CALIFORNIA COASTAL COMMISSION
455 MARKET STREET, SUITE 300
SAN FRANCISCO, CA 94105-2421
VOICE (415) 904-5200
FAX (415) 904-5400

To: Coastal Planning Directors, State Agency partners, and other interested parties
From: Karen Vu, Climate Change Specialist, Statewide Planning Unit, California Coastal Commission
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Re: **Nature-Based Adaptation Strategies**

I. Introduction and Purpose

Preparing California for the many impacts resulting from climate change involves adopting measures that improve the State's climate resilience. A climate-resilient California requires implementing practices and solutions that can respond to, adjust to, and withstand changing conditions while minimizing disruptions to communities and natural resources. Nature-based adaptation strategies (NBAS) are an example of a resilient approach to climate adaptation, including for coastal management. In coastal settings, NBAS incorporate ecological principles into shore protection strategies to support multiple benefits, including hazard adaptation and mitigation, natural resource resilience and enhancement, and recreation and scenic resource preservation.

The Coastal Commission's Sea Level Rise Policy Guidance supports and encourages the use of NBAS as a preferred alternative to traditional shoreline protective devices. Currently, a wide body of research exists on the implementation of NBAS on the Atlantic and Gulf coasts. However, California's coastal features and ecosystems may require tailored approaches that differ from some of these existing practices. This introductory memo distills relevant information from existing guidance on NBAS and aligns it with the mission and goals of the Commission. The following sections provide general information on NBAS, with a focus on various strategies appropriate for California, key considerations and challenges to implementing NBAS, and specific California Coastal Act policies to consider when developing and reviewing proposed NBAS. Additional memos will examine specific types of NBAS and provide insight on design considerations, performance evaluation, policy triggers, and relevant case studies.

It is important to note that, while nature-based adaptation strategies can offer a more resilient approach than hard shoreline armoring, such projects remain subject to full Coastal Act review to ensure that the proposed design and construction of the project protects coastal resources, minimizes and mitigates for any adverse impacts to coastal resources, and represents the least environmentally damaging feasible alternative. Although this memo provides an overview of some Coastal Act issues related to NBAS, it does not govern how the Commission or local governments will review NBAS projects. Each application will need to be reviewed on a case-by-case basis for consistency with the Coastal Act and any applicable LCP policies. Section IV of this document describes some of the primary Coastal Act provisions that could apply to NBAS projects.

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II. Terminology

The Commission does not have an adopted definition for what constitutes an NBAS. Although there are various existing definitions of NBAS, none of them align specifically with the work of the Commission nor the coastal hazard issues specific to California. Therefore, Commission staff developed the following terms and categories to describe NBAS in a way that supports how such strategies are discussed in various Commission documents.[1] Using one term, "nature-based adaptation strategy", will broadly encompass other synonymous terms including living shorelines and natural infrastructure.

Thus, for the purposes of this memo and to establish a shared understanding of terminology, Coastal Commission staff generally recognize a nature-based adaptation strategy as:

> *A coastal adaptation and/or erosion control method that is comprised of natural or mostly natural elements, which contributes to the persistence and enhancement of coastal processes and ecological benefits while also offering protection services to inshore areas.*

Nature-based adaptation strategies can be further subcategorized along a spectrum between:

> *(1) Soft Strategies, which avoid fixing the shoreline with hard structures and instead rely on the use of dynamic systems to attenuate coastal hazards, such as dune or wetland restoration, or sand replenishment and,*
>
> *(2) Hybrid Armoring, which combines fixing the shoreline, such as with a buried revetment or other shoreline protective device, with a nature-based feature to provide ecological and other benefits.*

Nature-Based Adaptation Strategies

This table provides an overview of various ecosystems where NBAS could potentially be used and includes appropriate physical settings as well as some of the protection and ecological benefits of those ecosystems.

Ecosystem	Protection Benefits	Ecological Benefits	Physical Settings
Sandy Beaches	• Buffers inshore coastal areas from storm surges, king tides, sea level rise, waves, and wave runup by increasing the distance between coastal development and coastal hazards • Provides space for recreation and coastal access • Acts as a seasonally-dynamic reservoir for sand supply	• Provides habitat opportunities for coastal species • Links offshore and inshore habitats through processes such as energy and nutrient transfer • Acts as a sediment supply for upland dune habitats	• Areas with adequate cross-shore space and a balanced sediment supply and demand

[1] Sea Level Rise Policy Guidance
Coastal Commission 2021-2025 Strategic Plan
Critical Infrastructure Guidance (forthcoming)

Coastal Dunes	• Dune topography and vegetation help dissipate wave energy and prevent flooding during high tides and coastal storms • Reduces coastal erosion by acting as a seasonally dynamic sediment supply to re-nourish beach	• Supports many unique and sensitive species across multiple microhabitats • Contributes to species diversity and resilience in coastal areas • Can become self-sustaining and even grow over time	• Open coast and bay areas with seasonal strong winds • Maximize benefits from coastal dunes by restoring or enhancing areas in conjunction with sandy beaches
Wetlands	• Contributes to storm abatement, erosion control, and sediment retention • Vegetation dampens water velocity and attenuates wave energy	• Important habitat for specialized plants and animals • Improves water quality and nutrient cycling • Can buffer species from ocean acidification effects • Contributes to carbon sequestration • Adaptive capacity to build-up vertically with sediment deposition and potentially keep pace with sea level rise	• Gently sloped, transitional lands that are entirely or partially saturated for an extended period • Areas with low storm and wave energy such as bays, harbors, lagoons, coastal plains, and areas in which wetlands historically existed • Areas with space that allows for wetlands to migrate inland as sea level rises
Oyster Beds	• Encourages sediment accretion • Contributes to erosion mitigation and wave attenuation	• Provides habitat, foraging grounds, and refuge for numerous flora and fauna species • Improves water quality by filtering algae, detritus, and excess nutrients • Reduces sediment suspension and decreases turbidity	• Intertidal and subtidal sheltered areas such as bays and harbors • Areas in which native oyster beds historically existed or near existing oyster beds • Areas where oysters will not compete with existing native species assemblages
Eelgrass Beds	• Increases bottom roughness and friction, which can dissipate wave energy and increase sediment accretion • Reduces sediment erosion as plant structures hold sediment in place	• Eelgrass is a foundation species that facilitate growth and survival of other marine species and trophic transfer to adjacent areas • Provides high levels of primary productivity, high biodiversity and high species density and biomass relative to surrounding areas without eelgrass • Crucial nursery and feeding habitat for many species	• Eelgrass beds require mud or sandy bottoms • Coastal and estuarine areas throughout tidal and subtidal habitats with relatively low wave energy and sufficient light penetration to encourage establishment, most commonly in sheltered bays and harbors • Avoid areas where dredging may occur

		• Improves water quality and turbidity • Can buffer species from ocean acidification effects • Contributes to carbon sequestration	
Artificial Reefs	• Attenuates wave energy by facilitating wave breaking further offshore or increasing roughness • Reduces shear bottom stress • Increases sediment accretion	• Provides physical habitat complexity that can support diversified niches for marine organisms, including types of substrate, refuge, growing conditions, and food sources • Increases species diversity, which fosters ecological resilience • Benefits some recreational and commercial fishery operations	• Intertidal and subtidal zones of open coast areas

Each of the strategies listed in the table may be implemented alone, in conjunction with other soft strategies, or, in the case of hybrid armoring, with a hard shoreline protective device. Hybrid armoring can provide additional stability and protection from coastal hazards to both inland development and to any of the softer elements utilized in the overall NBAS, such as stabilizing new dune plantings or reducing erosion for sand replenishment projects. Examples of hybrid armoring include vegetated dunes with a buried hard structure, wetlands with a constructed marsh sill, beach nourishment with a cobble or sand berm, and riparian habitat restoration intermixed with rock groins. Both soft strategies and hybrid armoring may also be a component of a phased adaptation approach to address short-, mid-, and long-term sea level rise adaptation goals.

III. Key Considerations

While NBAS can be a less environmentally harmful alternative to traditional shoreline protective devices, there are a number of challenges unique to NBAS. This section aims to describe some of the most common issues to consider when developing and evaluating NBAS projects. To maximize the success of an NBAS, project proponents should consult with Commission staff early in the planning process to ensure specific challenges are appropriately addressed.

Nature-Based Adaptation Strategies as Compared to Shoreline Protective Devices

The Commission's Sea Level Rise Policy Guidance defines shoreline protective devices as a broad term for constructed features such as seawalls, revetments, riprap, earthen berms, cave fills, and bulkheads that block the landward retreat of the shoreline and are used to protect structures or other features from erosion and other hazards. There are numerous existing guidelines to assist in the sizing and design of these types of engineered structures to ensure that they are stable and provide adequate shore protection; fewer such guidelines or protocols exist for NBAS. Therefore, depending on the purpose, structure, and location of a proposed NBAS, Commission staff may request information demonstrating that it is adequately designed to serve its intended protective purpose. NBAS monitoring (discussed further below) will be an important aspect to aid in validating and quantifying the safety and protective benefits of proposed NBAS.

In addition to the protection elements, the most important distinction between a traditional shoreline protective device and an NBAS is that the latter emphasizes the importance of providing both shoreline protection from coastal hazards *and* ensuring ecological stability or habitat enhancement. NBAS categorized as hybrid armoring can include shoreline protective devices as a part of the overall project design, such as a buried revetment or cobble berm. When employed in hybrid strategies, shoreline protective devices are typically used to increase stability and protection of the entire structure, and are more likely utilized along open coast areas with higher wave energy, in areas where the potential for storm surge is greater, along space-limited locations, and to protect critical infrastructure.

Space Requirements

Nature-based adaptation strategies often work by dampening or attenuating wave energy whereas many traditional armoring options protect the backshore areas by withstanding wave energy. Measures that dampen wave energy need to interact with waves over a broad area. As a result, NBAS often require a larger longshore area to be effective while shoreline protective devices might take up only a few feet of space. However, some NBAS may have benefits that are not associated with shoreline protective devices, such as benefits to coastal processes, habitats, and recreational and visual resources.

Habitat Conversion

Nature-based adaptation strategies will often involve a habitat conversion element, such as converting sandy beach area to vegetated dunes, soft bottom habitat to hard substrate for reefs, or mudflats to seagrass beds or marsh areas. Project proponents should be aware of any habitat conversion components of an NBAS and consult with Commission staff early in the project planning or analysis phase. Historically, the Commission has rarely permitted habitat conversions other than as a part of habitat restoration projects (e.g., wetland restoration); however, the challenges posed by sea level rise and associated erosion introduce a need to consider how nearshore ecosystems and natural processes can persist into the future, and habitat conversions may present one way to ensure such persistence. For example, some projects might aim to facilitate habitat persistence and/or inland migration by converting uplands to tidal wetlands in order to maintain this type of ecosystem in an area where existing wetlands will become permanently inundated with sea level rise. Other projects, such as offshore reefs, may convert soft bottom habitat to hard substrate in order to slow down or stop the erosion of adjacent beaches that would otherwise erode away. The consequences and propriety of these different approaches will need to be carefully considered on a case-by-case basis and may vary greatly depending on the scale and location of the project.

Project Labels

As discussed earlier, there are a variety of terms and definitions that constitute an NBAS. As such, project proponents may label a project as NBAS in a way that may not be consistent with the Commission's interpretation of NBAS. Specifically, the Commission pays close attention to the degree to which nature or natural elements are incorporated into projects that may be called NBAS as well as how these various elements will function. The natural components of the project should provide measurable ecological benefits and outcomes in order for the Commission to evaluate the project through the lens of an NBAS. Project proponents are encouraged to work with Commission staff to identify preferred ecological outcomes and avoid mislabeling projects as NBAS.

Some NBAS may involve habitat conversion that is labeled in a variety of ways. For example, NBAS can be called restoration projects, pilot studies, and/or adaptation. The labeling of an NBAS project by a proponent may not align with how the Commission would view the project. Therefore, it is important to be aware that the substance of a project, rather than its label, governs how it must be analyzed for Coastal Act and LCP conformity. For example, a true habitat restoration project that has an adaptation component may have

different requirements for measuring success than a pilot study or a hybrid armoring strategy, as discussed further below.

In short, there are policy and permitting process implications that will flow from the different characteristics that a proposed project may have. However, regardless of how an NBAS is characterized, all recommended projects should be the least environmentally damaging feasible alternative. Each project must also avoid or minimize adverse impacts to coastal resources, marine resources, agricultural areas, sensitive habitats, archeological resources, and scenic and visual resources in conformity with the Coastal Act and relevant LCP policies. Unavoidable impacts may require mitigation. Regardless of any labels, the Commission will evaluate the consistency of nature-based adaptation projects with all applicable Coastal Act and LCP policies.

a. Restoration

The Commission has historically understood ecological restoration to reference *past* conditions, meaning "bringing back" physical or biological characteristics to an area where they had once existed. Restoration generally involves alleviating stressors from the system that had led to the degradation of the habitat and actively facilitating the return of a suite of self-sustaining ecological functions. Restoration elements should reference the historic design and configuration of the specific habitat and may involve techniques such as manipulating landforms to return to natural processes or eradicating non-native species and revegetating with a variety of appropriate natives. NBAS that are not implementing habitat restoration but are instead primarily addressing *future* anticipated conditions may be better interpreted as ecological adaptation.

b. Pilot Studies

Pilot studies refer to projects that are meant to examine proof of concept for innovative or new types of projects to study performance, to allow for adjustments to improve performance, and to inform similar efforts in the future. NBAS can function as pilot studies to test their performance as a sea level rise adaptation strategy. Pilot studies should generally include clearly identifiable success criteria and conditions for removal at the end of the study period and/or if the project is not performing the way it was intended.

Public Access and Recreation

Some NBAS may conflict with the Commission's goal to maximize public access and coastal recreation. NBAS will often involve the restoration or creation of natural habitats that may require time to establish and may be sensitive to disturbance during the initial phases of the project. They may also restore or create habitat that is particularly sensitive to human disturbance and therefore inappropriate for public access. However, public access and recreation must still be protected and maximized. Like other types of development projects, NBAS should ensure maximum public access is provided within or adjacent to the site, consistent with the fragility of the site's natural, archaeological, and paleontological resources, and that space for recreational opportunities remains adequate in the surrounding areas. Where there is a conflict between the ecological needs of the NBAS and the need for public access, project proponents should work with Commission staff to find an appropriate balance between the two that maximizes all resource protection goals in a manner consistent with the Coastal Act or LCP.

Monitoring Considerations

Monitoring the performance of an NBAS is critical to ensuring compliance with the Coastal Act and to the Commission's goal of promoting coastal resilience. Among other things, it provides a means to validate the assumptions that have been made to justify permitting decisions, evaluate project performance, enable adaptive management, and determine whether the project is meeting success criteria and avoiding coastal resource impacts. Monitoring should include both the ecological and protection benefits that nature-based

adaptation projects are expected to deliver. While each project will have monitoring requirements particular to its case, this section identifies key themes that should be considered for monitoring programs for NBAS. Before creating requirements for a monitoring program, project proponents and Commission staff should identify success criteria relevant to the project's protection and ecological objectives.

1) **Baselines** document pre-construction and as-built conditions at the project site and are often accompanied by data from reference sites to better inform post-construction changes and project performance.
2) **Indicators** help analyze project performance and should cover both protection and ecological parameters. They should be relevant to the nature of change anticipated and practical for implementation. In addition to assessing traditional metrics (e.g., cross-shore width of the feature, erosion patterns, species diversity, and substrate cover), process-based indicators like those that characterize recovery patterns following major storm events are valuable for understanding system resilience. For example, the time required for foredunes to naturally rebuild and reach a target level of vegetation cover or species assemblage can be indicative of how resilient and successful a project is likely to be in response to and recovery from storm events.
3) Methods for **evaluating performance** relative to approved success criteria will vary, so a clear rationale supporting those selected is important. For example, assessment methods might include comparisons in time, space, design type, geography, response to disturbance events, and/or consideration of trends, patterns, or trajectories.
4) Ensuring confidence in the monitoring data improves its ability to be interpreted, compared, and improved upon in future NBAS. **Data confidence** is generally established through gathering sufficient, reliable data and having robust sampling that enables statistical interpretations. When new monitoring methods or indicators are being used, ground-truthing also becomes important.
5) **Monitoring schedules** describe who will collect the data, when and how often data is collected, and the length of time the project will be monitored. For adaptation projects, monitoring should capture data from typical coastal conditions as well as episodic events and should occur over a timeframe capable of informing long-term trends such as erosion and sea level rise. It may be appropriate for more intensive monitoring to occur during the initial period of NBAS establishment and then scaled back over the longer-term. Monitoring schedules should also indicate how often monitoring reports will be distributed and which agencies and staff personnel will receive the monitoring reports.
6) Monitoring programs should generally include course correction opportunities or requirements that would be triggered if an NBAS does not perform in the originally intended manner. **Adaptive management** may include triggers for interventions to address unintended changes or remedial actions to address project shortcomings, including and up to project removal.

IV. Coastal Act Considerations

The following Coastal Act sections, categorized by coastal resource, cover the main issues and policies that would most likely be triggered when reviewing an NBAS. Note that this section includes some of the most common Chapter 3 policies that would apply to NBAS projects, but the applicability of all Coastal Act policies, as well as any applicable LCP policies, must be considered on a case-by-case basis. As discussed above, the label of an NBAS is not definitive nor does it affect how a project is reviewed; each NBAS is required to be consistent with all applicable Coastal Act and LCP policies.

Hazards

Section 30253 requires, in relevant part, that new development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard, assure stability and structural integrity, and not require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs. Under the Coastal Act's broad definition of "development," an NBAS would most likely be considered new development and be reviewed for consistency with Section 30253 (or an equivalent LCP provision) if it proposed construction (e.g., placement of fencing, removal of vegetation) or changes to land uses.

Section 30235 provides a pathway for the potential approval of revetments, seawalls, and other structures that alter natural shoreline processes, if they are needed to serve coastal-dependent uses or to protect existing structures or public beaches in danger from erosion, and if they meet certain other conditions. Section 30235 may be relevant to an NBAS if the project includes a new or modified hard shoreline protective device to provide structural stability and additional protection. Therefore, hybrid armoring that includes a seawall, revetment or similar element that would fix or otherwise alter shoreline processes should be reviewed for consistency with Section 30235. NBAS with a hard armoring component that will alter natural shoreline processes must meet the following criteria in order to qualify for potential approval under Section 30235:

1) There is an existing structure, public beach, or coastal dependent use;
2) The existing structure, public beach, or coastal dependent use is in danger from erosion;
3) Shoreline-altering construction is required to protect the existing, threatened structure or public beach area, or to serve the coastal dependent use--i.e., it is the least environmentally-damaging, feasible alternative; and
4) The required protection is designed to eliminate or mitigate its adverse impacts on shoreline sand supply, and must also mitigate any other coastal resource impacts to the extent feasible.

While NBAS are typically considered a more resilient alternative to hard armoring, the project must demonstrate that an NBAS project is consistent with all relevant Coastal Act and LCP policies, including that it appropriately minimizes risks to life and property, and is the least environmentally damaging feasible alternative. The effectiveness of the NBAS will be evaluated under current and future coastal hazards to determine whether it can address near-term hazard risks and/or function as part of a long-term, phased adaptation approach.

Wetlands and Environmentally Sensitive Habitat Areas

Section 30233 lists the specific activities and uses for which diking, filling, or dredging of open coastal waters, estuaries, and wetlands is allowed. Examples of NBAS that involve diking, filling, or dredging activities include sediment augmentation to help restore or create wetland habitat, dredging of coastal waters to restore tidal inundation, and installing materials or structures to aid in the creation of oyster beds.

Other NBAS-related activities that would require Section 30233 consistency review include filling of open coastal waters for sandy beach and dune restoration or creation. Two important points of Section 30233 that need to be considered include:

1) Identifying whether the particular NBAS constitutes a restoration project or nature study intended to inform adaptation design, which may qualify as an allowable use under Section 30233.

2) Determining whether a proposed activity would involve "fill" by consulting the Coastal Act's definition of that term, which encompasses activities such as the installation of signage, placement of material such as sediment or rock, or creation of new recreation trails through wetlands or other submerged areas.

Section 30240 provides for the protection of environmentally sensitive habitat areas (ESHA) and includes specific conditions for development in and around these locations. Any component of an NBAS that may impact or threaten areas that qualify as ESHA will need to be evaluated under Section 30240, and development within ESHA is typically limited to resource-dependent uses. Previous Commission decisions have defined resource-dependent uses to include nature trails, public accessways, research or educational purposes, and restoration or wildlife management.

Marine and Biological Resources

Section 30230 requires the maintenance, enhancement, and, where feasible, restoration of marine resources, including by sustaining biological productivity and healthy populations of marine organisms. The implementation of various NBAS may impact species assemblages and trophic dynamics, including the potential for non-native species recruitment and changes to local food webs and energy flows. NBAS involving the creation or restoration of marine habitat such as offshore reefs, oyster beds, and eelgrass beds may be able to maintain consistency with Section 30230 by ensuring the project will provide significant ecological value despite minor or temporary disturbances to the marine environment. The Commission may ask for a survey of the area to identify current marine resources and species assemblages, and may require a monitoring plan that will identify any remedial actions to address unintended declines in biological productivity or adverse impacts from invasive species recruitment.

Section 30231 addresses the maintenance of water quality to prevent or minimize adverse impacts to marine organisms and public health. Beach nourishment projects, wetland sediment augmentation, and the creation or restoration of habitat are examples of NBAS that may result in increased turbidity, altered water flows, nutrient inputs, and disturbances to soft bottom habitat that contain legacy pollutants. To address potential water quality impacts, the Commission may recommend seasonally appropriate construction requirements and set guidelines through best management practices (BMPs) and stormwater pollution prevention plans.

Visual Resources

Section 30251 provides for the protection of scenic and visual qualities of the ocean and coastal areas. NBAS can impact natural landforms and potentially alter the current natural setting of coastal areas, either in a positive or negative way. Examples of nature-based project components that may impact visual resources include intertidal and shallow reefs, wetland restoration activities that include fencing, tagging, or other elements required to protect new plantings and seeding, dune heights that may block coastal views, and hybrid armoring components such as exposed revetments or retaining walls. While NBAS consist of more natural features compared to hard armoring structures, project proponents should design projects to be visually compatible with the surrounding area.

Public Access and Recreation

Sections 30210, 30211, 30212, 30214 and 30220 pertain to the protection of public access and recreation. Activities associated with NBAS that may limit access include partitioning areas of the project to reduce human disturbance and restoring or converting areas previously used for recreation or access in a manner that precludes continued access. Additionally, NBAS can also impact recreational activities by changing wave dynamics, creating habitat that conflicts with mooring and boating activities, and changing biological resources in an area that may impact proximate fishing activities, diver experiences, and bird-watching

opportunities. A project's conformity with these access provisions will be analyzed and may need permit conditions to ensure that adverse impacts to access and recreation are temporary and limited during project construction, that appropriate access and recreational opportunities are provided nearby, and that options are available to provide alternative access routes such as by adding or repairing trail segments, including the California Coastal Trail.

V. Consultation with Coastal Commission Staff

Nature-based adaptation strategies often include a variety of new and experimental project design elements that aim to improve or restore ecological values and services as well as provide protection to the upland environment from sea level rise and coastal hazards. Therefore, early consultation with the Commission's staff is imperative to the success of any NBAS. As we anticipate an increase in the number of nature-based adaptation projects to come before the Commission, contacting Commission staff as early as possible allows all stakeholders to streamline collaboration and design a project that maximizes protection and ecological services, meets the standards of the Coastal Act and applicable LCP policies, and avoids permitting delays. The Commission's website includes a Contact page that lists district offices pertaining to specific coastal counties and cities.