

Shoreline Adaptation and the Public Trust

Protecting California's Public Trust
Resources from Sea Level Rise



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Executive Summary

The coastal shorelines managed by the State Lands Commission (Commission) are impacted by climate change, upland development, and natural fluctuations in coastal processes. This report is intended to help the Commission update its leasing practices related to shoreline protection structures and management of coastal state lands and Public Trust resources. This update reflects the scientific and policy developments that have occurred since the Commission last provided a report on shoreline protection in 2001. The report describes in detail how a significant driver of change, sea level rise, is affecting shorelines and Public Trust resources, especially in areas where other factors, such as development and erosion, constrain the options for shoreline protection and adaptation. Multiple shoreline protection strategies are presented that the Commission and its lessees can consider to implement adaptive solutions that reduce impacts to Public Trust resources and protect shoreline assets.

As climate change impacts have become more severe and widespread, adaptation to the present and future environmental conditions is critical. In addition to raising sea levels, climate change increases wave energy, the frequency and severity of storms, rates of daily and episodic flooding, and rates of erosion. The types of Public Trust resources impacted by these phenomena are natural resources like coastal ecosystems, habitats, and species, and all of the Public Trust-consistent uses they support (such as recreation, fishing, public access, navigation, and commerce) as well as built resources like critical infrastructure (transportation routes, energy facilities, public utilities, etc.). The traditional strategies for protecting coastal structures and shorelines from erosion and flooding are to erect barriers parallel or perpendicular to the shore made from concrete, steel, and large boulders, among other conventional materials. Yet these strategies must be reconsidered now that change is occurring faster and faster. Many current protection structures under lease with the Commission were installed decades ago and have required increasing modifications and repairs over the years as they degrade with age. Extensive research has shown that these structures are exacerbating the conditions they are intended to address, such as erosion, and have caused significant damage to Public Trust resources by increasing erosion and beach loss, decreasing space for habitat, and preventing the migration of tidelands upland so that they can persist as the sea level rises.

There is growing recognition that nature can be the most durable and long-lasting defense to minimize risks for communities and build resiliency to ongoing environmental stressors along coastal shorelines. Nature-based solutions and strategies (sometimes referred to as 'green' or 'natural' infrastructure) use existing natural landscape features, or engineered structures of natural materials

that mimic naturally formed landscapes and functions to minimize the risks of floods, erosion, and runoff (NOAA, 2023). Nature-based strategies can be particularly effective at protecting and stabilizing shorelines because they use materials like rocks, sediment, and vegetation that are self-sustaining. Through its leasing authority and management of the state's Public Trust lands, the Commission has the responsibility to ensure that the shoreline adaptation structures, including newly proposed and existing structures, on state lands are in the best interest of the state. As sea level rise alters California's coastline and increasingly threatens Public Trust resources, the Commission must also continue to adapt its processes and procedures for managing its lands.

This report recommends multiple types of actions for the Commission and staff to take to shift shoreline protection strategies from the current conventional structures like seawalls to nature-based and hybrid solutions where appropriate and feasible. The first set of recommendations aims to increase awareness of where sea level rise is most likely to adversely affect state lands and Public Trust resources, and where different strategies for shoreline protection may be most effective. The next set of recommendations will improve coordination and collaboration with other coastal resource managers including agencies and local governments. The last set of recommendations is focused on changes that can be incorporated into the lease application review and development process. These changes include gathering more information on Public Trust impacts from hard armoring (conventional protection like seawalls), accounting for them, and minimizing them through lease terms and other methods. They also include steps that can be considered for incentivizing or encouraging the use of alternative protection strategies. None of these recommendations have been mandated, and some may require additional resources or authority to carry out. The Commission remains committed to evaluating each lease application and proposed action on state lands on a case-by-case basis. The main objective of the recommendations is to give staff and the Commission options for adapting shorelines to the realities of climate change and setting the course for a more resilient coastal future that protects state lands and Public Trust resources.

The entire state of California, including state and local agencies, is mobilizing to protect the state's unique biodiversity, communities, and economy from the devastating impacts of sea level rise. With direction from multiple executive orders and legislation, the Commission and other coastal management agencies are coordinating to accelerate the implementation of adaptation strategies, particularly nature-based solutions, and ensure alignment between each agency's policies. This report and its recommendations outline the steps

the Commission must take to contribute to the urgent, statewide effort to protect California from rising sea levels.

1.0 Introduction

The Commission manages over 1,100 miles of coastal shoreline in California and many thousands of miles of riverbanks and lake shores. Along the shoreline, there are hundreds of artificial structures, sometimes called hard armoring, designed to create a stable barrier between the water's edge and development that sits just landward of it. Many of these shoreline structures are wholly or partially leased by the Commission, and their function is often connected to Public Trust uses and resources, such as providing public access, protecting critical infrastructure, and underpinning structures like docks and harbors that facilitate recreation and fishing. Other structures protect upland property and development for private uses, such as residences. Management of these structures may be shared by the respective property owners, including the Commission.

Shorelines are the intersection between publicly owned tide or submerged lands and private upland property held by a local government or individual owners. Though multiple government entities may share management and regulation of shoreline protective structures, the Commission acts on behalf of the state as the landowner of tide and submerged lands, holding those lands in trust for the public. These lands are imperiled, facing a barrage of impacts from climate change, including sea level rise, rapid erosion, and increased flooding. Artificial shoreline protection structures can exacerbate those impacts and contribute to the permanent loss of the Public Trust uses, values, and resources they support.

The state has adopted principles, policies, and guidance to inform the use of nature-based strategies for shoreline protection, where feasible, in lieu of artificial shoreline protection structures, particularly those constructed from conventional materials like concrete, boulders (rip rap), and steel, that can have adverse effects on the shoreline and surrounding lands. Through the Ocean Protection Council (OPC), the state adopted a common set of principles for aligned state action on sea level rise, [Making California's Coast Resilient to Sea Level Rise: Principles for Aligned State Action](#). Principle 6 states the use of nature-based adaptation measures should be prioritized where appropriate to increase coastal resiliency (OPC, 2020). The California Coastal Commission (CCC) adopted their [Public Trust Guiding Principles and Action Plan](#) at their May 2023 meeting, which includes principles and proposed actions to protect Public Trust resources from sea level rise by considering the adverse impacts caused by traditional shoreline protection structures and encouraging the use of nature-based strategies. The State Coastal Conservancy (SCC), building on a long

history of supporting nature-based climate adaptation projects, has pledged to continue to do so through its [2023-2027 Strategic Plan](#), committing to fund 50 plans for sea level rise adaptation projects, and 30 implemented projects. In addition, the SCC commits to supporting 20 multi-benefit, nature-based adaptation project plans and the implementation of 15 projects. In 2019, the San Francisco Bay Conservation and Development Commission (BCDC) adopted amendments to the [San Francisco Bay Plan](#), requiring all shoreline protection projects to evaluate the use of natural and nature-based features and incorporate those features to the greatest extent possible. The [California Climate Adaptation Strategy](#) includes “accelerate nature-based climate solutions and strengthen climate resilience of natural systems” as one of its six key priorities.

Nature-based solutions are a high priority for state funding because they are a cost-effective strategy for protecting the shoreline and deliver multiple benefits to communities, such as preserving biodiversity and sequestering carbon. Compared to traditional shoreline protective structures, nature-based solutions typically have lower installation and maintenance costs, yet they can produce higher economic benefits by minimizing damages, enhancing recreational opportunities, and improving coastal ecosystems (Leo, et al., 2017). Investing in nature-based solutions is advantageous not only for the state but also for coastal communities and upland property owners. Recently, the state has made large investments in nature-based strategies for adaptation to climate change and resiliency. The Fiscal Year (FY) 2023-24 budget allocates \$1.4 billion for nature-based solutions over multiple years, nearly three percent of the total climate investments (\$52.3 billion over the next six years) (DOF, 2023). Across the 2022-23 state budget and the 2023-24 budget, \$420 million is allocated to the SCC to distribute as grants to local and regional jurisdictions for nature-based adaptation to sea level rise (LAO, 2023). In addition, SCC received \$50 million in the 2022-23 budget for coastal land acquisition, a key investment to facilitate coastal wetland and dune restoration and preservation which are important to coastal adaptation and resiliency (LAO, 2023). SCC also received \$135 million over the past two years to adapt infrastructure to sea level rise, while OPC will receive a total of \$103 from 2022 through 2025 to implement SB 1 (Atkins, 2022) and fund updated local and regional land use plans that incorporate sea level rise and related investments to implement those plans (LAO, 2023). These investments will be critical for piloting new nature-based strategies for coastal resiliency to climate change and scaling up solutions for regional adaptation.

Until recently, there has been some reluctance to pursue nature-based strategies for shoreline protection because information about their costs, effectiveness, and building techniques are not as familiar to many consultants

and contractors as conventional shoreline protection structures. Now, however, guidance for the use of nature-based shoreline protection and adaptation strategies has been developed by federal and state agencies so that these solutions can be more readily implemented and evaluated. The federal government provides guidance for these strategies through several sources, primarily the Federal Emergency Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), and the White House's National Climate Task Force¹. The state's [Fourth Climate Change Assessment](#) (a multi-agency effort coordinated by the Office of Planning and Research) provided a technical report, "[Toward Natural Shoreline Infrastructure to Manage Coastal Change in California](#)," written specifically for planners to fill in information gaps related to design standards and thresholds, as well as siting criteria. Through these many policy, guidance, and funding efforts, the state has clearly signaled that conventional shoreline protection structures should no longer be considered the default strategy to manage stability along the water's edge, should only be used where absolutely necessary, and, in many cases, should be viewed only as a short- to mid-term approach while long-term plans are developed and implemented for coastal resiliency.

As the primary Public Trust land manager of state sovereign lands, the Commission seeks alignment with other agencies, local governments, and state decision-makers to encourage the use of nature-based strategies and create shorelines that are resilient and adaptive to the impacts of the climate crisis. This report advances the commitments set forth in the [Commission's 2021-2025 Strategic Plan](#), which call for the Commission to lead climate activism by proactively addressing climate change and its impacts and enhancing climate-

¹ In 2021, FEMA released [Building Community Resilience With Nature-Based Solutions: A Guide for Local Communities](#). This guide covers the range of nature-based solutions available for climate adaptation, the economic justification for their use, guidance for getting through planning and policy-making, implementation steps, and funding opportunities. NOAA offers a suite of guidance, tools, and resources for planning and implementing nature-based coastal resiliency projects: <https://coast.noaa.gov/digitalcoast/topics/green-infrastructure.html>. NOAA also provides policy guidance through the [National Habitat Policy](#). The Biden-Harris White House issued a report in 2022 through its National Climate Task Force on [Opportunities to Accelerate Nature-Based Solutions](#) that makes recommendations for the federal government to update policies, unlock funding, and train workforces, among other priority actions, to increase the use of nature-based solutions for equitably adapting to climate change impacts.

resilient green (or ‘nature-based’) infrastructure. This report describes the impacts of shoreline protection structures on Public Trust lands, resources, uses, and values, and makes recommendations for staff to consider when processing applications for leases for these structures so that the Commission does its part to minimize adverse impacts and incentivize solutions that not only protect, but enhance, the Public Trust lands under its jurisdiction.

2.0 State Lands Commission and Shoreline Adaptation

2.1 Background

The Commission manages the state’s sovereign land: tidelands, submerged lands, and the beds of natural navigable rivers and lakes, which the state acquired upon its admission to the Union. The Commission does not regulate private property; the Commission decides how ungranted sovereign land should be used. The Commission has exclusive authority to lease ungranted sovereign land and, in its discretion, may approve, deny, or condition those leases.²

The Legislature has also granted management of some sovereign land to cities, counties, or ports and harbor districts. In these cases, the grantee is responsible for managing the granted sovereign land in accordance with the terms of its legislative grant and the Public Trust Doctrine.³ The Commission monitors the grantees compliance with the grant terms and Public Trust Doctrine but, with limited exception, does not have direct authority over the grantee’s land use decisions.

2.2 Boundary

On the coast, sovereign tidelands and submerged lands are those properties waterward of the Ordinary High-Water Mark, which is generally measured by the Mean High Tide Line (MHTL)⁴ where the shoreline is in a natural state. The MHTL is measured using an average high tide elevation over 18.6 Years.⁵ Above or landward the MHTL is ‘upland’, which is not sovereign land and may be privately owned. The MHTL is ambulatory; the location of the elevation moves as sand

² Pub. Resources Code, § 6301.

³ Pub. Resources Code, §§ 6009, 6009.1.

⁴ Civil Code, § 670.

⁵ *Borax Consolidated v. City of Los Angeles* (1935) 296 U.S. 10, 27, *Lechuza Villas West v. California Coastal Com’n* (1997) 60 Cal.App.4th 218, 235, as modified on denial of reh’g (Jan. 14, 1998).

deposition changes.⁶ Therefore, the boundary between the state's sovereign lands and the upland moves as well.⁷ A MHTL survey is evidence of a boundary's location at the time of the survey but does not fix the location of the boundary.

In some instances, the boundary between sovereign lands and uplands can be fixed by an agreement between the state and the upland landowner, or by a court order. When submerged land is filled or when artificial influences – like seawalls, jetties, groins, or shoreline protective structures – cause the gradual buildup of the upland, the boundary between sovereign land and the upland is the last natural location of the MHTL, rather than the MHTL's current location.⁸

2.3 Commission Leasing

The Commission has discretion to approve or deny lease applications, including the discretion to require lease conditions and compensation for the use of state land.⁹ The Commission is authorized to allow shoreline protective structures, as long as they do not unreasonably interfere with Public Trust purposes and uses, and to collect compensation or rent for those structures.¹⁰ The Commission's statutory and regulatory authority give it broad discretion in all aspects of leasing, but require that the Commission always evaluate any proposal through the lens that it is in the best interests of the state.¹¹

The Commission is required to set rent or other compensation for its leases.¹² The Commission's regulations authorize several methods of calculating rent, which can also be combined.¹³ The Commission has commonly used nine percent of the appraised value of the leased land, or a regional benchmark rate to set rent for shoreline protective structures.¹⁴ The Commission's regulations also allow rent or other compensation to be based on commonly-accepted appraisal practices and principles.¹⁵ When choosing how to calculate rent, the

⁶ *Lechuza Villas West v. California Coastal Com'n* (1997) 60 Cal.App.4th 218, 235, as modified on denial of reh'g (Jan. 14, 1998).

⁷ *Ibid.*

⁸ See *State of Cal. ex rel. State Lands Com. v. Superior Court* (1995) 11 Cal.4th 50, 66 [collecting cases].

⁹ Public Resources Code, § 6301.

¹⁰ Public Resources Code, §§ 6321, 6321.2.

¹¹ Public Resources Code, § 6005; see also, Cal. Code Regs., tit. 2, § 2000, subd. (b).

¹² Pub. Resources Code, § 6503.

¹³ Cal. Code Regs., tit. 2, § 2003, subd. (a).

¹⁴ Cal. Code Regs., tit. 2, § 2003, subd. (a)(1).

¹⁵ Cal. Code Regs., tit. 2, § 2003, subd. (a)(9).

Commission may consider the amount of rent the state would receive, the reliability and appropriateness of the method, and the monetary value of actual or potential environmental damage anticipated from an applicant's proposed use to the extent such damage is quantifiable.¹⁶ The Commission may also discount or waive rent if it determines that the lease provides a significant regional or statewide public benefit.¹⁷

2.4 Public Trust Doctrine

The Commission must ensure that its actions are consistent with the Public Trust Doctrine when managing sovereign land. The Public Trust Doctrine obligates the state to manage sovereign land for water-dependent uses for the benefit of the statewide public.¹⁸ These Public Trust uses are generally defined as navigation, maritime commerce, fishing, recreation, and environmental preservation, but Public Trust uses can change to reflect current public needs and values.¹⁹ The Legislature is the ultimate trustee of sovereign lands and may confirm or modify Public Trust uses.²⁰ For example, Public Resources Code section 6321 allows the Commission to authorize shoreline protective structures on sovereign land.

The Commission has the authority to choose between competing Public Trust uses.²¹ For example, shipping terminals in a port may impede public recreation, but they support the statewide public's interest in industrial harbors that support the maritime commerce, navigation and trade and regional, state, and national economies. Additionally, a private dock attached to a residence can be consistent with the Public Trust use of waterborne navigation and recreation, even if the dock itself creates minor impacts to public navigation. For shoreline protective structures, the Commission will often be asked to choose between potential benefits of the protective structure and potential detriments to public recreation, environmental preservation, or other Public Trust uses.

The Public Trust Doctrine requires the state to continually supervise uses of sovereign lands.²² The state cannot sell sovereign land, commit it to a particular use in perpetuity, or otherwise permanently bind the hands of future state

¹⁶ Cal. Code Regs., tit. 2, § 2003, subd. (d).

¹⁷ Cal. Code Regs., tit. 2, § 2003, subd. (e)(4).

¹⁸ *Illinois Cent. R. Co. v. State of Illinois* (1892) 146 U.S. 387, 452.

¹⁹ *Marks v. Whitney* (1971) 6 Cal.3d 251, 259-260.

²⁰ *Marks v. Whitney* (1971) 6 Cal.3d 251, 260-261.

²¹ *Citizens for East Shore Parks v. State Lands Com.* (2011) 202 Cal.App.4th 549, 577, as modified on denial of reh'g (Jan. 27, 2012).

²² *National Audubon Society v. Superior Court* (1983) 33 Cal.3d 419, 445.

legislators or Commissioners.²³ Therefore, when the Commission authorizes a lease of sovereign land, the lessee does not have a right to use the sovereign land beyond the term of the lease. Adjacent upland owners also have no right to continued uses on state land. Even when a proposed lease is for an existing shoreline protective structure, the Commission must consider current public needs and values when determining whether that structure may continue to occupy state land. The Commission is not constrained by previous authorizations and lease agreements and may condition or deny uses at its discretion upon lease expiration or if lease terms and conditions have been violated.

2.5 Environmental Justice

Climate change impacts, including rising sea levels, disproportionately affect low-income communities and communities of color. In addition to limiting opportunities for public access to the coast and increased likelihood of flooding, sea level rise may also have adverse impacts on the health of low-income communities and communities of color through the release of hazardous contaminants from nearby industrial development during high tide events or frequent inundation. According to UC Berkeley's Toxic Tides project, disadvantaged communities are over five times more likely to live within 1 kilometer of a hazardous facility that is at-risk of flooding due to sea level rise (Cushing, et al., 2023). As a result, environmental justice and equity are critical considerations for shoreline adaptation planning and implementation at the Commission.

The advancement of climate equity is a major goal articulated within the Commission's [Environmental Justice Policy](#). The Commission's policy prioritizes social equity and disadvantaged communities in sea level rise planning and adaptation strategies, as well as the protection of coastal habitat and preservation of equitable public access while balancing other Public Trust uses and existing water-dependent infrastructure along the coast. The Commission's 2021-2025 Strategic Plan emphasizes inclusive decision-making that addresses the disproportionate burdens of past decisions and practices on disadvantaged communities. These considerations inform the recommendations in this report and will continue to be incorporated into future actions and decisions.

Additionally, the Commission's approach to addressing environmental justice in coastal management aligns with other coastal agency policies, as well as broader state policy. The California Coastal Commission's [Environmental Justice Policy](#), adopted in 2019, provides guidance for how it will consider environmental justice in coastal development permits. In 2019, the San Francisco

²³ *City of Berkeley v. Superior Court* (1980) 26 Cal.3d 515, 523.

Bay Conservation and Development Commission voted to adopt the [Environmental Justice and Social Equity Bay Plan Amendment](#), amending the San Francisco Bay Plan to address environmental justice and social equity in its permitting processes. On a broader state level, Governor Newsom's [Californians for All](#) policy initiative emphasizes support for vulnerable communities affected by rising sea levels, as well as other dangerous impacts of the climate crisis, such as extreme heat and drought. The [State of California's Sea Level Rise Guidance](#), last updated in 2018, recommends adaptation planning and strategies prioritize social equity, environmental justice, and the needs of vulnerable communities.

2.6 Tribal Engagement

The Commission recognizes that California Native Tribes have used many of the state's lands, waterways, and resources, which may be affected by actions taken by the Commission, to support their cultures and ways of life for millennia. Tribes and their members have unique and valuable knowledge and practices for conserving and using these resources sustainably. The Commission is committed to collaboration with Tribes, tribal-affiliated organizations, and communities to incorporate tribal expertise into coastal resiliency and adaptation, while also protecting resources and artifacts that become exposed due to coastal erosion or submerged because of sea level rise. As part of the Commission's Tribal Consultation policy, the Commission commits to early, frequent, and meaningful consultation in its planning and project activities to ensure sustainable public land management, balanced resource protection, respect for and recognition of the sovereign rights, power, and authority of Tribal governments.

The Commission's commitments to tribal engagement also align with recent state policies and priorities. Governor Newsom's [Executive Order N-82-20](#) (Nature-Based Solutions Executive Order), the Pathways to 30x30, and Natural and Working Lands Climate Smart Strategy all emphasize a commitment to work towards meaningful partnerships with California Native American tribes in implementing nature-based solutions. Part of this commitment includes the recently established CNRA Tribal Nature-Based Solutions Program which seeks to provide grant funds to assist tribes in advancing nature-based solutions for their communities.

3.0 Sea Level Rise: Impacts on the Environment and Coastal Communities

The climate crisis and sea level rise are impacting California. Flooding and erosion are transforming the coastline and affecting coastal communities. Flooding in Humboldt Bay, bluff erosion in Pacifica, and beach loss in Southern

California are examples that highlight the threat sea level rise poses to the safety, infrastructure, economy, and natural and cultural resources of California's coastal communities.

3.1 Sea Level Rise Projections

Sea levels in most of California rose four to eight inches during the 20th century, and sea level rise will accelerate throughout the 21st century.²⁴ By 2050, there is growing confidence that sea levels will be approximately ten inches higher than in 2000. Multiple lines of evidence, including model projections and trends in historical tide-gauge observations and satellite altimeter measurements, are in agreement and provide increasing certainty in the projected sea level rise by 2050 (Sweet, et al., 2022)

Beyond 2050, the severity of sea level rise depends on the future trajectory of global greenhouse gas emissions. By 2100, San Francisco could see anywhere from 1.6 to 6.5 feet of sea level rise (for Los Angeles, the potential range of sea level rise is similar, 1.3 to 6.3 feet). However, a failure to reduce global emissions could lead to catastrophic ice sheet melt and even higher extreme sea level rise (Sweet, et al., 2022).

The magnitude of sea level rise varies from location to location across the state depending on local differences in land elevation and vertical land motion.²⁵ The [State of California Sea-Level Rise Guidance: 2018 Update](#) contains a set of projections for 13 tide gauges throughout California. OPC updates the guidance every five years, with an updated guidance anticipated to be

²⁴ The Center for Operational Oceanographic Products and Services has been measuring sea level for over 150 years, with tide stations of the [National Water Level Observation Network](#) operating on all U.S. coasts. During the last 30 years, [NASA has observed](#) that the rate has accelerated from an average of 0.1 inches per year to 0.13 inches per year. The rate is expected to accelerate faster each decade.

²⁵ There are many factors that can affect local land elevation relative to sea level, such as plate tectonics, sediment compaction, groundwater and hydrocarbon extraction, and land deformation from historic events of ice and ocean mass redistribution (for example, some land masses are still rebounding from the last ice age when they were depressed under heavy ice). In California, there is a major tectonic boundary at Cape Mendocino that uplifts the land from Cape Mendocino north all the way to Vancouver, British Columbia. Comparatively, the land below Cape Mendocino is generally subsiding, resulting in higher sea level relative to the land mass (Griggs, Arvaj, & Cayan, [Rising Seas In California: An Update On Sea-Level Rise Sciences](#), 2017).

published in early 2024. The guidance also includes a step-by-step approach to help decision-makers determine the most appropriate projections they should use when planning or reviewing a project. Decision-makers must also consider additional factors that influence the necessary levels of preparedness, including a project's lifespan, ability to adapt ('adaptive capacity'), and the consequences of potential impacts if sea level rise is underestimated.

3.2 Sea Level Rise Impacts

As sea level rise accelerates, its impacts are becoming more profound and widespread. Higher sea levels threaten coastal areas by exacerbating coastal hazards²⁶, including accelerated rates of erosion, more frequent and intense coastal flooding, saltwater intrusion into coastal watersheds and habitats, and inland flooding from emergent groundwater. The hazards themselves are not new, but sea level rise is worsening the severity and frequency of their impacts. Sea level rise is also increasingly impacting coastal and inland areas that were previously not at-risk but now must prepare and adapt to rising seas.

3.2.1 Coastal Erosion

Coastal erosion is one of the earliest and most common impacts of sea level rise that California has experienced, because significant erosion can occur with even small increases in sea levels. Under normal circumstances, coastal erosion occurs naturally, but the sediment that is lost is often replaced by sediment from other locations. However, sea level rise and coastal development exacerbate the loss of sediment and limit its natural replacement, causing a net loss of sediment and land.

As sea levels rise and shorelines recede inland, more of the natural and human-built environment becomes exposed to erosion, wave energy, flooding, and corrosion. This damage and erosion can occur repetitively over years, or in extreme cases, over the course of a few large winter storms. Over time, this can threaten coastal communities and infrastructure that are currently located inland or at high elevations and assumed to be out of harm's way. For example, in 2017, bluff erosion caused parts of the Esplanade apartment building in Pacifica to collapse into the ocean despite its location on a 100-foot-tall bluff that was 40 feet from the bluff's edge just seven years prior (CCC, 2012).

Low-lying coastal areas can experience the most significant inland migration of the shoreline due to sea level rise and erosion. Typical California beaches have

²⁶ Coastal hazards are any phenomena that threaten coastal structures, property, and the environment under extreme weather and water conditions (FEMA, 2018).

a slope between two percent to six percent. On a beach with a two percent slope, one foot of sea level rise would result in 50 feet of inland migration. When erosion occurs, the inland migration can be significantly further (Anderson, Patsch, Lester, & Griggs, 2020). According to [modeling performed by the United States Geological Survey \(USGS\)](#), sea level rise could cause the complete erosion of 31 to 67 percent of Southern California beaches by 2100 without large-scale interventions (Vitousek, Barnard, Limber, Erikson, & Cole, 2017). Beachfront properties and infrastructure will lose the shoreline protection that the beaches and dunes previously provided, and will become the next target of erosion, flooding, destructive wave energy, and corrosion.

3.2.2 Coastal Flooding

Flooding of coastal areas is commonly driven by short-term events, such as high-tides and storms. Sea level rise exacerbates these events by increasing the depth and range of the flood water. Areas that are prone to flooding will see an increase in the frequency, duration, and severity as sea levels rise. Coastal areas that currently experience flooding during king tides, the most extreme high tides which typically occur one to four times per year, will start flooding more frequently during normal high tides. For example, the number of floods La Jolla experiences each year during high tides will dramatically increase from the present-day range of one to four days per year to 20 to 40 days per year by 2050 (NOAA, 2022). Flooding will also begin to impact inland areas that historically did not flood during high tides or storms.

Inland areas near rivers and streams will also become more vulnerable to flooding during storms with extreme rainfall. Elevated sea levels at river mouths can restrict discharges, causing rivers and streams to get backed-up and flood the surrounding inland areas.

3.2.3 Emergent Groundwater Flooding and Saltwater Intrusion

In addition to flooding and erosion, coastal areas are vulnerable to rising groundwater and saltwater intrusion. As sea levels rise, saltwater can start reaching and filling the shallow groundwater tables in coastal communities, causing the groundwater to rise in elevation and become highly saline. The rising groundwater can flood communities from below, damage buried infrastructure, compromise sewage systems, spread toxic materials, and destroy foundations through corrosion and pressure changes.

When groundwater becomes contaminated with saltwater, known as saltwater intrusion, it can negatively impact freshwater aquifers, habitats, and agriculture. Communities, ranches, and farms that rely on well water might not be able to use their wells. Crops and natural flora and fauna that cannot tolerate high

salinity may perish, which can accelerate erosion and other sea level rise impacts.

Low-lying areas where the groundwater level is already high, within two meters (6.6 feet) or less from the surface, have the most significant risks for these impacts. This includes Northern California coastal plains, like Arcata, that receive relatively high precipitation and runoff, and areas throughout the state that are adjacent to lagoons and estuaries. A recent study of the San Francisco Bay Area suggests that flooding from groundwater may impact a larger area than coastal flooding from seawater and high tides (Plane, Hill, & May, 2019). Coastal beach developments, like the residences along Broad Beach in Malibu that have onsite wastewater disposal systems, such as septic systems, are at high-risk for these impacts because the discharged wastewater artificially raises groundwater levels beneath the homes. In these cases, the flood risks are especially concerning due to the health implications of sewage-contaminated groundwater. Rising groundwater can also mobilize buried toxic contaminants at former industrial facilities, power plants, refineries, and hazardous waste sites. According to [UC Berkeley's Toxic Tides project](#), 423 hazardous facilities in California are at-risk of flooding by 2100, potentially exposing 145,000 nearby residents to hazardous pollutants (Cushing, et al., 2023).

Groundwater flooding and saltwater intrusion can occur regardless of shoreline protection measures. If these impacts make coastal development or agricultural use infeasible over the long-term, there might not be an economic or environmental case for fortifying a coastline with soft or hard structures that will not protect against the changing groundwater dynamics.

3.3 Sea Level Rise and Impacts on Public Trust Uses, Values, and Resources

Public Trust lands, uses, values, and resources will be impacted by climate change, primarily from storms, changing precipitation patterns, and sea level rise. Activities and structures that are located along the shore or in the water will be affected by the net loss of dry space and an increase in the depth of submerged lands.

3.3.1 Flood Risks and Vulnerable Communities

Flooding will significantly and adversely affect vulnerable waterfront communities. Vulnerable communities are those that have been developed in low-lying areas prone to flood hazards and have reduced capacity to respond to flooding impacts or prevent them from occurring. The most vulnerable communities are those that experience a confluence of risk factors including: 1) high rates of historical environmental injustice, 2) low levels of investment in

physical infrastructure and community services, and 3) proximity to flood hazards. The risks these communities face from flooding can include: 1) flood damage to dwelling and work structures, which can lead to displacement; 2) loss of public services like utilities and transportation routes; 3) impacts to public health from pollution, contamination, and loss of access to emergency services; and 4) permanent displacement and slow economic recovery.

Several tools are available to assist in assessing and identifying vulnerable communities based on climate risk and other factors, such as those described above. In 2018, the Governor's Office of Planning and Research (OPR) released a resource guide, [Defining Vulnerable Communities in the Context of Climate Adaptation](#), that presents and summarizes tools that are available to evaluate climate risk and vulnerability.

Increased flooding events are also a major environmental justice concern. Historically, many low-income communities and communities of color were restricted to living in low-lying, flood-prone areas along the coast, which leave these communities particularly vulnerable to sea level rise. A 2009 study found that rising sea levels of four and a half feet, combined with a 100-year flooding event, would impact 56,000 individuals in California who earn less than \$30,000 annually. In the San Francisco Bay Area alone, 28,000 individuals from vulnerable populations could be subject to daily flooding from four feet of sea level rise. The San Francisco Bay Conservation and Development Commission's [Community Vulnerability mapping tool](#) is used to better understand community vulnerability and has been used to inform implementation of BCDC's Environmental Justice and Social Equity Bay Plan Amendment.

Additionally, hundreds of hazardous facilities along the coast are vulnerable to flooding by 2100 – these facilities are disproportionately located in low-income communities and communities of color. Ultimately, lack of local funding, constrained capacity, and competition for limited resources will influence individual communities' ability to respond to these environmental stressors.

3.3.2 Public Access

Public access will be greatly affected by sea level rise and flooding. The infrastructure that enables public access, such as roads, parking lots, stairways, ramps, trails and paths, docks, piers, harbors, and marinas, is vulnerable to increased inundation and erosion over time. Most public access infrastructure has been in place for some time, and as it ages, it is more susceptible to degradation and dislodgement from increased exposure to saltwater, wave action, and sediment loss from sea level rise and storms. Public safety may be jeopardized as public access routes and points are impacted by rising water. Cliffs and bluffs undercut by wave action pose a particularly dangerous threat,

as does flood overtopping of protective barriers and inundation of pedestrian paths and roadways.

Loss of public coastal access will disproportionately impact environmental justice communities. If the tide is prevented from moving landward by sea walls or other hard armoring structures, a process called ‘coastal squeeze’ can occur, diminishing the size of the public beach. While these protective structures benefit specific coastal properties, this occurs to the detriment of all Californians’ beach access. Loss of beaches will limit beach recreational opportunities, which are often the most available and affordable option for recreation, exacerbating the existing inequities in access to nature felt by low-income communities and communities of color. Additionally, individuals who are impacted by periods of extreme heat may struggle to find reprieve with diminished public beach space. Addressing these concerns in the shoreline adaptation planning process upholds the Commission’s environmental justice policy, which, in part, aims to minimize additional burdens and increase benefits to disadvantaged communities.



Figure 1: A large crowd of people celebrating a July 4th holiday at Santa Monica State Beach. Credit: Prayitno Photography

3.3.3 Recreation & Tourism

Millions of people visit California’s coast and inland waterways every year, signifying how profoundly important these spaces are to the culture and economy of the state. It is estimated that over 50 percent of California’s

population visits the coast for recreation each year, and the most popular forms of recreation are non-consumptive uses such as sight-seeing, swimming, photography, surfing, and boating (Center for the Blue Economy, 2021). The space along the water's edge that is available to support water-related recreation and tourism is decreasing as water levels rise, and opportunities to use the space will likewise decrease over time. Improvements on state lands that support recreation and tourism will be more susceptible to damage from flooding, erosion, and storms.

3.3.4 Economy & Jobs

Waterways and the coast are major economic drivers in the state, generating billions of dollars in local and state tax revenues, and supporting hundreds of thousands of direct jobs and millions of associated employment opportunities. The direct ocean economy alone employed nearly 600,000 people in 2019, with 445,000 of those jobs coming from the tourism and recreation industry (National Ocean Economics Program, 2022). The direct ocean economy, which is supported by much of the infrastructure located on state lands, contributed over \$51 billion to the state's Gross Domestic Product in 2019. These critical jobs and economic assets are at risk from flooding and other climate change impacts that will reduce the area of shorelines and damage or destroy critical infrastructure²⁷, private property, and public amenities.

²⁷ For the purposes of this report, 'critical infrastructure' includes, but is not limited to, roads, bridges, ports, airports, and railways; water, wastewater, drainage, and sewer systems; power plants; terrestrial, satellite, and wireless transmission systems; telecommunications and data information systems.



Figure 2: Major erosion from a large storm caused West Cliff Drive in Santa Cruz to close to traffic. Credit: Michael Wells

3.3.5 Natural Resources

The impacts of sea level rise also pose a significant threat to California's coastal habitats and the species that depend on them. California's coastline comprises a rich array of coastal habitats, including rocky intertidal habitats, beaches, dunes, wetlands, estuaries, and tidal marshes. Many of these habitats are already significantly reduced from their historical extent and are continually under pressure from human development and pollution. As sea levels rise and shorelines migrate inland, these habitats will become further impaired or lost by being submerged or degraded through erosion and altered environmental conditions. Some coastal habitats may adapt to higher sea levels by growing vertically or migrating inland; but, in many locations, coastal development and shoreline armoring block their ability to migrate and can exacerbate other impacts of sea level rise, like erosion.

According to a [2018 report by the SCC and the Nature Conservancy](#), 55 percent of California's coastal habitats are highly vulnerable to five feet of sea level rise, including 60 percent of the state's beaches, 58 percent of rocky intertidal habitat, and 58 percent of marshes. The reduction in these habitats has cascading effects on many rare and imperiled species that rely on them for resting, feeding, and breeding grounds. The report found that 159 imperiled species exist in the threatened coastal habitats, including 87 species that only live within those areas (Heady, et al., 2018).

3.3.6 Cultural Resources

Cultural resources are important to California's rich history and diverse population and reflect California's cultural heritage²⁸. Many cultural resources, which include physical objects like artifacts and sites, but also histories, memories, and cultural practices, are tied to the water and the water's edge. Thousands of important sites, such as former villages, could be threatened by erosion, flooding, and efforts to fortify and expand existing armoring structures. Additionally, California's Native people have an abundance of unique knowledge regarding the values of natural resources, locations of tribal cultural resources, as well as valuable ecological knowledge of California lands and resources. Understanding the impacts of sea level rise on tribal communities and their cultural resources will require continued tribal consultation and meaningful engagement in coastal planning.

4.0 Shoreline Adaptation Strategies for Coastal Resilience

The Commission and its staff need information on the range of shoreline adaptation strategies that can be deployed along the coast so that they are better able to make leasing decisions based on the best available science and policy to protect Public Trust lands and resources. Shoreline adaptation strategies may be more or less successful depending on where and how they are used. Without proper planning and adaptation, the public's ability to access and use California's coastline and waterways could become severely limited or lost in many locations. This section presents the advantages and disadvantages of shoreline adaptation strategies in relation to the Public Trust. It is intended to provide comprehensive information for lessees, lease applicants, staff, and the Commission as it evaluates lease applications and proposed actions on state lands on a case-by-case basis.

Shoreline adaptation strategies generally fall into one of three categories: protection, accommodation, or managed retreat. Protection strategies use engineered and/or natural infrastructure to protect structures or natural resources by creating a barrier between inland areas and the sea. Protection strategies can fall on a spectrum of hard or 'grey' stabilization measures, to natural or 'green' stabilization measures (Figure 3).

²⁸ To learn more about California's cultural resources, visit State Parks' Cultural Resources Division: https://www.parks.ca.gov/?page_id=22491.

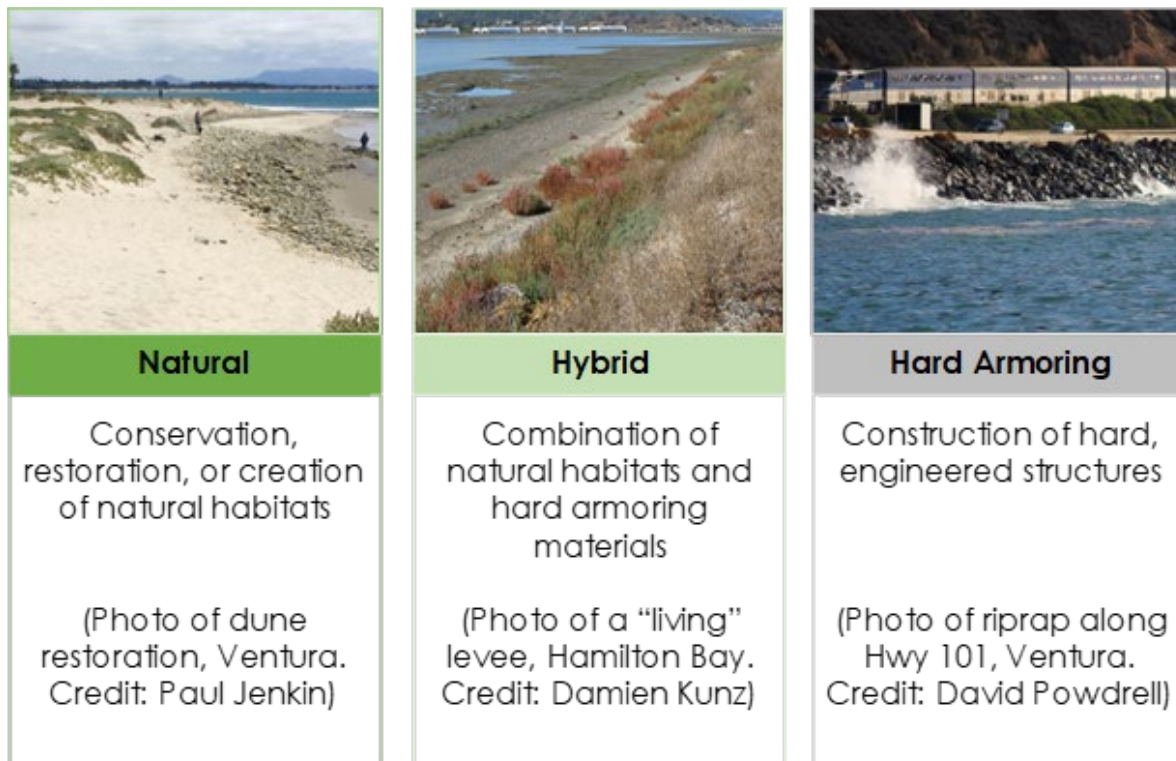


Figure 3: Protection Strategies

Accommodation and managed retreat strategies differ from protection strategies by relocating or altering structures to reduce their vulnerabilities without trying to interfere with or block the inland migration of the shoreline and the related coastal hazards, such as flooding, erosion, and wave impacts.

While certain strategies are preferred over others, a comprehensive approach to sea level rise and coastal resilience will likely require a combination of strategies from multiple categories. Additionally, the effectiveness of adaptation strategies will vary across time, so the suite of strategies selected for a given area may have to change with rising sea levels. Nevertheless, the following categories provide a framework with which to assess sea level rise adaptation and planning.

4.1 Protection: Hard Armoring

Examples: Seawalls, Revetments, Rip Rap, Bulkheads

Hard armoring structures are engineered structures that are constructed parallel to the coastline and provide a solid barrier between the land and sea to block or minimize the energy of tides and waves that interact with the land. They are commonly used to reduce the threats posed by coastal hazards, such as flooding, erosion, and damages from wave energy. However, hard armoring has several potential drawbacks, including high maintenance and repair costs,

declining effectiveness over time, accelerated beach erosion, blockage of beach access, and significant visual and environmental impacts.

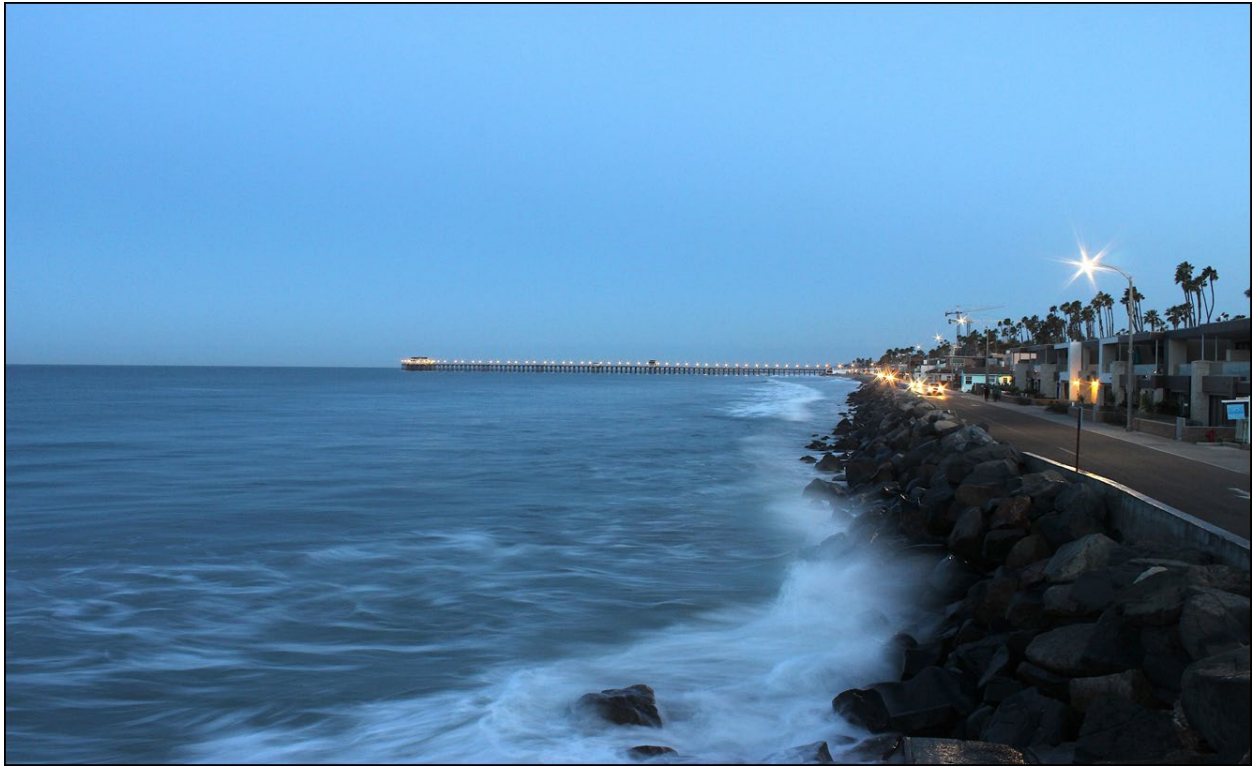


Figure 4: A rock revetment protects residences in Oceanside where the beach has eroded. Credit: Integral Consulting

4.1.1 Advantages for Hazard Mitigation

Hard armoring that is appropriately designed and well maintained can provide a high degree of protection for inland areas directly behind the structures. By using hard armoring, buildings and other structures can be protected from erosion, flooding, and the landward migration of the shoreline. The risks of coastal flooding can be reduced by designing the structures to be higher than potential sea levels when properly accounting for sea level rise, extreme high tides, and storm surges (Zhu, Linham, & Nicholls, 2010).

The use of hard armoring is typically only for protecting what is directly behind the structure, not the beach in front of it. This can be necessary to protect coastal-dependent structures and critical infrastructure, such as airports, ports, highways, and utilities, that would be too costly or impractical to relocate. In locations where hard armoring is the only available option to protect coastal-dependent structures, frequent inspections, maintenance, and upgrades are needed to ensure the armoring is structurally sound, does not pose safety hazards, and can continue to provide protection against rising sea levels.

4.1.2 Advantages for Public Trust Interests

Urban and working waterfronts often lack the space that is required for nature-based solutions or managed retreat, and hard armoring can be necessary to safeguard the coastal-dependent Public Trust uses, assets and resources at those locations. California's ports, harbors, and marinas rely on hard armoring to protect their built assets and to safely accommodate navigation, commerce, visitor serving and recreational uses, and fishing.

Similarly, critical infrastructure, such as transportation routes and utilities, must be adequately protected to serve the public. Hard armoring can be essential to provide the necessary levels of protection for critical infrastructure that are vulnerable to coastal hazards.

For these uses in these locations, the public benefits can outweigh the harmful impacts caused by hard armoring. However, the impacts on coastal ecosystems can be mitigated, to a degree, by using alternative construction materials, like bio-enhancing concrete²⁹ and designs that mimic rocky intertidal habitats (Perkol-Finkel, Hadary, Rella, Shirazi, & Sella, 2018).

In some unique situations, hard armoring can temporarily protect coastal access and recreation by providing short-term or emergency protections for any structures that are highly vulnerable to damage and pose immediate safety risks to the public. Until longer-term solutions, such as relocation, are implemented, hard armoring can provide the public with safe access and usage of coastal areas near the vulnerable structures.

4.1.3 Disadvantages for Hazard Mitigation

Hard armoring must be designed to withstand significant force and erosion from incoming waves. As incoming waves strike the structures, the reflected wave energy can erode the sediment below and surrounding the structures, leading to structural instabilities (Zhu, Linham, & Nicholls, 2010). Without continual repairs

²⁹ Bio-enhanced concrete is concrete whose composition has been altered by plant-based additives like arrowroot that lower the concrete's pH, making it less toxic and more environmentally suitable as habitat substrate for intertidal and marine flora and fauna. Seawalls are constructed by fitting together pre-molded blocks of concrete; bio-enhanced concrete blocks are molded in molds with complex features to mimic rock surfaces, rather than smooth surfaces as is typical in conventional seawall block molds. This provides greater amounts of area for flora and fauna to attach to, and form more complex biological assemblages. The assemblages also increase the strength of the bio-concrete blocks by decreasing surface exposure to corrosive seawater and degradation from wave energy.

and the upgrades necessary to keep pace with rising sea levels, the armoring can eventually become ineffective. The total costs, including repairs, upgrades, and removal, must be considered when the installation of hard armoring is being planned. If the lessee fails to adequately maintain the hard armoring, the lessor (either the Commission or a local grantee) may have to remove the armoring at its expense to avoid public hazards and seek costly legal remedies. On high energy coastlines, including much of California's open coast, any protective structure that comes in direct contact with wave energy has a high probability of eventual failure (Griggs, 2005).

If the hard armoring is located on or behind a beach, the protection of the areas behind the armoring can come at the expense of the beach in front of it (Griggs & Reguero, 2021). By artificially fixing the location of the coastline, hard armoring prevents the landward migration of the MHTL that would otherwise naturally occur due to sea level rise and other coastal processes. The result can be a loss in beach area, or coastal squeeze, as the distance between the MHTL and armoring gets narrower over time (Figure 4). The process is accelerated by hard structures limiting the natural erosion of coastal features, such as dunes or bluffs, that are a source of sediment for the beach. Once wave energy starts regularly colliding with the armoring, the wave energy is reflected seaward and may wash away the sediment that composes the beach seaward of the structure. This issue is especially prevalent with seawalls that have a smooth vertical surface and reflect most of the wave energy (Zhu, Linham, & Nicholls, 2010). Over time, these adverse effects can cause the beach area seaward of hard structures to become submerged. The loss of beach area can negatively affect coastal and marine ecosystems, beach recreation and tourism, and coastal economies (Griggs & Reguero, 2021).

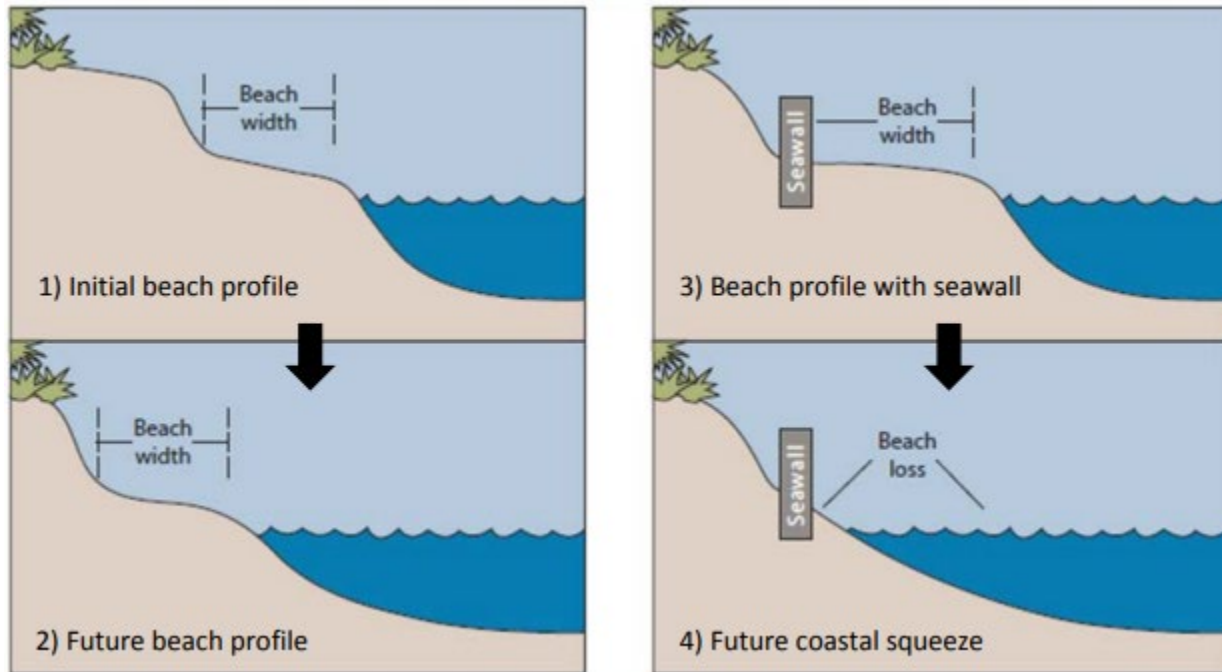


Figure 5: Coastal Squeeze, beach loss caused by the effects of hard armoring (U.S. Army Corps of Engineers, 1991)

4.1.4 Disadvantages for Public Trust Interests

Hard armoring can be detrimental to some Public Trust uses and resources by negatively impacting coastal areas in a variety of ways. The loss of beach area caused by the physical footprint of hard armoring and coastal squeeze adversely impacts the public's ability to access the Public Trust tidelands and use them for recreation, fishing, relief from extreme heat events, and for other purposes. Hard armoring can also have impacts downcoast, causing erosion of unprotected shorelines, affecting public access, and increasing the risk to communities who may lack the resources to install hard armoring.

When lateral beach access is blocked by armoring used to protect beachfront residential properties, beaches become accessible only to the residents of the beachfront properties (Figure 6). This de facto privatization of public property confers exclusive benefits to ocean-front property owners at the expense of the general public. People who rely on coastal access for low-cost recreation, escape from heat, subsistence fishing, and other vital uses are disproportionately affected by this practice because they cannot reach a space that is fundamental to their well-being (Reineman, Wedding, Hartge, McEnery, & Reiblich, 2016).



Figure 6: A revetment, used to protect private residential homes in Carpinteria, blocks lateral beach access between Santa Claus Beach and Sandyland Beach. Sandyland Beach cannot be accessed by the public during medium and high tides. Photo: Michael Wells

Hard armoring can also impair environmental preservation and restoration efforts by reducing beach habitats and significantly affecting species richness (the number of different species in an area) and abundance (the number of individuals of the same species). Compared to unarmored beaches, armored beaches in Santa Barbara County were found to have 50 to 67 percent lower species richness and 75 to 91 percent lower species abundance compared to adjacent unarmored beaches (Dugan, Hubbard, Rodil, Revell, & Schroeter, 2008).

The effects of hard armoring can degrade the quality of surf breaks, an important economic and cultural resource for many California coastal communities. Coastal squeeze caused by the hard armoring allows for more wave energy to impact the armoring and reflect seawards, negatively altering the bathymetry and quality of nearby surf breaks (Corne, 2009).

4.1.5 Recommended Locations and Considerations

Hard armoring is appropriate for protecting critical infrastructure and urban and working waterfronts where managed retreat or nature-based solutions are

infeasible alternatives in the short- and mid-term or are incompatible with the coastal dependent uses, like commerce or navigation, of the coastline. For example, the Port of Los Angeles cannot meaningfully relocate its facilities inland, and they cannot berth a cargo ship next to a shallow natural shoreline. The ports will likely continue to require hard armoring that is nearly vertical to ensure that the cargo cranes and other onshore equipment is close to cargo vessels, which require deep channels, to effectuate the safe and efficient transfer of goods. In these situations, hard armoring is recommended if it provides a public benefit that outweighs the adverse impacts caused by the armoring.

Hard armoring, however, is not recommended for solely protecting private property because it adversely impacts Public Trust resources and uses, including beach loss and the reduction of coastal habitat, opportunities for recreation, and space for the public to take refuge during heat waves. When that occurs, the hard armoring provides a private benefit at the expense of Public Trust resources, uses, and values.

In locations where nature-based strategies or managed retreat are feasible mid- or long-term strategies, hard armoring should be avoided or only be used for temporary purposes while the mid- and long-term strategies are implemented. In these situations, the removal of the armoring should be agreed on and pre-planned with financial surety in place.

4.2 Protection: Nature-Based Solutions

Examples: Berms, Artificial Dunes, Beach Nourishment, Vegetated Levees, Restoration or Conservation of Natural Ecosystems

Nature-based solutions are adaptation strategies that leverage natural ecosystems and processes to provide protection against sea level rise impacts and coastal hazards, while also providing other complementary benefits. The implementation of nature-based solutions can range from the preservation or restoration of natural ecosystems (i.e., salt marshes, beaches, dunes, oyster reefs) to the integration of natural materials with engineered designs or materials (i.e., dune-covered revetments, vegetated levees). Some of the benefits of nature-based solutions beyond sea level rise and climate adaptation include conserving open spaces that provide habitat, filtering water for nutrients and pollutants, offering recreation space, and accommodating public access to the water. Nature-based solutions are also often referred to as 'soft protection', 'natural infrastructure', 'living shorelines', 'green infrastructure' or 'green-grey infrastructure'.



Figure 7: Sand dunes and cobble berms at Surfers Point in Ventura provide protection during a large swell in 2015. Credit: Paul Jenkin

4.2.1 Advantages for Hazard Mitigation

Nature-based solutions can provide high levels of protection against coastal hazards by attenuating wave energy and storm surges, self-repairing after damaging events, retaining sediment, and potentially growing or accumulating sediment at a rate that keeps pace with sea level rise (Sutton-Grier, Wowk, & Bamford, 2015). Studies of coastal marshes and hybrid natural/built designs after hurricanes found that, compared to hard armoring, nature-based solutions provided more protection against erosion, suffered less damage, and recovered to pre-hurricane conditions within a year (Gittman, Popowich, Bruno, & Peterson, 2014).

Unlike hard armoring, the natural components of nature-based solutions, like sand, vegetation, and cobbles, are softer and reduce the reflection of wave energy that causes erosion of adjacent areas (NOAA, 2015). Nature-based solutions can also exhibit dynamic behavior that responds to the changes and movements of coastal processes, sea levels, and climatic conditions. As sea levels rise, nature-based solutions can migrate inland if unimpeded by development or grow vertically and keep pace with the inland migration of coastlines (Zhu, Linham, & Nicholls, 2010).

Naturally occurring and artificially constructed sand dunes can offer high degrees of protection against coastal flooding and erosion. Like hard armoring,

they provide a barrier between the ocean and inland areas that dissipates wave energy and restricts flooding. Dunes are highly dynamic, responding to changes in the wind, wave conditions, or sea levels. Vegetation on the dunes provides stabilization against erosion and promotes the accumulation of sand that causes dunes to grow over time. As a result, dunes can accumulate sediment in summer months and then, in winter months, supply sediment to the beach after winter storms cause erosion (Zhu, Linham, & Nicholls, 2010).

Some tidelands will need to be artificially nourished with additional sediment to keep pace with sea level rise and continue providing a buffer between coastal hazards and upland development. Due to the combined effects of sea level rise, drought, and human alterations to watersheds, San Francisco Bay's tidal marshes and mudflats are expected to become inundated by 2100 where they lack space to naturally migrate inland. Sediment nourishment and restoration projects can help them grow vertically at pace with sea level rise and continue providing a buffer against flooding (Dusterhoff, McKight, Grenier, & Kauffman, 2021). Similarly, beach nourishment projects can temporarily protect beachfront development from coastal hazards by widening beaches and providing a larger buffer between the upland development and the effects of erosion and storm damages (Figure 9). By making beaches wider and gradually sloped, beach nourishment reduces wave run-up and potential flooding and erosion of upland areas. Beach nourishment addresses sediment deficits, which can be an underlying cause of erosion, by increasing the quantity of beach sediment in the coastal region (Zhu, Linham, & Nicholls, 2010). Sand retention structures, like groins, can complement beach nourishment by retaining the added beach sediment and decreasing the frequency of future renourishment projects.



Figure 8: Beach nourishment at Goleta Beach Park, 2023. Photo: Michael Wells

Hybrid designs that combine built structures with natural components can provide the benefits of both while minimizing the weaknesses of each. For example, the Cardiff Living Shorelines Project in Encinitas protects Highway 101 with sand dunes that were constructed on top of an engineered revetment.

These hybrid approaches provide many opportunities for innovation and customization for specific locations and conditions, including locations that do not have the space needed to implement fully natural infrastructure. Where space is somewhat limited, dunes or sand embankments can be placed on top of revetments to provide a soft barrier to wave run-up and overtopping, and the revetments provide an extra line of defense during extreme conditions if the dunes or embankments are eroded. Where space is very limited, like at ports and other working waterfronts, nature-based materials and designs can be integrated into hard armoring to mitigate their environmental impacts while still providing similar levels of protection as traditional hard armoring. For example, the [Living Seawall Pilot](#) study in San Francisco is testing the use of textured tiles, as opposed to the traditional barren and exposed concrete surface of sea walls to promote biodiversity and encourage underwater habitat. Similarly, the [Port of San Diego](#) worked with EConcrete to replace existing riprap; the chemical composition of EConcrete promotes the growth of organisms such as oysters, corals, and barnacles, which add to the strength and durability of hard armored structures.

4.2.2 Advantages for Public Trust Interests

In most locations, nature-based solutions offer multiple social, environmental, and economic benefits to communities along the shoreline. By leveraging natural ecosystems and processes, nature-based solutions can protect or expand the ecosystem services that benefit the public. In addition to their hazard mitigation benefits, the ecosystem services can include, but are not limited to, habitat, water quality improvements, carbon sequestration and storage, maintenance of fisheries, and expanding recreational uses (Sutton-Grier, Wowk, & Bamford, 2015).

Notably, nature-based solutions can avoid or delay coastal squeeze processes that often occur with hard armoring and cause the loss of usable Public Trust tidelands. As a result, nature-based solutions are beneficial for maintaining and, in some cases, widening beaches, allowing for more beach space and other tidelands to be used by the public for coastal access, recreation, fishing, and scenic enjoyment. This is important for addressing the inequities in public coastal access that are often exacerbated by hard armoring, particularly revetments with large footprints. Nature-based solutions can provide similar levels of protection without restricting access and use of Public Trust tidelands.

Hybrid designs can also be beneficial for Public Trust interests when they protect certain Public Trust resources that require hard armoring, like ports, harbors, airports, and critical utilities, and mitigate the adverse effects of the hard armoring by creating functional habitats. In working waterfronts, armoring with bio-enhancing materials and designs has been found to increase species richness, biodiversity, and habitat area compared to traditional seawalls (Perkol-Finkel, Hadary, Rella, Shirazi, & Sella, 2018).

4.2.3 Disadvantages for Hazard Mitigation

Nature-based solutions can have limitations to their effectiveness or usability in certain locations. Where wave energy is high, vegetated shorelines, dunes, and nourished beaches can be eroded by severely strong waves and storm conditions. This can require periodic monitoring and maintenance.

The species and ecosystems used in nature-based solutions are also vulnerable to other environmental or anthropogenic stressors that can affect their longevity and ability to mitigate coastal hazards. Depending on the species and locations, the stressors can include pollution, ocean acidification, coastal development, or over-extraction or degradation from human activities. For example, ocean acidification and water pollution can affect the health of oyster reefs and, as a result, impair their ability to stabilize shorelines (Rodriguez, et al., 2014) Similarly, coastal development can impede the inland migration of

coastal ecosystems and compromise their ability to migrate with shifts in coastlines and sea levels rise (Griggs & Reguero, 2021).

Most nature-based solutions, like dunes and other vegetated shorelines, need ample space to accommodate the widths of their designs and abilities to migrate. Thus, they are often not suitable for locations that are space-limited and have coastal dependent structures, like ports, marinas, harbors, and other urban and working waterfronts.

4.2.4 Disadvantages for Public Trust Interests

While nature-based solutions are often the most beneficial adaptation strategy for protecting and serving Public Trust interests, there are some locations and applications where they cannot adequately protect Public Trust resources or accommodate certain Public Trust uses. Urban and working waterfronts cannot feasibly deploy nature-based solutions, like vegetated shorelines, that have large space requirements and would occupy the areas where ships need to berth or where the related infrastructure needs to be located. These locations support vital Public Trust uses and must be protected with adaptation strategies that can accommodate their uses. Similarly, protecting critical infrastructure, such as water, wastewater, transportation, energy, and other utilities, is crucial to serving the public. Because of their limitations, nature-based solutions might be unable to provide adequate levels of protection for critical infrastructure. The severe risks of damages to critical infrastructure or urban and working waterfronts can outweigh the benefits that nature-based solutions could provide.

Some nature-based solutions that involve dredging and placement of sediment, such as beach nourishment, can negatively affect environmental resources by disturbing or burying habitats and degrading water and sediment quality. Studies that monitored the impacts of beach nourishment have found some species that were affected recovered within a few months, whereas other species did not recover after the multi-year studies concluded (Wooldridge, Henter, & Kohn, 2016) (Peterson, Bishop, D'Anna, & Johnson, 2014).

Beach nourishment is not a permanent solution and often requires renourishment. As a result, demand for usable sediment is high and, in many cases, supply is low. Depositing sediment onto beaches can negatively impact coastal environments by burying species residing in the area or introducing sediment that does not match the native beach materials. The projects must be designed to limit these harmful effects on the environment (Zhu, Linham, & Nicholls, 2010).

Beach nourishment can also affect some recreational uses of Public Trust lands, including surfing, shore fishing, and diving. The placed sediment can bury reefs

and alter the unique bathymetry of surf breaks that create surfable waves. The degraded water quality, burying of habitats, and ecological impacts can impair diving and shore-based fishing opportunities.

4.2.5 Recommended Locations and Considerations

Because of their abilities to provide protection benefits and limit adverse impacts on Public Trust resources, nature-based solutions should be prioritized over other protection strategies, such as hard armoring, wherever feasible and consistent with regulatory permitting and policies. That should include most locations on Public Trust lands, except where hard armoring must be used to protect critical infrastructure and maritime industrial, commercial, and navigation facilities that serve Public Trust interests. Nature-based solutions should be prioritized when Public Trust lands are used to protect private property. This recommendation supports the Commission's "Advance Climate Equity" goal within its [Environmental Justice Policy](#) and the Commission's 2021-2025 Strategic Plan's goal to lead climate activism and to use green infrastructure to enhance coastal resiliency; it also aligns with statewide policies and initiatives, such as the Natural and Working Lands Climate Smart Strategy. Encouraging the use of nature-based solutions over hard armoring, where feasible, prioritizes social equity and disadvantaged communities in sea level rise planning and adaptation strategies by preserving and promoting coastal access. This recommendation also prioritizes the protection of coastal habitats and preservation of public access while balancing other Public Trust uses and the need to protect existing infrastructure along the coast.

A key consideration for planning and implementing nature-based solutions is sourcing the materials needed to build them. Maintaining existing shorelines and tidelands requires adequate sediment supplies, which are threatened by climate change. Bolstering these areas, restoring dilapidated habitats such as tidal marshes, dune complexes, beaches, and maintaining them continuously as seas continue to rise means developing sustainable sources and processes with minimal environmental impacts. Potential sediment sources could include offshore resources, dredged materials from harbors, marinas, ports, and navigation channels, and restoration of upland watershed systems where barriers (dams, channelized embankments, etc.) to natural sedimentation have been removed.

Since nature-based solutions are not always permanent solutions, they should be paired with monitoring programs and longer-term strategies, such as managed retreat. Nature-based solutions can be used to mitigate short-term risks and buy time until managed retreat strategies are implemented to address long-term risks.

4.3 Protection: Sand Retention Devices

Examples: Groins, Jetties, Breakwaters

Sand retention structures are coastal management structures that originate onshore and extend seaward, often perpendicular to the coastline. They can reduce the intensity of wave action, currents, and sediment transportation. Their primary purposes can vary depending on the location. Breakwaters and jetties are often constructed at the entrances to harbors, channels, or inlets to prevent sediment from clogging the entrances and protect anchorages or other built structures from wave action and erosion. Groins are typically located along beaches and primarily aim to retain sediment to widen or stabilize a beach. Breakwaters and jetties are generally hundreds to thousands of feet long, whereas groins are usually shorter in height and length. Using sand retention structures can be an effective sea level rise adaptation strategy, especially when paired with beach nourishment, by reversing or slowing beach loss and protecting existing structures (Griggs, Patsch, Lester, & Anderson, 2020).

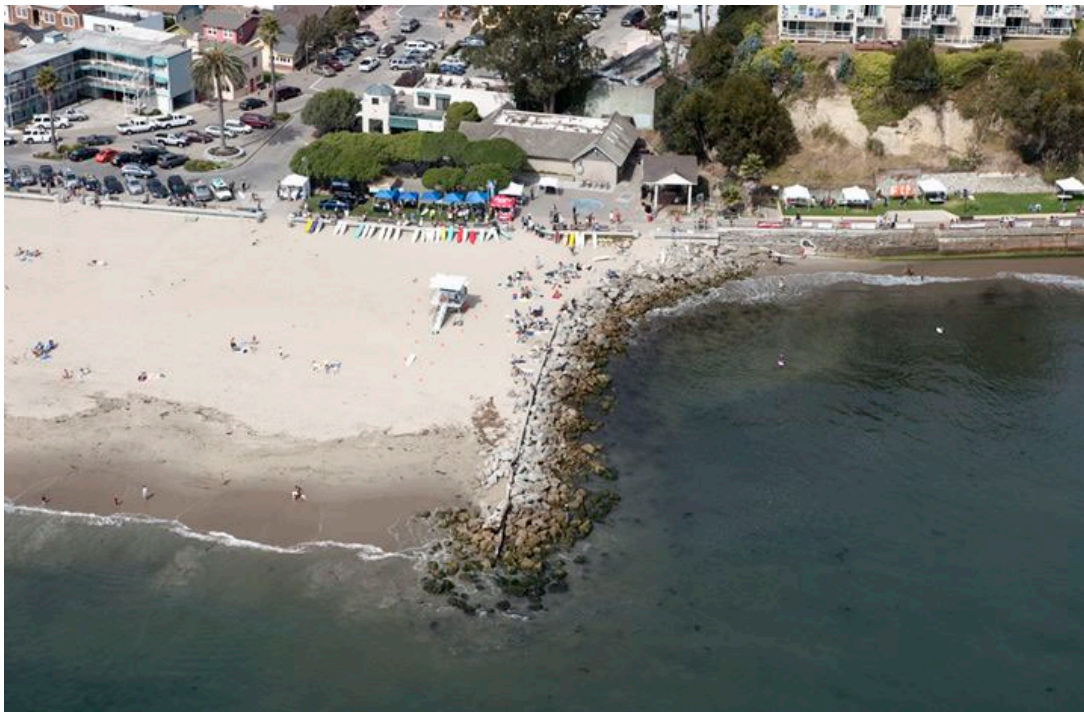


Figure 9: Groin at Capitola Beach. Credit: Copyright (C) 2002-2023, Kenneth & Gabrielle Adelman, California Coastal Records Project, www.Californiacoastline.org

4.3.1 Advantages for Hazard Mitigation

Sand retention structures can effectively mitigate beach loss and protect built assets from wave action and erosion. Breakwaters and jetties can protect harbors, marinas, and ports by intercepting wave energy before it reaches inshore areas, allowing for calm waters within the ports, harbors, or marinas. As a

result, wave-induced hazards, such as runup and overtopping, can be decreased for these locations.

Sand retention structures, particularly groins, can also play a critical role in sea level rise adaptation planning by retaining sediment, similar to natural barriers such as headlands and points, resulting in wider and more stable beaches than would otherwise exist. Depending on their location, the structures can trap sediment before it is funneled into submarine canyons and permanently removed from the littoral system. The widening and stabilizing of beaches can buffer the impacts of sea level rise and coastal hazards, such as flooding and erosion, that harm beaches and inland areas. Groins can aid beach nourishment and other sediment management efforts by retaining the sediment that was relocated and decreasing the frequency of future renourishment or other interventions. Groins can play an important role as short- to mid-term adaptation strategies that stabilize shorelines while long-term adaptations are being planned and implemented. In some instances, they may allow for the removal of parallel structures, like revetments and seawalls, which would restore natural supplies of sand to the beach while still protecting inland areas.

4.3.2 Advantages for Public Trust Interests

In many cases, sand retention structures may benefit Public Trust interests, such as navigation, commerce, recreation, and environmental preservation. Breakwaters and jetties can be critical to facilitating navigation and commerce by protecting important navigational channels, anchorages, and other structures. Without the structures, sediment would fill the entrances and restrict navigation, and wave energy would damage boats and structures within harbors, marinas, and ports.

Sand retention structures, particularly groins, can benefit beach and water recreation by stabilizing or widening beaches and providing the public with more beach areas to enjoy. Preserving and widening existing beaches is important for ensuring equitable beach access, especially for disadvantaged communities that rely on beaches for affordable recreation opportunities and respite from extreme heat events.

In some locations, these structures can result in new surf breaks where none previously existed. For example, jetties and groins in Half Moon Bay, Newport, Ventura, and Oceanside have created popular surf breaks that are important recreational and economic resources to the local communities.

Similarly, these structures can potentially support environmental stewardship by helping preserve or restore beach habitats through the retention and accretion of sediment and wrack (natural material that washes onto a beach such as kelp, sea grass, and shells). However, these effects could be beneficial or

harmful to existing ecological communities and should be evaluated on a case-by-case basis.

4.3.3 Disadvantages for Hazard Mitigation

While sand retention structures can effectively protect the coastline where they are located, they can have unintended consequences on adjacent and downcoast beaches. The sediment accretion on the updrift side of the structures can cause sediment starvation and erosion downcoast of the structures. This effect is more pronounced with larger structures, such as breakwaters and jetties, that intercept large volumes of sediment. For groins, the effect is smaller for a shorter duration, starving the downdrift beaches only until the sediment is fully built up on the updrift side of the groin. Once that occurs, sediment will resume drifting downcoast. The use of sand nourishment to pre-fill the updrift side of the structures during construction can minimize these adverse effects (American Shore & Beach Preservation Association, 2011).



Figure 10: The jetties at the Santa Cruz Harbor interrupt the flow of sediment, creating a wide beach immediately upcoast of the harbor but depleting downcoast beaches. Credit: Copyright (C) 2002-2023, Kenneth & Gabrielle Adelman, California Coastal Records Project, www.Californiacoastline.org

4.3.4 Disadvantages for Public Trust Interests

The Public Trust benefits that are achieved from stabilizing and widening a beach with sand retention structures may come at the expense of the Public Trust uses and resources of downcoast regions. Sediment starvation of downcoast beaches can harm coastal access, recreation, and ecological communities in those locations.

Depending on the design and location, sand retention structures can also negatively affect recreational activities where they are installed. The onshore portion of the structures can interrupt the public's ability to walk laterally along the beach and access adjacent beaches. Sand retention structures placed at or near existing surf breaks can destroy the surf breaks by interfering with the wave energy and accumulation of sediment responsible for creating the surf breaks. For example, the construction of the breakwater for Dana Point Harbor displaced a notorious surf break known as "Killer Dana."

Sand retention structures can conflict with environmental stewardship by decreasing habitat areas and connectivity. Structures with large footprints will displace larger areas of habitat. When the structures cover and replace shoreline and marsh vegetation, they can reduce the ecosystem functions, like water filtration and carbon sequestration. Similarly, the length of the structures can impede the longshore movement of benthic animals, wrack, and driftwood, causing a variety of environmental and ecological impacts (Dugan, et al., 2011).

4.3.5 Recommended Locations and Considerations

Jetties and breakwaters should only be installed where commerce and navigation need to be prioritized and where nature-based solutions for wave attenuation and shoreline stabilization are insufficient or not applicable. Similarly, groins should only be installed to address erosion hotspots on beaches where nature-based solutions are inadequate or unsuitable. In all instances, the negative impacts on downcoast areas must be evaluated, and steps should be taken to mitigate the consequences. Such steps can include prefilling the updrift areas of the structures with sediment or using sediment bypassing to limit the amount of sediment that is trapped and prevented from drifting downcoast. Similarly, the impacts on existing ecosystems, recreation, and other Public Trust interests should also be evaluated, mitigated, and weighed against the potential benefits for the public. For example, sand retention structures that are located along residential areas and upcoast of popular public beaches should be assessed for the equitable distribution of public benefits.

Sand retention structures can be especially beneficial when located upcoast from submarine canyons, like the groins at West Newport Beach that intercept sediment before it is permanently lost to the Newport Submarine Canyon. In those locations, at the end of a littoral cell, adverse impacts on downcoast beaches are less of a concern because the downcoast beaches are in separate littoral cells and receive sediment from other sources.

4.4 Accommodation

Examples: Elevated Structures, Floating Structures, Retrofits, Flood-Proofing, Drainage Improvements

Accommodation strategies use methods that modify existing structures or design new structures to withstand some degree of inundation, wave impacts, or rising sea levels. These strategies can allow structures to remain in hazard-prone areas but reduce their vulnerabilities. This may include elevating buildings with pilings or stilts, flood-proofing structures, using stronger and corrosion-resistant materials, or improving the drainage of floodwaters. At ports, marinas, and harbors, this could include elevating docks, raising guide piles, and flood-proofing any at-risk asset. Flood-proofing often includes the use of 'flood-resistant' materials, like brick or stone, that can withstand direct or prolonged floodwaters without significant damage. After hard armoring, accommodation strategies are the most widely used adaptation strategies to-date (Glavovic, et al., 2022).



Figure 11: The Santa Barbara Yacht Club is elevated on pilings to accommodate some wave run-up and flooding. However, it still experienced structural damage from large waves in January 2023. Credit: Michael Wells

4.4.1 Advantages for Hazard Mitigation

Accommodation strategies can be effective for current conditions and small changes in sea level rise (Oppenheimer, et al., 2019). They can play important roles in hybrid or phased adaptation approaches, buying time for longer-term strategies to be implemented or adding resilience to other adaptation

measures. Where the consequences of coastal hazards are low, some accommodation strategies, such as flood-proofing a building, can be more affordable and cost-effective approaches to reducing risks compared to the construction of hard armoring or the relocation of structures (Zhu, Linham, & Nicholls, 2010). Flood-proofing or drainage improvements can be undertaken by individuals to effectively reduce potential flood damages.

For coastal-dependent structures, such as working waterfronts or some critical infrastructure, accommodation strategies are a necessary component of their long-term hazard mitigation measures. Many accommodation strategies, such as elevating or floating structures and protecting against corrosion, are inherent design components for their built assets that are in or highly exposed to ocean water. Floating docks regularly prevent severe damage to boats during storms; whereas fixed docks break apart and damage boats when they become submerged (FEMA, 2021). As sea levels rise, working waterfronts can continue elevating docks and guide piles and flood-proofing inland infrastructure that will become increasingly exposed to floodwater and corrosion.

4.4.2 Advantages for Public Trust Interests

Compared to hard armoring, accommodation strategies have smaller footprints, which can be beneficial, to some degree, for landscape connectivity, coastal access, and accommodating the landward migration of coastal ecosystems. Elevated structures have less interference with coastal processes, such as sediment transportation, than non-elevated or armored structures. The results can be marginally beneficial to some Public Trust resources and uses, such as recreation and environmental preservation.

For working waterfronts, accommodation strategies are commonly used and critical to their Public Trust uses, such as navigation, commerce, and fishing. For example, floating docks that minimize damages during storms can allow marinas and harbors to quickly resume public services with minimal or no interruptions.

4.4.3 Disadvantages for Hazard Mitigation

Accommodation strategies have limits to their effectiveness due to practical and economic limitations for how much can be done to accommodate sea level rise and coastal hazards. Since accommodation strategies do not prevent flooding or other hazards, those events can still cause damages and require costly repairs and cleanups. The repairs and repetitive modifications that are required to keep pace with sea level rise can eventually become less practical and economical than relocating the structures.

Accommodation strategies can be risky since they rely on accurate understandings of the probabilities, severities, and consequences of coastal

hazards. If those are underestimated or poorly communicated, accommodation strategies can create a false sense of safety and expose people and structures to dangerous situations (Oppenheimer, et al., 2019).

4.4.4 Disadvantages for Public Trust Interests

While structures using accommodation strategies can have less interference with coastal processes relative to armoring, the structures can still adversely impact Public Trust uses and resources. Structures that are elevated on piles or stilts, like beachfront homes, can occupy unusable beach space and interfere with coastal access, recreation, and ecosystems. As coastlines migrate inland, elevated structures erected over tidelands will become located further seaward over Public Trust tidelands, becoming more exposed to hazards like flooding and wave impacts, and may create a larger area of unusable beach space below them.

4.4.5 Recommended Locations and Considerations

Accommodation strategies are most appropriate for critical infrastructure and urban and working waterfronts that have coastal dependent structures that cannot be easily relocated or adequately protected with nature-based solutions. In other locations, accommodation strategies should be used for existing structures to increase resilience in conjunction with long-term strategies.

Due to their limitations, accommodation strategies should not be solely relied on for new developments in hazardous zones where they otherwise would not be placed. Any existing elevated structures that are sited on state tidelands should inquire about the lease application process with the Commission if the structure is not already under lease.

4.5 Managed Retreat

Examples: Removal, Relocation, Realignment, Setbacks, Rolling Easements

Managed retreat is the coordinated movement of structures away from vulnerable coastal areas to minimize risks posed by coastal hazards and to accommodate the dynamic movements of tidelands. Managed retreat is often a long-term transition through multiple phases of adaptation strategies, such as risk avoidance, removal, relocation, and reuse (Lester, Griggs, Patsch, & Anderson, 2022). In some high-risk cases, the process can necessitate the temporary use of armoring to provide protection during the removal and relocation of structures. Managed retreat is often misunderstood as only a single and abrupt action, such as the immediate demolition or movement of private property. However, historical examples of managed retreat in California include incremental, multi-decadal transitions that accommodated the continued use of the properties or structures during the process. The final stage and goal of

managed retreat projects on Public Trust tidelands should be the reuse or restoration of the land previously occupied by the coastal structures for public benefits, such as preserving or restoring public access and coastal habitats.

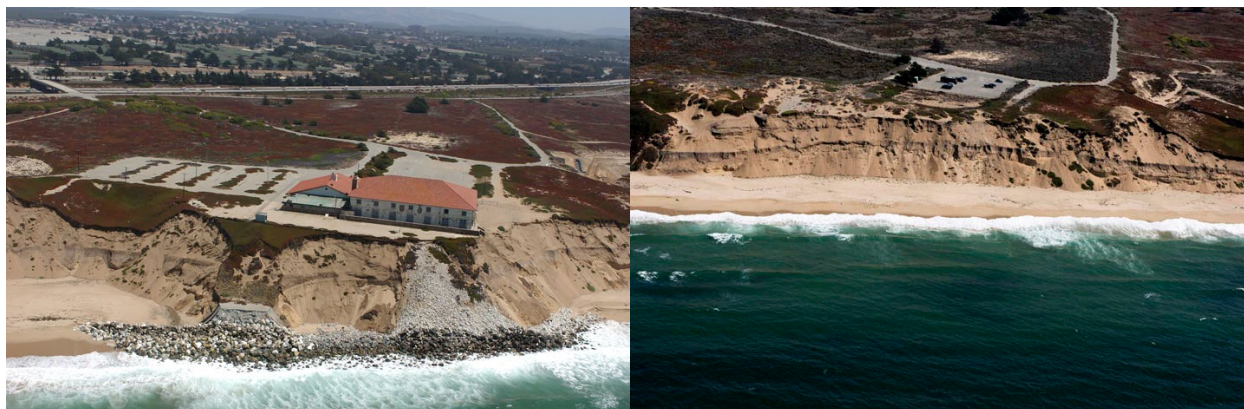


Figure 12: Before (left) and after (right) the removal of Stilwell Hall and a rock revetment at Fort Ord. Credit: Copyright (C) 2002-2023, Kenneth & Gabrielle Adelman, California Coastal Records Project, www.Californiacoastline.org

4.5.1 Advantages for Hazard Mitigation

Managed retreat is an effective long-term strategy for reducing risks to coastal structures by removing them from harm's way and preventing damaged structures from becoming public safety hazards. It is also beneficial for avoiding or reversing the beach loss that occurs from the placement of armoring and other structures on the coastline. When hard armoring is removed, the location of the coastline and the MHTL can naturally fluctuate and migrate without impediments.

In California, examples of managed retreat have been successful through avoidance strategies, such as erosion setbacks, monitoring programs, and other permit conditions, that prevent new or existing developments from being in or close to hazardous areas.³⁰ Mandatory setbacks from non-fixed boundaries, such as the edge of eroding coastal bluffs, can require the partial or complete removal of structures if and when necessary, allowing for continued use of structures until bluff erosion reaches a point where they are no longer safe. Similarly, zoning or permitting conditions that restrict the use of hard armoring or require removals upon triggering events, such as structural damages or minimum beach widths, can have the same effect of allowing structures to be used until they need to be moved out of harm's way (Spidalieri & Bennett, 2020).

³⁰ Examples include the Pismo Beach Silver Shoals residential subdivision, Cliffs Hotel in Pismo Beach, Bacara Resort in Goleta, Half Moon Bay Ritz Carlton (Lester, Griggs, Patsch, & Anderson, 2022).

Managed retreat projects can also take shape through long-term planning and redesign processes that proactively address future threats and consider ways to maximize public benefits and address stakeholder input. The realignment of Highway 1 at Piedras Blancas took 15 years of planning, design, and negotiations with stakeholders. But it created a new three mile highway segment that was designed to be safe for at least 100 years, expanded Hearst San Simeon State Park, and allowed for the construction of new visitor facilities, beach access, a public campground, and 3.4 miles of the California Coastal Trail (Lester, Griggs, Patsch, & Anderson, 2022) (CCC, 2014).

While managed retreat is often a long-term, multi-phase process, emergency situations can sometimes require the immediate removal and relocation of coastal structures to avoid potentially life-threatening situations. Pacifica experienced significant bluff erosions during El Niño winters in 1982-83, 1997-98, and 2015-16 that required multiple houses to be demolished as they were teetering on the edge of collapse. In those instances where the structures have irreparable damage and are public safety risks, the complete removal of the structures can be the only viable option.

4.5.2 Advantages for Public Trust Interests

In addition to addressing public safety risks, managed retreat projects can benefit multiple Public Trust interests, notably preventing or reversing coastal squeeze and the loss of Public Trust tidelands, increasing recreational opportunities, and accommodating ecological preservation.

After structures have been removed or relocated, many managed retreat projects in California have created new opportunities for beach access, coastal trails, and restoration projects. Before the removal of Stilwell Hall and a rock revetment at Fort Ord (Figure 12), the revetment and coastal squeeze blocked lateral beach access and eliminated any usable beach space. After the removal, the beach naturally restored itself and became a wide usable beach, and the site was redeveloped into Fort Ord Dunes State Park (Lester, Griggs, Patsch, & Anderson, 2022).

The restoration of Surfer's Point in Ventura is another example of a managed retreat project that benefited Public Trust interests by relocating a damaged bike path, restoring dune habitats, and protecting a popular surfing destination.

4.5.3 Disadvantages for Hazard Mitigation

Managed retreat projects face many hurdles that can complicate or delay their implementation. The projects can be expensive, take a long time to design and implement, and require complex negotiations with many stakeholders.

Some properties may lack the inland space needed to relocate structures, which can complicate managed retreat efforts by requiring land acquisitions or

negotiations with neighboring landowners. Without available relocation options, the removal without relocation may still be necessary but would result in a loss of the functions and services provided by the structures.

Strategies for managed retreat, such as removal and relocation, might not be feasible for coastal-dependent locations, like ports and other working waterfronts, that cannot be relocated inland. Some of these locations will continue to depend on hard armoring to accommodate their coastal-dependent uses and protect the supporting facilities and assets. Not only does relocation conflict with their coastal-dependent uses, but the cost of moving port infrastructure can also be prohibitive.

Regulatory tools, like setbacks, can require costly monitoring and enforcement programs to ensure compliance and be effective in achieving the long-term goals of managed retreat. Relocation and realignment projects can be costly for the asset owners due to the prolonged planning and design processes, as well as land acquisitions if necessary.

4.5.4 Disadvantages for Public Trust Interests

The removal of coastal-dependent structures that serve Public Trust uses, like ports, marinas, harbors, and their protective devices, will almost certainly conflict with the public and state interests that rely on commerce, navigation, or fishing. For example, a breakwater that protects a harbor also protects the Public Trust uses of the harbor for navigation and fishing, and therefore managed retreat strategies may not be appropriate for such structure.

4.5.5 Recommended Locations and Considerations

Managed retreat should be considered the long-term goal for all vulnerable structures that feasibly can be relocated or removed, are not coastal dependent, and are not critical for protecting Public Trust uses. Where applicable, the planning for long-term retreat should start during the planning and implementation of short- and mid-term strategies, such as accommodation or protection strategies. Managed retreat projects should also include plans for the reuse or restoration of the land previously occupied by the structures to achieve the maximum public benefits.

4.6 Phased Adaptation Approaches

All or some of the aforementioned strategies can be used with a phased adaptation approach, which is encouraged when developing a plan for sea level rise. Many of the strategies can be implemented concurrently or can be staggered into short-, mid-, and long-term time frames.

Short-term strategies, such as protection and accommodation strategies, can be used to allow for continued use of coastal structures during the planning,

permitting, and implementation of mid- and long-term strategies. For example, the City of Santa Monica created policies to guide implementation of accommodation strategies, like elevating and flood-proofing buildings, but have also established managed retreat policies to prepare for mid- to long-term risk.

Hard armoring should only be used short-term if transitions to nature-based solutions or managed retreat are feasible mid- or long-term strategies. For structures that are not coastal dependent, the long-term strategies will likely need to include some form of managed retreat or realignment since they are often the only strategies that can adequately adapt to long-range sea level rise projections.

The timelines for transitions between phases should be based on measurable thresholds that trigger specific actions. The thresholds could be based on increases in sea levels, amounts of erosion, or the frequency of damages or flooding. Monitoring programs are also needed to identify when thresholds are met. The timelines for transitions should not be based on future dates since hazards from sea level rise and extreme weather events can occur sooner than what is expected during the planning process.

5.0 Recommendations

Through its management of the state's Public Trust lands, the Commission has the responsibility to ensure that shoreline adaptation projects on Public Trust lands are in the best interest of the state. As sea level rise alters California's coastline and increasingly threatens Public Trust lands, assets, and resources, the Commission must also continue to adapt its processes and procedures for managing its Public Trust lands. From decades of research and evidence, the scientific community and the Commission now understand that traditional approaches to shoreline protection, including armoring, are not always suitable and can have serious negative effects on Public Trust resources. The Commission's historical processes and procedures for leasing can be augmented to incentivize best practices that protect and balance public interests while minimizing negative effects to Public Trust resources. This section provides recommendations to improve the Commission's procedures for processing lease applications for shoreline adaptation structures. Note that these recommendations do not change the case-by-case analysis associated with the existing lease application review process nor do they alter the Commission's discretionary decision-making. Most of these recommendations will require additional resources or support, such as funding, staff, legislation, or collaboration with other agencies to put them into practice since the Commission currently lacks the necessary resources, staffing, or authority to

implement the recommendations alone. The recommendations identify where additional resources or support are required to implement them successfully.

5.1 Recommendations for surveys and mapping

The ambulatory boundary between privately owned uplands and Public Trust boundaries is shifting landward as sea levels rise. The management of the shoreline depends on the allocation of responsibilities between public and private property owners, and it is therefore important to understand where the boundaries are and how they are changing over time to inform our adaptive management decisions.

1. Identify vulnerable shorelines to prioritize for tideland surveys.

Commission staff should identify discrete areas of shoreline throughout the state that are highly vulnerable to sea level rise and have significant lease interests. Staff should cross-reference those areas with available boundary and lease information to better understand the site-specific characteristics of the areas and identify data gaps, particularly in tideland surveys. Staff should engage local trustees of granted state lands, CCC, and BCDC to share and collect relevant data and records of tideland surveys, creating more comprehensive resources to analyze shoreline vulnerabilities. This proactive effort will help staff recognize which coastal areas would be most sensitive to the adverse impacts of hard armoring for shoreline protection strategies and can inform decision-making for adaptation in those areas. Completing this action will also inform and focus efforts to obtain additional resources, including personnel, that will be needed to perform more tideland surveys (see Recommendations 2 and 3 below).

2. Seek sustained funding for tideland surveys.

Staff should research and propose funding strategies that could be pursued to secure consistent resources for tideland surveys. Strategies could include seeking support from the state's budget process, federal government grants, and innovative partnerships with non-governmental partners such as academic institutions and organizations that support coastal resiliency. Currently, there is no dedicated funding source to conduct surveys and determine the location of tidelands along the coast. The rate of sea level rise is accelerating, and so is the rate of shoreline change. Determining the location of the tidelands and the Commission's jurisdiction is an important component of identifying impacts to Public Trust lands and resources, as well as planning for their adaptation and protection. Determining the location of tidelands will sometimes require conducting MHTL surveys, which can be performed by any California licensed Land Surveyor with an expertise in water boundary surveys, not only Commission

staff. In other instances, identifying the location of the tidelands will require in-depth studies and review of historical records and information to understand where the last natural location was of the Ordinary High-Water Mark – this is specialized work that must be performed by Commission staff.

- 3. Seek funding to study the existing shoreline infrastructure in areas identified as highly vulnerable to sea level rise with significant leasing interests.*

Staff should seek funding for a study of the existing infrastructure in areas identified in Recommendation 1. The purpose of this study would be to better understand from a representative sample area or areas what structures are under lease, how many structures are unleased but located on state tidelands, and the implications for future enforcement activities. The study should also consider the function of each structure and whether the function is consistent with the Public Trust, or not. Combining this data will yield important information for estimating future enforcement resource and capacity needs. Enforcement of the Commission's authorized jurisdiction in these areas will constitute a critical opportunity for education and outreach to property owners adjacent to state tidelands about the risks of sea level rise and climate change, the imperative to protect Public Trust resources and state tidelands, as well as the options available for flood protection, shoreline stabilization, adaptation, and resiliency. As a next step, Commission staff could coordinate with the CCC and local governments to identify the structures that could soon be located on tidelands, based on proximity to the MHTL and projections for sea level rise, and prioritize them for more frequent boundary surveys in the future. Staff should research LCPs and Local Hazard Mitigation Plans, where structures adjacent to vulnerable shorelines are likely already identified.

- 4. Complete a regional GIS inventory of state tidelands as a proof of concept to inform planning for a statewide inventory.*

Staff should work with the CCC to complete a GIS inventory of state tidelands in a discrete region of the open coast. This proof of concept should identify the resources required and actions needed to create a GIS map that depicts the location of state tidelands in a distinct area that can be periodically updated with the results of new boundary surveys. The map can help Commission staff identify encroachment and potential impacts to public interests, like blockage of coastal access. The lessons learned from this effort should inform a subsequent plan to complete a statewide inventory of tidelands. New funding may be required to implement this recommendation.

5.2 Recommendations for coordination and resource management

- 5. Avoid boundary line agreements.*

The Commission should avoid boundary line agreements that will not accommodate the landward migration of the Public Trust tidelands and result in the losses of Public Trust resources and uses.

6. *Enhance coordination with the CCC to monitor and identify development on state tidelands.*

Commission staff should coordinate with the CCC, including their Enforcement Program staff, to monitor and identify development located on or directly adjacent to Public Trust tidelands before the structures begin to impair Public Trust resources. Explore options for improving monitoring of the ambulatory MHTL, including remote sensing methods and periodic boundary surveys, to proactively identify development that may become located on state lands.

7. *Continue the Public Trust Coordination Project with the CCC.*

Staff coordination between the two agencies should continue under the 2019 Memorandum of Understanding (MOU), to work on current, near-term, and long-term needs and goals related to the protection and adaptation of Public Trust lands, uses, resources, and values under our respective jurisdictions. The MOU should be updated at least once every five years. In the past, this project was funded by a multi-year grant from the NOAA and resulted in numerous deliverables that strengthen collaboration and coordination, including the signed MOU in 2019. The project's federal funding expired in June 2023; however, both Commissions are still actively implementing the MOU and continuing to coordinate on shoreline management. Coordination with the CCC should continue to happen early and often in the lease application review process and through the development of lease terms for shoreline protection strategies and structures. Alignment of lease terms and permit conditions will benefit lessees and the public by emphasizing shared principles and policies and reducing unintentional discrepancies around similar requirements for compliance.

8. *Establish notification protocols with the CCC for emergency Coastal Development Permits issued for shoreline protection devices.*

Commission staff should establish a notification system or protocol with CCC staff when emergency permits are issued so that staff can follow up with potential lessees regarding submittal of lease application materials for any permanent structure or activity on state lands. During many storm seasons, the CCC and local authorities with approved Local Coastal Programs issue emergency Coastal Development Permits for shoreline protection devices and other coastal flood management strategies. The Commission should be notified

about these permits and the structures or actions that they authorize on state lands.

9. Participate in local planning related to shoreline management.

Commission staff should engage in local planning for shorelines as stakeholders to better understand and influence policies and ordinances related to land use on state lands and adjacent uplands. Commission staff, local jurisdictions, and other coastal management state and federal agencies should collaborate to explore the use of nature-based strategies for shoreline protection when possible and align management actions with the state's principles, policies, and guidance for sea level rise, centering environmental justice and equity considerations and solutions. It is critical to coordinate the management of shorelines with the local communities and jurisdictions that share these lands and resources. Many trustees of state lands are local government jurisdictions like cities and counties or special districts like ports and harbors and are engaged in coastal planning that integrates sea level rise, flooding, and erosion into shoreline management decision-making processes and plans. Additional funding may be needed to support staff's participation in local planning.

10. Create a proposal for a potential interagency working group to develop specific and detailed guidance for implementing shoreline protection and adaptation strategies.

Commission staff should create a scope of work for a potential interagency working group to guide implementation of strategies that will protect and adapt Public Trust lands and resources to the greatest extent possible. These strategies should minimize erosion to beaches and other coastal habitats, reduce flooding hazards to upland areas, and produce multiple environmental and community benefits, such as increasing public access and recreation space. Shoreline management and land use planning is becoming increasingly complex due to climate change; at stake are critically important Public Trust lands, uses, assets, resources, and values. As sea level rises and the storm season intensifies, it is likely there will be an increase in lease and permit applications to install new shoreline protection structures and fortify existing ones where there is upland development. A working group, potentially associated with the existing Sea Level Rise State and Regional Support Collaborative interagency group, should offer financial planning, technical design, and environmental impact analysis guidance to applicants and resource managers responsible for issuing leases and permits. Potential collaborating agencies could include the CCC, BCDC, SCC, OPC, OPR, CNRA, Department of Insurance, DWR, CalOES, USACE, Department of Navy, FEMA, and NOAA, in addition to local trustees of state lands, other local coastal governments, tribes and tribal governments.

11. Partner with BCDC to create a San Francisco Bay Public Trust Lands Guiding Principles for Shoreline Adaptation.

Commission staff should partner with BCDC to create a San Francisco Bay Public Trust Lands Guiding Principles for Shoreline Adaptation. BCDC regulates Public Trust tidelands within the San Francisco Bay, issuing permits for activities and infrastructure located on tidelands and submerged lands. The Commission and BCDC need to coordinate closely to guide adaptation strategies for climate change and sea level rise that protect Public Trust lands and resources. BCDC is deeply engaged in sea level rise planning and adaptation work throughout the San Francisco Bay, leading the Bay Adapt program to create a Regional Shoreline Adaptation Plan. The goal of the Public Trust guiding principles will be to ensure alignment of lease terms and permit conditions for the protection of Public Trust lands and resources, particularly related to the planning and implementation of shoreline adaptation strategies. This effort will also guide local jurisdictions and trustees as they draft sea level rise plans pursuant to the recently enacted SB 272 (Chapter 384, 2023), which requires all local governments within BCDC's jurisdiction to create a sea level rise plan by 2034.

5.3 Recommendations for application review and leasing

5.3.1 Location and use preferences for shoreline adaptation strategies

12. Hard armoring

Commission staff should limit recommendations for approval of lease applications for hard armoring on state lands to locations where it is necessary to protect Public Trust assets, resources or critical infrastructure and less impactful strategies, like nature-based solutions, are not suitable. When hard armoring must be used, staff should recommend and incentivize hybrid designs where feasible that include nature-based components to soften the armoring and provide habitat to minimize adverse effects on Public Trust resources. Employ a multi-disciplinary staff approach to these applications to integrate scientific knowledge with land management considerations and ensure staff recommendations for Commission approval are consistent with state policy and further the implementation of this report.

13. Nature-based solutions

The Commission and staff should educate and work with applicants to encourage the use of nature-based solutions wherever possible, particularly in areas where Public Trust land is highly vulnerable to sea level rise, erosion, and the impacts of hard armoring. Nature-based solutions are often space-dependent and are not typically suitable in areas that are already constrained by dense urbanization or backed by industrial uses or critical infrastructure.

Though some nature-based solutions are difficult to appropriately scale to the protection of individual private upland property, like individual residences, other alternatives to conventional hard armoring should still be considered first for shoreline protection. Innovative approaches can be explored to increase feasibility and use of nature-based solutions. For instance, a group of private property owners seeking protection for their residences along the shoreline could partner voluntarily to use a nature-based strategy like a vegetated earthen berm, or a cobble-anchored dune, to provide protection and adaptive capacity to their upland properties that will also help reduce long-term erosion and beach loss. Early, coordinated planning among the interdisciplinary Commission staff teams and applicants can ensure that leases approved by the Commission are aligned with state policy and the Commission's strategic goals.

14. Sand retention

Commission staff should limit recommendations for approval of lease applications for new jetties and breakwaters to areas where commerce and navigation need to be prioritized and where nature-based solutions for wave attenuation and shoreline stabilization are insufficient or not applicable. Similarly, groins should only be installed to address erosion hotspots on beaches where nature-based solutions are inadequate or unsuitable and the potential impacts to downcoast areas are minimal.

15. Beach nourishment

Commission staff should ensure that beach nourishment projects are based on the most recent and best available science on sea level rise and aligned with regional coastal sediment management plans. If Commission staff receives applications where project plans, environmental review documents, and monitoring plans have been developed prior to 2018, staff should carefully review whether additional environmental review, project modifications, or additional or different monitoring should be recommended to reflect expected environmental conditions and impacts based on the state's most recent sea level rise science and guidance from OPC. Staff should also consider recommending 10–20-year lease terms, rather than longer lease terms, due to the uncertainty associated with long-term beach and shoreline conditions as well as sand supplies and should develop lease terms requiring updated analyses of sea level rise impacts each time a lease is up for renewal. The rates of coastal erosion are accelerating, as is the rate of sea level rise, and expected to continue to do so, which subsequently will shorten the amount of time a nourishment event is effective. This could lead to more frequent nourishment activity, and potentially greater volumes of sand extracted from offshore borrow, or source, sites than originally planned. In Southern California, offshore borrow sites are being depleted faster than sediment supplies from onshore can

replenish them. Whenever and wherever possible, dredged sediments should be beneficially reused before offshore borrow sites are utilized.

16. Accommodation

Commission staff should limit recommendations for approval of lease applications for *permanent* floodproofing strategies, building retrofits, and the use of pilings and other supports that elevate structures above the water to use for critical infrastructure and urban and working waterfronts that have coastal dependent structures that cannot be easily relocated or adequately protected with nature-based solutions. In other locations, accommodation strategies should be used for *temporary* protection while plans are developed to relocate upland structures away from flood hazards and rising seas.

5.3.2 Application review

17. Use this report for assistance in reviewing applications for shoreline protection structures.

Commission staff should consider the information in this report on the disadvantages and advantages, as well as potential adverse impacts, when reviewing applications for shoreline protection structures and use it to assist with analysis and potentially the development of related lease terms.

18. Evaluate the financial costs of impacts to Public Trust resources.

Commission staff may consider it appropriate to assess the value of the loss of Public Trust resources from the adverse impacts from shoreline protective structures. Any compensation based on that assessment would be separate from annual rent, which is a value assigned based on the occupation of space, or land, owned by the state. This form of compensation could be based on the value of lost Public Trust resources such as the disruption of natural shoreline processes, acceleration of long-term erosion, loss of beach and other critical habitats and corresponding ecosystem benefits, and impaired beach access and recreational uses. The economic value of those lost Public Trust resources and uses, which are not bought and sold through normal market activities, are not included in the market-based valuations that annual rents are based on. Since the state is not being compensated for it, the lost value is currently costs borne by the public for losing access, use, and ecosystem services of their Public Trust lands.

To estimate the loss of Public Trust resources from shoreline protective structures, staff may use a valuation methodology prepared by academic experts on beach recreation use economics and beach ecology, described in a 2015 CCC report titled "[Improved Valuation of Impacts to Recreation, Public Access, and Beach Ecology from Shoreline Armoring](#)." This valuation methodology offers an

approximation of the recreational and public access value associated with the footprint of the amount of state land the structure covers. It does not require the gathering of any additional data from the applicant; it is calculated based on the existing footprint of the structure, and from beach attendance data available in the 2015 CCC report. Attendance data and value per visit data may also be available in other scientific studies.

The report's methodology recommends the following formula to estimate annual recreational value of a beach:

Annual Recreational Value = (Day Use Value) x (Attendance Density) x (Square Footage of Beach Area)

This valuation methodology only measures certain impacts to Public Trust resources and is not comprehensive. It is not recommended for every project or lease with shoreline protection structures. It is recommended for those projects that have significant impacts that cannot be mitigated or reduced substantially through other actions, and in locations where recreation and public access are feasible and safe. It is not recommended for areas where conventional armoring materials and structures are necessary to protect critical infrastructure, public health and safety, and navigation. Coordination with the CCC and BCDC is strongly advised, depending on where the lease premise is located, because the permitting agency may have data specific to the structure that will inform the factors in the calculation and may be considering similar methodologies and fees; applicants should not be subject to duplicate fees for their impacts to Public Trust resources.

5.3.3 Hard Armoring:

19. Risk-management options

Commission staff should continue to negotiate with applicants to ensure hard armoring leases include protections and benefits for Public Trust resources impacted by armoring. These options should be explored and considered even if they are not required by CEQA; if CEQA has been required, there may still be additional actions the applicant can take to reduce impacts to Public Trust resources. In many instances, additional protections that reduce harmful impacts are the most effective tool to manage, maintain, and even enhance Public Trust lands, resources, and uses. The following Recommendations (19 – 24) are examples of options that can be considered to manage risk for most shoreline protection structures and strategies.

20. Design for reduced impacts

Staff should recommend to applicants that new structures should be designed to minimize impacts. New structures should use alternative materials to

conventional armoring and be nature-based wherever possible and feasible. When amending a lease or applying for a new lease for existing structures, applicants should be educated about the potential to incorporate non-conventional materials and nature-based features and encouraged to integrate those improvements in a redesign or expansion wherever possible. Examples include project design modifications that would:

- Provide improved public access at locations of existing structures or ensure public access at proposed new structures.
- Engage in sustained beach nourishment projects at the same location if feasible.

21. Lease Duration

Staff should recommend short-term leases (10 years or less) in most cases to allow for more frequent evaluation of leasing approval, terms, and Public Trust consistency.

22. Bonding

Staff should require bonding or other financial assurance to cover removal costs in case of lease defaults and abandonments.

23. Transition Planning

For leases of existing hard armoring that mainly protect structures that are not coastal dependent, the lessees should consider planning for transitioning the armoring to alternative shoreline protective strategies, such as nature-based solutions, that have less adverse impacts on Public Trust resources.

24. Monitoring

Lessees should submit pictures of the armoring and surrounding coastal area to identify potential structural damages, beach loss, or interference with Public Trust uses. Pictures should be submitted after major storms, earthquakes, and at the time of applications for lease applications. The information gathered can be informative for staff's review of future lease applications, evaluation of impacts to Public Trust resources, and consideration of relevant lease terms.

25. Removal of Hard Armoring

Commission staff should develop a decision-support framework that identifies thresholds for impacts to Public Trust resources that, when surpassed, initiate an analysis to determine if removing hard armoring is in the public's interests and will not increase the surrounding community's vulnerabilities to coastal hazards. The thresholds could be based on levels of erosion, damages to the structures or caused by the structures, public safety risks, or significant obstruction of public uses like beach recreation or lateral beach access. The framework can

integrate data from tideland surveys and mapping, permit compliance from other agencies, and monitoring information to assist in identifying substantial impacts to Public Trust resources and determining whether removal is necessary. Equity should be a core component of the framework to ensure that both the public's rights and the lessee's rights are upheld and considered equally. In addition to developing the framework, staff should compile current state and federal guidance, planning tools, grant opportunities, and other resources that lessees and applicants can use to assist them in transitioning to more resilient solutions for shoreline protection, including variations on the solutions discussed in this report.

If thresholds have been surpassed and analysis shows that removal should be triggered, Commission staff should review if any CEQA exemptions are applicable to expedite the removal process, such as restoration or emergency exemptions, and reduce costs. The costs for removal should be funded by the lessees, who are responsible for restoring the conditions of the lease premise at the end of their lease and would be required to provide financial assurance for the removal costs, per Recommendation 21.

The removal of hard armoring that substantially impairs Public Trust resources is the first step in the adaptation pathway for correcting maladaptation that exacerbates coastal hazards and sea level rise impacts. It does not signify the end of protection or the resignation of the upland property to coastal hazards. It can initiate the transition to alternative adaptation and protection strategies. While the Commission has rarely needed to take such measures in the past, they could become more necessary for future conditions created by a combination of hard armoring and higher sea levels.

5.3.4 Sand Retention:

26. Engineering report

Coastal engineers should assess if specific sediment management practices are needed, such as prefilling the updrift areas, bypassing, or backpassing, to minimize erosion of downcoast areas.

27. Monitoring

Monitoring should be required for all sediment management activities related to installed sand retention structures.

5.3.5 Nature-based solutions:

28. Incentivize nature-based solutions.

Incentivize nature-based solutions, including the addition of nature-based designs or materials to hard armoring, by considering the public and environmental benefits in the lease terms. Lease term incentives could include

longer leases, lower bonding amounts, and rent incentives. Staff should also share resources and information with lessees about the economic and environmental benefits of nature-based solutions that can support decision-making around construction, operation, and maintenance of shoreline protection structures. Commission staff should review if any CEQA exemptions are applicable, potentially related to the Cutting the Green Tape initiative or similar policies, providing an incentive in the form of reduced environmental review and permitting costs.

29. Monitoring

Monitoring is a critical component that should be required for most nature-based solutions due to their dynamic attributes that necessitate an adaptive management approach. Some projects that may be smaller in scale or less risky for location and case-specific reasons may not require the same level of monitoring as larger or more consequential projects. Elements of nature-based solutions for shoreline protection that can be monitored could include, but are not limited to, ecological impacts and benefits; impacts to Public Trust resources and uses, particularly those that are space-dependent such as recreation, fishing, and public access; the location of the ambulatory MHTL of the lease premise; erosion rates of the lease premise; and flood protection performance. Staff should determine which monitoring requirements are most appropriate and what reporting mechanisms, if any, are necessary. The scope of monitoring and adaptive management could be influenced by the potential for these activities to be funded by grants or included in publicly funded research and resiliency efforts.

30. Adaptive Management Plans

Adaptive management is an iterative form of resource management that relies on monitoring information to make decisions to achieve the highest performance possible and maximize benefits while minimizing impacts. Most nature-based solutions should be accompanied by an adaptive management plan because these strategies have dynamic attributes that are not static and change over time. The adaptive management plan should account for the anticipated changes over time to the lease premise from sea level rise and other climate change-related impacts such as increasingly frequent and intense coastal flooding and erosion.

6.0 Alignment with State Policy and Other State Agencies

The entire state of California, including state and local agencies, is mobilizing to protect its unique biodiversity, public health and safety, infrastructure, coastal access, and economy from the devastating impacts of sea level rise and

coastal hazards. With direction from [Executive Order S-13-08](#) (2008) and [Executive Order B-30-15](#) (2015), the Commission and other coastal management agencies are incorporating sea level rise into all decision-making and coordinating to develop statewide adaptation strategies. [Senate Bill 1](#) (Atkins, 2021) established specific goals for the state's adaptation to sea level rise, including protecting and enhancing the coastal environment, maximizing public access and recreational opportunities, considering Californians' social and economic needs, and encouraging state and local collaboration.

To achieve these goals, the Commission partners with 16 other state agencies in an interagency group to develop statewide guidance for sea level rise planning. The group has developed a set of [Sea Level Rise Principles](#) for aligning the state agencies' approaches to sea level rise planning and an [Action Plan](#) containing 80 actions for specific agencies to achieve over the next five years to address the urgent need for a safer, more equitable, and resilient coast.

Section 5 outlines the steps the Commission must take to implement the interagency principles and action plan and to increase alignment with state policies and other state agencies. The recommendations in Section 5.1 will provide the Commission with information about the location of Public Trust lands, which is critical to protect and adapt all resources within its jurisdiction. The recommendations in Section 5.2 will improve state and local coordination for adaptation planning and development of mutually beneficial uses of the coast. The recommendations in Section 5.3 will ensure that the best adaptation strategies are used to increase resilience while maximizing Public Trust interests, such as protecting the coastal environment, public access, and coastal-dependent development.

The Commission taking these steps is just one part of a greater effort by state and local agencies, who have also published reports in recent years detailing their individual plans to implement the state's sea level rise policies within their jurisdictions and authorities. The following subsections describe the other agencies that play a role in coastal management and their plans for improving the state's resilience to sea level rise.

6.1 Granted Lands

The California Legislature has enacted over 300 statutes that grant Public Trust lands to over 70 cities, counties, and port districts (referred to as grantees or trustees) to manage on the state's behalf for the people of California. The trustees must manage their granted lands in accordance with the uses permitted in each granting statute. Some grants authorize the construction of ports, harbors, airports, wharves, docks, piers, and other structures necessary to facilitate commerce and navigation. Other grants allow only visitor-serving

recreational uses or open space. As the land managers for their granted lands, the trustees have the authority to implement or, at their discretion, lease the Public Trust lands for shoreline adaptation projects. The grant's authorized uses typically influence the types of shoreline adaptation strategies used within the granted lands. Since some granted lands are used to facilitate maritime commerce, navigation, and fishing, they have many coastal-dependent assets and uses that are protected with hard armoring. Other strategies, such as nature-based solutions and managed retreat, can be incompatible for some trustees that lack the necessary resources and space to facilitate those strategies.

In 2022, the Commission released a report, [AB 691 – Proactively Planning for Sea Level Rise on Granted Public Trust Lands](#), that summarizes sea level rise adaptation plans trustees submitted to the Commission. In their submissions, the trustees primarily detailed short-term strategies to maintain their existing hard armoring and repair or replace damaged assets as needed. Some trustees described plans to explore nature-based solutions, like living shorelines. The Port of San Francisco and Port of San Diego have installed pilot projects for living seawalls that augment hard armoring with nature-based designs to provide habitat for marine species.

Most trustees acknowledged that their adaptation plans would eventually need some form of managed retreat or realignment. Their plans for retreat were often hybrid strategies that would use protection and accommodation strategies to mitigate the short-term risks and buy time until managed retreat strategies could be implemented to address the long-term risks.

6.2 California Coastal Commission

CCC regulates development along the California coast. Through its authority designated by the California Coastal Act, the CCC plans and regulates land and water use in the coastal zone³¹. Development activities within the coastal zone must be permitted by the CCC or local governments with certified Local

³¹ The coastal zone is defined in Section 30103 of the Coastal Act and generally spans 1,000 yards inland from the MHTL to three miles into the ocean at the state-federal water boundary. In some places where there are intact important coastal habitats, like wetlands, the coastal zone reaches further inland, up to five miles from the MHTL; in other places that are highly urbanized and developed, the coastal zone does not extend as far as 1,000 yards inland. Learn more about the coastal zone here:

https://documents.coastal.ca.gov/assets/our-mission/Coastal_Zone_Slide_Show.pdf.

Coastal Plans. Many of the same shoreline protection structures that are leased by the Commission are also evaluated and permitted by the CCC, regulating aspects of the structures' design, location, and function.

6.2.1 California Coastal Act of 1972

The Coastal Act³² has multiple policies related to shoreline adaptation strategies, including those that protect coastal access and marine habitats and restrict certain development activities.

Section 30253 of the Coastal Act generally disallows new development from relying on hard armoring for stability, but Section 30235 of the Coastal Act requires the approval of hard armoring if it is necessary for protecting coastal-dependent uses, beaches, or existing structures if it is the least environmentally damaging feasible alternative, and all coastal resource impacts are mitigated. When armoring is allowed, it must meet specific conditions to address the impacts on coastal resources.

Relevant to rock revetments and some nature-based solutions, section 30233 of the Coastal Act restricts the placement of sediment or other materials in waterways unless it is the least environmentally damaging option and includes mitigation measures to minimize environmental impacts. It must also be for specific purposes, including protecting or maintaining coastal-dependent facilities, providing incidental public services, maintaining or restoring navigational channels, providing boating-related facilities for public access and recreation, or restoration projects. This section generally disallows the placement of rocks for revetments to protect residential development unless the development predates the Coastal Act (pursuant to section 30235). But the placement of sand for nature-based solutions, such as dune restoration or beach nourishment, may qualify as restoration activities in some circumstances and be allowed.

Coastal Act section 30240 requires the location and design of new development to prevent impacts to adjacent sensitive habitats and recreation areas and allow those areas to persist into the future. Because of the effects armoring and long-term accommodation strategies, like elevating houses on pilings, have on adjacent habitats and recreation areas by preventing their landward migration, such strategies may be incompatible with this section of the Coastal Act.

6.2.2 2015 Sea Level Rise Policy Guidance

In 2015, CCC adopted [Sea Level Rise Policy Guidance](#) that provides methods for addressing sea level rise in CCC's regulatory and planning actions. The

³² Pub. Resources Code § 30000 et seq.

guidance, which was then updated in 2018, is for CCC, local governments, and other stakeholders, focusing on how they can apply the Coastal Act towards addressing sea level rise through the certification of Local Coastal Programs and decisions regarding Coastal Development Permits. The guidance reviews sea level rise science, adaptation strategies, the impacts on coastal communities and coastal resources, and step-by-step processes for preparing and reviewing Local Coastal Programs and Coastal Development Permits. Also included is a legal review of the Coastal Act regarding sea level rise adaptation planning.

6.2.3 Critical Infrastructure at Risk

In 2021, CCC adopted [Critical Infrastructure at Risk: Sea Level Rise Planning Guidance](#) to promote resilient coastal infrastructure, including water and transportation infrastructure. The guidance recognizes that coastal communities depend on such infrastructure, so the consequences posed by rising sea levels and related coastal hazards towards critical infrastructure are high.

Recommendations in the report include:

- Consider phased adaptation pathways that are based on triggers.
- Site infrastructure away from hazards
- Where feasible, prioritize nature-based solutions over hard armoring.
- Where armoring must be used, mitigate the adverse impacts to coastal resources and require planning to identify long-term solutions that are most protective of coastal resources.
- Address the disproportionate burdens and benefits to tribal and environmental justice communities.

6.2.4 Public Trust Guiding Principles and Action Plan

In 2023, CCC adopted the [Public Trust Guiding Principles and Action Plan](#), a draft report that describes how the Public Trust Doctrine relates to the CCC's work on sea level rise planning. The report details how sea level rise affects Public Trust resources and uses due to the landward migration of tidelands and the related impacts caused by coastal development such as hard armoring. CCC lists guiding principles, including that the boundaries of Public Trust lands are ambulatory and upland owners cannot unilaterally and permanently prevent the landward migration of Public Trust lands with hard armoring. The report encourages the use of nature-based adaptation strategies because of their ability to address hazards and provide many benefits for Public Trust uses and values.

The report also provides the following steps CCC will pursue in collaboration with partner agencies to carry out the Public Trust Doctrine and the Coastal Act:

1. Participate in the development of interagency principles on sea level rise and the Public Trust doctrine.

2. Consult and coordinate with California Native American Tribes.
3. Continue working with local governments to update local coastal programs to address sea level rise, and include considerations for Public Trust lands and resources.
4. Conduct coordinated outreach, engagement, and public education.
5. Continue to analyze the impacts of residential-related development on Public Trust resources, uses, and needs.
6. Identify development and decisions, such as boundary line agreements, that result in coastal squeeze leading to the loss of Public Trust lands.
7. Consider updates to Coastal Commission regulations relating to mitigation of the adverse effects of sea level rise on Public Trust lands.
8. Complete a GIS inventory of public tidelands.
9. Explore alternatives for determining the mean high water elevation.
10. Evaluate new technologies for locating the boundary between public tidelands and private uplands.

6.3 San Francisco Bay Conservation and Development Commission

BCDC was established as a state agency in 1965 with the passage of the McAteer-Petris Act. BCDC is charged with preparing a plan for the long-term use of the San Francisco Bay, known as the [Bay Plan](#), and regulating development in and around the Bay. BCDC also exercises authority under Section 307 of the federal Coastal Zone Management Act in overseeing federal development projects or projects supported by federal funding. BCDC is the lead state agency responsible for preparing the Bay Area for the impacts of rising sea levels and storm surge due to climate change. BCDC leads the [Adapting to Rising Tides Program](#), a hub for local governments and communities to find planning guidance, tools, and information to address climate change and sea level rise risks and adaptation needs. [Bay Adapt](#) is BCDC's initiative to establish regional agreement on the actions necessary to protect people and the natural and built environment from rising seas. Through this initiative, [Guiding Principles](#) for Bay Area adaptation have been established and a [Joint Platform](#) of priority actions has been adopted, along with a commitment to act together as a region. These actions align with the state's Sea Level Rise Principles, as well as with many of the recommendations of this report.

6.3.1 Innovative Adaptation and Nature-Based Solutions

[BCDC's Bay Plan, Climate Change Policy 5](#) states that "wherever feasible and appropriate, effective, innovative sea level rise adaptation approaches should be encouraged". These types of approaches are defined as those that minimize public safety risks and impacts to critical infrastructure, are compatible and

integrate with natural processes to the maximum extent feasible, are resilient and adaptively managed. In further support of this policy, the Bay Plan's Shoreline Protection Policy 5 also requires consideration of nature-based features in all shoreline protection projects to the greatest extent practicable. In practice, BCDC staff may request a proponent consider certain types of nature-based shoreline protection mechanisms, and likewise, the project proponent may share an analysis regarding the suitability of nature-based approaches that are being considered.

6.3.2 Hard Armoring

If a project proposes shoreline protection, BCDC staff must consider a variety of factors outlined in the Bay Plan's Shoreline Protection Policy 1, including:

- The protective structure's suitability for the site and project type
- Proper engineering to provide erosion control and flood protection based on a 100-year flood event and sea level rise projections
- Limited physical and visual public access impacts
- The structure is integrated with nearby shoreline protection measures.
- Adverse impacts on nearby areas are minimized.

Project applicants are required to evaluate and address adverse impacts caused by shoreline protection projects to nearby areas. This is based on BCDC's climate change analysis, recognizing, in part, that some hardened shoreline protection structures intensify wave reflection and contribute to shoreline erosion. BCDC highlights the need to design projects that minimize these impacts, particularly when these sites are adjacent to lower-income and vulnerable communities. Therefore, nature-based solutions that will minimize these effects are favored. If the protection proposal does not fully avoid adverse impacts to surrounding communities, compensatory measures may be required.

6.4 California State Coastal Conservancy

The SCC is a non-regulatory agency that supports projects that protect coastal resources and public coastal access in California. It is among the most critical agency responsible for advancing the use of nature-based strategies for shoreline protection because it regularly invests in the conservation of existing coastal ecosystems and habitats that are crucial areas for climate change adaptation and resiliency, and it supports many pilot projects that demonstrate the design and effectiveness of alternative shoreline protection strategies, like living shorelines.

According to the Conservancy's [2023-2027 Strategic Plan](#), the agency will focus its Climate Ready Program funds and technical support on climate resilience

projects, prioritizing nature-based adaptation projects where feasible. In recent years, the Conservancy has invested in nature-based strategies for shoreline protection by granting funds to cities and counties for plans, designs, environmental review, and permitting costs of alternative approaches to conventional hard armoring, including living shorelines and rolling easements on private uplands that conserve space for the future landward migration of the shoreline. The Conservancy prioritizes funding for communities that are most vulnerable to climate change impacts.

6.5 California Department of Parks and Recreation

The California Department of Parks and Recreation is another significant partner in shoreline management, managing nearly one quarter of the coast within 128 coastal and marine parks³³ and many hundreds more that surround rivers and lakes. In their [Sea Level Rise Adaptation Strategy](#), the agency highlights that “nature-based green infrastructure that conserves natural processes, resilient infrastructure that accommodates sea level rise, and managed retreat, where necessary, will generally be preferred alternatives to hard armoring in the long-term management of coastal park units”.

6.6 California Department of Transportation

The California Department of Transportation manages many transportation routes along the shoreline, from major highways to public transit lines to smaller coastal access roads. The agency is engaged in long-range sea level rise planning and identifying adaptive solutions that can ensure the protection and safety of transportation for decades into the future. Caltrans highlights that incorporating sea level rise considerations during all phases of a relevant Caltrans project is necessary to ensure safe and resilient transportation infrastructure. The agency has acknowledged the adverse impacts of hard armoring on coastal resources and is working on pilot adaptation projects to identify natural infrastructure design solutions. See [Climate Change Adaptation Strategy Report](#) at page 95.

6.7 Ocean Protection Council

OPC was created in 2004 to protect California's coast and ocean by advancing science-based policy and management, making strategic investments, and facilitating partnerships and collaboration. By coordinating the state's sea level rise interagency working group (California Sea Level Rise State and Regional

³³ Coastal state parks with land area below the MHTL generally have leases from the Commission or a local trustee for the state lands within the park area.

Support Collaborative), OPC plays a central role in developing statewide sea level rise policy guidance and ensuring alignment between state agencies. Pursuant to [SB 1 \(Atkins, 2021\)](#), OPC is also responsible for overseeing the disbursement of grants to local and regional governments for incorporating sea level rise adaptation into their land use plans.

6.7.1 Principles for Aligned State Action (2020)

In 2020, OPC convened 17 state agencies, including the Commission, to develop [Sea Level Rise Principles](#) for use in planning, policy setting, project development, and decision making. The principles enable California to scale up coastal resiliency efforts through aligned strategies that create consistent, efficient decision-making processes and actions coastwide while improving collaboration across state, local, tribal, and federal partners. The Commission, as one of the 17 agencies that collaborated with OPC, is committed to integrating the principles into its actions and decision-making related to sea level rise. As such, the principles were integral in the drafting of this report and its recommendations.

The principles include:

1. Develop and Utilize the Best Available Science.
2. Build Coastal Resilience Partnerships
3. Improve Coastal Resilience Communications
4. Support Local Leadership and Address Local Conditions
5. Strengthen Alignment around Coastal Resilience
6. Implement and Learn from Coastal Resilience Projects
7. Integrate and Prioritize Equity and Social Justice

6.7.2 State Agency Sea-Level Rise Action Plan

Developed through collaboration with 17 state agencies, the [State Agency Sea-Level Rise Action Plan](#) outlines a five-year roadmap toward coastal resiliency for the state of California. The actions in this plan address urgent needs by identifying proposed new and ongoing work that will be leveraged in the next five years. The Action Plan includes over 80 trackable actions, covering both a regional and statewide scope. It is structured around each of the seven [Sea Level Rise Principles](#), and identifies the necessary goals, actions, metrics of success, timelines, and lead agencies for effectuating each principle.

The Commission is identified as a lead agency for eight actions. This report and its recommendations are intended to help the Commission fulfill its responsibilities for certain actions, including:

- **Action 1.11:** Apply the best available sea level rise science and use innovative technologies to analyze the current and expected future

location of the ambulatory mean high tide line or zone at a variety of locations, and the implications to Public Trust lands, uses, resources, and assets.

- **Action 2.7:** Develop resources to inform decisions that protect and adapt Public Trust lands, assets, and uses, from the impacts of SLR.
- **Action 5.5:** Develop shared state agency principles on the protection of Public Trust tidelands.
- **Action 7.2:** Develop and/or support policy guidance for incorporating Environmental Justice and tribal cultural resources into local planning and adaptation policy that is consistent with the Coastal Act, SB 1000 (Leyva, 2016) and the McAteer Petris Act.

6.8 California Natural Resources Agency

The California Natural Resources Agency (CNRA) leads the State's efforts to restore, protect, and manage the state's natural, historical, and cultural resources for current and future generations. CNRA oversees and supports more than 26 distinct departments, commissions, and conservancies, including the State Lands Commission. CNRA has been integral in identifying strategies for building resilience to climate change, expanding nature-based solutions, and protecting the rights of Californians to access and enjoy California's public lands and natural resources.

6.8.1 Climate Adaptation Strategy (2021)

The [California Climate Adaptation Strategy](#) (Strategy), mandated by Assembly Bill 1482 (Gordon, 2015), links together the state's existing and planned climate adaptation efforts, showing how they fit together to achieve California's six climate resilience priorities. The priorities include:

1. Strengthen Protections for Climate Vulnerable Communities
2. Bolster Public Health and Safety to Protect Against Increasing Climate Risks
3. Build a Climate Resilient Economy
4. Accelerate Nature-Based Climate Solutions and Strengthen Climate Resilience of Natural Systems
5. Make Decisions Based on the Best Available Climate Science
6. Partner and Collaborate to Leverage Resources

To achieve each priority, the Strategy identifies specific goals, actions, success metrics, and lead agencies. For example, the Strategy identifies the Commission as a lead agency for increasing the pace and scale of nature-based solutions, and the success metric is the number of lease applications that incorporate nature-based solutions.

6.8.2 Natural Working Lands Climate Smart Strategy

In 2022, CNRA released the [Natural Working Lands Climate Smart Strategy](#) to align state efforts for harnessing nature-based solutions across California's natural and urban landscapes to deliver multiple outcomes, including addressing climate change, improving public health, increasing equity, and protecting biodiversity. The Natural Working Lands Climate Smart Strategy identifies the protection and sustainable management of coastal wetlands, beaches, and marine habitats as critical for supporting the resilience of coastal communities and economies. This report and its recommendations can help the Commission achieve many strategies that were identified in CNRA's Natural Working Lands Climate Smart, including:

- Increase use of living shorelines, which are protected, stabilized shorelines constructed with natural materials. Living shorelines include a variety of strategies including beaches and vegetated dunes. Living shorelines can sequester carbon and maintain carbon stores of the wetlands they protect, build resilience to sea level rise, improve water quality, and provide habitat.
- Identify beach and dune habitats that are vulnerable to sea level rise and develop approaches for addressing loss of these habitats, including removing barriers and protecting buffer areas on adjacent undeveloped lands to allow for inland migration.
- Integrate nature-based climate solutions into (new and retrofit) community infrastructure investments.
- Protect landscapes that deliver multiple ecosystem services, are resilient and likely to persist under future climate conditions, and have high carbon storage capacity.
- Conserve established and potential climate change refugia and corridors, facilitating migration, range shifts, and connectivity to support biodiversity.

6.8.2 Outdoors for All

Outdoors for All is an initiative championed by Governor Newsom to recognize that many Californians do not have equitable access to nature and the outdoors. Outdoors for All is expanding parks and outdoor spaces in communities that need them most, supporting programs to connect people who lack access, and fostering a sense of belonging for all Californians. In 2023, CNRA released the [draft Outdoors for All Strategy](#) to chart progress on equitable outdoor access, highlight work underway, and identify additional actions to realize the promise of a California for All. Like this report and its recommendations, the draft Outdoors for All Strategy is focused on protecting public outdoor spaces for California's diverse communities, prioritizing nature-based solutions to protect public access, and recognizing the importance of

outdoor spaces for recreation, education, public health, and fostering communities.

7.0 Conclusion

The shoreline is rapidly changing due to climate change, and the Commission must shift its approach to managing Public Trust lands, uses, resources, and values along the water's edge so that it can proactively protect and adapt them to be more resilient to these challenges. Whenever possible, the Commission will strive to incentivize and promote the use of nature-based strategies for shoreline protection to reduce impacts to Public Trust lands from erosion, flooding, and development. The Commission should invest in and commit to relationship-building and collaboration with local resource managers, property owners, and stakeholders because solutions will be more effective if decision-making is aligned, coordinated, and reflects the values and needs of the community.

8.0 Report Preparation and Acknowledgements

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10.0 Appendix A – Lease Application Review Process

Shoreline Protection Structure Inventory

Presently, the Commission has 707 shoreline protection structures under lease. There are 138 leases on the open coast and 569 leases on inland waterways, including navigable rivers and lakes. There is one lease premise that has a shoreline protection structure that borders one side of a river mouth and the coast. Staff will develop a report similar to this one regarding recommendations for lease applications for shoreline protection of inland waterways.

Application Submittal & Processing Steps

Applicants can submit lease applications and inquiries regarding the status of the Commission's jurisdiction for a certain area of land through an online portal, the [Online System for Customer Applications and Records](#) (paper applications are also still accepted and are available for download or by calling the Commission office).

Each application requires a non-refundable filing fee and an Approximate Expense Deposit. The Approximate Expense Deposit reflects the typical staff costs to process a routine application. Actual staff costs may be more or less than the deposit. These fees are separate from and in addition to any charges for occupation or use of state land. Any unused amount is refunded to the Applicant at the finalization of the application process. If there are charges remaining, it is the Applicant's responsibility to pay the balance.

Staff reviews the proposed project to determine the necessity of the project with consideration of alternatives to the proposed project. Staff analyzes whether the proposed use or activity is in the state's best interest and takes the below items into account:

Title/Boundary Review of Tidelands and Submerged Lands

Staff conducts a review of historic maps, title records, and MHTL surveys (in tidally influenced areas) or Ordinary Low Water Mark surveys (in non-tidal waterways) to determine the [land and resource interest](#) and extent of state land and resources impacted by the proposed use.

Environmental Review

Staff evaluates the potential for environmental impacts from the proposed activity or use and the need for mitigation measures to reduce or minimize impacts, consistent with CEQA and examines potential impacts from climate change and sea level rise on the proposed use.

Public Trust Analysis (as applicable)

Staff assesses whether the proposed use is consistent with the Public Trust Doctrine. If a proposed activity or use is inconsistent with the Public Trust, staff may recommend that the project be revised or may recommend that the Commission deny the application.

Best Interests of the State

Staff conducts a qualitative analysis of the broader public costs and benefits of the proposed activity, including but not limited to review of sustainability, resiliency, enhancement, responsible economic development, equity, and the promotion of public access to determine if the proposed use is in the best interests of the state.

Regulatory Compliance

Staff reviews the proposed activity or use to ensure all necessary permits/leases and authorizations have been obtained or are in the process of being obtained. Most leases for the use of state lands require approvals from other agencies and the city or county where the proposed lease area is located.

Tribal Outreach and Consultation

Staff conducts outreach and consultation with tribal governments that may be impacted by the proposed use in accordance with statewide policies (Executive Orders B-10-11 and N-15-19), the Commission's Strategic Plan, the Commission's Environmental Justice (2018) and Tribal Consultation (2016) Policies, and CEQA.

Environmental Justice

Staff reviews the proposed use to ensure it is consistent with the Commission's Environmental Justice Policy. Staff may recommend lease terms or conditions to ensure consistency with the Policy.

Commission Meeting

Staff will prepare a staff report for Commission consideration with a staff recommendation whether to approve or deny a proposed use and issue a lease or permit. The Commission considers the proposed application during a public meeting and decides whether to approve or deny the proposed lease or permit and under what terms and conditions. Contract documents, (e.g., the lease, memorandum of lease, etc.) are expected to be signed and returned by the Applicant before the Commission meeting.

The Commission holds public meetings throughout the year at different locations. All meetings are public, as required by the Bagley-Keene Open Meeting Act, and publicly noticed with an agenda posted on the Commission's website at least 10 days before the meeting. Staff reports are prepared for each

item and posted on the Commission's website. The Commission may only act on items that are on the agenda.

Rent Valuation

California Code of Regulations (CCR) §2003 (a) provides that rent or other consideration shall be in the best interests of the state and may be based on one or more methods. Rent may be discounted or waived for use of sovereign lands if the Commission, at its sole discretion, determines that a significant regional or statewide public benefit is provided or accrues from such use (for more information about rent valuation, see Section 2.3 of this report).

In 2001, staff presented a shoreline protective structures report to the Commission that responded to issues raised about the issuance of leases for the construction and maintenance of shoreline protective structures along open coastal waters. ([Item 92, September 17, 2001](#)). The report acknowledged that although, protective structures have a direct benefit to the adjoining property owner by providing protection and preventing erosion, there is an indirect public benefit, i.e., providing protection for public roads, highways, and utilities inland of the private property. In coastal areas, protective structures that are designed and located to protect the base of eroding coastal bluffs may also provide a measure of safety to the public by reducing the potential of bluff collapse.

At the same meeting, the Commission acted as follows:

- Direct staff to continue to cooperate with local, state, and federal agencies that regulate and permit shoreline protection structures.
- Continue to work with project proponents to redesign projects so that they will be located on private property wherever possible.
- Encourage and recommend soft solutions, such as sand replenishment, wherever possible. If soft solutions are not practical or possible and a hard structure is the only feasible alternative, to issue a protective structure lease based on a case-by-case basis, evaluating individual solutions to determine whether the construction of such a protective device will have an impact on: 1) the public's ability to utilize sovereign lands; 2) the environment; and 3) the Public Trust resources in the area. Where a protective structure would have an unmitigated adverse impact on the public's continued enjoyment of sovereign lands, and insufficient public benefit exists, the Commission is to retain the ability, depending on the feasibility of alternatives and severity of impacts to require mitigation or deny a project.
- Issue protective structure leases to public agencies and private parties where there is sufficient evidence that the structure will occupy lands

under the Commission's jurisdiction, charging rent consistent with existing regulations, waiving or adjusting rent to reflect the degree of public benefit that is derived.

- Direct staff to continue research and review of Commission practices to seek solutions that will protect sovereign Public Trust lands.

Based on these directions from the Commission, staff has issued leases for protective structures charging rent based on 9 percent of land value or a benchmark (if one exists), with a public benefit discount (if appropriate) for protective structures on the open coast.

For protective structures on inland waterways, Commission staff are to determine the level of public benefit conferred to determine the extent of rent. For protective structures that offer a primarily public benefit there is no rent. For protective structures that share a benefit, minimum rent is applied. For protective structures that offer primarily a private benefit, rent is assessed for the protective structure based on 9 percent of the land value (if the square footage of the structure can be determined).

Staff Closing Transaction

Staff will sign contract documents following the Commission authorization and receipt of the signed contract document from the applicant. Once all parties have signed the contract documents, staff will provide a copy to the lessee/permittee (previously applicant). If a Memorandum of Lease was required as part of the lease document, staff will send signed copies to the appropriate county recorder's office. Once the document has been recorded, staff sends a copy to the lessee for their records.

If the actual staff costs are less than the approximate expense deposit, staff will issue the applicant a refund. If staff costs exceed the deposit, staff will send an invoice for the balance due. Invoices and refunds may be sent up to 6 months after the Commission acts on an application.