Appendix D
Regional Coastal Resiliency Options

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March 4, 2024

Introduction

Currently, existing and anticipated coastal resilience projects are being implemented by individual agencies or organizations rather than as a regional coastal resiliency option. This *South Orange County Regional Coastal Resilience Strategic Plan* (Strategic Plan) was developed to formulate strategies to minimize beach erosion and reduce wave storm damage and widen the regions beaches, with the ultimate goal of project implementation. A range of regional solutions, as described in the following sections, were presented to stakeholders to select a preferred regional solution. The options included a range of soft (i.e., green), hard (i.e., gray), and hybrid (green and gray) solutions that could increase beach width and provide recreational and environmental (e.g., wildlife habitat or living shoreline) resources and provide shoreline protection for the region's beaches. Both traditional solutions and innovative and/or experimental solutions were presented to the stakeholders for their consideration and feedback.

Soft solutions (i.e., green strategies) are methods using more natural elements (i.e., are nature based) and are considered more temporary and therefore may be more ephemeral. Hard solutions refer to methods that are intended to be in place for a longer period of time or may be permanent, such as structures constructed out of rocks or concrete. For the Strategic Plan, the preferred regional solution is intended to be implemented over the next 10 to 50 years; however, the entire range of solutions will be considered in the future because beach nourishment emerged as a top priority near-term solution and could be the foundation or a first-phase coastal resiliency project.

Shoreline Protection

Shoreline protection structures such as seawalls, riprap, and revetments are installed to prevent further erosion. Examples of shoreline protection structures include the intermittent sections of rock riprap along the seaward slope of the Los Angeles-San Diego-San Luis Obispo Rail Corridor and seawalls or rock revetments along oceanfront homes. Another example is the temporary armor rock and sand cubes that have been used at Capistrano Beach Park, which are anticipated to be replaced with a living shoreline. These shoreline protection structures—which are considered gray, or hard, solutions made from concrete or rock—fix the shoreline position and prevent further erosion. Coastal shoreline protection was not considered for the first phase of the Strategic Plan because it is a site-specific solution that would be best implemented by individual organizations that can tailor the design according to their specific needs. It should be noted that this Strategic Plan is not intended to hinder or otherwise delay the efforts of others in the planning, design, and implementation of current or future projects involving the use of shoreline protection structures.

Beach Nourishment

Beach nourishment is the placement of new sand onto a beach (referred to a receiver beach) to build the beach in elevation and the berm seaward, thus providing wave protection and reducing beach erosion while increasing recreational beach area available to the public and enhancing environmental resources (i.e., shorebird and grunion habitat). Beach nourishment is considered a green, or soft, solution and requires periodic maintenance to maintain beach fill design width. Supplemental, periodic nourishments would be required to maintain a given level of shore protection. The frequency of supplemental nourishments would vary based on sediment supply, wave climate, and longshore transport conditions in the littoral system, as well as the desired level of shore protection. Typically, beach nourishment is constructed by placing sand directly on the beach using hydraulic pumping of sand slurry from a pipeline if the borrow site/source is located offshore (as in the upcoming San Clemente Beach Nourishment Project) or, if sand is from upland sources, using trucks to dump sand (as in previous San Clemente Opportunistic Beach Sand Replacement Program) that is then reworked by dozers.

Beach nourishment can also be constructed by nearshore placement with new sand placed just offshore of the receiver beach that relies on wave action to move the new sand onto the beach. This method of beach nourishment is recommended for use where borrow site sediments are not within the grain size envelope, color, or other constituents of the receiving beaches. Nearshore placement may also be preferred when using a hopper dredge for sediment dredging to reduce overall construction costs.

Beach Nourishment with Sand Retention Structures

Beach nourishment on narrow and erosive beaches would require maintenance as noted previously. Sand retention structures that are green, hybrid, or gray can be used to stabilize the beach and extend the effectiveness of each beach nourishment event by keeping the sand in place longer and optimizing the period of time between each renourishment cycle. This method is currently used in North Orange County at Seal Beach and West Newport Beach, where constructed groins have been successful in maintaining wide beaches. This method is also under study by San Diego Association of Governments (SANDAG) for implementation within the San Diego region pursuant to the SANDAG 2001 Sand Retention Strategy.

By minimizing the loss of beach sand with retention structures, beach nourishment with retention structures improves the protective performance, increases the average beach width over time, and decreases costs from reducing the frequency of supplemental nourishments. On a regional scale, multiple retention structures would likely be needed with construction across multiple jurisdictions. Examples of retention structures are described in the following sections.

The City of Oceanside (located in San Diego County and south of the project study area) has recently initiated efforts to develop "innovative shoreline solutions" for their shoreline to combat shoreline erosion challenges. An international design competition is underway to provide the City of Oceanside with various designs that would provide both beach nourishment options, as well as structural solutions to retain the sand in place.

Groins

A groin is a shore-perpendicular structure that blocks the alongshore transport of sand to stabilize a beach. The structure is typically made of rock, but could also be made of concrete, steel, or wood. An example application of groins is the Newport Groin Field, which contains eight groins spaced approximately 300 feet apart along the West Newport Beach coastline that maintains a wide sandy beach fronting oceanfront homes. The groins inhibit sediment migration, creating reliable sandbars that cause waves to break hollow, which is favored for surfing (USACE 2013). Another example is at Seal Beach; a groin near the Seal Beach Municipal Pier divides the beach into West Beach and East Beach. West Beach tends to be wide and mildly sloping, and East Beach is narrow and steep. Despite the groin, East Beach has chronic erosion problems that are addressed by intermittent beach nourishment and semiannual sand backpassing from West Beach to East Beach (USACE 2013). In South Orange County, Thor's Hammer stabilizes the Dana Point Harbor entrance and functions as a groin, enabling the west area of Doheny State Beach to be relatively wide, stable beach. Groins help to retain sand and maintain wide beaches for recreational and environmental resources and can be constructed with rock and can also be constructed as natural infrastructure, such as living shoreline or living levee.

Nearshore Breakwaters

A nearshore breakwater is a shore-parallel structure made of rock or concrete that blocks incoming waves, allowing sand to accumulate behind the structure and widen the beach. It is constructed just offshore of the beach to reduce direct wave action and sand transport from the beach. In concept, this is similar to the West Breakwater that protects Dana Point Harbor by reducing wave heights in the interior of the harbor. Nearshore breakwaters help to retain sand by reducing wave exposure and maintain wide beaches for recreational and environmental resources. However, nearshore breakwaters could impact adjacent beaches, sensitive nearshore habitats, and recreation, such as surfing.

Multipurpose Offshore Reef

A multipurpose reef is an offshore, underwater structure that provides shore protection, marine habitat, and recreational benefits. A good local example is the 375-acre Wheeler Reef complex designed as a mitigation project for the San Onofre Nuclear Generating Station, although this reef was designed solely to create marine habitat. The Wheeler Reef is generally located offshore of

San Clemente, though the reef complex extends north into the area offshore of Dana Point and south offshore of Trestles.

A multipurpose reef could be designed to cause waves to break farther offshore, dissipating and reducing the direct wave exposure and partially sheltering the beach. The reduced wave climate allows sand accumulation behind (i.e., in the leeside) the reef similar to, but to a lesser degree than, the nearshore breakwater. A multipurpose reef also has the additional benefits of providing habitat for marine wildlife, as well as recreational opportunities for surfing, diving, and fishing. The implementation of a multipurpose reef is still considered to be experimental and lacks proof as a feasible solution and proven design method. Attempts to evaluate the effectiveness of a multipurpose reef for sand retention were being pursued for a site offshore of Fletcher Cove in Solana Beach and at Oil Piers in Ventura County by the City of Solana Beach and U.S. Army Corps of Engineers (USACE; 2007 to 2011) and USACE and the Beach Erosion Authority for Clean Oceans and Nourishment, respectively.

Sand Dunes/Living Shorelines

A coastal sand dune is a raised, alongshore feature along the back of beaches that can naturally occur landward of the beach berm where sand from aeolian transport accumulates (i.e., winds blowing onshore move sand from beach to dune). There are remnant sand dune examples in northern San Clemente, as well as at Cotton's Point/Trestles, for reference. Sand dunes can also be integrated with riprap and cobbles and geotextile fabric to create a living shoreline (hybrid green and gray solution) that could be shore-parallel (such as Cardiff Living Shoreline) or like a living levee concept currently being explored by the City of Del Mar (San Diego County).

Sand dunes protect landward areas by blocking direct wave action and provide recreational and environmental resources. Although sand dunes are typically considered a soft solution as an alternative to shoreline protection, sand dunes can be considered a nature-based or hybrid solution when constructed with a rock revetment or cobble berm core (hard) overlain with sand and vegetation cover. The effectiveness of a sand dune is heavily dependent on the amount of sand fronting the dune and site-specific conditions because the sand movement needs to be balanced between the existing beach and dune. For South Orange County, combinations of sand dunes with beach nourishment and hard solutions (e.g., rock revetment) would likely be needed.

Sand dunes are currently under consideration in Dana Point at Doheny State Beach and Capistrano Beach and in San Clemente as part of the Nature-Based Adaptation Project Feasibility Study.

Cobble Beach

A cobble beach is composed mostly of cobble stone—a larger-grain-size sediment. The larger-sized cobbles make it more resistant to erosion and more stable compared to sand in the same wave

conditions. A cobble beach, which is a soft solution, provides recreational and environmental resources but may be less desirable for recreation compared to a sandy beach and may not be suitable for native wildlife. An example of a cobble beach can be found locally at Trestles.

A cobble berm is currently under consideration in San Clemente as part of the Nature-Based Adaptation Project Feasibility Study.

Sand-and-Cobble Beach

A sand-and-cobble beach is a hybrid beach with a cobble base (cobble mattress) that is covered with sand. Doheny State Beach and Capistrano Beach Park have a mixture of sand with varying amounts of gravel and cobbles from alluvial sediments from San Juan Creek. A sand-covered cobble beach would still provide benefits for recreational and environmental resources but may be less desirable for recreation compared to an all-sand beach and may not be suitable for native wildlife. A sand-and-cobble beach could be used in a beach nourishment program to reduce the costs of supplemental sand nourishments. The feasibility of a sand-and-cobble beach is unclear because of limited research on the design and performance; therefore, additional research (e.g., pilot project) is needed to evaluate this potential solution, as well as many other innovative solutions described previously. The Nature-Based Coastal Resilience Pilot Project at Capistrano Beach Park and Doheny State Beach approved by the California Coastal Commission will help inform this research for the future.

Reference

USACE (U.S. Army Corps of Engineers), 2013. *Orange County Coastal Regional Sediment Management Plan*. Prepared for U.S. Army Corps of Engineers, County of Orange, and California Coastal Sediment Management Workgroup. Prepared by Everest International Consultants, Inc., in association with Science Applications International Corporation and Dr. Philip King. June 2013.