



MARIN BAYWAVE PROJECT
**BAY WATERFRONT ADAPTATION
VULNERABILITY EVALUATION**

**Marin BayWAVE (Marin Bay Waterfront Adaptation Vulnerability Evaluation):
Phase I**

Project Scope

November 2016

PROJECT OVERVIEW

Marin County ranks second of the nine Bay Area Counties for projected risk of impacts from sea level rise (SLR) flooding and storms, with potential losses of \$8.5 billion worth of buildings and contents on the bay shoreline¹. Flooding associated with high tides and storms already impacts infrastructure and disrupts people's lives on a recurring basis. These impacts are expected to increase in frequency and severity as sea level rise accelerates. Projected SLR also threatens serious impact to Marin's wetlands, creeks, beaches, other natural resources.

BayWAVE is a focused vulnerability assessment (VA) of the eastern Marin shoreline from Sausalito to the northern end of Novato. BayWAVE will evaluate the extent of impacted assets, assess the sensitivity and adaptability of selected assets and work with the local cities and towns to plan implementation of adaptation strategies. The fundamental goal of the BayWAVE project is to increase awareness and preparation for future SLR impacts by using this coordinated, multi-jurisdictional assessment.

BayWAVE will develop early actions to begin the adaptation planning along the shoreline. Early action items include coordination with Local Hazard Mitigation Planning on flood warnings, an adaptation toolkit to explain how the various engineering tools work and where they are appropriate on the shoreline, and lastly, several ongoing feasibility studies to integrate flood protection, sea level rise, and habitat in Novato, Santa Venetia, and Richardson Bay will be highlighted as demonstration projects with the intention to implement projects in the near-term.

BayWAVE is the first phase of an anticipated long-term planning effort. A second phase is expected to continue planning and response based on the Vulnerability Assessment. With guidance from elected officials throughout Marin, advice and collaboration from professional staff across the governmental spectrum, and informed participation of Marin's citizens, County staff dedicated to this project will achieve that goal by completing the tasks outlined below.

¹ Pacific Institute. 2009. The Impacts of Sea-Level Rise on the California Coast.

TASK 1- SLR MODEL SELECTION AND SCENARIO DEVELOPMENT

1.1 Evaluate Available SLR Inundation Models and Recommend Model for Vulnerability Assessment

There are several sea level rise inundation models and each one has its own particular advantages and disadvantages for use in a vulnerability assessment along the Eastern Marin shoreline. Under this task, staff will review the most commonly used models in San Francisco Bay to assess their applicability for the vulnerability assessment in Task 3. Currently the USGS *CoSMos* model underlying the *Our Coast Our Future* (OCOF) online display tool contains perhaps the most comprehensive list of various scenarios of SLR and storm events, however, other models such as NOAA may provide different advantages.

The first step will be to review the range of available models available for SF Bay for use in the vulnerability assessment. Two or three models will be run and results plotted at two to three locations of known flooding in eastern Marin County to compare the various model outputs to assess differences. The recommended model will be the best combination of scenarios, modeled processes, and accuracy of the underlying topography. We will build upon model review work conducted by Climate Central (<http://coastaladaptation.org/liftingthefog/which-tool-is-right-for-me/>) to assess the advantages and disadvantages of various models. A summary memo outlining the advantages and disadvantages of various models, and the basis for selection of SLR model for the eastern Marin shoreline will be included under the Task 1.2.2 submittal described below.

While no model is perfect, the goal of this task is to document the selection of the SLR inundation model for the subsequent work.

Task deliverable: Evaluation of models

Schedule: October 2015

1.2 Develop SLR Coastal Inundation Scenarios for Vulnerability Assessment

Staff will evaluate a range of direct coastal flooding and storm scenarios using the selected SLR model to assess a wide range of impacts and to make a recommendation for up to three scenarios for use in Task 3. We anticipate developing SLR/bay storm combinations roughly coinciding with near term, medium term, and long term projections. Riverine flooding extents will be based on the available FEMA flood maps (Q100 floods against an existing MHHW downstream boundary condition) as a first cut assessment of the extent of riverine flooding under 100-year flood flow conditions. No new riverine modeling will be conducted under this scope.

Task deliverable: Selection of up to three SLR scenarios for near-, medium-, and long-term projections

Schedule: October 2015

1.3 Prepare recommendations (Basis memo)

The basis for selecting the inundation model (Task 1.1) and scenarios of SLR (Task 1.2) will be sent out for review to gain input on the scenarios selected. Uncertainties and risks inherent in future predictions of SLR will be summarized for the memo.

At this time, the technical group will determine the reaches for the full Vulnerability Assessments and make any suggested changes to the boundaries (See Task 3 for more on the reaches and Task 4 below for more on the technical group).

Task deliverable: Basis memo for model and scenario selection

Schedule: November 2015

Outreach: Local city, town, and agency staff will provide input as the Technical Group on the inundation model and scenarios. The final recommendations will be included in the basis memo. At this time, we will get feedback on the shoreline reach breakdown to be used in the Vulnerability Assessment and Early Action tasks.

TASK 2- COLLABORATION WITH RELATED PROGRAMS

2.1 Update Inventory of Ongoing and Completed SLR Activities Relevant to Marin County.

The Marin County SLR team has previously identified a number of programs in Marin County and surrounding area that are developing information and activities that share common ground with the proposed Vulnerability Assessment. This inventory will be updated and the specific areas will be identified where data and technical approaches could be shared, activities integrated, with the objective of maximizing potential collaboration and cooperation toward a coherent, comprehensive and inclusive program.

The partial inventory of related programs is available on the MarinSLR website at <http://www.marincounty.org/depts/cd/divisions/planning/sea-level-rise/more-information>. This list will be maintained and updated as needed. Major program milestones and deliverables will be summarized with each program.

The Marin Countywide Watershed Program is currently active in the Southern Marin, Gallinas, and Novato watersheds. The Watershed Program is partnering with local cities and towns, flood control zones, water and sanitary districts, and stakeholders to provide a watershed perspective for flood protection and alternative development. BayWAVE will integrate with

ongoing efforts of the Marin Countywide Watershed Program. The Watershed Program currently works in the Southern Marin, Gallinas, and Novato Watersheds with feasibility studies under development in Bothin Marsh, McInnis Marsh, and the Novato Baylands, respectively. These projects will provide flood protection, habitat enhancement, beneficial sediment reuse, and adaptation to rising tides. The projects developed as part of the Watershed Program could be some of the first implementation projects planned for the shoreline when the feasibility studies are complete and funding is realized.

2.2 Collaborate with Other Similar Programs in the Region and Elsewhere.

Collaborate with other groups doing SLR planning and adaptation work to share information and ideas, and, where possible, divide labor to work more efficiently. Other SLR programs in the region, state, nation and the world are addressing issues similar to those facing Marin. Work on climate resilience is being conducted in San Mateo, San Francisco, Alameda, Contra Costa and Santa Clara Counties, among other areas. This work is being supported by a several agencies and organizations, including the Bay Conservation and Development Commission's Adapting to Rising Tides Program, (BCDC's ART Program) which is leading efforts in Alameda and Contra Costa Counties; and county sustainability divisions which are leading efforts in Santa Clara, San Mateo, Sonoma and San Francisco.

Task deliverable: Monthly County Public Works and Community Development Agency staff meetings to coordinate on local and regional SLR planning efforts.

Schedule: Monthly from November 2015 until March 2017

Outreach: Information about ongoing efforts will be updated and posted online at www.MarinSLR.org for the public and to increase the usefulness of these internal meetings.

TASK 3- PRELIMINARY VULNERABILITY ASSESSMENT (VA)

Under this task, the BayWAVE program will conduct a vulnerability assessment consisting of the tasks described below, in order to establish an initial understanding of the potential SLR conditions Marin County will face in the future. Given the length of the shoreline, we anticipate dividing up the analysis by either by political or shoreline characteristic boundaries or some combination of both.

3.1 Exposure Assessment

Staff will prepare maps of SLR inundation for each scenario across the eastern Marin shoreline. Using the MarinMap GIS database, we will develop maps and tables of critical utilities and infrastructure impacted by SLR. Other asset types such as homes, businesses, natural areas, recreational sites, etc. will be grouped and reviewed as data allows. We will use GIS to prepare

maps showing the extent and depth of flooding for each scenario and the impacted assets within each reach.

3.2 Sensitivity and Adaptive Capacity Assessment

The sensitivity and adaptive capacity assessments will parallel the Exposure Assessment to document the degree to which exposed assets and functions would be able to function or make adjustments to climate change. Assets and functions that are greatly impaired by SLR have a *high* sensitivity, whereas assets that are minimally impaired by the same change in sea level have a *low* sensitivity. Assets with the existing ability to respond successfully to sea level rise have *high* adaptive capacity, and those without have *low* adaptive capacities. Interviews with asset managers (the officials or individuals responsible for each asset) using the structure *Vulnerability Assessment Tool* to evaluate the degree to which assets and functions are sensitive to SLR and storm impacts such as flooding, inundation, saltwater intrusion, erosion, etc. Under this sub-task, interviews will be conducted with all significant asset managers. Questionnaires will be sent in place of interviews when necessary. Private property owners will not be contacted.

3.3 Summary of Potential Infrastructure Impacts

The impacted infrastructure within each reach will be classified and analyzed by type and sector (i.e. transportation, housing water, power, etc.). Staff will work with the various asset managers, in the towns, cities and agencies to assess and describe the economic, environmental and community consequences and the comparative magnitude of such consequences (to be qualitatively grouped into high, medium, and low impacts). Since sea level will be increasing over time, the timing and sequence of when these impacts transition from nuisance, to significant, to severe, will also be evaluated and presented.

Impacts may occur at the individual asset scale (a specific risk to a business or a group of residences), while others manifest at a community level (the disruption of an electrical substation that cuts power to a wide area), or at combinations in between. Issue statements will be prepared to provide succinct descriptions of the nature and interrelationship of these impacts to set the stage for analyzing potential adaptations. The goal of this task is to tell the story of sea level rise impacts under various stages of sea level rise in a way that visually communicates the issue to prepare communities for the next phase of the project of adaptation planning and help inform flood management policy of Marin jurisdictions.

Task deliverable: Identify sea level rise exposure by reach using maps. Assess sensitivity and adaptive capacity for assets and summarize potential infrastructure impacts by type and sector.

Schedule: November to February for internal GIS work, then outreach from March through June. A draft Vulnerability Assessment is expected in November 2017.

Outreach: Convene the Executive Steering Committee and Technical Group to preview results and to prepare for asset manager input in March, then meet with asset managers from March through June. Public meetings will be held after initial internal review with the asset managers.

TASK 4- PUBLIC AND AGENCY INVOLVEMENT

4.1 Executive Guidance and Management

Early countywide coordination for sea level rise is a critical piece of the adaptation and resiliency along the many miles of Marin County's shoreline. Sea level rise won't be held back by political boundaries or property lines so an approach unlike any other is needed to be responsive and resilient. This planning effort will bring cities, towns, agencies to the table to discuss sea level rise impacts, assets, and adaptation measures. This requires a robust framework of partners, communication, and many levels of staff to deliver a useful product. The relationships, data, and structure developed for this program will undoubtedly assist with planning long past the Vulnerability Assessment as changing scenarios and data will require new action.

Important Note: This structure extends ONLY to the management of the Vulnerability Assessment work under this scope. It does not apply to any implementation actions. Future decisions regarding implementing adaptation measures will be made by participating jurisdictions individually or in partnership. It is intended that adaptation measures identified through this project will increase effectiveness through protection of multiple assets spanning spatial/temporal scales, producing mutual benefit to jurisdictions working together.

Executive Steering Committee

The Executive Steering Committee would provide direction and guidance to project staff and the staff of their respective jurisdictions. The committee would consist of two members of the county Board of Supervisors, three elected officials representing the city and town councils, and a representative each from city and county staff. The committee will meet approximately quarterly, or as major deliverables are available.

Policy Group

The Policy Group consists of elected officials representing each municipality in the planning area. The group includes two members of the Marin County Board of Supervisors and one city council member from each participating city and town. Committee members are expected to support the project by: communicating progress to their own Councils/Board and constituents and carrying information, ideas, and concerns from their hometown constituents into the

collaborative process. The Policy Group will meet approximately biannually, as the Vulnerability Assessment and the Draft Report are complete.

Technical Group

The Technical Group supports the project by drawing upon specific expertise to advise project staff. The group provides input on deliverables and serves as a direct contact to reach the jurisdiction's staff and community. The group will be made up of staff from each of Marin's 11 municipalities as well as staff representing local agencies, utilities, and special districts with management of or property in Marin. These include water and sanitary districts, school, fire, PG&E, Caltrans, National Park Service, Marin Audubon, and others. Additional local and regional partners, resource agencies, and technical experts have been included in the group to provide insight on regulations, planning efforts, and scientific knowledge to support the project.

Schedule: Convene the Executive Steering Committee, Policy Group, and Technical Group for a kick off meeting. Other meetings are shown with tasks throughout the project.

4.2 Involvement Strategy and Program Development

4.2.1 Engage decision-makers and staff

Utilize existing meetings to get information efficiently to the bayside Marin decision-makers and staff to foster a cooperative approach to sea level rise planning. Existing forums include: Marin County Council of Mayors and Councilmembers, Marin Watershed Program committees, North Bay Watershed Association, Marin County Stormwater Program's agency staff, MarinMap, and others. Continued outreach will occur with major milestones as needed to build support and gain input on the deliverables.

Task deliverable: A schedule of outreach and specific target meetings for deliverables will be developed with program deliverables.

Schedule: October 2015

4.3 Public Engagement

Outreach to the community will focus on engaging all segments of the community, including stakeholders with interests in sea level rise. BayWAVE will launch a series of community meetings once the Vulnerability Assessment is complete and again when the draft final report summarizing the early actions and next steps for BayWAVE is prepared.

There are several broad efforts to connect with the community to present sea level rise issues and challenges in planning for adaptation. The work builds upon and strategically integrates

existing public education activities (funded by other sources) in the County and several cities. These include the innovative Marin OWL Project, which used high-tech visualizations of future SLR to galvanize public consciousness of climate disruption and lives on through the www.MarinSLR.org website; the Youth Engaging in Sea-level-rise Science (YESS) project, which is developing educational curriculum and involvement strategies for high school students, and the “Game of Floods”, which allows community players to plan for sea level rise on Marin Island using the adaptation measures available today to protect the island from sea level rise and flooding.

4.3.1 Low-income area focus program

Since many of the areas particularly susceptible to the effects of SLR are in low income neighborhoods², existing engagement efforts with minority and underserved communities and the groups working with them, will be expanded, with a particular emphasis on involving students and youth. Focus on Shore Up Marin and Youth Exploring Sea-level rise Science (YESS). Meetings will be summarized with outcomes and made available online.

4.3.2 Outreach to the public

The current www.MarinSLR.org website will be revamped to include information for the entire county. The site will host information for BayWAVE, the coastal SLR planning effort, Collaboration: Sea-level Marin Adaptation Response Team (CSMART), and be the place to direct residents, elected officials, and decision-makers to learn and engage in the SLR planning in Marin.

The general public in Marin is educated and engaged in the discussions of sea level rise impacts and adaptation measures. Presentations will be developed for groups and events to communicate with the public. Meeting summaries will be posted online. In addition, the existing SLR and Marin watershed websites, newsletters, and events will be used to keep the public informed and aware of deliverables as they become available.

Task deliverable: Update the www.MarinSLR.org website. Prepare information for the public (website content, fact sheets, presentations, etc.).

Schedule: Presentations will be given as requested in coordination with the outreach strategy to be developed in Task 4.2.1. Content for the www.MarinSLR.org website will be developed with individual tasks.

² Association of Bay Area Governments. 2015. Stronger Housing, Safer Communities.

TASK 5- EARLY ACTION: FLOOD WARNINGS, ADAPTATION TOOLKIT, AND DEMONSTRATION PROJECT DEVELOPMENT

Task 5.1: Develop an Early Warning Strategy

Based upon results of the Vulnerability Assessment, this task will identify cost-effective flood warning and avoidance actions that can be implemented early in areas identified as significantly and regularly impacted under current or near-term tidal flooding conditions. This task will draw upon project work already being conducted to develop a list of potential actions and strategies to increase awareness and mitigate impacts from known locations of chronic flooding.

Examples of actions will range from relatively easy to implement and lower cost options like warning and avoidance (i.e. lane closures and increased public notification of flooding on King Tide days) to coordination with the Office of Emergency Services (OES) to identify areas for common action, including strengthening preparations for near term effects in areas susceptible to climate change-associated flooding and other hazards. An Early Warning Strategy will be part of the Marin Multi-Jurisdictional Hazard Mitigation Plan and will outline actions that may be possible for near-term and chronic flooding. If complete in time for the draft report, it will be included as part of the Final Summary Report for this project as well.

Task deliverable: Coordinate with the Marin County Office of Emergency Services and the Marin Multi-Jurisdictional Hazard Mitigation Plan to develop an early warning strategy with actions to increase awareness and reduce impacts for current and near-term tidal flooding.

Schedule: Follow the Marin Multi-Jurisdictional Hazard Mitigation Plan schedule, currently anticipated for September 2016. Some initial input may be requested from the asset managers while completing the Vulnerability Assessment interviews from March through June.

Outreach: Meet with the Marin County OES team and asset managers.

5.2 Adaptation Toolkit

Experience and research have shown that it is important for government to identify potential solutions at the same time it introduces information about serious new problems that could affect people's lives. This subtask will provide the range of potential solutions along with a description of the general benefits and constraints of the various options to begin the education process for adaptation. A first-cut assessment of the eastern Marin shoreline will be conducted to discuss the applicability of various adaptation options along the shoreline.

To make the most of limited resources, work being done in comparable situations in other areas, including coastal Marin and work completed in the draft *Richardson Bay Shoreline Study* will be shared for BayWAVE, and efforts to address shared problems will be pursued.

5.2.1 Summarize available hard engineering adaptation tools

Develop fact sheets for each tool with graphics and photos to show how these tools work. Each sheet should have a rendering (like those from landscape architects) for context and a summary of benefits and constraints. Fact sheets should note any related tools that must be considered with each tool (like pump stations with levees) and the limitations given the regulatory and natural resource concerns.

5.2.2 Summarize available soft engineering adaptation tools

Develop fact sheets for each tool with graphics and photos to show how these tools work. Each sheet should have a rendering (like those from landscape architects) for context and a summary of benefits and constraints. Fact sheets should note any related tools that must be considered with each tool (like pump stations with levees) and the limitations given the regulatory and natural resource concerns.

5.2.3 Summarize land use and policy considerations

Provide descriptions of potential non-structural alternatives that are available, their benefits and constraints, and applicability to Marin County.

Task deliverable: Develop fact sheets for each engineering adaptation tool. Develop a first-cut evaluation of appropriate locations for each tool.

Schedule: Toolkit to be developed in coordination with the Vulnerability Assessment in November 2016. Evaluation of locations for tools will occur in time for inclusion with the draft project summary report.

Outreach: The toolkit will be shared with the Executive Steering Committee and Technical Group. It will be a highlight of presentations to the public in understanding the adaptation measures available for rising seas.

5.3 Demonstration Project Development

This task will summarize the outcomes of several significant efforts to prepare the Marin shoreline for adaptation to the impacts of sea level rise. The County has been a leader in SLR adaptation already implemented several studies and one completed pilot project that will pave the way for future adaptation efforts around the bay.

5.3.1 Bothin Marsh / Coyote Creek “Natural Levee”- Sediment Reuse Pilot Project Feasibility Study

The Flood Control District was recently given a \$25,000 grant by the North Bay Watershed Association (NBWA) to complete the Bothin Marsh Sediment Reuse and Wetlands SLR Enhancement Feasibility Study.

The project feasibility study will develop a site-specific plan to detail the ecological opportunities and impacts of placing dredged sediments along the back edge of the marsh. The Coyote Creek – Bothin Marsh pilot project is ideal because the volume of sediment from the Coyote Creek dredge is relatively low, (4,000 to 6,000 cubic yards) and the benefits marsh enhancement and flood attenuation are easy to monitor. Roads and infrastructure in this area currently experience flooding on high astronomical tides so this is a very visible location to test the viability of this approach. This study is expected to be completed in 2016.

Specific feasibility study elements include:

- Evaluation and mapping of site-specific ecology and habitat types.
- Development of dredge sediment placement locations to maximize habitat values (i.e. elevations and placement type) and provide flood protection now and with SLR along the back edge of the marsh for protection of infrastructure.
- Evaluation of dredge sediment placement engineering approaches (hydraulic, mechanical) to meet ecological and flood reduction goals.
- Preparation of conceptual and preliminary plans to meet project goals while protecting existing site resources.
- Work with the regulatory agencies that oversee permits to design a project that is feasible.
- Development of cost estimates for dredging and placement and monitoring for this type of project.
- Preparation and dissemination of a final report that can be used by other agencies and entities when assessing the feasibility of these types of projects and the beneficially reuse of dredge sediment.

5.3.2 Aramburu Island Constructed Beach Demonstration Project Monitoring

The Aramburu Island Constructed Beach Project was constructed in 2011 in Richardson Bay. It was the first sea level rise adaptation project constructed in San Francisco Bay to use coarse grained bay beaches as a natural approach to mitigate shoreline erosion. Visual observations have shown that the project has been successful in halting extensive shoreline erosion and is self-adjusting its elevation to mitigate sea level rise. The constructed habitat has also been very successful for bird usage including several threatened and endangered species, such as the snowy plover. The local Marin Audubon in Richardson Bay regularly monitors the site for bird usage and the results have been highly successful.

Surveys of the constructed beach pre- and post-storms will document changes to evaluate and promote the usefulness of constructed coarse grained beaches as an approach to adapt to sea level rise with significant habitat benefits.

5.3.3 Novato Creek Baylands (Flood Control 2.0 and IRWMP)

Marin County Department of Public Works (DPW) has been working for several years on flood control and sea level rise adaptation planning in the lower Novato Creek watershed. The Novato Creek Baylands contain large areas of diked, subsided baylands that could be restored to restore historic tidal marsh habitat to create wetlands that provide for attenuation of wave and buffering to the impacts of sea level rise as well as provide habitat for several threatened and endangered species of concern. In 2012, the Novato Creek Baylands project was selected to be one of three pilot projects included in a large EPA funded flood control and sea level rise adaptation program lead by the San Francisco Bay Joint Venture (SFBJV) and the San Francisco Estuary Institute (SFEI) to assist flood control agencies to design and operate their flood control channels called “Flood Control 2.0”. Flood Control 2.0 provided design guidance to DPW as well as a vision plan for the baylands and is also preparing an economic evaluation for the cost and benefits for other approaches to flood protection under a rising sea level.

The Novato Baylands project was also selected as one of eight projects from around the entire San Francisco Bay for inclusion into a special “shoreline resiliency” sub-group as part of the 2015 SF Bay submittal to the California Department of Water Resources under their Integrated Regional Water Management (IRWM) grant submittal. The grant was submitted in August 2015 and is expected to be approved in October/November 2015.

5.3.4 McInnis Marsh

The McInnis Marsh restoration project will restore over 100 acres of diked former tidal marsh at the mouth of Gallinas Creek on lands owned by Marin County Parks. The project is in the early feasibility design phase and will use wetland as a natural adaptation approaches to combat sea level rise while providing critical habitat for a variety of threatened and endangered species. Feasibility study due by early 2016. Preliminary design work is expected to begin in 2016.

Task deliverable: Summarize the outcomes of feasibility studies at Bothin Marsh, McInnis Marsh, and the Novato Baylands. Identify next steps towards implementation and describe sea level rise adaptation. Summarize the lessons learned from coarse grained beach monitoring at Aramburu for usefulness as an approach to adapt to sea level rise while providing significant habitat benefits.

Schedule: November 2016

TASK 6- PROJECT SUMMARY REPORT AND RECOMMENDATIONS

The deliverables for each task will be summarized in a draft and final report. The report will make a set of recommendations for future phases of sea level rise adaptation planning and implementation, including a process for updating the information in the vulnerability assessment, identifying grant funding opportunities and working with the cities, towns, and various asset managers to prepare for short-, medium, and long-term adaptation efforts. This planning process is iterative and a key outcome of the BayWAVE project will be the discussions, tools, and coordination across the entire shoreline to prepare for a changing bay.

Task deliverable: Draft and final report.

Schedule: Draft report expected in March 2017 for internal review. Public review anticipated in April 2017. A final report is planned for June 2017.

Outreach: The Executive Steering Committee, Policy Group, and Technical Group will be convened to present the draft report. Presentations are expected with the public release of the draft report. A presentation will be made to the Marin County Board of Supervisors to accept the final report.