



San Rafael Shoreline - 1953

**“CLIMATE ADAPTATION - SEA LEVEL RISE”  
SAN RAFAEL, CA  
WHITE PAPER**

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## EXECUTIVE SUMMARY

This document presents a “white paper” on the topic of sea level rise. This topic has been a growing concern in the last decade as studies continue to report and confirm its direct connection to climate change associated with global warming. This paper was prepared as a ‘first step’ in responding to the San Rafael Climate Change Action Plan (CCAP), which was adopted in 2009. The CCAP includes several programs related to long-term planning for sea level rise, which recommend, among others, completing an inventory of the public and private levees throughout San Rafael and preparing a vulnerability assessment that would include recommended strategies for adaptation. A discussion of the CCAP and these programs is provided in Section III, page 11 of this paper. Section III (pages 12-14) also summarizes other measures that San Rafael has employed or identified to address flooding, drainage and sea level rise (GIS Map Guide System, San Rafael Creek canal dredging, and SMART Station Area Plans).

This white paper is not a technical study nor is it a detailed quantitative analysis of sea level rise or its potential impacts on the community. Further, this paper does not present answers or solutions to sea level rise in San Rafael. Rather, this paper has been prepared to provide information that can be used in understanding this issue and moving forward to the next steps for long-range planning. This paper: a) identifies the key agencies that have been involved in studying and planning for this topic; b) presents the most current information and studies on sea level rise, particularly in the Bay Area; c) identifies potential funding sources to pursue for next steps; d) summarizes the studies underway in the Marin and the North Bay; e) describes techniques and tools that have been developed for adaptation; f) identifies the San Rafael shoreline and levees areas to study, as well as potential opportunity areas for studying adaptation; and g) presents suggestions for next steps in moving forward with preparing a vulnerability and long-term planning for sea level rise.

There are a number of federal, state, regional and county agencies as well as one North Bay organization that are currently addressing or studying sea level rise and related issues such as flooding. These efforts are presented in Section II of this paper (pages 4-11). The Bay Conservation and Development Commission (BCDC) has been in the lead with its initial publication of sea level prediction maps in 2007. The BCDC maps predict that water levels in the Bay will raise 16-inches by 2050 and 55-inches by 2100. Also, at the regional level, the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) have joined to prepare a Sustainable Communities Strategy (SCS) required by Senate Bill 375. Known as the Plan Bay Area, this SCS includes, among others, the formation of a Joint Policy Committee (JPC), which is a collaboration of four regional agencies working to develop: a) tools for conducting vulnerability and sea level rise assessments; b) a sea level adaptation strategy; and c) a funding plan for counties and local jurisdictions to plan for and assess sea level rise. At the federal level, the Federal Emergency Management Administration (FEMA) administers the flood hazard zone maps (FIRM), which are updated on-average every five years. The maps for the Central San Rafael basin are currently being updated. In response to the latest FIRM updates, FEMA will be recommending new regulations requiring higher finished floor elevations for structures. While this FEMA recommendation was in response to more detailed information available on tidal and wave action, this is some correlation to sea level rise.

There is an abundance of studies, reports and assessments that have been prepared on sea level rise since the 2007 publication of the BCDC prediction maps. Section IV of this paper (pages 14-25) provides a summary of studies and assessment efforts that have been completed since the 2007, with the primary focus on the Bay Area. Most notable is a 2011 risk assessment pilot project completed for the Alameda County shoreline, which was sponsored by BCDC, MTC and Caltrans. Known as the “ART Project,” this pilot project has established a template for other pilot projects and for the preparation of vulnerability assessments. “SPUR,” a Bay Area-based, member-supported non-profit organization have completed several reports/publications. One of the publications (2009) identifies seven adaptive strategies for addressing sea level rise, which are suited to the Bay Area conditions.

One of the biggest challenges to assessing and planning for sea level rise is funding. Section IV of this paper (pages 22-24) provides a list of available and possible funding sources for pursuing studies and adaptation. Funding sources and grant opportunities for studies include, among others: Government Issue (GI) bonds, the California Emergency Management Agency and FEMA, and the California Coastal Conservancy. Funding sources for construction (e.g., adaptation) include the US Army Corps of Engineers (funding shoreline restoration projects), the Coastal Conservancy and the North Bay Watershed Association. The major take-away regarding the availability of grants is that the City must have a current, adopted Multi-Hazard Mitigation Plan. These plans are required to be updated every five years. The City's current Multi-Hazard Mitigation plan was last updated in the mid-2000's, which must be updated.

There are a number of on-going pilot programs and studies underway in Marin County, which are discussed in Section V of this paper (pages 25-28). Most notable is the Richardson Bay Pilot Program, which was initiated by the Marin County Department of Public Works in 2010. Rather than focusing on assessing vulnerability, the pilot program has employed actual engineering concepts at bay front locations along the Richardson Bay. This program includes the Aramburu Beach/Island Restoration Project, the first demonstration project of its kind in the Bay Area. This demonstration project is designed to test natural shoreline approaches to monitor wind and wave erosion, as well as sea level rise. Further, Marin County Supervisor Kate Sears has initiated and is implementing a vulnerability assessment pilot program for the Tamalpais Valley and Marin City areas (Southern Marin Vulnerability Assessment Pilot Program). This pilot program primarily uses the BCDC "ART Project" template with a more "grassroots" approach that involves community input through all phases of this program. Closer to home, the County of Marin Department of Public Works is overseeing the Gallinas Watershed Program, which is studying flood protection and habitat restoration, which are both tied to planning for predicted sea level rise.

There have been a number of adaptation measures and tools that have been developed and tested to combat or plan for sea level rise. Section IV of this paper (pages 17-18 and 20-22) provides a description of some of the measures that have been developed, with some tested locally. Phillip Williams and Associates (now ESA-PWA), a Bay Area environmental planning and engineering firm has been in the forefront by introducing measures such as "retreat - levee relocation" (moving levees inland) and the "horizontal levee" (conversion of mudflats/tidelands to marsh). Other, more conventional measures include barriers (sea walls, tidal gates) and raising levees.

The San Rafael shoreline and levees are diverse and there are expansive areas that are vulnerable to projected sea level rise. Section VI (pages 28-29) and Appendix A of this paper broadly identifies the shorelines and levees, which include areas of Downtown, the inner Canal (areas bordering the San Rafael Creek), the East San Rafael shoreline (encompassing the low-lying areas that were filled in the last century and border the Bay), areas of the San Pedro Peninsula and the Gallinas Creek basin. Please note that the properties and areas presented in Appendix A were not identified based on engineering studies or technical data, but on historic knowledge and familiarity with the community. This paper also includes potential opportunity areas in San Rafael that are worthy of study for adaptation. These areas are described in Section VI (pages 29-30) and in Appendix B of this paper.

This paper presents a number of challenges that need to be acknowledged and considered before preparing a vulnerability assessment. As summarized in Section VII of this paper, long term planning for sea level rise cannot be done in isolation; it will require the collaborative effort of multiple agencies. Given the expanse of area that would be affected by predicted sea level rise, the number of stakeholders is substantial. Thirdly, the San Rafael shoreline and levee conditions substantially vary by neighborhood, so a "one-size-fits-all" approach is not possible. Further, there are limited City resources and funding. Lastly, this paper provides a list of suggested "next steps" (see Section VIII, page 31), which include, among others, a City commitment to prioritize and staff the preparation of a vulnerability assessment.

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## I. INTRODUCTION & PURPOSE

In the past decade, there have been groundbreaking studies and an increased public awareness on the worldwide effects of climate change associated with global warming. Studies continue to document that global warming is continuing at progressive rates, which has been demonstrated by warmer and colder seasonal temperatures and patterns of more severe seasonal storm events. It is projected that sea levels will continue to rise as precipitation continues to increase and ice caps continue to melt. While we will not be able to stop the rise in sea levels resulting from these changes, we have the opportunity and must plan to adapt to this change. There are number of large geographic areas of San Rafael that are at risk for flooding and will be dramatically impacted by sea level rise. These geographic areas include valley floors, properties with low-lying elevations (some at sea level), and areas that are now filled and were once marshland. Most of these areas are developed so returning them to original, natural state is not a viable option. To this end, the effects of sea level rise, while viewed as a “climate” problem is a “people” problem; the focus must be on adaptation (e.g., to plan for and protect vulnerable populations and neighborhoods). Starting with the 'big picture,' there is a need to identify what is going to happen, how fast is it going to happen, and what can be done about it.

The purpose of this paper is to: a) identify key agencies that have some level of oversight on this topic; b) provide a summary of resources and data prepared and available to date on the topic of sea level rise; c) preliminarily identify vulnerable areas in San Rafael that require further study, and potential areas for adaptation; d) report on what has been or is being studied and pursued in the Bay Area to date; and e) identify possible next steps for the City of San Rafael to complete a vulnerability assessment.

## II. BACKGROUND

As a global issue, sea level rise crosses over a number of federal, state, regional and county agencies. The following is a brief summary of the key agencies that are currently involved in studying and planning for this topic.

### A. Federal Level

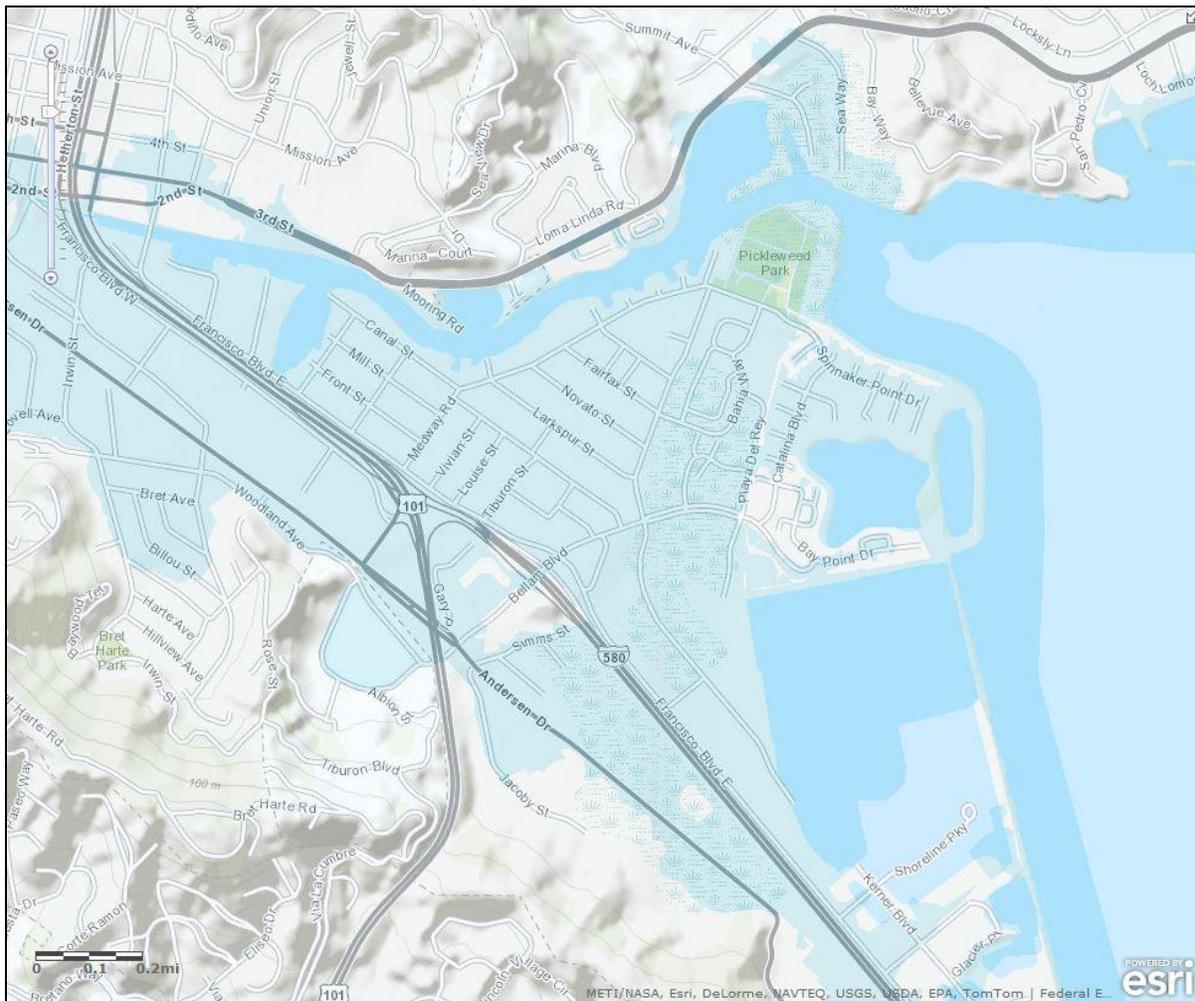
Historically, local and county jurisdictions have relied on and deferred to the Federal Emergency Management Administration (FEMA) to document and map areas that are prone to flooding. Generally, every five-six years, FEMA updates and publishes maps (FIRM- Flood Insurance Rate Map) identifying flood prone areas and zones of vulnerability. As discussed below, the next update of the FIRM maps for the Central San Rafael basin will be completed and released in 2014. The FIRM maps delineate several flood zones, which are defined as follows:

- Zones A, AE, AH, AO, AR, A99, V and VE (referenced as “Areas of Special Flood Hazard”)- areas subject to 1% chance of flooding in any given year (formerly referred to as the 100-year flood zone)
- Zone X- areas subject to 0.2% chance of flooding in any given year and areas protected by levees from the 1% chance of flooding in any given year
- Zone D- areas where flood hazards are undetermined

The FIRM maps play several critical roles. First, the maps are used by local and county agencies to identify and plan for local or area flood protection. Second, the maps are used by the banking and insurance industries to determine if flood insurance is mandated for a specific property or area. Lands located within the Areas of Special Flood Hazard require that flood protection insurance be secured for federally-funded loans. Lastly, the maps are used at the Federal (and State) level to plan for waterway projects that are administered by the US Army Corps of Engineers. The most current FIRM maps that are available were updated and published in 2009.

There are numerous areas of San Rafael that are prone to flooding and are within the two FEMA flood zones. Areas within the flood zone are near or border waterways and are typically, low-lying, former diked baylands and marshlands. The larger, more significant flood prone areas include: the Central San Rafael Basin (southern portions of Downtown San Rafael extending from the San Rafael Canal/Creek westward to E Street, south including portions of Gerstle Park; Woodland Avenue area extending into portions of the Bret Harte neighborhood); Southeast San Rafael (the Canal neighborhood and greater East San Rafael residential and commercial areas including Spinnaker Point, Kerner Boulevard, Andersen Drive), San Pedro Peninsula (low-lying residential neighborhoods north of the San Rafael Canal including Summit Avenue/Marina Vista and Mooring Road, Loch Lomond Marina and low-lying areas of Peacock Gap); and the Gallinas Creek Basin (east of US101).

A sample map of a portion of the East San Rafael area is provided in Figure 1 below. This map delineates areas within the Areas of Special Flood Hazard.



**Figure 1: Southeast San Rafael Sample 2011 FEMA “Areas of Special Flood Hazard”**

For all lands within the FEMA 100-year flood zone, construction is required to comply with elevation regulations. The 2009 FEMA regulations require a finished floor height elevation for buildings of +9.0 National Geodetic Vertical Datum (NGVD). This finished floor elevation requirement is applied to all new construction and is also required for substantial renovations or additions to existing buildings. As a matter of precaution, the City of San Rafael’s policy and practice is to require an additional 1-foot of elevation

("freeboard") above the FEMA standard. More recently, the City has approved even higher finished elevation provisions to address potential sea level rise. For example, in the planning of the Village at Loch Lomond Marina development, an additional 1.5 feet of elevation was approved, over and above the additional "freeboard" typically required by the City.

FEMA is in the process of updating the FIRM maps for Marin County. Updated maps have been completed for the Marin City/Tamalpais Valley and Ross Valley watershed areas. There is a small segment of San Rafael that is located within the Ross Valley watershed (portions of the Gerstle Park neighborhood) for which the City has received updated FIRM maps. These maps go into effect in March 2014. It is expected that the preliminary maps for the Central San Rafael basin will be completed in 2014. The map process will require that FEMA provide an appeal period which will allow for requests to adjust the mapping boundaries. The date of determination of the final FIRM maps and the effective dates of these maps will be in spring 2015.

Following this round of FIRM map updates, FEMA will be changing the finished floor height elevation thresholds for flood zone delineation and federal requirements for protective levees. FEMA has reported that the new regulations (expected to be adopted for application next year) will require a finished floor height elevation of +10.00 NGVD, which is being administered to address, in part, more detailed and technical information available on tidal and wave action. Therefore, it is expected that the geographic boundaries of the flood zones will increase or change. In summary, the change in the FIRM maps and finished floor elevation thresholds will influence the following:

- Regarding the Marin County shoreline levees, with the exception of the bayfront levee improvements being constructed by the US Army Corps of Engineers along the former Hamilton Airfield in Novato, none of the existing Marin bay front levees meet the predicted federal standards for height or type.
- It is expected that with the FEMA updates, there will be a substantial increase in the flood insurance rates for properties within the Areas of Special Flood Hazard. The Biggert-Waters Flood Insurance Reform Act (2013) will result in increased insurance premiums.

## **B. State Level**

In 2006, the State Legislature passed and former Governor Arnold Schwarzenegger signed AB 32, the Global Warming Solution Act of 2006. This action established a law mandating a statewide reduction of greenhouse gas (GHG) emissions by 2020. While AB 32 focuses on reducing GHG emissions, not rising sea levels, it was a landmark action as it is the first State law to establish mandates for combating global warming.

### ***Bay Conservation and Development Commission (BCDC)***

The Bay Conservation and Development Commission (BCDC) is a state agency that provides regulatory authority over the San Francisco Bay. Operating since 1970, BCDC: a) is responsible for implementing and enforcing the San Francisco Bay Plan (*Bay Plan*); and b) has review and permit authority over baylands and upland areas within 100 feet of the shoreline. In 2007, BCDC completed and published maps showing predictions for sea level rise in and around the San Francisco Bay for years 2050 and 2100. These maps are available on the BCDC website at [http://www.bcdc.ca.gov/planning/climate\\_change/index\\_map.shtml](http://www.bcdc.ca.gov/planning/climate_change/index_map.shtml). Given the limited yet evolving information that is available to date on this issue, there is still a great amount of uncertainty surrounding precise predictions on the extent on potential sea level rise. However, BCDC predicts, based on information available to date (FEMA flood zones, existing watersheds, and former tidelands/bay lands), that water levels in the San Francisco Bay will raise 16-inches by 2050 and 55-inches by 2100. It is important to note that BCDC includes a disclosure on its maps, which states, "For Informational Purposes Only." The intent of this disclosure is to ensure that they are not be used as a technical tool in making

local land use decisions, but rather a precautionary resource to trigger further study when addressing projects in areas prone to potential sea level rise.

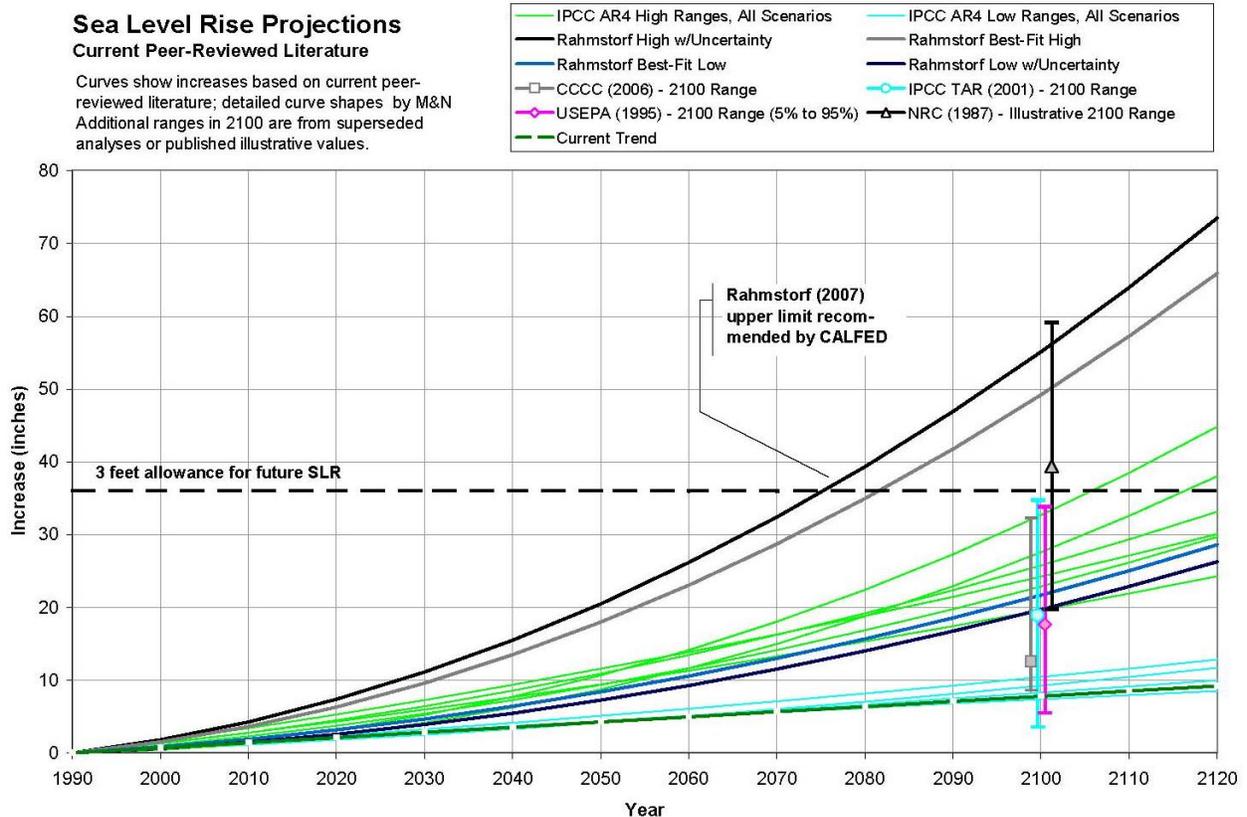


Figure 2- (Source: Argonaut Company- 2013)

To date, the City of San Rafael has used the BCDC maps as a reference in scoping and conducting environmental review on specific development projects. The BCDC maps identify four geographic areas of San Rafael that are vulnerable to projected sea level rise (see Figure 3), which are:

1. Central San Rafael Basin- includes San Rafael Canal/Creek and neighborhoods bordering the creek, and major portions of Downtown
2. Southeast San Rafael- includes Canal/Spinnaker Point/Baypoint residential areas and the greater commercial and light industrial areas around the I-580 corridor
3. San Pedro Peninsula- low-lying areas of Peacock Gap and Glenwood neighborhoods and portions of residential neighborhoods bordering the Bay
4. North San Rafael- greater Gallinas Creek Basin from the Bay west to US 101

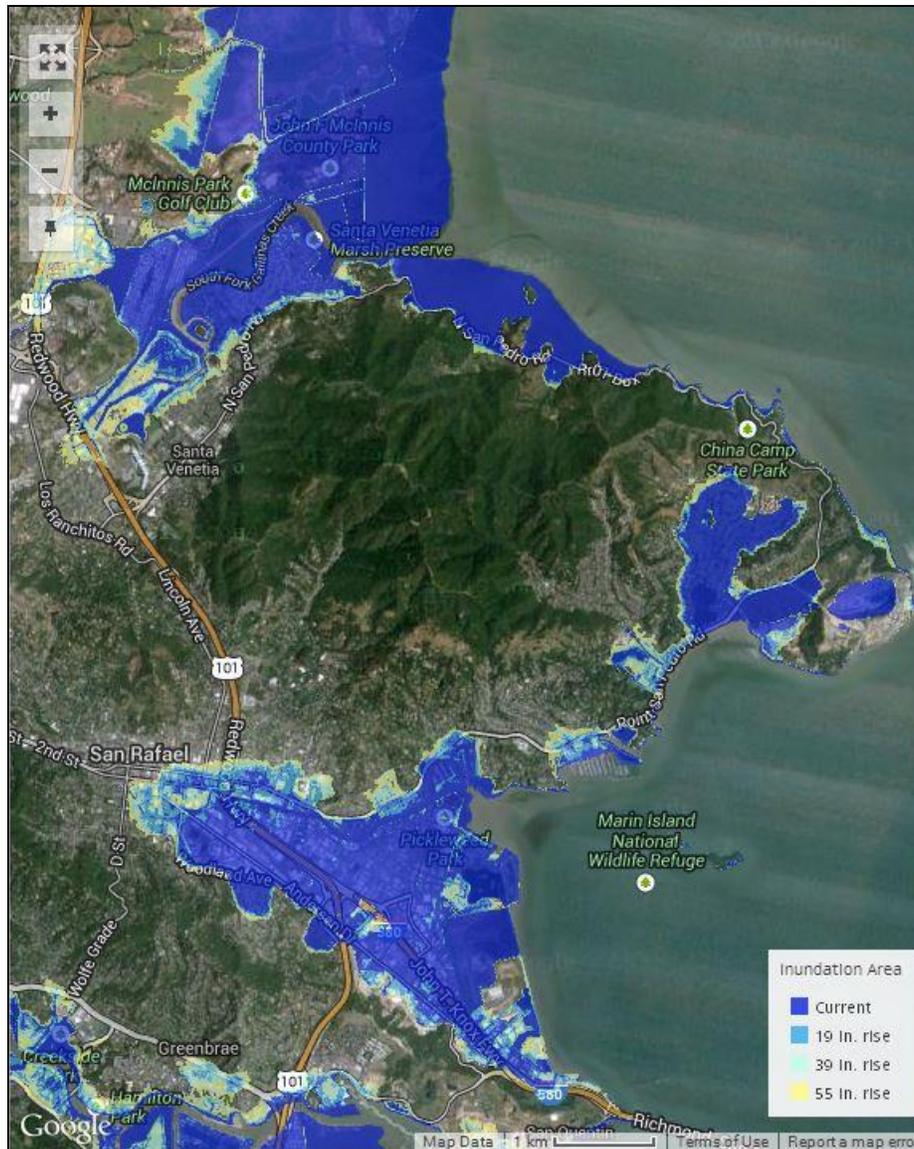


Figure 3: Cal-adopt.com BCDC (2007), USGS and Pacific Institute

In addition to the sea level prediction maps, BCDC has been developing a "toolbox" of basic recommendations and adaptive strategies for local agency and regional use (discussed below in Section IV).

In 2008, BCDC prepared a vulnerability assessment, *Living With A Rising Bay: Vulnerability And Adaptation In San Francisco Bay And On the Shoreline*, that identifies: (1) key Bay systems, both in the natural and the built environment; (2) the stressors they presently face; (3) the potential impacts due to sea level rise and coastal flooding; (4) the sensitivity of the systems to these impacts; and (5) their adaptability. Integral to preparation of the assessment was research on sea level rise inundation in the Bay Area by the United States Geological Survey (USGS) and an analysis of the socioeconomic impacts of that potential inundation by the Pacific Institute. The results show that approximately 180,000 acres of shoreline are vulnerable to flooding following a 16-inch rise in sea level, and more than 213,000 acres following a 55-inch rise in sea level, potentially flooding over a quarter-million of the Bay's residents. The replacement value of the resources at risk is about \$62 billion.

BCDC has taken a lead in developing a Local Government Adaptation Assistance Program (AAP) to provide information and resources to Bay Area local and regional governments to assist them in planning for and adapting to the impacts of a changing climate. These outreach efforts primarily focus on addressing the needs of land use planning, public works, park and open space districts, flood control districts and wastewater authorities, as well as resource-based managers. The long-term goal of the AAP is to help San Francisco Bay Area communities achieve coordinated and region wide adaptation to climate change impacts. The AAP contributes to this goal by building capacity within local governments to assess climate change issues, and to plan for and implement adaptation strategies.

BCDC has identified five broad program components for accomplishing these AAP objectives: (1) building partnerships that cut across jurisdictional boundaries, both geographic and sectorial; (2) public outreach to build community and institutional support for adaptation planning; (3) education to help planners and managers develop knowledge and skills for adaptation planning; (4) creation of a “one-stop shop” website and information clearinghouse; and (5) development and dissemination of strategies to improve the region’s resilience and adaptive capacity.

### ***California Coastal Commission***

The California Coastal Commission (est. 1976) is a state agency that provides planning and regulatory authority over the California coastline and points inland. The California Coastal Act (1972) requires that a Local Coastal Plan (LCP) be developed by each county in California that borders the coast. The LCP for Marin County has been incorporated into the *Marin Countywide Plan*. In November 2012, the California Coastal Commission prepared and released its *Draft Sea Level Rise Guidance*. This draft guidance document provides recommendations for local governments, applicants and others on how to address sea level rise in Local Coastal Programs and Coastal Development Permits. Further, this guidance explains the importance of using the best available science on sea level rise, avoiding hazards and protecting coastal habitats. This guidance can be accessed at <http://www.coastal.ca.gov/climate/SLRguidance.html>. The following are some of the guidance tools presented in this document:

- Acknowledge and address sea level rise as necessary in planning and permitting decisions
- Use the best available science to determine locally-relevant sea level rise projections, as well as the range of the projections for the study area
- Assess the potential risks from sea level rise to resources and development
- Avoid significant coastal hazard risks where feasible (e.g., areas of flooding or geologic instability)
- Minimize the hazard risk to new development over the life of the structures
- Account for the social and economic needs of people
- Property owners should assume the risks associated with new development in hazard areas
- Consider conducting vulnerability assessments and adaptation planning at the regional level
- Provide for maximum public participation in planning and regulatory processes

While the San Rafael bayfront is not within the coastal zone, this guidance provides some good recommendations that can be applied to future planning for sea level rise along the bayfront.

## **C. Regional & County Levels**

### ***Plan Bay Area- Strategy for a Sustainable Region***

The Bay Area, which encompasses nine counties, is served by a number of regional agencies, including the Association of Bay Area Governments (ABAG) and Metropolitan Transportation Commission (MTC). ABAG and MTC manage, administer and oversee regional planning and transportation matters. In 2008, Governor Schwarzenegger signed Senate Bill 375 (SB 375), which promoted a direct linkage of regional transportation plans (RTP) with the statewide goals to reduce GHG emissions (AB 32). SB 375 requires that metropolitan transportation organizations (such as MTC) develop a Sustainable Communities

Strategy (SCS), which is to serve as a new element of the RTP. The goal of the SCS is to reach a GHG reduction target for each region. The transportation target for the Bay Area is a seven percent (7%) GHG reduction per capita by 2020 and a 15% reduction per capita by 2040.

For the Bay Area region, the SCS process involves a partnership of four regional agencies: a) MTC; b) ABAG; c) the Bay Area Air Quality Management District (BAAQMD); and d) the Bay Conservation and Development Commission (BCDC). MTC and ABAG lead the SCS effort with the preparation of the “*Plan Bay Area- Strategy for a Sustainable Region*” (Plan Bay Area). The final Plan Bay Area was adopted by MTC and ABAG on July 18, 2013. While most of the Plan Bay Area addresses ways to achieve reductions in GHG emissions through tools such concentrated growth (“Priority Development Areas”) and funding strategies to promote increased transit use, it includes a section addressing climate adaptation and sea level rise. The Plan promotes, endorses and commits to regional efforts through a Joint Policy Committee (JPC) comprised of representatives from MTC, ABAG, BCDC and the Bay Area Air Quality Management District (BAAQMD). The JPC is commissioned to work collectively to conduct vulnerability and risk assessments, a sea level adaptation strategy, and develop a Transportation Asset Management Plan (TAMP) to provide funding to counties and local jurisdictions for planning and assessments.

In 2011, the JPC was given direction to produce a Bay Area Climate and Energy Resilience Project to provide guidance on how to include protecting the Bay Area’s economy, public health, infrastructure and ecosystems from sea-level rise, water shortages, high energy prices and other impacts in long-term regional and local planning, including Plan Bay Area. In May 2013, the project was completed presenting a six-month Needs Assessment and a proposed Action Plan. The findings from the Needs Assessment are contained in five reports:

- Stakeholder Interview Summary (including an inventory of nearly 100 Bay Area projects)
- Mapping Our Future: A Work Plan for Public Engagement and Social Equity
- Bay Area Integrated Win-Win Strategies (Resilience + GHG reduction)
- What’s Going to Happen and What Can We Do About It? (Science information for decision-makers)
- Effective Governance for Multi-Jurisdictional, Multi-Sector Climate Adaptation

The 12-Month Action Plan outlines a five-point plan to significantly accelerate and strengthen Bay Area adaptation planning. The plan will now be used to engage funders and supporters in discussions on moving forward. The reports and action plan can be accessed at <http://www.cakex.org/directory/organizations/bay-area-joint-policy-committee>.

In September 2012, the JPC adopted a work plan to develop a Regional Sea Level Rise Adaptation Strategy. The objective of this project is to ensure the on-going health and ecological viability of regional natural resources, such as San Francisco Bay; coordinate adaptation mechanisms that transcend local jurisdictional boundaries; and share the costs of adaptation responses at a regional level, especially when regional resources are involved. The sea level rise adaption strategy work plan focuses on providing enough background information and support to develop a “bottom-up” regional strategy where the regional agencies work with local entities to assess vulnerabilities and risks, identify critical assets, explore adaptation options, and use a balanced approach to identify costs, benefits and adaptation strategies for the natural resources/ecosystem services provided by the Bay and its watersheds. The lessons learned from these collaborative efforts will be used to inform the second iteration of Plan Bay Area and be fully integrated into the third iteration.

### **County of Marin**

The County of Marin Department Public Works (including Flood Control) takes the lead on addressing countywide issues related to flood control/protection and water quality. More recently, some of this work has transitioned into addressing sea level rise. The County manages over nine flood control zones,

including two in the North San Rafael area (Zones 6 and 7), which cover both incorporated and unincorporated lands in the Gallinas Creek Watershed. These are independent assessment districts formed for the sole purpose of addressing flood control.

In 2008, the Marin County Watershed Program was initiated as a project of the Marin County Department of Public Works. This watershed program covers all major developed watersheds in Marin including: San Antonio/Novato Creek, Gallinas Creek, Ross Valley, Richardson Bay, and Stinson Beach. The goals of this program are as follows:

- Partner with local municipalities, agencies, and non-profits
- System-wide analysis of flood protection options
- Identify multi-benefit type projects
- Protect, enhance and restore habitat and water quality
- Improve efficiency of flood control maintenance operations
- Evaluate the beneficial re-use of dredged material
- Identify sea level rise adaptation strategies
- Work with the natural watershed processes

The base of this program is stakeholder engagement. The program utilizes three working groups/committees which are: a) a Policy Advisory Committee (includes decision makers); b) a Technical Working Group (technical staff); and c) an Operations and Finance Committee (committee seeks out funding sources). Some of the goals are to develop models and other tools, potential alternatives and funding strategies. The funding partners include, among others, the County of Marin, the City of San Rafael, the City of Novato, the City of Mill Valley and several of the flood control and service districts. A 10-year work plan has been developed for this program, which includes the Gallinas Watershed Program. This project is discussed under Section V of the paper (Current Studies and Strategies Underway in Marin). For more information on the Marin County Watershed Program, please see the Marin County website at [www.marinwatersheds.org](http://www.marinwatersheds.org).<sup>1</sup>

#### ***North Bay Watershed Association (NBWA)***

While not a regulatory agency, the North Bay Watershed Association (NBWA) is a membership group of 16 regional and local public agencies located throughout Marin, Sonoma, and Napa counties. NBWA is committed to crafting a set of regional approaches to the problems and issues associated with managing the North Bay watersheds. The mission of NBWA is to facilitate partnerships across political boundaries that promote stewardship of the North Bay watershed resources.

The NBWA was created to help regulated local and regional public agencies work cooperatively on water resources issues that impact areas beyond traditional boundaries in order to promote stewardship of the North Bay watershed. Agencies participate in the NBWA in order to discuss issues of common interest, explore ways to work collaboratively on water resources projects of regional concern, and share information about projects, regulations, and technical issues. More recently, NBWA has been in the forefront of researching and addressing sea level rise. In 2013, NBWA commissioned PRBO, environmental consultants to prepare a report on adapting to sea level rise. This report is summarized in Section IV below. At present, the City of San Rafael is not a member of NBWA. The City's membership was not renewed several years ago.

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<sup>1</sup> Meeting with Marin County Department of Public Works; December 16, 2013

### III. BRINGING IT TO A LOCAL LEVEL- WHAT HAS SAN RAFAEL DONE TO DATE?

#### A. San Rafael Climate Change Action Plan & Sustainability Element

In response to AB 32, in 2008, the City of San Rafael embarked on preparing a Climate Change Action Plan (CCAP). The CCAP was prepared with the assistance and participation of a Green Ribbon Committee and stakeholders. Adopted in 2009, the City of San Rafael CCAP sets forth steps and implementing measures to combat and/or adapt to climate change. The “Our Environment” section of the CCAP the implementing measures that are specific to sea level rise are as follows:

##### ***Monitor sea level rise and plan for shoreline defense***

- EN7: Develop a program of levee analysis, including inventorying heights, testing and maintaining public and private levees.
- EN8: Install a sea level monitoring gauge to track changes over time.

##### ***Increase understanding and preparation for the effects of climate change***

- EN9: Participate in Marin County’s regional vulnerability assessment, and prepare a local vulnerability assessment for San Rafael.
- EN10: Continue to provide emergency planning and community awareness.

In 2011, the City folded the CCAP into the San Rafael General Plan 2020 by adopting a new Sustainability Element. The Sustainability Element includes the following policies and programs:

##### **Policy SU-14. Adapting to Climate Change.**

Increase understanding and preparation to adapt to the effects of climate change, including sea level rise.

**Program SU-14a. Vulnerability Assessment.** Participation in Marin County’s regional vulnerability assessment and prepare a local vulnerability assessment for San Rafael.

**Program SU-14c. Levee Analysis.** Develop a program of levee analysis, including inventorying heights, testing and maintaining public and private levees.

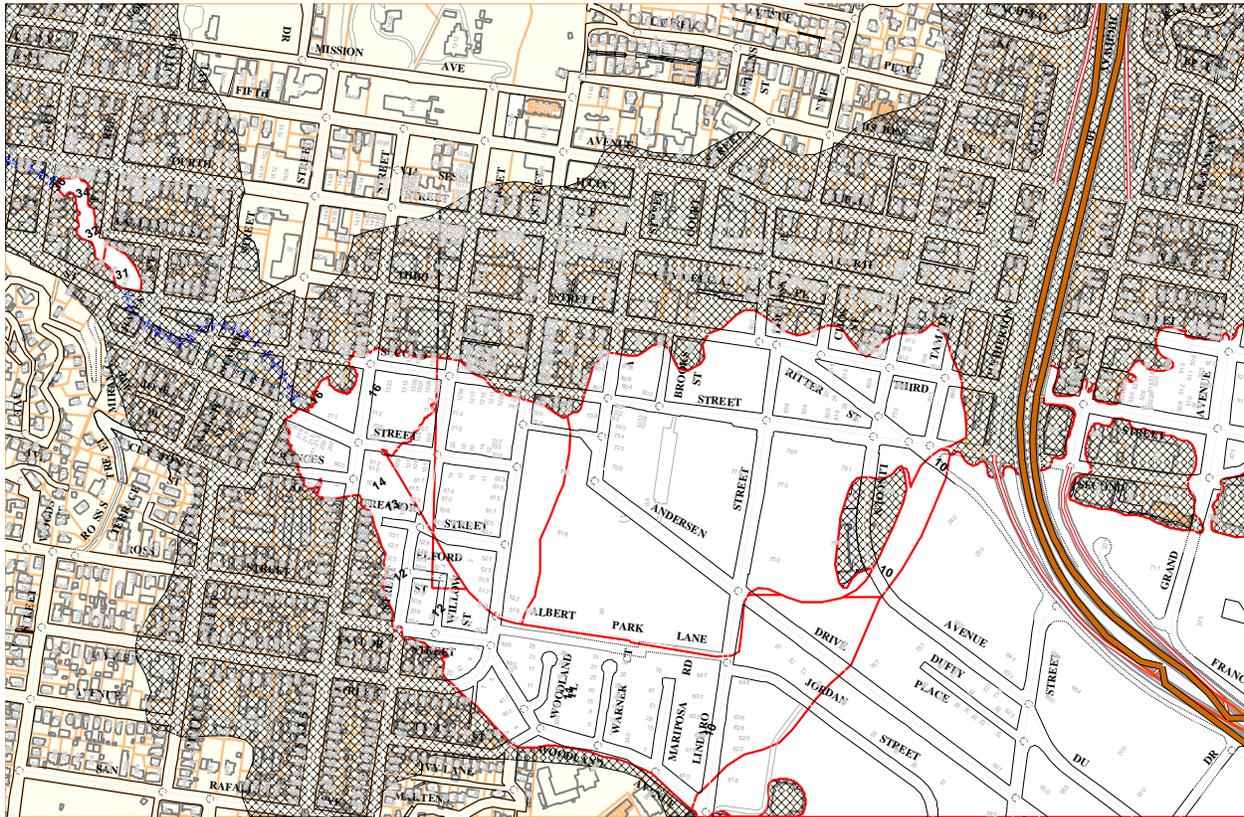
**Program SU-14d. Sea Level Monitoring and Planning.** Work with the Bay Conservation and Development Commission (BCDC) to monitor sea level rise and plan for shoreline defense.

The stakeholders involved in the initial CCAP process meet quarterly to discuss the City’s progress on implementing the CCAP programs. The CCAP group is tracking progress on addressing sea level rise. However, to date, limited progress has been made to initiate the above implementing programs. Most of these programs must be initiated, managed and completed by the City Department of Public Works, which would require budgeted funds in the future, as progress is made on this topic. Therefore, in order for the issue of sea level rise to be initiated, studied, and addressed, adequate funding for City staff (primarily Public Works Department) and the City’s Capital Improvement Program would need to be identified and prioritized.

#### B. GIS (Map Guide) System

The City utilizes a GIS software program, which provides mapping of the City and the neighboring unincorporated area that is linked and shared with the County of Marin GIS system ([www.marinmap.org](http://www.marinmap.org)). The GIS system provides electronic mapping of the City and the neighboring unincorporated areas and is programmed to provide assessor parcel based data such as property zoning, land use, property ownership, parcel size, etc. The program includes FEMA flood zone information. The GIS will be updated to incorporate the updated FEMA flood zone mapping that is currently being prepared.

At present, the GIS system is accessible on the City's internal network only, and cannot be accessed externally from the City's website. This system provides an opportunity to serve as a repository for mapping sea level rise data, as it becomes available.



**Figure 4: City GIS-Map Guide Program. Sample location showing FEMA zone overlay. Blue area shows limits of FEMA Areas of Special Flood Hazard and hatched area shows Zone X (500-year)**

### **C. San Rafael Creek - Canal Dredging**

Most of the Central San Rafael Basin drains into the San Rafael Creek. At one time, the San Rafael Creek existed as an open drainage channel westward as far as the Sun Valley and West End neighborhoods. This creek was also fed by tributaries (e.g., Mahon Creek) and bordered by low-lying marshland. In fact, most of Downtown San Rafael, the Woodland Avenue area, portions of the Bret Harte neighborhood and Canal neighborhood were once marshland that bordered and supported the creek. While filled, the lower elevation of these former marshland areas places much of the basin in the FEMA Areas of Special Flood Hazard. For this reason, much of the Central San Rafael Basin is vulnerable to sea level rise as shown in the BCDC prediction maps. The San Rafael Creek is a critical element in providing adequate drainage to the Central San Rafael Basin; it collects most of the surface water runoff from Downtown San Rafael and the bordering neighborhoods and provides a direct deposit of this runoff to the Bay.

Over time, the San Rafael Creek (as well as Mahon Creek) has been filled or realigned, and only limited segments remain as a surface drainage feature west of US 101. The one segment of this creek that remains as a continuous open channel is the segment east of US 101. Further, the portions of this creek that are east of the Grand Avenue bridge have remained navigable. Until the last two decades, the segments of the San Rafael Creek from the Grand Avenue bridge to the open Bay (referenced as the San

Rafael Canal) were dredged on a fairly regular basis. Available federal and state funding (including past funding sources such as the former San Rafael Redevelopment Agency), as well as available upland sites for disposing dredged spoils made it possible to conduct regular dredging and maintain the sediment levels in the Canal to ensure navigability. However, over time, funding sources for dredging have dwindled. Further, upland sites for spoils disposal are scarce, forcing other costly disposal options (e.g., selected deep water disposal sites in the Bay region).

In 2011-2012, the San Rafael Creek was dredged at a cost of approximately \$2.0 million. This cost covered dredging, spoils disposal, as well as surveying and permitting (\$500K). The project was fully funded by the US Army Corps of Engineers (Corps). Because of sediment contamination, a complete dredging of the inner canal was not possible and dredge spoils were required to be disposed at an upland landfill. As a result of this last dredging process, the Corps has reported that future dredging of the canal will be challenging because of limited funding resources.

The San Rafael Canal is an important resource that needs to be considered in long-term planning of drainage in the Central San Rafael Basin. While continued dredging of the Canal may not be an effective tool to combat sea level rise, it is critical for boat navigability and basin drainage. Lastly, depending upon the level of contamination for use, the spoils dredged from the Canal may prove to be valuable for local use such as: a) raising levees; b) wetland restoration; or c) other outboard adaptive strategies.

#### **D. SMART Station Area Plans**

In 2012, the City prepared “vision” documents for the area around the two planned SMART stations, one in Downtown San Rafael and one at the Civic Center. The *San Rafael Downtown Station Area Plan (2012)* and the *San Rafael Civic Center Station Area Plan (2012)* present a number of recommended actions to study transportation and land use improvements within a one-half-mile radius of the SMART station. Both Downtown and Civic Center include low-lying areas that are vulnerable to sea level rise. For this reason, both plans acknowledge sea level rise as a planning challenge and include a recommendation for the City to monitor sea level rise, plan for shoreline defense, develop a program of levee analysis and prepare a vulnerability assessment.

### **IV. WHAT HAS BEEN STUDIED AND EXPLORED IN THE BAY AREA AND BEYOND**

#### **A. Studies and Assessment Efforts Completed to Date**

Since the 2006 publication of the BCDC sea level prediction maps, there have been numerous reports and studies commissioned and completed to address climate adaptation for sea level rise. This section summarizes what has been prepared that is relative to the Bay Area and may be applicable and valuable for long-term planning in San Rafael. This section presents these studies and resource documents in chronological order.

In 2009, BCDC, the Association of Bay Area Governments (ABAG) and the San Francisco Bay National Estuarine Research Reserve presented, *Preparing for Sea Level Rise: Planning Sustainable Communities*, which recommended the inclusion of the Marin bayside into the “Baylands Corridor” and the need to develop detailed mapping and analysis for determining vulnerability and strategies for long-term adaptation.

In 2009, the County of Marin adopted the *Marin Countywide Plan*, which includes mapping, analysis, and policies to limit development and access, and control shoreline modification among other strategies. While the *Marin Countywide Plan* “Baylands Corridor” designation and policies are primarily focused on the protection of biological resources, water quality and flood protection, the issue of sea level rise is inherent in the Plan. County of Marin has indicated that the Baylands Corridor will likely be a good

planning tool to address sea level rise and adaptation. County staff will be reviewing the Baylands Corridor designation and policies for this purpose.

In 2009, “SPUR,” a Bay Area-based, member-supported non-profit organization completed its first report on the topic of sea level rise. Entitled, *Strategies for Managing Sea Level Rise*, this report weighs the advantages and disadvantages of seven strategies for managing sea level rise. The seven adaptive strategies assessed are barriers, coastal armoring, elevated development, floating development, floatable development, living structures, and managed retreat. See the section below entitled, Strategies in Managing Sea Level Rise for a description of these strategies.

In 2010, the City of Hayward contracted with Philip Williams & Associates, Ltd (PWA) to conduct a *Preliminary Study of the Effects of Sea Level Rise on the Resources of the Hayward Shoreline*. The study includes a map and analysis of each water management function, described by location and includes the types of and proximity to hazards, mode of failure, severity and risk of damage, and adaptation strategies. It also identified three possible adaptation strategies: “hold-the-line” (levee construction), realignment (moves levee inland), and gradual steeping (provides a mechanism to increase surface elevation at about the rate of sea level rise). The study found realignment and gradual steeping strategies preferable adaptation methods because of the various implementation benefits. Following these results, the study identified next steps for Hayward including a more detailed assessment of coastal hazards to specific infrastructure to gauge vulnerability based on the proximity of future erosion and flooding hazard zones to facilities.

In 2011, BCDC, MTC and the State Department of Transportation (Caltrans) commissioned the preparation of *Adapting to Rising Tides: Transportation Vulnerability and Risk Assessment Pilot Project* (with technical assistance of AECOM, consultants). Known as the “ART Project,” this pilot study includes a partnership with the National Oceanic and Atmospheric Administration Coastal Service Center (NOAA), with funding from the Federal Highway Administration (FHWA) and ICLEI. The ART Project assessed the highly varied and diverse shoreline in Alameda County (Emeryville to Union City) defining five shoreline categories based on their primary physical characteristics, functions and abilities to inhibit inland inundation. The five categories are: engineered flood protection structures (e.g., levees, sea walls), engineered shoreline protection structures (e.g., bulkheads, revetments), non-engineered berms (e.g., salt pond and agricultural berms), wetlands, and natural non-wetland shorelines (e.g., beaches, cliffs). The following are two fundamental “take-aways” from the ART Project:

- The shoreline categories developed for Alameda County reasonably encompass the range of shoreline types found throughout the nine-county San Francisco Bay Area.
- Non-engineered berms are common around the San Francisco Bay shoreline. Non-engineered berms protect marshes, ponds, and agricultural areas from wave erosion and provide flood protection to inland developments. These berms are often comprised of Bay mud that has been excavated from the Bay floor and piled and/or stacked in a mound. Many non-engineered berms have been in place around the Bay for several decades, with some dating back over 100 years. Most berms are periodically maintained to compensate for settlement, erosion, failure and rising sea levels. Several areas around the Bay contain extensive networks of non-engineered berms that provide multiple lines of flood defense between the Bay and developed areas. However, the non-engineered nature of their construction typically classifies them as highly vulnerable to sea level rise and seismic events.

The ART Project “template” has been structured to implement a five-phase planning process:

1. Scope & Organize. Identify and convene partners and stakeholders; define planning area
2. Assess. Inventory and assess conditions.
3. Plan. Identify appropriate adaptation strategies
4. Implement & Monitor.

Progress has been made on the ART Project. In 2012, a Vulnerability and Risk Assessment Report was completed. More recently, in December 2013, BCDC published two documents: 1) ART Vulnerability & Risk: The Define Step; and 2) ART Developing on Adaptation Response: The Plan Step.

In 2011, "SPUR" completed a second report on sea level rise entitled, *Climate Change hits home: Adaptation strategies for the San Francisco Bay Area*, which reviews sea level rise by sector impacts. This report recommends conducting shoreline risk assessments and preparing coastal inundation maps while revising local general plans so that policies relating to climate change hazards and sea level rise are included.

In 2012, the California Emergency Management Agency, California Natural Resources Agency, and the Federal Emergency Management Agency developed, *California adaptation planning guide: Planning for Adaptive Communities*. The guide recommends assessing climate change impacts, identifying areas most vulnerable and developing reasonable and rational risk reduction strategies at both a regional and local level. The guide also includes nine steps for conducting a vulnerability assessment, which are listed as follows:

Phase I- Identifying Conditions and Risks

- Step 1. Exposure: What climate change effects will a community experience?
- Step 2. Sensitivity: What aspects of a community (functions, structures, and populations) will be affected?
- Step 3. Potential Impacts: How will climate change affect the points of sensitivity?
- Step 4. Adaptive Capacity: What is or can be currently done to address the impacts?
- Step 5. Risk and Onset: How likely are the impacts and how quickly will they occur?

Phase II- Developing Adaptive Strategies

- Step 6. Prioritize Adaptive Needs: Which impacts require actions to address them?
- Step 7. Identify Strategies: Which strategies should be pursued to address adaptation needs?
- Step 8. Evaluate and Prioritize Strategies: Which strategies should be implemented first?
- Step 9. Phase and Implement: How can the strategies be funded, staffed, and monitored?

In 2013, the North Bay Watershed Association (NBWA) commissioned PRBO Conservation Science, environmental consultants to prepare *Adapting to Sea Level Rise Along the North Bay Shoreline*. PRBO had previously developed and published the *Future San Francisco Bay Tidal Marsh Climate Smart Planning Tool* (2011), which NBWA had commissioned PRBO to use in the North Bay shoreline study. This report presents excellent information that is specific to North Bay conditions. The purpose of the North Bay shoreline report is to demonstrate how the PRBO planning tool could be used by agencies responsible for coastal areas in North San Francisco Bay to develop adaptive management plans. Two NBWA workshops were held that brought together 50 managers, scientists, and other stakeholders from groups in the North Bay to identify what information they needed, but currently lacked, to make decisions. As a result of feedback gathered in these workshops and a pre-workshop survey, the NBWA established the following goals for this study:

- Address the ecosystem value of tidal marshes by estimating the amount by which they attenuate incoming waves;
- Analyze tidal marshes and other sites of interest in the North Bay region by calculating projected marsh composition, wave attenuation, and tidal marsh bird abundance
- Add summary reports containing data for 344 tidal marshes across San Francisco Bay to PRBO's sea-level rise decision support tool (<http://data.prbo.org/apps/sfbslr/index.php?page=marsh-reports>); and

- Produce more detailed vulnerability assessments (including estimates of adaptive capacity) for three case study areas selected as being of high interest to workshop participants: Inner Richardson Bay, Gallinas Creek, and Novato Creek.

PRBO had previously produced models of sea-level rise in San Francisco Bay that looked at projected tidal elevations five times over the next 100 years (2030, 2050, 2070, 2090, and 2110). Uniquely, these models include not only the rate of sea-level rise but also the rate of marsh accretion due to the deposition of suspended sediment and organic material. PRBO has found that marsh accretion serves to offset the effects of sea-level rise, as it causes increases in marsh elevation that can potentially match losses due to sea-level rise.

In 2013, the environmental firm of ESA-PWA completed *Analysis of the costs and benefits of using tidal marsh restoration as a sea level rise adaptation strategy in San Francisco Bay*, assigned financial value to tidal marshes for restoration cost-benefit analysis. The goal of the Marin Conservation League and the San Francisco Bay Area Wetlands Restoration Project is to restore at least 100,000 acres of wetlands within the footprint of the Bays original tidal marshes as 92% have been lost. The report indicated two cost effective strategies in adapting to sea level rise:

- Retreat- Levee Relocation. The first is a levee and wetland strategy, which suggests moving the levee to a new location further inland. The total cost for a new levee is over \$12 million per mile (over 50 years), while restoring a 200-foot-wide marsh cost about \$6.3 million per mile.

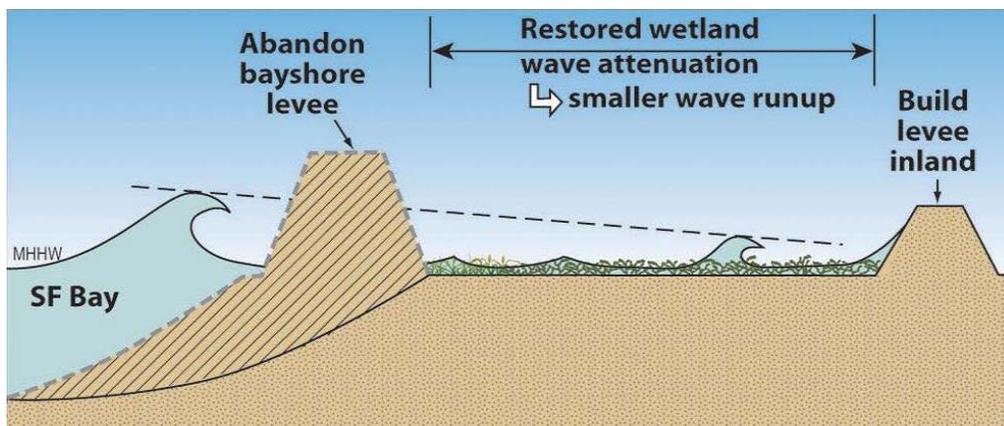


Figure 4- Retreat- Levee Relocation (Source: ESA-PWA, 2013)

- “Horizontal Levee.” The second strategy is a horizontal levee shoreline management system, which has an estimated total cost of \$6.3 million per mile (over 50yrs). The horizontal levee shoreline management system (levee, wetland and upland “ecotone slope”) would increase in elevation over time, enhance the ability of the flood risk management system to keep pace with sea level rise, and reduce damage to the levee thus reducing maintenance costs. The report demonstrated that complete tidal marshes have a better ability to provide a broad range of ecosystem and economic services; yet if restoration is delayed for too long, it may be unable to keep pace with expected sea level increases and fail to provide the desired benefits.

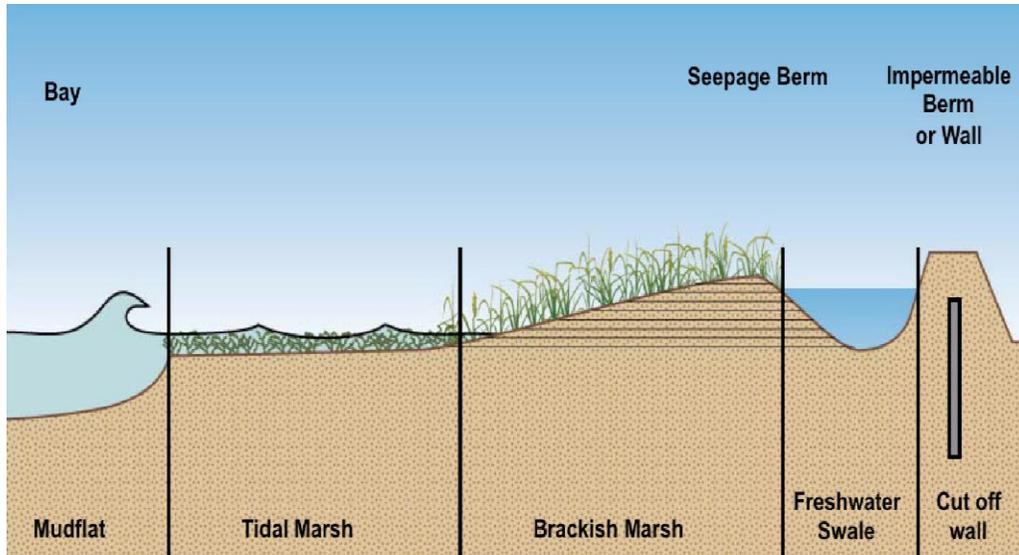


Figure 5- Horizontal Levee (Source: ESA-PWA, 2013)



Figure 6- "Horizontal Levee" (Source: ESA-PWA, 2013)

Lastly, in 2013, the San Francisco Bay Conservation and Development Commission and Corte Madera Baylands contracted with ESA-PWA to prepare, *Conceptual Sea Level Rise Adaptation Strategy for the Corte Madera Baylands*. The study reviewed existing literature, utilized field measurements, and one- and two- dimensional modeling to determine current tidal marsh and future response to sea level rise. A geomorphic conceptual model was used to identify alternative management measures for key processes of Baylands evolution and resilience. Currently, waves entering Corte Madera Bay were reduced in height and energy by roughly 80% by the time they reached the marsh edge. Both historic and restored tidal marshes are keeping pace with sea level rise; however, modeling studies suggest that they will not keep pace with accelerated sea level rise. The Corte Madera shoreline has already retreated inland by an average of 485 feet over the past 153 years and marsh habitats will continue to downshift until they are eventually lost and convert to mudflat before the end of the century. Further research is necessary to determine how much increase in sea level rise the marshes can handle.

## **B. Lessons Learned from Completed Assessments**

A review of sea level rise literature offers regional and national lessons that can be applied at the local level. The following section details recommendations on choosing sea level rise predictions, areas and infrastructure of concern, partnerships and communication.

Sea Level Rise predictions and models for California are between 10-17" by 2050 and 31-69" by 2100 (PWA, 2010), (ICLEI, 2012), (ESA PWA, 2013a). Locally, the Corte Madera Baylands study discussed above projected sea level rise rates are 6" by 2030, 11" by 2050, and 36" by 2100 (ESA PWA 2013b). Due to the uncertainty in identifying the exact quantity of sea level rise, regional studies suggest developing sea level rise models through an inclusive public process (PWA, 2010), and creating several sea level rise scenarios that include considerations for the amount of sea level rise, and variability (ICLEI, 2012). Overall, regional studies recognize an increase in depth, duration, and frequency in baylands inundation and erosion (SFBCDC and ESA PWA, 2013), with the greatest threat being from storms that occur in tandem with high tides (ESA-PWA, 2013).

The City of San Rafael has one main transportation corridor that is threatened by sea level rise and inundation. According to the 2011 SPUR Report, *Climate Change hits home: Adaptation strategies for the San Francisco Bay Area*, about half of the roads in the Bay Area are at risk of inundation and 60% of the state's railroads are at risk of a 100-year flood event. Additionally, wastewater treatment plants on the shoreline, such as the Central Marin Sanitation Agency and the Las Gallinas Valley Sanitary District, are vulnerable to a predicted 55" rise in sea level. The development of a countywide adaptation plan is recommended to ensure projects are resilient to predicted 2100 sea level rise.

Regional partnerships have developed to address and adapt to sea level rise. BCDC, ABAG and the San Francisco Bay National Estuarine Research Reserve have developed a plan to help protect the Baylands corridor through mapping, analysis, and policies to limit development, access, and shoreline modifications among other measures. Additionally, the California Emergency Management Agency provides tools to increase partnerships such as Cal Adapt ([cal-adapt.org](http://cal-adapt.org)), which provides local profiles, climate change tools, data and other resources. Furthermore, the California Emergency Management Agency, the California Natural Resource Agency, and the Federal Emergency Management Agency have indicated the importance of engaging a wide variety of stakeholders in order for vulnerability assessment strategies to be adopted, equitable, and implemented efficiently (2012).

To increase communication of sea level rise measures the Bay Area Climate & Energy Resilience Project calls for a Bay Area Campaign. The Campaign would make the case for climate change adaptation work and would tell a single science-based story explaining the impacts of climate change. The campaign should emphasize short term and long term benefits and demonstrate why it is not just a government issue (Riordan, Bruce, n.d). In developing the campaign, establishing a climate change adaptation public outreach and education program is necessary because this campaign requires community support so the potential consequences are understood. It is recommended that communication focus on raising public awareness to the potential threats of climate change and the community benefits of taking action to achieve tangible outcomes.

## **C. Approaches and Tools to Conducting a Vulnerability Assessment**

There is a wealth of sea level rise vulnerability assessment studies. Regionally and around the world, organizations have conducted assessments to better understand the impacts and possible strategies in addressing sea level rise vulnerabilities. The following is a description of the various approaches used in determining vulnerability and categorizing risk:

- Spatial Assessment of Impacts on Environmental and Socioeconomic Systems. In 1999, Klein, R. and Nicholls, R. focused on biogeophysical affects when conducting a vulnerability assessment. Their report, *Assessment of Coastal Vulnerability to Climate Change*, focused on

knowing the spatial and temporal dynamics of biogeophysical affects (flood frequency, erosion, inundation, rising water tables, saltwater intrusion, and biological effects) that trigger impacts and recommended including anticipated impacts and available adaptation options as well as environmental and socioeconomic systems.

- Map-Based Assessment and Inventory of Watershed. In 2012, the engineering firm of Aldaron Laird Trinity Associates created a GIS database to inventory and map existing shoreline conditions, assesses existing shoreline vulnerability, and identifies land uses and infrastructure that could be affected in Humboldt Bay. In the report, *Humboldt Bay: shoreline inventory, mapping and sea level rise vulnerability assessment*, the inventory included the location of tidal and upland boundary, distribution of shoreline attributes, presence of water control structures, and salt marsh. The database analysis determined that dikes are actively eroding, unmaintained, or with surfaces that are regularly overtopped. Previous fortification and rehabilitation of dikes did not offer protection from rising sea levels above 3-6 feet, with a 6-foot rise in water levels, concluding that nearly 94% of the dikes would fail to hold back rising tidewater.
- Participatory Citizen Engagement and Capacity-Building. A participatory approach has also been the focus of two sea level rise vulnerability assessments. The first study was conducted in 2011 by the UNHabitat Cities and Climate Change Initiative, *Negombo, Sri Lanka: Climate Change Vulnerability Assessment*. The purpose of the participatory approach was to build the citizen capacity to address city vulnerability to climate change scenarios and develop adaptation strategies. Data was collected through focus group discussions, interviews, field and participatory mapping, and GPS surveys. The study attempted to relate global predictions using local accounts of historic data and previous events to emphasize the evidence of climate change impacts in the city. This process was chosen to enable increased mobilization of effective local actions. In 2012, ICLEI and the Local Governments for Sustainability utilized a participatory approach to engage multiple stakeholders in developing *Sea Level Rise Adaptation Strategy for San Diego Bay*. A steering committee was organized to list guiding principles and develop milestones and deliverables. Multiple workshops and subgroup meetings were held. An adaptation working group was formed with representatives from public agencies and provided opportunities for stakeholder engagement, outreach and education to build capacity while promoting a region research agenda.
- Sector Vulnerability Analysis. The 2009 and 2011 SPUR reports (discussed above) reviewed sea level rise vulnerabilities by sector and created a storm vulnerability index (authored by Santos, M., Rio, L. & Benavente, J.). The index provides a rapid assessment of vulnerability and exposure levels and is based on location to pin-point areas of action (2013).

The aforementioned approaches demonstrate useful practices that may be adopted for the City of San Rafael's sea level rise vulnerability assessment. The general message in these approaches is that there is not one approved method for conducting a sea level rise vulnerability assessment. However, it is important that the assessment method meet the goals and needs of the community being assessed.

#### **D. Strategies in Managing Sea Level Rise**

Based on the results of various vulnerability assessments, several agencies have created a list of possible strategies in managing sea level rise. The California Emergency Management Agency, California Natural Resources Agency, & FEMA provide examples of management actions with descriptions, factors to consider, sources of information, examples of applications, funding sources, sector overlaps and co-benefits detailed by sector in their report, *California adaptation planning guide: identifying adaptation strategies (2012)*. The following list includes recommendations dealing specifically with sea level rise.

- Review any existing communitywide health assessments to evaluate their responsiveness to climate change impacts.
- Utilize mapping technologies to identify vulnerable neighborhoods show differential exposures to the health damaging impacts and can be examined from a geographical equity perspective with GIS.
- Refine emergency preparedness and response to address health impacts. Incorporate climate change risks into existing emergency preparedness plans and designs. Public health agencies should evaluate proposed/implemented climate adaptation strategies related to public health.
- Require accounting of sea level rise in all applications for new development in shoreline areas.
- Preserve undeveloped and vulnerable shorelines.
- Develop coordinated plans for mitigating future flood, landslide, and related impacts through concurrent adoption of updated general plan safety elements and local hazard mitigation plans.
- Update general plan elements to reduce potential losses of life and property from existing and increased flooding and landslide risks.
- Implement AB 167 (2002) requiring flood hazard information in the local general plan.
- Restore existing flood control and riparian corridors. Convert concrete-lined channels to soft bottomed waterways, install landscaping on embankments to slow flood water, provide natural planting to encourage biodiversity and build retention basins for percolation into aquifers.
- Implement general plan safety elements through zoning and subdivisions practices that restrict development in floodplain and landslide hazard areas. Minimize or avoid development in 100-year floodplain or landslide areas.
- Update plans that manage community infrastructure systems to include assessments of climate change impacts on community infrastructure.
- Create a “hot spots” map that identifies critical locations in infrastructure systems with economic risks and costs.
- Use low impact development stormwater practices in areas where storm sewers may be impaired by high water due to sea level rise or flood waters.
- Conduct an assessment to identify stormwater outfalls most likely to be flooded.

Additionally, as briefly discussed above, the 2009 SPUR report *Strategies for Managing Sea Level Rise* identified seven strategy measures to consider for long-term shoreline protection. These strategies are discussed below, which have their advantages and disadvantages:

- Barrier- a large dam, gate, or lock that manages tidal flows in and out of the Bay- it protects a large area of land in a single sweep with no social equity issues; however, they are expensive and ecologically damaging and they may not work.
- Coastal Armoring- linear protection such as levees and seawalls that fix the shoreline in its current place- can be used in combination with other strategies; however, it is a short term solution requiring costly annual maintenance and regular monitoring. Additionally, armored shorelines are more vulnerable to erosion and increase erosion of nearby beaches.

- Elevated Development- raising the height of land or existing development and protecting it with coastal armoring- allows structures to be built in vulnerable areas; however, this is a short-term strategy.
- Floating Development- structures that float on the surface of the water or may be floated during a flood- is largely invulnerable to changing tides, but structures do not work well in places subject to wind and wave action from storms.
- Floodable Development- structures that are designed to withstand flooding or to retain stormwater- is designed to resist damage with retention areas for ocean surges or heavy rainfall, catch water and slowly releasing it. This strategy is experimental and polluted stormwater is a public health hazard that requires combined sewer systems and new treatment facilities to ensure the released water meets water quality standards.
- Living Shorelines- wetlands are the natural shoreline formation and absorb floods, slow erosion, provide habitat, and are essential for estuarine health- requires at least 100,000 acres of tidal wetlands and the San Francisco Bay currently has 73,000 acres.
- Managed Retreat- the planned abandonment of threatened areas near the shoreline and is used when other efforts have become too expensive or are thought to be a losing battle- minimizes human suffering and is less expensive than armoring strategies, but it causes a loss of coastal property values, legal and equity issues and may require significant clean-up costs.

Some of these strategies may or may not be suitable for the Marin County Bay shoreline because of cost, environmental factors, existing development and feasibility.

## **E. Funding Sources and Regulatory Requirements**

### ***Funding Sources and Prerequisites***

There is one important factor about certain funding sources and prerequisites for grant qualification. In order to qualify for some grants, the City must have an adopted Multi-Hazard Mitigation Plan, which typically includes measures for emergency preparedness and operations. Hazard mitigation is “any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. A hazard mitigation plan identifies the hazards a community or region faces, assesses their vulnerability to the hazards and identifies specific actions that can be taken to reduce the risk from the hazards.” (ABAG, 2013) The Federal Disaster Mitigation Act of 2000 (DMA 2000) outlines a process which cities, counties, and special districts can follow to develop a Hazard Mitigation Plan. Development of this plan is a requirement for certain benefits from CalEMA and FEMA. The City of San Rafael prepared and received State-adoption of a Multi-Hazard Mitigation Plan in the mid-2000s. However, these plans must be renewed every five years. Given the age of this plan, it may not be adequate to qualify for all available grant opportunities. A review and update of the City’s Multi-Hazard Mitigation Plan should be included on the list of ‘next steps.’

The following is a list of funding sources used and referred to in the sea level rise literature provided in this paper. Some of these sources might be available for countywide or local sea level rise planning and study.

- U.S Army Corps of Engineers (USACE): is the primary federal agency funding shoreline restoration projects limited to large-scale structural alternatives. All projects funded by the USACE require reconnaissance and feasibility studies before implementation to determine

whether a federal interest exists in the project. For more information see <http://www.usace.army.mil/>.

- Section 14 Emergency stream bank and shore erosion, maximum federal contribution \$1million
  - Section 204 Beneficial uses of dredged material, maximum federal contribution for project development and construction \$5 million.
  - Section 206 Aquatic ecosystem restoration, maximum federal contribution is \$5million
- Government Issue (GI): funding requires congressional authorization and includes four phases: reconnaissance, feasibility, pre-construction engineering and design, and construction.
- California Emergency Management Agency and FEMA: provides grants for hazard mitigation including climate-related hazards planning. For more information see <http://www.calema.ca.gov/LandingPages/Pages/Grants-and-Funding.aspx>.
- U.S. Fish and Wildlife Service: requires a 50% match, normally, and federally-listed threatened or endangered species require a minimum of 25% match. For more information see <http://www.fws.gov/grants/>.
- California Coastal Conservancy: funds pre-project feasibility studies, property acquisition, planning, environmental review, construction, monitoring, and in limited cases, maintenance. Previous study projects include a consideration of sea level rise scenarios (2050-2100) to assess project vulnerability and reduce expected risks and increase resiliency to sea level rise. For more information see <http://scc.ca.gov/category/grants/>.
- North Bay Watershed Association: facilitates partnerships that promote the stewardship of the North Bay Watershed resources and has funded 17 projects totaling \$393,000 from 2008 to 2012. For more information see <http://www.nbwatershed.org/>.

In addition, the following funding sources should be explored for local sea level rise planning and study:

- One Bay Area Grant (OBAG): Grants available to Priority Development Areas (PDA) for planning and transportation/infrastructure projects. The Downtown San Rafael PDA would be eligible.
- Marin County Measure A: Marin County Measure A is a temporary ¼-cent sales tax increase that will protect the natural places, local parks, and family farms. The Measure A tax is intended to be used for the following purposes:
- Protect streams, baylands, natural areas, and wildlife habitat
  - Manage vegetation to preserve biodiversity and reduce wildfire risk
  - Protect water quality by conserving open space and other natural lands that feed our lakes, streams, lagoons, and baylands
  - Protect and preserve Marin County farms and ranches
  - Improve public access and recreational opportunities by maintaining and enhancing walking, hiking, biking and equestrian trails

Fifteen percent of the Measure A tax that is collected is made available to cities, towns, and special districts to manage their parks, nature preserves, recreation programs and vegetation to reduce wildfire risk. Locally, there are competing needs and tradeoffs that must be weighed in allocating these tax dollars. In San Rafael, the tax dollars have been allocated to public park improvements and public open space management. Use of Measure A funds may be appropriate to consider addressing sea level rise (either for assessment purposes or adaptation) on publicly-owned lands. However, such projects would have to compete with the other public park and open space projects.

- City of San Rafael – Long-Range Planning Support - General Plan 2020 Maintenance Fund: The revenue stream for this fund is a surcharge on all building permits. This fund is used to implement and manage the San Rafael General Plan 2020. As the Sustainability Element of the General Plan 2020 includes programs to support preparation of a vulnerability assessment, levee analysis and sea level monitoring and planning, this fund might be suitable to subsidize the implementation of these programs.

### ***Regulatory Requirements***

The following is a general list of regulatory requirements and/or clearances that may aid in the development of sea level rise adaptation strategies and were mentioned in the sea level rise literature.

- California Environmental Quality Act (CEQA) and National Environmental Protection Act (NEPA): the 2010 CEQA Guidelines amendments states, “*The EIR should evaluate any potentially significant impacts of locating development in other areas susceptible to hazardous conditions as identified in authoritative hazard map, risk assessments or in land use plans addressing such hazards areas.*” While an analysis of sea level rise is not mandated under the CEQA Guidelines, inclusion of this topic in environmental documents is advisable. On projects that are in low-lying areas or close to the shoreline, it has been the City of San Rafael policy to assess the potential impacts of sea level rise on a project through the environmental review process.
- Executive Order S-13-08: planning construction projects in vulnerable areas must consider a range of sea level rise scenarios.
- BCDC San Francisco Bay Plan: new climate change policies will affect design and siting requirements for some projects requiring permits from the BCDC. Any construction work that is conducted within the Bay or on upland areas that are within 100 feet of the shoreline are subject to a BCDC permit.
- Clean Water Act Section 401: requires water quality certification (from the regional water board) before a federal agency (U.S. Army Corps of Engineers) can issue a permit or license for an activity that may result in water discharge.
- Rivers and Harbors Act Section 10: requires authorization from the U.S. Army Corps of Engineers for the construction of any structure in or over any navigable water as well as the excavation/dredging, deposition of material, obstruction or alteration in these waters.
- National Historic Preservation Act Section 106: requires Federal agencies to take into account the effects of their undertakings on historic resources.
- Federal Endangered Species Act Section 7: requires all federal agencies to consult with the National Marine Fisheries Service or the United States Fish and Wildlife Service if they are proposing an action that may affect listed species or their designated habitat.
- Porter-Cologne Water Quality Act: gives the State Water Resources Control Board the ultimate authority over State water rights and water quality policy, while establishing Regional Water Quality Control Boards to oversee water quality at the local/regional level.
- California Endangered Species Act: protects and preserves all native species and their habitats, threatened with extinction or experiencing a significant decline that could lead to a threatened or endangered designation.
- California Fish and Wildlife Code Section 1602: requires any person, state or local governmental agency, or public utility to notify CDFW before beginning any activity that will substantially divert

or obstruct the natural flow of, change or use any material from, or deposit/dispose of debris, waste, or other material in any river, stream or lake.

- Magnusen-Stevens Fishery Conservation and Management Act: provides for the conservation and management of fisheries.

Please note that the above list may not be all-inclusive. There may be other agencies involved in the regulatory process for adaptation work that is completed in tidelands (e.g., State of California State Lands Commission) and navigable channels (e.g., State of California Department of Boating and Waterways).

## V. CURRENT STUDIES AND STRATEGIES UNDERWAY IN MARIN

### A. Richardson Bay Pilot Program

In 2010, the Marin County Department of Public Works initiated a pilot program in the Richardson Bay. Rather than focusing on assessing vulnerability, the pilot program employed actual engineering concepts at bay front locations along the Richardson Bay. The goals of the pilot program have been to: a) provide the education and engineering basis for adaptation planning; b) describe options along with their opportunities and constraints; c) determine costs; d) anticipate impacts; e) identify and plan for permitting; and f) prepare for grants as they become available.

Part of the pilot program effort has been the Aramburu Beach/Island Restoration Project, which was built in 2011-2012. The first demonstration project of its kind in the San Francisco Bay, it is designed to test natural shoreline approaches to wind and wave erosion, as well as sea level rise. The demonstration project involves the construction of a gravel/cobble beach with a sandy foreshore, as well as the use of wood micro groins (tree stumps). This project is currently being monitored.

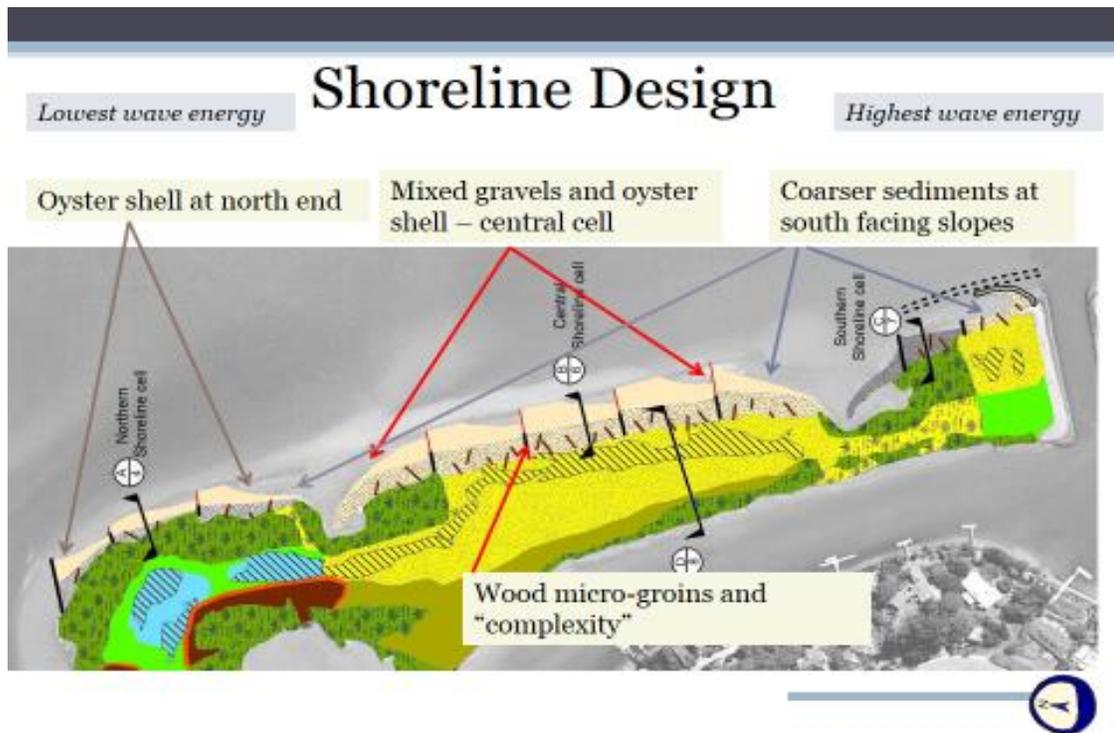


Figure 7: Aramburu Beach/Island Restoration Project 2012 (Source: Marin Co. Public Works Dept.)

## **B. C-SMART**

The Marin County western coastline is predicted to be subject to combined effects of sea level rise, more intense storms, extreme high tides and more coastal erosion. The State of California has invited local governments to apply for funding support to begin to understand, assess and prepare for these possibilities. The County of Marin, in partnership with affected local communities and leading organizations working on these issues, has proposed “C-SMART” (Collaboration on Sea-level Marin: Adaptation Response Team) to begin the process of responding to this challenge. C-SMART is overseen by the Marin County Community Development Agency. The C-SMART team includes the Marin County Department of Public Works, Office of Emergency Services, the County Counsel’s office, the Gulf of the Farallones National Marine Sanctuary, the U.S. Geological Survey, the U.S. National Park Service, Point Blue Conservation Science, the Federal Emergency Management Administration and the Coravai research and consulting firm.

In November 2013, the California Ocean Protection Council (OPC) awarded \$1.3 million to seven local governments, which includes a \$250,000 grant to a C-SMART. The project will evaluate the potential risks to homes, businesses, public facilities – including Highway 1 – as well as coastal resources such as shoreline wetlands, beaches and recreational areas that could be subject to inundation and damage from extreme storm surge events and projected sea level rise.

While C-SMART is not relevant to the San Rafael bayfront, the formula, process and output of this effort may be useful for future planning along the Bay shoreline. The take-aways include: a) assembling the right team for this project; b) finding the funding sources to conduct the project; and c) developing the appropriate scope for the study.

## **C. Marin Climate & Energy Partnership (MCEP) Efforts**

Efforts are underway to coordinate a county-wide approach to adaptation to Sea Level Rise (SLR). The [Marin Climate & Energy Partnership](#) (MCEP), a consortium of all Marin cities and some other agencies in Marin working on climate projects, in December 2013, convened a meeting of entities on behalf of the ABAG [Joint Policy Committee](#) (JPC). The intent of the meeting was to identify the major projects and priorities in Marin County that the JPC could support through a planned resource hub, which would offer financial, technical, and informational resources and guidance to local efforts to mitigate and adapt to climate change. A major discussion point was adaptation and sea level rise, and representatives from the County were there to offer insights on the projects they are involved with in the county regarding vulnerability assessments and other planning programs. MCEP has a goal to understand the current state of planning with regard to adaptation and SLR in order to become “grant ready” in 2014 to augment the efforts in the most efficient way.

## **D. Southern Marin (Vulnerability Assessment) Pilot Program**

The County of Marin is implementing a vulnerability assessment pilot program for Tamalpais Valley and Marin City entitled, *Climate Change, Sea Level Rise, Resilience and adaptation: How can we best prepare to meet the challenges ahead*. Initiated and sponsored by Marin County Supervisor Kate Sears, the project seeks to address how climate change impacts of sea level rise and storm events will affect these southern Marin communities, infrastructure, ecosystems, and economy and the strategies to pursue to reduce and manage these risks. The project area focuses on the portion of Mill Valley that touches Richardson Bay at the SASM Sewage Treatment Plan, continues along Shoreline Highway to Tamalpais Valley, and then south to Marin City. The area was selected for its diverse shoreline features, the presence of a regionally-significant transportation infrastructure that includes US101 and State Highway 1, as well as a wide variety of public, private, commercial and recreational assets.

While this pilot program primarily uses the BCDC ART Project template, the unique approach to this pilot program is that there is the commitment to engage the entire community through outreach in order to educate, share data and information and obtain feedback. Using a “grassroots” approach, it is the intent of this program to ultimately develop relevant adaptation strategies with the assistance of the community. As a pilot program, it is hopeful that this project will develop a template for other similar efforts throughout Marin County.

A 12-13-member steering committee has been formed that is comprised of community members, County of Marin (Department of Public Works) staff and BCDC staff. County/BCDC staff provide the scientific data and projections, mapping, and strategies; these are shared with the steering committee for comment and feedback. Ultimately, the steering committee will identify and evaluate possible adaptation strategies that take into account social, economic, environmental, jurisdictional, recreational and health impacts.<sup>2</sup>

### **E. Gallinas Creek Watershed Program**

As discussed in Section II (Background) above, in 2008, the County of Marin initiated the Marin County Watershed Program, which presents a 10-year work plan for five of Marin’s developed watersheds. One of the projects is the Gallinas Watershed Program, which is within the San Rafael planning area. The purpose of this project is to identify and describe the recommended watershed improvement measures and provide details on project feasibility, sequencing, preliminary costs and funding strategies. It is anticipated that some type of revenue measure (e.g., bond measure, assessment districts) will be required to implement the recommended measures.

By way of background, the 5.6-square-mile Gallinas Creek watershed has two main drainage basins. The main stream to the north is the larger of the two drainages and flows from the ridgeline down through the Santa Margarita Valley and the community of Terra Linda to its confluence with the South Fork Gallinas Creek near McInnis Park. South Fork Gallinas Creek is fed by several small tributaries that originate in the San Rafael Hills and San Pedro Ridge and flow through the communities of San Rafael Meadows, Los Ranchitos and Santa Venetia. Over the years of development in the greater valley, much of the open drainage ways west of US101 were filled or re-channeled into concrete structures. Sections of this basin are served by County Flood Zone #6 (San Rafael Meadows) and County Flood Zone #7 (Santa Venetia). Further, a Community Service Area (CSA#6) has been formed in the Santa Venetia area that covers the maintenance dredging of the channel for navigability.

The Gallinas Watershed Program will utilize a collaborative, iterative process to develop an integrated flood protection and habitat restoration program. The watershed program will build upon existing studies and develop new analytical tools to evaluate and quantify the extent of flooding and to evaluate the range of proposed solutions. This process will be summarized in a final report. The final report will also include recommendations on how to leverage local funds to attract State and Federal grant funds. The final report will provide an assessment of and describe the type of local revenue measures that could support project implementation. The current products of the work program that are underway are:

- McInnis Marsh Restoration Study- this study will study the potential for tidal restoration of the diked marshlands outboard of McInnis Park and contiguous uplands
- Las Gallinas Sediment Studies- this study will address sediment characteristics and build-up along Gallinas Creek
- Santa Venetia Storm Drain Analysis- this analysis consider options for storm drainage improvements in the Santa Venetia neighborhood

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<sup>2</sup> Meeting with Marin Co Supervisor Sears, Supervisor Aides Maureen Parton and Leslie Alden; December 18, 2013

- Levee Evaluation- the evaluation will consider levee options along Gallinas Creek. A community meeting is scheduled in January 2014 to present the results of a levee evaluation conducted by the County and the US Army Corps of Engineers.

The watershed approach considers the development of multi-benefit projects as a way to ensure that project priorities are eligible for the broadest range of funding at the State and Federal levels. The above studies will have both direct and indirect benefits to studying and planning for sea level rise.

Recently, the City of San Rafael contributed \$60,000 (includes \$20,000 from the San Rafael Airport property owner) to the Gallinas Watershed Program. This contribution can be spent on studies. The City will be working with County staff to decide where this contribution might be best directed.<sup>3</sup>

#### **F. BCDC Pilot Project for Priority Development Areas (PDA)**

In coordination with ABAG, BCDC has embarked on a pilot project that will involve assessing vulnerability in a selected group of Bay Area Priority Development Areas (PDA) that are in low-lying areas and close to shorelines. The Downtown San Rafael PDA is one of the areas selected for this pilot project for several reasons: 1) it is relatively close to the Bay shoreline and has an immediate linkage to the San Rafael Canal; 2) is developed at low elevations with much of the area within the FEMA 100-year flood hazard zone; and 3) is an area that would be greatly impacted by predicted rises in sea level.

Right now, little is known about how this program will be developed, except that it will follow the BCDC ART template. The pilot program will not only will not only establish a base for the scope of a vulnerability assessment but will identify adaptive strategies that are will likely be suitable for the unique characteristics and circumstances found in these PDAs. BCDC staff has commissioned a consultant in this effort and work is expected to be underway in early 2014.

### **VI. ASSESSING LOCAL CONDITIONS AND OPPORTUNITIES**

#### **A. Identifying San Rafael's Levees and Shorelines**

San Rafael has a diversity of shoreline and bayfront conditions. Conditions range from flat shorelines that are developed with levees and sea walls to steep uplands that drop to tidelands. Further, there are low-lying areas of the City that are developed, but are vulnerable to sea level rise because they were formerly tidelands or tidal marsh. A broad, general review of the San Rafael bay front and shoreline conditions has been completed; the information in this paper is not based on technical engineering studies of the levees or shorelines. Rather, the following five areas of San Rafael have been identified based on general, long-term knowledge of the community and past history of flooding, inundation and infrastructure failure during past storm events and high tides:

Section A Downtown - San Rafael Creek; general area is filled and developed at low elevations

Section B Inner Canal- San Rafael Creek, general area around creek is filled and developed at low elevations

Section C East San Rafael Shoreline; general area bordering the San Rafael Bay is filled and developed at low elevations; some shoreline levee protection

Section D San Pedro Peninsula; varying shoreline conditions ranging from filled lands developed at low elevations to steep uplands transitioning to tidelands; some levee and sea wall protection

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<sup>3</sup> Meeting with Marin County Department of Public Works; December 16, 2013

Section E Gallinas Creek Basin; general area around Gallinas Creek (two forks) including filled and developed low-lying areas (e.g., Santa Venetia, Marin Lagoon, Contempo Marin); limited levee protection

See Appendix A for a list of sites and properties that have been identified for each of the five areas.

### **B. Identifying Adaptation Strategies Potentially Suitable for San Rafael**

Based on the research summarized in this paper, there are a number of adaptation strategies that may be suitable for study by San Rafael. The following strategies should be considered and studied in conjunction with the preparation of a vulnerability assessment:

1. Develop and adopt an “overlay zone” in areas prone to potential sea level rise. Adopting an overlay zone (e.g., County of Marin Baylands Corridor designation), provides a nexus to require, as part of individual site review for development: a) a study of sea level rise impacts to the site and project; and b) the ability to impose adaptive measures on the site (e.g., non-development areas, setbacks, sea walls).
2. “Hold-the-line” levee/sea wall enforcement. Some areas of the San Rafael shoreline that are developed with levees may be suitable for raising or structural enhancement to adapt to rising tides. Possible areas suitable for this strategy are Spinnaker Point and the Peacock Gap/Glenwood shorelines.
3. Retreat and conversion of undeveloped upland and diked baylands to tidal marsh. This strategy may be suitable for some areas in San Rafael. There are a number of sites that border the Bay and creeks that should be studied (e.g., Canalways, Canal-side area of Pickleweed Park, McInnis Park/San Rafael Airport).
4. “Horizontal Levee” that converts mudflats to marsh plain. The horizontal levee concept has been successfully studied in other areas of the Bay. The outboard tidelands in southeast San Rafael may have the characteristics and conditions suitable for this strategy.
5. “Barrier” or controlled/locked gate system. This type of improvement is effective in controlling tide levels along channels but is very costly to install and maintain. Nonetheless, the feasibility of a gate system at the mouth of the San Rafael Creek/Canal should be studied.
6. Continued dredging of San Rafael Creek/Canal for basin drainage. While it may not be a tool for combatting sea level rise, maintaining the Canal as a navigable channel will help the flow of runoff from upstream. Depending upon the level of contamination, the dredged spoils may be locally useful for other adaptive strategies (e.g., raising or reinforcing levees).

### **C. Identifying Potential Opportunity Areas for Adaptation**

Given the diversity of shoreline and bayfront conditions, there are a number of potential “opportunity areas” within San Rafael that should be studied to determine their suitability for successful mid-term and long-term employment of adaptive strategies. Please see Appendix B of this paper, which identifies a number of potential sites and areas from the Gallinas Basin in North San Rafael to the Southeast San Rafael shoreline. For each potential site, information has been provided on property ownership (e.g., private vs. public ownership), property zoning, site/area characteristics and conditions/constraints. Further, for each sites/area, a potential adaptation measure has been identified.

Please note that the suggested adaptation strategies presented in Appendix B are not based on any technical or quantitative study. These strategies are not presented as solutions; these are to serve as a starting point for discussion to determine if they are worthy for review and further study. A more detailed study and analysis of the more broad conditions of the San Rafael shoreline and the individual site/areas

may conclude that suggested strategies in Appendix B may provide to be infeasible or inappropriate. Nonetheless, the suggestions are intended to serve as a starting point for future study and more importantly, to document opportunity areas.

## VII. CHALLENGES

Moving forward, there will be a number of challenges that need to be acknowledged and considered before preparing a vulnerability assessment. The following is a brief discussion of the challenges:

1. Assessment and long-term strategy planning for sea level adaptation cannot be done in isolation or be “piecemeal” in its approach. There are no jurisdictional boundaries to the impacts of or planning for sea level rise along the the Marin Bay shores and beyond.
2. Assessment and planning requires the involvement of multiple agencies. Given the complexity of this issue assessing and planning requires the participation, coordination and resources of a number of agencies. In addition to the City of San Rafael, other participating agencies would include, among others, County of Marin, BCDC, Regional Water Quality Control Board, FEMA, and US Army Corps of Engineers.
3. The number of stakeholders involved and effected is substantial. In the Central San Rafael Basin alone, there are thousands of property owners and business owners that are impacted by projected sea level rise, as well as the cost and implications of potential adaptation solutions. Public outreach and participation is critical.
4. Information on sea level rise continues to evolve which could impact impact long-range planning. For example, in the short-term, the long-awaited update of the FEMA FIRM maps will present new flood zone mapping information that may have broader area impacts and will likely result in higher insurance costs to effected property owners.
5. San Rafael has diverse shoreline and levee conditions that vary by neighborhood and area. So, a “one-size-fits-all” approach to long-term adaptation strategies is impossible. While an areawide assessment is critical, the assessment must carefully look at and consider localized conditions and solutions.
6. City resources and funding are limited. At this time, there are no Public Works Department staff resources, nor is there an earmarked City budget to intiate the preparation of a vulnverability assessment.
7. Long-term adaptation strategies will require trade-offs. Some of the adaptation strategies would have environmental implications that may be at-odds with current policies and priorities. For example, the retreat strategy that converts upland or seasonal marsh to tidal marsh could significantly impact private property rights, private view loss, and biological resources. Assessing the trade-offs will require the cooperation of and coordination with the appropriate stakeholders.
8. Long-term adaptation strategies will be costly. The cost of strategies such as “barriers” could be staggering. Even the raising of an earthen levee is extremely costly unless fill material is locally available. Planning the appropriate strategy for an area will need to consider cost in addition to effectiveness. While federal, state and other agency sources may be available to partially fund these strategies, the formation of assessment districts or other taxing measure will likely be necessary.

## VIII. NEXT STEPS

The following is a list of suggested tasks and actions to consider and pursue:

1. Prioritize Preparation of a Vulnerability Assessment
  - Investigate and determine Public Works Department staff resources needed to pursue next steps
2. Investigate and Pursue Funding Sources for Staffing, Studies and Adaptation
  - Monitor and pursue funding opportunities such as federal grants, OBAG grants
3. Engage in Countywide and Regional Efforts
  - Identify County, state, and regional agencies with Bay and shoreline oversight; participate in coordinating a collective effort, partnership and/or assistance in preparation of a vulnerability assessment
  - Consider re-joining the North Bay Watershed Association as it provides a good source for shared information and studies, as well as funding opportunities
4. Identify Stakeholders and Initiate Outreach
  - Utilize Community Engagement Strategy in identifying stakeholders
  - Initiate early outreach
5. Continue to Monitor and Participate in Studies and Efforts Underway
  - Monitor updates to FEMA FIRM Maps; document changes as needed
  - Work with and participate in County of Marin Public Works Department Gallinas Creek Watershed Project
  - Monitor and participate in BCDC Pilot Project for Priority Development Areas (PDA)
6. Complete Tasks to Stay Current on Data and to be Eligible for Funding Opportunities
  - Update GIS (Map Guide) maps as necessary to include new data as it becomes available (e.g., update of FEMA FIRM maps, mapping areas of vulnerability, mapping inventory of levees and shorelines); utilize GIS as a tool for tracking
  - Review and commission update to City of San Rafael Multi-Hazard Mitigation Plan
  - Complete an inventory of levees and shorelines
  - Raise FEMA elevation requirement for construction
7. Pursue Preparation of a Vulnerability Assessment
  - Assessment should include Identify long-term adaptation strategies
  - Assessment should identify tools for planning and localized implementation including adoption of a Bayfront Corridor zoning overlay or land use designation, continued Canal dredging
8. Commit to Long-Term Implementation and Programming
  - Identify tools for funding strategy implementation (e.g., including assessment districts or other taxing measures)

