

First Steps to Address Sea Level Rise in Marin County

Demonstration Projects on the Eastern Shoreline—Past, Present, and Future

Marin County's demonstration projects for sea level rise resiliency
Marin Bay Waterfront Adaptation and Vulnerability Evaluation (BayWAVE)
Marin County Department of Public Works



June 2017

Credits

This project was prepared with generous funding from the California State Coastal Conservancy's Climate Ready Grant Program.

Authored by:

Roger Leventhal, P.E.

Senior Engineer

Marin County Flood Control & Water Conservation District

3501 Civic Center Drive, Suite 304

San Rafael, CA 93913

(415) 473-3249

rleventhal@marincounty.org

Additional contributors: Marilyn Latta, California State Coastal Conservancy;
Veronica Pearson and James Raives, Marin County Parks

Technical Writer: Jack Curley

Designer: Laura Lovett | By Design

Editor: Mark Nichol

Photo credits:

Pg. 2, Top to bottom: *China Camp marsh*, Rene Rivers; *Egret among oyster shell reefs*, S. Kiriakopolos; *Removing vegetation on Arambu Island*, Richardson Bay Audubon Society

Pg. 7: U.S. Army Corps of Engineers

Pg. 9–10: CLE Engineering

Pg. 11: Richardson Bay Audubon Society

Pg. 12: County of Marin DPW

Pg. 13: CLE Engineering

Pg. 14: Rachel Kamman

Pg. 15: S. Kiriakopolos

Pg. 16: J. Poskazner

Pg. 17: San Francisco Estuary Institute

For more information about the county's sea level rise efforts,
visit: www.MarinSLR.org

What is a Demonstration Project?



Demonstration projects are small-scale projects constructed and monitored to evaluate the feasibility and effectiveness of a design concept or new restoration approach intended for implementation on a much larger scale. Demonstration projects are constructed to provide essential information to engineers, scientists, builders, and the public, and to help inform and guide actions to be taken in Marin County or elsewhere in San Francisco Bay in the near future to address the threats posed by sea level rise.



One of the more promising areas of adaptation planning for sea level rise is the use of nature-based solutions. Nature-based projects, known by several names, including “living shorelines” or “green shorelines,” seek to use adaptation approaches that mimic, in part or in whole, the way natural shorelines function and adapt. These types of projects have multiple benefits for habitat and water quality, as well as flood protection.



Scientists, planners, and engineers agree there is a need for more demonstration projects for nature-based adaptation approaches to sea level rise to determine their effectiveness and to develop effective design and construction techniques. With increased knowledge of project requirements and observing successful techniques, effective design and building methods and cost effectiveness will follow.

Marin County is a leader in the implementation of pilot-scale projects around San Francisco Bay. The eastern edge of Marin County contains a wide variety of shoreline types, from the flatter alluvial slopes of the Novato Creek Baylands to the steep, rocky shorelines of southern Marin, and therefore offers opportunities for learning for shoreline communities throughout Marin and the Bay Area. Marin County has a culture with a strong green ethic, active progressive communities, and political leadership interested in nature-based measures and in continuing to lead the Bay Area in green adaptation alternatives to sea level rise adaptation. The county is in the forefront

of public education with respect to the risks associated with sea level rise and the range of possible adaptation methods. The county Community Development Agency (CDA), the county Department of Public Works (DPW), and the BayWAVE process are leading outreach efforts with innovative methods and growing community engagement.

It is critically important to adaptation planning efforts that demonstration projects are built and monitored across a range of living-shoreline types (e.g., flat, alluvial-slope, steep, and rocky shorelines). The current design and permitting process can be onerous and expensive, thereby deterring the undertaking of projects for natural-shoreline alternatives. Planning and development agencies need to work with regulatory agencies to streamline the design and permitting process so that different approaches are allowed and designers and builders can test designs sufficiently.

Demonstration projects can be small parts of larger projects or they can be stand-alone efforts. Projects can evaluate design approaches or construction methods. For example, a project that evaluates improved methods for contractors to achieve the desired end is highly valuable, since all major public construction projects must be awarded through the public bidding process to the professional contracting community. Projects that promote community awareness through education programs for youth groups serve the community now and for succeeding generations.

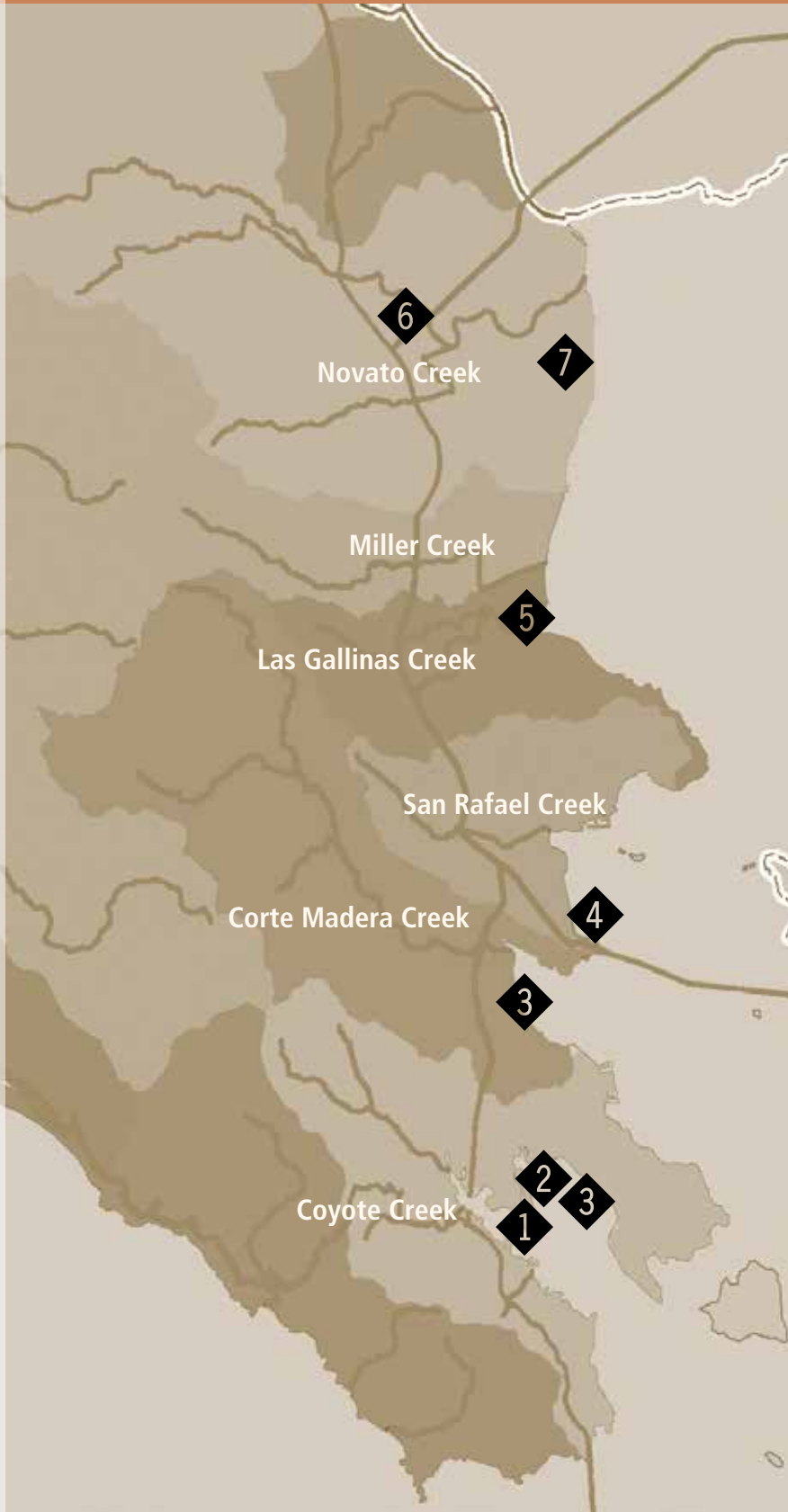
Marin County Demonstration Projects

We divided the demonstration projects into the following three categories:

Category #1
Public Education and Outreach

Category #2
**Streamlining and Easing of Permitting
Restrictions to Facilitate Implementation**

Category #3
**Constructing and Monitoring Natural
Shoreline Adaptation Projects**



- 1 Coyote Creek/Bothin Marsh Dredge Sediment Reuse Project, Richardson Bay
- 2 Aramburu Island Constructed Beach Demonstration Project, Richardson Bay
- 3 Potential Engineered Bay-Beach Shorelines: Blackie's Pasture, Tiburon; Corte Madera Marsh Ecological Reserve
- 4 Subtidal Oyster Reef Construction Project, San Rafael Bay
- 5 McInnis Marsh Restoration Project
- 6 Novato Placement of Dredged Sediment
- 7 Novato Creek Baylands Adaptation Projects

At present, many important regulatory and permitting requirements inhibit, even prevent, the ability to design and build projects to adapt to sea level rise. Important environmental laws such as the Endangered Species Act and the California Environmental Quality Act (CEQA) now prevent damaging projects from being built, thereby protecting and preserving endangered species and fragile habitats. However, these same laws that have been beneficial to the environment now present possible serious impediments to the efforts to reduce damages from flooding due to sea level rise, creek flooding, and outdated, underperforming storm-drainage systems. These laws may, ironically, inhibit our ability to protect human life and provide effective public safety. Projects in this category are intended to streamline and reduce the burdens of the permitting process. They look to rebalance the permitting process such that the DPW and other public-safety agencies are allowed to prepare for the impacts of sea level rise.

There are seven demonstration projects or studies at different stages of development in Marin County that involve the use of nature-based solutions. Interest in studying, designing, and building natural shorelines for sea level rise adaptation is relatively new. For most natural-shoreline alternatives, not enough projects have been built and monitored to develop that knowledge base and provide the needed insight as to where these measures work or don't work and why. The county's demonstration projects are providing experience in and knowledge of how these systems function and how to construct them in a cost-effective way.

The projects presented here are in various stages of development:

- Past and present (ongoing) demonstration projects: Completed and monitoring, or being implemented now
- Proposed demonstration projects: Developed in concept and design and submitted for funding consideration in the short term
- Potential demonstration projects: Yet-to-be-proposed concepts at early stages of development, included here for discussion purposes.

In reviewing these ideas, note that the information given here is based on the current status and condition of the projects. Those described as proposed or potential are conceptual at this point and may or may not ever be implemented. These projects still have to go through the public outreach and permitting process and find funding for implementation. Hence, this list will be ever evolving.

2. The Game of Floods, Extended Version

Proposed Demonstration Project

The long-term, primary goal of using the game as an educational and engagement tool is to genuinely involve community members in the details and decisions that will impact Marin County communities in the very near future.

The original intent of the game's creators is to use it as a scenario-based planning tool (Leventhal, 2014), envisioning it being played at a deeper and sustained level over several months with the goal of developing actual site-specific, community-generated adaptation plans for one or two selected reaches of the eastern shoreline. Playing the game in this way inverts the typical planning approach, one that is commonly top down from county staff and consultants to the communities. This inverted approach would empower community members to develop their own plans from the bottom up as they grapple with the difficult issues and trade-offs firsthand.

This unique type of planning is appropriate to sea level rise adaptation, a slow and expensive process requiring that options be envisioned that are both large and small and that take place over relatively long periods of time and in differing locations. Community-based plans will need to have multiple pathways to the desired objectives due to much uncertainty as to how sea level rise will play out over time.

Community teams would, by design, include a broad spectrum of community members so that different interests are reflected in the issues raised and the selected alternatives. The teams' standing would be more akin to the grand jury process, in which members are engaged over a period of time receiving, understanding, and evaluating the alternatives for a given location or community.

The goal of this potential pilot project is to produce plans for two locations along the eastern Marin shoreline within one year. The locations are

- the Canal Area of San Rafael
- along the Richardson Bay shoreline—a reach of shoreline with the most assets currently impacted by tidal flooding.

A series of meetings lasting several hours could be held with clearly identified milestones to reach. County staff,



Canal area of San Rafael

acting as consultants to the game players, will use the time between meetings to review team progress, evaluate results, answer questions, and bring forth issues for evaluation. Members of the task force will be supported and guided throughout the process and not allowed to flounder due to the complexity of the issues involved.

Issues to be considered in the process include, but are not limited to the following:

- Evaluation of public and private-property rights
 - o How would private-property rights be handled when more than the private property is threatened?
- Phasing of sea level rise adaptation
- Shall redevelopment of large areas into “floodable” developments be allowed?
 - o How would this look?
 - o What is the process to do so?
- Should private property owners be compensated after development occurs?
- Should private funds be permitted if public funds are scarce?
- How to track real costs for impacts to wetlands, mitigation costs, and site-specific engineering design and develop future cost projections accordingly. Real costs will surely differ from the average costs assigned to game tokens.
- Will trade-off mitigation (e.g., restoration of parks in one location in trade for impacts due to tide gates being installed in a different location) be possible?
- When does “hardening” the shoreline become ineffective, and how will planning for retreat occur?
- Will property owners be compensated if retreat is necessary?

Because these issues are and will be complex and controversial, the importance of having a diversity of opinions, allowing for dissent, and creating minority reports to track the dissenting voices for continuing discussion cannot be overstated. The goal is to recognize the options and potential issues and develop scenarios for dealing with them collectively, including putting off some decisions and actions into the future.

1. Novato Basin Dredging Sediment Beneficial Reuse

Ongoing

Novato Creek is presently dredged on a four-year cycle to maintain the flow capacity of the creek to prevent flooding. Adjacent to Novato Creek is Deer Island Basin, a historic tidal marsh in which full tidal ebb and flow is impacted by development. Restoring the marshes to full tidal conditions, a beneficial and protective condition, requires that sea level rise levees be constructed to protect surrounding properties. These levees are best built in stages over time and they require large amounts of earth to do so, which is typically a very costly undertaking. Reusing the dredged earth from Novato Creek would seem to be the expedient thing to do. However, current permitting requirements for doing so are inhibiting and may act as hurdles in planning, design, and implementation.

There are compelling reasons for focusing efforts on lowering the permitting hurdles for reusing dredge sediment. They include the following:

- Cost effectiveness: Moving large volumes of soil or sediment into position is very often the costliest component of large-scale landscape projects.
- Smart use of existing government funds: Marin County Flood Control Zones regularly spend funds to dredge creeks and channels. Reuse of the dredged sediment amounts to a dual benefit.
- Multibenefit projects: Grant-funding agencies require that projects have multiple benefits beyond the primary purpose of the project to be competitive for funds.



Dredging Novato Creek



Dredging Novato Creek

In 2016, Marin County Flood Control and Water Conservation District staff took the initiative and proposed the beneficial reuse of dredging sediment from Novato Creek. The proposal requested that the regulatory and permitting agencies allow placement of the dredged sediment from the Novato Creek watershed at the edge of the former Deer Basin marshlands for use in the construction of future sea level rise levees. Additionally, they requested that they not be required to mitigate for the impacts of this placement.

This unique permit request had no precedent, so obtaining permits for the proposed project has been a long process of district staff working with permitting-agency and

regulatory staff. Eventually, the permitting agencies did allow for placement of dredged sediments along the requested alignment, but to a lower height than requested. Instead of the requested four feet of fill, they permitted two feet. Even so, this permitting compromise was a successful outcome for the district, which was able to reuse the dredged sediment in a beneficial manner in the desired location.

This effort on the part of district staff served to move the regulatory and permitting paradigm, bringing a fresh awareness to the regulatory and permitting agencies of the issues, responsibilities, and limitations in the current permitting process with respect to sea level rise adaptation. Future demonstration projects can build on the approach taken here of rescinding the mitigation requirement when using dredged sediment for flood-protection levees and structures and for building nature-based solutions to protect property and the public safety from the impacts of sea level rise.

District staff continue to work with regional associations like the Bay Area Flood Protection Agencies Association (BAFPAA), the San Francisco Bay Regional Coastal Hazards Adaptation Resiliency Group (CHARG), the San Francisco Bay Conservation and Development Commission (BCDC), and the County Engineers Association of California (CEAC) to suggest and evaluate changes to planning policies and bring a raised awareness to regulatory and permitting-agency staff of the challenges to sea level rise adaptation imposed by permitting requirements.

1. Aramburu Island Constructed Beach

Completed 2012; Currently Monitoring

The Aramburu Island Constructed Beach Project was the first demonstration project created in San Francisco Bay for adaptation to sea level rise. The island is owned by Marin County Parks and Open Space and is operated by the Richardson Bay Audubon Society.

Constructed in 2011–2012 in outer Richardson Bay, this adaptation method used a coarse-grained, engineered beach system as a natural approach to mitigate shoreline erosion. Visual observations since completion show that the project has been successful in halting extensive shoreline erosion and is self-adjusting its elevation. This manmade habitat has also been effective in supporting bird populations, including several threatened and endangered species such as the snowy plover. The Richardson Bay Audubon Society monitors the site for bird usage and reports that results of the beach monitoring show overall success in attracting birds. Overall, the results are positive for using this approach to reduce shoreline erosion, with the added benefit of creating and/or enhancing wildlife habitat.

Lessons learned from this project include the following:

- In one location, erosion rates were higher than projected. To mitigate this, larger sized rocks could be used in the future.
- Structures made of wood and rock to direct flow away from the shoreline, called microgroins, worked well. Ways to improve their effectiveness were identified, such as using additional smaller wood pieces and extending the microgroins out into the mudflats.



Heavy equipment removing the top layer of weedy vegetation on Aramburu Island.

2. Coyote Creek/Bothin Marsh Dredge Sediment Reuse

Potential Demonstration Project



Bothin Marsh at high tide.

Part of Richardson Bay presents ideal conditions to conduct a feasibility study of the costs, impacts, and effectiveness of reusing dredge sediments. These could be taken from Coyote Creek in Tamalpais Valley to enhance habitat in the adjacent Bothin Marsh and prepare the marsh area to assist with sea level rise adaptation.

The Marin County Flood Control District was awarded a \$25,000 grant by the North Bay Watershed Association (NBWA) to do the feasibility study, completed January 2017, and developed a customized plan to show the ecological opportunities and potential impacts of placing dredged sediment along the back edge of the marsh.

Elements in the feasibility study include:

- Evaluation and mapping of site ecology and habitat types
- Determination of placement locations of the dredged sediment to maximize habitat value and provide flood protection of infrastructure now and for future sea level rise
- Evaluation of beneficial opportunities for using both fine-grained and coarse-grained sediment sizes, both of which are found in the Coyote Creek channel
- Evaluation of engineering methods for placing dredged sediment
- Preparation of conceptual plans to meet project goals while protecting existing site resources
- Development of concept-level cost estimates; such estimates are always very preliminary but provide a ballpark figure regarding potential cost.
- Preparation and dissemination of a final report for use by other agencies and organizations.

The feasibility study determined it is technically feasible to conduct the demonstration study. However, there are still significant hurdles before any project can be implemented, including development of a public process for receiving stakeholder and public input on the proposed project, permitting of the project, and securing costs for implementation. The next step in the project would be to secure funds to prepare a preliminary design study and begin the community outreach and permitting process.

3. Hydraulic Placement of Truck-Transported Dredged Sediment

Ongoing

The goal of this pilot demonstration project was to test different methods of mechanically mixing dredged sediment into a slurry and pumping it into place in a marsh in a manner that mimics the natural flow of sediment that might occur during a flood event or other natural high-flow events. This was done as a part of the Novato Basin Dredging Sediment Beneficial Reuse Project (see pg. 9).

Novato Creek is dredged with long-reach excavation equipment, and the sediment is transported away from the creek in trucks after it dries. Therefore, dredged sediment cannot be pumped directly from the creek and placed directly into the marsh, as is the case in some creeks around San Francisco Bay, so a means to pump it must be developed.

The contractors experimented with three methods:

- Placement using a slurry-mixing tank and pumping system
- Placement by constructing sediment slurry ponds
- Placement by using the long-reach excavator to place the slurry mixture directly into the ecotone area.

The contractor monitored these three methods and gathered data that included:

- A description of the placement methods
- A list of placement equipment and number of personnel required
- A placement-plan layout
- Daily averages of the volume (cubic yards and number of bins mixed) of dredged sediment placed
- Locations and approximate depths of material
- A photo log, including photos taken by aerial drones.



Equipment placing the dredged sediment into the ecotone area.

4. McInnis Marsh Restoration with Sea Level Rise Levees

Ongoing

McInnis Marsh is a 180-acre diked wetland east of McInnis Park between Miller and Gallinas Creeks. Historically, these creeks were connected through a system of channels. This connectivity was lost in the early 1900s with the construction of levees designed to make the marsh suitable for agricultural use. Marin County Department of Parks & Open Space, in partnership with the Las Gallinas Valley Sanitary District and the Marin County Flood Control and Water Conservation District, is proposing to restore the historic tidelands. A preliminary feasibility study was released in March 2017 and is available on the Marin County Parks website.



McInnis Marsh

The project will restore intertidal wetland habitat, protect habitat for threatened and endangered species, improve flood-control protection, reduce maintenance-dredging requirements on Miller Creek, and reduce the likelihood of flooding at a wastewater-treatment plant and its resultant environmental degradation.

The partners propose to construct a horizontal levee, which is shaped like a gently sloping ramp that gradually transitions from shallow bay to grassland and uplands. The elongated, marshy toe of the levee slows wave action and prevents overtopping in a flood or storm surge. Horizontal levees are designed to collect sediment and increase in height over time, providing incrementally increased protection from sea level rise. In addition to the horizontal levee, the project includes

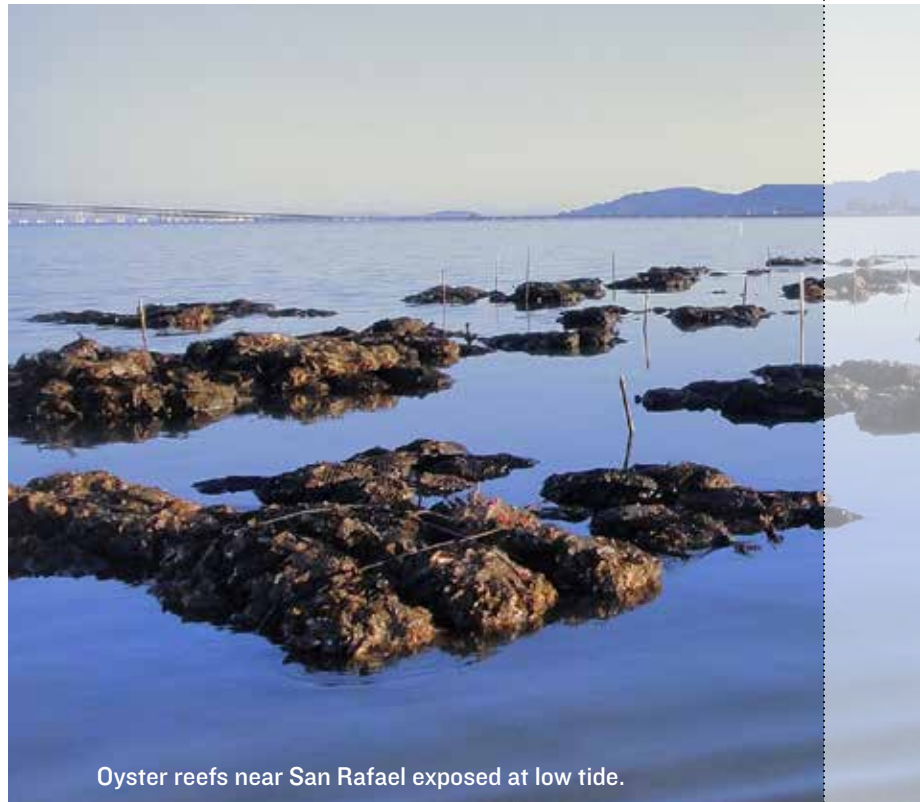
improved brackish and freshwater habitats and improved fish passage for salmon into Miller Creek. The new levee will include a public-access trail, interpretive signs, and viewing areas.

In late 2016, Marin County Parks was awarded a substantial grant from the California Department of Fish and Wildlife to continue with the design and planning for the project. This grant, along with contributions from Marin County Parks and the Las Gallinas Valley Sanitary District, will allow the county to complete the design and environmental review for the project.

5. Subtidal Oyster Reef Construction

Completed 2012; Currently Monitoring

As part of the San Francisco Bay Living Shorelines Project, the California State Coastal Conservancy and San Francisco State University, along with other partners, constructed oyster and eelgrass reefs at two sites in San Francisco Bay in July and August 2012. A large experiment and a small one were constructed near Jean & John Starkweather Shoreline Park in San Rafael, and a small experiment was constructed at Hayward near the Eden Landing Ecological Reserve. These projects use a suite of bank-stabilization and habitat-restoration techniques to reinforce the shoreline, minimize coastal erosion, and maintain coastal processes while protecting, restoring, enhancing, and creating natural habitat for fish and aquatic plants and wildlife.



Oyster reefs near San Rafael exposed at low tide.

Working with landowners, The Nature Conservancy, and the California Department of Fish and Wildlife, the project builds upon 50-year regional goals for the restoration and protection of submerged habitats in the bay (www.sfbaysubtidal.org). It is the first time that restoration of native oyster and eelgrass beds is occurring at this scale, and the results will provide critical information about potential benefits of using natural reefs along the shoreline to protect habitat in the face of sea level rise and climate change. This type of work is new to San Francisco Bay but builds on lessons learned from other restoration efforts in the estuary and around the nation. Through frequent monitoring, information is being generated to determine how the project can be scaled up while still balancing shoreline protection, environmental impacts, and habitat needs.

More than three million native oysters settled on the reefs at the San Rafael site, and they attracted juvenile Dungeness crabs, bay shrimp, white sturgeon, and a wide diversity of other fish, birds, and wildlife. There have been changes in the densities of these species each year depending on draught and flood conditions, with maintenance and replanting required after heavy flood events. Initial data shows that the reefs reduce wave energy by 30% at certain water levels. More information about the project and all partners is available at www.sfbaylivingshorelines.org.

6. Engineered Bay-Beach Shoreline Demonstration Projects

Proposed Demonstration Project

This proposed project will evaluate the effectiveness of constructing coarse-grained beach edges at a number of locations in the Richardson Bay and Corte Madera Creek watersheds. The unique geology and geography of Marin County, with its steep bluffs and historic beaches, supported by the green progressive culture of its citizens and politicians, makes the eastern shoreline of Marin County an ideal location for construction and monitoring for these types of projects.



Mill Valley–Sausalito multiuse pathway at high tide.

Much of the eastern Marin shoreline is actively eroding. The tidal marshes that form much of the shoreline and that provide wave attenuation as well as habitat are under the threat of severe erosion. The Corte Madera marsh complex has experienced dozens of feet of significant shoreline erosion over the past decades, and there is active edge erosion at other marshes along the shoreline. Sites with various wind-wave characteristics have been selected to allow for evaluation of this method of erosion control under diverse conditions. This will provide an understanding of the limits of this natural-shoreline approach.

Potential locations for engineered shorelines include:

- Bothin Marsh, Mill Valley; Mill Valley–Sausalito Multiuse Pathway
- Mill Valley city shoreline
- Corte Madera Marsh Ecological Preserve
- Marsh near Blackie’s Pasture, Tiburon
- Lower Novato Creek Baylands levees

In these pilot projects, each of several selected sites will be designed to address specific research questions that will be developed in the planning phase. The projects will be monitored to assess performance with respect to the research questions. Particular emphasis on constructability will be part of the design and monitoring program for each of the projects. Currently, there is no approval or funding for design or implementation at any of these sites except for the Corte Madera Ecological Preserve and Blackie’s Pasture, where conceptual design only has been funded and will begin in 2017.

7. Novato Creek Baylands Adaptation Projects

Proposed Demonstration Project

The Novato Creek Baylands contain large areas of diked, subsided baylands that could be restored to historic tidal-marsh habitat. This would create wetlands that provide for attenuation of wave energy, thereby buffering the impacts of sea level rise on the shoreline, and provide habitat for several threatened and endangered species. The Marin County Department of Public Works (DPW) has been working on flood control and sea level rise adaptation planning in the lower Novato Creek watershed for several years.

In 2012, the Novato Creek Baylands project was selected as one of three pilot project locations in a large flood control and sea level rise adaptation program funded by the US Environmental Protection Agency (EPA). This program is led by the San Francisco Bay Joint Venture (SFBJV) and the San Francisco Estuary Institute (SFEI). This innovative regional project seeks to integrate habitat improvement and flood-risk management at the bay interface. It also focuses on helping flood-control agencies and their partners create landscape designs that promote improved sediment transport through flood-control channels and improved flood conveyance, and help restore and create resilient bayland habitats.

Marin County has developed a modified version of the plan called the Novato Baylands Restoration Initiative. This initiative calls for the breaching of dikes and full tidal-marsh restoration of several basins that will increase tidal prism (the extent of daily tidal flows). These actions will improve channel scour to remove accumulated sediment without dredging and provide important habitat to several threatened and endangered species of concern. They will be carried out within current property-ownership boundaries. Adaptation to sea level rise is an important focus of the baylands restoration initiative.



Colored areas indicate the various sections of the Novato Creek Baylands Vision. Bel Marin Keys is at the center.