

June 2017



# Local Hazard Mitigation Plan

San Francisco Bay Area Rapid Transit District



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# 1 Introduction

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Hazard mitigation is a sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. A local hazard mitigation plan (LHMP) identifies the hazards a community or region faces, assesses their vulnerability to the hazards and identifies specific actions that can be taken to reduce the risk from the hazards. The Federal Disaster Mitigation Act of 2000 (DMA 2000) outlines a process which cities, counties, and special districts can follow to develop a LHMP. Development of this plan is a requirement for mitigation benefits from California Governor's Office of Emergency Service (Cal OES) and the Federal Emergency Management Agency (FEMA). Updates to the LHMP are required every five years.

This LHMP (Plan herein) represents an update to the previous 2011 Plan lead by Association of Bay Area Governments (ABAG). Beginning 2016 and forward, the San Francisco Bay Area Rapid Transit District (the District or BART) will prepare its own Plan as opposed to the partaking in a multi-jurisdictional plan. The rationale for this change is due primarily to the discontinuation of the ABAG in leading and implementing a multi-jurisdictional planning process for the region. In addition, given the uniqueness of the District's jurisdiction across multiple counties in the region and as a transit agency, it is advantageous to have a District-specific plan that can be more responsive to the hazards and issues that BART faces.

The District has been part of the multijurisdictional hazard mitigation planning prepared by ABAG for the greater San Francisco Bay Area including the 2005 and 2011 plans. These plans included hazard mitigation planning and strategies for people, cities, utility providers, organizations, and private entities living and operating in the region.

The Plan follows the guidelines outlined in the Local Mitigation Planning Handbook published by FEMA published in March of 2013. The five key elements of the Plan aim to produce a roadmap for identifying and mitigating hazard exposure.

- A. Planning Process
- B. Hazard Identification and Risk Assessment
- C. Mitigation Strategy
- D. Plan Review, Evaluation, and Implementation
- E. Plan Adoption

The scope of this Plan covers the District's jurisdiction, namely, property within BART's Right-of-Way. The Plan acknowledges that coordination with other local jurisdictions as well as members of the community can strengthen and enhance mitigation response.

## 1.1 BART System

BART is a public transportation system serving the San Francisco Bay Area. BART operates five routes on 107 miles (167 km) of line, with 45 stations in four counties. With an average of 423,120 weekday passengers and 126 million annual passengers in fiscal year 2015, BART is the fifth-

busiest heavy rail rapid transit system in the United States. As of 2016, the BART system is expanding to San Jose with the consecutive Warm Springs and Silicon Valley BART extensions.

## 1.2 BART Asset Profile

The Plan conducts the hazard risk assessment and hazard mitigation strategy prioritization on high priority fixed assets. High priority fixed assets in the Plan assessment include the following facilities:

- **Passenger stations** - There are currently 45 stations in the existing system. There are three basic types of station construction – aerial, at-grade, and subway. The stations are further classified between center platforms (located between tracks), and external platforms (located on the outside of the two tracks). The addition of Warm Springs station will make a total of 46 in the system.
- **Substations** – substations provide traction power used for vehicle propulsion. Traction power is stepped down from 34.5 kV AC to 1 kV DC and sent to the electrified third rail system mounted outside of and in parallel with the running rails.
- **Switching Stations** – These stations are the receiving points for high voltage power from the electric utility. The switching stations convert the power to 34.5 kV AC and distributed to substations.
- **Train Control Rooms** – These rooms house the automatic train control system equipment. The system provides vital train functions including train detection, speed control and switch machine operations. The system also provides non-vital train functions including platform functions, automatic route requests, and communication with operations control center.
- **Shops/Yards** – BART has four yards: Daly City, Hayward, Concord, and Richmond. The yards provide dispatching of trains for revenue service; train storage during non-revenue and off-peaks periods; and train washing and cleaning. BART has four shops co-located with the yards for repair and maintenance of train cars. A fifth shop in Oakland provides maintenance of non-revenue vehicles.
- **Ventilation Structures** – These structures provide ventilation for underground assets.
- **Emergency Exits** – These exits/entrances provide for safe evacuation in emergencies and are located throughout our system and right of way

BART prioritizes its assets (e.g. criticality) based on the impact of an asset failure on reliable and safe service capabilities. BART has defined the following priority ratings:

High Priority – Failure results in immediate impact to service capabilities, or shutdown of, any single or multiple operations or systems. This failure will prevent service to the public due to operational, safety, or environmental issues. Asset(s) assigned this priority typically will have no

redundancy and identified issues must be addressed immediately to meet District goals. All protective devices without back-up systems are included in this priority.

Medium Priority – Failure results in a limited impact to service capabilities, or shutdown of, any single or multiple operations or systems. Assets(s) assigned this priority may have redundancy or established by-pass equipment or systems but may limit the service schedule. Although this asset(s) could become highly critical if the redundancy or by-pass fails, identified issues should be planned and scheduled with a higher work order priority. All protective devices with back-up systems are included in this priority.

Low Priority- Failure has no impact to service capabilities. Some of these assets may have the maintenance strategy of run-to-fail associated with them, while others may require issues be addressed in a timely manner through the normal Planned Work flow process.

As of June 2015, The District reports cost of capital assets at \$7.1B including land and easements; stations, track, structures and improvements; buildings; revenue transit vehicles; other; and construction in progress.

## 2 Planning Process

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### 2.1 Overview

This section outlines the efforts undertaken in the preparation of the Plan and process taken. The Plan will be integrated within BART’s existing planning mechanisms, including emergency preparedness mitigation and planning efforts and/or strategies. Additionally, the plan will inform capital improvement programs and project planning.

### 2.2 Schedule

The following Table 1 summarizes the key planning activities and dates carried out by the Core Administrative Team with various District staff and consultant support.

Table 1: Activity Schedule

Date	Activity
4/15/2015	Kick off Meeting; identify responsibilities
4/16/2015	Attended ABAG Planning Workshop, Redwood City
Apr to May	Review existing documents including the Plan, District plans; Update goals; develop engagement strategy; develop capability assessment and critical facilities list;
4/30/2015	Emergency Preparedness Task Force Meeting 1

<b>May to Aug 2015</b>	Develop hazard profiles and GIS maps; vulnerability assessment
<b>8/11/2015</b>	LHMP Webinar
<b>8/11/2015</b>	Title VI Meeting 1 – Hazards Impact
<b>Aug to Nov 2015</b>	Develop mitigation strategies and prioritization method
<b>10/27/2015</b>	El Nino Planning Meeting
<b>12/2/2015</b>	Emergency Preparedness Task Force Meeting 2
<b>12/7-12/11/2015</b>	Review of LHMP Comments with Cities and Counties (OES)
<b>12/14/2015</b>	Title VI Meeting 2 – Mitigation Strategies
<b>12/14/2015-1/22/2016</b>	Consultant compile and draft Plan
<b>12/16/2016</b>	ABAG El Nino Workshop – Identify Mitigation Strategies
<b>1/22/2016-1/29/2016</b>	Core Administrative Team Review
<b>2/1/2016-2/5/2016</b>	Plan Revisions
<b>2/8/2016-2/26/2016</b>	Public comment period; LHMP posted on bart.gov and send to neighboring jurisdictions
<b>2/29/2016-3/4/2016</b>	Incorporation of public comments
<b>3/4/2016</b>	Submittal to CalOES/FEMA Review
<b>Winter 2016/Early 2017</b>	Board Adoption

### 2.3 Existing Document Review

The following existing documents were reviewed and incorporated into the Plan.

Table 2: Document Review List

<b>Study/Plan/Reports</b>	<b>Key Information</b>
<b>ABAG, Bay Area Risk Landscape Draft Report</b>	Hazard characterization
<b>ABAG, Disasters Affecting the San Francisco Bay Area, Federally Declared</b>	Declared disasters

<b>Study/Plan/Reports</b>	<b>Key Information</b>
<b>Disasters 1950-2015, State Declared Disasters 1950-2012</b>	
<b>ABAG, Policy Agenda for Recovery, March 2015</b>	Resiliency information
<b>ABAG, BCDC, Stronger Housing Safer Communities, Strategies for Seismic and Flood Risks, March 2015</b>	Hazard mitigation strategies,
<b>BART, Capital Needs Inventory 2015</b>	Mitigation strategies
<b>BART, Strategic Asset Management Plan, June 2015</b>	Asset information, criticality
<b>BART, Strategic Plan, 2008</b>	District goals
<b>BART, Total Annual Exits FY1973-FY2016</b>	Ridership data
<b>BART Emergency Plan, Vol. I, II</b>	Threat and Risk Information
<b>BART Hazardous Materials Business Plan</b>	Information about 89 BART facilities containing chemicals above the State reporting threshold
<b>BART Spill, Prevention, Control and Counter Measures Plan</b>	Oil Containing BART facilities above the Federal reporting threshold
<b>USGS San Francisco Bay Area Maps</b>	Tsunami and Inundation Maps
<b>CalOES, California Multi-Hazard Mitigation Plan 2013</b>	Hazard mitigation strategies, hazard information
<b>FY 2015 Annual Financial Report</b>	Financial Information
<b>USGS, Overview of the ARKStorm Scenario, Report 2012-1312</b>	Atmospheric rivers

## 2.4 Core Administrative Team

In early 2015, the District formed a Core Administrative Team tasked with updating the Plan. The team members include:

- Norman D. Wong, Environmental Engineer, Office of District Architect



- Marla Blagg, Emergency Manager, Office of the Police Chief, BART Police Department
- Tracy Johnson, Group Manager, Civil/Structural Engineering & Construction

Together, the administrative team is responsible for coordinating the planning process, updating and addressing all sections of the Plan based on the internal and external feedback. Key efforts carried out by the Core Administrative Team include but are not limited to:

- Participation in ABAG LHMP workshops
- Review of progress since the last Plan update
- Review of existing District plans
- Identification of critical assets
- Hazards identification and risks assessment
- Mitigation strategies development
- Engagement with the Core Planning Teams:
  - Emergency Preparedness Task Force Committee
  - Title VI Environmental Justice Advisory Committee
- Engagement with community in the planning process
- Solicitation and incorporation of feedback from external stakeholders and the public

## 2.5 Core Planning Teams

There were two Core Planning Teams invited to participate in the Plan development and planning process. The first Core Planning Team is an existing Task Force Committee called the Emergency Preparedness Task Force Committee (EPTFC). The second Core Planning Team is the Title VI/Environmental Justice Advisory Committee. The Plan could not be successfully developed without the inclusion of these teams.

Engagement discussions and comments received from the Core Planning Teams were incorporated into the final Plan submitted to the CalOES/FEMA.

## 2.6 Internal Engagement

### 2.6.1 Emergency Preparedness Task Force Committee (EPTFC)

The Emergency Preparedness Task Force Committee (EPTFC) serves as a steering committee to the District's Emergency Preparedness Program. They assisted the Core Administrative Team in plan evaluation and decision making. Functions of the EPTFC include:

- Advise, approve, and endorse plans
- Provide subject matter expertise in regards to preparedness, training, prevention, mitigation, response and recovery strategies for district restoration of critical infrastructure and essential services
- Peer Review Emergency Plan and Local Hazard Mitigation Plan
- Act as a working group on preparedness projects and/or activities

- Facilitate and promote preparedness and mitigation strategies
- Adopt and promote emergency preparedness policies and procedures

The committee is representative of all departments in BART and participants are senior managers from the following departments:

- System Safety
- Office of Civil Rights
- Chief Information Officer
  - GIS Mapping Program (EGIS)
- Office of External Affairs
  - Government and Community Relations
  - Communications
- Operations
  - Maintenance and Engineering
  - Transportation Operations
  - System Service
  - Rolling Stock & Shops
  - Operations Planning
- BART Police
  - Security and Emergency Preparedness Program
  - Operations/Support Services
- Administration and Budget
  - Customer Access
- Employee Relations
  - Human Resources
  - Labor Relations
- Planning Development & Construction
  - Earthquake Safety Program
  - Property Development & Real Estate

The goal of engaging the EPTFC was to understand existing efforts and gain direction on appropriate future action in their area of operation and expertise.

The Core Administrative Team held two engagements with the EPTFC. The EPTFC were notified through electronic meeting invitation.

#### Engagement 1 (April 30, 2015)

The Core Administrative Team introduced the need for the Plan and update. The Core Administrative Team provided plan overview identifying team members, deliverables, deadline, and role of the EPTFC. The goal of the engagement was to gain work approval and identify resource needs for the Plan update.

#### Engagement 2 (December 2, 2015)

The EPTFC met to identify and prioritize appropriate mitigation strategies for the Plan. Representatives from each department were responsible for communicating existing efforts and thoughts on appropriate future risk mitigation actions in the hazard area of their expertise. In addition, the draft mitigation strategies prepared by the Core Administrative Team following regional plans were forwarded to other responsible departments for comment.

The goal of the meeting was to review and prioritize the draft mitigation strategies for the five year plan period. The EPTFC provided valuable input in relation to existing programs to continue, critical issues to be addressed, urgent facility upgrade priorities and existing capital improvement programs. Input received through this engagement process was incorporated into the final Plan submitted to the CalOES.

## **2.7 External Engagement**

### **2.7.1 ABAG/BCDC LHMP Coordination**

BART engaged in three workshops supported by ABAG and BCDC in aiding communities in updating or developing hazard mitigation plans. The workshops provided key resources and guidance in the Plan update.

### **2.7.2 Title VI/Environmental Justice Advisory Committee**

The Title VI/Environmental Justice Advisory Committee consists of members from community-based organizations that represent Title VI and Environmental Justice populations within the BART service area. The Committee serves as a forum for public participation for the District on issues related to its Environmental Justice and Title VI Programs. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Title VI of the Civil Rights Act of 1964, prohibits discrimination based on race, color or national origin in programs or activities which receive federal financial assistance. The Title VI Advisory Committee holistically represents the District's jurisdiction by being reflective of the community served, both demographically and geographically. The Committee encourages the full and fair participation of minority and low-income populations in the District's transportation decision-making process.

The advisory committee was selected as an ideal and primary means for community engagement because minority and low-income populations are disproportionately more sensitive to natural disasters than other populations. The following are the community-based organizations represented on the Title VI/Environmental Justice Advisory Committee:

- Alameda County Office of Education
- Asian Pacific Environmental Network
- Center on Race, Poverty, and the Environment
- Communities for a Better Environment
- Girls Inc. Of Alameda County

- Office of Mayor Edwin M. Lee – Hope SF Initiative
- Richmond Main Street Initiative
- Satellite Affordable Housing associates
- The Unity Council
- TransForm
- Trinity Lutheran Church-Alameda
- Urban Habitat BCLI Alumni
- West County Toxics Coalition

Hosted by the Office of Civil Rights, BART engaged in two advisory meetings with the Committee. The Committee was notified through email with agenda. These meetings were held on:

#### Engagement 1 (August 11, 2015)

The Core Administrative Team introduced the purpose and goals of the Plan. The Core Administrative Team provided an overview identifying hazards and exposure to the BART system. The goal of the engagement was to gain feedback on plan process and hazard identification.

#### Engagement 2 (December 2, 2015)

The Core Administrative Team introduced the mitigation strategies of the Plan and solicited public comment on the BART mitigation strategy selection process. Participants could identify potential new strategies and areas of concern.

In addition, the proposed mitigation strategies were distributed to the community through the Title VI mailing list for feedback.

Input received through this engagement process was incorporated into the final Plan submitted to the CalOES.

See Appendix B for meeting agendas and sign-in sheets.

### **2.7.3 Local Cities and Counties**

The Core Administrative Team solicited input via email correspondence on the draft Plan from the following agencies and personnel.

- Alameda County, Technical Services Department, Architect
- Contra Costa County, Emergency Services Division, Senior Emergency Planner
- San Francisco County, Department of Emergency Management, Senior Emergency Planner
- San Mateo County, Office of Emergency Services, Director of Emergency Services
- City of San Leandro, Emergency Services Specialist
- City of Emeryville, Human Resources, Management Analyst
- City of Oakland, Director of Emergency Services
- City of Berkeley, Office of Emergency Services, Emergency Services Coordinator

Solicited input was incorporated into the final Plan submitted to the CalOES.

#### **2.7.4 Public Comment**

The Core Administrative Team solicited public comment on the Plan through posting of the draft Plan on the BART.gov public website. A dedicated webpage was made for the Plan update. The webpage can be found with the following URL.

<http://www.bart.gov/content/local-hazard-mitigation-plan-update>

The draft Plan was posted on the BART website in February 2016 for three weeks for public comment. Announcements were made to the public through news announcement. No feedback was received through this process.

See Appendix B for website screenshot and news announcement.

#### **2.8 Plan Maintenance**

The Core Administrative Team, as identified in Section 2.4, will be responsible for annual evaluation and determination of update needs. The Core Administrative Team will meet on the anniversary of the Plan adoption for review and will recommend updates, if any, to the EPTFC, as identified in Section 2.6.1, for approval. The EPTFC will ensure that monitoring of this plan will occur such that the status of each Mitigation Action is recorded. This monitoring will be on an on-going basis undertaken by the Core Administrative Team responsible for development of the Plan.

Necessary public participation in the plan maintenance process will be held at public board meetings and/or using existing community groups such as the Advisory Committee with the Office of Civil Rights.

## 3 Hazard Identification and Risk Assessment

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### 3.1 Hazard Exposure

Hazard exposure mapping was performed by the District's EGIS department using geographical information system (GIS) tools. GIS exposure mapping was performed for seven hazards having potential to threaten the BART system. These included Earthquakes, Tsunamis, Landslides, Flood, Sea Level Rise, Wildfire, and Drought. Hazard exposure evaluation assessed exposure levels of the hazard to BART high priority assets. Under each hazard scenario, high priority assets were identified for high exposure areas. Refinements in the assessment can be made in future updates to incorporate site-specific information about existing protections, hazard sensitivity, and adaptive capacity.

Overall, the main hazard of concern to BART facilities are related to earthquakes, followed by flooding. This is based on both the asset exposure mapping information and institutional understanding and past performance of the high priority assets to the hazards examined.

The BART service area has experienced several disasters over the past decades, including earthquakes, floods, droughts, wildfires, energy shortages, landslides, and severe storms. The most significant disasters impacting the District were the Loma Prieta earthquake and the East Bay Hills Firestorm. Events such as these when left unmitigated can diminish BART's ability to provide safe, reliable, quality transit services for the community. Diminished levels of BART service would have severe implications for the community. Passengers who shift from BART to private automobiles due to poor service would exacerbate congestion on highways that are already at capacity. A reduction in BART riders and increase in automobile users would further increase vehicle miles travelled, leading to greater greenhouse gas emissions, air pollution, and respective losses in the region's economic and environmental health.

### 3.2 Earthquake

Type: Earthquakes occur when two tectonic plates slip past each other beneath the earth's surface, causing sudden and rapid shaking of the surrounding ground. Earthquakes originate on fault planes below the surface, where two or more plates meet. As the plates move past each other, they tend to not slide smoothly and become "locked," building up stress and strain along the fault. Eventually the stress causes a sudden release of the plates, and the stored energy is released as seismic waves, causing ground acceleration to radiate from the point of release, the "epicenter."

Additionally, earthquakes are often not isolated events, but are likely to trigger a series of smaller aftershocks along the fault plane, which can continue for months to years after a major earthquake, producing additional damage.

The energy released in earthquakes can produce five different types of hazards:

- Fault rupture

- Ground shaking
- Liquefaction
- Earthquake-induced landslides
- Tsunamis and seiches

**Location:** Major faults cross through all nine Bay Area counties. Every point within the Bay Area is within 30 miles of an active fault, and 97 of the 101 cities in the Bay Area are within ten miles of an active fault. Figure 1 shows the location of active faults relative to the BART system.

Most of BART facilities are in areas with potential for high shaking potential. This is the major reason earthquakes pose the largest threat to much of BART's system and require the bulk of existing and planned hazard mitigation efforts. In terms of ground failure, associated with earthquakes, 32 assets are identified in very high liquefaction susceptibility zones.

**Extent:** Figure 2 shows the 10% probability of shaking level over the next 50 years. The BART system is in a Modified Mercalli Intensity (MMI) scale of 8 (Destructive) or 9 (Ruinous). The following are short descriptions of the MMI levels shown in the figure.

MMI 8 - General panic. Damage to masonry buildings ranges from collapse to serious damage unless modern design. Wood-frame structures rack, and, if not bolted, shifted off foundations. Underground pipes broken.

MMI 9 - Poorly built structures destroyed with their foundations. Even some well-built wooden structures and bridges heavily damaged and needing replacement. Water thrown on banks of canals, rivers, lakes, etc.

**Probability:** A powerfully damaging earthquake like the 1906 earthquake or 1989 Loma Prieta earthquake is rare but likely to occur in the next 30 years. The United States Geological Survey (USGS) estimates there is a 72% chance of one or more magnitude 6.7 or larger earthquakes in the next 30 years on one of the Bay Area's faults.<sup>1</sup> Smaller magnitude earthquakes are more likely to occur, potentially producing significant local damage, as experienced in the 2014 South Napa earthquake

Scientists continually study which Bay Area faults are more likely to produce large earthquakes, and how often. In March 2015, the USGS released an update to its 2008 earthquake probabilities for California faults. The Uniform California Earthquake Rupture Forecast 3 (UCERF3) provides detailed assessment on the likelihood of each fault segment producing M6.7, M7.0 and M8.0 and greater earthquakes. These probabilities are based on data such as fault length; how much energy the faults release annually through fault slip; and, known historical return periods for the fault. The faults with the four highest probabilities to produce a M6.7 earthquake over the next 30 years include San Andreas (33% probability), Hayward (28% probability), Calaveras (24% probability), and Hunting Creek/Berryessa/Green Valley/Concord (24% probability).

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<sup>1</sup> Field, E.H., et al, (2013)

Climate Change: Climate change is not expected to affect the seismic hazard.

### 3.2.1 Potential Impacts

In 2000, the District hired a team of consultants led by Bechtel Infrastructure and HNTB to evaluate all the facilities and components in the BART system. Completed in 2002, the Seismic Vulnerability Study was the most comprehensive evaluation of BART facilities since original construction of the system. It involved one and one-half years of engineering and statistical analyses, which included developing scenario earthquakes, computer models, damage predictions, upgrade options, and cost-benefit analyses. The study also incorporated new information from the 1994 Northridge, California and 1995 Kobe, Japan earthquakes.

The original system, consisting of 34 stations and 74 miles of track, was designed to criteria that were considered conservative at the time. However, lessons learned from subsequent earthquakes, including more knowledge about seismicity and behavior of structures, led BART to believe that the system had vulnerabilities that needed to be mitigated. The evaluation contained in the BART Seismic Risk Analysis Report and BART System Wide Seismic Vulnerability Study Report confirmed that the system and specific facilities/components in the original system were vulnerable to damage that would leave the system with significant life safety and operability impacts. The original BART system, completed between 1972 and 1976, has a service area spanning three Counties-Alameda, Contra Costa and San Francisco. System extensions, built mostly during the 1990s, employed more stringent and up-to-date seismic criteria than the original system, and thus do not require upgrades.

Since the formation of the Earthquake Safety Program (ESP), the District has made extensive progress in reducing the potential seismic impacts. See Section 4.3 under existing programs.

Vulnerability Summary: All high priority assets identified in the Plan are exposed to the seismic hazard. The types of assets include all those described in Section 1.1 BART Asset Profile. Key issues will be completing scoped seismic retrofit work.

### 3.2.2 Financial Impacts

Earthquake scenario studies, including but not limited to the San Andreas magnitude 8.0 and the Hayward magnitude 7.0, were used to assess the impact of likely earthquakes on the life safety and operability performance of the system, and to develop cost/benefit information of various retrofit packages as part of the Seismic Vulnerability Study Report. It was determined that it is not practical or economically feasible to retrofit to a “damage-proof” level. Thus, focused emergency response, inspection and repair plans/procedures are being developed to help expedite restoration of service, and a comprehensive seismic retrofit program for the original BART system was put underway.

Results of the Seismic Vulnerability Study indicated that if the BART system is not strengthened, it would take years to restore service after a major earthquake. The study found that portions of the system most susceptible to earthquake damage include the Transbay Tube, aerial structures,



stations and equipment. The study recommended that priority be given to the Transbay Tube, where soil backfill is prone to liquefaction.

BART generated estimates of potential dollar losses due to four earthquake scenarios. Estimates of direct capital losses to overhead and at-grade trackways, the Transbay Tube, the Berkeley Hills tunnel, stations, buildings, systems and equipment due to faulting, shaking, liquefaction, and landslides are provided below. Damage to specific components, and loss by type of component was also determined.

- Hayward Fault – Magnitude 7 - \$1.1B
- San Andreas Fault – Magnitude 8 - \$860M
- Calaveras Fault– Magnitude 6.8 - \$260M
- Concord Fault – Magnitude 6.8 - \$250M

The financial impact estimates have not been updated since Earthquake Safety Program began.

**BART** **LHMP: Faults & Alquist Priolo Zones**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016



Figure 1 Fault Zones

**BART** LHMP: Probabilistic Seismic Hazard Assessment (Shaking Hazard)  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

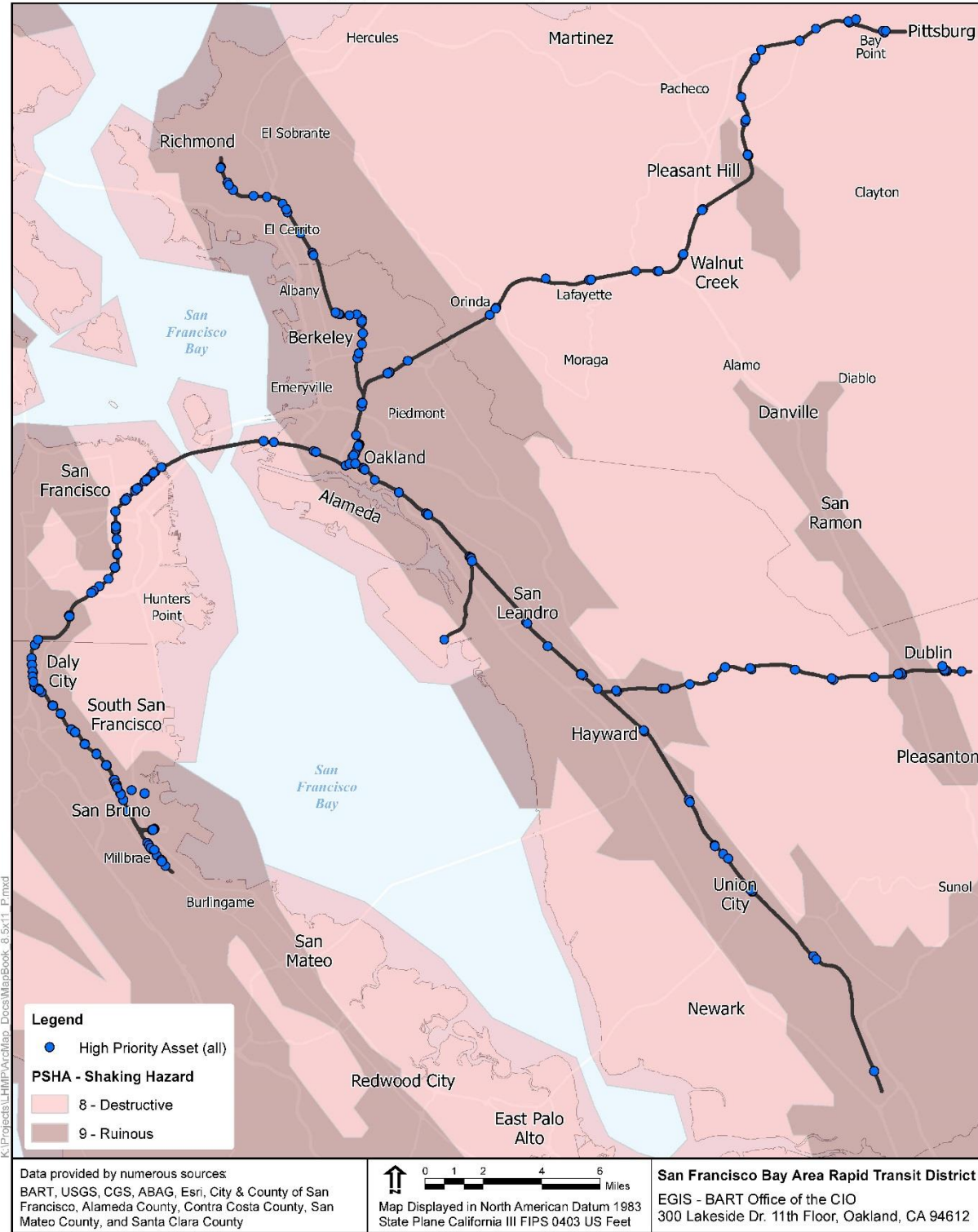


Figure 2 Shaking Zones

**BART** **LHMP: Liquefaction Susceptibility**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

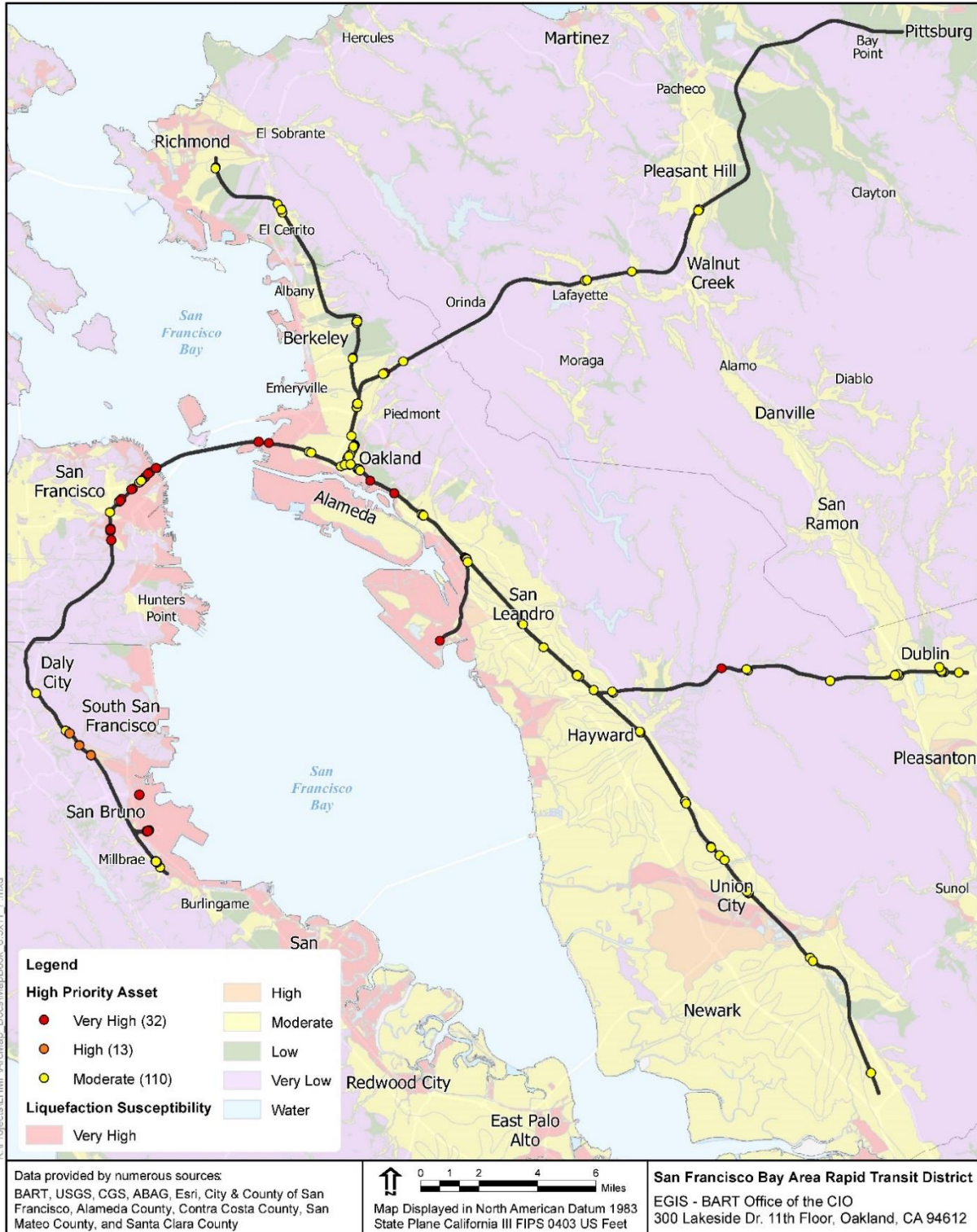


Figure 3 Liquefaction Zones



### 3.2.3 Historical events

#### 3.2.3.1 Napa Earthquake (August 2014)

A 6.0 magnitude earthquake struck the Bay Area on August 24, 2014. The event, localized approximately six miles southwest of Napa Valley, caused an estimated \$360 million in damages and resulted in over 200 injuries, including one fatality. Napa Division Fire Chief John Callanan stated that the event triggered six major fires. While this earthquake was not in our service area, it is noted that our Earthquake Early Warning System detected the earthquake. BART's earthquake early warning system provided up to 10 seconds of notice prior to the event, which would have allowed any moving trains enough time to stop and/or slow down, preventing derailments, injuries and deaths. Given the time of the earthquake (3:20 AM) no trains were in operation and no action was necessary by BART. No earthquake-related disruptions were identified, demonstrating progress by BART's extensive seismic retrofit program.<sup>2</sup>

Figure 4 illustrates the extent of shaking felt in and around the Bay Area. The United States Geological Service estimated that some 15,000-people experienced severe shaking, 106,000 persons felt very strong shaking and another 176,000 felt strong shaking.

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<sup>2</sup> <http://sfappeal.com/2014/08/barts-earthquake-early-warning-system-could-have-broader-applications/>

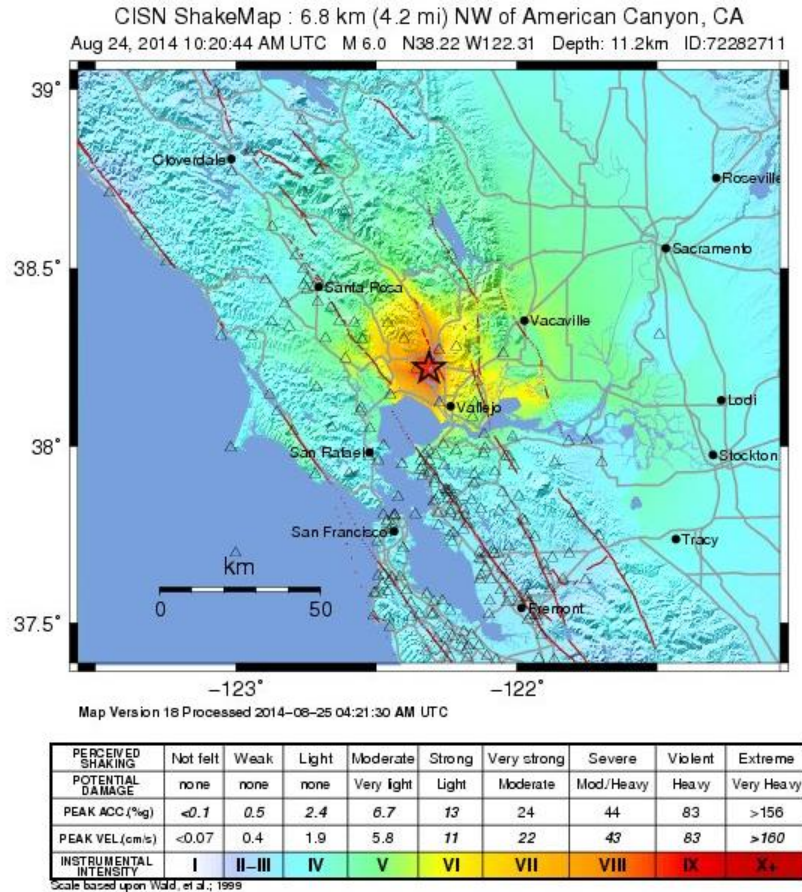


Figure 4 August 2014 earthquake shake map illustrates reach of shaking

### 3.2.3.2 Loma Prieta Earthquake of 1989

The Loma Prieta Earthquake of 1989 is an example of the kind of large-scale disaster which could strike the Bay Area. The event killed 63 persons, injured 3,757, and displaced over 12,000 persons. With over 20,000 homes and businesses damaged and over 1,100 destroyed, this quake caused approximately \$6 Billion of damage.

BART's success in maintaining continuous service directly after the 1989 Loma Prieta earthquake reconfirmed the system's importance as a transportation "lifeline." While the earthquake caused transient movements in the Tube there was no significant permanent movement and BART service was uninterrupted except for a short inspection period immediately following the quake. With the closure of the Bay Bridge and the Cypress Street Viaduct along the Nimitz Freeway, BART became the primary passenger transportation link between San Francisco and East Bay communities. Its average daily transport of 218,000 passengers before the earthquake increased to an average of 308,000 passengers per day during the first full business week following the earthquake.

### 3.3 Tsunamis

Type: Large underwater displacements from major underwater earthquake fault ruptures or landslides can lead to ocean waves called “tsunamis.” Since tsunamis have high velocities, the damage from a level of inundation is far greater than in a normal flood event. Similarly, water sloshing in lakes during an earthquake, called “seiche,” is also capable of producing damage.

Tsunamis can result from off-shore earthquakes within the Bay Area or from distant events. It is most common for tsunamis to be generated by offshore subduction faults such as those in Washington, Alaska, Japan, and South America. Tsunami waves generated at those far-off sites can travel across the ocean and can reach the California coast with several hours of warning time.

Local tsunamis can also be generated from offshore strike-slip faults. Because of their close proximity, we would have little warning time. However, the Bay Area faults that pass through portions of the Pacific coastline or under portions of the Bay are not likely to produce significant tsunamis because they move side to side, rather than up and down, which is the displacement needed to create significant tsunamis. They may have slight vertical displacements, or could cause small underwater landslides, but overall there is a minimal risk of any significant tsunami occurring in the Bay Area from a local fault. The greatest risk to the Bay Area is from tsunamis generated by earthquakes elsewhere in the Pacific.

Location: Figure 5 illustrates the Cal OES tsunami evacuation planning zones. These are areas that may inundate based on modeling several potential earthquake sources and hypothetical extreme undersea, near-shore landslide sources. Zones are intended for local jurisdictional, coastal planning uses only. With respect to overlap with BART’s right-of-way, this includes the coastal areas of San Francisco and Oakland.

Extent and Probability: In 2013, the USGS, in partnership with the US Department of the Interior, published a tsunami scenario as part of the Science Application for Risk Reduction (SAFRR) series.<sup>3</sup> In the scenario, the multi-disciplinary team modeled a M9.1 offshore Alaskan earthquake to study impacts to California. If the tsunami reaches the central coast at high tide, the Bay Area can expect heights ranging from two to seven meters near the shore. The study suggests that this scenario inundation is only likely to occur once in a 100-year period.

Climate Change: Climate change is causing sea levels to rise. Higher sea level is can broaden the extent of tsunami risk.

#### 3.3.1 Potential Impacts

The San Francisco bay has not yet experienced a tsunami with capacity to impact the BART system. The map is limited to evacuation planning, not infrastructure vulnerability assessments; the maps indicate that there is a need to incorporate tsunami evacuation planning into the BART Emergency Operations Plan. Flooding in these facilities would have major impacts in damage of property as well as service delays.

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<sup>3</sup> Ibid

Vulnerability Summary: Eleven high priority assets are exposed to the tsunami evacuation planning zone. The types of assets include all those described in Section 1.1 BART Asset Profile. A key issue will be further understanding the impact at a site-specific level with the San Francisco Embarcadero, West Oakland and Oakland Coliseum areas.

### 3.3.2 Historical Events

Though the Bay Area has experienced tsunamis, it has not experienced significant tsunami damage. In 1859, a tsunami generated by an earthquake in Northern California generated 4.6 m wave heights near Half Moon Bay. The M6.8 1868 earthquake on the Hayward fault is reported to have created a local tsunami in the San Francisco Bay. In 1960, California experienced high water resulting from a magnitude 9.5 off the coast of Chile. The tsunami generated by the 1964 Alaskan earthquake caused wave heights of up to 1.1 meters along the coasts of San Francisco, Marin and Sonoma Counties. The 2011 tsunami created by the M9.0 Tohoku earthquake did not cause damage inside the Bay, but did cause damage to marinas and ports in both Santa Cruz and Crescent City. California has been fortunate in past distant-source tsunamis (1960, 1964, and 2011) that the events occurred during low tides.<sup>4</sup>

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<sup>4</sup> Ross, S.L., and Jones, L.M, eds., (2013)



**BART** **LHMP: Tsunami Inundation Areas**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

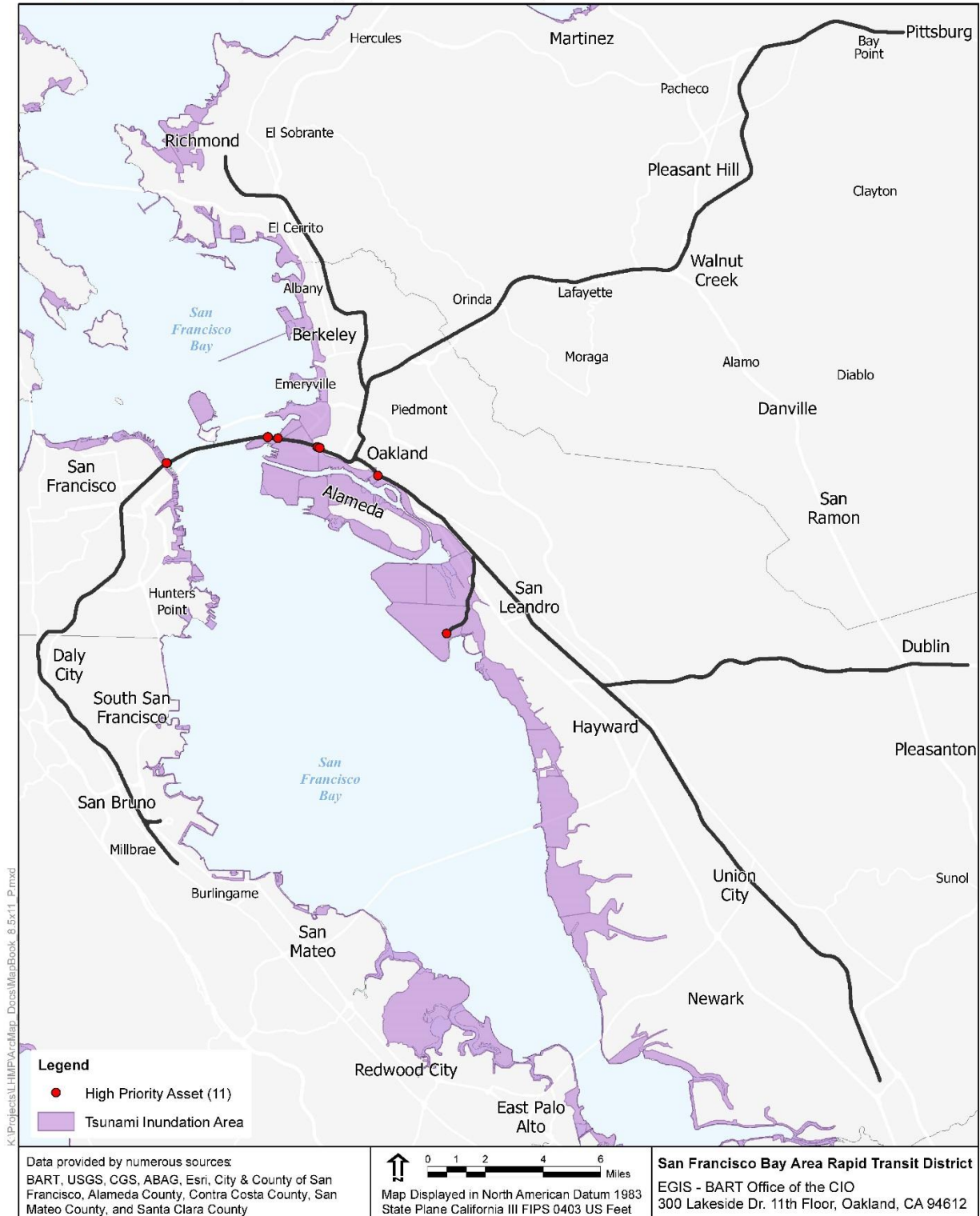


Figure 5 Tsunami Zones

### 3.4 Landslides

**Type:** Landslide is the sliding down of a mass of earth or rock from a mountain or hill. In the Bay Area, landslides can occur because of either earthquakes (earthquake-induced landslides), or during heavy and sustained rainfall events (weather induced landslides). A given area can be at risk for both earthquake-induced landslides as well as landslides caused by rain-saturated soils but the variables that contribute to each landslide risk are different. Typically, an earthquake-induced landslide occurs when seismic energy at the top of a slope gets concentrated and breaks off shallow portions of rock. In rainfall-induced landslides, the slide can begin much deeper in the slope, in very-saturated layers of soil.

**Location:** Figure 6 and 7 show areas of potential landslide. The greatest risk of landslide occurring is in the mountainous regions of the Bay Area including the C-line and L-Line crossing the East Bay hills.

The GIS mapping shown below shows areas with potential for land sliding and not explicit threat to BART systems. Previous assessments have identified that four miles of trackways and two facilities (LSR Substation and radio tower in Dublin) are in areas of existing susceptible landslide zones. Some assets in Berkeley area are shown to be exposed under weather-related landslide. For additional detail on landslide threats in Berkeley see the City of Berkeley LHMP.

<http://www.ci.berkeley.ca.us/Mitigation/>

**Extent:** The movement of landslide material can vary from abrupt collapses to slow gradual slides and at rates which range from almost undetectable to extremely rapid. Sudden and rapid events are the most dangerous because of a lack of warning and the speed at which material can travel down the slope as well as the force of its resulting impact. Extremely slow landslides might move only millimeters or centimeters a year and can be active over many years.<sup>5</sup> There is currently no method to estimate the scale of individual landslides in terms of size or extent based on available maps.

**Probability:** For both types of landslides, there currently are no methods available to estimate the probabilities of future landslides at a local, or jurisdictional, scale. Steep slopes and varied types of underlying soils can influence the likelihood of landslides. Additionally, surface and subsurface drainage patterns also affect landslide hazard, and vegetation removal can increase landslide likelihood. Future landslides are most likely to occur within and around the places where they have previously occurred.<sup>6</sup>

**Climate Change:** Climate change is not expected to change the seismic risk, but climate change could change the behavior of winter storms. The regional models project similar precipitation totals in the Bay Area, but the variability season to season may increase. If winters are compressed, with more rain falling in fewer months, or if individual years are more extreme the chance of rainfall-induced landslide will increase. Additionally, if fires burn greater portions of landslide- vulnerable hillsides, removing vegetation and increasing storm runoff, the landslide

<sup>5</sup> <http://www.ga.gov.au/scientific-topics/hazards/landslide/basics/what>

<sup>6</sup> USGS (1999)

probability will increase. Currently, there is not enough evidence to suggest with certainty that future landslide probabilities will increase across the region, however local studies that take local conditions into consideration may reveal the potential for greater landslide risks in the future.

### **3.4.1 Potential Impacts**

The BART system along the hilly regions (C and L line) is sited along major freeways and is not likely to be directly impacted by landslide. However, landslides in those areas could potentially impact roads needed to travel to BART.

Vulnerability Summary: Two high priority assets are exposed to the earthquake-induced hazard zone, and three high priority assets are exposed to the weather-induced hazard zone’s “mostly landslide” category. The types of assets include ventilation structures, substations, and train control rooms. No key issues are identified for this hazard.

### **3.4.2 Historical Events**

No past known landslide events have been known to impact BART services.

**BART** **LHMP: Landslide Potential (Earthquake Induced)**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

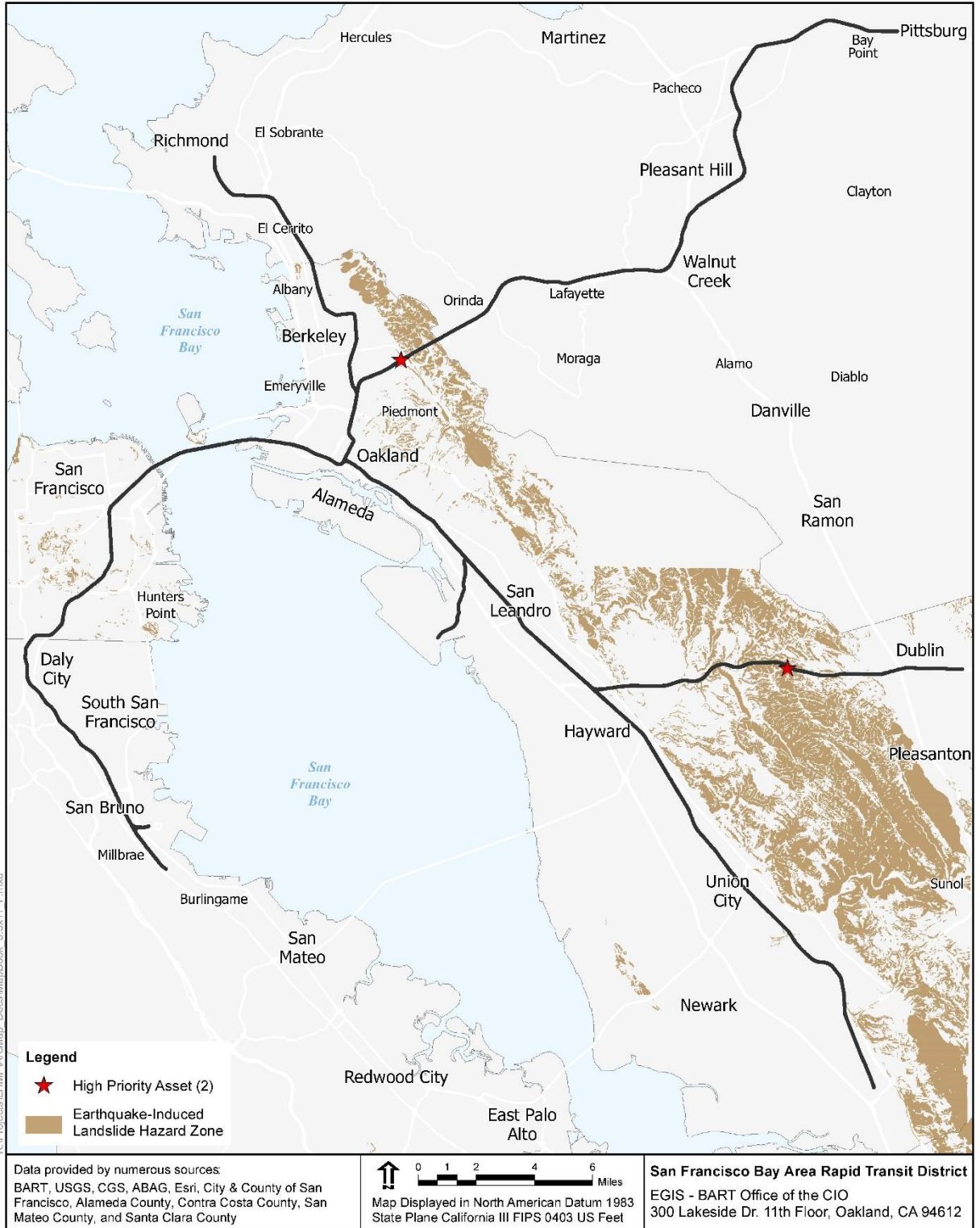


Figure 6 Landslide Zones (Earthquake)



**BART** LHPM: Landslide Potential (Weather Related)  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016



Figure 7 Landslide Zones (Weather)

## 3.5 Flooding

**Type:** Flooding is a temporary condition that causes the partial or complete inundation of land that is normally dry. Flooding occurs when streams, rivers, lakes, reservoirs, or coastal water bodies are abnormally high and overflow into adjacent low-lying areas, areas at risk of recurring floods known as floodplains.

Flooding can occur from several sources. Near the shoreline, flooding can occur from a combination of high tide, storm surges, or tsunami (see Tsunami in Section 3.4). In low lying areas near streams or creeks, flooding can occur from riverine overflow during extreme storm events. BART is especially exposed to the threat of flooding since many assets are at or below grade. During severe storm events, water intrusion to BART assets can occur from exposed entrances/exits and in the form of leaks from aged assets.

FEMA mapped flood plains and expected USGS predicted rainfall intensities are planned for during BART's standard design and construction process. However, elevated flood plain levels and increased rainfall during more intense storms are becoming more frequent and concentrated.

**Location and Extent:** Figure 8 Flood Zones shows overlaps of the BART system to FEMA flood zones. The flood map shows several assets are in areas subject to flooding either in the 100- or 500 year FEMA flood plain zones.

**Probability:** 100- year floods have a probability of occurrence of one percent in any given year. 500-year floods have a probability of occurrence of 0.2 percent in any given year.

**Climate Change:** Climate change causes great frequency of extreme storm events which will increase the frequency of flooding events. Sea level rise has the potential to influence the impact of coastal, riverine, and localized nuisance flooding.

### 3.5.1 Potential Impacts

Flooding can impact BART by damaging facility property and causing service delays. BART has not experienced severe flooding, resulting in extensive damage to our facilities or right of way. However, episodes of rain events have caused several service disruptions in winter months. In the November and December of 2014, wet weather events caused several delays including:

- October 25, 2014 – Water intrusion in San Leandro impaired train control equipment. 53 trains were delayed up to 5-20 minutes.
- October 30, 2014 – Water intrusion in San Leandro caused loss of routing control & indications. 64 trains were delayed up to 5-38 minutes.
- December 11, 2014 – San Bruno Station flooded due to drain problem. 20 trains were delayed up to 15 minutes.
- December 11, 2014 – Reduced train speeds due to wet tracks. 78 trains were delayed up to 5-20 minutes.

A past study for the four-station extension to San Francisco International Airport identified that water levels from a 100-year storm in Colma Creek running through South San Francisco could potentially flood the South San Francisco station.

Vulnerability Summary: Sixteen high priority assets are in a 500-year floodplain zone and ten high priority assets are in a 100-year floodplain zone (AE). The types of assets include passenger stations, emergency exits/entrances, passenger stations, switching stations, ventilation structures, substations, and train control rooms. Key issues will be to examine the existing flood/water protections in areas that have experienced water issues.

### **3.5.2 Historical Events**

Flooding associated with severe storms has been among the most common disaster in the Bay Area during the period from 1950 to 2015, occurring on average 1.3 times a year over the past 60 years. Often heavy rainfall brings many areas of localized flooding, especially in low lying areas of the region.

Many other locally significant floods have occurred during this time throughout the region. Extensive flooding occurred in 1950, 1957, 1958, 1959, 1962, 1963, 1964, 1965, 1966, 1969, 1970, 1973, 1980, 1982, 1983, 1992, 1995, 1996, 1997, 1998, 2005, 2006, and 2008, again, not affecting BART.

**BART** **LHMP: FEMA Flood Zones**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

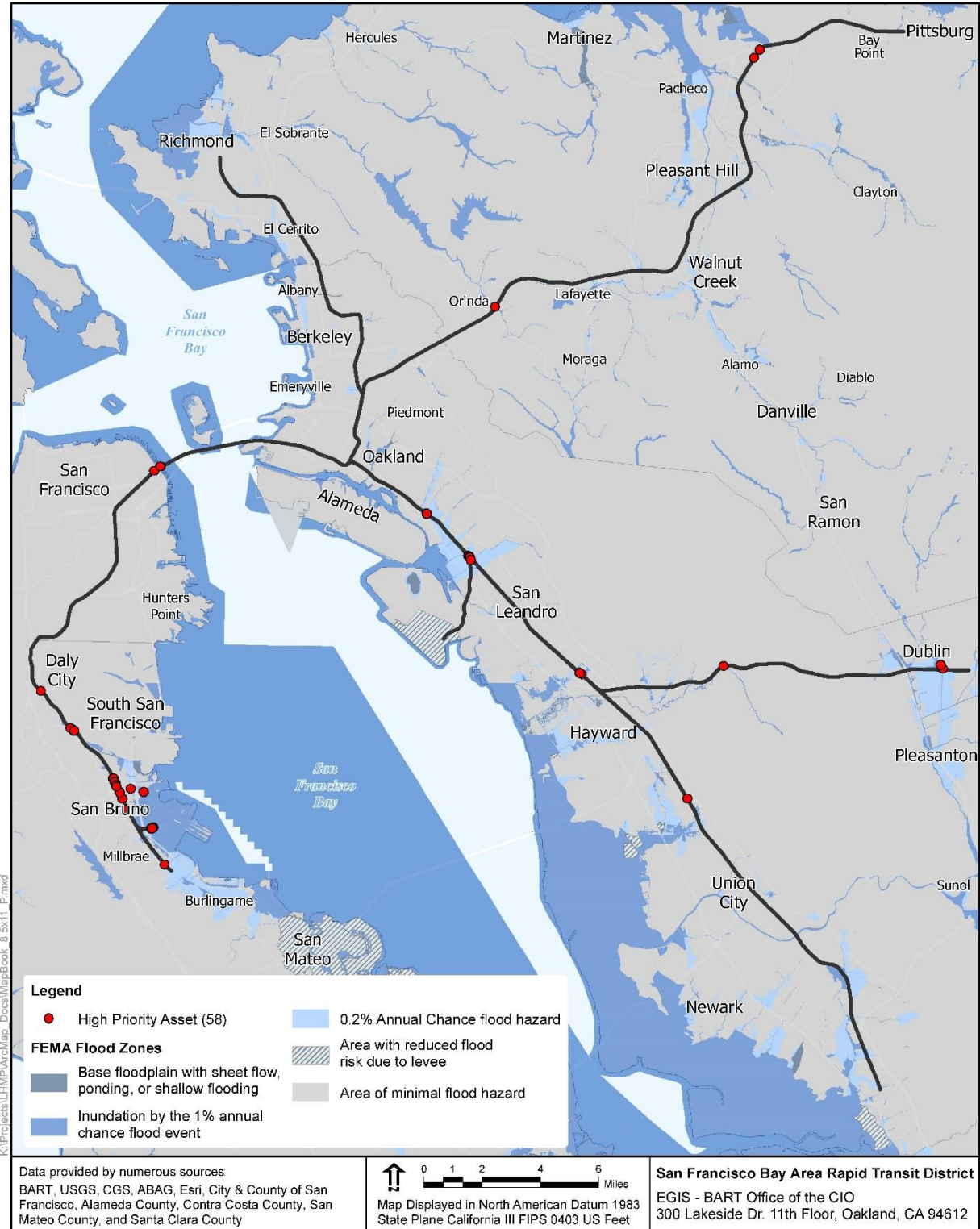


Figure 8 Flood Zones



## 3.6 Sea Level Rise

**Type:** Sea level rise (SLR) is the increase in sea level; it is caused by the added water from melting land ice and the expansion of sea water as it warms. It has the potential to increase the frequency and severity of coastal, riverine and localized nuisance flooding. Without intervention, rising sea levels may cause more frequent and longer flooding of existing flood-prone areas, shoreline erosion, elevate groundwater, and permanent inundation in the coastal zones. Sea level is projected to rise 16 inches by mid-century (Year 2050), and 55 inches by end of century (Year 2100).

As sea levels rise, groundwater and salinity levels are also predicted to rise. This will increase the risk of salt water intrusion into below grade assets including sensitive electrical/mechanical equipment. In addition, increasing groundwater levels may increase liquefaction susceptibility, and may increase the need for routine flood management activities.

**Location and Extent:** Figure 9 shows the exposure map illustrating projected sea-level rise. The greatest exposures include the W-line and Y-line around the San Francisco International Airport and the Oakland Airport Connector at the Oakland International Airport. Both the San Francisco Airport and Port of Oakland are aware of the low-lying conditions of these areas and are doing extensive work to address these risks and enhance existing shoreline protections.

**Probability:** The matrix of numbers presented in Table 3 can be used to understand a range of total water levels, from 0 to 95 inches above MHHW, represented both in terms of today's tides and future tides as sea level rises. Each total water level represents a combination of sea level rise (0 to 60") and tide levels (MHHW to a 100-year extreme event). As an example, the likely mid-century daily high tide is projected to be 12" above today's high tide, or 12"+MHHW. This water level is color coded in green in Table 3. This total water level is approximately the level observed during King Tide, which is an astronomical tide that occur approximately twice per year when the Moon and the Sun simultaneously exert their gravitational influence on the Earth.

Because of the uncertainties associated with modeling and mapping sea level rise it is reasonable to allow for a +/- 3-inch range when interpreting the total waters in Table 3. As an example, the likely end-century high tide is projected to be 36 inches above today's high tide, or 36"+MHHW. Water levels ranging from 33 to 39 inches can be used to understand what other combination of tides and sea level rise that may result in the same amount of flooding or inundation as 36"+MHHW.

Table 3: Matrix of Sea Level Rise and Extreme Tide Level

Time Frame	Sea Level Rise	Total water level above today's daily high tide, MHHW (inches NAVD88), by tide recurrence interval							
		MHHW (≈ daily high tide)	1-yr (≈ King Tide)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr (1% annual chance)
Today		0	12	19	23	27	32	36	41
	+6	6	18	25	29	33	38	42	47
Likely Mid-Century	+12	12	24	31	35	39	44		53
	+18	18	30	37	41	45	50	54	59
	+24	24	36	43	47	51	56	60	65
	+30	30	42	49	53	57	62	66	71
Likely End-Century	+36	36	48	55	59	63	68	72	77
	+42	42	54	61	65	69	74	78	83
	+48	48	60	67	71	75	80	84	89

Climate Change: Climate change is causing sea levels to rise.

### 3.6.1 Potential Impacts

SLR will exacerbate coastal and riverine flooding. See Section 3.5.1 for potential impacts from flooding.

Vulnerability Summary: Seventeen high priority assets are in a SLR impact area of 3, 5, and 6 feet. The types of assets include emergency exits/entrances, passenger stations, ventilation structures, substations, and train control rooms. Key issues will be coordination with coastal managers and regional partners in regional adaptation efforts.

### 3.6.2 Historical Events

SLR has not caused major events in the BART system now. Increases to storm intensities have caused drainage issues however, which is expected to continue and be accelerated.

**BART** LHMP: Potential Sea Level Rise Inundation  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

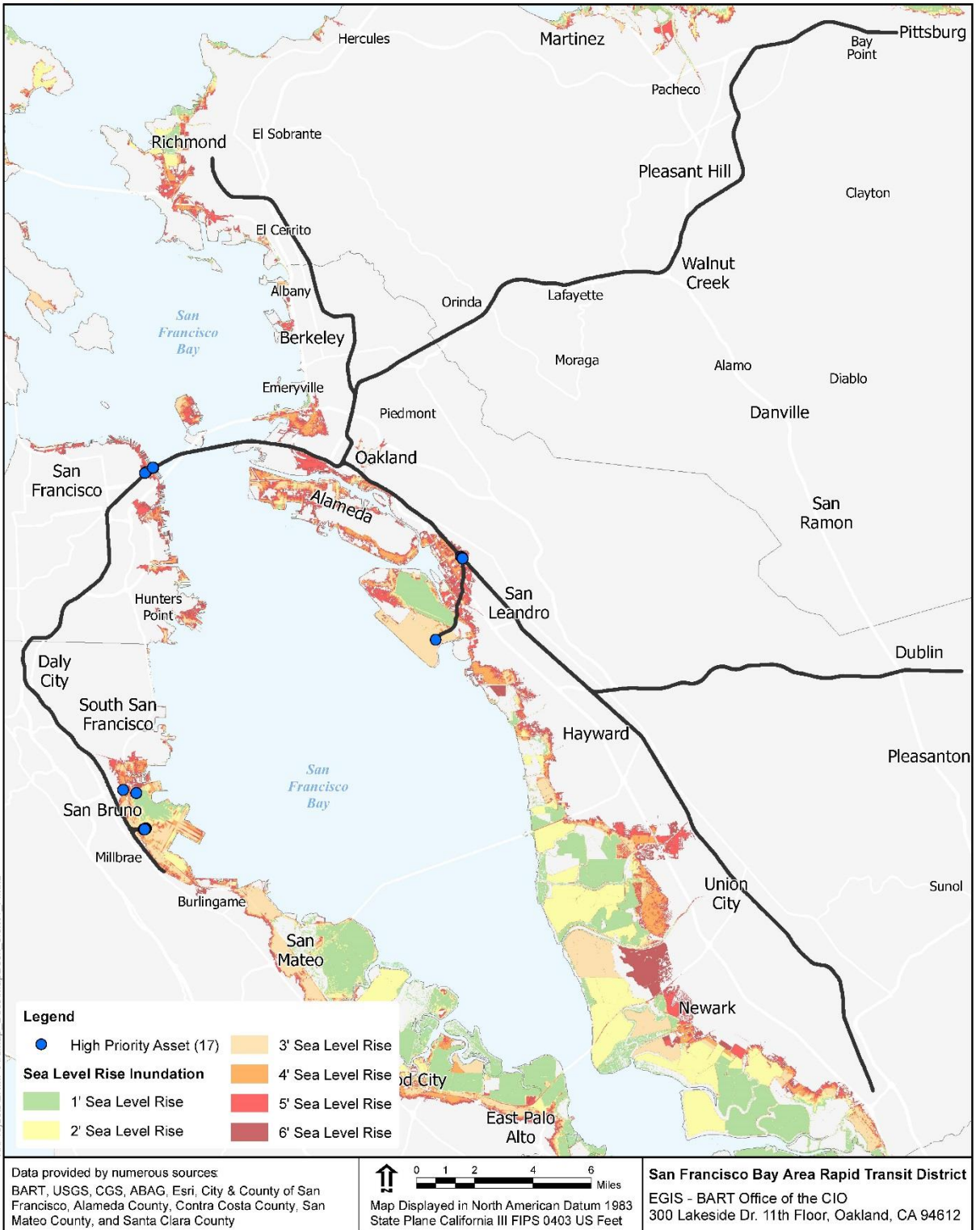


Figure 9 Sea Level Rise Zones

## 3.7 Fire

**Type:** Wildfires are fires that rage out of control and are common to wildland settings, such as forests and regions with little rainfall, where there is combustible vegetation. Wildfires occur when a 'fire triangle' is met; that is, when there is heat, fuel and an oxidizing agent such as oxygen. Such events, while typically small at its inception, spread rapidly, igniting nearby vegetation and buildings. Their danger lies in its speed, ability to change directions unexpectedly and jump gaps (e.g. rivers, roads). They can be naturally-occurring or human-caused. Fires can take place in the urban, wildland settings, and the wildland-urban interface (WUI).

**Location:** Figure 10 Wildfire Zones illustrate the wildfire severity in the State Responsible Areas (SRAs) and very high severity regions for Local Responsible Areas (LRAs). Federal Areas are not available via Cal Fire and are not presented in the figure.

**Extent:** In CY 2015, the California experienced 6,335 fires, impacting 307,598 acres or approximately 49 acres per fire.<sup>7</sup>

**Probability:** Figure 10 shows fire hazard severity which represents the likelihood of an area burning over a 30-50-year time period.<sup>8</sup> Fire hazard severity takes into account the amount of vegetation, the topography, and weather (temperature, humidity, and wind).

**Climate Change:** Wildfire risk increases due to climate change because of higher temperatures and longer dry periods over a longer fire seasons. Additionally, wildfire risk will also be influenced by potential changes in vegetation.<sup>9</sup>

Research out of UC Merced has projected the future fire risk, impacted by climate change, compared to existing fire risk. In the Bay Area the results are mixed. The research projects some locations in the East Bay and South Bay to exhibit decreased fire risk, while areas on the Peninsula and North Bay exhibit a 150 percent increase in fire risk by 2085. Generally, across the Bay Area there is limited change in fire risk in the year 2050, with the greatest change in occurring between 2050 and 2085, especially in the high emission scenario. The Cal Adapt data suggests that some jurisdictions might have to adapt more aggressively compared to others.

### 3.7.1 Potential Impacts

Fires occurring on BART facilities have the impact of damaging facility property and causing service delays. However, BART may have service delays due to poor visibility or health conditions of wildland fires near the BART system. BART also services Richmond, where there may be some station closures or shelter in place orders due to fire or hazardous materials release from the Richmond Refinery.

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<sup>7</sup> Calfire, [http://cdfdata.fire.ca.gov/incidents/incidents\\_stats?year=2015](http://cdfdata.fire.ca.gov/incidents/incidents_stats?year=2015)

<sup>8</sup> CDF Fire and Resource Assessment Program

<sup>9</sup> California Climate Change Center, (2012)

In addition to the loss of property in fires, the loss in vegetation and changes in surface soils alters the environment. When all supporting vegetation is burned away, hillsides become destabilized and prone to erosion. The burnt surface soils are harder and absorb less water. When winter rains come, this leads to increased runoff, erosion, and landslides in hilly areas.

Wildfire does not present a major threat impacting BART services. The greatest risk to wildfire is in the mountainous regions along the Pittsburg/Bay Point and Dublin/Pleasanton lines. However, on these lines, BART is sited alongside the freeway providing buffer to wildfire exposure. In addition, there is limited amounts of vegetation adjacent to BART's Right-of-Way and the vegetation that do exists are in small isolated patches. Drought conditions such as those currently experienced in 2014, 2015, and 2016 can heighten the risk of urban wildland interface fires.

**Vulnerability Summary:** Seventeen high priority assets are in high to very high wildfire potential zones. The types of assets include passenger stations, ventilation structures, switching stations, substations, and train control rooms. Due to low threat to BART assets, no key issues are identified.

### 3.7.2 Historic Events

Wildfires were common disasters in the Bay Area during the period from 1950 to 2014. Large wildfires occurred in 1961, 1962, 1964, 1965, 1970, 1981, 1985, 1988, 1991, and 2008. The 1991 fire in the Oakland-Berkeley Hills was the largest urban-wildland fire in the Bay Area, and resulted in \$1.7 billion in losses. In that fire, 3,354 single-family dwellings and 456 apartments were destroyed, while 25 people were killed and 150 people were injured.<sup>10</sup> Despite the drought conditions locally over the past four years the Bay Area has had very few fires, and few large fires.

While no large wildland fire has affected BART's service for a complete shutdown, in 1991, the Oakland Hills fire did cause a minor service disruption (less than 24 hours) for replacement of a short stretch of rail. BART also closed for several hours to replace a portion of track and equipment that was affected by a neighboring structure fire. The wooden structure building was under construction and in close proximity to the trackway, causing damage due to the high heat from the working structure fire.

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<sup>10</sup> State of California Multi-Hazard Mitigation Plan, California Governor's Office of Emergency Services

**BART** **LHMP: Wildfire Potential**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

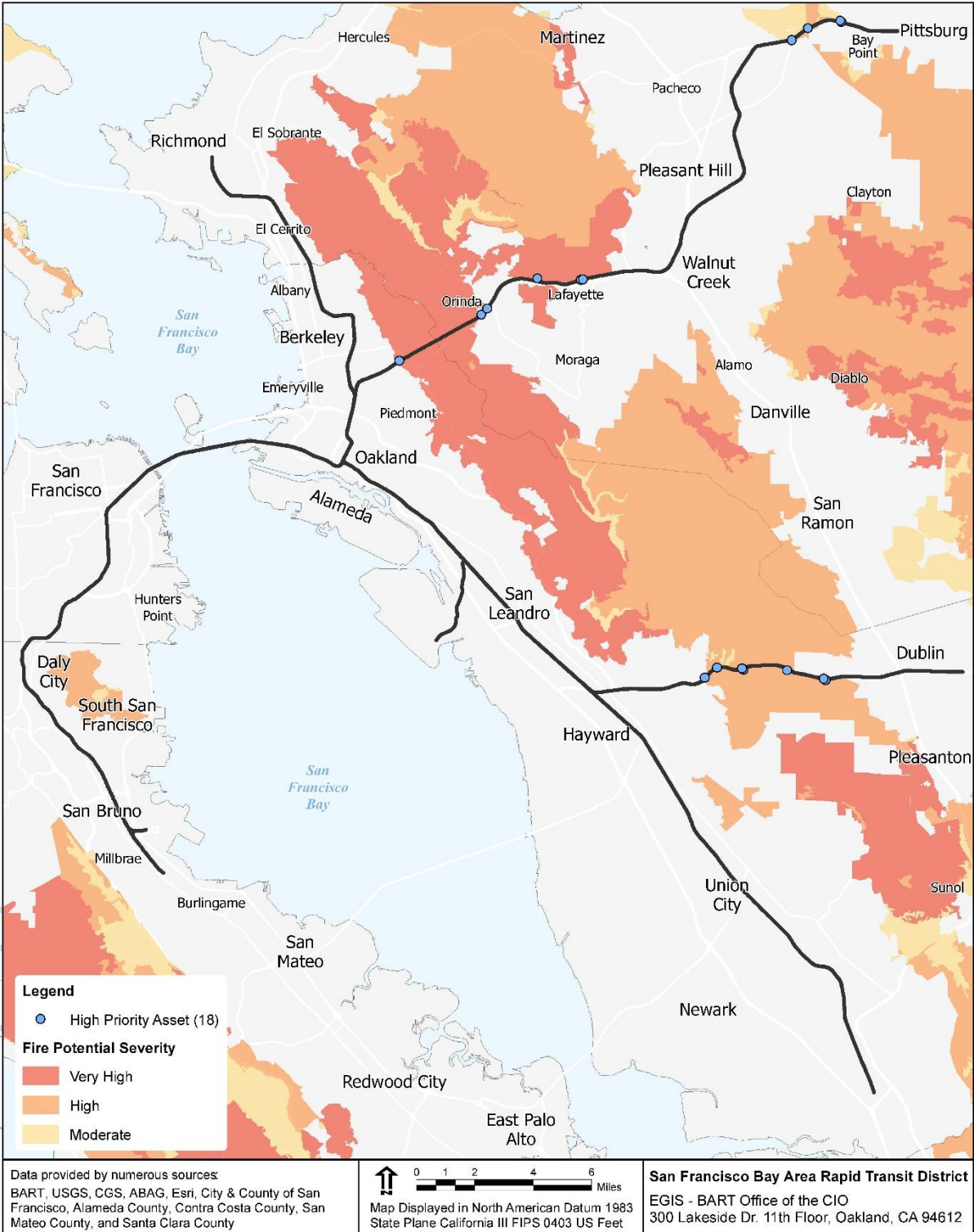


Figure 10 Wildfire Zones

## 3.8 Drought

**Type:** A drought is characterized as a period of below-average precipitation in a particular region which culminates in water supply shortages. Such storages may be surface or ground level. A drought is a gradual phenomenon that occurs over several dry years, depleting reservoirs and groundwater basins without the expected annual recharge from winter precipitation.

**Location:** Figure 11 drought severity illustrates areas impacted by drought. Drought is not localized, but occurs simultaneously across the region, and may extend statewide or across a larger expanse of western states.

**Extent:** Duration of droughts can last many years. Studies of tree rings have shown that drought periods in California's history can last more than 200 years and there have been multiple droughts in the past thousand years lasting 10 to 20 years.<sup>11</sup>

**Probability:** Multi-year droughts of statewide scale occur relatively infrequently. See Section 4.8.2 for a list of past droughts affecting the Bay Area.

**Climate Change:** Climate change is likely to increase the occurrence and severity of drought. In the Bay Area temperatures are projected to increase between 3 degrees (low emission scenario) and 6 degrees Fahrenheit (high emission scenario).<sup>12</sup> In the eastern regions of the state the increase is 4 to 9 degrees.

### 3.8.1 Potential Impacts

Fire hazard increases where drought conditions are high. There are multiple drought related factors that contribute to increased fire hazard: longer fire season, drier vegetation, and hot days. Additionally, drought reduces the water supplies available to fight wildfires, leading to larger and more extended fires. The Bay Area is adversely impacted by the severe reduction in snow pack in the Sierras, the source of two-thirds of the regions water. By the end of the century the spring snow pack in the Sierra could be reduced by as much as 70 to 90 percent the historic average.<sup>13</sup>

Drought has a lower impact on BART operation. When drought conditions do occur, BART can curtail use of water for such purposes as station cleaning, washing trains, and landscape irrigation. However, severe drought in the Bay Area can increase risk of other hazards such as wildfires. At minimum, the District requires a water supply to support fire protection of the system. Without fire protection, BART facilities would be forced to shut down impacting community mobility.

**Vulnerability Summary:** All high priority assets identified in the Plan are exposed to the seismic hazard. The types of assets include all those described in Section 1.1 BART Asset Profile. Key issues will be addressing water conservation efforts through the sustainability group.

<sup>11</sup> Mercury News, (2014), <http://www.mercurynews.com/2014/01/25/california-drought-past-dry-periods-have-lasting-more-than-200-years-scientists-say/>

<sup>12</sup> Cayan, D., et al. (2009)

<sup>13</sup> Scripps Institute of Oceanography (2012)

### 3.8.2 Historic Events

Major droughts occurred in California that affected the Bay Area in 1973, 1976-77, 1987-1991, and 2007-09. Drought conditions in 1973 led to a state-declared disaster in Glenn, San Benito, and Santa Clara counties, resulting in \$8 million in agricultural loss. Between 1976 and 1977, California experienced one of its most severe droughts. 1977 was the state's driest year on record. In the Bay Area, Contra Costa, Napa, San Mateo, and Marin counties were four of the several counties where a state disaster was declared. Statewide, \$2.67 billion in damages occurred in the two-year period. Marin, Solano, and Sonoma counties were also affected in the 1987-1991 drought, which caused \$1.7 billion in crop losses nationwide. The 2007-2009 drought did not directly affect Bay Area counties, but caused \$300 million in crop loss statewide.<sup>14</sup>

In January 2014, the Governor declared a State of Emergency in California in response to current drought conditions, which began in 2012. Thus, far, 2015 has surpassed 1977 as the driest year on record in California. As of June 2015, statewide reservoirs are at 18-67 percent of average and Sonoma County has declared a local Emergency Proclamation.<sup>15</sup>

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<sup>14</sup> State of California Multi-Hazard Mitigation Plan, California Governor's Office of Emergency Services

<sup>15</sup> California Governor's Office of Emergency Services (2015)





**LHMP: Drought Severity**  
EGIS - Enterprise Geographic Information System

Date: 2/2/2016

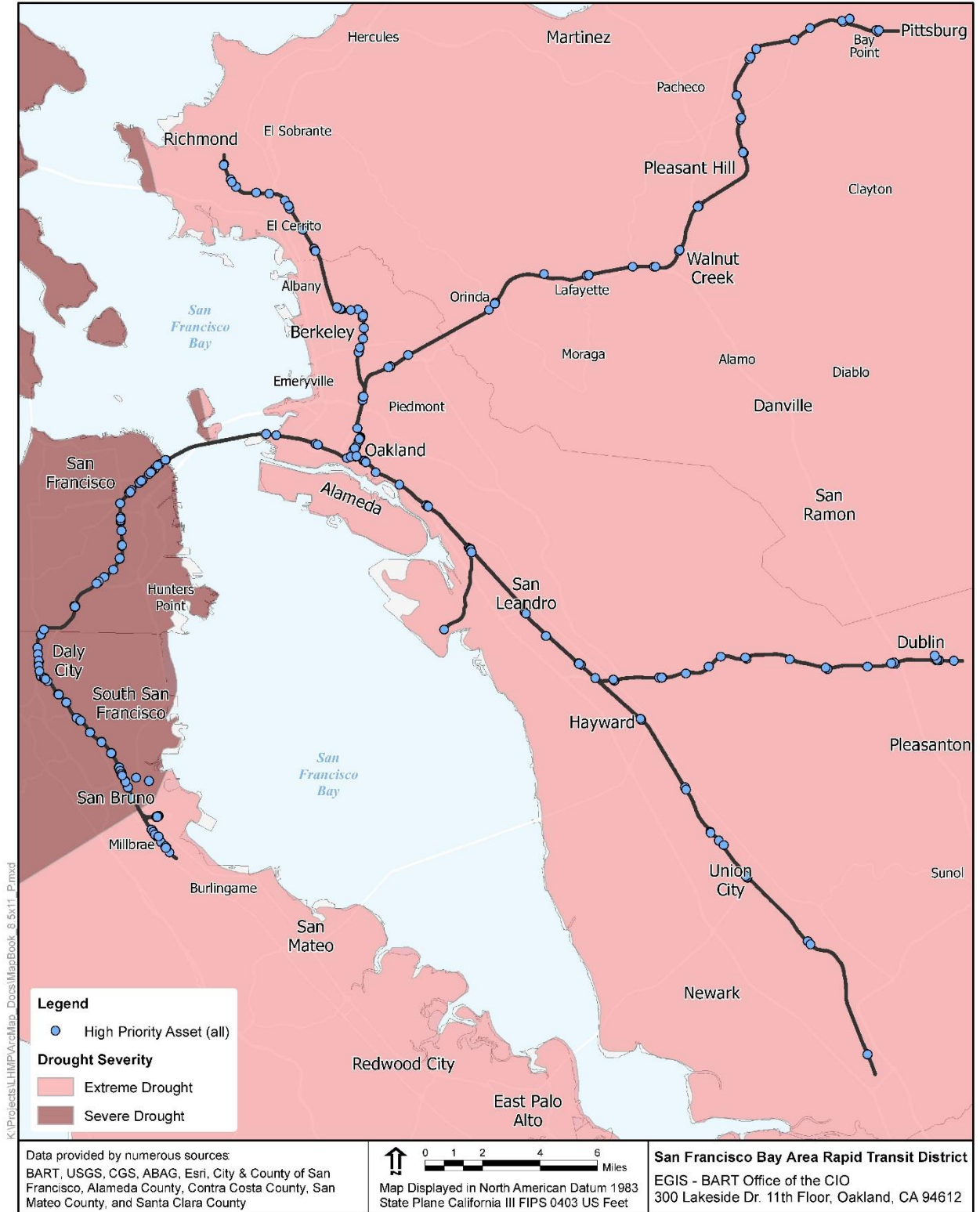


Figure 11 Drought Zones

### 3.9 Extreme Heat

**Type:** Extreme heat occurs when where the Heat Index, a function of heat and relative humidity, is high. The Bay Area, especially the parts further away from the coast and bay, can experience extreme heat days.

Heat emergencies occur when residents are subject to heat exhaustion and heatstroke, and are more likely to occur in areas not adapted to heat and without air conditioning, cooling centers, or vegetation to mediate heat impacts in exposed areas. Certain populations are typically the most at risk during extreme heat emergencies, including people with disabilities, chronic diseases, the elderly, and children.

**Location:** Extreme heat issues are most likely to impact the BART system in the inland areas including the C and L lines.

**Extent:** Extreme heat days pose a public health threat, causing symptoms such as exhaustion, heat cramps, and sunstroke if the Heat Index is over 90° F. The National Weather Service has developed a Heat Index Program Alert which gets triggered when high temperatures are expected to exceed 105° to 110° for at least two consecutive days.

The intensity of extreme heat is defined differently for each location in the region. In San Francisco County an extreme heat day is defined as a day above 78°, while for inland portions of Solano County extreme heat is defined as a day above 100°. The threshold is the 98<sup>th</sup> percentile historic maximum temperature. The threshold is set locally to recognize services and buildings in cooler climates may not be designed to handle moderate heat, while those areas where high heat has always been an occurrence, already have measures to address their historic temperatures.

**Probability:** Extreme heat is made worse when it is experienced over a longer stretch of time. The number of heat waves (five or more consecutive days of extreme heat) will increase as will the length of heat waves.<sup>16</sup> By the end of the century most of the region will average six heat waves a year, with the average longest heat wave lasting ten days. In addition to the more frequent occurrence and duration of heat waves, they are expected to occur in months the region historically hasn't experienced extreme heat. Historically, extreme heat occurs between July and August, but in the future, extreme heat will be an issue the region faces in both the Spring and Fall.<sup>17</sup>

**Climate Change:** Climate change is expected to generate an increase in ambient average air temperature, particularly in the summer. The outer Bay Area will likely experience greater temperature increases than coastal or bayside jurisdictions, though likely not as great as in the eastern-most inland communities. The frequency, intensity, and duration of extreme heat events and heat waves are also expected as regional climate impacts.

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<sup>16</sup> Cayan, D., et al. (2009)

<sup>17</sup> California Climate Change Center (2006)

Per California Climate Change Center, by mid-century, extreme heat in urban centers could cause two to three times more heat-related deaths than occur today. Statewide, temperatures could increase anywhere from 3 to 10.5 depending on CO2 emission levels, leading to more frequent, hotter days throughout the year.

### 3.9.1 Potential Impacts

Extreme heat events have the potential to severely impact BART service. Increases in overall temperatures strain the regional power network and could lead to more frequent PG&E brown-outs resulting in service delays within the system. In addition, extreme heat can cause BART's own electrical systems to overheat which would impact delivery to the third rail and stations. Air conditioning systems can become strained and lead to failure.

Heat waves could impact patron and employee health and safety particularly among vulnerable populations.

In other transit agencies, extreme heat has caused rail buckling. Rail buckling is not a known issue at BART.

Vulnerability Summary: High priority assets in the inland areas including the C and L lines will be most at risk. The types of assets most vulnerable will be those with electrical and mechanical equipment including substations, train control rooms, passenger stations, and ventilations structures. Key issues will be addressing any overheating issues electrical and mechanical equipment.

### 3.9.2 Historical Events

No heat emergencies in California have been declared a disaster at the state or federal level between 1960 and 2008.<sup>18</sup> The Spatial Hazard Events and Loss Data for the United States estimates approximately 47 heat events in California during this time. In 2006 a notable heat wave spread throughout most of the United States and Canada, causing 140 fatalities in California.<sup>19</sup>

The Bay Area has historically experienced 4 extreme heat days a year.<sup>20</sup>

## 3.10 Terrorism

Terrorism is the calculated use of unlawful violence or threat of unlawful violence to inculcate fear; intended to coerce or to intimidate governments or societies. Terrorism is a criminal act that draws attention of the local populace, the government and the world to their cause.

BART is a transit industry leader in security. As of FY16, BART has a police department with over 300 employees. BART police maintain police presence patrolling inside stations and on trains and

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<sup>18</sup> State of California Multi-Hazard Mitigation Plan, California Governor's Office of Emergency Services

<sup>19</sup> Ibid

<sup>20</sup> Cayan, D., et al. (2009)

responding to emergencies quickly. Protection measures such as alarm systems, video surveillance, and intrusion prevention, support a secure BART infrastructure. In addition, the District maintains an “eyes and ears” public awareness campaign to encourage patrons to report unattended packages or suspicious behavior.

## 4 Mitigation Strategy

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### 4.1 Mitigation Goal

The mitigation goal of the Plan is to maintain and enhance a disaster-resilient District by reducing the potential for loss of life, property damage, and environmental degradation from natural disasters, while supporting economic recovery from such disasters. This goal is unchanged from the previous plan and continues to be the goal of BART in designing its mitigation program.

### 4.2 Mitigation Measures

Mitigation measures are in Appendix C.

The Core Administrative Team reviewed mitigation measures identified in the previous plan and supplemented these with mitigation measures based on current emergency preparation practices and identified needs including those from BART's Capital Needs Inventory (CNI). The CNI is an internal inventory of BART's capital project needs including projects for repair, retrofit, and replacement. Relevant mitigation strategies were identified from the CNI and are referenced in Appendix C.

Prioritization of mitigation actions was established through a voting method in the EPTFC. Participating members of the EPTFC upvoted strategies they viewed as important and in alignment with the following priorities:

1. Mitigation goal
2. Hazard exposure reduction
3. Public and political support
4. Environmental benefit
5. Cost to benefit value
6. Funding availability
7. Timeline for completion

EPTFC members were allowed multiple votes but were not allowed to vote on a strategy more than once. All votes had equal weight. Adjustments on rank were made based on verbal comments from the EPTFC and the Title VI committee. Support of each proposed mitigation strategy was determined based on the alignment of each strategy

Twenty-nine actions were identified and prioritized through this process. "High" (6-9 votes), "Medium" (4 or 5 votes), and "Low" (1-3 votes) rankings reflect the District priorities. All actions identified are important; "Low" does not mean that the action is not important but that it holds a lower rank relative to other actions identified. Actions that did not receive votes in this process were excluded from the Plan.

## 4.3 Existing Mitigation Programs and Resources

The following are the District's authorities, policies, programs and activities that support efforts to mitigate hazards. This is not inclusive of all mitigation activities that occur on an ongoing basis at BART. For example, the Maintenance and Engineering Department has staff that is assigned to conduct vegetative management activities. This helps to reduce any trackway intrusion and reduce any obstructions (such as downed trees) which may cause service delays. Another example is the Preventive Maintenance Schedule for our emergency equipment, such as generators. Properly maintaining and testing the equipment ensures its readiness to use during a disaster or emergency. Also, the Emergency Management Program provides technical assistance and support to any department in the district who may want to include mitigation strategies within their unit or service. For example, providing support to Shops on how to reduce hazardous materials spills by properly storing containers in the event of an earthquake.

The next revision of the LHMP will include a list of ongoing mitigation strategies and staffing levels, which may not be captured in the list below.

### 4.3.1 National Flood Insurance Program

As a transit agency BART is not eligible to participate in the National Flood Insurance Program (NFIP). BART is however engaged in numerous other efforts to reduce flood exposure of the critical system assets.

### 4.3.2 Emergency Preparedness Program

The District operates an Emergency Preparedness Program that provides employees with training, tools, and resources to prepare the District in restoration of critical infrastructure and essential service in a safe and timely manner in emergency situations.

### 4.3.3 Earthquake Safety Program

The Earthquake Safety Program is tasked with upgrading vulnerable portions of the original BART system to ensure safety for the public and BART employees. Portions of the original system with the highest traffic are being upgraded not only for life safety but also to ensure that they can return to operation shortly after a major earthquake. The upgrades will be accomplished by using the latest seismic standards to improve the structural integrity of BART facilities. Completion of all earthquake upgrades is expected by 2022.

The Earthquake Safety Program addresses the original BART system completed between 1972 and 1976, with a service area spanning three counties-Alameda, Contra Costa and San Francisco. System extensions, built mostly during the 1990s, employed more stringent and up-to-date seismic criteria than the original system, and thus do not require upgrades.

The original Earthquake Safety Program budget is \$1.307 billion. The current funding sources include:

- \$125 million from California Department of Transportation Local Seismic Safety Retrofit Program
- \$143 million from Regional Measure 2 (RM2), State Transportation Improvement Program (STIP), Prop 1B
- \$11.5 million from Transportation Congestion Relief Program (TCRP)
- \$3 million from FEMA Pre-Disaster Mitigation Program
- \$980 million from General Obligation Bonds (Regional Measure AA)
- \$60 million from other Funds

#### 4.3.4 Water Intrusion Program

The Water Intrusion Program is a rehabilitation program to address water leaks. Water leaks are caused by infrastructure degradation from structural fatigue, environmental impacts, materials performance, and high rates of usage in actual operating conditions. The following are the Program efforts:

- Water intrusion mitigation for the Pleasant Hill station was completed in 2012.
- BART addressed water intrusion at the concourse level of the Powell St station.
- BART is working to address station train control rooms in its next phase.

In 1997, BART converted most of the M line sumps from column type to submersible pumps and standardized the controllers to Warrick controllers. There were/are specific cases that remained as column, split case, etc type of pumps. Most of these pumps were designed for 20 year life and thus we are currently going through a round of purchases so that BART maintenance staff can replace the existing pumps that are approaching the 20 year mark. As for the actual sumps, most of them are concrete structures buried in the ground and would not normally need replacing.

There have been a variety of designs put forward to expand the pumping system to attempt to address large scale flooding. The current system is designed to address standard rain water intrusion, minor structure leakage and water removal in the event of a fire in the tunnel. These systems are fully redundant and based on two 250 gpm fire hose streams for a total of 500 gpm. Being a fully redundant system, the system as designed should be able to handle 1000 gpm at any time.

Recent proposals look to provide a pumping system piggybacked on the existing system that could move around 5000 gpm. This system will add sumps and various pumps and piping to the M line to move flood water from the low points of tube 24 and 38 to the vent structures at Oakland and San Francisco where the water would be discharged. Since this proposed emergency flooding pumping system is 10 times the size of the current pumping system it will not likely be useful during normal operations.

### 4.3.5 Annual Winterization

On an annual basis, the BART Operating Departments engage in preparatory efforts to ready the system for the rainy season. These activities include:

1. Cleaning and flushing right of way, station and shop culverts and drains.
2. Cleaning Station and Shop Facility Gutters
3. Patching and repairing roofs at Stations, Traction Power Substations, Train Control Hut, Shops and Yard facilities
4. Testing and make necessary repairs to elevator, escalator and station sump pumps
5. Trimming trees and bushes that could create a potential hazards
6. Securing backup generators and staging them at vital locations
7. Reviewing procedures for deployment of staff to critical areas for 'Storm Watch' during periods of heavy rain and high wind
8. Reviewing protocols with for response to mutual problems with MUNI.
9. Reviewing System Service protocols for response to flooding and wet conditions at stations
10. Inventorying and ordering materials to ensure necessary maintenance materials will be readily available.
11. Ensuring that maintenance vehicles are properly stocked to respond to weather related issues
12. Designating vehicles that will always have a generator hitched to it for quicker response
13. Reconfirming protocol, providing training and performing increased inspections for debris management and flood avoidance.
14. Identifying flood risks and per staging sand bags
15. Ensuring adequate inventory of emergency supplies in stations and facilities
16. Ordering large floor mats to be installed as necessary to mitigate slip and fall risk
17. Leak inspections of all rooms during first rains.

### 4.3.6 Sustainability Program

The District has a long history of advancing sustainability. In 2003, the District adopted its first sustainability policy that directs the District to integrate best practices in sustainability in the organization. In 2017, the District will be updating the sustainability policy, formalizing its sustainability program and defining more clearly its program objectives. Three aspects of the program which relate directly to the Plan are water conservation, greenhouse gases (GHG) mitigation, and extreme weather adaptation.

BART has been active in conserving water and is continually investigating and evaluating opportunities for water savings. California faced a significant drought starting in 2014. The governor of California called for a 20 percent voluntary reduction in water use across the State. In response to the drought, the District has reduced irrigation schedules by 66%.

BART's role in "taking cars off the road" by expanding ridership results in a reduction of regional transportation emissions. Catalyzed by the 2006 passage of California's AB32, which set a



reduction target of 1990 emission levels by 2020 and required adoption of reduction measures by 2011, BART conducted its first GHG inventory in 2007. In an effort to curtail GHG emissions, BART made shifts in its energy portfolio by evaluating opportunities for procurement of more zero and low carbon energy sources. In addition, the District is in the process of installing on-site solar at several BART facilities.

BART is taking proactive steps to assess climate change impacts. In 2012, BART took its first step by conducting a climate change adaptation assessment looking at water-related climate change impacts including sea level rise, flooding, and heavy downpours. BART is also developing design standards for mitigating the effects of heavy rain events through installation of stormwater retention systems.

### **4.3.7 Strategic Asset Management Program**

The Strategic Asset Management program aims to minimize risk and cost and to maximize safety and service from BART's assets. The program follows federal guidelines delineated in MAP 21 and the International Standard ISO 55000 for asset management. The asset management policy was adopted by the BART Board in March 2014 to 1) ensure BART's service are provided and infrastructure maintained in a sustainable manner; 2) Safeguard BART assets, including employees and physical assets, by implementing asset management strategies and directing appropriate resources to these strategies; 3) demonstrate transparent and responsible asset management processes that align with accepted best practice and federal standards; and 4) meet federal legislative requirements for asset management. The program establishes a governance group to coordinate activities and oversee the implementation of the policy and to ensure that the information about assets and risks is adequately reported and used as a basis for decision making and accountability at all relevant organizational levels.

## **4.4 Plan Integration**

After adoption of the Plan, the Core Administrative Team will work with the relevant BART departments to incorporate the elements of the Plan into capital improvement planning and budgeting mechanisms. Elements will be incorporated into various planning documents when those plans and policies are updated or when new ones are developed. Specifically, Core Administrative Team will integrate the Plan into the following activities:

- Incorporate the hazard and vulnerability analysis information in the emergency preparedness plan and procedures.
- Incorporate mitigation strategies into capital needs inventories.
- Incorporate hazard maps data into the District EGIS system.
- Incorporate mitigation strategies into department four-year strategic plan workplans.

## 5 Plan Review, Evaluation and Implementation

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### 5.1 Plan Update

This Plan is an update from the 2011 plan. The lead in updating this Plan was taken by the Core Administrative Team.

As required by the Disaster Mitigation Act of 2000, BART will update this plan at least once every five years. In this update, the followings sections have been revised to better reflect actions pertinent to the BART system

- The Planning Process section has been redefined to reflect the departure from participation in a multijurisdictional plan.
- The Hazard and Risk Assessment section has been updated to incorporate the new mapping compiled by ABAG for the region. Specific information on BART has also been updated to reflect additional engineering studies, institutional understanding of assets and progress of mitigation activities that have occurred in the past five years, including seismic retrofitting.
- The Asset Profile Section has been developed to provide more granular understanding of the District's assets and make more concrete the potential impacts from hazards.
- Mitigation Actions have been updated to reflect changes in priorities
- Existing Mitigation Program have been updated to reflect changes in development and progress in local mitigation efforts.

## 6 Plan Adoption

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The BART Board will adopt the Plan in a public meeting via an official Resolution upon pre-approval by FEMA.

## 7 Plan Point of Contact

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### Point of Contact

Name: Marla Blagg  
Title: Emergency Manager  
Mailing Address: P.O. Box 12688 (LKS-18),  
Oakland, CA 94604-2688  
Telephone: 510.464.7069  
Email: mblagg@bart.gov

### Alternate Point of Contact

Name: Tracy Johnson  
Title: Acting Group Manager Civil/Structural Engineering and Construction  
Mailing Address: P.O. Box 12688 (LKS-925)  
Oakland, CA 94604-2688  
Telephone: 510.464.6448  
Email: tjohnso@bart.gov

# Appendix A

## BART System Overview

# A1 BART System Overview

## A1.1 BART System

Approximately one-third of the BART System is underground, one-third is aerial and one-third is at grade. Service patterns are largely dictated by the topography of the region. Lines run along the east and west sides of the San Francisco Bay, under San Francisco Bay and then traverse the hills and valleys of inland areas.

The BART system radiates from the Oakland Wye, which is located under downtown Oakland. Lines running west from the Wye travel under San Francisco Bay, through downtown San Francisco and terminate at Daly City, Millbrae or the San Francisco International Airport. Other lines radiate out from the Oakland Wye and terminate in Richmond, Pittsburg/Bay Point, Dublin/Pleasanton or Fremont. A second wye is located on the San Francisco Peninsula between the San Bruno station, the Millbrae station and the San Francisco International Airport station. In addition to the two wyes, merges and diverges also occur at two other locations in Alameda County.

For an interactive version of the map below, see <http://www.bart.gov/stations/closest.aspx>.



Figure 12 BART System Map

## A1.2 BART Service

As of June 30, 2012, the District owned 669 rail cars. Trains are from three to ten cars in length and contain one control equipped vehicle (an A-car or C-car) at each end with mid-train vehicles (B-cars or C cars) making up the remainder of each train. Control-equipped C-cars can be used as lead, mid-train, or trail vehicles. All station platforms are constructed to accommodate trains of up to ten cars. Trains are operated from the lead A-car or C-car. Computers located along the right of way automatically control train movements. BART System train supervision is provided by the BART train control computer located at the BART Operations Control Center at the Lake Merritt station. Should the need arise, train operators aboard each train may override the automatic system. The District's 669 car operating fleet currently consists of 59 A-cars, 380 B-cars and 150 C-1 cars, and 80 C-2 cars.

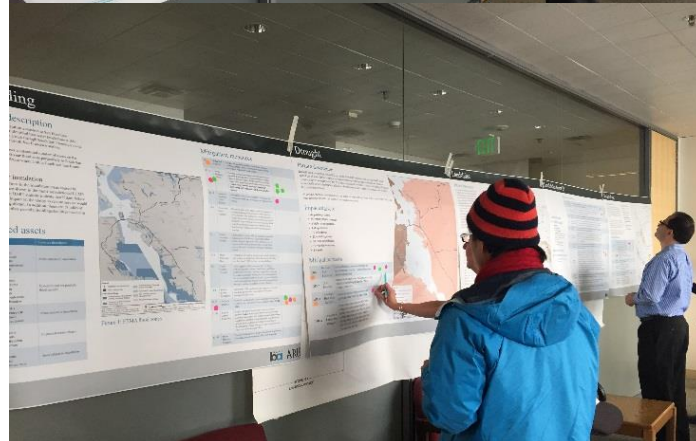
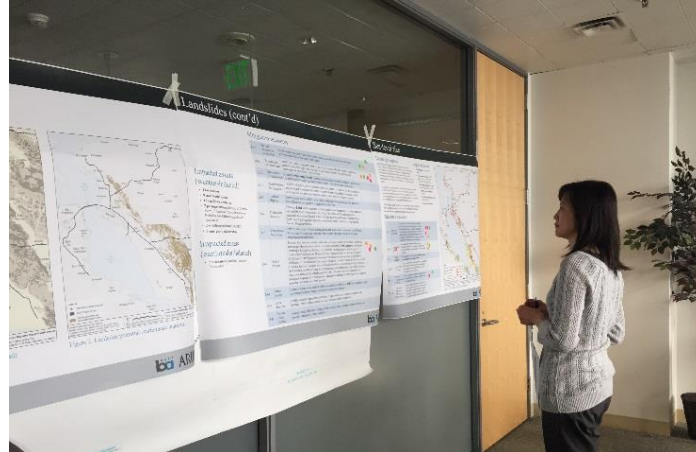
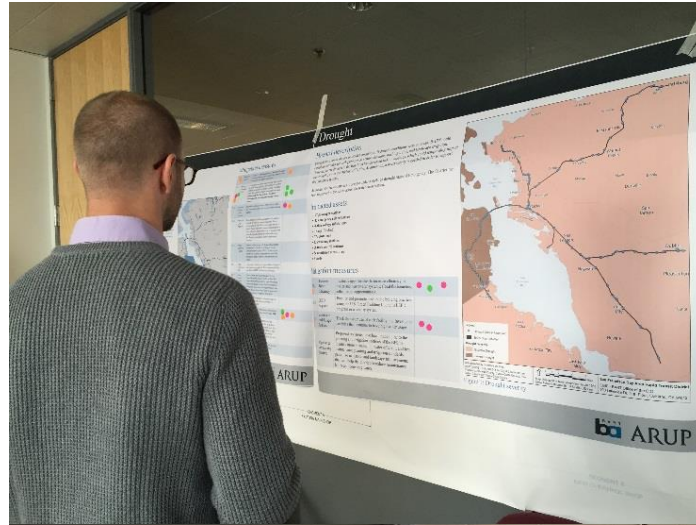
BART revenue hours run from 4:00 a.m. to midnight Monday through Friday, 6:00 a.m. to midnight on Saturdays, and 8:00 a.m. to midnight on Sundays. The last trains depart each end of the line around midnight, so passengers can get anywhere in the BART system if they arrive at any station by midnight. Depending upon demand, holiday rail service is provided on a full or modified weekday schedule, a Saturday schedule or a Sunday schedule.

# Appendix B

Engagement Documentation

## B1 Engagement Activities Photos

### B1.1 December 2 Emergency Preparedness Program Task Force Committee Meeting





## B1.2 Title IV Agendas and Sign-in Sheets

**NOTICE OF MEETING AND AGENDA  
OFFICE OF CIVIL RIGHTS  
TITLE VI/ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE**

August 10, 2015  
2:00 p.m. – 4:30 p.m.

A meeting of the Title VI/Environmental Justice Advisory Committee will be held on Monday, August 10, 2015, at 2:00 p.m. The meeting will be held in the Joseph P. Bort Metro Center - Conference Room 171, 101 Eighth Street, Oakland, California.

**AGENDA**

1. Overview of BART's Draft Hazard Mitigation Plan and Mitigation Strategies. For discussion and/or action.
2. Update on Current Performance of BART to Oakland International Airport; Overview of Proposed Service Changes. For discussion and/or action.
3. Update on Possible Changes to the BART Youth Fare Discount and Overview of Draft Title VI Analysis Findings for Proposed Youth Discount Options. For discussion.
4. General Discussion and Public Comment.
5. Next Committee Meeting Date.
6. Adjournment.

Please refrain from wearing scented products (perfume, cologne, after-shave, etc.) to this meeting, as there may be people in attendance susceptible to environmental illnesses.

BART provides services/accommodations upon request to persons with disabilities and individuals who are limited English proficient who wish to address BART Board matters. A request must be made five days in advance of a Board or committee meeting. Please contact the District Secretary's Office at (510) 464-6083 for information.

NOTES

Title VI / Environmental Justice

Advisory Committee

August 10, 2015

2:00 p.m. - 4:30pm

Sign-In Sheet

1. GEOFFREY JOHNSON - TRANSFORM - [GJOHNSON@TRANSFORMCA.ORG](mailto:GJOHNSON@TRANSFORMCA.ORG)
2. Lauren Small, The Unity Council
3. Robb Smith, Urban Strategies Council
4. Michelle Bouchard, BART
5. Dr. Henry Clark - WCPC
6. Aronk Elliott - Richmond Main Street

**NOTICE OF MEETING AND AGENDA  
OFFICE OF CIVIL RIGHTS TITLE VI/ENVIRONMENTAL JUSTICE ADVISORY  
COMMITTEE**

December 14, 2015  
2:00 p.m. – 4:30 p.m.

A meeting of the Title VI/Environmental Justice Advisory Committee will be held on Monday, December 14, 2015, at 2:00 p.m. The meeting will be held in the Joseph P. Bort Metro Center - Conference Room 171, 101 Eight Street, Oakland, California.

**AGENDA**

1. Preliminary Plans for Systemwide Multimodal Access Design Guidelines Project. For discussion.
2. Update on Preliminary Plans for Systemwide Station Access Policy. For information.
3. Overview of Proposed Mitigation Strategies for BART Local Hazard Mitigation Plan. For discussion.
4. General Discussion and Public Comment.
5. Next Committee Meeting Date.
6. Adjournment.

Please refrain from wearing scented products (perfume, cologne, after-shave, etc.) to this meeting, as there may be people in attendance susceptible to environmental illnesses.

BART provides services/accommodations upon request to persons with disabilities and individuals who are limited English proficient who wish to address BART Board matters. A request must be made five days in advance of a Board or committee meeting. Please contact the District Secretary's Office at (510) 464-6083 for information.



**BART Title VI/Environmental Justice Advisory Committee  
Monday, December 14, 2015**

Contact Name	Organization	Signature
Dr. Henry Clark	West County Toxics Coalition	
Samuel Kang	Urban Habitat	
Aisha Knowles	Alameda County Office of Education	
Lauren Small	Glide	
Joel Ramos	TransForm	
Madeline Stano	Center on Race, Poverty, and the Environment	
Robb Smith		
Aditya Potluri	Satellite Affordable Housing Associates	
Alvina Wong	Asian Pacific Environmental Network	
Amanda Elliott	Richmond Main Street Initiative	
Macha Harper	Girls Inc. of Alameda County	





## B1.3 Website Screenshot and News Announcement



The screenshot shows a web browser window displaying a news article on the BART website. The address bar shows the URL: <http://www.bart.gov/news/articles/2016/news20160208-1>. The page header features the BART logo and the text "Bay Area Rapid Transit". A navigation menu includes links for Stations, Schedules, Rider Guide, Tickets, News, About BART, and Contact Us. A search bar is located in the top right corner.

The main content area displays a news article dated 02.08.2016 with the title "Public comment for Local Hazard Mitigation Plan". A red notice above the article states: "This story is archived. Visit [bart.gov/news](http://bart.gov/news) for the latest BART news." The article text reads: "Public Comment for the Local Hazard Mitigation Plan Update. The District is pleased to announce the opportunity for public comment on the Local Hazard Mitigation Plan (LHMP) Update. The public comment period will be open February 8, 2016 through February 26, 2016. This LHMP identifies the hazards that potentially impact BART, assesses the vulnerability to the hazards and identifies specific actions that can be taken to reduce the risk from the hazards. The Federal Disaster Mitigation Act of 2000 (DMA 2000) outlines a process which cities, counties, and special districts can follow to develop a LHMP. An electronic draft of the LHMP can be found on the [LHMP homepage](#)." A sidebar on the left contains navigation links for News Articles, Media Resources, BART TV, BARTable, Email Alerts, and Feeds. On the right, there are two promotional banners: one for "bartable" with the tagline "deals. events. fun" and another titled "IT'S TIME TO REBUILD" with the text "Learn about the plan to reinvest in BART's aging system." The footer includes the text "BARTable / BART TV / Mobile Site", "Contact / Pri", and "© 2016 San Francisco Bay Area Rapid Transit District". Language options for Japanese, Chinese, German, French, Italian, Korean, and Spanish are also listed.

# Appendix C

## Mitigation Strategies

### Mitigation Strategies

Rank	Mitigation No.	Mitigation Name	Mitigation Description	Relevant Capital Needs Inventory Project IDs	Time Frame (Years)	Potential Funding Sources	Hazards Addressed*	Responsible Departments
High	1	Emergency Operations Center	Establish a back-up Emergency Operations Center with redundant communications systems.		1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Police, Operations, Planning Development & Construction
High	2	Portable Emergency Equipment	Purchase portable equipment including hoses, pumps, emergency generators, radios to allow for continuity and recovery of service in locations and/or assets prone to failure.	SY0030, PM0349	1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, EH	Operations
High	3	Erosion Control	Upgrade and repair facility foundations, embankments, and drainage to mitigate erosion issues. Work that may be included are excavation, fill placement, cut-fill transitions, slope stability, drainage and erosion control, slope setbacks, expansive soils, collapsible soils, environmental issues, geological and geotechnical investigations, grading plans and specifications, protection of adjacent properties, and review and permit issuance.	WF0334, WF0335, WF0126	1-5	Operating, Grants, Capital	LS	Operations, Planning Development & Construction
High	4	Safe Evacuations	Improve evacuation and evacuation communications. Improvements include upgrades for water sensors, emergency lighting, cable protection, cameras, signage, and replacement of cross passage doors and hatch doors.	WF0305, PM0252, WF0048, WF0182	1-5	Operating, Grants, Capital	EQ, FL	Operations



### Mitigation Strategies

Rank	Mitigation No.	Mitigation Name	Mitigation Description	Relevant Capital Needs Inventory Project IDs	Time Frame (Years)	Potential Funding Sources	Hazards Addressed*	Responsible Departments
High	5	Storm Drainage System	Repair or replace dilapidated roofs, storm drains, pipelines, sump pumps, and channels to enable them to perform to their design capacity in handling water flows as part of regular maintenance activities.	WF0219, WF0123, WF0267, PM0173, WF0039, WF0298, WF0345, WF0147, WF0123A, PM0024	1-10	Operating, Grants, Capital	FL, SLR	Operations
High	6	Sandbags and Sheeting	Purchase sandbags and plastic sheeting in anticipation of rainstorms, and deliver those materials to key BART sites.		1-5	Operating, Grants, Capital	FL	Operations
High	7	Water Distribution System	Repair or replace water distribution systems on BART facilities including sewer and water lines and valves that are not in a state of good repair.	WF0339, PM0348, WF0156	1-10	Operating, Grants, Capital	F, DR	Operations
High	8	Investigate High Usage Facilities	Track the water use of each facility and Investigate and address facilities that have high water usage.		Ongoing	Operating, Grants, Capital	DR	Sustainability
High	9	Flood Safe Facilities (Water Intrusion)	Repair cracks and leaks resulting in water intrusion via sealing and other water proofing techniques. Replace corroded equipment/components resulting from water intrusion impacts.	WF0039, WF0298, WF0147, PM0024, WF0216, WF0215, WF0217	1-10	Operating, Grants, Capital	TS, FL, SLR	Operations, Planning Development & Construction

### Mitigation Strategies

Rank	Mitigation No.	Mitigation Name	Mitigation Description	Relevant Capital Needs Inventory Project IDs	Time Frame (Years)	Potential Funding Sources	Hazards Addressed*	Responsible Departments
Medium	10	Power Resilience	Minimize the likelihood that power interruptions will adversely impact lifeline utility systems or critical facilities by ensuring that there is redundancy and reliability in power systems. Improvements include procuring uninterruptible power supply (UPS), replacing train control batteries, upgrading emergency lighting systems including dedicated circuits, upgrading and installing new transformers, replacing old power distribution networks including cabling and switching equipment, and upgrading installing new emergency generators.	PM0278, PM0064, PM0065, PM0335, PM0079, PM0260, PM0081, PM0310, PM0048A, PM0205, PM0211, PM0212, PM0336, PM0073, PM0086, PM0256, PM0054, PM0323, PM0067, SY0003, PM0313, PM0076	1-10	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Operations, Planning Development & Construction
Medium	11	Retrofit Cooling Equipment	Retrofit or replace emergency cooling equipment for computer room.	PM0138	1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Operations

### Mitigation Strategies

Rank	Mitigation No.	Mitigation Name	Mitigation Description	Relevant Capital Needs Inventory Project IDs	Time Frame (Years)	Potential Funding Sources	Hazards Addressed*	Responsible Departments
Medium	12	Fire Suppression and Alarm Systems	Upgrade facilities to ensure a reliable system fire suppression for existing and new development. Work includes replacing/upgrading old fire alarm systems, water piping, control wiring, adequate wet stand pipes, fire hose cabinet, and chemical fire suppression systems.	PM0057, PM0255, PM0281, PM0130, PM0326, PM0072, PM0259, PM0339, PM0107, PM0166, PM0190	1-10	Operating, Grants, Capital	F	Operations
Medium	13	Best Available Science	Conduct study to further understand adaptation needs. Stay informed of scientific information compiled by regional and state sources on the subject of rising sea levels and global warming, especially on actions that local governments can take to mitigate this hazard including special design and engineering of facilities in low-lying areas.	WF0262	1-5	Operating, Grants, Capital	FL, SLR	Planning Development & Construction, Operations
Medium	14	Improve Water Systems	Improve water efficiency, upgrading to low flow water fixtures, water recycling, and other water conservation techniques.		1-5	Operating, Grants, Capital	DR	Sustainability, Operations
Medium	15	Public Communication	Improve communication systems to the public including personal planning when there are system disruptions due to natural disasters.		1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	External Affairs, Operations, Planning Development & Construction
Medium	16	Construct Resilient Systems	Ensure that systems in BART developments are constructed in ways that reduce or eliminate water damage. Mitigation includes replacing and installing new canopies to protect system from rain weather.	PM0266	1-5	Operating, Grants, Capital	FL, SLR	Operations, Planning Development & Construction

### Mitigation Strategies

Rank	Mitigation No.	Mitigation Name	Mitigation Description	Relevant Capital Needs Inventory Project IDs	Time Frame (Years)	Potential Funding Sources	Hazards Addressed*	Responsible Departments
Medium	17	Low Impact Development	For new development or redevelopments, incorporate low impact development (LIDs) to mitigate storm water runoff and peak flows in the watershed.		Ongoing	Operating, Grants, Capital	FL, SLR	Operations, Planning Development & Construction
Medium	18	Promote Low-Carbon Travel	In addition to promoting riding BART, promote active modes of transportation to BART such as biking and walking to further reduce the region's carbon footprint. Work includes improvements in bike facilities and pedestrian pathways, and transit oriented developments.		Ongoing	Operating, Grants, Capital	FL, SLR	Customer Access, Planning Development & Construction
Low	19	Asset Management Integration	Include climate risk information into Asset Management		1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Office of District Architect, Asset Management
Low	20	Conduct Structural Fragility Inventory	Conduct inventory and model structural fragilities for the BART system	WF0347	1-10	Operating, Grants, Capital	EQ	Operations
Low	21	Seismic Retrofit Work	Continue ongoing seismic infrastructure retrofit of the BART system. Including incorporation of seismic design criteria in the BART's Facilities Standards and design of a bypass for the Berkeley Hills Tunnel.	WF0341, WF0165	1-10	Operating, Grants, Capital	EQ	Planning Development & Construction
Low	22	Fire Hazard Removal	Conduct clean up of debris from district property that pose a fire hazard.	WF0210	1-5	Operating, Grants, Capital	F	Operations
Low	23	Elevate/Protect Critical Facilities	Elevate/protect critical assets in FEMA flood plain areas to lower the risk of service disruption.		1-10	Operating, Grants, Capital	FL	Operations, Planning Development & Construction

### Mitigation Strategies

Rank	Mitigation No.	Mitigation Name	Mitigation Description	Relevant Capital Needs Inventory Project IDs	Time Frame (Years)	Potential Funding Sources	Hazards Addressed*	Responsible Departments
Low	24	BART Emergency Plan Update	Integrate climate change considerations into BART's Emergency Plan		1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Police
Low	25	Emergency Response Training	Improve emergency response training for employees.		1-5	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Police, System Safety
Low	26	Watershed Analysis	Conduct (or partner with the local watershed jurisdiction to conduct) a watershed analysis of runoff and drainage systems to predict areas of insufficient capacity in the storm drain and natural creek system.		1-5	Operating, Grants, Capital	FL	Operations, Planning Development & Construction
Low	27	Engage in Regional Planning for Flooding and Sea Level Rise	Support and engage in county and/or other regionally-led planning efforts in mitigation of flooding from sea level rise and other weather related issues.		Ongoing	Operating, Grants, Capital	TS, FL, SLR	Planning Development & Construction
Low	28	Irrigation and Landscape Improvements	Upgrade irrigation and landscaping for water efficiency that reduces maintenance needs and conserve water.		1-10	Operating, Grants, Capital	DR	Operations, Planning Development & Construction
Low	29	Climate Risk of Projects	Incorporate best available climate risk in design criteria and projects		Ongoing	Operating, Grants, Capital	EQ, LI, TS, LS, FL, SLR, F, DR, EH	Operations, Planning Development & Construction

\* EQ - Earthquake, LI - Liquefaction, TS - Tsunami, LS - Landslide, FL-Flood, SLR - Sea Level Rise, F - Fire, DR - Drought, EH - Extreme Heat

# Appendix D

## Adoption Resolution