

Highlighting Regulatory Pathway Priorities for Nature-Based Shoreline Adaptation Projects in the San Francisco Bay Area

About This Document

Thank you to our funder—the U.S. Environmental Protection Agency, Region 9, San Francisco Bay Water Quality Improvement Fund. This document was developed as part of the Transforming Urban Water Initiative, an interagency initiative led by the San Francisco Estuary Partnership that works to advance on-the-ground implementation of nature-based solutions (NbS) projects. Special thanks to document reviewers and contributors Xavier Fernandez, San Francisco Bay Regional Water Quality Control Board; Jackie Zipkin, East Bay Dischargers Authority; Ethan Lavine and Dominic Maccormack, San Francisco Bay Conservation and Development Commission; Jeremy Lowe, San Francisco Estuary Institute; Jim Mazza, U.S. Army Corps of Engineers; Caitlin Sweeney and Heidi Nutters, San Francisco Estuary Partnership; and Jennifer Siu and Luisa Valiela, U.S. Environmental Protection Agency. The lead consultant on this project was Environmental Science Associates.

Suggested citation: Sunahara, J. *Highlighting Regulatory Pathway Priorities for Nature-Based Shoreline Adaptation Projects in the San Francisco Bay Area*. September 2023. San Francisco Estuary Partnership and Environmental Science Associates.

Purpose and Use of This White Paper

This white paper is intended for use by organizations working toward sea level rise (SLR) solutions and regulatory agencies, to promote discussion and elevate opportunities to advance NbS projects in the San Francisco Bay Area (Bay Area).

Key objectives of this white paper are to:

- Identify the drivers for NbS in the Bay Area.
- Identify key advancements and outstanding challenges related to permitting NbS projects, such as ecotone slopes, horizontal levees, and tidal marsh migration projects.
- Propose pathways for a regulatory landscape that accommodate and are adaptable to NbS projects.

Background

As summarized in Harris-Lovett et al. (2021), the Bay Area is especially vulnerable to SLR challenges. Mean water levels at the Golden Gate Bridge were 7 inches (18 centimeters) higher in 2018 than in 1900 (OEHHA 2018). Experts expect an additional range of 29–122 inches (73–310 centimeters) of SLR by 2100 (CNRA and OPC 2018).

At the national level, presidential executive orders have been issued to emphasize the need to take actions to address climate change effects, including SLR. Among these orders are the following:

- Executive Order (EO) 13653, “Preparing the United States for the Impacts of Climate Change,” issued November 6, 2013.

- EO 13990, “Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,” issued January 20, 2021.
- EO 14008, “Tackling the Climate Crisis at Home and Abroad,” issued January 27, 2021.
- EO 14057, “Catalyzing Clean Energy Industries and Jobs through Federal Sustainability,” issued December 8, 2021.
- EO 14072, “Strengthening the Nation’s Forests, Communities, and Local Economies,” issued April 22, 2022.
- EO 14096, “Revitalizing Our Nation’s Commitment to Environmental Justice for All,” issued April 21, 2023.

In November 2022, the White House issued a report to the National Climate Task Force encouraging the acceleration of NbS (White House Council on Environmental Quality et al. 2022). Additionally, on October 7, 2020, California Governor Gavin Newsom issued EO N-82-20, which launched the “30x30 initiative” with the goal of conserving 30 percent of California’s land and coastal waters by 2030.

The Bay Area must respond at the speed and scale required to meet the increasingly urgent need to resolve complex challenges at the shoreline—climate change adaptation, water quality improvements, infrastructure management, habitat protection, enhancement, and restoration. To respond effectively, the Bay Area must simultaneously reduce contaminants in treated wastewater and stormwater, restore ecological health to aquatic and coastal ecosystems, and include underrepresented communities in planning and implementation. The region must also secure reliable potable water resources, mitigate SLR, and replace aging infrastructure. A key approach to addressing these challenges is nature-based solutions or NbS (defined below under “Glossary of Terms”). The benefits of NbS include habitat improvement, public access to open space, protection of infrastructure or habitat in the face of rising sea levels, access for traditional cultural uses, and water quality improvement.

Regional initiatives, support, and study of climate change resiliency and nature-based SLR solutions have increased in the past 10 years:

- The *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* clarifies the scale of habitat restoration necessary to support endangered marsh species (USFWS 2013).
- The Estuary Blueprint, led by San Francisco Estuary Partnership, maps out the regional actions needed for the San Francisco Estuary, including measures on water, climate change, habitat, and stewardship (San Francisco Estuary Partnership 2022).
- The Adaptation Atlas develops a science-based framework for adaptation strategies at the scale of operational landscape units, utilizing natural processes (SFEI and SPUR 2019).
- The *Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region: Management Plan 2001* (USACE et al. 2001) and various ongoing technical studies have analyzed the efficacy of beneficial reuse of dredged sediment to rebuild wetlands as a critical climate resiliency action.

- BayAdapt convened collaborators to delineate a roadmap for adaptation to SLR. The Bay Adapt Joint Platform focuses on people, information, plans, projects, and progress to catalyze shoreline protection (BCDC 2021).
- The U.S. Army Corps of Engineers (USACE) San Francisco District was named as an Engineering with Nature “Proving Ground” in 2023 (<https://ewn.erd.dren.mil/proving-grounds/region/san-francisco/>). (NOTE: This is a Civil Works planning and projects initiative, not Regulatory.)
- The San Francisco Bay Regional Water Quality Control Board has amended its basin plan to better reflect the permitting challenges/opportunities for habitat restoration and nature-based shoreline resilience projects (San Francisco Bay RWQCB 2023).
- The San Francisco Bay Joint Venture’s Implementation Strategy identifies habitat needs for fish and wildlife species, identifies projects that will address those needs, and helps identify and achieve funding for those projects, some of which are NbS.
- Various community-based groups are organizing and taking actions. There is importance in building trust and engagement with the community, as highlighted in Harris-Lovett et al. (2021).
- Bay Area wastewater agencies have an interest in shoreline transformation because many of their treatment plants are located in areas vulnerable to SLR. It is also important to utilize NbS for infrastructure to reduce nutrient discharge; reduce discharges of constituents of emerging concern, such as pharmaceuticals; protect wastewater infrastructure and nearby communities from flooding; and potentially employ wastewater effluent as a freshwater source for vegetated habitat.

Funding opportunities for NbS have also expanded in recent years. The Bay Area’s Measure AA, a 2016 voter-approved property tax, provides \$500 million for shoreline protection and restoration projects over 20 years. Since 2008, Region 9 of the U.S. Environmental Protection Agency (EPA) has funded \$71.4 million in grant awards, and in 2023 it invested an additional \$50 million to protect San Francisco Bay watersheds and build climate resilience: the San Francisco Bay Water Quality Improvement Fund. The Federal Emergency Management Agency (FEMA) allocated \$919 million to fund climate hazard mitigation in 2021. The State of California has designated \$3.7 billion to climate resilience projects in the next three years, with \$1.37 billion specifically earmarked for “multi-benefit and nature-based solutions.”

This white paper builds on action items identified in [*Nature-Based Solutions for Coastal Resilience, Habitat Enhancement, and Water Quality Improvement at the San Francisco Bay Shoreline: Challenges, Solutions, and Next Steps*](#)¹ published by the San Francisco Estuary Partnership and Bay Area One Water Network (Harris-Lovett et al. 2021). That report synthesizes the input received during a three-day roundtable workshop conducted with representatives from regulatory agencies, community-based organizations, wastewater agencies, academic institutions, and shoreline planning groups. The report identifies the following key challenges for NbS projects:

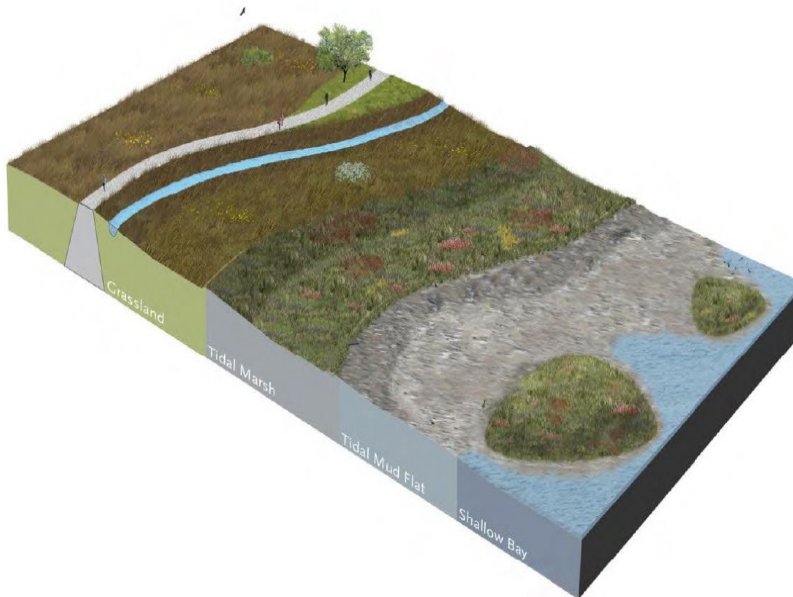
- Current pathways to permitting NbS projects are complex, expensive, and time-consuming. Regulatory agencies must collaborate to increase transparency, streamline cross-agency planning, and incentivize multi-benefit NbS.

¹ https://www.sfestuary.org/wp-content/uploads/2022/07/SFEP_NBS_Report.070722.pdf

- The voices and lived experience of communities and Tribes have historically been excluded from the planning process, including for NbS. Developing meaningful partnerships and a formalized, capacity-building system for community and tribal engagement will create a sustainable route to improved and expedited project implementation.
- Funding for NbS, especially for implementation, is dispersed and difficult to access. Opportunities for collaborative funding for partnerships, innovations, and pilot projects should be explored and encouraged.
- Working with landowners, multiple agencies, and businesses and involving community members in the process is often slow and cumbersome. Public-private partnerships or new entities (such as joint powers authorities) may be critical mechanisms for addressing the development of multi-benefit solutions, given the complex landscape of land ownership, land use, and infrastructure on the San Francisco Bay shoreline.

Case Study: Horizontal Levees—Why Innovation is Hard to Implement

A horizontal levee (shown graphically here) is one innovative NbS project type being explored in the Bay Area. The first horizontal levee was built in 2018, at the Oro Loma Sanitary District as a proof of concept. Although every project type is different, horizontal levees can include flood protection (that meets current levee standards or not), an ecotone slope, and the use of treated wastewater for subsurface water treatment and irrigation of vegetation.



Oblique section through horizontal levee transition zone
(ESA PWA, 2013)

The ecotone slope for a horizontal levee is often located between the uplands along the levee core and the adjacent tidal marsh habitat. Slopes should be generally flatter than 15:1 to 20:1 (H:V) but may be as steep as 10H:1V, depending on the location and constraints. Shallow surface/subsurface irrigation may occur with treated wastewater, reverse osmosis concentrate, or stormwater. The subsurface treatment zone, consisting of permeable gravels and a labile carbon source, can significantly reduce nutrient loads (primarily nitrogen), as well as contaminants of emerging concern including trace pharmaceuticals and possibly per- and polyfluoroalkyl substances or PFAS.

As an innovative concept with high potential for benefits for people and nature, horizontal levees are an example of a strong and proven project concept that is incredibly difficult to implement in practice. Horizontal levee projects located within existing fringing tidal marsh habitat present unique permitting

complexities and benefits. Permitting complexities arise from the placement of fill materials in waters of the United States or state (e.g., wetland fill) to create the ecotone slope and flood control levee; the range of created and enhanced habitat types including upland, freshwater marsh, tidal marsh, and open water; and the intentional design to enable evolving habitat types in conjunction with SLR. As discussed below, the present regulatory environment does not easily support the permanent loss of existing wetlands, regardless of whether those wetlands will become open water as sea levels rise.

The benefits of horizontal levees are wide-ranging and long-term. Among these benefits are carbon sequestration, environmental justice and equity (disadvantaged communities are disproportionately more vulnerable in low-lying areas and commonly the most in need of SLR protection), recreation opportunities (trails and wildlife viewing overlooks incorporated into flood protection levee designs), protection of wildlife and aquatic resources, and improvement of water quality. The horizontal levee concept has been pilot tested at the Oro Loma Wastewater Treatment Facility in San Lorenzo and the Palo Alto Horizontal Levee will be built in 2024 in partnership with the City of Palo Alto and San Francisco Estuary Partnership. However, a large-scale horizontal levee in a fully tidal environment has yet to be permitted. To advance horizontal levees, additional evaluation is required, involving identification of net benefits to habitat functions and values and community benefits of habitat type conversions that would result from horizontal levee and similar nature-based shoreline projects. The benefits and tradeoffs need to be determined.

Navigating Complexities in Project Types and Permitting Landscapes

The Bay Area's regulatory landscape has always been dynamic and innovative. The call for multi-benefit projects that respond to multiple needs, including SLR adaptation and climate change resiliency, have led to increasingly complex and innovative projects. As communities and project sponsors bring these projects forward, the environmental documentation and permitting landscape have become increasingly complex for all parties.

From Regulatory Coordination to Implementation

The permitting process for restoration projects in the Bay Area has improved since establishment of the San Francisco Bay Restoration and Regulatory Integration Team (BRRIT) in 2019, in association with the San Francisco Bay Restoration Authority and Measure AA parcel tax funds. This multi-agency coordination effort has successfully approved five restoration projects to date (BRRIT 2022). However, challenges remain for the BRRIT in its efforts to effectively expedite and innovate the permitting process to enable the advancement of complex, multi-benefit habitat restoration and enhancement projects within a reasonable time frame and level of effort.

At the state level, California's 2020 Cutting Green Tape (CGT) Initiative has produced a statewide regulatory compliance pathway for restoration projects to advance in a clearer, more consistent manner. In 2022, this initiative established a statewide programmatic permitting and approval process for eligible restoration projects reviewed by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), State Water Resources Control Board (State Water Board), and California Department of Fish and Wildlife (CDFW). Multi-benefit projects that result in a net gain of restored or enhanced habitat may be covered by most of the CGT permits listed in the inset box below; however, in

the Bay Area, complex NbS projects are not likely eligible to utilize the CGT permit pathways because the permits have established limits on special-status species impacts (e.g., low species take limits) or due to the nature of the project's multi-beneficial goals.

California Cutting Green Tape Accelerated Restoration Permits:

- State Water Board—401 Certification for Small Habitat Restoration Projects and Statewide Restoration General Order
- CDFW—Habitat Restoration and Enhancement Act (Lake and Streambed Alteration Agreement and California Endangered Species Act for small projects), Restoration Consistency Determinations, Restoration Management Species Take Permits
- USFWS—Statewide Restoration Programmatic Consultation
- NMFS—Restoration Biological Opinions (North Coast, Central Coast, Central Valley, South Coast)
- California Coastal Commission—National Oceanic and Atmospheric Administration (NOAA) Federal Consistency Determinations (North, Central, South Coast)
- USACE—Nationwide Permits 27, 33, 54: Aquatic Habitat Restoration, Temporary Construction, Living Shorelines, respectively

Further, although the CGT permits are coordinated as a statewide effort, the project-specific applicability of CGT permits is evaluated by regional regulatory representatives of regional water quality control boards (RWQCBs), NMFS, USFWS, and CDFW; as a result, some projects may not be approved to use the CGT permits. The headquarters offices for each CGT agency are monitoring regional application of the CGT permits, but it is yet to be seen whether and how consistent application of the CGT permits will be implemented at the regional level. For example, species take limits in the USFWS Restoration Programmatic Biological Opinion (PBO) (USFWS 2022) are established as statewide take limits per year, not per-project take limits, so USFWS headquarters is tracking take occurrences authorized by the Restoration PBO statewide but has not made the information publicly accessible. Locally, the San Francisco Bay-Delta USFWS office has declined use of the Restoration PBO because of the statewide take limit and other conditions. Additionally, the BRRIT is actively tracking which projects are utilizing the CGT permits.

Placement of Fill for Net Benefit Nature-Based Solutions Projects

Lack of a clear pathway for regulatory implementation of NbS projects requiring substantial fill into wetland and special-status species habitat is a real challenge. These regulations were not written for a changing climate future during which fill into habitat might be necessary and beneficial. By the nature of their innovative design and placement, NbS projects such as horizontal levee projects will directly affect (both positively and negatively) wetland and special-status species habitats to fulfill long-term project objectives. These projects can conflict with regulatory mandates to avoid impacts on wetlands and special-status species. In many cases, when assessing whether NbS projects are appropriate and permissible, existing regulatory analysis does not consider the permanent loss of existing aquatic

habitats from future SLR elevations (i.e., the no project scenario), especially in land constrained by urban-shoreline interfaces:

- The Clean Water Act (CWA) regulations provide a basic structure for appropriate analysis of project impacts, no matter the complexity and scale, via the CWA 404(b)(1) Guidelines. In the absence of specific NbS guidance, regional regulatory offices have discretion in how they interpret the guidelines. This is a challenging assessment because regulators must make determinations on risk and uncertainty with limited experience and information on NbS projects and future aquatic resources. In addition to project-specific information, regulators should use outcomes from pilot projects, and analogues from other regions to inform permitting assessments.
- Although federal regulatory agencies must consider cumulative and reasonably foreseeable future impacts (Code of Federal Regulations Title 40, Part 230, Section 404(b)(1)), there is no unified regional guidance to consider future wetlands that will develop because of SLR as a sole offset for the project under permit review.
- In preparation for future SLR conditions, the state regulatory agencies, the San Francisco Bay RWQCB and San Francisco Bay Conservation and Development Commission (BCDC), have confirmed that existing policies can accommodate fill for habitat in future inundated areas where determined to be appropriate. *Fill placed in waters of the state that results in the conversion of wetlands to uplands will not require mitigation if these areas are inundated by 2050 and are converted back to waters of the state again* (BRRIT 2021). Further, Jim Mazza (USACE San Francisco District) notes: *Regionally, regulatory agencies governing impacts to open waters and wetlands subject to SLR, should agree on a single SLR prediction model so that we're all using the same timeline when evaluating temporal loss impacts. There will be challenges in extending monitoring timeframes to see if the SLR predictions do follow model guidance.*
- As implemented by USACE and the San Francisco Bay RWQCB, the CWA Section 404(b)(1) Guidelines require that the final project alternative chosen be the Least Environmentally Damaging Practicable Alternative (LEDPA). This presents another challenge for NbS projects, which are typically location dependent. Engineering design alternatives can reduce aquatic impacts; for example, building a smaller footprint floodwall would be the LEDPA when compared to a horizontal levee that would fill more existing tidal marsh. However, complex NbS with substantial fill into habitats might not be considered the LEDPA when compared against alternatives with less fill (i.e., the floodwall example). However, the overall purpose and need for an NbS project likely has more than one objective. The LEDPA requirement presents an opportunity to consider a range of project benefits, such as habitat resiliency, equity, flood protection, and other considerations for overall benefit. Agencies must consider reasonably foreseeable conditions; some conditions such as SLR are more difficult to nail down. Future conditions must be compared to existing conditions and net future benefits must be evaluated fairly, despite uncertainty in the analysis.
- In both federal and state regulations (e.g., the CWA regulations, California's State Water Board Procedures), there is a required sequence for determining whether fill can be permitted. First, impacts must be avoided; then measures must be taken to minimize impacts, and finally compensatory mitigation is provided for any unavoidable resource impacts. A robust project purpose and need statement and a design integrating avoidance and minimization measures are necessary and result in better environmental outcomes. Ideally, this can result in more practical and cost-efficient projects. However, in many proposed projects, elements of the compensatory

mitigation package are developed before determination of a complete purpose and need and subsequent alternatives analysis. Landscape site analysis for NbS projects is a key aspect of assessing appropriate alternatives.

- Compensatory mitigation for wetland loss is costly and options in the Bay Area are limited. Although regulatory agencies have discretion on accepting mitigation options, compensatory mitigation is often driven by the CWA regulations' preference hierarchy, which prioritizes mitigation banks over other options, such as in-lieu fees (ILF) and CDFW-sponsored Regional Conservation Investment Strategy programs and mitigation credit agreements. The challenge in the Bay Area is that federally and state-approved wetland mitigation banks with available credits are limited, thus requiring project sponsors and regulatory agencies to explore other opportunities and concur on a solution, which takes time.
- Regulatory project review requires extensive information about project design, goals, impacts, and outcomes. Innovative NbS projects are being asked to provide additional design, risk, and impact analysis information that can be costly and premature for project sponsors to address. Multiple agency requests often lack coordination among the agencies for consistency or standardization, and a clear explanation of the concern and direct link to the approval requirements. Further, regulators sometimes suggest tools like the *Aquatic Resource Type Conversion Framework*, Version 2.0 (ARTC framework) (Stein et al. 2022) and California Rapid Assessment Method (CRAM) assessments to support their decision-making on multi-benefit projects. However, completing these assessments requires additional budget and planning effort for the project sponsor, which is feasible, but no clarity is provided regarding whether the assessment outcomes will be used and address the regulatory agencies' concerns.²
- Grant funding budgets for NbS and other restoration projects are typically developed well in advance of regulatory agency engagement; thus, the permitting phases of grant-funded projects do not include the level of effort needed to complete these types of evaluations. By the time pre-application meetings with regulatory agency representatives are held, the project budgets have been solidified; as a result, when project sponsors are pressed to respond to agency requests for additional project analysis or surveys, the sponsor's ability to respond is often limited by funding, which can result in project delays. If additional analysis and documentation, such as conducting the ARTC framework analysis, is necessary to complete regulatory agency review of NbS project effects and benefits, the application process should be clarified so that project sponsors can adequately plan and procure funding in advance of the project permitting phase. Further, regulatory agencies could consider providing time to agency staff to conduct in-house evaluations using innovative tools based on the standard application requirements to support the project sponsor's efforts and ensure that public grant funds are spent effectively. For example, the ARTC framework suggests that either the project sponsor or reviewing agency can complete the analysis.

² The ARTC framework provides an analytical structure to assess functions at the site-specific, landscape, and regional levels to determine overall impacts and benefits of anticipated wetland conversion, while the CRAM assessment is used primarily to evaluate existing overall wetland condition. Both tools provide semi-quantitative information. The ARTC framework requires additional analysis but can utilize existing data (i.e., no field sampling required); additional analysis time to run the ARTC framework can be anywhere from 15 to 40 hours of staff time. The CRAM assessment procedure is a field-based assessment that can be conducted by two people in one day; the procedure requires specialized training to conduct the surveys.

The Challenge for Implementers—Feasibility and Risk

Project sponsors must find a cost/benefit balance. They must determine whether these projects are feasible, considering the complex challenges and unclear pathways for implementing the projects. Further, clear funding for construction is not in place for many projects.

As alluded to previously, baseline information needs for these innovative projects will be higher than for traditional hardscape approaches, so NbS will need more permitting guidance, design flexibility, and upfront adaptation planning. Perhaps this could include incentives for avoidance and minimization of impacts (and thus a lower compensatory mitigation burden) and for a project that results in an overall beneficial outcome. Funding for nature-based shoreline projects from federal, state, and local grants could be jeopardized by substantially high compensatory mitigation requirements. (Grant funding may be repealed if the project's mitigation requirements disqualify the project from receiving those funds.)

Monitoring

Adaptive monitoring can be a critical feedback mechanism for innovative projects and is often required by regulators. Monitoring can assist in reducing the risk and uncertainty associated with NbS construction and long-term maintenance and management. Monitoring can be costly and project sponsors are generally unsure how much monitoring is warranted to ensure the correct level of data directly applicable to project performance criteria. Determining the appropriate monitoring indicators, scale, frequency of occurrence, and parameters for regional monitoring versus project-specific monitoring is necessary for both project sponsors and regulators. The Wetland Regional Monitoring Program, currently under development, is working to address this need in tidal wetlands through an interagency programmatic approach, bringing together both regulators and project sponsors. Then there is the issue of whether the intended outcome that is being monitored is successful, and whether the project may need adaptive management actions, which may be highly variable and unplanned for, and require regulatory agency approval and additional capital investment.

Future Opportunities to Advance Nature-Based Solutions

In order to address the challenges described here, a range of strategic actions will be required. The opportunities described here are informed by a [Transforming Shorelines Collaborative](#) meeting dedicated to this topic in March 2023, as well as continued discussion and coordination with partners. Potential opportunities to advance NbS projects include:

- Clearly identify regulatory and technical issues and provide support to agencies for problem-solving and innovative decision-making:
 - Provide responsive technical assistance to regulatory and resource agencies (EPA, USACE, the San Francisco Estuary Partnership, CDFW, the State Water Board and San Francisco Bay RWQCB, BCDC, USFWS, NOAA-NMFS, and others) and streamline technical requests to project sponsors through the BRRIT and other interagency bodies.
 - Leverage agency-wide successes for better cross-agency permit streamlining. For example, the USFWS 2023 PBO for restoration projects will expedite the federal Endangered Species Act Section 7 consultation process for USACE permits in California.

- Encourage pilot projects in the Bay Area. Research relevant regulatory and technical analogues in other parts of the nation, and actively seek collaboration with USACE’s Engineering with Nature initiative on NbS effectiveness research.
- Increase the capacity of regulatory agency staff. Provide regulatory agencies with more staff, effective training, and empowerment to efficiently advance evolving needs in the project review process.
- Explore successes from other states, such as Virginia, which requires living shoreline approaches to address shoreline erosion management (Virginia Code Section 28.2-104.1) and enables expedited permitting for living shorelines as an incentive. Further, Virginia Code Section 28.2-1301 establishes guidelines for tidal wetlands permits that take SLR into account—the only state in the country with this authority—and in 2020, the state mandated that projects up to 100 feet upland and adjacent to tidal wetlands must address coastal resilience and adaptation to SLR and climate change (Virginia Code Section 62.1-44.15:72).
- Explore permitting pathways at various scales, such as the operational landscape unit (OLU) or sub-regional scale. Certain permitting considerations related to net-benefit projects and tradeoffs may be better suited at this scale. For example, project proponents might consider a permitting strategy for an entire OLU that considers the balance between open water and wetland fill and establishment of new multi-beneficial habitat.
- Find the right forums to advance permitting conversations:
 - Convene a regulatory working group to foster a proactive, solution-oriented dialogue about where there is space to shift the regulatory landscape. Possible partners: California Natural Resources Agency, others.
 - Identify and engage regulatory agency staff with both interest/expertise and decision-making capacity to champion and advance permit problem-solving for NbS actions, both internally within their agencies and externally with other agencies. Example: BCDC’s new climate adaptation specialists.
 - Engage a broad range of contributors in these discussions, including project proponents.
- Apply an analytical approach to evaluate net-benefit projects:
 - Ensure that purpose and need statements fully elucidate the “why” of projects: Why does the project need to be built in wetlands? Why can it not be built landward? Where is the most appropriate location and what are the project benefits in areas with rising marsh elevation and constrained marsh migration? Clearly tie in the project’s needs with regional plans (e.g., Adaptation Atlas, shoreline plans, Bay Habitat Goals) that identify priority areas for NbS projects based on elevation and other relevant factors.
 - Understand the time horizon for establishing an impact-to-benefit balance and advancing/spotlighting different projects for development.
 - Explore the right scale at which to advance permitting for NbS projects. Integrate existing and developing regional shoreline plans into watershed-based or OLU considerations.
 - Leverage USACE Civil Works, FEMA, and NOAA approaches to comprehensive benefit analyses that could be evaluated for application to NbS projects like horizontal levees. Evaluate

regionally specific carbon sequestration benefits, such as the Dutch Slough Restoration Project.

- Use innovative approaches to address near-term and long-term regulatory constraints:
 - Establish regional- or sub-regional-scale permits, such as a focused CGT program for the Bay Area. Example outcomes: USACE 404 Regional General Permit (RGP) and corresponding 401 General Order for projects identified in OLU or similar sub-regional scale plans, PBOs for bay-specific species/habitats modeled from the statewide PBOs, BCDC Regionwide Permit, and establishment of a one-stop permit application form. The goal is to streamline the permit process for similar nature-based shoreline horizontal levee/ecotone slope projects.
 - Identify local sponsor(s) and funding to establish San Francisco regionwide permits. For example, USACE could initiate an RGP itself or an entity or group of participants could apply for an RGP, and the RGP would trigger collaboration with other federal and state agencies.
 - Request the development of a joint USACE/EPA 404 guidance document reinforcing consideration of future climatic conditions (like SLR) in the 404(b)(1)/LEDPA process, as well as innovative avoidance and minimization measures to reduce mitigation requirements. The goal is to overcome unnecessary regulatory hurdles to allow nature-based shoreline SLR adaptation projects to proceed in an environmentally sound and cost-effective manner.
 - Convey awareness and highlight key issues to USACE and EPA headquarters, as well as appropriate members of California’s congressional delegation and the U.S. Congress as a whole, and other policy change advocates.
 - Explore modification of the USACE Nationwide Permit Program. Although this is an effective program that streamlines the permitting process for many project types, the current suite of nationwide permit options does not cover horizontal levee projects. For example, the current Nationwide Permit Number 27 (Aquatic Habitat Restoration, Enhancement, and Establishment Activities) does not authorize conversion of wetlands to uplands, nor does it authorize the conversion or relocation of tidal waters or wetlands to other aquatic uses. The next round of updates to the Nationwide Permit Program will be in 2026 and a wider range of NbS project types should be considered.
- Implement broader approaches for compensatory mitigation.
 - Support local ILF programs, such as the future San Francisco Bay ILF program in progress by Ducks Unlimited.
 - Support the application of mitigation credit agreements.
 - Explore the potential for regional mitigation banks.

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Glossary of Terms

This white paper uses the following terms:

- **Adaptation (climate change)**—Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (EPA 2016).
- **Adaptive management**—A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables (IPCC 2014).
- **Ecotone slope**—A wide, gently sloped or ramped vegetated terrace on the bay side of a levee above the tidal marsh. Ecotone slopes stretch from the levee crest to the marsh surface and can provide wetland/upland transition zone habitat when properly vegetated with native clonal grasses, rushes, and sedges. They can attenuate waves, provide high-tide refuge for marsh wildlife, and allow room for marshes to migrate upslope with SLR (Oro Loma Sanitary District 2015).
- **Horizontal levee**—An engineered sloped subsurface treatment wetland built between coastal levees and tidal marshes; essentially an ecotone levee that incorporates nature-based treatment of wastewater effluent (Harris-Lovett et al. 2021).
- **Multi-benefit projects**—“Planned, designed, implemented, and maintained with the intended purpose of providing two or more benefits or of meeting two or more objectives... these benefits can include: flood reduction, water supply, water quality, water treatment, habitat enhancement, aesthetics, and recreation.” SLR adaptation is another important potential benefit (North Bay Watershed Association 2008).
- **Nature-based solutions (NbS)**—As defined by the International Union for Conservation of Nature, “actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (IUCN 2016).

This white paper uses the following acronyms and other abbreviations:

Acronym or Abbreviation	Definition
ARTC framework	<i>Aquatic Resource Type Conversion Framework, Version 2.0</i>
Bay Area	San Francisco Bay Area
BCDC	San Francisco Bay Conservation and Development Commission
BRRIT	San Francisco Bay Restoration and Regulatory Integration Team
CDFW	California Department of Fish and Wildlife
CGT	Cutting Green Tape
CRAM	California Rapid Assessment Method
CWA	Clean Water Act
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
ILF	in-lieu fee(s)
LEDPA	Least Environmentally Damaging Practicable Alternative
NbS	nature-based solutions
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OLU	operational landscape unit
PBO	Programmatic Biological Opinion
RGP	Regional General Permit
RWQCB	Regional Water Quality Control Board
SLR	sea level rise
State Water Board	State Water Resources Control Board
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service