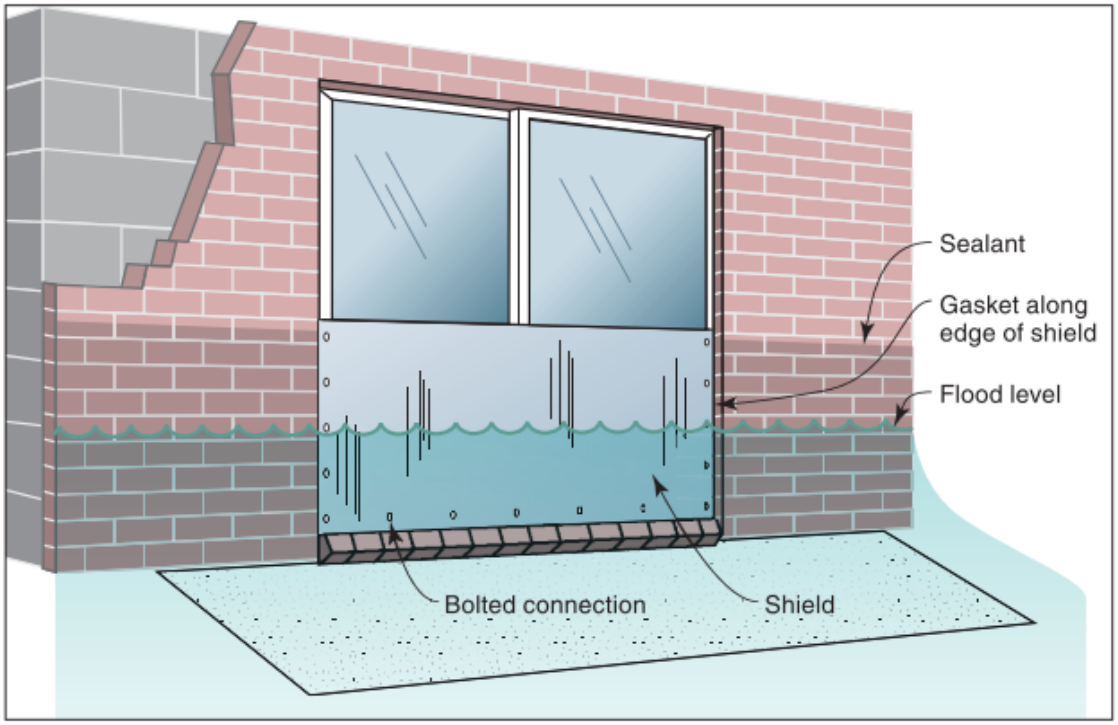



*Figure 5-2: Conceptual example of dry floodproofing measures using bolted connections (FEMA, 2014).*

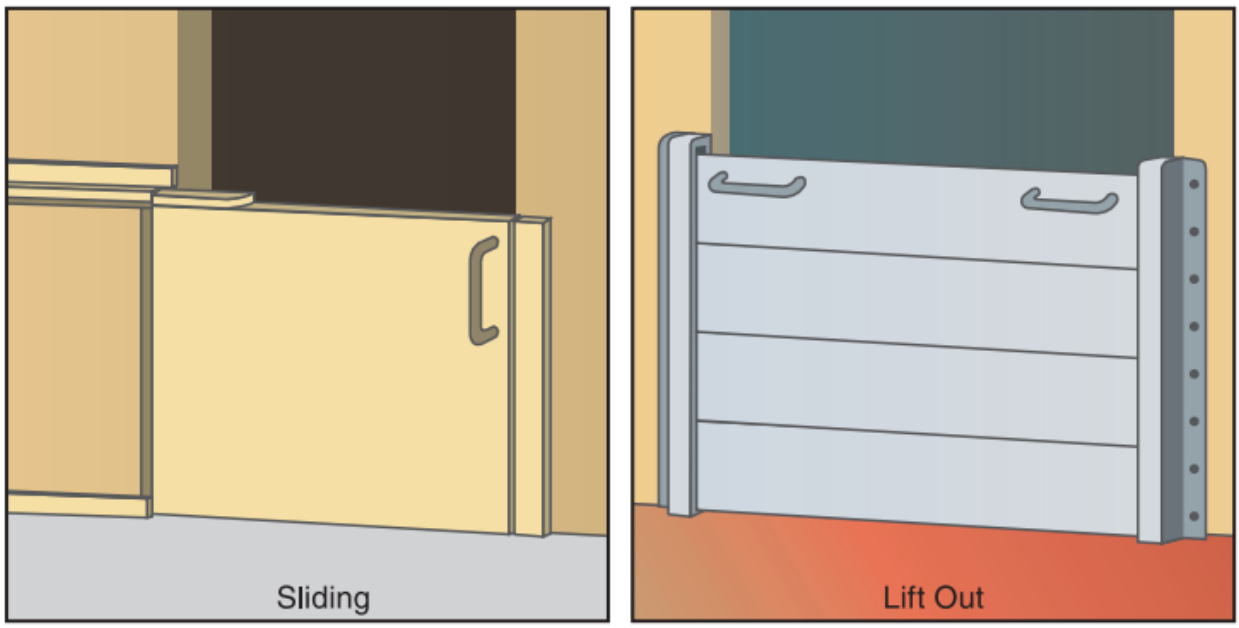



*Figure 5-3: Conceptual example of sliding and lift-out flood shields for building entrances (FEMA, 2013).*

### Explore Options for Beach Nourishment

Beach nourishment programs can provide an alternative shoreline protection method when other techniques such as shoreline armoring are not feasible or would cause unwanted adverse impacts. Sand placement from inland or offshore sources allows local beaches to maintain or

increase their width as sea levels rise, providing a buffer to wave energy while preserving recreational and environmental value. Beach nourishment also complements other forms of adaptation to provide multiple layers of protection along the downtown coastline.

To be successful and cost-effective, beach nourishment programs should account for local and regional oceanographic processes and include monitoring efforts to evaluate performance of the program. Knowledge of sand transport and erosion rates along local coastlines is key to determining the amount and timing of sand placements and preserving the life span of nourishment efforts. Littoral processes within Pismo Beach can potentially contribute to the success of nourishment efforts due to the relatively low rate of net sediment transport out of the area. Nourishment programs could also potentially be designed to duplicate historic rates of sediment supply to the region.

While natural processes can be leveraged to increase the effectiveness of nourishment programs, beach nourishment efforts involve an inherent level of variability due to seasonal changes in local erosion rates and episodic erosion events. Due to this variability, nourishment projects should not be considered one-time events but should instead include planned maintenance and subsequent nourishment efforts. Nourishment planning on a regional or watershed level can facilitate adaptability by allowing for opportunistic nourishment events and coordinated nourishment activities along neighboring stretches of coastline, ultimately increasing the long-term efficiency of beach nourishment projects. The CRSMP provides a good starting point for implementing regional solutions that can benefit from a coordinated effort to permit and fund beach nourishment projects. Dredged material from Port San Luis and sediment accumulated behind the Twitchell Dam are two potential sources of sediment described in the CRSMP.

Benefits

- Effectively offsets loss of recreational value due to projected declines in beach width.
- Provides flood protection benefits without aesthetic impacts or loss of community character.
- Littoral processes within the region are generally favorable.

Challenges

- Required CEQA and NEPA environmental permitting processes associated with sediment placement in the coastal zone.
- CRSMP recommends detailed study of the potential impact of sea level rise and beach nourishment on fluvial flooding.
- Potential costs associated with ongoing nourishment programs.
- Ongoing beach width and elevation monitoring requirements.
- Timing of nourishment activities to avoid disruption to recreational use of beaches.
- Potential loss of nourishment material following coastal storm events.

### 5.1.3 Low-Lying Areas

#### Deployable Flood Protection Barriers

Deployable flood barriers are structures that can be erected under high-hazard conditions to prevent flooding landward of the structure. Structures are then removed once flood risk subsides. Although not a permanent solution, deployable barriers can be employed within the Low-Lying study area to provide an additional layer of protection for critical structures or as a supplement to permanent structural flood protection. Such measures could potentially be effective in addressing storm flood hazards projected within the RV park bordering Pismo Creek under the near-term, 1.6-ft SLR scenario. Floodwaters enter the park within a relatively small area where use of a temporary barrier during severe storm conditions could prevent the majority of landward flooding. Temporary barriers could also be used as a means to protect the permanent recreational facilities within the park under high-hazard conditions.

A wide variety of deployable flood barriers are available to accommodate the specific risk and protection requirements at various sites, including those that can be completely constructed and deconstructed as part of deployment or barriers that are permanently installed, rising into position when needed due to hydrostatic pressure (Figure 5-4). Alternative flood barriers such as water-filled structures can also be used to temporarily reduce flood risk around specific structures (Figure 5-5).

Benefits

- Deployable barriers do not require the permanent, dedicated space necessary for structural flood protection measures.
- The temporary nature of deployed barriers facilitates maintenance of existing coastal viewsheds and coastal access points.
- Flexibility in terms of deployment location and level of flood protection provided allows for adjustment of adaptation strategies over time.

Challenges

- Successful implementation of temporarily installed barriers depends on advance flood warning.
- Barrier height is restricted compared to permanent protection measures, though height can be increased through additional barrier reinforcement and stabilization.
- Equipment storage, assembly, and disassembly costs must be considered if barriers are not self-deploying.
- Barrier placement may result in additional flooding of adjacent areas depending on the extent and configuration of these flood barriers.



*Figure 5-4: A "pop up" flood barrier that is forced up automatically when the site is flooded (FEMA, 2014)*



*Figure 5-5: Conceptual design of water-filled barriers that can be rapidly deployed around threatened structures. (Visualization produced by M&N for NYCEDC, Interim Flood Protection Citywide)*

### Drainage Improvements

Drainage improvements within the Low-Lying study area can mitigate storm related flood hazards as projected under a 1.6-ft SLR scenario by facilitating drainage of floodwaters through increased storage and conveyance capacity. Flood projections under this near-term SLR scenario are generally confined to the RV park bordering Pismo Creek. Interior flooding projected within this area primarily stems from floodwaters that overtop a small segment of the adjacent Pismo Creek shoreline. Floodwaters are then transported across low-lying roadways within the RV park.

Drainage infrastructure such as pump stations, storm drains, and water storage features within the RV park can reduce potential flood extents and damages by conveying floodwaters away from development if shoreline overtopping occurs. Similar improvements would be effective at the State Park campground, which experiences similar flooding from Meadow Creek when high ocean water levels coincide with a fluvial event.

Drainage improvements are unlikely to be effective if areas become subject to non-storm flooding or if elevated water levels persist for an extended period of time. While these conditions are not projected within the Low-Lying study area under a 1.6-ft SLR scenario, these limitations should be considered when developing specific adaptation measures. Despite limitations under more severe SLR projections, drainage improvements could complement other measures such as structural flood barriers by reducing the extent and duration of flooding if barriers are overtopped under extreme conditions. Drainage improvements should also be considered in combination with any permanent flood barriers as a means to remove interior floodwaters that can result from rainfall runoff or fluvial flood events.

Benefits

- Provides a means to control the extent and path of floodwaters without significant alterations to structures or other coastal resources.
- Improvements can be integrated into existing features such as roadways and park areas, where additional water features could potentially serve as detention ponds.
- Drainage improvement measures additionally mitigate fluvial flood hazards driven by rainfall.
- Improvements provide a redundant layer of flood protection in the event coastal barriers are overtopped or a significant rainfall event coincides with a high ocean water level, further elevating water levels at the mouth of Pismo Creek.

Challenges

- Improvements must be coordinated across the area of implementation to be effective.
- Ongoing maintenance requirements may be costly based on the type and extent of drainage measures implemented.
- Measures do not directly prevent entry of floodwaters within an area.
- Limited effectiveness as a standalone measure beyond reducing impacts from temporary, storm-driven flood events.

## 5.2 Long-Term Adaptation Strategies

The vulnerabilities identified for SLR projections of 3.3 ft and higher are overwhelming, but unlikely to occur until the end of the century or later. There is a 98% probability that sea level rise will not exceed 5 ft this century. Given the long-term planning horizon associated with these scenarios, there is time to plan, fund, and implement adaptation strategies in response to the

evolving hazards. SLR of this magnitude would result in significant vulnerabilities to the entire coastline of Pismo Beach and require more consequential adaptation strategies as a result. Several long-term adaptation strategies are discussed in this plan and may come in the form of protection, accommodation, retreat, or a combination of these approaches.

### 5.2.1 Bluffs

Long-term SLR adaptation within the Bluffs study area is complicated by the stochastic nature of bluff erosion hazards, as significant bluff erosion can occur over a relatively short period of time during severe storm events. The City has a long history of managing these hazards, including construction of shoreline stabilization infrastructure along high-risk bluff areas or relocation of access paths and park amenities away from the bluff edge. These existing protective structures, along with the complex coastal dynamics within the Bluffs study area, cause hazard vulnerability and adaptive capacity to vary from parcel to parcel. Thus, while SLR is projected to exacerbate existing bluff erosion hazards, it is difficult to predict the precise areas or timing of coastal hazards.

While near-term project-level SLR adaptation measures for the Bluffs area primarily focus on ways to augment existing hazard mitigation practices where necessary, additional measures designed to continually manage development within high-hazard zones may be necessary to address potential coastal hazards under long-term SLR scenarios. Given the history of bluff erosion hazard management within Pismo Beach, incorporating SLR into existing hazard management practices may provide an effective method to bolster resilience to SLR hazards. As bluff-top setbacks often represent a key component of hazard mitigation in coastal communities, accounting for the potential acceleration in bluff erosion due to SLR in required site assessments is likely to be a critical aspect of hazard management moving forward. Realignment or removal of existing development within current high-hazard areas may also become necessary under severe SLR scenarios if bluff erosion undermines structural foundations. Planning for such scenarios and identifying necessary actions ahead of time can substantially reduce risks to life and property.

Long-term SLR adaptation planning within the Bluffs study area requires a balance of additional protection structures, softer solutions like beach nourishment, living shorelines and artificial reefs, and bluff top development restrictions. While bluff armoring represents an effective means of limiting erosion of the bluff face, extensive armoring could result in loss of beach areas within the Bluff study area, impacts to the aesthetics and character of local communities, reduced coastal access, and costly infrastructure maintenance requirements. Armoring may also limit the natural adaptive capacity of areas where a sandy beach provides a buffer against wave energy by reducing future sediment supply to nearby areas. Despite these potential drawbacks, armoring may still be appropriate under extreme cases or if alternative actions are not feasible, provided that structures are compatible with current or future regulatory frameworks. These

determinations will likely need to be made on a case by case basis given the variable SLR hazard exposure within the study area.

Key Considerations

- Incorporation of SLR into site-specific hazard analyses required for bluff top development.
- Potential realignment or removal of development in high-risk areas.
- Limitations on the use of armoring to avoid adverse impacts to natural coastal processes.
- Need for a site-specific approach due to high variability in potential SLR hazard exposure.

### 5.2.2 Downtown

Long-term SLR adaptation within the Downtown study area is largely tied to the beach width remaining and condition of protection structures fronting development in the area. The dry beach area represents both a critical cultural and recreational resource for the City as well as a buffer against wave impacts for landward areas. Though a decline in beach width is projected under the near-term, 1.6-ft SLR scenario, this does not cause a significant change in coastal hazard conditions along the Downtown shoreline. Beach width loss and flood hazard projections become more pronounced under 3.3-ft and greater SLR scenarios, as shoreline and non-storm flood projections extend up to the current line of development. As discussed in Section 5.1.2, beach nourishment programs may be able to offset these impacts given the favorable littoral processes in the area, though the feasibility of potential nourishment programs declines under more severe SLR scenarios. Sediment supply to downtown beaches can also potentially be supplemented by restoring historic rates of sediment delivery to the area from nearby rivers over a long-term time frame.

Flood projections under long-term SLR scenarios do not extend past current shoreline protection infrastructure until scenarios above 6.6 ft, which are extremely unlikely to occur by the end of the century. While the landward extent of flood projections is limited under long-term SLR scenarios, substantial improvement or replacement of current shoreline protection infrastructure may be required to account for non-storm flood impacts and more severe storm conditions. This is particularly true for infrastructure surrounding the Pier, which is projected to be exposed to non-storm flood hazards under a 3.3-ft SLR scenario. The timing of these higher SLR scenarios (2070-2100+) also coincide with the end of the service life associated with many of the coastal protection structures lining the back shore, including the Pier. Any existing shoreline protection to the north or south of the Pier will also become more frequently exposed to storm and non-storm flood impacts under long-term SLR scenarios and may require additional maintenance, improvement, or replacement. Under extreme SLR scenarios realignment of coastal infrastructure and development within the Downtown study area would likely become a more feasible adaptation option as protection or accommodation measures may no longer be feasible due to high costs and coastal squeeze impacts resulting from extreme SLR.

The unprotected bluffs along the northern portion of Pismo State Beach are projected to become exposed to greater erosive forces as beach width declines and wave impacts occur on a more regular basis under 3.3-ft and greater SLR scenarios. Adaptation solutions like beach nourishment combined with living shoreline techniques like a cobble berm and dunes could provide additional protection under these scenarios. However, these strategies will become very costly and difficult to maintain under extreme SLR scenarios. Relocation of development away from the bluff edge could become a feasible option under these extreme scenarios and would allow the sandy beach and bluff areas to follow a natural pattern of landward migration in response to extreme SLR.

Key Considerations

- Adaptation measures to offset loss of beach width, potentially through beach nourishment or restoration of historic rates of sediment supply.
- Improvement or relocation of existing shoreline protection to account for additional hazard exposure over the expected service life of each structure.
- Evaluate potential for realignment of development and infrastructure along northern bluffs if beach width loss results in additional hazard exposure.
- Evaluate potential landward realignment or setbacks of development or infrastructure as a component of redevelopment initiatives that are expected to have a service life extending beyond 2100.

### 5.2.3 Low-Lying Areas

Long-term SLR adaptation planning within the Low-Lying study area will need to address coastal flood hazards as well as potential increases to existing fluvial flood hazards. The 100-year floodplain as described in the most recent FEMA flood study currently covers close to the entirety of development within the Low-Lying study area. Ongoing compliance with FEMA floodplain regulations and insurance requirements can help mitigate potential flood impacts, but it should be noted that FEMA flood studies do not explicitly account for the potential effects of future SLR scenarios. Ongoing use of flood mitigation measures above FEMA requirements, such as the use of additional freeboard above flood elevations, can potentially be used within areas where SLR hazard projections overlap with FEMA floodplain mapping studies to account for potential increases in flood hazards driven by SLR.

Long-term SLR adaptation within the Low-Lying study area will also likely require a combination of additional flood hazard protection and accommodation strategies, particularly in areas where non-storm flooding extends inland. Under a 3.3-ft SLR scenario, non-storm flood projections in areas west of Dolliver Street can potentially be addressed through targeted protection at vulnerable or low-lying segments along Pismo Creek. Targeted protection along Pismo Creek could also potentially address non-storm flood hazards under a 4.9ft SLR scenario, though large areas west of Dolliver Street would become exposed to non-storm flooding if protective structures gave way or floodwaters overtopped other portions of the Pismo Creek shoreline. Storm flood projections cover significant portions of the Low-Lying study area under both the

3.3-ft and 4.9-ft SLR scenarios, though projections do not extend beyond the current FEMA 100-year floodplain. Given the existing potential for fluvial flooding in the region it is possible that fluvial flood hazard mitigation practices could be implemented that also provide increased adaptive capacity for SLR and potential coastal storm flooding.

The 6.6-ft SLR scenario represents a potential tipping point for the Low-Lying study area as non-storm flood projections overtop the Pismo Creek shoreline at multiple locations and extend landward to areas east of Dolliver Street. Extensive SLR adaptation efforts would likely be required to address non-storm flooding to the west of Dolliver Street under this scenario. Under these severe SLR conditions, removal or reconfiguration of development west of Dolliver Street may become necessary if widespread elevation or flood protection within the area proves infeasible or cost-prohibitive. Reconfiguration of the RV resort and campground facilities would provide an opportunity to implement nature-based systems such as wetland buffers and vegetated dunes that could be more adaptable to extreme SLR scenarios.

Additional non-storm flood projections east of Dolliver Street and along the northern Pismo Creek shoreline with 6.6 ft of SLR could potentially be mitigated though targeted elevation of at-risk infrastructure, including low-lying portions of Dolliver Street and areas surrounding the Cypress Street Bridge. SLR adaptation under extreme SLR scenarios beyond 6.6 ft will likely require significant elevation or realignment of development and coastal resources throughout the Low-Lying study area due to widespread non-storm flood projections. As is the case in other areas of the City, this scale of SLR adaptation is most likely to be achieved as a component of large-scale redevelopment efforts.

Key Considerations

- Adjustment of FEMA flood mitigation standards and practices to account for potential increases in flood hazards due to SLR
- Targeted protection efforts along Pismo Creek to prevent landward flooding under non-storm conditions.
- Potential elevation or realignment of coastal development and resources under severe to extreme SLR scenarios.

## 5.3 Monitoring and Phasing

The SLR projections and coastal hazard modeling results used to inform this adaptation plan are based upon the best available science at the time of this study. These data sources will likely be updated at regular intervals to keep pace with the evolving science. When coupled with local monitoring data on sea level change and local coastal hazards this information can be used to determine when to implement certain adaptation strategies. The following sections describe a phased adaptation plan that can be implemented based on triggers associated with increased hazards or SLR thresholds.

### 5.3.1 Phased Adaptation Implementation

Developing a phased adaptation approach can provide a flexible implementation mechanism for future SLR adaptation efforts. Appropriate SLR hazard mitigation trigger types, hazard thresholds, and responsive actions can substantially improve the implementation of SLR adaptation measures by providing guidelines for the timing and type of future SLR adaptation efforts. An example of a phased series of SLR adaptation measures is provided in Table 2.

A key benefit of a phased adaptation approach is that the timing of phases can be adjusted as new SLR hazard information becomes available, mitigating the uncertainty surrounding long-term SLR projections. Due to this reliance on continually updated hazard information, any phased adaptation strategies must also involve a monitoring plan related to coastal hazards to inform hazard thresholds, discussed further in Section 5.3.2. Including community participation provisions in the initial phased adaptation planning process can also increase clarity surrounding the potential timing and justification of future SLR adaptation measures.

Along with updates to coastal hazard information based on monitoring programs, a phased adaptation approach must also consider the potential lead times associated with various adaptation measures. The amount of time necessary for planning, funding, and implementation will vary based on the type and specific design considerations of each adaptation measure, and so action may need to be taken before triggers are met to avoid potential hazard impacts. This is particularly true for long-term adaptation strategies triggered by extreme SLR scenarios that involve significant changes within densely developed areas due to the large amount of infrastructure present. The challenges associated with extended project lead times can be mitigated through the use of short- and medium-term adaptation measures while long-term adaptation planning and implementation occurs.

*Table 2: Example of a phased SLR adaptation approach for the City of Pismo Beach.*

| SLR Scenario | Adaptation Trigger | Adaptation Measures[1] |
|---|---|---|
| 0ft | N/A | • Incorporate SLR into Capital Improvement Planning and updated GP/LCP documents.<br>• Evaluate fluvial flood hazard reduction measures that increase adaptive capacity to SLR.<br>• Evaluate existing shoreline and bluff protection structures.<br>• Develop bluff and beach width monitoring programs.<br>• Explore opportunities for beach nourishment. |

| SLR Scenario | Adaptation Trigger | Adaptation Measures[1] |
|---|---|---|
| 1.6ft | • Sustained loss of beach fronting Downtown or Bluffs.<br>• Increased rate of bluff erosion.<br>• Coastal storm flooding in development adjacent to Pismo Creek. | • Pursue beach nourishment opportunities to maintain beach width in Downtown or Bluffs study area.<br>• Dry floodproofing retrofits to Downtown structures in high-hazard areas.<br>• Shoreline and bluff protection improvements in critical areas where no feasible alternative is available.<br>• Improve drainage and utilize deployable flood barriers within Low-Lying study area.<br>• Develop a shoreline management program to identify specific adaptation measures to be applied along the Downtown waterfront in response to SLR scenarios of 3.3 ft or more. |
| 3.3ft+ | • Inundation of Downtown beach area during spring tides.<br>• Limited non-storm flooding within Low-Lying study area.<br>• Loss of bluff-backed beach areas. | • Adjust any shoreline management program as needed to account for additional coastal hazard impacts.<br>• Implement flood hazard mitigation measures along Pismo Creek. Develop long-term plan for adapting low-lying resources to SLR scenarios higher than 3.3 ft.<br>• Evaluate feasible alternatives for at-risk buildings and infrastructure within Bluffs study area. |

1. Measures listed for each progressive SLR scenario may be necessary only if previously implemented measures become insufficient based on performance and hazard monitoring

### 5.3.2 Hazard Monitoring Programs

Regular coastal bluff and beach width monitoring programs can greatly benefit the implementation, evaluation, and adjustment of future SLR adaptation measures throughout the City. Coastal bluff and cliff erosion have historically been prominent hazards within the Bluffs study area. As discussed in the VA, the link between SLR and increased bluff erosion is well established, but uncertainty remains regarding the precise timing and extent of erosion impacts. Coastal bluff monitoring programs can provide actionable data in the face of these uncertain projections that can be used to determine whether mitigation thresholds have been met or surpassed. This data will also be useful for the site-specific geologic hazard analyses that are required for development along the bluffs. In a similar manner, ongoing beach width monitoring data can be utilized to verify projected rates of shoreline retreat along the Downtown and Low-Lying study areas and quantify the efficacy of any beach nourishment or additional sediment management activities.

A number of methodologies can be employed to carry out coastal hazard monitoring programs, including 3D topographic modeling through LIDAR (Light Detection and Ranging), illustrated in Figure 5-6, and beach profile surveys along transects running perpendicular to the shoreline. Apart from tracking physical impacts such as bluff erosion or shoreline retreat, data related to

hazard conditions such as overtopping of existing shoreline protection or frequency of fluvial flood events can also inform ongoing SLR adaptation efforts.

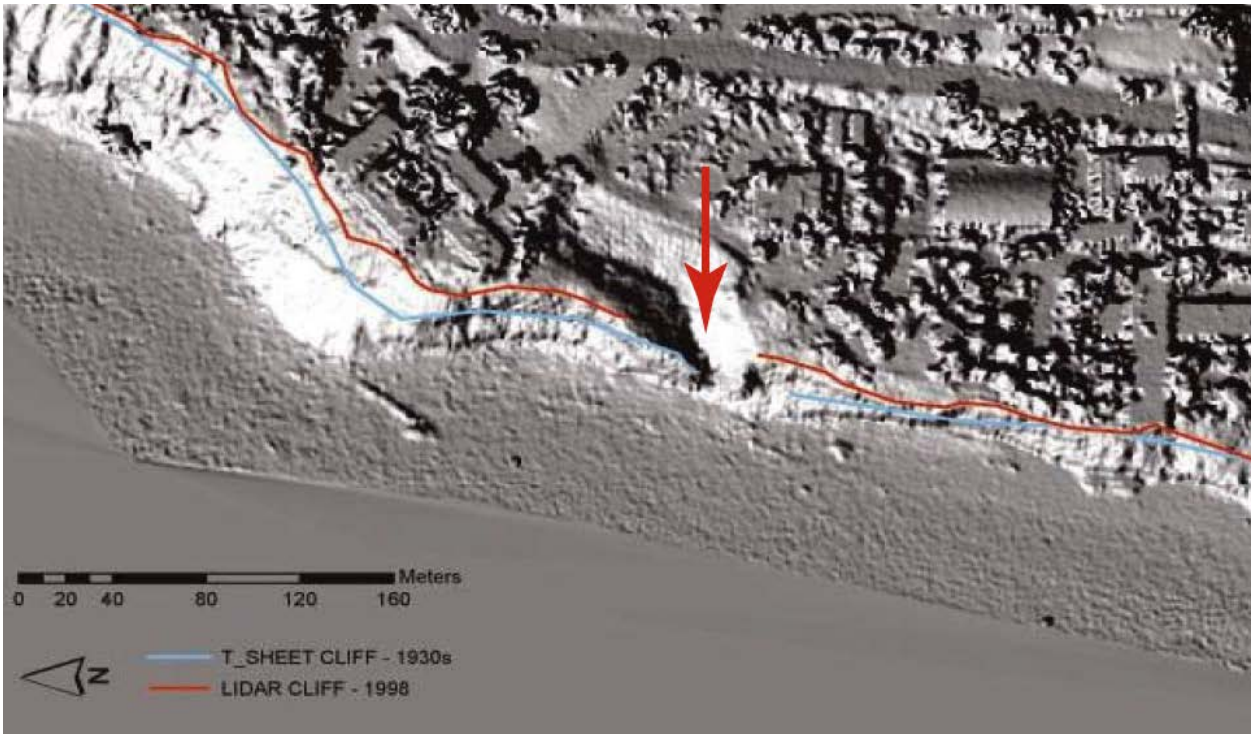



*Figure 5-6: Example of bluff monitoring using LIDAR techniques (Hapke & Reid, 2007)*

Potential Applications

- Conduct coastal bluff surveys at 5-year intervals using LIDAR or a similar technology that allows for 3D modeling of the bluff face and documentation of bluff top and toe position, nearshore slope, bluff face slope, and other bluff features as needed.
- Conduct annual or seasonal beach profile surveys documenting shoreline width, slope, height, or other features as necessary to inform adaptation decisions.
- Perform supplementary surveys immediately following any significant bluff or shoreline erosion events.
- Document survey findings in reports and update coastal hazard projections as necessary based on best available information and methods, including any updates in SLR science or projections.

# 6. Next Steps and Additional Research Needs

SLR adaptation within the City of Pismo Beach will be an ongoing process. While a number of potential SLR adaptation strategies are identified throughout this Adaptation plan, specific actions or design of adaptation measures are beyond the scope of this document. This section identifies important next steps the City may undertake to fill these gaps in knowledge in order to advance SLR adaptation efforts.

- Develop policies related to SLR hazards to be included in the City General Plan and Local Coastal Program update.
- Conduct additional research on combined fluvial and coastal flood hazards in low-lying areas bordering Pismo and Meadow Creek.
- Establish an inventory of bluff protection structures.
- Develop coastal hazard monitoring programs to inform ongoing SLR adaptation efforts.
- Perform feasibility assessments for beach nourishment programs within the Bluffs and Downtown study areas.
- Identify federal, state, regional, and local funding opportunities for SLR adaptation measures.
- Establish pilot programs studying the effects of rocky intertidal habitat restoration on bluff erosion.

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