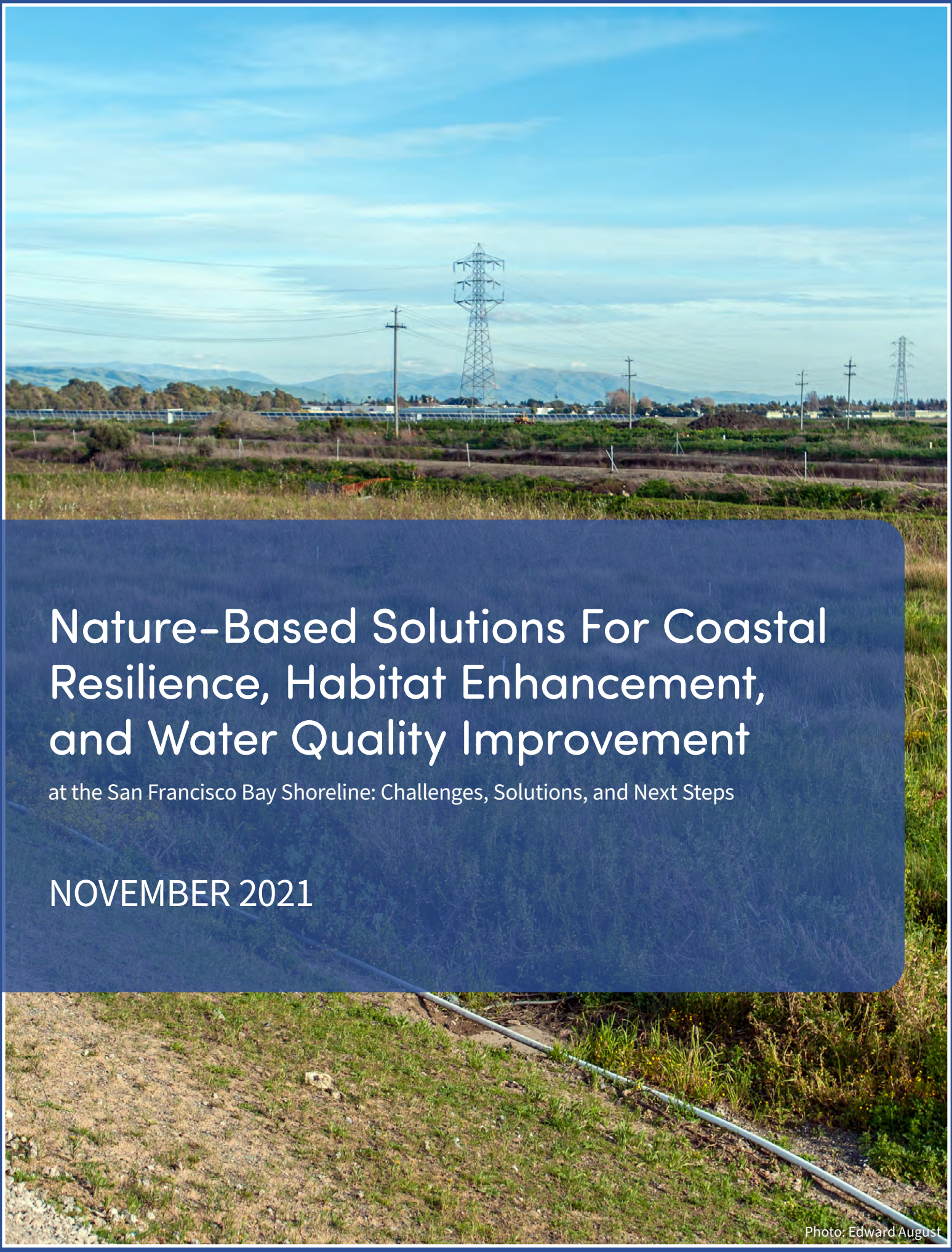

# Nature-Based Solutions For Coastal Resilience, Habitat Enhancement, and Water Quality Improvement

at the San Francisco Bay Shoreline: Challenges, Solutions, and Next Steps

NOVEMBER 2021

Photo: Edward August

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# Nature-Based Solutions For Coastal Resilience, Habitat Enhancement, and Water Quality Improvement at The San Francisco Bay Shoreline: Challenges, Solutions, and Next Steps

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## Executive Summary

The successful implementation of Nature-based Solutions (NbS) along the San Francisco Bay shoreline offers a pathway to sustainable coastal resilience that is equitable, economical, and long-lasting. However, this pathway is not easily paved without careful planning and collaboration.

Over the course of a three-day workshop hosted by the San Francisco Estuary Partnership (SFEP) and Bay Area One Water Network, participants shared insights on the cross-sectoral challenges facing stakeholders impacted by NbS, goals and drivers behind NbS for shoreline resilience in the Bay Area, and opportunities for working together to create shared solutions that lead to the implementation, funding, and regulation of NbS. Participants represented diverse stakeholder groups including regulatory agencies, community-based organizations, wastewater agencies, academic institutions, and shoreline planning groups. The workshop was facilitated by staff from SFEP, the Bay Area One Water Network, and the Meridian Institute.

Emerging from this workshop were a set of both expected and innovative ideas for how to proceed, as well as lessons learned that can help guide work in this field for years to come. The throughline of these ideas rang clear: there is no one-size-fits-all approach to designing, planning, or implementing NbS. These varied infrastructural assets (such as horizontal levees, floating wetlands, oyster reefs, etc.) are place-based, nuanced, and have tangible impacts on all stakeholders. Their planning and implementation should be guided by several key goals: be cost-effective, adaptable, achievable, provide long-term value, steward the natural environment, and serve the surrounding communities.

This report provides a summary of workshop themes and outcomes, along with key near-term milestones to strategically advance towards multi-benefit shoreline resilience in the Bay Area. Important audiences for the report include regional, state, and local partnerships working to advance NbS in communities, elected officials, project funders, technical experts, community groups, and academics.

This report also calls on decision makers to examine the lens with which they execute place-based infrastructural work to ensure that community members and Tribes with local knowledge are empowered to lead and have ample representation throughout the entire process.

Photo: Rick Lewis

## Key Takeaways

- Current pathways to permitting NbS are complex, expensive, and time-consuming. Regulatory agencies must collaborate to increase transparency, streamline cross-agency planning, and incentivize multi-benefit NbS.
- 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 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 to address the development of multi-benefit solutions given the complex landscape of land ownership, land use, and infrastructure on the SF Bay shoreline.

NbS for shoreline resilience will not occur without concerted, sustained effort. Regional opportunities for building partnerships, defining performance criteria, engaging in a master-planning process that builds upon previous work, evaluating permitting processes, and investing in community and tribal engagement are critical for advancing NbS for shoreline resilience.

Photo: San Francisco Estuary Partnership Archive

## About This Report

This report reflects a synthesis of discussions held at a virtual roundtable discussion on nature-based solutions for shoreline resilience (NbS) in the San Francisco Bay Area. The roundtable, held on November 2-4, 2021, was hosted by the San Francisco Estuary Partnership and the Bay Area One Water Network. The roundtable aimed to:

- Characterize the key cross-sectoral barriers to adopting NbS and identify practical strategies for overcoming them while still protecting ecosystems and communities.
- Develop a strategy and roadmap of next steps to advance funding and regulatory support for NbS in the San Francisco Bay Area.
- Identify allies and forge partnerships for collaboration on the planning, implementation, and maintenance of NbS projects.

The roundtable and report are part of the San Francisco Estuary Partnership's Transforming Shorelines Project, which works to:

- Build regional capacity for NbS through technical support and analyses
- Advance a suite of NbS projects through design, permitting, and implementation
- Advance state-of-the-art approaches to water quality improvement at the Oro Loma Horizontal Levee site.

This report complements a series of documents developed by the Bay Area One Water Network intended to assess options for advancing water system sustainability, resilience, and security in the San Francisco Bay Area (Bay Area). By sharing lessons learned, showcasing successes, and identifying best practices, the Bay Area One Water Network aims to inform decision-makers about approaches that can enable them to meet the Bay Area's future water needs.

This report acknowledges the need to reevaluate planning strategies to meaningfully engage communities, starting by centering frontline and tribal stakeholders in the conversation early in the planning process. The NbS roundtable planners engaged professionals with diverse expertise to participate in this workshop. Invitees included regulators, land-use planners, wastewater and flood control managers, leaders from community-based groups, businesses and researchers (see Appendix A for a list of participants). The varied backgrounds and insights of roundtable participants included in this synopsis are a critical piece of our regional effort towards a resilient, vibrant, and ecologically healthy shoreline. This cross-sector collaboration is starting, but more must be done to make regional environmental planning processes more inclusive and equitable.

The Bay Area One Water Network and the San Francisco Estuary Partnership prepared this report with support from the sponsors of the Bay Area One Water Network and the US Environmental Protection Agency. The workshop was facilitated by staff from SFEP, the Bay Area One Water Network, and Molly Mayo of the Meridian Institute. While this report synthesizes the themes and ideas presented in the November 2021 roundtable discussion, this document does not represent a comprehensive assessment of NbS opportunities in the Bay Area. Instead, the intent is to identify key challenges and potential solutions to spur discussion and facilitate action.

Photo: Karl Nielsen

## Land Acknowledgement

The report authors honor and acknowledge the many Ohlone tribal groups and families, including the Ramaytush and Chochenyo, as well as the Coast and Bay Miwok, Southern Pomo, Wappo, and Patwin peoples as the rightful stewards of the lands on which we reside. Work to protect and restore the margins of the Bay should acknowledge and be informed by the history of injustices, by the fact that we are working on the land of Native people who were forced to relocate, and by the fact that our work is often adjacent to or even on top of sacred cultural sites. Recognizing the intersections between wetland restoration, shoreline recreation, and historical sacred sites can facilitate opportunities throughout our estuary to restore, create, and protect for multiple purposes. We do this work in good faith, knowing it is centrally important that we work toward repair, reconciliation, and reparations wherever possible.

# Introduction

Sea level rise poses major challenges to the San Francisco Bay Area. Mean water levels at the Golden Gate Bridge in 2018 were 7 inches (18 cm) higher than they were in 1900 (Office of Environmental Health Hazard Assessment and California Environmental Protection Agency 2018) and experts expect an additional 40 inches (100 cm) of sea level rise by 2100 (California Natural Resources Agency 2018).

Collective action is necessary to protect the region's communities and infrastructure from sea level rise. A broad set of stakeholders make decisions about, and will be affected by, the complex challenge posed by sea level rise. Stakeholders with an interest in these discussions include tribal organizations, community-based groups, water managers, regulatory agencies, governmental agencies, businesses, environmental advocates, and science institutions. Cross-sector collaboration among these groups is imperative to achieving effective and equitable outcomes.

Transforming shorelines for resilience requires innovative, boundary-spanning approaches. Over the coming years and decades, the Bay Area faces complex, interrelated, and expensive water management and infrastructure decisions. The region must simultaneously reduce the amount of contaminants in treated wastewater and stormwater, restore ecological health to aquatic and coastal ecosystems, engage underrepresented communities in planning processes, secure reliable potable water resources, mitigate sea level rise impacts, and replace aging infrastructure.

Nature-based Solutions (NbS) are particularly promising for providing multiple benefits to address the Bay Area's shoreline challenges. The International Union for Conservation of Nature defines nature-based solutions as "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." NbS benefits can 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. In comparison, while appropriate in certain circumstances, hardening shorelines (i.e., sea walls) in response to sea level rise provides a sole benefit of local flood risk reduction, but will likely exacerbate flooding elsewhere in the estuary (Hummel et al. 2021).

A great deal of funding at the local, state, and federal levels is available to engage communities to plan and implement NbS for shoreline resilience. Measure AA, which 70% of Bay Area voters supported, provides $500 million for wetland restoration over 20 years ("San Francisco Bay Restoration Authority" 2016). The Federal Emergency Management Agency (FEMA) allocated $919 million to fund climate hazard mitigation through its 'Building Resilient Infrastructure and Communities' (BRIC) program in 2021 alone. The State of California has designated $3.7 billion to climate resilience projects in the next three years, with 1.37 billion of that specifically earmarked for "multi-benefit and nature-based solutions" (State of California 2021a; 2021b).

Planning for the shoreline's future is critical for Bay Area communities to be resilient to a changing climate. Many local and regional plans and guidance documents exist, prepared by community-based groups, government agencies and other stakeholders. Project staff worked in coordination with these efforts during the planning and follow up process. Opportunities are being explored to transfer the key findings of this report to the decision-makers and audiences associated with these efforts. Some key plans that informed the scope and focus of the roundtable include:

- The **Recovery Plan for Tidal Marsh Ecosystem for Northern California** clarifies the scale of habitat restoration necessary to support endangered marsh species in the face of a changing climate in the Bay Area (U.S. Fish and Wildlife Service 2013).
- The **Adaptation Atlas** develops a science-based framework for adaptation strategies at the scale of operational landscape units, which take advantage of natural processes along the diverse Bay shoreline (San Francisco Estuary Institute and SPUR 2019).
- The BayAdapt process convened stakeholders to delineate a roadmap for adaptation to sea level rise. The emergent **BayAdapt Joint Platform** focuses on people, information, plans, projects, and progress to catalyze shoreline protection (San Francisco Bay Conservation and Development Commission 2021).
- The Bay Area Regional Water Quality Control Board is evaluating potential amendments to the **Basin Plan** to better understand the permitting challenges and opportunities for habitat restoration and nature-based shoreline resilience projects (San Francisco Bay Regional Water Quality Control Board 2019b).
- The **Estuary Blueprint**, led by the SF Estuary Partnership, maps out the regional actions needed for a healthy, resilient San Francisco Estuary, including a suite of measures on water, climate change, habitat, and stewardship (San Francisco Estuary Partnership 2016).
- The San Francisco Bay Joint Venture's **Implementation Plan** 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 will be NbS.

Several community-based groups are also organizing and planning around sea level rise and climate adaptation, and staff members from several of these groups attended the roundtable. As communities and agencies across the region grapple with climate change, deeper partnerships will need to be established. Ongoing inequities and past mismanagement affect relationships between marginalized communities and government institutions seeking to co-create solutions. Some of the recommendations in this report point to the need for building trust and stronger relationships among staff members at government agencies, community-based groups, tribal partners and residents in historically marginalized communities. Agencies are in an iterative learning process to build cultural competency, capacity for ongoing engagement, and trust within the communities they serve. This process will be important to implementing some of the community and equity recommendations in this report.

Bay Area wastewater agencies are important stakeholders for regional shoreline transformation efforts due to the proximity of most of their treatment plants to the Bay and the recognized vulnerability to sea level rise. Some wastewater agencies are considering adopting NbS for the multiple benefits they can provide, including water quality improvement and protection from sea level rise. Concern about excessive nutrient levels in the San Francisco Bay (i.e., eutrophication) drives wastewater agency interest in NbS: wastewater treatment plants discharge up to 120,000 pounds (54,000 kg) of nitrogen to the Bay each day (HDR 2022), which threatens to cause nutrient excessive algal growth in parts of the Bay (Novick and Senn 2014). Conventional approaches to upgrading wastewater treatment operations around the Bay to reduce nutrient levels in effluent are estimated to cost up to $12 billion (HDR 2018). The San Francisco Bay Regional Water Quality Control Board has mandated that all the wastewater agencies around the Bay evaluate the potential for NbS for nutrient removal from wastewater effluent (San Francisco Bay Regional Water Quality Control Board 2019a).

Linking NbS to wastewater infrastructure could provide a suite of benefits including:

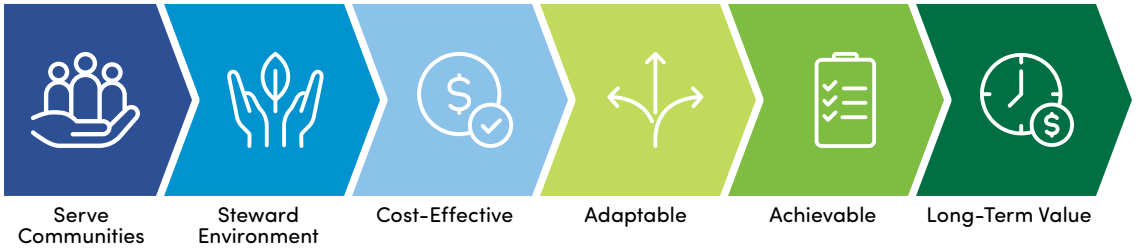
- Employing wastewater effluent as a freshwater source for vegetated habitat at the margins of the Bay
- Enhancing protection of wastewater infrastructure and nearby communities from flooding due to sea level rise
- Reducing nutrient discharges to the Bay
- Reducing discharges of constituents of emerging concern, such as pharmaceuticals.

Several pilot projects that incorporate NbS are in various stages of development and implementation in the region. Pilot projects provide important opportunities to test innovative approaches that incorporate treated wastewater (either for additional water treatment or for irrigation) as well as identify challenges and opportunities for full-scale implementation. Notable pilot projects are the Oro Loma Horizontal Levee, Palo Alto Horizontal Levee, San Leandro Treatment Wetland, and North Richmond Horizontal Levee. In addition, several wastewater agencies are testing out pilot-scale approaches for designing NbS to meet specific needs, such as the productive use of biosolids, treatment of reverse osmosis concentrate from water recycling projects, and detention and treatment of stormwater. These pilot projects shine a light on many of the opportunities NbS can provide to communities, as well as the myriad challenges for design, permitting, construction, and maintenance of these unique places.

This report provides a nuanced view of the goals and multiple drivers for NbS for shoreline resilience in the Bay Area. It identifies challenges and highlights a suite of potential solutions for overcoming barriers to NbS implementation. Finally, it lists key near-term milestones to strategically advance towards multi-benefit shoreline resilience. Key audiences for this report include regional, state, and local partnerships working to advance NBS in communities, elected officials, project funders, technical experts, community groups, and academics.

## Goals for NbS for shoreline resilience in the San Francisco Bay Area

Overall, NbS for shoreline resilience in the San Francisco Bay Area should provide multiple benefits. There is a crucial opportunity to make shoreline infrastructure investments, such as those planned for improved water quality and transportation, more resilient by employing NbS.




1. Serve Communities
   - Provide public access to the shoreline and green space, including for traditional uses
   - Protect communities and infrastructure from flooding
   - Create jobs for local community members
   - Publicly recognize the history and original inhabitants of the place
   - Support outreach and education by providing materials that are accessible to community members
   - Improve public health
   - Center local community engagement in the process from the start - including the problem definition and goal-setting stage
2. Steward Natural Environment
   - Integrate shoreline solutions into a regional ecosystem view with the goal of preserving the Bay's ecological health, recognizing its international importance for biodiversity and for waterbird and aquatic migratory species
   - Create and protect habitat in the face of sea level rise
   - Provide habitat connectivity
   - Improve water quality
3. Be Cost Effective
   - Employ funding in a manner that provides multiple benefits
   - Include mechanisms for cost-sharing among agencies and organizations
   - Use pilot studies to inform engineering of larger projects
   - Consider innovation construction methods
4. Be Adaptable
   - Create dynamic systems that are adaptable to changing conditions
   - Create systems of ongoing monitoring and governance that can facilitate adaptation if needed
   - Create project timelines that allow for adaptation and learning by doing

5. Be Achievable
    - Find the "right size" for shoreline resilience projects - large enough to achieve a meaningful and measurable impact, but not so big that they become too unwieldy to plan and maintain
    - Develop appropriate governance structures to facilitate leadership, permitting, and long-term oversight
    - Be implementable in terms of permitting, design, and long-term maintenance
6. Provide Long-Term Value
    - Find the right metrics to assess success over time
    - Have a feasible long-term maintenance and governance plan

## Insights

- A **diversity of viewpoints about goals** for NbS for shoreline resilience exists. Project proponents will benefit from the development of a framework to **equitably balance the varied goals** for specific projects.
- Once stakeholders establish project-specific goals, they must then **identify metrics and conduct monitoring** to assess project success.

> "Honor the past to shape the future." –Kanyon Coyote Woman Sayers-Rood
>
> We have an opportunity to develop shoreline resilience in a way that recognizes the missteps taken by agency leaders and learns from the rich history of Indigenous stewardship in the region.

Photo: Karl Nielsen

## CHALLENGE: PERMITTING PATHWAYS

Permitting pathways to NbS are currently complex and expensive for project proponents to navigate. Furthermore, it is inefficient and risky for proponents to interpret regulatory issues during individual permitting processes. As a result, a streamlined approach to developing more efficient regulatory pathways for NbS is necessary. The complexity of permitting NbS is a deterrent to many potential champions of future projects, such as community-based organizations, landowners, municipalities, and wastewater agencies.

Required permits for NbS include approvals at multiple levels of government. Efforts like the Bay Restoration Regulatory Integration Team (BRRIT), funded by the SF Bay Restoration Authority, are leading efforts to ensure early consultation with regulatory agencies as a means of providing more efficiency in the permitting process. The Bay Adapt Joint Platform identified several options to improve regulatory pathways for multi-benefit NbS projects.[1]

NbS projects at the shoreline often require a host of permitting approvals and regulatory processes, outlined below.

### Key Federal Approvals:

i. Clean Water Act (CWA), Section 404
ii. Rivers and Harbors Act, Section 10
iii. Endangered Species Act (ESA), Section 7/10
iv. Magnuson-Stevens Fishery Conservation and Management Act, including provisions for essential fish habitat
v. Federal Aviation Administration / US Department of Agriculture (relating to potential for bird strikes)
vi. National Environmental Policy Act (NEPA)
vii. Marine Mammal Protection Act
viii. National Historic Preservation Act Section 106

### Key State Approvals:

i. CA Environmental Quality Act (CEQA)
ii. Porter-Cologne Water Quality Control Act Waste Discharge Requirements (WDRs) and NPDES Permit
iii. Clean Water Act (CWA), Section 401
iv. State Endangered Species Act
v. Streambed Alteration Agreement (CDFW)
vi. State Lands Commission (ownership of tidal lands)
vii. Bay Conservation & Development Commission- Coastal Zone Management Act (CZMA)
ix. CalTrans (where relevant)

### Key Local Approvals:

i. County Mosquito Abatement Districts (for design as well as operations and maintenance)
ii. Air Quality Management District (construction-phase)
iii. Department of Toxic Substances Control (for development on contaminated lands)

1 See Bay Adapt Joint Platform Action 7: Refine and accelerate regulatory approvals processes. https://www.bayadapt.org/wp-content/uploads/2022/01/BayAdapt_JointPlaform_Final_Oct2021.pdf

## SOLUTIONS: PERMITTING PATHWAYS

- **Permitting agencies or the legislature can develop regulatory integration processes** to facilitate coordination among agencies involved in NbS projects. This integration is essential to lower costs and make projects more achievable for NbS project developers engaging in the permitting process. As a first step, NbS project proponents can **engage early with the Policy and Management Committee (PMC)** of the BRRIT to identify regulatory flexibilities and permitting pathways for NbS projects.
- Regulatory agencies can make **institutional commitments** to provide information to project proponents and to identify processes to establish clear regulatory pathways for NbS, including:
  - Provide information on statutory authority for each agency.
  - Clarify how permitting for NbS for shoreline resilience differs from permitting for shoreline housing development or other land uses beyond restoration or recreation and establish the steps in the NbS permitting process.
  - Develop shared guidance for performance metrics between regulators and project developers to ensure adaptive management of projects.
  - Incentivize NbS projects by pre-negotiating terms for permits on topics like obtaining mitigation credit for the habitat created on the slopes.
- Regulators and researchers can **quantify the regulatory risk of inaction** or the threat of delayed action, particularly around the critical challenges of habitat protection and wetland fill in the face of a changing climate.
- Regulatory agencies can **increase regulatory incentives for multi-benefit** NbS projects across all phases of projects from design to construction and long-term operations and maintenance.
- Regulatory agencies could consider **penalties or compensation fees** for the development of hardened barriers against sea level rise that exacerbates flooding elsewhere.
- **Programmatic permits and plans** may be developed for the region or on a sub-regional basis to promote NbS projects as an alternative to projects that harden the Bay margins, such as sea walls.[2]
- Develop **early, open, and consistent communication** between regulators and project proponents.
- Create incentives for projects that **provide multiple benefits**, including for community uses, water quality and flood control. Project developers should allocate resources for monitoring performance metrics.
- **Conduct scientific research** to demonstrate how well different types of NbS for shoreline resilience meet project goals over time.

2 Programmatic permits, including sub-regional planning documents typically related to habitat management and compliance with state or federal endangered species laws, tend to increase transparency among federal agencies but might not align with state and regional agencies.

## CHALLENGE: ELEVATE COMMUNITY AND TRIBAL VOICES AND PERSPECTIVES

Engaging community and tribal partners early and throughout NbS project conceptualization, design, and implementation, is a crucial facet of equitable shoreline resilience. NbS projects require unique partnerships, bringing together stakeholders who have sometimes never worked together before. Not all stakeholders possess skills or best practices for racial justice and community engagement, and some NbS project proponents lack experience in the kind of broad, inclusive community engagement necessary for successful implementation of projects.

## SOLUTIONS: ELEVATE COMMUNITY AND TRIBAL VOICES AND PERSPECTIVES

- **Support ecoliteracy** in frontline community members who can meaningfully engage with planning processes and be part of the workforce. To do so, **invest in technical capacity-building** for local community-based organizations and provide them with **funding opportunities for educational program development**.
- **Develop a formalized system** for planners, engineering consultants, and other NbS project proponents to engage with a broad range of community members and access information about the relevant community partners for their area.
- **Convene potential partners early** from tribal and community groups and stakeholders from the public and private sectors. **Planning and technical assistance grants** can assist with strategic planning to center projects based on community needs.
- Tap into **public-private partnerships** to fund convenings to build upon community vision before any particular project's outcome is decided upon.
- Create **regular opportunities to meet** with stakeholders, **create shared definitions and timelines**, and **establish shared goals**. These long-term, routine processes can help build trust between all stakeholders.
- Consider **community engagement at the scale of Operational Landscape Units**, which are areas defined in the Adaptation Atlas that are expected to support a coherent suite of ecosystem functions, to create collaborative visions for the shoreline.
- Establish a **sustainable funding stream** to support genuine community engagement on particular projects and sub-regional planning efforts, following the Climate Equity Consortium model, described by Bay Adapt (BCDC 2021).
- Compensate **low-income community members and groups** for participating in planning processes to ensure equitable access. **Provide training in cultural competency and inclusive practices** to project proponents who start community engagement processes.
- **Leverage pilot or demonstration projects**, like the Oro Loma Horizontal Levee, to educate and engage stakeholders regionally.
- **Engagement fatigue is real**, and a similar pool of participants are frequently asked to engage in similar efforts in a manner that alienates communities. Agencies and project proponents must **develop opportunities to engage that are accessible to community members** and reduce the barriers to engagement by meeting in places and at times most appropriate for the objective at hand.

- **Provide multilingual resources** and make meetings more accessible by **providing childcare and food**.
- Utilize adaptive management frameworks that incorporate iterative learning during project development **to build capacity** for community engagement and racial justice in this work.
- Agencies, funders, and grantees should **develop performance metrics** for community engagement and equitable decision making. Many state and federal grants maintain community engagement requirements - though success in this realm is undefined.

## CHALLENGE: FUNDING

Funding for NbS is dispersed, originating in a complex patchwork of grant programs and opportunities. Community-based planning requires a nuanced, place-based approach that doesn't always fit funding guidelines. While more funding has become available in recent years, accessing it can be challenging for project proponents of NbS. In addition, funding programs focus on projects that are farther along in the process and thus don't always support the principle of early community engagement needs or the complex stakeholder engagement process that are important to the success of NbS projects.

## SOLUTIONS: FUNDING

- Develop **mechanisms for pooling resources** among multiple private and public entities. These may include new purpose-driven agencies, joint-powers authorities, or other entities that operate independently from short-term political or funding cycles.
- Develop **legal frameworks** so that everyone who benefits from NbS for shoreline resilience projects helps pay for them. For example, **tolls or micropayments for transportation corridors at the shoreline** could support resilience efforts that will help protect road infrastructure.
- Identify **multiple funding sources** that can help support the different stages of projects, including capacity-building and project planning, design and construction, operations and maintenance, and research.
- **Establish a regional institutional resource** to help NbS projects facilitate collaboration, fundraising, and capacity building. This entity would have the resources needed to track interested parties, apply for funding, enable capacity building, and act as a matchmaker across interest groups for particular projects or at the subregional scale (i.e., Operational Landscape Unit). An additional role for this institutional resource could be to **establish a sustainable funding model** to support regional and sub-regional planning, fundraising, and engagement with community-based organizations or stakeholders.
- **Cultivate funding for collaborative partnerships, innovation, and pilot projects** to help develop NbS for and by communities.

## CHALLENGE: LAND USE, PLANNING, AND GOVERNANCE

Working with landowners, multiple agencies and businesses, and involving community members in the process is often cumbersome. Public-private partnerships or new entities (such as joint powers authorities) may be critical mechanisms to address the development of multi-benefit solutions given the complex landscape of land ownership, land use, and infrastructure on the SF Bay shoreline.

## SOLUTIONS: LAND USE, PLANNING AND GOVERNANCE

- Consider **incentivizing the development of public NbS projects on private land** through mechanisms such as easements, buyouts, or land trusts.
- **Identify regulatory incentives** to encourage cooperation among multiple landowners during project planning phases.
- Consider **institutional agreements** like Memorandums of Understanding to define a common charge and delineate the roles of different entities.
- Consider **creating new institutions** to lead the governance of NbS projects in a particular location, including Joint Powers Authorities or hazard abatement districts.
- **Iterate and build upon** existing structures and planning tools, including the Adaptation Atlas, the Estuary Blueprint, SF Bay Joint Venture Implementation Plan and Bay Adapt, for establishing planning boundaries and setting policy objectives.
- **Empower individuals as change-makers** to facilitate and build sub-regional collaborations, including public-private partnerships and cost-sharing mechanisms for multi-benefit projects. Key agencies may consider ensuring that individuals are tasked with championing shoreline resilience efforts and have the time and resources needed to engage the parties necessary to make these projects happen. Similarly, sub-regional partnerships could employ one or more individuals to facilitate project coordination across multiple sectors.
- **Incentivize the participation of public agencies and community-based organizations** in collaboration efforts and governance structures, by funding involvement and providing capacity-building resources.

## Additional areas of research or technical analysis needed

NbS are in their infancy in the Bay Area and in many other parts of the world. Research is needed to reduce uncertainty about NbS performance and their integration into the broader set of ecological challenges for San Francisco Bay. Roundtable participants identified several additional areas of research that are necessary for advancing NbS regionally.

**Research to facilitate optimization of NbS for specific ecological outcomes:**

- Assess the effect of seepage slope design and levee material composition on pollutant removal efficiency in subsurface NbS, such as horizontal levees.
- Identify strategies for minimizing the need for fill in the construction of NbS projects (i.e., low-sediment NbS designs).
- Characterize the habitat benefits over time for different NbS designs.
- Develop metrics to quantify benefits (including wave attenuation, carbon sequestration, habitat, recreation values). Determine methods for quantifying the benefits of using NbS against the risk of not doing so, in order to incentivize federal investment.
- Investigate ways to ensure accessibility of resources to diverse partners, including assessing the opportunities and resources needed to implement suggestions in documents like Bay Adapt, which has provided guidance on development of an NbS "help desk."

**Research to inform policies for sediment allocation:**

- Develop technical guidance on NbS soil/fill quality and intended uses.
- Develop strategic regional priorities and regulatory guidance for dredged material and sediment allocation.
- Quantify the strengths, weaknesses, opportunities, and threats to using upland sources and/or biosolids for NbS for shoreline resilience.

Photo: Ken James

## Key Milestones in the Near Term

### Build and cultivate partnerships

- Forge connections among and across agencies, organizations and communities.
- Invest in a regional NbS community of practice, similar to the Transforming Shorelines Collaborative, with stakeholders including Caltrans, railroads, cities, airports and ports, and individual entities that wish to maintain existing operations at the shoreline.
- Cultivate a skilled and diverse set of decision-makers through paid internship programs and training opportunities focused on NbS.
- Establish or empower an entity to facilitate collaboration, fundraising, and capacity-building. Such an entity would advance priorities identified in this Roundtable and elsewhere and help secure funding.
- Invest regionally in processes to build capacity for collaboration and establish professional networks among potential partners.
- Train and support individuals and organizations to be facilitators of collaboration and partnerships in the service of building shoreline resilience through NbS. These individuals should have subject matter expertise of NbS, regulatory processes, community and tribal engagement, or funding opportunities, and be able to help connect the relevant people and organizations at the right times.

### Develop metrics that reflect the full range of stakeholder goals

- Metrics should include performance, monitoring, and adaptive management triggers, as well as the potential for adaptive actions.
- Metrics should also address social goals, for example shoreline access for recreation or traditional uses.

### Develop a strategic plan to scale shoreline resilience projects to align with Operational Landscape Units (OLUs) developed in the Adaptation Atlas

- Prioritize projects that are important to a larger strategic plan.
- Leverage permitting similarities across OLUs to streamline processes.
- Identify and collaborate with stakeholders and potential community engagement partners in each OLU.
- Identify champions and champion organizations, structures for collaborative management, and pooled funding mechanisms for each OLU.
- Identify funding resources for coordination and collaboration within OLUs.
- Research governance strategies that help solidify the OLU approach (what governance strategy would work, and help diverse stakeholders find common ground and work cross jurisdictionally).

### Critically evaluate permitting pathways

- Identify and make transparent the degree of regulatory discretion possible at the staff level to support NbS for shoreline resilience versus what permitting changes require official policy guidance or statutory changes.
- Establish a regulatory forum for resolving regulatory challenges for NbS and strategically planning ways to overcome them to develop a more cohesive regulatory framework. This framework could serve to create cross-cutting guidance related to performance standards, habitat mitigation, and monitoring expectations.

### Invest regionally in community and tribal engagement

- Create engagement processes that are separate from individual NbS project planning and thus not subject to the same constraints faced by projects.
- Develop a sustainable funding mechanism to support partnerships among community-based organizations, tribal groups, environmental planners, regulators and project designers.
- Develop strategies and supporting materials that are accessible to non-specialists and that are available in languages relevant to project partners.
- Hire bilingual and bicultural urban planner(s) to build the capacity of community leaders on planning processes and create opportunities for engagement.
- Commit technical expertise to support community visions of NbS for shoreline resilience.
- Expand existing programs that cultivate community-led visioning and ecoliteracy about the shoreline.

### Build on successes

- Create and disseminate NbS design manuals to help translate local successes into regional guidelines.
- Expand the SF Bay Restoration Authority to wastewater and stormwater projects.
- Identify models of collaborative governance and management for climate adaptation to develop best practices.
- Expand the BRRIT in scope and scale to include all NbS measures and approaches.

## Lessons Learned

NbS for shoreline resilience will not occur without concerted, sustained effort. This report lays out the goals, challenges, and potential solutions for NbS for shoreline resilience in the San Francisco Bay Area. Notably, many of the next steps identified are regional in scale. Regional opportunities for building partnerships, defining performance criteria, engaging in a master-planning process that builds upon previous work, evaluating permitting processes, and investing in community and tribal engagement are critical for advancing NbS for shoreline resilience. This regional approach has the potential to maximize ecological and social benefits while maintaining project benefit, cost-effectiveness and supporting efficient development of individual NbS projects for shoreline resilience.

Ongoing engagement efforts are needed to advance priorities at all scales. One lesson from this meeting was the importance of broader and more equitable inclusion in convenings on this topic. While the planning team made efforts to broaden participation to include a range of stakeholder groups, the roundtable discussion and the recommendations listed here would have benefited from greater representation of community-based and Indigenous groups.

As always, advancing NbS is an adaptive process. Likewise, fostering collaboration among diverse sets of stakeholders is an iterative process. Although the process can be slow in comparison to approaches used to create infrastructure in the past, it has the potential to create greater benefits by ensuring more resilient and equitable outcomes.

Photo: San Francisco Estuary Partnership Archive

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# Appendix B: Glossary

### BayAdapt
An initiative led by the San Francisco Bay Conservation and Development Commission (BCDC) to establish regional agreement on the actions necessary to protect people and the natural and built environment from rising sea levels, which concluded in October 2021.

### Ecotone Levee
Gentle slopes or ramps (with a length to height ratio of 20:1 or gentler) bayward of flood risk management levees and landward of a tidal marsh. They 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 sea level rise. Ecotone levees are sometimes listed in other documents as ecotone slopes or upland transition zones (San Francisco Estuary Institute and SPUR 2019).

### Habitat Enhancement
Making existing habitat (i.e., salt ponds) more amenable to wildlife.

### Habitat Restoration
Re-creating and/or rebuilding a habitat that was once found in a specific place and was previously removed.

### 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. It is designed to meet multiple objectives, including removing contaminants from wastewater effluent, providing transitional wetland habitat, protecting existing levees from erosion, and reducing the threat of coastal flooding by attenuating storm waves (Cecchetti et al. 2020). A pilot horizontal levee has been built at Oro Loma Sanitary District in San Lorenzo.

### Nature-based Solutions
Nature-based solutions are actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits (Cohen-Shacham et al. 2016).

### Operational landscape unit (OLU)
A delineated area that effectively provides specific ecosystem functions and services within the natural and built environment. Each OLU consists of a number of landscape features: one or more watersheds that connect to the Bay by a tidal creek, with associated fluvial floodplains, alluvial fans and tidal wetlands. These landscape features function in a coherent manner, they are connected by the movement of sediment and water, and they evolve together (SFEI and SPUR 2018).

### Reverse Osmosis (RO) Concentrate
The briny effluent from reverse osmosis water treatment, which contains relatively high concentrations of salts, nutrients, and pollutants. RO concentrate typically comprises 20 - 40% the volume of the water treated by a reverse osmosis system, though many technologies to efficiently reduce the volume of RO concentrate are in development (Pérez-González et al. 2012).

### San Francisco Bay Restoration Regulatory Integration Team (BRRIT)
Consists of staff from the six state and federal regulatory agencies with jurisdiction over habitat restoration projects in San Francisco Bay. It was formed to improve the permitting process for multi-benefit habitat restoration projects and associated flood management and public access infrastructure in the San Francisco Bay and along the shoreline of the nine Bay Area counties (excluding the Delta Primary Zone).

### Sea Level Rise
Increase in still sea water level due to climate change, caused by the added water from melting ice sheets and glaciers and the expansion of seawater as it warms (NASA n.d.).

### Still Water Level
Sea water level inclusive of tides and atmospheric storm surges (Idier et al. 2019).

### Storm Surge
The abnormal rise of water generated by a storm, over and above the normal tides (NOAA, n.d.)

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