



SEA LEVEL RISE ADAPTATION STUDY REPORT

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SEACLIFF STATE BEACH AND NEW BRIGHTON STATE BEACH

Sea Level Rise Vulnerability Assessment and
Shoreline Adaptation Alternatives



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List of Abbreviations

1LR	One-Lane Road
2LR	Two-Lane Road
ADA	Americans with Disabilities Act
AS	Adaptation Study
Approx.	Approximately
BE	Beach Erosion
CR	Cliff Retreat
CSP	California State Parks
DSM	Deep Soil Mixing
(F)	Facilities
Fm	Formation
ft	feet
H:V	{Slope} Horizontal:Vertical
IPCC	Intergovernmental Panel on Climate Change
MN	Moffatt & Nichol
OPC	{California} Ocean Protection Council
OT	{Wave} Overtopping
(P)	Parking
PD	Present Day
PD	Present Day
PVUSD	Pajaro Valley Unified School District
RV	Recreational Vehicle
SB	State Beach
SC	Seacliff
SLR	Sea Level Rise
SR	Shoreline Retreat
SS	Steam Ship
T	Trail
VA	Vulnerability Assessment
WR	Wave Runup

Executive Summary

This Sea Level Rise (SLR) Adaptation Study Report (ASR) presents SLR alternatives for Seacliff State Beach (SB) and New Brighton SB subareas, including New Brighton Beach, the former Seacliff RV Campground, Day Use Area, Rio Del Mar Esplanade, Rio Del Mar Beach, and the Platforms Parking Lot and beach. The adaptation alternatives presented are based on a broad range of possible SLR adaptation strategies rooted in the fundamental strategies to elevate vulnerable assets and facilities, protect these, or employ strategies for managed retreat to accommodate SLR and/or decommission or relocation of facilities. The driving factors considered in the study were categorized into permanent and temporary exposure of State Park assets to coastal processes and flood hazards exacerbated by SLR. The permanent exposure conditions considered include: 1) tidal inundation, 2) shoreline retreat, and 3) cliff retreat. Temporary exposure conditions considered include coastal flooding associated with 4) wave runup and 5) wave overtopping exacerbated by SLR and storm surge, and 6) temporary beach erosion resulting from storm events.

Adaptation strategies are incorporated via landscape elements, grouped by area of improvements and level of resilience as follows:

- A. **Cliff top.** i) Habitat enhancement to create new or improve existing habitat, ii) delineation of setbacks to limit public access and development in vulnerable cliff top areas, typically along the edge of the cliff.
- B. **Cliff face.** i) Erosion control planting over the talus deposits at the base of the cliff, ii) stabilization of the cliff by geotechnical engineering methods and/or supporting structures.
- C. **Back beach.** Protection via: i) seawalls, ii) rock slope protection, and/or iii) raising of vulnerable assets; and resilience-building via: iv) vegetated dune features, and v) shore platform enhancement.
- D. **Foreshore.** Resilience-building via: i) cobble enhancement¹, ii) beach nourishment, and iii) driftwood staking².
- E. **Offshore.** Resilience-building via: i) rocky reef habitat, ii) kelp forest, iii) groins to trap sand and retain a wider beach, iv) breakwaters³.

Pairing of the above landscape elements with possible adaptation strategies led to the development of three characteristic adaptation pathways for the subareas, as follows:

1. **Fortify & Protect.** Aiming to preserve State Park facilities, assets, and public amenities as they are present-day.
2. **Restore & Relocate.** A managed retreat strategy, aiming to relocate vulnerable State Park facilities to areas less susceptible to projected SLR, and phased relocation of built infrastructure for the purpose of gaining space for beach restoration and broader opportunities for public access, recreation, and water activities and aim for a shoreline environment better suited at accommodating the natural coastal processes.

¹ Note: Highlighted as being undesirable to Park visitors.

² Note: Potential use as a component of habitat restoration, but would not be used in isolation to avoid unnatural visual impacts.

³ Note: State Parks would not consider breakwaters as a potential landscape element due to cost, regulatory feasibility, visual impacts, and impacts to coastal processes and safety.

3. Hybrid Approach. Aiming for a balanced blend of adaptation strategies to address the vulnerability of State Park assets to SLR-related hazards with an emphasis on incorporating nature-based and living shoreline solutions where feasible.

In the process of development, the proposed adaptation alternatives were shaped by the feedback gained from public outreach to park visitors and local communities, and State Park policies and guiding principles for SLR adaptation strategies. The range of proposed adaptation alternatives were evaluated against a base case of taking no action to address projected SLR, and ranked across a broad range categories including:

- Level of protection and/or resilience to SLR offered by the proposed improvements, and potential for downcoast impacts.
- Ability to reduce flood hazards and mitigate wave runoff and overtopping, temporary beach erosion, and shoreline retreat as a result of SLR.
- The extent of beach and habitat created by the proposed alternatives.
- How alternatives support visitor values by improving scenic quality, opportunities for nature observation, physical and mental health benefits, public access for beach recreation and water activities, and opportunities for walking, hiking, running, bicycling, and camping.
- Permitting complexity and level of cost for capital improvements and maintenance. For most alternatives phased over an adaptation pathway to address 1 foot of SLR by 2050 (near term), 2 feet of SLR by 2070 (mid term), and 4 to 6 feet of SLR projected by the end of the century (long term).

Recommended Preferred Adaptation Alternatives

Based on feedback from the public outreach and engagement activities, SLR vulnerability assessment and adaptation alternatives development, the following recommended preferred adaptation alternatives were selected in consultation with State Parks. Refer to the Alternatives Analysis in Chapter 6 and the Storyboards in Appendix A for details.

New Brighton Beach – Hybrid Alternative

The Hybrid alternative combines strategies to maintain consolidated infrastructure while making room for coastal processes. They utilize both green and grey infrastructure. Presently, proactive adaptation planning can identify asset relocation areas and advance funding and design of facilities being relocated or fortified in place. In the near term, reduce the road extent to remove assets from hazardous areas and restore beach habitat. Construct a consolidated, fortified ramp to preserve pedestrian and vehicular access from the upper lot to the beach. Install native planting on the lower cliff face to provide erosion control.

Seacliff RV Campground – Hybrid Alternative

The Hybrid alternative combines strategies to maintain assets while making room for coastal processes. They utilize both green and grey infrastructure. Presently, a preferred near-term adaptation alternative should be selected for this site as it sustained significant damage in recent storms. In the near term, remove damaged parking areas, restrooms and timber seawall. Consolidate into one smaller, elevated parking area at the east end of the site with a concrete toe wall and seat blocks

along the edge. Create beach habitat by installation of vegetated dunes and support public access via a boardwalk trail in reclaimed space.

Seacliff Day Use Area – Hybrid Alternative

The Hybrid alternative combines strategies to maintain consolidated infrastructure while making room for coastal processes. Both green and grey infrastructure is utilized. Presently, proactive adaptation planning can identify asset relocation areas and advance funding and design of facilities being relocated or fortified in place. In the near term, create space on the beach by setting back State Park Drive against the cliff base and reduce the extent of the parking and picnic area. Construct a concrete toe wall and seat blocks to replace the timber seawall along the beach front edge of the consolidated parking area. Restack and replenish rip-rap as needed. Create beach habitat by installation of vegetated dunes and support public access via a boardwalk trail. Incorporate native plantings on the cliff face to expand native habitat and provide erosion protection.

Rio Del Mar Esplanade – Restore & Relocate

The Restore & Relocate alternative prioritizes natural resource restoration. Assets and infrastructure are relocated to create space for beach habitat and make room for coastal processes. Presently, proactive adaptation planning can identify asset relocation areas and change in use and access patterns. In the near term, remove the restroom and seawall. Create beach habitat with living shoreline elements and install cobble berms to protect the living shoreline planting areas.

Platforms Parking Lot and Platforms Beach – Fortify & Protect

The Fortify & Protect alternative uses grey infrastructure to secure existing infrastructure and assets, such as parking. Presently, proactive planning can continue to help to build maintenance capacity and prioritize funding for adaptation to coastal hazards projected to occur in by mid-century. In the near term, remove the timber seawall and replace with a concrete toe wall and seat blocks along the edge of the Platforms parking lot.

1. Introduction

1.1. Overview

Waves and storm surge during winter storms in January 2023 produced severe beach erosion along the Seacliff SB and New Brighton SB shorelines. Seacliff SB was especially impacted, including the RV Campground, Day Use, and Rio Del Mar beach areas. The exposure to coastal hazards and erosion has placed public structures and resources at risk of further damage and loss if measures are not taken to reduce their vulnerability.

A SLR Vulnerability Assessment (VA), MN (2024) was conducted to quantify the processes driving coastal hazards and erosion, identify and categorize Parks Assets⁴ and evaluate the vulnerability of these to coastal processes exacerbated by SLR.

This report presents a SLR adaptation plan providing adaptative pathways and measures that can be considered near-, mid-, and long-term. The proposed adaptation alternatives were developed in collaboration with State Park staff and incorporate stakeholder feedback gained from public outreach and engagement activities conducted over the course of the project. Refer to Chapter 5 for an overview of public outreach and engagement activities.

1.2. Project Location

Figure 1-1 shows the location of Seacliff State Beach and New Brighton State Beach at the northern end of Monterey Bay.

In the following, Seacliff State Beach (SB) refers to all Parks assets included in this 85-acre State Park facility. Similarly, New Brighton SB encompasses all State Park assets at the 95-acre New Brighton State Beach.

⁴ Existing visitor serving infrastructure including natural and cultural resources.

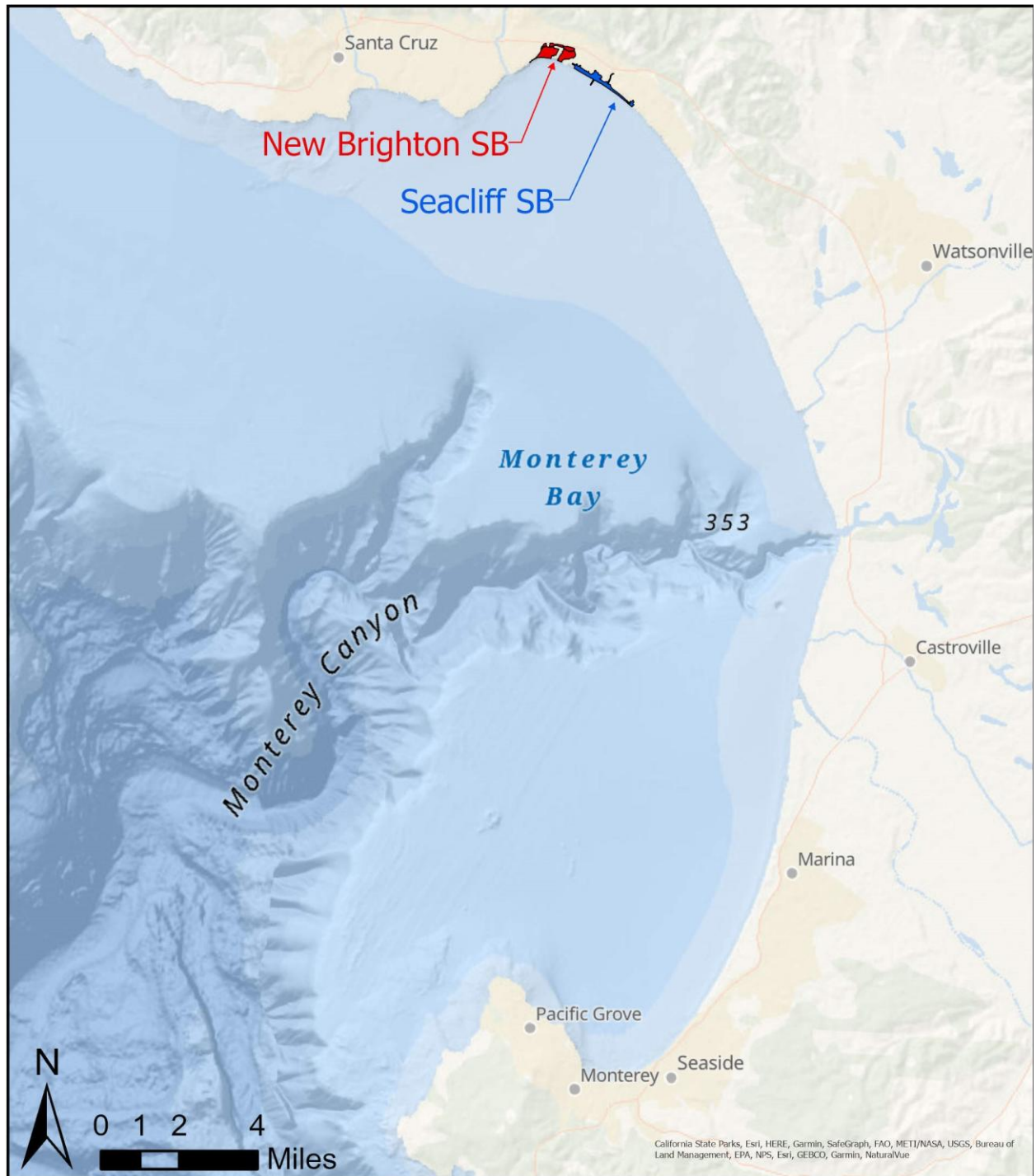


Figure 1-1: Location of Seacliff SB and New Brighton SB.

1.2.1. Seacliff SB

Refer to Figure 1-2 for an overview of Seacliff SB, which provides public access to picnic sites, ramadas, and Americans with Disabilities Act (ADA) accessible parking and restroom facilities. Park facilities are generally ADA accessible and beach wheelchairs are available via Friends of Santa Cruz State Parks Beach⁵. The Seacliff Visitor Center and Park Store enables visitors to learn about the historic setting of the site, cultural resources, the geology of the site and fossils, and features a tide pool and aquarium where the public can observe some of the marine life that exists at the site.

The Seacliff area was historically occupied by Native people up until the Spanish colonization around 1833. Seacliff was inaugurated as a state beach in 1931. The remains of the SS Palo Alto cement ship are a central feature of the site and an important historic and cultural resource from this period, now a natural resource platform supporting shore birds and marine habitat.

1.2.2. New Brighton SB

Refer to Figure 1-3 for an overview of New Brighton SB. The Pacific Migrations Visitor Center at New Brighton enables visitors to learn about the diversity of marine life on the coast, and delve into the cultural resources of the site, which includes Chinese immigrants who occupied a fishing village in the area in the 1870's to 1880's, when it was known as China Beach. New Brighton became a state beach in 1933. Today, the New Brighton SB offers campfire and Junior Ranger programs, hiking trails, and more than one hundred family, group, bicycle, and RV campsites, including lifeguard access, restroom and shower facilities. Beach wheelchairs are available for ADA accessibility to the park area. Popular activities on the beach include fishing, swimming, and beach combing.

⁵ Reservations available via the Friends of Santa Cruz State Parks Beach Wheelchairs website.

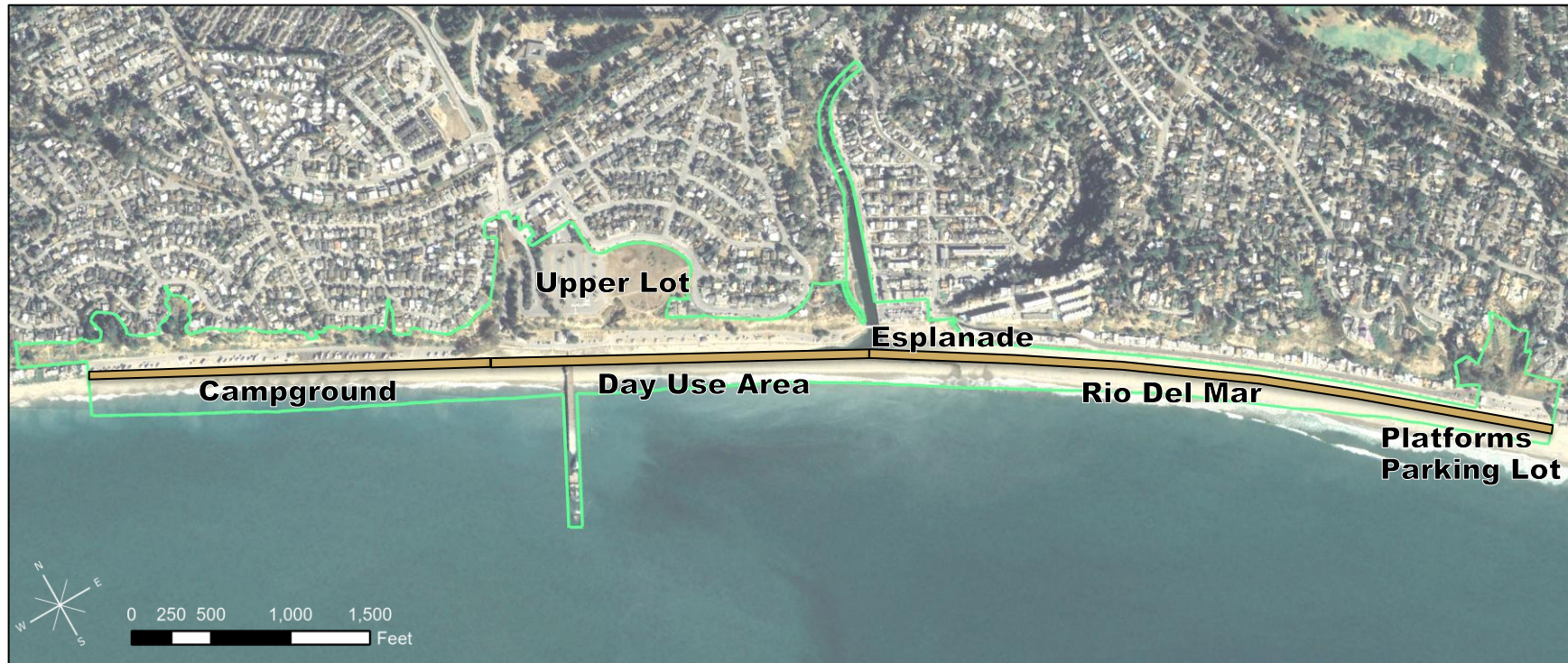


Figure 1-2: Subareas at Seacliff SB.

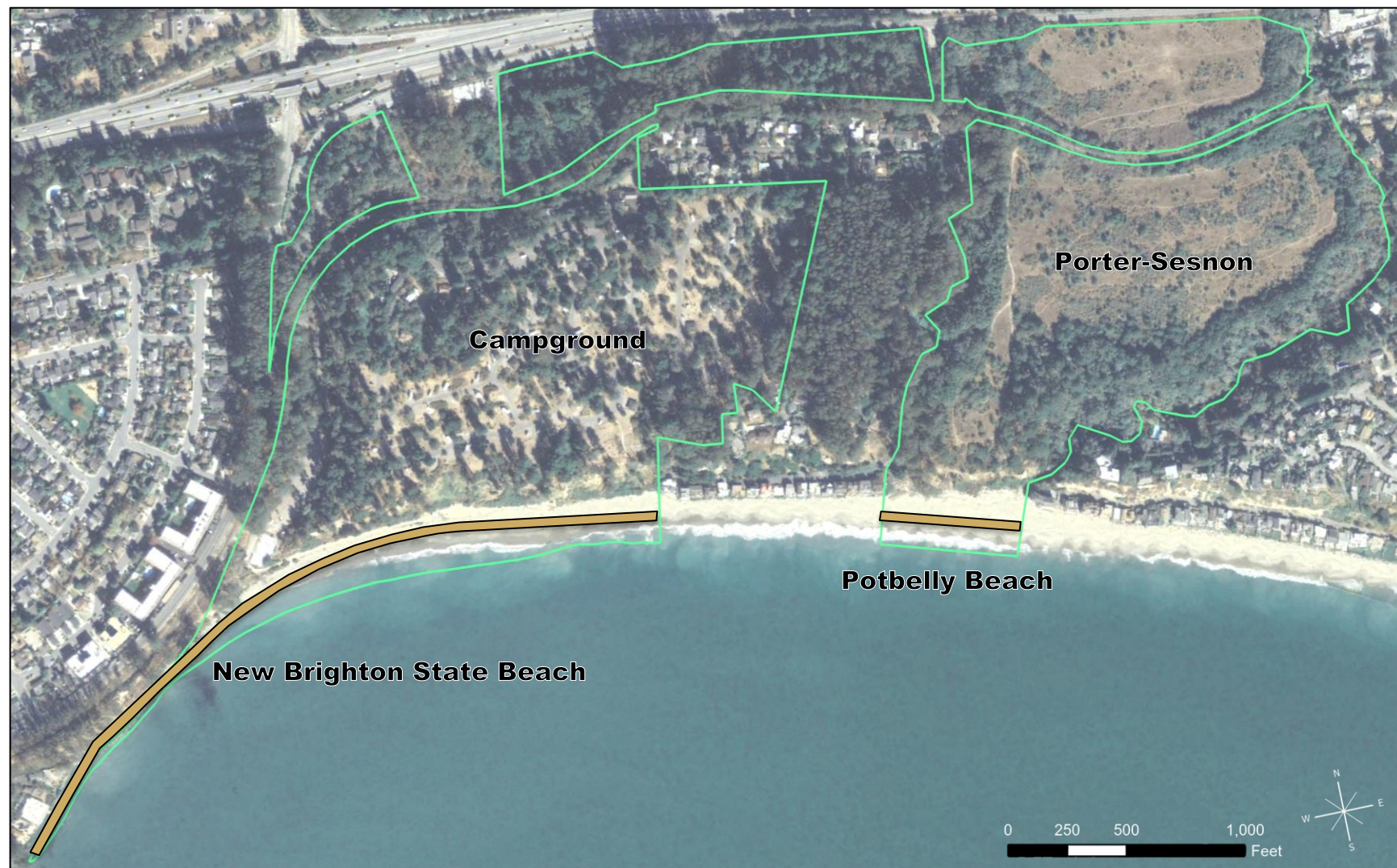
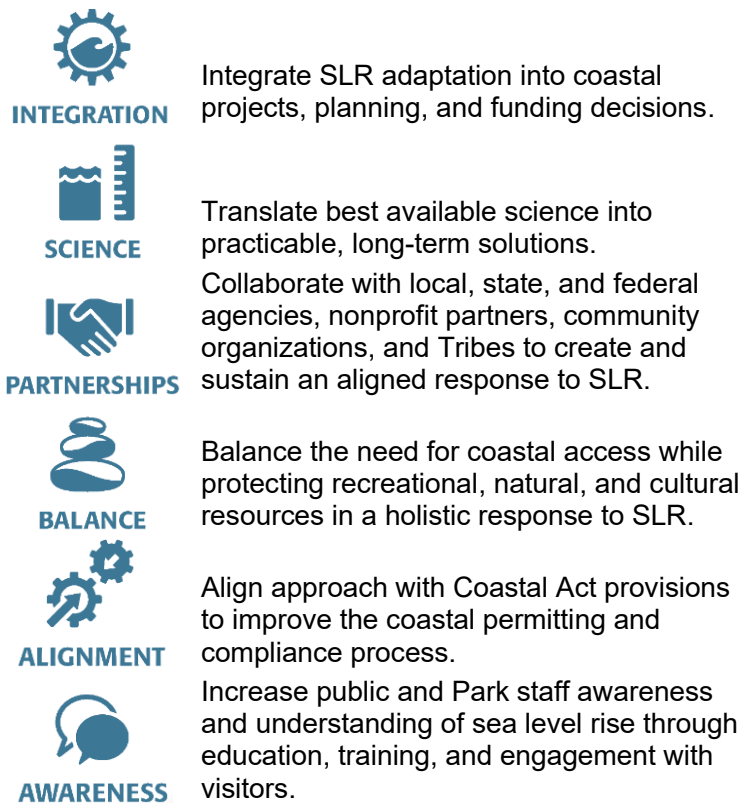


Figure 1-3: Subareas at New Brighton SB.

2. Basis of SLR Adaptation Planning

2.1. State Parks SLR Adaptation Strategy

California State Parks released a SLR adaptation strategy in 2021, CSP (2021), which emphasizes the following guiding principles articulating State Parks recommended approach to coastal management across the 128 coastal units managed by State Parks, which support coastal access and recreational activities to over 50 million visitors annually.



Parks SLR adaptation guidelines were employed in the development of this SLR Adaptation Study Report. An overview of possible SLR outcomes based on the best available science is provided in the following.

2.2. SLR Projections

Updated SLR guidance for California was issued by the California Ocean Protection Council (OPC) on June 6, 2024, OPC (2024). Figure 2-1 summarizes SLR projections for Monterey Bay provided in the updated guidance. The projections can be characterized as follows:

- High (dark blue). This scenario assumes high future emissions and high warming with large potential contributions from rapid ice sheet loss, and representative of a worst-case scenario.
- Intermediate-High (purple). This scenario reflects rapid ice sheet loss contributing to sea level rise and is representative of a plausible high-end projection.

- Intermediate (red). This scenario is driven predominantly by high emissions scenarios and provides a reasonable upper bound for the most likely range of sea level rise through 2100.
- Intermediate-Low (yellow). This scenario provides a reasonable estimate of the lower bound for the most likely sea level rise through 2100.
- Low (light blue). Linear trend based on the current rate of sea level rise continuing into the future. This scenario is on the lower bounding edge of plausibility given current warming trajectories.

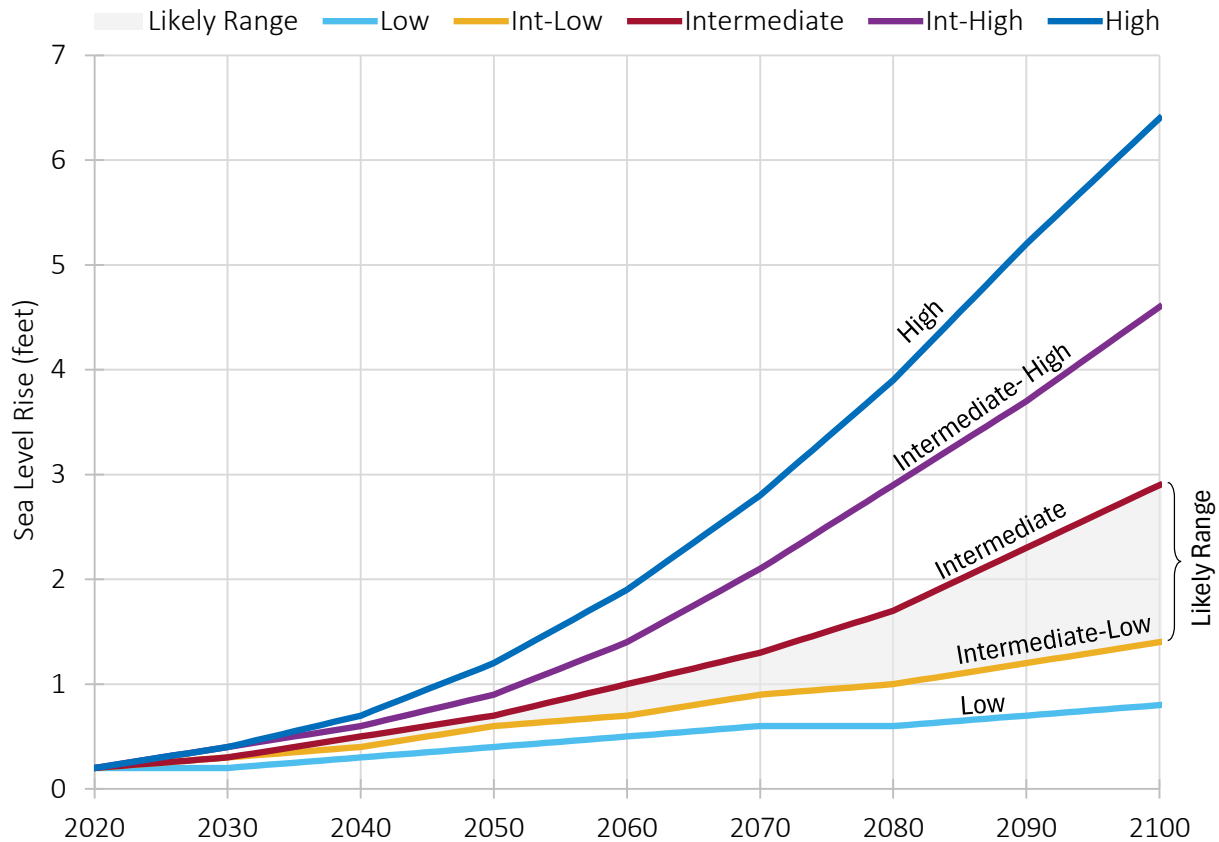


Figure 2-1: Sea level rise projections for Monterey Bay, OPC (2024).

Table 2-1 summarizes the SLR projections adopted for the VA and present SLR-AS document based on OPC (2024) and State Park consultation with regulatory agencies. The Intermediate-High SLR scenario reflects rapid ice sheet loss contributing to sea level rise and is representative of a plausible high-end projection. The High SLR scenario assumes high future emissions and high warming with large potential contributions from rapid ice sheet loss, and representative of a worst-case scenario.

Table 2-1: SLR projections.

Scenario	Projected SLR in feet by:			
	PD	2050	2070	2100
Intermediate-high SLR scenario	0.1'	1.0'	2.0'	4.0'
High SLR scenario	-	-	-	6.0'

PD – Present-day

The project-adopted SLR projections can be characterized as follows:

- 1 foot of SLR by ~2050. Intermediate-high SLR scenario for near-term actions.
- 2 feet of SLR by ~2070. Intermediate-high SLR scenario for mid-term planning.
- 4 feet of SLR by ~2100. Intermediate-high SLR scenario for long-term planning.
- 6 feet of SLR by ~2100. High SLR scenario for the purpose of evaluating the higher-end of possibilities for highly risk-averse facilities for long-term planning.

2.3. State Park Assets

The methodology adopted for the typology of State Park assets follows the San Diego Coast District Sea Level Rise Adaptation Pathways Report and Statewide Toolkit, Final Statewide Methodology Memo, AECOM (2022). Refer to the SLR-VA, MN (2024) for details. This framework includes typologies for shoreline types, Parks assets, natural resources, and cultural resources categorized by sensitivity to Temporary Exposure and Permanent Exposure to flood hazards, defined as follows:

- Temporary Exposure. Temporary flooding due to coastal storms.
- Permanent Exposure. Permanent tidal inundation from SLR, emergent groundwater, and/or shoreline change and cliff retreat.

State Park assets were classified according to the following categories:

- Facilities and Infrastructure
 - Buildings
 - Utilities
 - Park assets
 - Coastal armoring
- Access
 - Roads
 - Parking
 - Trails
 - Structures
- Recreation
 - Recreational amenities
 - Recreational assets
- Cultural resources
 - Historic-age sites with artifacts and nonpermanent features
 - Indigenous archeological resources
 - Historic buildings, structures, and objects
- Natural resources
 - Land cover
 - Vegetation

2.4. SLR-VA Findings

Coastal processes and flood hazards exacerbated by SLR and storm surge considered as the driving factors for potential impacts to State Park Assets were categorized into permanent and temporary exposure conditions. The permanent exposure conditions considered include tidal inundation, shoreline retreat, and cliff retreat. Temporary exposure conditions considered include coastal flooding associated with wave runup and wave overtopping, and temporary beach erosion resulting from storm events.

Table 2-2 summarizes the overall findings of the SLR-VA, organized by Seacliff SB and New Brighton SB subareas. The VA assigned vulnerability ratings ranging from Low (yellow) to Severe (dark red) as a function of SLR ranging from 1 to 6 feet. In terms of timeline, 1 foot of SLR was taken as representative of the projected potential near-term conditions by 2050; 2 feet of SLR was adopted to support mid-term planning by around 2070, and 4 feet of SLR was considered for long-term planning looking towards the end of the century. An additional scenario of 6 feet of SLR was considered as a worst-case scenario based on the higher-end of projected SLR.

Table 2-2: Summary of SLR-VA vulnerability ratings by subarea.

Asset	Sea Level Rise (ft)				WR	OT	BE	SR	CR
	1'	2'	4'	6'					
Seacliff SB									
Campground	H	S	S	S		⦿	⦿	○	●
Day Use Area	M	H	S	S	○	⦿	⦿	○	●
Upper Lot	L	M	S	S					●
Rio Del Mar	M	H	S	S	○	●	⦿	○	●
New Brighton SB									
Campground	M	S	S	S					●
New Brighton Beach	M	H	S	S	○	●	⦿	⦿	○
Porter-Senon	M	H	H	H					●
Potbelly Beach	L	L	M	H	○		●	⦿	

Vulnerability Rating:

L	Low
M	Moderate
H	High
S	Severe

Legend:

WR	Wave Runup
OT	Wave Overtopping
BE	Beach Erosion
SR	Shoreline Retreat
CR	Cliff Retreat

Influence of Coastal Processes:

○	Slight influence
●	Moderate influence
●	High influence
●	Very high influence

The right side of Table 2-2 provides a breakdown of the range of coastal processes contributing to exposure of the respective subareas. These processes include: wave runup (WR), wave overtopping (OT), beach erosion (BE), shoreline retreat (SR), and cliff retreat (CR). Wave runup, wave overtopping, and beach erosion denote temporary exposure conditions, while shoreline and cliff retreat are representative of permanent exposure. Refer to the SLR-VA report for details on coastal processes,

MN (2024) and assessment of the vulnerability of State Park assets and facilities to SLR. SLR and tides were also considered as permanent exposures as these will incrementally exacerbate flood hazards and coastal processes over time.

At the Seacliff SB Campground and Day Use Area, the primary coastal processes that drive vulnerability are wave overtopping and beach erosion. Along Rio Del Mar Beach, the governing driver is beach erosion and secondarily wave overtopping. With SLR, these areas will increasingly become affected by shoreline retreat and wave runup. Across these areas, the potential for cliff retreat is projected to have a moderate influence on the vulnerability of State Park assets.

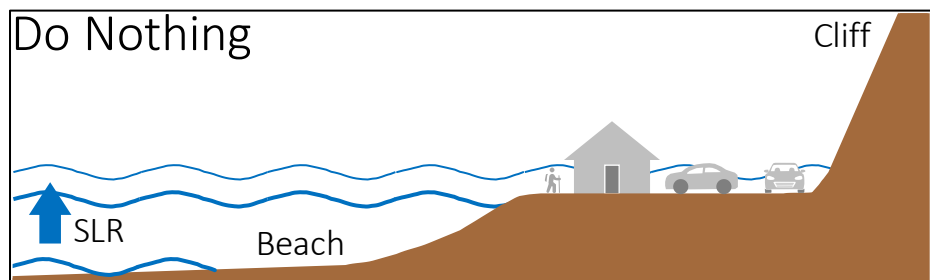
At New Brighton Beach, the coastal processes that primarily drive vulnerability include beach erosion and shoreline retreat. Vulnerability at Potbelly Beach is mainly influenced by shoreline retreat (permanent impact) and secondarily beach erosion (temporary impact). With SLR and projected loss of beach, wave runup will become more of an influencing factor. Vulnerability of the clifftop areas at the New Brighton SB Campground and Porter-Sesnon is primarily associated with potential cliff retreat.

3. SLR Adaptation Strategies

The Intergovernmental Panel on Climate Change (IPCC) and other authorities on climate change have outlined a number of strategies to address SLR, which include elevating assets and facilities, managed retreat, accommodating SLR with varying forms of protective and resilience-building elements. The latter two covers a broad range of approaches ranging from hard protective structures to softer solutions with nature-based elements. Possible SLR adaptation strategies are discussed in the following. These were adopted from the Intergovernmental Panel on Climate Change, IPCC (2019), and adapted to the setting at Seacliff SB and New Brighton SB, a key feature being that the beaches in these areas are generally backed by a tall cliff, which separates the beach areas from the clifftop areas and manifests as a backstop to inland transgression of the shoreline in retreat-based strategies.

3.1. Do Nothing

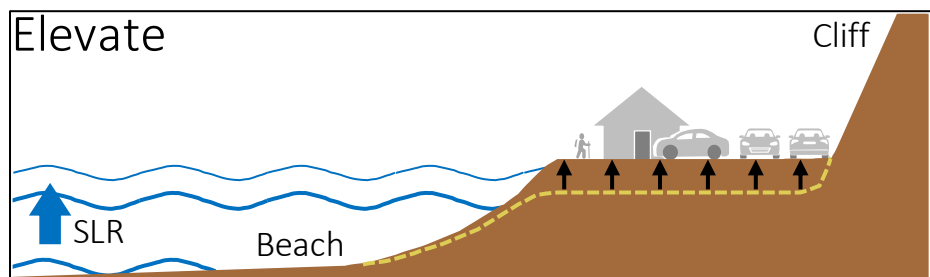
A Do Nothing Strategy is illustrated in the figure to the right, where the area shaded in brown depicts the shoreline profile consisting of beach and back beach fronting the cliff face.



State Park assets and facilities supporting public recreational elements and amenities are shown in gray. The wavy blue lines denote SLR projected mid- to long-term. Under this strategy representative of a No Action Alternative, the beach would be inundated by SLR near-term. Subject to rising sea level, the beach face would progressively narrow to the point where it would become inundated and no longer support safe public access. SLR would impact the raised back beach area where Parks assets and facilities are concentrated at the base of the cliff. Because this area is generally level, the plateau would be impacted by SLR areawide. At the point where SLR would start inundating the back beach and reach the base of the cliff, the base of the cliff would no longer be safely accessible.

3.2. Elevate

A SLR adaptation strategy focused on elevating assets and infrastructure can be partly successful in addressing SLR in the near- to mid-term. Subject to rising sea level, the beach would narrow and eventually become inundated, but raising the back beach to an elevation above projected SLR could prevent or postpone flooding of this area. So, although the beach area would be lost to SLR, public access and amenities could remain at the base of the cliff. A point to note is that for as long as a reasonably wide beach can remain, it can serve as a buffer against SLR and provide resilience to coastal processes. However, as waves would start to interact with the slope at the

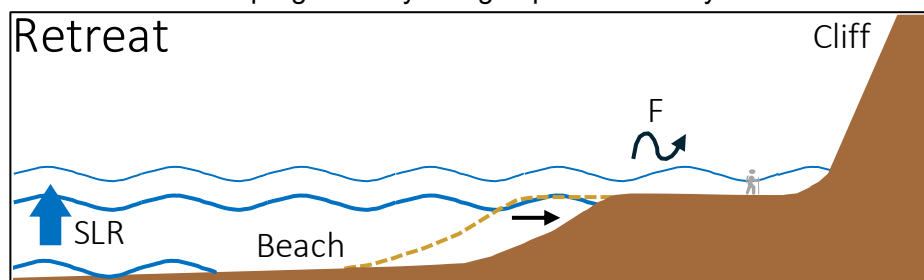


back beach, it would need to be faced with hard shore protection to prevent erosion and protect the upland facilities and public access. Another apparent outcome of the Elevate Strategy, is that when the beach is backed by a cliff, the plateau has less available space after being elevated. This will be the case unless the slope fronting the plateau is replaced with a vertical wall. This could allow a 1:1 ratio between the area pre- and post elevation. While this would be possible, it would be anticipated that the beach face would be lost sooner due to the reflective nature of vertical wall elements in response to wave action, which would accelerate erosion of the beach face.

3.3. Retreat

Under a Retreat Strategy, vulnerable Facilities (F) would be removed before being impacted by SLR, which could occur over phases depending on the location and elevation of individual State Park assets and facilities. For this reason, this strategy is often termed managed retreat. Open space and public access would be preserved for as long as feasible and new development at the base of the cliff would not be permitted. This strategy would take a course similar to the Do Nothing strategy in that the managed removal of assets is akin to assets progressively being impacted as they would under the Do Nothing Strategy.

This, because the function of assets would cease when they are strategically removed rather than moved due to SLR.

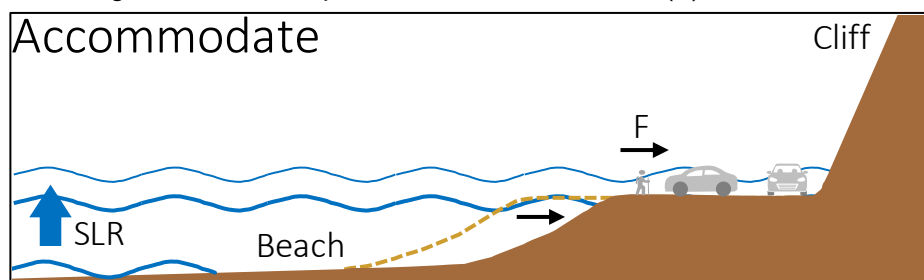


While the base strategy is chiefly focused on as-needed removal of assets, it could be softened if aligned with strategic relocation of State Park facilities to areas with no or reduced vulnerability to SLR.

3.4. Accommodate

The objective of a strategy to Accommodate SLR is to balance the benefits of public access with loss of use associated with SLR. The figure shows how public access and facilities (F) at the base of the cliff can be scaled back to gain more space on the beach.

This action transitions public space from a built environment to a more natural environment, which also incorporates more resilience to SLR through the wider beach. An example of phasing to implement this strategy is provided in the following. Refer to Figure 3-1 for a schematic. In the figure, available beach area is indicated by the yellow bars on the left over stages of phasing from 1 to 5. "T" denotes Trail, "P/R/C" space for Picnic areas, Ramadas, and Comfort stations, (P) denotes parking, "2LR" indicates 2-lane road, "1LR" 1-lane road, and "SC" denotes the Sea Cliff (Purisima Fm). Black vertical line segments indicate possible locations of shore protection structures.



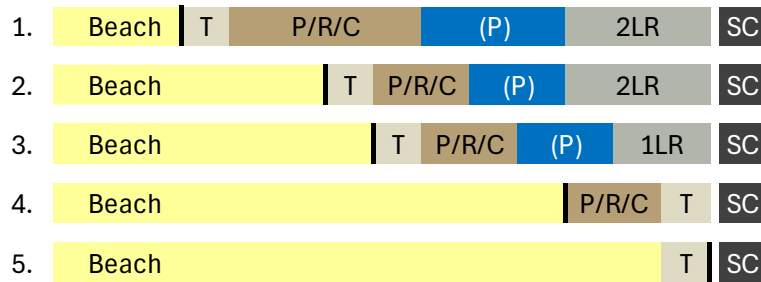


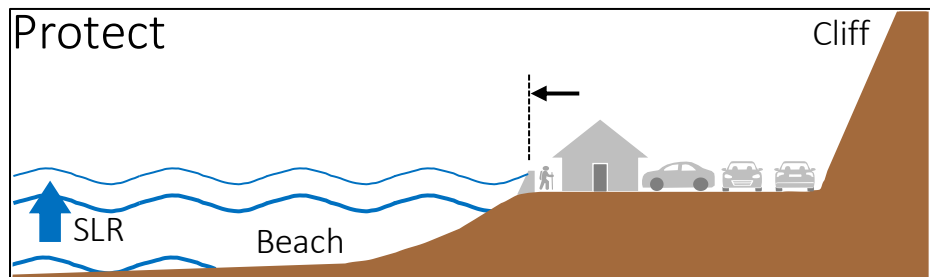
Figure 3-1: Phasing to accommodate SLR.

The adaptation sequence 1 to 5 in Figure 3-1 would provide the following levels of public access and support for recreational activities:

1. Walking trail, picnic areas, ramadas, comfort stations, parking, 2-lane vehicle access (present-day).
2. Walking trail moved inland to make room for wider beach; picnic areas, ramadas, comfort stations, and parking side-by-side; 2-lane vehicle access.
3. Walking trail, picnic areas, ramadas, comfort stations, and parking moved inland to make room for beach widening, 1-lane one-way vehicle access.
4. Parking and vehicular access decommissioned. 1-lane road transitioned to pedestrian/bicycle path.
5. Picnic areas, ramadas, and comfort stations decommissioned, beach trail maintained at the base of the cliff.

3.5. Protect

Strategies to protect facilities and infrastructure have evolved into a diverse range of structures such as seawalls and revetment, commonly termed hard structures. Revetment normally consists of large rock, while seawalls can be constructed from timber, concrete and steel. To some extent, marine grade structural plastic lumber is making inroads as a new material type that is resistant to degradation by marine life and UV exposure.



The objective of this strategy is to hold the line, and in doing so protect facilities and public access, which however can come with the following disadvantages:

- Visual impacts and a prevalence of built environment potentially detracting from mental health benefits.
- By virtue of creating protection to address a high flood stage, hard structures often incorporate vertical access constraints.
- A significant amount of space can be taken up by the protective structures, their foundations, or footprint, which can create horizontal access restrictions. Rock revetment, for example, at a slope of 2H:1V will take up twice as much space on the beach as its height above beach level.
- Loss of sand supply to the beach, which can occur if the structures are located within the surf or zone of wave runup.
- Passive erosion, which can occur when structures interrupt the natural, seasonal variation of the beach profile. This can cause the shoreline to move inland to the face of the structure whereafter the beach is lost.
- Active erosion, which can occur when structures are located in the zone of wave runup, which can cause erosion of the fronting beach due to waves being reflected back from the structures.

Despite the disadvantages of hard shoreline armoring, these structures still find application by their ability to protect important assets. There are alternative structures being introduced that are capable of bridging between hard and soft structures. One such approach is Deep Soil Mixing (DSM), which is an advanced ground improvement technique in which cement is mixed in with the native soil to create a weakly cemented rock like material that mimics the natural beach rock/cliff formations (Figure 3-2). This method has a number of advantages, including:

1. The native soil is strengthened and primarily consists of in-situ material and therefore retains a color and composition representative of the native material on site.
2. The resulting structure is resilient to wave action and erosion, but erodible, which enables it to be part of the natural coastal processes. Material from the weakly cemented material matrix is gradually released back to the environment over time.
3. The improved soil can gain some verticality, in particular if expanded into an abutment.

A DSM abutment is akin to weakly cemented sandstone formations, which are natural features at many shoreline areas in California. Figure 3-2 (left) shows how wave action impacting the base of the cliff leads to sea cave formation, resulting in collapse of the cliff face and retreat of the clifftop edge. The figure on the right shows how DSM can mitigate cliff erosion by serving as a protective buffer and enhance the shore platform in the form of frictional elements to reduce wave action and improve the resilience of the shoreline. The DSM will typically be buried under the sand in the summer conditions and if emergent will be similar to the natural cliff and bedrock outcrops in terms of appearance. DSM is a relatively new concept and nature-based method of improving shoreline resilience. A similar approach of stabilizing sea cave formation with erodible concrete has been in practice since the 1990's.

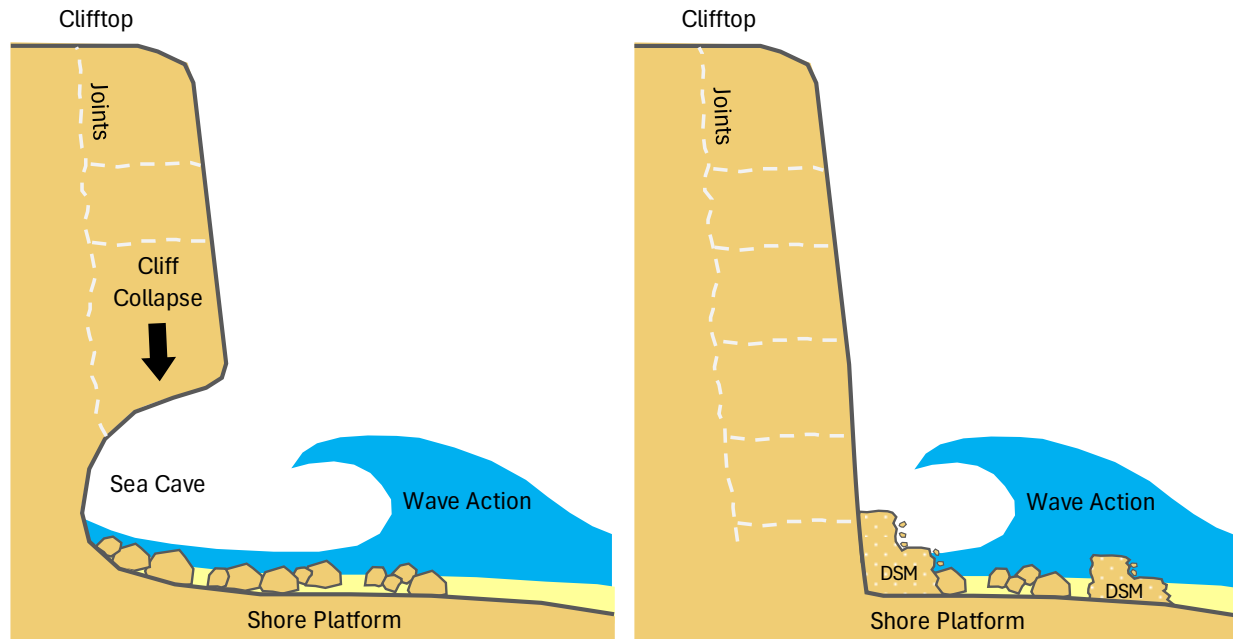
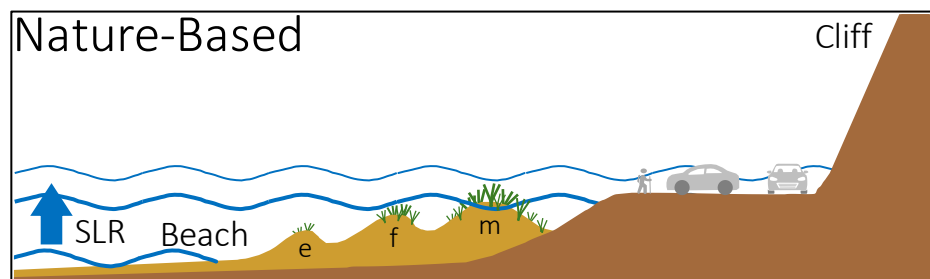


Figure 3-2: Cliff retreat processes (left), DSM shore platform enhancement (right).

3.6. Nature-Based Adaptation

The goal of nature-based adaptation strategies is to incorporate natural materials as elements of SLR adaptation. Solutions based on this strategy go by popular

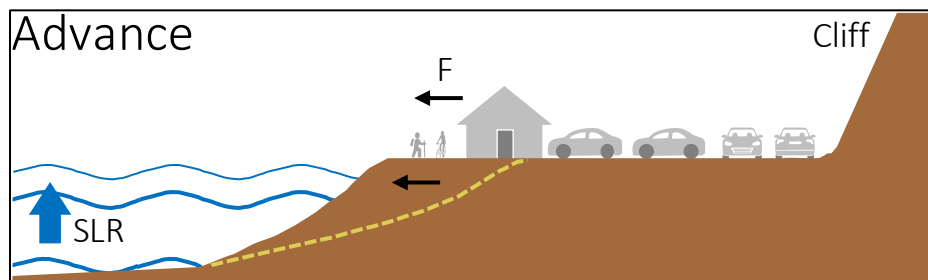


names such as green or soft shoreline stabilization, and living shoreline, which aim to provide a protected and stabilized shoreline consisting of natural materials such as plants, sand, or rock, intended to reduce erosion and provide valuable habitat that enhances coastal resilience. Certain types of natural materials can provide a level of protection and resilience to SLR while providing habitat for plant and animal life. The figure above exemplifies two nature-based solutions that are found in Monterey Bay which incorporate resilience via an expansive beach face or via dune features. Resilience from a beach face comes its wide extent and flat slope, which triggers wave breaking. Wave breaking is a way for waves to release energy, which manifests as a reduction in their height as they propagate towards shore. Wave breaking mobilizes sand from the seabed, which can be transported in large quantities either onto or off the shore, and along the shore driven by wave-induced longshore currents. In this context, a wide beach helps accommodate the highly dynamic response of the beach face when subject to wave action. Beach widening can be achieved via regular beach nourishment. However, the stability afforded by a beach being wide and flat means it has limited capacity to mitigate flooding due to the limited elevation rise over its extent. Dune systems can provide a wide range of

benefits in that the native vegetation traps wind-blown sand and thereby accumulate a significant sand volume, which can build resilience and serve as a buffer to aid in protecting the coast during storm events. The root systems of the dune vegetation help contain the sand matrix, which thereby offers better erosion resistance than loose sand. The dune vegetation enhances the shore habitat by being able to support a range of plant and animal life. The figure above depicts a dune system consisting of embryo dunes (e), foredunes (f) and mature dunes (m), which are the natural features of a developing dune field. However, these features need a large spatial extent over which to develop. Existing dune fields further south in Monterey Bay are on the order of 1,000 to 2,500 feet wide. Consequently, expansive dune fields are not immediately suitable for the shoreline areas of Seacliff SB and New Brighton SB, where the beach width is on the order of 30 to 250 feet. A lesser version of a dune field comprised of a single or limited number of dune features could however serve as a nature-based element along the Seacliff SB shoreline. Patches of emergent vegetated dune formations can be found on the back beach along the Day Use Area and along Rio Del Mar Beach. Without widening, the shoreline along New Brighton SB is deemed too narrow to support dunes.

3.7. Advance

The idea behind the Advance Strategy is to create new land at an elevation above projected sea levels and with sufficient space for facilities and infrastructure.



The classical way of conducting this type of land reclamation is to build rock jetties out from shore enclosing the area to be reclaimed. Sand fill is then typically pumped in hydraulically to fill the land reclamation area up to grade. Although this strategy creates new land above the projected flood levels there are many adverse effects of this approach. When conducted in an ocean environment, the finished grade of the reclaimed area often needs to be at a fairly high elevation to address wave runoff and projected SLR. In the area of Seacliff SB and New Brighton SB, current the 1% annual chance wave runoff elevation is up to 20 to 25 feet NAVD88. Consequently, the edge of the reclamation area would need to be at a somewhat higher elevation to reduce wave overtopping and incorporate a freeboard allowance for SLR. Creation of a sizable area of reclaimed land would consequently require placement of very large fill quantities. The rock utilized for the jetties would need to be very large in order to remain stable when exposed to storm waves in the bay. Wave interaction with the rock jetties would be likely to promote scour and deepen the waters surrounding the reclaimed area. Land reclamation based on this strategy would create a promontory on the bay shoreline that would encroach on the Monterey Bay National Marine Sanctuary and obstruct the natural coastal processes and sand transport. For these reasons, this SLR adaptation strategy is not considered further.

3.8. Strategies for Clifftop Areas

Facilities located in the clifftop areas of Seacliff SB and New Brighton SB are presently not directly threatened by sea level rise. Potential impacts related to coastal processes would be limited to wave attack at the base of the cliff. This in turn can then cause sections of the cliff face to become unstable and prone to failure. Additionally, there is the natural process of gradual erosion due to surface runoff. As a result, the areas along the cliff edge are most at risk.

Measures to address the potential for instability of the cliff face could range from stabilization and protection of the cliff face to incorporating a setback that would allow for natural retreat of the cliff edge. Protection of the cliff face, or a portion thereof, is often achieved by incorporation of a concrete shell over the cliff face. A setback is simply the delineation of a zone inland from the cliff edge where any vulnerable development would be removed, and new development prohibited. The setback zone could still be utilized for trail access, open space, wildlife corridors, or other habitat enhancement.

In context, it should be noted that Parks policy guidance for SLR adaptation would not support incorporation of structures or systems to protect or stabilize the cliff. The recommended approach would be incorporation of setbacks to enable gradual cliff retreat.

4. Landscape Elements

This section provides an overview of landscape elements that can be incorporated to realize specific SLR adaptations strategies.

Figure 4-1 illustrates a variety of traditional and nature-based adaptation solutions. These landscape elements are strategically located at the top of the cliff, on the cliff face, at the back beach, front beach, or in the water offshore of the beach. The placement is designed to serve as protective or resilience-building measures to mitigate potential impacts from shoreline processes.

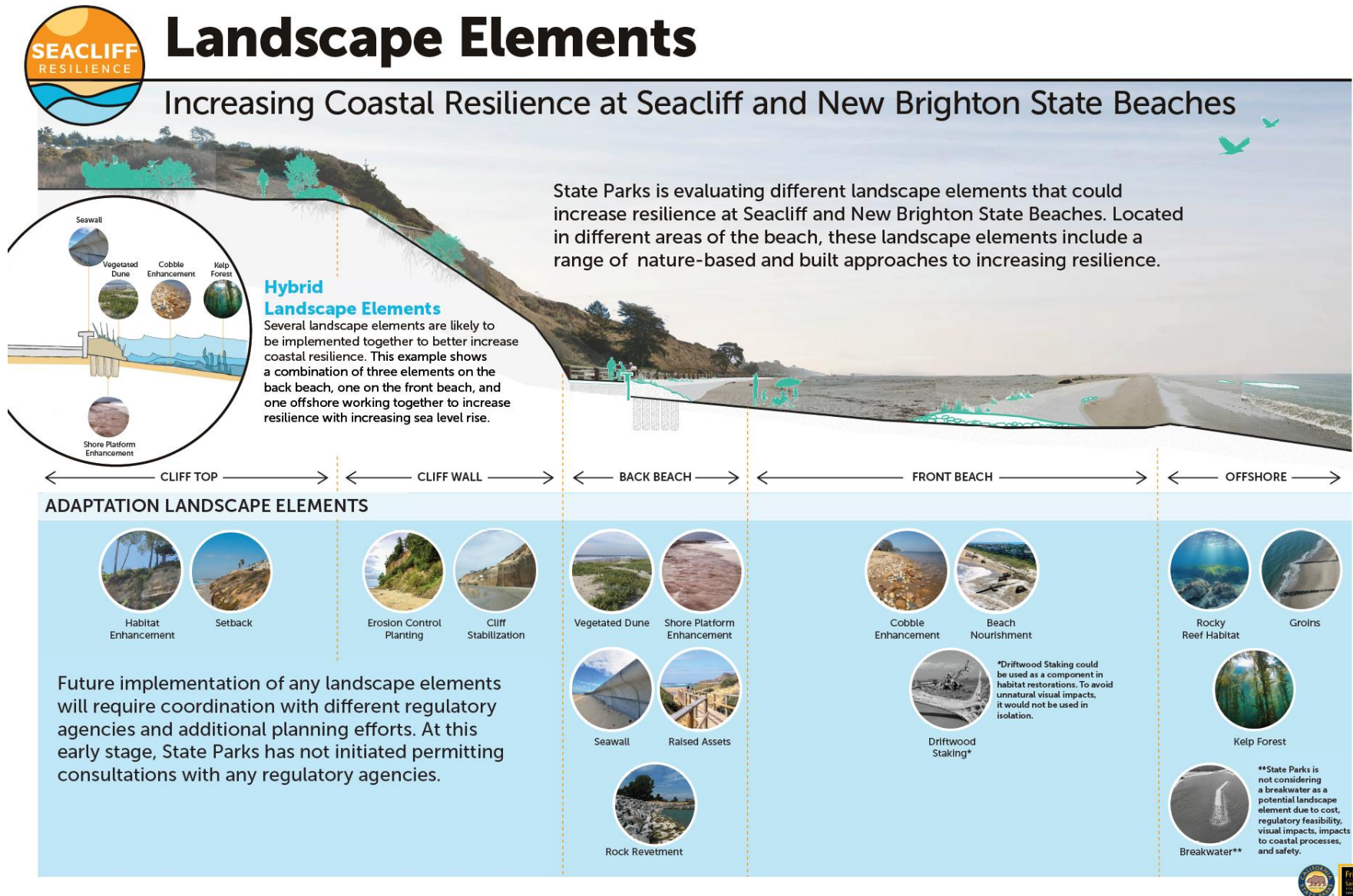


Figure 4-1: Overview of landscape elements supporting adaptation solutions.

4.1. Clifftop Landscape Elements

4.1.1. Habitat Enhancement

Establishing vegetation along the top of the cliff is an effective way to reduce cliffside erosion. This method is implemented by planting along the top of the bluff. The roots will help anchor loose sediment from wind and rain erosion. Vegetating the top of the bluff not only harnesses plant's ability to hold soil, but it increases the natural habitat for wildlife and improves the natural aesthetic of the bluff top. When a bluff is exposed, runoff from roadways, parking lots, and homeowner lots can erode the soil and result in mass soil movement (Menashe, 2008). By including vegetation, the runoff will slow and the risks associated with soil erosion will decrease (Menashe, 2008). Establishing vegetative habitat on top of the Seacliff or New Brighton cliff will contribute to bluff stabilization and erosion protection. The vegetation would further improve the aesthetics of the park and increase habitat for wildlife, while not diminishing user experience or beach access.



Figure 4-2: Habitat enhancement.

Habitat Enhancement Advantages:

- Strengthens the cliff to reduce potential for stormwater erosion.
- Can improve the diversity in shoreline habitats.
- Maintains the natural aesthetic of the cliff.

Habitat Enhancement Disadvantages:

- The cliff stabilization provided is limited to the root strength of the vegetation.
- May need irrigation after initial construction to help vegetation set in.

4.1.2. Setback

A setback is an area along the cliff edge within which all or certain types of new development are prohibited. The purpose of a setback is to provide a safety buffer between potentially unstable cliff areas and developed areas. A setback can also include the elevation of beach assets such as walkways and infrastructure. Elevating assets helps decrease the risk of water and wave damage to critical infrastructure.



Figure 4-3. Setback from cliff edge.

Figure 4-4 summarizes how existing cliff top setbacks are defined by Seacliff SB and New Brighton SB General Plans, CSP (1990a,b), which are to be considered when designing and placing facilities near the cliff top edge. These include a Zone of Demonstration, defined by a shear plane inclined at 20 degrees from the horizontal measured at the base of the cliff; transitioning to a Zone of Exclusion, defined by a shear plane inclined at 45 degrees to the horizontal measured at the base of the cliff.

The Zone of Exclusion encompasses the cliff base, cliff face, and cliff top areas extending inland to the Zone of Demonstration. Within the Zone of Exclusion, development is limited to expendable or movable facilities, CSP (1990a,b). Existing facilities may remain in use subject to regular inspection in consultation with a designated geologist. The Zone of Demonstration extends inland from the Zone of Exclusion as defined in Figure 4-4. Within this zone, permanent facility development is permitted if the stability and geologic suitability can be demonstrated.

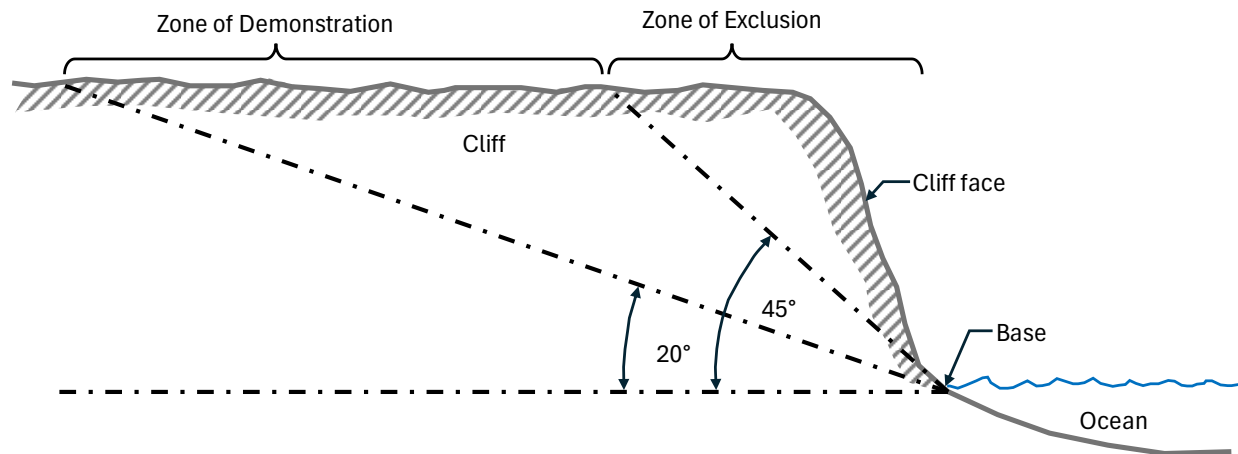


Figure 4-4: Delineation of existing cliff setbacks at Seacliff SB and New Brighton SB.

Setback Advantages:

- Allows for natural erosion of the cliff edge.
- Provides a measure of protection against slide activity.
- Setback may be designated for habitat enhancement.

Setback Disadvantages:

- Much of the cliff development at Seacliff SB is already close to the edge of the cliff.
- A need to retrofit or remove vulnerable development may arise.

4.2. Cliff Wall Landscape Elements

4.2.1. Erosion Control Planting

The purpose of erosion control planting is to utilize native plants to hold soil and rock in place on the cliffside. The portions of the cliffside that can benefit from incorporation of erosion control planting would be the lower cliff and talus deposits at the base of the cliff, which are reasonably accessible and provide a better substrate for plantings. The introduction of native plantings also gives the option to remove invasive species and, in the process, significantly increase the biodiversity of native flora and fauna.

Commonly occurring invasive species include pampas grass and ice plant, which displace and outcompete other plant species. Plants species native to the area that are capable of thriving in a low-nutrient, salt rich, coastal environment include: American dune grass, beach evening primrose, coastal sagewort, creeping wild rye, beach burr, coast buckwheat, lizard tail, seaside daisy, beach morning glory, beach pea, coast Indian paintbrush, and yellow sand verbena.



Figure 4-5. Erosion control planting stabilizing slide debris at base of cliff.

Erosion Control Planting Advantages:

- Creates wildlife habitat.
- Improves aesthetic quality of cliff.

Erosion Control Planting Disadvantages:

- Difficult access to cliff face.
- Need temporary soil stabilization during vegetation establishment.

4.2.2. Cliff Stabilization

Cliff stabilization techniques are employed to bolster the structural integrity of cliff faces, mitigating erosion caused by wave action combined with rising sea levels. One method involves anchoring bolts into the existing cliff formations to increase stability and cohesion. Additionally, softer cliff surfaces can be made less erodible by applying a layer of shotcrete/gunite, typically 50-100 mm thick, comprising fine aggregates and mortar. This armoring serves to protect weak materials and reduce the risk of erosion or block detachment, thereby enhancing overall stability.

While cliffs naturally form part of the shoreline, their armoring allows them to function akin to natural seawalls, influencing shoreline processes in a similar manner. Because of this they can cause similar disruptions to natural shoreline processes. Although the majority of the cliff face becomes more resistant, the base of the cliff can still experience wave scouring during storms which can lead to undercutting at the base and potential failure. Still, compared to traditional seawalls, cliff stabilization methods tend to be more cost-effective and preserve a more natural aesthetic.

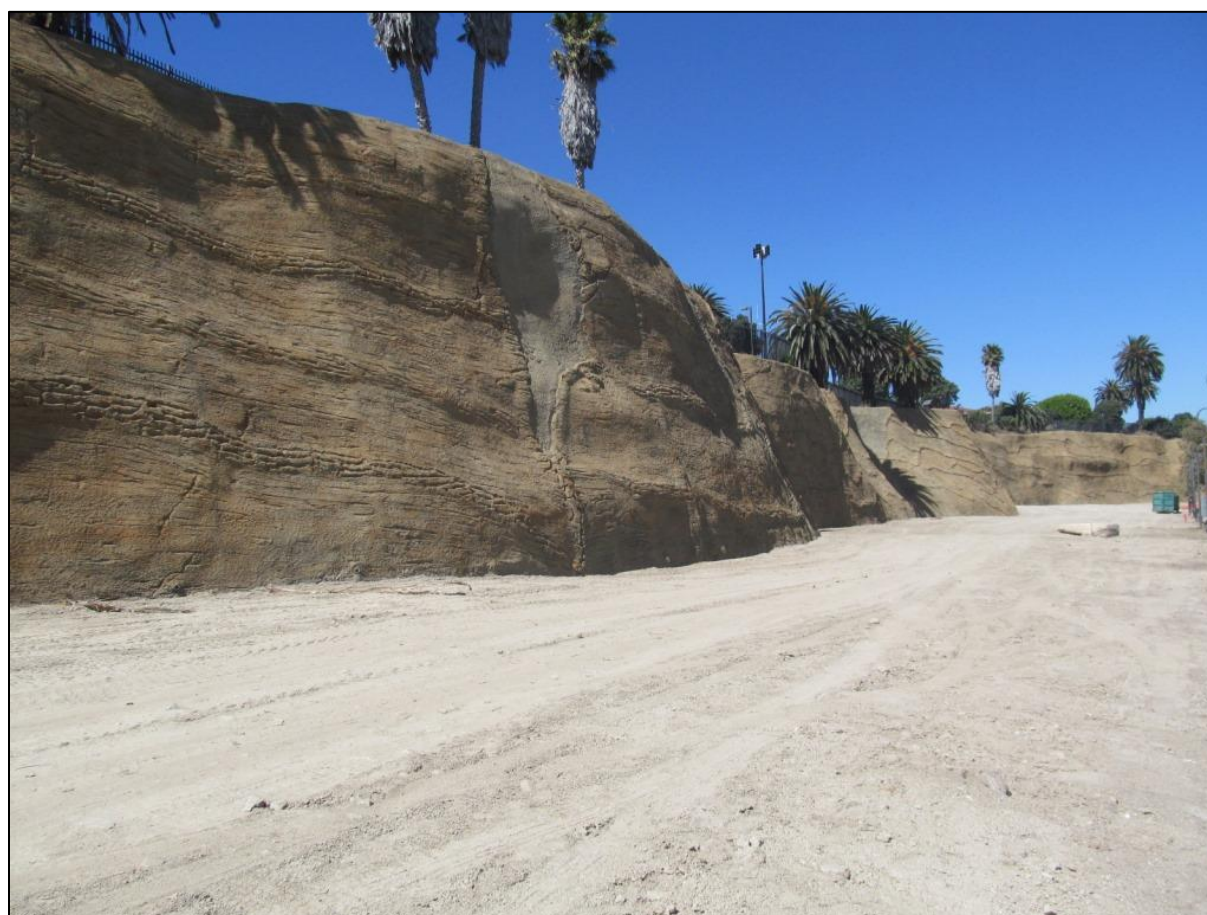


Figure 4-6: Cliff stabilization.

Implementing cliff stabilization measures at Seacliff State Beach and New Brighton State Beach could offer supplementary protection against cliff erosion and rockfalls. However, these interventions would not broadly protect vulnerable assets located at the base of the cliff.

Cliff Stabilization Advantages:

- Reduces cliff erosion.
- Can be constructed to mimic the natural aesthetic of the cliff wall.
- Reduces hazards from rock falls.

Cliff Stabilization Disadvantages:

- Construction could potentially weaken cliff wall, as it relies on anchors drilled into the cliff face.
- Removes beach sediment source from coastal processes.
- The increased strength allows the cliff to act as a seawall and may therefore promote beach loss due to wave reflection.

4.3. Back Beach Landscape Elements

4.3.1. Seawalls

A seawall serves as a shoreline structure designed to shield upland areas from the impact of waves, wave overtopping, and flooding exacerbated by rising sea levels. The function of a seawall is to reflect wave energy back to the ocean, but as a result often causes erosion of the fronting beach. Seawalls are most commonly constructed using reinforced concrete. After a seawall is constructed, it can last up to 50 years with appropriate maintenance. Maintenance of a seawall includes inspection, identifying and repairing cracks, spalling and other damage, and rust stains if necessary.

Since seawalls are static in terms of location and thereby fix the back beach, they tend to conflict with the dynamic nature of the shoreline environment. Unlike natural substrates consisting of sand, gravel, pebbles and cobble, seawalls often promote scouring, where wave action erodes sediment at their base. Seawalls also disrupt the natural littoral drift process by altering the patterns of wave swash and backwash. The incorporation of seawalls can disrupt the natural ecosystem of beaches. It has been observed that seawalls can lower biodiversity of shorelines by 23% and supports 43% fewer organisms than natural shorelines, Gittman (2016). The shift in ecological dynamics of the shoreline may also impact the recreational experience for visitors.



Figure 4-7: Concrete seawall.

Seawall segments constructed at Seacliff SB and New Brighton SB could provide protection for upland areas and facilities but could also impact biodiversity and cause a reduction in beach width, eventually leading to loss of the beach area altogether. This process would be exacerbated by sea level rise.

Seawall Advantages:

- Prevents shoreline and cliff erosion by wave action.
- Can provide protection of upland assets from wave action.
- Features a narrow footprint along shore.

Seawall Disadvantages:

- Removes sediment source from coastal processes.
- Scouring at the base of the wall can take place and eventually erode the remaining beach.
- Alters patterns of natural sand movement along the shore.
- Can disrupt the natural ecosystem of the shoreline.
- Fixes the shoreline location, eliminating natural variation over time.

4.3.2. Vegetated Dune

Establishing vegetation in shoreline areas can be an effective nature-based solution for stabilizing loose sediment and mitigating wave-induced erosion. This approach not only enhances the aesthetic appeal of the area but also improves the natural habitat. Planting vegetation along the shoreline facilitates the deposition and retention of sand grains. As the plants mature, their roots and rhizomes anchor the sand dunes, providing additional stability. Although scientific research on the role of vegetation in storm wave erosion is limited, small-scale studies have demonstrated that dune systems can reduce shoreline erosion by more than 30% by volume (Sigren et al., 2014). Figure 4-8 provides an example of a vegetated dune.

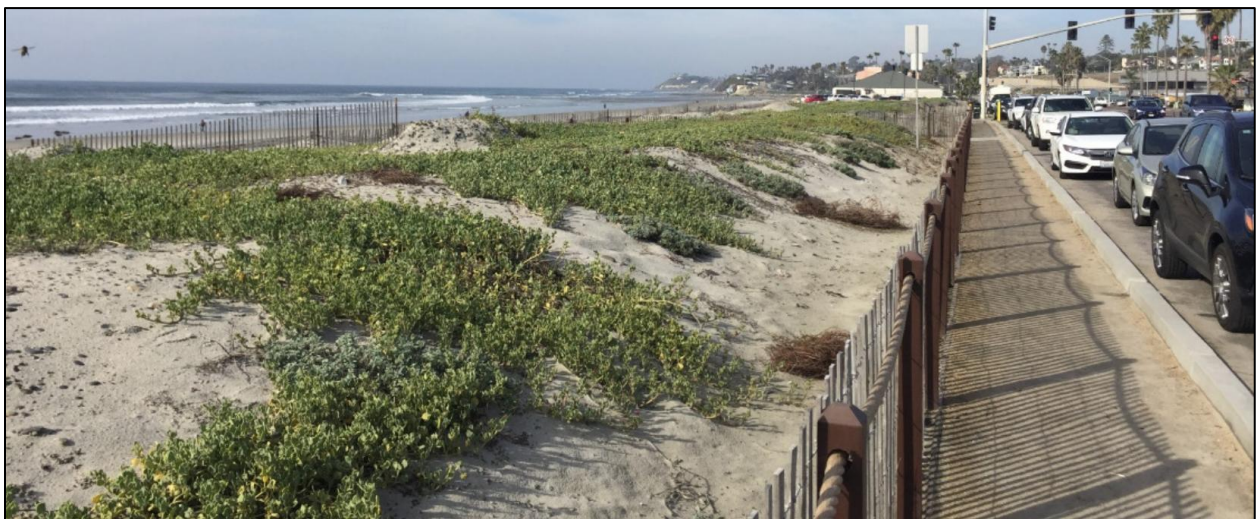


Figure 4-8: Vegetated dune.

Vegetated dunes aim to return the shoreline to its natural state, leveraging the inherent ability of plant roots to stabilize sand. Given that vegetation is naturally adapted to wave environments, it does not disrupt wave energy as static infrastructure might. However, because vegetation is not static, it

presents a higher risk of failure and offers limited protection against sea level rise. Dune restoration and vegetation could appeal to park users as it would enhance habitat and nature viewing opportunities as well as continued beach recreation.

Implementing dune features at Seacliff SB and New Brighton SB offers a promising solution for erosion protection, habitat improvement, and maintaining beach aesthetics. All sections of these beaches could benefit from dune formations, particularly the Seacliff Campground area, to ensure that sediment remains anchored. However, a full dune system needs a large footprint to exist as an ecosystem, typically on the order of several hundred feet of width. Such dune fields can be found along the southern half of Monterey Bay. Lesser dune systems, approximately 150 feet in width exist on Carmel Beach. The beaches found at Seacliff SB and New Brighton SB are insufficient to fully accommodate dune systems of this scale without significant widening of the beaches e.g. via beach nourishment. However, a smaller version of a dune system would be applicable to beaches at Seacliff and Rio Del Mar. This would be a single row or a few overlapping dunes, which would support the same types of plant species found in dune fields.

Vegetated Dune Advantages:

- Provides a measure of flood protection, based on the size of the dunes.
- Can improve a diversity of shoreline habitats.

Vegetated Dune Disadvantages:

- Sand from dunes can be blown into public areas, creating a maintenance issue.
- Needs maintenance and revitalization after storm events.
- Requires a wide beach.

4.3.3. Raised Assets

Figure 4-9 presents an example of how raising assets can be adopted as a means to implement a SLR adaptation strategy focused on elevating infrastructure and assets above projected flood levels. A solution of this type could be applicable to raise Beach Dr. and the Rio Del Mar Platforms Parking Lot. Each foot of elevation would incorporate about one foot of SLR allowance. However, raising the roadway elevation would pose a complex project as this road is the only means of access to residences along Rio Del Mar Platforms. The upgrade project would likely raise one roadway lane at a time, and only permit one way access during the period of construction. At the Platforms Parking Lot, the roadway would need to ramp down to the private portion of Beach Dr. (gated). Riser sections would need to be added to manholes to maintain access to below grade utilities. All access points to the beach would likewise need to be reconstructed to match the new elevation of the roadway.

Advantages of elevating assets:

- Reduces impacts of wave runup and coastal flooding on infrastructure and assets.
- Does not increase footprint of existing infrastructure and assets.
- Facilitates public access.

Disadvantages of elevating assets:

- Complex design and construction effort required to avoid impacts to utilities.
- Needs planned, phased construction to implement in relation to daily traffic.



Figure 4-9: Elevated timber walkway.

4.3.4. Shore Platform Enhancement

A shore platform is a wave-cut platform carved in rock formations along the coast. The shore platform is typically overlain by sand but may emerge following storm events. Figure 4-10 provides an example photo of an exposed shore platform, which manifests as an expanse of hardpan at the base of the cliff. In earlier times, the cliff face would have been out where the waterline is seen in the image. The wave-cut platform then forms as a result of cliff retreat over time.



Figure 4-10: Shore Platform.

The objective of shore platform augmentation is to increase the resilience of the coast by restoring a portion of the eroded cliff. The method is implemented with use of deep soil mixing (DSM), which utilizes augering into the beach and incorporating a cementitious component. The result becomes a columnar formation of cemented native material. Refer to Figure 4-11 for an example of shore platform augmentation with a DSM buttress, prior to features being subject to wave exposure and abrasion. These features are erodible and therefore continue to provide a supply of sediment to the natural system in the same way cliff retreat would.

This approach has many benefits, including that the augmented shore platform features will be buried under the beach sand in the day-to-day usage condition and potentially only emerge during storm events, where they will serve the function of providing resilience to the shore environment by attenuating waves and protecting the base of the cliff from being undercut.

Shore Platform Enhancement Advantages:

- Strengthens the shore against erosion.
- Composed of cemented native material and therefore retains the same color and material composition.
- The features are erodible, with native material released back to the environment over time.

Shore Platform Enhancement Disadvantages:

- Construction could impact sand burrowing species.



Figure 4-11: Shore Platform Enhancement with DSM.

4.3.5. Rock Revetment

A rock revetment constitutes a form of semi-dynamic coastal protection structure characterized by the placement of rock along the shoreline gradient to absorb wave energy and thereby safeguard assets located inland from the shoreline, while mitigating shoreline erosion. Unlike static seawalls, rock revetments can move slightly, enabling them to absorb and redistribute wave energy during storm and seismic events.

Rock revetment incorporates a solution that can prevent erosion and stabilize the shoreline once constructed. Economically, they present an attractive option, with a break-even typically achieved within a decade of installation, Ayutthaya (2023). Similarly to seawalls, rock revetment has environmental impacts. The sediment at the base of the revetment can either scour or bury the base of the structure or erode the area at the end of the revetment (downcoast impact). The wide footprint of the revetment and its base erosion potential could reduce beach width and recreational space altogether. The ecology of the shoreline will also be altered. Benthic organisms, such as barnacles and fucoid seaweeds, are found to increase due to the extra rock face introduced, Ayutthaya (2023). Studies have shown that revetment reduces dune plant species, and an armored shoreline decreases the vegetation's ability to develop over time Ayutthaya (2023).



Figure 4-12: Rock revetment.

A rock revetment at Seacliff SB and New Brighton SB could reduce immediate shoreline erosion and protect upland assets while being economically feasible but as a result the revetment could reduce beach width and recreational space.

Rock Revetment Advantages:

- Retains protective quality even as rocks shift and settle over time.

Rock Revetment Disadvantages:

- Occupies a significant footprint of what could otherwise be accessible space on the beach.
- Fixes the shoreline location, eliminating natural variation over time.
- Removes sediment source from coastal processes.
- Disrupts natural systems.

4.4. Front Beach Landscape Elements

4.4.1. Cobble Enhancement

Cobble enhancement is a soft engineering strategy involving the placement of cobble to create a dynamic berm aimed at reducing wave energy and protecting sand. While the individual cobbles are designed to move during exposure to wave runup, the overall berm shape remains constant. Due to their dynamic nature, cobble berms adapt to changes in sea levels by moving upland, thereby protecting the upper portion of the beach and reducing erosion (Bayle et al., 2020). Figure 4-13 provides an example of cobble enhancement. In the day-to-day use condition, the cobble will be buried below the beach sand and not be visible. The cobble enhancement finds its function when the beach face is eroded, exposing the cobble blanket to wave action, at which point it provides a resilient surface to resist wave action and curb further erosion. Following storm events, the beach will revert to its natural modes of fluctuation and sand will return to cover the cobble blanket.

Studies have shown that cobble enhancement allows beaches with high wave energy to retain sand and reduce upland erosion. Due to longshore sediment transport, cobbles move down towards the end of the berm and renourishment is likely required over time (Bayle et al, 2021). The construction of cobble berms is also much less intensive due to the smaller size of rock and the randomness of the rock placement (Allan C, Jonathan et al, 2005). Once constructed, native plants can be incorporated back into the environment, which can further stabilize the berm.



Figure 4-13: Cobble enhancement.

The dynamic nature of cobble enhancement allows natural processes to continue while providing additional protection from wave erosion. Implementing cobble enhancement at Seacliff and New Brighton State Beaches would reduce upland erosion, support the existing habitat, and maintain the beach's usability for visitors.

Figure 4-14 provides an example of a vegetated cobble berm integrated with the beach setting. This solution can be applicable in areas where the beach width is limited and the cobble therefore exposed for the majority or all of the time. The objective then becomes to size the cobble so that it will permit foot traffic and integrate with the beach environment. In the photo, the cobble enhancement was constructed in the form of a cobble berm placed along the back beach, with patches of vegetation incorporated along the crest. In this context it should be noted the shore presents a tough environment for plants to proliferate due to saltwater exposure, heat stress, and very low nutrient conditions. Only a handful of species that have adapted to these strenuous conditions can exist and propagate in this environment. In the case shown, the larger diameter of the cobble further curbs the ability of the vegetation to flourish, which is why there is sparsity in terms of vegetation cover.



Figure 4-14: Vegetated cobble berm.

Cobble Enhancement Advantages:

- Reduces or slows coastal erosion.
- Dynamic feature that can be reshaped by wave action to protect the upland shoreline.
- Maintains the shoreline's natural aesthetic.

Cobble Enhancement Disadvantages:

- May need addition of more cobble over time.
- Vegetation has a hard time establishing in this environment.

4.4.2. Beach Nourishment

Beach Nourishment describes the process of placing sediment from borrow areas onto a shoreline that has lost, or is at risk of losing, sediment through erosion and sea level rise. This method aims to widen the beach, thereby reducing wave energy before it reaches upland assets. Beach nourishment can also replenish lost beach area for the purpose of continued beach recreation, and lengthen the shoreline's lifespan. The effectiveness of beach nourishment typically spans between 3 to 10 years, contingent upon factors such as storm intensity and frequency, and sea level dynamics. Shorelines that are longer in length and experience lower erosion rates may benefit from beach nourishment to protect upland assets. The construction cost for large-scale beach nourishment projects is fairly high, and while building resilience does not guarantee long-term protection.

When sediment is deposited, it alters the shoreline's profile, often resulting in a steeper slope that can intensify wave energy and exacerbate erosion (Greene, 2005). Beach nourishment can have biological impacts on local wildlife at the dredge and placement site. The compaction of the sediment and machinery, required for sediment placement, can damage borrowing organisms and the nature of the existing sediment. Beach nourishment can benefit endangered species, such as sea turtles and shorebirds, by restoring nesting habitats if they offer the proper conditions (Greene, 2005).



Figure 4-15: Beach nourishment.

A beach nourishment project at Seacliff SB and New Brighton SB could potentially protect upland assets but would not be ideal due to the short shoreline lengths and high costs required for mobilization of construction equipment, material sourcing, and placement on the beach. Although beach nourishment would add more recreational space and create a larger buffer between waves and upland assets, the high cost and uncertain longevity would make it undesirable for Seacliff and New Brighton.

Beach Nourishment Advantages:

- Replenishes eroding shoreline.
- Provides a larger beach width for recreation and improves shoreline longevity.
- Can provide habitat for marine mammals and shorebirds.

Beach Nourishment Disadvantages:

- Large volume of sand needed to achieve a reasonable benefit-cost ratio.
- Unpredictable longevity.
- Can be disruptive to wildlife at the dredge and placement site.

4.5. Offshore Landscape Elements

4.5.1. Rocky Shore and Reef Habitat

Rocky shore and reef features have the ability to support a diversity of marine species, while reducing wave energy and beach erosion. When a shallow feature of rocky habitat is introduced on the seabed, it creates a surface area for organisms and vegetation to colonize. Additionally, reef features work to stabilize sediment and dissipate incoming wave energy before it reaches the shoreline.

Rocky shore and reef habitat offers significant benefits for habitat creation and erosion control but come with some of the consequences of introducing a hard structure into a dynamic ecosystem. A three-year study on artificial reefs in the Dutch Wadden Sea demonstrated a 30% reduction in wave height and a significant increase in sediment accumulation. However, this also resulted in an amount of scouring at the base of the reef feature (Martin Mork, 2012). Studies have shown that wider rocky features provide increased wave attenuation. Rocky shore and reef features also reduce the frequency of wave exposure of adjacent beach areas, which is critical when stabilizing shorelines (Armono, 2004). Additionally, artificial reefs enhance recreational activities by improving fishing and diving opportunities for beach visitors (Chong et al., 2021).



Figure 4-16: Rocky shore and reef habitat.

Incorporation of rocky shore reef habitat at Seacliff State Beach and New Brighton State Beach could provide substantial protection against sediment loss and reduce wave action. By considering currents, wave dynamics, and beach morphology, an offshore reef could effectively protect against beach erosion, enhance habitats, and increase recreational opportunities.

Rocky Shore and Reef Habitat Advantages:

- Can support a diversity of marine wildlife.
- Stabilizes sediment and reduces wave action.

Rocky Shore and Reef Habitat Disadvantages:

- Can increase scouring at the base of the reef.
- Research on the effectiveness of reducing wave energy is inconclusive.

4.5.2. Kelp Forest

Kelp forests can be used as an adaptive element to reduce wave energy. The extension of a living shoreline, under the surface of the water, has the potential to reduce wind wave energy by 30% to 50% (University of Maine, 2018). Unlike other hard engineering methods, kelp forests are not affected by sea level rise and therefore can act as a long-term sustainable element to improve shoreline resiliency. Historically, planting kelp required scuba divers to hand-plant each seedling on rocky substrate. However, new research demonstrates that kelp seedlings embedded in small gravel, known as green gravel, can be easily deployed from the water's surface (Fredricksen et al., 2020).

Dense kelp forests create bulk drag and attenuate currents when planted offshore. Their effectiveness in reducing wave energy varies depending on the kelp species and shoreline morphology (Morris et al., 2019). Wave attenuation is most successful in shallow waters and at low tide (Mork, 2012). Kelp forests offer numerous ecosystem services, including nursery habitats, foraging grounds for marine organisms, carbon sequestration, and nutrient pollution removal, generating an estimated \$500 billion annually in ecosystem services (Christensen, 2023).



Figure 4-17: Kelp forest.

While kelp forests show promise for reducing shoreline erosion, further research is needed to determine the most suitable coastlines for their implementation. If the depth and morphology of the shoreline are appropriate, kelp forests could be a viable option for Seacliff and New Brighton State Beaches. This approach would not impact beach user experiences and would enhance fish habitats, benefitting recreational fishing.

Kelp Forest Advantages:

- Reduces wave action before it hits the shoreline.
- Would not negatively impact user experience.

Kelp Forest Disadvantages:

- May contribute to buildup of wrackline debris/organics.
- Research on the effectiveness of kelp forests to reduce wave action is limited.

4.5.3. Groins

A groin is a linear structure of large boulders built perpendicular to the shoreline. Its purpose is to stabilize the beach against erosion associated with longshore sand transport. A number of groins in sequence is termed a groin field. A single, large groin is often referred to as a jetty and usually has a function to prevent ingress of sand into an adjacent navigation channel, in addition to functioning as a groin.

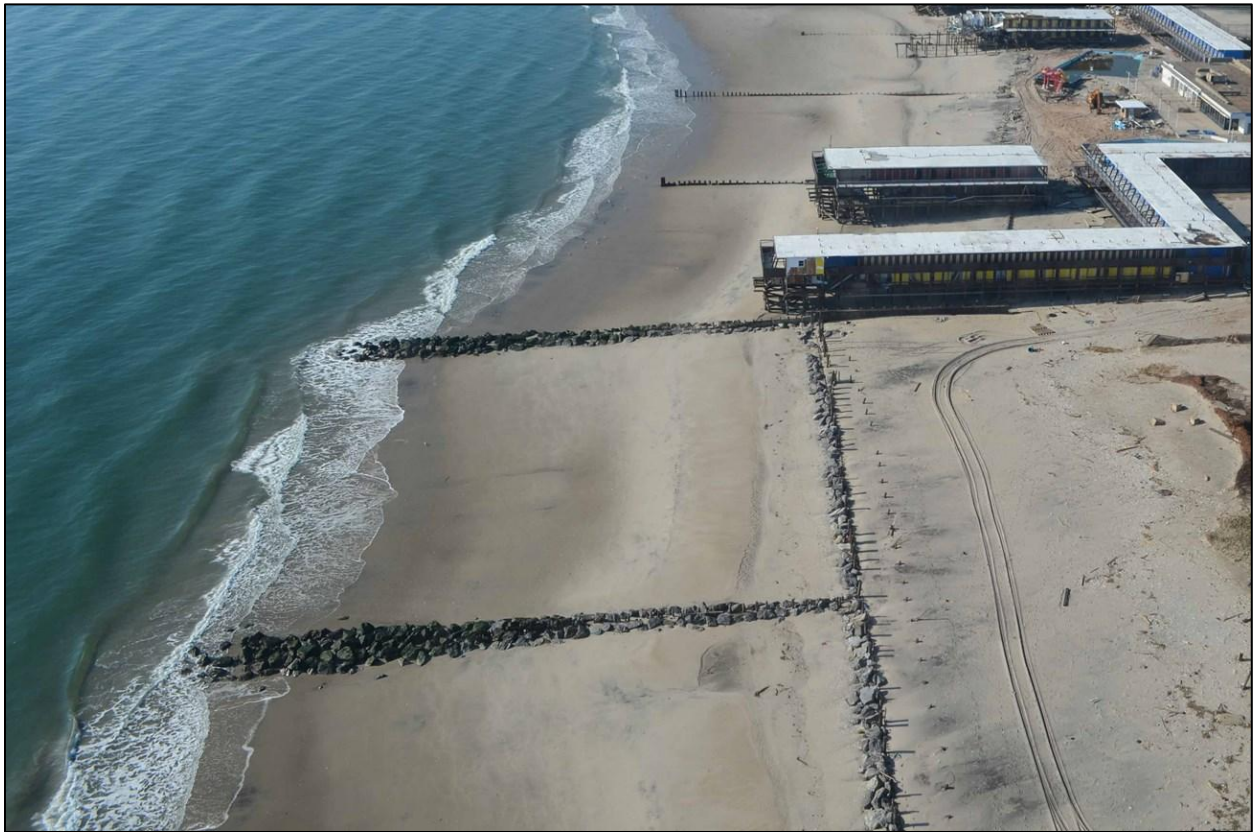


Figure 4-18. Groin field retaining sandy beach.

Groin Advantages:

- Helps retain sand on the shoreline by reducing longshore sand transport.
- The addition of sand helps widen the beach and protect upland assets.

Groin Disadvantages:

- Disrupts natural sand transport processes
- The disruption of sand transport processes can negatively impact wildlife.
- Can increase erosion.
- Can disrupt the user experience on the beach.

4.6. Nature-Based Hybrid Solutions

Conventional hard shoreline armoring can be designed to meet a given level of protection but typically incur other impacts and often fix the shoreline in place. These solutions are therefore often referred to as holding-the-line or providing a first line of defense.

Softer and nature-based solutions focus on incorporating resilience, but at the cost of retaining a degree of vulnerability. Figure 4-19 provides an example of adaptive strategies implemented together to provide increased resilience. In this case in the form of a seat wall fronted by a DSM abutment

overlain by vegetated dune. The sub-beach is enhanced with cobble fronted by rocky shore habitat and kelp forest.

During a significant storm event, the dune system could be impacted, but the seat wall backing it would serve to protect the cliff and public access behind. If exposed due to beach erosion, the DMS buttress would serve as a resilient, erodible feature to attenuate wave runup and wave overtopping, and prevent undercutting of the seat wall and area behind. The function of the sub-beach cobble is to improve the erosion resistance of the beach and reduce wave runup through frictional resistance. The kelp forest habitat and rocky shore would similarly provide a level of wave attenuation.

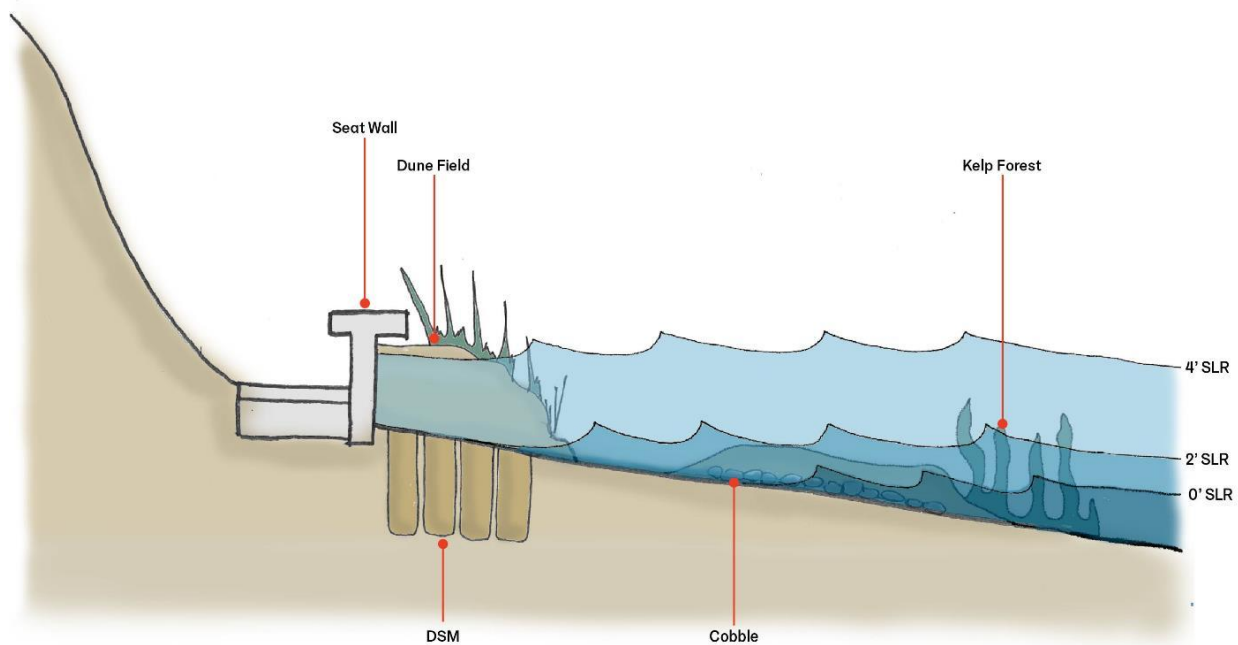


Figure 4-19: Example of a nature-based hybrid adaptation concept.

4.7. Do Nothing

A "Do Nothing" approach involves maintaining the shoreline in its current state without introducing any new landscape elements or structural interventions. This approach provides no mitigation for hazards, no adaptability to sea level rise (SLR), and no enhancement of structural integrity for the shoreline or associated park infrastructure. In the short term, this option would leave the shoreline vulnerable to impacts from storm events, which have already been observed to damage park infrastructure (Figure 4-20). Over the long term, as SLR progresses, the shoreline is expected to narrow significantly, ultimately leading to loss of public access and recreational use.

Advantages of taking no action:

- Maintains the shoreline's natural ecological processes.
- Does not introduce manmade infrastructure.
- No additional construction costs.

Disadvantages of taking no action:

- Does not protect against SLR, wave action and storm surge.
- Will greatly reduce beach space and back beach habitat.
- Public access to the shoreline will become restricted.

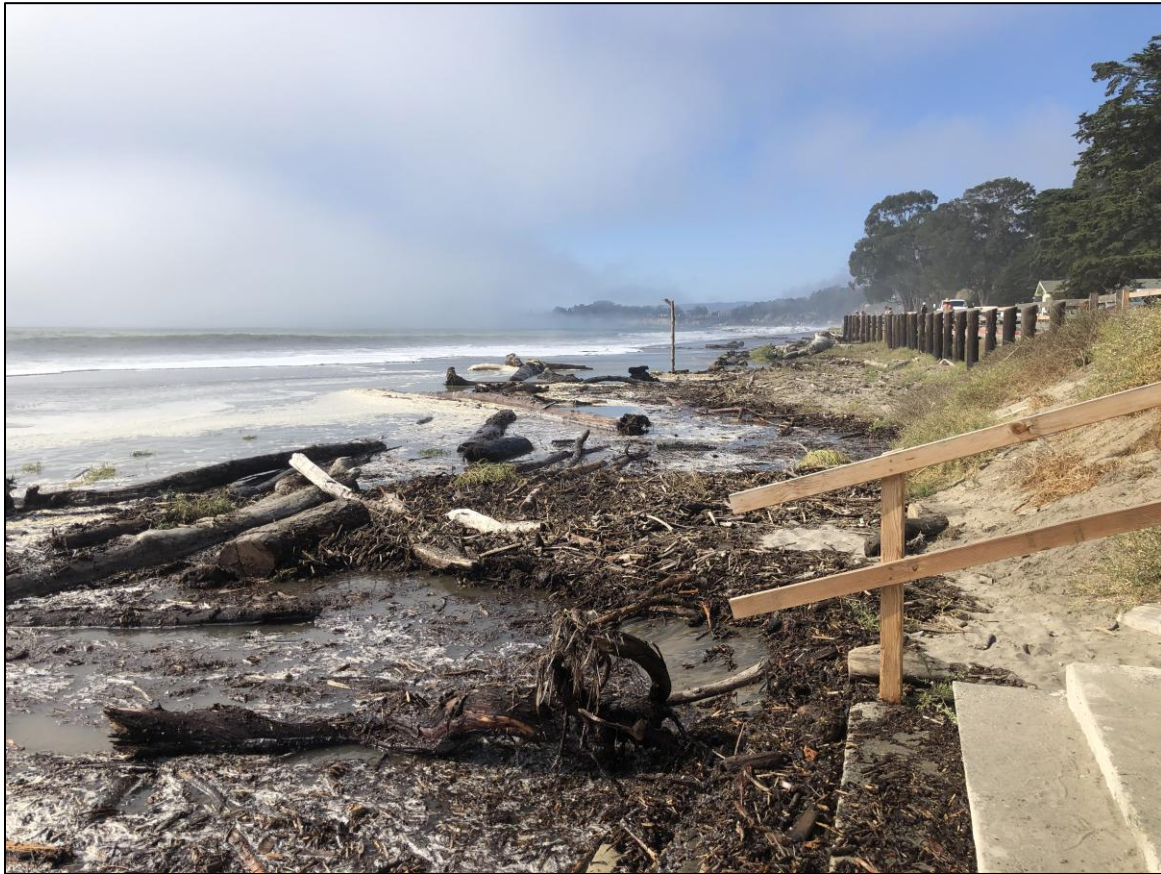


Figure 4-20: Example storm impacts at Seacliff State Beach.

5. Public Outreach

Public outreach conducted for the Seacliff SB and New Brighton SB adaptation planning has included a wide range of community and visitor outreach activities as described in the following. A significant portion of community outreach and engagement was conducted by State Park staff, with the overall planning for community and visitor outreach and open house events led by PlaceWorks, inc. Open House events included an in-person event and a follow-up virtual webinar, refer to PlaceWorks (2023, 2025) for details and summaries of community feedback. Miller Maxfield, Inc. was retained by State Parks for public relations, community outreach, open house coordination, and project website design for www.seacliffresilience.org.

5.1. Approach

A multi-faceted approach was adopted for public outreach and engagement, which included the following activities:

In-Person Outreach Events:

- Scheduled Public Events
- Pop-ups
- Tabling events
- OSU visitor intercept surveys
- Open House (on location)
- Open House Webinar (virtual)

Printed Media:

- Banners
- Posters
- Handouts
- Booklet(s)
- Storyboards

Languages:

- Public outreach materials provided in English and Spanish.
- Translators available during public events.

Digital Media:

- Posts and updates on Parks Seacliff SB and New Brighton SB websites.
- Social media posts on Facebook and Instagram
- Accessible PDF documents.
- Web-based public outreach surveys.

5.2. Public Outreach Chronology

Table 5-1 provides an overview and specifics of the outreach efforts.

Table 5-1: Chronological record of State Parks led public outreach activities.

Date	Public Outreach Activity
FEB 2023	Press Release, Public Process for Resilient Recovery.
MAY 2023	Press Release for Memorial Day Public Access.
AUG 2023	Study Fact Sheet.
	Meeting with organizational leadership of Seacliff Improvement Association to Discuss SLR study and upcoming survey.
	Meeting with Pajaro Valley Unified School District (PVUSD) to discuss potential youth and underserved community engagement in the areas of Watsonville and Pajaro. Connections for other organizations to speak with through outreach scoping. Key takeaways: Potential sensitivity due to flooding in Pajaro. Need for Spanish speaking content identified.
	Regeneración outreach scoping. Discussion of underserved community engagement opportunities. Takeaways: Need for funding and groundwork identified to potentially fund a position, and outreach to underserved, and severely underserved community members who won't have phones, and may not be able to read in English or Spanish.
SEP 2023	- Recovery and Resilience Banner. - Visitor Experience Survey.
	- Press release. - Interview with KCBS following survey release. - Discuss community engagement with City of Watsonville staff. Takeaways: Youth engagement is key to reaching underserved communities in Watsonville. - Engagement with families and local pedestrian traffic at Seacliff Movie Night. Provide survey awareness.
	Discussions with Watsonville Wetlands Watch climate stewardship interns about SLR related to climate change. Planning exercise based on budgets. Disseminated survey information. Students instructed to speak with family members and teachers/other school staff regarding survey. Key takeaways: youth care about sea level rise, climate change, and stewardship. When given representative budgets, understood decisions that need to be made in design.
	- Flyers distributed to Wilder Ranch, Blacks Beach, New Brighton, and Seacliff for distribution among Coastal Cleanup Day participants at Coastal Cleanup Day. - Planning presentation at weekly tabling event at Cabrillo College Farmers Market.
OCT 2023	- Fall Festival Tabling Event with PlaceWorks staff in Santa Clara County at Martial Cottle Park. Very large event, lots of traffic. State Parks participation with other public agencies. Takeaways: People in Santa Clara county are aware of Santa Cruz District park units and damage to Big Basin and Seacliff. - Press release.
	- Visitor Experience Survey Reminders and Closing. - Social Media Posts.
	Interview with Goodtimes Editor for Goodtimes article on study/survey.

Date	Public Outreach Activity
	• Interview with Santa Cruz Voice (streaming talk radio) about Seacliff recovery, SLR study, and visitor experience survey.
MAR 2024	• Public Survey Results. • Survey Handout Fact Sheet. • Study Update Four-Page Booklet.
SEP 2024	• California Coastal Cleanup – Flyers distributed to Natural Bridges, Seabright, Twin Lakes, New Brighton, Manresa, Sunset, and Palm Beach. Tabling at Seacliff and Rio del Mar.
	• Aptos Farmers Market –sharing public open house event information, high interest/ involvement with Seacliff.
	• Climate of Hope Fair- Watsonville: sharing public open house event information.
	• Grantee Visits- Pajaro Valley Pride & Barrios Unidos. Takeaways: PVP- Advocates for park inclusivity. Preference for natural based solutions. Barrios Unidos- interest leveraging funds to support other communities impacted by flooding (Pajaro)
	• Aptos Chamber of Commerce – Provide update to local business organizations on study progress and upcoming opportunities to engage.
	• Marketplace on the Green – Tabling at community event. Provided information on upcoming opportunities to engage including open house and webinar.
	• Launch of project website • Press Release and media interviews • Seacliff Open House flyer posting throughout Aptos • Seacliff Open House advertising (social media, KAZU, Aptos Times, Lookout Santa Cruz) • Seacliff video debut – shared on YouTube, Instagram, Facebook, website, with partners • Seacliff promo card (points to website for more information — ongoing distribution) • Seacliff Resilience sticker production • Mailer to Seacliff Fund donors (completed by Friends in advance of the Open House event) • Banners posted at Seacliff State Beach (ongoing placement) • A-frame signage posted at Seacliff State Beach (ongoing placement) • Newsletter (Mailchimp)
	• Seacliff Open House
OCT 2024	• Webinar advertising (social media, Lookout Santa Cruz) • Newsletter (Mailchimp)
	• Fall Festival Tabling at Martial Cottle Park- takeaways: high interest in work happening at Seacliff, great turnout. Over 600 contacts
	• Rio del Mar Improvement Association bi-annual meeting – Present findings to local community members. Key Takeaways: members understood vulnerabilities of the area, were very interested in coastal processes. Supported landscape elements that would beautify the park unit.
	• Seacliff Street Fair – Tabling at neighboring community street fair immediately adjacent Seacliff SB. Shared findings of vulnerability and provided information on

Date	Public Outreach Activity
	opportunities to engage. 175 contacts. Key takeaway: Community at Seacliff understands vulnerability, looking forward to engaging.
	• Cabrillo College Collaboration – working with 2 classes. Key takeaways: College students are a great resource for climate change/SLR feedback. Great thought partners for activities with younger audiences. High engagement with online survey.
	• Interview with Hilltromper about the study and survey, general outreach and engagement, adaptation.
	• Social Media Posts – webinar • Social media posts – survey (October and November) • Seacliff Webinar.
NOV 2024	• Outreach Survey #2. • Social media advertising for survey (Santa Cruz County, SF Bay Area/Silicon Valley, Central Valley) • Newsletter (Mailchimp) • Storymaps launch on website

5.3. SLR Strategy Outreach Mind Map

To assess the alignment of user preferences at Seacliff and New Brighton State Beaches with proposed strategies for addressing sea level rise (SLR), PlaceWorks conducted an outreach survey. The results showed that users value the scenic beauty, water activities, and the benefit to their physical and mental health, of the State Beaches. The activities that are most important to users are beach recreation, nature observation, running/walking/hiking, and camping. The potential SLR adaptation strategies each present distinct benefits and potential drawbacks. Managed retreat, or accommodate, entails creating additional beach area while potentially reducing public facilities and infrastructure. This strategy would improve all the stated values by making more beach area available to public recreation. The protection strategy would incorporate hard protective structures that would preserve existing built-up facilities. It would create well-defined spaces for public use that would enhance public access, ADA access, and public safety. The protection strategy would also preserve existing amenities such as ramadas, seating, comfort stations, and grill areas. As a result, the beach area could be greatly reduced or lost altogether and no longer be a place for water activities. The last strategy is the use of nature-based solutions. This would leverage natural structures to minimize the impact of SLR and enhance habitat but could result in reduced built-up facilities. Some of the existing beach could be lost to new planted habitat. This would increase availability to nature observation, while also accommodating all the other important values stated by beach users. A hybrid solution would combine all three strategies. Figure 5-1 illustrates how user's preferences, as identifies in the public outreach and visitor experience survey, PlaceWorks (2023) visitor experience survey, align with each SLR adaptation strategy.

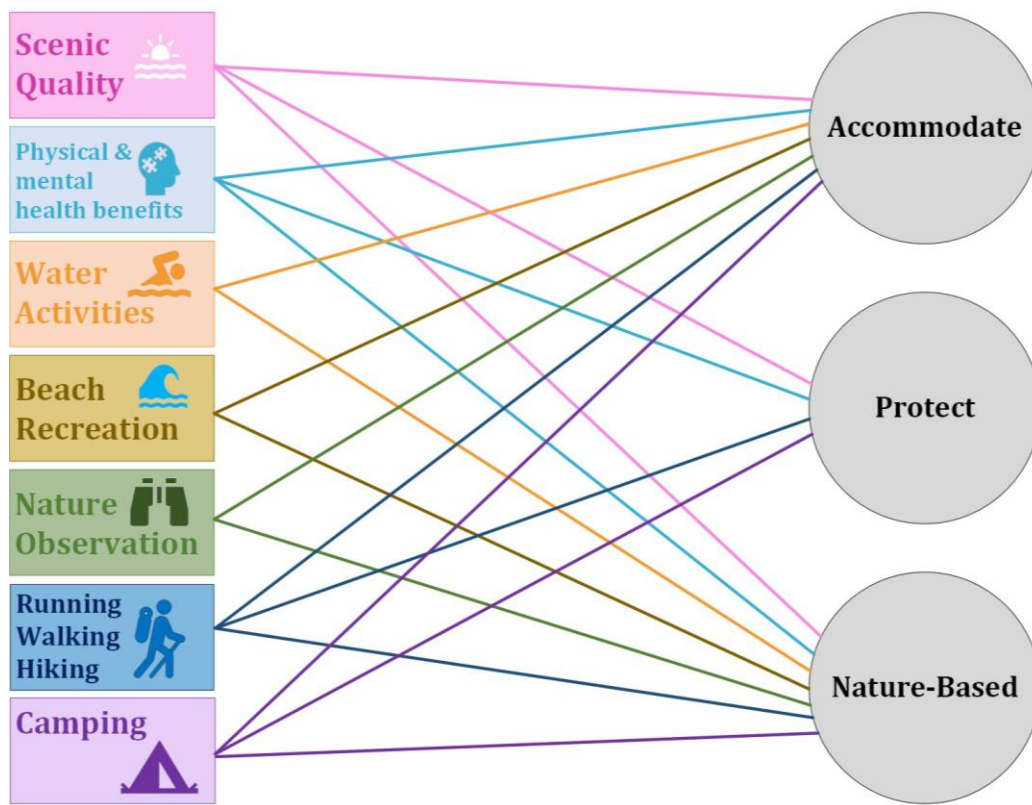


Figure 5-1: Capacity of SLR adaptation strategies to support public access and recreation.

5.4. Public Feedback and Ranking of Adaptation Elements

The landscape elements were evaluated in terms of:

1. **Structural Integrity.** A high level of structural integrity typically representative of traditional hard shoreline protection structures, moderate levels assigned to landscape elements that are erodible over time, and lower levels of structural integrity assigned to green solutions.
2. **Construction Cost.** The relative capital cost of incorporating landscape elements.
3. **SLR Adaptability.** How readily landscape elements can be adapted to SLR beyond the initial baseline.
4. **Hazard Reduction.** What level of protection landscape elements provide, typically measured in their ability to reduce flood impacts, attenuate wave action, and withstand wave impact and erosion.
5. **Ecological Enhancement.** The level to which landscape elements can provide a habitat enhancement function.
6. **Regulatory Feasibility.** Reflecting the preference regulatory agencies may have in permitting landscape elements.
7. **Public Feedback.** The preference for landscape elements reported by the public based on surveys, open house, and webinar events.

Figure 5-2 provides an evaluation of the landscape elements across the above categories, ranging from bright blue bars indicating the most favorable to bright red bars indicating least favorable in terms of ranking. Dual color bars in the Public Feedback column indicate the range of feasibility reported by participants. As an example, clifftop habitat enhancement would provide limited structural integrity as it would be vulnerable to SLR-related impacts, however would rank favorably in terms of construction cost, adaptability to SLR, and ecological enhancement benefits provided. Regulatory agencies would likely look favorable on a nature-based green solution such as this, which also categorized as desirable based on public feedback. Note, the qualities typically desired for public recreation include: the scenic quality of Seacliff SB and New Brighton SB, the physical and mental health benefits of being in the natural environment, access to the ocean and water related activities, beach recreation, nature observation, activities involving running, walking, and hiking, and solutions that support camping activities.

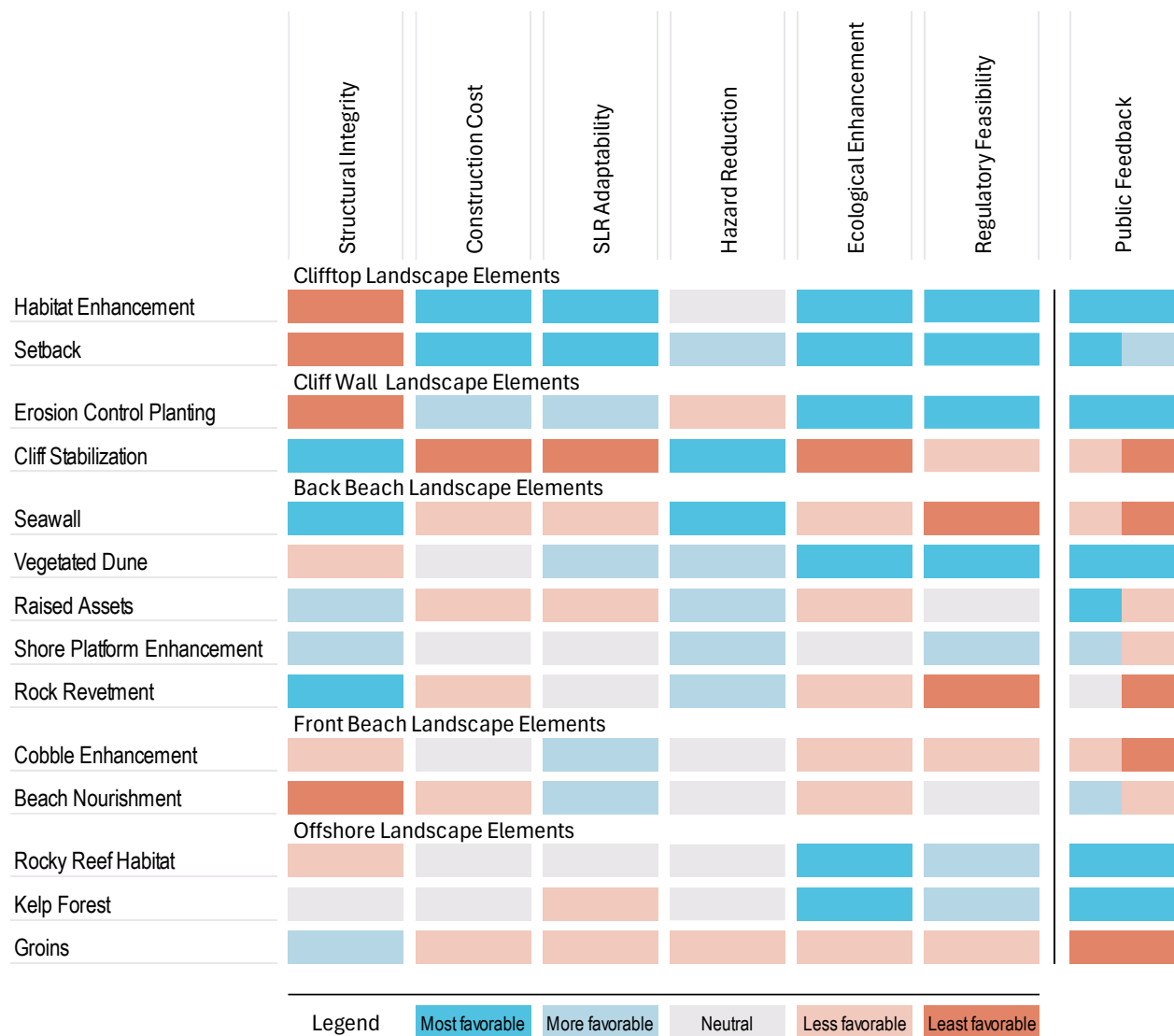


Figure 5-2: Evaluation of landscape elements.

6. Alternatives Analysis

Alternatives for the New Brighton and Seacliff SB subareas are presented in the following with the following base strategies and objectives:

- **Fortify & Protect.** Protect State Park Facilities and assets as they are present-day. The key SLR adaptation strategies forming the basis for this alternative are to elevate and protect assets.
- **Restore & Relocate.** Beach restoration with nature-based emphasis to accommodate SLR via managed retreat, removal of vulnerable State Park assets and relocation of key facilities. Create more space on the beach to maintain and broaden opportunities for public access, recreation, and water activities and aim for a shoreline environment better suited at accommodating the natural coastal processes.
- **Hybrid.** A balanced approach adopting a blend of adaptation strategies with emphasis on incorporating nature-based and living shoreline elements.

Refer to the storyboards in Appendix A for illustrative exhibits of the proposed adaptation alternatives.

6.1. New Brighton Beach

New Brighton Beach features approximately 2,000 feet of open beach, accessible from a parking lot located at the west end of the beach. The parking lot features 170 parking spaces of which 6 are accessible spaces. A short connector trail from the south end of the parking lot provides access to the Beach Trail along the base of the cliff, which runs atop an elevated berm faced with rock slope protection. A comfort station, shower facilities, and drinking fountain are located approximately 700 feet along the Beach Trail. Approximately 150 feet further east, the Beach Trail provides connectivity to the Sunset Trail (pedestrian/hiking trail), which connects to the New Brighton Campground area atop the cliff. The Beach Trail provides public access to the beach via a stairway located at the west end of the trail and a ramp section located by the comfort station and shower facilities.

The beach width along New Brighton Beach fluctuates significantly and can vary from about 100 to 150 feet of dry beach width to about 20 to 30 feet of dry beach width at times when there is a limited volume of sand and conditions of high tide and/or wave runup. Under these conditions, there is no beach along Beach Trail segment faced with rock slope protection. Wave runup is about up to the base of the cliff annually, evidenced by significant amounts of driftwood deposited along the base of the cliff and inability of vegetation to grow on the beach. A key concern at New Brighton Beach is that SLR could trigger a more permanent condition of no beach due to the reflectivity of the rock slope protection and cliff face. Present day, the beach width can vary significantly, seemingly dependent on sand supply past Santa Cruz and Capitola. The sand transport direction in this area is consistently northeast along the Opal Cliffs, providing sand to New Brighton Beach. But, because of the high rate of sand transport along New Brighton Beach and further south along Monterey Bay, periods of sand accumulation and sand depletion at New Brighton Beach are highly irregular. Times of southerly swell typically occurring in the summer months typically produce sand accumulation at New Brighton Beach as the typical southward sand transport direction changes to a northward direction.

Although New Brighton Beach still experiences a seasonal cycle of beach width (wider in the summer) and narrower in the winter), the concern is that the beach dynamic equilibrium could collapse and transition to a condition with generally no or limited beach width.

The drivers that promote this condition include:

1. Loss of beach width due to gradual submergence caused by SLR.
2. Dramatically increased reflectivity once wave runup begins to more frequently interact with the rock slope protection along the Beach Trail and cliff face along the remainder of the beach. The concern being that the reflectivity of the rock and cliff face would produce more turbulence, keeping sediment in suspension that would otherwise deposit and aggregate on the beach, enabling sand to be evacuated with wave run-down. The shore platform under the beach sand conceivably consists of Purisima formation overlain by large cobble, which once exposed will also present as highly reflective elements further contributing to loss of sand.
3. Decline in sand supply from Santa Cruz and Capitola. This effect has already taken place over the years due to land development reducing sediment output from rivers and creeks.
4. Loss of sand due to SLR. Effected by the Bruun Rule, (Bruun 1962), the active zone of sand movement extends from the beach out to a depth of about 50 feet. Along the arc of the Monterey Bay shoreline, this constitutes a sizable area⁶, where even a limited amount of SLR (inches) will constitute an unsurpassable deficit⁷. Shoreline areas will therefore experience sand loss as nature works to bring the seabed back into equilibrium in terms of the sand balance.

Possible strategies to SLR adaptation at New Brighton Beach are described in the following.

6.1.1. Fortify & Protect

This alternative focuses on protection of existing Park assets at New Brighton Beach, which are periodically exposed to wave overtopping projected to intensify with SLR and loss of beach. Parks assets in the predominant zone of potential exposure include the elevated Beach Trail, access stairs and ramps, comfort station, shower facilities, drinking fountain, rock slope protection along the Beach Trail, and the function of the trail serving for public access and emergency vehicle access.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Restack dislodged rip-rap after storm events to mitigate flooding associated with wave overtopping. Plan for maintenance capacity, and advance funding and design of adaptation solutions.
2. Near term. Incorporate seat blocks along the edge of the beach trail to mitigate flooding and wave overtopping exacerbated by SLR. The seat blocks would also provide seating for visitors

⁶ Estimated 10,400 acres for the northern part of Monterey Bay from New Brighton Beach to the Monterey Submarine Canyon.

⁷ Estimated deficit of 1.4M cubic yards per inch of sea level rise. Sand supply on the order of 265,000 to 400,000 cubic yards per year.

and serve as overlook points for scenic views of the shoreline and ocean environment. Restack dislodged rip-rap after storm events and replace as-needed.

3. Mid term. Raise beach trail grade to reduce wave overtopping driven by SLR. Replenish the rip-rap as needed. Reconstruct the comfort station and shower facilities at higher elevation.
4. Long term. Replace the seat blocks with a low-profile concrete seat wall and raise the grade of the beach trail.

This alternative would preserve the function and facilities provided for public access and emergency vehicular access as they are present day. The seat blocks and seat wall elements will reduce flood hazards by reduction of wave runup and wave overtopping. Potential erosion hazards would be addressed by the rock slope protection along the Beach Trail.

It is estimated that the existing toe of the rock slope protection can remain where it is present-day and would not encroach further on the beach. Space needed for improvements of infrastructure and facilities will be gained on the side of the Beach Trail facing the cliff. Approximately 1.2 feet gain in width can be achieved for every foot of elevation.

This alternative would provide elevated ocean viewpoints and maintain the Beach Trail for running/walking/hiking and connectivity to the Sunset Trail. Beach recreation and nature observation would be provided opportunistically at times when beach access is available.

6.1.2. Restore & Relocate

This alternative would focus on beach restoration and relocating existing Parks facilities along the present-day Beach Trail, consisting of the elevated trail, comfort station, shower facilities, drinking fountains, access stairways and ramps. This alternative would remove this infrastructure and provide a comfort station at the south end of the parking lot. Access to the beach from the parking lot would be via a staircase. Rock slope protection would be maintained along the segment from the culvert outlet to the new staircase to protect the outlet and trail/access infrastructure from erosion. The remainder of the elevated Beach Trail, rock slope protection, comfort station, shower facilities, drinking fountain and access ramps would be removed. This deconstruction activity would free up about 40 to 50 feet of beach width, corresponding to a footprint of about 1 acre.

Note: as an option, the rock riprap removed along the Beach Trail could potentially be used for rocky shore habitat creation but would need to consider potential habitat benefits balanced against public access and recreation benefits. If placed as a submerged reef, the rock would need to be placed far enough from shore to remain a distance from shore at low tide when the beach profile is at its widest (summer). Alternatively, the rock could be placed at the west end of New Brighton Beach in the form of a groin to help retain sand in this area.

This alternative would improve the scenic quality of the shore environment by removing a significant portion of built infrastructure, and provide wider opportunities for water activities, beach access and recreation, and nature observation. Elevated views would be limited to the trail segment coming down from the parking lot or could be provided via one or more observation towers on skids similar to Parks' seasonal skid-mounted lifeguard towers to enhance nature observation. Access for running, walking,

and hiking would be maintained, but would be on the beach as opposed to a paved trail segment. Connectivity to the clifftop campground area via the Sunset Trail would also be maintained.

The adaptation pathway for this alternative would be flexible in terms of timing as follows:

1. Current. Plan for less frequent beach access at times of high surf and seasonal and tidal access constraints. Identify asset relocation area(s), and advance funding and design of new facilities.
2. Near term. Develop relocation planning and deconstruction activities to take benefit of the additional space for beach habitat. Remove the beach trail and rip-rap to create space for beach habitat. Install a staircase to support visitor access to beach from the Upper Lot. Reconstruct restroom and shower facility in upper parking lot, remove existing. Update building setbacks on clifftop for new construction.
3. Mid term. Potential SLR-related impact to Parks facilities is mitigated by removal of said facilities.
4. Long term. With gradual SLR, the beach level would rise equally provided that sufficient sand supply exists. If a deficit in sand supply manifests, the outcome would be narrowing of the beach, and more frequent and impactful instances of wave runup impacting the base of the cliff. Such impacts could lead to cliff instability and rock slides, and/or erosion of talus deposits serving as a base for the vegetation. In either case, the more dynamic environment would be a detriment to the vegetation. To the extent that wave-related erosion could incite cliff failures, a setback should be maintained at the clifftop plateau to limit public access to clifftop areas identified as unstable or susceptible to rock falls.

The beach elevation is projected to rise with SLR, provided that sufficient sand supply is available. To the extent that wave runup can impact and erode the base of the cliff, a setback should be incorporated at the clifftop plateau in consultation with a geotechnical engineer to limit public access to clifftop areas deemed unstable or susceptible to rock falls.

6.1.3. Nature-Based Hybrid

This alternative emphasizes restoration of native habitat and accommodating natural coastal processes, while balancing access preservation. Steps toward this objective would be achieved by reduction of the existing elevated Beach Trail, rock slope protection, comfort station, shower facilities, drinking fountain, utilities, and concrete access ramps to the beach. The removal of existing facilities would create about 1 acre of additional space for beach recreation and activities, and beach habitat. A comfort station and shower facilities would be constructed at the south end of the parking lot. Access to the beach from the parking lot would be maintained via an accessible 12H:1V ramp down to the beach level. Rock slope protection would be maintained along the segment from the culvert outlet to the new ramp to protect the outlet and trail infrastructure from erosion. The trail and ramp would be wide enough to support public access and emergency vehicular access to the beach.

This alternative would provide enhanced erosion control planting over the lower portion of the talus deposits along the base of the cliff and aim to replace pampas grass and other invasives. The removal of invasive plant species and incorporation of native species would improve native biodiversity.

This alternative would provide improved mental health benefits via addition of native plantings to improve scenic quality and support a diversity of native bird and insect species and other native wildlife, affording visitors a more immersive natural environment. The removal of built infrastructure would create additional space for public recreational use, water activities, beach recreation, nature observation and habitat for shoreline species. Public access for running, walking, and hiking would be on the beach. Connectivity to the clifftop campground area via the Sunset Trail would also be maintained.

The adaptation pathway outlook for this alternative could be as follows:

1. Current. Plan for maintenance capacity and less frequent beach access at times of high surf and seasonal and tidal access constraints. Identify asset relocation area(s) and advance funding and design of new facilities.
2. Near term. Remove rip-rap and berm to create space for beach habitat and relocation of the beach trail. Relocate the comfort station and shower facility to the upper parking lot. Refurbish beach access via a ramp from the parking lot down to the beach. Incorporate native erosion control planting over the lower cliff. Vegetation should be planted at elevations above the base of the cliff, approximately corresponding to the limit of annual wave runup. The present-day vegetation line can be taken as a guide for the approximate limit of wave runup. Update building setbacks on clifftop for new construction.
3. Mid term. Potential SLR-related impact to Parks facilities is mitigated by removal of said facilities. With gradual SLR, the lower limit of vegetation would be expected to rise accordingly. More frequent instances of wave runup impacting the base of the cliff would be likely to cause localized slide failures in the talus deposits supporting the vegetation. A decision could be made at this point in time to let progressive impacts continue or to incorporate protective or resilient landscape elements to reduce impacts to the vegetation.
4. Long term. With gradual SLR, the beach level would rise equally provided that sufficient sand supply exists. If a deficit in sand supply manifests, the outcome would be narrowing of the beach, and more frequent and impactful instances of wave runup impacting the base of the cliff. Such impacts could lead to cliff instability and rock slides, and/or erosion of talus deposits serving as a base for the vegetation. In either case, the more dynamic environment would be a detriment to the vegetation. To the extent that wave-related erosion could incite cliff failures, a setback should be maintained at the clifftop plateau to limit public access to clifftop areas identified as unstable or susceptible to rock falls.

6.2. Seacliff RV Campground

From the area of the Visitor Center, the Seacliff RV Campground area extends approximately 2,500 feet northwest along Las Olas Drive. A timber bulkhead forms the interface between the edge of the campground area and the beach. Stairs and ramps provide access to the beach. The timber bulkhead has historically been subject to recurring damage. Since its initial construction in 1926, sections of the timber bulkhead have been damaged and reconstructed every 2 to 6 years on average. Refer to

Anderson and Griggs et al. (2023), Fig. 9: History of seawall/bulkhead construction and destruction from 1926 through 2023. Most recently, the timber bulkhead and seaward edge of the campground was damaged significantly in a storm event on January 5, 2023. Horizontal timber boards were undercut and knocked out by wave action and a significant portion of fill retained by the timber bulkhead was washed out and the leading edge of the roadway undercut and damaged. Between 50 and 60 feet of the roadway edge was lost, which included parking spaces and utility hookups for RV camping. In the present-day setting, Las Olas Drive retains two vehicle lanes, and the seaward edge is utilized as a trail for public access along Las Olas Beach. The dry beach width along the RV Campground Area varies from about 30 to 190 feet seasonally, at times with a variation in width of 20 to 30 feet at the waterline due to formation of beach cusps. The elevation of Las Olas Drive ranges from approx. +16.5 feet NAVD88 by the Visitor Center to +17.5 by the homes at the northwest end of the former RV Campground area. The seaward edge of the roadway is subject to instances of wave overtopping annually at times of high tides coinciding with long-period swell. Wave events occurring about every 5 years on average produce wave runup and overtopping of the roadway to the base of the cliff. High surf and wave overtopping is also capable of depositing significant quantities of sand and debris on Las Olas Drive, necessitating subsequent removal and cleanup. A primary concern is increased frequency and magnitude of damaging wave overtopping events.

The drivers that promote this condition include:

1. Loss of beach width due to gradual submergence caused by SLR and deficit in sand supply.
2. Shoreline retreat encroaching on the roadway and facilities.
3. Erosion and undercutting caused by temporary beach erosion.
4. Wave runup and overtopping impacts.

Possible strategies to SLR adaptation at the RV Campground Area are described in the following.

6.2.1. Fortify & Protect

This alternative focuses on preservation and protection of remaining Parks assets and facilities along Las Olas Drive, and adaptation of these to projected SLR. Potential hazards to be addressed include gradual shoreline retreat and loss of beach due to SLR, beach erosion associated with temporary changes in beach width, and flood hazards associated with wave runup and overtopping. Vulnerable Parks assets along Las Olas Drive include the RV campground, comfort stations, shower facilities and drinking fountains; pump station (a Santa Cruz County facility), public access trail and access points to the beach, Las Olas Drive and below grade utilities within.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Replenish dislodged rip-rap following storm events. Plan for maintenance capacity, and advance funding and design of repairs and adaptations.
2. Near term. Elevate Las Olas Drive and parking area and incorporate a concrete retaining wall and rip-rap along the leading edge to mitigate erosion hazards. Reconstruct impacted facilities,

including lost aggregate fill, campsite supporting utilities, and paving. Rebuild and elevate restroom facilities. Install new access ramps and incorporate seat blocks along Las Olas Drive to mitigate flooding associated with wave overtopping. The seat blocks would also provide seating for visitors and serve as overlook points for scenic views of the beach.

3. Mid term. Remove seat blocks, incorporate a low-profile seat wall and elevate the trail and roadway grade to reduce wave overtopping impacts. Potential erosion hazards can be addressed with a skirt wall and rip-rap rock slope protection along the base of the seat wall. Note: rock slope protection to be located so that it is below the beach sand level during the summer season.
4. Long term. Add 2 ft height extension with recurve to seat wall to convert it to a low-profile seawall. Raise grade along Las Olas Drive and trail correspondingly. Replenish rip-rap along the base of the seawall.

This alternative would preserve the function and facilities provided for public and vehicle access as they are present day. The seat blocks and seat wall elements would function as public seating elements and mitigate flood hazards by reduction of wave runup and wave overtopping. Good surfacing for running/walking/hiking/bicycling would be available along Las Olas Drive. Potential erosion hazards would be addressed by the rock slope protection and skirt wall.

6.2.2. Restore & Relocate

This alternative prioritizes relocation of Parks facilities along Las Olas Drive to make room for natural resource restoration and coastal processes. Potential hazards associated with coastal processes include shoreline retreat and loss of beach due to SLR, beach erosion and seasonal variation in beach width, and flood hazards associated with wave runup and overtopping. This alternative would remove existing damaged facilities and subsequently relocate the comfort stations to the Seacliff Day Use Area or Upper Lot. Parking space would be removed in the near term to gain space for beach habitat.

The former RV Campground featured a wide paved area for vehicular and pedestrian access, in total approximately 100 feet wide, from the base of the cliff and seaward consisting of: Las Olas Drive 14 ft wide westbound vehicle lane and 14 ft wide eastbound vehicle lane, 25 ft vehicle access to RV camping spaces, 35 ft width assigned to RV parking spaces (slanted), fronted by a 12 ft wide trail along the crest of the fronting timber bulkhead.

Approximately 50 feet of the seaward edge was lost during the January 5, 2023 storm event, which damaged the 12 ft wide trail, 35 ft wide RV parking spaces, and portions of the vehicle access to the RV spaces. The removal of these elements freed up approximately 2 acres of space on the beach. The remaining 50 feet of blacktop could strategically be pared back to provide additional space on the beach to accommodate coastal processes⁸. The minimum width capable of supporting vehicular access along Las Olas Drive would be a single lane, 12 ft wide in combination with shoulder sections at intervals to permit two-way traffic. These adaptive measures could yield a further 22 to 30 feet of beach width, between 1.2 and 1.7 acres of additional beach area.

⁸ Wave runup, temporary beach erosion associated with changes in the beach profile, and long term shoreline retreat.

A key hurdle of this alternative is that the present-day elevation range of Las Olas Drive, ranging from El. +16.5 feet NAVD88 at the southeast end to +17.5 feet NAVD88 at the northwest end is already subject to incidental wave overtopping. For this reason, this segment of Las Olas Drive is recommended to primarily serve for purposes of access, and not for vehicle parking.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Remove existing damaged facilities. Plan for change in use and access patterns, identify asset relocation area(s), and advance funding and design of new facilities.
2. Near term. Remove parking lot and restore area to beach habitat. The restroom facilities would be relocated to the Seacliff Day Use Area or Upper Lot.

This alternative would enhance the scenic quality and biodiversity of the shoreline and create a significant amount of beach area for public use, access, water activities, nature observation and beach recreation. Running/walking/hiking would be possible on the beach or via a boardwalk or trail, if constructed.

6.2.3. Hybrid Solution

The aim of this alternative is to accommodate SLR via managed retreat and relocation of some existing assets and thereby create space on the beach for dune plantings. Facilities, such as the comfort stations and shower facilities would be selectively relocated to other areas of the SB.

This alternative aims for a balanced approach to address the potential hazard exposure of the RV Campground Area, which include wave runup and overtopping and associated flood hazards, and erosion hazards stemming from beach erosion due to temporary changes in beach width, and loss of beach long term due to shoreline retreat and SLR inundation.

Wave overtopping and flood hazards are mitigated by elevating and consolidating assets and incorporating protective elements. Erosion hazards are addressed via introduction of a layered approach which improves the resiliency of the beach and incorporates protection along the leading edge of Las Olas Drive to prevent undercutting and subsequent damage and collapse. Public access and recreational space are improved by creation of additional space on the beach, and the scenic quality of the beach improved with native dune plantings.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Remove existing damaged facilities. Plan for maintenance capacity and reduced access. Identify asset relocation area(s), and advance funding and design of new facilities.
2. Near term. Remove the RV campground area and existing damaged facilities and consolidate vehicular access to the parking lot and incorporate an elevated comfort station. These managed retreat measures would reduce the overall width of built infrastructure at the base of the cliff by approximately 20 feet and create 1 acre of space on the beach for dune plantings, public access and recreation. A boardwalk could be installed in the reclaimed space to provide public access. The widened beach and dune plantings would increase resiliency of the beach to flood hazards. Seat blocks would be incorporated along the edge of the public parking area to provide elements for public seating and enjoyment of the beach, shoreline and ocean views.

The seat blocks would also serve to reduce flood hazards associated with incidental wave overtopping.

3. Mid term. As wave runup intensifies with SLR and storm events may become more frequent, the parking lot grade would be raised and gain resiliency by being elevated above the predominant hazard exposure at the beach level. The edge along the parking lot would be protected with a low-profile seawall. At this stage, replenishment of the dunes on the beach or protection for dune plantings could be considered if the dune habitat is significantly impacted.
4. Long term. Additional resilient measures that could be explored long term would include added protective elements and further raising of the parking lot grade and seawall.

This alternative would significantly enhance the scenic quality of the shoreline, improve native biodiversity, and create beach space for public access, beach recreation, water activities, and nature observation. Running/walking/hiking would be possible on the beach, with additional access via a pedestrian boardwalk through the dunes.

6.3. Seacliff Day Use Area

Starting at the Visitor Center, the Seacliff Day Use Area extends approximately 2,400 feet southeast to Aptos Creek, where a pedestrian bridge provides access to the Rio Del Mar Esplanade and Rio Del Mar State Beach. The seaward edge of the Day Use Area consists of an approximately 10 ft tall timber bulkhead fronted by beach. Portions of the timber bulkhead were damaged in the January 5, 2023 storm. A range of Parks assets for educational and public recreational activities are located at the Day Use Area, including the Visitor Center, comfort stations, drinking fountains, parking spaces, picnic areas, and ramadas. A pathway runs along the edge of the timber bulkhead, providing points of access to the beach.

The beach fronting the timber bulkhead is wider than along the RV Campground area, on the order of 70 to 240 feet wide, which provides a higher degree of resilience of the shoreline in this area. Wave runup can at times reach the timber bulkhead, but the occurrences are infrequent enough that emergent dune vegetation exists in a 10 to 20 ft wide band along the base of the timber bulkhead. The indication is therefore that a potential exists to enhance vegetated dune habitat along this stretch of beach, although these landscape features would be sensitive to SLR.

Because the timber bulkhead fixes the shoreline, a primary concern is wave damage, erosion, and undercutting of the bulkhead causing impacts to facilities on the platform retained by the bulkhead. A secondary hazard is wave overtopping of the bulkhead impacting the facilities.

The drivers that promote this condition include:

1. Loss of beach width due to gradual submergence caused by SLR and deficit in sand supply.
2. Beach erosion and long-term shoreline retreat encroaching on the timber bulkhead and facilities.
3. Erosion and undercutting caused by wave action and beach erosion.

4. Wave runup and overtopping impacts.

Possible strategies to SLR adaptation at the Day Use Area are described in the following.

6.3.1. Fortify & Protect

The aim of this alternative would be to protect and maintain the existing Parks assets and facilities at the Day Use Area, and address potential hazards associated with shoreline retreat, beach erosion, and flood hazards associated with wave runup and overtopping.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Plan for maintenance capacity and advance funding and design of adaptations. Replenish rip-rap.
2. Near term. As coastal processes exacerbated by SLR begin to impact the timber bulkhead and it nears the end of its useful service life, replace the timber bulkhead with a concrete toe wall. The wave overtopping potential would be reduced by placement of rip-rap rock slope protection at the toe of the wall.
3. Mid term. Raise the grade in the Day Use Area as needed; elevate the parking and picnic area, and rebuild elevated restroom and shower facilities. A concrete retaining wall would be included to form the edge and the fronting rip-rap replenished as needed.
4. Long term. Install a seat wall to raise the edge of facilities and limit the flood hazard potential associated with wave overtopping exacerbated by SLR. Replenish rip-rap to further reduce the wave overtopping potential.

This alternative would aim to maintain facilities at the Day Use Area as they are today. The constructed toe wall, later upgraded to a seat wall would mitigate flood hazards by reduction of wave runup and wave overtopping. Erosion hazards would be addressed by the wall foundation and rock slope protection at the base of the wall.

This alternative would provide public seating and elevated views from the Day Use Area platform, which would also support nature observation over the beach, ocean, and SS Palo Alto shipwreck. Paved surfacing would support running/walking/hiking/bicycling via trail segments and via State Park Drive. These pathways would provide access to the Rio Del Mar Esplanade via the pedestrian bridge across Aptos Creek. Access to water activities and beach recreation would be provided initially but would become limited with SLR resulting in narrowing of the beach fronting the timber bulkhead or wall. Because of the high degree of wave reflectivity of the timber bulkhead or wall, there would be a risk of losing the beach once wave runup begins to frequently impact the wall.

6.3.2. Restore & Relocate

This alternative adopts a managed retreat strategy to gradually adapt to SLR by restoring beach habitat to accommodate landward transgression of the shoreline. Existing facilities would be maintained for as long as feasible and gradually relocated, with the long-term objective being to maintain connectivity between the Visitor Center and Rio Del Mar SB.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Plan for reduced beach access at times of high surf and seasonal and tidal access constraints. Identify asset relocation area(s), and advance funding and design of new facilities.
2. Near term. As coastal processes exacerbated by SLR begin to impact the timber bulkhead and it nears the end of its useful service life, set back the road along the base of the cliff, consolidate the parking and picnic area, and replace the timber bulkhead with a concrete toe wall to gain space for beach habitat.
3. Mid term. Relocate restrooms and picnic spaces to upper parking lot.
4. Long term. Remove the road along the base of the cliff, remaining parking and assets to gain space for beach habitat.

This alternative would improve scenic quality by maintaining views of the beach, ocean and shoreline. Parks facilities and amenities for public recreation would remain available as space permits, but would gradually be relocated to other areas of the SB. Access to the beach for recreation, water activities, and nature observation would be maintained across all phases of this alternative. Opportunities for running/walking/hiking would be available along the beach and running/walking/hiking/bicycling on the trail and roadway along the base of the cliff, maintaining connectivity to Rio Del Mar SB.

6.3.3. Hybrid Solution

The aim of the Hybrid Alternative is to accommodate SLR via managed retreat and relocation of Parks facilities and public amenities as space becomes limited. The space created on the beach would support opportunities for beach recreation and water activities. Vegetated dune formations would be created on the beach to enhance the scenic quality of the shore and increase opportunities for nature observation and enhance resilience. Erosion control planting would be incorporated over the lower cliff and talus deposits, aiming to remove invasive plant species and incorporate native species to promote greater biodiversity and habitat suitable for native fauna.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Plan for maintenance capacity and changes in access patterns. Identify asset relocation area(s). Advance funding and design of new facilities, and replenish the existing rip-rap.
2. Near term. Reduce the extent of the Day Use Area by: a) setting back the roadway, b) consolidate parking, c) reduce the space for picnic areas, d) consolidate comfort stations. A toe wall would be incorporated along the edge of the new pavement to gain space for beach habitat. A significant amount of the space created on the beach would be utilized for incorporation of a vegetated dunes interspersed with boardwalk trail segments providing access for nature observation, beach recreation, and water activities. The widened beach and dune plantings would increase the resiliency of the beach and help mitigate flood hazards. Erosion control planting with native species would be installed at the base of the cliff.
3. Mid term. Elevate the consolidated parking lot and picnic area and incorporate a concrete retaining wall. Consolidate the comfort stations into one elevated facility to gain space for

beach habitat. The dune habitat would be replenished. Protection of the dunes could be considered if the dune habitat is significantly impacted.

4. Long term. Having a risk of being at odds with significant amounts of SLR projected long term, this alternative could have two pathways forward. One would be to let the dune system deteriorate, which could already be occurring at this stage, and transition to a fortify and protect strategy for the Day Use Area. Another pathway would be to have the Day Use Area revert to a coastal trail along the base of the cliff and replenish the dune system. This measure would free up a significant amount of space on the beach for shoreline transgression with SLR, but would maintain public access and connectivity between the Visitor Center and Rio Del Mar SB. A seat wall would be installed to raise the edge around remaining facilities.

This alternative would provide mental health benefits and significantly enhance the scenic quality of the shoreline by creating beach space for public access, beach recreation, water activities, and dune habitat. The dune habitat, plantings, removal of invasive plant species, and incorporation of native species over the base of the cliff would significantly expand on native habitat and enhance biodiversity of native species. Nature observation would be possible from the Day Use Area trail, and via the trail weaving through the dunes enabling visitors to immerse in and be closer to nature. Running/walking/hiking would be possible on the beach. Additionally, bicycling and other wheeled access would be available via the Day Use Area trail.

6.4. Rio Del Mar Esplanade

The area at Rio Del Mar Esplanade and Aptos Creek outlet to the Pacific consists of low-lying land between the cliff formation at Seacliff on the west side of Aptos Creek and the ridge and cliff backing Rio Del Mar Beach. This low-lying portion of Aptos is within the 1% annual chance floodplain and at risk of flooding from Aptos Creek (fluvial flooding) and from the Pacific (coastal flooding). A floodwall has been constructed at the back beach along the Rio Del Mar Esplanade to reduce the potential for coastal flood hazards to impact the Rio Del Mar Flats community. However, at times of high surf combined with storm surge and high tide conditions, the seawall is at times heavily overtopped by wave action. Parks maintains a comfort station on the seaward side of the seawall and maintains the bridge across Aptos Creek providing connectivity between Rio Del Mar Flats and Seacliff Day Use Area. The comfort station features a floodwall to reduce the potential for wave overtopping and to prevent ingress of sand from the beach. A groin has historically been in place to facilitate a more direct path of the Aptos Creek outlet to the Pacific. Without this structure, the creek outlet would be much more dynamic and would tend to veer sharply to the southeast over the beach due to this being the predominant sand transport direction along the beach. At times, there can be a northwest-ward reversal in the sand transport direction, and the creek outlet will typically change direction accordingly. The mechanisms that govern the creek outlet dynamics are as follows:

1. Swell breaking at the shore will typically tend to bring sand up on the beach, forming a beach berm along the shore.
2. If the creek outflow is low to modest, it will be contained behind the beach berm and follow the path of least resistance downhill towards the ocean. If the swell is persistent, the creek outlet may be contained behind the beach berm and form a lagoon.

3. The beach berm may breach for a number of reasons, these being: a) if the creek outflow is strong enough to punch through the beach berm, b) if the lagoon water level rises to a point where the hydrostatic head is sufficient to cause the berm to fail, or c) if wave conditions are such that the beach erodes and encroaches on the beach berm.

At times of large swell, the creek outlet has been observed to run along the seawall and to some extent undercut the comfort station foundation pad. Because of the creek outlet dynamics and meandering, the beach fronting the comfort station is somewhat lower in elevation, which makes the area generally more susceptible to wave runup, overtopping, and flooding. One indicator of these conditions is the fact that vegetation is unable to take hold on the beach due to the frequently shifting substrate and above normal wave exposure. For comparison, an approximately 25 ft wide band of vegetation has established in front on the beach homes to the southeast. This vegetation band is unable to take root by the comfort station for the aforementioned reasons. However, it indicates that a vegetated dune environment could be incorporated on the beach, provided that it is at sufficient elevation and fronted by approximately 150 feet of beach to accommodate high surf and wave impact.

6.4.1. Rio Del Mar Living Shoreline Project

The beach area fronting the seawall along the Rio Del Mar Esplanade currently features a living shoreline project, initiated by California State Parks in 2021 and implemented in 2022. The dune design was developed by Integral Consulting Inc., and restoration design by Integrated Ecology. Two large dune features were constructed with access to the beach via the entry point along the Rio Del Mar Esplanade. The dune features were constructed as sand mounds over a core of logs and driftwood. Upright logs were installed as indicator piles to gauge the sand level in the area of the dunes. Native plant species considered for dune plantings included: American dune grass, beach evening primrose, coastal sagewort, creeping wild rye, beach burr, coast buckwheat, lizard tail, seaside daisy, beach morning glory, beach pea, coast Indian paintbrush, and yellow sand verbena.

With this setting in mind, potential strategies to adapt to SLR are described in the following.

6.4.2. Fortify & Protect

This alternative would focus on protection of the comfort station and adaptation of this facility to SLR. Because the comfort station is located on the seaward side of the floodwall and at times subject to wave exposure, the strategies that could be employed for protection would include a larger seawall enclosing the comfort station and/or elevating the facility to bring it out of the floodplain and above the level of the most intense wave exposure, which is at beach level.

The adaptation pathway for this alternative could be envisioned as follows:

1. Current. Plan for maintenance capacity, and advance funding and design of adaptations.
2. Near term. Rebuild and elevate the restroom and pedestrian area.

3. Mid term. If incidental wave overtopping of the pedestrian areas materializes, install seat blocks along the edge of the raised pedestrian area. The seat blocks would help reduce wave overtopping and serve as seating elements for the public.
4. Long term. If SLR-related impacts and wave overtopping become more frequent and more severe, a seat wall would be installed along the pedestrian area and parking lot to reduce overtopping. The seat wall would facilitate public access during non-storm conditions. Potential erosion hazards would be addressed with the riprap placement or by extending the seat wall to sufficient depth to prevent undercutting.

This alternative would preserve the public amenities and emergency vehicular access provided in the present day and would significantly reduce coastal flood risk in the low-lying areas of Rio Del Mar. Although the proposed infrastructure will fix the shoreline location, this would be at a setback of approximately 150 feet, providing an allowance for transgression of the shoreline with SLR. This alternative would preserve the scenic quality of the beach, shoreline and ocean views and enhance these by providing an elevated platform for viewing (the promenade level). Running/walking/hiking would be possible on the beach and bicycling possible at the promenade level. Consequently, this alternative would maintain connectivity between the Seacliff Visitor Center and Day Use Area to Rio Del Mar SB, and via Beach Drive a connection to the Platforms Parking Lot. The fact that this alternative would fix the back beach would also mean that there wouldn't be any reliance on the fronting beach. This means that the beach space would be fully open to other incentives such as beach recreation, water activities, and could provide space for dune habitat or restoration of the Aptos lagoon. In this case there would no longer be a need to maintain the timber pile and rock groin directing the creek outlet to the Pacific.

6.4.3. Restore & Relocate

This alternative would focus on beach restoration and relocation of the comfort station, which would be vulnerable to wave, erosion and flood hazards exacerbated by SLR. Emergency vehicle access would be maintained on the southeast side by Beach Drive. Relinquishing the beach in this area could provide space for the Aptos Lagoon to revert to its original cycle. Restoration of the natural lagoon function could support migratory fish passage on Aptos Creek, shorebird habitat on the beach, and would significantly enhance the biodiversity of species native to this environment, which could encompass native species of plants, insects, birds, mammals, fish and other marine life.

The adaptation pathway for this alternative could be envisioned as follows:

1. Current. Plan for change in use and access patterns. Identify asset relocation area(s), and advance funding and design of new facilities.
2. Near term. Remove or relocate the existing comfort station. Install cobble berms to protect the living shoreline plantings.
3. Mid to long term. Monitor and maintain the living shoreline project.

This alternative would improve the scenic quality of the beach by removal of facilities and enabling the creek outlet over the beach to revert to its natural function, including seasonal formation of a lagoon on the beach. Mental health benefits could be supported by the enhanced opportunity for nature observation of shorebirds, fish and other marine species in the lagoon. Public access for beach

recreation and water activities would be maintained as would emergency vehicle access by the beachfront homes on the southeast side of the esplanade. Running/walking/hiking would be possible on the beach and Running/walking/hiking/bicycling along the esplanade.

It should be noted that enabling the creek outlet to revert to its natural state, there will likely be times when the creek outlet will veer sharply to the southeast along the front of the esplanade and thereby prevent access to the beach, and possibly also emergency access to the beach. At times when these conditions manifest, public access could be via the Aptos Creek pedestrian bridge and beach access on the northwest side of the creek outlet. Another possibility to maintain beach access at Aptos could be to incorporate a boardwalk on piles to bridge across the creek outlet. However, due to the propensity for the creek outlet to naturally meander and at times form a lagoon, this solution might not provide access at all times.

6.4.4. Nature-Based Hybrid

This alternative would aim to provide a balanced blend of beach restoration, restoration of the creek outlet, and incorporation of native habitat balanced with flood hazard reduction. This would be achieved by elevating the comfort station. Space on the beach would be utilized for incorporation of vegetated dune formations, and could enable the Aptos Creek beach outlet to meander more freely and revert to its original state. Rocky habitat would be incorporated at the leading edge of the dunes, so as to guide the creek outlet over the beach and prevent it from eroding the dunes. Flood hazard reducing measures would need to be maintained to protect the low-lying areas of Aptos. It would make sense to maintain these measures along the esplanade where they are today as this is the dividing line between fluvial and coastal flood hazards.

The adaptation pathway for this alternative could be as follows:

1. Current. Plan for maintenance capacity and reduced access. Identify asset consolidation opportunities and relocation areas, and advance funding and design of adaptations.
2. Near term. Rebuild and elevate the comfort station. Incorporate cobble berms on the beach to protect the living shoreline plantings and establish vegetated dune features on an elevated pad behind the cobble.
3. Mid term. If the dune features are impacted by erosion, it could be mitigated by replenishment of the cobble and dunes.
4. Long term. Replenish the living shoreline cobble and dunes.

This alternative would significantly improve the scenic quality of the beach by introduction of dune habitat and native vegetation with the possibility to serve as habitat for native species and enhance biodiversity. Mental health benefits could be supported by the enhanced opportunity for nature observation of dune and lagoon habitat, shorebirds, fish and other marine species in the lagoon. Public access for beach recreation and water activities would be maintained via a ramp at the southeast end of the esplanade, which would also serve as emergency vehicle. Running/walking/hiking would be possible on the beach, but at times potentially impacted by the dynamics of the beach outlet. Running/walking/hiking/bicycling would also be possible along the esplanade.

6.5. Rio Del Mar Beach

Rio Del Mar Beach extends for about 3,000 feet from the Rio Del Mar Esplanade to the Platforms Parking Lot. This area is backed by private residences along Beach Drive. There are no Parks facilities along this stretch of beach that would need protection, and retreat strategies are not feasible as they would encroach on Beach Drive. Consequently, the available adaptation strategies are a no action alternative or a nature-based hybrid solution focused on enhancement of native habitat on the beach as outlined in the following.

6.5.1. Nature-Based Hybrid

This alternative would improve resilience by incorporating nature-based elements along the back beach to mitigate erosion and flood hazards driven by SLR. These improvements would provide improved mental health benefits with the addition of dune features vegetated with native plants to improve the scenic quality and provide habitat for species native to a dune environment. The habitat improvements would support native species and have the potential to significantly improve biodiversity. A hiking trail could be incorporated through the dunes to provide beachgoers with a more immersive experience of the dune habitat.

The adaptation pathway for this alternative could be as follows:

1. Current. No action.
2. Near term. Vegetated dune features would be incorporated along the back beach, optionally with trail segments to facilitate nature observation and public access to the beach. The dune features would improve the resiliency of the shore by acting as a buffer to mitigate beach erosion, wave runup and wave overtopping. Emergency vehicle access to the beach would be via access from the Rio Del Mar Esplanade or from the Platform Parking Lot.
3. Mid term. The dune system and plantings would be maintained.
4. Long term. There is a potential for SLR, shoreline retreat, loss of dry beach width, wave overtopping and erosion having a significant impact on the dune habitat and trail segments. Potential adaptation strategies that could be considered going forward could be to: a) retreat the dune elements, or b) incorporate resilient or protective elements to mitigate impacts to the dune system.

This alternative would significantly improve the scenic quality of the beach and provide improved mental and health benefits via incorporation of dune habitat vegetated with native plant species to support fauna native to dune systems. Nature observation would be possible via the trail segments, if incorporated, which could also support public access for beach recreation, water activities, and walking.

6.6. Rio Del Mar Platforms Parking Lot

The Rio Del Mar Platforms Parking Lot is located about half a mile down Beach Drive from Aptos beach front and provides 60 parking spaces and 2 ADA accessible spaces, public access to the beach, and emergency vehicle access. The width of the beach in this area can range from about 85 to 300

feet summer/winter, which provides a measure of resilience to beach erosion (temporary), shoreline retreat (long term), and the potential for gradual narrowing as a result projected SLR.

A key concern in this area is that although the beach incorporates a measure of resilience by being wide⁹ it is limited in elevation and therefore does not provide substantial mitigation of flood hazards during storm events characterized by storm surge coinciding with high tide. One such event was the January 5, 2023 storm which produced wave overtopping over the parking lot and Beach Drive, reaching the base of the cliff. Most if not all of the beachfront properties experienced some level of flooding, and many homes at the base of the cliff along Beach Drive had the lower portion of their garage doors knocked in as a result of wave runup capable of reaching the base of the cliff.

Strategies to adapt the Platforms Parking Lot to address SLR are described in the following.

6.6.1. Fortify & Protect

This alternative focuses on protecting and maintaining existing Park assets at the Platforms Parking Lot, which include the paved parking space, comfort station, drinking fountains, beach access, and emergency vehicle access.

The adaptation pathway for this alternative can be outlined as follows:

1. Current. Plan for maintenance capacity, and advance funding and design of repairs and adaptations.
2. Near term. The seaward edge of the parking lot features open railing, which enables wave runup to overtop the parking area, producing a flood hazard and deposition of sand and debris during storm events. Seat blocks would be installed to mitigate wave overtopping.
3. Mid term. Elevate the parking area and the comfort station to mitigate potential wave impact and flood hazards. A decision at this point in time could be to elevate the comfort station in anticipation of SLR projected long term. The comfort station would then be at grade with subsequent long term improvements at the parking lot.
4. Long term. A concrete seat wall would be installed around the edge of the parking lot to address projected SLR.

This alternative would preserve the function and facilities provided for public access and emergency vehicular access as they are present day. This alternative would preserve scenic quality much as it is today. The parking apron would be elevated in line with projected SLR, enabling nature observation and providing views of the beach and shore beyond. Public and emergency access to the beach would be maintained. Activities for running/walking/hiking would be on the beach.

⁹ Note: Beach width generally widens along New Brighton SB and Seacliff SB, being the narrowest at New Brighton Beach and the widest at the Platforms Parking Lot.

6.6.2. Restore & Relocate

This alternative adopts a managed retreat strategy to adapt to projected SLR by creating beach space to accommodate landward transgression of the shoreline. Existing facilities would be maintained as feasible and relocated over time, with the long-term objective being to provide public parking and access to the Platforms Beach.

A possible adaptation sequence could be implemented as follows:

1. Current. Plan for change in use and access patterns. Identify asset relocation area(s), and advance funding and design of new facilities.
2. Near term. Reduce parking and construct a concrete toe wall around the new consolidated parking area.
3. Mid term. Remove all parking and comfort station to gain beach habitat.
4. Long term. Monitor and maintain beach habitat.

It should be noted that an inherent feature of the Platforms Area is the low elevation of the parking lot in the range from El. +15.5 feet NAVD88 at the southeast end to El. +18.5 feet NAVD88 at the northwest end by the comfort station. If significant wave overtopping, sand ingress, and/or flood hazards manifest, elements of strategies to elevate and protect facilities could be considered.

This alternative would maintain present-day scenic quality, featuring views of the beach, shoreline and ocean beyond. Access for beach recreation, water activities, and nature observation would be maintained across all phases of this alternative. The amount of available parking space would decrease over time. Opportunities for running/walking/hiking would be available along the beach and running/walking/hiking/bicycling along Beach Drive between Aptos and the Platforms Parking Lot.

6.6.3. Nature-Based Hybrid

This alternative aims for a balanced approach to incorporate nature-based elements into the Platforms Parking Area beach frontage, while building resilience to erosion and flood hazards driven by SLR. While this section focuses primarily on the Platforms Parking Lot Area, the nature-based adaptation described for the beach area would apply to the entire shoreline segment from Aptos to the Platforms Lot (Rio Del Mar Beach and Platform State Beach).

This alternative would provide improved mental health benefits with the addition of dune features vegetated with native plants to improve the scenic quality and provide habitat for species native to a dune environment. The habitat improvements would support native species and have the potential to significantly improve biodiversity. A hiking trail would weave through the dunes providing visitors with a more immersive experience of the dune habitat. Space on the beach for these improvements would be gained by removal of a portion of the existing parking facilities at the Platforms Lot.

The adaptation pathway for this alternative could be as follows:

1. Current. Plan for maintenance capacity and reduced parking opportunity. Identify asset consolidation opportunities and relocation areas, and advance funding and design of repairs and adaptations.
2. Near term. Eliminate the outer (angled) parking spaces along the beach and feeder lane through the parking lot to increase the width of the beach by 44 feet. The angled parking adjacent to Beach Drive would be restriped to be accessible directly from Beach Drive. The number of available parking spaces would be 26 standard parking spaces and 2 ADA accessible spaces. Seat blocks would be incorporated along the edge of the parking area to serve as public seating and reduce wave overtopping and associated flood hazards. Vegetated dune features would be incorporated on the beach fronting the parking lot with boardwalk trail segments to enable nature observation and public access to the beach. The dune features would also improve the resiliency of the shore by acting as a buffer to mitigate beach erosion, wave runup and wave overtopping. Emergency vehicle access to the beach would be maintained at the southeast end of the lot.
3. Mid term. Elevate the parking area and the comfort station to mitigate potential wave impact and flood hazards. A ramp would be incorporated to provide access up to the parking area. The dune field would be replenished as needed.
4. Long term. A concrete seat wall would be installed around the edge of the parking lot to address projected SLR, and the dune field replenished.

This alternative would significantly improve the scenic quality of the beach and provide improved mental and health benefits via incorporation of dune habitat vegetated with native plant species to support fauna native to dune systems. Nature observation would be possible from seating elements along the parking lot (later elevated), and via a beach trail through the dune features to facilitate an immersive experience and an improved feeling of being one with nature. Public access for beach recreation and water activities would be provided via trail segments from the parking lot. Opportunities for running/walking/hiking would be on the beach, or via Beach Drive, which would additionally facilitate bicycling access and connectivity to the Rio Flats Area.

6.7. Comparison of Adaptation Alternatives

The adaptation alternatives were ranked across a broad range of performance criteria in terms of how the proposed alternatives meet:

- State Park goals and vision for the future of Seacliff SB and New Brighton SB.
- How well the alternatives align with California Coastal Commission State policies, State Park policies CSP (2021) and guidance for adaptation to SLR, and Park Unit planning, CSP (1990a,b).
- How alternatives would interact with coastal processes
- The level of resilience provided by each alternative, and efficacy in reducing wave overtopping and flood hazards, erosion hazards, and other potential hazards as they relate to the stability and integrity of landscape elements and public safety.

- The area(s) of beach and habitat that would be created by each alternative.
- How alternatives support public access and recreation in terms of scenic quality, improved health benefits, and opportunities for nature observation, beach recreation, walking/hiking/running/bicycling, and water activities.
- Permit complexity; and
- Construction and maintenance costs.

Table 6-1 provides a comparison and ranking of alternatives by the above performance categories.

Table 6-1: Comparison and Ranking of Adaptation Alternatives.

State Beach Area	New Brighton Beach			Seacliff RV Campground			Seacliff Day Use Area			Rio Del Mar Esplanade			Rio Del Mar Beach	Platforms Parking Lot		
Adaptation Alternative Area of Potential Effect	Fortify & Protect	Restore & Relocate	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid
Implementation and Upkeep																
Construction Cost	\$\$	\$	\$	\$\$\$\$\$	\$	\$\$	\$\$\$\$\$	\$\$\$\$	\$\$\$\$\$	\$\$	\$	\$	\$\$	\$	\$	\$
Maintenance Cost	\$	\$	\$\$	\$\$	\$	\$\$\$	\$\$\$	\$\$	\$\$\$\$\$	\$\$	\$	\$	\$\$\$	\$	\$	\$
Permitting Complexity	Difficult, but within existing footprint	Feasible	Feasible, living shoreline	Difficult, but within prior campground footprint	Feasible	Feasible, living shoreline	Difficult, but within existing footprint	Feasible	Feasible, living shoreline	Difficult, but within existing footprint	Feasible, living shoreline	Feasible, living shoreline, native habitat	Feasible, living shoreline, native habitat	Difficult, but within existing footprint	Feasible	Feasible, living shoreline, native habitat
Design/Planning Complexity	Complex	Simple, relocation	Simple, landscape elements	Complex	Simple, relocation	Simple, landscape elements	Complex	Complexity associated with phased retreat	Consideration needed for phased retreat	Complex	Simple, relocation	Moderate, relocation	Moderate	Complex	Simple, reduction	Moderate, reduction
Vulnerability of Built Environment	Facilities Preserved	Relocated	Relocated	Facilities Preserved	Removed	Relocated	Facilities Preserved	Reduced	Reduced	Facilities Preserved	Relocated	Relocated	No impact	Facilities Preserved	Reduced	Reduced
Adaptability	Adaptable, but ultimately limited, fixed service life	Provides a basis for adaptation, unconstrained	Provides a basis for adaptation, unconstrained	Adaptable, but ultimately limited, fixed service life	Provides a basis for adaptation, unconstrained	Provides a basis for adaptation, unconstrained	Adaptable, but ultimately limited, fixed service life	Adaptable, but frequent construction needed	Adaptable, but construction phasing needs consideration	Adaptable, but ultimately limited, fixed service life	Highly adaptable	Adaptable, possible constraints	Adaptable, possible constraints	Adaptable, but ultimately limited, fixed service life	Provides a basis for adaptation, unconstrained	Adaptable, possible constraints
Policy & Guidance Alignment																
Alignment with State Guidance	Revetment and seawalls only permitted if no feasible alternatives exist	Revetment permitted for coastal dependent use only	Revetment permitted for coastal dependent use only. Nature-based approach	Revetment and seawalls only permitted if no feasible alternatives exist	Avoidance of shoreline armoring which impacts coastal resources	Nature-based approach with seawall	Revetment and seawalls only permitted if no feasible alternatives exist	Avoidance of shoreline armoring which impacts coastal resources	Nature-based approach with seawall	Revetment and seawalls only permitted if no feasible alternatives exist	Avoidance of shoreline armoring which impacts coastal resources	Nature-based approach with seawall	Avoidance of shoreline armoring which impacts coastal resources. Nature-based approach	Revetment and seawalls only permitted if no feasible alternatives exist	Avoidance of shoreline armoring which impacts coastal resources	Nature-based approach with seawall
Alignment with Parks Policies	Structural protection measures possibly not consistent with coastal development siting policies	Build resilience, preserves natural processes consistent with coastal development siting policies	Build resilience, integrate access and recreation with nature-based solutions in a holistic approach to address SLR	Structural protection measures possibly not consistent with coastal development siting policies	Build resilience, integrate a holistic approach to address SLR	Build resilience, integrate a holistic approach to address SLR using nature-based solutions	Structural protection measures possibly not consistent with coastal development siting policies	Build resilience, integrate a holistic approach to address SLR	Build resilience, integrate a holistic approach to address SLR using nature-based solutions	Structural protection measures possibly not consistent with coastal development siting policies	Build resilience, integrate a holistic approach to address SLR using nature-based solutions	Build resilience, integrate a holistic approach to address SLR using nature-based solutions	Build resilience, integrate a holistic approach to address SLR using nature-based solutions	Structural protection measures possibly not consistent with coastal development siting policies	Build resilience, integrate a holistic approach to address SLR	Build resilience, integrate a holistic approach to address SLR using nature-based solutions

Table cont'd.

State Beach Area	New Brighton Beach			Seacliff RV Campground			Seacliff Day Use Area			Rio Del Mar Esplanade			Rio Del Mar Beach	Platforms Parking Lot		
Adaptation Alternative Area of Potential Effect	Fortify & Protect	Restore & Relocate	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid	Hybrid	Fortify & Protect	Restore & Relocate	Hybrid
Resource Preservation																
Natural Resource/Process Preservation	Landward transgression obstructed, potential for significant impact	Enhanced by beach widening	0.25 acres Cliffside planting	Landward transgression obstructed, potential for significant impact	Enhanced by beach widening	1 acre dune habitat	Landward transgression obstructed, potential for significant impact effect	Enhanced by beach widening	1.7 acre dune habitat	Landward transgression obstructed, potential for significant impact	3 acres of coastal lagoon habitat	0.7 acres of dune, 2 acres of coastal lagoon habitat	3 acres dune habitat	Landward transgression obstructed, potential for significant impact	Enhanced by beach widening	0.5 acres dune habitat
Aesthetics (natural)	Visual impact of hardscape and gray infrastructure	Beach	Beach & Cliffside	Visual impact of hardscape and gray infrastructure	Beach	Beach & Cliffside	Visual impact of hardscape and gray infrastructure	Beach, shore, ocean, SS Palo Alto	Beach, shore, ocean, SS Palo Alto	Visual impact of hardscape and gray infrastructure	Beach, shore, lagoon, ocean	Beach, dune shore, lagoon, ocean	Beach, dune habitat	Visual impact of hardscape and gray infrastructure	Beach	Beach, dune habitat
Acreage of Beach Habitat Gain/Loss due to Adaptation	No gain, erosion potential	1 acre gained	1 acre gained	No gain, erosion potential	2 acres gained	1 acre gained	No gain, erosion potential possible	3.7 acres gained	2 acres gained	Slight reduction	Slight increase	Reduced	Slight reduction	No change	0.5 acres gained	Slight reduction

6.8. Review of Adaptation Alternatives

An overview and discussion of advantages and disadvantages of proposed adaptation alternatives is provided in the following. The review serves as a basis for identification of recommended subarea alternatives, and rejection of alternatives not meeting key State Park and visitor objectives, or deemed infeasible on account of significant negative impact potential and other key factors detracting from the viability of alternatives.

6.8.1. New Brighton Beach

Fortify & Protect. This alternative would preserve the function and facilities as they are present day, maintain public access and emergency vehicular access along the Beach Trail, and address potential flood hazards exacerbated by projected SLR. However, the adaptation pathway for this alternative would come at a significant cost and reliance on shoreline structure hardscape that would impact the seasonal variation of the beach and curb landward transgression of the shoreline with SLR. Introduction of the hardscape would likely accelerate beach erosion and result in significant (or complete) loss of beach habitat in the near term. Incorporation of extensive hardscape and gray infrastructure would be inconsistent with State Park policies and coastal development siting policies and would only be permitted if no feasible alternatives exist. Consequently, this alternative was not carried forward.

Restore & Relocate. This alternative would address projected SLR hazards by relocation of vulnerable facilities along the Beach Trail. Removal of the existing facilities and the elevated trail would free up a significant footprint, which would be dedicated to restoration of beach habitat. The wider beach would provide opportunities for water activities, beach access and recreation, and nature observation. Public access would be maintained but would be on the beach as opposed to a paved trail segment. With these access impacts in mind, reduced accessibility, and no or limited ADA access, this alternative was not selected.

Nature-Based Hybrid. This alternative emphasizes restoration of native habitat and accommodating natural coastal processes, while balancing access preservation. Facilities vulnerable to projected SLR, including the comfort station and shower facilities, would be relocated to the south end of the parking lot. The existing elevated Beach Trail, rock slope protection, and present-day facilities would be reduced, which would create about 1 acre of beach habitat for shoreline species, public recreational use, water activities, beach recreation, and nature observation. Public access and emergency vehicle access to the beach would be maintained via an accessible ramp from the parking lot. Native plants would be incorporated over the lower cliffside slope to incorporate a measure of erosion control that can also serve as habitat for native species. This alternative makes significant strides by incorporation of facility reduction and building resilience to SLR with nature-based solutions integrated with public access, recreation, and opportunities for nature observation. This alternative was selected as the preferred alternative for New Brighton Beach.

6.8.2. Seacliff Campground

Fortify & Protect. This alternative focuses on preservation and protection of Parks assets and facilities along Las Olas Drive, and adaptation of these to projected SLR. Significant hardscape would be

introduced to protect facilities, mitigate wave overtopping and flood hazards, and address projected SLR. Gradual shoreline retreat and loss of beach due to SLR would be countered by introduction of a continuous hardscape edge along Las Olas Drive. However, this infrastructure would fix the back beach, impact the natural seasonal variation of the beach profile, and accelerate erosion. The outcome would be significant loss of beach habitat in the near term, and potentially complete loss of the beach. This approach to ‘hold-the-line’ would come at a high construction cost and would tend to limit future SLR adaptation to further fortification with hardscape. In the face of a significant rise in sea level, there would be a point where further upgrading of the hardscape would become cost prohibitive. The significant armoring that would ensue could damage the beach for future generations. Incorporation of extensive hardscape would be inconsistent with State Park policies and coastal development siting policies and would only be permitted if no feasible alternatives exist. Consequently, this alternative was not carried forward.

Restore & Relocate. The objective of this alternative would be to accommodate projected SLR by beach restoration and phased relocation of Parks facilities along Las Olas Drive. Public access along Las Olas Drive would be maintained, and potentially vulnerable Parks facilities such as the comfort stations and shower facilities would selectively be relocated to other areas. More than 2 acres of space would be available for beach habitat, public use, water activities, nature observation and beach recreation. Running/walking/hiking would be possible on the beach or via a boardwalk or trail, if constructed but would be vulnerable to coastal hazards. While this alternative would create a significant amount of beach space for public recreation, it would be limited in supporting other forms of recreation. Therefore, this alternative was not carried forward.

Nature-Based Hybrid. The aim of this alternative is a balanced approach to address projected SLR, wave runup and wave overtopping flood hazards impacting the RV Campground Area. Additionally, facility reduction would create sufficient beach width to mitigate erosion hazards associated with annual beach profile variation. This alternative accommodates SLR via managed retreat and relocation of existing assets, thereby creating space on the beach for dune habitat with native plantings. Facilities, such as the comfort stations and shower facilities would be selectively relocated to other areas, creating the need for reestablishing the former RV campground at another location. Benefits to this alternative include significantly increased beach width sufficient to maintain beach recreation and activities, and areas of native beach and dune habitat to enhance local biodiversity. Public access would be maintained over the length of the beach. This alternative was selected as the preferred alternative for the Seacliff Campground.

6.8.3. Seacliff Day Use Area

Fortify & Protect. The aim of this alternative would be to protect and maintain existing Park assets and facilities at the Day Use Area and address potential hazards associated with shoreline retreat, beach erosion, and flood hazards associated with wave runup and overtopping. These hazards would be addressed via a seawall sufficient in scope to mitigate wave overtopping, flood hazards, and erosion hazards. However, a seawall would require a large investment in terms of construction cost and would introduce a significant element of hardscape and gray infrastructure into the shoreline environment. Wave action combined with the high reflectivity of the hardscape would likely impact the fronting beach and result in reduced beach width and potentially loss of the beach. From this point on, options for further adaptation may chiefly be limited to further fortification. Introduction of the significant amount of hardscape and gray infrastructure would be inconsistent with State Park policies and coastal

development siting policies and would only be permitted if no feasible alternatives exist. Consequently, this alternative was not carried forward.

Restore & Relocate. This alternative adopts a managed retreat strategy to gradually adapt to SLR by restoring beach habitat to accommodate landward transgression of the shoreline. Existing Park facilities would be maintained for as long as feasible and gradually relocated, with the long-term objective being to maintain connectivity between the Visitor Center and Rio Del Mar SB. This alternative would provide a significant gain in beach width for public access and recreation, water activities, and nature observation. However, the significant scaling back of Park facilities with this alternative would mean a considerable reduction in access, parking and amenities available to support public recreation. Consequently, this alternative was not carried forward.

Nature-Based Hybrid. The aim of this alternative is to accommodate SLR via managed retreat and relocation of Parks facilities and public amenities as space becomes limited. This alternative will create a significant amount of beach habitat, and space for beach recreation and water activities. Vegetated dune formations would be created on the beach to enhance the scenic quality of the shore and increase opportunities for nature observation and improve resilience and enhance biodiversity. Erosion control planting would be incorporated over the lower cliff talus deposits, aiming to remove invasive plant species and incorporate native species to promote greater biodiversity and habitat suitable for native fauna. A potential downside to this alternative is that seawalls would remain as an element to provide an interface between elevated upland areas and the fronting beach. However, to a practicable extent, the face of the seawall would be covered by the fronting vegetated dune habitat, and relocation of significant lengths of seawall will be moved further to the back beach and away from seasonal wave action. A benefit to this alternative is that vulnerable facilities can be removed from areas of potential hazards and consolidated in a less vulnerable area at a higher elevation close to the Visitor Center. The significant addition of beach habitat and cliffside plantings would help greatly in supporting native biodiversity. This alternative was selected as the preferred alternative for the Seacliff Day Use Area.

6.8.4. Rio Del Mar Esplanade

Fortify & Protect. This alternative would focus on protection of the comfort station. Elevation of the comfort station and incorporation of a larger seawall would be proposed to address projected SLR. While raising of the comfort station could provide a point overlooking the beach, elevation of the facilities would impact the broader viewshed and could present as a visual impact. The beach space fronting the comfort station would be utilized for vegetated dune habitat, beach recreation, and water activities. With projected SLR and increased intensity of rainfall with climate change, the Aptos Creek beach outlet would likely become more dynamic and could lead to worsening river flood conditions. These effects could to some extent be mitigated by the cobble berms and living shoreline on the beach fronting the comfort station. With these potential detriments in mind, this alternative was not carried forward.

Restore & Relocate. This alternative focuses on restoration of beach habitat and relocation of the comfort station, thereby removing its vulnerability to wave action, erosion and flood hazards exacerbated by SLR. Emergency vehicle access would be maintained on the southeast side by Beach Drive. Portions of the beach along the Esplanade would be utilized for living shoreline nature-based habitat and would provide an opportunity for the Aptos Lagoon to function more naturally and

potentially revert to its original cycle, which could potentially support migratory fish passage on Aptos Creek, shorebird habitat on the beach, and would significantly enhance the biodiversity of native species. This alternative makes significant inroads for continued support for restoration and enhance of native habitat along the Esplanade and adjacent Aptos Creek with habitat enhancement that can potentially benefit native species of plants, insects, birds, mammals, fish and other marine life. This alternative was selected as the preferred alternative for the Rio Del Mar Esplanade.

Nature-Based Hybrid. This alternative would aim to provide a balanced blend of beach restoration, restoration of the creek outlet, and incorporation of native habitat balanced with flood hazard reduction. The comfort station would be elevated and enclosed by a seawall to reduce potential flood hazards with projected SLR. A downside to this action is that the raised comfort station would present as an element of significant visual impact in the broader viewshed. The stretch of beach along the Esplanade would be utilized for vegetated dune habitat. This could create an opportunity for the Aptos Creek beach outlet to meander more freely and potentially revert to its original state. Rocky habitat would be incorporated at the leading edge of the dunes. However, the risk would remain that the living shoreline habitat would be unable to withstand the dynamic geomorphology of the beach outlet, and worsening river flood conditions could unfold over time as a result of SLR and increased intensity and duration of rainfall projected with climate change. For these reasons, this alternative was not carried forward.

6.8.5. Rio Del Mar Platforms Parking Lot

Fortify & Protect. This alternative focuses on protecting and maintaining existing Park assets at the Platforms Parking Lot, including paved parking space, the comfort station, drinking fountains, beach access, and emergency vehicle access. This alternative leaves the wide beach fronting the parking lot open to public recreational access and water activities. The beach is inherently wider in this area, which can serve as a buffer to mitigate loss of beach with projected SLR. However, it is conceivable that SLR will encroach on the beach space over time, reduce beach width, and thereby increase the potential vulnerability of the facilities at this location. Relocation of facilities could subsequently be considered in the future. Benefits to this alternative is that the existing facilities and access can be maintained and do not require elevation increase in the near to mid-term. This alternative was selected as the preferred alternative for the Rio Del Mar Platforms Parking Lot, a key reason being that the current level of public access and parking would be preserved without negative impacts to beach conditions in the near term. Other alternatives would reduce space available for parking, see the descriptions in the following.

Restore & Relocate. This alternative would adopt a managed retreat strategy and create space on the beach to accommodate landward transgression of the shoreline associated with projected SLR. Existing facilities would be maintained as feasible and relocated over time, with the long-term objective being to provide public parking and access to the Platforms Beach. A downside to this alternative is that initial adaptation steps would reduce the available parking space, and the remaining parking space would decrease over time and significantly limit the number of users that can visit the beach at a given time. Because of the significant loss of parking access and small percentage gain in beach width, this alternative was not carried forward.

Nature-Based Hybrid. This alternative would aim for a balanced approach to incorporate vegetated dunes and nature-based elements into the Platforms Parking Area beach frontage, and build resilience to erosion and flood hazards exacerbated by SLR. The proposed habitat improvements could support

native species and have the potential to improve biodiversity. A hiking trail would be incorporated into the dune system, aiming to provide visitors with opportunities for nature observation. A downside to this alternative is that space for the proposed improvements would be gained by removal of a portion of the existing parking facilities at the Platforms Lot, which would constitute a reduction in parking access. Consequently, this alternative was not carried forward.

6.9. Recommended Preferred Adaptation Alternatives

Based on the public outreach and engagement feedback, SLR vulnerability assessment and adaptation alternatives development, the following recommended preferred adaptation alternatives were selected in consultation with State Parks. Refer to the Storyboards in Appendix A for details.

New Brighton Beach – Hybrid Alternative

The Hybrid alternative combines strategies to maintain consolidated infrastructure while making room for coastal processes. They utilize both green and grey infrastructure. Presently, proactive adaptation planning can identify asset relocation areas and advance funding and design of facilities being relocated or fortified in place. In the near term, reduce the road extent to remove assets from hazardous areas and restore beach habitat. Construct a consolidated, fortified ramp to preserve pedestrian and vehicular access from the upper lot to the beach. Install native planting on the lower cliff face to provide erosion control.

Future action pathway: Remove restroom facility and relocate a new restroom in the upper parking lot.

Seacliff RV Campground – Hybrid Alternative

The Hybrid alternative combines strategies to maintain assets while making room for coastal processes. They utilize both green and grey infrastructure. Presently, a preferred near-term adaptation alternative should be selected for this site as it sustained significant damage in recent storms. In the near term, remove damaged parking areas, restrooms and timber seawall. Consolidate into one smaller, elevated parking area at the east end of the site with a concrete toe wall and seat blocks along the edge. Create beach habitat by installation of vegetated dunes and support public access via a boardwalk trail in reclaimed space.

Future adaptation pathway: Replace seat blocks with a contiguous concrete seat wall to protect it from waves and higher water levels. In the long-term, raise the seawall and adjacent path. Supplement dunes as needed.

Seacliff Day Use Area – Hybrid Alternative

The Hybrid alternative combines strategies to maintain consolidated infrastructure while making room for coastal processes. Both green and grey infrastructure is utilized. Presently, proactive adaptation planning can identify asset relocation areas and advance funding and design of facilities being relocated or fortified in place. In the near term, create space on the beach by setting back State Park Drive against the cliff base and reduce the extent of the parking and picnic area. Construct a concrete toe wall and seat blocks to replace the timber seawall along the beach front edge of the consolidated parking area. Restack and replenish rip-rap as needed. Create beach habitat by installation of

vegetated dunes and support public access via a boardwalk trail. Incorporate native plantings on the cliff face to expand native habitat and provide erosion protection.

Future adaptation pathway: Elevate the consolidated parking and picnic area. Consolidate restrooms into one elevated facility at the western-most location. Maintain dune plantings.

Rio Del Mar Esplanade – Restore & Relocate

The Restore & Relocate alternative prioritizes natural resource restoration. Assets and infrastructure are relocated to create space for beach habitat and make room for coastal processes. Presently, proactive adaptation planning can identify asset relocation areas and change in use and access patterns. In the near term, remove the restroom and seawall. Create beach habitat with living shoreline elements and install cobble berms to protect the living shoreline planting areas.

Future adaptation pathway: Restore Aptos Creek outlet to a natural condition.

Platforms Parking Lot and Platforms Beach – Fortify & Protect

The Fortify & Protect alternative uses grey infrastructure to secure existing infrastructure and assets, such as parking. Presently, proactive planning can continue to help to build maintenance capacity and prioritize funding for adaptation to coastal hazards projected to occur in by mid-century. In the near term, remove the timber seawall and replace with a concrete toe wall and seat blocks along the edge of the Platforms parking lot.

Future adaptation pathway: Elevate the parking area can and ramp the road up to the parking lot entry point. Reconstruct an elevated restroom and shower facility. Replace seat blocks with a seat wall around the parking lot to protect it from higher water levels.

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Appendix A:

Storyboards