Adapting to Rising Tides

EXISTING CONDITIONS AND STRESSORS REPORT

PREPARED BY:

SAN FRANCISCO BAY CONSERVATION
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JANUARY 2012

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PROJECT INTRODUCTION

Since people first settled the area, the San Francisco Bay has been a focal point. The Bay shapes the economy, culture, and landscape of the region, supporting prosperous businesses, vibrant neighborhoods, and productive ecosystems. Through visionary planning efforts, the Bay Area has preserved and protected this prosperity. There is a long history of stewardship of Bay resources, and it has been evolving over the last century. At one time, filling the Bay (commonly known as reclamation) was a widely accepted practice, allowing for the development of significant resources, including airports, neighborhoods, and landfills, along the shoreline. This trend has now been reversed, and many areas that were previously filled are being restored to tidal wetland and parkland.

Now, as we are gaining a better understanding of the real potential for global climate change to significantly affect the Bay Area, it is time to extend this commitment to building the resilience necessary to preserve and protect the Bay and its communities into the future. Unlike the unpredictable and sudden devastation of an earthquake or wildfire, sea level rise is a slow-moving, but predictable, hazard. Although the exact degree and timing of sea level rise is uncertain, there is little doubt that the Bay Area's future success will depend on how soon it begins planning for rising tides and a changing landscape.

While the challenge of climate change may seem daunting, the San Francisco Bay Area has successfully confronted a number of serious challenges. Known for its beauty and wealth of natural resources, economic and entrepreneurial strength, top academic institutions, and diversity of thought, the Bay Area has proven that one need not choose between the environment and the economy, or between innovation and conservation. All are possible.

I. Project Purpose, Goals and Objectives

The Adapting to Rising Tides (ART) project is a collaborative effort evaluating how the Bay Area can become more resilient to climate change, in particular sea level rise and storm events. The ART project is a pilot project that will ultimately provide guidance on how best to approach two broad questions:

- How will sea level rise and other climate change impacts affect the future of Bay Area communities, ecosystems, infrastructure, and economy?
- What strategies should we pursue, both locally and regionally, to address these challenges and reduce and manage these risks?

The primary goal of the ART project is to increase the Bay Area's preparedness and resilience to sea level rise and storm events while protecting critical ecosystem and community services. To achieve this goal, the specific project objectives are:

1. Work collaboratively with partners and project stakeholders to assess vulnerabilities and risks related to sea level rise and other climate change impacts, particularly storms and other high-impact events, on the ART project shoreline (See Figure 1), communities, and ecosystem; comprehensively identify and prioritize adaptation

strategies and options; and identify ways to integrate adaptation measures into local planning and decision-making.
2. Develop a template for integrative (cross-sector, cross-jurisdiction, shoreline, and watershed) adaptation planning at the subregional level that can be applied to other subregions in the Bay Area.
3. Test risk-based adaptation planning processes and tools on a variety of shorelines within a subregion of the Bay Area to develop approaches that can be applied to similar shoreline types throughout the entire region.
4. Build relationships and strengthen partnerships among institutions and organizations in the region that enable them to integrate and leverage adaptation into existing planning efforts.
5. Develop, test, and refine communication, community engagement, decision-making, and prioritization models, processes, and tools to help the region address climate change at scales appropriate for local and regional implementation; ensure that users of these resources can easily access the information and tools developed through the project and that they understand how to use them.
6. Increase the number of Bay Area local governments that assess their communities' climate change risks and develop adaptation options as part of ongoing planning and decision-making processes.

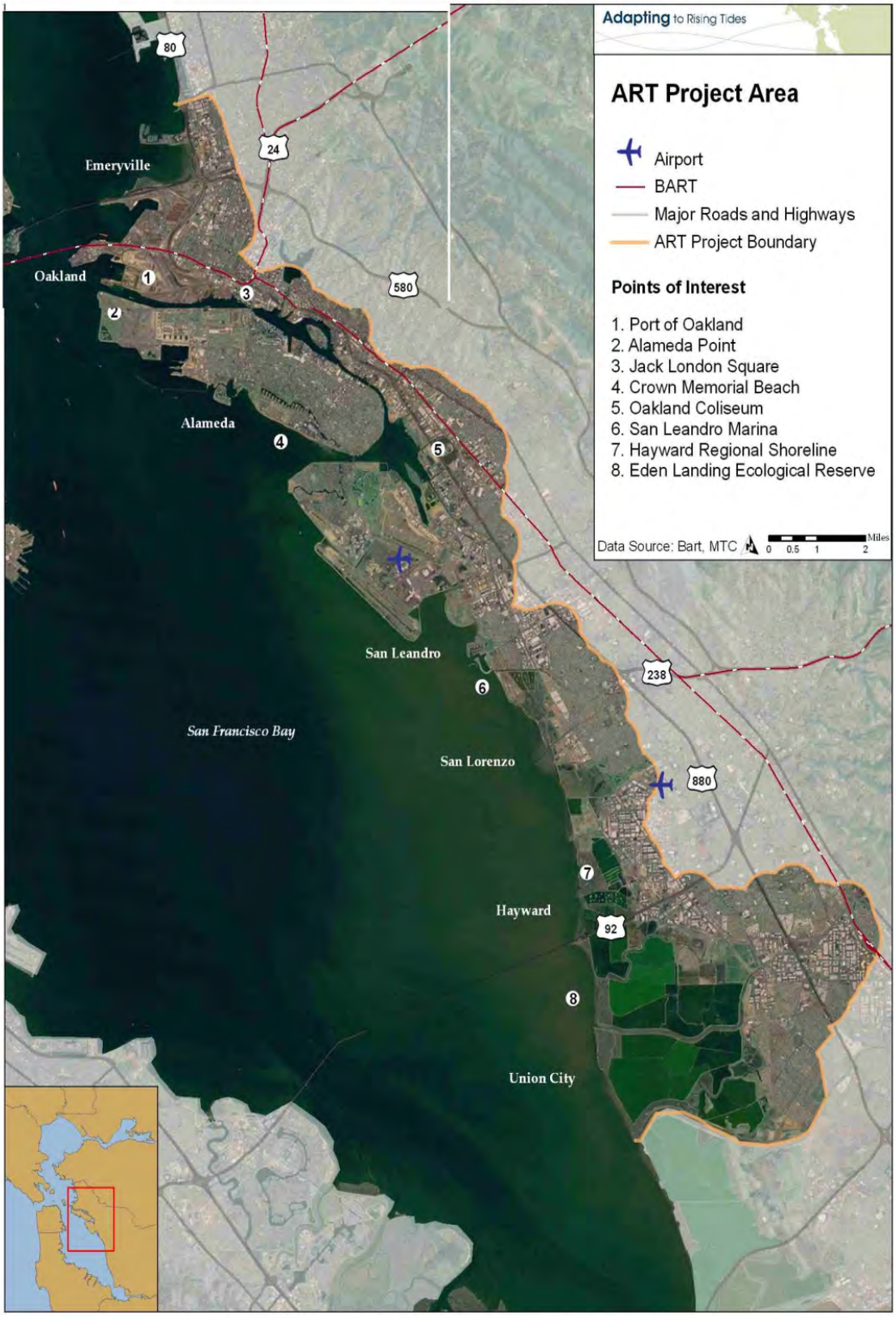
II. Sustainability Framework for Understanding Vulnerability and Risk

The Adapting to Rising Tides project is evaluating vulnerability and risk of shoreline communities and ecosystems through the lens of four, overarching frames.

- Society and equity
- Economy
- Environment
- Governance

Together, these four frames comprise a sustainability framework that will inform the consideration of adaptation strategies and options and will help address how shoreline communities and the region as a whole can support a sustainable and prosperous Bay Area while building resilience to climate change.

Figure 1. Map of ART Project Area



III. Site Selection and Project Area

In order to identify a site for the project, the ART project management team developed criteria for site selection and solicited interest from all around the region. The criteria for site selection included:

- A diversity of land uses and shoreline characteristics.
- Regionally significant transportation infrastructure along the shoreline.
- Desire and capacity to become a partner in the project.

Interest in the project came from communities and organizations in seven of the nine counties in the Bay Area. Within Alameda County, a number of cities, county departments, park districts, and other agencies expressed interest in becoming part of the project. This area also had a diversity of land uses, including an airport, seaport, marshes, parks, endangered species habitat, neighborhoods, employment centers and regionally significant transportation infrastructure including the Bay Bridge, the San Mateo–Hayward Bridge, passenger and cargo rail, Bay Area Rapid Transit track, and stations and major highways like Interstate 80 and Interstate 880. Based on this diverse land use, regionally significant transportation infrastructure, and a strong desire and capacity of interested entities, the portion of Alameda County shoreline from the City of Emeryville to the City of Union City, extending inland approximately a half-mile beyond the area projected to be exposed to storm event flooding with 55 inches of sea level rise, was selected as the ART project area (see Figure 1, "Map of ART Project Area").

IV. Project Management Team

The San Francisco Bay Conservation and Development Commission (BCDC) is leading the ART project with the strong financial support and involvement of a number of partners, including:

- The National Oceanic and Atmospheric Administration's Coastal Services Center (NOAA CSC)
- The U.S. Department of Transportation's Federal Highway Administration (FHWA)
- The Metropolitan Transportation Commission (MTC)
- The California Department of Transportation (Caltrans)
- ICLEI—Local Governments for Sustainability

In addition to the project management team, several consultants have been brought into the project to assist with a variety of tasks. Eastern Research Group, Incorporated, has assisted the project management team on all aspects of the project including meeting design and graphic assistance. AECOM has led a team of consultants to conduct a vulnerability and risk assessment for the ground transportation component of the ART project, and developed sea level rise and storm event inundation maps and analyses of the ART project area. The Pacific Institute is assisting in a socioeconomic analysis of potential climate impacts identified within the project area, including an analysis of social vulnerability.

V. Project Funding

In addition to staff time from a number of agencies and organizations, the following funding sources have been directed to the ART project:

- FHWA funding, with matching funds from BCDC, MTC, and Caltrans, to conduct an assessment of transportation infrastructure vulnerability ($300K grant and $300K of in-kind match from the three agencies).
- A NOAA Coastal Zone Management Act Section 309 grant for community adaptation planning and sharing the ART subregional project with the region ($125K).
- A NOAA Coastal Zone Management Act Section 310 grant for ART project scoping, including three public meetings ($100K).
- NOAA CSC technical assistance and staff support for ART project scoping, including three public meetings.
- ICLEI technical assistance and staff support for community-scale planning through the National Inaugural Adaptation Communities Program.
- US DOI BOEMRE Coastal Impacts Assessment Program funding to support ART project assessment and planning activities ($200K).

VI. Working Group and Subcommittees

A working group and two subcommittees were formed to meet regularly, review documents, and assist the project management team with data needs and project design. From the beginning, the ART project team wanted to ensure that the project was a collaborative effort because the people in the best position to understand the resources in the project area, and develop strategies to protect these resources, are the people at the local and county level who interact with them on a daily basis—from wastewater systems to parkland to seaport activities. Since much of the responsibility and authority for undertaking adaptation lies at the local level, the project was designed to ensure that local perspectives were included in an ongoing, fluid way throughout the project. The working group and subcommittees have provided a valuable conduit through which the project team has received informed input to help shape the project. The working group members have defined many aspects of the project, including the asset categories to be evaluated, the climate impacts to consider, and the overall scope and extent of the project.

Members of the ART working group represent:

- Alameda County Community Development Agency
- Alameda County Department of Environmental Health
- Alameda County Emergency Medical Services
- Alameda County Flood Control and Water Conservation District
- Alameda County Transportation Commission
- Association of Bay Area Governments (ABAG)
- Bay Area Rapid Transit (BART)
- California State Coastal Conservancy

- California Department of Fish and Game
- California Department of Transportation
- Capitol Corridor Joint Powers Authority
- City of Alameda
- City of Emeryville
- City of Hayward
- City of Oakland
- City of San Leandro
- City of Union City
- East Bay Dischargers Authority (and its member agencies)
- East Bay Municipal Utility District
- East Bay Regional Park District
- Hayward Area Recreation and Park District
- Metropolitan Transportation Commission (MTC)
- Pacific Institute
- Pacific Gas and Electric (PG&E)
- Port of Oakland
- PRBO Conservation Science
- San Francisco Bay Trail Project
- San Francisco Estuary Institute
- U.S. Army Corps of Engineers
- U.S. Geological Survey

The two subcommittees, a technical subcommittee and a communication subcommittee, are also made up of working group members. The purpose of the subcommittees is to allow focused time to discuss sea level rise and storm event maps and analyses, potential climate impacts, and communications strategies that will guide the project.

VII. Assets Under Consideration

The project management team consulted with the working group to define the assets within the project area to be included in scope of the project. The asset categories selected are:

- Airport
- Community land use, services, and facilities
- Contaminated lands
- Energy infrastructure and pipelines
- Ground transportation
- Hazardous material sites
- Nonstructural shorelines/natural areas
- Parks, recreation, and the Bay Trail
- Seaport
- Stormwater infrastructure
- Structural shorelines
- Wastewater facilities

VIII. Climate Impacts Being Evaluated by the Project

The ART project is assessing flooding and inundation impacts associated with changes in storm events and sea level rise, and the effects these impacts may have on the assets in the project area. Flooding events in flood-prone areas are expected to occur more often and to last longer as a result of changes in storm events and sea level rise. Higher high tides, shifts in tidal range, and increases in depth and duration of tidal inundation will cause frequent or permanent inundation in some areas that are not currently in the daily tidal range, or subject to periodic flooding. Also addressed by the project are locations along the shoreline that are vulnerable to increased shoreline erosion and waves over-topping shoreline protection structures due to changes in wave activity as Bay water levels rise. Lastly, the ART project is considering, to the extent feasible, where elevated groundwater levels and salinity intrusion due to sea level rise may affect shoreline assets.

IX. Related Projects and Processes

There are several projects that either directly relate to or are being coordinated with the ART project.

The FHWA funded a pilot study to test its vulnerability assessment process. This work was developed as a partnership, with the MTC as the project lead and BCDC and Caltrans as members of the project management team. The study, which was conducted by a consultant team led by AECOM, was designed to develop two key products for the ART project: (1) an assessment of the vulnerability of ground transportation in the ART project area; and (2) sea level rise and storm event maps and analyses. The results of the study, which is titled *Adapting to Rising Tides: Transportation Vulnerability and Risk Assessment Pilot Project, December 2011* (available at www.bcdc.ca.gov), will be incorporated into the vulnerability assessment of the larger ART project.

The ART project management team is also coordinating with local and regional agencies to ensure consistency with related projects, such as the Sustainable Communities Strategy being led by MTC and ABAG, MTC's Regional Transportation Plan, ABAG's FOCUS program, and a variety of projects and process being undertaken by the City of Oakland, Alameda County, BART, and others.

X. Planning Process and Project Design

The ART project includes the following components or milestones:

- An Existing Conditions and Stressors Report that identifies current conditions within the project area for each of the asset categories and will form the foundation of the vulnerability and risk assessment (December 2011).
- A Vulnerability and Risk Assessment that will identify the exposure, sensitivity, and adaptive capacity of the subregional assets and analyze the consequences of impacts to these assets. The Vulnerability and Risk Assessment will provide the basis for the Adaptation Strategy (March 2012).

- Two white papers, one on equity and one on governance, analyzing both issues with respect to vulnerability and adaptation to climate impacts (August 2012).
- An Adaptation Strategy that uses the information from the Vulnerability and Risk Assessment to develop a range of options that address economy, equity, environment, and governance resilience. The Adaptation Strategy will be developed in partnership with the working group and will include policy recommendations that working group members can consider adopting through existing processes or processes developed to specifically address climate impacts. It will also include implementation strategies that will consider financing options, appropriate scales and timeframes, adaptive management, trade-offs, and ways to increase community resilience to a variety of impacts and stressors and integrate adaptation and greenhouse gas emission strategies (December 2012).

XI. The Existing Conditions and Stressors Report

This report is intended to provide a brief overview of the ART project and to provide information on the current conditions within the project area. This will report will serve as a foundation for the vulnerability and risk assessment, which will look at exposure to climate impacts, sensitivity to these impacts, and the potential to adapt to these impacts with little financial or structural intervention. The current condition of a shoreline or community asset, and existing stressors affecting it, have implications on vulnerability and risk, and can contribute to an asset's resilience (or lack thereof) to projected climate impacts. The Existing Conditions and Stressors Report also describes the asset categories under evaluation specifically through the frames of economy, equity, environment, and governance to lay the groundwork for considering these issues in the vulnerability and risk assessment and in developing adaptation strategies.

ASSET EXISTING CONDITIONS AND STRESSORS

1. COMMUNITY LAND USE

Part A. Community Land Use, Facilities and Services

I. Definition

Community land use describes the buildings and infrastructure that together make up the neighborhoods and communities in the ART project area. Land use is the foundation upon which people in an area live. Understanding the existing conditions and stressors for community land use means examining the facilities and services that support and maintain the social and economic interactions and activities that tie communities together, and identifying the challenges residents face to maintain their communities.

Alameda County Courthouse in Oakland. Source: www.panoramio.com.

Alameda County is located on the eastern shore of San Francisco Bay. Along with neighboring Contra Costa County to the north, Alameda County makes up what is commonly referred to as the East Bay of the greater San Francisco Bay Area. As of the 2010 U.S. Census, Alameda County had a population of 1,510,271, making it the second most populous county in the Bay Area (second to Santa Clara), and the seventh most populous county in the state. The county encompasses 821 square miles, of which 90% is land and 10% is water; has an average population density of 2,048 residents per square mile; and is home to approximately 712,850 jobs (again, second to Santa Clara). Oakland is the county's largest city and the county seat.

The ART project is located in the western part of Alameda County, along the shoreline from the City of Emeryville to the City of Union City (see Figure 1). As a whole, Alameda County has a variety of landscapes, from wetlands and marshes along the Bay to redwood forests in the coastal hills to grasslands and oak woodlands in the east. The portion of the county selected to be the project area is a relatively flat coastal plain that gradually increases in elevation until it meets the East Bay hills. The northern part of this coastal plain includes the traditional urban core of the Bay Area, including the cities of Oakland, Emeryville, and Alameda, which share the characteristics of pre-automobile-era land use patterns and densities. These cities were developed along electric streetcar lines in the late nineteenth and early twentieth centuries. The

density gradient gradually decreases further south along the coastal plain, approaching the unincorporated community of San Lorenzo and the Cities of San Leandro, Hayward, and Union City. These previously agricultural communities were developed during the suburban housing boom following World War II and thus share a more Euclidian zoning pattern, with lower densities and separated residential, commercial, and industrial land uses.

Today, Alameda County is home to a diverse mix of land uses (see Table 1), from traditional single-family residential to modern transit-oriented development, from seaport and airport to light manufacturing, and from neighborhood-serving retail to big-box commercial. The county's diverse land use reflects its diverse population and employment mix.

Table 1. Major Land Uses in Alameda County

Land Use	Acres
Residential	74,074
Commercial	20,213
Industrial	14,808
Mixed-use	1,461
Total non-urban	290,946
Total urban	180,503
Grand total	471,449

Source: ABAG, 2008a

II. Overview of Land Use Patterns

The county's residential areas are made up of approximately 582,549 housing units (US Census County Quick Facts, 2011). Within the ART project area, Oakland has the largest number of housing units at 172,774, followed by Hayward (48,296) and San Leandro (32,419). Over half of the county's housing is in the form of detached, single-family units (52%), followed by housing in structures of 20 units or more (16%). Cities in the northern, more urban part of the county have a smaller share of housing in single-family homes relative to the more suburban south. For example, 41% of Oakland's housing is single-family, compared with 61% in Union City. Comparatively, a smaller share of housing in the southern cities is in large, multi-family units, with Hayward at 12%, versus Oakland with 19%.

Over half of the county's residential land is zoned for medium density housing, from between three to eight dwelling units per acre (ABAG, 2010). Over a quarter of residential land is zoned for high-density housing (>8 dwelling units per acre). As shown in Table 2 below, Alameda County has a higher percentage of higher density housing than the nine-county Bay Area average, a reflection of it being located within the traditional core of the region.

Table 2. Percentage of Residential Land by Density

	Rural Residential (<1 unit/acre)	Low-Density (1-3 units/acre)	Medium-Density (3-8 units/acre)	High-Density Residential (>8 units/acre)	Mobile Home Parks	Mixed-Use
Alameda County	9.6%	11.0%	51.9%	26.1%	1.1%	0.2%
9-County Bay Area	37.9%	12.0%	33.5%	15.4%	1.0%	0.3%

Source: ABAG Multi-Jurisdictional Local Hazard Mitigation Plan, 2010.

Over a quarter (26%) of all jobs in Alameda County are concentrated in Oakland, with half of that total, or roughly 90,000 jobs, located within downtown Oakland and Jack London Square (ABAG, 2010). Emeryville, a former industrial and warehouse city, has redeveloped much of its built spaces into a hub for light industrial, research and development space, as well as regional retail. Today Emeryville has over 18,000 jobs within its small 1.2 square mile limits. Employment outside these two cities, although considerable, is much more dispersed. For example, Hayward has the second largest employment total within the ART project area at over 70,000 jobs, but only 6,200 of those jobs are within downtown Hayward. Similarly, San Leandro has over 40,000 jobs within its city limits, but only 2,700 of those are within its downtown. Instead, employment is dispersed in industrial and commercial business parks that are vital to the southern Alameda County economy. In fact, manufacturing and wholesale jobs account for 34%, 36%, and 38% of San Leandro, Hayward, and Union City's total jobs, respectively, compared with a county-wide average of 24% (ABAG Projections, 2009).

Land Use: Northern Alameda County—Emeryville, Oakland, Alameda

City of Emeryville

The City of Emeryville occupies 1.2 square miles of land and 0.8 square miles of water. It is bordered by the City of Oakland to the south and east and the City of Berkeley to the north. As of the 2010 U.S. Census, Emeryville had a population of 10,080 residents at a population density of 8,089 residents per square mile, which is higher than Alameda County's average population density of 2,048 residents per square mile (US Census State and County Quick Facts, 2011).

According to the Emeryville General Plan (City of Emeryville, 2009), about 20% of the city's total land area, 153 acres, are roads, highways, and other rights-of-way, leaving about 615 acres of developable land. Approximately half of the city's developable land is commercial (36%) or industrial (14%) uses, and just under a quarter (21%) is housing. The remainder of the city land is in public use (7%), parks and open space (7%), or a mix of uses (7%). Only around 20 acres, or 4% of the land, are vacant.

While Emeryville was once dominated by heavy industrial land uses, over the past 30 years almost all of the bayfront and land west of the Union Pacific Railroad tracks has been redeveloped into regional retail, high-rise office or residential buildings, and mixed-use residential. The residential developments in this area are large in size and high in density,

comprising about 2,750 housing units—half of the housing in the city. The Emeryville Crescent lies west of Interstate 80. This area extends into the Bay and includes the Emeryville marina as well as high-rise office, hotel, and residential buildings (zoning regulations allow buildings over 100 feet). Just east of the freeway are major retail, entertainment, and commercial facilities.

Development to the east of the railroad is more diverse in use, scale, and age. Block, parcel, and building sizes generally diminish toward the east, where pre-war structures are supplemented with new residential and commercial construction. The area north of Powell Street contains a wide variety of uses, including offices, old homes and new residential complexes, and industry. Corporate campuses and "big box" retail occupy much of the area south of Powell Street. Emeryville's public schools and many of its locally oriented retail businesses lie along or near San Pablo Avenue, a major boulevard and state route that connects Emeryville with Oakland, Berkeley, and other East Bay cities. The residential neighborhoods east of San Pablo Avenue include lower density single-family homes, many of which are California bungalows.

Emeryville is planning to continue to grow as a mixed-use, higher-density inner-ring suburb with a projected 71% increase in population and 46% increase in jobs by 2030 (City of Emeryville, 2009).

City of Oakland

In 2010, the City of Oakland had a population of 390,724, making it the largest city in the ART project area, the third largest in the San Francisco Bay Area, and the eighth largest in the state. The city encompasses 56.8 square miles of land and 22.2 square miles of water, and has a population density of 7,002 residents per square mile (US Census State and County Quick Facts, 2011). Of Oakland's 35,742 total acres of land, about a third, or 12,165 acres, is residential, with smaller percentages of commercial (10%, 3,517 acres) and industrial (5%, 1,744 acres) (ABAG, 2006a).

Oakland is a primary urban center within the greater Bay Area and is a regional hub for transportation, employment, and cultural resources. Downtown Oakland is a primary central business district in the San Francisco Bay Area and has the highest density of high-rise buildings in Alameda County. Certain sections of Broadway, Telegraph, and San Pablo Avenues have no building height limits in the zoning code (City of Oakland, 2011). Lake Merritt, a lagoon lined with public trails and parks, forms the eastern boundary of downtown.

The eastern part of the city includes the Oakland Hills, composed mostly of single-family homes and quiet, neighborhood-serving commercial districts, while the western part of the city is home to a wide variety of land uses, including California bungalow-style single-family homes, high-density transit-oriented residential and commercial development along the BART line and within downtown, and industry along the Interstate 880 corridor. West Oakland, the community west of Interstate 980 and south of the San Francisco-Oakland Bay Bridge, is a neighborhood of mixed residential and light industrial uses, rail yards and the Seaport.

With the exception of a few public parks, the Oakland waterfront is highly urbanized and owned and operated by the Port of Oakland, a semi-autonomous entity of the city. The Port manages the seaport (the fifth largest container port in the country), Oakland International Airport (OAK), and commercial real estate, including Jack London Square, a mixed-use entertainment district fronting the Oakland Estuary just south of downtown. The southern part of Oakland contains the Oracle Arena and Oakland Coliseum (O.co Coliseum) sports facilities and the Coliseum Industrial Complex.

City of Alameda

The City of Alameda had a 2010 population of 73,812 and encompasses 10.6 square miles of land and 12.3 square miles of water (US Census State and County Quick Facts, 2011). The city has a population density of 6,957 people per square mile. Of Alameda's 6,827 total acres, 2,663 acres are residential, followed by commercial (698 acres) and industrial (196 acres) (ABAG, 2006a).

Most of Alameda is on an island immediately south of downtown Oakland and the Port of Oakland. The western 918-acre portion of the island is home to the former Alameda Naval Air Station. The Station closed in 1997 and is now owned by the city, which hopes to redevelop the property with mixed-use housing, commercial, and industrial development with 6,000 jobs and 2,700 units of housing. The central and eastern portions of the island are home to the traditional core of the city, including its downtown. This section of the city is an example of an old "streetcar suburb" of Oakland and San Francisco, with dense neighborhoods of older Victorian and craftsman-style homes, narrow residential lots, and compact shopping districts built around the historic Key System and East Bay Electric streetcar lines. Crown Memorial State Beach lines the southern shore of Alameda Island and offers one of the few sandy beaches along the San Francisco Bay shoreline. Physically part of the East Bay mainland and adjacent to OAK is Bay Farm Island. Built in the 1980s, Bay Farm Island is a mostly residential community lined with lagoons and community parks, with some office, retail, and light industrial uses along its southern boundary.

Land Use: Southern Alameda County—San Leandro, San Lorenzo, Hayward, Union City

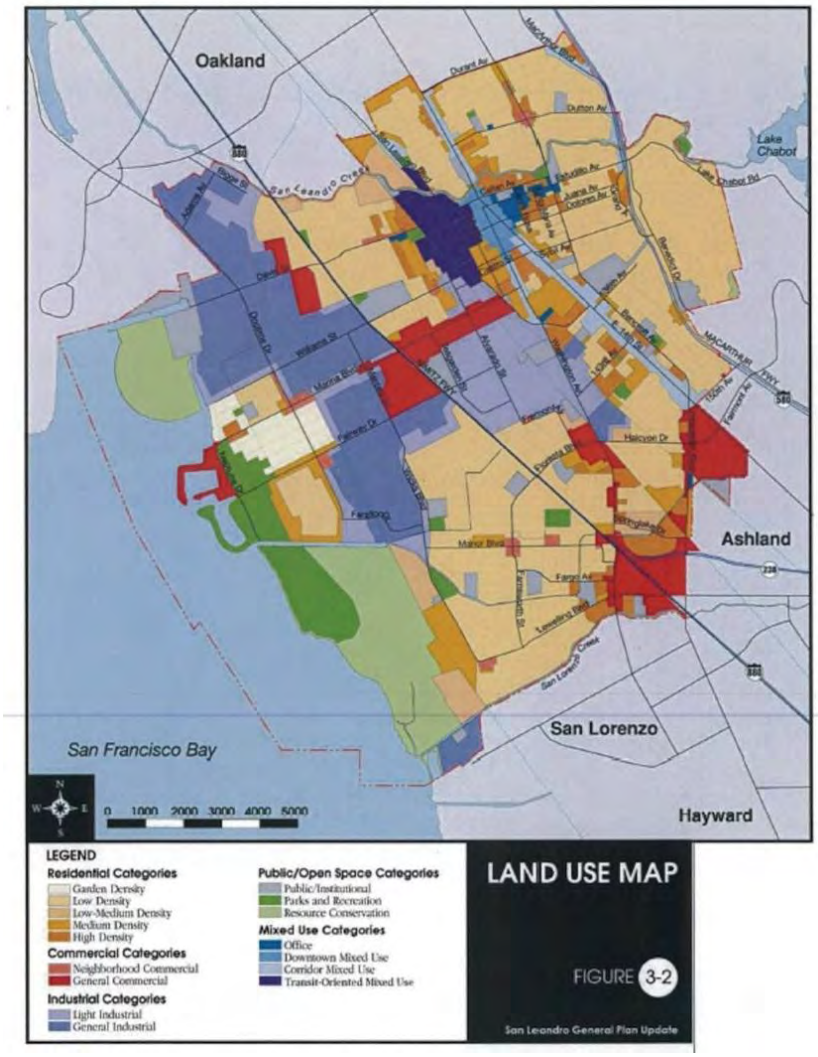
City of San Leandro

The City of San Leandro comprises 13.3 square miles of land and 2.3 square miles of water, and in 2010 had a population of 84,950. An older, inner-ring suburb developed largely in the 1940s and 1950s, San Leandro has a population density of 6,366 residents per square mile. Of San Leandro's 9,924 acres, residential uses occupy 3,402 acres, followed by industrial (1,643 acres) and commercial (1,533 acres) (ABAG, 2006a) (see Figure 2).

Over half of the city is residential, ranging from low-density, single family homes to high-density developments along the BART corridor (City of San Leandro, 2002). Commercial/mixed land uses account for 12% of the city's land area, and public/open space almost 6%. San Leandro has taken steps to preserve its industrial base. Over 20% of the city's land area (much of which is west of Interstate 880 and relatively close to the bay) is zoned industrial. Along San

Francisco Bay, the city also owns the San Leandro Marina, which consists of a full service marina with 455 berths, a boat launch ramp, and two yacht clubs. The bayfront also has two golf courses, restaurants, a hotel, parks, picnic areas, and walking trails. Oyster Bay Regional Shoreline, owned and maintained by the East Bay Regional Park District, is located just to the north of the San Leandro Marina and offers additional bayfront open space and recreational opportunities.

Figure 2. Land Use Map of San Leandro



Village of San Lorenzo

San Lorenzo is an unincorporated census-designated area with a 2010 population of 23,452 residents in its 2.8 square miles of land (8,488 residents per square mile) governed by the Alameda County Board of Supervisors (Alameda County, 2010).

Most of San Lorenzo is west of Interstate 880 and north of the Hayward Regional Shoreline. Nearly all of San Lorenzo's houses, infrastructure, and community facilities were constructed as part of a master-planned community called San Lorenzo Village between 1944 and 1958. The Village consisted of 3,000 homes, schools, churches, a shopping center, and civic buildings and is a prototypical example of a large-scale, postwar suburban housing development akin to Levittown in New York and Lakewood in southern California (Hope, 2005).

Today, the San Lorenzo Village Homes Association enforces the covenants, conditions, and restrictions (CC&Rs) on the deeds of most properties within San Lorenzo Village. Homeowners whose properties are subject to these CC&Rs must seek permission from the association board of directors if they wish to alter their property (second-story addition, exterior color choice, etc.). In addition, a homeowner seeking a variance from county zoning rules must first get a recommendation from the association board.

City of Hayward

The City of Hayward had a 2010 population of 144,186 within its 35 square miles of land and 26 square miles of tidal marsh and managed wetlands (City of Hayward, 2002). The city's population density is 4,120 residents per square mile. Of Hayward's 28,181 total acres, 5,628 are residential, followed by industrial (2,763 acres) and commercial (1,917 acres) (ABAG, 2006a).

Before World War II, Hayward was a rural agricultural town with a population of 7,000. Explosive growth in the 1950s, facilitated by the opening of Interstate 880, brought about a substantial increase in the city's population, which exceeded 72,000 by 1960 (City of Hayward, 2010). As vast tracts of agricultural land were annexed, pushing the city limits south to Union City and west toward the bay, farmland gave way to more subdivisions, shopping centers, and industrial parks. As a result of the post-war housing construction boom, Hayward was transformed into a suburban bedroom community. More than 70% (approximately 15,000 units) of Hayward's single-family detached homes were built between 1950 and 1960. During the late 1960s and 1970s, Hayward experienced a surge in industrial development that created numerous employment opportunities, balancing to some extent the housing that was developed earlier. Much of the industrial development is west of Interstate 880. Construction of multifamily housing and small-lot single family housing on infill lots became more common throughout the 1980s and 1990s as available land decreased and the city matured. Today, townhouse and mixed-use developments have become more common, especially in the downtown area.

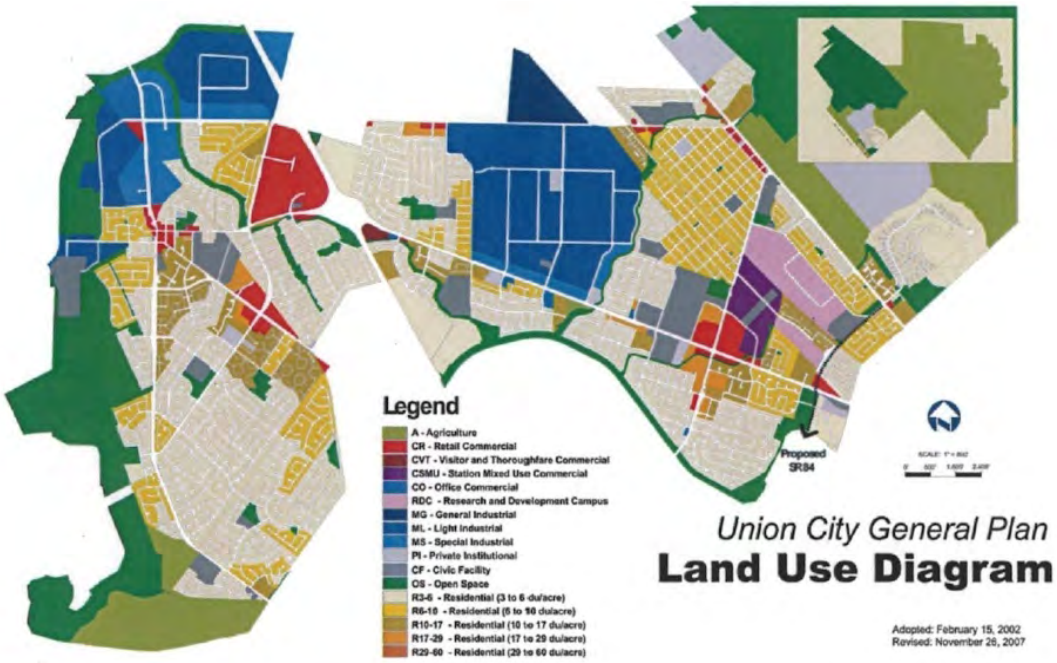
The Hayward shoreline is not urbanized like the shorelines in northern Alameda County. Much of the Hayward shoreline is owned and maintained by the East Bay Regional Park District and the Hayward Area Recreation and Park District (HARD). The Hayward Regional Shoreline consists of 1,713 acres of salt, fresh, and brackish water marshes, seasonal wetlands, and public trails. South of the San Mateo-Hayward Bridge are the marshes of the Eden Landing Ecological Reserve, which is owned and maintained by the California Department of Fish and Game. The reserve comprises 5,040 acres of former industrial salt ponds that are now being restored to marsh habitat as part of the South Bay Salt Ponds Restoration Project.

City of Union City

The City of Union City, the southernmost city in the ART project area, had a 2010 population of 69,516 within its land area of 19.5 square miles, resulting in a population density of 3,571 residents per square mile (US Census State and County Quick Facts, 2011). Of Union City's 12,365 total acres, 2,772 are residential, followed by industrial (964 acres) and commercial (664 acres) (ABAG, 2006a).

Union City is bounded by the City of Hayward on the north and west sides, the City of Fremont on the south and east sides, and salt marshes on the west. The western half of the city lies on a flat coastal plain and is intensely developed, while the remainder is composed of hillside areas devoted mainly to agricultural activities (i.e., grazing) and permanent open space.

Figure 3. Land Use Map of Union City



Single-family residential development is a predominant land use in the city (see Figure 3). The community also has a sizable industrial base located primarily in three industrial parks (City of Union City, 2002). Commercial activities are limited primarily to uses serving the immediate needs of residential neighborhoods. During the 1960s and 1970s, suburban, single-family home developments and industrial parks shaped much of Union City's land use pattern. New infill development has continued and several local businesses have expanded, including Union Landing, a subregional entertainment and retail center along I-880. Recent efforts to redevelop the Union City BART station area as a transit village with office, research and development, and residential uses have yielded higher-density, mixed-use development.

III. Critical Facilities

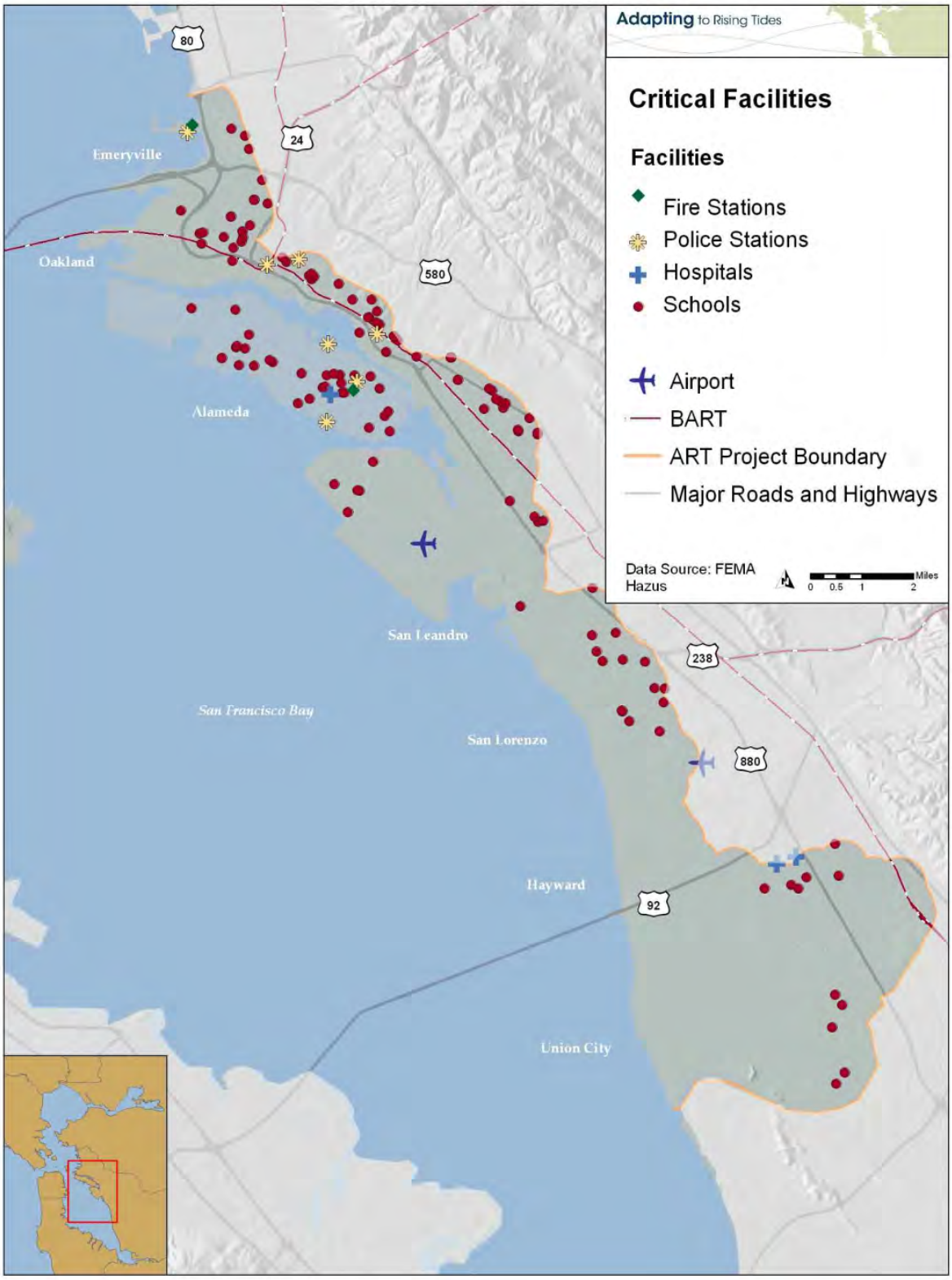
While the above descriptions offer a brief snapshot of land use within each jurisdiction of the ART project area, it is also important to identify critical facilities in each city. These include schools, hospitals, police stations, and fire stations. Within the ART project area there are 126 schools, three hospitals, nine police facilities, and two fire stations (see Figure 4).

These community facilities are critical to the health and public welfare of the cities and contribute to the community's capacity for resilience. Therefore, the ART project will provide a special focus on these and other essential community land uses.

Representative Critical Facilities in the ART Project Area

Alameda County Sheriff Headquarters
Alameda High School, Alameda
Alameda Hospital, Alameda
Alameda Police Department Headquarters
Arroyo High School, San Lorenzo
City of Alameda Fire Department
Emeryville Fire Department
Emeryville Police Department
Kaiser Hospital, Hayward
McClymonds Senior High School, Oakland
Oakland Police Administration Building
St. Rose Hospital, Hayward

Figure 4. Map of Critical Facilities in ART Project Area



IV. Land Use Policies and Governance

In California, local municipalities (cities and the county in unincorporated areas) have primary authority over the planning and regulation of land use. The state has traditionally given local governments wide discretion over land use planning policy decisions. However, California state law requires every local jurisdiction to prepare a General Plan to establish comprehensive, long-range policies for physical development within the community (OPR, 2003). The broad policies and statements of the General Plan are intended to act as the vision upon which all land use decisions are made.

Each General Plan includes a number of required elements, and some cities include additional elements focused on sustainability, climate change, public health and economic development. All cities within Alameda County have a General Plan, as do the unincorporated areas that fall under the jurisdiction of the county. The broad goals and policies of each General Plan are implemented through municipal Specific Plans, zoning ordinances, subdivision regulations, development agreements, and capital improvement programs. These policies describe more detailed information on the regulation of the use, height, bulk, and other land development controls. With the exception of zoning regulations in charter cities in California, all zoning, land use plans and decisions must be consistent with the goals and policies of the General Plan.

While cities have broad latitude with regards to their land use decisions, their policies are shaped by the Bay Area's strong tradition in regional planning. The San Francisco Bay Area has four regional government agencies that respectively address the critical issues of housing, transportation, air quality, and land use.

- **Association of Bay Area Governments** (ABAG)—the Bay Area's council of governments covering the nine counties and 101 cities of the San Francisco Bay Area. ABAG's chief responsibility is to determine the region's proper amount of housing through the state-mandated Regional Housing Needs Allocation (RHNA). The RHNA dictates how many housing units at specific affordability levels are needed within each local government's jurisdiction.
- **Metropolitan Transportation Commission** (MTC)—the nine-county Bay Area's metropolitan planning organization. As such, it is responsible for updating the Regional Transportation Plan and Transportation Improvement Program, which includes a list of all transportation projects eligible to receive state and federal funding.
- **Bay Area Air Quality Management District** (BAAQMD)—the public agency in charge of regulating stationary sources of air pollution within the nine-county San Francisco Bay Area. The Air District also develops regional air quality plans in order to attain state and federal air quality standards.
- **San Francisco Bay Conservation and Development Commission** (BCDC)—a state agency that has planning and regulatory responsibility for San Francisco Bay, its marshes, and a 100-foot shoreline band. BCDC maintains its state-mandated *San Francisco Bay Plan,* which addresses the beneficial and priority uses of the Bay and its shoreline, including areas for recreation, ports, water-related industry, and transportation. Local government land use decisions within BCDC's jurisdiction must be consistent with the Bay Plan and projects must receive permits from BCDC.

These four regional agencies coordinate their planning efforts through the Joint Policy Committee (JPC). One of the JPC's core responsibilities is the FOCUS program (Bay Area Vision). This Bay Area-wide voluntary program encourages focused infill development in strategic urban areas, including within the urban core, along high-capacity transportation corridors, and within a half-mile radius of major transit stations. These locations, approved by both the JPC and the local government, are called Priority Development Areas (PDAs). Altogether, these areas cover only about 115,000 acres of urban and suburban land, less than 5% of the Bay Area's total land area; however, the proposed PDAs could accommodate over half of the Bay Area's projected housing growth to the year 2035. A total of eighteen PDAs are located within the boundaries of the cities in the ART subregion, and 10 of these are located within the ART project area (see Table 3).

Table 3. Planned Priority Development Areas (PDAs) in the ART Project Area

Priority Development Area	Lead Agency	Jobs (2010)	Acres (approx)	Households (2010)	Future Land Use Designation
Alameda: Naval Air Station	Alameda	1,307	1,052	1,088	Transit town center
Emeryville: Mixed-Use Core	Emeryville	11,487	584	3,525	City center
Hayward: South Hayward BART	Hayward	483	226	1,658	Urban neighborhood
Oakland: Coliseum BART Station Area	Oakland	5,000	1,014	3,436	Transit town center
Oakland: Downtown and Jack London Square	Oakland	91,477	803	10,626	Regional center
Oakland: Eastmont Town Center	Oakland	3,567	578	5,960	Urban neighborhood
Oakland: Fruitvale and Dimond Areas	Oakland	8,211	1,510	12,835	Urban neighborhood
Oakland: MacArthur Transit Village	Oakland	10,415	935	8,025	Urban neighborhood
Oakland: Transit-Oriented Development Corridors	Oakland	32,177	8,049	60,971	Mixed-use corridor
Oakland: West Oakland	Oakland	6,603	1,630	9,025	Transit town center

While the Alameda County Planning Commission and Board of Supervisors implements County land use policies, there are a number of other agencies with land use planning and management responsibilities in including:

- **Hayward Area Shoreline Planning Agency** (HASPA)—established in 1970, a JPA of the Hayward Area Recreation and Park District, the East Bay Regional Park District, and the City of Hayward. The primary purpose of HASPA is to coordinate efforts to plan for the management and improvement of the Hayward shoreline.
- **East Bay Regional Park District** (EBRPD)—a bi-county independent special district that owns and operates 91,000 acres of land within its network of 55 parks and 15 trails within Alameda and Contra Costa Counties. The District owns and/or manages

numerous parks within the ART project area, including Oyster Bay Regional Shoreline in San Leandro and Hayward Regional Shoreline in Hayward.

- **California Department of Fish and Game** (DFG)—a state agency that manages the state's fish, wildlife, and plant species and their critical habitat. The Department owns and maintains Eden Landing Ecological Reserve in Hayward.
- **California Department of Parks and Recreation**—a state agency that owns and operates a network of 270 natural and cultural areas for the public's use. The Department owns Crown Memorial State Beach in Alameda and Eastshore State Park in Emeryville (although both are managed under contract by the East Bay Regional Park District).
- **Alameda County Flood Control and Water Conservation District** (ACFCWCD)—a department of the County of Alameda that plans, designs, and inspects the construction of flood control projects. The District also maintains flood control infrastructure, owning a vast system of levees and maintaining the creeks and waterways throughout Alameda County.

V. Existing Stressors

Alameda County is highly subject to natural hazards. The Hayward Fault runs parallel to the East Bay hills throughout the entire ART project area and is a major threat to Alameda County's most urbanized areas, which happen to be located along the San Francisco Bay shoreline and portions of some are constructed on top of bay fill. Thus, as is the case in much of the Bay Area, earthquake-induced shaking and liquefaction are major threats to the county that could be exacerbated by sea level rise. ABAG has identified the percent of land within each county that is located in high-hazard areas (see Table 4).

Table 4. Percentage of Land in Alameda County in High Hazard Areas (as of 2005)

Hazard	Percent
Fault study zone	3.2
Earthquake shaking potential	51.3
Liquefaction susceptibility	27.7
100-year flood zone	8.1
Rainfall-induced landslide areas	26.8
Wildfire threat	57.2
Dam failure inundation	18.7

Source: ABAG, 2010.

ABAG has also calculated the number of properties located within the Federal Emergency Management Agency's (FEMA's) 100-year and 500-year flood plains. The 100-year flood plain is an area mapped by FEMA for the National Flood Insurance Program (NFIP). The NFIP program components include flood insurance, flood management, and flood hazard mapping (FEMA, 2010). According to FEMA standards, the 100-year flood plain is an area having a 1% chance of flooding in any given year and the 500-year flood plain is an area with a 0.2% annual chance of flooding. Table 5 describes land uses within Alameda County located within the current 100-year or 500-year flood plain.

Table 5. Acres of Alameda County by Land Use in FEMA Flood Zones

Type of Land Use	100-Year Flood Plain (acres)	500-Year Flood Plain (acres)	Total (acres)
Residential and mixed-use	8,764	16,189	342,263
Commercial and recreational	265	763	14,128
Industrial and other	238	601	11,729
Alameda County total	9,265	17,553	368,120

Source: ABAG, 2006a.

Part B. Socio-economic Trends

I. Demographic Trends

Alameda County is one of the most racially and ethnically diverse regions in the nation. Of the county's 1,510,271 residents, 43% are White, 26.1% are Asian, 22.5% are Hispanic/Latino, 12.6% are Black/African American, and 0.6% are American Indian/Alaska Native (US Census State and County Quick Facts, 2011). English is the most commonly spoken language in the county (63.7% of households), although many other languages are spoken as well, for example Asian/Pacific Island languages (14.5%), Spanish (12.8%), and other Indo-European languages (7.7%) (ACPH, 2006a).

Income is often used as an important indicator of public health and poverty, and to inform the capacity for resilience. In Alameda County, the median household income is $68,258, slightly higher than the statewide average of $58,925. Countywide, 10.8% of the population lives below the poverty level, which is lower than the statewide average of 14.2% (US Census Bureau, 2009); however, 13.8% of children in the county are living in poverty (ACPH 2006b). Education levels in the county are relatively high, with 85.7% of residents having a high school diploma and 39.9% having a bachelor's degree or higher.

II. Economic Trends

Alameda County has a highly diversified economy (See Table 6) including major employment in health care and social assistance, retail trade, manufacturing, and professional and technical services. Other industries include educational services, utilities, management, and transportation. The county has also seen significant growth in recent years in emerging green industries (East Bay EDA, 2010).

Table 6. Major Industries and Employment in Alameda County

Industry Type	Number of Establishments	Number of Paid Employees
Manufacturing	2,355	94,682
Wholesale trade	3,047	54,671
Retail trade	4,420	66,883
Information	904	33,261
Professional, scientific, and technical services	4,936	53,436
Administrative and support and waste management and remediation service	1,741	55,971
Health care and social assistance	4,001	69,127
Accommodation and food services	2,937	42,053

Source: US Economic Census, 2011.

III. Vulnerable Populations and Existing Inequalities

Social factors, such as disparities in income, education, and access to resources, indicate how communities or individuals may be disproportionately affected by a climate-related impact. Recent disasters, such as the 2005 hurricanes in the USA, demonstrate the ways that social factors and vulnerability can play a role in the devastation experienced by different communities (Vogel, 2007). A number of studies have begun to examine how existing issues of equity will affect the way communities might be affected by climate change. In "The Climate Gap," published by University of California, Berkeley (Morello-Frosh, 2009), researchers highlight the fact that climate change is interlinked with human rights, public health, and social fairness. In California, heat waves, increased air pollution, the cost of basic necessities, job opportunities, and the cost of insurance were all cited as factors that could disproportionately affect vulnerable communities. This information is compounded with knowledge of existing disparities in the state. When California's cost of living is taken into account, it has one of the highest poverty rates in the nation, with Los Angeles, Monterey, and San Francisco having especially high poverty rates (Reed, 2006).

Income inequalities have grown in recent years in the United States, a trend that also has occurred in Alameda County. While there has been employment growth in service industries, these jobs often pay below the living wage. In the Bay Area, almost 40% of the workforce is employed in this industry, which includes service, sales, and office work (BARHII, 2008). Across the state of California, poverty rates are highest among adults without a high school diploma, families of single mothers, and foreign-born Latinos (Reed, 2006). Housing takes up a significant portion of income for Alameda County residents: 21% of renters spend 50% or more of their income on rent, while owner-occupied households spend more than 30% of income (ACPH, 2006a). Recent studies indicate that the Bay Area is also becoming more segregated by income, and that income disparities have been on the rise since 1990 (Pastor, M. et al., 2008). This trend has been exacerbated by gentrification and displacement in many communities.

Racial disparities are also apparent in Alameda County, including significant health inequalities. African American residents within the county have the highest rates of morbidity

and mortality. In addition, the size of the gap between African Americans and other ethnic groups for several health indicators, such as overall mortality, has grown in the past decade (ACPH, 2006a). These gaps continue to widen, as public health indicators are improving faster for other ethnic groups than for African Americans.

Inequalities among youth populations track similar patterns of race and income. Poverty, violence, mental health issues, and lack of role models have been highlighted as major issues for youth. Homicide is the leading cause of death for youth in Alameda County (ACPH, 2006b). African American youth within the County experience the greatest level of health disparities, including the greatest rates of poverty, homicides, foster care placements, and high school dropout (ACPH, 2006b). Young people within the county are also important and vital assets for community health and well being. Groups such as Youth Uprising and PUEBLO develop youth-centered programming around leadership development, arts and education, community safety, and urban greening.

IV. Community Organizations and Social Capital

A number of community-based organizations provide services that contribute to community resiliency. To help bring this information to those in need, Alameda County provides a searchable map of community-based organizations (www.acgov.org/ms/cbomaps/). Many organizations have worked to build partnerships with local and county governments around issues similar to those addressed in the ART project, such as transportation, housing, conservation, public outreach and education, ecological restoration, and scientific research. These groups have had varying levels of success in advocating for community benefits strategies for new developments and in addressing widespread inequalities in the region through policy, planning and advocacy (Pastor, M. et al., 2008). However, new and innovative partnerships are leading to success in planning for climate change. For example, the City of Oakland worked with the Oakland Climate Action Coalition to develop a Climate Action Plan for the city. This Coalition included a broad range of groups, including Bay Localize, Causa Justa: Just Cause, the Center for Progressive Action, Communities for a Better Environment, the Local Clean Energy Alliance, the Ella Baker Center for Human Rights, Movement Generation, the Pacific Institute, TransForm, and the West Oakland Environmental Indicators Project (Ella Baker Center, 2011).

Oakland Climate Action Coalition, Oakland Fruitvale meeting. Source: planet a., Flickr Creative Commons.

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2. AIRPORT

I. Definition

Oakland International Airport (OAK) is located in the City of Oakland, about 6.5 miles southeast of downtown Oakland in Alameda County along San Francisco Bay (see Figure 5). OAK encompasses 2,600 acres and is owned and operated by the Port of Oakland, an independent department of the City of Oakland. The Port of Oakland was created in 1927 as an autonomous department of the City of Oakland under the exclusive direction of the Board of Port Commissioners by an amendment to the City's Charter. The Port manages property stretching along 20 miles of the eastern shore of San Francisco Bay. OAK's property is divided into North Field and South Field, and its facilities include terminal, airfield, parking, air cargo, general aviation, and maintenance facilities. Passenger terminal facilities, commercial airline service, and air cargo operations are concentrated at South Field while general aviation operations are concentrated at North Field.

II. Location and Facilities

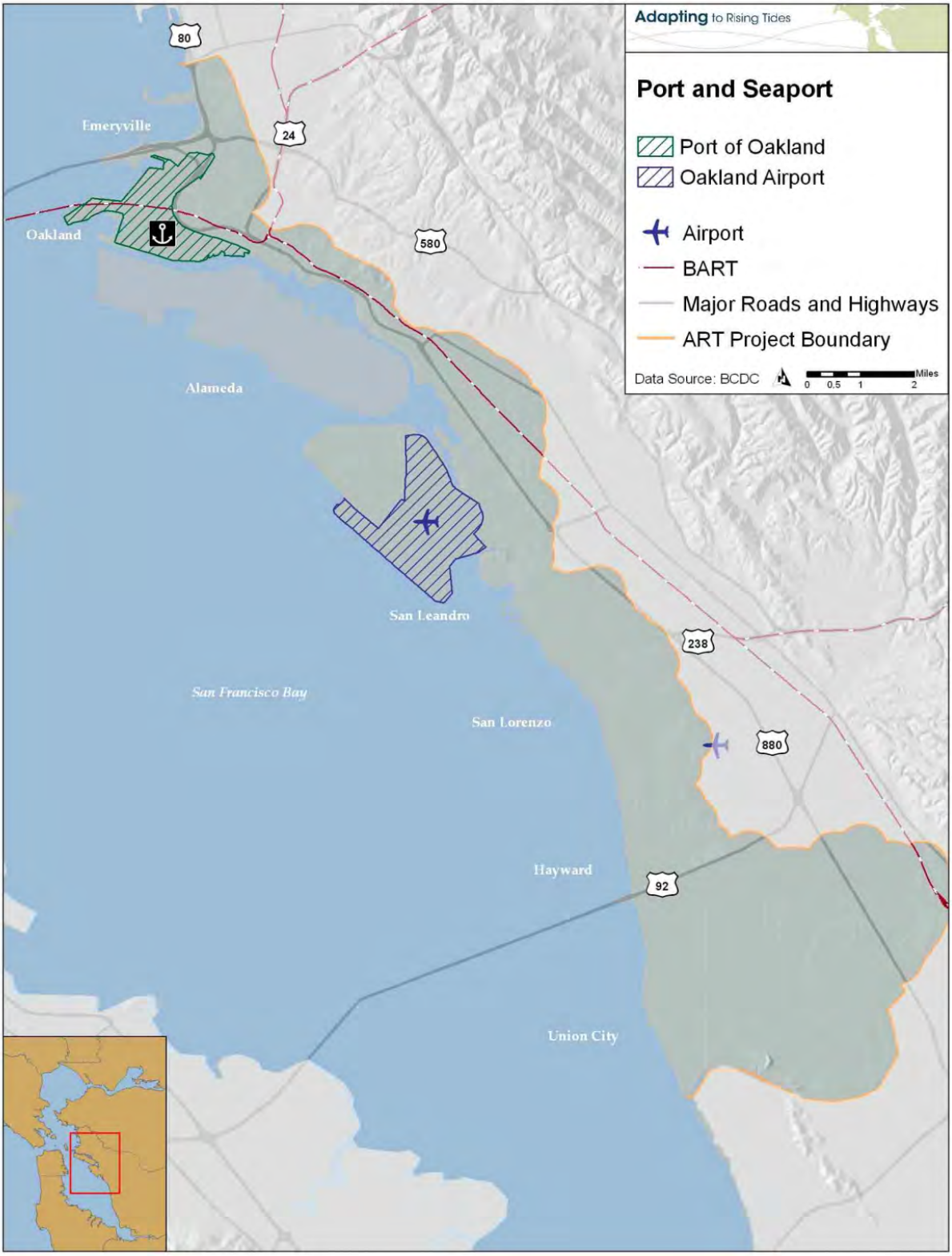
South Field has OAK's primary air carrier runway (Runway 11/29) and North Field has three runways (Runway 9R/27L, Runway 9L/27R, and Runway 15/33). South Field's Runway 11/29 provides service to larger commercial aircraft, including turbo-jet and turbo-fan aircraft, four-engine reciprocating powered aircraft, and turbo-props over 17,000 pounds. North Field's three runways provide service to smaller aircraft, including general aviation and some air cargo. As Table 7 summarizes, the elevations of these critical runway facilities range from a low of only 1.8 feet above mean sea level to a high of only 8.7 feet.

Table 7. Oakland International Airport Runway Facilities

Runway	Length (ft)	Width (ft)	Surface Type	Runway end / Elevation (ft, MSL)	Runway end / Elevation (ft, MSL)
09L/ 27R	5,454	150	Asphalt	09L = 5.6	27R = 5.8
09R/ 27L	6,213	150	Asphalt	09R = 8.1	27L = 8.2
11/ 29	10,000	150	Asphalt	11 = 7.8	29 = 8.7
15/ 33	3,372	75	Asphalt	15 = 1.6	33 = 4.0

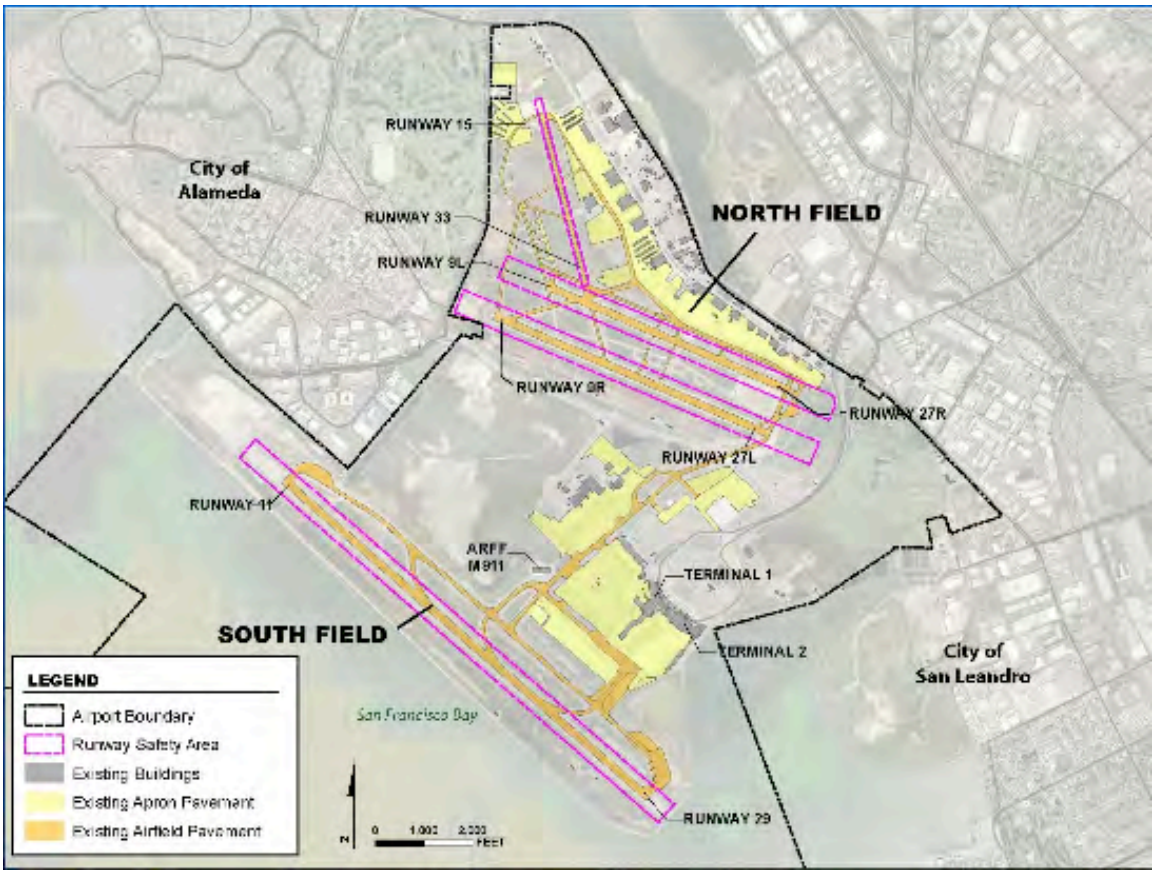
Source: FAA Form 5010 Summary.

Figure 5. Map of Port of Oakland Facilities, Airport and Seaport



Runways constitute the largest aviation land use at OAK at approximately 1,078 acres (Oakland Airport Master Plan, 2006) (See Figure 6). South Field, which is defined as the airport area south of Ron Cowan Parkway, contains 208 acres of passenger facilities, which include Terminals 1 and 2. Additionally, South Field holds 104 acres of air cargo facilities, the largest of which is the FedEx Metroplex (their West Coast hub operation). North Field (the airport area north of Ron Cowan Parkway) contains a variety of aviation land uses, the largest of which is general aviation (approximately 85 acres), including aircraft hangars, ramps, and three fixed base operators, KaiserAir, Business Jet Center, and Landmark Aviation. North Field also accommodates some air cargo facilities (approximately 30 acres), including Ameriflight, a small package carrier. South Field currently has 29 aircraft gates at two terminals: Terminal 1 with 16 aircraft gates and Terminal 2 with 13 aircraft gates.

Figure 6. Oakland International Airport Layout



Source: Oakland International Airport Master Plan.

III. Existing Plans and Future Capacity

Based on forecasts of the number of passengers and flights through the airport, the 2006 Airport Master Plan estimated a need for 46 to 50 total aircraft gates to efficiently handle demand between 2010 and 2012. Currently, the airport has a total of 29 gates. The Master Plan Forecasts assumed a 2010 passenger demand of 18 million passengers per year, based on the 2005 FAA Terminal Area Forecast (TAF) and similar forecasts made in the 2000 Regional Airport System

Plan (RASP). However, due to several factors—the national economic recession, airline competition, the steep and sudden increase in jet fuel prices, and several airline bankruptcies—the 2010 passenger projections were not met. Reflecting such changes in airport demand, new projections were evaluated in 2010 as part of the update to the RASP. The RASP's Baseline and Delay Report predicts a decline in passenger and aircraft operations at OAK until 2020, followed by a surge in activity. The 2020 aviation forecast predicts 300,600 annual aircraft operations, which includes all commercial, general, and cargo aviation activity, followed by a steady annual increase to 354,000 by 2035.

Airfield capacity at OAK is affected by its runway configuration and use patterns. The single air carrier runway on the South Field, Runway 11/29, is used by nearly all commercial flights. The three runways on the North Field have restrictions on turbojet operations due to noise ordinances and are used almost exclusively by general aviation and some charter and cargo flights. FAA regulations and airport policies dictate what type of planes can land on which runways. Aircraft with experimental or limited certification having over 1,000 horsepower or 4,000 pounds are restricted to Runway 11/29. It is preferred that aircraft landing at the North Field arrive on Runway 27L and depart on 9R or 27R. However, if these runways are unusable based on air traffic control instruction, then Runway 11/29 must be used. OAK has a 24-hour noise abatement procedure which prohibits turbojet- and turbofan-powered aircraft, turboprops over 17,000 pounds, four-engine reciprocating powered aircraft, and surplus military aircraft over 12,500 pounds from departing on Runways 27L and 27R or landing on Runways 9R and 9L (FAA Airport Master Record, 2011). However, these noise prohibitions can be waived in emergencies or whenever Runway 11/29 is closed due to maintenance, safety issues, high wind, or weather.

According to the 2011 Regional Airport System Plan Update forecast for OAK, traffic growth is not projected to be a significant issue in the future. Accommodating the 2035 growth in activity with today's airfield facilities is feasible at only a four-minute average aircraft delay, which is well below the FAA standard metric of 15 minutes as the point at which delays must be reported (Regional Airport System Plan Update, 2011). The practical annual capacity of OAK (including North Field and South Field operations) is estimated to be between 400,000 and 450,000 annual operations. With actual operations at fewer than 220,000 in 2010, airfield capacity is not expected to be reached until after 2035.

IV. Existing Stressors

Earthquakes are a major hazard throughout the Bay Area, and OAK's location on top of bay fill makes it particularly susceptible to liquefaction and shaking. As such, airport operations were affected by the 1989 Loma Prieta earthquake, in spite of its location over 40 miles from the epicenter. Runway 11/29, the airport's main 10,000-foot runway, built on hydraulic fill over Bay mud, was severely damaged by liquefaction; 3,000 feet of the runway sustained cracks, some of which were a foot wide and a foot deep (USGS, 1998). Spreading of the adjacent unpaved ground resulted in cracks up to 3 feet wide. Large sand boils appeared on the runway and adjacent taxiway, a few as wide as 40 feet (see Figure 7).

Figure 7. OAK's Main Runway after Loma Prieta Earthquake, with sand boils and cracks (above) and a close up of a sand boil on the main runway (below)

Sources: U.S. Geological Survey, Photo from 10/18/1989.

As a result, OAK was immediately shut down to evaluate runway damage. North Field's general aviation Runway 9R/27L was used to accommodate diverted air traffic for several hours before the main runway was reopened with a usable length of only 7,000 feet. This shorter runway length impacted cargo loads during takeoff. Over the 30 days following the earthquake, 1,500 feet of the 3,000-foot damaged section of the runway was repaired. An adjacent taxiway was also damaged by liquefaction. Repairs of this taxiway segment and the

final 1,500 feet of the main runway were completed six months later, with repair costs totaling approximately $6.8 million, including $3.5 million for runway repairs, $2.2 million for taxiway repairs, and $1.1 million for repair of other (non-liquefaction-related) damage. FAA funded approximately $5.5 million of the repairs, with the remainder funded by OAK. Neither San Francisco International Airport nor San Jose International Airport was affected by liquefaction in the Loma Prieta earthquake.

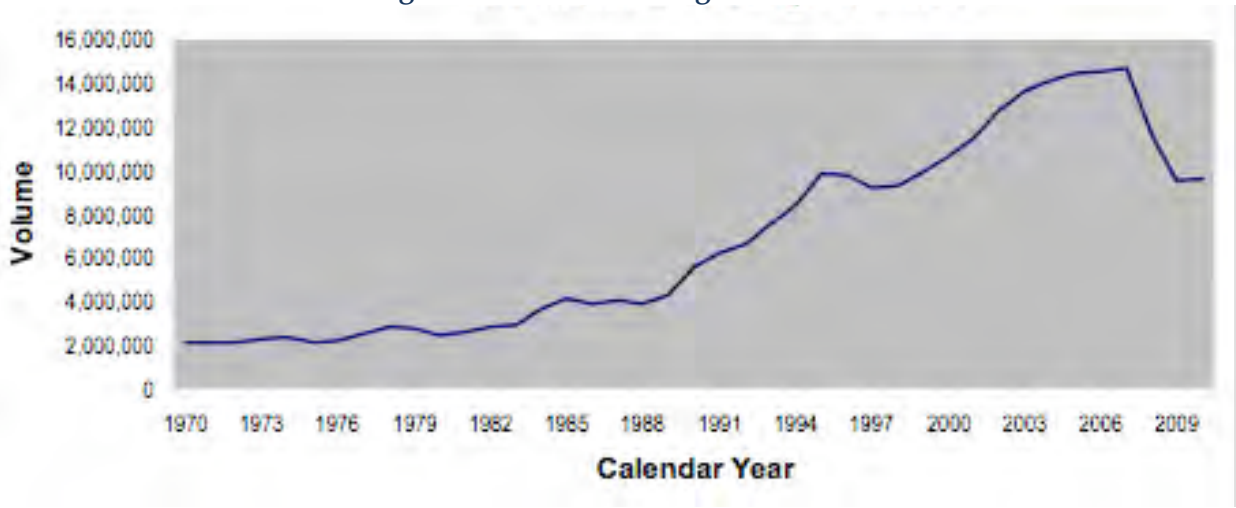
A perimeter dike forms the southwestern shoreline of the airport property and protects the South Airport from flooding by waters of San Francisco Bay. The dike was constructed in three phases during the 1950's, '60s, and '70s, mainly from materials dredged from the Bay, for the purpose of "reclaiming" land on which to develop and expand OAK's facilities. Dredged materials (mainly sand) were used to fill the area behind the dike. Portions of the dike currently do not meet FEMA 100-year flood standards, and portions are susceptible to liquefaction in a major seismic event. The Port of Oakland plans to construct improvements to the perimeter dike to correct these deficiencies, enabling the dike to withstand severe storms and seismic events, protect the Airport from potential flooding, and meet FEMA certification standards. In addition, the planned improvements would help mitigate the effects of potential sea level rise due to global warming. The project is currently in the environmental review phase.

V. Economics/Jobs

Twelve scheduled passenger airlines currently serve OAK. Southwest Airlines dominates market share, serving nearly 74% of all OAK passengers in 2010 (Port of Oakland, 2011), followed by Alaska/Horizon Air and JetBlue at 6.7% and 6.5%, respectively. OAK is currently the largest operating hub in California for Southwest. The airport is also the North American West Coast hub for FedEx, the largest air cargo operator at OAK, which performs intermodal sort and distribution of freight and overnight packages from around the world from its OAK facilities. FedEx averaged 15 flights a day, handling 907 million pounds of cargo in 2010 (Port of Oakland, 2011). UPS also has a large cargo presence at Oakland, averaging four cargo flights per day in 2010, transporting a total of 174 million pounds of goods. Ameriflight and West Air also operate air cargo transportation services out of OAK.

In 2010, OAK carried 9,857,845 passengers, making it the 33rd busiest airport in the United States in terms of total passengers, according to Airports Council International-North America (see Figure 8). This number is down from a 2007 all-time high of 14,613,489 passengers, reflecting both the downturn in the economy as well as a shift in travel to San Francisco International Airport from key domestic markets (Port of Oakland, 2011).

Figure 8. Annual Passengers at OAK



Source: Port of Oakland, 2011.

In 2010 the airport handled 510,947 metric tons of cargo and had 219,652 total aircraft movements (landings and takeoffs), ranking 12th in the country by metric tons and 34th by total aircraft movements. The 2010 figures represent a 4% increase from 2009 levels in metric tons of cargo, but a 6% decrease in total aircraft movements.

In the Bay Area alone in 2010, aviation activity from OAK yielded 7,680 direct, 5,578 induced, and 1,408 indirect jobs, for a total of 14,466 (Martin Associates 2011). An additional 24,428 hospitality industry jobs are dependent upon OAK, and nationwide, over 383,000 jobs are estimated to be in some way related to aviation activity at OAK. These jobs generated $4.2 billion in business revenue and $1.9 billion in personal income. OAK also generated $197 million in state and local taxes. Direct payments to the City of Oakland totaled $3.2 million.

VI. Equity/Environment

OAK has a long history of working with its adjacent communities to develop programs that improve environmental quality and reduce the airport's negative impacts. For example, to reduce noise impacts on adjacent communities, the airport spent $34 million to insulate 760 houses and five schools in the cities of Alameda and San Leandro, reducing the average interior sound level by five to seven decibels. To help improve air quality, OAK has a compressed natural gas fueling station that is open to the public and helps fuel taxis, parking shuttles, and door-to-door vans. The station pumps the equivalent of 35,000 gallons of gasoline per month (Port of Oakland, 2011). To protect water quality, the airport organizes workshops, conducts pollution prevention training, collects and analyzes stormwater samples, and inspects approximately 40 Port and tenant facilities annually in compliance with the State Water Resources Control Board's industrial stormwater permit. The airport also reviews stormwater regulations with contractors and assists them in the development of stormwater pollution prevention plans.

OAK, as a department of the Port of Oakland, strives to work collaboratively and inclusively with its surrounding communities to ensure that its plans and projects yield benefits for the

local community. The Maritime and Aviation Project Labor Agreement (MAPLA) was adopted by the Board of Port Commissioners in March 2000 (for more information see *www.portofoakland.com/business/contract.asp*). MAPLA is intended to ensure that 50% of the total hours worked on most Port projects are by residents within the Port Local Impact Area, which consists of the Cities of Oakland, Emeryville, San Leandro, and Alameda. Additionally, all workers covered by MAPLA are to be paid prevailing wages, as determined by the State of California. MAPLA projects include non-federally-funded on-site construction, modifications, alterations, repair, and demolition of Port projects in the Maritime and Aviation areas that are over $50,000 and Tenant Improvements in Maritime and Airport North Field over $150,000 and over $50,000 in the Airport area. In addition to MAPLA, the Port's Living Wage Program applies to all businesses with more than 20 employees working on Port-related contracts.

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3. CONTAMINATED LANDS

I. Definition

Contaminated lands are sites known to be contaminated with materials that pose a hazard to people and/or the environment. In general, the threat posed by contaminated sites depends on:

- The likelihood that a site has released or has the potential to release hazardous substances into the environment.
- The characteristics of the waste (e.g., toxicity and waste quantity).
- People or other sensitive receptors potentially affected by the release.

The release of hazardous substances occurs through four pathways: groundwater migration, surface water flow, soil exposure, and release to the air (vaporization). These pathways lead to effects on receptors through contamination of drinking water and food chains, as well as direct exposures to human populations and sensitive ecosystems (US EPA, Hazard Ranking System).

This report identifies four types of contaminated lands: federal Superfund sites, State of California Cleanup program sites, sites with leaking underground storage tanks (USTs), and landfills. It does not address sites that were contaminated in the past but have been successfully cleaned up or permitted facilities for transport, use, and storage of hazardous materials.

- A federal Superfund site is an abandoned area where hazardous waste is located, possibly affecting local ecosystems or people (US EPA, Pacific Southwest). These areas have been designated on a National Priorities List through the federal Superfund cleanup program (see below).
- Cleanup program sites (under the jurisdiction of the California State Water Resources Control Board's Site Cleanup Program and the State Department of Toxic Substances Control) are locations that have had chemical releases that contaminated soil and/or groundwater.
- Leaking USTs are sites that have or had leaking USTs. The vast majority of leaking UST sites are contaminated with petroleum products associated with gasoline service station operation. Tetrachloroethylene (TCE) is another common contaminant from leaking USTs and is commonly associated with the dry cleaning process (Water Board, Brownfields Program, Regional Board, UST Program).
- A landfill is a solid waste management facility where waste is or once was disposed of on land. Landfills do not include surface impoundments, waste piles, land treatment units, injection wells, or soil amendments (CalRecycle, Solid Waste Facilities).

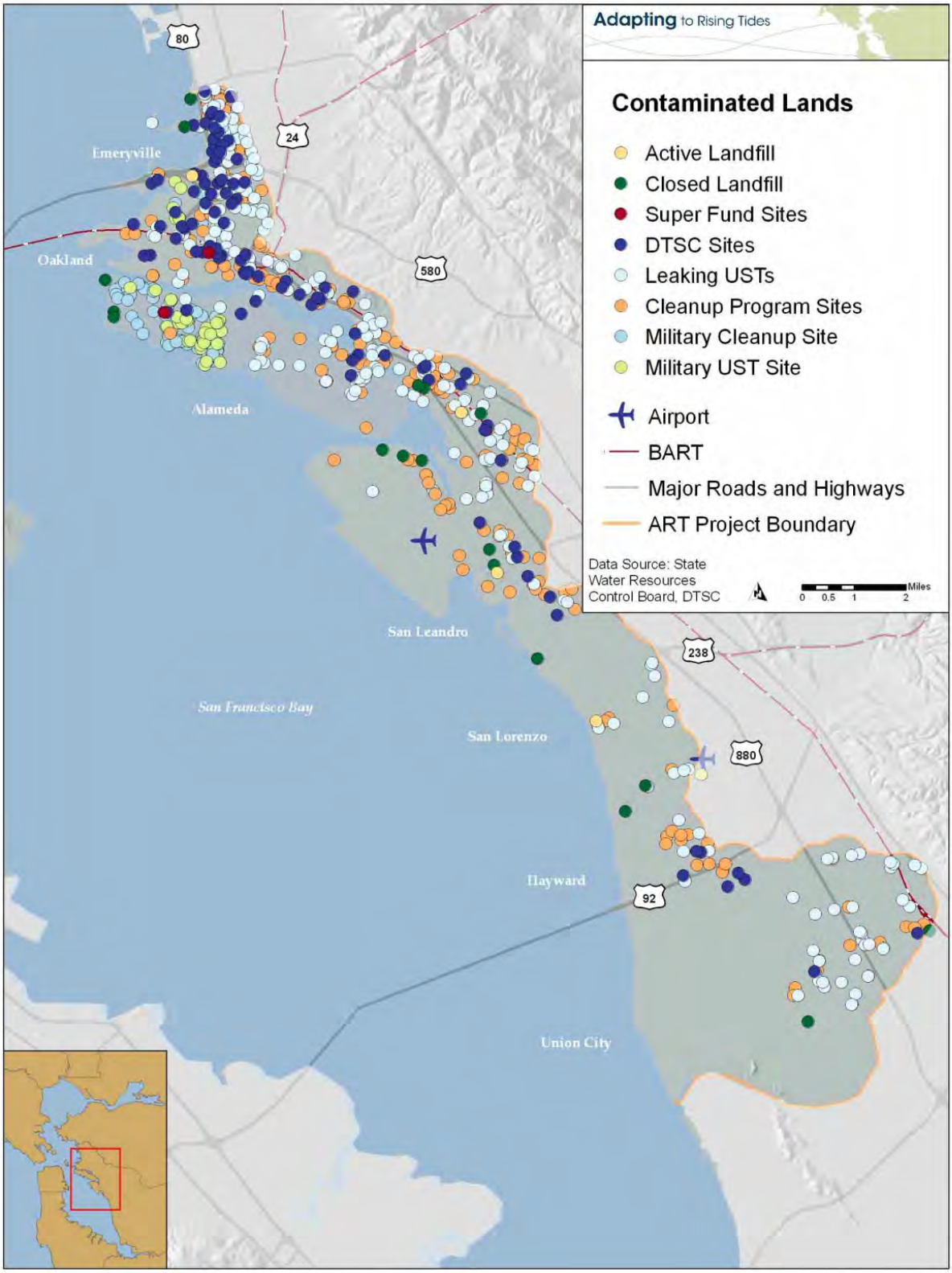
II. Locations and Physical Features

There are two Superfund sites in the ART study area (see Figure 9). The Alameda Naval Air Station (now known as Alameda Point) is a closed Navy installation located on Alameda Island, adjacent to the City of Alameda (US EPA, Superfund Site Reports). The boundaries of the former installation are roughly rectangular (approximately 2 miles in length and 1 mile in width) and occupy 2,634 acres. Of the total acreage, approximately 1,636 acres are dry land and 998 acres are submerged. The site is bordered by the Oakland Inner Harbor to the north, and by San Francisco Bay on the west and south. To the east is a mixture of residential, commercial,

industrial, and public lands including single-family homes, restaurants, retail stores, schools, shipyards, and a state beach. Contaminants historically generated at the site include industrial solvents, acids, paint strippers, degreasers, caustic cleaners, pesticides, chromium and cyanide wastes, waste oils containing PCBs, radium associated with dial painting and stripping, medical debris, and unexploded ordnance.

Alameda Point (former Alameda Naval Air Station) Superfund site. Source: Telstar Logistics', Flickr Commons.

Figure 9. Map of Contaminated Lands in the ART Project Area



The other Superfund site is the former AMCO Chemical Facility at 1414 3rd Street in Oakland, one block south of the West Oakland Bay Area Rapid Transit (BART) station. The site is bordered on the north by a vacant lot owned by BART, on the west by residences, on the south by 3rd Street, and on the east by Nelson Mandela Parkway. The size of the AMCO property is approximately 0.9 acre. The I-880 Freeway corridor crosses just to the south, passing over 3rd Street near the southeast corner of the property. The site is currently used for storage of cables. Land use in surrounding areas is a mix of commercial/light industrial and residential. The nearest residences are immediately adjacent along 3rd and Center Streets. Investigations of the site have confirmed the presence of chlorinated solvents and other contaminants (including vinyl chloride) in soil, soil gas, and groundwater on or near the site.

In the ART study area, more than 400 cleanup program sites are associated with many types of shoreline land uses (see Figure 9). The majority of sites are clustered in current industrial and retail land use areas, such as along Doolittle Drive in Oakland, and in San Leandro. However, cleanup program sites are also found in residential areas where past industrial land uses are being replaced by housing and mixed-use developments, for example in Emeryville. Approximately a dozen cleanup program sites are located in or adjacent to parks or recreational areas (for example, Union Point Park on the Oakland Inner Harbor). Although none are located in natural areas (such as wetlands), a few are in close proximity, such as in Union City near the former salt ponds at the Eden Landing restoration area.

There are approximately 450 leaking underground storage sites in the study area (see Figure 9). These storage tank sites are located in and adjacent to similar land uses as cleanup program sites but they are more dispersed throughout the area (DTSC, Envirostor, August 1, 2011, Regional Board, GeoTracker, August 10, 2011).

Twenty-four active and closed landfills are located in the ART project area (see Figure 9).[1] A few of the landfills are co-located with the other types of contaminated lands (e.g., three closed landfills on the Alameda Naval Air Station Superfund site and the closed landfill at Oyster Bay Regional Shoreline; photo below). With only three exceptions, the landfills in the study area are located adjacent to or in the Bay, and thus are near natural habitat areas. Other adjacent land uses include industrial, recreation, and residential.

[1] Tri-Cities Landfill is an active commercial Class III (i.e., it accepts nonhazardous wastes) solid waste disposal facility located just south of the study area in Newark.

Oyster Bay Regional Shoreline, located on a former landfill that closed in the early 1980s. Source: Bing Maps (www.bing.com/maps).

The five active landfills include a composting facility for biosolids and another for green wastes, a chipping and grinding operation, and two processing facilities for construction debris. Of the nineteen closed landfills, eight were solid waste disposal sites that accepted primarily municipal, or household, wastes (Personal communication, Terry Seward, San Francisco Regional Water Quality Control Board, August 30, 2011). Other types of closed landfills include composting operations; transfer and processing facilities for construction debris; a disposal site for foundry wastes; a dredge disposal site; and military sites that accepted all types of wastes, including hazardous materials. Two of the closed landfills were developed as golf courses, another two into shoreline parks, and one site was developed for residential use (Regional Board, GeoTracker, August 10, 2011, CalRecycle, SWIS, August, 16, 2011).

Residential green waste. Source: Sean Gin, www.berkeleyside.com.

Compost screener at work. Source: http://www.ethicurean.com/2008/07/14/food-scrap-composting/.

III. Ownership

Most of the identified contaminated lands in the study area are privately owned. Some are managed for commercial uses—such as gas stations, dry cleaners, retail stores, waste and recycling centers, etc.—while other sites are unused or underutilized areas known as brownfields (see below). Cities and other agencies own and manage some of the sites, for example municipal buildings, marinas, parks, composting facilities, etc. (Regional Board,

GeoTracker, August 10, 2011, CalRecycle, SWIS, August, 16, 2011). The majority of the closed landfills are owned by municipalities. Approximately 15% of cleanup program sites and leaking UST sites are owned by the Department of Defense. (State and local agencies work with the Department on cleanup of these sites.)

IV. Existing Stressors

Managers of the two Superfund sites face unique challenges related to the characteristics of the sites. At the Alameda Naval Air Station, remediating the large contaminant plume will be especially difficult. At the AMCO Chemical site, ongoing negotiations between the US EPA and potentially responsible parties could delay the final cleanup. For both Superfund sites, treatment such as soil excavations to remove contaminants can lead to additional exposures. This can raise concerns and even opposition to cleanup among nearby communities and other interested stakeholders.

Most cleanup program sites and leaking UST sites are funded by the party that caused the spill or contamination or the land owner, or both. In some cases, these sites benefit from the brownfields program, which provides funding for cleanups as well as mechanisms for liability relief. Even with these incentives, barriers involving funding and reticence on the part of the discharger deter cleanups (Per review by Linsay Whalin, Regional Water Quality Control Board. October 3, 2011, and Wheeler, 2001). Lack of resources for the regulatory agency is considered a significant hurdle to cleaning contaminated sites (Per review by Linsay Whalin, Regional Water Quality Control Board. October 3, 2011). At some sites the nature of the contamination (e.g., type, amount, location) can limit treatment or removal options and result in contaminants having to be left in place. For example, at Union Point Park on the Oakland Inner Harbor, metal-contaminated soil was excavated and placed under an engineered cap. Uses and activities (e.g., excavations) at the site are restricted through a legal covenant between the site owner (the Port of Oakland) and the Regional Board to prevent additional exposures (Regional Board, Union Point Park).

At some landfills, identification and prevention of contamination is a significant challenge. For example, at Turk Island Landfill in Union City, the final landfill cover was designed and constructed to provide water infiltration protection and proper drainage. However, settlement and animal burrowing seeps developed, and cap repairs have not resolved these issues (Regional Board, 1997). Some closed landfills do not have leachate collection and recovery systems as required today at active landfills; instead leachate is extracted via wells. This occurs at West Winton Landfill in Hayward. Leachate at that site is not highly toxic (toxicity has degraded over time), but the landfill is surrounded on three sides by wetlands. In the event of an earthquake, the proximity of the landfills to the Hayward and Calaveras faults is a potential stressor on the integrity of landfill protection structures (e.g., liners, collection systems and caps).

V. Governance

Superfund is the name of the fund established by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended. This law allows the U.S. Environmental

Protection Agency (US EPA) to clean up Superfund sites and to compel responsible parties to perform cleanups or reimburse the government for US EPA-led cleanups. Sites are listed on a National Priorities List upon completion of Hazard Ranking System screening, public solicitation of comments about the proposed site, and after all comments have been addressed (US EPA, National Priorities List).

For the Alameda Naval Air Station, the Navy is the lead agency responsible for cleanup of the site. US EPA is the lead regulatory agency charged with oversight of the Navy, with assistance from the California Department of Toxic Substances Control (DTSC) and the San Francisco Bay Regional Water Quality Control Board (Regional Board). The Navy, with US EPA oversight, has conducted investigations of all contaminated sites, or "response sites," at the Naval Air Station. The response sites are at various stages in the Superfund cleanup process. Six response sites are undergoing remedial investigations or feasibility studies to determine the nature and extent of contamination. Twenty have records of decision that explain which cleanup alternatives will be used; of those, five required no remediation, while the remainder are undergoing remediation (US EPA, Superfund Site Reports).

Currently US EPA is the lead agency for the responses at the AMCO Chemical Superfund site. The agency is investigating parties that may be responsible for the contamination. The US EPA Emergency Response Program operated a treatment system to remove vinyl-chloride-contaminated groundwater and soil vapors until July 1998, when it was turned off in response to community concern over potential exposure to contaminants from the system's exhaust stack. The US EPA later conducted a preliminary assessment and site investigation that led to listing of the AMCO Chemical facility on the National Priorities List in 2003 (US EPA, Superfund Site Reports). The US EPA has a Superfund process (i.e., a plan) for remediation of the site. Interim remediation actions, including excavation of contaminated soils and removal of subsurface liquid organic compounds, are planned for fall and winter 2011. Following these remedial actions, the US EPA will conduct a site-wide assessment and develop a final remedy for remaining contamination (e.g., of groundwater) that the agency anticipates will take at least 10 years (US EPA, 2010).

Remediation of cleanup program sites is managed through the California State Water Resources Control Board's (Water Board's) Site Cleanup Program (SCP), which is implemented by the Regional Board or by the Department of Toxic Substance Control (DTSC) Brownfields and Environmental Restoration Program. The Water Board's SCP focuses on unauthorized releases of pollutants to soils and groundwater, but in some cases also to surface waters. Sites that are investigated and remediated within the SCP include those with contamination from recent or historical surface spills, subsurface releases (e.g., pipelines, sumps), and all other unauthorized discharges that pollute or threaten to pollute surface or groundwater. The SCP also includes groundwater cleanup at brownfields, refineries, and other large industrial facilities. The program provides oversight at these sites and requires that responsible parties implement site investigations, source removals, soil and groundwater treatment, and monitoring. Because many SCP sites also have leaking USTs, the SCP interacts closely with the UST Program (Regional Board, Site Cleanup Program).

Under contract with the state and in coordination with the Regional Board, the Alameda County Environmental Health Department (ACEH) manages the SCP program for Emeryville, Oakland, Alameda, and San Lorenzo. The Regional Board and the Cities oversee Berkeley, San Leandro, and Hayward. The Regional Board and Alameda County Water District (ACWD) oversee Fremont, Newark, and Union City (ACEH, LUFT/SLIC Program). (Note that Berkeley, Fremont, and Newark are not within the study area.)

In addition to remediation of cleanup program sites, DTSC's Brownfields and Environmental Restoration Program oversees the cleanup of State Superfund Sites. State Superfund sites are also called Annual Workplan sites, listed sites, or Cortese List sites. EnviroStor, DTSC's tracking database, provides site-specific information. These are sites with evidence of a hazardous substance release or releases that could pose a significant threat to public health and/or the environment. DTSC issues Orders to responsible parties to compel the cleanup of these sites. Where no responsible parties can be found or where they do not take proper and timely action, DTSC may use State funds to undertake the cleanup. If necessary, emergency actions may be taken. Due to their known or suspected contamination, many of these sites become "Brownfields." The process used to address these sites is generally consistent with the National Oil and Hazardous Substances Contingency Plan (the "National Contingency Plan" NCP). DTSC also has other programs such as the Voluntary Cleanup Program, where a project proponent can ask DTSC to provide oversight for an investigation and cleanup.

Leaking UST sites are addressed through the Water Board's UST Program. Underground storage tank owners or operators are required to report a leak to a local regional agency within 24 hours of detection. To encourage reporting, the site investigation and cleanup costs can only be reimbursed by a cleanup fund once the leak has been reported to the Regional Board or other local regulatory agency. Similarly to the SCP, the Water Board contracts with ACEH, the Cities, and ACWD to manage the UST program for leaking underground fuel tanks. The Regional Board, authorized by the Water Board, directly oversees many storage tank investigations and cleanups (Regional Board, UST Program, ACEH, LUFT/SLIC Program). Once a site has been identified, a site assessment is conducted to provide details about the size and magnitude of the release and to determine an appropriate cleanup strategy. Cleanup is conducted under the direction of the lead regulatory agency and may include free product removal, vapor extraction, ozone sparging, or technologies such as groundwater extraction. In some cases, soil excavation and disposal completes the cleanup (Regional Board, UST Program).

Some cleanup program and leaking UST sites are also brownfields. A brownfield site is "a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties protects the environment, reduces blight, and takes development pressures off greenspaces and working lands." The California Environmental Protection Agency (CalEPA) oversees management of a brownfields program through the Water Board (which authorizes the Regional Board to implement the program) and DTSC, which share oversight of cleanups through a 2004 Memorandum of Agreement (Water Board, Brownfields Program , CalEPA, Brownfields Program).

California law makes landfill owners and operators responsible for maintaining active and closed landfills in a manner that does not present a threat to public health, safety, or the environment. Further, owner/operators must provide financial assurances to the State for closed landfills to ensure their ongoing maintenance (CalRecycle, 2009). The California Department of Resources Recycling and Recovery (CalRecycle) manages a program for review of permits for active solid waste facilities that are issued by local enforcement agencies (e.g., ACEH). Permits include design, operational, financial, and closure/postclosure requirements. CalRecycle is also responsible for ensuring that operators demonstrate adequate financial assurances for closure and postclosure maintenance, corrective action, and operating liability (CalRecycle, Solid Waste Facilities). The Regional Board regulates both active and closed landfills to ensure that non-hazardous wastes contained in these facilities do not escape to either surface water or groundwater. Regulation consists of design standards for protective features (e.g., liners, covers), environmental monitoring, and cleanup when necessary (Regional Board, Landfills). Some of CalRecycle's and the Regional Board's regulatory duties overlap (e.g., margin of safety), while others are split (e.g., the Regional Board's focus on water and leachate and CalRecycle's focus on landfill gas). DTSC regulates the disposal of wastes classified as hazardous through its permitting and enforcement program. Other local, state, or federal permits or approvals for solid waste facilities may also be required.

VI. Environment

By virtue of inclusion in the National Priorities List, Superfund sites pose high risks to people and or the environment. The Hazard Ranking System screening that is used to assess potential Superfund sites has three categories of risk factors (US EPA, Hazard Ranking System):

- Likelihood that a site has released or has the potential to release hazardous substances into the environment.
- Characteristics of the waste (e.g., toxicity and waste quantity).
- People or sensitive environments (targets) affected by the release.

The two Superfund sites in the ART project area pose significant hazards to people and the environment and require challenging and lengthy remediations. Large quantities of highly toxic solid wastes that were generated at the Alameda Naval Air Station were disposed into two on-base landfills that are adjacent to San Francisco Bay. One of the landfills surrounds both fresh and saltwater wetlands, which provide nesting and foraging habitat for a wide range of migratory and native birds. Liquid industrial wastewaters were discharged untreated into Seaplane Lagoon and the Oakland Inner Harbor, posing a threat to the surrounding San Francisco Bay aquatic life and a potential threat to terrestrial ecological receptors. "Past activities at the base have resulted in a three acre plume of mostly dense non aqueous phase liquid (DNAPL) contamination … These plumes pose a potential long term human health threat from inhalation of volatile vapors and possible ingestion of groundwater" (US EPA, Superfund Site Reports).

The AMCO Chemical Superfund site has chlorinated solvents that are human carcinogens. Although monitoring has indicated that the site poses no immediate threat to residents, there is concern that if nothing is done to remedy the contamination, it will pose a threat. The EPA

facility report notes that the groundwater beneath the site is not being used by the community as a drinking water source (US EPA, Superfund Site Reports).

Contamination at cleanup program sites can include trichloroethylene (TCE), polychlorinated biphenyls (PCBs) and other chlorinated hydrocarbons, metals (e.g., lead, chromium, nickel), and solvents such as acetone and benzene.

At leaking UST sites, the most frequently found contaminants are gasoline, diesel, and petroleum byproducts (e.g., benzene).

The vast majority of cleanup program sites and leaking USTs (where the contaminated media has been determined) have contamination of groundwater that is not used as a drinking water source. Some of these sites also have soil and soil vapor contamination. Drinking water is contaminated at relatively few sites (Regional Board, GeoTracker, August 10, 2011).

Releases of leachates, or contaminated waters from active and closed solid waste landfills, pose a potential environmental threat. Many older landfills that are now closed were not lined (e.g., Turk Island Landfill in Union City) or were lined inadequately to prevent leachate contamination of surrounding lands and/or waters. Often, a natural geologic barrier provides some leak protection. For instance, the Bay margin landfills have a layer of bay mud, a natural clay that typically has very low permeability. When combined with pressure from the overburden (weight of waste) causing compaction, the bay mud acts as a liner in many ways. This is not to say that leaks never exist, but that they are infrequent and are generally detected as the majority of these sites are monitored and regulated by the Regional Board (Per review by Linsay Whalin, Regional Water Quality Control Board. October 3, 2011). Despite this, new exposures to water (e.g., due to higher groundwater levels) could lead to leaching. Both groundwater and surface waters at the landfills are monitored regularly, and some of the closed landfills and all active ones have leachate collection systems to prevent environmental contamination (Per conversation with Terry Seward, San Francisco Regional Water Quality Control Board, on August 30, 2011). Landfill methane (a byproduct of organic waste decomposition) also poses public health and environmental risks. Collection systems for landfill gas are required, and the methane is burned or used for the production of electricity, to prevent air pollution.

VII. Economy/Equity

The negative public health and environmental impacts of exposures to pollution released from contaminated lands, as well as the financial burden of addressing these impacts and cleaning up sites, have significant social, economic, and environmental consequences in the study area. At the same time, remediation and redevelopment or restoration of these sites offer opportunities for economic growth, community services (e.g., additional parks), and even habitat creation. Coordinating and streamlining regulatory agency oversight, and offering incentives for cleanups, are important governance mechanisms that make it easier to take advantage of these opportunities.

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4. ENERGY, PIPELINES, AND TELECOMMUNICATION INFRASTRUCTURE

I. Definition

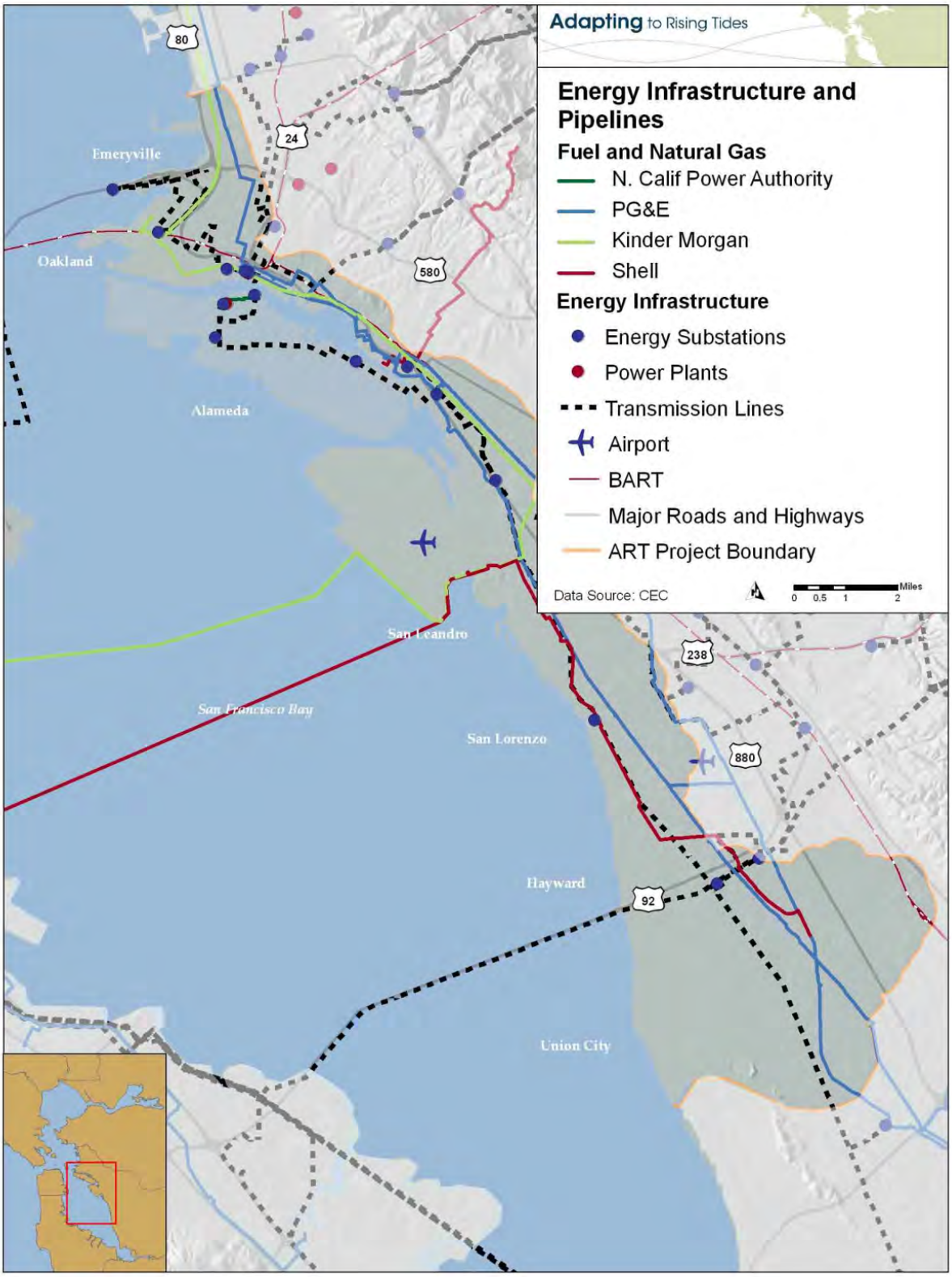
This asset category includes the electric transmission network, pipelines, and telecommunication infrastructure that carry electricity, natural gas, petroleum/fuel, and phone/Internet cables throughout the project area. This essential infrastructure provides electricity and natural gas to homes and businesses, fuel for multiple modes of transportation, and cables that allow shoreline residents to communicate. Much of this infrastructure connects the project area with other parts of the region, state, and nation. For example, the fuel pipelines connect refineries outside the project area with major consumers of fuel within, such as OAK and the truck terminals that distribute to local providers.

II. Locations and Physical Features

In general, the underground pipelines that carry various types of liquid fuel and natural gas run more or less parallel to the shoreline (see Figure 10). The electricity grid is a more complex network, but major overhead transmission lines run parallel to the shoreline with a number of substations situated near the shoreline. Many of the pipelines and much of the telecommunication infrastructure are located in railroad and California Department of Transportation (Caltrans) right-of-ways. The telecommunication infrastructure is either buried underground or carried overhead via utility lines. In many cases data accessibility regarding this infrastructure is limited due to security concerns and data gaps, making it challenging to accurately inventory the relevant infrastructure within the project area. However, there are publically available maps and digital geospatial data depicting much of the pipeline and electricity infrastructure.

Electrical transmission lines on the Hayward side of the San Mateo-Hayward Bridge. Source: Rafael Montes, BCDC.

Figure 10. Map of Energy and Pipeline Infrastructure in the ART Project Area



III. Ownership

Much of the infrastructure is owned by private companies; regulatory oversight is provided by a number of federal and state agencies.

The Federal Energy Regulatory Commission regulates some aspects of the transmission of electricity, natural gas, and oil while the California Public Utilities Commission (CPUC) regulates the natural gas and the electricity grid at the state level. The natural gas and electrical grid in the project area is almost exclusively owned and operated by PG&E.

The fuel pipelines are overseen by the Office of Pipeline Safety (OPS)/U.S. Department of Transportation at the federal level and the CPUC and State Fire Marshall at the state level. The OPS develops regulations and other approaches to risk management to ensure safety in design, construction, testing, operation, maintenance, and emergency response of pipeline facilities. The fuel pipeline infrastructure is owned by private companies such as Shell and Kinder Morgan, but the property where the pipelines are located is often owned by a separate private entity such as Southern Pacific Railroad.

The Federal Communications Commission (at the federal level) and CPUC (at the state level) regulate certain aspects of the telecommunication infrastructure. The telecommunication/fiber optics lines are owned by a number of service providers such as AT&T, Qwest, and Comcast, but the property where the infrastructure is located may be owned by separate entities.

IV. Asset Characteristics

While there is no data that reflects the source of electricity, natural gas, and petroleum within the subregion, there is statewide data on the source and type of energy consumed within the state. California's electricity sources are 56% natural gas, 15% nuclear, 13% renewable, 12% hydroelectric, and 1% coal. Of the state's natural gas, 46% comes from the Southwest, 22% comes from the Rocky Mountain area, 19% comes from Canada, and 13% comes from in-state sources. The state also consumes crude oil from a variety of sources: 47% comes from foreign sources, 14% comes from Alaska, and 13% comes from in-state sources. (Source: California Energy Commission, 2010.)

Electricity is largely carried by overhead transmission lines until it reaches a substation, from which it is distributed via utility lines to individual homes and businesses. Electricity is also carried via underground conduits. A portion of the electricity grid that serves Alameda County is powered by hydroelectric energy generated in the Sierra Nevada mountain range.

Natural gas is transported via underground pipelines. A major natural gas pipeline parallels I-880. Liquid petroleum jet fuel, gasoline, and diesel fuels are transported via pipelines that cross the subregion. The fuel is often refined at regional refineries and then consumed by large consumers such as OAK or distributed to the market via rail and truck. In general, these pipelines are buried at a depth of 3 to 4 feet in high-carbon steel pipelines. Most of these pipelines are buried along the shoreline; some cross the Bay, such as at the Carquinez Strait.

Many of the pipelines were built in the 1960s and 1970s and are maintained regularly as mandated by state and federal regulations.

Telecommunication infrastructure tends to be buried underground in cables at a depth of 2 to 5 feet. There are locations along the cables that allow for periodic maintenance and replacement. Additionally, telecommunication infrastructure is located in cables that are carried by overhead telephone lines.

V. Existing Stressors

Much of the state's electricity grid has been in place for decades and is in need of improvements. The CPUC has begun the process of modernizing the grid, and these improvements will lead to a safer, more efficient, and more reliable "smart" grid. However, in addition to aging energy infrastructure, natural hazard risks due to earthquakes, wildfires, floods or landslides has the potential to stress or disrupt power supply and distribution. Likewise, much of the telecommunication infrastructure has been in place for decades. However, due to rapid changes in technology and consumer behavior, it is unclear how long the existing telecommunication infrastructure will be in use.

The pipelines' role in the regional economy is subject to a number of forces beyond the operators' control. The pipelines are built to support the energy needs for the current economy. If there are significant changes to the economy or consumer behavior, or rapid changes in technology/fuel efficiency, then changes to the existing infrastructure may be needed. The existing pipelines could accommodate certain changes in demand by increasing the volume of material moving through the pipelines or by increasing the size of the pipeline.

Due to the importance of this asset category, much of the infrastructure has been built to withstand minor changes in environmental conditions such as wind, rain, and heat. However, if these conditions change significantly in the future, there may need to be some modifications to the infrastructure.

Likewise, pipelines and other transmission infrastructure have been constructed in accordance with regulations that should minimize the impact of a major seismic event. However, such an event could still significantly affect the infrastructure depending on its magnitude and location.

As mentioned earlier, it is difficult to access accurate data on the location of pipeline infrastructure. This poses a challenge to local communities and agencies that manage other resources in the same vicinity.

VI. Economy

The facilities described in this asset category provide the electricity, fuel, and telecommunication infrastructure that are fundamental drivers of the economy. These facilities are critical to the ART project area's economic engine, and provide a source of jobs and tax revenues to governments. Any disruption of these assets could have significant direct and indirect economic impacts within the project area as well as throughout the region and state.

VII. Equity

The majority of the pipelines/energy transmission lines run along the shoreline and cross a wide section of land use types and communities. However, as the large consumers of the fuel and energy tend to be industrial/commercial consumers, residents adjacent to industrial and commercial areas are likely to be more exposed to the potential for adverse public health and environment impacts associated with an accidental release or spill.

VIII. Governance

Much of the regulatory oversight is at the state and federal level. There appears to be minimal oversight at the local level. However, local agencies that maintain general plans, specific plans, and zoning ordinances can guide the placement of infrastructure within this asset category. For example, the Union City General Plan Public Facilities and Service Element contains policy PF-G.1.2, which reads as follows: "The City shall promote technological improvements and upgrading of utility services in Union City to serve existing and future needs while minimizing noise, electromagnetic, and visual impacts on existing and future residents."

IX. Environment

Under normal operating conditions, there are no significant impacts upon the environment from this infrastructure. However, a spill or accident could lead to significant impacts upon public health and the surrounding environment, both immediate and long-term. Furthermore, the placement of new infrastructure would likely have localized impacts upon the environment and could further degrade it. In some instances the infrastructure could serve as a barrier to movement along a corridor and could also serve as a visual barrier.

References

US Dept of Transportation Pipelines and Hazardous Material Administration. http://phmsa.dot.gov/pipeline

Federal Energy Regulatory Commission. http://www.ferc.gov/

State of California Fire Marshall. http://osfm.fire.ca.gov/pipeline/pipeline.php

California Energy Commission. http://www.energy.ca.gov/index.html

California Public Utilities Commission. http://www.cpuc.ca.gov/puc/

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Union City General Plan. http://www.union-city.ca.us/commdev/general_plan.htm

5. HAZARDOUS MATERIAL SITES

I. Definition

Hazardous wastes are substances that pose a risk to the health of humans and the environment. They can be liquid, solid, sludge, or gas; they may be the byproducts of industrial/manufacturing operations or discarded commercial products such as pesticides and cleaning solvents. Other examples of hazardous waste include used oil, solvents, cleaning compounds, byproducts of chemical processes, and paint. Hazardous waste may be stored or generated at facilities such as research laboratories, hospitals, manufacturing/industrial facilities, and automotive repair shops. The commonly used term "hazardous materials" is a general term and may include contaminated substances/waste, contaminated soil, USTs, and hazardous waste. This report focuses on the facilities where hazardous waste substances are located, as defined by the US EPA.

II. Locations and Physical Features

Hazardous materials facilities are distributed more or less evenly throughout the study area. However, the majority of the large facilities are located in industrial and commercial areas (see Figure 11).

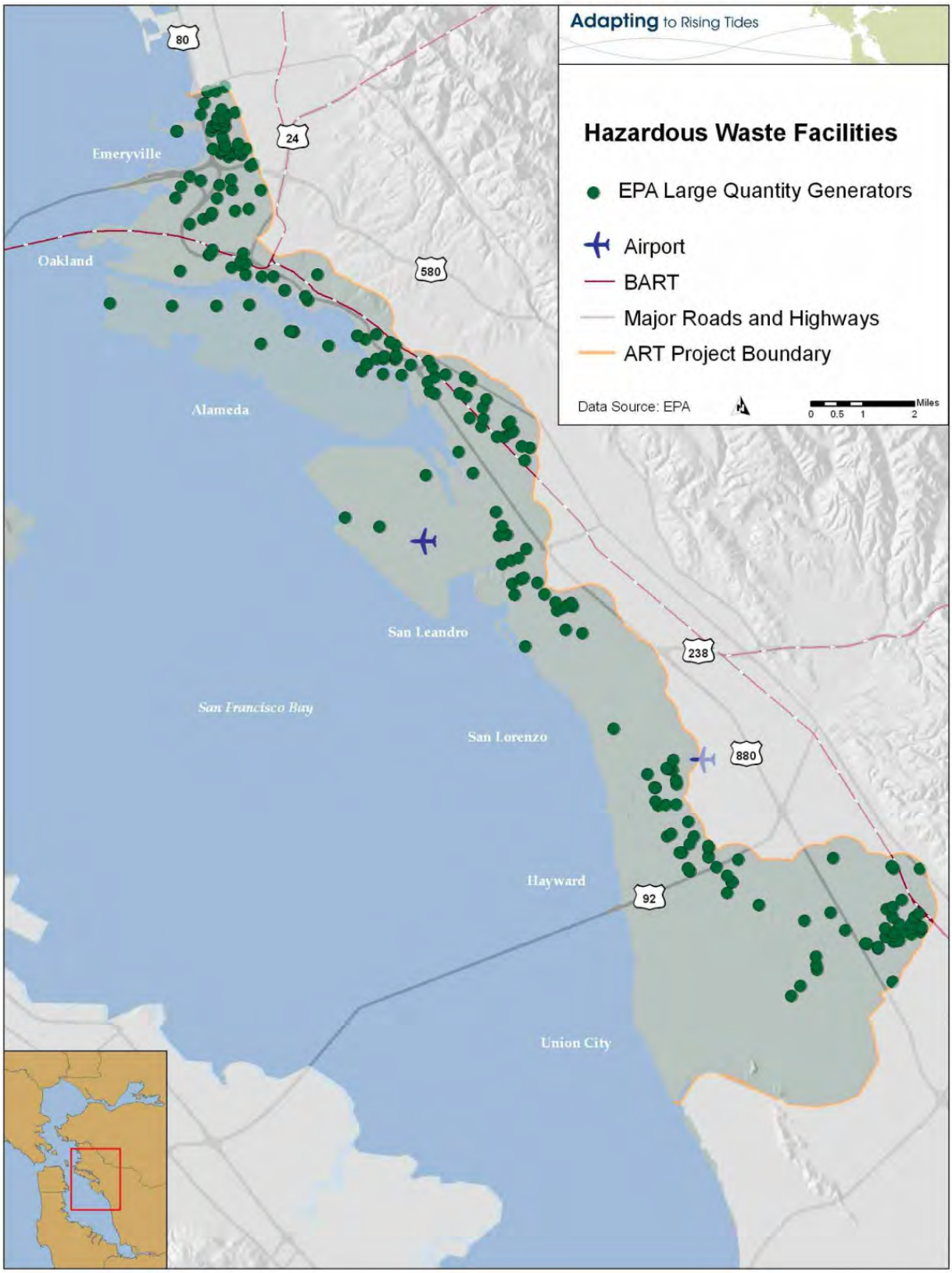
III. Ownership

Preliminary data provided by project partners indicates that the vast majority of the facilities are privately owned.

IV. Governance

At the federal, state, and local levels, there are regulations, policies, and programs that manage hazardous waste/hazardous materials and associated facilities. The US EPA maintains federal oversight over hazardous wastes through the Resource Conservation and Recovery Act (RCRA). At the state level, the Department of Toxic Substance Control (DTSC) and the State Water Resources Control Board are the US EPA's partners for the management of hazardous waste. At the local level, the Alameda County Environmental Health Department, the Hayward City Fire Department, the Oakland City Department, the City of San Leandro, and the Union City Environmental Program are the Certified Unified Program Agencies (CUPAs) that are authorized to carry out several of the hazardous materials regulatory programs administered by state and local government agencies.

Figure 11. Map of RCRA Large Quantity Generator (LQG) Hazardous Waste Facilities



Federal

The US EPA's RCRA provides guidelines for the federal waste management program. RCRA is implemented through Title 40, CFR Part 260, Subtitle C. It contains a mandate directing the US EPA to craft regulations to implement the law and allows for both EPA and state partners to enforce the regulations. RCRA applies to the generation, transportation, storage, treatment, and disposal of hazardous waste. It regulates the following types of facilities (US EPA, 2011):

- "Generators"—individuals or facilities whose processes or actions lead to the creation of hazardous waste. Large Quantity Generators (LQGs) generate 1,000 kilograms per month or more of hazardous waste, or more than 1 kilogram per month of acutely hazardous waste. Small Quantity Generators (SQG) generate more than 100 kilograms, but less than 1,000 kilograms, of hazardous waste per month. Conditionally Exempt SQGs(generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste.
- "Treatment"—facilities that change the physical, chemical, or biological characteristics of a waste to minimize its threat to the public and the environment. These facilities are referred to as treatment, storage, and disposal (TSD) sites.
- "Transporters"—facilities or entities that move waste from site to another via roadways, rail, water, or air.

According to the US EPA's Envirofacts, the following RCRA facilities are located in the ART project area:

- 86 LQGs (example: Applied Biosystems, LLC, Davis Street Transfer Station).
- 12 SQGs (example: Pacific Motor Trucking Co., Port of Oakland Construction Dept.).
- 1 TSD facility.
- 81 Transporters (example: Abbley Transportation Inc).

Hazardous wastes are defined and regulated by the Resource Conservation and Recovery Act, known as RCRA. Source: www.fedcenter.gov/resources/facilitytour/hazardous/whatis/

Hazardous materials facilities may include research laboratories, hospitals, manufacturing/industrial facilities, and automotive repair shops. Source: www.wired.com/wiredscience/tag/sustainability/page/2/.

In regulatory terms, a RCRA hazardous waste can fall into one of two categories: "Listed" or "Characteristic." The four RCRA lists are as follows (DTSC, 2010):

- The **F list** (non-specific-source wastes) contains material from common manufacturing and industrial processes.
- The **K list** (source-specific wastes) is for material from specific industries such as petroleum refining and pesticide manufacturing.
- The **P and U lists** (discarded commercial chemical products) contain information on material that will be used and then discarded.
- Finally, the **M list** (discarded mercury-containing wastes) lists wastes that contain mercury.

Waste substances may also be hazardous if they are toxic, reactive, ignitable, or corrosive (DTSC, 2010).

State

DTSC and the State Water Resources Control Board are the US EPA's partners for the management of hazardous waste. DTSC is tasked with both regulating existing hazardous materials facilities and cleaning up contaminated sites. CalEPA oversees the local CUPAs, but the other state agencies involved in the oversight of the CUPAs are Department of Toxic Substance Control, the California Emergency Management Agency (CalEMA), the Office of the State Fire Marshall, and the State Water Resources Control Board.

DTSC and the US EPA jointly require that certain RCRA generators—as well as facilities that treat, store, and dispose of hazardous materials—report their hazardous material activities through annual facility reports.

The regulations dealing with hazardous waste are found in the Health and Safety Code Section 25100 and Title 22 CCR. The state has a slightly broader definition of hazardous waste than the US EPA. For example, the state considers used oil to be a hazardous waste, while the US EPA does not.

Local CUPAs consolidate the administration, permits, inspections, and enforcement activities of the following six programs that are listed below. As mentioned above CUPAs, are the local agencies that are authorized to implement state hazardous materials programs and regulations for five different state agencies. The CUPA program elements are listed below:

- **Hazardous Materials Release Response Plan and Inventory.** This program requires businesses that handle hazardous materials above 55 gallons, 500 pounds, or 200 cubic feet of gas to develop a business plan which inventories their hazardous materials, create a map, develop an emergency response plan, and implement a training program for employees. CalEMA provides support for this program.
- **California Accidental Release Program (CalARP).** This program aims to prevent the release of substances that can cause harm to the public and the environment. CalARP requires the development of a Risk Management Plan (RMP). CalEMA provides support for this program.
- **Underground Storage Tank Program.** A UST is a tank and connected pipes, used to store hazardous substances, which is beneath the surface of the ground. The purpose of the UST Program is to protect the public and the environment from releases of petroleum and other hazardous substances from tanks. The four program elements are leak prevention, cleanup, enforcement, and tank tester licensing. The State Water Resources Control Board provides technical assistance and evaluation for the UST program.
- **Aboveground Petroleum Storage Act.** An aboveground storage tank is a tank that stores petroleum above ground. The act requires CUPA staff to inspect tanks with more than 55 gallons of petroleum at least every three years. In addition, the act requires the owner of any tank with over 1,320 gallons of petroleum to prepare and implement a Spill Prevention Plan consistent with federal regulations. The State Water Resources Control Board provides technical assistance and evaluation for the aboveground storage tank program.
- **Hazardous Waste Generator and Onsite Hazardous Waste Treatment Programs.** DTSC provides technical assistance and evaluation for the hazardous waste generator program.
- **California Fire Code: Hazardous Materials Management Plans/ Hazardous Materials Inventory Statements (HMMP/HMIS).** The Plans are similar to the Business Plans and to the extent possible they have been merged. The main goal of the statute and regulations is to increase communication, coordination, and consistency/consolidation. The Office of the State Fire Marshal provides support for this program.

V. Existing Stressors

The initial emergency response to accidents at facilities is largely the responsibility of local fire departments and to some extent CalEMA. The limited capacity to respond in a flood with multiple impacts in different locations could be challenging for emergency responders, who need to respond to all incidents and to effectively prioritize facilities to visit/monitor.

A major seismic event could lead to a similar situation wherein emergency responders are overwhelmed by the multitude of impacts in an array of locations. In both flood and seismic events, emergency responders may be overwhelmed by other priorities beyond those associated with hazardous waste facilities.

Other stressors include the limited resources for the upgrades and improvements to hazardous waste facilities. Finally, the complexity of agencies with oversight of hazardous materials facilities could serve as a barrier to an efficient and prioritized response in the event of a hazard release.

VI. Economy

As hazardous materials facilities often occur within existing businesses, they are a source of jobs and tax revenues, and are generally a byproduct of or essential components of economic activity. In addition, staff from local, state, and federal agencies are employed in the management and regulation of hazardous facilities. In the event of an accident at a facility, there could be immediate and long-term negative economic impacts due to loss of jobs or tax revenues, or the cost and liability associated with cleanup.

VII. Equity

There tend to be more hazardous materials facilities in areas where industrial activities and manufacturing takes place. These sites tend to have a higher than average proportion of low-income residents in adjacent areas. Therefore, such residents are more likely to be affected by the ongoing operation of hazardous materials facilities and in the event of an accident.

VIII. Governance

As noted above, the governance of hazardous materials is complex and is overseen by an array of agencies at the federal, state, and local levels. It is further complicated by the fact that each program has slightly different regulations and capacity/resources.

IX. Environment

While the risk associated with hazardous waste is reduced through the array of local, state, and federal programs, hazardous waste still poses a potential threat to the public and the environment. In the event of an accident, there could be immediate and long-term impacts upon local communities, natural resources, and groundwater resources.

References

Alameda County Hazardous Material/Waste Program (CUPA).
http://www.acgov.org/aceh/hazard/

California Department of Toxic Substance Control.
http://www.dtsc.ca.gov/HazardousWaste/index.cfm#Treatment,_Storage_and_Disposal_Facility_Information

California Environmental Protection Agency. http://www.calepa.ca.gov/cupa/default.htm

California Emergency Management Agency.
http://www.calema.ca.gov/HazardousMaterials/Pages/Hazardous-Materials.aspx

Environmental Protection Agency. http://www.epa.gov/waste/hazard/index.htm

State of California Fire Marshall-CUPA. http://osfm.fire.ca.gov/cupa/hhmp-hmis.php

6. PARKS AND RECREATION

I. Definition

Parks and recreation areas are publicly owned lands in the ART project area that are open to the public for recreation activities. Resources and activities at parks and recreational areas include scenic views; walking, running, and biking on paths and trails; nature viewing; interpretive displays; educational facilities and activities; swimming; paddleboating; sailboarding; motorboating; picnicking; playgrounds; family/group event areas and facilities; dog recreation; historic or cultural activities; team sports; and golf. These parks and recreational areas serve users at three scales.

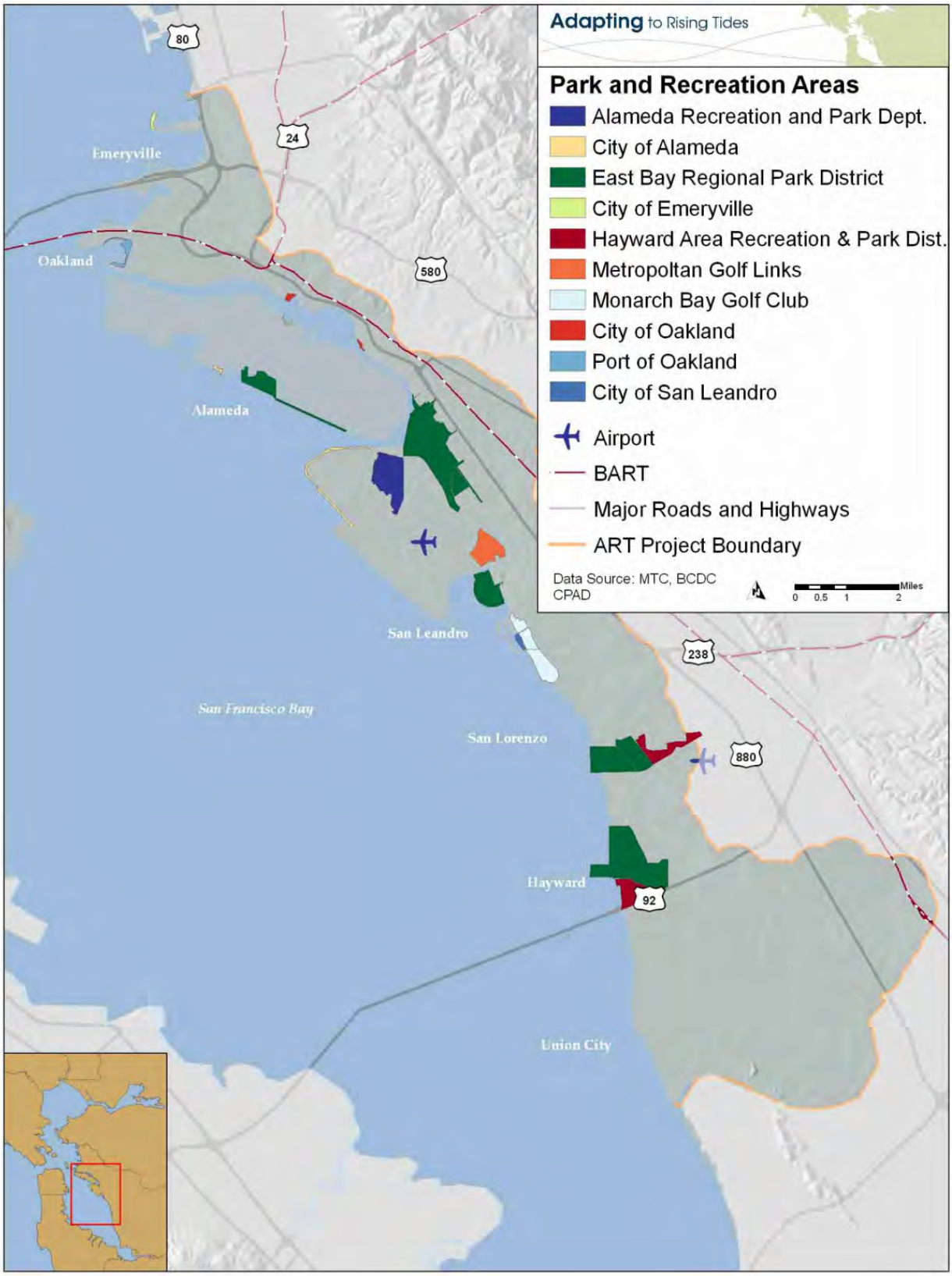
- Regional shoreline areas that attract visitors from throughout the Bay Area (and beyond).
- Parks or community centers that provide sports facilities used primarily by Alameda County residents.
- Small shoreline parks that serve a surrounding community or neighborhood.

This section focuses on 22 parks and recreation areas (see Figure 12 and Table 8 at the end of this chapter) that are located immediately on the shoreline and/or provide significant *regional* recreation resources. For the most part, parks smaller than 5 acres are not included. Neighborhood, or "pocket" parks that are not on the shoreline are also not addressed here. Although they are important recreation resources for the surrounding communities, individual pocket parks are generally not considered significant resources for the ART project area. Furthermore, due to their location within neighborhoods, assessing climate change impacts to pocket parks can easily be folded into future, community-based adaptation planning efforts—the scale at which these parks are most relevant. This section does not describe privately owned recreational facilities (e.g., private golf courses, amusement parks).

II. Locations and Physical Features

All of the parks addressed here are located in low-lying areas on or near the shoreline (see map). Parks such as Middle Harbor Shoreline Park, Crown Memorial State Beach, Martin Luther King Jr. Regional Shoreline, Hayward Regional Shoreline, and Hayward Interpretive Center are largely low-lying beach or wetlands. The shoreline is hardened with riprap and other hardscape features (e.g., boat ramps and stairs) along many of the smaller, more urban parks in the study area. In the southern portion of the ART project area, levees protect and form the shoreline border to parks. A few of the parks and recreation areas that are constructed over former landfills and contaminated sites have areas of slightly higher topography (e.g., two of the golf courses and Oyster Bay Regional Shoreline).

Figure 12. Map of Parks and Recreation in the ART Project Area



Natural, created, and restored habitat features of the park assets include eelgrass, beaches, mudflats, tidal marshes and flats, fresh water marshes, salt ponds, transitional uplands, high marsh, and upland grasses.

Improvements found in almost all of the parks are paths and trails (both paved and unpaved), bathrooms, benches and picnic tables, landscaped areas, and parking lots. Playgrounds, barbequing grills, and interpretive signage are also common features. Larger capital improvements include visitor centers (interpretive, community, and educational), boardwalks and piers, boat launch ramps and/or floats, boathouses, a bath house, and sports fields and courts.

The Bay Trail is aligned through most of the parks in the ART project area and connects many of these recreation assets. Depending on the location of its segments, the Bay Trail consists of paved multi-use paths, dirt trails, gravel-topped levees, bike lanes, or sidewalks on city streets.

III. Ownership and Management

The East Bay Regional Park District and the Hayward Area Recreation and Park District own and/or manage almost half of the park and recreation assets in the study area. Cities in the ART project area and the Port of Oakland own and manage the remaining assets, except the three municipally owned and privately managed golf courses, and Crown Memorial State Beach owned by the State of California. ABAG administers the Bay Trail Project, which plans and provides program-level management for the trail. Individual site owners manage and maintain designated Bay Trail segments on their properties.

Middle Harbor Shoreline Park. Source: Sara Polgar, BCDC.

East Bay Regional Park District (EBRPD)

EBRPD is a special district that provides regional park and recreation services and operates golf courses in properties located throughout Alameda and Contra Costa Counties. Within the ART project area, EBRPD owns and/or manages about 2,800 acres in five different parks. In 2010, the district's total budget was $197.1 million and it employed 622 permanent personnel and 85 seasonal/ temporary personnel. EBRPD provides police and fire services on its parklands and assists local agencies with mutual aid (EBRPD, 2011).

EBRPD relies primarily on property tax revenues, and secondarily on special assessments and service charges. Service charges include parking fees, shuttle fees, facility rental fees, concession leases, and public safety charges, among others. Additionally, the district levies parcel taxes for public safety and park maintenance services. These taxes sunset in 2014 and 2020 and must be reaffirmed by a two-thirds vote. EBRPD reserves contingency funds in its budget for economic uncertainty and disasters as well as reserves for cash flow purposes (Alameda LAFCO, 2006).

A master plan for the district (with a 20-year planning horizon) was prepared in 1997. In 2010, the district prepared an annex to ABAG's regional Local Hazard Mitigation Plan, which enables the EBRPD to be eligible for FEMA mitigation funding (EBRPD, 2011).

Hayward Area Recreation and Park District (HARD)

HARD is an independent special district formed to provide park and recreation services to Hayward, San Lorenzo, and surrounding areas. The district's key infrastructure in the ART project area consists of approximately 100 acres of park space, a golf course, a sports park, an interpretive center, and rental facilities. HARD provides maintenance of park areas, trees, landscaping, buildings, and other structures at the district's park sites and facilities.

The district's primary revenue sources are property taxes, recreation fees (e.g., rents, concessions), a special per-household tax levied by HARD that was approved by voters in 1997, and grants for capital improvements. The district's past practice has been to maintain a reserve of 5% to 10% of the annual budget (Alameda LAFCO, 2006). A master plan for HARD (with a 15-year planning horizon) was prepared in 2006.

Point Emery Shorebird Park. Source: www.walking-the-bay.com/2011_04_01_archive.html.

Local Agencies

Parks and recreation departments within the Cities of Emeryville, Oakland, Alameda, and San Leandro are responsible for managing nine of the sites in the ART project area.

Point Emery, Shorebird Park, and Marina Park are owned and managed by the City of Emeryville. The city's parks budget revenues are from the general fund and (to a small extent) park fees and revenues (from recreation services, facility rentals, and concessions) (Alameda LAFCO, 2006). The city adopted a Parks and Recreation Strategic Plan in January 2011 that provides an overview of activities at the city's parks, and lays out decision-making criteria to help the city move toward achieving the community's vision for recreation. The plan also summarizes approximate costs for capital improvements and ongoing maintenance in city parks (City of Emeryville, 2011).

The City of Oakland's Office of Parks and Recreation manages Estuary Park and Union Point Park in the ART project area. The parks and recreation budget revenue sources are primarily the general fund, park fees and revenues, and special taxes (Alameda LAFCO, 2006). The city's General Plan includes an Open Space, Conservation, and Recreation Element (last updated in 1996) that addresses park land use, operations, and funding; it also includes a human resources section with policies that emphasize providing equitable and diverse recreation opportunities and engaging underserved communities (City of Oakland, 1996). More recently the city has prepared master plans for some parks and recreation areas; however, the parks within the ART project area were not part of these planning efforts.

Monarch Bay golf course along the shoreline of San Leandro. Source: Derrick Coetzee, Wikimedia Commons

The City of Alameda owns and manages Shoreline Park (Estuary), Encinal Boat Ramp Park, and Shoreline Park (Bay Farm Island). The city's parks and recreation budget comes primarily from enterprise funds (from golf service fees at the city-owned and privately managed golf course) and the general fund, with a small contribution from parks fees and revenues (Alameda LAFCO, 2006). The City of Alameda's 1991 General Plan includes a Parks and Recreation, Shoreline Access, Schools, and Cultural Facilities Element that primarily outlines priorities for development of new recreation facilities (City of Alameda, 1991).

The Cities of Oakland, Alameda, and San Leandro contract with private management firms for the management of their municipally owned golf courses.

The City of San Leandro Recreation Division is responsible for the operation of the Marina Park. The city's general plan includes an Open Space Parks and Conservation element (adopted in 2002) with policies for existing parks that emphasize maintenance and rehabilitation (City of San Leandro, 2002). General funds, park fees and revenues, and enterprise funds (generated from golf service fees and the city's marina) provide the city's parks revenues (Alameda LAFCO, 2006).

The Bay Trail

Administered by ABAG, the San Francisco Bay Trail Project plans, promotes, and advocates for implementation of the Bay Trail by distributing grant funds for trail planning and construction, providing technical assistance to local governments, encouraging consistency with the adopted Bay Trail Plan, and educating the public about the benefits of the trail. Trail segments are built, owned, managed, and maintained by cities, counties, park districts, and other agencies with land-management responsibilities, often in partnership with local nonprofit organizations, citizens' groups, or businesses.

San Francisco Bay Trail along the Hayward Regional Shoreline. Source: San Francisco Bay Trail. Source: baytrail.abag.ca.gov.

Three full-time employees staff the Bay Trail Project. It is governed by a 36-member volunteer board of directors representing a broad range of interests that meets twice a year, and by a smaller steering committee that meets every other month to discuss program and planning issues (Bay Trail Project).

Funds for the Bay Trail Project staff and grants for planning and construction of trail segments come from Proposition 84 park bond funds and regional bridge toll funds. Since 2008, the project has allocated over $4 million for 35 grants. The Bay Trail is part of the Regional Bicycle Network, identified in the Metropolitan Transportation Commission's Regional Bicycle Plan and ABAG's Bay Trail Plan, and is supported in the general plans of all local jurisdictions and special districts along the shoreline (Pers. comm. Laura Thompson, Bay Trail Project, October 19, 2011).

Other Relevant Agencies, Policies, and Plans

To make improvements to shoreline parks in the ART project area, park managers need to coordinate with various other agencies with land and resource-management responsibilities, such as local agencies and utility and flood protection districts, as well as communities that use and care about the park or recreation area. Additionally, permits and approvals may be required from local city councils, BCDC, the Regional Water Quality Control Board, the U.S. Army Corps of Engineers, and the California Department of Fish and Game.

IV. Asset Characteristics

To provide an overview of the diverse recreation opportunities in the ART project area, this section summarizes the different types of recreation services provided, and notes where these opportunities or features are uniquely available at a (subset of) park(s).

Walking, Running, Hiking, and Biking Trails

Designated portions of the Bay Trail along the shoreline provide most of the walking, running, hiking, and biking trails in the study area. The Bay Trail is a recreational corridor that, when completed, will encircle San Francisco and San Pablo Bays with a continuous 500-mile network of bicycling and hiking trails. Depending on the location of its segments, the Bay Trail consists of paved multi-use paths, dirt trails, gravel-topped levees, bike lanes, or sidewalks on city streets. The Bay Trail serves as an important commute corridor for bicyclists traveling between home, work, and school. The trail links residential areas, transit stations, employment centers, and regional destinations providing a transportation alternative to the automobile.

With only a few exceptions, the parks and recreation areas in the ART project area include a segment of the Bay Trail. Long stretches of the trail (i.e., more than a mile) are located in Middle Harbor Shoreline Park, Crown Memorial State Beach, Shoreline Park (Bay Farm Island), Martin Luther King Jr. Regional Shoreline, Oyster Bay Regional Shoreline, and Hayward Regional Shoreline.

The study area also includes extensive segments of Bay Trail that are not within parks and recreation areas. For example, along levees the Bay Trail connects Marina Park and Tony Lema Golf Course (San Leandro) with Hayward Regional Shoreline and extends south of Highway 92 into Eden Landing Ecological Preserve (owned and managed by the California Department of Fish and Game). Some parks, such as Shorebird Park and Hayward Interpretive Center, are popular stopping points or destinations along these longer stretches of the Bay Trail for views and/or interpretive and educational activities. Additionally some of the smaller parks in the ART project area connect segments of the Bay Trail and offer parking for access to the trail (e.g., Encinal Boat Ramp Park).

Larger parks such as Hayward Regional Shoreline and Oyster Bay Shoreline Park have some additional (non-Bay Trail) paths.

Views

Almost all of the shoreline parks in the ART project area have scenic views of the Bay or Oakland Estuary. Parks in Emeryville, the Port of Oakland, and the west sides of Alameda and Bay Farm Islands specifically attract visitors due to their iconic views of San Francisco and the Bay Bridge.

Nature and Wildlife Viewing

Shallow waters, tidal marsh, mudflats, salt ponds, and upland habitats adjacent to and within the ART project area's parks are important habitat for shorebirds (e.g., the endangered California clapper rail) and waterfowl. As such, many of the parks and recreation areas offer excellent opportunities for nature and wildlife viewing. The most notable parks for these activities are Crab Cove and Elsie Roemer Bird Sanctuary (at Crown Memorial State Beach), Arrowhead Marsh (at Martin Luther King Jr. Regional Shoreline), and the Hayward Regional Shoreline.

Interpretive and Education Resources

Parks in the ART project area showcase the natural, historic, and cultural resources of the East Bay shoreline. For example, the Hayward Shoreline Interpretive Center introduces visitors to the ecology of the San Francisco Bay Estuary through featured exhibits and activities, and naturalist-led interpretive programs (HARD, Hayward Shoreline Interpretive Center). The Crab Cove Visitor Center at Crown Memorial State Beach in Alameda features an aquarium exhibit of bay creatures and interactive interpretive displays, and EBRPD offers a field trip program for school and other groups at this site (EBRPD, Crab Cove). Interpretive signage and historic features (e.g., bollards once used for tying up ships and a viewing tower) at Middle Harbor Park teach visitors about the maritime history of the area (Port of Oakland). Many of the other parks in the ART project area also feature interpretive signage (along paths and at viewpoints) about the natural, historical, and cultural features of San Francisco Bay.

Family/Group Settings and Facilities

Family and group activities and facilities include picnicking, barbequing, playgrounds, grass or turf areas, and event space or facilities for rent. Benches and picnic tables are available at most of the parks in the ART project area and are heavily used on weekends.

Space and facilities (that can be reserved or rented) for gatherings are in high demand at Bay Area parks. San Lorenzo Park is a popular community park that has both a recreation center and group picnic facilities available for rent. The Hayward Shoreline Interpretive Center offers meeting spaces and accommodates birthday parties (HARD, Facilities for Rent). The only other event space in the ART project area is the Shoreline Center at the Martin Luther King Jr. Regional Shoreline. EBRPD offers reservations for group picnic sites at Crown Memorial State Beach and Martin Luther King Jr. Regional Shoreline (EBRPD, Activities). Group picnic facilities are also available for reservation at Marina Park in San Leandro.

Sports Facilities

Team or field sports facilities include turf or grass playing fields for soccer and baseball, basketball and tennis courts, and golf courses. Although most of the parks in the study area have some grassy or turf area that could be used for a sport activity, only three offer dedicated sports fields and courts. These are located in Hayward (Alden E. Oliver Sports Park and Gordon E. Oliver Eden Shores Park) and San Lorenzo Park. Four golf courses are in the study area: Chuck Corica Golf Complex (Bay Farm Island, Alameda), Metropolitan Golf Links (Oakland), Tony Lema Golf Course (San Leandro), and Skywest Golf Course (Hayward).

Water Sports Access and Facilities

Public access onto the water for paddleboating (e.g., kayaking, paddleboarding) is available at numerous parks from Emeryville to San Leandro. South of this area, the Alameda County shoreline is primarily salt ponds, tidal marsh, and mudflats, offering few of these types of access opportunities. Three public ramps for launching motorboats are available at Marina Park in Emeryville, Encinal Boat Ramp Park on Alameda Island, and Martin Luther King Jr. Regional Shoreline.

Point Emery, Marina Park in Emeryville, and Crown Memorial Beach are popular sites for sailboarding (kitesurfing and windsurfing) due to their uniquely favorable wind conditions and access onto the Bay.

Two locations within the Oakland Estuary and San Leandro Bay, which have calmer waters than the Bay, offer unique opportunities for team rowing (i.e., sculling): the Aquatic Center at Estuary Park in Oakland and the Tidewater Boathouse in the Martin Luther King Jr. Regional Shoreline. Both of these facilities are relatively new.

Two locations in the study area provide easy access and are popular for swimming: Point Emery and Crown Memorial State Beach.

Fishing

Recreational fishing is allowed in the Bay with a fishing license from the California Department of Fish and Game. Popular fishing spots at seven fishing piers are found between Emeryville and San Leandro (though not all of these are located within parks). Most parks specifically allow fishing from the shoreline (with a license), though fishing is prohibited in portions of some parks to protect wildlife.

Encinal Boat Ramp Park. Source: Sara Polgar, BCDC.

Dog Recreation

Parks that allow dog recreation are in high demand, though none of the parks addressed in this section include a dog park. Surveys of use of Emeryville's parks demonstrate that visitors bring dogs to parks regardless of rules against them, and in Marina Park (dogs allowed on leash) and Point Emery (no dogs allowed), dogs are often off leash.

Accessible Recreation

Recreation features and support facilities in the ART project area that are accessible to persons with mobility disabilities include paths and trails through diverse shoreline areas, opportunities for views and wildlife observation, picnicking and family/group events, interpretive and educational signage and visitor centers, parking, and restrooms. Levels of accessibility (e.g., usable for persons in motorized wheelchairs but not manual wheelchairs) varies depending on characteristics of the site, types of accessibility improvements that have been made, and current conditions of accessible features. (See discussion under "Existing Stressors.") A few sites have unique accessible features: the public boat launch and dock at the Aquatic Center at Estuary Park in Oakland, a special ramp that allows wheelchair users to explore tidepools at low tide at Crab Cove (at Crown Memorial State Beach), the playground at Union Point Park in Oakland, and the par course at Marina Park in San Leandro (Lewkowicz, 2006).

Resources for Non-English-Speakers

Parks and recreation areas in the ART project area provide few resources for non-English-speakers. There have been state-funded school programs and weekend interpretive programs at

the Hayward Shoreline Interpretive Center for Spanish-speaking participants. Additionally, a Spanish-speaking naturalist at the Hayward Shoreline Interpretive Center provides translation services and occasional interpretive programs in Spanish.

Business Resources

Concessions at some of the parks provide business revenue sources. These concessions include the contracts for management of the three municipally owned golf courses and the sailboard rental/school concession at Crown Memorial State Beach (City of San Francisco, 2007). Additionally, visitors to the parks and recreation areas can support revenue opportunities outside these recreation assets (e.g., adjacent restaurants and shopping).

Hayward Shoreline Interpretive Center. Source: www.haywardrec.org/hayshore.html.

Table 8. Park Recreation Services in the ART Project Area

(NA = not available; BT = Bay Trail)

Park	Manager, *Owner*	Acres	Miles of Trail, Bay Tr. Present	Views	Nature Wildlife Viewing	Education Interpretive Features	Water Sports (access)	Fish-ing	Family Group Facilities	Team/ Sport Facilities
Point Emery	City of Emeryville	1.4	0.15, BT	Scenic Iconic			Sailboards, paddleboats, swimming (beach)	Yes	Picnic	
Shorebird Park	City of Emeryville	2	0, BT	Scenic Iconic			Sailboards, paddleboats, swimming (beach)	Yes		
Marina Park (E)	City of Emeryville	7.5	1, BT	Scenic Iconic			Sailboards (stairs), motorboats (ramp)	Yes	Picnic, BBQ	
Middle Harbor Shoreline Park (Port View Park)	Port of Oakland	38	2, BT	Scenic Iconic	Yes, habitat restoration	Signage, historic lookout/tower	Paddleboats (beach)	Yes	Picnic, BBQ	
Estuary Park (Aquatic Center)	City of Oakland	12	0.25, BT				Paddleboats (ramp, boathouse)	Yes		Grass field, boat house
Shoreline Park, Estuary	City of Alameda	5	0.7, BT						Lawn areas	
Union Point Park	City of Oakland	7	0.4, BT	Scenic					Picnic, BBQ, lawn area, playground	
Encinal Boat Ramp Park	City of Alameda	<5	NA, BT	Scenic Iconic			Motorboats, paddleboats (ramp)		Picnic	
Crown Memorial State Beach (Crab Cove Visitor Center; Elsie Roemer Bird Sanctuary)	EBRPD, *State of CA & City of Alameda*	181	2, BT	Scenic Iconic	Yes, bird sanctuary	Signage, visitor center, educational displays	Sailboards, paddleboats, swimming (beach)	Yes	Picnic, BBQ, lawn area	Bath house
Chuck Corica Municipal Golf Course	Private, *City of Alameda*	350								Golf course
Shoreline Park, Bay-Farm Island	City of Alameda	32	2.5, BT	Scenic iconic					Lawn areas	

Table 8. (*continued*) Park and Recreation Services in the ART Project Area
(NA = not available; BT = Bay Trail)

Park	Manager, *Owner*	Acres	Miles of Trail, Bay Tr. Present	Views	Nature Wildlife Viewing	Education Interpretive Features	Water Sports (access)	Fishing	Family Group Facilities	Team/ Sport Facilities
Martin Luther King, Jr. Shoreline (Tidewater Boathouse)	EBRPD, *Port of Oakland*	741	3.7, BT	Scenic	Yes, marsh restoration	Signage, wetlands boardwalk	Motorboats (ramp), paddleboats (ramps, floats)	Yes	Event space, picnic	Turf field, boathouse
Metropolitan Golf Links	Private, *City of Oakland*	?	0.91, BT		Yes, bird watching					Golf course
Oyster Bay Regional Shoreline	EBRPD	157	2.1, BT	Scenic	Yes, bird watching	Signage, sculpture			Picnic	
Marina Park (SLe)	City of San Leandro	30	1, BT						Picnic, BBQ, lawn area, playground	Sand volleyball court
Tony Lema Golf Course	Private, *City of San Leandro*	178	1, BT	Scenic						Golf course
Hayward Regional Shoreline	EBRPD	1,713	5, BT	Scenic	Yes, marsh restoration	Signage		Yes		
Hayward Shoreline Interpretive Center	HARD	28	NA, BT	Scenic	Yes, marsh, birds	Signage, interpretive center			Picnic, meeting center	
Alden E. Oliver Sports Park of Hayward	HARD	25							Picnic, BBQ, lawn area, playground	Baseball, soccer fields, basketball
Skywest Golf Course	HARD	117	NA						Picnic, BBQ	Golf course
Gordon E. Oliver Eden Shores Park of Hayward	HARD	6	3.3, BT						Picnic, BBQ, lawn area, playground	Tennis courts, soccer field, half-court basketball
San Lorenzo Park	HARD	24	1.7, BT						Event space, picnic, BBQ, lawn area, playground	Baseball, soccer field, basketball

Sources: City of Emeryville, City Parks, ; EBRPD, Parks, ; HARD, 2008; City of San Leandro, City Parks; Port of Oakland, ; Waterfront Action, ; and CPAD, .

V. Existing Stressors

Overall Management and Enforcement Issues

Demand for park services—particularly on weekends—can exceed park capacity (e.g., for parking and picnic availability). Popular parks and recreation areas, such as Crown Memorial State Beach and San Leandro Marina Park, are heavily used and sometimes overused; this can lead to traffic congestion (as visitors park on neighboring streets), damage to facilities, and user conflicts. These situations can overwhelm managers' capacity for immediate enforcement and emergency response, as well as overall maintenance and repair.

Financial Constraints

Due to budget shortfalls, cities have had to lay off parks department employees, defer preventative maintenance, reduce budgets for maintenance and repairs, and limit operating hours. At the same time, the downturn in the economy has hurt nonprofit organizations that help provide recreational services in the ART project area. Reduced funding can result in deferred maintenance, longer timeframes for planning and opening up new park spaces, enforcement challenges, and fewer programs and services available at the parks.

Accessibility

Site characteristics can affect the ability to make paths and trail accessible to all persons with mobility issues. For example, the stretch of Bay Trail from the Hayward Interpretive Center to the next access point at Winton Avenue is hard-packed dirt and some gravel atop a levee—a trail surface that may be impassable for persons in manual wheelchairs. Older accessibility improvements at some parks are not suitable for all persons with mobility disabilities (e.g., the undersized accessible bathroom at the Crab Cove Visitor Center at Crown Memorial State Beach). Some facilities are almost completely accessible (by design or chance) but lack a specific feature to fully achieve accessibility (e.g., the accessible restroom at Estuary Park in Oakland has a steep curb cut onto the sidewalk in front of it making it inaccessible to wheelchair users). Accessibility of sites is especially vulnerable to maintenance issues. For example, erosion on the trails at Middle Harbor Park makes travel in a wheelchair challenging (Lewkowicz, 2006).

Regulatory and Permitting Issues

Improvements in ART project area's parks often require multiple permits/approvals from agencies such as BCDC and the Regional Water Quality Control Board, and usually require an Environmental Impact Report that describes impacts and mitigations to comply with the California Environmental Quality Act. These regulatory requirements can add significantly to managers' planning costs and timelines.

Habitat and Wildlife Impacts

Negative impacts to habitat and wildlife occur in and around parks and the Bay Trail due to allowed or planned-for recreational activities (e.g., boating and use of trails adjacent to habitats)

and prohibited, unplanned, or unmanaged activities such as off-trail usage, intrusion into habitat areas, the presence of non-native species, and littering. These impacts can reduce habitat usage by wildlife and cause direct harm (e.g., stress) to species.

Golf Courses

Golf facilities are intended to generate funds to help cover operating costs for other parks and recreation areas within a park district or city. However, declining usage has reduced revenues at the same time as maintenance and improvement costs have increased due to aging infrastructure and worsening drainage and salinity problems. Within the past five years, the Chuck Corica Golf Complex and the Skywest Golf Course have operated at a loss and required general fund money to continue operations (City of San Francisco, 2007).

Hazards

In the Bay Area's Local Hazard Mitigation Plan annex, EBRPD reported on its exposures, costs, and responses to natural and human-induced disasters over the last 50 years (EBRPD, 2011). The district has been affected by damage from severe storms and weather over the past 20 years. As examples, the '05-'06 winter storms caused over $6 million in damages to 52 sites, and the February 1998 El Niño storms caused nearly $1.2 million in damages to 34 sites. The damages were due to flooding, landslides, debris flows, and erosion.

Two oil spills in the Bay have had direct impacts on parks in the ART project area.

- The *COSCO Busan* oil spill (November 7, 2007) released 53,500 gallons of heavy fuel oil, sometimes referred to as bunker fuel, into San Francisco Bay. The East Bay's shoreline and wildlife were seriously affected by the spill. Beaches and shorelines were closed, though they later reopened. EBRPD devoted much effort to the disaster since the East Bay was the area most affected. The East Bay segments were the last ones to be signed off as cleaned because of the additional maintenance and monitoring that were required.
- The *Dubai Star* oil spill (October 30, 2009) released 422 gallons of bunker fuel into the Bay. Crown Memorial State Beach and other EBRPD shorelines including Middle Harbor and Martin Luther King Jr. Shoreline were immediately closed following the spill. On October 31, 2009, one day after the oil spill, tarballs and oil sheen appeared on the southern portion of Crown Beach. Cleanup crews responded and removed tarballs that continue to wash onto shore.

VI. Economy/Equity/Governance/Environment

Parks and recreation areas provide the ART project area with significant economic, societal, and environmental benefits. In 2000, EBRPD published an economic analysis of the district's park resources that clearly demonstrated some of the economic benefits provided. For example, contributions to quality of life helped drive local and regional economic growth by attracting business and generating jobs and income for residents. In some cases, parks and recreation assets enhance property values of homes adjacent to parks and trails due to views and the

access provided. Societal benefits include direct health and education benefits; services to underserved communities (e.g., persons with disabilities); public safety services from police, fire and wildland management provided by park managers; and transit resources from trails that connect parks, homes, employment centers, and shops. In addition to providing habitat for plants and animals, preservation of these parks and recreation areas provides ecosystem services such as erosion control, waste treatment, and nutrient recycling.

Stressors on parks and recreation assets diminish these economic, societal, and environmental benefits. For example, the management, enforcement, and financial stressors that lead to reduced services and access at parks and recreation areas especially affect underserved communities that are unable to afford or access alternative resources that provide similar benefits. Furthermore, to continue to provide these benefits, park districts and departments must balance the challenge of an increased demand for more park space and resources to serve a growing and more diverse population, with the need to maintain existing facilities.

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7. SEAPORT

Port of Oakland: Seaport

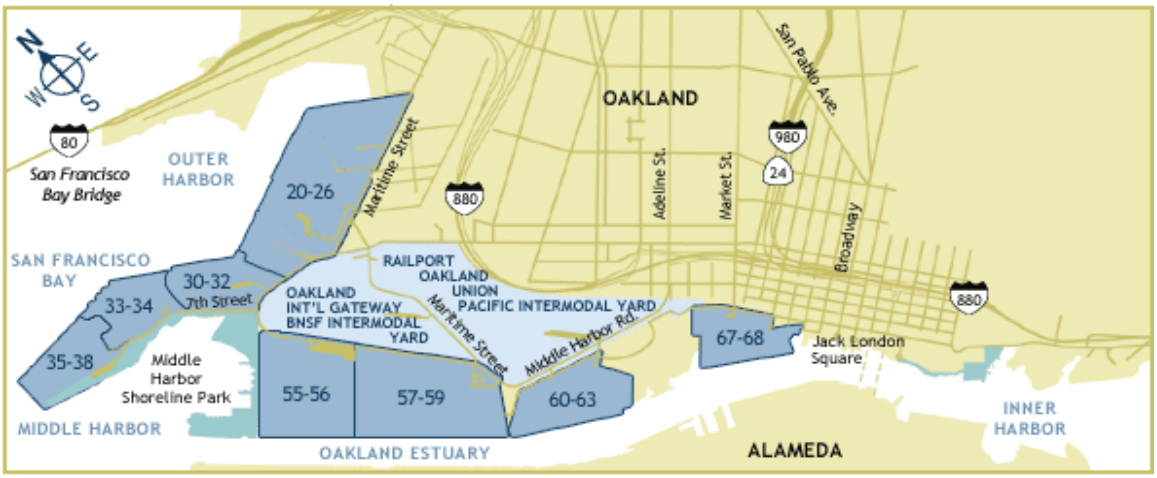
I. Definition

The Port of Oakland was created in 1927 as an autonomous department of the City of Oakland under the exclusive direction of the Board of Port Commissioners by an amendment to the City's Charter. As an independent department of the City, the Port manages property stretching along 20 miles of the eastern shore of San Francisco Bay. In addition to its airport and real estate assets, its marine seaport facilities—which include shipping berths, container storage areas, and intermodal rail facilities—constitute approximately 1,200 acres.

II. Location and Physical Features

The Seaport includes four major terminal areas, which total a combined 791 acres: the Outer Harbor Terminal Area, the 7th Street Terminal Area, the Middle Harbor Terminal Area, and the Inner Harbor Area. Figure 13 below shows the Port's location along the eastern shore of San Francisco Bay.

Figure 13. Layout and Location of the Port of Oakland. Source: Port of Oakland, 2011.



The Seaport has 18 deep water berths, 13 of which reach depths of 50 feet, and 36 container gantry cranes (30 of which are post-Panamax types), as well as two intermodal rail yards: the Oakland International Gateway, operated by Burlington Northern Santa Fe on Port-owned land; and Railport, owned and operated by Union Pacific Railroad on adjacent private property. Table 9 lists the operating characteristics of the berths at the Port.

Table 9. Berths at the Port of Oakland

Berths	Operator	Berth length (meters)	Water depth (ft, MLLW)	Terminal yard acreage (excluding berth area)	Container Cranes	Cranes
20/21, 22, 23, 24, 25/26	Ports America Outer Harbor LLC	1,677	20/21: 42 22-25/26: 50	210	10	
30, 32	TransPacific Container Service Corporation (TraPac)	610	50	65.7	4	
33, 34*	Port of Oakland's Chief Wharfingers	33: 258 34: 338	33: 50 34: 38	30		
35, 37	Evergreen Marine Corporation Ltd.	684	50	58.1	4	
55, 56	Total Terminals Inc., LLC	732	50	120	4	
57-59	SSA Terminals, LLC	1,091	50	151.2		6
60/61, 62/63	Eagle Marine Services	836	44	80		4
67-68	SSA Terminals, Inc.	614	42	50.3		4

* Berth function is vehicle roll-on / roll-off

III. Existing Plans and Future Capacity

The Port of Oakland's Vision 2000 Program more than doubled the port's size with the transfer of 530 acres of the former Navy Fleet Industrial Supply Center Oakland (FISCO) to new cargo transport land uses. Specifically, the program called for the deepening of the main marine navigation channel and terminals to 50 feet to accommodate 6,500-TEU[2] ships (completed in 2010 at $432 million), a new 150-acre Joint Intermodal Rail Terminal with eight permanent tracks to provide direct access to the Union Pacific and Burlington Northern Santa Fe railroads, and the construction of two new marine terminals—

Post-Panamax crane delivered to Port of Oakland. Source: Flickr user Niall Kennedy, 2005.

[2] "Twenty-foot equivalent units," a standardized size of the containers in which goods are shipped.

Berths 55-56 and 57-59—which provide 6,000 linear feet of berthing area and 270 acres of new marine terminals and container yards. The Port is also currently planning the development of a trade and logistics center on a portion of the former Oakland Army Base. This project would create an improved connection between marine terminals and intermodal railyards, as well as provide additional goods warehousing and truck parking.

Trade at the Port of Oakland is projected to increase from 2.33 million TEUs in 2010 to 3.1 million TEUs by 2018 (Table 10).

Table 10. Cargo Forecast at Port of Oakland

Container Forecast for Port of Oakland (1,000 TEUs)		
Fiscal Year	Actual	Forecast
2010	2,330	
2011		2,387
2012		2,491
2013		2,617
2014		2,696
2015		2,804
2016		2,889
2017		2,976
2018		3,078

Source: BST Associates, 2011.

At its present size of about 779 acres of terminal space and with its existing rail infrastructure, the Port of Oakland is projected to have adequate capacity through 2021 (Tioga Group, 2009). Infrastructure improvements on rail and road connections would mean the Port would have sufficient capacity to meet forecast demand through 2030 or beyond. Thus, the Port of Oakland is not faced with immediate capacity constraints based on projected cargo demand.

IV. Existing Stressors

Earthquakes and liquefaction are a particular risk to Port facilities, with much of the complex situated on bay fill. Damage to facilities at the Port of Oakland in the 1989 Loma Prieta earthquake was due primarily to liquefaction of the hydraulic fill (ABAG, 2001). The most extensive damage was to the 7th Street Terminal (Berths 35-38), although all other terminals were also affected (see photo below). Yard areas settled up to 1 foot relative to the pile-supported crane rails. Ground accelerations at the Port caused widespread liquefaction in several terminals, resulting in settlement and distress to backland pavement, utilities, and small buildings. The damage to the perimeter dikes, yard pavements, and wharf structures of the 7th Street Terminal was severe enough to close the terminal for several months and reduce operations for over a year until emergency repairs were completed.

Damaged pavement at Berths 36 and 37 after Loma Prieta earthquake, 1989.
Source: U.S. Geological Survey, 1998.

Significant sand boils observed in the yard pavements indicated that much of the hydraulic sand fill behind the perimeter dike liquefied as a result of the earthquake. Horizontal ground movements were on the order of 4 to 6 inches near and along the Berth 37 perimeter dike. Ground settlements on the order of 5 to 7 inches (and as much as 10 inches) were recorded immediately behind the wharf deck. The landside crane rail behind the Berth 37 wharf was reported to have settled approximately 8 to 12 inches. The observed damage to the Berth 37 wharf structure included failure of most of the landside batter piles and about half of the waterside batter piles, as well as some damage to vertical piles at pile/deck connection.

The Port of Oakland conducted studies of its vulnerability after both the 1989 Loma Prieta earthquake and the 1995 Kobe earthquake in Japan. These studies show that the soils in Oakland are muddier and less sandy than in Kobe (ABAG, 2001). In addition, the Port of Oakland uses pilings ranging from 20 to 100 feet in depth, rather than caissons; the pilings are considered a sounder approach. The 30 deep water berths in Oakland are up to 50 feet deep; in Kobe, the equivalent berths are more than 100 feet deep. It is interesting to note, however, that despite the damage from the 1989 Loma Prieta earthquake, the Port of Oakland experienced very little disruption in cargo service. Through quick response and flexible operations, it was able to double up service at the remaining functional berths. Reportedly, only one ship turned away because of the earthquake damage (Port of Oakland, 1999).

In 2000, the Port authorized an extensive Wharf and Embankment Strengthening Program (WESP). The program was split into three phases and involved retrofitting or rebuilding over 12,000 linear feet of pile-supported wharf structures (see photo below). While many of the port facilities may still be vulnerable to liquefaction, the WESP projects have done much to reduce catastrophic damage to critical embankments and wharfs.

Pier 37 embankment strengthening. Source: Ben C. Gerwick, Inc., 2007.

V. Economics/Jobs

In total, nearly 444,000 jobs are related, in some way, to the movement of cargo at the Port of Oakland seaport (Martin Associates, 2011). In 2010, cargo handled at the Port supported about $2.2 billion of total personal income, $2.1 billion in revenue for businesses providing maritime services for cargo and vessels, and $233 million in state and local tax revenue. In the Bay Area alone, cargo activity at the Port generated 28,833 direct, induced, and indirect jobs. Each year, depending upon the revenue surplus, the Port also makes financial contributions to the City of Oakland.

By number of annual TEUs, the Port of Oakland is the third busiest container port on the West Coast (after the Port of Los Angeles and the Port of Long Beach) and the fifth busiest in the United States (after the Port of New York/New Jersey and the Port of Savannah). In 2010, the Port of Oakland saw the arrival of 1,973 cargo vessels, transporting a total of over 2.33 million TEUs (see Table 11). Although total TEUs are up 13% from 2009 levels, shipping is still below the record peak of 2.39 million TEUs in 2006.

Table 11. Actual TEU Cargo Shipments at Port of Oakland

Year	TEUs	Percent Change from Previous Year
2005	2,273,990	+11.1%
2006	2,391,745	+5.2%
2007	2,387,911	-0.2%
2008	2,233,533	-6.5%
2009	2,045,211	-8.4%
2010	2,330,214	+13.9%

Source: Port of Oakland, 2011.

The Port serves as the principal ocean gateway for container cargo in northern California and provides an interface for waterborne international and domestic cargo moving between inland points in the United States and the Pacific Basin, as well as other points in the world (East Bay Economic Outlook, 2011). Ten percent of international cargo bound for the West Coast travels through the Port with machinery, electrical equipment, knit apparel, furniture, and beverages the leading types of goods. These imports arrive primarily from Asia, particularly China and Japan. In sum, over $24.3 billion worth of imports flowed through the Port in 2010.

However, although international imports constitute a major economic role, the Port of Oakland plays a much greater role in the export of goods, specifically as a critical gateway for California's agricultural products (see Table 12). The Port is unique in that it exports more than it imports. More than 60% of all California exports of beverages, spirits, vinegar, coffee and tea, fruits, nuts, citrus, and melons leave the state via Oakland. In 2010, more than $10.1 billion in California-made goods and commodities were shipped through the Port of Oakland, the highest level on record, representing over 29% of all exports produced in the state. More than 20% of all products shipped abroad through the Port were edible fruits, nuts, citrus, or melons from the Central Valley, totaling $3.2 billion. An additional $1.9 billion in meat and offal products were also exported via the Port. The value of all exports through the Port of Oakland in 2010 represented 9.3% of all California exports.

Table 12. Value of Import and Export Commodities Shipped Through the Port of Oakland

Port of Oakland Top 10 Imports and Exports by Value, 2010						
Rank	**Import Commodity**	**Import $ Millions**	**Import Percent**	**Export Commodity**	**Export $ Millions**	**Export Percent**
1	Machinery	5,380	22.1%	Edible fruit and nuts	3,200	20.8%
2	Electrical equipment	3,260	13.4%	Meat	1,900	12.3%
3	Knit apparel	2,140	8.8%	Machinery	955	6.2%
4	Furniture and bedding	1,430	5.9%	Inorganic chemicals/rare earth	901	5.9%
5	Beverages	1,250	5.1%	Electrical machinery	684	4.4%
6	Toys and sports equipment	860	3.5%	Beverages	682	4.4%
7	Vehicles	761	3.1%	Vehicles	569	3.7%
8	Plastic	757	3.1%	Cereals	420	2.7%
9	Coffee	593	2.4%	Optical/medical instruments	411	2.7%
10	Woven apparel	465	1.9%	Misc. chemical products	297	1.9%
	Other	7,404	30.5%	Other	5,381	34.9%
	Import Total	**24,300**	**100.0%**	**Export Total**	**15,400**	**100.0%**

Source: Port of Oakland, July 2011.

VI. Equity and Environment

As a public agency, the Port of Oakland strives to solicit public input on its various plans and programs. The Port has many community-based programs that aim to reduce its impacts on adjacent neighborhoods.

The ships, trains, and approximately 2,000 trucks that operate out of the Port impact air quality by emitting diesel emissions that pollute surrounding neighborhoods such as West Oakland and East Oakland. As such, the Port of Oakland worked with a community task force from 2007 to 2009 to develop an air quality plan to reduce the environmental burden placed on the local community by diesel-fueled freight equipment serving the seaport. The Port's Board of Port Commissioners approved the Maritime Air Quality Improvement Plan (MAQIP) on April 7, 2009. MAQIP's primary goal is to reduce excess community cancer risk caused from Port-related diesel particulate matter by 85% from 2005 to 2020. The nearly 40-person task force that designed the MAQIP's goals and measures used seven guiding principles:

1. Seek economic growth.
2. Promote environmental stewardship.
3. Apply the concept of fair share.
4. Exercise the Port's authority.
5. Engage stakeholders.
6. Promote environmental justice.
7. Build knowledge.

The primary emissions control measures outlined in the MAQIP are:

- Early action retrofit and/or replacement of port drayage trucks.
- Compliance with the California Air Resources Board's shore power regulation.
- Design and operational efficiencies.
- Participation in pilot and verification projects for NO_x and diesel particulate matter reduction strategies.
- Early action construction emissions reductions.
- Support of enforcement of regulations by the California Air Resources Board and BAAQMD through coordination with Port tenants.
- Accountability, monitoring, and reporting

The complete plan is available at http://www.portofoakland.com/pdf/maqip090515.pdf.

Many of the Port's hiring policies promote local community benefits. The Maritime and Aviation Project Labor Agreement (MAPLA) was adopted by the Board of Port Commissioners in March 2000 (for more information on the MAPLA see page 32 of this report or go to *www.portofoakland.com/business/contract.asp*). In addition to MAPLA, the Port's Living Wage Program applies to all businesses with more than 20 employees.

Thus, the Port of Oakland strives to be an active community participant by developing innovative programs that ensure low-income and adjacent communities do not bear

disproportionate impacts and are able to benefit from the economic benefits of global trade and commerce.

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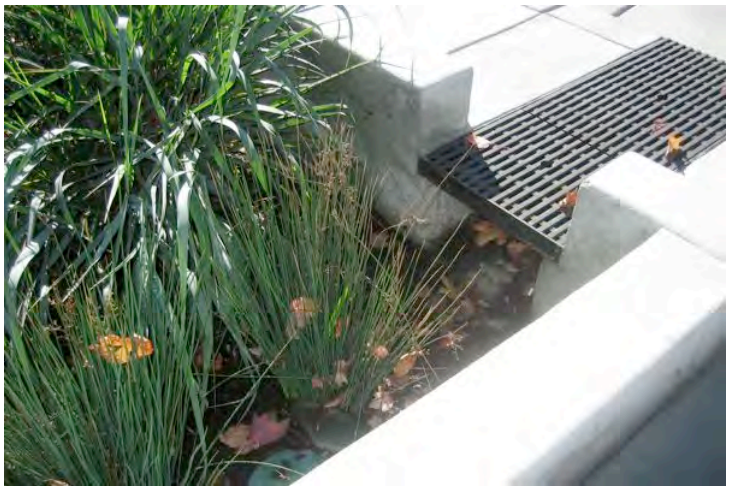
8. STORMWATER INFRASTRUCTURE

I. Definition

Stormwater runoff is generated when precipitation from rain and snowmelt flows over land or impervious surfaces and does not percolate into the ground (US EPA). The stormwater runoff collects in urban storm drains and eventually empties into creeks, waterways and waterbodies. Unlike Alameda County's wastewater, which is cleaned at wastewater treatment plants before being discharged into San Francisco Bay, stormwater does not receive the same level of treatment. Aside from a basic sump that collects coarse-grained sediment, and grates that collect trash and other debris, once inside the storm drainage system, stormwater carries a host of pollutants including oil and grease, metals, bacteria, nutrients, and suspended solids into creeks and eventually San Francisco Bay (Alameda Local Agency Formation Commission, 2005). Most of the stormwater from the cities within the ART project area drains from city-owned and maintained storm drains into the Alameda County flood control system, which consists of managed creeks, culverts, and channels. The exception is the City of Alameda, all of their stormwater drains directly to the Bay. Stormwater management and flood control differ in both the scope and in provider type; in Alameda County, cities provide stormwater services (and the County in unincorporated areas), while the Alameda County Flood Control and Water Conservation District (ACFCWCD) provides regional flood control services.



Pre-treatment of stormwater by vegetated swales helps reduce pollutants before runoff reaches flood control channels and ultimately the Bay. Source: City of El Cerrito.

II. Locations and Physical Features

Stormwater infrastructure consists of storm drains that collect urban runoff from city streets and underground pipes that carry stormwater to regional flood control channels (see Figure 14). Stormwater services include direct maintenance, preventative maintenance, regulatory activities, and pre-treatment services.

- Direct maintenance services include removal of blockage from storm drainage and piping, cleaning stormwater inlets and basins, and repair of stormwater infrastructure. The ACFCWCD also performs direct maintenance work on its regional flood control facilities, into which stormwater eventually empties.

- Preventative services include street sweeping and inspection of inlets.
- Regulatory activities involve public outreach and education, industrial and commercial discharger permitting and inspections, development of source controls and site design for development projects, and inspection for illicit wastewater discharge. Much of this work is performed by the Alameda Countywide Clean Water Program, a collaboration of the county and all its cities to implement and enforce the provisions of the federal Clean Water Act.
- Pre-treatment involves methods to prevent polluted runoff from entering the storm drain system. These methods, which collectively are often referred to as "low-impact development" methods, include vegetated swales, surface sand filters, retention ponds, bioretention units, rain gardens, gravel wetland units, porous asphalt pavement, tree box filters, and other devices meant to naturally filter runoff pollutants *before* they enter the stormwater system. Pre-treatment is a key step in cleaning stormwater runoff before it is collected into storm drains and is a major requirement under Alameda County's stormwater discharge permit.

Most of the runoff in the ART project area flows from the storm drain system into ACFCWCD flood control channels and eventually to San Francisco Bay. Only the City of Alameda discharges all of its stormwater directly into the Bay, bypassing the flood control district's waterways (see Figure 15 and Table 13).

Figure 14. Overview of Urban Stormwater Infrastructure
Source: Adapted from www.lastormwater.org/siteorg/general/lastrmdrn.htm

Figure 15. Map of Stormwater Infrastructure in the ART Project Area

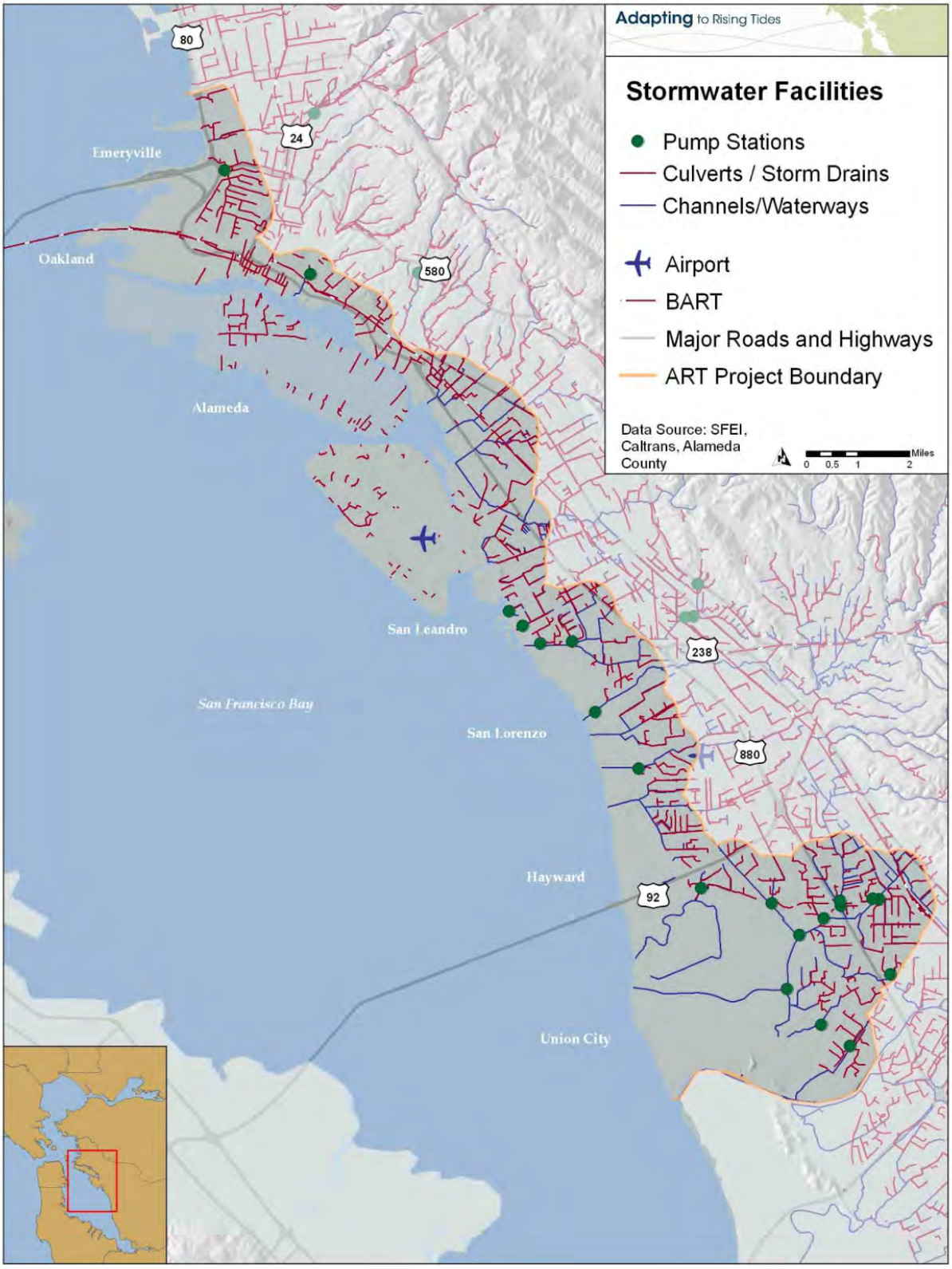


Table 13. Overview of Stormwater Drainage Systems in the ART Project Area

Area	Description
Alameda	Pipes and channels flow directly to San Francisco Bay.
Emeryville	Storm drains flow to channels and Temescal Creek and to the San Francisco Bay.
Hayward	Flows through storm drains, pipes, channels, and natural creeks including Sulphur, Ward, Ziele, and Alameda Creeks to San Francisco Bay.
Oakland	Several creeks generally flow in a southwesterly direction from the hills down to developed areas and to San Francisco Bay through culverts, channels, and creeks including Sausal Creek, Peralta Creek, Lion Creek, Arroyo Viejo, and Elmhurst Creek.
San Leandro	Pipes, Estudillo Canal, Corvalis Canal, San Leandro Creek, and San Lorenzo Creek carry water to San Francisco Bay.
Union City	Storm drains, pipes, and channels drain to Alameda Creek, Dry Creek, and San Francisco Bay.
Alameda County	The Flood Control District and the County Public Works Department manage the storm drains, which flow to the flood control system.

Source: Alameda LAFCo.

III. Governance and Regulatory Requirements

Stormwater infrastructure in the ART project area is owned and maintained by the municipalities, with service boundaries coterminous with the municipalities' respective city limits (Alameda LAFCo). Only Emeryville outsources its street sweeping and inspection services. The cities are responsible for maintenance of their stormwater facilities, including storm drains, underground pipes, and local channels. All of the cities regularly inspect and clean their stormwater infrastructure. ACFCWCD is responsible for the maintenance and upkeep of creeks and other flood control channels within each city.

The Clean Water Act (CWA) is the primary federal law that regulates stormwater management. Adopted in 1972, CWA requirements have subsequently become more stringent. To reduce runoff pollution, the CWA directs states to adopt and enforce water quality standards, to establish maximum allowable pollution levels for water bodies called TMDLs (total maximum daily loads), and to monitor and regulate discharges into water bodies through the establishment of National Pollution Discharge Elimination System (NPDES) permits. In California, the State Water Resources Control Board (Water Board) has overall responsibility for water quality and the authority to regulate point source discharges, such as municipal stormwater discharges, and the administration of NPDES permits. The SWRCB delegates the responsibility to its regional boards. The San Francisco Bay Regional Water Quality Control Board (Regional Board) is the agency in charge for water quality permitting activities for the ART project area. Each of the cities and certain industries known to contribute to stormwater runoff pollution are regulated by NPDES permits. In Alameda County, each of the 14 cities, the unincorporated area and the two flood control districts all share one NPDES permit through a

consortium of 17 agencies called the Alameda Countywide Clean Water Program (ACCWP). ACCWP has been issued NPDES municipal stormwater permits since 1991. The NPDES permits outline the requirements that jurisdictions must adhere to for the improvement and protection of water quality within their jurisdictions (Alameda County Public Works Agency, 2005). The NPDES Permit provides requirements and standards for categories such as municipal maintenance, public outreach, illicit discharge controls, industrial and commercial discharge controls, and new development discharge controls. For example, as part of its compliance with the NPDES permit, the City of Emeryville requires new and redevelopment projects on lots greater than 10,000 square feet to incorporate Best Management Practices (BMPs) to minimize discharge of pollutants to the storm drain system (City of Emeryville, 2005). These BMPs are listed in the State of California's Stormwater Best Management Practices Handbook and include detention/retention ponds, wetlands, vegetated swales, sand filters, and other impervious surfaces. Stormwater regulations for unincorporated Alameda County require vegetated swales, filters, and wetlands to be sized and engineered to ensure that runoff is treated from a rain event of 0.2 inches per hour in intensity (Alameda County, 2004).

IV. Existing Stressors

The ability to convey, treat and discharge stormwater is affected by the amount of precipitation, pervious and impervious surfaces, and the overall condition of infrastructure (Alameda LAFCo). Rainwater can be dispersed by infiltration into the soil, reducing the volume and intensity of runoff into local creeks and channels. However, the amount of rainwater infiltrated decreases dramatically by the expansion of impermeable surfaces such as paved streets, sidewalks, driveways, building footprints, and parking lots.

While most cities have facilities that are in fair to good condition, some cities' systems either are very old or have insufficient capacity to handle current peak flows. Future population growth and the associated urban development or redevelopment can increase the demand on stormwater services. This increased demand will likely translate into not only additional conveyance capacity, but the need for detention, retention and water quality treatement.

V. Economy

All of the cities within the ART project area, except Emeryville and Oakland, levy service charges and assessments to finance stormwater services (Alameda LAFCo). The city of Alameda also levies a stormwater-related development impact fee on construction projects. General fund revenues are used to supplement the fees and assessments charged to residents or as the sole source of financing. Assessments used by some cities to finance stormwater service are based on the square footage of impervious surface or parcel size; however, the Cities of San Leandro and Union City charge a flat rate for residential property, regardless of size. The assessment rates may differ between residential and commercial properties. In Alameda County, the average city receives approximately $35 per parcel in assessments and the unincorporated area assessment is only $7 per parcel. In all cases, the amount is eroded over time by inflation and increasing costs of complying with new regulatory requirements.

- **Alameda:** The city finances stormwater service primarily with stormwater assessments. Although stormwater assessments are inflation-indexed, they do not fully cover service costs, leaving a small portion of stormwater costs to be financed by general fund revenues.
- **Emeryville:** The city finances stormwater service with general fund revenues, and does not levy a stormwater assessment.
- **Hayward:** The city charges a stormwater assessment. The assessment is calculated by multiplying parcel size (square feet) by run-off factor. The charge for an average single family home is $28.56. There is a higher rate for commercial or industrial properties.
- **Oakland:** Stormwater services are financed by sewer fund assessments and a general fund. There is currently no stormwater assessment, but the city plans to pursue a ballot measure in the near future for stormwater assessments.
- **San Leandro:** Primary funding comes from stormwater assessments, with some general fund support. Residential assessments are a flat fee levied per unit. An average single family home is assessed $26.33. Non-residential rates are calculated by parcel size (acres).
- **Union City:** The primary funding source is a stormwater assessment fee. Residential properties are charged a flat fee, while commercial and industrial properties are assessed a percentage of their solid waste charge.

The most significant constraints on the financing of stormwater services are legal requirements that limit property taxes and require voter approval of new taxes and tax increases. Several cities do not levy stormwater assessments and instead finance services from their general funds. Stormwater assessments are considered property-related fees under California's Proposition 218, and are subject to two-thirds voter approval requirements for imposition of new or increased assessments.

VI. Equity and Environment

Equity is a large concern in the financing of stormwater infrastructure. Flat fees are regressive financial burdens that will typically affect poorer homeowners more than wealthier families. Local governments may decide to tier their fees on the basis of property value, or grant waivers to those who are less able to pay, in order to create a more progressive financing structure (University of South Carolina, 2007). Other ways to tier finance systems are on residential lot size, with larger residential lots paying more than

During heavy rains runoff can quickly overwhelm aging, undersized, or poorly maintained stormwater infrastructure. Source: US EPA.

small lots. A fee can also be tiered so that those with more impervious surfaces pay a greater amount.

Older neighborhoods within the ART project area are home to low-income communities. These areas have older infrastructure that is more susceptible to leaking and breaking, which increases the likelihood and risks of flooding (US EPA, 2011). Older infrastructure is not designed to handle heavy rainfall in addition to growing urban populations and industrial discharges. As a result, stormwater can overflow from storm drains into waterways, or back up into city streets or basements of homes.

Lastly, stormwater runoff from urban streets and construction sites can carry pollutants such as sediment, metal, oil and grease, acid, chemicals, toxic materials, and industrial waste into surface waters, threatening public health and environmental quality.

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9. STRUCTURAL AND NATURAL SHORELINES

I. Definition

The ART project has a diverse shoreline composed of a variety of structural and natural areas. In general, structural shoreline protection assets in the project area are built features that have been constructed and maintained for specific purposes such as flood or erosion control. Natural shoreline areas are either fully tidal or managed wetlands, former salt ponds, storage/treatment ponds, or non-wetland beaches. These areas are generally managed, maintained, or enhanced to preserve or restore key ecosystem functions, species, and habitats.

The shoreline in the northern portion of the project area is generally composed of structural assets interspersed with a few natural areas. This portion of the project area is fairly urbanized, with development extending to the edge of the Bay. For example, the Port of Oakland, the Oakland Airport, East Bay Municipal Utility District's main treatment plant, and the toll plaza for the San Francisco Bay Bridge are all located along the shoreline of the northern portion of the project area.

The shoreline in the southern portion of the project area is less urbanized, with development generally located inland of Bay edge natural areas. The natural areas on the shoreline are composed of natural, restored, and managed wetlands of varying tidal regimes, with one notable non-wetland beach area. In many locations along the shoreline, natural areas are co-located with structural shoreline protection assets. For example, non-engineered berms on the Bay (outboard) side of wetlands help to reduce the exposure to wind and wave erosion, while levees on the inland (inboard) side help to reduce flooding of adjacent developed areas.

II. Locations and Physical Features

Five categories of shoreline were mapped onto the project area (Adapting to Rising Tides Transportation Vulnerability and Risk Assessment Pilot Project Technical Report, Chapter 2). These categories and the subcategories within them were developed in order to characterize the diverse and varied shoreline of the project area in a simplified manner. The categories were developed to best reflect the primary function of the shoreline, including the potential to protect inland areas from inundation due to sea level rise and storm events (see Table 14). Detailed descriptions of the shoreline categories follow below and are shown in Figure 16.

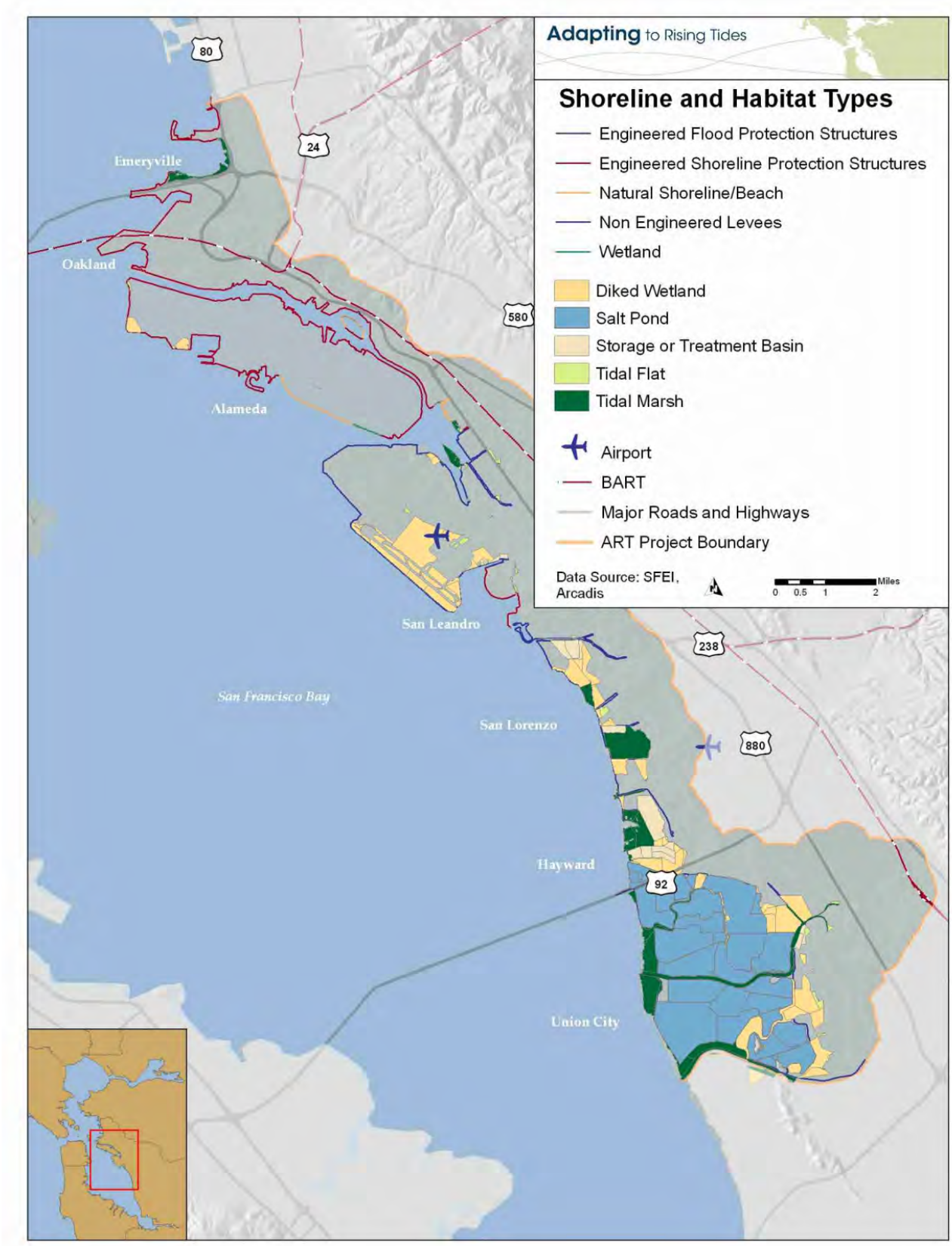
Table 14. Summary of Shoreline Categories

Category		Subcategory	Primary Function	Potential to Inhibit Flooding
1	Engineered flood protection structures	Levees	Protect inland areas from flooding and inundation	High
		Flood walls		
2	Engineered shoreline protection Structures	Bulkheads	Harden the shoreline to reduce erosion and prevent land loss	Moderate-high, not primary function
		Revetments		
3	Non-engineered berms		Protect marshes and ponds from wave erosion, provide flood protection to inland developments, and maintain hydraulic separation between the Bay and protected/managed areas	Moderate
4	Wetlands	Diked wetlands	Dissipate wave energy and provide ecological habitat value	Moderate-low
		Tidal marsh		
		Salt ponds		
		Storage or treatment basins		
5	Natural non-wetland shorelines	Beaches	Some wave energy dissipation	Low

The shoreline categories were mapped onto the project area using various sources of information including data from the San Francisco Estuary Institute's Bay Area Aquatic Resource Inventory (BAARI) and EcoAtlas, the NOAA Environmental Sensitivity Index, the FEMA San Francisco Bay Flood Study, locations and elevations of shoreline structures developed by Alameda County Flood Control, and best professional judgment. In locations with more than one type of shoreline category, e.g., a combination of levee and revetment, the shoreline category with the highest potential to protect against inundation or flooding was reflected on the map.

Arrowhead Marsh in Oakland supports Clapper Rail. Source: www.prbo.org.

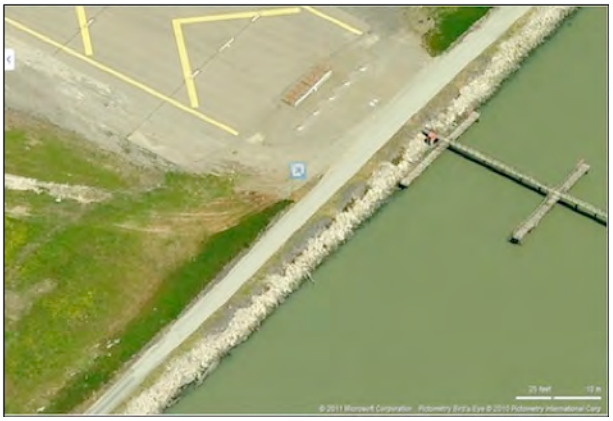
Figure 16. Map of Shoreline and Habitat Types in the ART Project Area



Category 1. Engineered Flood Protection Structures

Levee

Engineered levees are a common type of river and coastal structure that generally provide protection from a 100-year extreme water level that may be accompanied by large, powerful waves. They are designed to meet specific criteria with respect to freeboard (the distance between the levee crest and the 100-year extreme water level with wave run-up), embankment protection, embankment and foundation stability, and settling.



Aerial view of an engineered levee at Oakland Airport. The roadway is located along the levee crest, and the outboard slope (or embankment) of the levee is armored with a riprap revetment that protects the levee from wave-induced erosion.

The protective value of levees depends on the amount of freeboard provided, which may be reduced as sea level rises. Levee embankments can be susceptible to wave erosion, and frequent or infrequent overtopping can result in erosion along the levee crest and the backside of the levee, thus weakening it and increasing the potential for failure.

Most engineered levees are regularly maintained by the agencies responsible for them, and they can be upgraded by increasing the height of the levee crest or the amount of protection on the embankment. Levee upgrades generally result in an increase in the overall footprint of the structure and may not be feasible in all locations. Levees can be combined with other means of flood protection, such as flood walls constructed along the levee crest.

Flood Wall

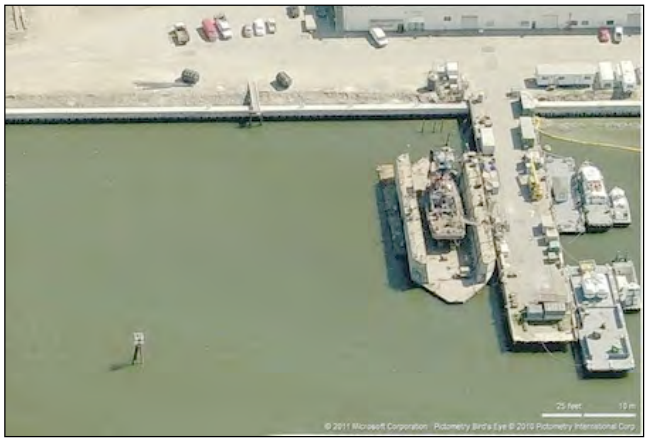
A flood wall is a vertical barrier designed to protect inland areas from flooding. Flood walls are design to meet freeboard and overall stability criteria similar to that for engineered levees. Similar to levees, flood walls require ongoing maintenance and their flood protection value depends on the amount of available freeboard and the structural stability light of settling and wave erosion.

Flood wall at Eden Shores located landward of the Eden Landing Ecological Reserve in Hayward. Outboard of the flood wall is a non-engineered berm with a road on the crest.

in

Category 2. Engineered Shoreline Protection Structure

The primary purpose of engineered shoreline protection structures is to harden the shoreline and reduce land erosion and land loss. Shoreline protection structures may provide some amount of flood protection, but unlike engineered flood protection structures they are not designed to protect inland areas from specific storm events and conditions. In the project area, bulkheads and revetments are the most common types of engineered shoreline protection.



Bulkhead at the Port of Oakland Inner Harbor Turning Basin.

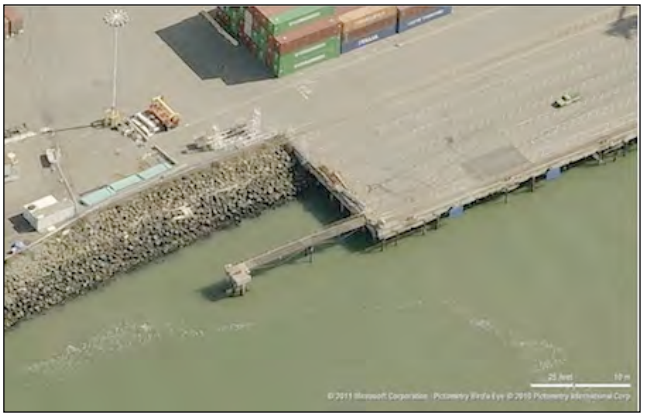
Bulkhead

A bulkhead is a vertical retaining structure that primarily serves to reduce land loss, and secondarily protects inland areas from wave damage. Bulkheads can be cantilevered over the water surface or unanchored shoreline (gravity) structures. They will be susceptible to overtopping as sea level rises and wind wave conditions change.

Revetment

Revetments harden the shoreline, protecting it from waves and strong currents that could cause erosion and land loss. In the project area, revetments are commonly found either alone or in combination with other shoreline types such as engineered levees, non-engineered berms, and wetlands.

Revetments are generally constructed using three components: a stable armor layer of erosion resistant material (such as concrete or riprap), a filter cloth underlayer, and toe of slope protection. However, the presence of shoreline riprap does not always indicate there is a revetment. For example riprap can also be used to protect the side slopes of non-engineered berms. In these cases, riprap has generally been placed in an ad hoc manner to address erosion, and not necessarily in accordance with specific design standards to ensure it will withstand waves and strong currents.



Revetment at Shoreline Park in Alameda (above) and at the Port of Oakland (below).

Revetments are primarily designed to protect the shoreline, but they are susceptible to damage from strong currents and wave conditions that occur beyond the "design" event. For example, the size of riprap used is based on existing wave and current condition. As sea level rises, wave heights and velocities may increase, exposing the revetments to conditions beyond those for which the armor layer was designed. Additionally, increased overtopping could result in a loss of foundation material and undercutting of the toe, potentially causing the entire revetment to become unstable.

Revetments generally require ongoing maintenance. They can be upgraded over time by placing additional armoring sized for increasing wave conditions, the revetment height can be increased, and additional toe protection can be added.

Riprap revetments protecting a non-engineered berm in Hayward (above), and the wastewater treatment plant in San Leandro (below).

Category 3. Non-Engineered Berm

Non-engineered berms are similar to engineered levees in appearance; however, they have not been designed or constructed to meet specific criteria as described above. The most common non-engineered berms in the project area are salt pond berms. These structures are essentially excavated bay mud that has been piled and/or stacked into a mound. The characteristics of salt pond berms around the Bay vary greatly. Along the Bay front, berms tend to be larger because they protect inland areas from waves. Many berms contain maintenance roadways along the crest, and riprap protection on the wave-exposed sections (often consisting of concrete construction debris).

Maintenance of non-engineered berms can be reactive, e.g., when erosion or failures are observed, or proactive, e.g., on a regular cycle based on the wave exposure and the amount of settling that is occurring. Non-engineered berms are not designed to provide flood protection; however, they do help maintain the expansive network of salt ponds and former salt ponds that serve as ad hoc flood protection by providing a substantial buffer between the Bay and inland developed areas.

Maintenance of a non-engineered berm at the Eden Landing Ecological Reserve in Hayward by the Mallard.

Non-engineered berms are susceptible to changes in sea level, wind and wave condition. While the berms can continue to be maintained over time, historically the bay floor directly adjacent to the berm has been excavated and placed on top of the berm. Many of these adjacent borrow pits are already very deep, and this source of material could be exhausted over time, requiring the import of suitable material. Due to the non-engineered nature of these structures, there may also be a maximum height to which the berms can be built and maintained.

Category 4. Wetlands

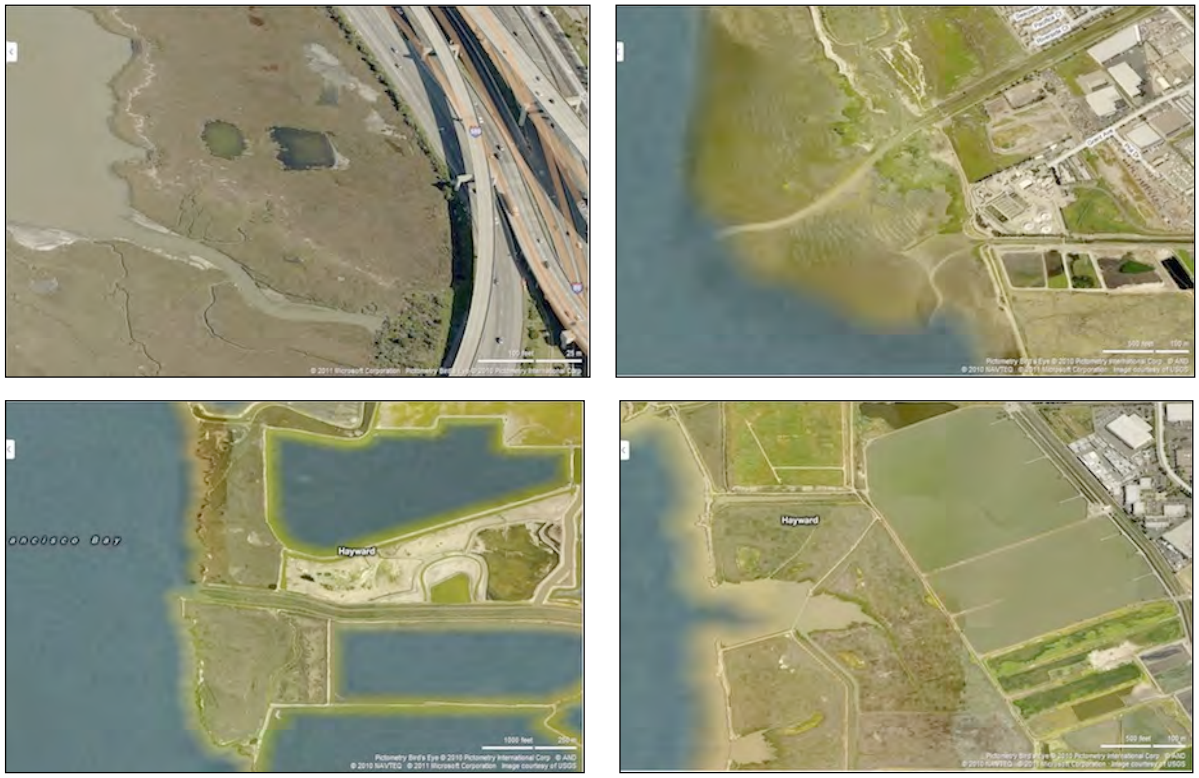
There are several different types of wetlands in the project area, with the majority located in the southern portion of the project areas where the shoreline is less urbanized. Natural and managed wetland resources located in the project area have been classified into four categories based on the Bayland Ecosystem Habitat Goals and using the San Francisco Estuary Institute's Bay Area Aquatic Resource Inventory (BAARI) and EcoAtlas data (see Table 15).

Wetlands in the northern portion of the project area that have a natural marsh edge exposed to the Bay include Arrowhead Marsh in Oakland and the Emeryville Crescent just to the north of the Oakland-Bay Bridge.

In the mid-portion of the study area, at the confluence of San Lorenzo Creek and the Bay, is a complex of wetlands that transition from shallow sub-tidal, to tidal flats, to fringing marsh, to managed marsh up to the inland margin.

In the southern portion of the project area, along the Hayward shoreline in particular, is a complex mosaic of tidal marshes and tidal flats, managed marshes and ponds. The outboard regions of these managed wetlands are generally protected against waves by non-engineered berms; the exception is Whales Tail marsh in the Eden Landing Ecological Reserve, just south of the San Mateo Bridge.

Wetlands are sensitive to sea level rise, storms, and wave conditions. Historically, wetlands have kept pace with rising sea levels, either through the accumulation of inorganic and organic material (horizontal accretion) or by migrating inland (upland transgression). However, as sea level rise accelerates in response to global climate change, wetlands may not have sufficient sediment supply or vegetative productivity to keep pace. If this is the case, and there is little or no access to upland areas for inland migration, tidal wetlands may be inundated and eventually converted to open water.



Wetlands in Emeryville with a natural marsh edge exposed to the Bay (above, left), tidal flat-marsh complex at the confluence of San Lorenzo Creek and the Bay in San Leandro (above, right), Whales Tail marsh at the Eden Landing Ecological Reserve in Hayward (below, left), and managed protected tidal marsh and ponds with an extensive non-engineered berm network in Hayward (below, right).

Table 15. Wetland Categories and Subcategories Used in the ART Project

Wetland Category*,**	Subcategory
Diked wetland—historic tidal marsh that has been isolated from tidal influence by a dike or levee	*Managed marsh*—diked wetland habitat managed for wildlife, primarily waterfowl
	Diked marsh—not actively managed for wildlife, generally seasonal wetlands
Tidal marsh—a vegetated wetland that is subject to tidal action	*High tidal marsh*—occurs between MHHW and the highest margin of the marsh
	Mid-tidal marsh—occurs between MHW and MHHW
	Low tidal marsh—occurs between the lowest margin of the marsh and MHW
	Muted tidal marsh—receives less than full tidal flow due to a physical impediment
Salt pond—large, persistent hypersaline ponds that are intermittently flooded with Bay water	
Storage or treatment basin—diked, perennial shallow or deepwater pond constructed to store or treat runoff, sewage, or industrial discharges	

* Bay Area Aquatic Resource Inventory (BAARI)
** Baylands Ecosystem Habitat Goals

Category 5. Natural Non-Wetland Shorelines

Natural non-wetland shorelines are found in the project area in one notable location, the stretch of shoreline known as Robert Crown Memorial State Beach in Alameda. The beach, which is 2.5 miles long and backed by sand dunes, was constructed on the margin of Bay fill placed to expand Alameda island, and is maintained by nourishment with imported sand and through the use of engineered sand-retaining structures.

Robert Crown Memorial State Beach in Alameda. The erosion-prone shoreline is maintained through nourishment; steep dunes currently protect a local road and bicycle trail (right).

The shoreline beach and dunes provide some protection to the inland area from large waves; however both are already experiencing erosion and require ongoing maintenance and capital improvements. As sea level rises and wave intensity increases, natural shorelines such as the nourished beach in the project area will be extremely susceptible due to increased wave energy and currents, potentially requiring additional maintenance measures or perhaps hardening.

III. Ownership and Management

Structural Shorelines

Structural shorelines, including engineered flood protection, engineered shoreline protection, and non-engineered berms, are owned and maintained by various public and private entities. In the northern portion of the project area, the majority of the publicly owned structural shoreline is owned and maintained by the Port of Oakland (airport and seaport), ACFCWCD, and California Department of Transportation. In the southern portion of the project area the majority of the publicly owned structural protection is owned and maintained by DFG, ACFCWCD, EBRPD, and HARD.

Natural Shorelines

Natural shorelines, including tidal marsh, diked wetlands, former salt ponds, storage/treatment basins, and beaches are mostly owned and maintained by public entities including EBRPD, HARD, DFG, the Port of Oakland, and the City of Hayward (see Figure 17). Below is a list of significant

natural areas found in the project area identified by the entity that either owns or maintains the shoreline.

California Department of Fish and Game (DFG)
Eden Landing Ecological Reserve (ELER)

DFG is actively managing approximately 6,400 acres of former salt ponds at ELER. Efforts are underway to restore the former salt ponds to a mixture of tidal marsh and managed pond habitat. The effort at ELER is part of the South Bay Salt Ponds Restoration Project, which is returning thousands of acres of diked salt ponds throughout the South Bay to tidal action in order to restore essential wetland habitat, provide flood protection, and provide wildlife-oriented public access and recreation.

City of San Leandro, State Lands Commission and Citation Homes
Robert's Landing

Robert's Landing is an area of approximately 475 acres, a portion of which is owned by the City of San Leandro and the State Lands Commission (272 acres) and a portion by Citation Homes (206 acres). Restoration activities at Robert's Landing include the conversion of 172 acres of wetland to muted tidal marsh (Shoreline Marsh Enhancement Project, City of San Leandro and State Lands Commission), restoration of the 95-acre "citation marsh" to a muted tidal regime, a 16-acre compensatory mitigation upland wetland creation area, and an 18-acre upland habitat refugia enhancement for the endangered salt marsh harvest mouse (Citation Homes).

EBRPD—Eastshore State Park
Emeryville Crescent

The Emeryville Crescent is a distinctive and highly visible complex of tide marsh and mudflats. The horseshoe-shaped Crescent is adjacent to I-80, extending from the Bay Bridge Toll Plaza to the Powell Street Interchange and Emeryville Peninsula. The tidal wetlands were enhanced as part of the mitigation required for improvements to I-80. The area supports clapper rails and black rails; has a relatively natural plant community, potentially including two rare or endangered plant species (the soft bird's-beak and Point Reyes bird's-beak); provides habitat to an abundance and diversity of shorebirds; and supports eelgrass beds just north of the Toll Plaza.

EBRPD—Martin Luther King Regional Shoreline
Arrowhead Marsh / Damon Slough

The Martin Luther King Jr. Regional Shoreline is located in the Oakland Estuary at the southern end of San Leandro Bay. The Shoreline sits at the mouths of five major creek systems and has natural and restored wetlands including Damon Slough, Arrowhead Marsh, and Doolittle Pond Wildlife Sanctuary. Arrowhead Marsh is thought to have formed in the late 1860s when sediment was released during the Lake Chabot Reservoir construction and the logging of the San Antonio Forest. In 1998, tidal flow was restored to 71 acres of tidal and seasonal wetlands at Arrowhead Marsh that had been filled in the mid-1980s. The effort resulted in the recolonization of native plants and the return of many species of birds. Thousands of migrating birds have returned to the marsh to rest and feed during the winter. Other species such as avocets, terns, egrets, and the endangered California clapper rail and burrowing owl live at the marsh year round. Restoration of the 9-acre Damon Slough in 2002

enhanced seasonal wetland and shallow pond habitat, improving the area for seasonal foraging and as a refuge for migrating waterfowl and shorebirds.

EBRPD—Robert M. Crown Memorial State Beach

Located along the southwestern shoreline of Alameda Island, Crown Beach is a nearly 2-mile-long artificial public beach. The berm between the beach and Shoreline Drive is a gently sloping sandy habitat that supports native and introduced plants. The beach is located near Crab Cove, a marine reserve where all plant and animal life is protected, and Elsie Roemer Bird Sanctuary, which provides habitat for aquatic, bird, and mammal species. Additionally, just offshore of the beach is a perennial eelgrass bed, a sensitive resource that provides nursery habitat for a variety of juvenile fish and a food source for aquatic birds. The beach has had significant sand loss over the years due to ordinary erosion and damage from severe storms. A major, multi-phased beach restoration project was completed in 1988, and there is a proposed plan to bring in more than 82,000 cubic yards of sand and extend the existing groin that separates the beach from the Elsie Roemer Bird Sanctuary.

EBRPD—Hayward Regional Shoreline

Oro Loma Marsh

Oro Loma Marsh is a 364-acre former diked, degraded marsh that was restored to tidal action in 1997. It is now a complex of tidal marsh, seasonal wetlands, and transitional uplands managed for California clapper rails and salt marsh harvest mice, and to control non-native *Spartina alterniflora* in tidal areas. There are several islands and numerous refugial mounds that provide areas for wildlife nesting and refuge. There are extensive tidal flats outboard of the Bayshore levees that protect the marsh. The levees are from historic salt pond activities and are not built to flood control standards, but they are part of the Bay Trail and the outboard levee has armored slopes that are maintained annually. Also in the marsh is a utility corridor that runs through the middle of the property, and access roads to service numerous utilities that cross the marsh including overhead PG&E transmission lines, underground distribution lines, the East Bay Dischargers Authority 60-inch pipeline, and the abandoned 6-inch Shell Oil Jet Fuel pipeline.

Cogswell Marsh

Cogswell Marsh is a 250-acre site that was restored to full tidal action in 1980. The marsh includes numerous islands for wildlife nesting, is managed for California clapper rails and salt marsh harvest mice, including predator management, and to control non-native *Spartina alterniflora* in tidal areas. Extensive tidal flats outboard of the Bayshore levees protect the marsh. The levees are from historic salt pond activities and are not built to flood control standards, but they are part of the Bay Trail and the outboard levee has armored slopes that are maintained annually.

Hayward Marsh

Hayward Marsh consists of 145 acres of fresh water and brackish ponds that were constructed in 1985. There are five ponds in total, three fresh and two brackish. Fresh water is supplied to the ponds by Union Sanitary District (secondary treated effluent), and the overall system is highly managed as required by a NPDES permit from the Regional Water Quality Control Board. There are a total of 15 islands in the marsh that are managed for waterfowl, shorebirds, and terns, and the marsh is fenced to protect nesting habitat. One of the islands is specifically

managed for California least terns and Western snowy plovers, including predator management activities. The Bayshore levees that protect the marsh are from historic salt pond activities and are not built to flood control standards, but they are part of the Bay Trail and the outboard levee has armored slopes that are maintained annually.

Salt Marsh Harvest Mouse Preserve

The preserve is a 27-acre site that provides critical habitat to the salt marsh harvest mouse. It was enhanced in 1985 and again in 1997 to improve water management. The site includes a muted tidal marsh system controlled by tide gates and culverts, seasonal wetlands, and some transitional uplands. It is hydrologically connected to City of Hayward seasonal wetlands property to the east, which EBRPD is in the process of acquiring. The levees, which were enhanced in 1985, are from historic salt pond activities and are not built to flood control standards.

Hayward Area Recreation Division

Triangle Marsh

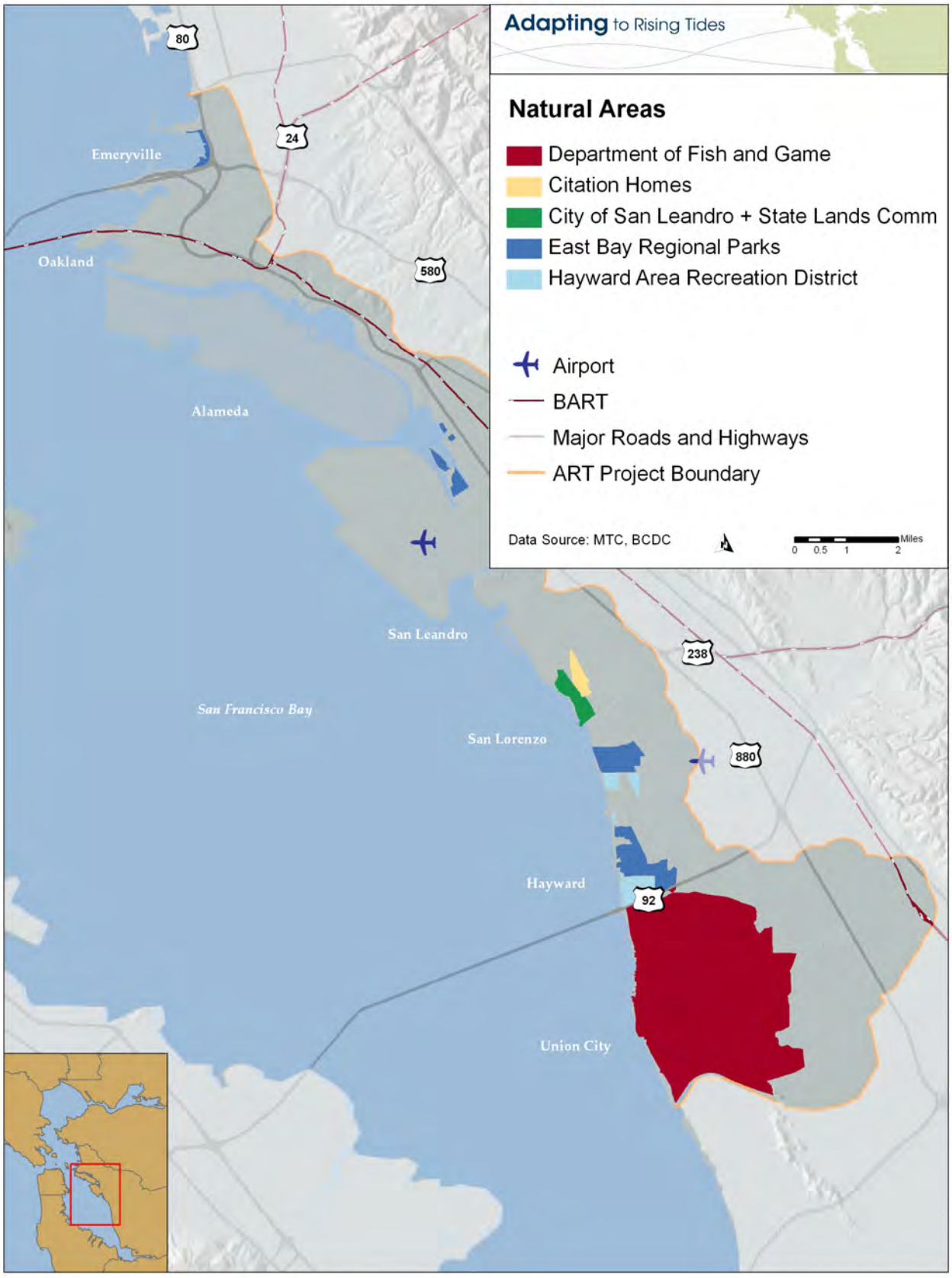
Triangle Marsh is an 8.7-acre site located at the west end of West Winton Avenue, on the north side of a former landfill. Prior to restoration it was partially isolated by levees, a road, and a flood control channel, and much of the marsh contained dead or dying pickleweed most likely due to restricted tidal flow. The site was enhanced to improve biological productivity, habitat diversity, and water quality, and to reduce mosquito breeding and prevent flooding at high tide. Site enhancements were targeted at improving habitat for the salt marsh harvest mice, salt marsh song sparrow, California clapper rail, black rail, and other shorebirds, waterfowl, herons, and egrets. Improvements to the tidal regime at the site and other features have resulted in more vigorous marsh vegetation and use of the site by shorebirds, waterfowl, fish, and macroinvertebrates.

Port of Oakland

Middle Harbor Shoreline Park

Middle Harbor Shoreline Park is located on the site of former salt marshes and shallow tidal wetlands. The Port of Oakland and the U.S. Army Corps of Engineers are working to restore shallow water habitat and provide habitat enhancement, including eelgrass planting in the 180-acre Middle Harbor Enhancement Area that is adjacent to the park. Numerous shorebirds, diving ducks, and sea birds can be seen just offshore of the park. Year-round residents include the Forster's tern, western gull, double-crested cormorant, and brown pelican; summer visitors include the Caspian tern, least tern, California gull, Canada goose, and snowy egret; and winter visitors include the common goldeneye, ruddy duck, bufflehead, scaup, western sandpiper, dunlin, surf scoter, Western grebe, Clark's grebe, and eared grebe.

Figure 17. Map of Natural Shoreline Areas in the ART Project Area



IV. Existing Stressors

Many structural and natural shoreline areas are currently exposed to stressors that can limit their capacity to respond to climate change, in particular to sea level rise. Existing stressors generally include:

- Lack of resources to conduct necessary maintenance, enhancements, and restorations
- Regulatory requirements that create barriers to improving, enhancing, or maintaining shorelines, both structural and natural
- Potentially inadequate sediment supply to maintain natural area accretion rates
- Limited or no access to upland areas for inland migration and historic sea level rise
- Invasive plant and animal species
- Erosion
- Subsidence

V. Equity

Many low-income communities are disproportionally located in low-lying areas that are currently protected from Bay flooding by either structural or natural shorelines. The maintenance and improvement of the protective nature of the shoreline will be critical to those living and working in these low-lying areas that are highly susceptible already to Bay flooding.

VI. Economy

Many of the natural shoreline areas in the project area have either been restored or are being restored/enhanced. The region as a whole has made a significant financial commitment to restoring natural areas around the Bay, and special consideration will be necessary for protecting the unique functions and values they provide (see Table 16).

VII. Governance

Shoreline areas, both structural and natural, are regulated by a variety of state, regional, and federal agencies. These include, but are not limited to:

- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- U. S. Environmental Protection Agency
- National Oceanic and Atmospheric Administration National Marine Fisheries Service
- Federal Emergency Management Agency
- California State Lands Commission
- California Department of Fish and Game
- San Francisco Bay Conservation and Development Commission
- San Francisco Bay Regional Water Quality Control Board
- Alameda County Flood Control and Water Conservation District

Table 16. Natural Area Restoration Projects, Completed and Ongoing, in ART Project Area

Owner/Operator	Location	Name	Acreage	Habitat	Activity	Compensatory Mitigation?
Port of Oakland	Middle Harbor Shoreline Park	Oakland Middle Harbor Restoration Project	4.94	Estuarine	Restored	No
City of San Leandro and State Lands Commission	Robert's Landing	San Leandro Shoreline Marshland Enhancement Project	171.9	Estuarine	Mixed	Yes
Citation Homes	Citation Homes, behind Robert's Landing	Citation Marsh	95.3	Estuarine	Mixed	Yes
East Bay Regional Parks	Eastshore State Park	Emeryville Crescent	50.3	Estuarine	Mixed	Yes
	Martin Luther King Regional Shoreline	Damon Slough Seasonal Wetland Mitigation	9.75	Estuarine	Mixed	Yes
	Martin Luther King Regional Shoreline	MLK New Marsh Restoration	70.6	Estuarine Depressional	Restored	Yes
	Hayward Regional Shoreline	Oro Loma Marsh Enhancement Project	315.29	Estuarine	Mixed	No
	Hayward Regional Shoreline	Cogswell Marsh	229.12	Estuarine	n/a	Yes
	Hayward Regional Shoreline	Hayward Marsh Fresh	85.9	Depressional	Mixed	No
Hayward Area Recreation	Hayward Regional Shoreline	Triangle Marsh at Hayward Shoreline	8.7	Estuarine Depressional	Restored	Yes
	Hayward Regional Shoreline	Hayward Shoreline Enhancement Project—Oliver Salt Ponds	134	Depressional	Restored	Yes
California Department of Fish and Game	Eden Landing Ecological Reserve	Whales Tail	254	Estuarine	Restored	No
	Eden Landing Ecological Reserve	Cargill Mitigation Marsh	49.16	Estuarine	Restored	Yes
	Eden Landing Ecological Reserve	Eden Landing Ecological Reserve Restoration (Baumberg Tract)	835	Estuarine Depressional	Mixed	Yes
	Eden Landing Ecological Reserve	South Bay Salt Ponds Restoration Project	6,300	Estuarine Depressional	Mixed	No
	Eden Landing Ecological Reserve	Ponds E8A, E9, E8X	630	Estuarine	Restored (11/2011)	Yes (partial)

Information in this table is from the California Wetlands Portal at http://www.californiawetlands.net/tracker and the California Department of Fish and Game, Region 3 (Bay Delta).

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10. WASTEWATER FACILITIES

I. Definition

Wastewater is water containing sewage and other wastes from residential, commercial, and industrial sources. It includes water from sinks, showers, washers and toilets, chlorinated pools, commercial car washes, and industrial processes. Wastewater requires treatment to remove pollutants prior to discharge.

Wastewater infrastructure includes collection and conveyance pipes, pump stations, treatment plants, storage and discharge facilities, monitoring stations, and overflow locations. Wastewater infrastructure is owned and operated by either limited purpose agencies (districts) or multipurpose agencies (cities) that provide either a single service—e.g., collection, treatment, or discharge—or a combination of services.

Most wastewater in Alameda County is treated and discharged by the public wastewater system; however, private on-site septic systems are allowed in Alameda County where no public sewer system is nearby. This report does not discuss private on-site septic systems, because the number of systems in Alameda County is relatively low (approximately 1%, or 5,000 households in 2005), with possibly only one system located in the ART project area (at the Monarch Bay Golf Course in San Leandro).

II. Overview of the Public Wastewater System

The wastewater system is an interconnected network of collection, treatment, and discharge infrastructure that is often owned and operated by separate service providers. In the ART project area, all wastewater is handled by at least two separate service providers (see Table 17).

Collection Systems

The wastewater collection systems convey wastewater to the various treatment facilities. The system includes both private sewer lines, known as laterals, and public sewer lines such as mains and interceptors. Laterals connect the plumbing of a home or business to the public system (generally located in the street), and are owned and maintained by individual property owners. The public collection system includes sewer mains, interceptors, and pump stations. Five cities and three districts provide wastewater collection services in the ART project area (see Table 18). EBMUD owns and operates a system of interceptor pipes and pump stations that conveys wastewater from some of the city-owned collection systems in the ART project area (those of Alameda, Emeryville, and Oakland) to EBMUD's treatment facilities. The EBMUD interceptors and pump stations are discussed together with the treatment facilities below.

Table 17. Wastewater Services Providers in the ART Project Area

Community Served	Collection Provider	Treatment Provider	Discharge Provider
Alameda	Alameda	EBMUD	EBMUD
Emeryville	Emeryville		
Oakland	Oakland		
Hayward	Hayward and OLSD	Hayward and OLSD	EBDA
San Leandro	San Leandro and OLSD	San Leandro and OLSD	
San Lorenzo	OLSD	OLSD	
Union City	USD	USD	EBDA and USD

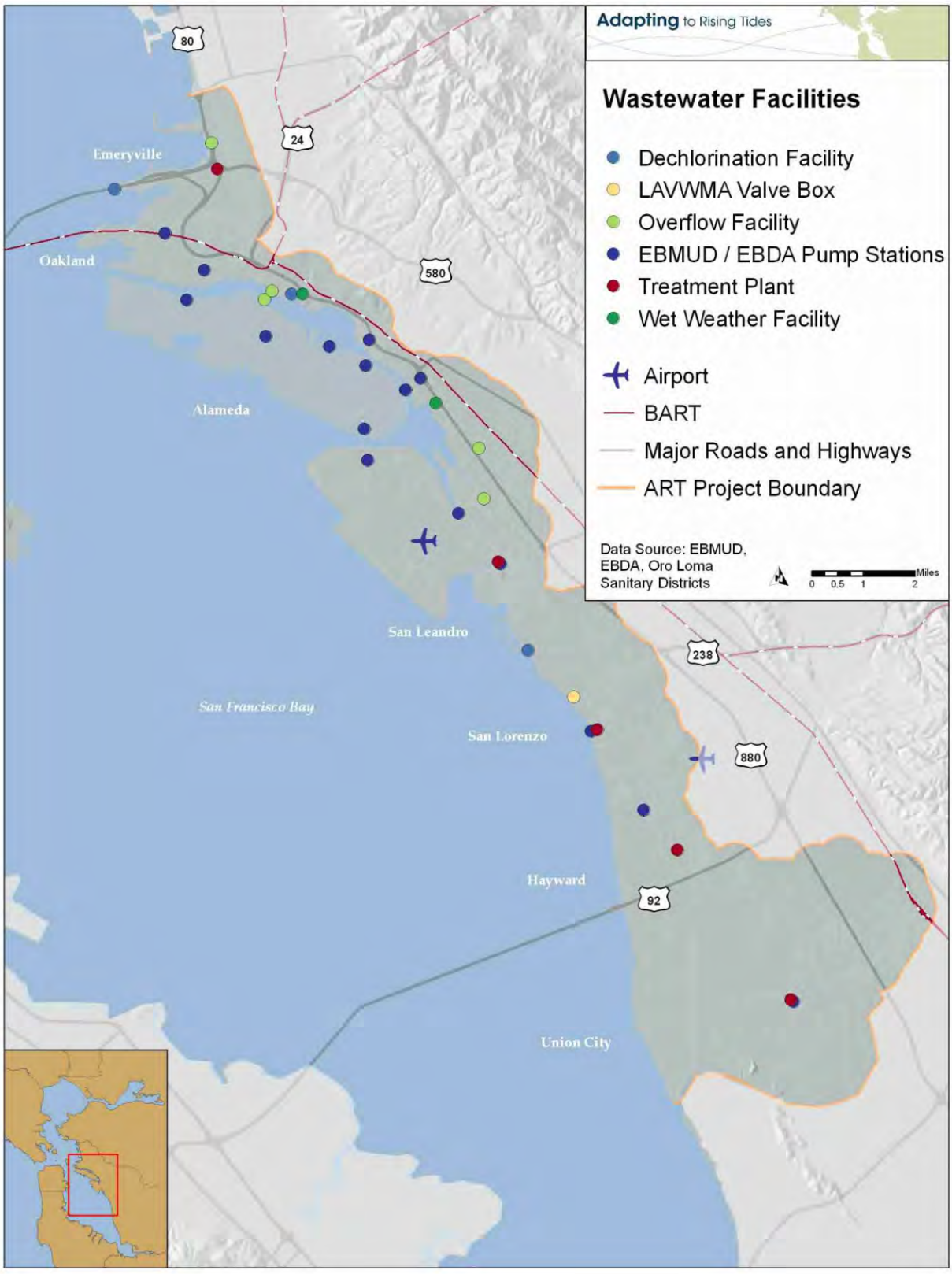
OLSD = Oro Loma Sanitary District
USD = Union Sanitary District

Table 18. Wastewater Collection Systems in the ART Project Area

Agency	Collection Area	Size of Collection Area (square miles)*	Total Connections	Pump Stations	Pipe Miles (public sewer)**
Alameda	Citywide	10.8	20,050	32	136
Emeryville	Citywide	1.2	1,000	1	14
Hayward	Most of city	62	33,000	8	375
Oakland	Citywide	56.1	100,000	7	1,069
San Leandro	Northern 2/3 of the city	8.5 (approx.)	18,500	13	130
OLSD	San Lorenzo, Ashland, Cherryland, and Fairview; portions of Castro Valley, Hayward, and San Leandro	13	46,000 households 11,000 businesses	14	300
USD	Union City, Freemont and Newark	60	110,524	3	760

Source: CIWQS, February 2011 and wastewater district websites (various).
* Square miles of public sewer do not include privately owned sewer laterals.
** Miles of public sewer do not include privately owned sewer laterals.

Figure 18. Map of Wastewater Facilities in the ART Project Area



Treatment Systems

Of the seven wastewater treatment plants in Alameda County, five are within the ART project area (see Figure 18 and Table 19). The two treatment plants outside of the ART project area, the Livermore Wastewater Treatment Plant and the Dublin San Ramon Services District (DSRSD) Wastewater Treatment Plant, both discharge via the Livermore-Amador Valley Water Management Agency (LAVWMA) export pipeline to the East Bay Dischargers Authority (EBDA) discharge system, which is located within the project area. Taken together, the EBDA agencies and LAVWMA serve 953,000 people.

Oro Loma Wastewater Treatment Plant

The Oro Loma Wastewater Treatment Plant is jointly owned by Oro Loma Sanitary District (OLSD, 75%) and Castro Valley Sanitary District (CVSD, 25%). It has a permitted average dry day design capacity of 20 million gallons per day (mgd), and treats an average dry weather flow of 10.95 mgd and a peak wet weather flow of 69.2 mgd. Wastewater is treated to a secondary level by physical, biological, and chemical processes, including screening, grit removal, primary sedimentation, activated sludge, secondary clarification, and chlorination. In wet weather conditions, excess flows can be diverted around the secondary treatment process.

An average of 1.7 million gallons of treated effluent from OLSD is reused monthly to irrigate the Skywest Golf Course. The remainder is transported to the EBDA system for dechlorination and discharge. Sludge is anaerobically digested, dewatered using a belt filter press, and dried in open drying beds. Approximately 11 dry tons of biosolids are recovered per day and safely processed for beneficial reuse.

Alvarado Wastewater Treatment Plant

The Alvarado Wastewater Treatment Plant is owned and operated by Union Sanitary District (USD). It has a design capacity of 33 mgd, and an average dry weather flow of approximately 24.9 mgd and peak wet weather flow of 42.9 mgd. The facility provides secondary treatment for all wastewater generated within the service area, including peak wet weather flows. Secondary treatment includes screening, primary sedimentation, activated sludge, secondary clarification, and chlorination.

Approximately 3 mgd of reclaimed effluent is delivered to the Hayward Marsh, operated by East Bay Regional Parks District. The remainder of treated effluent is transported to the EBDA system for dechlorination and discharge. If flows exceed the capacity of the EBDA pipeline, USD is authorized to discharge treated, dechlorinated effluent to Old Alameda Creek since they do not have a wet weather bypass or overflow. Sludge is anaerobically digested, dewatered using centrifuges, and disposed of at an authorized site.

Hayward Treatment Plant

The Hayward Water Pollution Control Facility is owned and operated by the City of Hayward. It has a permitted design capacity of 18.5 mgd, and peak wet weather flows of 35 mgd.

Secondary treatment is provided for all flows, and includes grit removal, primary sedimentation, flow equalization, trickling filter, solid contact stabilization, secondary clarification, and chlorination.

Treated effluent is transported to the EBDA system for dechlorination and discharge. The City has 240 acres of out-of-service oxidation ponds that can be used for effluent storage in an emergency. Sludge is anaerobically digested, air-dried, and disposed of at an authorized site.

San Leandro Water Pollution Control Plant

The San Leandro Water Pollution Control Plant, which serves the northern two-thirds of San Leandro, is owned and operated by the City. It has an average dry weather flow of 5.5 mgd and peak wet weather flow of 22.3 mgd. Secondary treatment is provided for all flows, and includes grinding, primary sedimentation, trickling filter, activated sludge, secondary clarification, and chlorination.

Approximately 200 million gallons of treated effluent are reclaimed annually for irrigation of municipal golf courses. The remainder is transported to the EBDA system for dechlorination and discharge. Sludge is anaerobically digested, dewatered using a belt filter press, and dried in open drying beds. An average of 4 dry tons of biosolids suitable for reuse are recovered annually.

Treatment and Discharge

East Bay Municipal Utility District (EBMUD)

EBMUD serves an 88-square-mile area with a population of more 650,000. The district receives residential, commercial, and industrial wastewater from seven East Bay communities, including Alameda, Albany, Berkeley, Emeryville, Oakland, Piedmont, and the Stege Sanitary District (El Cerrito, Kensington, and a part of Richmond). The individual agencies that discharge to EBMUD's Interceptor System own, operate, and maintain their own approximately city-owned collection systems that serve approximately178,400 residential, commercial, industrial, and institutional users. EBMUD facilities include a wastewater treatment plant, three wet weather treatment facilities, 15 pumping stations, 29 miles of intercepting sewers, 8 miles of sewer force mains, and three overflow structures.

The EBMUD Main Wastewater Treatment Plant. Source: KQED QUEST. Source: www.flickr.com/photos/kqedquest.

The Main Wastewater Treatment Plant (MWWTP) permitted dry weather design capacity is 120 mgd. The permitted wet weather design flow capacity is 320 mgd, with 320 mgd receiving primary treatment and 168 receiving secondary treatment provides secondary treatment for up to 168 mgd, and primary treatment for up to 320 mgd. The plant treats an annual average dry weather flow of approximately 70 mgd. An on-site wet weather storage basin provides additional capacity for a short-term hydraulic peak wet weather flow of 194 mgd, and has a maximum wet weather capacity of 412 415 mgd. Secondary treatment is provided for all average dry weather flow. Treatment steps include odor control, grit removal, primary clarification, activated sludge, secondary clarification, disinfection, and dechlorination. Treated effluent is discharged through a submerged diffuser adjacent to the San Francisco-Oakland Bay Bridge, more than a mile offshore at a depth of 45 feet. Sludge is anaerobically digested, dewatered, and beneficially reused as a soil amendment through land application or as alternative daily cover at landfills. EBMUD produces Class B biosolids that are collected in an enclosed air-scrubbed hopper located next to the dewatering building at the MWWTP. In 2010, 76,780 wet tons of biosolids were produced and all were beneficially reused as either land-applied soil amendment or as alternative daily landfill cover.

EBMUD also operates three wet weather treatment facilities that provide storage and/or partial blending of primary and secondary effluent during wet weather periods when the flows exceed the secondary treatment capacity at the MWWTP. The Oakport, Point Isabel, and San Antonio Creek Wet Weather Facilities provide additional wet weather capacity of 158 mgd, 100 mgd, and 51 mgd, respectively. The flow to all three facilities undergoes screening, chlorination, and dechlorination. The Oakport and Point Isabel treatment plants also provide sedimentation, and the sedimentation basins at these two facilities allow

EBDA effluent pump station located at the Oro Loma Sanitary District wastewater treatment plant. Source: EBDA, www.ebda.org.

peak wet weather flows to be stored and returned via the interceptor system to the MWWTP for secondary treatment and discharge.

EBMUD also owns and operates three overflow structures within the interceptor system that prevent sanitary sewer overflows in the streets by discharging to the Oakland Inner Harbor or San Leandro Bay when flows exceed the conveyance capacity.

Discharge

East Bay Dischargers Authority (EBDA)

EBDA was formed in 1974 as a JPA. It has five member agencies: the Cities of San Leandro and Hayward, Union Sanitary District, Oro Loma Sanitary District, and Castro Valley Sanitary District. EBDA handles the discharge of wastewater from the communities served by its member agencies (San Leandro, Hayward, Union City, Newark, and Fremont) and from the communities of Pleasanton, Dublin, and Livermore through an agreement with LAVWMA. Overall, EBDA serves a population of approximately 800,000.

Wastewater from EBDA member agencies and LAVWMA are combined and treated at EBDA Dechlorination Facility and then discharged to the EBDA Joint Outfall. The Dechlorination Facility and Joint Outfall were built in 1978 with a design capacity of 189.1 mgd. The outfall pipeline is approximately 7 miles long, with the last 2,000 feet a diffuser section designed to ensure maximum dilution and mixing with deep Bay waters.

Table 19. Summary of Wastewater Treatment and Discharge Facilities in Alameda County

Operator	Facility	Capacity	Year Built
EBDA	EBDA Joint Outfall and Marina Dechlorination Facility	189.1 mgd	1978
LAVWMA*	LAVWMA Export Pipeline (New/Old)	20.2/21 mgd	2004/1979
DSRSD*	Wastewater Treatment Plant	17 mgd	2003
EBMUD	EBMUD Main WWTP	320 mgd	1950s
	San Antonio Creek Wet Weather Facility	51 mgd	1997
	Oakport Wet Weather Facility	158 mgd	1988
	Point Isabel Wet Weather Facility	100 mgd	1993
OLSD	Oro Loma WWTP	20 mgd	1969
San Leandro	San Leandro WWTP	13 mgd	1939
USD	Alvarado WWTP	33 mgd	1981
Hayward	Hayward WWTP	18.5 mgd	1954
Livermore*	Livermore Water Reclamation Plant	8.5 mgd	1958

* Not located within the ART project area.

III. Existing Stressors

There are a number of existing stressors on the wastewater system. Demand due to population and economic growth can stress the entire system if there is limited treatment capacity, lack of system redundancy, and 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.

Dry Weather Demand

During dry weather, the amount of wastewater conveyed, treated, and discharged generally depends on the amount of potable water consumed for indoor uses. Population and economic growth will increase average and peak flows. Water conservation measures can effectively reduce average dry weather flows but have limited impact on pollutant or organic loading factors. In fact, conservation can increase the organic strength of wastewater.

Wet Weather Demand

Although all of the wastewater collection systems in the ART project area are designed to be separate from the stormwater collection systems, wet weather causes increases in wastewater 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. Population and economic growth can increase wet weather flows to the extent that base flows increase, but in many cases the magnitude of I/I entering a sewer system can overshadow increases in base flow due to economic growth.

I/I is a stressor on all sewer systems, but is a much greater issue for older systems, and is highest during or just after heavy rainfall when the ground is saturated. Service providers can reduce I/I by investing in capital improvements such as pipeline rehabilitation, manhole cover replacement, and root eradication; however, I/I sources on private property must also be addressed to reduce the overall system impacts. Within the EBMUD service area, the impact of private sewer laterals on I/I is being addressed through a Regional Private Sewer Lateral (PSL) Ordinance that requires inspections and replacements of private sewer laterals with certain triggers (see www.eastbaypsl.com/eastbaypsl/).

Organic Loading and Pollutants

Organic loading levels depend on the amount of organic matter disposed of. 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 significantly reduce the concentration of these materials coming into the treatment system.

Wastewater discharge permits may limit the strength and contaminant levels in industrial and commercial wastewater; service providers may charge increased rates or surcharges on high-strength wastes; and there may be incentives for industrial and commercial water recycling and reuse.

Location in Relationship to the Current 100-Year FEMA Floodplain

Much of the wastewater infrastructure (including the treatment plants, pump stations, and wet weather facilities) is located along the Bay edge in proximity to the current 100-year FEMA floodplain. The facilities in the ART project area are currently either at an elevation above the existing base flood elevation or have structures protecting them from the flooding. However, the lack of redundancy in systems, and limited opportunity to hold or reroute wastewater if facilities are compromised due to flooding, is an existing stressor that could intensify with climate change.

IV. Existing Plans

All of the wastewater treatment providers in the ART project area prepare a Sewer System Management Plan (SSMP) that describes the activities used to effectively manage the wastewater collection system. In general, the goal of the SSMP is to maintain or improve the condition of the collection system infrastructure in order to provide reliable service into the future, cost-effectively minimize I/I and provide adequate sewer capacity to accommodate design storm flows, and minimize the number and impact of sanitary sewer overflows (SSOs). (Sewer System Management Plan (SSMP) Development Guide. San Francisco Bay Regional Water Quality Control Board in Cooperation with Bay Area Clean Water Agencies. July 2005)

Elements in an SSMP include:

- Collection system management goals
- Organization of personnel, including the chain of command and communications
- Overflow emergency response plan
- Fats, oils, and grease (FOG) control program
- Legal authority for permitting flows into the system; I/I control as well as enforcement of proper design, installation, and testing standards; and inspection requirements for new and rehabilitated sewers
- Measures and activities to maintain the wastewater collection system
- Design and construction standards
- Capacity management
- Monitoring plan for SSMP program effectiveness
- Periodic SSMP audits, periodic SSMP updates, and implementation of program improvements

Only some of the wastewater collection providers have master plans. For example, Alameda, Emeryville, and Oakland do not have wastewater collection plans, although each does have an I/I compliance plan (see Table 20).

Source: www.njfuture.org

Table 20. Status of the Existing Wastewater Facility Plans in the ART Project Area

Service Provider	Wastewater Master Plan	Wastewater Collection Plan	Wet Weather Flow Capacity	Sanitary Sewer Overflow	Other Plans
EBMUD	2000/10 years	Pump station (1998) Interceptor (2008)	Wet weather facilities plan	Included in sewer system management plan (current)	Biosolids (2004), land use (2011), odor control (2009), recycled water (1991)
OLSD	2001/20 years	2003/20 years	Included in WWMP	Included in WWMP	None
USD	1994/20 years	1997 20 years	1999	Included in WWMP	Area plans (1997, 2000, 2004)
Hayward	2001/20 years	2002/18 years	Included in WWMP	Included in WWMP	WPCF Facilities Plan (2001)
San Leandro	1995/5 years	Included in WWMP/5 years	Included in WWMP	Included in WWMP	WPCP facilities plan (2004)
Alameda	None	None	None	Addressed in compliance plan	Infiltration/inflow compliance plan (1985)
Emeryville	None	None	None	None	Infiltration/inflow compliance plan (1985); sanitary sewer inventory (FY 01-02)
Oakland	None	None	None	None	Infiltration/inflow compliance plan (1985)

V. Economics/Jobs

The primary source of revenue for wastewater service providers is service charges. Additional revenue sources include connection fees, property taxes, interest income, agency treatment charges, and miscellaneous fees and rents. Rates for service charges are generally based on the cost of service and are established by each agency's board. Rates are generally not subject to regulation by other agencies or entities, and are often revised annually. There are also opportunities to restructure rates and avoid costs through facility sharing and improved economies of scale.

There are approximately 600 jobs in wastewater in the ART project area. The number of employees varies depending on the size and scope of the services and service area. EBMUD and USD are the largest employers of the wastewater service providers in the ART project area. Approximately 275, or 15% of the EBMUD employees, work in wastewater services, and the EBDA agencies have more than 200 people working in their wastewater collection and treatment departments

VI. Equity

A number of factors can be used to determine if the wastewater service sector is adequately and equitably meeting the needs of the population served. These include the status of regulatory compliance, system integrity and effectiveness, response time to failures/overflows, and rates and connection fees.

Regulatory Compliance

Compliance with regulatory programs depends on a variety of factors, including system age, investment in capital improvements, and ongoing operations and maintenance levels. Much of the wastewater infrastructure in the ART project area is aging with deferred maintenance needs.

System Integrity/Effectiveness

Sanitary sewer overflows are discharges of untreated or partially treated wastewater from pipes, pumps, or manholes. Overflows can pollute surface and groundwater, threaten public health, and affect the recreational use of surface waters. Frequency of overflows generally reflects the capacity and condition of the collection system, as well as the effectiveness of ongoing maintenance.

To improve public access to sanitary sewer overflow information, the State Water Quality Control Board has a Web-based GIS mapping tool showing the sanitary sewer overflows and private lateral spills. The tool allows users to search for and view reported overflows or spills statewide. (For information about overflows, visit: www.waterboards.ca.gov/water_issues/programs/sso/sso_map/sso_pub.shtml; for information on lateral spills, visit: www.waterboards.ca.gov/water_issues/programs/sso/sso_map/sso_priv.shtml.)

Response Time to Failures/Overflows

Official notification is required within two hours of a failure or overflow that results in wastewater release to waters of the United States. Wastewater service providers also have sewer blockage response time policies. Response times are generally very good throughout all of Alameda County, with maintenance crews resolving problems on average within 2.5 hours.

Rates and Connection Fees

Service rates vary among the providers depending on the services, type of treatment, extent of service area, infrastructure age, and ongoing maintenance and capital improvement costs. For all service providers, ongoing operations and maintenance are generally the most significant costs, and these costs tend to be higher for collection providers as compared to treatment providers. Connection fees vary by provider, and are generally charged for expanding or extending infrastructure or accommodating new users. The US EPA defines "reasonable or affordable" rates as water and wastewater rates that are at or below 2% of the median household income for the service area. In 2009, EBMUD rates (including satellite-owned collection system charges) averaged 1.7% of the median household income in the EBMUD service area.

EBMUD has a Customer Assistance Program (CAP) that pays a portion of the water bill for qualified low-income residential customers and eligible homeless shelters. The CAP provides a 50% discount on water bills of households earning up to 214% of the federal poverty line.

VII. Governance/Environment

Governance Framework

EBMUD, OLSD, and USD are limited purpose agencies. Each is an independent special district governed by a publicly elected board. Board members are accessible to the public and open meetings are subject to State sunshine ordinances, including the Brown Act, and are noticed, held with agendas, minutes and staff reports available to the public.

EBDA and LAVWMA are JPAs. EBDA member agencies include the City of San Leandro, the City of Hayward, USD, OLSD, and CVSD. LAVWMA member agencies include the Cities of Livermore and Pleasanton and DSRSD. Each member agency owns an undivided portion of EDBDA equal to the share of the project construction costs paid, and has a discharge capacity allocation (not related to the ownership share). The EBDA Commission is composed of one member and an alternate appointed by each member agency.

All of the cities providing wastewater collection services in Alameda County are multipurpose agencies that hold open elections for their governing bodies, have open meetings subject to State sunshine ordinances, including the Brown Act, and are noticed with agendas and minutes available to the public, and make staff and local officials accessible to the public.

Regulatory Framework

The Clean Water Act (Federal Water Control Pollution Act of 1972) requires all point source wastewater dischargers to obtain and comply with NPDES, including specific wastewater discharge limits and required monitoring and reporting.

Pursuant to the Clean Water Act and California's Porter-Cologne Water Quality Control Act, the Regional Water Quality Control Board regulates wastewater discharges to surface waters, issues NPDES permits to wastewater dischargers, and enforces permit conditions and other requirements. The Regional Board has waste discharge requirements for discharges not subject to NPDES permits; for example, permits are required for wastewater recycled for reuse and wastewater discharged to land, including on-site treatment systems. Discharge permits contain specific requirements that limit pollutants and require monitoring of wastewater, maintenance of treatment facilities, and certification of treatment plant operators. Treatment facilities are routinely inspected and permit requirements enforced by the Regional Board.

The State Water Resources Control Board adopted "Statewide General Waste Discharge Requirements for Sanitary Sewer Systems," Water Quality Order 2006-0003, in May 2006. The order requires public agencies that own and operate more than one mile of pipe or sewer line to develop and implement Sewer System Management Plans and report sanitary sewer overflows. The Sewer System Management Plan documents the program providers use to properly operate and maintain the wastewater system.

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