Adapting to Rising Tides: Contra Costa County Assessment and Adaptation Project

March 2017

Executive Summary

Contra Costa County is one of the nine Bay Area counties and is the ninth most populous county in the state - home to over one million residents. In the coming years Contra Costa faces a number of opportunities, as well as numerous challenges. Many regionally important assets and services are located in the Contra Costa County project area including four of the five refineries in the Bay Area which provide important service to the entire region and the state. Other important assets include the Port of Richmond, passenger and cargo rail lines, communities with affordable housing, employment centers, wetlands, creeks, popular parks, many miles of Bay Trail, and 19 diverse cities and a many unincorporated communities. Many of the challenges faced in Contra Costa are familiar to communities around the Bay Area, such as the need for affordable housing, increased traffic congestion, issues of equity, a need for diverse and well-paying employment, safe and healthy neighborhoods, and current seismic and flood risks. In addition, the county is learning how to view these current challenges in light of the future risks associated with climate change, such as increased flood risk, higher heat, changes in ecological systems and possible changes to drought patterns.

The Adapting to Rising Tides (ART) Program conducted a climate adaptation planning effort in Contra Costa County, focusing on the risks to the county from current and future flooding, while also considering the other challenges and opportunities facing the county. Local interest in understanding and addressing these challenges led the ART Program to initiate a project along the Contra Costa County shoreline extending from Richmond to Bay Point. Additionally the ART Program was interested in conducting a project that could reveal diverse vulnerabilities and consequences. The Contra Costa shoreline, with its varying local topographies (from bluff to wetland to creek mouth), different types of land uses, diverse communities, and the presence of extensive rail and energy infrastructure, offered an excellent opportunity to better understand the varied vulnerabilities and consequences of current and future flooding. This project, along with others around the region, will increase local and regional capacity address the myriad challenges posed by sea level rise.

Over the past two years the project has produced many valuable products, partnerships and increased the knowledge and information needed for long term flood resilience in Contra Costa County. Some of the key outcomes of the work include:

- A diverse and capable working group
- Broad resilience goals
- Locally refined sea level rise maps and shoreline analyses
- A robust vulnerability assessment
- An understanding of how flooding may impact the four sustainability frames
- Detailed adaptation responses
- A clear and compelling case for taking action both together and individually
- A path forward toward resilience

Six key planning issues were also identified which encompass many of the vulnerabilities and adaptation responses that will have the greatest impact on the sustainability and resilience of Contra Costa County, particularly around issues related to society and equity, economic, environmental, and governance. Below are the key planning issues and a sample of the adaptation responses developed to address them.

- Water-dependent Industries

  Key Issue:

  The County's seaport, marine oil terminals, and shoreline refineries are at risk from current and future flooding, additionally these assets rely on transportation and utility networks that are vulnerable to sea level rise and storm events. Flooding of critical roads, rail lines, or pipelines both within the county and beyond could hinder critical goods export and import, negatively impacting the local and regional economy.

  Example Response:

  Advocate for the incorporation of sea level rise into the State's Regional Goods Movement Plan to ensure water-dependent industry supply chains (marine, rail, road transportation) are maintained.

- Employment Sites

  Key Issue:

  Commercial and industrial businesses in the project area that provide locally and regionally significant employment opportunities are clustered in Richmond and Martinez. Workers from within and outside of the county commute to employment sites, and vulnerabilities in the local and regional transportation system could impact their ability to reach their jobs. Flooding that disrupts the transportation system could also disrupt critical supply chains that employment sites rely on, resulting in lost employee wages and reduced output and profit.

  Example Response:

  Implement an annual King Tide site monitoring and inspection program to document local and regional critical transportation routes and nodes at early risk from flooding.

- Creek-side Communities

  Key Issue:

  Shoreline communities in the project area located in or near the floodplain of a tidal creek or channel are likely to experience flooding as sea levels rise. Members of creek-side communities have limited control over the maintenance and management of the creeks and channels they rely on, and those that are linguistically or socially isolated, elderly, very young, disabled or mobility-challenged, are less able to prepare for, respond to or recover from flood events. Community members with these specific characteristics can face difficulties evacuating and finding temporary shelter during a flood event as they depend on others for mobility, personal care and support, rely on universally accessible transportation and shelter-in-place facilities, and may require special care or equipment.

  Example Response:

  Support community-driven proactive relocation out of high hazard areas by providing funding and technical assistance particularly to low-income households, renters, and those that do not own vehicles.

- Access to Services

  Key Issue:

  A lack of redundant transportation options and the limited number of public facilities in this part of the County may result in shoreline communities becoming isolated from emergency services, public and private healthcare providers, jobs, schools, and other critical services during flood events. This could have significant consequences on public health and safety, local economies, and community function, and will be a particular challenge for communities with characteristics that place them at

greater risk of flooding.

Example Response:

Provide incentives or require facilities that provide critical public services either have access to temporary flood protection devices or retrofit with permanent flood protection solutions.

- Ad-hoc Flood Protection

  Key Issue:

  Some communities are protected from coastal flooding by rail lines, shoreline parks, and tidal wetlands. While these built and natural areas reduce the flood risks of adjacent communities, assets and infrastructure, they have not been specifically designed or maintained for this function and therefore provide only "ad-hoc" flood protection. Increased wind, wave and tidal energy, higher extreme high tides, and more frequent exposure to the tides as sea levels rise can decrease the ability of these ad-hoc systems to maintain the flood protection benefits they currently provide.

  Example Response:

  Initiate tidal wetland restorations that will protect and enhance the broad benefits they provide, including flood risk reduction, habitat, biodiversity, and water quality.

- Parks and Open Spaces

  Key Issue:

  Shoreline parks and open spaces are not only the first line of defense against inland flooding, they are also themselves vulnerable to the early impacts of sea level rise and therefore are key early adaptation opportunity sites. Damage or loss of these parks and open spaces would have significant impacts on recreational uses and health of the communities in the project area, many of which could not be replaced. Reduction in access to parks and open spaces would affect some individuals and communities more adversely than others, depending on their unique needs and capacity.

  Example Response:

  Establish a new authority, or expand an existing authority, to plan, fund, manage and maintain shoreline solutions to protect existing parks, open space, and the Bay Trail

This report is a summary of the products and outcomes from the project team and working group. It is intended to serve as a valuable resource for advancing resilience action in Contra Costa County, the region and providing information that can be used by other communities around the region. The following chapters provide an introduction to the ART Program and a summary of the planning process followed for this project. The remainder of the report and its appendices include detailed assessments of 30 asset categories from 11 sectors and key planning issues; the adaptation responses developed for asset categories and key planning issues; a summary of the mechanisms for evaluating specific responses; and guidance for implementing four of the key actions.

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Adapting to Rising Tides Program Introduction and Overview

In 2011, the San Francisco Bay Conservation and Development Commission (BCDC) and NOAA's Office for Coastal Management (NOAA OCM) brought together local, regional, state and federal agencies and organizations, as well as non-profit and private associations for a collaborative planning project along the Alameda County shoreline to identify how current and future flooding will affect communities, infrastructure, ecosystems and economy.

Since then, the ART Program has continued to both lead and support multi-sector, cross-jurisdictional projects that build local and regional capacity in the San Francisco Bay Area to plan for and adapt to sea level rise and storm event flooding. Through these efforts the ART Program continues to test and refine an adaptation method (the ART Approach) that ensures planning processes include these three core principles:

- **Collaborative by Design.** Climate change, similar to habitat conservation, hazard and watershed planning, requires decision-making to happen across jurisdictions, geographies, sectors, and time frames to address complex, cross-cutting issues. ART emphasizes convening and closely collaborating throughout a planning process with a stakeholder-working group representing the diverse values, viewpoints and responsibilities relevant to the project, to build relationships that lead to future collaborations.

- **A Transparent Process.** To build a strong, actionable case for adaptation, the ART Approach adheres to transparent decision-making throughout the planning process. ART Design Your Project guidance and supplies help maintain transparency and support clear communication to stakeholders about decisions and project outcomes, including resilience goals developed and agreed upon by the working group, and evaluation criteria that clearly reflect priorities and objectives.

- **Sustainability from Start to Finish.** A core aspect of ART is consideration of the relevance and implications of all aspects of sustainability in each step of the planning process, from who is included in the initial working group list to what evaluation criteria are selected to evaluate adaptation responses. ART uses four sustainability frames, discussed in Figure 1.

Figure 1 Four Frames of Sustainability

Sustainability From Start To Finish

A Core Component of ART is considering the relevance and implications of all aspects of sustainability throughout a project. Four Sustainability frames are incorporated into each step of the planning process, beginning with the development of the initial working group list, all the way to the selection of criteria to evaluate adaptation responses. ART frames these components of sustainability as:

SOCIETY AND EQUITY	ECONOMY	ENVIRONMENT	GOVERNANCE
Effects on communities and services on which they rely, with specific attention to disproportionate impacts due to inequalities.	Economic values that may be affected such as costs of physical and infrastructure damages or lost revenues during periods of recovery	Environmental values that may be affected, including ecosystem functions and services, and species biodiversity.	Factors such as organizational structure, ownership, management responsibilities, jurisdiction, mandates, and mechanisms of participation that affect vulnerability to impacts.

Throughout the Bay Area, the ART Program is helping integrate adaptation in local and regional planning and decision-making in multiple ways:

- **Leading collaborative adaptation planning projects** that build a comprehensive understanding of climate vulnerability and risk, develop effective and equitable adaptation responses, identify opportunities for implementing these responses and build capacity across the region to increase resilience.
- **Assisting adaptation planning efforts** with consistent staff support that includes recommendations, tools and approaches for selecting climate impact scenarios, tools, approaches and data to identify vulnerabilities and consequences, assist with selecting adaptation responses through the use of evaluation criteria and help with process and meeting design, review of work products and more.
- **Providing the ART Portfolio** which combines a comprehensive set of online resources, including how-to guides, tools and findings, with Help Desk support from experienced ART Program staff to enable users to make use of Portfolio resources to efficiently and effectively assess and plan for climate impacts.
- **Building regional capacity for adaptation** by working with local, regional, state and federal agencies to find funding, and develop capacity and support at all scales for this work.
- **Advocating for adaptation** through communicating findings, issues, processes and needs to state and federal agencies to ensure that grant and other assistance programs are informed by and responsive to conditions in the Bay Area.

ART in Alameda County

The initial ART Program project in Alameda County assessed sea level rise vulnerability and consequences across the Alameda County shoreline from Emeryville to Union City. The ART Alameda County Project

analyzed assets in twelve sectors: airport, community land use, contaminated lands, energy, infrastructure, pipelines and telecommunications, ground transportation, hazardous materials, nonstructural shorelines/natural areas, parks and recreation, seaport, stormwater, structural shorelines and wastewater. The impacts of sea level rise and storm events on these asset categories were evaluated, and the climate vulnerability and risk of representative and specific assets were determined. The ART Project staff and working group used the vulnerability and consequence assessment to identify key issues and develop adaptation responses and implementation options intended to improve the project area's climate resilience.

Adaptation responses were developed for specific assets, asset categories, and jurisdictions and at all assessment scales, from asset scale to federal scale. Additionally, the ART Alameda Project identified five key issues that were critical to the region and needed further assessment. These five issues, are referred to as overarching vulnerabilities because it was determined that they applied to the region, not just the study area, and that they needed to be addressed at a broader than local scale. The five overarching issues are:

- **Certain Land Uses.** Certain types of land uses are particularly vulnerable because of the specific functions they serve, and because they are difficult to protect, evacuate, or rebuild. If these land uses are damaged or their function is disrupted there can be significant consequences on public health and safety. Many of the plans, policies and practices that guide land use and capital investments do not consider sea level rise or storm events, and action at the local, regional, state and federal levels will be necessary to ensure that as the region grows that these land uses, and the people who rely on them, are not put at risk.
- **Population Characteristics.** There are particular characteristics that can make individual members of a community, or a community as a whole, especially vulnerable to sea level rise and storm events. These include lacking the financial means, the physical capacity, necessary information, or access to services to prepare for and respond to flooding or other hazards. Past disasters have demonstrated the consequences on public health and safety, as well as the local and regional economy, of not factoring specific community characteristics and needs into emergency and land use planning and policy making.
- **Networked Infrastructure.** Networked infrastructure that is connected as a continuous corridor or as a series of contiguous segments is particularly susceptible to disruption because it is generally only as resilient as its weakest link. Disruptions to one segment can cause cascading secondary impacts in adjoining segments or even farther away, resulting in a system-wide failure. This is especially true for long and linear ground transportation assets in the ART Alameda project area such as the Bay Trail and the regional rail system, as well as the utility infrastructure and the system of shoreline protection along the Bay's edge. Disruption of networked infrastructure can cause widespread economic and community consequences. The people and property that are protected by, or rely on these systems should be included in planning and funding decisions regarding maintenance, repair or upgrade.
- **Information Gaps.** There were significant gaps in the quality and availability of information needed to understand the social and physical dimensions of vulnerability and risk for every asset category assessed. For example, there is a growing but still very limited understanding of how natural, dynamic shoreline systems will respond to sea level rise, a lack of centrally coordinated, up-to-date, accurate information about hazardous material sites and contaminated lands, and limited access and availability of information on the ownership, location and condition of energy, pipeline, telecommunication, and stormwater infrastructure. These information challenges make it difficult to accurately characterize the vulnerability of shoreline communities and assets, and pose a barrier to further action.
- **Emergency Preparedness and Response.** Emergency plans, policies and practices in the ART Alameda project area and elsewhere do not consider storm events that could affect areas not currently at risk of flooding, or the contingencies and secondary impacts associated with widespread or longer lasting future storm events. Most plans do not identify or address the specific

needs of particularly vulnerable community members, and the information necessary to improve these plans is not always available, correct, up-to-date, or easily accessible. In addition, those that own or manage community assets, such as transportation and utility infrastructure that are critical during an emergency or disaster, do not have control over the lands that provide access to their facilities or the shoreline that protects them. Targeted information gathering and coordinated and, in some cases, shared decision making will all be necessary to avoid the widespread consequences of not addressing the future flood risks.

These findings gained broad interest and support from communities and stakeholders around the Bay Area, and led the ART Program initiating new projects including the Contra Costa County ART Project.

Figure 2. Contra Costa Coastline

The Contra Costa ART Project

Why ART in Contra Costa County

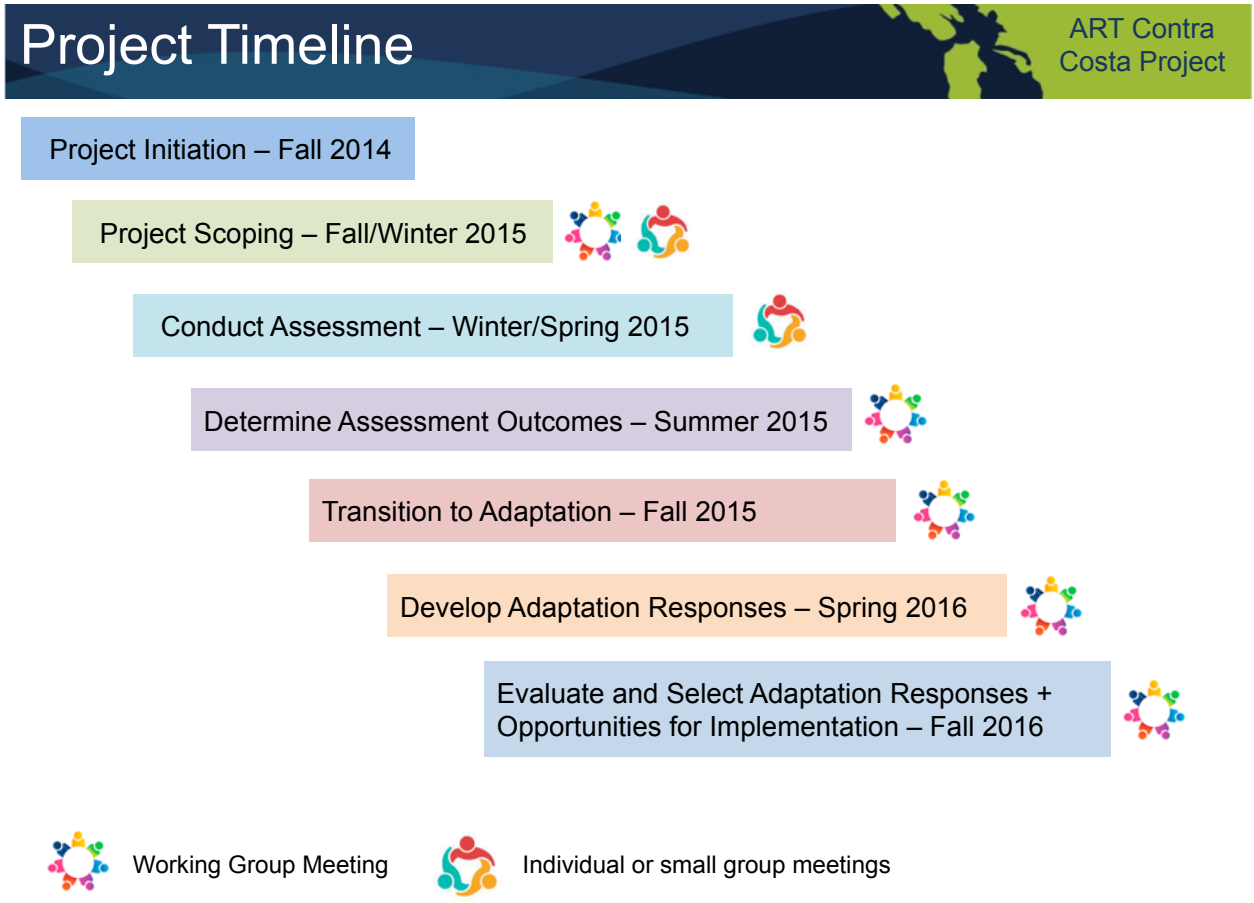
There was a strong local response from West and Central Contra Costa County in 2010 when BCDC asked local agencies and organizations about their interest in being the first ART project. Ultimately, Alameda County was chosen as the location for the ART Pilot Project, based on broad local support and commitment to participate, significant regional transportation infrastructure, and a shoreline at risk from current and future flooding. Upon the completion of ART Alameda County, the ART Program initiated several projects including ART's Hayward Shoreline Resilience Study, ART's Oakland/Alameda Resilience Study, sector specific assessments in transportation and parks and Safer Housing, Stronger Communities conducted in partnership with the Association of Bay Area Governments (ABAG). In 2014, based on the strong demonstrated interest from Contra Costa County representatives, the ART Program initiated a project along the Contra Costa County shoreline extending from Richmond to Bay Point. In addition to local interest and the availability of resources to convene and lead a second county-scale project, the ART Program was interested in conducting a project that would continue to provide information to the region and reveal different vulnerabilities, consequences and issues then the Alameda project, building upon the findings and conclusions of that project. The Contra Costa shoreline with its varying local topographies – from bluff to wetland to creek mouth – the different types of land uses and communities, and the presence of significant rail and energy infrastructure, offered an excellent opportunity to increase local and regional understanding of both current and future flooding. Using the ART adaptation planning process, tools, and data, staff from the ART Program worked with local jurisdictions, agencies, and organizations in Contra Costa County to understand the vulnerabilities and consequences the local shoreline communities may face, including the disproportionate impact to community members with characteristics that may make them more vulnerable to flooding, the disruption of transportation and utility infrastructure, the potential loss or disruption of employment sites, and limitations on access to goods and services. Ultimately, working with local stakeholders the project identified shared and individual actions that will help improve resilience to sea level rise and other climate change impacts both along the Contra Costa shoreline and throughout the region.

The ART Planning Process in Contra Costa

The ART Program's work in Contra Costa County was initiated in the fall of 2014. The ART Program worked with local representatives to scope a near countywide project that would meet local needs and help increase the region's understanding of the current and future challenges of a rising Bay. Over a two-year period, the ART Program led a diverse stakeholder-working group through a five-step planning process (See Figure 3) that was grounded in the ART Approach. Together, staff from the ART Program and a stakeholder-working group developed an understanding of how current and future coastal and riverine flooding may impact transportation and utility networks, industrial facilities and employment sites, residential neighborhoods and community facilities, and shoreline park and recreation facilities. The consequences of flooding both within and beyond the communities, assets and infrastructure in project area were also considered, with a particular focus on the potential for disproportionate consequences to community members with characteristics that may make them more vulnerable to flooding. The project resulted in extensive analyses, maps and other products that will help guide communities and managers in Contra Costa County to build resilience and adapt to rising tides. Figure 4 shows the timeline of the project, and the following sections will detail the process, tools and practices used in in each step of the project's planning process.

Figure 3 ART Planning Process

Figure 4 Planning Timeline



Scope and Organize

The first step in the ART planning process – Scope and Organize – is a critical step in the process and provided the ART Program staff team and a Contra Costa County working group the opportunity to identify the project location, the critical participants, the issues to be addressed and the assets and services that were important to include in the project. In scoping the project, ART staff worked with local representatives to identify and invite a diverse group of stakeholders to participate in the project's working group. A primary goal for the working group was to ensure that members had strong knowledge and expertise of the communities, services and assets in the project area, however, anyone who wanted to participate was welcome. The working group brought together diverse perspectives from city and county agencies, communities, the private sector, community-based organizations and NGOs. Members of the working group included representatives from six County Departments, all four shoreline cities, eight special districts, regional transportation and planning agencies, state and federal agencies, as well as private utilities, refineries, community-based organizations, and economic/industrial councils (see below).

Staff from the ART Program convened and led the stakeholder-working group in defining the scope and scale of the project to determine the expected outcomes of the project. Engaging the working group in defining the project was critical to ensuring the outcomes were based on a collaborative, transparent process. In scoping the project, a variety of issues that were important to the working group and the ART Program were balanced against available resources and data. One of these challenges was the lack of

Working Group Members

CITIES
Richmond
San Pablo
Pinole
Hercules
Martinez

COUNTY DEPARTMENTS
Department of Conservation and Development
Health Services
Water Agency
Flood Control and Water Conservation
Office of Emergency Services
Mosquito and Vector Control

DISTRICTS, AUTHORITIES, COMMITTEES
Contra Costa Water District
West County Wastewater
Central Contra Costa Sanitary District
East Bay Municipal Utility District
East Bay Regional Parks District
Mt View Sanitary District
Contra Costa Resource Conservation District
Contra Costa Transportation Authority
West Contra Costa County Transportation Advisory Committee
Capitol Corridor Joint Powers Authority

REGIONAL, STATE AND FEDERAL AGENCIES
Association of Bay Area Governments
Metropolitan Transportation Commission
Bay Area Resilience Collaborative
California Department of Transportation District 4
San Francisco Estuary Partnership
San Francisco Bay Trail
State Coastal Conservancy
Federal Emergency Management Agency
NOAA Office for Coastal Management
Office of Assembly member Tony Thurmond
Office of Representative Mike Thompson

NON-GOVERNMENTAL ORGANIZATIONS
Republic Services
Pacific Gas and Electric
Point Blue Conservation Science
Tesoro Martinez Refinery
Plains All American Pipelines
ESA Associates
Chabot Space and Science Center
Communities for a Better Environment
Environmental Justice Coalition for Water
Breakthrough Communities
East Bay Economic Development Alliance
Tom Leader Studio
UC Berkeley Office of Environment, Health & Safety

accurate sea level rise inundation mapping for Eastern Contra Costa County, which coupled with limited overall resources for the project resulted in the project's eastern boundary being set at Bay Point.

The first working group meeting, held March 23, 2015, ART staff introduced the ART Program, explained the benefits and outcomes of the ART Approach to adaptation planning, confirmed the geographic boundaries of the project, the climate impacts and scenarios to be considered, and the sectors and assets to be assessed. At this first meeting ART staff began the process of engaging the working group in setting the project's resilience goals that would guide Contra Costa's adaptation planning process.

PROJECT AREA

In collaboration with working group members and other stakeholders the ART team defined the project area, considering available data and information, and ensuring the area included a significant number of communities, infrastructure and natural areas at risk from rising sea levels. The project boundary includes West and Central Contra Costa County shoreline from Richmond to Bay Point (Figure 5). The project boundary was extended approximately ½ mile inland from the area potentially inundated by 6 feet of sea level rise during high tide (mean higher high water, MHHW), to the nearest major roadway or natural feature in order to includes areas potentially impacted by both coastal and riverine flooding.

Figure 5. Contra Costa County Project Area

CLIMATE IMPACTS AND SCENARIOS

The Contra Costa ART project evaluated both current and future flooding that could either be temporary or permanent in nature. Temporary flooding is generally short in duration but can have long lasting consequences on some types of assets and services. Some areas along the Bay shoreline or along creeks and rivers already experience temporary flooding. This temporary flooding usually occurs when there are storms over the Pacific Ocean during the winter, when high tide coincides with strong winds or when significant rainfall occurs over short durations and causes creeks and rivers to rise over their banks. While some assets and areas can maintain their function after the water recedes, other assets can suffer irreversible damage if exposed to any amount of water, even temporarily. Permanent inundation occurs if an area is exposed to regular daily flooding. Currently, only natural areas such as tidal flats, wetlands, ponds and creeks, are permanently inundated in the project area.

As sea level rises, higher water levels will become more frequent, increasing the extent, depth, and duration of temporary flooding and expanding the area that is permanently inundated. These impacts will not be confined to the shoreline as sea level rise will also affect tidal creeks. As the Bay rises, water levels in tidal creeks will also rise, pushing the extent of tidal influence further upstream, potentially making riverine flooding that already occurs worse. Furthermore, many urbanized areas are served by a network of infrastructure that require gravity to drain. Near the shoreline these networks typically outfall to the Bay or tidal creeks. Some of these systems are already at capacity or are already experiencing back ups during high Bay water levels. As sea levels continue to rise, the ability of these systems to move water effectively and efficiently will be impaired, and additional areas may begin to experience localized flooding (i.e., roads, basements, and parking lots).

Climate Impacts

Current and future flooding can have a number of impacts on communities, infrastructure and natural areas. The Contra Costa ART project considered the following impacts that could occur from either temporary or permanent coastal flooding, riverine or localized nuisance flooding:

- **Areas that currently flood may flood more frequently:** Rising sea levels can lead to more frequent flooding in existing flood-prone areas. This flooding can result in more frequent disruption of power, access to goods, services and jobs; can strain regional and local disaster response and recovery resources; and, result in economic losses if job sites, government services, and businesses are disrupted by a loss in communications, utilities, or goods or commuter access.
- **More extensive, longer-duration flooding in areas that currently flood and flooding of new areas:** As sea levels rise, there is the potential that storm events will flood larger areas for longer periods of time, including areas that flood now and areas that do not currently experience flooding. This can result in damage to structures and contents, disruption of power, water supply and wastewater services, and reduced access to goods, medical care, schools, jobs and other critical services. Power outages can damage homes and businesses that rely on electric sump pumps to keep below grade work, living or storage spaces dry. More extensive and longer duration flooding can also create a disproportionate burden on community members that are the least able to prepare, respond or recover from a hazard event.
- **Permanent inundation of areas currently not exposed to regular tides:** Sea level rise can cause areas that are not currently exposed to regular high tide inundation to be flooded, resulting in the need to either protect or move people and infrastructure, and the loss of trails, beaches, vistas, and other shoreline recreation areas. Prolonged inundation may cause the mobilization of pollutants from contaminated lands such as closed landfills, the release of sewage, hazardous or toxic

materials from wastewater treatment plants, storage tanks, pipelines, or industrial facilities, and can increase sedimentation in tidal creeks and flood control channels.

- **Shoreline erosion**: More extensive, longer duration flooding can cause shoreline protection, such as levees, berms and revetments, to be damaged or fail to due to increased water levels and wave energy. Erosion or scouring due to tidal and wave energy can damage structures such as roads, bridges, culverts, stream banks, embankments, foundations, bridge footings or piers.
- **Elevated groundwater and increased salinity intrusion:** As sea levels rise, groundwater and salinity levels are also predicted to rise. This will cause damage to below grade living spaces, finished basements, and electrical/mechanical equipment that is below or at-grade. In addition increasing groundwater levels can increase liquefaction susceptibility, require pumping in areas that are currently gravity drained, and increase both operations maintenance costs.

Climate Scenarios

The Contra Costa ART project used both an understanding of today's extreme tides that occur during storm events and tomorrow's future tides based on current best available sea level rise projections to assess how and when temporary or permanent flooding may occur, and to determine what assets may be impacted. Projections are based on climate model simulations that depend on assumptions about future global socio-economic and technological conditions, and are likely to change as our understanding of the future improves. The most recent science-based sea level rise projections for the West Coast of the United States (California, Oregon, and Washington) were published by the National Research Council in 2012 (see Table 1).

Table 1. Regional Sea Level Rise Projections Relative to Year 2000 for the California Coast South of Cape Mendocino (*National Research Council Sea-Level Rise for the Coasts of California, Oregon, and Washington study released June 2012*).

Sea Level Rise (inches)			
Year	**NRC 2012 Projection** (mean ± the standard deviation for the A1B Scenario[1])	**Low** (mean of the B1 scenario)	**High** (mean of the A1F1 scenario)
2030	**5.6** (±1.9)	2	12
2050	**11.0** (±3.6)	5	24
2100	**36.1** (±10)	17	66

Current riverine and coastal flooding in the project area was evaluated based on the 100-year flood, which is an event with a 1 percent probability of occurrence in any given year. The most readily available maps depicting the 100-year floodplain boundaries, also referred to as Special Flood Hazard Areas (SFHAs), are FEMA's Flood Insurance Rate Maps (FIRMs) which are the basis for flood insurance and floodplain management requirements under the National Flood Insurance Program (NFIP). The most up-to-date effective FIRMs for Contra Costa County were used2. The coastal floodplain boundaries were updated in September 2015 and include past sea level rise but do not consider future water level conditions. The updated FIRMs also do not include changes to the river systems that may have occurred in the project area.

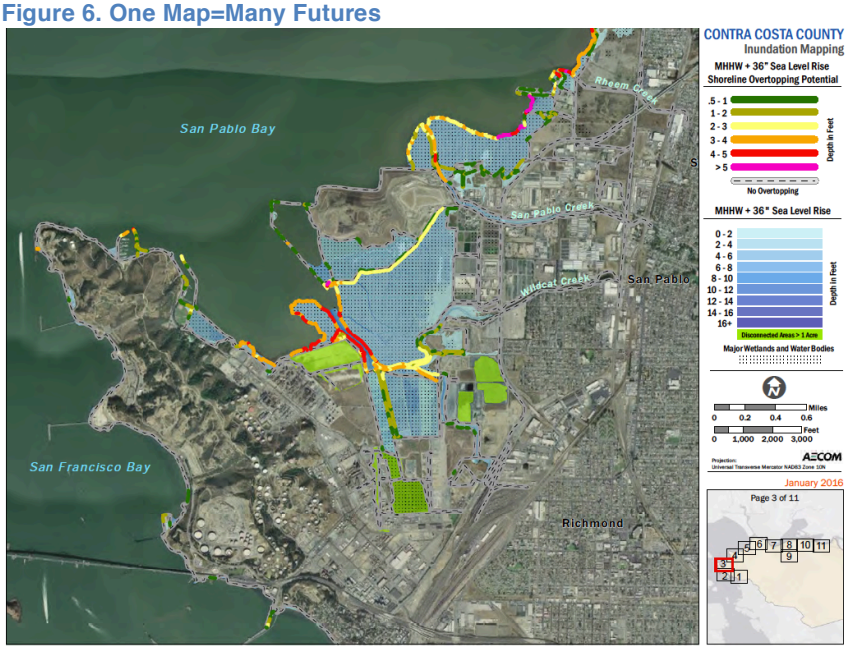
[1] The A1 scenario family assumes high economic growth, low population growth that peaks mid century, and the rapid

[2] FEMA's maps for the San Francisco Bay and the Outer Coast are publically available at: http://www.r9map.org/Pages/California.aspx?choState=California

Future coastal flooding was evaluated for a range of possible futures using ART's One Map = Many Futures approach (see Figure 6) that reduces the total number of maps needed because each map represents different unique combination of sea level rise and extreme tides (storm surge) that can result in current or future flooding3. Sea level rise is often visualized using maps that represent specific scenarios (e.g., 12 inches) or extreme water levels (e.g., the 100-year storm), however selecting the most appropriate scenarios to support project planning and analysis is not always simple. One Map = Many Futures avoids the need for pre-determined scenarios or for a large and unwieldy number of maps. Instead, this simple approach relies on equivalent water levels so that each ART map reflects a variety of possible sea level rise and extreme tide level combinations (i.e., 0 to 66 inches of sea level rise coupled with extreme tides from 1 to 100 years), and can be used to approximate impacts from either (1) permanent inundation from daily high tides or (2) temporary flooding from sea level rise and extreme tides likely to occur before 2100.

Figure 6. One Map=Many Futures

This One Map = Many Futures map depicts the inland extent of inundation and potential shoreline overtopping for 36 inches of sea level rise during a high tide (MHHW). This water level is equivalent to 24 inches of sea level rise during a 1-year extreme tide (King Tide); and therefore the map can be used to understand either scenario.



SECTORS AND ASSET CATEGORIES INCLUDED

Contra Costa County has a diverse shoreline comprised of natural areas (e.g. tidal marshes, mudflats); and constructed features including flood protection structures (e.g. levees and berms) and features such as railroad tracks that are not specifically intended for flood protection. Many communities and facilities of economic and environmental importance are in areas near the shoreline and so at threat from rising sea levels. The Contra Costa ART project included 11 sectors and 30 asset categories. Table 2 provides a summary of the sectors and assets considered and subsequent chapters provide detailed information about the vulnerabilities they face, the consequences that could occur if they are impacted, and possible adaptation actions that could be taken to reduce those risks.

[3] Extreme tides are the maximum high tide level that has occurred over a specific return period (recurrence interval) that correlates to a specific occurrence probability. For example a 50-year extreme tide has a 2% chance of occurring in any given year.

Table 2. Sectors And Assets

Sector	Asset Category
Business and Industry	Commercial Industrial land use Hazardous Material Sites
Contaminated Lands	Landfills Brownfields
Energy	Refineries Pipelines Power Generation Power Distribution (substations)
Ground Transportation	Freight and Passenger Rail Roadways (local streets and roads, interstates)
Housing	Single Multifamily Mobile homes
Natural Areas	Tidal Wetlands
Parks and Recreation	Regional Parks City Parks Marinas Bay Trail
People	Community Characteristics (socio-economic and other)
Public Services	Public Healthcare Facilities Emergency Response Facilities (police, fire) K-12 Schools Waste Collection (hazardous household waste and waste transfer stations)
Seaport and Marine Oil Terminals	Port of Richmond Marine Oil Terminals
Water Management	Water Supply Waste Water Services Flood Control Storm Water

Project Resilience Goals

Project resilience goals were developed to help define the desired outcomes of the project and provide a foundation upon which future project decisions could be made. Project resilience goals are set early in an adaptation planning process in order to:

- Build transparency at the outset so that all participants and others with an interest in the project know what will be included and what will be a priority
- Engage the working group early in deciding what shared desired outcomes they will work cooperatively to achieve, and provide an opportunity for them to ask their stakeholders for input and feedback on the project direction
- Encourage, and facilitate the inclusion of all four sustainability frames throughout the project

- Provide a framework for evaluating outcomes and recommendations at the end of the project, for example how well they will help meet the established resilience goals

The project resilience goals were developed with the working group in a two-step process. At the first working group meeting, held March 23, 2015, ART staff used the ART Functions and Values Mapping engagement exercise to begin a conversation about the factors that are critical to the economy, public health and safety, community and environment in the project area. The mapping exercise helped the working group identify the functions and values as a group and formed the basis of the draft project resilience goals. At the second working group meeting, held on May 28, 2015, ART staff presented the draft project resilience goals and some of the early assessment findings. Working group members provided input during and after the meeting on the specific resilience goals language. The project's resilience goals should be read in context of the project area, assets included, climate scenarios and impacts, and the functions and values identified as important for the participating agencies, organizations and communities. The resilience goals were revisited when the assessment was finalized to ensure they aligned with the identified planning issues and continued the values and visions of all in the project area.

Figure 6. Functions and Values Mapping Exercise

Governance Goals

Prioritize and resource agencies, organizations, private entities, and communities in Contra Costa to work cooperatively to address climate change.

Improve coordination among regulatory agencies to reduce programmatic or legislative barriers to addressing current and future flood risks.

Society and Equity Goals

Support communities, and in particular those with characteristics that could make them more vulnerable, in accessing affordable, safe and healthy housing, utilities and services, recreational opportunities, transportation and transit, and information about risk.

Protect the health, safety and welfare of all who live, work and recreate in Contra Costa County.

Economy Goals

Maintain and improve local economic vitality and access to diverse employment opportunities by preserving the function of major employment centers, infrastructure and utilities.

Recognizing Contra Costa County's regional refining and goods movement role, ensure the energy and transportation sectors and the interconnected networks and systems they rely on are resilient.

Environment Goals

Protect and improve the environment by preserving and restoring habitat, continuing to improve air and water quality, and safely addressing contaminated lands.

Promote the use of natural and nature-based approaches where possible and appropriate to improve community and economic resilience.

The Assess Step

The Asses step in an ART planning process is designed to clearly and efficiently identify the underlying causes and components of vulnerability and the associated consequences. During the Asses step, ART staff gathered answers to the ART assessment questions and sought working group and stakeholder input to confirm and refine the assessment answers. In addition, ART staff conducted a robust desktop assessment of asset exposure using the best available geospatial data and validated the analysis with working group members. The outcomes of the Assess step in Contra Costa included an exposure analysis and detailed vulnerability and consequences information for thirty asset categories across eleven sectors, and the completion of asset specific vulnerability and consequence evaluations of fifteen representative assets.

Figure 7. This is an example of a graphic used by ART Program staff in an engagement exercise with the Contra Costa ART project stakeholder-working group to explore functional and physical linkages among community assets and services, built infrastructure and natural shorelines that contribute to their climate vulnerability.

Assessment Questions

The ART assessment questions (see below) were used as the framework for collecting data and information to identify the vulnerabilities, consequences, and key planning issues most relevant to the communities, infrastructure and natural areas within the project boundary. The ART assessment questions, which have been tested and refined in a number of previous projects, were applied to the variety of asset categories and representative assets in the project area with only very minor customization. To gather the information needed to answer the assessment questions, ART staff conducted desktop research and met with individual working group members, asset owners, and other experts. The answers to the questions underpinned the project's understanding of the underlying causes and components of vulnerability and the potential consequences of those vulnerabilities on society and equity, environment and economy.

Types of Assessment Questions

Existing Conditions: Describes the asset and highlights current conditions or stressors that could affect its vulnerability.

- Where is the asset located?
- What is its function?
- Who owns and manages it?

Information: Determines if data or information is lacking, incomplete, poorly coordinated, or difficult to access.

- What types of information sources for the asset(s) are publicly available?
- What is the quality of available information?
- What types of mechanisms exist to share information between owners of connected infrastructure?

Functional: Considers the function of the assets and their relationship to or dependence on other assets.

- What services does the asset rely on?
- Is it physically connected to other assets such that failure in one part of the system disrupts the entire system?
- Does the asset provide functions or services that are limited?

Physical: Identifies conditions or design aspects that make an asset particularly vulnerable to impacts.

- Is the asset co-located with other assets?
- Are water- or salt-sensitive components of the asset located at- or below-grade?

Governance: Identifies challenges with management, regulatory authority or funding options for adapting to impacts.

- What plans, procedures, etc. are in place to manage the assets?
- What types of permits are needed to make changes?
- What funding sources exist that can be used for adaptation?

Consequences: Informs how climate change may impact society and equity, the economy and environment.

- Does the asset serve vulnerable communities or critical facilities?
- Are hazardous materials at the asset site that could pose a risk to the environment?
- What is the scale of economic costs if the asset experiences disruptions or damage?

Exposure Analysis

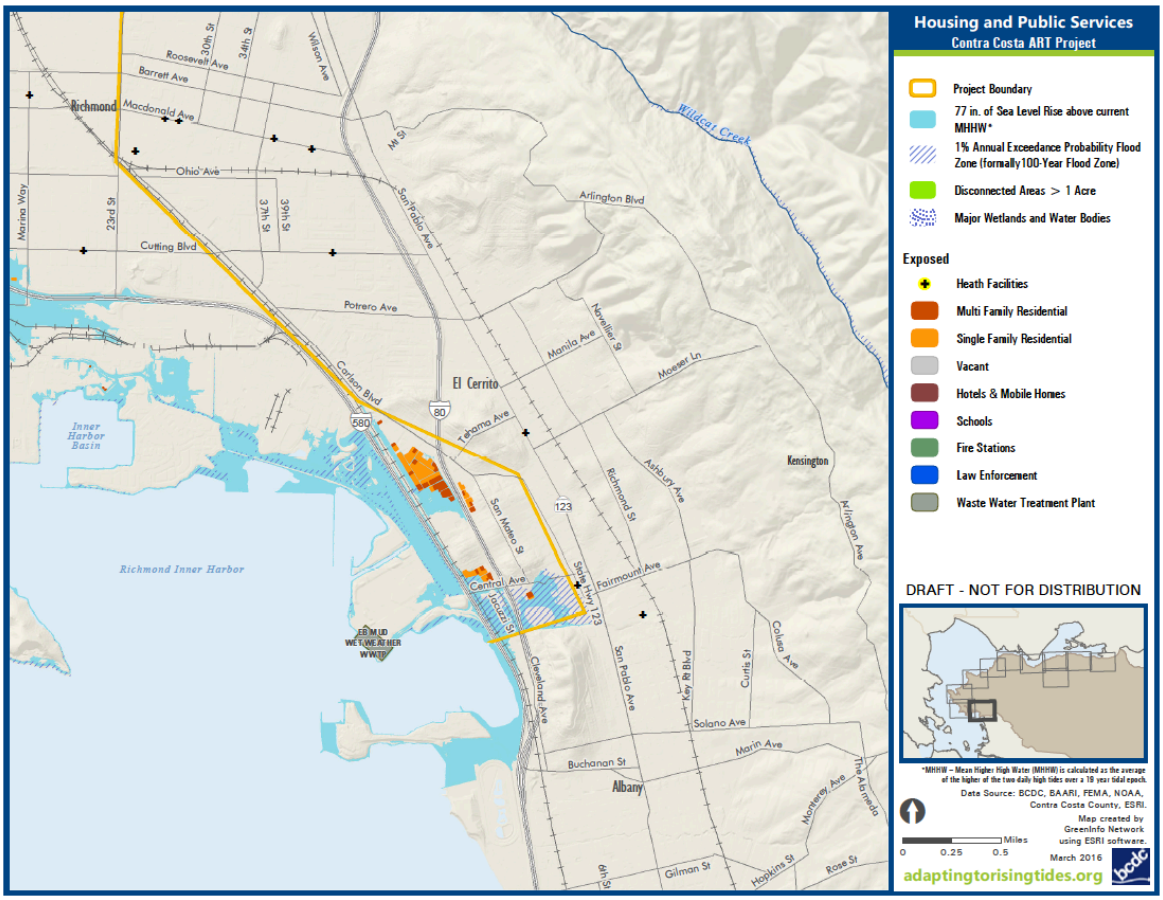
Assets on the Bay shoreline and along major creeks and channels in the project area were analyzed to determine if they were exposed to current and/or potential future flooding. Assets within the FEMA-designated 100-year floodplain are currently at risk of flooding, and as sea levels rise they could be at risk of more frequent or extensive flooding. This risk may, however, be underestimated in some locations as the potential for increased riverine flooding due to elevated Bay water levels was not investigated. We have conducted combined riverine and sea level rise analysis in other projects, including in the area around the Oakland Coliseum, and found the risk is significantly higher. In the future similar work should be done around

many of the creeks and flood channels in Contra Costa County. In addition, there are assets not currently at risk of flooding that could be exposed to flooding in the future as sea level rises. Some of these assets may be currently protected from the 100-year flood while others may be at a distance from either the Bay shoreline or creek and channel banks and therefore beyond the extent of current flooding.

Current flood risk was determined using the most current preliminary FEMA Flood Insurance Rate Maps (FIRMs) available when the analysis was conducted (January 2015). Future flood risk was determined using data from the NOAA Sea Level Rise Viewer, which was the best available data and mapping products at the time the project's exposure analysis was conducted. In addition to the flood and inundation mapping and data, four different types of asset data were obtained: parcel data from the Contra Costa County Assessor; population data from the U.S. Census; place based data; and linear data. Further information on the data sources and methodology of the exposure analysis is included in Appendix A.

The exposure analysis is visualized in a series of mapbooks and summarized in detailed analysis tables, which quantify the assets that may be exposed to the current 100-year flood and six future sea levels, from 1 to 6 feet. Figure 8 is an example of one of the exposure maps produced for this project, a complete set of the mapbooks available is in Appendix B.

Figure 8. Housing and Public Services Mapbook Example



In addition, new, locally refined ART sea level rise inundation and shoreline overtopping maps were also produced for the project. The new maps were used to identify the areas of the shoreline that were likely to allow flooding and to determine the water level that caused the flooding. This information provided the ART team and working group with the information necessary to determine the timing and scale of the actions that could be taken to reduce the flood risk.

The locally refined ART maps depict the potential depth and extent of inundation from increases in sea level of 0 to 66 inches in combination with different extreme tides ranging from the 1-year to the 100-year event. The mapping and analyses shows that as sea levels rise shorelines will become exposed to more frequent (higher probability) extreme tides. The result of this will be that the current shoreline will no longer protect inland areas from rising waters and these inland areas will experience an increase in flooding events first and then permanent inundation later. The ART team defines permanent inundation as an area experiencing flooding on a daily basis. In addition, the increased frequency of extreme tides will have important implications on the design of flood protection infrastructure and on the resilience and persistence of valuable natural shoreline habitats. The full report on the ART maps including details on the data and methodologies used and all of the map products can be found in Appendix C.

Preliminary assessment information was shared with the working group at the second meeting, held May 8, 2015 to ensure that available information, critical assets or local issues were included in the assessment. The preliminary assessment findings were shared at the third meeting, held August 5, 2015, and ART staff led the working group through a “World Café” exercise where they discussed options for organizing and summarizing the assessment findings to clearly describe the risks to the county’s assets from flooding. At the fourth meeting, held December 8, 2015, ART staff provided an overview of the assessment outcomes and shared the draft assessment products, including sector and asset category assessment chapters, asset-specific profile sheets, and draft inundation and shoreline analysis maps.

The Define Step

The Define step is unique to the ART planning process and not used in other climate adaptation planning efforts. The ART team developed the Define step during the first ART Program project in Alameda County and in response to concerns and feedback from the working group from that project. The Define step is the way that the ART Program works with working groups to prioritize the issues identified in the assessment. It is a foundational step that aids in the transition from Assess to Plan, and supports the development of adaptation responses that directly respond to specific and, potentially, multiple vulnerabilities both within and across asset categories. The Define step includes summarizing the answers to the assessment questions into clear, outcome-oriented vulnerability and consequence statements that help the working group prioritize the issues to that need attention and the scale of the action that might be taken.

In addition to using the Define step to organize and prioritize actions for asset scale and sector scale vulnerabilities (such as the vulnerability to a particular roadway in the County or to a sector such as parks and recreation), the ART team also engaged the working group in identifying the overarching or cross-cutting vulnerabilities and consequences that affect multiple assets and geographies. Based on this input staff developed six key planning issues that synthesized and summarized the cross-cutting and priority issues emerging from the assessment into six key planning issues. The key planning issues that were identified for Contra Costa included water-dependent industry, creek-side communities, access to services, ad-hoc flood protection, employment sites and parks and open space.

ART staff presented a brief summary of the key planning issues to the working group at the fifth meeting, which was held March 10, 2016. In small groups working group members discussed each of the key planning issues in light of the vulnerable assets, services and dependencies contributing to the issue, the project resilience goals, and the potential adaptation responses that would be necessary at the local, county or regional scale to resolve the underlying vulnerabilities. Based on input from the working group, ART staff refined and finalized the six key planning issues and incorporated additional challenges related to governance (regulatory barriers) as well as society and equity (communities with characteristics that place them at greater risk).

Plan Step

In the ART planning process, the development, review, refinement and evaluation of adaptation responses to address the vulnerabilities is known as the Plan step. Instead of just a list of strategies or actions, adaptation responses also include three important building blocks: a vulnerability or issue; one or more actions; and implementation options. This approach is valuable because it connects actions directly to the assessment outcomes, presents a number of possible stand-alone, or sequenced actions or alternative actions that can be taken, and provides a substantial level of detail about possible implementation partners, funding options and processes. In addition, during the Plan step the project resilience goals are reviewed against the assessment outcomes and, if needed, refined to better reflect the issues identified in the assessment. Additionally, evaluation criteria are selected to help identify benefits and trade-offs of the various adaptation responses identified.

The Plan step was introduced to the working group as part of the fifth meeting, held March 10, 2016, in order to gather input on the expected outcomes of the Plan step, discuss the approach for developing and reviewing the responses, and to include components designed to support local action implementation. ART staff then developed adaptation responses for the vulnerabilities of all 30 asset categories. Nine of the asset category adaptation responses were then shared with the working group in a facilitated open house at the sixth meeting, held June 9, 2016. During the open house, working group members provided input on the vulnerabilities, actions, implementation processes, leads and partners for individual actions. Following the open house the working group divided into subgroups to discuss the project's resilience goals to determine if changes were necessary. The key themes discussed by the small groups included minor suggested changes to the resilience goals as well as general issues regarding the four sustainability frames. Following the open house all 30 asset category adaptation responses were made available to the working group for their review, and the feedback was incorporated into the final adaptation responses.

ART staff also developed adaptation responses for the six key planning issues. These adaptation responses were shared with the working group using the same facilitated open house format at the seventh meeting, held September 28, 2016. In addition, at this meeting ART staff presented draft evaluation criteria to the working group, engaged them in an exercise to review and apply the proposed criteria to a series of key planning issue actions, and sought their input and feedback on the approach for evaluating and prioritizing actions for implementation. Additionally, to assist ART staff in determining which adaptation responses should be discussed further at the final working group meeting focusing on implementation, each working group member was asked to sticker vote for three actions during the open house.

Implementation

The last step of the ART planning process in Contra Costa County, the Implementation step, focused on helping working group members develop ways to advance priority actions within their individual agencies or organizations and identifying how to continue to work together on the six key planning issues that require shared responses. At the eighth and final working group meeting, held November 16, 2016, ART staff led the working group through an Implementation Pathways exercise that helped them craft a set of recommendations that would advance four adaptation actions. These were issues and actions that the group had already identified as priorities, addressed all six key planning issues, and required ongoing collaborations and new partnerships. As part of the exercise working group members worked in teams on crafting a pitch that synthesized the Implementation Pathways into statements that captured the nature of the vulnerability considered, the lead implementer and partners, information needs, and the steps to be taken to achieve the intended outcomes and ultimately address the project's resilience goals. The pitch exercise was designed to provide working group members with clear and succinct statements they can use to communicate to colleagues and partners why it is important to take the following actions:

- Action 1: Develop and disseminate guidance to business and industry on the best practices for reducing the potential impacts of flooding and sea level rise on their facilities and the services and systems they rely on.
- Action 2: Create a public-private shoreline working group tasked with developing a plan to fund and implement integrated shoreline solutions to reduce flood risk
- Action 3: Develop a county-wide program to monitor, maintain, and repair (as feasible) at risk shorelines most in need of intervention.
- Action 4: Establish a public-private partnership to better understand the consequences of flooding on commercial and industrial supply chains, employee access to job sites and the regional transportation networks goods and commuters rely on.

Assessment Findings

The Contra Costa ART project included an exposure analysis and detailed vulnerability assessment of 30 asset categories across 11 sectors as well as asset-scale evaluation for 15 representative assets.[4] The sections below present the detailed assessment information describing the vulnerabilities faced and the consequences that could occur if the sectors, asset categories or assets evaluated were impacted. The eleven sectors included in the assessment are:

- Business and Industry
- Contaminated Lands
- Energy
- Ground Transportation
- Housing
- Natural Areas
- Parks and Recreation
- People
- Public Services
- Seaport and Marine Oil Terminals
- Water Management

The complete exposure analysis tables can be found in Appendix D and asset profile sheets can be found in Appendix E.

Business and Industry

Commercial and industrial facilities provide jobs, goods, critical services, and opportunities for economic development and growth. Commercial businesses are an important part of community function as community members tend to shop and access services, including medical and dental services, near where they live and work. In addition, community members with limited mobility and those that rely on public transit typically have limited options for travelling outside of their neighborhood to access jobs, necessary services and critical goods.

The assessment of businesses and industries in the Contra Costa ART project area focused on key commercial and industrial land uses. While the types of uses considered in this chapter are broad, all provide jobs to people living both within and outside of the county, contribute to local and regional economies, and support the research, development and production of critical goods. In addition, the many commercial land uses in the project area provide necessary services to local residents who would need to either travel outside of the county to find what is needed or go without these services.

[4] A representative asset is an asset that is selected to represent an entire group of assets. For example, a vulnerability assessment of a single fire station or school can serve to demonstrate the types of vulnerabilities associated with that asset type. The ART team uses representative assets when vulnerabilities are very similar within an asset group, when data, information and partners are lacking and when there a large number of similar assets with similar vulnerabilities.

Commercial Land Uses

Commercial land uses provide goods and services that are critical to the day-to-day functioning of neighborhoods and communities. Community members tend to shop and access services (e.g., banks, auto service, grocery stores, medical and dental services) near where they live and work. For community members with limited mobility, or for those that do not have a car and rely on public transit, proximity to goods and services is especially important. Commercial land uses of all kinds are also a source of local jobs, and they contribute to the social cohesion of a neighborhood or community.

A variety of commercial land uses were assessed[5], including stores, supermarkets, auto repair and gasoline stations, medical and dental offices, banks and other financial institutions, restaurants, offices and small commercial businesses of all kinds. Many of these commercial uses, including supermarkets and medical offices, are limited in number and accessibility in the project area, and community members have to travel over distances by car or on public transit to obtain needed goods or services. Additionally, the cost of owning a business varies significantly across the county. For example, retail and office space is more expensive in West and Central County where there is above-average rental prices and low vacancy rates. East Contra Costa on the other hand has the lowest retail rental prices in the East Bay with much higher vacancy rates and difficulty filling units.

KEY ISSUE STATEMENT

Access to commercial facilities may be disrupted due to a flood event, which can have far-reaching consequences on local communities, including workers being unable to report to work, and necessary goods and services becoming unavailable to community members. Most commercial buildings are not designed to withstand flooding, and even those not directly at risk will be vulnerable if roads that provide access are flooded, or if power, water or wastewater services are disrupted. Even temporary closure of commercial uses can have significant social and economic impacts on neighborhoods and communities, and can impede a speedy recovery after a flood event.

EXPOSURE TO CURRENT AND FUTURE FLOODING

In the area assessed[6] there are a total of 277 parcels with designated commercial land uses at risk from flooding. Almost half of these are located in Martinez and most of the remainder are in Richmond (58 parcels) and Rodeo (55 parcels).

The majority of commercial uses at risk are within the current 100-year floodplain (229 parcels), and most of these are commercial stores (excluding supermarkets). Fifty-nine parcels already at risk of flooding may also experience more frequent or extensive flooding in the future due to sea level rise. Watershed-specific

[5] Commercial land uses were evaluated based on the County Assessor's Parcel data.
[6] Commercial parcels assessed are those located between Richmond and Bay Point up to ½ kilometer inland from the area inundated by 6 feet of sea level rise. This area represents the portion of the Contra Costa ART project area that is most likely to be directly impacted either by coastal flooding or by increased riverine flooding as sea level rises.

hydraulic modeling is, however, needed to improve the understanding of the impact that higher Bay water levels could have on flood risks within and beyond the existing 100-year riverine floodplain boundary.

A total of 36 parcels with designated commercial uses not currently within the 100-year floodplain are at risk of flooding as sea level rises, and most of these are office buildings. Some of these parcels may currently be protected from the 100-year flood by the existing shoreline while others may be at a distance from either the Bay shoreline or creek and channel banks and therefore beyond the extent of current flooding. Only six additional parcels are located in low-lying adjacent areas that may not be directly flooded with six feet of sea level rise, but could be impacted by stormwater system backups or failures as sea levels rise.

Table 3. Commercial parcels located in the current 100-year floodplain that could be exposed to sea level rise.

Commercial Parcels	Current 100-year Flood only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Auto repair, new car sales, service centers, car washes, mini lubes, etc.	24	24	24	24	24	25	29
Boat harbors/marinas	14	14	14	14	14	14	14
Motel, hotel, mobile home parks	4	4	4	4	4	5	7
Financial, medical, dental and other office buildings	42	42	42	42	42	42	47
Restaurants, drive thru and inside service	6	6	6	6	6	6	7
Recreational facilities	3	3	3	3	3	4	4
Commercial stores (not supermarkets), shopping centers, multiple and commercial	75	75	75	75	75	75	89
Vacant	23	23	23	23	23	26	32
Total	**191**	**191**	**191**	**191**	**191**	**197**	**229**

Table 4. Commercial parcels outside of the current 100-year floodplane that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Commercial Parcels	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1'	2'	3'	4'	5'	6'	
Auto repair, new car sales, service centers, car washes, mini lubes, etc.	0	0	0	2	3	3	0
Boat harbors/marinas	2	2	3	3	6	6	0
Motel, hotel, mobile home parks	0	0	0	1	1	1	1

Financial, medical, dental and other office buildings	0	0	0	0	2	5	0
Restaurants, drive thru and inside service	0	0	0	1	2	3	0
Recreational facilities	0	0	0	0	0	0	0
Commercial stores (not supermarkets), shopping centers, multiple and commercial	0	0	0	2	6	11	2
Vacant	0	0	0	1	4	7	3
Total	**2**	**2**	**3**	**10**	**24**	**36**	**6**

ASSET DESCRIPTION

The majority of commercial uses at risk of flooding are identified in the assessor's data as commercial stores (102), one of which is a shopping center (in Bay Point) and 11 that are multiple and commercial (miscellaneously improved). Of the 52 parcels identified as office buildings, one is a dental office in Rodeo and four are medical offices in Martinez. There are also four banks included in the office subcategory (all in Martinez). Most of the automobile related parcels are identified as auto repair facilities, although six are service stations and one is a new car business (in Martinez). A total of 42 parcels are identified in the assessor's data as vacant, however this number may not accurately reflect the current number of commercial parcels without a business use.

In addition, 20 parcels at risk are boat harbors located on the shoreline (see Parks and Recreation Chapter for a discussion of public marinas) and six of the eight "motel, hotel, mobile home parks" parcels comprise the two mobile home parks in the project area (see Housing Chapter for a discussion of mobile homes). The four recreational parcels include the Richmond Rod and Gun Club, the Martinez Gun Club, and Rithel Park in Crockett.

RICHMOND

There are 58 commercial parcels identified as at risk of current or future flooding in Richmond. Sixteen of these are boat harbors/marinas, most of which are in the Brickyard Cove neighborhood. The remainder of commercial uses is stores, office buildings and restaurants that are mostly located along the southern Richmond shoreline, to the south of I-580.

RODEO

There are 55 commercial parcels identified as at risk of current or future flooding clustered in Downtown Rodeo along Parker and San Pablo Avenues. Six of these are auto repair garages, 20 are commercial stores (excluding supermarkets), five are office buildings, and 12 are vacant. In addition, two of the parcels are associated with the Rodeo Marina, and five comprise the mobile home park.

PORT COSTA

There are 10 parcels with designated commercial uses in Port Costa that are within the current 100-year floodplain. This includes four vacant parcels, one hotel, and five commercial stores. Commercial uses are not shown at risk from sea level rise, although the Union Pacific (UP) rail line, which is neither constructed nor maintained to provide flood protection, protects the Port Costa shoreline.

HERCULES

There are four vacant commercial parcels in Hercules within the 100-year floodplain of Rodeo Creek. One of these parcels, located on Bayfront Boulevard, is also at risk from 5 feet of sea level rise. Although these parcels are identified in the assessor's data as vacant, they are part of the Hercules Waterfront (also referred to as Hercules Bayfront), a 40-acre transit-oriented, mixed-use, traditional neighborhood project.

MARTINEZ

There are 128 commercial parcels identified as at risk of flooding clustered in Downtown Martinez. The majority of these parcels are within the 100-year floodplain of Alhambra Creek and are not identified on the maps as at risk from sea level rise. Watershed-specific hydraulic modeling of Alhambra Creek is needed, however, to improve the understanding of what impacts higher Bay water levels could have on flood risks within and beyond the existing 100-year riverine floodplain of the creek. Commercial uses at risk include 20 automobile related businesses (mostly auto repair garages), 58 commercial stores, 29 office buildings, four medical/dental offices, and four banks. There are also eight vacant parcels, one recreation parcel (the Martinez Gun Club), and two restaurants at risk.

VULNERABILITIES

INFO: Commercial uses are privately owned, and there is often a lack of publically available information about the vulnerability of their facilities and operations, the status of their emergency management or contingency plans, or the economic consequences that would result if they were impacted by flooding.
GOV: Commercial uses may be operated by landowners that do not have the capacity to engage in local planning, or by renters that have little control over improvements to the property where their business is located.
FUNC1: Commercial uses rely on outside infrastructure and services provided by public and private agencies, including roads, electricity, water, and wastewater. Disruption of road access, power, water or wastewater services can impact the commercial use, which either may need to be closed or if open may not be accessible to customers.
FUNC2: Commercial uses providing medical and dental care are critical because loss of these services or access to them could have significant impacts on community members; in particular those that are mobility limited or rely on public transportation.
FUNC3: Commercial uses that provide neighborhoods and communities with goods and services that are otherwise locally limited are particularly important because if they close temporarily or go out of business residents will have to do without or travel to find alternative sources.
PHYS1: Most commercial uses are vulnerable to flooding because the buildings and structures were not designed to withstand flooding nor are constructed of waterproof or non-corrodible materials.
PHYS2: Some commercial entities use or store hazardous materials including paints, cleaners, oils, batteries, pesticides, asbestos, and medical waste, which if not stored properly or not elevated above possible flood waters could be released during a flood.
PHYS3: Many buildings rely on electric or mechanical components, such as fans, boilers, and pumps that cannot function if wet and are often located below grade or on the ground floor.
PHYS4: Commercial uses with unprotected at- or below-grade entrances are at risk of damage if flooded. This is particularly an issue for garages or warehouses with large roll up doors.
PHYS5: Commercial uses that rely on power but that do not have back-up power generation and fuel supplies are more vulnerable to disruption and loss of goods stored on site.

CONSEQUENCES

Society and Equity: Disruption of commercial uses that provide medical and dental services, other critical services, or goods and services that are locally limited could have significant consequences on neighborhoods and community members, particularly those who rely on public transportation or have limited mobility. The disruption or closure of commercial uses can have significant consequences for employees, as loss of access to the workplace can cause lost wages and jobs. This will be particularly true for small business owners that might not be able to afford costs associated with closures and/or recovery from damages. Community members may lose access to goods and services they rely on, impacting neighborhood function and community resilience. Flooding of facilities that store hazardous materials can result in public health or environmental impacts if contaminants are released into floodwaters.
Environment: Flooding of facilities that store materials such as pharmaceuticals, petroleum products, cleaners, pesticides or toxics can impair water quality if released into the Bay, river systems, or near-shore habitats.
Economy: Commercial uses provide Contra Costa County with economic benefits that include jobs for residents, services to communities, and tax revenue to the cities and the county. Damage or disruption of commercial uses could result in significant costs of replacement or repair of buildings, equipment, and goods stored onsite. Flooding of commercial uses could cause temporary or permanent jobs loss for hundreds of workers, resulting in lost business revenues, employee wages, and fees or taxes.

Industrial Land Uses

The Industrial Sector as described in the Contra Costa County General Plan includes industrial activities such as processing, packaging, machinery repair, fabricating, distribution, warehousing and storage, research and development, and similar uses as well as metalworking, chemical or petroleum product processing and refining, heavy equipment operation and similar activities. Industrial lands are diverse and include many different types of manufacturing, warehouse and light industrial sites, each with different characteristics designed to support different business operations7. For example, heavy industrial sites typically have buildings designed to house specialized equipment needed for manufacturing, while light industrial sites where light assembly operations take place have less extensive physical plant and space requirements.

Countywide there are a number of large and concentrated industrial land uses, many of which are used for heavy industry. Within the project area there are 482 industrial land use parcels, the majority of which are used for light industry (300 parcels)8. Additionally there are 115 parcels of heavy industrial (which comprise the bulk of the industrial land use acreage due to their large size), 50 industrial parks parcels, and 17 research and development parcels.

Chemical and petroleum refining is the most concentrated heavy industry in the county, and accounts for the most of the manufacturing jobs (see Energy Sector chapter for a discussion of refineries in the project area). A number of these large firms are located along the shoreline as these industries are often associated with marine terminals, rail, pipelines, or other modes of bulk goods transport. These facilities contain an array of

[7] Technical Memorandum #2, Contra Costa County Northern Waterfront Initiative Market Assessment, September 6, 2013.

[8] Industrial land use subclasses based on the county assessor's parcel data.

specialized equipment, and generally require high capacity power, ventilation, pressurized air or water lines, and access via local streets and roads to highways and interstates.

In addition to these heavy industrial land uses there are light industrial facilities where manufacturing activities such as processing, packaging, distribution, and machinery repair occurs. Light industrial uses also include research and development facilities focused on product development, some of which are also considered "flex space" as they have office space, retail showrooms, or small warehouse uses. Flex space facilities are used by a variety of industries, including information technology, electronics, and biotechnology.

Lastly, industrial parks have multiple types of facilities onsite, usually including a mix of light or heavy industrial, warehouse, and flex space uses. One of the largest industrial parks in the project area is located on Waterfront Road in Martinez, and is currently used by Copart Salvage Auto Auctions as an automobile storage and auction facility.

KEY ISSUE STATEMENT

While the four refineries in the project area comprise the majority of the industrial acres at risk of flooding, light industrial land uses comprise the majority of parcels at risk. About half of these light industrial parcels are not currently in the 100-year floodplain and therefore property owners and site operators may not be aware of the flood risk they may face in the future, and may not have facilities or site operations that can be made resilient to flooding either on or off site.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Of the 428 industrial parcels in the project area a total of 277 parcels (approximately 5,934 acres9) are at risk from current and/or future overland flooding or from street or site flooding that could occur if stormwater systems are unable to drain or are at capacity.

A total of 128 parcels (4,853 acres) of industrial lands are at least partially within the 100-year floodplain10. Approximately two-thirds of these (83 parcels totaling over 4,600 acres) are at risk of more frequent or extensive flooding due to sea level rise, and the majority of these will be at risk with only one to two feet of sea level rise.

There are 45 parcels totaling 214 acres within the 100-year floodplain that are not shown to be directly at risk of sea level rise; however, watershed-specific studies are needed to understand the potential for sea level rise to impact the frequency or extent of flooding both within and beyond the current floodplain.

[9] Because parcel acres is not reported for all records in the county assessors data acreage was calculated based on parcel area using the geometry function in ArcMap. Calculated numbers are similar but not identical to the acreage reported in the Assessors data. Therefore acreages are approximate.
[10] Industrial land use information based on the Contra Costa Assessor's parcel data. Parcels were counted as exposed if any portion of them intersected with the current 100-year floodplain or the inland extent of sea level rise. **Site-scale analyses are needed to better understand how flooding could affect the developed portion of these parcels, some of which are quite** large.

Table 5. Industrial parcels located in the current 100-year floodplain that could be exposed to sea level rise.

Industrial Parcels	Current 100-year Flood only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Heavy industrial	6	43	50	58	61	62	64
Industrial Park	8	9	9	9	9	9	10
Light industrial	31	41	43	45	50	52	54
Research and Development	0	0	0	0	0	0	0
Total Parcels	45	**93**	**102**	**112**	**120**	**123**	**128**

There are 137 parcels totaling 1,012 acres of industrial lands not currently at risk of flooding that could be exposed to sea level rise. These parcels are either protected from the 100-year flood or are at distance from either the Bay shoreline or creek and channel banks and therefore beyond the extent of current flooding. Most of these parcels are light industrial land uses (95 of the 137), however the 20 heavy industrial parcels comprise the majority of acreage at risk (740 acres).

An additional 12 light industrial parcels totaling 70 acres are within low-lying areas adjacent to the inland flood extent from six feet of sea level rise. While potentially not at risk of overland flooding, industrial sites within these low-lying, adjacent areas could be flooded by backups in the stormwater or flood management systems. Further investigation of the capacity and condition of the stormwater conveyance system both on and off site will be needed to determine the potential for localized flooding to occur during storm events as sea levels rises.

Table 6. Industrial parcels outside of the current 100-year floodplane that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Industrial Parcels	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1'	2'	3'	4'	5'	6'	
Heavy industrial	0	0	2	10	15	20	0
Industrial Park	0	0	0	1	10	13	0
Light industrial	1	1	3	26	60	95	12
Research and Development	0	0	0	5	7	9	0
Total Parcels	1	1	5	42	92	137	**12**

As many industrial parcels are large and located directly on the shoreline the analysis conducted for this assessment could over-estimate the exposure of industrial lands in the project area. In addition, the acreage calculations do not discount the portion of parcels that are water rather than land, as is the case for three parcels owned by Chevron USA Inc. in Richmond and one owned by Tosco Corporation (Conoco Phillips 66)

in Rodeo. Importantly, the analysis does not fully reflect the potential impacts of current or future flooding on site operations. Site-based analyses at these facilities are needed to understand what facilities or infrastructure are within the portion of the industrial site at risk of flooding.

ASSET DESCRIPTION

The majority of industrial land uses at risk are clustered in Richmond and Martinez, with a small number of industrial parcels at risk in San Pablo, Hercules, Rodeo, Crockett and Bay Point. Fifty-one of the industrial parcels at risk from current and/or future overland flooding or street or site flooding are owned and operated by the four refineries in the project area (see Energy Chapter for more information about the refineries in the project area). While the refineries comprise three-quarters of the total industrial land area at risk (approximately 4,459 acres), they represent only 20% of the parcels with industrial land uses in the project area. The majority of these other parcels are used for light industry by a diversity of individual property owners and site operators. About half of the light industrial parcels at risk from sea level rise are not in the current 100-year floodplain. These parcels are likely more vulnerable because property owners and site operators may not be aware of their flood risk, and therefore may not have considered the need for planning and capital improvements to protect their properties from flood damage.

RICHMOND / NORTH RICHMOND

The majority of industrial land uses at risk are clustered in the City of Richmond and in unincorporated North Richmond (186 of the 277 parcels). These include heavy industry and research and development parcels associated with Chevron's Richmond Refinery. Two of Chevron's larger parcels are identified as vacant and are currently mostly undeveloped and one, which sits under the Richmond-San Rafael Bridge approach, is mostly open water.

There is a cluster of mixed industrial land uses at risk associated with the seaport and related industries south I-580 between West Ohio Avenue and West Cutting Boulevard and to the west of South Garrard Boulevard. The remaining parcels at risk are mostly light industrial parcels associated with the West County Landfill, including the West County Resource and Recovery Center, and parcels near Parr Boulevard and the Richmond Parkway.

SAN PABLO, HERCULES, RODEO AND CROCKETT

There are four light industrial parcels in San Pablo that are within the existing 100-year floodplain but not shown to be directly at risk from sea level rise. In Hercules, Bio-Rad Laboratories (designated light industrial) is shown to have a portion of the site within an area that is low-lying and adjacent to flooding that could occur with 6 feet of sea level rise. As the developed portion of the parcel is fairly high above the Bay, it may not be the case that the stormwater drainage system could be impacted, however further investigation may be warranted. In addition, a very small undeveloped, portion of a 3.5 acre industrial park on Linus Pauling Drive is shown to be within the 100-year floodplain. Three heavy industrial parcels in Crockett associated with C&H Sugar are shown at risk. All three parcels are within the 100-year floodplain, and the main factory site is also shown at risk of one foot of sea level rise. The other two parcels are under the I-80 Bridge approach (including the wastewater treatment plant), and are low-lying and could be impacted by nuisance flooding with six feet of sea level rise.

The five industrial parcels at risk in Rodeo are owned by Tosco Corporation and comprise the Conoco Phillips 66 refinery site. Approximately half of one of the smaller parcels (44 acres) is open water.

MARTINEZ

Of the 68 industrial parcels at risk in Martinez, 23 comprise the Tesoro Martinez Refinery and eight comprise the Shell Martinez Refinery. The remainder of the parcels is a mixture of heavy and light industrial sites, with a small number of light industrial uses clustered in downtown Martinez and on Pacheco Boulevard near the I-680 interchange, and a cluster of industrial park designated parcels on Commercial Circle near the Mallard Reservoir. The exception is one of the largest industrial parks (74 acres) in the project area located on Waterfront Road. This parcel will be at risk from as little as one foot of sea level rise and is currently used by Copart Salvage Auto Auctions as an automobile storage and auction facility.

BAY POINT

Five heavy industrial parcels are located on Nichols Road on the bayward side of the Union Pacific (UP) and Burlington Northern Santa Fe (BNSF) rail lines. These parcels, owned by General Chemical West as part of the Bay Point Works, are within the current 100-year floodplain and are at risk from 1 to 4 feet of sea level rise depending on their proximity to the shoreline. In addition one industrial parcel on the Port Chicago Highway (Premark Packaging LLC) is within the 100-year floodplain and may be at additional flood risk as sea levels rise.

Vulnerabilities

GOV: Although industrial property owners and site operators may have engaged with public agencies on reducing flooding and other risks through existing regulatory programs, planning for sea level rise will require additional, non-regulatory collaboration and partnerships between the public and private sector to ensure that multi-benefit shoreline solutions are advanced that balance economic, environmental and social equity goals.

FUNC1: Many industrial land uses rely on off-site utilities connections (e.g., power, telecommunications, water supply, and wastewater treatment or discharge) that may be vulnerable to sea level rise impacts. Connections with off-site services can be critical to maintaining industrial operations, in particular for those facilities that need water for manufacturing processes.

FUNC2: Industrial land uses rely on roads, rail lines, pipelines, airports, seaports and marine terminals to ensure materials and supplies are imported, goods produced are exported, and employees can get to/from work. Many of these transportation systems are vulnerable to flooding and their disruption could impact operations at industrial facilities of all types.

FUNC3: Because heavy industrial land uses need large amounts of land, have specific operational facility needs, and are dependent on fixed infrastructure for goods movement (e.g., marine terminals, pipelines and rail lines), these land uses can be difficult, if not impossible, to relocate.

FUNC4: Many industrial processes are continually operating and would need adequate warning time to fully or partially shut down in advance of storm-related flooding.

PHYS1: Industrial buildings, infrastructure and associated facilities that are not currently with the 100-year floodplain are unlikely to have been constructed to be waterproof or flood resistant.

PHYS2: Industrial buildings, infrastructure and associated facilities that have at- or below-grade entrances or sensitive equipment, including fans, boilers, and pumps that cannot function if they are flooded or exposed to salt water, are especially vulnerable.
PHYS3: Many industrial land uses generate or store hazardous substances that could have public health or environmental impacts if released into groundwater or surface waters. Larger industrial facilities covered by CalARP and ISO programs typically have a high level of compliance with hazardous material inventories and contingency planning, while the diverse and numerous smaller industrial sites, some that are covered by Hazardous Business Plan Program, have differing levels of compliance with release prevention requirements.
PHYS4: Industrial land uses that rely on off-site power, and do not have adequate back-up supplies and systems in place, for example on-site generators and enough fuel, are more vulnerable to disruption.

Consequences

Society and Equity: The disruption or closure of industrial land uses can have significant consequences for employees as loss of access to the workplace can cause lost wages. Loss of these facilities may also have consequences on the people within the county and the region, as the industrial land uses within the county produce and provide a number of critical goods and products used in many other sectors. Unexpected flooding of facilities that store hazardous materials can also result in public health impacts in nearby communities.

Environment: Unexpected flooding of facilities that store hazardous materials can impair water quality, natural habitats and species, if released into the Bay or near-shore habitats.

Economy: Industrial land uses provide Contra Costa County with economic benefits that include jobs for residents, goods and products needed in other parts of the region, and tax revenue to the cities and the county. Damage or disruption of industrial facilities could result in high costs due to lost productivity, as well as the replacement or repair of buildings, specialized equipment, and goods stored onsite. Temporary or permanent closures of industrial operations of all kinds could have broad economic impacts throughout the region, particularly if heavy industrial facilities such as the refineries are damaged or their connections to goods movement infrastructure is disrupted.

Hazardous Materials Sites

Hazardous materials sites generate, treat, or transport materials that, because of the quantity, concentration, physical or chemical characteristics pose a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment11. Hazardous materials sites are typically industrial or commercial land uses, although there are some institutional facilities and utility service providers that use or generate smaller quantities of hazardous wastes.

The Hazardous Materials Program is one of Contra Costa Health Services core programs that, with few exemptions, covers most facilities with a hazardous material release potential. The Contra Costa Health Services Hazardous Materials Programs (CCHSHMP) is the Certified Unified Program Agency (CUPA) for all

[11] http://cchealth.org/hazmat/business-plan/

businesses within the county, and administers regulatory programs including the Hazardous Materials Business Plan Program, the California Accidental Release Prevention (CalARP) Program, and the Industrial Safety Ordinance (ISO).

Facilities in three of CCCHSHMP's programs were assessed to determine the types and numbers of hazardous material sites that could be at risk from current and future flooding. These three programs were selected because geospatial data identifying the location of these sites was available from CCHS; the materials these sites handle could pose a risk to human and environmental health if released during a flood; and many of the sites within these three programs are located on the shoreline.

The Hazardous Materials Business Plan Program (HMBP) requires businesses that handle hazardous materials in reportable quantities to submit an annual hazardous materials business plan (reportable quantities are equal to or greater than 55 gallons, 500 pounds, or 200 cubic feet of gas or extremely hazardous substances above the threshold planning quantity). Businesses are required to submit a revised plan if there are changes in the ownership, address, amount, type or handling of hazardous materials, and the plan is shared with the local fire agency in which the business operates.

The California Accidental Release Prevention Program (CalARP) requires that businesses handling more than a threshold quantity of a regulated substance develop a Risk Management Plan with a detailed engineering analysis of the risks and mitigation actions to prevent an accidental release12. While CalARP is a statewide program, it is implemented at the local level, in this case by CCCHSHMP. The county determines the level of detail required in the Risk Management Plans, reviews submitted plans, conducts facility inspections, and provides the public access to information about these sites13.

The county also administers the Industrial Safety Ordinance (ISO), which was established to expand on CalARP Program requirements for petroleum refineries and chemical plants. The ISO only regulates sites that are within unincorporated areas of the county or within the City of Richmond14. There are nine ISO facilities in the project area, two of which are in the City of Richmond.

While a single release from a site administered by CalARP or ISO could have a one-time, significant impact on public and environmental health, there is a significant risk of cumulative impact from the many small to mid-sized facilities in the HMBP program. In addition, the larger established facilities covered by CalARP and ISO typically have pollution prevention measures onsite (e.g., water retention basins), while smaller facilities typically do not.

In addition to the regulatory hazardous materials programs CCHSHMP is contracted to inspect businesses in unincorporated areas of the county for stormwater compliance under the Contra Costa Clean Water Program, and is the primary Hazardous Materials release incident response team (HazMat Team) serving the County, with the exception of the city of Richmond and San Ramon. CCHSHMP is also a primary partner in

[12] http://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/california-accidental-release-prevention
[13] http://cchealth.org/hazmat/rmp/
[14] http://cchealth.org/hazmat/iso/facilities.php

the Community Warning System (CWS) that would alert the public if there is a release of hazardous materials that could impact health and safety. The warning system is coordinated between CCHSHMP, the Office of the Sheriff, and some of the larger industrial facilities (e.g. Chevron) that have authority to activate nearby sirens.

The county also has a Hazardous Materials Commission that develops policy recommendations regarding storage, use, and management of hazardous materials and hazardous waste15 and a Hazardous Materials Ombudsman who responds to questions and concerns from the public. Lastly, CCHSHMP chairs the Hazardous Materials Interagency Task Force, which is a coalition of agencies that voluntarily cooperate to enhance public and environmental health and safety. CCHSHMP also co-chairs the Contra Costa County Enforcement Task Force, where local, state, and federal agencies coordinate regulatory and enforcement actions to address problems in the areas of public safety and environmental protection.

Key Issue Statement

Flooding of hazardous materials sites could result in a release of materials stored onsite, and could cause significant impacts to public health and the environment. Facilities may be particularly vulnerable if hazardous materials are stored at- or below-grade, are improperly contained, or if there is not enough time to safely shut down operations in advance of a storm event. Managers and owners of sites not currently in the floodplain may not be aware of the flood risks, and therefore may not be planning, preparing or operating in a manner to reduce the impacts of flooding should they occur.

Exposure to Current and Future Flooding

There is a total of 1,287 Hazardous Materials Business Plan sites located in the project area, a total of 329 are at risk from current and/or future flooding. A total of 226 Hazardous Materials Business Plan sites are at least partially within the 100-year floodplain16. Approximately one-third of these (76 sites) are at risk of more frequent or extensive flooding due to sea level rise. There are 140 sites within the 100-year floodplain that are not shown to be directly at risk of sea level rise; however, watershed-specific studies are needed to understand the potential for sea level rise to affect the frequency or extent of flooding both within and beyond the current floodplain.

An additional 103 Hazardous Materials Business Plan sites are not currently at risk of flooding but could be exposed to sea level rise. These sites are either protected from the 100-year flood or are at distance from either the Bay shoreline or creek and channel banks and therefore beyond the extent of current flooding. Most of these sites will be exposed to five to six feet of sea level rise.

There are a total of 18 CalARP sites within the project area, nine of which are also ISO sites (see Energy Sector chapter for a discussion of refineries in the project area which are regulated by ISO). Three of the

[15] http://cchealth.org/hazmat/hmc/

[16] Hazardous materials sites based on CCHSHMP information and the Contra Costa Assessor's parcel data. As some of these sites are large, **site-scale analyses may needed to better understand how flooding could affect the developed portion of the site, and in particular where materials are generated or stored**.

CalARP, and eight of the ISO sites are at least partially within the 100-year floodplain17 and are at risk of more frequent or extensive flooding due to sea level rise. Two CalARP sites (the Bollman Water Treatment Plant in Martinez and the Safeway Beverage Plant in Richmond) are within the 100-year floodplain but are not shown to be directly at risk of sea level rise; however, watershed-specific studies may be needed to understand the potential for sea level rise to impact the frequency or extent of flooding both within and beyond the current floodplain.

Four CalARP and one ISO site (Air Liquide Hydrogen Plant in Rodeo) that are not currently at risk of flooding could be exposed to sea level rise of four to five feet. These sites are either protected from the 100-year flood, or are at distance from either the Bay shoreline or creek and channel banks and therefore beyond the extent of current flooding. Most of these sites will be exposed to four to five feet of sea level rise.

Additional hazardous materials sites could be located within low-lying areas adjacent to areas that might flood as sea level rises. These sites are in particular risk of flooding due to failure of the stormwater system to adequately handle additional capacity or drain effectively. Due to resource constraints hazardous materials sites located in low-lying areas were not identified, however many of the sites were included in the commercial and industrial land uses assessment which did enumerate the number of parcels in low-lying areas (see above).

Table 7. Hazardous materials sites that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Hazardous Materials Sites	Current 100-year Flood only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Hazardous Business Plan	140	153	156	163	180	212	216
CalARP	2	4	5	5	5	5	5
CalARP + ISO	0	5	5	8	8	8	8
Total	**142**	**160**	**164**	**174**	**191**	**223**	**227**

Table 8. Hazardous materials sites outside of the current 100-year floodplane that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Hazardous Materials Sites	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1'	2'	3'	4'	5'	6'	
Hazardous Business Plan	0	1	1	13	70	103	ND

[17] Hazardous materials sites based on CCHSHMP information and the Contra Costa Assessor's parcel data. As some of these sites are large, **site-scale analyses may needed to better understand how flooding could affect the developed portion of the site, and in particular where materials are generated or stored**.

CalARP	0	0	0	3	4	4	0
CalARP + ISO	0	0	0	0	1	1	0
Total	**0**	**1**	**1**	**16**	**75**	**108**	

Asset Description

Sites in the Hazardous Business Plan Program are mostly clustered in Martinez, Rodeo, and Richmond. There are many different facilities in this program, and in the project area this includes those associated wastewater treatment, gas and electric distribution (substations), auto repair, trucking, and various commercial or industrial uses.

Hazardous material sites regulated by CalARP and ISO are associated with heavy industrial shoreline uses, and in particular the four refineries in Richmond, Rodeo, and Martinez, the Crockett Co-Generation Plant, and General Chemical West Bay Point Works. Many of these sites are located on large parcels, with only a portion of the facilities or operations potentially at risk from current and/or future flooding. The vulnerability of these sites will vary depending on the type of hazardous materials generated or treated, and how and where it is stored. Even if these sites are not directly flooded, in many cases the roads, rail line and utilities serving them will be, which could cause disruption of operations, including the treatment and transportation of hazardous materials.

Vulnerabilities

INFO: Hazardous Materials Business Plan information is available through the California Environmental Reporting System (CERS); however it is not in a format that can be easily used in sea level rise adaptation planning. In addition, there is limited information about the flood prevention or protection measures that may be in place at hazardous materials sites.
GOV1: In Contra Costa, the CalARP and ISO sites have a high level of compliance with hazardous material inventories and contingency planning requirements, while the diverse and numerous other hazardous material sites that use, generate or transport smaller quantities of hazardous materials have differing levels of compliance with operational and regulatory requirements.
GOV2: Because of the number and concentration of heavy industrial land uses in the project area there is already coordination among the multiple entities that have a role in responding to hazardous materials emergencies. However, the number and locations of hazardous materials sites, and the potential extent of flooding that could occur during a large storm may stress available resources, and could require a greater degree of coordination and contingency planning.
GOV3: Current emergency planning and response for many hazardous material sites does not require consideration of future flood risk. For CalARP and ISO stationary sources, there is a requirement to look at external events as part of a Hazard Review or Process Hazard Analysis, including flooding. As past flooding levels that was very improbable become a possibility, stationary sources will need to consider the risk of flooding, the safeguards that are in place, and how to reduce the risk to an acceptable level.
PHYS1: Industrial facilities containing hazardous materials are not generally designed to withstand flooding, and are difficult and costly to relocate.
PHYS2: Flooding during a storm event could cause releases of hazardous materials if they are not well contained, improperly stored, at ground level, or are difficult to move.
PHYS3: Facilities with hazardous materials stored below ground could be vulnerable to rising groundwater.

Consequences

Society and Equity: The flooding or other disruption of hazardous materials sites can expose communities to substances harmful to human health and safety.

Environment: The flooding or other disruption of hazardous materials sites can have significant environmental impacts. The release of persistent and mobile hazardous materials can have long-lasting and far-reaching consequences on wildlife and habitats, and can affect water quality.

Economy: Facilities that generate, treat, or transport hazardous materials are usually job sites, and their disruption or closure can result in lost wages and larger-scale economic impacts. Additionally, flooding of hazardous materials sites can strain local emergency resources and can result in high cleanup and recovery costs.

RESOURCES

California Office of Emergency Services, "California Accidental Release Prevention" http://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/california-accidental-release-prevention
Contra Costa County Northern Waterfront Initiative Market Assessment. (September 6, 2013). Technical Memorandum #2.
Contra Costa Health Services, "Business Plan Program" http://cchealth.org/hazmat/business-plan/
Contra Costa Health Services, "Hazardous Materials Commission" http://cchealth.org/hazmat/hmc/
Contra Costa Health Services, "ISO Facilities" http://cchealth.org/hazmat/iso/facilities.php
Contra Costa Health Services, "Risk Management Plans" http://cchealth.org/hazmat/rmp/

Contaminated Lands

Contaminated lands are sites with materials that pose a hazard to people and/or the environment. In general, the threat posed depends on the potential for the hazardous substances to be released, the characteristics of the waste (e.g., toxicity and quantity), and the sensitivity of the people or other receptors (such as waterways, wildlife, soils, vegetation) potentially affected. The release of hazardous substances typically occurs through four pathways: groundwater migration, surface water flow, soil exposure, and release to the air. These pathways can result in direct exposure to human populations and sensitive ecosystems, as well as contamination of drinking water and food chains.

Contaminated lands are vulnerable to sea level rise and storm events that could cause flooding or groundwater intrusion. Temporary or permanent surface flooding, erosive tidal or wave energy, and elevated groundwater levels could cause the release of hazardous substances with potentially significant consequences on public health, the environment, and the local economy. Most contaminated sites are remediated in place due to the technical challenges and environmental risks of hazardous substance removal and disposal. While there have been many advances in the field of remediation, most clean up practices, particularly for those sites that were closed prior to 2014, have not been designed for sea level rise or changing groundwater conditions. While remediation of contaminated lands offers opportunities for

economic growth and redevelopment, or improved community services, for example through the creation of a new park or open space, designing contaminated lands cleanup with the future in mind will help ensure public and environmental health is protected as sea levels rise.

In the Contra Costa project area two types of contaminated lands were evaluated, landfills and Brownfields. This includes open and closed landfills located in Richmond and Martinez, and Brownfields sites throughout the project area as identified by the California Department of Toxic Substances Control (DTSC) as active, inactive or cleaned up (certified). The assessment that follows describes the vulnerabilities of contaminated lands to sea level rise and storm events, as well as the consequences that could occur from flooding and changing groundwater levels.

Landfills

Landfills are solid waste management facilities where waste is or once was disposed. California law requires that open and closed landfills be maintained in a manner that protects public health, safety, and the environment. The California Department of Resources Recycling and Recovery (CalRecycle) is responsible for reviewing local permits for active solid waste facilities and for ensuring that operators demonstrate adequate financial assurances for closure and post-closure maintenance, corrective action, and operating liability. The Regional Water Quality Control Board (RWQCB) regulates both active and closed landfills to ensure that non-hazardous wastes do not enter surface waters or groundwater. RWQCB regulations include design standards for protective features (e.g., liners, covers), requirements for environmental monitoring and cleanup when necessary. Some of CalRecycle and the RWQCB regulatory duties overlap (e.g., margin of safety), while others are split (e.g., the RWQCB's focus on water and leachate and CalRecycle's focus on landfill gas). The California Department of Toxic Substances Control (DTSC) regulates the disposal of wastes classified as hazardous, and other local, state, or federal agencies also issue permits or approvals for solid waste facilities.

Since 2009, RWQCB has required that landfills located adjacent to the Bay, rivers or the ocean submit a long-term flood protection plan when updating existing Waste Discharge Requirements (WDRs). WDR's are most commonly updated every 10-15 years, or with a proposed expansion, significant changes in monitoring parameters or well locations, when ownership changes, or if new regulations are promulgated. Long-term flood protection plans must consider feasible options for achieving protection from the 100-year flood in the face of rising sea levels and increasing flood frequency and intensity. Once in place these plans must be updated every five years throughout the operational life and post-closure maintenance period of the landfill. In addition, the RWQCB can require consideration of long-term flood protection and sea level rise in actions requiring landfill implementation of site cleanup and other corrective actions.

KEY ISSUE STATEMENT

Increased flooding, groundwater levels, or tidal, wind and wave energy could have significant consequences on landfill waste containment systems, potentially impacting public health and nearby ecosystems if contaminants are released. Current RWQCB long-term flood protection requirements are one opportunity for landfills to identify and address increased flood risks due to sea level rise. However, this approach is geared towards site-specific actions, and may not suffice in locations where landscape-scale responses are warranted.

EXPOSURE TO CURRENT AND FUTURE FLOODING

All landfill parcels in the project area, except the East Parcel of the Acme Landfill, are located within the 100-year floodplain. The West Contra Costa Sanitary Landfill is at risk from 6 feet of sea level rise, although adjacent wetlands on the parcel could be inundated with 2 feet of sea level rise. Low-lying wetland areas on the Acme and IT Vine Hill Complex landfill parcels could be inundated with 1 foot of sea level rise.

Asset descriptions

There are three landfill complexes in the ART project area: the West Contra Costa Sanitary Landfill in Richmond, and the IT Vine Hill Complex (IT Vine Hill and IT Baker) and Acme Landfill in Martinez.

WEST CONTRA COSTA SANITARY LANDFILL

The West Contra Costa Sanitary Landfill (also known as the West County Sanitary Landfill) is a closed and capped facility that straddles the City of Richmond and unincorporated North Richmond. The landfill includes a 28-acre Class I landfill that is a Hazardous Waste Management Facility located within the footprint of the 160-acre Class II landfill. Both landfill components are surrounded by slurry walls and have a leachate extraction system and monitoring wells. Leachate is conveyed to the nearby West County Wastewater Treatment Plant for treatment and discharge. Access to the landfill is from Parr Boulevard, which could be disrupted with two to three feet of sea level rise.

Low-lying portions of the landfill are within the 100-year floodplain and are at risk from sea level rise. The permanent containment of non-hazardous and municipal wastes at the landfill is vulnerable to flooding because of the proximity to the Bay, limited access via Parr Road, the type of onsite facilities and uses, and the potential that flooding could be long duration or result in permanent inundation. The direct disruption of the closed landfill, particularly the Class I landfill component, could have significant consequences for public health and nearby ecosystems if contaminants were released into the environment. The current leachate collection system may or may not be sufficient to collect and treat additional water volumes that might result from sea level rise.

IT VINE HILL COMPLEX

The IT Vine Hill Complex is located in a heavily industrial area of Martinez near the Acme Landfill. The complex consists of two non-contiguous landfills: the 41-acre IT Vine Hill and 26-acre IT Baker Landfill. Both are former municipal and hazardous waste disposal facilities that are now closed and covered with a system of low permeability soils and geosynthetic layers. The landfills are surrounded by slurry walls and have a groundwater collection system. Groundwater from the IT Baker site is transferred via pipelines to the IT Vine Hill site, which has a groundwater treatment plant and two evaporation basins. Surface water is diverted from the IT Vine Hill site to Pacheco Creek via drainage ditches.

While the majority of the landfill parcels would not be flooded due to their elevation, low-lying areas between the landfills are potentially at risk. Access to the IT Vine Hill Landfill is from Waterbird Way and Waterfront Road, a portion of which floods temporarily during current extreme high tides and which could be further compromised in a flood event as sea level rises. As a portion of the IT Vine Hill Landfill is located within the Lower Walnut Creek Watershed along Pacheco Creek, and the IT Baker Landfill is located between Pacheco

Creek and Walnut Creek, protection from flooding will require ongoing coordination with the Contra Costa Flood Control District as well as nearby landowners and managers.

THE ACME LANDFILL

The 516-acre Acme Landfill is located in a heavily industrial area of Martinez near the IT Vine Hill Complex. The landfill consist of three separate waste disposal sites: the North Parcel, a closed 135-acre Class I (hazardous waste) landfill; the South Parcel, a closed 22-acre Class III landfill; and the East Parcel, an active 87-acre Class II landfill. Onsite facilities include a weigh station, pay booth, maintenance shop, two office buildings, recycling areas, and storage yards for vehicles and equipment. There is a groundwater and leachate monitoring system in place, a leachate barrier around the perimeter, a leachate treatment plant, and a landfill gas collection and treatment system, including gas turbines.

All three parcels where the landfills are located are within the existing 100-year floodplain and have low-lying portions that could be exposed to sea level rise. Although the majority of the landfill parcels will not be flooded due to their elevation, the low-lying portions of the landfill parcels and any facilities located in low-lying portions of the site could be at risk. Access to the landfill is from Waterbird Way and Waterfront Road, a portion of which floods temporarily during current extreme high tides and which could be further compromised in a flood event as sea level rises, potentially impacting active landfill operations at the East Parcel. The landfills are within the Lower Walnut Creek Watershed, and protection from flooding will require ongoing coordination with the Contra Costa Flood Control District as well as nearby landowners and managers.

Vulnerabilities

GOV: The IT Vine Hill Complex and Acme Landfills are located in the Lower Walnut Creek Watershed, and protection from flooding will require ongoing coordination with Contra Costa Flood Control District as well as with other landowners and managers.
FUNC: Landfills require local road access for site management (e.g. monitoring, repairs or upgrades to waste containment systems). The three landfill complexes in the project area rely on access roads that are vulnerable to flooding. Short-term disruption of road access during a storm, or longer-term disruption due to more persistent flooding will interrupt ongoing operations and make site management more difficult.
PHYS1: The volume and type of waste contained in shoreline landfills makes it extremely challenging and expensive to relocate them, therefore they need to be protected in place.
PHYS2: While landfill cover systems are designed to prevent water infiltration, leachate extraction systems may or may not be sufficient, depending on the volume of inundation, to collect and dispose of the additional volumes if flooding occurs.
PHYS3: Waste containment systems designed for existing conditions may not be adequate to withstand permanent flooding or increased storm energy depending on their design and maintenance and the location of the landfill.
PHYS4: The stability of waste containment facilities such as landfill caps or liners, caps over remediated sites, and slurry walls constructed to contain contaminants can be compromised by liquefaction during a seismic event. Liquefaction risk can increase due to rising groundwater levels, increasing the potential damage that could be costly to repair and would make the landfill more vulnerable to flooding.

Consequences

Society and Equity: Landfills pose a risk to public health if contaminants currently contained on site are released to surrounding surface or groundwater.

Environment: There could be significant water quality impacts if contaminants are released from landfills into the adjacent natural areas that support a variety of species and habitats. The Walnut Creek Watershed, for example, supports a variety of species, including federally threatened coho salmon, federally threatened steelhead trout, black rails (threatened), and California Ridgway's rails (endangered).

Economy: A release of contaminants from closed or active landfills could strain local emergency resources and could result in high cleanup and recovery costs.

Brownfields

Brownfields are environmentally distressed properties where expansion, redevelopment, or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Regulatory jurisdiction over Brownfields and other contaminated sites in Contra Costa County is shared among the U.S. Environmental Protection Agency, the State Water Resources Control Board (Water Board), the Department of Toxic Substances Control (DTSC) and Contra Costa Health Services. To facilitate the coordination and communication on Brownfields issues, the Water Board and DTSC have a Memorandum of Agreement that defines how a lead agency is assigned and specifies that cleanups address the requirements of both agencies (http://www.waterboards.ca.gov/water_issues/programs/Brownfields/).

The extent to which Brownfields sites are cleaned up depends on the sites' current land use designation or on its intended reuse. For example, sites intended for heavy industrial uses have less stringent cleanup standards than those intended for light industrial or commercial uses. In addition, sites are cleaned up to different standards depending on if they are dry (e.g., uplands) or wet (e.g., aquatic). Depending on cleanup costs and the level of remaining risks, some contamination can be allowed to remain on site. In these cases there are often restrictions on the future use of the site, and for activities on site such as digging in certain areas. Long-term monitoring, maintenance plans and site reviews are required for Brownfields where some contamination remains in place. Additionally, these sites are subject to deed restrictions, covenants, and administrative, institutional or engineering controls.[18]

Sites included as Brownfields in this assessment include those that have been identified by the U.S. Environmental Protection Agency as Superfund sites and by DTSC as State Response, Voluntary Cleanup, and Corrective Action Programs sites. It is highly likely however that this assessment of known sites underestimates the actual number of properties that could be defined as Brownfields[19] in areas at risk of flooding. As a framework for better understanding the potential vulnerabilities and consequences of identified

[18] Brownfields and Contaminated Sites Cleanup Policy in Contra Costa County, Recommendations for Improvement, Contra Costa Hazardous Materials Commission, September 2010

[19] Properties that are contaminated, or thought to be contaminated, and are underutilized due to perceived remediation costs and liability concerns (www.dtsc.ca.gov/SiteCleanup/Brownfields/index.cfm).

Brownfield sites in the project area, the analysis used DTSC classified of cleanup status including inactive sites and in sites in need of further action or evaluation; active sites with investigations or remediation by a responsible party underway; or sites certified that the cleanup has been completed, although possibly with waste left on site. The challenges of current and future flooding of Brownfields sites will be different depending on the status, and therefore these categories provided a useful distinction in the assessment.

KEY ISSUES

Brownfield cleanups are site-specific and based on the designated land use and/or the proposed site reuse, as well as current standards, which vary by location (e.g., upland or aquatic). Upland sites that become aquatic as sea level rises will not have been remediated to a high enough standard, as allowable aquatic contaminant concentrations are lower than upland concentrations. Opportunities for further cleanup of Brownfields to address changing flood or groundwater conditions will vary; remedies are site specific, and there may not be means to compel the further cleanup of certified sites.

EXPOSURE TO CURRENT AND FUTURE FLOODING

There are 63 identified Brownfields in the project area: 25 of which are Active, 18 are Certified with Operations and Maintenance, 12 are Certified with land use restrictions, and seven are Inactive - Action Required. Thirty-eight of these identified Brownfields are potentially exposed to flooding and one is in a low-lying area adjacent to an area that is exposed to six feet of sea level rise.

Table 9. Identified Brownfield parcels that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Brownfield Parcels	Current 100-year Flood	100 year Flood plus Sea Level Rise					
		1'	2'	3'	4'	5'	6'
Active	1	11	11	12	12	12	12
Certified / Operation & Maintenance	2	5	5	5	5	5	5
Certified O&M - Land Use Restrictions Only	3	7	7	7	7	7	7
Inactive - Action Required	0	2	2	2	2	4	4
Total	6	25	25	26	26	28	28

Table 10. Identified Brownfield parcels outside of the current 100-year floodplane that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Brownfield Parcels	Sea Level Rise not in Flood Zone						Low-lying, adjacent to 6 feet SLR
	1'	2'	3'	4'	5'	6'	
Active	1	1	1	2	3	5	0
Certified / Operation & Maintenance	0	1	1	1	1	2	0
Certified O&M - Land Use Restrictions Only	0	1	1	1	1	3	1
Inactive - Action Required	0	0	0	0	0	0	0
Total	1	3	3	4	5	10	1

Asset descriptions

While Brownfields have been identified across the entire project area, the highest concentration (over two-thirds) of identified sites is within the City of Richmond. There are at least 68 different contaminants of concern associated with Brownfields in the ART project area, including various metals, corrosive materials, petroleum products, volatile organics, organochlorine pesticides, and other compounds. Nearly all of the Brownfield sites have multiple contaminants of concern, and often have more than one contaminant of the same type, for example more than one kind of metal. The most common contaminant of concern is lead, which is found at nearly two-thirds of the sites evaluated in the project area. These contaminants can potentially affect soil, sediments, sediment vapor, groundwater, or surface water.
Brownfields cleanup status can vary from not yet initiated to complete. The four cleanup status categories are described below.[20]

INACTIVE

Inactive sites have either been screened and require action, following the identification of contamination, or whether further evaluation is needed, as the site has been identified as a possible problem but contamination has not yet been found. Beyond the sites identified as inactive, other sites may exist which have yet to be identified by any of the state, regional or federal regulatory agencies responsible for overseeing the cleanup of contaminated lands.

ACTIVE

Active sites are those either being investigated or undergoing cleanup. For these sites, there is an opportunity to examine how potential changes from sea level rise may impact the way that cleanup standards should be applied, and how future flooding may impact the efficacy of the remediation practice in use. There are different cleanup remedies, some relatively fast, and others slower and in place for longer

[20] Cleanup status as used by DTSC in the Envirostor database.

periods of time. In most cases, the remediation begins with removal of contaminated soils. Contamination that remains on site can then be capped or covered. Groundwater is treated either through traditional pump and treatment systems (which are not as prevalent), with in-situ oxidative/reductive technologies that are relatively fast and ideal for localized contamination, or with permeable reactive barriers, used when the area of contaminated groundwater is large. These treatment practices are sensitive to salinity levels. Because they stay in place for long periods and use passive groundwater flow, permeable reactive barriers will be affected by changes in groundwater. For example, if the rate and direction of groundwater flow is slowed or reversed, which can happen in shallow areas with a rising Bay, the treatment practice will not function as designed. In addition, permeable reactive barriers require maintenance over their lifespan, and if placed in an area that is permanently inundated or flooded for long periods of time, they may not be serviceable for the duration of the expected cleanup.

CERTIFIED

Certified sites are those where cleanup has been completed. In many cases contamination remains on site after cleanup, and there are three sub-classes of certified Brownfields sites. “Certified with Operations & Maintenance” sites must have an engineered or physical remedy in place that requires ongoing operations and maintenance. These sites may also have some form of land use controls, such as land reuse restrictions or covenants that describe the appropriate and allowable uses of the site. “Certified – Land Use Controls Only” sites do not require ongoing operations or maintenance, but do have land reuse restrictions. Finally, “Unrestricted” sites can be reused for any type of land use.

Brownfields with ongoing operations and maintenance are inspected annually by DTSC, and those that are subject to land use controls are reviewed by DTSC through inspections and reporting. Additionally, these sites are subject to review every five years to confirm that their cleanup remedy remains effective given changing conditions. These periodic reviews are an opportunity to evaluate whether the cleanup remedy will remain effective as sea level rises.

Certified sites that are unrestricted are not, however, subject to review. This can pose some challenges. For example, the amount of cleanup required to allow residential reuse (an unrestricted land use) is based on human health considerations, and may not adequately protect aquatic species.
The potential for flooding of contaminated sites, including those already cleaned up and those with contamination not yet uncovered, could impact sensitive aquatic receptors. As sea levels rise, the release of sequestered contaminants to aquatic environments is likely to be one of the most significant issues faced because:

- For Certified sites, cleaned up to the most appropriate standard at the time of remediation, the responsible party may be unwilling or financially unprepared to take on additional cleanup.
- Remedial actions necessary to clean up sites to aquatic standards are likely to be much more costly than clean up to upland standards, not only for private responsible parties but also for governments that might be funding the cleanup.
- It will be challenging to demonstrate that the existing cleanup will or will not suffice under inundation, as this will depend on the type of contaminant present, site specific characteristics, and what the original remediation approach.

Vulnerabilities

GOV1: Most Brownfield sites are privately owned, and cleanup depends in part on being able to locate the responsible party and on these parties having the necessary funds to undertake the cleanup. Where responsible parties cannot be found or do not have sufficient funds, the cleanup process may be delayed or public funds must be used.
GOV2: Agencies may have shared oversight responsibilities over individual Brownfield sites, or different agencies may have oversight over sites that are physically close to one another. This creates challenges in coordinating information and action to address sea level rise impacts.
GOV3: There are no effective regulatory or financing mechanisms to prioritize the remediation of Brownfields that will be affected by sea level rise. Additionally, these sites may not provide the most appropriate redevelopment opportunities, further diminishing any incentive to conduct cleanup activities. This is especially true for sites that once cleaned up are generally reserved for habitat or open space.
GOV4: Some of the identified Brownfields in the project area are protected from flooding by structures on site. For example, the Shipyard #3 and Union Carbide Brownfield sites are within the Port of Richmond and are protected from flooding by the port's structural shoreline. Other Brownfield sites are protected from flooding by shorelines that are owned and managed by others.
PHYS1: Some Brownfields can be cleaned up through the removal of contaminated soil. For sites where the removal of all contaminants is infeasible due to technical challenges or funding issues, remaining contamination is typically capped and remediated in place. Remediation practices such as permeable reactive barriers, that need to be in-situ for a long duration and rely on existing groundwater flow rates, directionality and salinity level, may not continue to be effective as sea level rises.
PHYS2: Past remediation and cleanup standards may not consider impacts of sea level rise, and sites that have been cleaned up to upland standards, or for specific groundwater and salinity levels, could be vulnerable if exposed to increased temporary flooding, permanent inundation, or changes in groundwater or salinity levels. Sites that become partially or fully exposed to the tides as sea level rises would need more stringent remediation to meet aquatic standards.
PHYS3: Sediment bound contaminants are vulnerable to erosion, which could transport them into the Bay, while water-soluble contaminants are vulnerable to flooding and rising groundwater. While groundwater in nearshore clay or mud deposits does not move very fast or far, sites that are located further inland may be vulnerable to increasing groundwater levels.

Consequences

Society and Equity: Brownfields that have not been fully cleaned up, or have been cleaned up to less stringent upland or reuse standards, may pose a risk to public health if onsite contaminants are released to residential areas or to areas with sensitive receptors (elderly, very young, medically challenged). Many contaminants are harmful to human health, and could cause problems for those who come into contact with them or if they migrate into groundwater. Engineering control methodologies and technologies are available for use at upland sites to protect the occupants of buildings constructed on contaminated sites, in particular where groundwater drives soil vapors up and into occupied spaces. However, these technologies will not be in place in areas newly exposed to contaminants due to sea level rise or changing groundwater levels.

Environment: Many common Brownfield contaminants that remain on site post-cleanup are at levels that are not harmful to people. However, contamination levels that remain on sites remediated to upland standards can be harmful to aquatic receptors, and if released to the Bay and shoreline, would have significant adverse

impacts on aquatic species and make their way into the food chain. Subsistence and recreational fishing in the Bay could provide a pathway for these contaminants to impact human health.

Economy: Brownfield cleanup can be very costly, and often must be undertaken with public funds, which are extremely limited and difficult to obtain. Brownfields undergoing active cleanup are also typically slated for redevelopment; disruption of these sites and release of contaminants could result in loss of economic investment or potential.

RESOURCES

California Department of Toxic Substances Control. EnviroStor Data Management System. http://www.envirostor.dtsc.ca.gov/public/
Contra Costa Hazardous Materials Commission. September 2010. Brownfields and Contaminated Sites Cleanup Policy in Contra Costa Count: Recommendations for Improvement. http://cchealth.org/hazmat/hmc/pdf/2010_09_reports_Brownfields.pdf

Energy Sector

Refineries, pipelines, electrical power distribution (substations) and generation facilities are energy sector assets analyzed for vulnerability to sea level rise. Energy infrastructure provides electricity and natural gas to homes and businesses, as well as fuel for multiple modes of transportation, both within the project area, and beyond to other parts of the region, state, and nation. Energy sector assets were considered together because these systems share similar vulnerabilities, and their damage or disruption can have wide ranging consequences on day-to-day community function as well as emergency response capacity.
The energy industries and infrastructure discussed in this assessment are regulated by a number of State and Federal agencies. The Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), through the Office of Pipeline Safety (OPS), is the federal regulatory agency responsible for the oversight of pipeline safety. At the State level, the California Public Utilities Commission (CPUC) regulates electric and gas utilities, as well as some aspects of the telecommunications sector. The State Fire Marshal acts as an agent of PHMSA with respect to pipeline safety, for example requirements such as pipeline coating and burial depth, as well as conducting periodic inspections of transmission pipelines, including surveying pipeline right-of-ways for excavation activities or population encroachment and detection of leaks and threats of corrosion.

Refineries

The primary purpose of an oil refinery is to process crude oil to make petroleum products and other chemicals, including motor fuel and lubricants. These products are then transported to distributors and consumers. All five Bay Area oil refineries are located near the shoreline, four of which are in the project area. The refineries are all located along the shoreline because they rely on marine oil terminals and they are considered a water-dependent use. They also depend on many other sectors, including road and rail for access to and from their sites and for goods movement, pipelines, power generation and distribution, water supply and wastewater services. Often, refinery operations and associated industries are co-located on adjacent industrial parcels owned by the refinery.

KEY ISSUE STATEMENT

Temporary or permanent disruption of refinery operations, due to on-site flooding or access to the refinery (roads or rail) being disrupted, would have significant impacts locally, regionally, and statewide. Improving the resilience of refinery operations will require coordination with asset owners and managers that operate on-site as well as those that provide goods and services from off site.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The four refineries in the Contra Costa ART project area are large industrial sites with assets and facilities both along the shoreline and inland. Three of the four refineries have at least a portion of their land area within the existing 100-year floodplain (coastal and/or riverine) and all of the refineries are exposed to as little as one foot of sea level rise. While this result is not surprising based on their shoreline location, site-scale analyses are needed to better understand which if any vulnerable refinery assets or facilities are located on the shoreline or in low lying areas that could be flooded either due to shoreline overtopping or a failure of the stormwater system to drain adequately.

Table 11. Refineries located in the current 100-year floodplain that could be exposed to sea level rise.

Refinery	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Tesoro Martinez	Martinez	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shell Martinez	Martinez	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conoco Phillips 66	Rodeo	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chevron's Richmond	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes

ASSET DESCRIPTIONS

TESORO MARTINEZ REFINERY

The Tesoro Martinez Refinery site includes many different types of assets and facilities. In addition to Tesoro's refinery operations the site includes the Amorco (import) and Avon (export) Marine Oil Terminals, as well as seven facilities that are owned and operated by other companies who either own or lease the land where the facility is located. These facilities include a Chevron Products Company bulk fuel terminal; a Monsanto catalyst and chemical manufacturing plant; a Shell Oil Company crude oil pump station and pipeline; a Kinder Morgan refined product pump station and the Santa Fe pipeline; a Foster Wheeler cogeneration plant; an Air Liquide plant where CO2 and compressed natural gas are manufactured; an Air Products hydrogen gas plant. In addition, Wickland Oil Company and Shore Terminals LLC own and operate pipelines on the refinery site21.

[21] RWQCB Transmittal of Order No.R2-2004-0056 (2004)
http://www.waterboards.ca.gov/sanfranciscobay/board_decisions/adopted_orders/2004/R2-2004-0056.

Connections to the Tesoro site are essential to refinery operations. Pipes, pumps, electrical utilities, and other mechanical equipment that connect services and operations are located on site. Transmission lines, roads, interstate roads (i.e. I-680 and Waterfront Road), terminals, pipelines (i.e. Kinder Morgan) and rail (i.e. Union Pacific) connect the refinery to services and markets located off site although the Refinery relies mainly on pipelines for its exports. Although Burlington Northern Santa Fe (BNSF) has a rail line that cuts through the refinery perpendicular to Solano Way and Walnut Creek, it does not service the Refinery. Tesoro receives water from the Contra Costa Water District and is developing a plan to use recycled water from Central Contra Costa Sanitary District. The refinery treats and discharges wastewater to Suisun Bay via a diffusion line under a NPDES permit, while clean stormwater is discharged to Pacheco Slough or Hastings Slough.

A portion of the Tesoro Martinez Refinery is located in the 100-year flood plain, in particular the northern side of the site closest to the Point Edith Wildlife area. Low elevation areas on the site, which may include some wastewater treatment ponds, are vulnerable to flooding. A portion of the Tesoro Martinez Refinery site is low-lying and vulnerable to future coastal storm flooding, and a portion is adjacent to Lower Walnut Creek and could be impacted by future riverine flooding. The site may also be exposed to rising groundwater levels and salinity intrusion as sea levels rise.

Local access to the Tesoro Martinez Refinery from Waterfront Road could be further compromised as sea level rises; currently, low portions of this road flood during extreme high tides and the annual King Tide.

SHELL MARTINEZ REFINERY

The Shell Martinez Refinery site includes refinery operations (e.g., distillation towers, cracking units, cooling towers, storage tanks), a marine oil terminal, a Cogeneration Power Plant (98.5 MW capacity), stormwater treatment (located on the northwest side) and industrial wastewater treatment ponds (located on the east side). Connections on and off the site are essential to the operation of the refinery. Pipes, pumps, electrical utilities, and other mechanical equipment connect services on the refinery site. Transmission lines, roads, interstate roads (i.e. I-680) terminals, pipelines, and rail (UPRR and BNSF) connect the refinery to services and markets located off site.

A portion of the Shell Refinery is located in the 100-year flood plain, and there are low-lying areas near the shoreline and northeastern borders along the Waterbird Regional Preserve. Low elevation areas on the site, which may include some wastewater treatment ponds, are vulnerable to flooding. The east side of Shell Martinez Refinery borders a marsh and is low-lying. Flooding from sea level rise and storm events could expose pipelines, roads (Waterfront Road), rail lines, buildings, and the wastewater treatment plant to potentially corrosive seawater and elevated groundwater levels.

CONOCO PHILLIPS 66 RODEO REFINERY

The Conoco Phillips 66 Rodeo Refinery site includes refinery operations (e.g., distillation towers, cracking units, cooling towers, storage tanks), a fuel gas center (remove sulfur compounds from gas), a marine oil terminal, a steam power plant (48 MW capacity), a Carbon Plant with an onsite steam power plant (14.2 MW), hydrogen plants (Unit 110 and Air Liquide Large Industries, which also manufactures energy and steam), stormwater treatment and industrial wastewater treatment plant. Connections on and off the site are essential to the operation of the refinery. Pipes, pumps, electrical utilities, and other mechanical equipment

connect services on the refinery site. Transmission lines, roads, interstate roads (i.e. I-80) terminals, pipelines, and rail (UPRR and BNSF) connect the refinery to services and markets located off site.

A small shoreline portion of the Rodeo Refinery is located in the 100-year flood plain and there are areas on site that are low-lying areas and could be flooded if the stormwater drainage system fails. With 6 feet of sea level rise, the wastewater treatment pond is vulnerable to inundation. Although much of the refinery at higher elevations will likely avoid flooding from sea level rise and storm events, pipelines, roads, rail lines, buildings and the wastewater treatment plant that the refinery operations rely on could be exposed to corrosive seawater and elevated groundwater. In addition, the rail line that runs along most of the shoreline may serve as an informal shoreline protection for some of the low-lying portions of the refinery site.

CHEVRON'S RICHMOND REFINERY

Chevron's Richmond Refinery site includes refinery operations (e.g., distillation towers, cracking units, cooling towers, storage tanks) a marine oil terminal, a cogeneration power plant (125 MW capacity), stormwater and industrial wastewater treatment ponds, and EBMUD's Richmond Advanced Recycling Expansion. Connections on and off the site are essential to the operation of the refinery. Pipes, pumps, electrical utilities, and other mechanical equipment connect services on the refinery site. Transmission lines, roads, interstate roads (i.e. I-580) terminals, pipelines, and rail (UPRR and BNSF) connect the refinery to services and markets located off site. The refinery's tank farm is located at higher elevation, but the refinery process area and off site connections are located at lower elevation.

Low-lying and shoreline portions of the Chevron Refinery site, in particular along the eastern side of the site, are located in the 100-year floodplain. These areas and adjacent low-lying areas could also be flooded with two feet of sea level rise or more. Flooding on the east side of the refinery may impact pipelines, roads, rail lines, buildings, and the wastewater treatment plant, and could expose these assets to potentially corrosive seawater. In addition, elevated groundwater levels may impact existing groundwater containment and extraction systems (groundwater protection system) and may interfere with the refinery's capacity to collect and treat wastewater, groundwater seepage, and stormwater runoff, and consequently discharge these water sources through the existing system of deepwater and perimeter outfalls.

VULNERABILITIES

INFO: There is limited information about refinery sites or operations that is available to public agencies and neighboring jurisdictions. The information that is lacking includes details regarding the components of each refinery and the associated industrial facilities such as cogeneration or wastewater treatment that are often co-located on sites.
GOV1: The number of agencies that regulate refinery planning and operations, the number of associated facilities, and the reliance on others to provide access and services (i.e. energy, wastewater, rail, marine terminals) will complicate implementing changes necessary to improve resilience to flooding disruptions.
GOV2: Refinery owners and associated industrial facility managers do not have control over the entire shoreline that protects low-lying areas that are at risk of flooding.
PHYS1: Refineries and associated industrial facilities that are located in low-lying areas are unlikely to have been constructed to withstand flooding or higher groundwater levels.

PHYS2: Pipelines and electrical components connecting the shoreside facilities, including Marine Oil Terminals, to land-based refinery facilities may corrode if they are exposed to salt water.
PHYS3: Linear, networked infrastructure such as pipelines that the refineries rely on may be more susceptible to damage during a seismic event if liquefaction potential increases due to higher groundwater.
FUNC1: Refineries rely on power, water supply and water treatment services to function. Disruption of these services, including from onsite cogeneration plant, recycled water supplies, or wastewater treatment plants may cause refinery operations to slow down or even shut down entirely.
FUNC2: Refineries operate continuously and the process of safely shutting down requires time and effort. During an unexpected flood event there could be far ranging consequences on the economy, environment, and public health if a refinery shuts down with little or no preparation.
FUNC3: Temporary or permanent disruption at ship/rail terminals that refineries rely on would affect the capacity to ship and receive goods, and potentially disrupt refinery operations.

CONSEQUENCES

Society and Equity: Slow downs or shut downs of refinery operations could impact local and regional jobs both on site and in the sectors serving the refinery. Flooding of the refinery site could also result in public health impacts if there is an unscheduled disruption in operations that results in the accidental release of pollutants to the air or waters near the facility.

Environment: Contaminants are present on site that could be carried with floodwaters into inland areas, released into the Bay, or migrate into rising groundwater. Most refineries have fire and emergency response teams on-site that could help mitigate impacts during a flood event. If the rail system is disrupted and trucks are used to bring goods to and from the refineries there may be an increase in roadway congestion, impacts on air pollution levels, and increased green house gas emissions.
Economy: Refinery operations disrupted for a significant period of time could result in a loss of jobs at the refinery site and in associated sectors, and potentially impact the regional economy, including higher fuel prices and potentially even fuel shortages.

ASSET SCALE ASSESSMENT FINDINGS

The Tesoro Martinez Refinery was selected as a representative refinery for assessment because refinery staff actively participated in the project working group. Staff shared information about the refinery site and its operations, and provided critical review and feedback on the information gathered to ensure it was as accurate and reflective of existing conditions as was possible. See the Tesoro Martinez Refinery profile sheet summarizing the assessment findings.

Pipelines

Pipelines transport hazardous liquids and gasses, including crude oil, refined, petroleum and natural gas to different locations throughout the region for processing, and then further to other locations and uses. Northern Contra Costa County contains a significant proportion of the refineries and industrial uses in the Bay Area and pipelines, which span the County, are an essential component to connecting many of these uses to the regional economy. The pipeline system serves an area that extends beyond the region as pipeline products are transported throughout Northern California and beyond. Pipelines are usually buried at a depth of three to four feet and comprised of high-carbon steel, although natural gas distribution systems

have been constructed from many materials including cast iron, steel, copper, and plastic pipe (commonly installed today for gas distribution systems). Natural gas and pipeline systems are owned and operated by different companies. The location, construction and operation of these systems are generally regulated by federal and state agencies. Many are located in railroad and state road or highway right-of-ways, and some cross natural areas such as marshes and flood control and stream channels.

KEY ISSUE STATEMENT

Buried pipelines are directly and indirectly sensitive to higher groundwater table and salinity intrusion. Exposure to salt water can corrode pipelines that are not protected as specified in federal and state regulations. Rising groundwater levels could increase liquefaction potential leading to additional damage during a seismic event. In the event of flooding, pipelines that are not weighted or anchored may float and become exposed, particularly during prolonged flooding and in marshy or sandy soils. Erosion during storm events could also expose and damage pipelines. Damage to pipelines could result in service disruptions as well as threats to public safety and the environment in the event of an explosion or release of hazardous contents.

EXPOSURE TO CURRENT AND FUTURE FLOODING

There is a total of 276 miles of pipeline within the project area. A total of 55 miles is within the current 100-year floodplain, 12 miles that carry natural gas and 43 that carry hazardous liquids. A total of 51 miles of pipeline is within the area potentially exposed to six feet of sea level rise. The majority of these exposed pipelines carry hazardous liquids. Due to the type of analysis conducted, the miles of pipeline reported exposed to existing and future flooding may not always represent separate pipelines and some of the pipelines included may overlap. Given the shoreline location of many pipelines in the project area, many that are exposed to sea level rise are likely within the existing floodplain.

Table 12. Miles of pipeline in the current 100-year floodplain and pipeline that could be exposed to sea level rise.

Miles of Pipeline by Type of Commodity	Current 100-year Flood	Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Gas*	12	1	2	3	5	6	7
Liquid**	43	11	21	24	28	34	44
Total	**55**	**12**	**23**	**28**	**33**	**40**	**51**

*Gas = natural gas; **Liquid = crude oil, natural gas liquid, other products

VULNERABILITIES

INFO: Lack of easily accessible information on pipeline material, age, eccentricities, and weld type make it difficult to understand the vulnerabilities of the different pipelines to sea level rise and the consequences that could occur if they are impacted.
GOV1: Pipeline operations and maintenance plans may not be well coordinated among different owners of networked pipeline systems, or adequately shared with emergency responders and other relevant entities.

Additionally, the plans may not clearly describe procedures for shutdown and other measures to minimize damages during a storm event.
GOV2: Pipelines are often co-located with other linear infrastructure such as railroads and roadways such that planning and implementing adaptation actions will require coordination among numerous private and public entities, regulatory agencies, utility owners, and transportation managers.
PHYS1: Pipes that are not properly protected can corrode if exposed to saltwater, either by flooding or saltwater intrusion into groundwater, resulting in potential damage to the pipeline.
PHYS2: Flooded pipelines could float and become exposed if not weighted or anchored, and may be damaged due to increased hydrostatic pressures in areas that are flooded.
PHYS3: Rising groundwater can increases the risk of liquefaction, which could damage buried pipelines in a seismic event.
FUNC1: Pipelines supply liquid fuels and other materials over long distances within the region, and are critical to the region's energy and goods movement economy. Damage to pipelines could result in service disruptions as well as threats to public safety and the environment in the event of an explosion or release of hazardous contents.
FUNC2: Pipelines function as interconnected systems such that even if pipelines in the project area are protected all parts of the regional pipeline network must be in working order to maintain system wide function.
FUNC3: Although many pipeline segments have safety valves to allow for a shut down in an emergency, this process may take some time. Therefore advance warning is necessary if the pipeline is to be safely shut down.

CONSEQUENCES

Society and Equity: Direct societal consequences of pipelines flooding will likely depend on the severity of disruption of fuel and natural gas transport and distribution. However, if damaged pipelines explode or leak there could be health risks to nearby populations.

Environment: Pipelines may carry jet fuel, diesel, and other petroleum products and hazardous materials, which, if released, would harm natural area habitats and sensitive species.

Economy: If the pipelines were disrupted, the movement of goods (fuel, gas, diesel) would either be suspended or transferred to an alternate means of transport. Pipelines are an essential component to refineries, which are a major part of the economy. Therefore interruption of pipeline operations in Contra Costa County could have far reaching economic consequences.

Power Distribution

Substations connect lines within both the transmission and distribution systems and are a critical component of the electricity system. High voltage transmission lines run underground and overhead and carry electricity from where it is generated to substations. Substations transform the power to a lower voltage to be carried by overhead and underground distribution lines to residences and businesses. Substations function together as a system; while the service area of each substation is local, the transmission lines that connect to them are networked.

Of the 33 substations in the project area, 19 are owned and managed by PG&E and 14 are owned by private entities (e.g., Shell Oil Company and others). Substations have expensive and potentially dangerous equipment such as transformers, which change the voltage of electrical current; capacitors, which store energy in an electric field; and voltage regulators, which maintain a constant voltage. Typically, substations are located aboveground in fenced enclosures or are within special-purpose buildings.

KEY ISSUE STATEMENT

Substations provide electricity through a networked grid; if one substation is damaged or disrupted there could be downstream (cascading) consequences even though there is some redundancy within the overall grid. Electricity is critical during an emergency. In addition to enabling communications, electricity is needed to run pumps (stormwater, flood control, wastewater) and maintain emergency response centers and facilities.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Of the 33 substations in the project area eleven substations are exposed to current and/or future flooding, six are located in the 100-year floodplain, and seven are exposed to four feet of sea level rise or more. Five of the substations are located in the City of Richmond, four of which are privately owned and one is owned by PG&E. Of the five substations located in the City of Martinez, two are potentially exposed to sea level rise – one of these is owned by PG&E and the other is privately owned. There is one PG&E substation in the City of San Pablo that is within the current floodplain but is not shown to be impacted by sea level rise; however additional studies are needed to understand the potential impact of sea level rise on current coastal and riverine floodplains.

Table 13. Substations that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Substation	City	Owner	Current 100-year Flood	Sea Level Rise					
				1'	2'	3'	4'	5'	6'
RICHMOND R	RICHMOND	PG&E						Yes	Yes
STANDARD OIL 1	RICHMOND	OTHER						Yes	Yes
STANDARD OIL 2	RICHMOND	OTHER						Yes	Yes
STANDARD OIL 4	RICHMOND	OTHER							Yes
STANDARD OIL 5	RICHMOND	OTHER	Yes				Yes	Yes	Yes
BROOKSIDE	SAN PABLO	PG&E	Yes						
ALHAMBRA	MARTINEZ	PG&E	Yes						
IMHOFF	MARTINEZ	PG&E	Yes						

URICH	MARTINEZ	PG&E	Yes			
STAUFFER	MARTINEZ	PG&E	Yes		Yes	Yes
URICH	MARTINEZ	OTHER		Yes	Yes	Yes

VULNERABILITIES

INFO: Information is not publically available about power substation vulnerabilities, the possibility of load sharing among substations, or the operational capacity to load share in the event of shutdowns.
GOV: Existing operations and maintenance procedures for power substations may not include well-coordinated shutdown plans to be implemented in the event of a flood emergency.
PHYS1: Substation equipment, and in particular below ground electrical or mechanical equipment, may be sensitive to flooding, rising groundwater, and salinity intrusion that can cause corrosion.
PHYS2: Substation structures and equipment may be damaged during a seismic event in areas susceptible to liquefaction, which may become more extensive as groundwater rises.
FUNC: Substations are part of the electricity grid, and if one substation goes out, electricity can usually be rerouted through another substation to its customers. However, if several substations go out, the service could be interrupted and resulting in downstream consequences.

CONSEQUENCES

Society and Equity: Disruptions to substations could result in loss of power, with consequences for residents and those who work in the affected areas. Substations contain hazardous materials that could harm people and contaminate their property if released into floodwaters.

Environment: Substations contain hazardous materials that could harm the health of wetland habitats and sensitive species if floodwaters carry them into the Bay or nearshore areas.

Economy: The disruption of power could result in business closures, with corresponding losses in productivity, revenues, and income.

POWER GENERATION

Of the nine power-generating facilities within the project area only the Crockett Cogeneration Plant is a significant power producing plant. Other smaller power-generating facilities serve specific industrial sites, such as two landfill gas operated systems in the project area. The Crockett Cogeneration Plant operates a natural gas fired cogeneration plant with 240 MW capacity. The plant sells energy to Pacific Gas and Electric Company (PG&E) and steam to the California and Hawaiian Sugar Company (C&H Sugar Company).

KEY ISSUE STATEMENT

Power in the project area is provided mainly by PG&E, which has a network of power plants, which includes the Crockett Cogeneration Plant. Having a network of power plants provides a more resilient system. However, ensuring uninterrupted electricity requires protecting the entire network, including transmission

lines and substations connecting the power that is generated to customers. The C&H Company is located directly adjacent to the plant, and relies on this plant for electricity to support goods processing. A shut down of Crockett Cogeneration Plant would not only disrupt C&H operations, but would also impact the PG&E power grid and would be economically costly to repair and bring back on line.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The portion of the Crockett Cogeneration Plant that is located within the 100-year floodplain will also be exposed to one to two feet of sea level rise. With three to four feet of sea level rise low lying areas further from the shoreline will be exposed to flooding, and with five to six feet of sea level rise the entire plant, and the adjacent C&H Sugar Company site will be flooded.

VULNERABILITIES

INFO: There is a lack of detailed, easily accessible, and well-coordinated information about the ownership, location, and condition of power generating infrastructure, which is needed for multi-sector and multi-jurisdictional vulnerability and risk assessments.
PHYS1: Many mechanical and electrical components of power generating infrastructure are vulnerable to flooding and rising groundwater levels. In the event of storm-related flooding, equipment at power generating facilities could be damaged particularly by saltwater, which causes corrosion, as well as by mud or debris carried by floodwaters.
PHYS2: Power generating facilities can be shut down to prevent major damage from floodwaters, such as corrosion to transformers, capacitors, switches and other equipment; however, as proper shutdown takes time, advance warning is necessary to avoid damages.
FUNC: Existing operations, maintenance, and emergency response plans and procedures for power generating facilities may be inadequate to address contingencies associated with widespread flooding or storm events.

CONSEQUENCES

Society and Equity: If power plants must be shut down or are damaged at a time of peak demand, or when reserve sources are needed, the insufficient power generation could affect the entire region.

Environment: Power plants and supporting infrastructure contain hazardous materials that could harm the health of wetland habitats and sensitive species if carried by floodwaters into the Bay or near shore areas.

Economy: The Crockett Cogeneration Plant provides energy to the PG&E grid and supports local economy. Temporary or permanent disruptions could affect local businesses and the community. C&H Company, in particular, is dependent on the plant for steam, and may face fiscal consequences if the plant is off line for a significant amount of time.

RESOURCES

Adapting to Rising Tides (ART). 2011. Adapting to Rising Tides Transportation Vulnerability Adapting to Rising Tides: Transportation Vulnerability and Risk

Assessment Pilot Project. http://www.mtc.ca.gov/news/current_topics/10-11/sea_level_rise.htm.
Association of Bay Area Governments (ABAG). 2014. Infrastructure Vulnerability & Interdependency Study. http://resilience.abag.ca.gov/projects/airport_infrastructure/
Braue, D. 2011. Telecoms lessons learnt in the flood. Retrieved January 18, 2011 from http://www.zdnet.com.au/telecoms---lessons---learnt---in---the---flood---339308645.htm.
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Current Recycled Water Users (n.d.). East Bay Municipal Utility District. Retrieved from https://www.ebmud.com/environment/conservation-and-recycling/recycling/current-water-recycling-projects
Pacific Gas & Electric (PG&E). 2011. Carbon Disclosure Project Investor Response 2011. https://www.cdproject.net/en-US/Results/Pages/responses.aspx.
Tajika, H., H. Horikawa, and N. Suzuki. 2008. Analysis of Buried Pipeline due to Liquefaction-Induced Permanent Ground Deformation. International Gas Union Research Conference, Paris, 2008.
Wang, L.R.L., and H. Zhang. 1992. Buried pipeline system in a liquefaction environment. Earthquake Engineering, Tenth World Conference.

Housing

In the Bay Area, habitable housing is crucial to ensuring an effective and efficient disaster recovery. Limiting catastrophic housing damage and keeping residents in their homes not only helps people who may lack the resources to effectively recover from a disaster, but also keeps communities intact, employees able to continue working, clients and customers able to continue to spend money and children in schools. Understanding where and what types of housing units are at risk from flooding will help prioritize efforts and will lay the foundation for developing comprehensive, actionable strategies to reduce vulnerabilities and build more resilient communities.

In Contra Costa County, single-family homes are about three-quarters of the total housing stock. Housing in Contra Costa County is relatively affordable compared to other parts of the region, and, as a result, many areas in the county serve as bedroom communities for workers who commute to other parts of the Bay Area, including San Francisco and San Mateo Counties22. However, within the county, housing cost is a challenge for low-income and even moderate to middle income residents. The county also has low home-vacancy rates and aging housing stock, which are additional concerns. Older homes can require major investments in repairs or updates, and may not be built to standards that are as protective of life and property in the event of a flood or seismic event.

Multi-family homes make up approximately one-quarter of the housing stock in the county. While the vacancy rates of multi-family rental units are higher than for single-family homes, affordability and access are still major concerns. Extremely low-income and very low-income23 residents cannot afford market-rate rentals in the county. Where low-income households are able to find apartments they either may overpay, or live with friends or relatives to help subsidize the cost. Approximately 1.7% of rental households in the entire

[22] Association of Bay Area Governments, as noted in Contra Costa County's 2014 Housing Element Update.
[23] Contra Costa County's 2014 Housing Element Update defines income levels as follows, as a percentage of the county's median family income: (a) *extremely low-income* households earn 30 percent or less; (b) *very low-income households* earn 50 percent or less; (c) *low-income households* earn 80 percent or less; and (d) *moderate-income households* earn 81 percent to 120 percent.

county are overcrowded (rather than the project area), typically occupied by larger, cost-burdened families. A number of neighborhoods in the project area are particularly subject to overcrowding, including Bayview-Montalvin and North Richmond.

Mobile homes are a small portion of the housing in the county, with an estimated 7,269 units that make up about 1.8% of housing stock. Of these, approximately 2,818 units are located in unincorporated areas of the county, where they make up 4.5% of housing stock. Mobile homes provide an affordable housing option for very low-income, low-income, and moderate-income households, who are generally priced out of buying homes, condos or even renting in some parts of the county. Mobile homes are typically single-family units, where the resident owns the mobile or manufactured home but rents a space in a mobile home park.

The assessment of housing conducted for the project area includes a description of single-family, multi-family and mobile home housing at risk from current and future flooding. The assessment was conducted using the Contra Costa County Assessor's records and the U.S. Census. (See the People Chapter for additional descriptions of existing housing and community characteristics.) More detailed information about housing and households at risk is needed. For example, some homes in the existing 100-year floodplain may not have elevated first floors or flood insurance, while some may have essential mechanical or electrical equipment or habitable living spaces below-grade. In addition, those living in the houses or housing units may have special needs, for example if they are elderly, medically dependent or are limited English speakers. Detailed information about specific homes and households in areas that may potentially flood (or elsewhere) is not readily available, and can be challenging to obtain from publically available datasets. A more detailed assessment would require information gathering in neighborhoods at risk of flooding through working with local jurisdictions and/or community-based organizations or through self-assessments. Such an assessment would be highly beneficial to both understanding the risks faced and the options for responding.

Single-family Residential

Attached, detached and vacant lots zoned for single-family homes were assessed based on whether the parcel was affected by current and/or future flooding, or whether the residential parcel was within an adjacent low-lying area where localized, nuisance flooding could occur if stormwater or flood management systems are either over capacity or fail to drain, causing back ups into streets and basements.

KEY ISSUE

Almost half of the single-family homes within the 100-year floodplain in the project area are at risk of more frequent or extensive flooding as sea level rises. And while only 74 homes not currently in the 100-year floodplain may be directly flooded due to sea level rise, there are almost 400 homes in adjacent low-lying areas that could be impacted by street or basement flooding as stormwater systems lose capacity or fail to drain. Most single-family homes were not built with their first floor elevated above the current 100-year flood level, nor designed to withstand flooding, meaning that any exposure to flooding is likely to cause damage and result in the displacement of residents for a period of time. Ultimately, displaced residents will have difficulties finding other comparable housing due to the low housing-vacancy rate and limited availability of affordable housing in the county.

EXPOSURE TO CURRENT AND FUTURE FLOODING

In the portion of the project area assessed24 there are 507 single-family residential parcels within the 100-year floodplain, 215 of which are at risk of more frequent or extensive flooding in the future due to sea level rise. An additional 74 single-family residential parcels not currently at risk of flooding (e.g., not within the 100-year floodplain) could be exposed to flooding as sea level rises.

Table 14. Single-family parcels located in the current 100-year floodplain that could be exposed to sea level rise.

Single-family Parcels	Current 100-year Flood only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Single Family Attached	4	4	4	4	4	4	35
Single Family Detached	323	414	414	415	415	417	488
Single Family Vacant	28	45	46	46	46	46	47
Total	355	463	464	465	465	467	570

Most of the dwellings at risk are single-family detached homes, although there are also a moderate number of attached homes and vacant single-family residential parcels at risk from sea level rise. Of the single-family dwellings, particular attention should be paid to the 392 single-family residential parcels that are within low-lying areas adjacent to the inland flood extent from six feet of sea level rise. While potentially not at risk of overland flooding, homes within these low-lying, adjacent areas could be flooded by backups in the stormwater or flood management systems.

Table 15. Single-family parcels outside of the current 100-year floodplain that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Single-family Parcels	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1'	2'	3'	4'	5'	6'	
Single Family Attached	10	13	14	14	14	14	103
Single Family Detached	46	49	55	67	124	244	275
Single Family Vacant	18	18	18	18	23	27	14
Total	74	80	87	99	161	285	392

ASSET DESCRIPTION

There are 11 neighborhood-scale areas in the project area with single-family homes at risk from either current or future flooding. These areas are within the Cities of Richmond, San Pablo, Pinole, Hercules and

[24] Single-family residential parcels assessed are those located between Richmond and Bay Point up to ½ kilometer inland from the area inundated by 6 feet of sea level rise. This area represents the portion of the Contra Costa ART project area that is most likely to be directly impacted either by coastal flooding or by increased riverine flooding as sea level rises.

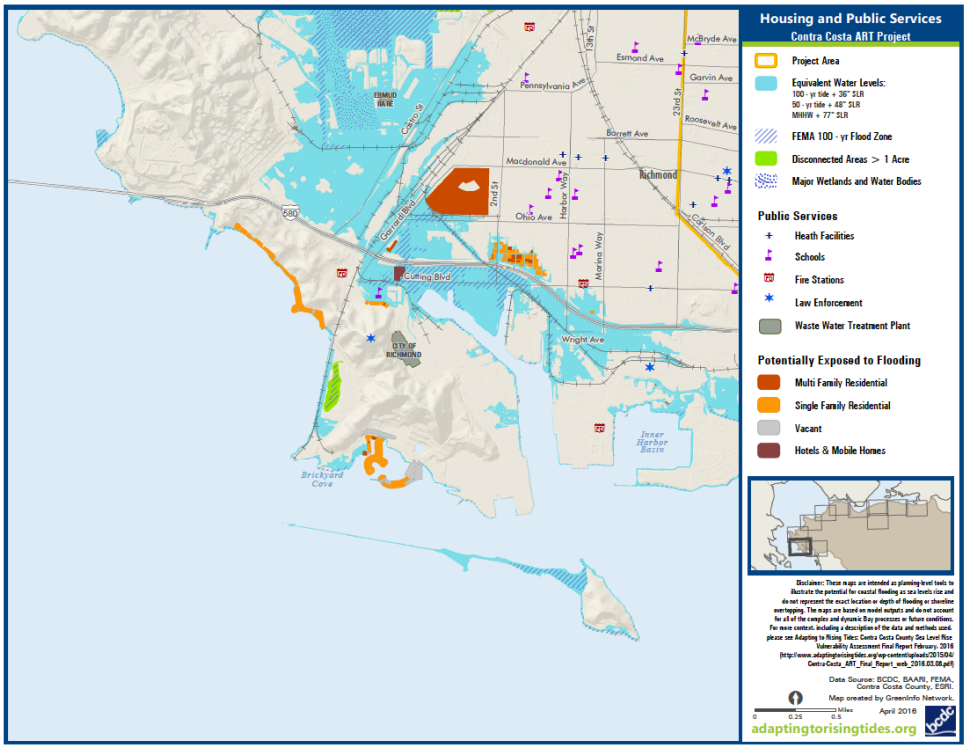
Martinez and in the unincorporated Contra Costa County communities of North Richmond, Rodeo and Port Costa.

RICHMOND

Three neighborhoods in the City of Richmond could be directly flooded by sea level rise. This includes the portion of Santa Fe between Virginia and Florida Avenues, and 1st to 6th streets. This neighborhood is not within the existing 100-year floodplain, but single-family residences in this neighborhood are at risk from five feet or more of sea level rise. Also at risk are the homes directly on the shoreline in the Brickyard Cove and Point Richmond neighborhoods, both of which are within the current 100-year floodplain. Many of the single-family homes in these neighborhoods may be elevated above the current 100-year base flood level, however as sea levels rise the amount of flood currently mitigation provided may not be adequate.

Two neighborhoods in the City of Richmond are not at direct risk of flooding as sea level rises but could be impacted by street or basement flooding if the stormwater system backs up due to insufficient capacity to store and convey flows during an storm events (see the City of Richmond Stormwater Profile Sheet). Homes in the southernmost and central part of Southwest Annex neighborhood are low-lying and at risk from nuisance flooding with three feet of sea level rise. This neighborhood sits between I-580 and I-80, and is protected from the Bay by I-580, the Union Pacific (UP) rail line, Point Isabel Regional Park, and the Hoffman Marsh wetlands associated with Baxter Creek. Homes in the northwest corner of Parchester Village at the corner of Banks Drive and Jenkins Way are low-lying and at risk of nuisance flooding from five feet of sea level rise. This neighborhood is separated from the Bay by the Union Pacific rail line and the Parchester Marsh.

Figure 9 City of Richmond Housing and Public Services Map



NORTH RICHMOND

Single-family homes in southernmost portion of North Richmond, between Vernon Avenue and West Gertrude, and Battery Street and York Street, are not at direct risk of flooding as sea level rises but could be impacted by street or basement flooding if the stormwater system backs up due to insufficient capacity to store and convey flows during storm events (see the City of Richmond Stormwater Profile Sheet). While not within the current 100-year floodplain, this neighborhood is just south of Wildcat Creek and additional flooding could occur as sea levels rise.

SAN PABLO

The single-family residential neighborhood located between Brookside Drive and Trenton Boulevard, and Giant Road and Manchester Avenue, is within the 100-year floodplain of San Pablo Creek. While not shown directly at risk of sea level rise, further watershed-specific studies of San Pablo Creek are needed to understand the potential for sea level rise to impact the frequency or extent of possible flooding both within and beyond the current floodplain. In addition, an investigation of the capacity and condition of the stormwater conveyance system to determine the potential for localized street or basement flooding during storm events is needed to understand the potential for additional flood risks as sea levels rise.

PORT COSTA

Almost all of the homes in Port Costa on Canyon Lake Drive, below Reservoir Street are within the existing 100-year floodplain. Residential uses, which are separated from the bay by the Union Pacific rail line, are not shown at risk from sea level rise. However, it is important to note that the rail line is neither constructed nor maintained to provide flood protection, and as such, provides ad hoc protection to the Port Costa shoreline.

RODEO

The neighborhood between 4th Street and San Pablo Avenue, and Parker Avenue and Pinole Avenue is within the existing 100-year floodplain of Rodeo Creek, and is at risk of additional flooding with six feet of sea level rise. As this neighborhood is low-lying, and because Lower Rodeo Creek currently only provides flood protection for approximately a 15 to 20-year storm (see Rodeo Creek profile sheet) a watershed-specific hydraulic modeling of Rodeo Creek is needed to understand when higher Bay water levels will exacerbate existing flooding and if areas beyond the existing 100-year floodplain will be impacted by flooding as sea levels rise.

PINOLE

The single-family neighborhood between the Burlington Northern Santa Fe (BNSF) rail line and Orleans Drive, and Tennent Avenue and Calais Drive is at risk from five feet of sea level rise. This neighborhood is adjacent to Pinole Creek but is not within the current 100-year floodplain, however Lower Pinole Creek provides flood protection for approximately a 25-year storm and bridge constrictions, ongoing channel sedimentation, and sea level rise will further reduce flood capacity. Watershed-specific hydraulic modeling of Pinole Creek is needed to understand if higher Bay water levels will exacerbate existing flooding or cause areas beyond the existing 100-year floodplain to flood.

HERCULES

The northernmost part of the Chelsea by the Bay neighborhood is at risk from six feet of sea level rise. In particular, the homes that are adjacent to Pinole Creek and the Chelsea wetlands are at risk, as are local streets including O'Neil Circle and Cardoza. This neighborhood is adjacent to Pinole Creek but is not within the current 100-year floodplain. However Lower Pinole Creek provides flood protection for approximately a 25-year storm and existing bridge constrictions, ongoing channel sedimentation, and sea level rise will further reduce flood capacity. Watershed-specific hydraulic modeling of Pinole Creek is needed to understand if higher Bay water levels will exacerbate existing flooding or cause areas beyond the existing 100-year floodplain to flood.

MARTINEZ

Single-family homes located in Downtown Martinez between Henrietta Street and Green Street, and Berrellessa Street and Pine Street are within the existing 100-year floodplain of Alhambra Creek. While this neighborhood is not shown at risk from sea level rise, watershed-specific hydraulic modeling of Alhambra Creek is needed to understand if higher Bay water levels will exacerbate existing flooding or cause areas beyond the existing 100-year floodplain to flood.

Single-family homes in the Vinehill neighborhood just south of the Waterbird Regional Preserve on Cabrillo Drive are not within the current 100-year floodplain but are at risk of varying amounts of sea level rise, from one to six feet. The homes on Cabrillo Drive are partially protected from the adjacent Pacheco Marsh by Service Road. Further investigation of this area to determine the source of potential flooding, and whether homes will be impacted, is necessary to more fully understand the risks faced.

Multi-family Residential

Multi-family residential housing assessed includes duplex, triplex and fourplex buildings; apartments with five or more units; condominiums and cooperatives; and vacant buildings. The actual number of multi-family housing units was assessed when available as it presents more actionable information, for example how many households could be displaced. For condominiums, cooperatives and vacant buildings the number of parcels was used because the number of units was not included in the assessor's data. Where possible the type of multi-family residences on these parcels is described, and the total number of housing units at risk (independent of type of housing) is discussed in the People Chapter.

KEY ISSUE STATEMENT

Multi-family residential in Contra Costa County can provide a more affordable housing alternative to single-family homes, which is particularly important for lower-income or medically dependent residents that may be unable to temporarily relocate after a flood event. Renters living in multi-family housing (e.g., apartments) have limited opportunity to improve the flood resilience of their residences; while improvements to housing in shared ownership, for example condominium or mutual homeowner associations, require cooperative decision-making in order to fund improvements.

EXPOSURE TO CURRENT AND FUTURE FLOODING

In the portion of the project area assessed25 there are 506 multi-family residential units on 56 parcels within the 100-year floodplain and 101 units on 19 parcels of which are at risk of more frequent or extensive flooding in the future due to sea level rise.

An additional 247 multi-family residential units on 30 parcels not currently at risk of flooding (e.g., not within the 100-year floodplain) could be exposed to flooding as sea level rises. The reason these units are not currently exposed varies, some of the units may be protected from today's 100-year flood by ad hoc or engineered flood protection that will be overtopped at higher water levels, while other units may be at low elevations that are currently far enough away from the Bay shoreline or creek and channel banks, and therefore beyond the extent of current flooding. Notably, this includes Berrellesa Palms, an affordable senior living community in Downtown Martinez and a portion of the Atchison Village Mutual Homes in Richmond. Of additional interest are the 196 multi-family residential units on 73 parcels located within adjacent low-lying areas. While these units are not depicted in the mapping as being at risk of overland flooding, the units are located in low-lying, adjacent areas that could be flooded by backups in the stormwater or flood management systems.

While there are no condominiums or cooperatives located within the current 100-year floodplain, there are 12 parcels containing condominiums or cooperatives at risk of flooding as sea levels rise and two in adjacent low-lying areas. Most notably, this includes a large portion of Atchison Village in Richmond.

Table 16. Multi-family units located in the current 100-year floodplain that could be exposed to sea level rise.

Multi-family Units	Current 100-year Flood Only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Apartment, 5 units or more	305	305	305	305	305	305	372
Duplex, Triplex, Fourplex	100	100	100	100	100	100	134
Total apartments	405	405	405	405	405	405	506

Table 17. Multi-family parcels located in the current 100-year floodplain that could be exposed to sea level rise.

Multi-family Parcels	Current 100-year Flood Only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Condos, cooperatives*	0	0	0	0	0	0	0

[25] Residential parcels assessed are those located between Richmond and Bay Point up to ½ kilometer inland from the area inundated by 6 feet of sea level rise. This area represents the portion of the Contra Costa ART project area that is most likely to be directly impacted either by coastal flooding or by increased riverine flooding as sea level rises.

Vacant Multi Family*	4	4	4	4	4	4	4

Table 18. Multi-family units outside of the current 100-year floodplain that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Multi-family Units	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1	2'	3'	4'	5'	6'	
Apartment, 5 units or more	0	0	0	100	155	178	62
Duplex, Triplex, Fourplex	2	2	9	9	21	69	134
Total apartments	2	2	9	109	176	247	196

Table 19. Multi-family parcels outside of the current 100-year floodplain that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Multi-family Parcels	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1	2'	3'	4'	5'	6'	
Condos, cooperatives*	2	2	2	2	6	12	2
Vacant Multi Family*	2	2	2	2	2	2	9

ASSET DESCRIPTION

There are seven neighborhood-scale areas in the project area with multi-family residential housing at risk from either current or future flooding. These areas are within the Cities of Richmond, San Pablo, and Martinez and in the unincorporated communities of North Richmond and Rodeo.

RICHMOND

Within the City of Richmond, the Southwest Annex and Atchison Village neighborhoods have multi-family units not directly at risk of sea level rise that could be impacted by street or basement flooding if the stormwater system backs up due to insufficient capacity to store and convey flows during an storm events (see single-family section above for a discussion of the risks faced in this area). In the Southwest Annex neighborhood, duplex, fourplex, and smaller apartments (5-12 units), and six vacant parcels on Monterey Street and Burlingame Avenue are low-lying and at risk of nuisance flooding from six feet of sea level rise. In the Atchinson Village Neighborhood, apartments on Chanslor Circle, West Chanslor Avenue and West Bissell Avenue are low-lying and at risk of nuisance flooding from six feet of sea level rise. In addition, apartments on Chanslor Circle, in the southwestern portion of Atchinson Village are at direct risk of flooding with four feet of sea level rise.

In addition, some of the duplex, fourplex, and apartments in the Santa Fe Neighborhood are at direct risk of sea level rise, and others could be impacted by nuisance flooding from six feet of sea level rise (see discussion in Single-family section above). Condominiums on South Garrard (approximately eight units) and in Marina Bay (three buildings) are at risk from six feet of sea level rise and one condominium, one duplex and two vacant parcels in Brickyard Cove are within the current 100-year floodplain and are at risk from one foot of sea level rise.

SAN PABLO

The El Paseo Apartment complex (over 100 units) and the Brookside Apartments in San Pablo, as well as a small number of fourplex units, are within the current 100-year floodplain of San Pablo and Wildcat Creeks (see Single-family section above for a discussion of the risks faced in this area).

RODEO

There is one 13- to 24-unit apartment building, and a number of 5- to 12-unit apartments, fourplexes, and duplexes within the current 100-year floodplain of Rodeo Creek that are also at risk from flooding with sea level rise (see single-family section above for a discussion of the risks faced in this area).

MARTINEZ

There are a number of 5- to 12-unit apartments, duplexes, and fourplexes in Downtown Martinez within the 100-year floodplain of Alhambra Creek. In addition, there are a small number of duplexes and, notably, the 48-unit Berrellesa Palms26 affordable senior living community within the current 100-year floodplain that are also at risk from five to six feet of sea level rise (see single-family section above for a discussion of the risks faced in this area).

SINGLE AND MULTI-FAMILY RESIDENTIAL VULNERABILITIES

INFO: Decision-makers and emergency responders have limited information about the specific characteristics or needs of individuals or households. This makes preparing for and response to flooding more difficult.

GOV: Single and multi-family residential landowners are unlikely to own or have control over the shoreline that protects their housing from flooding. In some cases this protection is either a road or railway embankment that provides ad-hoc flood protection. Ensuring current levels of flood protection is maintained, and enhanced as sea levels rises, will require cooperation and coordination between the community at risk and those that own and manage the shoreline.

FUNC1: Temporarily or permanently relocating residents affected by flood events is challenging, particularly for residents who are housing cost burdened. Flooding of multi-family housing with a large number of units

[26] Berrellesa Palms provides 48 affordable one-bedroom apartments to seniors 62 years of age and over, with incomes at or below 20 percent of Area Median Income or experiencing, transitioning out, or at risk of homelessness, with chronic health conditions.

could displace a sizable number of renters who would need to find alternative affordable housing. Relocation is more difficult in areas with limited affordable housing and low vacancy rates. Displaced residents may not have access to equivalent or affordable replacement housing near the jobs, schools, services, and facilities they rely on.

FUNC2: Single and multi-family housing units rely on infrastructure and services provided by public and private agencies to function, such as roads, electricity, food, water, wastewater, and telecommunications. If these services are damaged or disrupted residents may not be able to stay in their homes until repairs or upgrades are completed.

FUNC3: Housing occupied by people who are over 75, under five, speak limited or no English, rent, rely on public transportation, are medically dependent and/or have limited mobility is vulnerable because their occupants have characteristics that often make it harder for them to prepare, respond or recover from flood events.

FUNC4: Households with pets or other animals are vulnerable because in the event of an evacuation people will require temporary shelter or a permanent relocation site that can also house their animals. In past events, pet owners have been reluctant to evacuate if they were not able to bring their animals with them, resulting in loss of life and increasing the number of people in need of attention for emergency responders.

FUNC5: Renters often lack flood insurance, and therefore lack assistance with replacing damaged personal items or providing an alternative place to live during and/or after a flood event.

FUNC6: Single and multi-family units provide housing for community members who work, play, shop and live in neighborhoods. When this housing is damaged and people must relocate out of the neighborhood, businesses, schools and other neighborhood services that rely on employees, customers and clients for their livelihood can be impacted.

PHYS1: Most residential structures are vulnerable because they are not designed to withstand flooding, are not constructed from waterproof or non-corrodible materials, or were built to have only the first floor above the current 100-year flood elevation.

PHYS2: When flooding damages residences, household materials, many which are considered hazardous (including paints, cleaners, oils, batteries, pesticides, asbestos, and medical waste) can be released, not only impacting nearby habitats but also causing contamination of homes and businesses exposed to the floodwaters.

PHYS3: Single and multi-family residences with mechanical or electrical equipment (heating, cooling, appliances, electrical panels, etc), habitable spaces, or parking areas below-grade are vulnerable to both flooding and elevated groundwater.

PHYS4: Older residential housing with deferred maintenance such as older roofs, a lack of weatherization, or without flood mitigation to protect below-grade spaces (e.g. functioning sump pumps) will likely sustain significant damage in a major storm or flood event.

SINGLE AND MULTI-FAMILY HOUSING CONSEQUENCES

Society and Equity: Disruption or damage to single-family housing can have significant consequences for residents and the community, particularly for cost-burdened individuals who may have difficulty finding affordable and appropriate alternative housing. Flooding and storm events can result in significant hardships, including loss of lives, personal items and financial information; dislocation from homes, jobs and schools; and disconnection from community services and ties. Flooding can also have consequences for public health, as floodwaters can leave mold, mud, waste, and other toxics behind in residences; residents who are unable to move, temporarily relocate, or adequately repair their home after a flood are more vulnerable to these impacts. Relationships between residents are important for neighborhood function, and can be

severed during disaster events. These connections are difficult to repair once disrupted, which can have negative impacts on community resilience.

Environment: Floodwaters that pass through neighborhoods can pick up and carry household hazardous wastes and other debris that can impair water quality and habitats critical to biodiversity.

Economy: Flooding can result in costly damage to homes and belongings, which can result in financial burdens for residents. Residents may bear additional costs due to the need for alternative housing as well as dislocation from jobs and services. The broader community of taxpayers and ratepayers may also bear some of the expense of rebuilding areas even if they do not themselves live in affected areas. Additionally, long-term evacuations could result in the permanent relocation of residents outside of the community, with associated economic consequences for the neighborhoods, residents and employers that remain.

Mobile Home Parks

Mobile homes are especially vulnerable to flooding because of their construction. They are an affordable housing option that, once damaged, are difficult to repair and typically need to be completely replaced. Damages associated with flooding of mobile homes includes27:

- Footings, piers, and foundations that become unstable or fail when soils become saturated
- Support and anchoring systems become unstable or fail, and ceilings, walls and floors crack and failure, if the mobile home floats
- Insulation, framing, decking, siding, wall sheathing and interior wall finishes are damaged and can mold. Mobile home floor decking is typically structural particleboard, which is very susceptible to water damage.
- Failure of mechanical ductwork, gas and oil line, plumbing and electrical systems.
- Mold due to water damage or sustained high humidity levels.

The Contra Costa County Floodplain Management Program (February 2015) requires mobile homes within existing mobile home parks be anchored to prevent floatation and have a lowest floor level a least three feet above the ground or pad. Mobile homes outside a park or within a new mobile home park must be elevated and anchored above the 100-year flood level to satisfy freeboard requirements. These requirements, which are consistent with Federal Emergency Management Agency (FEMA) regulations for manufactured homes and mobile homes installed in special flood hazard areas, should help mitigate flood damage from the current 100-year flood, as long as the mobile homes are in compliance with the ordinance and are securely anchored to resist floatation, collapse, and lateral movement. Flood levels above the current 100-year base flood, or unexpected high velocity erosive flood flows, could however damage mobile homes as could saturated soils or sustained humidity levels after a flood occurs.

KEY ISSUE STATEMENT

Mobile homes are vulnerable both during and after flood events because of their design and the materials used to construct them. Mobile homes provide affordable housing options, however once damaged they are difficult to repair and typically need to be replaced. This can cause the permanent displacement of mobile

[27] http://www.doli.state.mn.us/CCLD/PDF/bc_ms017_manufactured_home_flood _mitigation.pdf

home park residents to other more affordable areas, where they could become disconnected from jobs, schools, and other community ties.

ASSET DESCRIPTION

There are two mobile home parks at risk from current and future flooding in the project area: the Tara Hills Mobile Manor in Bayview-Montalvin and the Rodeo Mobile Home and RV Park in Rodeo.
The Tara Hills Mobile Manor, located in Bayview-Montalvin, is home to residents who may be particularly vulnerable as it is a senior (55+) community. A small number of the mobile homes as well as Pacific Drive and Golden Gate Road within the park are within the 100-year floodplain of Garrity Creek. In addition, Tara Hills Drive at the northernmost corner of the mobile home park is at risk from five to six feet of sea level rise. Although mobile homes in the park are not shown at risk from future flooding due to sea level rise, watershed-specific hydraulic modeling of Garrity Creek is needed to understand if higher Bay water levels will exacerbate existing creek flooding or cause areas beyond the existing 100-year floodplain to flood. This is of particular importance as the mobile home park is protected from coastal storm flooding by ad hoc protection from the UP and BNSF rail lines and MonTara Bay Park. The Rodeo Mobile Home and RV Park is located on five separate parcels in Rodeo on Parker and Vaqueros Roads at 3rd Street. The mobile homes are on either side of Rodeo Creek, and all five parcels are located within the 100-year floodplain. The two larger parcels on Parker Road are also at risk from six feet of sea level rise. A watershed-specific hydraulic modeling of Rodeo Creek is needed to understand if higher Bay water levels will exacerbate existing flooding or cause areas beyond the existing 100-year floodplain to flood as sea levels rise. This is of particular importance as Lower Rodeo Creek currently only provides flood protection for approximately a 15 to 20-year storm, and ongoing sedimentation in addition to rising sea levels will further reduce flood capacity (see Rodeo Creek profile sheet).

VULNERABILITIES

INFO: Decision-makers and emergency responders have limited information about the specific characteristics or needs of individuals or households, or about the specific condition of mobile home or the mobile home park they live in. This makes preparing for and response to flooding more difficult.
GOV: Mobile home park residents own their mobile homes but lease the land where the mobile home resides. Mobile home owners may be subject to restrictions as part of their lease, and significant changes to the mobile home park will likely need to be coordinated with the landowner. Therefore, residents of mobile home parks have limited opportunity to make property improvements to reduce the parks flood risk.
FUNC1: Mobile homes rely on infrastructure and services provided by public and private agencies to function, such as roads, electricity, food, water, wastewater, and telecommunications. If these services are damaged or disrupted residents may not be able to stay in their homes until repairs or upgrades are completed.
FUNC2: Mobile homes occupied by people who are over 75, under 5, speak limited or no English, rent, rely on public transportation, are medically dependent and/or have limited mobility is vulnerable because their occupants have characteristics that often make it harder for them to prepare, respond or recover from flood events. Some mobile home parks, such as Tara Hills Mobile Manor, are designated as senior communities, and most parks provide affordable housing options to low income households.
FUNC3: Mobile homes parks provide housing for community members who work, play, shop and live in neighborhoods. When mobile homes are damaged and people must relocate out of the neighborhood, the businesses, schools and other neighborhood services that rely on employees and customers for their livelihood can be impacted.

PHYS: Mobile homes are vulnerable both during and after flood events due to their design and materials used to construct them. They are neither designed to withstand flooding nor are constructed of waterproof or non-corrodible materials. Even if the mobile home is elevated above the current 100-year base flood elevation, saturated soil conditions can cause the piers or foundations to fail, and high humidity can cause mold and other damage.

CONSEQUENCES

Society and Equity: Disruption or damage to mobile homes can have significant consequences for residents and the community, particularly for cost-burdened individuals who may have difficulty finding affordable and appropriate alternative housing. Flooding and storm events can result in significant hardships, including loss of lives, personal items and financial information; dislocation from homes, jobs and schools; and disconnection from community services and ties. Flooding can also have consequences for public health, as floodwaters can leave mold, mud, waste, and other toxics behind in mobile homes; residents who are unable to move, temporarily relocate, or adequately repair or replace their mobile home after a flood are more vulnerable to these impacts. Relationships between residents are important for neighborhood function, and can be severed during disaster events. These connections are difficult to repair once disrupted, which can have negative impacts on community resilience.

Environment: Floodwaters that pass through mobile home parks can pick up and carry hazardous household wastes and other debris that can impair water quality and habitats critical to biodiversity.

Economy: Flooding can result in costly damage to mobile homes and belongings, which can result in financial burdens for residents, particularly for those who are low-income. Residents may bear additional costs due to the need for alternative housing as well as dislocation from jobs and services. The broader community of taxpayers and ratepayers may also bear some of the expense of rebuilding areas even if they do not themselves live in affected areas. Additionally, long-term evacuations could result in the permanent relocation of residents outside of the community, with associated economic consequences for the neighborhoods, residents and employers that remain.

RESOURCES

Department of Conservation and Development, Contra Costa Couny Housing Element 2014, http://www.co.contra-costa.ca.us/4720/Housing-Element-2014
San Francisco Bay Conservation and Development Commission (BCDC), Adapting to Rising Tides Program. 2015. Stronger Housing, Safer Communities. http://www.adaptingtorisingtides.org/project/stronger-housing-safer-communities-strategies-for-seismic-and-flood-risks/
Minnesota Department of Labor and Indistry. April 2013. Manufactured (mobile) Home Flood Damage Assessment and Mitigation. https://www.dli.mn.gov/ccld/PDF/bc_ms017 _manufactured_home_flood _mitigation.pdf

Natural Shorelines

Natural shorelines include a range of shoreline types and conditions. Fully tidal marshes are either exposed to the open Bay or are protected from wave and tidal energy by offshore mudflats. At the other end of spectrum are muted tidal marshes and ponds, that are protected from the Bay by berms and levees and

have water levels controlled by tide gates and other structures. These systems provide an array of ecosystem service benefits, the loss of which will ultimately diminish the value of the Bay Area as a desirable, functional place to live.

Natural shorelines help reduce incoming wave heights, protecting shoreline structures from wind, waves, and tidal energy. Natural shorelines provide buffers to neighboring communities from sea level rise and storm surge. Their loss can place shoreline communities at greater risk of flooding by increasing the likelihood that structural shoreline protection is overtopped or fails, and can increase the cost of maintaining, repairing and upgrading these already expensive structural protection assets. In addition, many natural shorelines, including tidal and muted tidal marshes and ponds, have been restored and represent a significant financial and community investment. Many of these areas provide habitat to a number of state-listed or federally threatened and endangered species as well as migrating and wintering birds that rely on them for breeding, foraging, and high tide refuge. Additionally, they offer opportunities to view wildlife, provide access to the shoreline, and offer other ecological, scenic and aesthetic benefits.

Tidal Marshes

Historically, tidal marshes keep pace with changing sea levels by accumulating mineral sediment and by moving upward and landward in the tidal frame. The accelerating rates of sea level rise in tandem with the declining concentration of Bay sediment may outpace the capacity of these natural dynamic systems. Furthermore, much of the Bay shoreline, including the Contra Costa County shoreline, is fairly well developed and there are few opportunities for marshes to migrate inland without significant changes to land use. Due to this combination of factors, tidal marshes throughout the Bay Area, including those within the project area, are unlikely to survive without support and interventions. Potential support includes increasing sediment supplies, allowing for inland migration, increasing the pace of restoration, among other protection and restoration measures (http://www.sfei.org/projects/baylandsgoals).

Within the project area, fifteen tidal marshes were evaluated using the Point Reyes Bird Observatory (now Point Blue Conservation Science) online decision support tool (http://data.prbo.org/apps/sfbslr/) that predicts the conditions under which tidal marshes will “downshift” from higher- to lower-elevation marsh habitat (e.g., from high- to mid-marsh or mid- to low-marsh), and eventually to mudflat. This approach was used because tidal marshes are dynamic nearshore systems and their response to sea level rise depends on a number of physical and biological factors, including the rate of sea level rise, the current elevation relative to the tidal frame, mineral sediment availability either from the Bay or nearby tributaries, and the rate of organic matter. The sea level rise model used to evaluate the exposure of other assets in the project area do not account for potential changes in nearshore dynamic processes that will impact natural shoreline systems. Using the decision support tool allowed these factors to be considered in the analysis.

KEY ISSUE STATEMENT

Without improved maintenance, restoration and enhancement, the existing tidal marshes in the project area will be lost between 2070 and 2100 (under high sea level rise and low sediment assumptions). Low sediment supply constrains accretion rates, and the lack of broad transition zone habitat or landward marsh accommodation space constrains the natural process of marsh migration. High marsh that only floods now during extreme high tides may downshift to mid- and low-marsh by mid-century and convert to mudflat

before the end of century as sea level rise rates accelerate. Marsh edge erosion will increase due to greater wind-wave action in deeper water, narrowing marshes such as Stege Marsh in the Central Bay.

ASSET DESCRIPTION

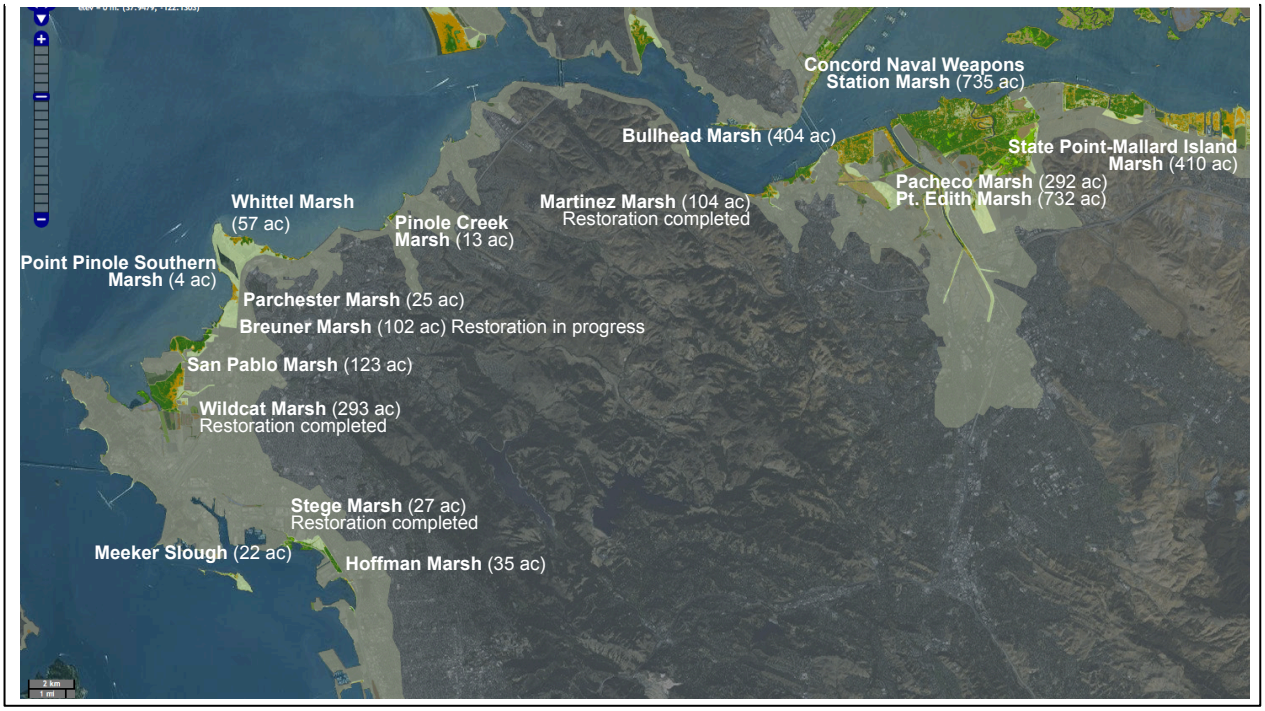
Fifteen tidal marshes of varying size (from 4 to 735 acres) are found along the ART project shoreline typically in locations with gentle slopes, and particularly at creek mouths (Map 1). These marshes are adjacent to a variety of land uses ranging from the urban development, highways, ports, and landfills around Richmond, to the Union Pacific Railroad from Point Pinole to I-80 bridge, to the heavy industry and military activities in the eastern project area. Salt marshes occur west of the I-80 Carquinez Bridge, and brackish marshes on the east.

In Richmond, Meeker Slough/Stege Marsh is located at the mouth of Baxter Creek, which the Berkeley Hills drain into. Wildcat Marsh and San Pablo Marsh are located at the toe of a large alluvial fan formed by Wildcat and San Pablo Creeks.28

Breuner Marsh and Parchester (also called "Giant") Marsh are located on the west side of Point Pinole, with a large eelgrass bed offshore. Whittell Marsh is located on the east side of Point Pinole, home to fringe beaches and rocky intertidal areas.

From Point Pinole to the I-80 Carquniez Bridge, a string of very small tidal marshes are located at the mouths of Garrity, Pinole, Refugio, and Rodeo Creeks.

Figure 10. Project area showing marsh habitats (http://data.prbo.org/apps/sfbslr/) and status of key projects (http://www.ecoatlas.org/regions/ecoregion/bay-delta). Point Blue Conservation Science (formerly PRBO) relied on previous studies to delineate site boundaries.

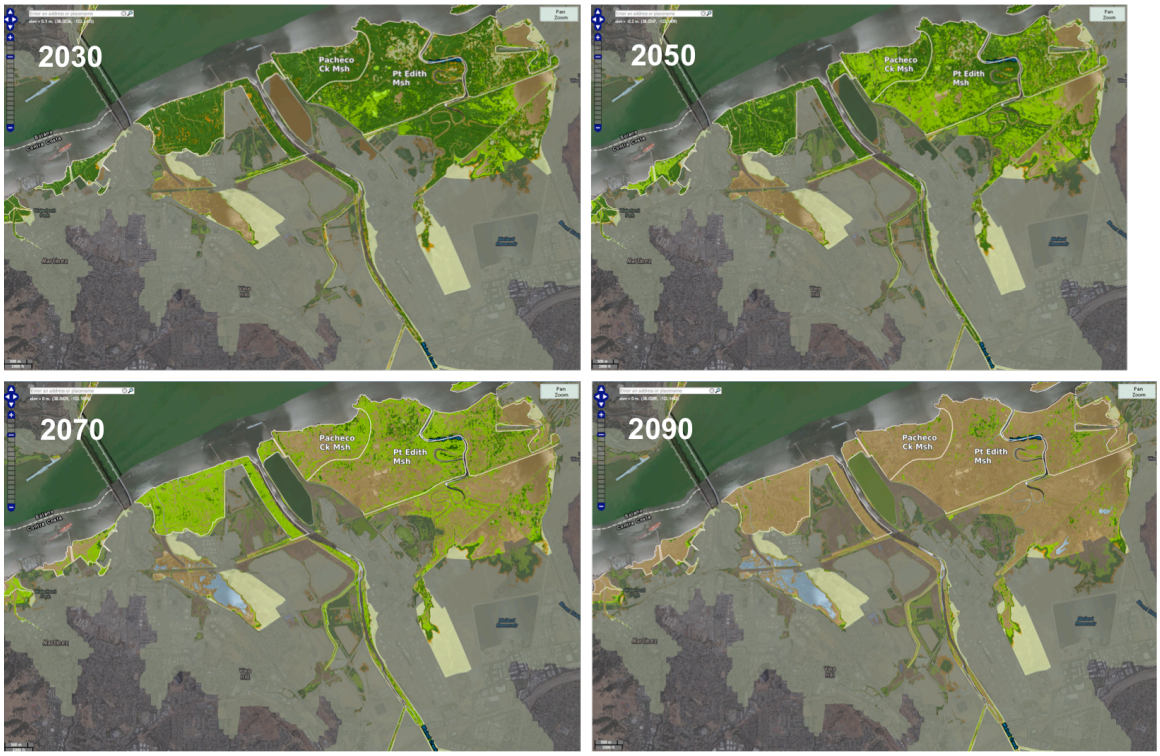


In Martinez, Martinez Marsh is located at the mouth of Alhambra Creek. Bullhead Marsh, Pacheco Marsh,

[28] Historically, the creeks meandered, at times joining each other, and shared a large, dynamic marsh.

Point Edith Marsh, and Concord Naval Weapons Station Marsh are large marshes located at the mouths of Walnut and Diablo Creeks and are part of the large Concord Marsh complex, which extends from the I-680 Bridge to Port Chicago. State Point-Mallard Island Marsh is located along the Bay Point shoreline.
Many of the marshes in the project area are managed by East Bay Regional Parks District (EBRPD), which invests more in restoration projects than in annual maintenance and monitoring. For example, EBRPD provided $1,000,000 to restore Breuner Marsh and secured more than 10 separate grants for the remaining $7,500,000. Similarly, to restore Martinez Marsh, EBRPD took advantage of an opportunity to partner with Caltrans, which needed to mitigate impacts related to bridge projects, and the City of Martinez, which needed to reduce flooding impacts to downtown. Most marshes do not have management plans and annual activities may be limited to annual invasive species treatment through the Invasive Spartina Project (for marshes from El Cerrito to Point Pinole).

Figure 11. Tidal marsh sustainability based on modeling results for a high sea level rise rate (1.65 m/century or 65 inches between 2010 and 2110) and low sediment supply (50 mg/L) in 2030, 2050, and 2070 (http://data.prbo.org/apps/sfbslr/). Given observed greenhouse gas emissions are exceeding climate change model emission scenarios, high sea level rise rate is shown. Regional experts report this part of the Bay has relatively low sediment supply, and since sediment concentrations in the Bay are declining, the low sediment supply may be closer to natural conditions.



The largest two marshes in the project area are managed by the California Department of Fish and Wildlife (Point Edith Marsh) and the Department of Defense (Concord Naval Weapons Station Marsh). Available information is limited on Concord Naval Weapons Station Marsh. Point Edith Marsh is currently being investigated through local and regional planning efforts. Contra Costa County Flood Control and Water Conservation District (CCFC&WCD) is working on the innovative Lower Walnut Creek Restoration Project to reduce current flood risk, improve wildlife habitat, accommodate sea level rise, and provide more recreational

opportunities. This work is being conducted in conjunction with the San Francisco Estuary Institute's regional Flood Control 2.0 project, which aims to develop approaches to reconnect watershed freshwater flows and sediment transport to marshes. Increasing the sediment supply to the marsh and identifying transition zone habitat would help Point Edith Marsh build upward or move landward, to avoid drowning as sea level rises.

Sea level rise will increase the depth, duration, and frequency that Point Edith Marsh is flooded, and by 2070 the marsh is predicted to shift to low marsh and mudflat under high sea level rise and low sedimentation assumptions (Map 2). Dominant species in Point Edith Marsh are alkali bulrush, pickleweed, Olney's bulrush, tule, broadleaf cattail, rush, saltgrass, and sedges. The marsh also supports black rails (threatened), Ridgway's rails (endangered), American bitterns, Suisun song sparrows, and thousands of shorebirds and waterfowl. In addition, the marsh provides habitat for the endangered salt marsh harvest mouse. Point Edith Marsh is currently over 6,000 feet wide and therefore provides a substantial amount of natural flood protection benefits. The Corte Madera study (http://www.adaptingtorisingtides.org/project/corte-madera-baylands-conceptual-sea-level-rise-adaptation-strategy/) and other studies have shown that approximately 1,000 feet of tidal marsh can reduce wave height and energy associated with extreme storm events by over 50%, decreasing the necessary height of the inland flood protection structures. Wider marshes provide even greater natural flood protection benefits, which if no action is taken, could be lost as sea levels rise and the marsh downshifts to mudflat.

VULNERABILITIES

INFO: There is a limited understanding of how tidal marshes and mudflats, and adjacent upland ecotone habitats and subtidal habitats, will respond to accelerating sea level rise, how these habitats will be affected by management actions to increase sediment supply or provide transition zone habitat to support upland migration, or how they will respond to shoreline adaptation measures.
GOV1: Proactive management of tidal marshes, mudflats, adjacent upland ecotone habitats and subtidal habitats to improve resilience to sea level rise and storm events will require review and authorization from multiple local, state and federal agencies, which can be cumbersome and time consuming and often results in limited work windows and/or restrictions on the types of actions that can be taken.
GOV2: Marsh restoration and enhancement projects that include railroad tracks, highways, pipelines, PG&E towers, etc. require additional approvals and coordination.
GOV3: The prevailing model of fragmented decision-making, existing natural resources laws, and a history of passive management limits the ability to advance innovative or untested marsh restoration and enhancement actions and nature-based shoreline resilience solutions.
FUNC: The wildlife habitat, recreation, flood protection and other ecosystem service benefits provided by tidal marshes will not be sustained if these systems downshift to low marsh or convert to mudflat.
PHYS1: Almost all of the tidal marshes in the project area are mostly mid-marsh and predicted to drown by 2070 (depending on sea level rise rates, sediment supply, and management interventions). The marshes with more high marsh habitat now – Parchester Marsh, Whittell Marsh, Bullhead Marsh, and State Point-Mallard Island Marsh – are predicted to convert to mudflat a few decades later.
PHYS2: All of the tidal marshes except Point Pinole Southern Marsh and Whittell Marsh are bordered or constrained by development and transportation assets, such that there is no accommodation space for them to migrate landward to avoid being squeezed by a rising Bay.

CONSEQUENCES

Society and Equity: Loss of marshes would be a loss of shoreline recreational opportunities since people enjoy views of marshes and the species within them. Natural areas buffer developed areas from inundation, including disadvantaged communities.

Environment: Marshes provide habitat for threatened and endangered species. Storm event flooding makes these species more vulnerable to predation and can reduce reproductive success if nests are flooded. Downshifting habitat means marshes will be flooded more often, exacerbating these population stresses, until conversion of marsh to mudflat results in complete loss of tidal marsh species at this marsh.

Economy: All of the tidal marshes except Hoffman Marsh, Stege Marsh/Meeker Slough, Point Pinole Southern Marsh, and Whittel Marsh are the first line of defense against coastal flooding of adjacent development and transportation assets. Loss of this nature-based flood protection would increase the height and cost of structural shoreline protection.

RESOURCES

California Wetlands Monitoring Workground. EcoAtlas. http://www.ecoatlas.org/regions/ecoregion/bay-delta
Point Blue Conservation Science and California Landscape Conservation Cooperative. Future San Francisco Bay Tidal Marshes: a Climate-Smart Planning Tool. http://data.prbo.org/apps/sfbslr/
San Francisco Estuary Institute. Baylands Ecosystem Habitat Goals Project. http://www.sfei.org/projects/baylandsgoals
San Francisco Bay Conservation and Development Commission, Adapating to Rising Tides Program. 2013. Corte Madera Baylands Conceptual Sea Level Rise Adaptation Strategy. http://www.adaptingtorisingtides.org/project/corte-madera-baylands-conceptual-sea-level-rise-adaptation-strategy/

Parks and Recreation

The San Francisco Bay area has more than one million acres of open space including regional, local and state parks. However, only 25,000 acres of this open space is along the shoreline29. These open spaces share the shoreline with seaports, residential development, airports, interstate highways, business parks and many other uses. The high-density character of development along much of the shoreline leaves little space for developing new major shoreline parks, so current and future demand for shoreline recreation will likely need to be met by existing parklands. However, as sea level rises and storm events begin to cause more extensive and longer duration flooding, park and recreation assets along the shoreline will become costlier to maintain, recreation services disrupted and compromised and some may disappear entirely. This will diminish the important regional role that shoreline parks and recreation serve in providing ecosystem and community services, and in defining, improving and maintaining the Bay Area's quality of life.

[29] Staff Report Recreation and San Francisco Bay July 7, 2006, http://www.bcdc.ca.gov/pdf/planning/bpa_02_06/bpa_02_06_rpt.pdf

Shoreline parks in the Bay Area are often comprised of marsh habitat, wetlands, bluffs and other natural areas that bring communities in direct contact with the Bay and its natural resources. The Bay Area's shoreline parks are most often used for walking, nature-viewing, and picnic areas but also provide shoreline-specific recreational opportunities such as kayaking launches, shorebird watching, beach access, and fishing piers. In addition to recreation, these shoreline parks provide a variety of benefits, including critical wildlife habitat for aquatic, terrestrial, and avian species, reduced flood risks to inland communities, and improved public health. These valuable services may be lost as these natural shorelines face increased wave and tidal energy, and in some locations, longer duration periods of flooding or permanent flooding as sea level rises.

Shoreline parks serve as de facto coastal flood protection for much of Alameda and Contra Costa counties. However, these parks were developed and are managed as park and recreation resources, not coastal flood protection for inland areas. In some parks this protection consists of structural shoreline components, such as levees and riprap shoreline; others provide natural shoreline protection through wetlands and coastal bluffs. Shoreline parks buffer Bay Area communities from flooding events in three ways. The first is by detaining stormwater in wetlands and permeable surfaces. The second is by reducing the height and strength of waves across wetlands, which reduces the need for expensive shoreline protection like levees and seawalls. The third is by serving as a setback from the Bay, separating denser and more sensitive development from storms and sea level rise. Sea level rise will increase the importance of the role of shoreline parks and natural areas as critical flood and stormwater management services.

Another important benefit of park and recreation areas is the economic benefit provided to communities and regions that have functional open space systems. EBRPD analyzed the economic benefits of all its 111,000 parkland acres, including shoreline parks, and found that the park system in Contra Costa and Alameda counties provides $200 million in direct, regional economic benefits (EBRPD 2013). The Trust for Public Land has observed that strong park systems can increase property values by 5% in cities across the country, therefore contributing to tax revenue30. The combined economic, environmental and community benefits of shoreline parks demonstrates that planning for sea level rise resilience must be a priority for the entire region, not just park supervisors and decision makers.

Parks and recreation areas in the ART Contra Costa project area provide a wide variety of services to the public. Resources and activities at these sites include scenic views; walking, running, and biking on paths and trails; nature viewing; interpretive displays; swimming; paddleboating; sailboarding; motorboating; picnicking; playgrounds; family/group event areas and facilities; dog recreation; historic or cultural activities; and sport facilities.

Parks and recreation areas in the ART Contra Costa project area serve users in four major categories:

- Regional shoreline areas that attract visitors from the region;
- Small shoreline parks that serve a surrounding community or neighborhood;
- Marinas, often privately owned or managed, which provide boat access and other for-profit recreation experiences; and

[30] Because there is not a good metric for park quality, a low end estimate of 5% increase in property value is included for parks that convey a strong positive value to surrounding residents, https://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/ccpe-econvalueparks-rpt.pdf

- San Francisco Bay Trail, a bicycle and pedestrian corridor with over 80 miles of trail in the Contra Costa Project. The Bay Trail is planned at the regional scale but individual trail segments are owned and maintained by cities, park districts, other agencies, and private landowners.

This section focuses on the vulnerability and risk to 13 parks, eight marinas, and the San Francisco Bay Trail in the project area from sea level rise impacts.

Regional Parks

East Bay Regional Park District owns and manages the seven regional shoreline parks in the Contra Costa project area. EBRPD is responsible for providing recreation and open space in a highly developed and growing area. EBRPD's role has expanded over the years to include a greater range of management objectives on the parklands it owns and operates, including natural area restoration, community engagement, and new partnerships with neighboring landowners.

KEY ISSUE STATEMENT

EBRPD shoreline parks face flooding, groundwater infiltration, erosion, and habitat shifts from one habitat to another, habitat loss and degradation from sea level rise and future flooding. These regional shoreline parks contain important marsh habitat, unique historical resources, and large-scale recreation assets including trails, fishing, wildlife viewing, and off-leash dog areas. The EBRPD shoreline parks serve 2.8 million visitors each year. Sea level rise and future flooding will not only affect parks and shoreline habitat, but will also affect inland areas in places where EBRPD provides the official or de facto shoreline protection. EBRPD will need to protect its park and recreation areas; it will also need to work with the inland neighbors that its shoreline parks protect from flooding, such as the Union Pacific Railroad, cities, and private landowners.

EXPOSURE TO CURRENT AND FUTURE FLOODING

All seven regional shoreline parks in the ART Contra Costa project area are exposed to some degree of current and future flood risk. This does not necessarily ensure damage or disruption by flooding; the regional parks contain marshes and seasonal wetlands that need temporary inundation to function. On the other hand, even short term flooding would damage certain aspects of shoreline parks, such as athletic fields, restrooms, and community facilities.

Water levels between MHHW and MHHW+6' were selected because they represent a reasonable range of potential Bay conditions that will affect flooding and inundation along the shoreline. For four parks in the project area, the amount of each park exposed to different water levels was determined (see table below). For many of the parks, the total park acreage includes submerged areas. To avoid a misrepresentation of the exposure percentages, the analysis on what will be flooded was based only on the dry land area of the park. However, inundation of wetland areas will also present problems, as marshes that are meant to be wet only some of the time and at a certain water level will be inundated at higher water levels and for longer periods of time. This land area, or footprint, was visually determined and digitized in GIS using aerial imagery in combination with maps that show park boundaries. Therefore, the footprint values in the table below are approximations, as are the calculated exposure percentages.

Table 20. Percentage of regional parks that could be exposed to sea level rise.

Asset	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Martinez Shoreline	Martinez	Yes	45%	56%	62%	66%	74%	78%
Point Pinole	Richmond	Yes	13%	18%	19%	21%	22%	23%
Miller Knox Shoreline	Richmond	Yes	1%	2%	2%	2%	2%	7%
Brooks Island/Point Isabel	Richmond	Yes	14%	22%	27%	30%	32%	33%

ASSET DESCRIPTION

MARTINEZ REGIONAL SHORELINE

Martinez Regional Shoreline is a 342-acre park with shoreline trails, marshes, fishing, picnic areas and separate recreation areas managed by the City of Martinez, including a marina and athletic fields. Park infrastructure is over 35 years old. Shorelines are rapidly eroding and erosion has forced the closure of over 300 feet of trail in past years. Outer turf areas are experiencing increasing salt-water intrusion, and planted trees are showing increasing signs of exposure to salt water. The interior marshes that are part of the park were designed and built to alleviate flooding in downtown Martinez through a joint agency project with the City of Martinez that was completed in 2004.

MILLER-KNOX REGIONAL SHORELINE

Miller-Knox Regional Shoreline is a 307-acre shoreline park that includes trails, a swimming area at Keller Beach, picnic facilities, the Golden State Model Railroad Museum, a fishing pier and a lagoon. The regional park is built at the site of a historic ferry terminal that no longer provides ferry service. Several historic structures are located on the property, although they are vacant and frequently vandalized. The park contains seven miles of Bay Trail with views of the Bay and historic sites. The park contains an unused railroad right-of-way that is now owned by EBRPD, but still contains railroad bed and tracks.

POINT ISABEL REGIONAL SHORELINE

Point Isabel Regional Shoreline covers 23 acres, and includes Bay Trail, grass areas, Hoffman Channel and Hoffman Marsh, and riprap shoreline segments. The park also contains a dog grooming business, cafe as a concessionaire, restrooms and a parking lot for visitors. Despite its small size, it is a very popular location for off-leash dog walking and serves 1.4 million visitors each year. EBRPD has worked to minimize erosion in Hoffman Channel with bank stabilization and fencing prohibiting dog activity. Dogs and humans are not allowed in Hoffman Marsh to protect its habitat value.

WILDCAT CREEK TRAIL AND WILDCAT MARSH TRAIL

Wildcat Creek Trail is an eight-foot wide asphalt trail, which extends from Wildcat Marsh to east of Giarmita Street, plus a parking lot, restroom, and a grassy meadow. A portion of the trail system is located under the

Richmond Parkway, and has been closed for over 10 years due to the overtopping of Wildcat Creek onto the trail, flooding of the trail and failure of the flood control district's pumping system. Budget constraints will determine whether the tunnel is repaired or a bridge overcrossing is built. Wildcat Marsh Trail is on the edge of the marsh, and therefore affected by future sea level rise and major storm events. This section of trail was constructed in 2012 to be resilient to future flooding and sea level rise up to MHHW+36" through increased trail elevation and the use of erosion-resistant materials. Wildcat Creek Trail is owned entirely by Contra Costa Flood Control District, and Wildcat Marsh Trail is the property of West County Wastewater District.

SAN PABLO BAY SHORELINE

San Pablo Bay Shoreline is currently a series of disconnected multi-use trail segments and adjacent parklands, extending along the southeastern shore of San Pablo Bay from west of Pinole Shores Drive in San Pablo to the town of Rodeo. When completed, this trail will connect Point Pinole Regional Shoreline with the shorelines in the cities of San Pablo, Pinole, Hercules, and Rodeo, and eventually to regional trails further east. Budget and jurisdictional constraints have delayed the completion of the trail due to the necessity of constructing bridges across the railroad tracks at two locations, which will require approval from the railroad and is an expensive trail segment to build. Completion of the trail is planned but not funded. The shoreline parks and trails serve communities in Hercules, Pinole, and Rodeo and these communities are disproportionately elderly and low income. Many users of the trail are elderly or disabled; therefore maintaining unobstructed access to the trail is critical. Lone Tree Beach, a popular recreation site along the San Pablo Bay Trail, has suffered severe erosion due to strong tidal action and poor shore stabilization. The cliffs are being undermined and are becoming unstable. In addition, Lone Tree Beach is adjacent to derelict private property that has drawn graffiti and crime to the area, making park management difficult and requiring more attention and resources.

POINT PINOLE REGIONAL SHORELINE

Point Pinole Regional Shoreline contains 2,315 acres of marsh, meadow and woodlands and provides fishing, walking, nature viewing and dog walking recreation opportunities. The park provides shuttle service seven days a week to bring visitors from the parking lot to the fishing pier and other attractions within the park. The park is heavily used as an off-leash dog area. The park has rerouted several pedestrian trails away from areas that are experiencing shoreline cliff erosion and collapse. So far, there has been sufficient space to reroute trails and maintain access to the shoreline. The fishing pier, the most significant built infrastructure at the park, is in good condition and sufficiently high to be resilient to future sea level rise. In addition, East Bay Regional Park District is planning to construct a visitor center, which will provide public education and interpretation opportunities about the changing climate and sea level rise.

CARQUINEZ STRAIT REGIONAL SHORELINE

Carquinez Strait Regional Shoreline is a 415-acre park that includes a variety of elevations from low-lying areas to bluffs/hills reaching 750 feet in elevation. The park is split into two major sections with trail connections from Crockett, through Port Costa, to Martinez. The park includes multi-use trails and historic wharves. There are also views into the delta and across Carquinez Strait from the park. The park includes the newly constructed George Miller Regional Trail, which provides a unique Bay Trail experience and views of boat traffic in the strait for bicyclists, pedestrians, and equestrians.

VULNERABILITIES

GOV: EBRPD will need to coordinate with neighboring landowners, county and city departments, the Bay Trail, and Union Pacific Railroad, to address shoreline erosion and coastal flooding impacts to its parks and trails.
PHYS1: Many of the EBRPD parks in the project area are already experiencing shoreline erosion and bluff collapse, which will worsen as sea levels rise, damaging trails, interrupting regional trail segments, and impacting Bay Trail continuity.
PHYS2: EBRPD parks include low-lying and salt-sensitive turf that will be damaged by storm event flooding and/or groundwater intrusion.
FUNC1: EBRPD shoreline parks contain extensive tidal marsh habitat that may downshift and/or disappear if sediment supplies and upland transition zones are insufficient to accommodate future water levels.
FUNC2: EBRPD shoreline parks rely on roads and trails for access that are vulnerable to current and future flooding. The county and cities manage these roads, so EBRPD will need to coordinate with local government to maintain park access.
FUNC3: EBRPD shoreline parks serve as a buffer against sea level rise and storm event flooding; however parks were developed and are managed as park and recreation areas and not as coastal flood protection systems. The degree of ad-hoc flood protection provided varies as some parks have structural shoreline components such as levees and riprap, while others have natural shorelines such as wetlands and coastal bluffs.
FUN4: Parks enhance well-being, provide health benefits, and serve as gathering places. Flooding which damages parks, or makes them inaccessible, will negatively impact communities' health and social capital.

CONSEQUENCES

Society and Equity: Residents and business owners could lose shoreline access and wildlife viewing recreation opportunities if the park is damaged or disrupted. The communities located near the San Pablo shoreline—Hercules, Pinole, Rodeo—are disadvantaged communities for which shoreline park and recreational facilities provide open space and recreational access, as well as serve as protection from current and future flooding from the Bay.
Environment: Marsh habitat in EBRPD shoreline parks may downshift or drown due to future water levels if there is not sufficient sediment supply and upland space for transgression. This could lead to habitat loss and impacts on shoreline species.
Economy: EBRPD provides $16.7 million dollars in recreation value each year to Contra Costa County and regional residents and visitors31. Regional parks also serve to increase surrounding property values.

Neighborhood Parks

Neighborhood Parks provide recreation facilities for city residents and visitors at the neighborhood scale. There are five parks in the city of Richmond, one in Contra Costa County community of Bayview-Montalvin, and one in the city of Martinez that are potentially exposed to current and future flooding. Most are relatively

[31] For valuation methodology see ART Parks and Recreation Area Economic Analysis at http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/ERG_EconAnalysis_ParksRecAreas.pdf.

small in size (compared to regional parks) and typically have more grass areas and active recreation facilities and fewer natural habitat areas than found in regional parks.

KEY ISSUE STATEMENT

Seven neighborhood parks may experience shoreline erosion and flooding in low-lying areas. Flood damage of shoreline protection, public access areas, lawns, restrooms, picnic areas, and parking lots would require park closures and costly repairs. Due to their small size, these parks will either need to be protected in place or relocated. Unlike larger parks where uses can be moved within the existing footprint, small parks do not often have the ability to move park functions farther from the shoreline. In addition, like most parks, neighborhood parks rely on vulnerable roads and trails for access.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Seven neighborhood parks in the project area are exposed to current and/or future flood risk.

Table 21. Neighborhood parks that could be exposed to sea level rise.

Asset	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Richmond Marina Park	Richmond	Yes	No	No	No	Yes	Yes	Yes
Lucretia Edwards Park	Richmond	Yes	No	No	No	Yes	Yes	Yes
Barbara and Jay Vincent Park	Richmond	Yes	No	No	No	Yes	Yes	Yes
Shimada Friendship Park	Richmond	Yes	No	No	No	Yes	Yes	Yes
Sheridan Observation Point	Richmond	Yes	No	No	No	Yes	Yes	Yes
MonTara Bay Park	Bayview-Montalvin	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Martinez Waterfront Park	Martinez	Yes	No	No	No	Yes	Yes	Yes

ASSET DESCRIPTIONS

City of Richmond Parks: Richmond City Parks provide recreation facilities for city residents and visitors at the neighborhood scale. There are five parks in the city that are potentially exposed to current and future flooding. These five parks represent about 8% of the City of Richmond's total park acreage (287 acres). While they do not have swimming or boat access, all are located along the shoreline and provide views of the Bay. The Public Works Parks and Landscaping Division manages park facilities while programs at the parks are managed by the Recreation Department. City parks are funded through city tax revenue and the city budget process.

Richmond Marina Park: This 11-acre park provides lawn and picnic areas, barbeque facilities, restrooms and connections to the Richmond Marina (see Marinas profile sheet) and the Rosie the Riveter National Historic Park.

Lucretia Edwards Park: This two-acre park contains picnic and lawn areas as well a parking lot and restroom.

Barbara and Jay Vincent Park: This six-acre park contains a playground, a picnic area with grills and a parking lot with restrooms.
Shimada Friendship Park: This three-acre park contains a lawn area and restroom.
Sheridan Observation Point: This one-acre park provides a small lawn area and parking lot.
MonTara Bay Park: This park is located in the Contra Costa County community of Bayview-Montalvin near Garrity Creek and the Bay shoreline. The park covers four acres and includes a community center and lighted baseball fields. The facilities are used for YMCA programs for youth and adults. Contra Costa County Public Works owns and manages the park.
Martinez Waterfront Park: This Martinez City Park is 150 acres and includes picnic areas, rental athletic fields for baseball, bocce, soccer and horseshoes, a Marina and Harbormaster facilities, a fishing pier, and a large 1200-seat amphitheater. The park is only accessible via Joe DiMaggio Drive as it is separated from downtown by the Union Pacific Rail line. Park facilities are frequently rented for baseball and bocce leagues. The park shares boundaries with Martinez Regional Shoreline, owned and managed by East Bay Regional Park District, and the Martinez Marina.

VULNERABILITIES

GOV: Richmond and Martinez's current Parks Master Plans do not account for the impact of climate change on park facilities or services, and the County's MonTara Bay Park does not have a current management plan.
PHYS1: City parks are vulnerable to shoreline erosion and saltwater intrusion in lawn areas.
PHYS2: Restrooms, parking lots and other structures can be damaged by short term flooding that can require costly repairs.
FUNC1: City Parks rely on others to provide local access roads as well as transit, power, water and wastewater services that can be disrupted during flooding or storm events.
FUNC2: There are limited city parks in the Contra Costa project area serving local needs. If parks are inaccessible or damaged by flooding, the remaining open or accessible parks are unlikely to have capacity to meet local resident needs.

CONSEQUENCES

Society and Equity: Residents could lose shoreline access recreation opportunities if parks are damaged or disrupted and for communities with fewer active recreation areas available, the loss of these parks could be significant. This consequence may be more severe for transit-dependent or limited-mobility residents who cannot access substitute recreation further away from their homes.

Environment: Local neighborhood parks and open spaces often reduce impervious surfaces, reduce the impacts of urban heat islands and serve as de-facto habitats for some wildlife species.

Economy: City parks provide recreation value to residents and also help maintain healthy and safe communities and can increase the property values of surrounding land.

Marinas

The project area includes eight active marinas spread across the project area from Richmond to Bay Point. Marinas provide public access to the shoreline for paddleboat water recreation as well as sail and motorboat access. Marinas can also house live-aboard residents and many marinas have inland facilities including office space, restaurants, and housing. Marinas often provide power, water treatment, and refueling services to boats that moor either in permanent berths or temporary slips. Marinas provide unique shoreline recreation and are difficult to expand or relocate due to their need for unique shoreline conditions such as natural harbors to minimize dredging.

KEY ISSUE STATEMENT

Marinas are vulnerable to sea level rise and storm event flooding because of their shoreline location and sensitive onshore equipment. Although boats and docks are able to accommodate changes in water levels, onshore facilities are not waterproofed and often contain hazardous materials like fuel, wastewater, and motor oil. Marinas provide water-oriented recreation and housing and are not easily relocated within the region.

EXPOSURE TO CURRENT AND FUTURE FLOODING

All eight marinas are exposed to current and future flood risk because of their shoreline location and functions.

Table 22. Marinas that could be exposed to sea level rise.

Asset	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Marina Bay Yacht Harbor	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Channel Marina Yacht Harbor	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sugar Dock	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Brickyard Cove Marina	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Richmond Yacht Club	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Point San Pablo Yacht Club	Point Molate	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Martinez Marina	Martinez	Yes	Yes	Yes	Yes	Yes	Yes	Yes
McAvoy Yacht Harbor	Bay Point	Yes	Yes	Yes	Yes	Yes	Yes	Yes

ASSET DESCRIPTION

Marina Bay Yacht Harbor, Richmond: Marina Bay Yacht Harbor is privately owned and has 850 berths for boats up to 120' in length. The marina provides restrooms, utility services, and boat refueling and oil

recycling services. The marina also provides sailing lessons and small-boat launches including kayaks and stand-up paddleboards.

Channel Marina Yacht Harbor, Richmond: Channel Marina Yacht Harbor is privately owned and has 66 covered berths for boats up to 32' in length. The Yacht Harbor provides water hookups, restrooms, and parking, but does not refuel boats.

Sugar Dock, Richmond: Sugar Dock is a privately owned deep-water dock with facilities for large boats including cranes for boat repair. The dock can accommodate boats up to 350' long and provides utility services and a bathhouse for boaters.

Brickyard Cove Marina, Richmond: Brickyard Cove Marina is privately owned and has 250 berths. It provides dryland storage for boats as well, utilities available for boaters and bathrooms. Brickyard Cove Marina is part of the Brickyard Cove neighborhood and has experienced substantial redevelopment that has increased housing and commercial uses.

Richmond Yacht Club, Richmond: The Richmond Yacht club has 270 berths (approximately), a clubhouse and a harbormaster facility. The club provides sailing berths for members, visitors, and youth and adult programs to encourage sailing. The club also hosts events on and off the water, including races and community events.

Point San Pablo Yacht Harbor, Point Molate: Point San Pablo Yacht Harbor is a privately owned marina that provides berths for motorized and non-motorized boats, as well as charter fishing opportunities.

Martinez Marina, Martinez: Martinez Marina is owned by the City of Martinez and operated by Almar Marinas. The marina also provides over 300 slips and the marina serves members, guests and live-aboard boaters. There are also utility services, a refueling station, and a Yacht Club (separately managed). The City of Martinez is developing a Marina Master Plan which encourages dryland development on the site, including commercial and residential land uses.

McAvoy Yacht Harbor, Bay Point: McAvoy Yacht Harbor is a privately owned marina that provides 300 slips and dryland storage for boats, as well as yacht club facilities, fishing opportunities, and boat repair and refueling. McAvoy Yacht Harbor can accommodate boats up to 65' in length.

VULNERABILITIES

GOV: Marinas, which are often privately owned, will need to coordinate with city and county departments, regional, state and federal agencies, neighboring landowners, and others to address the impact of sea level rise on marina assets and operations.

PHYS1: Marinas are located in low-lying shoreline areas such that dryland facilities are at risk of flooding. These facilities include restaurants, clubhouses, bathrooms and parking lots that have not been constructed to withstand flooding (e.g., elevated, salt resistant or waterproof materials).

PHYS2: Marinas often provide boaters refueling as well as oil change and recycling services to boaters. This results in marina's storing petroleum and other hazardous materials that could be mobilized during flood events, impairing water quality.

FUNC1: Marinas rely on local roads, highways and interstates that are vulnerable to flooding to obtain materials and supplies and be accessible to employees and boaters.

FUNC2: Marinas need adequate water depths both within the marina and between the marina and deeper Bay waters, and can only be built and maintained along certain parts of the shoreline where sediment accumulation patterns are appropriate. If flooding damages marinas, there may not be alternative locations to create new marinas of adequate capacity to expand existing marinas in the region.

FUNC3: Marinas provide limited, low-cost housing to live-aboard residents. These residents may need special consideration when planning for sea level rise that may lead to their eventual relocation as they may not be able to afford market rate housing.

CONSEQUENCES

Society and Equity: Marina residents and visitors rely on marinas for recreation and housing. If marinas are damaged or closed due to future flooding, other facilities may not be available, especially north of Richmond in the project area.
Environment: Marinas create, store, and transport hazardous materials like fuel and motor oil. If these facilities are flooded, hazardous materials may be mobilized and lead to impaired water quality and environmental habitat degradation.
Economy: Marinas provide unique shoreline recreation value and direct economic activity through berth rentals and inland businesses, such as restaurants. The closure of marinas may impact local economies and tax revenue.

Bay Trail

The Contra Costa County Project Area contains over 80 miles of Bay Trail, including 32 miles within the City of Richmond. These trail segments provide recreation for walkers, bikers, and joggers as well as serve as pedestrian and bicycle commuter pathways. Different portions of the trail are paved, gravel, boardwalk, or on-street bicycle lanes depending on the location and surrounding land uses. The Bay Trail is a regional trail network with over 330 miles of completed trail, and a total of 500 miles planned as a loop around San Francisco Bay. The Coastal Conservancy and Association of Bay Area Governments plan the overall Bay Trail and support projects through grants but the actual trail segments are built, owned, and managed by local agencies like park districts, cities, and flood control agencies and required by agencies like BCDC and local cities. Large sections of the Bay Trail are located on erodible shoreline such as levees, bluffs, and natural shorelines.

KEY ISSUE STATEMENT

The Bay Trail will potentially be exposed to shoreline erosion and flooding of low-lying portions, which may damage trails and lead to closures and costly repairs. Bay Trail relies on connectivity in its function as a regional network, so even small sections of damage can disrupt the use of large segments. In addition, the Bay Trail is managed and funded by many different agencies, so adaptation will require extensive coordination to maintain trail alignments and connectivity.

EXPOSURE TO CURRENT AND FUTURE FLOODING

There are a total of 86 miles of Bay Trail in the project area, 11 of which are within the current 100-year floodplain and 10 of which are exposed to six feet of sea level rise. Due to the type of analysis conducted, the miles of Bay Trail exposed to existing versus future flooding is reported separately even though they may not be unique and it is likely that these segments overlap. Given the shoreline location of the Bay Trail in the project area, many areas that are exposed to sea level rise are likely within the existing floodplain.

Table 23. Miles of Bay Trail (by owner) that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Miles of Bay Trail by Owner	Current 100-year Flood	Sea Level Rise					
		1'	2'	3'	4'	5'	6'
Caltrans	0.6	0.5	0.5	0.5	0.5	0.5	0.5
Contra Costa County Public Works	2.8	0.0	0.0	0.1	0.2	0.4	0.8
East Bay Regional Park District	1.6	0.1	0.2	0.5	0.9	1.3	1.7
Hercules Public Works Department	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Martinez Public Works Department	2.0	0.0	0.0	0.0	0.0	0.0	0.1
Pinole Public Works Department	0.2	0.0	0.0	0.1	0.2	0.3	0.5
Port of Richmond	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Richmond Public Works Dept	3.4	0.1	0.3	0.9	2.4	4.7	6.3
San Pablo Parks & Recreation	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Total	**10.9**	**0.7**	**1.0**	**2.0**	**4.3**	**7.3**	**9.9**

VULNERABILITIES

GOV1: The Bay Trail is required, owned, managed and funded by many different agencies, both public and private, and therefore extensive coordination will be necessary to adapt to future flooding while retaining connection to the greater trail network.

GOV2: The Bay Trail is co-located with flood control, shoreline protection, habitat, and transportation assets. Projects that improve the resilience of these assets to flooding will need to consider multi-objective solutions to protect Bay Trail function.

PHYS1: Nearly 10 miles of Bay Trail in Contra Costa County is exposed to future sea level rise of six feet, and nearly 11 miles are currently in the 100-year floodplain. Many of these sections are located atop levees and other erodible shoreline. Sea level rise and storm events may damage these shorelines and the trail.

PHYS2: Some Bay Trail surfaces, especially dirt and gravel paths, are sensitive to flood events. Even paved trails require clearing and cleaning after major flood events.

FUNC: The Bay Trail requires connectivity with other trail segments, staging areas such as parking lots, and local and regional transportation networks to function. Vulnerabilities of other road and trail segments may limit access to the Bay Trail, affecting its function for recreation and commuter movement.

CONSEQUENCES

Society and Equity: Residents could lose shoreline access, recreation opportunities, and non-motorized transportation corridors if the Bay Trail is damaged or closed due to future flooding. For those with limited

mobility or transportation options, the loss of Bay Trail segments in their neighborhoods could be significant, reducing the transportation and recreation opportunities provided by these segments.

Environment: Bay Trail segments provide nature viewing and environmental education opportunities that may be lost if the trail is flooded or damaged. Damage of the trail can also increase erosion and result in impacts to the natural areas surrounding the damaged trails segments.

Economy: The Bay Trail provides recreation value and non-motorized transportation options for county residents and employees. Proximity to the Bay Trail is an attractive feature to businesses and residential land uses and can increase the value of adjacent properties. This economic value may be lost if the trail is flooded or inundated.

RESOURCES

Adapting to Rising Tides Program, San Francisco Bay Conservation and Development Commission. (September 2015). Preserving Shoreline Parks in the Face of Climate Change. http://www.adaptingtorisingtides.org/wp-content/uploads/2015/09/ART-Parks-Report_Aug2015.pdf
Adapting to Rising Tides Program, San Francisco Bay Conservation and Development Commission. (2014). Economic Analysis of Recreational and Other Values of Parks in the Adapting to Rising Tides Project Area. http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/ERG_EconAnalysis_ParksRecAreas.pdf
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San Francisco Bay Conservation and Development Commission. (July 7, 2006). Staff Report on Recreation and San Francisco Bay. http://www.bcdc.ca.gov/pdf/planning/bpa_02_06/bpa_02_06_rpt.pdf
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People

People are the most important asset in any community. The health and resilience of a community is dependent on the health and resilience of the people within it. People are the workers, students, clients, customers, neighbors, volunteers and members that make up our cities, communities and region. People are responsible for creating the social and personal support networks, the culture and values, and the local economies that contribute to the resilience of communities. It is critical, therefore, to understand the unique needs, challenges and strengths of the people within each community when evaluating the potential risks faced from hazards such as flooding, sea level rise, and storm events.

Current and future flooding impacts a community when people are disrupted from getting to work, school and elsewhere, or are injured, lives are lost, and when homes and possessions are damaged. Flooding can also have significant impacts on a community if important services and transportation routes are disrupted in the days and weeks after the event. As flood hazards become more frequent and severe as the climate changes, greater proportions of the region's population will be either directly or indirectly impacted. The consequences of flood events will be more severe for some communities, especially those with people, housing, employment sites, and public services within existing coastal or riverine floodplain. In addition, communities where people are underserved, have limited personal resources, rely on public services including healthcare, require specialized housing and accessible transportation options, rely on others for daily living and personal care needs, or are otherwise disadvantaged, are at even greater risk both during

and after flood events. While social and personal support networks can improve the resilience of a community, offsetting some of the consequences of a flood event, not all communities have the plentiful individual, neighborhood and community social capital that will be needed.

For the Contra Costa ART project assessment, community vulnerability is described using the approach developed for Stronger Housing, Safer Communities completed by the ART Program in partnership with the Association of Bay Area Governments Resilience Program32. Stronger Housing, Safer Communities selected ten indicators that represent characteristics of individuals and households that affect their ability to prepare for, respond to, and recover from a disaster33. These indicators include financially constrained households, renters, non-English speakers, people of color, educational attainment, transit dependent individuals, the elderly and the very young. Indicators were mapped at a regional scale to identify areas (block groups) that may have a higher than average concentration of one or more indicator. Together, these 10 indicators begin to present a picture of community vulnerability across the region, with key themes that emerged including age-related vulnerabilities, language and ethnicity vulnerabilities, cost-burdened residents, housing tenure issues, and access to resources34. The assessment that follows presents the key themes and findings for the Contra Costa ART project area. It is based on the regional analysis of the ten Stronger Housing, Safer Communities indicators as well as research on readily available city and neighborhood scale information about the people and the resources in their communities that may underlie specific vulnerabilities or impart resilience.

KEY ISSUE

Individuals, households and neighborhoods in Richmond, North Richmond, Martinez and Bay Point have characteristics that could affect their ability to prepare for, respond to, and recover from a flood event. These characteristics include low-income households, individuals with low educational attainment, people of color, renters and households without a vehicle. In addition, across the project area most residents are housing and transportation cost-burdened.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The Contra Costa ART project area includes a portion of the shoreline cities of Richmond, Pinole, Hercules and Martinez, the inland adjacent cities of El Cerrito and San Pablo, and a very small portion of Pittsburg on the eastern boundary of the project area. Also included in the project area are portions of the unincorporated communities of North Richmond, Tara Hills, Bayview, Montalvin Manor, Rodeo, Crockett, Port Costa, Clyde, Vine Hill, Concord, Mountain View and Bay Point.

An analysis of the population that could be impacted by current and future flooding was conducted using census block data from the 2010 US Census, which is the smallest available geographic unit. There are 156,203 people living in the project area35, and approximately 11,387 people are at risk from current and future flooding (7% of the project area population). This includes people living in the current 100-year floodplain, those living in areas that could be exposed to six feet of sea level rise both within and outside of

[32] http://www.adaptingtorisingtides.org/project/stronger-housing-safer-communities-strategies-for-seismic-and-flood-risks/
[33] Indicators were selected that were regionally measurable and captured the breadth of vulnerability present within the Bay Area efficiently and with minimal overlap.
[34] http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/#community
[35] US 2010 Decennial Census (factfinder.census.gov/)

the existing 100-year floodplain, and those living within low-lying areas adjacent to the inland flood extent from six feet of sea level rise (see Table 1).

Within the project area there are 8,752 people living within the current 100-year floodplain, 699 of which are at risk of more frequent or extensive flooding in the future due to sea level rise. An additional 1,124 people that are not currently at risk of flooding (e.g., not living within the 100-year floodplain) could be exposed to flooding as sea level rises. Some of these people may live adjacent to the current 100-year floodplain but are protected from today's 100-year flood, while others may be located beyond the extent of current flooding. In addition, there are 1,522 people living within low-lying areas adjacent to the inland flood extent from six feet of sea level rise. While it is possible that these people are not at risk of overland flooding, people living within low-lying, adjacent areas could be at risk of flooding due to limited capacity of the stormwater and flood management systems. These limited capacity systems can cause backups into basements and flooding of local streets and roads.

Table 23. Population potential exposed to current and future flooding in the project area

Place	Total at Risk*	Current 100-year Flood only	100-year Flood + Sea Level Rise (cumulative count)						Sea Level Rise only (cumulative count)						Low-lying, adjacent to 6 feet SLR
			1'	2'	3'	4'	5'	6'	1'	2'	3'	4'	5'	6'	
Bay Point	283	281	0	1	1	1	1	1	0	0	0	1	1	1	0
Bayview	55	2	12	16	19	26	31	33	8	9	10	26	16	20	0
Clyde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concord	18	17	0	0	1	1	1	1	0	0	0	1	0	0	0
Crockett	44	43	0	0	0	0	0	0	0	0	0	0	0	1	0
El Cerrito	945	938	0	0	0	0	0	0	0	0	0	0	0	0	7
Hercules	228	57	8	10	12	14	21	31	7	9	12	14	70	114	26
Martinez	3028	2957	18	25	29	31	34	35	2	4	8	31	20	35	1
Montalvin Manor	17	14	0	0	0	0	0	0	0	0	0	0	0	1	2
Mountain View	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Richmond	753	50	0	1	1	3	4	6	0	0	6	3	109	160	537
Pinole	118	31	3	4	4	5	6	7	0	1	1	5	35	75	5
Pittsburg	21	21	0	0	0	0	0	0	0	0	0	0	0	0	0
Port Costa	76	76	0	0	0	0	0	0	0	0	0	0	0	0	0
Richmond	1845	144	51	59	64	73	83	96	29	37	48	73	260	661	944
Rodeo	722	216	0	0	0	0	0	488	0	0	0	0	1	18	0
San Pablo	3013	3013	0	0	0	0	0	0	0	0	0	0	0	0	0
Tara Hills	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Vine Hill	216	179	0	0	0	0	0	0	4	7	12	0	29	37	0
Total in Project Area**	**11387**	**8053**	**94**	**118**	**133**	**156**	**184**	**699**	**50**	**67**	**98**	**211**	**542**	**1124**	**1522**

* Total at risk is the summation of the number of people in the current 100-year floodplain, 100-year floodplain + 6' sea level rise, 6' sea level rise only, and low-lying adjacent to 6' sea level rise

** Population Total in Project Area does not equal the sum of the population in places, because some populated census blocks are not in a city or census-designated place

ASSET DESCRIPTION

CITIES, UNINCORPORATED AREAS AND NEIGHBORHOODS

Within the Contra Costa County ART project area, communities in Richmond, North Richmond, Martinez and Bay Point have more characteristics that could affect their ability to prepare for, respond to, and recover from a flood event. For example, the community indicators suggest that in these locations there are low-income households, individuals with low educational attainment, people of color, and a high number of renters and households without a vehicle. In addition, across the project area most residents are housing and transportation cost-burdened. These findings are consistent with the Contra Costa Health Services (CCHS) Climate Change Vulnerability in Contra Costa County: A Focus on Heat[36] study. The CCHS study evaluated a combination of social, economic, medical, biological, and environmental characteristics, and determined that communities in Richmond, North Richmond, San Pablo and Bay Point are at greatest health risk from extreme heat events.

In addition to the community indicators that were considered, additional information was gathered about communities in the project area to better understand the potential factors that could impact vulnerability and resilience. This chapter includes descriptions of three cities, three unincorporated areas and one neighborhood, including their potential exposure to current and future flooding, characteristics of existing housing and communities, and facilities serving the community. These seven areas were selected because of potential exposure to coastal and/or riverine flooding, and also because some members within these communities exhibit characteristics that could limit their ability to prepare for, respond to, or recover from flooding.

The data used in this analysis was obtained from publically available sources, primarily the US Census, and is based on the approach developed for the Stronger Housing, Safer Communities project[37]. Stronger Housing, Safer Communities profiled a community within the City of Richmond's southern shoreline area, and that community profile can be found here: http://resilience.abag.ca.gov/community-profiles/.

PARCHESTER VILLAGE, RICHMOND

Parchester Village in Northwestern Richmond is a neighborhood of approximately 400 single story homes that was master planned as a residential development in the early 1950's. The neighborhood is located just south of Point Pinole Regional Park between the Richmond Country Club to the east and the Union Pacific Railroad to the west. Parchester Village is geographically isolated from the rest of Richmond, with limited access provided by the Richmond Parkway and Giant Highway. AC Transit provides public transit to Parchester Village, although most of the households reported to the US Census that they have access to a vehicle. The limited number of roads that provide ingress and egress to the neighborhood are essential for residents who commute to work or school, need to obtain services or fulfill essential needs such as buying groceries, going to the doctor, emergency response and other critical activities.

[36] http://cchealth.org/health-data/pdf/2015-climate-change.pdf
[37] http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/

Parchester Village is protected from flooding by informal, or ad-hoc, shoreline protection that was not designed and is not managed to protect inland areas from flooding. This includes the Union Pacific Railroad and the tidal wetland complex that includes Breuner Marsh. The Union Pacific Railroad was not constructed and is not maintained as shoreline or flood protection. Additionally, flood mapping of this area may underestimate risk, as the potential for railroad embankments to serve as barriers to inland flooding is calculated solely using elevation, but these embankments often have culverts or passages that allow water through. A portion of Parchester Village, in particular the area around Jenkins Way and Banks Drive, is low-lying and therefore more vulnerable to damage if flooding does occur.

Figure 12 Aerial View of Parchester Village

Parchester Village is mostly single-story residential homes built in the early 1950s. This neighborhood is part of a large North Richmond census tract of over 10,000 residents and 3,000 households, that includes more recently developed upper middle-class neighborhoods to the east of the Richmond Country Club. This census tract has a median income of $76,132, which is approximately the County median income. Within Parchester Village there are about 829 residents, and households have a median income of approximately $29,00038. While it once was historically an African-American community, today Parchester Village is 36% Black or African-American, 20% White, and 30% other ethnicities. Almost 60% of the houses are owner-occupied, and approximately 30% of the residents are under 17 years of age.

38 US Census American Community Survey 2009-2013 ACS 5-Year Estimates, American Community Fact Finder (http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml)

Parchester Community Center is the primary community facility serving this neighborhood. The City provides services and utilities including water supply and wastewater services, fire department and police, but there are no medical facilities or K-12 schools within the community. In addition, most of the city emergency services are located outside of the neighborhood, however in an emergency community facilities or public spaces that could serve as gathering locations or sources of emergency information or assistance include Greater El Bethel Baptist Church and Parchester Park/Community Center.

MONTALVIN MANOR

Montalvin Manor is a census-designated place (CDP) located in Contra Costa County between Richmond and Pinole. It is a residential community comprised of single-family residences and a mobile home park. Garrity Creek runs along the eastern boundary of Montalvin Manor, separating it from Tara Hills. The Burlington Northern Santa Fe Railroad runs along the northern boundary, and the Union Pacific Railroad is located along the shoreline, with fringing tidal marsh and Montara Bay Park sitting between the rail line and the Bay. Montalvin Manor has limited roadway access, with the main points of ingress and egress from San Pablo Avenue and Tara Hills Drive. There is limited public transit and the community is highly dependent on personal vehicles as the main source of transportation, with less than 5% of households not having a vehicle available to them.39

The Union Pacific and Burlington Northern Santa Fe Railroads, which serve as the primary barriers between the Bay and the Montalvin Manor, were not constructed and are not maintained as shoreline or flood protection for the adjacent neighborhoods. Additionally, there is a road underpass that could allow inland areas to flood even when Bay water levels do not exceed the top of the railroad embankment. With four feet of sea level rise—a water level only about six inches higher than what could occur during today's 100-year costal storm—inland areas around Garrity Creek could begin to flood. The extent of potential increased riverine flooding due to sea level rise has not yet been determined. Parts of Tara Hills Drive and adjacent parcels are located within the existing 100-year floodplain, and these areas could be especially vulnerable to small increments of sea level rise in combination with current storm event tide levels. Montara Bay Park and Tara Hills Mobile Manor, a senior mobile home neighborhood, are both located in the floodplain, and a special needs school is located adjacent to the floodplain. San Pablo Avenue, a major thoroughfare for the community, is located in the 100-year floodplain at the intersection with Tara Hills Drive.

Montalvin Manor is primarily a residential community with approximately 846 occupied housing units. The majority of these occupied units are single-family detached homes (73%). Most of the remaining residences are mobile homes (23%). Approximately 72% of the housing units are owner-occupied40. Eastern Montalvin Manor, between Heather Drive and Tara Hills Drive, is comprised of very low-income population (earning less than 50% of County median income) and a high population of seniors, who typically have a fixed income after retiring which could limit their ability to recover if their home was flooded. West of Heather Drive, 15% or more of households are housing cost-burdened (spending 50% or more of income on housing)41. US

[39] US 2010-2014 Census American Community Survey 5-Year Estimates Table B08201: Household size by vehicles available (factfinder.census.gov/)
[40] US 2010-2014 Census American Community Survey 5-Year Estimates Table B25032: Tenure by units in structure (factfinder.census.gov/)
[41] Safer Housing, Stronger Communities (http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/)

census data suggests that approximately 59% of Montalvin Manor self-identifies as Hispanic or Latino42,with 11.5% of Spanish-speaking households considered linguistically isolated, defined as households without a member 15 years or older that speaks English well43.
Community services in Montalvin Manor are limited. There is one public school, Montalvin Manor Elementary School, and there are no medical facilities in the community. EBMUD provides potable water to the community, and wastewater is treated at the West County Wastewater District.
Community facilities that could potentially serve as gathering locations or places for emergency information centers include the public school and churches including Providence Missionary Baptist. The Contra Costa County Cities Citizen Corps is responsible for the local Community Emergency Response Team (CERT) program.

PINOLE

The City of Pinole is located south and west of Hercules, with an existing land use pattern of mixed residential neighborhoods, commercial and businesses, parks and open spaces. The portion of the city in the ART project area extends from the Bay shoreline to San Pablo Avenue, and includes lower Pinole Creek and the City's historic downtown. The Pinole-Hercules Water Pollution Control Plant is located at the mouth of Pinole Creek and its sole access, Tennent Avenue, could flood during a current large storm event. Routes of regional significance include I-80, San Pablo Avenue, and Appian Way. WestCAT local bus routes provide transit services to the city, including bus service to BART stations in Richmond and El Cerrito.

The city receives its water from the EBMUD Sobrante treatment plant and sends its wastewater to the Pinole-Hercules Water Pollution Control Plant, which is owned by the Cities of Pinole and Hercules and managed by the City of Pinole. Solid waste is collected by Richmond Sanitary Services, which transports waste to the Golden Bear Transfer Station for ultimate disposal in the Keller Canyon Landfill pursuant to a contract with the West Contra Costa Integrated Waste Management Authority. Recyclables are transported to West County Resource Recovery's Integrated Resource Recovery Facility in North Richmond.

The Union Pacific Railroad sits along the shoreline and serves as a barrier between the Bay and the city. The rail line was not constructed and is not maintained as shoreline or flood protection. The rail line crosses over Pinole Creek, which has limited capacity to handle higher water levels. Sea level rise will further reduce the capacity of Pinole Creek to safely convey riverine flows during coastal storm events, and overbank flooding could impact creek-side neighborhoods, especially those located on North Tennent Avenue, Railroad Avenue, Calais Drive and Orleans Drive. Pinole Creek was designed to carry flows from today's 50-year storm event; in a larger storm, or a combination of higher Bay water levels and extreme rainfall, areas adjacent to the creek may be flooded either due to overtopping of the creek banks or back ups of the stormwater drainage system (see the Pinole Creek profile sheet). Pinole has worked with the Contra Costa County Flood Control District to explore approaches to enhance the level of flood protection, including increasing channel capacity in the lower reaches and reducing flows by diverting stormwater to a detention

[42] US 2010-2014 Census American Community Survey 5-Year Estimates Table B03003: Hispanic or Latino origin (factfinder.census.gov/)
[43] US 2010-2014 Census American Community Survey 5-Year Estimates Table S1602: Limited English speaking households (factfinder.census.gov/)

basin in the upper portion of the watershed. For either strategy to succeed channel maintenance is essential, but unfortunately the Flood Control District does not have a dedicated source of funding to maintain Pinole Creek (see Pinole Creek profile sheet). The combination of coastal and riverine flooding may impact the wastewater treatment plant, the neighborhood known as Old Town, and residences near the intersection of Orleans and Calais Drive.

There are approximately 7,176 housing units within the city, the majority of which (71%) are single-family detached homes44. The average household size is 2.7 persons in owner-occupied units and 2.9 in renter-occupied, and approximately 74% of the households are owner-occupied. While there is a low vacancy rate (7%), 41% of residents spend greater than 30% of their income on housing, and are therefore considered housing cost-burdened45.

The racial composition within the city is approximately 50% White, 11% Black or African American and 23% Asian46. Only a few areas in the city, for example eastern Gateley and northwestern Pinole Valley neighborhoods, have greater than 30% of households that are very low income (earning less than 50% of County median income). Northwestern Pinole Valley and southeastern Downtown Pinole have greater than 10% of the population over 75 years old47. Many residents commute to work outside of the city48, and the two major fields of employment are educational services, health care and social assistance (25%), and professional, scientific, management, administrative and waste management services (12%)49.

Community services within the city include a police station, two fire stations, an emergency operations center, and six public schools. There are no hospitals or medical facilities in the city and the nearest emergency department is located in Martinez and urgent care center is located in San Pablo. Community facilities that could potentially serve as gathering locations or places for emergency information centers include the public schools, large churches (like Pinole United Methodist Church), Pinole Senior Center and Pinole Youth Center. The Pinole Fire Department is responsible for the city's Community Emergency Response Team (CERT).

HERCULES

The City of Hercules, located between Pinole and Rodeo, began in 1900 as a company town and is now primarily a residential community with a large commuting population. The second largest land use type in the city is open space, with local natural resources including the San Pablo Bay shoreline, Pinole Creek, Refugio Creek and Refugio Valley Park. The portion of the city in the ART project area extends from the Bay shoreline to San Pablo Avenue west of Highway 4, and along the I-80 corridor to the east.

[44] US 2010-2014 Census American Community Survey 5-Year Estimates Table B25024: Units in structure (factfinder.census.gov/)
[45] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP04: Selected housing characteristics (factfinder.census.gov/)
[46] US 2010-2014 Census American Community Survey 5-Year Estimates Table B02001: Race (factfinder.census.gov/)
[47] Safer Housing, Stronger Communities (http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/)
[48] City of Pinole General Plan
[49] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP03: Selected economic characteristics (factfinder.census.gov/)

Residents are highly dependent on private vehicles—less than 4% of households have no access to a vehicle[50]—and the city is connected to the rest of the region via San Pablo Avenue, I-80 and Highway 4. The Hercules Transit Center (HTC) is a major commuter and transfer nexus served by nine local WestCAT routes, providing connections to BART and the rest of the county, as well as the transbay commuter Lynx Express. The HTC has a park and ride lot, bike e-lockers, and a Casual Carpool designated pick up for commuters heading to San Francisco.

The city receives its water from EBMUD and sends its wastewater to the Pinole-Hercules Water Pollution Control Plant (WPCP), which is owned by the Cities of Pinole and Hercules and managed by the City of Pinole. Solid waste is collected by Richmond Sanitary Services, which is contracted to transport waste to the Portero Hills Landfill in Suisun City.

The southwestern portion of the city's shoreline is protected by the Union Pacific Railroad, which was not constructed nor is maintained as shoreline or flood protection. In addition, residential neighborhoods located near Pinole and Refugio Creeks are at risk of flooding as sea level rises. Pinole Creek was designed to carry flows from today's 50-year storm event; if there is a larger storm, or a combination of higher Bay water levels and extreme rainfall, areas adjacent may be flooded either due to overtopping of creek banks or back ups of the stormwater drainage system (see the Pinole Creek profile sheet). Specific areas vulnerable to flooding from Pinole Creek in the City of Hercules include parts of Fawcett Road, Cardoza Road, O'Neil Circle and Variz Road. With four feet of sea level rise—approximately six inches higher than today's 100-year coastal storm event—portions of Hercules by the Bay (near Pinole Creek) are vulnerable to flooding. The Pinole-Hercules Water Pollution Control Plant, which is located in Pinole but serves Hercules as well, is also vulnerable to flooding from the shoreline and Pinole Creek (see Pinole-Hercules Wastewater Treatment Plant profile sheet). While existing development adjacent to Refugio Creek is protected from a current 100-year storm, as sea levels rise, low-lying areas around Sanderling Drive and the shoreline could be flooded during a storm event (see the Refugio Creek profile sheet) either due to overtopping of the creek channel or back ups in the stormwater drainage system.

Figure 13 City of Hercules Planning

The City of Hercules had approximately 8,510 housing units in 2014, the majority of which are single-family detached homes (66%), and a smaller number that are single-family attached homes (16%)[51]. The average household size is 3.01 people in owner-occupied units and 2.96 in renter-occupied, with the majority of households (98%) with 1.0 or less occupants per room. About 78% of households are owner-occupied, and there is a low vacancy

[50] US 2010-2014 Census American Community Survey 5-Year Estimates Table B08201: Household size by vehicles available (factfinder.census.gov/)
[51] US 2010-2014 Census American Community Survey 5-Year Estimates Table B25024: Units in structure (factfinder.census.gov/)

rate (4%)[52]. Forty-six percent of residents, both renters and owners, spend greater than 30% of income on housing[53].

The racial composition of Hercules is approximately 44% Asian, 27% White and 18% Black or African American[54]. The city is comprised of mainly middle class residents, but Foxboro and the southeast corner of The Trees neighborhood have block groups with greater than 30% of households that are very low income (earning less than 50% of County median income). Only a couple of areas, southeast of The Trees and southeast of The Birds, have 20% or more of the households without a member 15 years or older that speaks English well (e.g., non-English speaking or linguistically isolated)[55].
Residents are diversely employed, with 27% in the fields of educational service, health care and social assistance, 10% working in retail trades, and 9% in transportation, warehousing or utilities. Approximately 85% of workers rely on a private vehicle to commute to work.[56]

Community services in the city include a police station, the Rodeo-Hercules Fire District, and five public schools. There are no hospitals or emergency medical facilities in the city, the nearest emergency department is located in Martinez and urgent care center is located in San Pablo.

Community facilities that could potentially serve as gathering locations or places for emergency information centers include the public schools, large churches such as the Valley Bible Church, Ohone Community Center, Hercules Senior Center/Parks & Recreation, and Hercules Community Swim Center. The Rodeo-Hercules Fire District organizes the Community Emergency Response Team (CERT).

RODEO

Rodeo is an unincorporated community with Contra Costa County located north of Hercules and south of Crockett that is primarily a residential community, but also home to the Phillips 66 Rodeo Refinery. The entire shoreline of Rodeo inland to I-80 is in the ART project area, including the floodplain of Rodeo Creek, which is heavily channelized and has a fairly broad floodplain. East Bay Municipal Utility District serves Rodeo's water needs, and the Rodeo Sanitary District provides wastewater treatment. Routes of regional significance that serve Rodeo include San Pablo Avenue and I-80.

The Union Pacific Railroad sits along the shoreline and serves as a barrier between the Bay and the developed portion of Rodeo. The rail line was not constructed and is not maintained as shoreline or flood protection. The rail line crosses over Rodeo Creek, which is currently capacity limited. Sea level rise will further reduce the capacity of the creek to safely convey riverine flow. Much of the land along Rodeo Creek and the shoreline is within the existing 100-year floodplain. Sea level rise will increase flood risk in this area

[52] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP04: Selected housing characteristics (factfinder.census.gov/)
[53] US 2010-2014 Census American Community Survey 5-Year Estimates Table B25106: Tenure by housing costs as a percentage of household income in the past 12 months (factfinder.census.gov/)
[54] US 2010-2014 Census American Community Survey 5-Year Estimates Table B02001: Race (factfinder.census.gov/)
[55] Stronger Housing, Safer Communities (http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/)
[56] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP03: Selected economic characteristics (factfinder.census.gov/)

and will also impact the area near Tosco Driveway and the western portion of the Phillips 66 Rodeo Refinery site.

There are approximately 3,236 housing units in Rodeo. Existing housing is mostly detached, single-family homes (75%), with a substantial amount of apartments (22%), attached single-family homes (2%), and a mobile home park (1%) that is within the floodplain of Rodeo Creek. Average household size in Rodeo is 2.8 people in rental units and 3.4 in owner-occupied units. Approximately 37% of the households are renter-occupied and 63% are owner-occupied. There is a low vacancy rate (6%), and 40% of residents, both renters and owners, are housing cost burdened[57]. Additionally, the majority of northwest Rodeo has greater than 30% of households that are very low income (earning less than 50% of area median income), housing cost burdened (spending 50% or more of their income on housing), and transportation cost burdened (spending 5% or more on transportation costs)[58].

In 2014 the total population was estimated at 9,648, with 56% of the community identified as White and 22% of the community identified as Hispanic or Latino[59]. Additionally, approximately 10% of households had non-English speakers as heads of their households and approximately 14% of the population had disability status[60]. Rodeo has a number of senior residents (15% of the population 65 years and over) as well as a sizeable youth population (18% of the population 14 years and under)[61]. Approximately 17% of residents do not have a high school degree, and 23% of the population have a Bachelor's degree or higher. Median household income is $68,701 (in 2014 inflation-adjusted dollars) based on the five-year estimate from 2010 to 2014 (US Census American Community Survey), and residents are diversely employed with the largest field of employment being sales and office and management[62].

Community services include the Rodeo-Hercules Fire District and one public school. The California Highway Patrol and Contra Costa County Sheriff's Office provide emergency services for this area, as well as other unincorporated County communities. Other than dental offices, there are no medical services located within the community, although there are some non-emergency medical services in nearby Hercules.

Community facilities that could potentially serve as gathering locations or places for emergency information centers include the public school, Lefty Gomez Community Center, Rodeo Senior Center, St. Patrick's Catholic Church and the local YMCA. The Rodeo-Hercules Fire District organizes the Community Emergency Response Team (CERT).

MARTINEZ

The City of Martinez is located east of Crocket and west of unincorporated county lands and the Lower Walnut Creek Watershed. Martinez has a mixture of land uses including residential neighborhoods, commercial businesses, industrial and public facilities, parks and open spaces. The entire shoreline of the

[57] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP04: Selected housing characteristics (factfinder.census.gov/)
58 Stronger Housing, Safer Communities (http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/)
[59] US 2010-2014 Census American Community Survey 5-Year Estimates Table B02001: Race (factfinder.census.gov/)
[60] US 2010-2014 Census American Community Survey 5-Year Estimates Table S1810: Disability characteristics (factfinder.census.gov/)
[61] US 2010-2014 Census American Community Survey 5-Year Estimates Table S0101: Age and sex (factfinder.census.gov/)
[62] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP03: Selected economic characteristics (factfinder.census.gov/)

city inland to Highway 4 is in the ART project area, including the 100-year floodplain of Alhambra Creek. In addition to Alhambra creek, the city's historic downtown and regionally significant assets—the County Court House and Martinez Detention Facility, Sheriff's Record Unit and Forensic Sciences Division—and the County's only public health facility, the Contra Costa County Regional Medical Center, are located within the project area. The city receives water from the Contra Costa Water District and sends its wastewater to Central Contra Costa Sanitary District. Solid waste is collected by Republic Services and sent to the Keller Canyon Landfill in Pittsburgh. Routes of regional significance include I-680 and Highway 4, an Amtrak rail station and two rail lines, Union Pacific and Burlington Northern Santa Fe that run through the city.

Martinez is at risk from current and future flooding along the Bay shoreline and Alhambra Creek (see the Alhambra Creek profile sheet). Only a small portion of lower Alhambra Creek is protected against the current 100-year storm. The reach of Alhambra Creek from Marina Vista Avenue to Highway 4 does not provide this same level of protection. Flooding of historic downtown Martinez and along Alhambra Avenue, which occurs now during storm events and extreme high tides, will be exacerbated by sea level rise. This will impact residential and commercial land uses in the Marina, Mococo, Alhambra Valley and Downtown Martinez neighborhoods, as well as the county medical center. This risk is likely to increase as sea level rises, with adjacent areas flooding if the creek channel overtops or if the stormwater drainage system backs up. In this event, the current strategy of sandbagging in advance of storm events may not be adequate. In addition, the Martinez waterfront, which the city is looking towards as an opportunity area for future growth, is currently within the 500-year floodplain and at risk of flooding during coastal storms that could overwhelm the existing shoreline tidal marshes and park areas.

There are approximately 14,839 housing units in Martinez. Existing housing is mostly detached, single-family homes (65%); other housing types include attached single-family homes (15%) and apartments (20%). The average household size is 2.5 people, and two-thirds of the households are owner-occupied. There is a low vacancy rate (4%) in the city, and over half of renters spend more than 30% of income on housing (cost burdened). About 39% of homeowners with a mortgage are also cost burdened, spending more than 30% of their income on housing[63].

The majority of northern Martinez has greater than 30% of households that are very low income (earning less than 50% of area median income). In addition to low-income households, the Marina neighborhood has a high percentage of renters and greater than 10% of the households that do not have a vehicle[64]. Community characteristics of Downtown Martinez are similar to the Marina neighborhood, however the demographics are likely affected by the presence of the Martinez Detention Facility.

Many Martinez residents are employed in educational services, and health care and social assistance (24%). Other large employment fields include retail trade (11%), professional, scientific, management, administrative and waste management (13%), and finance and insurance, and real estate and rental and leasing (10%).[65]

[63] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP04: Selected housing characteristics (factfinder.census.gov/)
[64] Stronger Housing, Safer Communities (http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/)
[65] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP03: Selected economic characteristics (factfinder.census.gov/)

Community services in the city include a police station, a fire station, and seven public schools. There are several medical facilities in the city, including the Contra Costa Regional Medical Center. Community facilities that could potentially serve as gathering locations or places for emergency information centers include the public schools and large churches. The city is home to many churches, and all of the public schools are located south of Marina Vista Avenue. However, at least three public schools are located within the 100-year floodplain and may not be appropriate emergency centers if a flood occurs. The City of Martinez in conjunction with the County Office of Emergency Services offers Community Emergency Response Team (CERT) programs.

BAY POINT

Bay Point is a census-designated place (CDP) located west of Pittsburg and north of Highway 4. Land uses are primarily residential, with some commercial and industrial uses, parks and open spaces. The entire shoreline of Bay Point is in the ART project area. The Union Pacific Railroad is located between the shoreline and the developed portions of Bay Point. The rail line parallels the Port Chicago Highway for a distance, and has significant tidal marshes on its Bayward side.

Bay Point is at risk from sea level rise and future storm events as the Union Pacific Railroad, which serves as the primary structural barrier between developed areas of Bay Point and the shoreline, was not constructed and is not maintained as flood protection. In addition, tidal marshes, which currently provide some level of flood risk reduction, may not be able to keep up with sea level rise. A small area of mostly residential land uses and some adjacent businesses is within the current 100-year floodplain (near Anchor Drive and Bayview Avenue). Additionally, a few neighborhoods have only single access roads, such as Bounty Way.

There are approximately 6,904 housing units in Bay Point. Existing housing is mostly detached, single-family homes (63%). Other housing types include 2-4 unit buildings (7%), 5+ unit buildings (13%), attached single-family homes (7%), and mobile homes/other (11%). Average household size is 3.3 people, and housing units are half renter-occupied, half owner-occupied. There is a low vacancy rate (7%), and over half of residents, both renters and owners, spend more than 30% of household income on housing (cost burdened)[66]. The majority of Bay Point has concentrations of 30% and higher of very low-income households (earning less than 50% of area median income). In addition, north Bay Point is also transportation cost burdened (spending 5% or more on transportation costs), and several block groups in Bay Point have low high school graduation rate compared to the regional block group average and high transit dependence, even though access to public transit is low[67].

The census estimates 21,586 as the 2014 total population in Bay Point, with 50% of the community identified as White and 56% of the community identified as Hispanic or Latino (of any race)[68]. Additionally, 15.2% of households had non-English speakers as heads of their households and approximately 11% of the community has disability status[69]. There is a fairly large youth population (25% 14 years and under) and a relatively low senior population (7% over 65 years)[70]. Approximately 30% of residents do not have a high

[66] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP04: Selected housing characteristics (factfinder.census.gov/)
[67] Contra Costa Health Services' Climate Change Vulnerability in Contra Costa County: A Focus on Heat 2015
[68] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP05: Selected demographic characteristics (factfinder.census.gov/)
[69] US 2010-2014 Census American Community Survey 5-Year Estimates Table S1810: Disability characteristics (factfinder.census.gov/)
[70] US 2010-2014 Census American Community Survey 5-Year Estimates Table S0101: Age and sex (factfinder.census.gov/)

school degree, and 15% of the population have a Bachelor's degree or higher. The median income for households was $41,749 (in 2014 inflation-adjusted dollars) in the five-year estimate from 2010 to 2014 (US Census American Community Survey). Residents are diversely employed, the largest fields of employment are professional, scientific, and management, and administrative and waste management services (17%), educational services, and health care and social assistance (16%), and retail trade (13%)[71]. In the project area, 282 people are in the current 100-year flood zone.

Community services in Bay Point include a fire station and six public schools. The California Highway Patrol and Contra Costa County Sheriff's Office provide emergency services for this area in addition to other unincorporated County communities. Bay Point Family Health Center and Willow Pass Medical Group provide medical services to the community. Golden State Water, which buys water from Contra Costa Water District, serves Bay Point's water needs and the Delta Diablo Sanitation District treats wastewater.

Community facilities that could potentially serve as gathering locations or places for emergency information centers include the public schools, large churches and Ambrose Community Center. Bay Point is part of the East County Community Emergency Response Team (CERT).

VULNERABILITIES

INFO1: Decision-makers and emergency responders have limited information about the specific characteristics and/or needs of individuals and households.
INFO2: Social networks strength and community capacity can be limited if community members have limited information about the specific characteristics and/or needs of individuals and households in their community, and/or surrounding neighborhoods.
GOV1: Renters and mobile home owners have a limited ability to make improvements to their homes or the properties where they reside to reduce flood risk.
GOV2: Individuals and households are unlikely to own or have control over the shoreline that serves as their flood protection. Communities rely on tidal marshes for flood protection, and the marshes may not keep up with sea level rise. Communities additionally rely on railroad embankments for protection from flooding. Embankments were not constructed for this purpose, and their level of protection was calculated based solely on their elevation, when in reality these embankments have culverts through which water may pass through.
GOV3: Creekside communities do not have control over the maintenance and management of creeks, which face significant budget limitations. For creeks currently at capacity during storm events, sea level rise will further reduce their ability to effectively convey riverine flows and prevent flooding.
GOV4: Some communities depend on neighboring cities or the county for emergency services, and/or may not have community or public buildings or spaces that can provide a place for gathering and information, or shelter.
GOV5: Non-profit, faith, and community-based organizations play a critical role in building and maintaining community resilience. Many of these organizations do not have the resources to fully participate in climate planning efforts, and government agencies lack the capacity to engage them in the robust and sustained

[71] US 2010-2014 Census American Community Survey 5-Year Estimates Table DP03: Selected economic characteristics (factfinder.census.gov/)

partnerships that will be necessary to address climate change in an equitable, environmentally conscientious, and economically feasible manner.

FUNC1: In most communities, over half the residents are housing cost burdened, and therefore have limited capacity to endure any other housing-related costs, such as flood proofing, recovery after a flood, or relocation. Very low-income people, which represent significant portions of some communities, face similar limitations. Additionally, many communities have very low housing vacancy rates, which makes temporarily or permanently relocating residents affected by flood events challenging, particularly for those residents that are already housing cost burdened or are low income. Displaced residents may not have access to equivalent or affordable replacement housing near the jobs, schools, services, and facilities they rely on.

FUNC2: Many renters do not have flood insurance, which could provide assistance with replacing damaged personal belongings. Additionally, rental units lost during a flood event may not be rebuilt, or may return at market rate.

FUNC3: Communities are highly dependent on private vehicles, and there are limited public transportation options. Some communities have very limited or only single access roads. Many residents commute to work outside their municipality, and disruptions to the limited roadways impedes their ability to get to work, as well as access services.

FUNC4: People rely on infrastructure and services provided by public and private agencies to function, such as roads, transit, shoreline recreation and trails, electricity, food, water, wastewater, waste management, and telecommunications. If these services are damaged or disrupted, it may not be safe or healthy for residents to stay in their homes until repairs or upgrades are completed. The health of a community may decline if important services are disrupted in the days and weeks after the event.

FUNC5: Flooding of wastewater treatment plants, waste transfer stations, and landfills may pose health risks to the surrounding community.

FUNC6: Non-English speakers, people with disabilities, such as vision and hearing impairment, and socially isolated individuals and households may face communication difficulties in responding to and preparing for flooding.

FUNC7: Neighborhoods are informal networks whose function depends on the relationships among the individuals and services within them. These informal connections are easily severed during disasters and are often difficult to rebuild once disrupted. Residents who are socially disconnected from their community are more vulnerable to hazards, as they have less access to information and fewer people to rely on in an emergency.

FUNC8: Elderly, very young, and disabled or mobility-challenged people are less able to prepare for, respond to or recover from flood events. People exhibiting these characteristics face difficulties during an evacuation, as they depend on others for mobility, care and consideration, and in finding suitable shelter-in-place facilities, as they require special care or equipment.

FUNC9: People work, play, shop, and live in their communities. If people must relocate, the local businesses, schools and other neighborhood services that rely on employees and customers for their livelihood can be impacted.

PHYS: Community facilities—potential gathering locations or places for emergency information centers—that are not designed to withstand flooding, are not constructed from waterproof or non-corrodible materials, or were built to have only the first floor above the current 100-year flood elevation are vulnerable. Facilities with mechanical or electrical equipment (heating, cooling, appliances, electrical panels, etc) or parking areas below-grade are vulnerable to both flooding and elevated groundwater. Older facilities with deferred maintenance such as older roofs, a lack of weatherization, or without flood mitigation to protect below-grade spaces (e.g. functioning sump pumps) will not be as able to withstand a major storm or flood event.

CONSEQUENCES

Society and Equity: Flooding can result in significant impacts, injuries and the loss of life, damage or loss of personal items and financial information; dislocation from homes, jobs and schools; and disconnection from community services and ties. Individuals and households that are currently underserved or disadvantaged may be disproportionally burdened by these impacts both during and after a flood event. Displaced residents may not have access to equivalent or affordable replacement housing near the jobs, schools, services, and facilities they rely on. Even temporary relocation of residents can sever long-standing neighborhood relationships, disrupting the social network that imparts collective strength and resilience.
Environment: Floodwaters that pass through neighborhoods can pick up and carry household debris and hazardous household products that can impair water quality, expose residents to hazardous materials and impair habitats critical to biodiversity.
Economy: Impacted community members may bear the cost of replacing or repairing belongings and homes, the cost of temporary housing or permanent relocation, increased insurance costs, if insured, and dislocation from jobs, schools and other services. The broader community of taxpayers and ratepayers may also bear some of the expense of rebuilding even if they do not themselves live in affected areas. Long-term evacuations could result in the permanent relocation of residents, employees, or entire business sectors outside of a community, with associated economic consequences for the neighborhoods, residents and employers that remain. The closure of schools and facilities serving vulnerable populations could result in parents and caretakers taking time off work, resulting in lost wages.

RESOURCES

Association of Bay Area Governments (ABAG). Resilience Program. 2015. Stronger Housing, Safer Communities: Strategies for Seismic and Flood Risk.
http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/#community
Contra Costa Health Services. 2015. Climate Change Vulnerability in Contra Costa County: A Focus on Heat.
http://cchealth.org/health-data/pdf/2015-climate-change.pdf
San Francisco Bay Conservation and Development Commission (BCDC), Adapting to Rising Tides Program. 2015. Stronger Housing, Safer Communities. http://www.adaptingtorisingtides.org/project/stronger-housing-safer-communities-strategies-for-seismic-and-flood-risks/
US Census Bureau. 2010 Decennial Census. factfinder.census.gov/

Public Services

Public services including healthcare, emergency response and law enforcement, schools that provide K-12 education, and waste collection facilities are critical to public health and welfare. Public services are also important in building and maintaining community resilience, and are key during and after any kind of natural disaster, including flooding due to extreme tides or storm events.

Hospitals and clinics, police and fire stations, schools, waste transfer stations and hazardous household waste sites are all important before, during and after storm events that cause flooding along the shoreline and inland, assisting residents in responding safely to hazardous events. It is important to understand and address the challenges these facilities may face from current and future flooding so that communities are able to prepare, respond and recover. Flooding could prevent hospitals and health clinics from providing care for patients, and police and fire stations from responding to emergencies. These impacts on public facilities present significant emergency response challenges because the populations they serve are

themselves vulnerable, including medically dependent individuals and young children. During periods of recovery, if public services are damaged, the services provided by these facilities may be unavailable to community members that need them most while buildings, equipment and supplies are restored.

Public Healthcare Facilities

Public healthcare facilities help communities address a range of issues that are often influenced by physical, social and economic factors. These include chronic diseases (such as cancer, obesity and diabetes), homelessness, communicable diseases, aging and maternal and child health. In Contra Costa County, Contra Costa Health Services (CCHS), three healthcare districts, and a variety of private facilities provide health services to those who live, work and recreate in the county. There are seven acute-care hospitals; only one is a public hospital (Contra Costa Regional Medical Center in Martinez) and only one operates a trauma center (John Muir Medical Center in Walnut Creek).

The three healthcare districts are public entities that provide community-based health care services to residents in the county both within and beyond the ART project area. The Los Medanos Community Healthcare District serves the Pittsburg and Bay Point areas, the Mt. Diablo Health Care District serves the cities of Martinez, Lafayette (portions), Concord, and Pleasant Hill (portions) along with the unincorporated communities of Clyde and Pacheco, and the West Contra Costa Healthcare District serves the western portion of Contra Costa County, including Hercules, El Sobrante, Richmond, Richmond Heights, Kensington, Pinole, Rodeo, El Cerrito, Crockett, and San Pablo. The West Contra Costa County Healthcare District operated Doctors Medical Center, a public hospital in San Pablo, until April 2015 when it closed due to lack of funds. The closure has reduced inpatient capacity in West Contra Costa by 79%, as the Kaiser Permanente Medical Center in Richmond is now the sole provider of hospital services.

Contra Costa Health Services (CCHS) is a comprehensive county health system focused on healthcare services, community health improvement, and environmental protection. CCHS is responsible for assessing community health and evaluating health concerns within the county. Additionally, CCHS owns and operates the Contra Costa Regional Medical Center, 10 health centers, offers school-based health clinics, and operates mobile clinics for the homeless in the County, with about 10,000 patient visits per year.

Contra Costa County residents primarily stay within the county for healthcare services, and tend to visit hospitals that are near them rather than in other parts of the county. Given the limited availability of healthcare options in West Contra Costa, those residents are now more likely to travel to other counties to obtain service.

KEY ISSUE

Healthcare facilities need to ensure continuity and quality of care for community members, and rely on outside infrastructure, staff, and services to function. Individuals with ongoing medical needs are more likely to be vulnerable in a disaster event, and may require specialized care, equipment or supplies. Both healthcare facilities in the 100-year floodplain have patients staying onsite that would need to shelter in place or be evacuated in an emergency. A major concern in Contra Costa County, particularly in areas with limited public health care facilities options, is that community members may be unable to access health care if their neighborhoods are cut off from the rest of the county.

EXPOSURE TO CURRENT AND FUTURE FLOODING

There are 13 healthcare facilities in the project area[72], two that are within the current 100-year floodplain and none that are directly exposed to sea level rise. The facilities in the floodplain are located in Martinez and include the Contra Costa Regional Medical Center (which includes the Martinez Family Practice Center and Martinez Specialty Center) and the Martinez Convalescent Hospital. Although these facilities are not shown to be at risk from future flooding due to sea level rise, watershed-specific hydraulic modeling of Alhambra Creek is needed to understand if higher Bay water levels will exacerbate existing flooding or cause areas beyond the existing 100-year floodplain to flood.

While other healthcare facilities evaluated are not directly at risk of current or future flooding, flooding of local roads or neighborhoods, loss of power, or disruption of water or wastewater services could prevent health centers and public health clinics from providing services. In addition, flooding of streets and roads could disrupt the ability of the mobile clinics to provide services, especially if they cannot get to locations where patients are able to access them.

ASSET DESCRIPTION

The Contra Costa Regional Medical Center (CCRMC) is a campus that includes the Martinez Family Practice Center, George and Cynthia Miller Wellness Center, and the Martinez Health Center/Martinez Specialty Center. CCRMC provides key medical services to the public, including the only public acute-care hospital and Emergency Department in the County.

While CCRMC is located on a hill, portions are at risk from riverine flooding – primarily those facilities located on the Alhambra Avenue side of the campus, including the Medical Library, Healthy Start, Medical Social Services, Financial Counseling, and several parking lots. The main hospital itself is located out of the floodplain, but access roads to the campus and local roads are all at risk from current flooding. As a result, the campus will likely be inaccessible in a flood event, which would disrupt medical services for the community, including access for emergency services.

The Martinez Convalescent Hospital is a private, licensed 36-bed skilled nursing facility located on Alhambra Way in Martinez, just north of Highway 4, in an area of residential and commercial land uses.

VULNERABILITIES

GOV: Healthcare facilities with emergency preparedness and response plans that do not consider current and future flooding are more vulnerable to coastal and riverine storm event.
FUNC1: Healthcare facilities may serve community members with limited mobility, or who have medical needs which require special equipment. Emergency evacuation of these facilities is challenging and will

[72] Location information for healthcare facilities provided by Contra Costa Health Services, included hospitals, clinics, skilled nursing facilities, pharmacies, durable medical providers, and other facilities

require sufficiently trained staff, a high level of coordination, specialized equipment, and an appropriate location to shelter those who were housed in these facilities.
FUNC2: Healthcare facility programs that serve individuals with limited economic resources, education, or English proficiency, may not be easily replaced if the facility is damaged or is inoperable or inaccessible during a flood.
FUNC3: Healthcare facilities rely on outside infrastructure and services to function, such as roads, electricity, clean water, telecommunications, and deliveries of specialized supplies that may be vulnerable to flooding impacts.
FUNC4: Some healthcare facilities provide highly specialized medical care (e.g., dialysis centers) that patients need to access on a regular basis. These facilities serve a critical function that cannot easily be replaced, and generally do not have temporary or mobile back-up facilities available.
FUNC5: Providers of durable medical equipment serve community members that have specific medical needs, and can serve individuals that are homebound and rely on a consistent delivery of medical supplies, e.g. oxygen tanks. These service providers can only operate if roadways are functioning and patients' homes are accessible.
PHYS: Most buildings, including healthcare facilities, are vulnerable because they are not designed to withstand flooding and may have sensitive equipment at- or below-grade.

CONSEQUENCES

Society and Equity: Healthcare facilities serve community members who rely on these services for care and quality of life. Disruption of facilities can result in significant hardships for these community members and their families, who may not have access to alternative care that is equivalent, affordable, and in an easily accessible location. Damage to neighborhoods where staff and clients live may also result in access issues and disconnection from healthcare services, and senior and healthcare facilities may not be able to function.

Environment: Healthcare facilities often store materials such as medical waste, pharmaceuticals, cleaners, and toxics that can impair water quality if released into the Bay or near-shore habitats.

Economy: Damage to healthcare facilities can result in financial burdens for building owners and operators, as well as staff that may end up out of work. Specialized medical equipment and the facilities that house them can be extremely costly and difficult to replace if damaged. Additionally, disruption or loss of healthcare services can result in community members needing alternative care arrangements or additional time off of work. This can lead to lost wages, and may require family members or other caregivers also taking time off of work.

Emergency Response Facilities

Emergency response facilities are critical in assisting others in the event of a disaster. These facilities may have service disruptions if exposed to flooding and the services they provide can be compromised if the facilities are damaged, or if access to and from the facilities are disrupted. Emergency response facilities can have an increased capacity to maintain function, for example, fire stations that are equipped to assist communities with flooding and have access to portable pumps and power, and police and fire fighters are trained emergency responders. In addition, emergency response services are often provided through mutual aid agreements with other cities, districts and counties in the event of insufficient resources are available to address the emergency at hand.

KEY ISSUE STATEMENT

Fire stations and law enforcement facilities in the ART project area are vulnerable to flooding because their buildings have at-grade openings and were not built to withstand flooding. In addition, emergency response services rely on roads that could be flooded and power supplies that could be disrupted. Ensuring that emergency and disaster response services are not interrupted will require actions to improve the individual facilities and coordination with city, county and state transportation agencies to ensure road access and utility services are maintained.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Two of the 12 fire stations and two of the 16 law enforcement facilities in the project area are within the exiting 100-year floodplain. Two law enforcement facilities, one in Rodeo and one in Martinez, are at risk of flooding with five and six feet of sea level rise, respectively.

Table 24. Assets that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Asset	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Contra Costa County Fire Protection District (#14)	Martinez	Yes						
Crockett-Carquinez Fire Protection District (#77)	Port Costa	Yes						
Contra Costa County Office of the Sheriff - Records Unit	Martinez	No						Yes
Contra Costa County Office of the Sheriff - Rodeo Sub-Station	Rodeo	Yes					Yes	Yes
Martinez Police Department	Martinez	Yes						

ASSET DESCRIPTION

There are 16 law enforcement facilities in the ART project area including the City of Richmond and Martinez police departments, six county sheriff's offices and two sub-stations, two detention facilities, three public safety radio repeater sites, and a California Highway Patrol office. These facilities rely on functional roads, telecommunication infrastructure, uninterrupted power, and therefore the services they provide could be disrupted even if they are not directly impacted by flooding. In addition, two detention facilities will be challenging to evacuate in an emergency, and if the incarcerated population is required to shelter in place then utility services and supplies, including clean water and food, will be needed as well as access to and from the facility so that employees can get to the facility to work.

FIRE STATIONS

There are 12 fire stations in the ART project area, including four Contra Costa County Fire Protection District Stations (13, 14, 18, 86), two Crockett-Carquinez Fire Protection District Stations (77, 79), the Rodeo-Hercules Fire Protection District Station (75), four City of Richmond Fire Stations (61, 62, 64, 67) and the City

of Richmond Fire Administrative Office. In addition, most of the refineries in the county have their own fire stations and emergency response facilities and personnel.

Fire stations provide critical day-to-day public safety services as well as emergency and disaster response functions. In addition, the Contra Costa County Fire Protection District also provides response support during hazardous material spills, leaks and releases.

VULNERABILITIES

GOV1: Planning and resources are inadequate to address contingencies and secondary impacts associated with widespread or long-lasting sea level rise or storm event impacts, especially if emergency response facilities are affected. Widespread flooding that affects multiple jurisdictions may worsen these impacts because cities and counties rely on mutual-aid agreements with neighboring communities for support during disasters.
GOV2: Emergency response agencies rely on emergency plans, which do not take future flood risk into account. Not all agencies and communities are in compliance with existing plans, and the need for coordination among local, regional, and state authorities increases the vulnerability of emergency response services and the people who rely on them.
FUNC: Emergency response facilities cannot maintain operations if connections to power, clean water, and telecommunications infrastructure are not available, or if vehicles cannot easily access them. This is of particular concern for facilities that play a role in emergency response and recovery such as fire stations and police stations.
PHYS1: Most emergency response facilities are susceptible to damage from sea level and groundwater rise because of their construction methods such as at-grade entrances and roll up doorways.
PHYS2: Emergency response facilities that have essential mechanical and electrical equipment below-grade or on the ground floor are vulnerable if flooded because this equipment may be damaged, leading to delayed ability to respond to emergencies and costly repairs.

CONSEQUENCES

Society and Equity: Fire stations and law enforcement facilities respond to disasters and smaller emergencies in the community, benefitting residents and those who work in the area. Martinez and Pinole include communities with vulnerable characteristics and are relatively remote. Connecting residents and visitors with emergency response elsewhere in the county may lead to delays in response time and dangers to public health and safety.

Economy: By protecting the local community, law enforcement and fire stations provide value to the local economy. If emergency response is delayed or impaired due to flooding recovery costs could rise and local communities and the region could suffer long-term economic consequences.

Environment: Emergency response facilities and personnel play a critical role in hazardous materials spills and emergencies, including oil spills and other environmental contamination events. Contra Costa County includes many major industrial sites with the potential for harmful chemical releases to occur if there is a widespread flood event. Emergency responders provide a critical function in helping protect environmental and human health from these events.

K-12 Schools

Schools are not only the place where children obtain education, they are also often a critical resources during an emergency, serving as temporary shelters for displaced residents and as a base of operations for relief efforts. In addition, schools are important to community resilience as they help build and maintain social networks, serving as a place for neighbors to meet each other, get information, and receive support services if necessary.

The ART project area is served by three public school districts and includes 46 public and private K-12 schools. The West Contra Costa Unified School District is the largest school district in the ART project area with 38 elementary schools, six middle schools, 11 high schools, and two adult education schools. John Swett Unified School District serving areas near Rodeo and Crocket has one elementary, one middle school, one high school, and one alternative educational campus. Martinez Unified School District has four elementary schools, two high schools, two alternative and independent study schools, and one adult education school.

KEY ISSUE STATEMENT

Schools are vulnerable to sea level rise and storm event impacts because of their physical construction and function. School buildings are not typically constructed to resist flooding, for example they have at-grade entrances and critical equipment either at or below grade that cannot get wet. In addition, because there are young children, and possibly limited-mobility or special education students on campus, schools are especially difficult to evacuate in the event of an emergency. Even schools that are not directly impacted by flooding may be vulnerable to disruptions in transit, road networks, utilities or other services.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Of the 46 public and private schools in the project area, one school, Washington Elementary School in Richmond, is exposed to four feet or more of sea level rise and is within the current 500-year floodplain. Seven other schools are within the 100-year floodplain, and while not directly exposed to sea level rise, the potential for increased flood risks within the current floodplain may be underestimated, as the effect of elevated Bay water levels on riverine flooding has not been fully investigated.

Table 25. Schools that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Asset	City	Type	Current 100-year Flood	Sea Level Rise					
				1'	2'	3'	4'	5'	6'
Washington Elementary School	Richmond	Public elementary					Yes	Yes	Yes
Lake Elementary School	San Pablo	Public elementary	Yes						
Briones Alternative School	Martinez	Private elementary	Yes						
Center For Creative	Martinez	Private	Yes						

Learning		elementary	
Montecito High School	Martinez	Public high school	Yes
Patchin's Schools	Martinez	Private elementary	Yes
St. Catherine Of Siena Elementary	Martinez	Private elementary	Yes
Vicente Martinez High	Martinez	Public high school	Yes

ASSET DESCRIPTION

Two of the schools identified to be at risk of flooding are in the West Contra Costa Unified School District and two are in the Martinez Unified School District.

Washington Elementary School, the oldest school in West Contra Costa Unified School District, is located in the City of Richmond on Wine Street and West Cutting Boulevard. The school has approximately 440 students and provides regular and special education classes, as well as a Spanish/English Dual Immersion Program and afterschool care. Students come from Point Richmond, North Richmond, and San Pablo, and the school has a diverse population that is majority Hispanic. Over half of the students (67%) participate in a free or reduced price lunch program. A community-based organization, Many Hands, assists with school programs and student needs. The school could be directly impacted by four feet of sea level rise, and as could access to the school because West Cutting Boulevard and adjacent streets are at risk of flooding with four feet of sea level rise. Although there may be alternative routes to get to and from the school they are unlikely to offer the same level of service.

Lake Elementary School is a public K-6 school located in the City of San Pablo at the corner of 11th and Lake Street. The school is housed in an older building and is on a list of schools in the West Contra Costa School District that are priorities to be rebuilt. The school has approximately 430 students, provides regular and special education classes. The school has a large number of English-learners and is diverse with a majority Hispanic population, almost all of which participate in a free or reduced price lunch program. Lake Elementary is within the floodplain of San Pablo Creek and could be impacted by a current 100-year flood event. Access from Giant Road and local streets to the south of the school could be disrupted due to flooding.

Vicente Martinez High School is a public alternative high school in the Martinez Unified School District on F Street and Alhambra Avenue. The school is co-located with the Briones Alternative School and Martinez Adult Education, and is within the 100-year floodplain of Alhambra Creek. There are just over 100 students on the campus, approximately half of whom are White and one-third are Hispanic. About half of the student population participates in a free or reduced price lunch program. Briones Alternative School-Martinez, a public school alternative program that provides K-12 students with independent study materials and supervising teachers. The school has no more than 50 students, approximately half of whom are White. The school also contains the New Leaf Leadership Academy, a project-based, collaborative high school program for 24 students with a focus on the environment and sustainability that receives support from Contra Costa County Behavioral Health Department.

Also in Martinez are two private schools in the 100-year floodplain of Alhambra Creek. St. Catherine of Siena Elementary is a private Catholic school that provides Pre-K through 8th grade education as well as afterschool care for 120 students, the majority of which are bi- or multi-racial. The Creekside Montessori is a private school that provides Pre-K childcare for children from two and a half to six years old.

VULNERABILITIES

GOV1: Schools may be protected from flooding by shoreline features that are owned and managed by others, so that improving the level of flood protection will require coordination of both public and private schools and school districts with other agencies and private entities.
GOV2: Evacuating schools and childcare centers will require careful coordination so that there is adequate supervision of young people and safe locations identified where families can be reunited. Some schools or childcare centers may not have the resources, capacity, or plans in place to manage an evacuation if there is an unexpected flood event.
GOV3: Schools may not have adequate resources or the capacity to improve their buildings, change the access to the school, or plan for the future relocation that may be necessary if the risk of flooding increases as sea level rises.
FUNC1: Many of the schools in the study area are already overcrowded. If one or more school is damaged, or is closed to provide disaster response, finding adequate alternative classrooms for the displaced student would be difficult.
FUNC2: Schools rely on roads, transit, electricity, water, wastewater, and communication services to function. Even short-term disruptions in these services could disrupt school activities and require school cancellations.
FUNC3: Schools need teachers and support staff to function. If staff cannot access the school because of flooding within or outside the area where it is located, school could be disrupted and may not be able to open.
FUNC4: Schools have an important role in emergency response as they both serve children which need special consideration to safely evacuate during disasters, and they may serve as temporary shelters during and post-disaster.
PHYS: Schools that have at- or below-grade facilities, mechanical and electrical equipment that could be damaged in a flood event are vulnerable to sea level rise and storm events.

CONSEQUENCES

Society and Equity: Schools provide a critical community function and contribute to the overall well-being of the community. They also provide shelter during emergencies for students and community members. Damage to school buildings could result in education disruptions for students and financial burdens for school districts that could exacerbate already stressed schools and districts that face budget shortfalls and overcrowding. Schools that serve low-income, transit-dependent, or linguistically isolated students are even more vulnerable because of the populations they serve. Schools rely on communities for staff, access, funding, and, most importantly, students. If the neighborhoods where students and teachers live are damaged, schools will not be able to fully function.

Economy: If schools are damaged or access to them is disrupted there could be local economic impacts on families that have to either stay home with young children rather than going to work or find and pay for day

care. If schools are closed for long enough periods some families may choose to move to other areas so children can attend a neighborhood school, which could impact local businesses and the economy.

Waste Collection

Waste collection services in the project area include two household hazardous waste collection sites and two water transfer stations. These facilities provide necessary day-to-day services to residents and businesses in the project area and beyond, including the regular collection of solid wastes and recycling, and a location to bring hazardous household wastes to make sure they excluded from the municipal waste stream, do not end up in the wastewater system, and are handled appropriately. These services will be critical to ensure that communities and neighborhoods that are impacted by flooding can clean up quickly and begin to recover, and will be needed by others not affected by flooding to make sure wastes continue to be collected, ensuring that public and environmental health is protected.

Household Hazardous Waste Collection Sites

Household hazardous waste (HHW) collection sites serve as a public drop-off point for a variety of household hazardous wastes, including acetone, acids, asbestos, batteries, cleaners, fertilizers, fuel/oils, pharmaceuticals, paint, and poisons. There are two HHW collection sites in the project area, the West County HHW Facility in Richmond and Central County HHW Facility in Martinez.
Hazardous wastes are received at these facilities on an ongoing basis. Both facilities have capacity limitations applicable for each type of hazardous material they receive and only store waste temporarily on site before it is transported to other locations for recycling or disposal, as appropriate. Hazardous waste is typically stored at these facilities in designated areas near similar types of waste, and is often “lab-packed” in 55-gallon drums.

KEY ISSUE STATEMENT

While neither of the household hazardous waste facilities in the project area are directly exposed to sea level rise, their function could be impacted if local roads are flooded. Diminished or lost access would disrupt community disposal of household hazardous waste, which after a flood would also have consequences on the efficiency and safety of the post-flood clean up process. If there was unexpected flooding of the HHW facilities there could be significant consequences for public health and nearby ecosystems if wastes were released into the environment.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Neither facility is projected to be directly at risk from sea level rise, nor within the 100-year floodplain, although the West County HHW Facility is within the current 500-year floodplain.

ASSET DESCRIPTIONS

The West County HHW Facility is located with the West County Resource Recovery Recycling Center on Pittsburg Avenue in Northern Richmond. It is owned and managed by different entities. The facility is owned by West Contra Costa Integrated Waste Management Authority (“RecycleMore”), a joint powers authority

(JPA) of the Cities of El Cerrito, Hercules, Pinole, Richmond and San Pablo, and Contra Costa County, and is managed by West County Resource Recovery, Inc., a subsidiary of Republic Services. Inc.

The Central County HHW Facility is located on Imhoff Place in the City of Martinez across from the Central Contra Costa Sanitary District. It is owned and managed by Central Contra Costa Sanitary District in partnerships and with shared funding from the Mt. View Sanitary District, the Cities of Concord and Clayton, and the City of San Ramon (serving south San Ramon).

Both of the HHW facilities rely on road access to get people (staff, county residents) and hazardous waste to and from the facility, and if the roads are disrupted due to flooding the facilities may not be able to function as collection sites. While the two facilities may be able to provide some level of redundancy for each other if one is disrupted, they serve different communities who may not be able to access the other facility. Other collection points for specific hazardous wastes include auto centers that collect used motor oil and police stations that collect unwanted pharmaceuticals.

VULNERABILITIES

GOV1: Funding and governance of HHW facilities is complex, and any comprehensive planning or major changes requires coordination among multiple entities. In particular, the West County HHW facility is owned by a JPA and managed by a separate private entity. While a JPA provides a framework for joint decision-making, it could complicate planning and funding decisions to address sea level rise and storm event challenges.
GOV2: If one or both HHW facilities in the project area were closed permanently, siting a new facility would be very challenging due to regulatory restrictions, funding, and concerns from the public.
FUNC: Both HHW facilities in the project area rely on local roads to function, and have limited access in and out. Flooding of the road network could easily disrupt operations at the facilities.
PHYS1: The HHW facilities are at grade, and may have hazardous waste stored at grade that could be impacted by a flood event.
PHYS2: The HHW facilities, like most buildings, are not designed to withstand flooding. If the facilities were exposed to floodwaters, they could suffer damage that would require extensive repairs.

CONSEQUENCES

Society and Equity: There could be significant consequences for public health if hazardous wastes were released into the environment. If either HHW facility were disrupted, the community would lose access to a safe disposal location for household hazardous waste, and would have to find alternative disposal locations either temporarily or permanently. Some individuals might resort to illegal dumping of hazardous waste. Access to HHW facilities is also important for the safe disposal of hazardous waste after a flood event in communities they serve, and disruption of one or both facilities could affect the efficiency and safety of the post-flood clean up process.

Environment: There could be significant consequences for habitat and wildlife if hazardous wastes were released into the environment. A release would most likely impact nearby creeks or groundwater. A number of household hazardous wastes are specifically designed to have negative biological impacts (e.g. pesticides, poisons), and many others are known to cause serious physical or reproductive harm to wildlife. Rising

groundwater levels could also result in hazardous waste leaching into the water table if the waste is not stored properly.

Economy: Flooding of the HHW facilities could strain local emergency resources and could result in high cleanup and recovery costs.

Waste Transfer Stations

Waste transfer stations act as intermediate collection points for municipal solid waste. At each facility, smaller garbage trucks that serve local communities transfer waste to larger trucks for shipment to a permanent waste disposal (landfill) site. The public can also drop off waste at a waste transfer station for a fee. There are two waste transfer stations in the project area: Golden Bear Transfer Station in Richmond and Contra Costa Transfer and Recovery Station in Martinez. Both of the stations transfer collected waste to the Keller Canyon Landfill in Pittsburg.

KEY ISSUE STATEMENT

The Golden Bear and Contra Costa Waste Transfer Stations are vulnerable to future flooding because they rely on vulnerable roads and access routes to move trucks and waste in and out of the facilities. Temporary or permanent closure of transfer stations could cause significant disruptions for community garbage collection services, and increase the distance and expense of hauling waste.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The Golden Bear Transfer Station is located within the 100-year floodplain and will be exposed to two to three feet of sea level rise. The Contra Costa Transfer and Recovery Station is not directly at risk from sea level rise and is not within the 100-year floodplain, however the station is within a former borrow pit and is therefore low-lying and could be subjected to nuisance flooding if the area it is located in has a stormwater drainage system that reaches capacity and is overwhelmed.

ASSET DESCRIPTIONS

The Golden Bear Transfer Station is owned and operated by Republic Services, Inc. It is located in the City of Richmond at the end of Parr Boulevard at the mouth of San Pablo Creek in an area of industrial and commercial land uses, including the West County Wastewater District and the West County Sanitary Landfill.

The Contra Costa Transfer and Recovery Station is located in Martinez on Waterbird Way adjacent to the Martinez Rod and Gun Club in an area with commercial and industrial land uses. It is owned and operated by Allied Waste Systems, Inc., a subsidiary of Republic Services, Inc.

Transfer stations rely on trucks that use local streets and roads for waste drop-off and transport. The Golden Bear Waste Transfer Stations is accessed solely by Parr Boulevard, which is at risk of flooding with two to three feet of sea level rise. The Contra Costa Transfer Station is located on a sole access road (Waterbird Way) from Waterfront Road that is the 100-year floodplain and could be flooded with two to three feet of sea level rise, although there is a secondary access road through an adjacent residential neighborhood that potentially could be used in an emergency.

VULNERABILITIES

GOV1: If one or both transfer stations were closed permanently, siting and operating a new, alternative transfer station would require numerous state and local approvals and permits from multiple agencies.
GOV2: The waste transfer stations in the project area are protected by shorelines owned and managed by others, therefore coordination will be required to address flood risks to these facilites as well as adjacent commercial and industrial land uses.
FUNC1: There are limited roadways into and out of each waste transfer station that are used by waste collection trucks and personal vehicles to drop lcoal waste. In addition large trailers use local, county and state roadways to transport waste from each station to the Keller Landfill in Pittsburgh. If these roads were disrupted, the transfer stations would be unable to function.
FUNC2: Transfer stations are specialized facilities and finding alternative sites for them would be challenging as there are a number of siting requirements, such as a location able to accommodate large trucks, and easy access to truck-accessible haul routes that avoid congested areas. Adjacent communities may also object to the creation of a new transfer station, due to concerns about increased truck traffic, noise, health and safety, property values, or other issues.
FUNC3: There are limited alternatives for collecting and transfering waste in the project area. Trucks that normally use Golden Bear Transfer Station may be able to go the Contra Costa Transfer and Recovery Station temporarily, although the reverse would be difficult, and there may not be adequate on site storage. If both transfer stations are inaccesible or flooded, carrying waste directly to the Keller Canyon Landfill in Pittsburgh would be challenging as it is currently not allowed with out special permission.
PHYS: Waste that is temporarily stored at the transfer station sites could be released into the environment if there was an unexpected, catastrophic high impact flood event that occurred without time for the waste stored on site to be removed or contained.

CONSEQUENCES

Society and Equity: If one or both transfer stations were disrupted, waste collection for communities in West and Central Contra Costa County would lack a transfer point, and would likely need to be temporarily or permanently re-routed to the other station (if active) or directly to the Keller Canyon Landfill. This could disrupt garbage collection services for the community, and some individuals might also resort to illegal dumping of waste without a convenient drop-off location. Access to transfer stations is also important for the safe disposal of waste after a flood event in communities they serve, and disruption of one or both stations could affect the efficiency and safety of the post-flood clean up process.

Environment: Because of the small quantities of waste material stored or transferred at these facilities, impacts to the environment would be limited. However, the disruption or closure of a transfer station could possibly create air quality impacts, given the increased distance that local garbage collection trucks would need to travel in order to drop off waste.

Economy: Disruption or closure of a transfer station would increase the cost associated with waste collection in West and/or Central Contra Costa, due to the additional distance that local garbage collection trucks would need to travel to drop off waste. Jobs at the transfer stations or driving transfer trucks could also be impacted.

RESOURCES

Contra Costa Health Services. Health Centers & Clinics. http://cchealth.org/centers-clinics/
Contra Costa Health Services. School-Based Health Clinics. http://cchealth.org/school-based-clinic/
Contra Costa Office of Emergeny Services. 2011. Contra Costa Operational Area Emergency Operations Plan. http://www.co.contra-costa.ca.us/158/Emergency-Services
DUDEK and the Abaris Group. August 2007. Public Healthcare Services Municipal Service Review prepared for Contra Costa Local Agency Formation Commission, http://www.contracostalafco.org/municipal_service_reviews.htm
Health Management Associates. 2011. Sustainability Audit of the Contra Costa County Regional Medical Center and Health Centers: Stage 2 Final Report. http://ca-contracostacounty.civicplus.com/DocumentCenter/Home/View/6524

Seaports and Marine Oil Terminals

The Bay Area is home to a significant amount of critical maritime facilities, including San Francisco's James R. Herman Cruise Ship Terminal, harbor services, commercial fishing, excursion vessels, ship repair, berthings for science, military and other vessels, cargo services, dry docks, ferry terminals in a number of communities that support commuter movement, marine oil terminals and six seaports. The region was built on maritime activity and although a smaller component of the economy and society than it once was, is still vitally important to the Bay Area. This sector moves people and goods within and outside the region, and provides jobs, goods, services and other opportunities.

Seaports

Seaports serve the region as employers, in moving goods in and out of the region and as an economic catalyst and incentive for industries to locate in the region. The six seaports in the region, listed in order of the number of calls they receive each year, are located at the Port of Oakland, Port of San Francisco, Port of Richmond, Port of Benicia and Port of Redwood City. Each seaport plays a different role within the region, with the Port of Oakland's seaport being the fifth busiest container port in the United States and handling 99 percent of the container goods that move through Northern California.

The Port of San Francisco has seen a significant shift away from its role in cargo movement and towards other types of maritime uses. The Port of San Francisco still plays a role in cargo movement handling small amounts of container, break bulk, neo-bulk, dry bulk and liquid bulk. The Port of Richmond handles the majority of the region's liquid bulk and automobile tonnage, and a variety of other cargo including petroleum projects, vegetable oil, molasses, steel, lumber, heavy machinery, automobiles, earth moving and road making equipment. The Port of Benicia handles automobiles and petrocoke. The Port of Redwood City has facilities to handle cement, sand, gravel, scrap metal, gypsum, bauxite and petroleum products. Due to the size and specialized nature of each of the ports, there is very little redundancy within the system and a disruption at one of these ports, particularly Oakland or Richmond, could have significant implications for the region's economy, environment and community wellbeing.

Seaports require a number of on-site and off-site facilities and services that can be disrupted or damaged by temporary flooding, storm surge or permanent flooding, such as utilities, transportation, storm water and pipelines. In other studies of seaport vulnerability there has been five key areas issue identified, including:

increased exposure of port operations to a range of climate hazards such as sea-level rise, storm surge, extreme waves and wind; interrupted shipping movements, material and container handling, and inland transportation into and out of ports; disruptions in transportation and storage of sensitive goods such as agricultural products or fuel; greater sensitivity of in-transport infrastructure to climate hazards; and an increased vulnerability of ports to disruptions to utilities, such as water and electricity.

Most seaports are not directly vulnerable to current or future flooding, although some have infrastructure located under wharves that could be damaged from increased tidal and wave energy as sea levels rise. Seaport operations, however, rely on other systems that are vulnerable, most notably rail lines, which are located along the shoreline and cross many tidal creeks and channels throughout the region. Damage at any point in the rail system can result in system-wide disruptions, and loss of rail service to the seaports could result in increased truck traffic, affecting congestion and air quality in surrounding neighborhoods, local roadways, and interstates.

PORT OF RICHMOND

The Port of Richmond is a deepwater port located along the City of Richmond's inner harbor, approximately nine miles from the Golden Gate Bridge. In 2012 the port had the highest amount of liquid bulk and automobile tonnage out of the San Francisco Bay Area's five ports. The port includes five city-owned and ten privately owned terminals (see Table 1) that handle bulk liquids, vehicles, dry bulk materials and break-bulk cargoes. The City of Richmond's Port manages the city-owned terminals, which are leased to various private entities. One city-owned terminal (Terminal One) is currently in the process of being sold for residential re-development.

The Port of Richmond seaport is linked to inland parts of the region, state, and nation through rail lines, including UPRR and BNSF lines, and roads, including I-580 and Canal Boulevard. On dock, rail service is provided to many of the terminals by UP and BNSF rail lines and there is truck access to I-580 from the port. The seaport supports employment in a variety of sectors, ranging from port-specific jobs such as longshoremen, to rail and truck operators.

Table 26. Summary of the Port of Richmond's 2014 goods movement from the Marine Exchange of San Francisco Bay Region

Terminal	Commodity	Metric Tons 2014	Vessels 2014
City-Owned			
R2- CA Oils	Bulk Liquids	103,852	15
R7- Auto Warehousing Co	Automobiles	164,628	90
Private			
BP/Arco	Bulk Liquids		
Castrol	Bulk Liquids	22,941*	11*
Chevron USA	Bulk Liquids	20,047,591	727
Phillips 66	Bulk Liquids	353,014	133
IMTT	Bulk Liquids	1,324,588	29
Kinder-Morgan	Bulk Liquids	283,750	46
Levin-Richmond	Bulk Dry/Scrap Metal	1,873,000	76
Natl Gypsum	Gypsum rock	152,971	7

Plains products	Bulk Liquids	1,075,918	468
Eagle rock	Bulk aggregates	290,216	17

* Numbers from 2013

KEY ISSUE STATEMENT

While most of the Port of Richmond, and in particular the terminals, are not directly vulnerable to climate impacts, sea level rise and storm events will affect operations by limiting access to and from the seaport. Temporary or permanent disruption of local road and interstate access and rail lines would disrupt seaport operations. In particular loss of rail service, which moves bulk materials and automobiles, would have significant impacts on the local and regional economy, as these goods cannot easily be moved by truck.

EXPOSURE TO CURRENT AND FUTURE FLOODING

A portion of the north end of the seaport, a number of access roads and some of the rail lines and terminals are located within the existing 100-year floodplain. These areas may be exposed to more frequent or extensive flooding with four or more feet of sea levels rise. A number of the roadways that provide access to the seaport are at lower elevations, where inundation could disrupt access and operations at the Port of Richmond and private marine terminal. This includes low-lying areas of West Cutting Boulevard and Canal Boulevard as well as Harbour Way South, Wright Avenue and Ohio Avenue.

VULNERABILITIES

INFO: There is a lack of detailed and easily accessible information about the private marine terminals at the Port of Richmond seaport.
GOV: Different entities own and manage the seaport and the vital transportation systems, such as rail (Union Pacific and Burlington Northern Santa Fe), interstates (Caltrans) and local access roads (City of Richmond) that port operations relies on.
PHYS1: The Port of Richmond terminals currently do not have groundwater pumping systems in place, and rising groundwater could damage infrastructure necessary for port operations.
PHYS2: Flooding could damage electrical equipment located at or below-grade, such as electrical equipment found in graving basins in the Port of Richmond.
PHYS3: The historic Shipyard 3 graving basins at the Port of Richmond does not have storm drain pumps to remove floodwaters, which could inundate the facility during a storm event.
FUNC1: Rail, interstate and local roadways that connect to the seaport are vulnerable to flooding and lack redundancy, with no alternative route for rail cargo and little additional capacity for truck traffic on existing or alternative routes.
FUNC2: In the event that a large portion of seaport operations is disrupted, there could be insufficient capacity at either on- or off-site terminals to handle displaced shipping needs, in particular petroleum shipping, which could cause a ripple effect in the economy.
FUNC3: Port operations rely on electrical power, domestic water, and sanitary sewer services provided by external agencies, although the port has backup power available to help maintain critical operations.
FUNC4: Seaport operations rely on local road access (Richmond Parkway/Canal Boulevard, South Garrard Boulevard, West Cutting Boulevard, Wright Avenue, Marina Way South, Hoffman Boulevard and Harbour Way South) and some of the marine terminals have only one road leading in and out.

CONSEQUENCES

Society and Equity: Temporary or permanent disruption at the seaport would affect the capacity to ship and receive goods, and this could impact employment, especially ship workers and truck drivers. Disruption of rail service to the seaport could result in increased road traffic—and the associated negative consequences—within the surrounding neighborhoods' local roads and Interstate system.

Environment: Hazardous materials present at various sites within the seaport could be released into the Bay by floodwaters, or contaminate rising groundwater. If the rail is disrupted, the use of trucks to bring goods to and from the seaport may increase. This would lead to greater air pollution from the increased road traffic.

Economy: Loss of power or the disruption of rail or interstate access would impact the goods movement network, and result in economic losses for the city, region, and state. Disruption of rail access to the port could be especially significant, not only because it could result in increased truck traffic, but also many of the commodities shipped through the Port of Richmond cannot easily be moved by truck.

Marine Oil Terminals

Marine Oil Terminals (MOTs) primarily load and unload the raw materials used in refineries, typically petroleum-based materials, and are rely on pipes, pumps, electrical utilities, and other mechanical equipment. Seven of the approximately 35 MOTs in California are located in the project area. Five of these are associated with refineries and two serve refinery operations but are not owned or managed by an individual refinery.

The State Lands Commission regulates all MOTs and monitors oil transfer operations. Most MOTs were built in the early 1900s, when oil was carried by smaller ships and before seismic safety standards and environmental review requirements were established. The Marine Oil Terminal Engineering and Maintenance Standards, known as MOTEMS, are guiding the upgrade of aging terminals to ensure better resistance to earthquakes, protect public health and the environment, and reduce the potential of an oil spill. MOTEMS, which is codified in the California Building Code, establishes minimum engineering, inspection, and maintenance criteria for all MOTs in California.

A revision to the 2007 California Code of Regulations (Title 24, Part 2, California Building Code, Chapter 31F, Marine Oil Terminals) includes a new Section 3103F.5.3.4 Sea Level Rise (SLR), which requires all MOTs to consider the predicted sea level rise over the remaining life of the terminal, including the effects of local subsidence and the maximum high tide and storm surge. In addition, there are suggested strategies to address sea level rise including consideration of fender locations, additional berthing loads (deeper draft vessels) and the vulnerability of components near potential splash zones.

KEY ISSUE STATEMENT

Marine Oil Terminals are built to withstand tidal, wind and wave erosion. However, sea level rise and storm events will affect access to and from the terminal, and may impact the equipment located on the terminals, including the pipelines connecting the terminals to their respective refinery/storage location. Temporary or permanent disruption of access to the terminal would result in economic impacts to the city, region, and state.

EXPOSURE TO CURRENT AND FUTURE FLOODING

MOTs are all vulnerable in varying degrees to rising sea levels due to their physical location next to the water, but it's the land components attached to the terminals that will be most vulnerable to sea level rise, as these assets may not be built to withstand tidal, wind and wave erosion. The MOTs' land connections already in the 100-year flood plain will be the first ones to face exposure to sea level rise.

ASSET DESCRIPTION

NUSTAR SHORE TERMINAL

The NuStar Shore Terminal is located on the south shore of the Carquinez Strait, just west of the Carquinez Bridge in Crockett, and is owned and managed by NuStar Energy LP. The terminal is part of a goods movement network that transports gasoline, diesel, aviation fuels, and ethanol by ship, barge, pipeline, truck and rail. The terminal operates solely as a transfer station, facilitating the loading and unloading of refined petroleum to and from storage tanks on behalf of oil companies, distributors, and brokers in the San Francisco Bay, Sacramento, and Northern California region. Terminal operations depend on many other sectors, including road and rail corridors, as well as power generation and distribution.

No flooding of the terminal site is anticipated, however pipelines, roads and rail serving the facility are potentially vulnerable to sea level rise. NuStar Energy LP has other refined product terminals throughout the United States; the closest alternative terminals to the Crockett location are Los Angeles and Portland, Oregon. These alternative terminals are a feasible option for temporary usage with some forethought, but Bay Area operations would be negatively impacted from these temporary changes.

PLAINS PRODUCTS MARTINEZ MARINE OIL TERMINAL

The Plains Products Martinez Marine Oil Terminal is located in Martinez and is owned and managed by Plains All American Pipeline. The shoreline portion of the terminal includes a wharf leased from the State Lands Commission and the upland portion of the site includes storage tanks, pumps and associated pipelines, an office building, and other equipment. The Tesoro, Shell and Valero refineries as well as the Kinder Morgan distribution system have pipeline connections to the terminal. Pipes, pumps, electrical utilities, and other mechanical equipment on site are necessary to maintain operations. The terminal relies on external utility sources (electrical, natural gas, water, sewer) as well as local roads and the interstate.

The terminal is located in the 100-year flood plain. While most of the terminal facilities are at a high enough elevation to avoid direct flooding, some of the critical land-side connections are vulnerable to flooding with as little as one foot of sea level rise.

TERMINALS ASSOCIATED WITH REFINERIES

Chevron Richmond Long Wharf Marine Oil Terminal supports operations at the Chevron Richmond Refinery. The Chevron Richmond Refinery uses the Richmond Long Wharf Marine Terminal to receive all its crude oil, and some intermediate feed and blending stocks. In addition, the Chevron Richmond Refinery uses the Richmond Long Wharf Marine Terminal to ship products and intermediate stocks to domestic and foreign markets.

The Phillips 66 Rodeo Marine Terminal was built in 1928 and is located just west of the Carquinez Bridge in San Pablo Bay. It is a "T-shaped" pier that contains a ship-and barge-berthing structure, a mooring breasting dolphin, and a trestle/pipeway that supports a ballast water pipeline, two crude oil pipelines, and 17 petroleum product pipelines.

The Shell Oil Terminal Martinez was built in 1964 (the original terminal was built in 1913). It includes a tanker and barge petroleum loading/unloading facility used to receive raw materials for the Shell Martinez Refinery and for exports of its refined products. In 2008, the terminal received over 2.1 million metric tons, and exported almost 464 thousand metric tons, of petroleum products.

The Tesoro Amorco Terminal has been in operation since 1923 and is located just west of the I-680 Benicia-Martinez Bridge in Martinez. It is primarily used to facilitate the transfer of crude oil feedstocks from tanker vessels to a tank farm immediately upland. The feedstocks are later transferred via pipelines from the tank farm to the refinery located approximately 2.5 miles east. The terminal is a single-berth docking facility supporting one active berth located on the eastern end of the wharf. The wharf supports associated unloading equipment, including pumps, pipelines, electrical utilities, fire protection equipment, spill response equipment, and other mechanical equipment.

The Tesoro Avon Terminal has been operating since 1925 and is located in Pacheco, east of the I-680 Benicia-Martinez Bridge. The terminal is used to export and import petroleum products to support refinery operations.

VULNERABILITIES

GOV: Marine Oil Terminals (MOTs) are leased from the California State Lands Commission (SLC), their building standards are defined in the California Building Code, and upgrades or improvements require authorization from a number of regulatory agencies. Increasing MOT resilience to sea level rise will require coordination among various state, regional and local agencies and potential changes to the state building code.
PHYS1: Pipelines and electrical components connecting the Marine Oil Terminals to land-based facilities may become exposed to increased tidal or wave energy, flooding, salinity, higher groundwater levels, and increased liquefaction susceptibility due to rising sea levels.
FUNC1: Marine Oil Terminals are largely resilient to rising sea levels, but the connections to the shoreline, such as roads and pipelines, may be exposed to impacts of rising sea level.
FUNC2: Marine Oil Terminals are part of the goods movement system, and if access to and from the terminals were disrupted by flooding or storm events, the economy would be severely impacted regionally and potentially nation-wide.

ASSET SCALE ASSESSMENT FINDINGS

The Plains Products Martinez Marine Oil Terminal was selected as a representative asset to assess because Plains All American Pipeline staff actively participated in the project working group, shared information about the terminal site, and provided critical review and feedback on the information gathered to ensure it was as accurate and reflective of existing conditions as possible. The Plains Products Martinez Marine Oil Terminal profile sheet summarizing the assessment findings can be found at the end of this chapter.

RESOURCES

CalTrans. 2012. Freight Planning Fact Sheet: Port of Richmond.
http://www.dot.ca.gov/hq/tpp/offices/ogm/ships/Fact_Sheets/Port_of_Richmond_Fact_Sheet_073012.pdf
City of Richmond. nd. Port Facilities
http://www.ci.richmond.ca.us/index.aspx?NID=324
CBRE Consulting, Inc. 2009. Port of San Francisco Maritime Cargo and Warehouse Market Analysis.
http://www.sfport.com/ftp/uploadedfiles/meetings/supporting/2009/Item%2010aMaritimeCargoandWarehouseMarketAnalysis.pdf
Finance Department, City of Richmond. Five-Year Financial Plan [from 2011/12-2015/16].
http://www.ci.richmond.ca.us/DocumentCenter/Home/View/9233
San Francisco Bay Conservation and Development Commission (BCDC) and Metropolitan Transportation Commission. 1999. San Francisco Bay Area Seaport Plan. April 18, 1996, amended through January 2012.
http://www.bcdc.ca.gov/seaport/seaport.pdf
World Port Source. nd. Port of Richmond.
http://www.worldportsource.com/ports/commerce/USA_CA_Port_of_Richmond_167.php

Ground Transportation

Unlike other parts of the state where major transportation corridors are located inland, a significant proportion of the Bay Area's critical transportation system are located on the shoreline at low elevations. Transportation systems, including freeways, seaports, railroads, airports, local roads, mass transit, and bicycle and pedestrian facilities, connect shoreline communities to each other and to the rest of the region, state and nation. In addition, much of the region's highest density development, businesses and industries are located on the shoreline and rely on a functioning transportation system.

Ground transportation assets include rail lines, local streets and roads, and interstates. Other transportation-related assets include pipelines, marine oil terminals and seaports that are integral to goods movement; and bicycle and pedestrian trails that link people to the shoreline and provide active transportation and recreation opportunities. These are discussed in other chapters (see the Seaport, Energy, and Parks and Recreation Chapters).

Transportation assets link people with community facilities and services, jobs, family and friends, recreation, and other important destinations. Contra Costa County, as well as Alameda County, is historically home to more residents than jobs, with a jobs-to-population ratio of about 0.39, or one position for every 2.5 residents (Contra Costa Economic Partnership, 2014). And while at least half of county residents work within the county this is less than the regional average of 66% (www.vitalsigns.mtc.ca.gov). Of the residents that work outside of the county, almost a quarter commute out of the East Bay each day, mostly to San Francisco and Santa Clara Counties. Inbound commuters fill almost 20% of the jobs located in the county, the largest share of which is from Solano County.

The majority of commuters in Contra Costa County (over 80%) drive, which is higher than the Bay Area average of 77%. Regionally, almost 90% of commuters drive and two-thirds of those drive alone. Congestion on the region's urban core freeways has increased slightly since 2004, with Alameda County having the highest share of miles driven in congested conditions. In Contra Costa County, there has been a greater increase in congestion than in the rest of the region, from a 2.8 mile share of miles driven in congested conditions in 2004 to 4.6 miles in 2013 (www.vitalsigns.mtc.ca.gov).

In addition to being critical to commuters, ground transportation networks link goods to markets, with goods movement-dependent industries in the Bay Area accounting for $490 billion (51%) of total regional output and providing over 1.1 million jobs (32% total regional employment). A total of $104,655 million (or 68%) of Contra Costa's 2011 output was from goods movement industries, with $82,911 million of this output from petroleum and coal products (MTC Regional Goods Movement Plan update, www.mtc.ca.gov/planning/rgm/).

Most goods in the Bay Area are moved by truck, although there are certain types of goods such as automobiles that are most efficiently moved by rail, and others such as liquid products that are most efficiently moved by pipeline. Because different industries rely on different modes of transportation depending on the types of goods they use or produce, different subregions of the Bay Area rely on different transportation modes. Contra Costa County, where four of the five regional refineries are located, relies heavily on marine terminals and pipelines to move petroleum products.

Table 27. Modes of transporting goods in the Bay Area, 2012.

Goods movement modes in the Bay Area*	
Trucks	72%
Pipeline (mostly petroleum)	11%
Multiple modes	6%
Water carry	3%
Rail carry	3%
Other & Unknown	2%
No Domestic Mode	3%
Air (includes truck-air)	<1%

*Source: San Francisco Bay Area Goods Movement Plan, February 2016 – Goods Movement and the Economy (http://mtc.ca.gov/sites/default/files/RGM_Full_Plan.pdf)

ART projects in the Bay Area, including a focused assessment of Alameda County, have demonstrated that flooding of the transportation network - even if temporary - can cause significant impacts on both goods and commuters, and the ability of emergency managers to provide critical response services. The lack of resilience in the transportation system is due, in part, to the lack of alternate routes with adequate capacity to serve all needs. In particular, there are very few options for rerouting goods to/from the region's seaports, airports, and shoreline industries, many of which rely on both truck and rail cars to move freight.

At the same time that many of the region's roadways could be flooded, the rail system, which is highly sensitive to even small amounts of water, could also be impacted. The rail system functions as a fixed network, and even if a small portion of track is damaged there can be closures of many miles of connected track. The region's capacity to withstand impacts to rail infrastructure is further hampered by the lack of redundant or alternative rail lines. Relocating or adding new rail track and right-of-ways is costly, and significant time and money are needed for planning, financing and implementing changes to the rail network. If the rail system is disrupted, truck traffic from the region's seaports would likely increase, having negative

and widespread effects on road congestion, air quality, noise and quality of life for those living and working near the ports.

Freight and Passenger Rail

Since the late 1800s rail has supported goods and commuter movement locally, regionally, across the state and nationally. In the San Francisco Bay Area goods and commuters both move by rail, on a shared track, along the shorelines of Santa Clara, Alameda, Contra Costa, and Solano Counties. The rail lines that cross the project area are critically important, and support inter- and intra-regional goods and commuter movement.

The Union Pacific Martinez Subdivision between the Port of Oakland and Martinez is the busiest rail segment in Northern California, carrying both goods and commuters. Freight volumes on the Union Pacific Martinez Subdivision are the highest in the region, and overall freight rail demand is anticipated to grow throughout the Subdivision, making it the largest bottleneck on the freight rail system in the Bay Area.

Table 28. Passenger and freight train traffic on the Union Pacific Martinez Subdivision.

Traffic on the Union Pacific Martinez Subdivision			
	Average # of trains/day (Capitol Corridor estimates)	Average # of cars on train	Average # of cars /day
Passenger trains	42	4 to 5	210
Freight trains	25	50 to 120*	2,125

* This number was calculated using the following assumptions: 5,280 feet=1 mile=90 rail cars; see pg.54 of www.camsys.com/pubs/AAR_Nat_%20Rail_Cap_Study.pdf

Goods moved by rail typically consists of high value manufactured products, as well as agricultural and food products transported from the region's ports to Northern and Southern California and throughout the country. Goods movement-dependent industries in the Bay Area account for $490 billion (51 percent of total regional output) and provide over 1.1 million jobs (32% percent of total regional employment). Rail provides a vital service in the region, supporting economic growth and connecting commuters to regional jobs.

The majority of commuter movement by passenger rail in the project area is provided by the Capitol Corridor Joint Powers Authority (Capitol Corridor), which is a partnership among six transit agencies in eight Bay Area counties, and provides service to over 1.7 million customers on the Capitol Corridor route, which connects Sacramento and San Jose. Other passenger lines that operate on the Union Pacific rail line in the project area include the Amtrak Coast Starlight and Amtrak California Zephyr.

Goods and commuter movement rely on a network of fixed, connected railroad assets including the railroad track, signal system, bridges, passenger stations, and maintenance facilities. Ownership and management of railroad assets can be complex since the operators of the commuter and freight trains do not own or manage the rail line or other connected assets. For instance, the Capitol Corridor operates most passenger trains but only Union Pacific can initiate actions to protect the rail line from flooding.

KEY ISSUE STATEMENT

Given the interconnected nature of rail, and lack of redundancy, a disruption of any segment, either within or beyond the project area, could have significant impacts. Rail lines in the project area are critical to moving agricultural, automotive, chemical, industrial, and other goods from the region's seaports to local and national markets, and are integral to inter-city passenger rail service. In addition, in many locations the rail line serves as the first line of defense against inland flooding. Collaboration between private rail owners (Union Pacific and Burlington Northern Santa Fe (BNSF)), local agencies that own or manage adjacent lands, and those that rely on rail either for providing service or for flood protection, will be necessary to find and implement appropriate, multi-benefit solutions to address flood risks.

EXPOSURE TO CURRENT AND FUTURE FLOODING

There are 153.5 miles of rail in the project area, which include rail track, sidings, and minor yards. A total of 14 miles of rail is within the current 100-year floodplain, including where the rail line crosses tidal creeks and channels and the coastal floodplain. A total of 40 miles of rail is exposed to sea level rise, with half of the miles at risk from four feet or less. Due to the type of analysis conducted, the miles of rail exposed to existing versus future flooding is reported separately even though they may not be unique and it is likely that these segments overlap. Given the shoreline location of the rail in the project area, most of the miles that are exposed to sea level rise are likely within the existing floodplain.

Table 29. Miles of rail that could be exposed to sea level rise.

Rail Owner	Miles in the Current 100-year Floodplain	Miles exposed to Sea Level Rise					
		1'	2'	3'	4'	5'	6'
BNSF	2	2	2	2	4	5	7
Union Pacific	9	3	6	7	12	18	22
Unknown	2	2	3	4	5	8	10
Total	14	7	10	13	20	31	40

ASSET DESCRIPTION

Within the project area, Union Pacific Railroad (UP) owns the right-of-way for the rail line from the county boundary in Richmond, around the coast, and past I-680. On this rail line Burlington Northern Santa Fe (BNSF) and Richmond Pacific Railroad Corporation (RPRC) have trackage rights, while Amtrak, Capitol Corridor, and San Joaquin have passenger rights. BNSF owns and operates the rail line from Richmond to Martinez, and UP holds trackage rights that are not currently in use. In addition to the rail track there are a number of rail sidings and minor yards in the project area, for example in Martinez, where rail switching is staged. RPRC operates on tracks south of Interstate 580, between South 11th Street and Regatta Boulevard in the Richmond Harbor area, on tracks adjacent to I-580 south to Berkeley, and north to Chesley Avenue along the UP right-of-way, and a section of track between Chesley Avenue and Chevron's Richmond Refineries yard.

Goods moved by rail in the project area include rail carload commodities (e.g., motorized vehicles and petroleum products other than gasoline or fuel oils) and intermodal rail shipments (shipping containers that

can be moved by container ship, rail or truck). On average, the UP rail line is used by 50 passenger trains and 12 freight trains daily, while 20-30 freight trains run on the BNSF owned rail line. RPRC leases 11 miles of track owned by UP and BNSF, runs two trains with 10 to 20 cars on the northern tracks and as many as 32 trains with two to 20 cars per day on the southern tracks, and handles over 22,000 carloads annually.

Most of the UP rail line in the project area is directly on the shoreline. The BNSF line parallels the UP rail line from Richmond to Pinole, heads inland, and then rejoins the UP line near Bay Point. Both rail lines cross at least 17 tidal creeks and channels as well as coastal floodplains. In many locations where the UP rail line is directly on the shoreline, there are tidal marshes and mudflats on the bayside of the rail track that help reduce wind, wave and tidal energy, protecting the rail line from erosion and flood damage.
The rail line, associated spurs and rail terminals provide an important landside connection to a number of large, water-dependent industries located on the shoreline, including the four refineries in the project area and the seaport, which includes the Port of Richmond and private marine terminals. For example, see the summary, below, of goods moved by railcars to and from the refinery between 2008 and 2012 from the Chevron Refinery Modernization Project EIR, Appendix 4.3.

Table 30. Goods transported to and from Chevron's Richmond Refinery by rail (2008-2012).

Goods Moved by Rail to and from Chevron's Richmond Refinery: 2008 to 2012
(from Chevron Refinery Modernization Project EIR, Appendix 4.3)

	Material type	Railcars	Tons
Import	LPG	2,034	130,176
	Additives	279	21,483
Export	LPG	1,485	95,040
	Lubricant	1,445	111,265
	Ammonia	112	7,168

VULNERABILITIES

INFO: There is insufficient public information available about existing track or siding type, level-of-use, condition, or planned capital improvements in the project area and beyond to thoroughly evaluate the vulnerability of the rail system.
GOV1: Planning for sea level rise and storm event impacts is challenging given that rail lines are owned and maintained by private entities that have not been willing in the past to coordinate and share information and resources, or work directly with local decision makers to find shared solutions for past or current issues.
GOV2: Significant coordinated decision making will be required to maintain the Capitol Corridor passenger rail service given the number of asset owners, managers, and service providers that need to work together. This coordination will be even more important in addressing the challenges of sea level rise while trying to achieve a vision of faster, more efficient passenger service.
GOV3: Improvements to rail track and associated infrastructure requires permits from a number of different regulatory agencies which increases the time needed to design and implement changes.
GOV4: A significant level of coordination and cooperation will be required to ensure solutions that address the needs of the railroads also benefit co-located assets such as pipelines and utilities, adjacent areas rail

currently protects, the natural areas that sit between the rail and the Bay, and the tidal creeks and channels rail crosses that provide flood protection to upstream communities.
GOV5: Funding rail improvements may be complicated or controversial as large public investments may be necessary to protect rail infrastructure which is privately owned.
PHYS1: In the event of an emergency, maintenance and repair of rail infrastructure may be delayed until a specialized team and custom materials are secured. Multiple disruptions throughout the system may further delay the recovery process.
PHYS2: Some segments of the rail line located along the shoreline serve as the first line of defense during storm events, however rail (track bed and ballast materials) is not constructed or maintained to prevent inland areas from flooding. In places where the railroad serves as the first line of defense (e.g., Bay Point, Montalvin Manor, Rodeo, Port Costa and Parchester Village), a failure of the railroad would result in flooding of inland communities and infrastructure.
PHYS3: A rising groundwater table could damage the track bed and ballast materials. If constantly saturated, more frequent maintenance is necessary to prevent the rail line from becoming structurally unsound.
PHYS4: Storm events and wave action have the potential to damage the ballast and embankment, and cause the rail tracks to become structurally unsound.
PHYS5: The Martinez station and many segments of rail line throughout the project area are at risk of liquefaction during a seismic event because they are located in areas of susceptible soils, particularly in Rodeo, Hercules, Pinole, and San Pablo.
FUNC1: Power is needed for traffic signal operation and functionality of passenger rail stations. Temporary protocols and backup supplies may not be sufficient during a prolonged outage or during system-wide failures. In addition, power outages pose a safety concerns at signalized intersections and will likely require direct human supervision until power returns.
FUNC2: If any segment of the rail line were disrupted the entire system would shut down, even in areas where the rail line is double tracked as it is likely that both would be affected at the same time in a flooding event.
FUNC3: There is no redundancy in the commuter rail system that would provide the same capacity as currently exists. Commuters could use alternate modes, however I-80 and I-680 could be flooded at the same time as the rail line, and are unlikely to provide the same level of service, resulting in longer commutes and delays.
FUNC4: There is no redundancy in the goods movement rail system that would provide the same capacity as currently exists. Depending on the location of the disruption, freight could be rerouted however this would result in increased costs and may not accommodate all types of cargo currently moved by rail. In addition, the roadways may not have the capacity needed to move freight in a timely manner.
FUNC5: Flooding around the Martinez Station would make it inaccessible to commuters such that passengers would need to travel to the next nearest passenger station in Richmond or use an alternative mode of commute.

CONSEQUENCES

Society and Equity: Disruption of the railroad would have an effect on commuters, goods movement, the economy and the region as a whole. Everyone sharing the road would spend more time in traffic and may have a difficult time getting to work or obtaining necessary goods and services. In the long run, commuters would have to spend more money to use their personal vehicles. Neighborhoods adjacent to alternate routes would be exposed to more air pollution, putting residents at greater risk of health problems (e.g., asthma).

Additionally, in places where the railroad serves as the first line of defense, a failure of the railroad would result in flooding of developed or natural areas inland of the rail line.

Environment: Long-term disruption would lead to more cars and trucks on the road, which would increase greenhouse gas emissions. Pipelines owned by Kinder Morgan are located under the UP right-of-way, which could be damaged if the embankment is destabilized. The pipelines transport petroleum and if ruptured during a flooding event, would result in a highly mobile spill that can cause great damage to the surrounding terrestrial environment and the Bay.

Economy: The railroads provide a key service moving agricultural, automotive, chemical, industrial, and other goods from the region's seaports to local and national markets.. The Surface Transportation Board classifies the BNSF and UP railroads as Class 1, which means that the annual operating revenue for each is over $433.2 million. Similarly, commuter movement is an important asset for the region, and Capitol Corridor alone generates $170 million in economic activity.

Roadways

The roadways in the project area are a networked system of interstates, freeways and expressways that connect to local streets and roads. Generally, arterials in the project area provide access to the interstate and state highway system via local interchanges that create connections between cities and provide the backbone to major corridors within cities, for example the Richmond Parkway or San Pablo Avenue. Collector streets then serve to create connections between these major corridors. Some collector streets and smaller roadways provide the only means of vehicular access to particular neighborhoods or industrial areas, and are therefore critical to keeping people and goods moving to and from those areas. In addition, there are three state toll bridges in the project area that are part of the interstate system. All three bridges serve to maintain connections between Contra Costa County and the broader East Bay and the North Bay and San Francisco peninsula.

Public transit operators that rely on the road network in the project area include AC Transit, WestCat, TriDelta Transit, and County Connection. These service providers offer regularly scheduled bus transit service that links together different parts of the county, as well as connects the county to the rest of the region, and importantly, to the intra-regional BART system.

Roadways in the project area are owned and managed by a number of different agencies, including the California Department of Transportation, each city, and the county. Public works departments within each of the cities and counties are responsible for road maintenance and improvements, including the storm drainage system, while planning departments are responsible for helping to ensure land development patterns support GHG reduction goals by focusing on transit-oriented development and encouraging opportunities for active transport. In addition, the Contra Costa Transportation Authority manages the county's transportation sales tax program and conducts countywide transportation planning in coordination with four Regional Transportation Planning Committees, including the West Contra Costa County Advisory Committee and TRANSPAC (Transportation Partnership and Cooperation) in the project area, that help guide transportation projects and programs.

KEY ISSUE STATEMENT

Critical connections both within the county, and between the county and the region, are at risk of flooding, including the Richmond Parkway, San Pablo Avenue, and I-580. Even short term closures of the roadway network could have significant social and economic costs as there is limited redundancy for car or bus commuters in the project area, especially those that live in fairly isolated communities, and if there are alternative routes they may not be able to accommodate the same capacity. Lastly, residents without access to a vehicle may be most vulnerable since rerouted buses would result in delays that could impact their ability to get to work, especially those that connect to other transit modes such as the intra-regional BART system.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Four classes of roadways were included in the exposure analysis: interstates, freeway or expressway, principal arterials, and major collectors. Of the 202 miles of roadway evaluated, 27.5 miles are within or cross over the existing 100-year floodplain and 16.3 miles are potentially exposed to sea level rise. Most of the roadway miles that are within or cross over the current 100-year floodplain are major collectors, which is proportional to the relative miles of each road class analyzed.

Because the analysis of road miles in the existing floodplain and exposed to sea level rise were conducted separately, some of the miles reported may overlap while others do not; that is, some miles within the 100-year floodplain may be at risk of more extensive or longer duration flooding due to sea level rise, while others may be only at risk from sea level rise.

Table 31. Roadways in the current 100-year floodplane and roadways that could be exposed to sea level rise.

Type of Road*	Total miles in project area	Miles in the current 100-year Flood	Miles exposed to Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Interstate	22.7	3.3	1.3	1.3	1.4	1.4	1.6	2.2
Freeway or Expressway	33.7	2.2	0.1	0.1	0.1	3.1	3.5	3.5
Principal Arterial	20.3	2.1	0.0	0.1	0.1	0.1	0.2	0.2
Major Collector	124.9	19.9	0.8	1.1	1.4	1.9	6.9	10.4

*Note: there are no minor arterials in the project area

ASSET DESCRIPTION

LOCAL STREETS AND ROADS

Local streets and roads support commuter and goods movement within a city, and between a city and the county, region and beyond. Residents, businesses and public service providers all need functioning roads. Among many other services, these roads are critical for a functioning emergency response system.

Flooding of local streets and roads may be caused by storm events that overtop the shoreline or by a failure of stormwater infrastructure to maintain function as sea level rises. Addressing local street and road vulnerabilities will require collaboration among different departments within the city, for example planning and

public works, and may necessitate partnerships with other agencies and entities including the county, West Contra Costa Transportation Advisory Committee, Metropolitan Transportation Commission, California Department of Transportation, adjacent private landowners, entities with right-of-way easements, and others.

There are a number of local streets and roads at risk of flooding in the project area, with many of the noted segments at risk where the roadways cross over tidal creeks that serve as flood control channels (see Water Management Chapter). In particular, all of the local streets and roads at risk of flooding in San Pablo are within the 100-year floodplain of Wildcat or San Pablo Creeks. Where roads are low-lying they could flood with lesser amounts of sea level rise than is currently depicted on inundation maps if the capacity and functions of stormwater infrastructure are affected by higher Bay water levels (as an example, see the Richmond Stormwater Profile Sheet).

Table 32. Local streets and roads at risk of current or future flooding.

Local Streets and Roads at Risk of Flooding*	
Richmond	San Pablo
Richmond Parkway	Rumrill Boulevard
Castro Street	23rd Street
Rydin Road at Central Avenue	San Pablo Avenue at San Pablo Creek
Pierce Street	Giant Road and Brookside Drive and numerous
San Mateo Street at Belmont Avenue	local streets around Wildcat Creek and San Pablo
Santa Clara Avenue at Yosemite Avenue	Creek
Carlson Boulevard and Jacuzzi Street between the county line and Central Avenue	
Bayview Avenue and South 51st Street between E. Montgomery Avenue and I-580	
Hercules	Pinole
Railroad Avenue at Santa Fe	Orleans Drive
Bayfront Boulevard	Railroad Avenue
Sanderling Drive	Tennent Avenue
Martinez	Unincorporated County Areas
Embarcadero Street	San Pablo Avenue, Parr Boulevard and Garden
Joe DiMaggio Drive	Tract Road (North Richmond)
North Court Street	San Pablo Avenue (Bayview-Montalvin)
Marina Vista Avenue between Pine Street and Alhambra Avenue	San Pablo and Parker Avenue (Rodeo)
Alhambra Avenue from HWY 4 to Marina Vista Avenue, including adjacent local streets	Dowrelio Drive, Loring Avenue and Rolph Avenue (Crockett)
Pine Street at Escobar, and between Pacheco Boulevard and Green	Canyon Lake Drive (Port Costa)
Waterfront Road near I-680 to the county line	Waterfront Road (from Martinez to Bay Point)
Service Road and Waterbird Way	Solano and Monsanto Way
	Main Street (Bay Point)

*this is by no means exhaustive.

Bus transit services rely on local streets and roads. A number of significant bus routes that connect communities along the shoreline of the project area to each other, to inland areas, and to rail transit, including BART, Amtrak and Capitol Corridor service, are at risk of disruption due to roadway flooding. Transit services are critical to those who reside and work in the county and do not own or operate automobiles. Significant delays or service disruptions could disproportionately impact resource-constrained households and individuals who rely on transit to access jobs, schools, goods and services.

Table 33. Transit lines at risk of current or future flooding.

Transit Lines at Risk Due to Road Flooding	
AC Transit	Tri-Delta Transit
Route 76: Richmond to El Cerrito Route 72M: Richmond BART/Amtrak Station Route 74: Hilltop Mall San Pablo to Richmond	Route 200: Martinez Amtrak Station to Pittsburg/Bay Point BART
WestCAT	County Connection
Route 11: Crocket to Hercules via San Pablo Avenue Route J: Hercules to San Pablo via San Pablo Avenue	Route 16: Martinez Amtrak/BART Concord Route 18: Martinez Amtrak/BART Pleasant Hill Route 19: Martinez Amtrak/BART Concord Route 28: BART/North Concord/Martinez Route 98x: Martinez/BART Walnut Creek Route 316: Martinez Amtrak/BART Pleasant Hill

While many local streets and roads in the project area may be impacted by flooding, the following discussion focuses on key roadways within the City of Richmond as their vulnerabilities are representative of the issues that may arise elsewhere within and beyond the county. (For a discussion of Waterfront Road in Martinez, which has current and significant flooding issues, see the Energy Chapter and the Tesoro Martinez Refinery Profile Sheet.)

ROADS IN THE CITY OF RICHMOND

Highly traveled roadways and those that provide interstate access such as Richmond Parkway, Castro Street, West Ohio Avenue, West Cutting, South Garrard and Canal Boulevard are critical for local traffic circulation and connecting Richmond to other parts of the county and region. Other roadways such as Central Avenue and Pelican Way are critical as they provide sole access to residential, commercial and recreational areas including the Point Isabel Regional Shoreline.

The City of Richmond owns and manages a number of roads at risk of flooding. Local streets and roads in the Point Richmond, Marina Bay, and Iron Triangle neighborhoods are potentially exposed to flooding with four feet of sea level rise or more. This exposure includes local streets and roads to the south of I-580 between South Marina Way and South Garrard Boulevard and north of I-580 where South Garrard Boulevard turns into West Ohio Avenue. As noted previously, where roads are low-lying they could flood with lesser amounts of sea level rise than is currently depicted on inundation maps if stormwater infrastructure is affected by higher Bay water levels (see Richmond Stormwater Profile Sheet).

Much of Richmond Parkway/Castro Street from the I-580 interchange north to Hensley Street is at risk of flooding with four feet of sea level rise or more, while the portions of Central and Bayview Avenues on the bayside of I-580 in the Southwest Annex neighborhood could flood with five to six feet of sea level rise. Richmond Parkway/Castro Street is an important arterial road that provides local access to jobs, goods and services. It also provides connections to important West County routes, including I-580, I-80 and San Pablo Avenue that commuters traveling between the East Bay, the North Bay, and San Francisco, as well as along the East Bay shoreline, rely on.

Central Avenue connects local goods and commuters to I-580, I-80, and San Pablo Avenue, and provides access to regional and local jobs, EBMUD's Point Isabel Wet Weather Facility, and the Point Isabel Regional Shoreline, which is one of the most visited East Bay Regional Parks.

Impacts that leave the Richmond Parkway/Castro Street and Central Avenue less than fully functional would affect Richmond residents, commuters' access to local and regional jobs, and the movement of goods. Both roadways are listed as a West County 'route of regional significance,' and are major truck and transit routes. Communities of concern in Richmond that do not have access to a vehicle could be most affected by service disruptions since rerouted buses would result in delays that could impact their ability to get to work on time. In addition, if either of these roads floods, emergency services may have difficulty reaching the communities in need, particularly between Carlson Boulevard and I-580, in a timely fashion.

INTERSTATES

There are three interstates each associated with a transbay bridge within the project area: I-580 and the Richmond-San Rafael Bridge, I-80 and the Carquinez Bridge, and I-680 and the Benicia-Martinez Bridge. I-580 (together with I-880) carries the highest truck volumes in the Bay Area. The I-580 Corridor is also critical to interregional truck traffic as the primary east-west access route to the Central Valley. I-80 has an average of 290,000 vehicles daily, is a route of regional importance, and is one of the most congested freeways in the region. I-80 is also a designated truck route with the third-largest truck volume in the Bay Area. For example, truck volumes along Segment 2 of the corridor, from Emeryville to Richmond, are some of the highest in the corridor, with locations that have more than 12,000 trucks a day (www.mtc.ca.gov/planning/rgm/). I-680 provides access to major local employment centers along the corridor, and connects commuters from Solano County and areas north to the greater East Bay and San Francisco via the Benicia-Martinez Bridge.

Interstates in the project area provide access to employment sites and public services within Contra Costa County, are critical for goods and commuter movement along the East Bay shoreline, and connect Contra Costa to Marin, the San Francisco Peninsula, Solano County, and points beyond.

The three segments of interstate, including two transbay bridge approaches, in the project area that are at risk of flooding are described in more detail below. The approach to the Richmond-San Rafael Bridge from I-580 is at a topographic elevation such that it is not at risk from current or future flooding.

I-580 from the Castro Street Interchange to the Contra Costa County Line

This segment of I-580 carries local and regional goods and commuter traffic from Contra Costa County to Marin County and San Francisco County, and provides local and regional access to shoreline recreation in West Contra Costa County, including Richmond Shoreline to Point Isabel and Albany Waterfront East Shore State Park. It is at risk of future flooding and storm events at various locations. Pavement elevations vary

from at-grade to below grade from northwest to south. The Castro Street interchange and the segment near 2nd Street are raised, while the Cutting Boulevard interchange to the 23rd Street interchange is below grade and low-lying. Around Cerrito Creek at the Contra Costa County line, I-580 is at grade, varying from 9 feet to 11 feet NGVD near South 51st Avenue, and would have to be elevated three to five feet to be protected from sea level rise. The below grade and low-lying segment of I-580 from the Cutting Boulevard interchange to the 23rd Street interchange has three pump plants that drain depressed sections of the roadway at the Harbor Way O.C., Meeker Avenue, and at South 23rd Street. Additionally, a 25-foot deep by 4500 foot long bentonite clay cutoff wall runs from Cutting Boulevard to South 23rd Street to protect the roadway from current groundwater levels. Sea level rise is likely to cause the groundwater table in coastal areas to rise, which could impact this segment of I-580 as pavement structural sections could be damaged if the roadbed is constantly saturated.

This segment of I-580 is a major truck route and a route of regional importance with an average daily traffic of 67,000 vehicles. Even temporary damage or a partial closure of this segment of I-580 would impact traffic at a regional scale. There are very limited alternatives to re-route goods movement, in particular because this segment is a main route for truck traffic to/from the Port of Oakland Seaport, and re-routing truck traffic in the Bay Area can be challenging due to road use restrictions. In addition, loss of this segment would have significant impacts on worker access to local and regional jobs, and would greatly affect access to local and regional shoreline recreation.

I-80 Approach to the Carquinez Bridge and San Pablo Avenue Interchange
This segment of I-80 connects commuters and facilitates the movement of goods between Contra Costa and Solano Counties through the Carquinez Bridge.

Transit operator SolTrans (78, 80) serves commuters traveling from South Vallejo to/from the El Cerrito Del Norte BART station. While much of I-80 and the bridge approach segment is raised, it still sits within the 100-year floodplain and is vulnerable to rising sea levels. The reinforcing in concrete structures that supports the elevated portion of the roadway and the south anchorage building, which houses the bridge tension cables, could be impacted by a rising groundwater table as well as exposure to higher salinities.
As one of the most congested freeways in the region, disruption of I-80 would affect commuters and the movement of goods. Moreover, this segment of I-80 provides local and regional access to shoreline recreation along West Contra Costa County, including Point Pinole Regional Shoreline, San Pablo Regional Shoreline, and Carquinez Strait Regional Shoreline. Even temporary damage or disruption of this segment will have consequences on local and regional shoreline recreational access.

I-680 Service Road to the Benicia-Martinez Bridge Toll Plaza
I-680 connects the northern Bay Area to the East Bay via the Benicia-Martinez Bridge. This segment of I-680 near the Benicia-Martinez Bridge carries an annual average daily traffic of 100,000 vehicles and is a designated lifeline route.

I-680 is in the 100-year floodplain and also at risk of future flooding and storm events from an area near Service Road to the Benicia-Martinez Bridge Toll Plaza. While sections of Service Road segment are raised on an embankment, other sections are at-grade. There are a number of separate tributary drainage areas along I-680 that rely on stormwater systems to drain water from the freeway. The capacity of these systems to continue functioning as the Bay rises is unknown. Of particular concern is the sufficiency of the self-regulating gates at Peyton Slough to contain future extreme water levels. Rising groundwater could damage

the at-grade pavement structural section of the segment of I-680 in the project area if the roadbed is constantly saturated.

Disruption of this segment of I-680 could have significant impact on worker access to local and regional jobs. There is limited redundancy for car or bus commuters who rely on this segment of I-680 to access the Benicia-Martinez Bridge. Alternative routes such as Pacheco Boulevard are unlikely to be able to accommodate the same capacity as this segment of the freeway.

Marina Vista Avenue and Waterfront Road are at risk of flooding, jeopardizing access to the Benicia-Martinez Bridge. This would make it more difficult for local commuters to get to the interstate and the bridge, and cause delays and re-routing for those trying to get to jobs in the area. These include a number of large industrial sites near I-680, as well as commercial and public services in Martinez. Access to the county's only public hospital, and the Martinez Regional Shoreline Waterfront Park would also be more difficult.

VULNERABILITIES

GOV1. Agency coordination is required to maintain regional connections between interstates and local roads as well as regional alternative transportation corridors, trails, and bicycle facilities; which increases the complexity, time and cost involved in ensuring flooding does not impact the functionality of the roadway network.
GOV2: Improvements to local streets, roads, interstates, or transbay bridges that impact the Bay or shoreline, or cross creeks, rivers, wetlands, or other natural habitats, may require permits from a number of different regulatory agencies which increases the time needed to design and implement changes.
GOV3: The lack of planning funds, capital improvement financing, regulatory mechanisms, incentives or internal priority limits the ability of public agencies to assess and address the impacts of sea level rise and storm events on local streets and roads, in particular where flooding will be caused by diminished capacity of the stormwater system or where sea level rise will increase riverine flood risks.
GOV4: Many types of assets are often co-located with streets and roads, for example buried electrical or communication utilities, roadway drainage systems, or pipelines are often within road right-of-ways. Improvements will require close coordination with public and private utility companies.
GOV5: Caltrans will need to collaborate with the county, a number of local jurisdictions, and private landowners to improve the flood resilience of interstates, transbay bridges, and their approaches within and beyond the project area.
PHYS1: Saltwater intrusion may cause corrosion of the reinforcing in concrete structures that support the elevated portion of I-80 and I-680, and the anchorage buildings. Protective measures are in place for only some portions of structures that would be exposed to salinity (e.g., steel coated with epoxy protecting it from salt corrosion, and bridge anchorage buildings equipped with pumps and other flood resistant items).
PHYS2: A rising groundwater table could damage the at-grade pavement structural sections, in particular if the roadbed is constantly saturated. This will be a particular problem for the Richmond Parkway and Castro Street, as well as I-580 where it is in close proximity to the Bay, between I-80 and South 51st Avenue, where the pavement is very low and already requires protection from current groundwater levels.
FUNC1: There are limited alternative routes for commuters if any of the three interstate segments in the project area are flooded. Local streets do not provide adequate redundancy, as they cannot accommodate the same traffic capacity, which is projected to increase considerably.

FUNC2: There are limited redundancies among transit providers serving corridors parallel to I-580 and I-680, and even where alternatives are possible, it is unlikely these transit providers could provide commuters an adequate alternative, both in terms of capacity and desired route, for more than a short duration disruption.
FUNC3: There is limited redundancy for car or bus commuters who rely on I-80 to access the Carquinez Bridge. Re-routing commuters across other bridges may not be an adequate alternative, both in terms of capacity and desired route.
FUNC4: There are very limited alternatives to re-route goods movement if I-580 was disrupted, especially because this segment in the project area supports truck traffic to/from the Ports of Oakland and Richmond, and re-routing truck traffic can be challenging due to road-use restrictions.
FUNC5: Damage to the local street network near interstates, including damage to on and off ramps to/from the local street network, would impede traffic movement, e.g., flooding on Central Avenue could leave Richmond and surrounding communities without access to both I-80, I-580. Additionally, Central Avenue provides the only entry to Point Isabel Regional Shoreline and is the sole access, on the southern end via San Joaquin Street, to the community located between I-580 and I-80.
FUNC6: Power is needed for local traffic signal operation and it is not known if there are alternative power supplies to maintain signal function in the event of an outage. Signalized intersections would likely be treated as three/four-way stops during power outages presumed to be temporary, with city workers, vehicles, equipment, power, and communication needed to effectively reroute traffic.
FUNC7: While traffic can be rerouted in the event of flooding, highly congested areas such as Central Avenue at I-80 could experience significant disruption at the same time I-580 could be impacted, further exacerbating traffic and delaying relief efforts.
FUNC8: AC Transit (72M) connects commuters via Richmond Parkway and MacDonald Ave to the Richmond BART station. Any alternative public transit routes could result in significant delays for commuters.

CONSEQUENCES

Society and Equity: I-580 and I-80 are two of the most congested roadways in the region, and even minor disruptions to their levels of service significantly affect commuters. In addition, the segment of I-680 in the project area is a designated lifeline route and therefore access to it during and after a flood or storm event is critically important. Moreover, all three interstates provide local and regional access to shoreline recreation, including access to Point Isabel and Albany Waterfront East Shore State Park, Point Pinole Regional Shoreline, San Pablo Regional Shoreline, and Carquinez Strait Regional Shoreline, and the Martinez Regional Shoreline Waterfront Park.

Local streets and roads in the project area, including Richmond Parkway, San Pablo Avenue, and Waterfront Road are key routes that would affect commuters, residents, and the movement of goods if not fully functional. Neighborhoods served by a single access road, such as in Pinole and Richmond, are at risk of being disconnected from emergency services and are less likely to be able to remain in their homes after a flood event. Those without access to a vehicle may be most vulnerable since there are limited alternative routes in the project area and the only transit alternative to buses, which rely on local streets and roads, is Capitol Corridor passenger rail, which is not affordable for short commuter trip. Rerouting buses would result in delays that could impact their ability to get to work on time. Transit disruptions and delays could cause more individuals to drive, increasing air pollution overall, and disproportionately affecting air quality in neighborhoods adjacent to alternate and/or key commute routes.

Environment: Disruption of local streets and roads that public transit relies on could cause more individuals to drive, which could affect air quality. In addition, the loss of a portion of the transportation network may increase congestion, potentially resulting in greater emissions and lower fuel efficiency. Lastly, prolonged flooding of segments of an interstate, such as I-680, that are adjacent to natural areas and marshes could cause trash and pollutants to mobilize and stress habitat.

Economy: Interstates in the project area are critical to both the flow of goods and the ability of commuters to access local and regional jobs. As many of workers inbound to the county come from Solano County, and those commuting outbound are heading to San Francisco and points south along the East Bay, disruption of I-580, I-80 and I-680, local approaches and on/off ramps, and the transbay bridges they are connected to could have significant consequences on both the local and regional economy. In particular, workers who rely on vulnerable public transit assets or roads may be unable to get to work, affecting not only their wages but the economy of the region as a whole.

As congestion currently impacts the region's economy, any increased congestion resulting from temporary or long-term damage to a part of the transportation network could have significant costs to the region. For example, I-580 and I-80 are important truck routes, and the loss of either, even for a short duration, would impact regional, intra-state and inter-state goods movements.

Local streets and roads, and in particular the Richmond Parkway and San Pablo Avenue, provide access to local jobs, goods and services. Central Avenue provides access to regional and local jobs and one of the highest revenue producing East Bay Parks, the Point Isabel Regional Shoreline. Disruption to any of these corridors could have significant impact on the local economy, which could also cause cascading consequences on the regional economy.

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Water Management

In Contra Costa County there are 31 major watersheds and sub-watersheds containing more than 1300 miles of creeks and drainages. Fifteen watersheds are either completely or partially within the project area, including a portion of one of the large watersheds, Walnut Creek, which spans many cities, and a number of smaller “community-sized” watersheds such as Alhambra and Pinole Creeks. Managing these watersheds is a multi-disciplined effort, with planners, public works, and natural resource specialists often working side-by-side. As sea levels rise and the risk of flooding increases, water managers will be able to address some expected impacts, through strategies such as raising levees and berms, or installing water control structures or pump systems. Ultimately, in order to ensure broad community benefits are met while managing future flood risks, integrated, watershed-wide and multi-sector solutions will be needed. A solid understanding of the risk that water management systems face will help lay the foundation for developing, evaluating, and implementing strategies that balance protecting public safety, growing the economy, and providing community and environmental benefits to ensure a vibrant and resilient future.

The assessment of water management systems includes the assets, infrastructure, agencies and districts that provide the critical services of maintaining adequate water supplies for consumption and industrial or commercial uses; collecting, treating and discharging wastewater from businesses, industries and residents; and managing stormwater and flood control systems that keep roads, parking lots, neighborhoods, and businesses dry during storms. In the project area, the cities, the county, and a number of special districts provide water, wastewater, stormwater and flood management services. Some of these systems are interconnected – for example, stormwater collection and conveyance systems often discharge into flood control channels that then flow into the Bay. They are also indirectly connected – for example, uncollected stormwater can enter the wastewater system causing wet weather flows that can lead to sewage overflows. And lastly, these water management systems can provide inter-system redundancy – for example, treated wastewater can be reclaimed, recycled, and reused as industrial process water, offsetting the use of potable water sources. While each of the water management systems has specific challenges, they also share vulnerabilities to current and future flooding. There are, therefore, opportunities for shared, multi-benefit solutions that will result in more resilient water management systems not only in the county but also in the region as a whole.

Water Supply

Contra Costa County has two distinct water supply and retail service zones – the Eastern/Central Region and the Western Region. Sources of water supply to the Eastern/Central Region include the San Joaquin River, local groundwater, some recycled water and the Central Valley Project. Within the ART project area, water suppliers in the Eastern/Central Region include the Contra Costa Water District (CCWD), which wholesales and retails water sourced from the Delta through the Central Valley Project, and the City of Martinez, which purchases water from CCWD and provides retail water service to customers within and outside of the city. In the Western Region, the East Bay Municipal Utility District (EBMUD) sources water from the Mokelumne River and the Pardee Reservoir for retail and wholesale in Contra Costa as well as other counties in the East Bay.

As the source of water can be far from the ultimate end user, many water systems extend well beyond the project area and the county line. Water suppliers manage large and complex conveyance systems that include aqueducts, reservoirs, water treatment plants, pumps, water mains and other infrastructure. While some assets within the project area are located in areas at risk of flooding, the greatest potential impact of sea level rise on water service will occur outside the county, in the Sacramento-San Joaquin Delta. Sea level rise will increase salinity in the Delta, impacting water quality. Additionally, increased liquefaction potential during seismic events, storm event flooding, and rising sea levels will increase the potential for failure of Delta levees. Failure of the levees could result in damage to the Mokelumne Aqueducts and disruption of water supply in particular to the Western Region.

To ensure water supply reliability suppliers have built redundancy into their distribution and treatment systems. However, as the fastest growing county in the Bay Area, with an expected population growth rate of 27% between 2010 and 204073 Contra Costa will need to find new opportunities to improve water supply resilience to both accommodate growth and adapt to a changing climate.

KEY ISSUE STATEMENT

Water supply relies on interconnected, and sometimes large and complex, conveyance, treatment and distribution systems. While these systems have built in redundancies to help ensure reliability, if source water quality is affected by sea level rise, or the levee system protecting Delta supplies is damaged or fails, it may become difficult to provide the amount and quality of water customers in the project area are accustomed to.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Contra Costa Water District (CCWD), the City of Martinez, and EBMUD have water supply infrastructure in the ART project area and could be impacted by flooding and the effects of sea level rise. Of these three districts, only CCWD has major assets in the existing 100-year flood zone (coastal and/or riverine), which

[73] Water and Wastewater District's MSR-SOI Study (2nd Round) Contra Costa LAFCO, http://www.contracostalafco.org/municipal_service_reviews.htm

could also be exposed to more frequent or longer duration flooding due to sea level rise. Because the project did not obtain georeferenced location data for CCWD's assets, the exposure of specific water supply infrastructure assets (e.g., pumps stations) was not evaluated. In addition, it is challenging to evaluate the exposure of the water supply infrastructure below ground (e.g., water mains), as little is known about how sea level rise will impact groundwater levels at any location along the Bay shoreline. Additional studies and refined site or asset specific scale analyses will be needed to better understand risks water supply assets face from flooding.

ASSET DESCRIPTIONS

CONTRA COSTA WATER DISTRICT (CCWD)

Contra Costa Water District provides water service to approximately 500,000 customers in central and northeastern Contra Costa County. CCWD delivers approximately 121,170 acre-feet annually of treated and untreated water to its customers, which include retail and wholesale customers, municipalities, agricultural users and industrial customers.

CCWD's water supplies are diverted from the Sacramento-San Joaquin Delta. CCWD operates four water intakes in the Delta: Mallard Slough, Rock Slough, Old River and Middle River. CCWD's main conveyance facility is the 48-mile Contra Costa Canal, which conveys untreated water from Rock Slough and terminates at the Martinez Reservoir located in the City of Martinez. The Canal also conveys water to an untreated water pipeline called the Shortcut Pipeline, which provides water service to several small industrial customers, and delivers water to Martinez Reservoir and Mallard Reservoir. Mallard Reservoir serves as a water storage forebay for CCWD's Bollman Water Treatment Plant. CCWD has several untreated and treated water interties with neighboring agencies that can be used in the event of emergency to provide mutual aid.

Only a portion of the CCWD service area and infrastructure are within the project area. Flooding may impact only the Mallard Reservoir and the Shortcut Pipeline, both of which are within the current 100-year floodplain and could be impacted by sea level rise. It is important to note, however, that the greatest potential risk posed by sea level rise to CCWD service will not be direct impacts on water supply infrastructure, rather impacts to water quality in the Delta.

THE CITY OF MARTINEZ

The City of Martinez was formed in 1876 and it is approximately 12.47 square miles. The City's Public Works Department manages its water system and provides service to 30,191 people in the city, unincorporated areas outside the city, and a portion of the City of Pleasant Hill. Additionally, Martinez provides service to commercial, industrial, public, and irrigation customers. Martinez's water supply assets include: Martinez water treatment plant, Martinez Reservoir, 10 storage reservoirs, 200 miles of water lines, and 13 pump stations. Although the City of Martinez water treatment plant and reservoirs are not at risk of flooding, if CCWD's assets are disrupted it could have an impact on Martinez since the city purchases its water from CCWD. The City of Martinez has worked with CCWD to build emergency contingencies between their systems.

EAST BAY MUNICIPAL UTILITY DISTRICT (EBMUD)

EBMUD was established in 1923 and provides water service to 477,212 residents within a 146 square mile area of Contra Costa County. Within the project area, EBMUD's service area includes the cities of Richmond, San Pablo, Pinole, Hercules, Rodeo and unincorporated areas of the County. EBMUD diverts water from the Mokelumne River Basin in the Sierra foothills and delivers it to the East Bay through the three Mokelumne Aqueducts a complex water conveyance system. EBMUD's water supply assets in Contra Costa County include: five terminal reservoirs, two water storage reservoirs, 170 neighborhood reservoirs, 91 miles of transmission aqueducts, six water treatment plants, 4,100 miles of water mains, and 140 pumping plants. None of EBMUD's reservoirs or treatment plants within the project area are at risk of flooding, however EBMUD relies on the Mokelumne Aqueducts that could be exposed to flooding as a result of Delta levee failure. While the three aqueducts do provide built-in redundancy, if all three fail, then EBMUD would need to rely on water from a local terminal reservoir that could provide only four to six months of service. EBMUD has documented reliability risks for all major infrastructures from various hazards, including flooding. Redundancies in the water system that address seismic hazard vulnerabilities could also help avoid service disruption during a flood event.

VULNERABILITIES

GOV1: Water suppliers that rely on others for source water and have systems that are interconnected will need to work collaboratively to adapt to sea level rise and develop emergency contingencies between systems to respond to flooding impacts.
GOV2: Water systems that are protected from sea level rise or storm events by assets or lands owned by others will need to engage in collaborative planning to find shared, multi-benefit solutions that protect water supplies as well as other community assets or infrastructure.
FUNC: Water supply agencies rely on chemicals for treatment, power to run the facilities, and road access to maintain their assets and ensure workers can reach them. If flooding impacts power supplies or the roads and highway system that provide access to and from water supply facilities, the ability to provide continuous water service may be interrupted.
PHYS1: Water supply pipelines and aqueducts located in predominantly low strength bay muds, loose sandy soils or filled land that are exposed to sea level or groundwater rise may be at increased risk of damage during a seismic event due to increased liquefaction susceptibility
PHYS2: Floodwaters as well as rising groundwater will increase the potential that pipelines become buoyant and float, making them susceptible to damage and increasing the need for maintenance, repair, and replacement.
PHYS3: As sea level rises, the Delta will get increasingly saline, which will impact the availability of fresh water sources used by Bay Area communities and beyond.

CONSEQUENCES

Society and Equity: Water is critical for emergency response, especially for hospitals, and fire protection, and is required for recovery after a disaster such as an earthquake or widespread flooding. Any unforeseen, long-term disruption of water would impact all customers, and in particular members of the community such as the elderly or young children who are particularly reliant on safe drinking water.

Environment: No direct environmental impacts are currently anticipated.

Economy: Water supply is disrupted and emergency supplies are exhausted, economic disruption would be significant throughout Contra Costa County.

ASSET SCALE ASSESSMENT FINDINGS

The Contra Costa Water District was selected as a representative water supply facility to assess because its agency staff actively participated in the project working group and provided critical review and feedback, to ensure that information gathered was as accurate and reflective of existing conditions as possible. Moreover, of the three water supply purveyors within the project area, CCWD was the only agency with assets directly at risk of flooding. The profile sheets summarizing the assessment findings for these assets can be found at the end of this chapter.

Wastewater Services

Wastewater is the refuse liquid and materials from washing, flushing or manufacturing processes, including water from sinks, showers, washers and toilets, chlorinated pools, commercial car washes, and industrial processes. To protect public and environmental health, wastewater is collected and treated prior to discharge by wastewater service providers, including special districts and local jurisdictions. Wastewater service providers own and manage systems that are typically large and complex, and include interconnected infrastructure such as pipes, pump stations, treatment plants, storage and discharge facilities, monitoring stations, and overflow outlets. Interconnected infrastructure is often owned and operated by different service providers as well as by public and private entities. For example, privately owned sewer laterals that are maintained by individual property owners connect individual properties to the public collection system. The public collection system, including sewer mains, interceptors, force mains and pump stations that lift wastewater throughout the collection system can be owned and managed by one service provider, while the treatment plant and discharge facility can be owned and managed by another.

Wastewater treatment plants and satellite facilities that store and manage flows during wet weather events (wet weather facilities) are critical to ensuring pollutants are removed prior to discharge. In addition, treated wastewater can be reclaimed and recycled for reuse at special facilities associated with the main treatment plant. In the project area there are eight treatment plants, a wet weather facility, a reclamation facility and a recycling facility.

There are a number of existing stressors on wastewater systems, including changes in demand due to population and economic growth, which can stress the entire system. This is particularly the case if capacity is already limited, if there is a lack of system redundancy, and if there is aging infrastructure that requires ongoing operation and maintenance. There is also stress on the system from pollutants and organic loading factors that can reduce treatment efficiency.

During dry weather, the amount of wastewater conveyed, treated, and discharged generally depends on the amount of water consumed. While water conservation measures can effectively reduce average dry weather flows these practices have limited impact on pollutant or organic loading factors, and in some cases conservation can increase the organic strength of wastewater. During wet weather wastewater flows can increase even where the collection system is designed to be separate from the stormwater system, as is the case in the project area. Wet weather causes increases in flows due to infiltration and inflow (I/I). Infiltration occurs when groundwater enters sewer pipes through cracks, pipe joints, and other system leaks. Inflow

occurs when rainwater enters the system from improper drain connections (e.g., yard, patio, roof gutter, footing), uncapped cleanouts, cross-connections with the stormwater system, and manhole covers. Water conservation will not significantly reduce the impact of wet weather flows, and while service providers can reduce infiltration and inflow by investing in capital improvements such as pipeline rehabilitation, manhole cover replacement, and root eradication, sources of infiltration and inflow on private property must also be addressed in order to reduce overall system impacts.

Organic loading levels depend on the amount of organic matter disposed. Higher loading levels may add additional stress on primary and secondary treatment processes. In addition to organic matter, wastewater may contain metals; sediment; hazardous household materials such as motor oil, paint, household cleaners, and pesticides; and high-strength or toxic substances from industries and commercial enterprises. Pretreatment programs and industrial permits can significantly reduce the concentration of these materials, such as by limiting the strength and contaminant levels in industrial and commercial wastewater. In addition, service providers can charge increased rates or surcharges on high strength wastes, or provide incentives for industrial and commercial water recycling and reuse.

KEY ISSUE STATEMENT

Wastewater treatment plants are large, expensive and complex, and are interconnected with collection, conveyance and discharge systems. As there is little to no redundancy within these systems, and because they rely on roads, power, materials and supplies from off-site, they are highly vulnerable to sea level rise and storm events. Flooding could result in significant wastewater service disruptions. Additionally, the combination of existing infrastructure problems and limited funding may prevent some agencies in Contra Costa County from planning and implementing adaptation responses to address the challenges of sea level rise.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Eight of the nine wastewater treatment plant sites in the project area are either completely or partially within the existing 100-year floodplain. Six of these eight treatment plants may also experience more frequent or extensive flooding with sea level rise of one to three feet. Watershed-specific hydraulic modeling is needed to improve the understanding of the impact that higher Bay water levels could have on flood risks within and beyond the existing 100-year floodplain boundary. This modeling is particularly important for the two treatment plants within the 100-year floodplain that are not shown impacted by sea level rise (Central Contra Costa Sanitary District and the CCSD C&H plant).

EBMUD's Point Isabel Wet Weather and Richmond Advanced Recycling Expansion (RARE) facilities are not within the current 100-year floodplain and both could be impacted by sea level rise. The shoreline that protects the Point Isabel facility will be exposed to as little as one foot of sea level rise. However, the wet weather facility itself will not be impacted by sea level rise, as the shoreline is high enough to prevent inland flooding. The EBMUD RARE facility, however, could be flooded with five to six feet of sea level rise.
The exposure analysis presented below is for the entire treatment plant site footprint, which varies in size depending on the type of service provided and service area. For larger treatment plants, site-specific exposure analyses will be needed to understand which, if any, infrastructure assets or components are at risk. In addition, public sewer lines (including mains, force mains and interceptors), pump stations, and

private sewer laterals were not evaluated in the exposure analysis, but are considered in the discussion of overall vulnerability and risk to the function of the wastewater system.

Table 34. Treatment plants that could be located in the current 100-year floodplain and/or exposed to sea level rise.

Asset	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Central Contra Costa Sanitary District	Martinez	Yes						
Mt View Sanitary District	Martinez	Yes			Yes	Yes	Yes	Yes
Pinole / Hercules Wastewater Treatment Plant	Pinole	Yes			Yes	Yes	Yes	Yes
Rodeo Sanitary District	Rodeo	Yes		Yes	Yes	Yes	Yes	Yes
Crocket Community Services District - Port Costa Wastewater Treatment Plant	Port Costa	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crocket Community Services District - C & H Wastewater Treatment Plant	Crockett	Yes						
Crocket Community Services District Wastewater Treatment Plant	Crockett	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Richmond Municipal Services District Wastewater Treatment Plant	Richmond							
West County Wastewater Treatment Plant	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EBMUD Wet Weather Wastewater Treatment Plant	Richmond	No	Yes	Yes	Yes	Yes	Yes	Yes
EBMUD RARE	Richmond	No					Yes	Yes

ASSET DESCRIPTION

WEST COUNTY WASTEWATER DISTRICT

West County Wastewater District (WCWD) was formed in 1921 and currently provides wastewater disposal services to 16.9 square miles of Contra Costa County, including the unincorporated areas of Contra Costa County (43% of District), portions of the cities of Richmond (40% of District), San Pablo (15% of District) and Pinole (2% of District). WCWD serves a population of approximately 92,976 residents, as well as industrial, commercial and public customers.

WCWD conveys wastewater via a system of pipes and pumps to the Water Pollution Control Plant for treatment prior to discharge or reuse. Currently, most of WCWD's eight million gallons per day (MGD) average dry weather flow (ADWF) secondary treated effluent is sent to EBMUD's North Richmond Water Reclamation Plant (NRWRP), and the Richmond Advanced Recycling Expansion (RARE) for reuse by Chevron's Richmond Refinery. Flows exceeding 12.5 MGD, or that do not meet quality standards required by EBMUD, are dechlorinated and discharged to the Bay through the West County Agency deep-water outfall.

WCWD owns and manages the treatment plant, which has a rated capacity of 12.5 MGD ADWF and a rated peak wet weather capacity of 21 MGD. The West County Agency, which is a joint powers authority of WCWD and the City of Richmond Municipal Sanitary Sewer District, constructed and maintains the outfall and diffuser. The outfall has a design capacity of 58.94 MGD and extends approximately 4,700 feet into Central San Francisco Bay, with the last portion being a diffuser section designed to ensure maximum dilution and mixing with deep Bay waters.

A portion of the WCWD treatment plant is located in the current 100-year floodplain of San Pablo and Wildcat Creeks. The main lift station that pumps wastewater to flow by gravity through the treatment plant, the pump station that pumps treated effluent either to the water reclamation/recycling facilities or the deep water outfall, and the equalization basin pump station that pumps influent flows in excess of 21 MGD to on-site storage basins, are all located in the 500-year floodplain. The north side of the plant is protected from San Pablo Creek by a county managed levee system, and there are 9-10 foot berms surrounding the treatment plant that may protect it through 2030, but will need to be adapted to withstand future flooding and storm events.

NORTH RICHMOND WATER RECLAMATION PLANT (NRWRP) AND THE RICHMOND ADVANCED RECYCLING EXPANSION (RARE)

East Bay Municipal Utility District (EBMUD) provides wastewater, recycled water, and drinking water service throughout the East Bay, including Contra Costa County. The EBMUD North Richmond Water Reclamation Plant (NRWRP) and the Richmond Advanced Recycling Expansion (RARE) receive secondary treated wastewater from West County Wastewater District (WCWD) and treat it for reuse by industrial, public and private customers. The RARE delivers purified water to Chevron's Richmond Refinery to generate steam and the NRWRP provides tertiary treatment to meet Chevron's tower cooling needs. The expected life of the existing EBMUD assets is to around mid-century. The NRWP is in the 500-year floodplain while RARE is at risk of future flooding and storm events.

POINT ISABEL WET WEATHER FACILITY (PIWWF)

EBMUD provides wastewater disposal services in the unincorporated community of Kensington, the cities of El Cerrito and Richmond through the Stege Sanitary District, which serves a population of approximately 28,107. Stege Sanitary District collects wastewater from these cities and delivers it to EBMUD's North Interceptor, which is then directed to EBMUD's Main Wastewater Treatment Plant in Oakland. During peak wet weather flow conditions, wastewaters from the North Interceptor are diverted to the Point Isabel Wet Weather Facility (PIWWF) for discharge via the Point Isabel Wet Weather Facility Outfall and diffuser to the Richmond Inner Harbor. While PIWWFF is not in the floodplain, the assets that convey flows to this facility, including the North Interceptor and Force Main, may be at risk of damage from flooding.

The PIWWFF and the outfall have a design capacity of 100 million gallons per day (MGD). The outfall extends approximately 300 feet into the Bay, with the last portion being a diffuser section designed to ensure maximum dilution and mixing with deep Bay waters. Wet weather overflows have declined in frequency since the PIWWF began operating, however according to the Regional Water Quality Control Board74, EBMUD's "annual discharge volumes for all [wet weather facilities] exceed the long-term design goal of 100 million gallons per year." EBMUD is planning for long-term changes to the system since negotiating a consent decree with the USEPA effective September 2014. In this agreement, EBMUD and its satellite collection agencies will implement projects to reduce inflow and infiltration in the collection system and gradually eliminate need for the wet weather facilities.

Although the PIWWF facility is planned for retirement by 2035, more frequent storm events may cause inflow and infiltration beyond current levels. Before PIWWF is retired, EBMUD may need to plan for maintenance or repairs in the event there is flooding that affects this facility or the interconnected infrastructure it relies on.

WASTEWATER TREATMENT IN THE CITY OF PINOLE, THE CITY OF HERCULES, AND RODEO

Wastewater from the Cities of Pinole and Hercules is treated at the Pinole-Hercules Water Pollution Control Plant in Pinole, which has an average annual flow of 3.5 million gallons per day (MGD) and a peak wet weather flow of 15 MGD. While Pinole manages the treatment plant, both cities have equal ownership over the asset and have entered into a Joint Powers Agreement with Rodeo Sanitary District to dispose of their secondary treated wastewater through a common outfall.

The treatment plant currently serves a residential and commercial population of approximately 40,000, including 6,000 Pinole customers and 3,000 Hercules customers, although the City of Hercules is expected to increase in population by 36% by 203075. The treatment plant capital improvement plan includes $42 million to upgrade aging infrastructure to meet this expected increase in demand and to reduce existing wet weather inflow and overflows to address Regional Water Quality Control Board disposal requirements. Capital improvements will also be needed to protect the treatment plant from flooding as it is within the existing 100-year floodplain and is at risk of more frequent or extensive flooding with three feet of sea level rise.

The Rodeo Sanitary District (RSD) owns and manages the Rodeo Sanitary District Water Pollution Control Plant and provides service to 8,000 customers in the unincorporated communities of Rodeo and Tormey. The plant treats an average of 500,000 gallons per day (GPD) and has a 1.14 MGD capacity, although the Rodeo collection system has insufficient hydraulic capacity to handle peak wet-weather flow larger than a 5-

[74] California Regional Water Quality Control Board San Francisco Region (October 2005). Order No. R2-200s-0047 NPDES Permit No. Caoo3844o. East Bay Municipal Utility District Special District No. 1. Wet Weather Facilities. Alameda and Contra Costa Counties. Adoption Date: September 21, 2005. Effective Date: October 1, 2005.

[75] Rodeo Sanitary District, February, 2014, Sewer System Management Plan, http://rodeosan.org/LinkClick.aspx?fileticket=M7TLxrw4WPc%3D&tabid=56&mid=406

year storm. RSD adopted a 20-year Comprehensive Wastewater Management Plan in 2013, which accounts for a 15% population increase in its service area. The plan calls for $37.2 million in improvements to address existing problems with its aging infrastructure. The treatment plant is in the 100-year floodplain and at risk of future flooding and storm events with two feet of sea level rise.

The Pinole-Hercules Water Pollution Control Plant and the Rodeo Sanitary District common outfall has a current design capacity of 13.45 MGD and planned improvements would expand capacity to 16.4 MGD. The outfall extends approximately 3,900 feet into the Bay; the last portion is a diffuser section designed to ensure maximum dilution and mixing with deep Bay waters.

WASTEWATER TREATMENT IN THE CITY OF MARTINEZ AND IN BAY POINT, CROCKET AND PORT COSTA

Wastewater services in the City of Martinez and in Bay Point, Crocket and Port Costa are provided by three different small systems operated by three different sanitary districts. Mt. View Sanitary District is one of the wastewater systems serving Martinez. Bay Point is served by Delta Diablo and Crockett and Port Costa are served by the Crockett Community Services District (CCSD). The Delta Diablo wastewater treatment plant is not at risk from either current or future flooding.

Wastewater from the northeasterly portion of the City of Martinez, and adjacent unincorporated areas to the northeast is treated at the Mt. View Sanitary District (MVSD) Wastewater Treatment Plant. The MVSD service area is approximately 4.7 square miles and the treatment plant serves a population of approximately 18,253. MVSD is designed to handle an average annual flow of 3.2 million gallons per day (MGD) and currently experiences an average dry weather flow of 1.25 MGD and peak wet weather flow of 7.5 MGD. The MVSD's $31 million capital improvement plan includes funding for upgrades to the treatment plant and pump stations. MVSD owns and manages the treatment plant as well as 151 acres of constructed marshland and adjacent wetlands. The District owns 87 acres and manages the balance under a conservation easement agreement with East Bay Regional Park District. MVSD discharges secondary treated effluent to the on-site constructed marsh, Peyton Slough and adjacent wetlands. While the MVSD treatment plant itself may not be at risk of flooding, the constructed marsh is within the 100-year floodplain and is at risk of future flooding and storm events with three feet of sea level rise.

Delta Diablo provides service to customers in the unincorporated community of Bay Point, and outside the project area in the Cities of Antioch and Pittsburg. The Delta Diablo Sewer System Master Plan and Master Plan of Facilities allocates $10 million in improvements over the next 10 years.

The Crockett Community Services District (CCSD) serves a one square mile area with a population of approximately 3,094 in Crockett and 190 in Port Costa. Wastewater from Crockett is treated at the Joint Use C&H Sugar Company-Crockett Community Services District Phillip F. Meads Water Treatment Plant, which is operated by C&H, the plant's majority owner.

CITY OF RICHMOND WASTEWATER TREATMENT PLANT

The Richmond Municipal Sewer District (RMSD), which is operated and managed by the City of Richmond, provides wastewater disposal service to a 52.6 square mile service area with approximately 65% of the city's residents (68,000) as well as industrial, commercial and public customers. The city operates and manages

the RMSD, but has contracted out the management of the treatment plant to Veolia Corporation. The treatment plant has a capacity of nine million gallons per day (MGD) and a peak wet weather flow of 16 MGD. Dechlorinated effluent from the plant is discharged to the Bay through a deep-water outfall owned and managed by the West County Agency, a joint powers authority between the city and WCWD to construct and maintain the outfall and diffuser. The West County Agency outfall has a design capacity of 58.94 MGD. The outfall extends approximately 4,700 feet into Central San Francisco Bay, with the last portion being a diffuser section designed to ensure maximum dilution and mixing with deep Bay waters. The treatment plant is neither within the 100-year floodplain nor at risk of flooding due to sea level rise; however the effluent pump stations that convey wastewater to the treatment plant may be at risk.

VULNERABILITIES

GOV1: Wastewater agencies collaborate with other entities to treat and discharge wastewater collected in their respective service areas and will therefore need to collaborate on funding, planning, and decision-making to avoid system-wide failures.
GOV2: Wastewater infrastructure is interconnected to, and affected by, other systems and assets (e.g., stormwater contributes to wet weather flows to wastewater treatment plants) that are owned and managed by different public and private entities. The process and relationships may not be in place to support the coordination and collaboration that will be needed to address these shared vulnerabilities.
GOV3: Directing resources to long-term planning to address the risks posed by sea level rise may not be a priority given existing capital demands. The majority of the wastewater plants have collection systems, which consist of aging infrastructure with numerous pipe segments in need of repair or replacement in the short term.
FUNC1: Wastewater treatment systems are large, expensive, and complex, and there is little to no redundancy within each system, making them highly vulnerable to sea level rise and storm events.
FUNC2: Storm events and extreme high tides have the potential to reduce outfall and diffuser capacity and exacerbate wet weather flows. Existing capacity limitations will be further reduced as sea levels rise, which would have consequences on how wastewater treatment plants handle wet weather flows and may threaten the overall performance of their respective systems.
FUNC3: Wastewater service providers rely on road access to maintain their infrastructure and facilities, obtain necessary supplies and equipment, and ensure employees can reach work sites. If flooding impacts the roads and highway system that provide access to and from wastewater facilities, the ability to provide continuous service may be interrupted.
PHYS1: The wastewater treatment plants adjacent to the San Francisco Bay are located on predominantly low soil strength bay muds and artificial fill and could be subjected to greater risk of liquefaction during a seismic event due to a high groundwater table.
PHYS2: Rising groundwater will increase the potential that interceptor pipelines will become buoyant and float, making them susceptible to damage that will increase the need for maintenance, repair, and replacement.
PHYS3: Flooding can increase inflow from stormwater to interceptor pipelines through manholes and other structures, and higher groundwater conditions can increase infiltration into the system. These increases in wet weather flows will further limit the capacity to convey and treat wastewater prior to discharge or reclamation/recycling.
PHYS4: Wastewater treatment plants and effluent pump stations require an uninterrupted power supply to maintain function

PHYS5: If electrical and mechanical components, including pumps and control panels, are at or below grade and are not waterproofed or salt-resistant, they could be damaged and the treatment plant may not be able to fully function.

CONSEQUENCES

Society and Equity: Wastewater treatment plants provide a critical public health and safety function. If storm events or sea level rise overwhelm and compromise the system, then a plant's ability to treat and discharge wastewater could be affected. Without service, sewer backups could occur in the affected cities and unincorporated areas, driving residents out of their homes, at least temporarily, and businesses to close.

Environment: If storm events or sea level rise overwhelm and compromise the treatment plants, toxic substances and excessive nutrients could overflow into the adjacent shoreline areas and Bay, degrading water quality and harming fish and other aquatic organisms.

Economy: A wastewater system disruption could potentially have wide-ranging consequences in the communities serviced by the wastewater treatment plants. Cumulative impacts on commercial and industrial businesses and the associated employment, goods, and services they provide could also be significant. Operations and maintenance costs, as well as capital improvement costs, could increase with storm event and sea level rise flooding.

ASSET SCALE ASSESSMENT FINDINGS

The West County Wastewater District (WCWD), North Richmond Water Reclamation Plant (NRWRP), and the Richmond Advanced Recycling Expansion (RARE) were selected to assess at the asset scale because staff at these agencies actively participated in the project working group, shared information about the sites and its operations, and provided critical review and feedback on the information gathered to ensure it was as accurate and reflective of existing conditions as possible. Moreover, the North Richmond Water Reclamation Plant (NRWRP), and the Richmond Advanced Recycling Expansion (RARE) differ from the wastewater treatment plants profiled in this Chapter in that their services have a unique set of vulnerabilities and consequences. The profile sheets summarizing the assessment findings for these assets can be found at the end of this chapter.

Flood Control

The impacts of sea level rise will not be confined to the shoreline. Sea level rise will also affect every creek and flood control channel that drains to the Bay. As the level of the Bay rises, the tide will push further upstream, reducing the capacity of tidal creeks and channels to accept stormwater runoff. This will cause backups or flooding in low-lying areas, and increase the risk of overbank flooding, in particular when rainfall events coincide with annual extreme high tides or during storm events.

Flood management responsibilities in the project area are shared by the Contra Costa Flood Control and Water Conservation District (District), which operates county flood protection and stormwater management infrastructure, and the Cities of Richmond, San Pablo, Hercules, Pinole and Martinez, which own and manage local stormwater systems. In addition, there are other public agencies, such as Caltrans, and private entities, including the Union Pacific Railroad, commercial shopping centers, and multi-family residential

properties that manage stormwater collection and conveyance systems that are connected to the public flood protection infrastructure. The interconnected nature of flood protection and stormwater management systems means that vulnerabilities are shared, and solutions to increase resilience will need to address both systems and their connected components, rather than a single system or only assets owned and managed by a single entity.

Countywide, the District manages 79 miles of channel and 29 dams and detention basins with an estimated value of over $1 billion. Many of these channels have engineered (improved) sections, and some are undersized for the amount of land development that has occurred in the contributing watershed. In addition, others may have been designed to convey flows for the 100-year flood standard protection level, but have lost capacity over time due to sediment accumulation. The District has a maintenance backlog due to insufficient funding, and due to the high cost and difficulty of completing sediment removal projects that for some channels (i.e. low gradient tidally influenced channels) is only a short-term solution, as sediment quickly accumulates. Many of the District's major facilities were constructed in partnership with the federal government and have ongoing federal oversight, with increasing federal protection requirements, and decreasing federal funding, making improvements or conducting ongoing maintenance difficult.

The District's ability to maintain or improve the county's flood protection system was sharply impacted, and in some watersheds virtually eliminated, by Proposition 13 in 1978 and Proposition 218 in 1996. Presently, the District has no mechanism to increase revenues in these watersheds even while they confront aging infrastructure and deferred maintenance. In addition, projects to address flooding can run into the tens of millions of dollars but there is public opposition to additional property-based assessments, limited grant funding, and decreasing Federal funding, concurrent with the desire for habitat preservation and increased community expectation and involvement. Even with these challenges, the District has developed a "50-year Plan," adopted in 2009, to convert traditional flood protection infrastructure (concrete and rip-rap lined channels) to natural systems through multi-objective creek enhancement efforts.

KEY ISSUE STATEMENT

Sea level rise coupled with ongoing sediment accumulation in low-gradient tidal creeks and channels will reduce the amount of flood protection in the project area. Funding is severely limited, and in some locations conflicting goals mean that maintenance or improvement activities are especially difficult and costly. To better understand the risks to the flood management system, watershed-scale hydraulic models are needed, and it is critical that planners work with flood managers to better understand the vulnerability of nearby homes, businesses, utilities, and community facilities. With this information, the county and cities can engage stakeholders in long-range planning and develop funding strategies to implement projects that improve resilience to sea level rise, while providing other community and environmental benefits.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Flood channel exposure to sea level rise was visually evaluated by overlaying FEMA Flood Insurance Rate Maps (FIRMs) and sea level rise inundation maps. While this approach can suggest if there is a potential risk of joint coastal-riverine flooding, only watershed-scale hydraulic modeling can accurately quantify the combinations of Bay water levels, sea level rise, and riverine flows that will cause adjacent areas to flood. Without this joint coastal-riverine flood modeling, the potential for an increase in flood risk in the current 100-

year floodplain due to sea level rise may be underestimated, and low-lying areas that rely on the flood control and stormwater management system to remain dry during storm events may be underrepresented.

ASSET DESCRIPTION

There are eight major creeks within the project area that are managed for flood protection. This includes Alhambra, Pinole, Refugio, Rheem, Rodeo, Walnut, Wildcat and San Pablo Creeks. The Contra Costa County Flood Control and Water Conservation District (District) manages six of the creeks, while the City of Martinez manages Alhambra Creek and the City of Hercules manages Refugio Creek. Brief descriptions of each creek are provided below, and more detailed descriptions can be found in the asset-specific profile sheets developed for this project.

ALHAMBRA CREEK

Alhambra Creek drains approximately 17 square miles of mostly open space and agricultural lands in the upper portion of the creek and downtown Martinez in the lower portion. The City of Martinez manages Alhambra Creek, a natural channel that was improved to reduce flood risks in the lower reaches in 2001. Areas adjacent to the creek below Marina Vista Avenue are no longer in the 100-year floodplain, while areas upstream beyond the current reach of the tides are within the100-year floodplain. Currently, flooding can occur during 10-year storms and when there are larger riverine flows, impacting adjacent land uses such as roads, homes and community facilities that must use sand bags to minimize flood risks.

PINOLE CREEK

Pinole Creek drains approximately 15 square miles of mostly open space and agricultural lands in the upper watershed, and flows through a mixture of residential, commercial, and industrial uses in the City of Pinole before entering the Bay. In 1965, the U.S. Army Corps of Engineers (USACE) constructed a 1.5-mile earthen trapezoidal channel designed for the 50-year riverine flow to prevent flooding in downtown Pinole. As the local sponsor, the District owns and maintains the channel, however, they do not receive funding due to restrictions associated with Propositions 13 and 218. In 2008 the District partnered with the City of Pinole and the State on a demonstration project to restore the design flow capacity of the channel, and ultimately inspire residents to raise local funds for improved maintenance. Sediment has been accumulating in the tidal reach of Pinole Creek because of conditions created by the original USACE 1.5-mile earthen trapezoidal channel designed for the 50-year riverine flow which has been reduced to now only convey approximately a 25-year riverine flow. During high creek stages, interior drainage backs up into the neighborhood around Orleans Drive on the south side of the creek, and the 2005/2006 New Year's Eve storm events almost caused overbank flooding.

REFUGIO CREEK

Refugio Creek drains approximately five square miles of mostly open space and residential land uses in the upper watershed, and an area slated for future mixed commercial and residential uses in the lower watershed. Lower Refugio Creek is a natural channel managed by the City of Hercules, funded through a stormwater assessment fee that is currently $37 per household. The creek has not been engineered to provide a specific level of flood protection; instead, Refugio Creek downstream of San Pablo Avenue is a "regulated floodway", meaning Hercules must regulate development in the creek and designated adjacent land uses to ensure discharge of the 100-year flood event. The creek was realigned and restored in the early

2000s as part of the remediation for an explosives manufacturing facility that began in the 1980s. While this improved flood capacity in Lower Refugio Creek, portions of the 100-year floodplain extend beyond the channel banks and into area slated for development.

RHEEM CREEK

Rheem Creek drains approximately three square miles of mostly residential lands in the City of San Pablo, flowing adjacent to East Bay Regional Park District's Bruener Marsh before entering the Bay. In 1960, the USACE constructed a trapezoidal, unlined earth channel from the Bay edge to Giant Road, designed for approximately a 15-year storm riverine flow. Since significant urbanization has occurred subsequent to the construction of the flood control project, the channel now provides protection from less than the 15-year riverine flow. Additionally, outdated FEMA Flood Insurance Rate Maps (FIRMs) underestimate the community flood risk. As the local sponsor, the District owns and maintains the channel, however they receive less than 20% of the funding necessary for maintenance due to restrictions associated with Propositions 13 and 218.

RODEO CREEK

Rodeo Creek drains approximately 10 square miles of mostly open space and agricultural lands in the upper watershed and the community of Rodeo in the lower watershed. In the 1960s, the USACE constructed a flood control project from the mouth to I-80 to provide 100-year flood protection. As the local sponsor, the District owns and maintains the channel, however receives only 5% of the funding necessary to perform channel maintenance, such as desilting, due to funding restrictions associated with Propositions 13 and 218. Sediment accumulates in the tidal reach of Rodeo Creek because of conditions created by the original USACE design. Since desilting is both expensive and difficult to permit, the last sediment removal effort was in the mid-1990s. As a result the channel now only conveys approximately the 15 to 20-year riverine flow, and the 2005/2006 New Year's Eve storm events almost caused overbank flooding.

WALNUT CREEK

Walnut Creek is the largest watershed in Contra Costa County, draining over 150 square miles and containing eight cities and over 300,000 residents. Starting in 1963, the USACE constructed about 22 miles of channel improvements consisting of channel enlargement, channel stabilization, and levees along Lower Walnut Creek and its tributaries to provide 100-year flood protection. The existing project is a classic trapezoidal earthen channel with levees on one or both banks, which has historically needed de-silting to maintain the design capacity. As the local sponsor, the District owns and maintains the channel, receiving only 75% of necessary maintenance funding due to restrictions associated with Propositions 13 and 218. Very high tides travel up the tidal channel in the marshland between Waterfront Road and Suisun Bay, resulting in the flooding of Waterfront Road (parallel to Union Pacific Railroad), impacting traffic flow in and out of the Tesoro Refinery. Approximately a three to five year storm event causes water to leave Walnut Creek and enter Pacheco Marsh, which is protected by only a small berm and not an engineered levee. Although much of Lower Walnut Creek provides the design level 100-year flood protection, a low-lying portion of a levee buffering the marshland has been shown to have a reduced level of protection (to approximately a 40-year storm event) based on revised hydrologic information being issued by the Army Corps of Engineers. The District is working on an innovative Lower Walnut Creek Restoration Project to reduce current flood risk, accommodate sea level rise, manage sediment, improve wildlife habitat, and provide more recreation opportunities.

WILDCAT AND SAN PABLO CREEKS

Wildcat and San Pablo Creeks drain approximately 11 and 42 square miles, respectively. Once the creeks exit upper watershed canyons, they flow westward and parallel to each other through San Pablo, Richmond, and North Richmond passing through an area of mostly industrial land uses before reaching Wildcat Marsh. From 1987 to 1992, the USACE constructed a flood control project on Wildcat and San Pablo Creeks to provide protection to development downstream of Union Pacific Railroad for the 100-year riverine flow at mean higher high water (MHHW). As the local sponsor, the District owns and maintains the channels, however it receives only 8% of the funding needed for management due to restrictions associated with Propositions 13 and 218.

The District is currently planning a levee rehabilitation project on Wildcat and San Pablo Creeks funded through a Local Levee Critical Repair grant from the Department of Water Resources. The project, expected to begin in 2016, will meet FEMA requirements and ensure the levees, which were decertified in 2010, will be recertified so that adjacent properties, including the West County Wastewater Plant and the low-income North Richmond neighborhood, will not be subject to flood insurance requirements.

VULNERABILITIES

INFO1: FEMA FIRMs depict riverine and coastal flooding as independent events and use the higher of the two flood elevations where riverine and coastal floodplains overlap. Joint probability analysis of riverine and coastal events will be necessary to understand the likely increases in elevation and extent of the 100-year floodplain as sea levels rise.
INFO2: The lack of up-to-date watershed-scale hydraulic models for the creeks and channels in the project area limits the understanding of current and future flood risks. These models are needed to evaluate various combinations of Bay water levels and sea level rise to determine the potential that combined coastal-riverine flooding will impact adjacent communities and infrastructure.
GOV1: Flood managers from the county and the cities in the project area currently have to compete for grants to improve flood control channel condition and capacity. A reliable financing mechanism is needed to address outstanding maintenance, capital improvement, and long-range flood management planning.
GOV2: Contra Costa County and cities have no dedicated funds for capital improvements or long-range flood management planning to address the impacts of sea level rise, or for flood mitigation actions such as purchasing properties in the existing 100-year floodplain as they become available.
GOV3: City and county flood managers do not have adequate maintenance funding to preserve what limited flood capacity exists in the channels they manage. For Pinole Creek the cities and county have developed a strategy for maintenance, capital improvements, and long-range flood management but have not yet been able to fund its implementation.
GOV4: Improvements to the five creeks that are federal facilities must be consistent with USACE policy to remain eligible for federal disaster relief. Current USACE policy prohibits vegetation on any part of flood control levees, which conflicts with original design criteria (e.g., for Wildcat and San Pablo Creeks) and make channel maintenance difficult. In addition, existing O&M Manuals that guides creek work do not reflect the existing channel sediment accumulations (e.g., Pinole Creek's aggraded channel) and do not allow for restoration measures to help relieve these issues.

GOV5: For some of the creeks (Alhambra, Pinole), the Union Pacific Railroad (UPRR) bridges are the most significant hydraulic constriction, and the dimensions of these UPRR bridges affect future flooding. However, UPRR has not been an active stakeholder in flood management planning in the project area.
GOV6: At present, there is no framework for planning and permitting innovative, multi-benefit flood protection projects. Each agency is constrained by its mandate and regulations, resulting in generally static and fragmented decision-making, passive management, and an emphasis on historic preservation despite the fact that climate change is expected to lead to unforeseen and potentially detrimental impacts. Since flood risk management is a long-term investment, it can take decades to develop concepts, obtain funding, build public support, and design and permit plans before initiating a multi-phase project.
FUNC: Creeks and channels provide flood protection to adjacent land uses, and sea level rise may diminish this function, exacerbating conditions in existing floodplains and causing new areas to be designated as floodplains.
PHYS1: Sea level rise will increase tidal action and reduce the capacity of the eight major creeks in the project area to convey and discharge flood flows, particularly when rainfall events coincide with high tide. This may lead to overbank flooding or backwater affects if channel water levels are too high to allow stormwater to drain by gravity.
PHYS2: There may be a limit to the efficacy of traditional engineering flood protection solutions in low-lying areas, at which point flood managers, planners, regulators, community groups, business owners and decision makers, among others, will need to leverage their collective expertise and resources to pursue land use planning solutions.

CONSEQUENCES

Society and Equity: Increased flooding in creeks and channels that currently provide adjacent communities flood protection could result in extreme burden on socio-economically disadvantaged communities. For example, in North Richmond, San Pablo and Rodeo, where community members have limited resources to pay for flood insurance and do not have the means or access to resources to prepare for, respond to, and recover from flood events. In addition, sea level rise may reduce available freeboard, and channel levees may lose their Federal Emergency Management Agency (FEMA) accreditation, which would require residents and property owners in the newly designated floodplain to purchase flood insurance, which could pose a significant financial burden.
Flooding may impact both local and regional jobs. If refineries or industrial sites located near the creeks and channels are flooded or are inaccessible, and if storm events and sea level rise shut down shoreline wastewater treatment plants, even temporarily, untreated wastewater could back up into homes, businesses, and neighborhoods and spread disease. Furthermore, mobilization of contaminants from facilities that have hazardous materials, some which are within the current 100-year floodplain, could pose a risk to public health.

Environment: Increased flooding in creeks and channels may mobilize hazardous substances from adjacent industrial sites, landfill/waste facilities, and wastewater treatment plants, decreasing water quality and affecting marsh habitat and endangered species, such as saltmarsh harvest mouse populations in Wildcat Marsh or threatened Coho salmon (federally listed), threatened steelhead trout (federally listed), threatened black rails (California State Threatened species), and endangered California Ridgway's rails (California State and federally endangered species) in Walnut Creek.

Economy: If the creeks and channels cannot provide adequate flood protection, there could be disruptions to local roads, damage to energy services, shutdowns to treatment plants serving residents and businesses, and lack of railroad service. This loss of goods, services and jobs will have a significant impact on the regional economy.

ASSET SCALE ASSESSMENT FINDINGS

All eight flood control channels in the project area were assessed with the assistance of Contra Costa Flood Control and Water Conservation District and city staff who actively participated in the project working group, shared information about the channels they manage, and provided critical review and feedback on the information gathered to ensure it was as accurate and reflective of existing conditions as possible. See the individual flood channel profile sheet for a description of each asset and a summary of the assessment findings.

Stormwater

Stormwater runoff is generated when rainfall or snowmelt runs overland rather than infiltrating into the ground. In urban areas stormwater runoff is typically collected by curbs and gutters, ditches, and catch basin systems, and then conveyed in underground pipes to outlet locations, which are in most cases a flood control channel, although in some areas, they are conveyed to the Bay shoreline. Where the grade allows, stormwater is conveyed by gravity. In low-lying areas where gravity is not adequate, stormwater pump stations are needed to transport water to a higher elevation before it can drain to an outfall location.

Stormwater runoff can also be retained, detained or treated prior to discharge, which is typical for runoff from industrial land uses or large developed areas. In some locations, pumping is necessary to manage systems, such as lagoons that provide retention/detention but are tidally influenced. The combination of water control structures (tide gates) and pumping in advance of rainfall events helps to ensure there is adequate capacity for runoff storage until the tide is low enough to allow for discharge.

The stormwater assessment for the project area considers how sea level rise will impact stormwater management systems – that is, how higher Bay water levels will affect the drains, pipe network, pump stations, and outfalls that collect and convey stormwater. A discussion of how current and future precipitation may interact with higher sea levels, potentially resulting in reduced flood management capacity, is discussed below. It should be noted, however, that in addition to sea level rise the amount and timing of precipitation may shift due to climate change. Changing precipitation patterns could cause flooding even far from the shoreline, for example where existing stormwater management systems do not have adequate capacity to handle larger rainfall runoff events.

KEY ISSUE STATEMENT

The capacity to collect, convey and discharge flows to flood control channels or the Bay will be reduced by sea level rise. Outfalls that are below the new high tide or storm event water level may need to be elevated, have check valves installed to prevent backups, or need to be pumped rather than drain by gravity. In addition, cities, counties and districts are extremely limited in their ability to raise revenues for stormwater system maintenance or improvement, even to address currently undersized systems or deferred maintenance, which will make taking action to adapt to sea level rise even more challenging.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The impact that exposure to sea level rise and storm events will have on the stormwater management systems depends on the current storage and flow capacity, the elevation and location of outfalls, whether the system is gravity drained or pumped, and whether there are valves to prevent Bay water from entering the stormwater system and taking up pipe capacity needed to convey and store stormwater. If elevated Bay water levels coincide with a precipitation event, the stormwater system may not have enough capacity to store and convey runoff, which could result in back ups and inland flooding.

Due to resource and data limitations, an exposure analysis was not completed for the stormwater systems in the project area. However, the City of Richmond Public Works Department staff did evaluate the exposure of their stormwater system working with ART Program staff, and their exposure analysis serves as an example of both how to complete a citywide analysis and the extent of impact sea level rise might have on other stormwater systems in the project area.

The City of Richmond exposure analysis determined which components of their storm system are either located in an area that could be flooded with six feet of sea level rise at high tide (i.e., mean higher high water, MHHW) or have their lowest point (invert elevations) below MHHW plus six feet of sea level rise. This analysis is displayed on a map at the end of this chapter. Seventy-nine (79) outfalls, which are the city stormwater system's first line of defense against sea level rise, could be inundated at high tide with six feet of sea level rise. As these outfalls do not have storm gates to prevent Bay water from entering the stormwater system, where upstream pipe capacity is insufficient to store both stormwater and Bay water, there is the potential for street and basement flooding during extreme tides or even the daily high tide. This is already a problem in many low-lying areas along the Richmond shoreline, such as in the Richmond Annex neighborhood, that already experiences "sunny day flooding" when stormwater does not drain during high tide and backs up into people's homes.

Table 35. Stormwater assets in the City of Richmond potentially affected by, or with an invert elevation below, 6 feet of sea level rise plus MHHW (NAVD88). Table courtesy Patrick Phelan, City of Richmond Engineering Services Department.

Collection Device	Total City-wide	Total with invert below 6 feet SLR	% at risk
	Number	**Number**	
Collection Device (storm drains, catch basins, etc.)	5270	396	8%
Manhole	1846	349	19%
Weir (engineered sanitary sewer overflow)	2	2	100%
Outfall	136	79	58%
Storm Gate (not including sluice gates)	16	9	56%
Pump Station	12	7	58%
	Miles	**Miles**	
Force Main	0.22	0.19	86%

Pipe	151.9	25.5	17%
Pipe with diameter of 36 inches or greater	36.1	8.6	24%
CMP (corrugated metal pipe)	4.8	0.4	9%
Culvert (large, often square conveyances)	6.1	2.4	39%
Concrete Ditch	13.5	0.4	3%

ASSET DESCRIPTION

In the ART project area, public stormwater management systems typically collect and convey runoff from roadway or public facilities, and are owned and managed by the county, the cities and Caltrans. Large private landowners own and maintain their own stormwater systems, which may or may not connect to the public stormwater system depending on the land use and location. Both public and private stormwater systems can ultimately discharge to flood channels, most of which are owned and operated by the Contra Costa County Flood Control and Water Conservation District, although Alhambra Creek is managed by the City of Martinez.

Stormwater discharges are regulated through National Pollution Discharge Elimination System (NPDES) permits under the federal Clean Water Act. NPDES directs states to adopt and enforce water quality standards, establish maximum allowable pollution levels for water bodies, and monitor and regulate discharges into water bodies. The State Water Resources Control Board, which has overall responsibility for water quality, delegates the administration of NPDES permits to its regional boards. Contra Costa County is within the jurisdiction of two water boards, the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the Central Valley Water Board, although the project area is within the jurisdiction of the RWQCB only. The permits issued by both boards are very similar. Each local jurisdiction must implement specified activities year-round, including incorporating stormwater pollution prevention into municipal operations; inspecting local businesses and construction sites; enforcing prohibitions against non-stormwater discharges entering creeks or storm drains; performing specified public outreach activities; requiring new developments to manage runoff pollutants; reducing the quantity of trash, copper, mercury, and PCBs entering creeks and storm drains; and, monitoring water quality, among other activities (http://www.cccleanwater.org).

The Contra Costa Clean Water Program (CCCWP) includes the county, 19 cities/towns (El Cerrito, San Pablo, Hercules and Martinez in the project area), and the Contra Costa County Flood Control and Water Conservation District, which are NPDES co-permitees. CCCWP assists with permit compliance by providing guidance and training, and by implementing public outreach and water-quality monitoring that can be done most cost-effectively at the countywide scale.

For most of Contra Costa County, stormwater management activities, including pollution prevention, are funded by various revenue sources including a stormwater utility assessment authorized in 1993. The City of Richmond does not have a stormwater utility assessment and other revenues, including the General Fund, are used to fund stormwater management activities.

VULNERABILITIES

INFO1: Studies to analyze stormwater system capacity to store and drain various combinations of future Bay water levels and precipitation events are needed to develop operational, maintenance and capital improvement plans to improve system resilience to sea levels rise.

INFO2: Information critical to evaluating the exposure of stormwater system components, such as outfall elevations and pipe capacity, is not readily available in GIS for all systems in the project area.
GOV1: City and county resources for stormwater management are strained to prevent stormwater pollution, protect local waterways, and preserve local environmental quality, leaving very limited or no resources to support the long-range planning necessary to address the impacts of sea level rise.
GOV2: The authority to raise taxes or fees to pay for stormwater management activities has been sharply constrained by voter initiatives, and most municipalities are unable to shift General Fund revenues to pay for stormwater activities. In addition, Contra Costa municipalities with a stormwater assessment have had level funding since 2009 even though NPDES permit compliance costs have increased.
GOV3: An integrated planning, regulatory, and funding framework for comprehensive, watershed and community-based stormwater and flood control management does not currently exist even though sea level rise impacts will increase the need for coordination and shared decision making among cities, property owners, and flood control managers.
FUNC1: Stormwater system components that rely on gravity drainage are often at the lowest elevation in the system, and these low-lying areas could be at the highest risk of flooding. These components will not function at full capacity as Bay water levels rise, therefore flooding in these areas may last longer than expected.
FUNC2: Pump stations rely on uninterrupted power to operate. While backup generators and onsite fuel storage can help avoid service disruption, the ability to resupply fuel and undertake necessary maintenance may be limited if the local streets and roads that provide access to the station are flooded.
FUNC3: In areas that already require pumping to manage stormwater and control flooding, pumps will have to lift water above the new, elevated Bay water level, which may exceed system design capacity.
PHYS1: As sea level rises, the capacity of stormwater pipes may be insufficient to store both rainfall runoff and the Bay water that could enter pipes if outfalls are below the high tide or storm event water level and check valves are not in place to keep tidal flows out.
PHYS2: As sea level rises, stormwater infrastructure such as pipes and pump stations that were not constructed for saline water conditions will suffer from corrosion if they are not improved or replaced. For example, corrugated metal pipes do not have as long a lifespan as other material types, and exposure to flooding or seawater could cause them to fail earlier than expected.
PHYS3: Higher groundwater levels could impact stormwater management systems, in particular, pipe networks that are subject to infiltration, green infrastructure and low impact development practices, as well as traditional stormwater detention and retention facilities
PHYS4: Pump stations that have sensitive electric or computerized components that are exposed to flooding could be temporarily interrupted or become permanently damaged, such as if corrosion due to saltwater exposure occurs.
PHYS6: If pump stations operate more frequently, or pump water to higher elevations, energy and maintenance costs will increase, and pumps will not last as long.

CONSEQUENCES

Society and Equity: Reduced discharge capacity of the stormwater system and failures of pump stations could cause flooding of streets and roads, neighborhoods, job centers and parks, and disrupt access to homes, schools, jobs and needed services. Stormwater system failures that cause street and road flooding could impede emergency response, important not only for the immediate problems caused by flooding, but also for medical or other emergencies that require urgent attention. If floodwaters are not removed quickly, they could become breeding grounds for mosquitoes and other disease vectors. There are also equity

concerns, as some low-lying areas that are currently pumped to maintain positive drainage have lower-income residents that are particularly vulnerable to flood impacts and displacement, especially when language barriers or poorly maintained infrastructure that could exacerbate existing street and basement flooding.

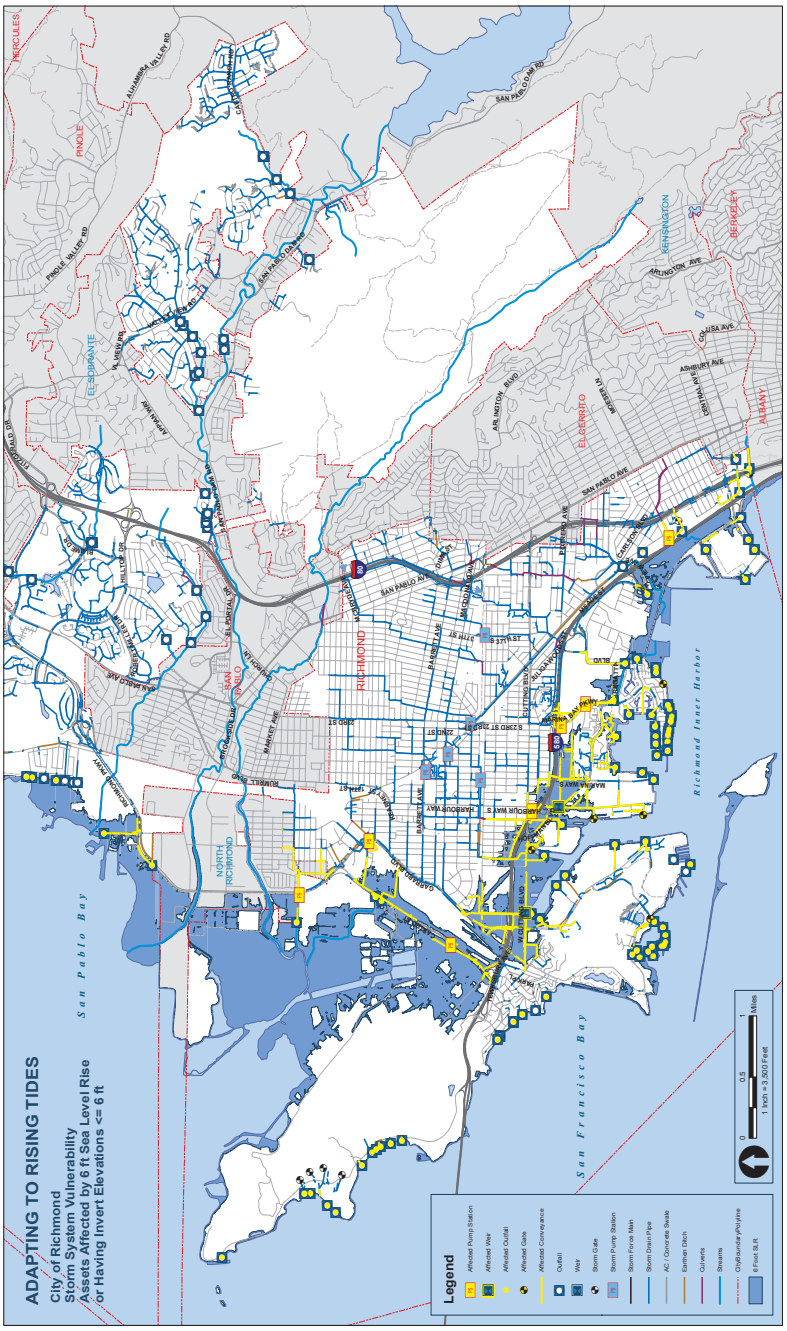
Environment: Damage, disruption or failure of the stormwater system could cause flooding in industrial or post-industrial areas, such as the South Richmond shoreline, as well as commercial and residential properties, where hazardous materials may not be stored securely above floodwaters. This may mobilize contaminants and impact wetland habitat and Bay water quality if stormwater redistributes contaminants. An impaired stormwater system would distribute contaminated runoff more broadly; rather than flowing directly to the Bay, pollutants could be deposited wherever the stormwater backups flow.

Economy: There will be a direct impact on the economy if stormwater systems are damaged, as the cost of water removal, cleanup, and repairs to damaged structures and landscapes could be quite high. Flooding or exposure to saltwater that damages stormwater system components, such as pumps, pipes, inlets, and outfalls, could also lead to costly system repairs or the need for replacement. Flooding of streets and roads due to diminished function of the stormwater system could disrupt access to local goods, jobs and services and affect local and regional economies, such as if the heavy industrial sites, including the four refineries, or the Port of Richmond, are affected. In addition, regional passenger and freight rail service could be affected, which would impact the regional economy. Flooding of homes and businesses in neighborhoods could impact the local economy if residents and employees must relocate where they live or work, especially if the disruption is long enough or the damage is severe.

ASSET SCALE ASSESSMENT FINDINGS

The City of Richmond's stormwater system was selected as a representative asset for assessment because City Public Works staff actively participated in the project working group, shared information about the system, conducted an in-house GIS exposure analysis, and provided critical review and feedback on the information gathered to ensure it was as accurate and reflective of existing conditions as possible. See the City of Richmond Stormwater profile sheet summarizing the assessment findings.

Figure 14 Map of city stormwater assets potentially affected by, or with an invert elevation below, six feet of sea level rise plus MHHW (NAVD88). Map courtesy Patrick Phelan, City of Richmond Engineering Services Department.



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http://rodeosan.org/LinkClick.aspx?fileticket=M7TLxrw4WPc%3D&tabid=56&mid=406

Project Key Planning Issues

Key planning issues are the challenges that require the collective focus of the project team, the working group and other stakeholders to take action. In the ART Approach to adaptation planning, the identification of key planning issues also serves as a process that summarizes and organizes the assessment findings across the sectors and assets so they can be clearly and succinctly communicated. In addition, the process of determining key planning issues gives the working group an opportunity to consider their shared priorities and lays the groundwork for the actions necessary to resolve some of the most challenging issues uncovered in the assessment. In the Contra Costa ART project, six key planning issues emerged that cut across the sectors, geographies and governance challenges identified in the assessment.

Why define key planning issues?

ART Program projects like other adaptation efforts develop adaptation actions for the individual assets, asset categories and sectors. These actions can be implemented by individual asset managers, owners, agencies or organizations to address asset-specific issues.

Key planning issues are the cross-cutting challenges and vulnerabilities that should not be solved separately because they require collaborative problem-solving by the working group and other stakeholders. ART has found that focusing on key planning issues with the working group makes the best use of often limited time and resources, and helps lay a pathway towards the collective action that will be necessary to achieve the project resilience goals.

Key Planning Issue #1: Water-dependent Industries

Contra Costa County's seaport, marine oil terminals, and shoreline refineries rely on transportation and utility networks that are vulnerable to sea level rise and storm events. Flooding of critical roads, rail lines, or pipelines both within the county and beyond could hinder critical goods export and import as well as processing operations within the County, negatively impacting the local and regional economy.

The Port of Richmond and associated industrial marine terminals handle the majority of the region's liquid bulk and automobile tonnage. Contra Costa County's seven marine oil terminals, transfer bulk fuel from ships to distributors and processors, including four of the region's five refineries that are located in the county. All of these facilities are large, sit at fairly fixed locations, and rely on both waterside and landside connections to move goods on and off-site as well as in and out of the region. Their continued operation depends on a functioning regional network of pipelines, rail lines, roadways and interstates, on- and off-site energy supplies, water and wastewater services. These facilities also rely on local road access, which is critical to ensuring that necessary materials and supplies, as well as workers, can reach them, and that goods and products can be shipped from the facilities to other locations..

Transportation and utility connections both within and outside the county are vulnerable to flooding and sea level rise. Damage or disruption to these connections could cause the slow down or cessation of operations

at the facilities they serve, such as the Port of Richmond, marine terminals and refineries. For example, while both city-owned and private terminals at the Port of Richmond may not flood or be damaged, disruption of the Union Pacific or Burlington Northern Santa Fe rail lines due to sea level rise or storm damage would significantly impact seaport operations because commodities such as automobiles and bulk materials cannot be easily moved by truck. The rail lines in the project area, which serve many shoreline industries, cross an estimated nine miles of coastal and riverine floodplain, run directly along the shoreline in many locations, and cross multiple creeks and channels on bridges that are below current and/or future 100-year flood levels. In addition, the entire rail network is highly vulnerable because damage at any point in the system can result in system-wide disruptions. Loss of rail service to the seaport could result in increased truck traffic, congestion, and air quality impacts in surrounding neighborhoods, local roadways, and interstates.

Flooding of local streets and roads, as well as local access to the region's interstates, will impact the water-dependent industries that rely on them. A number of the roads that provide access to the Port of Richmond are low in elevation and exposed to future flooding that could disrupt access and operations. This includes low-lying areas of West Cutting Boulevard and Canal Boulevard as well as Harbour Way South, Wright Avenue and Ohio Avenue in the City of Richmond. In addition, Waterfront Road, which provides access to a number of industrial land uses in and near Martinez, already floods during extreme tides including the annual King Tide. These challenges will only increase as sea levels rise, and along with it the frequency, extent, and duration will cause these critical locations to be at a higher risk of flooding.

Utility networks that serve water-dependent industrial uses, in particular those that rely on buried pipelines, are at risk from sea level rise impacts including higher groundwater levels, salinity intrusion and flooding, Exposure to salt water can corrode pipes, rising groundwater can increase liquefaction potential during a seismic event, and in the event of flooding, pipelines that are not weighted or anchored may float or break, particularly during prolonged flooding in marshy or sandy soils. Damage to pipelines will result in disruption or possibly a shut down of the marine oil terminals and refineries, as well as threaten public safety and the environment in the event of an explosion or release of hazardous materials.

Multi-agency cooperation, public-private partnerships, and coordinated local and regional action will be necessary to improve the resilience of Contra Costa County's water-dependent industries. Outreach is needed to educate businesses and industries that may be unaware that sea level rise can impact their operations by damaging or disrupting the transportation and utility networks they rely on. Additionally, clear guidance for how best to assess and respond to rising sea levels, as well as incentives and regulatory requirements to do so, will help water-dependent industries and others proactively address their own vulnerabilities. Outreach and educational efforts can also increase the participation of business and industry in collaborative efforts to address regional transportation system vulnerabilities and improve the resilience of goods movement networks serving Contra Costa County and the rest of the region. These efforts are critical as the goods movement corridor in Contra Costa is among the busiest in Northern California, and interruptions would produce significant repercussions regionally, statewide, and nationally.

Key Planning Issue #2: Creek-side Communities

Shoreline communities that are located in or near the floodplain of a tidal creek or channel are likely to experience more frequent or extensive flooding as sea levels rise. There are eight major creeks and channels within the project area that are managed as flood protection infrastructure. Communities adjacent to these eight tidal creeks and channels are at varying levels of risk from current flooding, and as sea levels rise and

the tides begin to push higher upstream, water levels may near channel capacity during storm events or overflow their banks causing flooding of adjacent areas. Communities near creeks and channels may also experience flooding if the stormwater systems they rely on to keeps roads, sidewalks and parking lots dry, begin to back up, which is a particular concern in low-lying areas and areas that are currently pumped to maintain drainage.

Those that live along creeks and channels can have both a limited understanding of the flood protection function these systems provide and have limited influence over their maintenance or management. Living within or near areas that could flood is a particular challenge for those that are linguistically or socially isolated, elderly, very young, disabled, mobility-challenged or low-income as these community members can be less able to prepare for, respond to or recover from flood events. For example, community members with these characteristics can face difficulties evacuating and finding temporary shelter during a flood event as they may depend on others for mobility, personal care and support, or may require special equipment or universally accessible transportation and shelter-in-place facilities.

Community economic and ownership factors including low-income, rental and cost-burdened households as well as households that do not own a vehicle can impact the outcome both during and after a flood event. For example, low-income households, renters and cost-burdened households may not find affordable replacement housing within or near their community, even if for a short period of time, and may not be able to easily get to work or access the services they need, resulting in their permanent displacement from the community.

Creeks and channels managed as flood protection infrastructure often have deferred maintenance due to a lack of funding and an extensive regulatory process. These challenges have reduced the capacity of these systems to convey design storm flows, placing adjacent communities at risk of flooding from smaller and potentially more frequent storm events. Many of the creeks and channels in the project area that were originally designed to provide protection from a 100-year storm now have reduced capacity, and provide a lower level of protection. Rodeo Creek, for example, was constructed by the USACE to provide the 100-year level of protection but now only protects adjacent areas from a 15 to 20-year riverine flow. The District receives only 5% of the funding necessary to perform channel maintenance such as desilting, which is both expensive and difficult to permit, thus the last removal was in the mid-1990s. The reduced channel capacity places the adjacent community at risk of flooding now, for example the New Year's Eve storm of 2005/2006 almost caused overbank flooding, and the risk will continue to increase as sea levels rise.

In addition, not all of the creeks and channels in the project area were designed for the 100-year level of protection. Communities adjacent to these creeks face even earlier risks of flooding as sea levels rise. For example, Pinole Creek was designed for the 50-year riverine flow but now conveys approximately a 25-year riverine flow because sediment accumulates in the channel's tidal reach due to conditions created by the original design. The District is responsible for managing Pinole Creek but has no funding to do so because zero dollars were allocated to it and the passage of Proposition 13 in the 1970s and restrictions associated with Proposition 218 make it extremely difficult to increase funds for flood protection. To inspire residents to raise local funds for improved maintenance, in 2008 the District partnered with the City of Pinole and the State on a demonstration project that restored the design flow capacity of the channel, however additional funding has not yet become available and the creek remains at 25-year capacity.

To better understand the risks to creek-side communities as sea levels rise, new or updated watershed-scale models are needed for many of the tidal creeks and channels in the project area. While the District has updated the model of Wildcat and San Pablo Creeks as part of a levee rehabilitation project funded by a Local Levee Critical Repair grant from the Department of Water Resources and for Lower Walnut Creek, all other models, if they exist, are outdated and there are no current resources to update them. Watershed-scale hydraulic models also inform how and where upstream flood mitigation projects can slow, store or retain stormwater, improving overall system function and reducing flood risk in the lower tidal portions of the watershed. This is critical as stormwater management systems collect and convey water may themselves be impacted by rising sea levels, which could impact the function and capacity of the flood management system they are connected to.

Addressing current and future flood management challenges in Contra Costa County will require new levels of coordination between state, federal, and local agencies, special districts, private landowners and communities. Flood managers, planners, private landowners, and others will need to work together to develop a shared understanding of the vulnerabilities of the infrastructure and communities within each watershed. This includes assessing the characteristics that will place some communities and community members at greater risk from flooding and at a disadvantage during recovery. Inviting community members to engage early on will increase the amount of community knowledge, values, and issues that are heard and addressed, and will ensure that community members know about and will more readily participate in the effort. A great example of a vigorous community-based process is the District's Lower Walnut Creek effort that will result in a multi-benefit restoration project to reduce current flood risk, accommodate sea level rise, manage sediment, improve wildlife habitat, and provide more recreation opportunities.

Key Planning Issue #3: Access to Services

The limited number public facilities and the lack of redundant transportation options in the project area may result in shoreline communities becoming isolated from essential services, with potentially significant consequences on public health and safety, local economies and community function. Shoreline communities in the project area rely on public services provided by law enforcement, fire districts, county health services, school districts, water, wastewater and solid waste districts. Several of these public services are already limited, and increased community needs both during and after a flood even will add an additional strain. And while reduced or lost access to services will impact all community members, those with characteristics such as limited income or mobility, may be disproportionally impacted if they cannot reach the healthcare providers, jobs, schools, and other critical services they rely on. For example, after the recent closure of the Doctors Medical Center in San Pablo the only remaining public hospital in the entire county is the Contra Costa Regional Medical Center in Martinez. Access to this medical center could be interrupted as Alhambra Avenue is currently at risk of flooding and sea level rise may increase the risk that adjacent Alhambra Creek overflows its banks during an extreme high tide.

During widespread flooding events, many of the county health services in project area could be inaccessible at the same time, including the regional medical center, health centers and school-based clinics. At the same time, the county's mobile clinics may not be able to reach those communities with the greatest need. In addition, emergency and other critical services provided by law enforcement and fire districts could be affected if the facilities providing these services are flooded, or if the local streets and roads used by emergency responders to access those in need are flooded.

Flooding may also disrupt other critical services, including solid waste collection. For example, the Golden Bear Waste Transfer Station in Richmond is within the current 100-year floodplain and will be at greater risk of flooding as sea levels rise. The continued operations of Golden Bear and the Contra Costa Transfer Station in Martinez will become more challenging as sea levels rise because both facilities rely on a wide network of local streets and roads to access the neighborhoods they serve and to move trucks and waste in and out of their facilities. Parr Boulevard, which provides sole access to the Golden Bear Waste Transfer Station, and Waterfront Road, which provides access to Waterbird Way and the Contra Costa Transfer Station are at risk from future flooding as sea level rises. Temporary or permanent closure of transfer stations could cause significant disruptions in community solid waste collection services, increase the distance and expense of hauling waste, and cause public health and nuisance pest concerns.

The lack of redundancy in the shoreline transportation system will not only mean that flooding of local streets and roads, critical intersections, and major routes and thoroughfares will impact community members' ability to access necessary services, it may also impede or delay emergency services from reaching neighborhoods and communities. While some storm related flooding could result in relatively short disruptions or delays, even temporary flooding can damage streets, roads and other transportation assets such as bridges, requiring a significant amount of time and funding to repair and resulting in longer travel times due to re-routing or increased congestion. The loss of transportation or transit options in areas that already have few alternatives, coupled with the already limited availability of public services, could translate to higher economic costs and health burdens on all shoreline community members, although those who are mobility or economic challenged or socially or linguistically isolated may experience even a greater impacts.

Updating emergency and hazard mitigation plans to consider and address the future flood risks of critical services and the roadway system will help communities be better prepared both before and after an event occurs. In addition to considering future flooding, updates that incorporate the unique characteristics and needs of the people who live in areas at risk will result in a more effective response and a more resilient recovery. By increasing knowledge sharing between first responders and community members, not only will the planning be stronger, but also relationships between those that may be in need and those that are responding to those needs will be improved. For example, inclusion of community members and leaders in planning can ensure the use of culturally and ethnically appropriate communication methods during an emergency. In addition, working together flood managers, planners, public service providers, emergency responders, transportation agencies and community members can create hazard mitigation plans to ensure neighborhoods do not become isolated from necessary services by flooding. Lastly, all of these efforts can help communities develop and maintain strong social capital that will help them be more resilient to changing conditions. Social capital—that is the informal relationships, supportive social ties, social cohesion and communication networks—helps buffer individuals and neighborhoods from stressors, keeping communities functioning when public services fail or are overwhelmed during disasters.

Key Planning Issue #4: Ad-hoc Flood Protection

Some communities are protected from coastal flooding by rail lines, shoreline parks, and tidal wetlands that currently reduce flood risks even through they were not specifically designed or are they maintained for this function. These types of shorelines therefore provide only "ad-hoc" flood protection, with the public and private entities that manage them neither having the capacity nor resources to maintain them as flood protection. In addition, as sea levels rise, increased wave and tidal energy, higher extreme tides, and more

frequent exposure to regular tidal inundation will decrease the ability of these ad-hoc systems to maintain the flood protection benefits they currently provide.

Communities in the project area that are protected by ad-hoc flood protection vary, and some have characteristics that may place them at greater risk, for example those with residents with limited resources, that are living in mobile homes, have mobility challenges, or lack access to information, transportation and public service options. Characteristics such as these can hinder communities and their member's ability to prepare for, respond to, and recover after, a flood event. Because these communities are currently protected—albeit in an ad-hoc manner—many have not experienced coastal flooding and therefore may not be aware of current risks or have sufficient information about the potential changes in flood risk that will result as sea level rises. Particular consideration and support will be necessary for communities that linguistically, socially or historically disconnected from political processes and decision-making regarding shoreline and flood protection improvements.

Miles of rail line that lay in between the Bay and communities such as Bay Point, Montalvin Manor, Rodeo, Port Costa and Parchester Village serve as ad hoc flood protection. Rail lines are neither constructed nor maintained to prevent inland areas from flooding, and there are often culverts or passages in the track that could allow coastal water through during a storm. Some segments of rail line in the project area have wetlands on their Bay side to help protect them from tidal and wave action, such as near Parchester Village and Bay Point. Other segments of rail line are the first line of defense along the shoreline, which is the case in Rodeo and Port Costa. As sea levels rise, higher water levels during extreme tides and storm events will increase the risk that track embankments and ballasts will be damaged. In addition, rising groundwater can damage the track bed and ballast materials, causing the rail line to become unstable. While ongoing maintenance may help prevent rail lines from becoming structurally unsound in the short term, rising Bay water levels coupled with a rising groundwater table calls for a new solution to protect both the function of rail lines and the inland areas they protect.

Some of the communities protected by rail lines have limited resources or live in mobile homes that are highly susceptible to flood damage. For example, Berrellesa Palms in Martinez is a 48-unit affordable housing community for low-income seniors (62+) with chronic health conditions. This community is currently protected from flooding by the Union Pacific (UP) Railroad as well as by the Martinez Regional Shoreline, but is at risk from sea level rise. Tara Hills Mobile Manor, located in Bayview-Montalvin, is a senior (55+) mobile home park that is protected from flooding by UP and Burlington Northern Santa Fe (BNSF) rail lines, as well as the MonTara Bay Park. Lastly, Parchester Village, a residential neighborhood built in the early 1950s with approximately 900 residents living in very low-income households is located adjacent the Union Pacific rail line just south of Point Pinole Regional Park. The railroad and natural habitats, including Breuner Marsh, sit between this neighborhood and the Bay shoreline. Failure of the rail embankment during a storm event, or the loss of tidal marsh habitat due to rising sea levels, will increase the risk that homes in Parchester Village may flood.

Shoreline parks in Contra Costa County also serve as a buffer to inland communities and protect against sea level rise and storm event flooding. Shoreline parks were developed and are managed for recreation and natural habitat preservation, and not as coastal flood protection systems. The degree of flood protection provided varies park to park, as some have structural shoreline components such as levees and riprap, while others have natural shorelines such as wetlands and coastal bluffs. East Bay Regional Park District (EBRPD) owns and manages seven regional shoreline parks in the project area. Many of these parks are already

experiencing shoreline erosion and bluff collapse, and the tidal wetlands within these parks are at risk from accelerating rates of sea level rise coupled with declining sediment supply. In addition to the regional shoreline parks there are seven city parks: five in the City of Richmond, one in Bayview-Montalvin and one in Martinez. While these parks are relatively small compared to the regional parks, they play a role in providing inland flood protection, yet are neither maintained for this role nor have the resources to do so.

Current complexities in land ownership, permitting requirements and limited funding mean that new approaches will be required to address how ad-hoc protection is maintained or improved as sea levels rise. For example, EBRPD, the cities, the Bay Trail, UP and BNSF railroads, and neighboring landowners will need to work together to address areas where shoreline erosion, bluff collapse and tidal wetlands loss are increasing the risk to shoreline rail and inland communities. Working to initiate collaborative planning among these entities is even more important, and challenging, given the railroads have not yet directly participated in sea level rise planning in Contra Costa County, are hesitant to openly share information about their operations and assets, and often do not engage locals in their planning or management decisions. This challenge is complicated further because large public investments are likely to be necessary to protect the functions of privately owned rail infrastructure.

Key Planning Issue #5: Jobs and Employment Sites

Commercial and industrial businesses in the project area that provide locally and regionally significant employment opportunities are clustered in Richmond and Martinez. While flooding may directly impact a number of these employment sites, the greater risk is from flooding of the local and regional transportation system which could keep workers from reaching employment sites and interrupt critical supply chains. All employment sites, even those not directly at risk, will need to consider the consequences of current and future flooding on their ability to remain operational and keep employees working. The disruption, closure or relocation of employment sites can result in lost wages and reduced output and profit, the impact of which will vary depending on the characteristics and capacity of both the community where the job site is located, as well as the employees who work there.

Employment sites in the project area rely on workers that commute from within and outside of the county. Over 80 percent of Contra Costa County residents that commute drive to work. Residents working within the county use local roads, state highways, interstates, and local transit services to get to jobs, while the estimated 43 percent of residents who work outside the county depend on local roads and state highways to connect to interstates and to access inter-county bus and rail transit services. Flooding of local roadway and key interstate exchanges could have significant impact on transportation and transit corridors, increasing workers' commute times due to congestion and the need to use longer alternative routes. In certain cases, workers may be prevented from reaching job sites, resulting in lost time and wages and reduced output and profit for commercial and industrial businesses. Flooding that causes more than short term disruptions in the transportation network may result in workers not being able to return to their jobs, which will hinder community recovery and strain personal resources, particularly those of low-income workers who are living paycheck to paycheck.

In addition, employment sites rely on local and regional goods movement systems to ensure necessary materials and supplies can reach them, and that their products can be shipped to other locations in the region and beyond. Flooding of goods movement infrastructure including roadways, rail lines, seaports,

pipelines, marine oil terminal, and airports both within and beyond the project area could have significant consequences on critical supply chains. Delivery of goods to the vast majority of employment sites and the shipping of products produced at these sites relies on a functional ground transportation system and operational airports, in particular for just in time supplies. Without necessary materials and supplies, or the ability to ship products once produced, employment sites will be unable to continue operations. If the disruption lasts long enough, employees may permanently lose their jobs, and local communities may lose tax revenues produced by these businesses.

Addressing sea level rise and storm event impacts on employment sites will require not only inter-agency partnerships, but public-private coordination as well. This increased level of coordination means that additional time and resources may be required to achieve the level of shared planning and decision-making necessary. In addition, in many cases there are both planning priorities and funding restrictions that can increase the complexity of advancing improvements to make public transportation systems more flood resilient.

In order to reach this higher level of coordination, it will be necessary to reach out to commercial and industrial businesses that are either directly or indirectly at risk from current or future flooding. Businesses and their employees will need to be aware of alternative routes that can be used during and after storm events to minimize economic disruption, and should be encouraged to participate in collaborative planning to improve the resilience of local and regional transportation systems They also need to be made aware of the consequences that could occur if their facilities or the essential services they rely on are flooded, and should be encouraged to increase the resilience of their facilities, reduce supply chain vulnerabilities, and have emergency or contingency plans in place in the event that a flood does occur.

Key Planning Issue #6: Parks and Open Space

Shoreline parks and open spaces are often the first line of defense against inland flooding and are themselves very vulnerable to the early impacts of sea level rise. Damage or loss of parks and open spaces in the project area, many of which would be difficult to replace, would have significant impact on recreational access, with consequences on the health of communities and their members. The loss of parks and open spaces will impact some individuals and communities more than others. The degree to which the loss is felt will depend on the unique needs of community, where community members live and work, and what capacity they have to seek and access alternative recreational opportunities.

In the Contra Costa project area there are more than 80 miles of parks, trails and natural areas. This includes large regional parks owned by East Bay Regional Park District (EBRPD), small city parks owned by various municipalities, public and private marinas, and an extensive Bay Trail network owned and managed by many different organizations. These recreation assets are vulnerable to sea level rise impacts depending on their location, form and function, although the risks are higher in areas where there is ongoing shoreline or bluff erosion, habitat downshifting, or loss of vegetation due to rising groundwater levels or salinity intrusion. Because parks, trails and natural areas are some of the first shoreline areas that will be impacted by sea level rise, they can also be key early adaptation sites. Successfully adapting parks can both reduce flood risks on inland communities and increase public awareness about sea level rise.

The seven EBRPD shoreline parks in the project area will face flooding, elevated groundwater and salinity levels, increased shoreline and bluff erosion, and habitat impacts including loss of tidal marshes as sea levels

rise. These regional shoreline parks contain extensive marsh habitat, unique historical resources, and large-scale recreation assets including trails, fishing, wildlife viewing, and off-leash dog areas. EBRPD parks in Contra Costa provide recreation for millions of visitors a year, and the types and capacity of recreation provided cannot be replaced within the county. In addition to regional parks, there are seven city parks in the project area that are at risk from sea level rise and storm events. Five of these parks are in Richmond, one is in Bayview-Montalvin and one is in Martinez. While these parks are relatively small compared to the regional parks, these parks provide recreation at the neighborhood scale in areas that are underserved for local recreation opportunities. Due to their small size, these parks will either need to be protected in place or relocated. Unlike larger parks where uses can be moved within the existing park footprint, small parks typically do not often have the space to move park functions farther from the shoreline.

Lastly, there are significant segments of Bay Trail in the project area that will potentially be exposed to shoreline erosion and flooding, especially in areas where the trail is low-lying. Flooding can damage trails and lead to closures and costly repairs. Because the Bay Trail relies on connectivity to function as a regional network, even small sections of damage can disrupt the use of large segments, and therefore it is critical to maintain a functioning network of trails within the project area.

Adaptation Responses

Adaptation responses were developed for the project's thirty asset categories and six key planning issues. ART adaptation responses go beyond a list of adaptation strategies, rather they are a comprehensive "package" of adaptation information that:

- Presents a number of possible stand-alone or sequenced actions
- Connects actions to the assessment outcomes (i.e. the vulnerabilities and key issues)
- Identifies possible implementation partners and processes
- Provides greater transparency and support for evaluation and implementation

The adaptation response approach is valuable because it connects the action to the assessment outcomes, presents a number of possible steps that can be taken, and provides a substantial level of detail about possible implementation partners and processes. As a package, the adaptation response helps to make a case for why certain actions are necessary and who needs to be involved in their implementation.

The Contra Costa ART project adaptation responses reflect the prominence of four overarching themes including the need for: 1) a resilient transportation system; 2) integrated shoreline management; 3) targeted education and outreach; and 4) improved emergency and hazard mitigation plans. These four themes – which were taken up in more detail in the Implement step – highlight opportunities where synergies may be found, for example by implementing actions that while similar address vulnerabilities and consequences of a range of assets, geographies, and communities.

The summary that follows describes a number of actions that can be taken to address these four overarching themes as well as the project wide key issues that were identified. The actions and implementation options exemplified below are drawn from both the asset category and key planning issue adaptation responses. In this way, the summary is both a guide to how Contra Costa County agencies, organizations and communities can seek efficiencies in implementation, and is an indicator of the most pressing actions needed to

The Three Components of an ART Adaptation Response

1. The **vulnerability** being addressed by the adaptation response. Including this provides a direct link to the outcomes of the assessment and ensures that the most critical issues are addressed. Identifying the key vulnerability that is addressed is a transparent way to ensure that each adaptation action is connected to a planning issue.

2. **Adaptation actions** (one or more). While some vulnerabilities can be addressed by a single action, most require multiple, often coordinated actions. Some actions can be taken at the same time, while others require a series of sequential steps that incrementally build towards resilience.

3. **Implementation options** for each action. These provide alternatives for initiating adaptation actions such as incorporating them into existing planning or processes or creating new initiatives. The options also should identify agencies and organizations – public and private – that have a role in implementing the actions.

address the challenges faced in the project area as the Bay rises. The complete set of adaptation responses for all thirty assets categories and the six key planning issues are presented in Appendix F.

Asset Category Adaptation Responses

The asset category adaptation responses included a variety of actions to address specific vulnerabilities identified during the assessment. Many of the actions are specific to the physical characteristics and conditions of assets within the asset category or sector that impart a greater vulnerability to flooding. Other actions focus on the function of the asset category or sector, for example in providing critical public services, ensuring people can reach their homes, jobs and necessary services, employers can maintain supply chains and employees can reach work sites, and that communities have power, clean water, wastewater services and access to recreation and open space. Lastly, many actions are targeted at address a wide array of information and governance challenges that cut across sectors, jurisdictions and geographies.

Many of the asset category adaptation responses include actions to increase the resilience of transportation systems including the network of roads, rail lines, seaport and marine terminals that are critical to the movement of goods, commuters and community members. Some of the actions are narrowly focused on a specific asset that if disrupted would have wide spread consequences. For example, one response to the vulnerabilities at the Port of Richmond is to increase the capacity of other Bay Area ports to serve as a backup in the event that import/export operations at either the public or private terminals are disrupted. Other actions are broader and if implemented would address vulnerabilities in the shoreline transportation system that impact many of the asset categories assessed (see sidebar).

Adaptation responses to address shoreline vulnerabilities were developed for many of the asset categories assessed, including Parks and Recreation, Natural Areas, Water Management, Housing and Public Services. For example, there is a regional parks adaptation response calling for the development of agency-specific guidance to ensure shoreline plans and projects consider the impact of sea level rise and include actions to address potential future flood challenges. A similar adaptation response is also included for natural areas, however in this case the guidance specifically encourages setbacks and buffers adjacent to tidal marshes to help maintain public access while supporting future marsh migration. In addition to improved guidance to assist shoreline owners and managers consider future flooding, there are a number of adaptation responses reflecting the need to address the governance challenges that currently

Example actions to address transportation system vulnerabilities that impact many asset categories:

- Conduct a "hot spot" assessment to identify and evaluate vulnerable local and regional critical transportation routes and nodes necessary to maintaining commercial supply chains, ensuring employees can access industrial job sites, and allowing responder access during an emergency.
- Expand or form broad public-private partnerships to guide the planning and implementation of multi-objective transportation and goods movement improvements to ensure existing infrastructure and new investments are resilient to sea level rise impacts.

impede creation of integrated shoreline management systems (see sidebar).

The need to create, implement and sustain targeted education and outreach efforts was a theme that cut across all sectors. While many education and outreach actions included in the adaptation responses are asset category specific, there are many similarities among them. For example, most of the adaptation responses call for a collaboration of public, private and non-profit partners to develop and deliver the educational campaign. This includes the Business, Transportation and Housing Sectors. This presents an opportunity for coordination and collaboration, the exchange of ideas and best practices, and leveraging of expertise across outreach campaigns. For example, there is a need to engage communities living or working within the existing floodplain as well as those that are protected from flooding by rail lines. A coordinated campaign could be a resource efficient approach for increasing broad community awareness about current and future flooding and the actions that can improve flood resilience, and could spawn new partnerships and future collaborations among those that come together to lead the campaign.

Example actions to address shoreline system vulnerabilities that impact many asset categories:

- Expand or form partnerships among agencies, organizations and community members to facilitate cooperative decision-making regarding shoreline improvements and new investments.
- Develop and implement a regional permit authorization program to expedite the ongoing maintenance, minor repair, or upgrade of shorelines that are already experiencing erosion.
- Develop a decision-making framework for planning and implementing resilient, multi-benefit flood management projects that clearly weigh the trade-offs among short and long term impacts and benefits to the economy, environment and social equity.

Adaptation responses to improve hazard and emergency planning across different scales – from asset to sector and community to countywide – were identified for many of the asset categories. For example, the Public Services adaptation responses include an action to review and update health care facility emergency plans to address current and future flooding including contingencies and secondary impacts that could be widespread or long lasting. The Water Management Sector includes an adaptation response to establish inter-agency mutual aid agreements to provide assistance with inspection and repair of damaged or compromised facilities as well as the provision of mobile or alternative facilities during emergency response and recovery. Finally, the Hazardous Materials adaptation responses has an action to include a specific and detailed Hazardous Materials Section in Emergency Operations Plans, in particular the county's plan developed by the Office of Emergency Services, to ensure there are protocols, resources, and equipment in place to respond to a flood event with widespread impacts on hazardous materials sites. Together, the adaptation responses, focused on integrating consideration of current and future flood into emergency response, hazard mitigation, and operations and management plans, will increase resilience within each sector as well as for all communities within the county.

Key Planning Issue Adaptation Responses

The adaptation responses for the six key planning issues address the challenges that cut across assets, communities and geographies. They typically required the collective focus of working group members and other stakeholders because the underlying vulnerabilities cannot (or should not) be solved by individual agencies, organizations, asset managers or communities. The key planning issues adaptation responses, while not exhaustive, are a guide for how a broad coalition could work together towards solving some of the cross-cutting issues faced in the project area. To provide the working group a guideline for the timing of initiation and to support implementation, actions within each response were categorized as "Near-term", "Mid-term", or "Long-term". In general, near-term actions focus on investigation or conducting new analysis, education or outreach, or maintaining current assets. Mid-term actions focus on increasing coordination, building new partnerships, and planning for programs to address future conditions. Long-term actions focus on potential policy changes, complex planning projects, or efforts that require shared decision-making, funding and management. Action implementation leads and supporters are also identified, including agencies and organizations that function local, regional, statewide and federal scales.

The adaptation response to address the Water-dependent Industry key planning issue focus on improving the resilience of the transportation and utility networks that the County's seaport, marine oil terminals, shoreline refineries and industries rely on. For example, a near-term priority action is a targeted outreach campaign to water-dependent industrial owners and operators about the impacts sea level rise could have on land-based facility operations and the movement of goods and products by pipeline, water, road and rail. This action would be followed up in the mid-term by the formation of a private-partnership to develop and disseminate guidance with best management practices for how to best include sea level rise in operations, emergency, and contingency plans. This action could be lead by City and County Economic Development Departments, Contra Costa Health Services and the Contra Costa Office of Emergency Services with assistance from a wide array of local, regional, state and federal stakeholders.

The Creek-side Communities adaptation response includes a number of near-term actions to increase the understanding of how sea level rise may impact the flood risk of those living along tidal creeks and channels and longer-term actions to support the relocation of sensitive land uses through community-driven planning. The working group identified near-term priority actions to educate residents about the risks and the actions that can be taken to improve individual and neighborhood social capital, and to revise hazard mitigation and emergency response plans to strengthen relationships between first responders, community members and business owners. These actions could be led by a collective of county and city departments in partnership with community-based organizations, with additional support from local, regional, state and federal stakeholders.

The Access to Services key planning issue adaptation response includes actions to ensure that communities are not isolated from necessary emergency services, transportation, healthcare, jobs, schools, personal support networks and other daily needs during and after a flood events. This includes a number of actions to increase the resilience of shoreline transportation and utility systems, such as the near-term actions to conduct locally refined studies to pinpoint the sources of flooding that could disrupt critical local access routes and nodes, and requiring community facilities to have contingency plans that ensure uninterrupted access to water, power, food and other necessary supplies during a flood event. In addition, mid-term actions include developing and funding county-wide plans to increase the redundancy of the shoreline transportation road system, including increasing the number and capacity of alternative routes, and for

increasing the resilience of wastewater treatment systems by combining small systems and relocating or protecting at risk facility components. In the long-term, evaluating the continued siting of critical public services and protecting the access to that cannot be relocated is suggested, as is developing a unified county-wide emergency plan with robust community input that addresses future conditions. For many of these actions, county transportation and wastewater districts were identified as the lead, with implementation assistance from regional and state planning entities such as the Metropolitan Transportation Commission and the Integrated Regional Water Management Plan.

Adaptation responses to address the key planning issue of Ad-hoc Shoreline Protection recognize that some communities are protected from coastal flooding by rail lines, shoreline parks and tidal wetlands that were neither designed nor maintained specifically as flood protection. As these shorelines are often themselves vulnerable to sea level rise, near-term priority actions include developing a countywide program to identify, monitor and repair shoreline hot spots at risk of erosion, collapse or failure. In addition, in the near-term the adaptation response identifies joining the region in establishing an early detection network to track the response of tidal wetlands to sea level rise and forming a coalition to outreach and engage railroad owners in planning for sea level rise. Over the mid- to long-term actions focus on advocating for public agencies that own or manage the shoreline to have the explicit authority to provide flood protection and for the federal government to require railroad owners partner with local communities to plan for and adapt to sea level rise. Some of these actions can be led by East Bay Regional Parks District in partnership with the County and shoreline cities, while others will need to be led by elected officials or regional entities such as the Bay Area Regional Collaborative or the SF Bay National Estuary Research Reserve.

The Employment Site key planning issue adaptation response focuses on actions to avoid damage or disruption of the regional transportation system from flooding to ensure workers and goods can get to employment sites. Near-term actions that can be locally implemented include improving the understanding of business and industry owners about the risks they face from current and future flooding, and implementing an annual King Tides initiative to document areas at early risk of flooding. In the mid- to long-term, incorporating sea level rise in the Regional Goods Movement Plan and investigating incentives for relocating employment sites to areas with lower flood risk are actions that need to be implemented in partnership with the regional entities such as the Metropolitan Transportation Commission or the Bay Area Regional Collaborative with assistance from a broad array of public and private stakeholders.

The adaptation response to address the Park and Open Space key planning issue acknowledges that parks are often the first line of defense to inland flooding and are vulnerable to flooding in their own right. Near-term actions include educating the public about the risks the parks they love and rely on are at risk, and identifying and repairing (as feasible) natural and recreational areas that are already impacted by flooding. In the mid-term, actions include forming or expanding partnerships among public, private and community-based organizations to develop a shared vision for protecting and maintaining park function and to develop a countywide plan to enhance the function and capacity of parks that are not vulnerable to sea level rise. Lastly, in the long-term action could be taken to establish a new authority to plan, fund and manage multi-benefit shoreline solutions that protect existing park, open space and Bay Trail functions. Both East Bay Regional Parks District and the County can lead a number of the identified action, however support and guidance will be necessary from local and regional entities including the Bay Trail, San Francisco Estuary Partnership, State Coastal Conservancy and local planning, parks and recreation departments.

Many of the key planning issue adaptation response actions fall into one of the project's four overarching themes, which are: 1) a resilient transportation system; 2) integrated shoreline management; 3) targeted education and outreach; and 4) improved emergency and hazard mitigation plans. Given the prevalence of these four themes both across the six key planning issues and the individual asset categories, it is important for stakeholders that seek opportunities to collaborate with others to exchange best practices and increase efficiency in action implementation moving forward.

Evaluation and Implementation Pathways

The development of project-specific evaluation criteria plays a central role in ensuring transparent decision-making in adaptation planning. In the Contra Costa ART project a set of evaluation criteria were developed and applied to a select number of key planning issue actions. This exercise helped the working group more deeply understand the issues and trade-offs that need to be considered when prioritizing and selecting adaptation actions for implementation. The working group noted that the evaluation exercise was beneficial in informing them of how they could improve the transparency of their decision-making. Some of the group did note however that it will be more straight forward to evaluate actions that have are fairly detailed, for example with specific implementation leads and very concrete outcomes. In addition, the working group acknowledged that for some actions the evaluation process would be easier for individuals with specific knowledge or experience in owning, operating or managing the asset, asset category or sector.

Table 36. The project evaluation criteria spanned all four sustainability frames – society and equity, the environment, economy and governance – and reflected the project's resilience goals.

Criteria Type	Description
Feasibility	Administrative: Can the action be accomplished with existing operations or procedures?
	Community support: Will a strong advocate or local champion support the action?
	Legal: Can the action be accomplished with existing authorities or policies?
Social Benefits	Access: Will the action protect car, transit, bike or pedestrian access to housing, jobs or services?
	Life safety: Will the action protect public health and safety?
	Vulnerable residents: Will the action protect especially vulnerable community members?
	Community: Will the action preserve community function, and/or advance other community objectives?
	Recreation: Will the action maintain recreational or educational opportunities?
Economic Benefits	Jobs: Will the action promote or retain jobs?
	Commuter movement: Will the action maintain commuter movement?
	Goods movement: Will the action maintain goods movement?
	Service and networks: Will the action reduce service or network disruptions?
Environmental Improvement	Habitats and biodiversity: Will the action create or maintain appropriate habitat and biodiversity?
	Water quality: Will the action maintain or improve water quality?
	Nature based: Will the action promote grey to green, nature-based solutions?
Governance	Decision-making: Will the action support or create collaborative, transparent decision-making?
	Partnerships: Will the action encourage broad public and/or private sector partnerships?
Disaster Lifecycle	Preparedness: Will the action build disaster preparedness?
	Response: Will the action improve disaster response?

	Recovery: Will the action encourage resilient recovery?

As the last step in the project, implementation pathways were developed for four near-term, priority actions to help address the four overarching themes identified in the project: 1) a resilient transportation system; 2) integrated shoreline management; 3) targeted education and outreach; and 4) improved emergency and hazard mitigation plans.
The four actions were:

- Action 1: Develop and disseminate guidance to business and industry on the best practices for reducing the potential impacts of flooding and sea level rise on their facilities and the services and systems they rely on.
- Action 2: Create a public-private shoreline working group tasked with developing a plan to fund and implement integrated shoreline solutions to reduce flood risk
- Action 3: Develop a county-wide program to monitor, maintain, and repair (as feasible) at risk shorelines most in need of intervention.
- Action 4: Establish a public-private partnership to better understand the consequences of flooding on commercial and industrial supply chains, employee access to job sites and the regional transportation networks goods and commuters rely on.

The implementation pathways provided the working group a roadmap with specific recommendations for the timing, partners and processes necessary to advance the action. In addition, the implementation pathways include a description of the key outcomes of each action. Lastly, using the implementation pathway for each action was evaluated against a subset of the project evaluation criteria as a quick check on whether when implemented the action would help achieve the resilience goals. The criteria used to evaluate the four action implementation pathways were:
Improves or protects multi-modal access housing, jobs or services
Protects public health and safety
Protects especially vulnerable community members
Maintains recreational and educational opportunities
Promotes or retains jobs
Maintains commuter movement
Maintains goods movement
Reduces service or network disruptions
Creates or maintains appropriate habitat and biodiversity
Maintains or improves water quality
Promotes grey to green and nature-based solutions
Supports or creates collaborative, transparent decision-making
Encourages broad public and/or private sector partnerships

The implementation pathways developed for the four actions by the working group are provided below.

Action 1: Develop and disseminate guidance to business and industry on the best practices for reducing the potential impacts of flooding and sea level rise on their facilities and the services and systems they rely on.		
Key outcomes of this action: **Businesses understand the internal and external threats they face and have information on how to take action and who to go to for assistance.**		
1) Actors and Information ***Who will lead:*** **A county or regional agency in partnership with a business group such as Bay Area Council, East Bay Economic Development Association, or the Chamber of Commerce.** ***Who are interested and affected constituents:*** **Large and small businesses, Taxpayers, Landlords, Cities, Public Safety agencies, Railroads, Unions** ***Information needed to initiate action:*** **Much of the information is already available; the challenge will be to translate information, such as ART Project reports and materials, into business friendly concise guidance. A clear idea of who should lead will be the most important piece of information to initiate the action.** ***Sources of information:*** **Vulnerability assessments, ART materials, Other existing reports.**	**2) Timeline for Implementation** *What can we do now:* • Find a leader. • Begin to share resources (ART mapping, other products from ART and other sources) with business groups such as the Chamber of Commerce and East Bay EDA. Meetings or workshops with these groups may be the best venue to do this. Approach East Bay EDA about presenting at their March Conference. • Market analysis – determine the need, and identify a potential pilot industry or business (the most at risk industry). • Outreach by the County Hazardous Materials Program • Find funding to produce the guidance *What can we do next:* • Broad Education Campaign, pamphlets, documents, one-pagers,	**3) Feasibility** *Roadblocks:* • There may need to be regulation or incentives for businesses to take guidance seriously. • Need for a better understanding of financial impacts of changes recommended by the guidance • Need for language that will speak to businesses • Language barriers and limited outreach to small businesses and underserved communities. *Potential solutions:* • Work with business groups to improve messaging • Monetize the impacts (show what will be lost if businesses don't prepare) • Produce multiple types of guidance based on industry, size of business, location, and provide translations. *Funding:* • Non-profit grants • Prop 1 funds

	presentations • Produce guidance that will be given to new businesses *What can we do long term:* Establish a resilience award for businesses that can be integrated into a LEED type program or stand alone similar to Green Seal	• Federal – FEMA, EPA *What support is needed:* State and Federal data, information and maps.

Action 2: Create a public-private shoreline working group tasked with developing a plan to fund and implement integrated shoreline solutions to reduce flood risk		
Key outcomes of this action: Consensus on shoreline vulnerabilities and integrated adaptation strategies and a shovel-ready PLAN by 2018		
1) Actors and Information ***Who will lead:*** • County-sustainability office (potential to integrate this action with the Northern Waterfront Economic Initiative) • Challenging to identify a single leader, may need multiple land owners to lead together *Who needs to be an engaged partner?* • Public Works, Save the Bay, State Coastal Conservancy, ABAG, Contra Costa Board of Supervisors, Hazardous Materials Commission, City Councils, EBRD, Tesoro and other major landowners, industry groups, Contra Costa OES. *Who are interested and affected constituents:*	**2) Timeline for Implementation** *What can we do now:* • Identify stakeholders and establish the working group. • Get County Supervisors, County Staff, City Boards of Supervisors support. • Develop a PLAN framework and start getting support for it. *What can we do next:* • Work on a PLAN that includes guidance on SLR that can be a standard the whole county can use. • Disseminate the PLAN *What can we do long term:* • Add to the PLAN a set of cohesive adaptation actions • Fund and implement those adaptation	**3) Feasibility** *Roadblocks:* • Non-participatory complainers • Lack of motivators (unclear leader, driving policy) • Reaching consensus (especially when not everyone needed participates). *Potential solutions:* • Identify a strong lead agency that will convene a broad working group and built trust for taking shared action. *Funding:* • Conservancy Prop 1 Urban Greening Grants • Measure AA Funds • Civic Spark or Climate Corps Bay Area (fellowships) • FMA grant • FEMA funding for planning related to flood mitigation • Funding plan development by

• Industry, residents, business, recreation, environmental advocates *Who are the strong advocates or local action champions?* • Rep. Mike Thompson, Supervisors John Gioia and Federal Glover, Jody London, Diana Burgess, Mark Desauliner *Information needed to initiate action*: • How to support lead • Identify areas where shoreline infrastructure upgrades are already needed *Sources of information:* • BCDC, Northern Waterfront Economic Initiative	actions.	students at Haas, Goldman, UCB *What support is needed:* • Coordinated permitting to simplify the process and reduce the resources needed to implementing shoreline projects • USFWS, BCDC, USACE,State Lands. *What support is needed from the region, state, and federal government?* • Streamlined permitting • Funding • Marketing: help communicate a vision that will assist county champions take action

Action 3: Develop a county-wide program to monitor, maintain, and repair (as feasible) at risk shorelines most in need of intervention.		
Key outcomes of this action: Inventory of shoreline land uses (future and current), collaboration/partnership between managers of the shoreline, identification of priorities in repair and funding, evaluation tool, diverse participation which generates public support and includes an education component		
1) Actors and Information *Who will lead:* Contra Costa County Flood Control District, with representation from private entities *Who needs to be an engaged partner:* private entities (i.e. pipelines, chemical industry, oil refineries), East Bay Regional Park District, Bay Trail, Delta Trail, Contra	**2) Timeline for Implementation** *What can we do now:* • Convene a working group of public and private entities • Engage and educate private entities, especially rail *What can we do next:* • Expand	**3) Feasibility** *Roadblocks:* • Low local participation • Lack of private owner involvement • Contra Costa's role not recognized within the region *Potential solutions:* • Collaborate with ongoing efforts

Costa County Office of Emergency Services, BNSF and UP rail, county and cities, nonprofits (i.e. Greenbelt Alliance, Communities for a Better Environment) *Who are interested and affected constituents:* leaders and partners listed above, the region, business and industrial councils *Who are the strong advocates or local action champions:* Contra Costa Health Services Environmental Health Division, Contra Costa Clean Water Program, EBRPD, environmental nonprofits, environmental justice nonprofits (i.e. Communities for a Better Environment), *Information needed to initiate action:* best practices for monitoring, determination of type of intervention that is most responsive to vulnerability identified *Sources of information:* San Francisco Estuary Institute, CCCFCD, EBRPD, ART Program	collaboration to include Eastern Contra Costa County • Make presentations to the public on issues, and communicate that the process will be transparent • Create a plan with principles, goals, and a vision that identifies key transformative opportunities *What can we do long term:* • Working group members continue to provide input to county's and cities' general plans • Ongoing public participation and engagment • Potential structural and/or land use changes • Evaluate the need for new institutions and laws	including infrastructure improvement projects • Working group bring information to city and county governments • Ensure transparency • Develop an education and marketing campaign *Funding:* • Measure AA Funds • CA Strategic Growth Council • Cap and Trade • Private foundations • FEMA mitigation and resilience funds *What support is needed:* • Coordinated regional, state and federal permitting • Showcasing of best practices • Technical resources • Research • Better data repository • Standardized tools that are applicable at the local level

Action 4: Establish a public-private partnership to better understand the consequences of flooding on commercial and industrial supply chains, employee access to job sites and the regional transportation networks goods and commuters rely on.

Key outcomes of this action: **Existing communities and new** investments are resilient and are able to quickly recover after a flood, including a transformative shoreline transportation system that is multi-modal with improved redundancy. Communities understand and acknowledge and accept their flood risks based on their local values and perceptions.

1) Actors and Information	2) Timeline for Implementation	3) Feasibility
Who will lead: An economic stakeholder, e.g., the Bay Area Council, East Bay Leadership Council or East Bay EDA plus the County's Planning Directors *Who are interested and affected constituents:* Chambers of Commerce, Refineries, UC Berkeley Shoreline Environmentalists Parks, All of the county (west, central and east), Caltrans, CCTA, Railroads, CBOs, Cities, MTC, ABAG *Information needed to initiate action:* • **Fact check SLR mapping and analysis** • **Future market trends for industry/business** • **Opportunities to consolidate industries and develop "exit plan" if needed** *Sources of information:* • **Regional Goods Movement Plan (MTC)** • **LBL – Berkeley and Department of Energy** • **Marin Clean Energy** • **Industrial Councils / Refinery organizations** • **CalOES Catostrophic Flood Plan for**	*What can we do now:* • Launch and annual King Tides campaign • Convince people it is real by making a clear, simple and unified case • Identify a local champion or leader • Engage the Northern Waterfront Economic Initiative • Educate job providers and communities • Initiate a grass roots campaign with talking points for each locality *What can we do next:* • Align planning and policy tools (land use, zoning, transportation) to ensure action is taken • Consider developing a recovery plan or post disaster plan that is visionary *What can we do long term:* • Have info accessible to all parties to enable good decision-making • Initiate a marking campaign about county workforce and investments that will be supported into the future	*Roadblocks:* • Inertia in all sectors • Lack of synergy or integration into existing efforts • Private sector moves faster than public *Potential solutions:* • Leverage/synergize with ongoing efforts • Private sector can speed up public sector • Work towards less red tape in government • Leverage private sustainability efforts and government or community relations efforts *Funding:* • Private entity (could fund recovery plan) • FEMA Mitigation funds • Pooled available resources • CalOES Catastrophic Plan funds *What support is needed:* Funding • Guidance and concrete direction about what amount of sea level rise to plan for • Actionable steps and timelines

Northern CA	• Develop and fund partnership projects with shared and committed resources to build trust and buy-in • Improve collaboration, find new synergies and advance partnerships • Develop better relationships between public and private sectors.	

In addition to the implementation pathways, the working group members used a “mad-lib” exercise to develop a simple pitch for each of the four actions to help communicate the project findings and outcomes to stakeholders as varied as elected officials, grant funders, project financers, community members and other interested and affected parties. Below is an example of one completed “mad-lib” for Action #1.

Implementation Pathways "Mad Lib" (Action #1)

Complete the Mab Lib to write your pitch.

The goal is to synthesize the information from the implementation pathways exercise into a statement that captures: the nature of the vulnerability; the lead implementer and partners; any information that needs to be gathered; the steps to be taken to achieve the outcome and ultimately address the resilience goals. The pitch should be clear and succinct, as it should help communicate to colleagues and partners why it is important to take action.

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ACTION #1 Commercial and industrial businesses may not have the knowledge and experience to appropriately prepare for flooding. To address this vulnerability,

CC Sustainability Chief
Lead

will work with *Public and Private Partners*
Partners

to *Collaborate and Educate Businesses and Industry Owners and Operator* .
Scope effort (information, advocates, constituencies)

The next step is to *Develop clear and simple educational materials for different industries and groups*
First step (Do Now)

within *6 months* **and then** *disseminate at industry council and public meetings*
Timeframe Next step

within *1 year* **. These steps will lead to** *increased support to businesses and the*
Timeframe

advnacement of smart choices pertaining to facility management, supply chains, and employee access

which will support the resilience goal by *protecting economic security and public health and safety within the project area.*
Checked Evaluation Criteria

Conclusion and Recommendations

The completion of the last two steps of the ART planning process is not the end of adaptation planning, rather it is a jumping off point for local and regional action implementation, the advancement of further collaborations and partnerships, and the identification of additional strategies for building resilience both within and beyond the project area. The ART Program will continue using advocacy, research, guidance and regional planning to support working group members and their stakeholders as they advance their own planning and engage in regional efforts to advance climate resilience efforts.

Actions to increase flood resilience in Contra Costa will include a continued commitment to partnerships and collaboration at the local, county, regional, state and federal scales. The county has the opportunity to partner with other county-scale efforts to exchange ideas as well as participate in ongoing and planned of regional efforts. Examples of ongoing efforts include:

- Exchange ideas with San Mateo and Marin Counties (SeaChange San Mateo and BayWAVE)
- Engage with BCDC's ART Program on developing a regional assessment and adaptation plan
- Track progress on the region's Resilience by Design effort and advocate for a design team to work in Contra Costa County
- Broaden the ART project partnerships to include Eastern Contra Costa County
- Work with representatives from unincorporated Contra Costa County and from the smaller towns to build understanding and capacity for advancing resilience efforts on the shoreline
- Engage with the region's Sustainable Community Strategy update and encourage the inclusion of flood resilience in long-range planning in the 2017 update and 2021 plan.

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