



COUNTY OF VENTURA
RESOURCE MANAGEMENT AGENCY | PLANNING DIVISION



VC RESILIENT COASTAL ADAPTATION PROJECT

DRAFT SEA LEVEL RISE ADAPTATION STRATEGIES REPORT

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2012 Coastal Resilience Ventura Model:

- The Nature Conservancy, California Chapter
- County of Ventura
- Environmental Science Associates (ESA)

2017 Coastal Storm Modeling System (CoSMoS v3.0):

- United States Geological Survey
- California Coastal Conservancy

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ACRONYMS/ABBREVIATIONS

BEACON	Beach Erosion Authority for Clean Oceans and Nourishment
Coastal Resilience Model	Coastal Resilience Ventura Project (The Nature Conservancy, County of Ventura, and Environmental Science Associates, 2012)
CoSMoS	Coastal Storm Modeling System of the United States Geologic Survey
County	County of Ventura
FEMA	Federal Emergency Management Agency
LCP	Local Coastal Program
OPC	Ocean Protection Council
Report	2019 VC Resilient Coastal Adaptation Project Sea Level Rise Adaptation Strategies Report
SLR	Sea Level Rise
USFWS	United States Fish and Wildlife Service

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DEFINITIONS

The following terms are defined for the purpose of use in this Report:

1% Annual Chance Storm: often called a 100-year storm event, it is an exceptionally large storm with a 1% chance of occurring in any given year. It is the basis for the FEMA regulatory flood maps. In rivers it is based on streamflow, and on the open coast it is based on wave run up.

Adaptation: anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the vulnerabilities.

Adaptation Pathway: an adaptation pathway is a planning approach addressing the uncertainty and challenges of climate change decision-making. It enables consideration of multiple possible futures and allows analysis/exploration of the robustness and flexibility of various options across those multiple futures.

Adaptive Management: a process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables.

Adaptive Capacity: the ability of a system to respond to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities, and to cope with the consequences.

Base Flood Elevation: reflects the height (in feet) above sea level that flood water is predicted to rise during a 1% annual chance storm. Base Flood Elevations are shown on FEMA Flood Insurance Rate maps. The relationship between the BFE and a structure's actual elevation above sea level determines flood insurance premiums.

Coastal Armor: structures developed for shoreline protection constructed from durable materials such as rock and reinforced concrete. In Ventura County, most shoreline protective devices consist of seawalls and rock revetments.

Coastal Erosion: loss of land in the dunes or cliffs along the coast caused by wave attack.

Coastal Flooding: pooling of seawater on land as a result of any wave uprush with momentum that causes damage. A 1% annual chance storm would cause coastal flooding, but common storm events may also cause coastal flooding.

Coastal Zone: a regulatory zone established by State Legislature and shown on maps prepared by the California Coastal Commission for which the California Coastal Act establishes policies and regulations.

Climate Change: a shift in climate and weather patterns over time, due to natural causes or as a result of human activity.

Cumulative Effects: the interconnected land use, ecological, social, and economic systems, and how these systems change during the past, present, and future, particularly with sea level rise.

Ecosystem Services: the many and varied benefits that humans freely gain from the natural environment and from properly-functioning ecosystems that contribute to the natural, social, and economic well-being of society.

Littoral Cell: an area of coastline that contains the complete cycle of sedimentation, including sources, transport pathways, and sinks. The presence of sand on any beach depends on the transport of sand within the littoral cell.

Long-term Adaptive Capacity: the viability of an adaptation measure with 5 feet or more of sea level rise. The extent to which harmful secondary and cumulative effects are minimized is also considered.

Maladaptation: inadvertently increases the vulnerability to sea level rise hazards and can be a result of badly planned adaptation actions or decisions that place greater emphasis on short-term outcomes than longer-term threats.

Mean High Tide Line: the average of the higher high water height of each tidal day, as observed over a 19-year period by the National Ocean Service.

Risk: commonly considered to be the combination of the likelihood of an event and its consequences – i.e., risk equals the probability of climate hazard occurring multiplied by the consequences a given system may experience.

Secondary Effects: the way different adaptation measures that are used to alleviate a vulnerability in one sector then interact with the adaptation measures applied to other sectors. Socially equitable adaptation measures do not benefit one population to the detriment of another or reinforce existing environmental and societal inequities.

Sector: a category of natural or built resources, such as building structures, wastewater infrastructure, beach access, and sensitive biological resources.

Tidal Inundation: flooding caused during predictable high tides that occurs with some regularity.

Vulnerability Assessment: the process of identifying, quantifying, and prioritizing the potential exposure of resources or infrastructure in an area or a system. A Sea Level Rise Vulnerability Assessment was completed for the unincorporated areas of Ventura County in December 2018.

REPORT, MAP, AND DATA DISCLAIMER

This information is intended to be used for planning purposes only. There are inherent uncertainties associated with modeling and projecting future hazards and their potential impacts. All model results are subject to uncertainty due to limitations in the data used, incomplete knowledge of all factors that contribute to coastal hazards and sea level rise, and simplifications of those factors. This Report is advisory and not a regulatory or legal standard of review for actions that the County of Ventura or the California Coastal Commission may take.

This Report is part of an ongoing process to understand and prepare for coastal hazards. We do not accept responsibility for any errors, omissions, or for any positional inaccuracies. Users of the data included with this report are strongly cautioned to verify all information. Additional monitoring and site-specific specific evaluations may be needed to verify the information presented herein.

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EXECUTIVE SUMMARY

There is growing concern and a desire to plan for the potential harmful effects of sea level rise. Climate science is constantly evolving but it's clear that sea levels are rising due primarily to the warming expansion of the ocean and melting glaciers. Climate experts estimate that by 2100, the sea level will rise by 5 feet or more, although the specific timing and magnitude of impacts is difficult to predict. In the near term, rising sea level alone will not be the primary cause of damage to resources and infrastructure. These impacts will be caused by coastal erosion and coastal flooding, both of which occur during storms and large wave events, and will result in more damage when combined with sea level rise.

The VC Resilient Coastal Adaptation Project Sea Level Rise Vulnerability Assessment (Vulnerability Assessment) prepared by the Ventura County Planning Division in 2018 identified areas of the County that are at risk from sea level rise and related hazards through the end of the century without any intervention. Vulnerability was assessed in terms of potential exposure of land uses, sensitive populations, structures, recreational and natural resources, and critical infrastructure. The modeling used for this assessment reaffirmed that most of the County's coast is currently vulnerable to large storms (i.e. 1% annual chance storm) and found that storm damage will be exacerbated by sea level rise. It also predicted that by about 2030, the effects of approximately 8 inches of sea level rise will be noticed in the following areas:

- North Coast beaches at La Conchita, Oil Piers, Rincon Parkway, Mondos, and Solimar;
- The beach and sand dunes near the jetty at Hollywood Beach;
- The southern areas of Arnold Road, near Ormond Beach;
- The confluence of the Calleguas Creek and Revolon Slough;
- The campsites at Thornhill-Broome Beach; and,
- South Coast Beaches at Sycamore Cove and Yerba Buena.

Additional areas that will be vulnerable with 16 inches of sea level rise and without any intervention, by approximately 2060, include:

- Rincon Point;
- Silverstrand near the Hobie and Kiddie Beaches in the Channel Island Harbor;
- Agricultural areas located inland of Ormond Beach;
- Narrow beaches on the North and South Coast, as they will become being tidally inundated daily, and overall beach widths are reduced by about 20 percent.

With 5 feet of sea level rise, and without any intervention, by approximately 2100, the areas exposed to rising tides will continue to include beaches, and begin to severely affect developed areas. Areas vulnerable by about 2100 will include:

- The protective seawalls and rock revetments that armor the shoreline on the North Coast are overtopped, first at Hobson Beach Park then at various residential communities, along the Rincon Parkway, and at Faria Beach Park.
- On the Central Coast, the peninsula and streets at Hollywood Beach become regularly flooded, and nearly all the Silverstrand neighborhood is inundated.

- On the South Coast, the homes on pilings will be located deeper into the surf zone and the bluffs near Leo Carrillo State Park could be eroded up to the Pacific Coast Highway.
- Wide beaches will be about half of today's width. Narrow beaches and coves on the North and South Coasts will be inundated daily at high tide.

Preparation of this Adaptation Report followed the Vulnerability Assessment as the next step in initial adaptation planning. The Vulnerability Assessment is a starting point for a common understanding of the risks, but it does not provide solutions. There are few easy solutions and all of them require additional public input and additional funding. As an informational document, this Report expands upon the Vulnerability Assessment to provide a foundation for developing future sea level rise policies to be integrated into the County's Local Coastal Program (LCP). Adaptation planning will remain an iterative process to protect the County's coast as conditions change and new strategies are developed and tested.

This Report provides a comprehensive overview of the various adaptation strategies that could be employed to protect the County's vulnerable assets for future generations. The State of California is still in its infancy with developing a robust toolbox for responding to sea level rise at the local level. As such, some of these strategies are tested, some are experimental in nature; others have been successfully employed in marshes or bays, but never in the context of the high wave energy of the Pacific Ocean.

Five case studies are provided at the end of this Report and summarized below. Each provides a framework for managing risk and taking action to minimize the immediate threat of coastal flooding and the long-term threat of sea level rise. The adaptation case studies focus primarily on strategies that apply to publicly owned assets and infrastructure, where the County has more authority. However, the strategies summarized throughout the Report include options that could apply equally to privately owned land or to publicly owned beaches and infrastructure. It's understood that collaboration with landowners and other regional and local stakeholders would be needed before adaptation approaches for privately held land could be developed or implemented.

A written narrative and a general implementation timeline is provided for each case study with proposed triggers for implementing the next phase of adaptation planning. A limited fiscal analysis of four of these case studies is included in Appendix B. These case studies are meant to allow for dialogue and to illustrate the trade-offs of waiting or more actively addressing sea level rise now. They are not intended to prescribe a specific plan of action, but rather are intended to inform decisionmakers on the types of responses available. Future Local Coastal Program amendments, proposals, feasibility studies and project-level analysis would be required before employing the proposed adaptation strategies.

This Report will be revised after a Planning Commission Work Session. It will then be used to develop potential LCP policies for review by the Board of Supervisors. In a future phase of this project, an update to the Coastal Area Plan and the Coastal Zoning Ordinance to address sea level rise will be drafted and reviewed by the Ventura County Planning Commission, the Ventura County Board of Supervisors, and ultimately certified by the California Coastal Commission.

High priorities for the adaptation of County-owned facilities and public assets to be evaluated in the near term include:

- Sand retention at narrow beaches along the Rincon Parkway and coves with public access such as Mondos, Beacon's Beach, Sycamore Cove, and Yerba Buena;
- Dune restoration and drainage improvements at Hollywood Beach;
- Flood-proofing of Victoria Avenue at Silverstrand, near Hobie Beach;

- Accommodation or protection from tidal inundation for roads and other infrastructure at inland areas of Ormond Beach;
- Accommodation of flooding at Calleguas Creek and the Revolon Slough;
- Accommodation and possible relocation of the campground at Thornhill-Broome Beach;
- Accommodation and protection of new bridges being planned at Harbor Boulevard over the Santa Clara River, and at Pacific Coast Highway over Sycamore Creek.

After an evaluation of these vulnerable areas and potential applicable adaptation measures, and through discussion of strategies with other County agencies, the following adaptation plans are examples that could be developed in further detail. The recommendations are calibrated to approximate years referenced in the sea level rise models used to develop the Vulnerability Assessment. It should be noted that measurable sea level rise may occur sooner or later than the models predict, but the best available science indicates it will eventually rise by at least 5 feet.

Hollywood Beach and Existing Community

Before year 2030: Conduct dune restoration near the Channel Islands Harbor jetty. Consider planning to expand dune protection along the shoreline, or supplement dune restoration with seasonal winter berms on the remainder of the beach before large storms. Add a stormwater detention basin and pump for segments of Ocean Drive inland of the dunes. Begin requiring new development to be designed to accommodate flooding.

Between years 2030 and 2060: If dune restoration is successful, restore sand dunes along the entire unincorporated shoreline, and preferably along the entire beach to Mandalay Beach in coordination with the City of Oxnard. Coordinate with the Harbor Department regarding potential measures to reduce the projected flooding from the Channel Islands Harbor. Plan stormwater system improvements for local streets.

Between years 2060 and 2090 (or sooner if the dunes are eroded): Replace the restored dunes with cobble berm-based dunes. Add storm drain system with pipes and pumps to the streets in preparation for 5 feet of sea level rise. Relocate restroom at La Brea Street, or design it to accommodate flooding. Coordinate with the Harbor Department regarding flood protection improvements, such as flood gates.

By approximately 2100: If erosion continues, review dredging practices to consider the feasibility of sediment deposition to upshore areas at Hollywood Beach. Install perpendicular structures to retain sand, such as groins or cobble-berms. Buildings built after about year 2020 would be designed to accommodate some flooding.

Alternatives: Instead of nature-based protection and design of the built environment for accommodation as discussed above, the other options include armoring the area or purchasing land for retreat. Armoring the coast would be inconsistent with the Coastal Commission's *Sea Level Rise Guidance*, is likely to increase beach erosion, and would adversely affect sensitive species. Voluntary buy-out programs as an alternative have high start-up costs and have yet to be widely used.

Silverstrand Beach and Existing Community

Before year 2030: Consider development of the dune field along the shoreline through inexpensive devices such as sand fencing that allow for natural formation of a dune field. Alternatively, construct seasonal sand berms during the winter. Plan for resiliency of the existing parking lots and lifeguard tower. Coordinate with the Harbor Department and the City of Oxnard to flood-proof the harbor at Hobie Beach

and the storm drains on South Victoria Avenue. Begin requiring new development to be designed to accommodate flooding.

Between years 2030 and 2060: The beach width should continue to be maintained through deposition of biennial dredging sediment from the Channel Islands Harbor. If dunes or seasonal berms are eroded, they may need to be rebuilt with more resilient materials such as with cobble foundations dunes and more vegetation to retain sand. A perpendicular groin structure on Silverstrand is not recommended because it is likely to affect the popular surf break. Replace or re-site the existing lifeguard tower and design the parking area next to the lifeguard tower to accommodate sea level rise or to be protected from periodic flooding. Plan stormwater system improvements for local streets.

Between years 2060 and 2090: Continue beach nourishment from the Channel Islands Harbor dredging. Relocate restroom at the end of Van Nuys Avenue, or design it to accommodate flooding. Implement sea level rise measures in the maintenance and design upgrades to the storm drain system. Coordinate with the Navy and Port of Hueneme to ensure the canal system does not flood the Silverstrand neighborhood and install/upgrade floodgates as needed. Coordinate with the Harbor Department regarding flood protection improvements, such as flood gates.

By approximately 2100: Consider improvements for public access while the beach is flooded during high tides, such as elevated boardwalks and look-out points. Consider modifying the San Nicolas Road pump station to pump storm water effluent to another location if the Harbor is inundated.

Alternatives: Instead of nature-based protection and design of the built environment for accommodation as discussed above, the other options include armoring of the area or the purchasing of land for retreat. Installing armor would be inconsistent with the Coastal Commission *Sea Level Rise Guidance*, is likely to increase beach erosion, and could adversely affect popular surf breaks. Voluntary buy-out programs as an alternative have high start-up costs and have yet to be widely used.

Rincon Parkway, Hobson and Faria County Parks¹

Before year 2030: Coordinate with Caltrans to construct a pilot project with non-permanent, nature-based sediment retention devices such as cobble-based groins. Supplement with beach nourishment as feasible. Another pilot project could include replacement of the revetment at Hobson Beach Park with a seawall that has a smaller design footprint and possibly tidepools for nature viewing. Since seawalls increase the rate of beach erosion, it would be optimal to test sediment retention measures in unison with a small-footprint seawall, in order to potentially preserve the beaches for a few more decades.

Between 2030 and 2060: Develop more sophisticated beach nourishment programs that source sediment from local bluffs and watersheds. Coordinate with the Union Pacific rail line and Caltrans to transport sediment from watershed debris basins or the sand-rich Central Coast for deposition on public beaches and rock revetments during spring and summer months. Install permanent rock groins if cobble-based groins underperform. Plan alternatives to rock revetments, such as curved seawalls that have smaller structural footprints.

Begin to evaluate options to relocate public facilities further inland and coordinate with Caltrans and utility providers regarding long-term options for Old Coast Highway. Decide whether to continue to increase heights of shoreline armor and eventually lose the beaches, or plan retreat in some areas. The

¹ The County and Caltrans have a longstanding Memorandum of Understanding that allows the County to maintain and operate public recreational uses along the Rincon Parkway, while Caltrans retains ownership of the roadway and associated coastal armor.

retreat approach would phase-out existing facilities, while acquiring access to inland areas for relocation of camping and day use facilities. If armor is selected, then the design should include improvements such as the Coastal Trail, tidepools, and access points to popular surf breaks.

Between years 2060 and 2090: If a small-footprint seawall and sediment retention devices at Hobson Beach Park increase the beach and provide enhanced protection over the existing revetments, extend use of the strategy to along the Rincon Parkway and at Faria Beach Park. Approximately 160 additional RV camping spaces could be added to the Rincon Parkway if the existing revetment was replaced with a seawall.

By approximately 2100: Depending on the adaptation pathway chosen between approximately 2030 and 2060, either acquire access to inland areas for relocation of recreational facilities, or if armor is selected, then a well-planned design should include improvements for the Coastal Trail, tidepools, and access points to popular surf breaks.

Alternatives: “A wait and see” approach resulting in continual use of rock revetments will require them to be taller, wider, and more costly, which could block public views, obstruct access, and occupy dwindling sandy areas or camping spaces. Visitation may decrease due to less beach access. Storm damage combined with rising tides is likely to increase the frequency of closures of the County’s most popular parks.

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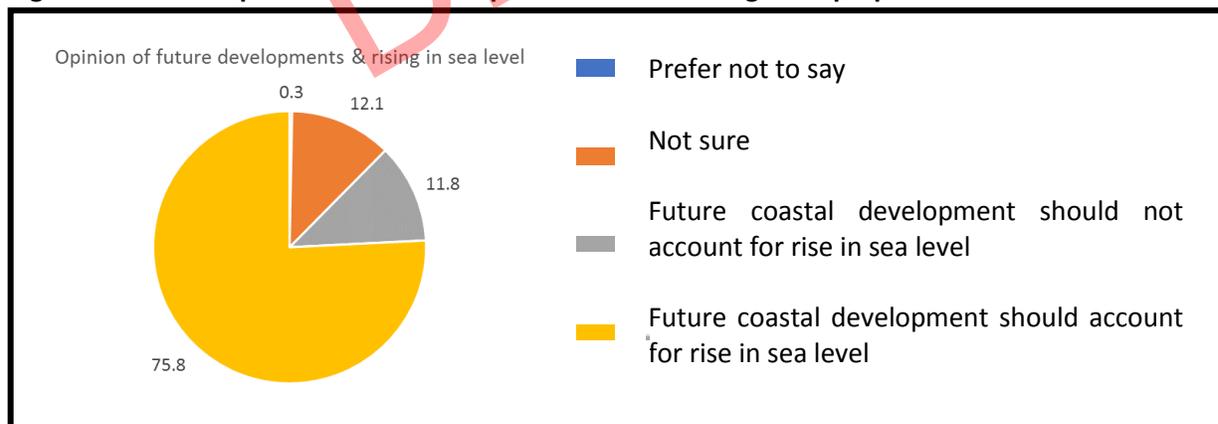
1. INTRODUCTION

This Report expands upon the Vulnerability Assessment completed in December 2018 which identified unincorporated areas that could be exposed to coastal hazards and sea level rise. This VC Resilient Coastal Adaptation Report (Report) assumes the reader is generally familiar with the unincorporated Ventura County coastline and has reviewed the Vulnerability Assessment. In this Report, sea level rise adaptation strategies are presented for consideration by the public and decision makers. In some cases, sea level rise adaptation strategies could be implemented through the Planning Division’s day-to-day development review that is conducted through the certified Local Coastal Program. Other strategies represent case studies or pilot projects that would require pro-active coordination with other organizations and funding sources yet to be identified. While this Adaptation Report does not provide the tools for a comprehensive approach to address sea level rise, when combined with the Vulnerability Assessment, these documents provide a foundation for sea level rise planning in Ventura County. A comprehensive approach to coastal resilience would need to be developed after additional feedback from stakeholders, decisionmakers, and State agencies such as the California Coastal Commission (Coastal Commission²).

1.1 Advanced Planning for Sea Level Rise

Coastal resource protection in California is instituted through decades of local, State and federal initiatives. For over 40 years the Ventura County General Plan has directed polices that “protect and conserve coastal beaches and sand dunes.”³ The General Plan update that is currently underway will likely continue to direct the County to conserve coastal resources, and the public supports these efforts. A public survey conducted for the General Plan update in 2017 estimated that over 75% of residents

Figure 1-1. Public opinion on how to respond to climate change and prepare for sea level rise.



²While the 12 voting members of the California Coastal Commission ultimately decide whether to certify new LCP policies, most coordination occurs with Coastal Commission staff at the local office. This reference applies to the local Coastal Commission staff.

³Ventura County General Plan, Goals Policies and Programs, 1.10.1 Goal.

believe that future coastal development should account for sea level rise (Figure 1-1). Thus, a clear majority of residents support an adaptive approach to sea level rise.

While public perception favors planning for sea level rise, the County's approach to adaptation requires making difficult decisions. Some of these decisions could reduce coastal hazards today, and others could require planning for actions that extend beyond the year 2040 horizon of the General Plan Update. Science tells us that change along the county's coastline is inevitable, and while there is still time, failure to act could be catastrophic. The Vulnerability Assessment and Appendix B demonstrate that there are high economic and safety risks associated with not planning for increasing coastal hazards. Over the next few generations, the Pacific Ocean will encroach inland and it will become increasingly difficult to maintain the current shoreline. To answer the question, "How to plan for sea level rise?" the challenge will be for Ventura County to engage in proactive, thoughtful planning to identify manageable solutions that minimize risks at the appropriate times.

1.2 Report Goals and Deliverables

This Report identifies strategies that are based on the results of the Vulnerability Assessment and were selected after initial coordination with other agencies. The strategies include analysis and recommendations from the consultant for this project, Revell Coastal LLC., and are based on input from Caltrans, the State Department of Parks and Recreation, California Coastal Commission staff, the Natural Resources Working Group, and County agencies including the Agricultural Commissioner's Office, the Watershed Protection District, the Harbor Department, the Transportation Division, and the Environmental Health Division. Public comments received in response to the Vulnerability Assessment were also integrated into the strategies that are covered in the most detail. Most of the public comments were received from coastal residents who expressed support for sand retention strategies and generally opposed any new restrictions on the use of shoreline armor.

This administrative draft of the Adaptation Strategies Report will be revised after receiving public input and comments from the Ventura County Planning Commission and California Coastal Commission. The revised Report, and the Vulnerability Assessment, will be used to draft potential sea level rise policies for review and comment by the Board of Supervisors. Adoption and certification of comprehensive sea level rise policies in the County's Local Coastal Program (LCP) will require future public hearings before the Planning Commission, Board of Supervisors, and Coastal Commission before they become effective. The adoption and certification process is not included in the current work program for the VC Resilient Coastal Adaptation Project. Additional grants or other funding sources would be needed to process these amendments.

Adaptation strategies for the Channel Islands Harbor are generally not included in this report because, while the harbor is owned and operated by the County, it is included in the City of Oxnard's LCP and is regulated through a separate Coastal-Commission-approved Public Works Plan. Nonetheless, some of the strategies highlighted in this Report require adaptation efforts in coordination with the Harbor Department and the City of Oxnard to protect unincorporated areas.

1.3 Adaptation Planning Guidance

Adaptation to sea level rise hazards involves a range of small and large adjustments in natural and human-made systems that need to occur as the coastline evolves. Every day the natural shoreline is in a constant state of disequilibrium, as waves move sand the beaches erode and accrete, but more profound and higher intensity changes to the shoreline are projected over time. All the County's coastline and shoreline resources are vulnerable to temporary flooding from storms and to sea level rise (see Section 2). However, it is extremely unlikely that the entire coastline could be simultaneously impacted by a single storm event. This Section describes State guidance for sea level rise planning that can be used to develop County policies relative to sea level rise. The California Coastal Commission and the Ocean Projection Council have finalized sea level rise guidance documents that are being used by local jurisdictions. These documents include the "Coastal Commission Residential Adaptation Policy Guidance" (2018), "Coastal Commission Sea Level Rise Policy Guidance" (2015/2018), and the "State of California Sea-Level Rise Guidance" (2018). The guiding principles and preferred adaptation approaches are listed below. This information is useful for developing principles for the County's adaptation strategies.

California Coastal Commission Sea Level Rise Policy Guidance (2015/2018)⁴

In 2015 the California Coastal Commission adopted its first *Sea Level Rise Policy Guidance* document. This document provides an overview of the best available science on sea level rise for California and a recommended methodology for addressing sea level rise. In 2018, the Coastal Commission adopted a Science Update to the *Sea Level Rise Policy Guidance*. The science-focused changes reflect recent scientific studies and statewide guidance to further understanding of sea level rise projections relevant to California. Though the Sea Level Rise Policy Guidance is not tailored to local conditions, it contains 20 guiding principles for addressing sea level rise in the coastal zone that fall into four general categories:

1. Use science to guide decisions;
2. Minimize coastal hazards through planning and development standards;
3. Maximize protection of public access, recreation, and sensitive coastal resources; and,
4. Maximize agency coordination and public participation.

These guiding principles are derived from the requirements of the Coastal Act and complement the priorities outlined in the State of California's climate adaptation strategy, the *Safeguarding California plan: 2018 Update*.⁵

⁴ This document can be found on the following website: <https://www.coastal.ca.gov/climate/slrguidance.html>

⁵ This document can be found on the following website:

<http://resources.ca.gov/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf>

State of California Sea-Level Rise Guidance (2018)⁶

The 2018 California Natural Resources Agency and Ocean Protection Council *State of California Sea-Level Rise Guidance* includes eight preferred sea level rise planning and adaptation approaches:

1. Adaptation planning and strategies should prioritize social equity, environmental justice and the needs of vulnerable communities.
2. Adaptation strategies should prioritize protection of coastal habitats and public access.
3. Adaptation strategies should consider the unique characteristics, constraints and values of existing water-dependent infrastructure, ports and Public Trust uses.
4. Consider episodic increases in sea level rise caused by storms and other extreme events.
5. Coordinate and collaborate with local, state and federal agencies when selecting sea level rise projections; and where feasible, use consistent sea level rise projections across multi-agency planning and regulatory decisions.
6. Consider local conditions to inform decision making.
7. Include adaptive capacity in planning and design.
8. Assessment of risk and adaptation planning should be conducted at community and regional levels, when possible.

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⁶ This document can be found on the following website: <http://www.opc.ca.gov/updates-californias-sea-level-rise-guidance/>

2. EXISTING SETTING AND POTENTIAL IMPACTS

The Ventura County Local Coastal Program (LCP) regulates land uses on approximately 29 miles of coastline with tremendous coastal resources. These resources include 7.5 linear miles of public beaches, dozens of public coastal access points, over 400 acres of County and State Parks, and critical infrastructure such as State highways and the Point Mugu Naval Air Weapons Station.⁷ There are small residential communities that host about 4,700 residents,⁸ 5,900 acres of agricultural fields,⁹ and the Navy employs over 18,000 residents.

Natural resources within the coastal zone include sandy and rocky beaches, kelp and surfgrass beds, tidepools, coastal bluffs, dunes, estuaries, wetlands, riverine environments, and all the species that these habitats support. The coastal zone also loops inland to include the Santa Monica Mountains National Recreation Area, home to over 1,500 plant and animal species. Wide sandy beaches support a sand dune ecosystem at Hollywood Beach, and a network of interconnected coastal back dunes, estuaries, freshwater wetlands and creek/river ecosystems reside among the three major tributaries of the Ventura River, Santa Clara River, and Calleguas Creek. Over time, the wetlands at Ormond Beach could also be restored, adding more valuable habitat to the unincorporated area.¹⁰

While there are exceptional coastal resources in Ventura County, coastal hazards have historically left an imprint and resulted in over 18 miles of shoreline protective devices. This amounts to about 17 percent of the existing shoreline armor along the entire State of California.¹¹ According to the Vulnerability Assessment, this shoreline armor will begin to be persistently flooded when sea level rise reaches about 5 feet in additional height, but before that occurs, storm waves combined with lesser amounts of sea level rise will cause waves to overtop the armor and exacerbate the coastal hazards that have historically occurred.

This Section briefly summarizes the key findings from the Vulnerability Assessment that was completed in December 2018 for the North, Central, and South Coasts (Figure 2-1). The Vulnerability Assessment

⁷ The Point Mugu Naval Air Weapons Station is physically located within the unincorporated coastal zone, but since it is a federal facility its land uses are not regulated by the County's LCP.

⁸ The population estimate includes Census blocks located along the unincorporated area coastline that are within 500 feet of the coastal zone. In some cases, the blocks that are included extend further inland. For more on the methodology, see Appendix C in the Vulnerability Assessment (Vulnerable Populations).

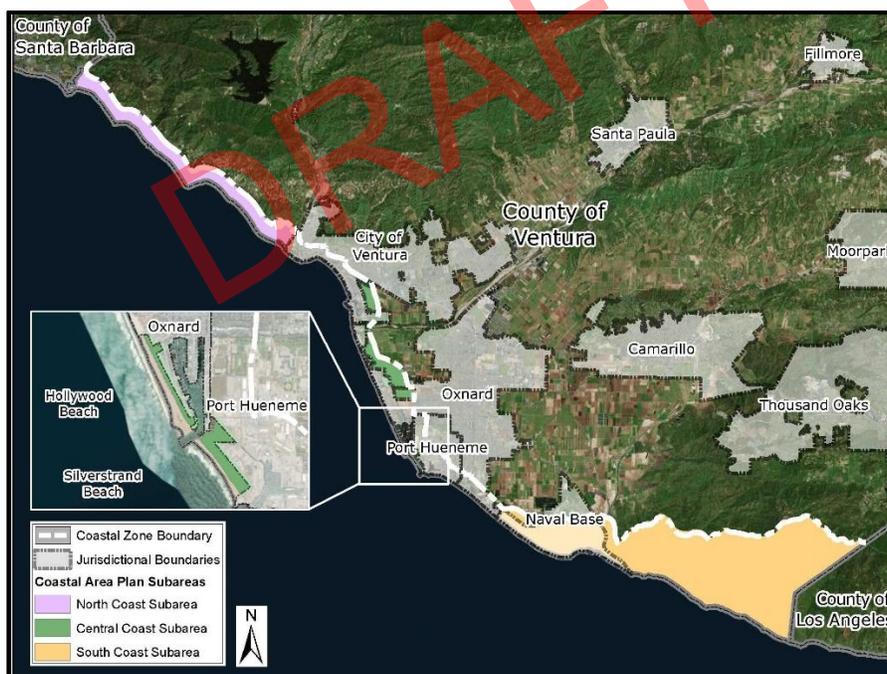
⁹ This figure is based on agricultural areas evaluated in the Vulnerability Assessment, which include some agricultural uses that are located outside of the coastal zone.

¹⁰ Currently there are only about 13 acres of unincorporated wetland area at Ormond Beach, excluding the ponds for the Ventura County Game Preserve and excluding the wetlands at the Naval Weapons Station.

¹¹ While estimates vary, the California Beach Restoration Study, (Griggs et al., 2002) estimated there are 102 miles of armor on California's coastline. Unincorporated Ventura County has about 18 miles of armor.

summarized which coastal resources in the unincorporated area could be affected by up to approximately 5 feet of sea level rise, or about year 2100.¹² The resource sectors that were evaluated in the Vulnerability Assessment included land use parcels and structures, agriculture, wastewater infrastructure, stormwater infrastructure, water supply infrastructure, public access and recreational facilities, natural resources, roads and parking, oil and gas infrastructure, hazardous material sites, and critical facilities such as fire stations and wireless communication facilities. These resource sectors were mapped using Geographic Information Systems software (GIS) along with modeling results from the Coastal Resilience Sea level Rise Model showing the extent of coastal erosion, coastal flooding, tidal inundation, and fluvial (river) flooding at 8 inches, 16 inches, and 58 inches of sea level rise. More information on the sea level rise modeling methodology can be found in Section 4 of the Vulnerability Assessment. Throughout this Section, the results from the Vulnerability Assessment and the Coastal Resilience model are also compared to the results of the Coastal Storm Modeling System (CoSMoS) sea level rise model in order to provide a broad context of potential exposure according to the best available sea level rise science. The CoSMoS model projections do not precisely match the 8-inch, 16-inch, and 58-inch amounts of sea level rise used in the Coastal Resilience model and the Vulnerability Assessment, so the closest equivalent amounts of 9.6 inches, 19.2 inches, and 58.8 inches were analyzed in CoSMoS, but are reported here as being approximately 8-inches, 16 inches, and 58 inches to help clearly convey the general results of the analysis to the reader.

Figure 2-1. County of Ventura, Coastal Area Plan, North, Central, and South Coast Subareas that are referenced in the organization of this Report.



¹² According to the State of California Sea Level Rise Guidance 2018 Update, there is between a 0.5% to 5% probability that 5 feet of sea level rise will occur by the year 2100, based on the high emissions scenario.

2.1 North Coast

This Section summarizes the Vulnerability Assessment results for the North Coast area of the County (Figure 2-1) and describes how services could be affected without adaptation planning for sea level rise.

Existing Conditions and Community Narrative

The North Coast spans 12 miles from the northern County line at Rincon Point southward to the Ventura River. It encompasses coastal bluffs, a portion of the Santa Ynez Mountains, narrow sandy beaches, rocky tidepools, small creeks, and an estuary. Approximately 90 percent of the area inland of Highway 101 is open space or agriculture. Most of the land consists of large parcels of 20 to 40 acres or more, but residential neighborhoods along the coast have single-family homes on much smaller parcels. Six residential and two industrial “existing communities” are located on the North Coast (Table 2-1). Oil wells and related production facilities are scattered throughout the area. US Highway 101 and the tracks of the Union Pacific Railroad wind along the narrow strip of land at the base of the mountains. Portions of the North Coast are set aside for recreation. Emma Wood State Beach, Hobson County Park, Faria County Park, and the Rincon Parkway provide opportunities for camping and beach access.

The North Coast has historically had few beaches due to the steep topography and obtuse angles between the shoreline and northerly waves and winds that drive strong downshore currents and carry sand to the Central Coast (Photo 2-1). The North Coast beaches include naturally occurring cobble, tidepools, and sandy areas that fluctuate with the seasons. These beaches tend to accrete sand in the spring and summer months, then erode during fall and winter storms (Photo 2-2). With the effects of sea level rise, the North Coast beaches will increasingly be submerged during high tides, particularly during the fall and winter.

Photo 2-1. This image of Old Coast Highway in 1912, with Rincon Point on the horizon, suggests that historically there was very little beach width along this stretch of the North Coast.



Photo 2-2. Difference in beach width at Solimar between October 2017 (left) and April 2018 (right).



Highway 101 on the North Coast is a critical transportation corridor, providing the only high-speed route to northern California besides Interstate 5. Pacific Coast Highway, sometimes referenced as “Old Coast Highway” and the “Rincon Parkway” is the predecessor of Highway 101, and today it is used primarily for access by beach visitors and local residents. About 750 residents live on the North Coast¹³ and a substantial number of these residents could be particularly vulnerable to hazards during severe storm events. Approximately 25% of the residents are seniors (65 and over), 35% are renters, and 10% are Hispanic.¹⁴ The North Coast attracts many beachgoers and has popular surf breaks that beckon beginning surfers during the gentle waves of the summer, and experienced surfers when the large West/Northwest swells hit the coast in the winters. Public beaches and the shoreline constellation of County and State parks attract over one million visitors annually. Together, Hobson and Faria County Parks, the Rincon Parkway, and Emma Wood State Beach offer 290 oceanside campsites. On busy days, these parks have the capacity to host over 400 tent campers and over 200 recreational vehicles. Lastly, the relatively new Ralph Fertig Memorial Bike Path offers 4 miles of spectacular Class I Coastal Trail along the North Coast (Photo 2-3).

Photo 2-3. Ralph Fertig Memorial Bike Path



Natural resources along the County’s North Coast include kelp and surfgrass beds that support local fisheries, resource-rich tidepools, and seasonally narrow sandy beaches

¹³ According to the Vulnerability Assessment Appendix C.

¹⁴ For more information on the demographic composition of the North Coast, read the VC Resilient Coastal Adaptation Vulnerability Assessment Report Appendix C (Vulnerable Populations).

that support foraging shorebirds and spawning California grunion in the summer and fall. A small estuary is located at the mouth of Rincon Creek that historically supported Southern steelhead trout. It is also surrounded by trees that may provide Western monarch butterfly overwintering habitat.

Summary of Vulnerabilities

Using the Coastal Resilience model, the Vulnerability Assessment identified the areas discussed below that may be exposed along the North Coast. These areas of potential exposure were also compared to the CoSMoS modeling results that were recently published for Ventura County.¹⁵ Locations that are predicted to be exposed to tidal inundation are identified first in order to strategically focus on the effects of sea level rise, although the Vulnerability Assessment showed that more areas could be impacted when coastal storms combine with rising tides.

Tidal Inundation Vulnerabilities

Except for Rincon Point, all 12 miles of the North Coast are presently armored with rock revetments and vertical seawalls. The beaches located between the sea and these devices will be the North Coast's most vulnerable resource over the next few decades. With time, small "pocket" beaches will be submerged more frequently and for longer time periods, eventually becoming inaccessible for recreational activities, foraging shorebirds, and spawning grunion.

Tidal inundation at Rincon Point has the potential to directly affect nearby residences and the biological habitat within the small estuary located at the mouth of Rincon Creek (Figure 2-2). Some sea level rise studies have suggested that marsh habitat within small creek estuarine systems will be susceptible to conversion into subtidal habitat due to a lack of a transition zone which is most often caused by steep topography or development (as in the case of Rincon Creek).¹⁶ These changes are likely to significantly affect plant and animal habitat niches within the estuary. If the flood regime is high enough, a potential benefit of an increase in tidal inundation within the Rincon estuary is that it may reconnect the aquatic ecosystem in the estuary to the upper portion of the creek, which is blocked by a raised spillway associated with Highway 101.¹⁷

¹⁵ CoSMoS modeling results can be viewed through the "Flood Map" tab at <http://data.pointblue.org/apps/ocof/cms/>

¹⁶ Doughty, C., K. Cavanaugh, R. Ambrose, and E. Stein. 2017. Sea Level Rise Impacts to Coastal Habitats in Southern California Estuaries. University of Southern California Sea Grant Traineeship Program Report. Pp.1-35

¹⁷ This result is also dependent upon the sedimentation dynamics of the system and whether the mouth of the creek opens to the ocean.

Figure 2-2. Tidal inundation with about 5 feet of sea level rise at Rincon Point according to Coastal Resilience (left) and CosMoS (right).



Like the Coastal Resilience model, the CoSMoS model shows most beaches on the North Coast as submerged with just 2.5 feet of sea level rise. Otherwise there are **only** subtle differences between the two model results until about 5 feet of sea level rise. In Figure 2-3 below, both models show that the rising tides begin to overtop the rock revetments at the Seacliff neighborhood and there is extensive flooding at Hobson County Park. In fact, Hobson County Park could have one of the first revetments to be overtopped by rising tides, as the CoSMoS model reveals flooding beginning to occur on this site with 3.3 feet of sea level rise. The results showing tidal flooding with about 5 feet of sea level rise that begins to overtop the shoreline protective devices is also shown to a lesser extent at the Solimar, Faria, and Mussel Shoals neighborhoods. County-owned Faria Beach Park is not as exposed to tidal flooding as Hobson Park, but any tidal flooding would be more extensive with the combined effects of coastal storms and erosion.

Figure 2-3. Tidal inundation with about 5 feet of sea level rise in Seacliff according to Coastal Resilience (left) and CosMoS (right). The green-colored areas are low-lying areas that could be flooded but are not connected to the shoreline or there is an obstacle blocking the flow.



Storm Flooding Vulnerabilities

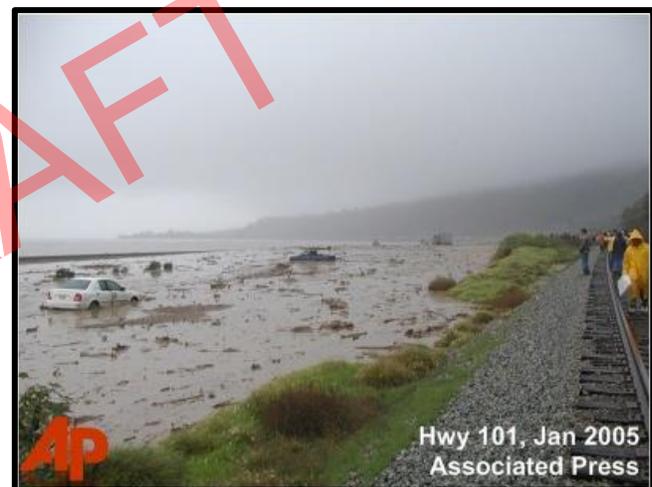
The Vulnerability Assessment maps appear to have more severe effects than the maps shown in Figures 2-3 and 2-4 above because they show combined exposure from sea level rise and a 1% annual chance storm event. A 1% annual chance storm event could cause extensive damage to the North Coast, as similar storms have resulted in road closures and required emergency repairs (Photo 2-4). All existing residential communities located oceanside of Highway 101 are vulnerable to coastal storm hazards today. With sea level rise, the vulnerabilities increase gradually. With 16 inches of sea level rise, the strawberry fields inland of the Seacliff community become vulnerable to coastal storm hazards. With about 5 feet of sea level rise, coastal storms could impact the first row of houses located inland of Highway 101 in La Conchita.

The vulnerability of Rincon Point will increase if coastal erosion diminishes the cobble beach. Coastal storm and sea level rise effects at Rincon Creek are likely to cause an increase in pollution within the estuary if adjacent development is flooded. Storm damages and secondary effects such as pollution could also degrade or destroy trees along the shores of the estuary that may have historically had Western monarch overwintering roosts. Erosion could also expose cultural resources such as Native American historic villages, shell middens, and cemeteries, as this area has a high likelihood of containing archaeological resources.

Services into the Future

How services are maintained in the North Coast will depend on the adaptation strategies employed by the County, resource managers, and residents. Under business as usual, clean-up and maintenance costs for coastal flooding will increase with time until persistent tidal flooding occurs. Nearly all development on the oceanside of Highway 101 is vulnerable to coastal storm hazards in the short term, and many areas on the oceanside of Old Coast Highway could be exposed to tidal flooding with greater than 5 feet of sea level rise. Storm damage along Highway 101 could have repercussions for the entire North Coast if erosion exposes a gas or oil line, ruptures a wastewater line, or damages an electric line. Closure of the highway would also heavily impact the movement of goods and services within the region. Commuters between Santa Barbara and Ventura Counties would also need to find alternative modes of transportation.¹⁸

Photo 2-4. Example of coastal flooding on Highway 101



Maintaining the services in the North Coast will rely largely on the resilience of infrastructure in the face of increasing coastal hazards. Highway 101, Old Coast Highway, and the Union Pacific Rail line are the backbone of the North Coast community. In particular, the response to sea level rise may depend on the strategy for Old Coast Highway, as it is the most seaward located of the major roads and rail line, and it is

¹⁸ As was done during the Highway 101 closure following the Montecito floods.

associated with other infrastructure such as the underlying Service Area 29 sewer line, water lines, and overhead electricity lines. Hobson Park, Faria Park, the Rincon Parkway, and Emma Wood State Beach are all accessed via Old Coast Highway.

Inland of Old Coast Highway, most of the oil and gas pipelines run beneath Hobson Road and Frontage Road, and these roads generally lie within the Highway 101 or railroad right of way. The most vulnerable areas are oil lines along the inland side of Highway 101 south of Rincon Point, and oil and natural gas lines in areas where Hobson Road is near the sea, such as along the Faria and Solimar neighborhoods. There are also some gas lines on Frontage Road, which runs parallel to the rail line at Emma Wood State Beach. All of these segments are projected to be exposed to flooding during major storms, but as long as Old Coast Highway remains protected, the pipelines cannot be affected by erosion, which is the greatest threat that sea level rise presents to underground utilities.

Erosion was not modeled along the North Coast in the Vulnerability Assessment because the natural process is restricted by shoreline armor. But in addition to erosion concerns that could affect Rincon Point, erosion at Emma Wood near the County/Ventura City Boundary is an area of special concern due to the conglomeration of all the infrastructure, except water lines, passing through a shoreline area at the toe of bluffs that is as narrow as approximately 355 feet in width (Figure 2-4). Currently the area is protected by seawalls, and some need repairs. It would be in the interest of Caltrans, the Union Pacific, the Gas Company, the oil purveyors, and the County Water and Sanitation Department to assist State Parks in limiting potential erosion and maintaining or expanding the current shoreline width to protect this proverbial bottleneck from erosion and maintain services.

Figure 2-4. A damaged seawall at Emma Wood State Beach protects a thin stretch of shoreline that includes the State Park access road, the rail line, Old Coast Highway, Highway 101, and power, oil, gas, and sewer lines. The bottleneck of infrastructure on a thin stretch of the shoreline is shown in the Google Earth image below.



Maintaining the services that allow the North Coast to retain its community character with increasing sea level rise and coastal hazards will require proactive adaptation planning to balance the recreational, residential, industrial, and other needs in the subarea. For example, the community at Rincon Point will require the development of an adaptation strategy that balances the residential use, recreational use (world class surf break/bike trail), and the ecosystem services provide by the natural resources. Predicting

how the surf break or estuary will change as the sea rises requires a more detailed approach that includes monitoring and data collection.

The North Coast is nearly completely armored. The seawalls and revetments provide an important service but are in various conditions of repair. A uniform approach to armor, with design standards to minimize beach impacts, would provide more certainty until other long-term solutions are identified. Strengthening or elevating existing armor in one area could increase the exposure and impacts to surrounding areas. In many areas, sediment retention and beach nourishment could be considered alongside armoring options. Elevating buildings as they are redeveloped, either with pilings or uninhabitable ground floors, could be an alternative to more armor, but such actions have drawbacks; for example, they could result in dramatic differences in building heights, and gaps in shoreline armor enhance the effects of erosion on downshore development. The constraints are many and alternatives are few as the North Coast is in a narrow stretch of land between the ocean and steep cliffs. Generally, the existing armor is projected to withstand about 5 feet of sea level rise, but its protective utility will be diminished as coastal storms increase in predicted severity and waves more frequently overtop the structures.

2.2 Central Coast

This Section summarizes the Vulnerability Assessment results for the Central Coast area of the County (Figure 2-1) and describes how services could be affected without adaptation planning for sea level rise.

Existing Conditions and Community Narrative

The Central Coast begins along the Santa Clara River and ends at the southern border of the City of Oxnard. The Cities of Ventura, Oxnard and Port Hueneme, as well as the Navy, share 16.5 miles of coast with agriculture, beaches, sand dunes, fresh and saltwater marsh ecosystems, two power plant facilities, a harbor and a port, and a variety of heavy industry and oil operations. Unincorporated lands within the Central Coast are varied. Several agricultural parcels are surrounded by the City of Ventura just north of the Santa Clara River. Further south, inland from McGrath Lake and Mandalay Beach, are approximately 1,400 acres of unincorporated land used primarily for agriculture with some oil production. Edison Canal is located among dunes and agriculture and extends between the Channel Islands Harbor and it was used to cool the turbines of the shuttered Edison Mandalay power station.

To the north and south of the mouth of the Channel Islands Harbor lie the most densely populated unincorporated residential neighborhoods along the County's coast: Hollywood Beach and Silverstrand. Limited commercial uses and numerous stub-end streets that provide public beach access characterize these beach communities. The City of Oxnard and the Port of Hueneme border these beach communities on three sides. Jurisdiction over the Channel Islands Harbor is shared between the County Harbor Department and the City of Oxnard.

The Central Coast communities of Hollywood Beach and Silverstrand are home to about 4,700 residents¹⁹ and a substantial number of these residents could be particularly vulnerable to hazards. Approximately

¹⁹ According to the Vulnerability Assessment Appendix C.

14% of residents are seniors (65 and over), 48% are renters, and 14% are Hispanic.²⁰ Silverstrand is also one of the most popular beaches in the County and has a yearly attendance of about 410,000 visitors.

The natural resources within the Central coast were formed and influenced by the hydrological forces of the Santa Clara River on the Oxnard floodplain. The remnants of a broad barrier beach-dune ecosystem which once spanned from the Santa Clara River to Point Mugu still remains inland of McGrath Lake and Mandalay Shores. Hollywood Beach also has dunes near the harbor sand trap. These beach-dune systems were once interconnected to the coastal back dunes, estuaries, freshwater wetlands and creek/river ecosystems located along the Ventura and Santa Clara Rivers, Calleguas Creek, and the Ormond beach area. Numerous rare and sensitive species are dependent upon these habitats such as the California grunion, the endangered Ventura marsh milk vetch, the iconic Western monarch butterfly, California least tern, Red Sand Verbena, and the Western snowy plover, and others.

Summary of Vulnerabilities

Using the Coastal Resilience model, the Vulnerability Assessment identified the areas discussed below that may be exposed on the Central Coast. These areas of potential exposure were also compared to the CoSMoS modeling results that were recently published for Ventura County.²¹ Locations that are predicted to be exposed to tidal inundation are identified first in order to strategically focus on the effects of sea level rise, although the Vulnerability Assessment showed that more areas could be impacted when coastal storms combine with rising tides.

Tidal Inundation Vulnerabilities

Compared to the North and South Coasts, the unincorporated coastal areas in the Central Coast are projected to be the most extensively affected by tidal inundation with 5 feet of sea level rise, including the Hollywood Beach and Silverstrand communities that are immediately adjacent to the ocean. These two communities boast the widest beaches on the unincorporated coast, approaching 1,000 feet in width near the dunes at Hollywood Beach, yet this is an area that is vulnerable to tidal flooding with only 8 inches of sea level rise (Photo 2-5). The CoSMoS model shows that with about 8 inches of sea level rise, the dune flooding may begin to reach some shoreline homes along Ocean Drive. While the Coastal Resilience model shows incremental additional dune flooding with 8 and 16 inches of sea level rise (Figure 2-5). The differences in the modeling results are likely due to fluctuations in the amounts of sand in this area, as it functions as a sand trap and is periodically dredged.

Eight inches of sea level rise would expose breeding habitat for birds such as the Western Snowy Plover and California Least Tern, who select wide sandy beaches to nest. Other species of plants and animals found in sand dunes, such as the red sand verbena, beach evening primrose, and the globose dune beetle, will also be impacted by the reduction of foredune habitat. California grunion are not likely to be

²⁰ For more information on the demographic composition of the North Coast, read the VC Resilient Coastal Adaptation Vulnerability Assessment Report Appendix C (Vulnerable Populations).

²¹ CoSMoS modeling results can be viewed through the “Flood Map” tab at <http://data.pointblue.org/apps/ocof/cms/>

significantly affected if sandy areas above the high tide line are available for the fish to spawn. However, the likelihood of trampling or damaging grunion eggs and embryos increases as beach widths narrow.

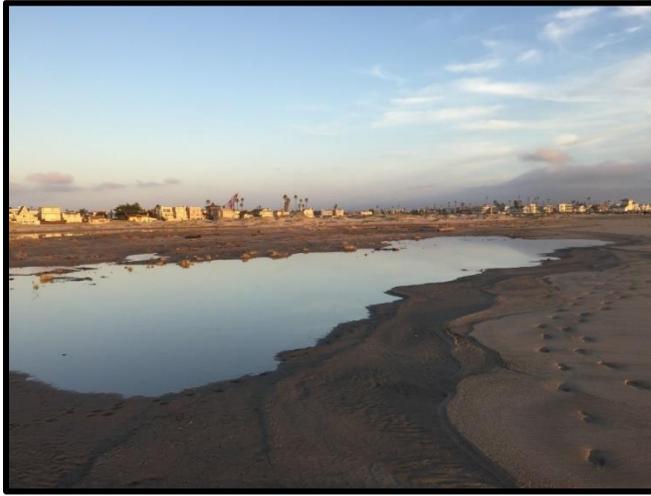


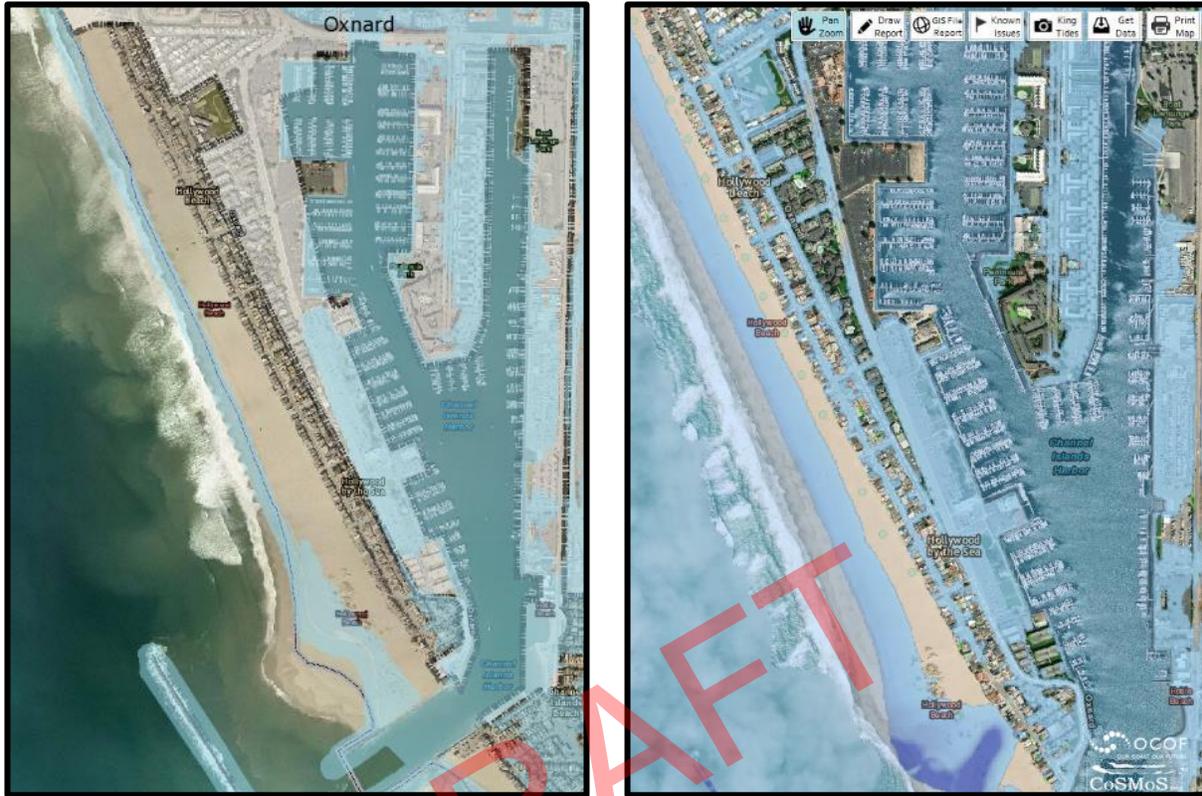
Photo 2-5. King tide flooding of sand dunes at Hollywood Beach on December 22, 2018 (source: Eugene Peck)

Figure 2-5. Tidal inundation with about 8 inches of sea level rise at the sand trap and dunes at Hollywood Beach according to Coastal Resilience (left, shown in orange color) and CosMoS (right).



With about 5 feet of sea level rise, Figure 2-6 shows tidal flooding from the Channel Islands Harbor begins to spill into the residential and commercial areas of Hollywood Beach and Silverstrand. At Hollywood Beach, both sea level rise models show extensive tidal flooding at the end of the peninsula. The CoSMoS model also shows extensive flooding of Ocean Drive, Sunset Lane, connector streets, the elementary school, and some residential development located along those roads.

Figure 2-6. Hollywood Beach flooding with about 5 feet of sea level rise as modeled by Coastal Resilience (left) and CoSMoS (right).

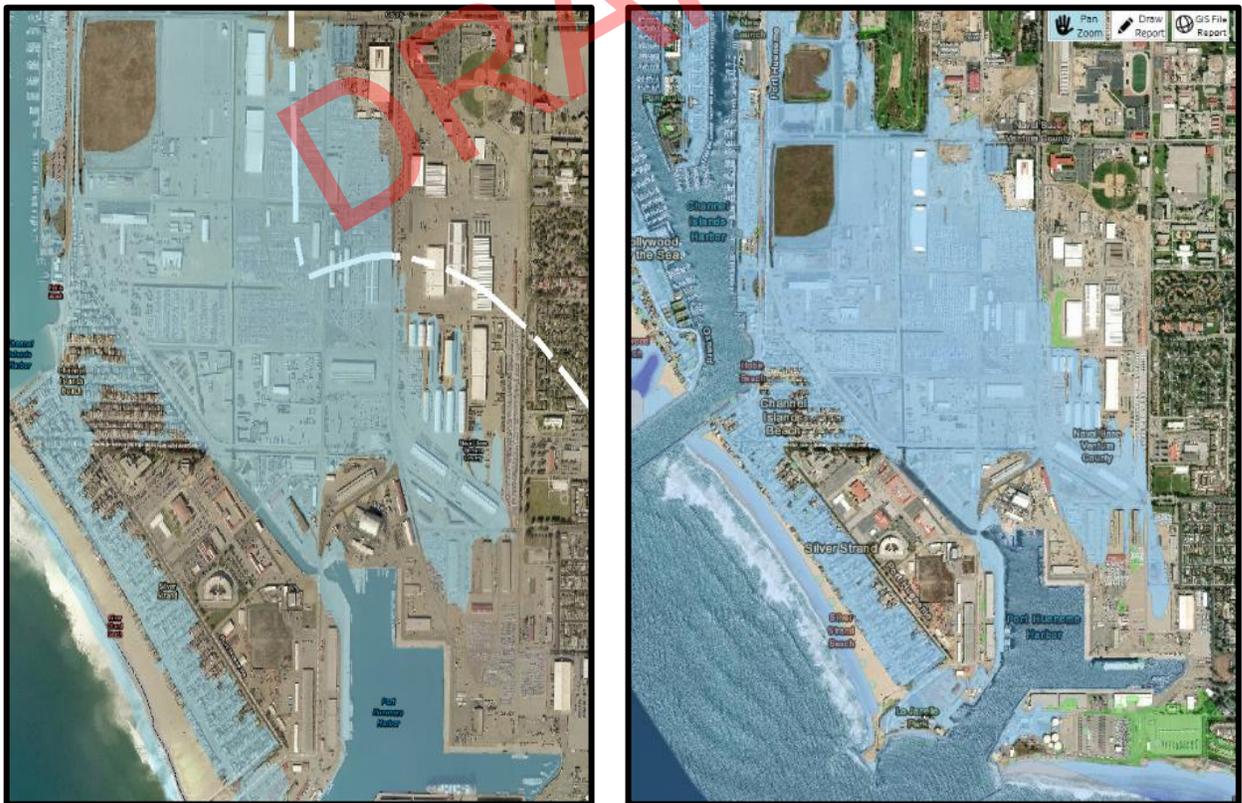


The Silverstrand neighborhood is a low-lying area that is vulnerable to tidal inundation. In between 16 inches and 5 feet of sea level rise CoSMoS reveals that rising tides breach the shores of Hobie and Kiddie Beaches in the Harbor and begin to inundate residential areas as well as Port Hueneme (Figure 2-7). When the sea level rises by 5 feet, both models show in Figure 2-8 that the flooding extends into a large plume of tidal inundation that impacts Silverstrand and much of the Port.

Figure 2-7. Silverstrand area flooding with about 3.3 feet of sea level rise as modeled by CoSMoS. The green areas represent low-lying areas that could flood but flooding is obstructed by obstacles such as barrier or higher ground.



Figure 2-8. Silverstrand flooding with about 5 feet of sea level rise as modeled by Coastal Resilience (left) and CoSMoS (right).

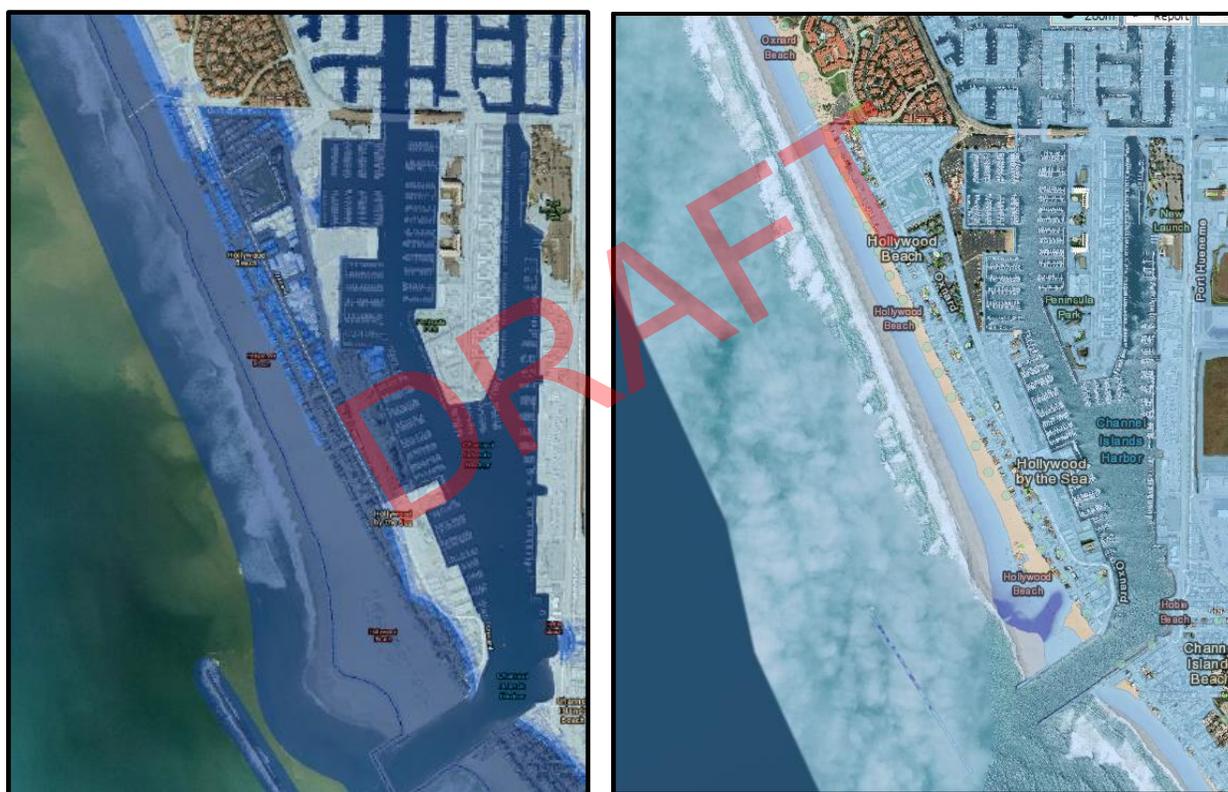


Storm Flooding Vulnerabilities

The Central Coast is highly vulnerable to coastal storm flooding and erosion due to the low elevations and gentle-sloping topography. All the areas described above would be exposed to more flooding when sea level rise is combined with a storm that brings heavy rain and large waves.

At Hollywood Beach, the Coastal Resilience model shows storm waves combined with rising tides overtopping the beach, flowing through the developed areas of the peninsula, and into the harbor. However, the CoSMoS model shows that, except for the area near the dunes that could flood up to the back of the homes on Ocean Drive, the wide beach protects the neighborhoods from storm waves (Figure 2-9).

Figure 2-9. Flood Potential at Hollywood Beach with approximately 5 feet of sea level rise and a 1% annual chance storm. Note that the strip of sand on Hollywood Beach is the only unincorporated area that is not flooded in the CoSMoS model on the right.



Storm flooding could also exacerbate the effects of rising tides at Silverstrand. Unlike Hollywood Beach, Silverstrand has some stormwater pumps to assist with drainage. But the County's storm water system cannot address flooding where it may be needed most--the sea level rise models reveal a bottleneck where the Silverstrand tsunami evacuation route, at Hobie Beach, could be flooded for 12 or more hours with 8

inches of sea level rise and a 1% annual chance storm.²² While the depth of flooding is difficult to clearly estimate using the models, it is likely to be more than a few feet in depth, which is an amount that is unsafe for civilian vehicle travel. This area of Victoria Avenue and Hobie Beach is under the City of Oxnard's and the Harbor Department's jurisdiction.

Along the Santa Clara River, fluvial river flooding caused by rain events can mix with rising tides and flood agricultural areas inland of McGrath State Park and around the McGrath Lake area. Similar fluvial flooding could occur along the Ventura River. All Central Coast habitats and species evaluated in the Vulnerability Assessment are vulnerable to extreme flood events, including USFWS designated critical habitats that support Ventura marsh milk vetch, Western snowy plover, tidewater goby, and the Southwestern willow flycatcher.

Services into the Future

Critical services such as utility service and emergency response may be disrupted during sea level rise and storm events. There is a slant-drilling oil facility downshore from McGrath State Beach, oil wells in the Montalvo Oil Fields inland of McGrath, and agricultural lands that could be more frequently flooded over time, disrupting the oil supply and food production. In addition, floods are likely to spread containments such as oil, fertilizers, pesticides and other toxic chemicals associated with surrounding land uses into sensitive habitats, which may have a significant impact on plant and animal species' growth, fertility, and overall survivorship. The Vulnerability Assessment determined that the slant-drilling facility on the shore at McGrath is not vulnerable with up to 5 feet of sea level rise, but this facility and other land uses in the area are vulnerable to 1% annual chance storms that will become more hazardous combined with the effects of sea level rise.

Adaptation approaches that the County takes upshore from critical facilities in other jurisdictions could still affect those facilities. The power and wastewater treatment facilities are located nearby in the Cities of Oxnard and Ventura, and the Point Mugu Naval Air Weapons Station and Port Hueneme Base could all be affected. For instance, if additional sand retention devices were added to Hollywood Beach, and the accrued sand was removed and sent it to other areas where there is beach erosion, then the downshore areas of Hueneme Beach and the Navy Base at Point Mugu would receive less sand for their beaches.

At the neighborhood scale, local infrastructure, such as water and wastewater lines in Hollywood Beach and Silverstrand would experience more frequent temporary service disruptions from flooding, but erosion could cause permanent damage (Photo 2-6). If the beaches are eroded, the foundations of the neighborhoods, set on ancient sand dunes and fill from the construction of the ports and harbors, could be eroded and undercut. The stormwater system could be affected if the outfalls are infiltrated by rising

²² According to the CoSMoS model, the extent of flooding predicted at Hobie Beach is about equal among scenarios showing approximately 8 inches of sea level rise with a 1% annual chance storm event (100-year storm event), and 16 inches of sea level rise with a 20-year storm event. A "20-year storm" event is expected to occur once in 20 years. There is a 5% chance that a 20-year storm will occur in any one year.

tides and storm waves. Adaptation may require electrical equipment to be elevated, pump capacity increased, and manholes waterproofed.

Photo 2-6. Oxnard Shores beach erosion following 1982-1983 El Nino winter storms (1984).



Transportation corridors in these communities also need adaptation planning, and coastal flooding could sever evacuation routes, particularly in Silverstrand Beach. The area at Hobie Beach (Photo 2-7) is a concern because the frontage road is also the only evacuation route in the area. The Tsunami Evacuation Route is shown in red in Figure 2-10 below. The County should coordinate adaptation planning for southern Victoria Avenue with the Harbor Department and the City of Oxnard to reinforce this particularly vulnerable location. For example, the road could be elevated, or revetments or bulkheads could be added to the harbor shoreline.

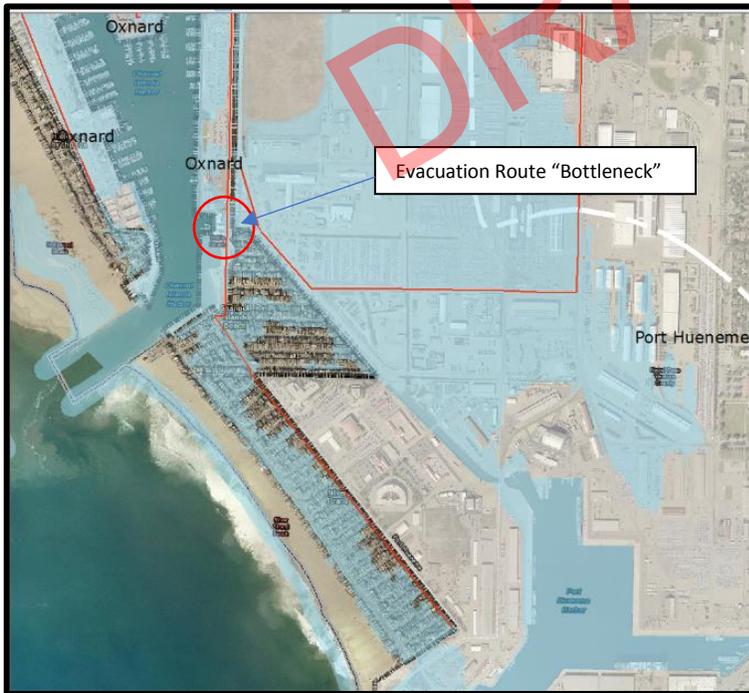


Figure 2-10. Flooding of tsunami evacuation route at Silverstrand with about 5 feet of sea level rise as modeled by Coastal Resilience.

Photos 2-7. Flooding at Hollywood Beach following March 2018 storm event (left) and elevated water levels at Hobie Beach near the Harbor entrance on Victoria Avenue during King Tides 2017 (right).



Continued coastal recreation on the County's most-visited beach, Silverstrand, and the largest coastal campground in the county, McGrath State Beach, will also depend on the adaptation approaches selected in coordination with other jurisdictions. The services that wide, accessible beaches provide to protect the Central Coast should not be taken for granted, and if the beaches are substantially eroded, or their respective elevations begin to be outpaced by rising tides, then beach berms or natural dune fields can help maintain these natural storm buffers while providing ecosystem services such as habitat and stormwater filtration. In the long-term, sand may become more valuable as the effects of sea level rise damage coastal areas. The Channel Islands Harbor was designed to provide a valuable service that traps and accumulates sand, and this sand may be increasingly sought after as the sea level rises.

2.3 South Coast

This Section summarizes the Vulnerability Assessment results for the South Coast area of the County (Figure 2-1) and describes how services could be affected without planning adaptation for sea level rise.

Existing Conditions and Community Narrative

The South Coast encompasses about 18,600 acres of some of the most striking and diverse coastal terrain in the County. Included along its 13.1-mile length are lagoons, coastal marshes, rocky intertidal zones and kelp beds, and approximately seven miles of the coastal Santa Monica Mountains. The South Coast's northern boundary is the Ormond Beach area that is located just north of the Point Mugu Naval Air Weapons Station, with the Los Angeles County line as the southern end point. Most of the federally-owned land in the County coastal zone is in the South Coast. The lagoon at the Navy Base at Point Mugu is fed by Calleguas Creek, and combines with Ormond Beach to be one of the largest and most important estuaries and tidal marshes in Southern California. A small community area is located immediately north of the Ventura-Los Angeles County line along a narrow coastal terrace. The area, named Solromar, is designated as an "existing community".

At Ormond Beach, some heavy and light industrial development has occurred within the City of Oxnard, and there is a green waste processing facility in the unincorporated area, but most of the land remains open space and agriculture. Two private game preserves that date from the 1880s occupy much of the

unincorporated land in the Ormond Beach area. The nearly 900-acre private facility contains saltmarsh and freshwater ponds that are used for duck hunting and nature viewing.

The South Coast has about 750 residents living mostly at Solromar and in scattered development up in the Deer Creek Road area of the Santa Monica Mountains. Some segments of the population that are potentially vulnerable to coastal hazards include the roughly 18% seniors (65 and over), 41% renters, and 17% Hispanic.²³ About 120 residents also live on agricultural lands in the Ormond Beach area. This community is composed almost entirely of Hispanic renters. Both Hispanics and renters were identified as populations that are particularly vulnerable to coastal hazards.²⁴

The South Coast is also home to Point Mugu State Park, featuring five miles of ocean shoreline, rugged mountains, coastal bluffs, sandy beaches, a few sand dunes, a small lagoon, and ephemeral streams. Thornhill-Broome Beach (Photo 2-8), Sycamore Cove, and La Jolla Group campgrounds of Point Mugu State Park are all located within the unincorporated coastal zone of Ventura County. Sycamore Canyon and La Jolla Canyon support valuable natural resources such as a small lagoon and monarch butterfly overwintering sites. The estuary within Sycamore Canyon is also designated as USFWS critical habitat for the tidewater goby. Thornhill-Broome and Sycamore Cove campgrounds have a total of 115 campsites and La Jolla Group campground can host a maximum of 50 visitors. Point Mugu State Park also has over 70 miles of hiking trails through the Santa Monica Mountains in Ventura County.

Other recreation areas include small beaches and day use parking areas at Mugu Rock, Yerba Buena Beach, and on the bluffs at the County Line/Leo Carillo State Park area. Pacific Coast Highway (PCH) is an important transportation corridor on the South Coast, connecting Ventura and Los Angeles Counties. Most of the entire length of PCH is protected by rock revetments.

Photo 2-8. Thornhill-Broome Campground Flooding Following March 2018 Storm Events. Figure 2-12.



²³ For more information on the demographic composition of the North Coast, read the VC Resilient Coastal Adaptation Vulnerability Assessment Report Appendix C (Vulnerable Populations).

²⁴ According to the Vulnerability Assessment Appendix C.

Summary of Vulnerabilities

Using the Coastal Resilience model, the Vulnerability Assessment identified the areas discussed below that may be exposed along the South Coast. These areas of potential exposure were also compared to the CoSMoS modeling results that were recently published for Ventura County.²⁵ Locations that are predicted to be exposed to tidal inundation are identified first in order to strategically focus on the effects of sea level rise, although the Vulnerability Assessment showed that more areas could be impacted when coastal storms combine with rising tides.

Tidal Inundation Vulnerabilities

The lagoons and estuaries at Ormond Beach and Point Mugu are the most extensive South Coast areas vulnerable to tidal inundation. Predicting habitat changes within these ecosystems in response to sea level rise is difficult and depends upon several variables such as the rate of marsh sediment accretion, estuarine mouth dynamics, the amount of sea level rise, and extent of habitat fragmentation. Some beneficial changes within these habitats may occur, such as expansion of wetlands, but in most cases the current land uses surrounding these areas would not allow for wetland expansion. There is likely to be a loss of wetlands as sea level rise increases the depths and converts the habitat into mudflats and subtidal zones, causing a cascade of changes to wetland types and habitat niches. While the wetlands at Point Mugu are in the unincorporated area, they remain under federal jurisdiction and are managed by the US Navy.

According to the Vulnerability Assessment, The Ormond Beach area is the largest area projected to be exposed to tidal flooding with as little as 8 inches of sea level rise, and over 1,000 acres of agriculture could be vulnerable when the sea level rises by 5 feet (Figure 2-11). The extent of flooding will depend upon strategies undertaken by the City of Oxnard, the US Navy, and the Ventura County Game Preserve to manage flooding of the estuaries and wetlands, as Ormond is part of the interconnected network of tidally-influenced ponds, channels, and canals in these areas.

The unincorporated areas near Ormond Beach primarily consist of agriculture, and landowners may elect to build berms that shield their land from tidal flooding that would otherwise degrade the soils. Other adaptation options include elevating the fields with sediment supplementation, protecting the area with large-scale levee improvements, use of nature-based horizontal levees, moving sensitive crops inland and planting salt-resistant crops in vulnerable areas, allowing wetland migration through voluntary managed retreat, or a combination of approaches. The County's Coastal Area Plan also discusses the potential for aquaculture in this area.

As an example, a green waste recycling facility in the area has built berms, but they are mostly configured along the ocean frontage of the property, and the two sea level rise models show that tidal flooding may still affect the site by flowing around the berms and through the site entryway, as shown occurring on the northeast corner of the site in Figure 2-12 below. There is, however, some discrepancy among the two

²⁵ CoSMoS modeling results can be viewed through the "Flood Map" tab at <http://data.pointblue.org/apps/ocof/cms/>

models regarding the extent of potential tidal inundation at Ormond. The Coastal Resilience shows flooding beginning to occur at 8 inches (dark blue) and 16 inches (light blue), while the CoSMoS model suggests that the flooding may not occur until there is over 4 feet of sea level rise.

Figure 2-11. Potential Tidal inundation in the Ormond Beach area with approximately 5 feet of sea level rise as modeled by Coastal Resilience (left) and CoSMoS (right).



Figure 2-12. Earthen berms, such as the ones shown encircling most of the parcel below could be used to hold-off tidal flooding in agricultural areas located inland of Ormond Beach. Shown with approximately 5 feet of sea level rise as modeled by Coastal Resilience (left) and CoSMoS (right).



With 8 inches of sea level rise, County floodplain infrastructure at Calleguas Creek and the Revolon Slough are projected to be exposed to greater tidal inundation, surging up the channelized areas approximately 1-2 miles from the PCH bridge (Figure 2-13). The Revolon Slough is 10 feet lower in elevation than the Calleguas Creek at their confluence near PCH, and the Slough could increasingly become a miles-long brackish canal. The drainage capacity of these facilities, which needs to be efficient during rain events, is likely to be substantially impeded during high tides.

Figure 2-13. Tidal inundation in the Mugu Lagoon area with approximately 8 inches of sea level rise, as modeled by Coastal Resilience (left) and CoSMoS (right).



The beaches in small coves along the South Coast are equally as vulnerable as the North Coast, with about 16 inches of sea level rise causing significant exposure at Thornhill-Broome Beach, Sycamore Cove, and Yerba-Buena Beach (Figure 2-14). These beaches are projected to be completely tidally inundated with about 5 feet of sea level rise. As with the North Coast, tidal inundation is expected to adversely affect historic spawning beaches of the California grunion. Changes to the biological conditions of the Sycamore Cove estuary will be similar to the estuary at Rincon Point discussed in the North Coast Vulnerabilities, although there is more potential for habitat migration because there is no spillway at Sycamore Cove.

Figure 2-14. Tidal inundation along the Thornhill-Broome Beach and Sycamore Cove area at Point Mugu State Park with approximately 16 inches of sea level rise according to CoSMoS (top). The Coastal Resilience model shows tidal flooding with about 5 feet of sea level rise (bottom).



Near the Ventura-Los Angeles County line, coastal homes north of Yerba Buena Beach will have foundations and septic systems that are located on the seaward side of the property more exposed to tidal inundation. At the County line, approximately 24 acres of State-Parks-owned property on coastal bluffs, with coastal access and public parking at Staircase Beach, are expected to experience more erosion with as little 8 inches of sea level rise, and this erosion could undercut PCH with greater tides and large storms (Figure 2-15).

Figure 2-15. Tidal inundation along the Solromar Existing Community area with approximately 5 feet of sea level rise. The red lines represent potential bluff erosion. Results of sea level rise as modeled by Coastal Resilience (top) and CoSMoS (bottom).

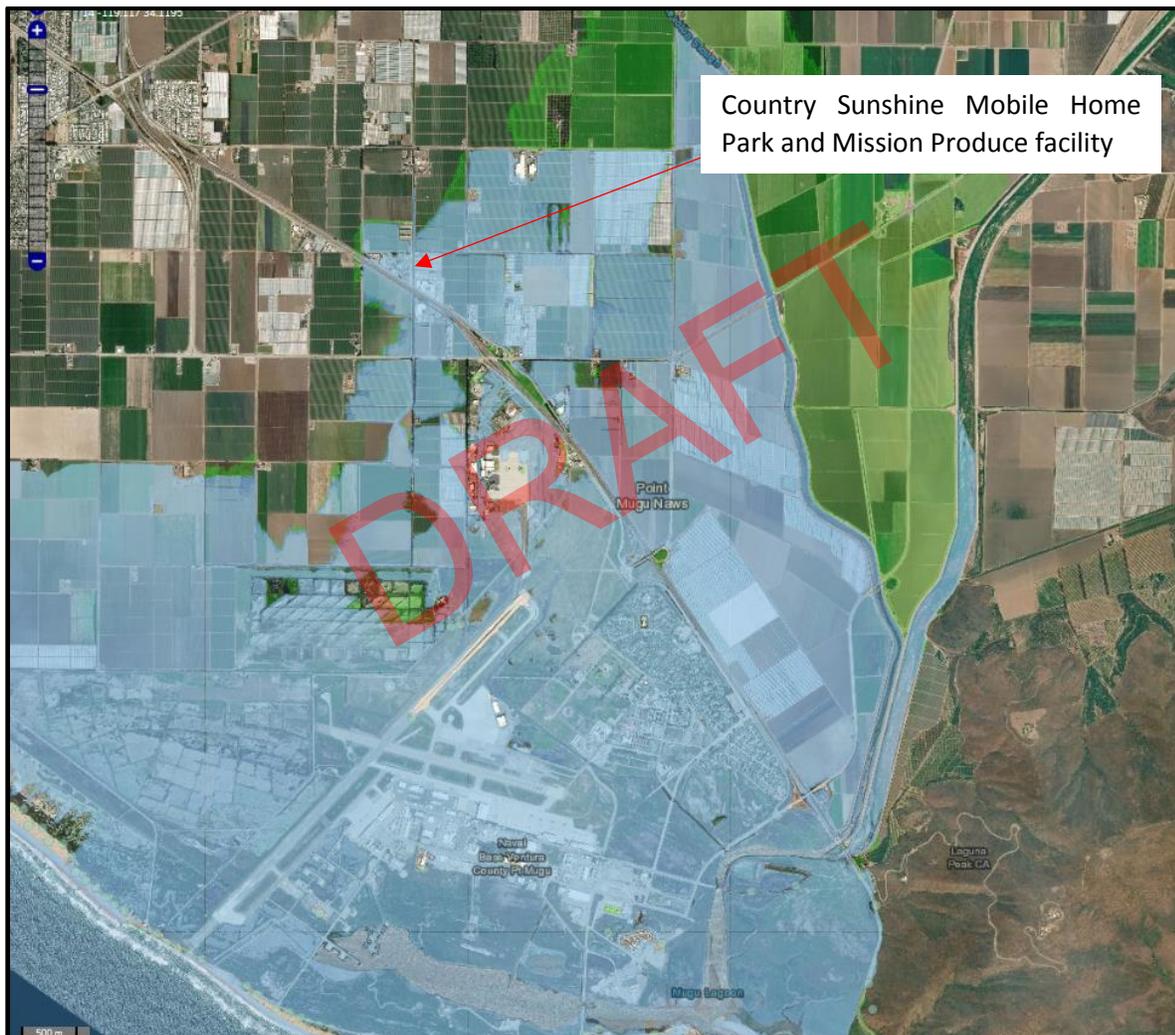


Storm Flooding Vulnerabilities

The Ormond Beach, Calleguas Creek and Revolon Slough areas may become extensively flooded with a 1% annual chance storm combined with 5 feet of sea level rise (Figure 2-16). The surrounding agricultural land has the potential to function as temporary stormwater detention basin, but existing development that lies along PCH could also be exposed to stream flooding, such as the Country Sunshine Mobile Home Park

(includes eight units), the Mission Produce processing facility, and nearly the entire Navy Base. A few existing farm residences will be susceptible to flooding, and saltwater will degrade the productive soil. If agricultural lands are protected by berms or traditional levees, these structures are likely to potentially cause flooding in other areas such as into Oxnard and upstream toward the City of Camarillo. Consideration could be given to employing horizontal levees and securing floodplain conservation easements that help to direct flooding into areas east of the slough, toward Calleguas Creek and the sparsely developed agricultural fields at the foot of the Santa Monica Mountains.

Figure 2-16. Flood Potential at areas inland of the Point Mugu Naval Air Weapons Station and west of Revolon Slough with approximately 5 feet of sea level rise and a 1% annual chance storm as modeled by CoSMoS.



Further south, rock revetments that protect PCH are currently vulnerable to erosion (Photo 2-9). Washouts along PCH are expected to increase as storm surge and sea levels continue to rise, escalating repair and maintenance costs and economically impacting residents and business owners dependent on the highway for access. With a 1% annual chance storm and 8 inches of sea level rise, over three miles of PCH on the

South Coast is likely to be flooded. The length of exposed highway increases to over 10 miles with about 5 feet of sea level rise and a 1% annual chance storm.

Photo 2-9. Recent erosion at Thornhill-Broome Beach that occurred on October 6th, 2018 (Source: Caltrans).



All coves and pocket beaches below the Santa Monica Mountains are vulnerable to coastal storm flooding today. Fifteen first-come, first-serve campsites in the Thornhill-Broome Beach campground located in Point Mugu State Park are currently only open when weather and tides permit, and is occasionally closed in the winter (Photo 2-8). The day use facilities and parking at Sycamore Cove become flooded with 5 feet of sea level rise. As the tides extend further into Sycamore Creek, coastal storm flooding may damage shelter trees at Western monarch butterfly roost sites.

In the Solromar community further south, homes on pilings and residences behind shoreline armor at the Malibu Shores Village could be flooded by large waves today and will become more vulnerable over time. The coastal storm flooding for development on bluffs does not substantially increase with rising tides, but Solromar and the southern County boundary is projected to experience severe bluff erosion. Bluff erosion could also expose cultural resources such as Native American historic villages, shell middens, and cemeteries, as this area has a high likelihood of containing archaeological resources.

Services into the Future

The South Coast provides a host of services that are vulnerable to sea level rise and coastal storms today and into the future. The continued use of recreation areas, agricultural fields, and private property will depend on the adaptation strategy chosen for the region. Compared with the river flooding projected to occur on agricultural fields south of the Santa Clara River in the Central Coast, the agricultural fields on the

South Coast will be exposed to more tidal flooding. Thus, consideration of the effects of higher salinity levels on crop production will be needed.²⁶ Currently, blueberries, row crops, and sod are planted. If the green-waste processing facility near Ormond Beach is more frequently flooded over time, local waste collection agencies that rely on the facility may be required to haul the waste greater distances to other sites.

Continued services to the residential areas of the South Coast will largely depend on the maintenance of PCH, as water supply lines and power lines run along portions of PCH. PCH also provides a route for emergency services and evacuation of the area. While no wastewater lines run under PCH, septic system maintenance companies use the highway to access the septic tanks that service the residences in Solromar. PCH can be protected by reinforcing the existing seawalls or it can be designed to accommodate some flooding by increasing drainage capacity at key points. Eventually the highway may need to be elevated or relocated inland, which would be the costliest option.

While the continued services will depend on the methods used by Caltrans to maintain PCH, the residential structures oceanside of PCH will be increasingly exposed to coastal storms and rising tides. As noted above, most of the homes at Solromar are either elevated on pilings (Photo 3-5) or protected behind armor (or both). Continued use of these properties will depend on how homeowners choose to adapt for the future. Options include reinforcing the foundations on pilings, increased the armor heights, and increasing the sediment supply to the beaches in front of the development.

As mentioned above, the South Coast has over 100 oceanfront campsites in Point Mugu State Park. The pocket beaches and coves along PCH also offer recreation points for day visitors. While the trails in the Santa Monica mountains have lower risk of coastal hazard exposure and will continue to provide coastal recreation into the future, adaptation strategies for the vulnerable campsites should be considered. The campsites that get flooded during storms today are expected to be closed more frequently with sea level rise. In the long-term, it is likely that these campgrounds will need to be moved inland of PCH. In the short-term, a sediment plan, increased drainage, and elevating key infrastructure could provide some resilience and allow continued use of these low-cost visitor serving accommodations.

²⁶ Also see: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/523643/Salinity-tolerance-in-irrigated-crops.pdf

3. Adaptation Planning

Adaptation to sea level rise hazards involves a range of small and large adjustments in natural or human systems that occur in response to already experienced or expected coastal hazards. Adaptation planning involves a wide range of policy, project-level, and programmatic measures that can be undertaken in advance of the potential impacts, or reactively, depending on the degree of preparedness and the willingness to tolerate risk. Thoughtful adaptation planning should improve community resilience to coastal hazards and specifically address the identified vulnerabilities.

Maladaptation, in contrast to adaptation, is a result of adjustments in natural or human systems that are or become more harmful than helpful. An example of maladaptation is the levee system for the City of New Orleans. While the levees provided short-term adaptation and allowed communities to remain in areas that lie below sea level, they increased the long-term vulnerability to flooding—both by providing a false sense of security and by being under-engineered or insufficiently maintained to account for the impact of large storm events.

Given the range of impacts that could occur, and the uncertainties associated with sea level rise projections, the County will need to develop adaptation strategies that effectively address coastal hazard risks and protect coastal resources over the long term. At the same time, climate science is constantly advancing. Thus, it is expected that adaptation measures identified as most appropriate today will be revisited and revised over time as science and projections evolve. Good adaptation stems from a solid understanding of the County's specific risks, the projected timing of the impacts, and the physical processes responsible for causing the risks, now and in the future.

Sea level rise adaptation planning requires considering each vulnerable "resource sector," or asset, which as described in the Vulnerability Assessment, included land uses, natural resources, and populations. Effective and timely action will be needed to alleviate the range of potential consequences to those sectors. One adaptation measure may reduce an identified hazard but lead to unintended secondary effects. The long-term viability of beaches is one of the most important sectors that could be impacted by unintended effects. The County's desirable beaches provide substantive economic revenue and, in some cases, define the community's identity. Ventura County beaches are highly valued by both residents and visitors alike. What would Ventura County be like without beaches? Allowing the loss of these beaches would certainly contribute to a diminished quality of life.

Good adaptation planning considers these secondary effects and the way different adaptation measures that are used to alleviate a vulnerability in one sector then interact with the adaptation measures applied to other sectors. An interwoven tapestry of adaptation measures is needed to develop a sustainable community adaptation plan. In considering impacts, it is also important to ensure that adaptation strategies are socially equitable and do not benefit one population to the detriment of another or reinforce existing environmental and societal inequities. This approach is consistent with the recent State of California Sea-Level Rise Guidance, 2018 Update and the Coastal Commission Sea Level Rise Policy Guidance (2015). Some social adaptation recommendations from Appendix C of the Vulnerability Assessment are provided below:

- Develop a sea level rise retreat strategy with habitat restoration and public access in Ormond Beach that could reduce current environmental pollution and increase coastal recreational opportunities for the most vulnerable populations in the unincorporated County coastal zone.
- Initiate an “adopt a neighbor” campaign to help senior residents that are most vulnerable during a coastal emergency evacuation, particularly in the communities of the North and South Coasts.
- Provide education materials with information on renter’s insurance to residents of the coastal zone. These should also be made available in Spanish, especially for Central Coast populations.
- Incorporate a coordinated population vulnerability analysis for all coastal jurisdictions in the county, possibly in the Ventura County Multi-Hazard Mitigation Plan.

Good adaptation planning should also include the consideration of cumulative effects on land uses such as the interconnected ecological, social, and economic systems, and how these systems change during the past, present, and future, particularly with sea level rise. A local example of an organization that works toward the development of collectively beneficial adaptation strategies for the entire region is the Beach Erosion Authority for Clean Oceans and Nourishment (BEACON). This organization is a proponent for regional sediment management that would reduce the cumulative effects of erosion on all beaches between Point Conception (north of Santa Barbara) and Point Mugu. They partnered with local agencies and the Surfrider Foundation to complete the innovative Surfer’s Point Managed Retreat project in the City of Ventura. This project is frequently referenced as one of the premier examples of nature-based adaptation in California.

The County must choose the level of risk it is willing to tolerate. Inaction will likely result in costly damages and emergency repairs. Failure to take forward-thinking approaches to adaptation will result in increasing clean-up and maintenance costs. Increasing infrastructure resilience by negating the risk through technological changes such as equipment upgrades or improved construction design, planned relocation, or new monitoring programs can be used to help manage risk.

As not all issues can or should be addressed at once, it is important that the responses to risks be prioritized and phased to maximize the use of the County’s resources while avoiding a costly emergency response. Specific early investments, particularly on long-lasting infrastructure, can help avoid costly maintenance or repairs in the future. For example, an economic analysis conducted for Imperial Beach shows that by purchasing coastal properties and leasing them back to owners, the City could realize its return on investment within a normal 30-year mortgage period.

It is quite probable that an overarching adaptation plan will use a variety of approaches over time. Hybrid approaches through time will likely cycle from protect, to accommodate, and then possibly to retreat, as the sea level rise impacts exceed individual strategies’ ability to reduce vulnerabilities from higher, more frequent exposure. For example, maintaining the existing armoring on the North Coast may be combined with some sediment retention and beach nourishment to increase coastal access and provide more storm protection. Ultimately, the adaption strategies selected should be included in a plan that will provide high long-term adaptive capacity, which means resiliency to 5 or more feet of sea level rise for the vulnerable study area.

Many of these adaptation strategies take substantial time to implement. For example, the Surfer’s Point project referenced above took 16 years to conceive, design, permit, finance and construct. Advanced planning and fundraising are critical. Also needed is the identification of important thresholds that will trigger planning processes and implementation efforts. Policies and programs in the LCP can help identify

specific thresholds that trigger specific actions. Factors to consider when prioritizing projects include: public health and safety, available funding sources, legal mandates, planning consistency, capacity and level of service, cost-benefit relationship, environmental impacts, and public support. Risks that present the most serious consequences and are projected to occur first should raise a project's level of priority.

This Report should increase understanding of the vulnerabilities associated with coastal hazards and encourage decision-makers to consider these potential impacts without creating further vulnerabilities or liabilities. As this is the beginning of the County's process of developing its adaptation response, many early initiatives are exploratory in nature and aim to identify potential changes or actions to respond to the impacts of the most immediate concern.

Reviewing current County programs and policies associated with risk reduction is the first step to identify potential short-term adjustments to alleviate or eliminate risks. Where adjustments to current practices will not sufficiently address the risks, more substantial actions should be identified and implemented.

Critical to the successful implementation of an adaptation strategy is communicating the issues and proposed response strategies to the community. Studies repeatedly show that knowledgeable and prepared communities with educated decision-makers that understand how to respond to extreme events will be far more resilient. An informed community is also more likely to make decisions that anticipate and plan for the projected changes.

In undertaking adaptation strategy development, focus will be needed on policies and development standards that could be included in the Local Coastal Program, as well as on strategies that could become programs in cooperation with other agencies. The approach for the County of Ventura's first sea level adaption effort has been to gather information about potentially useful adaptation strategies through consultant recommendations and meetings with other agencies and to apply the strategies in five hypothetical case studies that are presented in Section 3.2. After public workshops and community input regarding the strategies, LCP amendments will be prepared that address sea level rise. This approach assumes that there will be a second phase of the project in order to adopt and certify the LCP amendments.

Maladaptation

According to the Intergovernmental Panel on Climate Change, maladaptation inadvertently increases the vulnerability to sea level rise hazards and can be a result of poorly planned adaptation actions or decisions that place greater emphasis on short-term outcomes than longer-term threats.

One of the most significant concerns with maladaptation is that it reduces incentives to adapt for the future by establishing a false sense of security in the near term that places the community, its assets, and residents at risk. Maladaptation occurs when efforts intended to "protect" communities and resources result in increased vulnerability, often realized indirectly or too late after a direction has been set. Often these maladapted strategies are costly and time consuming and misplace financial resources that often result in more expensive future disasters. Previously unaffected areas can become more prone to sea level rise-induced hazards if the system that is being altered is not sufficiently understood. For instance, if new shoreline development is designed based on the assumption that beach widths will not decrease, yet the rate of littoral cell sediment deposition on the beaches is declining, the new development will be damaged or destroyed as the beach erodes. Likewise, if too much focus is placed on one time period—either the future or the present—effects on the other can be ignored, resulting in an increased likelihood of impacts from climate-induced hazards.

Key characteristics of maladaptation include:

- Creates a more rigid system with a false sense of security and severe consequences;
- Increases greenhouse gas emissions; and
- Reduces incentives to adapt.

When local communities are awarded federal funding to rebuild after natural disasters such as floods or fires, the requirement to rebuild according to the current policies and zoning code standards could be considered maladaptation, if adaptation is not already integrated into the policies and standards. Similarly, maintenance of highly-exposed infrastructure, such as some areas of Pacific Coast Highway along the County's South Coast, could be considered maladaptation if the maintenance activities preserve the facility's high exposure to hazards.

Avoiding maladaptation is critical to a successful sea level rise resilience strategy. To do so, the County must first be able to make informed decisions based on an accurate Vulnerability Assessment and determine its own level of tolerance. Flexibility and a precautionary approach are critical to avoiding maladaptation in the adaptation planning process.

Challenges

Adaptation planning comes with challenges. A single jurisdiction like the County of Ventura cannot likely adapt to sea level rise on its own. A successful process requires regional dialogue and partnerships to identify, fund, and implement solutions. Challenges include acquiring the necessary funding for adaptation strategies, communicating the need for adaptation to elected officials and local departments, and gaining commitment and support from federal, state, and local government agencies to address the realities of local adaptation. Lack of resources and limited coordination between local, state, and federal agencies can make it difficult for local governments to make significant gains in adaptation. Regional partnerships and dialogues between the County of Ventura, local jurisdictions, and regional entities such as BEACON—a regional organization ideally suited to take a leadership role—will be paramount in developing and implementing sound regional strategies.

When identifying appropriate adaptation responses, the County should consider taking a precautionary approach by using the following principles:²⁷

1. The strategy should support the protective role of ecosystems and sustaining their physical processes.
2. The strategy should avoid disproportionately burdening the most vulnerable citizens.
3. The strategy should avoid high-costs, unless holistic economic work (including ecosystem services, infrastructure upgrades, and damages) demonstrates a strong net benefit over time.
4. The strategy should incentivize adaptation (e.g., reward early actors).
5. The strategy should increase flexibility and not lock the community into a single long-term solution.
6. The strategy should reduce decision-making time horizons to better incorporate the evolving science of sea level rise.

²⁷ Barnett and O'Neill, 2010

7. The strategy should not increase long-term greenhouse gas emissions.
8. The strategy should account for long-term maintenance costs over time, and those costs should be lower than they would be without use of the strategy.

Protect, Accommodate, and Retreat: The Approaches to Coastal Adaptation

Coastal adaptation generally falls into three main categories: protect, accommodate, or retreat. There are also the options of doing nothing or hybridizing the strategies over time.

The Protection Approach

Protection strategies employ some sort of engineered structure or other measure to defend development (or other resources) in its current location without changes to the development itself. Protection strategies can be divided into “gray” and “green” defensive measures, and then further divided into “hard” and “soft” measures. A “gray”, “hard” approach is usually an engineered structure that can be positioned either alongshore (such as a seawall, revetment, or offshore breakwater) or cross-shore (such as a groin or harbor jetty). Cross-shore structures tend to trap sand and widen the beach up coast of the structure. A “soft” protection approach may be to nourish beaches, while a “green”, “soft” approach may be to restore sand dunes.

Although the California Coastal Act clearly allows protective devices for “existing development,” it also directs that new development be sited and designed to not require future protection that may alter a natural shoreline. It is important to note that most protective devices are costly to construct, require steadily increasing maintenance costs, and have secondary consequences to recreation, habitat, and natural defenses such as beaches and wetlands. Many of these consequences are forms of maladaptation, especially if the protective device was intended to be a long-term solution.

The Accommodation Approach

Accommodation strategies employ methods that modify existing development or design new development standards to decrease hazard risks and therefore increase resilience to the impacts of sea level rise. On an individual project scale, these accommodation strategies include actions such as elevating structures, performing retrofits, using materials to increase the strength of development to handle additional wave impacts, building structures that can easily be moved and relocated, or using additional setback distances to account for acceleration of erosion. On a community-scale, accommodation strategies requiring the above-mentioned types of actions could be integrated into the land use plans, zoning ordinances, and strategic planning documents for partner agencies.

The Retreat Approach

Retreat strategies relocate or remove existing development out of hazard areas and limit the construction of new development in vulnerable areas. These strategies include acquisition and buy-out programs, transfer of development rights programs, and hazard buffers or setbacks.

The Wait and See Approach

Choosing to “wait and see” or following a policy of “non-intervention” may be considered a form of adaptation. This approach tends to result in substantial damages and potentially costly repairs. As natural

disasters have occurred around the country in recent years, many communities rebuild at a huge expense. If this approach is taken, then redevelopment should include strategies for addressing sea level rise hazards and reducing maintenance costs.

The Hybrid Approach

For purposes of implementing the California Coastal Act, no single category or even specific strategy should be considered the “best” option as a rule. Different types of strategies will be appropriate in different locations and for different hazard management and resource protection goals. The effectiveness of different adaptation strategies will vary across both spatial and temporal scales. In many cases, a hybrid approach that uses strategies from multiple categories will be necessary, and the suite of strategies chosen may need to change over time. Nonetheless, it is useful to think about the general categories of adaptation strategies to help frame the discussion around adaptation and to consider the land use planning and regulatory options that are available to the County.

3.1 Adaptation Strategies for County of Ventura

The Vulnerability Assessment identified areas with existing hazards and areas that will be affected by sea level rise. After meetings to review the results of the Vulnerability Assessment with other agencies and the Natural Resources Working Group, the following sea level rise adaptation strategies were identified as potential solutions that could be used to address existing hazards in a manner that is generally compatible with goals, projects, and programs of the County and partner agencies. Additional strategies developed by the Natural Resources Working Group may be employed in future adaptation planning efforts for site specific areas. A table containing the identified threats and proposed adaptive strategies for focal species and habitats can be found in Appendix A.

The adaptation strategies range in scale, and in most instances additional planning and updates will be needed for implementation. Some strategies would fall in the permitting category of repair and maintenance, such as sand dune restoration. Others would fall in the category of new development, such as the construction of sediment retention devices. Such “pilot projects” would require funding for feasibility studies, future permits, construction, and later for ongoing maintenance and monitoring. In Section 3.2, hypothetical timelines and thresholds are identified for how and when some of these strategies could be implemented according to the 8-inch, 16-inch and 5-foot sea level rise thresholds evaluated in the Vulnerability Assessment. An economic analysis in Appendix B evaluates how some strategies maximize benefits at the lowest cost.

County-Wide Adaptation Strategies

Although existing land uses vary considerably on the North, Central, and South Coasts, the following strategies could be applied throughout the coastal zone. The “wait and see approach” was described above and is not included in the lists below, although it remains an option.

Coastal Hazard Overlay Zone (Strategy CW-1)

Overlays are a land use planning tool that prescribe regulations for a specified geographical area. Given the projected extent of coastal hazards and sea level rise, an overlay could provide a method to bundle coastal hazard and sea level rise land use regulations into one reference source that is easy to find and

understand. For example, studies, disclosures, or development standards could be required for properties located within the overlay zone that may be inside and outside of the coastal zone.

Cumulative effects: The regulatory capacity of the overlay depends on quantity and scale of the regulations that are included, but each regulation would generally be consistent with an adaptation strategy.

Impacts: In some areas the coastal hazards extend inland beyond the coastal zone, and therefore the County's General Plan, Local Coastal Program, and Non-Coastal Zoning Ordinance could be required to be updated to identify a defined coastal hazard overlay. Also, as sea level rise projections and science evolve, the maps showing the areas that will be exposed to sea level rise are likely to change over time. Evolving science showing the areas that may be impacted could require progressive updates to the overlay zone, which could be costly to process.

Long-term adaptive capacity: Moderate. An overlay zone provides a conduit to implement targeted standards and land use regulations. Many of the adaptation strategies listed below could be implemented using a coastal hazard overlay.



Real Estate Disclosures (Strategy CW-2)

Real estate disclosures provide notice during real estate transactions when a property is located within a hazardous coastal area.

Cumulative effects: While disclosures provide information and notifications, they are not intended to dissuade property transactions that are in hazardous areas, but rather inform property owners that their holdings are considered vulnerable to sea level rise exposure.

Impacts: A disclosure per se is unlikely to impact real estate transactions because most people understand that beachfront properties are inherently affected by coastal processes and forces. Whether a disclosure could decrease real estate values is a subject of ongoing research. One recent study concluded that it depends on whether the home buyers believe that the effects of climate change are real. It found that homes projected to be affected by sea level rise in neighborhoods where the residents have a high tendency to believe in climate change tend to sell for less than comparable homes in neighborhoods where there is less belief in climate change.²⁸

Long-term adaptive capacity: Low. Disclosures provide notice of sea level rise hazards and educate the public on what those likely changes may be, but such notices do little to implement a physical action to minimize sea level rise impacts.



²⁸ Baldauf, Markus and Garlappi, Lorenzo and Yannelis, Constantine, Does Climate Change Affect Real Estate Prices? Only If You Believe in it (August 28, 2018). Available at SSRN: <https://ssrn.com/abstract=3240200> or <http://dx.doi.org/10.2139/ssrn.3240200>

Elevate New Development (Strategy CW-3)

This accommodation strategy addresses sea level rise hazards through raising the base elevation at which the building is constructed. New development could include an increased base flood elevation following FEMA's new preliminary flood insurance rate maps (FIRM)s with an additional freeboard elevation to accommodate anticipated levels of sea level rise for the expected life of the structure, using whichever height is greater. Including sea level rise in the base elevation of building design would be necessary for adaptation because FEMA maps are based on historical flooding and do not include future sea level rise. The sea level rise amount would be calibrated to the amount of sea level rise that could occur during the anticipated life of the structure according to the best available science (e.g., 75 years for residential). Development standards would likely need to be revised to accommodate the different building design.

Cumulative effects: Elevated structures may cause impacts to visual resources from inland locations, require changes to development standards, and result in the alteration of neighborhood character.

Impacts: Elevated structures may appear to be out-of-scale with neighboring properties, especially if adjacent lands have smaller, older residences. The shade from taller development may be considered a significant environmental impact that is difficult to mitigate. Coastal armor may need to be eventually heightened, and in these instances elevating the protected structures would maintain private views of the ocean.

Long-term adaptive capacity: Moderate. The elevation strategy requires significant changes, costs, and engineering. However, when land is redeveloped, the structure's foundation may be required to be elevated, especially if setbacks or alternative sites for the development are insufficient to minimize the sea level rise risks.



Interjurisdictional Conservation Planning for Vulnerable Focal Species (Strategy CW-4)

The Vulnerability Assessment report indicates that several federal or state endangered/threatened species and their habitats may be adversely affected by sea level rise. The Natural Resources Working Group identified the need for a Countywide comprehensive assessment of all available habitat (regardless of jurisdiction) that supports a federally/state listed species vulnerable to sea level rise (focal species). While the Vulnerability Assessment demonstrated which habitat and focal species in the unincorporated County may be exposed to the effects of sea level rise, an interjurisdictional Countywide assessment would be helpful to assess the overall loss or degradation of all habitat available to threatened or endangered species. Such an effort would leverage limited resources and prioritize needed adaptation measures for focal species. Using population numbers, species fitness, existing habitat quality, and other factors, habitats could be prioritized to identify areas critical to maintain or replace as sea levels rise. This would allow local biologists to identify which adaptive management approach may be needed to minimize sea level rise impacts on local species populations. In addition, these planning efforts may also include several strategies identified by the Natural Resources Working Group for specific focal species or habitats that are represented in Appendix A.

Cumulative effects: A regional focal species vulnerability assessment and adaptation analysis would provide a more accurate representation of the sea level rise threats to imperiled species because all

existing habitat in the County would be included in the analysis. It also allows for a more comprehensive approach to the management of the species over a geographic area and the targeting of limited resources and planning tools to areas where they will be most beneficial for the conservation of the species over time. Such an effort could be spearheaded by a federal or state agency with jurisdiction in Ventura County.

Impacts: Impacts are likely to include additional benefits from ecosystem services such as improved water quality, increased flood protection, and recreation opportunities. Some of those services, such as flood protection, require collaboration with other jurisdictions to be effective against rising seas (e.g., flooding along the Santa Clara River). These interjurisdictional projects are usually very time consuming and difficult to implement due to the varied interests involved. Therefore, differences in adaptation planning from different localities may depend on the political climate and the priorities of each jurisdiction. This could result in wide variation in the extent to which the jurisdiction is willing to implement the plan. When public lands are occupied by federally- and state-protected species, as well as managed for multiple uses (e.g., recreation), the governing land management agencies are more likely to require additional planning, permitting, management, and enforcement resources than those lands that are unoccupied by these protected species. However, these additional costs may be negligible because the species are currently occupying those lands and the land management agency is already implementing the requirements.

Long-term adaptive capacity: Moderate–High. The long-term adaptive capacity for focal species is moderate to high. This strategy allows for a more targeted approach to the management of listed species based on the effects of sea level rise. Once developed and adopted, the County would not have any authority over whether other jurisdictions implement the recommended adaptation strategies. Such planning projects often require collaboration and coordination from multiple stakeholders which increases the difficulty and time required to implement them. Nonetheless, this targeted strategy would provide a more effective implementation approach to species conservation across the County.



Adaptive Management Planning for Sensitive Habitats (Strategy CW-5)

The development of adaptation strategies for complex environmental systems such as sand dunes, wetlands, streams, rivers and estuaries will require the analysis of site-specific data to understand how these ecosystems will be affected by changes in sea levels. Often, systems containing water resources are under the jurisdiction of several entities with numerous stakeholders associated with their management. These two factors require that there be a far more detailed planning process to develop viable strategies, which is beyond the scope for this project.

The Natural Resources Working Group recommended that all stakeholders responsible for the management of the County’s estuaries (Rincon Creek, Ventura and Santa Clara Rivers, and Sycamore Canyon) and connected habitats, develop site specific management plans that select the appropriate adaptation and monitoring strategies (protect, accommodate, retreat) and actions (e.g., construction of marsh sill/horizontal levee to protect adjacent land uses, restoration of niche habitat for rare species, development standards, etc.), with specific triggers for policies or implementation of management activities associated with definitive changes from sea level rise.

These planning efforts could also identify vulnerable populations for translocation due to future isolation, habitat fragmentation, and loss. Beach grooming, vector control, invasive species prevention, and other maintenance/management activities could also be addressed. Adaptation strategies developed could also utilize additional studies and data developed by The Nature Conservancy and California State Coastal Conservancy's Coastal Habitat Assessment Tool. It's unclear who would take the lead in developing these site-specific management plans.

Cumulative effects: This report provides no recommendations for adaptation strategies associated with these areas due to the number of stakeholders, information, and time that would be required to develop a viable approach to sea level rise resilience. These natural systems arguably provide the most valuable ecosystem services to the County (such as flood control and water supply filtration, etc.). The cumulative losses could be high if nothing is done for habitats such as sand dunes, estuaries, and lagoons that are projected to be imperiled throughout Southern California due to development and the long-term effects of sea level rise.

Impacts: This planning effort would require significant time to be developed and implemented. The issues are complex when the habitat covers multiple properties or straddles jurisdictional boundaries, which is the case for most habitat areas evaluated in the Vulnerability Assessment.

Long-term adaptive capacity: Moderate–High. Sensitive habitat adaptation planning could provide a context to employ green solutions and conserve areas that are refugia for protected species only found in Ventura County. Since the planning effort would provide a conduit for implementation of multiple strategies and methods, as shown in Appendix A, the individual strategies would still require evaluation of the cumulative effects, potential impacts, and long-term adaptive capacity.



Sediment Management (Strategy CW-6)

Sediment such as sand and rock cobble are an increasingly valuable commodity for coastal management. Utilization of these natural materials could increase overall coastal resilience by buffering the coast from storms. In addition to being a nature-based adaptation strategy, sediment management generally ensures there is habitat for beach-dwelling species such as the California grunion and promotes public beach access. Coastal residents have expressed some support for using this natural buffer in conjunction with shoreline armor but placement often requires costly suitability testing, permitting, and transportation.

BEACON is a California Joint Powers Agency established in 1986 to address coastal erosion, beach nourishment and clean oceans from Point Conception to Point Mugu. The member agencies of BEACON include the Counties of Santa Barbara and Ventura as well as the coastal cities of Santa Barbara, Goleta, Carpinteria, Ventura, Oxnard and Port Hueneme. The BEACON Board adopted a Coastal Regional Sediment Management Plan that provides a framework for how regional sand management could be employed on the North and Central Coasts. However, high expenses and a complex permitting process for projects in the surf zone have limited the number of projects that it has completed. The Surfer's Point Managed Shoreline Retreat restoration project in the City of Ventura was a milestone project that was included in the plan. BEACON's Coastal Regional Sediment Management Plan is only applicable to areas within the reach of the Santa Barbara Littoral Cell, and therefore the South Coast of the County is not included.

The different possibilities identified for sand management in Ventura County include: (1) opportunistic sediment placement that could include dredge sediment reutilization/nourishment; (2) sand retention through non-permanent perpendicular shoreline structures; (3) re-establishment of native coastal dune habitats on the Central Coast; and (4) sediment bypassing around Point Mugu to nourish the Zuma Littoral cell on the South Coast. Of the above strategies, only the third one, dune restoration on the Central Coast, is a project in which the County could choose to be the lead agency. The other three strategies all involve activities below the mean high tide line, which require State and federal authorization. The opportunistic sediment placement option is described below, since it could be used county-wide. The others are discussed in subsequent sub-area discussion sections, because those are the locations that could benefit the most from that particular sand management strategy.

Cumulative effects: Depending on the management activity, ongoing monitoring and maintenance could be required. However, it's believed that increasing the number of dunes at Hollywood and Silverstrand Beaches would lower beach grooming costs. The presence of wider sandy beaches and more dune habitat would also be beneficial to vulnerable species such as the California grunion, Western snowy plover, and several other focal species studied in the Vulnerability Assessment. Sand management provides a good strategy for the short-to mid-range, but when sea levels rise by about 5 feet, the sediment will be tidally inundated unless combined with other strategies.

Impacts: Sand is beneficial in that it provides ecosystem services by filtering and percolating water, it provides valuable habitat, and it is used to accommodate recreational activities. However, sand is difficult to manage, and may be blown on shore, into storm drains, and throughout developed areas. Sand could be deposited on a beach, through a costly process, only to result in it being transported by longshore currents out to sea or onto other beaches.

Long-term adaptive capacity: Moderate. Would need to be combined with other strategies such as design of development for accommodation of coastal storm flooding to improve long-term resiliency.



Opportunistic Sediment Placement (Strategy CW-7)

Deposition of sediment, such as sand and cobble, where and when needed on shorelines is a method that can be used to offset erosion or protect development. Such an effort would augment natural sediment delivery systems to mitigate the effects of erosion and reduce the frequency and time required for emergency repairs.

One goal could be to retain sand in the same littoral cell that would otherwise naturally be delivered through erosion of bluffs, outflow of rivers, and through longshore currents, but has not been delivered due to obstacles and drought. Overall, there has been an approximately a 40 percent reduction of natural sand supply in the Santa Barbara Littoral Cell.²⁹

²⁹ Also see: http://www.dbw.ca.gov/csmw/pdf/Sand_Budgets_Major_Littoral_Cells.pdf

The separation of bluffs from the beaches on the North and South coasts due to roads and other improvements such as the rail line on the North Coast impedes the natural erosion process. The sediment from coastal landslides is typically hauled to offsite disposal areas rather than following natural pathways to deposition into the sea. Perennial drought and lack of large rain events means that the rivers are washed-out less frequently, resulting in accumulation of sediment in inland debris basins and storm channels. The County has 55 drainage basins that are accumulating sand and cobble of various qualities and conditions. Finally, harbors and groins have historically impeded downshore sediment movement that otherwise occurs through longshore currents. Some specific examples of sediment placement practices that could restore inland and bluff sediment sources to the sea include the following:

- Identify sources of sediment in watershed debris basins and stockpiling areas that could be provided to landowners, Caltrans, State Parks etc. for deposition on sites with erosion “hotspots” or on areas that have been identified for beach nourishment.
- Identify sorting and stockpiling areas near the coast that could be used to store excess sediment until it can be utilized for placement.
- The equipment in debris basin could be modified to allow more sediment to reach the coast. The removal of the Matilija Dam would be a prime example. Including perforated debris bleeders on detention basin spillways is another example of improvements that allow sediment to bypass basins in order to reach the coast (see Figure 3-1).
- Hazards and the time of closures required to clean up roads due to landslides could be reduced if Caltrans could deposit sediment from landslides onto the shore. Coastal bluffs could be pretested for sections with sand grains suitable for deposition onto beaches or in the surf zone.³⁰



Figure 3-1 This debris basin includes a perforated “debris bleeder” made from a corrugated metal pipe (circled in red). (Source: VC Watershed Protection District)

Cumulative effects: An opportunistic sediment placement would restore some of the sand supply that historically reached the coastal beaches but is regularly impeded or sent elsewhere today. Depending on

³⁰ See Recommendations to Facilitate Sediment Management, number 19, at https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/RMS/2016/25_Sediment_Mgt_July2016.pdf

the extent of the practice, it could restore thousands of tons of sand to the shoreline and reduce the rate of beach loss. However, the amount of sand manually delivered would depend on how many source areas prove to be a suitable match to sediment that naturally occurs on local beaches. Ongoing management and maintenance are needed, but may be factored into the costs of business as usual for managing the debris basins, cleaning up after landslides, and mitigating coastal erosion.

Impacts: Sand placement on the beaches could include unintended consequences. Sand placed on a beach typically drifts downshore and could inhibit the activities and uses of adjacent lands. One example of a deleterious impact was when sand placed on the shoreline to protect homes drifted downshore and clogged the mouth of an estuary near San Diego. Generally, sand-dwelling, burrowing animals are negatively impacted when large amounts of sand are deposited. Overall, if opportunistic sediment placements help retain beaches, the need for coastal armor could be reduced.

Long-term adaptive capacity: Moderate – High. Unless the natural pathways for sediment deposition on beaches are restored, creative solutions will be required to maintain beach widths. Sediment placement and retention would help accommodate the near- to mid-range sea level rise projections and provide an alternative to traditional shoreline armor. In the long range, however, more permanent solutions may be required, as higher elevations will need to be needed to maintain beaches.



Voluntary Managed Retreat (Strategy CW-8)

In the long run, beaches, dunes, bluffs, and marshes will need space to migrate inland or risk permanent loss due to erosion and inundation. When existing development such as seawalls, roads and buildings block the pathways for these habitats to migrate inland, there are few viable alternatives to conserve the shorelines in the high-wave-energy Pacific coastal environment. Managed retreat could be used to identify key areas that could be allowed to naturally erode, inundate, or be realigned to provide space for beaches, dunes, bluffs or marsh. There are several methods available to facilitate retreat, but the overall high value of coastal properties makes the fiscal realities behind the retreat option challenging. Generally high start-up costs would be needed to purchase ocean front property or easements for that property.

While the Coastal Commission Sea Level Rise Policy Guidance generally suggests that retreat should be considered for all land uses, beaches and other undeveloped areas are typically the areas that are the most feasible to accommodate retreat. Another benefit is that this is possibly the only adaptation strategy that managers could generally “walk away” from and still allow for the continuation of natural coastal processes such as beach erosion and accretion with only minimal management needed. Local and state agencies that manage undeveloped and sparsely developed areas are more likely to elect to use a managed retreat approach to relocate facilities inland when compared to private landowners. The objective of public agencies is to manage the land for the benefit of the public, and managed retreat is the only relatively certain long-term option to conserve public beaches.

The Vulnerability Assessment identified the following sparsely-developed areas and recreational areas as being potentially suitable for managed retreat:

- **Inland Areas of Ormond Beach:** Though primarily located in the City of Oxnard, restoration planning for the Ormond Beach wetlands by the City, the Nature Conservancy, and US Army Corps has included consideration of its historic extent, which would include unincorporated inland areas. If

restoration of the historic reaches of the wetlands is pursued, this scale would be conducive to supporting a variety of wetland habitats that may otherwise be constricted by sea level rise.

- Thornhill-Broome Beach Campsite: This campsite in Point Mugu State Park could be relocated inland as seasonal closures increase in frequency. If facilities are relocated into the mouth of La Jolla Canyon, the campsite could partially be designed in a similar configuration as Sycamore Cove.
- County Line Bluffs: The bluffs on the South Coast near the Ventura-Los Angeles County line could be allowed to retreat inland without any impacts to Pacific Coast Highway, although a few structures and outbuildings on State Parks property would be affected.
- County Parks and Rincon Parkway: A more progressive and long-term retreat strategy on the North Coast could include shifting Hobson and Faria County Parks, and the Rincon Parkway, inland. But new sites would need to be leased or acquired, such as the agricultural field on Hobson Road. This could allow for expansion of camping and other recreational uses that would otherwise be affected by increasingly frequent closures. Such a strategy would largely depend on long-term plans for Old Coast Highway, which to date has not been associated with any planning efforts that considered retreat or removal.

Some voluntary retreat options are described below. They include outright purchase of vulnerable properties and conservation easements:

- Purchase with Lease Back: The premise of this strategy is that private landowners who are willing to sell early would receive market-rate returns on their real estate investments and the transaction would allow the purchasing agency to manage the properties for the effects of sea level rise. State, federal, or local governments would fund purchase of properties in hazardous areas, with an emphasis on areas that will be inundated by rising tides within a few decades. The property would then be leased back to the original owner or others until it is destroyed, eroded, or frequently submerged by rising tides. Ideally, a 30-year mortgage could be paid in full by the time the property is affected by severe sea level rise and or/storm events. However, the Vulnerability Assessment determined that a large coastal storm could destroy oceanfront property at any time and, thus, there is some inherent risk for the buyer. This may also be a viable option for agricultural properties located directly on the coast.
- Transfer of Development Rights: Landowners of coastal property located in hazardous areas could become “TDR sending areas” and sell unused development potential from vacant lots in exchange for agreeing not to develop their property in the future. Areas inland that are designated to accommodate future population growth could be “TDR receiving areas” where developers pay for the right to develop at a density in excess of the amount allowed by underlying zoning. This type of program is usually used to conserve rural or undeveloped property that is under pressure to be developed due to urban sprawl and rapid population growth, but it could also be applied to undeveloped areas that will be exposed to sea level rise.

In the unincorporated areas of Ventura County there are some obstacles to using transfer of development rights. To start, there is little unused development potential on the coast, and any unused development rights are highly-valued. Coastal transfer of development right programs have the tendency to require high startup costs and high transfer ratios due to the expense of coastal development rights, although the cities of Oxnard and Malibu have successfully used transfer of development rights programs to retire nonconforming ocean front lots. There are other limitations relative to identification of suitable receiving areas that could accommodate the additional

development potential. The County's Existing Communities are mostly built-out and there is little remaining development potential. Also, neighboring cities may be reluctant to agree to receive additional density and development from unincorporated areas.

- **Easements:** An easement creates a legally binding interest in a property that is recorded with the deed and granted to a third party by or on behalf of the landowner to protect or enable someone other than the landowner to use the land in a specific way. Easements are commonly recorded for properties that require access for utilities or have shared driveways among neighbors. When privately-owned land is identified for conservation or includes unforeseen hazards, an easement can be used to retain the land predominately in its natural, scenic, agricultural, forested, or open space condition. In Ventura County, agricultural conservation easements have been used to compensate farmers for allowing periodic flooding and for agreeing to restrict future development on agricultural land.

Rolling easements are also frequently recommended to facilitate nature-based sea level rise adaptation. These conservation easements can be designed to allow development in some areas, but not others. The basis of a rolling easement is a "rolling design boundary", such as a dune vegetation line, that is used to identify seaward areas where development is restricted, and inland areas where development continues to be allowed.³¹ On the coast, the developable areas of a parcel may change in response to natural processes such as coastal erosion or accretion, and rolling easements are an agreement to forgo the use of new coastal armor such as sea walls. Such a program could be used for areas with large contiguous parcels, such as agriculture and undeveloped areas near estuaries, but would be less useful for small parcels with single homes because there are typically few alternative sites for development.

Cumulative effects: Retreat allows for the continuation of natural processes and ecosystem services; however, it inevitably reduces the overall acreage of valuable coastal property including land uses such as sensitive habitat and agriculture that are protected by the California Coastal Act.

If methods that reduce development potential in hazardous coastal areas are institutionalized, they could also potentially be applied to other hazardous areas of the County, such as landslide-prone areas of the La Conchita community.

Impacts: Retreat of some areas would increase the exposure of other areas that currently experience the effects of erosion, such as headlands. It could also result in a decrease in property tax revenues. The benefits of retreat include the option to redesign public facilities to enhance public recreation and access. Camping venues, day-use facilities, trails and natural habitat could be expanded if a retreat option is chosen.

Long-term adaptive capacity: Moderate-High. Managed retreat allows space for the coastal physical processes to function naturally and relocates uses further away from the vulnerabilities.



However, some landowners may opt to not to participate in voluntary retreat. Also, any of the options described above, such as purchase with leaseback, transfer of

³¹ Also see: <https://www.epa.gov/sites/production/files/documents/rollingeasementsprimer.pdf>

development rights, and the purchase of easements have high start-up and /or administrative costs.

Regulatory Mechanisms for Accommodation and Retreat (Strategy CW-9)

A reduction in the extent or number of times that a property can be developed is often an unpopular and controversial way to reduce the risk of hazards because it typically results in a loss of property value. However, it is an effective method to minimize the amount of lives and property that may be exposed to dangerous conditions. Development restrictions could be implemented through an overlay zone, as described above, or through one of the methods that are listed below:

- **Severe Repetitive Loss:** Property owners that have submitted multiple flood insurance claims to FEMA can be compensated in exchange for agreeing to a deed restriction that addresses the future demolition or relocation of flood-prone structures. When a structure is demolished or damaged beyond repair, the deed restriction could require the property to be used for open space. In the past, landowners in flood-prone inland areas that were approached by the County declined to apply for a repetitive loss grant through FEMA. According to the 2010 Multi-Jurisdictional Hazard Mitigation Plan, there were only three severe repetitive loss properties in the County, and only one was located along the coast, at Solromar.
- **Buffers:** Geographic boundaries that either restrict potential development or require additional review for development proposals can be applied in the form of buffers that radiate from points or polygons on a map that represent land uses deemed worthy of preservation or conservation. An example of buffers for land use planning are the “redline” channels that are identified by the Watershed Protection District. A permit for development in redline channels requires analysis of the project’s effects on the watercourse, and the use of project features and mitigation measures to offset impacts. For sea level rise, similar types of buffers could be used to conserve areas that should be reserved for habitat, or could be unsafe for use when the effects of sea level rise become more pronounced.
- **Mitigation/In-Lieu Fee Programs:** The objective of a beach sand in-lieu fee program is to compensate the public for the potential loss of recreational use of the public beach due to the installation of shoreline protective devices such as seawalls on public lands. Money collected through the program is based on an estimate of sand lost from the beach and usually is used for sand restoration programs or beach access projects such as stairways.

Cumulative effects: These tools can be effective mechanisms to reduce the amount of development that could potentially be exposed to coastal and flood hazards. Though most of the coastal land in the unincorporated area is either already developed or protected from development by the voter-approved initiative called “SOAR”. The repetitive loss program would be less extensive in the sense that specific parcels would be addressed, and it relies on the availability of FEMA funding. The other options would require amendments to the zoning code and possibly the General Plan.

Impacts: Development, or redevelopment restrictions can result in non-conforming structures on parcels that were previously developed to capacity.

Long-term adaptive capacity: High. This strategy would directly reduce the amount of development that could be in hazardous areas, therefore reducing the potential impacts on life and property.



Bridges, Roads and other Major Infrastructure Design (Strategy CW-10)

The general life expectancy for bridges and other major infrastructure is intended to be 100+ years and therefore any new bridges are likely to be in use when the sea level has risen by at least 5 feet. Substantial modifications or a replacement are being considered for the County-owned Harbor Boulevard bridge over the Santa Clara River on the Central Coast. The Pacific Coast Highway bridge at Sycamore Cove on the South Coast will be replaced by Caltrans (Photo 3-1). In addition, the Highway 101 culvert at Rincon Creek has been identified as a significant barrier for aquatic species and is recommended for retrofit to allow for Southern steelhead trout, lampreys and other aquatic wildlife to travel up the creek from the estuary. The design and features for these bridges should accommodate sea level rise and address the following: sea level rise effects, wave transformation, wave run-up on coastal structures, short/long-term beach evolution, sediment discharge, estuary hydrology, aquatic and terrestrial connectivity for wildlife, recreational access, potential tsunami impacts, and coastal structure susceptibility. Additionally, new bridges should be improved when they are replaced to include the following: improvements for the California Coastal Trail, reinforcements to allow 50-year fire debris flow, culverts that can withstand increased fluvial flooding and storm flow, and the use of construction methods that limit impacts on estuaries and other sensitive habitat, such as pre-assembly of materials outside of sensitive areas.

Cumulative effects: Through planning for the effects of sea level rise in major infrastructure improvements, essential services will continue to be available through the anticipated 100-year life time of the structures. In addition, those improvements will help increase the overall connectivity of habitats and minimize barriers to species dispersal and migration.

Impacts: The design, engineering, and construction costs to improve or replace bridges and other major infrastructure will increase because they may require additional height and could potentially be sited further inland. However, by incurring higher development costs now, assurance is provided that the structure can perform adequately through the course of its planned life time and greatly reduce the chances that the structure could be severely damaged or destroyed.

Long-term adaptive capacity: High. This strategy would ensure that key infrastructure performs through the course of its anticipated lifetime. To a large extent, transportation agencies such as the County's Transportation Department and Caltrans will be responsible for the improved design, which could require sea level rise amendments to their respective design manuals and capital improvement plans.



Photo 3-1: Sycamore Canyon Bridge located on the South Coast is 80+ years old and needs to be replaced. The new bridge will be built at a higher elevation.

North Coast

The North Coast is nearly entirely armored with different types of shoreline protective structures in various conditions that shield a wide variety of private and public development and infrastructure from large waves. These structures primarily consist of rock revetments, bulkheads, and concrete seawalls. Except for Rincon Point, the beaches that draw many visitors to the North Coast are in front of rock revetments. The beach widths vary extensively by season and are therefore difficult to monitor (Photo 2-2).

Given the existing shoreline configuration with protective structures and topographic constraints, major transportation corridors and other infrastructure, retreat from sea level rise would be prohibitively expensive in most instances along the North Coast. Rather the North Coast could benefit from a regional coastal armoring strategy that combines consistently designed neighborhood-scale armoring with the development of sand retention structures to enhance the narrow existing beaches. While this combination of beach nourishment and carefully-designed armor would be experimental, it could reduce long term maintenance costs to the shoreline protective structures and improve coastal access and recreation. The exception to this strategy is the residential community at Rincon Point. The homes along the shoreline are currently unarmored. The community was built in a sensitive area that is known for a world-class surf break, as well as Western monarch overwintering roost sites and a small creek estuary that has historically supported various protected species.

After review of the Vulnerability Assessment and other studies, potential adaptation strategies for the North Coast are described below. The order is not ranked or prioritized. Each description also includes a brief analysis of the cumulative effects, potential impacts, and a brief statement about the long-term resiliency of the strategy or the “long-term adaptive capacity”.

Photo 3-2: A wave hits seawalls at Faria Beach during a coastal storm.



Coastal Armor (Strategy NC-1)

With the distinction of having one of the most armored coastlines in California, shoreline protection is a key issue for Ventura County. Most of the County's armor can be attributed to rock revetments built to protect Caltrans' roadways such as Highway 101 and Pacific Coast Highway that provide critical access routes to area residents and businesses. However, the consistent practice of rebuilding Caltrans' protective armor that is vulnerable to coastal storms keeps it largely exempt from the County's land-use control pursuant to Section 30600(e)(2) of the California Coastal Act. Discretionary permits that allow the County to have more control over the project design are required if modifications require roadway expansion outside of the existing right-of-way.

Private seawalls are a complex issue to address. Section 30235 of the Coastal Act allows use of armor to protect coastal dependent uses or "existing development" or public beaches that are vulnerable to coastal erosion provided they are designed to eliminate or mitigate adverse impacts on shoreline sand supply. Additionally, Section 30253 of the Coastal Act also requires that new development minimize risks to life and property in areas of high geologic and flood hazard, and not require the construction of protective devices that would substantially alter natural landforms. Sometimes armor is installed during a severe coastal storm event through the issuance of an emergency coastal development permit, and later it is either removed or formally authorized through a follow-up coastal development permit. If any element of a revetment or seawall is located below the mean high tide line, it is outside of the County's jurisdiction and the Coastal Commission becomes the lead agency responsible for permit review and authorization.

During outreach, some North Coast residents expressed interest in identification of a consistent approach to shoreline armoring for contiguous shoreline segments. A consistent approach to armoring could be achieved through the formation of neighborhood armoring associations or private Geological Hazard Abatement District that would be responsible for funding and maintaining the armoring. The permitting process could also be simplified to provide an economic incentive for neighborhood-scale protective devices compared to individual residences. However, since the structures are often retroactively authorized, it is difficult to gauge how the permitting process could really be improved. In addition, the age and condition of existing seawalls varies considerably.

Design preferences could be assigned to specific types of armor, such as recurved seawalls that dissipate wave energy, reduce wave overtopping, use less beach area than revetments, and reduce reflected wave energy that would otherwise alter nearshore processes and/or exacerbate active erosion and sediment transport (Photo 3-2). Development of in-lieu fees for sand mitigation, public beach encroachment, and ecological values could continue to be included as conditions of permit approval. Maintenance/removal bonds that are posted prior to construction could also potentially be leveraged to ensure adequate project design. If design standards can be applied to new coastal armor, consideration could be given to requiring mitigation for loss of public access, beach sand, and tidepools.



Photo 3-3: Example of a curved seawall with some revetment materials for protection of the toe of the structure.

Cumulative effects: In natural settings with erodible shorelines, beaches can migrate inland, but where there are roads and other forms of existing development, coastal armoring obstructs the natural migration pathway and beaches cannot retreat. Protective devices may also block wildlife movements between and among adjacent habitats and cause the overall loss of sandy beach habitats that many species rely upon such as the California grunion or shorebirds. Armoring is also aesthetically unappealing, and if the height is increased, it may obstruct views from the residences that it is designed to protect. Maintenance is typically required every 15 years or so, and the costs can escalate rapidly depending on the condition of the structure and if any modifications are required. Specially engineered features designed to mitigate for the loss of beach access are also more expensive. Homeowner associations could form hazard abatement districts to assess their units for armor improvements, but this practice may lead to increasingly privatized shorelines.

Impacts: Seawalls and revetments tend to have two main impacts: placement loss and passive erosion. Placement loss is the area of the beach that the footprint of the structure occupies. Beaches are sometimes buried under rocks following construction of revetments, and this degrades beach ecosystems. Passive erosion results in beach loss in front of protective armor in areas where there is pervasive erosion. Both placement loss and passive erosion tend to narrow the beach and affect beach access. As the structure interacts more frequently with waves during more of the tide cycle, active erosion impacts cause scour and increase maintenance costs and adjacent impacts. State guidance suggests that the loss of public beaches as a result of shoreline protective devices for private property is an environmental justice issue that should be remedied.

In some cases, the armoring may increase longshore currents, increasing the rate of beach loss in front of the structure, and escalate the erosion rates along adjacent unarmored sections of the coast. Active erosion refers to interactions between the coastal armoring and the physical processes that increase the erosive forces. Some of these processes can include wave reflection, positive wave interference which causes waves to get bigger before breaking, and increased beach scouring. Active erosion is typically site-specific and dependent on the length of structure, sand supply, wave direction, specific design characteristics, and other local factors. There is some debate in the scientific literature, particularly in areas where sediment transport direction can reverse, but there are clear indications in the Santa Barbara littoral cell of active erosion causing increases in longshore currents (Revell et al. 2008).

Passive erosion reduces the beach area between rising seas and a non-erodible coast. The effect of this migration will be the gradual loss of beach in front of the seawall or revetment as the water deepens and the shore face moves landward while the backshore cannot erode. While private structures may be temporarily saved, the public beach is lost. This process of passive erosion is a generally agreed-upon

result of fixing the position of the shoreline on an otherwise eroding stretch of coast and is independent of the type of seawall constructed. Passive erosion will eventually destroy the recreational and sandy beach habitat area unless the shoreline is continually replenished. Excessive passive erosion may impact the beach profile such that shallow areas required to create breaking waves for surfing are lost.

Each of these impacts significantly disrupt the ecological food chain on beaches. For example, invertebrate communities associated with beach wrack deposits (which are a critical resource to foraging shorebirds) are lost. In addition, the increased erosion and tidal inundation from sea walls create unsuitable habitat for species like the California grunion which require sandy areas above the monthly high tide line to spawn every year.

Long-term adaptive capacity: Low. The armoring strategy has limited ability to adapt without significant changes, costs, and engineering. Also, the County has limited authority to address this issue. Revetments within road rights-of-way are large exempt from permits authorized by the County and the County cannot require the formation of the special districts needed to design neighborhood-scale armor unless public health and safety is at risk. Efforts to streamline the permit authorization process may not be supported by the Coastal Commission because the state guidance seeks to dissuade use of coastal armor. In addition, this is not a strategy that supports the long-term adaptive capacity of the beach ecosystem.



Sand Retention Through Non-Permanent Perpendicular Cross-Shore Features (Strategy NC-2)

The nearly unidirectional longshore sediment transport along the North Coast makes sand retention relatively feasible and effective. It's believed this could be done using traditional techniques such as groins, or by using more innovative, nature-based approaches such as erodible cross-shore cobble berms. Boulder-size groins are generally aesthetically unappealing, impede access, and permanently alter the configuration of the shoreline. According to a recent California Natural Resources Agency report³², cobble berms and sand dunes are the only types of natural shoreline infrastructure that are suitable for the open coastline in California. Since the beaches along the North Coast are too thin to develop significant dune systems, cobble berms that are shaped like groins may be the only short-to-midterm nature-based adaptation strategy suitable for this area. Thought feasibility studies from technical experts would be needed prior to moving forward with the untested, more progressive nature-based approaches like erodible cross-shore cobble berms.

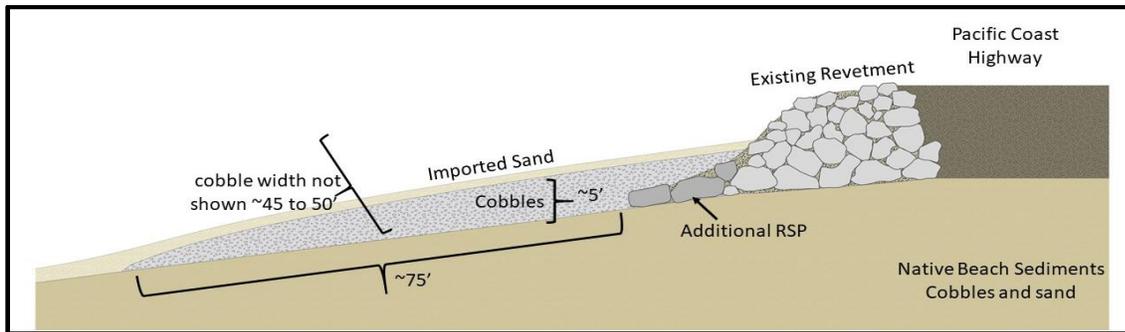
Cobble-based groins are suitable where cobble is a naturally occurring feature and can be designed to be anchored by revetments, as shown in Figure 3-3 below. They would be covered by sand that is either imported or when sand accretes during the summer and fall. Berms, groins, and other sand retention structures should be pre-filled (aka charged) with sediment to continue the downshore littoral drift unabated and minimize the risk of downcoast erosion impacts. It's believed they would function for 2-5 years, depending on coastal storm events.

This strategy would require coordination with the Coastal Commission, Caltrans, and County Parks to identify a case study site to construct a few non-permanent sand retention structures. If the strategy

³² [Toward Natural Shoreline Infrastructure to Manage Coastal Change in California, Newkirk, Sarah et. al. August 2018.](#)

performs well, it could be used to mitigate erosion on both North and South Coasts. Funding for sand retention structures could come from FEMA pre-disaster mitigation funds and adaptation grants to reduce maintenance costs for Pacific Coast Highway. This is the only nature-based alternative to shoreline armor besides retreat that has been identified for high energy wave environments with little space along the shoreline.

Figure 3-2. An ephemeral cobble berm could be constructed of sandstone and cobble that can naturally erode.



Cumulative effects: Permanent sand retention structures alter the natural shoreline, but non-permanent devices have fewer cumulative impacts. The presence of cross-shore features can obstruct horizontal beach access unless specifically designed to accommodate access, such as seasonal sand deposition on top of cobble berms.

Impacts: Shore-perpendicular structures, such as groins and harbor jetties tend to trap or impound sand. The subsequent downcoast erosion that could result from such installations can be offset if the sand retention structures are pre-filled (aka charged) with sediment, allowing the continued drift of sand downshore and minimizing the risk of downcoast erosion impacts.

Long-term adaptive capacity: Moderate-High. Depends on if permanent devices or cobble groins are selected. Boulder-based groins are proven to be effective, but they also essentially permanently alter the shoreline. Cobble-based groins are a relatively untested device, but they could potentially last for three to five years until maintenance is required. (Also See Appendix B.)



Central Coast

The Central Coast is the most densely populated area of the unincorporated coastline, with single-family and multi-family homes, neighborhood commercial, recreational activities at the Channel Islands Harbor, and day use of Silverstrand and Hollywood Beach. It is characterized by wide beaches with sand dunes, rivers, marshes, and inland agricultural uses. Other prominent features of the relatively flat topography have pronounced effects on the littoral sand supply and include the Santa Clara and Ventura Rivers, the deep-sea canyon the lies offshore from the Port of Hueneme, and the Channel Islands Harbor. Sand that travels downshore from as far as Point Conception eventually settles in this area or drifts offshore. The placement of sand is driven primarily by predominant onshore wind and wave conditions. Sediment dredging maintenance at the Ventura and the Channel Islands harbors, as well as Port Hueneme, is used

to nourish local beaches throughout the area until it reaches the next downshore deep sea canyon at Point Mugu.

Overall, the Central Coast would benefit from protection from temporary flooding during severe storms using strategies that would re-establish native dune systems to protect residents from tidal and storm flooding. Multi-jurisdictional sand management strategies could be implemented through a variety of means, but a good near-term strategy for the County would be to develop its own beach and dune management plan for Silverstrand and Hollywood Beaches. The City of Oxnard is considering a similar adaptation approach for the Oxnard Shores and Mandalay Bay shoreline communities. An expanded collaborative planning effort or communication between the County and City as the County's plan is developed would be beneficial to both localities.

For agricultural areas adjacent to the Cities of Oxnard and the Santa Clara River, depending on the overall adaptation strategy developed for the area (protect, accommodate, retreat), the feasibility of a horizontal levee, tidal bench, or other greener solutions should be evaluated to reduce the inland extent of coastal flood and tidal inundation. These "green" approaches could provide additional areas to accommodate the future transition of habitats while protecting valuable agricultural lands. Any planning efforts that are used to address the projected flooding hazards along the Santa Clara and Ventura Rivers will require a multi-jurisdictional approach, due to the shared-water resources, sensitive species of plants and animals, and the jurisdictional boundaries that bisect these resources. Shoreline armor is not prevalent on the Central Coast, although some revetments are occasionally exposed after 1% annual chance storms.

After review of the Vulnerability Assessment and other studies, some potential adaptation strategies for the Central Coast are described below.

Re-establish Native Coastal Dune Habitats (Strategy CC-1)

The wide beaches and onshore wind direction of the Oxnard Plain are supportive of naturally protective sand dunes, which historically supported a large dune field that spanned for miles along the coastline. Low-lying dunes provide a buffer that protects existing development from storm waves, stabilizes windblown sand, and provides important habitat for native species of plants and animals. Coastal development has led to a steady decline in the number of coastal dunes existing in Southern California. To utilize sand dunes as an adaptation strategy to protect adjacent beachfront homes, beach widths of approximately 100 to 200 feet are needed to support successful dune installation and functionality.³³ Silverstrand and Hollywood Beach widths range from 250 to over 1,000 feet, making this strategy an attractive option for these communities because of the benefits provided across multiple resource sectors evaluated (e.g., flood protection, natural resources, recreation, tourism, reduced beach maintenance costs). In addition, these beaches tend to have native seedlings sprout up, showing that the initial formation of dunes occurs naturally when areas are not groomed. This is an indicator that re-establishment of a dune field is likely to be a cost-effective approach for coastal storm and natural resource protection.

Currently, Hollywood Beach is the only beach in the unincorporated Central Coast that still contains a portion of the historic dune field. It is home to sensitive species of plants and animals such as the Western

³³ Toward Natural Shoreline Infrastructure to Manage Coastal Change in California; Newkirk, Sarah et al. 2018

snowy plover, but it has also been degraded by invasive vegetation. The structure of a dune is affected by the type of vegetation that may grow on it. For example, a low-crested, wide hummocky dune is associated with native vegetation such as red sand verbena (*Abronia maritima*), while comparatively wider and much taller dunes are associated with the presence of invasive vegetation such as European beach grass (*Ammophila arenaria*). While dune restoration at Hollywood Beach would require several phases over an extended period of time, it could begin relatively quickly after community outreach, through permits for nature-based projects, and with relatively low start-up costs (See Appendix B).

Several key aspects would be considered for recreating a protective dune field, including potential ponding of water (Figure 2-6), initial shape and construction, desired elevations and orientation of the dunes, plant species, and potential secondary issues such as coastal access, minimization of adverse impacts on sensitive species, wind gaps, and erosion. Dune management would coordinate maintenance activities such as keeping sand away from residences, beach grooming for access, and harbor dredging to re-create low-crested hummocky dunes on appropriate areas that protect homes.

Given the jigsaw pattern of jurisdictional boundaries in this area, a multi-jurisdictional approach to dune management would be preferable, involving the County of Ventura Planning Division, Harbor Department, and the Cities of Oxnard and Port Hueneme.

Cumulative effects: If the weakest point in a dune system is breached by flooding, substantial damages could occur. Therefore, a comprehensive line of dunes along Central Coast beaches would provide the highest level of protection. In addition, the creation of additional dune fields would significantly benefit many sensitive plant and animal species that are vulnerable to sea level rise by providing additional habitat.

Impacts: Dunes provide ecosystem services that filter water and support rare plants and animals. Dunes planted with native vegetation are not likely to reduce ocean views from ground floors of ocean front properties and roadways, although without invasive species management, the potential exists. On Hollywood Beach, there may be issues with stormwater drainage, which can be addressed through dune placement combined with storm drain system improvements. While vegetated dunes help stabilize sand, neighborhood nuisance sand abatement may continue to be an ongoing challenge for this area. Low-lying curb walls constructed at the back of the beach may also help to reduce wind-blown sand migration from beaches and dunes onto roadways and private property.

Long-term adaptive capacity: High. There is historic presence of dunes, onshore wind direction and abundant sediment in the Central Coast that is actively managed by the Harbor Department which includes beach grooming, sand removal, and dredge practices on the up coast and downcoast ends. The project would significantly benefit natural resources, as well as increase protections to these vulnerable residential communities. (Also See Appendix B.)



Dredge Sediment Reutilization for Beach Nourishment (Strategy CC-2)

Maintenance dredging at Ventura and Channel Islands harbors is generally a biennial activity critical to maintaining sandy beaches in the City of Port Hueneme and downcoast to Point Mugu. Dredging is a federal activity completed by the Army Corps of Engineers with federal permits. The existing dredging practices on the West Coast are largely determined by the amount of federal funding allocated through Congress each

year. Typically, between one and three million cubic yards of sediment is dredged from the sand trap at the jetty on the northern mouth of the Channel Islands Harbor, and it is mostly deposited near the pier at Hueneme Beach, while about 200,000 cubic yards is also used to nourish Silverstrand Beach. Dredging activity has been ongoing since the Harbor was constructed in 1960.

A six-year program for maintenance dredging was last evaluated by the Army Corps of Engineers in the summer of 2018. When the new dredging programs are proposed, it may be useful to determine if any of the sediment can be used for dune restoration, if needed. In addition to reconsideration of the dredged sediment placement, the seasonal timing and annual availability could be revisited with consideration of sea level rise vulnerabilities.

Cumulative effects: An updated approach to dredge sediment management could help maintain protective dunes while supporting adequate downcoast sand supply that will protect all sectors from coastal hazards into the future.

Impacts: Lapses in dredging or substantial decreases in dredge bypassing may have downcoast impacts. Dredge operations may adversely impact federally/state protected species that utilize the adjacent beaches and dunes, although impacts to nesting birds and grunion eggs can potentially be avoided depending on the timing of the dredging and sand deposition.

Long-term adaptive capacity: Moderate. There is high adaptive capacity given the abundant sediment in the Central Coast that is actively managed by harbor dredge practices on the upcoast and downcoast ends, however it is uncertain the degree to which the federal government is interested in modifying its dredging practices for the local harbors and port.



Photo 3-4: This photo shows nuisance flooding that occurs during high tides at the southern terminus of Victoria Avenue near Hobie Beach in the Channel Islands Harbor.



Storm Drain Improvements for Streets at Hollywood Beach and Silverstrand Communities (Strategy CC-3)

Coastal flooding currently occurs in the densely populated coastal neighborhoods of Silverstrand and Hollywood Beach during large storms (Photo 3-4). At Silverstrand there is nuisance flooding at high tides and seawater stagnates among storm drains that line the only tsunami evacuation route for the neighborhood.

There are three stormwater pump stations at Silverstrand Beach and none at Hollywood Beach. The pump stations at Silverstrand are located on San Nicolas Avenue, Santa Paula Avenue, and Santa Monica Avenue. In a study that was conducted in 2007, Watershed Protection District staff noted that, in the dry season, the San Nicolas Avenue Pump Station diverts more water than can otherwise be attributed to urban runoff. The analysis concluded that “seawater-influenced groundwater” infiltrates the storm drain system. Water samples of the outlet at Kiddie Beach found that the concentration of harmful bacteria is significantly higher at high tide, which could also be another harmful effect of sea level rise.

The outlets for two other pump stations were recently upgraded. The outlet pipes on the beach were reduced in length to have less exposure to tides and raised by about 5 feet in order to exceed the height of tides with 4.5 feet of sea level rise and a 1% annual chance storm. However, the pumps will exceed their service life in about 10 years and may need to be replaced in the short-term.

The County could work with the Channel Islands Beach Community Service District to make the stormwater system more resilient to sea level rise and reduce nuisance flooding. The following improvements could be considered:

- Install equipment such as flap-gates that would restrict tidal flow up storm drains and sand flow into storm drains;
- Waterproof pipes to prevent sea water intrusion—particularly where pumps and electrical equipment are sited; and
- Upgrade and install pump stations as needed to accommodate tidal infiltration.

Cumulative effects: If the storm drains are inadequately sealed, or the pump stations fail, the Vulnerability Assessment shows that significant areas of Silverstrand and Hollywood Beach communities could be inundated during a large storm. Upgrades to the storm drain system that would reduce the hazard risk can be costly, and the system requires ongoing monitoring, maintenance, and repairs. Previous capital improvements were funded through grants, but the life cycle costs of maintaining the facilities were not included. The full costs to operate and maintain pump stations need to be addressed as the system is upgraded.

Impacts: If not properly adapted for sea level rise, storm drains, culverts and pipes could become a conduit for seawater to flow into residential neighborhoods.

Long-term adaptive capacity: Moderate-High. Pump stations and storm drains alleviate episodic coastal flooding, particularly in conjunction with barriers such as dunes that shield the neighborhoods from wave overtopping. But when daily tidal inundation occurs, the entire system may need to be redesigned to divert outflows to inland areas as sea water intrudes. (Also see Appendix B.)



South Coast

The South Coast is relatively diverse subarea in the county, with agricultural lands reaching inland from Ormond Beach and along the Calleguas Creek at the foot of the Santa Monica Mountains. Ormond Beach is adjacent to the Point Mugu Naval Air Weapons Station which includes beaches, sand dunes, fresh/salt water marshes, and national defense facilities such as an airport. The coastline south from Point Mugu is mostly armored, generally with rip-rap revetments in various ages and conditions that protect a variety of development and infrastructure, particularly Pacific Coast Highway. The small pocket beaches along the south coast have historically supported spawning grunion and foraging shorebirds, while historic Western monarch butterfly overwintering roosts may be found in the riparian corridors of the creeks that empty into the sea. In addition, a small creek estuary at the mouth of Sycamore Cove is designated as critical habitat for the tidewater goby. Some of the State Parks property on bluffs near the County boundary at Leo Carrillo remain relatively unarmored but are at risk of exposure to bluff erosion.

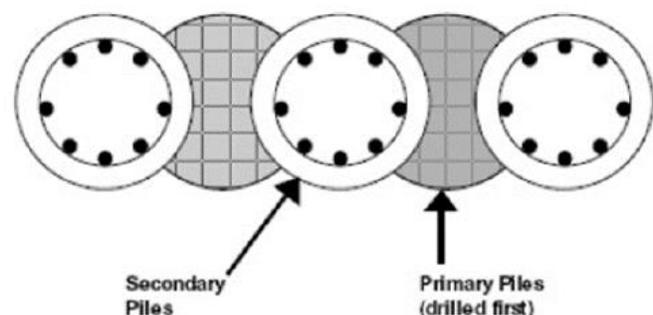
The South Coast could benefit from a sand retention and sediment bypassing program around Mugu Canyon which would help to nourish and retain sand on beaches. Maintenance of existing armoring could be done in a more comprehensive fashion using Geological Hazard Abatement Districts for private developments, and a Caltrans Corridor Improvement Plan for Pacific Coast Highway. In the long term, inland relocation should be considered for some of State Parks' facilities and portions of the highway where feasible. For agricultural areas along Calleguas Creek and near Ormond Beach, one or more horizontal levees, marsh sills, or tidal benches (see below) could reduce the inland extent of coastal flooding, tidal inundation, and provide some additional elevation to accommodate wetland habitat migration.

After review of the Vulnerability Assessment and other studies, some potential adaptation strategies for the South Coast are described below.

Coastal Armor (Strategy SC-1)

While this topic was covered in the North Coast discussion above, shoreline armoring is revisited here due to its prevalence along the South Coast, primarily in the form of rock revetments that protect Pacific Coast Highway. Protective devices, such as revetments and retaining walls, have traditionally been used to stabilize and protect shoreline development from erosion. As the effects of coastal erosion accelerate in this area, Caltrans is concluding that rock slope protection is only a temporary solution in erosion hotspots and is currently planning to use a secant pile wall design for permanent stabilization of the slope and roadway near Sycamore Cove (Figure 3-3). Two secant pile walls are being designed to reinforce rocky headland areas on the North and South sides of Sycamore Cove. Each secant piles will consist of concrete reinforced with steel that is constructed about 100 feet into the ground. When completed, the Secant Pile Wall will extend

Figure 3-3: Typical Schematic of a Secant Pile Wall (Source: Caltrans VEN-1 Permanent Slope Restoration Project Initial Study, October 2018)



between 200 and 600 feet long. The design is shown in Figure 3-3 below and consists of piles that are drilled in a staggered formation, followed by another series of piles that are drilled into the gaps between the first set of piles to form a wall. While the revetments are proposed to remain along the toe of the secant walls to dissipate wave energy, secant walls could provide another option for shoreline protection.

Please refer to the North Coast, Coastal Armor section for a discussion on cumulative effects, impacts, as well as long-term adaptive capacity.

Standards for Bluff Setbacks (Strategy SC-2)

This strategy addresses sea level rise hazards through increased setbacks. Setbacks would likely apply to bluff-top development that could be severely eroded near the County line of the South Coast. Setback calculations could be expanded to include not only historic rates of erosion, but also acceleration of the erosion rates due to rising sea levels and an additional factor of safety to account for potential storm erosion damages.

Cumulative effects: Increased setbacks will require departure of any “string line” approach and affect visibilities of the ocean and coast of new development that is set farther back.

Impacts: Setbacks also could eventually lead to the structures still being at risk as erosion could continue to impact the properties. Historically significant structures could be prohibitively difficult to elevate or setback, but there are not any registered landmarks on the shoreline of the unincorporated area.

Long-term adaptive capacity: Low-Moderate. The setback strategy has limited ability to adapt without significant changes, costs, and engineering. Setbacks are moderately adaptive, although once set, they typically require relocation or reconstruction on the landward side of parcels as ocean front portions are eroded.



Standards for Pilings (Strategy SC-3)

A piling is a column of wood, steel, concrete, or other material that is driven into sediments to form support foundations for structures (Photo 3-5). Traditionally pilings are made from timber with treatments that preserve them in the harsh coastal environment. Modern forms of pilings include reinforced concrete and traditional wood that is wrapped in plastic or epoxy materials. Pilings may be a useful alternative to armor, because they can be used to elevate structures and serve as a foundation for when the footprint of the structure is flooded or inundated. They also are not associated with the active and passive erosion forces that are characteristic of revetments and seawalls. The fewer impacts caused by pilings indicates that they could become a preferable alternative to shoreline armor.

Cumulative effects: Pilings are generally visually unappealing and would alter the character of beaches, but they may provide a transition between continued armor and removal of the structure as the high-tides encroach inland.

Impacts: Compared to seawalls, pilings accommodate more sand and are more conducive to lateral beach access. If a new structure is built on pilings, and it is sandwiched between two armored structures, there would be an increase in the forces of passive erosion and scour on the armored structures.

Long-term adaptive capacity: Moderate. The piling design occupies less beach than seawalls, but it accommodates development in hazardous areas.



Photo 3-5: Residence constructed on pilings during a king tide on December 3, 2017.



Sand Retention Through Non-Permanent Perpendicular Cross-Shore Features (Strategy SC-4)

The nearly unidirectional longshore sediment transport along the South Coast makes sand retention relatively feasible and effective. This could be done using traditional techniques such as groins or using more innovative, nature-based approaches such as erodible cross shore cobble berms. According to a recent California Natural Resources Agency report³⁴, cobble berms and sand dunes are the only types of natural shoreline infrastructure that are suitable for open coastline in California. Since the beaches along the South Coast are too thin to develop significant dune systems, cobble berms may be the only short-to-mid-range nature-based adaptation strategy suitable for this area.

Ideally these structures would retain sand through the summer and fall months but since sediment supply to the coast south of Point Mugu is limited, supplementation with sediment from bluffs, inland watershed areas, or through bypassing of dredging sediment around the Point Mugu and Port Hueneme submarine canyons would be helpful.

This strategy would require coordination with the Coastal Commission, Caltrans, and State Parks to identify a few case study sites to construct a few non-permanent sand retention structures.

See the North Coast Strategy NC-2 discussion of cumulative effects, potential impacts and long-term adaptive capacity.

³⁴ Toward Natural Shoreline Infrastructure to Manage Coastal Change in California, Newkirk, Sarah et. al. August 2018.

Sediment Bypassing (Strategy SC-5)

Presently, the South Coast, east of Point Mugu is in a sediment deficit due to landward migration of the head of the Mugu submarine canyon, which has increased the volume of sand historically captured by the deep-sea canyon. Estimates are that 10-15% of sand in the longshore transport used to pass the deep-sea canyons at Point Mugu and Port Hueneme and feed into the South Coast beaches, but this amount is down to 5%.

By developing a sediment bypass program around Point Mugu, more sediment would be available to reduce the coastal hazards along the South Coast and subsequently northern Los Angeles County beaches. The bypassing could be done through revisions to the dredging practices of ports and harbors, in coordination with the Point Mugu Naval Air Weapons Station to trap sand before it dissipates into the underwater canyon, and through utilization of debris in basins along the Calleguas Creek that would otherwise be carried out with storms to the deep-sea canyon. The Watershed Protection district could partner with the Navy, State Parks, and Caltrans to move the sediment a few miles from Calleguas Creek to an onshore deposition site near Point Mugu.

Cumulative effects: Sediment bypassing on the South Coast would have mainly positive effects such as expansion of recreational beach area, less coastal hazard exposure, and reduced long term maintenance costs for Pacific Coast Highway and State Parks facilities. If sediment is deposited near Point Mugu, which is at the beginning of the littoral cell, ideally during the early spring when conditions promote on-shore accretion, up to 57-miles of coastline could benefit.

Impacts: Sediment that is removed from debris basins and trucked to the coast would increase traffic and greenhouse gas emissions, although such activities may result in a net in an emissions reduction if less revetment rip-rap is transported from distant inland quarries. Speculatively, less sediment entering the deep-sea canyon could potentially increase chances of a submarine landslide and a tsunami.

Long-term adaptive capacity: Moderate. There is abundant sediment in the Central Coast that is actively managed by harbor dredge practices on the upcoast and downcoast ends, but the volumes needed elsewhere require further examination.



Horizontal Levee (Ormond Beach or Calleguas Creek/Revolon Slough areas) (Strategy SC-6)

Horizontal levees are generally used to protect urbanized areas from flooding in estuaries and bays and allow room for habitat migration or recreational uses on the gentle slope of the levee. Horizontal levees sometimes also called “super levees”, are a greener alternative to traditional levees and could include crops and orchards (Photo 3-6). Although still experimental in practice along the California coast, a horizontal levee approach would theoretically increase the inland slope along the Oxnard Plain and provide some protection from coastal hazards, particularly tidal inundation and coastal storm flooding. They are generally designed to be three times wider than traditional levees and reach the same height.³⁵ Such

³⁵ Coastal Infrastructure: A typology for the next century of adaption to sea level rise, Hill, Kristina, 2015

structures could also be used for backshore protection in conjunction with dune restoration, to control and facilitate the migration of wetlands, and provide a buffer between wetlands and agricultural areas. Horizontal levees could be considered as part of an Ormond Beach restoration strategy and at the confluence of the Calleguas Creek and Revolon Slough to reduce hazards and protect the Point Mugu Naval Air Weapons Station.

Cumulative effects: This is one adaptation strategy that may not require extensive maintenance and monitoring by the managing agency because once constructed, horizontal levees are inert earthen structures that have a long expected operational life-time, especially if they are protected from toe scour and are not overtopped by floods.

Impacts: The slope which may pose problems for certain types of agriculture and for stormwater drainage across the Oxnard Plain. Like other levee systems, horizontal levees are designed to control flooding, and areas that are not protected could experience increased flooding.

Long-term adaptive capacity: Low-Moderate. Horizontal levees have been used in other regions to shore up marshes, wetlands, and stormwater detention basins. The suitability of horizontal levees in conjunction with farmland adjacent to Ormond Beach, Calleguas Creek, or the Revolon Slough would require feasibility studies and additional analysis.



Photo 3-6: This horizontal levee provides a transition area between an estuary and an orchard that includes recreational pathways.



3.2 Adaptation Pathways

Reviewing current County programs and policies associated with risk reduction is the first step to identify potential short-term adjustments to alleviate or eliminate sea level rise risks. Where adjustments to current practices will not sufficiently address the risks, more substantial actions should be identified and implemented.

Of critical importance to the successful implementation of an adaptation strategy is communicating the issues and proposed response strategies to the community. Studies repeatedly show that knowledgeable and prepared communities with educated decision-makers that understand how to respond to extreme events, will be far more resilient. An informed community is also more likely to implement programs and make decisions that proactively plan and prepare for extreme events, and this minimizes potential impacts.

Many of these adaptation strategies take substantial time to implement, in part due to extensive interjurisdictional coordination. For example, the Surfer's Point Managed Shoreline Retreat project in the City of Ventura took 16 years to conceive, design, permit, finance and construct. Many of the characteristics of that project, such as the use of cobble to retain sediment, and dune restoration, are included in this Report. Identifying important thresholds that will trigger planning processes and implementation is important. Policies and implementation programs in the LCP can help to identify specific thresholds that trigger specific actions. Factors to consider when prioritizing adaptation projects include: public health and safety, available funding sources, legal mandates, planning consistency, capacity and level of service, cost-benefit relationship, environmental impacts, and public support. Risks that present the most serious consequences and are projected to occur first should raise a project's level of priority.

This Report will increase understanding of the vulnerabilities associated with coastal hazards and encourage decision-makers to consider these potential impacts without creating further vulnerabilities or liabilities. As this is the beginning of the County's process of developing its adaptation response, many early initiatives are exploratory in nature and aim to identify potential changes or actions that would address the impacts of concern.

Adaptation Pathway Case Studies

To demonstrate how the adaptation strategies discussed above could be applied to some of the vulnerable areas that were identified, this Section provides some examples of adaptation pathways that can be used. An adaptation pathway is a planning approach that addresses the uncertainty and challenges of sea level rise decision-making. It enables consideration of multiple possible futures and allows flexibility of various options for implementation. The intent of these case studies is to begin a dialogue and eventually craft policies for the LCP. The adaptation pathway case studies presented below were distilled through a five-step process:

1. The process began with a review of vulnerable areas that would be affected first by tidal inundation, as summarized in Section 2 of this report. Tidal inundation was selected as the primary indicator because, although many areas may be flooded temporarily by storms, areas that are tidally inundated will be permanently changed and potentially unusable. Also, the probabilities assigned in the State guidance are only applicable to sea level rise and not to coastal storm frequency, so an approach that focuses on tidal inundation allows for a more precise assessment of risks.
2. Research was conducted to identify potential adaptation strategies that could be applicable to the land uses in the vulnerable areas. Additional consideration was given to strategies that are already being used or considered in the County and in other jurisdictions.
3. After compilation of available adaptation strategies, Revell Coastal provided recommendations for each planning subarea that were integrated into the summaries of viable adaptation strategies in Section 3.2.
4. The updated list of strategies was reviewed during meetings with other agencies to determine whether any additional strategies could be identified, and which strategies would be compatible the missions of other agencies, including other County agencies.
5. After the interviews, a basic economic analysis was conducted to evaluate four adaptation strategies that could be applied to public resources and government-owned facilities. This analysis

allows the cost of increasing coastal resilience by using these strategies to be contrasted with the value of assets that would be protected, as summarized in the Vulnerability Assessment Report. The economic analysis of selected strategies is summarized in Appendix B.

6. The adaption information gathered through this process was summarized and discussed with a management team from the Planning Department, which resulted in the strategy recommendations described below. This is simply a starting point to begin discussion about adaptation. Before any strategies are implemented, additional coordination and input will be needed from the general public, stakeholder groups, the County Planning Commission, and the County Board of Supervisors.

Case Studies 1 and 2: Sediment Management at Hollywood Beach and Silverstrand

The Coastal Resilience, CoSMoS sea level-rise models, and FEMA flood zone maps demonstrate that existing development at Hollywood Beach and Silverstrand Beach are somewhat protected from coastal storm flooding by the existing wide beaches. According to State guidance, use of nature-based protection is a preferred adaptation strategy over the use of shoreline armor. However, the summary of vulnerabilities in Section 2.2 above described that wide beaches alone are not enough to protect these neighborhoods when there is 5 or more feet of sea level rise, or approximately by the year 2100, because reinforcements to the Harbor will be needed well before that time, on the Hollywood Beach peninsula, and at the entrance to Silverstrand, at Kiddie and Hobbie Beaches.

Since the characteristics of Hollywood and Silverstrand Beaches vary, the hypothetical adaptation implementation timelines provided below are slightly different for each location. One of the major differences is that Silverstrand is far more popular for beach visitors and day-users than Hollywood Beach, and Hollywood Beach is home to existing sand dunes that provide sensitive species habitat.

1. Sediment Management at Hollywood Beach

Hollywood Beach is one of the few areas in the unincorporated County where accretion, or build-up of sand occurs over time. While the scientists are uncertain why the beaches continue to accrete, despite reductions in the amount of sediment carried in the littoral cell, the direction of the waves and onshore winds contribute to the proliferation of sand on the Central Coast. Sediment management for Hollywood Beach could include the following components that are also illustrated in Figure 3.4 below. The strategies that are numbered correspond with the descriptions in Section 3.1 above.

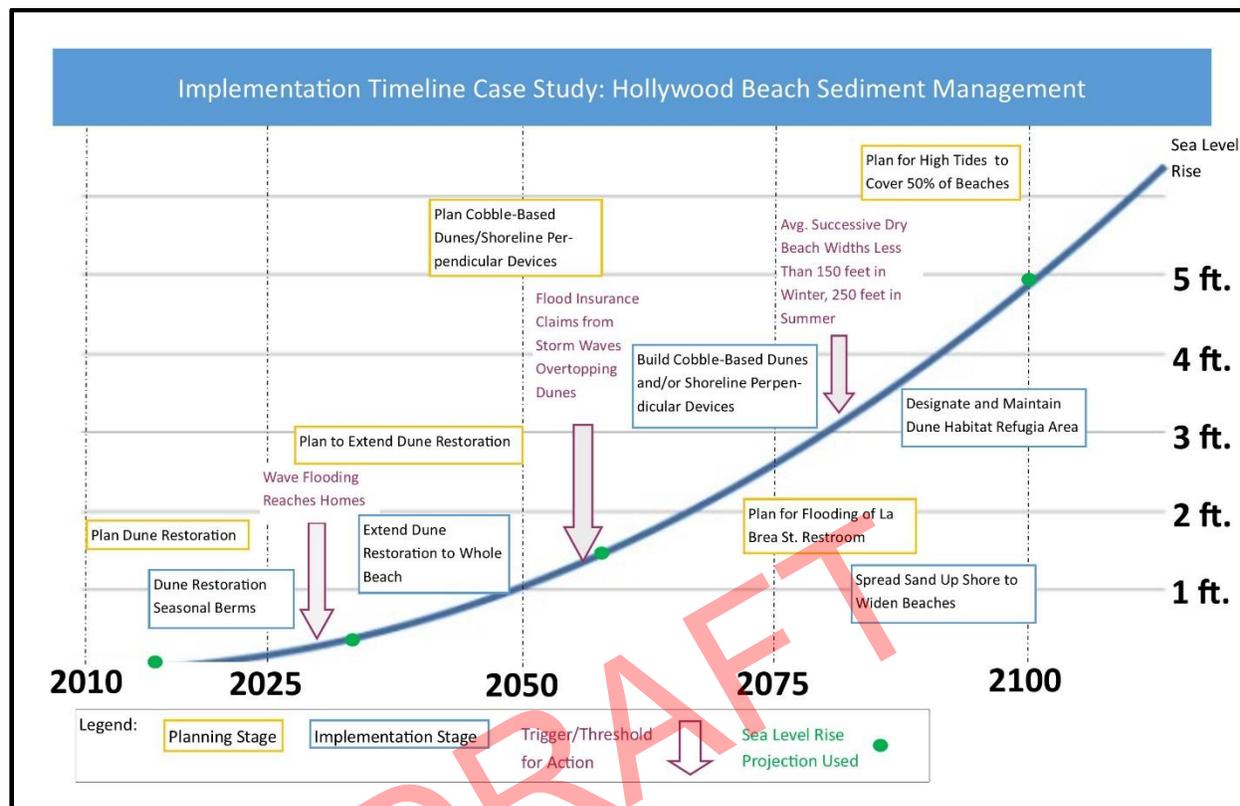
- **Before 8" of sea level rise.** In the near term, existing sand dunes near the harbor jetty sand trap could be restored to remove invasive species and improve drainage (Strategy CC-1). While monitoring the dune restoration, other areas along the beach could be considered for building seasonal sand berms in front of homes for some protection from winter storms. Potential triggers for implementation of the next adaption strategy could occur when coastal storm flooding reaches the homes that lie behind the existing dunes and any seasonal berms are eroded. Appendix B discusses the economic costs of building and maintaining sand dunes.
- **Between 8" and 16" of sea level rise.** If the dune restoration is successful, the project could be extended along the remaining Hollywood Beach shoreline, and through coordination with the City of Oxnard, further up coast along Oxnard Shores. Given that sand naturally accretes in this area, sand fencing and other low-cost barriers could be used to begin to create new dunes. New dunes could also create sensitive habitat, leading to the need for future coastal access planning that

would balance the uses. Potential triggers for implementation of the next adaptation strategy could occur after coastal storm flooding overtops or erodes dunes and damages the homes that lie behind the existing beach dunes to the extent that there are flood insurance claims.

- **Between 16" and 5' of sea level rise.** When dunes are destroyed by a storm, they could be rebuilt with more resilient materials such as cobble foundations with deeply buried toes. These dunes would be more expensive to construct, but they would last longer than sand-based dunes that accrete using simplistic collection devices. The restroom at the end of La Brea Street should be planned to accommodate coastal storm flooding. A possible trigger to implement the next adaptation strategy could be when the beaches decrease by a significant width for successive years, and before they become too narrow to support dunes, such as a decrease of width, as measured according to the mean high tide line, by 150 or 200 feet. (See Figure 3-4 below.)
- **5'+ of sea level rise.** If the beaches are eroded in the long-term, consider whether the sand trap can be used as a source to spread sand back up shore onto the remainder of Hollywood Beach (Strategy CC-2). An alternative would be to consider the use of perpendicular shoreline structures to trap more sand (Strategy NC-2). These structures could be permanent groin structures, like those at Pierpont Beach in Ventura, or they could be cobble-based groins, like the cobble berms at Surfers Point in Ventura. A high-lying beach area located inland of the sand trap, that is partially protected from storms by the breakwater, should be designated as a refugia for dune habitat (Strategy CW-5). If the beaches begin to be overtopped by waves, it would be prudent to have employed adaptation strategies for the residential areas, such as raised development designed to accommodate flood water.

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



2. Sediment Management at Silverstrand Beach

In contrast to Hollywood Beach, Silverstrand has only fragmented remnants of sand dunes and much higher rates of recreational use, including a popular surf break. The beach is thinner than Hollywood Beach, and can be less than 200 feet in width at times. The southern end of Silverstrand Beach is periodically replenished when the sand trap at the Harbor Jetty is dredged. Assets on the beach include a lifeguard tower and one parking lot on the north end of the beach, and a restroom and a parking lot on the south end of the beach. Sediment management for Silverstrand Beach could include the following components that are also illustrated in Figure 3-5 below.

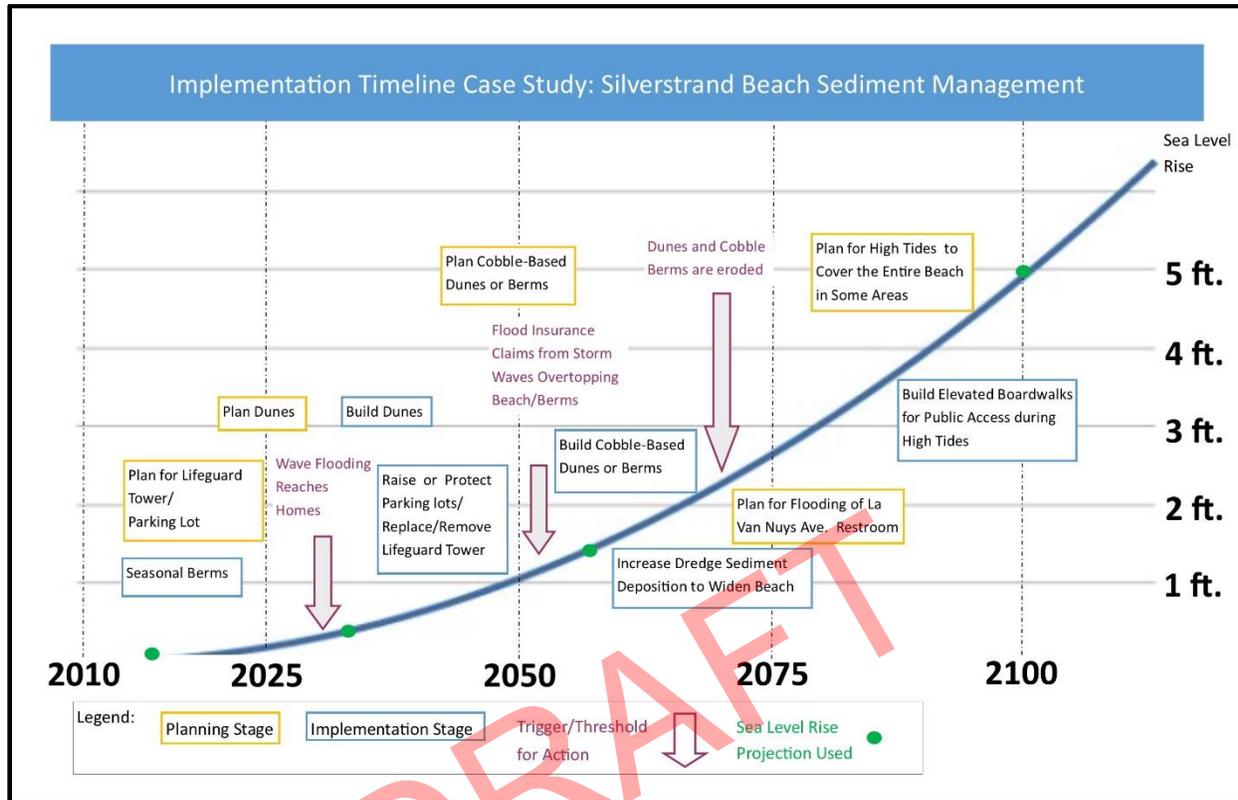
- **Before 8" of sea level rise.** In the near-term seasonal sand berms could be used to protect residences during winter storms. In the calmer summer months, the berms could be removed, improving beach access and views from the first floors of residences. Planning for resiliency of the lifeguard tower and parking areas should also be considered during this time. Possible triggers to implement the next adaption strategy could be when the seasonal berms are eroded by storms, when wave flooding reaches the streets, or when a minimum beach width threshold is triggered for successive years.
- **Between 8" and 16" of sea level rise.** In the mid-term, when the effects of sea level rise begin to increase, and there is more exposure to storm waves and erosion, the beach width may need to be maintained or increased through enhanced dredging sediment deposition, or seasonal berms

may need to be rebuilt with more resilient materials such as sand dunes or berms with cobble foundations. These engineered structures that mimic nature would theoretically erode slower than sand berms and they could provide ecosystem services if they are covered with sand and planted. It's anticipated that they could erode over a 2-5-year time period, depending on the intensity of storm events. A perpendicular structure on Silverstrand is not recommended because it is likely to affect the popular surf break. Appendix B discusses the economic costs of building and maintaining sand dunes and cobble-based sediment retention devices.

As sea level rise is projected to reach about 8 inches, the 25-year planned lifespan of the lifeguard tower will mature, and the effectiveness of project features that were included to improve resiliency will need to be reassessed. These features include a 13.5-foot elevated first floor, deepened perimeter footing, and masonry block construction design. During the permitting process for the tower, the Coastal Commission applied a condition that excludes potential armoring to protect it, leaving only accommodation and retreat as viable options for this facility. The design of the parking lot behind the tower will also need to be reassessed, and either raised, protected, or removed. Potential triggers for implementation of the next adaptation strategy could occur after coastal storm flooding overtops or erodes dunes and damages the homes that lie behind the existing beach dunes to the extent that there are flood insurance claims.

- **Between 16" and 5' of sea level rise.** Plan for continued public access when tidal inundation reaches homes at the narrowest areas of the beach. The restroom at the end of Van Nuys Avenue should be planned to accommodate coastal storm flooding. A possible trigger to implement the next adaptation strategy could be when the dunes or cobble-based sediment retention devices are eroded or destroyed by storms.
- **5'+ of sea level rise.** Continuation of sand deposition from dredging will be needed (Strategy CC-2). If the beaches begin to be overtopped, it would be prudent to have strategies for public access, such as elevated boardwalks and lookout points that would continue to allow horizontal public access when the beaches are inundated at high tide (see Figure 2-9). If the beaches erode, coastal armoring may be needed during emergencies (Strategy NC-2).

Figure 3-5: Hypothetical Adaptation Pathway Case Study for Silverstrand Beach Sediment Management. Note that the purple-colored arrow representing a “Trigger for Action” would initiate the next phase of adaptation measures.



Case Studies 3 and 4: Stormwater Drainage Improvements at Hollywood Beach and Silverstrand Neighborhoods

Various forms of Sediment management could advance the “front line” of coastal resilience for the Hollywood Beach and Silverstrand communities (Strategy CW-6), and the modeling results in Appendix B indicate that this activity may suffice through 5 feet of sea level rise, but a 1% annual chance storm with heavy rains, large surf, and high tides could nevertheless erode and overcome sand dunes and berms on beaches and temporarily flood the entire area. There is also the potential for sea level rise to percolate into areas with high ground-water tables and cause saltwater to pond onto streets, particularly in the Silverstrand neighborhood (see Appendix B). The sea level rise models also show that there are low-points on the shore of the Channel Islands Harbor that should be reinforced before there is about 16 inches of sea level rise. A coastal resiliency strategy for these areas should consider how stormwater management, specifically how the storm drains and pump stations, can be improved to reduce these flooding risks.

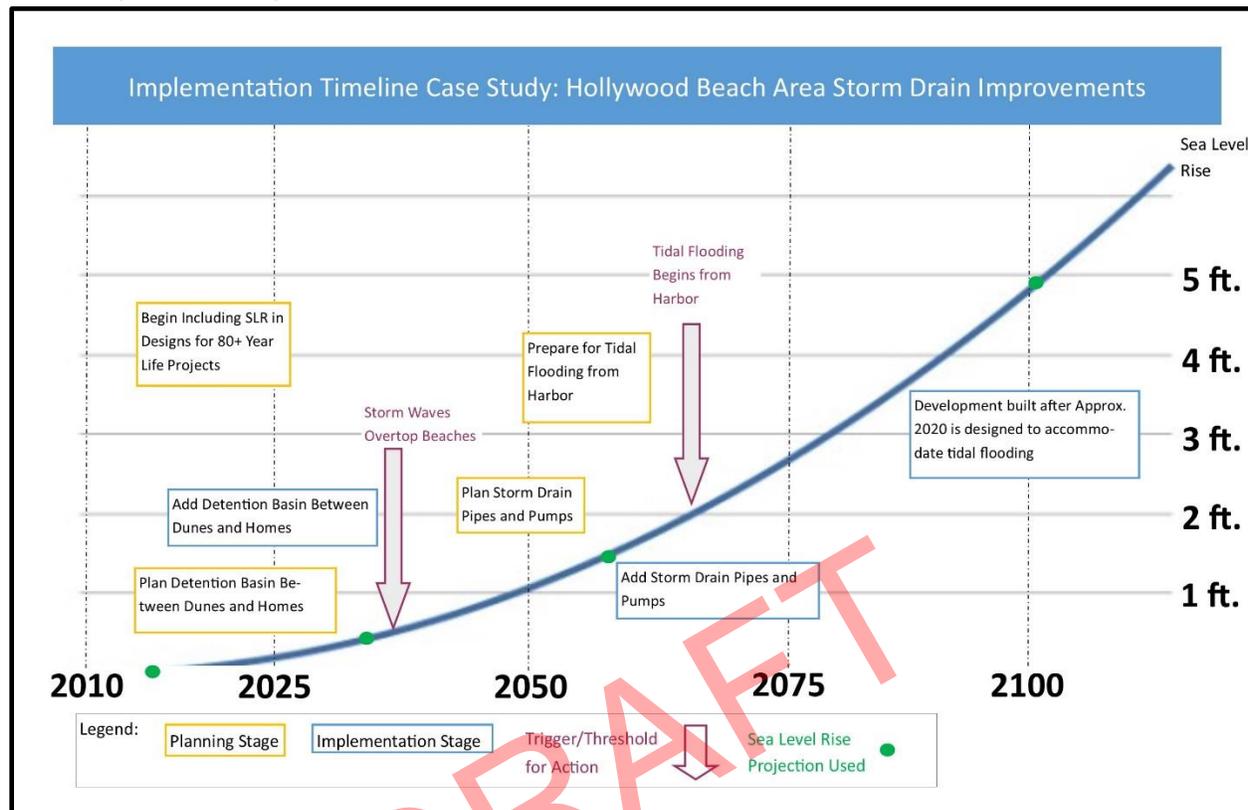
3. Storm Drain Improvements at Hollywood Beach

The storm drain system at Hollywood Beach relies on a gravity-based system of drains and culverts. There are fewer low-lying areas that tend to pond water here than at Silverstrand. The Hollywood Beach system

primarily drains through drop inlets with subterranean catch basins that allow stormwater to percolate into the ground. There are also a few detention basins located under the road near Los Robles Street. Improvements to include storm drains and pumps may be needed as the tides rise on three sides of the peninsula and if the underlying sandy soil becomes saturated by rains and tides. Storm drain improvements for Hollywood Beach could include the following components that are also illustrated in Figure 3-6 below.

- **Before 8" of sea level rise.** The developed areas behind the dunes along Ocean Drive may be one of the first areas affected by tidal flooding. A detention basin with a pump should be considered for this area. Sea level rise accommodation principles could begin to be incorporated into the design of new projects with an 80+ year planned lifespan (Strategy CW-3).
- **Between 8" and 16" of sea level rise.** Plan funding and implementation for stormwater system improvements on local streets (Strategy CC-3).
- **Between 16" and 5' of sea level rise.** Between about 16 inches and 5 feet of sea level rise, the Channel Islands Harbor will begin to experience tidal flooding. Coastal storms that periodically flood the area also become more severe. This is the time to implement storm water system improvements, such as add storm drain pipes and outfalls with flap gates designed at sufficient heights to discharge waters out to the beach (Strategy CC-3). The height of the outfalls would need to be designed to exceed the heights of coastal storm waves and setback sufficiently to withstand erosion during 1% annual chance storms. Consideration should be given to whether to discharge stormwater into the Harbor while it is flooded.
- **5'+ of sea level rise.** With 5 feet of sea level rise, tidal flooding will begin to affect most streets and some developed areas at the end of the peninsula and the elementary school. Risk would be reduced if the storm drain system is designed to convey stormwater to inland detention basins. It may be useful to coordinate with the Harbor Department to explore whether it is feasible to install flood gates to minimize flooding potential from this source. If the beaches begin to fail as a storm barrier, it would be prudent to have employed adaptation strategies for the residential and commercial areas, such as development that is designed to accommodate flooding.

Figure 3-6: Hypothetical Adaptation Pathway Case Study for Hollywood Beach Area Storm Drain Improvements. Note that the purple-colored arrow representing a “Trigger for Action” would initiate the next phase of adaptation measures.



4. Storm Drain Improvements at Silverstrand

The storm drain system at Silverstrand includes drop inlets, storm drain pipes, and three pump stations (Figure 3-7 below). The three pump stations are spaced at relatively even distances across Silverstrand, and two with outfalls on the beach were recently upgraded to higher elevations and setback further on the beach berm. The third station is beside the Harbor and sends some initial effluent to a treatment facility, and then it releases the rest to Kiddie Beach in the Harbor. Adjacent to Kiddie Beach, Hobie Beach experiences some nuisance tidal flooding of storm drains today, along South Victoria Avenue, but this infrastructure is within the City of Oxnard’s jurisdiction (Photo 2-2). Storm drain improvements for Silverstrand could include the following components that are also illustrated in Figure 3-8 below.

- Before 8” of sea level rise.** Coordination is needed with the Harbor Department, Transportation Department, and the City of Oxnard to begin planning to reinforce the harbor at Hobie Beach. According to the CoSMoS Model, with as little as about 8 inches of sea level rise and a 1% annual chance storm, the evacuation route through this location that serves the Silverstrand community is temporarily flooded. The County could work with the City of Oxnard to improve the drainage and elevate the roadway (Strategy CW-10) so that tidal inundation that causes nuisance flooding today, does not hinder the ability to evacuate the area when it may be needed in the future (Figure 2-10). Sea level rise accommodation principles should begin to be incorporated into the design of new projects with an 80+ year planned lifespan (CW-3).

- **Between 8" and 16" of sea level rise.** Conduct a sea level rise analysis and review the design of the existing stormwater system, its planned lifespan, and consider modifications that could be included during routine maintenance and planned upgrades to improve resiliency to sea level rise. Such modifications could include elevating and flood proofing pump station electrical equipment, adding detention basins, and extending the length of drain pipes to areas around Panama Drive (Strategy CC-3). Coordination with the Port and neighboring Navy base will be needed to determine if the existing flood gates on the Port's canal system can accommodate 5 feet or more of sea level rise.
- **5'+ of sea level rise.** Consider modifying the pump station at San Nicolas Road to pump all stormwater to a wastewater treatment facility or other locations inland other than into the Harbor, unless the Harbor is modified to accommodate rising tides and stormwater. If the beaches begin to fail as a storm barrier, it would be prudent to have employed adaptation strategies for the residential and commercial areas, such as development that is designed to accommodate flooding.

Figure 3-7: This diagram shows the stormwater system at Silverstrand that results from modeling water depth during a 1% annual chance storm, not including sea level rise (Source: Silverstrand Pump Stations Deficiency Study, 2014).

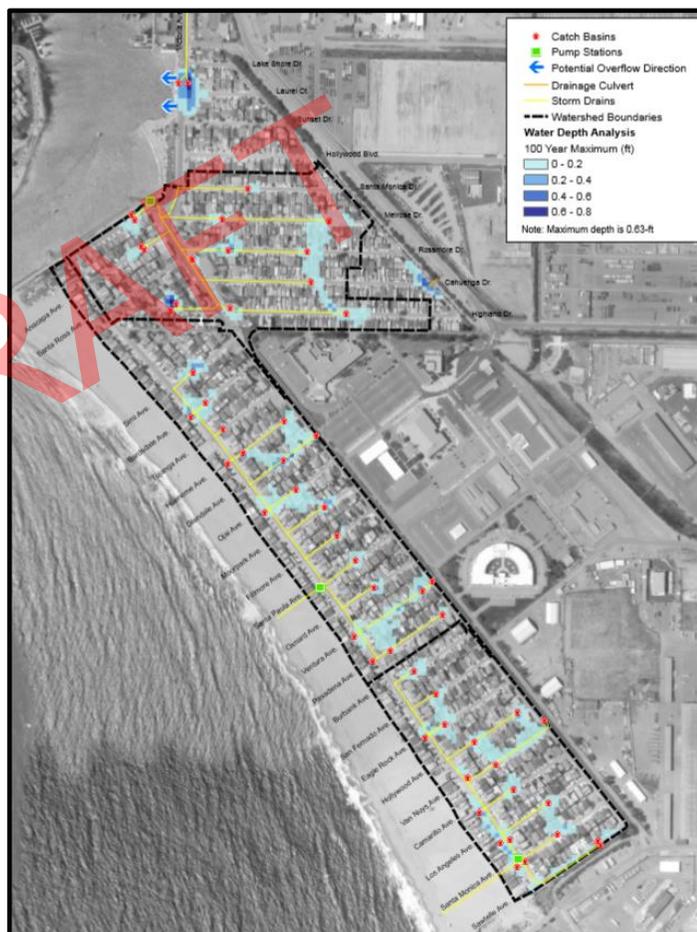
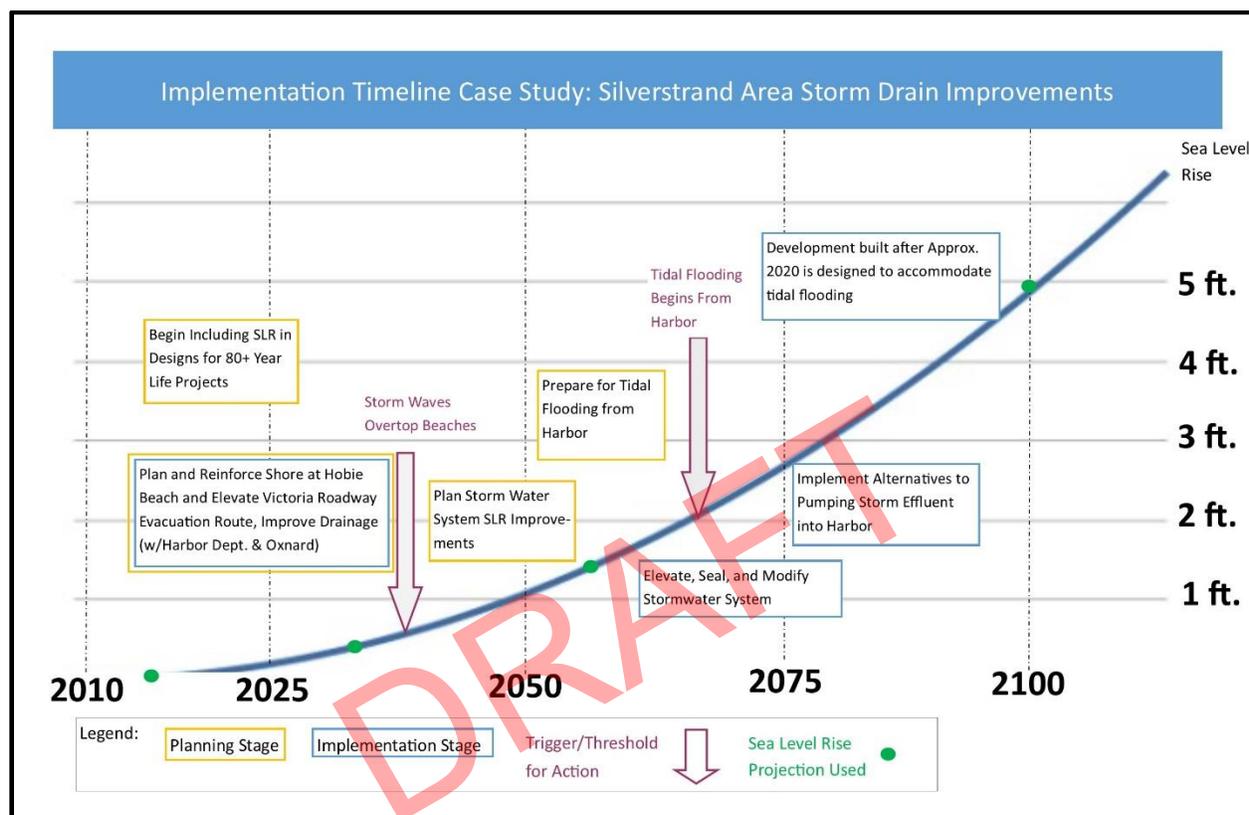


Figure 3-8: Hypothetical Adaptation Pathway Case Study for Silverstrand Storm Drain Improvements. Note that the purple-colored arrow representing a “Trigger for Action” would initiate the next phase of adaptation measures.



Case Study 5. Adaptation of the Rincon Parkway, Hobson and Faria County Parks

The North and South Coasts have many coastal access areas that consist of thin beaches that are backed by shoreline revetments (Photo 3-5). The most popular County-operated public camping facilities, at the Rincon Parkway and at Hobson and Faria Beach Parks, have thin, seasonal beaches in front of rock revetments. The revetments that line Old Coast Highway on the Rincon Parkway and at Faria Beach Park are expected to withstand up to approximately 5 feet of tidal inundation, but Hobson Beach Park may be consistently flooded before this time, and all of these facilities will be closed more frequently with sea level rise and 1% annual chance storms. Any adaptation strategies involving the Rincon Parkway will require coordination with Caltrans, the owner of the revetments along Old Coast Highway.³⁶ Adaptation plans for these sites could be used as a case study for areas with similar conditions on the North and South Coasts.

³⁶ The County and Caltrans have a longstanding Memorandum of Understanding that allows the County to maintain and operate public recreational uses along the Rincon Parkway.

Adaptation for the beach parks and the Rincon Parkway could include the following components that are also illustrated in Figure 3-10 below.

- **Before 8" of sea level rise.** Coordinate with Caltrans to construct a pilot project with non-permanent, nature-based sediment retention devices such as cobble-based groins (Strategy NC-2). Another pilot project could include replacement of the revetment at Hobson Beach Park with a seawall that has a smaller design footprint and possibly tidepools for nature viewing (Strategy NC-1). Since seawalls increase the rate of beach erosion, it would be optimal to test sediment retention measures in unison with a small-footprint seawall, in order to potentially preserve the beaches for a few more decades.
- **Between 8" and 16" of sea level rise.** In the short- to mid-term, sediment retention and beach nourishment strategies would help to maintain and potentially extend beach widths in front of the shoreline armor. Sand would buffer the parks from storms, and the perseverance of dry sandy areas during high tides would benefit recreation and natural resources such as spawning grunion and birds that feed on beach wrack. Beach nourishment could be conducted through various methods (Strategy CW-7). For example, soft coastal bluffs that are prone to slide onto roadways can be pretested for suitability of grain size and for pollutants, potentially allowing for deposition on the shoreline. Or the existing Union Pacific rail line could be used to transport sediment from more distant locations, such as the sediment-rich Central Coast or the County Watershed Protection District's inland debris basins. Sediment retention could include perpendicular shoreline structures such as permanent rock groins, or nature-based cobble groin projects (also see Appendix B). The North Coast beaches are generally too thin to accommodate the addition of sand dunes, as consistent year-round beach widths of at least approximately 100 feet are needed.

A significant seasonal improvement could include the deposition of large amounts of sand to cover the revetments at Hobson County Park. The covered revetments would function as sand berms during the summer months. While this sand will eventually erode, most of it would move downshore, providing a temporary benefit at the Rincon Parkway, Faria and Rincon neighborhoods, and Emma Wood State Beach.

- **Between 16" and 5' of sea level rise.** Public agencies that maintain public beaches should consider alternatives to rock revetments along thinning beaches, as the footprint of such structures can consume large areas of sandy beach that could otherwise be used for recreation and habitat. For example, Figure 3-9 below shows a segment of the Rincon Parkway that includes both a seawall and rock revetments. In the aerial image on the right of Figure 3-9, the same amount of space that the revetment occupies is used for camping and parking at the adjacent location where there is a vertical seawall. If all of the RV camping areas were lined with vertical seawalls instead of revetments, about 145,000 square feet of space could be used for 160 additional RV camping sites or for other amenities such as Coastal Trail improvements.³⁷ A smaller footprint for shoreline armor would also leave space for sand and beach wrack that benefits shorebirds and spawning grunion.

Hobson County Park is projected to be the first revetment that protects a park on the North Coast to be inundated by rising tides (see Figure 2-3). This site could become a pilot project for adaptation

³⁷ The calculation to reach 160 RV spaces estimated that the revetments occupy 14,500 sq ft of space per every 0.10 miles of length on the Rincon Parkway. The Parkway is about 1 mile long, and each designated space is about 900 sq. ft.

strategies on the North Coast and it may be the first instance where the decision between retreat and continue to armor comes to the forefront. Retreat would be unlikely unless other sites are found to relocate the park. Instead of having to extend the revetment to be higher and wider, a seawall is likely to be the least damaging option in the long-run, other than voluntary retreat (Strategy CW-8) or closure.

Photo 3-5: Coastal access at Hobson County Park with rock revetments. The Rincon Parkway can be seen in the distance.



- **5'+ of sea level rise.** In the long run, difficult decisions will need to be made if sea level rise is as severe or worse than expected for these public parks on the coast. The County and Caltrans may elect to raise the heights of shoreline armor, acquire property, or develop partnerships to move the facilities to higher elevations inland of the rail line. Or little to no action could be taken and resources would be expended to address more frequent seasonal closures, and additional cleanup and maintenance costs. Either alternative will increase costs to the County and Caltrans. If reinforcing the armor is chosen, then design standards could be used to minimize the impacts on habitat and to protect public access. For instance, seawalls built on tidepools could have naturalistic features included in the design (Photo 3-6).

Figure 3-9: The Rincon Parkway is entirely armored with rock revetments and seawalls.



Figure 3-10: Hypothetical Adaptation Pathway Case Study for Rincon Parkway, Hobson and Faria Parks Improvements. Note that the purple-colored arrow representing a “Trigger for Action” would initiate the next phase of adaptation measures.

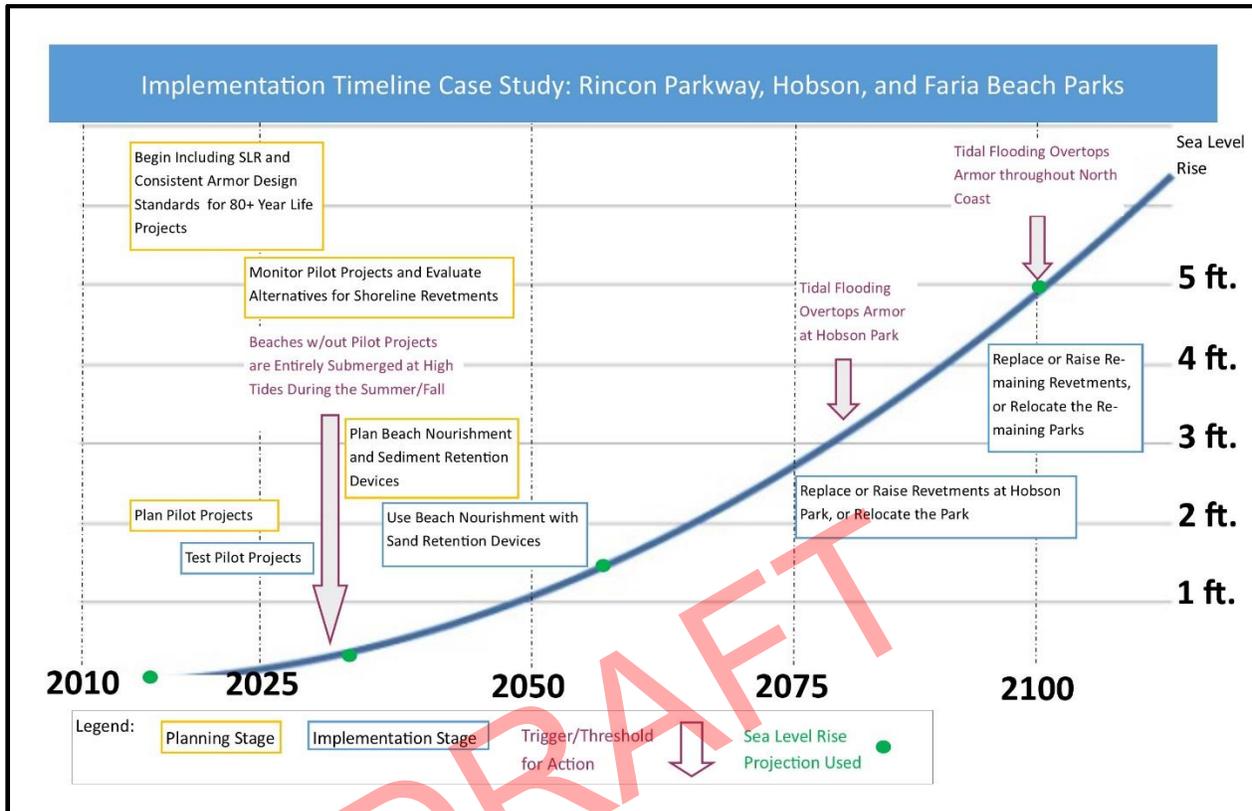


Photo 3-6: Coastal armor can be designed to include naturalistic features.



APPENDIX A. NATURAL RESOURCES ADAPTATION MATRIX

This Section includes a data table developed by the Natural Resources Working Group. It summarizes identified vulnerabilities and the potential adaptation strategies that could be employed to minimize sea level rise impacts on focal species and habitats. Many of these strategies were integrated into Sections 3.1 and 3.2 of this Report.

At the beginning of VC Resilient, The County formed a Natural Resources Working Group with 35 participants to help evaluate and assess the vulnerability of selected coastal species and habitats. This group consisted of federal, state, and local biologists, botanists, and ecologists familiar with the County's flora and fauna and who are subject-matter experts in the natural ecosystems of Ventura County. Participants were directly involved with the Vulnerability Assessment and helped with the identification of adaptation strategies.

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Summary of Potential Adaptation Strategies for Natural Resources Impacted by Sea Level Rise				
Habitat Type	Focal Species	Identified Vulnerability	Causes	Potential Adaptation Strategies
All four evaluated (beaches, dunes, estuaries, fresh water)	All (19)	Loss of shoreline habitats (includes USFWS Western Snowy Plover critical habitat)	<ul style="list-style-type: none"> Erosion and tidal inundation Lack of areas for habitat migration Decline of sediment transport 	<ul style="list-style-type: none"> Species monitoring for sea level rise (SLR) changes Increase sediment supply: Beach nourishment, minimize shoreline armoring, removal of dams/dikes/levee/channelized stream areas Protect shoreline: Off-shore living reefs, living seawalls, dune restoration/creation, tidal benches, marsh sills, horizontal levees Voluntary managed retreat: Allow for migration of habitats using fee-acquisition, easements, downzoning, etc. in appropriate areas
All four evaluated	All (19)	Degradation of niche habitat from SLR primary effects (inundation, flooding, erosion) and secondary effects (habitat fragmentation; increased susceptibility to invasive species; increased human activity and use on remaining habitats, pollution, temperature changes, etc.)	<ul style="list-style-type: none"> Erosion Tidal inundation Storm flooding Decline of sediment transport 	<ul style="list-style-type: none"> Multi-jurisdictional (if needed) habitat management plans that include adaptive management strategies and monitoring for projected SLR impacts Flooding: Setbacks from adjacent agriculture operations and development to prevent pollution runoff Inundation/Flooding: Restrictions on pesticide/fertilizer use on agricultural fields adjacent to salt marsh and tributaries to estuaries at projected SLR heights Inundation/Flooding: Provide adequate buffers around estuaries and potential migration areas Sediment Transport: Increase sediment supply (see above); elevate wetlands; cobble berm/dune restoration
			<ul style="list-style-type: none"> Habitat fragmentation 	<ul style="list-style-type: none"> Require habitat connectivity to nearby larger native habitats during review of new development proposals Reduced zoning on adjacent parcels to at-risk habitats Development setbacks to surface water features Habitat restoration
			<ul style="list-style-type: none"> Invasive species spread by development, maintenance activities, intentional release, recreational activities, and natural forces Predation and competition from invasive species 	<ul style="list-style-type: none"> Invasive species removal/control in area management plans and adjacent development proposals Develop breeding programs for at risk species (e.g., Southwestern pond turtles)
			<ul style="list-style-type: none"> Lack of refuge habitats during flood events 	<ul style="list-style-type: none"> Habitat restoration to create refugia habitat for major flood events (See Sediment Transport, above) (areas containing slow-moving water with ample adjacent quality terrestrial habitats, access to habitat with higher elevations) Identify sensitive estuarine habitat areas in vector control plans
			<ul style="list-style-type: none"> Pollution and temperature changes <ul style="list-style-type: none"> Non-point source runoff from adjacent land uses Removal of vegetation Drought 	<ul style="list-style-type: none"> Employ adequate setbacks for all land uses Habitat restoration Identify sensitive estuarine habitat areas in vector control plans Strategic water releases for wildlife from reservoirs
<ul style="list-style-type: none"> Increased development/use pressures on remaining habitat <ul style="list-style-type: none"> Disruption of dune formations from grooming and recreation Noise/lighting from nearby development and recreation Disturbance/mortality from vehicles, aircraft, dogs, people Predation pressures associated with human development 	<ul style="list-style-type: none"> Dune Disruption: Dune restoration/establishment; County/multi-jurisdictional sand management plan; beach grooming and sand moving protocols Lighting and Noise: apply restrictions on beach front properties and on temporary events Disturbance/Mortality: Education to beachgoers for sensitive grunion and plover species (signage, pamphlets, etc.) restriction of special events on certain beaches at certain times of year; Design beach infrastructure to funnel people away from sensitive areas (walkways, fencing, signage/kiosks) Predation Pressure: Provide adequate buffers around estuaries and potential migration areas from future development 			

Habitat Type	Focal Species	Identified Vulnerability	Causes	Potential Adaptation Strategies
All four evaluated	All (19)	Disruption of species pollination/breeding and dispersal mechanisms	<ul style="list-style-type: none"> Coastal storm and tidal inundation events (wind, flooding) <ul style="list-style-type: none"> Artificial breaches, freshwater releases and extractions, groundwater extraction, vector control, etc. Salinity changes in upper estuaries and coastal wetlands Flooding or destruction of breeding areas 	<ul style="list-style-type: none"> Multi-jurisdictional habitat management plans (see Degradation of Niche Habitat, above) Estuarine/Freshwater Salinity: Develop monitoring plans that track populations and changes in salinity Flooding/Inundation: Reduce wave energy on beaches (off-shore reefs, breakwaters)
All four evaluated	Western Snowy Plover California Grunion Belding's Savannah Sparrow	Reduced primary food sources (plankton, invertebrates, beach wrack, etc.)	<ul style="list-style-type: none"> Beach grooming Warming water conditions and loss of kelp forests Pollution/algae blooms caused by stormwater runoff or flooding 	<ul style="list-style-type: none"> Explore feasibility of regulatory triggers or disincentives for chemical use on properties subject to flooding or tidal inundation Setbacks from creeks/rivers for new development Adopt beach grooming and sand moving protocols
Beach / Dune / Estuarine	California Grunion Tidewater Goby	Potential increase in unsuitable spawning substrates	<ul style="list-style-type: none"> Storm flooding and tidal inundation Sand movement activities Changes in salinity during spawning events 	<ul style="list-style-type: none"> Determine factors influencing grain size and beach shape/salinity to develop strategies Beach grooming and sand moving protocols Estuarine management plan (See Degradation of Niche Habitat, above)
Dune Estuarine Freshwater	All Seven Plant Species	Loss of insect pollinators	<ul style="list-style-type: none"> Increased fragmentation of remaining habitats that may influence plant pollinators Pesticide drift from adjacent development and uses 	<ul style="list-style-type: none"> Within resource management plans account for fragmentation effects Require habitat connectivity with development proposals that includes projected SLR effects Provide education of native plants for pollinators in landscaping Adequate setbacks of habitats from agricultural fields and development
Freshwater / Upland Habitat	Monarch Overwintering Sites	Changes in microsite roost habitat	<ul style="list-style-type: none"> Tidal inundation and storm flooding <ul style="list-style-type: none"> Kill nectar plants or roost/shelter trees; create pooling water under roost trees; or increase saline conditions in nearby freshwater sources. 	<ul style="list-style-type: none"> Restore nearby/adjacent habitat to migrate roost areas from areas of potential tidal inundation. Monitor roost populations Establishment of new roost/shelter trees and restoration of roost areas
USFWS Ventura Marsh-Milk Vetch Critical Habitat	Ventura Marsh-Milk Vetch Habitat	Unknown flood effects Herbicide runoff	<ul style="list-style-type: none"> Storm flooding 	<ul style="list-style-type: none"> Monitor populations

APPENDIX B. ECONOMIC ANALYSIS of ADAPTATION STRATEGY CASE STUDIES

As part of the adaptation planning process, following a relatively comprehensive identification of potentially suitable adaptation strategies (See Chapter 3), an initial economic evaluation of four prioritized adaptation strategies was conducted to correspond with the adaptation pathway case study examples presented in Section 3.3. The intent of this analysis is to provide further information to decision makers to help identify appropriate next steps for sea level rise adaptation. While these strategies would improve County-owned facilities and public assets that are among the first coastal areas predicted to be exposed to sea level rise, all of these strategies would either also protect adjacent private lands or could also be used on private lands if they are initially successful.

In this section the following adaptation strategies and their respective cost estimates were explored:

- The construction and maintenance of low hummocky native vegetated sand dunes along Hollywood and Silverstrand beaches.
- Improvements to the stormwater system at the Silverstrand Beach neighborhood.
- Coastal armor design changes associated with replacement of existing rock revetments with a vertical seawall along the Hobson/Rincon Parkway/Faria Beach Parks.
- Sediment retention on narrow beaches along Hobson/Rincon Parkway/Faria Beach Parks with ephemeral cobble-based groins.

This economic analysis generally compares the estimated costs of employing the adaptation strategies listed above, with the estimated values of the resources that would be protected. The value of vulnerable property, residential dwellings, agriculture, coastal access (e.g. tourism), and key types of infrastructure are summarized in Section 5.2 of the Vulnerability Assessment. In both this report and the Vulnerability Assessment, cost estimates are converted into 2018-dollar values. The estimated costs for the adaptation strategies are derived from similar projects within Ventura and nearby counties.

B.1 Native Dune Construction

Sand dunes have been proven around the world to provide natural protection to coastal communities during large storm events. Dunes in Ventura County could take many forms. The native dune form is a wider low-lying dune field which has shown to reduce coastal wave flooding. Non-native vegetated dunes

can be very high and restrict views, limit stormwater conveyance, and increase the effort required to access the beach. Figure B-1 shows a native vegetation restored dune at Surfer's Point in the City of Ventura during the ~25 year wave event which occurred on December 11, 2015.



Figure B-1. Restored native vegetation dune at Surfer's Point taken during a major coastal wave flood event. Notice that in the foreground and background the dunes limit coastal wave flooding, while in the unvegetated kiteboarding landing area, waves reach all the way back to the bike path.

In concept a dune restoration and maintenance program could enhance protection of land uses and development for many decades, even in the face of sea level rise (Figure B-2).

This economic analysis examined the costs and benefits of a native vegetation dune restoration focused on two vulnerable neighborhoods – Hollywood Beach and Silverstrand. The comparisons show the potential economic impact due to a reduction in the vulnerability of residential land uses with and without coastal storm protection from dunes. While the suitability of dune restoration along the entire expanse of Hollywood and Silverstrand Beaches remains to be decided, and public outreach and support from decision-makers would be needed, there was only incremental additional effort required to include both areas in the analysis. Given the recreational popularity of Silverstrand Beach, seasonal sand berms could provide an alternative to natural dunes.

The analysis of this living shoreline dune adaptation approach utilized coastal hazard modeling data developed as part of the Coastal Resilience Ventura project (citation) and the Fair Market Value adjusted assessor parcels (used in the County's vulnerability assessment). Hazard modeling that considered a constructed and maintained dune show that with periodic maintenance the dunes could provide 100% protection from projected storm erosion and coastal flooding. Given the abundance of sediment on the Central Coast, and sediment management controls associated with navigational dredging of Channel Islands Harbor near both beaches, this adaptation approach could likely be viable to protect these neighborhoods from coastal erosion and wave flooding damages for up to 5 feet of sea level rise.

Some flooding could still occur during rain events without changes in stormwater conveyance systems which presently drain along roadways onto the beach. With dunes in place, stormwater may not be able

to gravity drain and so, it is likely that additional stormwater retrofits and increased pumping capacity may be required.

Costs

To bracket the uncertainty surrounding dune construction costs, this study obtained multiple cost estimates for both dune construction and dune maintenance. The low-end construction estimates were provided by Karina Johnston of the Bay Foundation based on the pilot dune experiment in Santa Monica. The project was initiated in December 2016 and uses natural processes and native vegetation and sand sources to allow beach wrack and natural windblown sediment processes to occur in a fenced off area³⁸. Her cost estimates assume a cost of \$300 per linear foot, assuming a 100 ft. dune width³⁹. The high-end cost estimates for dune construction (\$1,200 per linear foot) are taken from a report by Everest Consulting provided to the City of Oxnard as part of their LCP Update. These costs are also comparable to those provided by the City of Imperial Beach for a similar project (\$1,000 per linear foot).⁴⁰ The low-end construction and maintenance costs are significantly lower than those provided by Everest and Imperial Beach in part because they assume, natural wind-blown sand, volunteer labor and non-profit rates.⁴¹ The high-end maintenance costs are taken from adaptation costs provided to the City of Morro Bay, which estimate that 50% of the dunes must be reconstructed every five years.⁴² The costs per linear foot were multiplied to the 7,000 and 4,500 foot lengths that approximate the lengths of Hollywood and Silverstrand reaches, respectively.

Benefits

The analysis of benefits summarized the value of property damages that would otherwise occur without adaptation and any changes to recreational benefits from creating dunes. The key benefit of the constructed and maintained sand dune is the avoided damages from erosion and flooding during large storm wave events.

Recreational use at both Silverstrand and Hollywood beaches differ in types and amount of use. Silverstrand has much higher recreational use of both beach and surfers and thus higher benefits despite being a smaller area. As reported in the Vulnerability Assessment, Silverstrand generates \$15.5 million in direct recreation spending, and \$19.8 million in non-market benefits per year from its estimated 410,000 in annual attendance; surfing contributes almost half, \$8.8 million, of the non-market benefits.

Hollywood Beach has a smaller attendance per year (50,000 visitors) and generated \$2 million in non-market benefits (just under \$500 million for surfing) and \$1.2 million in direct spending. Hollywood Beach

³⁸Also see: <https://www.santamonica.org/explore/beaches-dunes-bluffs/beach-restoration/santa-monica-beach-restoration-pilot/>

³⁹ Personal communication with Karina Johnston 12/20/2018.

⁴⁰ Revell, D. L., King, P., Calil J., Giliam, J. (September 2016). City of Imperial Beach Sea Level Rise Assessment. Available at <https://goo.gl/xiGzTn>

⁴¹ Personal communication with Karina Johnston 12/20/2018.

⁴² See City of Morro Bay, Sea Level Rise Adaptation Strategy Report.

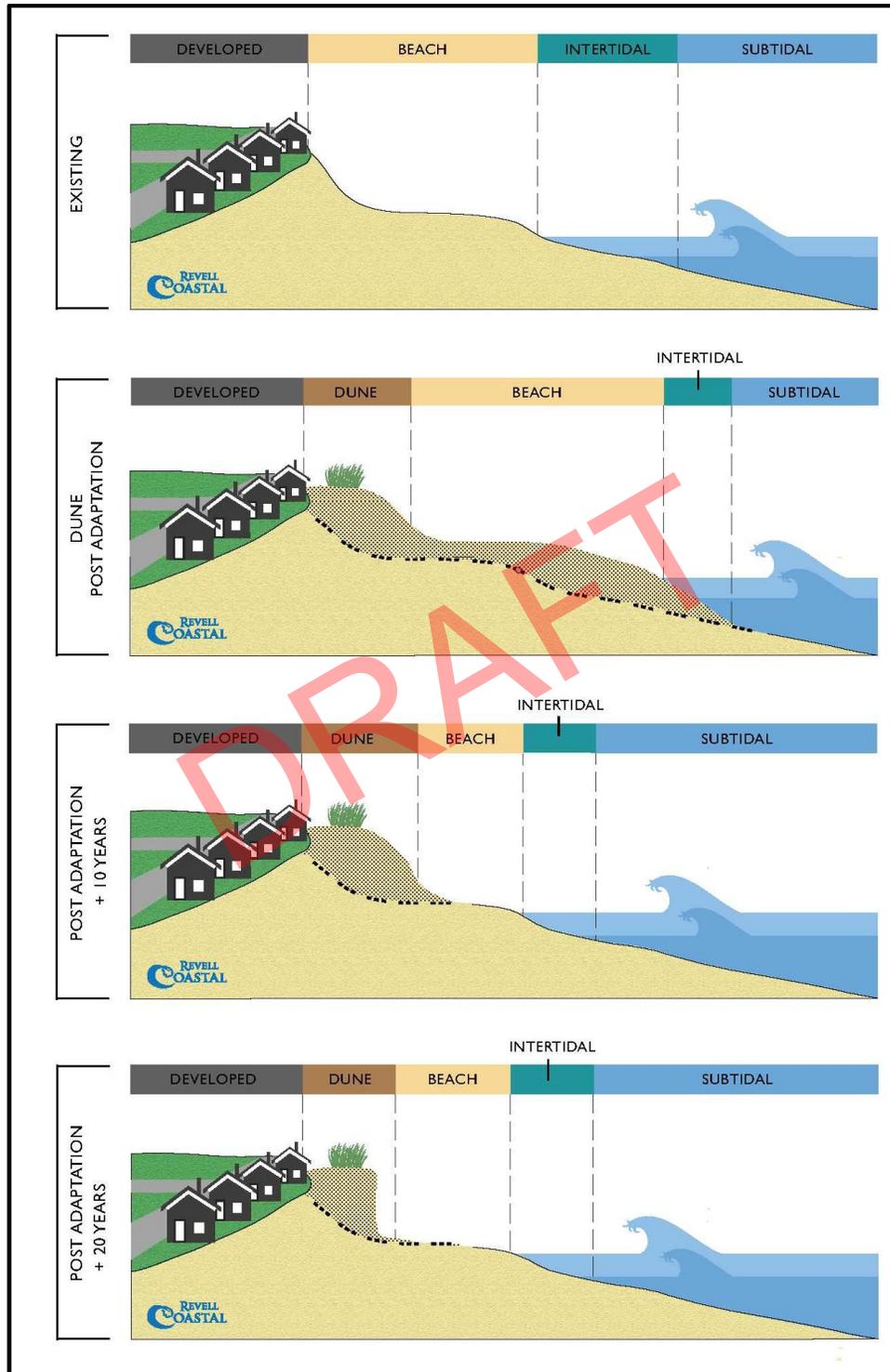
has a smaller attendance per year (50,000 visitors) and generated \$2 million in non-market benefits and \$1.2 million in direct spending.

In both areas, however, there is adequate beach width (greater than 250 ft.) to sustain current levels of beach recreation and there would not be any impact to popular surf breaks from having the dunes on the beach. The sand dunes, built along the back of the beach, would reduce the usable dry sand beach width by approximately 75 feet. However, the space available for visitors to put down their towels and recreate is more than adequate and the dunes may also give beach visitors an additional amenity of separation from the residential area behind the beach. Recreational economic models have shown that if the beach is wider than ~250 ft, there is a decline in recreational value of having an even wider beach, since people tend to avoid the long walk over the sand, especially when it is hot. Consequently, this analysis assumes that the recreational value of each of these beaches does not change significantly with dune construction.

The analysis did not include any consideration of habitat enhancement benefits such as: (1) water filtration; (2) the processing of organic matter and recycling of nutrients within the beach and nearby ecosystems; (3) invertebrate infaunal and kelp wrack community that provides food for fish and birds; (4) critical spawning habitat for the California grunion and other beach spawning species, and; (5) nesting, roosting, and foraging habitat for sea and shorebirds. The value of these benefits would likely be enhanced with dunes, provided that the source of dune sand is not contaminated before use.

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Figure B-2. Conceptual evolution of a native vegetation dune restoration. Maintenance of the dunes may be required following major coastal erosion events, as shown in the bottom panel.



Hollywood Beach

Figure B-3 and Table B-1 (below) maps the differences and provides a summary of the estimated vulnerability of Hollywood Beach parcels and structures to storm erosion and coastal flooding, comparing vulnerabilities with and without the protection of dunes to show the projected benefits of dune protection. This analysis is based on nature-based adaptation modeling that was included in the Coastal Resilience Model.

Figure B-3. Potential vulnerabilities to land use and structures between a do-nothing approach and a restore-native-dunes approach at Hollywood Beach (Source: Coastal Resilience Model).



Table B-1. Estimated Benefits from Dunes at Hollywood Beach.

Sea Level Rise	Losses w/o Dunes	Losses w/ Dunes	Total Benefits (Undiscounted)	Present Value of Benefits (@3%)
Storm Erosion				
8 Inches	\$613,000,000	\$0	\$74,000,000	\$63,000,000
16 Inches	\$705,000,000	\$0	\$272,000,000	\$155,000,000
58 Inches	\$768,000,000	\$0	\$567,000,000	\$206,000,000
Coastal Flooding				
8 Inches	\$110,000,000	\$0	\$13,000,000	\$11,000,000
16 Inches	\$126,000,000	\$0	\$49,000,000	\$28,000,000
58 Inches	\$196,000,000	\$0	\$113,000,000	\$39,000,000

As indicated in Table 1 above, sand dunes could prevent \$613 million to \$768 million (with 8 and 58 inches of sea level rise, respectively) of property losses due to storm erosion during a 1% (100-year storm) event and \$110 million to \$196 million (with 8 and 58 inches of sea level rise, respectively) in property damages and losses due to coastal wave flooding during such an event.⁴³ When one accounts for the probability of a 1% annual chance storm (i.e. 100-year storm) event over the time period, the expected benefits will be significantly lower. Table 1 provides the *expected potential* property damages and losses from a 1% annual chance storm event over the time horizon. If we assume future benefits are no less valuable than present benefit, (equivalent to a 0% discount rate) then the dunes provide an estimated savings by avoiding \$567 million losses in erosion and \$113 million in flooding damages with 58 inches of sea level rise. If, future benefits are discounted at 3%, then the benefits are significantly smaller— \$206 million and \$39 million, respectively.

Table B-2 (below) estimates the cost of constructing and maintaining the sand dunes along the 7,000 ft. Hollywood beach. While the estimates for dune construction vary considerably – between \$300 and \$1,200 per linear ft. – those of dune maintenance differ by larger amounts. The differences in maintenance costs are due to the lack of comparable successful case studies. The metrics used by the City of Morro Bay put 20-year dune maintenance at twice the cost of the construction itself. Those used by Johnston are significantly lower.⁴⁴ Given the prevailing westerly onshore wind direction and relatively stable beaches due to the sand traps and harbor jetties associated with Channel Islands Harbor, it could be anticipated that recovery of the beach and dune system could occur naturally and reduce these maintenance costs to the lower end of the estimate range.

Table B-2. Estimated Cost of Dunes at Hollywood Beach.

	Estimate (High)	Estimate (Low)	Present Value of Estimate (High)	Present Value of Estimate (Low)
Dune Construction	\$8,600,000	\$2,100,000		
20-yr Maintenance	\$17,100,000	\$42,000	\$13,600,000	\$33,000

Silverstrand Beach

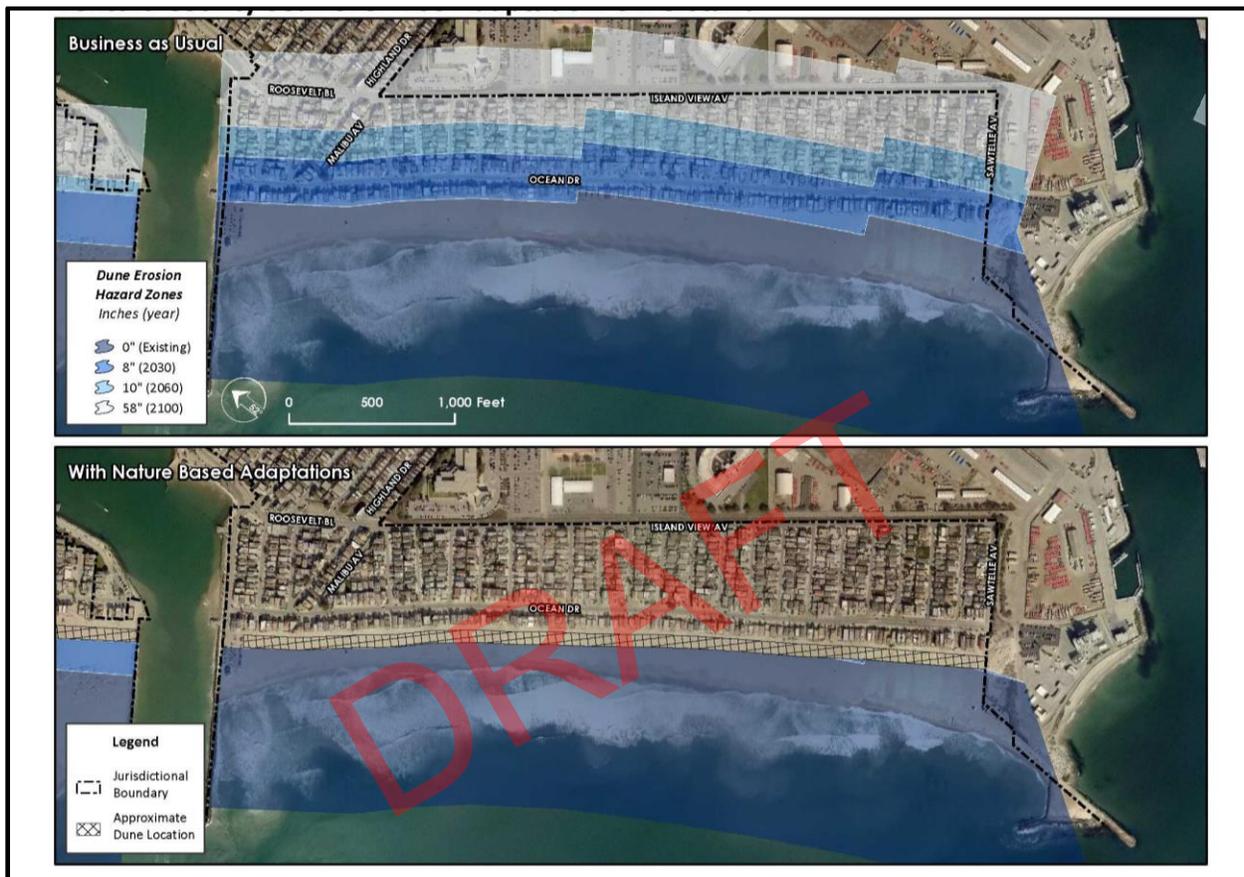
Figure B-4, Tables B-3 and B-4 provide the results of the same analysis for Silverstrand Beach. As in the case of Hollywood Beach, dune construction is assumed to protect against all storm erosion and coastal flooding in the case of a 100-year storm event. Consequently, this adaptation strategy is estimated to prevent \$368 million to \$712 million (with 8 and 58 inches of sea level rise, respectively) in property losses to storm erosion and \$41 million to \$207 million (with 8 and 58 inches of sea level rise, respectively) in

⁴³ Consistent with the method used for the Vulnerability Assessment, erosion losses are assumed to be 100% of impacted land area and structures. Flooding damages are estimated using Army Corps of Engineer depth damage curve estimates.

⁴⁴ See City of Morro Bay, Sea Level Rise Adaptation Strategy Report.

property losses and damages to coastal flooding. As with Hollywood Beach above, the expected benefits and the present value of these benefits is lower: \$436 million in erosion losses and \$70 million in coastal flooding damages, or \$144 million in erosion losses and \$18 million in coastal flooding damages if a 3% discount rate is applied.

Figure B-4. Potential vulnerabilities to land use and structures between a “wait and see” approach and a restore native dunes approach at Silverstrand Beach.



However, unlike Hollywood Beach, the Silverstrand neighborhood is much more exposed to future tidal inundation and potential groundwater daylighting than Hollywood Beach.⁴⁵ Consequently, while sand dunes significantly reduce the exposure of Silverstrand property to tidal inundation (~95%), there is likely still \$37 million in property value exposed to inundation with 58 inches in sea level rise that may have to be addressed with increased pumping capacity (see Stormwater Upgrade Section below).

⁴⁵ “Groundwater daylighting” is a term used to describe a physical process during which previously dry areas with high ground-water become wet with ponded water. During high tides and sea level rise, the high groundwater “daylights in low lying areas as seawater and groundwater percolate above the ground and appear as ponds.

Table B-3. Estimated Benefits from Dunes at Silverstrand Beach.

Sea Level Rise	Losses w/o Dunes	Losses w/ Dunes	Total Benefits	Present Value of Benefits
Storm Erosion				
8 Inches	\$368,000,000	\$0	\$44,000,000	\$38,000,000
16 Inches	\$551,000,000	\$0	\$183,000,000	\$101,000,000
58 Inches	\$712,000,000	\$0	\$436,000,000	\$144,000,000
Coastal Flooding				
8 Inches	\$41,000,000	\$0	\$5,000,000	\$4,000,000
16 Inches	\$48,000,000	\$0	\$18,000,000	\$10,000,000
58 Inches	\$207,000,000	\$0	\$70,000,000	\$18,000,000

Because the alongshore length of beach at Silverstrand is shorter than that at Hollywood, the costs of constructing and maintaining the dune are therefore reduced.

Table B-4. Estimated Cost of Dunes at Silverstrand Beach.

	Estimate (High)	Estimate (Low)	3% PDV Estimate (High)	3% PDV Estimate (Low)
Dune Construction	\$5,500,000	\$1,400,000		
20-yr Maintenance	\$11,000,000	\$27,000	\$8,700,000	\$21,000

Summary

At both Hollywood and Silverstrand beaches, the benefits of dune construction, in terms of storm damage prevention, are significantly higher than the costs, indicating that dune construction is worth serious attention as an adaptation alternative. There are likely to be several ways to implement such an adaptation strategy and there would also be a necessity to engage the communities and regulatory agencies around visual, aesthetic, access, and habitat issues that may arise in the future.

B.2 Stormwater System Improvements

A couple of challenges with dune restoration is that it may inhibit stormwater conveyance during rainfall events, and that it does not stop tidal inundation that can percolate through sandy soils in low-lying areas (groundwater daylighting) or flow from the Channel Islands Harbor and storm drain network. One solution to address these types of flooding is to install pumps to remove this water during extreme high tides and/or rainfall events. For the Silverstrand neighborhood in particular, several areas appear vulnerable in the future (Figure B-5).

Figure B-5. Potential locations of groundwater daylighting and stormwater induced flooding with 58” of sea level rise.



The Silverstrand Pump Deficiency Study provided low- and high-end cost estimates for the upgrading of all stormwater pump stations at \$900,000 and \$2,400,000, respectively (Table B-5).⁴⁶ By way of comparison, Everest estimated the cost of a similar stormwater system upgrade for Oxnard Shores to cost between \$800,000 and \$1.2 million.⁴⁷

Table 5. Estimated Costs of Upgrading Stormwater Pump Stations in Silverstrand.

	Estimate (High)	Estimate (Low)	Tidal Exposure w/o Dunes	Tidal Exposure w/ Dunes or Berms
Stormwater Upgrades	\$2,400,000	\$900,000	\$603,000,000	\$37,000,000

⁴⁶ See Silverstrand Pump Deficiency Study (2014), emailed from County December 4, 2018. Subsequent communications with the Watershed Protection District estimated the costs to be \$150,000 per pump, and there are four pumps.

⁴⁷ See Oxnard LCP Cost Estimate excel file. Sent from Rincon December 6, 2018.

Additional engineering designs would be required to upgrade the stormwater system to address sea level rise, and particularly to reduce the exposure of the stormwater outfalls to coastal erosion or wave exposure. The most effective ways to collect and convey the stormwater also need to be more thoroughly addressed, which are beyond the scope of this limited investigation; however, the projected benefits of upgrading the system to reduce tidal exposure far outweigh the projected costs.

B.3 Replacement of the Revetment with a Seawall at Hobson and Faria County Parks, and Along the Rincon Parkway

One of the impacts of a revetment is the placement loss or burial of portions of the beach under the footprint of the armoring. In narrow beach areas, this placement loss can significantly limit available recreational beach and lateral beach access. This analysis evaluated the potential benefits to recreational use by replacing the existing revetments along the Rincon Parkway, and at Hobson and Faria County Beach Parks with a vertical seawall which has a much smaller footprint (Figure B-6). Conceptually over time as sea level rises, the beach is still lost, but the additional beach for a couple decades may provide some additional recreational revenues that may offset the cost. Any adaptation strategies involving the Rincon Parkway will require coordination with Caltrans, as they own the revetments along Old Coast Highway.⁴⁸

Table B-6 (below) provides the high and low estimated costs for the construction of a 10,300 ft. seawall along Hobson/Rincon/Faria coastline. Everest Consulting estimated the cost for the construction of a seawall at \$5,300 per linear ft.⁴⁹ and the high and low-end estimates represent 120% and 80% of this figure. Caltrans similarly estimates the cost of construction to be \$5,225 per linear foot, essentially the same arrived at by Everest.⁵⁰ The cost of maintenance was taken from an estimate provided at the City of Imperial Beach which placed it at 2% of the original construction cost every 10 years.⁵¹ The Imperial Beach study also provided the high-end estimate for removing the revetment (\$1,000 per linear ft.), while the low-end estimate (\$600 per linear ft.) was taken from the Hobson/Rincon/Faria Caltrans estimates. In addition, the various structures along the Rincon Parkway are in a wide variety of conditions and it is also likely that the existing revetments will be needed to be rebuilt and or augmented over this next 20-year cycle (Figure B-7).

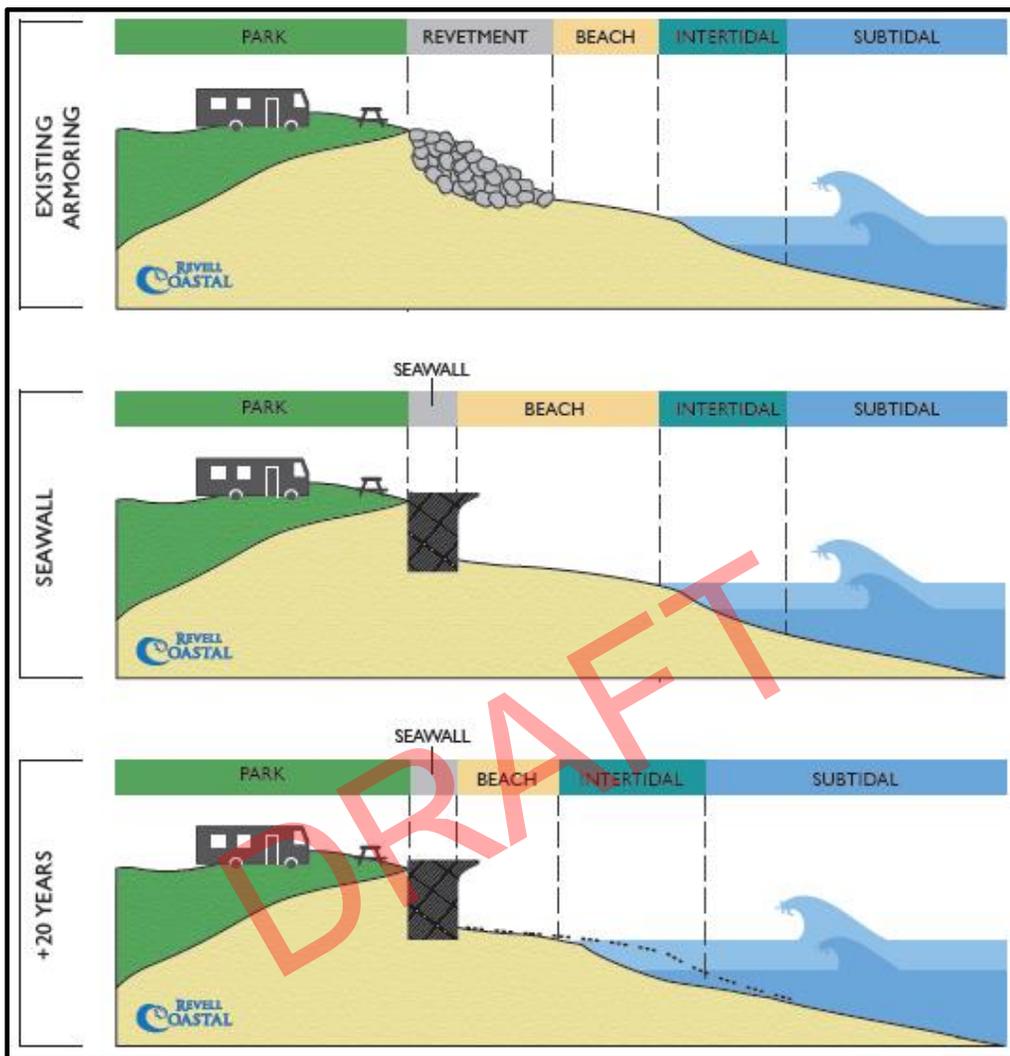
⁴⁸ The County and Caltrans have a longstanding Memorandum of Understanding that allows the County to maintain and operate public recreational uses along the Rincon Parkway.

⁴⁹ See Oxnard LCP Cost Estimate excel file. Sent from Rincon December 6, 2018.

⁵⁰ Personal communication with Melton Wilford, January 18, 2019.

⁵¹ Revell, D. L., King, P., Calil J., Giliam, J. (September 2016). City of Imperial Beach Sea Level Rise Assessment. Available at <https://goo.gl/xiGzTn>

Figure B-6. Conceptual illustration of how removal of the revetment and construction of a seawall creates more usable recreational beach and lateral access.



Using data provided by Everest and Caltrans, we were also able to estimate the potential cost of constructing revetments and maintaining them for 20 years. While Everest estimates this cost to be \$5,300 per linear ft., Caltrans provides a lower estimate at \$2,500 per linear ft., for a total of \$54.6 million

Figure B-7. Example of existing conditions of coastal armor along the Rincon Parkway.



to \$25.8 million.⁵² Caltrans also estimates 20-year maintenance costs for revetments to be between \$720 and \$480 per linear ft., for a total of \$5.9 million to \$3.9 million in present discount value over the subsequent 20-year period.

While the use of maintenance costs from Imperial Beach may not be the most applicable because there are different geomorphic settings and wave exposure (Imperial Beach has wider beaches and deeper sand on the beaches), however additional engineering analysis would be required to determine actual maintenance costs. Conceptually, following initial construction, the wider fronting beach would have lower maintenance costs as wave energy is dissipated more on the beach, but as sea level rises, and the beach narrows maintenance costs would be expected to increase.

Recreational Benefits of a Seawall Increasing Beach Width

This analysis estimated the additional recreational benefits associated with a wider beach if the revetment along this corridor were to be replaced with a seawall, which would add an estimated 20 feet of additional beach width to a very narrow beach. As indicated in Table B-6, the increase in beach width along this corridor, from a current width of approximately 20 feet, to 40 feet, will significantly enhance recreational value. To estimate the increase in recreational value, this analysis employed the CSBAT model, which DR. King developed for the Army Corps of Engineers and the State of California.⁵³ The analysis indicates that the recreational benefits over a 20-year period would be \$36.5 million; or \$27.7 applying a discount rate.

⁵² See Oxnard LCP Cost Estimate excel file. Sent from Rincon December 6, 2018, and personal communication with Melton Wilford, December 28, 2018.

⁵³ For example, see "The Economic Costs of Sea Level Rise to California Beach Communities," w. A. McGregor and J. Whittet, California Resources Agency & Dept. of Boating and Waterways.

Table B-6. Estimated Costs of Construction and Maintenance of 10,300 ft-long Seawall.

	Estimate (High)	Estimate (Low)	Present Value of Estimate (High)	Present Value of Estimate (Low)	High Metric	Low Metric
Seawall Construction	\$65,500,000	\$43,700,000			\$6,360 per ft.	\$4,240 per ft.
20-yr Seawall Maintenance	\$2,620,000	\$1,748,000	\$2,100,000	\$1,400,000	40% of construction cost	40% of construction cost
Revetment removal	\$10,300,000	\$6,180,000			\$1,000 per ft.	\$600 per ft.
Total	\$78,420,000	\$51,628,000	\$77,900,000	\$51,280,000		
Revetment Construction	\$54,600,000	\$25,800,000			\$5,300 per ft.	\$2,500 per ft.
20-yr Revetment Maintenance	\$7,400,000	\$4,900,000	\$5,900,000	\$3,900,000	\$720 per ft.	\$480 per ft.
Total	\$62,000,000	\$30,700,000	\$56,100,000	\$26,800,000		

For a 30-year period, the benefits increase to \$54.5 and \$36.6 million (Table B-7). These recreational benefits are based on an assumption that the increase in beach width remain for the stated time periods, however, in this setting, without additional sediment or sand retention, in the face of sea level rise, this beach would likely narrow.

Table B-7. Estimated Recreational Benefits of a Seawall (PV = Present Value).

Scenario	Recreational Benefit per Year	Recreation: 20-Year Benefits	Recreation: 20Yr. PV Benefits @ 3%	Recreation: 30-Year Benefits	Recreation: 30Yr. PV Benefits @ 3%
Current Conditions	\$27,250,000.00	\$2745,000,000.00	\$1,10,925,000.00	\$2717,500,000.00	\$146,366,295.78
Reduced Footprint	\$29,062,500.00	\$2781,250,000.00	\$138,656,250.00	\$271,875,000.00	\$182,957,869.72
Additional Recreational Value	\$21,812,500.00	\$2786,250,000.00	\$27,731,250.00	\$2754,375,000.00	\$36,591,573.94

Summary

Given the costs from Table 6 above, the costs of revetment removal, seawall construction and maintenance would be roughly in-line with the benefits over a 30-year period, but costs would exceed recreational benefits over a twenty-year period. If Ventura County is interested in pursuing this option, a more careful analysis that considers existing armor conditions, access, beach stability with and without sand retention, is warranted. These estimates assume that attendance will stay the same (290,000 per year). If removing the revetment significantly increased visitation, or additional camping was created, then the project might be justified, or if one could quantify other benefits (e.g., other ecological benefits). Given the lack of an engineering assessment of the existing conditions (a recommended next step), replacement cost of a new revetment should also be considered and could be between \$54.6 million and \$25.8 million although total removal of the existing revetment would not be required as the existing revetment could be repurposed. Another consideration not evaluated directly, would be the use of sand retention structures along the Rincon Parkway, such as groins or cobble groins (Figure B-8) which could

further increase the recreational beach width, potentially prolong the life of the beach and reduce the armoring maintenance costs, none of which was included in this initial analysis.

B.4 Sediment Retention through Cobble-Based Groins at Hobson and Faria County Parks, and the Rincon Parkway

Along the North Coast, sediments are moved by waves and currents in a largely unidirectional west to east transport. Erosion along PCH has increased in recent years and threatens the beaches, Hobson and Faria Parks, Old Pacific Highway and roadway, public access and ocean front residential communities as far south as the City of Ventura. There are similar vulnerabilities along the South Coast of the County. Sections 3.1 and 3.2 of this Report discuss the possibility of using non-permanent cross-shore features that function similarly to groins in trapping and retaining sand, yet do not permanently alter the coastline. Sediment management with retention structures is one of the few nature-based strategies available to mitigate erosion of critical infrastructure in high-energy coastline environments.

Potential Pilot Project

The potential pilot project would place three small cobble⁵⁴ features into a cross shore alignment at locations along the beach to increase sand retention (Figure 8). These cross-shore features are based on existing sediment sizes on the North Coast and standard coastal engineering principles associated with groins which trap sand upcoast but would not be designed as permanent structures.

Figure B-8. Map view of cross-shore cobble groins with retained sand on the Rincon Parkway and at Faria County Beach Park (not to scale).



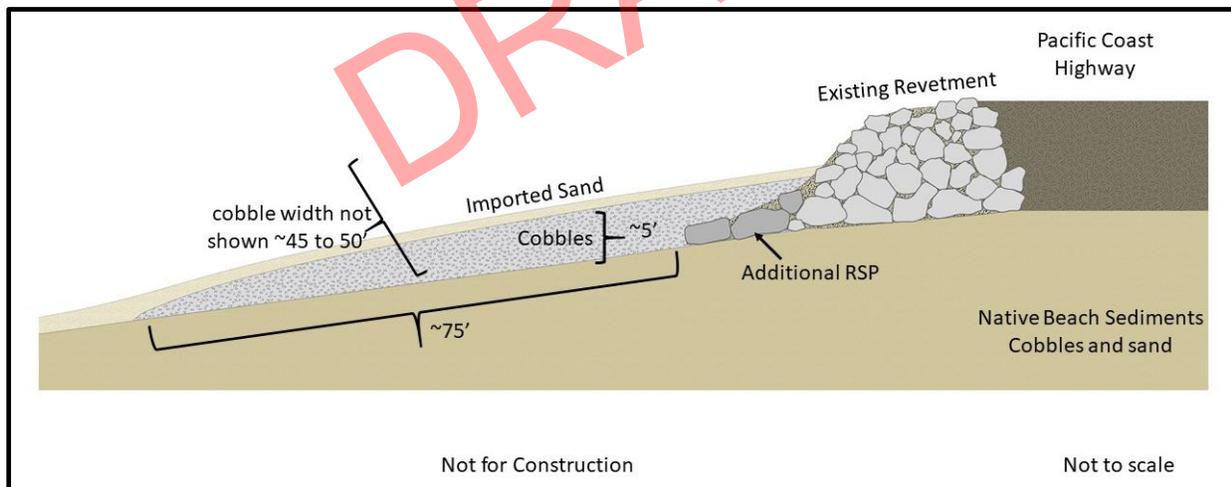
⁵⁴ Cobbles are small rounded rocks sized between a baseball to watermelon.

They would be designed to naturally settle into the surrounding environment and avoid costly removal or maintenance activities. They could be covered in sand during the gentle wave months in the summer and fall to encourage recreational use (see Figure 9). More project specific geomorphic considerations, sediment analysis and coordination are necessary and would be included in subsequent, more detailed proposals.

Funding sources need to be identified. It is estimated that about 700 cubic yards would be needed for each cobble-based groin using the conceptual design dimensions shown in Figure B-9 below. Based on other adaptation projects estimates for groins⁵⁵ (~\$4000/ linear ft.), and Surfers' Point cobbles (~\$3000/ linear ft.) the estimated costs of each of these cobble groins could be between \$225,000 to \$300,000. Differences between these estimates likely relate to the transportation and engineering costs. Additional work to develop a design-level cost estimate would be necessary.

Presently, no funding is available from the Ventura County Watershed Protection District who maintains the County's flood control channels, but it is possible that the sediment can be provided at little to no cost. Plans and specifications for 200,00 cubic yards of sediment removal from a watershed near Camarillo were drafted in 2017, and the cost to remove the sediment from a Ventura County Watershed Protection District in-stream debris basin was estimated to be \$2.2 million. This did not include transportation costs.

Figure B-9. Cobble-based groin concept in cross section (not to scale or for construction).



The project as described is expected to increase the residence time of any sand placed along the beach and may provide about a five or more-year benefit to the Rincon Parkway and Faria Beach Park, and a

⁵⁵ Revell, D. L., King, P., Calil J., Giliam, J. (September 2016). City of Imperial Beach Sea Level Rise Assessment. Available at <https://goo.gl/xiGzTn>

much longer benefit by feeding downcoast beaches. Over time it should be assumed that the cobble cross shore retention features would evolve, and the cobbles become part of a shore parallel cobble beach berm similar to the cobble beach that is currently visible and occurs naturally at along the Faria Beach area and in downcoast locations.

While groins in the coastal engineering literature have often caused downcoast erosion, the use of smaller, more mobile cobbles of a lower height would avoid these potential downcoast impacts as they are reworked by waves over time and incorporated into the rock revetments already present at the site. The addition of a large volume of sand would also reduce or eliminate the potential for downcoast erosion impacts.

A complete failure of this project would result in the cobble berm rapidly migrating onto the beach and down coast, and the retention function of the deposited nourishment would likely not last the anticipated five years. The sediment would continue to provide incremental benefits down coast. With much of the site backed by shoreline armoring, no additional erosion impacts would be anticipated.

Project Benefits

The biggest benefits would be to augment beach compatible sediments in Northern Ventura County and the following:

- Reduce maintenance costs associated with the Old Coast Highway revetments that protect the scenic highway.
- Improve camping and beach recreation at County Parks and along the Rincon Parkway. Over time, downcoast beaches such as Solimar Beach and Mondos Cove would also benefit.
- Reduce greenhouse gas emissions by sourcing shoreline protection materials locally and within the same “sandshed”.
- Improve community flood safety by removing sediment from debris basins.
- Test a new coastal management technique to inform longer term future adaptation planning.

B.5 Limitations of the Study

This analysis was conducted on a very limited budget with limited data and a limited amount of time. All estimates are tentative. In particular, the vulnerability estimates assume that vulnerable property is perfectly protected from all other hazards. As an example, the same building cannot be both completely lost due to erosion and damaged by coastal flooding. For this reason, there is some double counting between the two figures that only becomes problematic when the estimated losses due to flooding and erosion are aggregated together.

Other limitations involve the idealized assumptions regarding damages and losses. In the case of tidal inundation there are currently no accepted methods or estimates for the points at which tidal nuisances tagged. Such begin to have economic impacts or when such impacts present a danger to inhabitants and must be red-methods and their application must await future research. Finally, estimates regarding the cost of maintenance are necessarily speculative, and do not take the increasing cost of sand, for example, into consideration. As such, analyses such as these should be revisited and updated on a regular basis.

B.6 Conclusion

Restoration of a native dune fronting both Hollywood and Silverstrand make sense economically in terms of reducing existing and future vulnerabilities with little impact expected to recreational uses. Additional considerations of reducing private flood insurance rates, reduced beach grooming costs, private and public aesthetics and potential habitat considerations warrant additional consideration for dune management.

Along the Rincon Parkway the revetment replacement with a seawall shows some recreational benefits but overall only makes marginal economic sense without additional adaptation measures to increase camping or parking revenues, retain sediment or place additional sediment opportunistically to help to maintain the sandy beach into the future.

Cobble-based groins present a nature-based pilot project strategy that could help to retain sediment on narrow beaches. However, such a project is relatively untested, as only cobble-based dunes and cobble berms have been successfully used.

Additional engineering analysis on the existing condition of the structures across the County, but particularly along the Rincon Parkway is recommended.

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